San Joaquin Valley Drainage Authority

San Joaquin River
Up-Stream DO TMDL Project
ERP - 02D - P63

Task 4: Monitoring Study

Final Task Report
May, 2008

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List of Acronyms

Acronyms/Abbreviations	Description
Ag	Agriculture
Algal pigments	Chlorophyll-a and pheophytin
BOD	Biochemical oxygen demand
CBOD	Carbonaceous biochemical oxygen demand
CDEC	California Data Exchange Center
CEQA	California Environmental Quality Act
Chl-a	Chlorophyll-a
Chl-b	Chlorophyll-b
Chl-c	Chlorophyll-c
Chl-a by SM	Chlorophyll-a by spectrophotometric method
Chl-a by TC	Chlorophyll-a measured by the trichromatic method
CV	Coefficient of variation (%)
CVRWQCB	Central Valley Regional Water Quality Control Board
CWI	California Water Institute
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DOM	Dissolved organic matter
DWR	California Department of Water Resources
DWSC	Deep water ship channel
EC	Specific conductance
EERP	Environmental Engineering Research Program
GPS	Global Positioning System
ID	Irrigation District
IEP	Interagency Ecological Program
Max	maximum value
Mean	Mean value or average
mg/L	Milligrams per liter
Min	Minimum value

Acronyms/Abbreviations	Description
MSS	Mineral suspended solids
n	Number of values used in analysis
NBOD	Nitrogenous BOD
NEPA	National Environmental Policy Act
NH4-N	Ammonia nitrogen
NO3-N	Nitrate nitrogen
NPDES	National Pollutant Discharge Elimination System
NRM	Normalized rank mean
NTU	Nephelometric turbidity units
ODS	Oxygen-depleting substance
oPO4-P	soluble reactive ortho-phosphate phosphorous
PI	Principal Investigator
POM	Particulate organic carbon
ppb	Parts per billion
PRR	Peer Review Recommendation
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RWQCB	Regional Water Quality Control Board
Regional Board	Central Valley Regional Water Quality Control Board
SCADA	Supervisory Control and Data Acquisition
SCUFA	Self-Contained Underwater Fluorescence Apparatus
SJR	San Joaquin River
SJRGA	San Joaquin River Group Authority
SJVDA	San Joaquin Valley Drainage Authority
SM	Standard Method
Sonde Chl-a	Chlorophyll-a measured by sonde, calibrated to laboratory measurements of Chl-a
Spec Cond	Specific conductance
SR	Stakeholder Recommendation
Std Dev	Standard deviation

Acronyms/Abbreviations	Description
SD	Standard deviation
TAC	Technical Advisory Committee
TC	Trichromatic method for measuring Chl-a, Chl-b, and Chl-c
T-Alk	Total alkalinity (pH 4.5)
TMDL	Total maximum daily load
TOC	Total organic carbon
Total-P	Total phosphorous
Tol P	Total phosphorous
TP	Total phosphorous
TSS	Total suspended solids
TWG	Technical working group
UCB	University of California, Berkeley
UCD	University of California, Davis
ug/L	micrograms per liter
μg/L	micrograms per liter
UOP	University of the Pacific
USGS	U.S. Geological Survey
VSS	Volatile suspended solids
WWTP	Wastewater treatment plant

Introduction

The purpose of the Upstream Dissolved Oxygen Total Maximum Daily Load Project (DO TMDL Project) is to provide a comprehensive understanding of the sources and fate of oxygen-consuming materials in the San Joaquin River (SJR) watershed between Channel Point and Lander Avenue (upstream SJR). This study has collected sufficient scientific information to provide the stakeholders an understanding of the baseline conditions in the watershed, provide a scientific foundation for a TMDL allocation decision, provide a scientific basis for a management response to the DO TMDL allocation, and provide the stakeholders with a tools for measuring the impact of any water quality management program that may be implemented as part of the DO TMDL process.

Previous studies have identified algal biomass as the most significant oxygen-demanding substance in the DO TMDL Project study-area between of Channel Point and Lander Ave on the SJR (Lehman et al., 2004; Volkmar and Dahlgren, 2006). Other oxygen-demanding substances found in the upstream SJR include ammonia and organic carbon from sources other than algae. The DO TMDL Project study-area contains municipalities, dairies, wetlands, cattle ranching, irrigated agriculture, and industries that could potentially contribute biochemical oxygen demand (BOD) to the SJR. This study is designed to discriminate between algal BOD and other sources of BOD throughout the entire upstream SJR watershed. Algal biomass is not a conserved substance, but grows and decays in the SJR; hence, characterization of oxygen-demanding substances in the SJR is inherently complicated and requires an integrated effort of extensive monitoring, scientific study, and modeling.

In order to achieve project objectives, project activities were divided into a number of Tasks with specific goals and objectives. Monitoring and related research was conducted under Task 4 of the DO TMDL Project. The specific objectives of Task 4 include collection of flow data from existing monitoring stations; collection of discrete water quality data; the installation and operation of continuous chlorophyll and turbidity, DO and pH monitoring on the SJR and major tributaries; and compiling and distributing collected data to the other scientists, engineers, and modelers on the project.

The major objective of Task 4 was to collect sufficient hydrologic (flow) and water quality data to characterize the loading of algae, other oxygen-demanding materials, and nutrients from individual tributaries and sub-watersheds of the upstream SJR between Mossdale and Lander Avenue. This Task was specifically being executed to provide data for the Task 6 Modeling effort. Task 4 provided input and calibration data for flow and water quality modeling associated with the low DO problems in the SJR watershed, including modeling of the linkage among nutrients, algae, and low DO. Task 4 has provided a higher volume of high quality and coherent data to the modeling team and stakeholders than was available in the past for the upstream SJR. The monitoring and research activities under Task 4 are integrated with the Modeling effort (Task 6) and are not designed to be a stand alone program. Although, the majority of analysis of the Task 4 data is occurring as part of the Task 6 Modeling program, analysis of Task 4 data independently of the modeling effort is also a component of the DO TMDL Project effort.

In this Task 4 Final Report, we present the results of monitoring and research conducted under Task 4. The primary purpose of this report is to document all activities conducted under Task 4 and to specifically document how data was collected and what data was collected. Some analysis of the data is presented here, to assist stakeholders, including the Regional Board, in understanding the scope and utility of the information collected as part of Task 4. Emphasis is placed on defining the strengths and weaknesses of the data, particularly as it relates to the development of a management response to the DO TMDL ambient water quality criteria. How the Task 4 data can be used to assist stakeholders in setting remediation priorities is discussed. Use of the Task 4 data for model calibration and verification is discussed in the Task 6 Final Report.

Due to the extensive scope of the Task 4 portion of the DO TMDL Project, the Task 4 Final Report is written as a short report referring to a series of appendixes. The appendixes are written as reports designed to be able to stand independently of each other. Each appendix documents specific activities conducted under Task 4, presents organized data sets, or presents an analysis on a particular subject. This Task 4 Final Task Report and associated electronic files represent the final deliverable for Task 4.

Methods

The DO TMDL Project Study Area is shown in Figure 1. Surface water samples were collected throughout the SJR study area (Table 1, Figures 1 and 2). Laboratory and field water quality parameters measured in the Upstream DO TMDL Project are listed on Tables 2 and 3. **Appendix A** describes the methods used for data collection and analysis and includes the results of the Task 4 quality assurance program. **Appendix B** describes and documents field research activities undertaken by EERP. **Appendix C** describes the stations that were installed as part of the DO TMDL Project (Task 5). These stations were maintained and repaired by EERP as part of Task 4 (Table 4). **Appendix D** describes the rating data used to calculate flow measurements and documents the quality assurance measurements made at the flow monitoring stations maintained by the EERP. Chlorophyll measurements are a very important component of the DO TMDL Project and **Appendix E** discusses and explains the calibration of field chlorophyll fluorescence measurements.

The Task 4 data have been provided to the State contracting agency (GCAP) in electronic form. Electronic data is provided as a final Task 4 deliverable as **Appendix T, U, and V** of this report. Electronic data is available to other cooperators as a data down-load from a FTP-site or will be provided on CD if requested. Additionally, the data has been provided to the Interagency Ecological Program (IEP) and is entered in their database for dissemination to cooperators and the public. The IEP is a cooperator on the DO TMDL Project under Task 11.

Results

Permanent continuous flow, temperature, and specific conductivity (EC) monitoring stations were installed at key locations in the SJR watershed (**Appendix C**) and maintained by the EERP for the duration of the project (Table 4). Additional flow and EC data were collected and compiled from existing stations operated by state and federal agencies and local water districts. A statistical summary of flow data collected as part of this project can be found in **Appendix F**. Appendix F also includes a temporal analysis of flow by year for each location where flow data was available.

An analysis of annual trends in flow data is presented in **Appendix G**. The trend analysis in Appendix G only uses final data from USGS gaging stations, which is considered high quality data. This analysis shows a consistent decline in dry season agricultural return flows from both westside and eastside drains. This demonstrates the efficacy of water efficiency best management practices being implemented throughout the valley, but also has long-term implications for the management of the SJR, which above the Merced River consists predominantly of agricultural and wetland return flows.

One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed. Water quality was assessed at 97 locations in the SJR basin (Table 1). Sampling locations included a majority of locations from a list of 120 potential monitoring sites developed by the TAC in 2002. Stations were selected based on their importance to the establishment of a sustainable monitoring program; sites useful for conducting a mass balance on algal, BOD and nutrients in the upstream SJR; sites included in other monitoring and research programs; sites included as part of watershed surveys and sites of importance and relevance to water quality modeling.

Twenty sites were designated “core” sites these sites were sampled approximately every two weeks during the irrigation season (March through October) and monthly during the winter season (November through February). These sites represent the main stem of the SJR, the major tributaries, and most primary and some secondary locations on drainages from both the east- and west-sides of the SJR. [Primary (1^{o}) locations are sites the water passing the site enters the SJR without passing another sampling location, drainage at secondary (2^{o}) sites pass 1^{o} sites before entering the SJR, etc.] Figure 1 shows the location of the core sites.

Sampling at other sites was less frequent and was conducted with the objective of building data to allow comparison between different drainage areas or to conduct studies in specific drainages. The locations of these intermittent sites are shown in Figure 2. A summary of the collected water quality data by location is presented in **Appendix H**. A temporal analysis of water quality data is presented by parameter in **Appendix I**. A description and discussion of ion and nutrient analytical results are presented in **Appendix Q and R**.

A statistical comparison between drainages is useful for optimizing the long-term monitoring plan and for resolving outstanding issues concerning the validity of modeling smaller tributaries based on water quality results from larger tributaries, which is the current practice. A statistical comparison of water quality between drainages on the westside of the SJR are presented in **Appendix J**. A similar analysis for eastside agricultural drains and eastside rivers is presented in **Appendix K and L**, respectively. These analyzes can be used to compare individual water quality constituents between drainages or sampling locations. In **Appendix M**, statistical methods useful for comparing multiple water quality constituents simultaneously are discussed (Stringfellow, 2008). In the results section, discriminant function analysis is used to evaluate multiple parameters simultaneously for the purpose of selecting of sampling locations for future studies.

Continuous chlorophyll, pH, EC, and turbidity were measured during summer months at key locations in the SJR drainage. Continuous monitoring data from this study are compiled and presented in **Appendix N**. This data is being used in the SJR-WARMF model and is not analyzed independently in this report.

Several studies have been conducted on the San Luis Drain as part of this project. During July 2007, an experiment was conducted where the flow from the San Luis Drain was stopped and the effect on phytoplankton growth in the SJR was measured. The experimental procedure and result from continuous monitoring during this period are presented in **Appendix O**. Analysis of this experiment is included in Task 6. The San Luis Drain is a major source of algae biomass to the SJR. A complete analysis of phytoplankton growth in the San Luis Drain is presented in **Appendix P**.

Data collected between 2005 and 2007 has been compiled, quality checked, and delivered to the Upstream SJR DO TMDL Project modeling group, the Environmental Restoration Program (ERP) project managers, and have been posted on the Interagency Ecological Program (IEP) public database. A complete record of flow and water quality data collected by this study are provided in Microsoft Excel™ format as **Appendixes T, U, and V**.

Discussion

The data collected in Task 4 will be used by the RWQCB and other stakeholders to develop a management strategy to meet the DO TMDL ambient water quality criteria. The National Research Council recommends that the uncertainty surrounding environmental measurements be recognized in TMDL implementations (National Research Council, 2001). Water quality data was collected by a single group (EERP) under uniform procedures and under strict QA/QC protocols and is considered of high precision and accuracy (**Appendix A**). The greatest variance is associated with sample collection, which can be large even at well mixed sites (e.g. field duplicate samples may not agree). Some sampling locations did not allow access to collect samples that are representative of the whole flow, these locations were to every extent possible excluded from the program.

Flow data was collected using a variety of procedures and differing QA/QC regimens, therefore the accuracy and precision of the flow data varies widely. Flow data is collected by many different agencies and collection methods differ by location. Other factors that differ between flow data collection regimes include, but are not limited to: frequency of data collection, method of data collection, reporting units, lower detection limits, upper detection limits (particularly as it relates to standing water under flood conditions), quality of calibration, frequency of calibration, and standards for record-keeping. In some cases the precision and accuracy of the flow data can be determined (e.g. **Appendix D**), but in many cases flow data is of unknown quality. For example, flow data is typically posted on-line without calibration data, QA data, or maintenance documentation. Another example is diversion data supplied by cooperating stakeholders, which in some cases consists of a single number for total acre-feet by month with no supporting QA/QC information. In the electronic data deliverable for Flow (**Appendix V**) each excel file has a worksheet which reports the source of the data and what, if anything, is known about the calibration of the flow data. The variability in the precision and accuracy of flow data should be recognized when calculating loads and other analysis under the DO TMDL implementation.

The data collected as part of Task 4 can be used to evaluate drainages as individual systems or as groups of similar drainages. In many cases, both water quality and flow data from the drainages investigated as part of this study were not normally distributed (non-normal), even after transformation. Non-parametric methods (used for analysis of non-normal data) were found to be useful for the comparison of water quality between individual drainages (**Appendix J - M**). Calculation of normalized rank means (NRMs) can be used calculate water quality indexes to guide remediation activities, including TMDL implementation (Stringfellow, 2008). Average values or standardized average values can also be used for ranking or comparing water quality between drainages (Alberto et al., 2001; Guo et al., 2004; Singh et al., 2006; Sinha and Shah, 2003) however, any assumptions concerning a normal distribution of the data should be verified.

Calculating accurate analyte loads in the SJR watershed will present a number of analytical challenges. Although the SJR-WARM model is expected to be the primary tool for TMDL management (see Task 6 Final Report), direct measurements will be important for characterizing drainages and setting remediation priorities, especially for smaller drainages not included (individually) in the SJR-WARMF model. In addition to the uncertainty surrounding flow measurements discussed above, the relative importance of the wet and dry seasons should be considered. There is a significant temporal variance in water quality for many parameters and many locations (**Appendix I**). Flows vary greatly between days, within days, yearly, and seasonally (**Appendix G**). The outcome of a loading analysis will be influenced by such factors as the inclusion or exclusion of periods of zero loading (no flow) from agricultural and wetland drains. Comparison between drainages should also consider statistical such factors as the frequency of sample collection (Lehmann, 2006; Shabman and Smith, 2003; Zar, 1999).

Loading in the San Joaquin Basin is dominated by drainage from the eastside rivers. For example, Table 5 presents the simple loading estimates for selected nutrients and BOD, incorporating both wet and dry season data collected between 2005 and 2007. Eastside rivers typically have low concentrations of water quality constituents of concern and relatively high flow rates (**Appendix F and H**). Focusing management efforts on high-flow, low-concentration systems is impractical from both an economic and engineering perspective, therefore assignment of priorities based simply on loading analysis seems unlikely to produce the outcome of water quality improvement and alternative analytical approaches are needed.

Iterative methods and adaptive approaches are recommended for TMDL implementation (National Research Council, 2001). It is also important that the process for identifying implementation priorities be science based and perceived as fair by the stakeholder community. Given the precision and accuracy of the water quality measurements and the uncertainty surrounding flow measurements, iterative methods where flow and water quality data are analyzed independently and then combined may be more useful than traditional loading analysis where flow and water quality data are combined before analysis. The use of flow and water quality matrixes as an alternative methods to loading calculations for setting

TMDL management priorities appears promising and is described in **Appendix S**. Using matrix and other iterative methods allows influences such as seasonality, parameter variance, and sample size to be explored with less likelihood of compounding errors or having to discard data (e.g. where flow and water quality data are not matched).

The DO TMDL Project involved the collection of water quality data from almost 100 locations in the SJR watershed (Table 1). It is not practical to continue monitoring every location and one objective of Task 4 is to select locations for continued water quality monitoring. A list of priority sites for continued monitoring is presented in Table 6. All mainstem SJR sites between Crows and Mossdale were included in this list, but little information would be lost if sampling at Maze Boulevard was eliminated. The SJR Maze location (DO-6) and the SJR Vernalis site (DO-5) are approximately five river miles apart and the SJR-WARMF model appears accurate at estimating chlorophyll at Maze. The eastside rivers (Stanislaus, Tuolumne, and Merced) are all included on the list, but differences in water quality between the sites (**Appendix L**) is not large in comparison to differences between agricultural drains (**Appendix J and K**).

Selection of other drainages to include in Table 6 is more challenging. Previously, water quality had been (in majority) sampled at Orestimba Creek (DO-21) on the westside and Harding Drain (DO-29) on the eastside and water quality at those sites was used in models as representative of water quality in the smaller westside and eastside tributaries. This was of particular concern to eastside water and agricultural interests, who insisted that water quality in the Harding Drain was more strongly influenced by municipal wastewater that previously recognized. A major objective of Task 4 was to collect sufficient data to compare water quality between a broad number of eastside and westside drainages and determine which drains could be used to accurately represent water quality in areas influenced by agricultural and other activities.

Based on geography and land-use information collected during the course of the Upstream DO TMDL study, drainage water quality sampling locations were assigned to five categories: eastside-agricultural, westside-agricultural, wetland, agriculture-wetland-mixed, or agricultural-urban-mixed. Harding Drain (DO-29) was the only drainage assigned to the agricultural-urban-mixed category. Discriminant function analysis was used to compare multiple water quality parameters simultaneously. Various parameters for differentiation were investigated and five parameters (EC, DOC, MSS, nitrate-N, and o-phosphate concentrations) were found to be particularly useful for differentiating watersheds. Only the analysis using these parameters is included in this report. Figure 3 shows that drainage categories can be discriminated and that the agricultural-urban-mixed category (Harding Drain) is well separated from the other categories, indicating that water quality in Harding Drain is unique in comparison to other sources. Agriculture-eastside was not a coherent group and several eastside sites fell well within the agriculture-westside grouping using these parameters, which suggests that these categories are more similar to each other than to wetlands or mixed drainages.

In order to select representative drainages for continued monitoring, each eastside and westside drainages were also investigated independently. Using the same parameters (EC, DOC, MSS, nitrate-N, and o-phosphate concentrations), eastside drainage sites were differentiated into three groups, one of which represents only Harding Drain (Figure 4). This analysis confirms the analysis shown in Figure 3 that demonstrated water quality in Harding drain is not representative of other eastside drains. Representatives of each group (Sites 23, 25, 28, 29, and 30) were selected for inclusion in the recommended list for continued monitoring as part of the DO TMDL implementation program (Table 6).

Westside drains were differentiated into six groups, three of which represent single drains (Figure 5). The three groupings with multiple members in Figure 5 mostly correspond to the agricultural, wetland and agriculture-wetland-mixed categories shown in Figure 3, confirming the validity of their assignments to these categories based on land-use information collected independently. Sites number 18, 19, 20, 21, 31, 34, 36, 44, and 57 are suggested for continued monitoring, based on their grouping in discriminate analysis and their importance to the continued model calibration.

In summary, the objectives of Task 4 have been met. Flow data has been collected from existing monitoring stations; discrete water quality data has been collected and analyzed from year round sites and other sites; the installation and operation of continuous chlorophyll and turbidity, DO and pH monitoring has been completed; discrete and continuous data have been compiled, quality checked and distributed to the scientists, engineers, and modelers on the project. A scientific and engineering analysis of the data is provided in the appendix and in the Task 6 report. This report includes a recommendation of what monitoring stations and parameters should be considered for continued sampling under a DO TMDL implementation plan.

Acknowledgements

The DO TMDL Project was developed under the auspices of CALFED Bay-Delta Program and the guidance of the DO TMDL Steering Committee and the DO TMDL Technical Advisory Committee. The Steering Committee and the TAC are voluntary organizations and we thank the participants for their guidance. The TAC was subsequently replaced by the DO TMDL Technical Working Group. The TWG, also a voluntary organization, played a key role in the execution of the project adaptive management plan and the participation of the TWG is greatly appreciated. The project was originally funded by the California Bay Delta Authority (CBDA) in a contract with the San Joaquin Valley Drainage Authority (SJVDA). The SJVDA volunteered to serve as lead contracting organization an made the Upstream DO TMDL Project possible. In 2006, the project was moved from CBDA to the Department of Fish and Game (DFG). The project is administered by GCAP Services, Inc., which accepts deliverables on behalf of the State. SJVDA has subcontracted to the Environmental Engineering Research Program (EERP) at the University of the Pacific to be the lead scientific agency for the DO TMDL Project. Lawrence Berkeley National Laboratory (LBNL), University of California Davis (UCD), the San Joaquin River Group Authority (SJRGA) and SJVDA are cooperating participants on Task 4. The cooperation of regional landowners, water districts, and drainage districts was a key component of this project. We would particularly like to thank Chris Linneman, Mike Neimi, and Keith Larson for their technical support on Task 4.

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Figure 1: Upstream DO TMDL Project study area with the location of the water quality sampling stations included in the core sampling program shown.

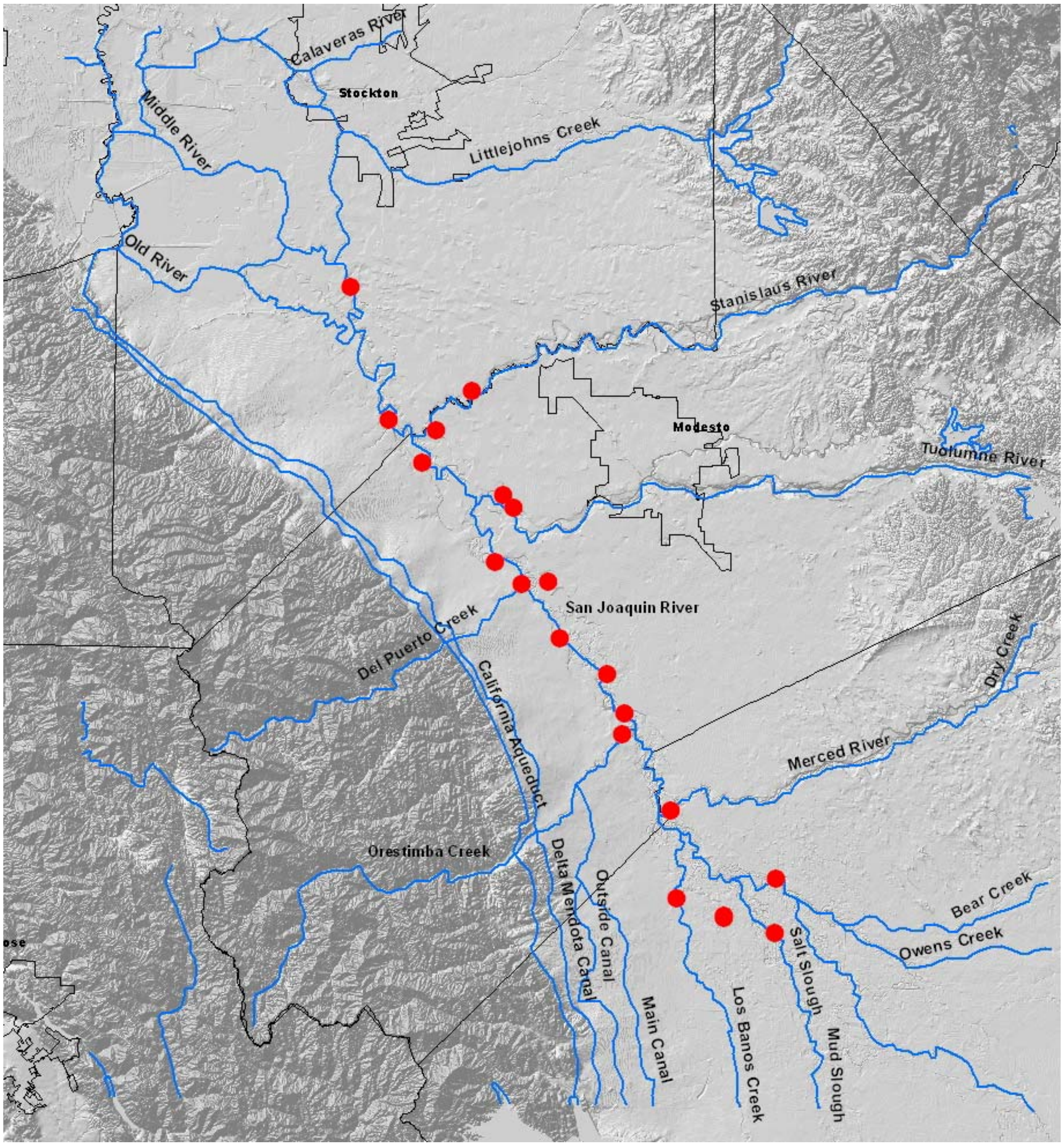

Figure 2: Location of the water quality sampling stations included in the Task 4 intermittent sampling program.

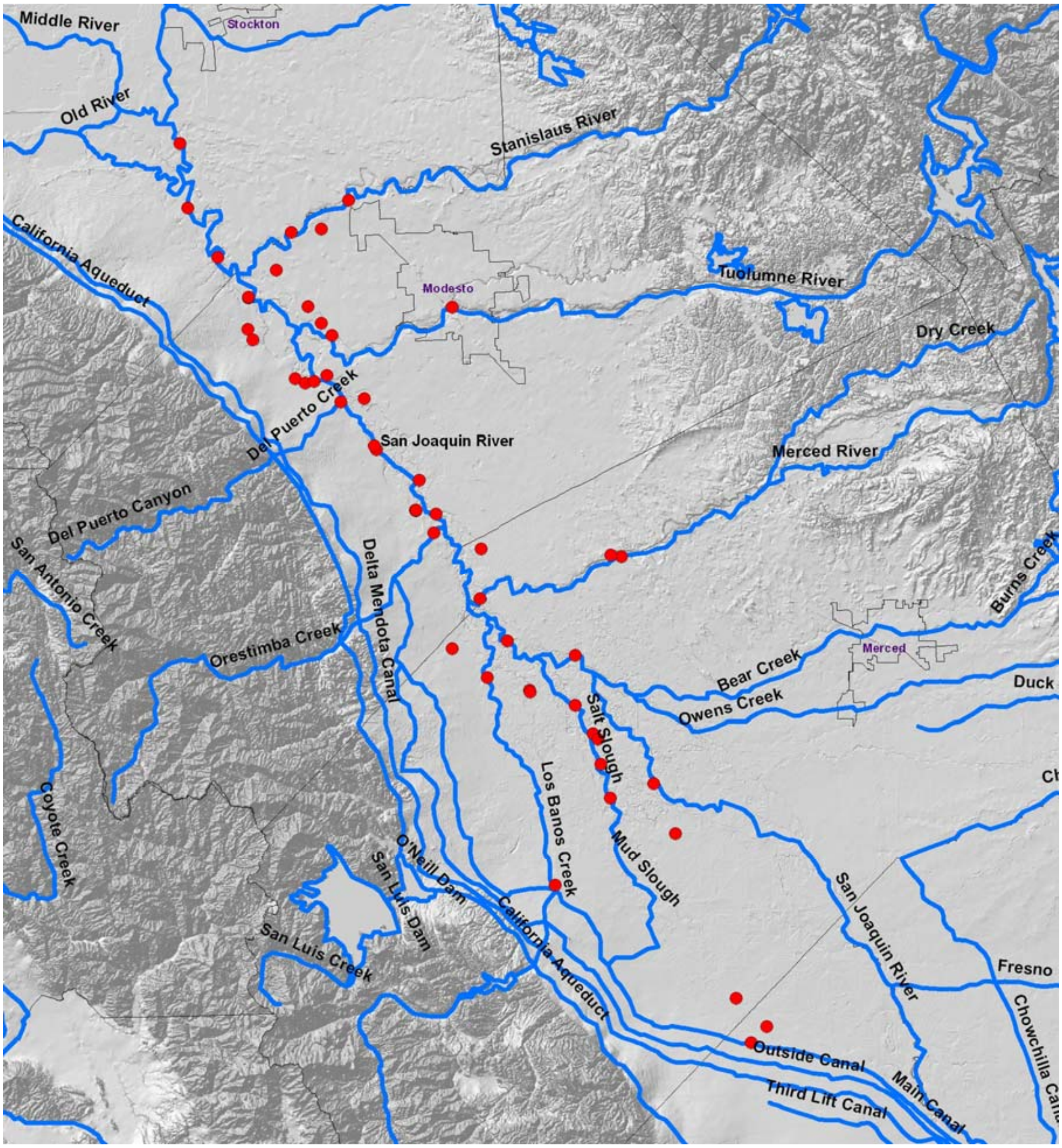

Figure 3. Discrimination of drainages by category using the water quality parameters specific conductance, dissolved organic carbon, mineral suspended solids, soluble phosphate, and nitrate. Significant water quality differences occur between different drainage categories. In this analysis, differentiation between eastside and westside agriculture is not shown (see text for discussion). Circles represent one standard deviation for each category as labeled, dots represent means of individual drainages.

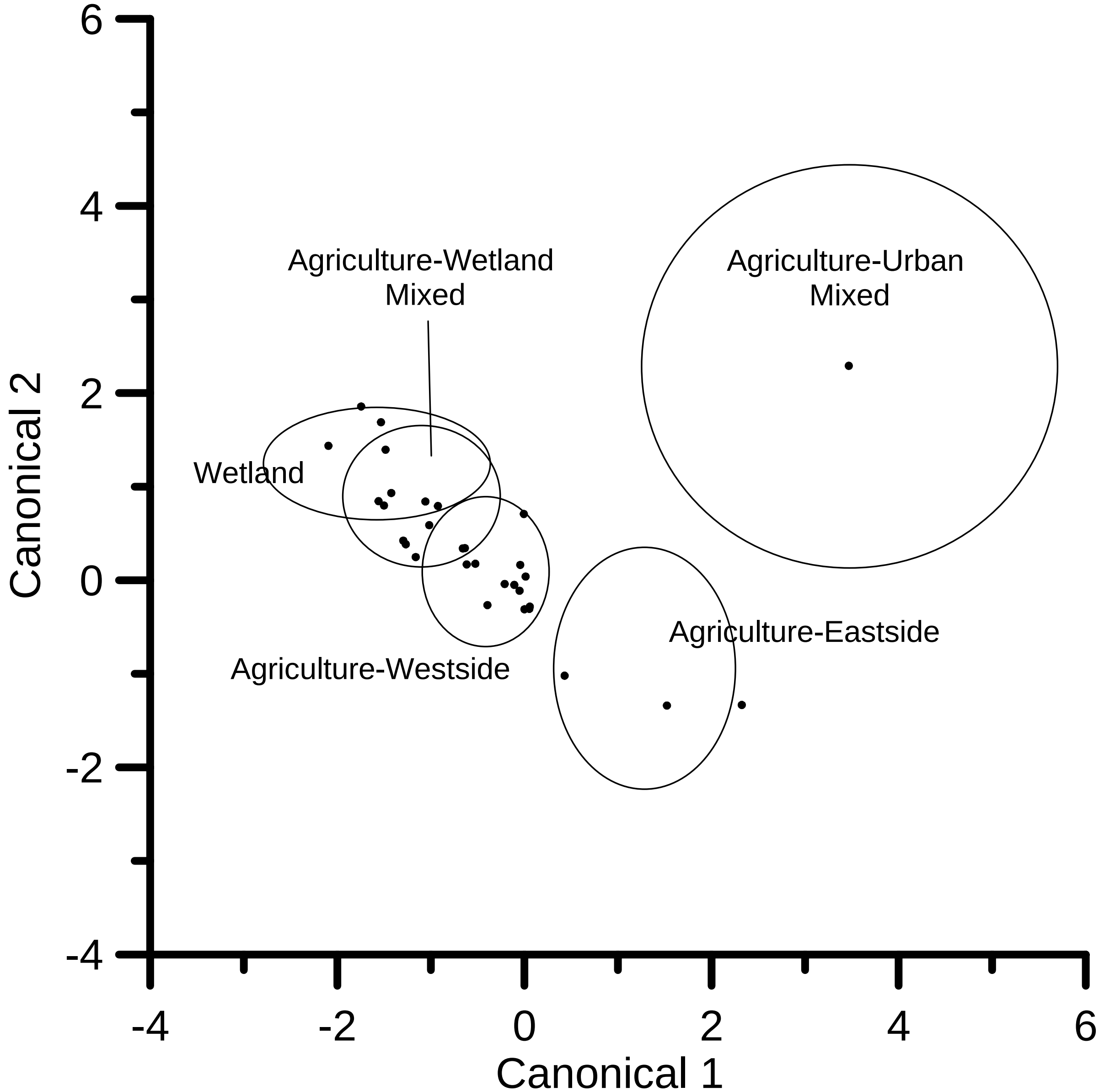

Figure 4. Discrimination of Eastside drainages using the water quality parameters specific conductance, dissolved organic carbon, mineral suspended solids, soluble phosphate, and nitrate. Eastside drainage sites can be placed in three groups, one of which represents a single drain. Numbers correspond to DO site numbers as listed in Table 1. Circles are for illustration only and do not have statistical significance. Representatives of each group are included in Table 6 for continued monitoring as part of the DO TMDL implantation program.

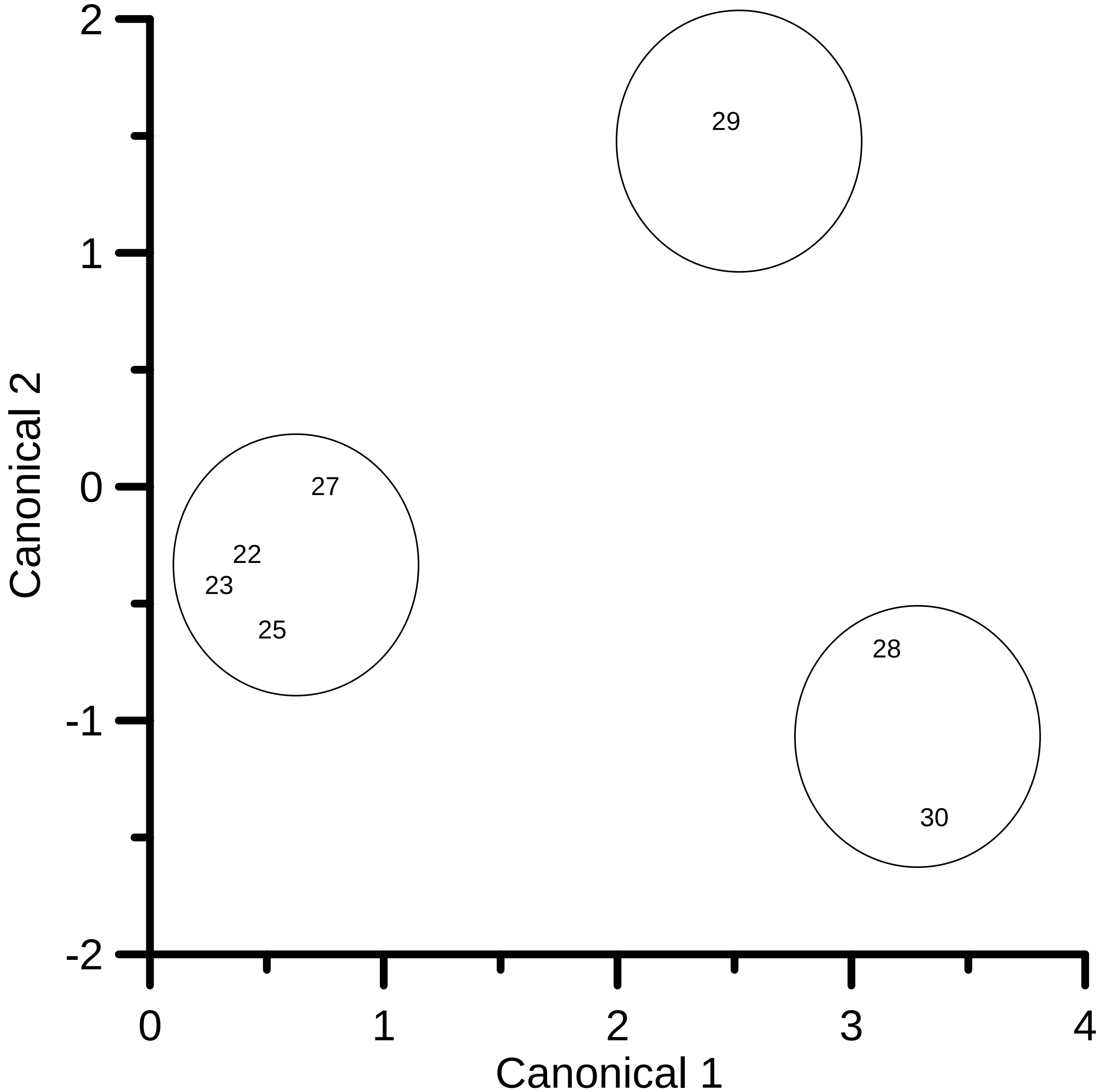

Figure 5. Discrimination of Westside drainages using the water quality parameters specific conductance, dissolved organic carbon, mineral suspended solids, soluble phosphate, and nitrate. Westside drainage sites can be placed in six groups, three of which represent single, outlying drains. Circles are for illustration only and do not have statistical significance. Representatives of each group are included in Table 6 for continued monitoring as part of the DO TMDL implantation program.

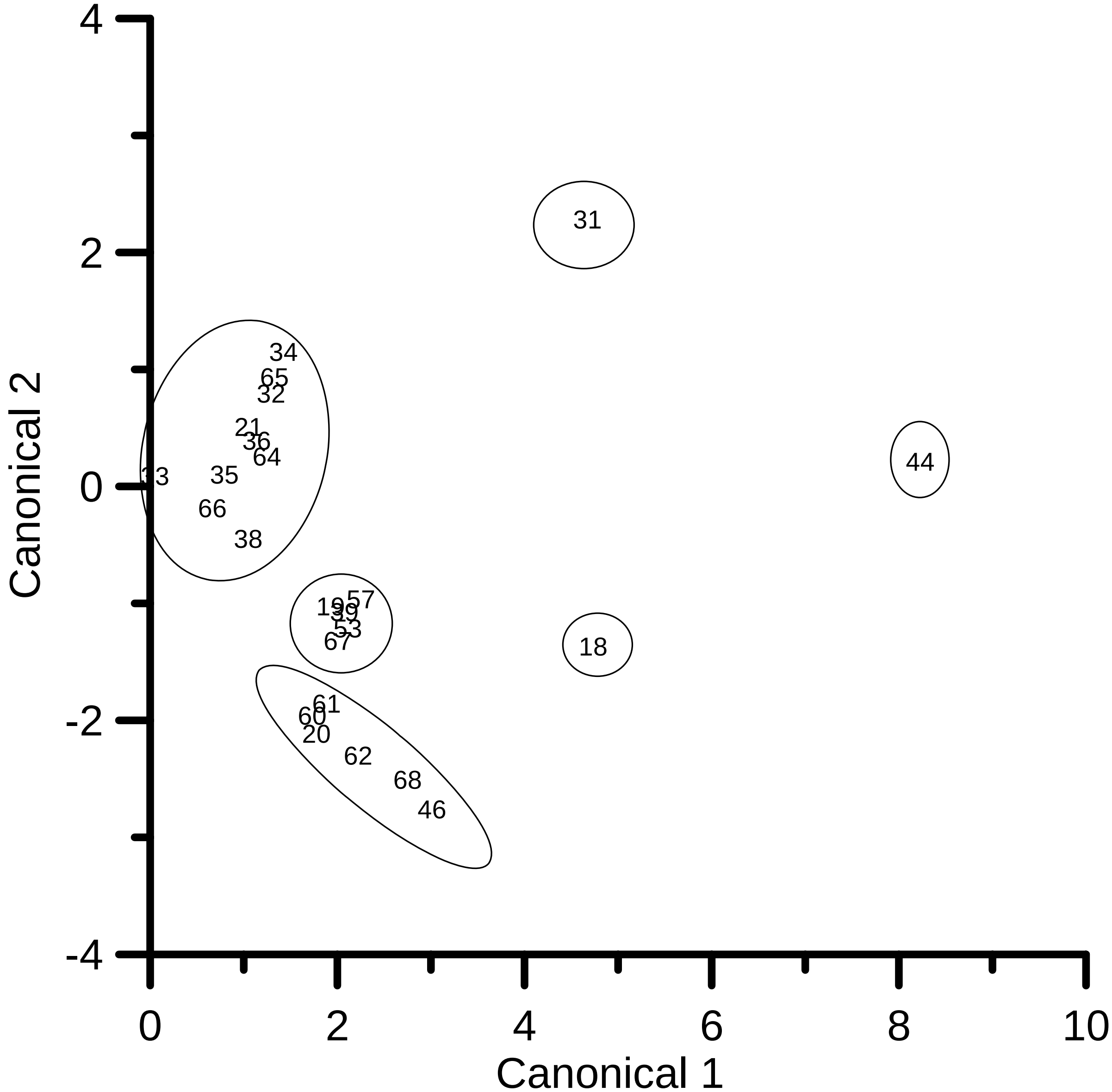

Table 1: List of water quality sampling location included in the Task 4 for the DO TMDL Project. Site degree indicates the relationship of the sample location to the San Joaquin River (SJR) and other sample stations. Flows at primary (1^o) stations connect to the river stations (0^o) without passing any other water quality measurement station. Sampling locations labeled as "2" and "3" degree convey water that passes through two or three other sampling locations before reaching the SJR. Sample locations of "4" degree are watershed sites four or more stations away from the SJR. Negative sites are diversions.

DO Site Number	Sample Station Name	Site Degree	Latitude	Longitude
1	**SJR at Channel Point**	0	37.95027	-121.33715
2	**SJR at Dos Reis Park**	0	37.83053	-121.31107
3	**SJR at Old River (DWR Lathrop)**	0	37.81082	-121.32392
4	**SJR at Mossdale**	0	37.78710	-121.30757
5	**SJR at Vernalis-McCune Station**	0	37.67936	-121.26504
6	**SJR at Maze**	0	37.64142	-121.22902
7	**SJR at Patterson**	0	37.49373	-121.08081
8	**SJR at Crows Landing**	0	37.43197	-121.01165
9	**SJR at Fremont Ford**	0	37.30985	-120.93055
10	**SJR at Lander Avenue**	0	37.29424	-120.85125
11	**French Camp Slough**	1	37.91613	-121.30447
12	**Stanislaus River at Caswell Park**	1	37.70160	-121.17719
13	**Stanislaus River at Ripon**	2	37.73113	-121.10811
14	**Tuolumne River at Shiloh Bridge**	1	37.60350	-121.13125
15	**Tuolumne River at Modesto**	2	37.62722	-120.98742
16	**Merced River at River Road**	1	37.35043	-120.96196
17	**Merced River near Stevinson**	2	37.38730	-120.79366
18	**Mud Slough near Gustine**	1	37.26250	-120.90555
19	**Salt Slough at Lander Avenue**	1	37.24795	-120.85194
20	**Los Banos Creek Flow Station**	1	37.27546	-120.95532
21	**Orestimba Creek at River Road**	1	37.41396	-121.01488
22	**Modesto ID Lateral 4 to SJR**	1	37.63057	-121.15888

DO Site Number	Sample Station Name	Site Degree	Latitude	Longitude
23	**Modesto ID Lateral 5**	1	37.61452	-121.14339
24	**Modesto ID Lateral 6**	1	37.70383	-121.14143
25	**Modesto ID Main Drain**	1	37.67026	-121.21904
26	**Turlock ID Highline Spill**	1	37.38921	-120.80568
27	**Turlock ID Lateral 2 to SJR**	1	37.56522	-121.13836
28	**Turlock ID Westport Drain**	1	37.54196	-121.09408
29	**Turlock ID Harding Drain**	1	37.46427	-121.03093
30	**Turlock ID Lateral 6 & 7 at Levee**	1	37.39782	-120.97225
31	**BCID - New Jerusalem Drain**	1	37.72669	-121.29963
32	**El Solyo WD - Grayson Drain**	1	37.58563	-121.17699
33	**Hospital Creek**	1	37.61029	-121.23082
34	**Ingram Creek**	1	37.60026	-121.22506
35	**Westley Wasteway Flow Station**	1	37.55818	-121.16375
36	**Del Puerto Creek Flow Station**	1	37.53947	-121.12206
38	**Marshall Road Drain**	1	37.43605	-121.03600
43	**El Solyo Water District Diversion**	-1	37.64011	-121.22949
44	**San Luis Drain End**	2	37.26090	-120.90520
45	**Volta Wasteway at Ingomar Grade**	3	37.10528	-120.93643
46	**Mud Slough at Gun Club Road**	2	37.23145	-120.89923
48	**FC-5 - Grassland Area Farmers**	4	36.92428	-120.65411
49	**PE-14 - Grasslands Area Farmers**	4	36.93884	-120.63555
50	**San Luis Drain Site A**	4	36.96660	-120.67060
52	**Salt Slough at Sand Dam**	4	37.12415	-120.73735
53	**Salt Slough at Wolfsen Road**	2	37.15937	-120.81292
54	**Los Banos Creek at Ingomar Grade**	2	37.07780	-120.88046
57	**Ramona Lake Drain**	1	37.47881	-121.06850
59	**SJR Laird Park**	0	37.55731	-121.15011
60	**Moffit 1 South**	2	37.22068	-120.83178

DO Site Number	Sample Station Name	Site Degree	Latitude	Longitude
61	**Deadmans Slough**	2	37.21531	-120.82629
62	**Mallard Slough**	2	37.19187	-120.82379
63	**Inlet C Canal**	3	37.17224	-120.7616
64	**Moran Drain**	1	37.43547	-121.03551
65	**Spanish Grant Drain**	1	37.43576	-121.03581
66	**ESWD Maze Blv. Drain**	1	37.64060	-121.22925
67	**Newman Wasteway at Brazo Road**	1	37.30378	-120.99632
68	**S-Lake Basin**	2	37.25326	-120.91793
69	**Santa Fe Canal**	3	37.24717	-120.91510
84	**SJR at Garwood Bridge**	0	37.92819	-121.32843
86	**Ramona Drain Apple Ave**	4	37.44474	-121.04405
87	**Ramona Drain Prune Ave**	4	37.45147	-121.04642
88	**Ramona Drain Apricot Ave**	4	37.46078	-121.06255
89	**Ramona Drain Pomelo Ave**	4	37.46547	-121.07030
90	**Ramona Drain Almond Ave**	4	37.47432	-121.06919
91	**Paradise Drain Prune Ave**	4	37.45533	121.04750
92	**Paradise Drain Apricot Ave**	4	37.46436	-121.05387
93	**Paradise Drain Pomelo Ave**	4	37.46900	-121.05387
94	**Paradise Drain Almond Ave**	4	37.47398	-121.06686
95	**Ramona Drain at Ramona Lake**	4	37.47398	-121.06686
96	**WPF-VD-1**	4	37.44346	-121.05474
97	**WPF-VD-2**	4	37.44430	-121.05282
98	**WPF-VD-3**	4	37.44515	-121.05099
101	**WPF-UD-IN**	4	37.44346	-121.05474
102	**WPF-UD-OUT**	4	37.44688	-121.04724
103	**SLD Check 18**	4	36.96013	-120.66275
104	**SLD Check 16**	4	36.98261	-120.69002
105	**SLD Check 15**	4	36.98901	-120.70459

DO Site Number	Sample Station Name	Site Degree	Latitude	Longitude
106	**SLD Check 14**	4	36.99981	-120.72400
107	**SLD Check 13**	4	37.00737	-120.73754
108	**SLD Check 12**	4	37.01070	-120.74387
109	**SLD Check 11**	4	37.03939	-120.77164
110	**SLD Check 10**	4	37.05537	-120.78780
111	**SLD Check 9**	4	37.07150	-120.80380
112	**SLD Check 8**	4	37.09966	-120.82168
113	**SLD Check 7**	4	37.10600	-120.82028
114	**SLD Check 6**	4	37.11795	-120.81778
115	**SLD Check 5**	4	37.14673	-120.82385
116	**SLD Check 4**	4	37.17693	-120.83313
117	**SLD Check 3**	4	37.20752	-120.84597
118	**SLD Check 2**	4	37.21507	-120.85081
119	**SLD Check 1**	4	37.23127	-120.87577
120	**South Marsh-1-Intermediary**	4	37.18234	-120.78642
121	**South Marsh-1-East**	4	37.18411	-120.79002
122	**South Marsh-1-West**	4	37.18261	-120.79272
123	**Ramona Lake NW Quad**	4	37.47697	-121.07071
124	**Ramona Lake NE Quad**	4	37.47750	-121.06954

End Table 1

Table 2: Laboratory water quality parameters measured as part of the Upstream DO TMDL Project.

Analyte	Abbreviation	Rationale
10-Day Biochemical Oxygen Demand	BOD_{10}	BOD_{10} is widely used in scientific and regulatory studies as a fundamental and direct measurement of oxygen-demanding materials.
10-Day Carbonaceous and Nitrogenous Biochemical Oxygen Demand	$CBOD_{10}$/ $NBOD_{10}$	Examining relationships between $CBOD_{10}$ and $NBOD_{10}$ are useful for developing DO management strategies.
Chlorophyll *a*	Chl-*a*	Chl-*a* is a major algal pigment that is measured as an indicator of algal biomass concentration.
Pheophytin *a*	Phe-*a*	Phe-*a* is a degradation product of Chl-*a*. Pha-*a* is typically interpreted as an indicator of dead or inactive algal biomass and can be added to Chl-*a* to give a measure of total algal pigments.
Total Organic Carbon	TOC	TOC is a major component contributing to oxygen demand (BOD). Examining relationships between TOC and BOD are useful for developing DO management strategies.
Dissolved Organic Carbon	DOC	DOC is measured to maintain continuity with existing databases and to identify areas with significant amount of TOC that are not algal biomass.
Inorganic carbon	IC	Algae use IC as a carbon source for biomass
Volatile Suspended Solids	VSS	VSS is direct measure of organic detritus and is a surrogate measure for algal biomass.
Total Suspended Solids	TSS	TSS measurement is necessary to measure in order to measure VSS. TSS is also an important determinant in light-limited algal growth.
Total Nitrogen	TN	TN is an important component of BOD and another surrogate measure for algal biomass.

Analyte	Abbreviation	Rationale
Nitrate and Nitrite Nitrogen	NO_3/NO_2-N NO_3-N	NO_3/NO_2-N is a basic water quality parameter and an important algal nutrient.
Ammonia Nitrogen	NH_4-N	NH_4-N is an important component of BOD and an algal nutrient.
Orthophosphate, soluble	o-PO_4	o-PO_4 is a key algal nutrient that may control algal growth potential in some sub-watersheds.
Total Phosphate	TPO_4	TPO_4 is a basic water quality parameter that will be measured to insure continuity with historical databases.
Ions	Na, K, Mg, Ca, Cl, SO_4, Br	Common ions found in water are derived from soils and used in the model to characterize different sources of water
Trace nutrients	Si, Fe	Silica (Si) and iron (Fe) are trace nutrients required for growth of diatom algae
Alkalinity	Alk	Alk is a basic water quality parameter
Microbial Biomass		Protein and lipid concentrations are methods for algae and bacterial biomass estimation
Absorbance at 254 nm	Abs-254 UV254	Absorbance of UV light at 254 nm is used as a measure of the aromatic content of water.

End Table 2

Table 3: Field water quality parameters measured as part of the Upstream DO TMDL Project.

Parameter	Instrument	Rationale
Chlorophyll-a Fluorescence	YSI 6600	Fluorescence provides a direct, *in-situ* measurement of chlorophyll *a* concentrations, a general measure of phytoplankton biomass concentration.
Turbidity	YSI 6600	Turbidity is automatically measured with fluorescence and used to correct for instrument interference. Turbidity also is an important parameter influencing light-limited algal growth.
Temperature	YSI 6600	Temperature is a basic water quality parameter that directly influence algal growth rate.
Electrical conductivity (EC)	YSI 6600	EC is a basic water quality parameter that is a surrogate measure for salt concentration. EC measurements will be used in algal mass balance calculations as a conservative reference.
Dissolved oxygen (DO)	YSI 6600	DO is a basic water quality parameter that can be used in combination with pH to estimate algal growth condition.
pH	YSI 6600	pH is a basic water quality parameter that can be used in combination with DO to estimate algal growth condition.
Incident light	PAR	Light available for photosynthesis

Table 4: Continuous flow monitoring stations maintained by the Environmental Engineering Research Program (EERP) or by Grasslands Water District (GWD) with assistance from EERP.

Site Number	Site name	Primary Maintenance	Latitude	Longitude
20	**Los Banos Creek**	GWD	37.2762	-120.9555
31	**New Jerusalem Drain**	EERP	37.7267	-121.2996
33	**Hospital Creek**	EERP	37.6105	-121.2308
34	**Ingram Creek**	EERP	37.6003	-121.2251
35	**Westley Wasteway**	EERP	37.5582	-121.1637
36	**Del Puerto Creek**	EERP	37.5395	-121.1221
38	**Marshall Rd Drain**	EERP	37.4363	-121.0362
45	**Volta Wasteway**	GWD	37.1053	-120.9364
46	**Mud Slough at Gun Club Rd**	GWD	37.2315	-120.8992
53	**Salt Slough at Wolfsen Rd**	EERP	37.1594	-120.8129
57	**Ramona Lake Drain**	EERP	37.4788	-121.0685
60	**Moffit 1**	EERP	37.2207	-120.8318
61	**Deadmans Slough**	EERP	37.2153	-120.8263
62	**Mallard Slough**	EERP	37.1919	-120.8238
63	**Inlet C Canal**	EERP	37.1722	-120.7616
64	**Moran Drain**	EERP	37.4355	-121.0355
65	**Spanish Grant Drain**	EERP	37.4358	-121.0358
68	**S-Lake Basin**	GWD	37.2533	-120.9179

Table 5: Mean flow and loading of nitrate as nitrogen (Nitrate), total phosphate as phosphorous (Total-P), and 10-day biochemical oxygen demand (BOD) for major and minor drainages in the San Joaquin River Valley as measured between 2005 and 2007.

Drainage	Flow (m^3 per day) Mean	Nitrate load (kg/d) Mean	Total-P load (kg/d) Mean	BOD load (kg/d) Mean
Tuolumne River	4,505,437	1,757	399	7,324
Merced River	2,913,088	2,101	193	4,565
Stanislaus River	2,753,013	438	179	3,243
Salt Slough	617,348	907	215	2,020
Mud Slough	337,527	1,284	101	2,569
Harding Drain	96,168	882	177	441
Orestimba Creek	81,936	121	37	160
Westport Drain	63,837	752	23	141
Los Banos Creek	60,622	50	37	552
Ramona Drain	48,937	125	20	628
Lateral 5	48,279	56	20	97
Lateral 6 & 7	41,659	664	34	106
Del Puerto Creek	28,854	127	16	199
Spanish Grant Drain	27,039	143	16	331
Ingram Creek	23,863	139	21	286
Miller Lake Drain	22,847	67	41	201
Newman Wasteway	22,721	58	13	92
Grayson Drain	11,465	54	10	174
Hospital Creek	10,046	30	17	132
Marshall Road Drain	7,557	41	13	132

Table 6: List of proposed sample sites for continued as part of the DO TMDL implementation process.

Site No.	Sample Station Name	Latitude	Longitude
4	**SJR at Mossdale**	37.78710	-121.30757
5	**SJR at Vernalis-McCune Station**	37.67936	-121.26504
6	**SJR at Maze**	37.64142	-121.22902
7	**SJR at Patterson**	37.49373	-121.08081
8	**SJR at Crows Landing**	37.43197	-121.01165
10	**SJR at Lander Avenue**	37.29424	-120.85125
12	**Stanislaus River at Caswell Park**	37.70160	-121.17719
14	**Tuolumne River at Shiloh Bridge**	37.60350	-121.13125
16	**Merced River at River Road**	37.35043	-120.96196
18	**Mud Slough near Gustine**	37.26250	-120.90555
19	**Salt Slough at Lander Avenue**	37.24795	-120.85194
20	**Los Banos Creek Flow Station**	37.27546	-120.95532
21	**Orestimba Creek at River Road**	37.41396	-121.01488
23	**Modesto ID Lateral 5**	37.61452	-121.14339
25	**Modesto ID Main Drain**	37.67026	-121.21904
28	**Westport Drain**	37.54196	-121.09408
29	**Harding Drain**	37.46427	-121.03093
30	**Turlock ID Lateral 6 & 7 at Levee**	37.39782	-120.97225
31	**New Jerusalem Drain**	37.72669	-121.29963
34	**Ingram Creek**	37.60026	-121.22506
36	**Del Puerto Creek Flow Station**	37.53947	-121.12206
44	**San Luis Drain End**	37.26090	-120.90520
57	**Ramona Lake Drain**	37.47881	-121.06850

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Appendix A

Summary of Analytical Methods, Quality Assurance, and Quality Control for Field Sampling and Laboratory Water Quality Analysis 2005-2007

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February, 2008

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Introduction

In 2005, 2006, and 2007, nearly 2000 water samples were collected along the San Joaquin River (SJR) and major tributaries by the Environmental Engineering Research Program (EERP) located at the University of the Pacific (UOP) in support of the DO TMDL project. During sample collection field measurements were taken including water velocity, chlorophyll fluorescence, specific conductivity, pH, dissolved oxygen, oxidation-reduction potential and turbidity, solar radiation, TDS, temperature, sonde depth, and barometric pressure. Vertically integrated water grab samples were collected and brought to the EERP laboratory for immediate processing. Two sampling teams were deployed to insure all sites were sampled during the same day to allow for consistent environmental conditions for all samples. At the EERP laboratory samples were filtered, analyzed, or preserved within 24 hours of sample collection. Samples were transported to University of California, Davis (UCD) on the sampling day and filtered, analyzed, or preserved in the lab within 24 hours.

The purpose of this report is to describe the performance of the analytical and field crew and the quality of the data set as defined in the DO TMDL Quality Assurance Project Plan (QAPP) (Stringfellow, 2005). For the purpose of this report, Quality Assurance (QA), as outlined in the QAPP, is the process in which the project data is evaluated and handled. Quality Control (QC) guidelines are the requirements specified in the QAPP to determine if the data is valid. The QAPP provides both a QA process and QC requirements for production of accurate and precise water quality analysis from the laboratory and the field in support of the project objectives. The QAPP imposes several layers of quality review on the data. These include procedures established for data collection and processing by the laboratory analyst and the field personnel; oversight by the QA/QC manager; review by data analysts; and review by independent personnel. This iterative process has helped create a complete and high quality data set.

Methods

Data Quality Assurance and Quality Control

Each analytical group (UC Davis or EERP) has established Standard Operating Procedures (SOPs) (Borglin et al., 2005) for all routine analysis methods. The SOPs insure consistency in the analysis procedures, data reporting, and QC requirements. The SOPs were prepared by experienced analysts in collaboration with the QA/QC manager. The SOPs were kept in the analysis area and a master copy was kept on file. Daily laboratory work at the bench level was carried out according to these documents.

Data produced daily by analysts was recorded electronically and in a laboratory notebook. Electronic forms were used for entering data and calculation of results from the unknown samples and standards using calibration parameters. Preliminary review of data quality was completed by the analyst who confirmed that all standards and quality control samples met quality control guidelines. If the guidelines were not met, the analyst met with the QA/QC manager to identify the problem and the samples were then re-analyzed after remediation of any problems with analytical instrumentation, standards, calibration, or analysis procedures. Data that passed QC guidelines was then entered into the master spreadsheet.

Data in the master spreadsheet was subject to further review by applying simple linear regressions between correlated analyses to identify data outliers. This procedure was used to check for data entry or calculation errors. If problems were discovered during this process, the analyst was asked to recheck the data entry and quality of the sample analysis.

Quality control procedures for each laboratory analysis, discrete field sampling events, and continuous field monitoring data collection include calibration of instruments with certified standards. Quality control samples were run in conjunction with unknown samples and, depending on the analysis, could include all or some of the following: calibration check standards, laboratory control samples, sampling and analytical duplicates, matrix spikes, and analytical blanks (Table 1). In addition, analyses of performance test standards were conducted at a minimum of once a year to verify the proper working order of equipment, quality of reagents, analytical technique, and analytical methods.

Sampling and Field Water Quality Measurements

Field sampling consisted of collecting water samples, measuring water quality with a sonde, and recording of field conditions at sites within the study area. Prior to sampling, field equipment was calibrated (see below) and trip blanks were gathered and loaded into the sampling vehicles. Field sheets describing the sampling routine were disseminated before sampling to the sample crew and other pertinent individuals. Sampling was attempted at each site on the field sheets the day of sampling. At each site, water and water quality measurements were collected. The samples were stored at 4°C after collection and returned to the lab for analysis.

The day before sample collection YSI 6600 Sonde connected to YSI 650 MDS handset were calibrated at EERP following procedures in the YSI 6-Series Environmental Monitoring Systems Handbook (YSI Inc., Yellow Springs, CO). The sonde has several probes which were calibrated independently. Dissolved oxygen and depth were calibrated using the wet-towel method where the sonde was placed in a tube with a wet-towel around the sensors and calibrated in a water-saturated air environment. Specific conductance, measured with a temperature compensated electrical conductivity probe (EC), was calibrated using a 0.01D KCL conductivity standard with a value of 1408µS/cm (Radiometer Analytical SAS, Lyon, France). Temperature calibration is checked against a NIST certified thermometer. The pH probe was calibrated using standards of pH 4, pH 7, and pH 10 (VWR International, West Chester, PA). Oxidation-reduction potential (ORP) was calibrated with Zobell's solution (Ricca Chemical Company, Arlington, TX). The fluorescence probe output (for estimating chlorophyll) was recorded in Millipore water or 0 NTU water to account for drift. The turbidity probe was calibrated with three standards of 0 NTU or Millipore water, 40 NTU, and 200 NTU (HACH, Loveland, CO).

Each sampling day, the sonde was recalibrated for dissolved oxygen at the first site to correct for ambient barometric pressure. At each sampling location, water quality data was collected for at least 2 minutes using a sonde deployed in the sample water and programmed to measure and record every parameter every four seconds, providing a statistically significant sample size ($n > 30$). The data from the sonde was also recorded in the field notebook. The parameters measured by the sonde at each site included time, temperature (°C), specific conductance (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO), DO concentration (mg/L), DO charge, depth (ft), pH, oxidation-reduction potential (mV), turbidity (NTU), chlorophyll content (µg/L), fluorescence, and barometric pressure (mmHg).

While the sonde logged water quality data, water samples were collected and incident sunlight and water velocity were measured to document current field conditions. During sampling in 2005, the Photosynthetically Active Radiation (PAR) was measured in triplicate in full sun mode using a LI-250A meter with the LI-192 underwater quantum sensor and LI-193 spherical quantum sensor (Li-cor, Lincoln, NE). Light measurements were also taken using a Model 3252 (LUX) Traceable® Dual-Display Light Meter (Control Company, Friendswood, TX). It was found that the readings between the model 3252 and the LI-192 were highly correlated in 2005 and only the LUX meter readings were taken in 2006 and 2007. For 2006 and 2007, each LUX meter was independently correlated to the PAR meter and PAR was calculated from the LUX measurements. Velocity measurements were taken with a Marsh-McBirney Model 2000 Flo-Mate (Marsh-McBirney, Frederick, MD) with the velocity sensor facing upstream and horizontal to the water flow.

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International), as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analyses and volume requirements. Bottles were labeled with the appropriate sample number, site name, and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Post field activities included cleaning and storing all field equipment and post-calibrating the sondes to account for drift during the sampling day. Post-calibration consisted of checking the sonde value to that of the standard value and was completed within twenty-four hours of the sampling event. After post-calibration sondes were cleaned and stored with a small amount of water in the calibration cup to prevent drying of the DO membrane.

Sample preparation and processing

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at 4°C until filtering and analysis. Samples were filtered and preserved if necessary within 24 hours of collection. Archive filtrate and unfiltered samples were saved from all sites for any needed re-analysis or additional analysis that may be determined necessary. Samples were analyzed in laboratories at both EERP and UC Davis, and the procedures are described separately below.

Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998) unless otherwise indicated. Certified standards, trace clean and certified sample bottles, reagent grade chemicals, and high purity water produced by a Milli-Q gradient system (Millipore, Billerica, MA) were used for all analyses. Reused glassware was cleaned thoroughly within warm water with Alconox detergent, rinsed with 10% HCl, and rinsed a minimum of 5 times with high purity de-ionized water.

UC Davis

Samples for dissolved nitrate, ammonia, and phosphate (NO_3-N, soluble NH_4-N and PO_4-P) were filtered through a pre-rinsed, 0.22 µm polycarbonate membrane (Millipore Isopore^{TM}). NO_3-N and soluble NH_4-N were quantified simultaneously using an automated membrane diffusion/conductivity detection method (Carlson, 1978, 1986; Carlson et al., 1990). Total nitrogen was determined by the same method from unfiltered sample following persulfate oxidation (Yu et al., 1994) using a 1% persulfate oxidant concentration, a sample:oxidant ratio of 1:1 (V/V), and heating in an autoclave. The limit of detection for this method was 50 ppb N.

Ortho-phosphate (PO_4-P) was determined on the filtrate using the stannous chloride method. (SM 4500-P.D). The limit of detection for this method is approximately 3 ppb PO_4-P in clean water using a 1 cm cell for measurement. Total phosphorus (Tot P) was analyzed on unfiltered samples by the same method after digestion. To digest, 5.0 mL of each sample was aliquotted into trace clean, 5.0 mL digestion reagent (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) was added and then was autoclaved for 1 hour. After cooling, Tot P was determined using the stannous chloride method as described above.

EERP

Filters were used in the analysis of chlorophyll pigments, particulate organic matter (samples sent to USGS for analysis), total suspended solids and volatile suspended solids (TSS/VSS), and phospholipid fatty acid analysis (PLFA). Sample for NO_3-N, PO_4-P, and dissolved organic carbon (DOC) were filtered through 47mm Whatman GF/F filters (0.7µm pore size) for the collection of filterable solids. Filters used for TSS/VSS analysis were pre-rinsed with high purity water (Milli-Q gradient, Millipore, Billerica, MA). All filters were pre-combusted for 6 hours at 550°C prior to filtering. Sample bottles were shaken thoroughly before filtration and sample bottle weights were recorded before and after the sample was filtered and the difference was recorded as the filtered sample weight. Samples for dissolved Si (SiO_4-Si) were filtered through a pre-rinsed 0.45µm pore size cellulose luer-lock syringe filter (Nalgene, Rochester, NY) within 24 hours of collection and stored at 4°C until analysis.

Unfiltered samples were analyzed for biochemical oxygen demand (BOD) by Standard Method (SM) 5210 B (APHA, 2005) with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set will be consistent with prior studies. BOD was measured without seed, as in previous studies. Initial and final dissolved oxygen was measured using a calibrated YSI 5000 DO meter equipped with a YSI 5010 BOD probe (Yellow Springs, OH) and calibrated by Winkler titration according to SM 10200 H (APHA, 2005). Duplicate samples were prepared every 20 analyses and blanks consisted of BOD buffer solution prepared according to SM 5210 B. All samples were analyzed at both full concentration and diluted 100 mL of sample to 200 mL of BOD buffer solution to increase the number of reportable results. All BOD analyses were initiated within 24 hours of sample collection. A standard curve was prepared for each sample set consisting of a BOD standard solution (HACH, Loveland, CO) containing glucose and glutamic acid at 1, 2, 3, and 4 mg/L in dilution buffer with 5 mL of seed from a randomly selected sample. In addition, carbonaceous BOD (CBOD) was determined by adding 0.16 mg of nitrification inhibitor (N-serve, HACH, Loveland, CO) to a duplicate sample set. The resulting CBOD was subtracted from the total BOD to determine the nitrogenous BOD (NBOD). The limit of detection for BOD, CBOD, and NBOD is 1.0 mg/L.

Total organic carbon (TOC), inorganic carbon (IC), and DOC were analyzed on a Teledyne-Tekmar Apollo 9000 (Mason, OH) by high temperature combustion according to SM 5310 B (APHA, 2005) and quantified using a NDIR detector. TOC and IC were analyzed on unfiltered samples and DOC was analyzed on filtered samples. This machine was equipped with an auto-sampler that allows for continuous stirring of sample. Both DOC and TOC samples were preserved at less than pH 2 with concentrated H_3PO_4 and stored at 4°C until analysis. IC samples were collected in the field into vials preserved with no head space, 5-10 mg $CuSO_4$ powder and stored at 4°C until analysis. Samples were analyzed within 28 days of collection. The limit of detection for TOC and DOC is 1 mg/L C and for IC it is 5 mg/L.

Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E (APHA, 2005). Typically 1000 mL of sample was filtered on pre-weighed, pre-combusted, Whatman GF/F filters. The filters were placed in an aluminum dish and dried at 105°C under vacuum to constant weight. After drying, the filter and dish were allowed to cool in a dessicator and were weighed for TSS determination. The dried and weighed filters were subsequently combusted at 550°C for 6 hours and reweighed for VSS determination. Mineral suspended solids (MSS) concentration was calculated by subtracting VSS from TSS.

Chlorophyll-*a* (chl-a) and pheophytin-*a* (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin Elmer Lambda 35 spectrometer (PE Spec) using a 5 cm path length cuvette (Wellesley, MA).

For PLFA analysis, up to 1000 mL of water sample was filtered through a Whatman GF/F glass fiber filter within 24 hours of collection. After filtration, the filter was placed in a 25 mL glass tube or in foil packets and stored at -20°C until extraction. Total lipids and chlorophyll pigments were extracted from the filter with a modified Bligh-Dyer solution which consists of 5 mL of chloroform, 10 mL of methanol, and 4 mL of phosphate buffer. Chlorophyll pigments in the extract were quantified by measuring absorbance at 665 nm on the PE Spec. Extracted lipids were methylated with an alkaline methanol reagent and quantified on Agilent Model 6250 (Santa Clara, CA) gas chromatograph equipped with both a flame ionization and mass spectrometer detectors.

Total protein was quantified in all the samples using the Lowry method (Pierce Biosciences, Rockford, IL). The analysis was scaled up from the standard kit so the analysis was performed on 1 mL samples and analyzed in cuvettes with a 5 cm path length. Standard curves were made using bovine albumin from Pierce Biosciences (Rockford, IL). Samples were frozen within 24 hours of collection and defrosted prior to analysis. The limit of detection for this analysis is 0.5 mg/L Protein.

Alkalinity was measured on samples within 24 hours of sample collection by titration of a 50 mL sample with 0.02 N H_2SO_4 to an endpoint of pH 8.3 and 4.5. The samples were stirred continuously during titration. Quality control included analysis of two independent alkalinity standards, one from HACH (Loveland, CO) and the other from ERA (Arvada, CO), to insure proper preparation of the titrating solution and calibration of the pH probe. The limit of detection for this method is 2.0 mg/L $CaCO_3$.

Total Iron (Tot Fe) was measured using a reaction with phenanthroline according to SM 3500-Fe B using FerroVer reagents purchased from HACH (Loveland, CO). Within twenty-four hours of sample collection, 6 mL aliquots of unfiltered sample was placed in 15 mL disposable centrifuge tubes and stored at -20°C for later quantification of Tot Fe. Prior to analysis, the samples were defrosted and 1 mL of sample was removed and used to measure the background absorbance of the water sample at 510 nm on the PE Spec. Total Fe was measured on the remaining 5 mL of unfiltered sample by the addition of pre-made HACH FerroVer phenanthroline reagent and measurement at 510 nm. The background sample absorbance was subtracted from the sample absorbance with reagent added. The limit of detection for this method is 0.05mg/L Fe.

Total ammonia nitrogen (Tot NH_4-N) was quantified with the Nesslerization method (SM 4500-NH3 C, APHA, 1992) modified for use on SJR samples. The analysis was performed on unfiltered samples that were frozen within 24 hours of collection. After defrosting, 5 mL of sample was centrifuged at 3000 rpm for 5 minutes. Background interference from sample color was determined by measurement of 0.5 mL of the supernatant 425 nm prior to the addition of reagent. HACH Nessler reagent (Loveland, CO) was then added to the remaining sample; the sample was vortexed thoroughly and re-centrifuged (to remove interference from salts). Ammonia was quantified by subtracting the absorbance of the sample without reagent from the sample with reagent at 425 nm. The reportable limit for this method was 0.32 mg/L NH_4-N.

Starting in 2007 total ammonia nitrogen (Tot NH_4-N), dissolved nitrate (NO_3-N), and total nitrogen (TN) were quantified using the TL-2800 ammonia analyzer made by Timberline Instruments (Boulder, CO). The Tot NH_4-N analysis was performed on unfiltered samples that were frozen within 24 hours of collection. The reportable limit for this method is 0.045 mg/L NH_4-N. The NO_3-N analysis was performed on filtered samples that were frozen within 24 hours of collection. The reportable limit for this method is 0.08 mg/L NO_3-N. The TN analysis was performed on digested unfiltered samples that were frozen within 24 hours of collection. To digest samples, 5.0 mL of each sample was aliquotted into trace clean 16x150 glass tubes with PTFE lined caps (VWR International), 5.0 mL digestion reagent was then added (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water), and samples were autoclaved in a Tuttnauer Brinkman autoclave (Westbury, NY). After cooling, TN was determined using the nitrate electrode method as described above. The reportable limit for this method is 0.14 mg/L TN.

Dissolved Si (SiO_2-Si) concentration was determined using a modified Heteropoly Blue molybdosilicate method (modified SM 4500-SiO_2 D) using Hach reagents (Loveland, CO). Dissolved Si was measured in filtered samples at both 650 and 815 nm using the PE Spec. The reportable limit for this method is 0.05 mg/L SiO_2-Si.

Dissolved ortho-phosphate (PO_4-P) was quantified in filtered samples by the ascorbic acid method (adapted from SM 4500-P-E) using HACH PhosVer3 packets (Loveland, CO) and measurement at 890 nm on the PE Spec. The reportable limit for this method was 18 μg/L PO_4-P.

Combined nitrate (NO_3-N) and nitrite (NO_2-N) nitrogen were analyzed by the cadmium reduction method (adapted from SM 4500-NO3-E) using HACH NitraVer (Loveland, CO) reagents. The reportable limit for this method was 0.5 mg/L NO_3-N.

Total phosphorus (Tot-P) was determined on 5.0 mL of unfiltered sample by persulfate digestion and colorimetric determination by the ascorbic acid method (adapted from SM 4500-P B, E). To digest samples, 5.0 mL of each sample was aliquotted into trace clean 16x150 glass tubes with PTFE lined caps (VWR International), 5.0 mL digestion reagent was then added (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) and samples were autoclaved in a Tuttnauer Brinkman autoclave (Westbury, NY). After digestion and sample cooling, the total phosphorus concentrations were determined spectrophotometrically on the PE Spec using HACH PhosVer3 packets (Loveland, CO). The limit of detection for this analysis was 0.06 mg/L Tot-P.

Results

Summary of QC samples

Two major quantitative means were used to evaluate the performance of the laboratories and field crew. The first was routine measurement of QC samples, the second was the evaluation of independently prepared performance check samples. The summary of the QC samples run in conjunction with sample collection does not address the actual values or trends in the samples collected. The QC data collected addresses the precision, accuracy, and the overall confidence in the produced data set.

For the 2005-2007 sample years, EERP and UCD laboratories had an overall QC sample pass rate of 97%. This included all the required QC samples: calibration checks, laboratory check samples, analytical and field duplicates, matrix spikes, and blanks run in conjunction with the unknown samples. Average for the QC sample pass rates for each individual analysis is shown in Table 2 for EERP and Table 3 for UCD.

Shown in Table 4 are the Field QC samples, including both the pre and post calibration standards. These numbers represent an average of 9 different sonde units used throughout 2005 - 2007. The overall passage of QC samples for the field was 97.5 %.

Outside blind check samples (Ultra Scientific, North Kingstown, RI; RTC, Laramie, WY) were purchased for an additional assessment of the laboratory capabilities. This allows the analyst to address any weaknesses and provides a quality check from an independent source. From 2005 to 2007, all of the proficiency check standards were analyzed within acceptable limits as defined by the supplier with the exception of those highlighted in orange (see Table 5 and 6). In 2006 a sample was analyzed by both the EERP and UC Davis laboratories which produced 48.3 and 55.1 % recoveries for TN, respectively. Upon investigation it was discovered that this standard was made from Glycine. Analysts at EERP prepared Glycine standards and confirmed that this compound is not efficiently analyzed by our techniques. Ongoing method development has addressed this issue and now this compound is analyzed efficiently. Two TN samples analyzed by UCD in 2007 had low recoveries (DO-75-040507 and DO-75-120607), were high in TN, and outside the range of UCD analysis.

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Table 1: Definition of Analytical Quality Control samples used in laboratory analysis

QC Type	Definition	Frequency	Used to Evaluate	Limits	Corrective Action
Calibration Check (CC)	Standard solution at a concentration in the center of the calibration curve.	Every analytical batch or at least every 20 samples.	Accuracy Comparibility	80 –120%	Analysis can not proceed unless the CC passes.
Laboratory Control Sample (LCS)	Standard solution from a different vendor than that of the calibration standard spiked with compounds of interest into a clean water matrix.	Every analytical batch or at least every 40 samples.	Accuracy Comparibility	80 –120%	Perform instrument maintenance and prepare new standard solution if necessary.
Matrix spike & Matrix spike duplicate (MS/MSD)	Standard solution with compounds of interest spiked into a representative sample matrix.	Every 40 samples.	Precision Accuracy Comparability	80 –120%	If LCS passes, result may reflect matrix interference and may be reported with qualification.
Surrogate	The addition of a non-occurring substituted compound to the sample matrix.	Inorganics: Not Applicable. Organics: every sample if available.	Precision Comparability	75 –125%	Rerun sample. If second result is not within limits, report with qualifier.
Instrument or Analytical Blank (IB or AB)	Clean water matrix, free of analyte. Analyzed in same manner as samples.	Every analytical batch or at least every 20 samples.	Accuracy	Below Method Detection Limit (MDL)	In some cases, target compound values may be subtracted out, in other analyses target compounds present in blank must be flagged as contamination and may not be subtracted out.

Table 2: Summary of Quality Control samples for the EERP laboratory analyses, 2005-2007

	QA/QC type	Total Alkalinity	Ammonia-N	Nitrate-N	Dissolved Phosphate	Total Iron-Fe	Total P	Total Protein	Silica
	PQL (mg/L)	2	0.045	0.19	0.024	0.045	0.052	1.06	0.017
% of QA passed	**Total**	**99.87%**	**93.69%**	**96.71%**	**96.14%**	**96.20%**	**100.00%**	**95.56%**	**100.00%**
	LabDup	100.00%	97.37%	98.72%	98.72%	93.59%	100.00%	93.75%	100.00%
	Dup	100.00%	92.02%	94.87%	85.51%	89.24%	100.00%	88.44%	100.00%
	MS	100.00%	88.03%	92.09%	97.22%	97.22%	100.00%	97.44%	100.00%
	MSD	99.07%	86.99%	91.28%	93.94%	96.97%	100.00%	96.46%	100.00%
	LCS	100.00%	95.48%	100.00%	100.00%	100.00%	100.00%	92.86%	100.00%
	CC	100.00%	96.76%	100.00%	97.62%	96.37%	100.00%	100.00%	100.00%
	TB (<PQL)	100.00%	99.15%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	QA/QC type	(TOC)	Total Nitrogen (TN)	(DOC)	Disolved Nitrogen (DN)	Total N (Timberline)	BOD	CBOD	NBOD
	PQL (mg/L)	0.4872		0.4872		0.1500	1	1	1
% of QA passed	**Total**	**95.35%**	**99.40%**	**97.46%**	**99.03%**	**100.00%**	**96.85%**	**96.31%**	**88.99%**
	LabDup	99.06%	98.57%	98.72%	100.00%	100.00%	95.00%	97.50%	80.00%
	Dup	93.72%	98.61%	95.27%	100.00%	100.00%	97.41%	92.37%	88.82%
	MS	95.26%	100.00%	95.83%	98.61%	100.00%			
	MSD	95.04%	100.00%	95.83%	97.37%	100.00%			
	LCS	96.30%	100.00%	100.00%	100.00%	100.00%			
	CC	92.48%	100.00%	99.15%	98.61%	100.00%			
	TB (<PQL)	95.61%	98.61%	97.44%	98.6%	100.00%	98.15%	99.07%	98.15%

	QA/QC type	(TSS)	(VSS)	Chl-a SM UV	Phaeophyton	Chl-a SM UV &Phaeophyton Total	Chl-a TriChrom	Chl-b TriChrom	Chl-c TriChrom
	PQL (mg/L)	5 mg	5 mg	abs < 0.1	abs < 0.1	abs < 0.1	abs < 0.1	abs < 0.1	abs < 0.1
% of QA passed	**Total**	**94.75%**	**92.01%**	**86.26%**	**82.03%**	**86.07%**	**86.07%**	**78.65%**	**81.90%**
	LabDup								
	Dup	89.50%	85.74%	72.52%	64.05%	72.14%	72.14%	57.30%	63.81%
	MS								
	MSD								
	LCS								
	CC								
	TB (<PQL)	100.00%	98.29%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 3: Summary of the Quality Control samples for the UC Davis laboratory analyses

	QA Parameter	Total Number of Each Parameter Analyzed	Total N (mg/L) PQL<0.05	NH4-N (mg/L) PQL<0.01	NO3-N (mg/L) PQL<0.01	Total P (mg/L) PQL<0.005	PO4-P (mg/L) PQL<0.003
% of QA Passing	Field Duplicate	119	97.48%	88.24%	96.64%	95.80%	95.80%
	Laboratory Blank	20	100.00%	100.00%	100.00%	90.00%	80.00%
	Trip Blank	122	94.26%	95.90%	98.36%	95.08%	93.44%
	Total	**261**	**96.17%**	**92.72%**	**97.70%**	**95.02%**	**93.49%**

Table 4: Summary of the Quality Control samples for the Field analyses

Sonde Paramater

Sonde S/N	% Pass	Depth (ft)	DO %	DO (mg/L)	DO Charge	Temp (degC)	EC	LCS EC	pH 4.0	pH 7.0	pH 10.0	LCS pH 4.01	LCS pH 7.0	LCS pH 10.01	ORP	Turbidity 0 NTU	Turbidity 40 NTU	Turbidity 200 NTU	Chla	Flr	Average % For Each Sonde
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
04M1920AA	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #1	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
05B1294AA	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #2	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0	90.0	90.0	100.0	100.0	100.0	100.0	90.0	100.0	88.9	88.9	100.0	100.0	100.0	100.0	100.0	100.0	97.3
06E2316AA	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #3	% Pass Post-Deployment	100.0	100.0	100.0	80.0	80.0	100.0	100.0	100.0	100.0	80.0	100.0	80.0	80.0	100.0	100.0	100.0	100.0	100.0	100.0	94.7
Sonde S/N:	% Pass Total	100.0	87.5	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.7
06E2065AA	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #4	% Pass Post-Deployment	100.0	75.0	75.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.4
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	87.5	87.5	98.7
06E2065AB	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #5	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	75.0	75.0	97.4
Sonde S/N:	% Pass Total	87.5	100.0	100.0	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.7
06E2064AB	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
#6	% Pass Post-Deployment	75.0	100.0	100.0	75.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.4
Sonde S/N:	% Pass Total	100.0	90.0	90.0	87.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	98.2
06E2064AA	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
YSI #7	% Pass Post-Deployment	100.0	80.0	80.0	75.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	96.4
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
05J2250AB	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
YSI #8	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		83.3	100.0	100.0	100.0	100.0	99.1
05J2250AC	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
YSI #9	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		66.7	100.0	100.0	100.0	100.0	98.1
Sonde S/N:	% Pass Total	100.0	100.0	100.0	91.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6
06E2064AC	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI#10	% Pass Post-Deployment	100.0	100.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.1
Sonde S/N:	% Pass Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
05K1979AB	% Pass Pre-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #11	% Pass Post-Deployment	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07E101644	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #12	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07E101645	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #13	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07F101613	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #14	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07F101610	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #15	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07F101611	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #16	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sonde S/N:	% Pass Total	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
07F101612	% Pass Pre-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YSI #17	% Pass Post-Deployment	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Total % Pass for all Sondes	**99.3**	**98.7**	**98.7**	**96.1**	**99.4**	**100.0**	**100.0**	**100.0**	**100.0**	**99.4**	**100.0**	**99.3**	**99.3**	**100.0**	**99.0**	**100.0**	**100.0**	**99.3**	**99.3**	
																			Overall total		**99.4**

Table 5: EERP and UC Davis Nutrient Proficiency Check sample results

mg/L NO3 - N Sample ID	Catalog number (ultra scientific)	Code number	mg/L NO3 - N Expected concentration mg/L NO3 - N	Acceptable Range mg/L NO3 - N	UOP result mg/L NO3 - N	% recovery UOP	UCD result mg/L NO3 - N	%recovery UCD
DO-70-060806	QCI-757A	72039	6.92	6.23-7.61	6.57	94.9	na	
DO-70-100605	QCI-757A	75240	3.81	3.43-4.19	4.34	113.9	na	
DO-72-030206	QCI-710	79198	8.48	7.21-9.63	7.78	91.7	na	
DO-72-060806	QCI-710	76260	10.2	8.7-11.6	8.93	87.5	na	
DO-72-100605	QCI-710	75568	5.42	4.64 - 6.10	na		5.231	96.5
DO-72-101906	QCI-710	78633	12.3	10.5-14.0	10.6	86.2	12.52	101.8
DO-72-040507	QCI-710	78638	5.25	4.47-5.98	n/a		5.175	98.6
DO-72-120607	QCI-710	72427	2.06	1.75-2.36	2.22	107.8	n/a	
DO-74-030206	QCI-745A	78379	38.8	33.3-43.5	33.91	87.4	37.34	96.2
DO-74-060806	QCI-745A	74597	34.6	29.8-38.8	29.41	85.0	n/a	
DO-74-040507	QCI-745A	76967	22.2	18.9-25.2	23.84	107.4	24.336	109.6
DO-74-120607	QCI-745A	71708	34.6	29.5-39.3	34.16	98.7	30.41	

mg/L NH4 - N Sample ID	Catalog number (ultra scientific)	Code number	mg/L NH4 - N Expected concentration mg/L NH4 - N	Acceptable Range mg/L NH4 - N	UOP result mg/L NH4 - N	% recovery UOP	UCD result mg/L NH4 - N	
DO-74-030206	QCI-745A	78379	18.3	15.6-20.9	19.83	108.4	18.06	98.7
DO-74-060806	QCI-745A	74597	10.5	8.9-12.0	10.06	95.8	n/a	
DO-74-101906	QCI-745A	71269	13.1	10.8-15.2	14.31	109.2	15.72	120.0
DO-74-040507	QCI-745A	76967	18.3	15.2-21.1	16.71	91.3	18.865	103.1
DO-74-120607	QCI-745A	71708	10.5	8.6-12.2	9.22	87.8	10.15	96.7
DO-205-040507	QCI-042-1	10611	2.02	1.49-2.55	1.57	77.7	1.751	86.7

mg/L PO4 - P Sample ID	Catalog number (ultra scientific)	Code number	mg/L PO4 - P Expected concentration mg/L PO4 - P	Acceptable Range mg/L PO4 - P	UOP result mg/L PO4 - P	% recovery UOP	UCD result mg/L PO4 - P	
DO-74-030206	QCI-745A	78379	4.71	4.26-5.20	4.91	104.2	5.079	107.8
DO-74-101906	QCI-745A	71269	1.18	1.01-1.37	1.24	105.1	1.147	97.2
DO-74-040507	QCI-745A	76967	4.71	4.17-5.29	4.97	105.5	1.414	30.0
DO-74-120607	QCI-745A	71708	2.06	1.80-2.35	2.09	101.5	2.009	97.5
DO-205-040507	QCI-042-1	10611	0.74	0.615-0.871	0.72	97.3	0.655	88.5

TOTAL P Sample ID	Catalog number (ultra scientific)	Code number	TOTAL P Expected concentration mg/L P	Acceptable Range mg/L P	UOP result	% recovery UOP	UCD result mg/L P	
DO-75-030206	QCI-745B	78842	5.07	4.20-5.59	na		5.477	108.0
DO-75-101906	QCI-745B	77428	3.04	2.66-3.46	na		3.306	108.8
DO-75-040507	QCI-745B	78237	5.07	4.47-5.72	9.2368	182.2	4.904	96.7
DO-75-120607	QCI-745B	71050	2.03	1.76-2.34	1.6871	83.1	1.901	93.6

TOTAL N Sample ID	Catalog number (ultra scientific)	Code number	TOTAL N Expected concentration mg/L N	Acceptable Range mg/L N	UOP result mg/L N	% recovery UOP	UCD result mg/L N	
DO-72-101906	QCI-710	78633	12.3	10.5-14.0	12.87	104.6	12.86	104.6
DO-72-040507	QCI-710	78638	5.25	4.47-5.98	na		4.77	90.9
DO-74-101906	QCI-745A	71269	20	5.9-7.9	na		19.40	97.0
DO-74-040507	QCI-745A	76967	40.5	34.1-46.3	41.25	101.9	43.71	107.9
DO-74-120607	QCI-745A	71708	45.1	38.1-51.5	46.21	102.5	39.51	87.6
DO-75-030106	QCI-745B	78842	16.8	13.7-19.4	na		16.61	98.9
DO-75-101906	QCI-745B	77428	33.6	25.6-39.6	16.24	48.3	18.50	55.1
DO-75-040507	QCI-745B	78237	16.8	12.9-19.9	16.17	96.3	12.08	71.9
DO-75-120607	QCI-745B	71050	18.7	14.3-22.1	17.62	94.3	11.99	64.1
DO-200-030107	made in-house	na	3.5	+/- 20%	3.40	97.1	3.51	100.3
DO-201-030107	made in-house	na	6.8	+/- 20%	6.56	96.5	5.53	81.3
DO-202-030107	made in-house	na	1.4	+/- 20%	1.49	106.4	1.46	104.3

TSS Sample ID	Catalog number (ultra scientific)	Code number	TSS Expected concentration mg/L	Acceptable Range mg/L	UOP result mg/L	% recovery UOP
DO-73-030206	QCI-711	77754	151	134-159	145.2	96.2
DO-73-062906	QCI-711	70362	161	143-169	150.97	93.8
DO-73-100605	QCI-711	78352	164	138-170	156.11	95.2
DO-73-101906	QCI-711	72853	159	142-167	163.46	102.8
DO-73-040507	QCI-711	74747	120	106-132	122	101.7

Table 6: EERP Nutrient Proficiency Check sample results

TSS Sample ID	Catalog number (ultra scientific)	Code number	TSS Expected concentration mg/L	Acceptable Range mg/L	UOP result mg/L	% recovery UOP
DO-73-030206	QCI-711	77754	151	134-159	145.2	96.2
DO-73-062906	QCI-711	70362	161	143-169	150.97	93.8
DO-73-100605	QCI-711	78352	164	138-170	156.11	95.2
DO-73-101906	QCI-711	72853	159	142-167	163.46	102.8
DO-73-040507	QCI-711	74747	120	106-132	122	101.7
DO-73-120607	QCI-711	72255	21.9	16.2-25.2	17.53	80.0

TOC Sample ID	Catalog number (ultra scientific)	Code number	TOC Expected concentration mg/L	Acceptable Range mg/L	UOP result mg/L	% recovery UOP
DO-76-030206	QCI-731	77276	35.3	31.0-39.7	37.11	105.1
DO-76-030206	QCI-731	77276	35.3	31.0-39.7	35.44	100.4
DO-76-060806	QCI-731	75955	28.2	25.0-31.2	25.2	89.4
DO-76-101906	QCI-731	70488	47	41.8-51.8	51.9	110.4
DO-76-040507	QCI-731	73280	47	41.8-51.8	31.854	67.8
DO-76-120607	QCI-731	74810	28.2	25.0-31.2	28.28	100.3
DO-78-092706	QCI-026	10445	14.1	11.6-16.6	15.054	106.8

Conductivity			Conductivity Expected concentration	Acceptable Range	UOP result	% recovery UOP
DO-72-060806	QCI-710	76260	940	884-997	932	99.1
DO-72-101906	QCI-710	78633	814	764-864	851	104.5
DO-72-042607	QCI-710	78638	1350	1270-1430	1370	101.5
DO-72-120607	QCI-710	72427	1470	1390-1550	1465	99.7

pH			pH			
DO-72-060806 lab result	QCI-710	76260	9.23	9.03-9.43	9.18	
DO-72-060806 field result	QCI-710	76260	9.23	9.03-9.43	9.15	
DO-72-101906 field (sonde)	QCI-710	78633	9.28	9.08-9.48	9.13	
DO-72-040507 field (sonde)	QCI-710	78638	9.16	8.96-9.36	8.89, 8.92	
DO-72-120607 field (sonde)	QCI-710	72427	9.19	8.99-9.39	9.04,9.06	

BOD Sample ID	Catalog number (ultra scientific)	Code number	BOD Expected concentration mg/L	Acceptable Range mg/L	UOP result mg/L	% recovery UOP
DO-78-092706	QCI-026	10445	22.2	10.9-33.4	28.75	129.5
DO-78-040507	QCI-026	10647	26.1	12.9-39.3	34.6	132.6

CBOD Sample ID	Catalog number (ultra scientific)	Code number	CBOD Expected concentration mg/L	Acceptable Range mg/L	UOP result mg/L	
DO-78-092706	QCI-026	10445	19.2	8.56-29.8	28.5	148.4
DO-78-040507	QCI-026	10647	22.7	10.1-35.0	34	149.8

ALKALINITY Sample ID	Catalog number (ultra scientific)	Code number	ALKALINITY Expected concentration mg CO3/L	Acceptable Range mg CO3/L	UOP result mg CO3/L	% recovery UOP
DO-72-030206	QCI-710	79198	352	327-363	328	93.2
DO-72-060806	QCI-710	76260	231	208-254	239	103.5
DO-72-100605	QCI-710	75568	538	511-555	514	95.5
DO-72-101906	QCI-710	78633	249	224-274	234	94.0
DO-72-042607	QCI-710	78601	352	327-363	333	94.6
DO-72-120607	QCI-710	72427	146	132-161	134	91.8

Appendix B

Description and Photo-Documentation of Field Work Activities 2005-2007

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February 2008

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Introduction

The Environmental Engineering Research Program (EERP) at the University of the Pacific (UOP) is the lead scientific agency on several water quality and ecosystem restoration projects focused on understanding and improving water quality in the San Joaquin River (SJR). EERP projects include the development of a mass balance on phytoplankton and oxygen demanding materials in the SJR, evaluation of organic carbon sources and fate in the SJR, studies of wetland ecosystems, and studies examining the impact of current agricultural best management practices (BMPs) on water quality. For all of these projects, water quality and water flow must be measured at numerous locations throughout the watershed.

EERP works in cooperation with local, State, and Federal scientists and stakeholders to maintain a network of flow and water quality monitoring stations throughout its study region. The field research program effort includes water quality sampling (grab sampling), flow measurement, continuous flow monitoring station maintenance, quality assurance (QA), and flow rating events, as well as activities associated with directed scientific studies, such as deployment of continuous chlorophyll monitors to measure temporal variation in phytoplankton growth kinetics. Major objectives of the field research program are to support stakeholder flow monitoring efforts, maintain a high level of quality control on all flow and water quality monitoring activities, organize collected data for scientific and engineering analysis, and collect data in support of modeling efforts. The purpose of this report is to document EERP field activities for the 2005-2007 field seasons.

Methods

Field notebooks were used to document all field activities. The field activity summaries document field activities by day for 2005-2007. Each field activity summary includes a brief description of the objectives and the work performed. Each day was categorized with appropriate heading. Available photographs were included to provide further documentation. Any problems encountered in the field were documented in the field notebook and activity report. Each field day is categorized using headings of sampling, station maintenance and QA, extended deployment, or station upgrades, where applicable.

Equipment used in EERP field work is listed in Table 1. In 2005-2007, sampling events were categorized into Core sampling, Intermittent sampling, Wetland sampling, BMP sampling, and Extended Deployment sampling. The designations correspond to specific sampling lists and schedules developed to assist EERP field teams in organizing their activities. Core sampling events included up to 25 sampling sites. Wetland sampling events included up to 20 sites. BMP sampling included up to 17 sites. The number of sites sampled on Extended Deployment sampling events and Intermittent sampling events varied to accommodate specific scientific objectives. A comprehensive site list is provided in Table 2.

Sampling and Water Quality Measurements

At each location for each sampling event, water quality data was collected using an YSI 6600 multi-parameter sonde connected to an YSI 650 MDS handset (YSI Inc., Yellow Springs, CO). The sonde was deployed and programmed to log a reading for every parameter every four seconds for at least two minutes, providing a statistically significant sample size ($n > 30$)

(Graham and Hanlon, 2008). The parameters measured by the sonde at each site included time, temperature (°C), electrical conductivity (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO) percent, DO concentration (mg/L), DO charge, depth (ft), pH, oxidation-reduction potential (mV), turbidity (NTU), chlorophyll content (ug/L), fluorescence, and barometric pressure (mmHg).

While the sonde logged water quality data, water samples were collected and incident sunlight and water-velocity were measured (to document current field conditions) (Graham and Hanlon, 2008; Puckett, 2002). Water samples were collected in three different types of bottles: glass 1 liter bottles (Wheaton Science Products, Millville, NJ), 1 liter Trace-Clean plastic bottles (VWR International, West Chester, PA), and 250 mL Trace-Clean plastic bottles (VWR International)] in accordance with requirements for different lab analyses (Borglin et al., 2008). Samples were depth integrated and stored at 4°C after sampling. Light measurements were taken using a handheld LUX meter (Control Company, Friendswood, TX). Velocity measurements were taken with a model 2000 flow-meter (Marsh-McBirney, Frederick, MD) (Graham and Hanlon, 2008).

Station Maintenance and QA

Station maintenance included downloading data from the station logger, cleaning the EC probe, checking the bubbler line for leaks, clearing weir and instruments of debris, and inspecting equipment for damage. Oftentimes QA was performed at the same time as station maintenance. QA was performed on EC and flow.

For QA on the EC probe, the probe was cleaned with a small brush and the probe EC values were compared to an independently calibrated YSI sonde placed into the water adjacent to the other probe. If the EC probe showed more than 10% difference from the calibrated reference sensor, the probe was re-cleaned and basic maintenance performed, such as checking connections. If the probe continued to give low quality data, typically the only repair was to replace the faulty probe.

A QA value (rating measurement) for flow depended on the site being visited. If the site had a sharp crested weir structure, a weir stick (Cal Poly ITRC, San Luis Obispo, CA) measured flow and the flow measurement was entered into the QA and rating record. When the site did not have a sharp-crested weir, a cross-channel flow rating was taken by wading, using a handheld flow meter and measuring tape strung across the channel. Average water velocity was then taken at 60 percent depth from the bottom at set intervals across the stream channel, usually every foot but varied depending on the channel width. Flow was calculated by multiplying cross-sectional area of each section by the velocity for that section and adding sectional flows to obtain a total flow, or discharge, for the site. At all sites the staff gauge was recorded as the QA value and compared with in-situ stage measuring equipment. Discrepancies between manual ratings and continuous measurement were resolved by any number of means, up to and including replacing or moving the location of monitoring stations.

Extended Deployment

Extended deploy field events included taking sondes and leaving them at specific sites for an extended period of time, usually lasting two weeks (Graham and Hanlon, 2008). Extended deploy events were often in conjunction with a sampling event. Grab samples provided starting and ending water quality samples to compare with the extended deployment sonde values.

Sondes were calibrated the day before being placed in the field and modified with longer wiper brushes to better keep the sensors free of algae and debris. They were programmed to run unattended for the length of deployment. At the time of deployment, sondes were put into black PVC housings protecting the equipment from damage while at the site. Sondes were attached with a cable and padlock to an anchor, such as a metal post or bridge pylon. Once deployed, sondes were left unattended for periods of approximately two weeks. Upon conclusion of the deployment sondes were retrieved and placed into coolers to keep the membranes moist until post-calibration could be performed. Post-calibration was completed within twenty-four hours of deployment. After being post-calibrated sondes were cleaned with water, the DO membranes and batteries were changed, and the extended deploy wipers were removed (Graham and Hanlon, 2008).

Dye Studies

Dye study field events involved injecting Rhodamine dye into the site water and then using sondes to track the progress of the dye to measure flow within the target sampling area. Dye studies were performed on the San Joaquin River and the San Luis Drain. The dye study on the San Joaquin River involved the use of a boat floating with the current to measure the progress of the dye. On the San Luis Drain dye was injected and sondes were placed at specific points downstream to measure the progress of the dye. Flow could then be determined from the distance between sites and the time interval between detection of the dye.

Station Up-Grades

Activities performed during flow station upgrades depended on what was being done to the specific site. Upgrades often consisted of installing new equipment. A list of equipment used for flow measurement is listed in Table 1. Frequently upgraded equipment included bubbler units, Doppler flow meters, EC probes, and weir boards. A list of equipment for each upgrade was compiled and measurements were made for any equipment lines, weir boards or other materials that needed to be added to the station. Materials and supplies were purchased and brought back to UOP allowing easier access to a wider range of tools that could not be brought out to the field. Work was completed at UOP and the materials were brought to the site often needing to be cut or bent. The equipment was installed and lines were run from the station house to the equipment.

Results

During 2005-2007 crews went into the field a total of 201 times. Of these 201 trips, 128 were sampling events, 37 were flow ratings, 2 were dye studies, and the other 32 times consisted of station upgrades, training sessions, meetings, field reconnaissance, and station maintenance. Core sites were sampled 58 times, Wetland sites 27 times, Intermittent sites 12 times, Extended Deploy sites 18 times, BMP sites 9 times, San Luis Drain sites 3 times during San Luis Drain studies, San Luis Drain Shutoff sites 8 times, and San Luis Drain TOC sites 1 time. Grasslands monitoring and QA was performed 8 times and Westside monitoring and QA was performed 28 times.

During the 2005 field season crews went into the field a total of 47 times. Of these 47 trips, 30 were sampling events, 8 were flow ratings and station maintenance, 2 were San Luis Drain sampling events, 2 were dye studies, the other 5 times consisted of field reconnaissance, meetings, and training sessions. Core sites were sampled 18 times, Wetland sites 7 times, Intermittent sites 4 times, San Luis Drain TOC sites 1 time, and the San Luis Drain was sampled 1 time during the San Luis Drain study. Grasslands monitoring and QA was performed 1 time, Wetlands monitoring and QA was performed 1 time and Westside monitoring and QA was performed 6 times. A dye study was conducted 1 time on the San Joaquin River and 1 time on the San Luis Drain. On May 23^{rd} through May 27^{th} Jeremy Hanlon, Jesse Merkel, and William Stringfellow attended a confined space training session with the Stockton Fire Department at the Port of Stockton.

During the 2006 field season crews went into the field a total of 80 times. Of these 80 trips, 43 were sampling events, 16 were flow ratings, and the other 21 times consisted of station upgrades, training sessions, meetings, and station maintenance. Core sites were sampled 21 times, Wetland sites 12 times, Extended Deploy sites 4 times, BMP sites 3 times, Intermittent sites 2 times, and the San Luis Drain was sampled 1 time during the San Luis Drain study. Grasslands monitoring and QA was performed 6 times and Westside monitoring and QA was performed 10 times.

During the 2007 field season crews went into the field a total of 74 times. Of these 74 trips, 55 were sampling events, 13 were flow ratings, and the other 6 times consisted of station upgrades, field reconnaissance, meetings, and station maintenance. Core sites were sampled 19 times, Wetland sites 8 times, Extended Deploy sites 14 times, BMP sites 6 times, Intermittent sites 6 times, San Luis Drain Shutoff sites 8 times, and the San Luis Drain was sampled 1 time during the San Luis Drain study. Grasslands monitoring and QA was performed 1 time and Westside monitoring and QA was performed 12 times.

Occasionally equipment failures were discovered during station maintenance events. Most equipment failures were fixed in the field, other times equipment had to be switched out and taken back to the Hydraulics Lab at UOP to be fixed. On February 3^{rd}, 2005 the EC probe and cable were replaced at DO-68 S-Lake Basin and Fremont Drain next to DO-46 Mud Slough at Gun Club Road. The Starflow at DO-35 Westley Wasteway was removed on May 17^{th}, 2005 and brought back to UOP to troubleshoot. It was reinstalled on August 2^{nd}, 2005. The swage fitting on the bubbler line at DO-33 Hospital Creek was found to be leaking on May 17^{th}, 2005 and was fixed by removing and reassembling the fitting. On the same day the EC cable was replaced at DO-53 Salt Slough at Wolfsen. The Starflow unit at DO-31 New Jerusalem Drain was removed to troubleshoot back at UOP on September 6^{th}, 2005 and reinstalled on October 5th, 2005. On September 29th, 2005 the Starflow at DO-35 Westley Wasteway was ripped out and had to be reinstalled. A new Starflow unit was installed at DO-62 Mallard Slough on October 11th, 2005. The bubbler line pipe at DO-64 Moran Drain was loose and anchors were put into the concrete on October 11th, 2005 to support the pipe. On January 9th, 2006 the pressure transducer at DO-68 S-Lake Basin was non-functional. The cable for the pressure transducer was measured for a replacement sensor to be installed. January 31st, 2006 DO-31 New Jerusalem Drain had a leaky bubbler line that was fixed by having the line removed and connections retightened. DO-35 Westley Wasteway Flow Station had a short circuit with the Starflow, due to a damaged cable, that made the logger freeze. The logger was removed on February 8th, 2006 and reinstalled on February 14th, 2006 and the Starflow cable was disconnected from the logger. On May 9th, 2006 DO-38 Marshall Drain Road had a leaky bubbler that was fixed by removing the "T" valve. The Design Analysis (Logan, Utah) logger unit at DO-31 New Jerusalem Drain was reporting errors when downloading data on November 17th, 2006 and December 8th, 2006. The logger was replaced on December 18th, 2006. On May 22nd, 2007 the steel cables attached to the EC sensors at the Westside Stations were found to be corroded and were replaced on July 10th, 2007. On September 11th, 2007 the bubbler unit at DO-36 Del Puerto Creek was found with an unusually high tank pressure. The bubbler unit was switched out and brought back to the Hydraulics Lab at UOP on October 9th, 2007 to troubleshoot. The unit was found to be functional and a clog in the line was discovered and cleared out on November 1st, 2007. On September 9th, 2007 the weir structures at DO-38 Marshall Road Drain and DO-65 Spanish Grant Drain were found to be full of sediment. The drains were cleared out in January of 2008. The station at DO-57 Ramona Lake was repaired on March 20th, 2007 and 29th, 2007 after being washed out in the April 2006 floods. Sediment was cleared from behind the weir boards at DO-35 Westley Wasteway on August 14th, 2007 and from DO-34 Ingram Creek on November 1st, 2007. On November 15th, 2007 the EERP boat started to have problems with its engine performance. The jet drive on the boat was clogged with a few small twigs that prevented it from performing correctly. Jeremy Hanlon disassembled the jet drive on the boat and cleared out the twigs returning the boat to its full performance.

Sometimes natural events, such as storms, washed out a station. On January 9th, 2006 the sensors and bridge at DO-20 Los Banos Creek Flow Station were found washed out. The bridge was replaced by Grasslands Water District in March 2006 and the bubbler installed September 5th, 2006 and the Sontek installed October 31st, 2006. On Feb 2nd, 2006 DO-45 Volta Wasteway at Ingomar Grade the staff gauge was remounted on a metal pole because the first (wood) fixture had rotted out. The station at DO-57 Ramona Lake was washed out in the 2006 April floods and was repaired in March 2007. Occasionally there were problems with the wiper that cleans the optic sensors on the sonde used for sampling and extended deployments causing the wiper to park over the sensor and present invalid readings. This happened on September 7th, 2006 to one of the crews on a Core sampling event. On October 26th, 2006 the sonde used for sampling had the DO sensor membrane punctured and had to be replaced in the field.

Discussion

All fieldwork activities for 2005-2007 were documented. On average there was a crew in the field 1.3 times each week. There were 3.6 sampling trips on average each month. Core sites were sampled an average of 1.6 times a month. Field activities were documented with photographs. However, a picture was not taken on every field event. Photographs were taken on each field outing from 2007. In 2005 on average there was a crew in the field 0.9 times each week and there were 2.5 sampling trips each month. Core sites were sampled an average of 1.5 times a month. In 2006 there was a crew in the field 1.5 times each week and 3.5 sampling trips each month. Core sites were sampled an average of 1.75 times a month. During 2007 there was a crew in the field 1.4 times each week and there were 4.6 sampling trips each month. Core sites were sampled an average of 1.6 times a month during 2007.

The majority of continuous monitoring stations worked without major problems. Stations that were reliable in 2005 were reliable in 2006 and 2007 with the exception of DO-20 Los Banos Creek and DO-57 Ramona Lake which were washed out by spring floods in 2006 and not repaired until late 2006 and early 2007, and DO-36 Del Puerto Creek which had a clog in the bubbler line for the last half of 2007. DO-35 Westley Wasteway Flow Station was not reliable in 2005 (in part due to illegal dumping activities blocking structures) and this station was relocated and completely remodeled and upgraded in 2006. There were a number of Starflow related problems in 2005 and a few units had to be removed and brought to UOP to troubleshoot. The QA stage at DO-38 Marshall Road Drain and DO-65 Spanish Grant Drain was not reliable from September 9th, 2007 until the end of the year because of the sediment buildup in the bottom of the weir structure. Occasionally leaks were found in the bubbler lines, but these were due to loose connections that were easily fixed.

Major equipment failures, such as the Starflow short circuit from DO-35 Westley Wasteway, were nearly all caused by outside factors. The short circuit in the Starflow was the result of a backhoe accidentally slicing the cable while clearing debris from the channel. At the end of 2006, when data for December was downloaded from Westside monitoring stations, a faulty data collection card failed to retrieve data from loggers at the same time caused the loggers to stop recording data for the rest of December. This error was not discovered until January 2007.

Reliability of flow data depended on the site in question. Any station that had consistency in structure, such as a weir system that is routinely cleared of debris, provided reliable flow and water quality data. Sites that had a bubbler line installed and a developed flow stage relationship supplied high quality flow data. However, if the weir was not kept clear of debris then the flow data was not reliable. DO-35 Westley Wasteway did not provide reliable data for 2005. The station was upgraded in 2006. Sites located in wetlands, such as DO-61 Deadmans Slough and DO-62 Mallard Slough, were subject to significant beaver activity and consistently had large amounts of debris (beaver dams) in front of the weir structures. This caused the water to back up behind the weir and gave low quality flow readings. Theses sites are being evaluated for up-grading to the use of Doppler flow meters that could be put at the outlet of the pipes and do not require a sharp-crested weir for high quality flow measurements and should be able to provide high quality flow measurements even in the presence of beaver activity.

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Graham, J., Hanlon, J., 2008. EERP Field Standard Operating Procedures Protocol Book. Environmental Engineering Research Program, Stockton, CA.

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Table 1: Equipment Descriptions

Device	*Description*
Campbell Logger (Campbell Scientific Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
H-350XL Design Analysis Logger (Design Analysis Associates Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
MACE Agriflo (MACE, Sydney, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Starflow (Unidata, O'Connor, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Sontek (Sontek/YSI Inc., San Diego, CA)	Doppler device put in channel to measure flow. MACE units measure flow by looking out into the channel and are better for open, or natural, channel situations. Often used at monitoring stations.
H-350XL/355 Combo Bubbler (Design Analysis Associates Inc., Logan, UT)	A bubbler measures water level by detecting the pressure required to force air through a tube below the water level in the channel. In areas with a weir system a bubbler can be used to measure flow, as the height of water above the weir is proportional to the flow.
Staff Gauge (Wildlife Supply Company, Buffalo, NY)	A gauge put in a fixed location to observe water level. Often used to verify bubbler reading during QA visits.
Cal Poly ITRC Weir Stick (Cal Poly ITRC, San Luis Obispo, CA)	Scale mounted on a stick used to measure the height of the water above a weir structure. This value is then multiplied times the weir width to get flow.
EC Probe (YSI Inc., Yellow Springs, OH) (Campbell Scientific Inc., Logan, UT)	Sensor used to measure the Electrical Conductivity or Specific Conductivity of the water. Often deployed at monitoring stations in the field
YSI Sonde (YSI Inc., Yellow Springs, OH)	Multi-parameter instrument used to measure water quality. Most often used during sampling events and continuous monitoring.
Lux light meter (VWR International, West Chester, PA)	Meter used to measure light intensity.
GPS Map 188C Sounder with sonar (Garmin Intl. Inc., Olathe KS)	Global Positioning System. Used to track location when using the boat and to map out sample sites.

Table 2: EERP Site List

DO Number	*Site Name*	*Type*
1	**SJR at Channel Point**	Intermittent
2	**SJR at Dos Reis Park (Lathrop)**	Intermittent
3	**SJR at Old River**	Intermittent
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
9	**SJR at Fremont Ford**	Intermittent
10	**SJR at Lander Avenue**	Core sites
11	**French Camp Slough**	Intermittent
12	**Stanislaus River at Caswell Park**	Core sites
13	**Stanislaus River at Ripon**	Intermittent
14	**Tuolumne River at Shiloh Bridge**	Core sites
15	**Tuolumne River at Modesto**	Intermittent
16	**Merced River at River Road**	Core sites
17	**Merced River near Stevinson**	Intermittent
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
22	**Modesto ID Lateral 4 to SJR**	Intermittent
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
24	**Modesto ID Lateral 6 to Stanislaus River**	Intermittent
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
26	**Turlock ID Highline Spill**	Intermittent
27	**Turlock ID Lateral 2 to SJR**	Intermittent
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
31	**BCID - New Jerusalem Drain**	Intermittent
32	**El Solyo WD - Grayson Drain**	Intermittent, BMP
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
35	**Westley Wasteway Flow Station**	Intermittent, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
37	**Newman Wasteway at SJR**	Intermittent
38	**Marshall Road Drain**	Intermittent, BMP
39	**Salado Creek Flow Station**	Intermittent, BMP
40	**Patterson Irrigation District Diversion**	Diversion
41	**West Stanislaus Irrigation District Diversion**	Diversion
42	**Banta Carbona Irrigation District Diversion**	Diversion
43	**El Solyo Water District Diversion**	Diversion

DO Number	*Site Name*	*Type*
44	**San Luis Drain End**	Core sites
45	**Volta Wasteway at Ingomar Grade**	Intermittent
46	**Mud Slough at Gun Club Road**	Intermittent, Wetland
47	**Delta-Mendota Canal inlet to the Mendota Pool**	Intermittent, BMP
48	**San Luis Drain Site A**	Intermittent
49	**FC-5 - Grassland Area Farmers**	Intermittent
50	**PE-14 - Grasslands Area Farmers**	Intermittent
51	**Arroyo Canal**	Intermittent
52	**Salt Slough at Sand Dam**	Intermittent
53	**Salt Slough at Wolfsen Road**	Wetland
54	**Los Banos Creek at Ingomar Grade**	Intermittent
55	**Modesto WWTP**	NPDS
56	**Turlock WWTP**	NPDS
57	**Ramona Lake Drain**	Core sites, BMP
58	**San Luis Drain Site B**	Intermittent
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadmans Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
64	**Moran Drain**	Intermittent
65	**Spanish Grant Drain**	Intermittent, BMP
66	**ESWD Maze Blv. Drain**	Intermittent, BMP
67	**Newman Wasteway at Brazo Road**	Intermittent
68	**S-Lake Basin**	Wetland
69	**Santa Fe Canal**	Intermittent
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
84	**SJR at Highway 4 (Garwood Bridge Charter Way)**	Intermittent
85	**SJR Hills Ferry**	Intermittent
86	**Ramona drain Apple Ave**	BMP
87	**Ramona drain Prune Ave**	BMP
88	**Ramona drain Apricot Ave**	BMP
89	**Ramona drain Pomelo Ave**	BMP
90	**Ramona drain Almond Ave**	BMP
91	**Paradise drain Prune Ave**	BMP
92	**Paradise drain Apricot Ave**	BMP
93	**Paradise drain Pomelo Ave**	BMP
94	**Paradise drain Almond Ave**	BMP
95	**Ramona drain at Ramona Lake**	BMP, Intermittent
96	**WPF-VD-1**	BMP

DO Number	*Site Name*	*Type*
97	**WPF-VD-2**	BMP
98	**WPF-VD-3**	BMP
99	**WPF-VD-4**	BMP
100	**WPF-VD-5**	BMP
101	**WPF-UD-IN**	BMP
102	**WPF-UD-OUT**	BMP
103	**SLD Check 18**	Intermittent
104	**SLD Check 16**	Intermittent
105	**SLD Check 15**	Intermittent
106	**SLD Check 14**	Intermittent
107	**SLD Check 13**	Intermittent
108	**SLD Check 12**	Intermittent
109	**SLD Check 11**	Intermittent
110	**SLD Check 10**	Intermittent
111	**SLD Check 9**	Intermittent
112	**SLD Check 8**	Intermittent
113	**SLD Check 7**	Intermittent
114	**SLD Check 6**	Intermittent
115	**SLD Check 5**	Intermittent
116	**SLD Check 4**	Intermittent
117	**SLD Check 3**	Intermittent
118	**SLD Check 2**	Intermittent
119	**SLD Check 1**	Intermittent
120	**South Marsh-1-Intermediary**	Wetland
121	**South Marsh-1-East**	Wetland
122	**South Marsh-1-West**	Wetland
123	**Ramona Lake NW Quad**	BMP
124	**Ramona Lake NE Quad**	BMP
125	**Ramona Lake SW Quad**	BMP
126	**Ramona Lake SE Quad**	BMP
127	**SJR at Brant Bridge**	Intermittent
128	**SJR Brickyard Site**	Intermittent
129	**Hollow Tree drain**	Wetland
130	**Marshall Reservoir inlet**	BMP
131	**Marshall Reservoir outlet**	BMP
132	**Marshall RR Pond-1-West**	BMP
133	**Marshall RRr Pond-2-East**	BMP
135	**MID Main Drain Spill**	Intermittent

January 13, 2005

SLD Sampling Event
Sampling for SLD sites. The crew sampled the check stations along the San Luis Drain.

DO-50 San Luis Drain Site A (Check 17)
A stretch of the San Luis Drain near Site A.

DO-104 San Luis Drain Check 16
Water flowing over a weir structure at a check station along the San Luis Drain.

February 01, 2005

Sampling Site Scouting Trip
The crew spent the day scouting sample site locations with Randy Dahlgren (UC Davis).

DO-06 SJR at Maze
Maze Blvd crossing the San Joaquin River.

DO-19 Salt Slough at Lander
Sharon Borglin is returning from scouting out the sample site at DO-19 Salt Slough at Lander.

DO-12 Stanislaus River at Caswell
Randy Dahlgren (UC Davis) pointing out a sample location along the Stanislaus River.

DO-14 Tuolumne River at Shiloh
Photo showing the crew's vehicle near Shiloh Bridge over the Tuolumne.

February 03, 2005

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) and Rich Wright (California Water Foul Association) to assist with stream ratings and station maintenance at the DO sites they manage within the Grasslands water district.

DO-20 Los Banos Creek Flow Station
Picture showing the wood bridge over Los Banos Creek. The bridge was washed out in late 2005.

Kesterson Unit
Flooded wetland in the Kesterson unit of the San Luis National Wildlife Refuge.

February 04, 2005

Boat Survey
The crew spent the day surveying sites by boat along the San Joaquin River from Stockton to DO-31 New Jerusalem Drain with Gary Litton (University of the Pacific).

Gary Litton's Sampling Boat
Gary Litton surveying sites along the San Joaquin River.

Aeration Facility
Aeration facility near channel point in the Deep Water Ship Channel.

Input into San Joaquin River
Picture depicting a point source into the San Joaquin River.

San Joaquin River
A view from the back of Gary Litton's boat.

March 08, 2005

TID and MID Meeting
The crew met with Kieth Larson (TID) and Michael Niemi (MID) to look for possible sampling locations within Turlock Irrigation District and Modesto Irrigation District.

DO-26 TID Highline Spill
Highline Spill is managed by the Turlock Irrigation District. Flow data is collected from this site.

DO-27 TID Lat 2 to SJR
TID Lat 2 before spilling into the San Joaquin River.

DO-23 MID Lat 5 to the Tuolumne
Paradise Road crossing MID Lat 5 to the Tuolumne.

DO-25 MID Miller Lake
Photo showing Miller Lake.

March 10, 2005

Core Sampling Event
Sampling for core sites.

DO-18 Mud Slough Near Gustine
Photo of Mud Slough in the San Luis National Wildlife Refuge.

DO-16 Merced River at River Road
Merced River is sampled from the Old Bridge using a bucket to collect the sample water.

March 24, 2005

Dye Study
Dye study along the San Joaquin River with Gary Litton (University of the Pacific).

Gary Litton's Sampling Boat
Gary Litton preparing to release and track the dye in the San Joaquin River.

DO-05 SJR at Vernalis
When the dye is first dispensed it causes the river to take on a red hue.

DO-05 SJR at Vernalis
Gary Litton and crew tracking the dye as it moves downstream.

March 31, 2005

Core Sampling Event
Sampling for core sites.

DO-19 Salt Slough at Lander
Will Stringfellow and a Student Intern setting up the PAR sensors to record a light measurement.

DO-19 Salt Slough at Lander
Sampling crew recording light measurements from the PAR meters.

DO-08 SJR at Crows Landing
Sampling crew getting ready to go to the next sample location.

DO-08 SJR at Crows Landing
The bridge at SJR at Crows Landing was used before crews had permission to use the dock at the Turlock Sportsman's Club.

April 21, 2005

Core Sampling Event
Sampling for core sites.

DO-36 Del Puerto Creek
Picture of the sample location at Del Puerto Creek.

DO-06 SJR at Maze
The San Joaquin River near Maze Blvd.

DO-19 Salt Slough at Lander
Sample location at Salt Slough near Lander Ave.

DO-08 SJR at Crows Landing
Sample location under the bridge at DO-08 San Joaquin River at Crows Landing.

April 27, 2005

Wetland Station Maintenance
Performed maintenance on Wetland stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA.

San Luis National Wildlife Refuge
Picture of a coyote in the wetlands.

DO-62 Mallard Slough
Mallard Slough from inside the Elk Pasture.

DO-61 Deadmans Slough
Photo of debris placed over the weir structure by beavers.

DO-63 Inlet C Canal
Sample site at Inlet C Canal which is the source water for the wetlands.

May 05, 2005

Core Sampling Event and Sampling Site Scouting Trip
Sampling for core sites. Will Stringfellow and Gary Litton spent the day scouting sample site locations.

DO-32 Grayson Drain
Water flowing through El Solyo Water District's Grayson Drain.

DO-39 Salado Creek
A segment of Salado Creek near the flow station flows underground through pipes and can be accessed by openings like the one pictured above.

DO-05 San Joaquin River at Vernalis
Stilling wells for the instruments used by DWR at their Vernalis flow station.

Abandoned Vehicle
Photo of an abandoned vehicle the crew found while scouting potential sample sites.

May 17, 2005

Westside Station Maintenance
Performed maintenance on Westside stations. DO-35 Westley Wasteway, DO-33 Hospital Creek and DO-53 Salt Slough at Wolfsen were visited for data downloads, cleaning, flow, EC, and temperature QA. The Starflow was removed from Westley Wasteway to troubleshoot. Bubbler connector was leaking. It was reassembled and tested for leaks, but none were found.

DO-53 Salt Slough at Wolfsen
Sample location on Wolfsen bridge over Salt Slough. The EC cable was replaced at this site.

DO-33 Hospital Creek
Flow station shed at DO-33 Hospital Creek.

May 19, 2005

Core Sampling Event
Sampling for core sites. The crew sampled DO-12 Stanislaus River at Caswell from the beach in an eddy and DO-28 Westport Drain was sampled from Jennings Road.

DO-59 SJR at Laird Park
Sample location along the San Joaquin River at Laird Park.

DO-05 SJR at Vernalis
DWR flow station at Vernalis.

DO-06 SJR at Maze
San Joaquin River at Maze blvd.

May 23-27, 2005

Confined Space Training
Jeremy Hanlon, Will Stringfellow, and Jesse Merkel attended a confined space training course with the Stockton Fire Department. Confined spaces are a routine part of Westside maintenance and they require special training to enter them.

Confined Space Training
Photo showing one of the class members crawling over another member inside a concrete pipe.

Confined Space Training
Will Stringfellow with all of his safety equipment getting ready to go into an underground confined space.

Confined Space Training
Jeremy Hanlon about to be lowered down a grain silo to rescue a pretend victim at the bottom of the silo.

Port of Stockton
Class members inside of a concrete ship performing a staged rescue.

June 02, 2005

Core Sampling Event
Sampling for core sites.

DO-04 SJR at Mossdale
Picture of the train bridge over the San Joaquin River at Mossdale.

DO-28 TID Westport Drain
Westport Drain showing where old flow station had been washed out in the previous year.

DO-14 Tuolumne River at Shiloh Bridge
Sampling crew member collecting water quality samples from the Tuolumne River.

DO-06 SJR at Maze
Pump platform where the crew collects water quality samples.

June 16, 2005

Core Sampling Event
Sampling for core sites.

DO-29 Harding Drain
EERP van parked on the bridge over Harding Drain.

DO-04 SJR at Mossdale
Jesse Merkel and Student Intern collecting samples from the San Joaquin River.

DO-05 SJR at Vernalis
The sampling crew is getting ready to head to the next sampling location.

DO-07 SJR at Patterson
Sampling crew collecting a sample on the boat ramp.

June 30, 2005

Core Sampling Event
Sampling for core sites.

DO-18 Mud Slough near Gustine
Flow station shed on Mud Slough. The station is maintained by USGS.

DO-16 Merced River at River Road
Sampling crews collect water samples from the old historic Merced River bridge at River Road.

DO-19 Salt Slough at Lander Ave
Picture looking upstream from the sampling location at Salt Slough at Lander Ave.

DO-04 SJR at Mossdale
Sampling crews collect water samples from the boat ramp floating dock at Mossdale Crossing Regional Park.

July 06, 2005

SLD Dye Study
Dye study along the San Luis Drain. The study started at the bridge upstream of Check 17. The crew collected readings of Rhodamine dye with the Hydrolab Multiprobe.

DO-103 San Luis Drain Check 18
Gary Litton setting up the Rhodamine dye to be dispensed into the San Luis Drain.

DO-104 San Luis Drain Check 16
Garry Litton and Jesse Merkel preparing to deploy a Hydrolab Multiprobe into the San Luis Drain.

DO-103 San Luis Drain Check 18
Rhodamine dye was added to the San Luis Drain tinting the water with a red hue.

DO-50 San Luis Drain Site A (Check 17)
Gary Litton deploying a Hydrolab Multi-probe into the San Luis Drain just upstream of Check 17.

July 14, 2005

Core Sampling Event
Sampling for core sites. While at DO-25 MID Miller Lake the sampling crew noticed a fish kill near the inlet to Miller Lake. The crew recoded Sonde data along the canal to determine the cause of the fish kill.

Wildflowers
Many sample sites are surrounded by weeds and wildflowers like the one pictured above.

DO-25 MID Miller Lake
Dead fish floating in the canal at the inlet to Miller Lake.

DO-25 MID Miller Lake
Cattle in the canal just upstream of the fish kill.

DO-25 MID Miller Lake
Sampling crew collecting data just upstream of the fish kill.

July 28, 2005

Core Sampling Event
Sampling for core sites.

DO-25 MID Miller Lake
Often times Miller Lake has a large amount of Duckweed floating on its surface.

DO-36 Del Puerto Creek.
The photo is depicting the bubbler line, EC line, and staff gauge located in Del Puerto Creek.

DO-19 Salt Slough at Lander Ave
Salt Slough flowing under the bridge.

DO-28 TID Westport Drain
The sample location for Westport Drain is downstream of the flume structure and can be accessed from the levee road.

August 02, 2005

Westside Station Maintenance
Performed maintenance on Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, and DO-33 Hospital Creek were visited for data downloads, cleaning, flow, EC, and temperature QA. The Starflow at Westley Wasteway was reinstalled.

DO-35 Westley Wasteway
Weir structure confining the water in a pond at Westley Wasteway.

DO-34 Ingram Creek
Weir structure at DO-34 Ingram Creek.

August 11, 2005

Core Sampling Event
Sampling for core sites.

DO-18 Mud Slough near Gustine
Photo of Mud Slough meandering through the San Luis National Wildlife Refuge.

DO-21 Orestimba Creek
Water quality samples for Orestimba Creek are collected under the bridge next the flow station.

DO-44 San Luis Drain End
Weir structure at the end of the San Luis Drain.

August 17, 2005

Intermittent Sampling Site Scouting
Jeremy Hanlon and Jesse Merkel scouted out potential sample sites for intermittent sample events.

DO-15 Tuolumne River at Modesto
Flow station at the Tuolumne River at Modesto.

DO-15 Tuolumne River at Modesto
Transients living along the banks of the Tuolumne River near the flow station.

DO-24 MID Lat 6 to Stanislaus
Jeremy Hanlon standing next to MID Lat 6.

DO-13 Stanislaus River at Ripon
Jeremy Hanlon looking for a potential access point to collect a water quality sample.

August 18, 2005

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-52 Salt Slough at Sand Dam
Sample location at Salt Slough at Sand Dam.

DO-20 Los Banos Creek
Student Interns collecting water quality samples and taking notes at Los Banos Creek.

DO-17 Merced River at Stevinson
Jeremy Hanlon and Student Intern collecting sonde and flow data from the Merced River.

DO-19 Salt Slough at Lander Ave
Student Intern collecting water quality samples.

August 23, 2005

San Luis Drain TOC Study
Sampling for the San Luis Drain TOC Study.

DO-44 San Luis Drain End
Jeremy Hanlon and Will Stringfellow setting up the Hydrolab Multiprobe with the laptop.

DO-44 San Luis Drain End
Photo of the San Luis Drain End.

August 25, 2005

Core Sampling Event
Sampling for core sites.

DO-04 SJR at Mossdale
Student Intern setting up the LUX meter to collect light data.

DO-04 SJR at Mossdale
Sample location at San Joaquin River at Mossdale.

September 06, 2005

Westside Station Maintenance and San Luis Drain TOC Study
Performed maintenance on Westside stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA. The Starflow was removed from DO-31 New Jerusalem Drain to troubleshoot back at the lab. The Hydrolab Multiprobe instruments were picked up after being deployed for the San Luis Drain TOC Study.

DO-31 New Jerusalem Drain
Jesse Merkel setting up the equipment for confined space entry.

DO-31 New Jerusalem Drain
Weir structure, bubbler line, and EC probe in the bottom of the manhole at New Jerusalem Drain.

DO-50 PE-14 Grasslands Area Farmers
Jesse Merkel collecting the instruments that were deployed in the headwaters to the San Luis Drain.

DO-50 PE-14 Grasslands Area Farmers
Pictures of a Hydrolab Multiprobe after being deployed in the headwaters to the San Luis Drain.

September 08, 2005

Core Sampling Event
Sampling for core sites.

DO-12 Stanislaus River at Caswell
Sample location along the Stanislaus in Caswell Park.

DO-25 MID Miller Lake
Picture looking downstream of weir structure at Miller Lake.

DO-07 SJR at Patterson
Photo of the boat ramp and low water near the pump platform at Patterson.

September 20, 2005

Boat Training Event
Jeremy Hanlon and Will Stringfellow took the EERP boat out for a test drive along the San Joaquin River.

San Joaquin River
Will Stringfellow getting ready to try out the EERP boat.

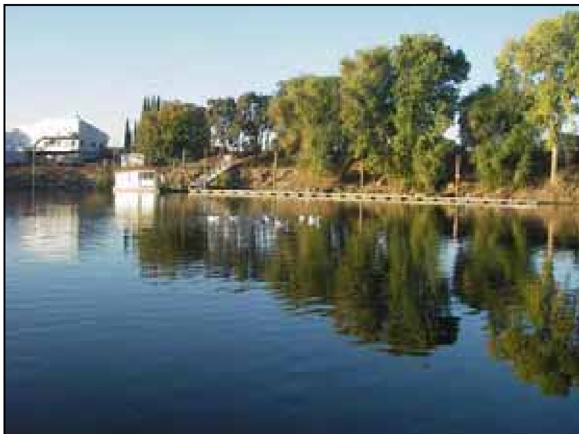
San Joaquin River
Jeremy Hanlon taking his turn at piloting the boat.

San Joaquin River
View from the back of the boat.

San Joaquin River
Will Stringfellow piloting the boat around the San Joaquin River.

September 22, 2005

Core Sampling Event
Sampling for core sites.



DO-04 SJR at Mossdale
San Joaquin River at Mossdale.

DO-06 SJR at Maze
Water quality samples are collected off of the pump platform at Maze.

DO-10 SJR at Lander Ave
Sampling location at DO-10 San Joaquin River at Lander Ave.

DO-08 SJR at Crows Landing
San Joaquin River from the dock at the Turlock Sportsmans Club.

September 29, 2005

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-32 El Solyo Water District Grayson Drain
Photo of one of the many field hazards encountered during sampling trips.

DO-32 El Solyo Water District Grayson Drain
Jesse Merkel preparing to collect sonde data from Grayson Drain.

DO-66 El Solyo Water District Maze Blvd Drain
Sample location at Maze Blvd Drain. The drain is next to DO-06 SJR at Maze.

DO-66 El Solyo Water District Maze Blvd Drain
Picture of the EERP van parked next to the sampling site.

October 04, 2005

Wetland Sampling Event
Sampling for wetland sites.

DO-63 Inlet C Canal
Inlet C Canal supplies water to the San Luis National Wildlife Refuge.

South Marsh 1
Photo of South Marsh 1 when it is flooded.

DO-19 Salt Slough at Lander
Sample location at DO-19 Salt Slough at Lander Ave.

DO-53 Salt Slough at Wolfsen
Flow station on Salt Slough at Wolfsen bridge.

October 05, 2005

Westside Station Maintenance
Performed maintenance on Westside stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA. The Starflow at DO-31 New Jerusalem Drain was reinstalled.

DO-38 Marshall Drain
Chris Linneman (Summers Engineering) collecting stage and flow QA data from the bottom of the Marshall Drain manhole.

DO-36 Del Puerto Creek
Chris Linneman performing a flow rating at Del Puerto Creek.

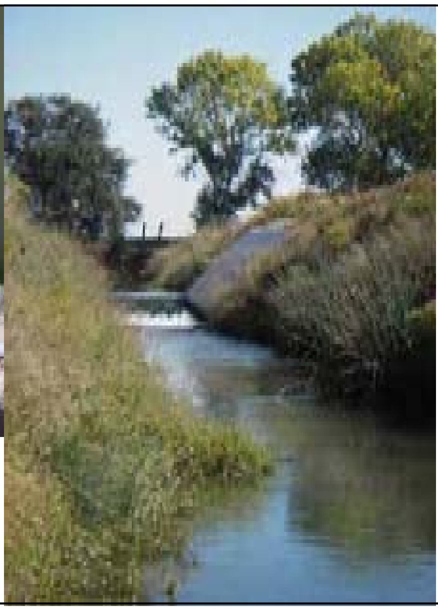
October 06, 2005

Core Sampling Event
Sampling for core sites.

DO-18 Mud Slough near Gustine
Samples are taken at the bridge that crosses over Mud Slough in the San Luis National Wildlife Refuge.

DO-16 Merced River at River Road
Merced River from the old bridge.

DO-29 TID Harding Drain
Water flowing over the weir structure in Harding Drain.



DO-28 TID Westport Drain
Water flowing through the concrete flume.

October 11, 2005

Wetland Sampling Event
Sampling for wetland sites. A Starflow unit was installed at DO-62 Mallard Slough.

DO-81 South Marsh 1 Outlet
Sampling crew are preparing to collect a sample.

DO-62 Mallard Slough
Photo taken from inside the culvert under the road.

DO-62 Mallard Slough
Underwater picture of the newly installed Starflow unit at DO-62 Mallard Slough.

DO-81 South Marsh 1 Outlet
Sonde data is being collected at the outlet structure in South Marsh 1.

October 13, 2005

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-67 Newman Wasteway at Brazo Road
Jesse Merkel collecting sonde data at Newman Wasteway.

DO-30 TID Lat 6 and 7
Jesse Merkel deploying the sonde to collect data from TID Lat 6 and 7 before it flows under the levee.

DO-31 BCID New Jerusalem Drain
Sampling crew preparing to collect a sample from New Jerusalem Drain.

DO-35 Westley Wasteway
Westley Wasteway just upstream of the flow station.

October 18, 2005

Wetland Sampling Event
Sampling for wetland sites.

DO-82 South Marsh 3 Inlet
The inlet to the permanent wetland.

DO-60 Moffit 1 South
Beaver debris often clogs up the weir structure which has to be cleared.

DO-62 Mallard Slough
Mallard Slough in the San Luis National Wildlife Refuge.

DO-61 Deadmans Slough
Sonde data is being collected at the outlet of DO-61 Deadmans Slough.

October 20, 2005

Core Sampling Event
Sampling for core sites. There was very little flow at Miller Lake because it was being drained.

DO-25 MID Miller Lake
Water being pumped out of Miller Lake.

DO-25 MID Miller Lake
Very low water level in Miller Lake.

DO-25 MID Miller Lake
Photo showing very little flow under the levee from Miller Lake.

DO-14 Tuolumne River at Shiloh
Student Intern collecting water quality samples from the Tuolumne River.

October 25, 2005

Wetland Sampling Event
Sampling for wetland sites. Weir boards at DO-60 Moffit 1 South were cleared and the data was downloaded from the station.

DO-60 Moffit 1 South
Jesse Merkel cleaning off the weir boards.

DO-62 Mallard Slough
Photo of what the beavers will do to a weir board if the top is not encased in a metal bracket.

DO-60 Moffit 1 South
Metal brackets were added to the weir boards to prevent the beavers from chewing the boards.

October 27, 2005

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-67 Newman Wasteway at Brazo Road
Sample location along Newman Wasteway.

DO-35 Westley Wasteway
Outflow from the culvert under the road at Westley Wasteway.

DO-31 BCID New Jerusalem Drain
Outlet of New Jerusalem Drain before it goes into the San Joaquin River.

DO-66 El Solyo Water District Maze Drain
Sampling crew storing the gear before heading to the next sample site.

November 02, 2005

Westside Station Maintenance
Performed maintenance on Westside stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA. Chris Linneman (Summers Engineering) installed concrete anchors for the bubbler pipe in Moran Drain.

DO-64 Moran Drain
Chris Linneman (Summers Engineering) drilling anchors into the concrete to stabilize bubbler pipe.

DO-36 Del Puerto Creek
Chris Linneman (Summers Engineering) performing a flow rating at Westley Wasteway while Liz Vonckx (Tetra Tech) cleans the EC probe.

November 08, 2005

Wetland Sampling Event
Sampling for wetland sites.

DO-63 Inlet C Canal
Samples are collected off of the walkway going over the Inlet C Canal.

DO-60 Moffit 1 South
Flow station at DO-60 Moffit 1 South.

DO-80 Marsh 1 Inlet
Picture of the inlet to temporary Marsh 1. Flow into the wetland is controlled by a screw gate.

DO-53 Salt Slough at Wolfsen
Flow station at DO-53 Salt Slough at Wolfsen.

November 10, 2005

Core Sampling Event
Sampling for core sites. DO-25 Miller Lake was dry and no sample was collected.

DO-07 SJR at Patterson
Student Intern collecting water quality samples from the pump platform.

DO-07 SJR at Patterson
Sample vehicle parked next to the pump platform at San Joaquin River at Patterson.

DO-29 TID Harding Drain
Student Intern is collecting a water quality sample using the bucket method.

DO-29 TID Harding Drain
Water is flowing through a hole in the middle of the weir structure instead of over the top.

November 29, 2005

Wetland Sampling Event
Sampling for wetland sites. DO-62 Mallard Slough was not sampled because the crew was locked out.

DO-53 Salt Slough at Wolfsen
Flow station on Salt Slough at Wolfsen.

DO-63 Inlet C Canal
Photo showing DO-63 Inlet C Canal.

November 30, 2005

Westside Station Maintenance
Performed maintenance on Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

Three Drain Site
Flow station at the Three Drain site.

DO-35 Westley Wasteway
Photo showing Westley Wasteway just upstream of the flow station.

December 01, 2005

Core Sampling Event
Sampling for core sites.

DO-12 Stanislaus River at Caswell Park
Sample site along the Stanislaus River in Caswell Park.

DO-44 SLD End
Weir structure at the end of the San Luis Drain.

DO-21 Orestimba Creek
The sample location for Orestimba Creek is under the bridge next to the flow station.

DO-07 SJR at Patterson
Photo of the San Joaquin River taken from the Patterson pump platform.

December 13, 2005

Wetland Sampling Event
Sampling for wetland sites.

DO-81 South Marsh 1 Outlet
Jesse Merkel is collecting a water sample from the temporary wetland.

DO-82 South Marsh 3 Inlet
The sonde is deployed in a float to prevent it from disturbing the sediments along the bottom of the sample site.

DO-53 Salt Slough at Wolfsen
Picture of the SonTek after being deployed in Salt Slough for a length of time.

DO-83 South Marsh 3 Outlet
Sample crew collecting sonde data and water quality samples from the outlet of the permanent wetland.

January 9, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and equipment issues at the DO sites she manages within the Grasslands water district.
DO-20 Los Banos Creek Flow Station: Arrived to find old bridge completely washed out and dangling downstream from the instrument cables. Used rope and truck to pull bridge onto east bank of stream. Removed Sontek and pulled cable into pipe along with EC probe. Disconnected bubbler orifice and pulled pipe up onto shore. Brought Sontek unit in for cleaning and functionality check. Equipment was functional.
DO-68 S-Lake basin and Hollow tree Drain: S-Lake was at flood stage, boards for platform where the staff gauge was attached were floating. Hyacinth was 2+ft thick. EC probe was lifted out of water by Hyacinth. Keller Pressure Transducer in Hollowtree was non-functional. Measured length of cable for replacement sensor.
DO-46 MudSlough at Gun Club Rd.: Flood stage. Staff gauge was completely submerged by several inches.

Coyote in Wetland
Typical wildlife encountered during wetland trips.

January 11, 2006

Westside Station Maintenance and QA
Met with Chris Linneman (Summers Engineering) and Kyle Kearney (Tetra Tech) at the 'three drains site' DO-38 Marshall Drain, DO-64 Moran Drain, and DO-65 Spanish Grant Drain for routine Westside station maintenance. In addition to the above sites, DO-36 DelPuerto Creek, DO-33 Hospital Creek, DO-35 Westley Wasteway, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-34 Ingram Creek
(left) Student Intern, Kyle Kearney, Jeremy Hanlon, and Chris Linneman removing EC probe which had been encased in sediment. (right) Chris and Jeremy clearing away sediment buildup.

DO-38 Marshall Drain
Chris is preparing for his confined space entry to make flow measurements while Kyle cleans the YSI EC probe from the surface.

January 17, 2006

SLNWR Station Maintenance
Data downloads and station maintenance/QA performed at DO-60 Moffit, DO-61 Deadmans Slough, DO-62 Mallard Slough, and DO-63 Inlet C canal.

Ducks flying over refuge
Waterfowl were often seen flying around the refuge.

January 19, 2006

Core Sampling Event
Sampling for core sites. Picture taken from DO-05 SJR at Vernalis from the Department of Water Resources (DWR) McClune station platform looking north, shows San Joaquin River (SJR) swollen with runoff from recent rains.

DO-05 SJR at Vernalis
Debris caught on DWR platform pylons.

DO-28 TID Westport Drain Flow station
Newly Installed flume and SCADA monitoring system, about 300 ft downstream of the previous station location.

DO-36 Del Puerto Creek monitoring site
Streambed is dry despite recent rains and high levels in SJR.

DO-06 SJR at Maze Blvd.
El Solyo pump platform submerged under swollen SJR.

January 26, 2006

Wetlands Sampling Event
Sampling for wetland sites.

DO-61 Deadmans Slough
Picture taken at DO-61 Deadmans Slough in the San Luis National Wildlife Refuge. William Stringfellow is taking YSI sonde measurements. Additional measurements were taken throughout the wetlands sampling area.

January 31, 2006

Station Maintenance
DO-31 New Jerusalem Drain was visited in response to the discovery of a leaky bubbler line. The Swagelok fitting was removed and properly re-inserted, the connection was tightened, and checked for leaks. No leaks were found. The weir was rated for correlation to the bubbler reading. DO-34 Ingram Creek was visited to remove some of the sediment from behind the weirboard. The Sontek Doppler instrument at DO-53 Salt Slough at Wolfsen Road was re-installed because the mounting had been discovered to be completely rusted through the previous month. A new mount with stainless steel attachments was used. Met with Karl Stromayer of USFWS while at DO-53 to discuss upcoming training on station maintenance and QA procedures.

DO-31 New Jerusalem Drain
(left) Station house on top of levee with SJR behind. Ropes are rigged for lowering or belaying confined space entrant. (right) Rope system rigged for hauling up of confined space entrant.

DO-31 New Jerusalem Drain
Shows location of bubbler line orifice and YSI EC meter just upstream of weirboards. The unusually clear water here made the Starflow unable to read velocity and so it was removed and eventually upgraded to a MACE Agriflo unit that was placed downstream of the weirboards.

February 2, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and QA at the DO sites she manages within the Grasslands water district. DO-45 Volta Wasteway Flow station staff gauge had been mounted to wood post that rotted away. The staff gauge was re-installed and anchored directly to a pole on the bridge with stainless steel clamps.

Stream Ratings
Pictures taken at DO-68 S-Lake Basin Monitoring site with Jeremy Hanlon and Lara Sparks performing a stream rating. Ratings were made at DO-68 S-Lake basin, Hollow tree Drain, DO-46 Mud Slough at Gun Club, and DO-45 Volta Wasteway Flow station.

February 8, 2006

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations and performed flow measurements. Added weir board to DO-38 Marshal Road Drain, DO-64 Moran Drain, and DO-65 Spanish Drain. DO-35 Westley Wasteway Flow station DA logger was not communicating with YSI EC probe. Removed Logger for inspection and testing at UOP. At DO-57 Ramona Lake noted that the cable the YSI EC probe hung from was almost rusted out. Measured length for replacement.

DO-31 New Jerusalem Drain
Installed new MACE Agriflow Doppler flow meter. Note new smaller solar panel in picture (left) provides 6V power supply for Agriflo unit. Picture of water flowing over weir boards (top right) and picture looking upstream of pipe under levee (bottom right).

February 14, 2006

Westside Station Repairs
Returned to DO-31 New Jerusalem Drain to update Firmware on new MACE Agriflo unit so it would correctly output SDI-12 to the DA logger.
Returned to DO-35 Westley Wasteway Flow station to re-install DA logger after ensuring it was functioning properly with equipment at UOP. Found that the cable to the Starflow Doppler flow meter had been sliced open while a backhoe was clearing debris from the channel. Determined that the destroyed Starflow Doppler flow meter was causing a short circuit and making the logger freeze every time it tried to take a measurement. Disconnecting the cable solved the problem.

Starflow Doppler flow meter
Picture of Sontek Doppler flow meter with protective tubing around cord. The Starflow is put on the bottom of the channel to measure flow.

February 23, 2006

Core Sampling Event
Sampling for core sites. All sites were accessible and no problems were encountered.

DO-07 San Joaquin River at Patterson
Picture of Jeremy Hanlon's truck near the pump platform.

March 2, 2006

Wetland sampling event
Sampling for wetland sites. In addition to collecting grab samples, data was downloaded from the stations and QA measurements were taken. Beaver dams and other debris were cleared from weir boards where possible.

Beaver Activity
Picture of beaver dam at DO-60 Moffit 1 South. Debris and beaver activity clogged the weirs which often had to be cleared.

March 8, 2006

Westside Station Maintenance and QA
Accompanied Kyle Kearney (Tetra Tech) to provide support for safe entry into confined spaces. Took flow measurements. Added one 2x8 board to each of the three drains sites DO-38 Marshall Road Drain, DO-64 Moran Drain, and DO-65 Spanish Grant Drain. DO-34 Ingram creek, repositioned rocks in stream to help avoid siltation of EC probe.

DO-33 Hospital Creek
Close-up photo of installation showing bubbler pipe, EC meter in cage, and stream gauge all just upstream of weirboard.

DO-33 Hospital Creek
Student Intern in foreground with Kyle Kearney in station.

March 9, 2006

Core Sampling Event
Sampling for core sites. No problems encountered. All sites sampled despite extensive flooding.

Flooded Wetlands
The Kesterson unit of SLNWR. Near DO-20 Los Banos Creek.

March 10, 2006

Station Maintenance
Met with Nigel Quinn (LBNL) to scout out locations of West Stanislaus Irrigation District diversion canal monitoring station and Patterson Irrigation District diversion canal monitoring station.



DO-41 West Stanislaus ID Diversion canal
Scouting location of West Stanislaus ID diversion monitoring station with Nigel Quinn to clean EC sensor and download data from the Campbell logger for Ron Roos of WSID.

DO-20 Los Banos Creek
Jeremy Hanlon met with Nigel Quinn, Lara Sparks (Grasslands Water District/Fish and Game), and William Stringfellow to review construction by Grasslands Water District on new bridge and to discuss plans for upgrading the Los Banos station equipment installation (see July28, 2006, September 5, 2006, and October 31, 2006).

DO-40 Patterson ID Diversion Canal
Scouting for location of YSI EC probe for periodic cleaning for Nigel Quinn.

March 21, 2006

USFWS training
Presented a 4 hour instructional clinic for US Fish and Wildlife Staff of the SLNWR on methods for flow monitoring; continuous data collection and compiling; station maintenance; and QA procedures. Training session attendees included: Karl Stromayer, Dennis Wollington, Tom Denniston, Brandon Jordan, Louise Zeringue, Ken Griggs, and Mike Enos.

Field Monitoring Training Station in UOP Hydraulics Laboratory
The training station set up at the UOP Hydraulics laboratory was used to simulate a real field monitoring station and allowed trainees the opportunity for hands-on practice.

March 23, 2006

Core Sampling Event
Sampling for core sites. DO-33 Hospital Creek was dry and DO-57 Ramona Lake had no flow. Neither site was sampled. All other sites were sampled.

DO-16 Merced River at River Road
Parking location for sampling vehicle to grab samples from the Merced River. Photo was taken from the bridge where samples are bucket sampled.

March 30, 2006

Wetland Sampling Event
Sampling for wetland sites. Met with Karl Stromayer (USFW) to deliver data CD. Weir at DO-60 Moffit 1 South was plugged with debris upon arrival. There was standing water and no flow so a sonde measurement was taken but no grab sample. DO-61 Deadmans Slough had no flow out of weir, but Bear creek unit pump was running so samples were collected. No samples were taken at DO-80 Marsh 1 Inlet because the screw gate was closed resulting in no flow at the site.

Photo of Hawk over Wetlands
One of the scenes during wetland sampling trips.

April 6, 2006

Core Sampling Event
Sampling for core sites. Flood conditions existed at most sites. DO-20 Los Banos Creek was not sampled because the access road was flooded. However, DO-33 Hospital Creek was dry and not sampled.

DO-21 Orestimba Creek at River Rd.
Photo of flooded Orestimba Creek. At non-flood stage the flow is a small stream at the bottom of the gorge.

DO-08 San Joaquin River at Crows Landing
Our normal access site at the Turlock sportsmans club is from the floating dock at the end of the normally dry boat ramp. High flows in the SJR made access impossible so samples were taken from the bank just to the left of this photograph's view.

DO-07 San Joaquin River at Patterson
Student Intern collecting grab samples from the Patterson Irrigation District diversion platform on the SJR. Water level in the SJR was just a couple feet below the platform.

April 11, 2006

YSI Training in Sacramento
YSI sponsored a free sonde features and calibration seminar at a hotel in Sacramento.

YSI Training
Remie Burks and Jeremy Hanlon attended an all day training seminar. This was a good opportunity for Remie to learn calibration procedures and for Jeremy to learn some trouble shooting tips and maintenance techniques.

April 20, 2006

Core Sampling Event
Sampling for core sites. River at flood conditions. DO-25 Miller Lake and DO-33 Hospital Creek had no flow and were not sampled. DO-59 SJR at Laird Park was not sampled because Laird Park was closed. DO-30 TID Lat 6&7 was not sampled because there was no access key. DO-36 Del Puerto Creek and DO-08 SJR at Crow's Landing were not sampled because they were flooded.

DO-44 San Luis Drain End
Remie Burks and Student Intern collecting samples.

DO-19 Salt Slough at Lander Avenue
Student Intern and Remie collecting samples.

DO-08 SJR at Crows Landing
Turlock Sportsman Club under water after flooding. Grab samples are normally pulled from a site just beyond the big tree in the center of the picture.

DO-07 SJR at Patterson
Sampling site off a PID pump structure

April 26, 2006

Port of Stockton Aeration Site Visit
Site Visit for Demonstration of Dissolved Oxygen Aeration Facility U-Tube Drilling at the Port of Stockton, Warehouse 20. The Department of Water Resources and Jones & Stokes invited the DOTMDL Technical Work Group to participate in a tour of the aeration device site.

Port of Stockton
Photos of tour of Dissolved Oxygen Aeration Facility.

April 27, 2006

Wetland Sampling Event
Sampling for Wetland sites. There was no flow at both DO-60 Moffit 1 South and DO-63 Inlet C Canal, so no samples was taken. DO-81 Marsh 1 Outlet was dry and had no water to sample.

DO-60 Moffit 1 South
Student Interns clear debris from a weir in the wetlands.

DO-19 Salt Slough at Lander Avenue
Collecting water samples and recording sonde data.

May 4, 2006

Core Sampling event
Sampling for core sites. River still flooded. DO-08 SJR at Crow's Landing was not sampled since the site was still flooded.

DO-07 SJR at Patterson
Photo of SJR near Patterson during flood conditions.

May 8, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and station maintenance at the DO sites she manages within the Grasslands water district.


Wetland ponds near DO-20 Los Banos Creek
Pictures are of drying temporary wetland ponds near DO-20.

May 9, 2006

Westside Maintenance and QA
Assisted in maintenance of Westside stations. Cleaned EC probe at DO-40 Patterson ID diversion canal at Elm Street. Downloaded data and cleaned EC probe at DO-41 West Stanislaus ID diversion canal. DO-57 Ramona Lake station was destroyed due to the high flood levels. Three drain site were backed up from the river, weirboards floated out, and access to road was blocked by telephone pole. Found that DO-38 Marshall Road Drain bubbler line had a leak, removed “T” valve which seemed to fix problem.

DO-57 Ramona Lake
Doing maintenance at the field station at Ramona Lake. The station at DO-57 was destroyed from high water levels in the SJR.

DO-41 West Stanislaus Irrigation District Diversion
Photo looking upstream of West Stanislaus Irrigation District Diversion monitoring station house.

May 11, 2006

Wetland Sampling Event
Sampling for wetland sites. DO-80 Marsh 1 Inlet had no flow and DO-81 Marsh 1 Outlet was dry, so samples were not taken.

DO-80 Marsh 1 Inlet
No flow at site, so no samples where taken.

DO-81 Marsh 1 Outlet
Photo of dry Marsh 1 Outlet

DO-82 Marsh 3 Inlet
Photo of Marsh 3 Inlet.

May 17, 2006

BMP Maintenance
Visited Perez Farms and Westside Patterson Farms to look at ideas for BMP project.


Drainage Ditch at Perez Farms
Cement weir structure at end of drainage ditch. Water is colored brown with tannins from the alfalfa field.


Westside Patterson Farms
Picture of Westside Patterson Farms and ditch next to the alfalfa fields.

May 18, 2006

Core Sampling Event
Sampling for core sites. Flood levels still high. DO-08 SJR at Crow's Landing was not sampled. DO-21 Orestimba Creek had stagnant water, so no samples were taken.

DO-7 SJR at Patterson
Photo of pipe structure near DO-07 SJR at Patterson.

May 31, 2006

BMP Maintenance
Will Stringfellow and Jeremy Hanlon met with Chris Linneman (Summers Engineering) at Westside Patterson Farms. Crew installed weir in un-vegetated ditch and created vegetated ditch for water to flow down. Survey work was done on the two ditches.

Head of Vegetated Ditch
Dirt pile from digging out canal. Notice the un-vegetated ditch next to the vegetated ditch.

Un-vegetated Ditch
Student Intern and Matt Rogers (LBNL) surveying ditch on Westside Patterson Farms.

Vegetated Ditch
Sonde in vegetated ditch. Water barely covered the sensors.

DO-101 WPF-UD-IN
Jeremy Hanlon working on weir structure for inflow into un-vegetated ditch.

June 01, 2006

Core Sampling Event
Sampling for core sites. DO-36 Del Puerto Creek and DO-23 MID Lat 5 to Tuolumne had no flow and were not sampled. DO-21 Orestimba Creek was backed up with water from the San Joaquin River, no sample was taken.

DO-07 SJR at Patterson
Saturated San Joaquin River near Patterson

June 06, 2006

Westside Station Maintenance and QA
Accompanied Kyle Kearney (Tetra Tech) to provide assistance in maintenance of Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC and temperature QA.

DO-31 New Jerusalem Drain
Exit of New Jerusalem Drain into the San Joaquin River.

DO-31 New Jerusalem Drain
San Joaquin River at high water level near DO-31.

Three Drain Site
Road leading up to levee with the three drain sites: DO-38, DO-64, and DO-65.

DO-35 Westley Wasteway
Westley Wasteway pond before being re-installed (see July 07, 2006 and August 01, 2006).

June 07, 2006

BMP Sample Site Scouting
Met with Matt Rogers (LBNL) at Westside Patterson Farms to discuss potential BMP sampling locations.

Un-vegetated Ditch near DO-86
Will Stringfellow and Matt Rogers (LBNL) follow irrigation runoff from Westside Patterson Farms.

DO-88 Ramona Drain at Apricot
Trash and Duckweed floating on top of the water at DO-88.

DO-88 Ramona Drain at Apricot
Matt Rogers looking at debris near DO-88.

DO-57 Ramona Lake
Cattle blocking the road near DO-57.

June 08, 2006

Boat Sampling
Tried to take the boat out for sampling. Started to go out, but engine kept lagging. Went back to dock and tried to locate problem. Called boat manufacturer, suggested fuel filter problems or auxiliary fuel intake getting air into it. Took boat out of water. Replaced fuel filter and caped off extra auxiliary fuel line at a later date. No further problems were encountered.

Photo of Boat
The boat is used in boat sampling events and boat studies on the San Joaquin River.

June 15, 2006

Core Sampling Event
Sampling for core sites. DO-36 Del Puerto Creek was not sampled because it had no flow.

DO-29 Harding Drain
Drain was backed up and full of debris. Crew sampled from clear area on the side.

DO-57 Ramona Lake
Student Intern and Justin Graham collecting water samples from Ramona Lake pump platform.

June 21, 2006

Boat Work
Cabinet was built and installed on back of boat to house gear and laptop for sampling trips.

Boat Work
Student Intern and Justin Graham worked on building and installing a cabinet for the boat. The cabinet houses boat equipment and a laptop for sampling (See July 27, 2006).

June 22, 2006

BMP Sampling Event
Sampling for BMP sites. DO-57 Ramona Lake and DO-91 Paradise at Prune had no flow and were not sampled. DO-90 Ramona at Almond was not accessible. DO-94 Paradise at Almond was blocked by a pipeline. Sample was taken south of actual sample site. DO-88 Ramona at Apricot was flowing in reverse to the south.

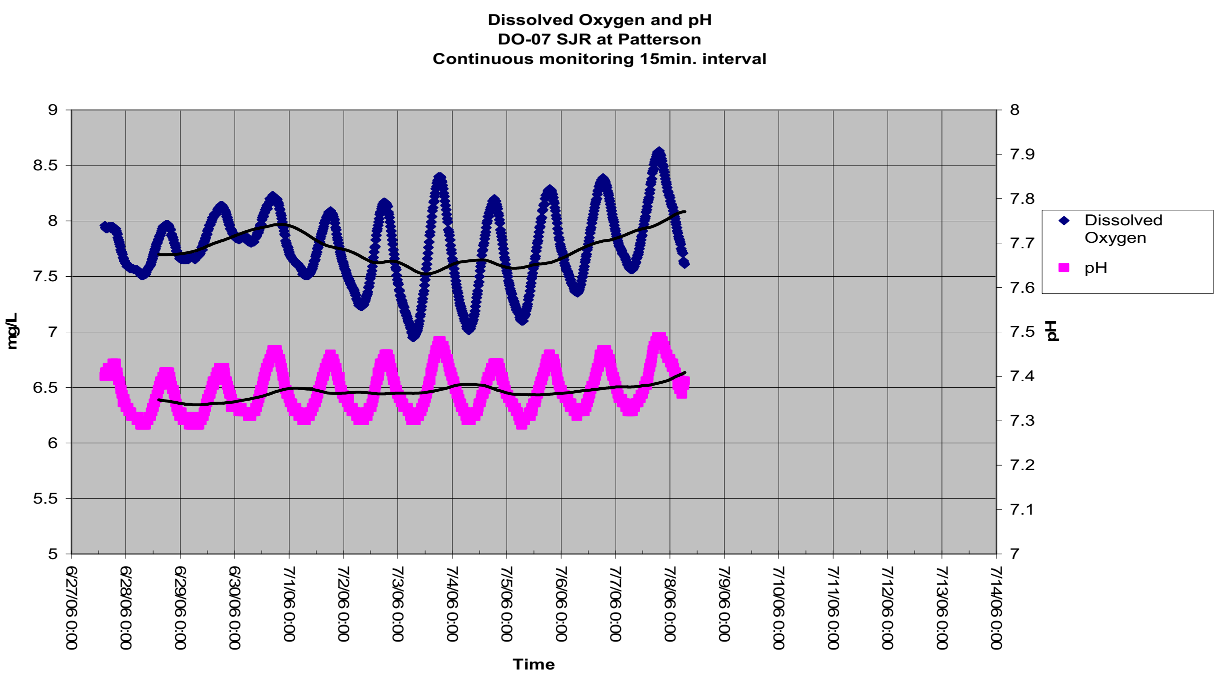
DO-91 Paradise at Prune
Site had no flow and was not sampled.

DO-92 Paradise at Apricot
Student intern and Justin Graham collecting samples from drain on side of road.

DO-94 Paradise at Almond
Pump was blocking access to actual sample site. Pump was taking water out of paradise drain and putting it onto adjacent fields. Velocity was flowing towards the pump intake.

June 27, 2006

Extended Deployment
Crew deployed sondes in field for extended deployment. Sondes were deployed at DO-44 San Luis Drain End, DO-19 Salt Slough at Lander, DO-08 SJR at Crows Landing, DO-07 SJR at Patterson, and DO-05 SJR at Vernalis.



Extended Deployment Data
Example of pH and dissolved oxygen data collected from extended deployment at DO-07 San Joaquin River at Patterson. Notice the daily fluctuations in the two graphs.

June 29, 2006

BMP sampling event
Sampling for BMP sites. No problems encountered.

Westside Patterson Farms
Photo of the landscape around Westside Patterson Farms.

July 06, 2006

Core Sampling Event
Sampling for core sites. No problems were encountered.

Photo of Sampling Vehicle
This is the EERP van that is used by one of the two field crews to collect grab samples.

July 11, 2006

Station Maintenance and QA
Stations in the San Luis National Wildlife Refuge were visited for cleaning, downloads, flow, and EC QA. DO-60 Moffit 1 South, DO-61 Deadmans Slough, DO-62 Mallard Slough, DO-63 Inlet C Canal, DO-53 Salt Slough at Wolfsen, DO-40 Patterson Irrigation District Diversion, and DO-41 West Stanislaus Irrigation District Diversion were visited. A flow rating was performed at DO-53. Mallard Slough's weir boards were clogged with mud and plants. Stopped by DO-35 Westley Wasteway to check on progress of station re-installation.

DO-35 Westley Wasteway
Checked on progress of Westley Wasteway. Irrigation District was installing a new weir board structure and reshaping canal. Installed new bubbler and EC line at a later date (see Aug 01, 2006).

July 13, 2006

Core Sampling Event and Extended Deployment
Sampling for core sites. Sampling Crew picked up and deployed extended deployment sondes at Sites DO-44 San Luis Drain End, DO-19 Salt Slough at Lander, DO-08 SJR at Crows Landing, DO-07 SJR at Patterson, and DO-05 SJR at Vernalis.

Post Deployment Sonde
Sonde covered in algae after extended deployment. Notice how the wipers kept the sensors free of algae.

DO-08 SJR at Crows Landing
Student Intern and Justin Graham Sampling from boat dock at Turlock Sportsman Club.

DO-19 Salt Slough at Lander
Custom fabricated PVC housing covered in algae.

DO-10 SJR at Lander
Custom float holds sonde off of river bottom to take water quality measurements. The green tint is due to suspended algae in river.

July 20, 2006

Intermittent Sampling Event
Sampling for Intermittent sites. Samples taken at DO-54 Los Banos Creek at Ingomar Grade, DO-45 Volta Wasteway at Ingomar Road, DO-46 Mud Slough at Gun Club Road, DO-67 Newman Wasteway at Brazo Road, DO-38 Marshall Road Drain, DO-65 Spanish Grant Drain, DO-64 Moran Drain, DO-35 Westley Wasteway, DO-32 El Soyo Grayson Drain, DO-27 TID Lat 2 to SJR, DO-66 Maze Blvd Drain, and DO-31 New Jerusalem Drain.

DO-54 Los Banos Creek at Ingomar
Student intern taking samples from bridge over Los Banos creek.

DO-46 Mud Slough at Gun Club
Sampling crew deploying sonde and taking water samples from bridge.

DO-64 Moran Drain
Student intern and Justin Graham taking samples from manhole.

DO-31 New Jerusalem Drain
Student intern and Justin Graham using bucket to sample down manhole over New Jerusalem Drain.

July 21, 2006

Westside Station Maintenance and QA
Accompanied Kyle Kearney (Tetra Tech) to provide assistance in maintenance of Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-34 Ingram Creek, DO-33 Hospital Creek, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-34 Ingram Creek
While working on the monitoring station, this school of fish was spotted near the outflow of a drainage pipe.

July 25, 2006

Extended Deployment
Crew picked up sondes left in field for extended deployment. Deployed sondes were picked up at DO-44 San Luis Drain End, DO-08 SJR at Crows Landing, DO-07 SJR at Patterson, and DO-05 SJR at Vernalis.

Post Deployment
Sondes were covered in algae and small aquatic macro invertebrates after being left in the field for an extended deployment. Sondes were put into coolers to keep the sensors moist while transporting.

July 27, 2006

Core Sampling Event
Sampling for core sites. Delta sites were sampled by boat.


Boat Sampling
Jeremy Hanlon (left) driving the boat. Will Stringfellow (right) collecting water samples off bow of boat.


Boat Sampling Equipment
Jeremy Hanlon putting cables through cabinet box. Jeremy Hanlon created a linked Sontek, sonde, and GPS unit to provide his laptop with correlated sampling data while on the boat.

July 28, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and station maintenance at the DO sites she manages within the Grasslands water district. DO-20 Los Banos Creek, Fremont Canal, DO-46 Mud Slough at Gun Club, DO-68 S-Lake Basin, Volta Wasteway, and DO-53 Salt Slough at Wolfsen were visited for maintenance and flow ratings.

DO-20 Los Banos Creek
Performed a flow rating at DO-20. Took pictures to get ideas for installation of bubbler, EC, and Sontek (See September 5, 2006 and October 31, 2006).

August 01, 2006

Station Upgrade
Visited DO-35 Westley Wasteway Flow station. Cut and installed five weir boards for a total of eight. Allowed pond to fill up and equilibrate. Took measurement for installation of bubbler line and EC probe (see September 5, 2006).

DO-35 Westley Wasteway
Pictures taken after weir boards installed. Bubbler and EC line have not yet been installed.

August 03, 2006

BMP sampling event
Sampling for BMP sites. DO-91 Paradise Drain at Prune Ave had no flow and was not sampled. A flow rating was done at DO-86 Ramona Drain at Apple Ave.

DO-86 Ramona Drain at Apple Ave.
Jeremy Hanlon performing a stream rating across Ramona Drain.

DO-101 WFP-UD-IN
Will Stringfellow looking at weir structure at start of un-vegetated ditch on Westside Patterson Farms.

DO-88 Ramona Drain at Apricot Ave.
Sonde deployed off of pipe. The site has large amounts of duck weed and other aquatic vegetation.

DO-101 WFP-UD-IN
The sonde is in the un-vegetated ditch with a custom made shield to protect it from the plants in the ditch.

August 04, 2006

San Luis Drain Extended Deployment Study
Crew deployed sondes in the San Luis Drain for extended deployment. No samples were taken. Sites deployed at were DO-103 Check 18, DO-106 Check 14, DO-108 Check 12, DO-110 Check 10, DO-112 Check 8, DO-114 Check 6, DO-116 Check 4, DO-118 Check 2, and DO-44 San Luis Drain End.

DO-115 Check 5
Photo of water flowing over weir structure during extended deployment. Note the green color due to algae in the water.

August 10, 2006

San Luis Drain Study
Sampling for San Luis Drain extended deployment sites. Samples were taken at sites where Sondes had been left for extended deployment. Sites sampled were DO-103 Check 18, DO-48 San Luis Drain Site A (Check 17), DO-104 Check 16, DO-105 Check 15, DO-106 Check 14, DO-107 Check 13, DO-108 Check 12, DO-109 Check 11, DO-110 Check 10, DO-111 Check 9, DO-112 Check 8, DO-113 Check 7, DO-114 Check 6, DO-115 Check 5, DO-116 Check 4, DO-117 Check 3, DO-118 Check 2, DO-119 Check 1, and DO-44 San Luis Drain End.


DO-106 Check 14
Student Intern and Justin Graham collecting water samples over drain.

DO-115 Check 5
Student Intern and Justin Graham deploying sonde and collecting water samples.

DO-103 Check 18
Sampling sonde next to extended deployment sonde in PVC housing.

August 17, 2006

Core Sampling Event
Sampling for core sites. DO-34 Ingram Creek wasn't well mixed at normal sample location. Grab samples were taken on other side of road where stream had a better chance to mix. Sonde was kept at normal sample location, downstream was too aerated to put sonde in.

DO-28 TID Westport Drain
Pictures of DO-28 and sampling from levee road.

August 18, 2006

San Luis Drain Extended Deployment Study
Crew retrieved sondes left in the San Luis Drain for extended deployment. Sondes were picked up from DO-103 Check 18, DO-106 Check 14, DO-108 Check 12, DO-110 Check 10, DO-112 Check 8, DO-114 Check 6, DO-116 Check 4, DO-118 Check 2, and DO-44 San Luis Drain End. No grab samples were taken.

DO-44 San Luis Drain End
Photo of platform at San Luis Drain End.

August 22, 2006

Westside Station Maintenance and QA
Accompanied Kyle Kearney (Tetra Tech) to provide assistance in maintenance of Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-40 Patterson Irrigation District Diversion Canal, and DO-41 West Stanislaus Irrigation District Diversion canal were visited for data downloads, cleaning, EC and temperature QA. Flow QA was measured at Marshall Drain, Spanish Drain, Moran Drain, Del Puerto Creek, Westley Wasteway, and Ingram Creek.

Wildlife in the Road
An occasional scene during Westside Station Maintenance.

August 24, 2006

Core Sampling Event and meeting with Summers Engineering
Sampling for core sites. The sonde cable for the southern sampling crew would not stay connected. Crew was able to fix problem by briefly connecting to sonde and having it log every 10 seconds. Will Stringfellow and Jeremy Hanlon met with Chris Linneman (Summers Engineering) at Marshall Road Pond.

Marshall Road Pond
Will Stringfellow and Jeremy Hanlon met with Chris Linneman at Marshall Road Pond to plan scientific studies examining water quality impact of water reuse facilities.

August 31, 2006

Intermittent Sampling Event
Sampling for intermittent sites. Samples were taken from DO-44 San Luis Drain End, DO-09 SJR at Fremont Ford, DO-21 Orestimba Creek, DO-38 Marshal Road Drain, DO-29 Harding Drain, DO-07 SJR at Patterson, DO-14 Tuolumne River, DO-25 Miller Lake, DO-31 New Jerusalem Drain, and DO-04 SJR at Mossdale.

DO-21 Orestimba Creek
Samples were taken from under the bridge at DO-21.

DO-14 Tuolumne River
Justin Graham and Student Intern taking samples from under bridge at DO-14.

DO-25 Miller Lake
Justin Graham and Student Intern taking water samples near outlet from Miller Lake.

DO-29 Harding Drain
Sampling crew taking water samples. On the left Megan Young (USGS) was collecting samples for her isotope work.

September 05, 2006

Station Upgrades
DO-35 Westley Wasteway Flow station and DO-20 Los Banos Creek were upgraded. A new bubbler and EC line were installed at DO-35. A junction box and bubbler liner were installed at DO-20. Two weir boards were added at DO-65 Spanish Grant Drain.



DO-35 Westley Wasteway Flow Station
A new bubbler and EC line were installed at DO-35. The green basket on the EC probe (right) protects the probe from debris. The picture in the middle shows Jeremy Hanlon clearing sediment in front of the weir boards.



DO-20 Los Banos Creek
A new bubbler line was installed at DO-20. A junction box (left) , fabricated by Jeremy Hanlon, was installed at the edge of the water. A separate EC and Sontek line were run from this junction box across the bridge at a later date (See October 31, 2006).

September 07, 2006

Core Sampling Event
Sampling for core sites. Sonde for northern crew was having chlorophyll sensor wiper parking problems. Data was still usable. DO-25 Miller Lake was sampled at a new location upstream in the same channel on opposite bank 100 ft downstream of bridge because old sample location was no longer safe to access due to a slippery embankment.

DO-25 Miller Lake
Photo of the usual sampling site. Due to the slippery slope that makes it unsafe to sample, samples were taken a few hundred feet to the right of this photo where it was safe to sample.

September 12, 2006

Extended Deployment
Crew deployed sondes in field for extended deployment. Sondes were deployed at DO-20 Los Banos Creek, DO-44 San Luis Drain End, DO-19 Salt Slough at Lander, DO-08 San Joaquin River at Crows Landing, DO-07 San Joaquin River at Patterson, and DO-05 San Joaquin River at Vernalis.

Sonde Deployment
At DO-20 Los Banos Creek (left) sonde was deployed from bridge in a pvc housing using cable. At DO-07 SJR at Patterson (Right) sonde was deployed from pump housing platform.

DO-44 San Luis Drain End
Sonde was deployed along the side of the outflow pipe at DO-44. The sonde was secured using a cable and padlock.

DO-08 SJR at Crows Landing
Picture shows the dock structure at the Turlock Sportsman Club. The sonde was deployed on the far side of the dock.

September 14, 2006

Wetland Sampling Event and Station Maintenance.
Sampling for wetland sites. Downloaded data from stations. Extra samples were taken at three sites for experiments at LBNL. Did not take a sample at DO-60 Moffit 1 South because there was no water. No flow and no sample taken at DO-61 Deadmans Slough and DO-62 Mallard Slough. A flow rating was done at DO-53 Salt Slough at Wolfsen.



DO-81 Marsh 1 Outlet
Pictures of flooded marsh and outflow structure of Marsh 1 in San Luis National Wildlife Refuge.

DO-82 Marsh 3 Inlet
Justin Graham and Student Intern at DO-82 taking water samples and Sonde measurements.

DO-120 Marsh 1 Intermediary
Sampling crew and EERP van next to sample site DO-120.

September 19, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and station maintenance at the DO sites she manages within the Grasslands water district. Performed stream ratings at DO-46 Mud Slough at Gun Club Road, DO-20 Los Banos Creek, and Fremont Slough.

Station in the Grasslands
One of the stations managed by Lara Sparks.

September 21, 2006

Core Sampling Event
Sampling for core sites. Sonde got stuck in weir at DO-29 Harding Drain. Crew was able to retrieve it after thirty minutes. Sonde values were not recorded for DO-29.

Photo of Spider
Spiders are commonly seen during summer and fall sampling events.

September 26, 2006

Extended Deployment
Crew retrieved sondes left in field for extended deployment. Sondes were retrieved from DO-20 Los Banos Creek, DO-44 San Luis Drain End, DO-19 Salt Slough at Lander, DO-08 San Joaquin River at Crows Landing, DO-07 San Joaquin River at Patterson, and DO-05 San Joaquin River at Vernalis. The Turbidity wiper was not working properly from sonde at DO-05.

DO-20 Los Banos Creek
Sonde was deployed from bridge in a pvc housing using cable. Sonde was halfway out of water, but sensors were still submerged

DO-19 Salt Slough at Lander
Sonde was deployed next to pipe running into the water. Cable was secured around the metal fence post.

DO-07 SJR at Patterson
Sonde was hung from bottom of pump platform. All cables were padlocked to the structure they were secured to.

September 28, 2006

Wetland Sampling Event
Sampling for wetland sites. Jeremy Hanlon and Will Stringfellow scouted new sampling locations for Marsh 1 temporary wetland.

DO-122 Marsh 1 West
(left) Picture of Will Stringfellow taking notes next to DO-122 Marsh 1 West. (right) Picture showing DO-122 Sampling location next to tree in levee road.

October 03, 2006

Westside Station Maintenance
Visited Westside station for routine maintenance. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC and temperature QA.

YSI 600 XL EC Probe
Photo of YSI 600 XL and hand-held used to measure independent EC for QA.

October 05, 2006

Core Sampling Event
Sampling for core sites. DO-36 Del Puerto Creek was inaccessible due to muddy road conditions.

DO-59 SJR at Laird Park
Remie Burks preparing to collect sample from Laird Park.

DO-25 Miller Lake
Looking north over bridge at start of the drain out of Miller lake. Sample site is north west of picture.

October 12, 2006

Wetland Sampling Event
Sampling for Wetland sites. DO-60 Moffit 1 South and DO-62 Mallard Slough were not sampled because they both had no flow.

Sandhill Cranes
Picture of Sandhill Cranes near a temporary wetland.

October 19, 2006

Core Sampling Event and Boat Study
Sampling for core sites. Jeremy Hanlon and Will Stringfellow used boat to run an integrated GPS, sonde, and Sontek sampling program on the San Joaquin River near Patterson. Boat was put in at the boat ramp at DO-07 SJR at Patterson and taken a few miles upstream.

Boat Study
Picture from bow of boat on San Joaquin River.

DO-07 SJR at Patterson
Picture of Patterson pump platform from the Boat.

Boat Study
Picture looking upstream of the San Joaquin River near Patterson.

DO-07 SJR at Patterson
Will Stringfellow setting up Par light meter for deployment off of boat.

October 24, 2006

Boat Training
Jeremy Hanlon, Remie Burks, and Justin Graham took the EERP boat out on the SJR from the Port of Stockton to Mossdale. Outing was a hands on boat training session for Remie Burks and Justin Graham.

Boat Training
Photo of Remie Burks (left) and Justin Graham (right) driving the EERP boat on the San Joaquin River.

October 26, 2006

Wetland Sampling Event
Sampling for wetland sites. DO-60 Moffit 1 South was not sampled because it had no flow. Dissolved Oxygen values for DO-80 Marsh 1 Inlet were not valid because the DO membrane on YSI sonde # 1 became punctured and had to be changed.

DO-60 Moffit 1 South
Water was below weir and site was not sampled.

DO-80 Marsh 1 Inlet
Canal inlet for Marsh 1. DO membrane became punctured and had to be changed.

DO-121 Marsh 1 East
Student Intern sampling Marsh 1, a temporary wetland.

DO-82 Marsh 3 Inlet
Algae across the surface of the water at Marsh 3, a permanent wetland.

October 27, 2006

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations and performed flow measurements. No water was flowing through DO-64 Moran Drain. Performed a stream rating at DO-36 Del Puerto Creek. Measured weir width at DO-35 Westley Wasteway Flow Station.

DO-31 New Jerusalem Drain
Station shed at DO-31. Data from monitoring equipment was stored on a data logger located in the station shed and downloaded during station maintenance.

October 31, 2006

Station Maintenance
Upgraded DO-20 Los Banos creek and DO-53 Salt Slough at Wolfsen. Installed Sontek mount to bridge at DO-20 and ran Sontek and EC line across bridge. Installed a solar panel at DO-53. Station was taken off of land power because it kept tripping the circuit breaker of a nearby house.

DO-20 Los Banos Creek
(Above) Nigel Quinn (LBNL) helping install Sontek mount to pylon. (Top right) Lara Sparks (Grasslands Water District/Department of Fish and Game) next to junction box for bubbler, EC, and Sontek lines. (Middle right) Jeremy Hanlon and Nigel Quinn installing Sontek mount.

DO-53 Salt Slough at Wolfsen
(Bottom right) New solar panel installed at Salt Slough at Wolfsen.

November 02, 2006

Wetland Sampling Event
Sampling for wetland sites. DO-60 Moffit 1 South had no flow but was still sampled.

DO-46 Mud Slough at Gun Club Road
Photo of aquatic vegetation near DO-46 Mud Slough at Gun Club Road.

November 09, 2006

Core Sampling Event
Sampling for core sites. Sample crew was locked out of pump platform at DO-07 SJR at Patterson. Sample taken from boat launch dock.

DO-07 SJR at Patterson
Photo taken from pump platform. Crew was locked out of pump platform and had to sample from boat launch dock seen on left side of photo.

November 16, 2006

Wetland Sampling Event
Sampling for wetland sites. All sites were accessible and no problems were encountered.

DO-20 Los Banos Creek
Student Intern Sampling near recently completed bridge.

DO-46 Mud Slough at Gun Club
Student Intern Sampling from bridge over Mud Slough.

November 17, 2006

Station Maintenance
Visited DO-31 New Jerusalem Drain for maintenance. Tried downloading data from MACE unit but got error. Downloaded config file. Restarted unit and downloaded data again. Cleared stored memory and ran bubble line test for three minutes.

DO-31 New Jerusalem Drain
Photo shows general setup of equipment in station shed. The MACE unit is on the right. Flow data is downloaded from the unit with a laptop connected via com port.

December 07, 2006

Core Sampling Event
Sampling for core sites. DO-25 Miller Lake the spill way was blocked with just a trickle through the boards. Sample was taken.

DO-19 Salt Slough at Lander Ave
Photo of sample location at DO-19. Samples are taken next to bridge.

December 8, 2006

Westside Station Maintenance and QA
Accompanied Kyle Kearney (Tetra Tech) to provide assistance in maintenance of Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC and temperature QA. The logger at DO-31 New Jerusalem Drain stopped recording data and was showing error 145 and 149. The logger was restarted and was able to record data without any further problems. Logger was replaced at a later date (see December 18, 2006).

Station Maintenance
YSI EC probe being cleaned at the three drain site.

December 14, 2006

Wetland Sampling Event
Sampling for wetland sites. DO-122 Marsh 1 West was just mud with no water, no sample was taken. Ground water was being pumped in east of sample site DO-82 Marsh 3 Inlet. The pond was stratified and sampling was depth integrated.

DO-122 Marsh 1 West
Sample location was not sampled because there was just mud and no water.

DO-61 Deadmans Slough
Weir boards were blocked by debris, making an accurate flow rating impossible.

DO-08 SJR at Crows Landing
Student intern taking water samples from dock.

DO-53 Salt Slough at Wolfsen Road
Downstream across bridge. Both a sample and a flow rating were taken at DO-53.

December 18, 2006

DO-31 New Jerusalem Drain Station Maintenance
Jeremy Hanlon switched out the logger at DO-31 New Jerusalem Drain with the logger from the Hydraulics lab training station. The logger at DO-31 randomly shut off and stopped logging data. It was taken to the Hydraulics lab training station to be tested.

H-350XL Design Analysis Logger
Photo of data logger used in the Westside stations.

December 21, 2006

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and station maintenance at the DO sites she manages within the Grasslands water district.

Stream Ratings
(Left) Jeremy Hanlon performing a stream rating at Volta Wasteway Flow Station. Water was too deep to complete rating safely. (Right) Jeremy Hanlon at DO-20 Los Banos Creek performing another stream rating. Note completed bridge with handrails along both sides and hinged ramps.

In addition to the above sites, Hollow Tree, Fremont Canal, DO-46 Mud Slough at Gun Club, and DO-68 S-Lake Basin were visited for maintenance and flow ratings. DO-33 Hospital Creek was also visited to verify the weir board width.

January 11, 2007

Core Sampling Event
Sampling for core sites. DO-25 Miller Lake had no flow and was not sampled. There wasn't any flow at DO-57 Ramona Lake but a sample was still collected. The outlet structure for Ramona Lake was blocked with mud.

DO-57 Ramona Lake
Mud blocking outlet structure at Ramona Lake. Flow was blocked, but sample was still collected.

DO-57 Ramona Lake
Looking down into manhole. Sample was collected on lake side of levee because of mud blocking outlet from the lake.

January 18, 2007

Wetland Sampling Event
Sampling for wetland sites. DO-61 Deadman's Slough was clogged with debris. Flow rating was taken at the outlet pipes. The gate at Turlock Sportsman's Club was locked blocking access to DO-08 SJR at Crows Landing. The site was sampled under the bridge just upstream of normal sample location.

DO-120 Marsh 1 Intermediary
Student Interns collecting water samples from temporary wetland.

DO-61 Deadman's Slough
Weir boards were blocked by debris from beaver activity.

DO-20 Los Banos Creek
Remie Burks recording water quality data from YSI sonde.

January 19, 2007

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations and performed flow measurements. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

Orchard on way to Three Drain site
The trees had ice on their branches from the irrigation sprinklers.

DO-65 Spanish Grant Drain
Kyle Kearney (Tetra Tech) cleaning EC probe at DO-65 Spanish Grant Drain.

DO-35 Westley Wasteway Flow Station
Weir structure at Westley Wasteway.

DO-31 New Jerusalem Drain
Jeremy Hanlon downloading data from the logger inside flow station shed.

February 01, 2007

Core Sampling Event
Sampling for core sites. No sample was collected at DO-25 Miller Lake because there wasn't any flow.

DO-44 SLD End
Chelsea Spier collecting samples from the end of the drain.

DO-21 Orestimba Creek
Looking downhill from side of bridge at sample site.

DO-08 SJR at Crows Landing
Sonde is deployed off of dock at Turlock Sportsman's Club.

DO-57 Ramona Lake
Outlet structure for Ramona Lake on the lake side of the levee.

February 13, 2007

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations and performed flow measurements. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-34 Ingram Creek, DO-33 Hospital Creek, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-65 Spanish Grant Drain
Jeremy Hanlon measuring stage using the blue pole.

DO-34 Ingram Creek Flow Station
Weir structure at Ingram Creek.

DO-33 Hospital Creek Flow Station
Flow station adjacent to road at Hospital Creek.

DO-33 Hospital Creek Flow Station
Team preparing to leave station. Vehicles were parked next to the road to minimize tracks left in the mud.

February 15, 2007

Wetland Sampling Event
Sampling for wetland sites. DO-61 Deadman's Slough was clogged with debris. Flow rating was taken at the outlet pipes.

DO-60 Moffit 1 South
Weir structure at Moffit 1 South. Structure has to occasionally be cleared of beaver debris for accurate flow measurements.

DO-61 Deadman's Slough
Weir boards blocked by debris from beaver activity. Water flowing over and around weir structure from damming action.

DO-45 Volta Wasteway at Ingomar
Chelsea Spier collecting samples at Volta Wasteway.

DO-53 Salt Slough at Wolfsen Road
Chelsea Spier collecting water samples from bridge over Salt Slough.

March 01, 2007

Core Sampling Event
Sampling for core sites.

DO-18 Mud Slough near Gustine
Student Intern collecting water samples.

DO-19 Salt Slough at Lander
Student Intern preparing to sample. An extra vehicle was rented on core sampling events to accommodate two sampling crews.

DO-10 SJR at Lander
Student Intern wearing yellow safety vest for visibility while sampling next to bridge.

March 06, 2007

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-38 Marshall Drain
Justin Graham suited up to go down manhole and collect flow measurements.

DO-31 New Jerusalem Drain
View of inside of station. Laptop is used to download data from the Mace flowmeter.

DO-57 Ramona Lake
Picture of newly installed weir box at lake opening. Weir box will divert flow into the main lake.

DO-33 Hospital Creek Flow Station
Water flowing over weir structure at Hospital Creek.

March 08, 2007

Wetland Sampling Event
Sampling for wetland sites. DO-61 Deadman's Slough was clogged with debris. Weirboards were pulled at DO-81 Marsh 1 Outlet and the temporary wetland was draining. DO-121 Marsh 1 East was sampled 30 ft west of normal sample location due to draining wetland. DO-120 Marsh 1 Intermediary had no water and was not sampled.

Sample bottles
Bottles are labeled in the field with the site number, date, and name for identification in the laboratory.

DO-61 Deadman's Slough
Student Intern collecting sample. Weir-boards blocked by debris from beaver activ-ity.

DO-81 Marsh 1 Outlet
Picture of the outlet structure for the tempo-rary wetland. Weirboards were pulled from the structure before the crew arrived.

DO-120 Marsh 1 Intermediary
Water was drained from wetland leaving this site dry. No sample was collected.

March 12, 2007

Grasslands Station Maintenance and QA
Met with Lara Sparks (Grasslands Water District/Department of Fish and Game) to assist her with stream ratings and station maintenance at the DO sites she manages within the Grasslands water district.

DO-20 Los Banos Creek Flow Station
Justin Graham carefully opening shed to Los Banos Creek. One of the hazards of field work are the many wasps and spiders that make their home in the flow sheds.

DO-68 S-Lake Basin
Lara Sparks (GWD/DFG) cleaning EC probe at S-Lake Basin.

DO-129 Hollow Tree
Justin Graham recording stage for Hollow tree. Water is flowing out of the flume into S-Lake Basin.

March 16, 2007

Boat Work
The boat was taken out onto the San Joaquin River to do a trial run of Jeremy Hanlon's real-time data collection program.

Boat Launch
Student Intern waiting for boat to be launched into the water.

Boat getting underway
Remie Burks piloting boat down the San Joaquin River.

En route to sample location
Justin Graham and Student Intern wearing life vests en route to the sample location.

Testing Equipment
Jeremy Hanlon and Justin Graham test real-time data collecting using a program that Jeremy Hanlon put together.

March 20, 2007

DO-57 Ramona Lake Station Upgrade
Installed a HOBO pressure logger at the weir at lake entrance to record stage. Installed a box and pipe inside of manhole for EC probe and Bubbler line after they were ripped out during last year's floods. Box was mounted to side of manhole but increasing rain prevented finishing re-installation of bubbler line and EC probe.

Probe Housing Box
Jeremy Hanlon making a box to mount the probes at DO-57 Ramona Lake

Weir at Lake Entrance
Jeremy and a Student Intern installing a stilling well and HOBO pressure logger at the lake inlet to record stage.

Probe Housing Box Mounting
Jeremy Hanlon using a hammer drill to mount the box to the side of the manhole.

Finishing Work on Sensor Mount
Jeremy Hanlon reviewing almost complete sensor mount at DO-57 Ramona Lake. Work was cut short due to increasing rain.

March 22, 2007

Wetland Sampling Event
Sampling for wetland sites. DO-54 Los Banos Creek at Ingomar Grade was dry and no sample was collected. DO-61 Deadman's Slough was clogged with debris.

DO-19 Salt Slough at Lander
Student Intern preparing to collect sample at Salt Slough.

DO-46 Mud Slough at Gun Club Road
Chelsea Spier retrieving sonde from bridge.

Sheep in wetlands
Occasionally sheep are seen grazing the wetlands.

Truck unloading the sheep
The sheep are trucked in and let out into temporary pens with electrified fencing.

March 29, 2007

DO-57 Ramona Lake Station Upgrade
Finished installing the EC probe and Bubbler line after they were ripped out during last year's floods.

DO-57 Ramona Lake
Picture of Ramona Lake from top of levee.

DO-57 Ramona Lake Manhole
Jeremy Hanlon installing a pipe to protect the EC probe and cable from debris.

Probe Housing Box Mounting
Jeremy Hanlon finished installing bubbler and EC line in manhole.

DO-57 Ramona Lake
Water flowing into outlet at Ramona Lake.

April 05, 2007

Wetland Sampling Event and BMP Ramona Lake Survey
Sampling for wetland sites. There was no water at DO-54 Los Banos Creek at Ingomar Grade. DO-61 Deadman's Slough was clogged with debris. Jeremy Hanlon and Will Stringfellow collected data on Ramona Lake from a small boat. Flow, temperature, depth, EC, DO, pH, turbidity, and chlorophyll data were collected from various points on the lake.

DO-54 Los Banos Creek at Ingomar Grade
Picture of dry riverbed at Los Banos Creek at Ingomar Grade. No sample was collected.

DO-53 Salt Slough at Wolfsen
Student Intern gathering gear from the rental sampling vehicle in preparation for sampling.

DO-57 Ramona Lake
Will Stringfellow packing up the gear after collecting data on the Lake.

DO-57 Ramona Lake
Will Stringfellow rowing the boat around Ramona Lake while Jeremy Hanlon collects data.

April 12, 2007

Core Sampling Event
Sampling for core sites. Could not access the gate for DO-30 TID Lat 6 and 7. No sample was collected for this site.

DO-19 Salt Slough at Lander
Photo of swallow nests under the bridge.

DO-29 TID Harding Drain
Picture depicting rendering plant next to sample site.

DO-29 TID Harding Drain
Justin Graham completing check sheet after collecting the sample at Harding Drain.

April 13, 2007

Westside Station Maintenance
Accompanied Kyle Kearney (Tetra Tech) to Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-38 Marshall Drain
Flow shed at the three drain site.

DO-31 New Jerusalem Drain
Picture of inside of flow shed at New Jerusalem Drain.

DO-57 Ramona Lake
Jeremy Hanlon downloading data from the flow shed at Ramona Lake.

DO-35 Westley Wasteway
Jeremy Hanlon and Kyle Kearney (Tetra Tech) are preparing to collect QA data from Westley Wasteway.

April 17, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes for extended deployment at Marshall Road Reservoir. The sondes were deployed at DO-130 Marshall Rd Reservoir Entrance, DO-132 Marshall Rd Reservoir Pond 1 West, DO-133 Marshall Rd Reservoir Pond 2 East, and DO-131 Marshall Rd Reservoir Exit.

DO-130 Marshall Rd Res Entrance
Jeremy Hanlon mounting the sonde to the side of the concrete structure.

DO-132 Marshall Rd Res Pond 1 West
Jeremy Hanlon and Student Intern mount the sonde to the side of the weir box.

DO-131 Marshall Rd Res Exit
Sonde was deployed off the side of the exit structure. The sonde was in a plastic housing attached to the structure with a cable and padlock.

April 19, 2007

Wetland Sampling Event
Sampling for wetland sites. There was no water at DO-54 Los Banos Creek at Ingomar Grade. DO-61 Deadman's Slough was clogged with debris.

DO-54 Los Banos Creek at Ingomar Grade
Picture of dry riverbed at Los Banos Creek at Ingomar Grade. No sample was collected.

Sheep near DO-60 Moffit 1 South
Sheep running from the van near Moffit 1 South.

Coyote in wetland
Picture of wildlife frequently seen while sampling in the wetlands.

DO-53 Salt Slough at Wolfsen
Samples are taken off of the bridge crossing Salt Slough.

April 26, 2007

Core Sampling Event
Sampling for core sites.

DO-12 Stanislaus River at Caswell
Photo of riparian vegetation around the sample location on the Stanislaus River.

DO-28 Westport Drain
Chelsea Spier collecting a sample.

DO-14 Tuolumne River at Shiloh
Sample location at Tuolumne River.

DO-04 SJR at Mossdale
Picture showing boat ramp at Mossdale.

May 01, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes for extended deployment at Marshall Road Reservoir. The sondes were deployed at DO-130 Marshall Rd Reservoir Entrance, DO-132 Marshall Rd Reservoir Pond 1 West, DO-133 Marshall Rd Reservoir Pond 2 East, and DO-131 Marshall Rd Reservoir Exit.

DO-130 Marshall Rd Res Entrance
Sonde was deployed into a housing bolted to the side of the structure.

DO-130 Marshall Rd Res Entrance
Chelsea Spier and Student Intern preparing to take a sample.

DO-57 Ramona Lake
Samples were also collected at Ramona Lake. Picture shows the outlet structure for Ramona Lake.

May 03, 2007

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-51 Arroyo Canal at Hwy 152
Student Intern collecting a sample.

DO-52 Salt Slough at Sand Dam
Site was not well mixed. Flow station downstream made new sample location for next sampling trip.

Inorganic Carbon Vials
Justin Graham fills IC vials for analysis at the Lab.

DO-31 New Jerusalem Drain
Justin Graham and Student Intern collecting a sample from the manhole.

May 10, 2007

Core Sampling Event
Sampling for core sites.

University of the Pacific campus
Back of EERP sampling van on the way to the first sampling site.

DO-44 SLD Drain
Student Intern unlocking the gate that leads out of the refuge by San Luis Drain.

DO-29 TID Harding Drain
Sample bottles set up for bucket sampling.

DO-95 Ramona Lake Inlet
Justin Graham taking a point velocity measurement.

May 15, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes for extended deployment at Marshall Road Reservoir. The sondes were deployed at DO-130 Marshall Rd Reservoir Entrance, DO-132 Marshall Rd Reservoir Pond 1 West, DO-133 Marshall Rd Reservoir Pond 2 East, and DO-131 Marshall Rd Reservoir Exit.

DO-130 Marshall Rd Res Entrance
Sonde had a lot of debris in housing. The housing was lowered to prevent debris accumulation.

DO-131 Marshall Rd Res Exit
Chelsea Spier in EERP sampling van.

DO-130 Marshall Rd Res Entrance
Sondes are deployed in a PVC pipe housing to protect them from debris in the water.

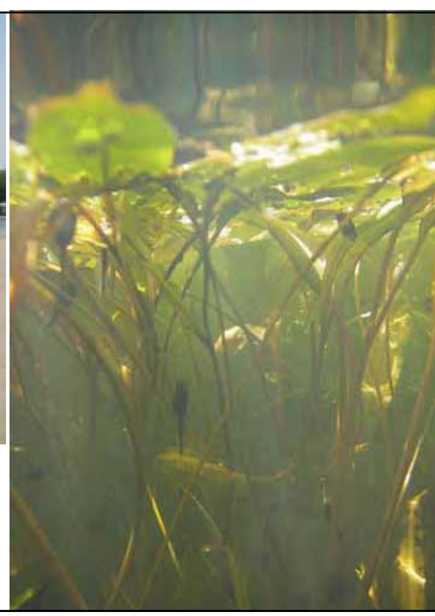
May 17, 2007

Intermittent Sampling Event
Sampling for Intermittent sites. Access to DO-26 TID Highline Spill sample location was blocked with a gate. Took a sample at the corner of Griffith and Williams downstream of sample location.

DO-52 Salt Slough at Sand Dam
Picture of new sample location near flow station.

DO-26 TID Highline Spill
Gate blocking access to sample location. Sample taken next to gate on other side of canal.

DO-24 MID Lat 6 to Stanislaus River
Student Intern collecting a water sample.



DO-24 MID Lat 6 to Stan. River
Underwater photo showing tadpoles and vegetation.

May 22, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA. Met with Mat Rogers at Ramona lake and Marshall Reservoir to collect samples for his microcosm experiment.

DO-31 New Jerusalem Drain
Jeremy Hanlon cleaning the EC probe.

DO-57 Ramona Lake
Justin Graham, Jeremy Hanlon, and Mat Rogers after collecting sediment samples in Ramona Lake.

DO-131 Marshall Road Res Exit
Mat Rogers holding a bullfrog.

DO-131 Marshall Road Res Exit
Mat Rogers and Justin Graham collecting a water sample.

May 24, 2007

Core Sampling Event
Sampling for core sites.

DO-25 Miller Lake
Bridge over the outlet of Miller Lake. Samples are collected from the bridge.

DO-25 Miller Lake
Sonde deployed in Miller Lake.

May 29, 2007

Extended Deployment Sampling Event and Westside Station Maintenance.
Sampling for extended deployment. Picked up extended deploy sondes. Performed maintenance on Westside stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-57 Ramona Lake
Jeremy Hanlon preparing to go down manhole.

DO-132 Marshall Road Res Pond 1 West
Jeremy Hanlon and Justin Graham picking up a deployed sonde.

DO-36 Del Puerto Creek
Justin Graham performing a flow rating on Del Puerto Creek.

DO-35 Westley Wasteway
YSI EC probe before being cleaned.

May 31, 2007

Intermittent Sampling Event
Sampling for Intermittent sites. DO-01 SJR at Channel Point, DO-02 SJR at Lathrop, and DO-03 SJR at Old River were collected from the boat.

DO-11 French Camp Slough
Sample site for French Camp Slough

San Joaquin River
Will Stringfellow piloting the boat to the next sample location.

DO-39 Salado Creek
Sample collected from opening in pipe that runs underground.

DO-35 Westley Wasteway
Debris in channel upstream of sample location.

June 05, 2007

Extended Deployment Sampling Event and Wetland Station Maintenance.
Sampling for extended deployment. Picked up extended deploy sondes at Ramona Lake. Performed maintenance on Wetland stations. Stations were visited for data downloads, cleaning, flow, EC, and temperature QA. Visited Marshall Road Reservoir weather station for data downloads.

DO-57 Ramona Lake
View of weir structure. Water is rushing under partially closed gate and hitting the weirboards causing a lot of turbulence.

DO-130 Marshall Road Res Entrance
Justin Graham and Student Intern downloading data from weather station.

DO-60 Moffit 1 South
One of the dangers encountered during fieldwork.

DO-62 Mallard Slough
Staff gauge at Mallard Slough in the wetlands.

June 07, 2007

Core Sampling Event
Sampling for core sites. The gate to DO-25 Miller Lake was locked and not accessible. The site was not sampled.

DO-04 SJR at Mossdale
Chelsea Spier collecting a sample.

DO-95 Ramona Lake Inlet
Jeremy Hanlon picking up an extended deploy sonde. Jeremy had to use the small boat because the water level was too high to safely wade out.

DO-95 Ramona Lake Inlet
Jeremy Hanlon in the small boat retrieving the sonde.

DO-07 SJR at Patterson
Chelsea Spier bucket sampling off of the pump platform.

June 12, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes in the San Joaquin River and tributaries. Sondes deployed at DO-19 Salt Slough at Lander, DO-44 SLD End, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, DO-07 SJR at Patterson, and DO-05 SJR at Vernalis.

DO-19 Salt Slough at Lander
The sonde and housing were deployed next to the EC sensor pipe and attached with a length of cable and padlock.

DO-10 SJR at Lander
Picture of the sonde housing attached to a fence post secured in the sediment.

DO-08 SJR at Crows Landing
The sonde was deployed off of the dock at the Turlock Sportsman's Club.

DO-07 SJR at Patterson
Justin Graham etches the side of the housing used to protect the sonde.

June 14, 2007

SLD Study Sampling Event
Sampling for SLD study sites. Sampled the check stations along the San Luis Drain.

DO-44 SLD End
EERP sample van with coolers to keep samples on ice until they can be delivered to the lab.

DO-116 Check 4
Chelsea Spier and Student Intern collecting a sample.

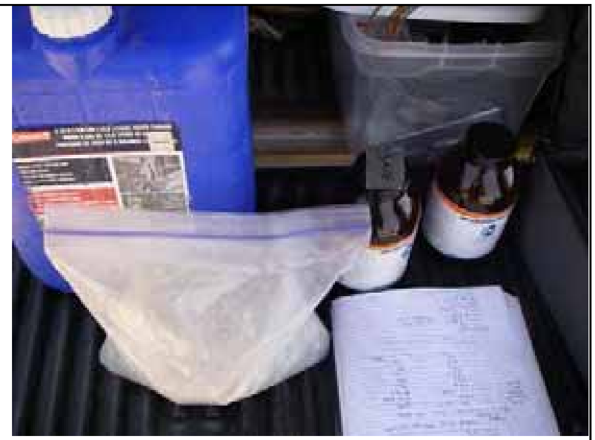
Sediment Sampling
Sharon Borglin and Will Stringfellow collecting a sediment sample from the SLD.

Sediment Sample
Picture of the sediment collected from the bottom of the drain.

June 19, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. Marshall Road Reservoir, DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA. Extended deploy sondes at Ramona Lake were retrieved.

Three Drain Site
Peacocks are frequently seen at the Three Drain site.



DO-35 Westley Wasteway
Desiccant is used in the stations to protect the electrical equipment from the moisture.

DO-36 Del Puerto Creek
Justin Graham returning from a flow rating.

DO-34 Ingram Creek
Justin Graham taking a staff gauge and weir stick reading at Ingram Creek.

June 21, 2007

Core Sampling Event
Sampling for core sites. The extended deploy sonde at DO-05 SJR at Vernalis was retrieved.

DO-12 Stanislaus River at Caswell
Chelsea Spier and Student Intern collecting a water sample.

DO-30 TID Lat 6 and 7
A wasp nest was discovered in dried out melon after being stepped on. Wasps are often found around sampling sites and flow sheds, especially in the summer.

DO-36 Del Puerto Creek
Chelsea Spier putting equipment into EERP van after collecting a sample.

DO-95 Ramona Lake Inlet
Student Intern collecting a sample at the inlet to Ramona Lake.

June 26, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes in the San Joaquin River and tributaries. Sondes deployed at DO-19 Salt Slough at Lander, DO-18 Mud Slough near Gustine, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, and DO-07 SJR at Patterson.

DO-18 Mud Slough near Gustine
Justin Graham calibrating Depth and DO in the field before the sondes are deployed.

DO-44 SLD End
Justin Graham collecting a sample.

DO-10 SJR at Lander
Justin Graham exchanging sondes. This site requires wading out to deploy the sonde.

DO-05 SJR at Vernalis
Student Intern collecting a sample. The monitoring station at this site has a pump to collect the sample water.

June 28, 2007

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-09 SJR at Fremont Ford
Picture of sample site at Fremont Ford looking downstream.

DO-67 Newman Wasteway at Brazo Rd
Photo of Newman Wasteway.

DO-39 Salado Creek
Student Intern collecting sample with a bucket.

DO-23 MID Lat 5 to the Tuolumne
After the samples are collected they are stored in the coolers with ice until they can be delivered to the lab at UOP.

July 05, 2007

Core Sampling Event
Sampling for core sites.

DO-10 SJR at Lander
Student Intern collecting a water sample.

DO-14 Tuolumne River at Shiloh
Sharon Borglin and Chelsea Spier using the bucket method to collect a sample. Water is evenly distributed to all of the bottles.

DO-29 Harding Drain
Rental van parked on the bridge over the sample site.

DO-07 SJR at Vernalis
Chelsea Spier and Sharon Borglin preparing to collect a water sample from the pump platform.

July 10, 2007

Extended Deployment Sampling Event and Westside Station Maintenance
Sampling for extended deployment and Westside maintenance. Deployed sondes in the San Joaquin River and tributaries. Marshall Road Reservoir, DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-08 SJR at Crows Landing
Jeremy Hanlon opening the gate at the Turlock Sportsman's Club.

DO-10 SJR at Lander
Jeremy Hanlon exchanging sondes.

DO-35 Westley Wasteway
Justin Graham and Jeremy Hanlon replacing the cable that holds the EC probe in place.

DO-06 SJR at Maze
Jeremy Hanlon and Chelsea Spier preparing to leave.

July 12, 2007

Core Sampling Event
Sampling for core sites. Sondes were deployed at DO-18 Mud Slough near Gustine and DO-05 SJR at Vernalis.

DO-04 SJR at Mossdale
Sample site at San Joaquin River at Mossdale.

DO-06 SJR at Maze
Sample site at San Joaquin River at Maze.

DO-21 Orestimba Creek
Photo looking downstream at Orestimba Creek.

DO-05 SJR at Vernalis
Extended deploy sonde hanging off of the platform at Vernalis.

July 13, 2007

San Joaquin River National Wildlife Refuge Field Recon
Field Recon of the San Joaquin River National Wildlife Refuge. Met with the refuge manager, Eric Hopson (US Fish and Wildlife Service), to locate potential sample locations.

SJR National Wildlife Refuge
Photo of dense riparian vegetation within the refuge.

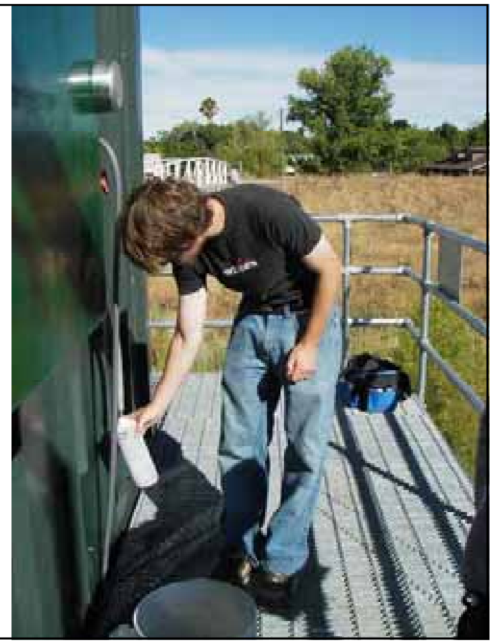
SJR National Wildlife Refuge
Eric Hopson and Will Stringfellow looking at a beaver dam in the refuge.

SJR National Wildlife Refuge
Photo of beaver activity within the refuge.

July 17, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had.

DO-05 SJR at Vernalis
(Top) Photo of sample site. (Right) Student Intern collecting a sample.



DO-10 SJR at Lander
Student Intern collecting a sample. The site is next to a busy highway so safety vests and cones are used.

DO-29 TID Harding Drain
A pipe from the nearby field is discharging water into Harding Drain. Note the abrupt change in turbidity of the sample water.

July 19, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had. The sonde at DO-10 SJR at Lander needed to be switched out with another sonde. The lock fell into the water while switching sondes and the crew had to run to the store to purchase a new one.

DO-12 Stanislaus River at Caswell
Student Intern using the sample bottle holder and pole to collect a sample.

DO-19 Salt Slough at Lander
Student Intern collecting a sample from Salt Slough.

DO-30 TID Lat 6 and 7
Student Intern filling out sample check sheet before leaving sample site.

DO-28 TID Westport Drain
Sample location for TID Westport Drain.

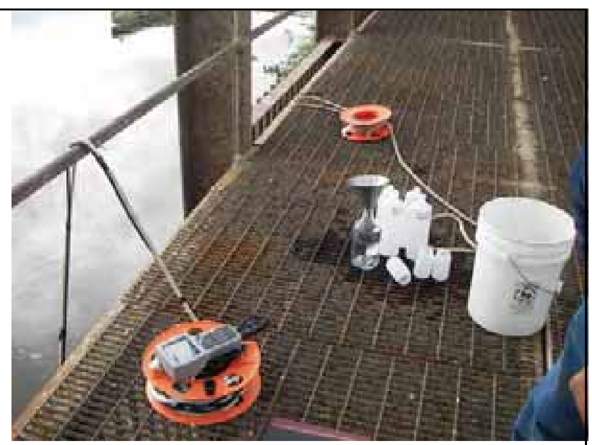
July 24, 2007

SLD Shutoff Sampling Event and Extended Deployment
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had. Sondes were switched out at DO-18 Mud Slough, DO-19 Salt Slough at Lander, DO-10 SJR at Lander, DO-08 SJR at Crows, DO-06 SJR at Maze, DO-05 SJR at Vernalis, and DO-07 SJR at Patterson.

DO-04 SJR at Mossdale
Remie Burks calibrating the depth and DO on the extended deployment sondes before they go out into the river.

DO-18 Mud Slough near Gustine
Photo of extended deploy sonde attached to the bridge with a padlock and cable.

DO-44 SLD End
Photo showing no flow out of San Luis Drain.



DO-06 SJR at Maze
Sonde collecting data off of pump platform. Bottles are set up for bucket sampling.

July 26, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had.

DO-18 Mud Slough near Gustine
Student Intern holding up an empty sample bottle.

DO-12 Stanislaus River at Caswell
Photo shows alternative sample location if campsite at normal sample location is occupied. Alternative sample location is just upstream of normal site.

DO-16 Merced River at River Road
Sample site from the old bridge over the Merced River. Notice how clear the water is.

DO-08 SJR at Crows Landing
Photo of another groups sampling vehicle at the Turlock Sportsman's Club.

July 27, 2007

BMP and San Luis Drain Field Work
Jeremy Hanlon met with Mat Rogers to collect sediment and plants from Ramona Lake for Mat Rogers' microcosm experiment. Jeremy Hanlon went to the San Luis Drain to check on the level of water in the drain.

DO-57 Ramona Lake
Mat Rogers packing up vegetation and sediment samples from Ramona Lake.

San Luis Drain
Chick found on side of access road along drain.

DO-44 SLD End
Photo of water flowing out of end of drain.

DO-119 SLD Check 1
Water leaking out from under the weir boards at Check 1 just upstream of DO-44 SLD End.

July 31, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had.

DO-14 Tuolumne River at Shiloh
Photo of a Carp swimming in the Tuolumne River.

DO-44 SLD End
Water flowing over the weir boards.

DO-16 Merced River at River Road
Remie Burks using the bucket method to sampling the Merced River.

DO-29 TID Harding Drain
Sample location at Harding Drain.

August 02, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had.

DO-12 Stanislaus River at Caswell
Student Intern collecting a sample with the sampling pole.

DO-34 Ingram Creek
EERP Van parked next to Ingram Creek flow station.

DO-30 TID Lat 6 and 6
Student Intern collects a sample near the trash rack at TID Lat 6 and 7.

August 07, 2007

SLD Shutoff Sampling Event and Extended Deployment
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had. Sondes were switched out at DO-18 Mud Slough, DO-19 Salt Slough at Lander, DO-10 SJR at Lander, DO-08 SJR at Crows, DO-06 SJR at Maze, DO-05 SJR at Vernalis, and DO-07 SJR at Patterson.

DO-18 Mud Slough near Gustine
Justin Graham about to take a LUX reading while waiting for the sonde to calibrate.

DO-19 Salt Slough at Lander
Justin Graham loosening the bolt holding the extended deploy sonde into its protective housing.

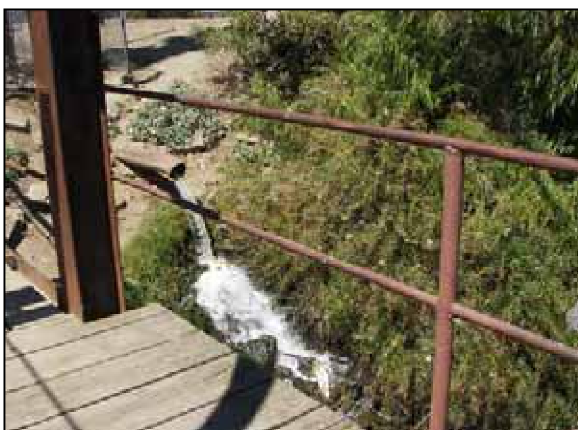
Sampling Gear
Photos of gear used to sample each site. The photo on the left shows the sample bottle holders, sampling pole, and the handheld for the sonde. The photo on the right shows the sonde, velocity meter and velocity pole, notebook, and safety vest.

August 09, 2007

SLD Shutoff Sampling Event
Sampling for SLD shutoff sites. The SLD was shutoff for a short period of time. Samples were collected twice a week for four weeks to see the influence the drain shutoff had.

DO-12 Stanislaus River at Caswell
Cattle use the shore opposite from the sample site.

DO-06 SJR at Maze
Picture of debris building up in front of pump platform at DO-06 SJR at Maze.



DO-07 SJR at Patterson
Water flowing out of pipe. Water input is downstream of sample location.

DO-29 TID Harding Drain
Harding Drain backed up over weir. Water sample is being collected with a bucket.

August 14, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-65 Spanish Grant Drain
Jeremy Hanlon unlocking the grate covering the manhole.

DO-35 Westley Wasteway
The weir boards were pulled to try and clear some of the sediment built up around the sensors.

DO-34 Ingram Creek
Chelsea Spier recording data from the QA EC probe.

DO-31 New Jerusalem Drain
Jeremy Hanlon cleaning the EC probe.

August 16, 2007

Core Sampling Event and SLNWR Field Work
Sampling for core sites. Jeremy Hanlon visited the Student Interns in the San Luis National Wildlife Refuge. The Students completed vegetation surveys within the refuge.

San Luis National Wildlife Refuge
Photos of Student Interns working in the Refuge. The Students were responsible for performing vegetation surveys within the refuge.

DO-25 Miller Lake
Miller Lake sample location.

DO-20 Los Banos Creek
Foot bridge over Los Banos Creek. The EC probe and doppler flow meter are mounted to the bridge.

August 21, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes in the San Joaquin River and tributaries. Sondes deployed at DO-19 Salt Slough at Lander, DO-18 Mud Slough near Gustine, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, DO-06 SJR at Maze, and DO-07 SJR at Patterson.

DO-67 Newman Wasteway at Brazo
There was a pulse of water at Newman Wasteway designed to improve water quality conditions. The water level was higher than normal within the wasteway.

DO-10 SJR at Lander
Justin Graham exchanging sondes.

DO-18 Mud Slough near Gustine
Sonde housing after being in the water for a few weeks.

DO-05 SJR at Vernalis
Justin Graham lowering the sonde to take water quality measurements.

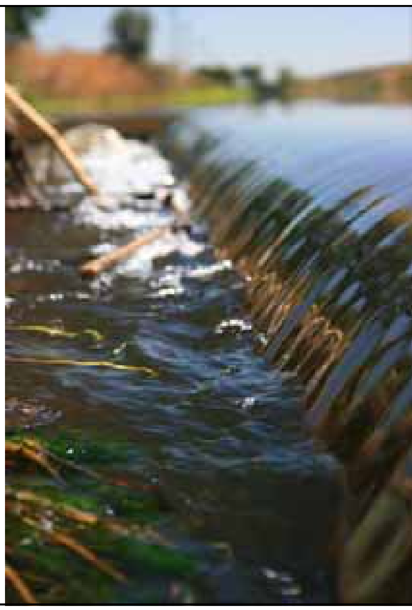
August 23, 2007

Intermittent Sampling Event
Sampling for Intermittent sites.

DO-47 Delta Mendota Canal at Hwy 140
Student Intern collecting a water sample from the DMC.

DO-86 Ramona Drain at Apple
Sample site at the start of Ramona Drain.

DO-135 MID Main Drain Spill
Water flowing over weir structure near the entrance to Miller Lake.



DO-25 Miller Lake
River Otters at the sample site at Miller Lake.

August 28, 2007

Wetland and BMP Sampling Event
Sampling for wetland and BMP sites. Crew sampled the permanent wetland and sites along Ramona and Paradise drains.

DO-82 Marsh 3 Inlet
Sample site for the permanent wetland Marsh 3 inlet.

DO-83 Marsh 3 Outlet
Photo of the outlet for Marsh 3.

DO-86 Ramona Drain at Apple
Student Intern collecting the sample and duplicate sample at Ramona Drain.

DO-94 Paradise at Almond
Student Intern collecting sample. A pump was taking water out of the drain to irrigate a nearby field just downstream of site.

August 30, 2007

Core Sampling Event
Sampling for core sites. The permanent wetland and BMP sites were also collected on this trip.

DO-12 Stanislaus River at Caswell
Campsite adjacent to the sample site in Caswell Park.

DO-82 Marsh 3 Inlet
Owl on top of power pole near Marsh 3 Inlet.

DO-08 SJR at Crows Landing
Jeremy Hanlon collecting a sample at the Turlock Sportsman's Club.

DO-94 Paradise at Almond
Chelsea Spier gathering data from the sonde.

September 04, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes in the San Joaquin River and tributaries. Sondes deployed at DO-19 Salt Slough at Lander, DO-18 Mud Slough near Gustine, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, DO-06 SJR at Maze, and DO-07 SJR at Patterson.

DO-19 Salt Slough at Lander
Justin Graham removing the sediment from the sonde housing before exchanging the sonde with a new one.

DO-18 Mud Slough near Gustine
Jeremy Hanlon exchanging the extended deploy sonde at Mud Slough.

DO-07 SJR at Patterson
Jeremy Hanlon bucket sampling on the pump platform.

DO-06 SJR at Maze
Photo of the San Joaquin River at Maze from the pump platform.

September 06, 2007

Intermittent Sampling Event
Sampling for Intermittent sites. Picked up and deployed sondes at DO-135 MID Main Drain Spill and DO-25 Main Drain Miller Lake. There was no flow at DO-92 Paradise at Apricot, no sample was collected.

DO-67 Newman Wasteway at Brazo
Sonde collecting data from Newman Wasteway.

DO-130 Marshal Road Res Inlet
Picture of the weather station at Marshall Road Reservoir. The station collects wind, air temperature and barometric pressure data.

DO-92 Paradise at Apricot
There was no flow at this site. No sample was collected.

DO-135 MID Main Drain Spill
Screen was wrapped around the extended deploy sonde to prevent debris entering the guard housing. Debris in the housing gives falsely high turbidity and chlorophyll readings.

September 11, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. Marshall Road Reservoir, DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

Marshall Road Reservoir
Justin Graham opening the gate.

DO-33 Hospital Creek
Chelsea Spier using the weir stick to measure the flow of Hospital Creek.

DO-36 Del Puerto Creek
Chelsea Spier performing a stream rating while Justin Graham records the data.

DO-57 Ramona Lake
Crew preparing to leave the site.

September 13, 2007

Core Sampling Event
Sampling for core sites. The BMP sites were also collected on this trip. DO-21 Orestimba Creek had no flow and was not sampled.

DO-05 SJR at Vernalis
Sonde handheld setup to record water quality measurements.

DO-06 SJR at Maze
Great Blue Heron flying over the newly plowed field near the San Joaquin River at Maze.

Corn Harvesting
A corn harvester grinding the corn and loading it into a truck for delivery near DO-28 Westport Drain.

DO-29 TID Harding Drain
Student Intern using a funnel and bucket to collect a water sample.

September 18, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Deployed sondes in the San Joaquin River and tributaries. Sondes deployed at DO-19 Salt Slough at Lander, DO-18 Mud Slough near Gustine, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, DO-06 SJR at Maze, and DO-07 SJR at Patterson.

DO-18 Mud Slough near Gustine
Photo of the sonde housing covered in algae. Justin Graham calibrating the extended deployment sondes for depth and DO.

DO-135 MID Main Drain Spill
Sampling sonde recording data next to the extended deploy sonde.

DO-25 Miller Lake
Sonde and housing deployed at Miller Lake. The cable is wrapped around the post preventing the sonde from going over the weir.

September 20, 2007

Wetland Sampling Event
Sampling for wetland sites. A flow rating was performed at DO-53 Salt Slough at Wolfsen. HOBO pressure loggers were installed in two wetlands to measure changes in water depth.

DO-53 Salt Slough at Wolfsen
Jeremy Hanlon performing a stream rating.

DO-61 Deadmans Slough
Beaver activity clogging the weir structure. This site lacks a good flow stage relationship because of all the debris blocking the weir structure.

DO-81 Marsh 1 Outlet
Jeremy Hanlon installing a HOBO logger at the outlet of the temporary wetland.

DO-63 Inlet C Canal
Fields next to Inlet C Canal were being sprayed while crew was visiting the site.

September 27, 2007

Core Sampling Event
Sampling for core sites. The BMP sites were also collected on this trip. DO-21 Orestimba Creek had no flow and was not sampled.

DO-44 San Luis Drain End
Rental van used for sampling. Magnets with the EERP and UOP logo are affixed to the sides of the van.

DO-04 SJR at Mossdale
Chelsea Spier collecting a sample.

DO-88 Ramona Drain at Apricot
This site is often covered with duckweed and waterprimrose.

DO-14 Tuolumne River at Shiloh
Remie Burks having fun with the camera.

October 02, 2007

Extended Deployment Sampling Event
Sampling for extended deployment. Picked up sondes in the San Joaquin River and tributaries. Sondes picked up at DO-19 Salt Slough at Lander, DO-18 Mud Slough near Gustine, DO-10 SJR at Lander, DO-08 SJR at Crows Landing, DO-06 SJR at Maze, and DO-07 SJR at Patterson.

DO-18 Mud Slough near Gustine
The bolt was missing from the housing. A stick was all that kept the sonde and housing together.

DO-10 SJR at Lander
A fish was found in the sonde housing when the extended deploy sonde was retrieved.

DO-07 SJR at Patterson
Photo of pump platform at the sample site. The extended deploy sonde is hung from the end of the pump platform into the river.

October 04, 2007

Wetland Sampling Event
Sampling for wetland sites. No sample was taken at DO-60 Moffit 1 South because there was no water.

Marsh 1 Temporary Wetland
Picture of Marsh 1. This wetland is only filled part of the year.

DO-122 Marsh 1 West
Special housing chamber for the sonde prevents the vegetation from interfering with the sensors.

DO-81 Marsh 1 Outlet
Jeremy Hanlon downloading the HOBO logger at the outlet of the temporary wetland.

DO-82 Marsh 3 Inlet
Jeremy Hanlon reading the level of the water from the staff gauge to compare to the HOBO logger.

October 09, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-57 Ramona Lake
Picture of extremely low water level at Ramona Lake.

DO-31 New Jerusalem Drain
Flow station at top of levee.

October 11, 2007

Core Sampling Event
Sampling for core sites. DO-21 Orestimba Creek had no flow and was not sampled.

DO-20 Los Banos Creek
Sampling location at Los Banos Creek.

DO-06 SJR at Maze
Remie Burks putting samples onto ice after being collected.

DO-06 SJR at Maze
View of the pump platform. Samples are collected in front of the trash rack.

DO-21 Orestimba Creek
There was no flow through Orestimba Creek. The site was not sampled.

October 25, 2007

Core Sampling Event
Sampling for core sites. DO-21 Orestimba Creek had no flow and was not sampled.

DO-20 Los Banos Creek
Photo depicting flooded wetlands near Los Banos Creek

DO-28 TID Westport Drain
Sample site for Westport Drain.

DO-34 Ingram Creek
This site is supplied with both tile drainage and field runoff causing the turbidity to fluctuate throughout the year.

DO-34 Ingram Creek
Weir structure at Ingram Creek.

November 01, 2007

Westside Station Maintenance
Performed maintenance on Westside stations. Marshall Road Reservoir, DO-38 Marshall Drain, DO-64 Moran Drain, DO-65 Spanish Grant Drain, DO-57 Ramona Lake, DO-36 Del Puerto Creek, DO-35 Westley Wasteway, DO-34 Ingram Creek, DO-33 Hospital Creek and DO-31 New Jerusalem Drain were visited for data downloads, cleaning, flow, EC, and temperature QA.

DO-57 Ramona Lake
Water level was still extremely low at Ramona Lake.

DO-34 Ingram Creek
Jeremy Hanlon cleaning the EC probe.

November 08, 2007

Core Sampling Event
Sampling for core sites.

DO-12 Stanislaus River at Caswell
Justin Graham collecting a water sample.

DO-19 Salt Slough at Lander
Boat going past sample site. Crew waited for awhile after the boat passed to collect the sample.

DO-25 Miller Lake
Justin Graham downloading data from the bubbler unit at Miller Lake.

DO-29 TID Harding Drain
Sample site at Harding Drain.

November 15, 2007

Field Reconnaissance by Boat
Used the boat to find the a continuous monitoring station recently upgraded along the San Joaquin River. The station was located and confirmed by Gary Litton and Mark Brunell of University of the Pacific. The crew noticed a dramatic drop in performance of the boat on the way back, but couldn't determine the cause on the water.

Continuous Monitoring Station
Picture of monitoring station recently upgraded.

Gary Litton's Sampling Boat
The crew met Gary Litton (UOP) and Mark Brunell (UOP). They confirmed the location of the monitoring station.

Boat Engine Problems
Jeremy Hanlon and Justin Graham examining the engine to determine cause of throttle issues.

Boat Jet Drive
Jeremy Hanlon disassembled the jet drive. Small twigs were caught between the blades and this caused the lack of performance.

November 20, 2007

Technical Working Group Meeting
Attended the TWG meeting for a demonstration of the new oxygenation facility in the Deep Water Ship Channel. The facility pumps water through a deep pipe that adds oxygen and then puts the oxygen enriched water back into the ship channel.

Oxygenation Facility
Various representatives from different agencies listen to presentation on how the facility works.

Oxygenation Facility
Picture of the oxygen storage tank.

Oxygenation Facility
Photo of control panel for the pumps.

Oxygenation Facility
Presentation on how the facility will increase the oxygen in the Deep Water Ship Channel.

December 06, 2007

Core Sampling Event
Sampling for core sites. It started to rain partway through the day and DO-30 TID Lat 6 and 7, DO-28 TID Westport Drain, and DO-36 Del Puerto Creek were not sampled because the roads were too wet to drive down. DO-135 MID Main Drain Spill did not have any flow and was not sampled.

DO-12 Stanislaus River at Caswell
Jeremy Hanlon in his rain jacket collecting a water sample.

University of the Pacific
Sampling crews preparing to leave.

DO-14 Tuolumne River at Shiloh
Airboat going down river. Boat was very loud and stirred up the turbidity of sample site. Crew had already finished sampling.

DO-08 SJR at Crows Landing
Chelsea Spier collects sample from the dock at Turlock Sportsman's Club.

December 13, 2007

San Joaquin River National Wildlife Refuge Field Recon
Field Recon of the San Joaquin River National Wildlife Refuge. The crew attempted to survey a stretch of Hospital Creek but the mud was too deep and sticky.

SJR National Wildlife Refuge
Jeremy Hanlon and Remie Burks discussing surveying possibilities.

SJR National Wildlife Refuge
Jeremy Hanlon standing next to a beaver dam near the outflow of the refuge.

SJR National Wildlife Refuge
Jeremy Hanlon reading off GPS coordinates to be recorded.

Appendix C

Description of Flow and Water Quality Monitoring Upgrades and Photo Documentation

Up-Stream DO TMDL Project

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February 2008

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Introduction

The main objective of the flow and continuous monitoring stations is to produce real-time data that can be used to support managerial decisions within the San Joaquin River system. Stations were to report flow, temperature, and electrical conductivity (EC) data on a real-time basis. This data could then be used to calculate loading levels of different water quality parameters to the San Joaquin River. Monitoring station sites were placed at existing stations, utilizing the structures and equipment already present. If a site did not have an existing station, the site was chosen based upon its accessibility and channel morphology. Existing monitoring stations were upgraded, or in locations where no station existed, were built from scratch.

Methods

Existing monitoring stations were used where possible. If no monitoring station existed a new station was constructed. New sites were chosen at locations along the tributary that had landowner permission and were accessible. Sites were chosen that had stable channels, and preferably an existing weir structure. Sites used existing telemetry, such as SCADA systems or phone lines, where possible and GOES satellite telemetry on sites that did not have access to these other systems. Power for the monitoring equipment was either provided by onsite electric service or from a battery and solar array.

At a minimum each site was equipped with a way to measure EC and flow. Data was measured and recorded every fifteen min at the westside stations and hourly at the eastside stations. Dataloggers stored data from the sensors that could be accessed through a telemetry system or manually downloaded using a PCMCIA flash card from the logger. GOES telemetry reported data directly to a DOMSAT station operated by the Department of Water Resources California Data Exchange Center, which could then be downloaded from the California Data Exchange Center website. SCADA systems reported data directly through e-mail to the persons responsible for the site's data collection.

Existing structures and channel morphology determined what equipment was used to measure flow at a given site. Where a weir was present, the stage value along with the weir equation was used to compute discharge. Pressure transducers, float and shaft encoders, Stevens chart recorders, and Design Analysis H355 Smartgas bubbler systems were all used to measure stage (Table 1). Sites with culverts and open channels were installed with Doppler units, such as a SONTEK, MACE, or STARFLOW, to measure the discharge (Table 1). Continuous monitoring sites that lacked a structure relied on a stage to discharge relationship from a rating curve to determine flow. These sites could then utilize a Design analysis H355 Smartgas bubbler system or some other stage measuring equipment to determine discharge. Doppler units, which can measure both stage and velocity, were deployed at some open channel sites to measure flow. Electrical conductivity was measured using an YSI 600XL with an attached temperature compensated conductivity probe (Table 1). DO-20 Los Banos Creek used a Campbell Scientific EC sensor in place of the YSI 600XL. The EC and flow could then be used to calculate total dissolved solids (TDS) loading.

Results and Discussion

Monitoring stations were placed on tributaries along the San Joaquin River. The sites were divided into westside and eastside monitoring stations depending on which side of the river they were on. There are thirteen westside stations and fifteen eastside stations. Nine of the westside stations were newly constructed. A list of stations and locations can be found in Table 2. Of the eastside stations, most already measured flow and only eight needed to be upgraded to include a YSI 600XL to measure electrical conductivity. Most of the stations operated by Turlock Irrigation District and Modesto Irrigation District already had SCADA systems installed.

Monitoring Station Operators

DO-13 Stanislaus River at Ripon, DO-15 Tuolumne River at Modesto, DO-18 Mud Slough near Gustine, DO-19 Salt Slough at Lander, and DO-21 Orestimba Creek are all operated by USGS. DO-20 Los Banos Creek is operated by the Grassland Water District. DO-17 Merced River at Stevinson is operated by DWR. DO-31 New Jerusalem Drain, DO-33 Hospital Creek, DO-34 Ingram Creek, DO-35 Westley Wasteway, DO-36 Del Puerto Creek, DO-38 Marshall Road Drain, DO-57 Ramona Lake at Levee, DO-64 Moran Drain, and DO-65 Spanish-Grant Drain are all operated by EERP at University of the Pacific. DO-22 Lateral 4 to SJR, DO-23 Lateral 5 to Tuolumne, DO-24 Lateral 6 to Stanislaus, and DO-25 Miller Lake Outfall are all operated by Modesto Irrigation District. DO-26 Highline Spill, DO-27 Lateral 2 to San Joaquin River, DO-28 Westport Drain, DO-29 Harding Drain, and DO-30 Lateral 6 & 7 at Levee are all operated by Turlock Irrigation District.

Monitoring Station Status

While all sites are currently operational, some sites have had problems that have had to be repaired. DO-20 Los Banos Creek was recently rehabilitated after being washed out during the storms of 2005/2006. A new bridge was constructed replacing the old wooden bridge. The SONTEK SL acoustic sensor was re-sited and new cable drawn. The EC sensor was replaced and a new pipe laid into the water for the bubbler sensor. At DO-38 Marshall Road Drain a leak in the T valve on bubbler line was found on 5/9/06. All flow data from the bubbler unit was low quality prior to this date. DO-65 Spanish-Grant Drain had sediment built up behind the weir resulting in low quality QA stage readings from 05/22/07 to 01/17/08. The sediment was cleared out on 01/17/08. DO-64 Moran Drain is currently operational with no significant problems. Sediment can build up behind the weir structure at these three sites and it occasionally needs to be cleared. The STARFLOW acoustic Doppler stage transducer is prone to clogging from the sediment and sometimes the unit becomes buried in the mud, especially at DO-38 Marshall Road Drain and DO-65 Spanish-Grant Drain. The monitoring systems for all three sites are powered by the same battery and solar panel which could cause a potential power issue. The steep bed slope at DO-36 Del Puerto Creek can result in low stage that is barely above bubbler at low flow events causing low quality flow values. The solar panel at this site has been stolen once. Frequent flow ratings are required due to a shifting channel bed. The bubbler line was found clogged with debris on 10/09/07 and cleared on 11/01/07. The clog resulted in low quality stage data from June 2006 until 11/01/07. DO-57 Ramona Lake at Levee was washed out during the 2005/2006 San Joaquin River flooding. Water flowed backwards through the culvert. The landowner dropped sandbags down the culvert to avert flooding his land and decommissioned the monitoring station. The EC sensor was redeployed and a new pipe laid for the bubbler sensor. The site is currently operational. The original culvert at DO-35 Westley Wasteway was undersized. The district replaced it with a lager diameter structure to accommodate more flow. A weir structure was installed at the same time. New pipe was laid for the EC probe and bubbler line just upstream of weir. Flow data was originally calculated with a STARFLOW acoustic Doppler which was prone to error from the small culvert and constant debris dumped upstream. The new weir provided high quality data from a bubbler system. DO-34 Ingram Creek has no significant problems. Heavy sediment load during summer months necessitated occasional removal of sediment behind weir structure. Sediment was last cleared out on 11/01/07. DO-31 New Jerusalem Drain was upgraded with a STARFLOW Doppler sensor which failed after six months of placement. Unit was replaced in mid-2006 with a MACE integrated stage/velocity acoustic Doppler sensor which has proved more reliable. The station is currently operational with no significant problems. DO-25 Miller Lake Outfall had a Design Analysis H355 Smartgas bubbler system installed in late 2007 and is currently operational with few significant problems. DO-22 Lateral 4 to SJR, DO-23 Lateral 5 to Tuolumne, DO-24 Lateral 6 to Stanislaus, DO-26 Highline Spill, DO-27 Lateral 2 to San Joaquin River, DO-28 Westport Drain, DO-29 Harding Drain, and DO-30 Lateral 6 & 7 at Levee are all operational with few significant problems. DO-33 Hospital Creek is operational with few significant problems.

Conclusions

Most sites that were upgraded are currently operational with no significant problems. Occasionally problems arise that are beyond the station operator's control, such as flooding and equipment failure. However, when these issues came up they were identified and corrected. Reliability of flow data depended on the site in question. Any station that had consistency in structure, such as a weir system that is routinely cleared of debris, provided reliable flow and water quality data. Sites that had a bubbler line installed and a developed flow stage relationship supplied high quality flow data. However, if the weir was not kept clear of debris then the flow data was not reliable. The goals of this report were met with the continuous monitoring of flow at the relevant EERP sample sites.

Table 1: Descriptions of equipment used.

Device	Description
Campbell Logger (Campbell Scientific Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
H-350XL Design Analysis Logger (Design Analysis Associates Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
MACE Agriflo (MACE, Sydney, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Starflow (Unidata, O'Connor, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Sontek (Sontek/YSI Inc., San Diego, CA)	Doppler device put in channel to measure flow. MACE units measure flow by looking out into the channel and are better for open, or natural, channel situations. Often used at monitoring stations.
H-350XL/355 Combo Bubbler (Design Analysis Associates Inc., Logan, UT)	A bubbler measures water level by detecting the pressure required to force air through a tube below the water level in the channel. In areas with a weir system a bubbler can be used to measure flow, as the height of water above the weir is proportional to the flow.
Staff Gauge (Wildlife Supply Company, Buffalo, NY)	A gauge put in a fixed location to observe water level. Often used to verify bubbler reading during QA visits.
Cal Poly ITRC Weir Stick (Cal Poly ITRC, San Luis Obispo, CA)	Scale mounted on a stick used to measure the height of the water above a weir structure. This value is then multiplied times the weir width to get flow.
EC Probe (YSI Inc., Yellow Springs, OH) (Campbell Scientific Inc., Logan, UT)	Sensor used to measure the Electrical Conductivity or Specific Conductivity of the water. Often deployed at monitoring stations in the field
YSI Sonde (YSI Inc., Yellow Springs, OH)	Multi-parameter instrument used to measure water quality. Most often used during sampling events and continuous monitoring.

Table 2: List of flow stations upgraded or constructed between 2005-2007 in the San Joaquin River Valley.

DO Site	*Station Name*	*Latitude*	*Longitude*	*Station Operator*	*Location*
20	Los Banos Creek Flow Station	37.275	-120.955	Grassland WD	Westside
22	Modesto ID Lateral 4 to SJR	37.630	-121.158	Modesto ID	Eastside
23	Modesto ID Lateral 5 to Tuolumne	37.6145	-121.143	Modesto ID	Eastside
24	Modesto ID Lateral 6 to Stanislaus River	37.703	-121.141	Modesto ID	Eastside
25	Miller Lake Outfall	37.670	-121.219	Modesto ID	Eastside
26	Turlock ID Highline Spill	37.386	-120.813	Turlock ID	Eastside
27	Turlock ID Lateral 2 to SJR	37.565	-121.138	Turlock ID	Eastside
28	Turlock ID Westport Drain Flow station	37.541	-121.094	Turlock ID	Eastside
29	Turlock ID Harding Drain	37.464	-121.030	Turlock ID	Eastside
30	Turlock ID Lateral 6 & 7 at Levee	37.397	-120.972	Turlock ID	Eastside
31	BCID - New Jerusalem Drain	37.726	-121.299	UOP EERP	Westside
33	Hospital Creek	37.610	-121.230	UOP EERP	Westside
34	Ingram Creek	37.600	-121.225	UOP EERP	Westside
35	Westley Wasteway Flow Station	37.558	-121.163	UOP EERP	Westside
36	Del Puerto Creek Flow Station	37.539	-121.122	UOP EERP	Westside
38	Marshall Road Drain	37.436	-121.036	UOP EERP	Westside
57	Ramona Drain at Levee	37.478	-121.068	UOP EERP	Westside
64	Moran Drain	37.435	-121.035	UOP EERP	Westside
65	Spanish-Grant Drain	37.435	-121.035	UOP EERP	Westside

EERP Site No. DO-20

Site Description	**20. Los Banos Creek** Located within the Kesterson National Wildlife Refuge approximately ¼ mile south of Hwy 140.
Power	Solar Panel with 12-volt battery
Datalogger	Campbell Scientific datalogger
EC Sensor	Campbell Scientific temperature-compensated EC sensor
Flow Measurement	SONTEK SL acoustic Doppler sensor with built-in stage sensor
Depth	Design Analysis H350XL with H355 Smartgas system
Velocity	SONTEK SL
Telecommunications	GOES Telemetry installed but not operational.

Figure 1: Bridge at Los Banos Creek before being damaged during storms of 2005/2006.

Figure 2: New bridge and equipment installed at Los Banos Creek after old bridge was washed out.

Figure 3: Jeremy Hanlon and Nigel Quinn installing new equipment at Los Banos Creek.

EERP Site No. DO-38

Site Description	**38. Marshall Road Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from Marshall Road Reservoir.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
Velocity	Unidata STARFLOW velocity
Telecommunications	GOES Telemetry installed but not operational.

Figure 4: Manhole at Marshall Road Drain. The manhole for Spanish Land Grant Drain is in the back of the picture.

Figure 5: Flow station shed for Marshall Road, Spanish Land Grant, and Moran Drains.

EERP Site No. DO-64

Site Description	**64. Moran Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from adjacent fields.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
Velocity	Unidata STARFLOW velocity.
Telecommunications	GOES Telemetry installed but not operational.

Figure 6: Manhole for Moran Drain. Manhole is about 50 ft south west of manhole for Spanish Land Grant Drain.

EERP Site No. DO-65

Site Description	**65. Spanish Land Grant Drain** Located within Patterson Irrigation District at the east end of Marshall Road. Carries agricultural return flows from Patterson Irrigation District.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge (primary) Unidata STARFLOW integrated stage/velocity acoustic Doppler transducer (secondary)
Depth	Design Analysis H350XL with H355 Smartgas system (primary) Unidata STARFLOW stage (secondary)
Velocity	Unidata STARFLOW velocity.
Telecommunications	GOES Telemetry installed but not operational.

Figure 7: Manhole for Spanish Land Grant Drain.

EERP Site No. DO-36

Site Description	**36. Del Puerto Creek** Ephemeral stream from the Coast Range that flows into the SJR through Patterson Irrigation District.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Stage-discharge relationship developed for a straight, narrowly incised and steep channel segment.
Depth	Design Analysis H350XL with H355 Smartgas system;
Velocity	n/a
Telecommunications	GOES Telemetry installed but not operational.

Figure 8: Flow station shed and stream channel for Del Puerto Creek.

EERP Site No. DO-57

Site Description	**57. Ramona Lake Drain** Drain receiving pumped discharge from a small lake that acts as a drainage sump to surrounding fields. Site located on top of the levee adjacent to the SJR
Power	Solar Panel with 12-volt battery Auxiliary solar panels to power a 24 volt analog to digital transducer attached to the propeller meter.
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Stage-discharge relationship developed for a sharp crested weir with no contractions.
Depth	Design Analysis H350XL with H355 Smartgas system.
Velocity	n/a
Telecommunications	GOES Telemetry installed but not operational.

Figure 9: Kyle Kearney inspecting the damage to Ramona Lake Drain flow station. San Joaquin River flooding backed up into the culvert and decommissioned the station.

Figure 10: Ramona Lake Drain flow station shed and manhole after repairing the damage from San Joaquin River flooding during 2005/2006.

EERP Site No. DO-35

Site Description	**35. Westley Wasteway** Located along River Road within the West Stanislaus Irrigation District
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Previously used a combination of STARFLOW acoustic Doppler transducer and bubbler stage. Current retrofit uses a regular contracted weir located approximately 30ft downstream. Flow measured using equation for contracted sharp crested weir.
Depth	Design Analysis H350XL with H355 Smartgas system (primary)
Velocity	n/a
Telecommunications	GOES Telemetry installed but not operational.

Figure 11: Old culvert at Westley Wasteway. Original culvert and acoustic Doppler system at site provided low quality data.

Figure 12: Irrigation district installing a new weir structure and culvert to provide higher quality flow data at Westley Wasteway.

Figure 13: Current setup at Westley Wasteway. Weir structure and pond with bubbler system provide high quality flow data with very few problems.

EERP Site No. DO-33

Site Description	**33. Hospital Creek** Located along River Road within the West Stanislaus Irrigation District. Hospital Creek is an ephemeral stream originating in the Coast Range.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis Datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir with minor contractions using weir equation and stage to compute discharge
Depth	Design Analysis H350XL with H355 Smartgas system
Velocity	n/a
Telecommunications	GOES Telemetry installed but not operational.

Figure 14: Flow station shed and weir structure at Hospital Creek.

EERP Site No. DO-34

Site Description	**34. Ingram Creek** Located along River Road within the West Stanislaus Irrigation District. Ingram Creek is an ephemeral stream originating in the Coast Range.
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge
Depth	Design Analysis H350XL with H355 Smartgas system
Velocity	n/a
Telecommunications	GOES Telemetry installed but not operational.

Figure 15: Weir and flow station shed at Ingram Creek.

Figure 16: Weir is located under the bridge next to the flow station shed.

EERP Site No. DO-31

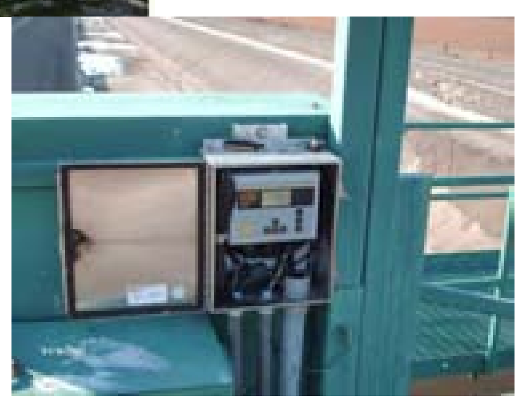
Site Description	**31. New Jerusalem Drain** Located ¼ mile north of the Banta Carbona Irrigation District fish facility
Power	Solar Panel with 12-volt battery
Datalogger	Design Analysis datalogger
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	MACE integrated stage/doppler sensor providing direct discharge output (primary). Flow over a sharp crested weir using weir equation and stage to compute discharge (secondary)
Depth	Design Analysis H350XL with H355 Smartgas system (primary) MACE pressure sensor (secondary)
Velocity	MACE acoustic Doppler sensor
Telecommunications	GOES Telemetry installed but not operational.

Figure 17: Flow station shed and manhole at New Jerusalem Drain.

EERP Site No. DO-22

Site Description	**22. MID Lateral 4** Modesto irrigation district operational outflow
Power	110 volt power
Datalogger	YSI 6500 Process Monitor which send data to a Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe located ¼ mile upstream of the weir
pH Sensor	YSI pH probe located ¼ mile upstream of the weir
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Systems transducer reporting directly to RTU (primary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Figure 18: (top) Weir at MID Lateral 4. (bottom) Sierra Systems RTU SCADA system.



EERP Site No. DO-23

Site Description	**23. MID Lateral 5** Modesto irrigation district operational outflow
Power	12 volt power supplied by battery and solar panel
Datalogger	Campbell Scientific CR-10 with digital to serial interface to process signal and make compatible with Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe
pH Sensor	YSI pH probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Systems transducer reporting directly to RTU (primary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Figure 19: Weir structure and monitoring equipment at MID Lateral 5.

EERP Site No. DO-24

Site Description	**24. MID Lateral 6** Modesto irrigation district operational outflow
Power	Solar Panel with 12-volt battery
Datalogger	Campbell Scientific CR-10 with digital to serial interface to process signal and make compatible with Sierra Systems SCADA RTU.
EC Sensor	YSI temperature compensated EC probe located upstream of the weir
pH Sensor	YSI pH probe located upstream of the weir
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Systems transducer reporting directly to RTU (primary) Stevens chart recorder (secondary) YSI 600XL internal pressure sensor (tertiary)
Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Figure 20: Weir structure and monitoring equipment at MID Lateral 6.

EERP Site No. DO-25

Site Description	**25. MID Miller Lake Outfall** Modesto irrigation district operational outflow. MID Main Drain canal empties into Miller Lake.
Power	110 volt power supplied to YSI and SCADA 12 volt power supplied by battery and solar panel to Design Analysis Smartgas system.
Datalogger	Design Analysis datalogger/YSI 6500 Process Monitor which send data to a Sierra Systems SCADA RTU
EC Sensor	YSI temperature compensated EC probe
Flow Measurement	Flow over a sharp crested weir using weir equation and stage to compute discharge
Depth	Design Analysis H350XL with H355 Smartgas system (primary) Stevens chart recorder (secondary)
Velocity	n/a
Telecommunications	Sierra Systems RTU SCADA Telemetry

Figure 21: Stevens chart recorder and YSI EC probe next to bridge over the weir structure at MID Miller Lake Outfall.

Figure 22: A Design Analysis Smartgas system was added to the Stevens chart recorder in late 2007, providing higher quality data.

EERP Site No. DO-26

Site Description	**26. TID Highline Canal** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Controls float and shaft encoder
Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry

Figure 23: (left) Sierra Controls SCADAPACK and (right) weir structure at TID Highline Canal.

EERP Site No. DO-27

Site Description	**27. TID Lateral 2** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Controls float and shaft encoder
Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry

Figure 24: (left) Flow monitoring equipment and (right) weir structure at TID Lateral 2.

EERP Site No. DO-28

Site Description	**28. TID Lateral 3 Westport Drain** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow through a flume.
Depth	Sierra Controls float and shaft encoder (primary) YSI 600XL internal pressure sensor (secondary)
Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry

Figure 25: Monitoring equipment at TID Lateral 3 Westport Drain.

EERP Site No. DO-29

Site Description	**29. TID Lateral 5 Harding Drain at Carpenter Rd.** Turlock Irrigation District drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	Flow over a long sharp crested weir using weir equation and stage to compute discharge
Depth	Sierra Controls float and shaft encoder
Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry

Figure 26: (left) Monitoring equipment and (right) weir structure at TID Lateral 5 Harding Drain at Carpenter Road.

EERP Site No. DO-30

Site Description	**30. TID Lateral 6 & 7** Turlock Irrigation District operational spill/drainage site
Power	110 volt power
Datalogger	Sierra Controls RTU with SCADAPACK
EC Sensor	YSI 600XL temperature compensated EC probe
Flow Measurement	No flow measurement at site. Combined flow of Lat 6 and Lat 7 are used to estimate flow
Depth	YSI 600XL internal pressure sensor
Velocity	n/a
Telecommunications	Sierra Controls SCADAPACK Telemetry

Figure 27: (left) Inside of monitoring shed and (right) culvert at TID Lateral 6 & 7.

Appendix D

EERP Flow Rating Data

Jeremy Hanlon
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February 2008

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DO-1 SJR at Channel Point

Location: 37.9630°N -121.3650°W

Water District or Organization: Rough and Ready Island is operated by the CA Department of Water Resources and is in San Joaquin County.

Station Description: The CDEC station at Rough and Ready Island (station ID: RRI) is operated by the CA Department of Water Resources and the data is collected by satellite. Flow data is directly from the CDEC website.

EC and stage data in this report are taken directly from the CDEC website for RRI.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	100 µS/cm (Values below 100 µS/cm were deleted.)
Maximum EC:	

DO-2 SJR at Dos Reis Park

Location: 37.9350°N -121.3290°W

Water District or Organization: San Joaquin River at Garwood Bridge is operated by USGS and is in San Joaquin County.

Station Description: The CDEC station at San Joaquin River at Garwood Bridge (station ID: SJG) is operated by USGS. Flow and stage data in this report are taken directly from the CDEC website.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	10/23/2007
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-3 SJR at Old River

Location: 37.8100°N -121.3230°W

Water District or Organization: San Joaquin River below Old River near Lathrop is operated by the CA Department of Water Resources and is located in San Joaquin County.

Station Description: The CDEC station at San Joaquin River below Old River near Lathrop (station ID: SJL) is operated by the CA Department of Water Resources, and the data is collected by satellite. Flow, EC and stage data in this report are directly taken from the CDEC website for SJL.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	10/18/2007
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-4 San Joaquin River at Mossdale Bridge

Location: 37.7860°N -121.3060°W

Water District or Organization: San Joaquin River at Mossdale Bridge is operated by the CA Dept of Water Resources/Central District and is in San Joaquin County, near Manteca.

Station Description: The CDEC station for San Joaquin River at Mossdale Bridge (station ID: MSD) is operated by the CA Department of Water Resources/Central District. Flow, EC, and stage data in this report are directly taken from the CDEC website for MSD.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	10/18/2007
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-5 San Joaquin River near Vernalis

Location: 37.667°N -121.267°W

Water District or Organization: San Joaquin River near Vernalis is operated by USGS and the CA Department of Water Resources, and is located in San Joaquin County, near Modesto.

Station Description: The CDEC station at San Joaquin River near Vernalis (station ID: VNS) is operated by USGS and the CA Department of Water Resources. The data is collected in dual path. Flow and stage data in this report are directly from the CDEC website for VNS, EC from VER station.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-6 San Joaquin River at Maze Blvd

Location: 37.641°N -121.229°W

Water District or Organization: San Joaquin River at Maze Blvd is operated by the CA Department of Water Resources and is located in Stanislaus County, at the Maze Blvd Bridge over the San Joaquin River.

Station Description: The CDEC station at San Joaquin River at maze Blvd (CDEC station ID is MRB) is operated by the CA Department of Water Resources; data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for MRB.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-7 San Joaquin River near Patterson

Location: 37.494°N -121.081°W

Water District or Organization: San Joaquin River near Patterson is operated by the CA Dept of Water Resources and is located in Stanislaus County, near Patterson.

Station Description: The CDEC station at San Joaquin River near Patterson (station ID: SJP) is operated by the CA Department of Water Resources; data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for SJP.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-8 San Joaquin River near Crows Landing

Location: 37.432°N -121.012°W

Water District or Organization: San Joaquin River near Crows Landing is operated by USGS and located in Stanislaus County, near Crows Landing.

Station Description: The CDEC station at San Joaquin River near Crows Landing (station ID: SCL) is operated by USGS. Data collection is by satellite. Flow, EC, and stage values in this report are directly from the CDEC website for SCL.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-9 San Joaquin River at Fremont Ford Bridge

Location: 37.310°N -120.930°W

Water District or Organization: San Joaquin River at Fremont Ford Bridge is operated by USGS and is located in Merced County, near Gustine.

Station Description: The CDEC station at San Joaquin River at Fremont Ford Bridge (station ID: FFB) is operated by USGS. Data is collected by satellite. Flow, EC, and stage values in this report are directly from the CDEC website for FFB.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-10 SJR at Lander Ave (Near Stevinson)

Location: 37.295°N -120.851°W

Water District or Organization: San Joaquin River near Stevinson is operated by the CA Department of Water Resources, and is located in Merced County, near Stevinson.

Station Description: The CDEC station at San Joaquin River near Stevinson (station ID: SJS) is operated by the CA Department of Water Resources. Data is collected by satellite. Flow, EC, and stage data in this report are directly taken from the CDEC website for SJS.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	01/08/08
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-13 Stanislaus River at Ripon

Location: 37.7300°N -121.10811°W

Water District or Organization: Stanislaus River at Ripon is operated by USGS and is located in San Joaquin County, near Ripon.

Station Description: The CDEC station at Stanislaus River at Ripon (station ID: RIP) is operated by USGS. Data is collected by satellite. Flow and stage data in this report are directly from the CDEC website for RIP.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-15 Tuolumne River at Modesto

Location: 37.6500°N -121.0010°W

Water District or Organization: Tuolumne River at Modesto is operated by the CA Department of Water Resources and is located in Stanislaus County, near Modesto.

Station Description: The CDEC station at Tuolumne River at Modesto (station ID: MOD) is operated by the CA Department of Water Resources. Data collection is by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for MOD.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-17 Merced River near Stevinson

Location: 37.3710°N -120.9310°W

Water District or Organization: Merced River near Stevinson is operated by the CA Department of Water Resources and is located in Merced County, near Stevinson.

Station Description: The CDEC station at Merced River near Stevinson (station ID: MST) is operated by the CA Department of Water Resources. Data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for MST.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-18 Mud Slough near Gustine

Location: 37.263°N -120.906°W

Water District or Organization: Mud Slough near Gustine is operated by USGS and is located in Merced County, near Gustine.

Station Description: The CDEC station at Mud Slough near Gustine (station ID: MSG) is operated by the USGS; data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for MSG.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-19 Salt Slough at Lander Ave

Location: 37.248°N -120.852°W

Water District or Organization: Salt Slough at Highway 165 near Stevinson is operated by USGS and is located in Merced County, near Stevinson.

Station Description: The CDEC station at Salt Slough at Highway 165 near Stevinson (station ID: SSH) is operated by the USGS; data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for SSH.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-20 Los Banos Creek at Hwy140

Location: 37.276°N -120.956°W

Water District or Organization: Los Banos Creek at Highway 140 is operated by the Kesterson unit of the San Luis National Wildlife Refuge

Station Description: Station is located in Kesterson unit just south east of Highway 140.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Velocity Sensor:	Sontek Argonaut SL
Stage Sensor:	Sontek Argonaut SL
Stage Sensor (Bubbler):	Design Analysis H350 XL
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel and 20W solar panel
Communications:	GOES Transmission
Stage to Flow Relationship:	
Bubbler:	Flow = 3.8335x2 + 6.5477(stage) - 8.0518
	r2 = 0.9948 Calibration good, using old data
Flow Calculation:	Flow = .0294((24.702 * stage - 15.687) * Sontek velocity)^2 + 1.3156O((24.702 * stage - 15.687) * Sontek velocity) + 1.4037 Sontek flow based on offset corrected stage of 0.59.
TDS or Salt Calculation:	mg/L = EC * (0.640) * 1000

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

	High	Low	
EC:	4	0.5	mS/cm
Flow:	150	0	CFS
Sontek Stage	7.0	0.7	feet
Bubbler Stage:	7	0	feet
Bubbler Stage Offset:	0.59 feet		
Sontek Offset:	approx 1.1 ft		

DO-20 Los Banos Creek QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
LosBanos Creek	1/9/2006	11:00	G2P17	SG	Bridge and all equipment attached to it was washed out.
LosBanos Creek	7/28/2006	na	F6P43	SG	stage reading taken from photo
LosBanos Creek	9/19/2006	11:30	G2P76	SG	EC meter not installed
LosBanos Creek	12/1/2006	12:15	G2P86	SG	
LosBanos Creek	12/21/2006	9:00	F10P86	SG	
LosBanos Creek	2/14/2007	9:52	G2P94	SG	
LosBanos Creek	3/12/2007	9:29	G2P96	SG	Too deep to rate
LosBanos Creek	4/5/2007	14:50	G2P102	SG	
LosBanos Creek	5/1/2007	9:10	G2P104	SG	

DO-20 Los Banos Creek QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°F)	Temp from Logger (°F)
LosBanos Creek	1/9/2006	11:00	na	5.80	na	1467	1357	na	51.6	50.92
LosBanos Creek	7/28/2006	na	na	2.00	na	na	na	na	na	na
LosBanos Creek	9/19/2006	11:30	2.23	2.26	na	796.6	na	na	71.4	na
LosBanos Creek	12/1/2006	12:15	3.11	3.12	na	915.3	869	890	49.3	47.6
LosBanos Creek	12/21/2006	9:00	3.03	3.04	na	1098	1042	1089	43.9	43.3
LosBanos Creek	2/14/2007	9:52	2.59	2.60	na	1644	1534	1631	54.3	54
LosBanos Creek	3/12/2007	9:29	4.26	4.30	na	2084	2029	2029	61.5	61.7
LosBanos Creek	4/5/2007	14:50	1.33	1.36	na	2228	2124	2231	73.4	72.9
LosBanos Creek	5/1/2007	9:10	1.31	1.36	na	1836	1738	1848	63.7	63.9

DO-20 Los Banos Creek QA data					
Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Bubbler to staff gauge offset	Rating Quality
LosBanos Creek	1/9/2006	11:00	stream/bubbler		fair
LosBanos Creek	7/28/2006	na	stream/bubbler		fair
LosBanos Creek	9/19/2006	11:30	stream/bubbler	0.030	fair
LosBanos Creek	12/1/2006	12:15	stream/bubbler	0.010	fair
LosBanos Creek	12/21/2006	9:00	stream/bubbler	0.010	fair
LosBanos Creek	2/14/2007	9:52	stream/bubbler	0.010	fair
LosBanos Creek	3/12/2007	9:29	stream/bubbler	0.040	fair
LosBanos Creek	4/5/2007	14:50	stream/bubbler	0.030	fair
LosBanos Creek	5/1/2007	9:10	stream/bubbler	0.050	fair

DO-20 Los Banos Creek QA data										
Reference			**Calculations**							
Site	Date	Time	QA Average Velocity (ft/s)	QA Area (ft^2)	Bubbler Calculated Area (ft^2)	QA Flow (CFS)	Bubbler Calculated Flow (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
LosBanos Creek	1/9/2006	11:00						92.50		98.68
LosBanos Creek	7/28/2006	na	0.48	17.44		9.95				
LosBanos Creek	9/19/2006	11:30	0.68	29.58	26.16	22.88	25.61			
LosBanos Creek	12/1/2006	12:15			49.32		49.39			
LosBanos Creek	12/21/2006	9:00	0.87	46.45	47.22	42.56	46.98	94.90	99.18	98.63
LosBanos Creek	2/14/2007	9:52	n/a	n/a	35.63	n/a	34.62	93.31	99.21	99.45
LosBanos Creek	3/12/2007	9:29	n/a	n/a	79.60	n/a	89.41	97.36	97.36	100.33
LosBanos Creek	4/5/2007	14:50	n/a	n/a	2.46	n/a	7.44	95.33	100.13	99.32
LosBanos Creek	5/1/2007	9:10	n/a	n/a	1.94	n/a	7.10	94.66	100.65	100.31

DO-21 Orestimba Creek at River Rd

Location: 37.414°N -121.015°W

Water District or Organization: Orestimba Creek at River Road near Crows Landing is operated by USGS and is located in Stanislaus County near Crows Landing.

Station Description: The CDEC station at Orestimba Creek at River Road near Crows Landing (station ID: OCL) is operated by USGS and data is collected by satellite. Flow, EC, and stage data in this report are directly from the CDEC website for OCL.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website
Stage to Flow Relationship:	Rating unknown, data is direct from CDEC.
Estimated data quality:	good
Date updated or calculated:	1/9/2008
Flow Calculation:	Rating unknown, data is direct from CDEC.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-22 MID Lateral 4 to SJR

Location: 37.63057°N -121.15888°W

Water District or Organization: Modesto Irrigation District

Station Description: Flow data is from Modesto Irrigation District's Lateral 4 site (from SCADA files when available or Spills files when not). Data is direct from Mike Niemi.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Mike Niemi, Water Resources Specialist, Modesto Irrigation District.
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	8/6/2007
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-23 MID Lateral 5 to Tuolumne

Location: 37.61452°N -121.14339°W

Water District or Organization: Modesto Irrigation District

Station Description: Flow data is from Modesto Irrigation District's Lateral 5 site, from SCADA files (if available; if not, from Spills files). Data is direct from Mike Niemi.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Mike Niemi, Water Resources Specialist, Modesto Irrigation District.
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	2/9/2007
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-24 MID Lateral 6 to Stanislaus River

Location: 37.70383°N -121.14143°W

Water District or Organization: Modesto Irrigation District

Station Description: Flow data is from Modesto Irrigation District's Lateral 6 site (from SCADA files when available, and Spills files otherwise). Data is direct from Mike Niemi.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Mike Niemi, Water Resources Specialist, Modesto Irrigation District.
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	10/30/2007
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-25 MID Miller Lake to Stanislaus River

Location: 37.66619°N -121.19553°W

Water District or Organization: Modesto Irrigation District

Station Description: Flow data is from Modesto Irrigation District's Miller Lake site, obtained from SCADA files. Data is direct from Mike Niemi.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Mike Niemi, Water Resources Specialist, Modesto Irrigation District.
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	1/8/2008
Flow Calculation:	Rating unknown except flow from 8/30/07 on is from bubbler. Flow = 3.33 * 14.5 * (stage^1.5)
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-26 TID Highline Spill

Location: 37.38921°N -120.80568°W

Water District or Organization: Turlock Irrigation District

Station Description: Flow data is from Turlock Irrigation District site Highline Spill. Data is direct from Keith Larson.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Keith Larson, Water Resources Analyst, Turlock Irrigation District
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	2/05/2008
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-27 TID Lateral 2

Location: 37.56522°N -121.13836°W

Water District or Organization: Turlock Irrigation District

Station Description: Flow data is from Turlock Irrigation District Lower Lateral 2 Spill Site. Data is direct from Keith Larson

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Keith Larson, Water Resources Analyst, Turlock Irrigation District
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	2/05/08
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-28 TID Westport Drain Flow Station

Location: 37.542°N -121.094°W

Water District or Organization: Turlock Irrigation District

Station Description: Flow data is from Turlock Irrigation District Westport Drain. Data is direct from Keith Larson.

Station Rating Variables:

Logger:	Unknown	
Conductivity Probe:	Unknown	
Velocity Sensor:	Unknown	
Stage Sensor:	Unknown	
Stage Sensor (Bubbler):	Unknown	
Battery:	Unknown	
Power:	Unknown	
Communications:	Keith Larson, Water Resources Analyst, Turlock Irrigation District	
Stage to Flow Relationship:	Rating unknown	
Estimated data quality:	Unknown	
Date updated or calculated:		
Flow Calculation:	Rating unknown	
TDS or Salt Calculation:	Not calculated.	
Expected Boundaries for Data (QA):		
Minimum flow:		
Maximum flow:		
Minimum EC:	0	µS/cm
Maximum EC:	916	µS/cm

DO-29 TID Harding Drain

Location: 37.46427°N -121.03093°W

Water District or Organization: Turlock Irrigation District

Station Description: Flow data is from Turlock Irrigation District Lateral 5 Drain (Harding Drain at Carpenter Rd.). Data is direct from Keith Larson.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Keith Larson, Water Resources Analyst, Turlock Irrigation District
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC	

DO-30 TID Lateral 6 & 7 at Levee

Location: 37.39767°N -120.95957°W

Water District or Organization: Turlock Irrigation District

Station Description: Flow data is calculated by adding values from Turlock Irrigation District Lateral 6 and Lateral 7 sites. Data is direct from Keith Larson.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Keith Larson, Water Resources Analyst, Turlock Irrigation District
Stage to Flow Relationship:	Rating unknown
Estimated data quality:	Unknown
Date updated or calculated:	
Flow Calculation:	Rating unknown
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	0 µS/cm
Maximum EC:	1779 µS/cm

DO-31 New Jerusalem Drain

Location: 37.72669°N -121.29963°W

Water District or Organization: New Jerusalem Drainage District/Banta Carbona Irrigation District

Station Description: Data is direct from Jeremy Hanlon with University of the Pacific. Bubbler data before 01/31/06 was not useful, Swagelok fitting installed backward allowing air leak. Swagelok corrected on Jan. 31, 2007. Mace Unit operational with data, bubbler data used preferentially

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	MACE Agriflo
Stage Sensor (Bubbler):	DA Bubbler
Battery:	Sealed 12V photovoltaic gel and 6V for Mace unit
Power:	Solar
Communications:	GOES Transmission
Structure description:	Square concrete culvert.
Structure shape:	Square with round pipes entering and exiting.
Staff gage stability:	No staff gage, hand-held gage used.
Width of structure:	Culvert 5 ft by 5 feet, pipes are 3.5feet diameter.
Depth of structure:	Bottom of culvert 0.5 feet below pipe opening
Board width:	5 feet
Board height:	Each board 30 inches with a total of 2.5 feet
Bubbler depth from top of board:	-3.278 according to bubbler reading
Bubbler off-set:	1.064 feet
Stage to Flow Relationship:	
Estimated quality:	good
Date update or calculated:	11/14/07

Bubbler staff gauge relationship:	Regression: Bubbler stage = 0.9633 * (QA stage) + 1.1603 r^2 = 0.9922
Gage flow relationship:	Ideal weir equation: 3.33 * W * H^1.5
	Regression: (bubbler flow) = 0.8485 * (weirstick flow) + 0.517 r^2=0.9951
Flow Calculation:	Flow = 3.33 * (5) * (bubbler value - 3.278)^1.5
	Secondary Flow is from Mace Agriflo. Unit calculates flow from internal formula based on culvert dimensions and velocity.

Expected Boundaries for Data (QA):

Maximum flow in summer:	12	CFS
Maximum flow:	12	CFS
Minimum flow in summer:	3	CFS
Minimum flow:	0.5	CFS
Maximum EC:	3	mS/cm
Minimum EC:	1	mS/cm

DO-31 New Jerusalem Drain QA data

WS = Weir Stick
SG = Staff Gauge
Reference

Site	Date	Time	Notebook Reference	Method	Comments
New Jerusalem	1/11/2006	11:04	TT011106P95	WS	Bubbler line was found to be leaking.
New Jerusalem	1/31/2006	8:30	F5P83	WS	Bubbler line was repaired.
New Jerusalem	2/8/2006	12:37	TT020806P105	WS	
New Jerusalem	3/8/2006	11:17	TT030806	WS	
New Jerusalem	4/4/2006	na	na	WS	The notebook was lost and data could not be entered.
New Jerusalem	5/9/2006	11:20	TT050906P135	WS	The river backed up into site causing the weir to be flooded.
New Jerusalem	6/6/2006	8:20	TT060606P145	WS	
New Jerusalem	7/21/2006	12:00	TT072106Pxx	WS	
New Jerusalem	8/22/2006	na	TT082206Pxx	WS	
New Jerusalem	9/28/2006	13:00	TT092806P19	WS	
New Jerusalem	10/3/2006	11:15	F9P133N7	WS	
New Jerusalem	10/27/2006	12:00	TT102706P27	WS	
New Jerusalem	11/17/2006	11:30	TT111706P36	WS	
New Jerusalem	12/8/2006	11:00	TT120806P45	WS	
New Jerusalem	1/19/2007	12:00	F11P83	WS	
New Jerusalem	2/13/2007	10:00	TTP61	WS	
New Jerusalem	3/6/2007	12:00	TTP69	WS	
New Jerusalem	4/13/2007	13:15	F12P3N3	WS	
New Jerusalem	5/22/2007	13:30	F12P65N1	WS	
New Jerusalem	6/19/2007	14:00	F12P130	WS	
New Jerusalem	8/14/2007	12:45	F14P122	WS	
New Jerusalem	9/11/2007	13:00	F15P57	WS	
New Jerusalem	10/9/2007	13:00	F15P123	WS	
New Jerusalem	11/1/2007	14:15	F15P145	WS	

DO-31 New Jerusalem Drain QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
New Jerusalem	1/11/2006	11:04	2.864	7.30	na	2340	2417		17.9	64.3
New Jerusalem	1/31/2006	8:30	3.427		0.15	na	na	na	na	na
New Jerusalem	2/8/2006	12:37	3.419	na	0.1	2420	2400		17.3	63.28
New Jerusalem	3/8/2006	11:17	4.618	3.50	na	2321	2395		16.58	62.11
New Jerusalem	4/4/2006	na	na	na	na	na	na	na	na	na
New Jerusalem	5/9/2006	11:20	12.514	na	na	2297	2266		17.06	62.8
New Jerusalem	6/6/2006	8:20	7.46	na	na	2553	2432		17.5	63.61
New Jerusalem	7/21/2006	12:00	4.084	3.00	2.5	2479	2419		18.48	65.37
New Jerusalem	8/22/2006	na	na	na	na	2507	2523		18.83	66
New Jerusalem	9/28/2006	13:00	na	na	na	2468	2404		19.07	66.35
New Jerusalem	10/3/2006	11:15	3.665	na	0.8	na	na		na	na
New Jerusalem	10/27/2006	12:00	3.666	na	0.79	2529	2477		19.74	66.61
New Jerusalem	11/17/2006	11:30	3.452	2.40	0.19	2494	2599		19.12	66.4
New Jerusalem	12/8/2006	11:00	3.433	na	0.15	2575	2517		18.11	65.32
New Jerusalem	1/19/2007	12:00	3.418	2.33	0.12	2245	2409	2424	17.01	62.92
New Jerusalem	2/13/2007	10:00	3.494	2.43	0.27	2418	2537	2476	16.65	62.28
New Jerusalem	3/6/2007	12:00	3.44	2.35	0.15	2567	2562	2569	16.59	61.97
New Jerusalem	4/13/2007	13:15	3.725	2.64	1	2424	2443	2468	17.06	62.76
New Jerusalem	5/22/2007	13:30	3.941	2.85	2.1	2334	2304		na	na
New Jerusalem	6/19/2007	14:00	4.036	2.99	2.5	2127	2157	2217	18.79	65.74
New Jerusalem	8/14/2007	12:45	3.945	2.90	1.9	2448	2250	2478	18.81	65.75
New Jerusalem	9/11/2007	13:00	3.79	2.75	1.3	2268	2257	2267	19.08	66.31
New Jerusalem	10/9/2007	13:00	3.587	2.55	0.5	2352	2487	2372	19.32	66.68
New Jerusalem	11/1/2007	14:15	3.486	2.43	0.3	2344	2456	2197	19.19	66.45

DO-31 New Jerusalem Drain QA data

Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
New Jerusalem	1/11/2006	11:04	Weir/bubbler	5	4.436		good
New Jerusalem	1/31/2006	8:30	Weir/bubbler	5	-3.427	3.300	good
New Jerusalem	2/8/2006	12:37	Weir/bubbler	5		3.322	good
New Jerusalem	3/8/2006	11:17	Weir/bubbler	5	-1.118		good
New Jerusalem	4/4/2006	na	Weir/bubbler	5			good
New Jerusalem	5/9/2006	11:20	Weir/bubbler	5			good
New Jerusalem	6/6/2006	8:20	Weir/bubbler	5			good
New Jerusalem	7/21/2006	12:00	Weir/bubbler	5	-1.084	3.258	good
New Jerusalem	8/22/2006	na	Weir/bubbler	5			good
New Jerusalem	9/28/2006	13:00	Weir/bubbler	5			good
New Jerusalem	10/3/2006	11:15	Weir/bubbler	5		3.279	good
New Jerusalem	10/27/2006	12:00	Weir/bubbler	5		3.283	good
New Jerusalem	11/17/2006	11:30	Weir/bubbler	5	-1.052	3.304	good
New Jerusalem	12/8/2006	11:00	Weir/bubbler	5		3.306	good
New Jerusalem	1/19/2007	12:00	Weir/bubbler	5	-1.088	3.309	good
New Jerusalem	2/13/2007	10:00	Weir/bubbler	5	-1.064	3.307	good
New Jerusalem	3/6/2007	12:00	Weir/bubbler	5	-1.090	3.313	good
New Jerusalem	4/13/2007	13:15	Weir/bubbler	5	-1.085	3.277	good
New Jerusalem	5/22/2007	13:30	Weir/bubbler	5	-1.091	3.206	good
New Jerusalem	6/19/2007	14:00	Weir/bubbler	5	-1.046	3.210	good
New Jerusalem	8/14/2007	12:45	Weir/bubbler	5	-1.045	3.257	good
New Jerusalem	9/11/2007	13:00	Weir/bubbler	5	-1.040	3.256	good
New Jerusalem	10/9/2007	13:00	Weir/bubbler	5	-1.037	3.305	good
New Jerusalem	11/1/2007	14:15	Weir/bubbler	5	-1.056	3.285	good

DO-31 New Jerusalem Drain QA data

Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
New Jerusalem	1/11/2006	11:04				103.29	0.00	100.12
New Jerusalem	1/31/2006	8:30	0.13	0.75	0.96			
New Jerusalem	2/8/2006	12:37	0.10	0.50	0.88	99.17	0.00	100.22
New Jerusalem	3/8/2006	11:17			25.83	103.19	0.00	100.43
New Jerusalem	4/4/2006	na						
New Jerusalem	5/9/2006	11:20			467.35	98.65	0.00	100.15
New Jerusalem	6/6/2006	8:20			142.39	95.26	0.00	100.17
New Jerusalem	7/21/2006	12:00	0.83	12.50	12.05	97.58	0.00	100.16
New Jerusalem	8/22/2006	na				100.64	0.00	100.16
New Jerusalem	9/28/2006	13:00				97.41	0.00	100.04
New Jerusalem	10/3/2006	11:15	0.39	4.00	4.01			
New Jerusalem	10/27/2006	12:00	0.38	3.95	4.02	97.94	0.00	98.63
New Jerusalem	11/17/2006	11:30	0.15	0.95	1.21	104.21	0.00	99.98
New Jerusalem	12/8/2006	11:00	0.13	0.75	1.02	97.75	0.00	101.12
New Jerusalem	1/19/2007	12:00	0.11	0.60	0.87	107.31	107.97	100.48
New Jerusalem	2/13/2007	10:00	0.19	1.35	1.67	104.92	102.40	100.50
New Jerusalem	3/6/2007	12:00	0.13	0.75	1.09	99.81	100.08	100.17
New Jerusalem	4/13/2007	13:15	0.45	5.00	4.98	100.78	101.82	100.08
New Jerusalem	5/22/2007	13:30	0.74	10.50	8.99	98.71	0.00	
New Jerusalem	6/19/2007	14:00	0.83	12.50	10.99	101.41	104.23	99.88
New Jerusalem	8/14/2007	12:45	0.69	9.50	9.07	91.91	101.23	99.84
New Jerusalem	9/11/2007	13:00	0.53	6.50	6.10	99.51	99.96	99.95
New Jerusalem	10/9/2007	13:00	0.28	2.50	2.86	105.74	100.85	99.86
New Jerusalem	11/1/2007	14:15	0.20	1.50	1.58	104.78	93.73	99.86

DO-33 Hospital Creek

Location: 37.61029°N -121.23082°W

Water District or Organization: SJVDA, Summers Engineering, Inc., and Tetra Tech

Station Description: Station is at the intersection of River Road and Hospital Creek. Data provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	None
Stage Sensor:	None
Stage Sensor (Bubbler):	DA Bubbler
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Concrete box with removable boards
Structure shape:	Rectangular box
Structure materials:	Concrete set in stream bed of clay and gravel
Staff gage stability:	Fixed to concrete structure
Width of structure:	approx 6 feet
Depth of structure:	2 x 12 inch board
Board width:	4.45 feet
Board height:	1.1 feet
Bubbler depth from top of board:	1.1 feet
Stage to Flow Relationship:	
Estimated quality:	good
Date data update or calculated:	1/11/2007
Observed stage vs. Bubbler stage:	Regression: Bubbler stage = 1.0295 * (QA stage) - 0.0024 r^2 = 0.9937

Observed stage vs. QA Flow:	Regression: Flow = 16.885 * (QA stage^1.8444) r^2 = 0.9925
Weir Stick Flow vs Bubbler Flow:	Regression: Flow = 0.9524 (Bubbler flow) - 0.1742 r^2 = 0.9734
Ideal Weir equation:	Flow = 14.819 * (Bubbler stage^1.5)
Flow Calculation:	Flow = 3.33 * 4.45 * ((bubbler stage - offset)^1.5)
TDS or Salt Calculation:	Salt mg/l = EC*0.64
Expected Boundaries for Data (QA):	
Minimum flow:	0.00 CFS
Maximum flow:	16.91 CFS
Minimum EC:	0 µS/cm
Maximum EC:	1966 µS/cm

DO-33 Hospital Creek QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Hospital Creek	1/11/2006	10:35	TT011106P94	WS	
Hospital Creek	2/8/2006	12:15	TT020806P104	WS	
Hospital Creek	3/8/2006	10:51	TT030806P114	WS	
Hospital Creek	4/4/2006	12:45	TT040406P124	WS	
Hospital Creek	5/9/2006	10:55	TT050906P134	WS	
Hospital Creek	6/6/2006	8:45	TT060606P144	WS	
Hospital Creek	7/21/2006	11:25	TT072106Pxx	WS	
Hospital Creek	8/22/2006	11:45	TT082206Pxx	WS	EC was changing rapidly, post-cleaning value questionable.
Hospital Creek	9/28/2006	12:30	TT092806P18	WS	EC was changing rapidly, post-cleaning value questionable.
Hospital Creek	10/27/2006	11:30	TT102706P26	WS	
Hospital Creek	11/17/2006	11:00	TT111706P35	WS	
Hospital Creek	12/8/2006	10:30	TT120806P45	WS	
Hospital Creek	1/19/2007	10:30	TTP53	WS	
Hospital Creek	2/13/2007	9:30	TTP60	WS	
Hospital Creek	3/6/2007	11:30	TTP68	WS	
Hospital Creek	4/13/2007	13:00	TTP78	WS	
Hospital Creek	5/29/2007	12:00	F12P79N3	WS	
Hospital Creek	6/19/2007	13:30	F12P130N1	WS	
Hospital Creek	7/10/2007	16:15	F14P28	WS	
Hospital Creek	8/14/2007	12:15	F14P122	WS	
Hospital Creek	9/11/2007	12:30	F15P57	WS	
Hospital Creek	10/9/2007	12:21	F15P123	WS	
Hospital Creek	11/1/2007	13:45	F15P145	WS	

DO-33 Hospital Creek QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Hospital Creek	1/11/2006	10:35	-0.002	0.01	No flow	163	186	168	9.22	48.6
Hospital Creek	2/8/2006	12:15	-0.154	Dry	No flow	na	0	2	na	62.48
Hospital Creek	3/8/2006	10:51	0.007	na	na	361	355	356	9.6	49.16
Hospital Creek	4/4/2006	12:45	0.18	0.19	0.25	205	202	212	12.77	59.3
Hospital Creek	5/9/2006	10:55	0.365	NA	NA	188	296	192	18.42	65.68
Hospital Creek	6/6/2006	8:45	0.178	0.19	0.2	198	213	195	18.95	66.4
Hospital Creek	7/21/2006	11:25	0.57	0.57	1.8	488	497	318	28.27	99.3
Hospital Creek	8/22/2006	11:45	0.363	0.32	0.65	514	527	545	22.26	71.73
Hospital Creek	9/28/2006	12:30	0.43	0.42	0.9	584	577	610	19.94	67.61
Hospital Creek	10/27/2006	11:30	0.118	0.12	0.1	575	573	593	11.61	52.49
Hospital Creek	11/17/2006	11:00	0.018	0.02	0	1177	1258		15.35	59.66
Hospital Creek	12/8/2006	10:30	0.015	0.02	0	635	661		7.18	46.928
Hospital Creek	1/19/2007	10:30	0.216	0.21	0.3	574	625	624	3.18	37.93
Hospital Creek	2/13/2007	9:30	0.019	0.01	0	304	312	312	10.24	51.35
Hospital Creek	3/6/2007	11:30	0.496	0.49	1.35	455	462	491	15.52	58.65
Hospital Creek	4/13/2007	13:00	0.391	0.39	0.85	1140	989	1170	18.73	65.32
Hospital Creek	5/29/2007	12:00	0.394	0.4	1	1059	760	1085	22.57	72.22
Hospital Creek	6/19/2007	13:30	0.441	0.46	1.3	717	664	776	28.51	83.42
Hospital Creek	7/10/2007	16:15	0.377	0.40	0.9	1210	1235	1316	26.96	80.69
Hospital Creek	8/14/2007	12:15	0.49	0.48	1.4	1093	759	1104	24.76	77.23
Hospital Creek	9/11/2007	12:30	0.285	0.28	0.6	1147	1113	1163	22.84	72.49
Hospital Creek	10/9/2007	12:21	0.015	na	No Flow	1332	1352	1358	17.05	62.82
Hospital Creek	11/1/2007	13:45	0.025	0.03	0	631		647	17.31	63.87

DO-33 Hospital Creek QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Hospital Creek	1/11/2006	10:35	Weir/bubbler	4.45	0.012		good
Hospital Creek	2/8/2006	12:15	Weir/bubbler	4.45			good
Hospital Creek	3/8/2006	10:51	Weir/bubbler	4.45			good
Hospital Creek	4/4/2006	12:45	Weir/bubbler	4.45	0.010	0.002	good
Hospital Creek	5/9/2006	10:55	Weir/bubbler	4.45			good
Hospital Creek	6/6/2006	8:45	Weir/bubbler	4.45	0.012	0.025	good
Hospital Creek	7/21/2006	11:25	Weir/bubbler	4.45	0.000	-0.094	good
Hospital Creek	8/22/2006	11:45	Weir/bubbler	4.45	-0.043	0.027	good
Hospital Creek	9/28/2006	12:30	Weir/bubbler	4.45	-0.010	0.012	good
Hospital Creek	10/27/2006	11:30	Weir/bubbler	4.45	0.002	0.021	good
Hospital Creek	11/17/2006	11:00	Weir/bubbler	4.45	0.002	0.018	good
Hospital Creek	12/8/2006	10:30	Weir/bubbler	4.45	0.005	0.015	good
Hospital Creek	1/19/2007	10:30	Weir/bubbler	4.45	-0.006	0.015	good
Hospital Creek	2/13/2007	9:30	Weir/bubbler	4.45	-0.009	0.019	good
Hospital Creek	3/6/2007	11:30	Weir/bubbler	4.45	-0.006	-0.052	good
Hospital Creek	4/13/2007	13:00	Weir/bubbler	4.45	-0.001	-0.011	good
Hospital Creek	5/29/2007	12:00	Weir/bubbler	4.45	0.006	-0.054	good
Hospital Creek	6/19/2007	13:30	Weir/bubbler	4.45	0.019	-0.093	good
Hospital Creek	7/10/2007	16:15	Weir/bubbler	4.45	0.023	-0.041	good
Hospital Creek	8/14/2007	12:15	Weir/bubbler	4.45	-0.010	-0.071	good
Hospital Creek	9/11/2007	12:30	Weir/bubbler	4.45	-0.005	-0.034	good
Hospital Creek	10/9/2007	12:21	Weir/bubbler	4.45			good
Hospital Creek	11/1/2007	13:45	Weir/bubbler	4.45	0.005	0.025	good

DO-33 Hospital Creek QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Hospital Creek	1/11/2006	10:35				114.11	103.07	100.01
Hospital Creek	2/8/2006	12:15						
Hospital Creek	3/8/2006	10:51				98.34	98.61	99.76
Hospital Creek	4/4/2006	12:45	0.18	1.11	0.99	98.54	103.41	107.85
Hospital Creek	5/9/2006	10:55			3.07	157.45	102.13	100.80
Hospital Creek	6/6/2006	8:45	0.15	0.89	0.98	107.58	98.48	100.44
Hospital Creek	7/21/2006	11:25	0.66	8.01	6.13	101.84	65.16	119.80
Hospital Creek	8/22/2006	11:45	0.34	2.89	3.04	102.53	106.03	99.53
Hospital Creek	9/28/2006	12:30	0.42	4.01	3.96	98.80	104.45	99.58
Hospital Creek	10/27/2006	11:30	0.10	0.45	0.49	99.65	103.13	99.23
Hospital Creek	11/17/2006	11:00	0.00	0.00	0.00	106.88	0.00	100.05
Hospital Creek	12/8/2006	10:30	0.00	0.00	0.00	104.09	0.00	104.46
Hospital Creek	1/19/2007	10:30	0.20	1.34	1.34	108.89	108.71	100.55
Hospital Creek	2/13/2007	9:30	0.00	0.00	0.00	102.63	102.63	101.82
Hospital Creek	3/6/2007	11:30	0.55	6.01	4.94	101.54	107.91	97.85
Hospital Creek	4/13/2007	13:00	0.40	3.78	3.42	86.75	102.63	99.40
Hospital Creek	5/29/2007	12:00	0.45	4.45	3.46	71.77	102.46	99.44
Hospital Creek	6/19/2007	13:30	0.53	5.79	4.12	92.61	108.23	100.12
Hospital Creek	7/10/2007	16:15	0.42	4.01	3.23	102.07	108.76	100.20
Hospital Creek	8/14/2007	12:15	0.56	6.23	4.85	69.44	101.01	100.86
Hospital Creek	9/11/2007	12:30	0.32	2.67	2.08	97.04	101.39	99.15
Hospital Creek	10/9/2007	12:21			0.00	101.50	101.95	100.21
Hospital Creek	11/1/2007	13:45	0.00	0.00	0.01	0.00	102.54	101.13

DO-34 Ingram Creek

Location: 37.60026°N -121.2251°W

Water District or Organization: SJVDA

Station Description: Station is at the intersection of River Road and Ingram Creek. Data is provided from Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Stage Sensor (Bubbler):	Design Analysis Bubbler
Battery:	Sealed photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Concrete bridge, weir entire width
Structure shape:	Rectangle
Structure materials:	Concrete with wood boards
Staff gage stability:	Set in concrete and attached to structure
Width of structure:	10 feet
Depth of structure:	1.1 feet above base
Board (Weir) width:	10 feet
Board (Weir) height:	1.1 feet above base
Bubbler depth from top of board:	Bubbler set to board height
Bubbler off-set	0 feet
Stage to Flow Relationship:	
Estimated quality:	good
Date data update or calculated:	1/24/2008
Date QA rating updated:	1/24/2008
Bubbler to weir offset:	0.021
Observed stage vs. Bubbler stage:	Regression: Bubbler stage = 0.9853 (QA stage) + 0.0036 r^2 = 0.9985

Weir Stick Flow vs Bubbler Flow:	Regression: Flow = 1.1215 (Bubbler flow) - 1.0605 r^2 = 0.9915
Flow Calculation:	Flow = 3.33 * 10 * ((Bubbler stage - offset)^1.5)
Expected Boundaries for Data (QA):	
Minimum flow:	0.00 CFS
Maximum flow:	30.00 CFS
Minimum EC:	400 µS/cm
Maximum EC:	2,100 µS/cm

DO-34 Ingram Creek QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Ingram Creek	1/11/2006	10:35	TT011106P93	WS	
Ingram Creek	2/8/2006	11:45	TT020806P102	WS	
Ingram Creek	3/8/2006	10:25	TT030806P113	WS	
Ingram Creek	4/4/2006	12:30	TT040406P123	WS	
Ingram Creek	5/9/2006	10:30	TT050906P133	WS	
Ingram Creek	6/6/2006	9:10	TT060606P143	WS	
Ingram Creek	7/21/2006	11:00	TT072106Pxx	WS	
Ingram Creek	8/22/2006	11:30	TT082206Pxx	WS	
Ingram Creek	9/28/2006	12:15	TT092806P17	WS	
Ingram Creek	10/27/2006	11:00	TT102806P25	WS	
Ingram Creek	11/17/2006	10:30	TT111716P34	WS	
Ingram Creek	12/8/2006	10:00	TT120806P43	WS	
Ingram Creek	1/19/2007	10:15	TTP52	WS	
Ingram Creek	2/13/2007	9:30	TTP59	WS	
Ingram Creek	3/6/2007	11:15	TTP67	WS	
Ingram Creek	4/13/2007	13:00	TTP76	WS	
Ingram Creek	5/29/2007	11:46	F12P79N1	WS	
Ingram Creek	6/18/2007	13:00	F12P129	WS	
Ingram Creek	7/10/2007	16:00	F14P28	WS	
Ingram Creek	8/14/2007	12:00	F14P122	WS	
Ingram Creek	9/11/2007	12:00	F15P57	WS	
Ingram Creek	10/9/2007	12:05	F15P123	WS	
Ingram Creek	11/1/2007	13:15	F15P145	WS	

DO-34 Ingram Creek QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Ingram Creek	1/11/2006	10:35	0.073	0.08	0.01	1926	1346	1601	11.98	57.97
Ingram Creek	2/8/2006	11:45	0.083	0.10	0.04	1332	1908	1338	13.08	57.36
Ingram Creek	3/8/2006	10:25	0.08	0.08	0.03	1664	1437	1631	10.7	53.22
Ingram Creek	4/4/2006	12:30	0.1597	0.16	0.15	550	722	573	15.95	60.542
Ingram Creek	5/9/2006	10:30	0.35	0.33	0.6	269	351	270	17.81	76.505
Ingram Creek	6/6/2006	9:10	0.441	0.47	1.1	559	433	553	19.58	66.84
Ingram Creek	7/21/2006	11:00	0.6486	0.66	1.8	818	696	819	27.4	94.978
Ingram Creek	8/22/2006	11:30	0.697	0.72	2.2	825	780	859	23.77	74.1
Ingram Creek	9/28/2006	12:15	0.182	na	na	914	702	848	19.62	68.78
Ingram Creek	10/27/2006	11:00	0.134	0.14	0.08	906	449	848	14.31	57.34
Ingram Creek	11/17/2006	10:30	0.124	0.12	0.08	1443	1440		16.3	61.42
Ingram Creek	12/8/2006	10:00	0.269	0.26	0.3	774	735		7.53	45.154
Ingram Creek	1/19/2007	10:15	0.1	0.09	0.04	1868	1756	1866	7.28	42.14
Ingram Creek	2/13/2007	9:30	0.104	0.10	0.04	1389	1452	1488	11.53	49.91
Ingram Creek	3/6/2007	11:15	0.169	0.17	0.06	606	660	650	14.88	58.81
Ingram Creek	4/13/2007	13:00	0.469	na	na	1179	1035	1279	18.11	64.29
Ingram Creek	5/29/2007	11:46	0.4076	0.41	0.9	1232	787	1230	18.11	64.29
Ingram Creek	6/18/2007	13:00	0.522	0.53	1.3	746	793	703	29.02	84.27
Ingram Creek	7/10/2007	16:00	0.6046	0.62	1.7	1049	1126	1079	28.42	81.24
Ingram Creek	8/14/2007	12:00	0.523	0.51	1.3	1129	1054	1144	24.75	77.12
Ingram Creek	9/11/2007	12:00	0.1266	0.13	0.1	1170	1109	1167	24.23	74.69
Ingram Creek	10/9/2007	12:05	0.102	0.10	0.08	1427	1326	1460	17.23	63.18
Ingram Creek	11/1/2007	13:15	0.124	0.12	0.1	945		955	16.84	62.38

DO-34 Ingram Creek QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Ingram Creek	1/11/2006	10:35	Weir/bubbler	10	0.007	0.052	good
Ingram Creek	2/8/2006	11:45	Weir/bubbler	10	0.012	0.031	good
Ingram Creek	3/8/2006	10:25	Weir/bubbler	10	0.000	0.037	good
Ingram Creek	4/4/2006	12:30	Weir/bubbler	10	0.000	0.033	good
Ingram Creek	5/9/2006	10:30	Weir/bubbler	10	-0.020	0.031	good
Ingram Creek	6/6/2006	9:10	Weir/bubbler	10	0.029	-0.037	good
Ingram Creek	7/21/2006	11:00	Weir/bubbler	10	0.011	-0.015	good
Ingram Creek	8/22/2006	11:30	Weir/bubbler	10	0.023	-0.062	good
Ingram Creek	9/28/2006	12:15	Weir/bubbler	10			good
Ingram Creek	10/27/2006	11:00	Weir/bubbler	10	0.006	0.051	good
Ingram Creek	11/17/2006	10:30	Weir/bubbler	10	-0.004	0.041	good
Ingram Creek	12/8/2006	10:00	Weir/bubbler	10	-0.009	0.068	good
Ingram Creek	1/19/2007	10:15	Weir/bubbler	10	-0.010	0.048	good
Ingram Creek	2/13/2007	9:30	Weir/bubbler	10	-0.004	0.052	good
Ingram Creek	3/6/2007	11:15	Weir/bubbler	10	0.001	0.100	good
Ingram Creek	4/13/2007	13:00	Weir/bubbler	10			good
Ingram Creek	5/29/2007	11:46	Weir/bubbler	10	0.002	-0.010	good
Ingram Creek	6/18/2007	13:00	Weir/bubbler	10	0.008	-0.012	good
Ingram Creek	7/10/2007	16:00	Weir/bubbler	10	0.015	-0.034	good
Ingram Creek	8/14/2007	12:00	Weir/bubbler	10	-0.013	-0.011	good
Ingram Creek	9/11/2007	12:00	Weir/bubbler	10	0.003	0.030	good
Ingram Creek	10/9/2007	12:05	Weir/bubbler	10	-0.002	0.019	good
Ingram Creek	11/1/2007	13:15	Weir/bubbler	10	-0.004	0.027	good

DO-34 Ingram Creek QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Ingram Creek	1/11/2006	10:35	0.02	0.10	0.68	69.89	83.13	108.23
Ingram Creek	2/8/2006	11:45	0.05	0.40	0.83	143.24	100.45	103.27
Ingram Creek	3/8/2006	10:25	0.04	0.30	0.78	86.36	98.02	103.82
Ingram Creek	4/4/2006	12:30	0.13	1.50	2.17	131.27	104.18	99.72
Ingram Creek	5/9/2006	10:30	0.32	6.00	6.95	130.48	100.37	119.43
Ingram Creek	6/6/2006	9:10	0.48	11.00	9.82	77.46	98.93	99.40
Ingram Creek	7/21/2006	11:00	0.66	18.00	17.47	85.09	100.12	116.80
Ingram Creek	8/22/2006	11:30	0.76	22.00	19.46	94.55	104.12	99.08
Ingram Creek	9/28/2006	12:15			2.63	76.81	92.78	102.17
Ingram Creek	10/27/2006	11:00	0.08	0.80	1.67	49.56	93.60	99.28
Ingram Creek	11/17/2006	10:30	0.08	0.80	1.49	99.79	0.00	100.13
Ingram Creek	12/8/2006	10:00	0.20	3.00	4.70	94.96	0.00	99.12
Ingram Creek	1/19/2007	10:15	0.05	0.40	1.08	94.00	99.89	93.43
Ingram Creek	2/13/2007	9:30	0.05	0.40	1.15	104.54	107.13	94.61
Ingram Creek	3/6/2007	11:15	0.07	0.60	2.35	108.91	107.26	100.04
Ingram Creek	4/13/2007	13:00			10.76	87.79	108.48	99.52
Ingram Creek	5/29/2007	11:46	0.42	9.00	8.73	63.88	99.84	99.52
Ingram Creek	6/18/2007	13:00	0.53	13.00	12.63	106.30	94.24	100.04
Ingram Creek	7/10/2007	16:00	0.64	17.00	15.73	107.34	102.86	97.70
Ingram Creek	8/14/2007	12:00	0.53	13.00	12.67	93.36	101.33	100.74
Ingram Creek	9/11/2007	12:00	0.10	1.00	1.54	94.79	99.74	98.78
Ingram Creek	10/9/2007	12:05	0.08	0.80	1.12	92.92	102.31	100.26
Ingram Creek	11/1/2007	13:15	0.10	1.00	1.49	0.00	101.06	100.11

DO-35 Westley Wasteway Flow Station

Location: 37.55818°N -121.16375°W

Water District or Organization:

Station Description: Station is northeast of the intersection of Cox and Frank Cox road. Data is provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	n/a
Stage Sensor (Bubbler):	DA Bubbler
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Flashboard riser/Sharp crested weir
Structure shape:	Rectangular
Structure materials:	Concrete/wood
Staff gage stability:	2-inch iron pipe set 2-feet deep, good stability
Width of structure:	4.33 ft
Depth of structure:	n/a
Board width:	4.33 feet
Board height:	approx. 4 feet
Bubbler depth from top of board:	approx 0.85 feet
Bubbler off-set	3.645
Stage to Flow Relationship:	
Estimated quality:	good
Date data update or calculated:	1/24/2008
Date QA rating updated:	11/1/2007
Observed stage vs. Bubbler stage:	Regression: Bubbler stage = 0.928 * (QA stage) + 0.2929 r^2 = 0.9724

Observed stage vs. QA Flow:	Regression: Observed stage = 8.5459 * (QA flow) - 31.078 r^2 = 0.9376
Weir Stick Flow vs Bubbler Flow:	Regression: Flow = 0.7948 * (Bubbler flow) + 0.4668 r^2 = 0.8968
Flow Calculation:	Flow = 3.33 * 4.33 * ((Bubbler stage - offset)^1.5)
Expected Boundaries for Data (QA):	
Minimum flow:	0.00 CFS
Maximum flow:	45.00 CFS
Minimum EC:	200 µS/cm
Maximum EC:	2,000 µS/cm

DO-35 Westley Wasteway QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Westley WW	1/11/2006	9:40	TT011106P92	WS	
Westley WW	2/8/2006	10:45	TT020806P102	WS	
Westley WW	3/8/2006	10:00	TT030806P112	WS	
Westley WW	5/9/2006	10:00	TT050906P132	WS	
Westley WW	6/6/2006	9:30	TT060606P142	WS	
Westley WW	8/1/2006	na	F10P48	WS	
Westley WW	8/22/2006	11:00	TT082206Pxx	WS	
Westley WW	9/5/2006	9:00	F10P77	WS	
Westley WW	9/28/2006	11:45	TT092806P16	WS	
Westley WW	10/3/2006	10:00	F9P133	WS	
Westley WW	10/27/2006	10:30	TT102806P24	WS	
Westley WW	11/17/2006	10:00	TT111706P33	WS	
Westley WW	12/8/2006	9:45	TT1208006P42	WS	
Westley WW	1/19/2007	10:00	TTP51	WS	
Westley WW	3/6/2007	10:45	TTP66	WS	
Westley WW	4/13/2007	12:30	TTP75	WS	
Westley WW	5/29/2007	11:30	F12P78N2	WS	
Westley WW	6/19/2007	12:45	F12P129N2	WS	
Westley WW	7/10/2007	15:30	F14P28	WS	
Westley WW	8/14/2007	11:30	F14P122	WS	
Westley WW	9/11/2007	11:30	F15P56	WS	There was heavy silt buildup around bubbler.
Westley WW	10/9/2007	11:40	FF15P122	WS	
Westley WW	11/1/2007	12:15	F15P144	WS	

DO-35 Westley Wasteway QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Westley WW	1/11/2006	9:40	1.714	na	na	190	na	na	9.15	na
Westley WW	2/8/2006	10:45	0.587	na	na	356	na	na	7.51	na
Westley WW	3/8/2006	10:00	0.073	0.29	na	257	275	259	7.61	45.71
Westley WW	5/9/2006	10:00	0.53	0.80	na	230	415	350	19.36	60.25
Westley WW	6/6/2006	9:30	2.158	1.69	na	413	318	390	22.22	73.06
Westley WW	8/1/2006	na	na	3.70	1	na	na	na	na	na
Westley WW	8/22/2006	11:00	na	na	0.75	614	na	na	26.95	na
Westley WW	9/5/2006	9:00	3.89	3.89	0.5	450	449	455	65	65.76
Westley WW	9/28/2006	11:45	3.968	na	na	440	451	438	21.52	69.86
Westley WW	10/3/2006	10:00	3.689	3.69	0.1	na	na	na	na	na
Westley WW	10/27/2006	10:30	3.787	3.78	0.29	389	511	456	9.95	49.3
Westley WW	11/17/2006	10:00	3.836	3.83	0.5	443	634	425	15.52	58.23
Westley WW	12/8/2006	9:45	3.717	3.68	0.1	517	1176	575	5.39	39.92
Westley WW	1/19/2007	10:00	3.707	3.69	0.1	655	938	720	1.32	35.17
Westley WW	3/6/2007	10:45	3.832	3.83	0.4	542	594	545	12.2	52.41
Westley WW	4/13/2007	12:30	3.98	3.94	0.7	1082	1062	1070	21.21	57.69
Westley WW	5/29/2007	11:30	3.741	3.74	0.15	1296	1068	1325	27.13	76.04
Westley WW	6/19/2007	12:45	3.761	3.76	0.2	453	688	505	32.52	89.94
Westley WW	7/10/2007	15:30	3.962	3.96	0.8	1213	1159	1280	28.93	84.06
Westley WW	8/14/2007	11:30	3.75	3.70	0.1	918	949	895	26.02	79.5
Westley WW	9/11/2007	11:30	4.03	3.90	0.5	1232	959	1254	24.39	70.71
Westley WW	10/9/2007	11:40	3.956	3.90	0.5	607	628	614	15.43	60.76
Westley WW	11/1/2007	12:15	4.17	4.20	1	560		592	17.38	63.95

DO-35 Westley Wasteway QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Westley WW	1/11/2006	9:40	Weir/bubbler	4.33			poor
Westley WW	2/8/2006	10:45	Weir/bubbler	4.33			poor
Westley WW	3/8/2006	10:00	Weir/bubbler	4.33	0.217		poor
Westley WW	5/9/2006	10:00	Weir/bubbler	4.33	0.270		poor
Westley WW	6/6/2006	9:30	Weir/bubbler	4.33	-0.468		poor
Westley WW	8/1/2006	na	Weir/bubbler	4.33			poor
Westley WW	8/22/2006	11:00	Weir/bubbler	4.33			poor
Westley WW	9/5/2006	9:00	Weir/bubbler	4.33	-0.005	3.608	fair
Westley WW	9/28/2006	11:45	Weir/bubbler	4.33			fair
Westley WW	10/3/2006	10:00	Weir/bubbler	4.33	0.001	3.592	fair
Westley WW	10/27/2006	10:30	Weir/bubbler	4.33	-0.007	3.591	fair
Westley WW	11/17/2006	10:00	Weir/bubbler	4.33	-0.006	3.554	fair
Westley WW	12/8/2006	9:45	Weir/bubbler	4.33	-0.037	3.620	fair
Westley WW	1/19/2007	10:00	Weir/bubbler	4.33	-0.017	3.610	good
Westley WW	3/6/2007	10:45	Weir/bubbler	4.33	-0.002	3.589	good
Westley WW	4/13/2007	12:30	Weir/bubbler	4.33	-0.040	3.626	good
Westley WW	5/29/2007	11:30	Weir/bubbler	4.33	-0.001	3.614	good
Westley WW	6/19/2007	12:45	Weir/bubbler	4.33	0.000	3.608	good
Westley WW	7/10/2007	15:30	Weir/bubbler	4.33	-0.002	3.576	good
Westley WW	8/14/2007	11:30	Weir/bubbler	4.33	-0.050	3.653	good
Westley WW	9/11/2007	11:30	Weir/bubbler	4.33	-0.130	3.748	fair
Westley WW	10/9/2007	11:40	Weir/bubbler	4.33	-0.056	3.674	good
Westley WW	11/1/2007	12:15	Weir/bubbler	4.33	0.030	3.722	good

DO-35 Westley Wasteway QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Westley WW	1/11/2006	9:40						
Westley WW	2/8/2006	10:45						
Westley WW	3/8/2006	10:00				107.00	100.78	100.03
Westley WW	5/9/2006	10:00				180.43	152.17	90.13
Westley WW	6/6/2006	9:30				77.00	94.43	101.48
Westley WW	8/1/2006	na	0.45	4.33				
Westley WW	8/22/2006	11:00	0.37	3.25				
Westley WW	9/5/2006	9:00	0.28	2.17	2.37	99.78	101.11	101.17
Westley WW	9/28/2006	11:45			3.35	102.50	99.55	98.76
Westley WW	10/3/2006	10:00	0.10	0.43	0.45			
Westley WW	10/27/2006	10:30	0.20	1.26	1.26	131.36	117.22	98.78
Westley WW	11/17/2006	10:00	0.28	2.17	1.76	143.12	95.94	97.15
Westley WW	12/8/2006	9:45	0.10	0.43	0.65	227.47	111.22	95.73
Westley WW	1/19/2007	10:00	0.10	0.43	0.22	143.21	109.92	102.31
Westley WW	3/6/2007	10:45	0.24	1.73	1.17	109.59	100.55	97.13
Westley WW	4/13/2007	12:30	0.35	3.03	2.80	98.15	98.89	82.21
Westley WW	5/29/2007	11:30	0.13	0.65	0.43	82.41	102.24	94.07
Westley WW	6/19/2007	12:45	0.15	0.87	0.57	151.88	111.48	99.34
Westley WW	7/10/2007	15:30	0.39	3.46	2.57	95.55	105.52	99.98
Westley WW	8/14/2007	11:30	0.10	0.43	0.49	103.38	97.49	100.84
Westley WW	9/11/2007	11:30	0.28	2.17	3.44	77.84	101.79	93.16
Westley WW	10/9/2007	11:40	0.28	2.17	2.50	103.46	101.15	101.65
Westley WW	11/1/2007	12:15	0.45	4.33	5.48		105.71	101.05

DO-36 Del Puerto Creek Flow Station

Location: 37.53947°N -121.1221°W

Water District or Organization:

Station Description: Site is located northeast of intersection of Cox Road and Condit Ave. Data is provided by Jeremy Hanlon with the University of the Pacific. Bubbler failure in mid 2007 caused loss of flow and stage data from July 2007 to November 2007.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	None
Stage Sensor:	bubbler only
Stage Sensor (Bubbler):	Design Analysis Bubbler
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Open streambed
Structure shape:	Lopsided "V", steeper right bank (South)
Structure materials:	Gravel and clay
Staff gage stability:	Two inch metal pipe set 3 feet into ground.
Width of structure:	n/a
Depth of structure:	n/a
Board width:	n/a
Board height:	n/a
Bubbler depth from top of board:	n/a
Bubbler off-set	0.18 feet until 11/1/07, then 0.5 feet
Stage to Flow Relationship:	
Estimated quality:	fair
Date data update or calculated:	1/18/2008
Date QA rating updated:	1/18/2008

Observed stage vs. Bubbler stage:	Regression: Bubbler stage =1.0428 * (QA stage) - 0.2003 r^2 = 0.9941
Flow Calculation:	
Bubbler stage vs. QA Flow:	Regression: Flow = 19.326 (Bubbler stage) - 6.465 r^2 = 0.9789
Expected Boundaries for Data (QA):	
Minimum flow:	0.00 CFS
Maximum flow:	40.00 CFS Highest QA flow was 17.81. Anything over this value is extrapolated from rating curve and may or may not be valid.
Minimum EC:	200 µS/cm
Maximum EC:	2,000 µS/cm

DO-36 Del Puerto Creek QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Del Puerto	1/11/2006	9:05	TT011106P91	SG	Bubbler flow takes into account different offset.
Del Puerto	2/8/2006	10:00	TT020806P101	SG	Bubbler adjusted to match staff gauge.
Del Puerto	3/8/2006	9:02	TT030806P111	SG	
Del Puerto	4/4/2006	na	TT040406P121	SG	No Access to site due to weather. Backwater conditions.
Del Puerto	5/9/2006	9:40	TT050906	SG	No Access to site due to weather. Backwater conditions.
Del Puerto	6/6/2006	10:10	TT060606P141	SG	No Access to site due to weather. Backwater conditions.
Del Puerto	7/21/2006	10:15	TT072106PXX	SG	
Del Puerto	8/22/2006	9:00	TT082206Pxx	SG	
Del Puerto	9/28/2006	11:00	TT092806P15	SG	
Del Puerto	10/27/2006	9:00	TT102706P23	SG	
Del Puerto	11/17/2006	9:30	TT111706P31	SG	
Del Puerto	12/8/2006	9:20	TT120806P41	SG	
Del Puerto	1/19/2007	9:25	TTP50	SG	
Del Puerto	2/13/2007	9:30		SG	No Access to site due to weather
Del Puerto	3/6/2007	10:05	TTP65	SG	
Del Puerto	4/13/2007	11:40	TTP74	SG	
Del Puerto	5/29/2007	10:45	F12P78N1	SG	
Del Puerto	6/18/2007	12:04	F12P129	SG	
Del Puerto	7/10/2007	14:45	F14P27	SG	
Del Puerto	8/14/2007	10:30	F14P121	SG	
Del Puerto	9/11/2007	10:15	F15P56	SG	Bubbler line is clogged, needs to be repaired.
Del Puerto	10/9/2007	10:10	F15P122	SG	Bubbler line is clogged, needs to be repaired.
Del Puerto	11/1/2007	12:00	F15P144	SG	Bubbler line was repaired and moved up by 0.318ft.
Del Puerto	12/13/2007	na		SG	No Access to site due to weather

DO-36 Del Puerto Creek QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Del Puerto	1/11/2006	9:05	2.329	1.93	na	533	534	538	8.47	47.54
Del Puerto	2/8/2006	10:00	1.155	0.60	na	425	414	416	9.16	48.65
Del Puerto	3/8/2006	9:02	0.167	0.46	na	814	793	830	9.53	49.02
Del Puerto	4/4/2006	na	2.22	na	na	na	463	463	na	na
Del Puerto	5/9/2006	9:40	7.088	na	na	304	600	600	16.9	65.24
Del Puerto	6/6/2006	10:10	5.025	5.23	na	472	620	473	20.16	68.83
Del Puerto	7/21/2006	10:15	0.992	1.25	na	1096	923	1117	23.92	74.66
Del Puerto	8/22/2006	9:00	0.916	1.15	na	703	623	727	21.24	70.57
Del Puerto	9/28/2006	11:00	0.533	na	na	591	581	583	17.81	64.02
Del Puerto	10/27/2006	9:00	0.739	0.99	na	954	919	964	12.59	54.82
Del Puerto	11/17/2006	9:30	0.574	0.80	na	572	571	604	14.32	57.96
Del Puerto	12/8/2006	9:20	0.455	0.7	na	1060	1063	1079	12.43	54.51
Del Puerto	1/19/2007	9:25	0.578	0.75	na	513	546	494	3.79	39.01
Del Puerto	2/13/2007	9:30	na	na	na	na	na	na	na	na
Del Puerto	3/6/2007	10:05	0.726	0.89	na	777	726	817	13.2	55.05
Del Puerto	4/13/2007	11:40	1.32	1.49	na	1334	1356	1348	14.5	57.32
Del Puerto	5/29/2007	10:45	0.61	0.68	na	1345	1254	1375	21.06	68.75
Del Puerto	6/18/2007	12:04	1.122	1.22	na	949	907	908	24.25	75.01
Del Puerto	7/10/2007	14:45	0.827	0.79	na	1399	1477	1488	25.03	77.01
Del Puerto	8/14/2007	10:30	2.101	1.25	na	1100	977	1101	21.04	69.83
Del Puerto	9/11/2007	10:15	2.269	0.72	na	1332	939	1347	20.44	68.79
Del Puerto	10/9/2007	10:10	3.043	1.14	na	1370	1071	1383	15.49	59.84
Del Puerto	11/1/2007	12:00	0.115	0.62	na	749	802	755	14.62	58.22
Del Puerto	12/13/2007	na	na	na	na	na	na	na	na	na

DO-36 Del Puerto Creek QA data

Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Bubbler to staff gauge offset	Rating Quality
Del Puerto	1/11/2006	9:05	stream/bubbler	-0.399	good
Del Puerto	2/8/2006	10:00	stream/bubbler	-0.555	good
Del Puerto	3/8/2006	9:02	stream/bubbler	0.293	good
Del Puerto	4/4/2006	na	stream/bubbler		good
Del Puerto	5/9/2006	9:40	stream/bubbler		good
Del Puerto	6/6/2006	10:10	stream/bubbler	0.205	good
Del Puerto	7/21/2006	10:15	stream/bubbler	0.258	good
Del Puerto	8/22/2006	9:00	stream/bubbler	0.234	good
Del Puerto	9/28/2006	11:00	stream/bubbler		good
Del Puerto	10/27/2006	9:00	stream/bubbler	0.251	good
Del Puerto	11/17/2006	9:30	stream/bubbler	0.226	good
Del Puerto	12/8/2006	9:20	stream/bubbler	0.245	good
Del Puerto	1/19/2007	9:25	stream/bubbler	0.172	good
Del Puerto	2/13/2007	9:30	stream/bubbler	na	good
Del Puerto	3/6/2007	10:05	stream/bubbler	0.164	good
Del Puerto	4/13/2007	11:40	stream/bubbler	0.170	poor
Del Puerto	5/29/2007	10:45	stream/bubbler	0.070	poor
Del Puerto	6/18/2007	12:04	stream/bubbler	0.098	poor
Del Puerto	7/10/2007	14:45	stream/bubbler	-0.037	poor
Del Puerto	8/14/2007	10:30	stream/bubbler	-0.851	poor
Del Puerto	9/11/2007	10:15	stream/bubbler	-1.549	poor
Del Puerto	10/9/2007	10:10	stream/bubbler	-1.903	poor
Del Puerto	11/1/2007	12:00	stream/bubbler	0.505	fair
Del Puerto	12/13/2007	na	stream/bubbler	-0.399	good

DO-36 Del Puerto Creek QA data									
Reference			**Calculations**						
Site	Date	Time	QA Ave Velocity (ft/s)	QA Area (ft^2)	QA Flow (CFS)	Calculated Flow 19.326x-6.465 (from 11/1/07 on there is a .318 offset) (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Del Puerto	1/11/2006	9:05	0.00			42.82	100.19	100.94	100.62
Del Puerto	2/8/2006	10:00	0.00		2.82	2.95	97.41	97.88	100.33
Del Puerto	3/8/2006	9:02	0.00	1.33	2.19	1.98	97.42	101.97	99.73
Del Puerto	4/4/2006	na	0.00			95.52			
Del Puerto	5/9/2006	9:40	0.00			1023.98	197.37	197.37	104.52
Del Puerto	6/6/2006	10:10	0.00			509.13	131.36	100.21	100.79
Del Puerto	7/21/2006	10:15	2.27	6.85	16.93	18.32	84.22	101.92	99.47
Del Puerto	8/22/2006	9:00	2.12	7.32	17.42	15.62	88.62	103.41	100.48
Del Puerto	9/28/2006	11:00	0.00			5.71	98.31	98.65	99.94
Del Puerto	10/27/2006	9:00	1.98	5.50	10.37	10.28	96.33	101.05	100.29
Del Puerto	11/17/2006	9:30	1.41	3.78	6.07	6.48	99.83	105.59	100.32
Del Puerto	12/8/2006	9:20	1.37	2.97	4.14	4.44	100.28	101.79	100.25
Del Puerto	1/19/2007	9:25	1.09	3.20	4.13	4.71	106.43	96.30	100.48
Del Puerto	2/13/2007	9:30	na	na	na	na	na	na	na
Del Puerto	3/6/2007	10:05	1.64	4.39	7.65	7.57	93.44	105.15	98.73
Del Puerto	4/13/2007	11:40	1.55	10.90	17.81	19.05	101.65	101.05	98.66
Del Puerto	5/29/2007	10:45	0.88	2.71	2.99	5.32	93.23	102.23	98.34
Del Puerto	6/18/2007	12:04	1.97	8.23	16.94	15.22	95.57	95.68	99.15
Del Puerto	7/10/2007	14:45	1.16	3.86	5.20	9.52	105.58	106.36	99.94
Del Puerto	8/14/2007	10:30	1.16	8.21	10.64	34.14	88.82	100.09	99.94
Del Puerto	9/11/2007	10:15	1.04	3.00	3.37	37.39	70.50	101.13	100.00
Del Puerto	10/9/2007	10:10	1.59	7.54	12.54	52.34	78.18	100.95	99.93
Del Puerto	11/1/2007	12:00	1.59	7.54	2.33	1.90	107.08	100.80	99.84
Del Puerto	12/13/2007	na	na	na	na	na	na	na	na

DO-38 Marshall Road Drain

Location: 37.43605°N -121.036°W

Water District or Organization:

Station Description: Station is at the bend in Marshall Road. Data provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	Unidata Starflow
Stage Sensor (Primary):	Design Analysis Bubbler
Stage Sensor (Secondary):	Unidata Starflow
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Concrete culvert, square
Structure shape:	Square
Structure materials:	Concrete
Staff gage stability:	No staff gage, measure with hand-held gage.
Width of structure:	Culvert 3 ft by 3 feet
Depth of structure:	Bottom of culvert 0.4 feet below pipe opening.
Board width:	4.67 feet
Board height:	approx 1.56 feet
Bubbler depth from top of board:	At floor of box, approx. 1.56 feet
Bubbler off-set	1.545 feet
Stage to Flow Relationship:	
Estimated quality:	good
Date data update or calculated:	1/24/2008
Date QA rating updated:	1/25/2008

Observed stage vs. Bubbler stage:	Regression: Bubbler stage = 0.9381 * (QA stage) + 0.0468 r^2 = 0.8365
Bubbler stage vs. QA Flow:	Regression: Flow = 19.029 * (Bubbler stage)^2 -54.839 * (Bubbler stage) + 38.929 r^2 = 0.9814
Weir Stick Flow vs Bubbler Flow:	Flow = 0.0524 (Weir stick flow)^2 + 0.8633 * (Weir stick flow)
Ideal Weir equation:	Flow = 3.33 * 4.66 * (Bubbler stage-offset)^1.5
Flow Calculation:	Flow = (3.33 * 4.66 * ((Bubbler stage-1.545)^1.5))^2 * 0.0524 + 0.8633 * (3.33 * 4.66 * (Bubbler stage-1.545)^1.5) r^2 = 0.9814
Expected Boundaries for Data (QA):	
Minimum flow for year:	0.00 CFS
Maximum flow for year:	10.20 CFS Flow values above this are beyond calibration curve and based solely on extrapolated calculation.
Minimum EC:	200 µS/cm Values below this were recorded while the sensor was out of the water.
Maximum EC:	2,000 µS/cm

DO-38 Marshall Road Drain QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Marshall Road	1/11/2006	8:15	TT011106P88	WS	
Marshall Road	2/8/2006	8:20	TT020806P97	WS	
Marshall Road	3/8/2006	8:00	TT030806P107	WS	Added an 8" board to weir structure.
Marshall Road	4/4/2006	8:30	TT040406P117	WS	
Marshall Road	5/9/2006	8:00	TT050906P127	WS	Bubbler line had a leak and was repaired. A weirboard became dislodged and floated out because the weir was submerged.
Marshall Road	6/6/2006	11:00	TT060606P137	WS	
Marshall Road	7/21/2006	9:00	TT072106Pxx	WS	
Marshall Road	8/22/2006	8:30	TT082206Pxx	WS	
Marshall Road	9/28/2006	9:45	TT092806P12	WS	
Marshall Road	10/3/2006	8:30	F9P133N2	WS	
Marshall Road	10/27/2006	8:30	TT102706P20	WS	
Marshall Road	11/17/2006	8:45	TT111706P28	WS	
Marshall Road	12/8/2006	8:15	TT120806P38	WS	
Marshall Road	1/19/2007	8:15	TTP47	WS	
Marshall Road	2/13/2007	8:30	TTP56	WS	
Marshall Road	3/6/2007	8:45	TTP62	WS	
Marshall Road	4/13/2007	9:15	TTP70	WS	
Marshall Road	5/22/2007	9:30	F12P64N2	WS	
Marshall Road	6/19/2007	9:00	F12P127N4	WS	
Marshall Road	7/10/2007	11:30	F14P26	WS	
Marshall Road	8/14/2007	8:30	F14P120	WS	
Marshall Road	9/11/2007	8:45	F15P55	WS	
Marshall Road	10/9/2007	8:30	F15P121	WS	

DO-38 Marshall Road Drain QA data

Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Marshall Road	1/11/2006	8:15	0.98	na	0	547	564	523	10.67	51.29
Marshall Road	2/8/2006	8:20	1.007	0.99	0.02	885	935	890	13.09	55.31
Marshall Road	3/8/2006	8:00	0.991	na	na	305	316	308	12.49	55.03
Marshall Road	4/4/2006	8:30	1.398	1.74	0.35	182	200	196	13.81	57.84
Marshall Road	5/9/2006	8:00	3.923	na	na	712	858	623	17.99	65.86
Marshall Road	6/6/2006	11:00	1.94	1.94	0.9	187	123	185	20.96	69.66
Marshall Road	7/21/2006	9:00	2.15	2.18	na	816	285	816	23.92	75.12
Marshall Road	8/22/2006	8:30	2.051	2.05	1.3	639	436	695	19.96	68
Marshall Road	9/28/2006	9:45	1.708	na	na	638	678	645	18.64	65.76
Marshall Road	10/3/2006	8:30	1.958	1.94	0.9	na	na	na	na	na
Marshall Road	10/27/2006	8:30	1.874	1.86	0.6	665	680	675	12.38	54.12
Marshall Road	11/17/2006	8:45	1.662	1.65	0.08	446	478		14.56	58.78
Marshall Road	12/8/2006	8:15	1.597	1.56	na	1300	1341		10.7	51.64
Marshall Road	1/19/2007	8:15	1.677	1.65	0.1	988	1074	1082	8.46	47.74
Marshall Road	2/13/2007	8:30	1.84	1.60	0.4	522	547	556	12.9	54.62
Marshall Road	3/6/2007	8:45	1.7	1.58	0.02	663	709	701	14.45	58.25
Marshall Road	4/13/2007	9:15	1.827	1.82	0.5	1387	1343	1568	11.94	53.56
Marshall Road	5/22/2007	9:30	2.127	1.95	1.8	858	584	874	na	61.63
Marshall Road	6/19/2007	9:00	1.854	1.83	0.8	680	741	721	21.83	71.08
Marshall Road	7/10/2007	11:30	2.19	2.20	2.2	1302	809	1393	23.74	74.69
Marshall Road	8/14/2007	8:30	1.892	1.86	0.7	1286	980	1310	20.96	69.52
Marshall Road	9/11/2007	8:45	1.8	1.73	0.4	1152	1166	1147	22.27	71.98
Marshall Road	10/9/2007	8:30	1.624	1.60	0.07	1253	1282	1264	17.3	63.15

DO-38 Marshall Road Drain QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Marshall Road	1/11/2006	8:15	Weir/bubbler	4.6		0.980	poor
Marshall Road	2/8/2006	8:20	Weir/bubbler	4.6	-0.017	0.974	poor
Marshall Road	3/8/2006	8:00	Weir/bubbler	4.6			poor
Marshall Road	4/4/2006	8:30	Weir/bubbler	4.6	0.342	1.175	poor
Marshall Road	5/9/2006	8:00	Weir/bubbler	4.6			poor
Marshall Road	6/6/2006	11:00	Weir/bubbler	4.6	0.000	1.522	good
Marshall Road	7/21/2006	9:00	Weir/bubbler	4.6	0.030		good
Marshall Road	8/22/2006	8:30	Weir/bubbler	4.6	-0.001	1.517	good
Marshall Road	9/28/2006	9:45	Weir/bubbler	4.6			good
Marshall Road	10/3/2006	8:30	Weir/bubbler	4.6	-0.018	1.540	good
Marshall Road	10/27/2006	8:30	Weir/bubbler	4.6	-0.014	1.555	good
Marshall Road	11/17/2006	8:45	Weir/bubbler	4.6	-0.012	1.579	good
Marshall Road	12/8/2006	8:15	Weir/bubbler	4.6	-0.037		good
Marshall Road	1/19/2007	8:15	Weir/bubbler	4.6	-0.027	1.580	good
Marshall Road	2/13/2007	8:30	Weir/bubbler	4.6	-0.240	1.597	good
Marshall Road	3/6/2007	8:45	Weir/bubbler	4.6	-0.120	1.667	good
Marshall Road	4/13/2007	9:15	Weir/bubbler	4.6	-0.007	1.545	good
Marshall Road	5/22/2007	9:30	Weir/bubbler	4.6	-0.177	1.463	good
Marshall Road	6/19/2007	9:00	Weir/bubbler	4.6	-0.024	1.468	good
Marshall Road	7/10/2007	11:30	Weir/bubbler	4.6	0.010	1.431	good
Marshall Road	8/14/2007	8:30	Weir/bubbler	4.6	-0.032	1.538	good
Marshall Road	9/11/2007	8:45	Weir/bubbler	4.6	-0.070	1.557	good
Marshall Road	10/9/2007	8:30	Weir/bubbler	4.6	-0.024	1.548	good

DO-38 Marshall Road Drain QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Marshall Road	1/11/2006	8:15	0.00	0.00	0.00	103.11	95.61	100.16
Marshall Road	2/8/2006	8:20	0.03	0.09	0.07	105.65	100.56	99.55
Marshall Road	3/8/2006	8:00			0.02	103.61	100.98	101.01
Marshall Road	4/4/2006	8:30	0.22	1.61	4.14	109.89	107.69	101.73
Marshall Road	5/9/2006	8:00			77.34	120.51	87.50	102.30
Marshall Road	6/6/2006	11:00	0.42	4.14	3.88	65.78	98.93	99.90
Marshall Road	7/21/2006	9:00			7.30	34.93	100.00	100.09
Marshall Road	8/22/2006	8:30	0.53	5.98	5.60	68.23	108.76	100.11
Marshall Road	9/28/2006	9:45			1.05	106.27	101.10	100.32
Marshall Road	10/3/2006	8:30	0.42	4.14	4.14			
Marshall Road	10/27/2006	8:30	0.32	2.76	2.96	102.26	101.50	99.70
Marshall Road	11/17/2006	8:45	0.08	0.37	0.65	107.17	0.00	100.98
Marshall Road	12/8/2006	8:15			0.18	103.15	0.00	100.74
Marshall Road	1/19/2007	8:15	0.10	0.46	0.73	108.70	109.51	101.08
Marshall Road	2/13/2007	8:30	0.24	1.84	2.45	104.79	106.51	98.91
Marshall Road	3/6/2007	8:45	0.03	0.09	0.93	106.94	105.73	100.41
Marshall Road	4/13/2007	9:15	0.28	2.30	2.29	96.83	113.05	100.13
Marshall Road	5/22/2007	9:30	0.66	8.28	6.80	68.07	101.86	
Marshall Road	6/19/2007	9:00	0.39	3.68	2.63	108.97	106.03	99.70
Marshall Road	7/10/2007	11:30	0.76	10.12	7.93	62.14	106.99	99.94
Marshall Road	8/14/2007	8:30	0.35	3.22	3.13	76.21	101.87	99.70
Marshall Road	9/11/2007	8:45	0.24	1.84	1.97	101.22	99.57	99.85
Marshall Road	10/9/2007	8:30	0.08	0.32	0.34	102.31	100.88	100.02

DO-40 Patterson Irrigation District

Location: 37.49716°N -121.08280°W

Water District or Organization: Patterson Irrigation District.

Station Description: Station is owned and operated by Patterson Irrigation District. Data provided from John Sweigard (General Manager of Patterson Irrigation District) and Chris Linneman (Summers Engineering).

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Chris Linneman
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	08/17/2007
Flow Calculation:	Rating unknown.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-41 West Stanislaus Irrigation District Diversion

Location: 37.58438°N -121.20053°W

Water District or Organization: West Stanislaus Irrigation District.

Station Description: West Stanislaus Irrigation District Diversion. Data provided by Chris Linneman from Ron Roos.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Ron Roos and Chris Linneman
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	02/05/2008
Flow Calculation:	Rating unknown.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-44 San Luis Drain End

Location: 37.2609°N -120.9052°W

Water District or Organization: Grasslands Bypass Project and the San Francisco Estuary Institute

Station Description: Data provided from Chris Linneman with Summers Engineering.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Chris Linneman (Summers Engineering).
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	7/27/2007
Flow Calculation:	Rating unknown.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-45 Volta Wasteway

Location: 37.105°N -120.936°W

Water District or Organization: Grassland Water District.

Station Description: Site is an open channel streambed with a Sontek Doppler meter. Data provided by Lara Sparks (Fish and Game and Grassland Water District) and Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Campbell CR10x
Conductivity Probe:	Campbell
Velocity Sensor:	Sontek SL
Stage Sensor:	Sontek SL
Stage Sensor (Bubbler):	n/a
Battery:	12V
Power:	Solar
Communications:	GOES
Stage to Flow Relationship:	
Estimated quality:	Poor
Date data update or calculated:	11/7/2007
Date QA rating updated:	7/20/2007
Observed stage vs. Sontek stage:	QA stage = 0.9551 * (Sontek stage) + 1.7415 r^2 = 0.9334
Observed stage vs. QA Flow:	Regression: Flow = 10.249 * (e^0.1686(stage)) r^2 = 0.9052
Flow Calculation:	Flow = (Sontek Calculated Area) * Velocity
TDS or Salt Calculation:	salt mg/l = EC*0.64
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-45 Volta Wasteway QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Volta WW	1/9/2006	13:45	G2P20	SG	Staff gauge loose and moving.
Volta WW	2/2/2006	11:45	G2P27	SG	
Volta WW	3/1/2006	12:00	G2P34	SG	
Volta WW	5/8/2006	12:45	G2P53	SG	
Volta WW	6/9/2006	9:00	G2P57	SG	
Volta WW	7/6/2006	10:15	G2P63	SG	
Volta WW	7/28/2006		F10P44	SG	
Volta WW	8/31/2006	13:45	G2P72	SG	
Volta WW	9/21/2006	11:00	G2P76	SG	
Volta WW	10/10/2006	8:15	G2P76	SG	
Volta WW	11/30/2006	13:45	G2P85	SG	
Volta WW	12/21/2006	12:15	G2P90	SG	
Volta WW	2/14/2007	12:12	G2P95	SG	
Volta WW	3/12/2007	12:11	G2P97	SG	Tried to rate, but water was too high to wade.
Volta WW	4/5/2007	13:50	G2P102	SG	
Volta WW	5/1/2007	12:09	G2P105	SG	
Volta WW	5/29/2007	15:32	G2P108	SG	
Volta WW	6/22/2007	13:59	G2P113	SG	
Volta WW	7/20/2007	7:55	G2P115	SG	Staff gauge loose and moving.

DO-45 Volta Wasteway QA data										
Reference			**Measured Variables**							
Site	Date	Time	Sontek reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°F)	Temp from Logger (°F)
Volta WW	1/9/2006	13:45	1.91	na	na	2023	1928		54.9	54.41
Volta WW	2/2/2006	11:45	2.44	3.93	na	956.5	999		58.3	57.04
Volta WW	3/1/2006	12:00	2.32	3.81	na	1218	1397		60	57.61
Volta WW	5/8/2006	12:45	0.088	1.83	na	744.5	715		72.7	71.9
Volta WW	6/9/2006	9:00	na	2.04	na	896.7	910		70.7	70.5
Volta WW	7/6/2006	10:15	0.82	2.51	na	714.2	706		73.8	73.7
Volta WW	7/28/2006			2.62	na	na	na		na	na
Volta WW	8/31/2006	13:45	2.21	4.20	na	441.1	431		77.2	76.5
Volta WW	9/21/2006	11:00	3.11	4.98	na	398	388		68.2	67.67
Volta WW	10/10/2006	8:15	2.68	4.60	na	385.7	437		62.4	64.94
Volta WW	11/30/2006	13:45	2.81	4.04	na	741.6	717		51.1	51.8
Volta WW	12/21/2006	12:15	2.7	4.09	na	700.8	695		47.5	47.4
Volta WW	2/14/2007	12:12	3.07	4.19	na	1533	2501	1761	56.3	55.3
Volta WW	3/12/2007	12:11	2.66	4.27	na	1190	2329	1306	67.1	64.7
Volta WW	4/5/2007	13:50	0.38	2.18	na	1549	1545	1606	69.6	68.8
Volta WW	5/1/2007	12:09	1.04	2.92	na	547.4	540	543	68.5	68.2
Volta WW	5/29/2007	15:32	0.89	2.80	na	716.9	711	729	74.3	74
Volta WW	6/22/2007	13:59	0.8	2.64	na	600.5	591	617	80.2	80.4
Volta WW	7/20/2007	7:55	0.47	2.34	na	1207	1198	1198	73.6	74

DO-45 Volta Wasteway QA data					
Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Bubbler to staff gauge offset	Rating Quality
Volta WW	1/9/2006	13:45	stream/bubbler		poor
Volta WW	2/2/2006	11:45	stream/bubbler	1.490	poor
Volta WW	3/1/2006	12:00	stream/bubbler	1.490	poor
Volta WW	5/8/2006	12:45	stream/bubbler	1.742	poor
Volta WW	6/9/2006	9:00	stream/bubbler		poor
Volta WW	7/6/2006	10:15	stream/bubbler	1.690	poor
Volta WW	7/28/2006		stream/bubbler	2.620	poor
Volta WW	8/31/2006	13:45	stream/bubbler	1.990	poor
Volta WW	9/21/2006	11:00	stream/bubbler	1.870	poor
Volta WW	10/10/2006	8:15	stream/bubbler	1.920	poor
Volta WW	11/30/2006	13:45	stream/bubbler	1.230	poor
Volta WW	12/21/2006	12:15	stream/bubbler	1.390	poor
Volta WW	2/14/2007	12:12	stream/bubbler	1.120	poor
Volta WW	3/12/2007	12:11	stream/bubbler	1.610	poor
Volta WW	4/5/2007	13:50	stream/bubbler	1.800	poor
Volta WW	5/1/2007	12:09	stream/bubbler	1.880	poor
Volta WW	5/29/2007	15:32	stream/bubbler	1.910	poor
Volta WW	6/22/2007	13:59	stream/bubbler	1.840	poor
Volta WW	7/20/2007	7:55	stream/bubbler	1.870	poor

DO-45 Volta Wasteway QA data											
Reference			**Calculations**								
Site	Date	Time	QA Ave Velocity (ft/s)	QA Area (ft^2)	QA Flow (CFS)	Sontek Area (ft^2)	Sontek Velocity (ft/s)	Sontek Flow (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Volta WW	1/9/2006	13:45	0.08	139.40	14.56	156.92	0.10	15.69	95.30	0.00	99.11
Volta WW	2/2/2006	11:45	0.10	172.12	20.38	182.98	0.13	23.79			
Volta WW	3/1/2006	12:00				177.08			114.70	0.00	96.02
Volta WW	5/8/2006	12:45	0.14	79.72	14.49	67.35	0.27	18.18			
Volta WW	6/9/2006	9:00							101.48	0.00	99.72
Volta WW	7/6/2006	10:15				103.33					
Volta WW	7/28/2006		0.12	101.93	14.92	63.02	0.23	14.49			
Volta WW	8/31/2006	13:45									
Volta WW	9/21/2006	11:00									
Volta WW	10/10/2006	8:15									
Volta WW	11/30/2006	13:45									
Volta WW	12/21/2006	12:15									
Volta WW	2/14/2007	12:12	n/a	n/a	n/a	213.95	0.13	27.81	163.14	114.87	98.22
Volta WW	3/12/2007	12:11	n/a	n/a	n/a	193.79	0.15	29.07	195.71	109.75	96.42
Volta WW	4/5/2007	13:50	n/a	n/a	n/a	81.70	0.25	20.43	99.74	103.68	98.85
Volta WW	5/1/2007	12:09	n/a	n/a	n/a	114.15	0.76	86.75	98.65	99.20	99.56
Volta WW	5/29/2007	15:32	n/a	n/a	n/a	106.78	0.4	42.71	99.18	101.69	99.60
Volta WW	6/22/2007	13:59	n/a	n/a	n/a	102.35	0.23	23.54	98.42	102.75	100.25
Volta WW	7/20/2007	7:55	n/a	n/a	n/a	86.13	0.18	15.50	99.25	99.25	100.54

DO-46 Mud Slough at Gun Club Road

Location: 37.23145°N -120.89923°W

Water District or Organization: Grassland Water District

Station Description: Data provided by Lara Sparks (Fish and Game and Grassland Water District) and Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Stage to Flow Relationship:	
Estimated quality:	Good
Date data update or calculated:	8/17/2007
Date QA rating updated:	12/21/2006
Observed stage vs. Keller stage:	Regression: Keller stage = 0.9581 * (QA stage) + 0.7616 r^2 = 0.9995
Keller stage vs. QA Flow:	Regression: QA Flow = 13.906 * (Keller stage)^2 - 29.417 * (Keller stage) + 15.483 r^2 = 0.9998
QA Flow vs. calculated Flow:	Regression: QA Flow = 0.8429 * (Calculated flow) - 0.042 r^2 = 0.9996
TDS or Salt Calculation:	salt mg/l = EC * 0.64
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-46 Mud Slough at Gun Club Road QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Mud Slough at Gun Club Rd.	1/9/2006	12:45	G2P19	SG	Water level is above top of staff gauge, staff reading is an estimate.
Mud Slough at Gun Club Rd.	2/2/2006	10:30	G2P25	SG	
Mud Slough at Gun Club Rd.	3/1/2006	9:45	G2P32	SG	Water level is above top of staff gauge, staff reading is an estimate.
Mud Slough at Gun Club Rd.	4/19/2006	12:15	G2P42	SG	
Mud Slough at Gun Club Rd.	5/8/2006	11:15	G2P48	SG	
Mud Slough at Gun Club Rd.	6/9/2006	12:15	G2P59	SG	
Mud Slough at Gun Club Rd.	7/9/2006	11:30	G2P63	SG	
Mud Slough at Gun Club Rd.	7/28/2006	10:30	F10P44	SG	
Mud Slough at Gun Club Rd.	8/31/2006	12:45	G2P71	SG	
Mud Slough at Gun Club Rd.	11/30/2006	14:45	G2P85	SG	
Mud Slough at Gun Club Rd.	12/21/2006	11:00	G2P90	SG	

DO-46 Mud Slough at Gun Club Road QA data									
Reference			**Measured Variables**						
Site	Date	Time	Keller reading	Staff Gauge Stage	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°F)	Temp from Logger (°F)
Mud Slough at Gun Club Rd.	1/9/2006	12:45	4.116	3.50	1468	1548	1476	52.7	52.75
Mud Slough at Gun Club Rd.	2/2/2006	10:30	2.739	2.06	1963	2055	2055	56.3	56.35
Mud Slough at Gun Club Rd.	3/1/2006	9:45	4.111	3.45	1585	1573	1560	55.8	55.86
Mud Slough at Gun Club Rd.	4/19/2006	12:15	1.9	1.15	2740	2711	2687	64.4	63.89
Mud Slough at Gun Club Rd.	5/8/2006	11:15	1.249	0.48	3350	3291	3314	73.2	75.1
Mud Slough at Gun Club Rd.	6/9/2006	12:15	1.568	0.87	2013	1988	1986	79.7	78.4
Mud Slough at Gun Club Rd.	7/9/2006	11:30	1.375	0.66	1155	1135	1003	77.2	77.1
Mud Slough at Gun Club Rd.	7/28/2006	10:30	1.155	0.41	na	na	Na	na	na
Mud Slough at Gun Club Rd.	8/31/2006	12:45	0.742	-0.02	1064	1098	1049	82.9	83.4
Mud Slough at Gun Club Rd.	11/30/2006	14:45	3.36	2.76	1139	1174	1170	49.1	48.75
Mud Slough at Gun Club Rd.	12/21/2006	11:00	3.27	2.64	1275	1338	1335	44.8	44.9

DO-46 Mud Slough at Gun Club Road QA data

Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Keller to staff gauge offset	Rating Quality
Mud Slough at Gun Club Rd.	1/9/2006	12:45	stream/Sontek/Keller Transducer	-0.616	good
Mud Slough at Gun Club Rd.	2/2/2006	10:30	stream/Sontek/Keller Transducer	-0.679	good
Mud Slough at Gun Club Rd.	3/1/2006	9:45	stream/Sontek/Keller Transducer	-0.661	good
Mud Slough at Gun Club Rd.	4/19/2006	12:15	stream/Sontek/Keller Transducer	-0.75	good
Mud Slough at Gun Club Rd.	5/8/2006	11:15	stream/Sontek/Keller Transducer	-0.769	good
Mud Slough at Gun Club Rd.	6/9/2006	12:15	stream/Sontek/Keller Transducer	-0.698	good
Mud Slough at Gun Club Rd.	7/9/2006	11:30	stream/Sontek/Keller Transducer	-0.715	good
Mud Slough at Gun Club Rd.	7/28/2006	10:30	stream/Sontek/Keller Transducer	-0.745	good
Mud Slough at Gun Club Rd.	8/31/2006	12:45	stream/Sontek/Keller Transducer	-0.762	good
Mud Slough at Gun Club Rd.	11/30/2006	14:45	stream/Sontek/Keller Transducer	-0.6	good
Mud Slough at Gun Club Rd.	12/21/2006	11:00	stream/Sontek/Keller Transducer	-0.63	good

DO-46 Mud Slough at Gun Club Road QA data

Reference			**Calculations**								
Site	Date	Time	QA Ave Velocity (ft/s)	QA Area (ft^2)	QA Flow (CFS)	Keller Area (ft^2)	Sontek Velocity (ft/s)	Sontek/ Keller Flow (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Mud Slough at Gun Club Rd.	1/9/2006	12:45				97.78	0.82	67.54	105.45	0.00	100.09
Mud Slough at Gun Club Rd.	2/2/2006	10:30	0.61	57.20	39.11	58.46	0.81	39.87	104.69	0.00	100.09
Mud Slough at Gun Club Rd.	3/1/2006	9:45				97.64	1.26	103.65	99.24	0.00	100.11
Mud Slough at Gun Club Rd.	4/19/2006	12:15				34.50	0.81	23.51	98.94	0.00	99.21
Mud Slough at Gun Club Rd.	5/8/2006	11:15	0.05	15.00	1.00	15.90	0.1	1.30	98.24	0.00	102.60
Mud Slough at Gun Club Rd.	6/9/2006	12:15				25.01	0.25	5.23	98.76	0.00	98.37
Mud Slough at Gun Club Rd.	7/9/2006	11:30				19.50	0.17	2.75	98.27	0.00	99.87
Mud Slough at Gun Club Rd.	7/28/2006	10:30	-0.03	14.40	-0.45	13.22	-0.09	-1.04			
Mud Slough at Gun Club Rd.	8/31/2006	12:45				1.43	0.38	0.41	103.20	0.00	100.60
Mud Slough at Gun Club Rd.	11/30/2006	14:45				76.19	1.11	71.24	103.07	0.00	99.29
Mud Slough at Gun Club Rd.	12/21/2006	11:00	0.77	74.60	68.06	73.62	1.09	67.60	104.94	0.00	100.22

DO-47 Delta Mendota Canal at Highway 140

Location: 37.24588°N -121.0773°W

Water District or Organization: Delta-Mendota Canal Company

Station Description: Flow is from taken from DMC Check 13 at O'Neill Forebay (MP 70.01) which is about 12 miles downstream of sample site. Data direct from Chris Linneman.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Data from Chris Linneman
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	Unknown
Flow Calculation:	Rating unknown.
TDS or Salt Calculation:	TDS = SpCond * 0.5317 + 21
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-48 FC-5 Grassland Area Farmers

Location: 36.92428°N -120.65411°W

Water District or Organization: Grassland Area Farmers

Station Description: Data provided by Chris Linneman (Summers Engineering).

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Chris Linneman
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	
Flow Calculation:	Rating unknown.
Expected Boundaries for Data (QA):	
Minimum flow for year:	
Maximum flow for year:	
Minimum EC:	
Maximum EC:	

DO-49 PE-14 Grassland Area Farmers

Location: 36.93884°N -120.63555°W

Water District or Organization: Grassland Area Farmers

Station Description: Data provided by Chris Linneman (Summers Engineering).

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	Unknown
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	Chris Linneman
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	
Flow Calculation:	Rating unknown.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-53 Salt Slough at Wolfsen Road Bridge

Location: 37.1290°N -120.9197°W

Water District or Organization: San Luis National Wildlife Refuge

Station Description: Stream is an open channel with a Sontek Doppler meter.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Velocity Sensor:	Sontek Argonaut SL
Stage Sensor:	Sontek Argonaut SL
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel
Communications:	None
Stage to Flow Relationship:	Sontek Area = 77.521 * (Sontek pressure + offset) - 62.933
Sontek stage and velocity data:	Flow = (Area * Velocity) * 0.6422 - 2.6455
Estimated data quality:	Fair
TDS or Salt Calculation:	TDS or Salt mg/L = EC * (0.640) * 1000

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

Minimum flow:

Maximum flow:

Minimum EC:

Maximum EC:

DO-53 Salt Slough at Wolfsen Road QA data

WS = Weir Stick
SG = Staff Gauge
Reference

Site	Date	Time	Notebook Reference	Method	Comments
Salt Slough at Wolfsen	1/31/2006	13:10	F5p84	SG	
Salt Slough at Wolfsen	7/11/2006	11:05	F9p14n1-2	SG	
Salt Slough at Wolfsen	7/28/2006	13:00	F10p45n1	SG	
Salt Slough at Wolfsen	9/14/2006	12:55	F9p104n1	SG	
Salt Slough at Wolfsen	12/14/2006	13:00	F11p65n2	SG	

DO-53 Salt Slough at Wolfsen Road QA data										
Reference			**Measured Variables**							
Site	Date	Time	Staff Gauge Stage	Sontek Pressure	Sontek Vertical Beam	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Salt Slough at Wolfsen	1/31/2006	13:10	2.93	0.537	1.13		1528	1528		55.33
Salt Slough at Wolfsen	7/11/2006	11:05	2.79	0.319	0.98	826	719	719	26.33	79.2
Salt Slough at Wolfsen	7/28/2006	13:00	2.99	0.406	1.2		874	874		81.1
Salt Slough at Wolfsen	9/14/2006	12:55	2.23	-0.023	0.43	1214	1000	1000	22.77	72.3
Salt Slough at Wolfsen	12/14/2006	13:00	2.00	0.213	0.37	2033	1944	1944	12.5	54.43

DO-53 Salt Slough at Wolfsen Road QA data						
Reference			**Constants**			
Site	Date	Time	Structure/ Equipment	Sontek pressure to staff gauge offset	Sontek vertical beam to staff gauge offset	Rating Quality
Salt Slough at Wolfsen	1/31/2006	13:10	Natural streambed/Sontek	1.691	1.800	fair
Salt Slough at Wolfsen	7/11/2006	11:05	Natural streambed/Sontek	2.054	1.810	fair
Salt Slough at Wolfsen	7/28/2006	13:00	Natural streambed/Sontek	2.053	1.790	fair
Salt Slough at Wolfsen	9/14/2006	12:55	Natural streambed/Sontek	2.283	1.800	fair
Salt Slough at Wolfsen	12/14/2006	13:00	Natural streambed/Sontek	1.509	1.630	fair

DO-53 Salt Slough at Wolfsen Road QA data											
Reference			**Calculations**								
Site	Date	Time	QA Ave Vel. (ft/s)	QA Area (ft^2)	QA Flow (CFS)	Sontek Area (ft^2)	Sontek Vel. (ft/s)	Sontek Flow (0.6422 * (Sontek flow) -2.6455) (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Salt Slough at Wolfsen	1/31/2006	13:10	0.803	176.60	172.18	164.20	1.5	155.53			172.91
Salt Slough at Wolfsen	7/11/2006	11:05	1.027	142.20	158.49	153.35	1.81	175.61	87.05	87.05	99.76
Salt Slough at Wolfsen	7/28/2006	13:00	0.891	166.56	188.25	168.85	1.74	186.04			253.44
Salt Slough at Wolfsen	9/14/2006	12:55	0.606	108.60	85.88	109.94	1.2	82.08	82.37	82.37	99.06
Salt Slough at Wolfsen	12/14/2006	13:00	0.579	95.10	47.53	92.11	0.94	52.96	95.62	95.62	99.87

DO-57 Ramona Lake at Levee

Location: 37.47881°N -121.06850°W

Water District or Organization: SJVDA and Twin Oaks Irrigation District

Station Description: Station is on top of levee at the exit of Ramona Lake. The weir structure is at the bottom of a man hole. Data is provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	na
Stage Sensor:	Bubbler only
Stage Sensor (Bubbler):	Design Analysis Bubbler
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Concrete culvert, square
Structure shape:	Square
Structure materials:	Concrete
Staff gage stability:	No staff gage, measure with hand-held gage.
Width of structure:	5.5 feet
Depth of structure:	Pipe enters culvert 0.4 feet from the bottom.
Board width:	5.08 feet
Board height:	approx 2.5 feet
Bubbler to QA offset:	0.013 feet
Bubbler to top of weir offset	2.329 feet
Stage to Flow Relationship:	
Estimated quality:	good
Date data update or calculated:	1/25/2008
Date QA rating updated:	1/25/2008

Observed stage vs. Bubbler stage:	Regression: OA stage = 0.9237 * (Bubbler stage) + 0.191 r^2 = 0.9863
Bubbler stage vs. QA Flow:	Flow = 19.014 * (Bubbler stage)^2 - 86.496 * (Bubbler stage) + 98.257 r^2 = 0.9977
Weir Stick Flow vs Bubbler Flow	Weir stick flow = 1.0764 * (Bubbler flow)
Ideal Weir equation	3.33 * 5.08 * (Bubbler stage - offset)^1.5
Flow Calculation:	Flow = 3.33 * 5.08 * (Bubbler stage - 2.33)^1.5 r^2 = 0.9933
Expected Boundaries for Data (QA):	
Minimum flow:	0.00 CFS
Maximum flow:	49.00 CFS Values above 12.9 are beyond QA calibration and based on ideal weir equation.
Minimum EC:	257 µS/cm Values below this were recorded while the sensor was out of the water.
Maximum EC:	2,141 µS/cm

DO-57 Ramona Lake QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Ramona Lake	4/13/2007	10:05	F12P2	WS	Installed monitoring equipment at site.
Ramona Lake	5/22/2007	11:25	F12P64	WS	
Ramona Lake	6/19/2007	11:15	F12P128N5	WS	
Ramona Lake	7/10/2007	13:00	F14P26	WS	
Ramona Lake	8/14/2007	9:30	F14P121	WS	
Ramona Lake	9/11/2007	9:30	F15P55	WS	
Ramona Lake	10/9/2007	9:30	F15P121	WS	
Ramona Lake	11/1/2007	10:30	F15P143	WS	

DO-57 Ramona Lake QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Ramona Lake	4/13/2007	10:05	3.025	2.96	2.1					
Ramona Lake	5/22/2007	11:25	3.065	3.00	2.4	1161		1167		
Ramona Lake	6/19/2007	11:15	3.062	3.06	2.2	1147	1201		24.34	75.75
Ramona Lake	7/10/2007	13:00	2.299	2.30	0	1578	1644	1349	24.98	77.03
Ramona Lake	8/14/2007	9:30	2.452	2.51	0.1	1594	1294	1606	22.9	73.21
Ramona Lake	9/11/2007	9:30	2.402	2.40	0	1368	1122	1357	21.98	71.52
Ramona Lake	10/9/2007	9:30	2.606	2.62	0.4	1399	645	1372	11.91	53.47
Ramona Lake	11/1/2007	10:30	2.516	2.47	0.2	1157	1139	1143	13.35	55.44

DO-57 Ramona Lake QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Ramona Lake	4/13/2007	10:05	Weir/bubbler	5.08	-0.065	2.290	good
Ramona Lake	5/22/2007	11:25	Weir/bubbler	5.08	-0.065	2.261	good
Ramona Lake	6/19/2007	11:15	Weir/bubbler	5.08	-0.002	2.303	good
Ramona Lake	7/10/2007	13:00	Weir/bubbler	5.08	0.001	2.299	good
Ramona Lake	8/14/2007	9:30	Weir/bubbler	5.08	0.058	2.355	good
Ramona Lake	9/11/2007	9:30	Weir/bubbler	5.08	-0.002	2.402	good
Ramona Lake	10/9/2007	9:30	Weir/bubbler	5.08	0.014	2.363	good
Ramona Lake	11/1/2007	10:30	Weir/bubbler	5.08	-0.046	2.363	good

DO-57 Ramona Lake QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Ramona Lake	4/13/2007	10:05	0.74	10.67	9.91			0.00
Ramona Lake	5/22/2007	11:25	0.80	12.19	10.77	0.00	100.52	0.00
Ramona Lake	6/19/2007	11:15	0.76	11.18	10.70	104.71	0.00	99.92
Ramona Lake	7/10/2007	13:00	0.00	0.00	0.00	104.18	85.49	100.09
Ramona Lake	8/14/2007	9:30	0.10	0.51	0.77	81.18	100.75	99.99
Ramona Lake	9/11/2007	9:30	0.00	0.00	0.36	82.02	99.20	99.94
Ramona Lake	10/9/2007	9:30	0.24	2.03	2.52	46.10	98.07	100.06
Ramona Lake	11/1/2007	10:30	0.15	1.02	1.41	98.44	98.79	98.95

DO-60 Moffit 1 South

Location: 37.221°N -120.832°W

Water District or Organization: San Luis National Wildlife Refuge

Station Description: Station is located in the SLNWR. Weir structure is just upstream of culvert. The bubbler is in the pond upstream of the weir.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Stage Sensor (Bubbler):	Design Analysis H350 XL
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel
Communications:	GOES Transmission
Board length:	44 inches
Bubbler Stage Offset:	0.109 feet
Stage to Flow Relationship:	
Estimated Quality:	Poor
Bubbler Flow:	Flow = 6.0618 * (Bubbler stage)^2 - 32.929 * (Bubbler stage) + 42.744 r^2 = 0.9829
Flow Calculation:	Flow = 3.33 * 3.67 * (Bubbler stage-3.38)^1.5 12.84 * (Bubbler stage) - 42.913 r^2 =0.9713
TDS or Salt Calculation:	TDS or Salt mg/L = EC * (0.640) * 1000
	Using data not corrected for temperature (EC)

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

Minimum flow:	0.00	CFS
Maximum flow:	30	CFS
Minimum EC:	0.2	mS/cm Values below 0.1 were removed as these are a sensor malfunction.
Maximum EC:	3.5	mS/cm
Minimum Bubbler Stage:	2.38	feet If the stage is less than 2.38 the bubbler cannot accurately measure flow.

DO-60 Moffit 1 South QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Moffit 1 South	1/17/2006	10:00	F5p69n1	WS	
Moffit 1 South	3/2/2006	9:00	F5p93n1	WS	
Moffit 1 South	3/2/2006	9:00	F5p93n1	WS	
Moffit 1 South	3/30/2006	10:00	F8p45n1	WS	
Moffit 1 South	4/27/2006	8:00	F8p69n1	WS	
Moffit 1 South	07/11/06	7:00	F9p11n1	WS	
Moffit 1 South	09/14/06	9:00	F9P99n1	WS	
Moffit 1 South	9/28/2006	9:00	F9p126n1	WS	
Moffit 1 South	10/12/2006	9:00	F9p144n1	WS	
Moffit 1 South	10/26/2006	9:00	F11p12n1	WS	
Moffit 1 South	11/2/2006	9:00	F11p23n1	WS	
Moffit 1 South	11/16/2006	9:00	F11p40n1	WS	
Moffit 1 South	12/14/2006	9:00	F11p60n1	WS	

DO-60 Moffit 1 South QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Moffit 1 South	1/17/2006	10:00	3.76	3.91	1.2	1.224	1.151	1.293	8.5	47.21
Moffit 1 South	3/2/2006	9:00	4.2	4.26	3.05	1.315	1.247	1.337	12.35	54.06
Moffit 1 South	3/2/2006	9:00	4.2	4.22	2.9	1.315	1.247	1.337	12.35	54.06
Moffit 1 South	3/30/2006	10:00	4.07	4.21	2.8	1.164	1.053	1.052	13.11	55.87
Moffit 1 South	4/27/2006	8:00	2.89	2.98	0	1.464	1.127	1.127	17.14	62.99
Moffit 1 South	07/11/06	7:00	2.43	n/a	0	n/a	0.005	0.005	n/a	69.55
Moffit 1 South	09/14/06	9:00	2.45	n/a	0	n/a	0.005	0.005	n/a	67.88
Moffit 1 South	9/28/2006	9:00	2.44	n/a	0	n/a	0.005	0.005	n/a	62.8
Moffit 1 South	10/12/2006	9:00	2.43	n/a	0	n/a	0.005	0.005	n/a	59.67
Moffit 1 South	10/26/2006	9:00	2.43	n/a	0	n/a	0.005	0.005	n/a	49.18
Moffit 1 South	11/2/2006	9:00	2.43	n/a	0	1.114	0.005	0.005	12.77	55.28
Moffit 1 South	11/16/2006	9:00	2.43	2.64	0	0.584	0.005	0.005	12.13	53.4
Moffit 1 South	12/14/2006	9:00	3.11	3.2	0	0.679	0.619	0.619	10.01	49.64

DO-60 Moffit 1 South QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Moffit 1 South	1/17/2006	10:00	Weir/bubbler	3.67	0.150	3.254	fair
Moffit 1 South	3/2/2006	9:00	Weir/bubbler	3.67	0.060	3.257	fair
Moffit 1 South	3/2/2006	9:00	Weir/bubbler	3.67	0.020	3.288	fair
Moffit 1 South	3/30/2006	10:00	Weir/bubbler	3.67	0.140	3.179	fair
Moffit 1 South	4/27/2006	8:00	Weir/bubbler	3.67	0.090	2.890	fair
Moffit 1 South	07/11/06	7:00	Weir/bubbler	3.67		2.430	fair
Moffit 1 South	09/14/06	9:00	Weir/bubbler	3.67		2.450	fair
Moffit 1 South	9/28/2006	9:00	Weir/bubbler	3.67		2.440	fair
Moffit 1 South	10/12/2006	9:00	Weir/bubbler	3.67		2.430	fair
Moffit 1 South	10/26/2006	9:00	Weir/bubbler	3.67		2.430	fair
Moffit 1 South	11/2/2006	9:00	Weir/bubbler	3.67		2.430	fair
Moffit 1 South	11/16/2006	9:00	Weir/bubbler	3.67	0.210	2.430	fair
Moffit 1 South	12/14/2006	9:00	Weir/bubbler	3.67	0.090	3.110	fair

DO-60 Moffit 1 South QA data									
Reference			**Calculations**						
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler calculated Flow from stage to weirstick relationship (12.84*(bubbler stage+offset)-42.913) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Moffit 1 South	1/17/2006	10:00	0.51	4.40	6.76	4.58	94.04	105.64	99.81
Moffit 1 South	3/2/2006	9:00	0.94	11.19	12.41	11.50	94.83	101.67	99.69
Moffit 1 South	3/2/2006	9:00	0.91	10.64	12.41	11.50	94.83	101.67	99.69
Moffit 1 South	3/30/2006	10:00	0.89	10.28	10.74	9.24	90.46	90.38	100.49
Moffit 1 South	4/27/2006	8:00	0.00	0.00	0.00	0.00	76.98	76.98	100.22
Moffit 1 South	07/11/06	7:00	0.00	0.00	0.00	0.00			
Moffit 1 South	09/14/06	9:00	0.00	0.00	0.00	0.00			
Moffit 1 South	9/28/2006	9:00	0.00	0.00	0.00	0.00			
Moffit 1 South	10/12/2006	9:00	0.00	0.00	0.00	0.00			
Moffit 1 South	10/26/2006	9:00	0.00	0.00	0.00	0.00			
Moffit 1 South	11/2/2006	9:00	0.00	0.00	0.00	0.00	0.45	0.45	100.53
Moffit 1 South	11/16/2006	9:00	0.00	0.00	0.00	0.00	0.86	0.86	99.19
Moffit 1 South	12/14/2006	9:00	0.00	0.00	0.00	0.00	91.16	91.16	99.24

DO-61 Deadmans Slough

Location: 37.21530°N -120.83209°W

Water District or Organization: San Luis National Wildlife Refuge

Station Description: Site has two weir structures. Undefined structure makes it impossible to rate. Beaver activity often clogs weir structure.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Velocity Sensor:	none installed
Pipe Stage Sensor:	none installed
Stage Sensor (Bubbler):	Design Analysis H350 XL
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel
Communications:	GOES Transmission
Weir Board Length:	4.35 feet and 4.3 feet
Weir Height:	7.5 feet
Stage to Flow Relationship:	
Flow Calibration:	Non-existent
Flow rating:	Undefined structure makes it impossible to rate. Water begins to flow out of pond at approximately 7.5 feet stage.
TDS or Salt Calculation:	TDS or Salt mg/L = EC*(0.640)*1000
	Using data not corrected for temperature (EC)

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

Minimum flow:	0	CFS
Maximum flow:	30	CFS
Minimum EC:	0.2	mS/cm Values below 0.1 were removed as sensor errors.
Maximum EC:	3.5	mS/cm

DO-62 Mallard Slough

Location: 37.19182°N -120.82399°W

Water District or Organization: San Luis National Wildlife Refuge

Station Description: Bubbler is in the pond upstream of weir structure. Starflow unit is in the pipe downstream of weir structure. Poor flow calculation from debris buildup.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Velocity Sensor:	Unidata Starflow
Stage Sensor:	Unidata Starflow
Stage Sensor (Bubbler):	Design Analysis H350 XL
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel
Communications:	GOES Transmission
Weir Board length:	4.7 feet
Bubbler Stage Offset:	-0.587 feet
Top of boards:	1.4 feet as measured by the bubbler
Starflow Stage Offset:	Approximately 1 inch
Stage to Flow Relationship:	
Estimated Quality:	Fair
Starflow Flow:	Area = -0.2312 * (Depth in pipe)^3+1.3941 * (Depth in pipe)^2+1.2753 * (Depth in pipe)
	Flow = Area * Velocity
	Outside of pipe and area should = 12.556 sq ft
Bubbler Flow:	Flow = 17.882 * (Bubbler stage) - 27.599
	r^2 = 0.9708
Flow Calculation:	Starflow Flow = Area * Velocity
TDS or Salt Calculation:	TDS or Salt mg/L = EC * (0.640) * 1000
	Using data corrected for temperature (EC)

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

Minimum flow:	0	CFS
Maximum flow:	30	CFS
Minimum EC:	0.2	mS/cm
Maximum EC:	3.5	mS/cm
Minimum Starflow stage:	0.08	feet
Maximum Starflow stage:	3.0	feet If the Starflow depth is greater than 4 feet the Starflow is measuring pressure.
Minimum Bubbler stage:	1.4	feet If the stage is less than 1.4 the bubbler cannot accurately measure flow.

DO-62 Mallard Slough QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Mallard	1/17/2006	10:15	F5p69n5	WS	
Mallard	1/26/2006	10:50	F5p78n2	WS	
Mallard	1/26/2006	10:50	F5p78n2	WS	
Mallard	1/26/2006	10:50	F5p78n2	WS	
Mallard	1/26/2006	10:50	F5p78n2	WS	
Mallard	3/2/2006	10:25	F5p64n1	WS	
Mallard	3/30/2006	10:00	F8p46n3	WS	
Mallard	4/27/2006	10:17	F8p70n3	WS	
Mallard	7/11/2006	10:09	F9p12n1	WS	
Mallard	9/14/2006	9:57	F9p100n1	WS	
Mallard	9/28/2006	9:43	F9p127n5	WS	
Mallard	10/12/2006	9:41	F9p145n1	WS	
Mallard	10/26/2006	9:50	F11p13n1	WS	
Mallard	11/2/2006	10:05	F11p24n1	WS	
Mallard	11/16/2006	9:53	F11p41n1	WS	
Mallard	12/14/2006	10:06	F11p61n1	WS	

DO-62 Mallard Slough QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (mS/cm)	Pre-cleaning EC from logger (mS/cm)	Post-Cleaning EC from logger (mS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Mallard	1/17/2006	10:15	2.11	1.34	1.9	1.593	1.07	1.541	na	46.98
Mallard	1/26/2006	10:50	2.32	1.65	2.7	1.668	1.532	1.532	8.28	45.78
Mallard	1/26/2006	10:50	2.12	1.28	2.45	na	1.532	1.532	na	45.78
Mallard	1/26/2006	10:50	2.03	1.18	2	na	1.532	1.532	na	45.78
Mallard	1/26/2006	10:50	1.77	0.9	1	na	1.532	1.532	na	45.78
Mallard	3/2/2006	10:25	3.22	2.38	7	1.857	1.728	1.728	11.61	52.88
Mallard	3/30/2006	10:00	2.32	1.58	na	1.542	1.581	1.58	12.66	54.86
Mallard	4/27/2006	10:17	2.91	2.59	na	1.964	1.862	2.067	16.1	60.68
Mallard	7/11/2006	10:09	2.52	2.43	na	2.93	0.564	3.098	21.68	71.7
Mallard	9/14/2006	9:57	0.65	na	na	na	0.028	0.035	na	70.4
Mallard	9/28/2006	9:43	0.65	na	na	na	0.008	0.008	na	67.04
Mallard	10/12/2006	9:41	0.65	na	na	na	0.007	0.008	na	63.83
Mallard	10/26/2006	9:50	1.05	0.43	na	5.847	6.252	6.261	10.83	56.44
Mallard	11/2/2006	10:05	1.6	na	na	3.667	3.765	3.773	12.12	51.93
Mallard	11/16/2006	9:53	2.07	1.7	na	1.055	1.114	1.126	12.09	53.31
Mallard	12/14/2006	10:06	2.08	2.02	na	1.132	1.107	1.107	8.99	47.42

DO-62 Mallard Slough QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Mallard	1/17/2006	10:15	Weir/bubbler/starflow	4.7	-0.770	1.422	fair
Mallard	1/26/2006	10:50	Weir/bubbler/starflow	4.7	-0.670	1.450	fair
Mallard	1/26/2006	10:50	Weir/bubbler/starflow	4.7	-0.840	1.305	fair
Mallard	1/26/2006	10:50	Weir/bubbler/starflow	4.7	-0.850	1.318	fair
Mallard	1/26/2006	10:50	Weir/bubbler/starflow	4.7	-0.870	1.322	fair
Mallard	3/2/2006	10:25	Weir/bubbler/starflow	4.7	-0.840	1.579	fair
Mallard	3/30/2006	10:00	Weir/bubbler/starflow	4.7	-0.740		fair
Mallard	4/27/2006	10:17	Weir/bubbler/starflow	4.7	-0.320		fair
Mallard	7/11/2006	10:09	Weir/bubbler/starflow	4.7	-0.090		fair
Mallard	9/14/2006	9:57	Weir/bubbler/starflow	4.7	na		fair
Mallard	9/28/2006	9:43	Weir/bubbler/starflow	4.7	na		fair
Mallard	10/12/2006	9:41	Weir/bubbler/starflow	4.7	na		fair
Mallard	10/26/2006	9:50	Weir/bubbler/starflow	4.7	-0.620		fair
Mallard	11/2/2006	10:05	Weir/bubbler/starflow	4.7	na		fair
Mallard	11/16/2006	9:53	Weir/bubbler/starflow	4.7	-0.370		fair
Mallard	12/14/2006	10:06	Weir/bubbler/starflow	4.7	-0.060		fair

DO-62 Mallard Slough QA data

Reference			**Calculations**					
Site	Date	Time	Starflow Level	Starflow Vel. (ft/s)	Starflow Flow (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Mallard	1/17/2006	10:15	1.263	0.18	0.61	67.17	96.74	
Mallard	1/26/2006	10:50	1.408	0.141	0.55	91.85	91.85	97.60
Mallard	1/26/2006	10:50	1.408	0.141	0.55			
Mallard	1/26/2006	10:50	1.408	0.141	0.55			
Mallard	1/26/2006	10:50	1.453	0.41	1.68			
Mallard	3/2/2006	10:25	3.645	0.345	4.13	93.05	93.05	99.97
Mallard	3/30/2006	10:00	3.274	0.157	1.73	102.53	102.46	100.13
Mallard	4/27/2006	10:17	3.127	6.516	68.75	94.81	105.24	99.51
Mallard	7/11/2006	10:09	1.476	0.266	1.11	19.25	105.73	100.95
Mallard	9/14/2006	9:57	0.637	0.217	0.29			
Mallard	9/28/2006	9:43	0.738	0.217	0.35			
Mallard	10/12/2006	9:41	1.188	0.217	0.67			
Mallard	10/26/2006	9:50	1.522	0.217	0.95	106.93	107.08	109.61
Mallard	11/2/2006	10:05	1.568	0.217	0.98	102.67	102.89	96.50
Mallard	11/16/2006	9:53	1.975	0.121	0.75	105.59	106.73	99.16
Mallard	12/14/2006	10:06	0.682	0.095	0.14	97.79	97.79	98.42

DO-62 Mallard Slough QA data

Reference			**Calculations**			
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler calculated Flow from stage to weirstick relationship (17.882*(bubbler stage)-27.599) (CFS)	Bubbler calculated Flow from (3.33 * Weir width * (bubbler stage-weir height)^1.5) (CFS)
Mallard	1/17/2006	10:15	0.69	8.93	10.13	9.36
Mallard	1/26/2006	10:50	0.87	12.69	13.89	13.81
Mallard	1/26/2006	10:50	0.81	11.52	10.31	9.56
Mallard	1/26/2006	10:50	0.71	9.40	8.70	7.83
Mallard	1/26/2006	10:50	0.45	4.70	4.05	3.52
Mallard	3/2/2006	10:25	1.64	32.90	29.98	38.43
Mallard	3/30/2006	10:00			13.89	13.81
Mallard	4/27/2006	10:17			24.44	29.04
Mallard	7/11/2006	10:09			17.46	18.55
Mallard	9/14/2006	9:57			0.00	0.00
Mallard	9/28/2006	9:43			0.00	0.00
Mallard	10/12/2006	9:41			0.00	0.00
Mallard	10/26/2006	9:50			0.00	0.00
Mallard	11/2/2006	10:05			1.01	1.40
Mallard	11/16/2006	9:53			9.42	8.58
Mallard	12/14/2006	10:06			9.60	8.78

DO-63 Inlet C Canal

Location: 37.17224°N -20.76142°W

Water District or Organization: San Luis National Wildlife Refuge

Station Description: Station is at the inlet of the water source for the SLNWR. Flow is based on three propeller meters the district uses.

Station Rating Variables:

Logger:	Campbell CR10X
Conductivity Probe:	Campbell EC
Flow sensor	District installed propeller meters
Battery:	Sealed 12V photovoltaic gel
Power:	40W Solar Panel
Communications:	Raven 1X cellular modem
Stage to Flow Relationship:	
Flow calculation:	Taken directly from meter in CFS. There is no stage measurement at this site because data is logged directly from the propeller meters.
Flow Calculation:	Flow taken directly from meter in CFS.
TDS or Salt Calculation:	TDS or Salt mg/L = EC * (0.640) * 1000
	Using data not corrected for temperature (EC).

Expected Boundaries for Data (QA): (data outside these boundaries are rejected or flagged)

Minimum flow:	0	CFS
Maximum flow:	90	CFS
Minimum EC:	0.2	mS/cm
Maximum EC:	2	mS/cm

DO-63 Inlet C Canal QA data

WS = Weir Stick   FM= Propeller Flow Meter
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Inlet C Canal	1/17/2006	10:00	F5p70n1	FM	Logger propeller meter values around -20 are invalid and correspond to a missing propeller meter.
Inlet C Canal	1/26/2006	12:37	F5p80n10	FM	
Inlet C Canal	3/2/2006	11:20	F5p95n2	FM	
Inlet C Canal	3/30/2006	11:01	F8p47n1	FM	
Inlet C Canal	4/27/2006	11:06	F8p71n5	FM	
Inlet C Canal	7/11/2006	9:00	F9p12n5	FM	
Inlet C Canal	9/14/2006	11:17	F9p101n3	FM	
Inlet C Canal	9/28/2006	10:37	F9p128n7	FM	
Inlet C Canal	10/12/2006	11:00	F9p148n1	FM	
Inlet C Canal	10/26/2006	12:02	F11p16n1	FM	
Inlet C Canal	11/2/2006	12:07	F11p27n1	FM	
Inlet C Canal	11/16/2006	11:54	F11p44n1	FM	
Inlet C Canal	12/14/2006	11:56	F11p64n1	FM	

DO-63 Inlet C Canal QA data												
Reference			**Measured Variables**									
Site	Date	Time	Staff Gauge Stage	ITRC Weirstick reading			EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
				East	Mid	West					
Inlet C Canal	1/17/2006	10:00	na	na	na	na	1791	1888	1888	na	47.93
Inlet C Canal	1/26/2006	12:37	na	0.4	na	2.3	572	529	529	10.37	49.08
Inlet C Canal	3/2/2006	11:20	na	na	na	1.8	927	967	967	13.43	55.12
Inlet C Canal	3/30/2006	11:01	na	na	na	na	390	445	445	14.25	57.25
Inlet C Canal	4/27/2006	11:06	na	na	na	na	na	458	458	na	65.4
Inlet C Canal	7/11/2006	9:00	na	na	na	na	569	598	598	25.59	77.1
Inlet C Canal	9/14/2006	11:17	6.01	na	na	na	767	855	855	21.41	70.3
Inlet C Canal	9/28/2006	10:37	5.86	na	na	na	507	525	525	20.53	69.6
Inlet C Canal	10/12/2006	11:00	na	na	na	na	428	462	462	18.19	65.03
Inlet C Canal	10/26/2006	12:02	5.3	na	na	na	357	378	378	15.14	60.01
Inlet C Canal	11/2/2006	12:07	5.68	na	na	na	373	395	395	16.07	60.49
Inlet C Canal	11/16/2006	11:54	na	na	na	na	393	420	420	15	58.73
Inlet C Canal	12/14/2006	11:56	na	na	na	na	1551	1652	1652	12.02	53.21

DO-63 Inlet C Canal QA data									
Reference			**Measured Variables**						
Site	Date	Time	Logger East pipe Propeller Meter (CFS)	Logger Middle pipe Propeller Meter (CFS)	Logger West pipe Propeller Meter (CFS)	Analog East pipe Propeller Meter (CFS)	Analog Middle pipe Propeller Meter (CFS)	Analog West pipe Propeller Meter (CFS)	
Inlet C Canal	1/17/2006	10:00	11.66	-0.086	11.48	11	0	12	
Inlet C Canal	1/26/2006	12:37	1.358	-0.068	13.26	3	0	12	
Inlet C Canal	3/2/2006	11:20	-0.279	-0.056	10.2	2	0	11	
Inlet C Canal	3/30/2006	11:01	-19.99	-0.081	20.84	na	0	22	
Inlet C Canal	4/27/2006	11:06	-19.98	-0.07	-0.305	0	0	0	
Inlet C Canal	7/11/2006	9:00	20.34	0.013	-0.288	22	0	0	
Inlet C Canal	9/14/2006	11:17	-0.363	-0.02	28.31	0	0	30	
Inlet C Canal	9/28/2006	10:37	-20.01	-0.069	32.21	0	na	32	
Inlet C Canal	10/12/2006	11:00	50.39	12.76	46.62	50	12	50	
Inlet C Canal	10/26/2006	12:02	35.43	-0.088	33.36	40	0	30	
Inlet C Canal	11/2/2006	12:07	45.19	-0.036	-20	48	0	na	
Inlet C Canal	11/16/2006	11:54	44.97	-0.097	-20	50	0	na	
Inlet C Canal	12/14/2006	11:56	7.18	-0.076	-19.98	8	0	na	

DO-63 Inlet C Canal QA data

Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Rating Quality
Inlet C Canal	1/17/2006	10:00	Weir/Propeller Meter	5.5	Good
Inlet C Canal	1/26/2006	12:37	Weir/Propeller Meter	5.5	Good
Inlet C Canal	3/2/2006	11:20	Weir/Propeller Meter	5.5	Good
Inlet C Canal	3/30/2006	11:01	Weir/Propeller Meter	5.5	Good
Inlet C Canal	4/27/2006	11:06	Weir/Propeller Meter	5.5	Good
Inlet C Canal	7/11/2006	9:00	Weir/Propeller Meter	5.5	Good
Inlet C Canal	9/14/2006	11:17	Weir/Propeller Meter	5.5	Good
Inlet C Canal	9/28/2006	10:37	Weir/Propeller Meter	5.5	Good
Inlet C Canal	10/12/2006	11:00	Weir/Propeller Meter	5.5	Good
Inlet C Canal	10/26/2006	12:02	Weir/Propeller Meter	5.5	Good
Inlet C Canal	11/2/2006	12:07	Weir/Propeller Meter	5.5	Good
Inlet C Canal	11/16/2006	11:54	Weir/Propeller Meter	5.5	Good
Inlet C Canal	12/14/2006	11:56	Weir/Propeller Meter	5.5	Good

DO-63 Inlet C Canal QA data									
Reference			**Calculations**						
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	QA Sum Flow from Analog (East Pipe + Middle Pipe + West Pipe) (CFS)	Sum Flow from Logger (East Pipe + Middle Pipe + West Pipe) (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Inlet C Canal	1/17/2006	10:00			23.00	23.05	105.42	105.42	
Inlet C Canal	1/26/2006	12:37	0.78	14.85	15.00	14.55	92.48	92.48	96.87
Inlet C Canal	3/2/2006	11:20	0.66	9.90	13.00	9.87	104.31	104.31	98.12
Inlet C Canal	3/30/2006	11:01			22.00	20.76	114.10	114.10	99.31
Inlet C Canal	4/27/2006	11:06			0.00	-0.38			
Inlet C Canal	7/11/2006	9:00			22.00	20.07	105.10	105.10	98.77
Inlet C Canal	9/14/2006	11:17			30.00	27.93	111.47	111.47	99.66
Inlet C Canal	9/28/2006	10:37			32.00	32.14	103.55	103.55	100.94
Inlet C Canal	10/12/2006	11:00			112.00	109.77	107.94	107.94	100.44
Inlet C Canal	10/26/2006	12:02			70.00	68.70	105.88	105.88	101.28
Inlet C Canal	11/2/2006	12:07			48.00	45.15	105.90	105.90	99.28
Inlet C Canal	11/16/2006	11:54			50.00	44.87	106.87	106.87	99.54
Inlet C Canal	12/14/2006	11:56			8.00	7.10	106.51	106.51	99.21

DO-64 Moran Drain

Location: 37.43547°N -121.0355°W

Water District or Organization: SJVDA

Station Description: Station is at the bend in Marshall Road. Data provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	Starflow
Stage Sensor (Primary):	DA Bubbler
Stage Sensor (Secondary):	Starflow
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Square concrete culvert
Structure shape:	Square
Structure materials:	Concrete
Staff gage stability:	No staff gage, measure with hand-held gage
Width of structure:	Culvert is 3 feet by 3 feet.
Depth of structure:	Pipe enters culvert 0.4 feet from bottom.
Board width:	4.67 feet
Board height:	11.25 inches; 0.9375 feet
Bubbler depth from top of board:	Bubbler is 0.258 feet off the bottom.
Bubbler offset	0.888 feet
Bubbler to weir offset:	0.893 feet
Stage to Flow Relationship:	
Estimated quality:	Poor
	Calibration points bunched at one end and weir was frequently submerged.

Date update or calculated:	01/25/08
Observed stage vs. Bubbler stage:	Regression: QA stage = 1.0375 * (Bubbler stage) - 0.0535 r^2 = 0.9991
Weir Stick Flow vs. Bubbler Flow:	Flow = 1.0584 * (Bubbler flow)
Gage flow relationship:	Regression: Flow = 19.264 * (Staff gauge) - 21.249 r^2 = 0.9068
Flow Calculation:	Flow = 3.33 * 4.67 * ((Bubbler stage - offset)^1.5) r^2 = 0.8753
Expected Boundaries for Data (QA):	
Maximum flow:	31.2 CFS The maximum QA flow was 7.25 CFS, anything above this is extrapolated using weir equation and bubbler stage. If the stage is greater than 2.5 feet the weir is submerged.
Minimum flow:	0 CFS
Maximum EC:	1876 mS/cm
Minimum EC:	100 mS/cm

DO-64 Moran Drain QA data

WS = Weir Stick
SG = Staff Gauge

Reference

Site	Date	Time	Notebook Reference	Method	Comments
Moran Drain	1/11/2006	8:15	TT011106P89	WS	The site was dry.
Moran Drain	2/8/2006	8:30	TT020806P99	WS	The site was dry.
Moran Drain	3/8/2006	8:00	TT030806P109	WS	The site was dry.
Moran Drain	4/4/2006	8:30	TT040406P119	WS	The site was dry.
Moran Drain	5/9/2006	8:00	TT050906P129	WS	
Moran Drain	6/6/2006	11:00	TT060606P139	WS	
Moran Drain	7/21/2006	9:30	TT072106Pxx	WS	
Moran Drain	8/22/2006	8:30	TT082206Pxx	WS	
Moran Drain	9/28/2006	10:00	TT092806P14	WS	EC QA only.
Moran Drain	10/3/2006	8:45	F9P133N4	WS	Flow QA only.
Moran Drain	10/27/2006	8:45	TT102706P22	WS	The site was dry.
Moran Drain	11/17/2006	8:45	TT111706P30	WS	The site was dry.
Moran Drain	12/8/2006	8:15	TT120806P40	WS	Top of weir measured at 0.95ft.
Moran Drain	1/19/2007	8:15	TTP47	WS	
Moran Drain	2/13/2007	8:30	TTP56	WS	
Moran Drain	3/6/2007	8:45	TTP62	WS	
Moran Drain	4/13/2007	9:15	TTP70	WS	
Moran Drain	5/22/2007	9:30	F12P64N2	WS	
Moran Drain	6/19/2007	9:00	F12P127N4	WS	Partially submerged weir.
Moran Drain	7/10/2007	11:30	F14P26	WS	Partially submerged weir.
Moran Drain	8/14/2007	8:30	F14P120	WS	Fully submerged structure, downstream field flooded.
Moran Drain	9/11/2007	8:45	F15P55	WS	
Moran Drain	10/9/2007	8:20	F15P121	WS	The site was dry.
Moran Drain	11/1/2007	9:35	F15P143	WS	The site was dry.

DO-64 Moran Drain QA data

Reference			Measured Variables							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Moran Drain	1/11/2006	8:15	0.127	0.00	na	na	na	na	na	na
Moran Drain	2/8/2006	8:30	0.127	0.00	na	na	na	na	na	na
Moran Drain	3/8/2006	8:00	0.128	0.00	na	na	na	na	na	na
Moran Drain	4/4/2006	8:30	0.126	0.00	na	na	na	na	na	na
Moran Drain	5/9/2006	8:00	2.075	na	na	207	214		16.69	62.17
Moran Drain	6/6/2006	11:00	1.103	1.10	0.3	197	195		20.68	69.42
Moran Drain	7/21/2006	9:30	1.319	1.29	na	371	371		25.71	77.94
Moran Drain	8/22/2006	8:30	1.32	1.32	1.8	441	471		20.41	68.29
Moran Drain	9/28/2006	10:00	1.146	na	na	446	337		18.56	65.51
Moran Drain	10/3/2006	8:45	1.15	1.15	0.5	na	na	na	na	na
Moran Drain	10/27/2006	8:45	0.127	0.00	na	na	na	na	na	na
Moran Drain	11/17/2006	8:45	0.127	0.00	na	na	na	na	na	na
Moran Drain	12/8/2006	8:15	0.128	0.00	na	na	na	na	na	na
Moran Drain	1/19/2007	8:15	0.128	0.00	na	na	na	na	na	na
Moran Drain	2/13/2007	8:30	0.127	0.00	na	na	na	na	na	na
Moran Drain	3/6/2007	8:45	0.126	0.00	na	na	na	na	na	na
Moran Drain	4/13/2007	9:15	0.126	0.00	na	na	na	na	na	na
Moran Drain	5/22/2007	9:30	1.271	1.24	0.8	973	823	981	na	71.42
Moran Drain	6/19/2007	9:00	1.551	1.58	2.1	904	783	951	21.41	70.04
Moran Drain	7/10/2007	11:30	1.49	1.50	1.6	868	634	921	23.35	74.56
Moran Drain	8/14/2007	8:30	2.679	2.72		909	907	919	19.17	66.36
Moran Drain	9/11/2007	8:45	1.315	1.31	0.6	1115	516	1105	19.9	67.91
Moran Drain	10/9/2007	8:20	0.127	na	na	na	na	na	na	na
Moran Drain	11/1/2007	9:35	0.127	na	na	na	na	na	na	na

DO-64 Moran Drain QA data

Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Moran Drain	1/11/2006	8:15	Weir/bubbler	4.6	-0.127		good
Moran Drain	2/8/2006	8:30	Weir/bubbler	4.6	-0.127		good
Moran Drain	3/8/2006	8:00	Weir/bubbler	4.6	-0.128		good
Moran Drain	4/4/2006	8:30	Weir/bubbler	4.6	-0.126		good
Moran Drain	5/9/2006	8:00	Weir/bubbler	4.6			good
Moran Drain	6/6/2006	11:00	Weir/bubbler	4.6	-0.003	0.902	good
Moran Drain	7/21/2006	9:30	Weir/bubbler	4.6	-0.029		good
Moran Drain	8/22/2006	8:30	Weir/bubbler	4.6	0.000	0.656	good
Moran Drain	9/28/2006	10:00	Weir/bubbler	4.6			good
Moran Drain	10/3/2006	8:45	Weir/bubbler	4.6	0.000	0.868	good
Moran Drain	10/27/2006	8:45	Weir/bubbler	4.6	-0.127		good
Moran Drain	11/17/2006	8:45	Weir/bubbler	4.6	-0.127		good
Moran Drain	12/8/2006	8:15	Weir/bubbler	4.6	-0.128		good
Moran Drain	1/19/2007	8:15	Weir/bubbler	4.6	-0.128		good
Moran Drain	2/13/2007	8:30	Weir/bubbler	4.6	-0.127		good
Moran Drain	3/6/2007	8:45	Weir/bubbler	4.6	-0.126		good
Moran Drain	4/13/2007	9:15	Weir/bubbler	4.6	-0.126		good
Moran Drain	5/22/2007	9:30	Weir/bubbler	4.6	-0.031	0.885	good
Moran Drain	6/19/2007	9:00	Weir/bubbler	4.6	0.029	0.816	good
Moran Drain	7/10/2007	11:30	Weir/bubbler	4.6	0.010	0.877	good
Moran Drain	8/14/2007	8:30	Weir/bubbler	4.6	0.041		good
Moran Drain	9/11/2007	8:45	Weir/bubbler	4.6	-0.005	0.996	good
Moran Drain	10/9/2007	8:20	Weir/bubbler	4.6			good
Moran Drain	11/1/2007	9:35	Weir/bubbler	4.6			good

DO-64 Moran Drain QA data								
Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Moran Drain	1/11/2006	8:15						
Moran Drain	2/8/2006	8:30						
Moran Drain	3/8/2006	8:00						
Moran Drain	4/4/2006	8:30						
Moran Drain	5/9/2006	8:00			18.28	103.38	0.00	100.21
Moran Drain	6/6/2006	11:00	0.20	1.38	0.92	98.98	0.00	100.28
Moran Drain	7/21/2006	9:30			3.43	100.00	0.00	99.57
Moran Drain	8/22/2006	8:30	0.66	8.28	3.45	106.80	0.00	99.35
Moran Drain	9/28/2006	10:00			1.33	75.56	0.00	100.16
Moran Drain	10/3/2006	8:45	0.28	2.30	1.37			
Moran Drain	10/27/2006	8:45						
Moran Drain	11/17/2006	8:45						
Moran Drain	12/8/2006	8:15						
Moran Drain	1/19/2007	8:15						
Moran Drain	2/13/2007	8:30						
Moran Drain	3/6/2007	8:45						
Moran Drain	4/13/2007	9:15						
Moran Drain	5/22/2007	9:30	0.39	3.68	3.56	84.58	100.82	
Moran Drain	6/19/2007	9:00	0.74	9.66	8.18	86.62	105.20	99.29
Moran Drain	7/10/2007	11:30	0.61	7.36	7.07	73.04	106.11	100.72
Moran Drain	8/14/2007	8:30			36.56	99.78	101.10	99.78
Moran Drain	9/11/2007	8:45	0.32	2.76	4.20	46.28	99.10	100.13
Moran Drain	10/9/2007	8:20						
Moran Drain	11/1/2007	9:35						

DO-65 Spanish Grant Drain

Location: 37.43576°N -121.0358°W

Water District or Organization: SJVDA

Station Description: Station is at the bend in Marshall Road. Data provided by Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Design Analysis
Conductivity Probe:	YSI 600
Velocity Sensor:	Starflow
Stage Sensor (Primary):	DA Bubbler
Stage Sensor (Secondary):	Starflow
Battery:	Sealed 12V photovoltaic gel
Power:	Solar
Communications:	GOES Transmission
Structure description:	Square concrete culvert.
Structure shape:	Square
Structure materials:	Concrete
Staff gage stability:	No staff gage, measure with hand-held gage.
Width of structure:	Culvert is 3 feet by 3 feet.
Depth of structure:	Pipe enters culvert 0.4 feet from bottom.
Board width:	4.67 feet
Board height:	11.25 inches; 0.9375 feet
Bubbler offset from top of board:	2.412
Stage to Flow Relationship:	
Estimated quality:	Fair
Date update or calculated:	01/25/08
Bubbler vs. QA stage	Regression: QA stage = 0.8329 * (Bubbler stage) + 0.1519 r^2 = 0.5803

Gage flow relationship:	Regression: Flow = 12.945 * (QA stage) - 26.452 r^2 = 0.5831
Weir Stick Flow vs. Bubbler Flow:	Regression: Weir stick = 1.0523 * (Bubbler flow) r^2 = 0.9495
Flow Calculation:	3.33 * 4.67 * ((Bubbler stage - 2.412)^1.5)
Expected Boundaries for Data (QA):	
Maximum flow:	69.39 CFS The highest flow during a QA rating is 23.92 CFS, any flow above this is extrapolated using the weir equation and bubbler stage.
Minimum flow:	0 CFS
Maximum EC:	3682 mS/cm
Minimum EC:	249 mS/cm

DO-65 Spanish Grant Drain QA data

WS = Weir Stick
SG = Staff Gauge
Reference

Site	Date	Time	Notebook Reference	Method	Comments
Spanish Grant	1/11/2006	8:00	TT011106P87	WS	
Spanish Grant	2/8/2006	8:31	TT020806P98	WS	
Spanish Grant	3/8/2006	8:15	TT030806P108	WS	Installed a new 8" weirboard.
Spanish Grant	4/4/2006	8:25	TT040406P118	WS	
Spanish Grant	5/9/2006	8:00	TT050906P128	WS	
Spanish Grant	6/6/2006	10:50	TT060606P138	WS	
Spanish Grant	7/21/2006	9:15	TT072106Pxx	WS	Weir was submerged. At least one board was lost.
Spanish Grant	8/22/2006	8:30	TT082206Pxx	WS	Installed a new 6" weirboard.
Spanish Grant	9/28/2006	9:45	TT092806P13	WS	
Spanish Grant	10/3/2006	8:30	F9P133	WS	
Spanish Grant	10/27/2006	8:40	TT102706P21	WS	
Spanish Grant	11/17/2006	8:50	TT111706P29	WS	
Spanish Grant	12/8/2006	8:15	TT120806P39	WS	
Spanish Grant	1/19/2007	8:15	TTP47	WS	
Spanish Grant	2/13/2007	8:30	TTP56	WS	
Spanish Grant	3/6/2007	8:45	TTP62	WS	
Spanish Grant	4/13/2007	9:15	TTP70	WS	
Spanish Grant	5/22/2007	9:30	F12P64N2	WS	
Spanish Grant	6/19/2007	9:00	F12P127N4	WS	
Spanish Grant	7/10/2007	11:30	F14P26	WS	
Spanish Grant	8/14/2007	8:30	F14P120	WS	Heavy sediment buildup in structure.
Spanish Grant	9/11/2007	8:45	F15P55	WS	
Spanish Grant	10/9/2007	8:20	F12P121	WS	
Spanish Grant	11/1/2007	9:30	F15P143	WS	

DO-65 Spanish Grant Drain QA data										
Reference			**Measured Variables**							
Site	Date	Time	Bubbler reading	Staff Gauge Stage	ITRC Weirstick reading	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°C)	Temp from Logger (°F)
Spanish Grant	1/11/2006	8:00	1.325	1.26	1.2	621	293	636	10.72	51.49
Spanish Grant	2/8/2006	8:31	1.063	1.00	0.04	1362	1398		12.45	55.04
Spanish Grant	3/8/2006	8:15	1.021	na	na	1533	1352		12.16	54.03
Spanish Grant	4/4/2006	8:25	1.811	1.60	0.25	223	210		13.94	57.3
Spanish Grant	5/9/2006	8:00	5.144	na	na	515	524		17.22	63.14
Spanish Grant	6/6/2006	10:50	3.105	na	na	400	606		21.94	68.84
Spanish Grant	7/21/2006	9:15	2.135	1.90	na	650	653		24.22	75.88
Spanish Grant	8/22/2006	8:30	1.698	na	na	747	451	754	20.45	68.71
Spanish Grant	9/28/2006	9:45	2.82	na	na	1263	1123		19.49	67.03
Spanish Grant	10/3/2006	8:30	3.061	2.91	1.8	na	na	na	na	na
Spanish Grant	10/27/2006	8:40	2.66	2.55	0.45	994	1043		12.97	55.74
Spanish Grant	11/17/2006	8:50	3.084	3.00	1.8	345	411		14.21	57.95
Spanish Grant	12/8/2006	8:15	2.543	2.45	0.1	1712	1961		12.02	53.8
Spanish Grant	1/19/2007	8:15	2.485	1.65	0.1	1223	1387	1301	8.52	47.92
Spanish Grant	2/13/2007	8:30	2.432	2.38	0.02	2030	2402	2082	12.3	54.34
Spanish Grant	3/6/2007	8:45	2.562	2.51	0.2	596	673	634	12.67	54.9
Spanish Grant	4/13/2007	9:15	3	2.95	1.7	1081	1143	1144	12.49	54.56
Spanish Grant	5/22/2007	9:30	3.184	2.91	2.7	1093	971	1127	na	59.82
Spanish Grant	6/19/2007	9:00	3.168	2.80	2.1	1164	1058	1244	21.32	69.4
Spanish Grant	7/10/2007	11:30	3.617	3.14	5.2	1019	1093	1101	23.33	73.83
Spanish Grant	8/14/2007	8:30	3.47	3.03	3.2	1289	1118	1271	19.56	67.15
Spanish Grant	9/11/2007	8:45	3.1035	2.31	1.3	1620	1353	1300	20.26	68.37
Spanish Grant	10/9/2007	8:20	2.583	2.16	0.08	2200	1312	2244	18.3	64.07
Spanish Grant	11/1/2007	9:30	2.713	2.75	0.6	1097	2063	1062	16.71	61.99

DO-65 Spanish Grant Drain QA data							
Reference			**Constants**				
Site	Date	Time	Structure/ Equipment	Width of weir (ft)	Bubbler to staff gauge offset	Top of weir offset	Rating Quality
Spanish Grant	1/11/2006	8:00	Weir/bubbler	4.6	-0.065	0.819	good
Spanish Grant	2/8/2006	8:31	Weir/bubbler	4.6	-0.063	1.011	good
Spanish Grant	3/8/2006	8:15	Weir/bubbler	4.6			good
Spanish Grant	4/4/2006	8:25	Weir/bubbler	4.6	-0.211	1.633	good
Spanish Grant	5/9/2006	8:00	Weir/bubbler	4.6			good
Spanish Grant	6/6/2006	10:50	Weir/bubbler	4.6			good
Spanish Grant	7/21/2006	9:15	Weir/bubbler	4.6	-0.235		good
Spanish Grant	8/22/2006	8:30	Weir/bubbler	4.6			good
Spanish Grant	9/28/2006	9:45	Weir/bubbler	4.6			good
Spanish Grant	10/3/2006	8:30	Weir/bubbler	4.6	-0.151	2.397	good
Spanish Grant	10/27/2006	8:40	Weir/bubbler	4.6	-0.110	2.397	good
Spanish Grant	11/17/2006	8:50	Weir/bubbler	4.6	-0.084	2.420	good
Spanish Grant	12/8/2006	8:15	Weir/bubbler	4.6	-0.093	2.446	good
Spanish Grant	1/19/2007	8:15	Weir/bubbler	4.6	-0.835	2.388	good
Spanish Grant	2/13/2007	8:30	Weir/bubbler	4.6	-0.052	2.399	good
Spanish Grant	3/6/2007	8:45	Weir/bubbler	4.6	-0.052	2.409	good
Spanish Grant	4/13/2007	9:15	Weir/bubbler	4.6	-0.050	2.361	good
Spanish Grant	5/22/2007	9:30	Weir/bubbler	4.6	-0.274	2.314	good
Spanish Grant	6/19/2007	9:00	Weir/bubbler	4.6	-0.368	2.433	good
Spanish Grant	7/10/2007	11:30	Weir/bubbler	4.6	-0.477	2.271	good
Spanish Grant	8/14/2007	8:30	Weir/bubbler	4.6	-0.440	2.496	good
Spanish Grant	9/11/2007	8:45	Weir/bubbler	4.6	-0.794	2.569	good
Spanish Grant	10/9/2007	8:20	Weir/bubbler	4.6	-0.423	2.500	good
Spanish Grant	11/1/2007	9:30	Weir/bubbler	4.6	0.037	2.394	good

DO-65 Spanish Grant Drain QA data

Reference			**Calculations**					
Site	Date	Time	Stage above boards back calculated from ITRC Weirstick	Weirstick Flow Calculated from (weirstick reading * board width) (CFS)	Bubbler Calculated Flow from weir equation (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
Spanish Grant	1/11/2006	8:00	0.51	5.52	2.84	47.18	102.42	100.38
Spanish Grant	2/8/2006	8:31	0.05	0.18	0.24	102.64	0.00	101.16
Spanish Grant	3/8/2006	8:15			0.05	88.19	0.00	100.26
Spanish Grant	4/4/2006	8:25	0.18	1.15	1.18	94.17	0.00	100.36
Spanish Grant	5/9/2006	8:00			100.90	101.75	0.00	100.23
Spanish Grant	6/6/2006	10:50			27.44	151.50	0.00	96.29
Spanish Grant	7/21/2006	9:15			5.50	100.46	0.00	100.38
Spanish Grant	8/22/2006	8:30			0.27	60.37	100.94	99.85
Spanish Grant	9/28/2006	9:45			4.17	88.92	0.00	99.92
Spanish Grant	10/3/2006	8:30	0.66	8.28	8.23			
Spanish Grant	10/27/2006	8:40	0.26	2.07	2.03	104.93	0.00	100.71
Spanish Grant	11/17/2006	8:50	0.66	8.28	8.29	119.13	0.00	100.65
Spanish Grant	12/8/2006	8:15	0.10	0.46	0.66	114.54	0.00	100.31
Spanish Grant	1/19/2007	8:15	0.10	0.46	0.25	113.41	106.38	101.23
Spanish Grant	2/13/2007	8:30	0.03	0.09	0.02	118.33	102.56	100.37
Spanish Grant	3/6/2007	8:45	0.15	0.92	0.82	112.92	106.38	100.17
Spanish Grant	4/13/2007	9:15	0.64	7.82	6.77	105.74	105.83	100.14
Spanish Grant	5/22/2007	9:30	0.87	12.42	10.23	88.84	103.11	
Spanish Grant	6/19/2007	9:00	0.74	9.66	9.91	90.89	106.87	98.61
Spanish Grant	7/10/2007	11:30	1.35	23.92	20.06	107.26	108.05	99.78
Spanish Grant	8/14/2007	8:30	0.97	14.72	16.48	86.73	98.60	99.91
Spanish Grant	9/11/2007	8:45	0.53	5.98	8.66	83.52	80.25	99.86
Spanish Grant	10/9/2007	8:20	0.08	0.37	1.01	59.64	102.00	98.66
Spanish Grant	11/1/2007	9:30	0.32	2.76	2.43	188.06	96.81	99.86

DO-68 S. Lake Basin

Location: 37.255°N -120.191°W

Water District or Organization: Grasslands Water District

Station Description: Data provided by Lara Sparks (Fish and Game and Grassland Water District) and Jeremy Hanlon with the University of the Pacific.

Station Rating Variables:

Logger:	Campbell CR10x
Conductivity Probe:	Campbell
Velocity Sensor:	Sontek SL
Stage Sensor:	Sontek pressure sensor
Stage Sensor (Bubbler):	n/a
Battery:	12V
Power:	Solar
Communications:	GOES and direct downloads
Stage to Flow Relationship:	Flow is calculated from sontek pressure sensor and QA ratings area relationship.
Flow Calculation:	Regression: Flow = 12.738 * (Sontek Pressure * 2.3067) - 3.5292 r^2 = 0.7184
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	
Maximum flow:	
Minimum EC:	
Maximum EC:	

DO-68 S-Lake Drain QA data

WS = Weir Stick
SG = Staff Gauge
Reference

Site	Date	Time	Notebook Reference	Method	Comments
S-Lake Drain	1/9/2006	12:15	G2P18	SG	
S-Lake Drain	2/2/2006	9:30	G2P23	SG	Staff gauge was moved to the footbridge.
S-Lake Drain	3/1/2006	10:45	G2P33	SG	
S-Lake Drain	4/19/2006	13:19	G2P43	SG	
S-Lake Drain	5/8/2006	10:30	G2P46	SG	
S-Lake Drain	6/9/2006	13:30	G2P61	SG	
S-Lake Drain	7/6/2006	12:15	G2P64	SG	
S-Lake Drain	7/28/2006	9:30	G2P66	SG	
S-Lake Drain	8/31/2006	12:00	G2P70	SG	
S-Lake Drain	9/19/2006	10:45	G2P75	SG	
S-Lake Drain	10/10/2006	10:45	G2P77	SG	
S-Lake Drain	10/31/2006	15:30	G2P79	SG	
S-Lake Drain	12/1/2006	11:45	G2P86	SG	
S-Lake Drain	12/21/2006	10:15	G2P89	SG	
S-Lake Drain	2/14/2007	10:30	G2P94	SG	
S-Lake Drain	3/12/2007	10:00	G2P96	SG	
S-Lake Drain	4/4/2007	11:15	G2P101	SG	
S-Lake Drain	5/1/2007	10:15	G2P104	SG	
S-Lake Drain	5/29/2007	14:00	G2P107	SG	
S-Lake Drain	6/22/2007	12:15	G2P111	SG	
S-Lake Drain	7/20/2007	9:30	G2P116	SG	

DO-68 S-Lake Drain QA data									
Reference			**Measured Variables**						
Site	Date	Time	Sontek reading	Staff Gauge Stage	EC QA from handheld meter (µS/cm)	Pre-cleaning EC from logger (µS/cm)	Post-Cleaning EC from logger (µS/cm)	Temp QA from handheld meter (°F)	Temp from Logger (°F)
S-Lake Drain	1/9/2006	12:15	4.47	6.05	1389	1334	1335	53.1	50.29
S-Lake Drain	2/2/2006	9:30	1.36	3.11	1926	1956	1954	55.4	54.84
S-Lake Drain	3/1/2006	10:45	3.3	5.06	1761	1719	1770	55	55.03
S-Lake Drain	4/19/2006	13:19	4.02	5.78	2062	3030	3029	66.7	59.76
S-Lake Drain	5/8/2006	10:30	3.17	4.94	859.8	2446	2366	72	66.61
S-Lake Drain	6/9/2006	13:30	2.3	4.09	1539	2195	2190	81.5	68.92
S-Lake Drain	7/6/2006	12:15		1.22	3045	2844	2902	80.6	82
S-Lake Drain	7/28/2006	9:30	-0.45	1.90	1771	2290	2553	79.3	78.3
S-Lake Drain	8/31/2006	12:00		0.98	2635	2268	2220	81.3	76.7
S-Lake Drain	9/19/2006	10:45	-0.78	1.56	1180	1216	1186	68.2	68.89
S-Lake Drain	10/10/2006	10:45	0.668	2.95	654.8	662	662	66.6	66.81
S-Lake Drain	10/31/2006	15:30	1.58	3.77	965.2	955	953	61.2	61.41
S-Lake Drain	12/1/2006	11:45	1.45	3.26	1130	1115	1115	48	47.1
S-Lake Drain	12/21/2006	10:15	1.55	3.36	1390	1401	1384	44.2	43.8
S-Lake Drain	2/14/2007	10:30	2.39	3.12	1631	1616	1612	54.3	54.6
S-Lake Drain	3/12/2007	10:00	2.76	3.78	1889	1884	1887	62.6	62.9
S-Lake Drain	4/4/2007	11:15	0.75	1.75	2880	3104	3112	64.9	65
S-Lake Drain	5/1/2007	10:15	na	1.26	3676	4985	5035	64.6	65.6
S-Lake Drain	5/29/2007	14:00	0.49	1.76	2067	1754	1755	80.6	80.8
S-Lake Drain	6/22/2007	12:15	na	0.98	2759	1855	1854	83.8	83.4
S-Lake Drain	7/20/2007	9:30	na	1.25	3589	1735	3819	69.8	69.9

DO-68 S-Lake Drain QA data

Reference			**Constants**		
Site	Date	Time	Structure/ Equipment	Sontek to staff gauge offset	Rating Quality
S-Lake Drain	1/9/2006	12:15	stream/Sontek/Keller Transducer	1.580	fair
S-Lake Drain	2/2/2006	9:30	stream/Sontek/Keller Transducer	1.750	fair
S-Lake Drain	3/1/2006	10:45	stream/Sontek/Keller Transducer	1.760	fair
S-Lake Drain	4/19/2006	13:19	stream/Sontek/Keller Transducer	1.760	fair
S-Lake Drain	5/8/2006	10:30	stream/Sontek/Keller Transducer	1.770	fair
S-Lake Drain	6/9/2006	13:30	stream/Sontek/Keller Transducer	1.790	fair
S-Lake Drain	7/6/2006	12:15	stream/Sontek/Keller Transducer	na	fair
S-Lake Drain	7/28/2006	9:30	stream/Sontek/Keller Transducer	2.350	fair
S-Lake Drain	8/31/2006	12:00	stream/Sontek/Keller Transducer	na	fair
S-Lake Drain	9/19/2006	10:45	stream/Sontek/Keller Transducer	2.340	fair
S-Lake Drain	10/10/2006	10:45	stream/Sontek/Keller Transducer	2.282	fair
S-Lake Drain	10/31/2006	15:30	stream/Sontek/Keller Transducer	2.190	fair
S-Lake Drain	12/1/2006	11:45	stream/Sontek/Keller Transducer	1.810	fair
S-Lake Drain	12/21/2006	10:15	stream/Sontek/Keller Transducer	1.810	fair
S-Lake Drain	2/14/2007	10:30	stream/Sontek/Keller Transducer	0.730	poor
S-Lake Drain	3/12/2007	10:00	stream/Sontek/Keller Transducer	1.020	poor
S-Lake Drain	4/4/2007	11:15	stream/Sontek/Keller Transducer	1.000	poor
S-Lake Drain	5/1/2007	10:15	stream/Sontek/Keller Transducer		poor
S-Lake Drain	5/29/2007	14:00	stream/Sontek/Keller Transducer	1.270	poor
S-Lake Drain	6/22/2007	12:15	stream/Sontek/Keller Transducer		poor
S-Lake Drain	7/20/2007	9:30	stream/Sontek/Keller Transducer		poor

DO-68 S-Lake Drain QA data											
Reference			**Calculations**								
Site	Date	Time	QA Ave Velocity (ft/s)	QA Area (ft^2)	QA Flow (CFS)	Sontek /Keller Area (ft^2)	Sontek Velocity (ft/s)	Sontek/ Keller Flow (CFS)	Pre-Cleaning EC (% of QA)	Post-Cleaning EC (% of QA)	Temp (% of QA)
S-Lake Drain	1/9/2006	12:15					0.31		96.04	0.00	94.71
S-Lake Drain	2/2/2006	9:30	0.52	51.20	31.31	49.87	0.6	29.92	101.56	0.00	98.99
S-Lake Drain	3/1/2006	10:45					0.51		100.51	0.00	100.05
S-Lake Drain	4/19/2006	13:19							146.94	0.00	89.60
S-Lake Drain	5/8/2006	10:30					0.21		284.48	0.00	92.51
S-Lake Drain	6/9/2006	13:30					0.11		142.63	0.00	84.56
S-Lake Drain	7/6/2006	12:15					na		93.40	0.00	101.74
S-Lake Drain	7/28/2006	9:30	0.04	19.05	0.74	19.28	0.1	1.93	129.31	0.00	98.74
S-Lake Drain	8/31/2006	12:00					na		86.07	0.00	94.34
S-Lake Drain	9/19/2006	10:45					na		103.05	0.00	101.01
S-Lake Drain	10/10/2006	10:45					0.54		101.10	0.00	100.32
S-Lake Drain	10/31/2006	15:30					0.4		98.94	0.00	100.34
S-Lake Drain	12/1/2006	11:45					0.35		98.67	0.00	98.13
S-Lake Drain	12/21/2006	10:15	0.51	55.10	33.65	56.20	0.5	28.10	100.79	0.00	99.10
S-Lake Drain	2/14/2007	10:30					0.5		99.08	0.00	100.55
S-Lake Drain	3/12/2007	10:00	0.27	66.91	21.85	63.75	0.29	31.67	99.74	0.00	100.48
S-Lake Drain	4/4/2007	11:15					0.08		107.78	0.00	100.15
S-Lake Drain	5/1/2007	10:15					na		135.61	0.00	101.55
S-Lake Drain	5/29/2007	14:00					0.13		84.86	0.00	100.25
S-Lake Drain	6/22/2007	12:15					na		67.23	0.00	99.52
S-Lake Drain	7/20/2007	9:30					na		106.41	0.00	100.14

DO-84 SJR at Garwood Bridge/Highway 4

Location: 37.9350°N -121.3290°W

Water District or Organization: San Joaquin River at Garwood Bridge is operated by USGS and is in San Joaquin County.

Station Description: The CDEC station at San Joaquin River at Garwood Bridge (station ID: SJG) is operated by USGS. Flow and stage data in this report are taken directly from the CDEC website.

Station Rating Variables:

Logger:	Unknown
Conductivity Probe:	None
Velocity Sensor:	Unknown
Stage Sensor:	Unknown
Stage Sensor (Bubbler):	Unknown
Battery:	Unknown
Power:	Unknown
Communications:	CDEC website.
Stage to Flow Relationship:	Rating unknown.
Estimated data quality:	Unknown
Date updated or calculated:	2/9/2007
Flow Calculation:	Rating unknown.
TDS or Salt Calculation:	Not calculated.
Expected Boundaries for Data (QA):	
Minimum flow:	-3,562 CFS
Maximum flow:	16,089 CFS
Minimum EC:	512.56 µS/cm
Maximum EC:	512.56 µS/cm
	EC was recorded at time of sampling.

Appendix E

Correlation of Standard Methods Chlorophyll Quantification and In-vivo Chlorophyll Fluorescence Measurements

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Introduction

The San Joaquin River in the Central Valley is a highly impaired water body and numerous studies are being conducted investigating the impact of diffuse pollution on water quality and habitat in this region (Stringfellow, 2008). One component of the larger water quality picture is the source and quantity of phytoplankton in this system. It has been well established that quantification of photosynthetic pigments in water samples is a reasonable method of estimating phytoplankton biomass because chlorophyll *a*, the main pigment present in green plants, has been shown to be between 1-2% of the dry weight of planktonic algae (Clesceri et al, 1998). The aim of this report is to analyze the relationship between two methods for measuring chlorophyll *a* concentrations, extraction and spectrophotometric determination of chlorophyll *a* content and fluorometric measurement in the field. Analysis was conducted on the data sets from each year, for all three years compiled, and for the different YSI units used during 2005 through 2007 by the Environmental Engineering Research Program (EERP).

Methods

Standard Methods for the Examination of Water and Wastewater section 10200 H. (Clesceri et. al., 1998) as well as the *EERP Lab Protocol Book* (Borglin et. al., 2008) and *EERP Field Protocol Book* (Hanlon et. al., 2008) describes the extraction and spectrophotometric quantification process used to determine chlorophyll *a* concentrations and thus relative phytoplankton loads in the San Joaquin River watershed by EERP for the years 2005 through 2007. In addition to extraction and spectrophotometric quantification of chlorophyll pigments from grab samples, a YSI Sonde 6600 with 6025 chlorophyll sensor was used at every grab sample site to fluorometrically measure and record a corresponding chlorophyll *a in-vivo* value during that same period, 2005-2007.

Results

Extracted chlorophyll *a* concentration in mg/L when compared to YSI Sonde 6600 fluorescence measurement had an r^2 value of 0.858 and a slope of 8.818 (where n = 370) in 2005, an r^2 value of 0.820 and a slope of 7.999 (where n = 504) in 2006, an r^2 value of 0.773 and a slope of 9.140 (where n = 702) in 2007, and an r^2 value of 0.7996 and a slope of 8.753 (where n = 1576) for 2005-2007 (Figures 1-4). For EERP Sonde no. 1 (serial no. 04M1920 AA), the chlorophyll *a* concentration versus Sonde fluorescence yielded an r^2 value of 0.814 and a slope of 8.634 (where n = 247) in 2006, an r^2 value of 0.725 a slope of 8.469 (where n = 432) in 2007, and an r^2 value of 0.776 a slope of 8.592 (where n = 1049) in for 2005-2007. For EERP Sonde no. 2 (serial no. 05B1294 AA), the chlorophyll *a* concentration versus Sonde fluorescence yielded an r^2 value of 0.873 and a slope of 6.918 (where n = 257) in 2006, an r^2 value of 0.914 a slope of 11.090 (where n = 270) in 2007, and a r^2 value of 0.861 a slope of 9.259 (where n = 527) for 2005-2007 (Figures 5-10). During the 2005 sampling year only EERP Sonde no. 1 (serial no. 04M1920 AA) was used. See Table 1 for results.

Discussion

Over the research period of 2005-2007 the slope between corresponding YSI Sonde fluorescence readings and chlorophyll *a* extract values remained relatively consistent, between 7.0 and 9.3. The value 8.8 was used to correct fluorescence to chlorophyll *a* concentration in reported electronic data sets. The variation in these values from year to year could be attributed to variations in each years range of chlorophyll concentrations due to the extremely wet conditions of 2006 and the drought-like conditions of 2007, which influence residence times and algal growth thus causing chlorophyll *a* levels to fluctuate to the extremes of both methods' valid ranges. This trend from 2005 through 2007 is also evidenced by the range of values from year to year (see Figures 1-3).

There is a decrease in r^2 values which tracks the total number of samples taken, from 304 in 2005 (r^2 value of 0.858), to 504 in 2006 (r^2 value of 0.820), and finally 702 in 2007 (r^2 value of 0.773). Some of the discrepancies between the values generated by these two methods can be explained by the inability of the fluorometric method to differentiate between healthy living chlorophyll *a* and one of its major degradation products, pheophytin, as well as the problems affiliated with the consistent handling and analysis of highly unstable compounds, such as chlorophyll *a*, as is the case with the standard methods extraction and quantification process.

Examination of the slope and r^2 value differences between YSI Sonde units1 and 2 shows further the dissimilarity in sample ranges between the two last sampling years, 2006 and 2007, due to the differing weather conditions (Figures 5 and 7). The variation in relationships (slopes) between the two methods for each unit can be explained to some extent by the disparity in sample sites routinely measured by each Sonde unit. Sample sites very greatly in accessibility and water quality and many sites prove problematic for getting accurate fluorometric and laboratory measurements due to heterogeneous chlorophyll concentrations, the particulate nature of chlorophyll, high pheophytin concentrations, and very shallow water columns. These problematic sites were not evenly divided between the two units and because the same Sondes were used in the same routine locations, those problem sites may have influenced the evident relationships between methods. In the future, rotating sondes between sampling crews is recommended to provide a better comparison between sondes.

References

American Public Health Association, 2005. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, D.C.

Stringfellow, W.T., 2008. Progress Report: Discharge Management Program Monitoring and Evaluation - West Stanislaus County. Stockton, CA.

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T., 2008. EERP Lab Protocol Book. University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, 2005. 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: R-squared and slope results for years 2005-2007

Year	Sonde 1 (no. 04M1920 AA)			Sonde 2 (no. 05B1294 AA)			Over All		
	n	R-Squared Value	Slope	*n*	R-Squared Value	Slope	*n*	R-Squared Value	Slope
2005	370	0.858	8.818				370	0.858	8.818
2006	247	0.814	8.634	257	0.873	6.918	504	0.82	7.999
2007	432	0.725	8.469	270	0.914	11.09	702	0.773	9.14
2005-2007	1049	0.776	8.592	527	0.861	9.259	1576	0.7996	8.753

Figure 1: 2005 Sonde fluorescence vs. chlorophyll *a* concentration (SM TC Method).

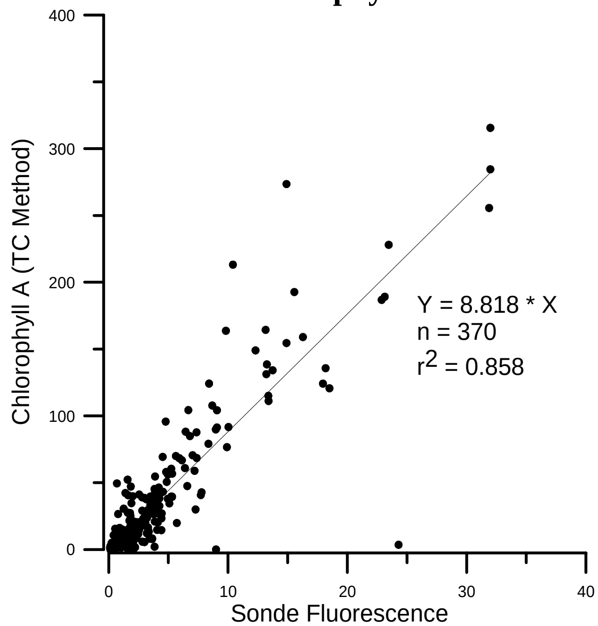


Figure 2: 2006 Sonde fluorescence vs. chlorophyll *a* concentration (SM TC Method).

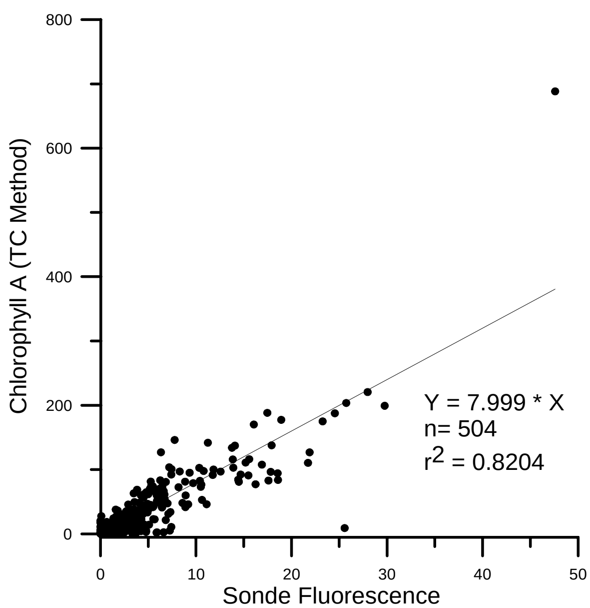


Figure 3: 2007 Sonde fluorescence vs. chlorophyll *a* concentration (SM TC Method).

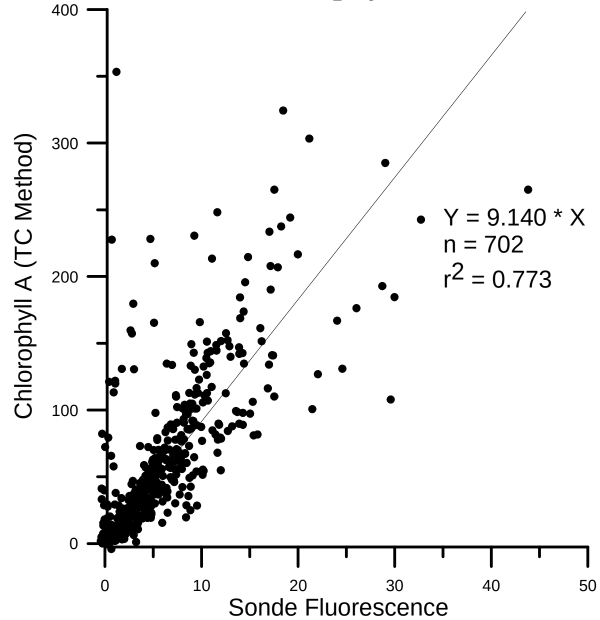


Figure 4: 2005 - 2007 Sonde fluorescence vs. chlorophyll *a* concentration (SM TC Method).

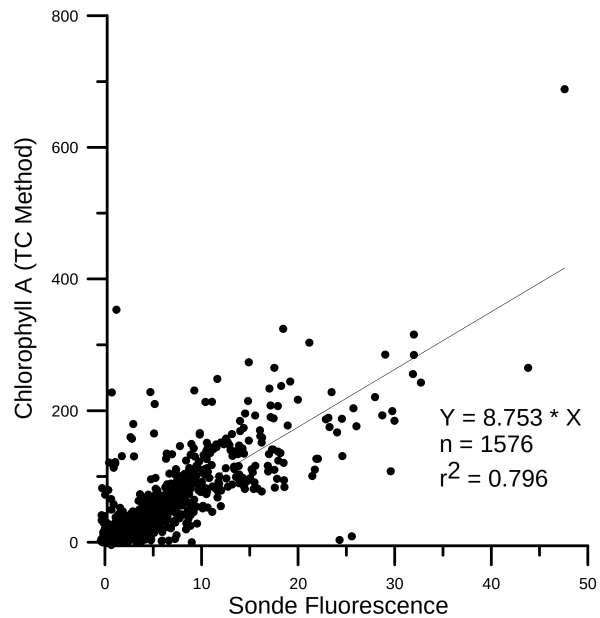


Figure 5: 2006 Sonde No. 1 fluorescence vs. chlorophyll *a* concentration (SM TC Method).

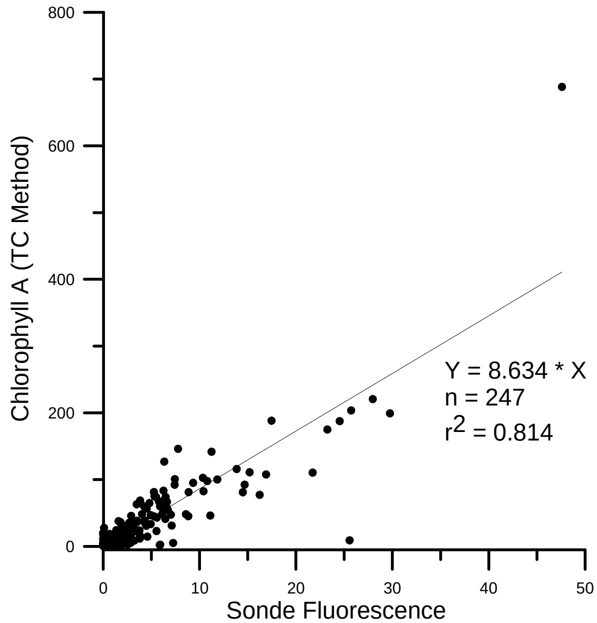


Figure 6: 2006 Sonde No. 2 fluorescence vs. chlorophyll *a* concentration (SM TC Method).

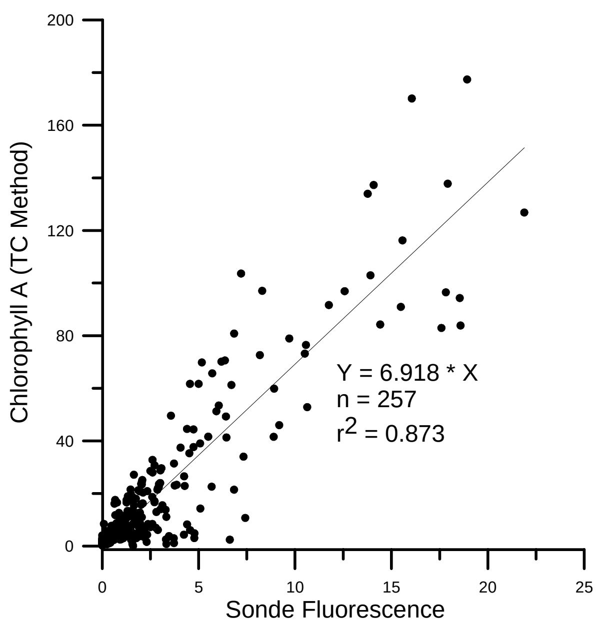


Figure 7: 2007 Sonde No. 1 fluorescence vs. chlorophyll *a* concentration (SM TC Method).

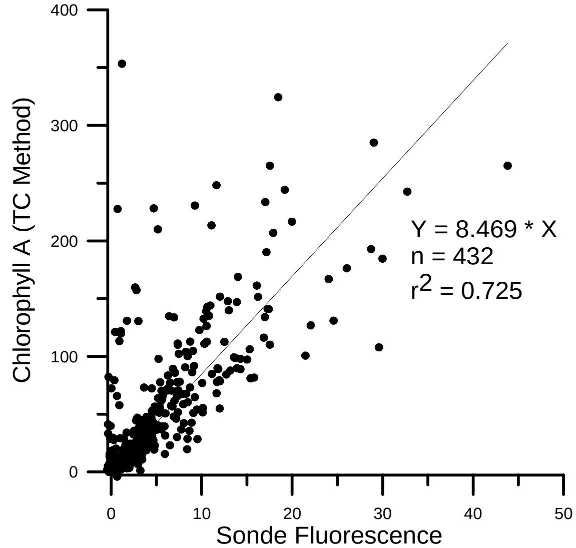


Figure 8: 2007 Sonde No. 2 fluorescence vs. chlorophyll *a* concentration (SM TC Method).

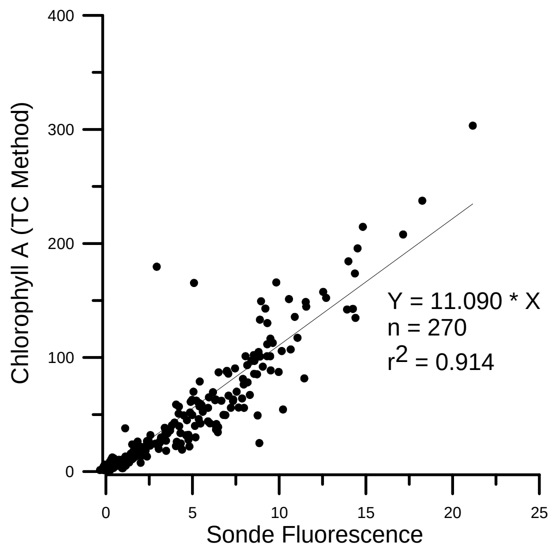


Figure 9: 2005 - 2007 Sonde No. 1 fluorescence vs. chlorophyll *a* concentration (SM TC Method).

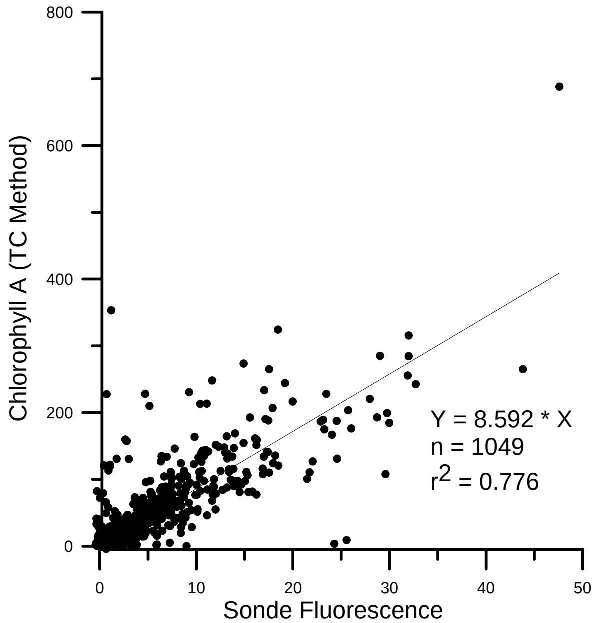
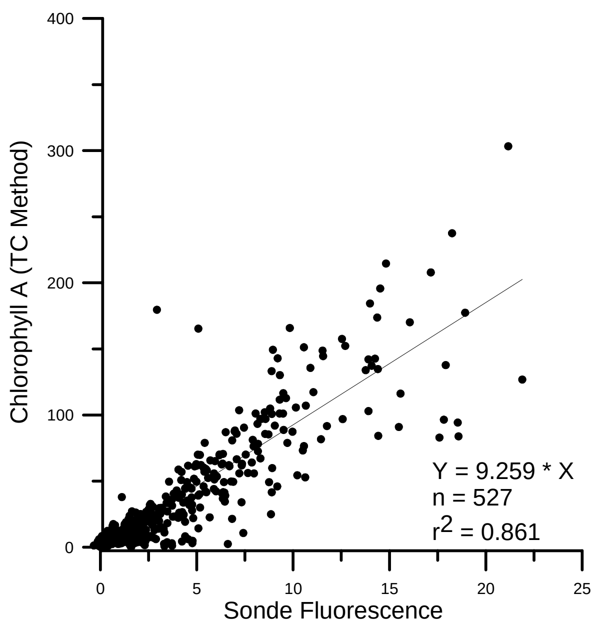


Figure 10: 2005 - 2007 Sonde No. 2 fluorescence vs. chlorophyll *a* concentration (SM TC Method).



Appendix F

Temporal Variation in Flow in the Mainstem and Tributaries of the San Joaquin River 2005-2007

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Introduction

The Environmental Engineering Research Program (EERP) at the University of the Pacific (UOP) is the lead scientific agency on several water quality and ecosystem restoration projects focused on understanding and improving water quality in the San Joaquin River (SJR). EERP projects include the development of a mass balance on phytoplankton and oxygen demanding materials in the SJR, evaluation of organic carbon sources and fate in the SJR, studies of wetland ecosystems, and studies examining the impact of current agricultural best management practices (BMPs) on water quality. For all of these projects, water quality and water flow must be measured at numerous locations throughout the watershed.

The objective of this report is to document all flow data collected by EERP between 2005-2007 at sites in the SJR Valley. Water quality data and flow were collected over a three year period (2005-2007). Data was then graphed by site for each year and for all three years together. Flow data is used to determine load of water quality parameters at the EERP sample sites.

Methods

Flow and water quality data were monitored at 53 sites in the San Joaquin River Valley (Table 1). At site data were averaged by day, where available, and then graphed over the three year period in Grapher 6 (Golden Software Inc., Golden, CO). Flow was plotted against all three years in one graph and day of year to produce three separate graphs, one for each year. If a station did not have flow available for a particular year the graph was labeled with data not available. Data for each of the flow stations were collected from a number of different sources (Table 1). Most of the flow data used in this report was preliminary data because data collected from the website for the California Data Exchange Center (CDEC) was tagged as provisional data and subject to change. CDEC has to date, not made available any data with verifiable accuracy nor offered any quality assurance data for what they are reporting.

Data was measured and recorded every fifteen minutes or hourly at the majority of flow stations while a few sites only reported daily averages, or in the case of DO-43 El Solyo Water District Diversion (Figures 71-72) and DO-40 Patterson Irrigation District diversion (Figures 65-66) monthly averages. All of the fifteen minute and hourly data was averaged by day, potentially washing out the effects of any daily variation at the site. Dataloggers stored data from the sensors that could be accessed through a telemetry system or manually downloaded using a PCMCIA flash card from the logger. Most stations were equipped with a telemetry system such as GOES or SCADA systems. The GOES telemetry system reported data directly to a DOMSAT station operated by the Department of Water Resources California Data Exchange Center, which could then be downloaded from the CDEC website. SCADA systems reported data directly through e-mail to the persons responsible for the site's data collection.

Existing structures and channel morphology determined what equipment was used to measure flow at a given site. Where a weir was present, the stage value along with the weir equation was used to compute discharge. Pressure transducers, float and shaft encoders, Stevens chart recorders, and Design Analysis H355 Smartgas bubbler systems were all used to measure stage (Table 2). Some sites with culverts and open channels were installed with Doppler units to measure the discharge, such as a SONTEK, MACE, or STARFLOW (Table 2). Continuous monitoring sites that lacked a structure relied on a stage to discharge relationship from a rating curve to determine flow. These sites could then utilize a Design analysis H355 Smartgas bubbler system or some other stage measuring equipment to determine discharge. Quality assurance was ensured at EERP managed sites with monthly flow ratings wherever possible to account for relational drift due to changing stream bed morphologies.

Results and Discussion

Data were collected and compiled for all sites. Summary statistics by annual year for flow are presented in Tables 3, 4, and 5 for 2005, 2006, and 2007, respectively. There are a total of 106 figures (Figures 1-106) representing data available for 53 sites, plotted data are presented in order of station number with the exception of the main stem San Joaquin River sites which are presented from most downstream to most upstream (Table 1). Each site is plotted on four plots consisting of one plot for each year (2005-2007) and a combined plot showing all three years on one axis. All the available data for a site is plotted and any gaps in the data are shown on the plot.

Analyzing the plots we can make observations on spatial and temporal trends in the flow data for each site as well as the San Joaquin River Valley system as a whole. Comparing main stem sites for the San Joaquin River (Figures 1-20), a difference in water year types is noticed (Table 6), with 2005 and 2006 being wet years and 2007 being a dry year (Letain and Stringfellow, 2007). Looking at the scales of the plots there is a significant difference between 2006 and 2007 and little difference between 2005 and 2006. Comparing the San Joaquin River and the major tributaries to the agricultural drains shows the flows for the agricultural drains were independent of water year type. In 2007 the average annual SJR diversions by three of the four main west-side irrigation districts increased slightly (Tables 3-5) due to an earlier start to the irrigation season rather than greater flows during the season as can be seen in the plotted data (Figures 65-72). East-side sites DO-22 through DO-30 (Figures 35-52) also showed earlier irrigation delivery flows for 2007 than for the especially wet spring and early summer of 2006 when there was widespread flooding throughout the valley. 2005 was also a wetter than average year (Table 6) but eastside irrigation deliveries for that year were more similar to 2007 than 2006. State water deliveries via DO-47, the Delta Mendota Canal, were inversely proportional to the water supply index for 2005 and 2006 and probably 2007 when that data becomes available.

The San Joaquin River system is highly variable with statistically significant variations in flow between seasons and between years (Letain and Stringfellow, 2007). There are numerous pumps, siphons, drains, and tributaries along the river, both removing and returning water to the system. Despite all of the variation, EERP and various other agencies were able to collect high quality flow data accurately representing the San Joaquin River in real-time. In general, the flow stations in the San Joaquin River watershed reported high quality data for 2005-2007. Occasionally equipment used at the flow stations malfunctioned or reported low quality data resulting in data gaps. DO-01 SJR at Channel Point uses data from the closest flow monitoring station located in the San Joaquin River Deep Water Shipping Channel at Rough and Ready Island. Flow data did not become available through the CDEC website until 2007. DO-04 SJR at Mossdale and DO-06 SJR at Maze Blvd. data became available through CDEC starting in 2006. DO-61 Deadmans Slough was not reported for 2005 because of low quality data from beaver activity affecting measurements. The data missing for 2005 and the gaps in 2006 at DO-31 New Jerusalem Drain were due to a faulty Starflow Doppler unit and leaky bubbler line at the site. The station at DO-28 TID Westport Drain was washed out prior to 2005 and was not reporting data until 2007. The stations at DO-20 Los Banos Creek and DO-57 Ramona Lake at Levee were washed out in the floods of 2006 and could not report data until late 2006 for DO-20 Los Banos Creek and mid 2007 for DO-57 Ramona Lake at Levee. DO-35 Westley Wasteway was unreliable due to original configuration and blockage from debris in the water until the station was upgraded in 2006. DO-36 Del Puerto Creek had a leak in the bubbler line in 2006 and a clogged bubbler line in 2007 resulting in gaps in the flow data for those years. DO-38 Marshall Road Drain was missing data from the beginning of 2006 as a result of a logger malfunction. Data was not reported for the end of 2007 for DO-20 Los Banos Creek, DO-45 Volta Wasteway, DO-46 Mud Slough at Gun Club Road, DO-53 Salt Slough at Wolfsen, DO-60 Moffit 1 South, DO-61 Deadmans Slough, DO-62 Mallard Slough, DO-63 Inlet C Canal, and DO-68 S-Lake Drain due to limitations on the agencies managing those stations.

Conclusions

Flow was reported for most sites for the three year period (2005-2007) with the record becoming more complete as monitoring stations and equipment are added over time by EERP and other agencies. The reported data was high quality despite the problems with occasional equipment failures and damages to the flow stations. Collected data covered all of the significant tributaries and drains into the study area on the San Joaquin River. The temporal plots show significant differences in water year types and between agriculture drains and other tributaries.

Most equipment failures were identified and corrected as quickly as possible and upgrades at some sites significantly improved data reliability. All data has been checked for accuracy to whatever extent possible but caution must still be exercised when comparing average annual flow values. Because of the great seasonal variability (Letain and Stringfellow, 2007) a small gap in data due to a temporary measurement failure can skew the annual average. This is why the data are presented graphically in addition to the simple tabulated averages. The goals of this report were met with the continuous monitoring of flow at the relevant EERP sample sites.

References

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Letain, T., Stringfellow, W., 2007. Statistical Comparison of Water Flow Rates for San Joaquin Valley Drainages and the San Joaquin 60-20-20 Water Supply Index for 2000 – 2006. Environmental Engineering Research Program, Stockton, CA.

Table 1: List of flow stations and data sources.

DO Site	Station Name	Latitude	Longitude	Station Owner	Data Contact/Source
1	SJR at Channel Point	37.950	-121.337	DWR	CDEC/DWR
84	SJR at Garwood Bridge (Hwy 4)	37.836	-121.311	DWR	CDEC/Joe Tapia
3	SJR at Old River	37.819	-121.324	DWR	CDEC/Joe Tapia
4	SJR at Mossdale	37.787	-121.308	DWR	CDEC/Joe Tapia
5	SJR at Vernalis-McCune Station	37.679	-121.265	DWR/USGS	CDEC/USGS Sacramento
6	SJR at Maze	37.641	-121.229	DWR	CDEC/Joe Tapia
7	SJR at Patterson	37.494	-121.081	DWR	CDEC/Joe Tapia
8	SJR at Crows Landing	37.432	-121.012	USGS	CDEC/USGS Sacramento
9	SJR at Fremont Ford	37.310	-120.931	USGS	CDEC/USGS Sacramento
10	SJR at Lander Avenue	37.294	-120.851	DWR	CDEC/Joe Tapia
13	Stanislaus River at Ripon	37.731	-121.108	USGS	CDEC/USGS Sacramento
15	Tuolumne River at Modesto	37.627	-120.987	USGS	CDEC/USGS Sacramento
17	Merced River near Stevinson	37.387	-120.794	DWR	CDEC/Joe Tapia
18	Mud Slough near Gustine	37.263	-120.906	USGS	CDEC/USGS Sacramento
19	Salt Slough at Lander Avenue	37.248	-120.852	USGS	CDEC/USGS Sacramento
20	Los Banos Creek Flow Station	37.275	-120.955	Grassland WD	Lara Sparks
21	Orestimba Creek at River Road	37.414	-121.015	USGS	CDEC/USGS Sacramento
22	Modesto ID Lateral 4 to SJR	37.631	-121.159	Modesto ID	Michael Niemi

DO Site	Station Name	Latitude	Longitude	Station Owner	Data Contact/Source
23	Modesto ID Lateral 5 to Tuolumne	37.615	-121.143	Modesto ID	Michael Niemi
24	Modesto ID Lateral 6 to Stanislaus River	37.704	-121.141	Modesto ID	Michael Niemi
25	Modesto ID Main Drain to Stan. R. via Miller Lake	37.670	-121.219	Modesto ID	Michael Niemi
26	Turlock ID Highline Spill	37.387	-120.814	Turlock ID	Kieth Larson
27	Turlock ID Lateral 2 to SJR	37.565	-121.138	Turlock ID	Kieth Larson
28	Turlock ID Westport Drain Flow station	37.542	-121.094	Turlock ID	Kieth Larson
29	Turlock ID Harding Drain	37.464	-121.031	Turlock ID	Kieth Larson
30	Turlock ID Lateral 6 & 7 at Levee	37.398	-120.972	Turlock ID	Kieth Larson
31	BCID – New Jerusalem Drain	37.727	-121.300	SJVDA	UOP EERP
33	Hospital Creek	37.610	-121.231	SJVDA	UOP EERP
34	Ingram Creek	37.600	-121.225	SJVDA	UOP EERP
35	Westley Wasteway Flow Station	37.558	-121.164	SJVDA	UOP EERP
36	Del Puerto Creek Flow Station	37.539	-121.122	SJVDA	UOP EERP
38	Marshall Road Drain	37.436	-121.036	SJVDA	UOP EERP
40	Patterson Irrigation District Diversion	37.497	-121.083	PID	John Sweigart
41	West Stanislaus Irrigation District Diversion	37.584	-121.201	WSID	Ron Roos
42	Banta Carbona Irrigation District Diversion	37.713	-121.311	BCID	David Wisenberger
43	El Solyo Water District Diversion	37.640	-121.229	ESWD	John Hanson (DPWD)

DO Site	Station Name	Latitude	Longitude	Station Owner	Data Contact/Source
44	San Luis Drain End	37.261	-120.905		Chris Linneman
45	Volta Wasteway at Ingomar Grade	37.105	-120.936	Grassland WD	Lara Sparks
46	Mud Slough at Gun Club Road	37.231	-120.899	Grassland WD	Lara Sparks
47	Delta-Mendota Canal at HW 140 (O'Neill Forebay)	37.246	-121.077	Delta-Mendota Canal Company	Chris Linneman
48	San Luis Drain Site A (Check 17)	36.967	-120.671	GBP	SFEI
49	PE-14 – Grasslands Area Farmers	36.939	-120.636	SJVDA	Joe McGahan, Mike Gardener
50	FC-5 – Grassland Area Farmers	36.924	-120.654	SJVDA	Joe McGahan, Mike Gardener
53	Salt Slough at Wolfsen Road	37.159	-120.813	SLNWR	USFWS
57	Ramona Drain at Levee	37.479	-121.069	SJVDA	UOP EERP
59	SJR Laird Park	37.557	-121.150	No station	Calculated Flow
60	Moffit 1 South	37.221	-120.832	SLNWR	USFWS
61	Deadmans Slough	37.215	-120.826	SLNWR	USFWS
62	Mallard Slough	37.192	-120.824	SLNWR	USFWS
63	Inlet C Canal	37.172	-120.762	SLNWR	USFWS
64	Moran Drain	37.435	-121.036	SJVDA	UOP EERP
65	Spanish-Grant Drain	37.436	-121.036	SJVDA	UOP EERP
68	S-Lake Basin	37.253	-120.918	Grassland WD	Lara Sparks

End Table 1

Table 2: Equipment descriptions.

Device	*Description*
Campbell Logger (Campbell Scientific Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
H-350XL Design Analysis Logger (Design Analysis Associates Inc., Logan, UT)	Logger put into continuous monitoring stations. Records and stores data from EC probe, flow device, and bubbler.
MACE Agriflo (MACE, Sydney, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Starflow (Unidata, O'Connor, Australia)	Doppler device put near bottom of channel to measure flow. This device is better for defined structures such as pipes and weir structures. Often used at monitoring stations.
Sontek (Sontek/YSI Inc., San Diego, CA)	Doppler device put in channel to measure flow. Sontek units measure flow by looking out into the channel and are better for open, or natural, channel situations. Often used at monitoring stations.
H-350XL/355 Combo Bubbler (Design Analysis Associates Inc., Logan, UT)	A bubbler measures water level by detecting the pressure required to force air through a tube below the water level in the channel. In areas with a weir system a bubbler can be used to measure flow, as the height of water above the weir is proportional to the flow.
Staff Gauge (Wildlife Supply Company, Buffalo, NY)	A gauge put in a fixed location to observe water level. Often used to verify bubbler reading during QA visits.
Cal Poly ITRC Weir Stick (Cal Poly ITRC, San Luis Obispo, CA)	Scale mounted on a stick used to measure the height of the water above a weir structure. This value is then multiplied times the weir width to get flow.

Table 3: Summary flow statistics for annual year 2005.

Site No.	Site name	N	Avg. flow (cfs)	Min. flow (cfs)	Max. flow (cfs)	S.D. flow (cfs)
84	**SJR at Garwood Bridge (Hwy 4)**	22685	3144	-3237	8376	2308
3	**SJR at Old River (DWR Lathrop)**	20976	3339	-2917	9532	1848
5	**SJR at Vernalis**	34915	5529	520	16200	3749
7	**SJR at Patterson**	33221	2356	689	12921	2281
8	**SJR at Crows Landing**	33591	2499	693	10300	1934
9	**SJR at Fremont Ford**	33508	885	135	4350	1000
10	**SJR at Lander Avenue**	34900	697	3	7923	1138
13	**Stanislaus River at Ripon**	33857	533	217	4350	490
15	**Tuolumne River at Modesto**	34376	2282	270	8600	1807
17	**Merced River near Stevinson**	30929	1162	183	4998	1086
18	**Mud Slough near Gustine**	34661	170	0	639	138
19	**Salt Slough at Lander Avenue**	34671	239	40	1080	156
20	**Los Banos Creek at Highway 140**	33882	51	-2	202	55
21	**Orestimba Creek at River Road**	33017	60	0	1280	111
22	**MID Lateral 4 to SJR**	306	5	0	49	9
23	**MID Lateral 5 to Tuolumne**	365	13	0	48	12
24	**MID Lat 6 to Stanislaus River**	365	26	0	89	23
25	**MID Main Drain to Stan. R. via Miller Lake**	275	11	0	142	21
26	**TID Highline Spill**	365	18	0	104	25
27	**TID Lateral 2**	365	3	0	27	4
29	**TID Harding Drain**	365	35	0	107	20
30	**TID Lateral 6 & 7 at Levee**	365	24	0	85	17
31	**BCID – New Jerusalem Drain**	3624	1	0	2	0
33	**Hospital Creek**	35068	4	0	22	3
34	**Ingram Creek**	19149	10	0	105	10
35	**Westley Wasteway Flow Station**	34992	3	0	12	2
36	**Del Puerto Creek Flow Station**	35039	8	0	34	7
38	**Marshall Road Drain**	37761	2	0	11	2
40	**Patterson Irrigation District (diversions)**	12	48	0	125	51
41	**West Stanislaus Irrigation District (diversions)**	365	108	0	461	139
42	**Banta Carbona Irrigation District (diversions)**	365	65	0	228	73
43	**El Solyo Pumping Station (diversions)**	12	15	0	47	17
44	**San Luis Drain End**	24804	49	23	138	14
45	**Volta Wasteway**	31497	105	1	542	107
46	**Mud Slough at Gun Club Road**	28431	28	0	99	22
47	**Delta-Mendota Canal Inlet to the O'Neill Forebay**	365	1260	50	3850	1011
48	**FC-5 Grasslands Area Farmers**	35033	37	8	159	18
49	**PE-14 Grasslands Area Farmers**	32075	11	0	160	10
50	**San Luis Drain Site A (Check 18)**	33880	22	4	74	14
53	**Salt Slough at Wolfsen Road**	20381	202	69	600	57
60	**Moffit 1 South**	8570	1	0	28	2
62	**Mallard Slough**	8573	9	0	30	6
63	**Inlet C Canal**	8759	37	-1	98	28
64	**Moran Drain**	37719	2	0	60	3
65	**Spanish Grant Drain**	37719	6	0	124	9
68	**S. Lake Basin**	30318	34	-1	157	34

Table 4: Summary flow statistics for annual year 2006.

Site No.	Site name	N	Avg. flow (cfs)	Min. flow (cfs)	Max. flow (cfs)	S.D. flow (cfs)
84	**SJR at Garwood/HW 4**	21892	4625	-3562	16089	4673
3	**SJR at Old River (DWR Lathrop)**	34674	-283	-12256	15010	8410
4	**SJR at Mossdale**	34654	9012	4	29425	7408
5	**SJR at Vernalis**	34605	10348	690	36098	9190
6	**SJR at Maze**	342	8423	1168	34077	8102
7	**SJR at Patterson**	34925	4936	675	27953	5857
8	**SJR at Crows Landing**	34172	4857	716	34300	5676
9	**SJR at Fremont Ford**	34201	2165	131	21600	3189
10	**SJR at Lander Avenue**	34411	2743	0	23438	4841
13	**Stanislaus River at Ripon**	34680	2198	453	6270	1466
15	**Tuolumne River at Modesto**	31003	3229	60	11400	2531
17	**Merced River near Stevinson**	14578	2845	595	6045	1548
18	**Mud Slough near Gustine**	34132	266	24	1140	213
19	**Salt Slough at Lander Avenue**	34655	440	40	2150	424
20	**Los Banos Creek at Highway 140**	11440	49	3	131	25
21	**Orestimba Creek at River Road**	32218	64	0	3190	234
22	**MID Lateral 4 to SJR**	6139	14	0	90	17
23	**MID Lateral 5 to Tuolumne**	6140	24	0	113	20
24	**MID Lat 6 to Stanislaus River**	6140	42	0	125	24
25	**MID Main Drain to Stan. R. via Miller Lake**	3581	16	0	208	15
26	**TID Highline Spill**	365	14	0	67	18
27	**TID Lateral 2**	365	5	0	35	7
28	**TID Westport Drain Flow Station**	best est.	30	5	50	
29	**TID Harding Drain**	365	34	4	92	15
30	**TID Lateral 6 & 7 at Levee**	365	14	0	55	12
31	**BCID – New Jerusalem Drain**	12949	7	0	19	5
32	**El Solyo WD – Grayson Drain**	best est.	10	0	20	
33	**Hospital Creek**	35040	2	0	15	3
34	**Ingram Creek**	35040	6	0	31	7
35	**Westley Wasteway Flow Station**	9037	2	0	33	2
36	**Del Puerto Creek Flow Station**	23459	10	0	49	9
38	**Marshall Road Drain**	18258	4	0	48	3
40	**Patterson Irrigation District (diversions)**	8751	41	0	153	54
41	**West Stanislaus Irrigation District (diversions)**	183	92	0	192	52
42	**Banta Carbona Irrigation District (diversions)**	364	67	0	254	82
43	**El Solyo Pumping Station (diversions)**	12	16	0	50	19
44	**San Luis Drain End**	35902	36	11	179	13
45	**Volta Wasteway**	31650	82	1	492	81
46	**Mud Slough at Gun Club Road**	31911	34	-1	131	29
47	**Delta-Mendota Canal Inlet to the O'Neill Forebay**	365	1083	40	3630	1023
49	**PE-14 Grasslands Area Farmers**	35040	19	5	76	10
50	**San Luis Drain Site A (Check 18)**	34922	32	7	191	14
53	**Salt Slough at Wolfsen Road**	29957	203	19	452	91
54	**Los Banos Creek at Ingomar Grade**	best est.	5	0	10	
57	**Ramona Lake**	best est.	20	0	30	
59	**SJR Laird Park**	342	5219	716	27255	5944
60	**Moffit 1 South**	8759	1	0	11	3
61	**Deadman's Slough**	8758	8	0	56	14
62	**Mallard Slough**	8759	8	0	49	10
63	**Inlet C Canal**	8568	22	0	113	22

Site No.	Site name	N	Avg. flow (cfs)	Min. flow (cfs)	Max. flow (cfs)	S.D. flow (cfs)
64	**Moran Drain**	30792	2	0	20	3
65	**Spanish Grant Drain**	27658	9	0	53	10
66	**ESWD Maze Blv. Drain**	best est.	5	0	15	
67	**Newman Wasteway at Brazo Road**	best est.	5	0	30	
68	**S. Lake Basin**	32371	25	-1	232	24
95	**Ramona Drain at Ramona Lake**	best est.	20			

End of Table 4

Table 5: Summary flow statistics for annual year 2007.

Site No.	Site name	N	Avg. flow (cfs)	Min. flow (cfs)	Max. flow (cfs)	S.D. flow (cfs)
1	**SJR at Channel Point (Rough and Ready Island)**	34137	1160	-16346	62246	4663
84	**SJR at Garwood/HW 4**	34581	648	-4273	4792	2157
3	**SJR at Old River (DWR Lathrop)**	31986	384	-1827	2444	801
4	**SJR at Mossdale**	33604	1699	-1056	5782	938
5	**SJR at Vernalis**	34535	1889	533	4321	771
6	**SJR at Maze**	25057	1078	312	2176	413
7	**SJR at Patterson**	34465	606	109	1328	243
8	**SJR at Crows Landing**	34090	697	315	1374	253
9	**SJR at Fremont Ford**	33481	189	33	781	96
10	**SJR at Lander Avenue**	34294	36	3	616	61
13	**Stanislaus River at Ripon**	34562	678	227	1510	413
15	**Tuolumne River at Modesto**	33979	368	186	1070	173
17	**Merced River near Stevinson**	29746	367	15	1330	300
18	**Mud Slough near Gustine**	34480	96	8	245	64
19	**Salt Slough at Lander Avenue**	34484	155	50	363	66
20	**Los Banos Creek at Highway 140**	24323	23	0	132	20
21	**Orestimba Creek at River Road**	28880	8	0	152	10
22	**MID Lateral 4 to SJR**	5227	8	0	86	12
23	**MID Lateral 5 to Tuolumne**	5236	23	0	98	19
24	**MID Lat 6 to Stanislaus River**	5242	22	0	107	25
25	**MID Main Drain to Stan. R. via Miller Lake**	7781	12	0	55	9
26	**TID Highline Spill**	365	7	0	53	8
27	**TID Lateral 2**	365	5	0	30	6
28	**TID Westport Drain Flow Station**	365	25	0	101	18
29	**TID Harding Drain**	365	36	0	89	15
30	**TID Lateral 6 & 7 at Levee**	365	11	0	43	10
31	**BCID - New Jerusalem Drain**	365	4	1	11	3
33	**Hospital Creek**	35040	3	0	17	3
34	**Ingram Creek**	35041	6	0	25	6
35	**Westley Wasteway Flow Station**	33274	2	0	42	2
36	**Del Puerto Creek Flow Station**	33559	17	0	90	16
38	**Marshall Road Drain**	34492	3	0	47	3
41	**West Stanislaus Irrigation District (diversions)**	365	67	0	203	54
42	**Banta Carbona Irrigation District (diversions)**	365	79	0	189	69
43	**El Solyo Pumping Station (diversions)**	12	22	0	73	22
44	**San Luis Drain End**	35039	25	1	54	10
45	**Volta Wasteway**	24318	45	1	469	59
46	**Mud Slough at Gun Club Road**	24908	19	-13	76	23
47	**Delta-Mendota Canal Inlet to the O’Neill Forebay**	334	1684	450	3650	784
48	**FC-5 Grasslands Area Farmers**	365	4	0	15	3
49	**PE-14 Grasslands Area Farmers**	365	14	4	31	7
53	**Salt Slough at Wolfsen Road**	22656	137	61	297	42
57	**Ramona Lake**	25209	6	0	49	6
60	**Moffit 1 South**	5910	0	0	4	1
61	**Deadman's Slough**	6634	12	0	100	19
62	**Mallard Slough**	6632	1	0	47	3
63	**Inlet C Canal**	4947	26	0	90	23
64	**Moran Drain**	34493	3	0	31	4
65	**Spanish Grant Drain**	34491	7	0	69	7
68	**S. Lake Basin**	24325	13	0	35	11

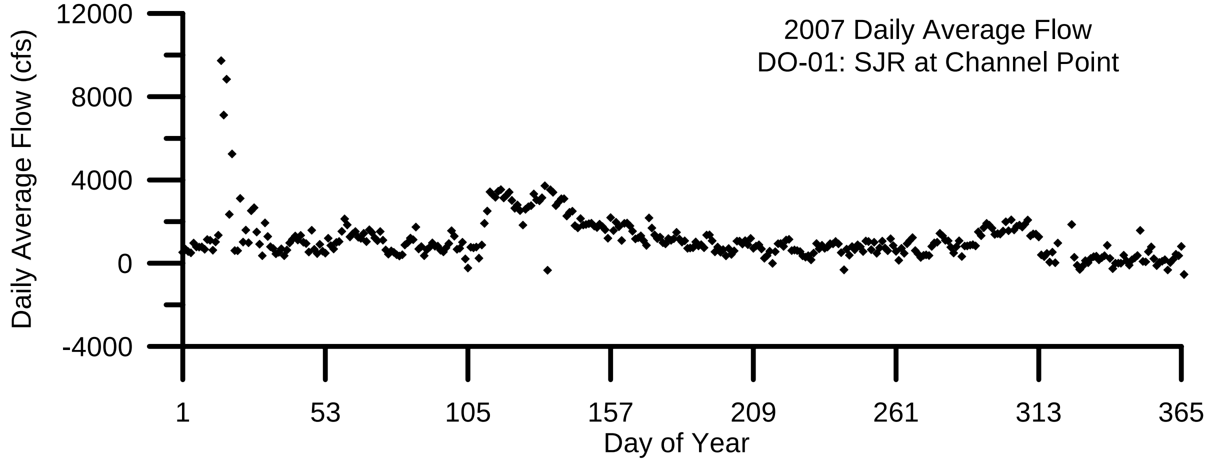
Site No.	Site name	N	Avg. flow (cfs)	Min. flow (cfs)	Max. flow (cfs)	S.D. flow (cfs)
95	**Ramona Drain at Ramona Lake**	12001	9	-38	64	9

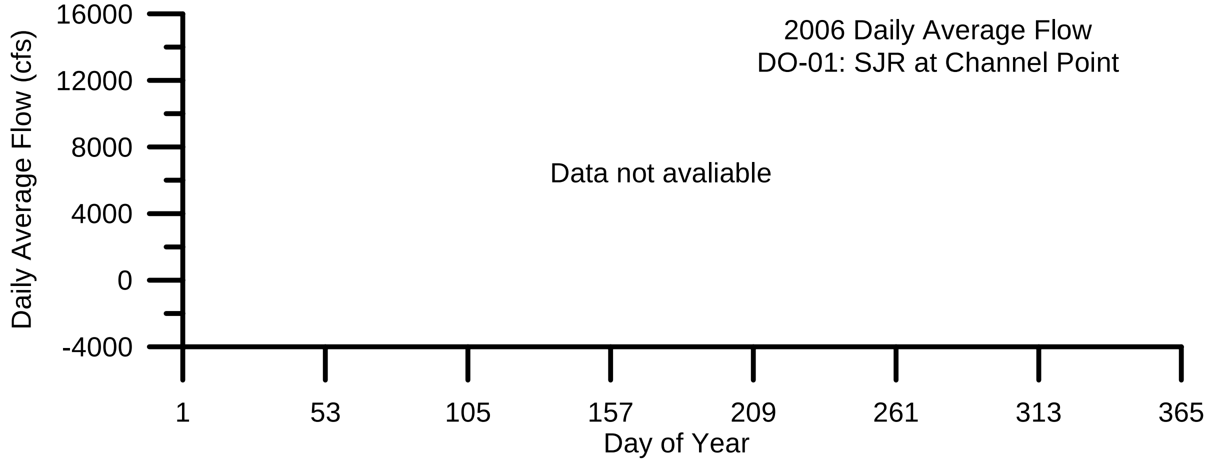
End of Table 5

Table 6: Water Supply Index (WSI) classification for water years 2000 – 2006

Water Year	San Joaquin Region 60-20-20 Water Supply Index	Classification
2000	3.38	Above Normal (> 3.1; < 3.8)
2001	2.20	Critical (≤ 2.2)
2002	2.34	Dry (> 2.2; ≤ 2.5)
2003	2.81	Below Normal (> 2.5; ≤ 3.1)
2004	2.21	Critical (≤ 2.2)
2005	4.75	Wet (≥ 3.8)
2006	5.90	Wet (≥ 3.8)

Figure 1: 2005 through 2007 flow plots for DO-01 SJR at Channel Point





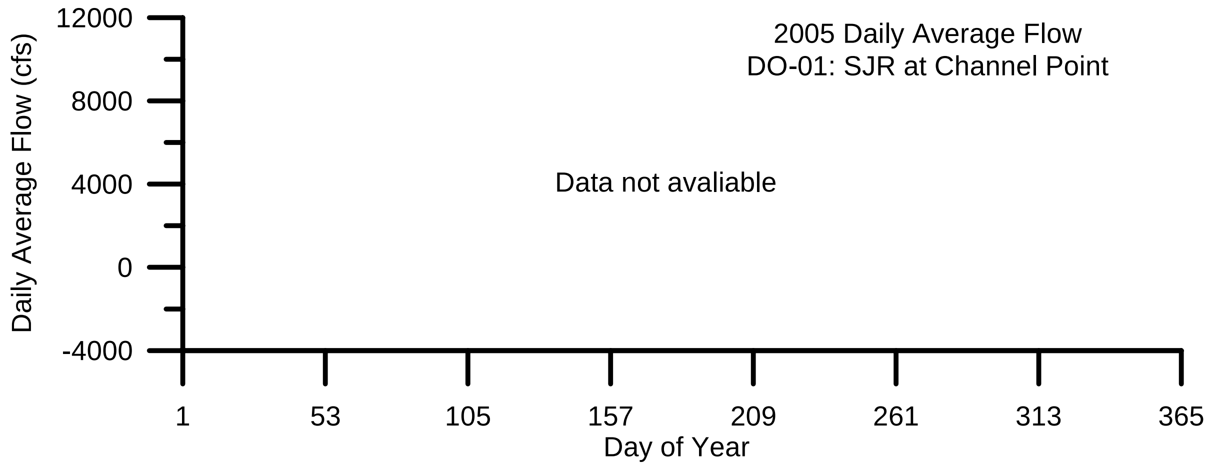


Figure 2: 2005 through 2007 flow plot for DO-01 SJR at Channel Point

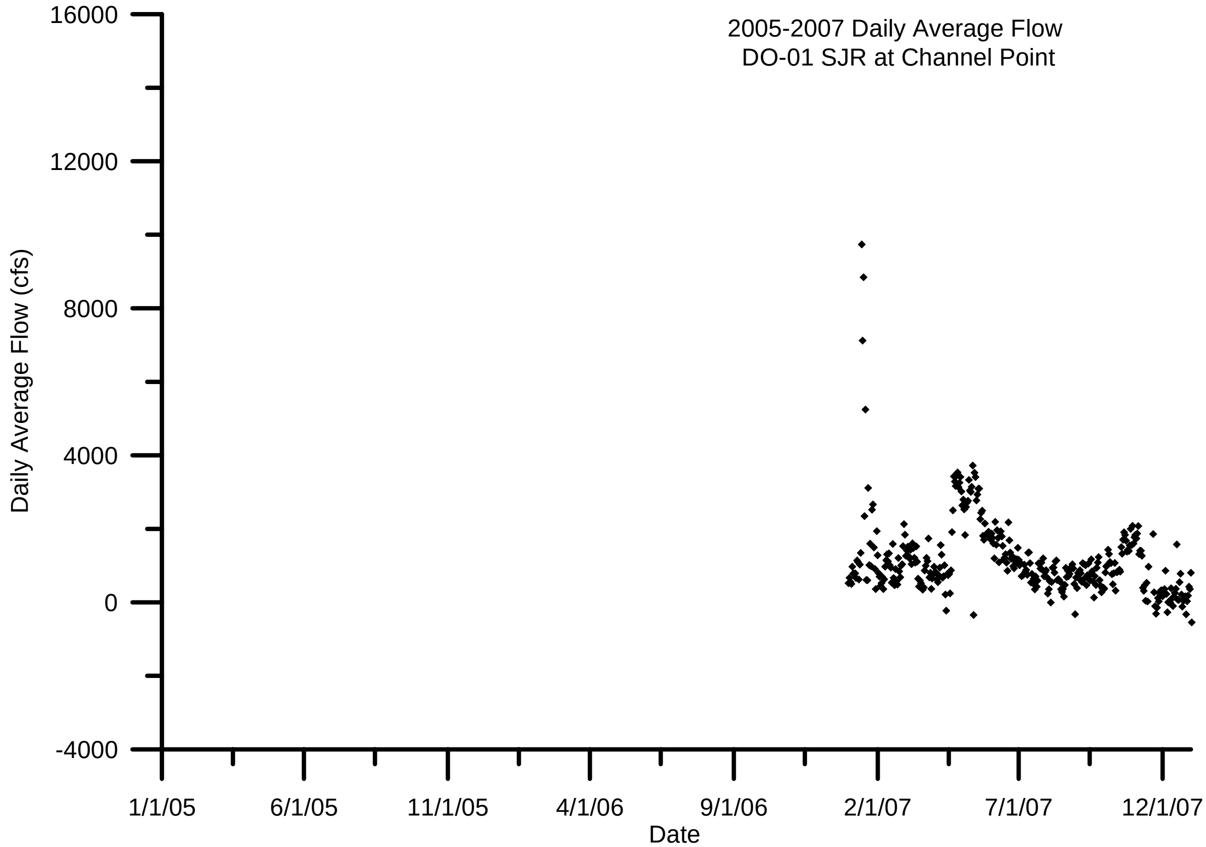


Figure 3: 2005 through 2007 flow plots for DO-84 SJR at Garwood Bridge (Hwy 4)

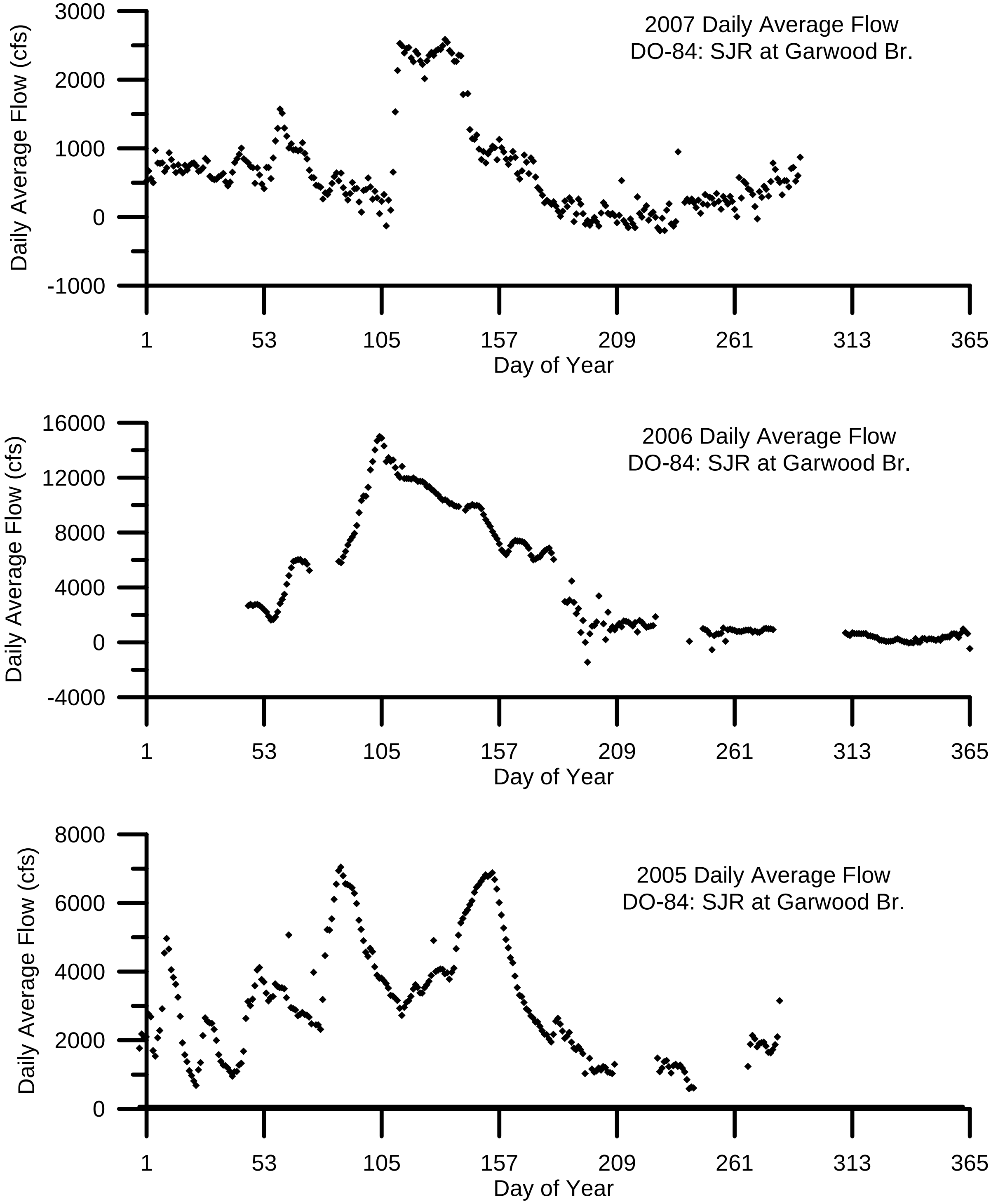


Figure 4: 2005 through 2007 flow plot for DO-84 SJR at Garwood Bridge (Hwy 4)

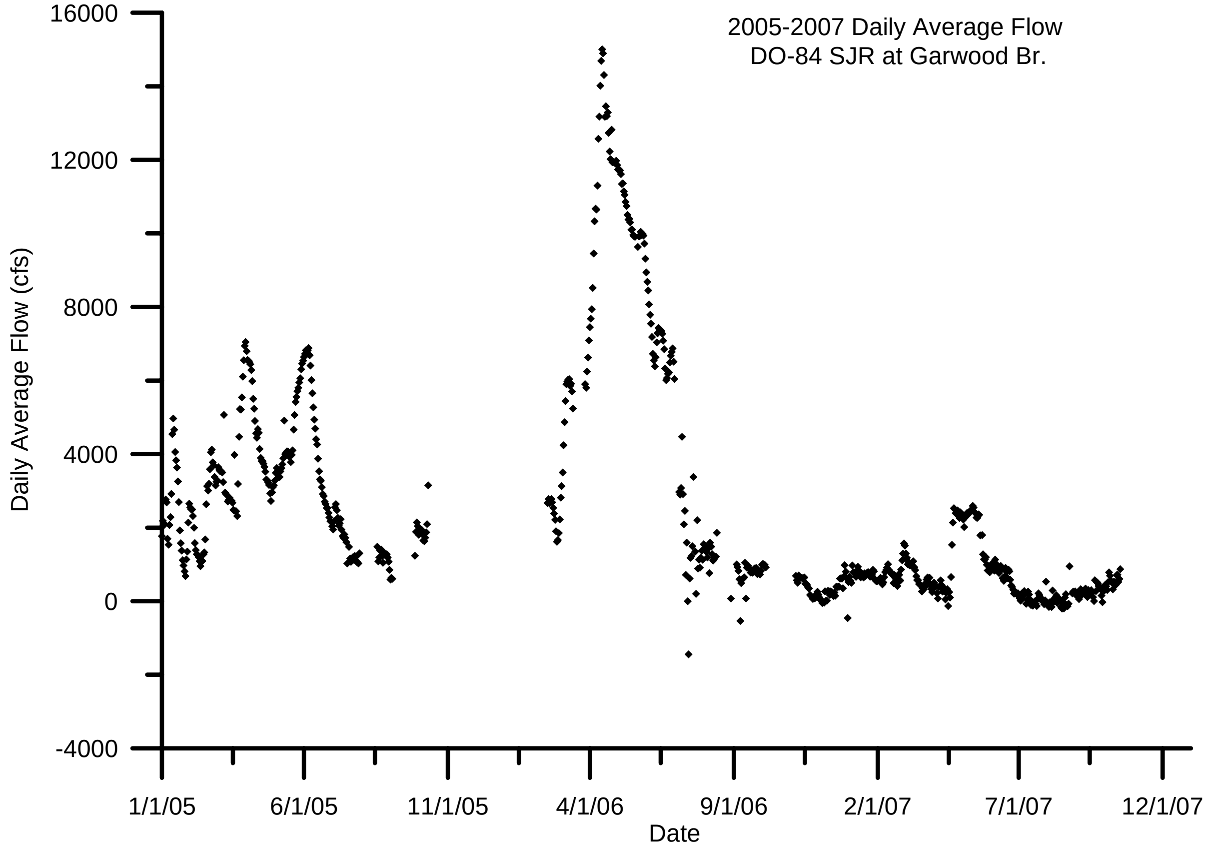


Figure 5: 2005 through 2007 flow plots for DO-03 SJR at Old River

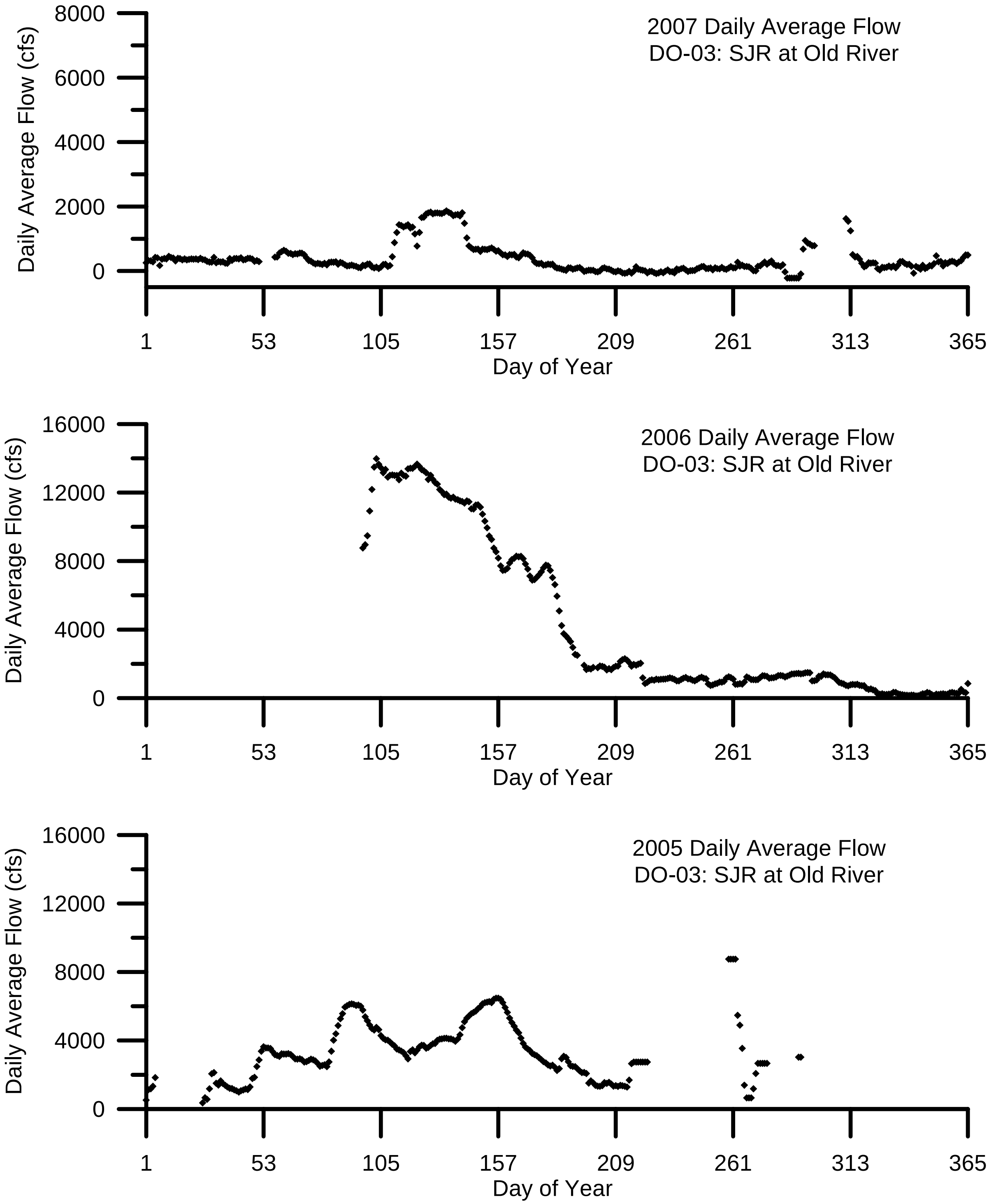


Figure 6: 2005 through 2007 flow plot for DO-03 SJR at Old River

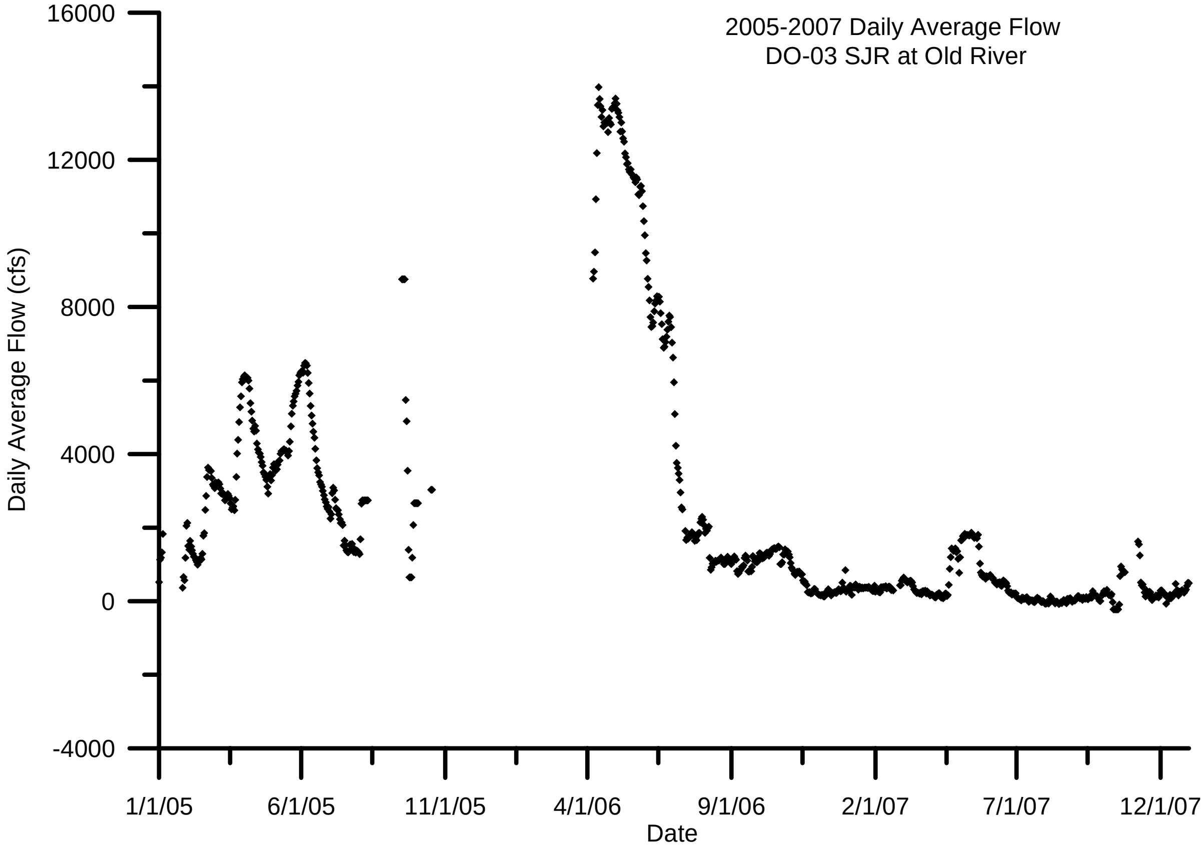
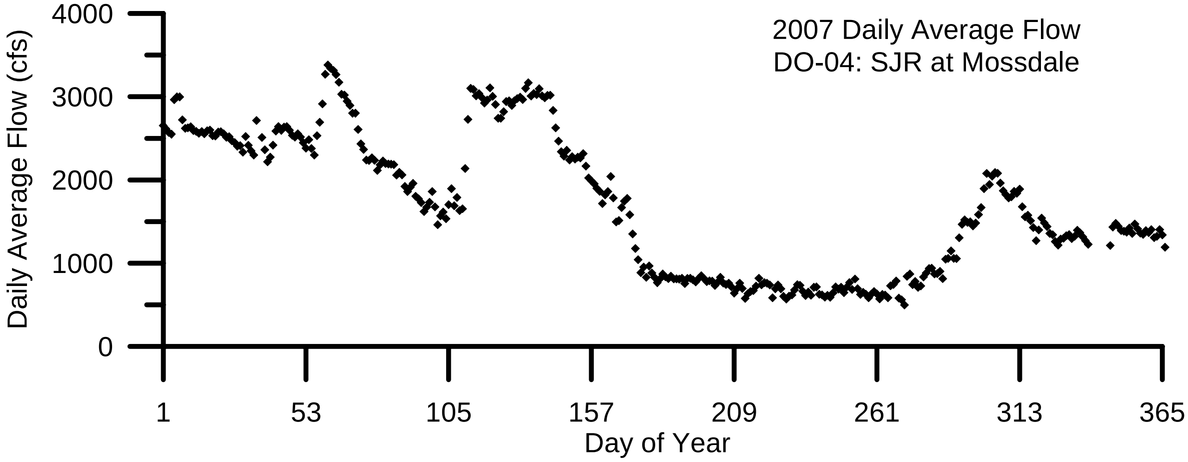
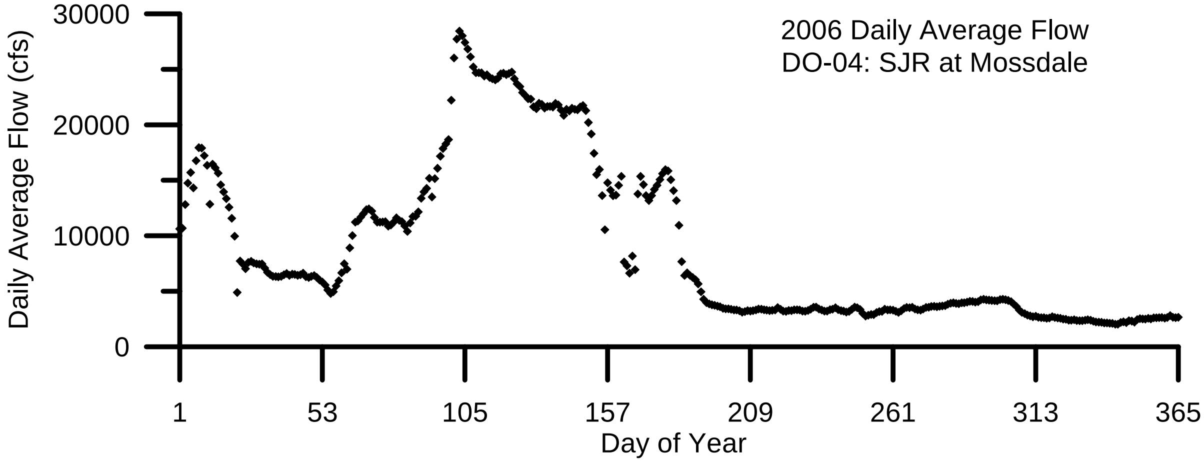


Figure 7: 2005 through 2007 flow plots for DO-04 SJR at Mossdale





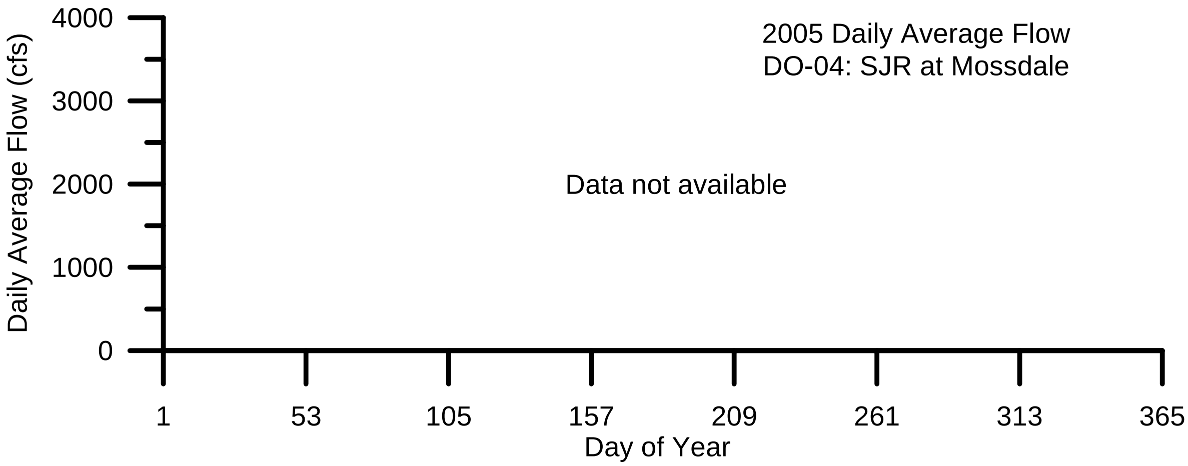


Figure 8: 2005 through 2007 flow plot for DO-04 SJR at Mossdale

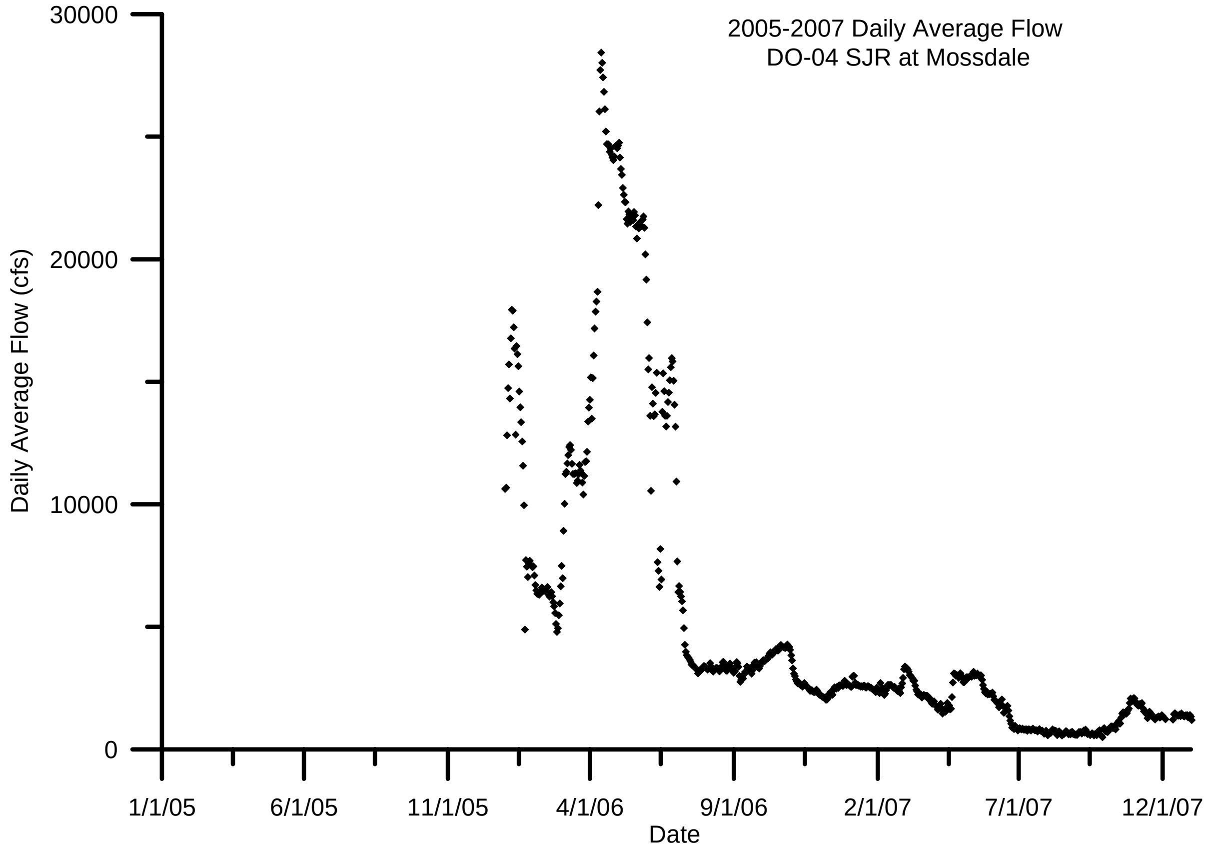
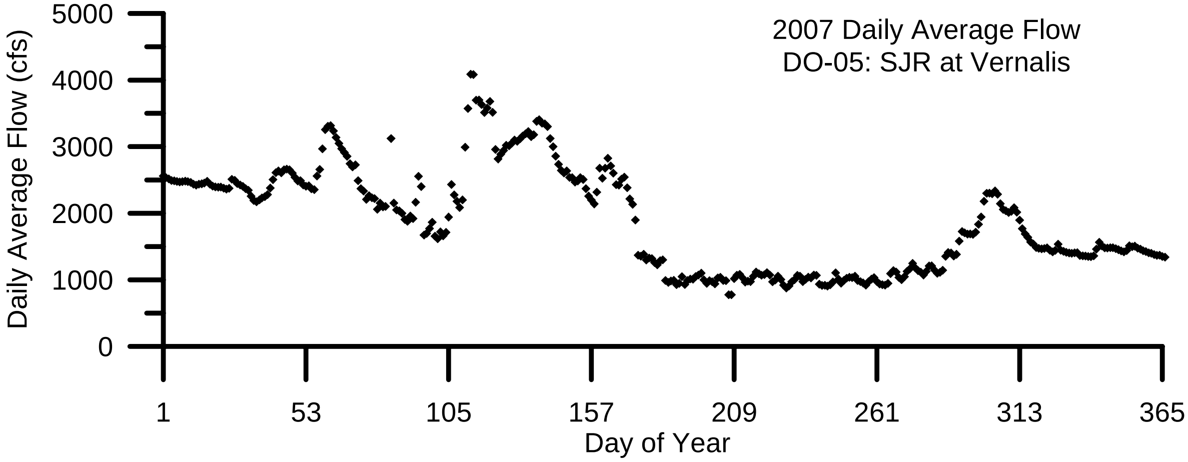
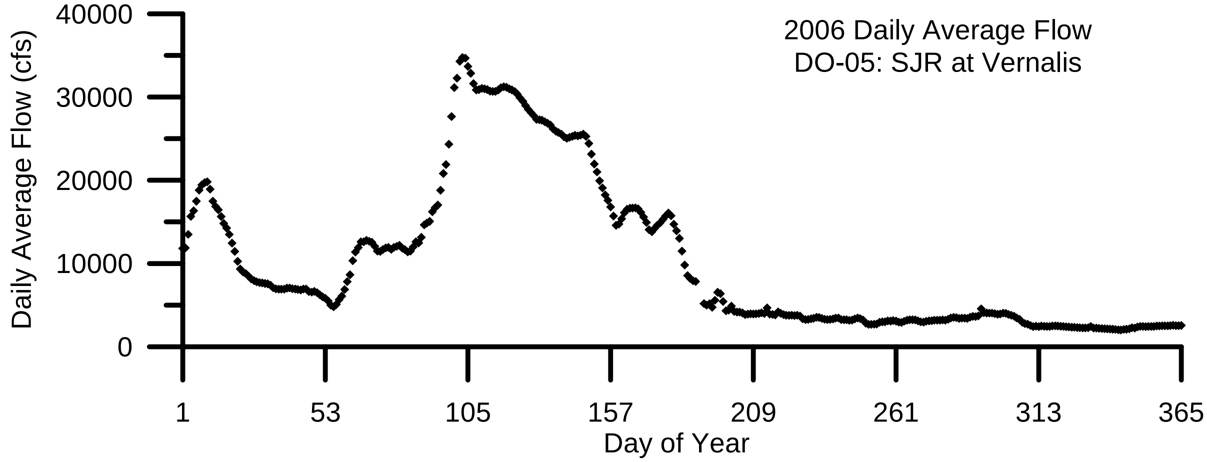


Figure 9: 2005 through 2007 flow plots for DO-05 SJR at Vernalis





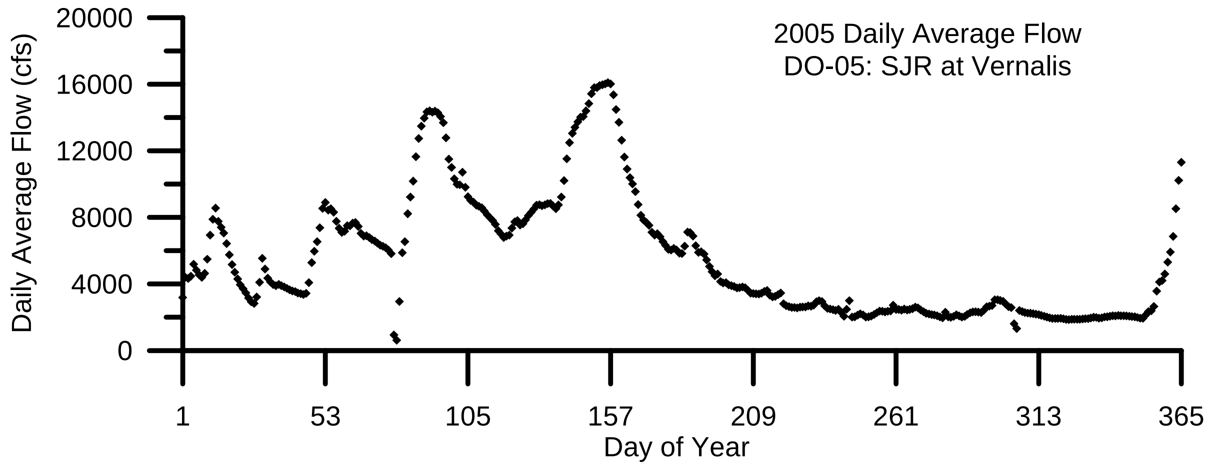


Figure 10: 2005 through 2007 flow plot for DO-05 SJR at Vernalis

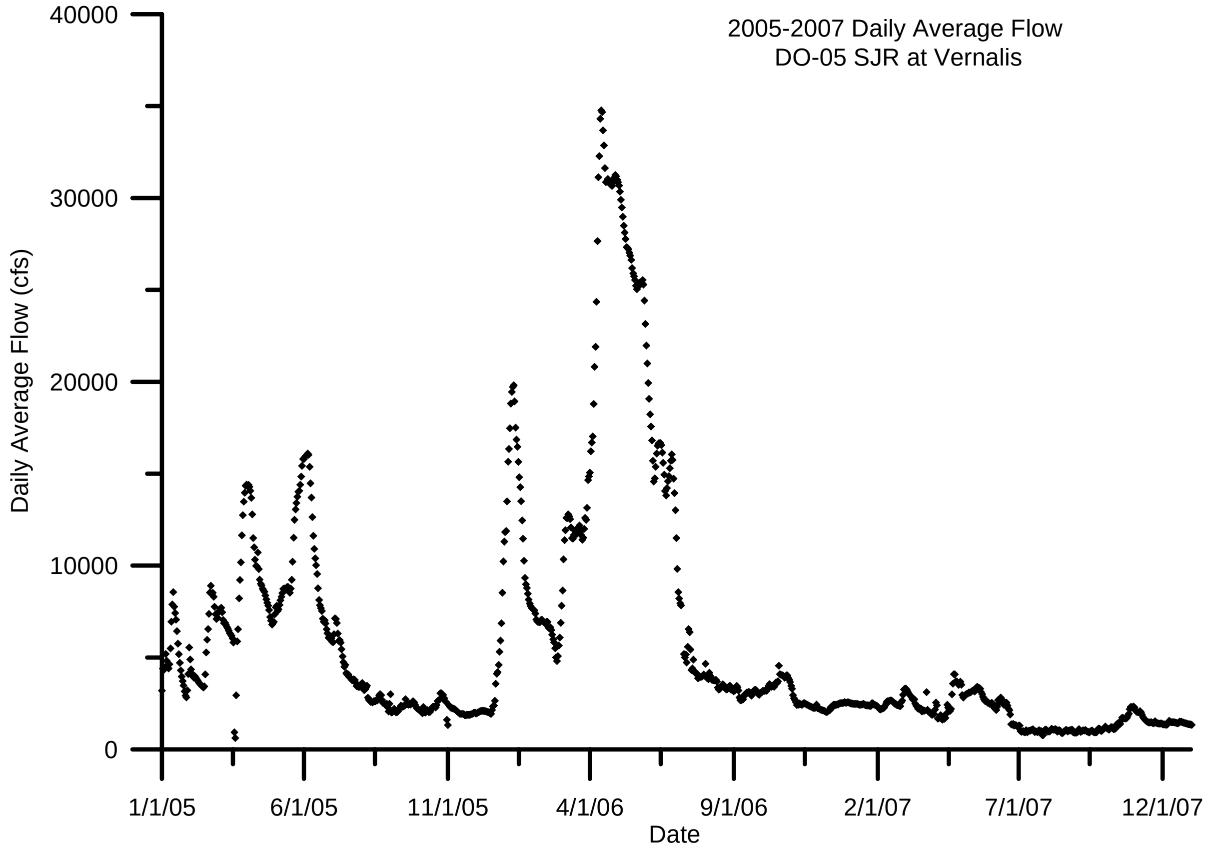
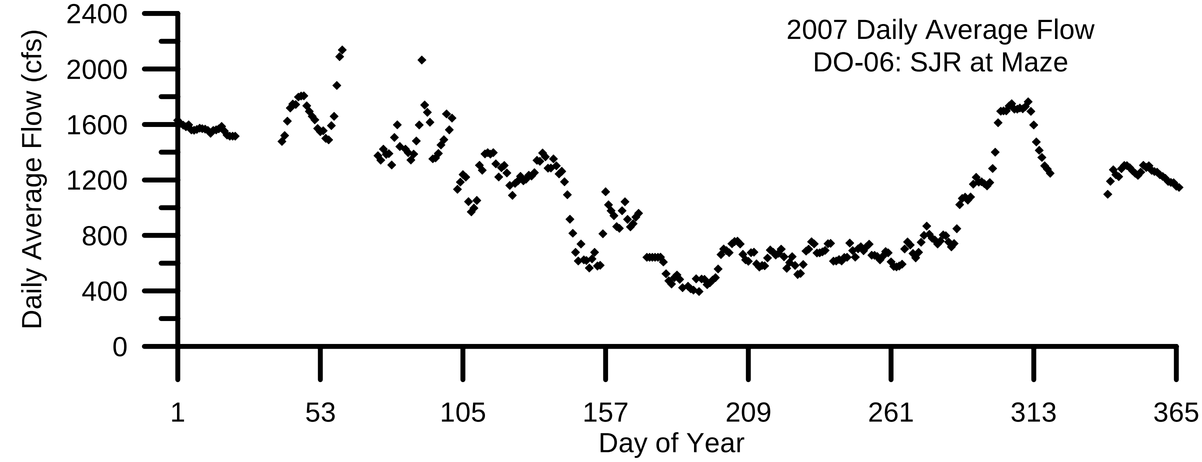
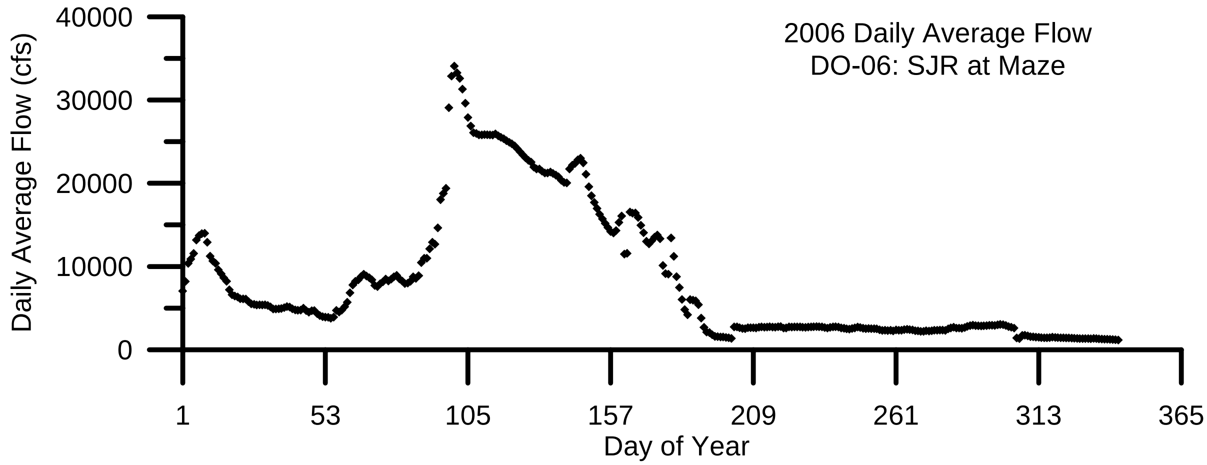


Figure 11: 2005 through 2007 flow plots for DO-06 SJR at Maze





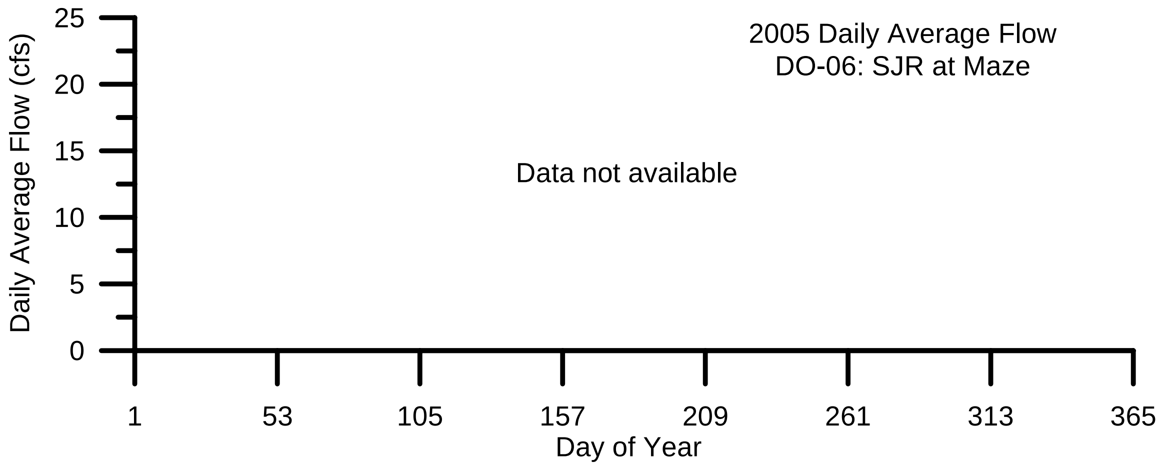


Figure 12: 2005 through 2007 flow plot for DO-06 SJR at Maze

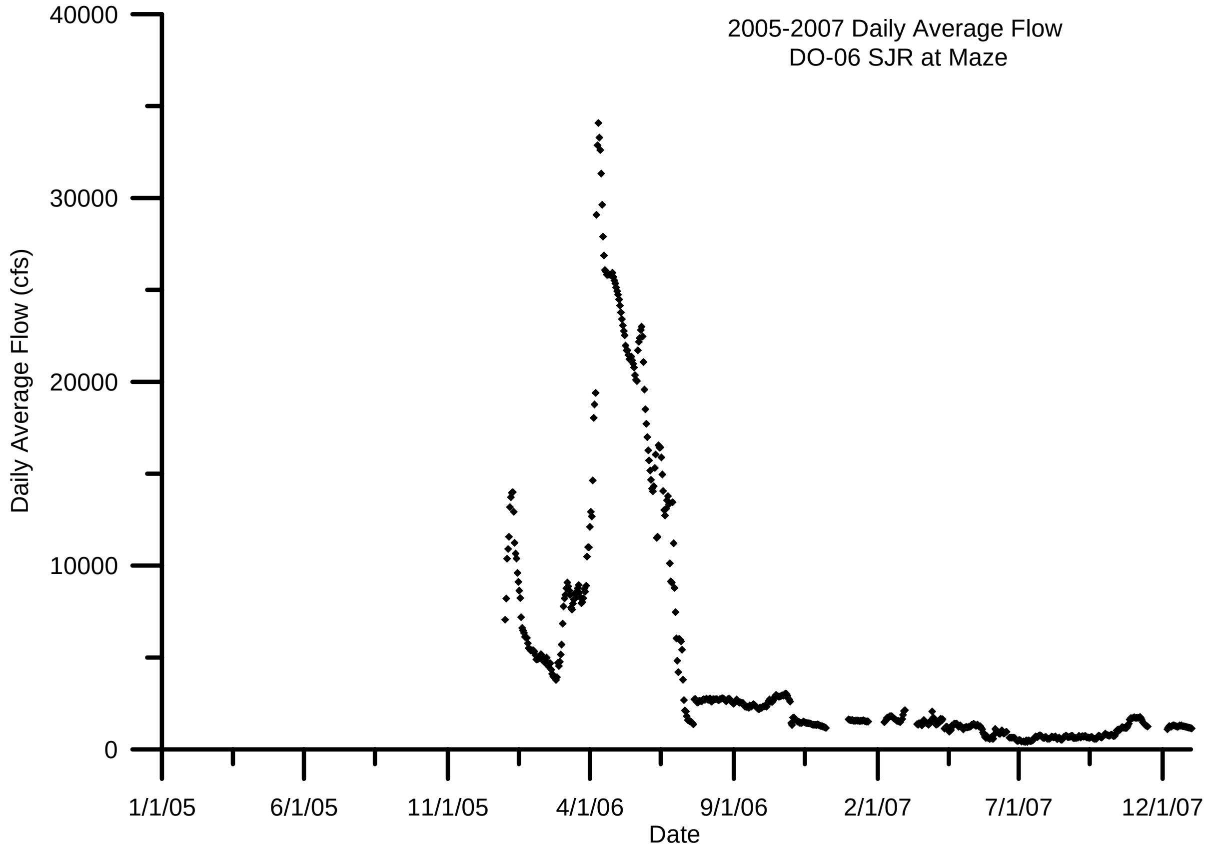
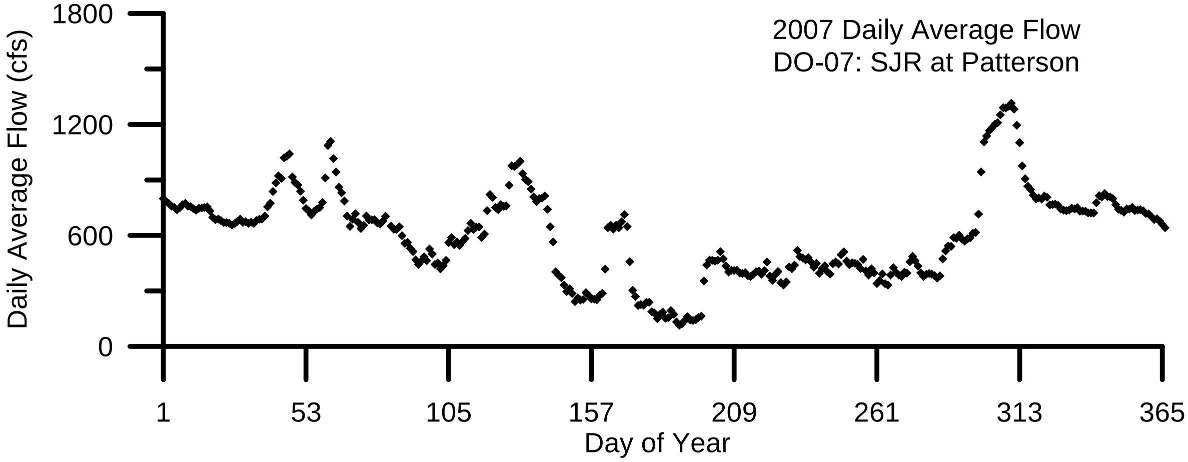
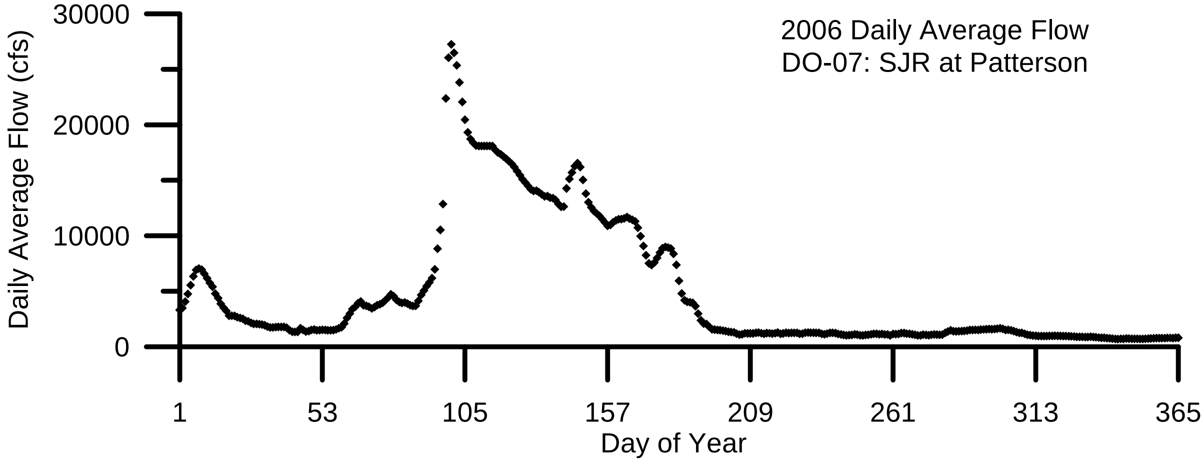


Figure 13: 2005 through 2007 flow plots for DO-07 SJR at Patterson





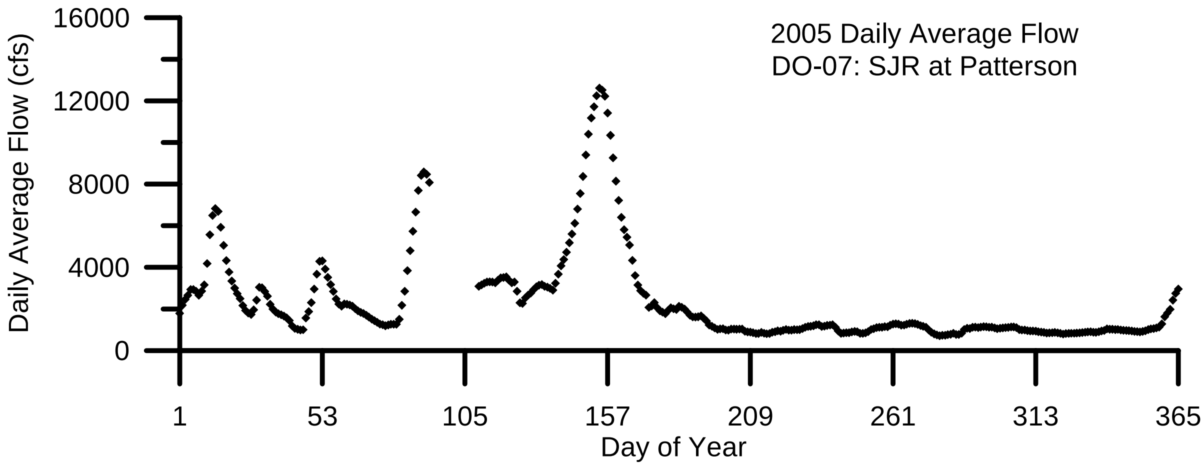


Figure 14: 2005 through 2007 flow plot for DO-07 SJR at Paterson

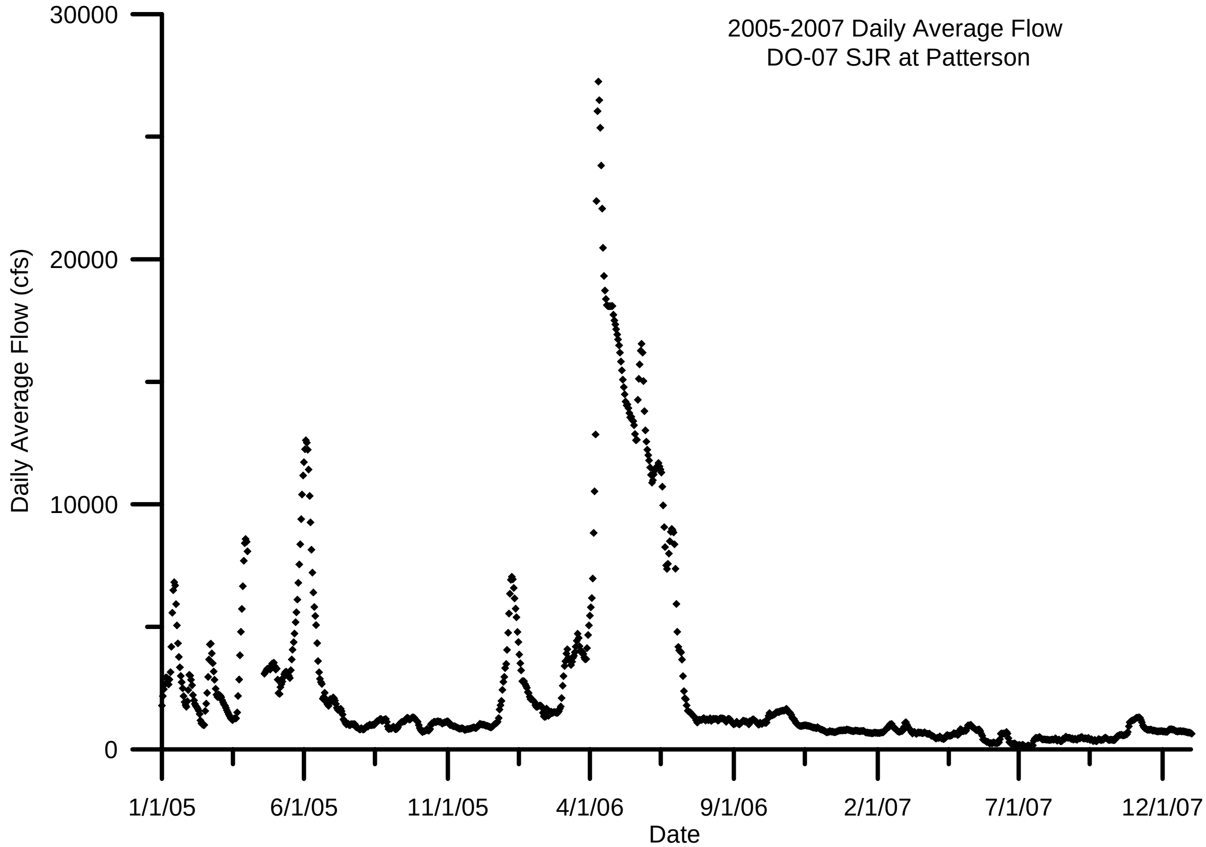


Figure 15: 2005 through 2007 flow plots for DO-08 SJR at Crows Landing

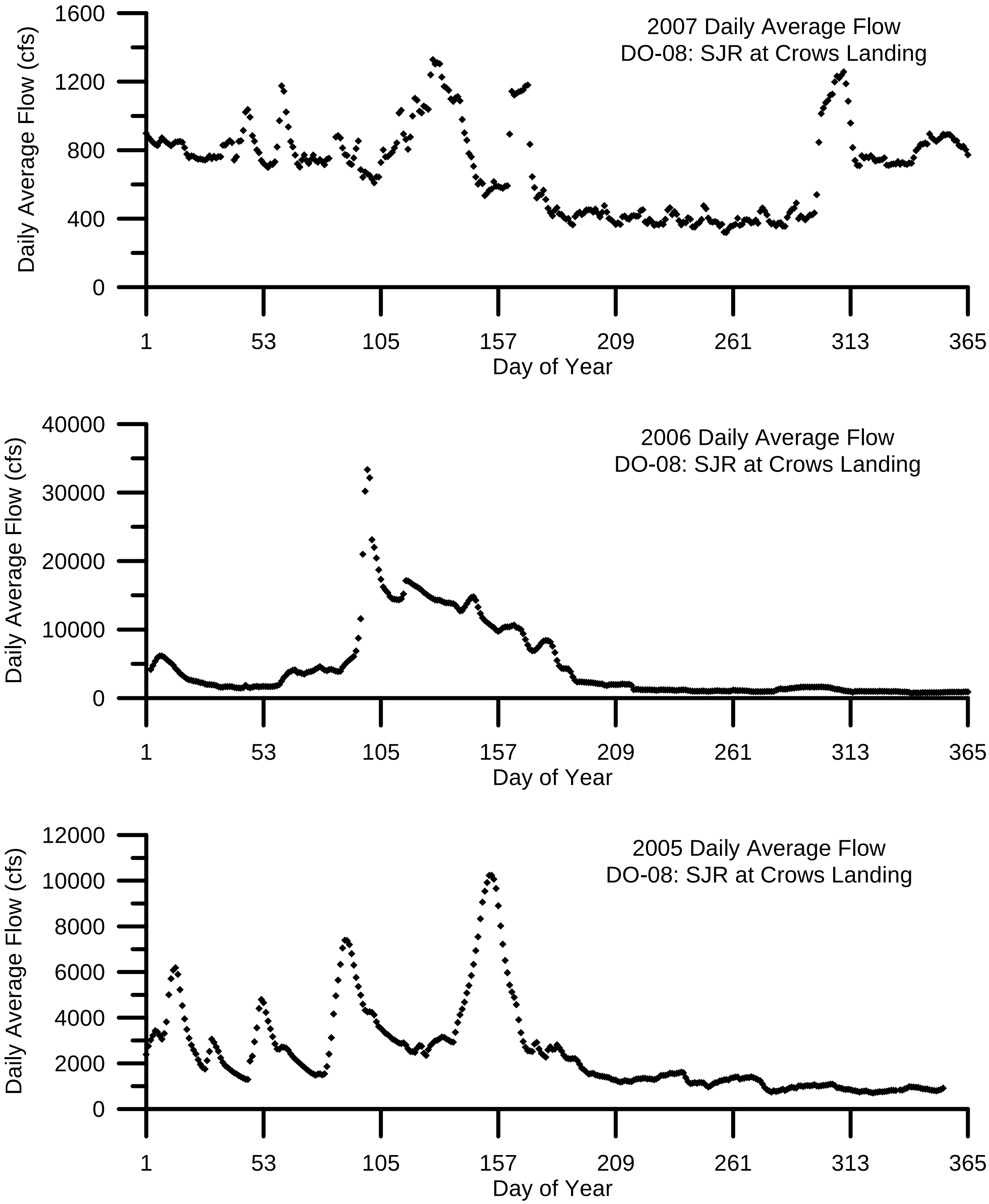


Figure 16: 2005 through 2007 flow plot for DO-08 SJR at Crows Landing

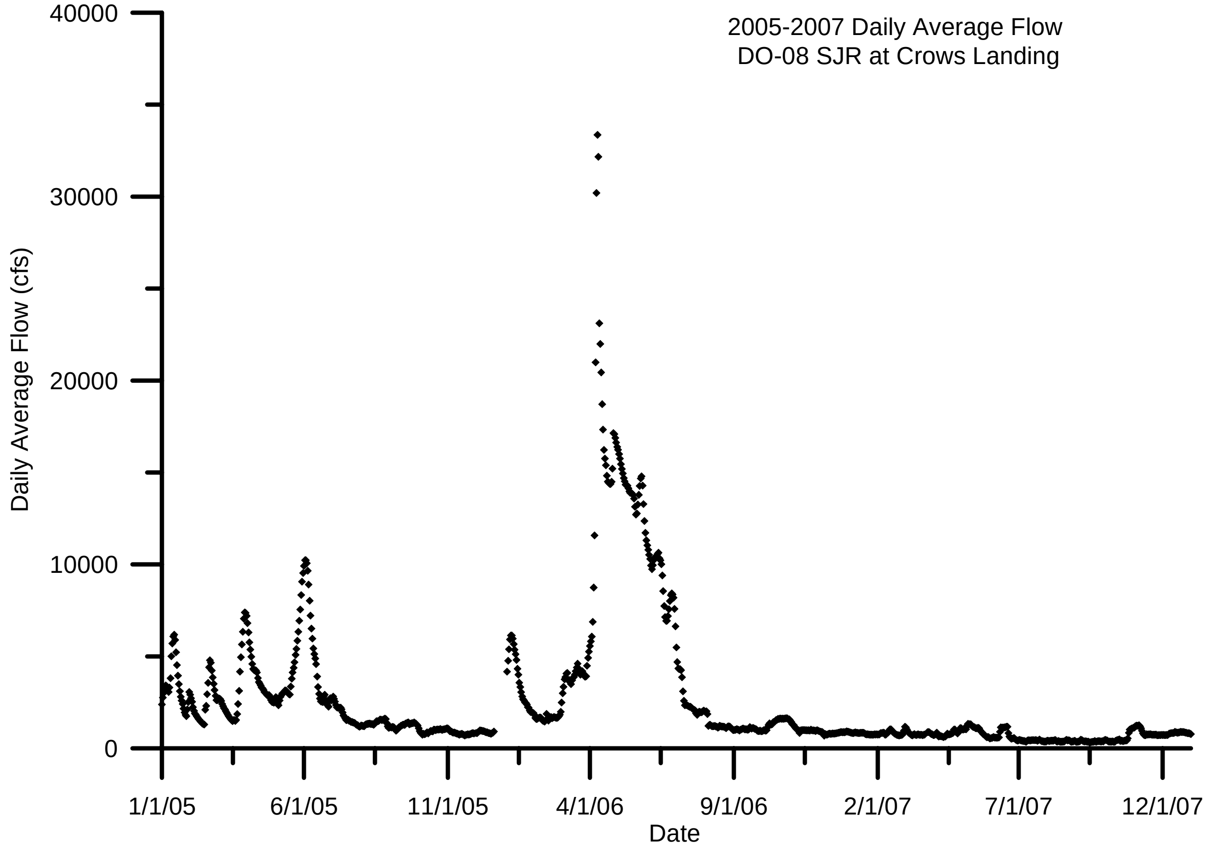


Figure 17: 2005 through 2007 flow plots for DO-09 SJR at Fremont Ford

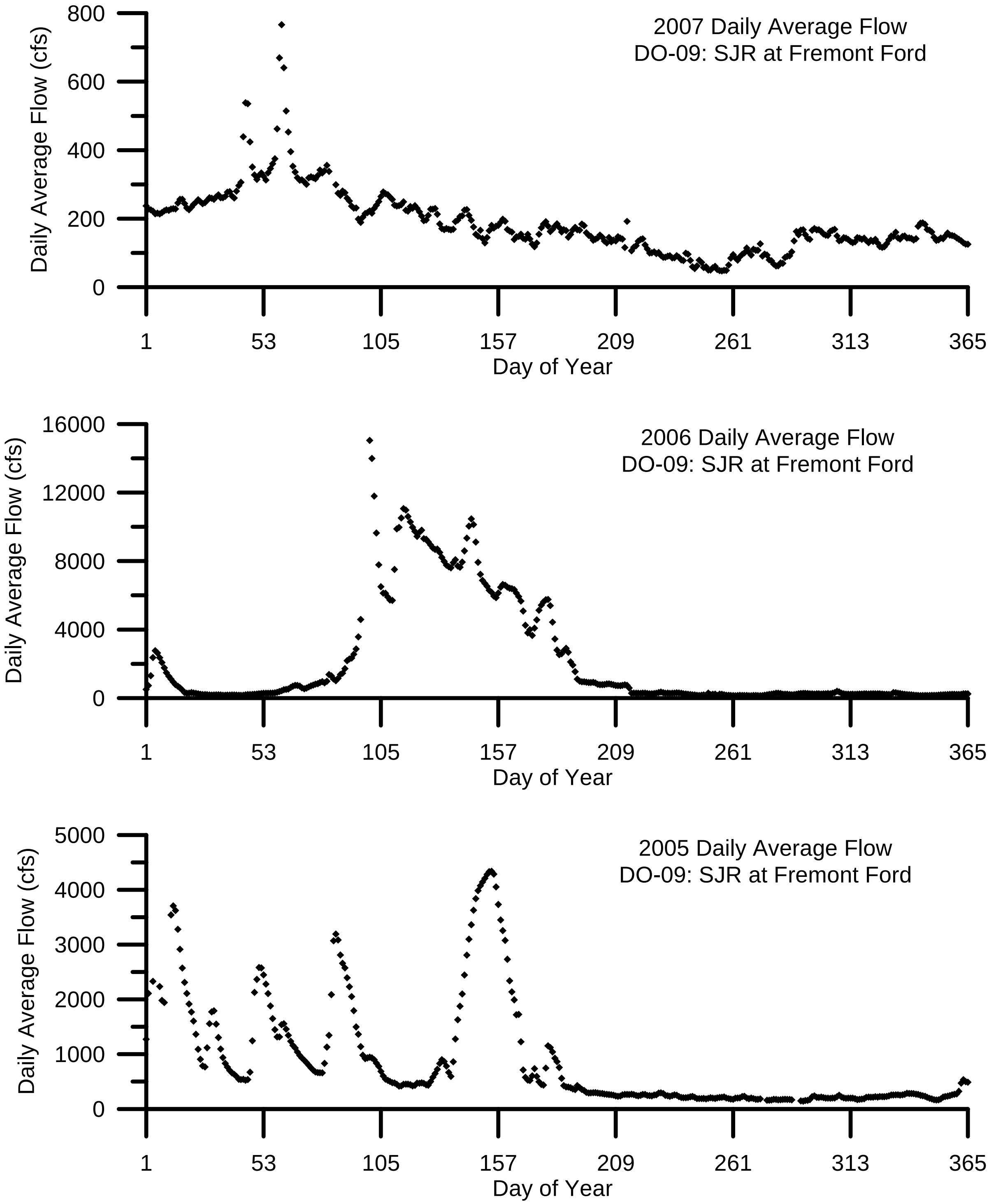


Figure 18: 2005 through 2007 flow plot for DO-09 SJR at Fremont Ford

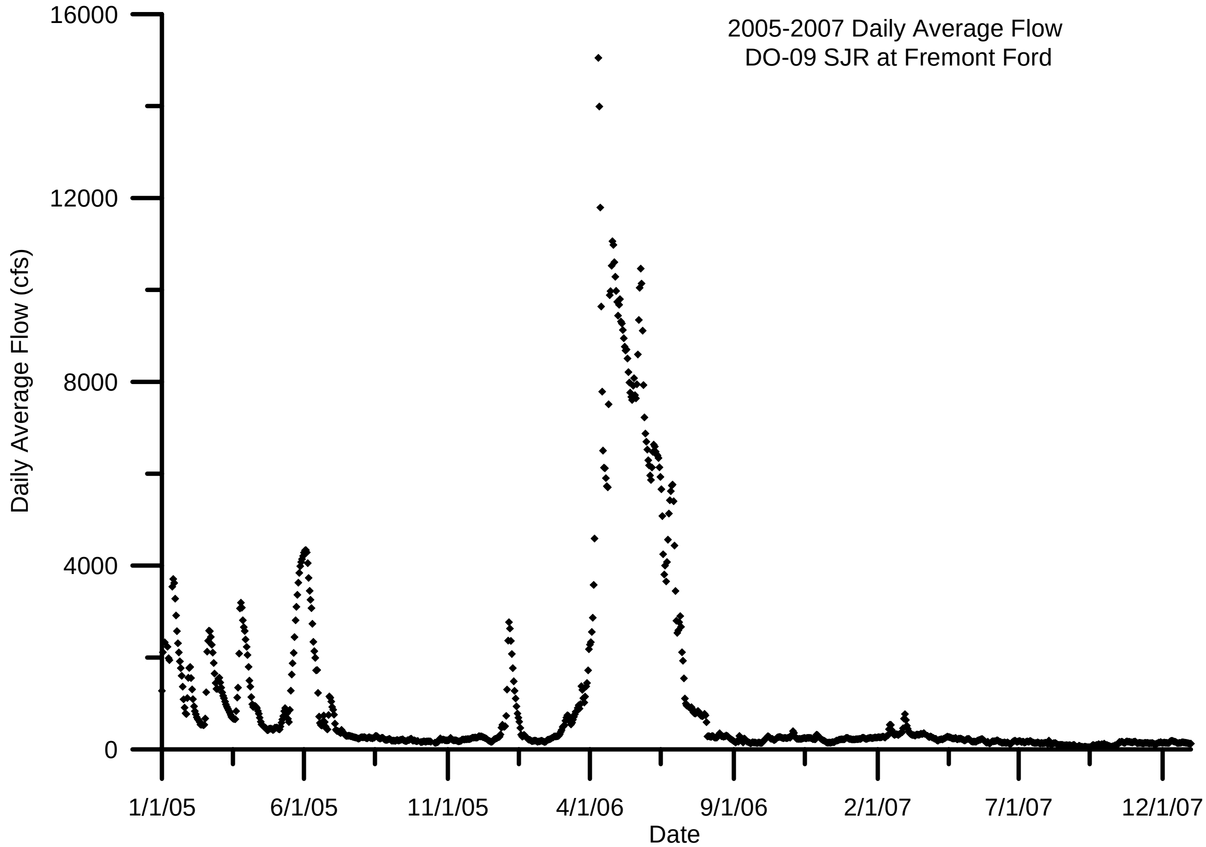


Figure 19: 2005 through 2007 flow plots for DO-10 SJR at Lander Avenue

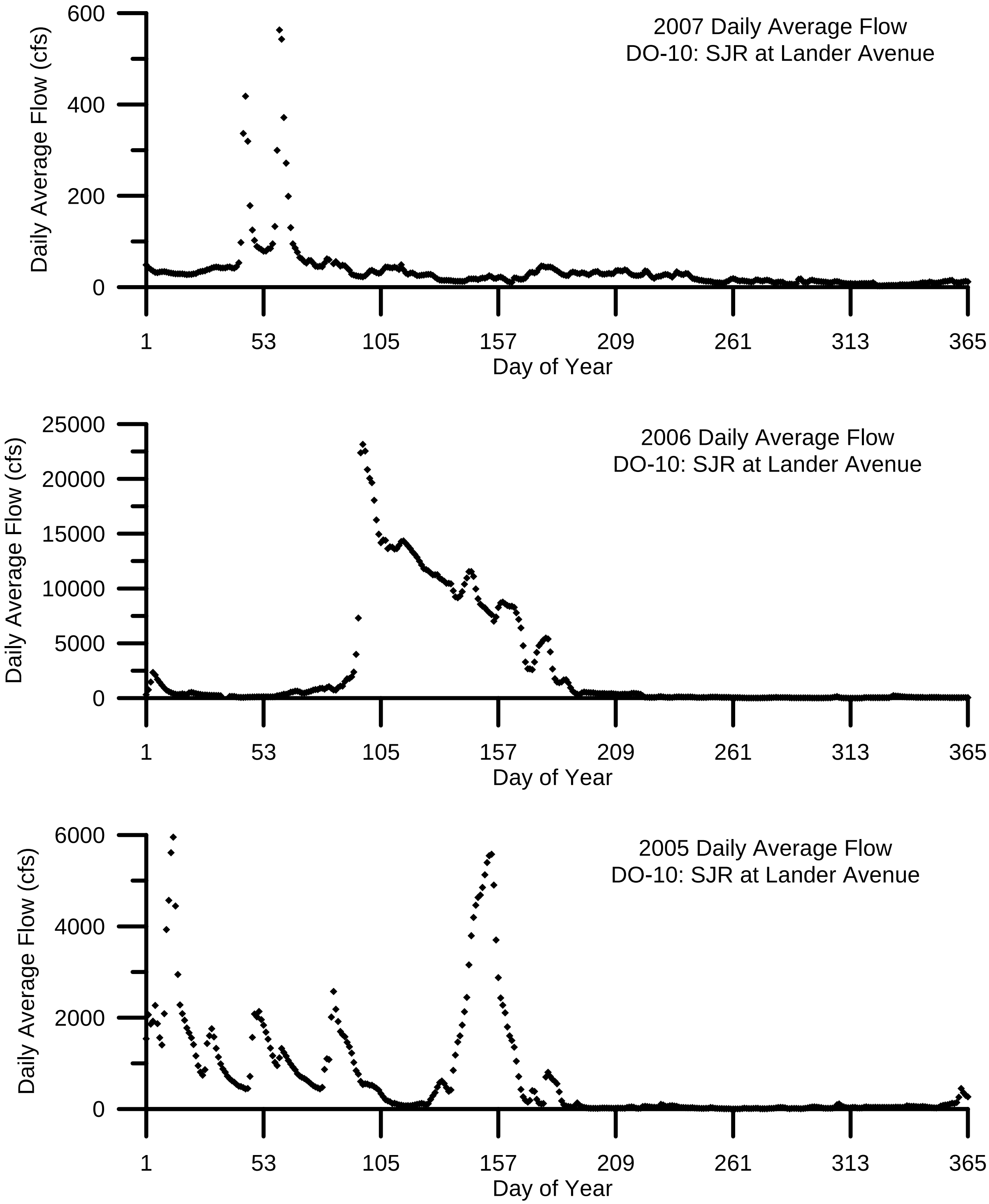


Figure 20: 2005 through 2007 flow plot for DO-10 SJR at Lander Avenue

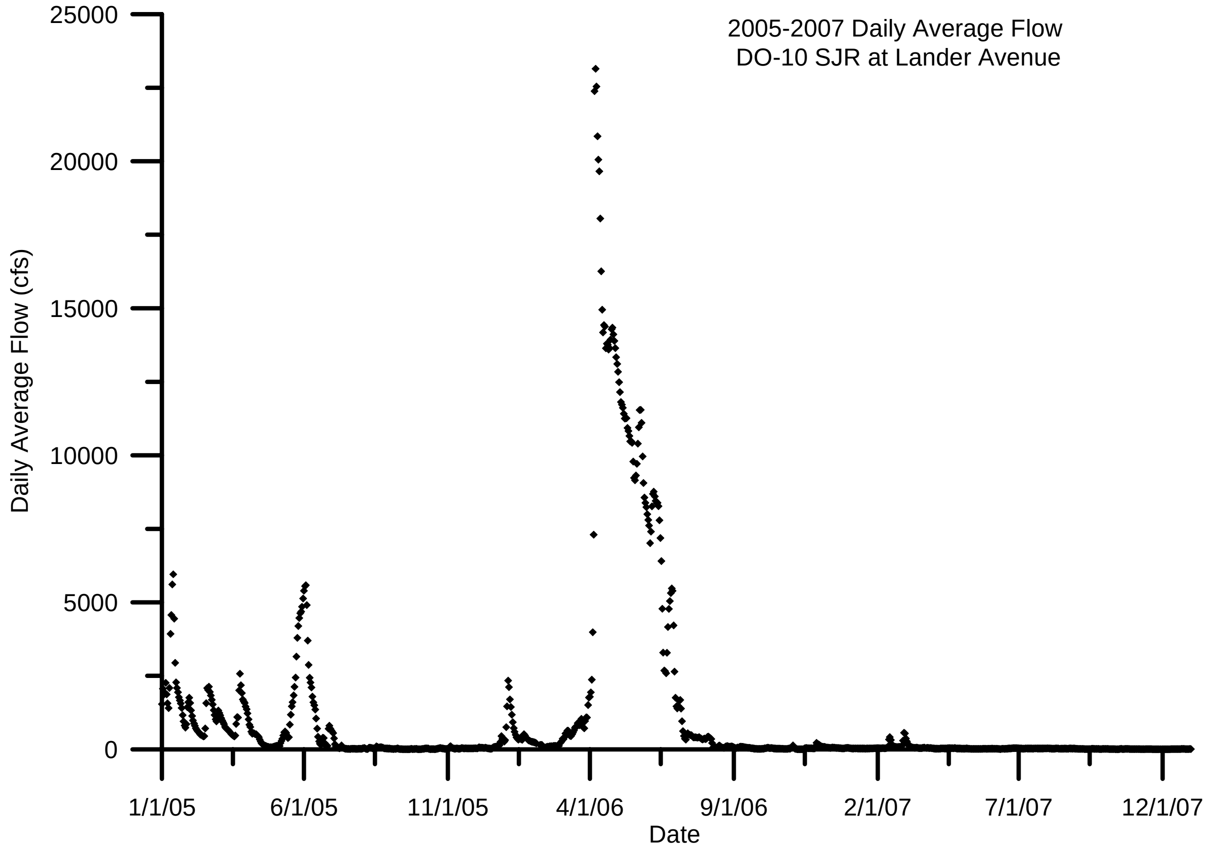


Figure 21: 2005 through 2007 flow plots for DO-13 Stanislaus River at Ripon

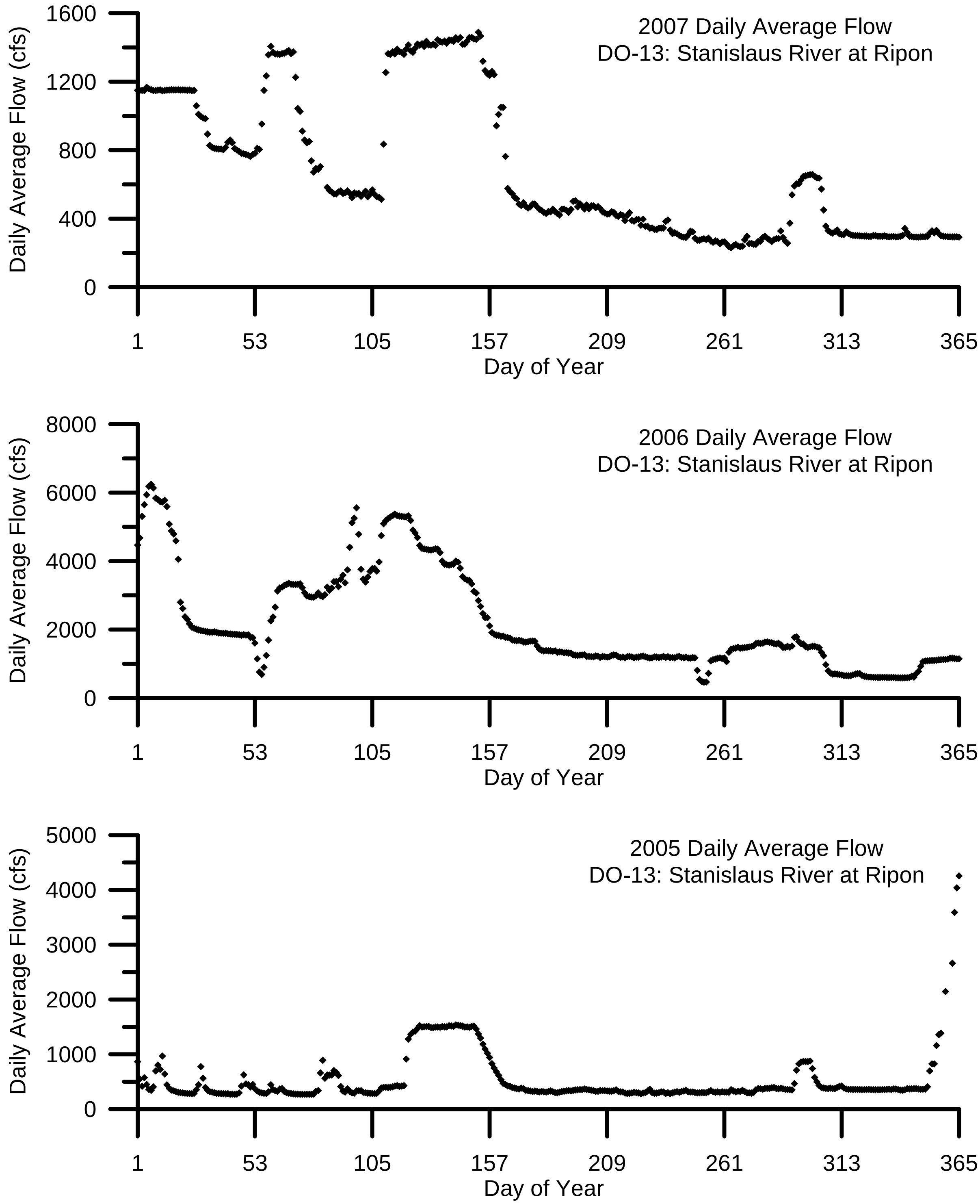


Figure 22: 2005 through 2007 flow plot for DO-13 Stanislaus River at Ripon

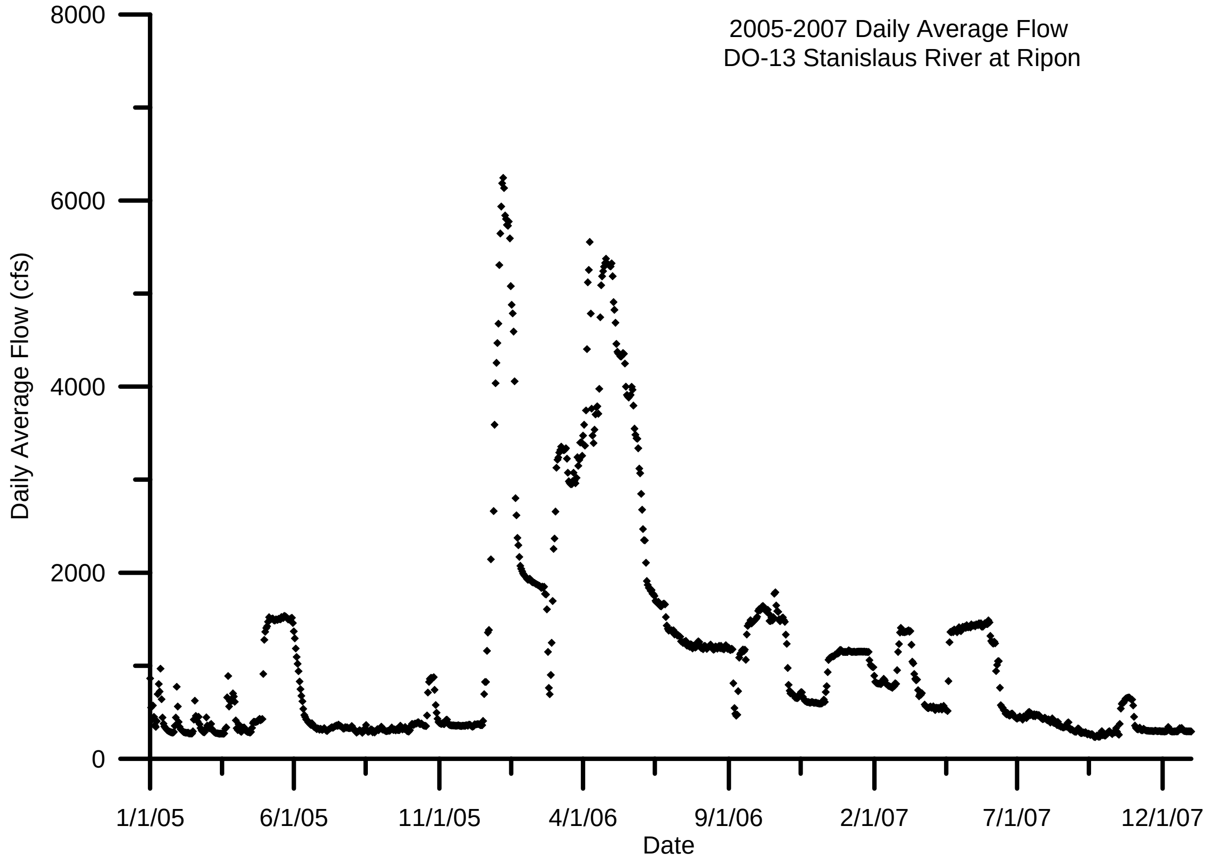
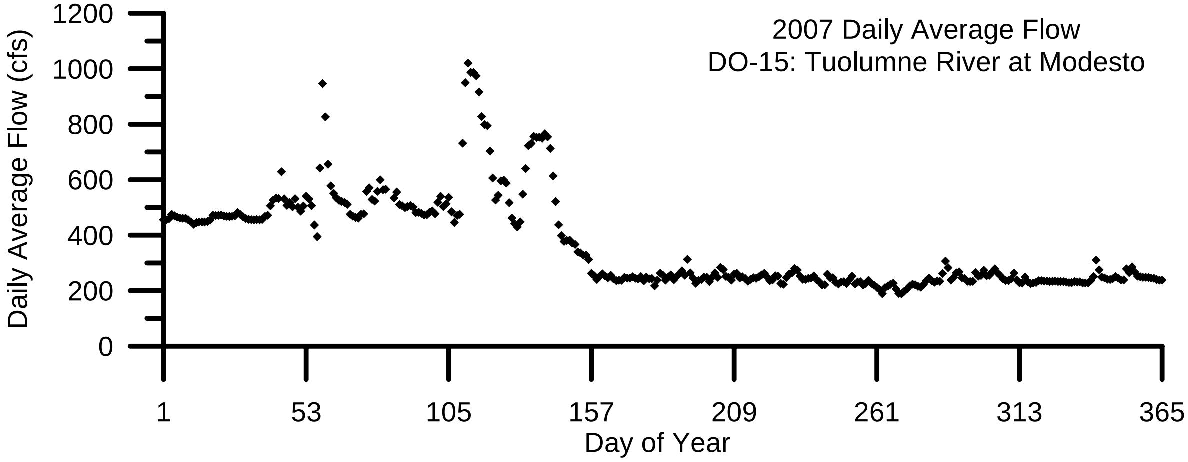
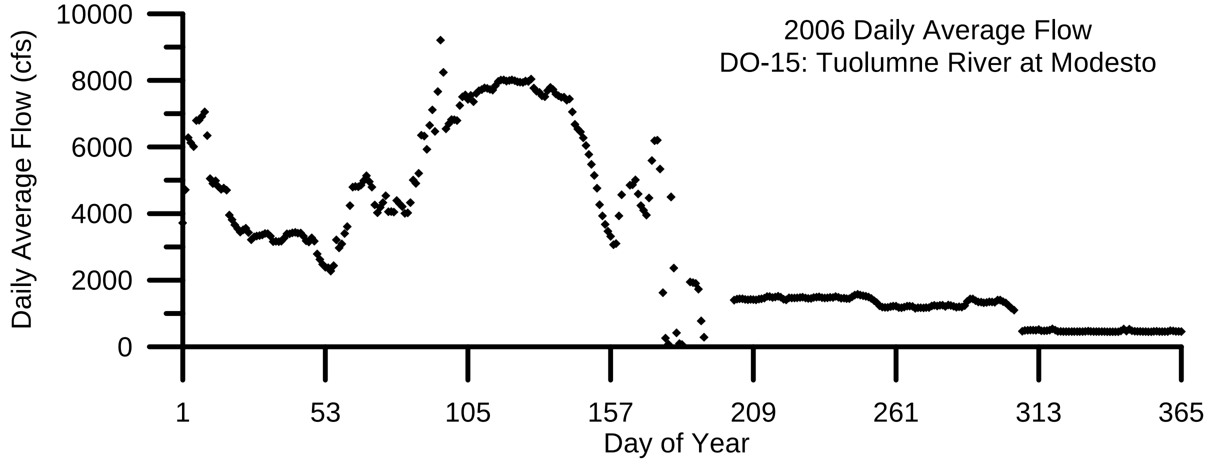


Figure 23: 2005 through 2007 flow plots for DO-15 Tuolumne River at Modesto





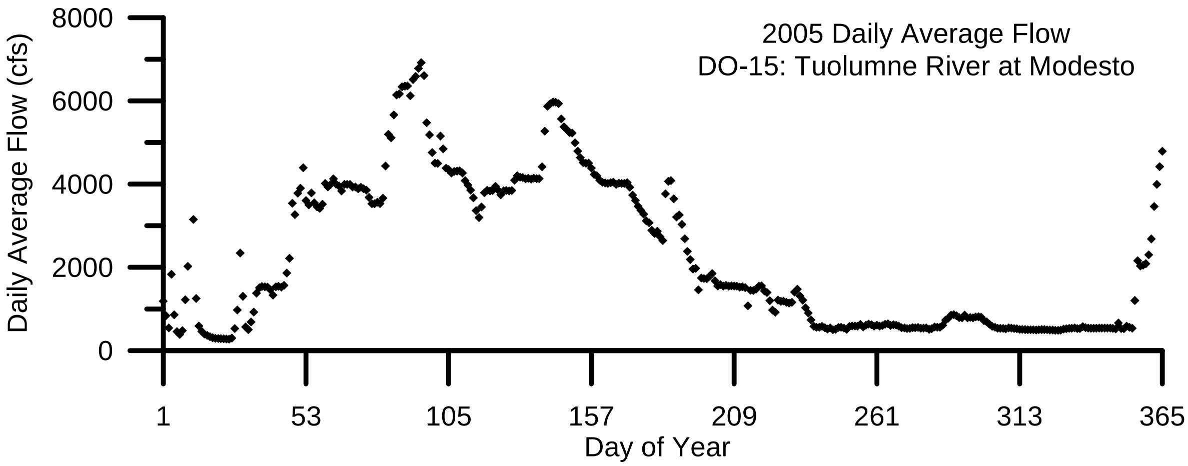


Figure 24: 2005 through 2007 flow plot for DO-15 Tuolumne River at Modesto

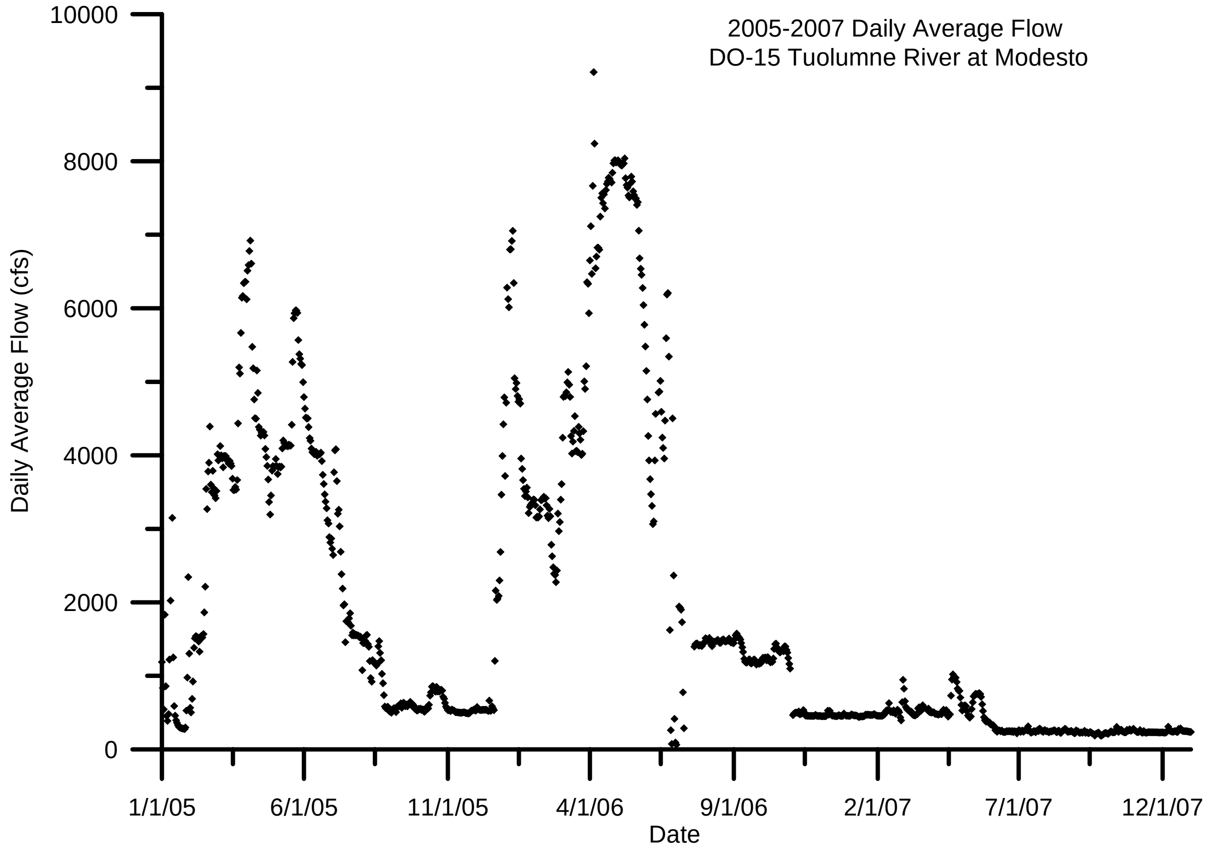
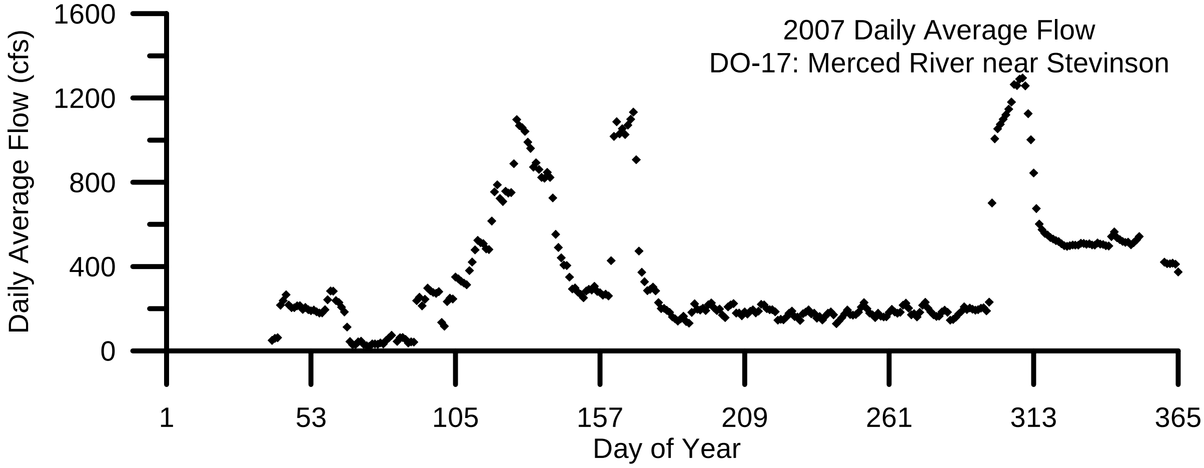
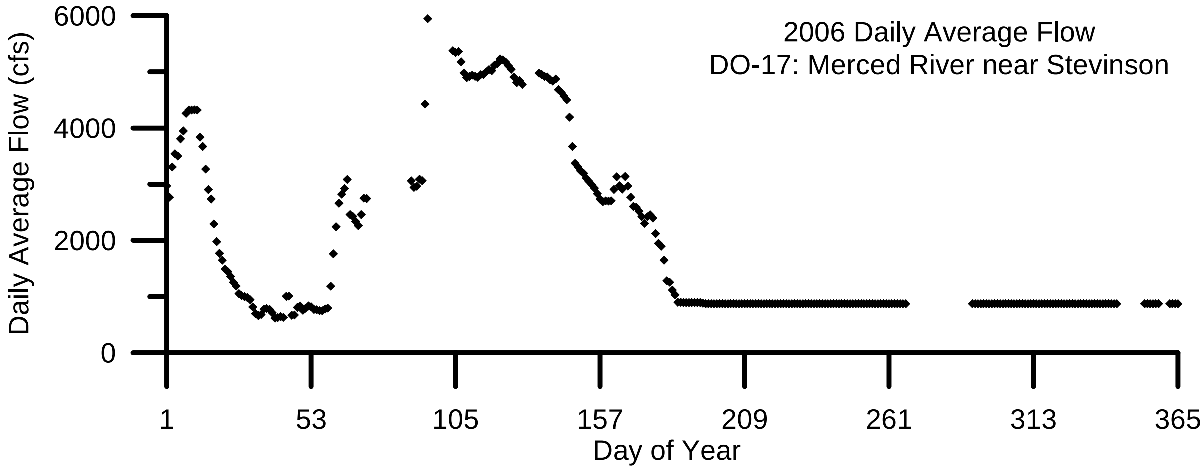


Figure 25: 2005 through 2007 flow plots for DO-17 Merced River near Stevinson





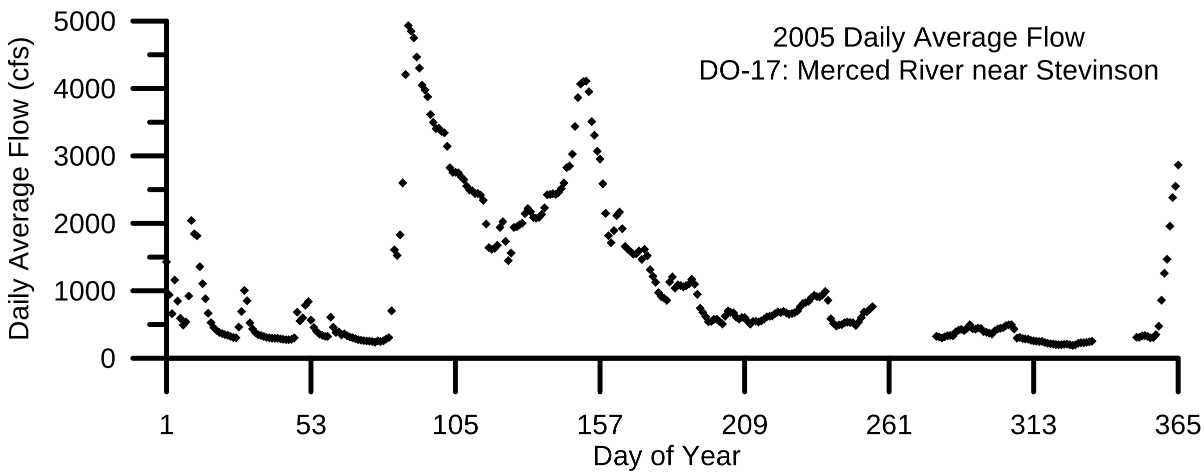


Figure 26: 2005 through 2007 flow plot for DO-17 Merced River near Stevinson

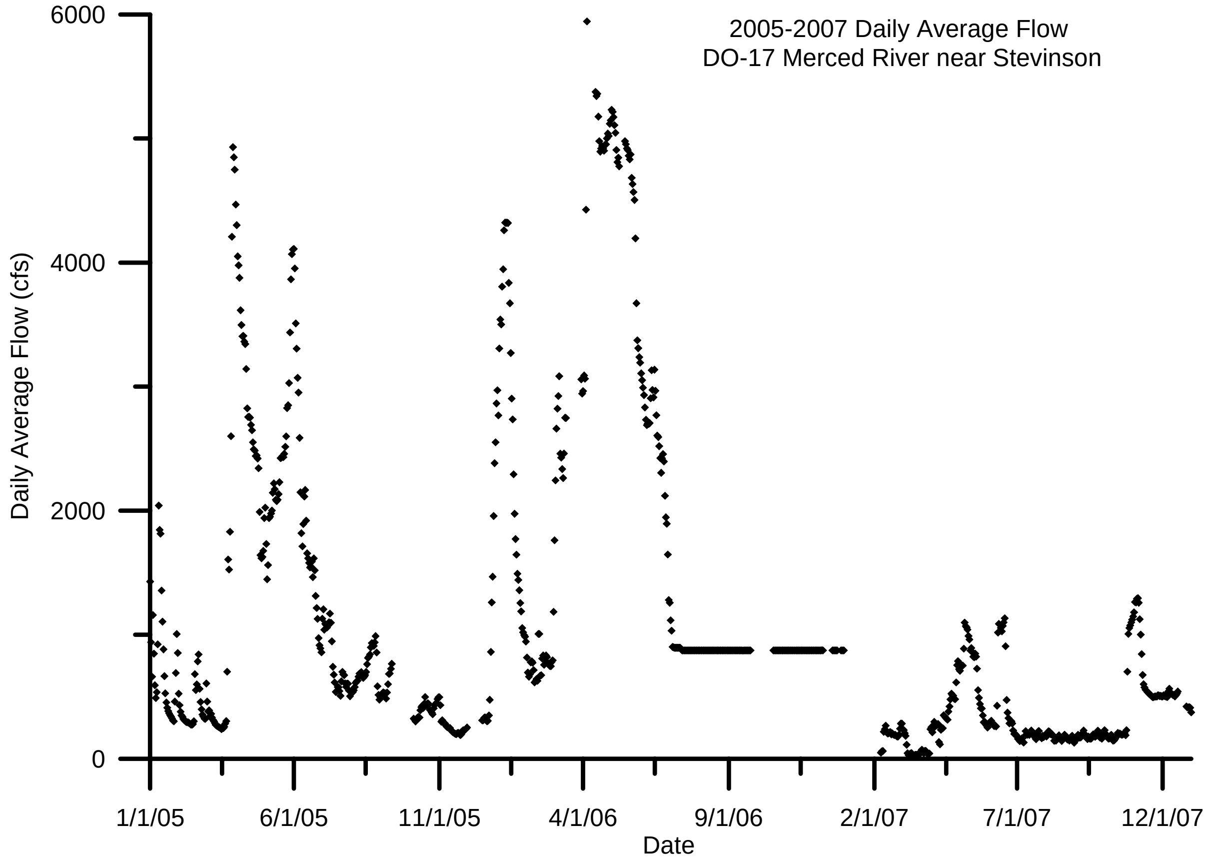


Figure 27: 2005 through 2007 flow plots for DO-18 Mud Slough near Gustine

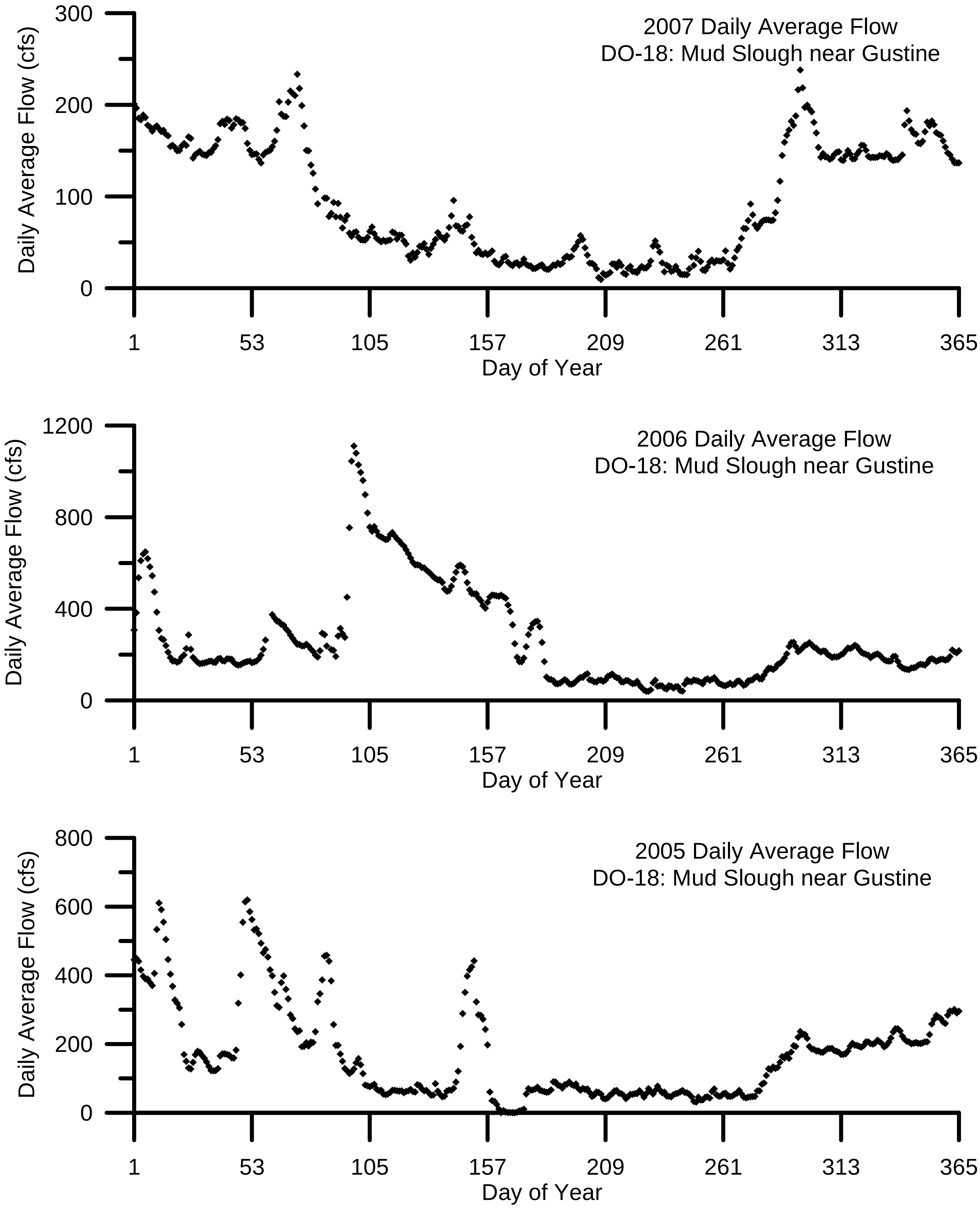


Figure 28: 2005 through 2007 flow plot for DO-18 Mud Slough near Gustine

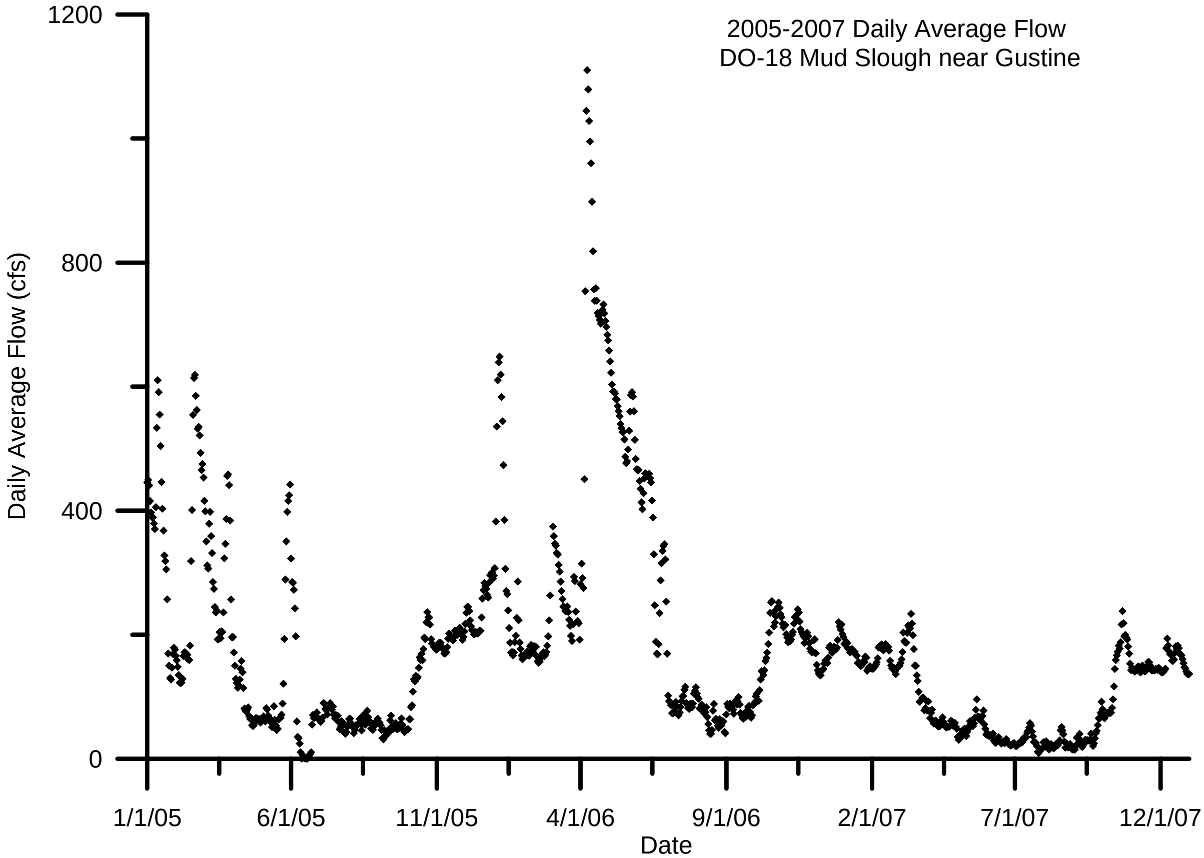


Figure 29: 2005 through 2007 flow plots for DO-19 Salt Slough at Lander Avenue

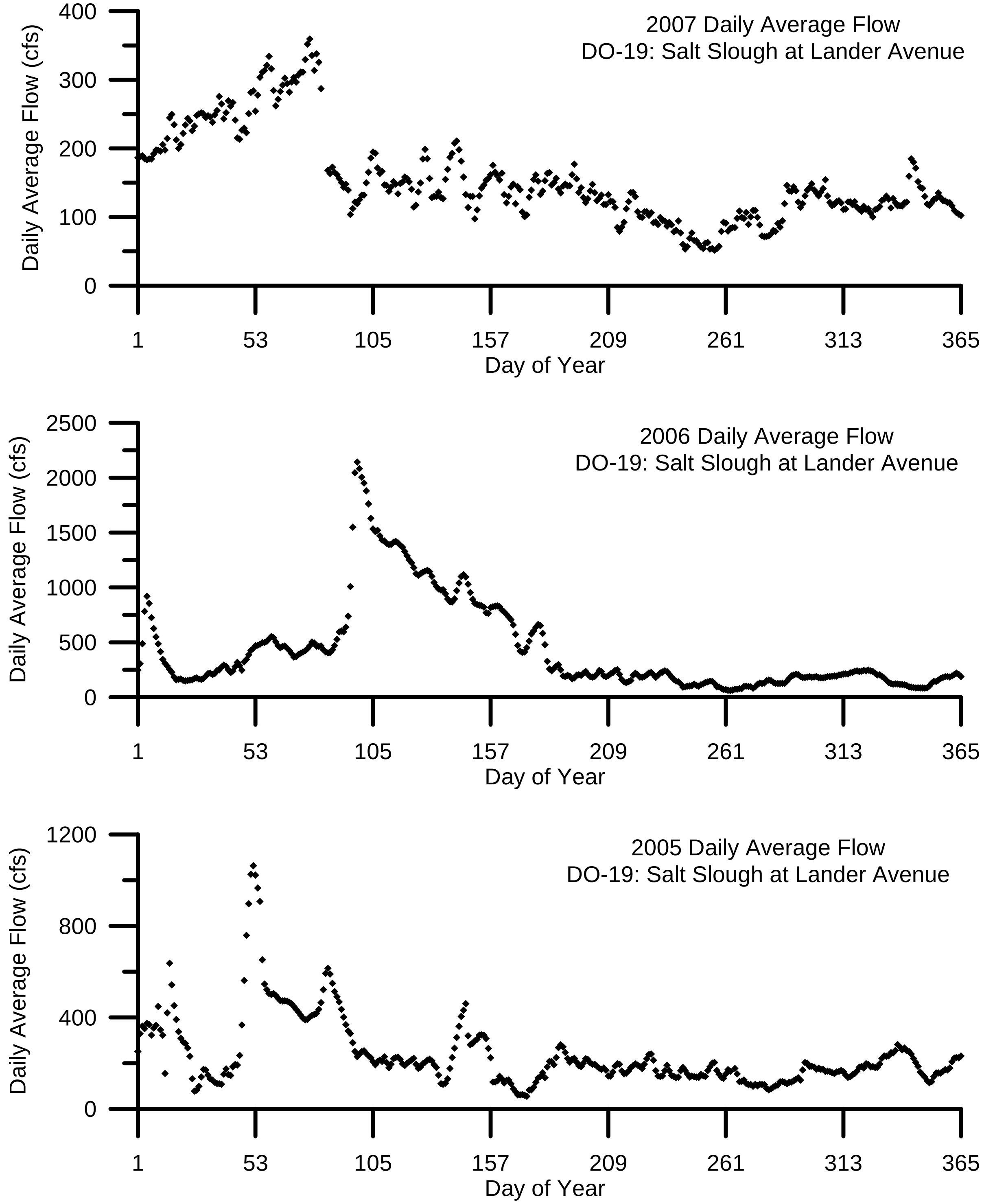


Figure 30: 2005 through 2007 flow plot for DO-19 Salt Slough at Lander Avenue

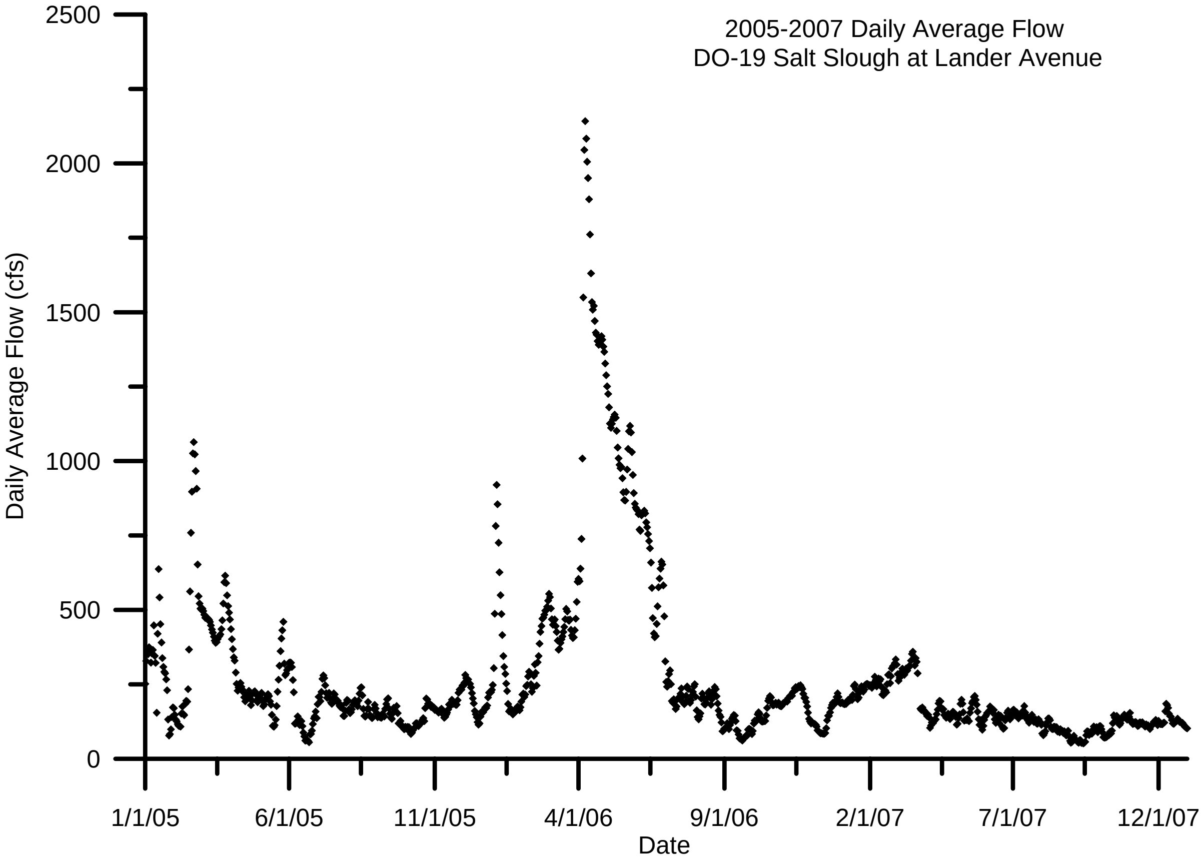


Figure 31: 2005 through 2007 flow plots for DO-20 Los Banos Creek

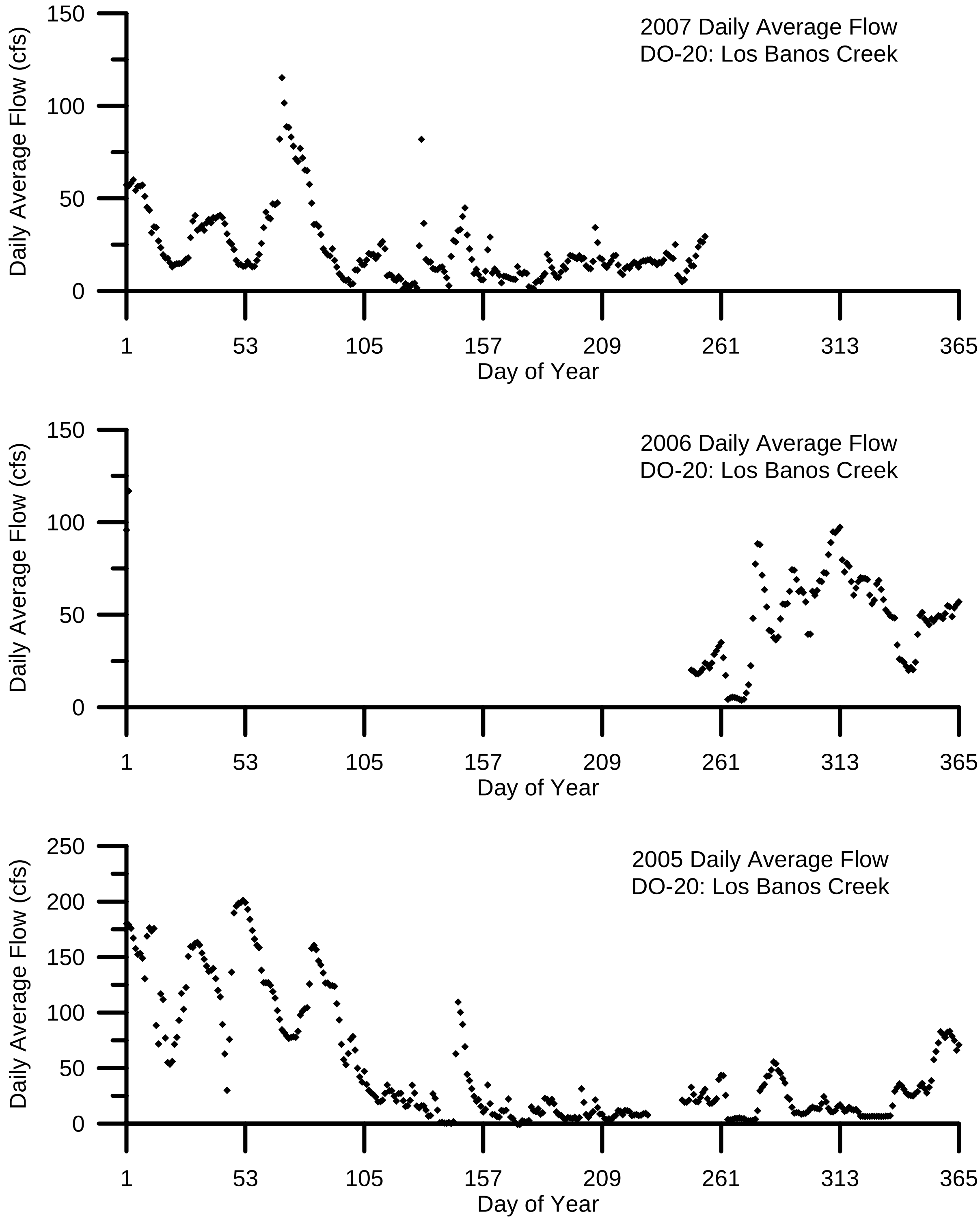


Figure 32: 2005 through 2007 flow plot for DO-20 Los Banos Creek

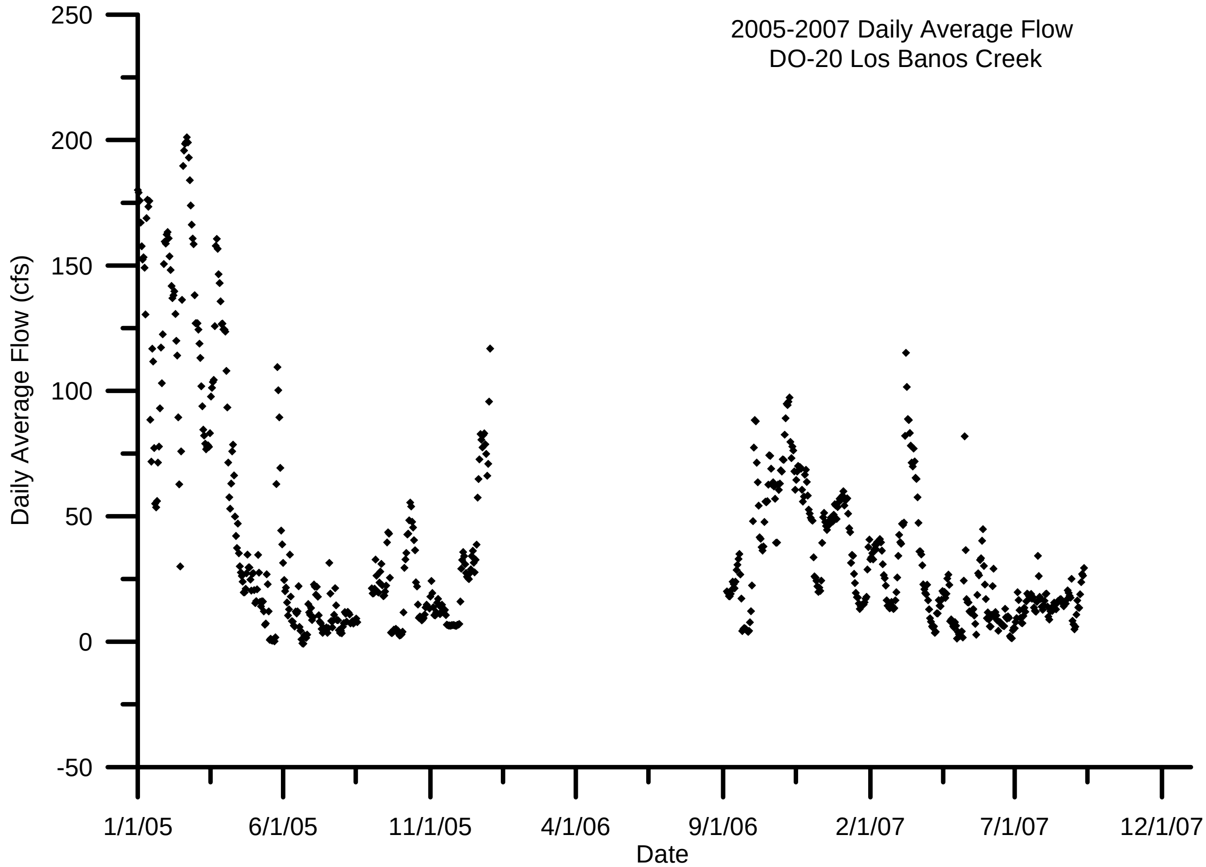
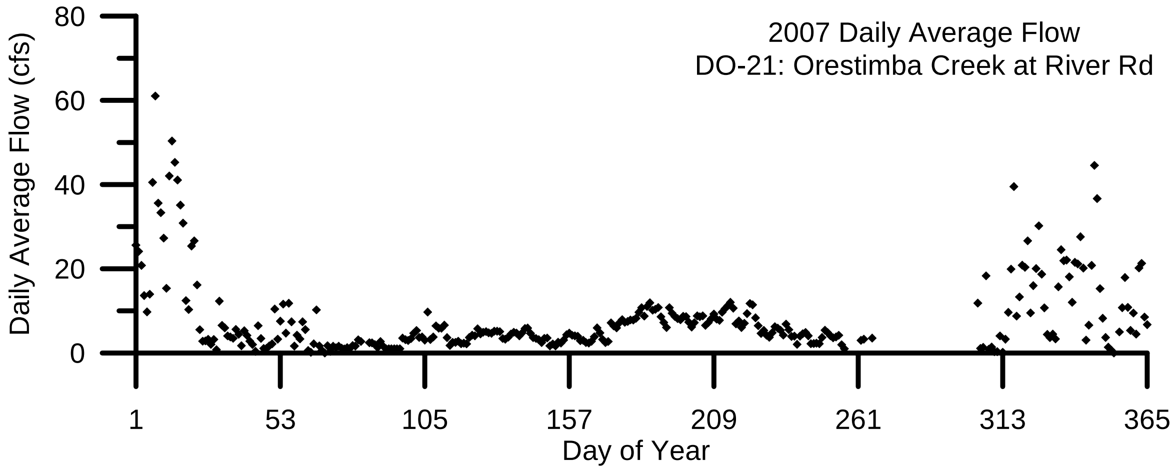
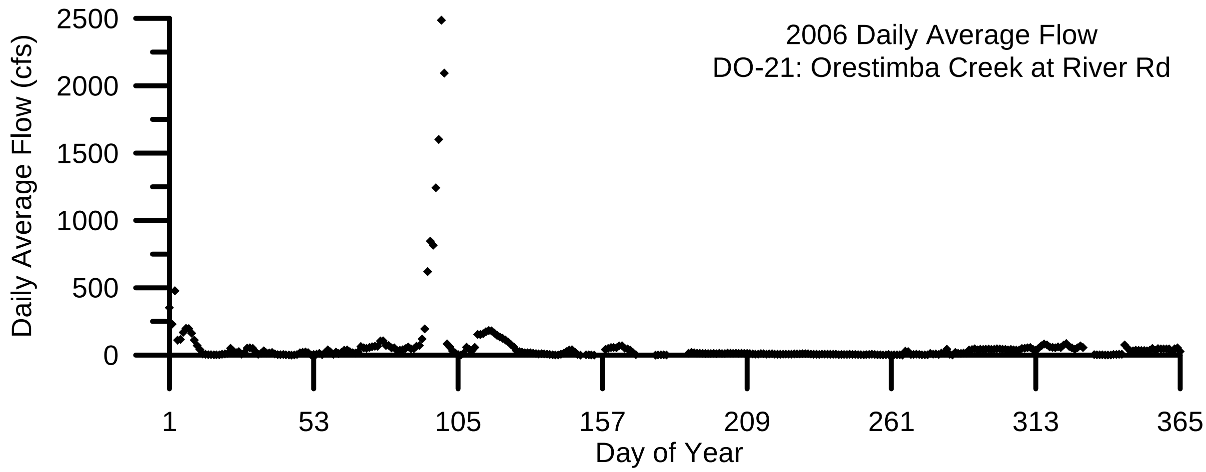


Figure 33: 2005 through 2007 flow plots for DO-21 Orestimba Creek at River Rd





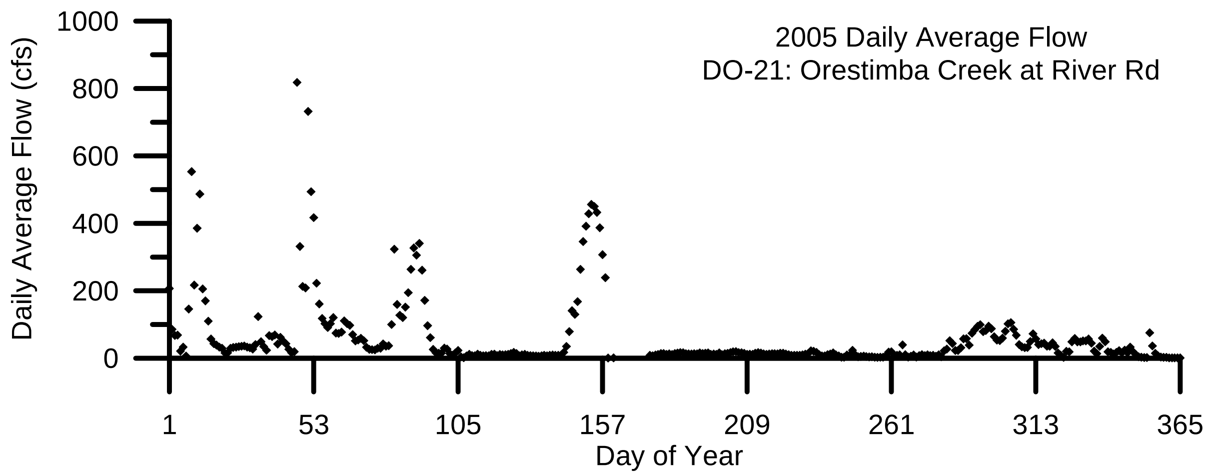


Figure 34: 2005 through 2007 flow plot for DO-21 Orestimba Creek at River Rd

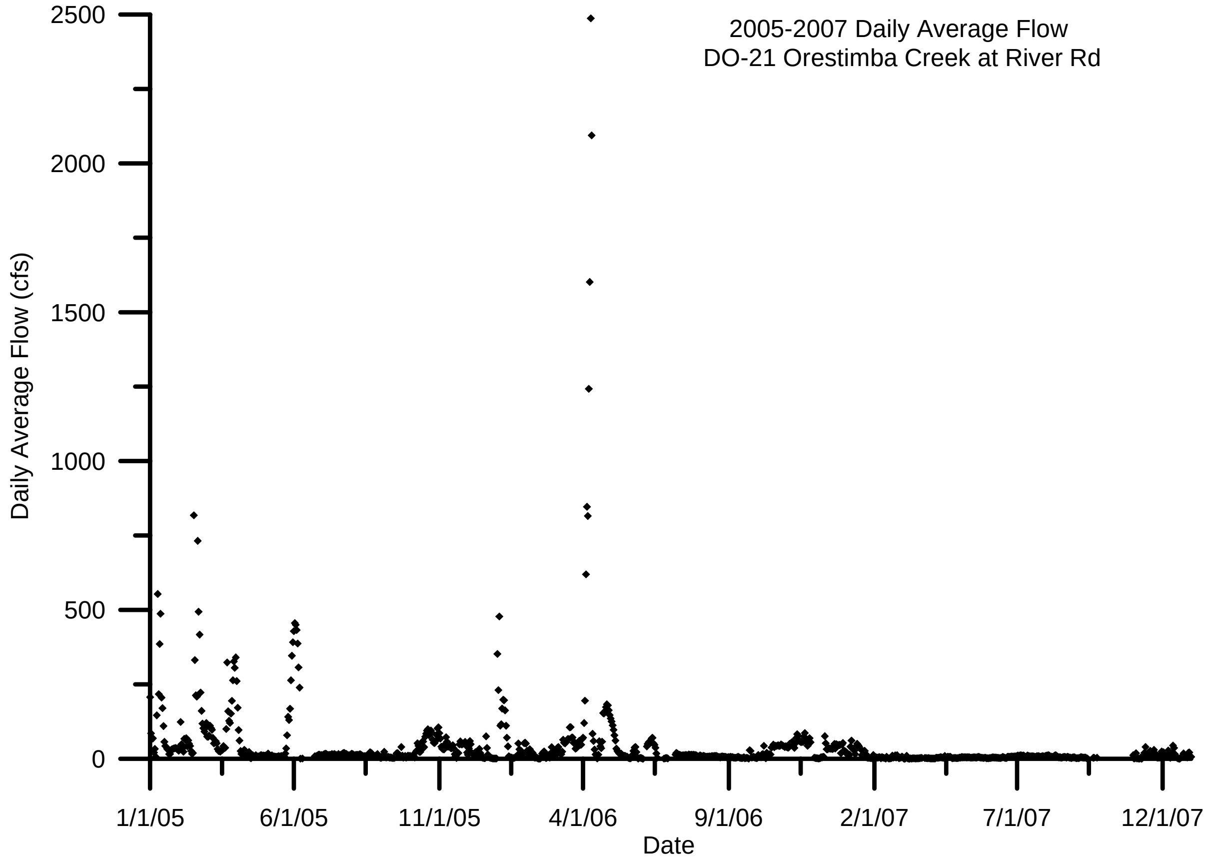


Figure 35: 2005 through 2007 flow plots for DO-22 MID Lateral 4 to SJR

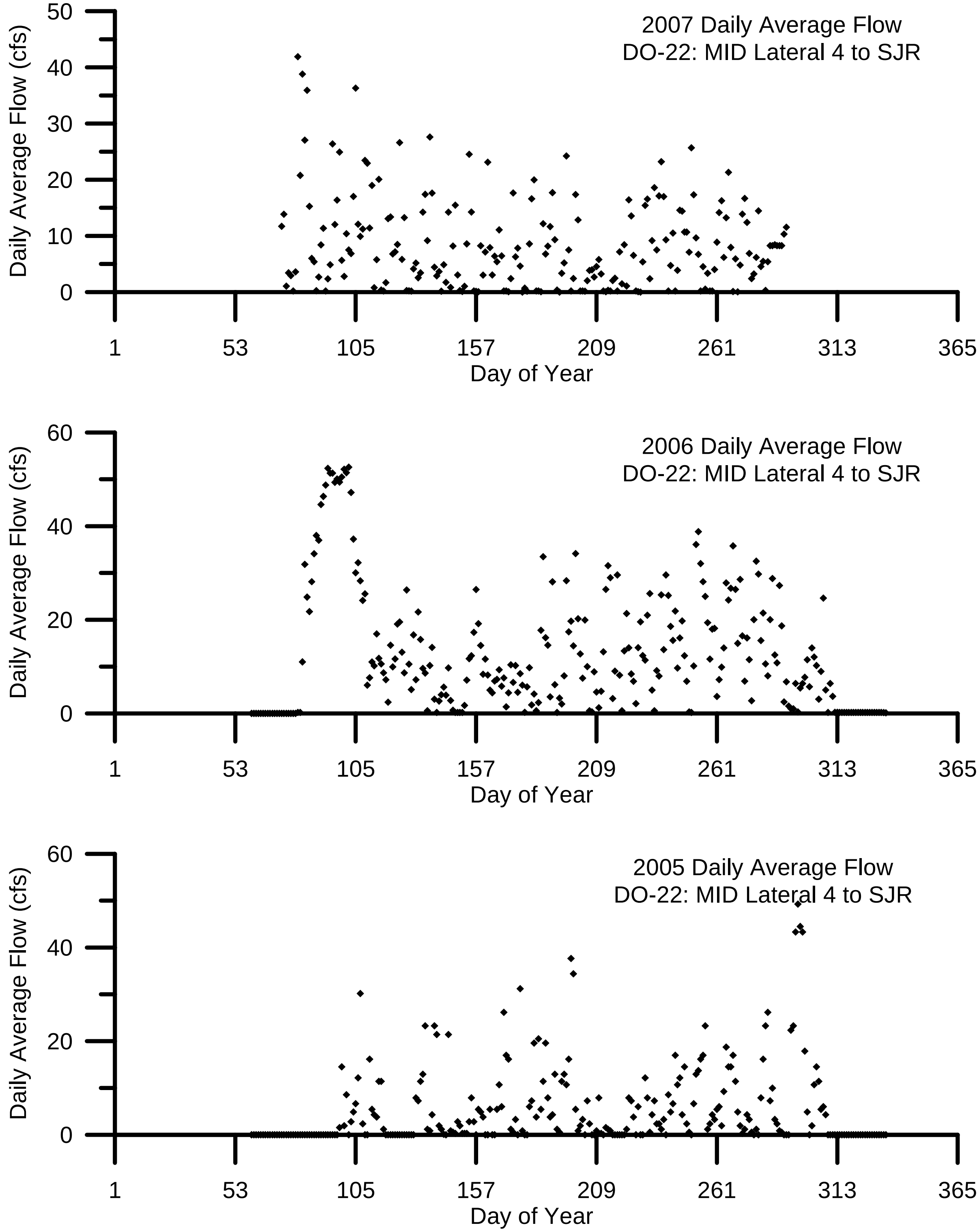


Figure 36: 2005 through 2007 flow plot for DO-22 MID Lateral 4 to SJR

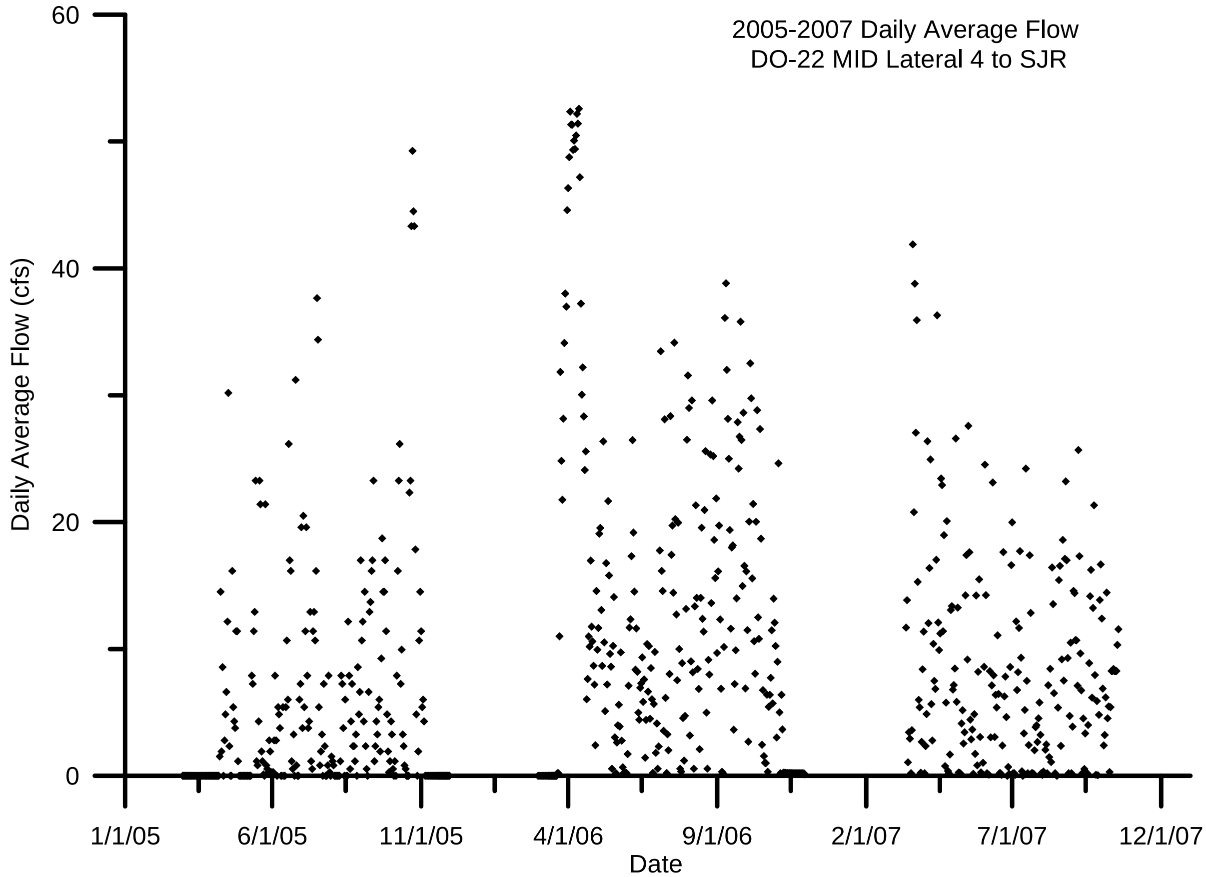


Figure 37: 2005 through 2007 flow plots for DO-23 MID Lateral 5 to Tuolumne

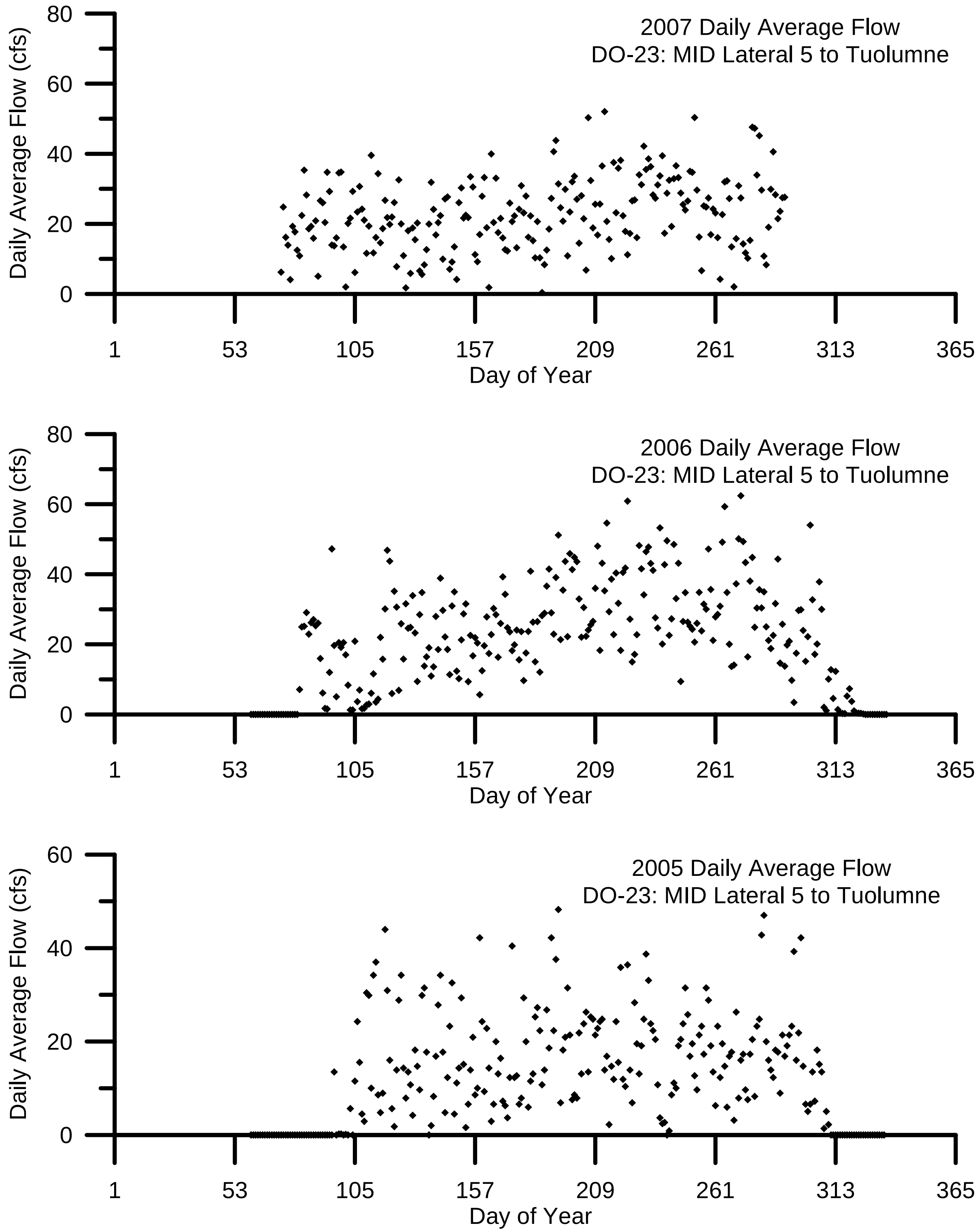


Figure 38: 2005 through 2007 flow plot for DO-23 MID Lateral 5 to Tuolumne

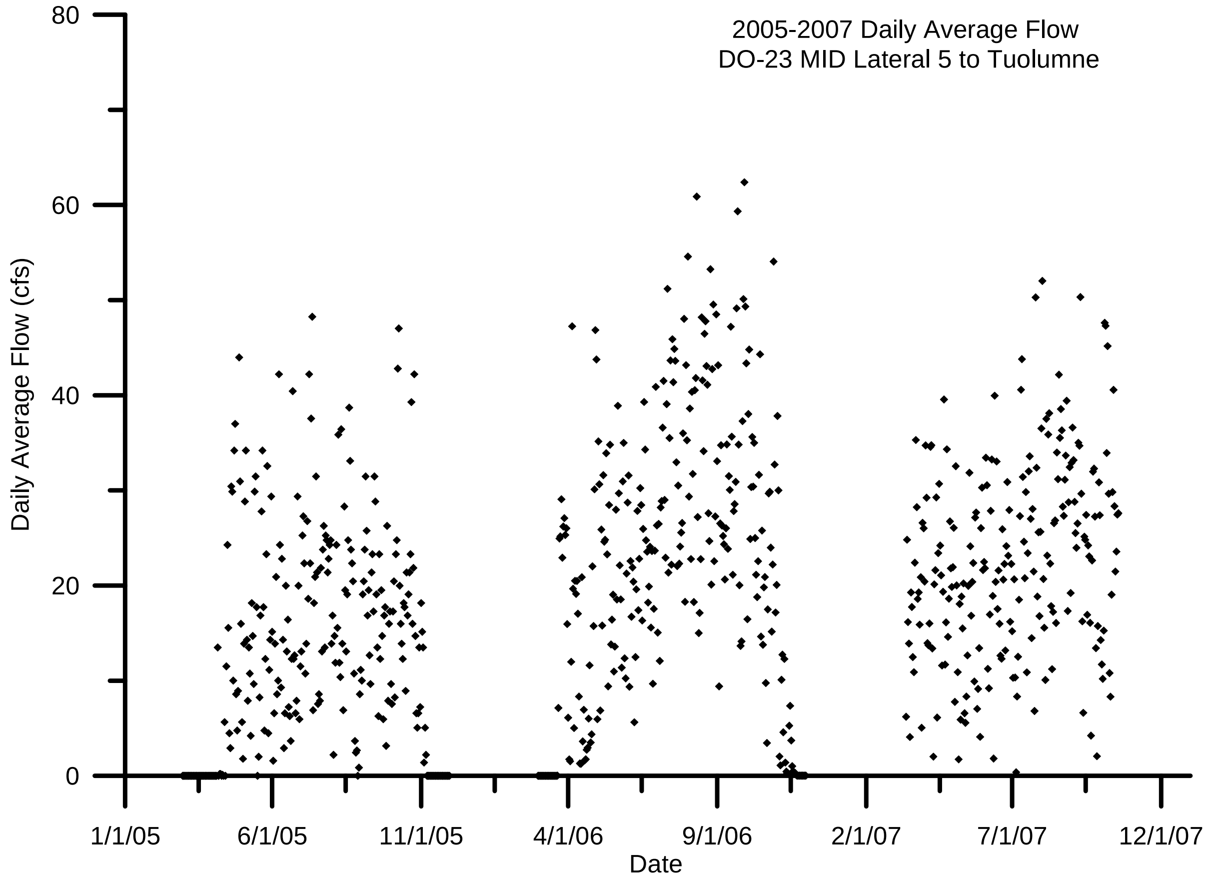


Figure 39: 2005 through 2007 flow plots for DO-24 MID Lateral 6 to Stanislaus River

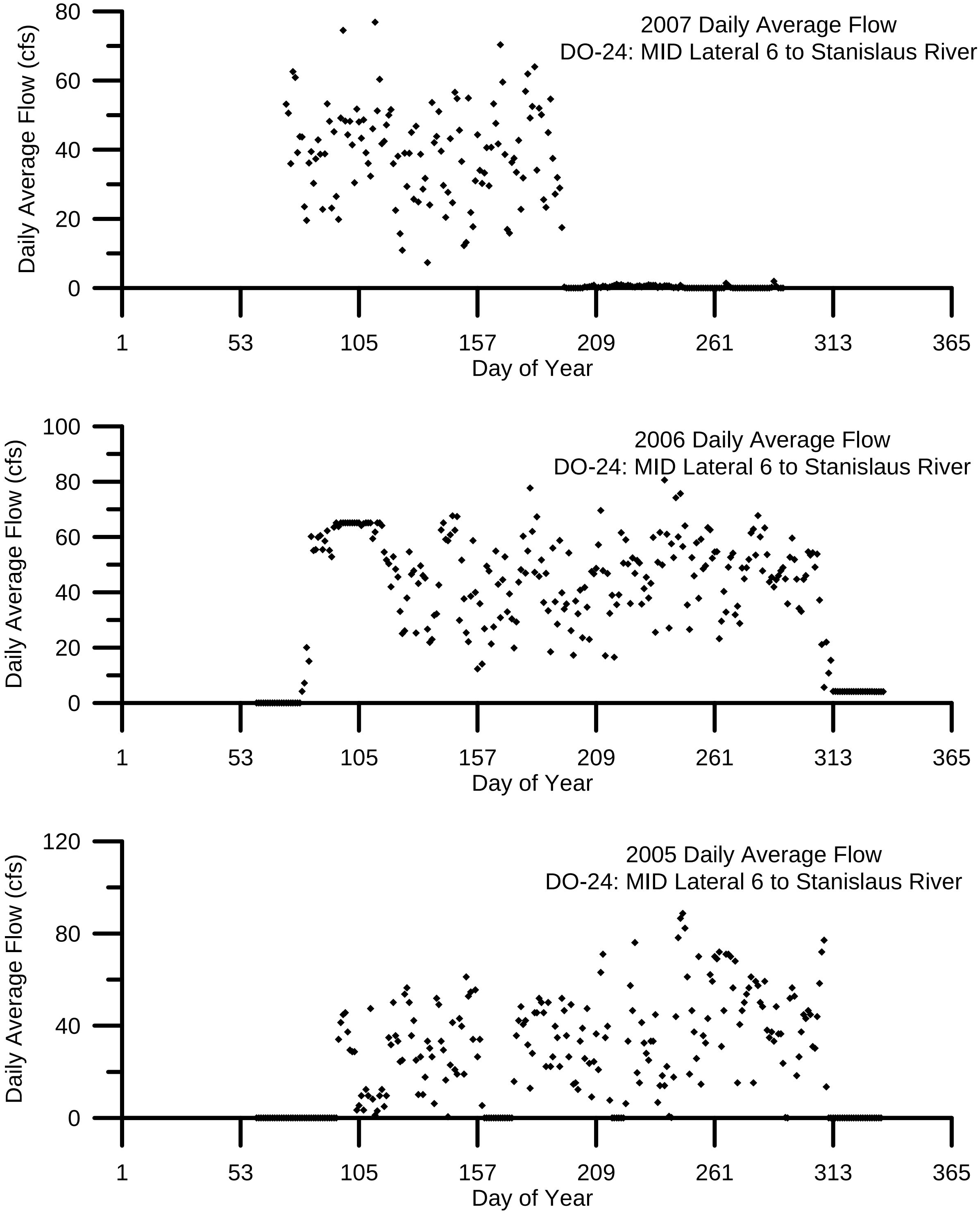


Figure 40: 2005 through 2007 flow plot for DO-24 MID Lateral 6 to Stanislaus River

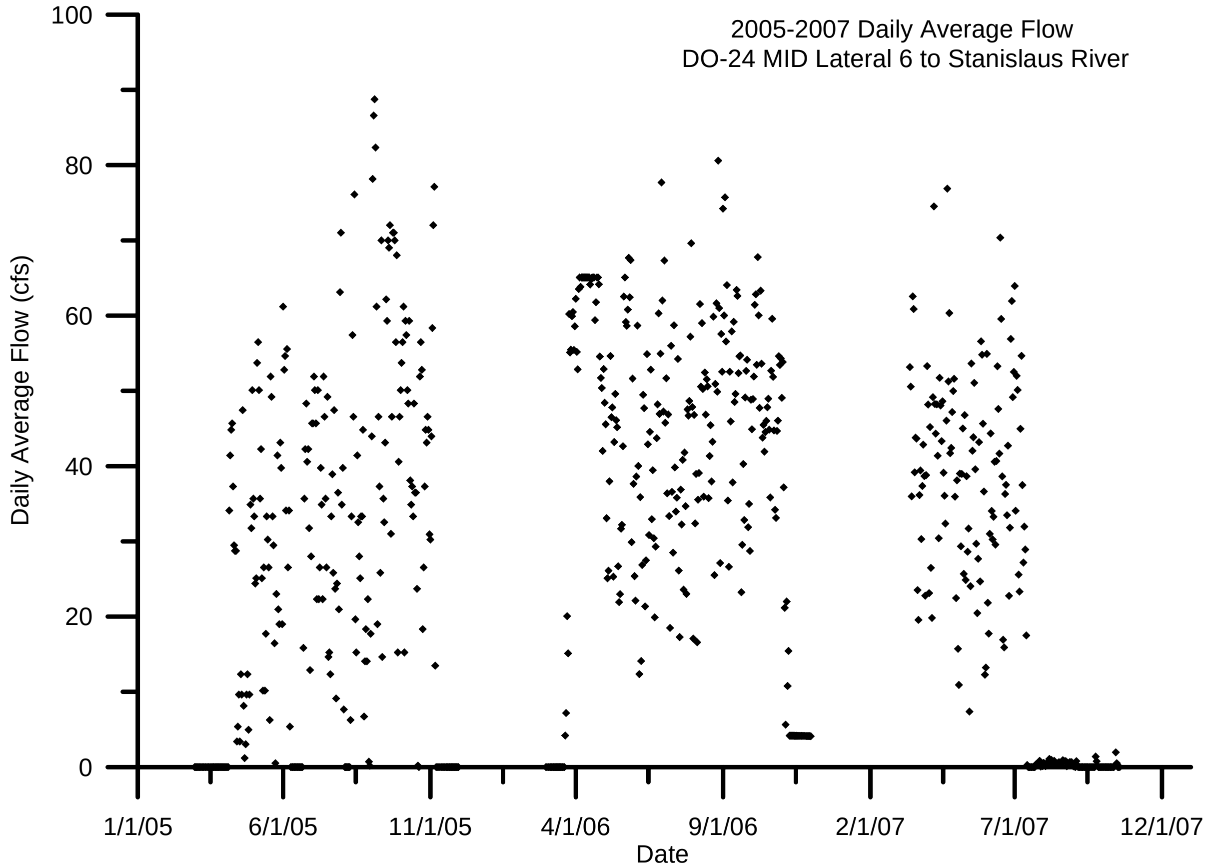


Figure 41: 2005 through 2007 flow plots for DO-25 MID Main Drain to Stanislaus River via Miller Lake

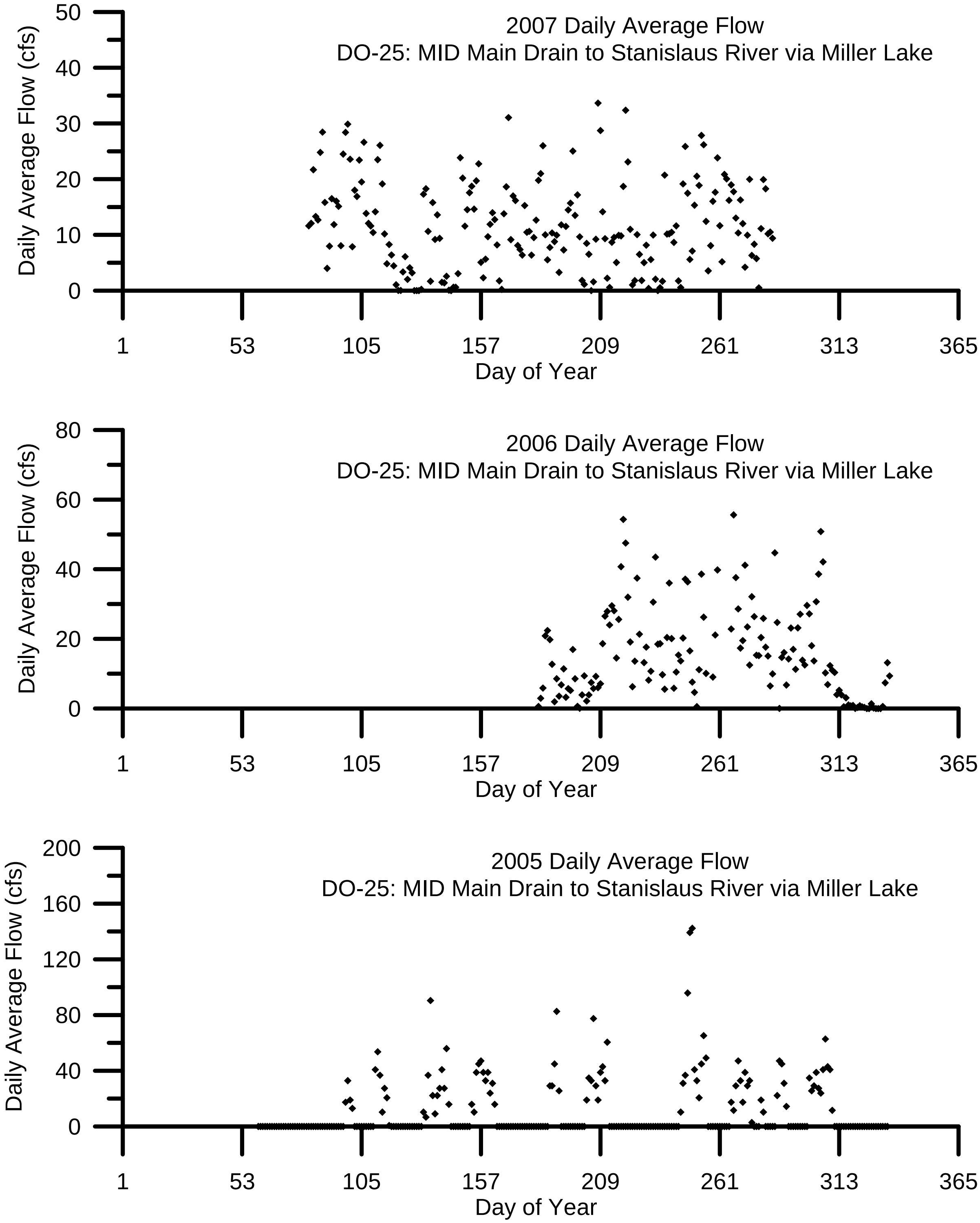


Figure 42: 2005 through 2007 flow plot for DO-25 MID Main Drain to Stanislaus River via Miller Lake

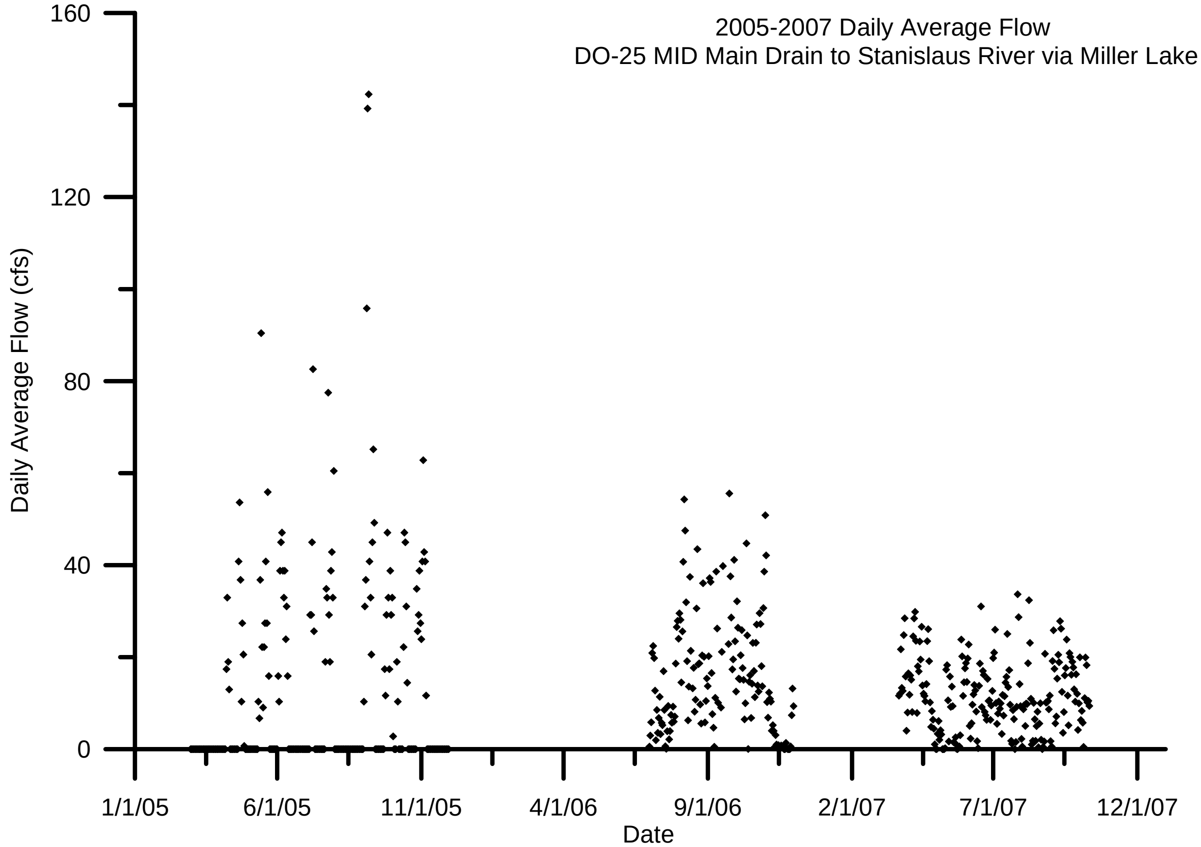
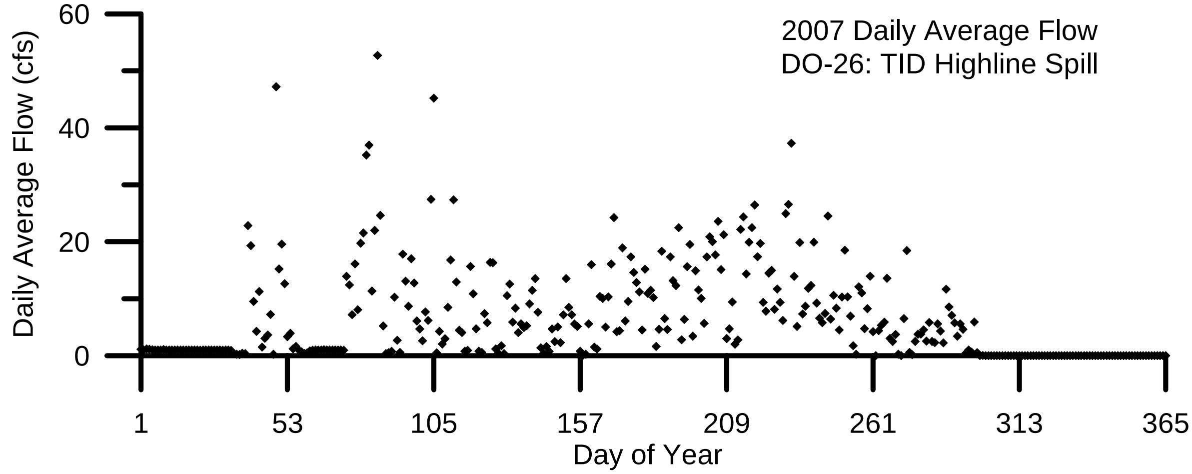
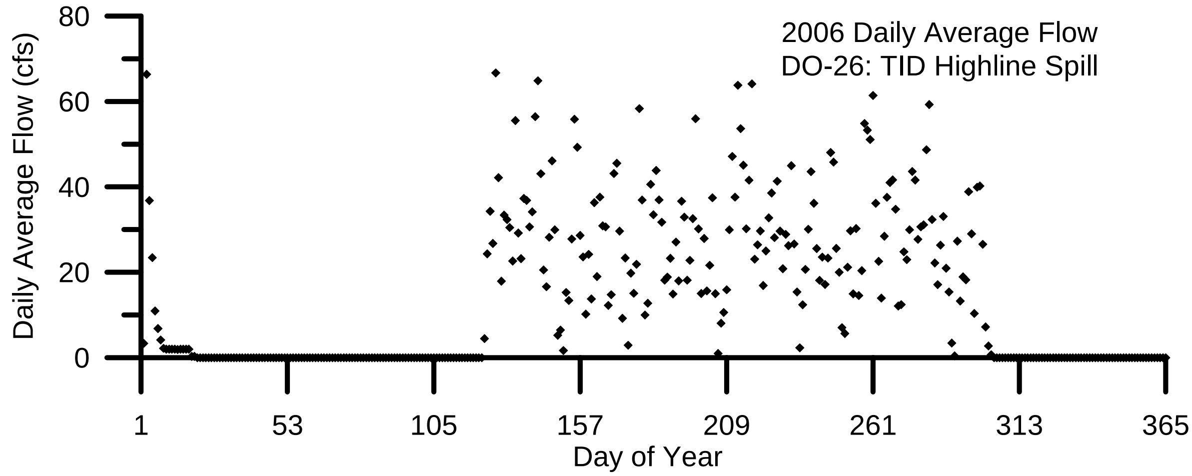


Figure 43: 2005 through 2007 flow plots for DO-26 TID Highline Spill





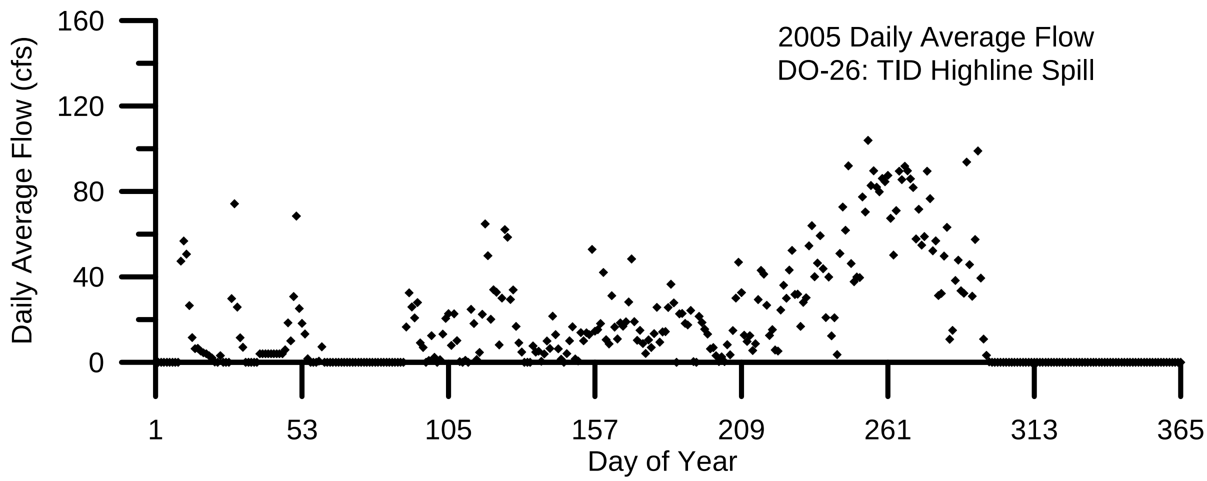


Figure 44: 2005 through 2007 flow plot for DO-26 TID Highline Spill

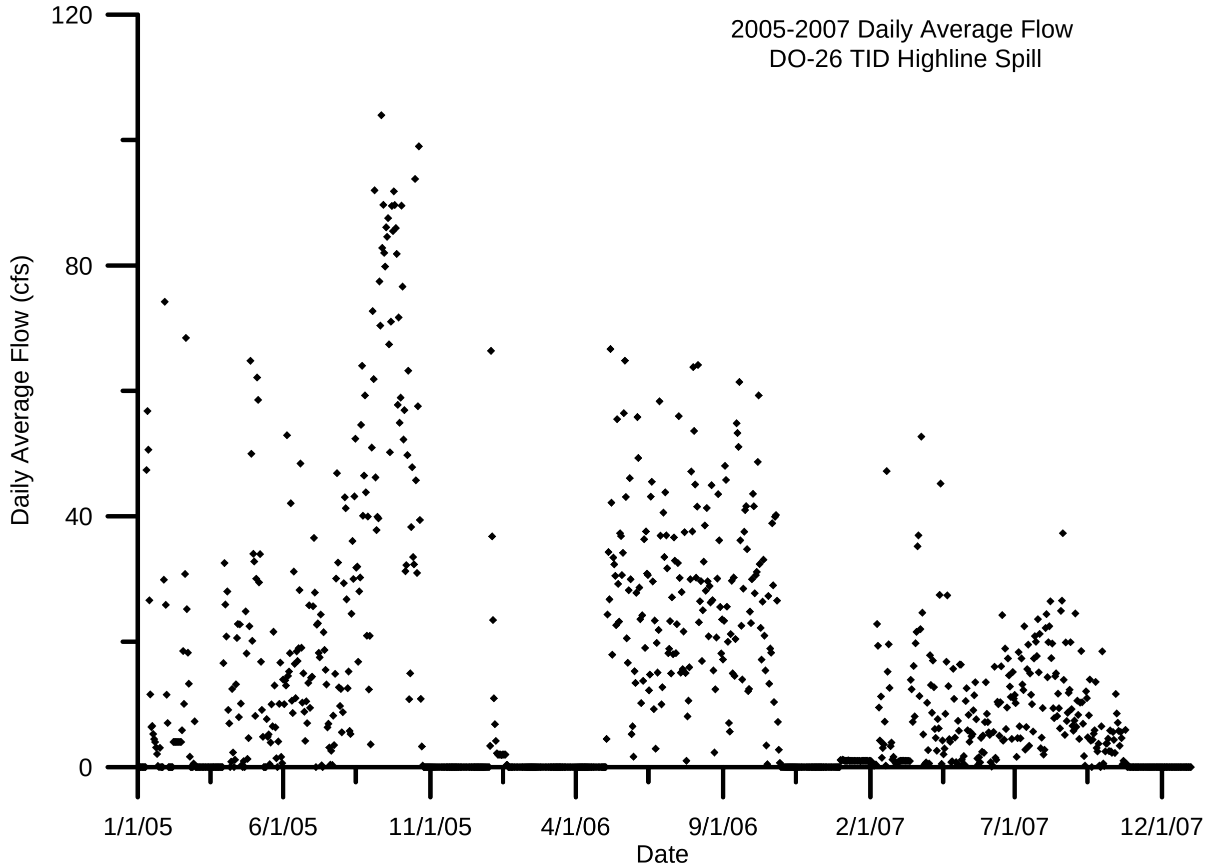


Figure 45: 2005 through 2007 flow plots for DO-27 TID Lateral 2

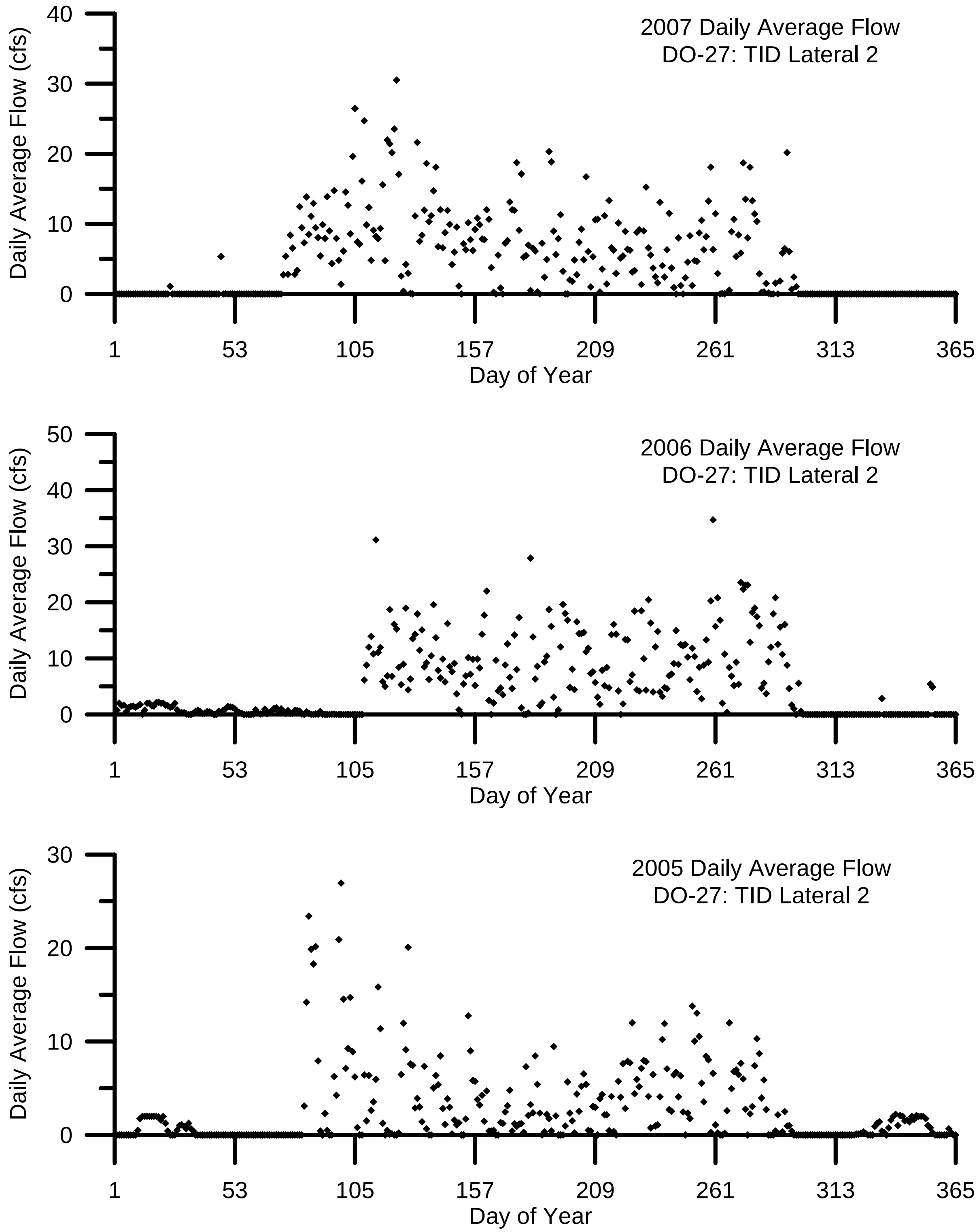


Figure 46: 2005 through 2007 flow plot for DO-27 TID Lateral 2

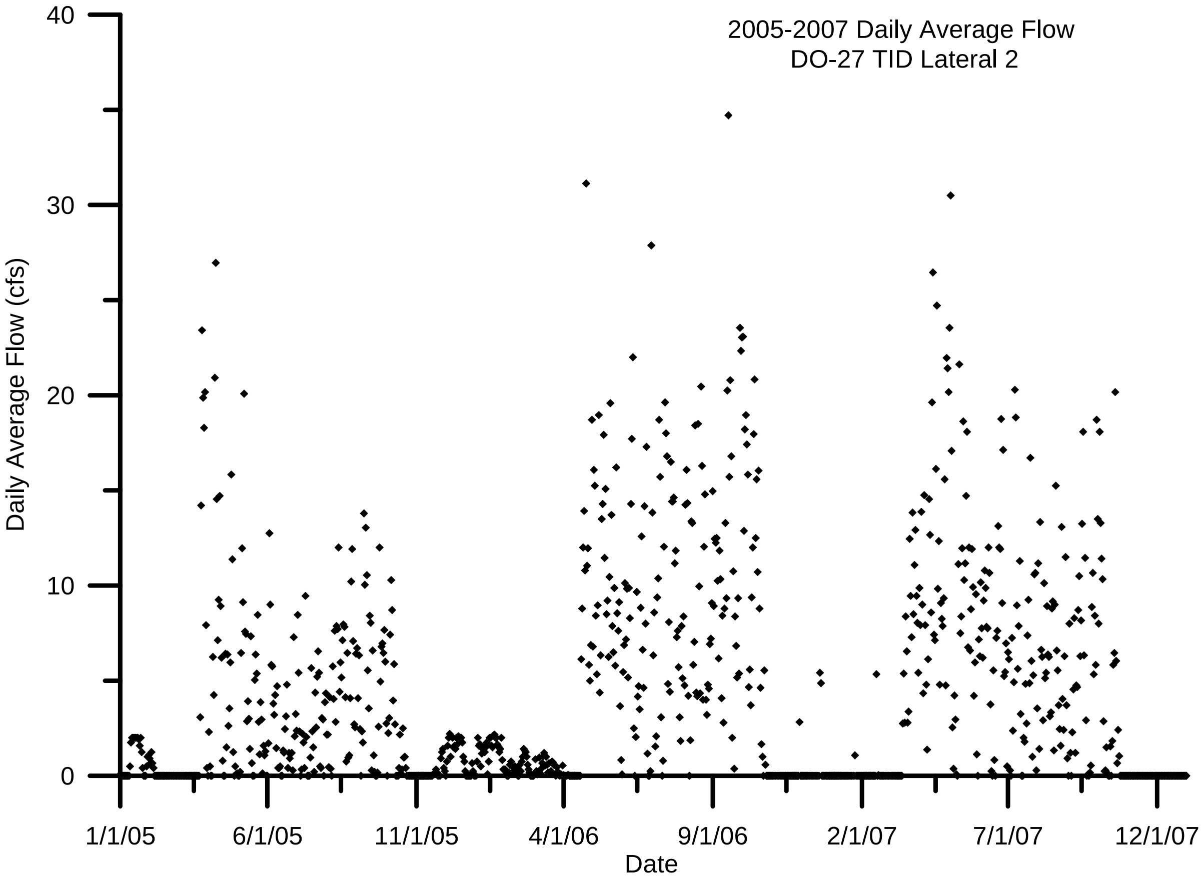
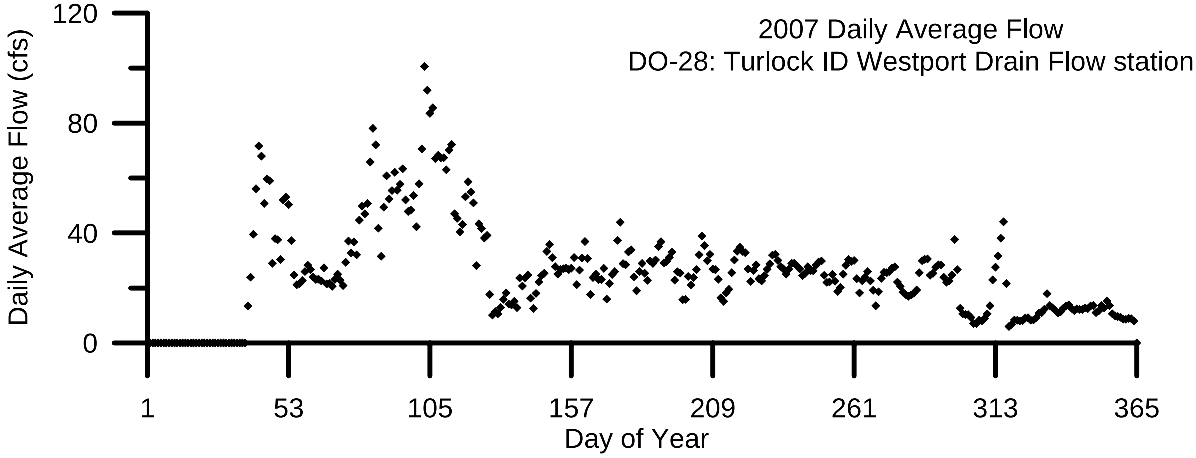
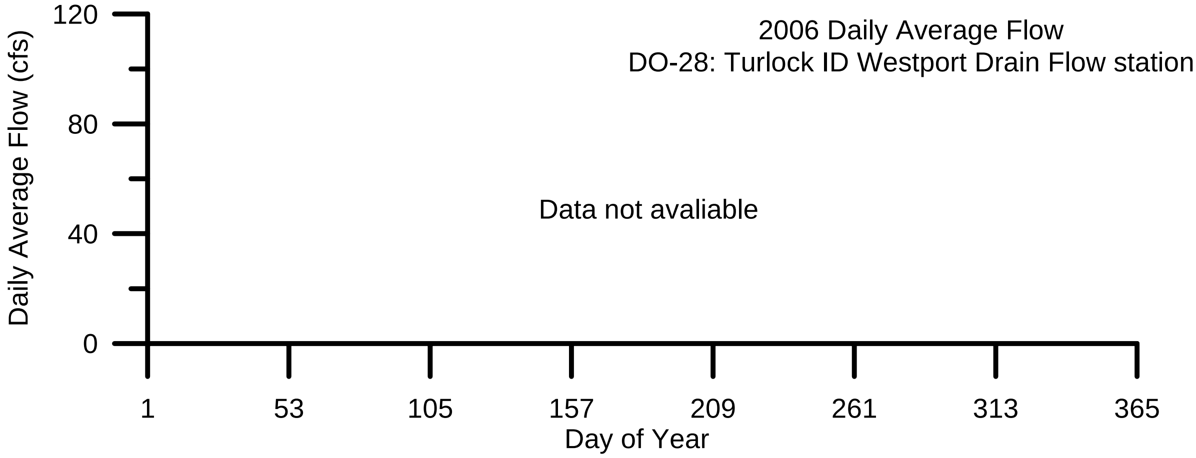


Figure 47: 2005 through 2007 flow plots for DO-28 TID Westport Drain





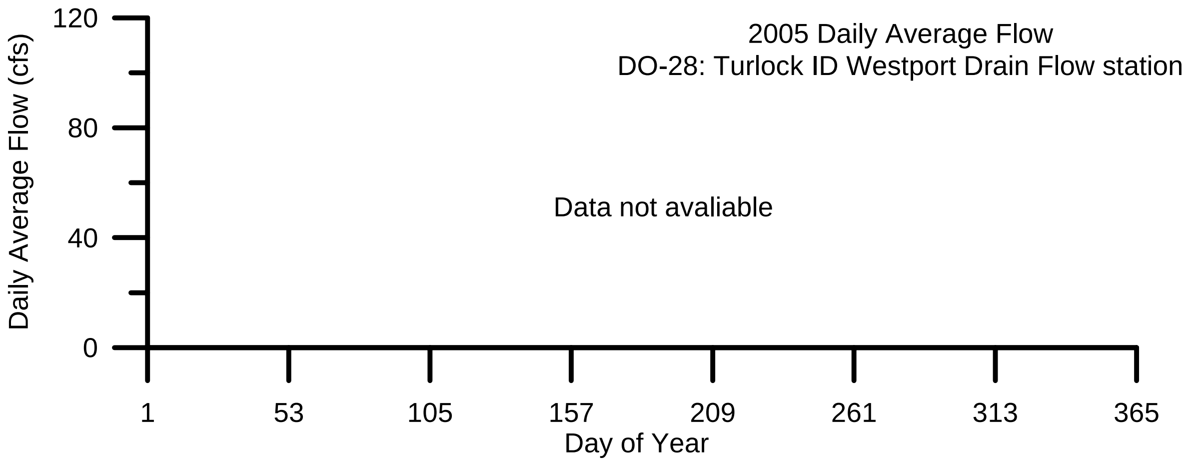


Figure 48: 2005 through 2007 flow plot for DO-28 TID Westport Drain

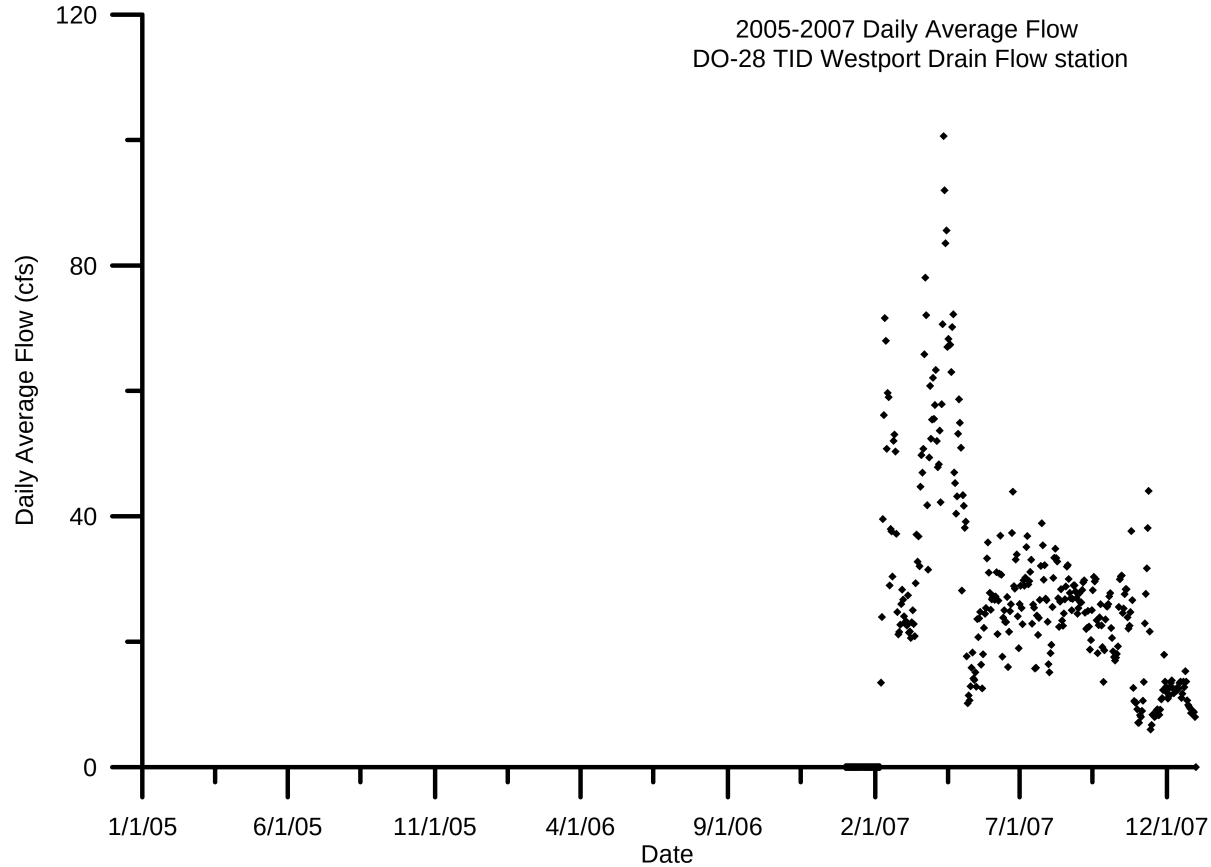
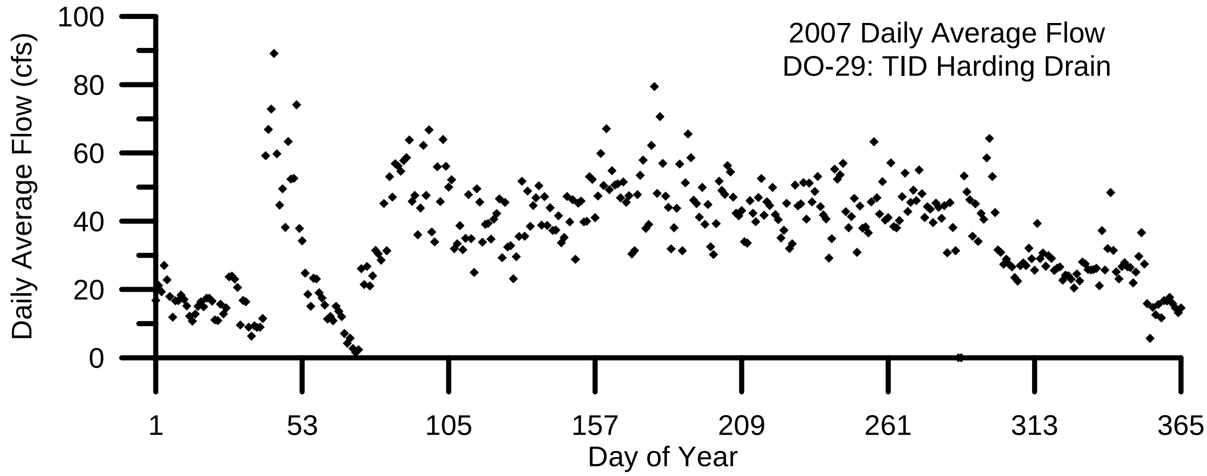
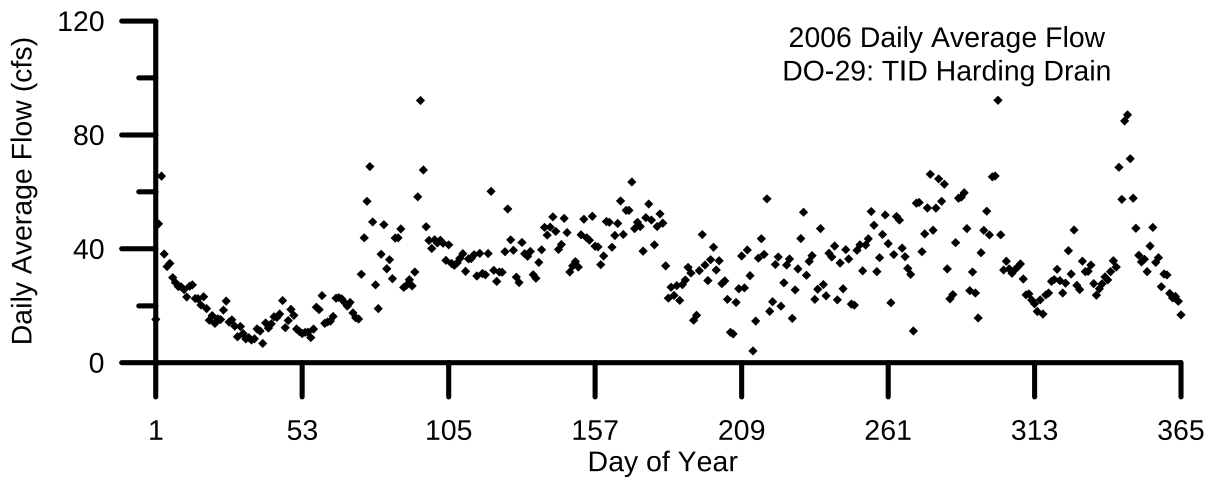


Figure 49: 2005 through 2007 flow plots for DO-29 TID Harding Drain





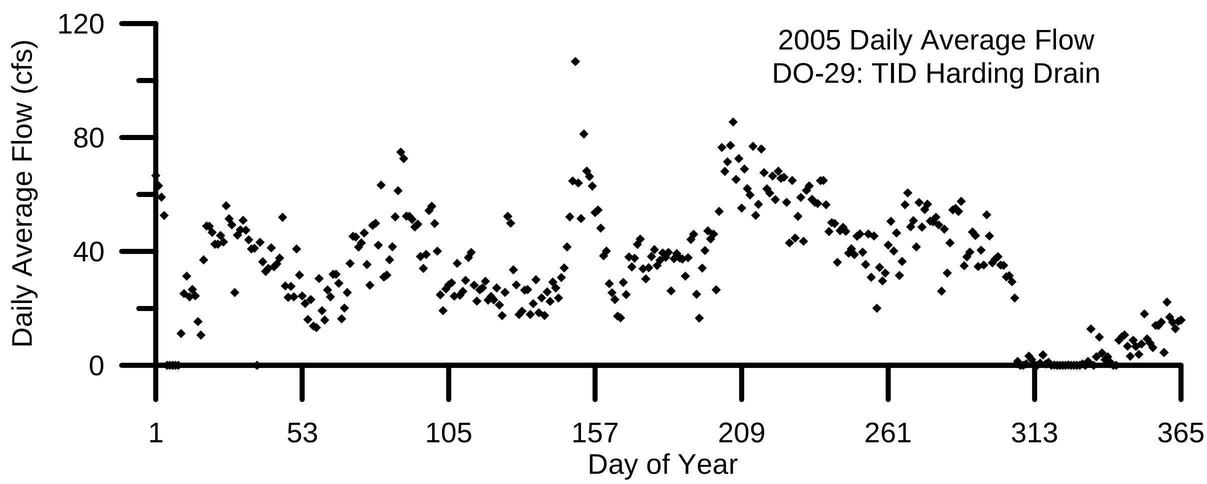


Figure 50: 2005 through 2007 flow plot for DO-29 TID Harding Drain

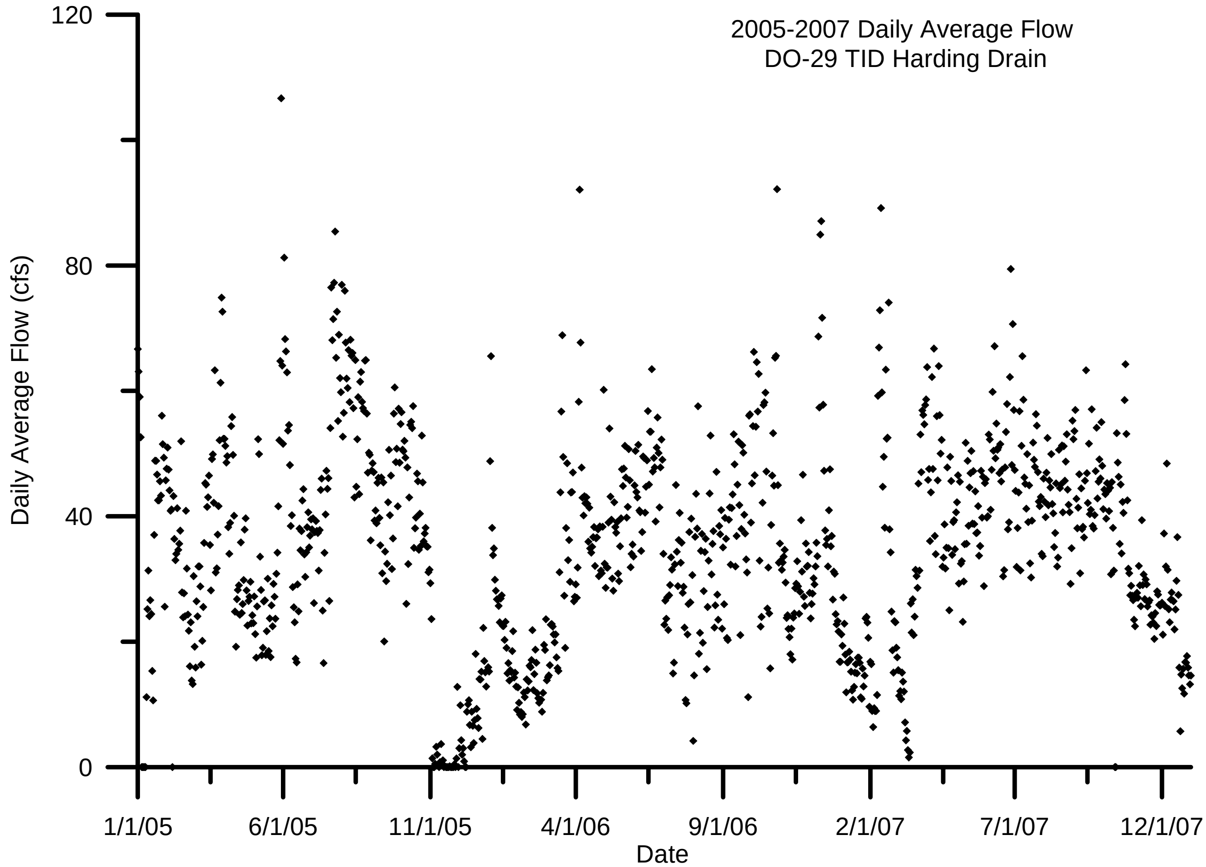


Figure 51: 2005 through 2007 flow plots for DO-30 TID Lateral 6 & 7 at Levee

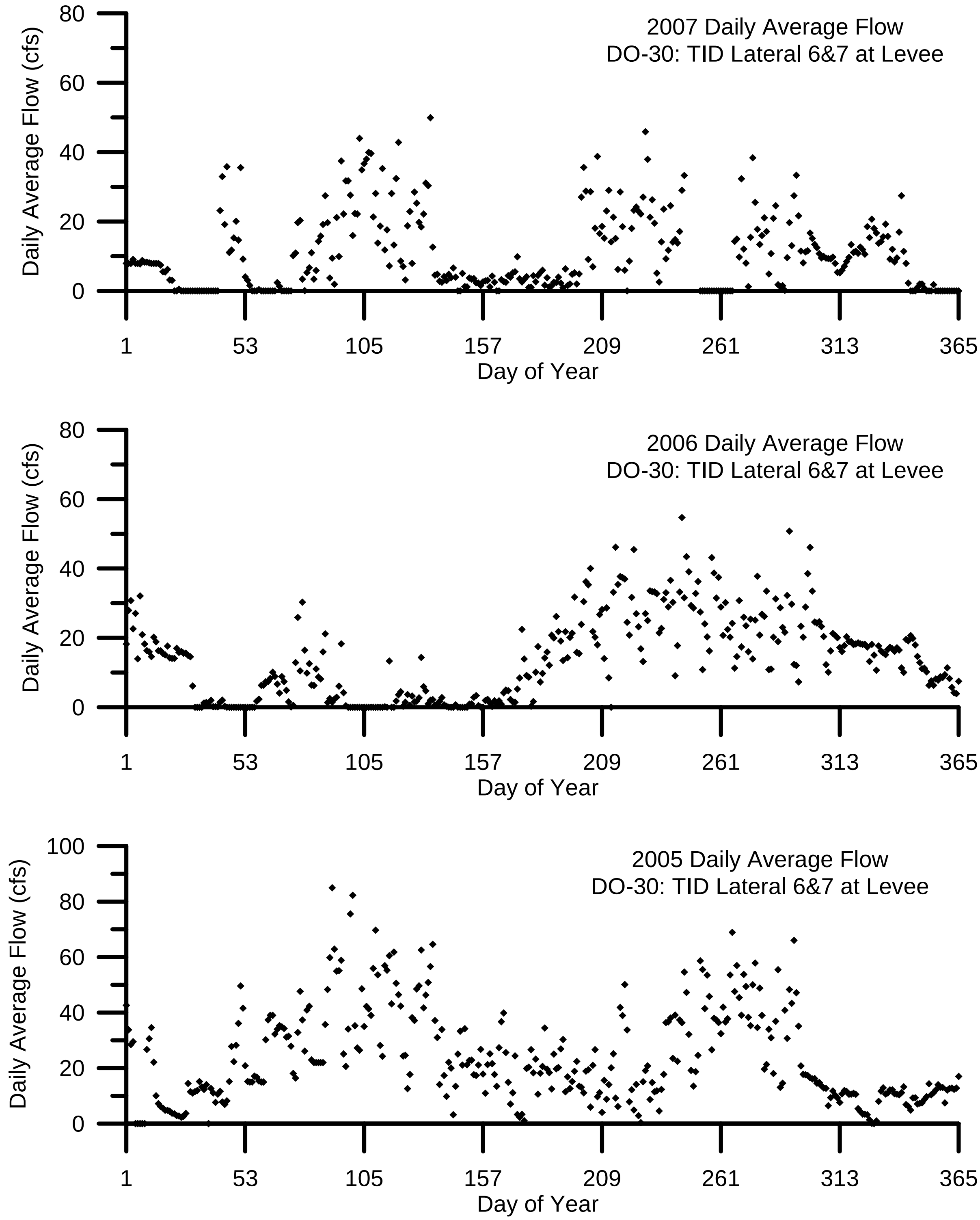


Figure 52: 2005 through 2007 flow plot for DO-30 TID Lateral 6 & 7 at Levee

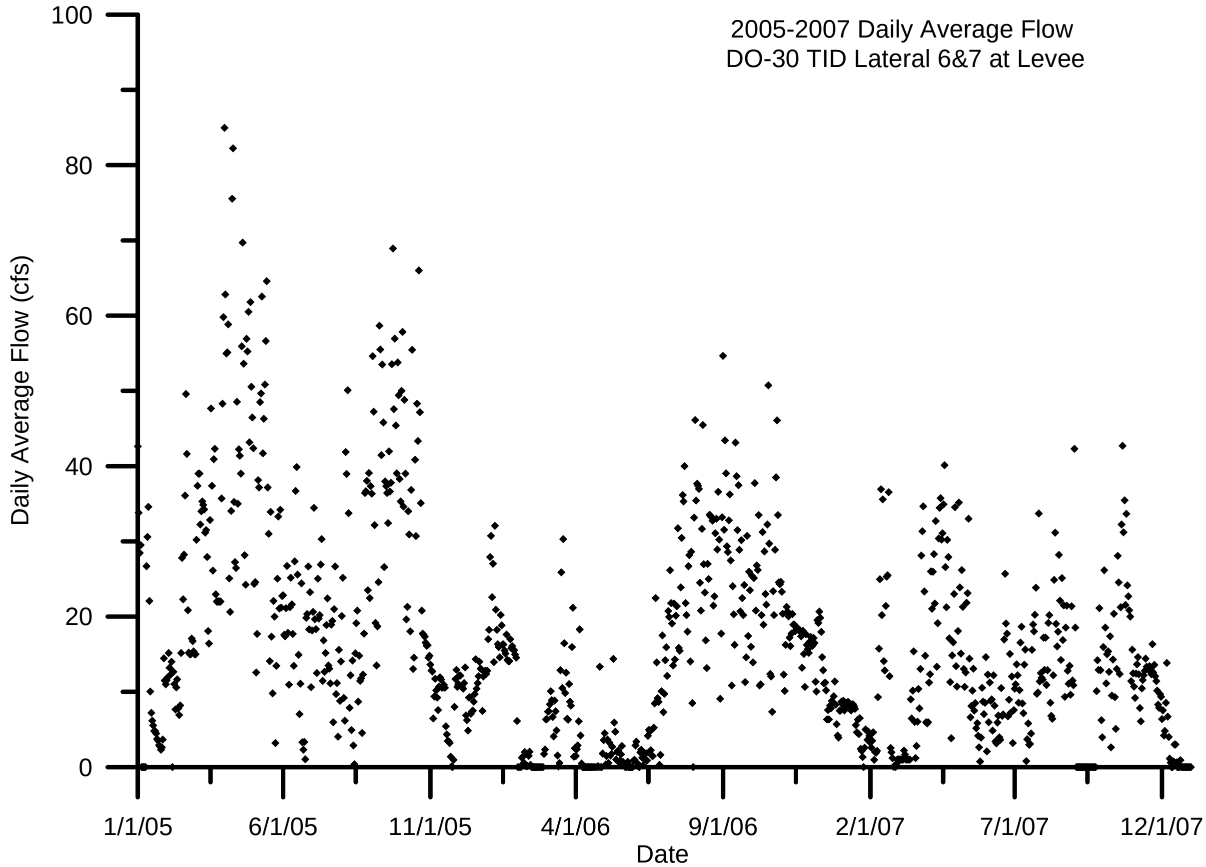
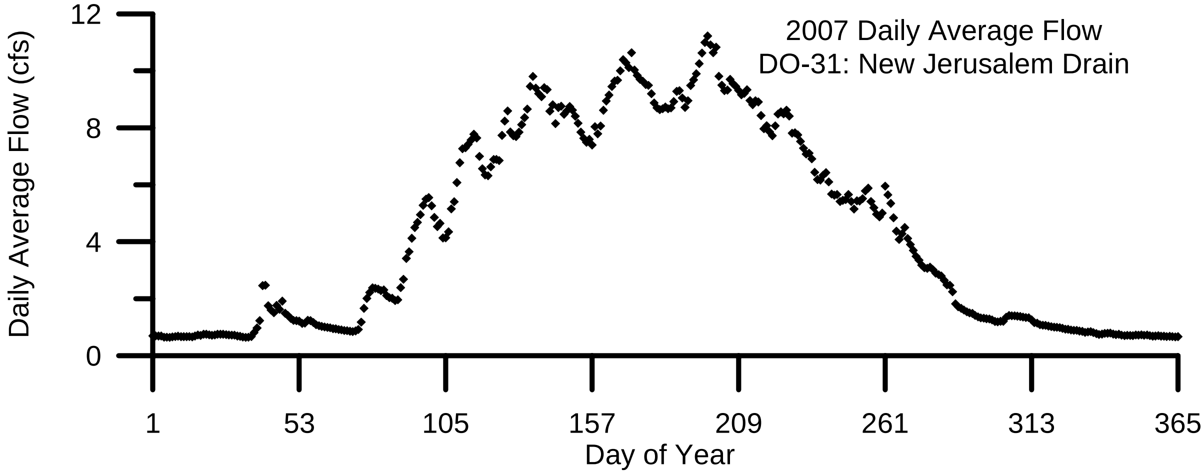
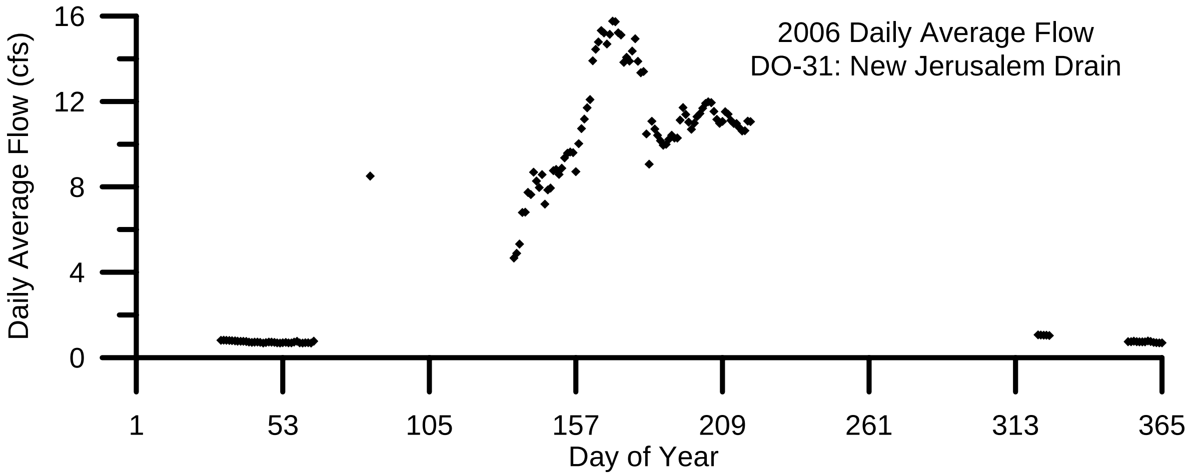


Figure 53: 2005 through 2007 flow plots for DO-31 New Jerusalem Drain





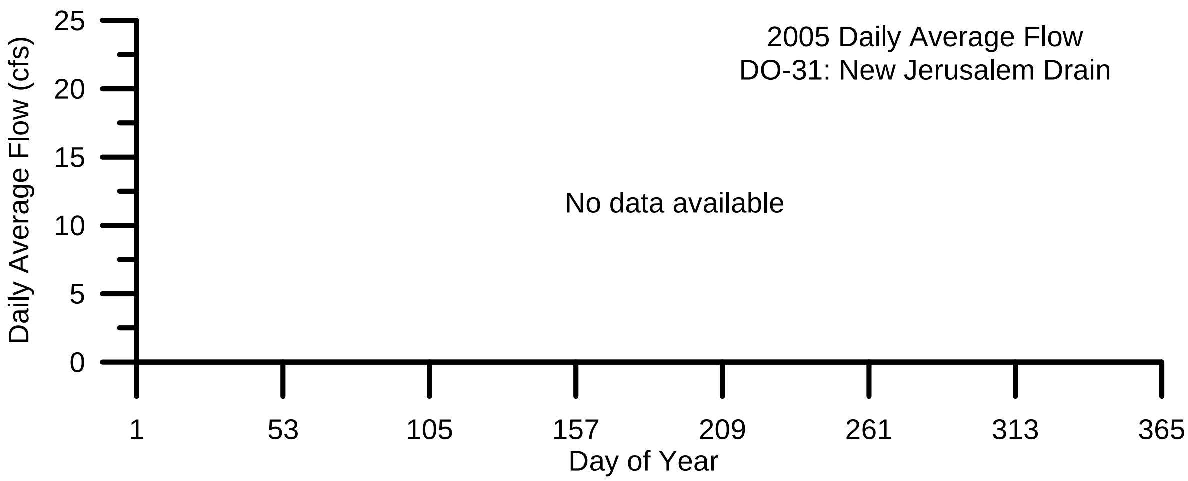


Figure 54: 2005 through 2007 flow plot for DO-31 New Jerusalem Drain

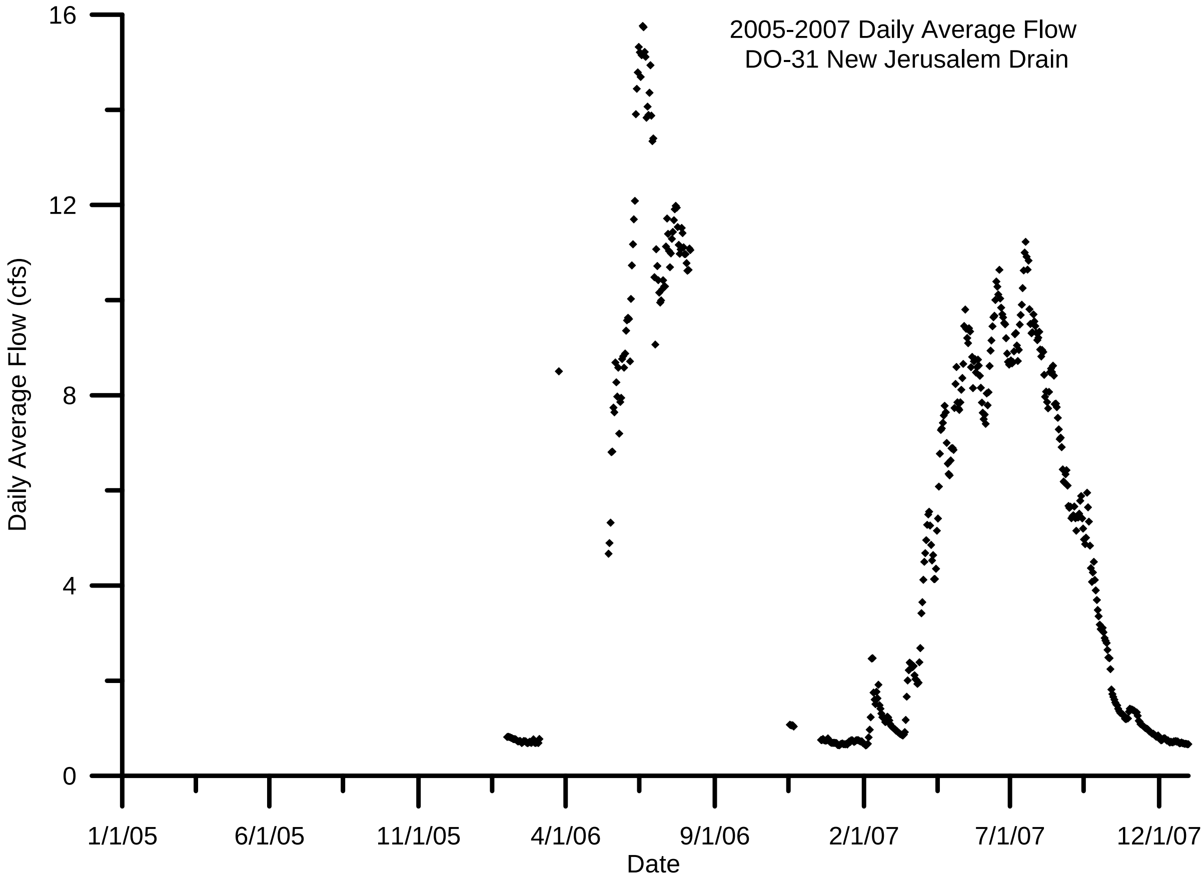
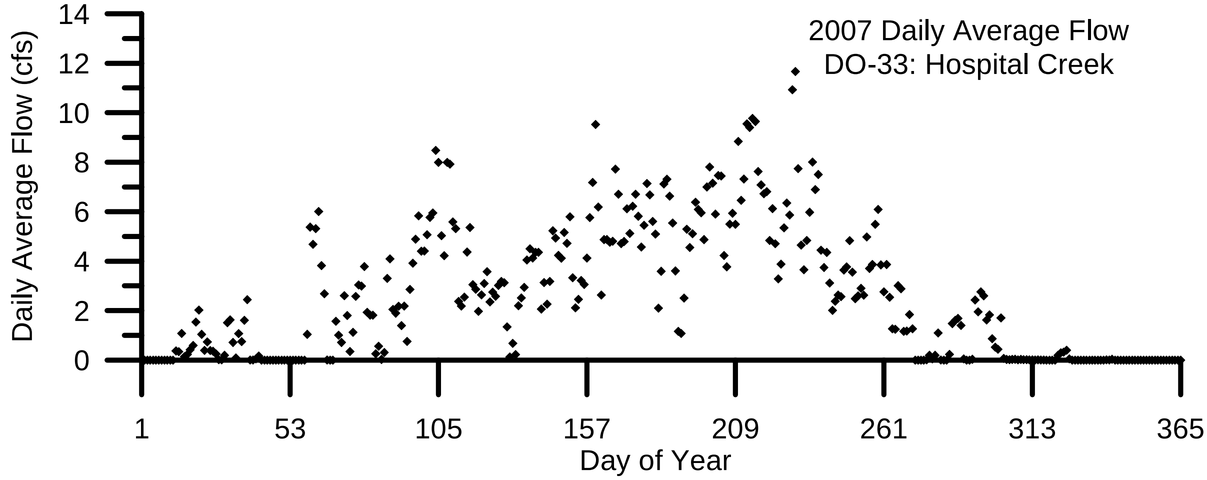
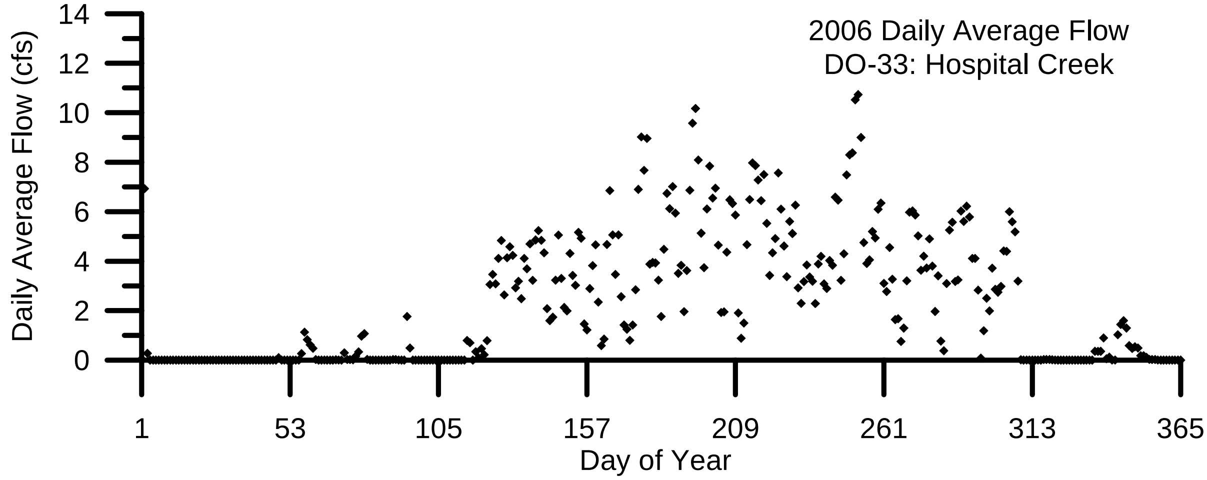


Figure 55: 2005 through 2007 flow plots for DO-33 Hospital Creek





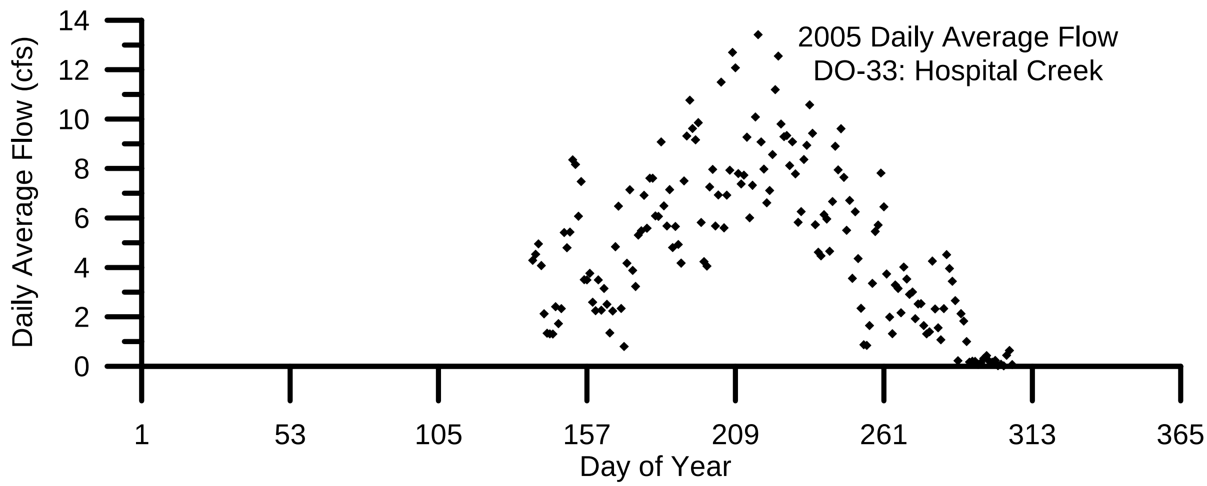


Figure 56: 2005 through 2007 flow plot for DO-33 Hospital Creek

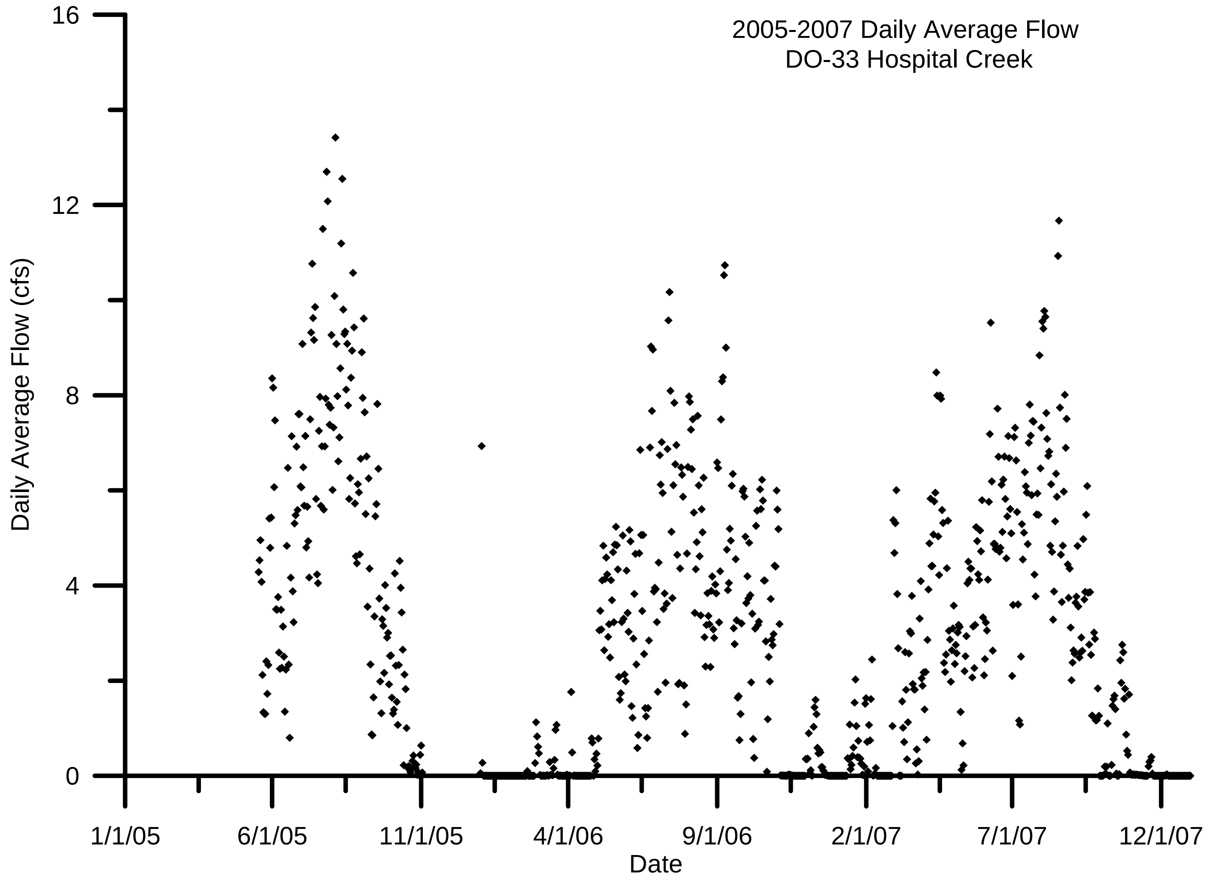


Figure 57: 2005 through 2007 flow plots for DO-34 Ingram Creek

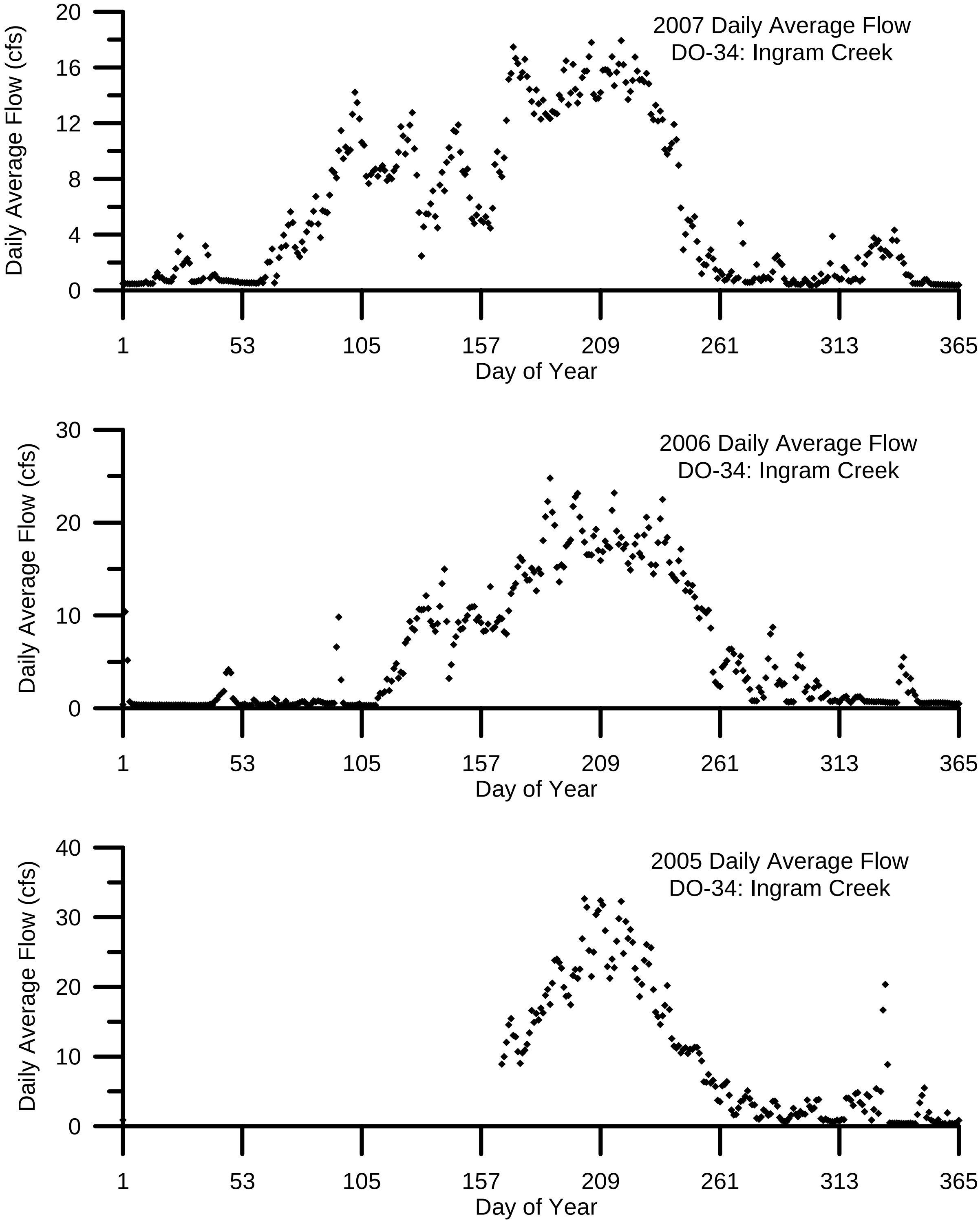


Figure 58: 2005 through 2007 flow plot for DO-34 Ingram Creek

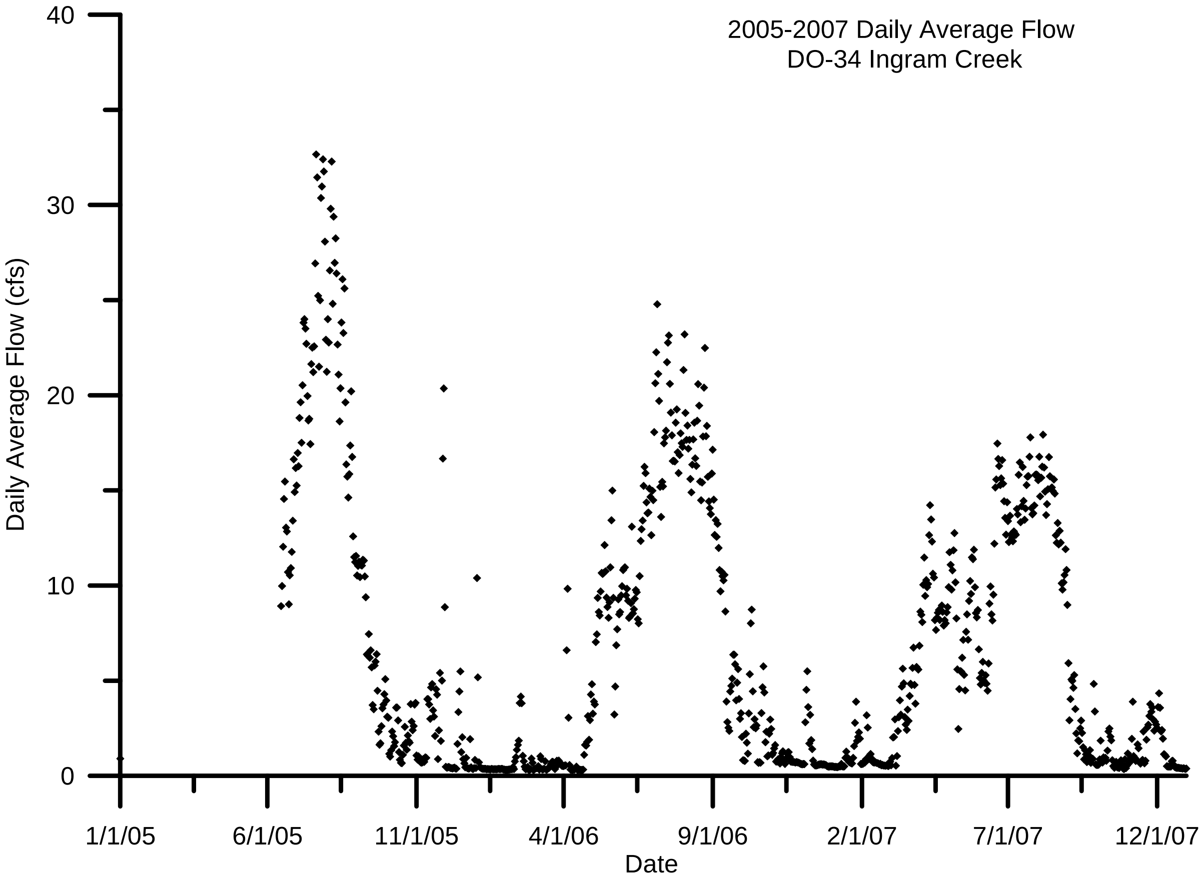
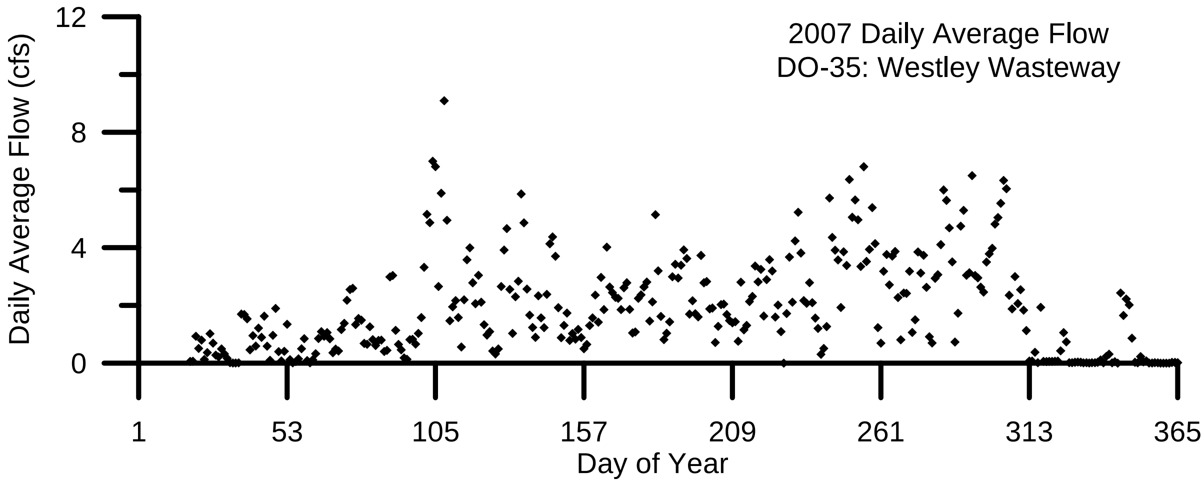
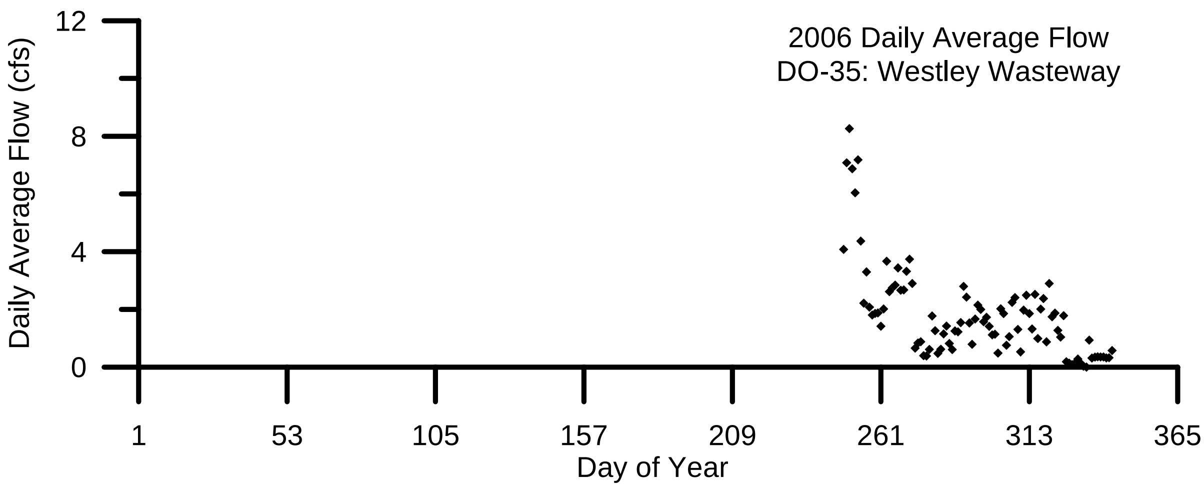


Figure 59: 2005 through 2007 flow plots for DO-35 Westley Wasteway





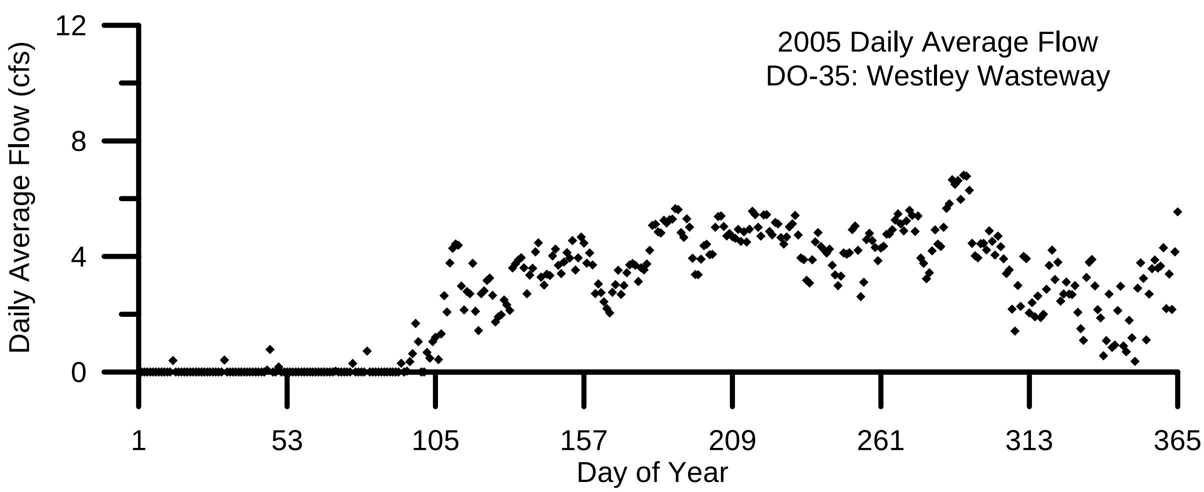


Figure 60: 2005 through 2007 flow plot for DO-35 Westley Wasteway

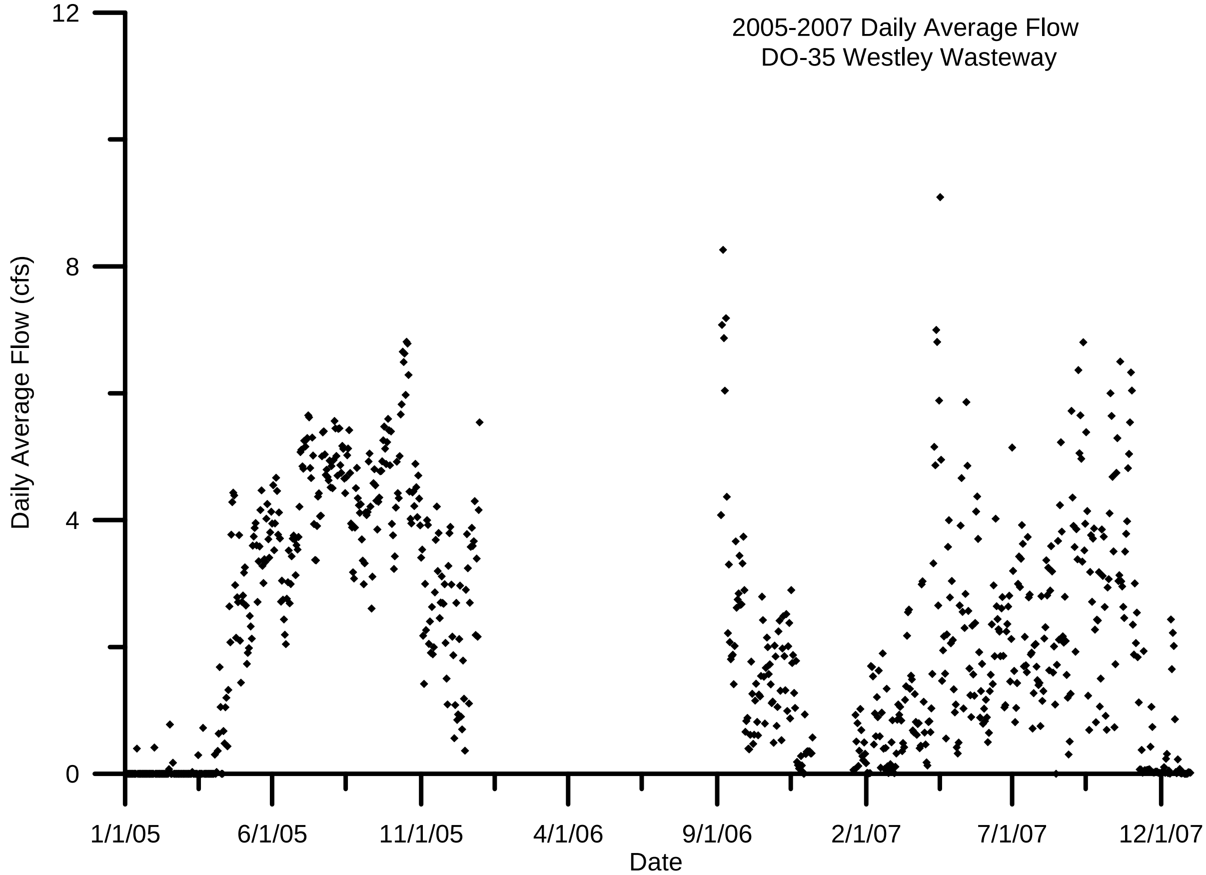
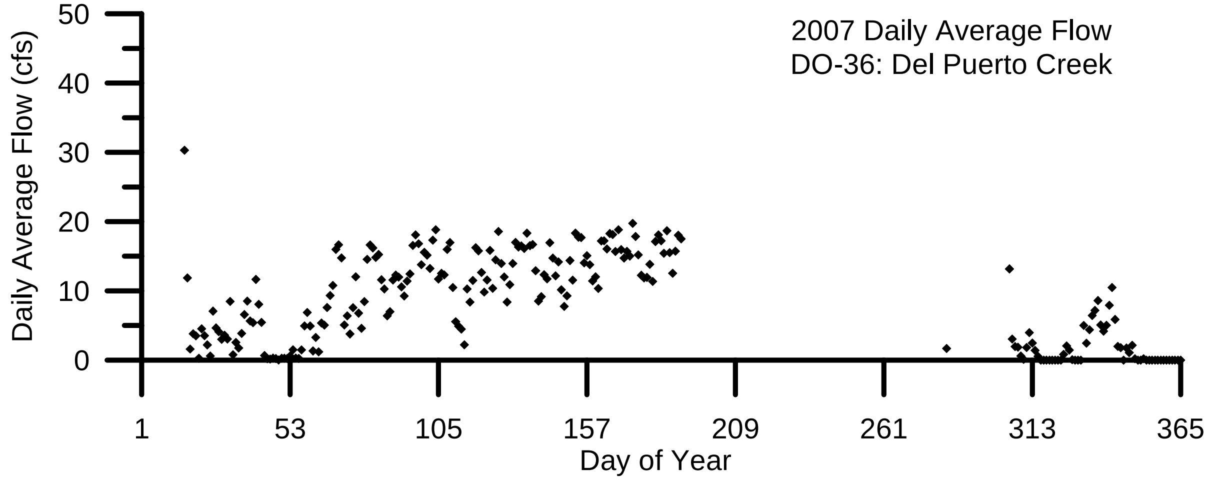
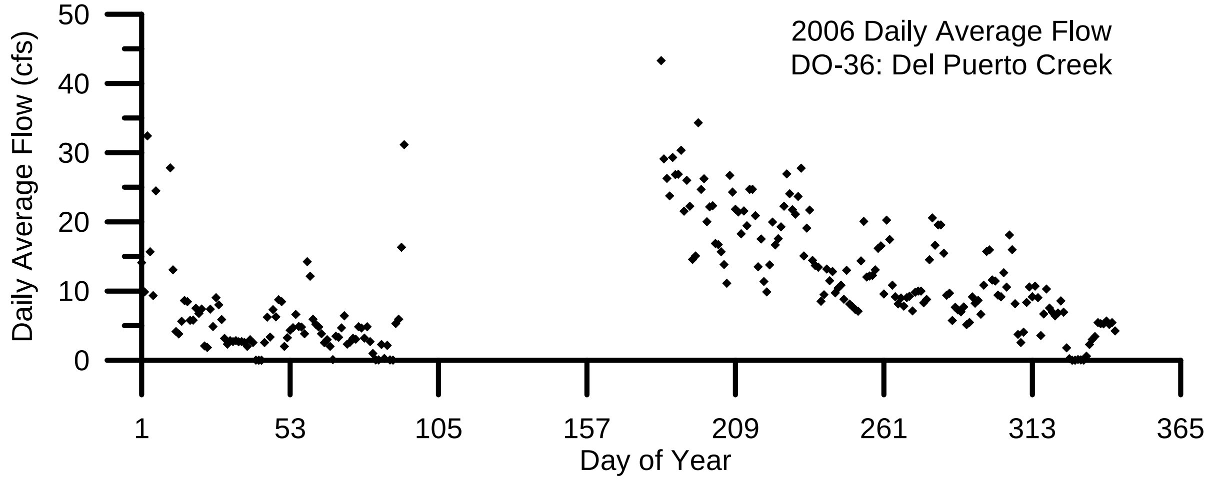


Figure 61: 2005 through 2007 flow plots for DO-36 Del Puerto Creek





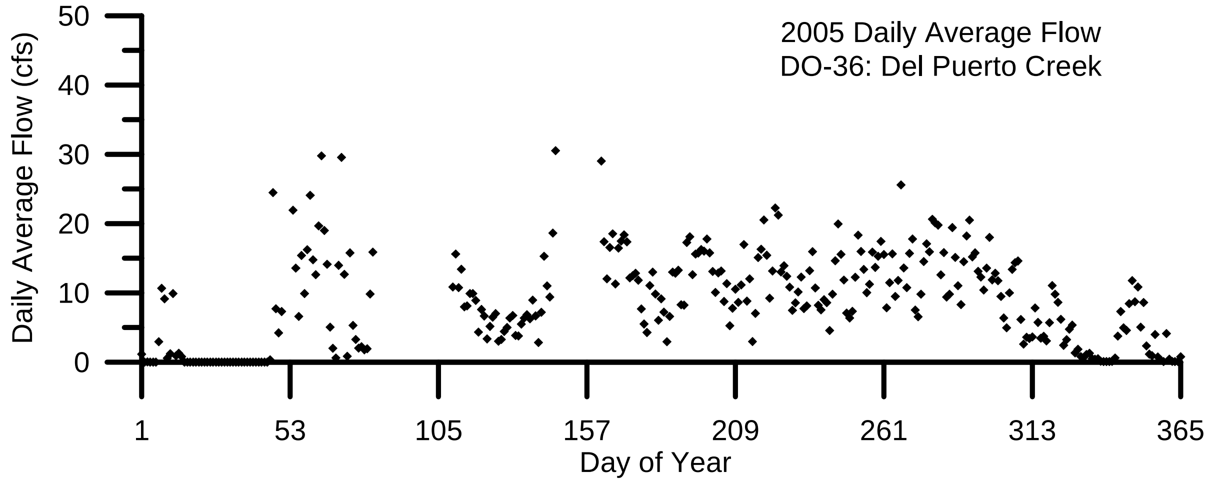


Figure 62: 2005 through 2007 flow plot for DO-36 Del Puerto Creek

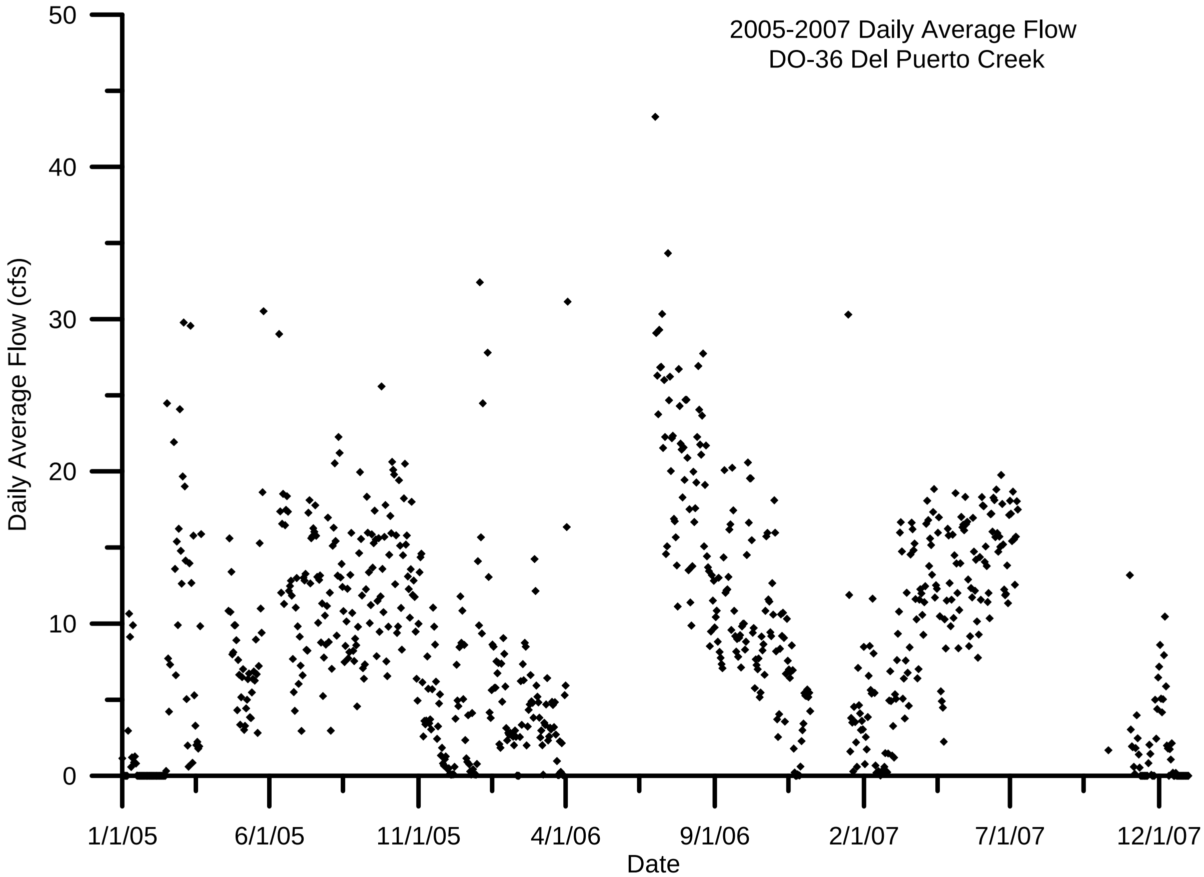
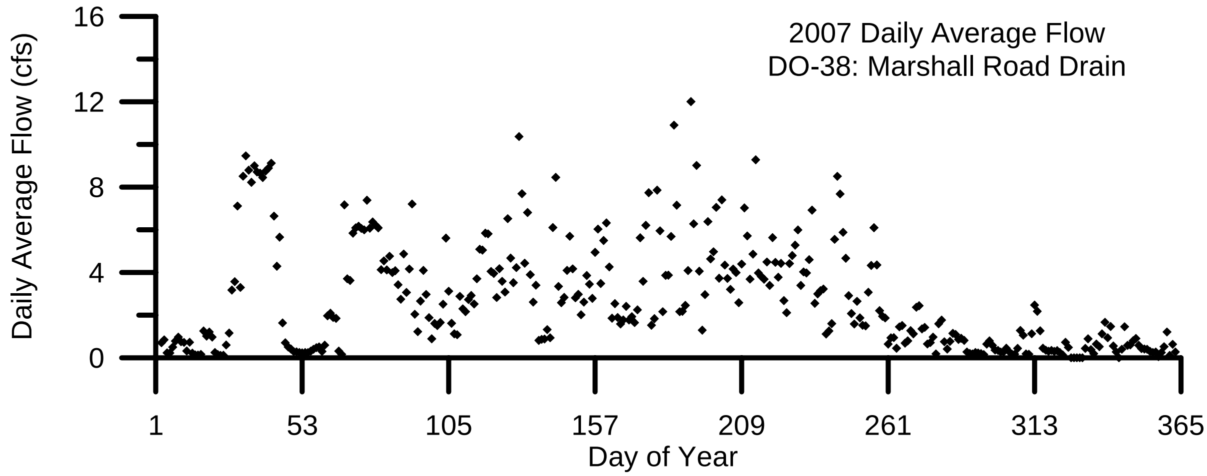
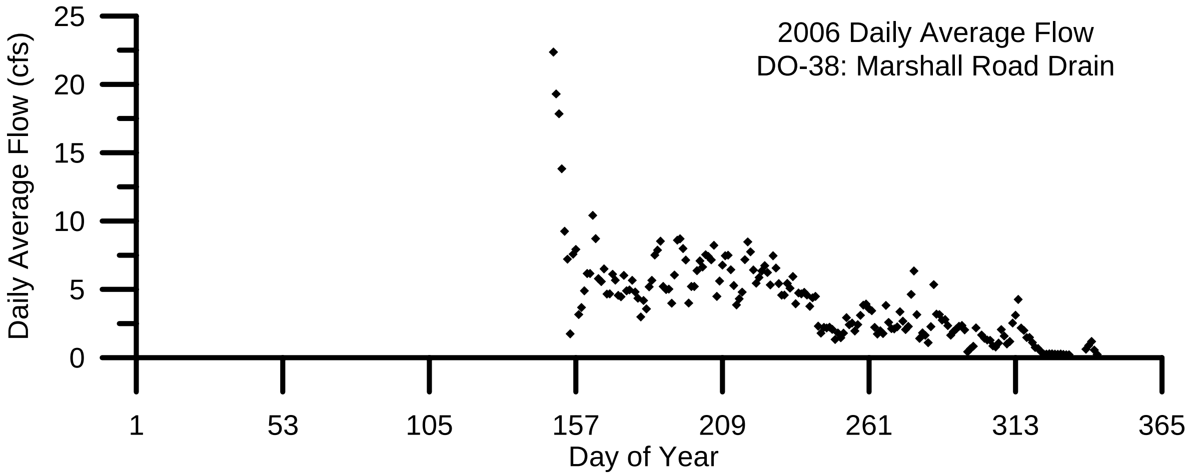


Figure 63: 2005 through 2007 flow plots for DO-38 Marshall Road Drain





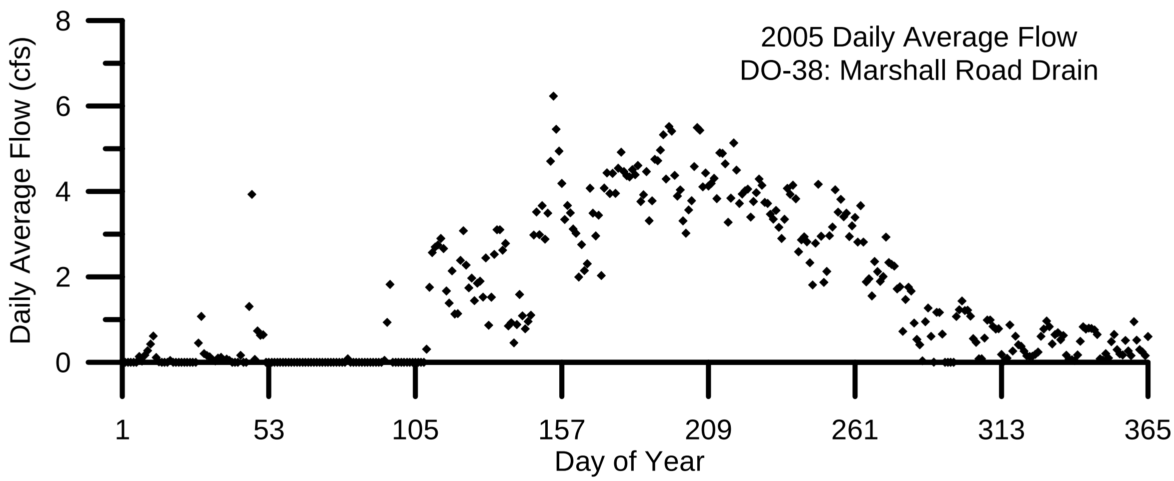


Figure 64: 2005 through 2007 flow plot for DO-38 Marshall Road Drain

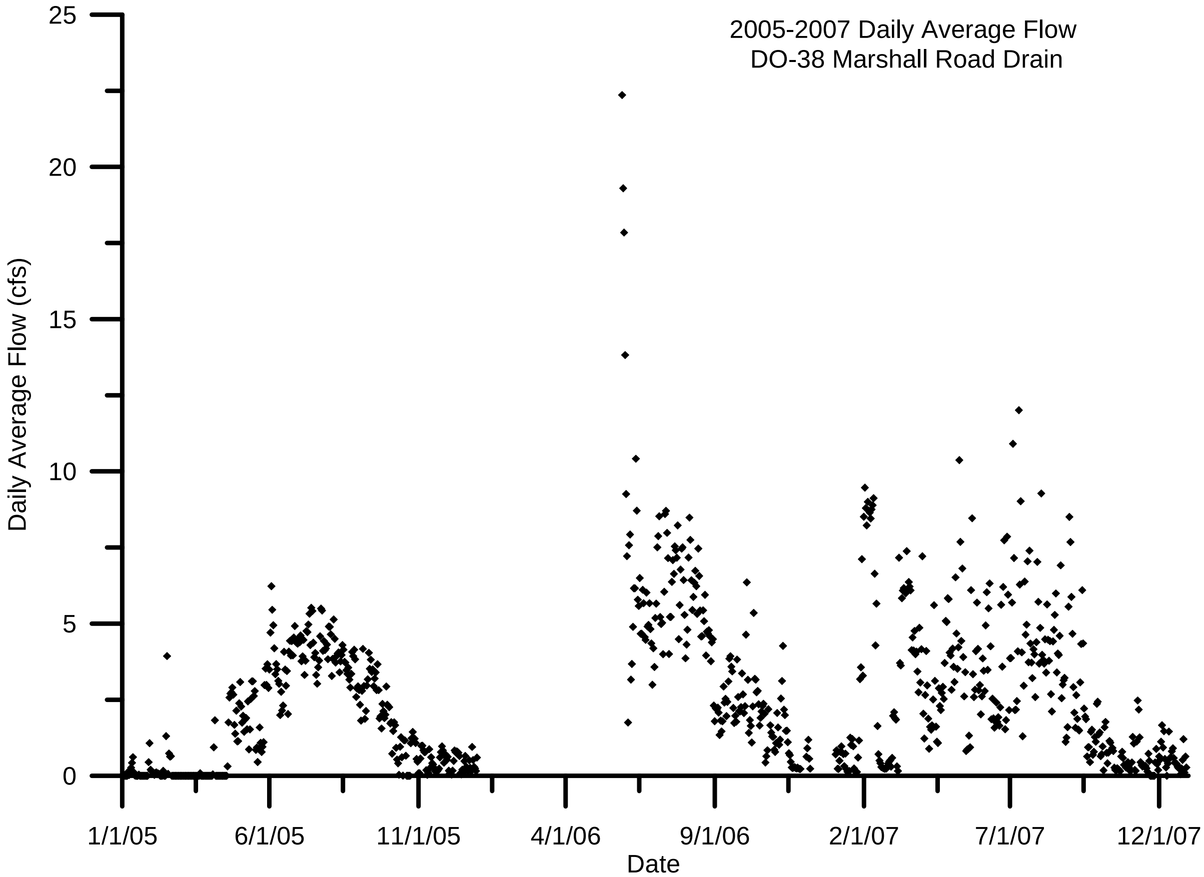


Figure 65: 2005 through 2007 flow plots for DO-40 Patterson Irrigation District

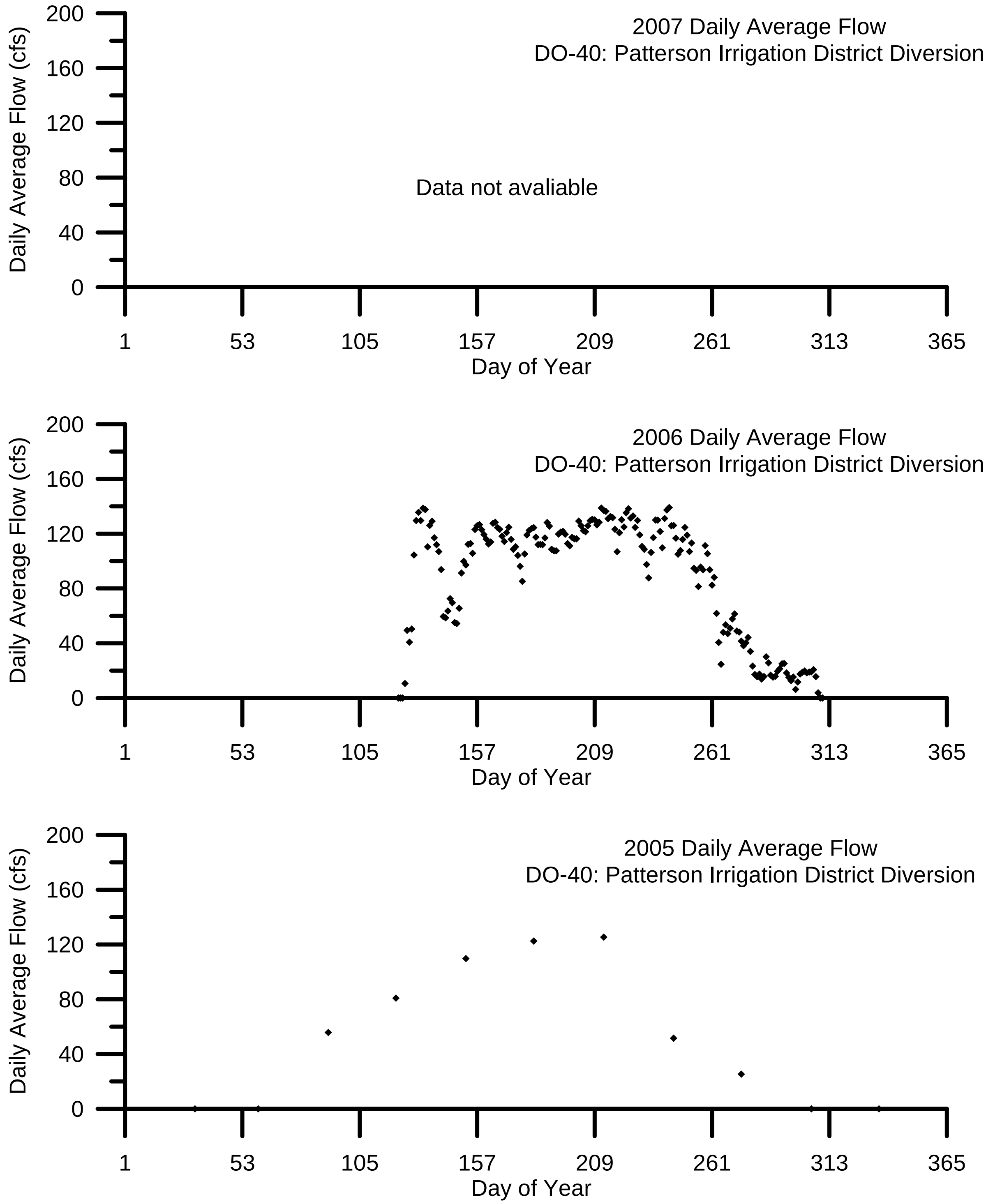


Figure 66: 2005 through 2007 flow plot for DO-40 Patterson Irrigation District

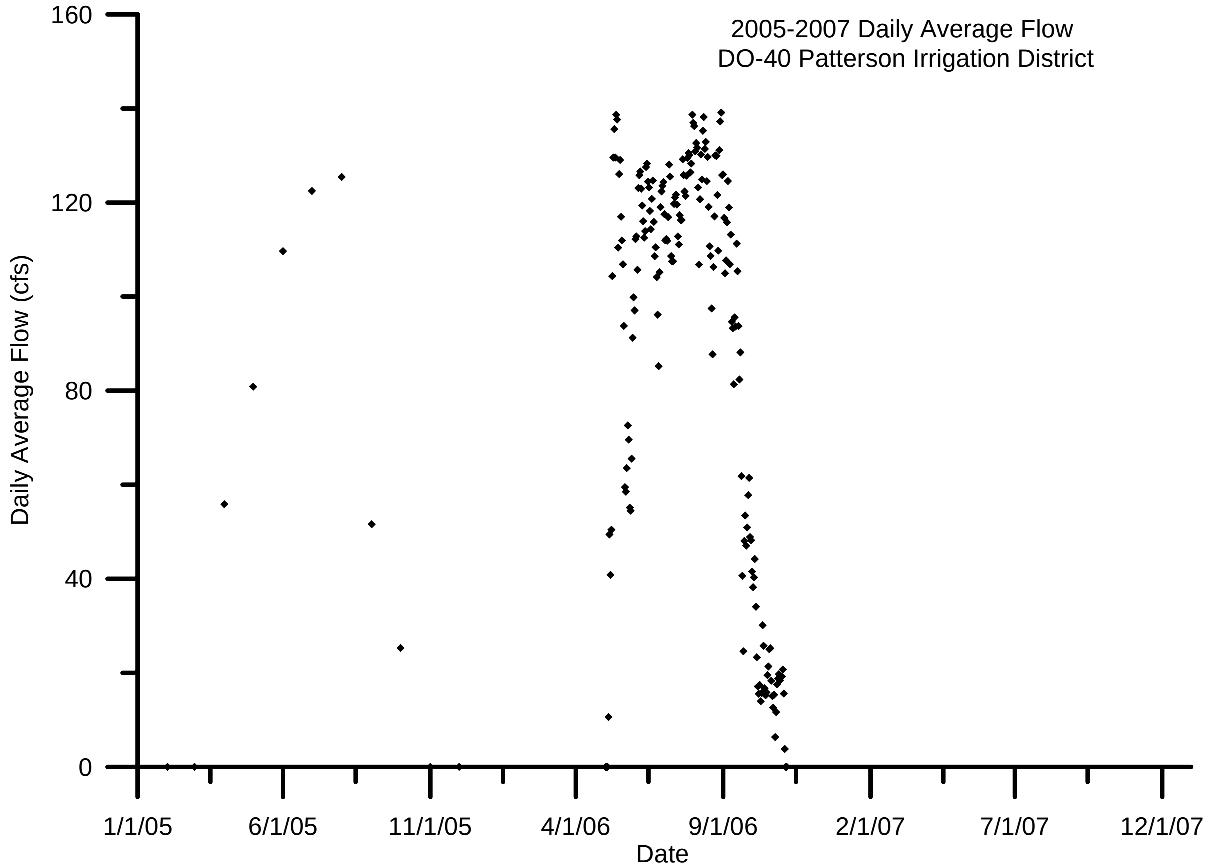


Figure 67: 2005 through 2007 flow plots for DO-41 West Stanislaus Irrigation District Diversion

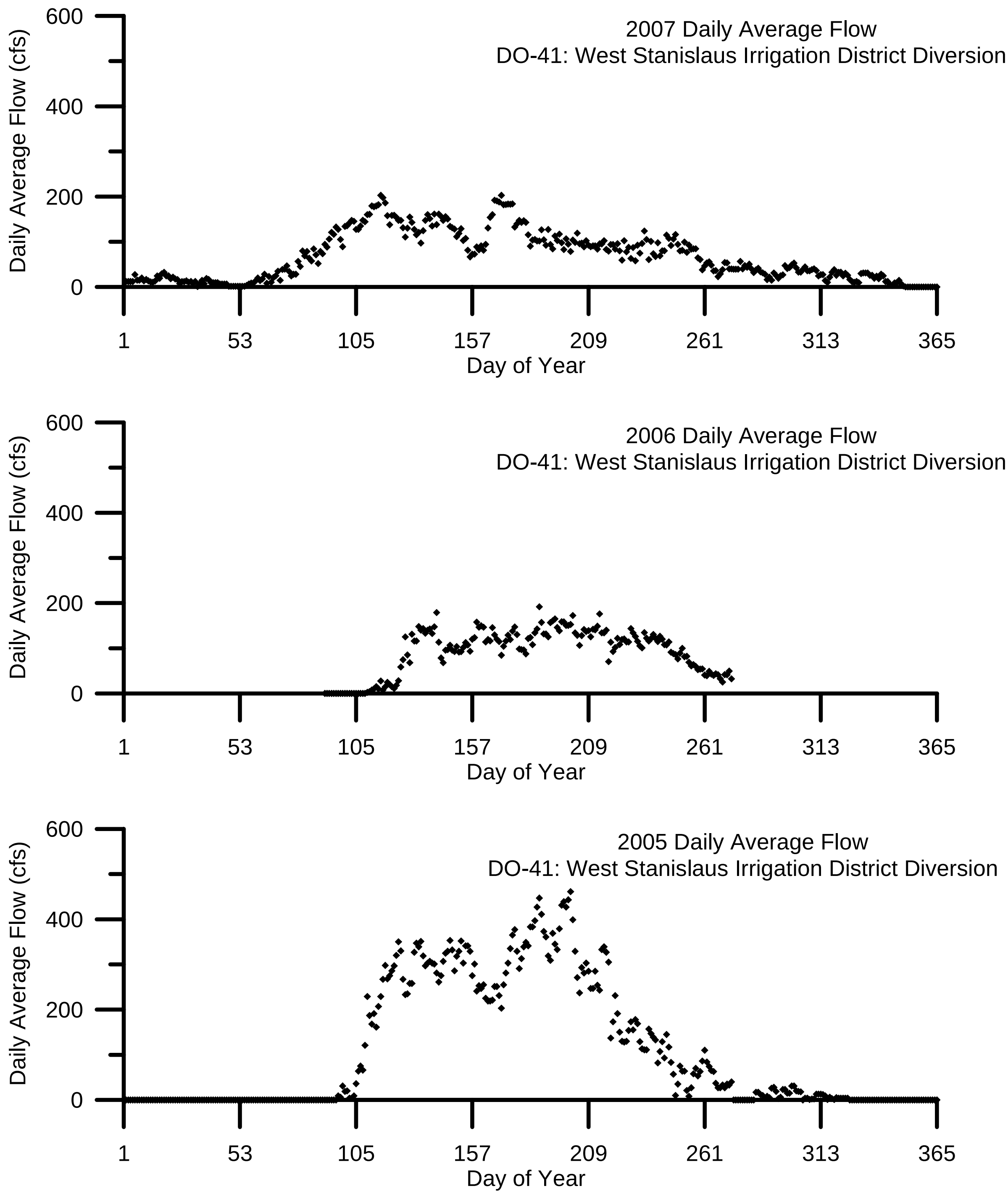


Figure 68: 2005 through 2007 flow plot for DO-41 West Stanislaus Irrigation District Diversion

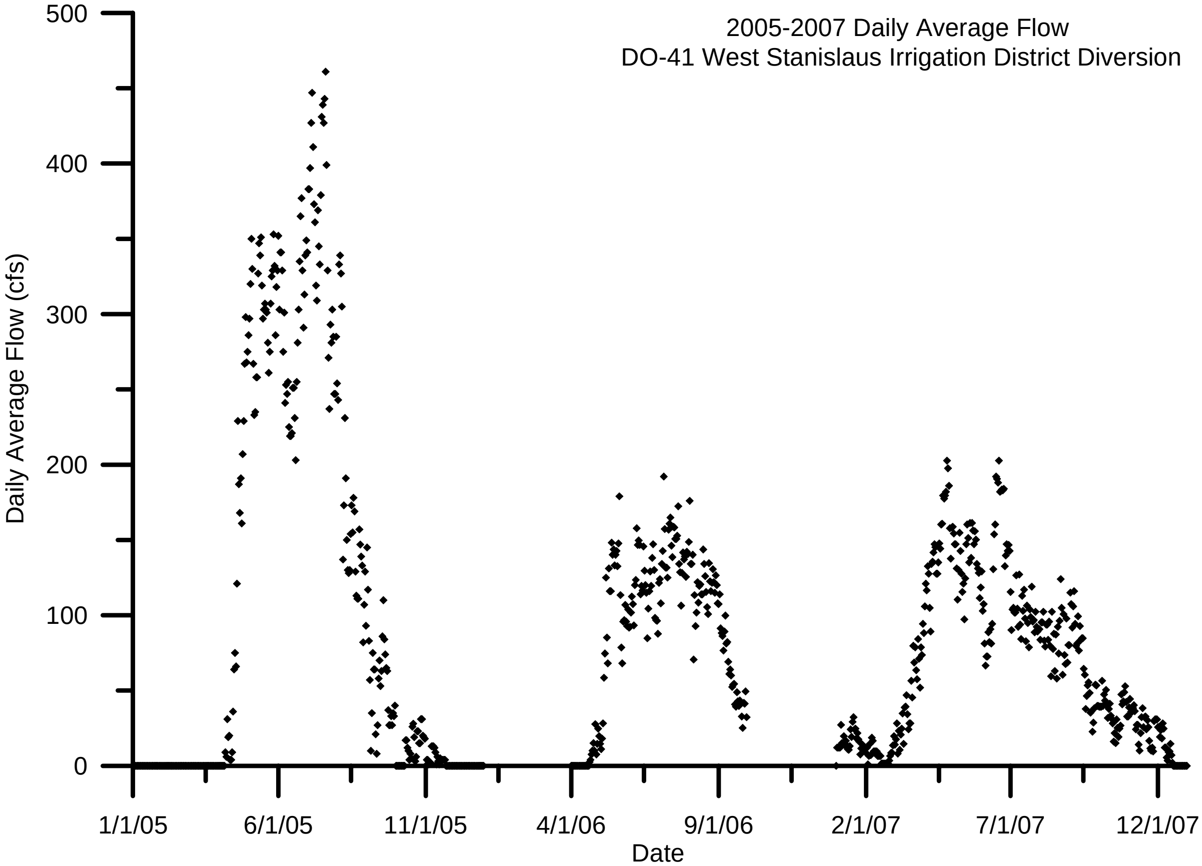
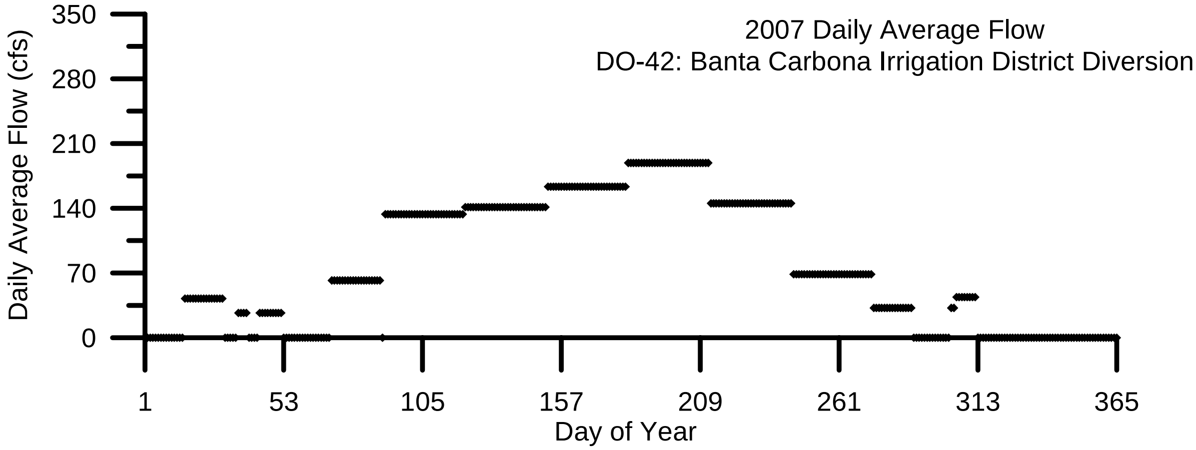
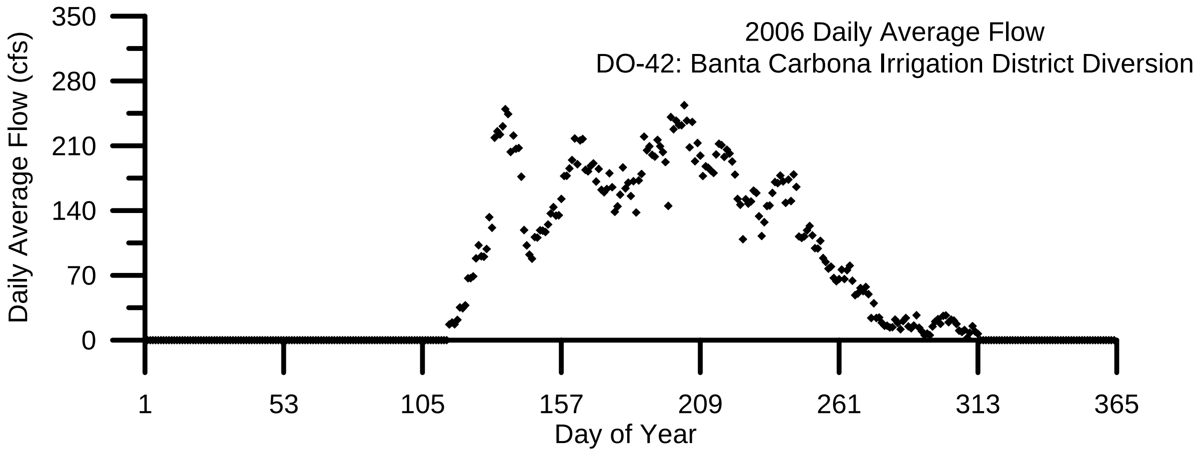


Figure 69: 2005 through 2007 flow plots for DO-42 Banta Carbona Irrigation District Diversion





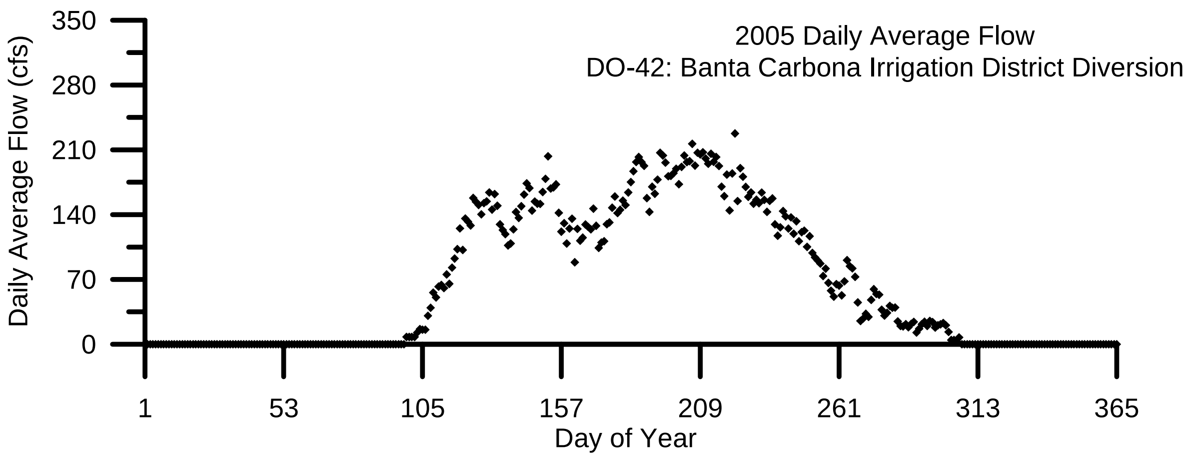


Figure 70: 2005 through 2007 flow plot for DO-42 Banta Carbona Irrigation District Diversion

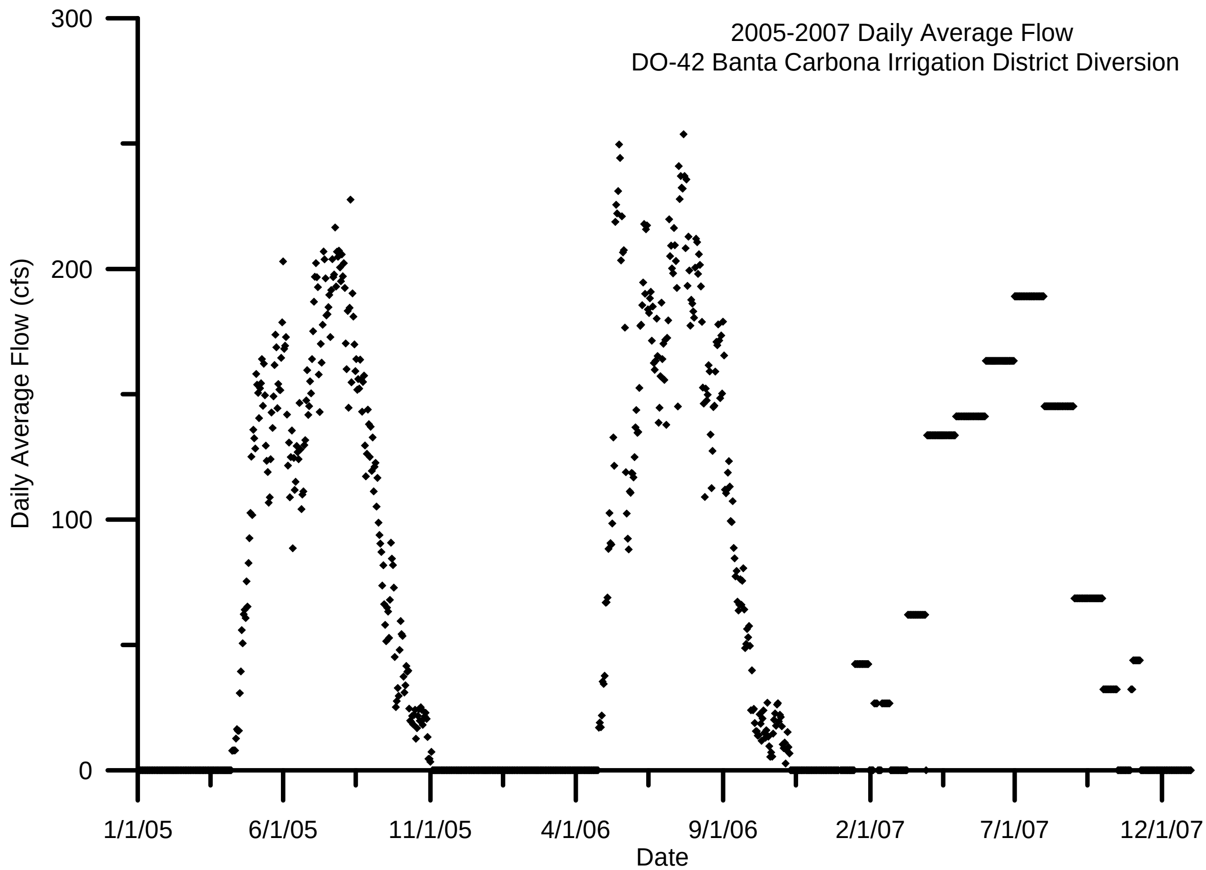
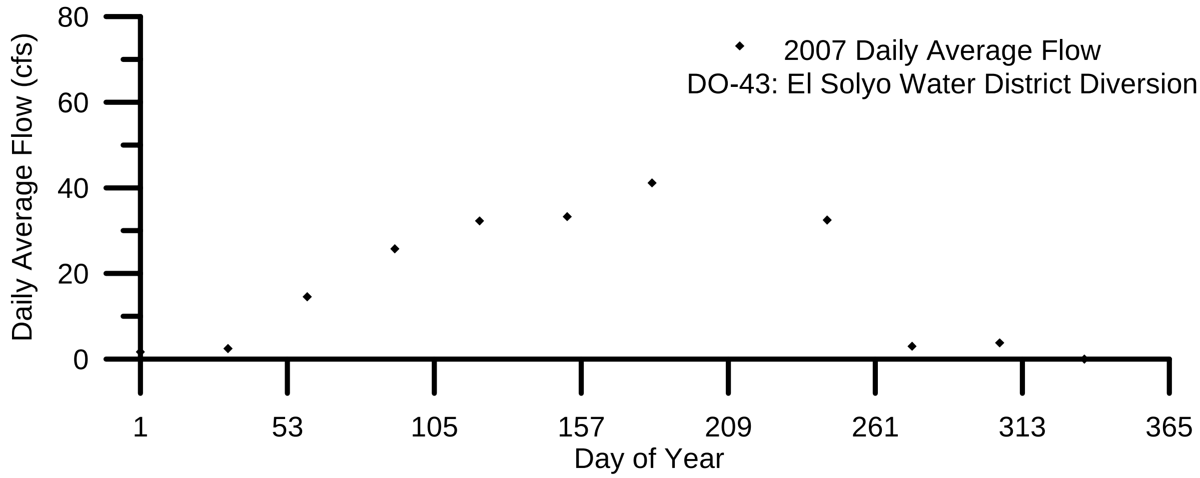
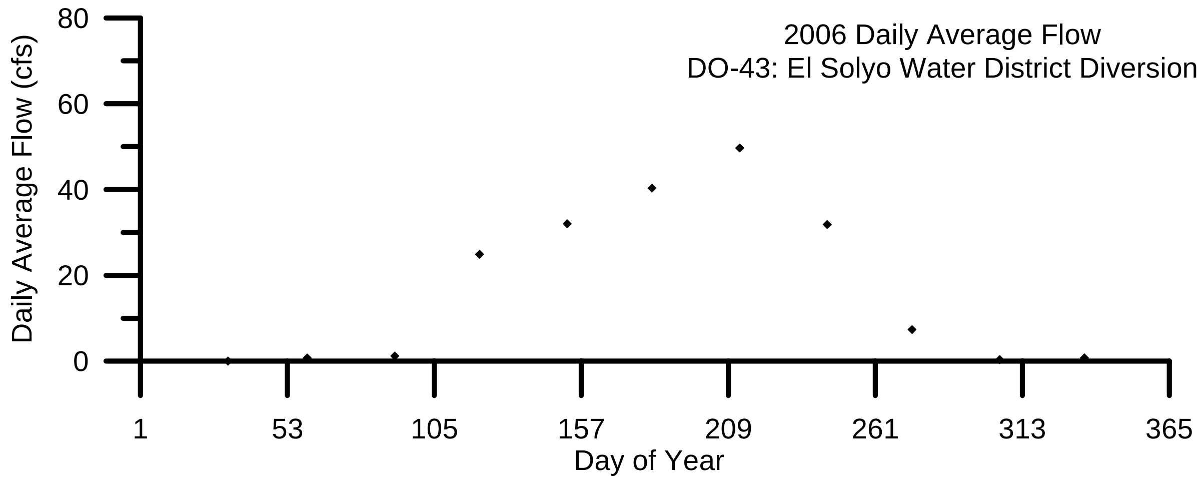


Figure 71: 2005 through 2007 flow plots for DO-43 El Solyo Water District Diversion





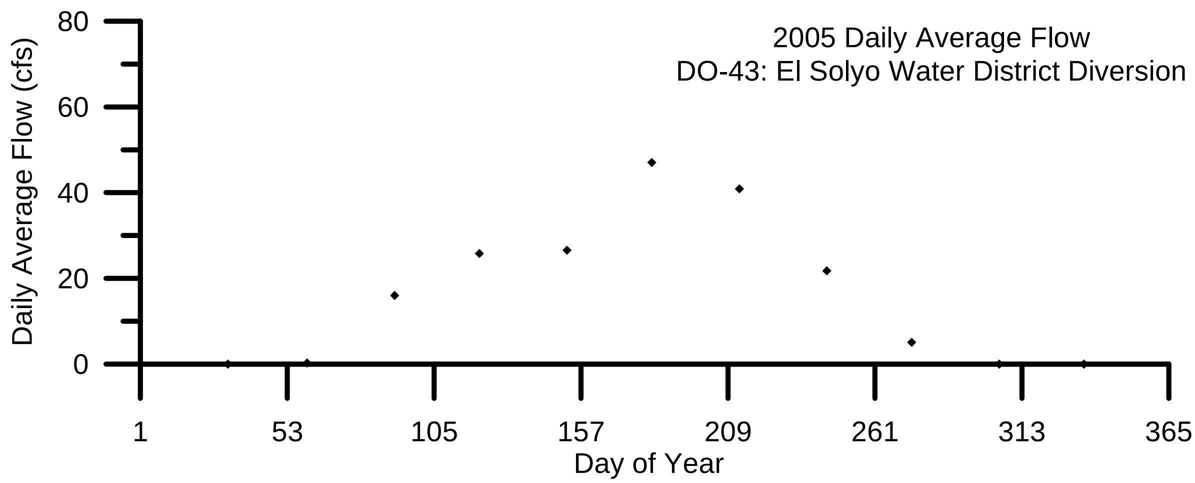


Figure 72: 2005 through 2007 flow plot for DO-43 El Solyo Water District Diversion

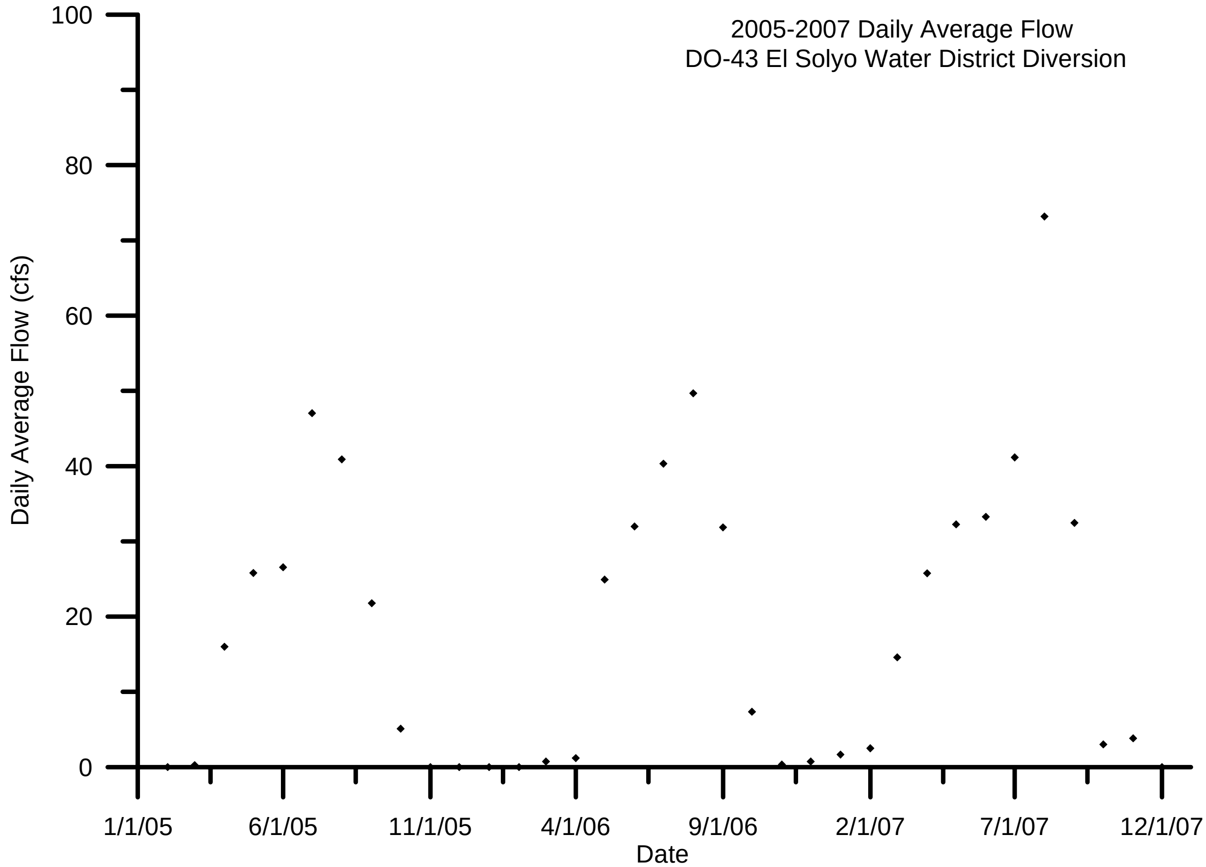
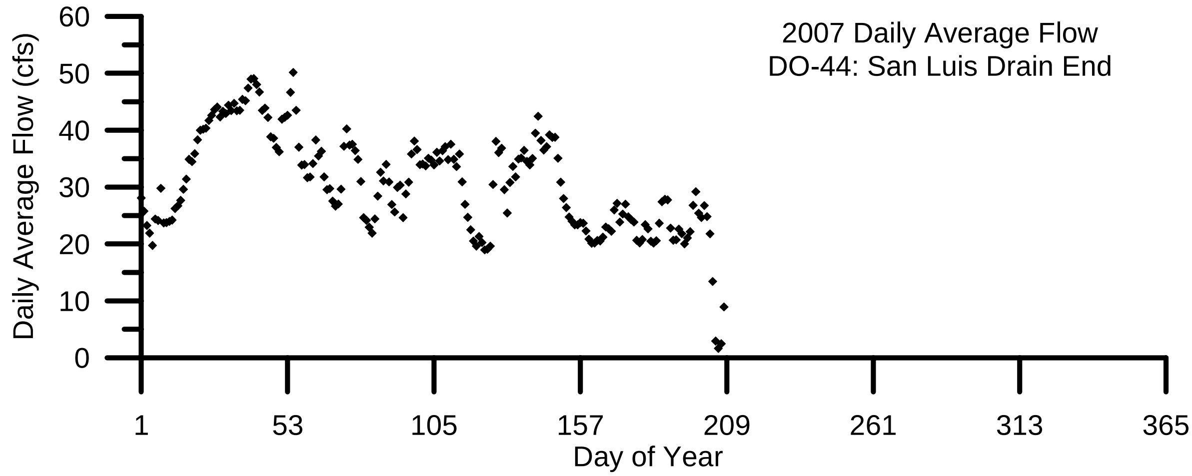
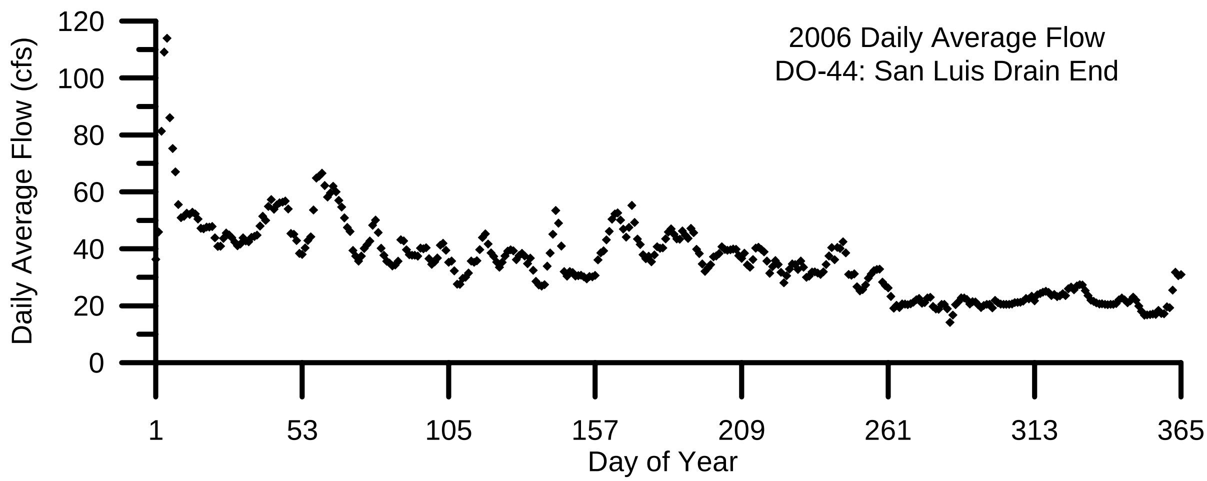


Figure 73: 2005 through 2007 flow plots for DO-44 San Luis Drain End





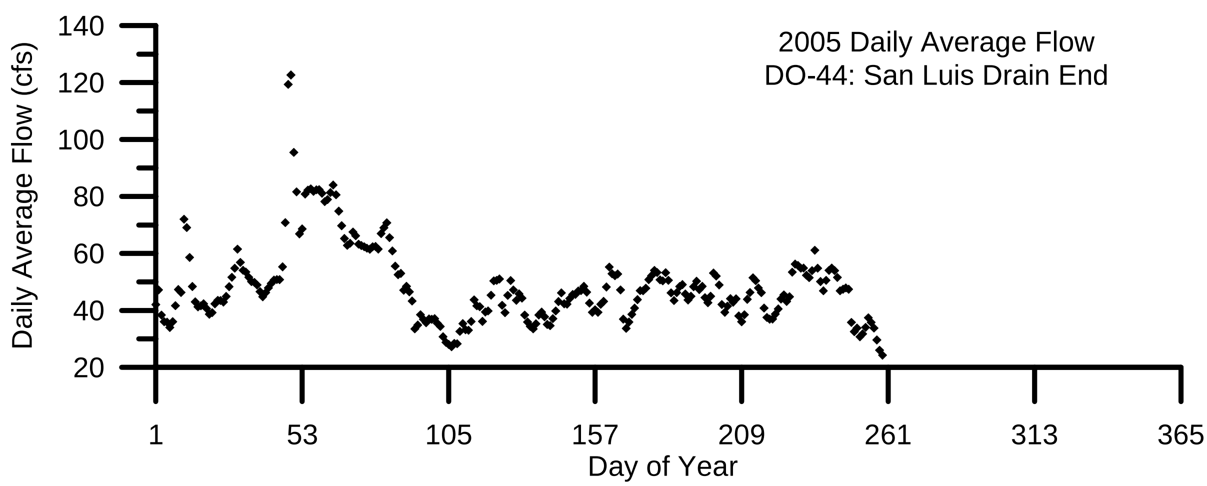


Figure 74: 2005 through 2007 flow plot for DO-44 San Luis Drain End

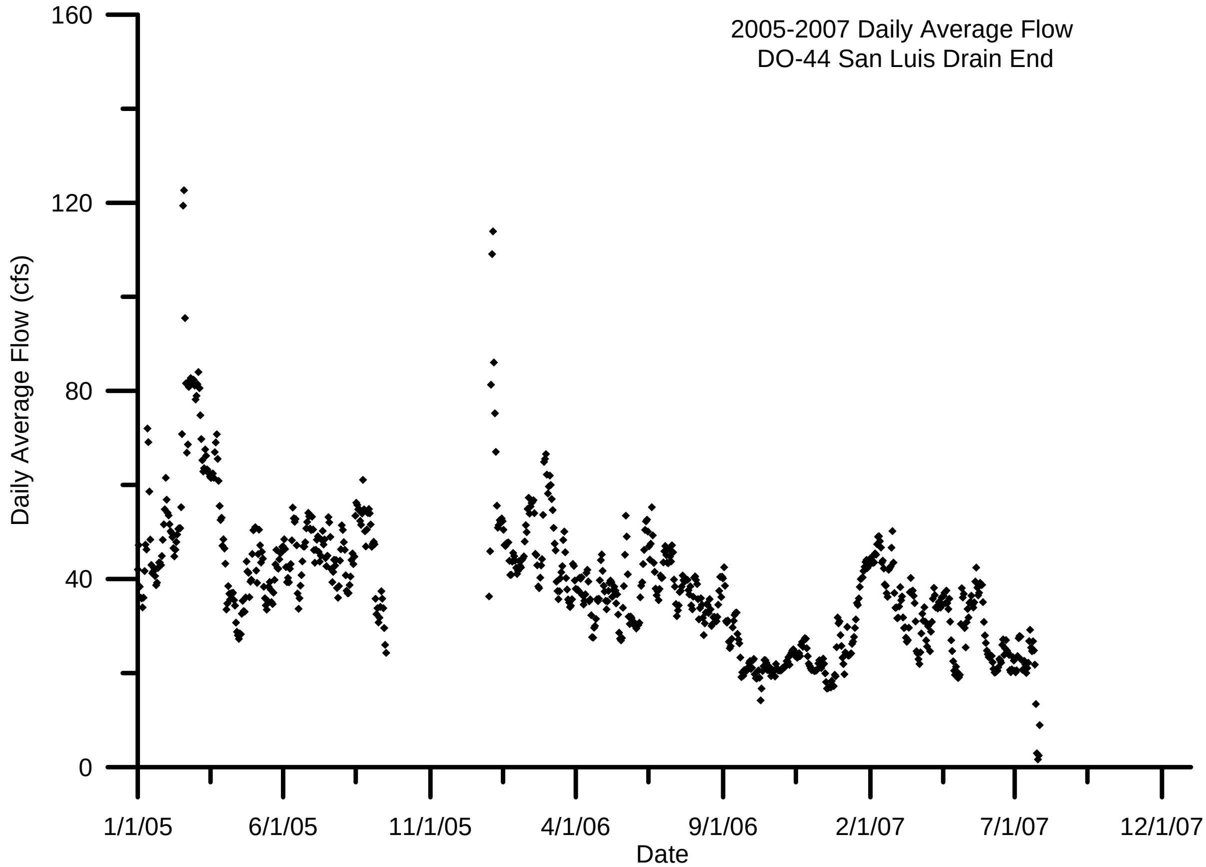
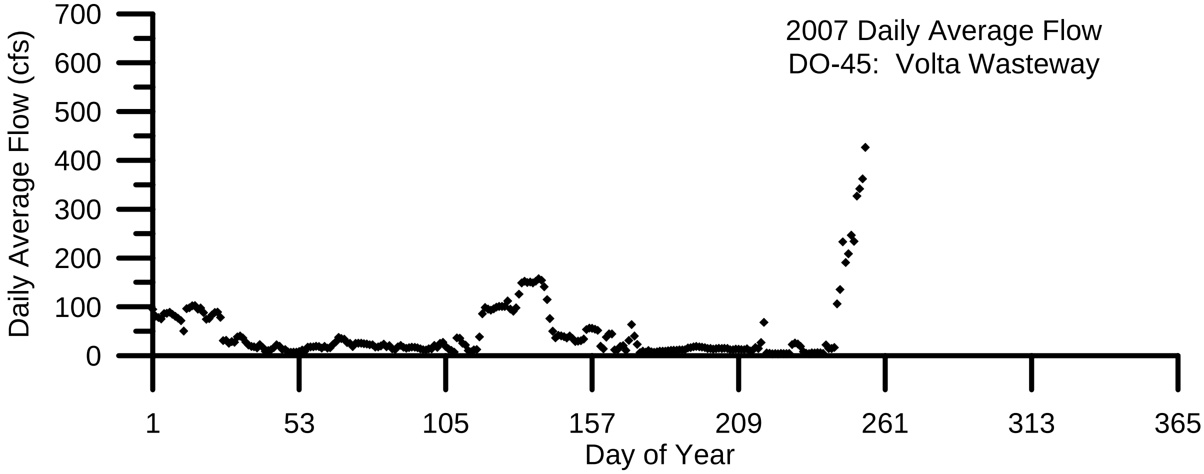
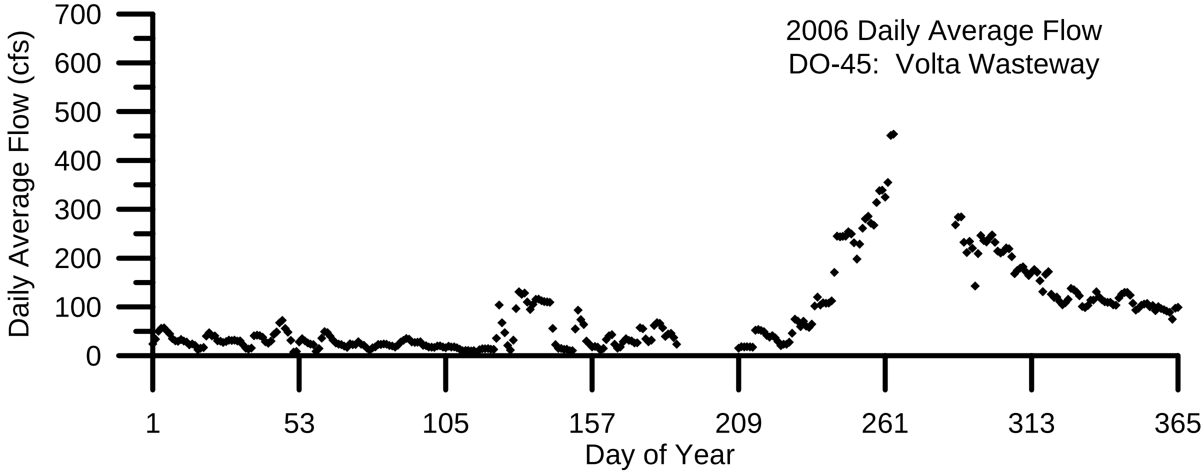


Figure 75: 2005 through 2007 flow plots for DO-45 Volta Wasteway





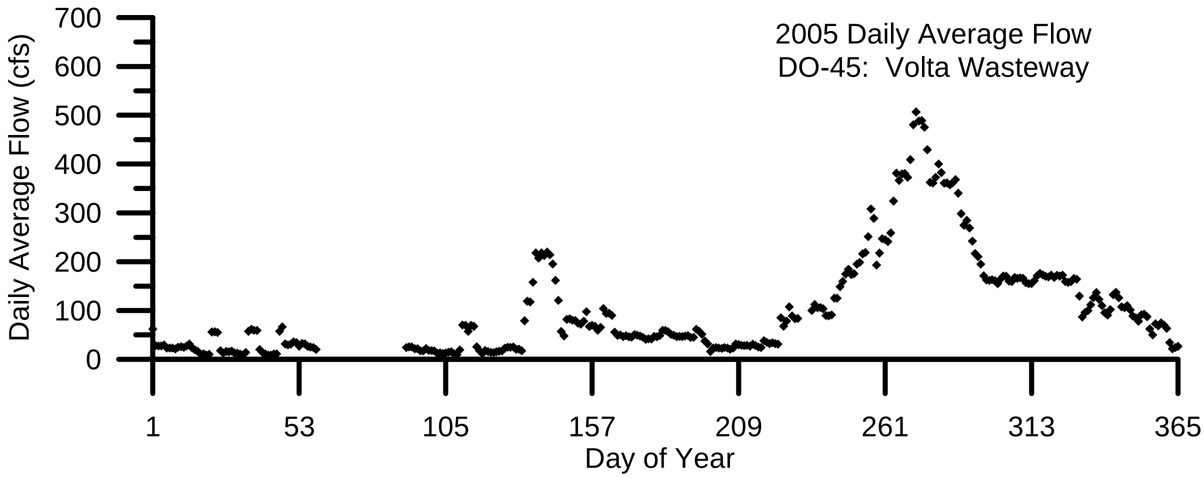


Figure 76: 2005 through 2007 flow plot for DO-45 Volta Wasteway

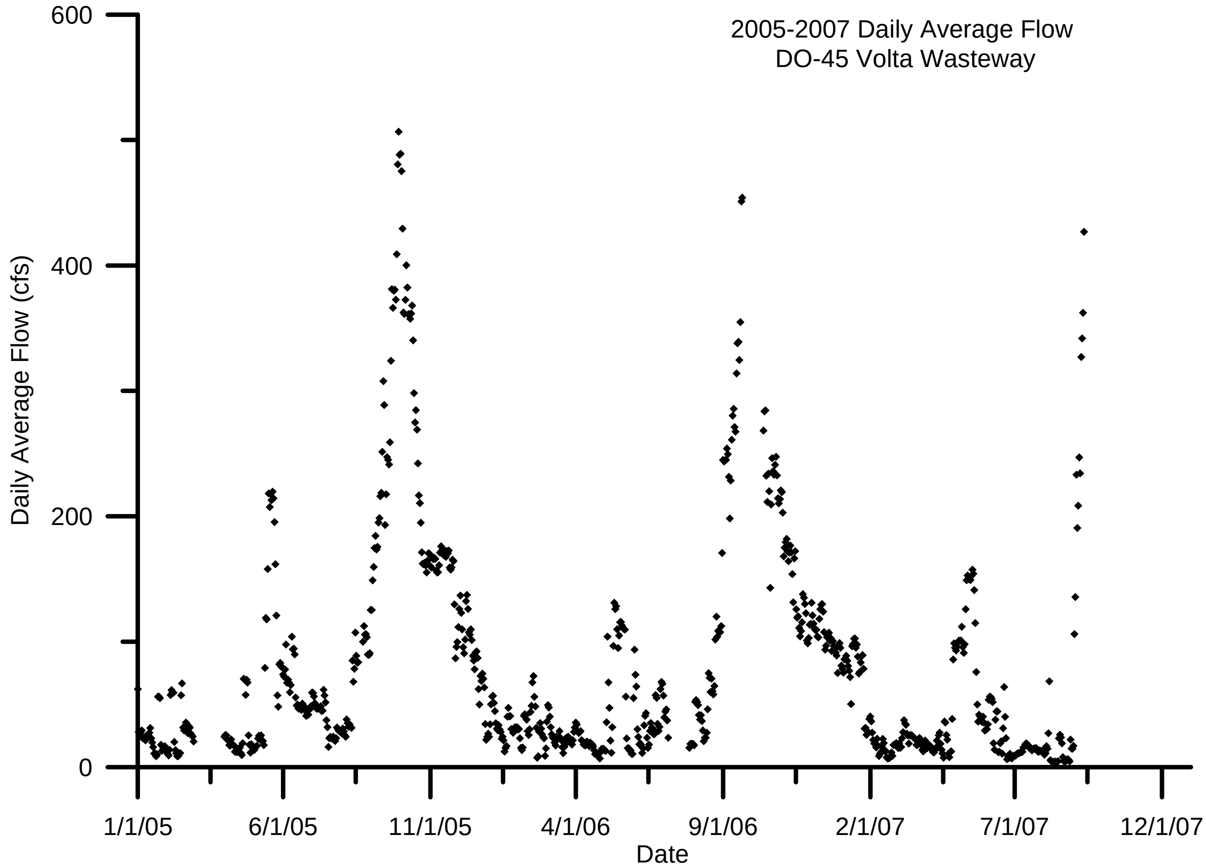
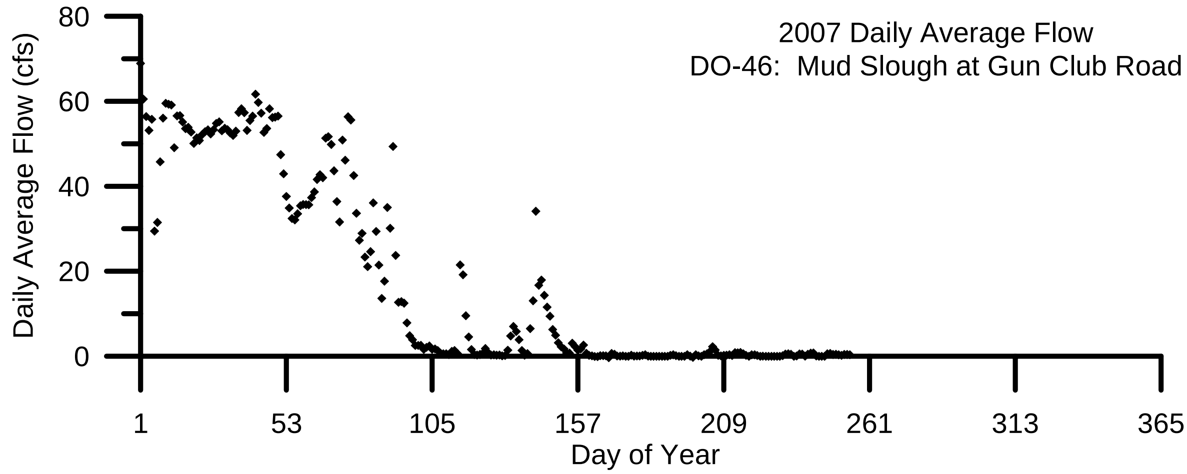
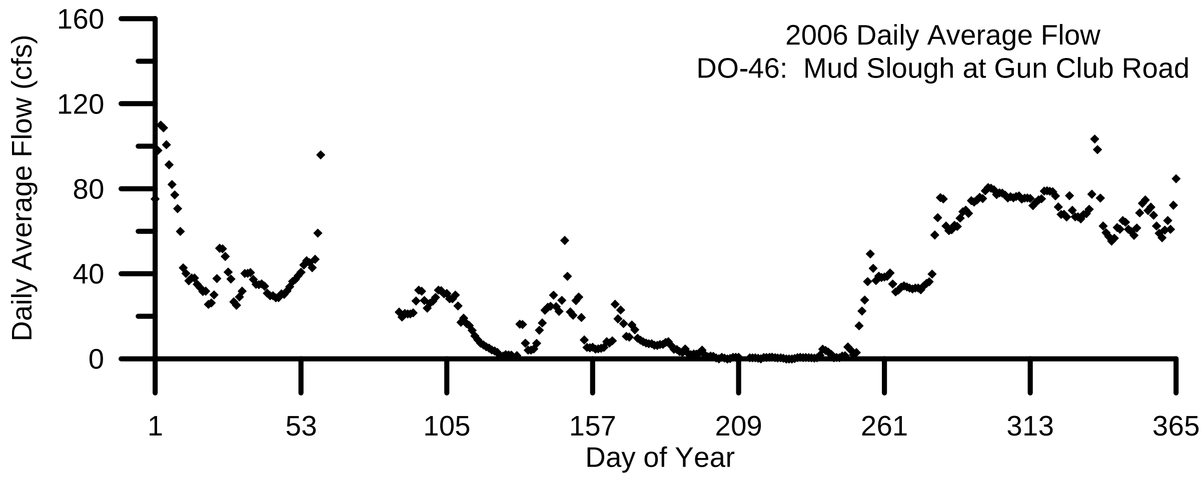


Figure 77: 2005 through 2007 flow plots for DO-46 Mud Slough at Gun Club Road





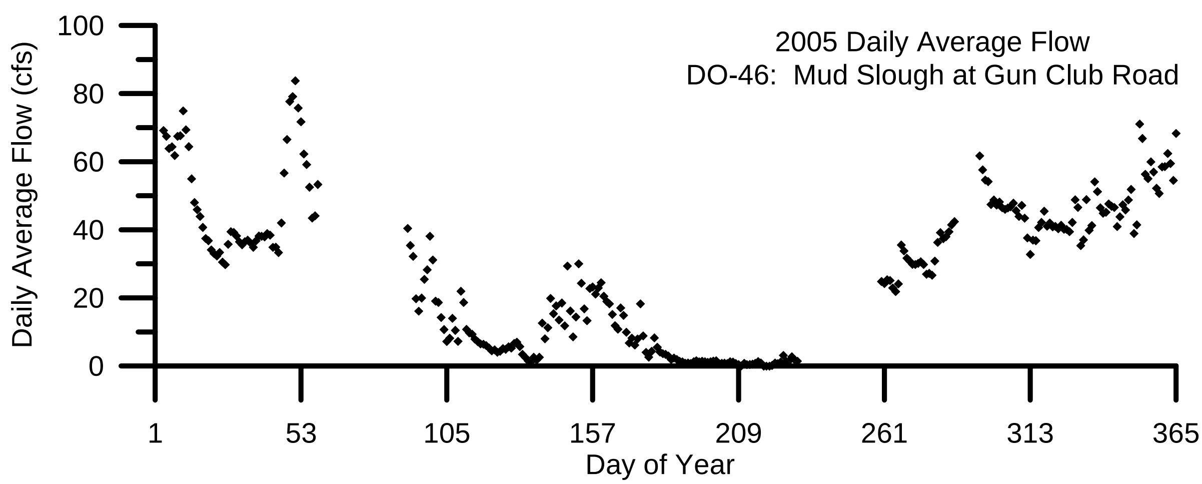


Figure 78: 2005 through 2007 flow plot for DO-46 Mud Slough at Gun Club Road

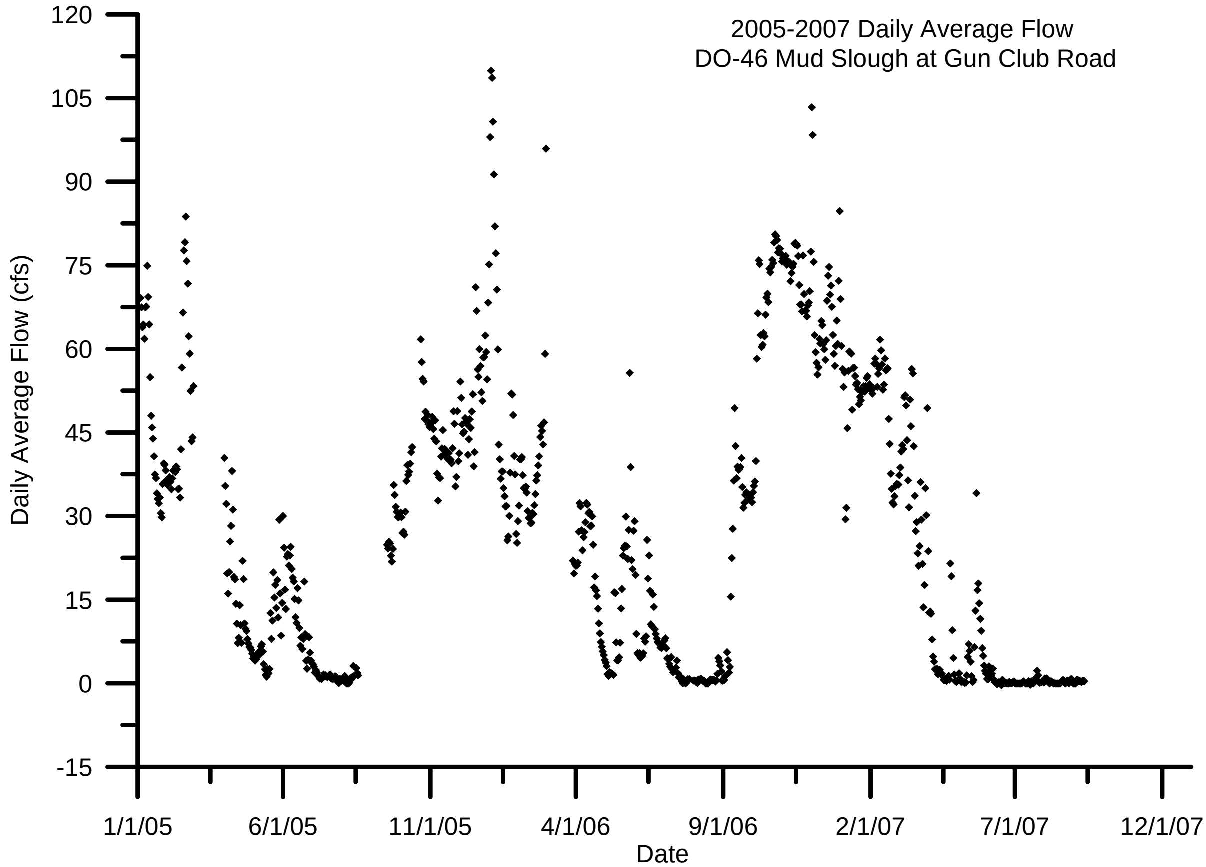


Figure 79: 2005 through 2007 flow plots for DO-47 Delta-Mendota Canal at HW 140

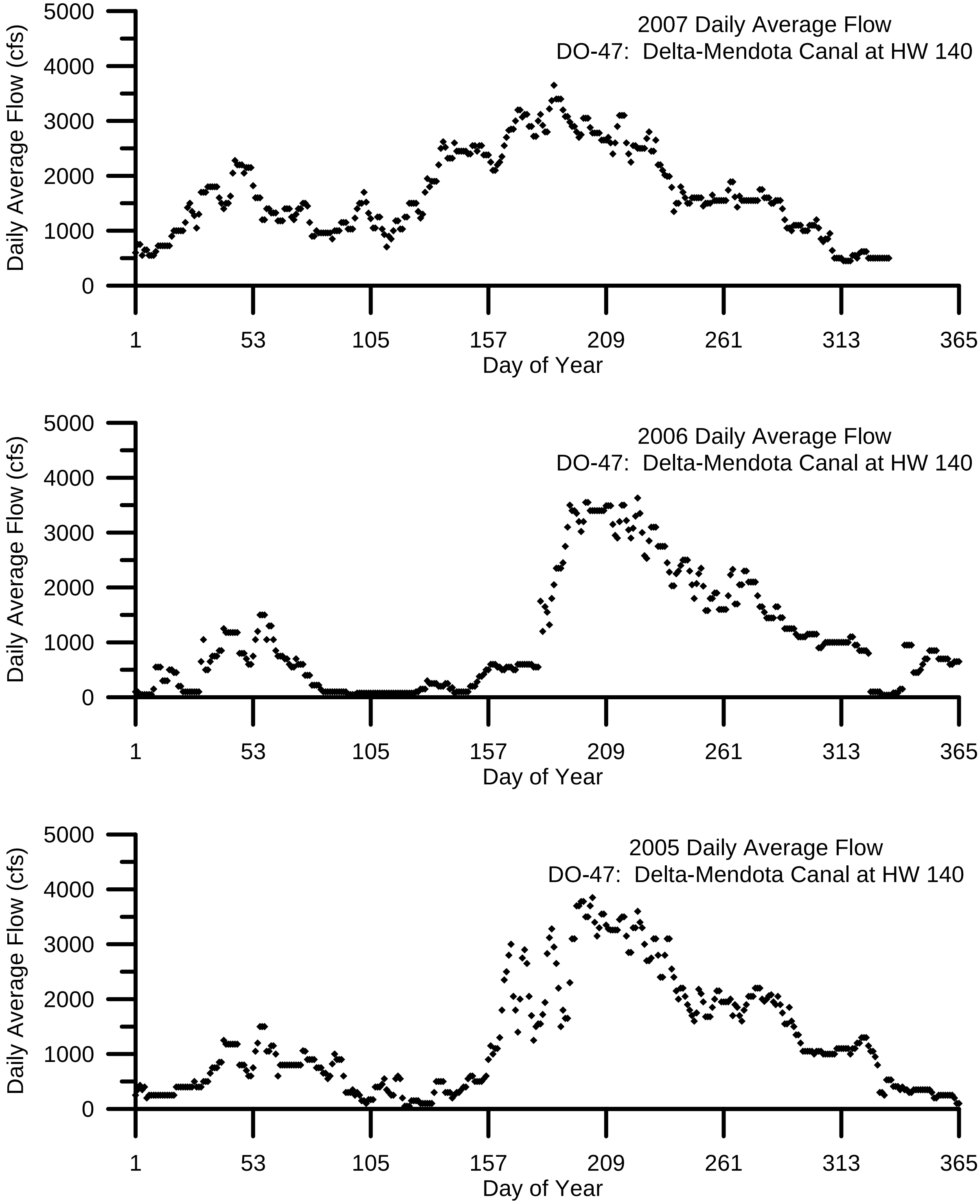


Figure 80: 2005 through 2007 flow plot for DO-47 Delta-Mendota Canal at HW 140

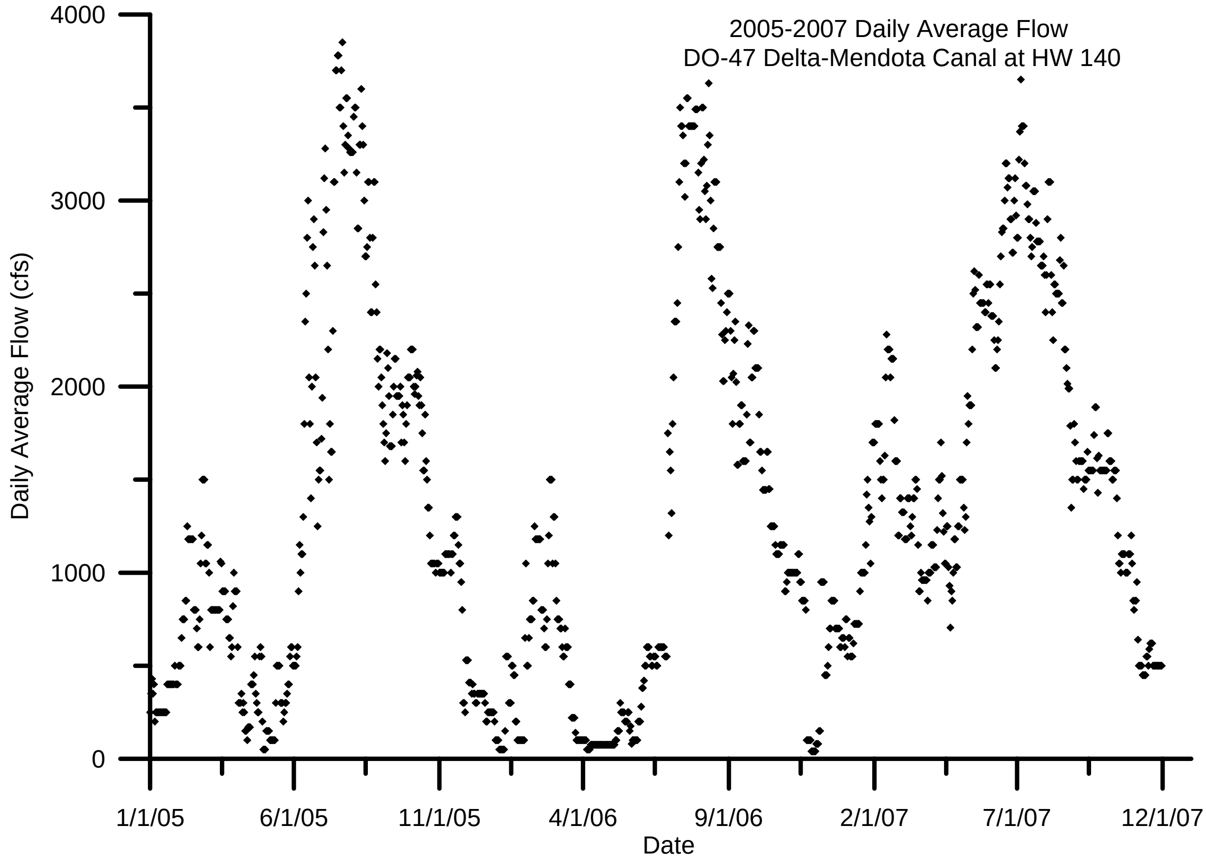
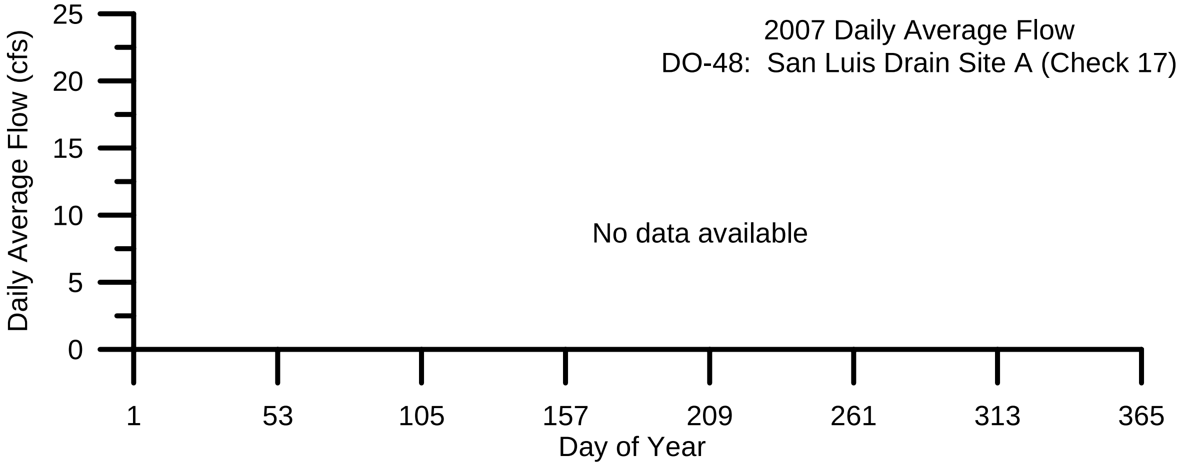
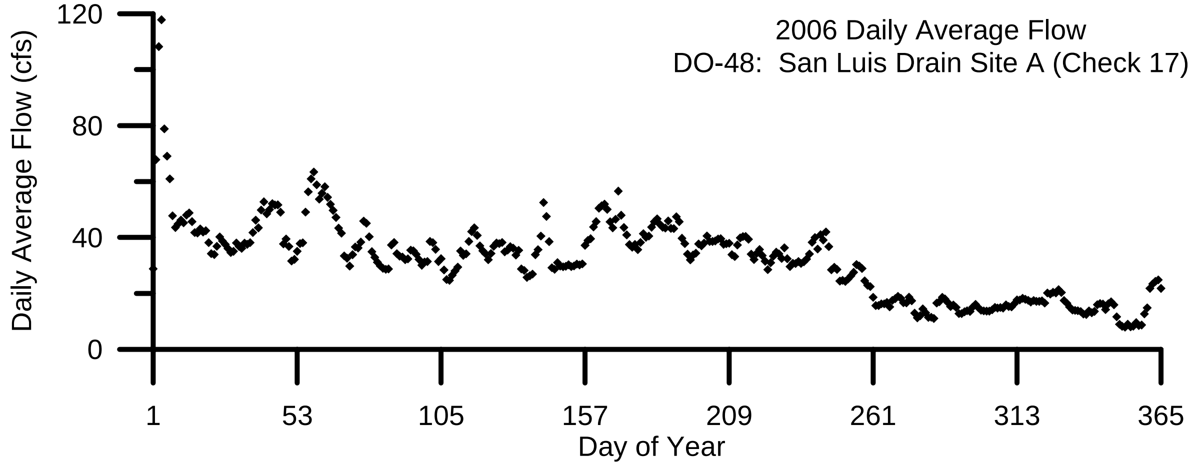


Figure 81: 2005 through 2007 flow plots for DO-48 San Luis Drain Site A (Check 17)





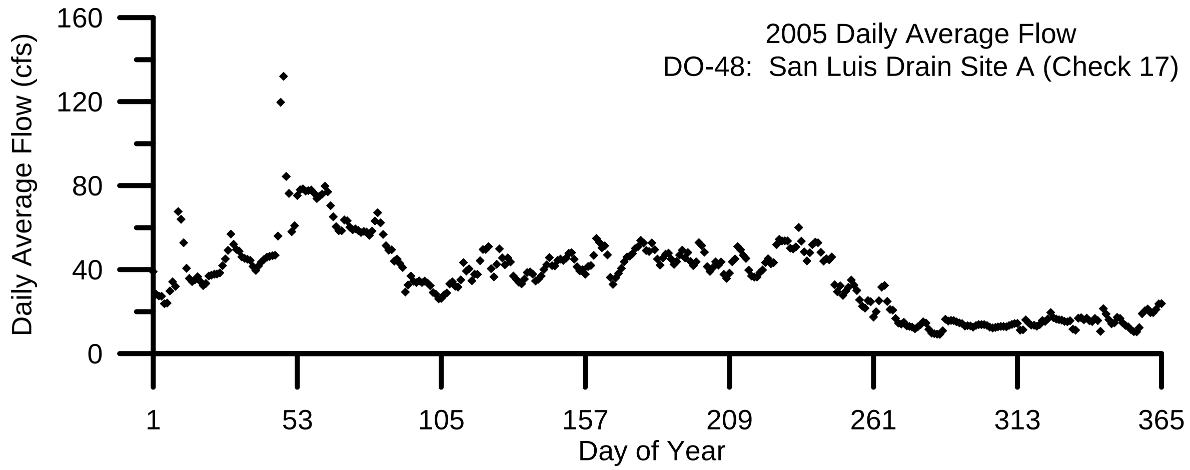


Figure 82: 2005 through 2007 flow plot for DO-48 San Luis Drain Site A (Check 17)

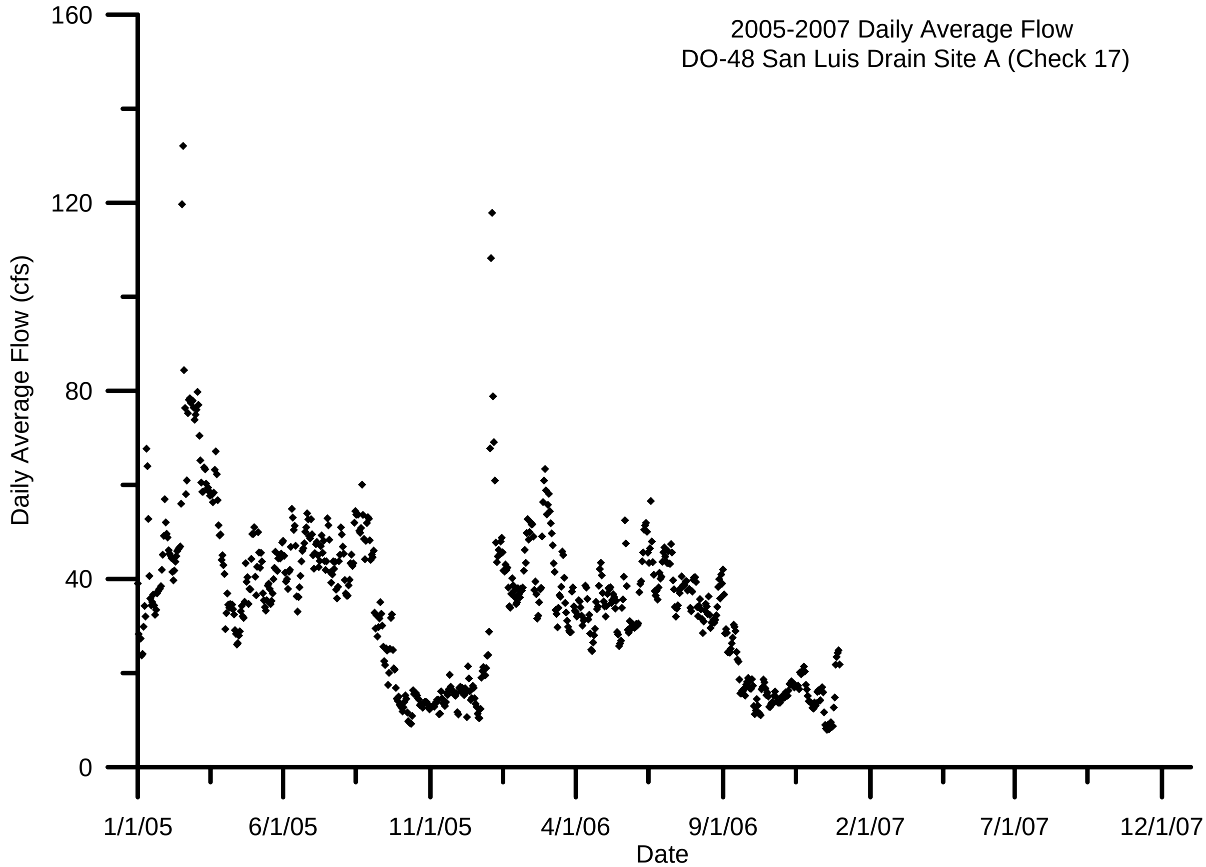
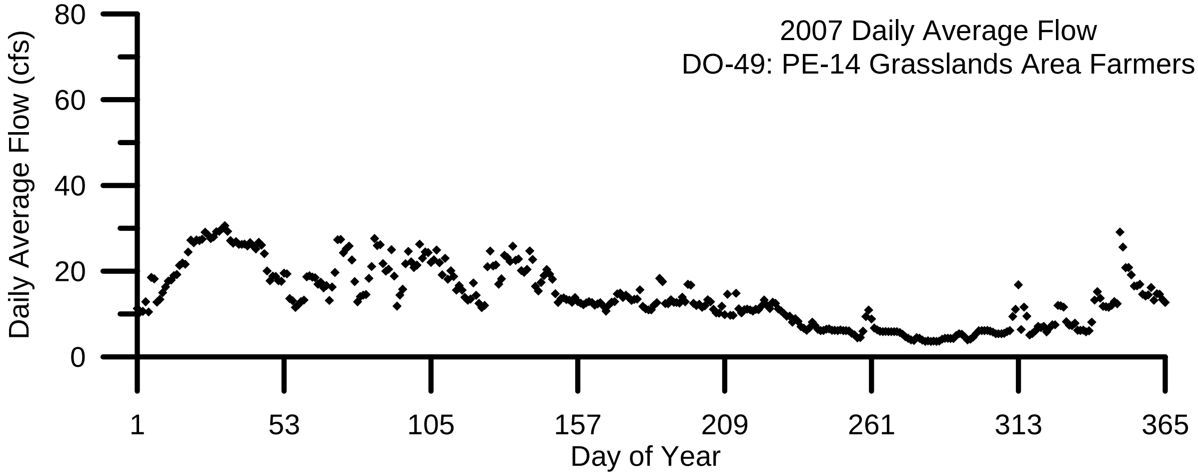
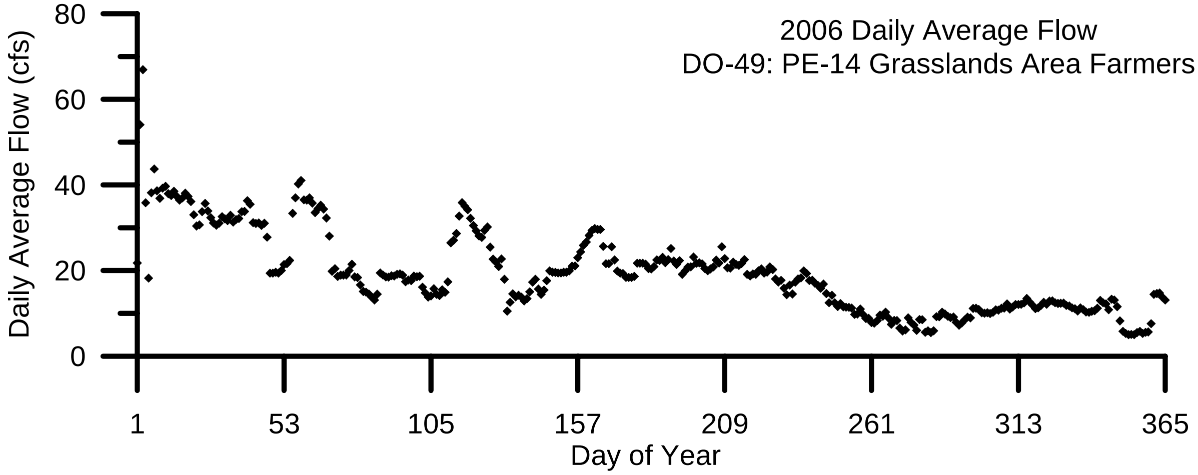


Figure 83: 2005 through 2007 flow plots for DO-49 PE-14 Grasslands Area Farmers





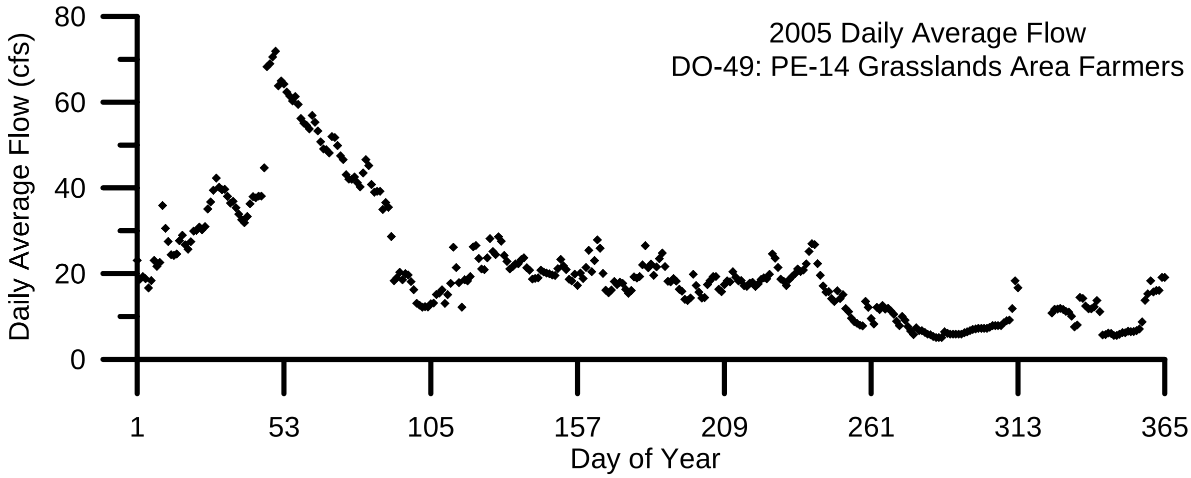


Figure 84: 2005 through 2007 flow plot for DO-49 PE-14 Grasslands Area Farmers

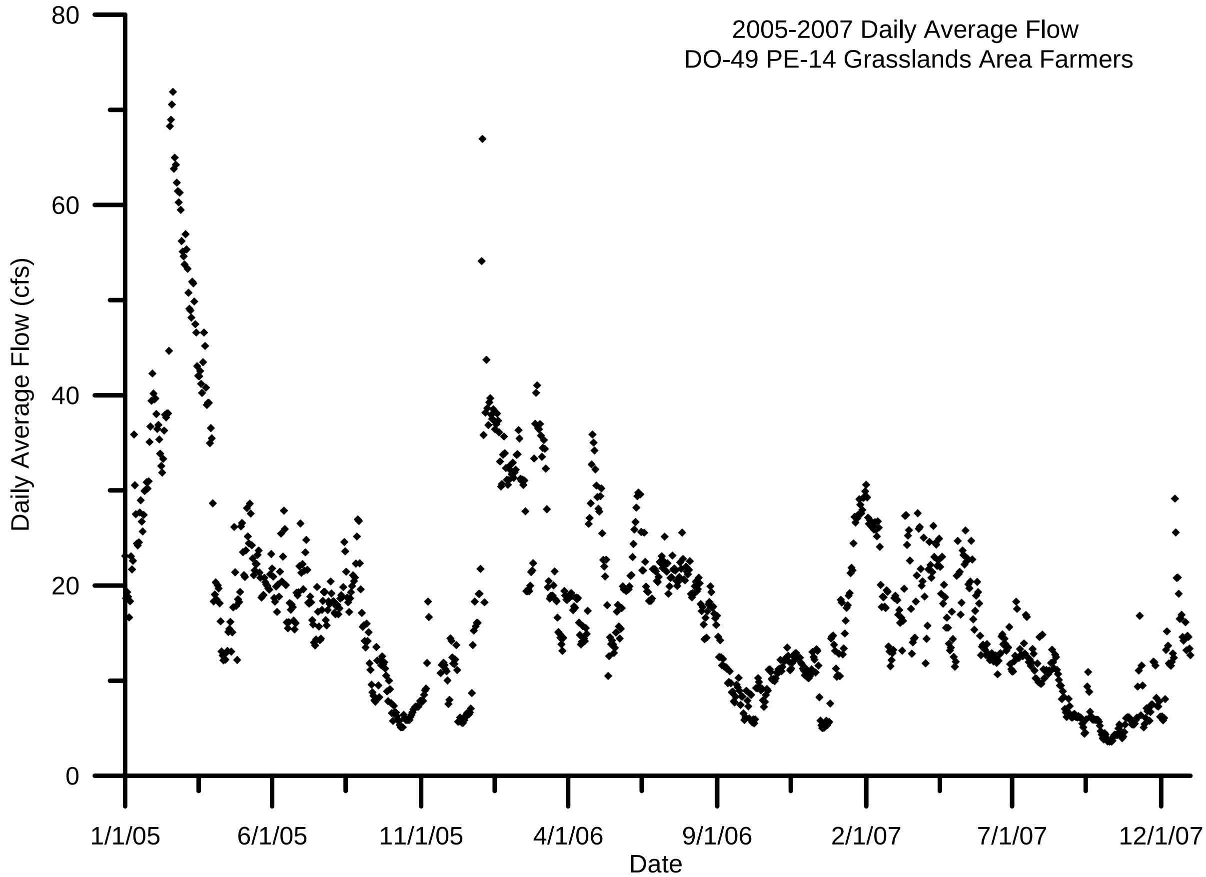
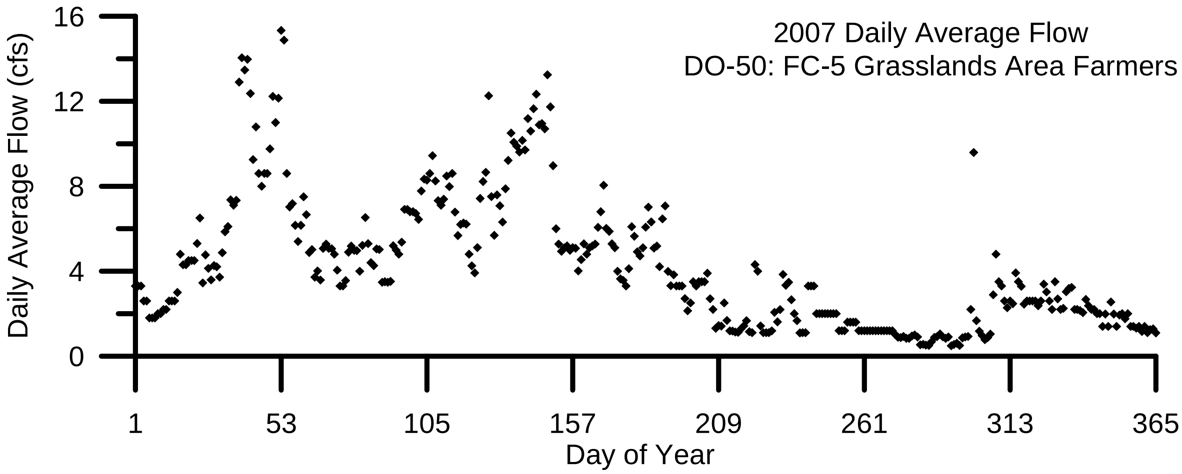
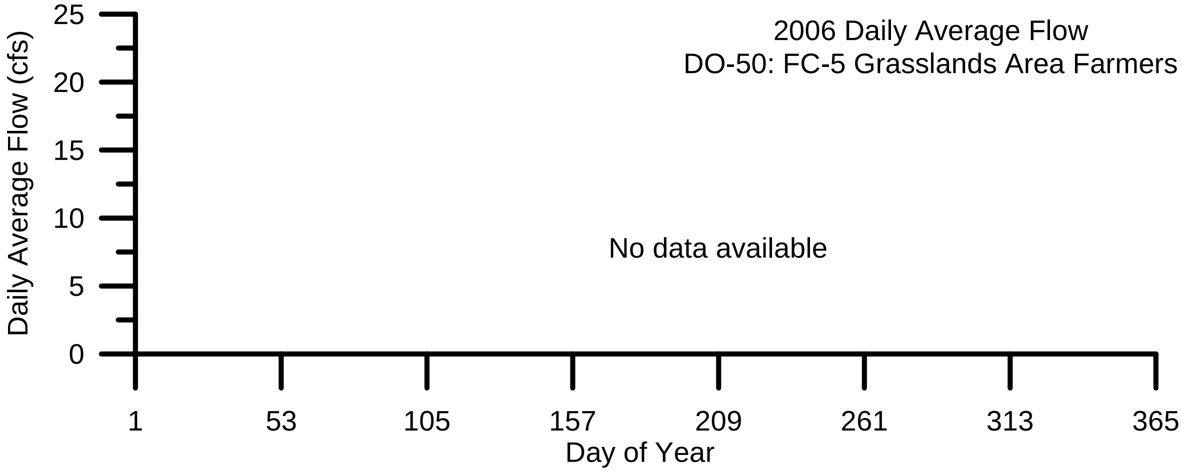


Figure 85: 2005 through 2007 flow plots for DO-50 FC-5 Grasslands Area Farmers





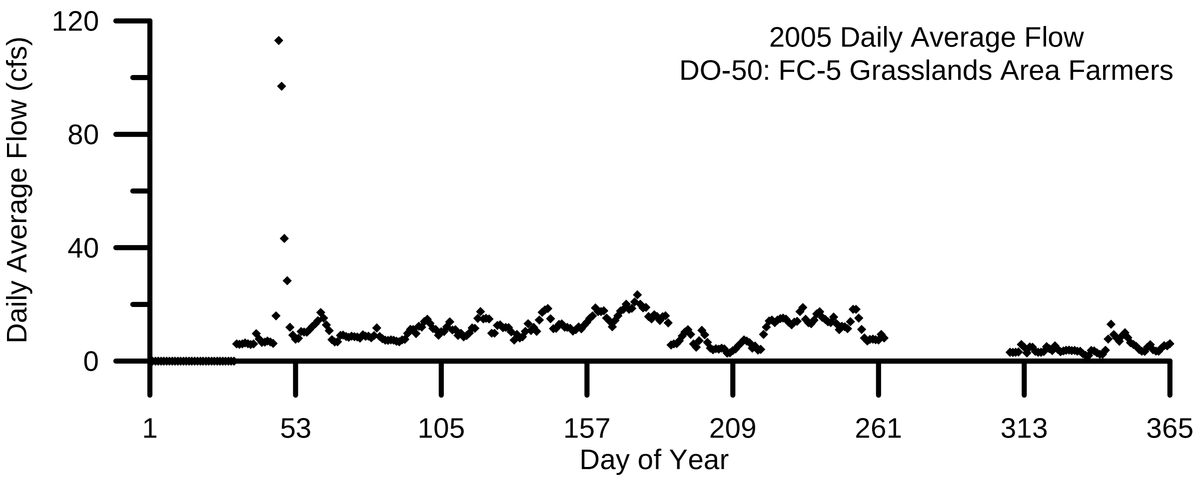


Figure 86: 2005 through 2007 flow plot for DO-50 FC-5 Grasslands Area Farmers

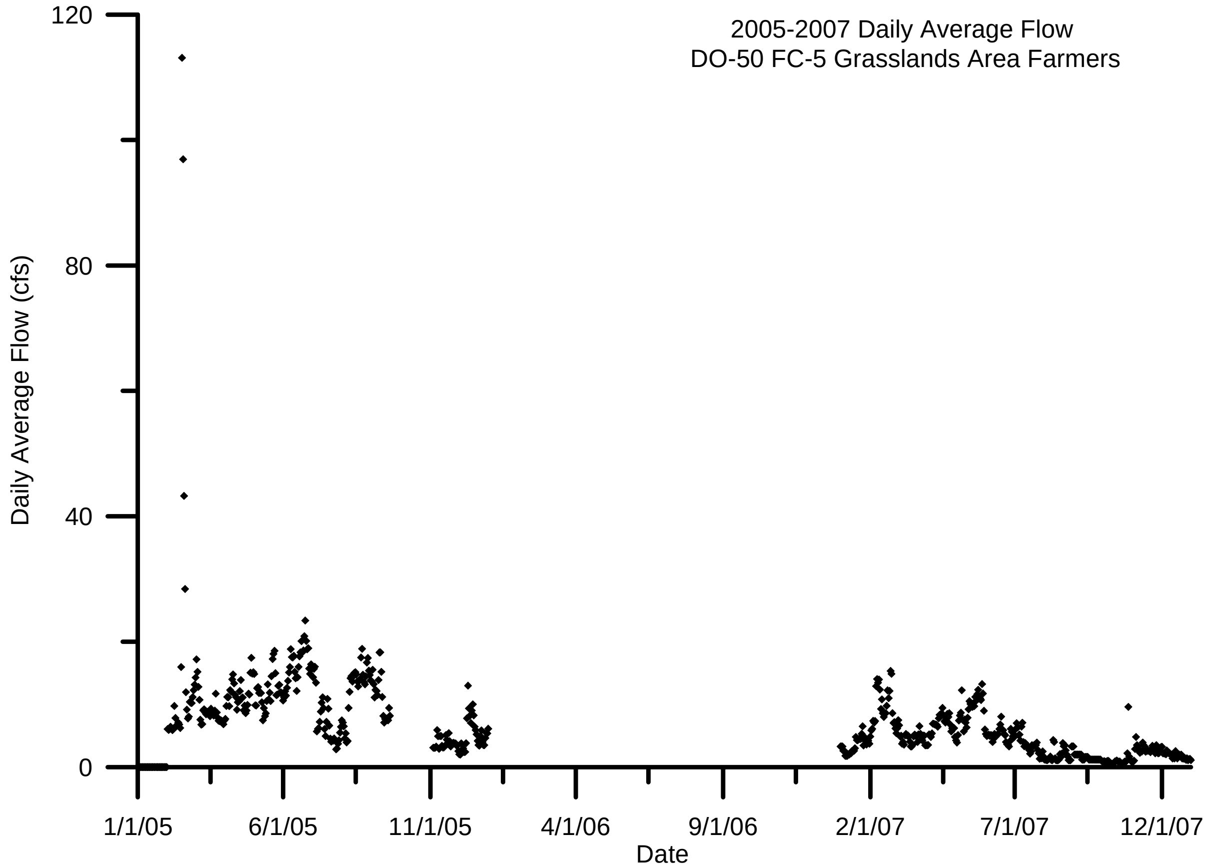


Figure 87: 2005 through 2007 flow plots for DO-53 Salt Slough at Wolfsen Road

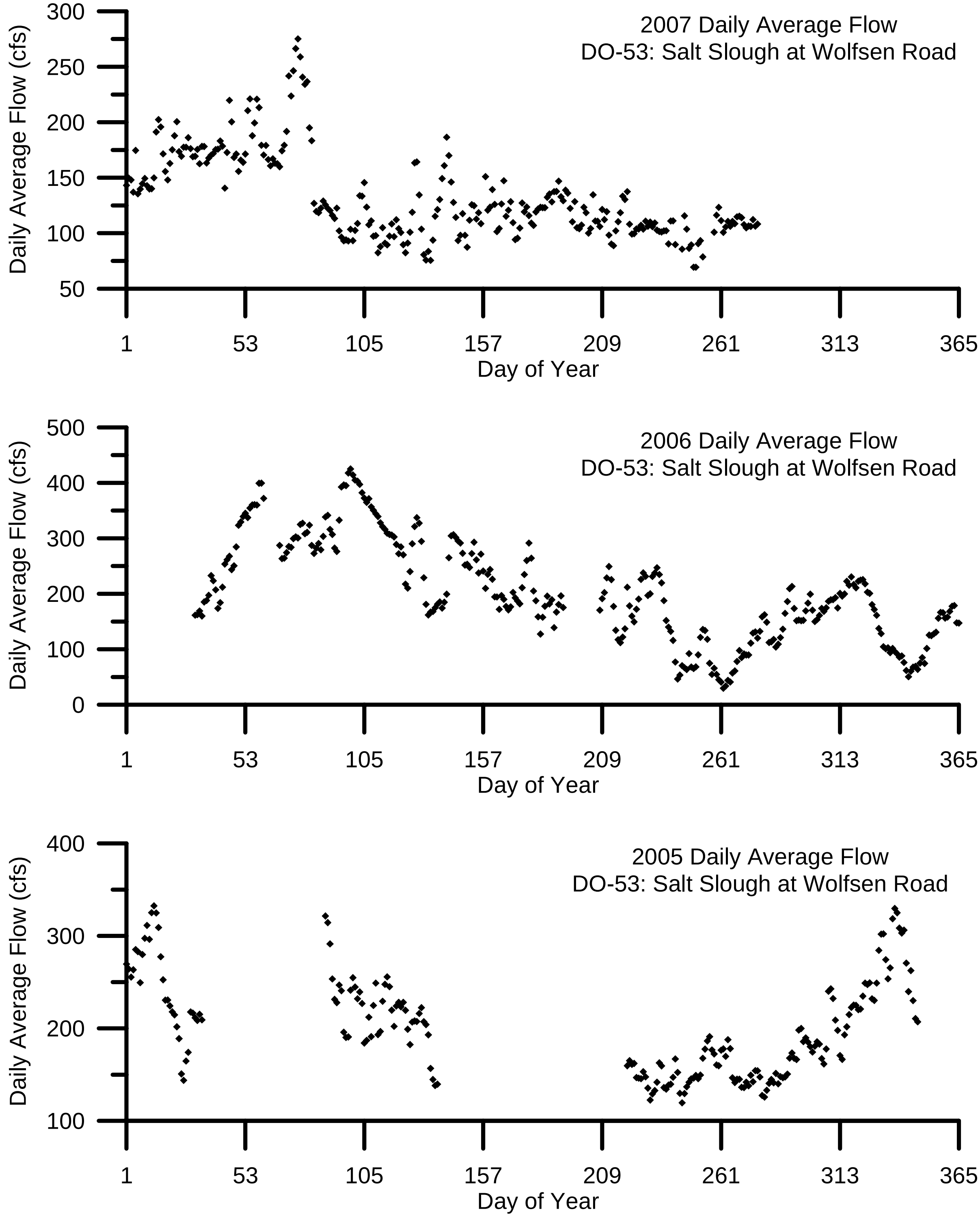


Figure 88: 2005 through 2007 flow plot for DO-53 Salt Slough at Wolfsen Road

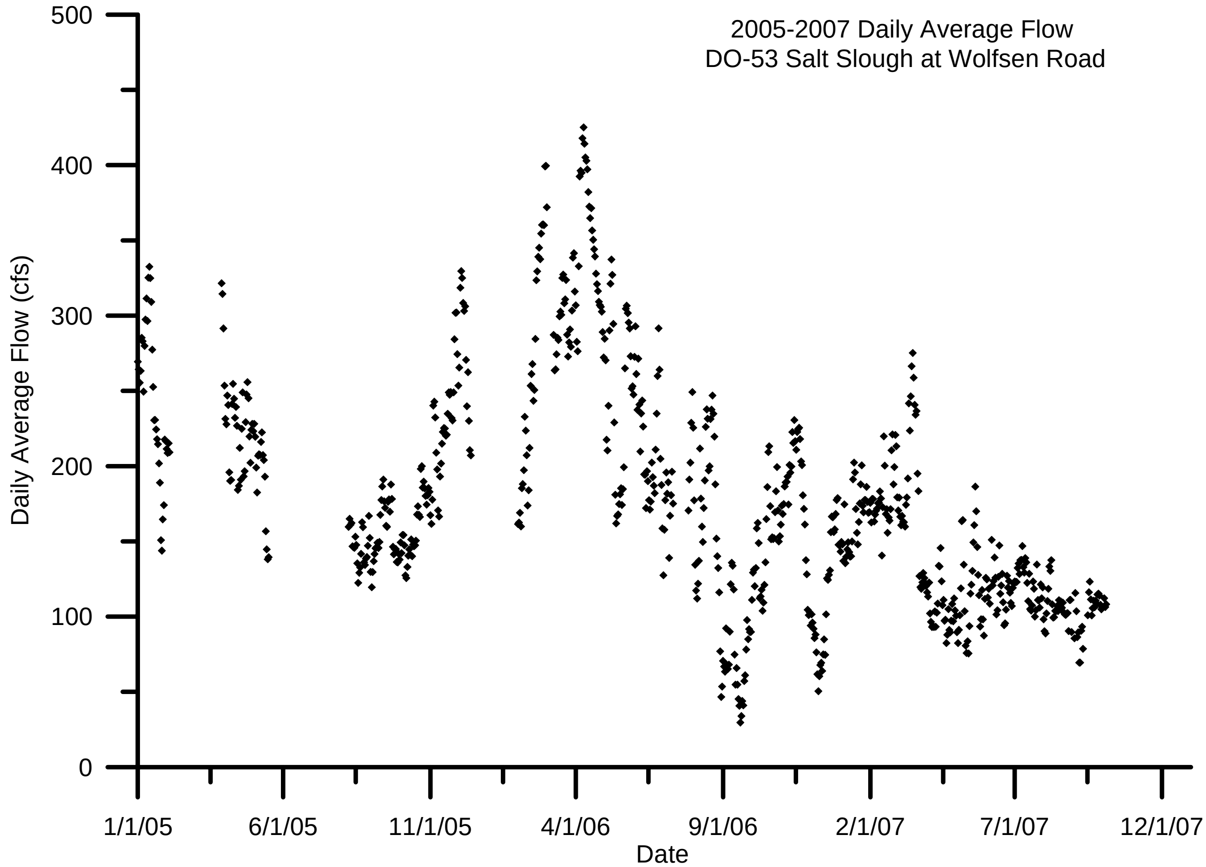
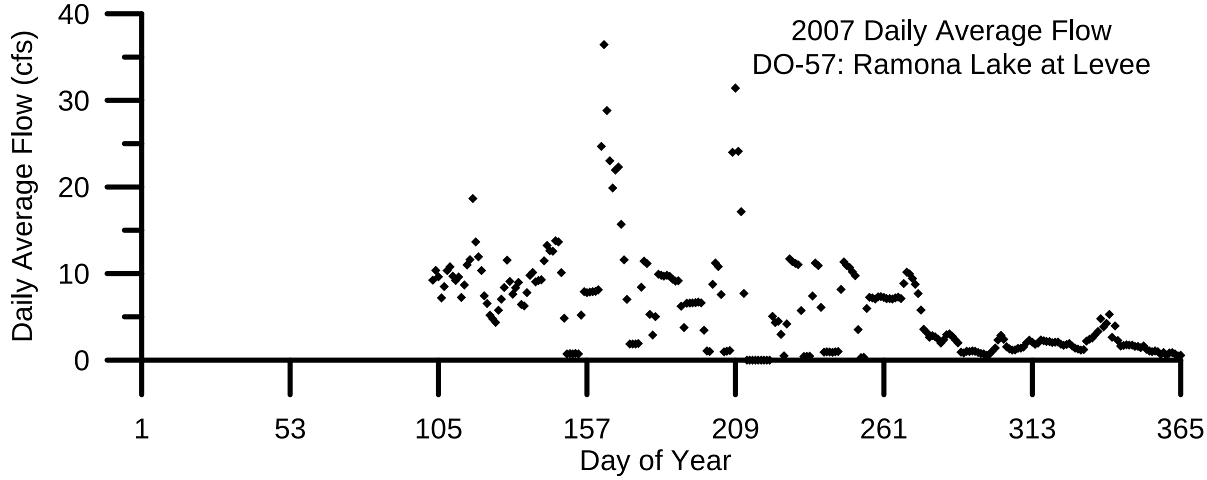
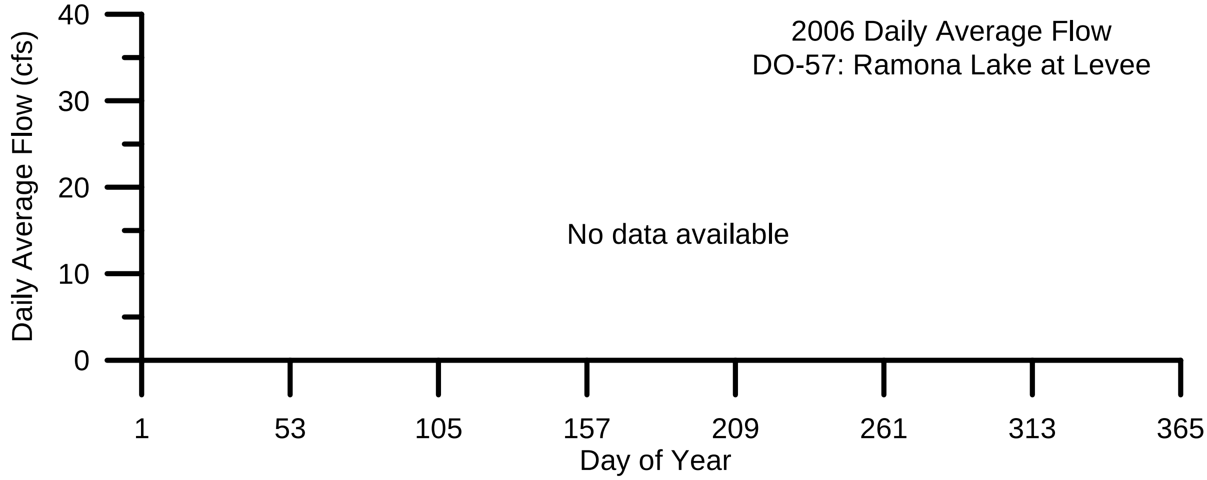


Figure 89: 2005 through 2007 flow plots for DO-57 Ramona Lake at Levee





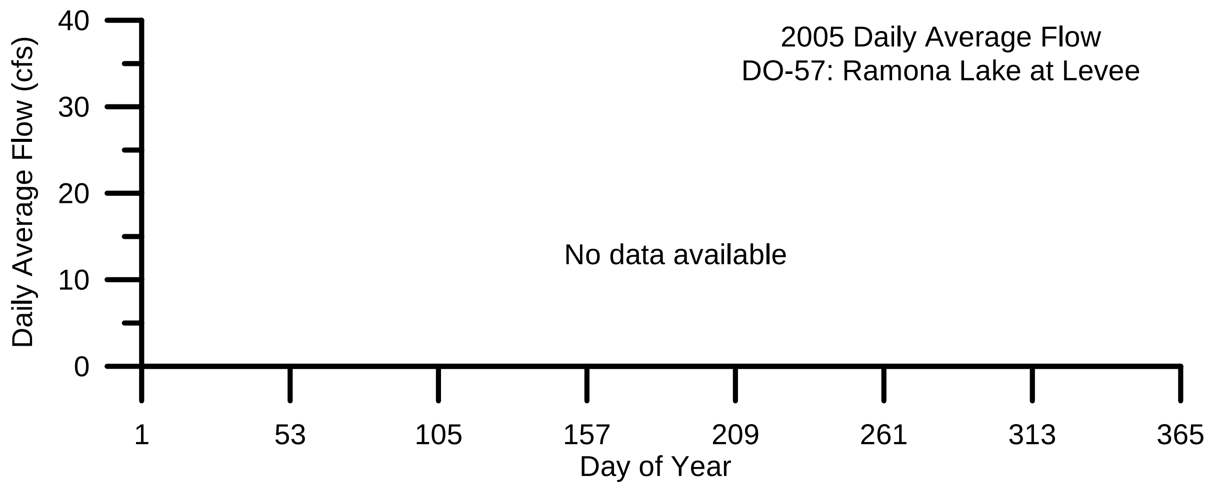


Figure 90: 2005 through 2007 flow plot for DO-57 Ramona Lake at Levee

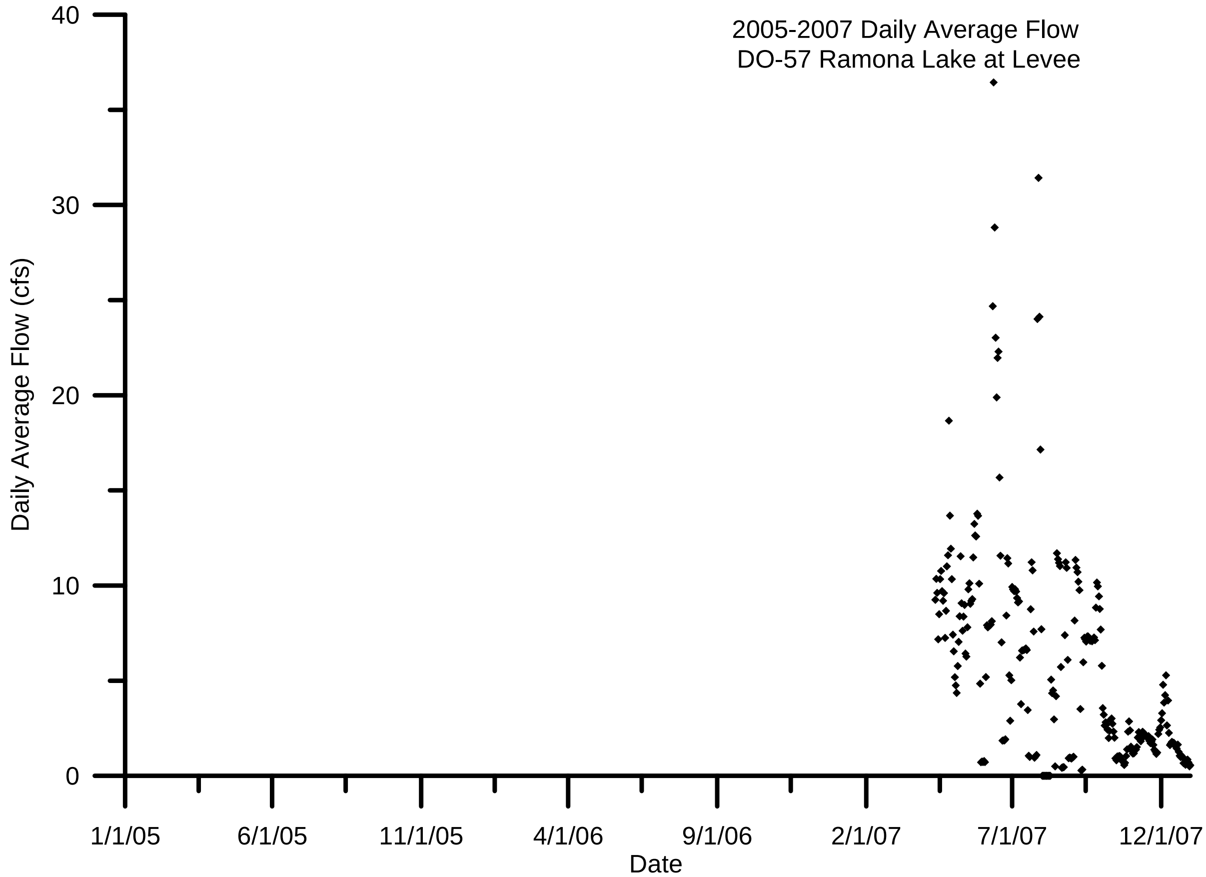


Figure 91: 2005 through 2007 flow plots for DO-59 SJR Laird Park

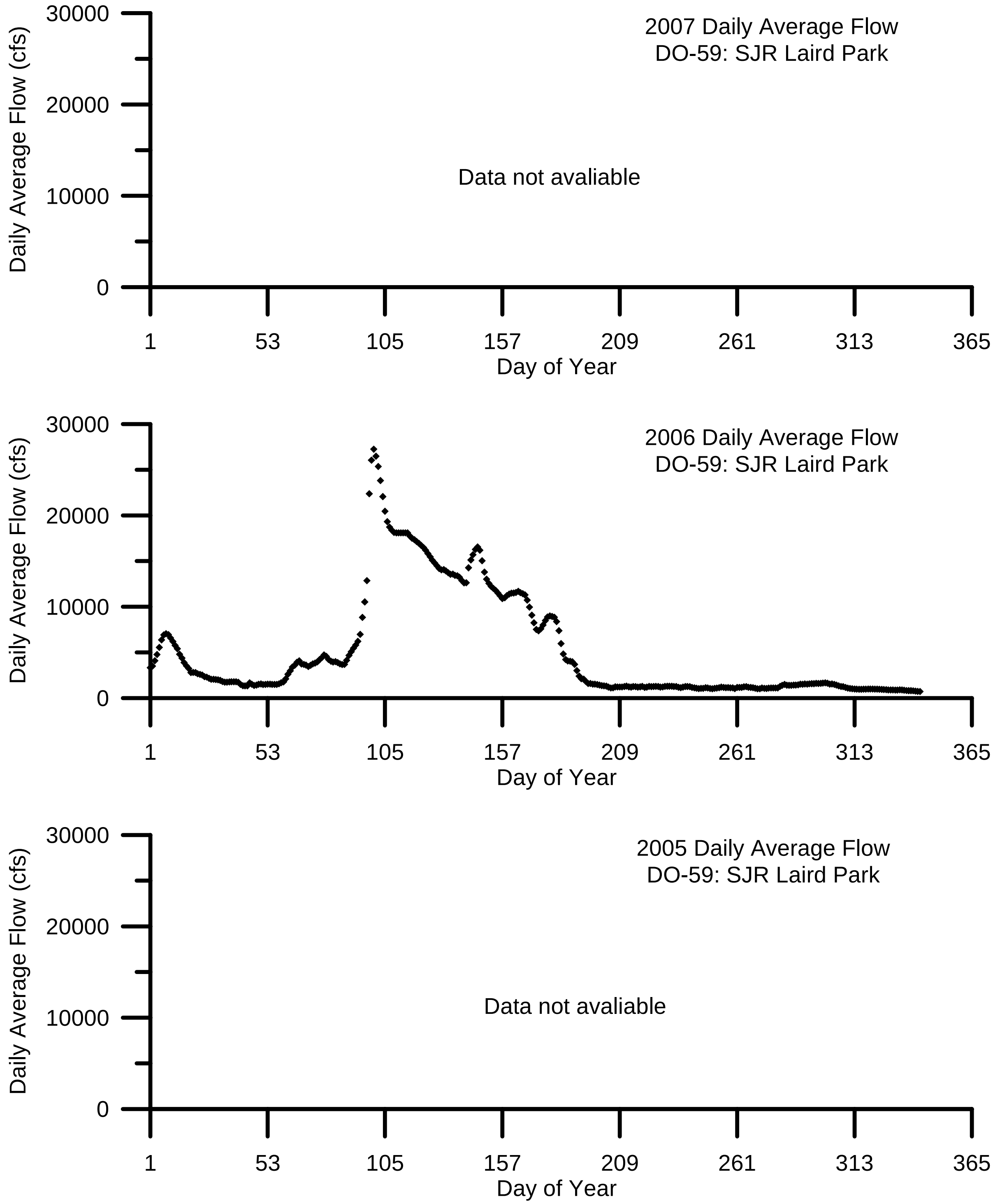


Figure 92: 2005 through 2007 flow plot for DO-59 SJR Laird Park

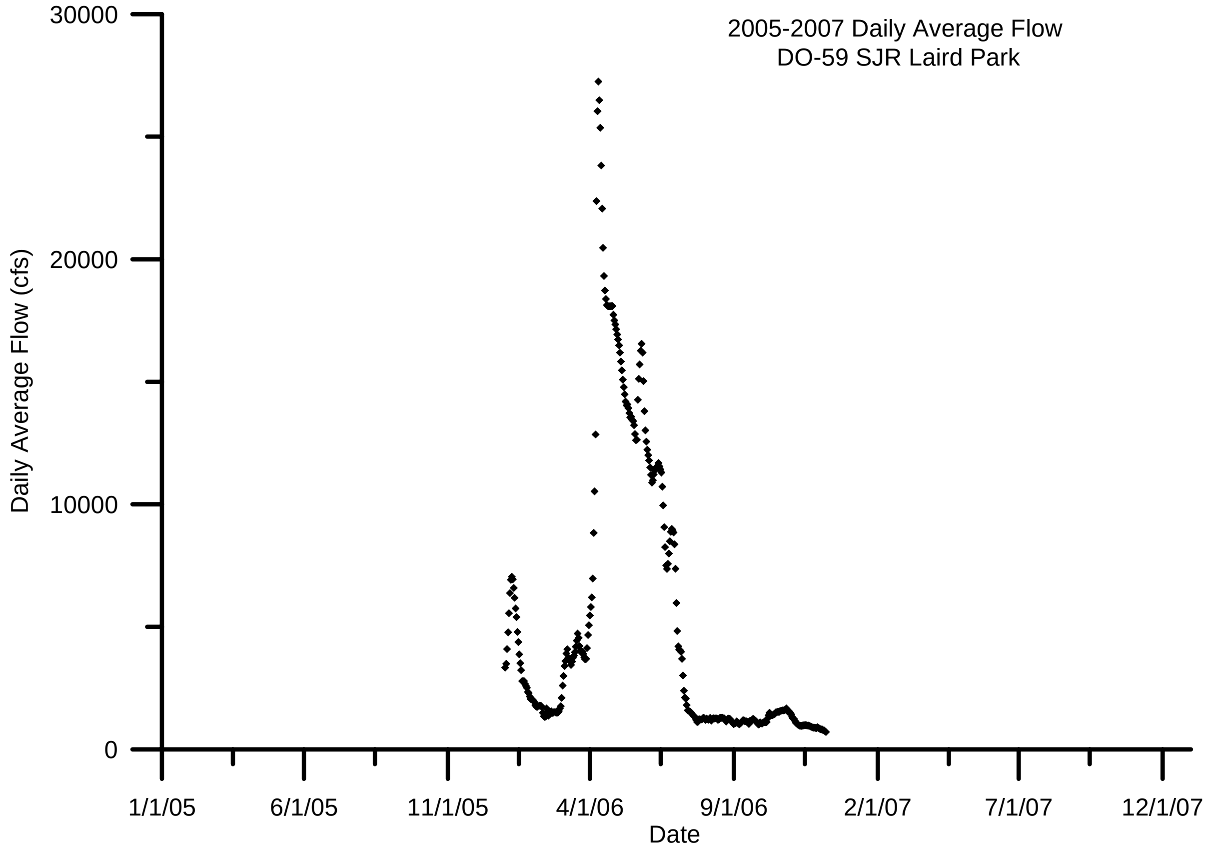


Figure 93: 2005 through 2007 flow plots for DO-60 Moffit 1 South

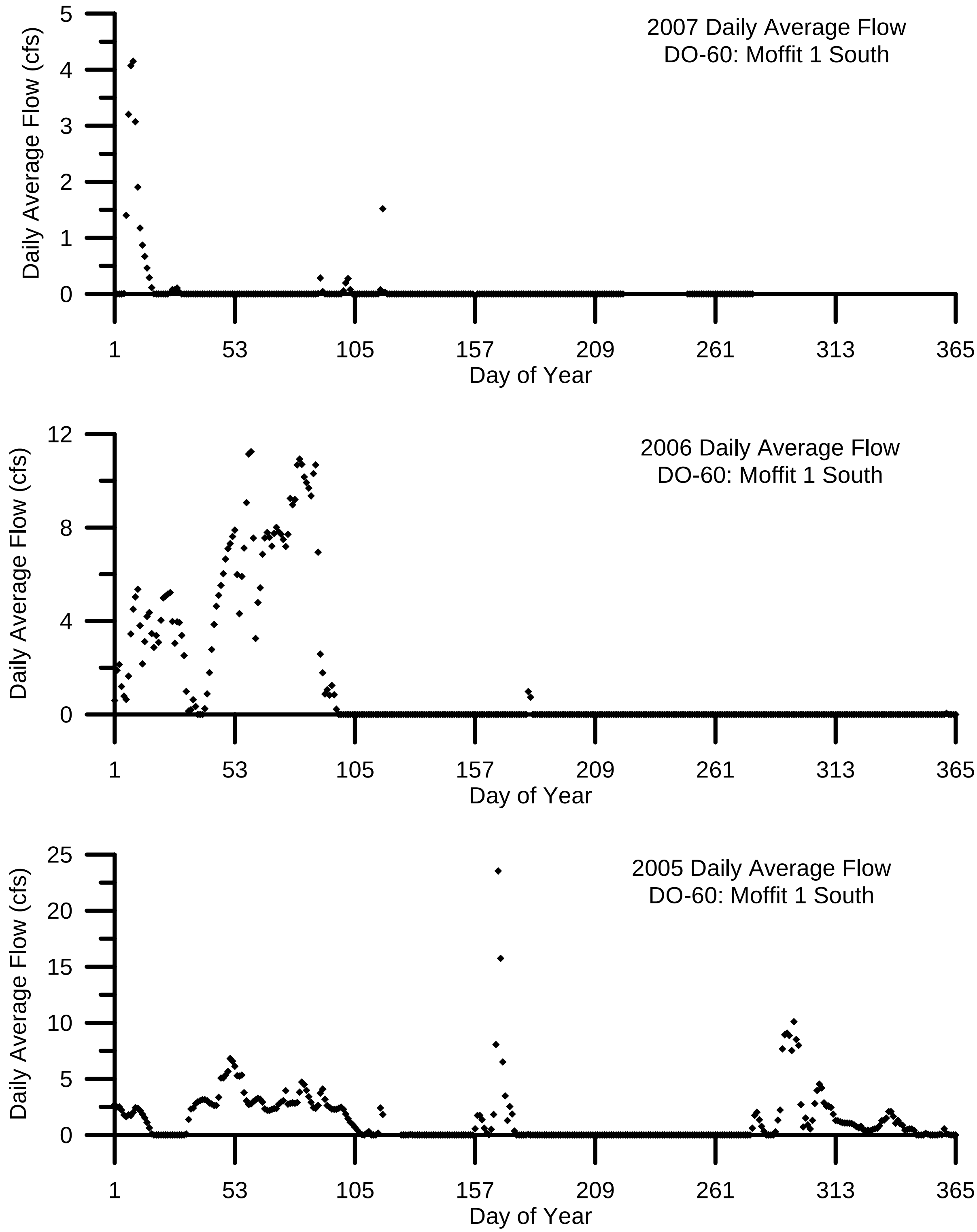


Figure 94: 2005 through 2007 flow plot for DO-60 Moffit 1 South

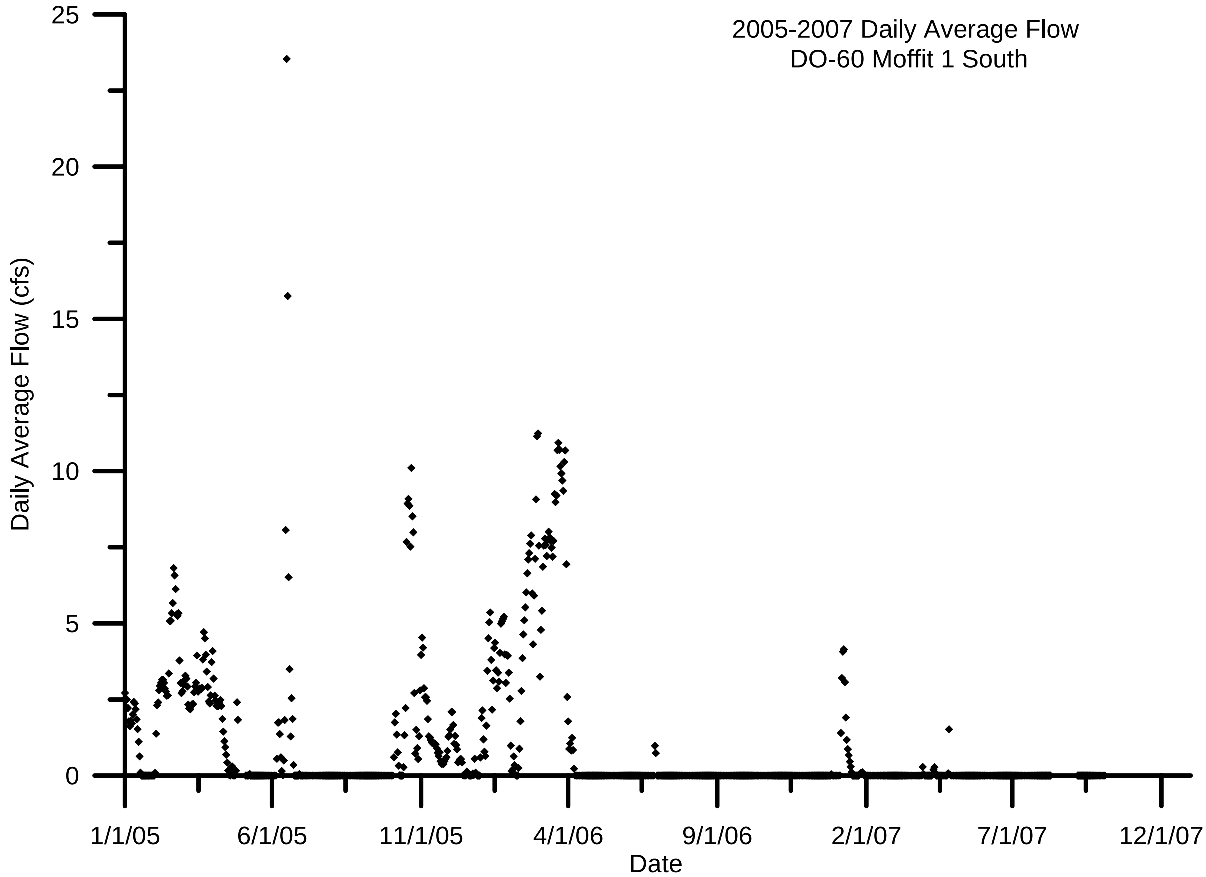


Figure 95: 2005 through 2007 flow plots for DO-61 Deadmans Slough

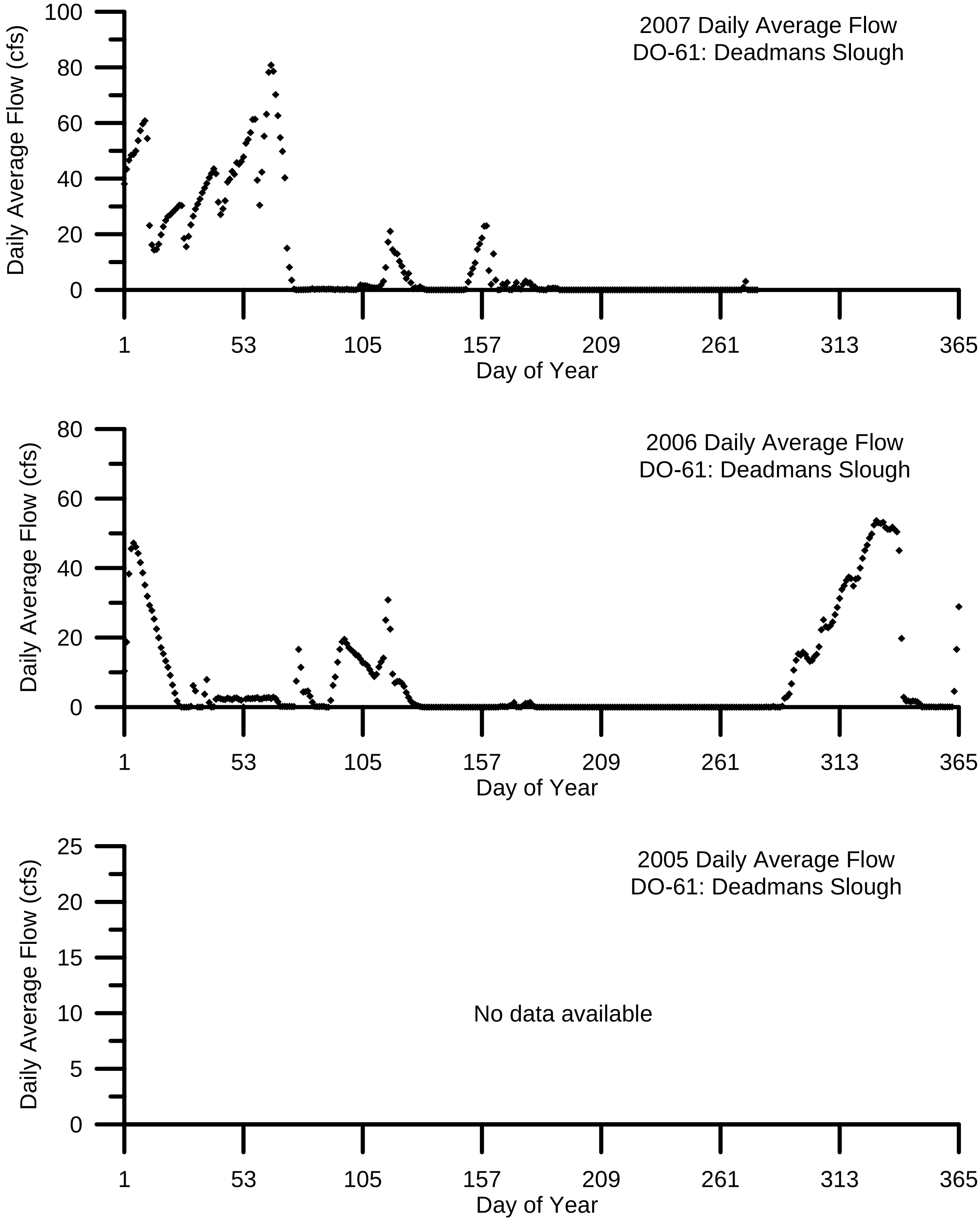


Figure 96: 2005 through 2007 flow plot for DO-61 Deadmans Slough

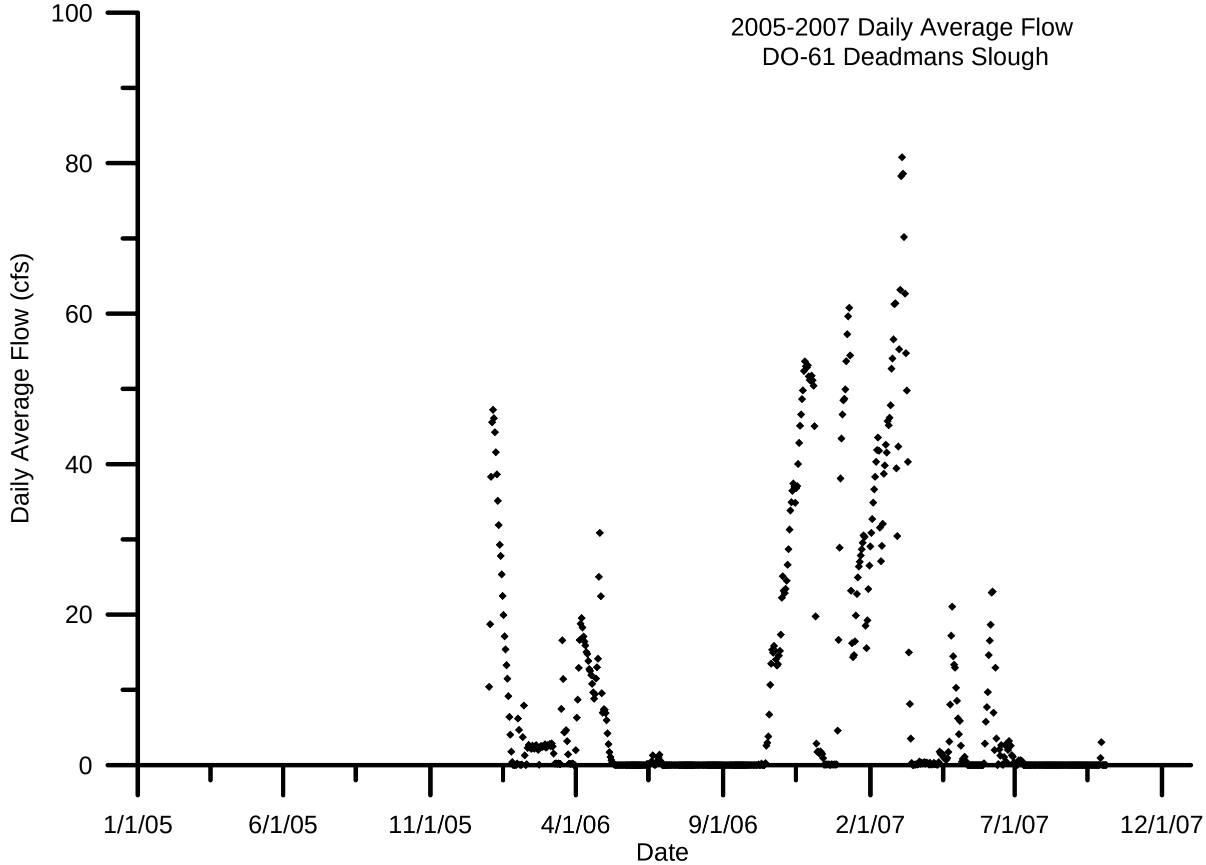


Figure 97: 2005 through 2007 flow plots for DO-62 Mallard Slough

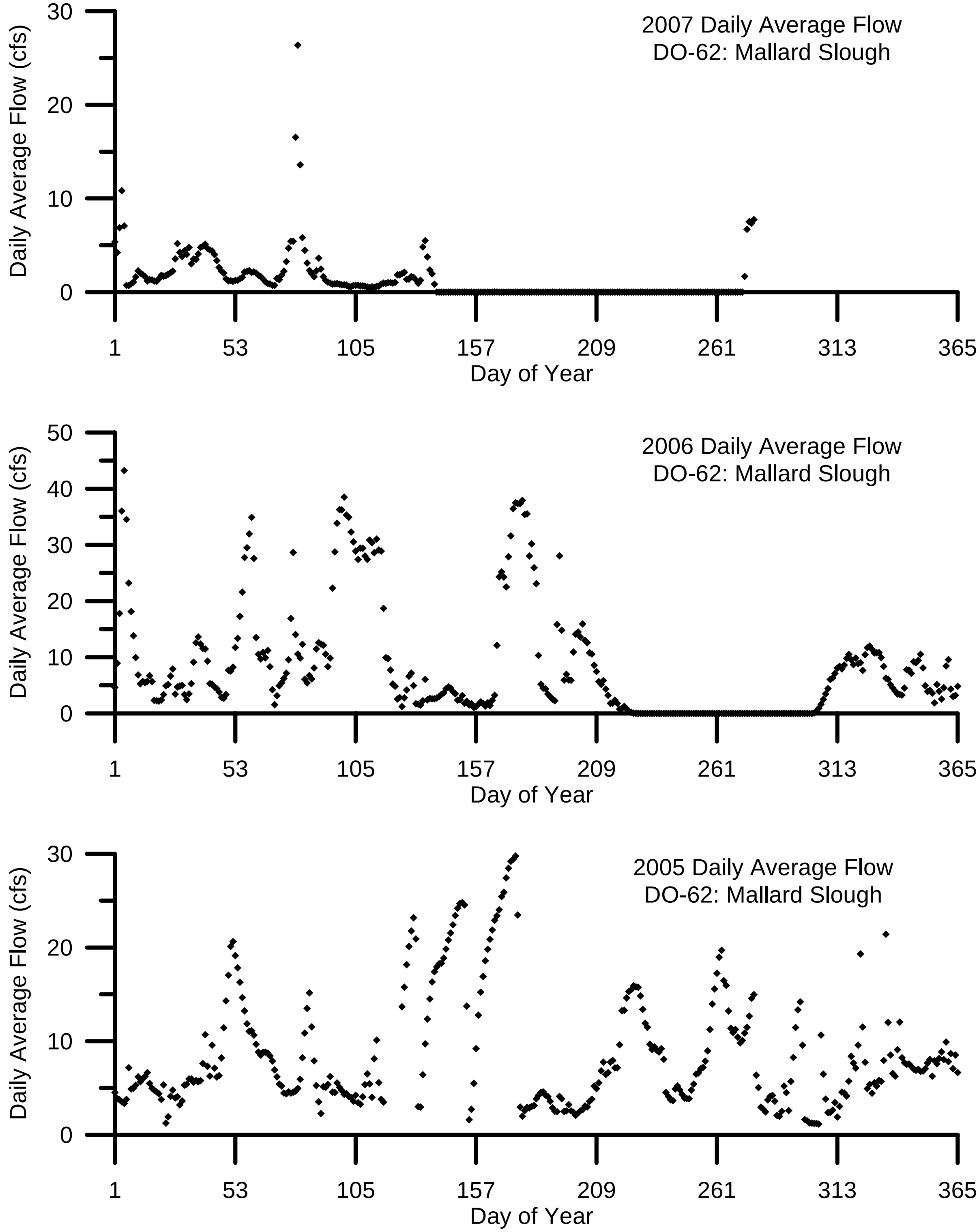


Figure 98: 2005 through 2007 flow plot for DO-62 Mallard Slough

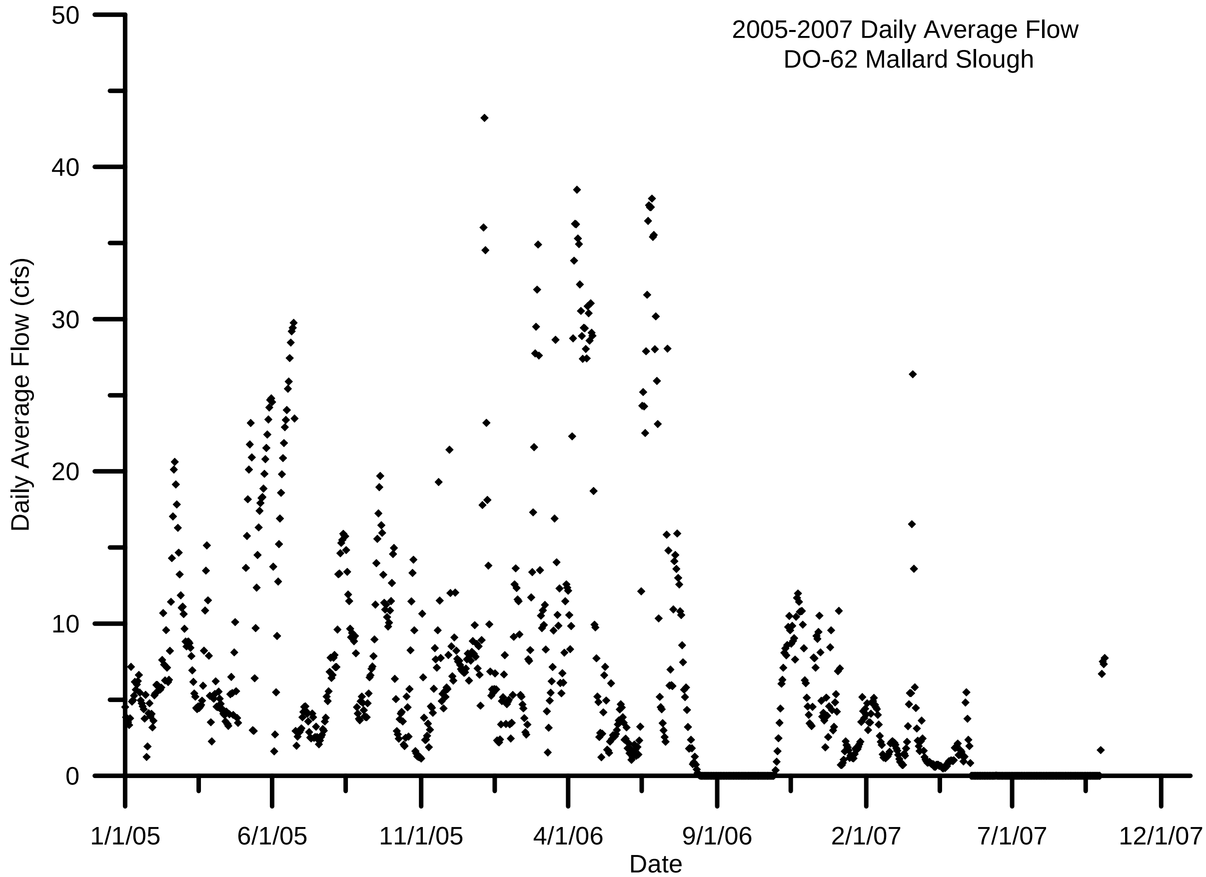
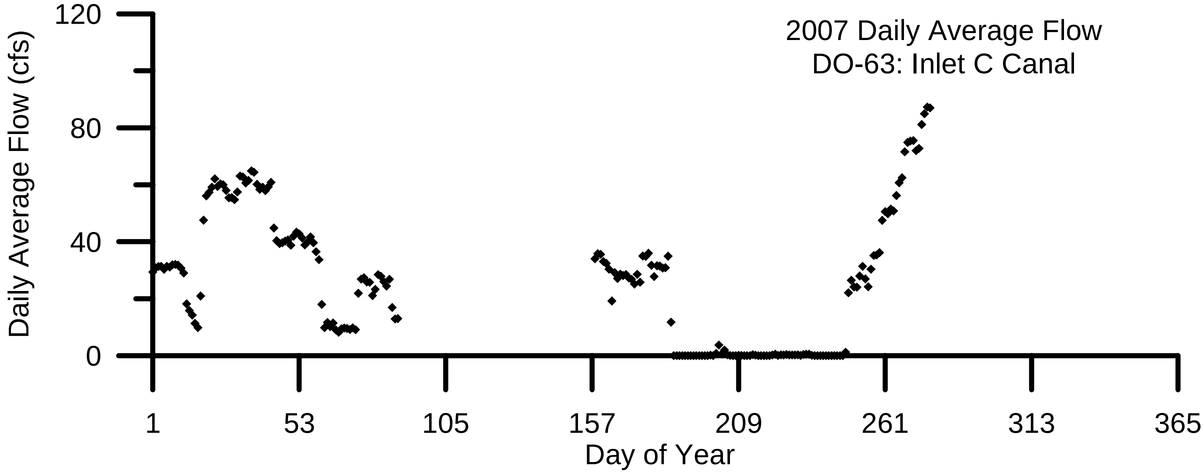
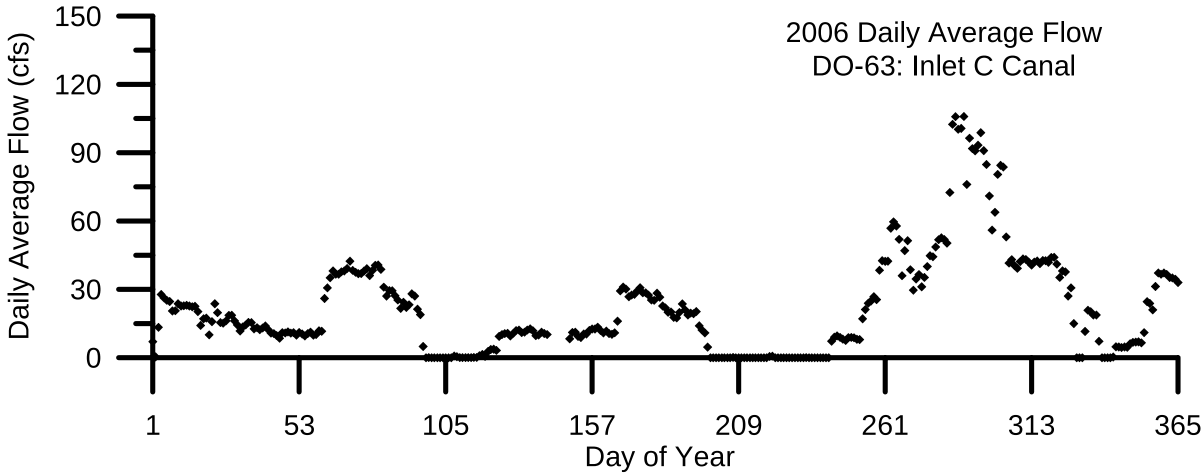


Figure 99: 2005 through 2007 flow plots for DO-63 Inlet C Canal





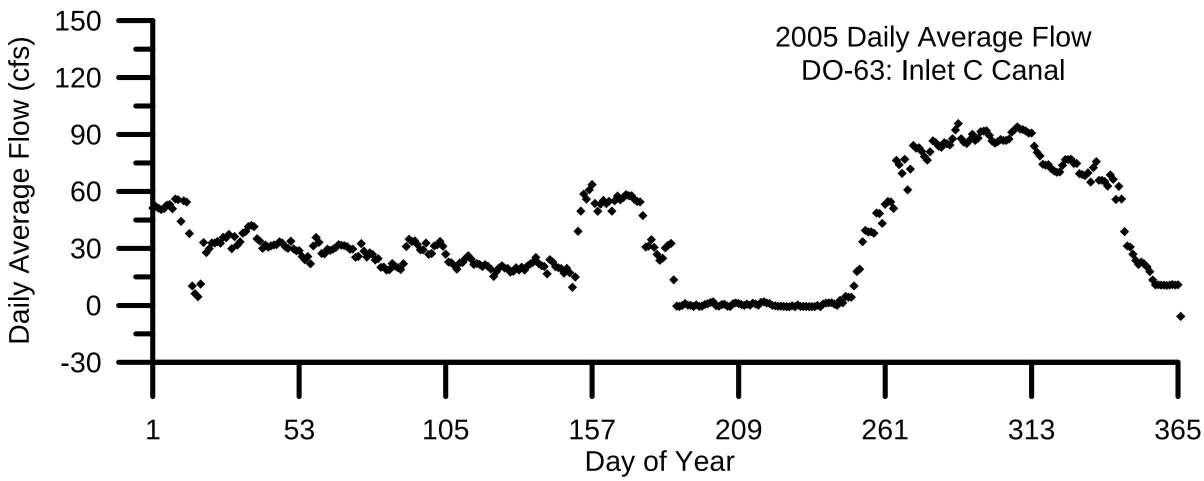


Figure 100: 2005 through 2007 flow plot for DO-63 Inlet C Canal

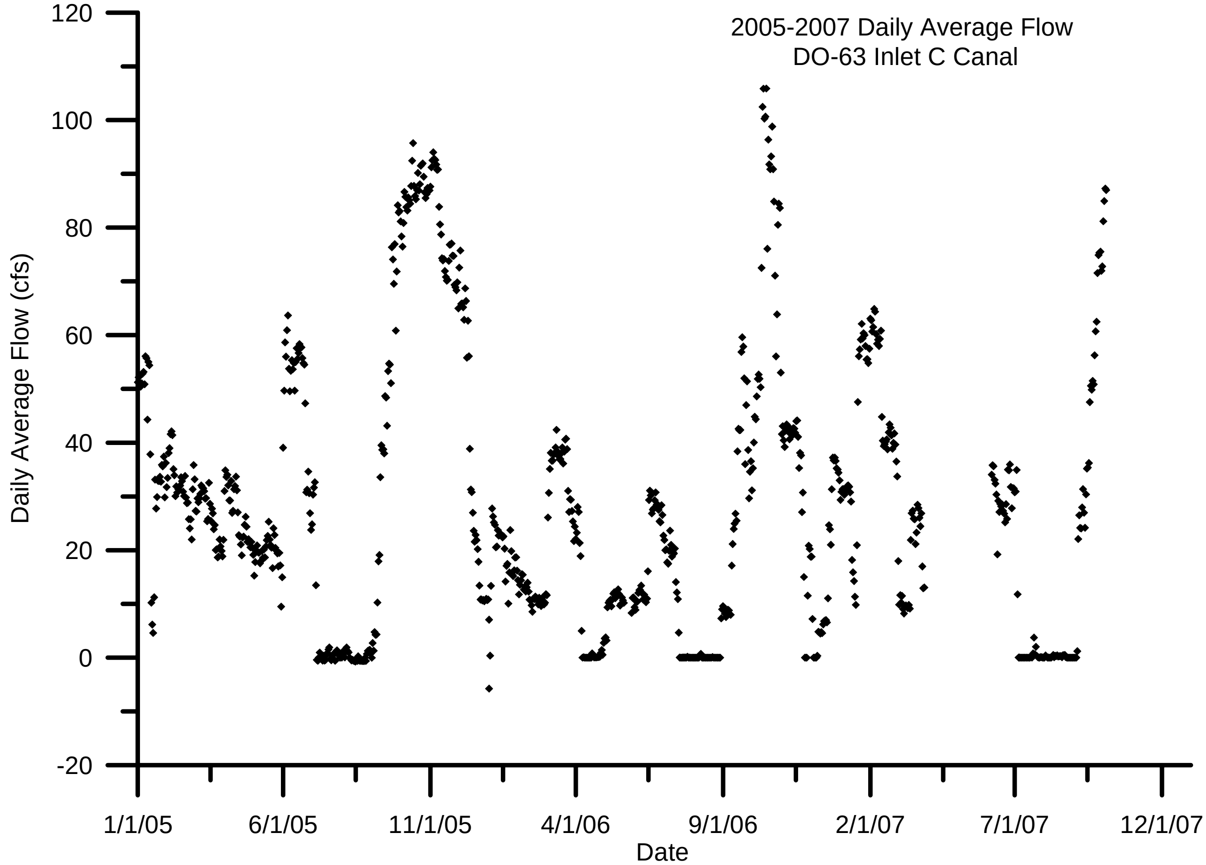


Figure 101: 2005 through 2007 flow plots for DO-64 Moran Drain

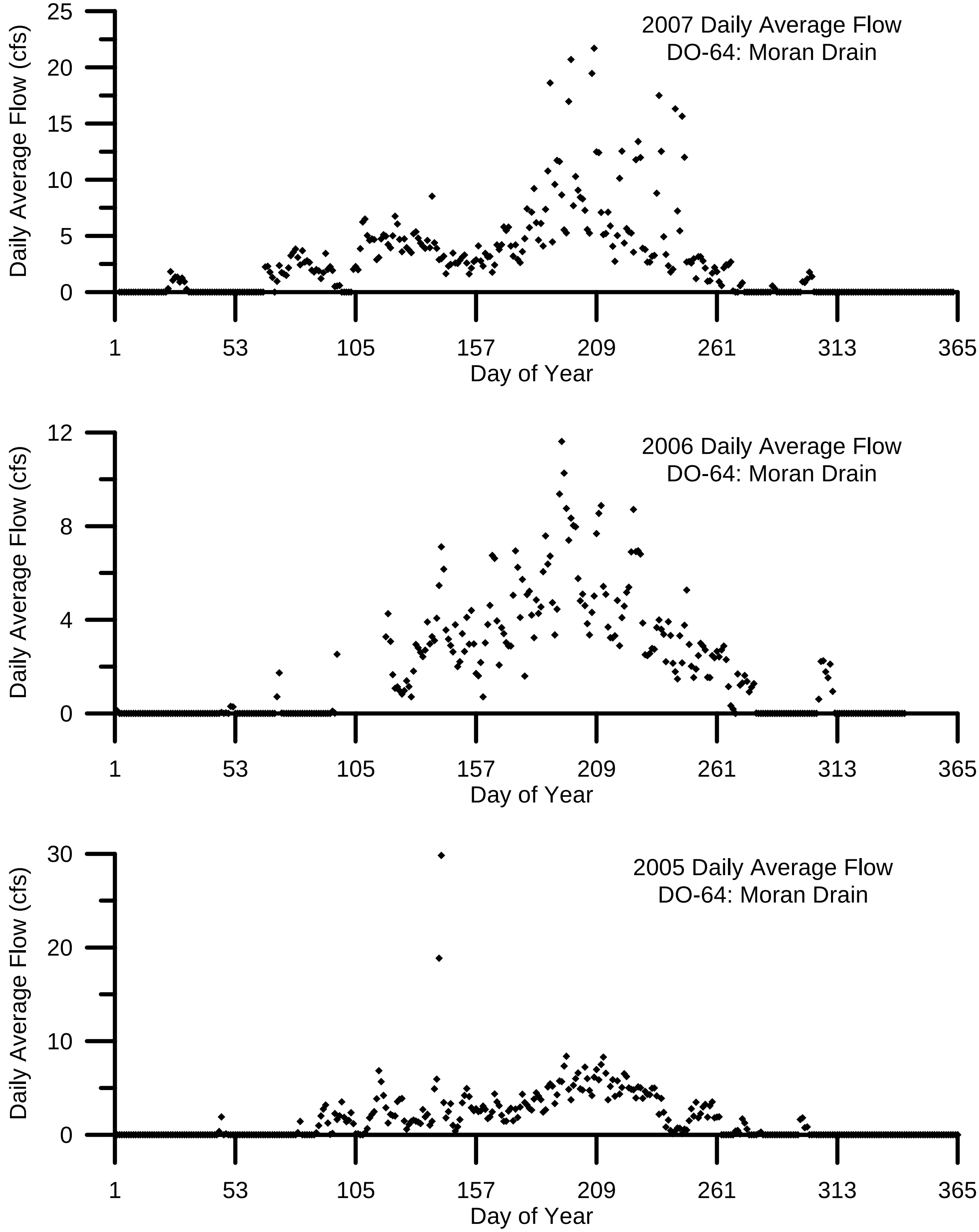


Figure 102: 2005 through 2007 flow plot for DO-64 Moran Drain

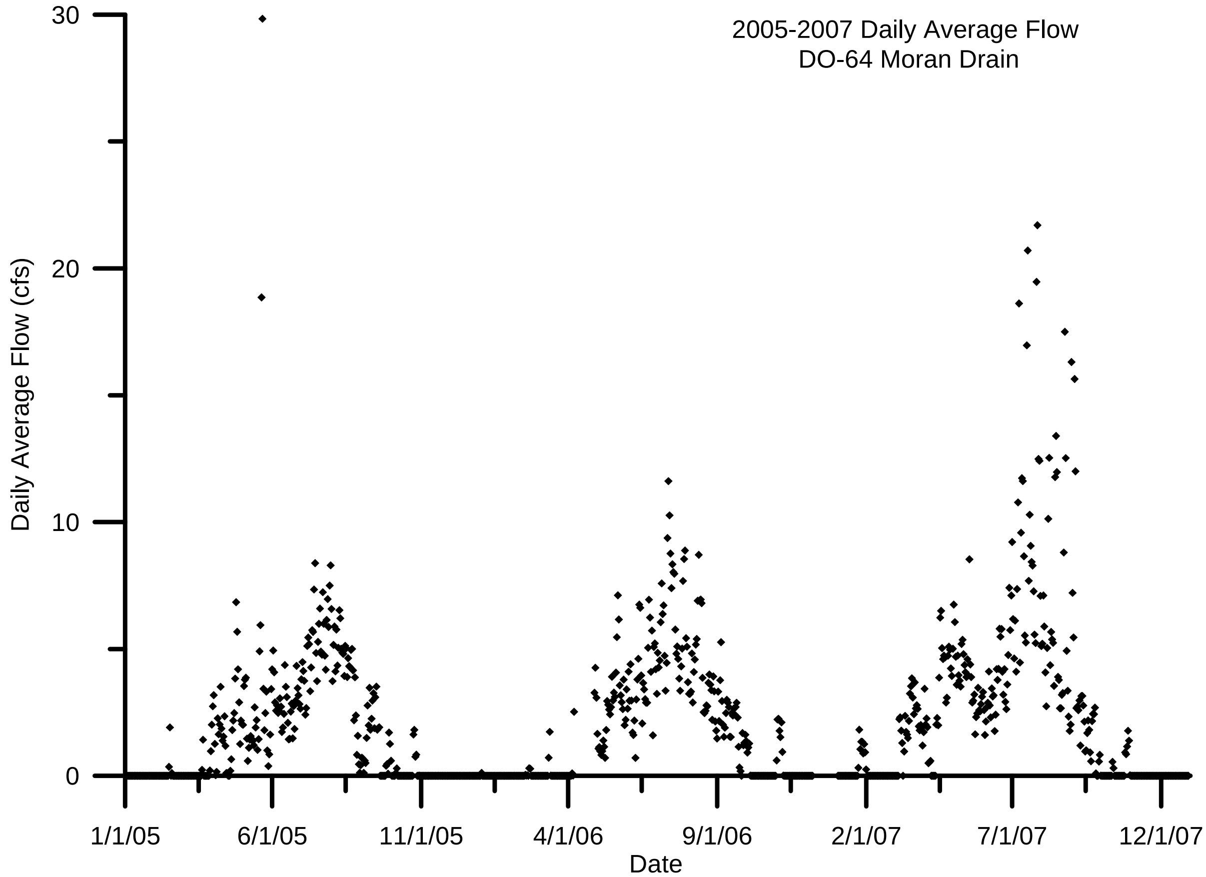
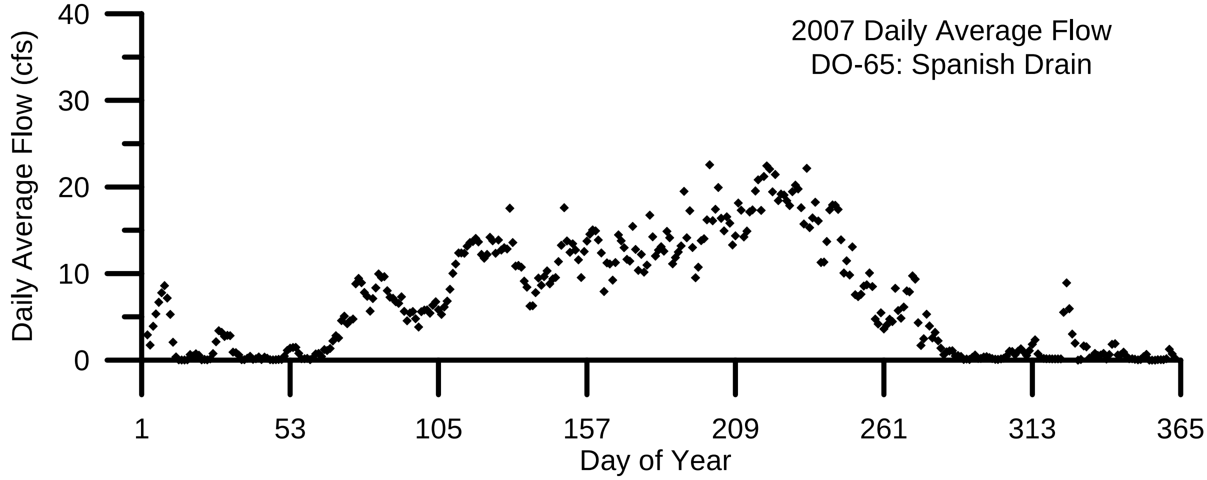
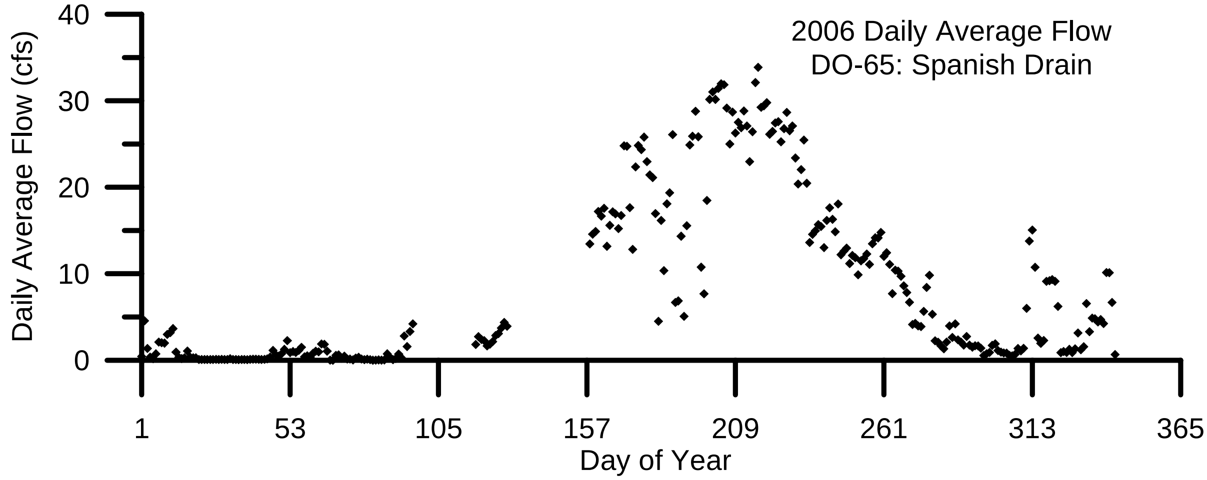


Figure 103: 2005 through 2007 flow plots for DO-65 Spanish Drain





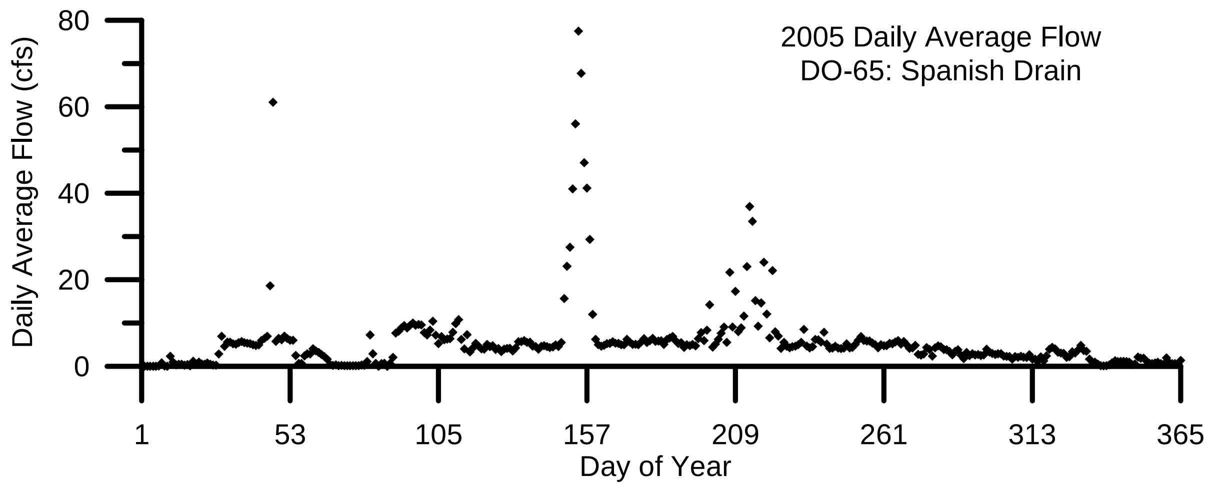


Figure 104: 2005 through 2007 flow plot for DO-65 Spanish Drain

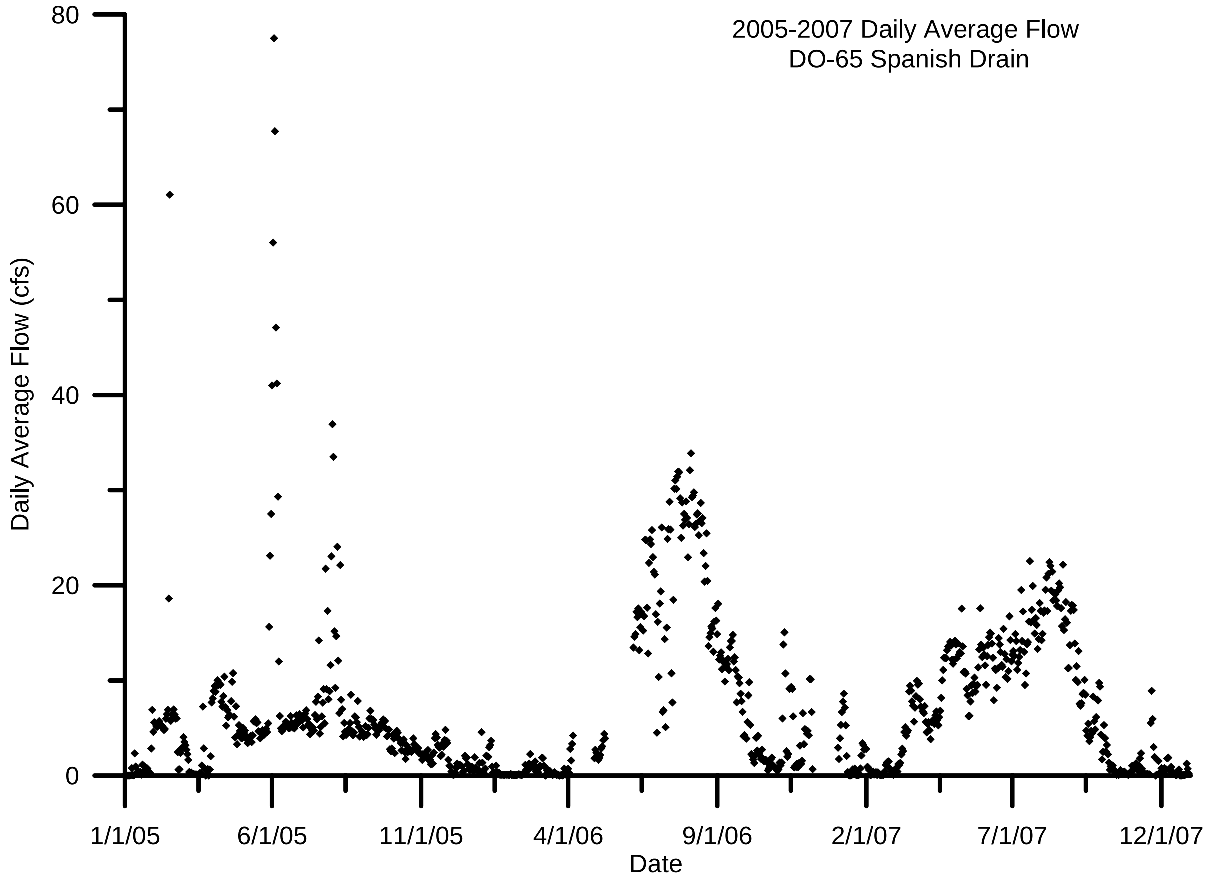


Figure 105: 2005 through 2007 flow plots for DO-68 S-Lake Drain

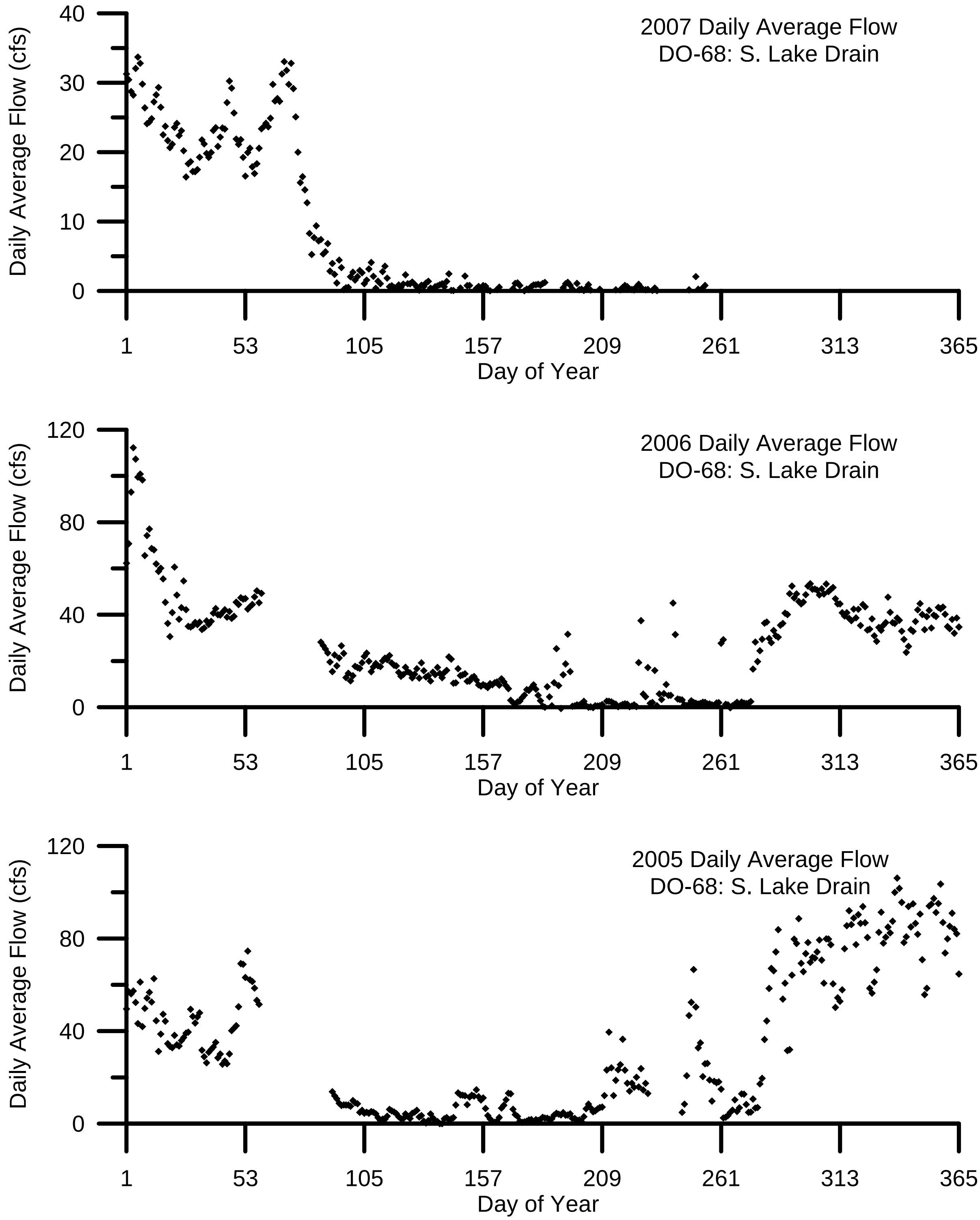
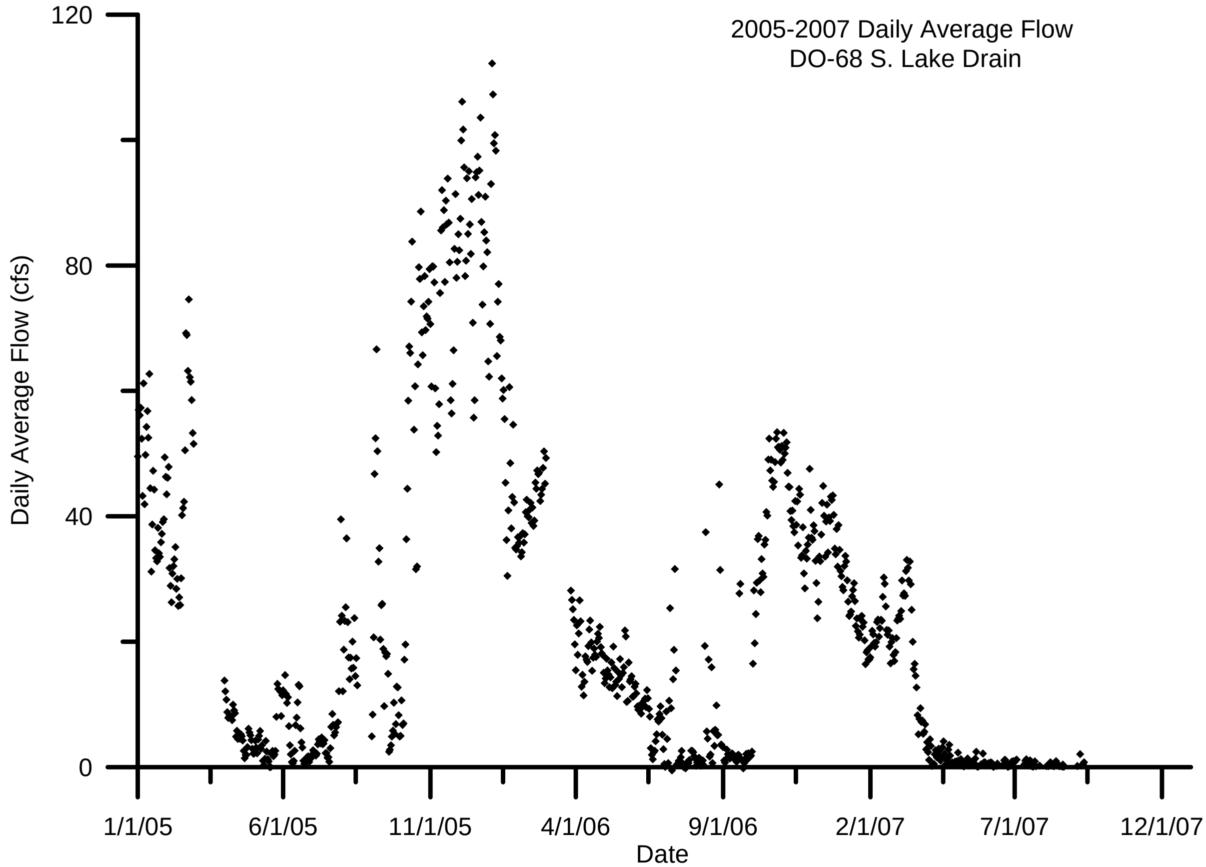


Figure 106: 2005 through 2007 flow plot for DO-68 S-Lake Drain



Appendix G

Statistical Comparison of Water Flow Rates for San Joaquin Valley Drainages and the San Joaquin 60-20-20 Water Supply Index for 2000 – 2006

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Objective & Hypothesis

The objective of this report is to analyze temporal (year to year and seasonal) trends in water flow for major agricultural drainages in the San Joaquin River (SJR) Watershed and to compare flow trends in agricultural drainages to flow conditions in the San Joaquin River and to the Water Supply Index (WSI) calculated by the California Department of Water Resources (DWR). The WSI for the SJR is a measure of annual water availability in the SJR watershed and is used by DWR to classify water years (wet, dry, normal, etc.) and provides a basis for water management in the region.

The following hypotheses were tested:

1. Year to year trends in summertime flow from drainages dominated by irrigated agriculture do not correspond to WSI.
2. Year to year trends in wintertime flow from drainages dominated by irrigated agriculture will correspond to WSI.
3. Year to year trends in both winter and summer flows in the San Joaquin River mainstem will correspond to WSI.
4. Summertime flows from agricultural drainages would be constant across water years, independent of water year WSI.
5. Water conservation best management practices, including drip irrigation and water recycling, implemented between 2000 and 2006 would be manifest in declining return flows as a function of year in agricultural drains.

Sites used for this study were chosen based upon their location in the San Joaquin basin and the availability of data for 2000 to 2006 (Table 1). The sites consisted of two SJR sites (Vernalis and Crows Landing), one site located east of the SJR (Harding Drain), and five sites located west of the SJR (San Luis Drain, Orestimba Creek, Salt Slough, Mud Slough, and Del Puerto Creek).

Introduction

The water flows in the San Joaquin Basin are dependent on both natural factors such as rainfall and snowmelt, and artificial water manipulations such as water storage, diversions, and irrigation return flows. Just how much of an effect these artificial manipulations have on drainage flow rates has not been studied in-depth. This study investigated the impact of artificial manipulations on flow rate by examining how well the San Joaquin Region 60-20-20 Water Supply Index (WSI) correlates with the flow rates of drainages in the San Joaquin Basin in the winter (when agricultural activities and other artificial manipulations are at a minimum) and in summer (when artificial manipulations are at a maximum).

The WSI is an assessment of water availability and storage conditions in the San Joaquin Basin. The WSI is calculated by combining water supply data from the previous year with the amount of runoff forecast for the rainy season and for the rest of the water year. It is used to analyze undiverted flows so a determination can be made of when and how much water may be available for irrigation and other uses throughout the San Joaquin basin. San Joaquin Valley unimpaired runoff is defined as the sum of unimpaired inflow to New Melones

Reservoir (from the Stanislaus River), Don Pedro Reservoir (from the Tuolumne River), New Exchequer Reservoir (from the Merced River), and Millerton Lake (from the San Joaquin River).

The WSI was developed by the State Water Resources Control Board for the San Joaquin basin to classify types of hydrologic years. This system defines one "wet" classification, two "normal" classifications (above and below normal), and two "dry" classifications (dry and critical), for a total of five water year types, and assigns a numerical indicator to each (Table 2). The SJR 60-20-20 Water Supply Index is computed from these assigned numerical indicators as a weighted average of the current water year's April-July unimpaired runoff forecast (60 percent), the current water year's October-March unimpaired runoff forecast (20 percent), and the previous water year's index (20 percent). The WSI classifications are similar to the San Joaquin Region basin classifications, with a numerical indicator range assigned to each (Table 3). This index has been in use since 1995, and is defined in SWRCB Decision 1641 (http://www.waterrights.ca.gov/baydelta/d1641.htm).

In this report, average daily flow for several San Joaquin Basin drainages for a two month time period from January/February and for a two month time period from July/August are compared with the WSI for the water years 2000 through 2006. A direct correlation between the WSI and the mean water flow for San Joaquin River drainages during January/February is expected since artificial manipulations are minimal at this time of year. However, we expect to see a much lower amount of correlation between the WSI and the mean water flow for San Joaquin River drainages during July/August, depending on how manipulated the flow of the water body is. For example, the San Joaquin River (SJR) should correlate closely with the WSI throughout the year, as its flow rates are dependent upon the amount of water originating in the San Joaquin Basin. However, drainages dependent on agricultural water management activities should not correlate as well with the WSI during July/August, as their flow rates are dependent on return flows from irrigation, and how much of that water subsequently drains back into the SJR.

Approach

Statistical analyses of flow rates were made using data from water years 2000 through 2006, with January-February representing winter flows when the water flow manipulations are minimal, and July-August representing summer flows when agricultural water flow manipulations occur. As shown in Table 3, each water year type is represented over the time period analyzed, with 2 “critical” years, one “dry” year, one “ below normal” year, one “above normal” year, and 2 “wet” years.

Site data were grouped for analysis by water year and by WSI type. Trends in flow by water year were analyzed. Note that each water year begins on October 1 of the previous calendar year (i.e. water year 2000 begins on Oct. 1, 1999) and ends on September 30. A comparison was made between the WSI and the mean flow rates to test the hypothesis that flow was or was not dependent on WSI. The “critical” and “dry” years were placed into a single “dry” category for the analysis, as the WSI of both “critical” years was on the borderline between “critical” and “dry” classifications. Water year data were placed into one of four groups by water year types: dry (2001, 2002, 2004); below average (2003); above average (2000); and wet (2005, 2006).

Analyses for each drainage are divided into separate sections of this report, with the results depicted in 3 tables and 3 figures for each section as described below:

Daily water flow means

Depicts the daily water flow means for water years 2000 – 2006. January/February (representing non-manipulated water flow) and July/August (representing manipulated water flow) time periods are highlighted.

Descriptive statistics

Descriptive statistics including the water flow mean, median, and standard deviation for all drainages are listed by water year for both the January/February and the July/August time periods.

Paired t- test comparisons

To compare average (mean) water flows, two-sample unpaired t-tests (assuming unequal variances) were performed for all drainages, comparing all possible water year/water year type subsets over the same two month period for each site. The hypotheses for these comparisons are:

H_0: Mean water flow rates are not significantly different for different water years/water year types.

H_1: Mean water flow rates are significantly different for different water years/water year types.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 95% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, D, or E), with different letters assigned to means that are statistically different. While the letters A, B, C, D, and E are used to designate statistically different water flow means for every analysis, only the same drainages over the same time periods are directly compared, so the same letter designations between different groups do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative.

Seasonal water flow mean and WSI trends

A comparison of the WSI and the mean water flow at each site for January/February and July/August for water years 2000 – 2006 was made by plotting each trendline on the same chart, with a separate linear scale used for the WSI and for the water body flow means. In this way, similarities/differences in the overall trends of both can be seen over the 2000 – 2006 time period. This technique is also useful for comparing overall trends between different sites. A second chart compares only the July/August water flow trend with the WSI trend so similarities/differences between July/August and WSI trends are more obvious.

July/August daily mean flow box plots

A box plot series of July/August daily mean flow data for each site was made, with the data grouped together by water year type. Water year types are plotted from highest to lowest WSI classification, with the leftmost box plot in each series representing the "wet" water year type, the next box plot representing the "above average" water year type, etc. If the data correlate with the WSI, the box plots should also indicate the highest to lowest daily flow means, from left to right. Because January/February site data correlated fairly well with the WSI for most drainages, no box plots were made for this time period.

Other data were also considered for correlation to the water body flow data. The average and the maximum daily air temperatures from water years 2000 – 2006 were analyzed, to see if there were any unusually high or low temperature spikes over the relevant time periods that might correlate with some of the daily mean water flow data. Air temperatures were obtained from the California Irrigation Management Information System (CIMIS) Los Banos station. The amount of water discharged from the Tracy pumping plant into the SJR was also analyzed for correlation to the mean water flow data. The results of these analyses are included as separate sections

Materials and Methods

Data sources

The primary water flow data source was the archive of federal surface water data for the nation maintained by the United States Geological Survey at http://waterdata.usgs.gov/nwis/sw. Quality assured, approved for publication daily mean flow data were used for these sites: SJR near Vernalis (USGS 11303500); SJR near Crows Landing (USGS 11274550); Orestimba Creek at River Road near Crows Landing (USGS 11274538); San Luis Drain Site B near Stevinson (USGS 11262895); Del Puerto Creek near Patterson (USGS 11274630); Salt Slough at Highway 165 near Stevinson (USGS 11261100); and Mud Slough near Gustine (USGS 11262900). Quality assured, approved for publication, daily mean discharge data were used for the Tracy Pumping Plant (USGS 11313000).

SJR Data Atlas daily mean flow data were used for Harding Drain (USGS 11274560), as USGS data was not available for the time periods analyzed. Quality assured, approved for publication daily mean and daily maximum air temperature data were used for Los Banos Weather station #56, California Irrigation Management Information System (CIMIS), Department of Water Resources, Office of Water Use Efficiency (http://www.cimis.water.ca.gov/cimis/welcome.jsp)

Statistical analyses

Data were analyzed using either Excel 2004 (Microsoft Corp.) or JMP 7 software (SAS Institute, Cary, NC). Flow rates for water years 2000 – 2006 were analyzed, with January-February representing the time period when the artificial water flow rate manipulations are minimal, and July-August representing the time period when agricultural water flow rate manipulations are frequent. To compare average (mean) water flows, two-sample unpaired t-tests (assuming unequal variances) were performed for all drainages, comparing all possible two year subsets over the same two month period for each site. The hypothesis tested in these comparisons is:

H_0: Mean water flow rates are not significantly different for different water years/water year types.

H_1: Mean water flow rates are significantly different for different water years/water year types.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 5% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, D, or E), with different letters assigned to means that are statistically different. While the letters A, B, C, D, and E are used to designate statistically different water flow means for each analysis, only the same drainages over the same time periods are directly compared, so the same letter designations between different groups do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative.

Average water flow mean charts for each water year, and site vs. WSI trendline charts were generated using Excel. Box plots of water year type for each site were generated using JMP 7 software.

Results

An analysis of the correspondence between WSI year type and seasonal flow from the flow monitoring locations (listed in Table 1) is presented in Table 4. In January/February, flow at all sites except Harding drain correlate well with water year type. In July/August, SJR at Vernalis, SJR at Crows Landing, and Mud Slough correlate with WSI year type, while Harding Drain, San Luis Drain, Orestimba Creek, and Salt Slough do not correlate with WSI year type. Del Puerto Creek correlates with the WSI in July/August, but as it has little to no water flow during that time of year.

Figure 1 shows the two general trends seen in July/August water body average flow rates, and how they compare to the WSI trend over the same 2000-2006 period. SJR at Vernalis has an upward trend from 2000-2006, and correlates quite well with the WSI trend. Other sites with this overall upward trend include SJR at Crows Landing and Mud Slough. Orestimba Creek has a general downward trend from 2000-2006, and flow is following the WSI trend. Other sites with an overall downward trend in July/August include Harding Drain, San Luis Drain and Salt Slough. Del Puerto Creek had little to no flow for the July/August time period.

Figure 2A shows a site (SJR at Vernalis) where the July/August average daily flow data, grouped by water year type, correlate with the WSI. Other sites that correlate with the WSI during July/August include SJR at Crows Landing, and, to a lesser extent, Mud Slough. Figure 2B shows a site (Orestimba Creek) where the July/August average daily flow data, grouped by water year type, do not correlate with the WSI. Other sites that do not correlate with the WSI during July/August include Harding Drain, San Luis Drain, and to a lesser extent, Salt Slough. Del Puerto Creek had little to no flow for the July/August time period.

Conclusions

A statistical comparison of daily flow means for various San Joaquin basin drainages with the WSI suggests that differences exist for some drainages when water flow is heavily manipulated, compared to when less artificial manipulation occurs. For drainages with comparable trends there may be implications for water quality as well. Future work should include determining if sites that have similar water flow patterns (whether similar to the WSI or not) also share similarities in water quality indicators. Some conclusions can be made based on the analyses in this report, including:

1. The average flow rates for the SJR sites (Vernalis and Crows Landing) correlated well with the WSI during both January/February and July/August. This is consistent with the SJR water flow being primarily dependent on the amount of water available in the SJR basin, and not severely affected by local agricultural manipulations.
2. For all other drainages except for San Luis Drain and Harding Drain (discussed below), the two or three highest water flow means were from "wet" or "above normal" years (2000, 2005, 2006) for January/February. For San Luis Drain (which had no data for 2006), the highest water flow mean was also from a "wet" year (2005). Since little agricultural irrigation/drainage and plenty of rainfall occurs during this time of year, this suggests that San Joaquin River tributary flow rates correlate well with the WSI in the absence of artificial water manipulations. One interesting similarity was seen between Orestimba Creek, Mud Slough, and San Luis Drain. The top three flow means for these sites from highest to lowest were: 2005; 2000; 2006; with no statistically significant difference between 2000 and 2006.
3. Harding Drain January/February flow data show no correlation with the WSI. The Harding Drain site is location on the eastern side of the San Joaquin River – all other sites are either on the SJR or west of the SJR – such that it is subject to different flow inputs than the other sites.
4. Two distinct trends are found in the July/August flow rate data:
    a. A general upward trend from 2000 to 2006, which correlates quite well with the WSI trend over the same time period. Sites showing an upward trend include both SJR sites (Vernalis and Crows Landing), and to a lesser extent, Mud Slough. While Del Puerto Creek has a definite upward trend it also has little to no flow during this time of year.
    b. A general downward trend from 2000 to 2006, which does not correlate with the WSI trend over the same time period. Sites showing a downward trend include Orestimba Creek, Harding Drain, San Luis Drain, and to a lesser extent, Salt Slough. There is considerable similarity in the flow rate trends of the first three sites, with 2000 (above normal) having a flow mean significantly higher than all other years analyzed, and 2005/2006 (wet) having a combined flow mean similar to or lower than all other year types. Similar to the other sites, Salt Slough's highest flow mean is from water year 2000 (above normal). However, unlike the other sites, Salt Slough's 2005 and 2006

flow means are also significantly higher than the “dry” and “below normal” years.

5. While Mud Slough and Salt Slough were grouped as described in conclusion 4, based on the general upward/downward trend of their July/August flow data from 2000-2006, neither showed the same degree of correlation with the WSI as other sites in the respective groups. Unlike the other sites in the upward trend group, July/August data for Mud Slough showed little correlation with the WSI except for 2006 (wet), which had the highest average flow and was responsible for the general upward trend of the flow data. Unlike the other sites in the downward trend group, July/August data for Salt Slough correlated fairly well with the WSI except for 2000 (above normal), which had the highest average flow and was responsible for the general downward trend of the flow data.
6. Air temperature data were evaluated for potential correlation with water flow rates. While fluctuations were seen, the overall air temperature averages for 2000-2006 for both January/February and July/August were less than 5˚F apart. No correlation was seen between higher/lower temperature averages and changes in water flow.
7. The amount of water discharged from the Tracy Pumping Plant into the SJR was considered for correlation to the water flow data. For January/February, mean discharge data showed no correlation with the WSI or with any water body flow data (which except for Harding Drain, do correlate with the WSI). For July/August, some correlation with the WSI was seen. However, since there was little variability in the discharge averages in July/August for all water years (the highest was 4396 cfs; the lowest was 4133 cfs), this is unlikely to account for either of the trends discussed in conclusion 4. This lack of a correlation in July/August between Tracy Pumping Plant discharge and water flow rate trends suggests that the year-to-year changes seen are due to more localized water management activities.

Table 1: Sites used for this study.

Full USGS Site Name (site name in report)	USGS Site No.	Location
San Joaquin River near Vernalis (Vernalis)	11303500	Lat. 37°40'34" Long. 121°15'55"
San Joaquin River near Crows Landing (Crows Landing)	11274550	Lat. 37°25'55" Long. 121°00'46"
Harding Drain at Carpenter Rd. near Patterson (Harding Drain)	11274560	Lat. 37°27'52" Long. 121°01'52"
San Luis Drain Site B near Stevinson (San Luis Drain)	11262895	Lat. 37°14'27" Long. 120°52'37"
Orestimba Creek at River Rd. near Crows Landing (Orestimba Creek)	11274538	Lat. 37°24'49" Long. 121°00'54"
Salt Slough at Hwy. 165 near Stevinson (Salt Slough)	11261100	Lat. 37°14'52" Long. 120°51'04"
Mud Slough near Gustine (Mud Slough)	11262900	Lat. 37°15'45" Long. 120°54'20"
Del Puerto Creek near Patterson (Del Puerto Creek)	11274630	Lat. 37°29'12" Long. 121°12'29"
Delta Mendota Canal at Tracy Pumping Plant (Tracy Pumping Plant)	11313000	Lat. 37°47'49" Long. 121°35'03"
CIMIS Weather Station at Los Banos (Los Banos)	Station #56	Lat. 37°05'36" Long. 120°45'39"

Table 2: Hydrologic classifications (taken from the State of California State Water Resources Control Board Decision 1641).

San Joaquin Region Basin Classification	Indicator
Wet	5
Above Normal	4
Below Normal	3
Dry	2
Critical	1

Table 3: WSI Classification for water years 2000 – 2006.

Water Year	San Joaquin Region 60-20-20 Water Supply Index	Classification
2000	3.38	Above Normal (> 3.1; < 3.8)
2001	2.2	Critical (≤ 2.1)
2002	2.34	Dry (> 2.1; ≤ 2.5)
2003	2.81	Below Normal (> 2.5; ≤ 3.1)
2004	2.21	Critical (≤ 2.1)
2005	4.75	Wet (≥ 3.8)
2006	5.9	Wet (≥ 3.8)

Table 4: Statistical analysis of the daily average water flow of all sites for 2000 – 2006, student t-test comparison of all pairs of water year types. Statistically similar means for each time period are grouped by letter designation.

Site Name	Year(s)	WSI Classification	January/ February	July/ August
San Joaquin River near Vernalis	2005, 2006	Wet	A	A
	2000	Above Normal	B	B
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	C
San Joaquin River near Crows Landing	2005, 2006	Wet	A	A
	2000	Above Normal	B	B
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	C
Harding Drain at Carpenter Rd. near Patterson	2005, 2006	Wet	C	D
	2000	Above Normal	A	A
	2003	Below Normal	B	B
	2004	Dry/Critical	B	C
San Luis Drain Site B near Stevinson	2005	Wet	A	C
	2000	Above Normal	B	A
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	B
Orestimba Creek at River Rd. near Crows Landing	2005, 2006	Wet	A	C
	2000	Above Normal	A	A
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	C
Salt Slough at Hwy. 165 near Stevinson	2005, 2006	Wet	A	B
	2000	Above Normal	B	A
	2003	Below Normal	B	C
	2001, 2002, 2004	Dry/Critical	B	C
Mud Slough near Gustine	2005, 2006	Wet	A	A
	2000	Above Normal	B	C
	2003	Below Normal	C	C
	2001, 2002, 2004	Dry/Critical	C	B
Del Puerto Creek near Patterson	2005, 2006	Wet	A	A
	2000	Above Normal	A	B
	2003	Below Normal	B	B
	2001, 2002, 2004	Dry/Critical	B	B

Figure 1: Water flow trends by water year (2000-2006) for SJR sites and the WSI.

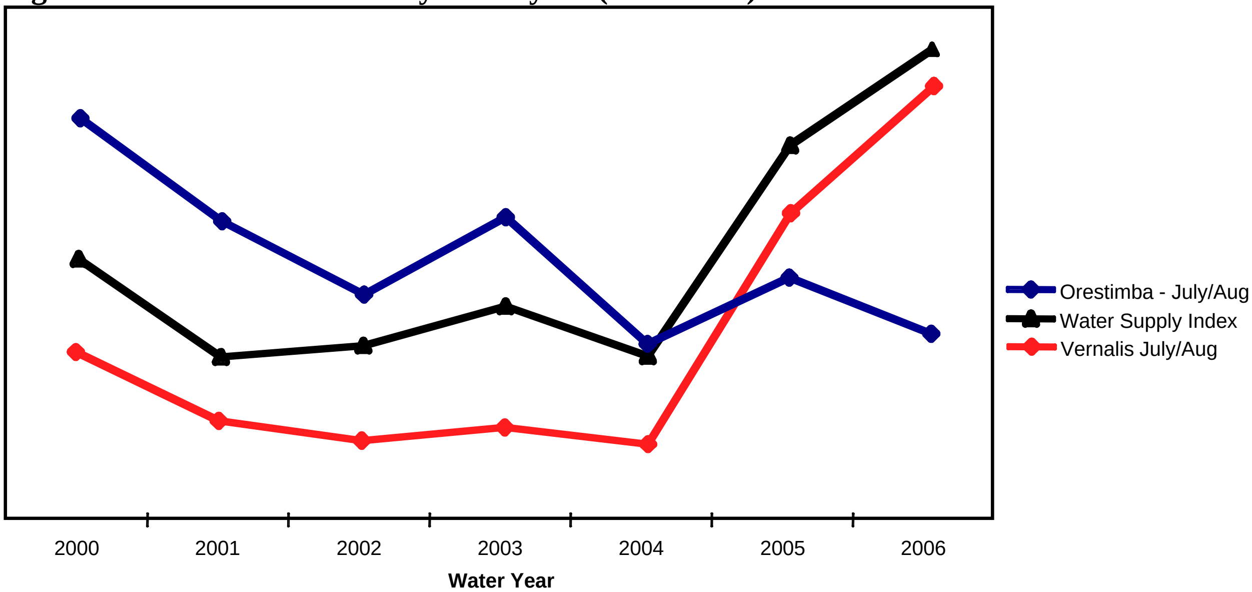
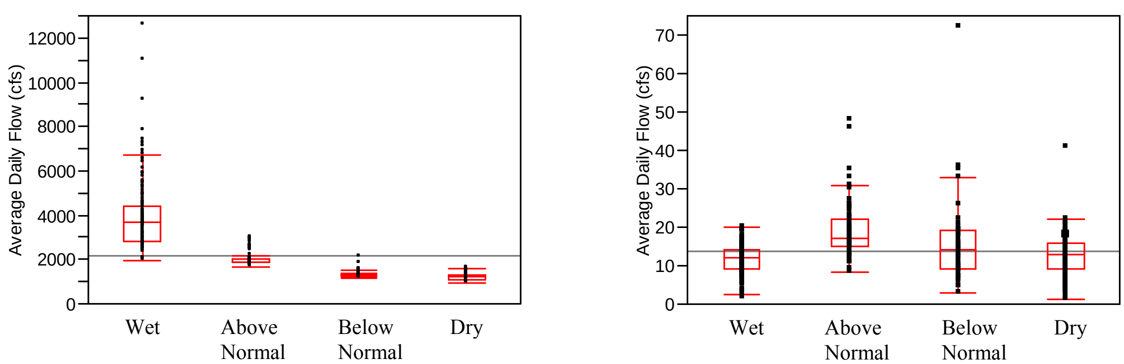


Figure 2: Relationship between water year type and July/August flow at two representative sites.

A. San Joaquin River at Vernalis July/August

B. Orestimba Creek at River Road Near Crows Landing July/August



Analyses 1 - 10

Results from the Statistical Comparison of Water Flow Rates for San Joaquin Valley Drainages and the San Joaquin Region 60-20-20 Water Supply Index for 2000 – 2006

Analysis 1: San Joaquin River near Vernalis

Data analysis by water year:

Figure 1-1: San Joaquin River near Vernalis average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

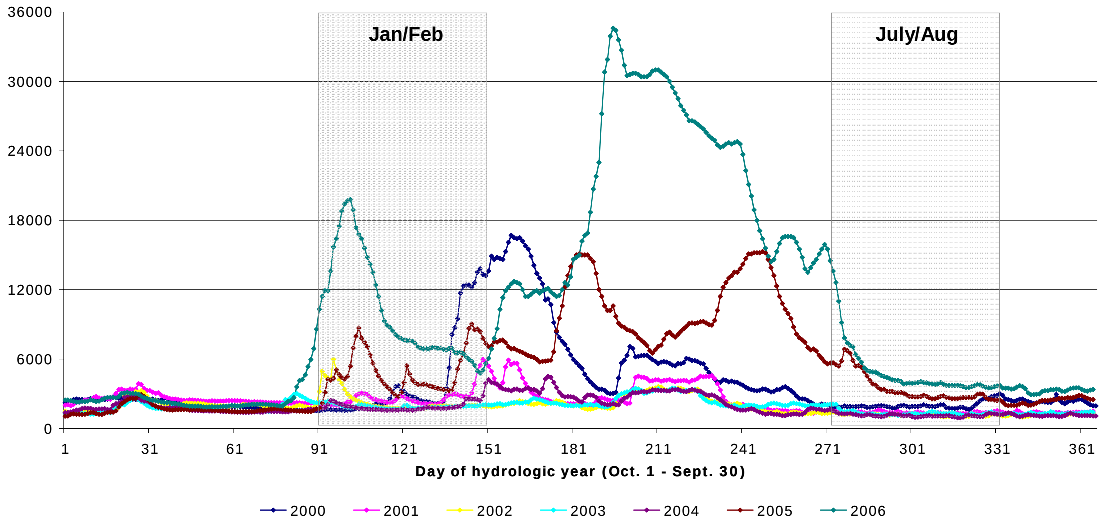


Table 1-1: San Joaquin River near Vernalis flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	4757.00	2335	4451.97	2034.52	1910	329.67
2001	Critical	2750.34	2470	928.41	1364.84	1360	87.87
2002	Dry	2298.98	1940	937.59	1171.94	1170	88.61
2003	Below Normal	1896.78	1880	152.58	1300.65	1270	157.47
2004	Critical	1989.83	1785	568.70	1135.95	1110	107.56
2005	Wet	5100.85	4320	1859.44	3385.48	2795	1232.60
2006	Wet	9985.08	7620	4587.43	4621.94	3925	1783.17

Table 1-2: Statistical analysis of San Joaquin River near Vernalis flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 1-2A: January-February

Year				Average	Classification
2006	A			9985.08	Wet
2005		B		5100.85	Wet
2000		B		4757.00	Above Normal
2001			C	2750.34	Critical
2002			C	2298.98	Dry
2004			C	1989.83	Critical
2003			C	1896.78	Below Normal

Table 1-2B: July-August

Year					Average	Classification
2006	A				4621.94	Wet
2005		B			3385.48	Wet
2000			C		2034.52	Above Normal
2001				D	1364.84	Critical
2003				D	1300.65	Below Normal
2002				D	1171.94	Dry
2004				D	1135.95	Critical

Figure 1-2A: Trendlines for the WSI (black), and for San Joaquin River near Vernalis average yearly flow for January/February (pink) and July/August (blue), by water year.

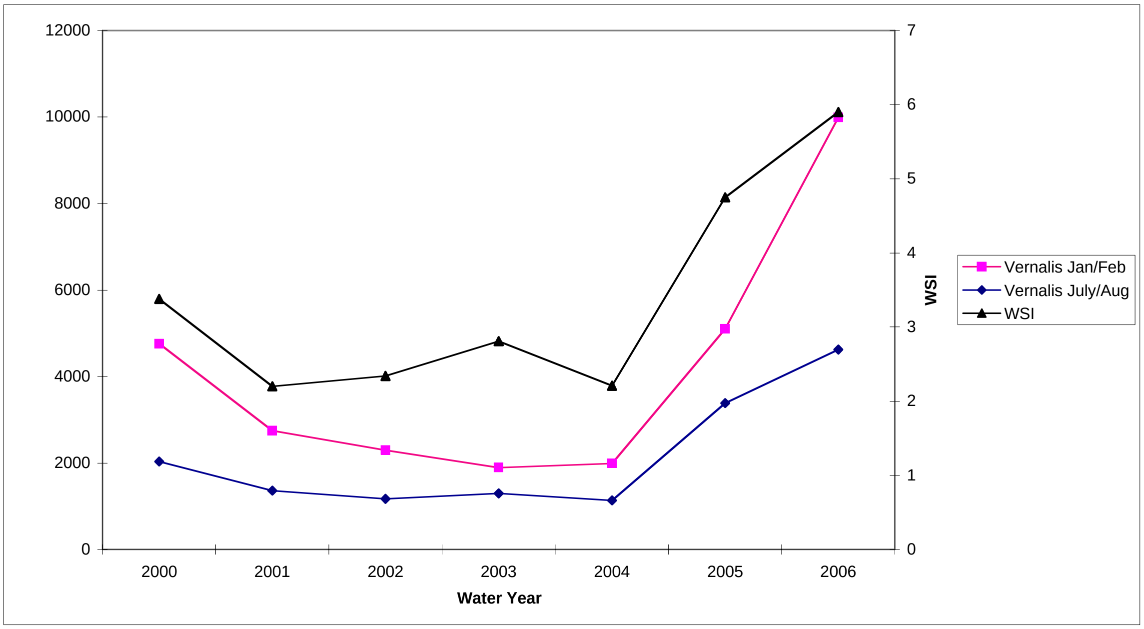
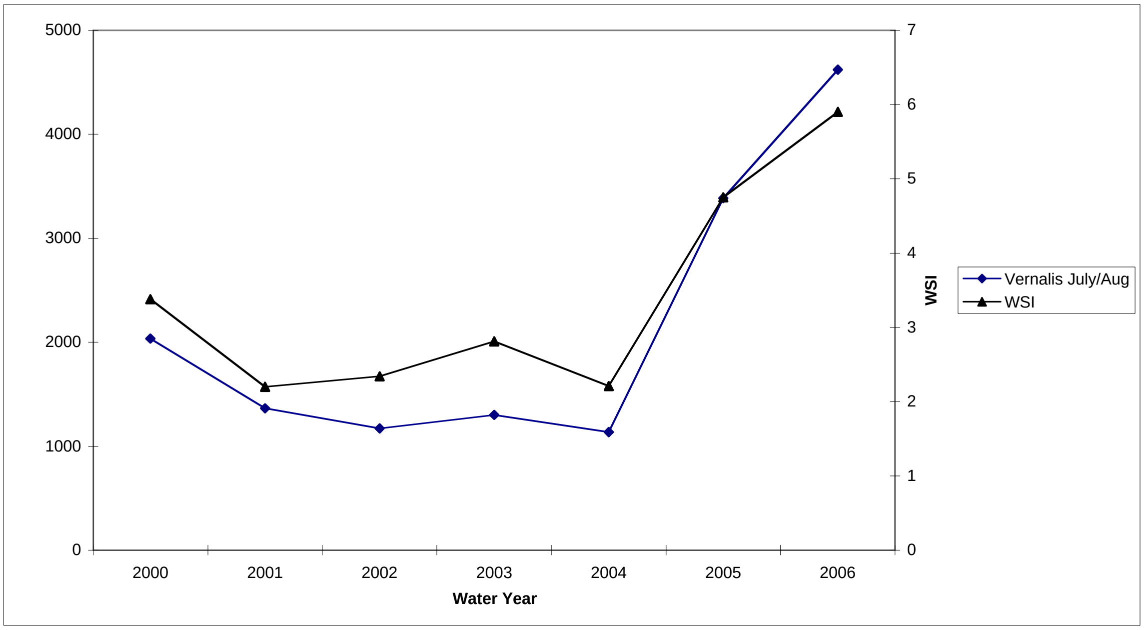


Figure 1-2B: Trendlines for the WSI (black), and for San Joaquin River near Vernalis average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 1-3: Statistical analysis of Vernalis flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

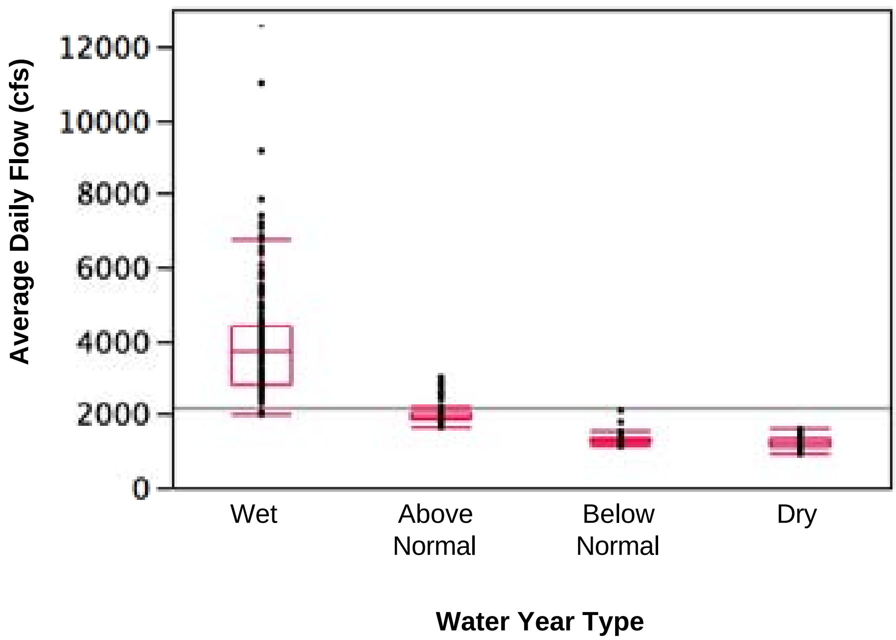
Table 1-3A: January-February

Classification				Average
Wet	A			7542.97
Above Normal		B		4757.00
Dry			C	2344.38
Below Normal			C	1896.78

Table 1-3B: July-August

Classification				Average
Wet	A			4003.71
Above Normal		B		2034.52
Below Normal			C	1300.65
Dry			C	1224.24

Figure 1-3: Box plots of San Joaquin River near Vernalis daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for San Joaquin River near Vernalis. Average water flow rates correlate well with the WSI for both January/February and July/August (Figures 1-2 & 1-3). As both Table 1-2 and Table 1-3 show, statistically significant differences are seen between wet and dry water year flow rates. "Wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004). This is an expected result for the San Joaquin River, which is dependent on the amount of water originating in the San Joaquin basin.

Analysis 2: San Joaquin River at Crows Landing

Data analysis by water year:

Figure 2-1: San Joaquin River at Crows Landing average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

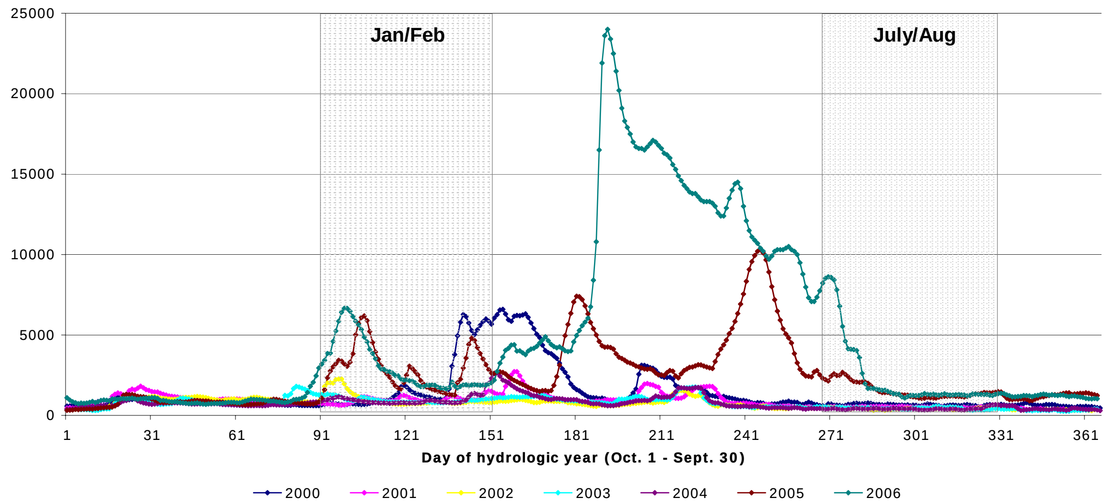


Table 2-1: San Joaquin River at Crows Landing flow descriptive statistics.

Water Year	Water year classification	January / February Average	Median	Std. dev.	July / August Average	Median	Std. dev.
2000	Above Normal	2191.68	1120	2019.63	653.87	645	50.44
2001	Critical	989.71	963	199.16	510.35	516.5	42.01
2002	Dry	1010.22	812	448.95	410.63	416	44.87
2003	Below Normal	938.42	904	142.32	440.95	445.5	63.03
2004	Critical	1000.80	863.5	369.58	440.00	409.5	91.47
2005	Wet	2996.61	2850	1296.23	1449.98	1325	418.36
2006	Wet	3019.66	2160	1595.56	1789.19	1320	1172.74

Table 2-2: Statistical analysis of San Joaquin River at Crows Landing flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 2-2A: January-February

Year				Average	Classification
2006	A			3019.66	Wet
2005	A			2996.61	Wet
2000		B		2191.68	Above Normal
2002			C	1010.22	Dry
2004			C	1000.80	Critical
2001			C	989.71	Critical
2003			C	938.42	Below Normal

Table 2-2B: July-August

Year					Average	Classification
2006	A				1789.19	Wet
2005		B			1449.98	Wet
2000			C		653.87	Above Normal
2001			C	D	510.35	Critical
2003				D	440.95	Below Normal
2004				D	440.00	Critical
2002				D	410.63	Dry

Figure 2-2A: Trendlines for the WSI (black), and for San Joaquin River at Crows Landing average yearly flow for January/February (pink) and July/August (blue), by water year.

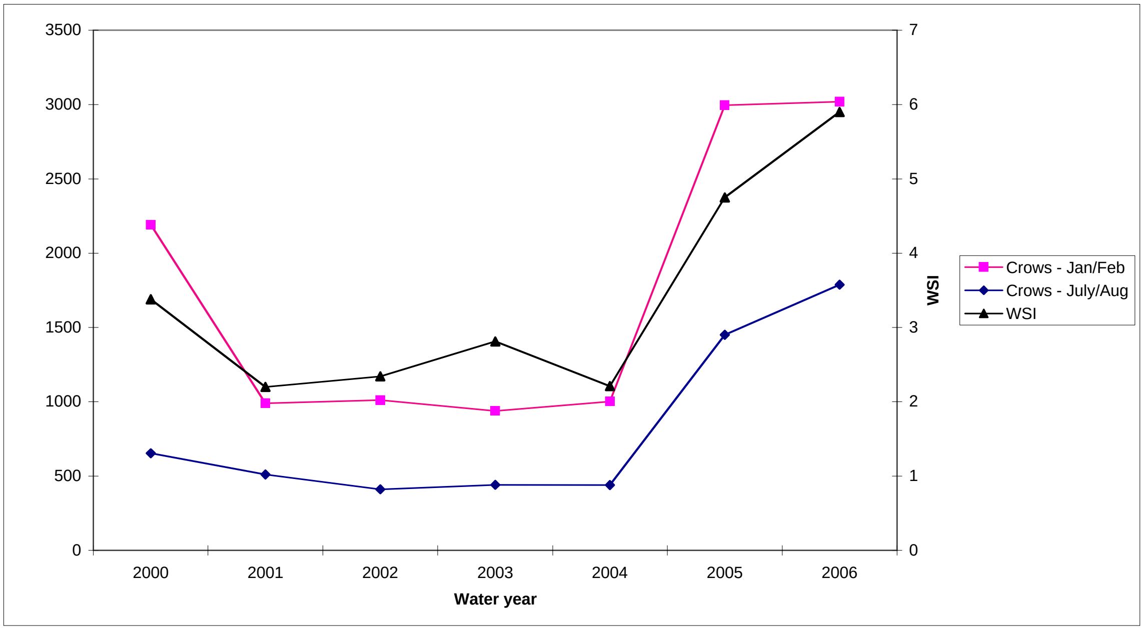
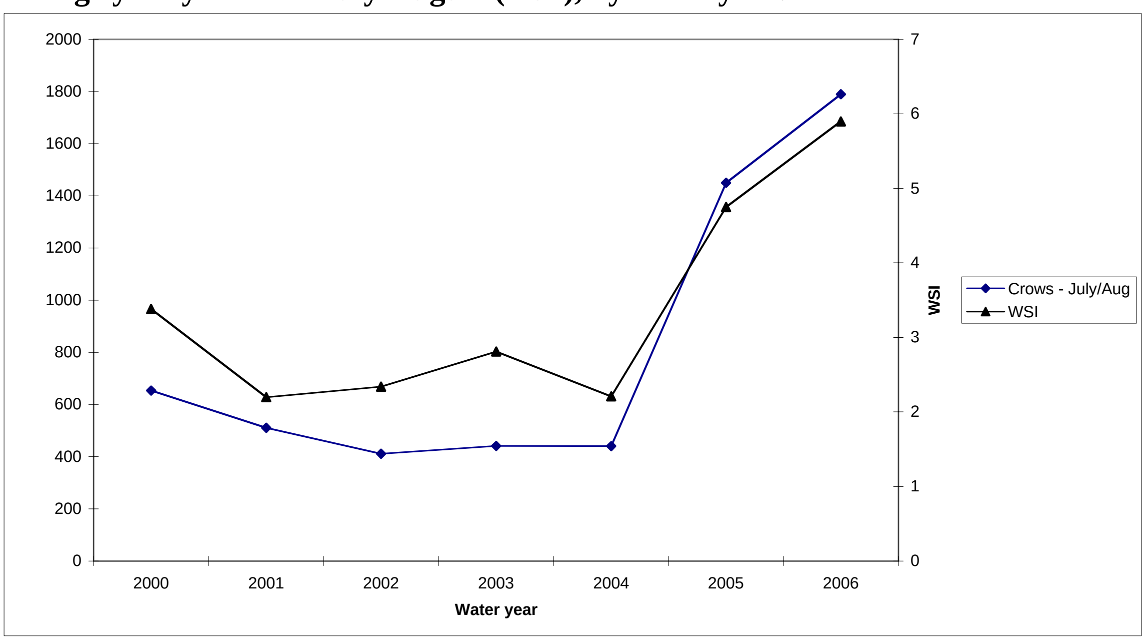


Figure 2-2B: Trendlines for the WSI (black), and for San Joaquin River at Crows Landing average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 2-3: Statistical analysis of San Joaquin River at Crows Landing flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

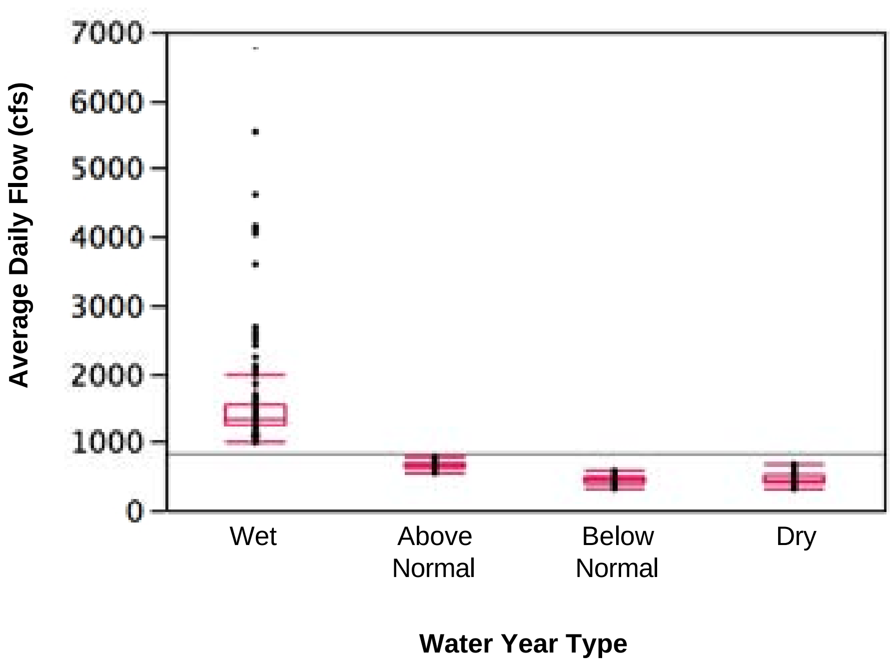
Table 2-3A: January-February

Classification				Average
Wet	A			3008.14
Above Normal		B		2191.68
Dry			C	1000.25
Below Normal			C	938.42

Table 2-3B: July-August

Classification				Average
Wet	A			1619.59
Above Normal		B		653.87
Dry			C	453.66
Below Normal			C	440.95

Figure 2-3: Box plots of San Joaquin River at Crows Landing daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for San Joaquin River at Crows Landing. Average water flow rates correlate well with the WSI for both January/February and July/August (Figures 2- 2 & 2-3). As both Table 2-2 and Table 2-3 show, statistically significant differences are seen between wet and dry water year flow rates. "Wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between July/August 2000 (above normal) and 2001 (critical). This is an expected result for the San Joaquin River, which is dependent on the amount of water originating in the San Joaquin basin.

Analysis 3: Harding Drain at Carpenter Road near Patterson

Data analysis by water year:

Figure 3-1: Harding Drain average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

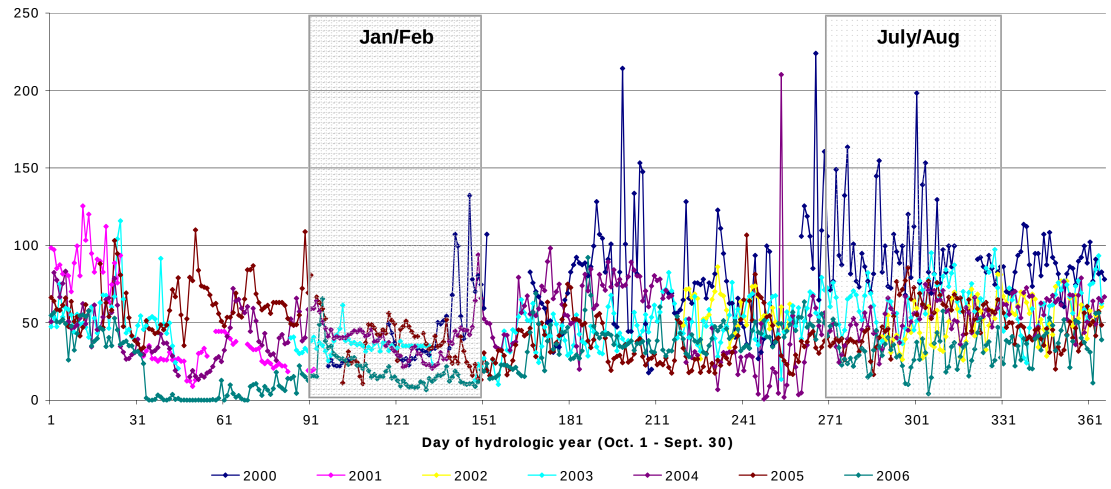


Table 3-1: Harding Drain flow descriptive statistics.

		January / February			July / August		
Water Year	Water year classification	Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	46.17	33.46	26.96	95.28	86.21	27.23
2002	Dry				49.05	48.25	15.33
2003	Below Normal	34.38	35.00	6.94	63.74	64.98	15.00
2004	Critical	39.77	40.48	12.75	53.45	55.21	11.04
2005	Wet	36.46	37.04	13.68	53.53	56.44	14.91
2006	Wet	18.62	15.45	10.36	29.99	29.83	10.18

Table 3-2: Statistical analysis of Harding Drain flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 3-2A: January-February

Year				Average	Classification
2000	A			46.17	Above Normal
2004		B		39.77	Critical
2005		B		36.46	Wet
2003		B		34.38	Below Normal
2006			C	18.62	Wet

Table 3-2B: July-August

Year					Average	Classification
2000	A				95.28	Above Normal
2003		B			63.74	Below Normal
2005			C		53.53	Wet
2004			C		53.45	Critical
2002			C		49.05	Dry
2006				D	29.99	Wet

Figure 3-2A: Trendlines for the WSI (black), and for Harding Drain average yearly flow for January/February (pink) and July/August (blue), by water year.

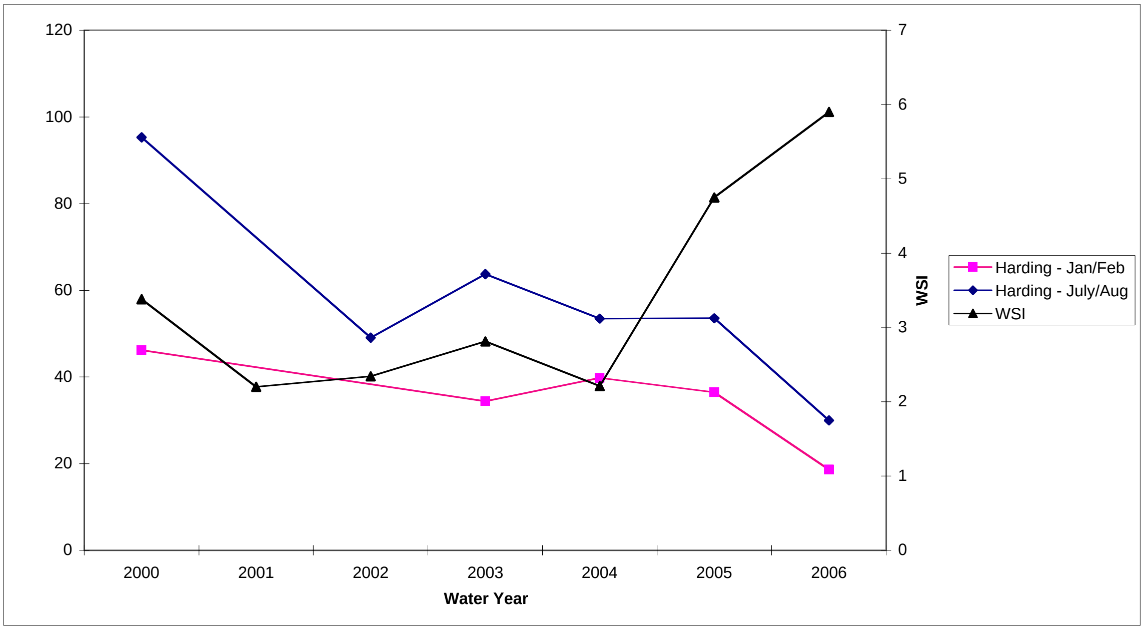
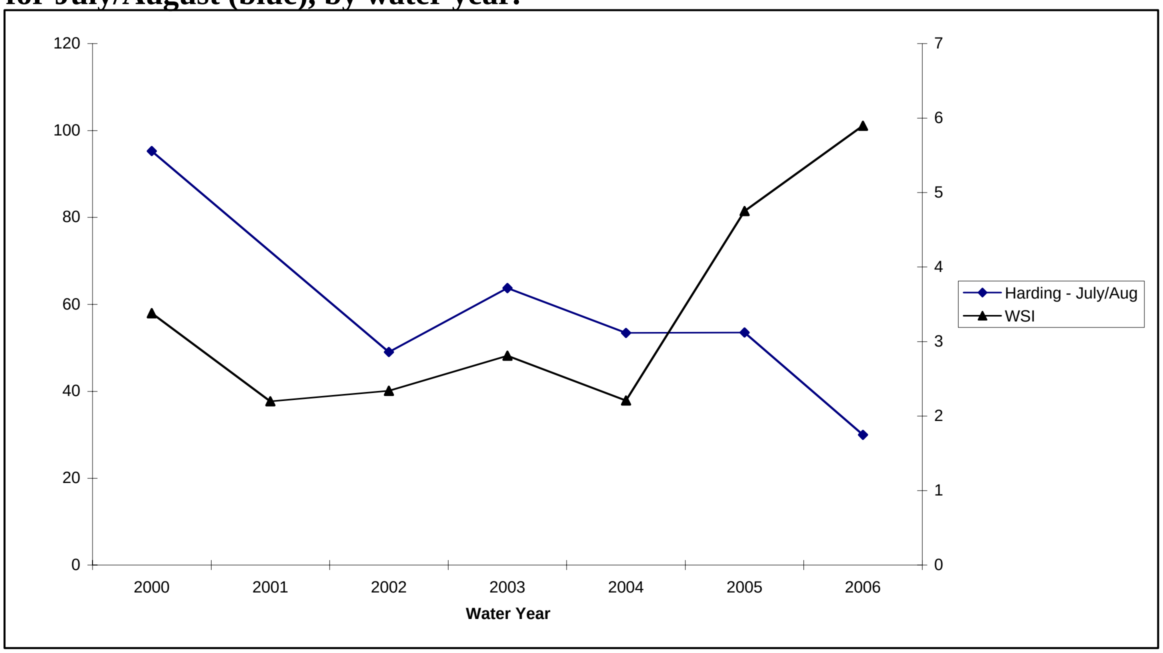


Figure 3-2B: Trendlines for the WSI (black), and for Harding Drain average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 3-3: Statistical analysis of Harding Drain flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

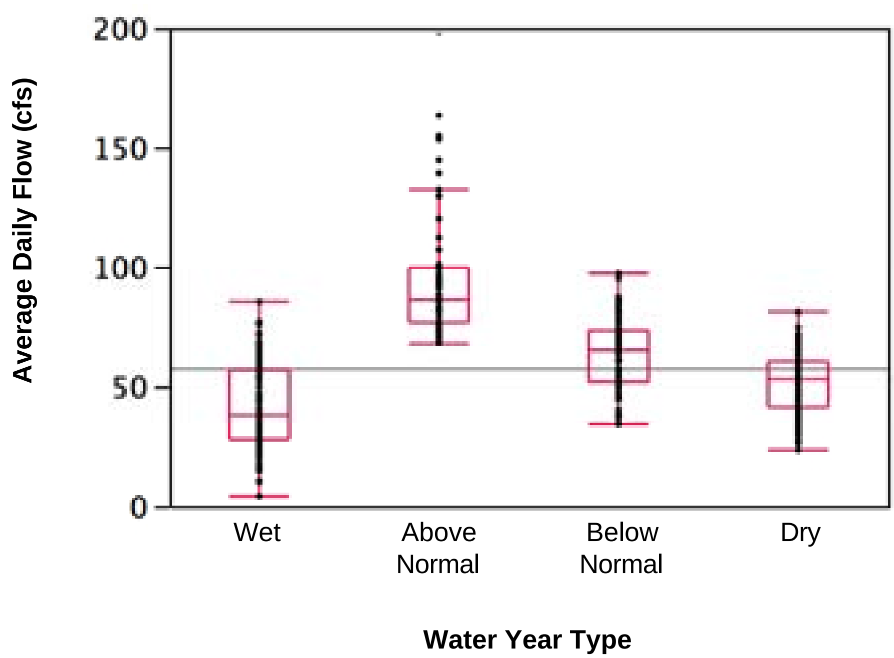
Table 3-3A: January-February

Classification				Average
Above Normal	A			46.17
Dry		B		39.77
Below Normal		B		34.38
Wet			C	27.06

Table 3-3B: July-August

Classification					Average
Above Normal	A				95.28
Below Normal		B			63.74
Dry			C		51.55
Wet				D	41.76

Figure 3-3: Box plots of Harding Drain daily flow averages in July/August for 2000 – 2006 by water year type.



Flow data were incomplete for Harding drain for water years 2001 and 2002, so only July/August 2002 was included in the analysis. Flow data for all other water years was analyzed. No correlation between the WSI and flow rate is seen for Harding drain for either January/February or July/August (Figures 3-2 & 3-3). As both Table 3-2 and Table 3-3 show, statistically significant differences are seen between different water year flow rates, but there is no correlation with water year type. Note that in July/August, 2000 has the highest average flow, while the average flow of the "wet" years (2005/2006) was either similar to or less than "dry" and "critical" years (Table 3-2).

Analysis 4: San Luis Drain near Stevinson

Data analysis by water year:

Figure 4-1: San Luis Drain average daily flow for water years 2000 – 2005. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

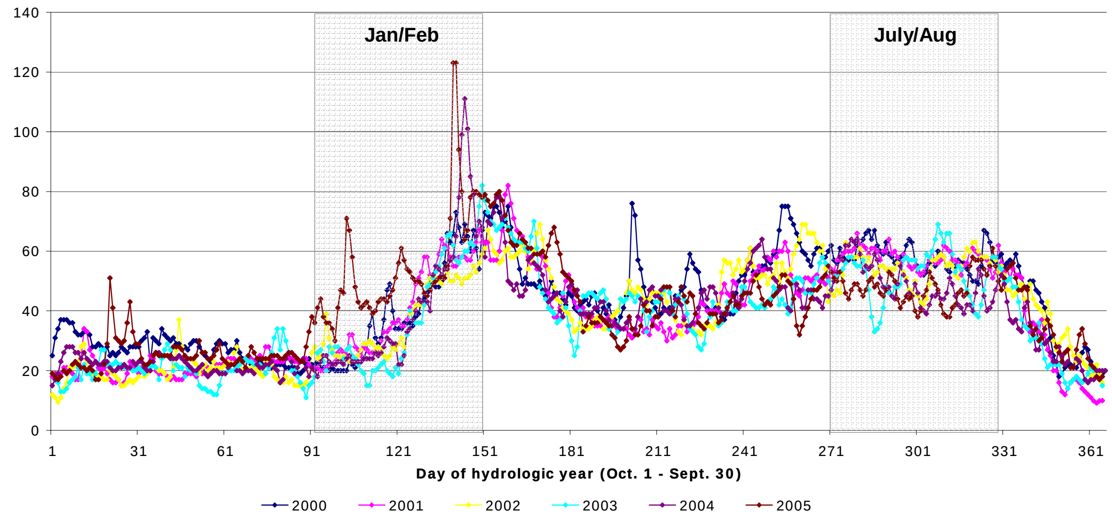


Table 4-1: San Luis Drain flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	41.23	37.5	17.40	57.97	57	4.29
2001	Critical	41.24	36	15.35	56.89	57	3.48
2002	Dry	37.59	31	12.09	54.23	55	5.11
2003	Below Normal	38.03	28	18.85	52.26	54	7.99
2004	Critical	41.68	30.5	22.88	47.87	46	7.30
2005	Wet	55.34	50	19.06	48.21	47	5.48

Table 4-2: Statistical analysis of San Luis Drain flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 4-2A: January-February

Year			Average	Classification
2005	A		55.34	Wet
2004		B	41.68	Critical
2001		B	41.24	Critical
2000		B	41.23	Above Normal
2003		B	38.03	Below Normal
2002		B	37.59	Dry

Table 4-2B: July-August

Year				Average	Classification
2000	A			57.97	Above Normal
2001	A			56.89	Critical
2002		B		54.23	Dry
2003		B		52.26	Below Normal
2005			C	48.21	Wet
2004			C	47.87	Critical

Figure 4-2A: Trendlines for the WSI (black), and for San Luis Drain average yearly flow for January/February (pink) and July/August (blue), by water year.

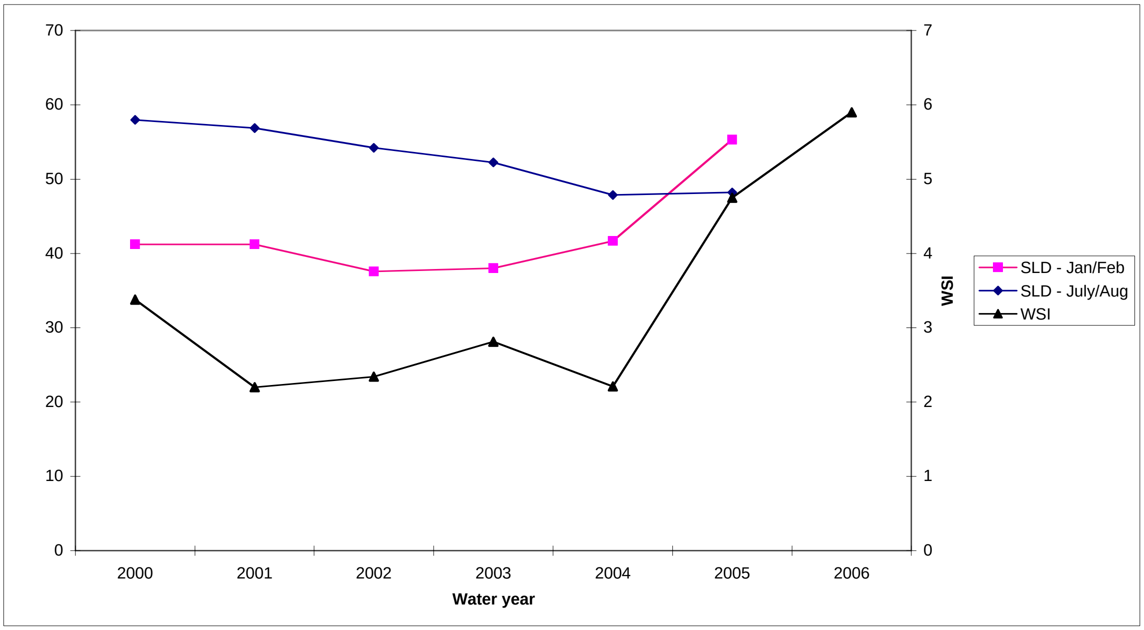
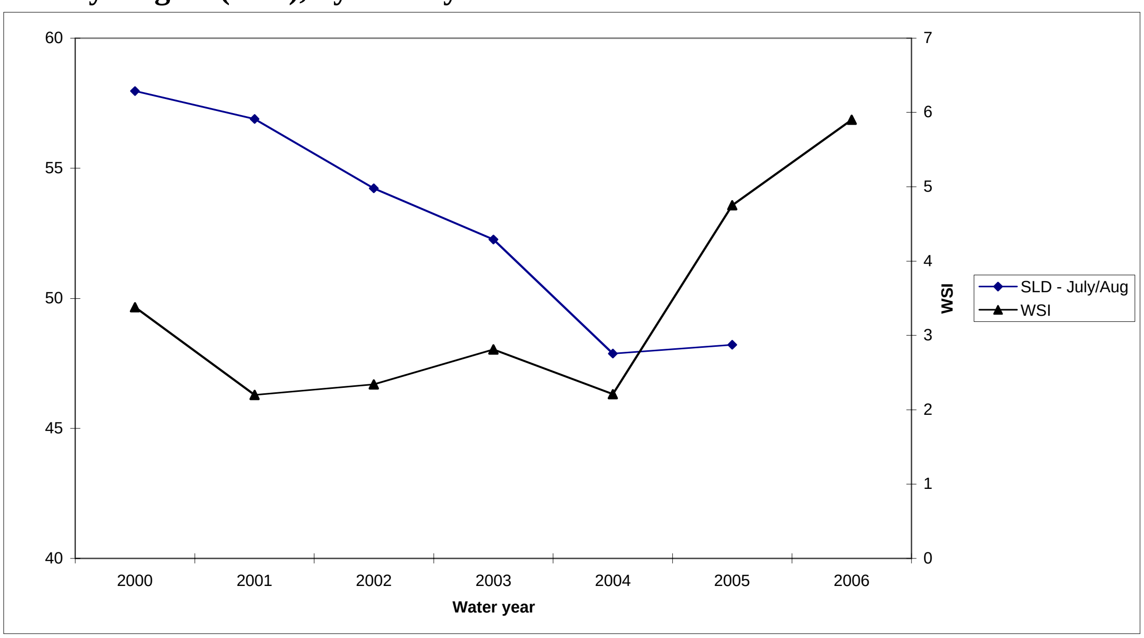


Figure 4-2B: Trendlines for the WSI (black), and for San Luis Drain average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 4-3: Statistical analysis of San Luis Drain flow averages for 2000 – 2005, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

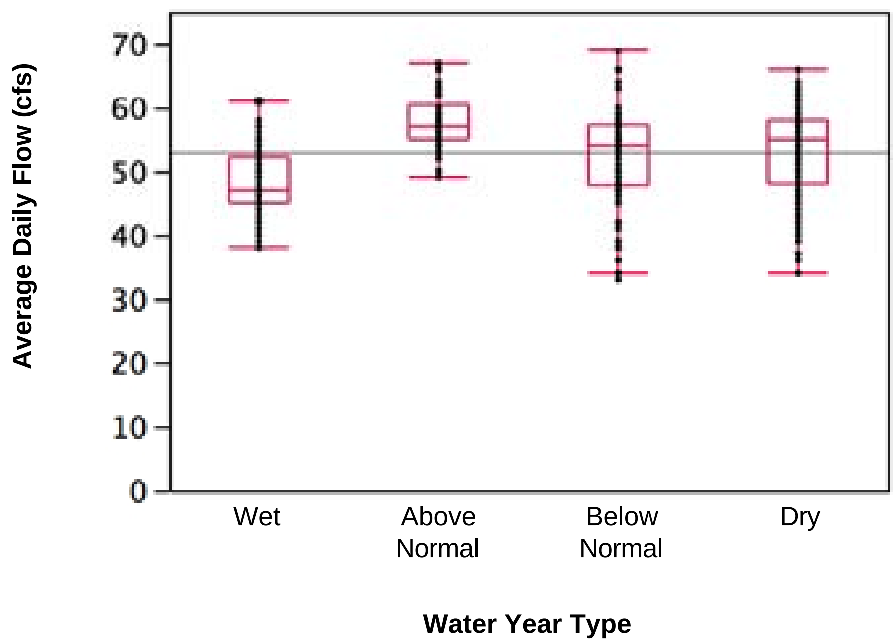
Table 4-3A: January-February

Classification			Average
Wet	A		55.34
Above Normal		B	41.23
Dry		B	40.18
Below Normal		B	38.03

Table 4-3B: July-August

Classification				Average
Above Normal	A			57.97
Dry		B		52.99
Below Normal		B		52.26
Wet			C	48.21

Figure 4-3: Box plots of San Luis Drain daily flow averages in July/August for 2000 – 2005 by water year type.



No USGS data for 2006 was available for San Luis Drain, so only 2000 through 2005 were analyzed. Relatively little variation in water flow data from year to year was seen, particularly for July/August. Some correlation between flow rates and the WSI is seen for January/February but not for July/August (Figures 4-2 & 4-3). As both Table 4-2 and Table 4-3 show, the January/February 2005 "wet" year flow rate is significantly higher than the flow rate of all other water year types. Note that for July/August, 2000 has the highest average flow, while the average flow of the 2005 "wet" year was either similar to or less than "dry" and "critical" years (Table 4-2).

Analysis 5: Orestimba Creek at River Road near Crows Landing

Data analysis by water year:

Figure 5-1: Orestimba Creek average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

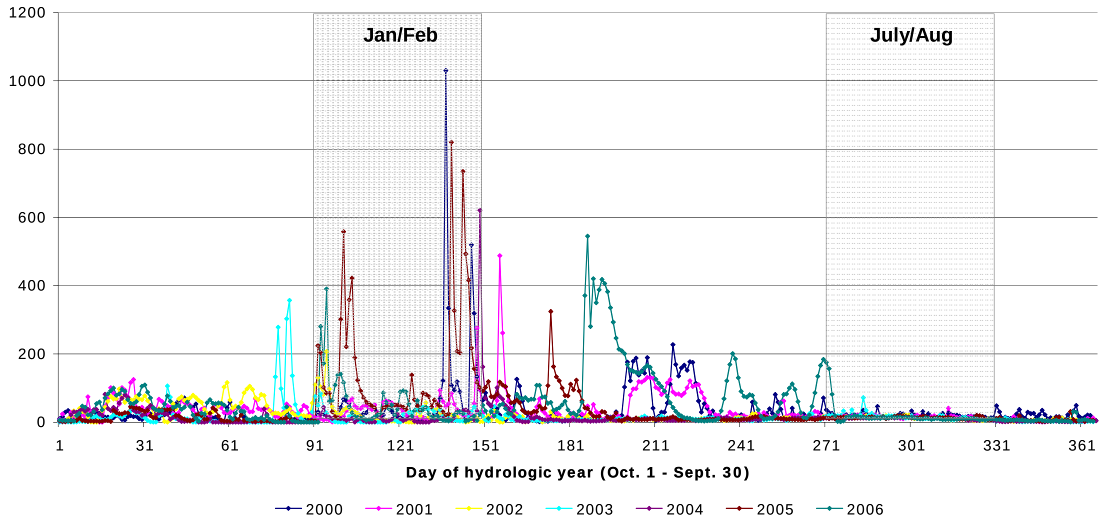


Table 5-1: Orestimba Creek flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	70.56	24.5	153.21	19.08	17	7.65
2001	Critical	7.47	17	0.45	15.09	16.5	5.68
2002	Dry	22.88	12	33.24	12.24	13	4.54
2003	Below Normal	15.97	8.5	17.12	15.24	14	10.03
2004	Critical	25.81	9.95	81.63	10.33	12	3.79
2005	Wet	142.08	72	172.38	12.90	12.9	3.36
2006	Wet	50.33	28	66.53	10.73	11	3.69

Table 5-2: Statistical analysis of Orestimba Creek flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 5-2A: January-February

Year				Average	Classification
2005	A			142.08	Wet
2000		B		70.56	Above Normal
2006		B	C	50.33	Wet
2001		B	C	37.82	Critical
2004			C	25.81	Critical
2002			C	22.88	Dry
2003			C	15.97	Below Normal

Table 5-2B: July-August

Year					Average	Classification
2000	A				19.08	Above Normal
2003		B			15.24	Below Normal
2001		B			15.09	Critical
2005			C		12.90	Wet
2002			C	D	12.24	Dry
2006				D	10.73	Wet
2004				D	10.33	Critical

Figure 5-2A: Trendlines for the WSI (black), and for Orestimba Creek average yearly flow for January/February (pink) and July/August (blue), by water year.

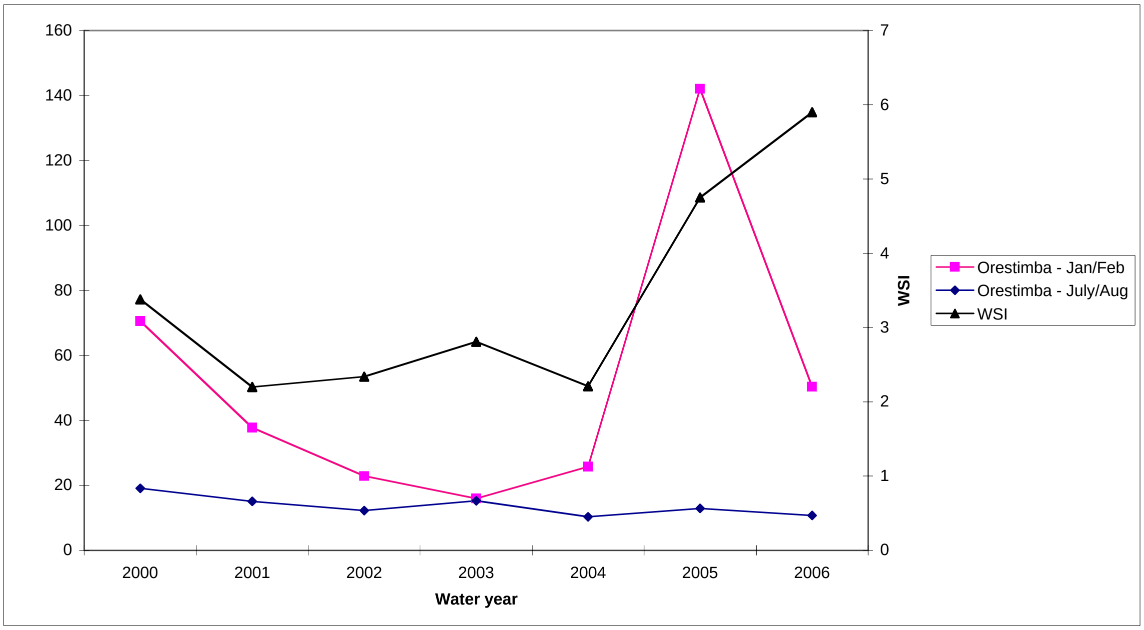
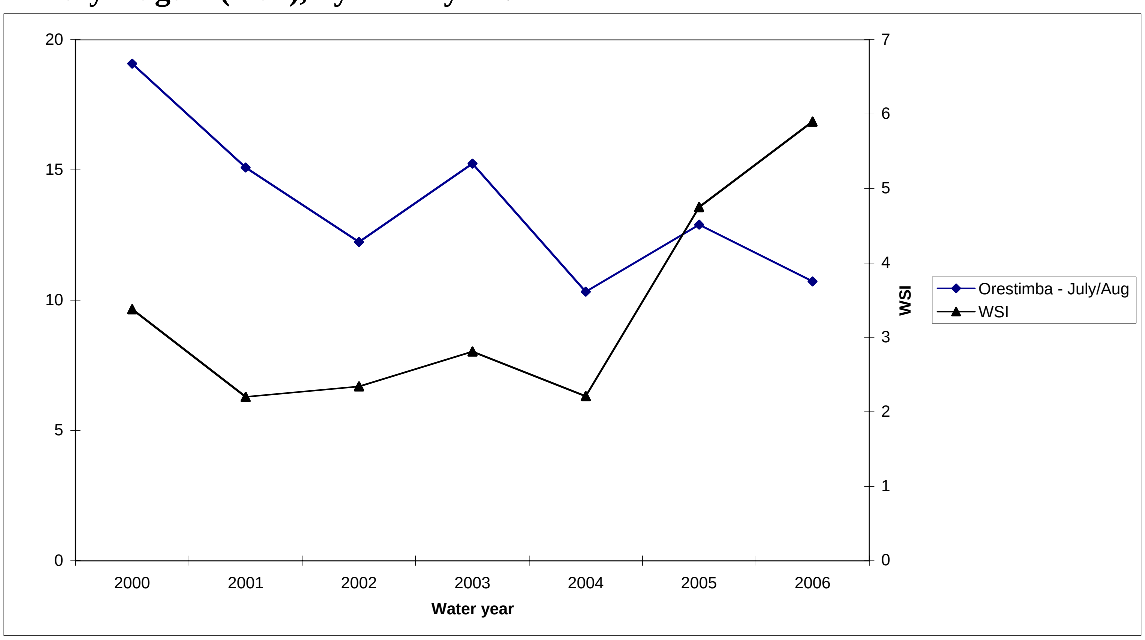


Figure 5-2B: Trendlines for the WSI (black), and for Orestimba Creek average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 5-3: Statistical analysis of Orestimba Creek flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

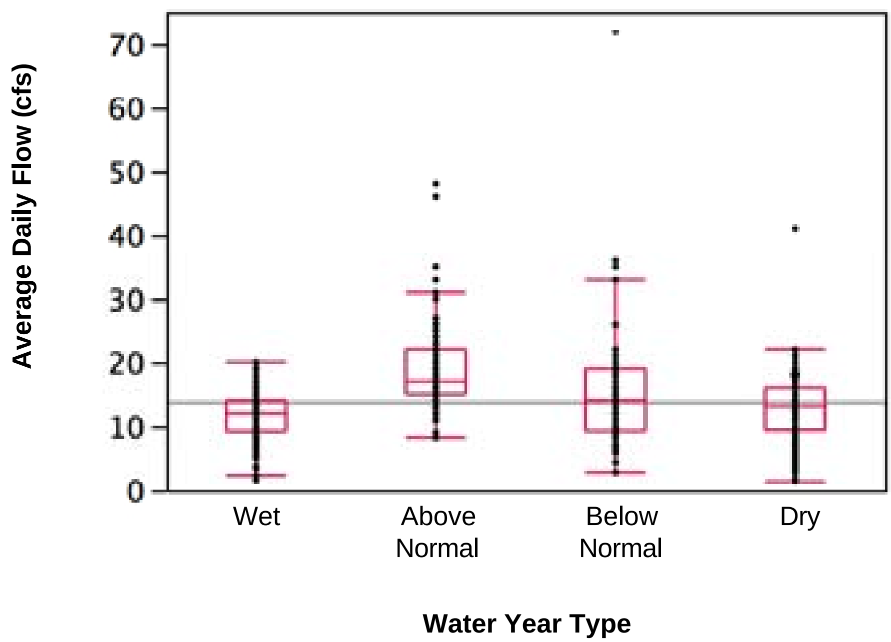
Table 5-3A: January-February

Classification			Average
Wet	A		96.21
Above Normal	A		70.56
Dry		B	28.82
Below Normal		B	15.97

Table 5-3B: July-August

Classification				Average
Above Normal	A			19.08
Below Normal		B		15.24
Dry			C	12.55
Wet			C	11.81

Figure 5-3: Box plots of Orestimba Creek daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Orestimba Creek. Good correlation between flow rates and the WSI is seen for January/February but not for July/August (Figures 5-2 & 5-3). As both Table 5-2 and Table 5-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2001 (critical). Note that for July/August, 2000 has the highest average flow, while the average flow of "wet" years (2005/2006) was either similar to or less than "dry" and "critical" years (Table 5-2).

Analysis 6: Salt Slough at Hwy. 165 near Stevinson

Data analysis by water year:

Figure 6-1: Salt Slough average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

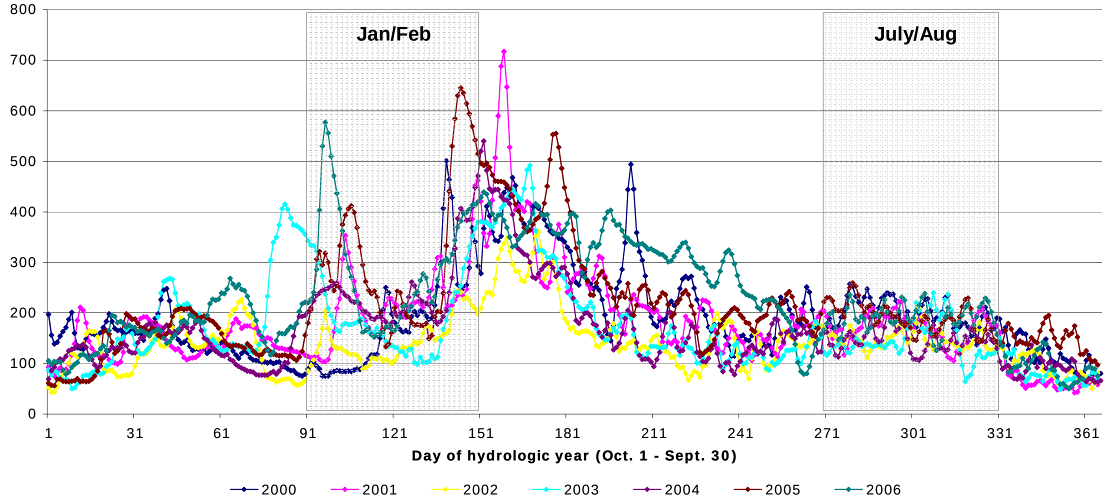


Table 6-1: Salt Slough flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	192.82	184	107.32	196.63	195.5	32.09
2001	Critical	227.25	218	78.74	165.60	170.5	34.22
2002	Dry	148.27	135	42.63	144.34	143	21.00
2003	Below Normal	191.29	176	77.99	145.63	136.5	38.45
2004	Critical	255.42	224.5	88.42	142.90	144.5	27.72
2005	Wet	313.58	253	148.59	186.61	186.5	28.34
2006	Wet	291.83	269	113.50	185.16	191	34.35

Table 6-2: Statistical analysis of Salt Slough flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 6-2A: January-February

Year						Average	Classification
2005	A					313.58	Wet
2006	A					291.83	Wet
2004		B				255.42	Critical
2001		B	C			227.25	Critical
2000			C	D		192.82	Above Normal
2003				D		191.29	Below Normal
2002					E	148.27	Dry

Table 6-2B: July-August

Year					Average	Classification
2000	A				196.63	Above Normal
2005	A	B			186.61	Wet
2006		B			185.16	Wet
2001			C		165.60	Critical
2003				D	145.63	Below Normal
2002				D	144.34	Dry
2004				D	142.90	Critical

Figure 6-2A: Trendlines for the WSI (black), and for Salt Slough average yearly flow for January/February (pink) and July/August (blue), by water year.

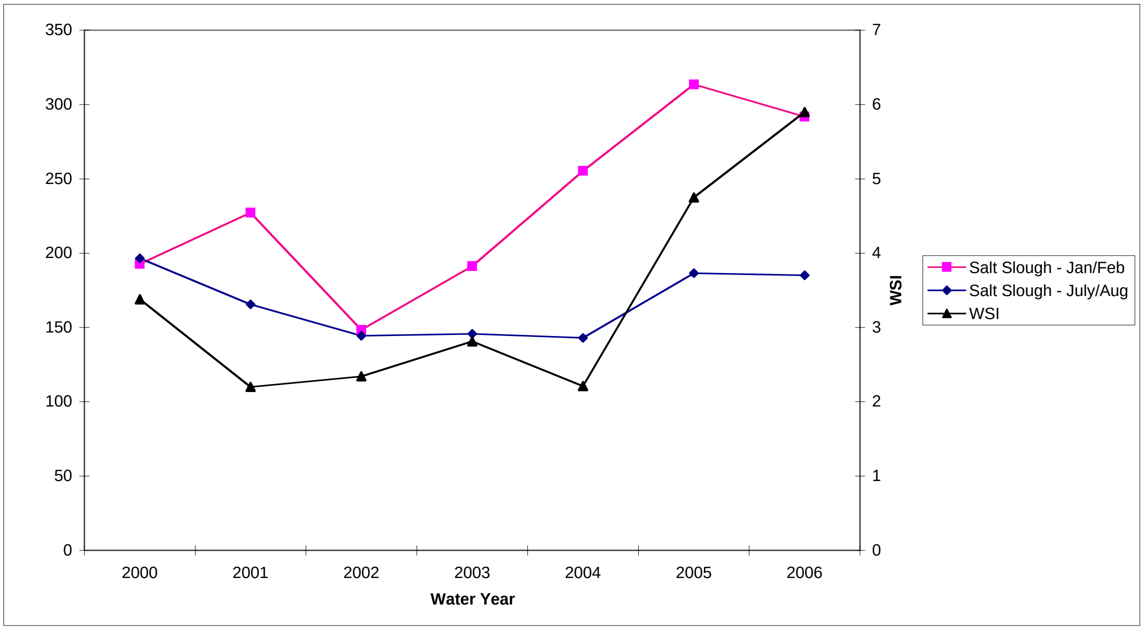
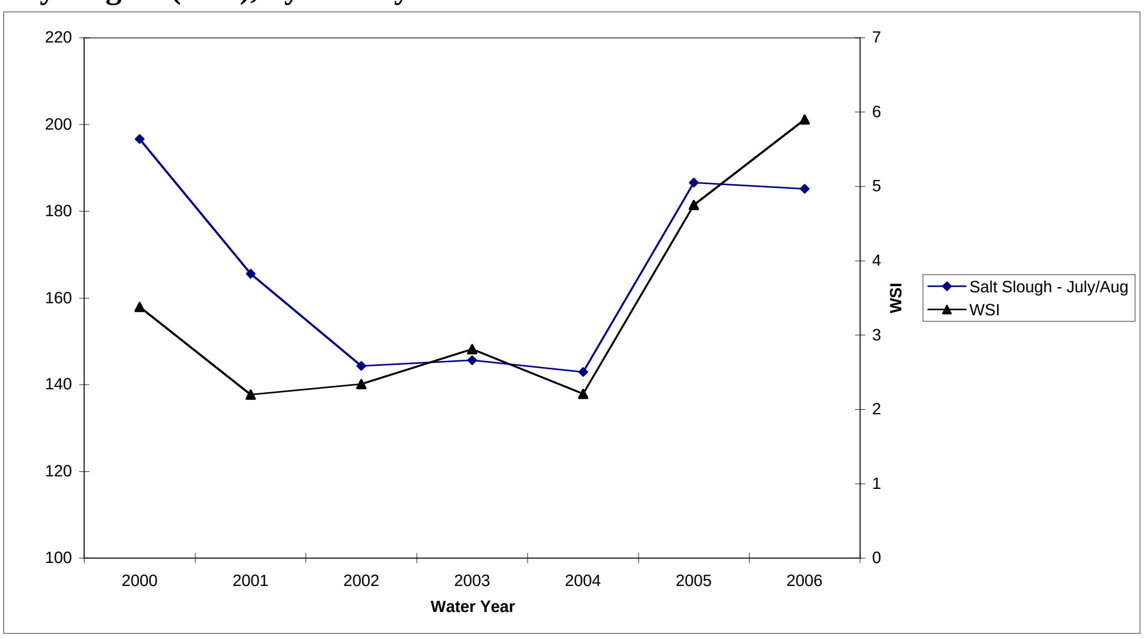


Figure 6-2B: Trendlines for the WSI (black), and for Salt Slough average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 6-3: Statistical analysis of Salt Slough flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

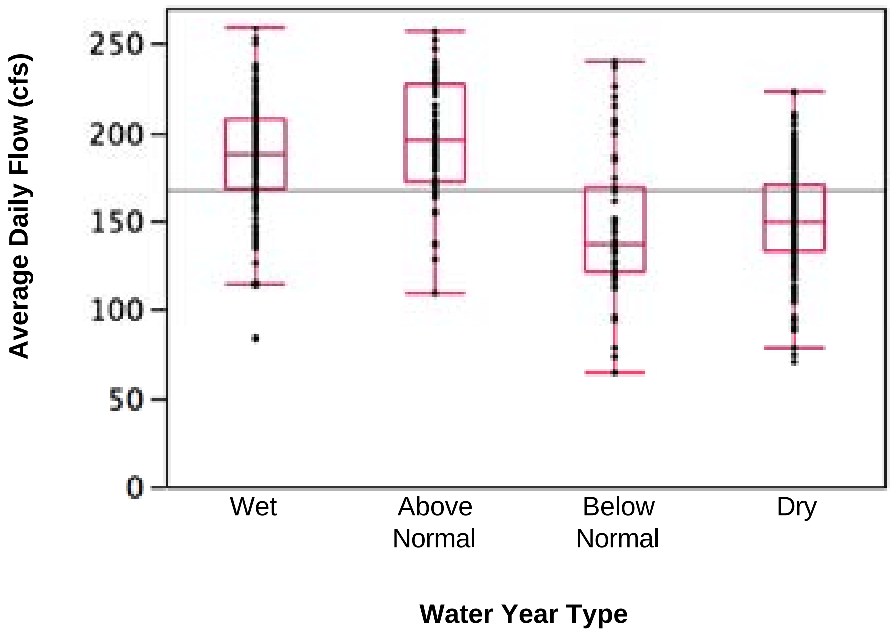
Table 6-3A: January-February

Classification			Average
Wet	A		302.70
Dry		B	210.57
Above Normal		B	192.82
Below Normal		B	191.29

Table 6-3B: July-August

Classification				Average
Above Normal	A			196.63
Wet		B		185.89
Dry			C	150.95
Below Normal			C	145.63

Figure 6-3: Box plots of Salt Slough daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Salt Slough. Some correlation between flow rates and the WSI is seen for both January/February and July/August (Figures 6-2 & 6-3). As both Table 6-2 and Table 6-3 show, the January/February 2005/2006 ("wet") flow rates are significantly higher than the flow rate of all other water year types. For July/August, 2000 has the highest average flow, the average flow of both "wet" years (2005/2006) are similar to 2000, and "below normal", "dry" and "critical" year average flows are significantly lower (Table 6-2).

Analysis 7: Mud Slough near Gustine

Data analysis by water year:

Figure 7-1: Mud Slough average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

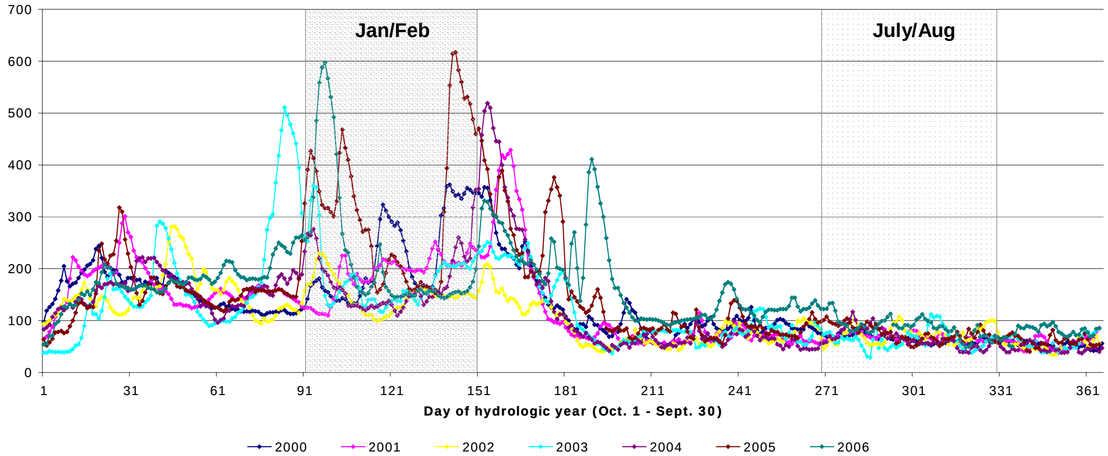


Table 7-1: Mud Slough flow descriptive statistics.

Water Year	Water year classification	January / February			July / August		
		Average	Median	Std. dev.	Average	Median	Std. dev.
2000	Above Normal	230.17	185.5	82.10	63.60	63	7.14
2001	Critical	193.47	201	37.14	68.10	67	6.98
2002	Dry	149.05	147	31.42	73.03	71	16.10
2003	Below Normal	177.03	157	54.11	62.65	62	18.28
2004	Critical	177.20	152	68.49	63.81	61	18.82
2005	Wet	313.10	301	141.14	73.50	72	13.46
2006	Wet	224.59	158	131.02	82.82	86	16.46

Table 7-2: Statistical analysis of Mud Slough flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 7-2A: January-February

Year						Average	Classification
2005	A					313.10	Wet
2000		B				230.17	Above Normal
2006		B	C			224.59	Wet
2001			C	D		193.47	Critical
2004				D	E	177.20	Critical
2003				D	E	177.03	Below Normal
2002					E	149.05	Dry

Table 7-2B: July-August

Year						Average	Classification
2006	A					82.82	Wet
2005		B				73.50	Wet
2002		B	C			73.03	Dry
2001			C	D		68.10	Critical
2004				D	E	63.81	Critical
2000				D	E	63.60	Above Normal
2003					E	62.65	Below Normal

Figure 7-2A: Trendlines for the WSI (black), and for Mud Slough average yearly flow for January/February (pink) and July/August (blue), by water year.

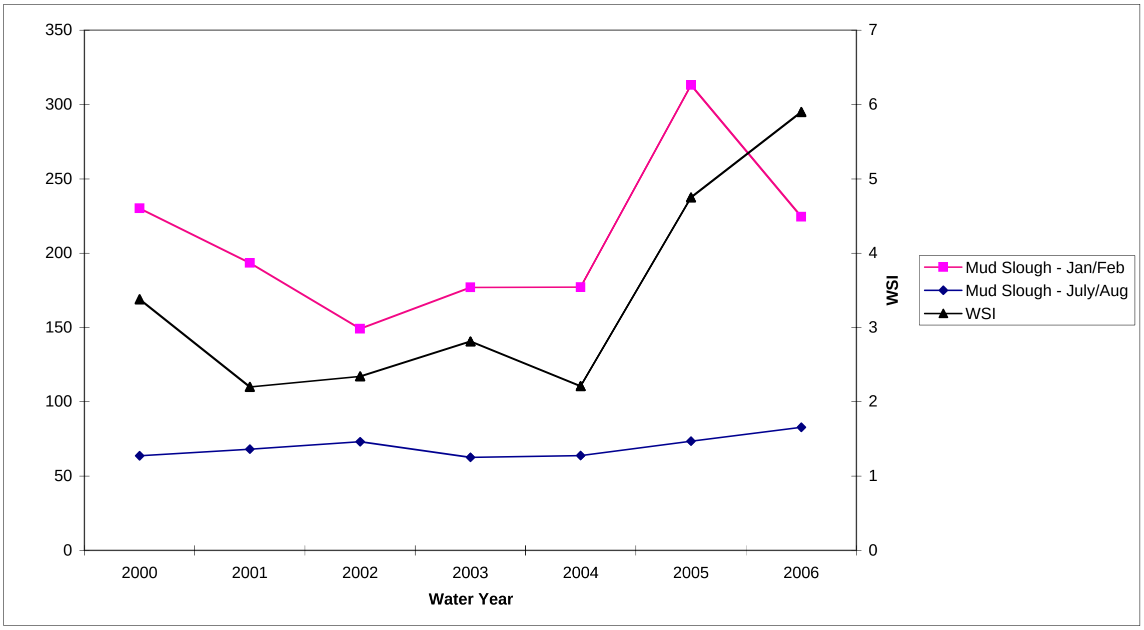
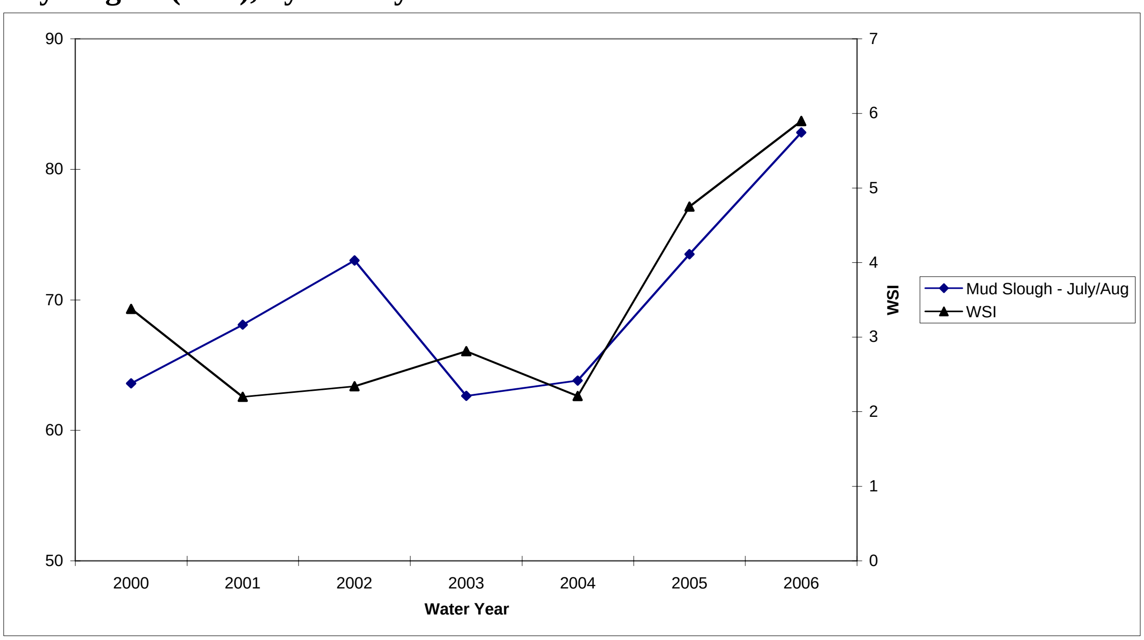


Figure 7-2B: Trendlines for the WSI (black), and for Mud Slough average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 7-3: Statistical analysis of Mud Slough flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

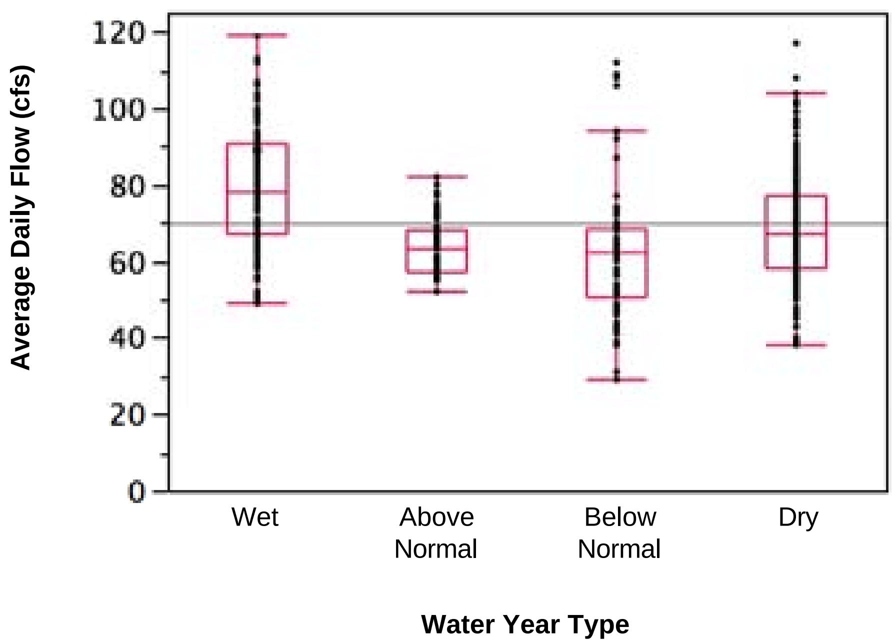
Table 7-3A: January-February

Classification				Average
Wet	A			268.85
Above Normal		B		230.17
Below Normal			C	177.03
Dry			C	173.26

Table 7-3B: July-August

Classification				Average
Wet	A			78.16
Dry		B		68.31
Above Normal			C	63.60
Below Normal			C	62.65

Figure 7-3: Box plots of Mud Slough daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Mud Slough. Good correlation between flow rates and the WSI is seen for January/February and a fair correlation between flow rates and the WSI is seen for July/August (Figures 7-2 & 7-3). As both Table 7-2 and Table 7-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2001 (critical). Note that this is identical to the January/February flow rate pattern seen at Orestimba Creek. While there is little variation in any of the July/August flow means, 2005/2006 ("wet") flow means are significantly higher than the flow means of all other water year types, except 2002 (dry), which is not significantly different from 2005 (wet) (Table 7-2).

Analysis 8: Del Puerto Creek near Patterson

Data analysis by water year:

Figure 8-1: Del Puerto Creek average daily flow for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

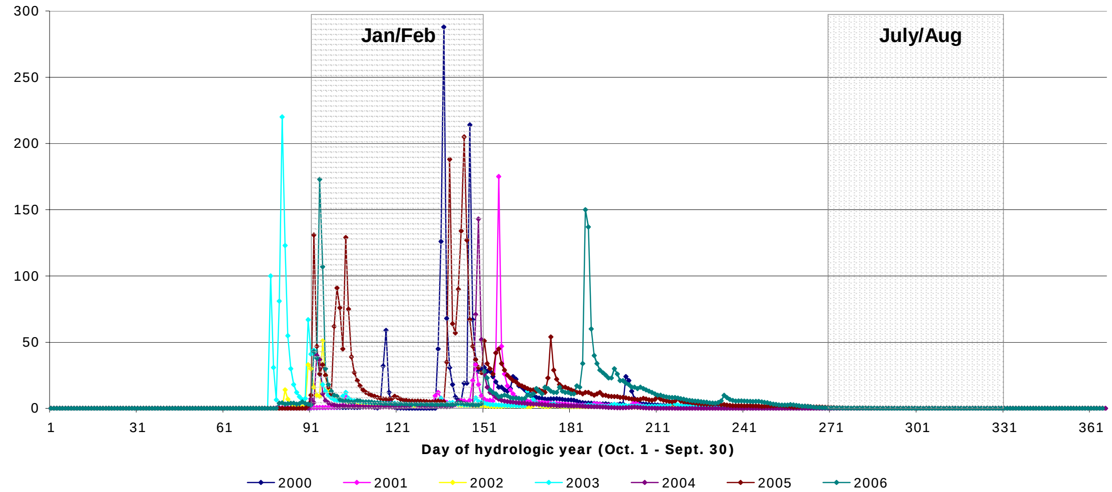


Table 8-1: Del Puerto Creek flow descriptive statistics.

Water Year	Water year classification	January / February Average	January / February Median	January / February Std. dev.	July / August Average	July / August Median	July / August Std. dev.
2000	Above Normal	19.99	0.77	49.30	< 0.1	0	< 0.1
2001	Critical	4.14	1.9	5.51	0	0	0
2002	Dry	4.82	3	7.12	0	0	0
2003	Below Normal	5.87	4	5.90	< 0.1	0	< 0.1
2004	Critical	8.31	1.6	21.92	0	0	0
2005	Wet	35.70	14	44.92	< 0.1	0	< 0.1
2006	Wet	10.42	3.7	26.11	< 0.1	0	< 0.1

Table 8-2: Statistical analysis of Del Puerto Creek flow averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 8-2A: January-February

Year				Average	Classification
2005	A			35.70	Wet
2000		B		19.99	Above Normal
2006		B	C	10.42	Wet
2004			C	8.31	Critical
2003			C	5.87	Below Normal
2002			C	4.82	Dry
2001			C	4.14	Critical

Table 8-2B: July-August

Year			Average	Classification
2005	A		0.0495	Wet
2006	A		0.0447	Wet
2000		B	0.0087	Above Normal
2003		B	0.00065	Below Normal
2001		B	0	Critical
2004		B	0	Critical
2002		B	0	Dry

Figure 8-2A: Trendlines for the WSI (black), and for Del Puerto Creek average yearly flow for January/February (pink) and July/August (blue), by water year.

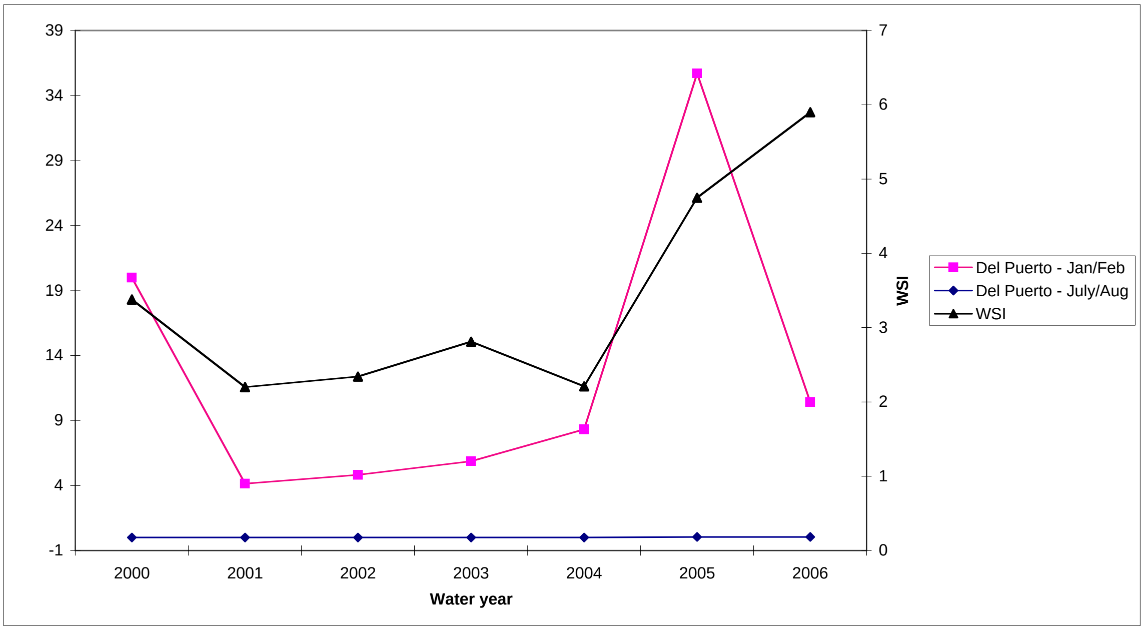
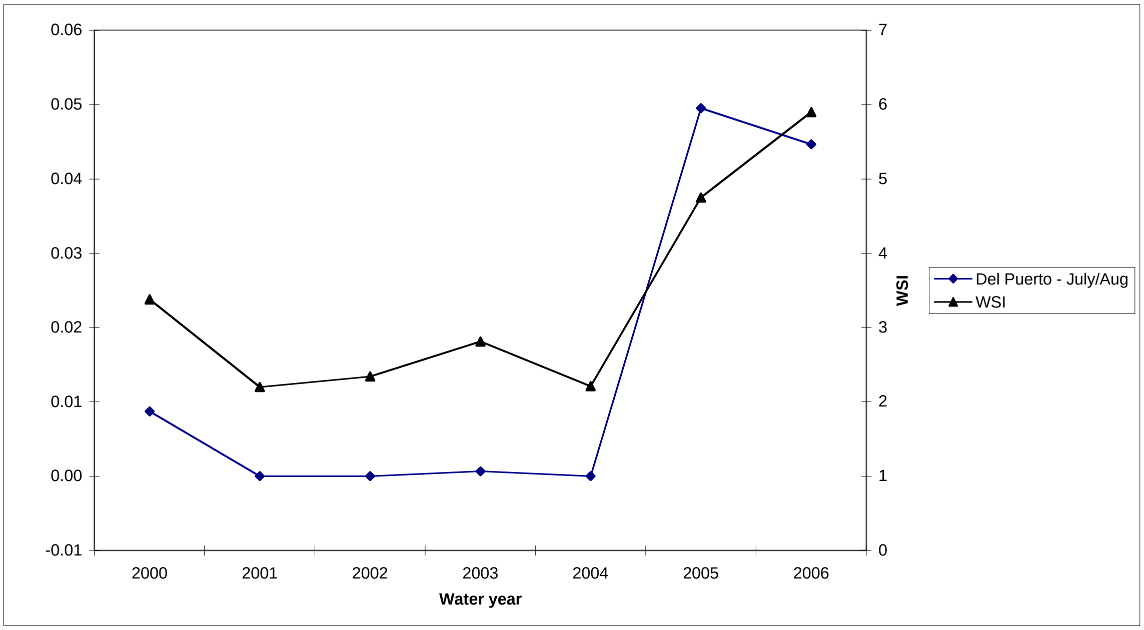


Figure 8-2B: Trendlines for the WSI (black), and for Del Puerto Creek average yearly flow for July/August (blue), by water year.



Data analysis by water year type:

Table 8-3: Statistical analysis of Del Puerto Creek flow averages for 2000 – 2006, student's t-test comparison of all pairs of water year types. Statistically similar averages for each time period are grouped by letter designation.

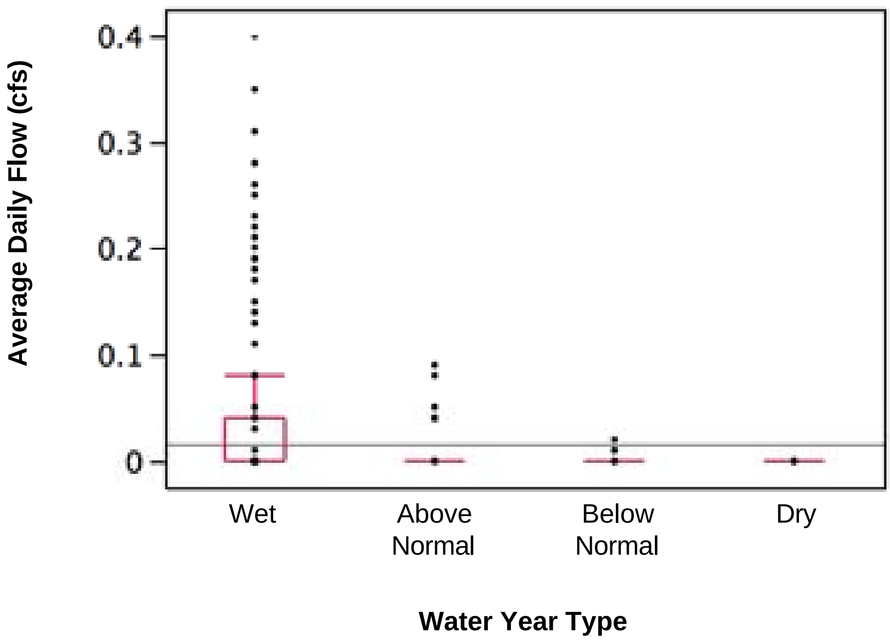
Table 8-3A: January-February

Classification			Average
Wet	A		23.06
Above Normal	A		19.99
Below Normal		B	5.87
Dry		B	5.77

Table 8-3B: July-August

Classification			Average
Wet	A		0.0471
Above Normal		B	0.0087
Below Normal		B	0.0006
Dry		B	0.0000

Figure 8-3: Box plots of Del Puerto Creek daily flow averages in July/August for 2000 – 2006 by water year type.



Data was analyzed for all water years for Del Puerto Creek. Good correlation between flow rates and the WSI is seen for both January/February and for July/August (Figures 8-2 & 8-3), although the July/August data is open to interpretation (discussed below). As both Table 8-2 and Table 8-3 show, January/February "wet" and "above normal" water flow rates (2000, 2005, and 2006) are significantly higher than "below normal", "dry", and "critical" year water flow rates (2001, 2002, 2003, and 2004), with one exception – there is no significant difference between 2006 (wet) and 2004 (critical). This is similar to the January/February flow rate pattern seen at Orestimba Creek and Mud Slough. While there is little variation in any of the July/August flow averages, 2005/2006 ("wet") flow averages are significantly higher than the flow averages of all other water year types (Table 8-2). However, the relevance of the correlation between the WSI and the July/August results is questionable, as all water flow means for July/August are quite low (Table 8-2).

Analysis 9: Delta Mendota Canal at the Tracy Pumping Plant

Figure 9-1: Tracy Pumping Plant average daily discharge for water years 2000 – 2006. January/February and July/August, the months for which flow was analyzed for this study, are highlighted.

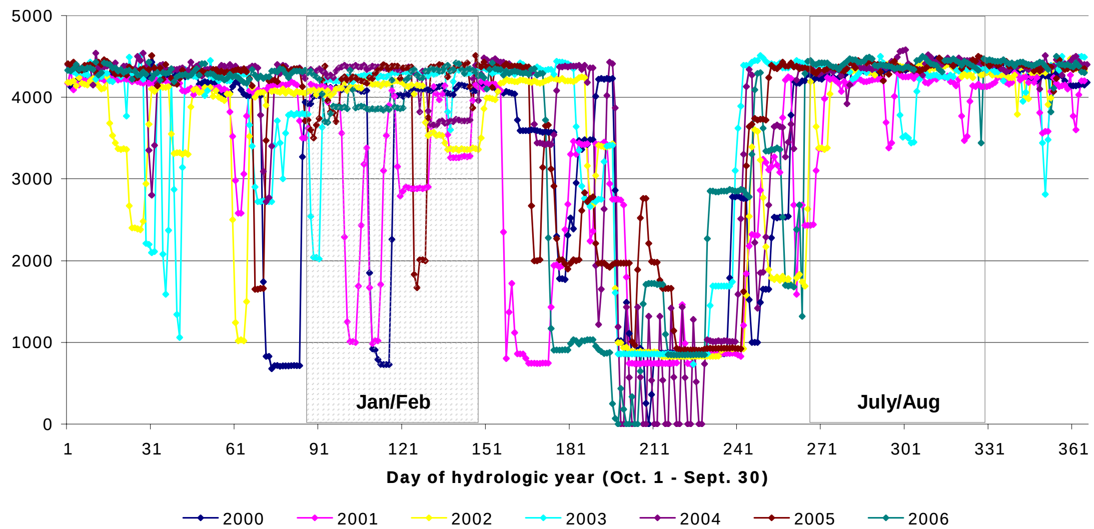


Table 9-1: Tracy Pumping Plant discharge descriptive statistics.

Water Year	Water year classification	January / February Average	January / February Median	January / February Std. dev.	July / August Average	July / August Median	July / August Std. dev.
2000	Above Normal	3640.92	4090	1109.17	4352.42	4350	52.16
2001	Critical	3108.41	3260	996.30	4133.23	4200	207.84
2002	Dry	3881.36	4100	339.92	4338.06	4355	60.13
2003	Below Normal	4260.17	4280	115.38	4246.45	4330	245.43
2004	Critical	4162.33	4335	293.02	4394.35	4405	94.55
2005	Wet	4061.19	4330	687.10	4390.81	4390	51.42
2006	Wet	4102.20	4210	233.05	4396.13	4410	131.86

Table 9-2: Statistical analysis of Tracy Pumping Plant discharge averages, student's t-test comparison of all pairs of water years. Statistically similar averages for each time period are grouped by letter designation.

Table 9-2A: January-February

Year					Average
2003	A				4260.17
2004	A				4162.33
2006	A	B			4102.20
2005	A	B			4061.19
2002		B			3881.36
2000			C		3640.92
2001				D	3108.41

Table 9-2B: July-August

Year					Average
2006	A				4396.13
2004	A				4394.35
2005	A				4390.81
2000	A	B			4352.42
2002		B			4338.06
2003			C		4246.45
2001				D	4133.23

No apparent correlation between the WSI and January/February discharge rates is seen. Some correlation between WSI and July/August discharge rates is seen, as "wet" and "above normal" years are significantly higher than "below normal", "dry" and "critical" years, except for 2004 (critical), which is similar to "wet" and "above normal" years, and 2002 (dry), which is similar to 2000 (above normal).

Analysis 10: Los Banos Weather Station

Figure 10-1: Los Banos CIMIS weather station average daily air temperatures for water years 2000 – 2006. January/February and July/August, the months for which air temperature was analyzed for this study, are highlighted.

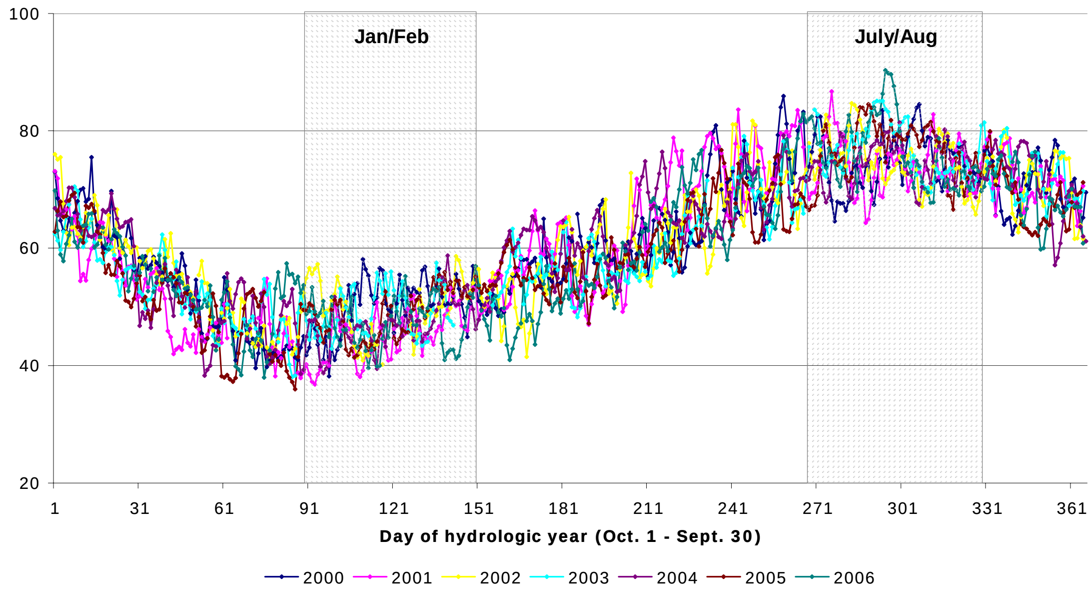


Table 10-1: Los Banos CIMIS weather station descriptive statistics.

Water Year	Water year classification	January / February Average	July / August Average
2000	Above Normal	50.47	73.91
2001	Critical	45.60	74.09
2002	Dry	49.57	74.58
2003	Below Normal	49.17	76.29
2004	Critical	47.46	74.74
2005	Wet	48.73	77.01
2006	Wet	47.30	75.62

While some sharp changes in air temperature are seen in both the January/February and July/August time periods (particularly for daily maximum air temperatures), they do not result in significantly higher or lower air temperatures than the averages for a sustained period of time for the water years analyzed.

Appendix H

Summary Report for Upstream San Joaquin River Water Quality Data: 2005-2007

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February, 2008

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Introduction

This report summarizes water quality data from grab samples collected from 2005 through 2007 in the upstream San Joaquin River watershed by the Environmental Engineering Research Program (EERP). The grab samples were collected to determine overall water quality and algal growth in the San Joaquin River (SJR) upstream of the Deep Water Shipping Channel (DWSC) in Stockton, CA. In this report are tables of average, maximum, minimum, and standard deviation of all measured parameters for the 2005-2007 sampling period. This report is meant as a quick reference for overall water quality in the upper San Joaquin River watershed.

Methods

Table preparation

The data presented was analyzed in accordance to the EERP Quality Assurance Plan (Stringfellow, 2004) and the EERP Standard Operating Procedures (Borglin et al, 2008). Analysis methods for specific analytes are outlined below and are described in detail in Borglin et al. (2008) and Graham and Hanlon (2008). The specific references and methods for each analysis are listed in Table 1. Approximately 25% of the nutrient samples were split between UC Davis and EERP to increase confidence in the results and for QA purposes, however, only the results from UC Davis are listed in the tables. Multiple chlorophyll- *a* (chl-a) techniques are also shown. Results were summarized using the pivot table function in Excel, reporting the average, maximum, minimum, standard deviation, and number of samples collected at each site for the 2005-2007 sampling years. The report is organized with one table for each analyte, listing all sites visited during the sampling period. Data that did not pass QA or was otherwise determined inaccurate was removed prior to calculating averages. If the sample was not analyzed for a specific analyte the notation 'na' (not analyzed) was listed. If a site was analyzed only one time, 'na' was listed for the standard deviation value, as this cannot be calculated from one sampling point. Table 2 lists sites and locations for reference and Figure 1 shows the sampling area with sampling sites.

Data Quality Assurance and Quality Control

Each analytical group (UC Davis or EERP) have established Standard Operating Procedures (SOPs) (Borglin et al., 2005) for all routine analysis methods. The SOPs insure consistency in the analysis procedures, data reporting, and QC requirements. The SOPs were prepared by experienced analysts in collaboration with the QA/QC manager. The SOPs were kept in the analysis area and a master copy was kept on file. Daily laboratory work at the bench level was carried out according to these documents.

Data produced daily by analysts was recorded electronically and in a laboratory notebook. Electronic forms were used for entering data and calculation of results from the unknown samples and standards using calibration parameters. Preliminary review of data quality was completed by the analyst who confirmed that all standards and quality control samples met quality control guidelines. If the guidelines were not met, the analysis met with the QA/QC manager to identify the problem and the samples were then re-analyzed after remediation of any problems with analytical instrumentation, standards, calibration, or analysis procedures. Data that passed QC guidelines was then entered into the master spreadsheet.

Quality control procedures for each laboratory analysis, discrete field sampling events, and continuous field monitoring data collection include calibration of instruments with certified standards. Quality control samples were run in conjunction with unknown samples and, depending on the analysis, could include all or some of the following: calibration check standards, laboratory control samples, sampling and analytical duplicates, matrix spikes, and analytical blanks. In addition, analyses of performance test standards were conducted at a minimum of once a year to verify the proper working order of equipment, quality of reagents, analytical technique, and analytical methods.

Sampling and Field Water Quality Measurements

Field sampling consisted of collecting water samples, measuring water quality with a sonde, and recording of field conditions at sites within the study area. Prior to sampling, field equipment was calibrated and trip blanks were gathered and loaded into the sampling vehicles. Field sheets describing the sampling routine were disseminated before sampling to the sample crew and other pertinent individuals. Sampling was attempted at each site on the field sheets the day of sampling. At each site water and water quality measurements were collected. The samples were stored at 4°C after collection and returned to the lab for analysis.

The day before sample collection, YSI 6600 Sonde connected to YSI 650 MDS handset were calibrated at EERP following procedures in the YSI 6-Series Environmental Monitoring Systems Handbook (YSI Inc., Yellow Springs, CO). The sonde has several probes which were calibrated independently. Dissolved oxygen and depth were calibrated using the wet-towel method where the sonde was placed in a tube with a wet-towel around the sensors and calibrated in a water-saturated air environment. Specific conductance, measured with a temperature compensated electrical conductivity probe (EC), was calibrated using a 0.01D KCL conductivity standard with a value of 1408μS/cm (Radiometer Analytical SAS, Lyon, France). Temperature calibration is checked against a NIST certified thermometer. The pH probe was calibrated using standards of pH 4, pH 7, and pH 10 (VWR International, West Chester, PA). Oxidation-reduction potential (ORP) was calibrated with Zobell's solution (Ricca Chemical Company, Arlington, TX). The fluorescence probe output (for estimating chlorophyll) was recorded in Millipore water or 0 NTU water to account for drift. The turbidity probe was calibrated with three standards of 0 NTU or Millipore water, 40 NTU, and 200 NTU (HACH, Loveland, CO).

Each sampling day, the sonde was recalibrated for dissolved oxygen at the first site to correct for ambient barometric pressure. At each sampling location, water quality data was collected for at least 2 minutes using a sonde deployed in the sample water and programmed to measure and record every parameter every four seconds, providing a statistically significant sample size ($n > 30$). The data from the sonde was also recorded in the field notebook. The parameters measured by the sonde at each site included time, temperature (°C), specific conductance (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO), DO concentration (mg/L), DO charge, depth (ft), pH, oxidation-reduction potential (mV), turbidity (NTU), chlorophyll content (mg/L), fluorescence, and barometric pressure (mmHg).

Light measurements were taken using a Model 3252 (LUX) Traceable® Dual-Display Light Meter (Control Company, Friendswood, TX). Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International), as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analyses and volume requirements.

Bottles were labeled with the appropriate sample number, site name, and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Post field activities included cleaning and storing all field equipment and post-calibrating the sondes to account for drift during the sampling day. Post-calibration consisted of checking the sonde value to that of the standard value and was completed within twenty-four hours of the sampling event. After post-calibration sondes were cleaned and stored with a small amount of water in the calibration cup to prevent drying of the DO membrane.

Sample preparation and processing

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at 4°C until filtering and analysis. Samples were filtered and preserved if necessary within 24 hours of collection. Archive filtrate and unfiltered samples were saved from all sites for any needed re-analysis or additional analysis that may be determined necessary. Samples were analyzed in laboratories at both EERP and UC Davis, and the procedures are described separately below.

Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater* (APHA, 2005, 1998), unless otherwise indicated. Certified standards, trace clean and certified sample bottles, reagent grade chemicals, and high purity water produced by a Milli-Q gradient system (Millipore, Billerica, MA) were used for all analyses. Reused glassware was cleaned thoroughly within warm water with Alconox detergent, rinsed with 10% HCl, and rinsed a minimum of 5 times with high purity de-ionized water.

UC Davis

Samples for dissolved nitrate, ammonia, and phosphate (NO_3-N and soluble NH_4-N and PO_4-P) were filtered through a pre-rinsed, 0.22 µm polycarbonate membrane (Millipore Isopore™). NO_3-N and soluble NH_4-N were quantified simultaneously using an automated membrane diffusion/conductivity detection method (Carlson, 1978, 1986; Carlson et al., 1990). Total nitrogen was determined by the same method from unfiltered sample following persulfate oxidation (Yu et al., 1994) using a 1% persulfate oxidant concentration, a sample:oxidant ratio of 1:1 (V/V), and heating in an autoclave. The limit of detection for this method was 50 ppb N.

Ortho-phosphate (PO_4-P) was determined on the filtrate using the stannous chloride method. (SM 4500-P.D). The limit of detection for this method is approximately 3 ppb PO_4-P in clean water using a 1 cm cell for measurement. Total phosphorus (Tot P) was analyzed on unfiltered samples by the same method after digestion. To digest, 5.0 mL of each sample was aliquotted into trace clean, 5.0 mL digestion reagent (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) was added, and then was autoclaved for 1 hour. After cooling, Tot P was determined using the stannous chloride method as described above.

EERP

Filters were used in the analysis of chlorophyll pigments, particulate organic matter (samples sent to USGS for analysis), total suspended solids and volatile suspended solids (TSS/VSS), and phospholipid fatty acid analysis (PLFA). Sample for NO_3-N, PO_4-P, and dissolved organic carbon (DOC) were filtered through 47mm Whatman GF/F filters (0.7µm pore size) for the collection of filterable solids. Filters used for TSS/VSS analysis were pre-rinsed with high purity water (Milli-Q gradient, Millipore, Billerica, MA). All filters were pre-combusted for 6 hours at 550°C prior to filtering. Sample bottles were shaken thoroughly before filtration and sample bottle weights were recorded before and after the sample was filtered and the difference was recorded as the filtered sample weight. Samples for dissolved Si (SiO_4-Si) were filtered through a pre-rinsed 0.45µm pore size cellulose luer-lock syringe filter (Nalgene, Rochester, NY) within 24 hours of collection and stored at 4°C until analysis.

Unfiltered samples were analyzed for biochemical oxygen demand (BOD) by Standard Method (SM) 5210 B (APHA, 2005) with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set will be consistent with prior studies. BOD was measured without seed, as in previous studies. Initial and final dissolved oxygen was measured using a calibrated YSI 5000 DO meter equipped with a YSI 5010 BOD probe (Yellow Springs, OH) and calibrated by Winkler titration according to SM 10200 H (APHA, 2005). Duplicate samples were prepared every 20 analyses and blanks consisted of BOD buffer solution prepared according to SM 5210 B. All samples were analyzed at both full concentration and diluted 100 mL of sample to 200 mL of BOD buffer solution to increase the number of reportable results. All BOD analyses were initiated within 24 hours of sample collection. A standard curve was prepared for each sample set consisting of a BOD standard solution (HACH, Loveland, CO) containing glucose and glutamic acid at 1, 2, 3, and 4 mg/L in dilution buffer with 5 mL of seed from a randomly selected sample. In addition, carbonaceous BOD (CBOD) was determined by adding 0.16 mg of nitrification inhibitor (N-serve, HACH, Loveland, CO) to a duplicate sample set. The resulting CBOD was subtracted from the total BOD to determine the nitrogenous BOD (NBOD). The limit of detection for BOD, CBOD, and NBOD is 1.0mg/L.

Total organic carbon (TOC), inorganic carbon (IC), and DOC were analyzed on a Teledyne-Tekmar Apollo 9000 (Mason, OH) by high temperature combustion according to SM 5310 B (APHA, 2005) and quantified using a NDIR detector. TOC and IC were analyzed on unfiltered samples and DOC was analyzed on filtered samples. This machine was equipped with an auto-sampler that allows for continuous stirring of sample. Both DOC and TOC samples were preserved at less than pH 2 with concentrated H_3PO_4 and stored at 4°C until analysis. IC samples were collected in the field into vials preserved with no head space, 5-10 mg $CuSO_4$ powder, and stored at 4°C until analysis. Samples were analyzed within 28 days of collection. The limit of detection for TOC and DOC is 1.00mg/L C and for IC it is 5.00mg/L.

Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E (APHA, 2005). Typically 1000 mL of sample was filtered on pre-weighed, pre-combusted, Whatman GF/F filters. The filters were placed in an aluminum dish and dried at 105°C under vacuum to constant weight. After drying the filter and dish were allowed to cool in a dessicator and were weighed for TSS determination. The dried and weighed filters were subsequently combusted at 550°C for 6 hours and reweighed for VSS determination. Mineral suspended solids (MSS) concentration was calculated by subtracting VSS from TSS.

Chlorophyll-*a* (chl-a) and pheophytin-*a* (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin Elmer Lambda 35 spectrometer (PE Spec) using a 5 cm path length (Wellesley, MA).

Total protein was quantified in all the samples using the Lowry method (Pierce Biosciences, Rockford, IL). The analysis was scaled up from the standard kit so the analysis was performed on 1 mL samples and analyzed in cuvettes with a 5 cm path length. Standard curves were made using bovine albumin from Pierce Biosciences (Rockford, IL). Samples were frozen within 24 hours of collection and defrosted prior to analysis. The limit of detection for this analysis is 0.5 mg/L protein.

Alkalinity was measured on samples within 24 hours of sample collection by titration of a 50 mL sample with 0.02 N H_2SO_4 to an endpoint of pH 8.3 and 4.5. The samples were stirred continuously during titration. Quality control included analysis of two independent alkalinity standards, one from HACH (Loveland, CO) and the other from ERA (Arvada, CO), to insure proper preparation of the titrating solution and calibration of the pH probe. The limit of detection for this method is 2.0 mg/L $CaCO_3$.

Total Iron (Tot Fe) was measured using a reaction with phenanthroline according to SM 3500-Fe B using FerroVer reagents purchased from HACH (Loveland, CO). Within 24 hours of sample collection, 6 mL aliquots of unfiltered sample was placed in 15 mL disposal centrifuge tubes and stored at -20°C for later quantification of Tot Fe. Prior to analysis, the samples were defrosted and 1 mL of sample was removed and used to measure the background absorbance of the water sample at 510 nm on the PE Spec. Total Fe was measured on the remaining 5 mL of unfiltered sample by the addition of pre-made HACH FerroVer phenanthroline reagent and measurement at 510 nm. The background sample absorbance was subtracted from the sample absorbance with reagent added. The limit of detection for this method is 0.05mg/L Fe.

At EERP, for QA purposes, total ammonia nitrogen (Tot NH_4-N), dissolved nitrate (NO_3-N), and total nitrogen (TN) were quantified using the TL-2800 ammonia analyzer made by Timberline Instruments (Boulder, CO). The Tot NH_4-N analysis was performed on unfiltered samples that were frozen within 24 hours of collection. The reportable limit for this method is 0.045 mg/L NH_4-N. The NO_3-N analysis was performed on filtered samples that were frozen within 24 hours of collection. The reportable limit for this method is 0.08 mg/L NO_3-N. The TN analysis was performed on digested unfiltered samples that were frozen within 24 hours of collection. To digest samples, 5.0 mL of each sample was aliquotted into trace clean 16x150 glass tubes with PTFE lined caps (VWR International), 5.0 mL digestion reagent was then added (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water), and samples were autoclaved in a Tuttnauer Brinkman autoclave (Westbury, NY). After cooling, TN was determined using the nitrate electrode method as described above. The reportable limit for this method is 0.14 mg/L TN.

Dissolved Si (SiO_2-Si) concentration was determined using a modified Heteropoly Blue molybdosilicate method (modified SM 4500-SiO_2 D) using Hach reagents (Loveland, CO). Dissolved Si was measured in filtered samples at both 650 and 815 nm using the PE Spec. The reportable limit for this method is 0.05 mg/L SiO_2-Si.

At EERP, for QA purposes, dissolved ortho-phosphate (PO_4-P) was quantified in filtered samples by the ascorbic acid method (adapted from SM 4500-P-E) using HACH PhosVer3 packets (Loveland, CO) and measured at 890 nm on the PE Spec. The reportable limit for this method was 18 μg/L PO_4-P. Total phosphorus (Tot-P) was determined on 5.0 mL of unfiltered sample by persulfate digestion and colorimetric determination by the ascorbic acid method (adapted from SM 4500-P B, E). To digest samples, 5.0 mL of each sample was aliquotted into trace clean 16x150 glass tubes with PTFE lined caps (VWR International), 5.0 mL digestion reagent was then added (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) and samples were autoclaved in a Tuttnauer Brinkman autoclave (Westbury, NY). After digestion and sample cooling, the total phosphorus concentrations were determined spectrophotometrically using HACH PhosVer3 packets (Loveland, CO) on the PE Spec. The limit of detection for this analysis was 6.0 ppb Tot-P.

Results

The data shown in these tables represents 2054 grab samples from 110 sampling sites analyzed for up to 43 analytes. For the nutrient analysis, due to the importance of these measurements, the samples were split between UC Davis and EERP to gain confidence in the analysis. Sample splitting was also very useful for method development and QA/QC of the results. If the separate analyses were significantly different, it was often possible to perform re-analysis to resolve correct values. For chlorophyll, sonde measurements in the field were recorded at the time of sampling and were used to compare to analysis on the whole water samples. Because the two methods measure chlorophyll differently it was a successful method for confirming chlorophyll concentration in the river.

References

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Table 1: List of analytes included in the 2007 summary report			
Analyte	**Page**	**Method**	**Reference**
Spec Cond mS/cm	15	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
TDS g/L	17	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
DO mg/L	19	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
pH	21	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
ORP mV	23	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
Turbidity	25	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
Sonde Chl-a TriC ug/L	27	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
Sonde Chl-a SM ug/L	29	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
LUX (lumen /m^2)	31	field	Graham, J. and J. Hanlon, EERP field SOP, Jan 2008
Chl-a SM ug/L	33	SM 10200 H-2b	Borglin et al, 2008; APHA, 2005
Chl-a TC ug/L	35	SM 10200 H-2b	Borglin et al, 2008; APHA, 2005
Pheophyton SM ug/L	37	SM 10200 H-2b	Borglin et al, 2008; APHA, 2005
4.5 Alk, mg $CaCO_3$/L	39	SM 2320 B	Borglin et al, 2008; APHA, 2005
8.3 Alk, mg $CaCO_3$/L	41	SM 2320 B	Borglin et al, 2008; APHA, 2005
BOD_{10} mg/L	43	SM 5210 B M	Borglin et al, 2008; APHA, 2005
$CBOD_{10}$ mg/L	45	SM 5210 B M	Borglin et al, 2008; APHA, 2005
$NBOD_{10}$ mg/L	47	SM 5210 B M	Borglin et al, 2008; APHA, 2005
Total Organic Carbon, mg/L	49	EPA 415.1	Borglin et al, 2008; APHA, 2005
Dissolved Organic Carbon, mg/L	51	EPA 415.1	Borglin et al, 2008; APHA, 2005
Inorganic Carbon, mg/L	53	Tekmar	Tekmar
Total Protein	55	Lowry	Borglin et al, 2008; APHA, 2005
TSS, mg/L	57	SM 2540 B	Borglin et al, 2008; APHA, 2005
VSS, mg/L	59	SM 2540 E	Borglin et al, 2008; APHA, 2005
Total N mg/L, UCD	61	potentiometric	Carlson (1978, 1986, 1990)
NH_3-N,mg/L, UCD	63	potentiometric	Carlson (1978, 1986, 1990)
NO_3-N, mg/L, UCD	65	potentiometric	Carlson (1978, 1986, 1990)
Total P mg/L, UCD	67	EPA 365.2	APHA, 2005
PO_4-P mg/L, UCD	69	SM 4500-P E	APHA, 2005
Total Fe mg/L	71	SM 3500-Fe DM	Borglin et al, 2008; APHA, 2005
Na mg/L	73	EPA 300.0	APHA, 2005
K mg/L	75	EPA 300.0	APHA, 2005
Mg mg/L	77	EPA 300.0	APHA, 2005
Ca mg/L	79	EPA 300.0	APHA, 2005
Cl mg/L	81	EPA 300.0	APHA, 2005
SO_4 mg/L	83	EPA 300.0	APHA, 2005
Br mg/L	85	EPA 300.0	APHA, 2005
Si mg/L	87	Borglin et al, 2008	Borglin et al, 2008
254 um	89	SM 4500-Si D	Borglin et al, 2008

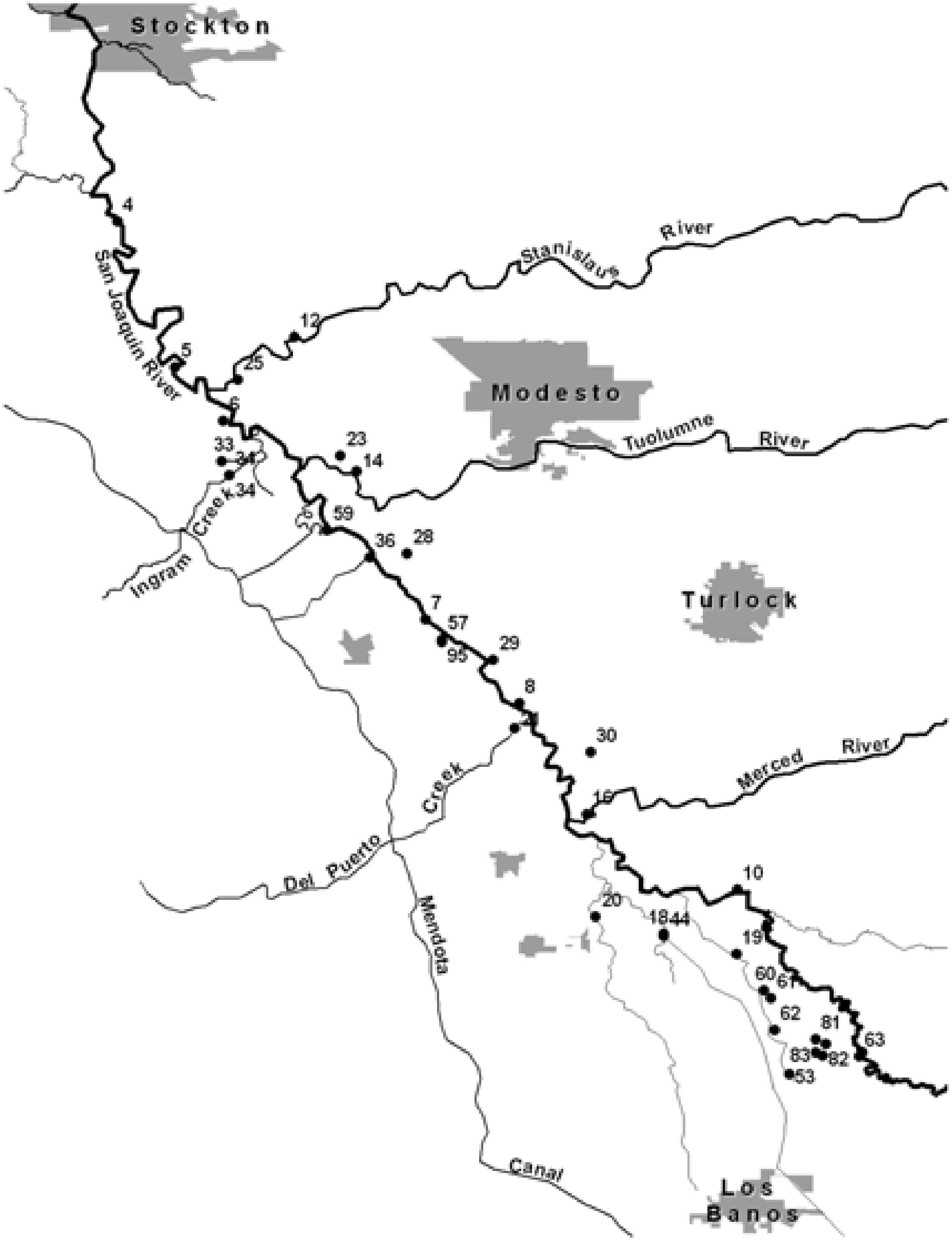
Table 1: EERP Site List

DO Number	Site Name	Type
1	**SJR at Channel Point**	Intermittent
2	**SJR at Dos Reis Park (Lathrop)**	Intermittent
3	**SJR at Old River**	Intermittent
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
9	**SJR at Fremont Ford**	Intermittent
10	**SJR at Lander Avenue**	Core sites
11	**French Camp Slough**	Intermittent
12	**Stanislaus River at Caswell Park**	Core sites
13	**Stanislaus River at Ripon**	Intermittent
14	**Tuolumne River at Shiloh Bridge**	Core sites
15	**Tuolumne River at Modesto**	Intermittent
16	**Merced River at River Road**	Core sites
17	**Merced River near Stevinson**	Intermittent
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
22	**Modesto ID Lateral 4 to SJR**	Intermittent
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
24	**Modesto ID Lateral 6 to Stanislaus River**	Intermittent
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
26	**Turlock ID Highline Spill**	Intermittent
27	**Turlock ID Lateral 2 to SJR**	Intermittent
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
31	**BCID - New Jerusalem Drain**	Intermittent
32	**El Solyo WD - Grayson Drain**	Intermittent, BMP
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
35	**Westley Wasteway Flow Station**	Intermittent, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
37	**Newman Wasteway at SJR**	Intermittent
38	**Marshall Road Drain**	Intermittent, BMP
39	**Salado Creek Flow Station**	Intermittent, BMP
40	**Patterson Irrigation District Diversion**	Diversion
41	**West Stanislaus Irrigation District Diversion**	Diversion

DO Number	Site Name	Type
42	**Banta Carbona Irrigation District Diversion**	Diversion
43	**El Solyo Water District Diversion**	Diversion
44	**San Luis Drain End**	Core sites
45	**Volta Wasteway at Ingomar Grade**	Intermittent
46	**Mud Slough at Gun Club Road**	Intermittent, Wetland
47	**Delta-Mendota Canal inlet to the Mendota Pool**	Intermittent, BMP
48	**San Luis Drain Site A**	Intermittent
49	**FC-5 - Grassland Area Farmers**	Intermittent
50	**PE-14 - Grasslands Area Farmers**	Intermittent
51	**Arroyo Canal**	Intermittent
52	**Salt Slough at Sand Dam**	Intermittent
53	**Salt Slough at Wolfsen Road**	Wetland
54	**Los Banos Creek at Ingomar Grade**	Intermittent
55	**Modesto WWTP**	NPDS
56	**Turlock WWTP**	NPDS
57	**Ramona Lake Drain**	Core sites, BMP
58	**San Luis Drain Site B**	Intermittent
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadmans Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
64	**Moran Drain**	Intermittent
65	**Spanish Grant Drain**	Intermittent, BMP
66	**ESWD Maze Blv. Drain**	Intermittent, BMP
67	**Newman Wasteway at Brazo Road**	Intermittent
68	**S-Lake Basin**	Wetland
69	**Santa Fe Canal**	Intermittent
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
84	**SJR at Highway 4 (Garwood Bridge Charter Way)**	Intermittent
85	**SJR Hills Ferry**	Intermittent
86	**Ramona drain Apple Ave**	BMP
87	**Ramona drain Prune Ave**	BMP
88	**Ramona drain Apricot Ave**	BMP
89	**Ramona drain Pomelo Ave**	BMP
90	**Ramona drain Almond Ave**	BMP
91	**Paradise drain Prune Ave**	BMP
92	**Paradise drain Apricot Ave**	BMP
93	**Paradise drain Pomelo Ave**	BMP
94	**Paradise drain Almond Ave**	BMP

DO Number	Site Name	Type
95	**Ramona drain at Ramona Lake**	BMP, Intermittent
96	**WPF-VD-1**	BMP
97	**WPF-VD-2**	BMP
98	**WPF-VD-3**	BMP
99	**WPF-VD-4**	BMP
100	**WPF-VD-5**	BMP
101	**WPF-UD-IN**	BMP
102	**WPF-UD-OUT**	BMP
103	**SLD Check 18**	Intermittent
104	**SLD Check 16**	Intermittent
105	**SLD Check 15**	Intermittent
106	**SLD Check 14**	Intermittent
107	**SLD Check 13**	Intermittent
108	**SLD Check 12**	Intermittent
109	**SLD Check 11**	Intermittent
110	**SLD Check 10**	Intermittent
111	**SLD Check 9**	Intermittent
112	**SLD Check 8**	Intermittent
113	**SLD Check 7**	Intermittent
114	**SLD Check 6**	Intermittent
115	**SLD Check 5**	Intermittent
116	**SLD Check 4**	Intermittent
117	**SLD Check 3**	Intermittent
118	**SLD Check 2**	Intermittent
119	**SLD Check 1**	Intermittent
120	**South Marsh-1-Intermediary**	Wetland
121	**South Marsh-1-East**	Wetland
122	**South Marsh-1-West**	Wetland
123	**Ramona Lake NW Quad**	BMP
124	**Ramona Lake NE Quad**	BMP
125	**Ramona Lake SW Quad**	BMP
126	**Ramona Lake SE Quad**	BMP
127	**SJR at Brant Bridge**	Intermittent
128	**SJR Brickyard Site**	Intermittent
129	**Hollow Tree drain**	Wetland
130	**Marshall Reservoir inlet**	BMP
131	**Marshall Reservoir outlet**	BMP
132	**Marshall RR Pond-1-West**	BMP
133	**Marshall RRr Pond-2-East**	BMP
135	**MID Main Drain Spill**	Intermittent

Figure 1: Sampling locations in the San Joaquin River Watershed.



Specific conductivity

DO site number	Site name	Average of Spec Cond mS/cm	Max of Spec Cond mS/cm	Min of Spec Cond mS/cm	StdDev of Spec Cond mS/cm	Count of Spec Cond mS/cm
1	SJR at Channel Point	0.471	0.483	0.458	0.018	2
2	SJR at Dos Reis Lathrop	0.508	0.511	0.505	0.004	2
3	SJR at Old River	0.524	0.525	0.523	0.002	2
4	SJR at Mossdale	0.478	0.811	0.042	0.229	65
5	SJR at Vernalis	0.475	0.801	0.094	0.213	76
6	SJR at Maze	0.656	1.077	0.104	0.303	69
7	SJR at Patterson	0.852	1.560	0.117	0.391	79
8	SJR at Crows Landing	0.881	1.658	0.002	0.397	84
9	SJR at Fremont Ford	1.314	1.614	0.986	0.227	5
10	SJR at Lander Avenue	0.901	1.672	0.049	0.485	83
11	French Camp Slough	0.476	0.736	0.099	0.253	7
12	Stanislaus River at Caswell Park	0.095	0.415	0.059	0.046	67
13	Stanislaus River at Ripon	0.104	0.104	0.104	na	1
14	Tuolumne River at Shiloh Bridge	0.148	0.494	0.041	0.089	68
16	Merced River at River Road	0.152	0.569	0.036	0.113	67
17	Merced River near Stevinson	0.039	0.039	0.039	na	1
18	Mud Slough near Gustine	2.642	4.707	1.118	0.943	77
19	Salt Slough at Lander Avenue	1.228	2.379	0.499	0.343	105
20	Los Banos Creek at Highway 140	1.371	3.154	0.499	0.579	68
21	Orestimba Creek at River Road	0.668	1.192	0.090	0.265	63
22	Modesto ID Lateral 4 to SJR	0.171	0.292	0.046	0.114	6
23	Modesto ID Lateral 5 to Tuolumne	0.124	0.536	0.030	0.115	29
24	Modesto ID Lateral 6 to Stanislaus River	0.064	0.068	0.061	0.005	2
25	MID Main Drain to Stan. R. via Miller Lake	0.335	0.968	0.065	0.150	40
26	Turlock ID Highline Spill	0.040	0.042	0.038	0.003	2
27	Turlock ID Lateral 2 to SJR	0.131	0.243	0.054	0.077	5
28	Turlock ID Westport Drain Flow Station	0.668	1.189	0.140	0.260	50
29	Turlock ID Harding Drain	0.694	1.227	0.298	0.224	65
30	Turlock ID Lateral 6 & 7 at Levee	0.641	1.511	0.366	0.223	36
31	BCID - New Jerusalem Drain	2.423	2.550	2.156	0.128	8
32	El Solyo WD - Grayson Drain	0.850	1.365	0.425	0.381	6
33	Hospital Creek	0.495	1.241	0.146	0.283	17
34	Ingram Creek Flow Station	0.982	2.030	0.247	0.413	44
35	Westley Wasteway Flow Station	0.642	0.814	0.547	0.087	8
36	Del Puerto Creek Flow Station	0.876	1.441	0.338	0.302	58
38	Marshall Road Drain	0.848	1.369	0.449	0.340	7
39	Salado Creek Flow Station	1.246	1.458	1.075	0.162	4
43	El Solyo Pumping Station	0.533	0.533	0.533	na	1
44	San Luis Drain End	4.401	5.706	3.089	0.578	76
45	Volta Wasteway at Ingomar Grade	0.838	1.430	0.325	0.420	11
46	Mud Slough at Gun Club Road	1.830	3.491	0.821	0.931	11
47	Delta-Mendota Cal Hwy 140	0.489	0.556	0.414	0.071	3
48	FC-5 Grasslands Area Farmers	5.165	5.165	5.165	na	1
49	PE-14-Grasslands Area Farmers	5.908	5.908	5.908	na	1
50	San Luis Drain Site A (Check 18)	4.748	5.437	4.028	0.705	3
51	Arroyo Cal at Hwy 152	1.153	1.221	1.084	0.097	2
52	Salt Slough at Sand Dam	0.872	1.010	0.726	0.142	3
53	Salt Slough at Wolfsen Road	1.311	2.033	0.811	0.324	29
54	Los Banos Creek at Ingomar Grade	0.680	0.680	0.680	na	1
57	Ramona Lake Drain at Levee	1.357	1.943	0.957	0.262	30
59	SJR Laird Park	0.592	0.958	0.149	0.274	17
60	Moffit 1 South	1.002	1.640	0.530	0.352	20
61	Deadman's Slough	1.150	2.019	0.566	0.463	26
62	Mallard Slough	1.630	5.984	0.594	1.177	22
63	Inlet C Canal	0.729	1.551	0.357	0.305	26

DO site number	Site name	Average of Spec Cond mS/cm	Max of Spec Cond mS/cm	Min of Spec Cond mS/cm	StdDev of Spec Cond mS/cm	Count of Spec Cond mS/cm
64	Moran Drain	0.739	0.950	0.434	0.217	6
65	Spanish Grant Drain	0.865	1.332	0.505	0.313	7
66	ESWD Maze Blv. Drain	0.488	0.543	0.417	0.052	4
67	Newman Wasteway at Brazo Road	1.155	1.740	0.602	0.382	7
68	S. Lake Basin	2.022	3.240	0.467	1.275	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	0.718	1.392	0.370	0.276	18
81	South Marsh 1 Outlet	0.718	1.346	0.379	0.231	21
82	South Marsh 3 Inlet	1.091	1.729	0.427	0.301	25
83	South Marsh 3 Outlet	1.127	1.839	0.634	0.275	28
84	SJR Garwood Bridge	0.513	0.513	0.513	na	1
86	Ramona Drain Apple Ave	1.222	1.594	0.662	0.268	9
87	Ramona Drain Prune Ave	0.790	1.024	0.658	0.204	3
88	Ramona Drain Apricot Ave	1.243	1.733	0.438	0.405	9
89	Ramona Drain Pomelo Ave	0.959	1.297	0.619	0.339	3
90	Ramona Drain Almond Ave	1.186	1.186	1.186	na	1
91	Paradise Drain Prune Ave	0.355	0.355	0.355	na	1
92	Paradise Drain Apricot Ave	1.445	3.053	0.815	0.747	7
93	Paradise Drain Pomelo Ave	1.684	3.008	0.809	1.166	3
94	Paradise Drain Almond Ave	1.467	2.958	0.773	0.703	7
95	Ramona Lake Entrance	1.546	2.372	0.894	0.391	17
96	WPF-VD-1	0.391	0.391	0.391	na	1
97	WPF-VD-2	0.426	0.426	0.426	na	1
98	WPF-VD-3	0.414	0.414	0.414	na	1
101	WPF-UD-IN	0.724	1.058	0.390	0.473	2
102	WPF-UD-OUT	0.686	0.980	0.393	0.416	2
103	SLD Check 18	4.364	4.794	3.934	0.608	2
104	SLD Check 16	4.526	4.888	4.165	0.511	2
105	SLD Check 15	4.593	4.922	4.264	0.465	2
106	SLD Check 14	4.570	4.968	4.171	0.564	2
107	SLD Check 13	4.541	4.969	4.114	0.605	2
108	SLD Check 12	4.567	4.946	4.187	0.537	2
109	SLD Check 11	4.553	5.053	4.052	0.708	2
110	SLD Check 10	4.571	4.910	4.231	0.480	2
111	SLD Check 9	4.494	4.636	4.352	0.201	2
112	SLD Check 8	4.392	4.538	4.246	0.206	2
113	SLD Check 7	4.377	4.440	4.315	0.088	2
114	SLD Check 6	4.323	4.516	4.129	0.274	2
115	SLD Check 5	4.441	4.472	4.411	0.043	2
116	SLD Check 4	4.467	4.727	4.207	0.368	2
117	SLD Check 3	4.641	4.762	4.520	0.171	2
118	SLD Check 2	4.499	4.500	4.498	0.001	2
119	SLD Check 1	4.558	4.582	4.534	0.034	2
120	South Marsh 1 Intermediary	0.648	0.957	0.378	0.230	11
121	South Marsh 1 East	0.656	0.959	0.388	0.240	10
122	South Marsh 1 West	0.782	1.189	0.453	0.216	9
123	Ramona Lake NW Quad	1.277	1.855	0.952	0.501	3
124	Ramona Lake NE Quad	1.464	1.954	0.978	0.488	3
125	Ramona Lake SW Quad	1.851	1.851	1.851	na	1
126	Ramona Lake SE Quad	1.867	1.867	1.867	na	1
129	Hollow Tree drain	3.991	4.247	3.702	0.274	3
130	Marshall Rd Reservoir Entrance	0.872	1.245	0.504	0.257	7
131	Marshall Rd Reservoir Exit	0.991	1.254	0.775	0.167	7
132	Marshall Rd Res Pond 1W	0.881	1.072	0.656	0.175	5
133	Marshall Rd Res Pond 2E	0.878	1.073	0.609	0.191	5
135	Modesto ID Main Drain Spill	0.250	0.337	0.163	0.073	7

Total Dissolved Solids

DO site number	Site name	Average of TDS g/L	Max of TDS g/L	Min of TDS g/L	StdDev of TDS g/L	Count of TDS g/L
1	SJR at Channel Point	na	na	na	na	na
2	SJR at Dos Reis Lathrop	na	na	na	na	na
3	SJR at Old River	na	na	na	na	na
4	SJR at Mossdale	0.310	0.527	0.027	0.150	64
5	SJR at Vernalis	0.309	0.521	0.061	0.139	76
6	SJR at Maze	0.426	0.700	0.068	0.197	69
7	SJR at Patterson	0.554	1.014	0.076	0.254	79
8	SJR at Crows Landing	0.572	1.078	0.001	0.258	84
9	SJR at Fremont Ford	0.854	1.049	0.641	0.147	5
10	SJR at Lander Avenue	0.586	1.087	0.032	0.315	83
11	French Camp Slough	0.309	0.478	0.064	0.165	7
12	Stanislaus River at Caswell Park	0.062	0.270	0.038	0.030	67
13	Stanislaus River at Ripon	0.068	0.068	0.068	na	1
14	Tuolumne River at Shiloh Bridge	0.097	0.321	0.027	0.058	68
16	Merced River at River Road	0.099	0.370	0.023	0.074	67
17	Merced River near Stevinson	0.025	0.025	0.025	na	1
18	Mud Slough near Gustine	1.717	3.059	0.727	0.613	77
19	Salt Slough at Lander Avenue	0.798	1.546	0.324	0.223	105
20	Los Banos Creek at Highway 140	0.891	2.050	0.325	0.376	68
21	Orestimba Creek at River Road	0.434	0.775	0.058	0.172	63
22	Modesto ID Lateral 4 to SJR	0.111	0.190	0.030	0.074	6
23	Modesto ID Lateral 5 to Tuolumne	0.081	0.348	0.019	0.074	29
24	Modesto ID Lateral 6 to Stanislaus River	0.042	0.044	0.039	0.003	2
25	MID Main Drain to Stan. R. via Miller Lake	0.218	0.629	0.042	0.097	40
26	Turlock ID Highline Spill	0.026	0.027	0.024	0.002	2
27	Turlock ID Lateral 2 to SJR	0.085	0.158	0.035	0.050	5
28	Turlock ID Westport Drain Flow Station	0.434	0.773	0.091	0.169	50
29	Turlock ID Harding Drain	0.451	0.798	0.194	0.145	65
30	Turlock ID Lateral 6 & 7 at Levee	0.417	0.982	0.238	0.145	36
31	BCID - New Jerusalem Drain	1.575	1.658	1.402	0.084	8
32	El Solyo WD - Grayson Drain	0.552	0.887	0.276	0.248	6
33	Hospital Creek	0.321	0.807	0.095	0.184	17
34	Ingram Creek Flow Station	0.639	1.320	0.160	0.269	44
35	Westley Wasteway Flow Station	0.417	0.529	0.355	0.056	8
36	Del Puerto Creek Flow Station	0.570	0.937	0.220	0.196	58
38	Marshall Road Drain	0.551	0.890	0.292	0.221	7
39	Salado Creek Flow Station	0.810	0.948	0.699	0.106	4
43	El Solyo Pumping Station	0.346	0.346	0.346	na	1
44	San Luis Drain End	2.861	3.709	2.008	0.375	76
45	Volta Wasteway at Ingomar Grade	0.545	0.929	0.211	0.273	11
46	Mud Slough at Gun Club Road	1.190	2.269	0.533	0.605	11
47	Delta-Mendota Cal Hwy 140	0.318	0.361	0.269	0.046	3
48	FC-5 Grasslands Area Farmers	3.358	3.358	3.358	na	1
49	PE-14-Grasslands Area Farmers	3.840	3.840	3.840	na	1
50	San Luis Drain Site A (Check 18)	3.086	3.534	2.618	0.458	3
51	Arroyo Cal at Hwy 152	0.749	0.794	0.705	0.063	2
52	Salt Slough at Sand Dam	0.567	0.656	0.472	0.092	3
53	Salt Slough at Wolfsen Road	0.852	1.321	0.527	0.211	29
54	Los Banos Creek at Ingomar Grade	0.442	0.442	0.442	na	1
57	Ramona Lake Drain at Levee	0.869	1.201	0.622	0.157	29
59	SJR Laird Park	0.385	0.623	0.097	0.178	17
60	Moffit 1 South	0.651	1.066	0.345	0.229	20
61	Deadman's Slough	0.748	1.312	0.368	0.301	26
62	Mallard Slough	1.059	3.890	0.386	0.765	22
63	Inlet C Canal	0.474	1.008	0.232	0.198	26

DO site number	Site name	Average of TDS g/L	Max of TDS g/L	Min of TDS g/L	StdDev of TDS g/L	Count of TDS g/L
64	Moran Drain	0.481	0.617	0.282	0.141	6
65	Spanish Grant Drain	0.562	0.866	0.328	0.203	7
66	ESWD Maze Blv. Drain	0.317	0.353	0.271	0.034	4
67	Newman Wasteway at Brazo Road	0.751	1.131	0.391	0.249	7
68	S. Lake Basin	1.314	2.106	0.303	0.829	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	0.467	0.905	0.241	0.179	18
81	South Marsh 1 Outlet	0.466	0.875	0.246	0.150	21
82	South Marsh 3 Inlet	0.709	1.124	0.278	0.195	25
83	South Marsh 3 Outlet	0.733	1.196	0.413	0.179	28
84	SJR Garwood Bridge	na	na	na	na	na
86	Ramona Drain Apple Ave	0.794	1.036	0.431	0.174	9
87	Ramona Drain Prune Ave	0.513	0.666	0.427	0.132	3
88	Ramona Drain Apricot Ave	0.808	1.126	0.285	0.263	9
89	Ramona Drain Pomelo Ave	0.623	0.843	0.402	0.220	3
90	Ramona Drain Almond Ave	0.771	0.771	0.771	na	1
91	Paradise Drain Prune Ave	0.231	0.231	0.231	na	1
92	Paradise Drain Apricot Ave	0.939	1.985	0.530	0.485	7
93	Paradise Drain Pomelo Ave	1.095	1.955	0.526	0.758	3
94	Paradise Drain Almond Ave	0.953	1.923	0.503	0.457	7
95	Ramona Lake Entrance	0.987	1.542	0.581	0.251	16
96	WPF-VD-1	0.254	0.254	0.254	na	1
97	WPF-VD-2	0.277	0.277	0.277	na	1
98	WPF-VD-3	0.269	0.269	0.269	na	1
101	WPF-UD-IN	0.471	0.688	0.254	0.307	2
102	WPF-UD-OUT	0.446	0.637	0.255	0.270	2
103	SLD Check 18	2.837	3.116	2.557	0.395	2
104	SLD Check 16	2.942	3.177	2.707	0.332	2
105	SLD Check 15	2.986	3.200	2.772	0.303	2
106	SLD Check 14	2.970	3.229	2.711	0.366	2
107	SLD Check 13	2.952	3.230	2.674	0.393	2
108	SLD Check 12	2.968	3.215	2.722	0.349	2
109	SLD Check 11	2.959	3.285	2.634	0.460	2
110	SLD Check 10	2.971	3.192	2.750	0.312	2
111	SLD Check 9	2.921	3.013	2.829	0.130	2
112	SLD Check 8	2.855	2.949	2.760	0.134	2
113	SLD Check 7	2.845	2.886	2.805	0.057	2
114	SLD Check 6	2.810	2.936	2.684	0.178	2
115	SLD Check 5	2.887	2.907	2.867	0.028	2
116	SLD Check 4	2.903	3.073	2.734	0.239	2
117	SLD Check 3	3.016	3.095	2.938	0.111	2
118	SLD Check 2	2.924	2.925	2.924	0.001	2
119	SLD Check 1	2.963	2.978	2.947	0.022	2
120	South Marsh 1 Intermediary	0.421	0.622	0.246	0.149	11
121	South Marsh 1 East	0.427	0.623	0.252	0.156	10
122	South Marsh 1 West	0.509	0.772	0.294	0.140	9
123	Ramona Lake NW Quad	0.642	0.666	0.619	0.033	2
124	Ramona Lake NE Quad	0.793	0.950	0.636	0.222	2
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	2.594	2.761	2.406	0.178	3
130	Marshall Rd Reservoir Entrance	0.567	0.809	0.327	0.167	7
131	Marshall Rd Reservoir Exit	0.644	0.815	0.503	0.109	7
132	Marshall Rd Res Pond 1W	0.573	0.697	0.426	0.114	5
133	Marshall Rd Res Pond 2E	0.571	0.698	0.396	0.124	5
135	Modesto ID Main Drain Spill	0.163	0.219	0.106	0.048	7

Dissolved Oxygen

DO site number	Site name	Average of DO mg/L	Max of DO mg/L	Min of DO mg/L	StdDev of DO mg/L	Count of DO mg/L
1	SJR at Channel Point	7.98	9.06	6.90	1.53	2
2	SJR at Dos Reis Lathrop	12.20	13.00	11.39	1.13	2
3	SJR at Old River	11.58	11.99	11.18	0.57	2
4	SJR at Mossdale	9.91	13.81	7.57	1.35	65
5	SJR at Vernalis	10.00	17.18	7.57	1.67	76
6	SJR at Maze	9.84	16.81	6.81	1.58	69
7	SJR at Patterson	10.09	15.59	6.28	1.92	79
8	SJR at Crows Landing	9.47	12.97	6.62	1.40	84
9	SJR at Fremont Ford	7.99	9.62	6.30	1.20	5
10	SJR at Lander Avenue	11.16	18.66	6.17	3.05	83
11	French Camp Slough	10.71	12.60	8.38	1.62	7
12	Stanislaus River at Caswell Park	9.60	11.72	7.60	1.08	67
13	Stanislaus River at Ripon	8.13	8.13	8.13	na	1
14	Tuolumne River at Shiloh Bridge	9.66	12.66	6.50	1.43	68
16	Merced River at River Road	9.51	12.49	7.54	1.18	67
17	Merced River near Stevinson	9.59	9.59	9.59	na	1
18	Mud Slough near Gustine	8.70	14.00	4.47	1.66	77
19	Salt Slough at Lander Avenue	7.87	12.28	4.03	1.49	105
20	Los Banos Creek at Highway 140	6.08	14.26	0.20	2.40	68
21	Orestimba Creek at River Road	9.21	13.90	7.01	1.64	63
22	Modesto ID Lateral 4 to SJR	10.36	11.23	9.30	0.85	6
23	Modesto ID Lateral 5 to Tuolumne	10.89	16.71	8.46	1.95	29
24	Modesto ID Lateral 6 to Stanislaus River	8.30	9.97	6.63	2.36	2
25	MID Main Drain to Stan. R. via Miller Lake	7.33	17.07	1.49	3.04	40
26	Turlock ID Highline Spill	9.35	9.80	8.90	0.64	2
27	Turlock ID Lateral 2 to SJR	11.05	11.98	10.26	0.67	5
28	Turlock ID Westport Drain Flow Station	10.73	15.12	7.35	1.64	50
29	Turlock ID Harding Drain	10.79	14.00	5.48	1.52	65
30	Turlock ID Lateral 6 & 7 at Levee	11.01	16.14	2.37	2.53	36
31	BCID - New Jerusalem Drain	9.07	9.65	8.55	0.35	8
32	El Solyo WD - Grayson Drain	7.94	9.07	6.27	1.00	6
33	Hospital Creek	8.12	10.17	5.53	1.30	17
34	Ingram Creek Flow Station	9.13	12.95	5.21	1.44	44
35	Westley Wasteway Flow Station	10.23	12.77	6.67	1.88	8
36	Del Puerto Creek Flow Station	9.59	15.16	7.18	1.85	58
38	Marshall Road Drain	8.27	9.82	7.11	0.94	7
39	Salado Creek Flow Station	6.24	7.64	5.16	1.16	4
43	El Solyo Pumping Station	8.49	8.49	8.49	na	1
44	San Luis Drain End	12.09	17.09	2.59	2.64	76
45	Volta Wasteway at Ingomar Grade	9.84	14.15	4.05	2.99	11
46	Mud Slough at Gun Club Road	7.18	12.43	1.18	2.75	11
47	Delta-Mendota Cal Hwy 140	8.03	8.40	7.71	0.35	3
48	FC-5 Grasslands Area Farmers	17.68	17.68	17.68	na	1
49	PE-14-Grasslands Area Farmers	18.32	18.32	18.32	na	1
50	San Luis Drain Site A (Check 18)	11.73	13.75	7.90	3.31	3
51	Arroyo Cal at Hwy 152	7.61	8.07	7.14	0.66	2
52	Salt Slough at Sand Dam	7.04	8.86	5.71	1.63	3
53	Salt Slough at Wolfsen Road	7.95	12.11	1.61	1.83	29
54	Los Banos Creek at Ingomar Grade	6.20	6.20	6.20	na	1
57	Ramona Lake Drain at Levee	10.34	20.59	2.57	4.27	30
59	SJR Laird Park	9.51	12.38	6.98	1.58	17
60	Moffit 1 South	6.18	12.17	0.53	2.76	20
61	Deadman's Slough	6.68	11.80	2.66	2.07	26
62	Mallard Slough	4.16	9.49	0.61	2.49	22
63	Inlet C Canal	9.86	15.60	7.22	1.57	26

DO site number	Site name	Average of DO mg/L	Max of DO mg/L	Min of DO mg/L	StdDev of DO mg/L	Count of DO mg/L
64	Moran Drain	8.90	10.63	6.90	1.22	6
65	Spanish Grant Drain	8.09	9.51	6.30	1.27	7
66	ESWD Maze Blv. Drain	9.75	12.08	7.17	2.36	4
67	Newman Wasteway at Brazo Road	6.72	7.63	4.80	0.97	7
68	S. Lake Basin	6.96	9.56	4.52	2.07	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	9.23	18.47	4.21	3.78	17
81	South Marsh 1 Outlet	6.41	13.66	0.15	4.00	21
82	South Marsh 3 Inlet	6.47	14.76	0.29	3.43	25
83	South Marsh 3 Outlet	8.30	15.72	2.06	3.27	28
84	SJR Garwood Bridge	9.54	9.54	9.54	na	1
86	Ramona Drain Apple Ave	4.54	8.59	0.41	2.54	9
87	Ramona Drain Prune Ave	2.62	3.14	2.11	0.52	3
88	Ramona Drain Apricot Ave	4.69	8.00	0.55	2.43	9
89	Ramona Drain Pomelo Ave	2.92	3.86	1.57	1.20	3
90	Ramona Drain Almond Ave	3.69	3.69	3.69	na	1
91	Paradise Drain Prune Ave	5.32	5.32	5.32	na	1
92	Paradise Drain Apricot Ave	10.35	14.84	7.60	2.49	7
93	Paradise Drain Pomelo Ave	6.99	9.76	5.57	2.40	3
94	Paradise Drain Almond Ave	5.98	7.71	3.75	1.40	7
95	Ramona Lake Entrance	9.38	17.25	3.06	3.63	17
96	WPF-VD-1	5.43	5.43	5.43	na	1
97	WPF-VD-2	4.77	4.77	4.77	na	1
98	WPF-VD-3	0.63	0.63	0.63	na	1
101	WPF-UD-IN	7.17	8.74	5.60	2.22	2
102	WPF-UD-OUT	7.00	7.63	6.37	0.89	2
103	SLD Check 18	10.67	13.43	7.90	3.91	2
104	SLD Check 16	11.43	14.25	8.62	3.97	2
105	SLD Check 15	11.38	13.77	9.00	3.37	2
106	SLD Check 14	11.61	13.53	9.68	2.72	2
107	SLD Check 13	11.28	11.59	10.97	0.44	2
108	SLD Check 12	10.84	11.25	10.43	0.58	2
109	SLD Check 11	9.51	10.56	8.47	1.47	2
110	SLD Check 10	14.70	15.54	13.86	1.19	2
111	SLD Check 9	13.73	15.01	12.44	1.82	2
112	SLD Check 8	13.03	14.12	11.93	1.55	2
113	SLD Check 7	13.72	13.92	13.51	0.28	2
114	SLD Check 6	13.78	15.75	11.81	2.78	2
115	SLD Check 5	13.03	15.68	10.37	3.76	2
116	SLD Check 4	13.56	15.81	11.32	3.18	2
117	SLD Check 3	15.15	19.60	10.70	6.29	2
118	SLD Check 2	14.80	19.04	10.56	6.00	2
119	SLD Check 1	12.75	17.39	8.11	6.56	2
120	South Marsh 1 Intermediary	8.66	19.78	4.09	4.14	11
121	South Marsh 1 East	7.14	16.66	0.94	5.21	10
122	South Marsh 1 West	4.60	7.18	0.51	2.58	9
123	Ramona Lake NW Quad	17.73	18.18	17.15	0.53	3
124	Ramona Lake NE Quad	15.41	21.57	12.04	5.34	3
125	Ramona Lake SW Quad	17.96	17.96	17.96	na	1
126	Ramona Lake SE Quad	18.02	18.02	18.02	na	1
129	Hollow Tree drain	7.21	8.94	6.01	1.53	3
130	Marshall Rd Reservoir Entrance	8.87	9.55	7.74	0.68	7
131	Marshall Rd Reservoir Exit	8.93	11.77	6.67	1.75	7
132	Marshall Rd Res Pond 1W	8.40	9.63	7.32	1.06	5
133	Marshall Rd Res Pond 2E	8.38	9.26	7.48	0.65	5
135	Modesto ID Main Drain Spill	7.38	9.58	5.18	1.88	7

pH

DO site number	Site name	Average of pH	Max of pH	Min of pH	StdDev of pH	Count of pH
1	SJR at Channel Point	7.87	8.14	7.59	0.39	2
2	SJR at Dos Reis Lathrop	8.87	9.05	8.69	0.26	2
3	SJR at Old River	8.79	8.94	8.64	0.21	2
4	SJR at Mossdale	7.96	9.14	6.84	0.60	65
5	SJR at Vernalis	7.91	9.11	7.06	0.47	76
6	SJR at Maze	7.92	8.92	7.14	0.40	69
7	SJR at Patterson	7.91	8.70	7.14	0.36	79
8	SJR at Crows Landing	7.87	8.53	7.32	0.26	84
9	SJR at Fremont Ford	7.97	8.13	7.89	0.10	5
10	SJR at Lander Avenue	8.26	9.17	7.20	0.46	83
11	French Camp Slough	7.78	8.06	7.23	0.28	7
12	Stanislaus River at Caswell Park	7.56	8.34	6.76	0.29	67
13	Stanislaus River at Ripon	7.64	7.64	7.64	na	1
14	Tuolumne River at Shiloh Bridge	7.76	8.73	6.96	0.35	68
16	Merced River at River Road	7.50	8.39	7.02	0.23	67
17	Merced River near Stevinson	7.37	7.37	7.37	na	1
18	Mud Slough near Gustine	8.13	8.83	7.42	0.36	77
19	Salt Slough at Lander Avenue	7.69	8.04	7.11	0.15	105
20	Los Banos Creek at Highway 140	7.64	8.50	7.08	0.30	68
21	Orestimba Creek at River Road	7.99	9.20	7.60	0.28	63
22	Modesto ID Lateral 4 to SJR	8.52	8.96	7.73	0.44	6
23	Modesto ID Lateral 5 to Tuolumne	8.32	9.76	7.44	0.63	29
24	Modesto ID Lateral 6 to Stanislaus River	7.75	8.15	7.35	0.57	2
25	MID Main Drain to Stan. R. via Miller Lake	7.69	8.81	7.22	0.38	40
26	Turlock ID Highline Spill	8.35	8.38	8.32	0.04	2
27	Turlock ID Lateral 2 to SJR	8.29	8.95	7.44	0.54	5
28	Turlock ID Westport Drain Flow Station	7.98	8.58	7.30	0.24	50
29	Turlock ID Harding Drain	7.78	8.28	7.00	0.21	65
30	Turlock ID Lateral 6 & 7 at Levee	7.80	8.58	7.43	0.27	36
31	BCID - New Jerusalem Drain	7.39	7.65	7.25	0.13	8
32	El Solyo WD - Grayson Drain	8.08	8.46	7.48	0.36	6
33	Hospital Creek	7.97	8.56	7.35	0.35	17
34	Ingram Creek Flow Station	8.03	8.63	7.32	0.24	44
35	Westley Wasteway Flow Station	8.50	9.13	7.91	0.42	8
36	Del Puerto Creek Flow Station	8.20	9.36	7.60	0.33	58
38	Marshall Road Drain	7.72	7.91	7.58	0.11	7
39	Salado Creek Flow Station	7.65	7.80	7.50	0.14	4
43	El Solyo Pumping Station	7.76	7.76	7.76	na	1
44	San Luis Drain End	8.49	9.09	7.75	0.29	76
45	Volta Wasteway at Ingomar Grade	7.69	7.91	7.30	0.17	11
46	Mud Slough at Gun Club Road	7.90	8.53	7.47	0.33	11
47	Delta-Mendota Cal Hwy 140	7.64	7.84	7.28	0.31	3
48	FC-5 Grasslands Area Farmers	8.46	8.46	8.46	na	1
49	PE-14-Grasslands Area Farmers	8.44	8.44	8.44	na	1
50	San Luis Drain Site A (Check 18)	8.16	8.29	7.98	0.16	3
51	Arroyo Cal at Hwy 152	7.84	8.00	7.67	0.23	2
52	Salt Slough at Sand Dam	7.48	7.61	7.40	0.11	3
53	Salt Slough at Wolfsen Road	7.48	7.74	7.05	0.14	29
54	Los Banos Creek at Ingomar Grade	7.75	7.75	7.75	na	1
57	Ramona Lake Drain at Levee	8.05	9.49	7.29	0.45	30
59	SJR Laird Park	7.83	8.27	7.60	0.20	17
60	Moffit 1 South	7.33	7.60	6.95	0.21	20
61	Deadman's Slough	7.43	8.25	6.96	0.31	26
62	Mallard Slough	7.26	7.97	6.84	0.25	22
63	Inlet C Canal	7.79	8.31	7.38	0.18	26

DO site number	Site name	Average of pH	Max of pH	Min of pH	StdDev of pH	Count of pH
64	Moran Drain	8.00	8.19	7.71	0.18	6
65	Spanish Grant Drain	7.78	8.15	7.46	0.27	7
66	ESWD Maze Blv. Drain	8.45	8.82	8.07	0.35	4
67	Newman Wasteway at Brazo Road	7.44	7.61	7.32	0.11	7
68	S. Lake Basin	7.83	8.18	7.52	0.24	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	7.70	8.55	7.32	0.33	18
81	South Marsh 1 Outlet	7.44	8.51	6.86	0.42	21
82	South Marsh 3 Inlet	7.38	8.09	6.82	0.28	25
83	South Marsh 3 Outlet	7.47	9.06	6.83	0.37	28
84	SJR Garwood Bridge	8.13	8.13	8.13	na	1
86	Ramona Drain Apple Ave	7.48	8.00	7.06	0.28	9
87	Ramona Drain Prune Ave	7.21	7.34	7.14	0.12	3
88	Ramona Drain Apricot Ave	7.52	8.00	6.79	0.34	9
89	Ramona Drain Pomelo Ave	7.32	7.44	7.18	0.13	3
90	Ramona Drain Almond Ave	7.41	7.41	7.41	na	1
91	Paradise Drain Prune Ave	7.32	7.32	7.32	na	1
92	Paradise Drain Apricot Ave	7.90	8.70	7.34	0.47	7
93	Paradise Drain Pomelo Ave	7.49	7.64	7.26	0.20	3
94	Paradise Drain Almond Ave	7.66	7.95	7.51	0.15	7
95	Ramona Lake Entrance	7.89	8.57	7.18	0.37	17
96	WPF-VD-1	7.25	7.25	7.25	na	1
97	WPF-VD-2	7.24	7.24	7.24	na	1
98	WPF-VD-3	6.98	6.98	6.98	na	1
101	WPF-UD-IN	7.42	7.58	7.25	0.23	2
102	WPF-UD-OUT	7.46	7.51	7.40	0.08	2
103	SLD Check 18	8.07	8.19	7.94	0.18	2
104	SLD Check 16	8.19	8.27	8.11	0.11	2
105	SLD Check 15	8.26	8.30	8.21	0.06	2
106	SLD Check 14	8.35	8.36	8.34	0.01	2
107	SLD Check 13	8.30	8.34	8.26	0.05	2
108	SLD Check 12	8.27	8.31	8.22	0.06	2
109	SLD Check 11	8.36	8.51	8.20	0.22	2
110	SLD Check 10	8.45	8.47	8.43	0.03	2
111	SLD Check 9	8.47	8.50	8.44	0.04	2
112	SLD Check 8	8.34	8.38	8.30	0.06	2
113	SLD Check 7	8.36	8.38	8.35	0.02	2
114	SLD Check 6	8.45	8.53	8.36	0.12	2
115	SLD Check 5	8.60	8.68	8.53	0.11	2
116	SLD Check 4	8.64	8.69	8.59	0.07	2
117	SLD Check 3	8.60	8.73	8.47	0.19	2
118	SLD Check 2	8.66	8.80	8.53	0.19	2
119	SLD Check 1	8.69	8.85	8.52	0.24	2
120	South Marsh 1 Intermediary	7.67	8.72	7.21	0.39	11
121	South Marsh 1 East	7.34	8.22	6.98	0.40	10
122	South Marsh 1 West	7.21	7.52	6.90	0.20	9
123	Ramona Lake NW Quad	8.94	9.04	8.81	0.11	3
124	Ramona Lake NE Quad	8.46	9.47	7.87	0.88	3
125	Ramona Lake SW Quad	8.83	8.83	8.83	na	1
126	Ramona Lake SE Quad	8.81	8.81	8.81	na	1
129	Hollow Tree drain	7.86	7.90	7.78	0.07	3
130	Marshall Rd Reservoir Entrance	7.93	8.18	7.73	0.19	7
131	Marshall Rd Reservoir Exit	8.55	8.98	8.12	0.36	7
132	Marshall Rd Res Pond 1W	8.07	8.45	7.74	0.34	5
133	Marshall Rd Res Pond 2E	7.96	8.22	7.75	0.20	5
135	Modesto ID Main Drain Spill	7.58	8.02	7.30	0.33	7

Oxidation Reduction Potential

DO site number	Site name	Average of ORP mV	Max of ORP mV	Min of ORP mV	StdDev of ORP mV	Count of ORP mV
1	SJR at Channel Point	0.00	0.00	0.00	na	1
2	SJR at Dos Reis Lathrop	0.00	0.00	0.00	na	1
3	SJR at Old River	0.00	0.00	0.00	na	1
4	SJR at Mossdale	181.06	419.63	0.00	96.11	65
5	SJR at Vernalis	190.10	412.89	40.17	86.54	76
6	SJR at Maze	188.87	402.14	35.47	81.08	69
7	SJR at Patterson	190.04	418.06	4.48	86.57	79
8	SJR at Crows Landing	176.94	397.54	16.54	84.53	84
9	SJR at Fremont Ford	154.11	191.83	119.95	32.68	5
10	SJR at Lander Avenue	164.27	392.41	17.03	87.42	83
11	French Camp Slough	186.71	278.85	141.62	46.72	7
12	Stanislaus River at Caswell Park	201.65	454.24	26.45	89.84	67
13	Stanislaus River at Ripon	286.36	286.36	286.36	na	1
14	Tuolumne River at Shiloh Bridge	201.77	446.41	76.14	83.22	68
16	Merced River at River Road	192.09	422.21	21.91	91.87	67
17	Merced River near Stevinson	367.64	367.64	367.64	na	1
18	Mud Slough near Gustine	160.33	376.45	47.89	80.35	77
19	Salt Slough at Lander Avenue	175.56	417.31	18.12	89.56	105
20	Los Banos Creek at Highway 140	161.89	440.48	-49.77	108.11	68
21	Orestimba Creek at River Road	195.94	425.67	15.65	93.36	63
22	Modesto ID Lateral 4 to SJR	300.10	373.28	127.95	107.11	6
23	Modesto ID Lateral 5 to Tuolumne	238.69	404.87	30.74	98.34	29
24	Modesto ID Lateral 6 to Stanislaus River	241.21	288.72	193.69	67.20	2
25	MID Main Drain to Stan. R. via Miller Lake	194.46	413.24	13.80	91.47	40
26	Turlock ID Highline Spill	244.52	323.36	165.67	111.51	2
27	Turlock ID Lateral 2 to SJR	181.25	290.64	115.72	66.82	5
28	Turlock ID Westport Drain Flow Station	208.53	415.78	23.86	94.88	50
29	Turlock ID Harding Drain	188.67	407.30	0.74	86.77	65
30	Turlock ID Lateral 6 & 7 at Levee	179.82	398.23	120.29	52.62	36
31	BCID - New Jerusalem Drain	230.16	426.80	136.31	104.93	8
32	El Solyo WD - Grayson Drain	160.69	325.30	90.81	89.10	6
33	Hospital Creek	192.89	406.42	104.58	87.10	17
34	Ingram Creek Flow Station	166.59	413.56	33.16	68.84	44
35	Westley Wasteway Flow Station	227.42	390.16	90.25	109.11	8
36	Del Puerto Creek Flow Station	204.49	420.76	44.52	102.19	58
38	Marshall Road Drain	233.76	382.83	139.31	99.82	7
39	Salado Creek Flow Station	139.54	176.66	102.89	35.01	4
43	El Solyo Pumping Station	315.83	315.83	315.83	na	1
44	San Luis Drain End	163.79	385.42	30.90	91.42	76
45	Volta Wasteway at Ingomar Grade	147.50	269.07	79.55	53.79	11
46	Mud Slough at Gun Club Road	144.78	260.64	86.62	56.33	11
47	Delta-Mendota Cal Hwy 140	127.56	169.22	102.72	36.30	3
48	FC-5 Grasslands Area Farmers	373.64	373.64	373.64	na	1
49	PE-14-Grasslands Area Farmers	361.06	361.06	361.06	na	1
50	San Luis Drain Site A (Check 18)	249.56	379.65	169.99	113.60	3
51	Arroyo Cal at Hwy 152	171.44	188.00	154.88	23.42	2
52	Salt Slough at Sand Dam	223.88	332.80	164.91	94.44	3
53	Salt Slough at Wolfsen Road	159.94	427.81	19.32	99.87	29
54	Los Banos Creek at Ingomar Grade	119.33	119.33	119.33	na	1
57	Ramona Lake Drain at Levee	139.50	229.19	-87.82	59.63	29
59	SJR Laird Park	253.14	400.73	26.05	120.64	17
60	Moffit 1 South	155.55	360.70	5.71	82.91	20
61	Deadman's Slough	163.05	394.99	14.42	82.13	26
62	Mallard Slough	138.44	422.52	-88.11	112.11	22
63	Inlet C Canal	151.30	421.49	17.00	94.78	26

DO site number	Site name	Average of ORP mV	Max of ORP mV	Min of ORP mV	StdDev of ORP mV	Count of ORP mV
64	Moran Drain	203.24	376.52	141.62	86.21	6
65	Spanish Grant Drain	238.34	414.24	146.99	107.08	7
66	ESWD Maze Blv. Drain	265.81	393.49	148.45	119.72	4
67	Newman Wasteway at Brazo Road	212.54	370.11	90.97	105.50	7
68	S. Lake Basin	214.90	362.20	118.66	121.30	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	167.33	455.49	67.57	108.01	18
81	South Marsh 1 Outlet	118.38	398.13	-279.40	146.44	21
82	South Marsh 3 Inlet	112.01	452.55	-137.53	137.37	25
83	South Marsh 3 Outlet	148.88	448.98	15.04	99.46	28
84	SJR Garwood Bridge	0.00	0.00	0.00	na	1
86	Ramona Drain Apple Ave	125.85	211.74	59.11	40.49	9
87	Ramona Drain Prune Ave	127.71	191.52	87.05	55.95	3
88	Ramona Drain Apricot Ave	93.57	125.46	53.45	28.82	9
89	Ramona Drain Pomelo Ave	101.22	146.35	71.85	39.67	3
90	Ramona Drain Almond Ave	220.96	220.96	220.96	na	1
91	Paradise Drain Prune Ave	122.74	122.74	122.74	na	1
92	Paradise Drain Apricot Ave	116.10	227.00	82.43	50.15	7
93	Paradise Drain Pomelo Ave	128.71	196.92	56.60	70.24	3
94	Paradise Drain Almond Ave	118.73	213.75	81.15	45.87	7
95	Ramona Lake Entrance	141.06	228.47	69.79	39.93	16
96	WPF-VD-1	146.12	146.12	146.12	na	1
97	WPF-VD-2	145.71	145.71	145.71	na	1
98	WPF-VD-3	78.29	78.29	78.29	na	1
101	WPF-UD-IN	193.52	239.11	147.93	64.47	2
102	WPF-UD-OUT	171.12	219.45	122.78	68.36	2
103	SLD Check 18	177.36	187.18	167.55	13.88	2
104	SLD Check 16	180.84	197.68	164.00	23.82	2
105	SLD Check 15	190.45	201.76	179.14	15.99	2
106	SLD Check 14	193.30	209.18	177.42	22.46	2
107	SLD Check 13	203.02	221.00	185.03	25.43	2
108	SLD Check 12	198.42	211.95	184.90	19.13	2
109	SLD Check 11	193.07	208.15	178.00	21.32	2
110	SLD Check 10	189.52	197.33	181.71	11.05	2
111	SLD Check 9	193.10	206.19	180.00	18.52	2
112	SLD Check 8	198.70	214.93	182.47	22.95	2
113	SLD Check 7	199.65	220.31	179.00	29.21	2
114	SLD Check 6	191.65	217.82	165.47	37.01	2
115	SLD Check 5	181.29	214.31	148.27	46.70	2
116	SLD Check 4	179.02	214.73	143.31	50.50	2
117	SLD Check 3	175.56	204.25	146.87	40.57	2
118	SLD Check 2	176.55	212.46	140.63	50.80	2
119	SLD Check 1	174.28	214.13	134.43	56.36	2
120	South Marsh 1 Intermediary	96.82	141.29	47.97	29.90	11
121	South Marsh 1 East	69.99	125.18	-129.00	75.30	10
122	South Marsh 1 West	46.13	129.83	-88.02	90.75	9
123	Ramona Lake NW Quad	151.27	242.40	60.14	128.88	2
124	Ramona Lake NE Quad	191.22	252.48	129.97	86.63	2
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	124.31	129.00	117.64	5.93	3
130	Marshall Rd Reservoir Entrance	139.84	180.97	101.30	34.14	7
131	Marshall Rd Reservoir Exit	135.56	182.17	95.64	30.47	7
132	Marshall Rd Res Pond 1W	141.33	183.52	108.82	31.58	5
133	Marshall Rd Res Pond 2E	146.39	187.67	113.71	29.92	5
135	Modesto ID Main Drain Spill	154.87	187.64	122.67	26.26	7

Turbidity (ntu)

DO site number	Site name	Average of Sonde Turbidity	Max of Sonde Turbidity	Min of Sonde Turbidity	StdDev of Sonde Turbidity	Count of Sonde Turbidity
1	SJR at Channel Point	23.89	32.20	15.58	11.75	2
2	SJR at Dos Reis Lathrop	20.26	29.84	10.68	13.55	2
3	SJR at Old River	19.04	28.39	9.70	13.21	2
4	SJR at Mossdale	20.65	63.99	4.94	9.55	65
5	SJR at Vernalis	20.38	74.05	3.71	9.64	76
6	SJR at Maze	25.14	78.75	7.57	11.72	69
7	SJR at Patterson	31.96	94.47	10.04	13.65	79
8	SJR at Crows Landing	28.49	90.82	10.92	12.47	84
9	SJR at Fremont Ford	47.41	77.04	12.94	23.81	5
10	SJR at Lander Avenue	27.15	191.31	11.48	24.37	83
11	French Camp Slough	28.88	115.16	4.58	39.14	7
12	Stanislaus River at Caswell Park	6.25	32.04	0.00	5.83	67
13	Stanislaus River at Ripon	2.73	2.73	2.73	na	1
14	Tuolumne River at Shiloh Bridge	5.41	46.31	0.00	7.34	68
16	Merced River at River Road	8.27	116.13	0.00	14.48	67
17	Merced River near Stevinson	7.17	7.17	7.17	na	1
18	Mud Slough near Gustine	34.84	95.57	9.69	18.48	77
19	Salt Slough at Lander Avenue	55.76	116.33	0.55	25.56	105
20	Los Banos Creek at Highway 140	62.51	206.98	11.11	50.65	68
21	Orestimba Creek at River Road	120.28	417.25	4.72	89.82	63
22	Modesto ID Lateral 4 to SJR	2.64	6.38	0.89	2.05	6
23	Modesto ID Lateral 5 to Tuolumne	6.97	46.81	0.00	10.83	29
24	Modesto ID Lateral 6 to Stanislaus River	8.81	11.91	5.72	4.38	2
25	MID Main Drain to Stan. R. via Miller Lake	21.42	77.71	1.57	13.92	40
26	Turlock ID Highline Spill	7.76	9.89	5.62	3.02	2
27	Turlock ID Lateral 2 to SJR	3.23	4.64	1.86	1.09	5
28	Turlock ID Westport Drain Flow Station	11.10	73.44	0.00	13.09	50
29	Turlock ID Harding Drain	15.35	77.38	1.67	15.22	64
30	Turlock ID Lateral 6 & 7 at Levee	7.02	43.72	0.70	10.16	36
31	BCID - New Jerusalem Drain	6.12	21.37	0.58	7.32	7
32	El Solyo WD - Grayson Drain	517.86	1582.13	90.69	535.71	6
33	Hospital Creek	526.71	2049.75	30.67	656.95	16
34	Ingram Creek Flow Station	334.51	2103.13	0.85	415.33	44
35	Westley Wasteway Flow Station	274.68	1282.90	12.62	422.65	8
36	Del Puerto Creek Flow Station	83.62	650.97	1.06	115.56	57
38	Marshall Road Drain	166.95	615.57	43.99	203.97	7
39	Salado Creek Flow Station	232.23	762.52	38.18	353.74	4
43	El Solyo Pumping Station	43.61	43.61	43.61	na	1
44	San Luis Drain End	22.01	47.21	7.40	8.73	75
45	Volta Wasteway at Ingomar Grade	10.03	17.31	4.57	3.77	11
46	Mud Slough at Gun Club Road	21.69	44.08	13.92	9.95	11
47	Delta-Mendota Cal Hwy 140	9.18	10.64	7.64	1.50	3
48	FC-5 Grasslands Area Farmers	19.02	19.02	19.02	na	1
49	PE-14-Grasslands Area Farmers	30.61	30.61	30.61	na	1
50	San Luis Drain Site A (Check 18)	46.74	70.55	25.88	22.48	3
51	Arroyo Cal at Hwy 152	92.92	118.27	67.56	35.86	2
52	Salt Slough at Sand Dam	68.26	95.67	49.22	24.33	3
53	Salt Slough at Wolfsen Road	45.99	106.76	1.43	20.55	29
54	Los Banos Creek at Ingomar Grade	73.95	73.95	73.95	na	1
57	Ramona Lake Drain at Levee	84.21	250.31	31.83	50.77	30
59	SJR Laird Park	29.78	52.35	4.78	15.08	17
60	Moffit 1 South	1.76	7.48	0.00	2.20	20
61	Deadman's Slough	16.61	63.96	0.00	17.49	26
62	Mallard Slough	8.17	27.81	0.00	7.89	22
63	Inlet C Canal	49.00	92.65	11.37	22.36	26

DO site number	Site name	Average of Sonde Turbidity	Max of Sonde Turbidity	Min of Sonde Turbidity	StdDev of Sonde Turbidity	Count of Sonde Turbidity
64	Moran Drain	96.44	181.07	34.96	56.22	6
65	Spanish Grant Drain	206.53	427.71	20.49	162.79	7
66	ESWD Maze Blv. Drain	378.81	1422.28	20.51	695.79	4
67	Newman Wasteway at Brazo Road	86.74	137.64	43.84	33.46	7
68	S. Lake Basin	20.86	27.02	16.26	4.89	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	26.38	106.27	4.98	22.33	18
81	South Marsh 1 Outlet	7.19	81.82	0.00	17.85	21
82	South Marsh 3 Inlet	16.37	43.83	4.39	12.18	25
83	South Marsh 3 Outlet	18.05	55.22	4.11	12.94	28
84	SJR Garwood Bridge	14.10	14.10	14.10	na	1
86	Ramona Drain Apple Ave	59.95	159.04	11.76	46.77	9
87	Ramona Drain Prune Ave	22.20	35.79	14.91	11.78	3
88	Ramona Drain Apricot Ave	95.04	195.37	9.56	67.63	9
89	Ramona Drain Pomelo Ave	145.37	181.25	114.95	33.48	3
90	Ramona Drain Almond Ave	92.19	92.19	92.19	na	1
91	Paradise Drain Prune Ave	15.09	15.09	15.09	na	1
92	Paradise Drain Apricot Ave	17.68	26.99	7.16	7.12	7
93	Paradise Drain Pomelo Ave	128.89	192.12	11.46	101.80	3
94	Paradise Drain Almond Ave	95.75	168.99	57.48	36.40	7
95	Ramona Lake Entrance	83.76	223.09	23.82	47.45	17
96	WPF-VD-1	297.72	297.72	297.72	na	1
97	WPF-VD-2	197.32	197.32	197.32	na	1
98	WPF-VD-3	46.60	46.60	46.60	na	1
101	WPF-UD-IN	155.43	305.64	5.21	212.44	2
102	WPF-UD-OUT	168.34	307.80	28.87	197.23	2
103	SLD Check 18	59.14	87.59	30.69	40.23	2
104	SLD Check 16	39.35	54.54	24.17	21.47	2
105	SLD Check 15	40.33	58.30	22.36	25.42	2
106	SLD Check 14	42.25	57.55	26.95	21.63	2
107	SLD Check 13	56.94	72.45	41.44	21.93	2
108	SLD Check 12	56.56	72.19	40.92	22.11	2
109	SLD Check 11	52.18	55.47	48.88	4.66	2
110	SLD Check 10	36.05	41.30	30.80	7.42	2
111	SLD Check 9	37.58	46.42	28.75	12.50	2
112	SLD Check 8	54.51	75.79	33.23	30.10	2
113	SLD Check 7	40.70	44.23	37.17	4.99	2
114	SLD Check 6	43.93	51.79	36.07	11.11	2
115	SLD Check 5	29.21	31.11	27.32	2.68	2
116	SLD Check 4	34.32	34.65	33.99	0.47	2
117	SLD Check 3	27.91	31.88	23.94	5.61	2
118	SLD Check 2	17.56	19.43	15.70	2.63	2
119	SLD Check 1	17.87	22.38	13.37	6.37	2
120	South Marsh 1 Intermediary	16.92	36.11	5.43	10.01	11
121	South Marsh 1 East	6.99	27.93	0.99	8.84	10
122	South Marsh 1 West	9.85	39.11	1.29	11.70	9
123	Ramona Lake NW Quad	75.90	99.79	57.92	21.55	3
124	Ramona Lake NE Quad	58.38	72.84	36.73	19.10	3
125	Ramona Lake SW Quad	65.97	65.97	65.97	na	1
126	Ramona Lake SE Quad	62.14	62.14	62.14	na	1
129	Hollow Tree drain	38.12	54.57	21.67	16.45	3
130	Marshall Rd Reservoir Entrance	132.67	261.92	45.64	98.94	7
131	Marshall Rd Reservoir Exit	50.09	72.14	35.88	14.67	7
132	Marshall Rd Res Pond 1W	80.43	179.69	26.08	64.55	5
133	Marshall Rd Res Pond 2E	77.54	183.17	31.41	62.95	5
135	Modesto ID Main Drain Spill	20.64	24.02	16.82	3.03	7

Sonde Chlorophyll-a: Trichromatic C calibration

DO site number	Site name	Average of Sonde Chl-a corr for TriC ug/L	Max of Sonde Chl-a corr for TriC ug/L	Min of Sonde Chl-a corr for TriC ug/L	StdDev of Sonde Chl-a corr for TriC ug/L	Count of Sonde Chl-a corr for TriC ug/L
1	SJR at Channel Point	26.75	53.49	0.00	37.82	2
2	SJR at Dos Reis Lathrop	37.96	75.91	0.00	53.68	2
3	SJR at Old River	37.77	75.53	0.00	53.41	2
4	SJR at Mossdale	40.13	186.54	3.22	43.74	64
5	SJR at Vernalis	30.48	143.05	3.04	28.53	74
6	SJR at Maze	34.33	154.63	0.00	32.03	70
7	SJR at Patterson	40.62	151.13	3.91	32.82	79
8	SJR at Crows Landing	31.92	113.67	0.00	24.68	87
9	SJR at Fremont Ford	38.18	76.82	0.00	27.18	5
10	SJR at Lander Avenue	48.83	183.96	3.68	38.97	82
11	French Camp Slough	15.70	41.24	0.68	16.55	7
12	Stanislaus River at Caswell Park	2.54	14.63	0.00	3.42	67
13	Stanislaus River at Ripon	3.21	3.21	3.21	na	1
14	Tuolumne River at Shiloh Bridge	3.18	50.15	0.00	6.55	68
16	Merced River at River Road	2.48	28.47	0.00	4.84	67
17	Merced River near Stevinson	2.38	2.38	2.38	na	1
18	Mud Slough near Gustine	55.64	176.09	0.00	42.10	78
19	Salt Slough at Lander Avenue	16.31	39.04	0.00	9.12	105
20	Los Banos Creek at Highway 140	42.01	169.09	0.00	32.72	69
21	Orestimba Creek at River Road	16.38	229.57	0.00	31.13	60
22	Modesto ID Lateral 4 to SJR	6.09	8.61	0.00	3.19	6
23	Modesto ID Lateral 5 to Tuolumne	5.89	34.40	0.00	8.79	32
24	Modesto ID Lateral 6 to Stanislaus River	3.57	6.59	0.55	4.27	2
25	MID Main Drain to Stan. R. via Miller Lake	23.31	94.89	0.00	18.86	44
26	Turlock ID Highline Spill	1.49	2.98	0.00	2.11	2
27	Turlock ID Lateral 2 to SJR	0.69	2.96	0.00	1.28	5
28	Turlock ID Westport Drain Flow Station	4.82	52.28	0.00	8.13	53
29	Turlock ID Harding Drain	6.54	33.87	0.00	7.11	65
30	Turlock ID Lateral 6 & 7 at Levee	6.60	27.87	0.00	6.12	38
31	BCID - New Jerusalem Drain	4.14	18.07	0.00	7.91	9
32	El Solyo WD - Grayson Drain	56.05	114.65	0.01	39.51	6
33	Hospital Creek	24.77	70.21	0.00	21.74	20
34	Ingram Creek Flow Station	40.46	126.90	1.89	32.45	44
35	Westley Wasteway Flow Station	25.10	66.33	4.03	19.52	8
36	Del Puerto Creek Flow Station	16.91	91.75	0.00	17.16	63
38	Marshall Road Drain	36.54	81.46	8.03	27.23	8
39	Salado Creek Flow Station	47.81	84.08	16.35	31.26	4
43	El Solyo Pumping Station	24.34	24.34	24.34	na	1
44	San Luis Drain End	133.19	386.26	0.00	82.79	78
45	Volta Wasteway at Ingomar Grade	4.70	14.19	0.87	3.71	11
46	Mud Slough at Gun Club Road	27.00	89.01	8.51	27.83	11
47	Delta-Mendota Cal Hwy 140	2.02	3.64	0.00	1.85	3
48	FC-5 Grasslands Area Farmers	76.99	110.24	43.74	47.03	2
49	PE-14-Grasslands Area Farmers	52.97	54.01	51.93	1.47	2
50	San Luis Drain Site A (Check 18)	37.20	59.93	17.33	17.88	4
51	Arroyo Cal at Hwy 152	11.97	21.73	2.20	13.81	2
52	Salt Slough at Sand Dam	16.51	18.86	15.07	2.06	3
53	Salt Slough at Wolfsen Road	15.00	26.80	7.27	5.02	29
54	Los Banos Creek at Ingomar Grade	0.00	0.00	0.00	na	1
57	Ramona Lake Drain at Levee	90.17	406.47	0.00	96.55	31
59	SJR Laird Park	21.34	166.64	0.00	33.15	27
60	Moffit 1 South	10.35	34.27	0.00	7.28	23
61	Deadman's Slough	23.68	167.47	0.00	34.55	27
62	Mallard Slough	17.40	73.36	0.00	15.85	24
63	Inlet C Canal	9.00	16.79	0.00	4.02	27

DO site number	Site name	Average of Sonde Chl-a corr for TriC ug/L	Max of Sonde Chl-a corr for TriC ug/L	Min of Sonde Chl-a corr for TriC ug/L	StdDev of Sonde Chl-a corr for TriC ug/L	Count of Sonde Chl-a corr for TriC ug/L
64	Moran Drain	13.55	19.38	5.72	5.79	6
65	Spanish Grant Drain	21.61	29.44	14.36	5.52	7
66	ESWD Maze Blv. Drain	21.19	55.04	6.67	23.00	4
67	Newman Wasteway at Brazo Road	14.52	30.23	5.87	7.92	7
68	S. Lake Basin	13.13	50.31	0.00	17.33	8
69	Santa Fe Canal	3.63	14.51	0.00	7.26	4
80	South Marsh 1 Inlet	13.28	72.71	0.00	19.42	21
81	South Marsh 1 Outlet	7.09	20.37	0.00	5.70	22
82	South Marsh 3 Inlet	19.42	80.11	3.35	18.37	25
83	South Marsh 3 Outlet	25.28	134.43	0.97	31.58	28
84	SJR Garwood Bridge	0.00	0.00	0.00	na	1
86	Ramona Drain Apple Ave	14.84	40.83	0.00	10.83	9
87	Ramona Drain Prune Ave	13.39	25.83	0.00	12.94	3
88	Ramona Drain Apricot Ave	34.86	102.59	16.79	26.15	9
89	Ramona Drain Pomelo Ave	30.89	32.49	28.39	2.19	3
90	Ramona Drain Almond Ave	25.67	25.67	25.67	na	1
91	Paradise Drain Prune Ave	23.33	46.65	0.00	32.99	2
92	Paradise Drain Apricot Ave	22.71	54.10	7.93	15.88	7
93	Paradise Drain Pomelo Ave	35.34	62.56	15.38	24.42	3
94	Paradise Drain Almond Ave	29.83	42.48	0.00	13.11	8
95	Ramona Lake Entrance	23.15	96.52	0.00	31.29	18
96	WPF-VD-1	40.77	40.77	40.77	na	1
97	WPF-VD-2	31.67	31.67	31.67	na	1
98	WPF-VD-3	56.49	56.49	56.49	na	1
101	WPF-UD-IN	23.76	36.18	11.35	17.56	2
102	WPF-UD-OUT	25.57	37.58	13.57	16.97	2
103	SLD Check 18	31.49	40.41	22.58	12.61	2
104	SLD Check 16	39.61	48.72	30.50	12.89	2
105	SLD Check 15	51.49	61.49	41.50	14.13	2
106	SLD Check 14	64.61	90.22	39.00	36.22	2
107	SLD Check 13	83.58	120.23	46.93	51.83	2
108	SLD Check 12	95.68	132.99	58.38	52.75	2
109	SLD Check 11	92.95	103.04	82.85	14.28	2
110	SLD Check 10	106.29	112.19	100.39	8.35	2
111	SLD Check 9	121.16	134.96	107.37	19.51	2
112	SLD Check 8	136.70	154.59	118.80	25.31	2
113	SLD Check 7	132.39	132.53	132.25	0.20	2
114	SLD Check 6	137.25	158.36	116.15	29.84	2
115	SLD Check 5	139.06	152.20	125.92	18.58	2
116	SLD Check 4	136.44	137.12	135.75	0.97	2
117	SLD Check 3	112.93	123.12	102.74	14.41	2
118	SLD Check 2	121.19	153.02	89.36	45.02	2
119	SLD Check 1	100.52	117.57	83.47	24.11	2
120	South Marsh 1 Intermediary	3.34	11.06	0.00	3.68	11
121	South Marsh 1 East	34.39	189.72	1.50	62.05	10
122	South Marsh 1 West	22.33	77.07	0.00	24.03	10
123	Ramona Lake NW Quad	394.01	467.53	320.49	103.97	2
124	Ramona Lake NE Quad	53.83	104.45	1.88	51.30	3
125	Ramona Lake SW Quad	415.07	415.07	415.07	na	1
126	Ramona Lake SE Quad	374.36	374.36	374.36	na	1
129	Hollow Tree drain	53.81	59.44	47.43	6.04	3
130	Marshall Rd Reservoir Entrance	31.94	74.05	14.96	19.50	7
131	Marshall Rd Reservoir Exit	48.12	122.55	11.04	40.81	7
132	Marshall Rd Res Pond 1W	31.94	39.91	22.63	7.06	5
133	Marshall Rd Res Pond 2E	30.51	41.93	19.54	8.51	5
135	Modesto ID Main Drain Spill	9.10	13.84	4.19	4.32	6

Sonde Chlorophyll-a: SM calibration

DO site number	Site name	Average of Sonde Chl-a corr for SM ug/L	Max of Sonde Chl-a corr for SM ug/L	Min of Sonde Chl-a corr for SM ug/L	StdDev of Sonde Chl-a corr for SM ug/L	Count of Sonde Chl-a corr for SM ug/L
1	SJR at Channel Point	19.34	48.48	0.00	25.68	3
2	SJR at Dos Reis Lathrop	45.66	68.80	0.00	39.54	3
3	SJR at Old River	47.38	73.69	0.00	41.12	3
4	SJR at Mossdale	36.88	169.06	2.91	39.55	65
5	SJR at Vernalis	27.96	129.65	2.75	25.83	74
6	SJR at Maze	31.58	140.14	0.00	29.06	70
7	SJR at Patterson	37.24	136.97	3.54	29.65	79
8	SJR at Crows Landing	29.31	103.02	0.00	22.39	87
9	SJR at Fremont Ford	34.59	69.62	0.00	24.63	5
10	SJR at Lander Avenue	44.53	166.72	3.33	35.16	82
11	French Camp Slough	14.23	37.37	0.61	15.00	7
12	Stanislaus River at Caswell Park	2.10	12.47	-0.35	2.80	67
13	Stanislaus River at Ripon	2.91	2.91	2.91	na	1
14	Tuolumne River at Shiloh Bridge	2.71	45.40	0.00	5.79	68
16	Merced River at River Road	2.05	25.80	0.00	4.17	67
17	Merced River near Stevinson	2.15	2.15	2.15	na	1
18	Mud Slough near Gustine	50.94	159.59	0.00	37.92	78
19	Salt Slough at Lander Avenue	14.86	35.38	0.00	8.30	105
20	Los Banos Creek at Highway 140	38.62	153.25	0.00	29.53	69
21	Orestimba Creek at River Road	14.93	208.05	0.00	28.22	60
22	Modesto ID Lateral 4 to SJR	5.52	7.80	0.00	2.89	6
23	Modesto ID Lateral 5 to Tuolumne	5.02	31.14	0.00	7.84	32
24	Modesto ID Lateral 6 to Stanislaus River	3.24	5.98	0.50	3.87	2
25	MID Main Drain to Stan. R. via Miller Lake	21.11	85.89	0.00	17.08	44
26	Turlock ID Highline Spill	1.35	2.70	0.00	1.91	2
27	Turlock ID Lateral 2 to SJR	0.63	2.68	0.00	1.16	5
28	Turlock ID Westport Drain Flow Station	4.18	47.32	0.00	7.26	53
29	Turlock ID Harding Drain	5.70	30.70	-1.69	6.44	65
30	Turlock ID Lateral 6 & 7 at Levee	5.76	25.26	0.00	5.41	38
31	BCID - New Jerusalem Drain	3.75	16.38	0.00	7.17	9
32	El Solyo WD - Grayson Drain	50.78	103.91	0.01	35.80	6
33	Hospital Creek	25.83	81.20	0.00	23.52	20
34	Ingram Creek Flow Station	37.92	115.01	1.72	29.57	44
35	Westley Wasteway Flow Station	22.74	60.04	3.65	17.67	8
36	Del Puerto Creek Flow Station	15.30	83.15	0.00	15.56	63
38	Marshall Road Drain	33.11	73.83	7.28	24.68	8
39	Salado Creek Flow Station	43.33	76.20	14.82	28.33	4
43	El Solyo Pumping Station	22.06	22.06	22.06	na	1
44	San Luis Drain End	121.55	350.06	0.00	74.11	78
45	Volta Wasteway at Ingomar Grade	4.26	12.85	0.78	3.36	11
46	Mud Slough at Gun Club Road	24.46	80.67	7.70	25.23	11
47	Delta-Mendota Cal Hwy 140	1.83	3.30	0.00	1.68	3
48	FC-5 Grasslands Area Farmers	69.62	99.60	39.64	42.40	2
49	PE-14-Grasslands Area Farmers	48.11	48.95	47.27	1.19	2
50	San Luis Drain Site A (Check 18)	33.56	54.31	15.15	16.41	4
51	Arroyo Cal at Hwy 152	10.85	19.70	2.00	12.52	2
52	Salt Slough at Sand Dam	14.96	17.10	13.65	1.86	3
53	Salt Slough at Wolfsen Road	13.59	24.29	6.59	4.55	29
57	Ramona Lake Drain at Levee	82.58	367.91	0.00	86.87	31
59	SJR Laird Park	18.30	130.12	0.00	26.58	27
60	Moffit 1 South	9.38	31.06	0.00	6.59	23
61	Deadman's Slough	21.46	151.78	0.00	31.31	27
62	Mallard Slough	15.76	66.41	0.00	14.34	24
63	Inlet C Canal	8.15	15.21	0.00	3.65	27

DO site number	Site name	Average of Sonde Chl-a corr for SM ug/L	Max of Sonde Chl-a corr for SM ug/L	Min of Sonde Chl-a corr for SM ug/L	StdDev of Sonde Chl-a corr for SM ug/L	Count of Sonde Chl-a corr for SM ug/L
64	Moran Drain	12.28	17.54	5.19	5.24	6
65	Spanish Grant Drain	19.58	26.68	13.01	5.00	7
66	ESWD Maze Blv. Drain	19.19	49.82	6.04	20.81	4
67	Newman Wasteway at Brazo Road	13.16	27.40	5.32	7.18	7
68	S. Lake Basin	11.90	45.60	0.00	15.71	8
69	Santa Fe Canal	2.78	11.13	0.00	5.57	4
80	South Marsh 1 Inlet	12.03	65.82	0.00	17.59	21
81	South Marsh 1 Outlet	6.42	18.44	0.00	5.16	22
82	South Marsh 3 Inlet	17.60	72.60	3.04	16.65	25
83	South Marsh 3 Outlet	22.91	121.83	0.88	28.61	28
84	SJR Garwood Bridge	12.09	24.17	0.00	17.09	2
86	Ramona Drain Apple Ave	13.44	36.96	0.00	9.80	9
87	Ramona Drain Prune Ave	12.12	23.38	0.00	11.71	3
88	Ramona Drain Apricot Ave	31.59	92.97	15.22	23.70	9
89	Ramona Drain Pomelo Ave	27.96	29.41	25.70	1.98	3
90	Ramona Drain Almond Ave	23.24	23.24	23.24	na	1
91	Paradise Drain Prune Ave	21.11	42.23	0.00	29.86	2
92	Paradise Drain Apricot Ave	20.56	48.97	7.18	14.37	7
93	Paradise Drain Pomelo Ave	31.98	56.63	13.92	22.10	3
94	Paradise Drain Almond Ave	27.02	38.50	0.00	11.88	8
95	Ramona Lake Entrance	20.98	87.48	0.00	28.36	18
96	WPF-VD-1	36.90	36.90	36.90	na	1
97	WPF-VD-2	28.67	28.67	28.67	na	1
98	WPF-VD-3	51.14	51.14	51.14	na	1
101	WPF-UD-IN	21.51	32.74	10.27	15.89	2
102	WPF-UD-OUT	23.15	34.01	12.29	15.36	2
103	SLD Check 18	28.52	36.58	20.46	11.40	2
104	SLD Check 16	35.87	44.10	27.64	11.64	2
105	SLD Check 15	46.63	55.66	37.61	12.76	2
106	SLD Check 14	58.50	81.66	35.35	32.75	2
107	SLD Check 13	75.68	108.82	42.53	46.88	2
108	SLD Check 12	86.64	120.37	52.91	47.70	2
109	SLD Check 11	84.19	93.39	74.99	13.01	2
110	SLD Check 10	96.27	101.68	90.86	7.65	2
111	SLD Check 9	109.75	122.31	97.19	17.77	2
112	SLD Check 8	123.82	140.11	107.53	23.03	2
113	SLD Check 7	119.91	120.11	119.71	0.28	2
114	SLD Check 6	124.30	143.34	105.27	26.92	2
115	SLD Check 5	125.94	137.76	114.12	16.72	2
116	SLD Check 4	123.57	124.11	123.03	0.77	2
117	SLD Check 3	102.28	111.44	93.11	12.96	2
118	SLD Check 2	109.75	138.51	80.99	40.68	2
119	SLD Check 1	91.03	106.42	75.65	21.75	2
120	South Marsh 1 Intermediary	3.02	10.01	0.00	3.33	11
121	South Marsh 1 East	31.13	171.73	1.36	56.16	10
122	South Marsh 1 West	20.22	69.76	0.00	21.76	10
123	Ramona Lake NW Quad	356.91	423.72	290.10	94.49	2
124	Ramona Lake NE Quad	48.76	94.66	1.70	46.49	3
125	Ramona Lake SW Quad	376.17	376.17	376.17	na	1
126	Ramona Lake SE Quad	339.28	339.28	339.28	na	1
129	Hollow Tree drain	48.76	53.87	42.98	5.47	3
130	Marshall Rd Reservoir Entrance	28.94	67.11	13.56	17.67	7
131	Marshall Rd Reservoir Exit	43.61	111.07	10.00	36.98	7
132	Marshall Rd Res Pond 1W	28.95	36.17	20.51	6.40	5
133	Marshall Rd Res Pond 2E	27.65	38.00	17.71	7.71	5
135	Modesto ID Main Drain Spill	8.25	12.55	3.80	3.92	6

LUX (incident light)

DO site number	Site name	Average of LUX (lumen /m2)	Max of LUX (lumen /m2)	Min of LUX (lumen /m2)	StdDev of LUX (lumen /m2)	Count of LUX (lumen /m2)
1	SJR at Channel Point	88000	88000	88000	na	1
2	SJR at Dos Reis Lathrop	107800	107800	107800	na	1
3	SJR at Old River	112500	112500	112500	na	1
4	SJR at Mossdale	26108	109100	970	19718	53
5	SJR at Vernalis	61227	144300	2400	34095	64
6	SJR at Maze	64562	136800	7410	26868	58
7	SJR at Patterson	90638	151600	5100	32205	64
8	SJR at Crows Landing	89679	157100	1800	42909	69
9	SJR at Fremont Ford	51900	74000	34700	17252	4
10	SJR at Lander Avenue	75224	143100	11300	30594	70
11	French Camp Slough	26786	54400	2720	22213	7
12	Stanislaus River at Caswell Park	28162	110600	3090	22158	52
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	73273	138800	9750	27684	56
16	Merced River at River Road	88428	130500	18000	27281	53
17	Merced River near Stevinson	na	na	na	na	na
18	Mud Slough near Gustine	56990	98700	7500	19703	65
19	Salt Slough at Lander Avenue	71979	121200	2800	27991	90
20	Los Banos Creek at Highway 140	49353	96100	7330	21862	56
21	Orestimba Creek at River Road	96978	142800	10250	36376	47
22	Modesto ID Lateral 4 to SJR	126100	126100	126100	na	1
23	Modesto ID Lateral 5 to Tuolumne	76178	154600	14160	31970	20
24	Modesto ID Lateral 6 to Stanislaus River	137900	137900	137900	na	1
25	MID Main Drain to Stan. R. via Miller Lake	65959	134000	9580	29732	38
26	Turlock ID Highline Spill	103600	103600	103600	na	1
27	Turlock ID Lateral 2 to SJR	124375	144300	76100	32298	4
28	Turlock ID Westport Drain Flow Station	79504	117700	16670	25088	42
29	Turlock ID Harding Drain	101444	147600	14300	33930	52
30	Turlock ID Lateral 6 & 7 at Levee	97791	137100	13400	31725	35
31	BCID - New Jerusalem Drain	89956	143900	57900	30889	9
32	El Solyo WD - Grayson Drain	103380	136100	78600	24815	5
33	Hospital Creek	91794	147000	42600	28096	16
34	Ingram Creek Flow Station	92136	154300	8430	25064	43
35	Westley Wasteway Flow Station	70000	127400	22000	35476	6
36	Del Puerto Creek Flow Station	84406	142300	5740	32492	47
38	Marshall Road Drain	70750	118200	6800	35826	8
39	Salado Creek Flow Station	119875	139900	108100	14740	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	60473	106500	15100	21212	62
45	Volta Wasteway at Ingomar Grade	55670	89200	25400	23983	10
46	Mud Slough at Gun Club Road	53640	75400	29900	15270	10
47	Delta-Mendota Cal Hwy 140	32867	56800	20500	20731	3
48	FC-5 Grasslands Area Farmers	63600	63600	63600	na	1
49	PE-14-Grasslands Area Farmers	74000	74000	74000	na	1
50	San Luis Drain Site A (Check 18)	79233	142200	32200	56705	3
51	Arroyo Cal at Hwy 152	63700	87900	39500	34224	2
52	Salt Slough at Sand Dam	78650	100600	56700	31042	2
53	Salt Slough at Wolfsen Road	69336	126600	21600	31719	28
54	Los Banos Creek at Ingomar Grade	30000	30000	30000	na	1
57	Ramona Lake Drain at Levee	98869	146200	36300	37660	29
59	SJR Laird Park	74367	106400	21100	23452	15
60	Moffit 1 South	32477	67000	5520	19444	21
61	Deadman's Slough	49871	89200	8440	19592	26
62	Mallard Slough	64711	115000	8760	26385	24
63	Inlet C Canal	74552	119100	23800	29427	25

DO site number	Site name	Average of LUX (lumen /m2)	Max of LUX (lumen /m2)	Min of LUX (lumen /m2)	StdDev of LUX (lumen /m2)	Count of LUX (lumen /m2)
64	Moran Drain	82750	126600	6800	43462	6
65	Spanish Grant Drain	75129	125000	6800	41112	7
66	ESWD Maze Blv. Drain	71475	93900	55700	17203	4
67	Newman Wasteway at Brazo Road	51294	89900	13460	28683	7
68	S. Lake Basin	67140	88600	44800	16172	5
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	69867	123600	33600	25906	18
81	South Marsh 1 Outlet	63918	99100	12360	24646	21
82	South Marsh 3 Inlet	74304	124000	27100	30880	25
83	South Marsh 3 Outlet	73929	122500	23600	31772	28
84	SJR Garwood Bridge	na	0	0	na	0
86	Ramona Drain Apple Ave	86738	136000	51600	27218	8
87	Ramona Drain Prune Ave	59450	62600	56300	4455	2
88	Ramona Drain Apricot Ave	93500	121300	70600	16013	8
89	Ramona Drain Pomelo Ave	76550	77200	75900	919	2
90	Ramona Drain Almond Ave	74800	74800	74800	na	1
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	87557	118200	55400	23399	7
93	Paradise Drain Pomelo Ave	78600	80000	77200	1980	2
94	Paradise Drain Almond Ave	90914	121500	77500	16700	7
95	Ramona Lake Entrance	118000	147500	40100	33539	16
96	WPF-VD-1	na	na	na	na	na
97	WPF-VD-2	na	na	na	na	na
98	WPF-VD-3	na	na	na	na	na
101	WPF-UD-IN	34000	34000	34000	na	1
102	WPF-UD-OUT	50500	50500	50500	na	1
103	SLD Check 18	84450	146500	22400	87752	2
104	SLD Check 16	88150	140500	35800	74034	2
105	SLD Check 15	89900	139800	40000	70569	2
106	SLD Check 14	91100	136100	46100	63640	2
107	SLD Check 13	90600	131800	49400	58266	2
108	SLD Check 12	91200	127300	55100	51053	2
109	SLD Check 11	92250	125500	59000	47023	2
110	SLD Check 10	88750	114400	63100	36275	2
111	SLD Check 9	90950	112700	69200	30759	2
112	SLD Check 8	88450	106400	70500	25385	2
113	SLD Check 7	88300	102600	74000	20223	2
114	SLD Check 6	86350	95800	76900	13364	2
115	SLD Check 5	81100	85400	76800	6081	2
116	SLD Check 4	77050	78300	75800	1768	2
117	SLD Check 3	73700	76900	70500	4525	2
118	SLD Check 2	70650	74000	67300	4738	2
119	SLD Check 1	63500	72800	54200	13152	2
120	South Marsh 1 Intermediary	78991	128800	25700	28711	11
121	South Marsh 1 East	68828	108700	15380	28647	10
122	South Marsh 1 West	80489	98200	51900	14546	9
123	Ramona Lake NW Quad	133200	133200	133200	na	1
124	Ramona Lake NE Quad	129200	129200	129200	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	65833	88600	44800	21951	3
130	Marshall Rd Reservoir Entrance	75129	123500	51700	24158	7
131	Marshall Rd Reservoir Exit	93429	136400	62000	26325	7
132	Marshall Rd Res Pond 1W	96040	126600	65300	21972	5
133	Marshall Rd Res Pond 2E	101280	130000	70800	21846	5
135	Modesto ID Main Drain Spill	98817	141200	42300	39896	6

Chlorophyll -a: Standard Methods

DO site number	Site name	Average of Chl-a SM ug/L	Max of Chl-a SM ug/L	Min of Chl-a SM ug/L	StdDev of Chl-a SM ug/L	Count of Chl-a SM ug/L
1	SJR at Channel Point	28.14	41.08	15.19	18.31	2
2	SJR at Dos Reis Lathrop	77.12	83.27	70.97	8.70	2
3	SJR at Old River	76.00	93.58	58.41	24.87	2
4	SJR at Mossdale	44.93	286.61	1.80	59.08	65
5	SJR at Vernalis	29.78	145.63	2.22	33.62	76
6	SJR at Maze	39.47	256.62	0.25	48.59	70
7	SJR at Patterson	42.28	226.01	2.33	45.72	77
8	SJR at Crows Landing	36.46	137.76	0.96	32.77	72
9	SJR at Fremont Ford	57.58	75.07	36.14	18.36	5
10	SJR at Lander Avenue	62.78	233.90	1.95	56.04	73
11	French Camp Slough	14.23	41.06	0.50	14.23	7
12	Stanislaus River at Caswell Park	1.72	6.32	0.00	1.04	63
13	Stanislaus River at Ripon	1.51	1.51	1.51	na	1
14	Tuolumne River at Shiloh Bridge	2.79	10.49	0.25	2.71	67
16	Merced River at River Road	1.92	8.62	0.00	1.74	66
17	Merced River near Stevinson	1.22	1.22	1.22	na	1
18	Mud Slough near Gustine	53.06	240.08	4.08	49.92	68
19	Salt Slough at Lander Avenue	14.05	38.45	1.81	8.92	79
20	Los Banos Creek at Highway 140	34.54	216.39	2.05	41.87	58
21	Orestimba Creek at River Road	8.34	169.30	0.81	23.61	59
22	Modesto ID Lateral 4 to SJR	2.65	4.54	1.05	1.30	6
23	Modesto ID Lateral 5 to Tuolumne	4.89	35.97	0.37	8.47	29
24	Modesto ID Lateral 6 to Stanislaus River	1.52	1.97	1.07	0.64	2
25	MID Main Drain to Stan. R. via Miller Lake	18.35	70.68	0.76	14.89	38
26	Turlock ID Highline Spill	1.35	2.37	0.33	1.44	2
27	Turlock ID Lateral 2 to SJR	2.29	3.07	1.01	0.97	4
28	Turlock ID Westport Drain Flow Station	4.42	41.10	0.52	6.44	47
29	Turlock ID Harding Drain	3.45	9.20	0.84	1.90	64
30	Turlock ID Lateral 6 & 7 at Levee	3.32	19.77	0.00	3.27	35
31	BCID - New Jerusalem Drain	0.34	0.89	0.13	0.26	8
32	El Solyo WD - Grayson Drain	71.05	133.76	7.20	48.48	5
33	Hospital Creek	15.03	68.90	0.86	19.86	17
34	Ingram Creek Flow Station	39.33	171.30	0.61	43.47	44
35	Westley Wasteway Flow Station	30.47	125.51	5.18	42.63	7
36	Del Puerto Creek Flow Station	13.07	74.43	1.59	13.34	57
38	Marshall Road Drain	25.29	65.79	2.91	23.57	8
39	Salado Creek Flow Station	19.87	42.17	4.05	17.74	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	100.88	439.00	7.44	78.51	67
45	Volta Wasteway at Ingomar Grade	18.86	18.86	18.86	na	1
46	Mud Slough at Gun Club Road	19.06	19.06	19.06	na	1
47	Delta-Mendota Cal Hwy 140	2.65	2.79	2.58	0.12	3
48	FC-5 Grasslands Area Farmers	73.87	99.60	48.13	36.40	2
49	PE-14-Grasslands Area Farmers	53.88	60.49	47.27	9.34	2
50	San Luis Drain Site A (Check 18)	38.65	75.06	15.15	25.57	4
51	Arroyo Cal at Hwy 152	14.13	15.22	13.03	1.55	2
52	Salt Slough at Sand Dam	7.70	12.69	2.14	5.30	3
53	Salt Slough at Wolfsen Road	8.09	8.76	7.43	0.94	2
57	Ramona Lake Drain at Levee	119.72	652.20	4.40	123.67	29
59	SJR Laird Park	31.75	130.12	2.12	31.99	22
60	Moffit 1 South	na	na	na	na	na
61	Deadman's Slough	na	na	na	na	na
62	Mallard Slough	na	na	na	na	na
63	Inlet C Canal	na	na	na	na	na

DO site number	Site name	Average of Chl-a SM ug/L	Max of Chl-a SM ug/L	Min of Chl-a SM ug/L	StdDev of Chl-a SM ug/L	Count of Chl-a SM ug/L
64	Moran Drain	6.61	12.08	1.66	3.85	6
65	Spanish Grant Drain	8.36	12.29	5.45	2.57	7
66	ESWD Maze Blv. Drain	16.83	36.89	1.92	18.05	3
67	Newman Wasteway at Brazo Road	6.12	10.79	0.00	4.43	7
68	S. Lake Basin	10.58	16.29	4.87	8.08	2
69	Santa Fe Canal	11.13	11.13	11.13	na	1
80	South Marsh 1 Inlet	na	na	na	na	na
81	South Marsh 1 Outlet	na	na	na	na	na
82	South Marsh 3 Inlet	28.31	39.19	17.42	15.39	2
83	South Marsh 3 Outlet	27.92	31.93	23.91	5.68	2
84	SJR Garwood Bridge	49.30	49.30	49.30	na	1
86	Ramona Drain Apple Ave	6.57	18.27	1.80	5.46	9
87	Ramona Drain Prune Ave	7.98	12.88	2.77	5.06	3
88	Ramona Drain Apricot Ave	40.53	240.13	3.18	75.26	9
89	Ramona Drain Pomelo Ave	16.85	29.16	8.81	10.82	3
90	Ramona Drain Almond Ave	22.33	22.33	22.33	na	1
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	37.55	112.99	3.44	36.51	7
93	Paradise Drain Pomelo Ave	24.64	35.28	8.79	14.00	3
94	Paradise Drain Almond Ave	26.95	39.75	12.80	8.94	7
95	Ramona Lake Entrance	40.81	126.11	4.66	36.62	16
96	WPF-VD-1	2.59	2.59	2.59	na	1
97	WPF-VD-2	2.32	2.32	2.32	na	1
98	WPF-VD-3	3.00	3.00	3.00	na	1
101	WPF-UD-IN	11.43	19.65	3.21	11.62	2
102	WPF-UD-OUT	7.89	8.05	7.74	0.22	2
103	SLD Check 18	34.06	37.81	30.32	5.30	2
104	SLD Check 16	45.36	57.93	32.79	17.78	2
105	SLD Check 15	65.89	95.29	36.50	41.57	2
106	SLD Check 14	61.11	77.15	45.07	22.68	2
107	SLD Check 13	88.89	132.32	45.46	61.42	2
108	SLD Check 12	80.21	108.33	52.08	39.77	2
109	SLD Check 11	71.63	72.44	70.81	1.15	2
110	SLD Check 10	80.96	84.28	77.64	4.69	2
111	SLD Check 9	92.88	96.72	89.04	5.43	2
112	SLD Check 8	96.83	99.76	93.90	4.14	2
113	SLD Check 7	86.80	89.14	84.45	3.31	2
114	SLD Check 6	84.91	87.63	82.20	3.83	2
115	SLD Check 5	87.76	92.52	82.99	6.74	2
116	SLD Check 4	114.53	154.29	74.78	56.22	2
117	SLD Check 3	70.82	79.47	62.17	12.24	2
118	SLD Check 2	88.68	126.66	50.70	53.71	2
119	SLD Check 1	86.26	124.36	48.16	53.88	2
120	South Marsh 1 Intermediary	na	na	na	na	na
121	South Marsh 1 East	na	na	na	na	na
122	South Marsh 1 West	na	na	na	na	na
123	Ramona Lake NW Quad	242.85	242.85	242.85	na	1
124	Ramona Lake NE Quad	20.39	20.39	20.39	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	na	na	na	na	na
130	Marshall Rd Reservoir Entrance	17.03	37.72	6.63	10.12	7
131	Marshall Rd Reservoir Exit	32.91	73.24	8.42	27.57	7
132	Marshall Rd Res Pond 1W	17.46	26.77	10.70	6.90	5
133	Marshall Rd Res Pond 2E	16.81	30.12	11.73	7.67	5
135	Modesto ID Main Drain Spill	4.48	7.88	2.55	2.00	6

Chlorophyll a: Trichromatic method

DO site number	Site name	Average of Chl-a TriChrom ug/L	Max of Chl-a TriChrom ug/L	Min of Chl-a TriChrom ug/L	StdDev of Chl-a TriChrom ug/L	Count of Chl-a TriChrom ug/L
1	SJR at Channel Point	40.79	56.04	25.53	21.57	2
2	SJR at Dos Reis Lathrop	88.97	95.61	82.33	9.39	2
3	SJR at Old River	84.60	103.54	65.66	26.78	2
4	SJR at Mossdale	50.86	303.32	3.00	64.29	65
5	SJR at Vernalis	33.88	152.28	2.84	35.87	76
6	SJR at Maze	44.30	265.06	1.60	51.61	70
7	SJR at Patterson	46.37	233.58	2.44	47.49	77
8	SJR at Crows Landing	40.10	147.78	7.33	33.74	72
9	SJR at Fremont Ford	63.72	82.22	44.55	17.12	5
10	SJR at Lander Avenue	71.28	230.60	3.06	59.69	73
11	French Camp Slough	17.77	45.08	1.24	16.58	7
12	Stanislaus River at Caswell Park	2.43	6.89	0.09	1.33	64
13	Stanislaus River at Ripon	2.97	2.97	2.97	na	1
14	Tuolumne River at Shiloh Bridge	3.46	12.41	0.32	3.03	66
16	Merced River at River Road	2.62	13.69	0.00	2.27	66
17	Merced River near Stevinson	2.10	2.10	2.10	na	1
18	Mud Slough near Gustine	61.02	273.50	5.61	52.44	68
19	Salt Slough at Lander Avenue	17.35	44.16	3.58	10.09	79
20	Los Banos Creek at Highway 140	42.55	244.19	2.83	46.66	58
21	Orestimba Creek at River Road	9.79	176.31	0.85	24.55	59
22	Modesto ID Lateral 4 to SJR	3.14	4.68	1.47	1.36	6
23	Modesto ID Lateral 5 to Tuolumne	5.24	48.22	0.16	8.96	29
24	Modesto ID Lateral 6 to Stanislaus River	2.57	3.44	1.69	1.24	2
25	MID Main Drain to Stan. R. via Miller Lake	24.47	80.81	1.19	18.10	38
26	Turlock ID Highline Spill	0.84	1.16	0.51	0.46	2
27	Turlock ID Lateral 2 to SJR	2.76	4.42	1.16	1.36	4
28	Turlock ID Westport Drain Flow Station	5.99	48.68	0.78	7.59	47
29	Turlock ID Harding Drain	4.90	14.48	1.15	2.74	64
30	Turlock ID Lateral 6 & 7 at Levee	4.79	26.47	1.13	4.36	35
31	BCID - New Jerusalem Drain	0.28	0.82	0.02	0.28	9
32	El Solyo WD - Grayson Drain	78.23	139.90	7.84	49.51	5
33	Hospital Creek	17.09	73.19	0.83	20.98	17
34	Ingram Creek Flow Station	43.98	184.39	0.71	47.39	44
35	Westley Wasteway Flow Station	35.43	146.12	7.76	49.63	7
36	Del Puerto Creek Flow Station	21.79	213.17	2.62	31.45	58
38	Marshall Road Drain	33.55	90.55	5.03	30.36	8
39	Salado Creek Flow Station	25.28	47.31	12.44	16.46	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	110.98	315.56	10.74	74.54	67
45	Volta Wasteway at Ingomar Grade	23.70	23.70	23.70	na	1
46	Mud Slough at Gun Club Road	22.67	22.67	22.67	na	1
47	Delta-Mendota Cal Hwy 140	4.18	4.75	3.87	0.49	3
48	FC-5 Grasslands Area Farmers	83.15	110.24	56.05	38.32	2
49	PE-14-Grasslands Area Farmers	59.36	66.80	51.93	10.51	2
50	San Luis Drain Site A (Check 18)	44.11	84.88	17.33	28.74	4
51	Arroyo Cal at Hwy 152	19.32	19.50	19.14	0.26	2
52	Salt Slough at Sand Dam	11.35	20.80	3.15	8.89	3
53	Salt Slough at Wolfsen Road	11.84	13.25	10.43	2.00	2
57	Ramona Lake Drain at Levee	132.02	688.31	5.75	132.32	29
59	SJR Laird Park	36.05	166.64	3.32	35.48	22
60	Moffit 1 South	na	na	na	na	na
61	Deadman's Slough	na	na	na	na	na
62	Mallard Slough	na	na	na	na	na
63	Inlet C Canal	na	na	na	na	na

DO site number	Site name	Average of Chl-a TriChrom ug/L	Max of Chl-a TriChrom ug/L	Min of Chl-a TriChrom ug/L	StdDev of Chl-a TriChrom ug/L	Count of Chl-a TriChrom ug/L
64	Moran Drain	8.57	14.14	1.84	5.06	6
65	Spanish Grant Drain	10.59	16.18	8.00	2.88	7
66	ESWD Maze Blv. Drain	19.06	41.03	3.34	19.61	3
67	Newman Wasteway at Brazo Road	10.14	14.46	0.00	4.89	7
68	S. Lake Basin	13.00	19.84	6.17	9.66	2
69	Santa Fe Canal	14.51	14.51	14.51	na	1
80	South Marsh 1 Inlet	na	na	na	na	na
81	South Marsh 1 Outlet	na	na	na	na	na
82	South Marsh 3 Inlet	36.50	51.03	21.98	20.54	2
83	South Marsh 3 Outlet	35.20	40.36	30.04	7.30	2
84	SJR Garwood Bridge	67.30	67.30	67.30	na	1
86	Ramona Drain Apple Ave	8.59	23.01	1.92	7.38	9
87	Ramona Drain Prune Ave	9.09	14.03	4.12	4.95	3
88	Ramona Drain Apricot Ave	43.73	248.16	6.82	77.06	9
89	Ramona Drain Pomelo Ave	19.61	31.41	11.14	10.54	3
90	Ramona Drain Almond Ave	24.00	24.00	24.00	na	1
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	41.36	126.95	4.15	41.23	7
93	Paradise Drain Pomelo Ave	28.04	36.27	13.83	12.36	3
94	Paradise Drain Almond Ave	29.27	39.73	14.58	8.64	7
95	Ramona Lake Entrance	45.68	144.07	5.71	39.92	16
96	WPF-VD-1	3.08	3.08	3.08	na	1
97	WPF-VD-2	3.02	3.02	3.02	na	1
98	WPF-VD-3	2.47	2.47	2.47	na	1
101	WPF-UD-IN	11.66	18.97	4.34	10.35	2
102	WPF-UD-OUT	8.36	8.44	8.27	0.12	2
103	SLD Check 18	39.45	44.37	34.53	6.96	2
104	SLD Check 16	51.05	65.69	36.41	20.70	2
105	SLD Check 15	71.87	103.62	40.12	44.91	2
106	SLD Check 14	62.56	76.47	48.66	19.67	2
107	SLD Check 13	94.26	137.26	51.25	60.82	2
108	SLD Check 12	86.78	116.22	57.34	41.64	2
109	SLD Check 11	78.40	78.93	77.87	0.75	2
110	SLD Check 10	87.99	91.65	84.34	5.16	2
111	SLD Check 9	101.55	106.18	96.91	6.56	2
112	SLD Check 8	106.55	110.15	102.95	5.09	2
113	SLD Check 7	94.12	97.28	90.95	4.48	2
114	SLD Check 6	91.05	94.30	87.79	4.60	2
115	SLD Check 5	92.71	96.48	88.95	5.32	2
116	SLD Check 4	125.60	170.16	81.04	63.02	2
117	SLD Check 3	76.15	84.26	68.03	11.48	2
118	SLD Check 2	96.57	137.77	55.37	58.26	2
119	SLD Check 1	93.96	133.94	53.99	56.53	2
120	South Marsh 1 Intermediary	na	na	na	na	na
121	South Marsh 1 East	na	na	na	na	na
122	South Marsh 1 West	na	na	na	na	na
123	Ramona Lake NW Quad	353.32	353.32	353.32	na	1
124	Ramona Lake NE Quad	29.49	29.49	29.49	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	na	na	na	na	na
130	Marshall Rd Reservoir Entrance	21.32	44.50	7.92	11.65	7
131	Marshall Rd Reservoir Exit	41.47	89.74	12.05	32.61	7
132	Marshall Rd Res Pond 1W	20.64	31.70	12.81	8.58	5
133	Marshall Rd Res Pond 2E	19.39	33.65	13.04	8.28	5
135	Modesto ID Main Drain Spill	6.81	10.16	4.49	2.02	6

Pheophytin: standard methods

DO site number	Site name	Average of Pheophyton SM ug/L	Max of Pheophyton SM ug/L	Min of Pheophyton SM ug/L	StdDev of Pheophyton SM ug/L	Count of Pheophyton SM ug/L
1	SJR at Channel Point	18.91	21.85	15.97	4.16	2
2	SJR at Dos Reis Lathrop	14.34	14.46	14.21	0.18	2
3	SJR at Old River	9.15	10.08	8.22	1.32	2
4	SJR at Mossdale	7.39	32.42	0.00	6.35	62
5	SJR at Vernalis	5.12	18.98	0.00	3.72	74
6	SJR at Maze	5.58	18.42	0.00	4.12	69
7	SJR at Patterson	4.61	27.85	0.00	4.18	75
8	SJR at Crows Landing	4.70	25.45	0.00	4.09	70
9	SJR at Fremont Ford	7.11	11.57	0.00	4.32	5
10	SJR at Lander Avenue	11.32	51.69	0.00	10.93	72
11	French Camp Slough	4.80	13.46	1.03	5.44	7
12	Stanislaus River at Caswell Park	1.26	3.01	0.00	0.60	59
13	Stanislaus River at Ripon	2.35	2.35	2.35	na	1
14	Tuolumne River at Shiloh Bridge	1.41	11.70	0.00	1.65	63
16	Merced River at River Road	0.93	3.81	0.00	0.73	63
17	Merced River near Stevinson	1.37	1.37	1.37	na	1
18	Mud Slough near Gustine	11.30	58.29	0.00	10.95	67
19	Salt Slough at Lander Avenue	4.90	15.86	0.83	2.63	76
20	Los Banos Creek at Highway 140	12.55	132.17	0.00	20.42	57
21	Orestimba Creek at River Road	2.01	8.07	0.00	1.73	57
22	Modesto ID Lateral 4 to SJR	1.25	3.25	0.43	1.34	4
23	Modesto ID Lateral 5 to Tuolumne	2.44	25.65	0.00	5.11	25
24	Modesto ID Lateral 6 to Stanislaus River	1.63	2.34	0.92	1.01	2
25	MID Main Drain to Stan. R. via Miller Lake	9.07	43.98	0.42	9.25	38
26	Turlock ID Highline Spill	0.23	0.23	0.23	na	1
27	Turlock ID Lateral 2 to SJR	0.66	2.09	0.00	0.97	4
28	Turlock ID Westport Drain Flow Station	2.38	10.50	0.04	2.04	46
29	Turlock ID Harding Drain	2.38	11.79	0.45	1.97	60
30	Turlock ID Lateral 6 & 7 at Levee	2.35	13.57	0.05	2.79	35
31	BCID - New Jerusalem Drain	0.07	0.21	0.00	0.09	7
32	El Solyo WD - Grayson Drain	6.78	19.41	0.89	7.70	5
33	Hospital Creek	2.62	10.21	0.00	3.02	17
34	Ingram Creek Flow Station	5.06	23.92	0.00	4.75	44
35	Westley Wasteway Flow Station	9.75	26.07	4.05	8.25	6
36	Del Puerto Creek Flow Station	8.28	43.35	0.15	9.68	56
38	Marshall Road Drain	11.96	36.03	1.78	11.44	8
39	Salado Creek Flow Station	7.50	13.38	2.39	4.68	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	13.64	94.32	0.00	16.49	67
45	Volta Wasteway at Ingomar Grade	6.69	6.69	6.69	na	1
46	Mud Slough at Gun Club Road	4.92	4.92	4.92	na	1
47	Delta-Mendota Cal Hwy 140	2.31	2.97	1.93	0.58	3
48	FC-5 Grasslands Area Farmers	10.68	11.13	10.23	0.63	2
49	PE-14-Grasslands Area Farmers	5.86	6.46	5.26	0.85	2
50	San Luis Drain Site A (Check 18)	6.57	11.55	2.68	3.81	4
51	Arroyo Cal at Hwy 152	7.62	9.76	5.48	3.02	2
52	Salt Slough at Sand Dam	5.54	12.63	1.51	6.17	3
53	Salt Slough at Wolfsen Road	5.65	6.89	4.41	1.76	2
57	Ramona Lake Drain at Levee	13.65	86.29	0.00	18.20	29
59	SJR Laird Park	9.36	52.19	0.44	13.08	20
60	Moffit 1 South	na	na	na	na	na
61	Deadman's Slough	na	na	na	na	na
62	Mallard Slough	na	na	na	na	na
63	Inlet C Canal	na	na	na	na	na

DO site number	Site name	Average of Pheophyton SM ug/L	Max of Pheophyton SM ug/L	Min of Pheophyton SM ug/L	StdDev of Pheophyton SM ug/L	Count of Pheophyton SM ug/L
64	Moran Drain	2.80	6.59	0.15	2.52	6
65	Spanish Grant Drain	3.15	5.53	0.43	1.83	7
66	ESWD Maze Blv. Drain	2.57	4.24	1.26	1.52	3
67	Newman Wasteway at Brazo Road	6.24	21.37	0.00	6.97	7
68	S. Lake Basin	3.37	4.89	1.85	2.14	2
69	Santa Fe Canal	4.92	4.92	4.92	na	1
80	South Marsh 1 Inlet	na	na	na	na	na
81	South Marsh 1 Outlet	na	na	na	na	na
82	South Marsh 3 Inlet	12.58	18.33	6.83	8.13	2
83	South Marsh 3 Outlet	10.90	12.58	9.22	2.38	2
84	SJR Garwood Bridge	26.35	26.35	26.35	na	1
86	Ramona Drain Apple Ave	3.05	15.28	0.00	4.89	9
87	Ramona Drain Prune Ave	1.87	2.48	1.09	0.71	3
88	Ramona Drain Apricot Ave	4.20	9.63	0.03	2.78	9
89	Ramona Drain Pomelo Ave	5.33	7.48	3.09	2.20	3
90	Ramona Drain Almond Ave	5.95	5.95	5.95	na	1
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	4.73	18.51	0.96	6.23	7
93	Paradise Drain Pomelo Ave	6.60	9.29	2.84	3.36	3
94	Paradise Drain Almond Ave	3.01	5.07	0.99	1.56	7
95	Ramona Lake Entrance	5.53	21.79	1.13	5.06	16
96	WPF-VD-1	0.36	0.36	0.36	na	1
97	WPF-VD-2	0.68	0.68	0.68	na	1
98	WPF-VD-3	0.00	0.00	0.00	na	1
101	WPF-UD-IN	1.39	1.42	1.36	0.04	2
102	WPF-UD-OUT	0.89	1.67	0.12	1.09	2
103	SLD Check 18	6.71	8.20	5.21	2.11	2
104	SLD Check 16	6.56	9.03	4.09	3.49	2
105	SLD Check 15	5.63	7.46	3.81	2.58	2
106	SLD Check 14	1.57	3.14	0.00	2.22	2
107	SLD Check 13	3.35	6.71	0.00	4.74	2
108	SLD Check 12	5.65	5.92	5.39	0.38	2
109	SLD Check 11	6.43	8.60	4.26	3.07	2
110	SLD Check 10	6.13	6.32	5.93	0.28	2
111	SLD Check 9	8.07	9.25	6.88	1.68	2
112	SLD Check 8	9.61	10.65	8.56	1.48	2
113	SLD Check 7	6.29	7.66	4.91	1.94	2
114	SLD Check 6	4.36	5.09	3.64	1.02	2
115	SLD Check 5	2.26	4.27	0.26	2.83	2
116	SLD Check 4	10.57	15.74	5.41	7.30	2
117	SLD Check 3	3.96	5.51	2.42	2.19	2
118	SLD Check 2	7.10	9.94	4.26	4.01	2
119	SLD Check 1	6.97	7.53	6.41	0.79	2
120	South Marsh 1 Intermediary	na	na	na	na	na
121	South Marsh 1 East	na	na	na	na	na
122	South Marsh 1 West	na	na	na	na	na
123	Ramona Lake NW Quad	164.74	164.74	164.74	na	1
124	Ramona Lake NE Quad	13.59	13.59	13.59	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	na	na	na	na	na
130	Marshall Rd Reservoir Entrance	5.96	9.27	1.54	2.41	7
131	Marshall Rd Reservoir Exit	12.06	30.40	3.48	8.57	7
132	Marshall Rd Res Pond 1W	4.07	7.46	1.89	2.71	5
133	Marshall Rd Res Pond 2E	3.16	4.51	1.32	1.28	5
135	Modesto ID Main Drain Spill	3.51	5.08	2.64	0.85	6

pH 4.5 Alkalinity

DO site number	Site name	Average of 4.5 Alk, mg CaCO3/L	Max of 4.5 Alk, mg CaCO3/L	Min of 4.5 Alk, mg CaCO3/L	StdDev of 4.5 Alk, mg CaCO3/L	Count of 4.5 Alk, mg CaCO3/L
1	SJR at Channel Point	75.50	76.00	75.00	0.71	2
2	SJR at Dos Reis Lathrop	82.00	82.00	82.00	0.00	2
3	SJR at Old River	83.00	84.00	82.00	1.41	2
4	SJR at Mossdale	81.33	129.00	29.00	30.89	64
5	SJR at Vernalis	82.60	130.00	27.00	30.45	70
6	SJR at Maze	102.23	168.00	28.00	43.06	69
7	SJR at Patterson	119.90	186.60	27.00	46.97	72
8	SJR at Crows Landing	119.42	202.00	26.00	44.26	79
9	SJR at Fremont Ford	157.23	180.40	145.90	15.89	4
10	SJR at Lander Avenue	146.30	248.00	18.00	61.31	82
11	French Camp Slough	78.36	119.00	39.00	31.13	7
12	Stanislaus River at Caswell Park	36.43	56.60	22.00	6.49	65
13	Stanislaus River at Ripon	43.00	43.00	43.00	na	1
14	Tuolumne River at Shiloh Bridge	49.39	178.40	18.00	25.96	65
16	Merced River at River Road	43.04	124.00	16.00	23.69	66
17	Merced River near Stevinson	17.00	17.00	17.00	na	1
18	Mud Slough near Gustine	169.00	308.00	80.60	60.14	75
19	Salt Slough at Lander Avenue	158.55	254.00	104.00	32.56	102
20	Los Banos Creek at Highway 140	239.21	544.00	0.00	94.64	65
21	Orestimba Creek at River Road	134.33	232.00	42.00	47.06	59
22	Modesto ID Lateral 4 to SJR	86.07	268.40	21.00	94.45	6
23	Modesto ID Lateral 5 to Tuolumne	36.03	160.00	15.00	30.20	29
24	Modesto ID Lateral 6 to Stanislaus River	25.50	27.00	24.00	2.12	2
25	MID Main Drain to Stan. R. via Miller Lake	132.09	405.00	77.00	58.53	39
26	Turlock ID Highline Spill	17.80	18.60	17.00	1.13	2
27	Turlock ID Lateral 2 to SJR	41.78	65.00	19.00	20.18	4
28	Turlock ID Westport Drain Flow Station	199.01	361.00	47.00	87.30	50
29	Turlock ID Harding Drain	141.73	225.00	60.00	38.98	64
30	Turlock ID Lateral 6 & 7 at Levee	150.59	286.00	80.00	49.99	35
31	BCID - New Jerusalem Drain	308.62	324.00	292.00	11.38	9
32	El Solyo WD - Grayson Drain	127.80	185.00	90.00	39.59	5
33	Hospital Creek	84.29	133.00	36.00	23.68	17
34	Ingram Creek Flow Station	139.62	262.00	27.10	50.40	44
35	Westley Wasteway Flow Station	90.14	115.00	74.00	13.56	7
36	Del Puerto Creek Flow Station	141.10	388.00	64.00	65.10	58
38	Marshall Road Drain	114.38	174.60	73.00	35.12	8
39	Salado Creek Flow Station	164.25	185.00	144.40	19.60	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	136.07	226.00	61.40	45.52	72
45	Volta Wasteway at Ingomar Grade	177.82	336.00	75.00	101.91	11
46	Mud Slough at Gun Club Road	271.73	438.00	185.00	93.60	11
47	Delta-Mendota Cal Hwy 140	68.20	76.00	62.00	7.14	3
48	FC-5 Grasslands Area Farmers	185.00	198.00	172.00	18.38	2
49	PE-14-Grasslands Area Farmers	152.00	162.00	142.00	14.14	2
50	San Luis Drain Site A (Check 18)	175.05	182.00	169.00	5.45	4
51	Arroyo Cal at Hwy 152	118.25	120.50	116.00	3.18	2
52	Salt Slough at Sand Dam	136.67	154.00	120.00	17.01	3
53	Salt Slough at Wolfsen Road	168.12	369.00	117.00	47.23	30
57	Ramona Lake Drain at Levee	178.78	252.00	135.00	29.00	30
59	SJR Laird Park	100.61	166.00	36.00	30.75	22
60	Moffit 1 South	163.09	256.00	117.00	46.98	18
61	Deadman's Slough	167.78	290.00	83.00	54.30	23
62	Mallard Slough	245.60	782.00	90.00	137.73	23
63	Inlet C Canal	114.84	250.00	65.00	39.79	26

DO site number	Site name	Average of 4.5 Alk, mg CaCO3/L	Max of 4.5 Alk, mg CaCO3/L	Min of 4.5 Alk, mg CaCO3/L	StdDev of 4.5 Alk, mg CaCO3/L	Count of 4.5 Alk, mg CaCO3/L
64	Moran Drain	138.97	196.00	81.00	57.39	6
65	Spanish Grant Drain	168.11	250.00	102.00	56.13	7
66	ESWD Maze Blv. Drain	79.00	82.00	74.00	3.83	4
67	Newman Wasteway at Brazo Road	257.63	412.00	82.40	111.48	7
68	S. Lake Basin	323.60	454.00	188.00	125.53	5
69	Santa Fe Canal	97.00	97.00	97.00	na	1
80	South Marsh 1 Inlet	107.88	151.60	75.00	26.26	18
81	South Marsh 1 Outlet	123.19	194.00	79.00	28.66	20
82	South Marsh 3 Inlet	128.98	208.60	78.00	38.93	25
83	South Marsh 3 Outlet	133.01	204.40	74.60	42.20	28
84	SJR Garwood Bridge	81.00	81.00	81.00	na	1
86	Ramona Drain Apple Ave	162.11	193.60	118.00	27.39	9
87	Ramona Drain Prune Ave	98.00	111.00	87.00	12.12	3
88	Ramona Drain Apricot Ave	164.57	203.60	72.00	43.35	9
89	Ramona Drain Pomelo Ave	153.33	230.00	100.00	68.07	3
90	Ramona Drain Almond Ave	176.00	176.00	176.00	na	1
91	Paradise Drain Prune Ave	80.00	80.00	80.00	na	1
92	Paradise Drain Apricot Ave	183.56	329.00	105.00	72.10	7
93	Paradise Drain Pomelo Ave	196.33	335.00	104.00	122.27	3
94	Paradise Drain Almond Ave	185.86	338.00	99.00	74.97	7
95	Ramona Lake Entrance	198.59	272.00	137.40	38.02	17
96	WPF-VD-1	64.00	64.00	64.00	na	1
97	WPF-VD-2	64.00	64.00	64.00	na	1
98	WPF-VD-3	106.00	106.00	106.00	na	1
101	WPF-UD-IN	87.00	110.00	64.00	32.53	2
102	WPF-UD-OUT	91.84	116.67	67.00	35.12	2
103	SLD Check 18	177.00	178.00	176.00	1.41	2
104	SLD Check 16	163.50	166.00	161.00	3.54	2
105	SLD Check 15	162.00	165.00	159.00	4.24	2
106	SLD Check 14	154.00	156.00	152.00	2.83	2
107	SLD Check 13	159.20	163.40	155.00	5.94	2
108	SLD Check 12	163.80	166.00	161.60	3.11	2
109	SLD Check 11	153.00	165.00	141.00	16.97	2
110	SLD Check 10	127.00	134.00	120.00	9.90	2
111	SLD Check 9	133.00	151.00	115.00	25.46	2
112	SLD Check 8	140.20	146.00	134.40	8.20	2
113	SLD Check 7	144.15	148.00	140.30	5.44	2
114	SLD Check 6	133.00	137.00	129.00	5.66	2
115	SLD Check 5	114.50	117.00	112.00	3.54	2
116	SLD Check 4	108.00	120.00	96.00	16.97	2
117	SLD Check 3	110.70	118.40	103.00	10.89	2
118	SLD Check 2	102.20	109.40	95.00	10.18	2
119	SLD Check 1	104.00	114.00	94.00	14.14	2
120	South Marsh 1 Intermediary	108.74	137.10	74.00	25.15	11
121	South Marsh 1 East	115.81	198.00	76.00	37.15	10
122	South Marsh 1 West	157.96	186.00	107.00	26.45	9
123	Ramona Lake NW Quad	169.00	180.00	158.00	15.56	2
124	Ramona Lake NE Quad	184.00	226.00	160.00	36.50	3
125	Ramona Lake SW Quad	180.00	180.00	180.00	na	1
126	Ramona Lake SE Quad	186.00	186.00	186.00	na	1
129	Hollow Tree drain	470.33	499.00	428.00	37.42	3
130	Marshall Rd Reservoir Entrance	118.09	151.60	85.40	26.26	7
131	Marshall Rd Reservoir Exit	133.54	160.40	113.00	16.68	7
132	Marshall Rd Res Pond 1W	121.48	142.00	102.40	17.89	5
133	Marshall Rd Res Pond 2E	124.52	146.00	99.00	19.20	5
135	Modesto ID Main Drain Spill	89.37	119.40	61.60	23.48	6

pH 8.3 Alkalinity

DO site number	Site name	Average of 8.3 Alk, mg CaCO3/L	Max of 8.3 Alk, mg CaCO3/L	Min of 8.3 Alk, mg CaCO3/L	StdDev of 8.3 Alk, mg CaCO3/L	Count of 8.3 Alk, mg CaCO3/L
1	SJR at Channel Point	0.00	0.00	0.00	0.00	2
2	SJR at Dos Reis Lathrop	6.00	8.00	4.00	2.83	2
3	SJR at Old River	5.00	7.00	3.00	2.83	2
4	SJR at Mossdale	1.99	15.60	0.00	4.14	64
5	SJR at Vernalis	0.95	15.20	0.00	2.69	70
6	SJR at Maze	1.00	15.40	0.00	2.68	68
7	SJR at Patterson	0.75	11.00	0.00	2.07	72
8	SJR at Crows Landing	0.33	6.40	0.00	1.10	78
9	SJR at Fremont Ford	0.00	0.00	0.00	0.00	4
10	SJR at Lander Avenue	3.93	22.00	0.00	5.74	81
11	French Camp Slough	0.00	0.00	0.00	0.00	7
12	Stanislaus River at Caswell Park	0.00	0.00	0.00	0.00	65
13	Stanislaus River at Ripon	0.00	0.00	0.00	na	1
14	Tuolumne River at Shiloh Bridge	0.00	0.00	0.00	0.00	64
16	Merced River at River Road	0.00	0.00	0.00	0.00	65
17	Merced River near Stevinson	0.00	0.00	0.00	na	1
18	Mud Slough near Gustine	2.50	18.00	0.00	4.24	75
19	Salt Slough at Lander Avenue	0.10	8.00	0.00	0.82	101
20	Los Banos Creek at Highway 140	0.18	12.00	0.00	1.49	65
21	Orestimba Creek at River Road	0.41	14.00	0.00	2.11	58
22	Modesto ID Lateral 4 to SJR	0.83	2.00	0.00	0.98	6
23	Modesto ID Lateral 5 to Tuolumne	0.96	12.00	0.00	2.92	29
24	Modesto ID Lateral 6 to Stanislaus River	0.00	0.00	0.00	0.00	2
25	MID Main Drain to Stan. R. via Miller Lake	0.38	7.00	0.00	1.48	39
26	Turlock ID Highline Spill	0.00	0.00	0.00	0.00	2
27	Turlock ID Lateral 2 to SJR	0.30	1.18	0.00	0.59	4
28	Turlock ID Westport Drain Flow Station	0.72	8.00	0.00	1.90	50
29	Turlock ID Harding Drain	0.05	2.00	0.00	0.28	64
30	Turlock ID Lateral 6 & 7 at Levee	0.33	4.60	0.00	1.12	35
31	BCID - New Jerusalem Drain	0.00	0.00	0.00	0.00	9
32	El Solyo WD - Grayson Drain	1.00	4.00	0.00	1.73	5
33	Hospital Creek	0.18	1.50	0.00	0.50	17
34	Ingram Creek Flow Station	0.25	6.00	0.00	1.04	44
35	Westley Wasteway Flow Station	7.57	15.00	0.00	6.08	7
36	Del Puerto Creek Flow Station	1.09	22.00	0.00	3.39	57
38	Marshall Road Drain	0.00	0.00	0.00	0.00	8
39	Salado Creek Flow Station	0.00	0.00	0.00	0.00	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	8.95	23.40	0.00	6.52	72
45	Volta Wasteway at Ingomar Grade	0.00	0.00	0.00	0.00	11
46	Mud Slough at Gun Club Road	0.55	6.00	0.00	1.81	11
47	Delta-Mendota Cal Hwy 140	0.00	0.00	0.00	0.00	3
48	FC-5 Grasslands Area Farmers	10.00	14.00	6.00	5.66	2
49	PE-14-Grasslands Area Farmers	14.00	16.00	12.00	2.83	2
50	San Luis Drain Site A (Check 18)	2.30	8.00	0.00	3.84	4
51	Arroyo Cal at Hwy 152	0.00	0.00	0.00	0.00	2
52	Salt Slough at Sand Dam	0.00	0.00	0.00	0.00	3
53	Salt Slough at Wolfsen Road	0.07	2.00	0.00	0.37	30
57	Ramona Lake Drain at Levee	2.35	29.00	0.00	6.12	30
59	SJR Laird Park	0.00	0.00	0.00	0.00	22
60	Moffit 1 South	0.00	0.00	0.00	0.00	18
61	Deadman's Slough	0.22	5.00	0.00	1.04	23
62	Mallard Slough	0.26	5.00	0.00	1.05	23
63	Inlet C Canal	0.00	0.00	0.00	0.00	26
64	Moran Drain	0.00	0.00	0.00	0.00	6
65	Spanish Grant Drain	0.43	3.00	0.00	1.13	7
66	ESWD Maze Blv. Drain	2.75	8.00	0.00	3.77	4
67	Newman Wasteway at Brazo Road	0.00	0.00	0.00	0.00	7
68	S. Lake Basin	0.00	0.00	0.00	0.00	5

DO site number	Site name	Average of 8.3 Alk, mg CaCO3/L	Max of 8.3 Alk, mg CaCO3/L	Min of 8.3 Alk, mg CaCO3/L	StdDev of 8.3 Alk, mg CaCO3/L	Count of 8.3 Alk, mg CaCO3/L
69	Santa Fe Canal	0.00	0.00	0.00	na	1
80	South Marsh 1 Inlet	0.12	2.20	0.00	0.52	18
81	South Marsh 1 Outlet	0.30	6.00	0.00	1.34	20
82	South Marsh 3 Inlet	0.00	0.00	0.00	0.00	25
83	South Marsh 3 Outlet	0.50	14.00	0.00	2.65	28
84	SJR Garwood Bridge	0.00	0.00	0.00	na	1
86	Ramona Drain Apple Ave	0.00	0.00	0.00	0.00	9
87	Ramona Drain Prune Ave	0.00	0.00	0.00	0.00	3
88	Ramona Drain Apricot Ave	0.00	0.00	0.00	0.00	9
89	Ramona Drain Pomelo Ave	0.00	0.00	0.00	0.00	3
90	Ramona Drain Almond Ave	0.00	0.00	0.00	na	1
91	Paradise Drain Prune Ave	0.00	0.00	0.00	na	1
92	Paradise Drain Apricot Ave	1.57	11.00	0.00	4.16	7
93	Paradise Drain Pomelo Ave	0.00	0.00	0.00	0.00	3
94	Paradise Drain Almond Ave	0.00	0.00	0.00	0.00	7
95	Ramona Lake Entrance	0.00	0.00	0.00	0.00	17
96	WPF-VD-1	0.00	0.00	0.00	na	1
97	WPF-VD-2	0.00	0.00	0.00	na	1
98	WPF-VD-3	0.00	0.00	0.00	na	1
101	WPF-UD-IN	0.00	0.00	0.00	0.00	2
102	WPF-UD-OUT	0.00	0.00	0.00	0.00	2
103	SLD Check 18	0.00	0.00	0.00	0.00	2
104	SLD Check 16	1.80	3.60	0.00	2.55	2
105	SLD Check 15	2.00	4.00	0.00	2.83	2
106	SLD Check 14	5.00	6.00	4.00	1.41	2
107	SLD Check 13	7.00	10.00	4.00	4.24	2
108	SLD Check 12	3.20	3.40	3.00	0.28	2
109	SLD Check 11	7.70	12.40	3.00	6.65	2
110	SLD Check 10	8.00	10.00	6.00	2.83	2
111	SLD Check 9	7.20	8.40	6.00	1.70	2
112	SLD Check 8	9.20	9.40	9.00	0.28	2
113	SLD Check 7	6.50	10.00	3.00	4.95	2
114	SLD Check 6	7.00	8.00	6.00	1.41	2
115	SLD Check 5	12.30	14.00	10.60	2.40	2
116	SLD Check 4	14.50	17.00	12.00	3.54	2
117	SLD Check 3	16.00	24.00	8.00	11.31	2
118	SLD Check 2	13.30	14.00	12.60	0.99	2
119	SLD Check 1	15.80	22.00	9.60	8.77	2
120	South Marsh 1 Intermediary	0.27	3.00	0.00	0.90	11
121	South Marsh 1 East	0.00	0.00	0.00	0.00	10
122	South Marsh 1 West	0.00	0.00	0.00	0.00	9
123	Ramona Lake NW Quad	18.00	18.00	18.00	0.00	2
124	Ramona Lake NE Quad	8.33	25.00	0.00	14.43	3
125	Ramona Lake SW Quad	16.00	16.00	16.00	na	1
126	Ramona Lake SE Quad	14.00	14.00	14.00	na	1
129	Hollow Tree drain	0.00	0.00	0.00	0.00	3
130	Marshall Rd Reservoir Entrance	0.00	0.00	0.00	0.00	7
131	Marshall Rd Reservoir Exit	6.06	13.00	0.00	4.89	7
132	Marshall Rd Res Pond 1W	0.40	2.00	0.00	0.89	5
133	Marshall Rd Res Pond 2E	0.00	0.00	0.00	0.00	5
135	Modesto ID Main Drain Spill	0.00	0.00	0.00	0.00	6

Biochemical Oxygen Demand (10 day)

DO site number	Site name	Average of BOD10	Max of BOD10	Min of BOD10	StdDev of BOD10	Count of BOD10
1	SJR at Channel Point	4.990	5.850	4.130	1.216	2.000
2	SJR at Dos Reis Lathrop	6.283	6.560	6.005	0.392	2.000
3	SJR at Old River	5.950	6.350	5.550	0.566	2.000
4	SJR at Mossdale	3.637	11.310	0.955	2.999	60.000
5	SJR at Vernalis	3.584	15.810	0.880	2.710	64.000
6	SJR at Maze	3.655	10.710	1.070	2.540	62.000
7	SJR at Patterson	4.904	14.190	1.510	2.837	65.000
8	SJR at Crows Landing	3.877	11.370	1.390	2.118	70.000
9	SJR at Fremont Ford	6.874	12.360	3.695	3.287	5.000
10	SJR at Lander Avenue	7.924	21.060	1.130	5.339	71.000
11	French Camp Slough	2.386	5.040	0.830	1.830	7.000
12	Stanislaus River at Caswell Park	1.159	4.310	0.000	0.728	61.000
13	Stanislaus River at Ripon	0.700	0.700	0.700	na	1.000
14	Tuolumne River at Shiloh Bridge	1.297	3.895	0.195	0.906	63.000
16	Merced River at River Road	1.507	6.520	0.550	1.070	62.000
17	Merced River near Stevinson	0.680	0.680	0.680	na	1.000
18	Mud Slough near Gustine	8.512	16.710	2.330	3.721	69.000
19	Salt Slough at Lander Avenue	3.413	6.855	1.530	1.186	90.000
20	Los Banos Creek at Highway 140	10.478	34.300	2.710	6.419	64.000
21	Orestimba Creek at River Road	2.857	11.500	0.836	1.873	53.000
22	Modesto ID Lateral 4 to SJR	2.397	3.600	1.790	0.660	6.000
23	Modesto ID Lateral 5 to Tuolumne	2.172	10.230	0.670	2.170	29.000
24	Modesto ID Lateral 6 to Stanislaus River	5.615	5.615	5.615	na	1.000
25	MID Main Drain to Stan. R. via Miller Lake	6.475	17.700	2.950	3.816	37.000
26	Turlock ID Highline Spill	0.810	0.810	0.810	na	1.000
27	Turlock ID Lateral 2 to SJR	1.397	1.480	1.280	0.104	3.000
28	Turlock ID Westport Drain Flow Station	2.240	13.350	0.610	1.915	44.000
29	Turlock ID Harding Drain	4.625	16.020	1.470	2.509	58.000
30	Turlock ID Lateral 6 & 7 at Levee	2.889	8.430	0.890	1.970	30.000
31	BCID - New Jerusalem Drain	0.446	0.900	0.000	0.320	8.000
32	El Solyo WD - Grayson Drain	11.270	12.270	9.960	1.186	3.000
33	Hospital Creek	9.658	22.950	0.920	7.523	16.000
34	Ingram Creek Flow Station	7.650	22.710	0.700	5.612	37.000
35	Westley Wasteway Flow Station	6.476	16.830	0.790	5.641	6.000
36	Del Puerto Creek Flow Station	6.057	23.610	0.840	4.806	50.000
38	Marshall Road Drain	9.824	19.410	2.510	6.270	6.000
39	Salado Creek Flow Station	18.688	35.600	4.935	15.575	3.000
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	12.096	20.790	2.000	5.471	66.000
45	Volta Wasteway at Ingomar Grade	2.038	5.040	0.730	1.373	10.000
46	Mud Slough at Gun Club Road	7.655	14.520	3.880	3.818	10.000
47	Delta-Mendota Cal Hwy 140	1.248	1.515	0.990	0.263	3.000
48	FC-5 Grasslands Area Farmers	18.420	18.420	18.420	na	1.000
49	PE-14-Grasslands Area Farmers	6.550	6.550	6.550	na	1.000
50	San Luis Drain Site A (Check 18)	5.243	5.980	4.505	1.043	2.000
51	Arroyo Cal at Hwy 152	7.540	7.540	7.540	na	1.000
52	Salt Slough at Sand Dam	5.913	6.175	5.650	0.371	2.000
53	Salt Slough at Wolfsen Road	4.029	7.225	2.230	1.329	26.000
57	Ramona Lake Drain at Levee	16.515	30.700	2.990	7.039	24.000
59	SJR Laird Park	3.860	6.815	2.090	1.313	22.000
60	Moffit 1 South	4.273	14.400	1.170	3.403	17.000
61	Deadman's Slough	5.320	19.100	1.300	4.919	21.000
62	Mallard Slough	3.523	11.550	0.420	2.945	20.000
63	Inlet C Canal	2.424	7.020	0.915	1.507	24.000

DO site number	Site name	Average of BOD10	Max of BOD10	Min of BOD10	StdDev of BOD10	Count of BOD10
64	Moran Drain	5.114	9.510	1.425	4.008	4.000
65	Spanish Grant Drain	7.322	12.000	1.660	4.512	5.000
66	ESWD Maze Blv. Drain	3.042	6.115	1.490	2.662	3.000
67	Newman Wasteway at Brazo Road	4.783	11.520	2.380	3.358	6.000
68	S. Lake Basin	8.584	19.350	1.440	7.189	5.000
69	Santa Fe Canal	2.570	2.570	2.570	na	1.000
80	South Marsh 1 Inlet	2.341	5.385	1.100	1.349	16.000
81	South Marsh 1 Outlet	5.611	35.600	1.410	7.819	18.000
82	South Marsh 3 Inlet	6.763	18.990	2.300	4.589	21.000
83	South Marsh 3 Outlet	6.962	25.500	1.590	5.837	24.000
84	SJR Garwood Bridge	6.420	6.420	6.420	na	1.000
86	Ramona Drain Apple Ave	16.024	32.100	4.100	8.639	8.000
87	Ramona Drain Prune Ave	7.495	13.740	3.585	5.465	3.000
88	Ramona Drain Apricot Ave	15.185	24.000	5.764	8.186	9.000
89	Ramona Drain Pomelo Ave	12.700	21.450	4.770	8.370	3.000
90	Ramona Drain Almond Ave	4.605	4.605	4.605	na	1.000
91	Paradise Drain Prune Ave	13.350	13.350	13.350	na	1.000
92	Paradise Drain Apricot Ave	8.953	14.940	5.225	3.104	7.000
93	Paradise Drain Pomelo Ave	8.212	13.470	4.115	4.784	3.000
94	Paradise Drain Almond Ave	8.496	17.430	5.175	4.212	7.000
95	Ramona Lake Entrance	13.013	19.920	8.560	4.141	13.000
96	WPF-VD-1	22.740	22.740	22.740	na	1.000
97	WPF-VD-2	21.330	21.330	21.330	na	1.000
98	WPF-VD-3	21.120	21.120	21.120	na	1.000
101	WPF-UD-IN	12.735	19.920	5.550	10.161	2.000
102	WPF-UD-OUT	11.175	19.800	2.550	12.198	2.000
103	SLD Check 18	4.955	4.955	4.955	na	1.000
104	SLD Check 16	4.855	4.855	4.855	na	1.000
105	SLD Check 15	5.415	5.415	5.415	na	1.000
106	SLD Check 14	7.520	7.520	7.520	na	1.000
107	SLD Check 13	9.390	9.390	9.390	na	1.000
108	SLD Check 12	9.660	9.660	9.660	na	1.000
109	SLD Check 11	10.320	10.320	10.320	na	1.000
110	SLD Check 10	11.340	11.340	11.340	na	1.000
111	SLD Check 9	12.750	12.750	12.750	na	1.000
112	SLD Check 8	13.770	13.770	13.770	na	1.000
113	SLD Check 7	11.670	11.670	11.670	na	1.000
114	SLD Check 6	13.980	13.980	13.980	na	1.000
115	SLD Check 5	14.340	14.340	14.340	na	1.000
116	SLD Check 4	19.410	19.410	19.410	na	1.000
117	SLD Check 3	18.870	18.870	18.870	na	1.000
118	SLD Check 2	20.460	20.460	20.460	na	1.000
119	SLD Check 1	22.650	22.650	22.650	na	1.000
120	South Marsh 1 Intermediary	2.104	4.905	0.950	1.222	10.000
121	South Marsh 1 East	5.543	14.730	1.080	4.445	9.000
122	South Marsh 1 West	7.925	18.300	2.780	4.916	9.000
123	Ramona Lake NW Quad	41.000	51.000	31.000	14.142	2.000
124	Ramona Lake NE Quad	13.355	14.305	12.405	1.344	2.000
125	Ramona Lake SW Quad	26.500	26.500	26.500	na	1.000
126	Ramona Lake SE Quad	34.000	34.000	34.000	na	1.000
129	Hollow Tree drain	7.260	8.850	5.130	1.918	3.000
130	Marshall Rd Reservoir Entrance	4.037	4.545	3.140	0.652	5.000
131	Marshall Rd Reservoir Exit	7.175	19.440	2.930	6.955	5.000
132	Marshall Rd Res Pond 1W	5.052	6.370	4.355	1.142	3.000
133	Marshall Rd Res Pond 2E	4.633	5.540	4.110	0.788	3.000
135	Modesto ID Main Drain Spill	4.210	6.220	2.870	1.367	5.000

Carbonaceous Biochemical Oxygen Demand (CBOD, 10 day)

DO site number	Site name	Average of CBOD10	Max of CBOD10	Min of CBOD10	StdDev of CBOD10	Count of CBOD10
1	SJR at Channel Point	2.918	3.545	2.290	0.887	2.000
2	SJR at Dos Reis Lathrop	4.643	5.105	4.180	0.654	2.000
3	SJR at Old River	4.420	4.540	4.300	0.170	2.000
4	SJR at Mossdale	2.245	7.210	0.310	1.782	60.000
5	SJR at Vernalis	2.466	14.340	0.300	2.233	64.000
6	SJR at Maze	2.361	6.365	0.510	1.573	62.000
7	SJR at Patterson	3.429	8.485	0.810	2.029	65.000
8	SJR at Crows Landing	2.581	6.755	0.910	1.374	70.000
9	SJR at Fremont Ford	4.015	6.640	2.285	1.784	5.000
10	SJR at Lander Avenue	6.142	18.060	0.980	4.394	73.000
11	French Camp Slough	1.350	2.740	0.000	1.096	7.000
12	Stanislaus River at Caswell Park	0.728	1.840	0.000	0.402	61.000
13	Stanislaus River at Ripon	0.190	0.190	0.190	na	1.000
14	Tuolumne River at Shiloh Bridge	0.847	2.965	0.020	0.656	63.000
16	Merced River at River Road	1.027	3.415	0.090	0.707	62.000
17	Merced River near Stevinson	0.140	0.140	0.140	na	1.000
18	Mud Slough near Gustine	6.439	14.460	1.440	3.471	69.000
19	Salt Slough at Lander Avenue	2.020	5.360	0.660	0.821	90.000
20	Los Banos Creek at Highway 140	7.046	25.300	1.075	4.882	64.000
21	Orestimba Creek at River Road	1.726	8.515	0.314	1.229	53.000
22	Modesto ID Lateral 4 to SJR	1.810	3.430	1.010	0.850	6.000
23	Modesto ID Lateral 5 to Tuolumne	1.297	4.600	0.125	0.962	29.000
24	Modesto ID Lateral 6 to Stanislaus River	1.010	1.010	1.010	na	1.000
25	MID Main Drain to Stan. R. via Miller Lake	4.005	17.040	1.510	3.016	37.000
26	Turlock ID Highline Spill	0.170	0.170	0.170	na	1.000
27	Turlock ID Lateral 2 to SJR	1.033	1.040	1.030	0.006	3.000
28	Turlock ID Westport Drain Flow Station	1.495	9.030	0.000	1.378	44.000
29	Turlock ID Harding Drain	2.716	7.895	0.000	1.321	58.000
30	Turlock ID Lateral 6 & 7 at Levee	1.922	7.920	0.000	1.749	30.000
31	BCID - New Jerusalem Drain	0.329	0.780	0.000	0.303	8.000
32	El Solyo WD - Grayson Drain	6.564	7.645	4.420	1.491	4.000
33	Hospital Creek	7.796	22.770	0.590	7.489	16.000
34	Ingram Creek Flow Station	3.566	8.640	0.440	2.319	38.000
35	Westley Wasteway Flow Station	3.753	10.620	0.850	3.693	6.000
36	Del Puerto Creek Flow Station	3.168	23.340	0.350	3.536	50.000
38	Marshall Road Drain	6.897	11.700	1.700	4.059	6.000
39	Salado Creek Flow Station	14.343	27.000	2.960	12.070	3.000
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	10.454	23.730	0.360	5.561	67.000
45	Volta Wasteway at Ingomar Grade	1.434	4.440	0.360	1.238	10.000
46	Mud Slough at Gun Club Road	5.047	13.110	2.090	3.767	10.000
47	Delta-Mendota Cal Hwy 140	0.478	0.615	0.300	0.162	3.000
48	FC-5 Grasslands Area Farmers	13.560	13.560	13.560	na	1.000
49	PE-14-Grasslands Area Farmers	5.425	5.425	5.425	na	1.000
50	San Luis Drain Site A (Check 18)	4.158	5.045	3.270	1.255	2.000
51	Arroyo Cal at Hwy 152	3.855	3.855	3.855	na	1.000
52	Salt Slough at Sand Dam	2.625	3.920	1.330	1.831	2.000
53	Salt Slough at Wolfsen Road	2.269	5.380	0.330	0.981	26.000
57	Ramona Lake Drain at Levee	11.934	23.430	1.660	5.536	25.000
59	SJR Laird Park	2.734	5.325	1.210	1.281	22.000
60	Moffit 1 South	3.606	11.700	0.670	2.891	17.000
61	Deadman's Slough	3.933	17.150	0.840	4.437	21.000
62	Mallard Slough	2.668	11.550	0.420	2.598	20.000
63	Inlet C Canal	1.273	3.095	0.470	0.648	24.000

DO site number	Site name	Average of CBOD10	Max of CBOD10	Min of CBOD10	StdDev of CBOD10	Count of CBOD10
64	Moran Drain	3.951	7.130	0.930	3.234	4.000
65	Spanish Grant Drain	4.561	7.130	1.230	2.780	5.000
66	ESWD Maze Blv. Drain	2.242	4.435	1.140	1.899	3.000
67	Newman Wasteway at Brazo Road	2.889	5.560	1.450	1.403	6.000
68	S. Lake Basin	6.464	16.140	0.740	6.274	5.000
69	Santa Fe Canal	1.880	1.880	1.880	na	1.000
80	South Marsh 1 Inlet	1.550	4.835	0.595	1.128	16.000
81	South Marsh 1 Outlet	4.353	23.460	0.250	5.534	18.000
82	South Marsh 3 Inlet	5.227	14.550	1.290	3.578	21.000
83	South Marsh 3 Outlet	6.748	25.560	1.440	6.372	25.000
84	SJR Garwood Bridge	5.150	5.150	5.150	na	1.000
86	Ramona Drain Apple Ave	9.537	16.080	2.130	4.413	9.000
87	Ramona Drain Prune Ave	4.712	6.145	2.050	2.307	3.000
88	Ramona Drain Apricot Ave	9.072	18.520	2.630	5.785	9.000
89	Ramona Drain Pomelo Ave	7.007	9.420	5.640	2.096	3.000
90	Ramona Drain Almond Ave	4.550	4.550	4.550	na	1.000
91	Paradise Drain Prune Ave	10.320	10.320	10.320	na	1.000
92	Paradise Drain Apricot Ave	7.046	12.270	4.240	2.557	7.000
93	Paradise Drain Pomelo Ave	5.728	7.530	3.488	2.056	3.000
94	Paradise Drain Almond Ave	4.956	7.260	3.310	1.621	7.000
95	Ramona Lake Entrance	8.165	15.210	4.395	3.425	13.000
96	WPF-VD-1	12.960	12.960	12.960	na	1.000
97	WPF-VD-2	16.710	16.710	16.710	na	1.000
98	WPF-VD-3	23.910	23.910	23.910	na	1.000
101	WPF-UD-IN	6.985	12.630	1.340	7.983	2.000
102	WPF-UD-OUT	9.915	12.810	7.020	4.094	2.000
103	SLD Check 18	3.870	3.870	3.870	na	1.000
104	SLD Check 16	3.775	3.775	3.775	na	1.000
105	SLD Check 15	4.450	4.450	4.450	na	1.000
106	SLD Check 14	5.990	5.990	5.990	na	1.000
107	SLD Check 13	7.355	7.355	7.355	na	1.000
108	SLD Check 12	8.030	8.030	8.030	na	1.000
109	SLD Check 11	8.340	8.340	8.340	na	1.000
110	SLD Check 10	8.370	8.370	8.370	na	1.000
111	SLD Check 9	11.100	11.100	11.100	na	1.000
112	SLD Check 8	11.100	11.100	11.100	na	1.000
113	SLD Check 7	10.080	10.080	10.080	na	1.000
114	SLD Check 6	10.770	10.770	10.770	na	1.000
115	SLD Check 5	11.310	11.310	11.310	na	1.000
116	SLD Check 4	17.550	17.550	17.550	na	1.000
117	SLD Check 3	16.500	16.500	16.500	na	1.000
118	SLD Check 2	18.600	18.600	18.600	na	1.000
119	SLD Check 1	21.330	21.330	21.330	na	1.000
120	South Marsh 1 Intermediary	1.164	2.590	0.450	0.691	10.000
121	South Marsh 1 East	4.364	11.295	1.060	3.845	9.000
122	South Marsh 1 West	6.256	12.490	2.320	3.687	9.000
123	Ramona Lake NW Quad	36.100	45.100	27.100	12.728	2.000
124	Ramona Lake NE Quad	8.445	9.090	7.800	0.912	2.000
125	Ramona Lake SW Quad	20.500	20.500	20.500	na	1.000
126	Ramona Lake SE Quad	21.200	21.200	21.200	na	1.000
129	Hollow Tree drain	4.897	5.675	4.305	0.704	3.000
130	Marshall Rd Reservoir Entrance	2.233	3.075	1.840	0.490	5.000
131	Marshall Rd Reservoir Exit	4.306	11.130	1.320	3.912	5.000
132	Marshall Rd Res Pond 1W	2.738	3.515	1.860	0.832	3.000
133	Marshall Rd Res Pond 2E	2.527	2.955	1.770	0.657	3.000
135	Modesto ID Main Drain Spill	2.216	3.870	1.200	1.179	5.000

Nitrogeneous Biochemical Oxygen Demand (NBOD, 10 day)

DO site number	Site name	Average of NBOD10	Max of NBOD10	Min of NBOD10	StdDev of NBOD10	Count of NBOD10
1	SJR at Channel Point	2.073	2.305	1.840	0.329	2.000
2	SJR at Dos Reis Lathrop	1.640	1.825	1.455	0.262	2.000
3	SJR at Old River	1.530	1.810	1.250	0.396	2.000
4	SJR at Mossdale	1.400	5.905	0.000	1.452	59.000
5	SJR at Vernalis	1.122	4.855	0.000	0.894	64.000
6	SJR at Maze	1.296	5.115	0.000	1.143	62.000
7	SJR at Patterson	1.475	5.850	0.160	1.160	65.000
8	SJR at Crows Landing	1.296	4.825	0.180	0.980	70.000
9	SJR at Fremont Ford	2.859	5.720	1.410	1.675	5.000
10	SJR at Lander Avenue	2.032	7.460	0.150	1.652	71.000
11	French Camp Slough	1.018	2.470	0.075	0.959	6.000
12	Stanislaus River at Caswell Park	0.400	2.140	0.000	0.411	60.000
13	Stanislaus River at Ripon	0.510	0.510	0.510	na	1.000
14	Tuolumne River at Shiloh Bridge	0.446	1.927	-0.005	0.424	62.000
16	Merced River at River Road	0.483	4.310	0.000	0.653	62.000
17	Merced River near Stevinson	0.540	0.540	0.540	na	1.000
18	Mud Slough near Gustine	2.073	5.790	0.360	1.128	69.000
19	Salt Slough at Lander Avenue	1.408	3.350	0.000	0.697	89.000
20	Los Banos Creek at Highway 140	3.432	13.600	0.835	2.562	64.000
21	Orestimba Creek at River Road	1.135	4.980	0.000	1.019	52.000
22	Modesto ID Lateral 4 to SJR	0.587	1.080	0.170	0.394	6.000
23	Modesto ID Lateral 5 to Tuolumne	0.875	5.630	0.070	1.316	29.000
24	Modesto ID Lateral 6 to Stanislaus River	4.605	4.605	4.605	na	1.000
25	MID Main Drain to Stan. R. via Miller Lake	2.470	13.795	0.660	2.154	37.000
26	Turlock ID Highline Spill	0.640	0.640	0.640	na	1.000
27	Turlock ID Lateral 2 to SJR	0.363	0.450	0.240	0.110	3.000
28	Turlock ID Westport Drain Flow Station	0.688	4.320	0.000	0.748	41.000
29	Turlock ID Harding Drain	1.882	8.125	0.290	1.546	57.000
30	Turlock ID Lateral 6 & 7 at Levee	0.965	3.090	0.090	0.691	29.000
31	BCID - New Jerusalem Drain	0.184	0.590	0.000	0.253	8.000
32	El Solyo WD - Grayson Drain	3.992	5.590	2.315	1.639	3.000
33	Hospital Creek	1.962	6.390	0.000	1.962	16.000
34	Ingram Creek Flow Station	4.215	17.150	0.000	4.059	37.000
35	Westley Wasteway Flow Station	2.733	6.210	0.000	2.513	6.000
36	Del Puerto Creek Flow Station	3.019	14.675	0.000	3.449	50.000
38	Marshall Road Drain	2.928	7.710	0.810	2.638	6.000
39	Salado Creek Flow Station	4.345	8.600	1.975	3.693	3.000
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	1.853	15.175	0.000	2.025	66.000
45	Volta Wasteway at Ingomar Grade	0.604	1.300	0.230	0.301	10.000
46	Mud Slough at Gun Club Road	2.609	6.505	0.000	1.802	10.000
47	Delta-Mendota Cal Hwy 140	0.770	0.995	0.625	0.198	3.000
48	FC-5 Grasslands Area Farmers	4.860	4.860	4.860	na	1.000
49	PE-14-Grasslands Area Farmers	1.125	1.125	1.125	na	1.000
50	San Luis Drain Site A (Check 18)	1.085	1.235	0.935	0.212	2.000
51	Arroyo Cal at Hwy 152	3.685	3.685	3.685	na	1.000
52	Salt Slough at Sand Dam	3.288	4.320	2.255	1.460	2.000
53	Salt Slough at Wolfsen Road	1.760	4.980	0.080	1.029	26.000
57	Ramona Lake Drain at Levee	4.823	11.730	0.420	2.798	24.000
59	SJR Laird Park	1.126	2.470	0.350	0.562	22.000
60	Moffit 1 South	0.675	2.700	0.000	0.718	17.000
61	Deadman's Slough	1.398	4.195	0.000	1.007	21.000
62	Mallard Slough	0.910	2.430	0.000	0.866	20.000
63	Inlet C Canal	1.110	3.925	0.000	0.986	22.000

DO site number	Site name	Average of NBOD10	Max of NBOD10	Min of NBOD10	StdDev of NBOD10	Count of NBOD10
64	Moran Drain	1.163	2.380	0.495	0.863	4.000
65	Spanish Grant Drain	2.761	4.870	0.430	1.873	5.000
66	ESWD Maze Blv. Drain	0.800	1.680	0.350	0.762	3.000
67	Newman Wasteway at Brazo Road	1.893	5.960	0.900	2.005	6.000
68	S. Lake Basin	2.120	3.210	0.700	1.014	5.000
69	Santa Fe Canal	0.690	0.690	0.690	na	1.000
80	South Marsh 1 Inlet	0.721	1.930	0.090	0.552	15.000
81	South Marsh 1 Outlet	1.367	12.140	0.000	2.908	16.000
82	South Marsh 3 Inlet	1.562	5.850	0.000	1.410	21.000
83	South Marsh 3 Outlet	0.873	3.000	0.000	0.880	25.000
84	SJR Garwood Bridge	1.270	1.270	1.270	na	1.000
86	Ramona Drain Apple Ave	6.484	27.190	1.560	8.575	8.000
87	Ramona Drain Prune Ave	3.043	7.595	0.000	4.016	3.000
88	Ramona Drain Apricot Ave	6.113	17.905	1.354	5.621	9.000
89	Ramona Drain Pomelo Ave	5.983	12.030	0.000	6.015	3.000
90	Ramona Drain Almond Ave	0.055	0.055	0.055	na	1.000
91	Paradise Drain Prune Ave	3.030	3.030	3.030	na	1.000
92	Paradise Drain Apricot Ave	1.906	3.055	0.485	1.042	7.000
93	Paradise Drain Pomelo Ave	2.484	5.940	0.628	2.996	3.000
94	Paradise Drain Almond Ave	3.540	10.215	1.465	3.088	7.000
95	Ramona Lake Entrance	4.848	8.970	2.710	1.862	13.000
96	WPF-VD-1	9.780	9.780	9.780	na	1.000
97	WPF-VD-2	4.620	4.620	4.620	na	1.000
98	WPF-VD-3	na	na	na	na	na
101	WPF-UD-IN	5.750	7.290	4.210	2.178	2.000
102	WPF-UD-OUT	6.990	6.990	6.990	na	1.000
103	SLD Check 18	1.085	1.085	1.085	na	1.000
104	SLD Check 16	1.080	1.080	1.080	na	1.000
105	SLD Check 15	0.965	0.965	0.965	na	1.000
106	SLD Check 14	1.530	1.530	1.530	na	1.000
107	SLD Check 13	2.035	2.035	2.035	na	1.000
108	SLD Check 12	1.630	1.630	1.630	na	1.000
109	SLD Check 11	1.980	1.980	1.980	na	1.000
110	SLD Check 10	2.970	2.970	2.970	na	1.000
111	SLD Check 9	1.650	1.650	1.650	na	1.000
112	SLD Check 8	2.670	2.670	2.670	na	1.000
113	SLD Check 7	1.590	1.590	1.590	na	1.000
114	SLD Check 6	3.210	3.210	3.210	na	1.000
115	SLD Check 5	3.030	3.030	3.030	na	1.000
116	SLD Check 4	1.860	1.860	1.860	na	1.000
117	SLD Check 3	2.370	2.370	2.370	na	1.000
118	SLD Check 2	1.860	1.860	1.860	na	1.000
119	SLD Check 1	1.320	1.320	1.320	na	1.000
120	South Marsh 1 Intermediary	0.892	2.315	0.250	0.636	9.000
121	South Marsh 1 East	1.527	5.520	0.020	1.751	8.000
122	South Marsh 1 West	1.718	5.810	0.000	1.771	9.000
123	Ramona Lake NW Quad	4.900	5.900	3.900	1.414	2.000
124	Ramona Lake NE Quad	4.910	5.215	4.605	0.431	2.000
125	Ramona Lake SW Quad	6.000	6.000	6.000	na	1.000
126	Ramona Lake SE Quad	12.800	12.800	12.800	na	1.000
129	Hollow Tree drain	2.363	3.175	0.825	1.333	3.000
130	Marshall Rd Reservoir Entrance	1.804	2.465	1.300	0.549	5.000
131	Marshall Rd Reservoir Exit	2.869	8.310	0.415	3.135	5.000
132	Marshall Rd Res Pond 1W	2.313	2.855	1.590	0.652	3.000
133	Marshall Rd Res Pond 2E	2.107	2.585	1.395	0.628	3.000
135	Modesto ID Main Drain Spill	1.994	2.440	1.590	0.394	5.000

Total Organic Carbon (mg/L)

DO site number	Site name	Average of Total Organic Carbon, mg/L	Max of Total Organic Carbon, mg/L	Min of Total Organic Carbon, mg/L	StdDev of Total Organic Carbon, mg/L	Count of Total Organic Carbon, mg/L
1	SJR at Channel Point	3.86	3.94	3.78	0.11	2
2	SJR at Dos Reis Lathrop	4.48	4.71	4.26	0.32	2
3	SJR at Old River	4.61	4.73	4.49	0.18	2
4	SJR at Mossdale	4.23	11.93	0.36	1.68	63
5	SJR at Vernalis	4.56	17.85	1.84	2.21	71
6	SJR at Maze	4.64	11.62	2.14	1.55	69
7	SJR at Patterson	6.06	13.43	2.35	1.92	73
8	SJR at Crows Landing	5.80	12.98	2.75	1.96	79
9	SJR at Fremont Ford	8.37	10.31	7.61	1.10	5
10	SJR at Lander Avenue	7.69	16.13	3.21	2.40	81
11	French Camp Slough	5.33	13.95	2.34	3.90	7
12	Stanislaus River at Caswell Park	2.50	8.53	0.96	0.97	65
13	Stanislaus River at Ripon	1.84	1.84	1.84	na	1
14	Tuolumne River at Shiloh Bridge	2.84	9.18	0.96	1.35	65
16	Merced River at River Road	2.83	14.27	1.07	1.59	67
17	Merced River near Stevinson	1.43	1.43	1.43	na	1
18	Mud Slough near Gustine	11.05	16.31	4.60	2.63	77
19	Salt Slough at Lander Avenue	7.69	20.10	4.10	2.04	101
20	Los Banos Creek at Highway 140	13.97	32.62	6.78	5.18	65
21	Orestimba Creek at River Road	5.62	14.31	2.49	2.25	58
22	Modesto ID Lateral 4 to SJR	2.74	2.96	2.58	0.16	5
23	Modesto ID Lateral 5 to Tuolumne	4.16	18.51	1.87	3.93	27
24	Modesto ID Lateral 6 to Stanislaus River	3.44	3.71	3.17	0.38	2
25	MID Main Drain to Stan. R. via Miller Lake	8.38	40.91	3.76	6.00	38
26	Turlock ID Highline Spill	1.88	2.22	1.55	0.48	2
27	Turlock ID Lateral 2 to SJR	1.89	2.28	1.55	0.36	4
28	Turlock ID Westport Drain Flow Station	4.15	14.79	2.33	2.30	49
29	Turlock ID Harding Drain	5.81	13.45	2.50	1.81	63
30	Turlock ID Lateral 6 & 7 at Levee	6.31	13.71	3.87	2.35	34
31	BCID - New Jerusalem Drain	2.57	6.34	1.67	1.56	8
32	El Solyo WD - Grayson Drain	17.34	22.69	13.31	4.03	5
33	Hospital Creek	12.47	52.52	3.30	11.75	16
34	Ingram Creek Flow Station	8.75	34.55	1.96	6.38	43
35	Westley Wasteway Flow Station	10.56	33.58	3.90	11.51	6
36	Del Puerto Creek Flow Station	6.56	43.62	2.00	5.79	56
38	Marshall Road Drain	7.75	12.95	3.67	3.08	7
39	Salado Creek Flow Station	14.94	25.35	8.67	7.37	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	10.64	23.22	4.54	3.66	71
45	Volta Wasteway at Ingomar Grade	4.09	5.42	2.72	0.76	11
46	Mud Slough at Gun Club Road	14.07	25.51	8.97	4.99	11
47	Delta-Mendota Cal Hwy 140	3.71	5.58	2.18	1.72	3
48	FC-5 Grasslands Area Farmers	12.18	16.76	7.60	6.47	2
49	PE-14-Grasslands Area Farmers	9.49	10.00	8.98	0.72	2
50	San Luis Drain Site A (Check 18)	7.89	8.96	6.10	1.28	4
51	Arroyo Cal at Hwy 152	7.28	7.76	6.80	0.68	2
52	Salt Slough at Sand Dam	6.64	7.84	4.96	1.50	3
53	Salt Slough at Wolfsen Road	7.77	11.51	5.59	1.29	29
57	Ramona Lake Drain at Levee	11.38	18.68	4.98	2.73	30
59	SJR Laird Park	4.82	6.69	3.02	1.15	20
60	Moffit 1 South	11.30	16.24	4.24	2.90	18
61	Deadman's Slough	11.15	24.17	6.46	5.12	23
62	Mallard Slough	11.65	38.83	6.58	7.00	22
63	Inlet C Canal	4.94	8.55	2.43	1.39	26

DO site number	Site name	Average of Total Organic Carbon, mg/L	Max of Total Organic Carbon, mg/L	Min of Total Organic Carbon, mg/L	StdDev of Total Organic Carbon, mg/L	Count of Total Organic Carbon, mg/L
64	Moran Drain	5.73	9.67	3.38	2.53	6
65	Spanish Grant Drain	7.92	13.16	4.64	3.02	6
66	ESWD Maze Blv. Drain	10.46	21.73	3.26	9.88	3
67	Newman Wasteway at Brazo Road	6.43	10.49	4.58	2.08	6
68	S. Lake Basin	13.40	25.00	4.45	9.53	5
69	Santa Fe Canal	3.92	3.92	3.92	na	1
80	South Marsh 1 Inlet	4.52	6.73	2.00	1.47	17
81	South Marsh 1 Outlet	9.67	21.81	4.18	5.37	19
82	South Marsh 3 Inlet	10.91	30.75	2.49	6.88	24
83	South Marsh 3 Outlet	11.76	24.30	3.30	5.52	27
84	SJR Garwood Bridge	3.95	3.95	3.95	na	1
86	Ramona Drain Apple Ave	14.20	24.29	9.13	4.68	9
87	Ramona Drain Prune Ave	11.58	13.16	9.27	2.04	3
88	Ramona Drain Apricot Ave	14.15	23.06	6.30	5.55	9
89	Ramona Drain Pomelo Ave	12.52	14.03	11.42	1.35	3
90	Ramona Drain Almond Ave	10.44	10.44	10.44	na	1
91	Paradise Drain Prune Ave	15.36	15.36	15.36	na	1
92	Paradise Drain Apricot Ave	11.15	16.01	6.11	2.91	7
93	Paradise Drain Pomelo Ave	11.66	14.07	7.69	3.46	3
94	Paradise Drain Almond Ave	9.81	12.58	7.70	1.84	7
95	Ramona Lake Entrance	9.38	15.41	6.16	2.87	17
96	WPF-VD-1	20.58	20.58	20.58	na	1
97	WPF-VD-2	23.16	23.16	23.16	na	1
98	WPF-VD-3	79.30	79.30	79.30	na	1
101	WPF-UD-IN	13.61	21.01	6.21	10.46	2
102	WPF-UD-OUT	15.62	20.00	11.23	6.20	2
103	SLD Check 18	9.88	10.44	9.32	0.79	2
104	SLD Check 16	8.64	9.29	7.99	0.92	2
105	SLD Check 15	9.45	9.68	9.22	0.33	2
106	SLD Check 14	10.13	10.60	9.66	0.67	2
107	SLD Check 13	10.68	10.82	10.53	0.21	2
108	SLD Check 12	10.21	10.83	9.59	0.87	2
109	SLD Check 11	10.50	12.35	8.66	2.61	2
110	SLD Check 10	9.86	11.52	8.20	2.35	2
111	SLD Check 9	10.46	11.09	9.83	0.89	2
112	SLD Check 8	11.34	12.27	10.42	1.31	2
113	SLD Check 7	12.45	14.22	10.67	2.51	2
114	SLD Check 6	12.05	13.46	10.65	1.99	2
115	SLD Check 5	11.96	12.76	11.16	1.13	2
116	SLD Check 4	12.84	14.35	11.33	2.13	2
117	SLD Check 3	13.77	16.34	11.19	3.64	2
118	SLD Check 2	13.54	16.12	10.97	3.64	2
119	SLD Check 1	13.85	17.19	10.51	4.73	2
120	South Marsh 1 Intermediary	4.91	9.91	2.63	1.89	11
121	South Marsh 1 East	7.63	19.07	2.84	5.45	10
122	South Marsh 1 West	16.72	26.55	9.21	5.77	9
123	Ramona Lake NW Quad	15.11	20.91	9.30	8.21	2
124	Ramona Lake NE Quad	11.94	20.52	7.61	7.43	3
125	Ramona Lake SW Quad	9.93	9.93	9.93	na	1
126	Ramona Lake SE Quad	8.50	8.50	8.50	na	1
129	Hollow Tree drain	18.10	21.15	16.09	2.68	3
130	Marshall Rd Reservoir Entrance	6.75	10.50	3.35	2.84	7
131	Marshall Rd Reservoir Exit	5.66	7.14	4.35	1.06	7
132	Marshall Rd Res Pond 1W	5.10	6.52	4.08	1.09	5
133	Marshall Rd Res Pond 2E	5.30	6.80	4.17	1.06	5
135	Modesto ID Main Drain Spill	6.35	11.47	3.14	3.54	6

Dissolved Organic Carbon, mg/L

DO site number	Site name	Average of Dissolved Organic Carbon, mg/L	Max of Dissolved Organic Carbon, mg/L	Min of Dissolved Organic Carbon, mg/L	StdDev of Dissolved Organic Carbon, mg/L	Count of Dissolved Organic Carbon, mg/L
1	SJR at Channel Point	2.92	3.49	2.35	0.81	2
2	SJR at Dos Reis Lathrop	2.69	3.48	1.91	1.11	2
3	SJR at Old River	2.57	3.31	1.83	1.05	2
4	SJR at Mossdale	3.23	6.97	0.88	1.04	65
5	SJR at Vernalis	3.40	8.10	1.83	1.21	72
6	SJR at Maze	3.81	10.12	1.75	1.51	70
7	SJR at Patterson	4.73	10.16	2.26	1.44	74
8	SJR at Crows Landing	4.64	8.06	2.02	1.36	80
9	SJR at Fremont Ford	5.88	7.54	4.50	1.11	5
10	SJR at Lander Avenue	5.81	10.77	2.90	1.70	83
11	French Camp Slough	4.80	10.41	2.42	2.98	7
12	Stanislaus River at Caswell Park	2.26	5.25	0.71	0.77	67
13	Stanislaus River at Ripon	1.42	1.42	1.42	na	1
14	Tuolumne River at Shiloh Bridge	2.52	5.95	0.97	1.04	68
16	Merced River at River Road	2.48	7.36	1.00	0.92	67
17	Merced River near Stevinson	1.32	1.32	1.32	na	1
18	Mud Slough near Gustine	8.87	18.81	3.50	3.05	77
19	Salt Slough at Lander Avenue	6.04	9.14	4.14	1.14	102
20	Los Banos Creek at Highway 140	12.85	36.28	4.83	5.81	66
21	Orestimba Creek at River Road	4.10	14.02	2.26	1.92	58
22	Modesto ID Lateral 4 to SJR	2.59	3.78	1.92	0.68	6
23	Modesto ID Lateral 5 to Tuolumne	3.03	11.32	1.48	2.08	29
24	Modesto ID Lateral 6 to Stanislaus River	3.66	4.44	2.88	1.11	2
25	MID Main Drain to Stan. R. via Miller Lake	7.49	24.25	3.21	4.54	39
26	Turlock ID Highline Spill	1.47	1.65	1.29	0.25	2
27	Turlock ID Lateral 2 to SJR	2.11	3.16	1.18	0.91	4
28	Turlock ID Westport Drain Flow Station	4.12	11.35	1.66	2.13	50
29	Turlock ID Harding Drain	5.31	10.00	2.22	1.66	65
30	Turlock ID Lateral 6 & 7 at Levee	6.21	14.70	3.56	2.71	35
31	BCID - New Jerusalem Drain	5.48	13.81	1.52	4.12	9
32	El Solyo WD - Grayson Drain	7.30	14.99	3.13	4.57	5
33	Hospital Creek	6.60	16.65	2.61	3.88	17
34	Ingram Creek Flow Station	4.33	11.17	1.77	1.62	44
35	Westley Wasteway Flow Station	3.57	5.31	1.81	1.23	7
36	Del Puerto Creek Flow Station	4.83	19.13	2.21	2.63	58
38	Marshall Road Drain	10.02	37.63	2.84	11.46	8
39	Salado Creek Flow Station	12.90	24.82	6.70	8.16	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	6.64	11.19	3.71	1.45	73
45	Volta Wasteway at Ingomar Grade	3.57	4.21	2.38	0.54	11
46	Mud Slough at Gun Club Road	12.82	26.97	6.15	5.86	11
47	Delta-Mendota Cal Hwy 140	3.02	3.58	2.72	0.48	3
48	FC-5 Grasslands Area Farmers	8.85	10.79	6.90	2.75	2
49	PE-14-Grasslands Area Farmers	7.88	9.00	6.76	1.58	2
50	San Luis Drain Site A (Check 18)	6.45	7.28	5.50	0.73	4
51	Arroyo Cal at Hwy 152	6.13	6.49	5.77	0.51	2
52	Salt Slough at Sand Dam	4.67	5.37	4.20	0.62	3
53	Salt Slough at Wolfsen Road	6.37	8.78	4.56	1.09	29
57	Ramona Lake Drain at Levee	7.41	10.75	3.57	1.59	30
59	SJR Laird Park	3.91	6.77	2.55	1.04	22
60	Moffit 1 South	11.35	14.82	5.61	2.49	18
61	Deadman's Slough	10.27	22.01	5.26	4.37	23
62	Mallard Slough	10.90	34.48	6.40	6.02	22
63	Inlet C Canal	3.76	6.70	1.84	1.31	26

DO site number	Site name	Average of Dissolved Organic Carbon, mg/L	Max of Dissolved Organic Carbon, mg/L	Min of Dissolved Organic Carbon, mg/L	StdDev of Dissolved Organic Carbon, mg/L	Count of Dissolved Organic Carbon, mg/L
64	Moran Drain	4.00	6.57	1.51	1.98	6
65	Spanish Grant Drain	5.32	7.94	2.96	1.85	7
66	ESWD Maze Blv. Drain	3.98	6.20	1.77	1.91	4
67	Newman Wasteway at Brazo Road	13.37	37.71	2.89	15.53	7
68	S. Lake Basin	12.89	21.15	3.37	8.14	5
69	Santa Fe Canal	2.88	2.88	2.88	na	1
80	South Marsh 1 Inlet	4.02	7.68	2.14	1.54	17
81	South Marsh 1 Outlet	8.87	17.61	2.62	4.27	19
82	South Marsh 3 Inlet	8.56	17.27	0.42	4.15	24
83	South Marsh 3 Outlet	10.36	26.71	0.42	5.23	27
84	SJR Garwood Bridge	3.48	3.48	3.48	na	1
86	Ramona Drain Apple Ave	11.88	18.37	6.18	3.97	9
87	Ramona Drain Prune Ave	10.32	11.52	8.47	1.62	3
88	Ramona Drain Apricot Ave	9.64	13.81	5.60	2.25	9
89	Ramona Drain Pomelo Ave	8.84	9.33	7.94	0.79	3
90	Ramona Drain Almond Ave	7.28	7.28	7.28	na	1
91	Paradise Drain Prune Ave	13.87	13.87	13.87	na	1
92	Paradise Drain Apricot Ave	8.50	12.31	5.64	2.41	7
93	Paradise Drain Pomelo Ave	7.56	9.09	6.27	1.42	3
94	Paradise Drain Almond Ave	6.89	7.98	6.25	0.61	7
95	Ramona Lake Entrance	7.12	9.97	5.01	1.30	17
96	WPF-VD-1	13.72	13.72	13.72	na	1
97	WPF-VD-2	16.32	16.32	16.32	na	1
98	WPF-VD-3	58.17	58.17	58.17	na	1
101	WPF-UD-IN	9.61	13.73	5.49	5.82	2
102	WPF-UD-OUT	11.11	13.72	8.50	3.70	2
103	SLD Check 18	7.28	7.65	6.92	0.52	2
104	SLD Check 16	6.91	7.41	6.41	0.71	2
105	SLD Check 15	7.13	7.44	6.82	0.44	2
106	SLD Check 14	7.16	7.50	6.82	0.48	2
107	SLD Check 13	7.10	7.64	6.55	0.77	2
108	SLD Check 12	7.03	7.39	6.68	0.50	2
109	SLD Check 11	7.30	8.85	5.75	2.19	2
110	SLD Check 10	7.06	8.21	5.92	1.62	2
111	SLD Check 9	7.03	8.22	5.84	1.68	2
112	SLD Check 8	6.24	6.87	5.61	0.89	2
113	SLD Check 7	6.63	7.49	5.77	1.22	2
114	SLD Check 6	6.57	7.56	5.58	1.40	2
115	SLD Check 5	7.21	8.29	6.12	1.54	2
116	SLD Check 4	6.86	7.96	5.76	1.56	2
117	SLD Check 3	7.44	8.91	5.97	2.08	2
118	SLD Check 2	7.00	8.12	5.88	1.58	2
119	SLD Check 1	7.50	8.59	6.41	1.54	2
120	South Marsh 1 Intermediary	3.97	6.16	2.26	1.00	11
121	South Marsh 1 East	7.15	19.85	2.67	5.16	10
122	South Marsh 1 West	15.69	24.70	7.54	6.26	9
123	Ramona Lake NW Quad	8.21	8.78	7.65	0.80	2
124	Ramona Lake NE Quad	8.06	10.15	5.98	2.09	3
125	Ramona Lake SW Quad	9.08	9.08	9.08	na	1
126	Ramona Lake SE Quad	8.65	8.65	8.65	na	1
129	Hollow Tree drain	17.82	19.69	15.53	2.11	3
130	Marshall Rd Reservoir Entrance	4.07	5.90	2.85	1.23	7
131	Marshall Rd Reservoir Exit	4.02	5.29	3.10	0.70	7
132	Marshall Rd Res Pond 1W	4.32	5.60	3.15	1.00	5
133	Marshall Rd Res Pond 2E	4.19	5.70	3.18	1.09	5
135	Modesto ID Main Drain Spill	6.39	18.68	2.76	6.17	6

Inorganic Carbon, mg/L

DO site number	Site name	Average of Inorganic Carbon, mg/L C	Max of Inorganic Carbon, mg/L C	Min of Inorganic Carbon, mg/L C	StdDev of Inorganic Carbon, mg/L C	Count of Inorganic Carbon, mg/L C
1	SJR at Channel Point	13.45	13.45	13.45	na	1
2	SJR at Dos Reis Lathrop	14.47	14.47	14.47	na	1
3	SJR at Old River	13.42	13.42	13.42	na	1
4	SJR at Mossdale	21.51	28.75	9.99	5.12	24
5	SJR at Vernalis	22.07	29.97	9.67	5.07	29
6	SJR at Maze	27.39	35.15	14.70	5.72	29
7	SJR at Patterson	30.43	40.63	12.56	6.33	31
8	SJR at Crows Landing	29.97	38.59	11.96	6.10	33
9	SJR at Fremont Ford	34.63	36.60	31.65	2.63	3
10	SJR at Lander Avenue	35.08	59.57	4.02	10.64	33
11	French Camp Slough	12.45	12.45	12.45	na	1
12	Stanislaus River at Caswell Park	10.36	14.58	5.40	2.28	24
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	15.84	20.12	7.57	3.96	24
16	Merced River at River Road	14.53	22.79	2.65	5.29	24
17	Merced River near Stevinson	na	na	na	na	na
18	Mud Slough near Gustine	30.89	64.95	12.77	13.03	31
19	Salt Slough at Lander Avenue	34.55	50.85	22.06	7.25	36
20	Los Banos Creek at Highway 140	61.49	97.63	39.40	17.50	18
21	Orestimba Creek at River Road	34.94	45.79	15.54	6.70	20
22	Modesto ID Lateral 4 to SJR	31.95	31.95	31.95	na	1
23	Modesto ID Lateral 5 to Tuolumne	14.68	14.68	14.68	na	1
24	Modesto ID Lateral 6 to Stanislaus River	5.27	5.27	5.27	na	1
25	MID Main Drain to Stan. R. via Miller Lake	25.40	34.08	18.18	4.23	19
26	Turlock ID Highline Spill	4.76	4.76	4.76	na	1
27	Turlock ID Lateral 2 to SJR	11.18	17.58	6.10	5.86	3
28	Turlock ID Westport Drain Flow Station	36.84	84.58	18.38	17.45	23
29	Turlock ID Harding Drain	30.19	51.65	4.30	9.00	24
30	Turlock ID Lateral 6 & 7 at Levee	29.13	67.94	8.94	10.97	22
31	BCID - New Jerusalem Drain	61.02	72.80	40.69	14.18	4
32	El Solyo WD - Grayson Drain	29.79	42.00	17.68	12.16	3
33	Hospital Creek	25.99	29.61	22.38	5.11	2
34	Ingram Creek Flow Station	32.50	51.75	19.64	7.38	24
35	Westley Wasteway Flow Station	20.78	23.18	18.37	3.40	2
36	Del Puerto Creek Flow Station	33.06	61.66	15.44	8.72	23
38	Marshall Road Drain	29.37	36.93	16.78	10.98	3
39	Salado Creek Flow Station	36.21	41.60	32.22	4.09	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	19.86	52.36	3.54	12.24	23
45	Volta Wasteway at Ingomar Grade	46.80	65.09	28.50	25.88	2
46	Mud Slough at Gun Club Road	96.98	105.55	88.41	12.12	2
47	Delta-Mendota Cal Hwy 140	23.81	44.54	11.74	18.03	3
48	FC-5 Grasslands Area Farmers	na	na	na	na	na
49	PE-14-Grasslands Area Farmers	na	na	na	na	na
50	San Luis Drain Site A (Check 18)	38.84	38.84	38.84	na	1
51	Arroyo Cal at Hwy 152	20.01	22.60	17.41	3.67	2
52	Salt Slough at Sand Dam	26.79	27.78	25.81	1.39	2
53	Salt Slough at Wolfsen Road	36.15	41.53	26.35	5.84	5
54	Los Banos Creek at Ingomar Grade	na	na	na	na	na
57	Ramona Lake Drain at Levee	35.78	47.61	19.96	7.94	15
59	SJR Laird Park	na	na	na	na	na
60	Moffit 1 South	52.22	55.47	48.96	4.61	2
61	Deadman's Slough	47.24	51.19	41.84	3.98	4
62	Mallard Slough	39.94	63.89	27.59	20.75	3
63	Inlet C Canal	29.88	30.47	29.07	0.69	4

DO site number	Site name	Average of Inorganic Carbon, mg/L C	Max of Inorganic Carbon, mg/L C	Min of Inorganic Carbon, mg/L C	StdDev of Inorganic Carbon, mg/L C	Count of Inorganic Carbon, mg/L C
64	Moran Drain	36.40	39.91	34.09	3.09	3
65	Spanish Grant Drain	44.12	47.61	39.82	3.96	3
66	ESWD Maze Blv. Drain	na	na	na	na	na
67	Newman Wasteway at Brazo Road	43.78	66.44	18.77	23.92	3
68	S. Lake Basin	88.89	91.08	86.70	3.09	2
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	28.06	30.87	25.25	3.97	2
81	South Marsh 1 Outlet	32.21	35.40	29.02	4.51	2
82	South Marsh 3 Inlet	43.33	58.64	31.31	12.19	4
83	South Marsh 3 Outlet	43.75	60.86	24.99	12.02	6
84	SJR Garwood Bridge	na	na	na	na	na
86	Ramona Drain Apple Ave	39.32	49.17	34.36	5.29	6
87	Ramona Drain Prune Ave	na	na	na	na	na
88	Ramona Drain Apricot Ave	43.08	52.24	34.64	7.05	6
89	Ramona Drain Pomelo Ave	na	na	na	na	na
90	Ramona Drain Almond Ave	na	na	na	na	na
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	40.24	48.44	35.74	5.77	4
93	Paradise Drain Pomelo Ave	na	na	na	na	na
94	Paradise Drain Almond Ave	39.24	50.47	30.98	7.42	5
95	Ramona Lake Entrance	39.97	51.21	26.83	7.85	15
96	WPF-VD-1	na	na	na	na	na
97	WPF-VD-2	na	na	na	na	na
98	WPF-VD-3	na	na	na	na	na
101	WPF-UD-IN	na	na	na	na	na
102	WPF-UD-OUT	na	na	na	na	na
103	SLD Check 18	38.56	38.56	38.56	na	1
104	SLD Check 16	39.55	39.55	39.55	na	1
105	SLD Check 15	35.73	35.73	35.73	na	1
106	SLD Check 14	29.89	29.89	29.89	na	1
107	SLD Check 13	32.28	32.28	32.28	na	1
108	SLD Check 12	34.47	34.47	34.47	na	1
109	SLD Check 11	26.81	26.81	26.81	na	1
110	SLD Check 10	29.27	29.27	29.27	na	1
111	SLD Check 9	24.76	24.76	24.76	na	1
112	SLD Check 8	25.70	25.70	25.70	na	1
113	SLD Check 7	28.37	28.37	28.37	na	1
114	SLD Check 6	25.91	25.91	25.91	na	1
115	SLD Check 5	18.00	18.00	18.00	na	1
116	SLD Check 4	16.31	16.31	16.31	na	1
117	SLD Check 3	14.38	14.38	14.38	na	1
118	SLD Check 2	12.02	12.02	12.02	na	1
119	SLD Check 1	12.22	12.22	12.22	na	1
120	South Marsh 1 Intermediary	26.98	27.66	26.29	0.97	2
121	South Marsh 1 East	33.94	34.93	32.95	1.40	2
122	South Marsh 1 West	43.53	45.34	41.71	2.57	2
123	Ramona Lake NW Quad	31.09	31.09	31.09	na	1
124	Ramona Lake NE Quad	28.42	28.42	28.42	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	106.88	122.58	91.19	22.19	2
130	Marshall Rd Reservoir Entrance	24.94	35.77	16.63	8.09	7
131	Marshall Rd Reservoir Exit	24.28	34.68	15.54	7.54	7
132	Marshall Rd Res Pond 1W	21.26	25.25	17.58	3.26	4
133	Marshall Rd Res Pond 2E	23.21	27.28	16.72	4.54	4
135	Modesto ID Main Drain Spill	19.75	23.79	12.82	4.39	5

Total Protein, mg/L

DO site number	Site name	Average of Total Protein mg/L	Max of Total Protein mg/L	Min of Total Protein mg/L	StdDev of Total Protein mg/L	Count of Total Protein mg/L
1	SJR at Channel Point	6.39	6.39	6.39	na	1
2	SJR at Dos Reis Lathrop	7.64	7.64	7.64	na	1
3	SJR at Old River	7.07	7.07	7.07	na	1
4	SJR at Mossdale	5.52	9.71	1.76	1.82	37
5	SJR at Vernalis	5.61	11.40	2.08	2.01	40
6	SJR at Maze	6.05	13.82	3.00	2.39	37
7	SJR at Patterson	7.23	13.25	1.58	2.34	41
8	SJR at Crows Landing	7.26	13.56	4.15	2.30	43
9	SJR at Fremont Ford	5.21	5.21	5.21	na	1
10	SJR at Lander Avenue	9.37	19.81	4.19	3.42	46
11	French Camp Slough	10.69	20.99	5.12	8.93	3
12	Stanislaus River at Caswell Park	3.59	10.95	0.88	1.76	39
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	3.92	12.86	1.12	2.12	39
16	Merced River at River Road	4.25	14.12	1.79	2.23	38
17	Merced River near Stevinson	1.12	1.12	1.12	na	1
18	Mud Slough near Gustine	16.39	29.23	9.58	5.10	42
19	Salt Slough at Lander Avenue	9.16	22.77	1.88	3.61	61
20	Los Banos Creek at Highway 140	18.93	45.54	7.55	8.90	43
21	Orestimba Creek at River Road	10.29	36.65	2.19	7.79	35
22	Modesto ID Lateral 4 to SJR	5.80	8.15	4.46	1.39	5
23	Modesto ID Lateral 5 to Tuolumne	5.72	21.00	1.10	5.28	26
24	Modesto ID Lateral 6 to Stanislaus River	2.00	2.00	2.00	na	1
25	MID Main Drain to Stan. R. via Miller Lake	14.78	61.79	5.17	13.92	16
26	Turlock ID Highline Spill	1.15	1.15	1.15	na	1
27	Turlock ID Lateral 2 to SJR	2.36	2.36	2.36	na	1
28	Turlock ID Westport Drain Flow Station	5.00	14.28	0.45	2.66	28
29	Turlock ID Harding Drain	6.40	18.46	3.12	3.18	36
30	Turlock ID Lateral 6 & 7 at Levee	7.20	20.12	1.43	5.80	13
31	BCID - New Jerusalem Drain	3.26	3.65	2.65	0.43	4
32	El Solyo WD - Grayson Drain	32.71	41.18	24.23	11.99	2
33	Hospital Creek	21.25	56.12	2.08	18.72	13
34	Ingram Creek Flow Station	13.17	55.03	0.45	12.41	21
35	Westley Wasteway Flow Station	10.05	38.18	1.23	15.79	5
36	Del Puerto Creek Flow Station	9.38	21.77	1.61	5.98	32
38	Marshall Road Drain	11.18	21.61	2.23	9.08	4
39	Salado Creek Flow Station	na	na	na	na	na
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	22.76	42.79	3.38	7.71	47
45	Volta Wasteway at Ingomar Grade	3.92	5.37	2.64	1.19	6
46	Mud Slough at Gun Club Road	14.08	16.75	9.84	2.76	6
47	Delta-Mendota Cal Hwy 140	na	na	na	na	na
48	FC-5 Grasslands Area Farmers	26.96	28.15	25.77	1.69	2
49	PE-14-Grasslands Area Farmers	32.38	34.65	30.12	3.21	2
50	San Luis Drain Site A (Check 18)	24.06	31.77	21.29	5.14	4
51	Arroyo Cal at Hwy 152	na	na	na	na	na
52	Salt Slough at Sand Dam	4.96	4.96	4.96	na	1
53	Salt Slough at Wolfsen Road	8.31	13.77	4.17	2.37	20
57	Ramona Lake Drain at Levee	17.46	33.83	8.35	5.40	15
59	SJR Laird Park	9.80	60.23	3.81	12.10	20
60	Moffit 1 South	12.16	29.04	7.20	5.61	15
61	Deadman's Slough	10.98	22.85	5.65	5.23	16
62	Mallard Slough	9.00	17.07	3.38	4.06	17
63	Inlet C Canal	5.24	9.70	1.69	2.24	18

DO site number	Site name	Average of Total Protein mg/L	Max of Total Protein mg/L	Min of Total Protein mg/L	StdDev of Total Protein mg/L	Count of Total Protein mg/L
64	Moran Drain	9.44	16.58	4.85	6.27	3
65	Spanish Grant Drain	7.95	17.22	3.73	6.24	4
66	ESWD Maze Blv. Drain	13.03	40.72	1.69	18.64	4
67	Newman Wasteway at Brazo Road	5.76	12.52	2.77	4.55	4
68	S. Lake Basin	18.65	35.92	7.38	12.30	4
69	Santa Fe Canal	4.65	4.65	4.65	na	1
80	South Marsh 1 Inlet	5.28	8.09	2.31	1.74	11
81	South Marsh 1 Outlet	10.58	21.09	6.26	5.03	12
82	South Marsh 3 Inlet	11.03	24.58	1.77	5.62	15
83	South Marsh 3 Outlet	10.93	19.46	3.32	3.61	17
84	SJR Garwood Bridge	6.10	6.10	6.10	na	1
86	Ramona Drain Apple Ave	21.99	28.90	16.56	6.30	3
87	Ramona Drain Prune Ave	15.90	21.19	11.18	5.03	3
88	Ramona Drain Apricot Ave	17.93	33.09	8.33	13.29	3
89	Ramona Drain Pomelo Ave	26.33	29.78	23.05	3.37	3
90	Ramona Drain Almond Ave	20.54	20.54	20.54	na	1
91	Paradise Drain Prune Ave	20.21	20.21	20.21	na	1
92	Paradise Drain Apricot Ave	16.97	18.67	14.96	1.88	3
93	Paradise Drain Pomelo Ave	25.50	32.38	14.27	9.80	3
94	Paradise Drain Almond Ave	21.01	22.11	19.91	1.56	2
95	Ramona Lake Entrance	13.50	22.01	0.00	7.68	7
96	WPF-VD-1	45.79	45.79	45.79	na	1
97	WPF-VD-2	41.71	41.71	41.71	na	1
98	WPF-VD-3	76.46	76.46	76.46	na	1
101	WPF-UD-IN	23.97	44.33	3.62	28.79	2
102	WPF-UD-OUT	28.84	41.71	15.98	18.19	2
103	SLD Check 18	20.94	21.00	20.87	0.09	2
104	SLD Check 16	19.23	21.34	17.13	2.97	2
105	SLD Check 15	20.46	21.07	19.86	0.86	2
106	SLD Check 14	21.32	22.42	20.21	1.56	2
107	SLD Check 13	24.98	26.75	23.21	2.50	2
108	SLD Check 12	21.10	21.64	20.55	0.77	2
109	SLD Check 11	21.13	23.15	19.11	2.86	2
110	SLD Check 10	19.76	20.14	19.38	0.54	2
111	SLD Check 9	23.23	24.69	21.76	2.08	2
112	SLD Check 8	20.67	23.19	18.14	3.57	2
113	SLD Check 7	20.76	21.37	20.16	0.86	2
114	SLD Check 6	19.91	20.94	18.88	1.45	2
115	SLD Check 5	17.39	18.59	16.18	1.70	2
116	SLD Check 4	18.11	18.40	17.82	0.41	2
117	SLD Check 3	19.28	19.57	18.99	0.41	2
118	SLD Check 2	22.28	23.37	21.18	1.55	2
119	SLD Check 1	21.89	22.02	21.77	0.18	2
120	South Marsh 1 Intermediary	6.77	7.56	5.56	1.06	3
121	South Marsh 1 East	17.36	40.31	5.04	19.89	3
122	South Marsh 1 West	19.00	21.66	15.75	3.00	3
123	Ramona Lake NW Quad	19.68	19.68	19.68	na	1
124	Ramona Lake NE Quad	6.61	6.61	6.61	na	1
125	Ramona Lake SW Quad	15.67	15.67	15.67	na	1
126	Ramona Lake SE Quad	16.24	16.24	16.24	na	1
129	Hollow Tree drain	19.94	25.01	14.86	7.18	2
130	Marshall Rd Reservoir Entrance	na	na	na	na	na
131	Marshall Rd Reservoir Exit	na	na	na	na	na
132	Marshall Rd Res Pond 1W	na	na	na	na	na
133	Marshall Rd Res Pond 2E	na	na	na	na	na
135	Modesto ID Main Drain Spill	na	na	na	na	na

Total Suspended Solids

DO site number	Site name	Average of TSS, mg/L	Max of TSS, mg/L	Min of TSS, mg/L	StdDev of TSS, mg/L	Count of TSS, mg/L
1	SJR at Channel Point	45.81	66.58	25.04	29.38	2
2	SJR at Dos Reis Lathrop	48.22	73.85	22.58	36.25	2
3	SJR at Old River	47.44	70.59	24.30	32.73	2
4	SJR at Mossdale	40.62	98.35	16.64	17.74	64
5	SJR at Vernalis	42.83	106.51	7.37	16.74	75
6	SJR at Maze	49.11	127.80	14.46	21.80	68
7	SJR at Patterson	57.16	146.29	19.35	26.20	77
8	SJR at Crows Landing	52.37	281.39	4.32	31.97	83
9	SJR at Fremont Ford	85.47	140.10	23.59	43.08	5
10	SJR at Lander Avenue	39.27	175.34	14.87	21.51	81
11	French Camp Slough	48.40	195.21	7.10	66.83	7
12	Stanislaus River at Caswell Park	12.67	48.53	1.69	7.26	65
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	15.09	252.59	0.00	30.62	66
16	Merced River at River Road	18.81	109.53	2.21	19.01	63
17	Merced River near Stevinson	30.16	30.16	30.16	na	1
18	Mud Slough near Gustine	64.26	155.21	4.62	28.96	76
19	Salt Slough at Lander Avenue	96.28	204.65	21.01	43.20	105
20	Los Banos Creek at Highway 140	83.04	314.53	13.13	71.51	66
21	Orestimba Creek at River Road	154.39	579.89	15.75	123.55	58
22	Modesto ID Lateral 4 to SJR	6.38	11.24	3.56	2.92	6
23	Modesto ID Lateral 5 to Tuolumne	13.14	138.36	0.80	25.66	28
24	Modesto ID Lateral 6 to Stanislaus River	12.13	19.29	4.98	10.12	2
25	MID Main Drain to Stan. R. via Miller Lake	34.81	219.04	4.49	34.69	38
26	Turlock ID Highline Spill	10.60	16.10	5.10	7.78	2
27	Turlock ID Lateral 2 to SJR	36.09	119.81	4.22	55.95	4
28	Turlock ID Westport Drain Flow Station	19.78	93.43	1.97	16.51	49
29	Turlock ID Harding Drain	36.03	260.59	5.50	45.89	62
30	Turlock ID Lateral 6 & 7 at Levee	15.05	110.96	1.31	21.36	34
31	BCID - New Jerusalem Drain	5.46	13.92	1.96	4.15	9
32	El Solyo WD - Grayson Drain	808.73	1447.96	395.48	388.37	5
33	Hospital Creek	1033.53	6335.39	13.68	1627.78	17
34	Ingram Creek Flow Station	552.66	3454.53	6.02	693.81	42
35	Westley Wasteway Flow Station	627.16	3106.37	14.62	1124.13	7
36	Del Puerto Creek Flow Station	130.46	1367.91	7.06	204.98	57
38	Marshall Road Drain	192.77	981.89	36.92	320.58	8
39	Salado Creek Flow Station	283.35	922.56	54.35	426.32	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	42.01	71.88	16.92	12.44	75
45	Volta Wasteway at Ingomar Grade	25.07	105.57	8.87	27.40	11
46	Mud Slough at Gun Club Road	67.31	277.43	30.70	75.37	10
47	Delta-Mendota Cal Hwy 140	13.80	14.65	12.29	1.31	3
48	FC-5 Grasslands Area Farmers	68.13	80.23	56.03	17.11	2
49	PE-14-Grasslands Area Farmers	86.21	94.23	78.18	11.35	2
50	San Luis Drain Site A (Check 18)	88.07	172.76	29.78	61.32	4
51	Arroyo Cal at Hwy 152	125.56	158.94	92.18	47.21	2
52	Salt Slough at Sand Dam	57.77	85.37	3.39	47.10	3
53	Salt Slough at Wolfsen Road	78.05	179.37	28.24	32.52	30
57	Ramona Lake Drain at Levee	122.90	339.22	46.63	64.16	27
59	SJR Laird Park	85.76	333.04	9.31	64.76	22
60	Moffit 1 South	3.14	10.81	0.87	2.18	19
61	Deadman's Slough	30.01	121.66	1.44	31.24	24
62	Mallard Slough	12.12	55.56	1.46	12.98	23
63	Inlet C Canal	85.27	196.60	16.22	48.64	27

DO site number	Site name	Average of TSS, mg/L	Max of TSS, mg/L	Min of TSS, mg/L	StdDev of TSS, mg/L	Count of TSS, mg/L
64	Moran Drain	123.75	265.84	51.50	75.35	6
65	Spanish Grant Drain	274.72	592.47	42.56	230.88	7
66	ESWD Maze Blv. Drain	493.78	1911.80	6.98	945.42	4
67	Newman Wasteway at Brazo Road	99.81	189.36	37.19	54.09	7
68	S. Lake Basin	66.28	211.51	16.93	81.62	5
69	Santa Fe Canal	8.01	8.01	8.01	na	1
80	South Marsh 1 Inlet	27.28	55.81	7.00	10.70	18
81	South Marsh 1 Outlet	9.36	94.32	1.15	20.24	20
82	South Marsh 3 Inlet	22.04	78.84	1.90	17.90	25
83	South Marsh 3 Outlet	19.42	47.16	6.39	12.55	27
84	SJR Garwood Bridge	22.65	22.65	22.65	na	1
86	Ramona Drain Apple Ave	117.76	388.40	39.62	106.43	9
87	Ramona Drain Prune Ave	30.08	52.71	15.68	19.84	3
88	Ramona Drain Apricot Ave	158.32	380.43	11.81	140.35	9
89	Ramona Drain Pomelo Ave	185.85	231.04	149.69	41.42	3
90	Ramona Drain Almond Ave	114.28	114.28	114.28	na	1
91	Paradise Drain Prune Ave	39.07	39.07	39.07	na	1
92	Paradise Drain Apricot Ave	36.29	53.78	16.73	13.54	7
93	Paradise Drain Pomelo Ave	235.30	403.99	29.20	190.18	3
94	Paradise Drain Almond Ave	118.13	156.29	75.22	29.21	7
95	Ramona Lake Entrance	135.17	324.99	40.36	73.71	16
96	WPF-VD-1	438.97	438.97	438.97	na	1
97	WPF-VD-2	168.85	168.85	168.85	na	1
98	WPF-VD-3	70.33	70.33	70.33	na	1
101	WPF-UD-IN	190.45	372.37	8.53	257.28	2
102	WPF-UD-OUT	243.75	415.56	71.95	242.97	2
103	SLD Check 18	119.36	182.90	55.81	89.86	2
104	SLD Check 16	99.04	113.00	85.08	19.74	2
105	SLD Check 15	70.64	90.21	51.07	27.67	2
106	SLD Check 14	76.20	102.79	49.61	37.61	2
107	SLD Check 13	111.74	127.59	95.89	22.41	2
108	SLD Check 12	96.90	128.95	64.84	45.33	2
109	SLD Check 11	64.93	68.83	61.02	5.52	2
110	SLD Check 10	71.01	86.91	55.11	22.48	2
111	SLD Check 9	62.15	65.74	58.57	5.07	2
112	SLD Check 8	62.85	72.37	53.32	13.47	2
113	SLD Check 7	57.40	63.04	51.76	7.98	2
114	SLD Check 6	56.87	65.86	47.88	12.71	2
115	SLD Check 5	48.12	52.17	44.07	5.73	2
116	SLD Check 4	50.68	61.18	40.18	14.85	2
117	SLD Check 3	46.06	48.59	43.53	3.57	2
118	SLD Check 2	61.10	86.14	36.07	35.41	2
119	SLD Check 1	59.46	63.19	55.73	5.28	2
120	South Marsh 1 Intermediary	20.38	41.65	6.31	10.23	11
121	South Marsh 1 East	9.52	33.38	1.98	9.49	10
122	South Marsh 1 West	20.87	82.89	2.72	26.34	9
123	Ramona Lake NW Quad	169.29	241.71	96.87	102.42	2
124	Ramona Lake NE Quad	60.69	64.36	57.02	5.19	2
125	Ramona Lake SW Quad	109.84	109.84	109.84	na	1
126	Ramona Lake SE Quad	77.12	77.12	77.12	na	1
129	Hollow Tree drain	61.40	83.20	37.42	22.97	3
130	Marshall Rd Reservoir Entrance	235.98	775.62	70.88	248.40	7
131	Marshall Rd Reservoir Exit	84.32	185.89	28.78	54.46	7
132	Marshall Rd Res Pond 1W	69.52	127.29	32.92	41.93	5
133	Marshall Rd Res Pond 2E	84.58	157.59	28.38	49.23	5
135	Modesto ID Main Drain Spill	47.52	127.84	19.34	39.98	6

Volatile Suspended Solids

DO site number	Site name	Average of VSS, mg/L	Max of VSS, mg/L	Min of VSS, mg/L	StdDev of VSS, mg/L	Count of VSS, mg/L
1	SJR at Channel Point	7.31	9.53	5.09	3.14	2
2	SJR at Dos Reis Lathrop	9.73	10.94	8.52	1.71	2
3	SJR at Old River	8.76	9.97	7.55	1.72	2
4	SJR at Mossdale	6.68	15.69	0.51	3.73	64
5	SJR at Vernalis	6.46	19.70	0.68	3.37	75
6	SJR at Maze	7.75	40.96	0.42	5.95	69
7	SJR at Patterson	8.84	41.99	0.13	5.64	77
8	SJR at Crows Landing	7.67	13.70	0.53	3.05	82
9	SJR at Fremont Ford	12.37	17.80	5.24	4.82	5
10	SJR at Lander Avenue	10.23	26.62	0.55	5.42	81
11	French Camp Slough	6.36	22.34	0.33	7.61	7
12	Stanislaus River at Caswell Park	1.92	7.96	0.00	1.27	66
13	Stanislaus River at Ripon	4.55	4.55	4.55	na	1
14	Tuolumne River at Shiloh Bridge	1.93	8.23	0.03	1.39	66
16	Merced River at River Road	2.54	15.44	0.00	2.24	66
17	Merced River near Stevinson	0.74	0.74	0.74	na	1
18	Mud Slough near Gustine	13.29	28.47	0.49	5.77	76
19	Salt Slough at Lander Avenue	10.72	21.65	0.89	4.47	104
20	Los Banos Creek at Highway 140	13.03	37.01	1.36	8.45	67
21	Orestimba Creek at River Road	13.93	51.15	0.84	9.68	58
22	Modesto ID Lateral 4 to SJR	1.69	2.96	0.75	0.87	6
23	Modesto ID Lateral 5 to Tuolumne	2.73	18.95	0.00	3.47	28
24	Modesto ID Lateral 6 to Stanislaus River	2.88	4.50	1.26	2.29	2
25	MID Main Drain to Stan. R. via Miller Lake	8.91	104.79	1.02	16.35	38
26	Turlock ID Highline Spill	1.03	1.27	0.79	0.34	2
27	Turlock ID Lateral 2 to SJR	4.45	12.95	1.00	5.72	4
28	Turlock ID Westport Drain Flow Station	2.92	8.62	0.09	1.80	49
29	Turlock ID Harding Drain	4.55	15.32	0.15	3.13	64
30	Turlock ID Lateral 6 & 7 at Levee	2.16	8.45	0.36	1.66	34
31	BCID - New Jerusalem Drain	0.57	1.20	0.00	0.40	9
32	El Solyo WD - Grayson Drain	58.68	82.75	33.36	18.10	5
33	Hospital Creek	60.38	344.24	0.49	87.55	17
34	Ingram Creek Flow Station	35.56	180.13	1.22	38.97	43
35	Westley Wasteway Flow Station	35.19	147.77	5.75	51.88	7
36	Del Puerto Creek Flow Station	12.82	126.36	0.70	18.40	57
38	Marshall Road Drain	19.08	72.85	3.87	22.20	8
39	Salado Creek Flow Station	25.06	64.21	10.56	26.13	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	16.61	37.22	0.43	7.05	76
45	Volta Wasteway at Ingomar Grade	3.10	5.18	1.30	1.22	11
46	Mud Slough at Gun Club Road	9.88	21.66	5.55	5.42	10
47	Delta-Mendota Cal Hwy 140	2.10	2.40	1.79	0.31	3
48	FC-5 Grasslands Area Farmers	12.54	13.92	11.17	1.94	2
49	PE-14-Grasslands Area Farmers	17.88	20.44	15.32	3.62	2
50	San Luis Drain Site A (Check 18)	10.51	15.48	4.88	4.35	4
51	Arroyo Cal at Hwy 152	14.20	16.14	12.25	2.75	2
52	Salt Slough at Sand Dam	6.30	10.09	1.21	4.58	3
53	Salt Slough at Wolfsen Road	9.42	20.52	3.26	3.44	30
57	Ramona Lake Drain at Levee	22.84	40.77	3.50	9.15	27
59	SJR Laird Park	9.37	29.31	2.78	6.10	22
60	Moffit 1 South	1.85	7.90	0.24	1.98	19
61	Deadman's Slough	6.29	29.56	0.41	6.68	24
62	Mallard Slough	3.89	18.74	0.29	3.86	23
63	Inlet C Canal	8.33	16.18	1.66	3.65	27

DO site number	Site name	Average of VSS, mg/L	Max of VSS, mg/L	Min of VSS, mg/L	StdDev of VSS, mg/L	Count of VSS, mg/L
64	Moran Drain	10.64	21.09	3.28	5.88	6
65	Spanish Grant Drain	22.11	43.35	4.42	14.63	7
66	ESWD Maze Blv. Drain	27.62	102.66	1.40	50.03	4
67	Newman Wasteway at Brazo Road	10.55	19.36	4.59	5.11	7
68	S. Lake Basin	11.04	22.31	3.08	8.23	5
69	Santa Fe Canal	2.00	2.00	2.00	na	1
80	South Marsh 1 Inlet	4.18	8.80	1.02	1.97	18
81	South Marsh 1 Outlet	3.41	24.67	0.30	5.46	20
82	South Marsh 3 Inlet	7.26	48.91	0.84	9.59	25
83	South Marsh 3 Outlet	6.16	27.64	1.41	6.81	27
84	SJR Garwood Bridge	7.14	7.14	7.14	na	1
86	Ramona Drain Apple Ave	13.69	33.56	7.31	7.72	9
87	Ramona Drain Prune Ave	5.01	7.87	3.04	2.53	3
88	Ramona Drain Apricot Ave	18.85	35.01	3.75	12.16	9
89	Ramona Drain Pomelo Ave	21.96	30.31	16.49	7.35	3
90	Ramona Drain Almond Ave	13.01	13.01	13.01	na	1
91	Paradise Drain Prune Ave	8.66	8.66	8.66	na	1
92	Paradise Drain Apricot Ave	7.50	9.14	3.69	1.99	7
93	Paradise Drain Pomelo Ave	22.57	33.01	4.48	15.73	3
94	Paradise Drain Almond Ave	15.10	17.78	11.88	1.94	7
95	Ramona Lake Entrance	17.53	24.15	7.34	4.04	16
96	WPF-VD-1	38.14	38.14	38.14	na	1
97	WPF-VD-2	17.81	17.81	17.81	na	1
98	WPF-VD-3	29.32	29.32	29.32	na	1
101	WPF-UD-IN	17.54	32.99	2.09	21.85	2
102	WPF-UD-OUT	22.56	36.85	8.27	20.21	2
103	SLD Check 18	12.88	16.88	8.88	5.66	2
104	SLD Check 16	11.29	12.16	10.43	1.22	2
105	SLD Check 15	11.12	11.39	10.85	0.38	2
106	SLD Check 14	12.91	15.99	9.84	4.35	2
107	SLD Check 13	16.96	19.01	14.91	2.90	2
108	SLD Check 12	16.79	21.31	12.26	6.40	2
109	SLD Check 11	14.25	14.55	13.95	0.42	2
110	SLD Check 10	15.64	18.86	12.43	4.55	2
111	SLD Check 9	16.62	17.21	16.03	0.84	2
112	SLD Check 8	17.32	18.11	16.54	1.11	2
113	SLD Check 7	16.19	16.23	16.15	0.06	2
114	SLD Check 6	18.01	19.25	16.77	1.75	2
115	SLD Check 5	16.00	18.01	13.99	2.84	2
116	SLD Check 4	19.69	24.12	15.25	6.27	2
117	SLD Check 3	20.42	23.73	17.10	4.69	2
118	SLD Check 2	19.77	24.30	15.24	6.41	2
119	SLD Check 1	23.28	28.13	18.43	6.85	2
120	South Marsh 1 Intermediary	3.19	4.51	2.28	0.76	11
121	South Marsh 1 East	3.86	11.68	0.34	3.59	10
122	South Marsh 1 West	6.76	15.74	2.22	3.92	9
123	Ramona Lake NW Quad	58.11	77.68	38.54	27.67	2
124	Ramona Lake NE Quad	14.55	14.77	14.33	0.31	2
125	Ramona Lake SW Quad	36.90	36.90	36.90	na	1
126	Ramona Lake SE Quad	26.12	26.12	26.12	na	1
129	Hollow Tree drain	15.02	18.20	10.82	3.80	3
130	Marshall Rd Reservoir Entrance	19.83	58.09	8.91	17.74	7
131	Marshall Rd Reservoir Exit	12.18	21.72	5.82	5.58	7
132	Marshall Rd Res Pond 1W	9.58	13.86	6.61	3.24	5
133	Marshall Rd Res Pond 2E	10.64	14.82	5.72	3.92	5
135	Modesto ID Main Drain Spill	5.07	6.34	3.54	0.99	6

Total Nitrogen (analyzed by UC Davis)

DO site number	Site name	Average of UC Davis Total-N mg/L	Max of UC Davis Total-N mg/L	Min of UC Davis Total-N mg/L	StdDev of UC Davis Total-N mg/L	Count of UC Davis Total N mg/L
1	SJR at Channel Point	2.07	2.12	2.02	0.08	2
2	SJR at Dos Reis Lathrop	1.48	1.53	1.42	0.08	2
3	SJR at Old River	1.69	1.83	1.56	0.19	2
4	SJR at Mossdale	1.74	2.76	0.32	0.66	64
5	SJR at Vernalis	1.79	2.94	0.31	0.70	70
6	SJR at Maze	2.52	4.10	0.35	1.13	68
7	SJR at Patterson	3.26	6.02	0.49	1.49	72
8	SJR at Crows Landing	2.94	6.45	0.44	1.31	78
9	SJR at Fremont Ford	2.28	4.82	1.16	1.70	4
10	SJR at Lander Avenue	2.41	9.58	0.02	1.84	81
11	French Camp Slough	1.81	2.33	0.76	0.54	7
12	Stanislaus River at Caswell Park	0.43	0.98	0.10	0.17	65
13	Stanislaus River at Ripon	0.79	0.79	0.79	na	1
14	Tuolumne River at Shiloh Bridge	1.41	3.00	0.19	0.78	66
16	Merced River at River Road	1.97	12.85	0.20	1.93	65
17	Merced River near Stevinson	0.17	0.17	0.17	na	1
18	Mud Slough near Gustine	6.04	15.96	1.51	3.30	74
19	Salt Slough at Lander Avenue	2.03	5.32	0.58	1.06	101
20	Los Banos Creek at Highway 140	2.17	5.94	0.56	1.07	65
21	Orestimba Creek at River Road	4.69	13.01	0.45	3.20	57
22	Modesto ID Lateral 4 to SJR	1.54	5.24	0.30	1.88	6
23	Modesto ID Lateral 5 to Tuolumne	1.87	18.35	0.08	3.56	29
24	Modesto ID Lateral 6 to Stanislaus River	0.68	0.92	0.44	0.34	2
25	MID Main Drain to Stan. R. via Miller Lake	3.43	30.79	0.59	4.61	40
26	Turlock ID Highline Spill	0.24	0.30	0.17	0.09	2
27	Turlock ID Lateral 2 to SJR	1.90	4.07	0.30	1.83	4
28	Turlock ID Westport Drain Flow Station	13.53	30.53	2.21	6.15	50
29	Turlock ID Harding Drain	10.69	23.30	4.56	4.05	64
30	Turlock ID Lateral 6 & 7 at Levee	16.39	40.06	6.41	5.39	35
31	BCID - New Jerusalem Drain	14.50	16.79	13.36	1.00	9
32	El Solyo WD - Grayson Drain	7.53	21.46	2.75	7.85	5
33	Hospital Creek	2.70	5.65	0.83	1.51	17
34	Ingram Creek Flow Station	7.36	16.94	1.64	4.30	44
35	Westley Wasteway Flow Station	2.42	4.30	0.37	1.41	7
36	Del Puerto Creek Flow Station	5.75	19.56	0.22	3.46	57
38	Marshall Road Drain	4.60	9.08	1.31	2.80	8
39	Salado Creek Flow Station	5.51	11.68	1.84	4.27	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	13.99	28.63	3.76	5.44	72
45	Volta Wasteway at Ingomar Grade	2.81	5.36	1.00	1.62	11
46	Mud Slough at Gun Club Road	1.40	2.23	0.77	0.45	11
47	Delta-Mendota Cal Hwy 140	3.64	9.15	0.38	4.80	3
48	FC-5 Grasslands Area Farmers	18.11	23.02	13.19	6.96	2
49	PE-14-Grasslands Area Farmers	16.93	23.00	10.86	8.59	2
50	San Luis Drain Site A (Check 18)	15.60	18.25	13.61	1.95	4
51	Arroyo Cal at Hwy 152	1.57	1.66	1.47	0.13	2
52	Salt Slough at Sand Dam	2.85	4.25	1.99	1.23	3
53	Salt Slough at Wolfsen Road	1.76	4.43	0.68	0.92	30
57	Ramona Lake Drain at Levee	4.10	5.67	2.81	0.89	28
59	SJR Laird Park	2.74	8.06	0.57	1.46	22
60	Moffit 1 South	0.95	2.10	0.37	0.47	19
61	Deadman's Slough	1.25	3.99	0.29	0.77	24
62	Mallard Slough	0.88	2.30	0.33	0.46	23
63	Inlet C Canal	2.06	5.53	0.81	1.34	27

DO site number	Site name	Average of UC Davis Total-N mg/L	Max of UC Davis Total-N mg/L	Min of UC Davis Total-N mg/L	StdDev of UC Davis Total-N mg/L	Count of UC Davis Total N mg/L
64	Moran Drain	3.89	6.43	1.14	2.60	6
65	Spanish Grant Drain	6.84	11.28	3.19	2.84	7
66	ESWD Maze Blv. Drain	1.37	2.25	0.53	0.82	4
67	Newman Wasteway at Brazo Road	3.83	5.79	0.95	1.66	7
68	S. Lake Basin	1.69	3.78	0.45	1.29	5
69	Santa Fe Canal	2.38	2.38	2.38	na	1
80	South Marsh 1 Inlet	1.68	5.24	0.62	1.37	18
81	South Marsh 1 Outlet	1.06	4.42	0.25	1.02	20
82	South Marsh 3 Inlet	1.03	2.03	0.16	0.48	25
83	South Marsh 3 Outlet	0.84	1.64	0.35	0.30	28
84	SJR Garwood Bridge	2.23	2.23	2.23	na	1
86	Ramona Drain Apple Ave	7.43	24.48	2.48	7.73	9
87	Ramona Drain Prune Ave	2.96	3.72	1.76	1.05	3
88	Ramona Drain Apricot Ave	5.02	13.76	0.40	3.86	9
89	Ramona Drain Pomelo Ave	4.88	6.11	3.59	1.26	3
90	Ramona Drain Almond Ave	6.27	6.27	6.27	na	1
91	Paradise Drain Prune Ave	2.02	2.02	2.02	na	1
92	Paradise Drain Apricot Ave	2.86	4.54	1.08	1.27	7
93	Paradise Drain Pomelo Ave	2.40	4.53	1.20	1.85	3
94	Paradise Drain Almond Ave	3.98	5.61	1.58	1.31	7
95	Ramona Lake Entrance	5.17	7.65	3.10	1.33	15
96	WPF-VD-1	17.47	17.47	17.47	na	1
97	WPF-VD-2	18.54	18.54	18.54	na	1
98	WPF-VD-3	15.89	15.89	15.89	na	1
101	WPF-UD-IN	13.18	16.57	9.78	4.80	2
102	WPF-UD-OUT	10.44	16.80	4.07	9.00	2
103	SLD Check 18	16.67	18.40	14.94	2.45	2
104	SLD Check 16	17.16	18.69	15.64	2.16	2
105	SLD Check 15	16.60	17.48	15.72	1.24	2
106	SLD Check 14	15.76	17.33	14.19	2.22	2
107	SLD Check 13	14.74	16.47	13.02	2.44	2
108	SLD Check 12	15.28	17.21	13.34	2.74	2
109	SLD Check 11	14.40	16.21	12.59	2.56	2
110	SLD Check 10	14.25	14.84	13.66	0.84	2
111	SLD Check 9	15.24	16.77	13.70	2.17	2
112	SLD Check 8	15.95	17.52	14.39	2.21	2
113	SLD Check 7	15.39	16.54	14.25	1.62	2
114	SLD Check 6	15.25	16.91	13.59	2.35	2
115	SLD Check 5	14.23	14.39	14.07	0.23	2
116	SLD Check 4	14.83	15.47	14.18	0.91	2
117	SLD Check 3	14.23	14.88	13.58	0.92	2
118	SLD Check 2	13.70	13.89	13.51	0.27	2
119	SLD Check 1	13.71	15.00	12.41	1.83	2
120	South Marsh 1 Intermediary	1.31	4.42	0.53	1.07	11
121	South Marsh 1 East	1.40	3.51	0.38	1.17	10
122	South Marsh 1 West	1.42	2.33	0.05	0.75	9
123	Ramona Lake NW Quad	4.52	4.52	4.52	na	1
124	Ramona Lake NE Quad	4.76	4.76	4.76	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	1.50	1.78	1.34	0.24	3
130	Marshall Rd Reservoir Entrance	3.36	5.79	1.79	1.54	7
131	Marshall Rd Reservoir Exit	3.67	6.13	2.39	1.51	7
132	Marshall Rd Res Pond 1W	3.36	5.72	2.00	1.42	5
133	Marshall Rd Res Pond 2E	3.38	5.56	2.20	1.35	5
135	Modesto ID Main Drain Spill	3.42	4.95	0.99	1.49	6

Ammonium (NH4-N) (analyzed by UC Davis)

DO site number	Site name	Average of UC Davis NH4-N, mg/L	Max of UC Davis NH4-N, mg/L	Min of UC Davis NH4-N, mg/L	StdDev of UC Davis NH4-N, mg/L	Count of UC Davis NH4-N, mg/L
1	SJR at Channel Point	0.29	0.40	0.18	0.16	2
2	SJR at Dos Reis Lathrop	0.06	0.10	0.02	0.05	2
3	SJR at Old River	0.06	0.10	0.02	0.05	2
4	SJR at Mossdale	0.03	0.10	0.00	0.02	65
5	SJR at Vernalis	0.04	0.13	0.01	0.03	72
6	SJR at Maze	0.04	0.17	0.01	0.04	69
7	SJR at Patterson	0.04	0.45	0.00	0.06	74
8	SJR at Crows Landing	0.04	0.21	0.00	0.04	80
9	SJR at Fremont Ford	0.02	0.03	0.01	0.01	5
10	SJR at Lander Avenue	0.05	0.52	0.01	0.07	83
11	French Camp Slough	0.06	0.16	0.01	0.05	7
12	Stanislaus River at Caswell Park	0.04	0.40	0.00	0.05	67
13	Stanislaus River at Ripon	0.02	0.02	0.02	na	1
14	Tuolumne River at Shiloh Bridge	0.03	0.15	0.00	0.03	68
16	Merced River at River Road	0.05	0.14	0.01	0.03	67
17	Merced River near Stevinson	0.03	0.03	0.03	na	1
18	Mud Slough near Gustine	0.11	1.09	0.01	0.14	76
19	Salt Slough at Lander Avenue	0.10	1.25	0.01	0.13	103
20	Los Banos Creek at Highway 140	0.23	3.22	0.01	0.43	66
21	Orestimba Creek at River Road	0.21	5.76	0.01	0.77	58
22	Modesto ID Lateral 4 to SJR	0.05	0.08	0.03	0.02	6
23	Modesto ID Lateral 5 to Tuolumne	0.14	1.16	0.01	0.25	29
24	Modesto ID Lateral 6 to Stanislaus River	0.16	0.26	0.07	0.14	2
25	MID Main Drain to Stan. R. via Miller Lake	0.72	21.76	0.01	3.44	40
26	Turlock ID Highline Spill	0.06	0.08	0.03	0.04	2
27	Turlock ID Lateral 2 to SJR	0.02	0.02	0.01	0.01	4
28	Turlock ID Westport Drain Flow Station	0.11	1.44	0.02	0.22	50
29	Turlock ID Harding Drain	0.28	2.67	0.02	0.44	65
30	Turlock ID Lateral 6 & 7 at Levee	0.13	0.91	0.02	0.20	35
31	BCID - New Jerusalem Drain	0.02	0.10	0.00	0.03	9
32	El Solyo WD - Grayson Drain	1.14	4.99	0.01	2.17	5
33	Hospital Creek	0.15	0.77	0.02	0.21	17
34	Ingram Creek Flow Station	0.49	2.85	0.02	0.72	44
35	Westley Wasteway Flow Station	0.09	0.20	0.04	0.06	7
36	Del Puerto Creek Flow Station	0.46	4.93	0.00	0.85	58
38	Marshall Road Drain	0.17	0.67	0.05	0.21	8
39	Salado Creek Flow Station	0.47	1.36	0.04	0.60	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	0.07	0.58	0.00	0.11	73
45	Volta Wasteway at Ingomar Grade	0.07	0.28	0.02	0.07	11
46	Mud Slough at Gun Club Road	0.11	0.18	0.01	0.05	11
47	Delta-Mendota Cal Hwy 140	0.87	2.58	0.01	1.48	3
48	FC-5 Grasslands Area Farmers	0.19	0.33	0.04	0.21	2
49	PE-14-Grasslands Area Farmers	0.04	0.06	0.02	0.03	2
50	San Luis Drain Site A (Check 18)	0.03	0.04	0.02	0.01	4
51	Arroyo Cal at Hwy 152	0.08	0.13	0.04	0.06	2
52	Salt Slough at Sand Dam	0.23	0.47	0.10	0.20	3
53	Salt Slough at Wolfsen Road	0.13	0.39	0.04	0.08	30
57	Ramona Lake Drain at Levee	0.31	1.38	0.01	0.34	28
59	SJR Laird Park	0.08	0.39	0.00	0.10	22
60	Moffit 1 South	0.08	0.25	0.01	0.06	19
61	Deadman's Slough	0.11	0.65	0.01	0.13	24
62	Mallard Slough	0.08	0.32	0.01	0.08	23
63	Inlet C Canal	0.11	0.64	0.02	0.13	27

DO site number	Site name	Average of UC Davis NH4-N, mg/L	Max of UC Davis NH4-N, mg/L	Min of UC Davis NH4-N, mg/L	StdDev of UC Davis NH4-N, mg/L	Count of UC Davis NH4-N, mg/L
64	Moran Drain	0.06	0.10	0.02	0.03	6
65	Spanish Grant Drain	0.13	0.25	0.04	0.09	7
66	ESWD Maze Blv. Drain	0.09	0.26	0.03	0.11	4
67	Newman Wasteway at Brazo Road	0.26	0.98	0.05	0.33	7
68	S. Lake Basin	0.10	0.24	0.01	0.09	5
69	Santa Fe Canal	0.03	0.03	0.03	na	1
80	South Marsh 1 Inlet	0.07	0.29	0.02	0.08	18
81	South Marsh 1 Outlet	0.17	2.52	0.02	0.55	20
82	South Marsh 3 Inlet	0.11	0.57	0.01	0.12	25
83	South Marsh 3 Outlet	0.05	0.17	0.01	0.04	28
84	SJR Garwood Bridge	0.80	0.80	0.80	na	1
86	Ramona Drain Apple Ave	1.44	5.89	0.04	2.16	9
87	Ramona Drain Prune Ave	0.82	1.22	0.36	0.43	3
88	Ramona Drain Apricot Ave	0.89	2.25	0.01	0.80	9
89	Ramona Drain Pomelo Ave	1.25	2.12	0.70	0.76	3
90	Ramona Drain Almond Ave	0.58	0.58	0.58	na	1
91	Paradise Drain Prune Ave	0.16	0.16	0.16	na	1
92	Paradise Drain Apricot Ave	0.15	0.29	0.01	0.10	7
93	Paradise Drain Pomelo Ave	0.28	0.61	0.08	0.29	3
94	Paradise Drain Almond Ave	0.34	0.72	0.08	0.26	7
95	Ramona Lake Entrance	0.38	1.68	0.04	0.40	15
96	WPF-VD-1	3.54	3.54	3.54	na	1
97	WPF-VD-2	3.31	3.31	3.31	na	1
98	WPF-VD-3	4.37	4.37	4.37	na	1
101	WPF-UD-IN	1.87	3.63	0.10	2.50	2
102	WPF-UD-OUT	1.89	3.39	0.39	2.12	2
103	SLD Check 18	0.02	0.02	0.02	0.00	2
104	SLD Check 16	0.02	0.02	0.02	0.00	2
105	SLD Check 15	0.03	0.03	0.03	0.00	2
106	SLD Check 14	0.03	0.03	0.03	0.00	2
107	SLD Check 13	0.02	0.02	0.02	0.00	2
108	SLD Check 12	0.02	0.02	0.02	0.00	2
109	SLD Check 11	0.02	0.02	0.02	0.00	2
110	SLD Check 10	0.02	0.03	0.02	0.01	2
111	SLD Check 9	0.02	0.03	0.02	0.01	2
112	SLD Check 8	0.02	0.03	0.02	0.01	2
113	SLD Check 7	0.02	0.03	0.02	0.01	2
114	SLD Check 6	0.03	0.03	0.02	0.01	2
115	SLD Check 5	0.02	0.03	0.02	0.01	2
116	SLD Check 4	0.03	0.03	0.02	0.01	2
117	SLD Check 3	0.04	0.04	0.03	0.01	2
118	SLD Check 2	0.04	0.04	0.03	0.01	2
119	SLD Check 1	0.07	0.08	0.05	0.02	2
120	South Marsh 1 Intermediary	0.09	0.36	0.02	0.10	11
121	South Marsh 1 East	0.09	0.40	0.02	0.11	10
122	South Marsh 1 West	0.05	0.12	0.02	0.03	9
123	Ramona Lake NW Quad	0.17	0.17	0.17	na	1
124	Ramona Lake NE Quad	0.08	0.08	0.08	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	0.11	0.15	0.02	0.08	3
130	Marshall Rd Reservoir Entrance	0.06	0.16	0.02	0.05	7
131	Marshall Rd Reservoir Exit	0.07	0.14	0.01	0.05	7
132	Marshall Rd Res Pond 1W	0.08	0.24	0.02	0.09	5
133	Marshall Rd Res Pond 2E	0.08	0.26	0.01	0.10	5
135	Modesto ID Main Drain Spill	0.13	0.35	0.06	0.11	6

Nitrate (NO3-N) (analyzed by UC Davis)

DO site number	Site name	Average of UC Davis NO3-N, mg/L	Max of UC Davis NO3-N, mg/L	Min of UC Davis NO3-N, mg/L	StdDev of UC Davis NO3-N, mg/L	Count of UC Davis NO3-N, mg/L
1	SJR at Channel Point	1.09	1.30	0.89	0.28	2
2	SJR at Dos Reis Lathrop	0.79	0.83	0.74	0.06	2
3	SJR at Old River	0.95	0.96	0.95	0.01	2
4	SJR at Mossdale	1.24	2.45	0.08	0.61	65
5	SJR at Vernalis	1.32	2.78	0.07	0.65	72
6	SJR at Maze	1.94	3.72	0.06	1.00	69
7	SJR at Patterson	2.55	5.90	0.08	1.40	74
8	SJR at Crows Landing	2.24	6.11	0.08	1.25	80
9	SJR at Fremont Ford	1.40	3.44	0.15	1.29	5
10	SJR at Lander Avenue	1.38	6.65	0.01	1.54	83
11	French Camp Slough	1.33	2.03	0.49	0.56	7
12	Stanislaus River at Caswell Park	0.23	0.74	0.03	0.13	67
13	Stanislaus River at Ripon	0.33	0.33	0.33	na	1
14	Tuolumne River at Shiloh Bridge	1.10	2.42	0.02	0.75	68
16	Merced River at River Road	1.65	12.43	0.04	1.86	67
17	Merced River near Stevinson	0.11	0.11	0.11	na	1
18	Mud Slough near Gustine	4.82	14.96	0.14	3.28	76
19	Salt Slough at Lander Avenue	1.28	4.31	0.01	0.96	103
20	Los Banos Creek at Highway 140	0.62	2.09	0.01	0.53	66
21	Orestimba Creek at River Road	3.84	12.04	0.05	2.97	58
22	Modesto ID Lateral 4 to SJR	1.19	4.69	0.01	1.80	6
23	Modesto ID Lateral 5 to Tuolumne	1.32	17.97	0.00	3.36	29
24	Modesto ID Lateral 6 to Stanislaus River	0.09	0.11	0.06	0.04	2
25	MID Main Drain to Stan. R. via Miller Lake	1.73	4.44	0.00	1.31	40
26	Turlock ID Highline Spill	0.08	0.13	0.03	0.07	2
27	Turlock ID Lateral 2 to SJR	1.62	3.68	0.06	1.73	4
28	Turlock ID Westport Drain Flow Station	11.95	29.83	0.62	6.06	50
29	Turlock ID Harding Drain	9.56	22.39	4.21	3.84	65
30	Turlock ID Lateral 6 & 7 at Levee	14.95	36.46	5.66	5.15	35
31	BCID - New Jerusalem Drain	13.78	14.96	12.82	0.73	9
32	El Solyo WD - Grayson Drain	5.29	15.87	0.86	6.10	5
33	Hospital Creek	1.28	3.72	0.35	0.97	17
34	Ingram Creek Flow Station	5.74	16.53	0.61	3.57	44
35	Westley Wasteway Flow Station	1.50	4.26	0.10	1.30	7
36	Del Puerto Creek Flow Station	4.04	10.71	0.01	2.15	58
38	Marshall Road Drain	3.41	8.25	1.03	2.40	8
39	Salado Creek Flow Station	3.44	7.13	0.70	2.73	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	13.05	30.29	2.82	5.85	73
45	Volta Wasteway at Ingomar Grade	2.45	4.73	0.74	1.48	11
46	Mud Slough at Gun Club Road	0.06	0.13	0.01	0.04	11
47	Delta-Mendota Cal Hwy 140	1.46	3.24	0.16	1.60	3
48	FC-5 Grasslands Area Farmers	16.20	21.19	11.20	7.07	2
49	PE-14-Grasslands Area Farmers	15.53	22.16	8.91	9.37	2
50	San Luis Drain Site A (Check 18)	14.45	16.96	11.76	2.13	4
51	Arroyo Cal at Hwy 152	0.60	0.76	0.44	0.23	2
52	Salt Slough at Sand Dam	2.09	3.21	1.29	1.00	3
53	Salt Slough at Wolfsen Road	1.04	3.93	0.20	0.85	30
57	Ramona Lake Drain at Levee	2.05	4.02	0.09	1.03	28
59	SJR Laird Park	2.05	6.63	0.16	1.31	22
60	Moffit 1 South	0.05	0.77	0.00	0.17	19
61	Deadman's Slough	0.31	3.24	0.00	0.69	24
62	Mallard Slough	0.09	0.45	0.00	0.14	23
63	Inlet C Canal	1.55	4.92	0.53	1.21	27

DO site number	Site name	Average of UC Davis NO3-N, mg/L	Max of UC Davis NO3-N, mg/L	Min of UC Davis NO3-N, mg/L	StdDev of UC Davis NO3-N, mg/L	Count of UC Davis NO3-N, mg/L
64	Moran Drain	3.29	6.32	0.39	2.83	6
65	Spanish Grant Drain	5.74	9.82	2.63	2.58	7
66	ESWD Maze Blv. Drain	0.74	1.26	0.35	0.39	4
67	Newman Wasteway at Brazo Road	3.01	5.28	0.36	1.58	7
68	S. Lake Basin	0.80	3.01	0.02	1.28	5
69	Santa Fe Canal	1.89	1.89	1.89	na	1
80	South Marsh 1 Inlet	1.16	4.58	0.13	1.23	18
81	South Marsh 1 Outlet	0.15	2.66	0.00	0.59	20
82	South Marsh 3 Inlet	0.09	0.78	0.00	0.19	25
83	South Marsh 3 Outlet	0.03	0.38	0.00	0.07	28
84	SJR Garwood Bridge	0.70	0.70	0.70	na	1
86	Ramona Drain Apple Ave	3.16	6.90	1.65	1.96	9
87	Ramona Drain Prune Ave	1.00	1.64	0.64	0.55	3
88	Ramona Drain Apricot Ave	2.25	4.64	0.17	1.71	9
89	Ramona Drain Pomelo Ave	2.02	2.32	1.68	0.32	3
90	Ramona Drain Almond Ave	4.22	4.22	4.22	na	1
91	Paradise Drain Prune Ave	0.15	0.15	0.15	na	1
92	Paradise Drain Apricot Ave	1.98	4.08	0.19	1.43	7
93	Paradise Drain Pomelo Ave	1.12	2.37	0.41	1.09	3
94	Paradise Drain Almond Ave	2.74	3.71	0.77	1.11	7
95	Ramona Lake Entrance	3.43	6.30	1.18	1.30	15
96	WPF-VD-1	4.35	4.35	4.35	na	1
97	WPF-VD-2	4.89	4.89	4.89	na	1
98	WPF-VD-3	5.95	5.95	5.95	na	1
101	WPF-UD-IN	4.53	4.55	4.52	0.02	2
102	WPF-UD-OUT	3.54	4.72	2.36	1.67	2
103	SLD Check 18	16.00	17.63	14.37	2.30	2
104	SLD Check 16	15.98	17.73	14.24	2.47	2
105	SLD Check 15	15.17	17.39	12.94	3.15	2
106	SLD Check 14	14.87	16.42	13.32	2.19	2
107	SLD Check 13	14.36	16.40	12.31	2.89	2
108	SLD Check 12	14.99	16.69	13.28	2.42	2
109	SLD Check 11	14.32	16.07	12.57	2.48	2
110	SLD Check 10	14.22	14.81	13.64	0.82	2
111	SLD Check 9	14.70	16.00	13.41	1.84	2
112	SLD Check 8	14.47	16.27	12.67	2.54	2
113	SLD Check 7	14.76	15.86	13.67	1.55	2
114	SLD Check 6	14.67	15.96	13.39	1.81	2
115	SLD Check 5	13.72	13.74	13.70	0.03	2
116	SLD Check 4	13.81	14.23	13.39	0.60	2
117	SLD Check 3	14.01	14.52	13.51	0.72	2
118	SLD Check 2	13.46	13.63	13.29	0.24	2
119	SLD Check 1	12.80	13.50	12.11	0.98	2
120	South Marsh 1 Intermediary	0.85	3.69	0.12	0.98	11
121	South Marsh 1 East	0.44	2.60	0.00	0.78	10
122	South Marsh 1 West	0.01	0.01	0.00	0.01	9
123	Ramona Lake NW Quad	0.10	0.10	0.10	na	1
124	Ramona Lake NE Quad	3.19	3.19	3.19	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	0.02	0.04	0.01	0.02	3
130	Marshall Rd Reservoir Entrance	2.86	5.54	1.27	1.55	7
131	Marshall Rd Reservoir Exit	2.84	5.52	1.49	1.72	7
132	Marshall Rd Res Pond 1W	2.78	4.91	1.60	1.29	5
133	Marshall Rd Res Pond 2E	2.76	4.89	1.50	1.32	5
135	Modesto ID Main Drain Spill	2.80	4.58	0.42	1.53	6

Total Phosphorus (analyzed by UC Davis)

DO site number	Site name	Average of UC Davis Total P mg/L	Max of UC Davis Total P mg/L	Min of UC Davis Total P mg/L	StdDev of UC Davis Total P mg/L	Count of UC Davis Total P mg/L
1	SJR at Channel Point	0.19	0.22	0.15	0.05	2
2	SJR at Dos Reis Lathrop	0.18	0.19	0.17	0.01	2
3	SJR at Old River	0.17	0.18	0.15	0.03	2
4	SJR at Mossdale	0.18	0.38	0.06	0.06	64
5	SJR at Vernalis	0.17	0.64	0.06	0.08	70
6	SJR at Maze	0.21	0.41	0.05	0.07	68
7	SJR at Patterson	0.33	0.80	0.09	0.13	72
8	SJR at Crows Landing	0.19	0.38	0.07	0.06	78
9	SJR at Fremont Ford	0.35	0.43	0.26	0.07	4
10	SJR at Lander Avenue	0.23	0.50	0.06	0.09	81
11	French Camp Slough	0.19	0.26	0.16	0.04	7
12	Stanislaus River at Caswell Park	0.06	0.32	0.01	0.04	65
13	Stanislaus River at Ripon	0.05	0.05	0.05	na	1
14	Tuolumne River at Shiloh Bridge	0.09	0.39	0.01	0.07	66
16	Merced River at River Road	0.06	0.40	0.01	0.06	65
17	Merced River near Stevinson	0.03	0.03	0.03	na	1
18	Mud Slough near Gustine	0.22	0.56	0.04	0.11	74
19	Salt Slough at Lander Avenue	0.35	0.75	0.14	0.13	101
20	Los Banos Creek at Highway 140	0.62	1.46	0.20	0.29	65
21	Orestimba Creek at River Road	0.28	0.76	0.05	0.16	57
22	Modesto ID Lateral 4 to SJR	0.07	0.10	0.03	0.03	6
23	Modesto ID Lateral 5 to Tuolumne	0.15	1.43	0.01	0.30	29
24	Modesto ID Lateral 6 to Stanislaus River	0.36	0.46	0.26	0.14	2
25	MID Main Drain to Stan. R. via Miller Lake	0.55	6.34	0.04	1.00	40
26	Turlock ID Highline Spill	0.04	0.05	0.03	0.01	2
27	Turlock ID Lateral 2 to SJR	0.02	0.03	0.01	0.01	4
28	Turlock ID Westport Drain Flow Station	0.29	0.98	0.04	0.20	50
29	Turlock ID Harding Drain	2.01	5.20	0.12	1.28	64
30	Turlock ID Lateral 6 & 7 at Levee	0.59	1.22	0.29	0.21	35
31	BCID - New Jerusalem Drain	0.07	0.08	0.04	0.02	9
32	El Solyo WD - Grayson Drain	0.50	0.77	0.11	0.26	5
33	Hospital Creek	0.52	1.44	0.10	0.36	17
34	Ingram Creek Flow Station	0.40	1.49	0.04	0.27	44
35	Westley Wasteway Flow Station	0.26	0.55	0.12	0.16	7
36	Del Puerto Creek Flow Station	0.34	0.92	0.05	0.20	57
38	Marshall Road Drain	0.43	0.77	0.16	0.23	8
39	Salado Creek Flow Station	0.42	0.48	0.28	0.09	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	0.08	0.22	0.02	0.03	72
45	Volta Wasteway at Ingomar Grade	0.11	0.16	0.07	0.03	11
46	Mud Slough at Gun Club Road	0.36	0.77	0.13	0.18	11
47	Delta-Mendota Cal Hwy 140	0.23	0.44	0.11	0.18	3
48	FC-5 Grasslands Area Farmers	0.20	0.32	0.07	0.18	2
49	PE-14-Grasslands Area Farmers	0.17	0.19	0.16	0.02	2
50	San Luis Drain Site A (Check 18)	0.13	0.15	0.11	0.01	4
51	Arroyo Cal at Hwy 152	0.22	0.29	0.15	0.10	2
52	Salt Slough at Sand Dam	0.50	0.84	0.29	0.29	3
53	Salt Slough at Wolfsen Road	0.31	0.95	0.14	0.15	30
57	Ramona Lake Drain at Levee	0.42	0.85	0.15	0.18	28
59	SJR Laird Park	0.24	0.38	0.15	0.07	22
60	Moffit 1 South	0.17	0.43	0.03	0.12	19
61	Deadman's Slough	0.27	0.86	0.03	0.19	24
62	Mallard Slough	0.46	2.83	0.08	0.66	23
63	Inlet C Canal	0.28	1.13	0.04	0.22	27

DO site number	Site name	Average of UC Davis Total P mg/L	Max of UC Davis Total P mg/L	Min of UC Davis Total P mg/L	StdDev of UC Davis Total P mg/L	Count of UC Davis Total P mg/L
64	Moran Drain	0.18	0.23	0.15	0.03	6
65	Spanish Grant Drain	0.27	0.36	0.15	0.08	7
66	ESWD Maze Blv. Drain	0.18	0.35	0.06	0.13	4
67	Newman Wasteway at Brazo Road	0.29	0.52	0.19	0.12	7
68	S. Lake Basin	0.53	1.41	0.20	0.50	5
69	Santa Fe Canal	0.30	0.30	0.30	na	1
80	South Marsh 1 Inlet	0.18	0.39	0.07	0.09	18
81	South Marsh 1 Outlet	0.20	1.12	0.03	0.26	20
82	South Marsh 3 Inlet	0.41	1.71	0.13	0.34	25
83	South Marsh 3 Outlet	0.41	1.50	0.11	0.32	28
84	SJR Garwood Bridge	0.18	0.18	0.18	na	1
86	Ramona Drain Apple Ave	0.51	0.96	0.16	0.24	9
87	Ramona Drain Prune Ave	0.49	0.74	0.28	0.23	3
88	Ramona Drain Apricot Ave	0.51	0.97	0.10	0.28	9
89	Ramona Drain Pomelo Ave	0.63	0.98	0.43	0.30	3
90	Ramona Drain Almond Ave	0.27	0.27	0.27	na	1
91	Paradise Drain Prune Ave	0.23	0.23	0.23	na	1
92	Paradise Drain Apricot Ave	0.39	0.66	0.15	0.18	7
93	Paradise Drain Pomelo Ave	0.56	0.89	0.38	0.29	3
94	Paradise Drain Almond Ave	0.47	0.83	0.14	0.20	7
95	Ramona Lake Entrance	0.45	0.83	0.25	0.18	15
96	WPF-VD-1	0.76	0.76	0.76	na	1
97	WPF-VD-2	0.80	0.80	0.80	na	1
98	WPF-VD-3	2.28	2.28	2.28	na	1
101	WPF-UD-IN	0.44	0.70	0.18	0.37	2
102	WPF-UD-OUT	0.51	0.77	0.26	0.36	2
103	SLD Check 18	0.12	0.14	0.11	0.02	2
104	SLD Check 16	0.10	0.12	0.08	0.03	2
105	SLD Check 15	0.12	0.15	0.08	0.05	2
106	SLD Check 14	0.13	0.16	0.10	0.04	2
107	SLD Check 13	0.12	0.14	0.11	0.02	2
108	SLD Check 12	0.15	0.16	0.13	0.02	2
109	SLD Check 11	0.13	0.14	0.11	0.02	2
110	SLD Check 10	0.10	0.11	0.08	0.02	2
111	SLD Check 9	0.10	0.12	0.08	0.03	2
112	SLD Check 8	0.12	0.14	0.11	0.02	2
113	SLD Check 7	0.11	0.13	0.10	0.02	2
114	SLD Check 6	0.09	0.11	0.07	0.03	2
115	SLD Check 5	0.07	0.08	0.06	0.01	2
116	SLD Check 4	0.08	0.10	0.07	0.02	2
117	SLD Check 3	0.07	0.08	0.06	0.01	2
118	SLD Check 2	0.05	0.07	0.04	0.02	2
119	SLD Check 1	0.06	0.06	0.06	0.00	2
120	South Marsh 1 Intermediary	0.17	0.29	0.05	0.07	11
121	South Marsh 1 East	0.36	1.62	0.03	0.51	10
122	South Marsh 1 West	0.29	0.54	0.04	0.16	9
123	Ramona Lake NW Quad	0.54	0.54	0.54	na	1
124	Ramona Lake NE Quad	0.24	0.24	0.24	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	0.50	0.53	0.44	0.05	3
130	Marshall Rd Reservoir Entrance	0.31	0.48	0.15	0.12	7
131	Marshall Rd Reservoir Exit	0.26	0.46	0.12	0.11	7
132	Marshall Rd Res Pond 1W	0.26	0.46	0.16	0.12	5
133	Marshall Rd Res Pond 2E	0.26	0.46	0.14	0.12	5
135	Modesto ID Main Drain Spill	0.29	0.43	0.14	0.12	6

Phosphate (PO4-P) (analyzed by UC Davis)

DO site number	Site name	Average of UC Davis PO4-P, mg/L	Max of UC Davis PO4-P, mg/L	Min of UC Davis PO4-P, mg/L	StdDev of UC Davis PO4-P, mg/L	Count of UC Davis PO4-P, mg/L
1	SJR at Channel Point	0.092	0.099	0.084	0.010	2
2	SJR at Dos Reis Lathrop	0.052	0.052	0.052	0.000	2
3	SJR at Old River	0.059	0.062	0.057	0.004	2
4	SJR at Mossdale	0.095	0.194	0.005	0.041	65
5	SJR at Vernalis	0.086	0.198	0.005	0.034	72
6	SJR at Maze	0.114	0.201	0.052	0.035	69
7	SJR at Patterson	0.205	0.450	0.045	0.091	74
8	SJR at Crows Landing	0.084	0.213	0.032	0.030	80
9	SJR at Fremont Ford	0.133	0.189	0.091	0.038	5
10	SJR at Lander Avenue	0.084	0.347	0.005	0.055	83
11	French Camp Slough	0.113	0.157	0.069	0.031	7
12	Stanislaus River at Caswell Park	0.040	0.206	0.005	0.035	67
13	Stanislaus River at Ripon	0.044	0.044	0.044	na	1
14	Tuolumne River at Shiloh Bridge	0.062	0.173	0.000	0.050	68
16	Merced River at River Road	0.027	0.309	0.005	0.039	66
17	Merced River near Stevinson	0.011	0.011	0.011	na	1
18	Mud Slough near Gustine	0.074	0.318	0.000	0.087	75
19	Salt Slough at Lander Avenue	0.145	0.677	0.025	0.092	103
20	Los Banos Creek at Highway 140	0.325	1.026	0.071	0.212	66
21	Orestimba Creek at River Road	0.110	0.311	0.005	0.066	58
22	Modesto ID Lateral 4 to SJR	0.029	0.048	0.012	0.014	6
23	Modesto ID Lateral 5 to Tuolumne	0.099	1.053	0.001	0.217	29
24	Modesto ID Lateral 6 to Stanislaus River	0.294	0.381	0.206	0.123	2
25	MID Main Drain to Stan. R. via Miller Lake	0.400	5.307	0.014	0.852	40
26	Turlock ID Highline Spill	0.014	0.021	0.008	0.009	2
27	Turlock ID Lateral 2 to SJR	0.007	0.009	0.005	0.002	3
28	Turlock ID Westport Drain Flow Station	0.231	0.872	0.011	0.188	50
29	Turlock ID Harding Drain	1.793	4.740	0.064	1.208	65
30	Turlock ID Lateral 6 & 7 at Levee	0.525	1.173	0.292	0.184	35
31	BCID - New Jerusalem Drain	0.042	0.049	0.036	0.005	9
32	El Solyo WD - Grayson Drain	0.172	0.231	0.088	0.054	5
33	Hospital Creek	0.265	0.740	0.042	0.222	17
34	Ingram Creek Flow Station	0.161	0.333	0.021	0.069	44
35	Westley Wasteway Flow Station	0.113	0.185	0.019	0.059	7
36	Del Puerto Creek Flow Station	0.204	0.711	0.024	0.141	58
38	Marshall Road Drain	0.244	0.501	0.108	0.130	8
39	Salado Creek Flow Station	0.150	0.238	0.048	0.080	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	0.009	0.105	0.000	0.019	56
45	Volta Wasteway at Ingomar Grade	0.071	0.104	0.028	0.025	11
46	Mud Slough at Gun Club Road	0.157	0.323	0.040	0.083	11
47	Delta-Mendota Cal Hwy 140	0.137	0.235	0.062	0.089	3
48	FC-5 Grasslands Area Farmers	0.018	0.029	0.008	0.015	2
49	PE-14-Grasslands Area Farmers	0.018	0.035	0.000	0.025	2
50	San Luis Drain Site A (Check 18)	0.009	0.016	0.005	0.005	4
51	Arroyo Cal at Hwy 152	0.098	0.124	0.071	0.037	2
52	Salt Slough at Sand Dam	0.347	0.662	0.121	0.281	3
53	Salt Slough at Wolfsen Road	0.126	0.704	0.039	0.122	30
57	Ramona Lake Drain at Levee	0.104	0.418	0.005	0.095	27
59	SJR Laird Park	0.125	0.260	0.000	0.064	22
60	Moffit 1 South	0.094	0.207	0.020	0.057	19
61	Deadman's Slough	0.133	0.446	0.015	0.111	24
62	Mallard Slough	0.308	2.508	0.016	0.584	23
63	Inlet C Canal	0.145	1.036	0.027	0.198	27

DO site number	Site name	Average of UC Davis PO4-P, mg/L	Max of UC Davis PO4-P, mg/L	Min of UC Davis PO4-P, mg/L	StdDev of UC Davis PO4-P, mg/L	Count of UC Davis PO4-P, mg/L
64	Moran Drain	0.074	0.134	0.039	0.035	6
65	Spanish Grant Drain	0.148	0.225	0.086	0.050	7
66	ESWD Maze Blv. Drain	0.067	0.124	0.038	0.039	4
67	Newman Wasteway at Brazo Road	0.131	0.213	0.060	0.055	7
68	S. Lake Basin	0.380	1.120	0.061	0.427	5
69	Santa Fe Canal	0.173	0.173	0.173	na	1
80	South Marsh 1 Inlet	0.089	0.209	0.024	0.049	17
81	South Marsh 1 Outlet	0.115	0.795	0.010	0.186	20
82	South Marsh 3 Inlet	0.249	1.305	0.069	0.268	25
83	South Marsh 3 Outlet	0.285	1.238	0.031	0.271	28
84	SJR Garwood Bridge	0.081	0.081	0.081	na	1
86	Ramona Drain Apple Ave	0.290	0.593	0.101	0.142	9
87	Ramona Drain Prune Ave	0.341	0.512	0.214	0.154	3
88	Ramona Drain Apricot Ave	0.196	0.354	0.052	0.079	9
89	Ramona Drain Pomelo Ave	0.210	0.316	0.140	0.094	3
90	Ramona Drain Almond Ave	0.165	0.165	0.165	na	1
91	Paradise Drain Prune Ave	0.079	0.079	0.079	na	1
92	Paradise Drain Apricot Ave	0.244	0.477	0.095	0.138	8
93	Paradise Drain Pomelo Ave	0.313	0.568	0.123	0.229	3
94	Paradise Drain Almond Ave	0.231	0.603	0.104	0.174	7
95	Ramona Lake Entrance	0.233	0.555	0.081	0.140	15
96	WPF-VD-1	0.173	0.173	0.173	na	1
97	WPF-VD-2	0.223	0.223	0.223	na	1
98	WPF-VD-3	1.339	1.339	1.339	na	1
101	WPF-UD-IN	0.159	0.160	0.158	0.002	2
102	WPF-UD-OUT	0.191	0.214	0.169	0.032	2
103	SLD Check 18	0.008	0.012	0.005	0.005	2
104	SLD Check 16	0.005	0.006	0.005	0.000	2
105	SLD Check 15	0.008	0.008	0.008	na	1
106	SLD Check 14	0.006	0.006	0.006	na	1
107	SLD Check 13	0.005	0.005	0.005	na	1
108	SLD Check 12	0.005	0.005	0.005	na	1
109	SLD Check 11	0.005	0.005	0.005	na	1
110	SLD Check 10	0.005	0.005	0.005	na	1
111	SLD Check 9	0.005	0.005	0.005	na	1
112	SLD Check 8	0.005	0.005	0.005	na	1
113	SLD Check 7	0.005	0.005	0.005	na	1
114	SLD Check 6	0.005	0.005	0.005	na	1
115	SLD Check 5	0.005	0.005	0.005	na	1
116	SLD Check 4	0.005	0.005	0.005	na	1
117	SLD Check 3	0.005	0.005	0.005	na	1
118	SLD Check 2	0.005	0.005	0.005	na	1
119	SLD Check 1	0.005	0.005	0.005	na	1
120	South Marsh 1 Intermediary	0.098	0.177	0.019	0.053	11
121	South Marsh 1 East	0.171	0.812	0.015	0.233	10
122	South Marsh 1 West	0.114	0.339	0.011	0.118	9
123	Ramona Lake NW Quad	0.136	0.136	0.136	na	1
124	Ramona Lake NE Quad	0.168	0.168	0.168	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	0.329	0.400	0.246	0.078	3
130	Marshall Rd Reservoir Entrance	0.174	0.236	0.132	0.038	7
131	Marshall Rd Reservoir Exit	0.110	0.195	0.060	0.050	7
132	Marshall Rd Res Pond 1W	0.144	0.203	0.095	0.039	5
133	Marshall Rd Res Pond 2E	0.142	0.201	0.098	0.037	5
135	Modesto ID Main Drain Spill	0.186	0.228	0.084	0.058	6

Total Fe

DO site number	Site name	Average of Total Fe mg/L	Max of Total Fe mg/L	Min of Total Fe mg/L	StdDev of Total Fe mg/L	Count of Total Fe mg/L
1	SJR at Channel Point	0.40	0.48	0.32	0.11	2
2	SJR at Dos Reis Lathrop	0.40	0.55	0.25	0.21	2
3	SJR at Old River	0.27	0.52	0.03	0.34	2
4	SJR at Mossdale	0.38	0.96	0.03	0.19	64
5	SJR at Vernalis	0.41	1.02	0.07	0.18	70
6	SJR at Maze	0.45	1.23	0.08	0.24	68
7	SJR at Patterson	0.50	1.29	0.12	0.25	72
8	SJR at Crows Landing	0.45	1.00	0.12	0.18	78
9	SJR at Fremont Ford	0.48	1.10	0.15	0.42	4
10	SJR at Lander Avenue	0.35	1.59	0.00	0.28	81
11	French Camp Slough	0.39	1.25	0.14	0.39	7
12	Stanislaus River at Caswell Park	0.17	0.56	0.06	0.07	65
13	Stanislaus River at Ripon	0.16	0.16	0.16	na	1
14	Tuolumne River at Shiloh Bridge	0.15	0.55	0.02	0.10	66
16	Merced River at River Road	0.26	1.41	0.03	0.19	65
17	Merced River near Stevinson	0.26	0.26	0.26	na	1
18	Mud Slough near Gustine	0.42	1.08	0.00	0.25	74
19	Salt Slough at Lander Avenue	0.94	2.11	0.00	0.43	101
20	Los Banos Creek at Highway 140	0.94	2.39	0.03	0.59	65
21	Orestimba Creek at River Road	1.36	9.48	0.25	1.50	58
22	Modesto ID Lateral 4 to SJR	0.06	0.10	0.00	0.04	6
23	Modesto ID Lateral 5 to Tuolumne	0.11	0.62	0.00	0.16	29
24	Modesto ID Lateral 6 to Stanislaus River	0.17	0.24	0.10	0.09	2
25	MID Main Drain to Stan. R. via Miller Lake	0.33	1.56	0.03	0.31	38
26	Turlock ID Highline Spill	0.09	0.10	0.09	0.01	2
27	Turlock ID Lateral 2 to SJR	0.07	0.09	0.02	0.03	4
28	Turlock ID Westport Drain Flow Station	0.10	0.47	0.00	0.11	49
29	Turlock ID Harding Drain	0.12	0.67	0.00	0.13	64
30	Turlock ID Lateral 6 & 7 at Levee	0.05	0.25	0.00	0.06	34
31	BCID - New Jerusalem Drain	0.04	0.17	0.00	0.05	9
32	El Solyo WD - Grayson Drain	2.46	7.59	0.66	2.93	5
33	Hospital Creek	6.98	60.27	0.05	14.92	17
34	Ingram Creek Flow Station	1.58	11.43	0.00	2.14	43
35	Westley Wasteway Flow Station	1.87	6.51	0.11	2.34	7
36	Del Puerto Creek Flow Station	0.95	6.43	0.04	1.24	57
38	Marshall Road Drain	1.22	3.78	0.21	1.20	8
39	Salado Creek Flow Station	1.00	2.65	0.23	1.13	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	0.15	0.54	0.00	0.14	72
45	Volta Wasteway at Ingomar Grade	0.18	0.35	0.00	0.13	11
46	Mud Slough at Gun Club Road	0.44	0.69	0.08	0.16	11
47	Delta-Mendota Cal Hwy 140	0.15	0.20	0.12	0.04	3
48	FC-5 Grasslands Area Farmers	1.23	1.84	0.62	0.86	2
49	PE-14-Grasslands Area Farmers	0.37	0.73	0.02	0.51	2
50	San Luis Drain Site A (Check 18)	0.88	1.66	0.50	0.53	4
51	Arroyo Cal at Hwy 152	0.97	0.98	0.97	0.01	2
52	Salt Slough at Sand Dam	0.76	0.87	0.66	0.11	3
53	Salt Slough at Wolfsen Road	1.02	1.95	0.27	0.40	30
57	Ramona Lake Drain at Levee	0.96	2.30	0.09	0.59	29
59	SJR Laird Park	0.52	1.28	0.13	0.29	22
60	Moffit 1 South	0.12	0.42	0.02	0.10	19
61	Deadman's Slough	0.45	1.44	0.00	0.41	24
62	Mallard Slough	0.71	2.39	0.00	0.67	23
63	Inlet C Canal	0.58	1.11	0.00	0.25	27

DO site number	Site name	Average of Total Fe mg/L	Max of Total Fe mg/L	Min of Total Fe mg/L	StdDev of Total Fe mg/L	Count of Total Fe mg/L
64	Moran Drain	1.24	2.08	0.43	0.60	6
65	Spanish Grant Drain	1.14	2.99	0.35	0.89	7
66	ESWD Maze Blv. Drain	3.23	12.72	0.00	6.33	4
67	Newman Wasteway at Brazo Road	0.83	1.33	0.19	0.47	7
68	S. Lake Basin	0.57	1.11	0.34	0.31	5
69	Santa Fe Canal	0.60	0.60	0.60	na	1
80	South Marsh 1 Inlet	0.28	0.49	0.00	0.13	18
81	South Marsh 1 Outlet	0.11	0.80	0.01	0.17	20
82	South Marsh 3 Inlet	0.39	1.33	0.05	0.36	25
83	South Marsh 3 Outlet	0.35	0.98	0.03	0.26	28
84	SJR Garwood Bridge	0.19	0.19	0.19	na	1
86	Ramona Drain Apple Ave	0.58	1.87	0.06	0.55	9
87	Ramona Drain Prune Ave	0.37	0.50	0.18	0.17	3
88	Ramona Drain Apricot Ave	0.61	1.30	0.22	0.41	9
89	Ramona Drain Pomelo Ave	1.40	1.90	1.14	0.43	3
90	Ramona Drain Almond Ave	0.35	0.35	0.35	na	1
91	Paradise Drain Prune Ave	0.19	0.19	0.19	na	1
92	Paradise Drain Apricot Ave	0.08	0.14	0.00	0.06	7
93	Paradise Drain Pomelo Ave	0.60	1.02	0.36	0.36	3
94	Paradise Drain Almond Ave	0.29	0.66	0.15	0.18	7
95	Ramona Lake Entrance	0.93	1.61	0.09	0.47	16
96	WPF-VD-1	2.30	2.30	2.30	na	1
97	WPF-VD-2	1.52	1.52	1.52	na	1
98	WPF-VD-3	0.47	0.47	0.47	na	1
101	WPF-UD-IN	0.85	1.62	0.09	1.08	2
102	WPF-UD-OUT	1.29	2.32	0.27	1.45	2
103	SLD Check 18	0.67	0.75	0.58	0.12	2
104	SLD Check 16	0.88	1.31	0.45	0.61	2
105	SLD Check 15	0.67	0.89	0.45	0.31	2
106	SLD Check 14	1.03	1.60	0.46	0.80	2
107	SLD Check 13	0.65	0.78	0.52	0.18	2
108	SLD Check 12	0.54	0.54	0.53	0.01	2
109	SLD Check 11	0.61	0.75	0.47	0.19	2
110	SLD Check 10	0.51	0.61	0.41	0.15	2
111	SLD Check 9	0.54	0.61	0.47	0.10	2
112	SLD Check 8	0.55	0.72	0.37	0.24	2
113	SLD Check 7	0.47	0.63	0.30	0.23	2
114	SLD Check 6	0.45	0.59	0.32	0.19	2
115	SLD Check 5	0.28	0.40	0.17	0.16	2
116	SLD Check 4	0.35	0.43	0.28	0.11	2
117	SLD Check 3	0.22	0.32	0.13	0.14	2
118	SLD Check 2	0.19	0.23	0.16	0.05	2
119	SLD Check 1	0.20	0.24	0.17	0.05	2
120	South Marsh 1 Intermediary	0.28	0.60	0.02	0.16	11
121	South Marsh 1 East	0.24	0.83	0.05	0.25	10
122	South Marsh 1 West	0.17	0.63	0.00	0.21	9
123	Ramona Lake NW Quad	0.79	0.88	0.70	0.13	2
124	Ramona Lake NE Quad	0.73	0.79	0.67	0.09	2
125	Ramona Lake SW Quad	0.88	0.88	0.88	na	1
126	Ramona Lake SE Quad	1.21	1.21	1.21	na	1
129	Hollow Tree drain	0.71	1.04	0.51	0.29	3
130	Marshall Rd Reservoir Entrance	1.05	2.17	0.38	0.70	7
131	Marshall Rd Reservoir Exit	0.51	0.80	0.11	0.26	7
132	Marshall Rd Res Pond 1W	0.64	1.34	0.33	0.41	5
133	Marshall Rd Res Pond 2E	0.78	1.88	0.33	0.63	5
135	Modesto ID Main Drain Spill	0.14	0.25	0.00	0.10	6

Na (mg/L)

DO site number	Site name	Average of Na mg/L	Max of Na mg/L	Min of Na mg/L	StdDev of Na mg/L	Count of Na mg/L
1	SJR at Channel Point	55.61	55.78	55.43	0.25	2
2	SJR at Dos Reis Lathrop	60.00	62.43	57.57	3.44	2
3	SJR at Old River	62.40	64.91	59.89	3.55	2
4	SJR at Mossdale	57.89	102.16	9.22	28.17	65
5	SJR at Vernalis	57.82	99.97	8.50	27.31	73
6	SJR at Maze	81.56	145.12	9.53	40.57	70
7	SJR at Patterson	118.50	216.36	11.36	54.66	75
8	SJR at Crows Landing	121.66	235.20	13.65	54.63	80
9	SJR at Fremont Ford	187.41	248.91	124.31	45.77	5
10	SJR at Lander Avenue	130.76	280.10	4.00	78.01	83
11	French Camp Slough	53.58	92.19	5.49	35.83	7
12	Stanislaus River at Caswell Park	4.74	11.22	2.70	1.59	67
13	Stanislaus River at Ripon	5.94	5.94	5.94	na	1
14	Tuolumne River at Shiloh Bridge	11.26	26.44	2.22	7.12	68
16	Merced River at River Road	13.75	52.45	2.05	11.96	67
17	Merced River near Stevinson	2.23	2.23	2.23	na	1
18	Mud Slough near Gustine	416.61	762.90	12.57	174.69	77
19	Salt Slough at Lander Avenue	175.38	394.66	91.76	56.12	103
20	Los Banos Creek at Highway 140	202.59	560.55	53.01	105.09	66
21	Orestimba Creek at River Road	62.54	160.40	13.25	25.80	58
22	Modesto ID Lateral 4 to SJR	12.37	21.62	2.27	8.92	6
23	Modesto ID Lateral 5 to Tuolumne	12.18	66.45	1.80	16.08	29
24	Modesto ID Lateral 6 to Stanislaus River	3.71	3.91	3.52	0.28	2
25	MID Main Drain to Stan. R. via Miller Lake	29.97	158.11	0.00	26.34	42
26	Turlock ID Highline Spill	2.10	2.27	1.93	0.24	2
27	Turlock ID Lateral 2 to SJR	8.16	21.25	0.00	9.29	4
28	Turlock ID Westport Drain Flow Station	69.54	145.78	12.78	35.65	50
29	Turlock ID Harding Drain	84.61	157.82	16.03	32.78	64
30	Turlock ID Lateral 6 & 7 at Levee	57.51	125.02	25.56	22.72	35
31	BCID - New Jerusalem Drain	320.80	345.72	298.33	17.19	8
32	El Solyo WD - Grayson Drain	115.24	169.79	46.56	47.25	5
33	Hospital Creek	49.15	87.18	14.57	25.32	17
34	Ingram Creek Flow Station	116.94	277.96	23.96	55.77	44
35	Westley Wasteway Flow Station	73.01	100.94	60.73	14.47	7
36	Del Puerto Creek Flow Station	101.92	183.56	33.35	39.26	58
38	Marshall Road Drain	97.47	168.21	52.14	44.50	8
39	Salado Creek Flow Station	162.83	183.83	128.25	24.28	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	691.47	1043.90	55.07	148.85	73
45	Volta Wasteway at Ingomar Grade	114.94	218.04	35.01	68.11	11
46	Mud Slough at Gun Club Road	311.52	608.20	102.59	176.95	11
47	Delta-Mendota Cal Hwy 140	64.87	78.38	44.62	17.86	3
48	FC-5 Grasslands Area Farmers	879.10	924.65	833.55	64.42	2
49	PE-14-Grasslands Area Farmers	892.80	984.05	801.55	129.05	2
50	San Luis Drain Site A (Check 18)	748.14	982.45	625.90	163.48	4
51	Arroyo Cal at Hwy 152	142.43	149.31	135.54	9.74	2
52	Salt Slough at Sand Dam	102.49	125.97	83.97	21.43	3
53	Salt Slough at Wolfsen Road	181.06	303.91	104.69	53.83	30
57	Ramona Lake Drain at Levee	172.76	262.48	110.81	39.61	29
59	SJR Laird Park	119.54	801.55	13.36	157.14	22
60	Moffit 1 South	127.42	230.85	63.22	54.87	19
61	Deadman's Slough	161.65	289.84	67.82	78.81	23
62	Mallard Slough	229.34	913.80	97.14	179.80	22
63	Inlet C Canal	87.62	187.68	39.14	40.94	27

DO site number	Site name	Average of Na mg/L	Max of Na mg/L	Min of Na mg/L	StdDev of Na mg/L	Count of Na mg/L
64	Moran Drain	67.09	83.03	47.50	15.67	6
65	Spanish Grant Drain	112.93	158.76	80.83	33.52	7
66	ESWD Maze Blv. Drain	55.46	68.44	44.70	9.98	4
67	Newman Wasteway at Brazo Road	141.83	216.93	83.18	50.35	7
68	S. Lake Basin	339.71	536.55	64.90	220.25	5
69	Santa Fe Canal	41.24	41.24	41.24	na	1
80	South Marsh 1 Inlet	80.11	129.84	39.63	30.98	17
81	South Marsh 1 Outlet	80.22	133.32	43.64	25.41	19
82	South Marsh 3 Inlet	178.01	281.02	45.51	64.69	23
83	South Marsh 3 Outlet	180.99	301.71	104.30	54.96	26
84	SJR Garwood Bridge	63.49	63.49	63.49	na	1
86	Ramona Drain Apple Ave	137.16	179.72	42.59	53.36	9
87	Ramona Drain Prune Ave	87.49	119.42	65.82	28.23	3
88	Ramona Drain Apricot Ave	150.91	240.49	43.33	63.86	9
89	Ramona Drain Pomelo Ave	113.98	151.66	69.16	41.71	3
90	Ramona Drain Almond Ave	119.69	119.69	119.69	na	1
91	Paradise Drain Prune Ave	96.38	155.73	37.03	83.93	2
92	Paradise Drain Apricot Ave	206.08	505.90	105.90	135.11	7
93	Paradise Drain Pomelo Ave	255.51	485.80	105.37	202.49	3
94	Paradise Drain Almond Ave	207.51	477.90	103.54	123.29	7
95	Ramona Lake Entrance	190.01	276.26	112.05	41.30	16
96	WPF-VD-1	36.20	36.20	36.20	na	1
97	WPF-VD-2	38.14	38.14	38.14	na	1
98	WPF-VD-3	44.67	44.67	44.67	na	1
101	WPF-UD-IN	77.99	119.74	36.25	59.03	2
102	WPF-UD-OUT	76.85	116.17	37.54	55.60	2
103	SLD Check 18	673.28	737.95	608.60	91.46	2
104	SLD Check 16	703.60	751.35	655.85	67.53	2
105	SLD Check 15	719.85	773.25	666.45	75.52	2
106	SLD Check 14	719.50	784.45	654.55	91.85	2
107	SLD Check 13	725.45	802.35	648.55	108.75	2
108	SLD Check 12	723.85	777.90	669.80	76.44	2
109	SLD Check 11	718.00	798.55	637.45	113.91	2
110	SLD Check 10	725.20	781.35	669.05	79.41	2
111	SLD Check 9	716.78	728.55	705.00	16.65	2
112	SLD Check 8	696.70	714.95	678.45	25.81	2
113	SLD Check 7	680.00	690.15	669.85	14.35	2
114	SLD Check 6	683.83	703.75	663.90	28.18	2
115	SLD Check 5	713.25	727.50	699.00	20.15	2
116	SLD Check 4	711.18	747.50	674.85	51.37	2
117	SLD Check 3	746.13	759.25	733.00	18.56	2
118	SLD Check 2	727.40	734.00	720.80	9.33	2
119	SLD Check 1	725.20	735.35	715.05	14.35	2
120	South Marsh 1 Intermediary	77.16	129.66	40.39	33.69	11
121	South Marsh 1 East	80.40	131.64	42.09	36.25	10
122	South Marsh 1 West	96.41	158.40	48.04	33.87	9
123	Ramona Lake NW Quad	212.37	212.37	212.37	na	1
124	Ramona Lake NE Quad	172.70	172.70	172.70	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	681.93	734.55	642.80	47.34	3
130	Marshall Rd Reservoir Entrance	102.05	157.37	50.72	38.41	7
131	Marshall Rd Reservoir Exit	118.86	151.26	87.16	24.09	7
132	Marshall Rd Res Pond 1W	94.09	136.39	58.04	32.89	5
133	Marshall Rd Res Pond 2E	97.69	134.76	68.68	29.22	5
135	Modesto ID Main Drain Spill	18.89	33.69	9.55	8.48	6

K (mg/L)

DO site number	Site name	Average of K mg/L	Max of K mg/L	Min of K mg/L	StdDev of K mg/L	Count of K mg/L
1	SJR at Channel Point	3.36	3.52	3.20	0.23	2
2	SJR at Dos Reis Lathrop	2.84	3.23	2.44	0.56	2
3	SJR at Old River	2.98	3.39	2.57	0.58	2
4	SJR at Mossdale	2.68	5.16	1.06	1.03	65
5	SJR at Vernalis	2.59	5.15	1.05	0.96	73
6	SJR at Maze	3.41	7.52	1.07	1.51	70
7	SJR at Patterson	4.59	9.28	1.19	1.98	75
8	SJR at Crows Landing	3.91	7.90	1.08	1.56	80
9	SJR at Fremont Ford	4.97	5.10	4.79	0.13	5
10	SJR at Lander Avenue	4.56	9.91	0.65	2.15	83
11	French Camp Slough	3.00	3.61	1.53	0.75	7
12	Stanislaus River at Caswell Park	1.10	2.18	0.67	0.31	67
13	Stanislaus River at Ripon	1.15	1.15	1.15	na	1
14	Tuolumne River at Shiloh Bridge	1.61	11.01	0.45	1.46	68
16	Merced River at River Road	1.18	3.29	0.37	0.58	67
17	Merced River near Stevinson	0.49	0.49	0.49	na	1
18	Mud Slough near Gustine	8.58	14.30	1.17	2.31	77
19	Salt Slough at Lander Avenue	5.93	14.74	3.12	1.61	103
20	Los Banos Creek at Highway 140	8.34	17.33	3.60	2.93	66
21	Orestimba Creek at River Road	3.48	9.31	1.57	1.42	58
22	Modesto ID Lateral 4 to SJR	1.37	2.90	0.65	0.82	6
23	Modesto ID Lateral 5 to Tuolumne	1.57	5.64	0.36	1.41	29
24	Modesto ID Lateral 6 to Stanislaus River	2.39	2.67	2.12	0.39	2
25	MID Main Drain to Stan. R. via Miller Lake	5.28	18.01	0.00	3.43	42
26	Turlock ID Highline Spill	0.57	0.68	0.46	0.15	2
27	Turlock ID Lateral 2 to SJR	0.61	1.07	0.00	0.46	4
28	Turlock ID Westport Drain Flow Station	4.61	33.08	1.00	4.48	50
29	Turlock ID Harding Drain	11.80	29.36	1.28	6.23	64
30	Turlock ID Lateral 6 & 7 at Levee	5.70	12.46	3.12	2.35	35
31	BCID - New Jerusalem Drain	4.07	11.34	0.00	3.94	8
32	El Solyo WD - Grayson Drain	6.77	8.22	5.31	1.05	5
33	Hospital Creek	4.13	7.65	1.93	1.81	17
34	Ingram Creek Flow Station	4.45	11.07	1.90	1.86	44
35	Westley Wasteway Flow Station	3.33	5.05	2.37	0.92	7
36	Del Puerto Creek Flow Station	4.41	9.98	1.36	2.02	58
38	Marshall Road Drain	4.54	7.18	1.98	1.63	8
39	Salado Creek Flow Station	9.56	14.11	6.48	3.25	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	11.50	27.80	3.34	3.85	73
45	Volta Wasteway at Ingomar Grade	3.83	7.83	2.07	1.63	11
46	Mud Slough at Gun Club Road	9.43	22.24	5.69	4.93	11
47	Delta-Mendota Cal Hwy 140	3.71	4.99	2.56	1.22	3
48	FC-5 Grasslands Area Farmers	na	0.00	0.00	na	2
49	PE-14-Grasslands Area Farmers	na	0.00	0.00	na	2
50	San Luis Drain Site A (Check 18)	11.30	12.25	10.35	1.34	4
51	Arroyo Cal at Hwy 152	5.81	5.84	5.78	0.04	2
52	Salt Slough at Sand Dam	4.66	5.97	3.07	1.47	3
53	Salt Slough at Wolfsen Road	5.80	8.15	3.87	1.12	30
57	Ramona Lake Drain at Levee	6.02	10.94	3.80	1.65	29
59	SJR Laird Park	3.51	10.50	0.56	1.87	22
60	Moffit 1 South	5.95	8.32	3.45	1.18	19
61	Deadman's Slough	6.77	13.69	3.72	2.58	23
62	Mallard Slough	10.63	54.70	3.67	11.57	22
63	Inlet C Canal	3.64	6.86	2.08	1.17	27

DO site number	Site name	Average of K mg/L	Max of K mg/L	Min of K mg/L	StdDev of K mg/L	Count of K mg/L
64	Moran Drain	3.53	4.82	1.96	1.02	6
65	Spanish Grant Drain	4.46	5.94	3.09	1.05	7
66	ESWD Maze Blv. Drain	3.32	4.35	2.12	0.98	4
67	Newman Wasteway at Brazo Road	5.35	9.19	2.71	2.10	7
68	S. Lake Basin	7.97	11.57	2.40	3.78	5
69	Santa Fe Canal	2.27	2.27	2.27	na	1
80	South Marsh 1 Inlet	3.50	6.66	2.08	1.23	17
81	South Marsh 1 Outlet	4.78	7.76	2.86	1.42	19
82	South Marsh 3 Inlet	6.52	12.58	2.61	2.53	23
83	South Marsh 3 Outlet	6.40	10.40	4.17	1.64	26
84	SJR Garwood Bridge	4.39	4.39	4.39	na	1
86	Ramona Drain Apple Ave	7.67	10.75	1.32	2.74	9
87	Ramona Drain Prune Ave	5.97	8.00	4.52	1.81	3
88	Ramona Drain Apricot Ave	8.00	10.67	3.15	2.85	9
89	Ramona Drain Pomelo Ave	7.78	11.74	4.35	3.73	3
90	Ramona Drain Almond Ave	7.06	7.06	7.06	na	1
91	Paradise Drain Prune Ave	5.19	8.01	2.37	3.99	2
92	Paradise Drain Apricot Ave	8.63	18.95	5.47	4.66	7
93	Paradise Drain Pomelo Ave	11.46	22.50	5.90	9.56	3
94	Paradise Drain Almond Ave	9.84	25.45	5.71	6.96	7
95	Ramona Lake Entrance	6.21	9.45	4.19	1.48	16
96	WPF-VD-1	3.87	3.87	3.87	na	1
97	WPF-VD-2	6.23	6.23	6.23	na	1
98	WPF-VD-3	20.68	20.68	20.68	na	1
101	WPF-UD-IN	4.63	5.40	3.86	1.09	2
102	WPF-UD-OUT	5.44	6.89	3.99	2.05	2
103	SLD Check 18	10.93	11.10	10.75	0.25	2
104	SLD Check 16	11.18	12.60	9.75	2.02	2
105	SLD Check 15	11.48	12.05	10.90	0.81	2
106	SLD Check 14	12.93	13.05	12.80	0.18	2
107	SLD Check 13	12.65	13.00	12.30	0.49	2
108	SLD Check 12	12.10	12.10	12.10	0.00	2
109	SLD Check 11	12.65	12.80	12.50	0.21	2
110	SLD Check 10	13.05	14.50	11.60	2.05	2
111	SLD Check 9	11.67	11.68	11.65	0.02	2
112	SLD Check 8	12.05	12.45	11.65	0.57	2
113	SLD Check 7	11.35	11.45	11.25	0.14	2
114	SLD Check 6	11.68	11.70	11.65	0.04	2
115	SLD Check 5	12.35	12.90	11.80	0.78	2
116	SLD Check 4	11.53	11.55	11.50	0.04	2
117	SLD Check 3	11.85	12.10	11.60	0.35	2
118	SLD Check 2	12.55	13.35	11.75	1.13	2
119	SLD Check 1	12.80	13.35	12.25	0.78	2
120	South Marsh 1 Intermediary	3.75	6.59	2.43	1.30	11
121	South Marsh 1 East	4.38	6.41	2.52	1.37	10
122	South Marsh 1 West	7.38	10.64	5.25	1.71	9
123	Ramona Lake NW Quad	8.23	8.23	8.23	na	1
124	Ramona Lake NE Quad	5.88	5.88	5.88	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	13.28	14.75	11.90	1.43	3
130	Marshall Rd Reservoir Entrance	4.23	6.20	2.96	1.17	7
131	Marshall Rd Reservoir Exit	4.48	6.09	2.99	0.96	7
132	Marshall Rd Res Pond 1W	3.77	4.94	2.41	0.93	5
133	Marshall Rd Res Pond 2E	3.64	4.65	2.54	0.82	5
135	Modesto ID Main Drain Spill	3.06	4.36	1.96	0.89	6

Mg (mg/L)

DO site number	Site name	Average of Mg mg/L	Max of Mg mg/L	Min of Mg mg/L	StdDev of Mg mg/L	Count of Mg mg/L
1	SJR at Channel Point	12.92	13.50	12.34	0.82	2
2	SJR at Dos Reis Lathrop	14.35	15.28	13.42	1.31	2
3	SJR at Old River	14.62	15.49	13.75	1.23	2
4	SJR at Mossdale	13.96	24.81	3.19	6.45	65
5	SJR at Vernalis	14.27	24.49	3.12	6.47	73
6	SJR at Maze	18.78	33.41	3.16	8.95	70
7	SJR at Patterson	24.06	41.48	3.12	10.48	75
8	SJR at Crows Landing	24.80	45.80	3.06	10.55	80
9	SJR at Fremont Ford	34.11	41.54	23.42	7.48	5
10	SJR at Lander Avenue	20.35	38.73	1.31	10.26	83
11	French Camp Slough	12.84	18.33	3.20	5.58	7
12	Stanislaus River at Caswell Park	3.57	9.71	2.15	1.30	67
13	Stanislaus River at Ripon	3.86	3.86	3.86	na	1
14	Tuolumne River at Shiloh Bridge	4.89	9.86	1.92	2.32	68
16	Merced River at River Road	4.49	13.21	1.40	2.81	67
17	Merced River near Stevinson	1.49	1.49	1.49	na	1
18	Mud Slough near Gustine	66.81	117.65	4.39	23.20	77
19	Salt Slough at Lander Avenue	33.86	66.74	19.28	9.65	103
20	Los Banos Creek at Highway 140	49.60	118.26	16.76	22.80	66
21	Orestimba Creek at River Road	27.37	48.87	5.25	11.26	58
22	Modesto ID Lateral 4 to SJR	6.14	12.18	1.93	4.44	6
23	Modesto ID Lateral 5 to Tuolumne	4.59	20.24	1.19	5.16	29
24	Modesto ID Lateral 6 to Stanislaus River	2.23	2.35	2.12	0.16	2
25	MID Main Drain to Stan. R. via Miller Lake	14.02	37.61	0.00	7.74	42
26	Turlock ID Highline Spill	1.63	1.68	1.57	0.08	2
27	Turlock ID Lateral 2 to SJR	2.70	5.96	0.00	2.49	4
28	Turlock ID Westport Drain Flow Station	16.94	33.44	3.88	7.17	50
29	Turlock ID Harding Drain	12.27	20.46	5.11	3.47	64
30	Turlock ID Lateral 6 & 7 at Levee	15.96	32.95	9.52	4.47	35
31	BCID - New Jerusalem Drain	73.30	82.80	65.33	6.76	8
32	El Solyo WD - Grayson Drain	30.72	49.85	14.51	13.48	5
33	Hospital Creek	12.99	23.34	4.06	5.41	17
34	Ingram Creek Flow Station	29.22	65.98	6.75	13.55	44
35	Westley Wasteway Flow Station	21.51	39.59	14.36	8.76	7
36	Del Puerto Creek Flow Station	36.18	75.22	8.12	14.95	58
38	Marshall Road Drain	22.51	40.97	11.58	10.35	8
39	Salado Creek Flow Station	35.19	42.21	28.68	5.83	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	110.79	957.25	15.55	102.21	73
45	Volta Wasteway at Ingomar Grade	26.46	48.97	10.32	14.38	11
46	Mud Slough at Gun Club Road	56.06	103.65	24.41	27.74	11
47	Delta-Mendota Cal Hwy 140	14.86	16.69	12.77	1.97	3
48	FC-5 Grasslands Area Farmers	124.28	133.35	115.20	12.83	2
49	PE-14-Grasslands Area Farmers	121.63	125.85	117.40	5.98	2
50	San Luis Drain Site A (Check 18)	101.55	131.45	85.00	20.51	4
51	Arroyo Cal at Hwy 152	30.75	34.73	26.76	5.64	2
52	Salt Slough at Sand Dam	22.24	25.64	19.33	3.19	3
53	Salt Slough at Wolfsen Road	35.64	55.34	21.43	10.00	30
57	Ramona Lake Drain at Levee	40.33	54.35	26.92	7.89	29
59	SJR Laird Park	23.56	114.75	2.34	21.95	22
60	Moffit 1 South	26.38	41.92	15.70	8.54	19
61	Deadman's Slough	31.54	50.55	14.69	12.13	23
62	Mallard Slough	45.59	182.05	21.54	36.69	22
63	Inlet C Canal	19.61	41.41	10.64	7.55	27

DO site number	Site name	Average of Mg mg/L	Max of Mg mg/L	Min of Mg mg/L	StdDev of Mg mg/L	Count of Mg mg/L
64	Moran Drain	25.06	36.07	13.60	10.49	6
65	Spanish Grant Drain	30.54	38.79	20.66	8.63	7
66	ESWD Maze Blv. Drain	14.16	15.15	13.12	1.02	4
67	Newman Wasteway at Brazo Road	48.81	82.68	20.02	21.69	7
68	S. Lake Basin	67.63	108.75	22.95	39.11	5
69	Santa Fe Canal	7.68	7.68	7.68	na	1
80	South Marsh 1 Inlet	18.41	24.87	10.62	5.06	17
81	South Marsh 1 Outlet	18.16	25.53	10.54	4.30	19
82	South Marsh 3 Inlet	21.02	47.00	11.42	7.16	23
83	South Marsh 3 Outlet	20.21	26.58	15.03	4.03	26
84	SJR Garwood Bridge	14.60	14.60	14.60	na	1
86	Ramona Drain Apple Ave	37.00	66.23	15.49	13.66	9
87	Ramona Drain Prune Ave	28.14	36.15	23.29	6.98	3
88	Ramona Drain Apricot Ave	36.09	48.64	14.04	11.74	9
89	Ramona Drain Pomelo Ave	32.79	46.33	20.54	12.94	3
90	Ramona Drain Almond Ave	31.17	31.17	31.17	na	1
91	Paradise Drain Prune Ave	24.11	37.25	10.98	18.57	2
92	Paradise Drain Apricot Ave	43.79	93.90	24.85	23.62	7
93	Paradise Drain Pomelo Ave	54.30	99.90	23.57	40.28	3
94	Paradise Drain Almond Ave	45.76	102.25	22.81	26.35	7
95	Ramona Lake Entrance	42.32	58.57	24.56	8.99	16
96	WPF-VD-1	11.78	11.78	11.78	na	1
97	WPF-VD-2	12.59	12.59	12.59	na	1
98	WPF-VD-3	20.46	20.46	20.46	na	1
101	WPF-UD-IN	25.33	38.96	11.69	19.28	2
102	WPF-UD-OUT	23.66	35.49	11.84	16.72	2
103	SLD Check 18	90.25	97.05	83.45	9.62	2
104	SLD Check 16	93.50	98.65	88.35	7.28	2
105	SLD Check 15	94.80	100.65	88.95	8.27	2
106	SLD Check 14	94.28	100.90	87.65	9.37	2
107	SLD Check 13	94.68	103.35	86.00	12.27	2
108	SLD Check 12	94.15	100.00	88.30	8.27	2
109	SLD Check 11	94.98	104.00	85.95	12.76	2
110	SLD Check 10	94.93	100.65	89.20	8.10	2
111	SLD Check 9	94.38	96.90	91.85	3.57	2
112	SLD Check 8	93.40	96.25	90.55	4.03	2
113	SLD Check 7	93.45	93.60	93.30	0.21	2
114	SLD Check 6	91.20	94.80	87.60	5.09	2
115	SLD Check 5	94.75	95.55	93.95	1.13	2
116	SLD Check 4	94.53	99.55	89.50	7.11	2
117	SLD Check 3	98.45	100.60	96.30	3.04	2
118	SLD Check 2	96.15	96.25	96.05	0.14	2
119	SLD Check 1	96.98	97.60	96.35	0.88	2
120	South Marsh 1 Intermediary	17.29	24.62	10.65	5.40	11
121	South Marsh 1 East	17.68	24.84	10.98	5.94	10
122	South Marsh 1 West	20.41	28.97	12.01	5.06	9
123	Ramona Lake NW Quad	46.68	46.68	46.68	na	1
124	Ramona Lake NE Quad	39.71	39.71	39.71	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	136.83	146.85	130.10	8.84	3
130	Marshall Rd Reservoir Entrance	25.55	40.57	13.59	9.87	7
131	Marshall Rd Reservoir Exit	30.61	43.26	22.00	8.47	7
132	Marshall Rd Res Pond 1W	24.78	37.29	13.06	9.54	5
133	Marshall Rd Res Pond 2E	25.49	36.54	15.37	8.52	5
135	Modesto ID Main Drain Spill	9.88	13.71	5.33	3.60	6

Ca (mg/L)

DO site number	Site name	Average of Ca mg/L	Max of Ca mg/L	Min of Ca mg/L	StdDev of Ca mg/L	Count of Ca mg/L
1	SJR at Channel Point	28.23	29.03	27.43	1.13	2
2	SJR at Dos Reis Lathrop	31.22	32.92	29.52	2.40	2
3	SJR at Old River	31.77	33.28	30.27	2.13	2
4	SJR at Mossdale	29.44	52.38	8.20	12.55	65
5	SJR at Vernalis	29.13	48.46	8.06	12.02	73
6	SJR at Maze	37.13	59.47	8.37	16.28	70
7	SJR at Patterson	50.21	84.17	8.83	20.22	75
8	SJR at Crows Landing	49.85	85.74	8.64	19.49	80
9	SJR at Fremont Ford	68.47	81.84	53.22	11.43	5
10	SJR at Lander Avenue	52.65	90.72	5.45	24.71	83
11	French Camp Slough	28.77	44.74	9.20	13.06	7
12	Stanislaus River at Caswell Park	9.12	15.00	6.33	1.63	67
13	Stanislaus River at Ripon	10.04	10.04	10.04	na	1
14	Tuolumne River at Shiloh Bridge	12.13	22.91	4.56	5.68	68
16	Merced River at River Road	13.42	40.98	4.69	8.49	67
17	Merced River near Stevinson	4.60	4.60	4.60	na	1
18	Mud Slough near Gustine	156.67	292.20	13.30	61.18	77
19	Salt Slough at Lander Avenue	69.41	120.50	43.43	16.48	103
20	Los Banos Creek at Highway 140	67.60	134.67	30.55	22.17	66
21	Orestimba Creek at River Road	52.80	94.77	11.29	21.36	58
22	Modesto ID Lateral 4 to SJR	15.53	28.01	4.88	10.59	6
23	Modesto ID Lateral 5 to Tuolumne	11.68	46.18	3.12	10.56	29
24	Modesto ID Lateral 6 to Stanislaus River	5.15	5.67	4.63	0.73	2
25	MID Main Drain to Stan. R. via Miller Lake	31.99	69.25	0.00	15.54	42
26	Turlock ID Highline Spill	3.82	4.04	3.60	0.31	2
27	Turlock ID Lateral 2 to SJR	8.26	19.42	0.00	8.18	4
28	Turlock ID Westport Drain Flow Station	60.10	112.78	13.56	25.02	50
29	Turlock ID Harding Drain	46.69	90.57	18.62	14.91	64
30	Turlock ID Lateral 6 & 7 at Levee	52.73	112.16	29.45	14.68	35
31	BCID - New Jerusalem Drain	164.55	200.85	126.60	26.60	8
32	El Solyo WD - Grayson Drain	52.99	74.13	24.33	19.21	5
33	Hospital Creek	29.40	57.84	10.56	12.30	17
34	Ingram Creek Flow Station	62.16	151.16	17.99	29.86	44
35	Westley Wasteway Flow Station	33.54	43.27	29.27	4.53	7
36	Del Puerto Creek Flow Station	48.30	92.06	19.84	15.65	58
38	Marshall Road Drain	44.92	79.36	24.43	20.02	8
39	Salado Creek Flow Station	64.88	82.07	55.31	12.63	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	294.87	403.25	25.89	61.26	73
45	Volta Wasteway at Ingomar Grade	46.35	81.56	19.33	23.63	11
46	Mud Slough at Gun Club Road	81.49	118.70	45.32	26.86	11
47	Delta-Mendota Cal Hwy 140	20.30	23.34	17.96	2.76	3
48	FC-5 Grasslands Area Farmers	378.70	490.95	266.45	158.75	2
49	PE-14-Grasslands Area Farmers	350.00	413.40	286.60	89.66	2
50	San Luis Drain Site A (Check 18)	326.14	395.70	277.30	56.40	4
51	Arroyo Cal at Hwy 152	69.15	80.33	57.97	15.81	2
52	Salt Slough at Sand Dam	53.89	57.34	48.77	4.52	3
53	Salt Slough at Wolfsen Road	70.87	108.40	49.19	17.77	30
57	Ramona Lake Drain at Levee	76.48	102.75	41.82	14.38	29
59	SJR Laird Park	53.14	338.60	5.14	65.71	22
60	Moffit 1 South	56.04	87.55	34.49	17.26	19
61	Deadman's Slough	63.23	93.53	29.38	20.87	23
62	Mallard Slough	98.84	304.40	48.62	64.39	22
63	Inlet C Canal	46.82	112.37	24.48	21.56	27
64	Moran Drain	51.06	72.47	30.53	21.84	6
65	Spanish Grant Drain	65.53	87.78	41.11	20.50	7
66	ESWD Maze Blv. Drain	26.92	31.00	23.36	3.14	4
67	Newman Wasteway at Brazo Road	72.67	107.50	27.70	25.38	7
68	S. Lake Basin	83.82	106.60	56.21	23.16	5

DO site number	Site name	Average of Ca mg/L	Max of Ca mg/L	Min of Ca mg/L	StdDev of Ca mg/L	Count of Ca mg/L
69	Santa Fe Canal	15.88	15.88	15.88	na	1
80	South Marsh 1 Inlet	43.07	65.13	25.15	13.61	17
81	South Marsh 1 Outlet	42.30	63.67	24.59	10.56	19
82	South Marsh 3 Inlet	47.49	99.65	27.80	14.87	23
83	South Marsh 3 Outlet	46.48	63.20	34.17	9.05	26
84	SJR Garwood Bridge	30.32	30.32	30.32	na	1
86	Ramona Drain Apple Ave	70.72	143.64	27.43	30.66	9
87	Ramona Drain Prune Ave	59.43	72.42	51.63	11.33	3
88	Ramona Drain Apricot Ave	69.29	92.88	31.74	20.30	9
89	Ramona Drain Pomelo Ave	69.50	97.38	45.71	26.08	3
90	Ramona Drain Almond Ave	64.89	64.89	64.89	na	1
91	Paradise Drain Prune Ave	52.14	78.55	25.72	37.35	2
92	Paradise Drain Apricot Ave	88.86	199.05	54.87	50.67	7
93	Paradise Drain Pomelo Ave	108.98	193.10	53.61	74.06	3
94	Paradise Drain Almond Ave	89.71	205.00	52.10	53.24	7
95	Ramona Lake Entrance	87.81	121.93	53.37	17.29	16
96	WPF-VD-1	24.93	24.93	24.93	na	1
97	WPF-VD-2	25.97	25.97	25.97	na	1
98	WPF-VD-3	36.40	36.40	36.40	na	1
101	WPF-UD-IN	50.89	77.23	24.55	37.25	2
102	WPF-UD-OUT	47.25	69.50	25.00	31.46	2
103	SLD Check 18	315.53	351.60	279.45	51.02	2
104	SLD Check 16	319.75	350.05	289.45	42.85	2
105	SLD Check 15	321.23	353.00	289.45	44.94	2
106	SLD Check 14	312.73	344.45	281.00	44.87	2
107	SLD Check 13	316.80	355.65	277.95	54.94	2
108	SLD Check 12	314.33	342.50	286.15	39.85	2
109	SLD Check 11	309.73	348.85	270.60	55.33	2
110	SLD Check 10	302.33	321.25	283.40	26.76	2
111	SLD Check 9	301.33	321.05	281.60	27.90	2
112	SLD Check 8	300.80	319.80	281.80	26.87	2
113	SLD Check 7	302.18	313.10	291.25	15.45	2
114	SLD Check 6	286.15	305.55	266.75	27.44	2
115	SLD Check 5	294.88	298.90	290.85	5.69	2
116	SLD Check 4	286.88	314.25	259.50	38.71	2
117	SLD Check 3	298.15	315.00	281.30	23.83	2
118	SLD Check 2	287.93	302.65	273.20	20.82	2
119	SLD Check 1	290.10	298.70	281.50	12.16	2
120	South Marsh 1 Intermediary	41.42	61.50	25.28	13.00	11
121	South Marsh 1 East	41.00	56.73	24.98	13.34	10
122	South Marsh 1 West	52.12	64.90	31.30	10.49	9
123	Ramona Lake NW Quad	58.00	58.00	58.00	na	1
124	Ramona Lake NE Quad	73.02	73.02	73.02	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	135.08	139.55	131.30	4.17	3
130	Marshall Rd Reservoir Entrance	51.06	75.81	33.48	15.11	7
131	Marshall Rd Reservoir Exit	57.94	77.53	46.43	12.68	7
132	Marshall Rd Res Pond 1W	48.61	66.92	29.80	14.75	5
133	Marshall Rd Res Pond 2E	51.61	65.77	39.74	11.29	5
135	Modesto ID Main Drain Spill	22.65	31.08	13.33	7.38	6

DO site number	Site name	Average of Cl mg/L	Max of Cl mg/L	Min of Cl mg/L	StdDev of Cl mg/L	Count of Cl mg/L
1	SJR at Channel Point	62.76	66.57	58.96	5.39	2
2	SJR at Dos Reis Lathrop	68.40	68.76	68.03	0.52	2
3	SJR at Old River	70.62	71.91	69.32	1.83	2
4	SJR at Mossdale	64.07	123.30	7.18	34.33	65
5	SJR at Vernalis	62.88	112.35	6.31	31.94	73
6	SJR at Maze	89.68	160.16	7.20	47.79	70
7	SJR at Patterson	122.59	231.56	8.75	59.03	75
8	SJR at Crows Landing	124.98	244.86	11.25	58.24	80
9	SJR at Fremont Ford	223.31	299.81	147.79	54.90	5
10	SJR at Lander Avenue	157.10	334.14	2.20	99.06	83
11	French Camp Slough	58.05	103.55	3.21	41.06	7
12	Stanislaus River at Caswell Park	3.16	9.60	0.97	1.81	67
13	Stanislaus River at Ripon	2.98	2.98	2.98	na	1
14	Tuolumne River at Shiloh Bridge	10.67	35.70	0.90	8.02	68
16	Merced River at River Road	10.91	44.27	0.83	10.30	67
17	Merced River near Stevinson	0.89	0.89	0.89	na	1
18	Mud Slough near Gustine	350.12	640.71	10.65	141.19	77
19	Salt Slough at Lander Avenue	201.09	476.21	89.02	68.23	103
20	Los Banos Creek at Highway 140	191.22	459.14	56.49	92.35	66
21	Orestimba Creek at River Road	72.28	165.87	7.94	32.75	58
22	Modesto ID Lateral 4 to SJR	8.27	22.73	0.97	8.25	6
23	Modesto ID Lateral 5 to Tuolumne	12.14	80.78	0.71	18.77	29
24	Modesto ID Lateral 6 to Stanislaus River	2.87	3.00	2.74	0.19	2
25	MID Main Drain to Stan. R. via Miller Lake	19.71	173.00	0.00	27.32	42
26	Turlock ID Highline Spill	1.00	1.13	0.88	0.18	2
27	Turlock ID Lateral 2 to SJR	10.95	20.78	2.71	7.60	4
28	Turlock ID Westport Drain Flow Station	45.43	140.84	5.67	24.98	50
29	Turlock ID Harding Drain	82.54	176.73	8.00	37.36	64
30	Turlock ID Lateral 6 & 7 at Levee	46.04	97.75	0.00	19.07	36
31	BCID - New Jerusalem Drain	326.72	340.34	312.07	9.65	8
32	El Solyo WD - Grayson Drain	135.85	205.05	54.75	58.30	5
33	Hospital Creek	53.64	127.04	12.19	32.31	17
34	Ingram Creek Flow Station	135.28	323.26	22.57	71.02	44
35	Westley Wasteway Flow Station	83.81	108.85	68.53	13.34	7
36	Del Puerto Creek Flow Station	112.68	202.47	15.72	48.45	58
38	Marshall Road Drain	100.29	184.51	52.87	48.38	8
39	Salado Creek Flow Station	174.85	190.82	132.66	28.17	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	548.00	832.80	64.07	105.84	73
45	Volta Wasteway at Ingomar Grade	106.78	178.14	37.19	52.30	11
46	Mud Slough at Gun Club Road	271.28	539.92	97.93	149.58	11
47	Delta-Mendota Cal Hwy 140	91.13	117.19	49.55	36.39	3
48	FC-5 Grasslands Area Farmers	700.68	966.03	435.32	375.27	2
49	PE-14-Grasslands Area Farmers	673.57	770.21	576.92	136.68	2
50	San Luis Drain Site A (Check 18)	615.09	796.66	507.80	128.49	4
51	Arroyo Cal at Hwy 152	139.58	141.10	138.05	2.16	2
52	Salt Slough at Sand Dam	122.64	147.06	94.35	26.56	3
53	Salt Slough at Wolfsen Road	198.95	317.70	67.57	62.29	30
57	Ramona Lake Drain at Levee	170.39	259.80	114.48	40.89	29
59	SJR Laird Park	113.85	624.83	12.57	121.29	22
60	Moffit 1 South	143.91	255.63	73.76	58.20	19
61	Deadman's Slough	181.65	335.86	75.57	84.98	23
62	Mallard Slough	223.66	787.15	103.79	154.38	22
63	Inlet C Canal	106.13	226.51	40.51	51.98	27

DO site number	Site name	Average of Cl mg/L	Max of Cl mg/L	Min of Cl mg/L	StdDev of Cl mg/L	Count of Cl mg/L
64	Moran Drain	84.02	114.40	49.72	26.20	6
65	Spanish Grant Drain	103.89	144.10	71.58	28.19	7
66	ESWD Maze Blv. Drain	61.05	72.41	50.64	8.91	4
67	Newman Wasteway at Brazo Road	134.68	173.87	105.42	28.52	7
68	S. Lake Basin	292.30	425.08	62.64	174.38	5
69	Santa Fe Canal	41.45	41.45	41.45	na	1
80	South Marsh 1 Inlet	96.44	160.73	41.84	40.92	17
81	South Marsh 1 Outlet	95.16	168.00	47.74	35.28	19
82	South Marsh 3 Inlet	190.55	315.38	49.65	73.06	23
83	South Marsh 3 Outlet	201.80	347.86	107.46	65.73	26
84	SJR Garwood Bridge	68.21	68.21	68.21	na	1
86	Ramona Drain Apple Ave	147.50	192.52	60.08	52.51	9
87	Ramona Drain Prune Ave	90.22	128.34	60.78	34.60	3
88	Ramona Drain Apricot Ave	160.15	268.79	41.76	71.76	9
89	Ramona Drain Pomelo Ave	117.53	167.34	63.12	52.26	3
90	Ramona Drain Almond Ave	121.74	121.74	121.74	na	1
91	Paradise Drain Prune Ave	90.68	148.66	32.69	82.00	2
92	Paradise Drain Apricot Ave	196.49	433.78	104.84	110.18	7
93	Paradise Drain Pomelo Ave	222.28	413.26	102.51	167.16	3
94	Paradise Drain Almond Ave	205.14	414.87	101.98	98.44	7
95	Ramona Lake Entrance	191.40	267.28	115.24	42.85	16
96	WPF-VD-1	31.16	31.16	31.16	na	1
97	WPF-VD-2	33.34	33.34	33.34	na	1
98	WPF-VD-3	46.95	46.95	46.95	na	1
101	WPF-UD-IN	78.38	125.72	31.05	66.94	2
102	WPF-UD-OUT	77.55	123.23	31.87	64.60	2
103	SLD Check 18	576.14	623.18	529.09	66.54	2
104	SLD Check 16	604.18	643.60	564.77	55.74	2
105	SLD Check 15	610.07	646.21	573.94	51.10	2
106	SLD Check 14	611.00	652.66	569.34	58.92	2
107	SLD Check 13	601.77	644.11	559.44	59.88	2
108	SLD Check 12	607.16	641.97	572.35	49.23	2
109	SLD Check 11	605.68	657.58	553.79	73.39	2
110	SLD Check 10	618.67	640.04	597.31	30.21	2
111	SLD Check 9	595.20	600.72	589.69	7.80	2
112	SLD Check 8	585.16	585.33	584.99	0.24	2
113	SLD Check 7	587.20	592.01	582.39	6.80	2
114	SLD Check 6	575.25	577.03	573.47	2.51	2
115	SLD Check 5	595.38	630.28	560.49	49.35	2
116	SLD Check 4	602.03	606.13	597.93	5.79	2
117	SLD Check 3	627.70	635.99	619.40	11.73	2
118	SLD Check 2	623.11	641.70	604.51	26.30	2
119	SLD Check 1	609.47	624.36	594.57	21.07	2
120	South Marsh 1 Intermediary	115.42	314.28	44.37	79.43	11
121	South Marsh 1 East	96.49	165.10	45.19	48.06	10
122	South Marsh 1 West	119.15	200.68	54.31	46.90	9
123	Ramona Lake NW Quad	215.45	215.45	215.45	na	1
124	Ramona Lake NE Quad	166.16	166.16	166.16	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	620.41	681.66	582.11	53.59	3
130	Marshall Rd Reservoir Entrance	109.42	162.28	66.99	37.02	7
131	Marshall Rd Reservoir Exit	119.85	162.25	88.62	25.23	7
132	Marshall Rd Res Pond 1W	98.42	138.71	57.23	33.30	5
133	Marshall Rd Res Pond 2E	98.68	137.05	60.90	32.76	5
135	Modesto ID Main Drain Spill	9.96	18.16	5.28	4.62	6

SO4 (mg/L)

DO site number	Site name	Average of SO4 mg/L	Max of SO4 mg/L	Min of SO4 mg/L	StdDev of SO4 mg/L	Count of SO4 mg/L
1	SJR at Channel Point	57.15	57.28	57.03	0.18	2
2	SJR at Dos Reis Lathrop	64.74	66.69	62.79	2.76	2
3	SJR at Old River	69.13	70.88	67.37	2.48	2
4	SJR at Mossdale	57.73	99.79	8.41	26.00	65
5	SJR at Vernalis	57.19	98.38	7.96	24.88	73
6	SJR at Maze	82.34	159.90	8.69	38.75	70
7	SJR at Patterson	131.14	251.36	11.26	59.34	75
8	SJR at Crows Landing	139.43	294.73	16.64	64.68	80
9	SJR at Fremont Ford	163.93	211.81	114.00	37.55	5
10	SJR at Lander Avenue	81.97	192.70	2.76	48.80	83
11	French Camp Slough	60.54	97.80	4.51	35.63	7
12	Stanislaus River at Caswell Park	3.78	10.28	1.95	1.30	67
13	Stanislaus River at Ripon	4.30	4.30	4.30	na	1
14	Tuolumne River at Shiloh Bridge	6.19	13.49	1.76	3.45	68
16	Merced River at River Road	9.80	35.92	1.74	7.72	67
17	Merced River near Stevinson	1.78	1.78	1.78	na	1
18	Mud Slough near Gustine	724.23	1449.13	10.07	372.32	77
19	Salt Slough at Lander Avenue	180.62	430.52	73.29	66.08	103
20	Los Banos Creek at Highway 140	200.69	498.26	37.77	112.26	66
21	Orestimba Creek at River Road	99.38	207.47	16.26	49.17	58
22	Modesto ID Lateral 4 to SJR	7.52	13.09	1.74	4.93	6
23	Modesto ID Lateral 5 to Tuolumne	7.81	57.41	1.21	14.14	29
24	Modesto ID Lateral 6 to Stanislaus River	2.11	2.18	2.04	0.10	2
25	MID Main Drain to Stan. R. via Miller Lake	18.70	158.30	0.00	24.61	42
26	Turlock ID Highline Spill	1.64	1.66	1.62	0.03	2
27	Turlock ID Lateral 2 to SJR	6.43	10.77	2.50	3.66	4
28	Turlock ID Westport Drain Flow Station	38.52	84.23	8.48	20.62	50
29	Turlock ID Harding Drain	37.14	70.57	9.67	13.33	64
30	Turlock ID Lateral 6 & 7 at Levee	32.33	81.18	0.00	14.82	36
31	BCID - New Jerusalem Drain	465.26	524.09	419.85	40.35	8
32	El Solyo WD - Grayson Drain	114.94	174.53	27.59	62.05	5
33	Hospital Creek	50.82	108.82	15.52	31.47	17
34	Ingram Creek Flow Station	135.54	357.12	26.65	73.08	44
35	Westley Wasteway Flow Station	80.31	113.68	52.03	18.96	7
36	Del Puerto Creek Flow Station	128.84	281.41	21.20	57.94	58
38	Marshall Road Drain	126.17	274.27	40.53	83.10	8
39	Salado Creek Flow Station	193.93	268.87	164.74	50.12	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	1513.64	2107.61	43.87	304.15	73
45	Volta Wasteway at Ingomar Grade	85.31	163.04	23.05	53.65	11
46	Mud Slough at Gun Club Road	325.54	668.29	92.06	193.27	11
47	Delta-Mendota Cal Hwy 140	29.00	42.49	21.27	11.72	3
48	FC-5 Grasslands Area Farmers	1943.54	2058.77	1828.31	162.96	2
49	PE-14-Grasslands Area Farmers	1895.58	2030.76	1760.40	191.17	2
50	San Luis Drain Site A (Check 18)	1610.31	1978.62	1343.62	302.85	4
51	Arroyo Cal at Hwy 152	248.02	284.25	211.78	51.24	2
52	Salt Slough at Sand Dam	98.62	123.11	78.37	22.67	3
53	Salt Slough at Wolfsen Road	191.63	328.16	60.70	69.90	30
57	Ramona Lake Drain at Levee	248.66	372.15	164.78	56.39	29
59	SJR Laird Park	173.15	1794.51	15.24	364.60	22
60	Moffit 1 South	98.39	206.83	39.91	52.47	19
61	Deadman's Slough	140.06	299.59	48.05	80.42	23
62	Mallard Slough	246.28	1388.96	74.78	334.52	22
63	Inlet C Canal	84.28	201.04	37.43	43.91	27

DO site number	Site name	Average of SO4 mg/L	Max of SO4 mg/L	Min of SO4 mg/L	StdDev of SO4 mg/L	Count of SO4 mg/L
64	Moran Drain	81.01	120.87	30.73	39.77	6
65	Spanish Grant Drain	150.41	231.04	74.29	62.07	7
66	ESWD Maze Blv. Drain	46.81	74.74	30.62	20.39	4
67	Newman Wasteway at Brazo Road	139.21	225.38	30.31	62.64	7
68	S. Lake Basin	361.14	649.23	43.79	265.68	5
69	Santa Fe Canal	39.23	39.23	39.23	na	1
80	South Marsh 1 Inlet	69.97	120.07	37.98	28.96	17
81	South Marsh 1 Outlet	64.33	118.55	39.97	24.07	19
82	South Marsh 3 Inlet	107.77	242.97	44.34	48.21	23
83	South Marsh 3 Outlet	115.73	300.87	57.21	57.70	26
84	SJR Garwood Bridge	107.03	107.03	107.03	na	1
86	Ramona Drain Apple Ave	188.53	446.04	70.08	105.16	9
87	Ramona Drain Prune Ave	146.62	201.12	118.77	47.20	3
88	Ramona Drain Apricot Ave	190.59	275.19	76.51	64.33	9
89	Ramona Drain Pomelo Ave	159.24	199.62	104.87	48.90	3
90	Ramona Drain Almond Ave	172.85	172.85	172.85	na	1
91	Paradise Drain Prune Ave	124.09	214.22	33.96	127.46	2
92	Paradise Drain Apricot Ave	267.74	707.76	142.25	198.38	7
93	Paradise Drain Pomelo Ave	370.05	713.61	138.22	303.53	3
94	Paradise Drain Almond Ave	268.67	713.07	137.82	202.36	7
95	Ramona Lake Entrance	279.10	373.49	173.27	58.05	16
96	WPF-VD-1	57.34	57.34	57.34	na	1
97	WPF-VD-2	58.93	58.93	58.93	na	1
98	WPF-VD-3	72.88	72.88	72.88	na	1
101	WPF-UD-IN	149.80	242.77	56.84	131.47	2
102	WPF-UD-OUT	125.64	193.62	57.66	96.14	2
103	SLD Check 18	1546.15	1756.79	1335.50	297.90	2
104	SLD Check 16	1625.46	1807.09	1443.84	256.86	2
105	SLD Check 15	1643.12	1818.99	1467.26	248.72	2
106	SLD Check 14	1626.20	1822.74	1429.66	277.95	2
107	SLD Check 13	1615.75	1809.66	1421.84	274.23	2
108	SLD Check 12	1631.62	1799.08	1464.15	236.83	2
109	SLD Check 11	1623.23	1859.56	1386.90	334.22	2
110	SLD Check 10	1636.22	1801.45	1470.98	233.68	2
111	SLD Check 9	1626.44	1684.40	1568.48	81.96	2
112	SLD Check 8	1584.27	1661.87	1506.66	109.75	2
113	SLD Check 7	1576.96	1635.75	1518.18	83.14	2
114	SLD Check 6	1521.97	1627.86	1416.08	149.75	2
115	SLD Check 5	1618.42	1623.73	1613.11	7.51	2
116	SLD Check 4	1606.79	1765.60	1447.98	224.59	2
117	SLD Check 3	1684.03	1779.84	1588.22	135.50	2
118	SLD Check 2	1641.12	1705.20	1577.05	90.62	2
119	SLD Check 1	1636.76	1649.72	1623.81	18.32	2
120	South Marsh 1 Intermediary	86.47	263.21	40.32	63.25	11
121	South Marsh 1 East	60.87	102.55	39.30	24.75	10
122	South Marsh 1 West	57.67	90.62	36.85	19.67	9
123	Ramona Lake NW Quad	314.26	314.26	314.26	na	1
124	Ramona Lake NE Quad	257.63	257.63	257.63	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	797.33	850.68	753.91	49.15	3
130	Marshall Rd Reservoir Entrance	135.95	211.85	57.29	60.72	7
131	Marshall Rd Reservoir Exit	178.40	236.41	130.41	40.18	7
132	Marshall Rd Res Pond 1W	141.99	203.36	76.99	54.89	5
133	Marshall Rd Res Pond 2E	145.60	206.92	93.40	51.50	5
135	Modesto ID Main Drain Spill	10.44	13.31	5.93	3.25	6

Br (mg/L)

DO site number	Site name	Average of Br (mg/L)	Max of Br (mg/L)	Min of Br (mg/L)	StdDev of Br (mg/L)	Count of Br (mg/L)
1	SJR at Channel Point	0.67	0.87	0.46	0.29	2
2	SJR at Dos Reis Lathrop	0.68	0.73	0.64	0.06	2
3	SJR at Old River	0.93	1.00	0.86	0.10	2
4	SJR at Mossdale	0.67	1.66	0.10	0.43	65
5	SJR at Vernalis	0.52	1.48	0.09	0.30	73
6	SJR at Maze	0.87	3.54	0.13	0.60	70
7	SJR at Patterson	1.16	2.68	0.13	0.68	75
8	SJR at Crows Landing	1.19	3.23	0.11	0.70	80
9	SJR at Fremont Ford	1.15	1.33	0.75	0.24	5
10	SJR at Lander Avenue	1.04	4.22	0.08	0.73	83
11	French Camp Slough	0.46	0.78	0.02	0.27	7
12	Stanislaus River at Caswell Park	0.02	0.27	0.00	0.06	67
13	Stanislaus River at Ripon	0.00	0.00	0.00	na	1
14	Tuolumne River at Shiloh Bridge	0.19	0.64	0.00	0.18	68
16	Merced River at River Road	0.18	0.79	0.00	0.21	67
17	Merced River near Stevinson	0.00	0.00	0.00	na	1
18	Mud Slough near Gustine	3.60	9.02	0.14	2.01	77
19	Salt Slough at Lander Avenue	1.66	4.79	0.28	0.89	103
20	Los Banos Creek at Highway 140	1.94	4.59	0.28	1.18	66
21	Orestimba Creek at River Road	1.03	2.75	0.16	0.58	58
22	Modesto ID Lateral 4 to SJR	0.47	1.37	0.10	0.49	6
23	Modesto ID Lateral 5 to Tuolumne	0.13	0.88	0.00	0.23	29
24	Modesto ID Lateral 6 to Stanislaus River	0.00	0.00	0.00	0.00	2
25	MID Main Drain to Stan. R. via Miller Lake	0.35	2.06	0.00	0.47	42
26	Turlock ID Highline Spill	0.00	0.00	0.00	0.00	2
27	Turlock ID Lateral 2 to SJR	0.12	0.37	0.00	0.18	4
28	Turlock ID Westport Drain Flow Station	0.86	2.54	0.00	0.77	50
29	Turlock ID Harding Drain	0.71	1.92	0.00	0.54	64
30	Turlock ID Lateral 6 & 7 at Levee	0.79	2.29	0.00	0.53	35
31	BCID - New Jerusalem Drain	2.80	4.26	0.00	1.36	9
32	El Solyo WD - Grayson Drain	0.94	1.62	0.40	0.50	5
33	Hospital Creek	0.38	1.22	0.00	0.33	17
34	Ingram Creek Flow Station	1.44	3.49	0.00	0.93	44
35	Westley Wasteway Flow Station	0.78	1.10	0.38	0.28	7
36	Del Puerto Creek Flow Station	1.10	2.95	0.00	0.70	58
38	Marshall Road Drain	0.77	1.99	0.24	0.61	8
39	Salado Creek Flow Station	1.26	2.15	0.78	0.61	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	6.11	13.40	0.52	3.00	73
45	Volta Wasteway at Ingomar Grade	1.16	3.85	0.29	1.13	11
46	Mud Slough at Gun Club Road	2.35	6.16	0.89	1.68	11
47	Delta-Mendota Cal Hwy 140	0.61	0.80	0.47	0.17	3
48	FC-5 Grasslands Area Farmers	11.59	11.74	11.45	0.20	2
49	PE-14-Grasslands Area Farmers	6.39	7.47	5.31	1.53	2
50	San Luis Drain Site A (Check 18)	8.31	9.72	6.84	1.56	4
51	Arroyo Cal at Hwy 152	1.79	2.48	1.09	0.98	2
52	Salt Slough at Sand Dam	1.25	2.32	0.69	0.93	3
53	Salt Slough at Wolfsen Road	1.64	3.86	0.62	0.77	30
57	Ramona Lake Drain at Levee	1.70	4.57	0.34	1.14	29
59	SJR Laird Park	1.25	10.47	0.12	2.12	22
60	Moffit 1 South	0.93	3.39	0.35	0.68	19
61	Deadman's Slough	1.50	4.14	0.35	0.94	23
62	Mallard Slough	1.61	5.11	0.46	1.18	22
63	Inlet C Canal	0.84	2.54	0.17	0.50	27

DO site number	Site name	Average of Br (mg/L)	Max of Br (mg/L)	Min of Br (mg/L)	StdDev of Br (mg/L)	Count of Br (mg/L)
64	Moran Drain	1.13	1.77	0.54	0.54	6
65	Spanish Grant Drain	0.89	2.07	0.15	0.76	7
66	ESWD Maze Blv. Drain	0.58	1.04	0.37	0.31	4
67	Newman Wasteway at Brazo Road	1.34	2.15	0.40	0.55	7
68	S. Lake Basin	2.69	4.54	0.83	1.44	5
69	Santa Fe Canal	0.51	0.51	0.51	na	1
80	South Marsh 1 Inlet	1.00	3.30	0.20	0.74	17
81	South Marsh 1 Outlet	0.73	1.64	0.21	0.38	19
82	South Marsh 3 Inlet	1.32	5.39	0.47	1.04	23
83	South Marsh 3 Outlet	1.14	1.96	0.52	0.44	26
84	SJR Garwood Bridge	0.00	0.00	0.00	na	1
86	Ramona Drain Apple Ave	1.27	2.42	0.31	0.76	9
87	Ramona Drain Prune Ave	2.15	3.92	1.21	1.53	3
88	Ramona Drain Apricot Ave	1.49	2.63	0.00	1.00	9
89	Ramona Drain Pomelo Ave	1.90	2.54	1.09	0.74	3
90	Ramona Drain Almond Ave	1.95	1.95	1.95	na	1
91	Paradise Drain Prune Ave	1.49	2.35	0.63	1.22	2
92	Paradise Drain Apricot Ave	2.07	3.23	1.22	0.85	7
93	Paradise Drain Pomelo Ave	2.66	3.72	1.85	0.96	3
94	Paradise Drain Almond Ave	3.40	11.37	1.24	3.55	7
95	Ramona Lake Entrance	2.17	5.38	0.81	1.26	16
96	WPF-VD-1	0.32	0.32	0.32	na	1
97	WPF-VD-2	0.38	0.38	0.38	na	1
98	WPF-VD-3	0.83	0.83	0.83	na	1
101	WPF-UD-IN	1.92	3.39	0.46	2.07	2
102	WPF-UD-OUT	1.00	1.43	0.57	0.61	2
103	SLD Check 18	11.78	14.69	8.87	4.12	2
104	SLD Check 16	9.50	13.28	5.73	5.34	2
105	SLD Check 15	10.02	13.79	6.25	5.33	2
106	SLD Check 14	7.36	10.49	4.23	4.43	2
107	SLD Check 13	5.63	7.64	3.61	2.85	2
108	SLD Check 12	7.86	8.19	7.54	0.46	2
109	SLD Check 11	8.04	8.76	7.33	1.01	2
110	SLD Check 10	7.92	8.22	7.62	0.42	2
111	SLD Check 9	8.00	8.98	7.03	1.38	2
112	SLD Check 8	6.98	7.32	6.63	0.49	2
113	SLD Check 7	6.47	8.86	4.08	3.38	2
114	SLD Check 6	7.40	7.54	7.25	0.21	2
115	SLD Check 5	7.04	9.58	4.51	3.59	2
116	SLD Check 4	8.65	11.30	5.99	3.75	2
117	SLD Check 3	8.75	13.07	4.43	6.11	2
118	SLD Check 2	3.96	4.57	3.35	0.86	2
119	SLD Check 1	7.24	11.05	3.42	5.39	2
120	South Marsh 1 Intermediary	0.69	1.51	0.17	0.46	11
121	South Marsh 1 East	0.69	1.64	0.23	0.45	10
122	South Marsh 1 West	1.19	2.56	0.32	0.93	9
123	Ramona Lake NW Quad	0.76	0.76	0.76	na	1
124	Ramona Lake NE Quad	0.64	0.64	0.64	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	4.25	6.44	2.43	2.04	3
130	Marshall Rd Reservoir Entrance	1.37	4.44	0.16	1.45	7
131	Marshall Rd Reservoir Exit	2.17	6.46	0.70	2.00	7
132	Marshall Rd Res Pond 1W	1.46	3.52	0.28	1.22	5
133	Marshall Rd Res Pond 2E	1.26	3.36	0.00	1.30	5
135	Modesto ID Main Drain Spill	0.32	0.77	0.00	0.37	6

Silica (SiO4-Si) mg/L

DO site number	Site name	Average of Dissolved Si, mg/L	Max of Dissolved Si, mg/L	Min of Dissolved Si, mg/L	StdDev of Dissolved Si, mg/L	Count of Dissolved Si, mg/L
1	SJR at Channel Point	4.28	4.28	4.28	na	1
2	SJR at Dos Reis Lathrop	4.40	4.40	4.40	na	1
3	SJR at Old River	4.39	4.39	4.39	na	1
4	SJR at Mossdale	5.39	8.37	3.13	1.58	24
5	SJR at Vernalis	6.15	8.61	2.76	1.58	30
6	SJR at Maze	7.15	9.83	4.12	1.49	29
7	SJR at Patterson	7.58	10.51	1.77	2.05	31
8	SJR at Crows Landing	6.67	10.35	2.16	2.06	33
9	SJR at Fremont Ford	8.08	10.57	4.62	3.09	3
10	SJR at Lander Avenue	9.23	14.46	0.38	3.33	33
11	French Camp Slough	4.36	4.36	4.36	na	1
12	Stanislaus River at Caswell Park	4.99	6.78	1.51	1.53	24
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	7.54	9.83	1.37	2.34	24
16	Merced River at River Road	5.33	7.34	0.77	1.75	24
17	Merced River near Stevinson	na	na	na	na	na
18	Mud Slough near Gustine	4.72	11.51	0.93	2.78	31
19	Salt Slough at Lander Avenue	8.47	11.22	2.10	2.17	36
20	Los Banos Creek at Highway 140	6.60	14.12	2.64	2.92	18
21	Orestimba Creek at River Road	7.16	9.54	4.53	1.34	20
22	Modesto ID Lateral 4 to SJR	3.95	3.95	3.95	na	1
23	Modesto ID Lateral 5 to Tuolumne	5.52	5.52	5.52	na	1
24	Modesto ID Lateral 6 to Stanislaus River	0.53	0.53	0.53	na	1
25	MID Main Drain to Stan. R. via Miller Lake	8.18	15.08	2.39	3.25	19
26	Turlock ID Highline Spill	0.38	0.38	0.38	na	1
27	Turlock ID Lateral 2 to SJR	3.07	4.26	1.46	1.45	3
28	Turlock ID Westport Drain Flow Station	13.79	23.35	4.53	5.05	23
29	Turlock ID Harding Drain	15.41	26.28	3.96	5.01	24
30	Turlock ID Lateral 6 & 7 at Levee	11.82	25.52	3.44	5.42	22
31	BCID - New Jerusalem Drain	16.33	19.42	12.14	3.54	4
32	El Solyo WD - Grayson Drain	6.74	7.92	5.41	1.26	3
33	Hospital Creek	4.52	4.75	4.30	0.32	2
34	Ingram Creek Flow Station	6.28	10.63	0.86	2.21	24
35	Westley Wasteway Flow Station	4.12	4.24	3.99	0.18	2
36	Del Puerto Creek Flow Station	6.24	8.47	2.75	1.55	23
38	Marshall Road Drain	5.26	6.26	3.71	1.36	3
39	Salado Creek Flow Station	6.73	9.07	3.48	2.40	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	3.10	9.95	0.05	2.88	24
45	Volta Wasteway at Ingomar Grade	5.29	5.29	5.29	0.00	2
46	Mud Slough at Gun Club Road	6.03	6.03	6.03	0.00	2
47	Delta-Mendota Cal Hwy 140	5.79	6.67	4.12	1.45	3
48	FC-5 Grasslands Area Farmers	na	na	na	na	na
49	PE-14-Grasslands Area Farmers	na	na	na	na	na
50	San Luis Drain Site A (Check 18)	7.22	7.22	7.22	na	1
51	Arroyo Cal at Hwy 152	4.38	4.90	3.87	0.73	2
52	Salt Slough at Sand Dam	6.88	6.91	6.86	0.03	2
53	Salt Slough at Wolfsen Road	8.20	10.94	6.59	2.17	5
54	Los Banos Creek at Ingomar Grade	na	na	na	na	na
57	Ramona Lake Drain at Levee	5.03	7.09	2.55	1.48	15
59	SJR Laird Park	na	na	na	na	na
60	Moffit 1 South	6.22	6.22	6.22	0.00	2
61	Deadman's Slough	4.24	11.20	0.24	4.79	4
62	Mallard Slough	5.08	7.71	3.77	2.27	3
63	Inlet C Canal	7.93	10.55	5.73	2.56	4

DO site number	Site name	Average of Dissolved Si, mg/L	Max of Dissolved Si, mg/L	Min of Dissolved Si, mg/L	StdDev of Dissolved Si, mg/L	Count of Dissolved Si, mg/L
64	Moran Drain	5.71	6.63	4.86	0.89	3
65	Spanish Grant Drain	5.75	7.30	2.88	2.49	3
66	ESWD Maze Blv. Drain	na	na	na	na	na
67	Newman Wasteway at Brazo Road	7.26	7.68	6.82	0.43	3
68	S. Lake Basin	8.41	8.41	8.41	0.00	2
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	9.96	10.20	9.73	0.33	2
81	South Marsh 1 Outlet	8.92	10.14	7.71	1.72	2
82	South Marsh 3 Inlet	12.70	15.27	10.20	2.39	4
83	South Marsh 3 Outlet	11.50	14.27	6.89	3.60	6
84	SJR Garwood Bridge	na	na	na	na	na
86	Ramona Drain Apple Ave	11.45	17.00	8.34	4.12	6
87	Ramona Drain Prune Ave	na	na	na	na	na
88	Ramona Drain Apricot Ave	9.19	9.70	8.36	0.47	6
89	Ramona Drain Pomelo Ave	na	na	na	na	na
90	Ramona Drain Almond Ave	na	na	na	na	na
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	8.70	9.12	7.94	0.52	4
93	Paradise Drain Pomelo Ave	na	na	na	na	na
94	Paradise Drain Almond Ave	8.50	9.36	7.57	0.76	5
95	Ramona Lake Entrance	6.97	15.85	2.36	3.22	15
96	WPF-VD-1	na	na	na	na	na
97	WPF-VD-2	na	na	na	na	na
98	WPF-VD-3	na	na	na	na	na
101	WPF-UD-IN	na	na	na	na	na
102	WPF-UD-OUT	na	na	na	na	na
103	SLD Check 18	7.04	7.04	7.04	na	1
104	SLD Check 16	5.09	5.09	5.09	na	1
105	SLD Check 15	6.78	6.78	6.78	na	1
106	SLD Check 14	6.40	6.40	6.40	na	1
107	SLD Check 13	5.07	5.07	5.07	na	1
108	SLD Check 12	5.88	5.88	5.88	na	1
109	SLD Check 11	5.55	5.55	5.55	na	1
110	SLD Check 10	4.68	4.68	4.68	na	1
111	SLD Check 9	4.11	4.11	4.11	na	1
112	SLD Check 8	4.09	4.09	4.09	na	1
113	SLD Check 7	4.00	4.00	4.00	na	1
114	SLD Check 6	3.34	3.34	3.34	na	1
115	SLD Check 5	2.68	2.68	2.68	na	1
116	SLD Check 4	3.11	3.11	3.11	na	1
117	SLD Check 3	2.77	2.77	2.77	na	1
118	SLD Check 2	2.75	2.75	2.75	na	1
119	SLD Check 1	3.12	3.12	3.12	na	1
120	South Marsh 1 Intermediary	10.04	10.17	9.90	0.19	2
121	South Marsh 1 East	9.72	10.08	9.35	0.52	2
122	South Marsh 1 West	19.84	22.36	17.33	3.56	2
123	Ramona Lake NW Quad	0.71	0.71	0.71	na	1
124	Ramona Lake NE Quad	4.93	4.93	4.93	na	1
125	Ramona Lake SW Quad	na	na	na	na	na
126	Ramona Lake SE Quad	na	na	na	na	na
129	Hollow Tree drain	5.34	5.34	5.34	0.00	2
130	Marshall Rd Reservoir Entrance	5.84	9.12	3.76	2.07	7
131	Marshall Rd Reservoir Exit	5.29	10.01	1.19	3.17	7
132	Marshall Rd Res Pond 1W	4.97	9.13	1.88	2.67	5
133	Marshall Rd Res Pond 2E	5.73	8.92	4.35	1.96	5
135	Modesto ID Main Drain Spill	8.79	13.18	3.59	3.89	6

254 absorbance (estimate of THM formation)

DO site number	Site name	Average of Abs. at 254 nm (w/1 nm slit)	Max of Abs. at 254 nm (w/1 nm slit)	Min of Abs. at 254 nm (w/1 nm slit)	StdDev of Abs. at 254 nm (w/1 nm slit)	Count of Abs. at 254 nm (w/1 nm slit)
1	SJR at Channel Point	0.052	0.052	0.052	na	1
2	SJR at Dos Reis Lathrop	0.043	0.043	0.043	na	1
3	SJR at Old River	0.046	0.046	0.046	na	1
4	SJR at Mossdale	0.070	0.138	0.000	0.026	33
5	SJR at Vernalis	0.078	0.234	0.033	0.037	38
6	SJR at Maze	0.093	0.361	0.038	0.051	37
7	SJR at Patterson	0.113	0.391	0.044	0.055	40
8	SJR at Crows Landing	0.118	0.326	0.072	0.041	48
9	SJR at Fremont Ford	0.140	0.172	0.110	0.025	4
10	SJR at Lander Avenue	0.144	0.325	0.042	0.051	47
11	French Camp Slough	0.135	0.423	0.023	0.136	7
12	Stanislaus River at Caswell Park	0.061	0.489	0.000	0.082	32
13	Stanislaus River at Ripon	na	na	na	na	na
14	Tuolumne River at Shiloh Bridge	0.075	0.210	0.000	0.044	33
16	Merced River at River Road	0.060	0.301	0.000	0.054	32
17	Merced River near Stevinson	na	na	na	na	na
18	Mud Slough near Gustine	0.229	1.481	0.039	0.210	45
19	Salt Slough at Lander Avenue	0.159	0.314	0.075	0.042	51
20	Los Banos Creek at Highway 140	0.345	0.878	0.181	0.158	32
21	Orestimba Creek at River Road	0.117	0.422	0.020	0.083	29
22	Modesto ID Lateral 4 to SJR	0.059	0.059	0.059	na	1
23	Modesto ID Lateral 5 to Tuolumne	0.048	0.092	0.000	0.046	3
24	Modesto ID Lateral 6 to Stanislaus River	0.124	0.124	0.124	na	1
25	MID Main Drain to Stan. R. via Miller Lake	0.152	0.226	0.024	0.041	24
26	Turlock ID Highline Spill	0.058	0.058	0.058	na	1
27	Turlock ID Lateral 2 to SJR	0.040	0.047	0.033	0.007	3
28	Turlock ID Westport Drain Flow Station	0.081	0.403	0.000	0.073	25
29	Turlock ID Harding Drain	0.089	0.150	0.000	0.030	33
30	Turlock ID Lateral 6 & 7 at Levee	0.139	0.284	0.017	0.055	24
31	BCID - New Jerusalem Drain	0.030	0.053	0.000	0.019	5
32	El Solyo WD - Grayson Drain	0.088	0.105	0.065	0.021	3
33	Hospital Creek	0.163	0.204	0.140	0.036	3
34	Ingram Creek Flow Station	0.118	0.709	0.044	0.121	26
35	Westley Wasteway Flow Station	0.086	0.110	0.062	0.033	2
36	Del Puerto Creek Flow Station	0.112	0.352	0.029	0.053	29
38	Marshall Road Drain	0.144	0.228	0.024	0.096	4
39	Salado Creek Flow Station	0.273	0.513	0.173	0.161	4
43	El Solyo Pumping Station	na	na	na	na	na
44	San Luis Drain End	0.106	0.164	0.042	0.027	38
45	Volta Wasteway at Ingomar Grade	0.071	0.115	0.000	0.036	9
46	Mud Slough at Gun Club Road	0.292	0.570	0.107	0.149	9
47	Delta-Mendota Cal Hwy 140	0.083	0.102	0.065	0.019	3
48	FC-5 Grasslands Area Farmers	na	na	na	na	na
49	PE-14-Grasslands Area Farmers	na	na	na	na	na
50	San Luis Drain Site A (Check 18)	0.137	0.137	0.137	na	1
51	Arroyo Cal at Hwy 152	0.163	0.174	0.153	0.015	2
52	Salt Slough at Sand Dam	0.155	0.172	0.138	0.024	2
53	Salt Slough at Wolfsen Road	0.170	0.287	0.092	0.046	14
54	Los Banos Creek at Ingomar Grade	na	na	na	na	na
57	Ramona Lake Drain at Levee	0.172	0.217	0.024	0.044	22
59	SJR Laird Park	0.107	0.107	0.107	na	1
60	Moffit 1 South	0.348	0.425	0.178	0.082	8
61	Deadman's Slough	0.277	0.480	0.157	0.114	13
62	Mallard Slough	0.430	1.192	0.240	0.286	10
63	Inlet C Canal	0.097	0.164	0.009	0.050	13

DO site number	Site name	Average of Abs. at 254 nm (w/1 nm slit)	Max of Abs. at 254 nm (w/1 nm slit)	Min of Abs. at 254 nm (w/1 nm slit)	StdDev of Abs. at 254 nm (w/1 nm slit)	Count of Abs. at 254 nm (w/1 nm slit)
64	Moran Drain	0.076	0.120	0.039	0.041	3
65	Spanish Grant Drain	0.143	0.191	0.097	0.047	3
66	ESWD Maze Blv. Drain	na	na	na	na	na
67	Newman Wasteway at Brazo Road	0.151	0.263	0.079	0.099	3
68	S. Lake Basin	0.330	0.590	0.137	0.234	3
69	Santa Fe Canal	na	na	na	na	na
80	South Marsh 1 Inlet	0.087	0.169	0.007	0.062	8
81	South Marsh 1 Outlet	0.220	0.416	0.062	0.136	10
82	South Marsh 3 Inlet	0.270	0.423	0.106	0.111	12
83	South Marsh 3 Outlet	0.333	0.592	0.030	0.130	15
84	SJR Garwood Bridge	na	na	na	na	na
86	Ramona Drain Apple Ave	0.217	0.294	0.127	0.062	5
87	Ramona Drain Prune Ave	na	na	na	na	na
88	Ramona Drain Apricot Ave	0.208	0.245	0.181	0.024	6
89	Ramona Drain Pomelo Ave	na	na	na	na	na
90	Ramona Drain Almond Ave	na	na	na	na	na
91	Paradise Drain Prune Ave	na	na	na	na	na
92	Paradise Drain Apricot Ave	0.154	0.186	0.104	0.035	4
93	Paradise Drain Pomelo Ave	na	na	na	na	na
94	Paradise Drain Almond Ave	0.154	0.189	0.123	0.023	5
95	Ramona Lake Entrance	0.177	0.211	0.095	0.027	16
96	WPF-VD-1	na	na	na	na	na
97	WPF-VD-2	na	na	na	na	na
98	WPF-VD-3	na	na	na	na	na
101	WPF-UD-IN	na	na	na	na	na
102	WPF-UD-OUT	na	na	na	na	na
103	SLD Check 18	0.134	0.134	0.134	na	1
104	SLD Check 16	0.131	0.131	0.131	na	1
105	SLD Check 15	0.130	0.130	0.130	na	1
106	SLD Check 14	0.134	0.134	0.134	na	1
107	SLD Check 13	0.133	0.133	0.133	na	1
108	SLD Check 12	0.131	0.131	0.131	na	1
109	SLD Check 11	0.118	0.118	0.118	na	1
110	SLD Check 10	0.116	0.116	0.116	na	1
111	SLD Check 9	0.111	0.111	0.111	na	1
112	SLD Check 8	0.110	0.110	0.110	na	1
113	SLD Check 7	0.104	0.104	0.104	na	1
114	SLD Check 6	0.103	0.103	0.103	na	1
115	SLD Check 5	0.109	0.109	0.109	na	1
116	SLD Check 4	0.109	0.109	0.109	na	1
117	SLD Check 3	0.109	0.109	0.109	na	1
118	SLD Check 2	0.110	0.110	0.110	na	1
119	SLD Check 1	0.117	0.117	0.117	na	1
120	South Marsh 1 Intermediary	0.100	0.173	0.024	0.044	8
121	South Marsh 1 East	0.169	0.528	0.047	0.155	9
122	South Marsh 1 West	0.447	0.710	0.199	0.174	9
123	Ramona Lake NW Quad	0.223	0.257	0.189	0.048	2
124	Ramona Lake NE Quad	0.181	0.182	0.180	0.001	2
125	Ramona Lake SW Quad	0.197	0.197	0.197	na	1
126	Ramona Lake SE Quad	0.189	0.189	0.189	na	1
129	Hollow Tree drain	0.448	0.503	0.386	0.059	3
130	Marshall Rd Reservoir Entrance	0.108	0.172	0.061	0.034	7
131	Marshall Rd Reservoir Exit	0.103	0.119	0.074	0.015	7
132	Marshall Rd Res Pond 1W	0.105	0.140	0.073	0.024	5
133	Marshall Rd Res Pond 2E	0.107	0.150	0.069	0.029	5
135	Modesto ID Main Drain Spill	0.166	0.363	0.087	0.106	6

Appendix I

Compilation of Reports Describing Temporal Trends in Water Quality Data in the Upstream San Joaquin River

***Remie Burks*[1]**
***Chelsea Spier*[1]**
***Sharon Borglin*[1]**
***Randy Dahlgren*[2]**
***Jeremy Hanlon*[1]**
***Justin Graham*[1]**
***William Stringfellow*[1]**

February 2008

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Department of Land, Air, and Water Resources
University of California, Davis
Davis, CA

Temporal Plots of 2005-2007 Total Phosphorus Data from the Upstream San Joaquin River

Chelsea Spier[1]
Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of total phosphorus (Tot-P) data analyzed by the UCD Dahlgren laboratory from 2005-2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory were they were stored at $-20^{\circ}C$ until the analysis could be completed.

Tot-P was analyzed on unfiltered samples using the stannous chloride method after digestion using the SM 4500-P.D (APHA,2005). To digest, 5.0 mL of each sample was aliquotted into trace clean, 5.0 mL digestion reagent was added (10 g potassium persulfate, 6 g boric acid, and 3 g NaOH in 1000mL Millipore water) was added and then was autoclaved for 1 hour. After cooling, Tot-P was determined using the stannous chloride method.

Results/Discussion

With each set of Tot-P field samples analyzed in the UCD laboratory, quality assurance samples including a a field duplicate, a trip blank, and lab blanks were also analyzed. Between 2005 and 2007, 95.0% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Four proficiency check samples were analyzed for Tot-P in the UCD laboratory during 2005-2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.01-6.34 mg/L Tot-P. The average concentration of Tot-P in water samples collected was 0.33 mg/L Tot-P. Tot-P was also analyzed by the EERP laboratory on all of the same water samples starting in late 2006 and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.951, and both labs have similar recovery rates. EERP measured 89.1% of Tot-P as UCD (Figure 2).

These temporal plots (Figures 3-104) as well as plotting EERP data against UCD's data (Figure 2) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

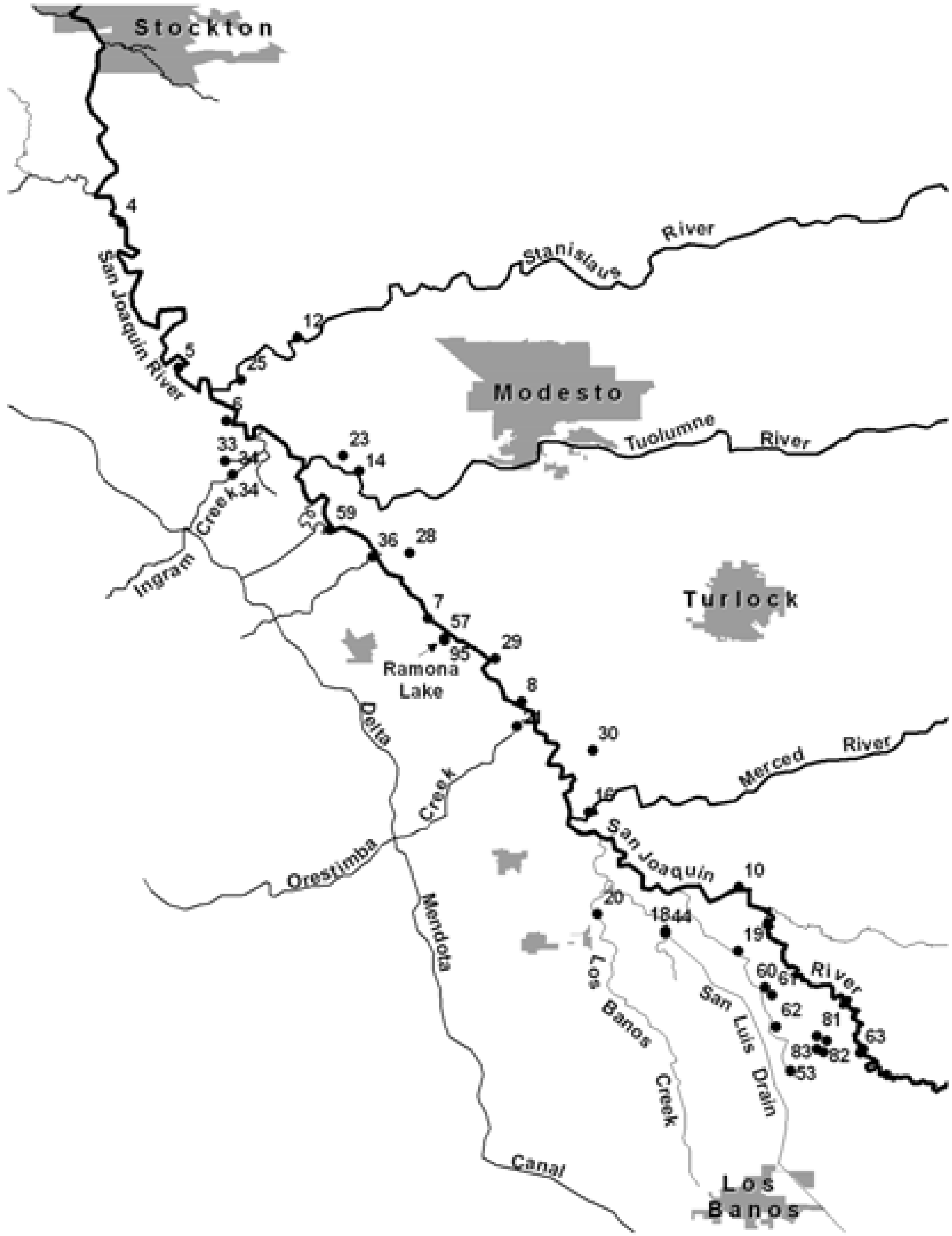
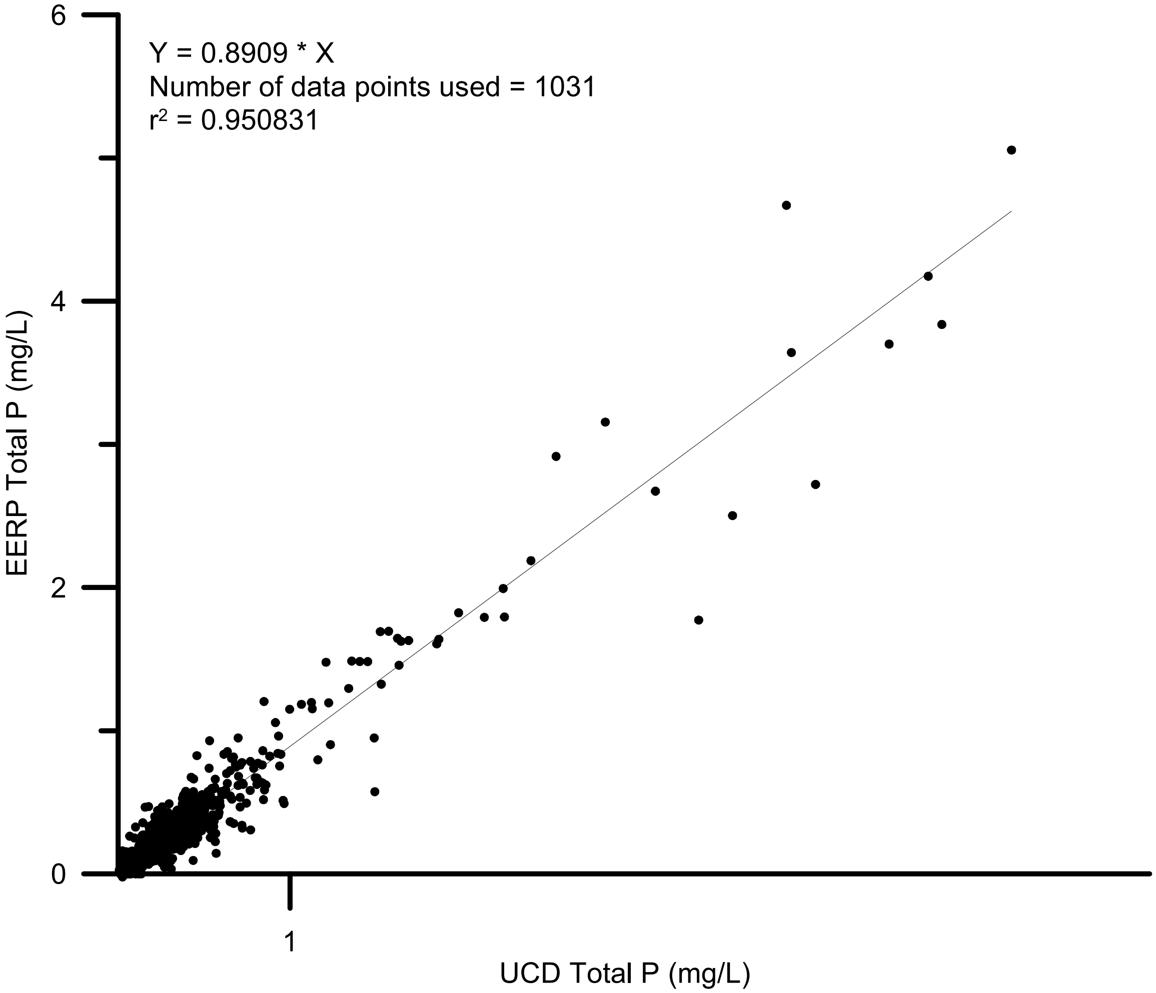
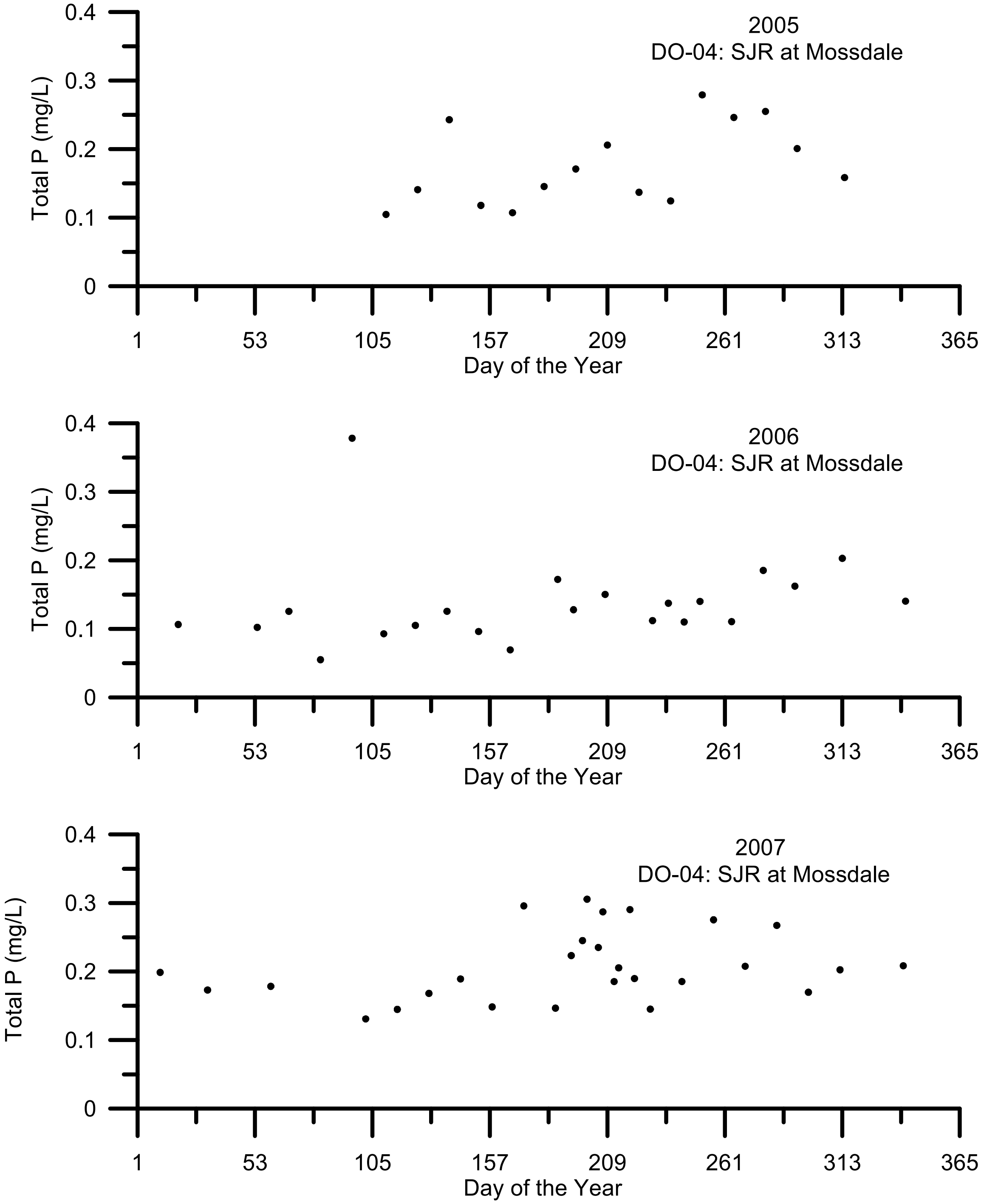
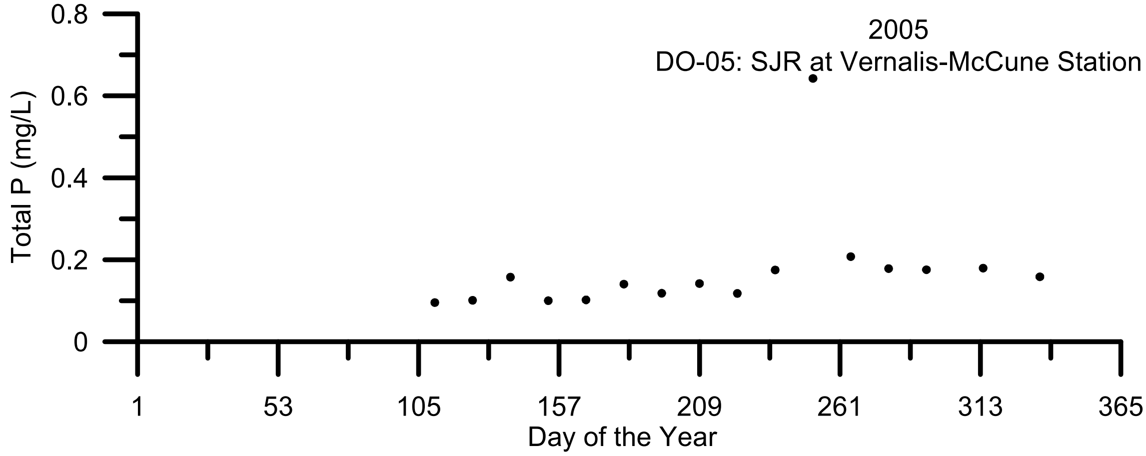


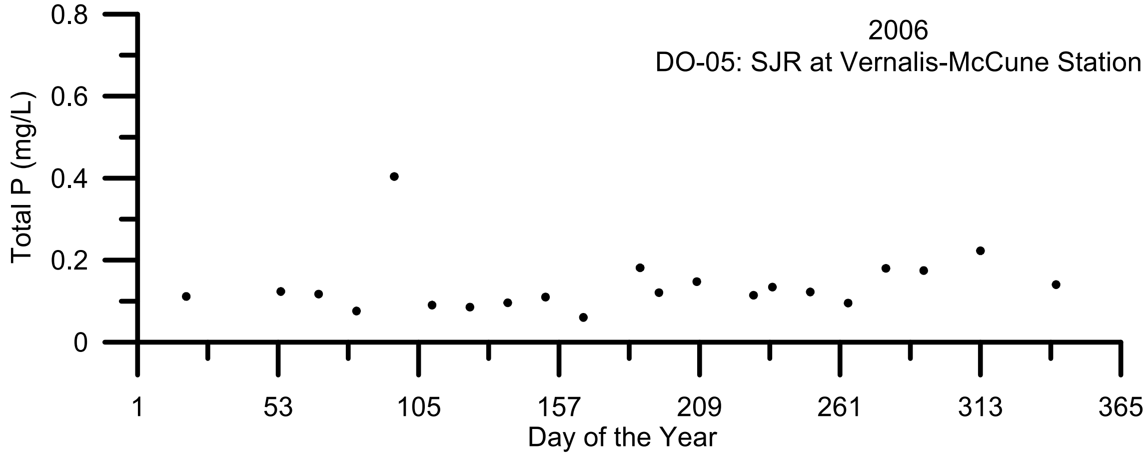
Figure 2: EERP vs UCD Tot-P Data 2006-2007

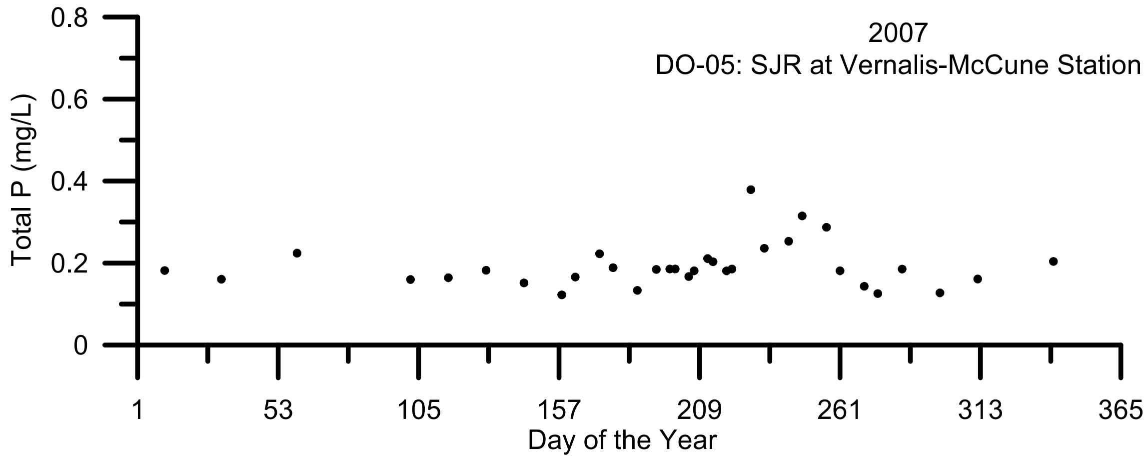


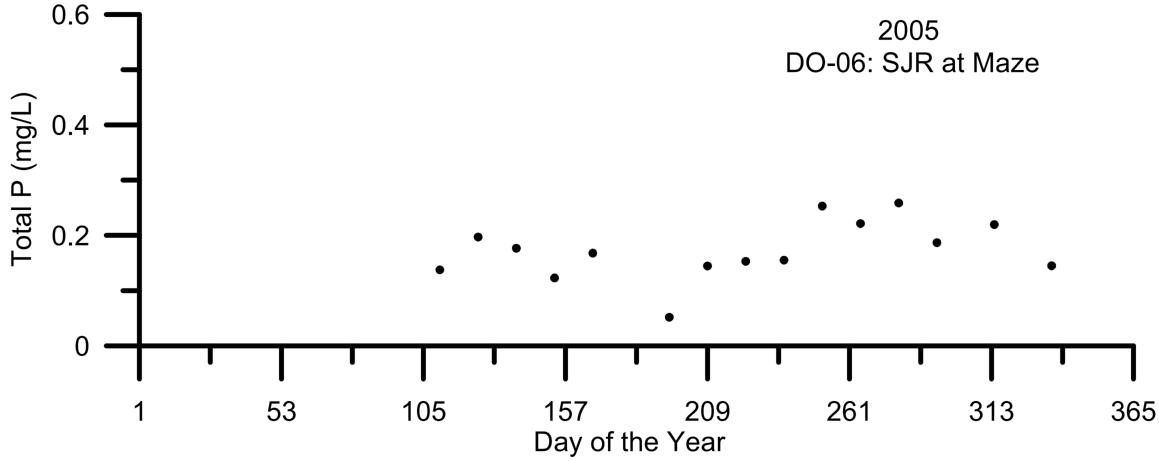
Figures 3 -104: Temporal Plots of Tot-P By Site ID

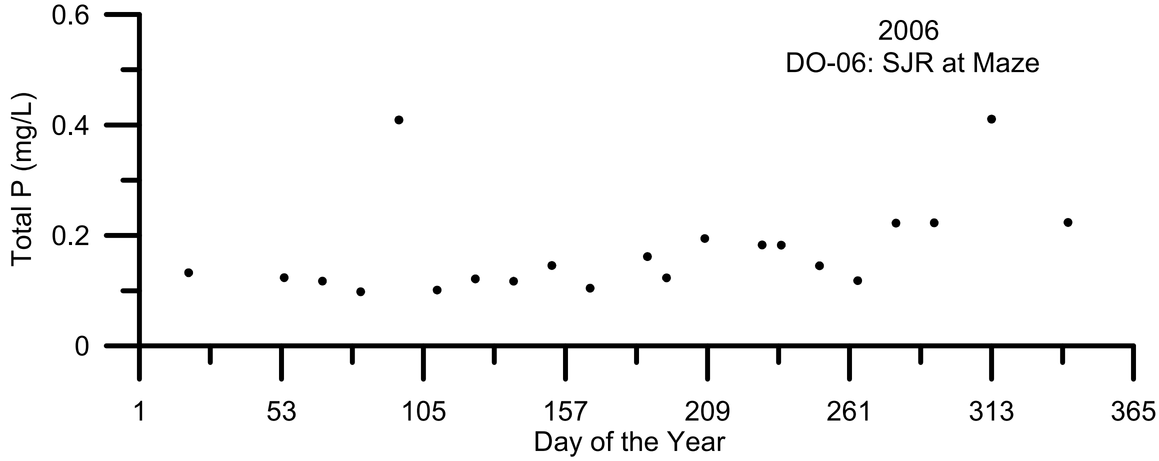


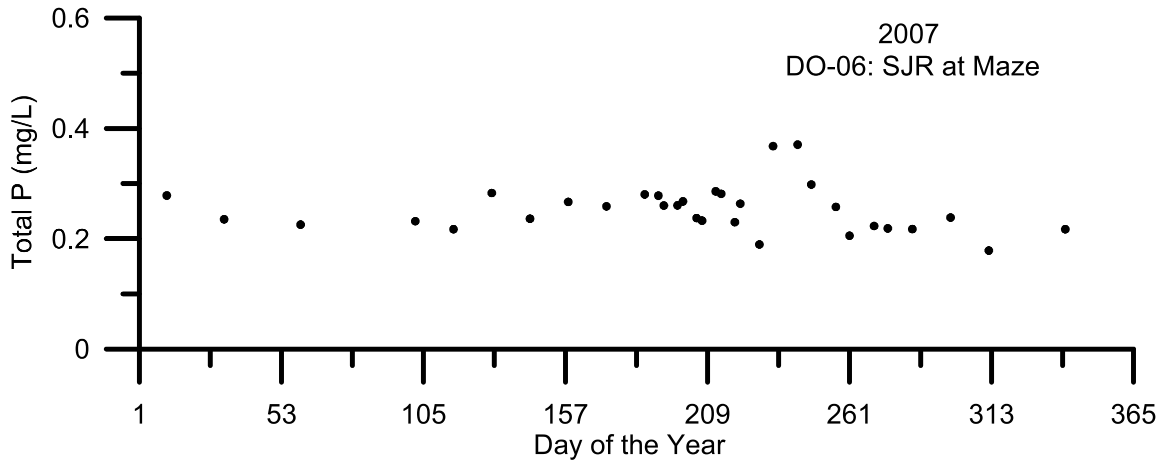

2005
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

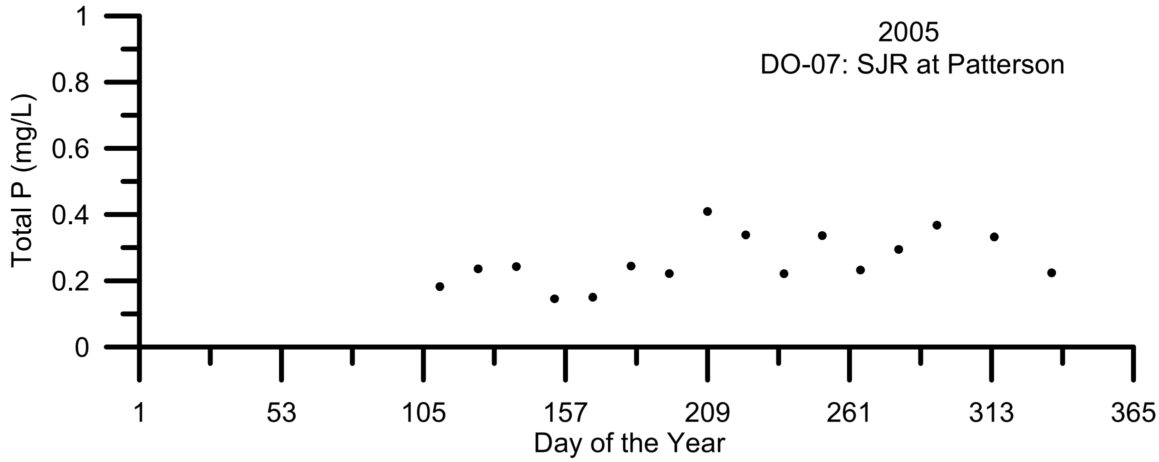

2006
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-05: SJR at Vernalis-McCune Station
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-06: SJR at Maze
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-06: SJR at Maze
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-07: SJR at Patterson
Total P (mg/L)
Day of the Year
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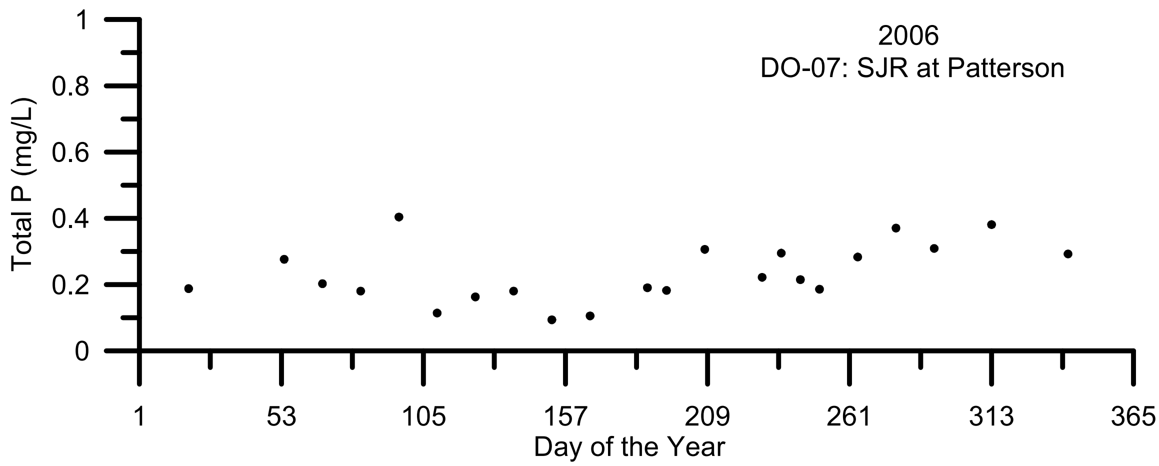
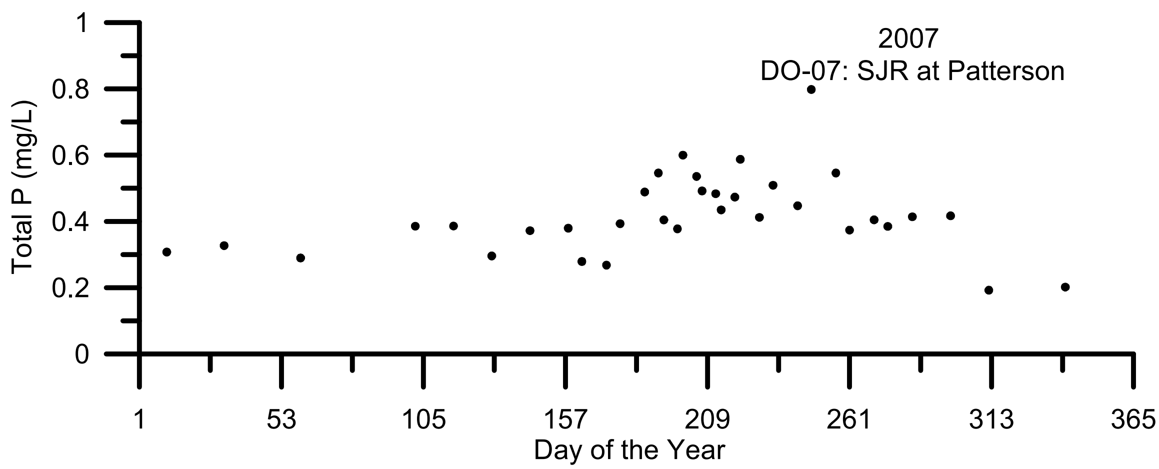
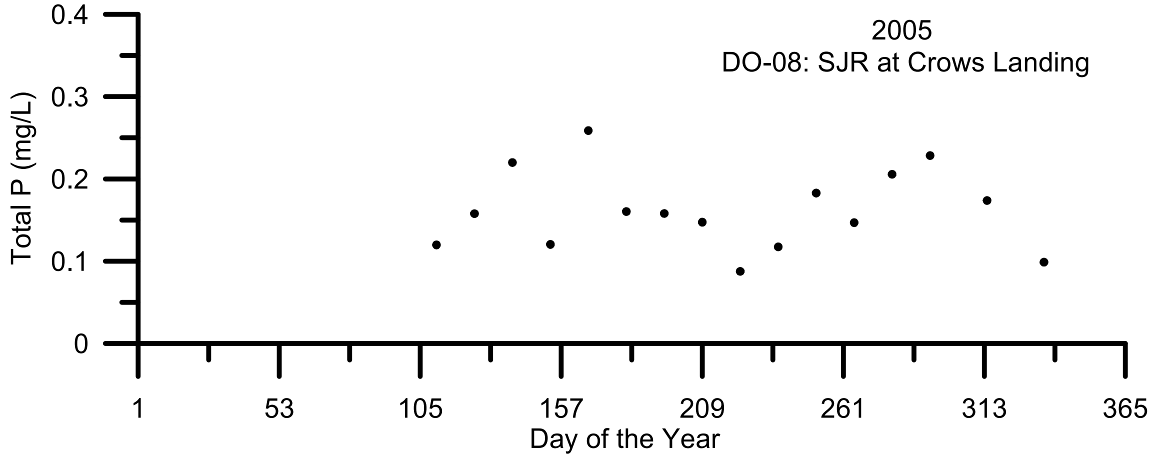
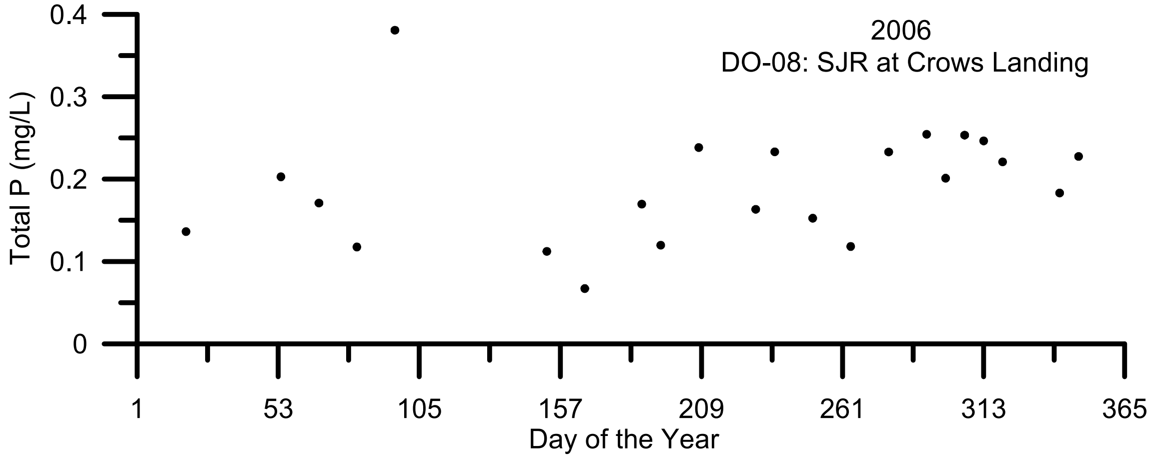
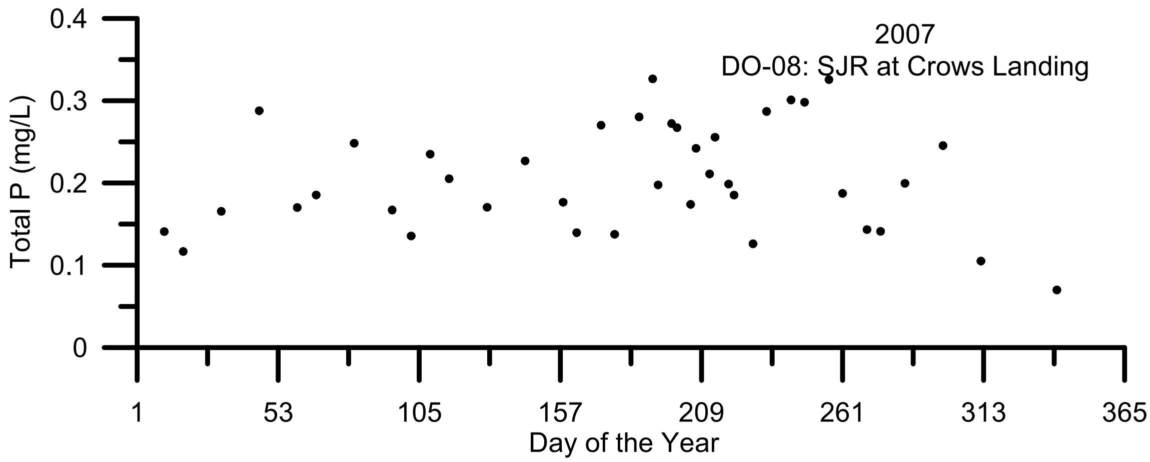
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

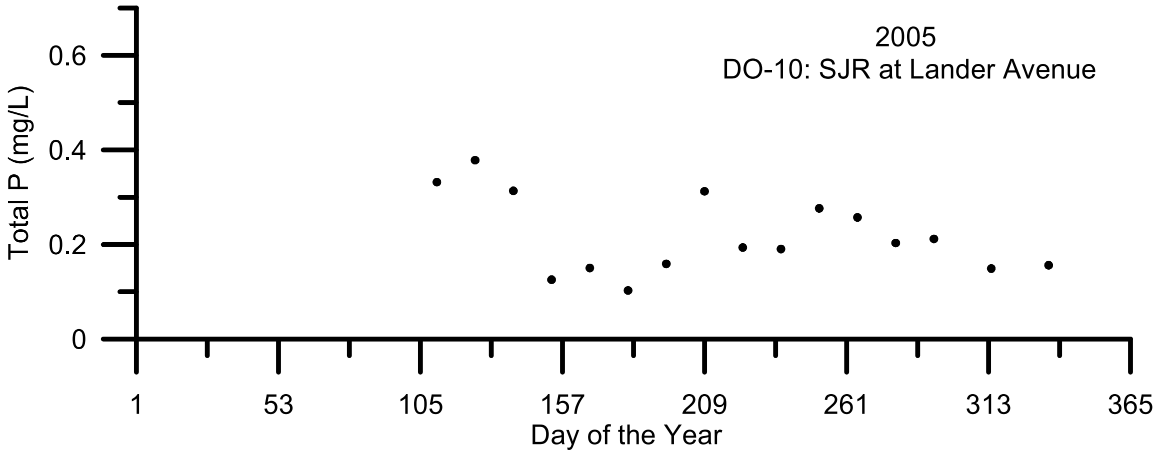

2006
DO-07: SJR at Patterson
Total P (mg/L)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

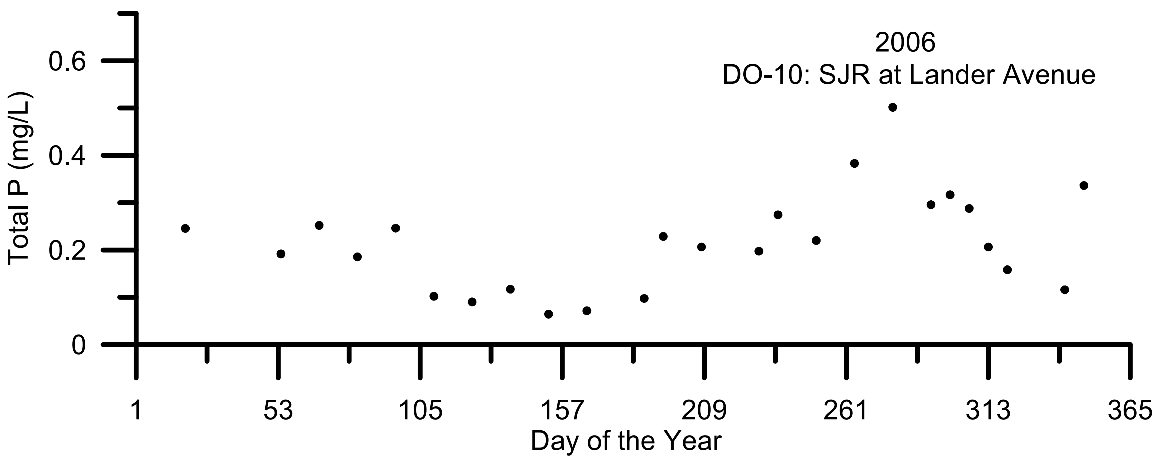

2007
DO-07: SJR at Patterson
Total P (mg/L)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365


2005
DO-08: SJR at Crows Landing
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-08: SJR at Crows Landing
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-08: SJR at Crows Landing
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-10: SJR at Lander Avenue
Total P (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-10: SJR at Lander Avenue
Total P (mg/L)
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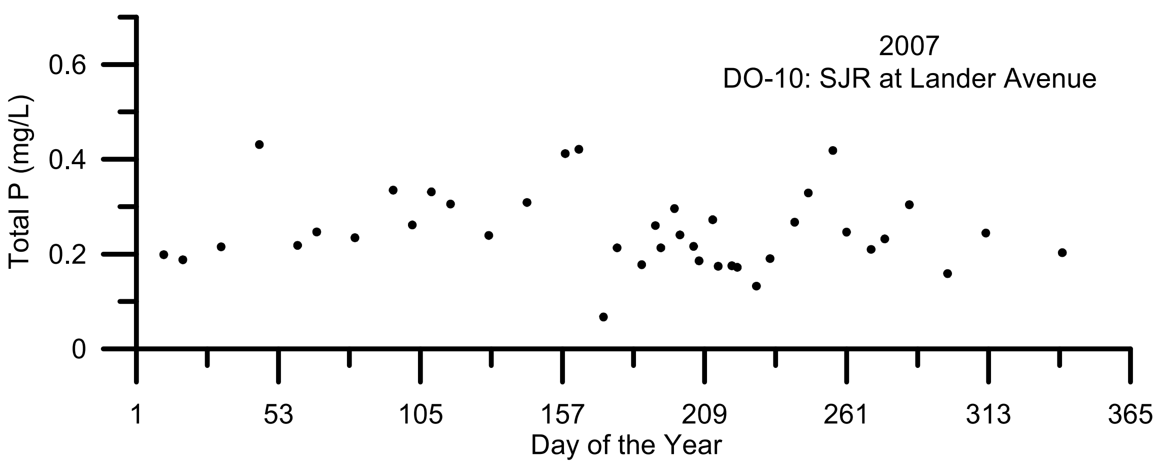
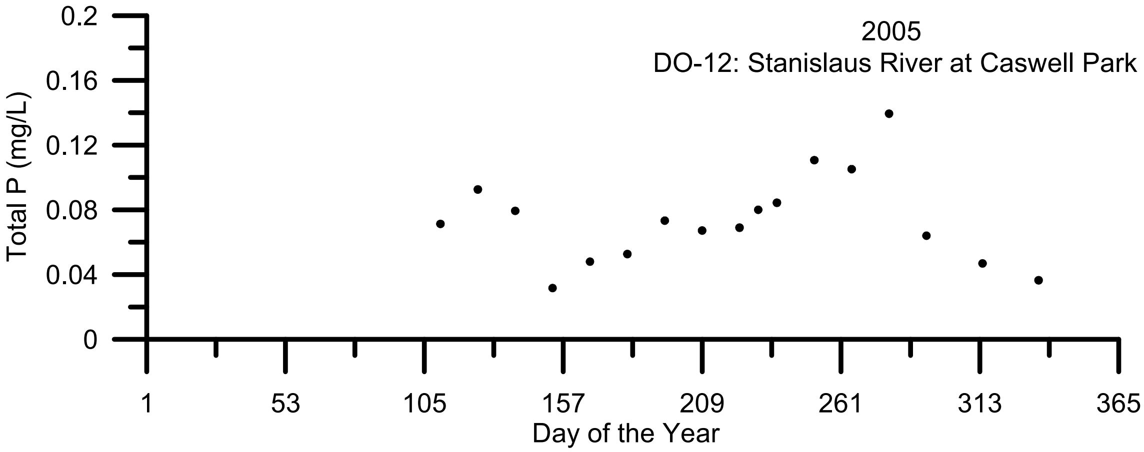
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-10: SJR at Lander Avenue
Total P (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
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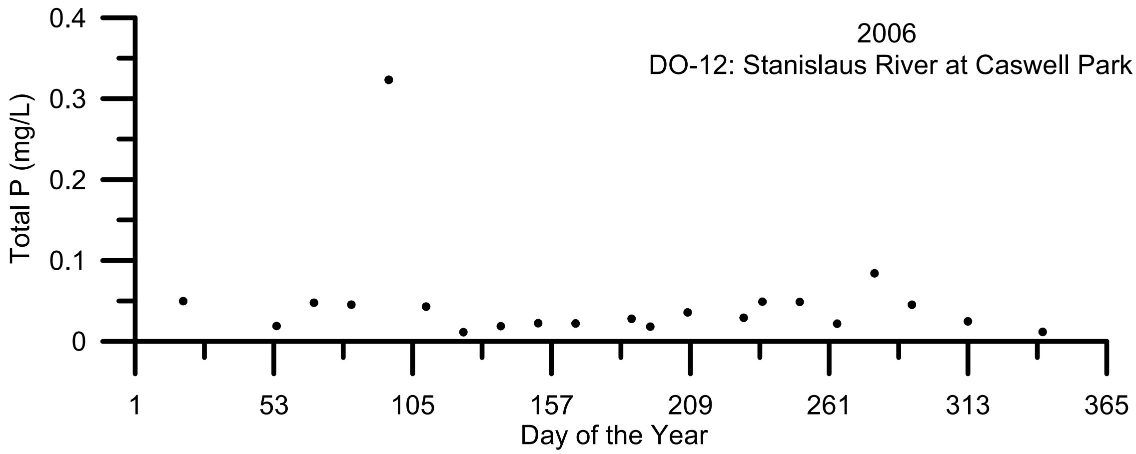
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
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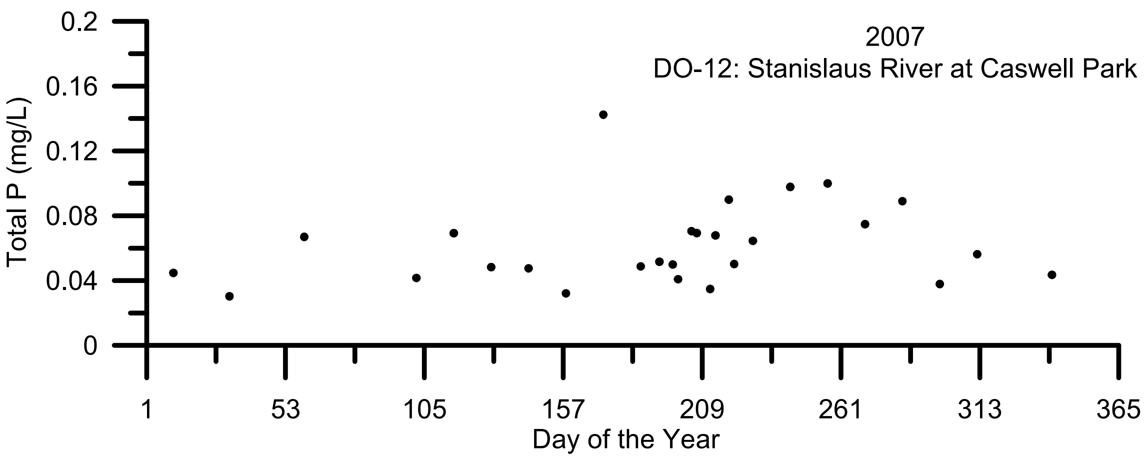
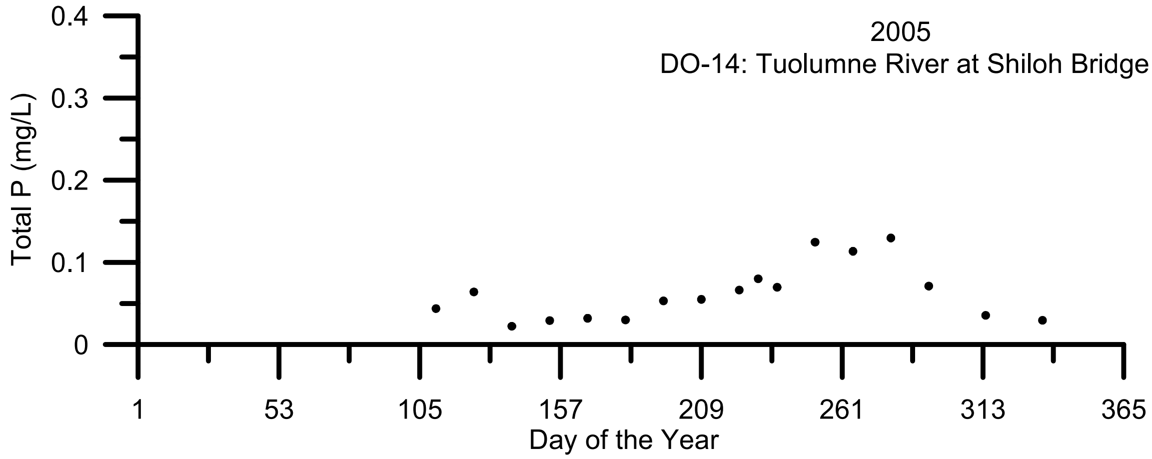
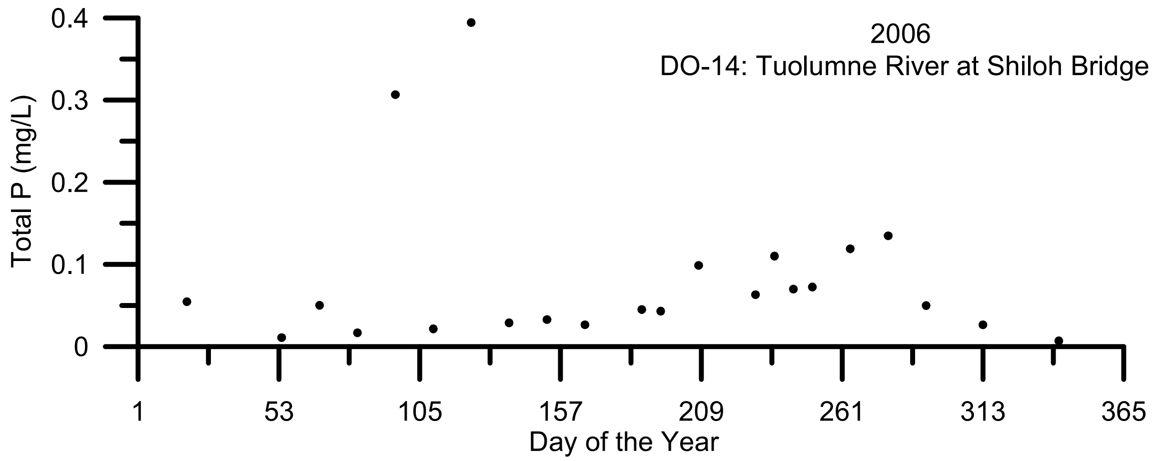
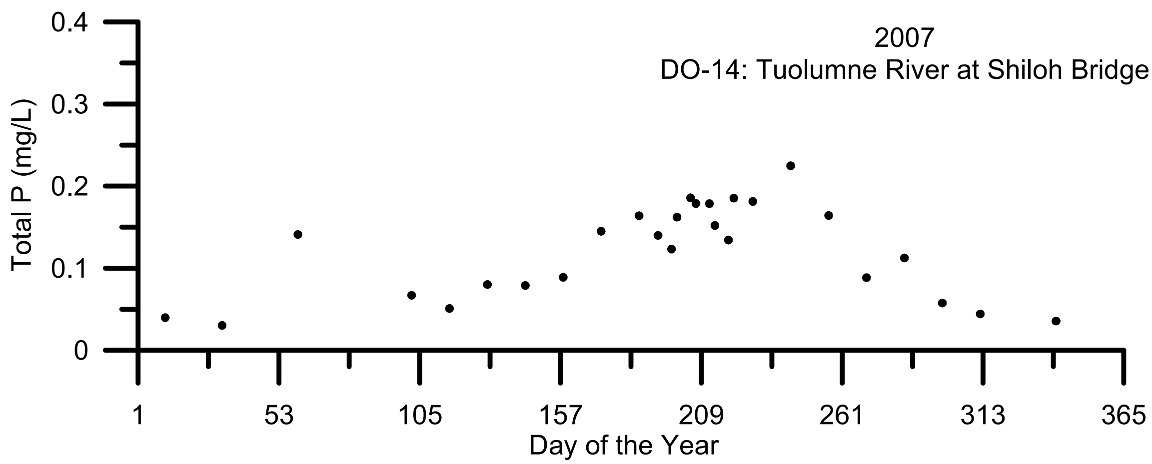
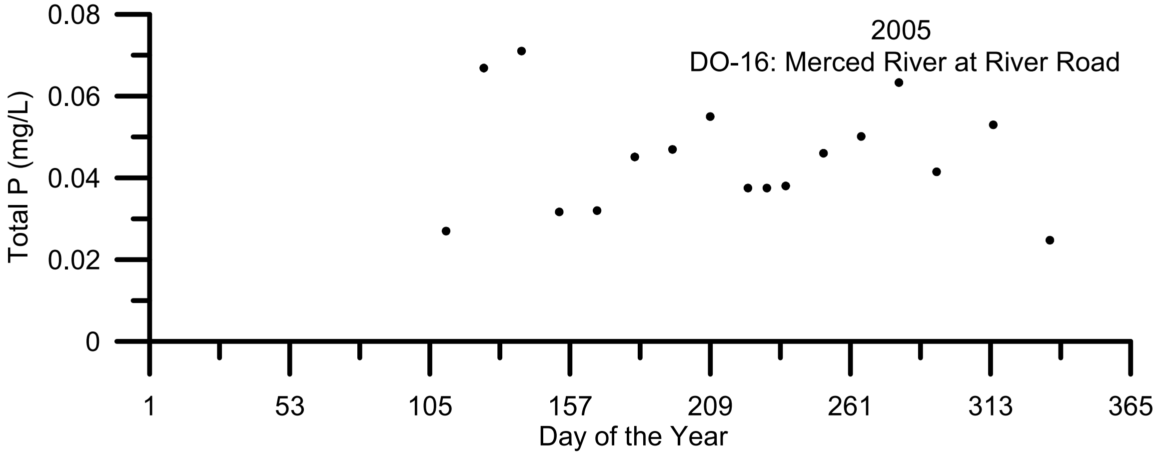
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

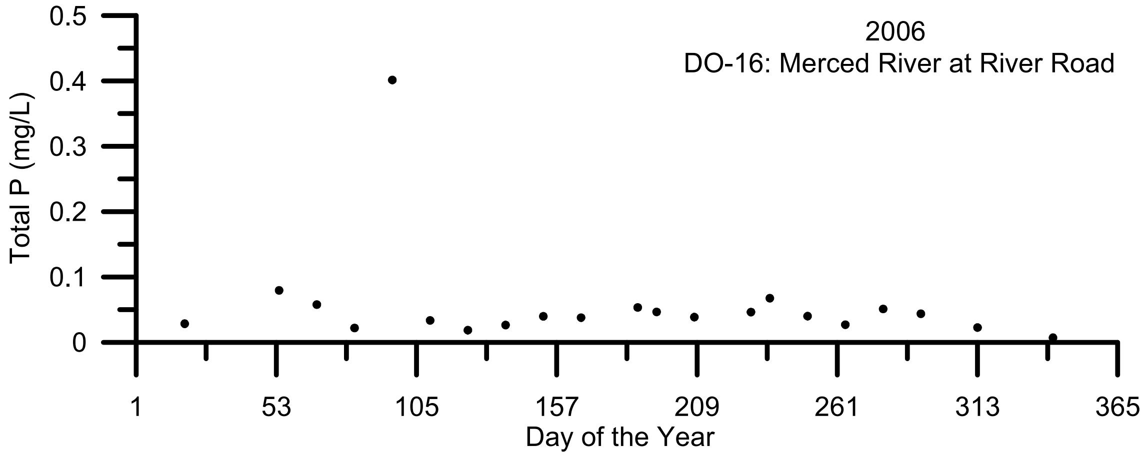

2007
DO-12: Stanislaus River at Caswell Park
Total P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

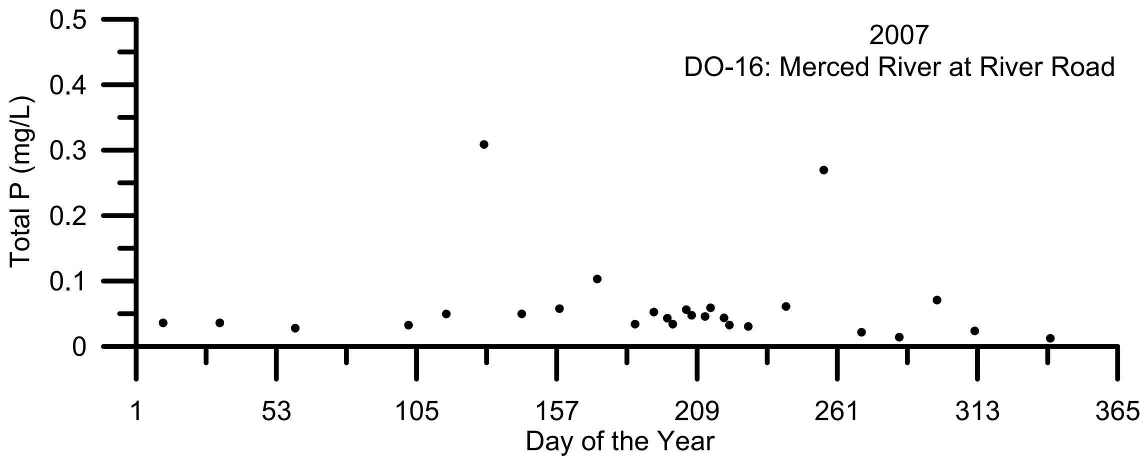

2005
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

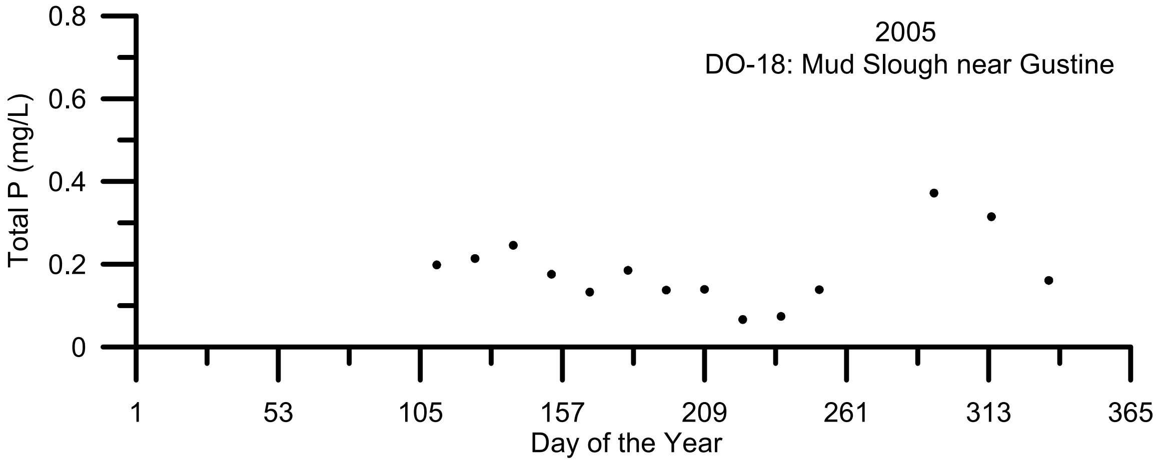

2006
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

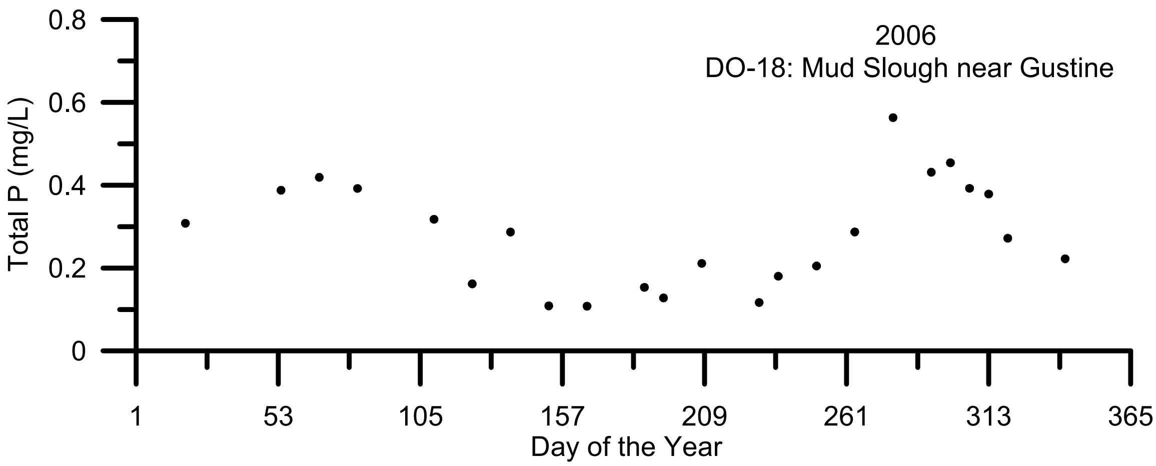

2007
DO-14: Tuolumne River at Shiloh Bridge
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

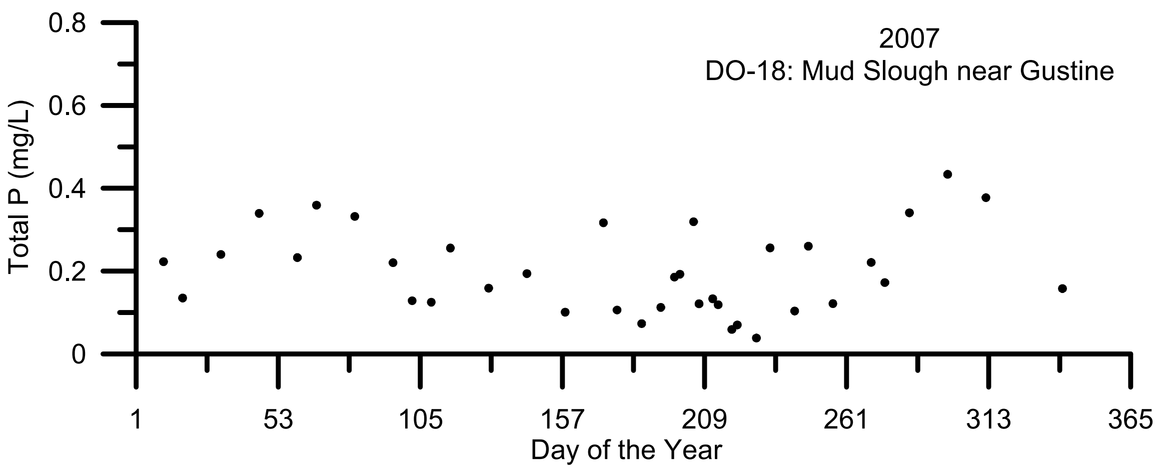

2005
DO-16: Merced River at River Road
Total P (mg/L)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

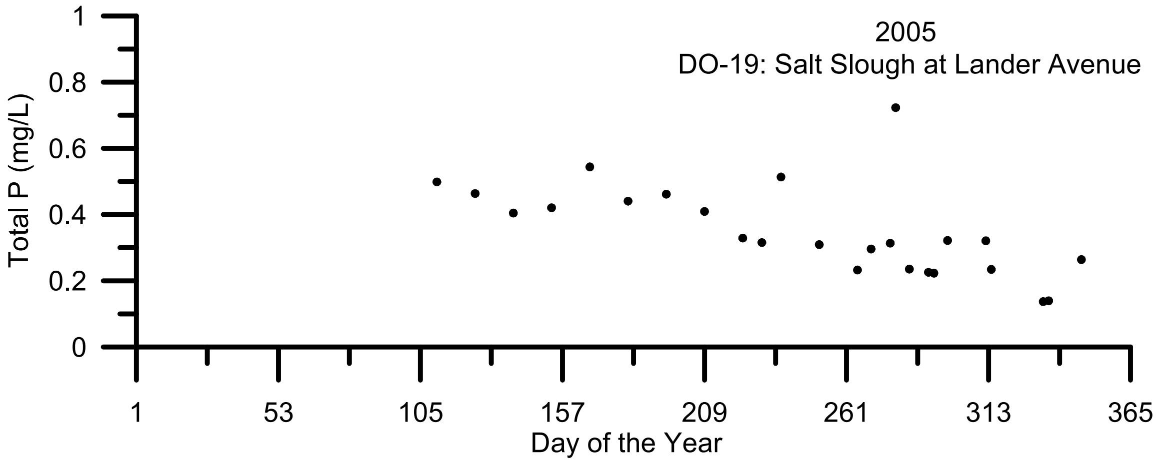

2006
DO-16: Merced River at River Road
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

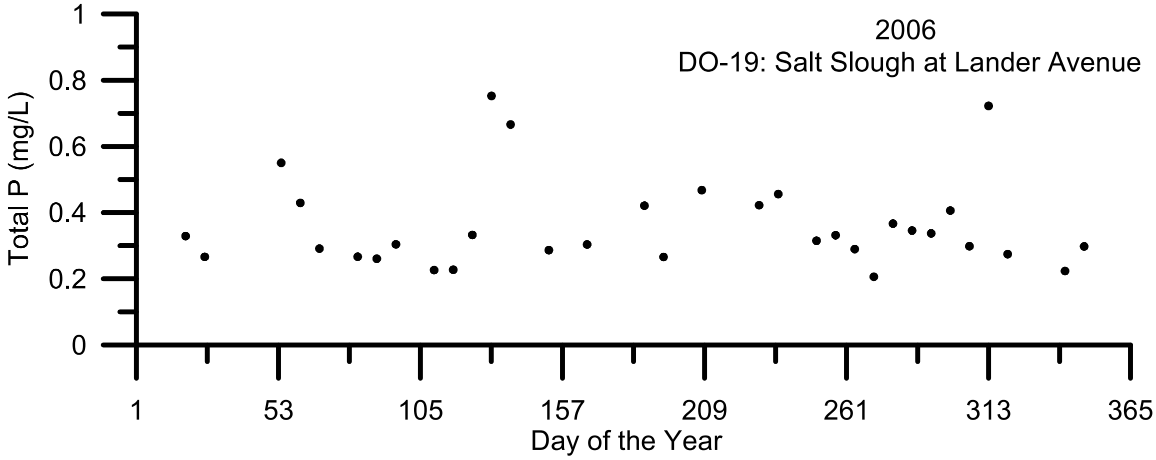

2007
DO-16: Merced River at River Road
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

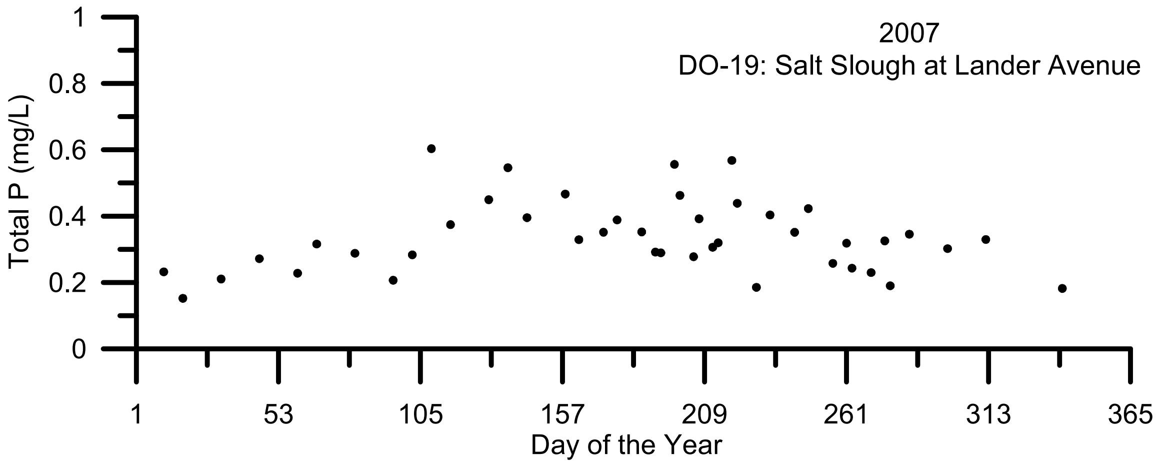

2005
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

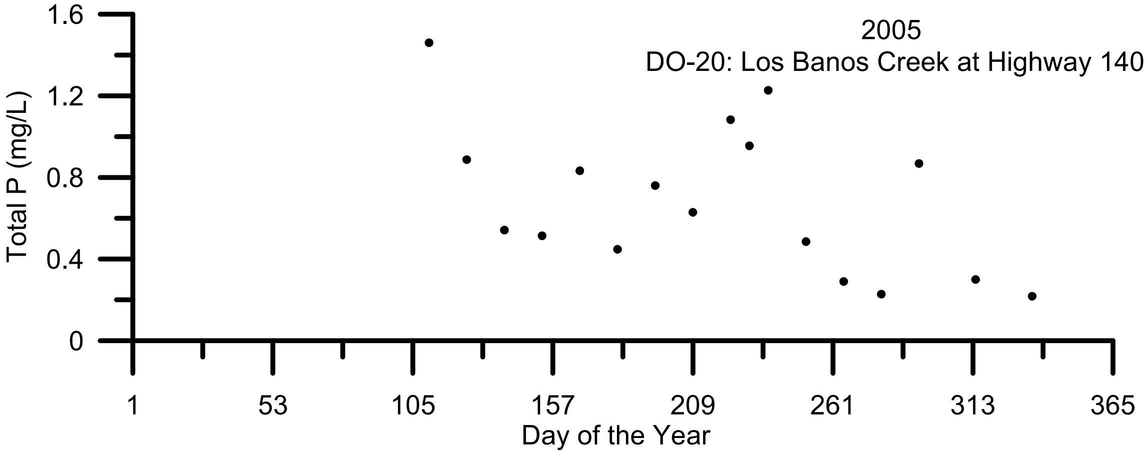

2006
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

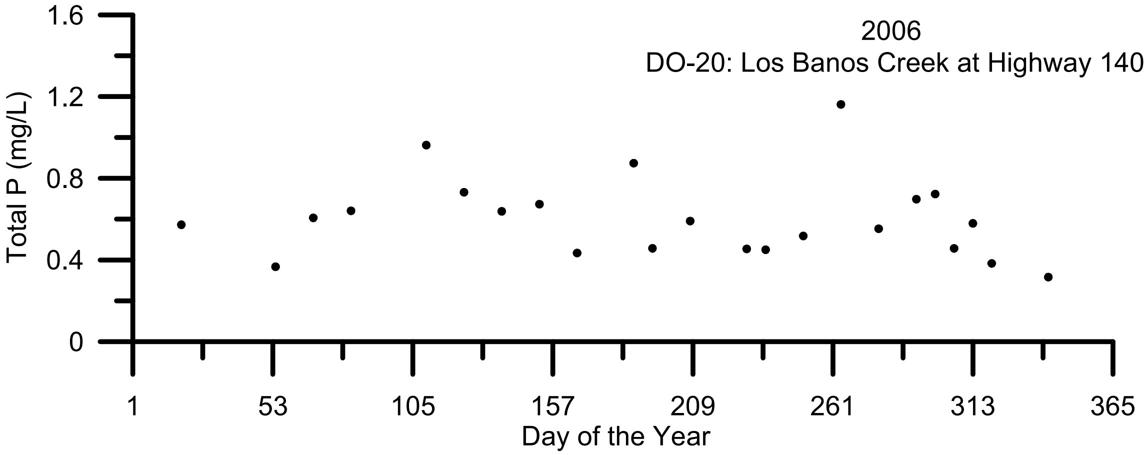

2007
DO-18: Mud Slough near Gustine
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

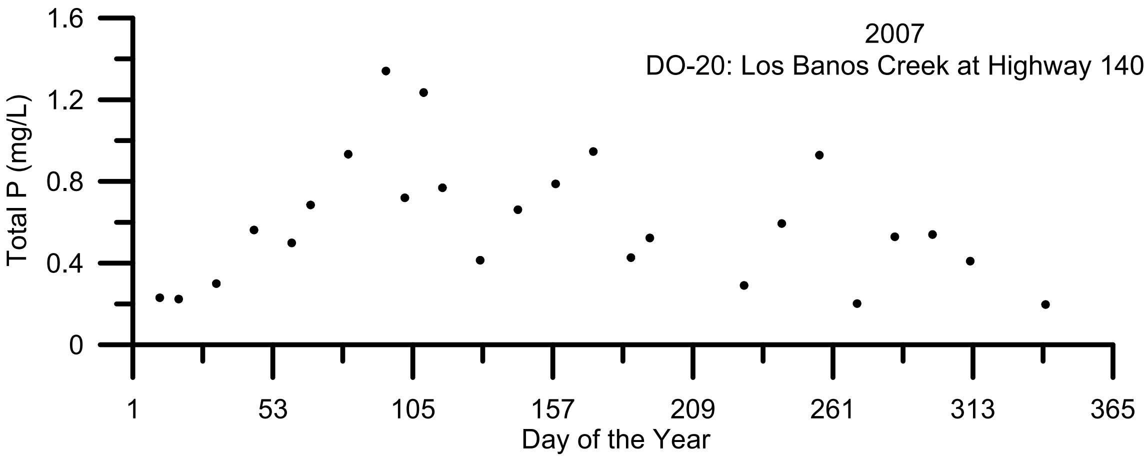

2005
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

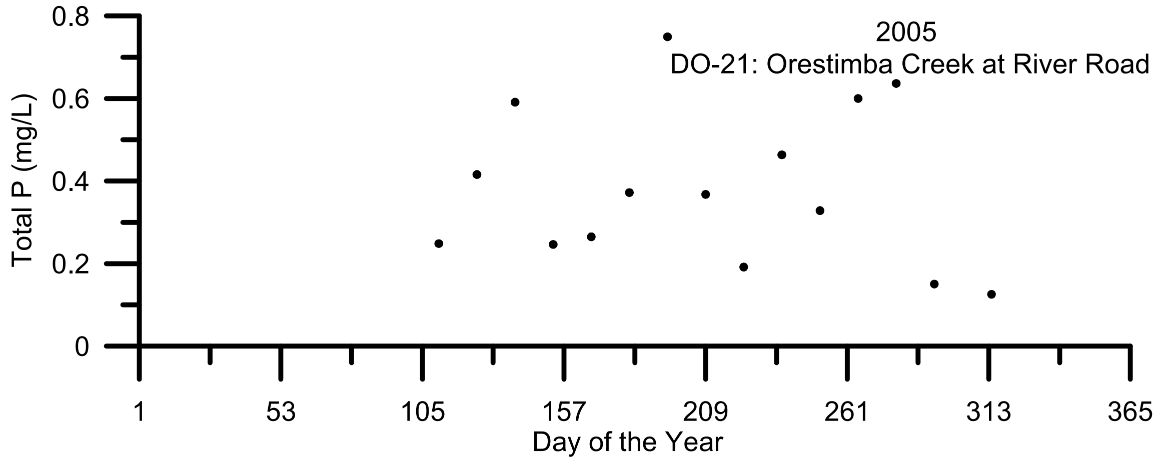

2006
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

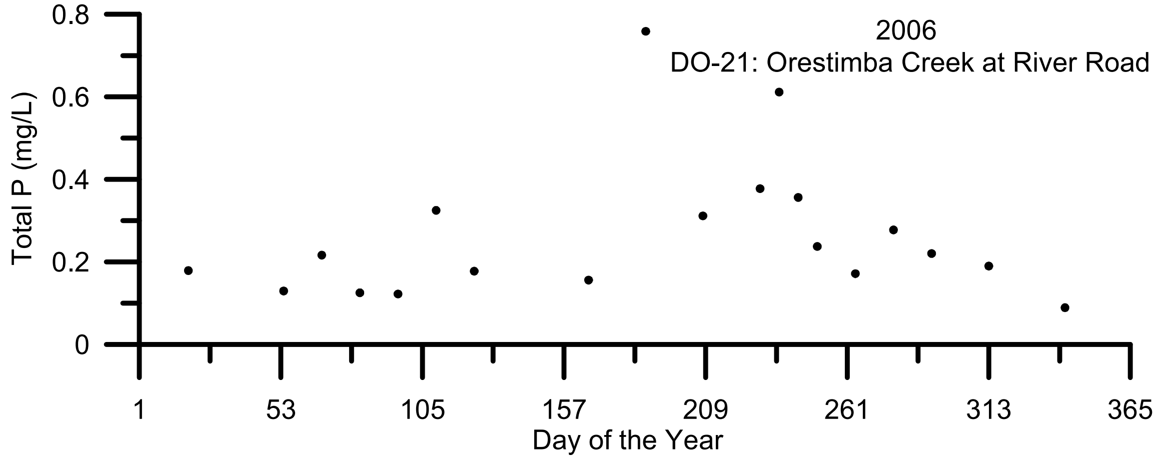

2007
DO-19: Salt Slough at Lander Avenue
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

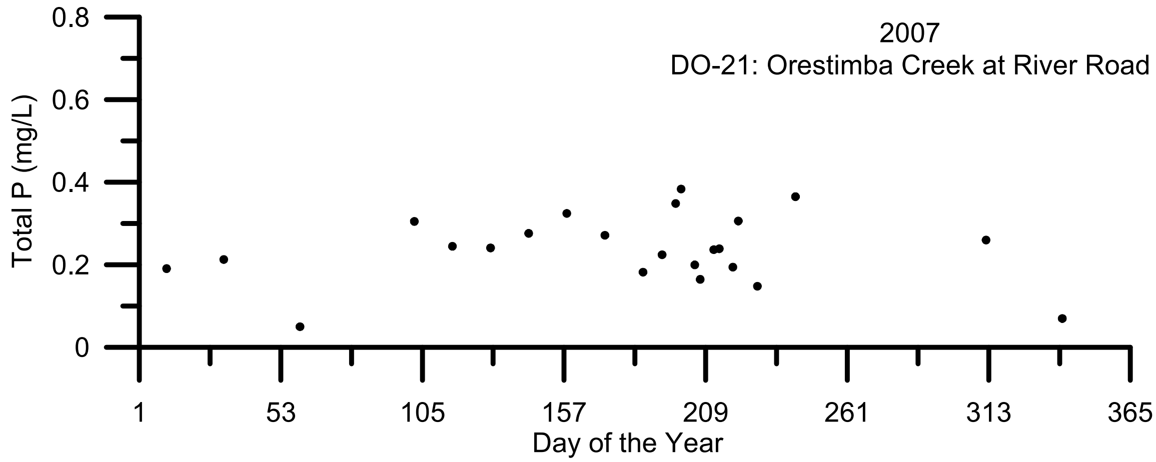

2005
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

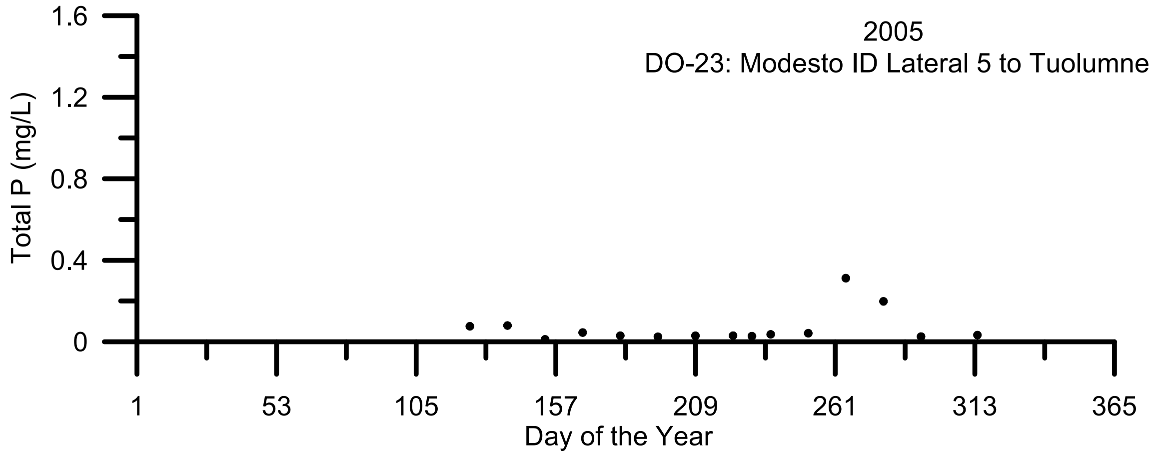

2006
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

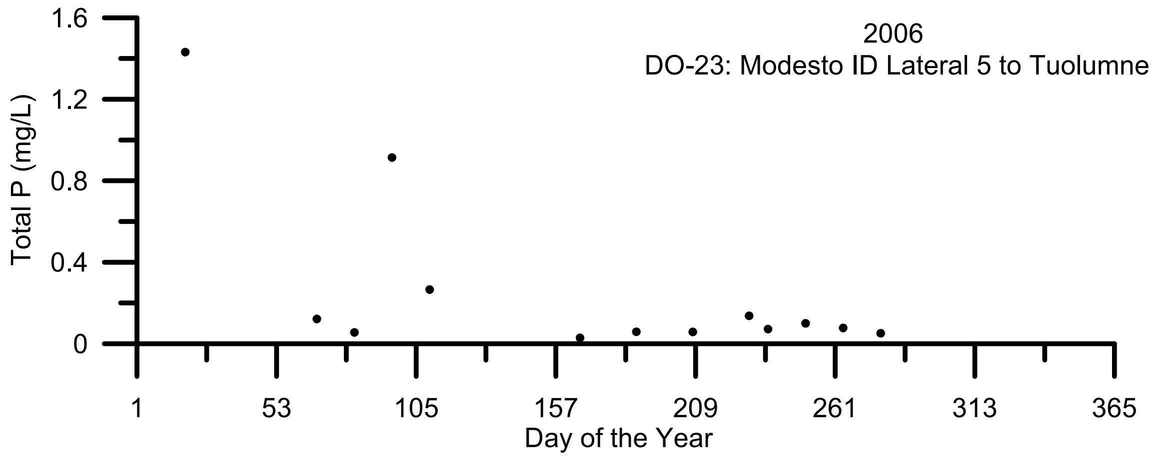

2007
DO-20: Los Banos Creek at Highway 140
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

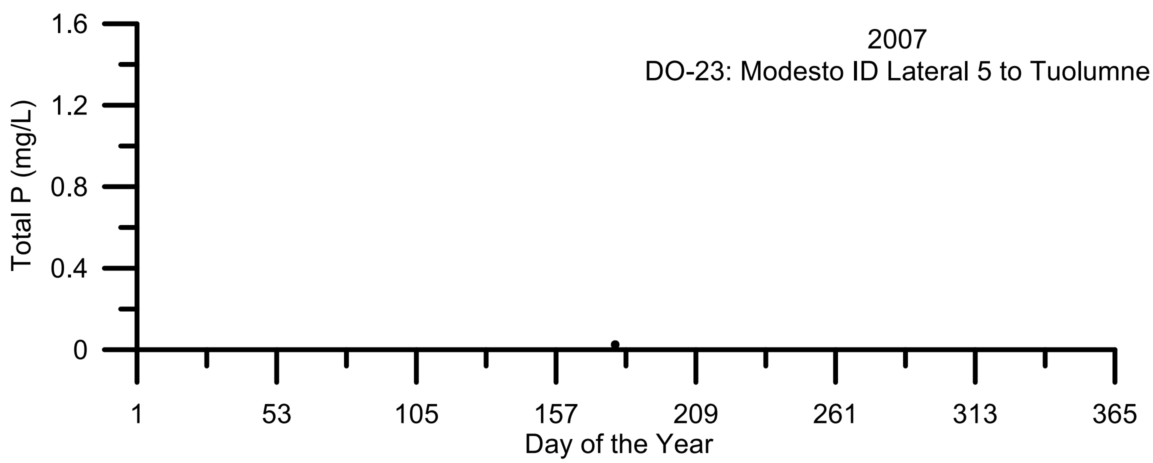

2005
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

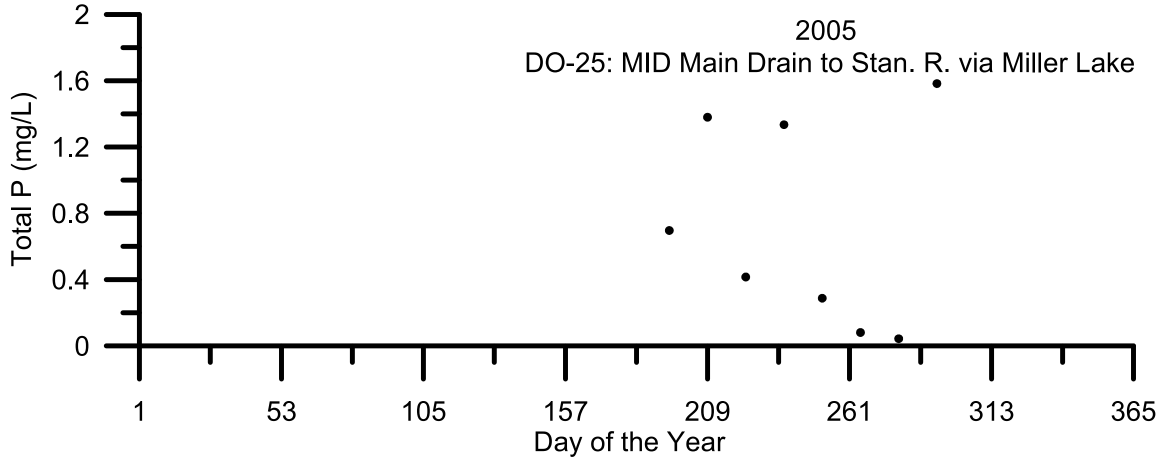

2006
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

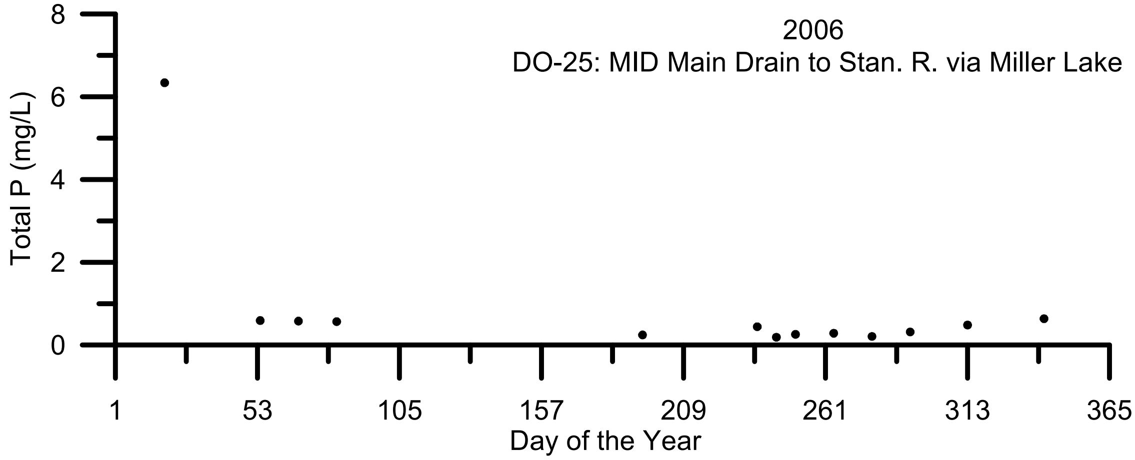

2007
DO-21: Orestimba Creek at River Road
Total P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

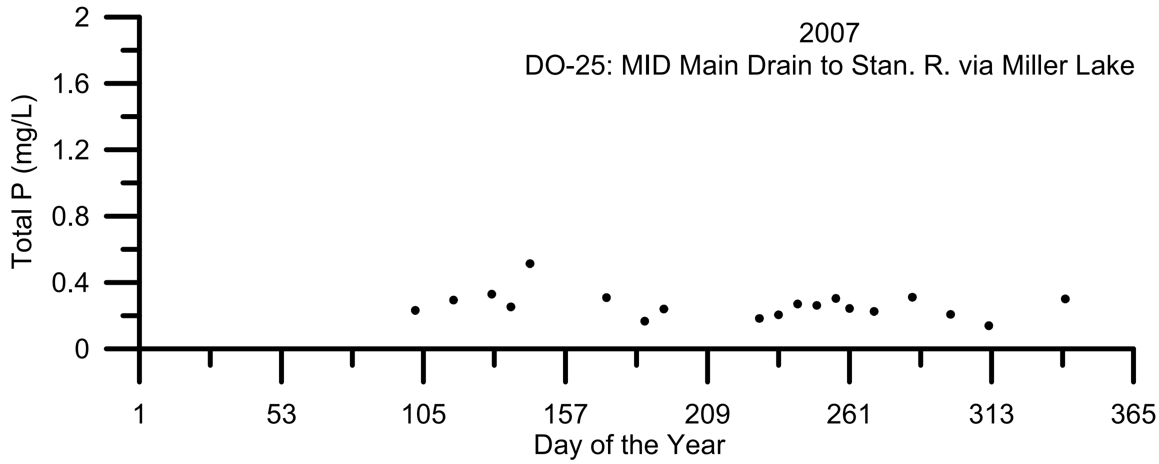

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
Day of the Year

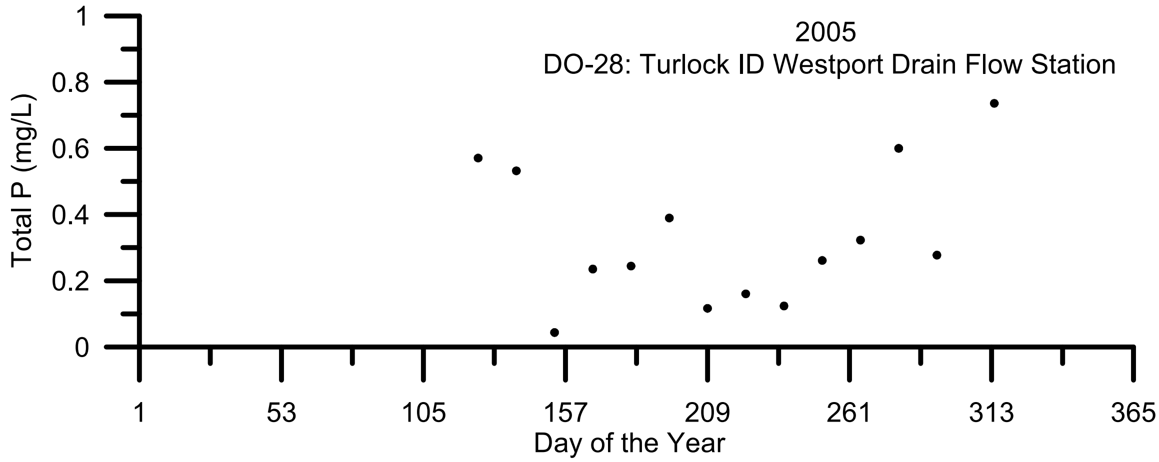

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
Day of the Year

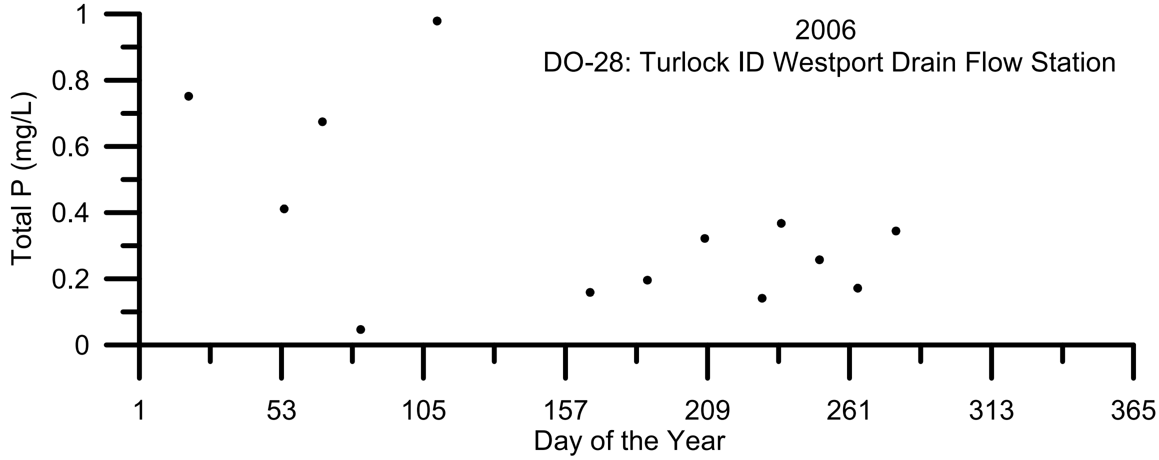

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total P (mg/L)
Day of the Year

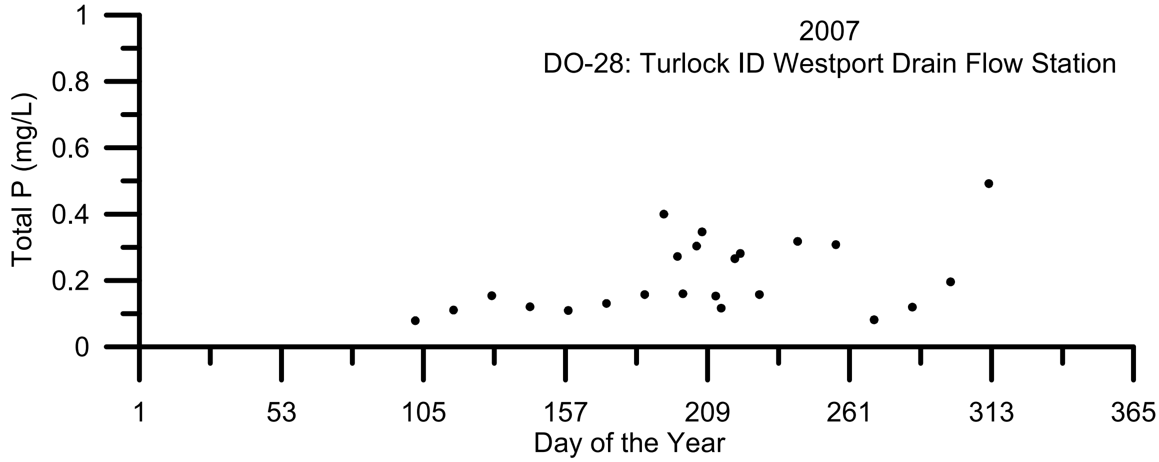

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total P (mg/L)
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365
Day of the Year

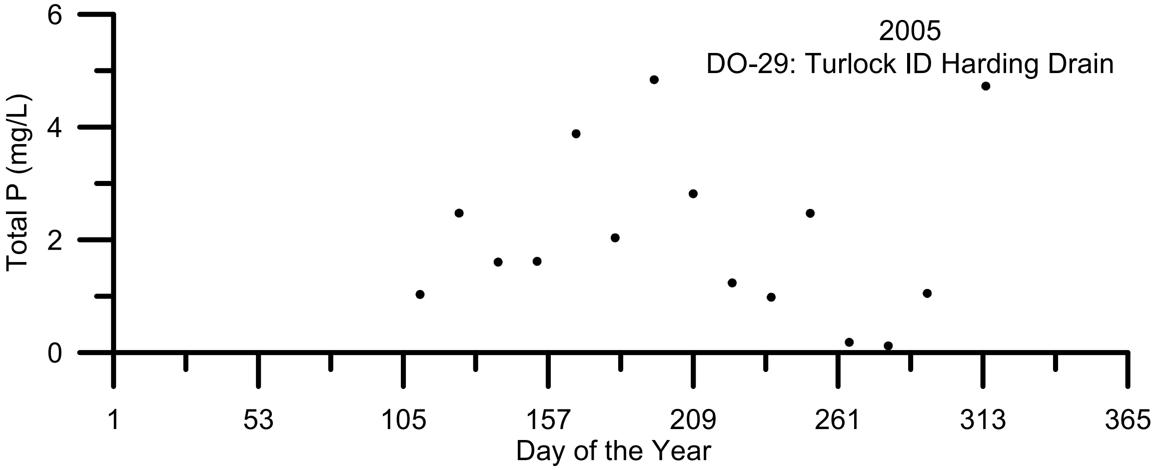

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total P (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

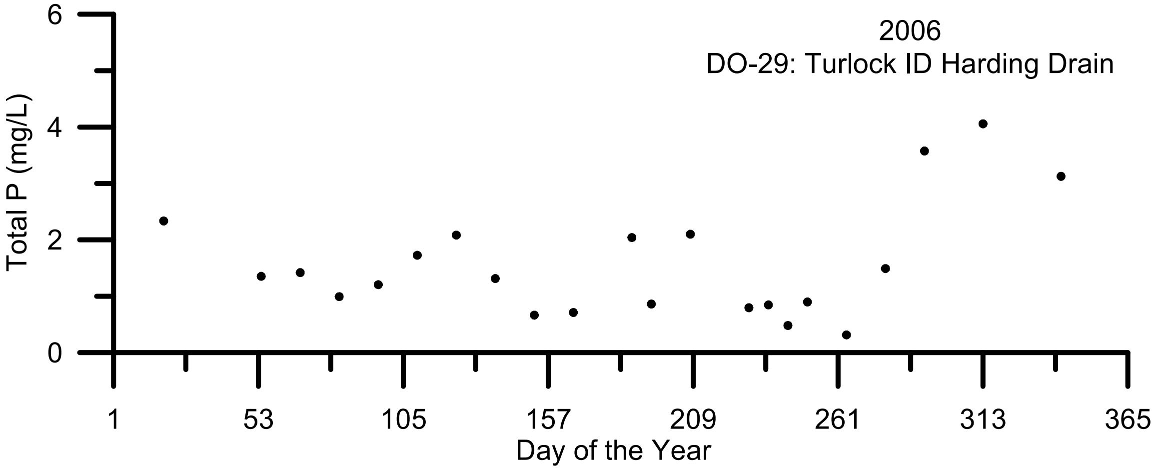

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total P (mg/L)
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365
Day of the Year

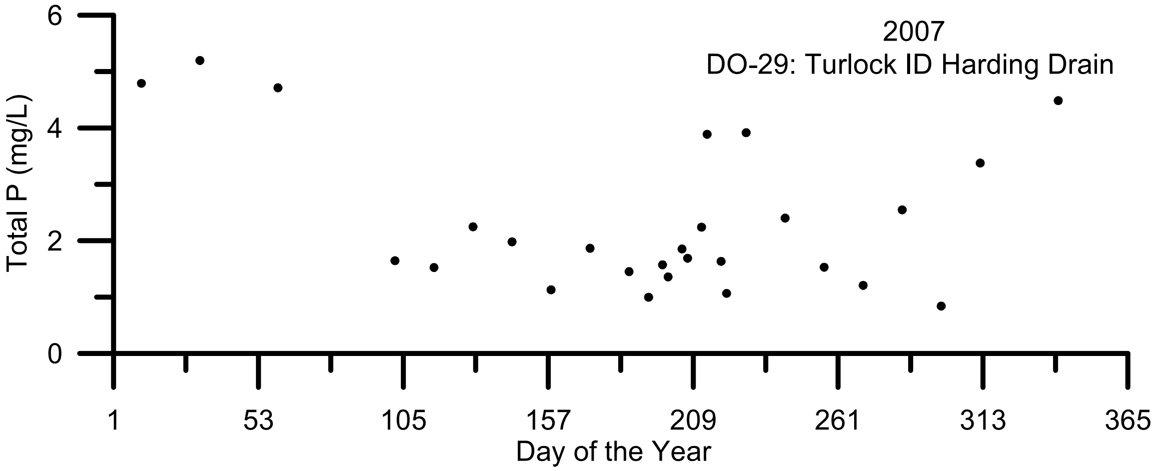

2005
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

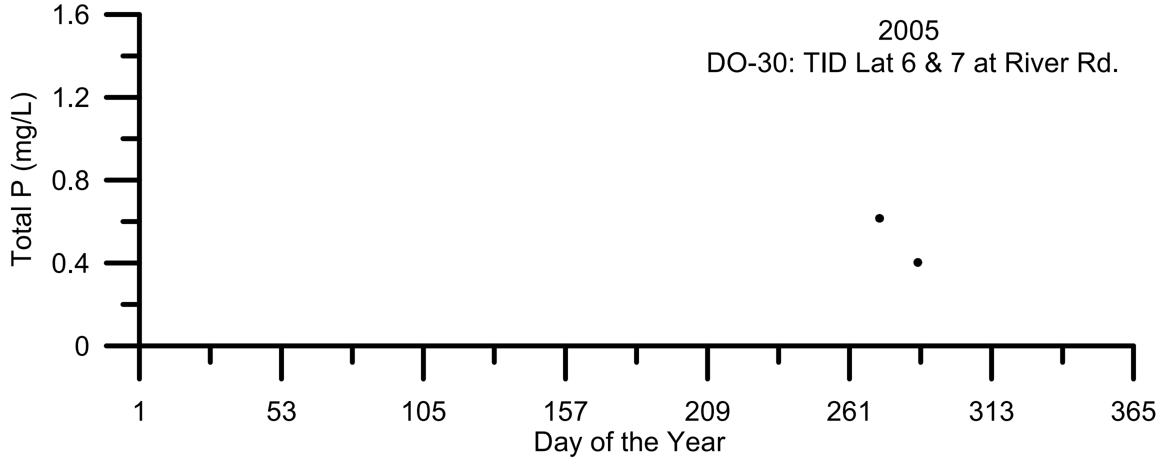

2006
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

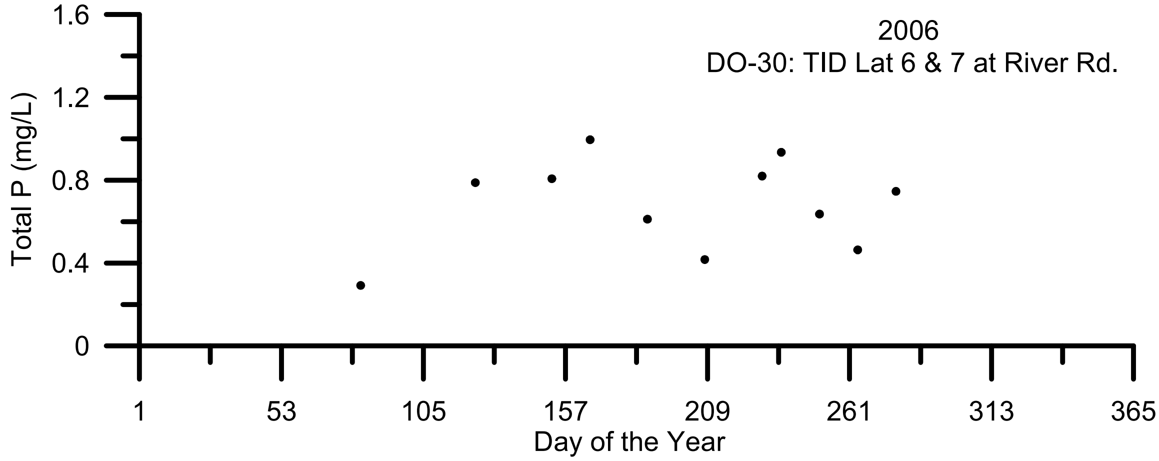

2007
DO-28: Turlock ID Westport Drain Flow Station
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

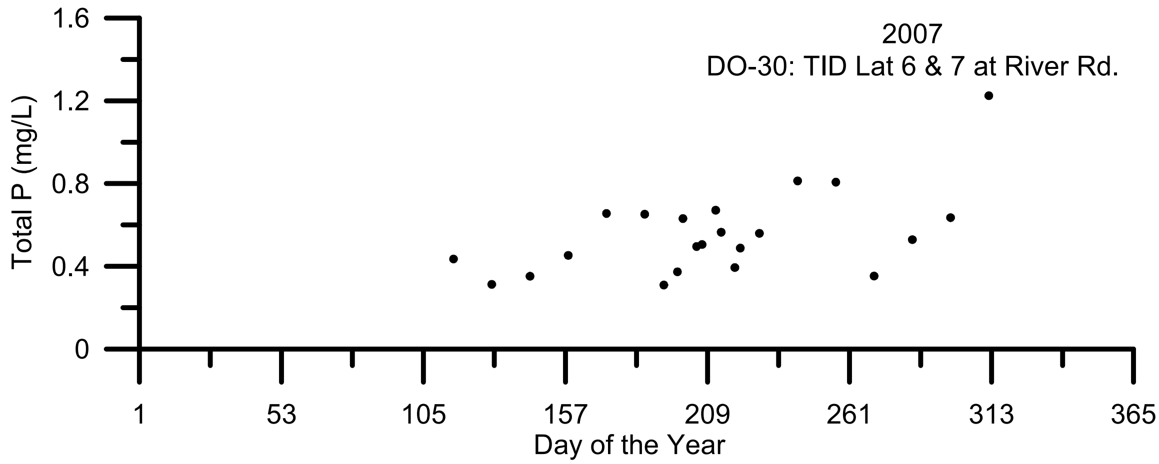

2005
DO-29: Turlock ID Harding Drain
Total P (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

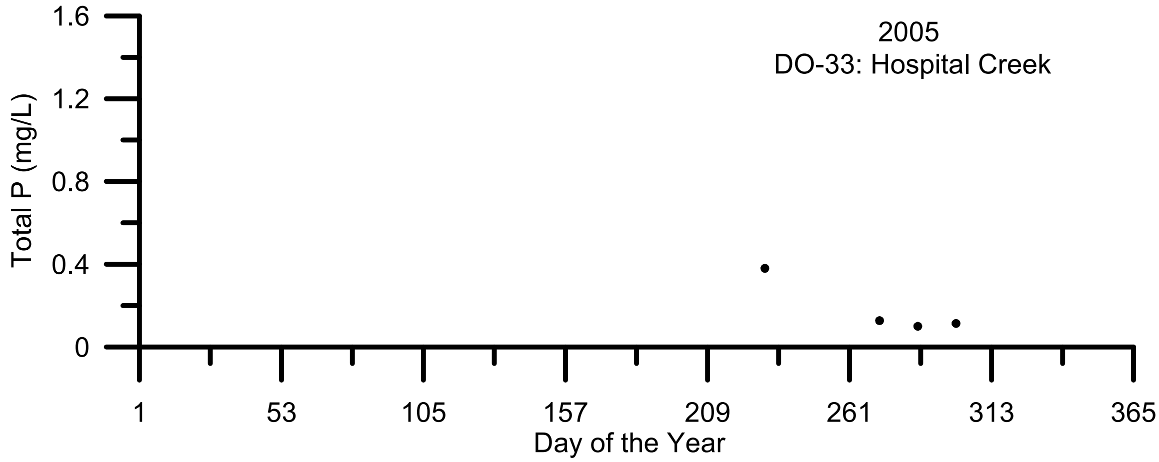

2006
DO-29: Turlock ID Harding Drain
Total P (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

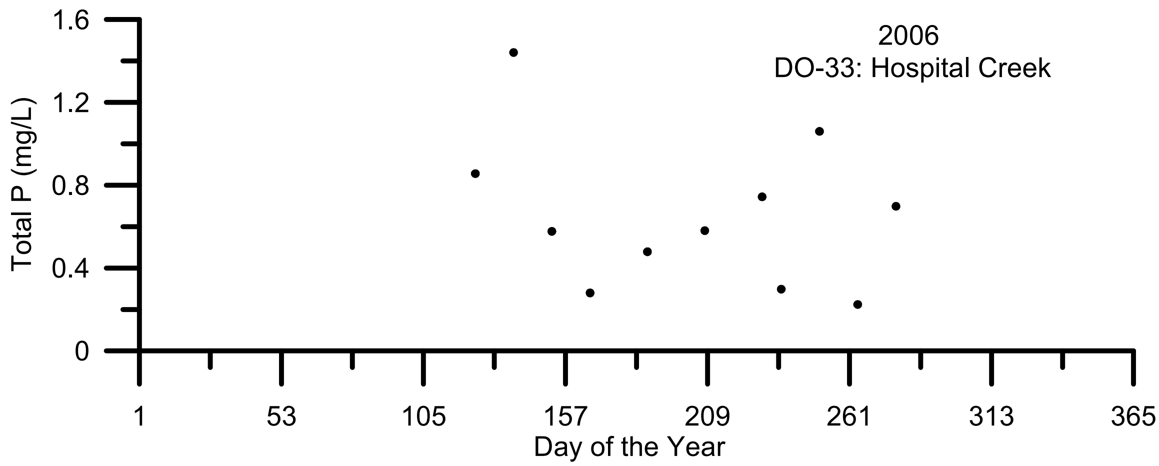

2007
DO-29: Turlock ID Harding Drain
Total P (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

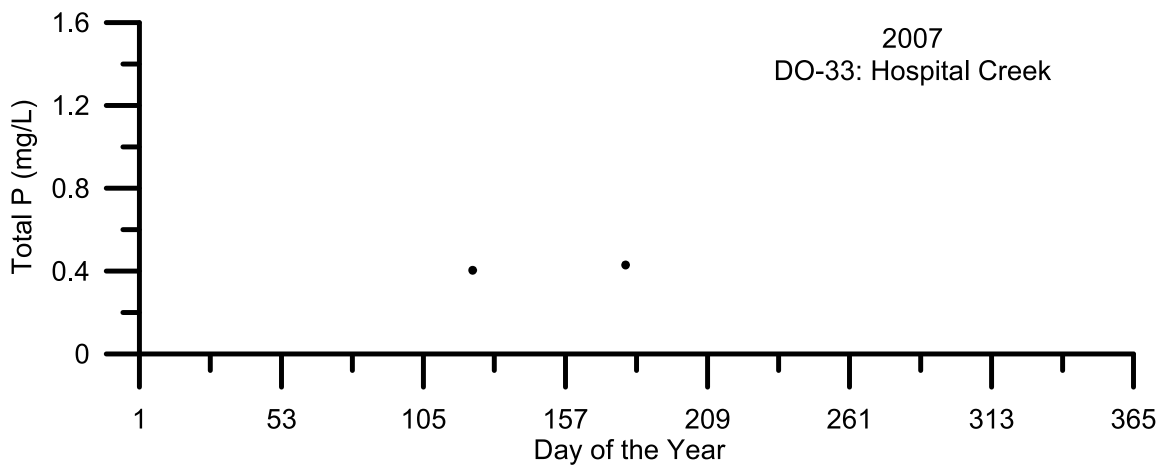

2005
DO-30: TID Lat 6 & 7 at River Rd.
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

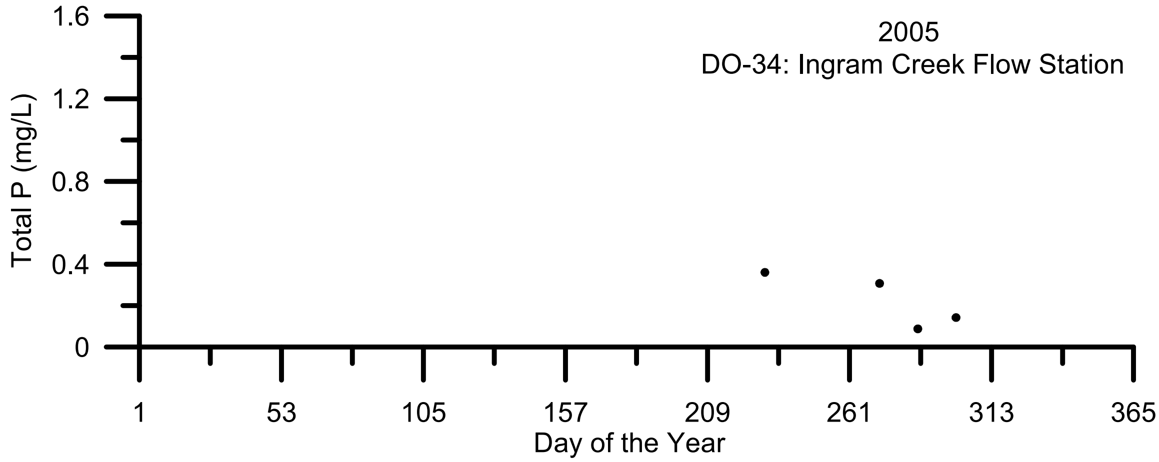

2006
DO-30: TID Lat 6 & 7 at River Rd.
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

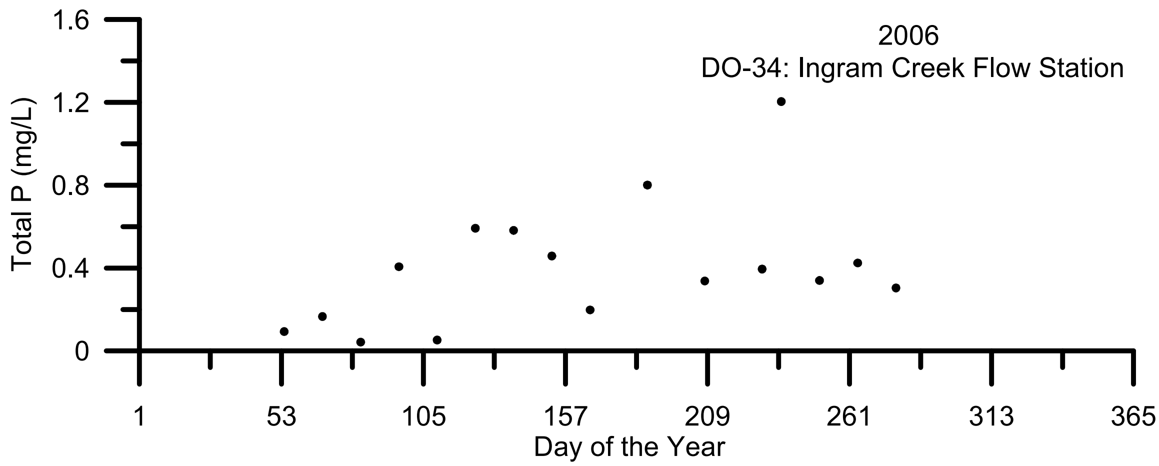

2007
DO-30: TID Lat 6 & 7 at River Rd.
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

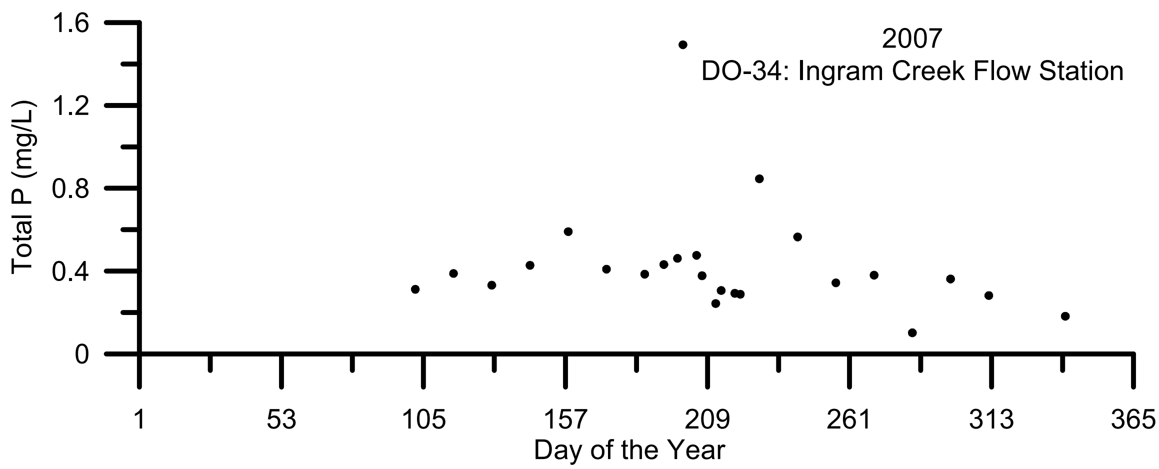

2005
DO-33: Hospital Creek
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

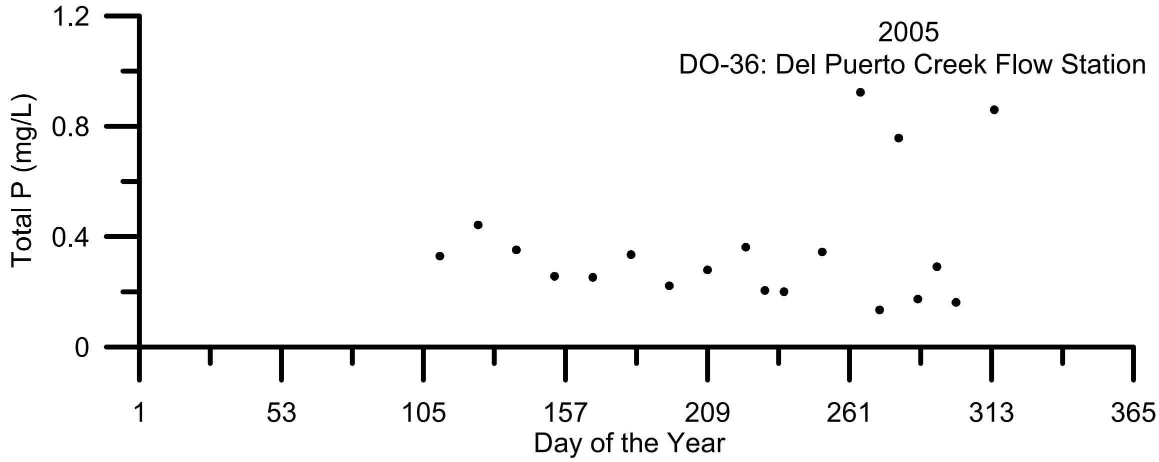

2006
DO-33: Hospital Creek
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

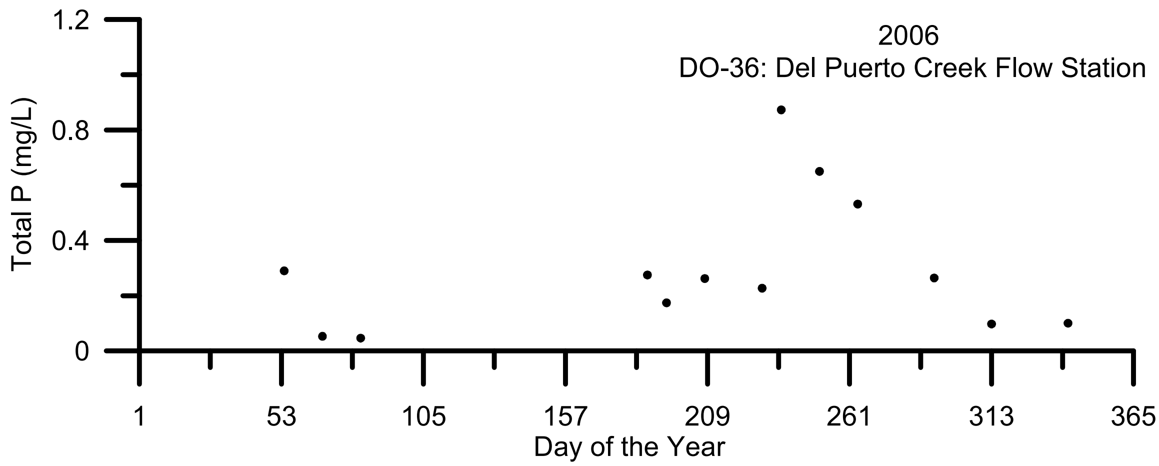

2007
DO-33: Hospital Creek
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

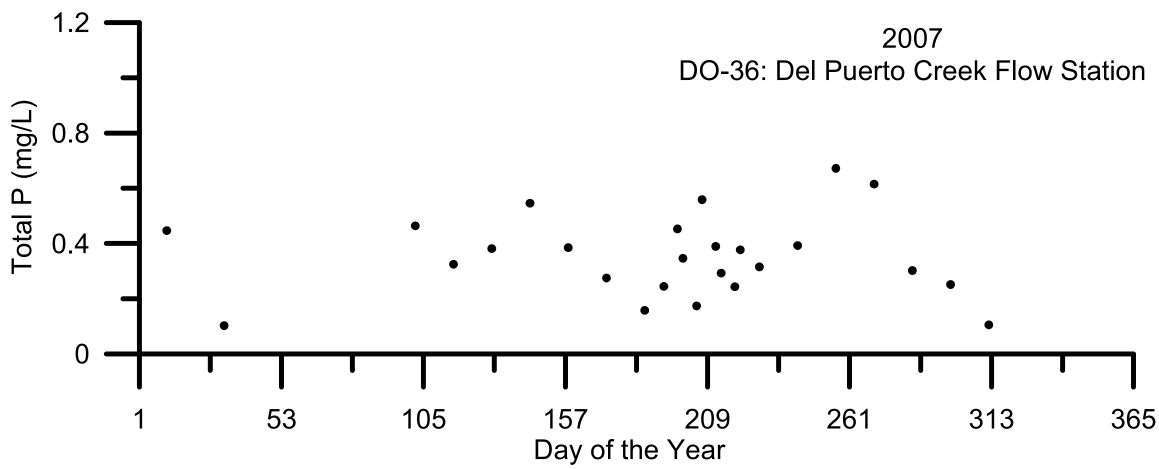

2005
DO-34: Ingram Creek Flow Station
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

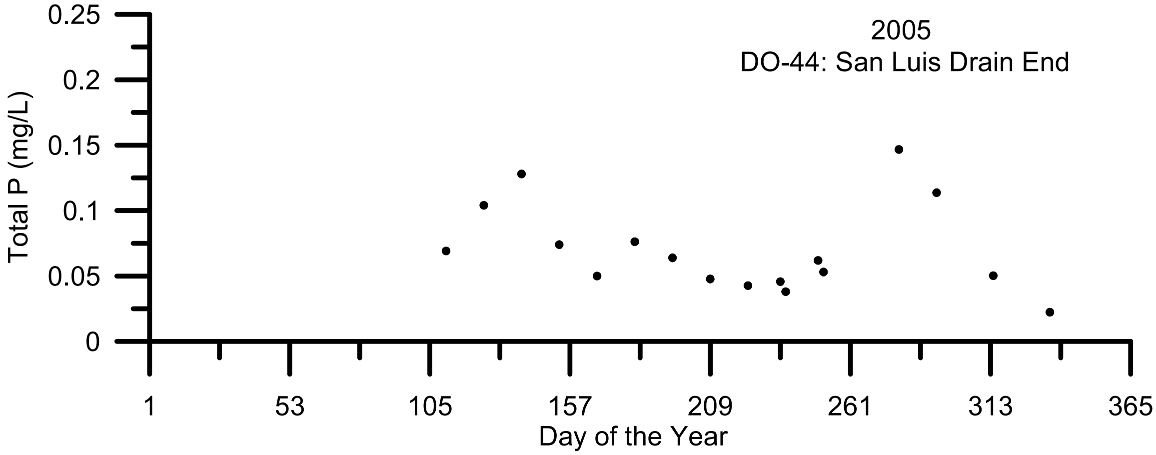

2006
DO-34: Ingram Creek Flow Station
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

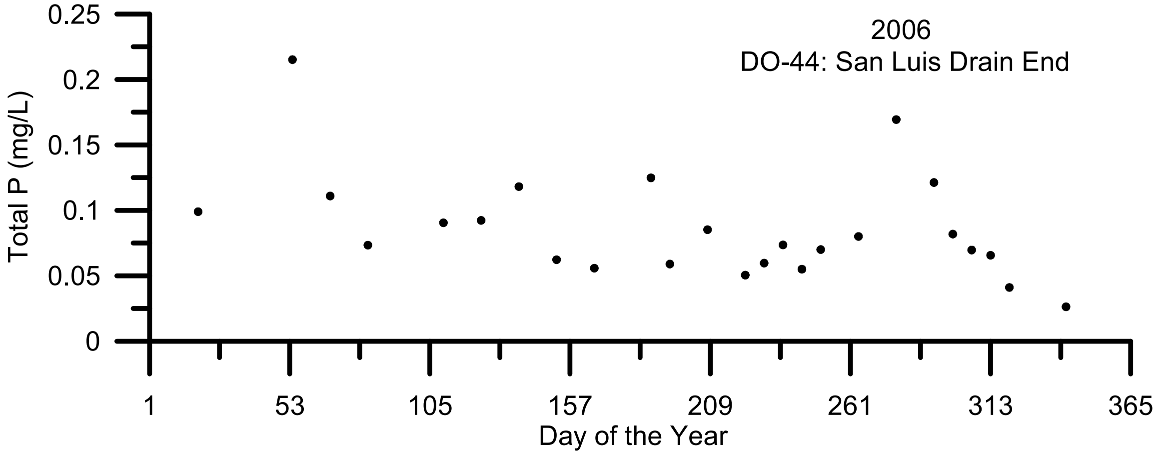

2007
DO-34: Ingram Creek Flow Station
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

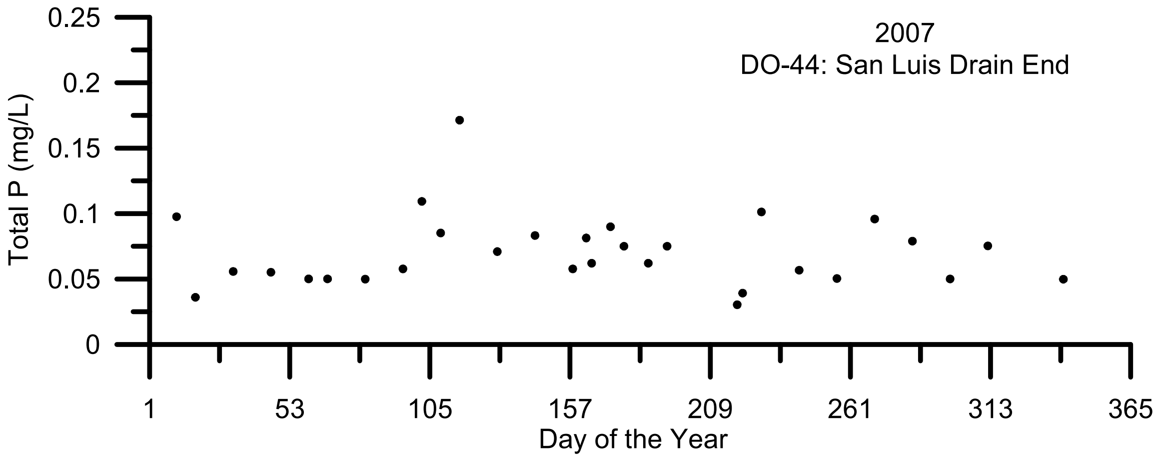

2005
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

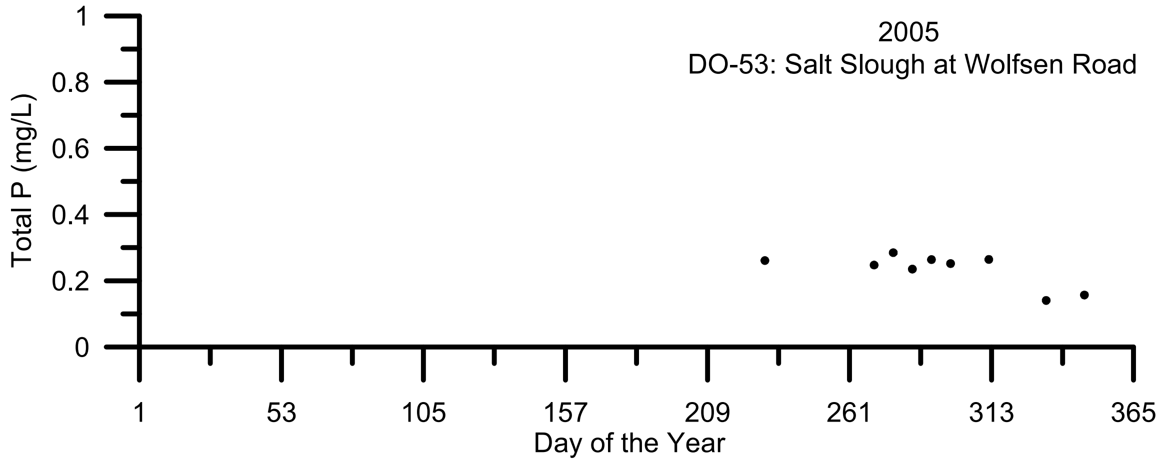

2006
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

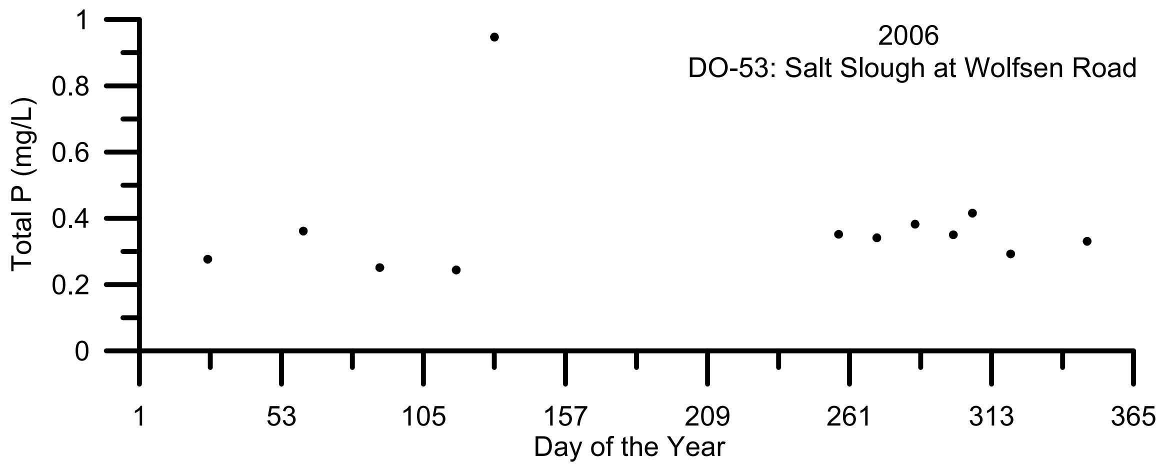

2007
DO-36: Del Puerto Creek Flow Station
Total P (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

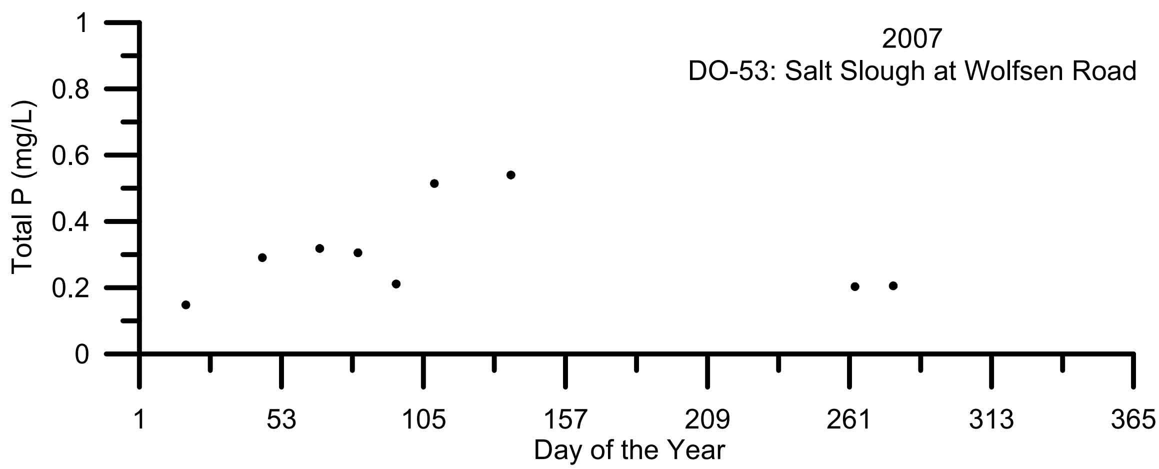

2005
DO-44: San Luis Drain End
Total P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

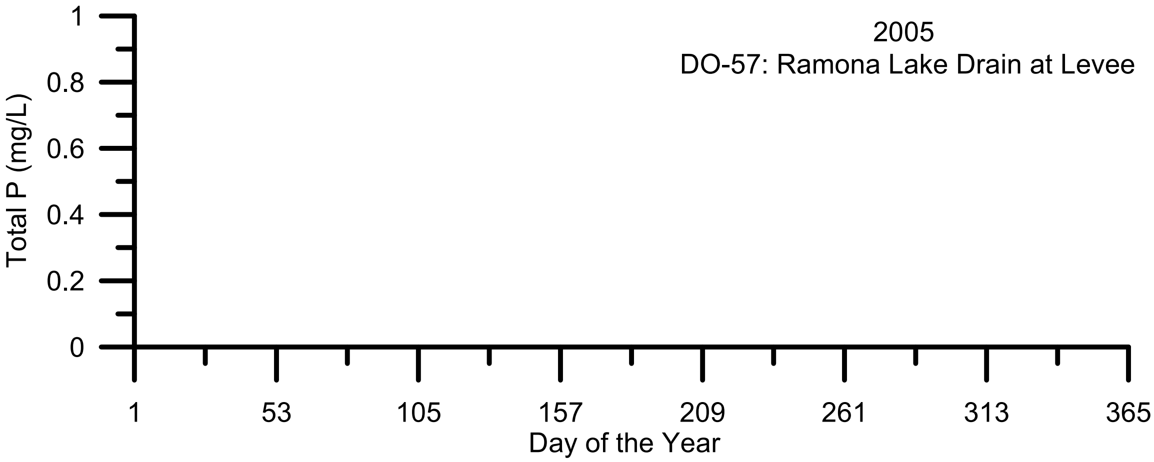

2006
DO-44: San Luis Drain End
Total P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

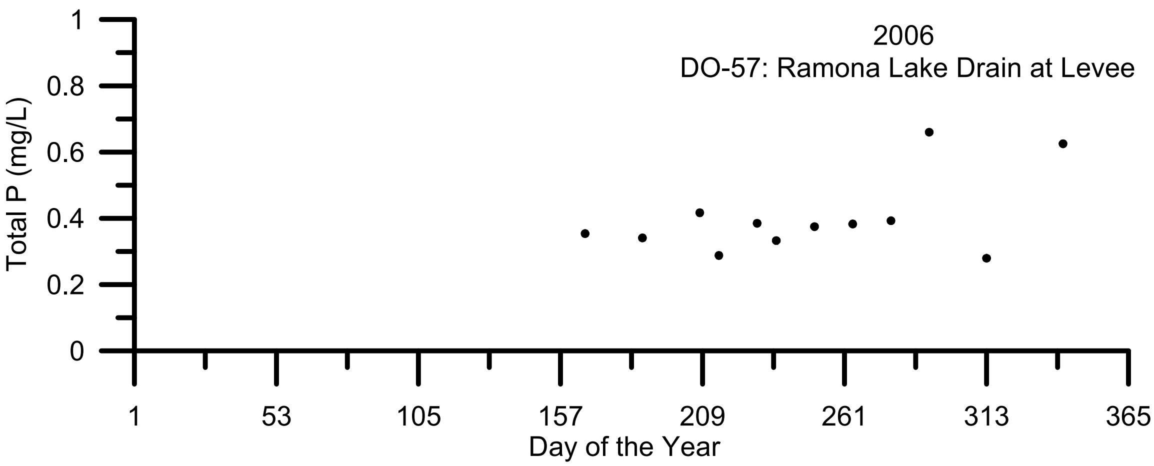

2007
DO-44: San Luis Drain End
Total P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

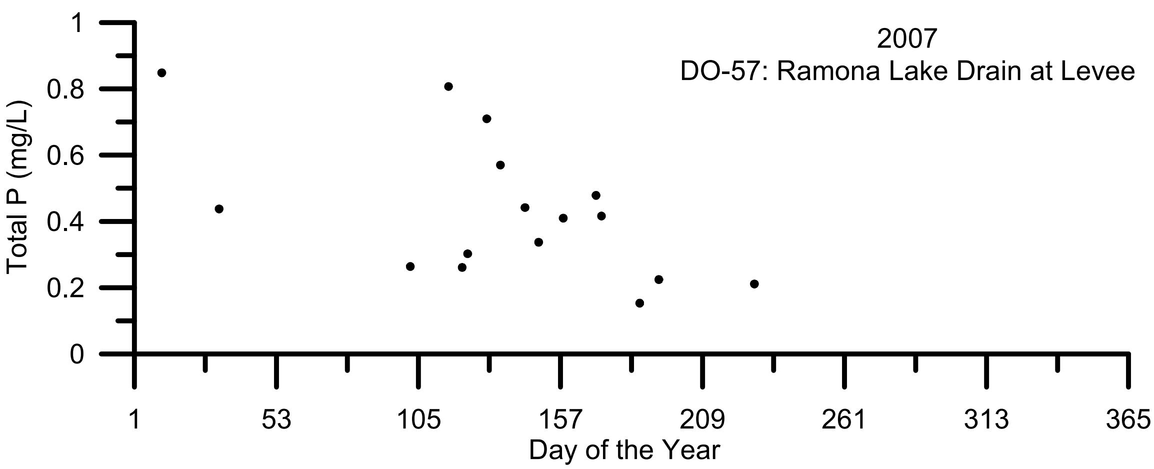

2005
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

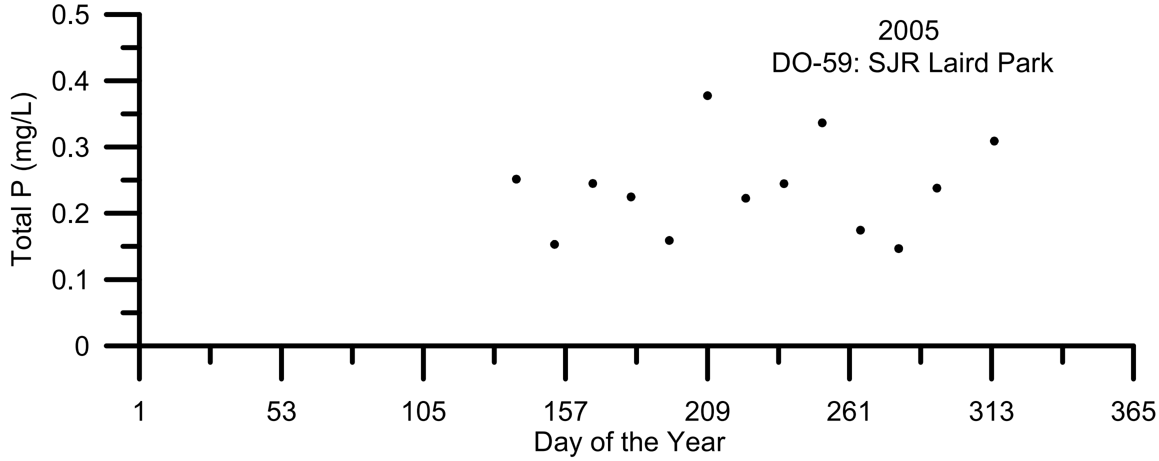

2006
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

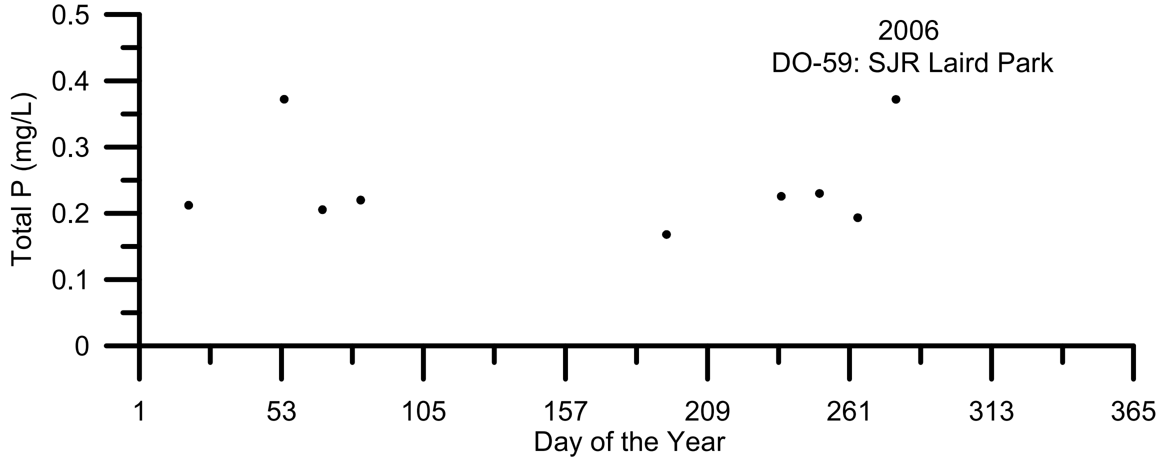

2007
DO-53: Salt Slough at Wolfsen Road
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

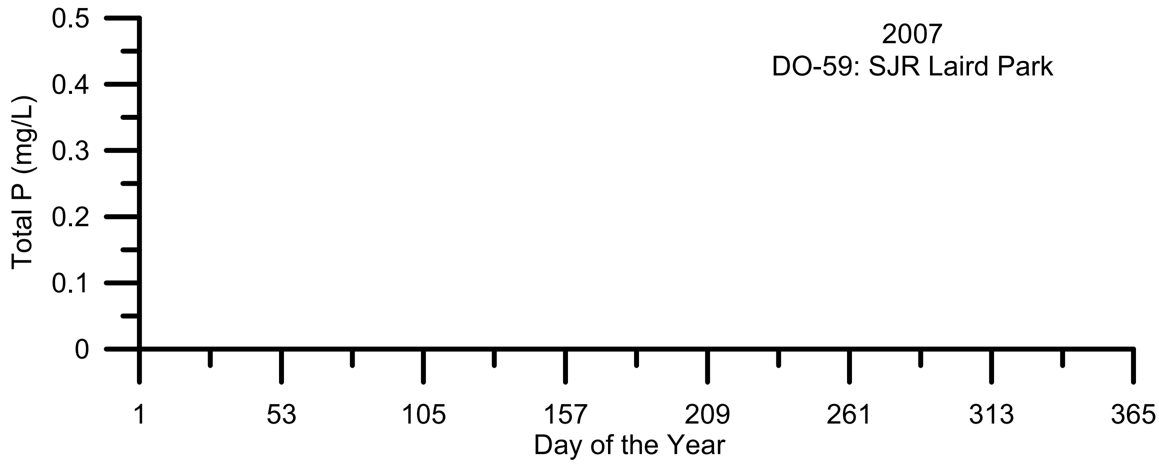

2005
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

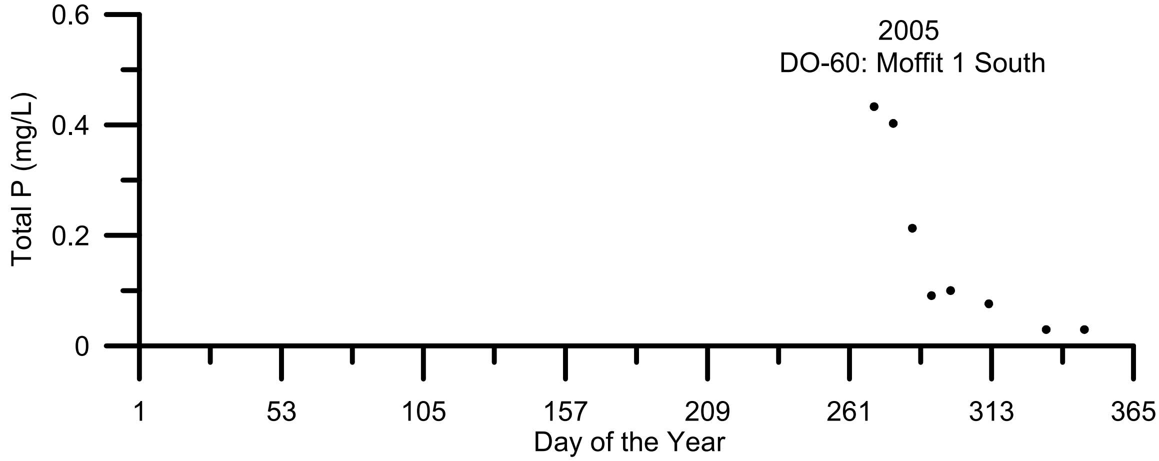

2006
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

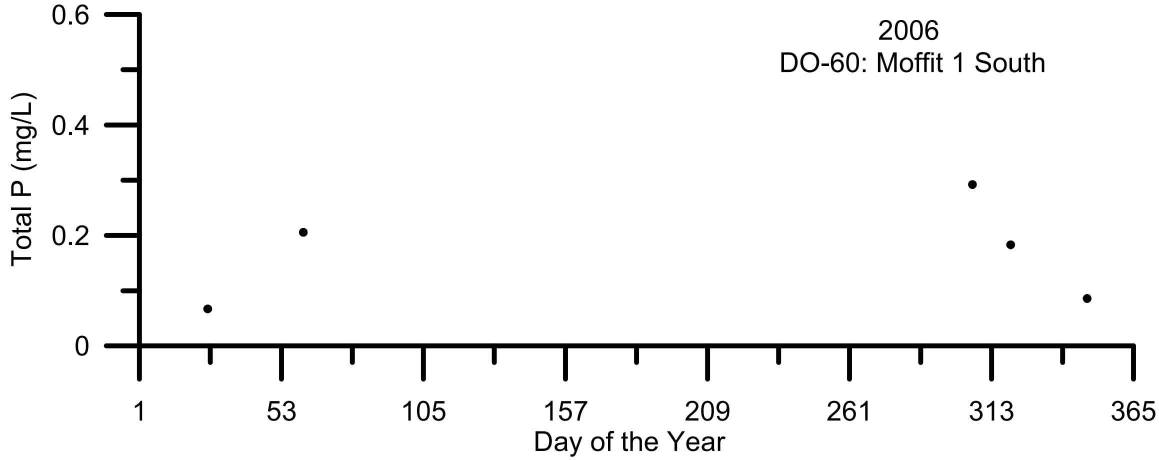

2007
DO-57: Ramona Lake Drain at Levee
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

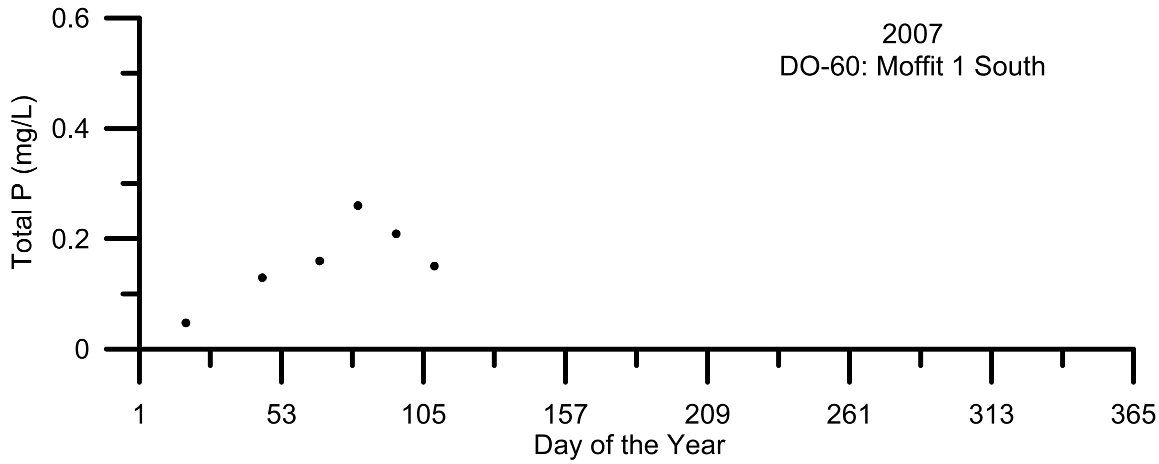

2005
DO-59: SJR Laird Park
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

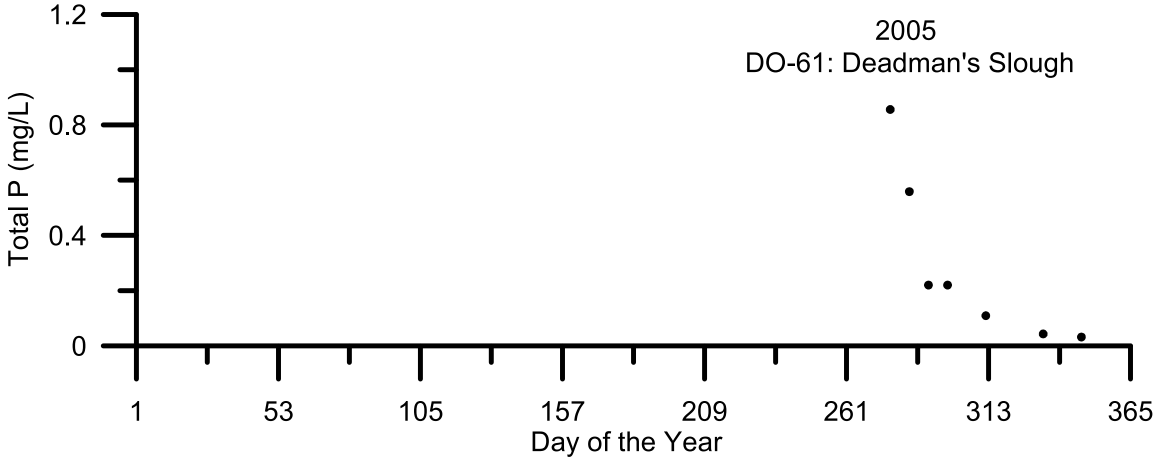

2006
DO-59: SJR Laird Park
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

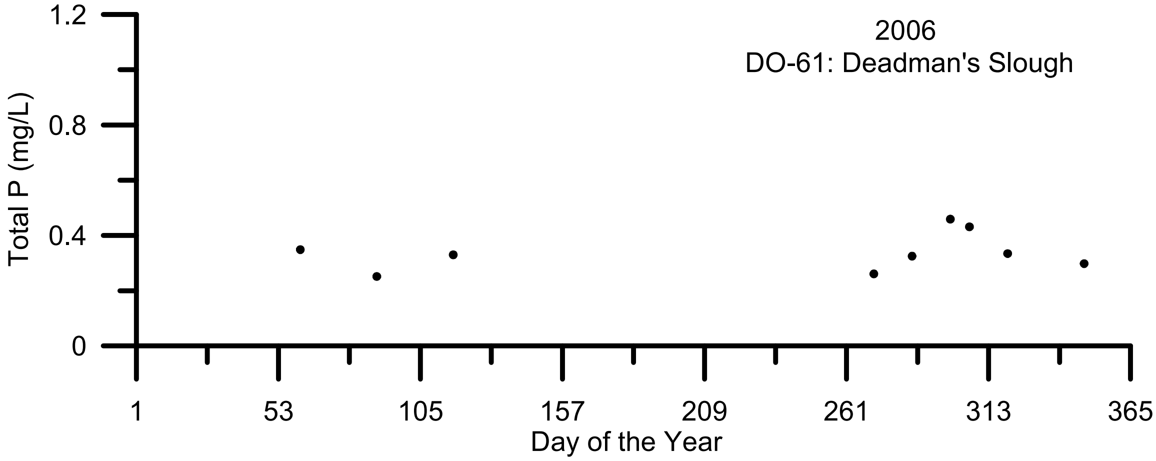

2007
DO-59: SJR Laird Park
Total P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

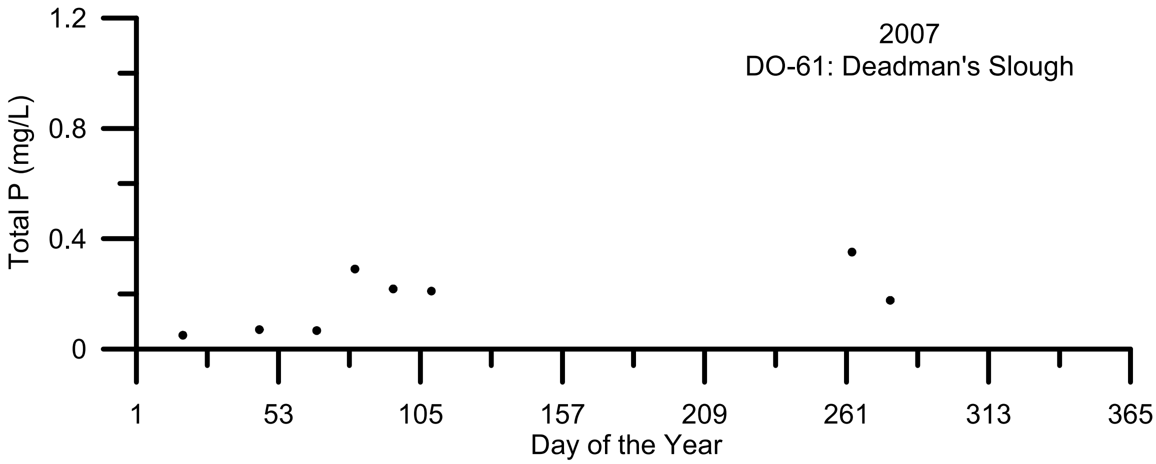

2005
DO-60: Moffit 1 South
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

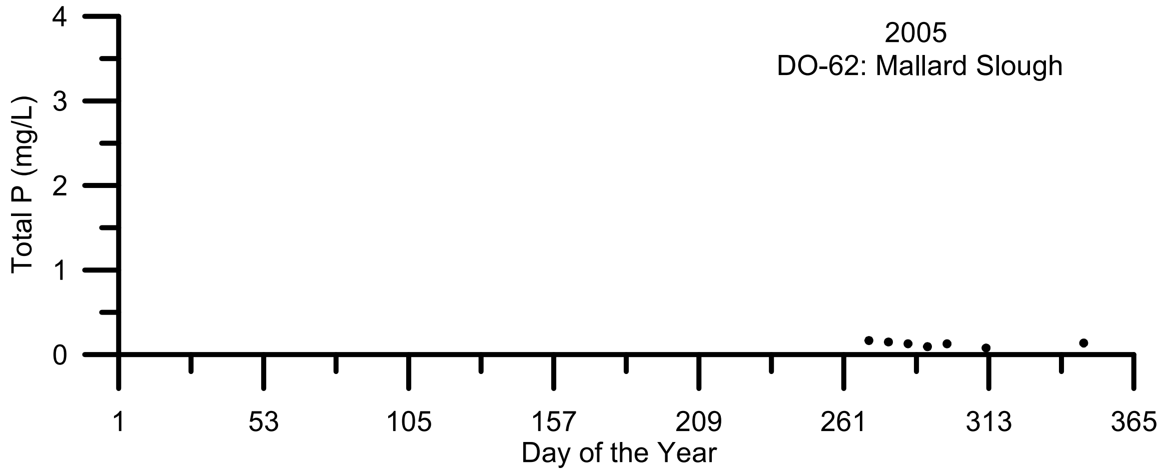

2006
DO-60: Moffit 1 South
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

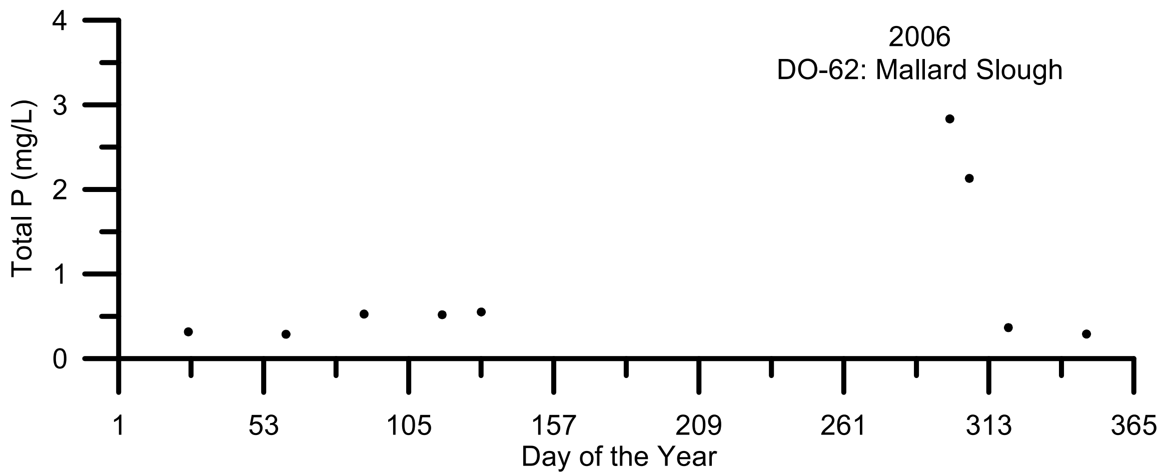

2007
DO-60: Moffit 1 South
Total P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

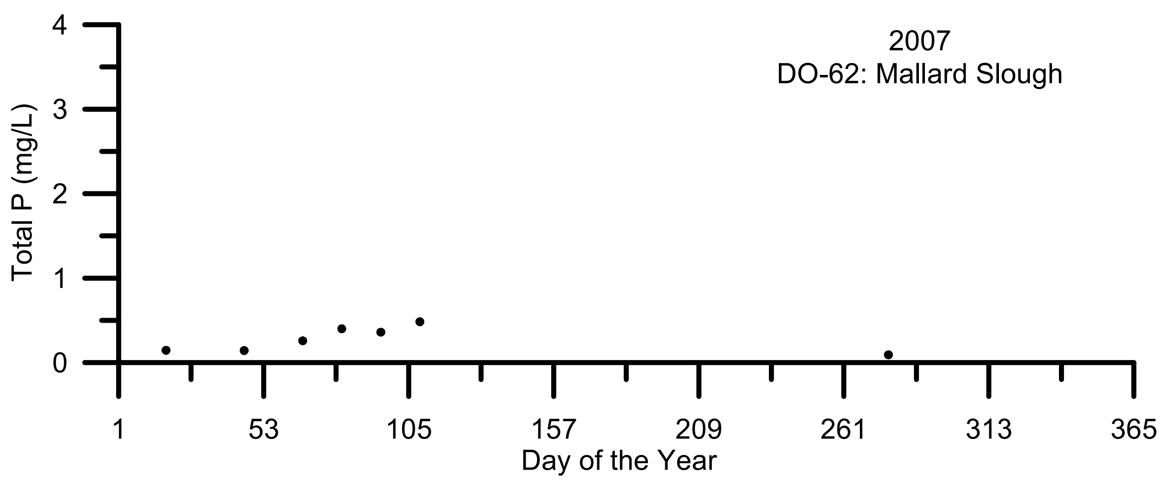

2005
DO-61: Deadman's Slough
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

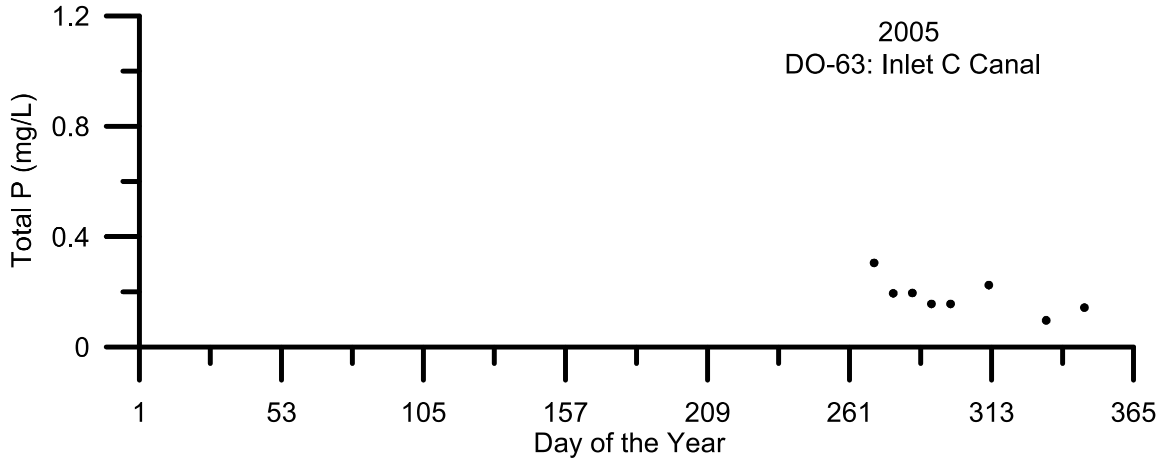

2006
DO-61: Deadman's Slough
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

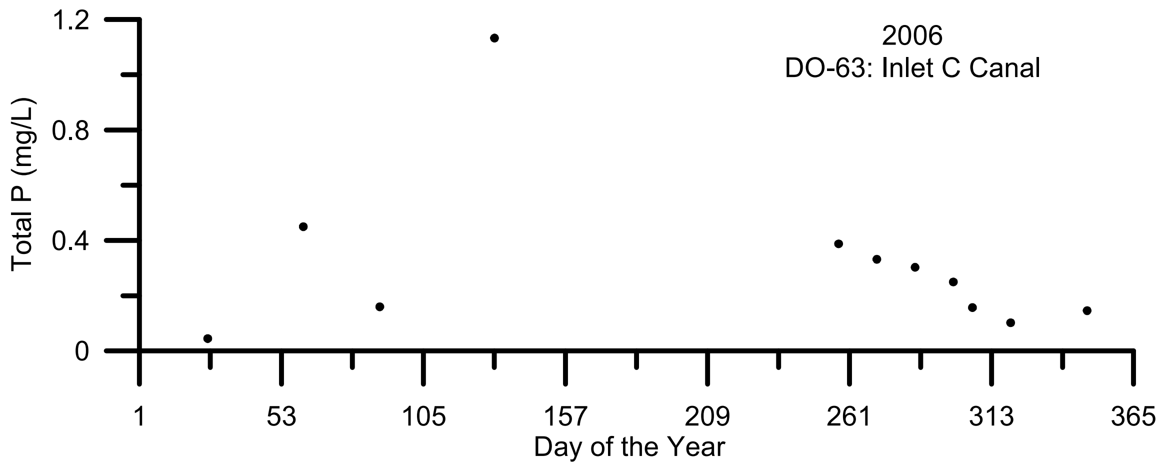

2007
DO-61: Deadman's Slough
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

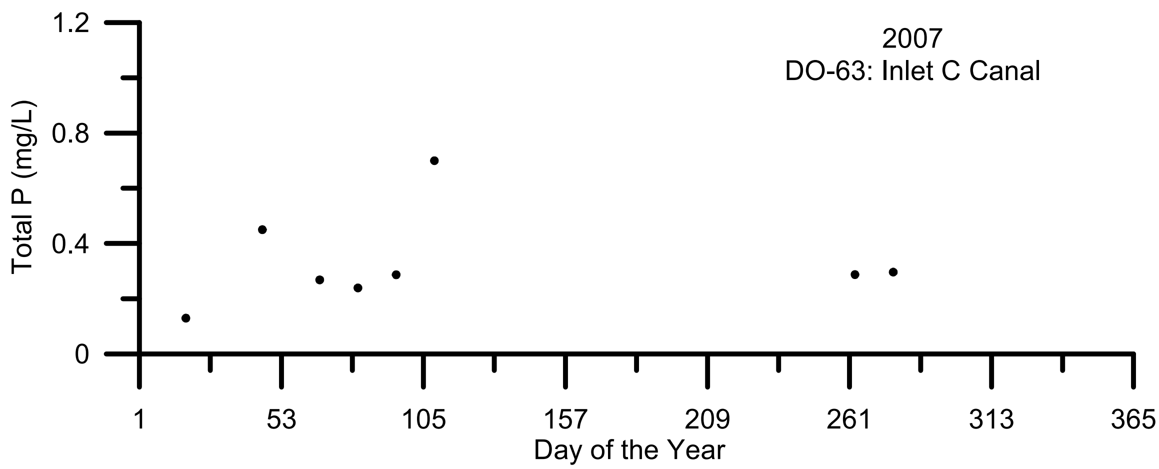

2005
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

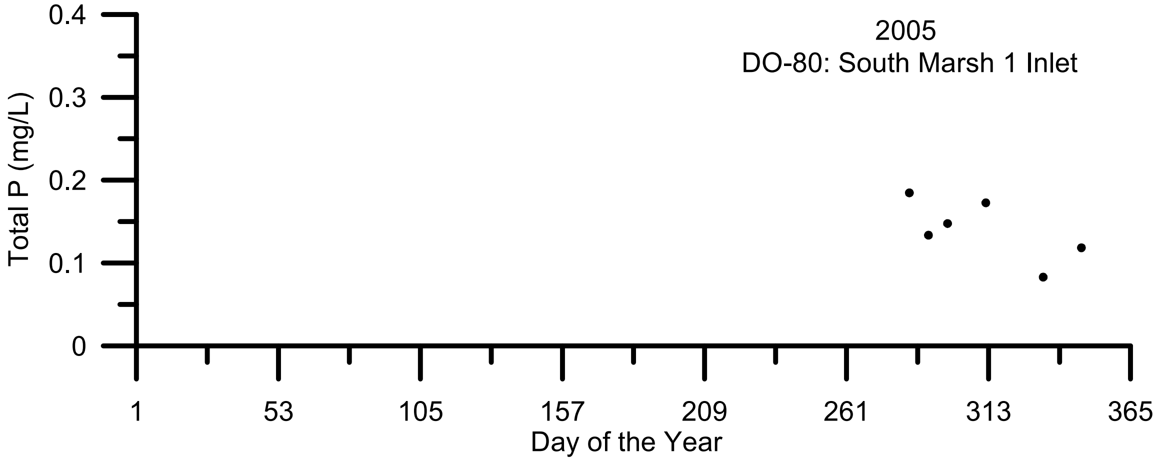

2006
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

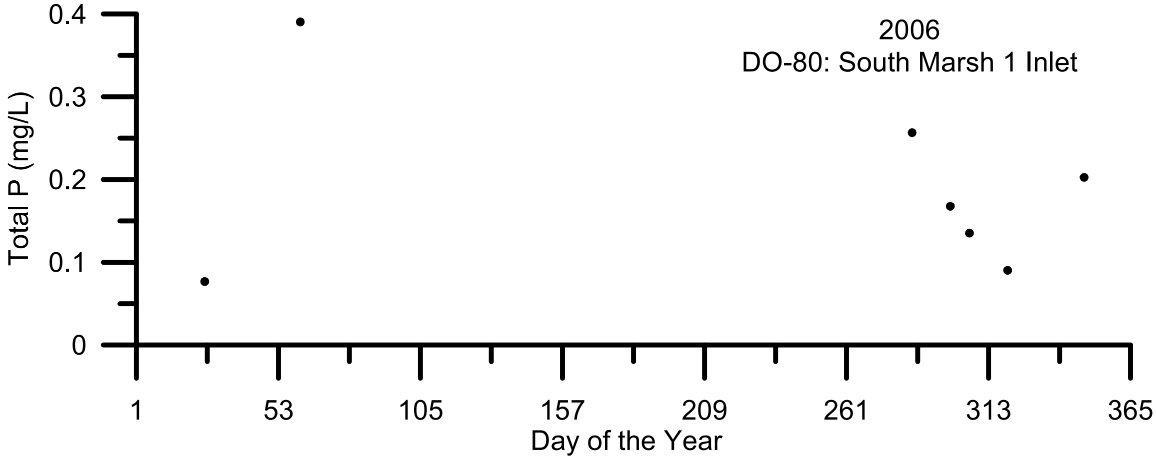

2007
DO-62: Mallard Slough
Total P (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

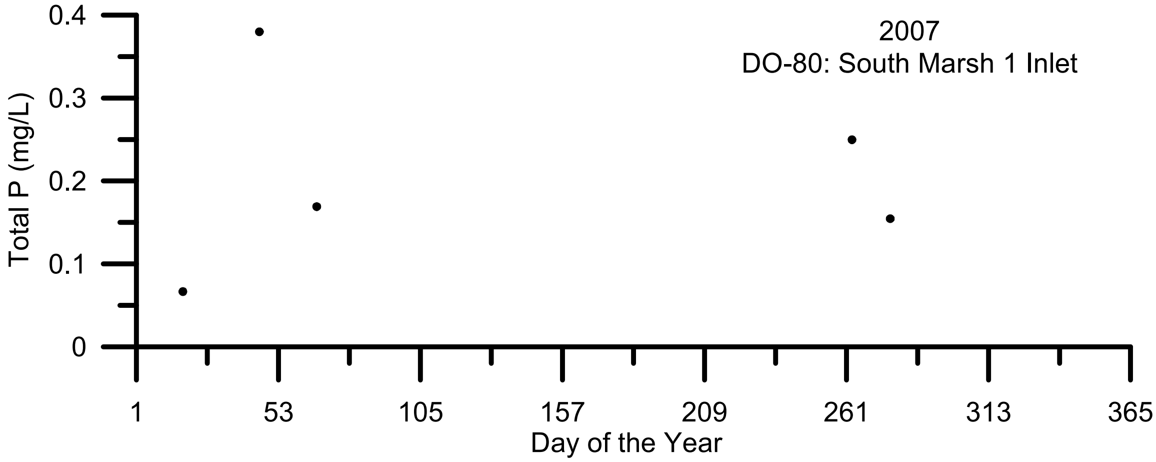

2005
DO-63: Inlet C Canal
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

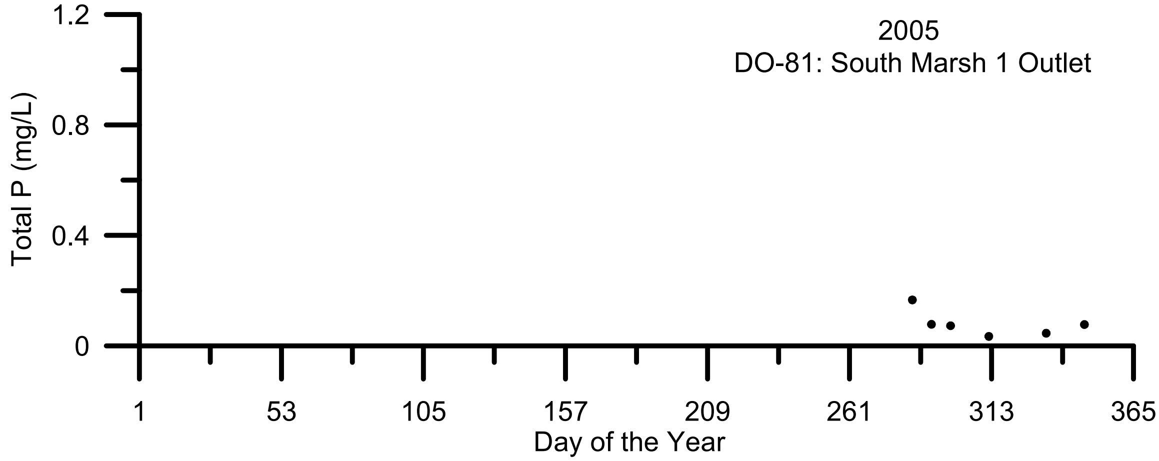

2006
DO-63: Inlet C Canal
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

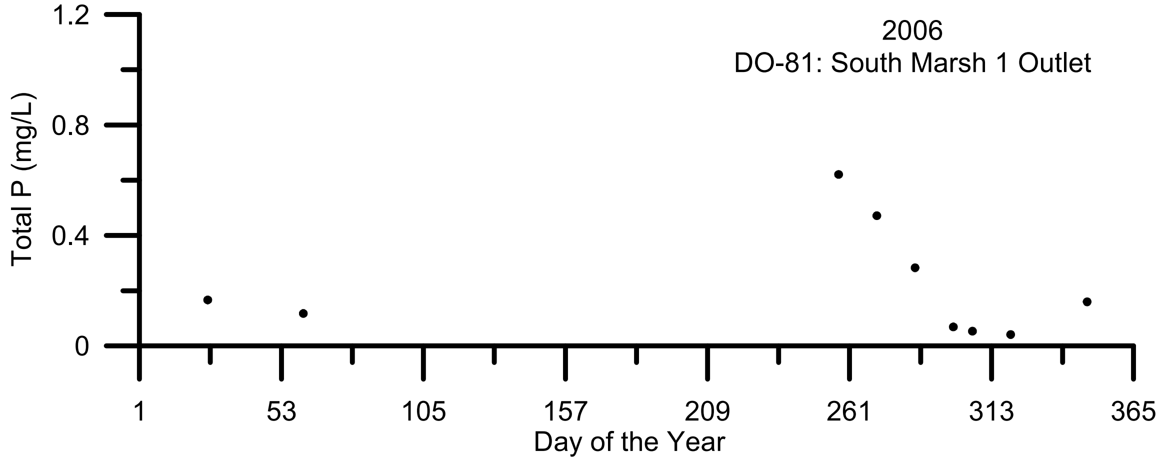

2007
DO-63: Inlet C Canal
Total P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

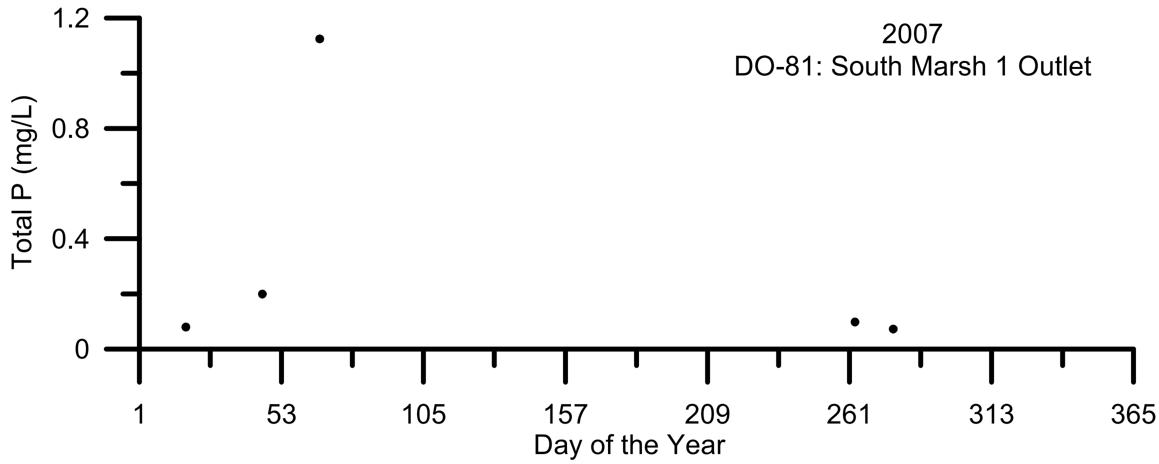

2005
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

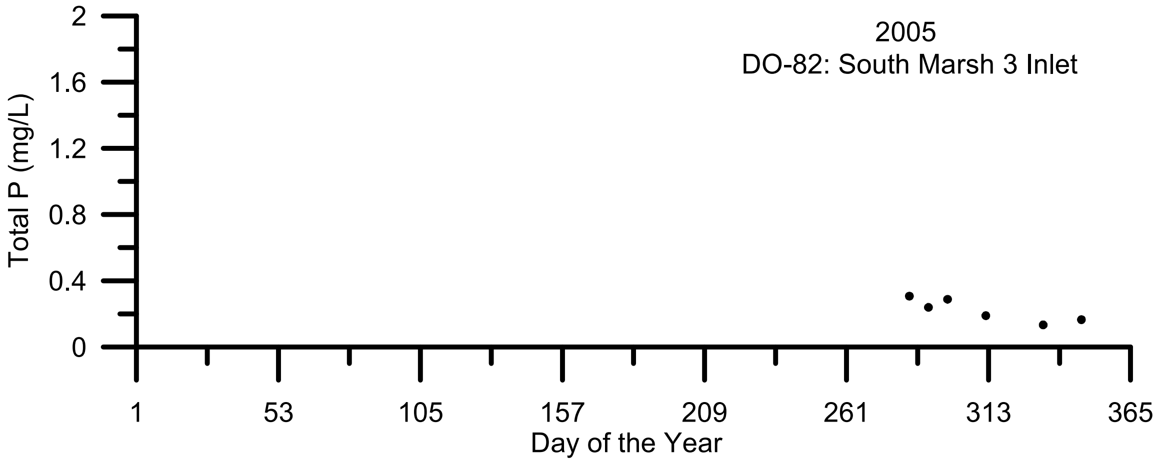

2006
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

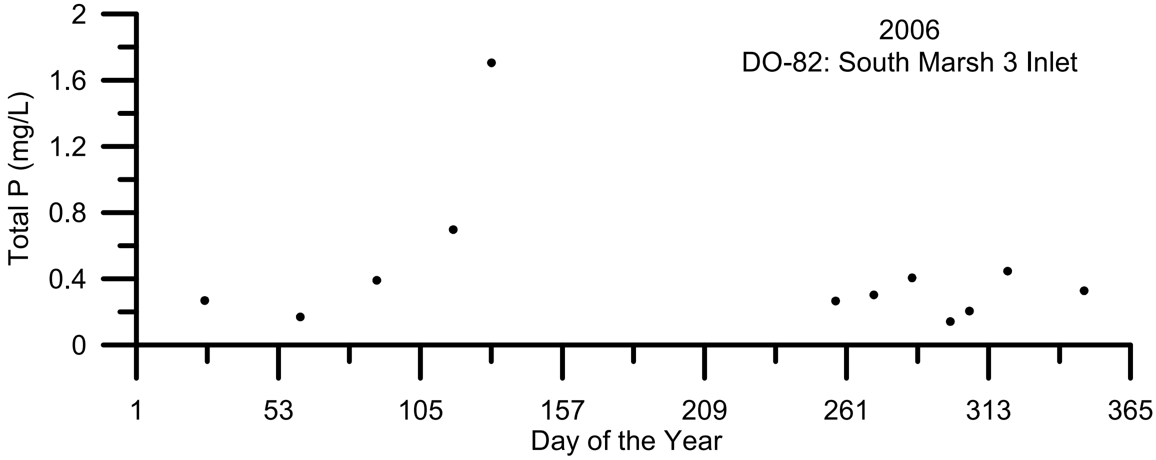

2007
DO-80: South Marsh 1 Inlet
Total P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

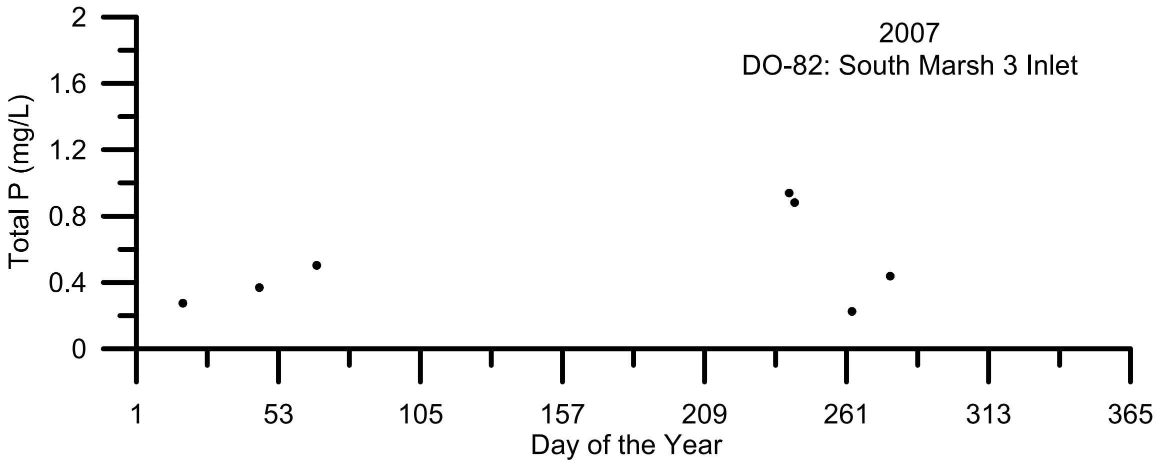

1.2
0.8
0.4
0
Total P (mg/L)
2005
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year

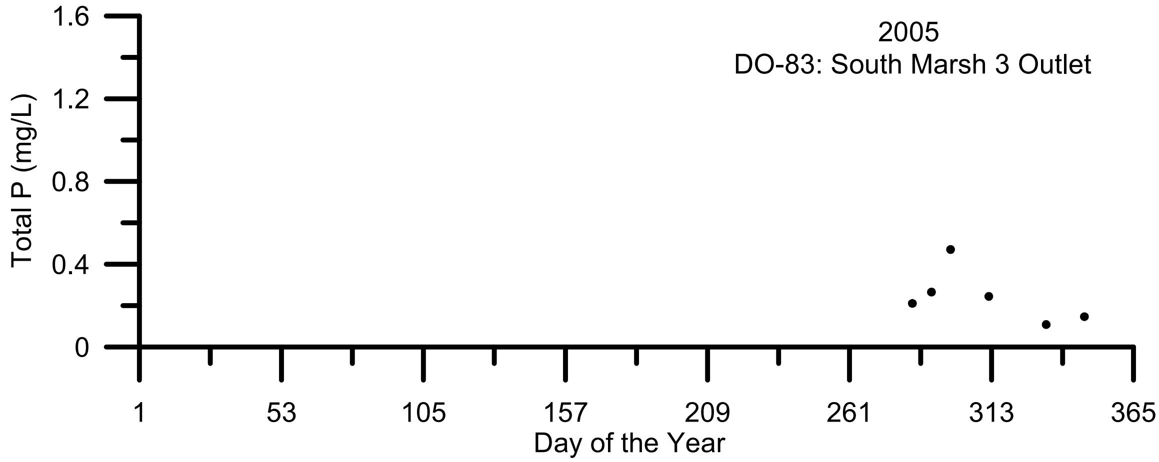

1.2
0.8
0.4
0
Total P (mg/L)
2006
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year

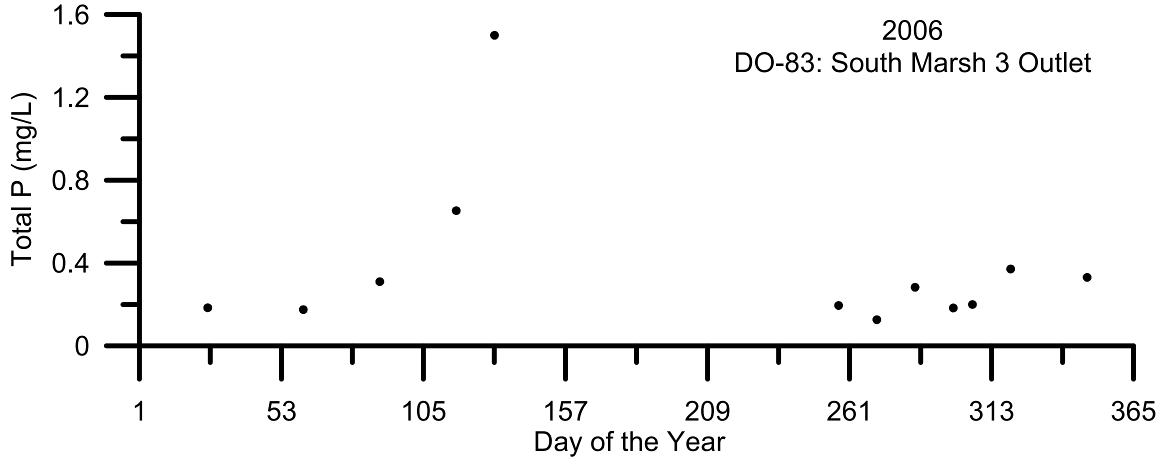

1.2
0.8
0.4
0
Total P (mg/L)
2007
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year

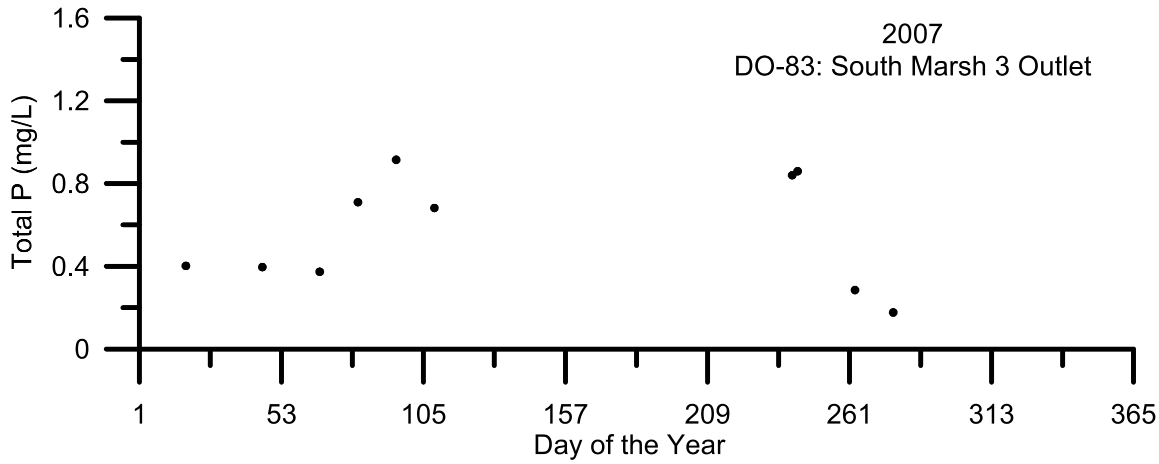

2005
DO-82: South Marsh 3 Inlet
Total P (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

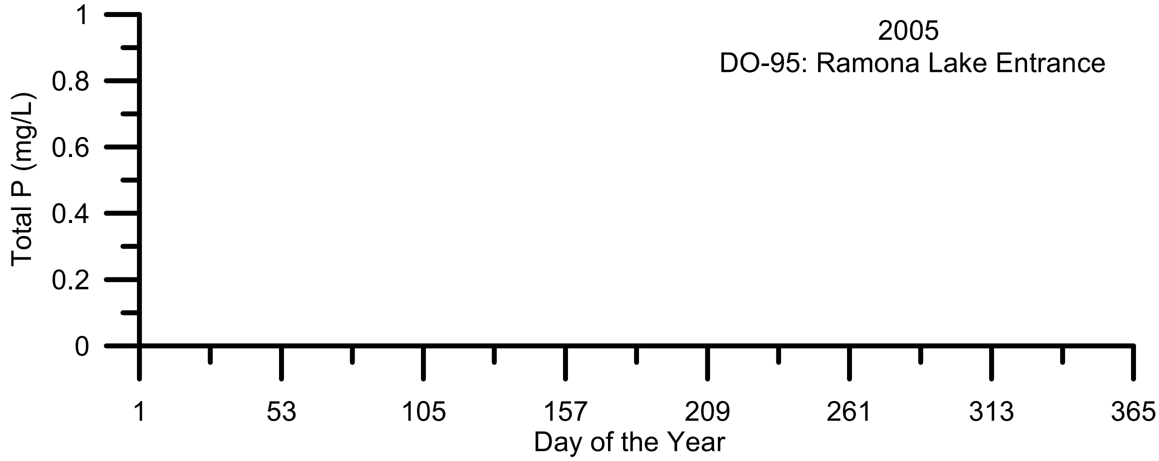

2006
DO-82: South Marsh 3 Inlet
Total P (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

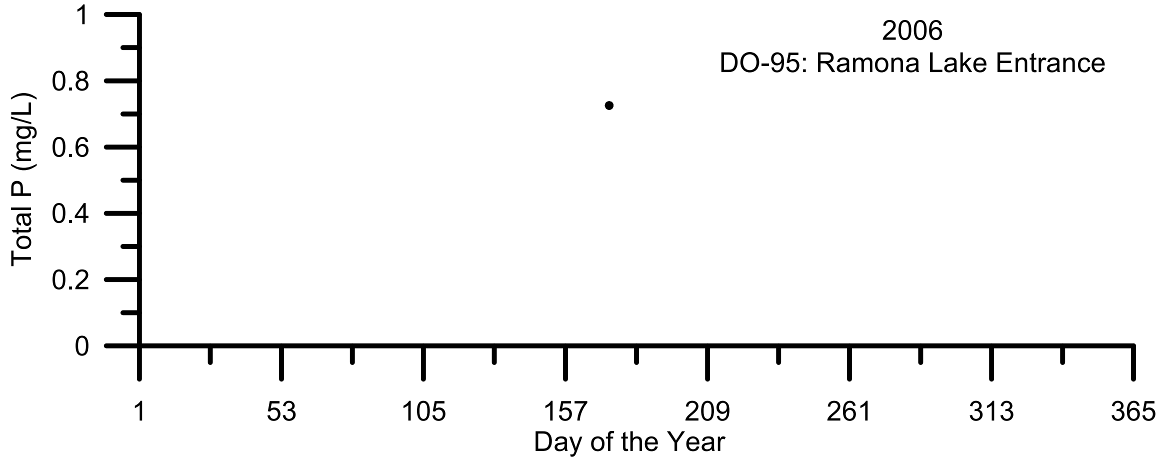

2007
DO-82: South Marsh 3 Inlet
Total P (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

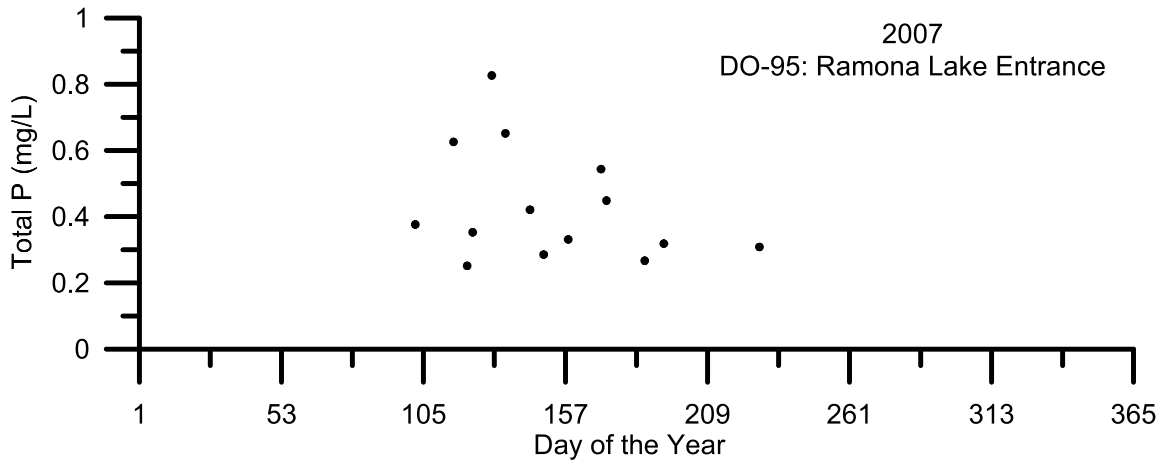

2005
DO-83: South Marsh 3 Outlet
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Total P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Total P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Total Nitrogen Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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University of the Pacific
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Stockton, CA 95211

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of total nitrogen (Tot-N) data analyzed by the UCD Dahlgren laboratory from 2005-2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory where they were stored at $-20^{\circ}C$ until Tot-N analysis could be completed.

Tot-N was determined using an automated membrane diffusion/conductivity detection method (Carlson, 1978, 1986; Carlson et al., 1990) from unfiltered sample following persulfate oxidation (Yu et al., 1994) using a 1% persulfate oxidant concentration, a sample:oxidant ratio of 1:1 (V/V), and heating in an autoclave. The limit of detection for this method was 50 ppb N.

Results/Discussion

With each set of Tot-N field samples analyzed in the UCD laboratory, quality assurance samples including a field duplicate, a trip blank, and lab blanks were also analyzed. 96.17% of all quality assurance samples were within a passing range (Spier et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Twelve proficiency check samples were analyzed for Tot-N in the EERP laboratory during 2007, and nine of these samples were found to be within the acceptable range. Samples were measured ranging from 0.02-40.06 mg/L Tot-N. The average concentration of Tot-N found in samples collected was 4.39 mg/L Tot-N. Tot-N was also analyzed by the EERP laboratory on the same water samples starting in the summer of 2007and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.9896 (Spier et al, 2008). Tot-N samples measured by EERP have about 101% as much Tot-N as the same samples measured by UCD (Figure 2).

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American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

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Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Carlson, R.M., R. Cabrera, J. Paul, J. Quick and R.Y. Evans. 1990. Rapid direct determination of ammonium and nitrate in soil and plant tissue extracts. Comm. Soil Sci. Plant Anal. 21:1519-1530.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Spier, C., Burks, R., Borglin, S.E. (2008) Comparison of Methods for Analyzing Ammonia, Nitrate and Total Nitrogen, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	SJR at Mossdale	Core sites
5	SJR at Vernalis-McCune Station (River Club)	Core sites, BMP
6	SJR at Maze	Core sites, BMP
7	SJR at Patterson	Core sites, BMP
8	SJR at Crows Landing	Core sites, BMP
10	SJR at Lander Avenue	Core sites
12	Stanislaus River at Caswell Park	Core sites
14	Tuolumne River at Shiloh Bridge	Core sites
16	Merced River at River Road	Core sites
18	Mud Slough near Gustine	Core sites, Wetland
19	Salt Slough at Lander Avenue	Core sites, Wetland
20	Los Banos Creek Flow Station	Core sites, Wetland
21	Orestimba Creek at River Road	Core sites, BMP
23	Modesto ID Lateral 5 to Tuolumne	Core sites
25	Modesto ID Main Drain to Stan. R. via Miller Lake	Core sites
28	Turlock ID Westport Drain Flow station	Core sites
29	Turlock ID Harding Drain	Core sites
30	Turlock ID Lateral 6 & 7 at Levee	Core sites
33	Hospital Creek	Intermittent, BMP
34	Ingram Creek	Core sites, BMP
36	Del Puerto Creek Flow Station	Core sites, BMP
44	San Luis Drain End	Core sites
53	Salt Slough at Wolfsen Road	Wetland
57	Ramona Lake Drain	Core sites, BMP
59	SJR Laird Park	Core sites
60	Moffit 1 South	Wetland
61	Deadman's Slough	Wetland
62	Mallard Slough	Wetland
63	Inlet C Canal	Wetland
80	South Marsh-1-Inlet	Wetland
81	South Marsh-1-Outlet	Wetland
82	South Marsh-3-Inlet	Wetland
83	South Marsh-3-Outlet	Wetland
95	Ramona drain at Ramona Lake	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

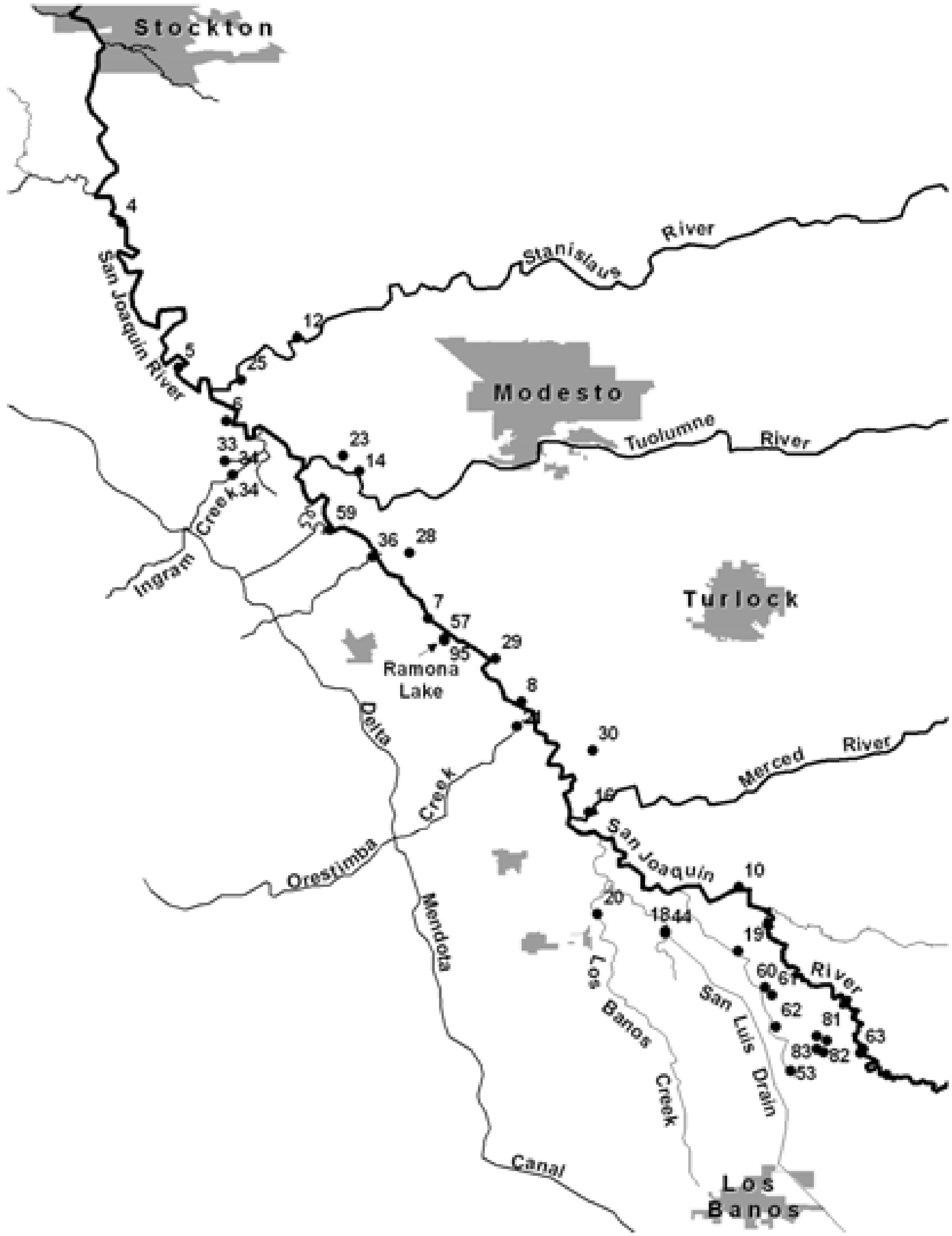
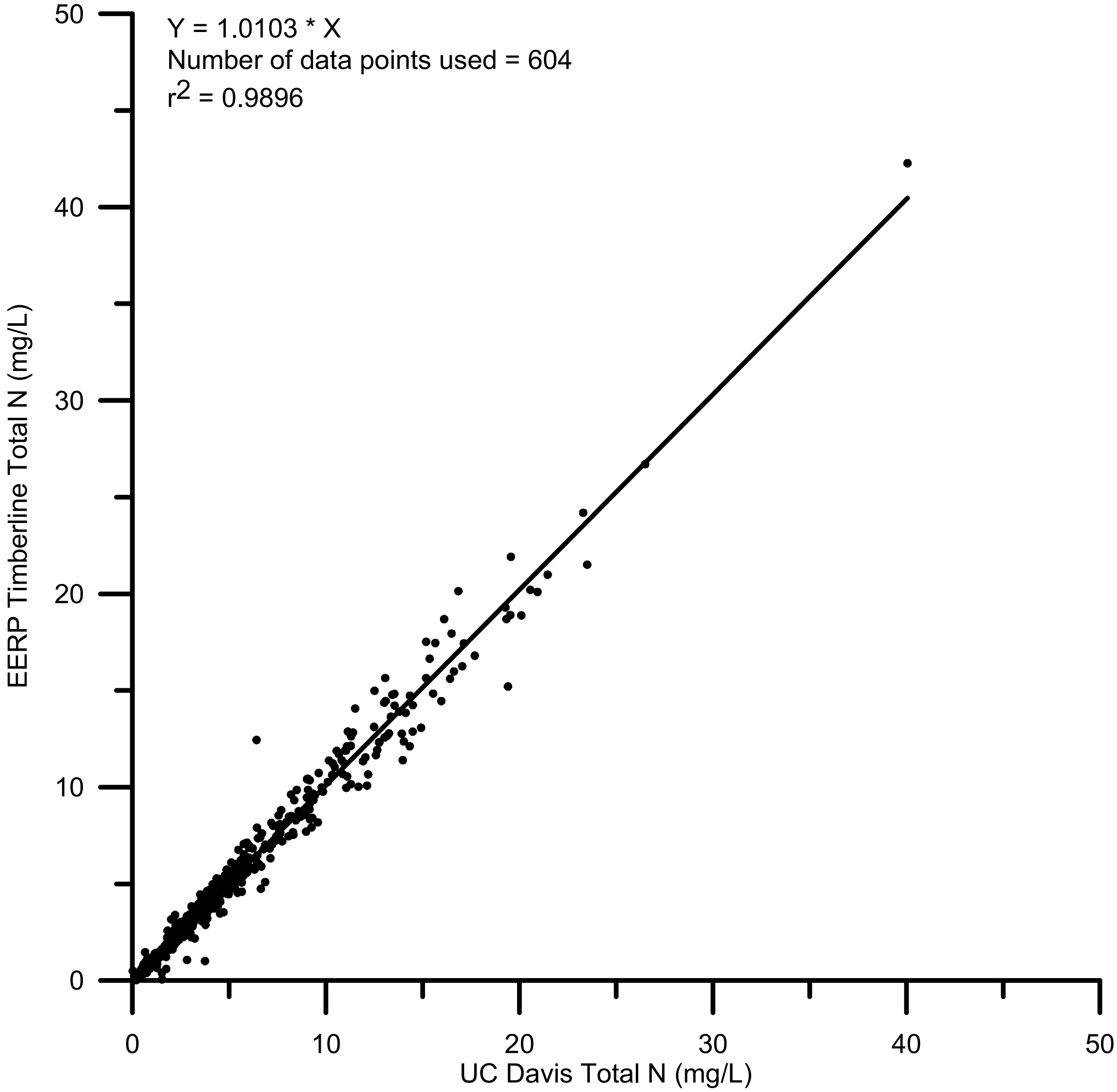
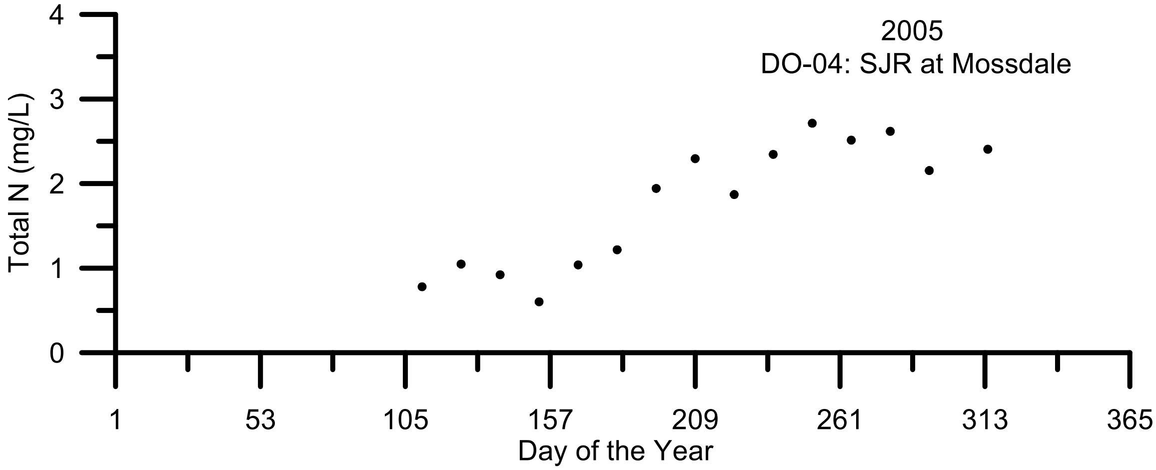
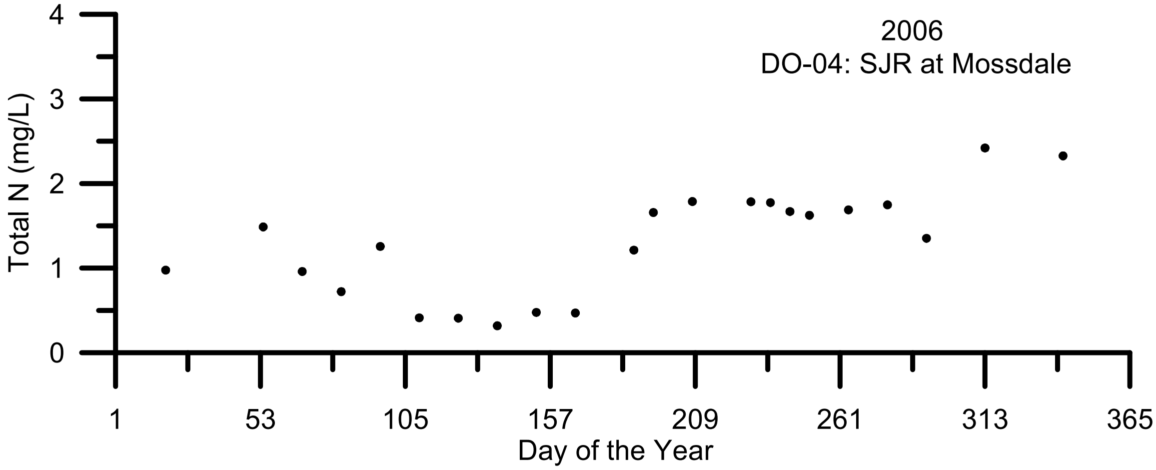


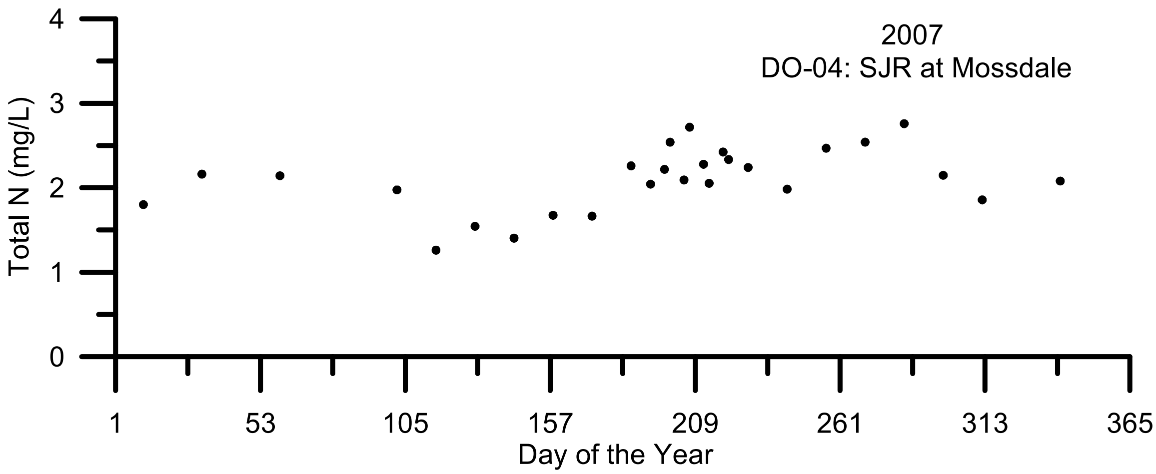
Figure 2: UCD vs EERP Timberline Plot of Tot-N.

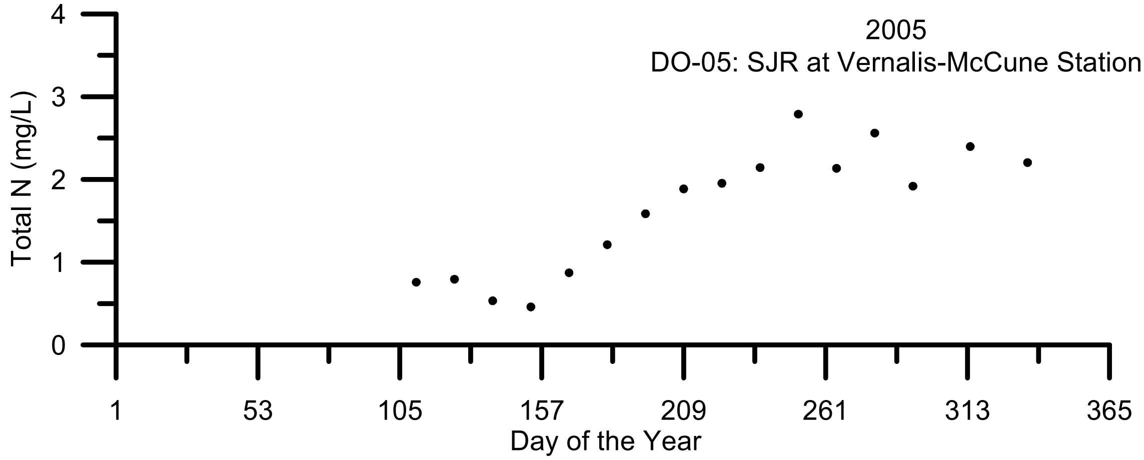


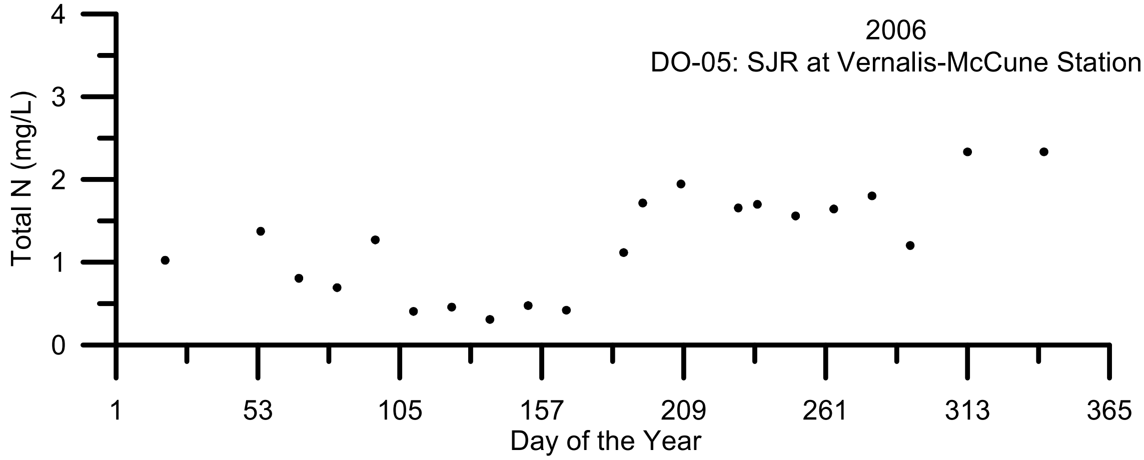
Figures 2 -103: Temporal Plots of Tot-N By Site ID

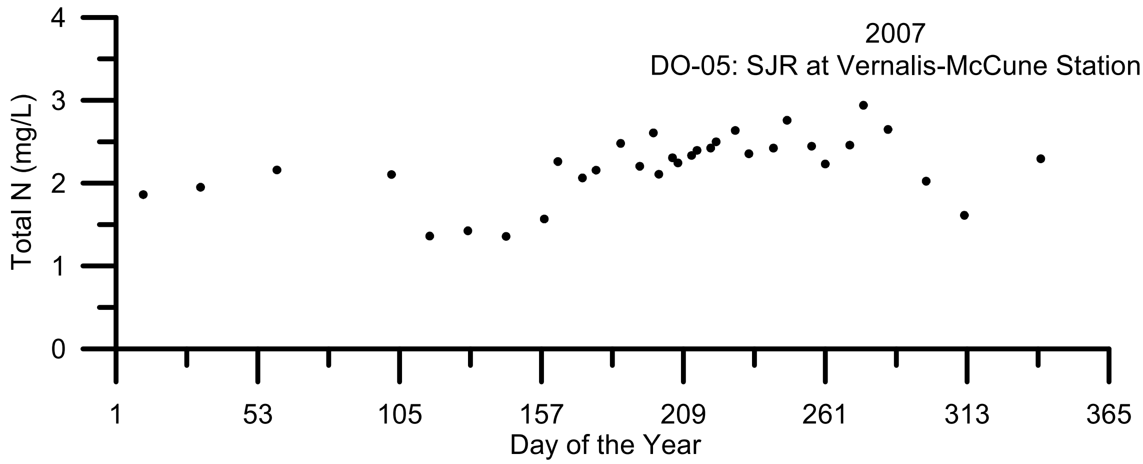


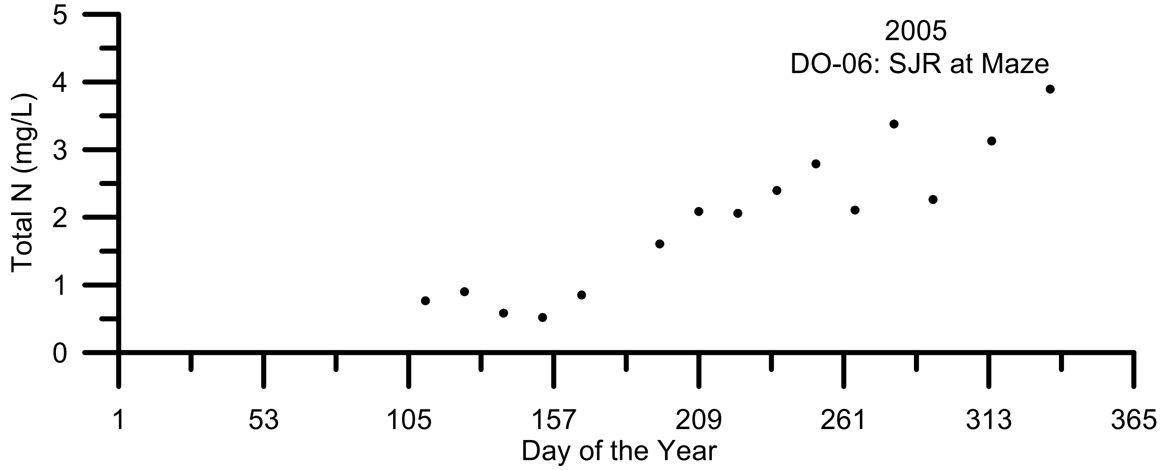




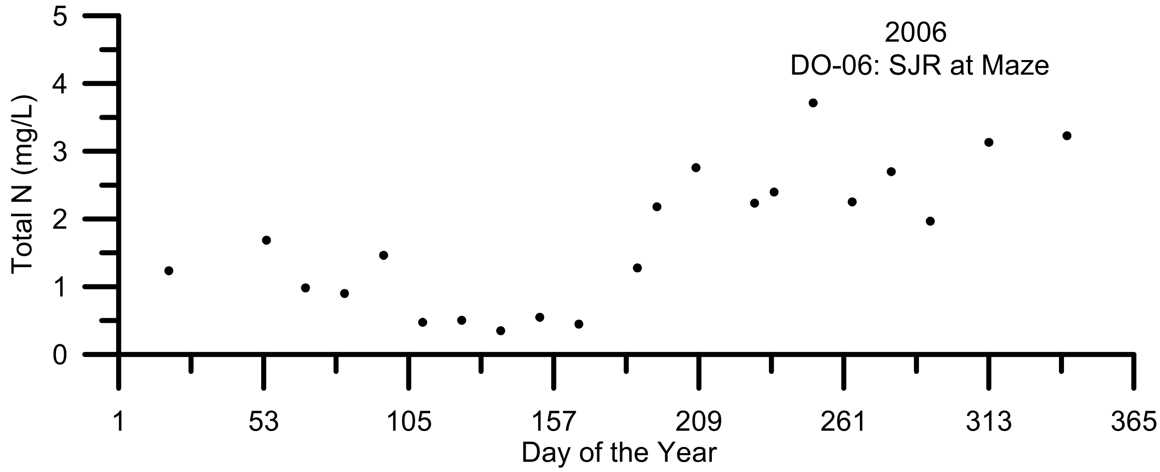

2005
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

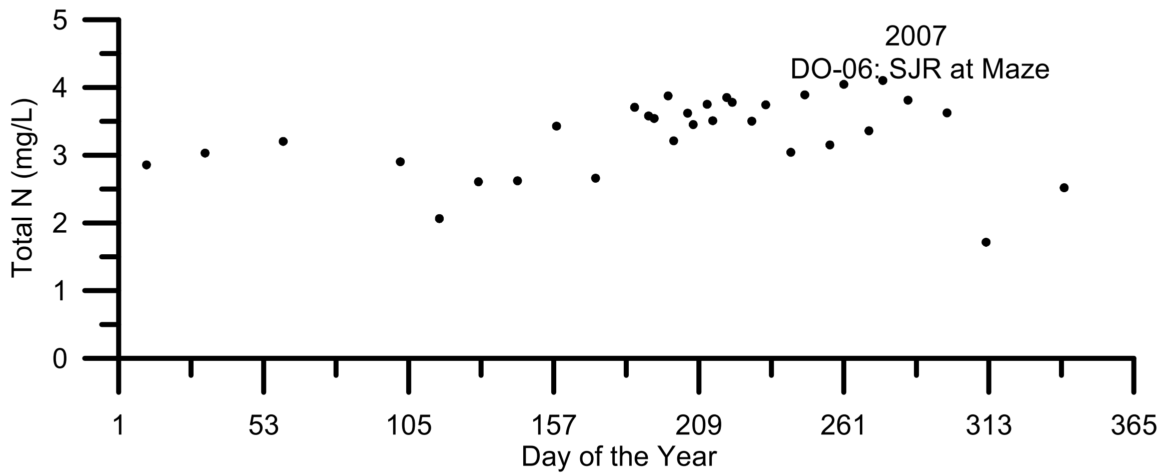

2007
DO-05: SJR at Vernalis-McCune Station
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year



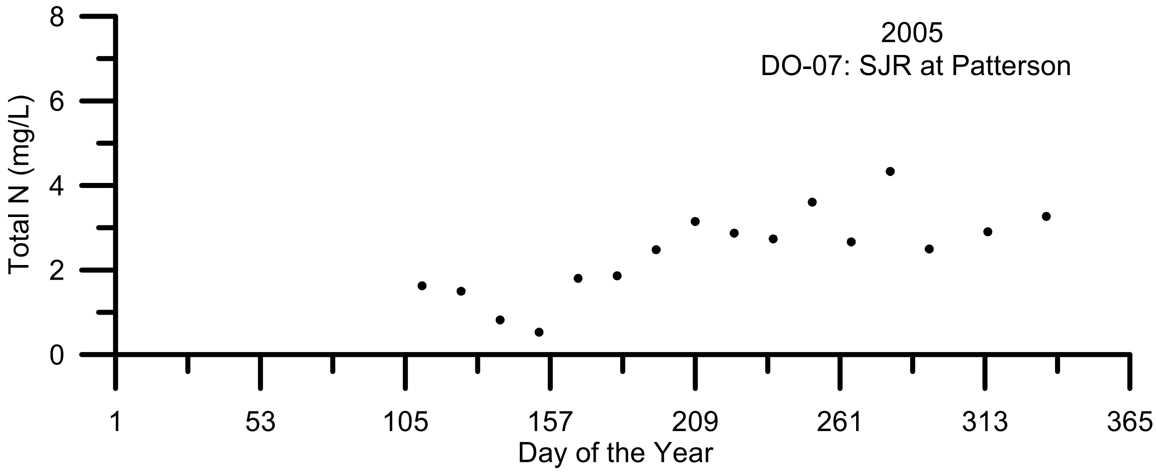
2005
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

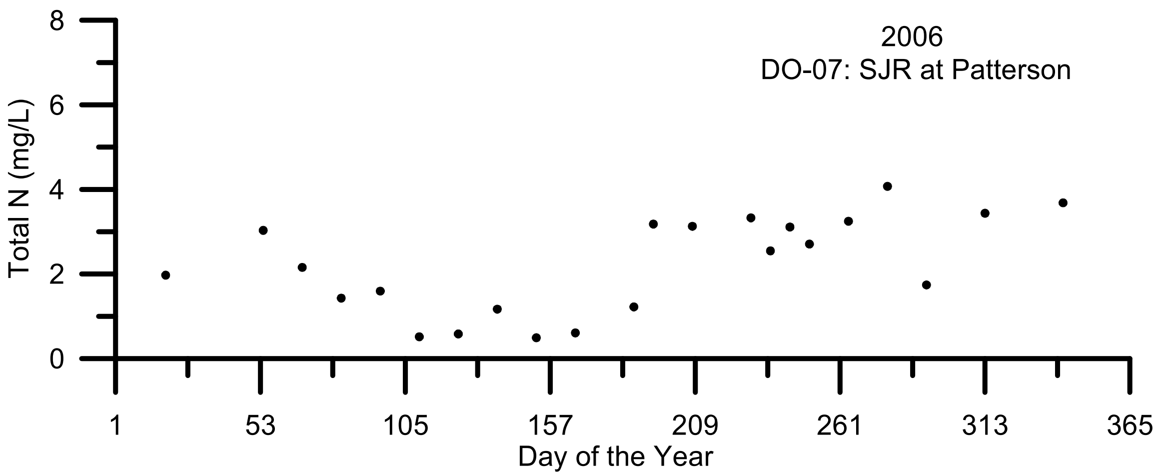


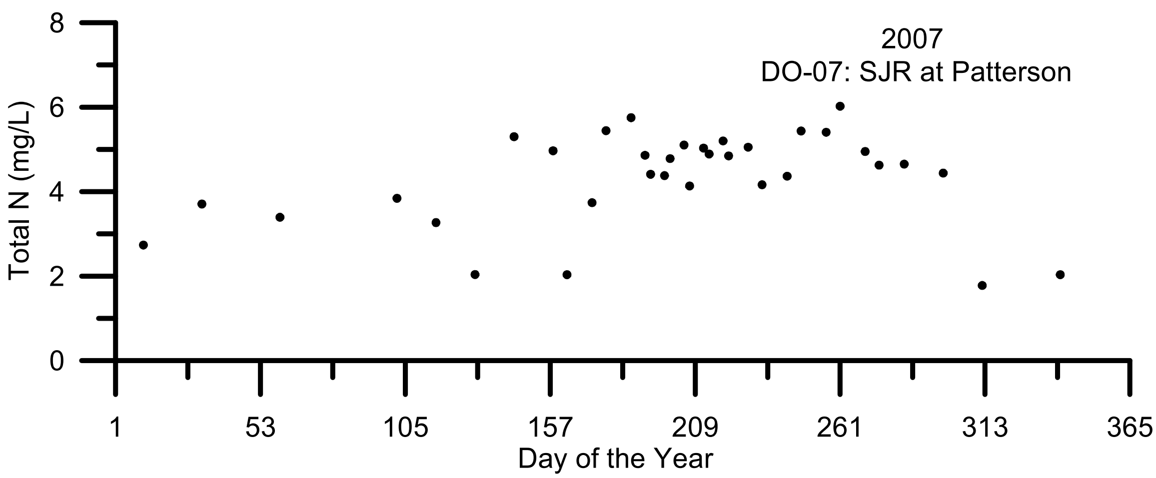
2006
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

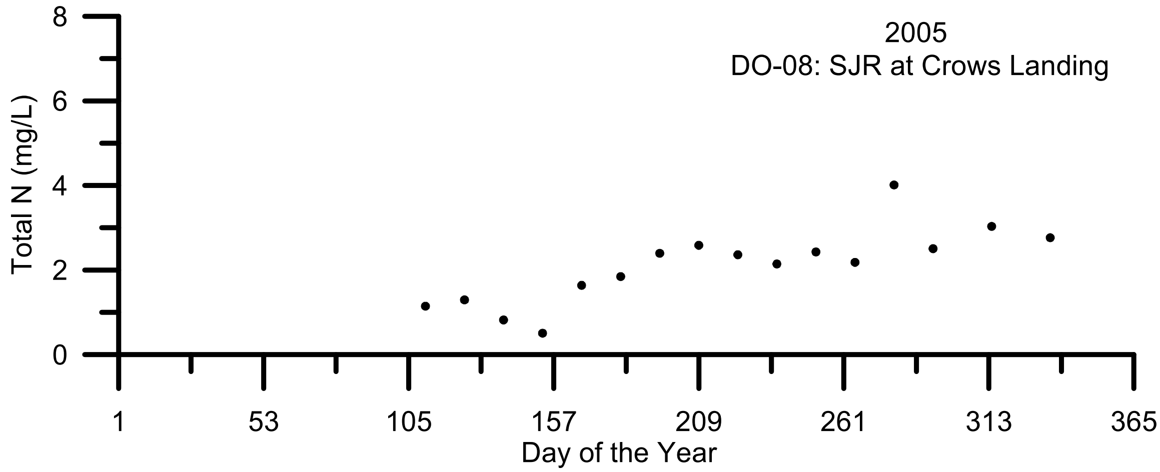


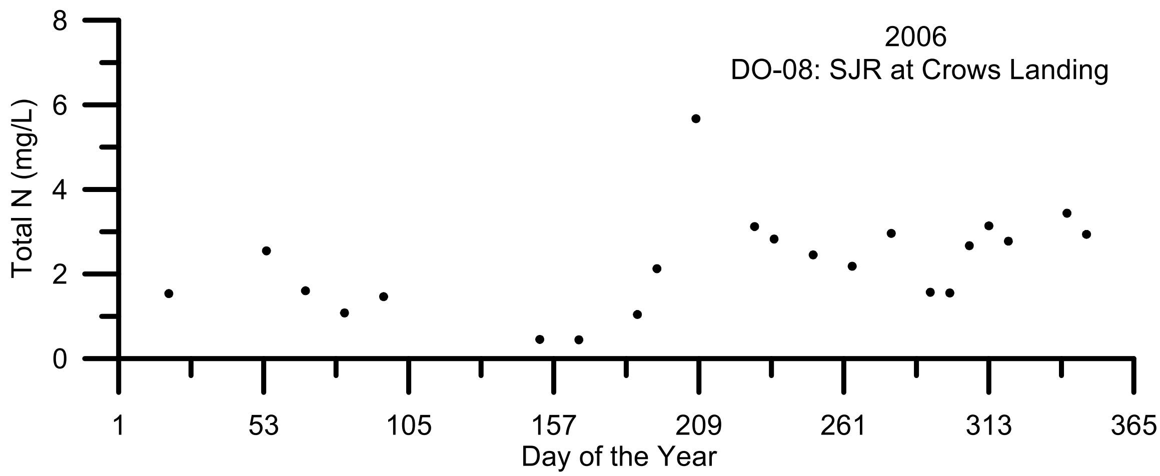
2007
DO-06: SJR at Maze
Total N (mg/L)
Day of the Year

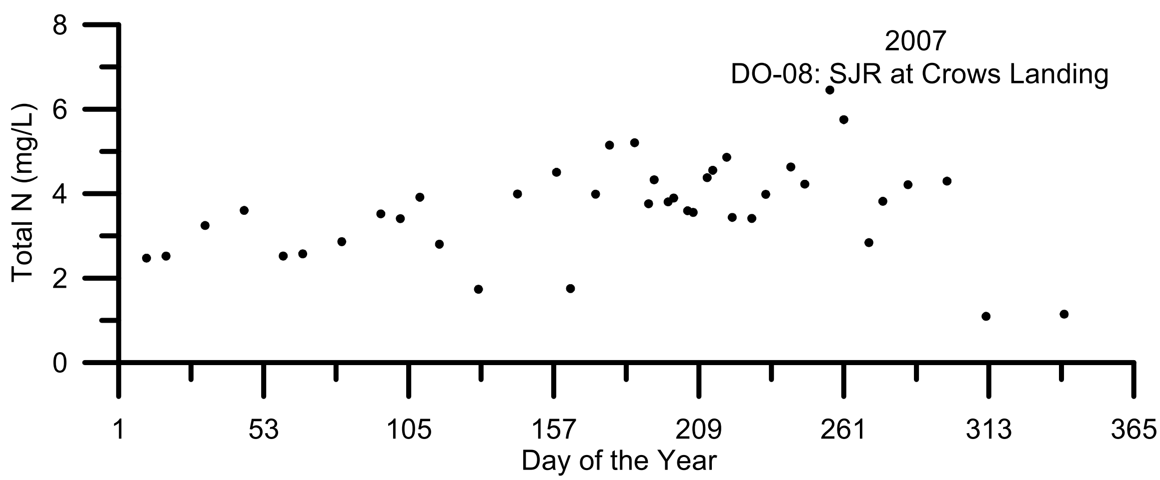

2005
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

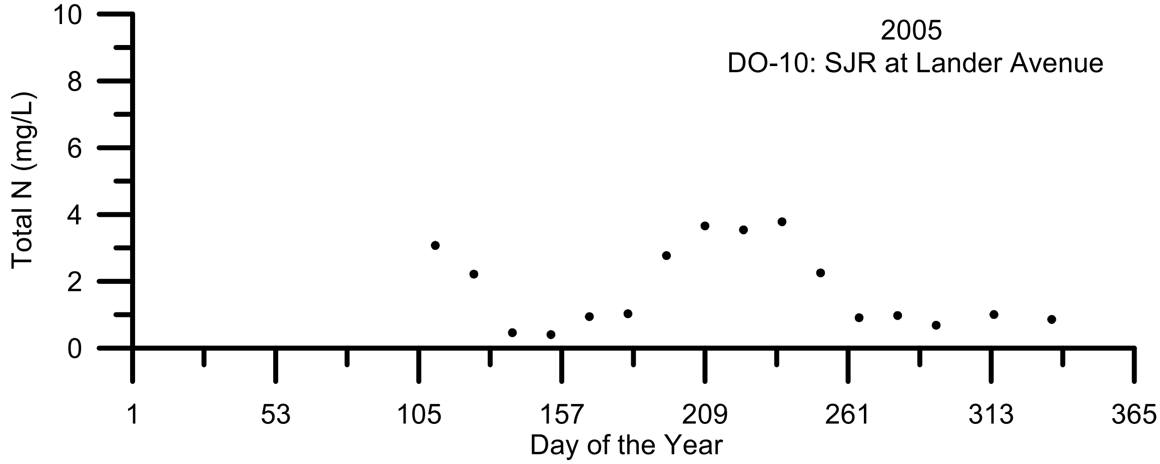

2006
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

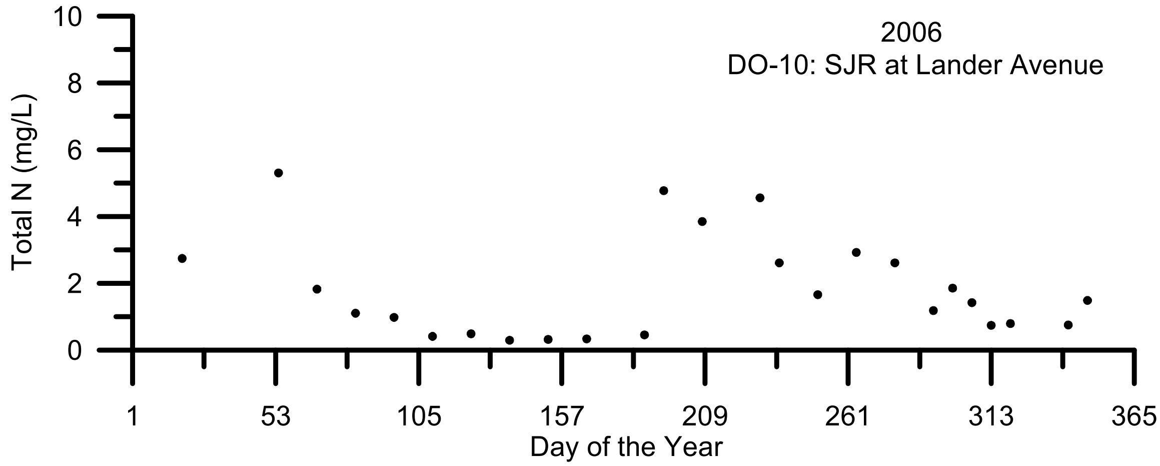

2007
DO-07: SJR at Patterson
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

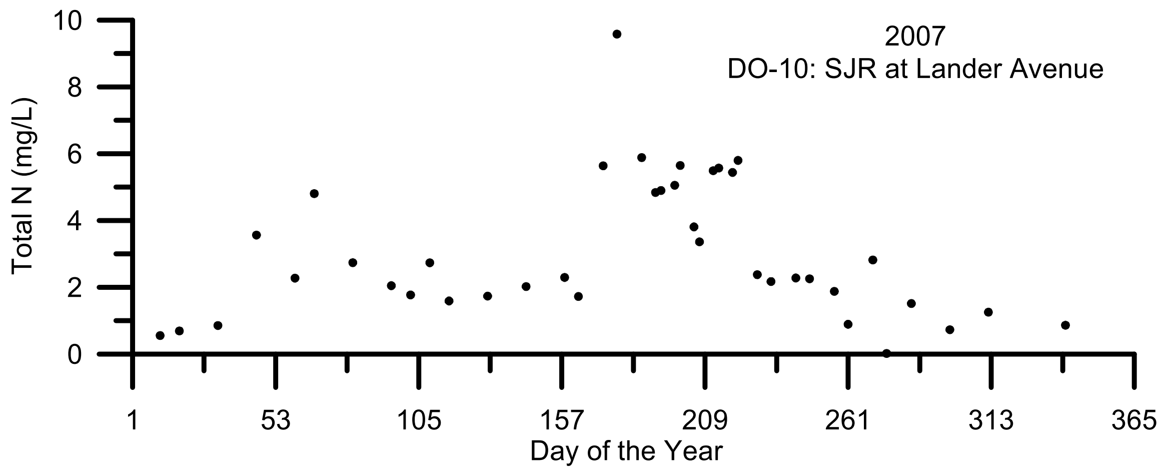

2005
DO-08: SJR at Crows Landing
Total N (mg/L)
Day of the Year
0
2
4
6
8
1
53
105
157
209
261
313
365

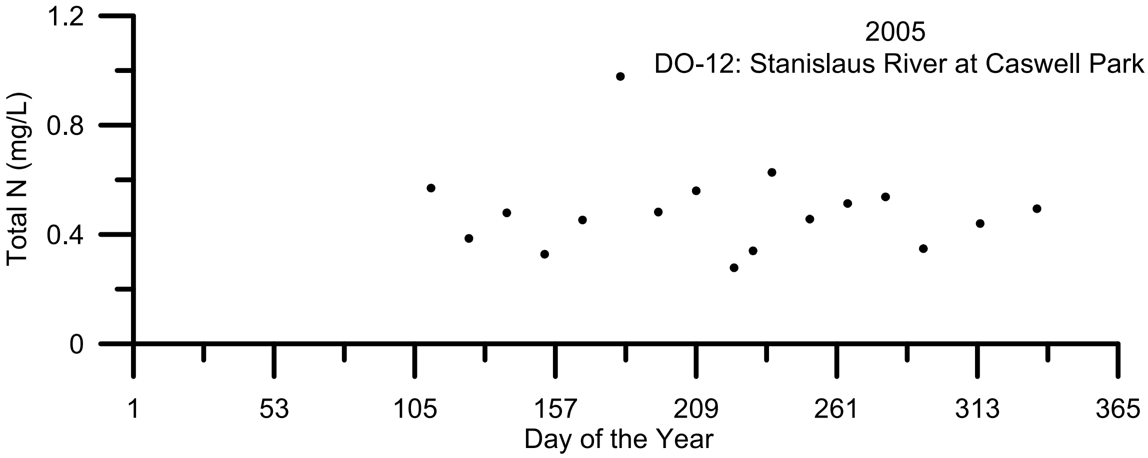

2006
DO-08: SJR at Crows Landing
Total N (mg/L)
Day of the Year
0
2
4
6
8
1
53
105
157
209
261
313
365

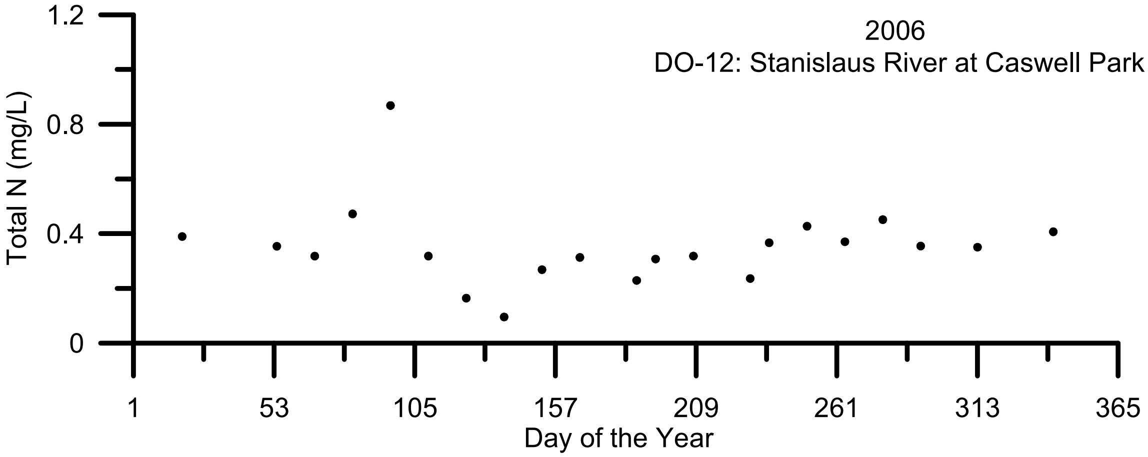

2007
DO-08: SJR at Crows Landing
Total N (mg/L)
Day of the Year
0
2
4
6
8
1
53
105
157
209
261
313
365

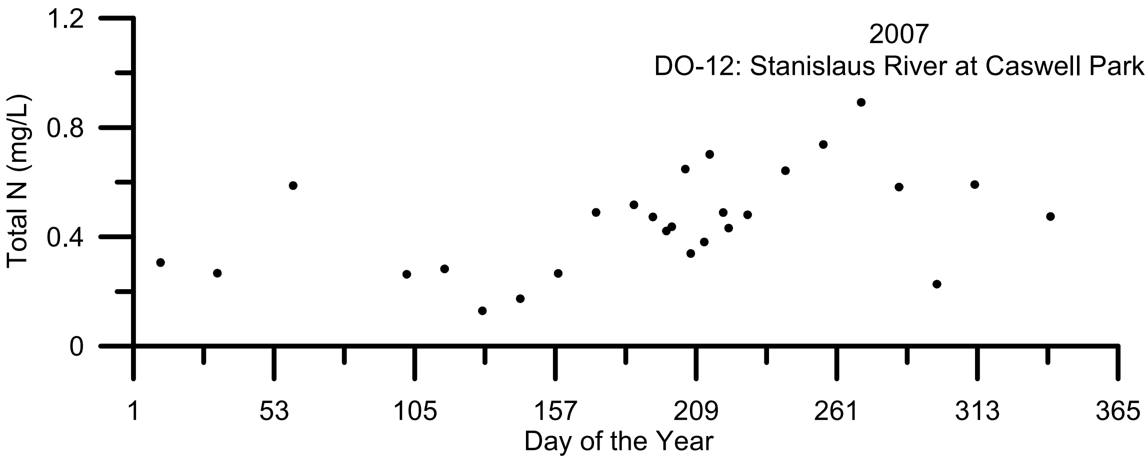

2005
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

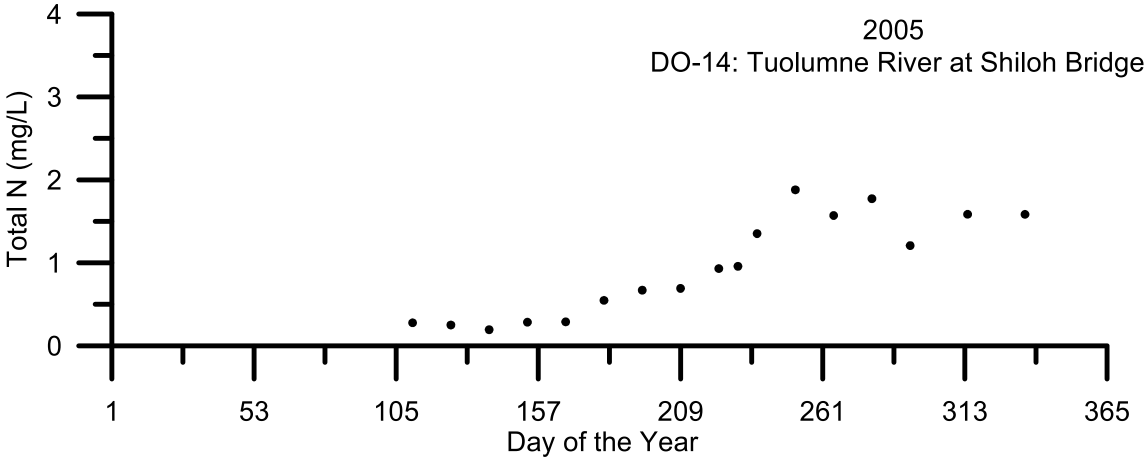

2006
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

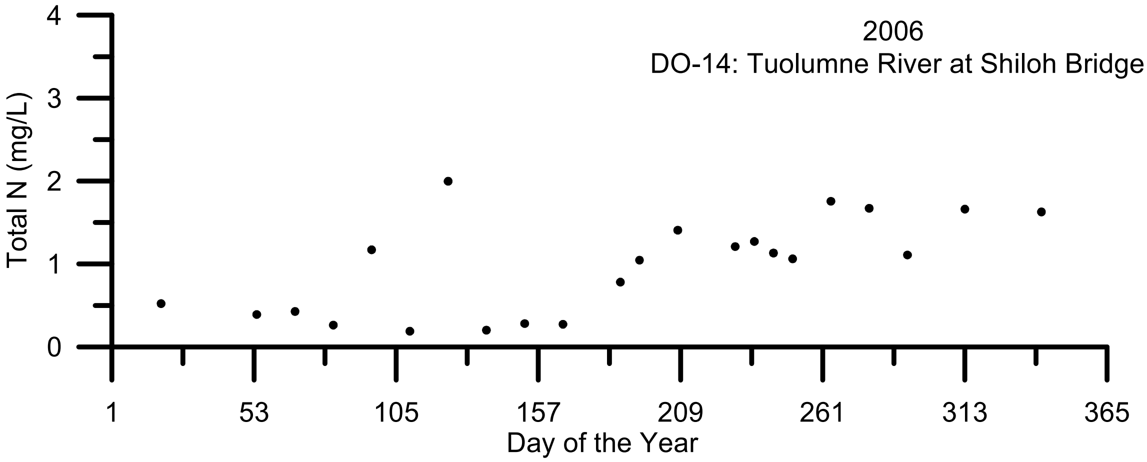

2007
DO-10: SJR at Lander Avenue
Total N (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

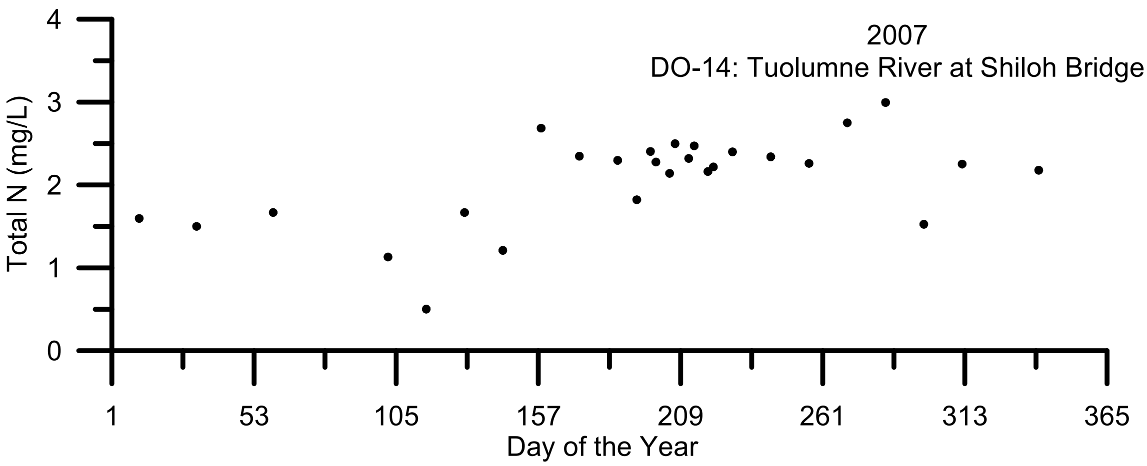

1.2
0.8
0.4
0
Total N (mg/L)
2005
DO-12: Stanislaus River at Caswell Park
1
53
105
157
209
261
313
365
Day of the Year

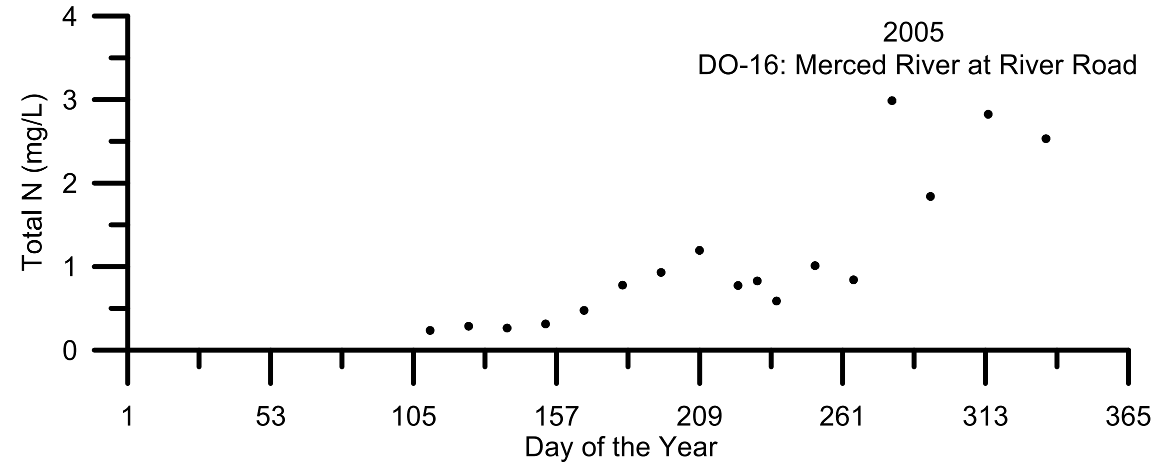

1.2
0.8
0.4
0
Total N (mg/L)
2006
DO-12: Stanislaus River at Caswell Park
1
53
105
157
209
261
313
365
Day of the Year

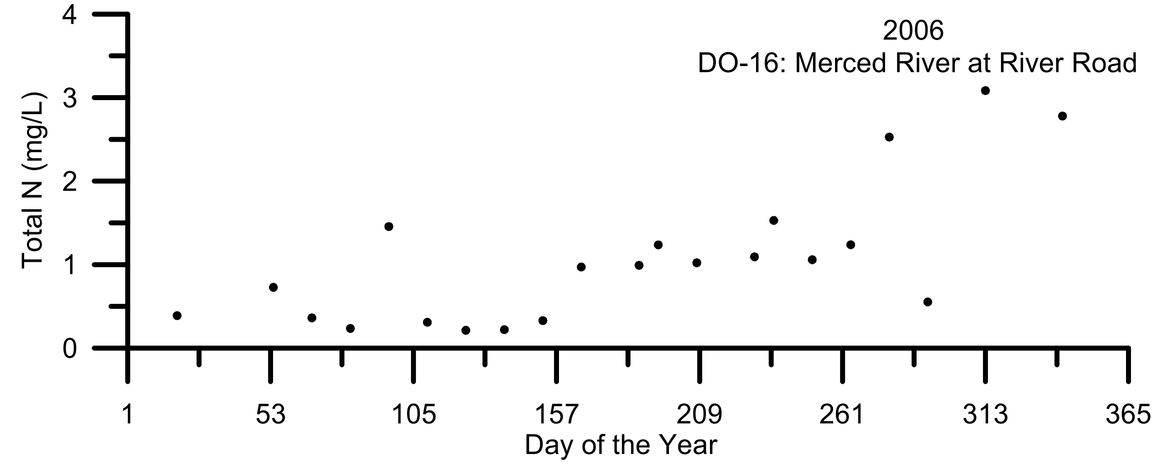

1.2
0.8
0.4
0
Total N (mg/L)
2007
DO-12: Stanislaus River at Caswell Park
1
53
105
157
209
261
313
365
Day of the Year

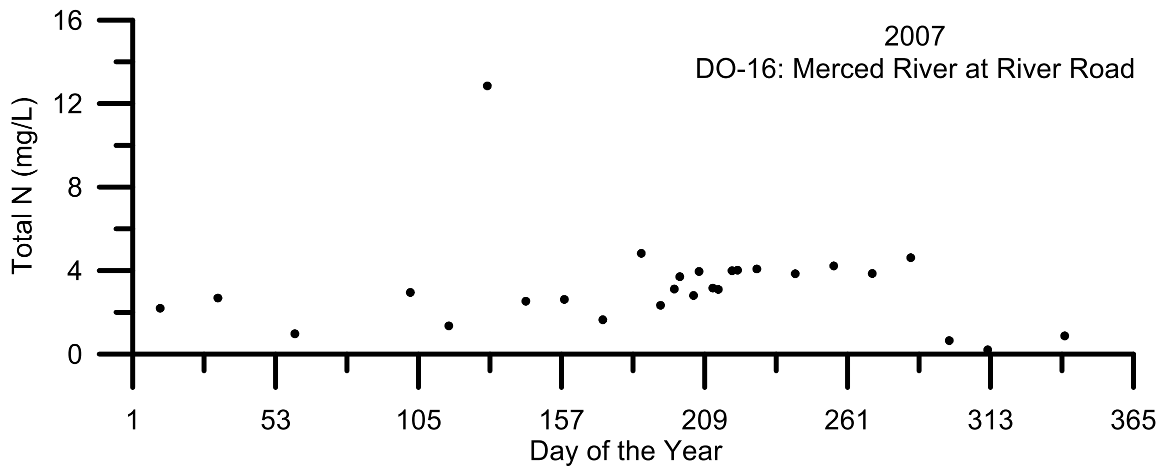

2005
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

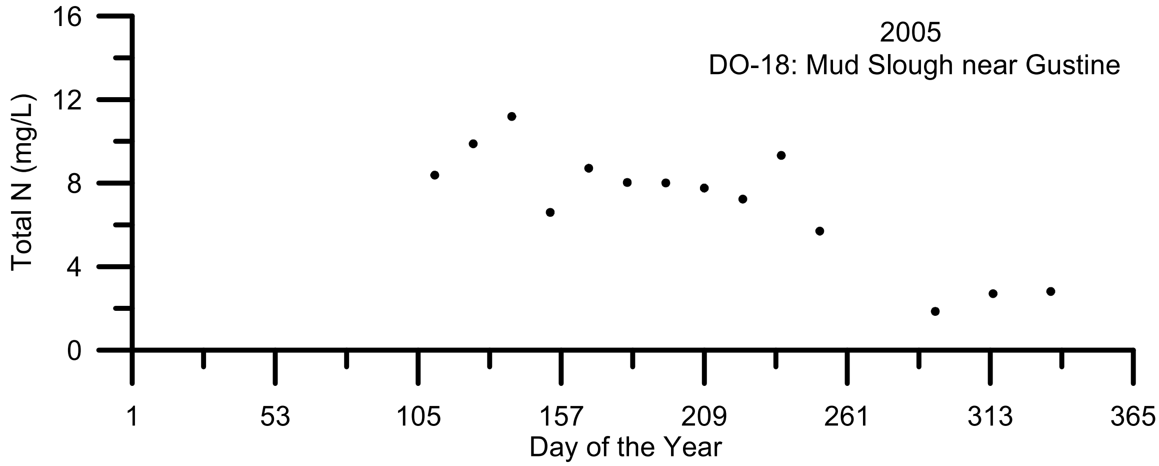

2006
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

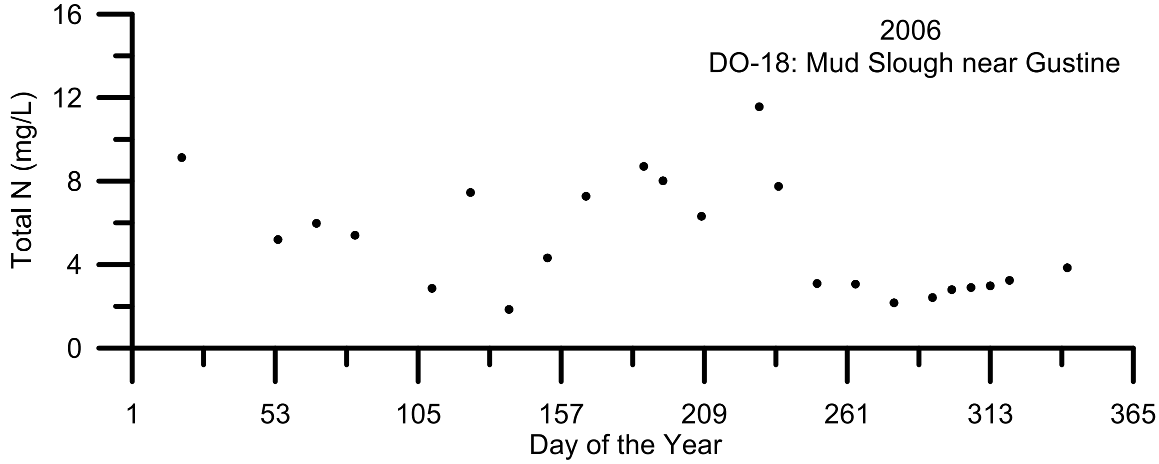

2007
DO-14: Tuolumne River at Shiloh Bridge
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

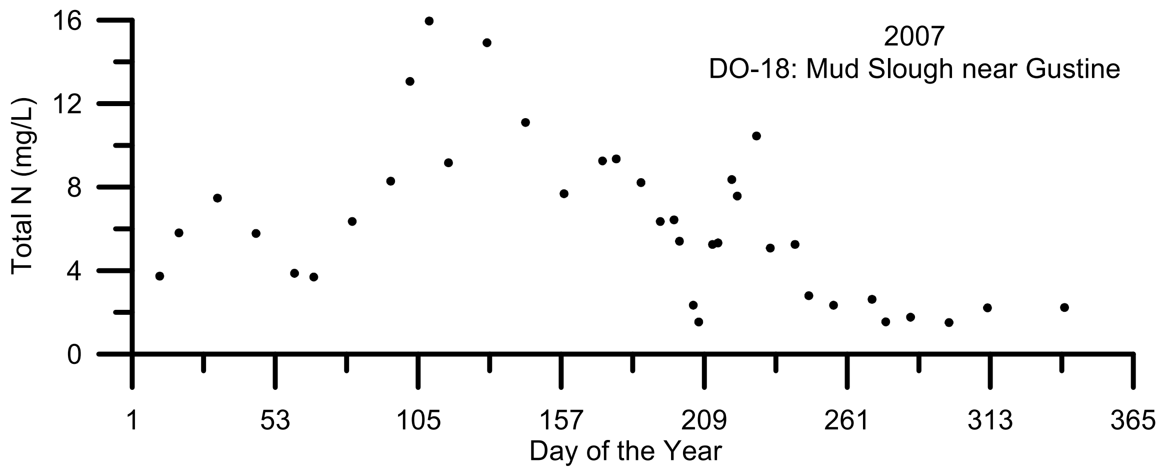

2005
DO-16: Merced River at River Road
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

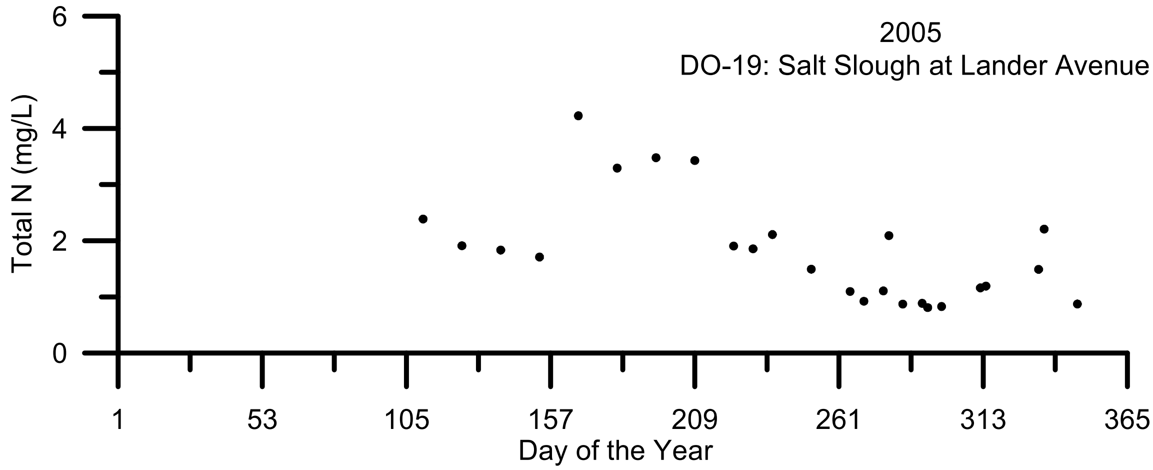

2006
DO-16: Merced River at River Road
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

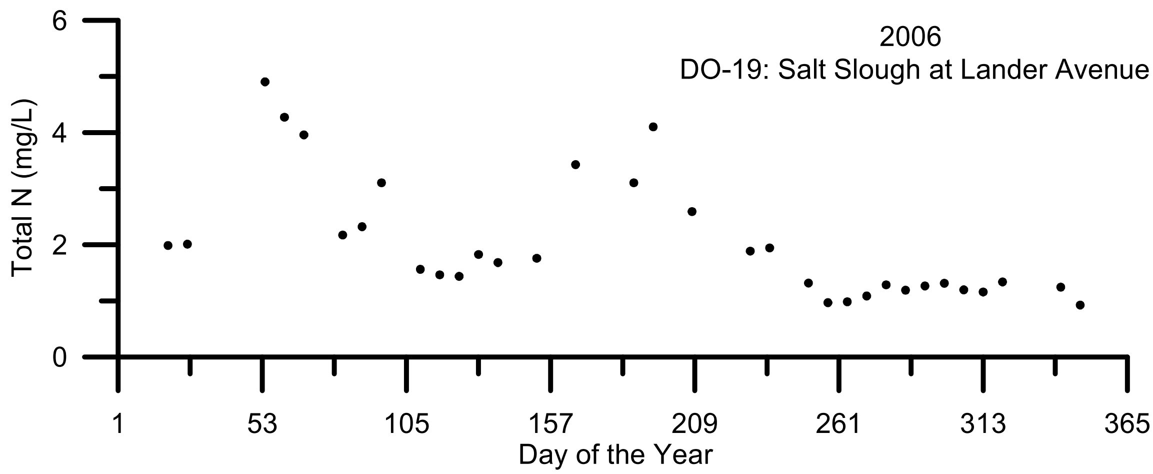

2007
DO-16: Merced River at River Road
Total N (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

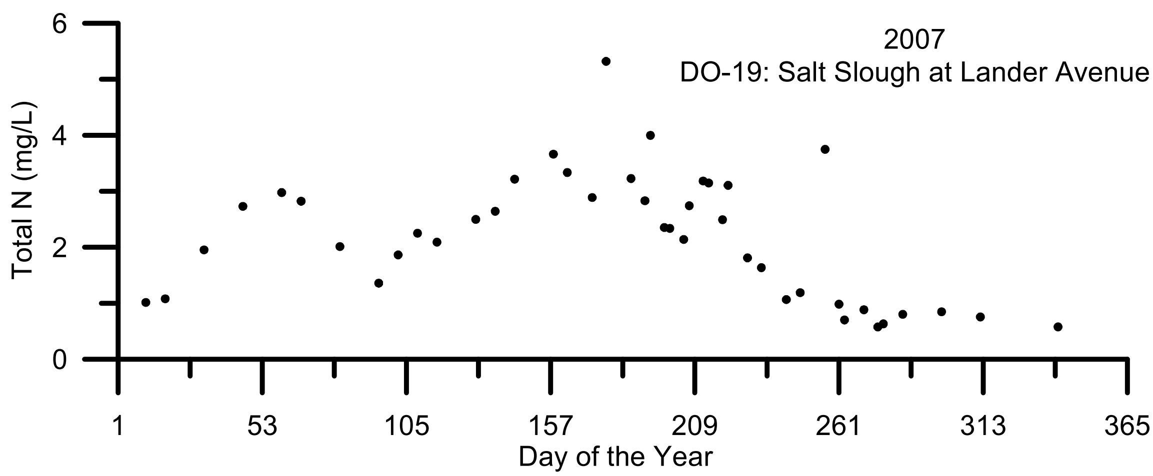

2005
DO-18: Mud Slough near Gustine
Total N (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

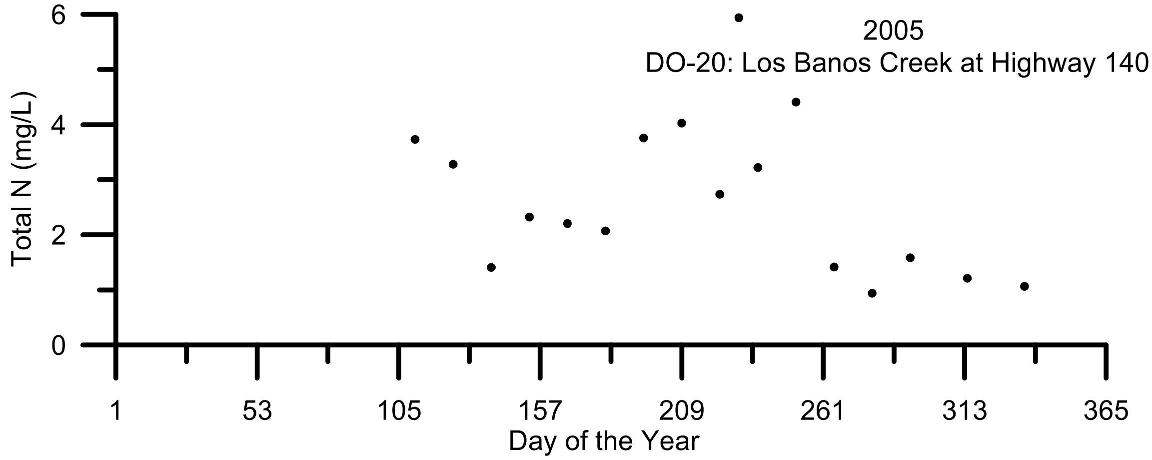

2006
DO-18: Mud Slough near Gustine
Total N (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

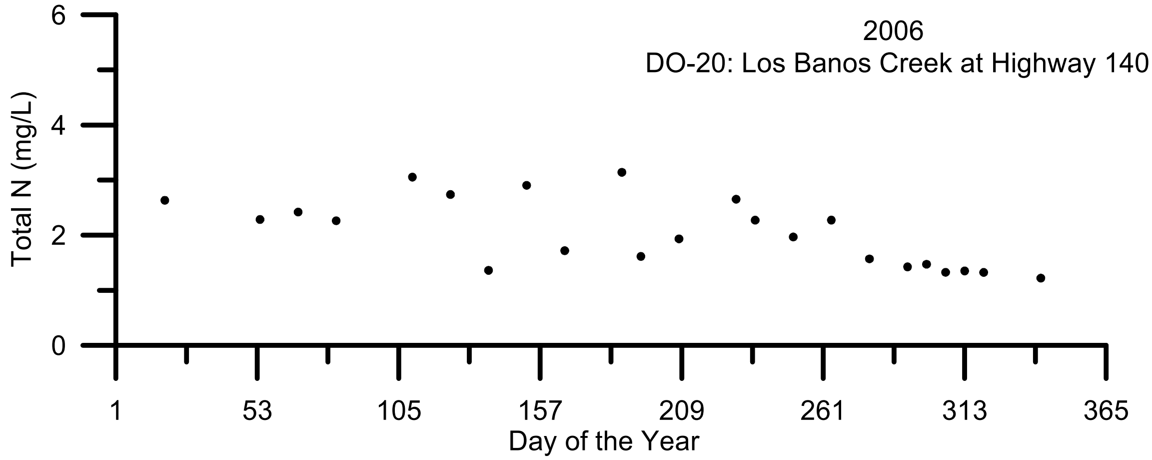

2007
DO-18: Mud Slough near Gustine
Total N (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

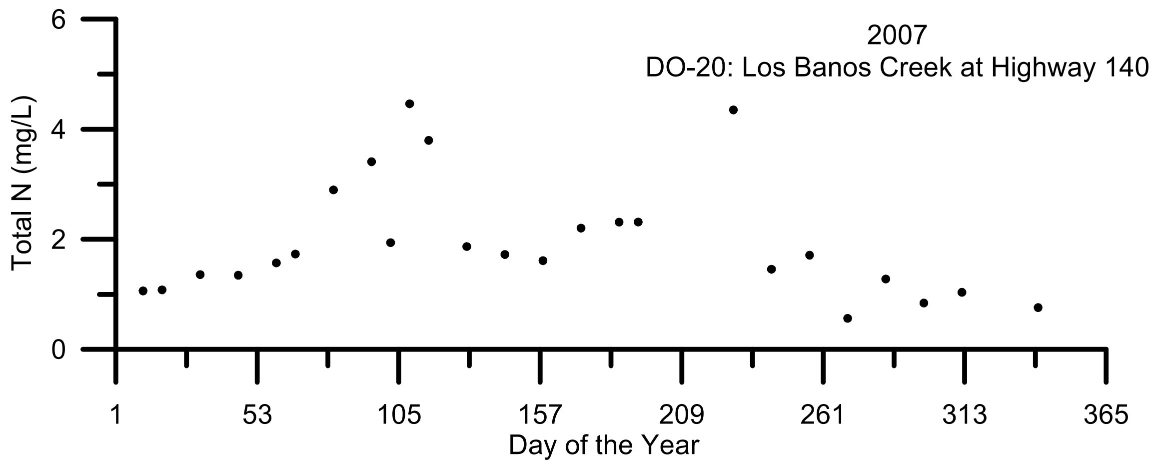

2005
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

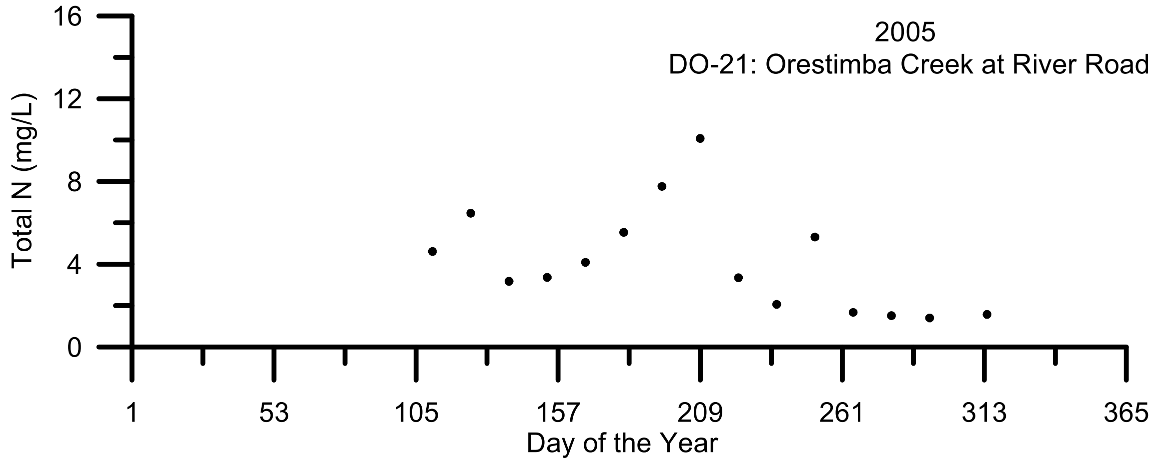

2006
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

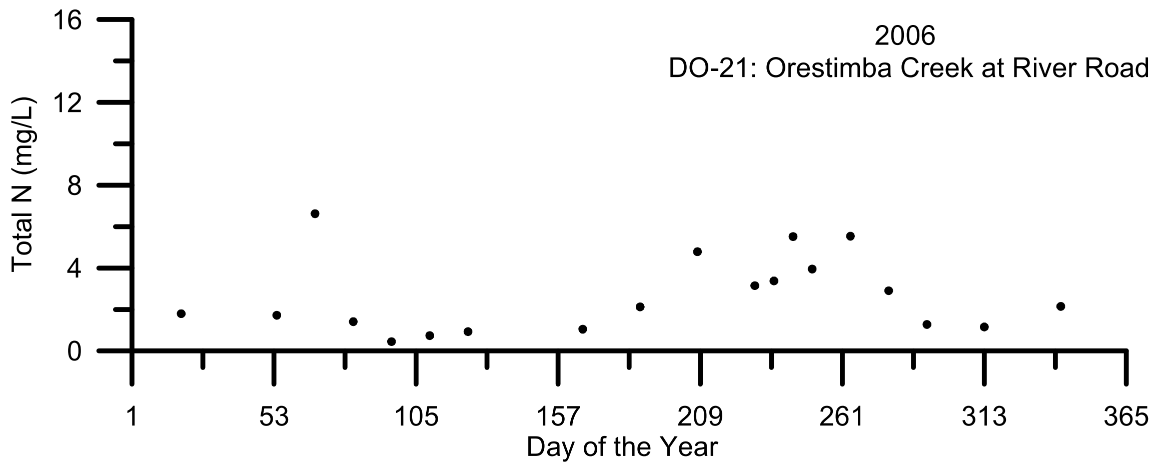

2007
DO-19: Salt Slough at Lander Avenue
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

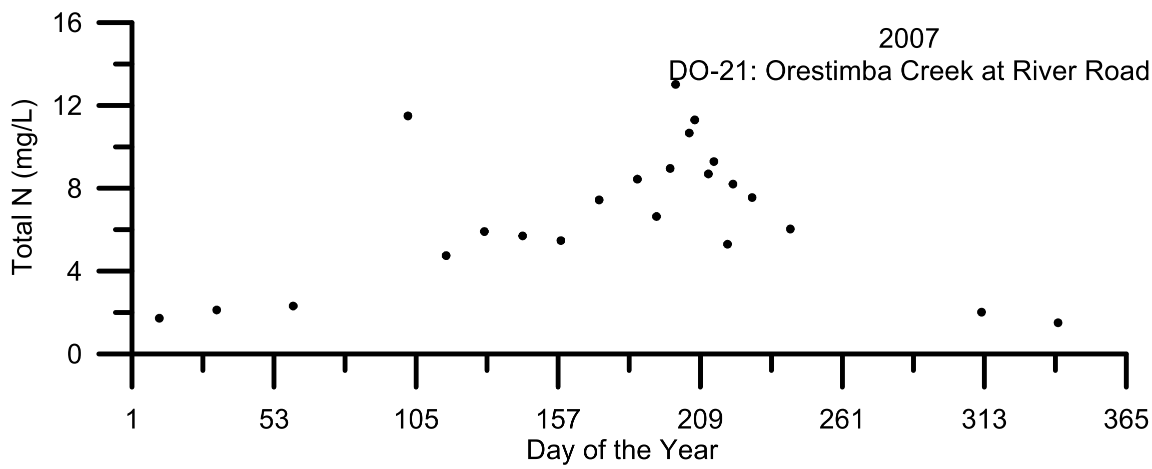

2005
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

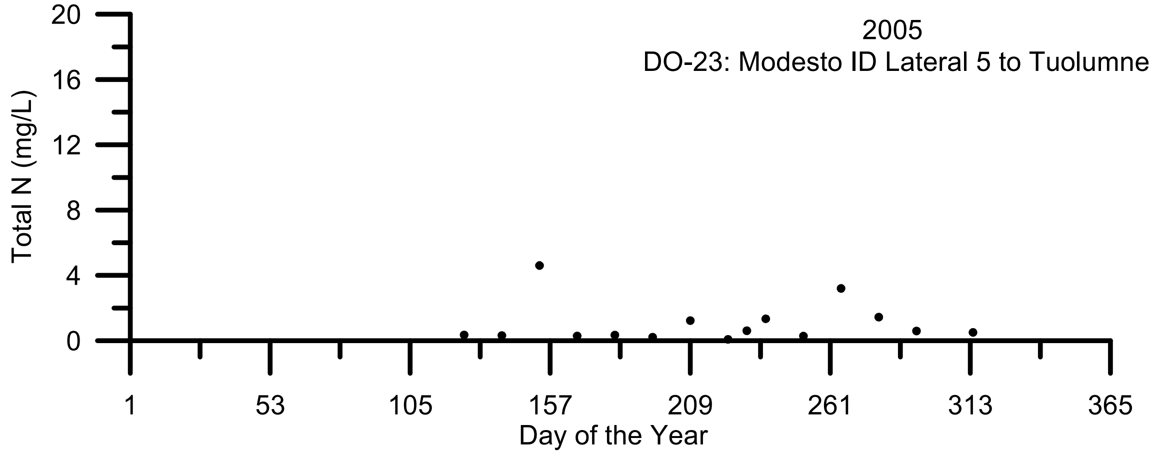

2006
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

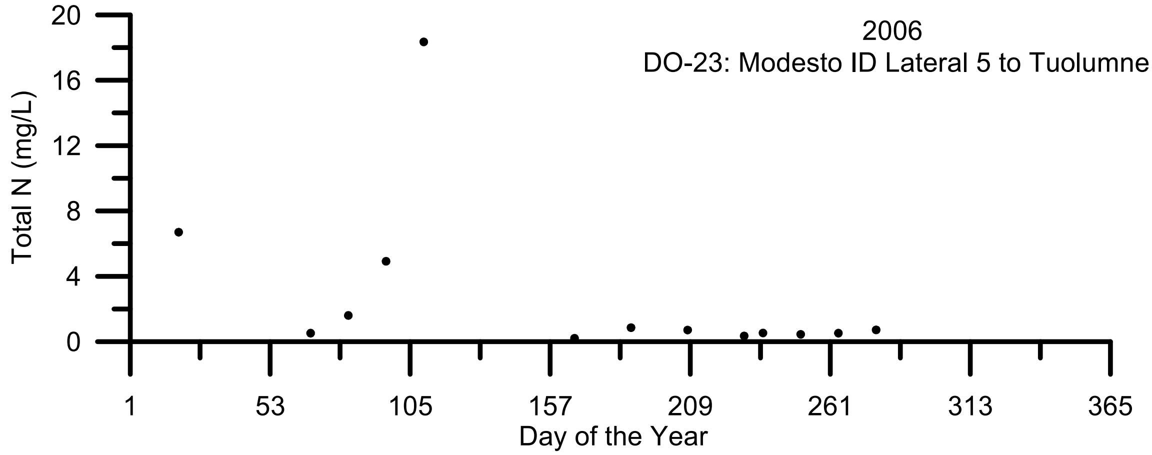

2007
DO-20: Los Banos Creek at Highway 140
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

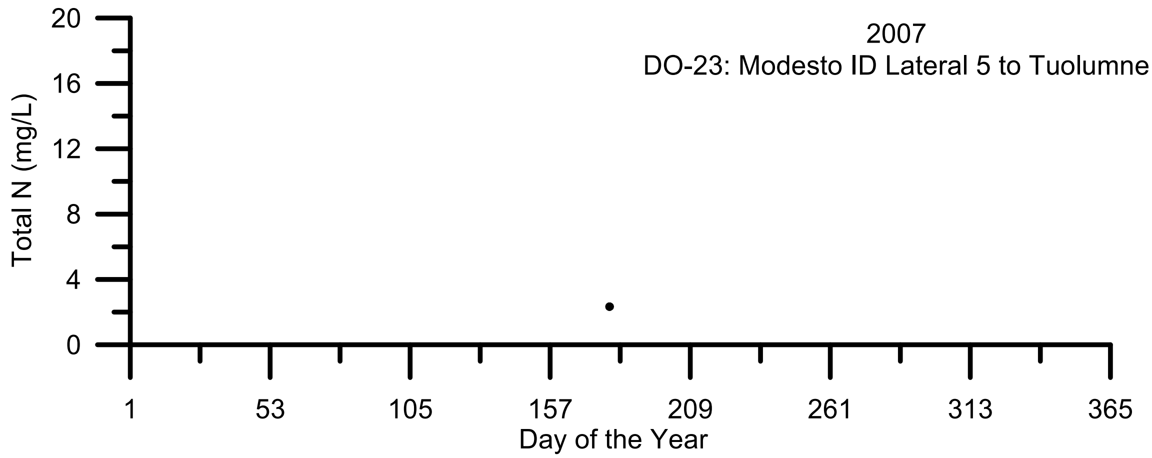

2005
DO-21: Orestimba Creek at River Road
Total N (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

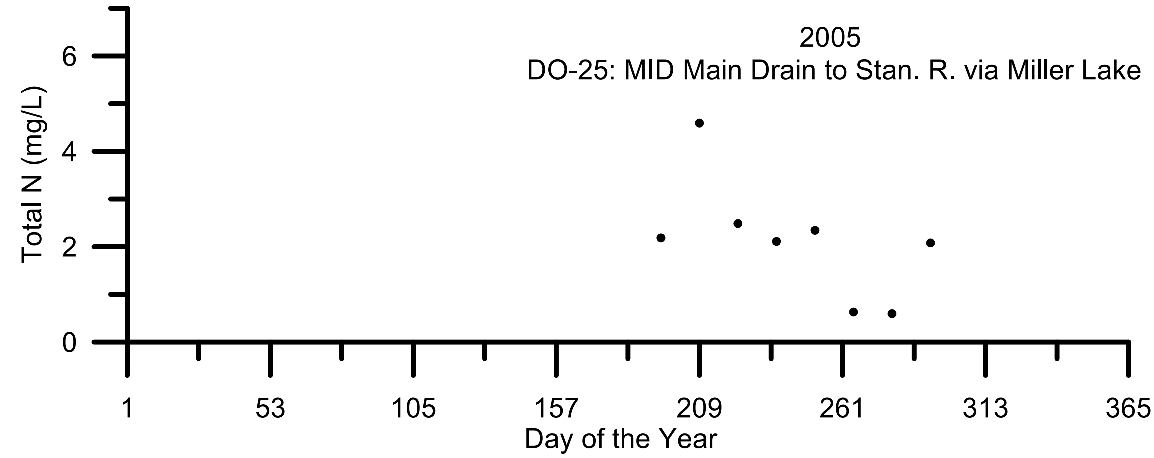

2006
DO-21: Orestimba Creek at River Road
Total N (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

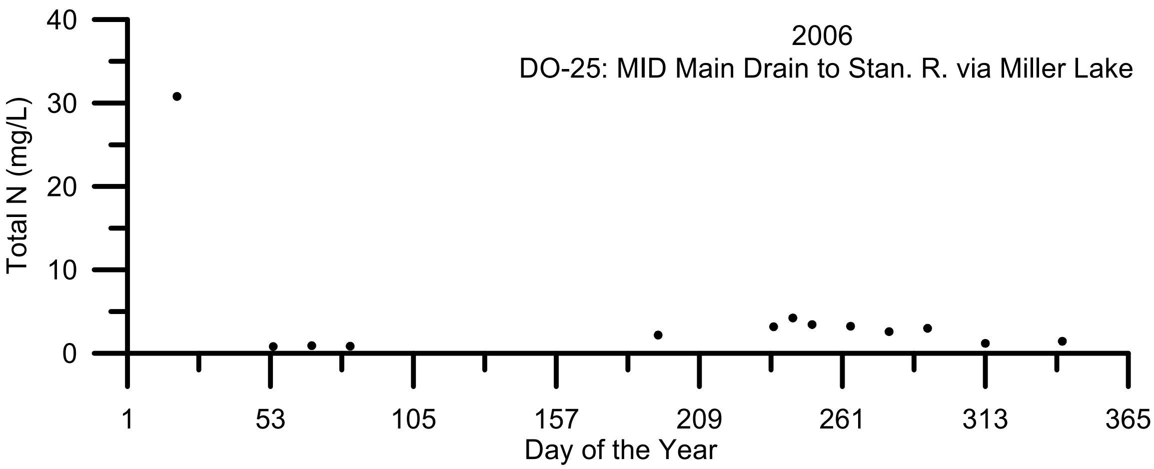

2007
DO-21: Orestimba Creek at River Road
Total N (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

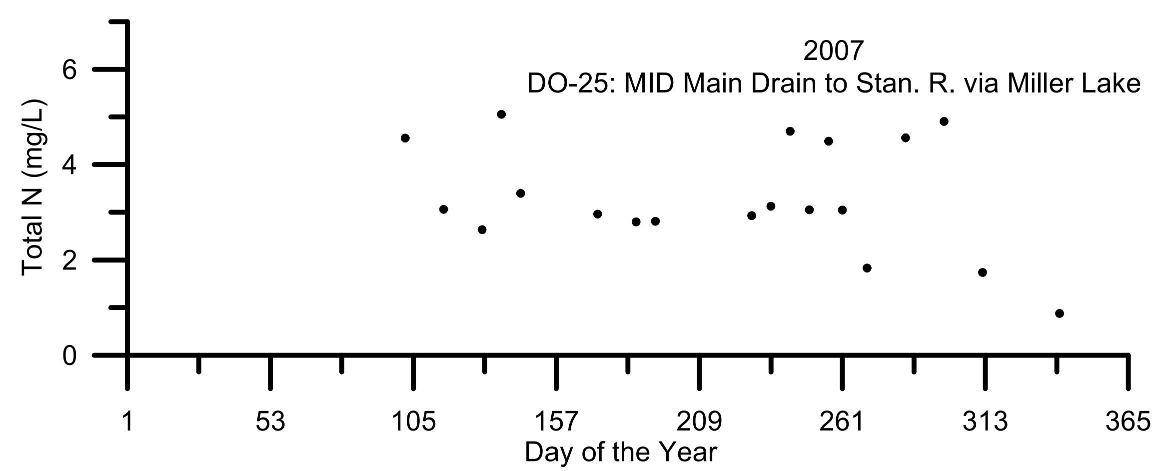

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

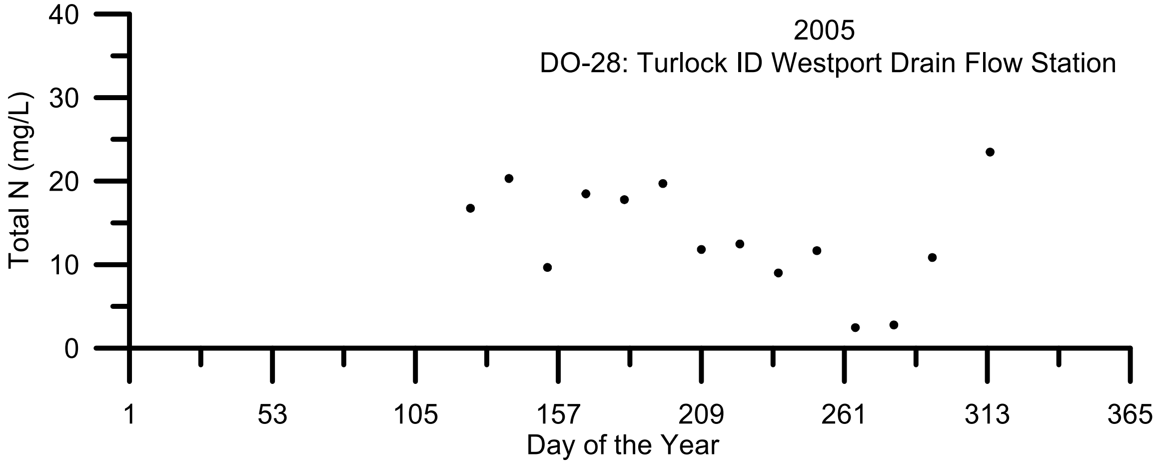

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

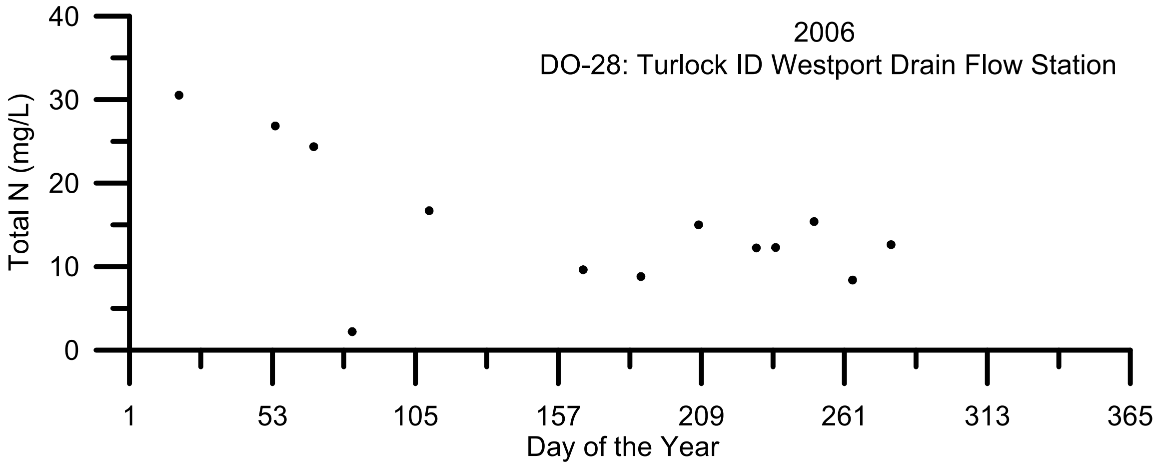

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

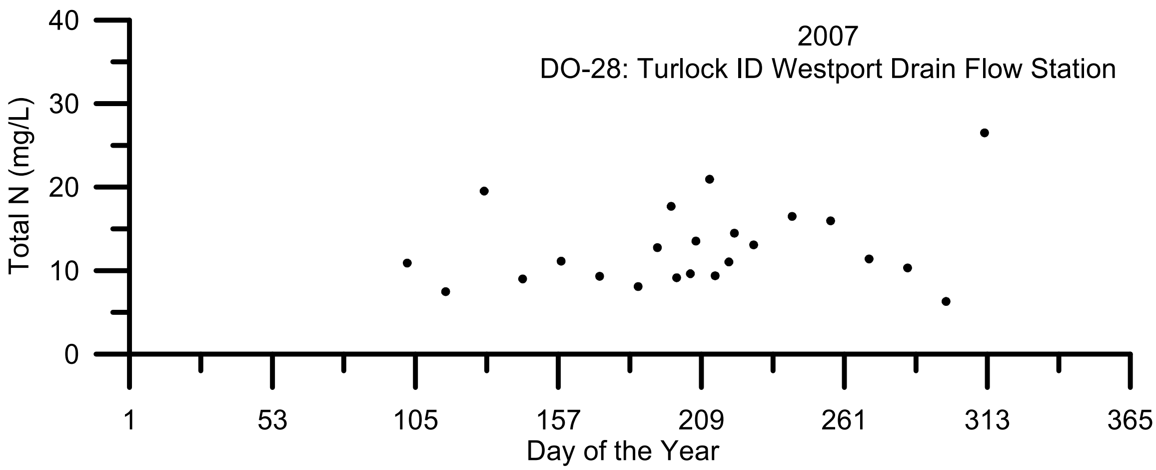

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

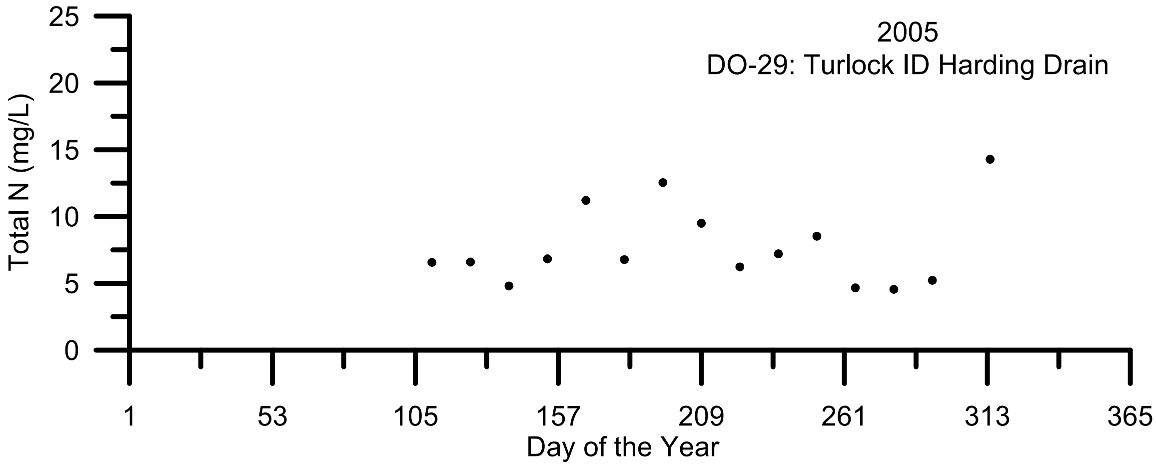

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

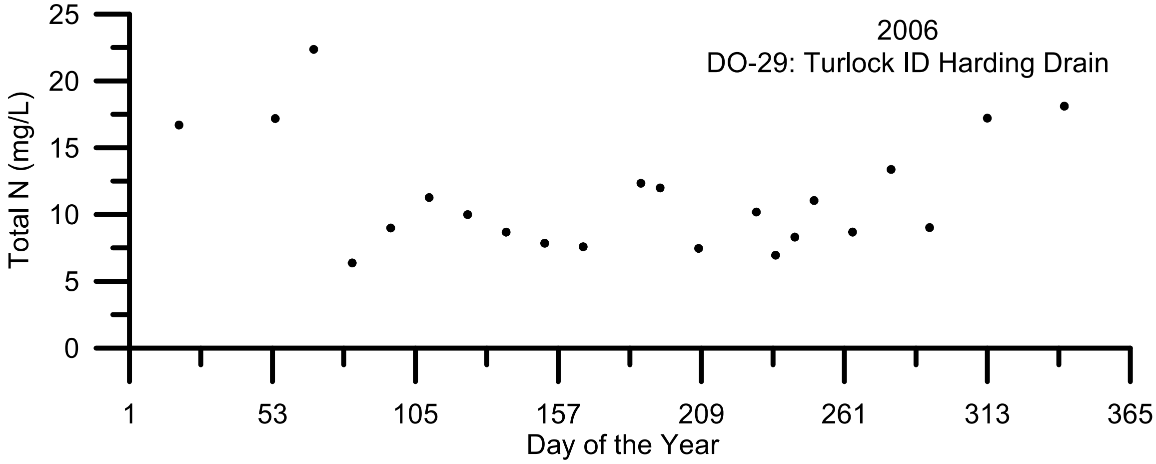

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

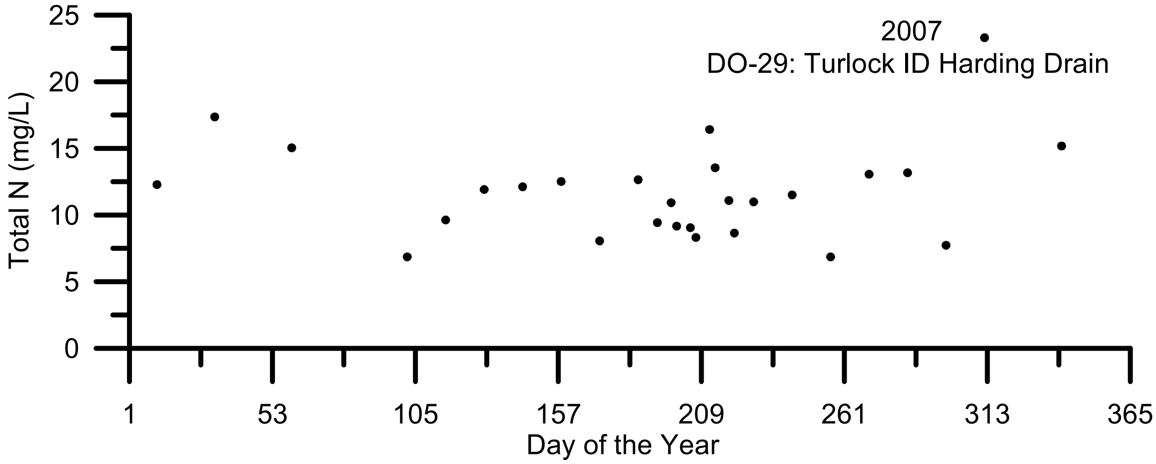

2005
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

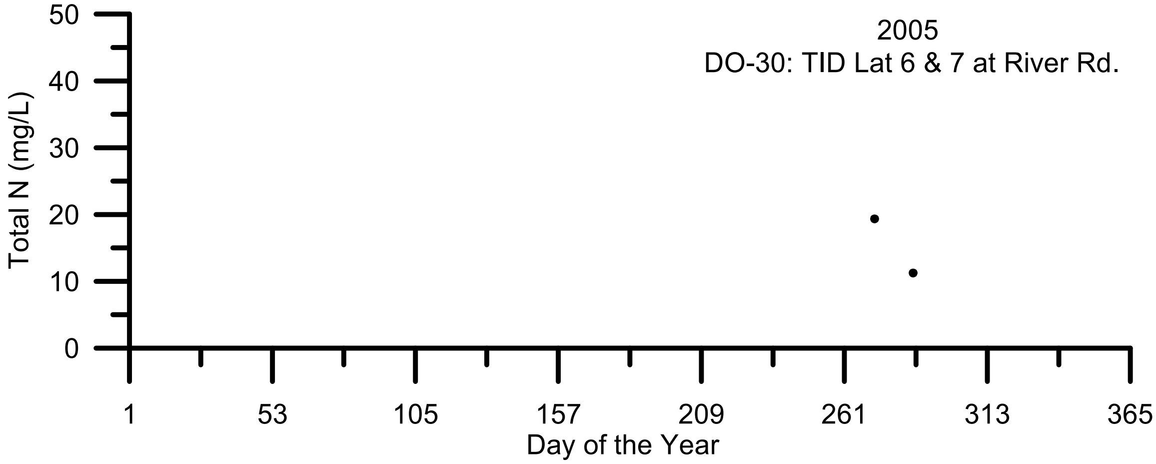

2006
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

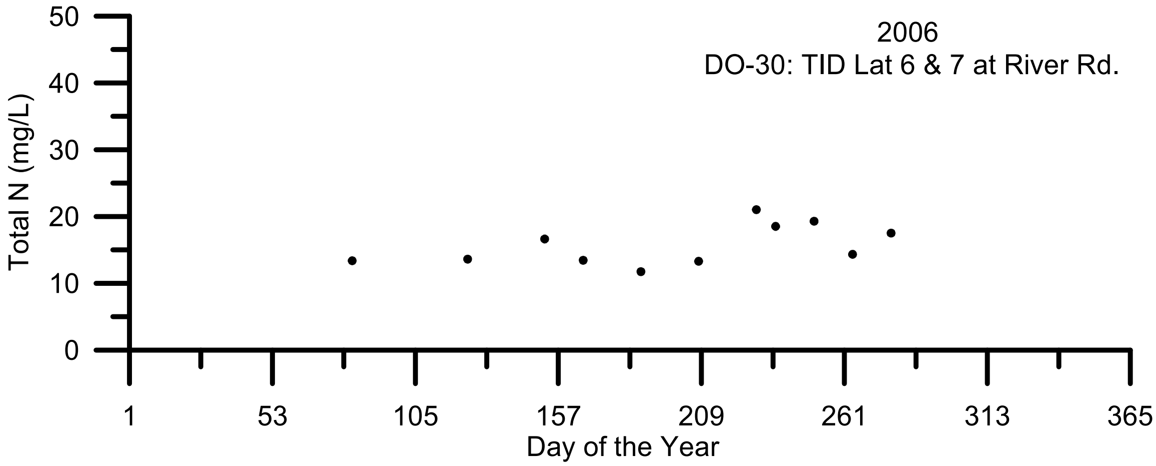

2007
DO-28: Turlock ID Westport Drain Flow Station
Total N (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

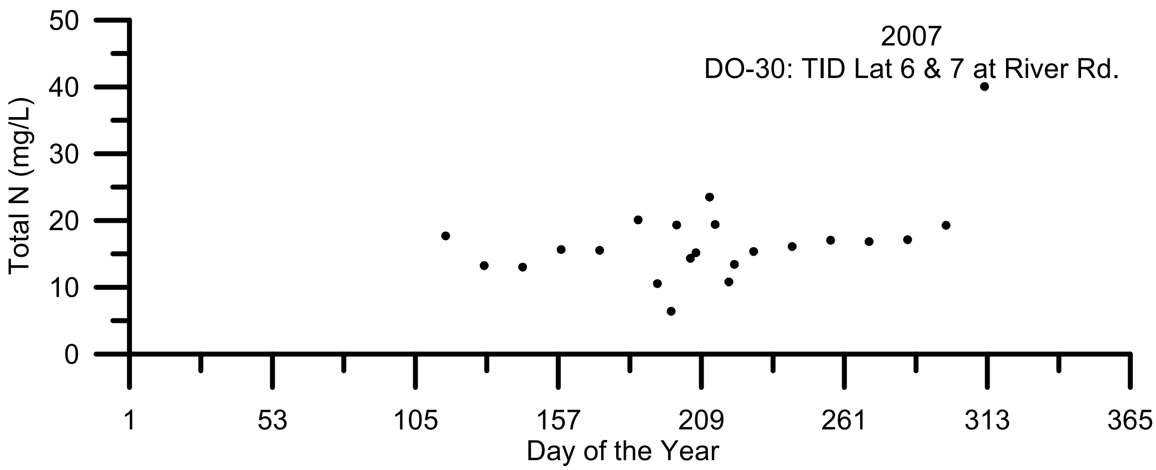

2005
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

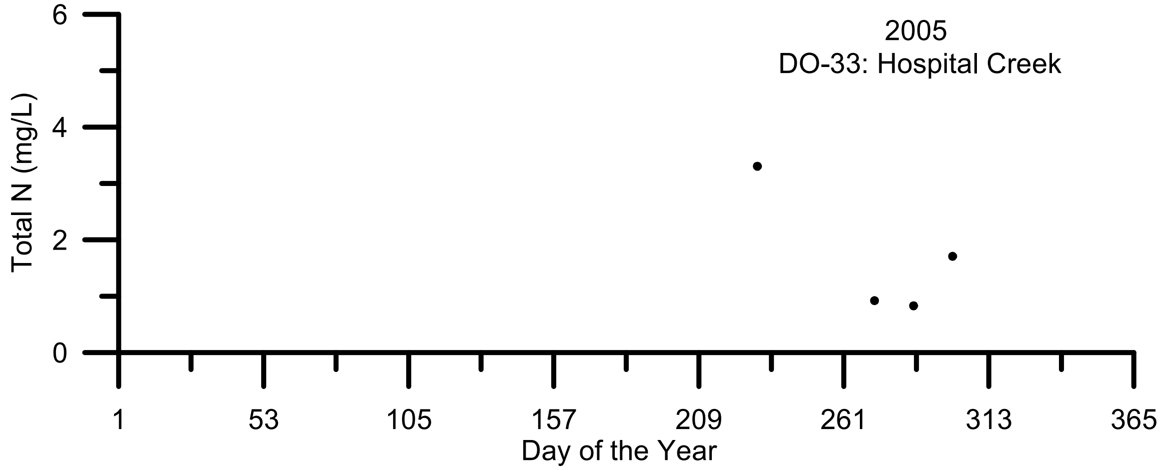

2006
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

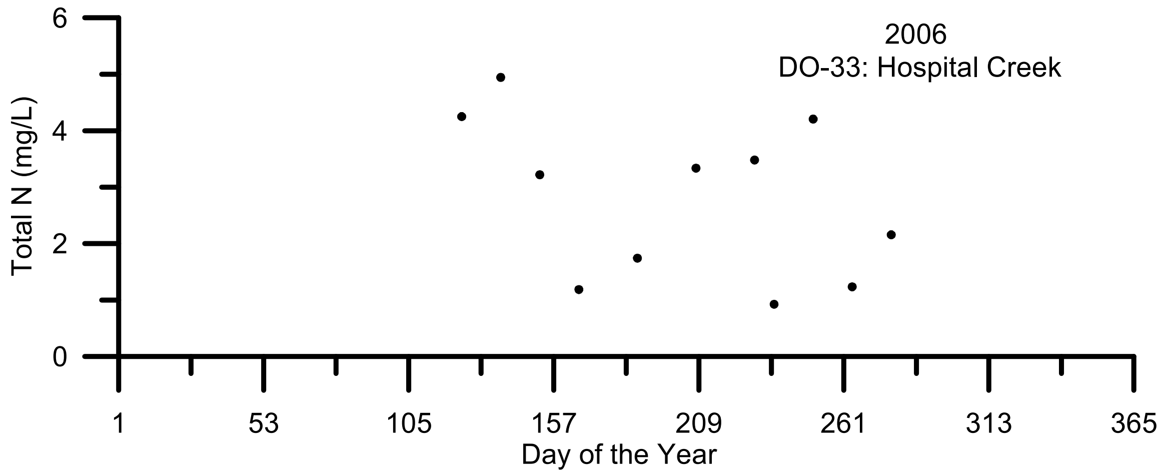

2007
DO-29: Turlock ID Harding Drain
Total N (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

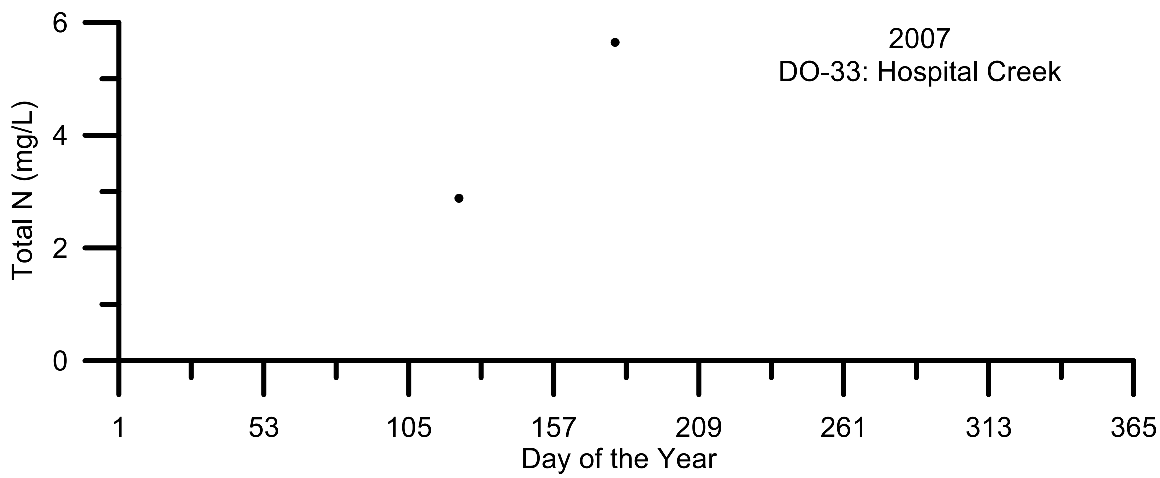

2005
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

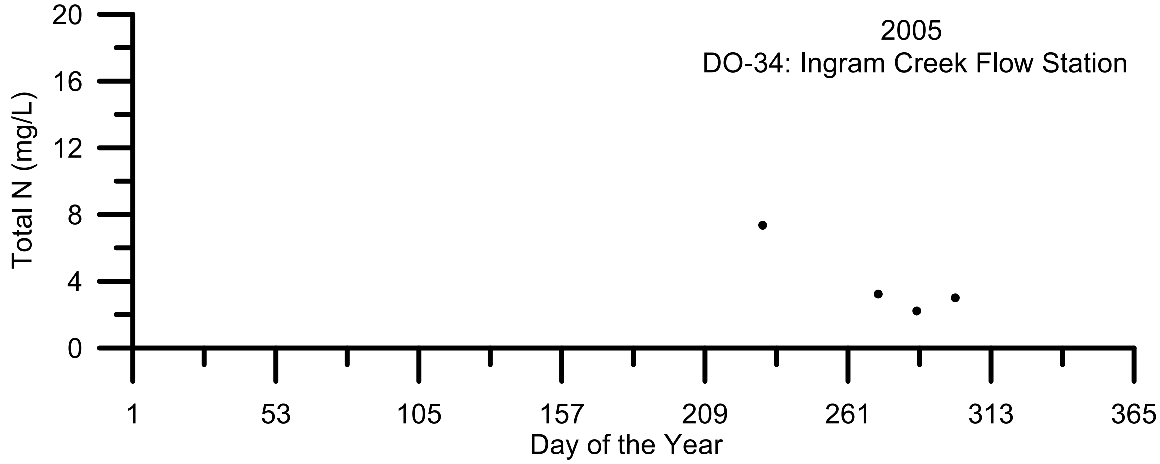

2006
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

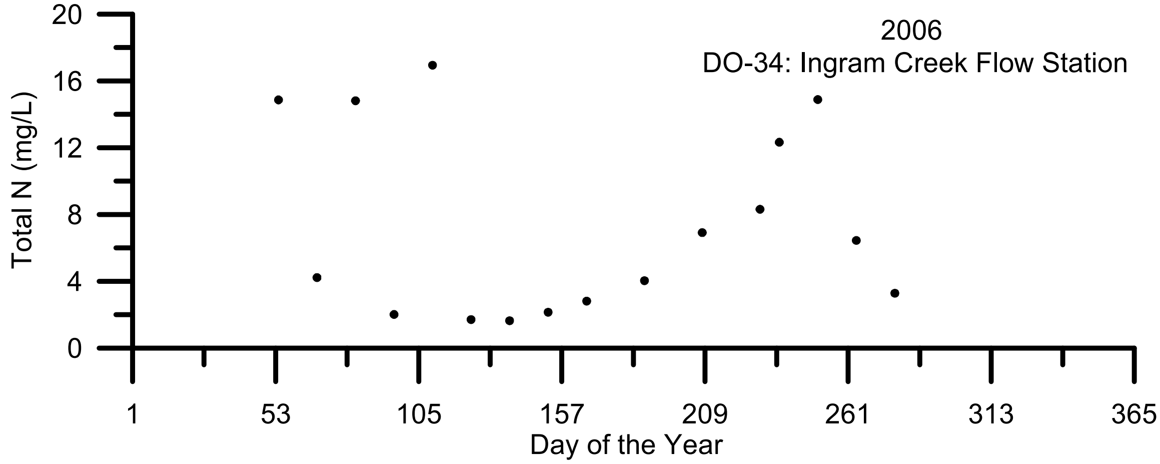

2007
DO-30: TID Lat 6 & 7 at River Rd.
Total N (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

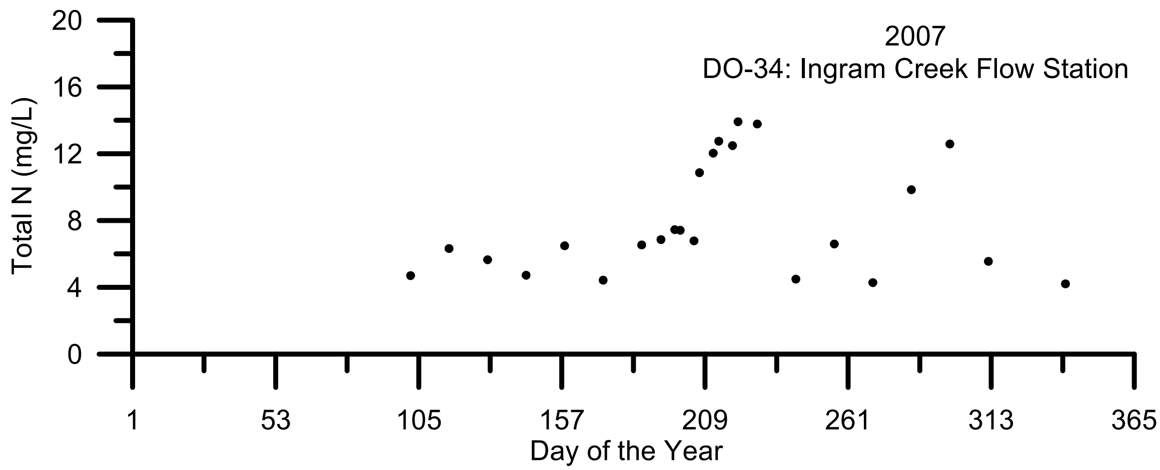

2005
DO-33: Hospital Creek
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

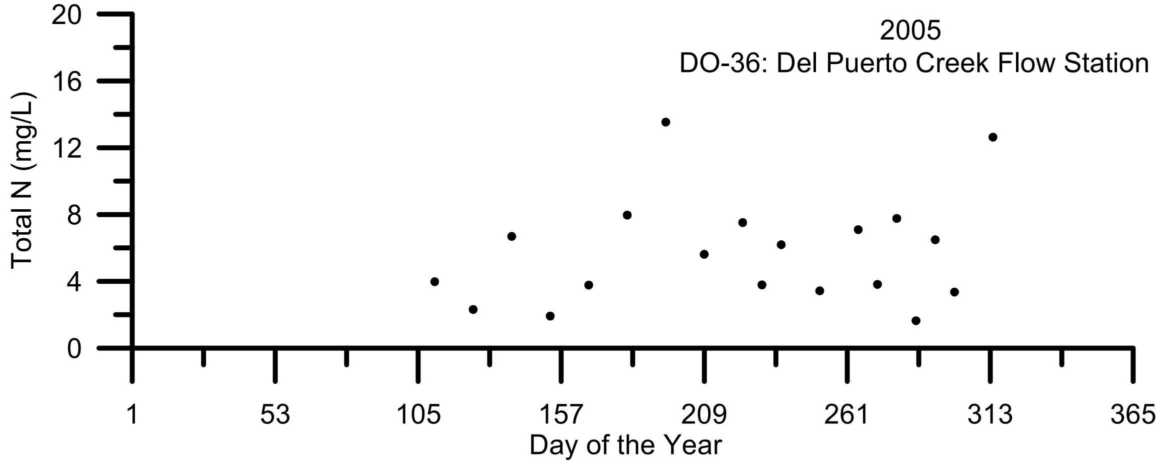

2006
DO-33: Hospital Creek
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

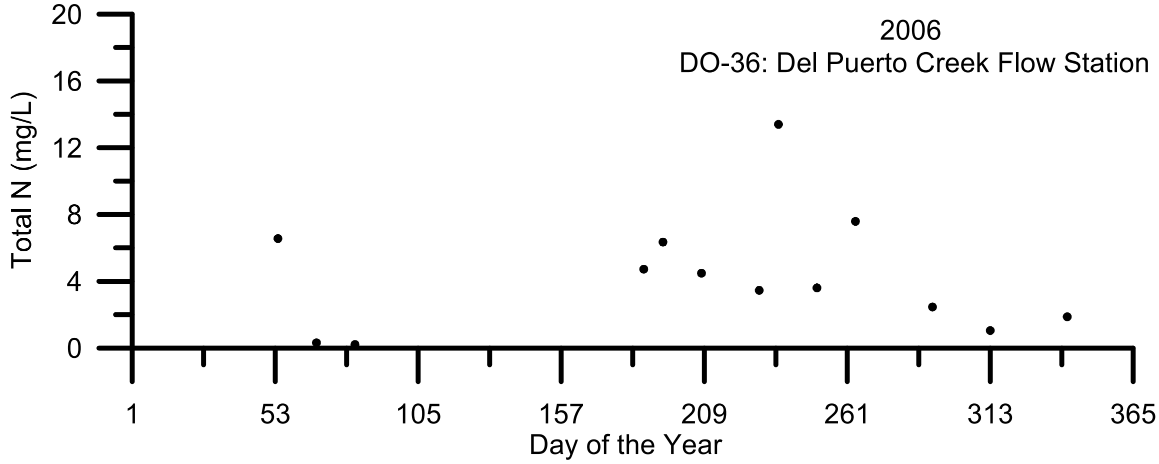

2007
DO-33: Hospital Creek
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

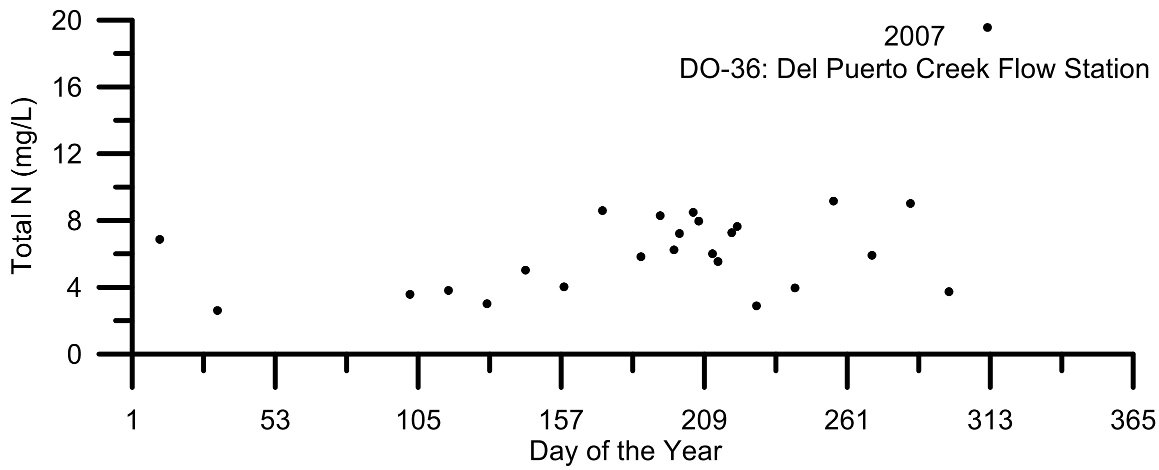

2005
DO-34: Ingram Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

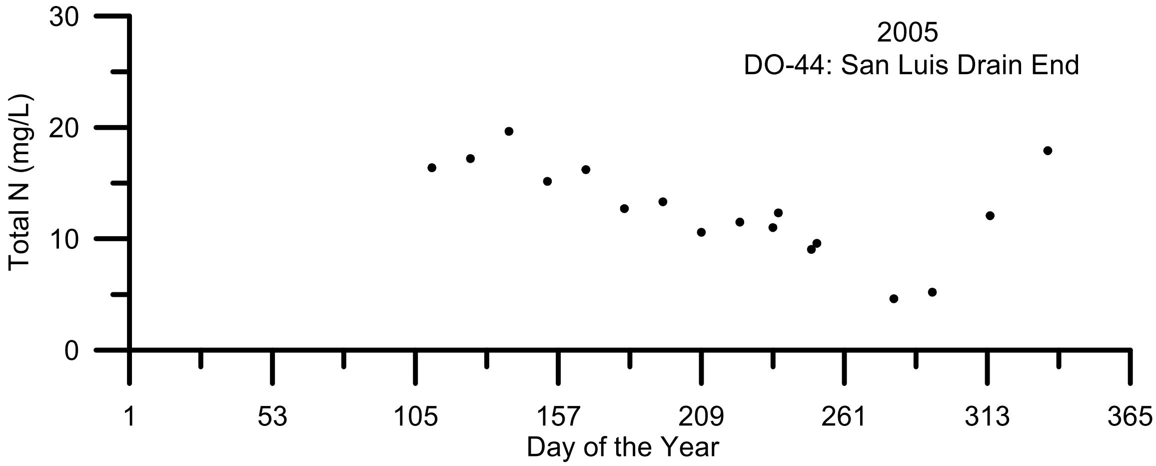

2006
DO-34: Ingram Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

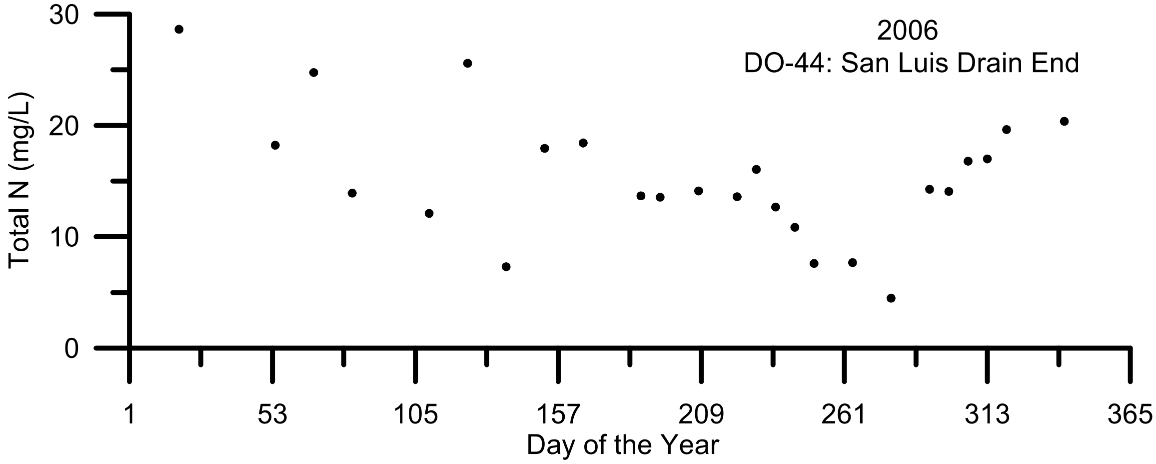

2007
DO-34: Ingram Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

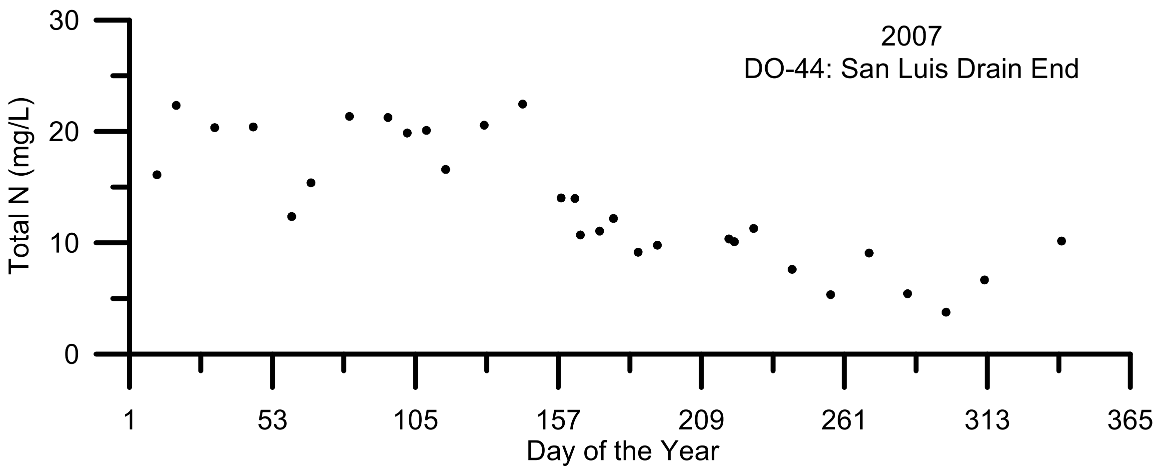

2005
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

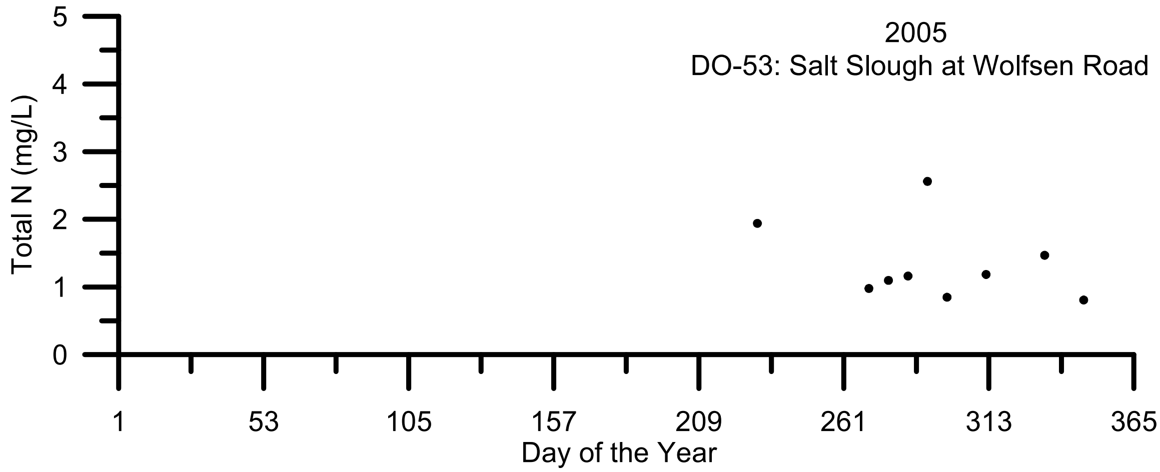

2006
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

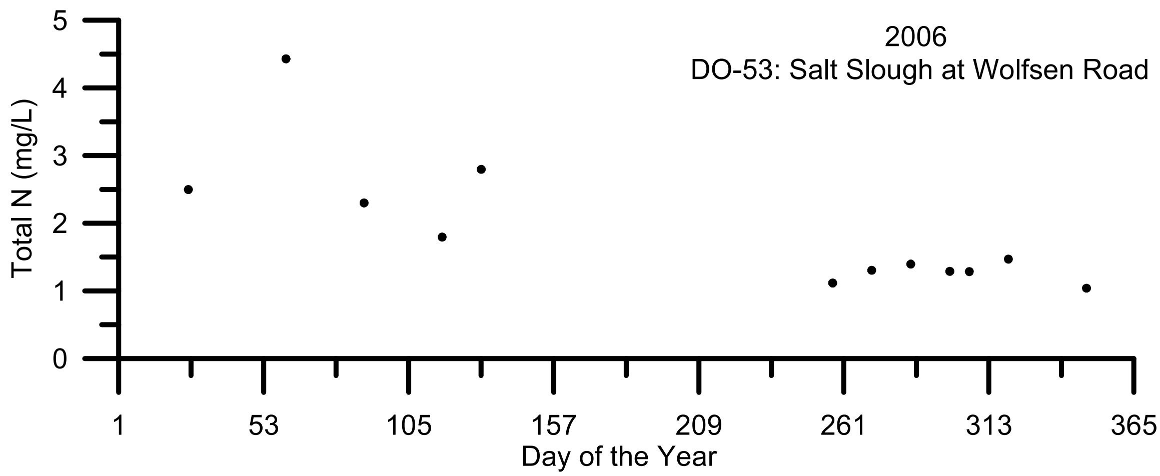

2007
DO-36: Del Puerto Creek Flow Station
Total N (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

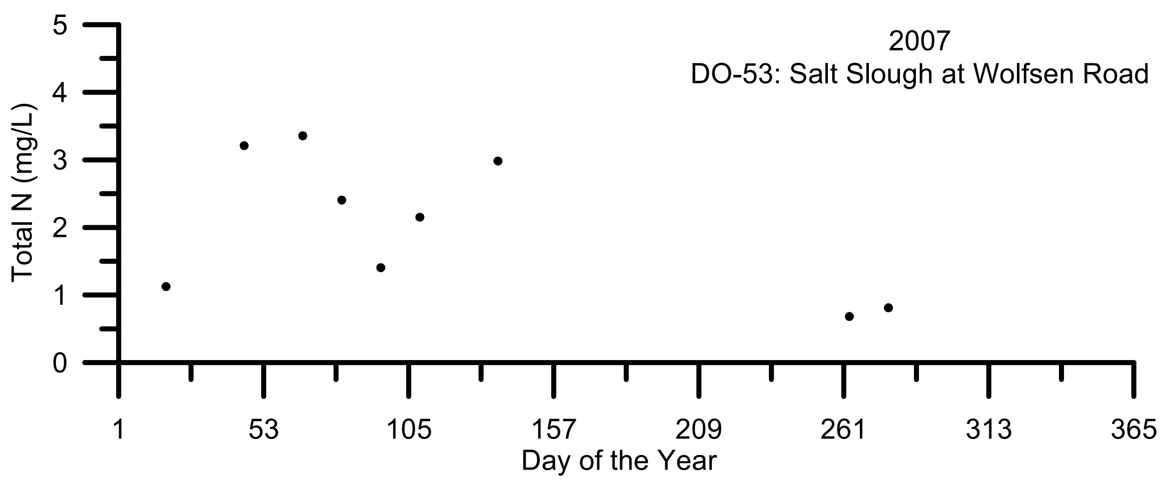

2005
DO-44: San Luis Drain End
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

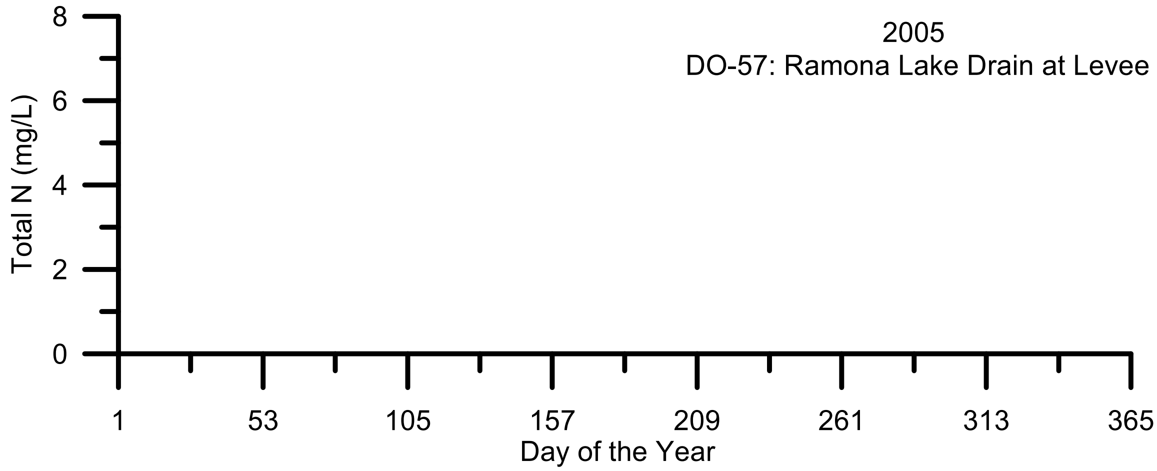

2006
DO-44: San Luis Drain End
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

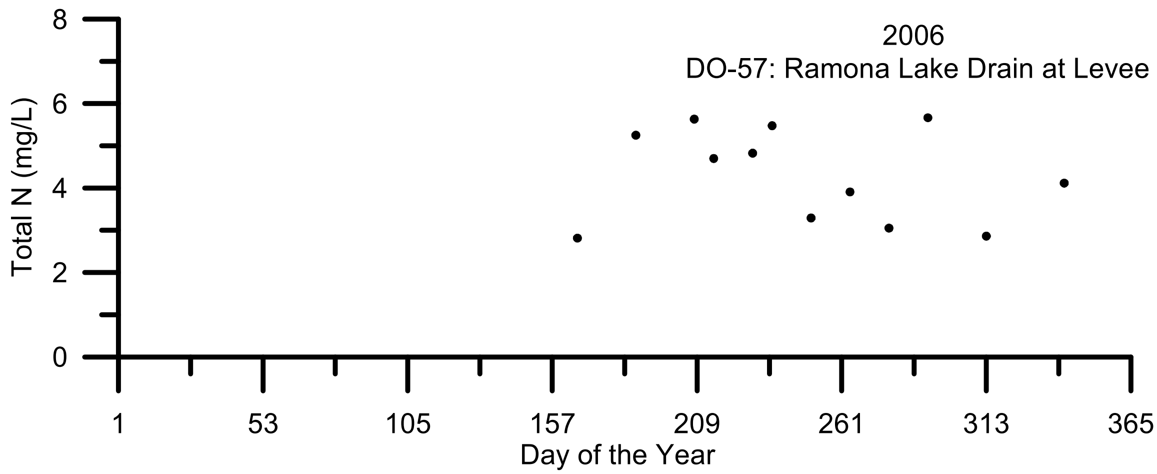

2007
DO-44: San Luis Drain End
Total N (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

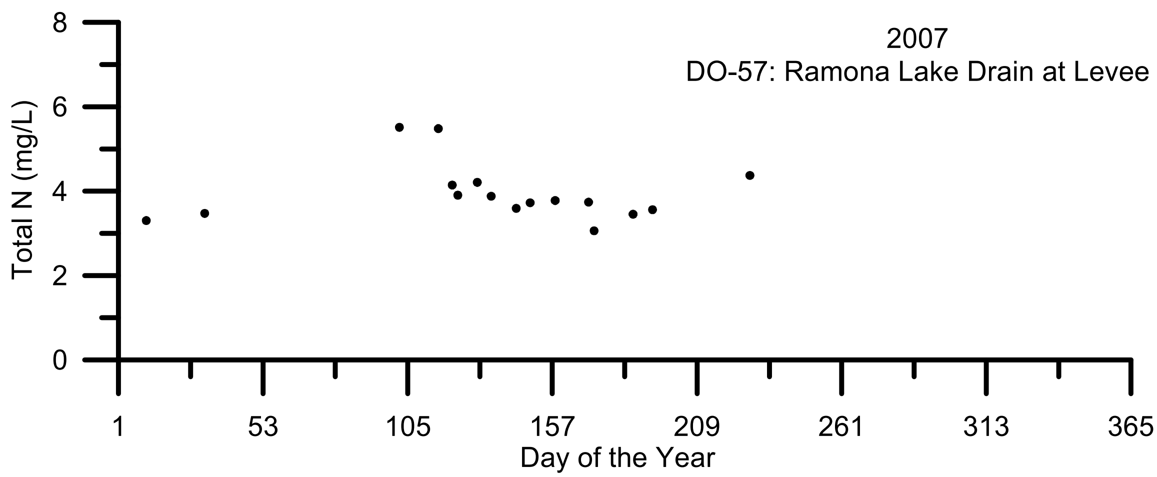

2005
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
Day of the Year
0
1
2
3
4
5
1
53
105
157
209
261
313
365

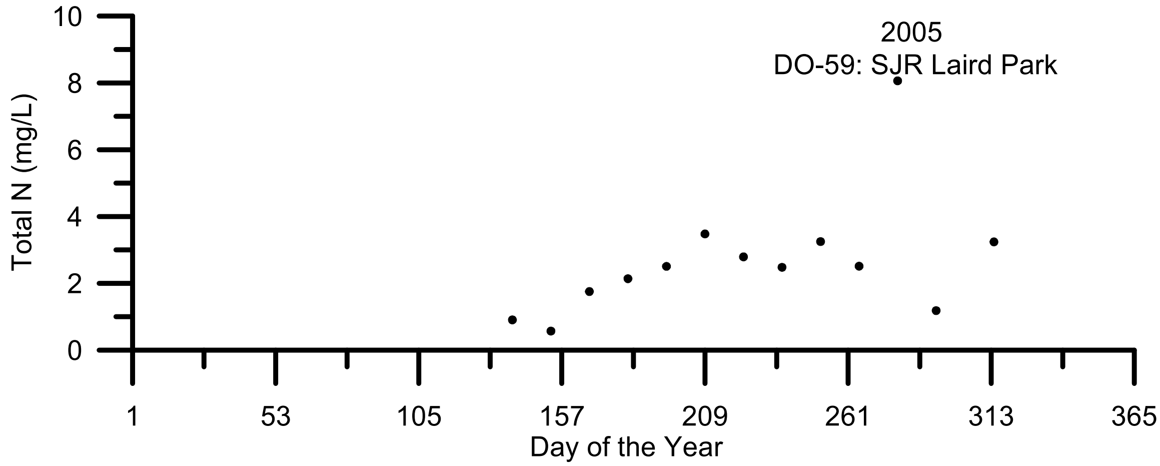

2006
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
Day of the Year
0
1
2
3
4
5
1
53
105
157
209
261
313
365

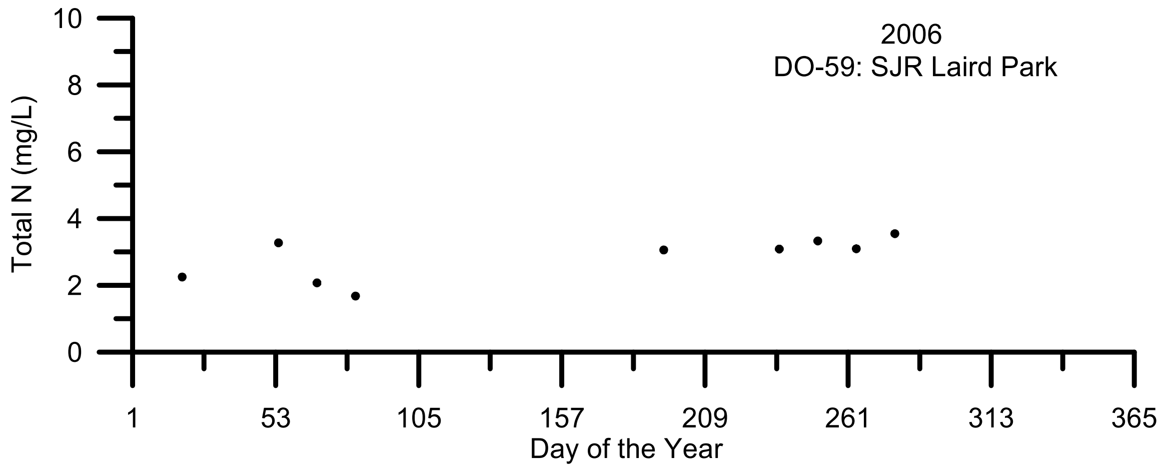

2007
DO-53: Salt Slough at Wolfsen Road
Total N (mg/L)
Day of the Year
0
1
2
3
4
5
1
53
105
157
209
261
313
365

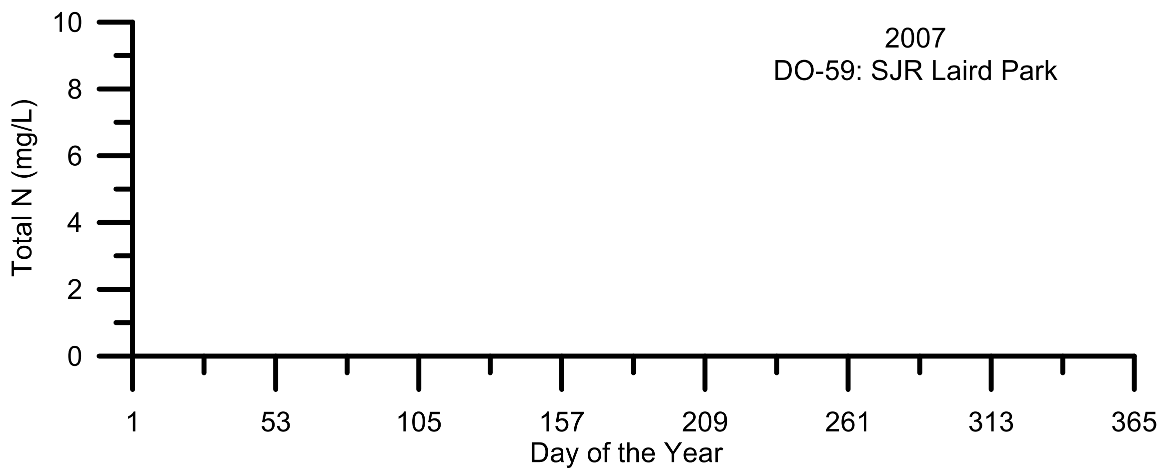

2005
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

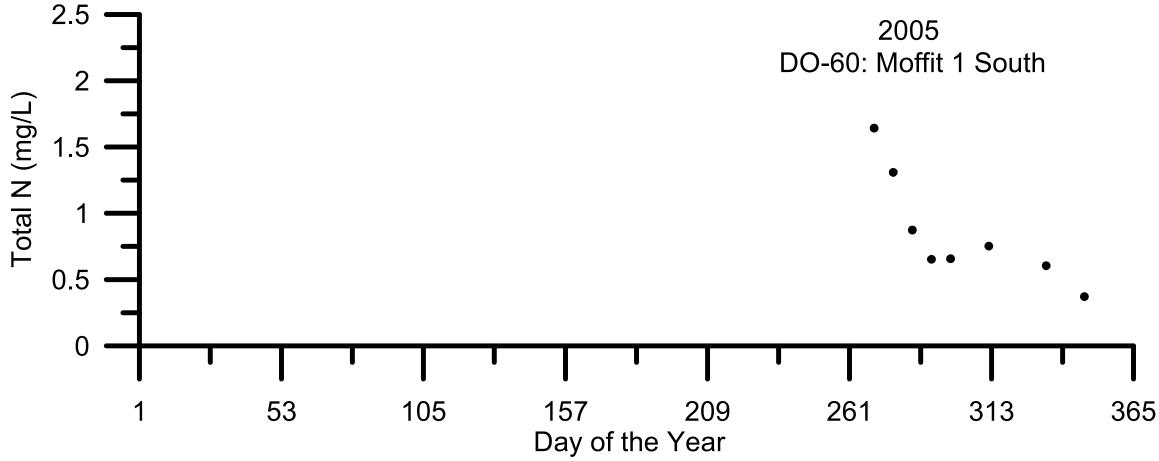

2006
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

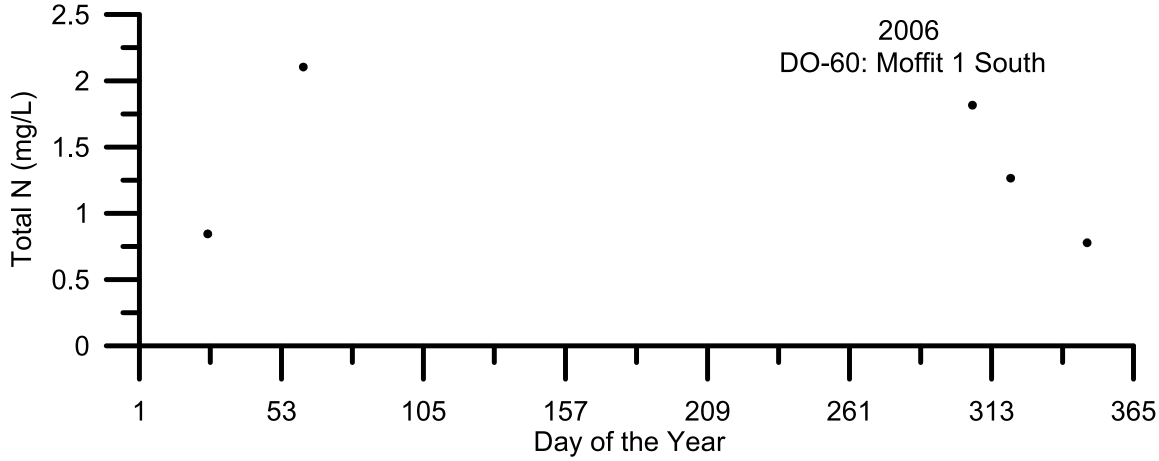

2007
DO-57: Ramona Lake Drain at Levee
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

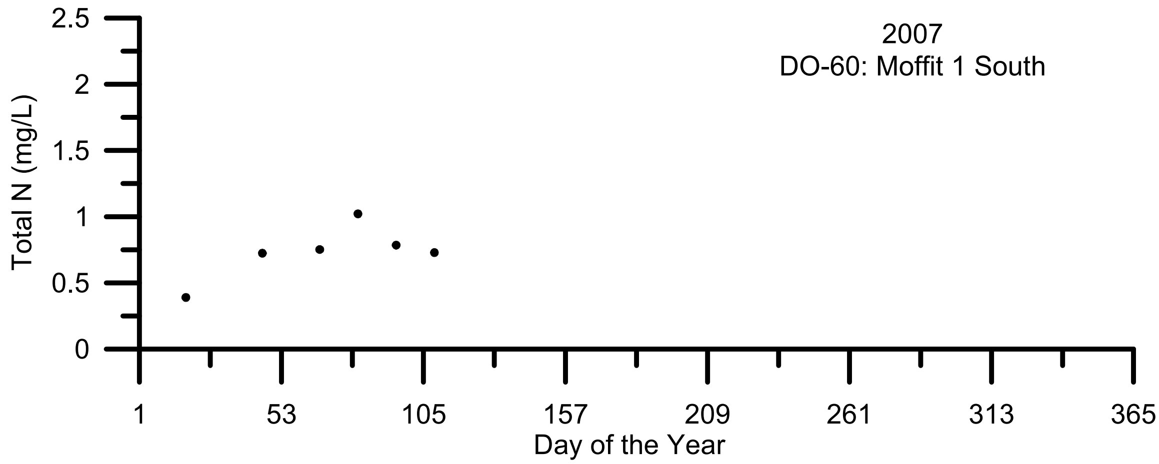

2005
DO-59: SJR Laird Park
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

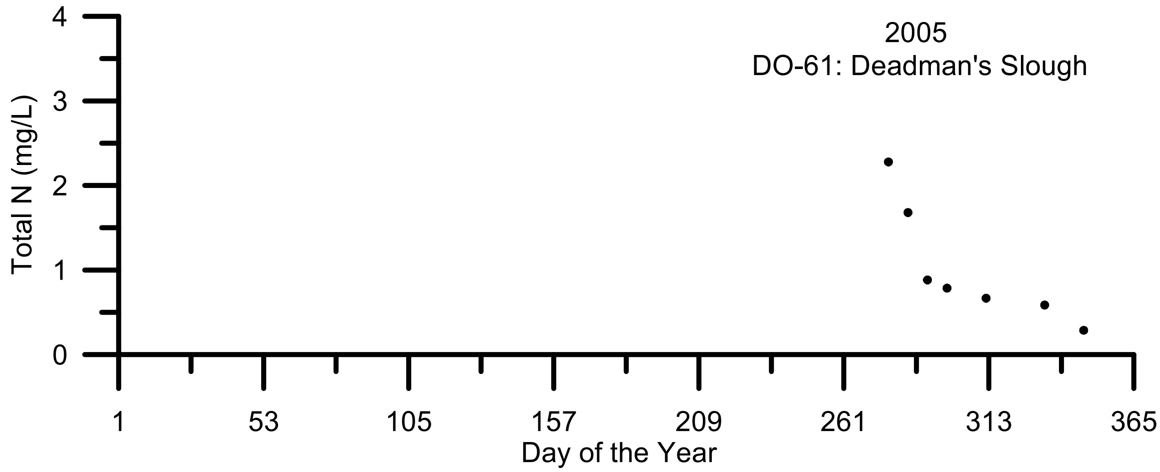

2006
DO-59: SJR Laird Park
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

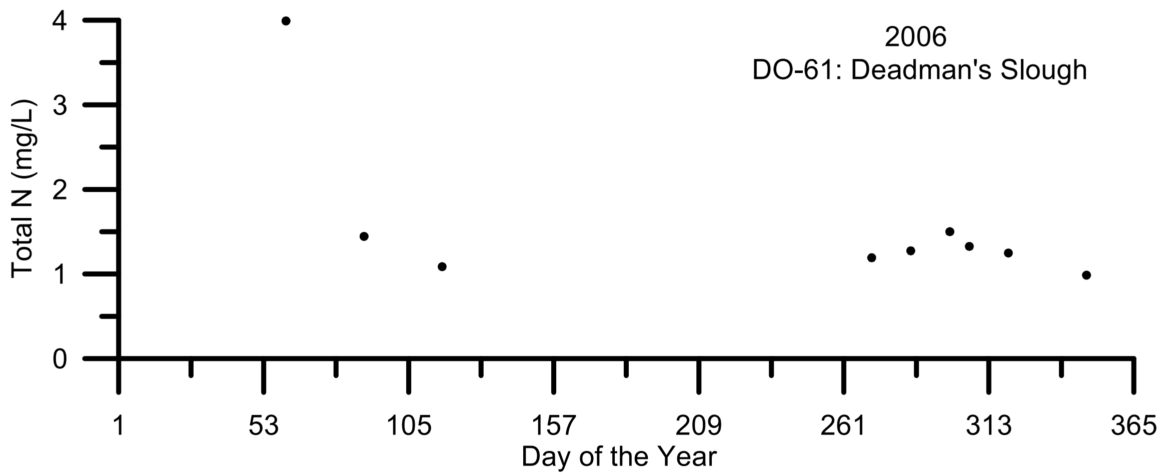

2007
DO-59: SJR Laird Park
Total N (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

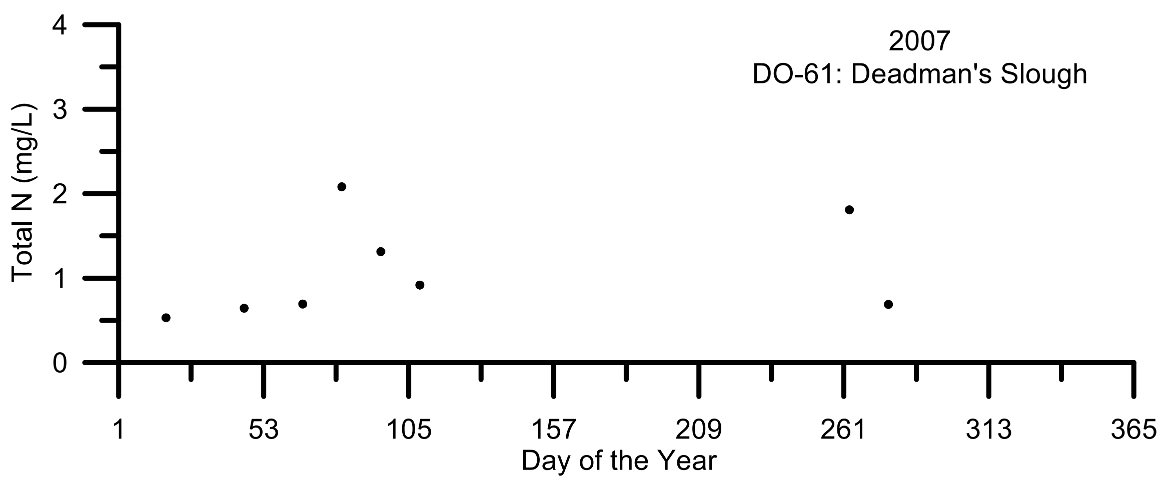

2005
DO-60: Moffit 1 South
Total N (mg/L)
Day of the Year

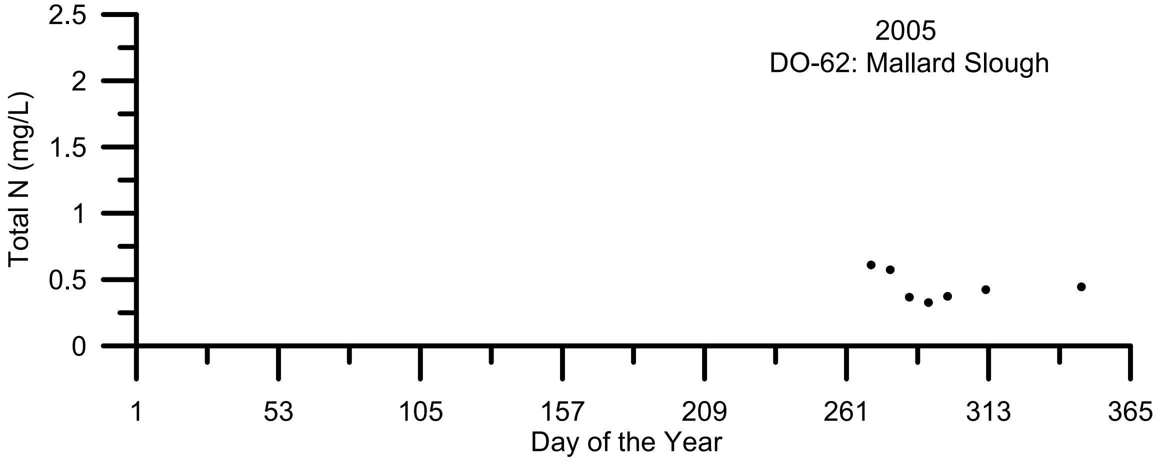

2006
DO-60: Moffit 1 South
Total N (mg/L)
Day of the Year

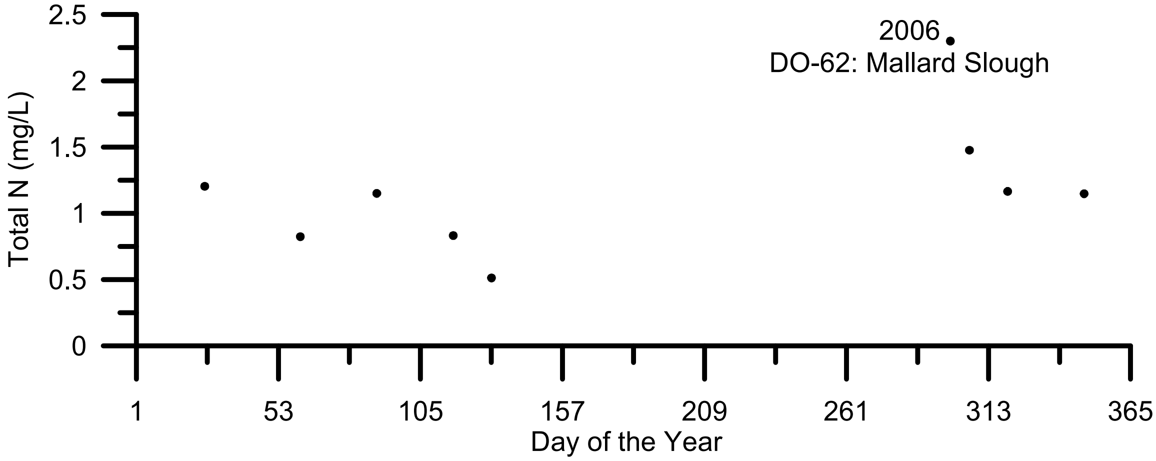

2007
DO-60: Moffit 1 South
Total N (mg/L)
Day of the Year

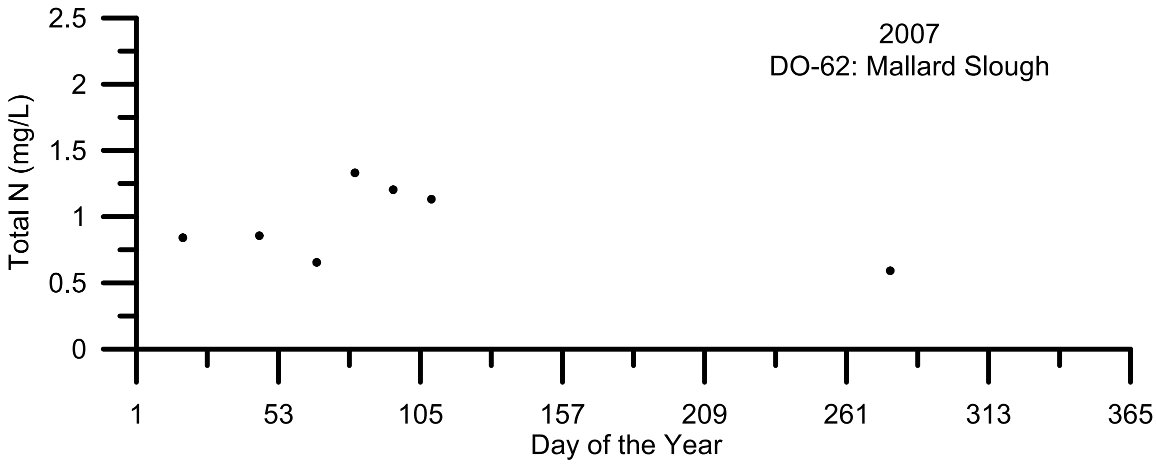

2005
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

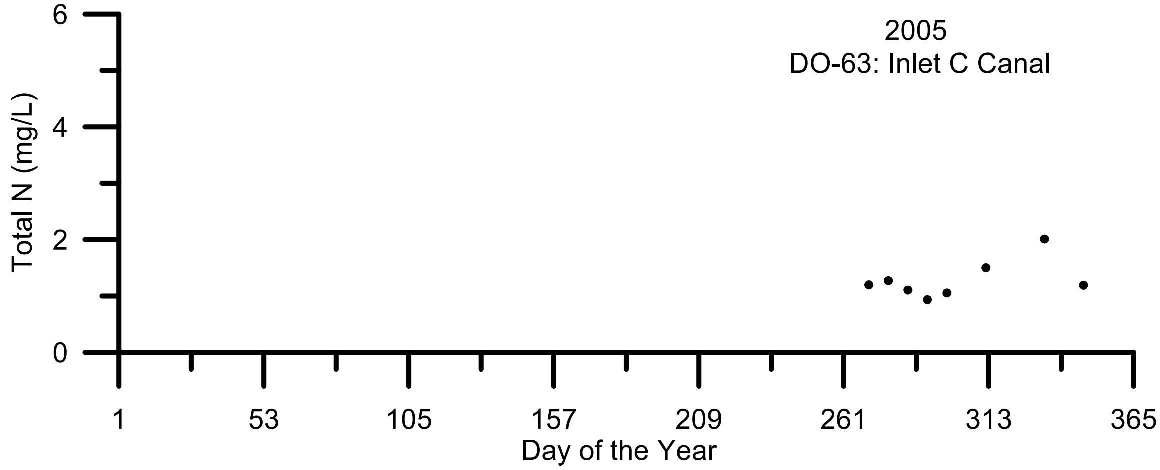

2006
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-61: Deadman's Slough
Total N (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

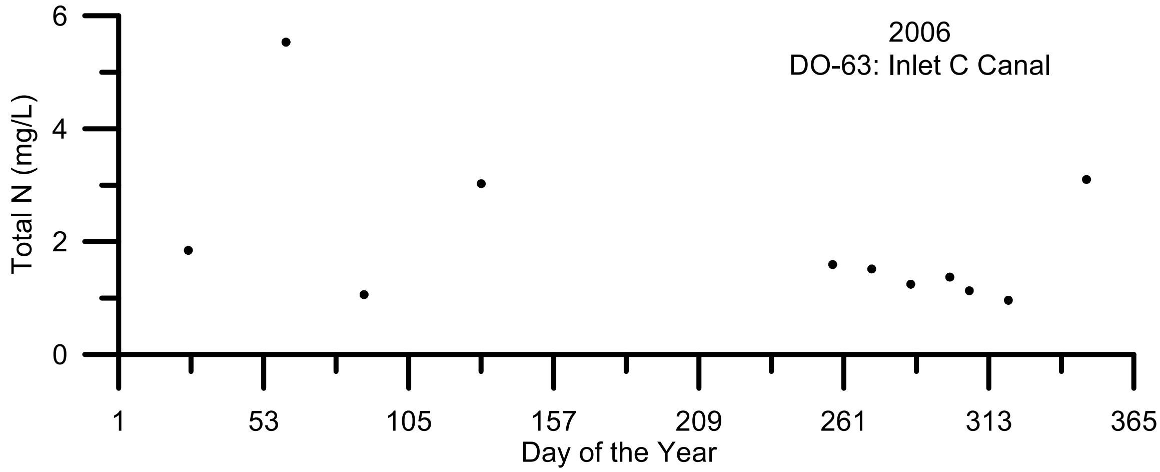

2005
DO-62: Mallard Slough
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-62: Mallard Slough
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

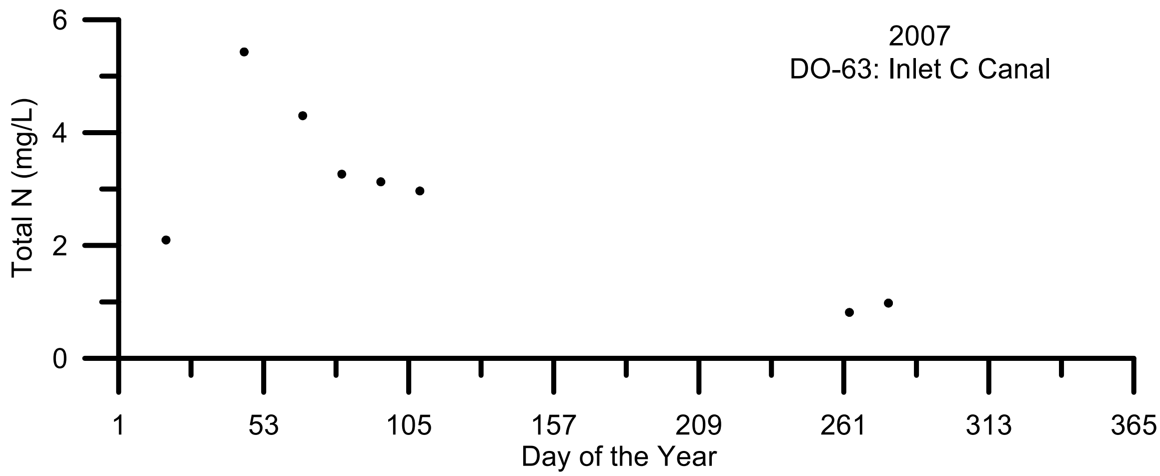

2007
DO-62: Mallard Slough
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year



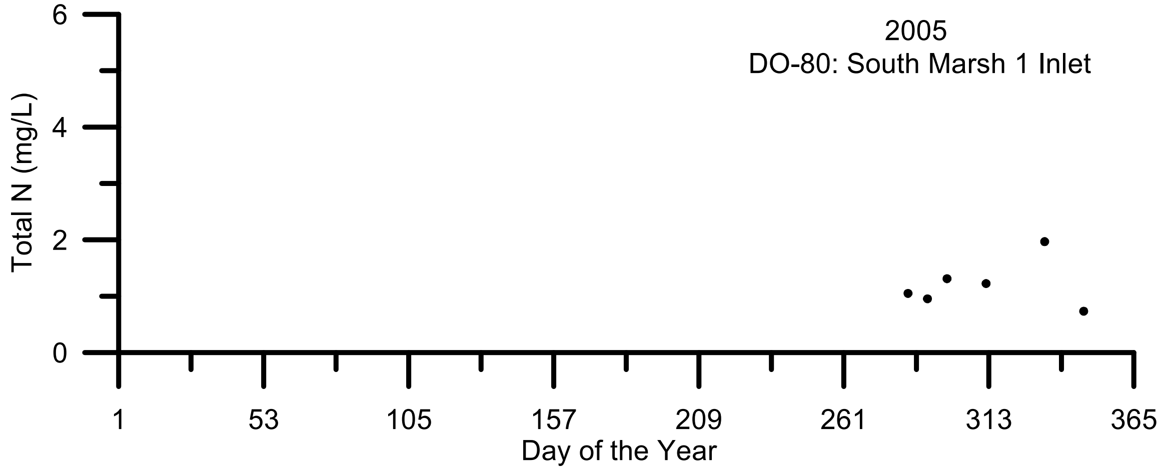
2005
DO-63: Inlet C Canal
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

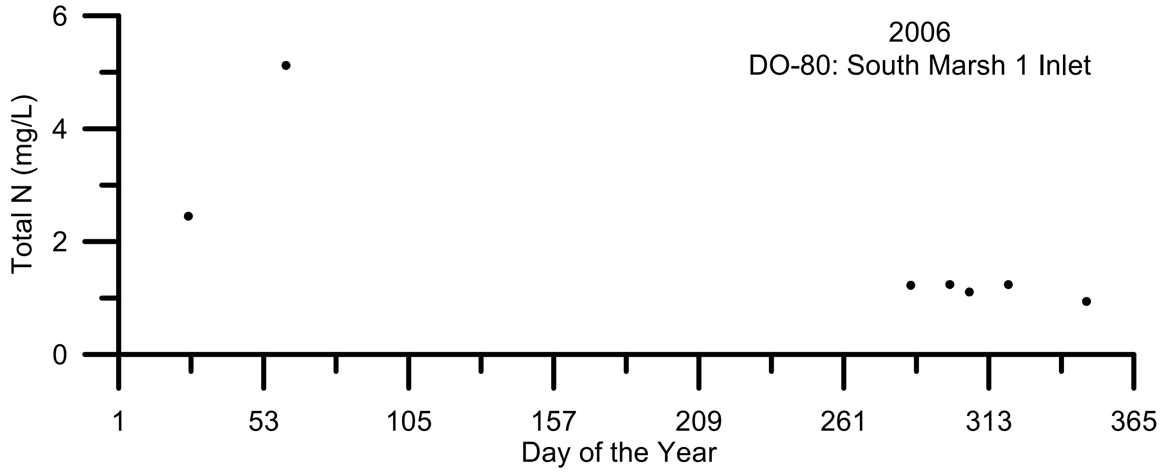


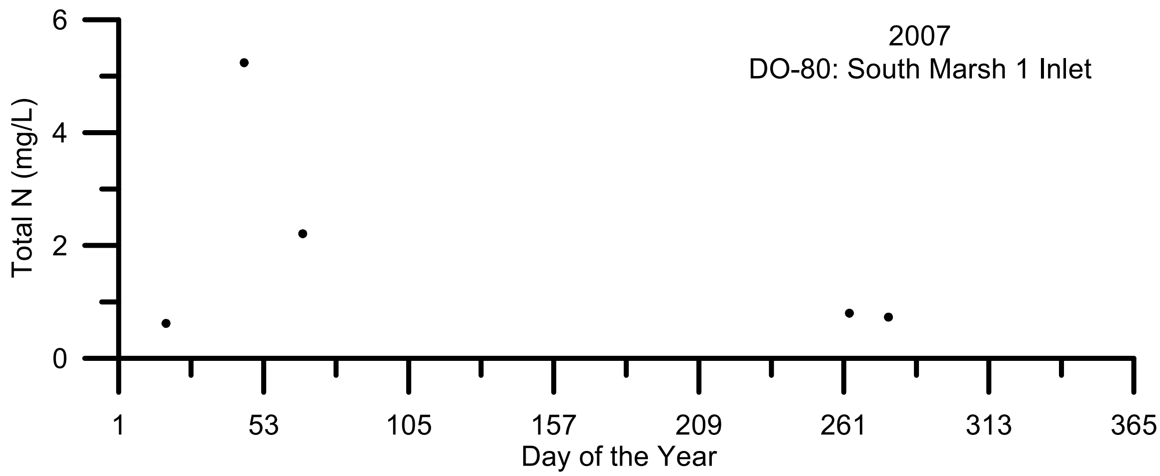
2006
DO-63: Inlet C Canal
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

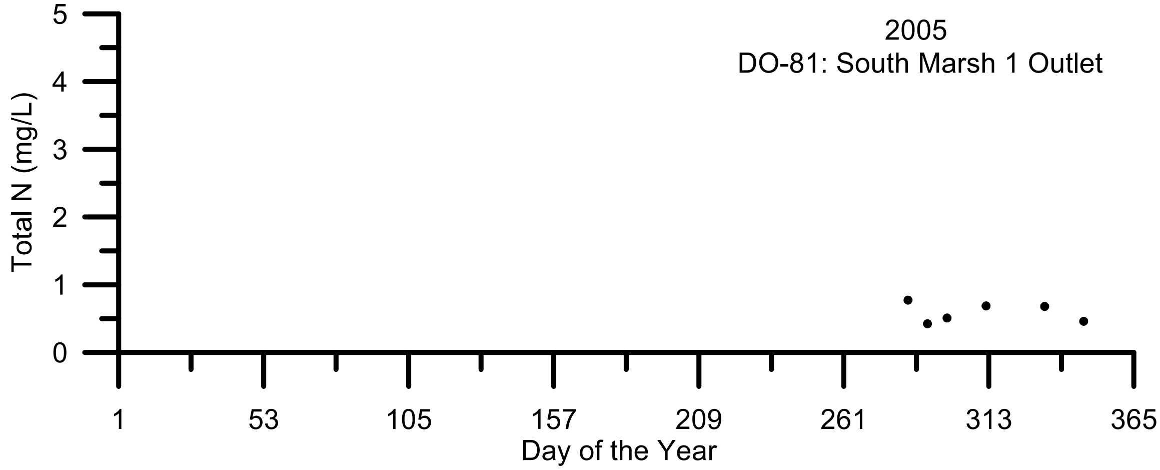


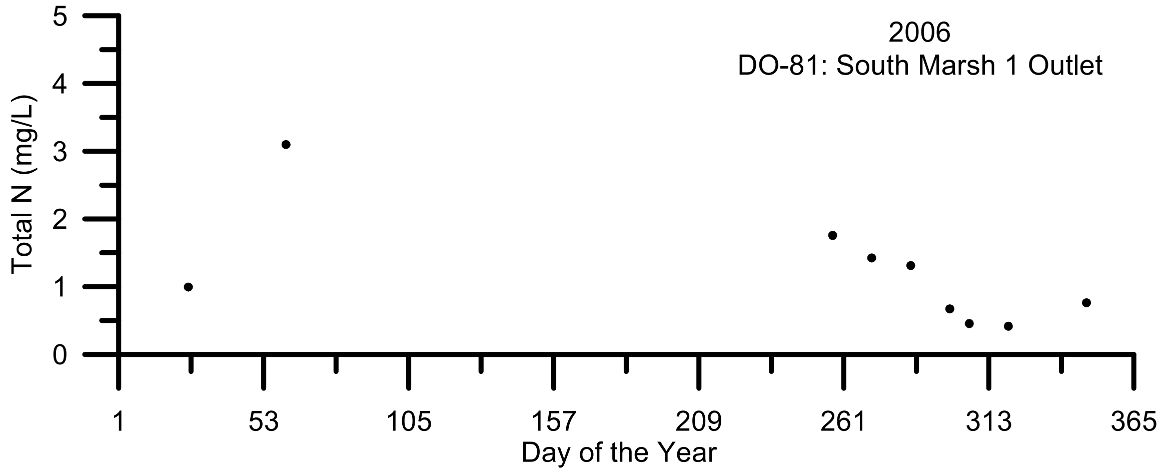
2007
DO-63: Inlet C Canal
Total N (mg/L)
Day of the Year
0
2
4
6
1
53
105
157
209
261
313
365

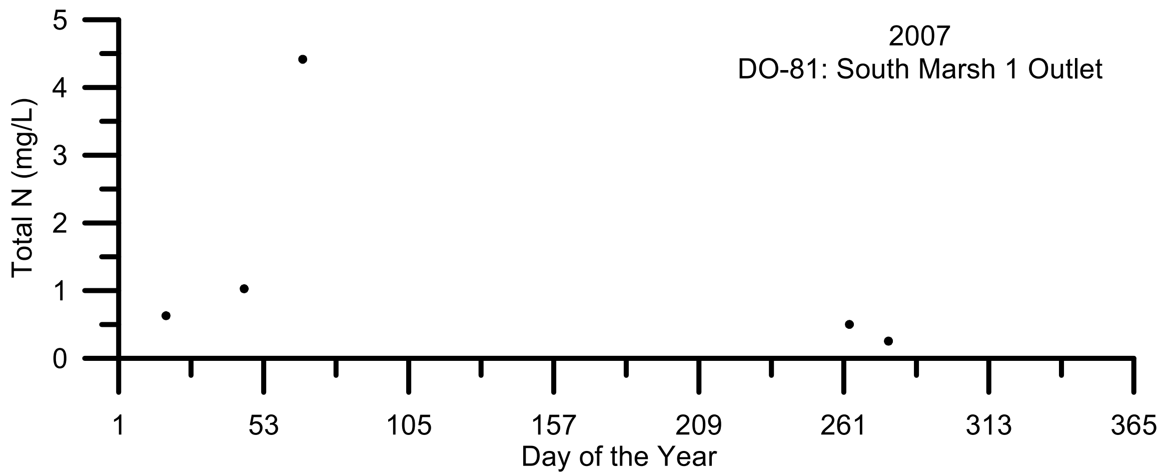

2005
DO-80: South Marsh 1 Inlet
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

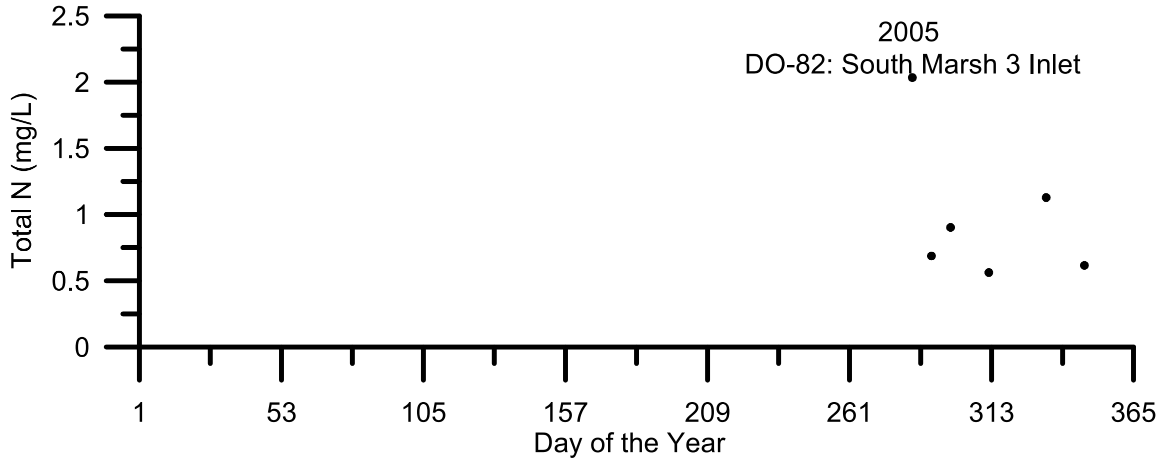

2006
DO-80: South Marsh 1 Inlet
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

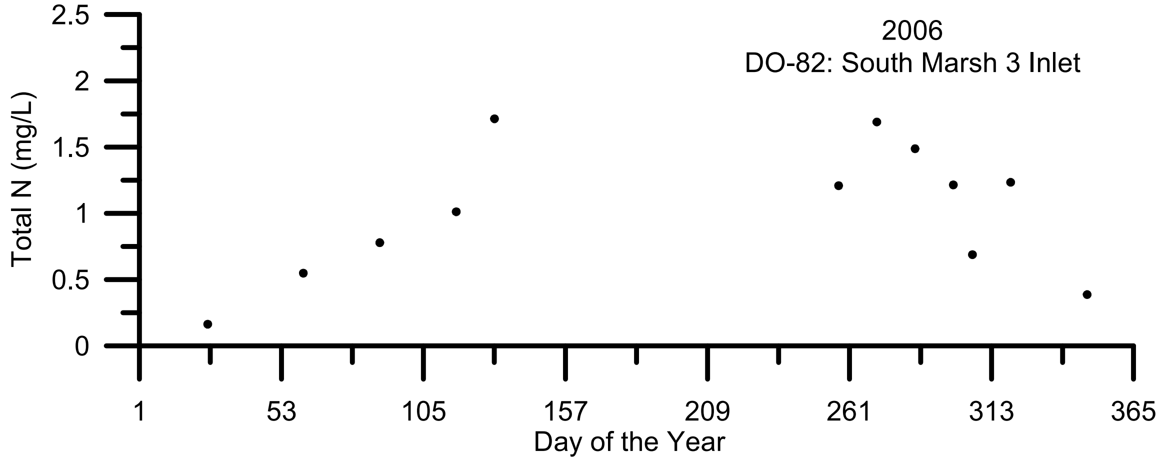

2007
DO-80: South Marsh 1 Inlet
Total N (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

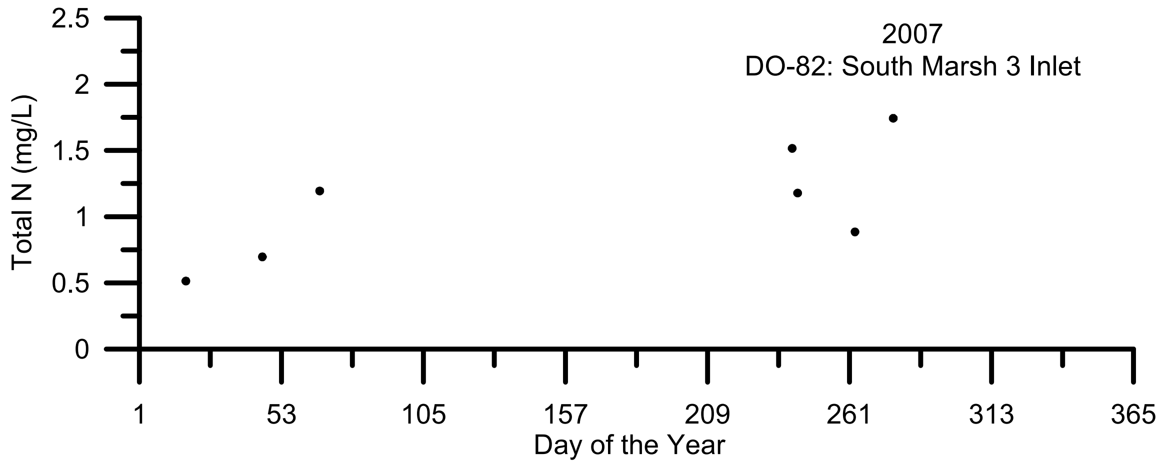

2005
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

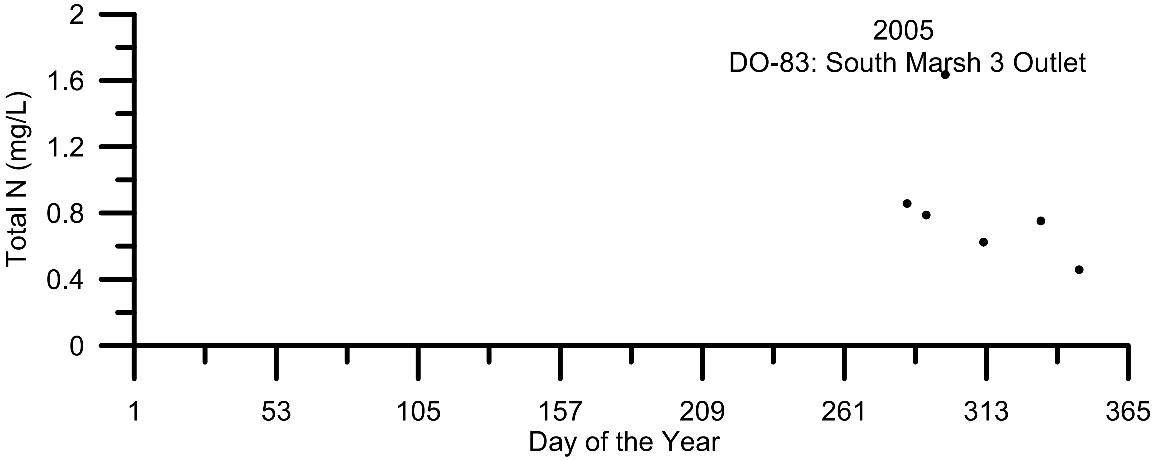

2006
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

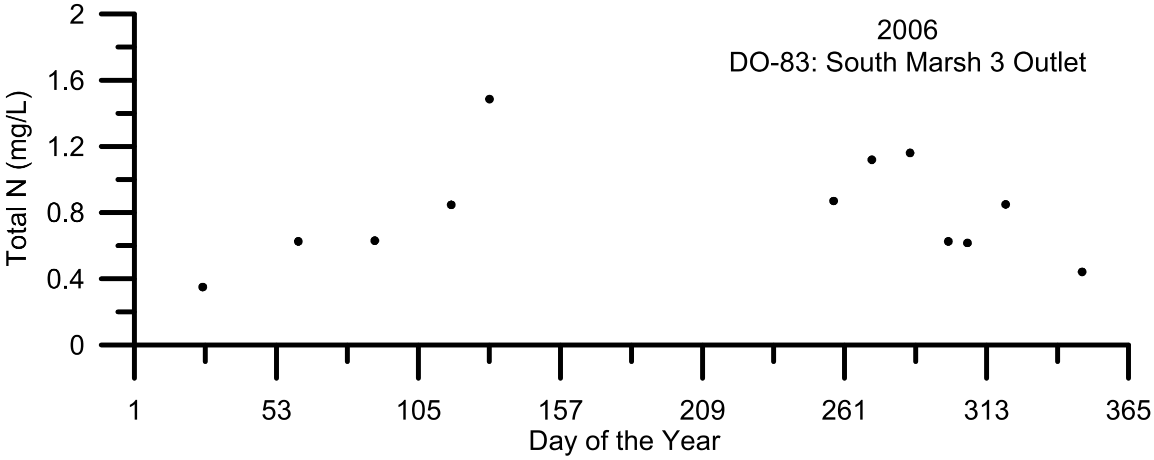

2007
DO-81: South Marsh 1 Outlet
Total N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

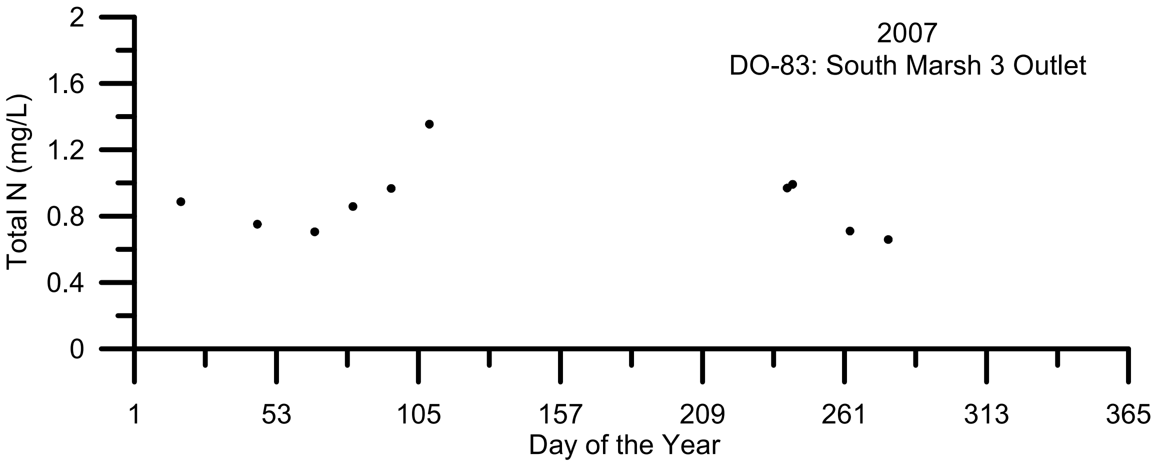

2005
DO-82: South Marsh 3 Inlet
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

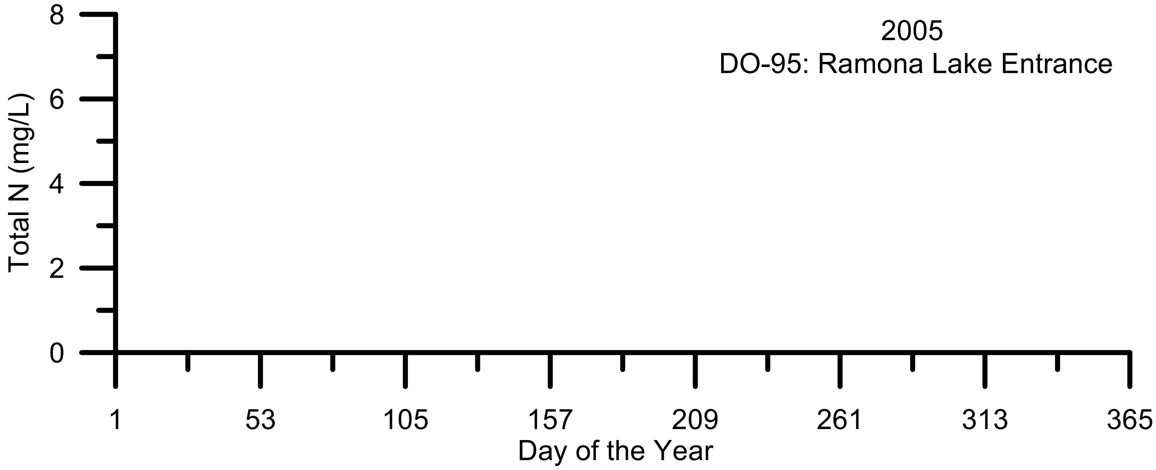

2006
DO-82: South Marsh 3 Inlet
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

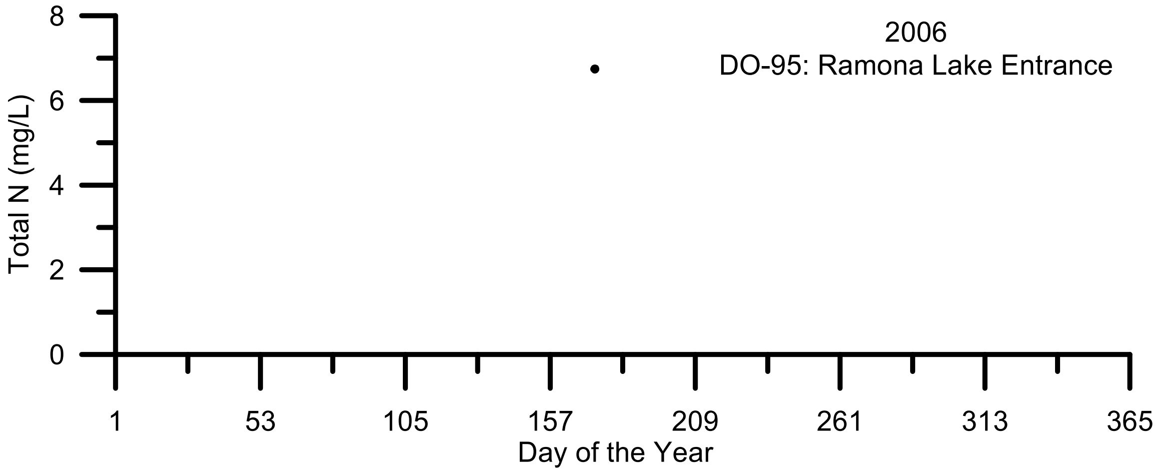

2007
DO-82: South Marsh 3 Inlet
Total N (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

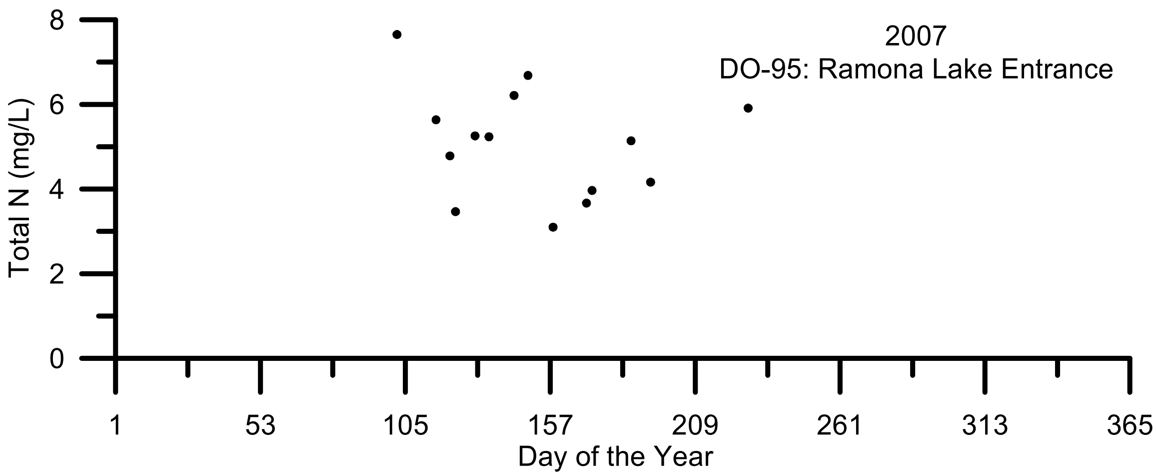

2005
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Total N (mg/L)
0
0.4
0.8
1.2
1.6
2
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Total N (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Sulfate Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of sulfate (SO_4) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at 4°C.

Ion chromatography was utilized for measuring SO_4^{2-} using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (SM-4110 B). The reportable limit for this method is 0.02 mg/L SO_4^{2-} .

Results/Discussion

Samples were measured ranging from 0.0-2108 mg/L SO_4. The average concentration of SO_4 in water samples collected was 213.9 mg/L SO_4. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

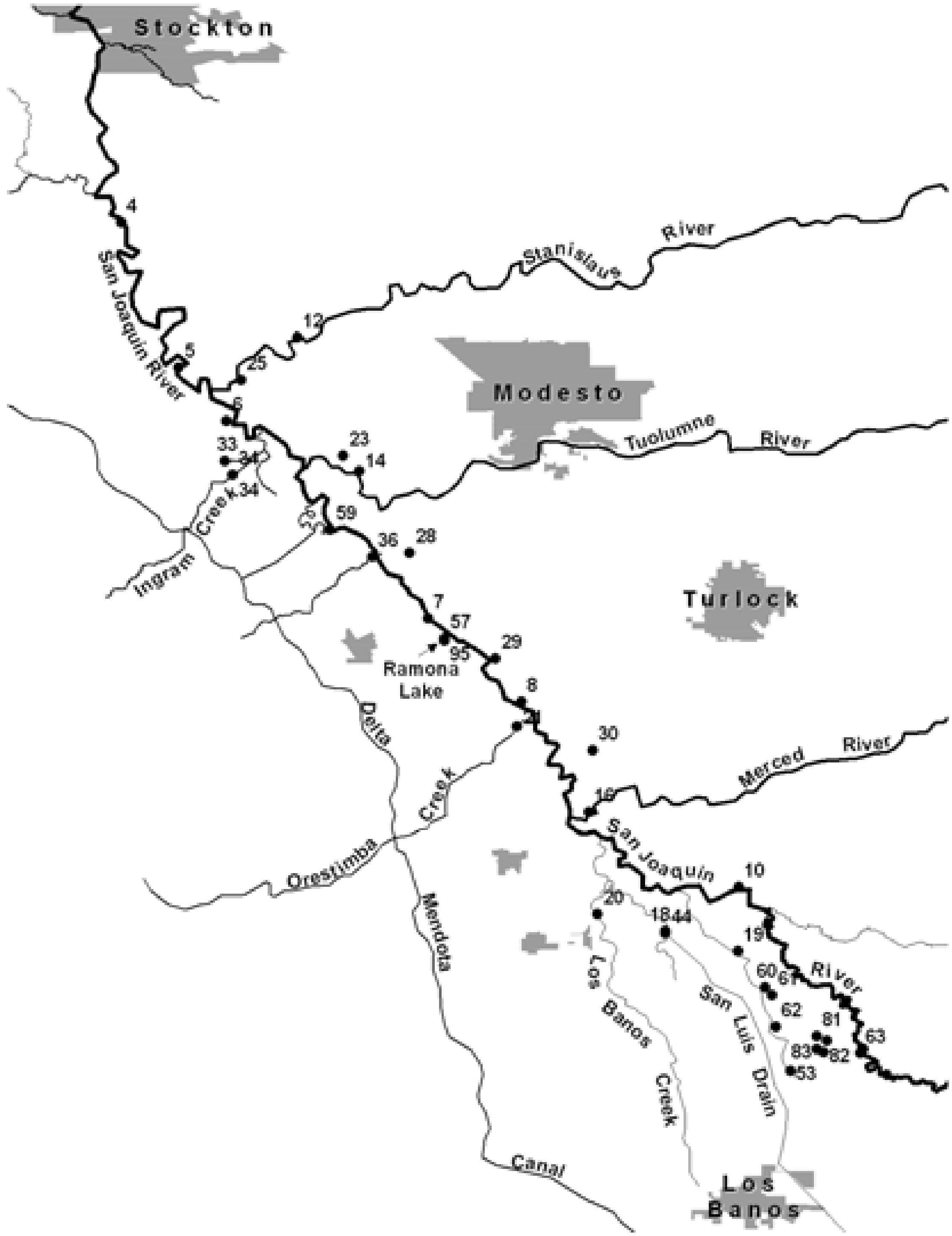
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

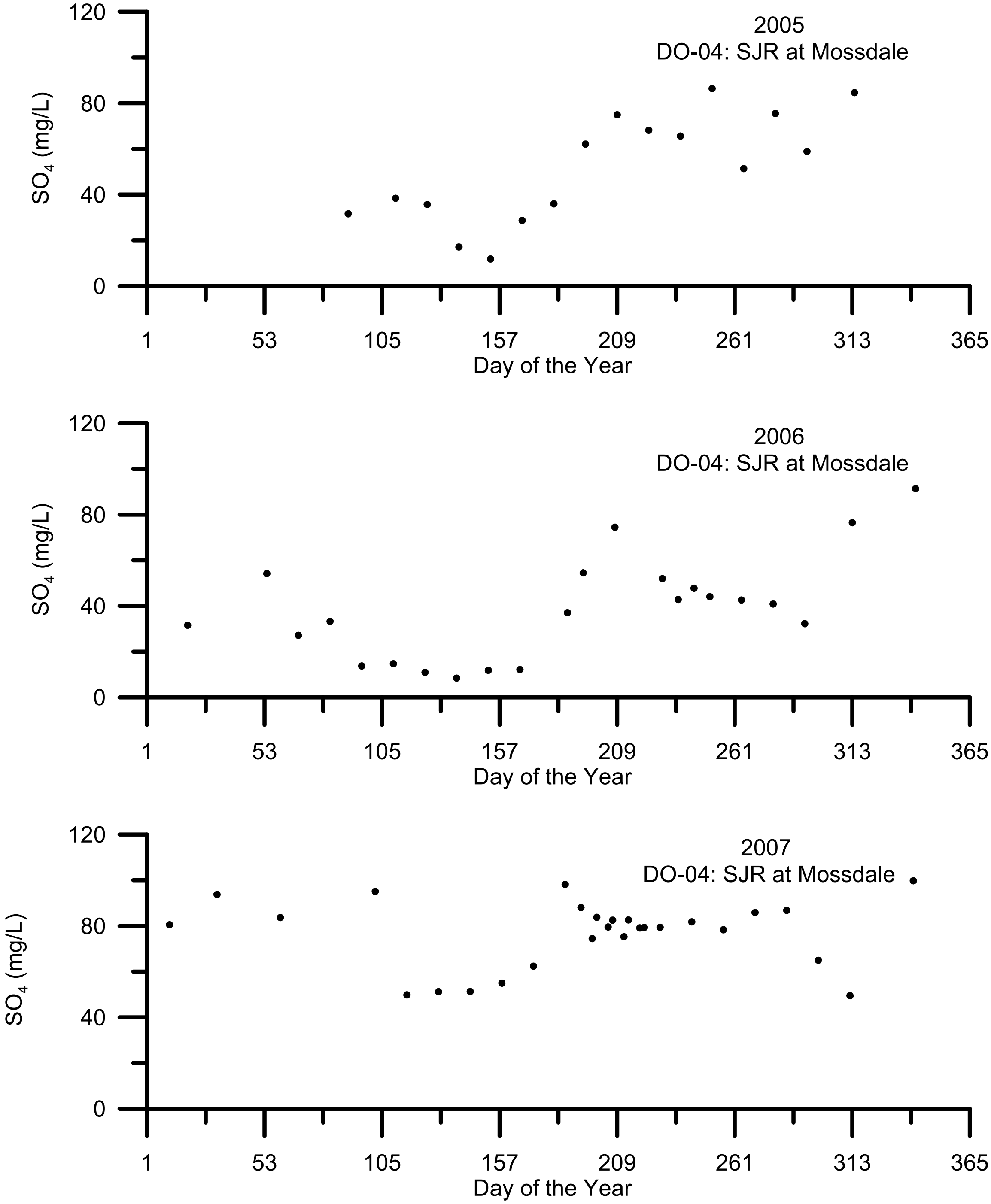
Table 1: EERP Sampling Site List

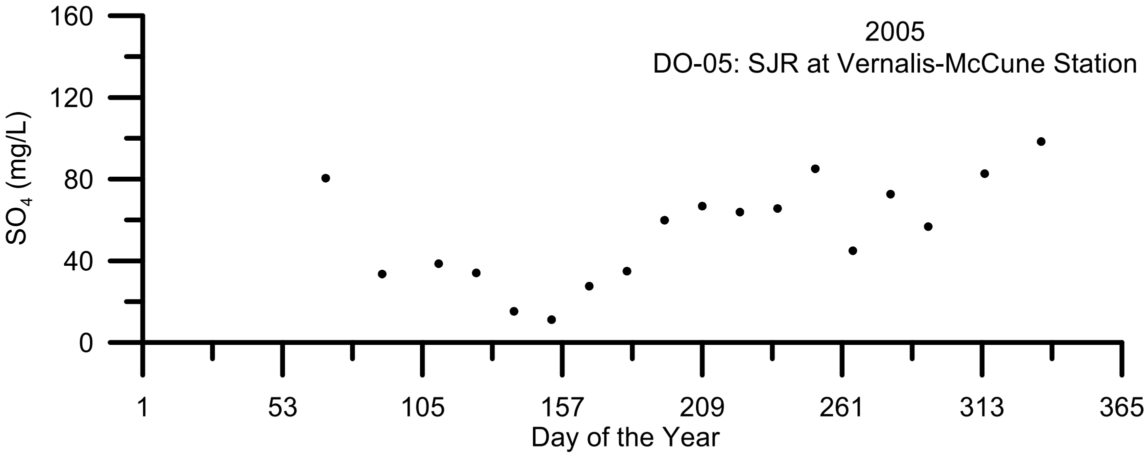
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

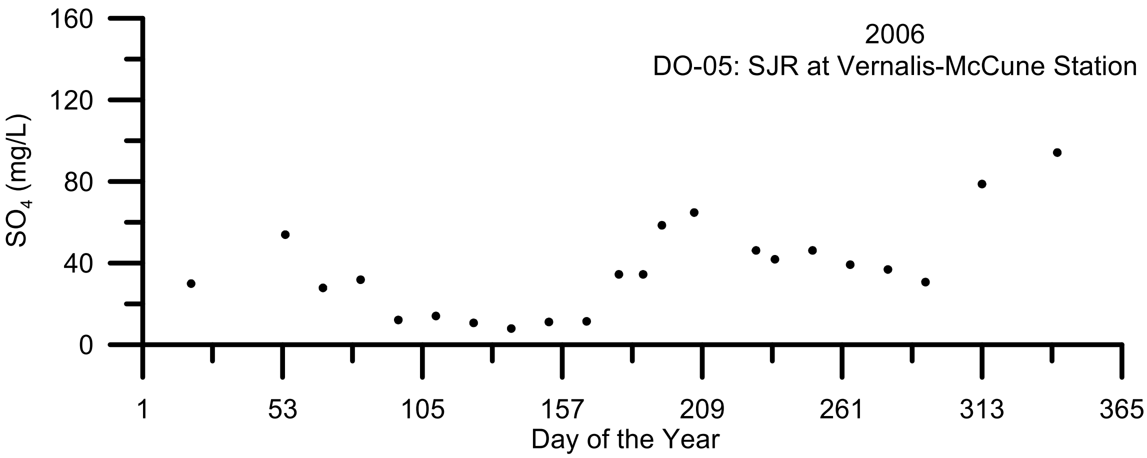
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

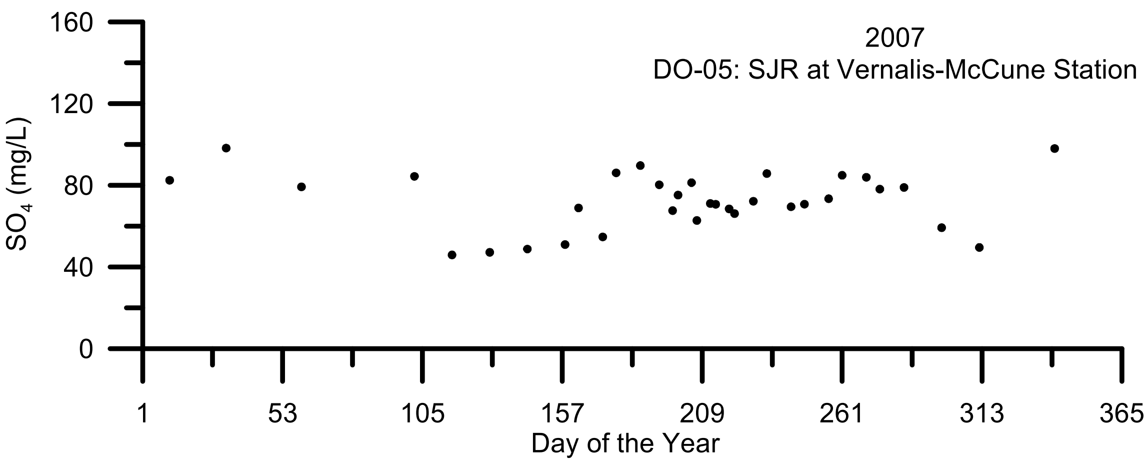


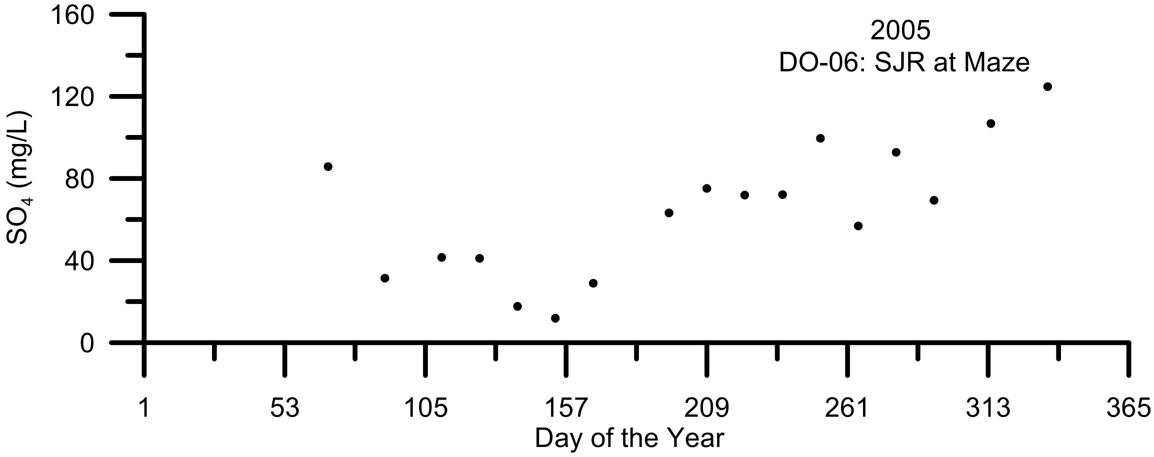
Figures 2 -103: Temporal Plots of SO_4 By Site ID



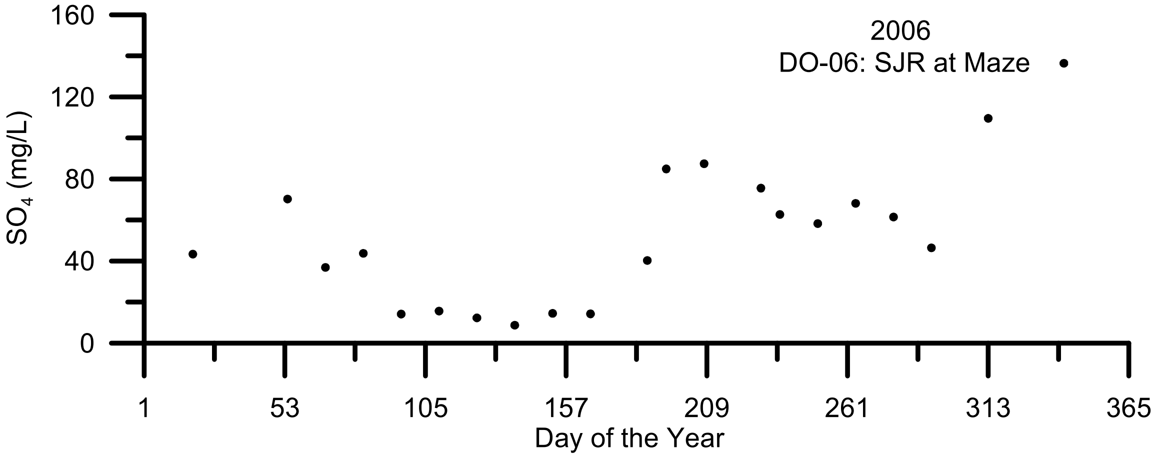

2005
DO-05: SJR at Vernalis-McCune Station
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-05: SJR at Vernalis-McCune Station
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

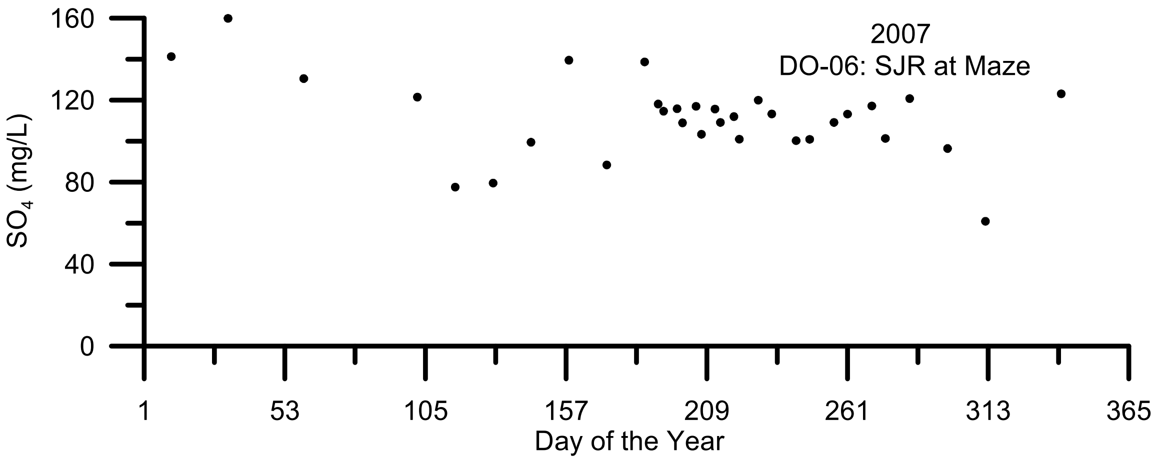

2007
DO-05: SJR at Vernalis-McCune Station
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year



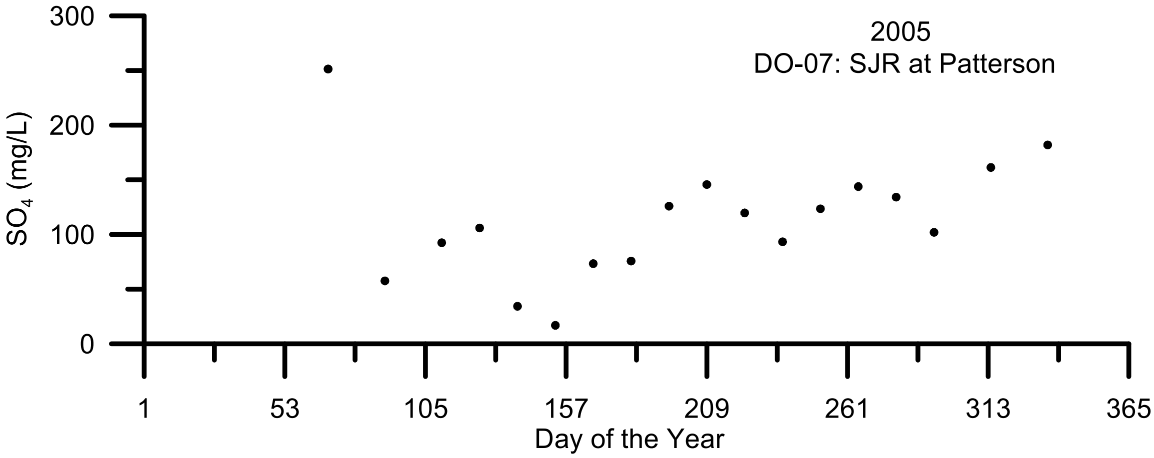
2005
DO-06: SJR at Maze
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

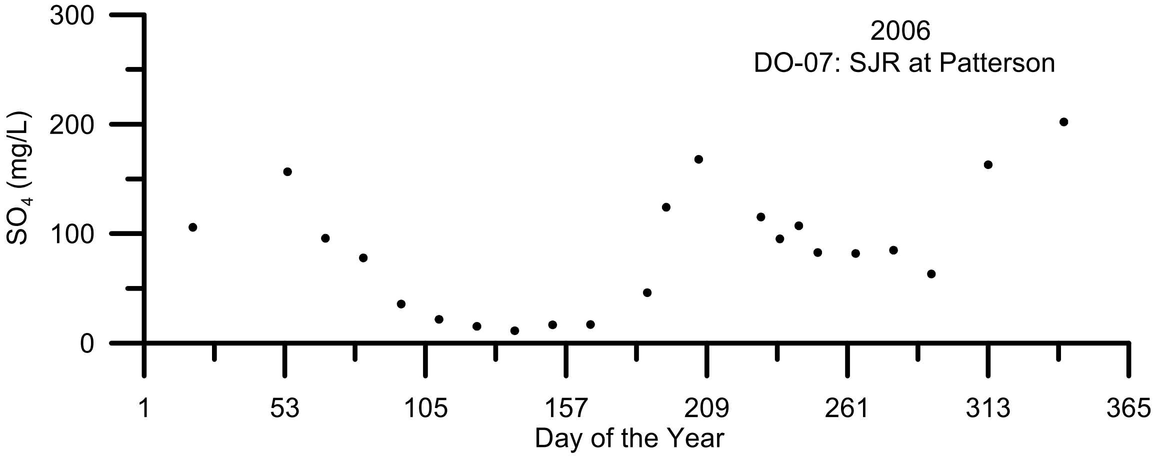


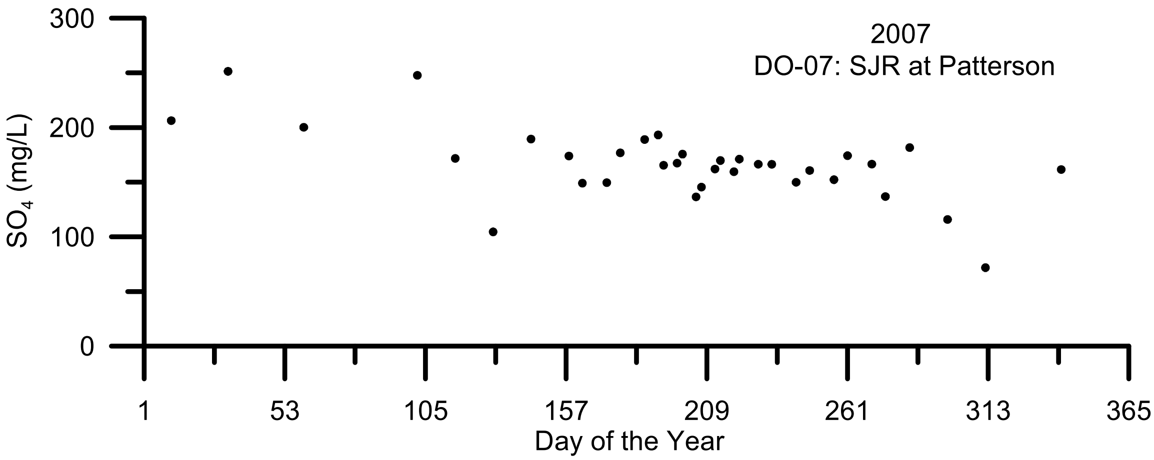
2006
DO-06: SJR at Maze
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

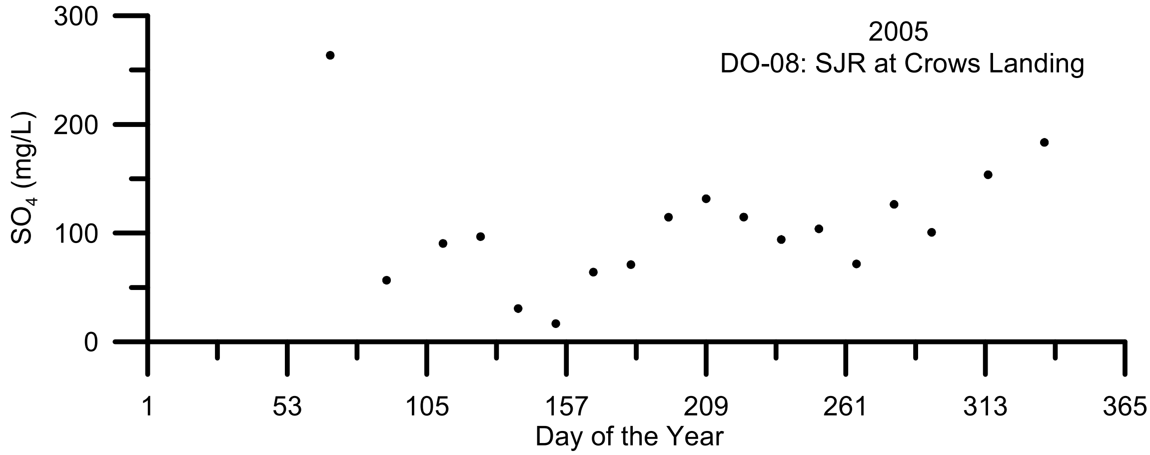


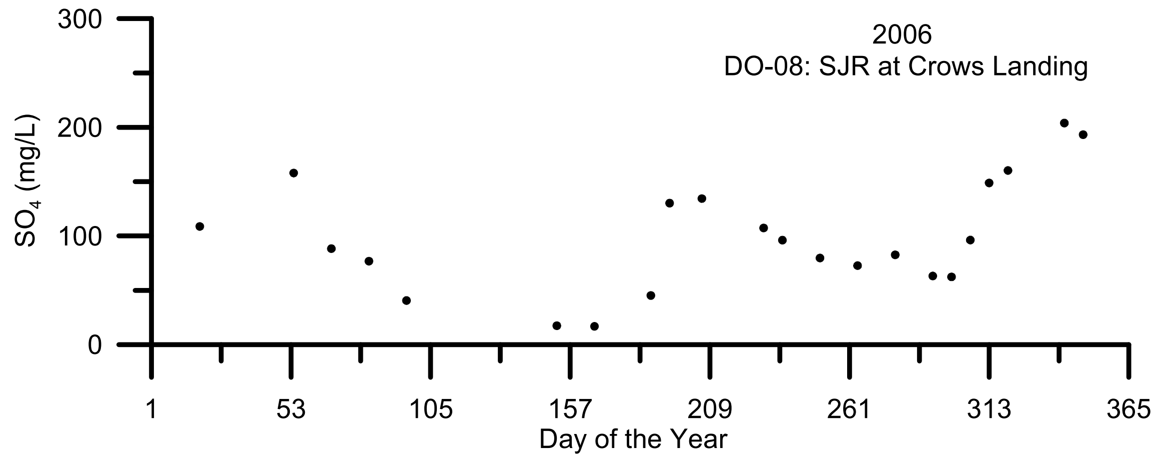
2007
DO-06: SJR at Maze
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

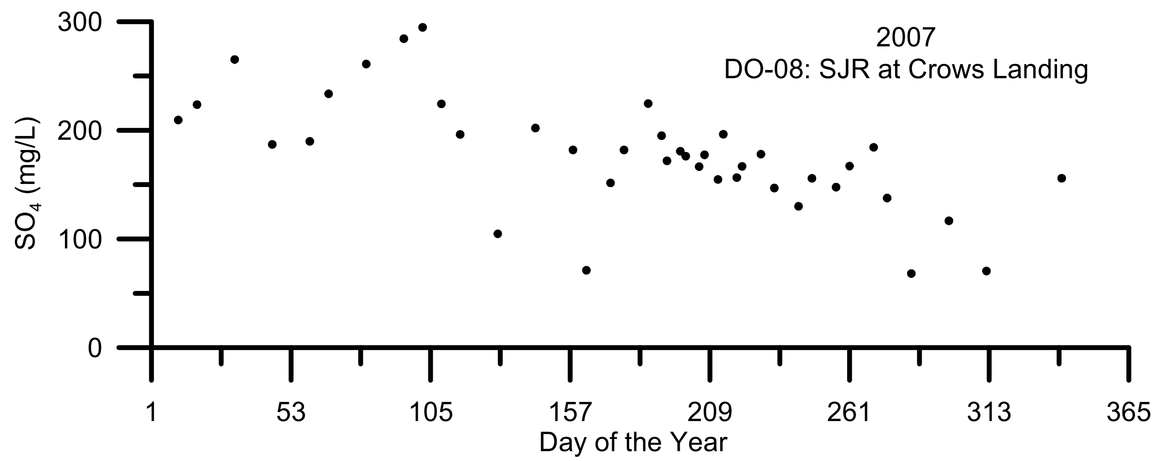

2005
DO-07: SJR at Patterson
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

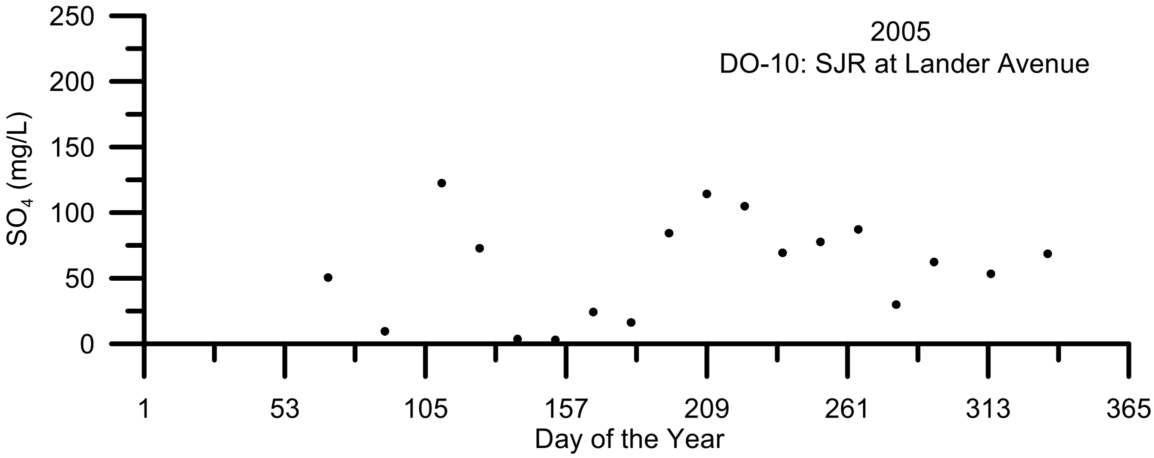

2006
DO-07: SJR at Patterson
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

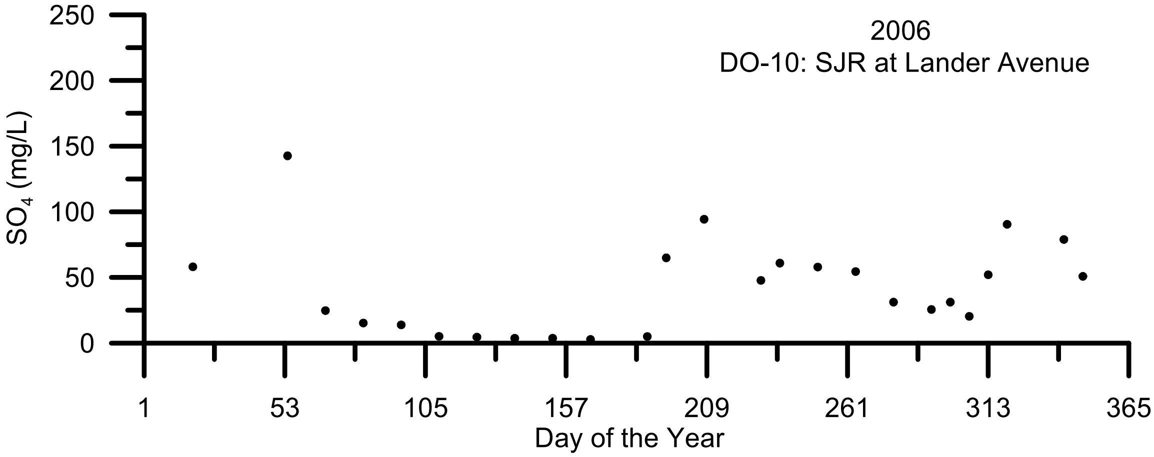

2007
DO-07: SJR at Patterson
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

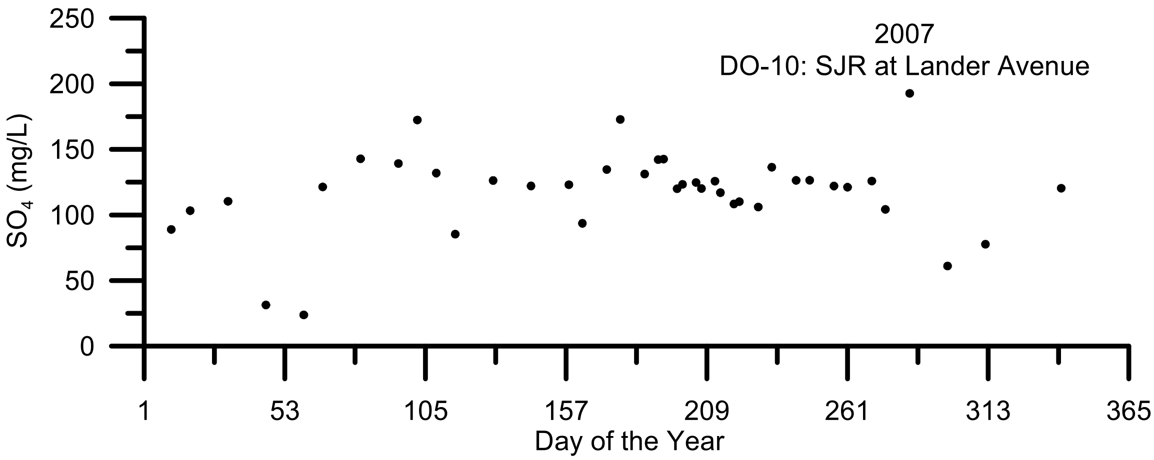

2005
DO-08: SJR at Crows Landing
SO4 (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

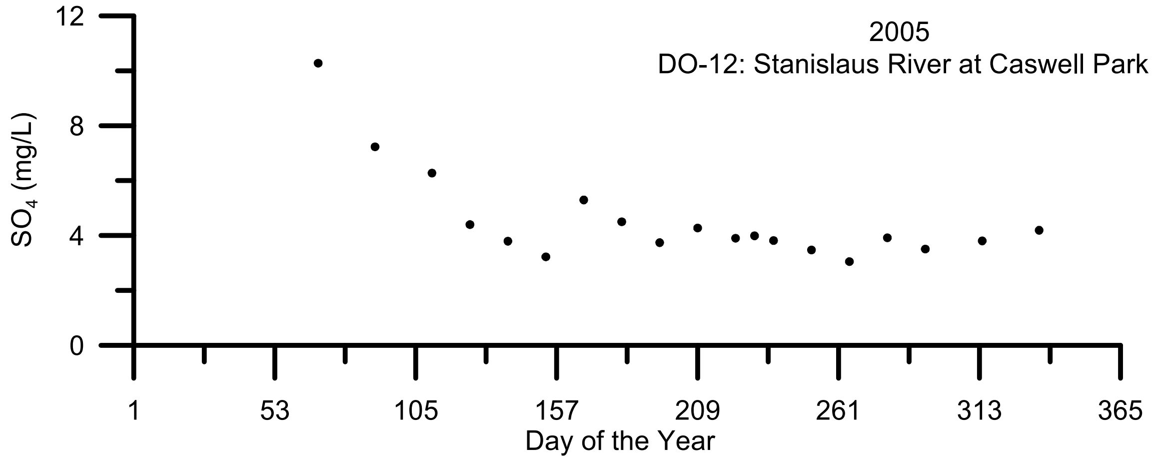

2006
DO-08: SJR at Crows Landing
SO4 (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

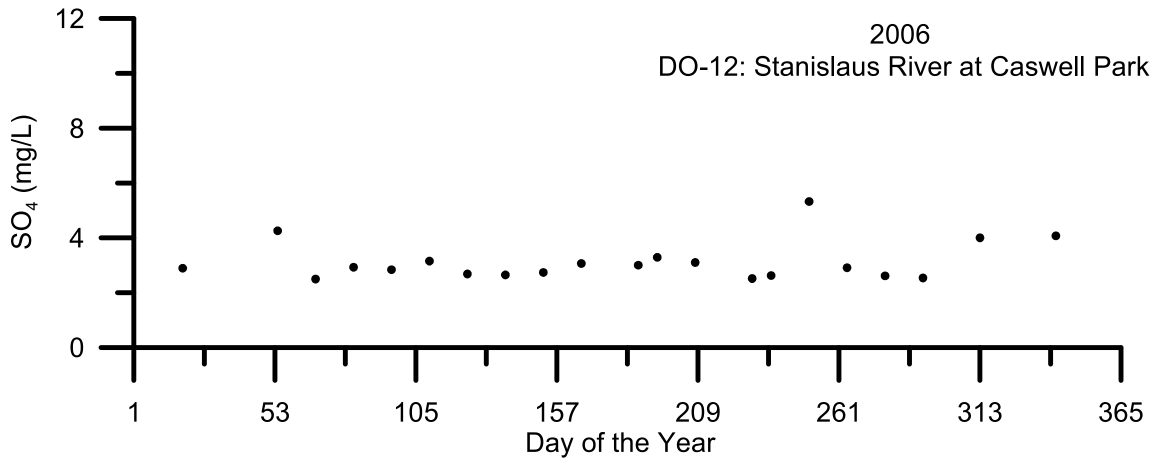

2007
DO-08: SJR at Crows Landing
SO4 (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

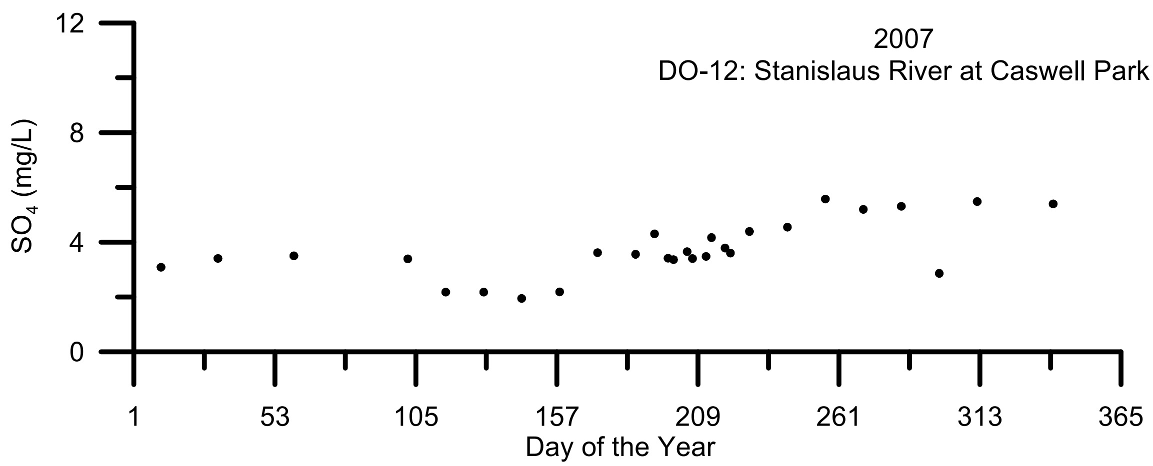

2005
DO-10: SJR at Lander Avenue
SO_4 (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

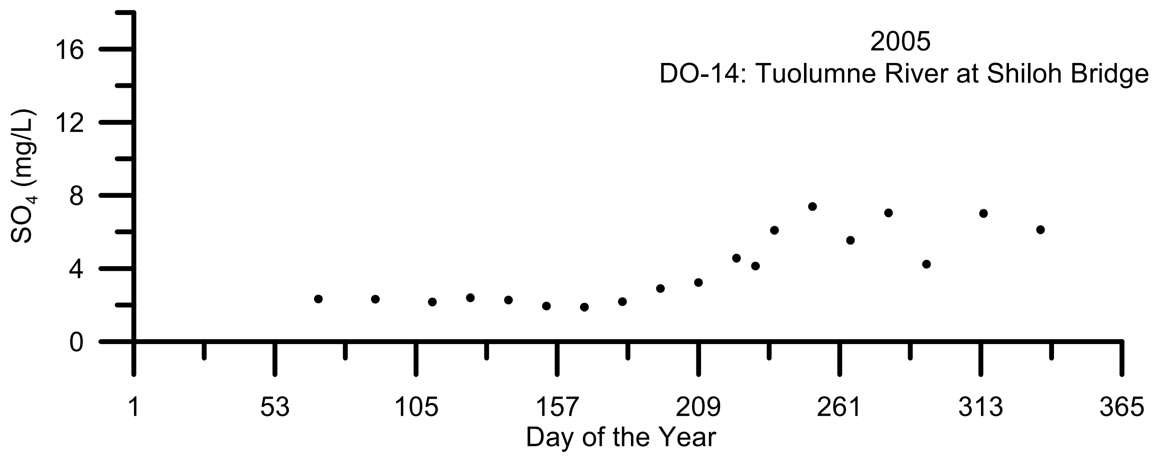

2006
DO-10: SJR at Lander Avenue
SO_4 (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

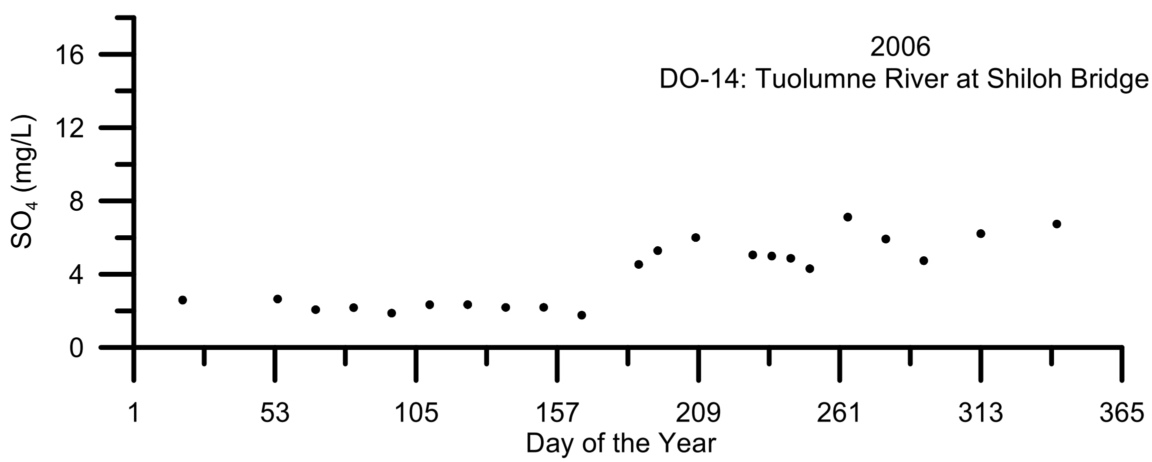

2007
DO-10: SJR at Lander Avenue
SO_4 (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

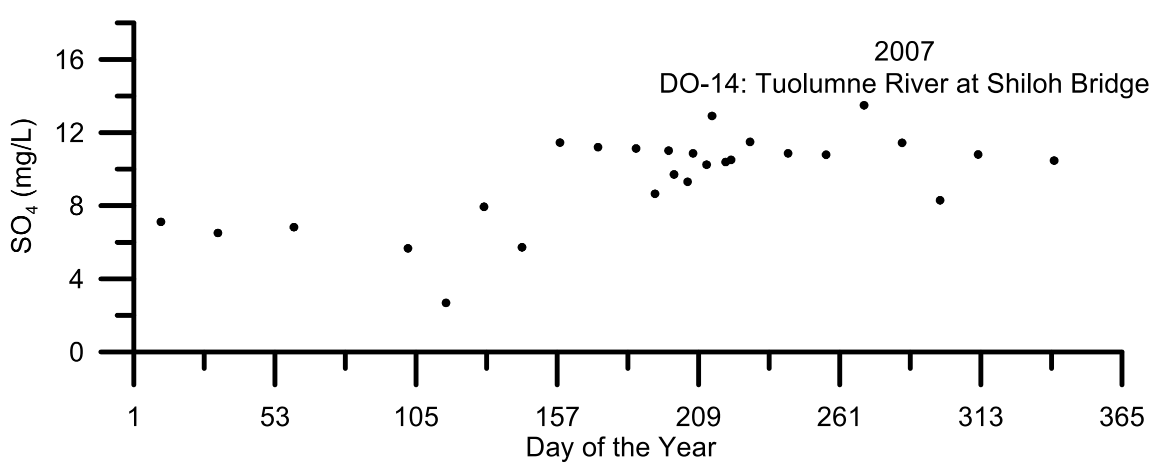

2005
DO-12: Stanislaus River at Caswell Park
SO4 (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

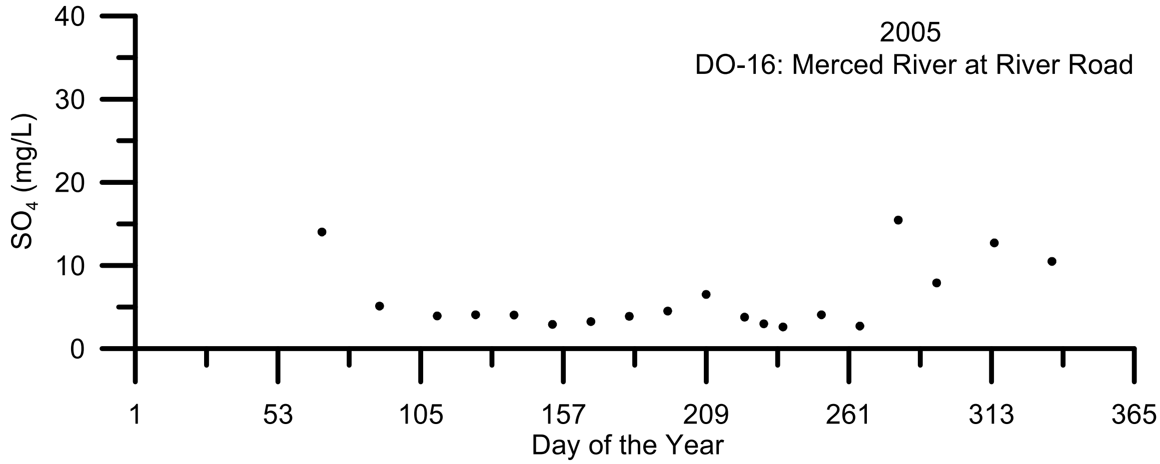

2006
DO-12: Stanislaus River at Caswell Park
SO4 (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

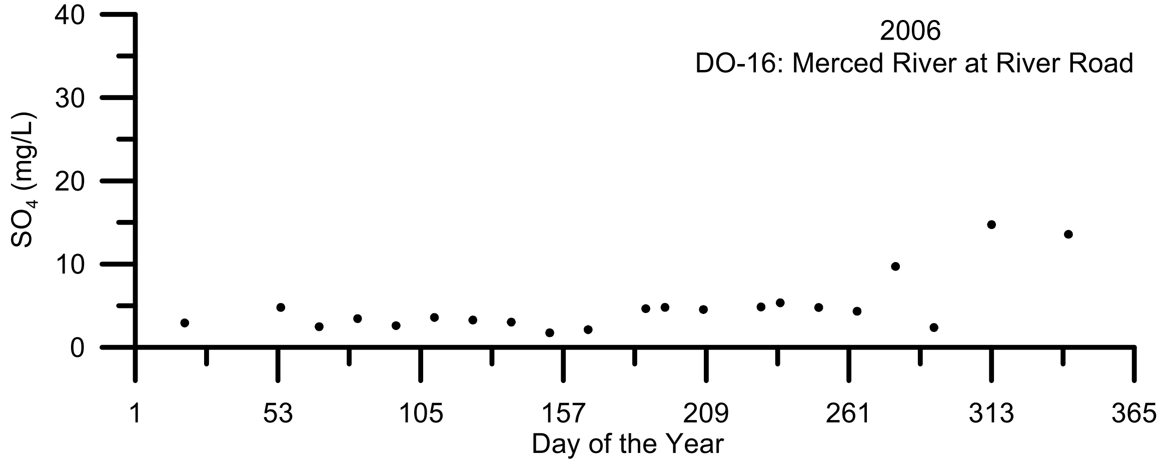

2007
DO-12: Stanislaus River at Caswell Park
SO4 (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

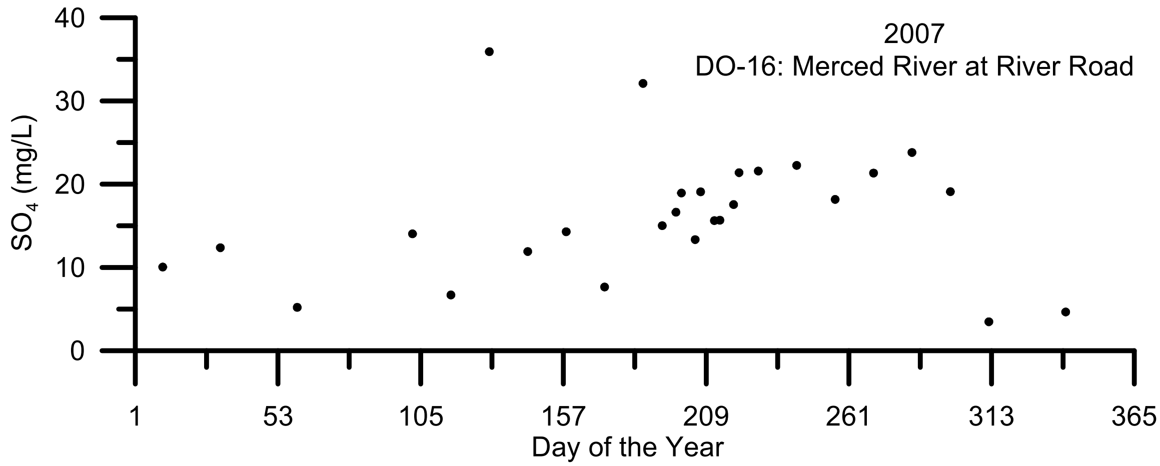

2005
DO-14: Tuolumne River at Shiloh Bridge
SO4 (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

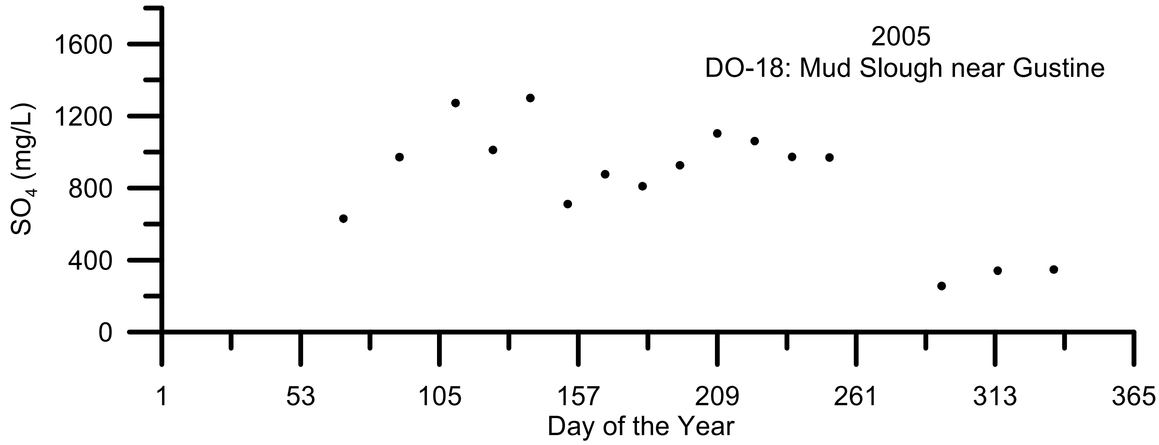

2006
DO-14: Tuolumne River at Shiloh Bridge
SO4 (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

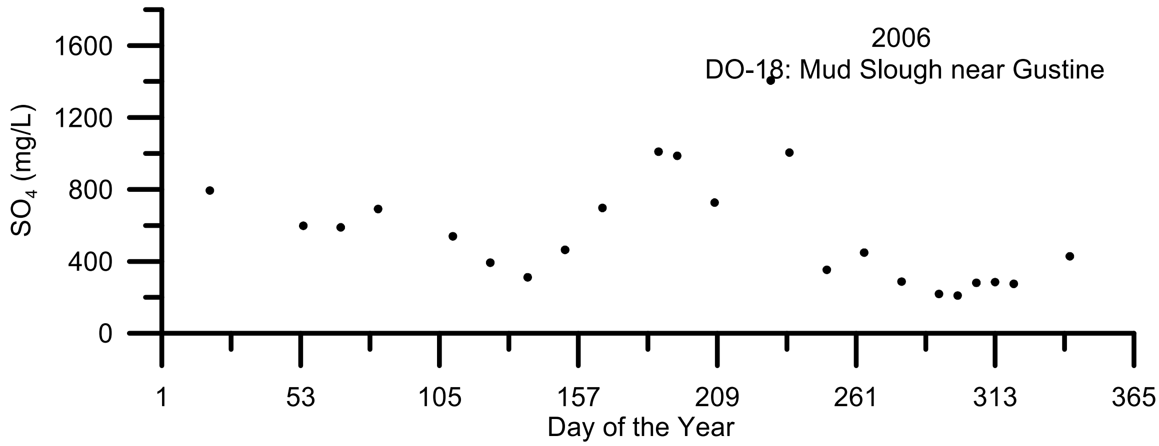

2007
DO-14: Tuolumne River at Shiloh Bridge
SO4 (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

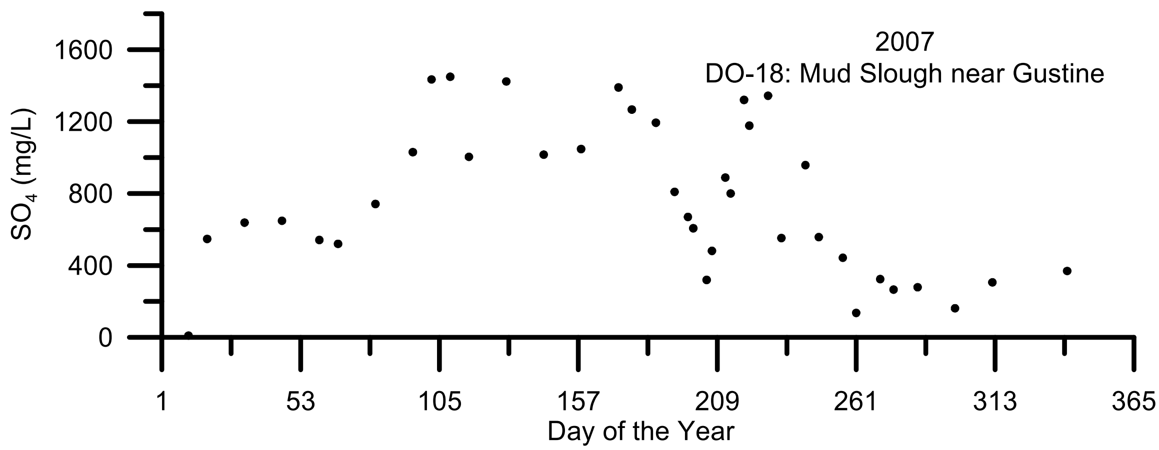

2005
DO-16: Merced River at River Road
SO4 (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

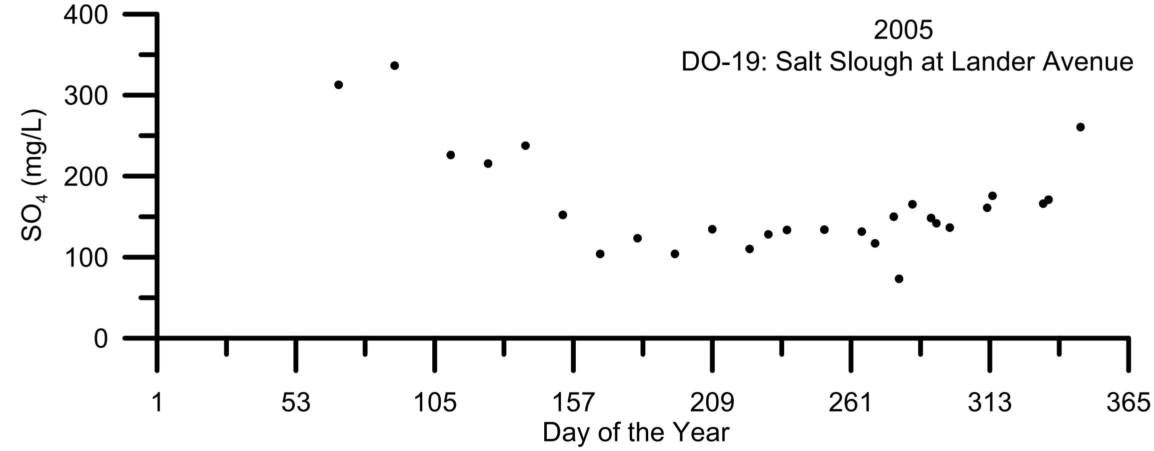

2006
DO-16: Merced River at River Road
SO4 (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

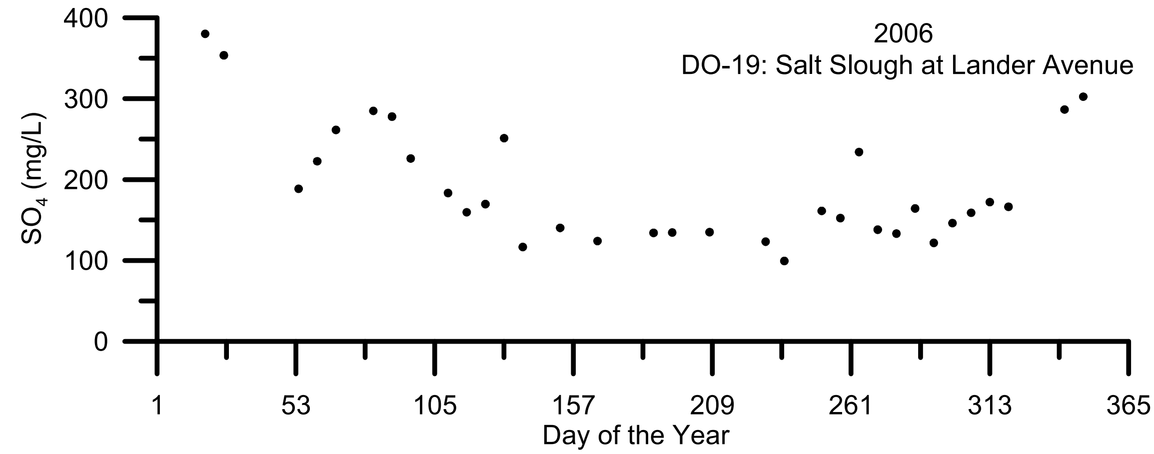

2007
DO-16: Merced River at River Road
SO4 (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

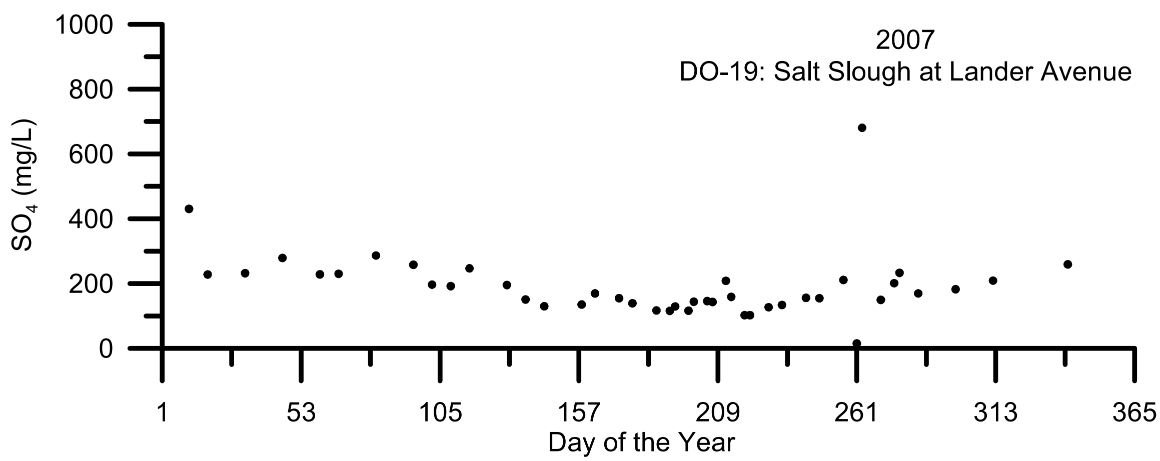

2005
DO-18: Mud Slough near Gustine
SO_4 (mg/L)
0
400
800
1200
1600
1
53
105
157
209
261
313
365
Day of the Year

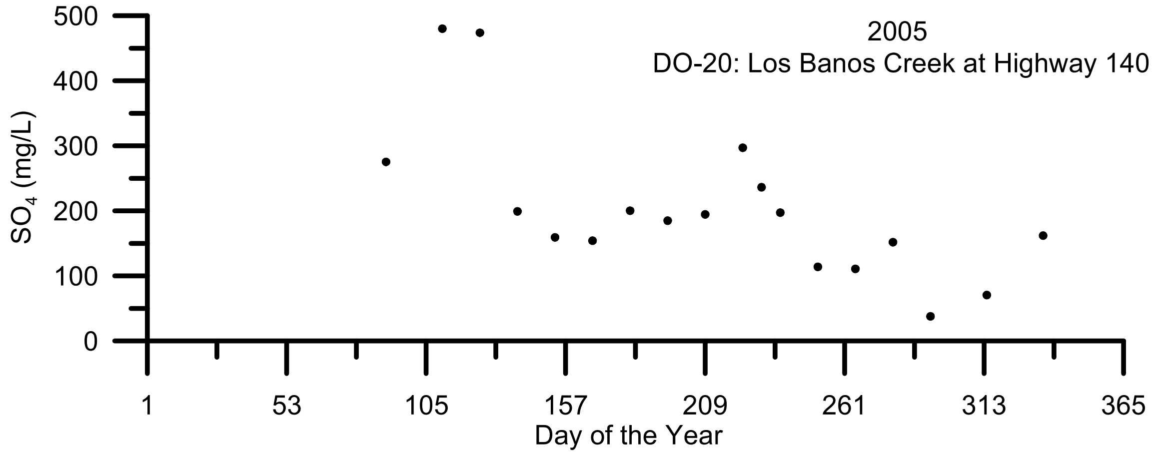

2006
DO-18: Mud Slough near Gustine
SO_4 (mg/L)
0
400
800
1200
1600
1
53
105
157
209
261
313
365
Day of the Year

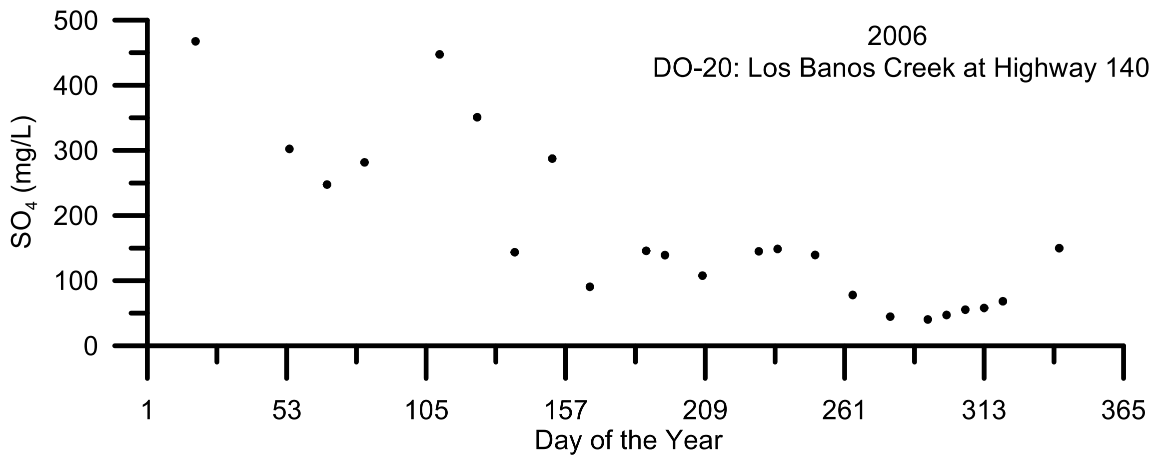

2007
DO-18: Mud Slough near Gustine
SO_4 (mg/L)
0
400
800
1200
1600
1
53
105
157
209
261
313
365
Day of the Year

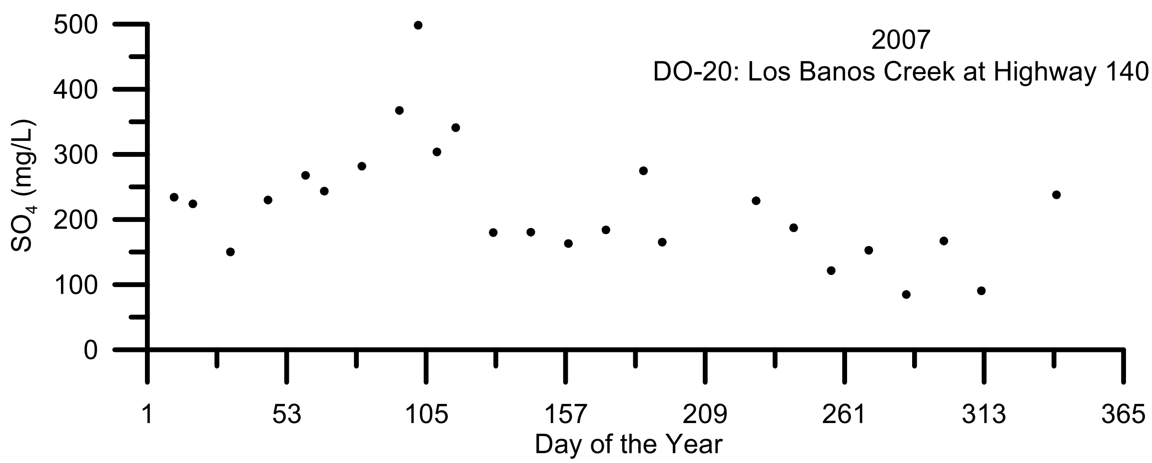

2005
DO-19: Salt Slough at Lander Avenue
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

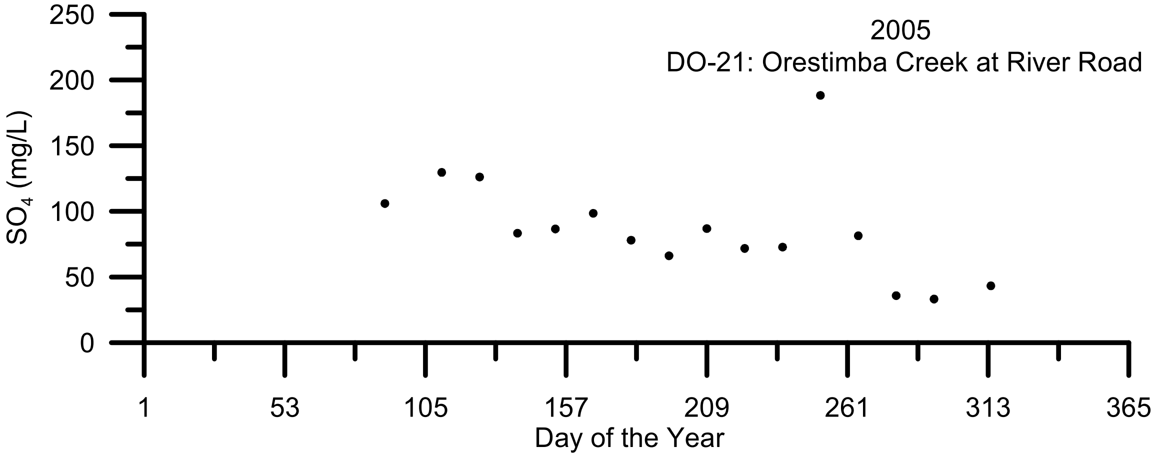

2006
DO-19: Salt Slough at Lander Avenue
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

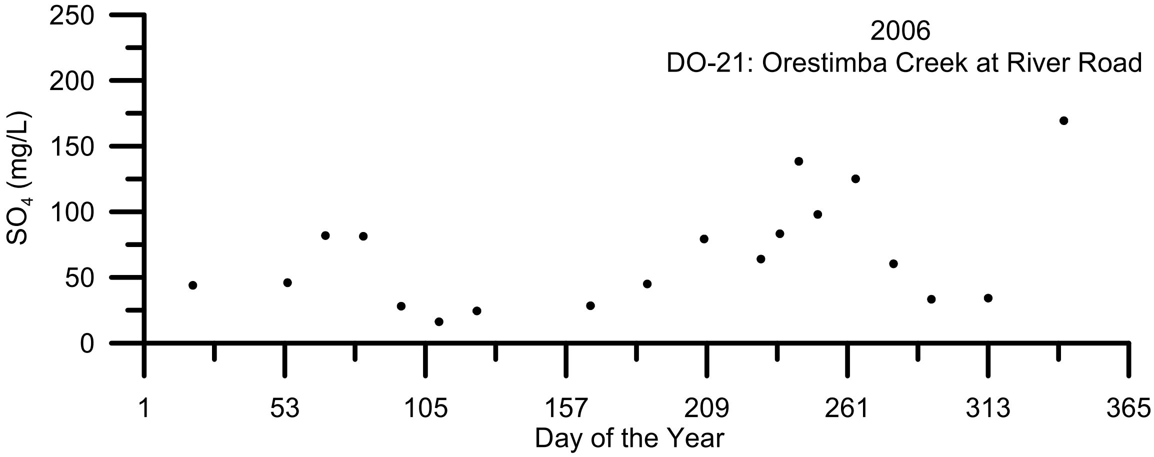

2007
DO-19: Salt Slough at Lander Avenue
SO_4 (mg/L)
0
200
400
600
800
1000
1
53
105
157
209
261
313
365
Day of the Year

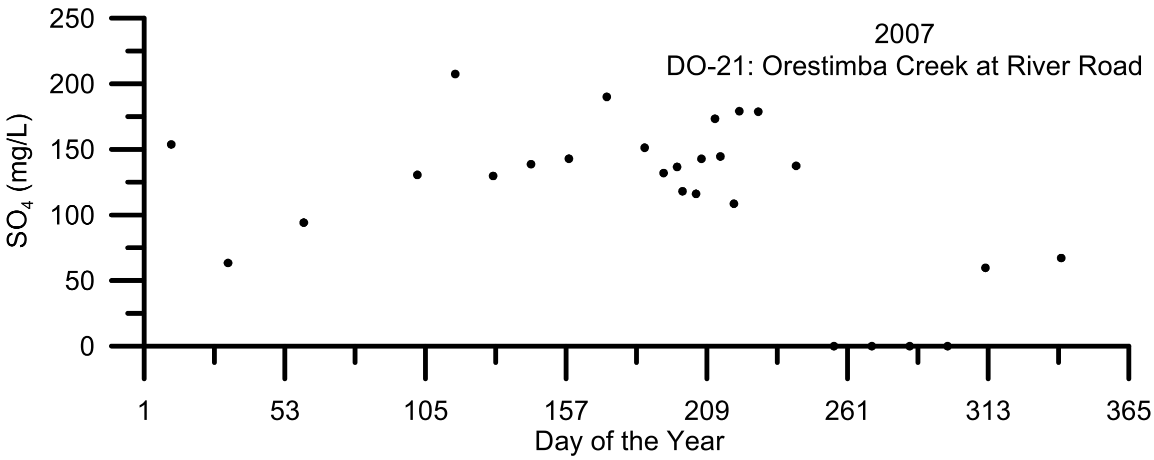

2005
DO-20: Los Banos Creek at Highway 140
SO4 (mg/L)
Day of the Year
0
100
200
300
400
500
1
53
105
157
209
261
313
365

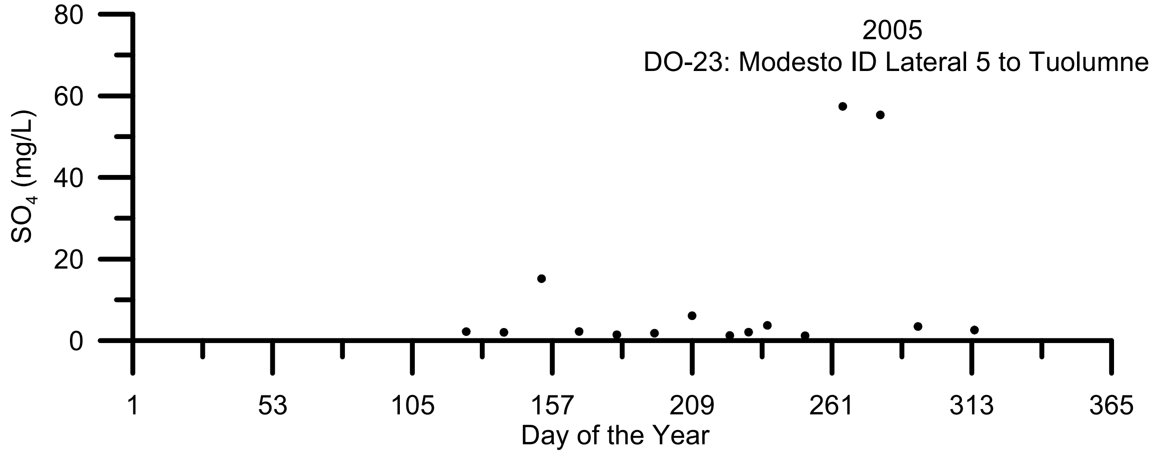

2006
DO-20: Los Banos Creek at Highway 140
SO4 (mg/L)
Day of the Year
0
100
200
300
400
500
1
53
105
157
209
261
313
365


2007
DO-20: Los Banos Creek at Highway 140
SO4 (mg/L)
Day of the Year
0
100
200
300
400
500
1
53
105
157
209
261
313
365

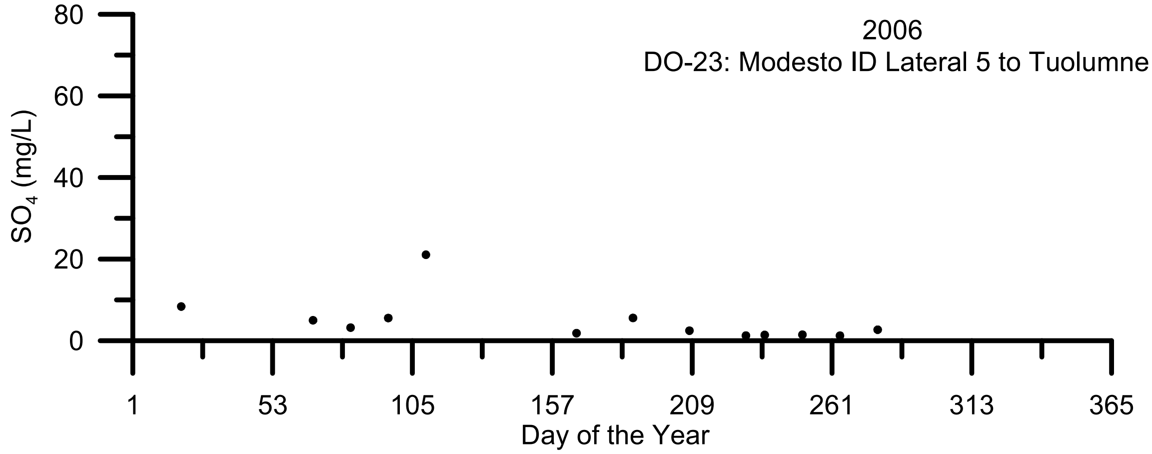

2005
DO-21: Orestimba Creek at River Road
SO4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-21: Orestimba Creek at River Road
SO4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

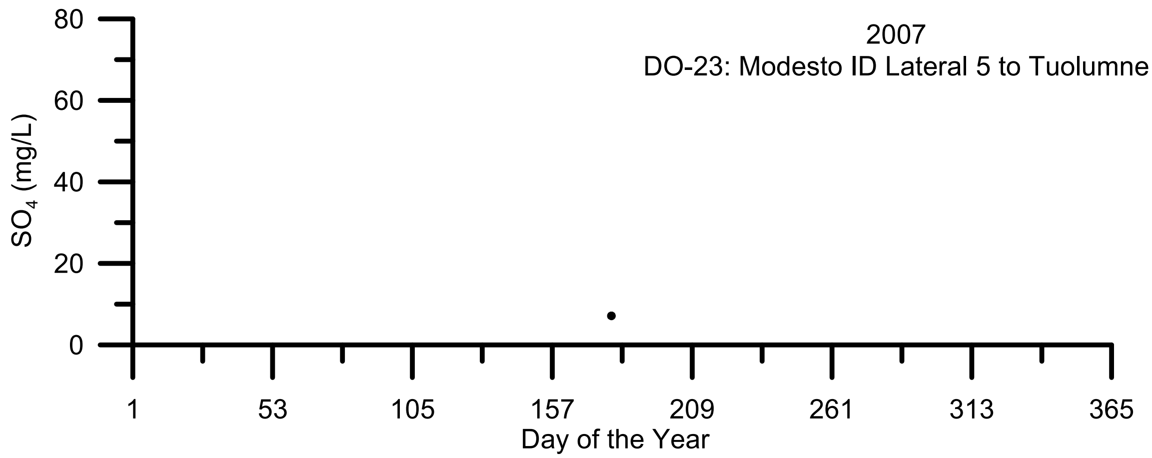

2007
DO-21: Orestimba Creek at River Road
SO4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year



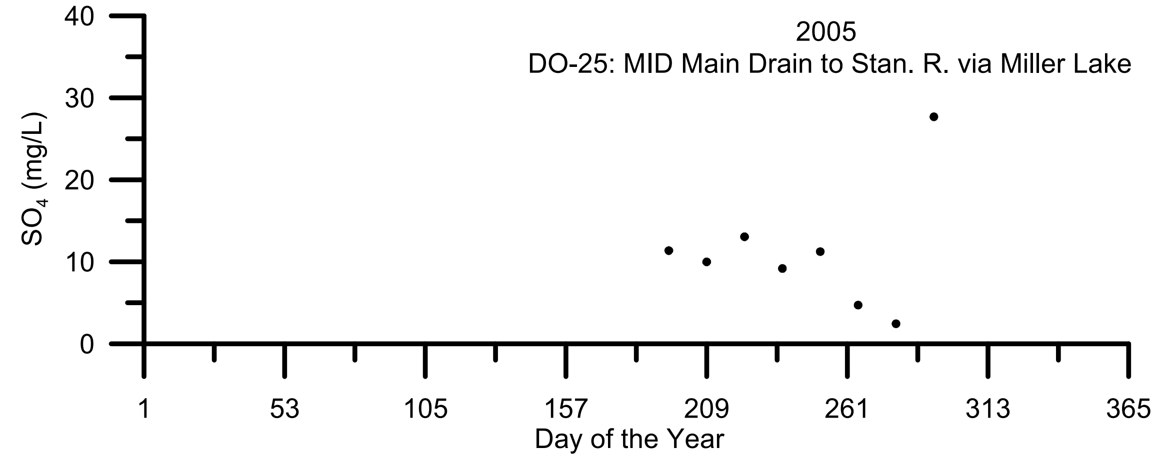
2005
DO-23: Modesto ID Lateral 5 to Tuolumne
SO4 (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

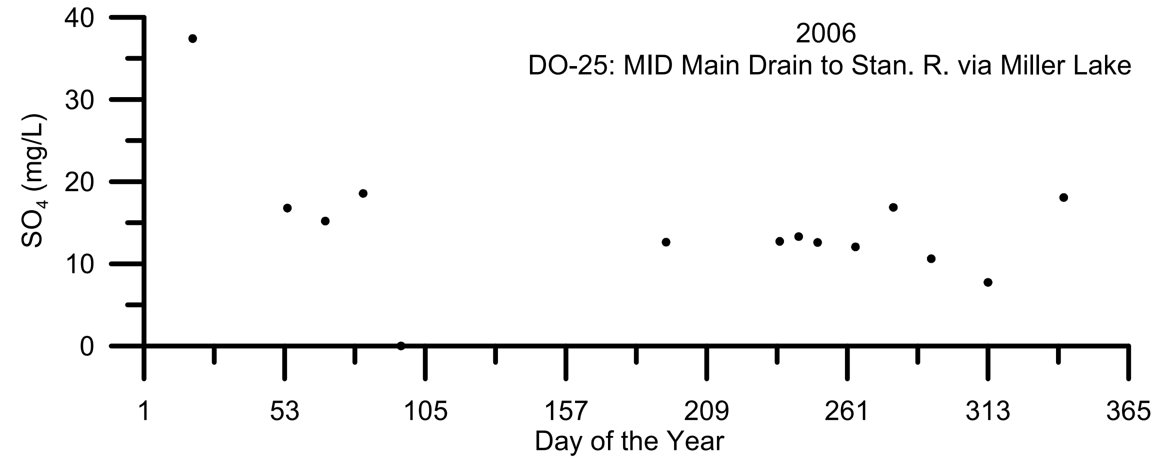


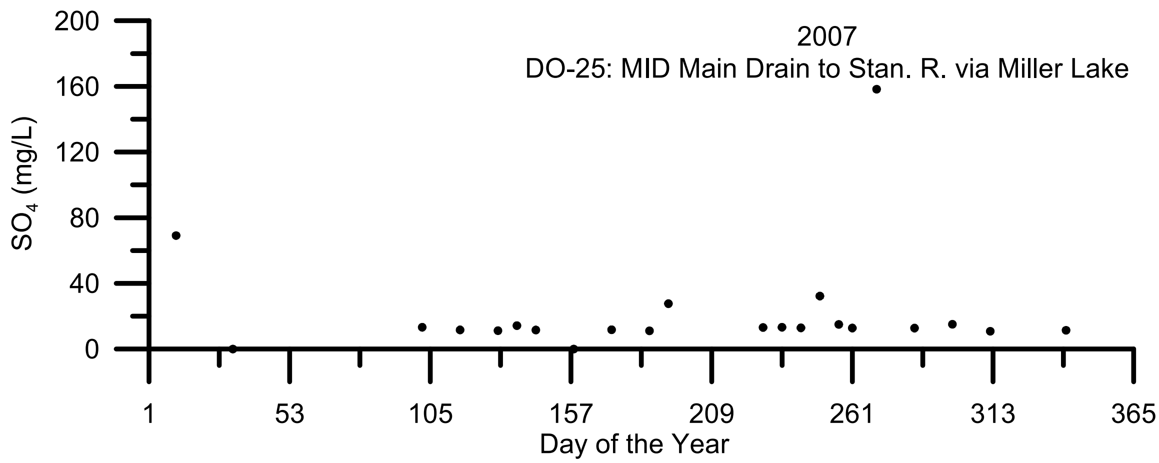
2006
DO-23: Modesto ID Lateral 5 to Tuolumne
SO4 (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

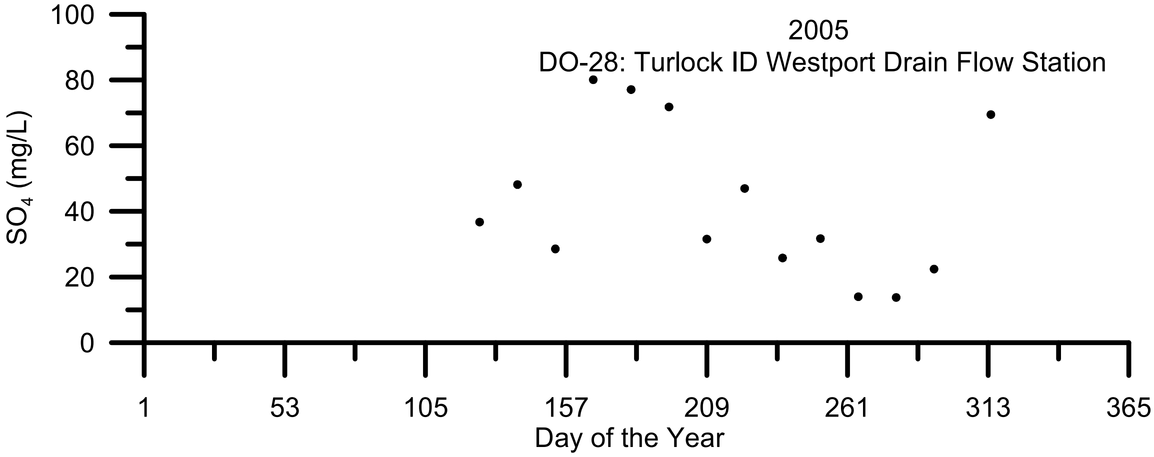


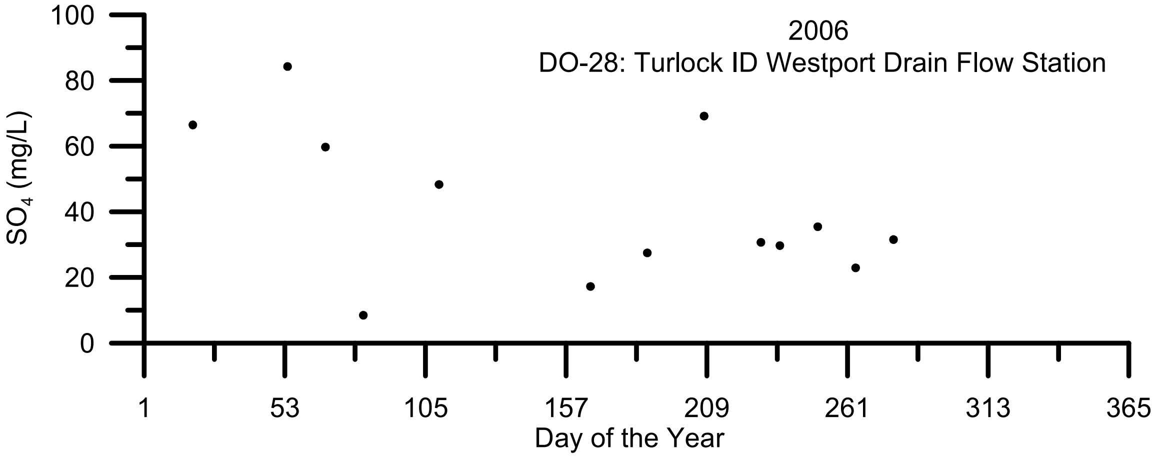
2007
DO-23: Modesto ID Lateral 5 to Tuolumne
SO4 (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

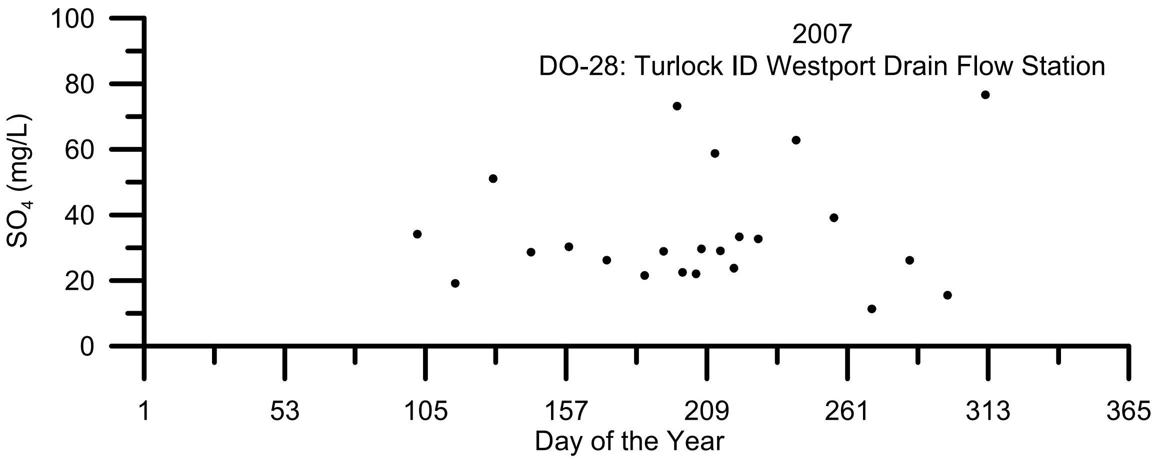

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
SO4 (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

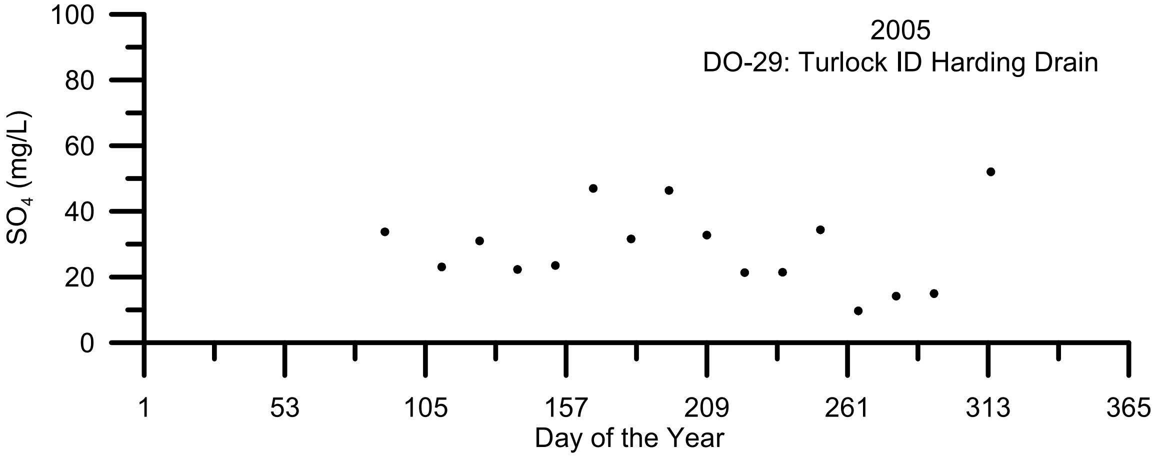

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
SO4 (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

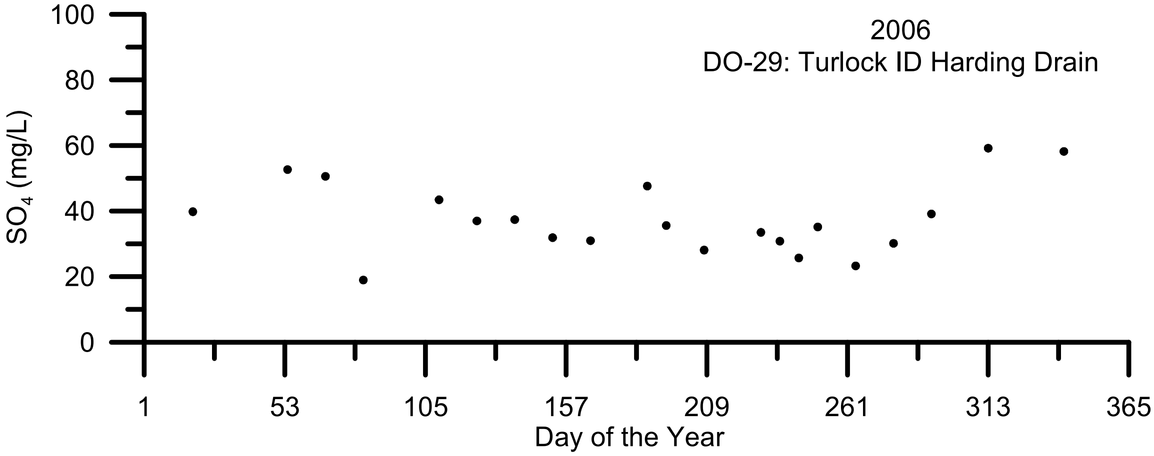

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
SO4 (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

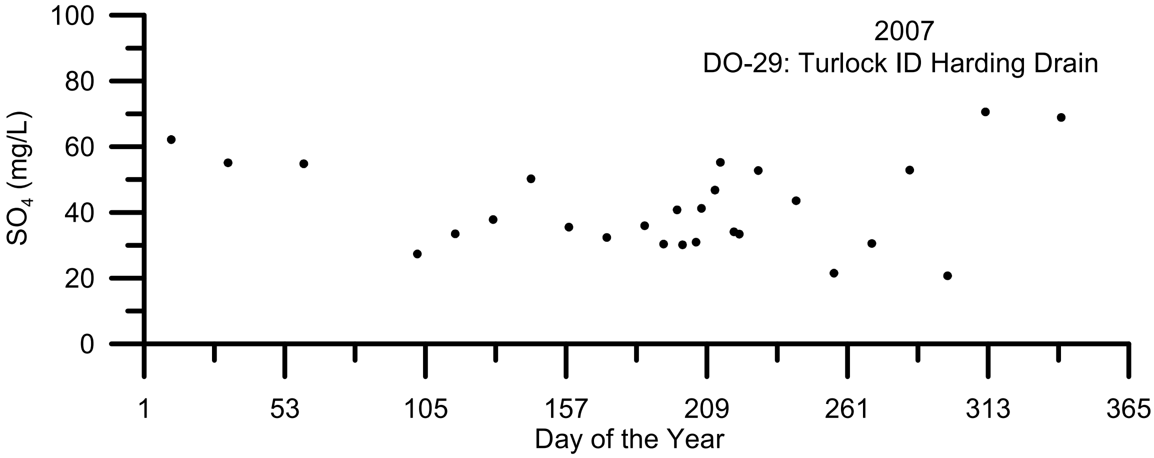

2005
DO-28: Turlock ID Westport Drain Flow Station
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

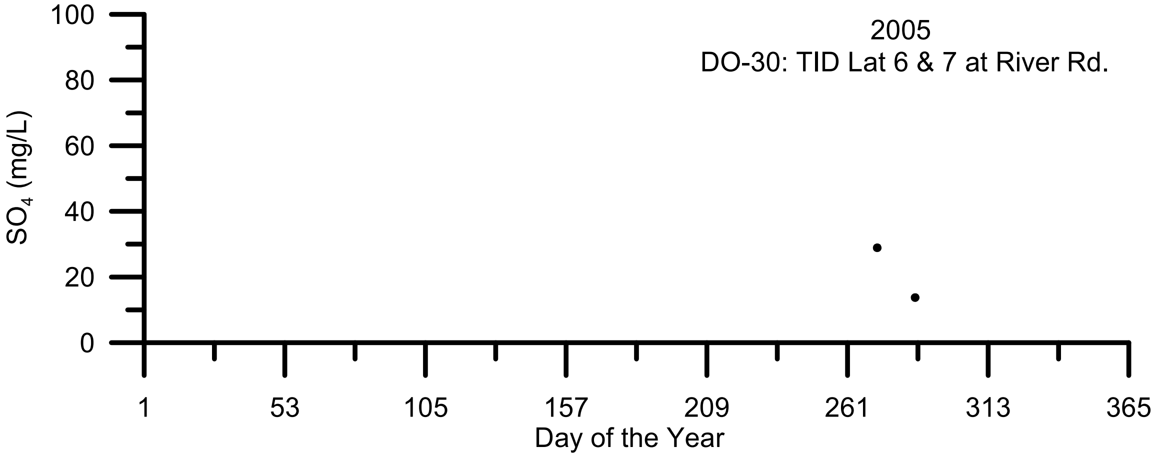

2006
DO-28: Turlock ID Westport Drain Flow Station
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

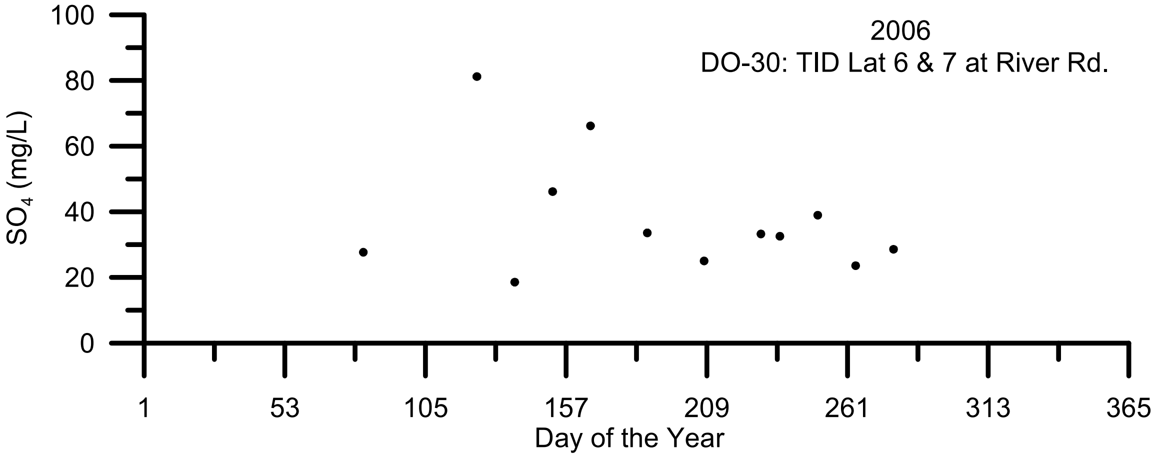

2007
DO-28: Turlock ID Westport Drain Flow Station
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

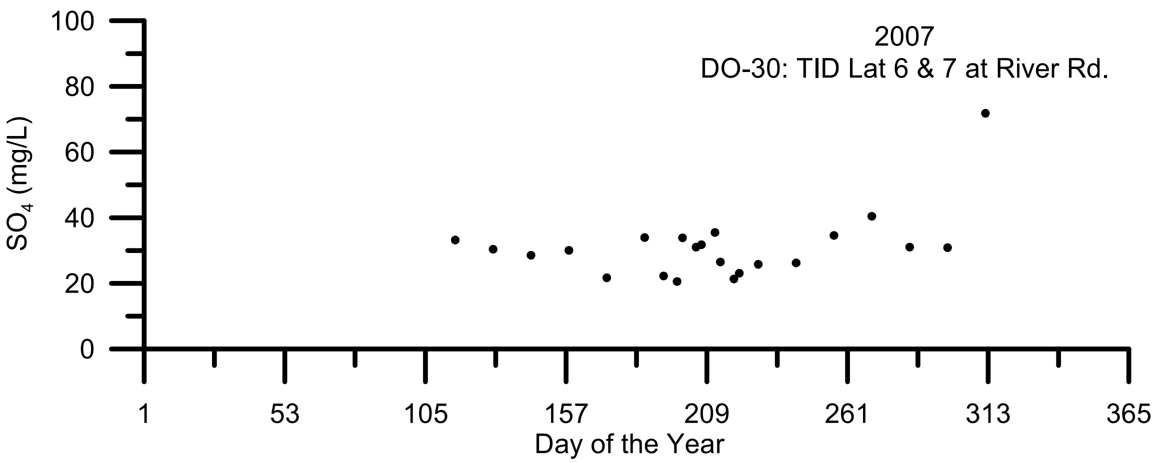

2005
DO-29: Turlock ID Harding Drain
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

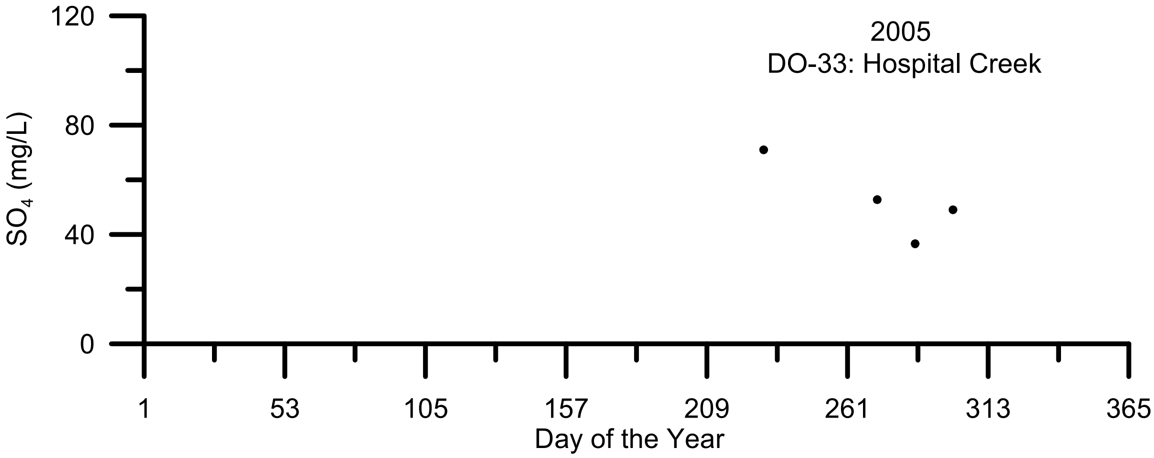

2006
DO-29: Turlock ID Harding Drain
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

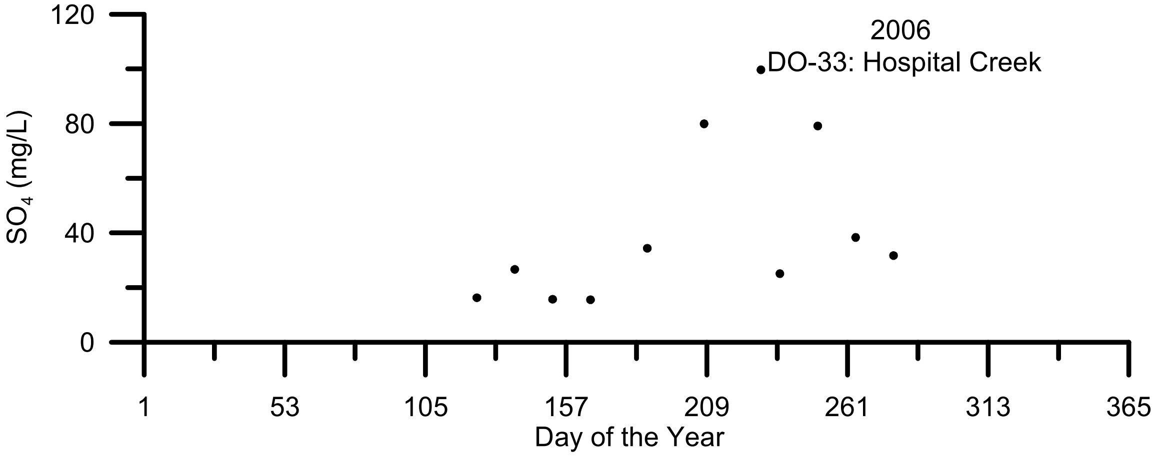

2007
DO-29: Turlock ID Harding Drain
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

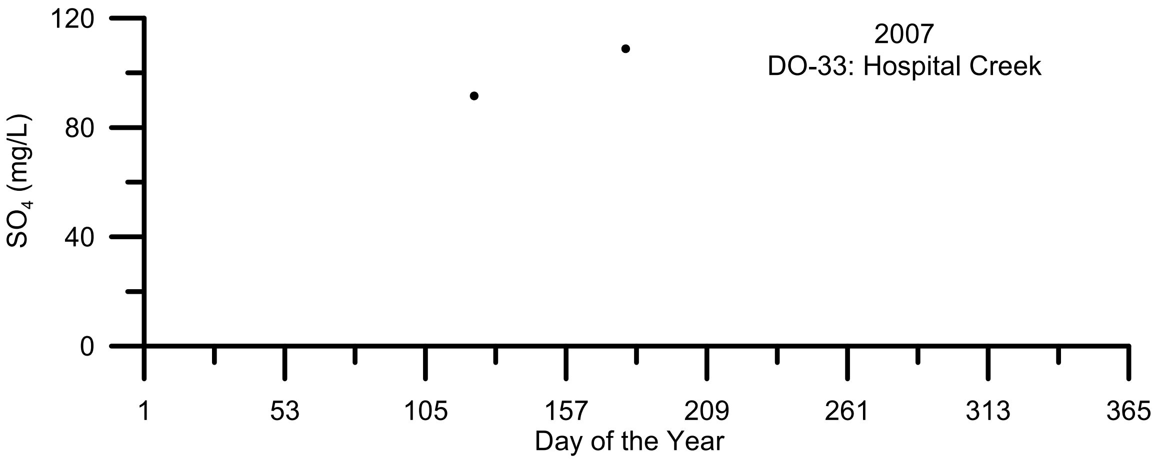

2005
DO-30: TID Lat 6 & 7 at River Rd.
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

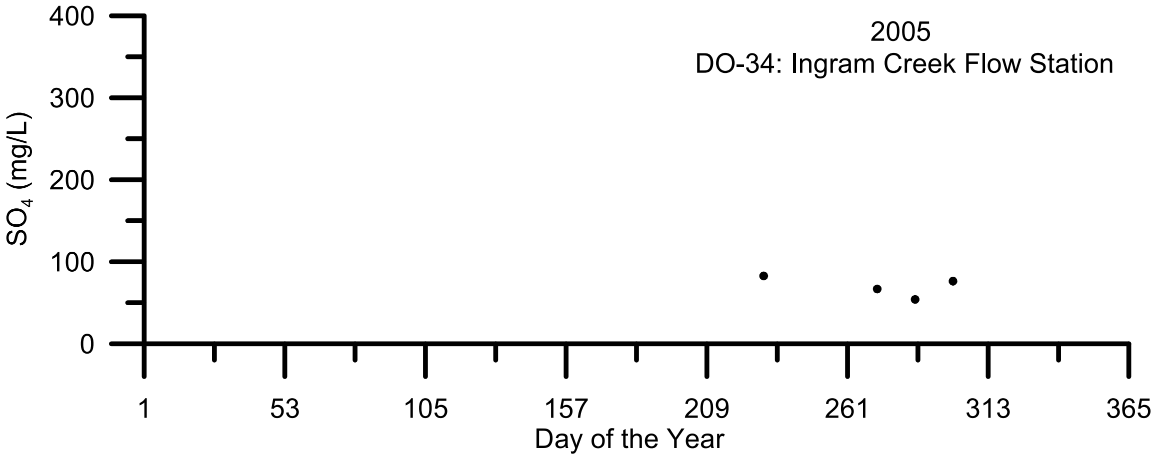

2006
DO-30: TID Lat 6 & 7 at River Rd.
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

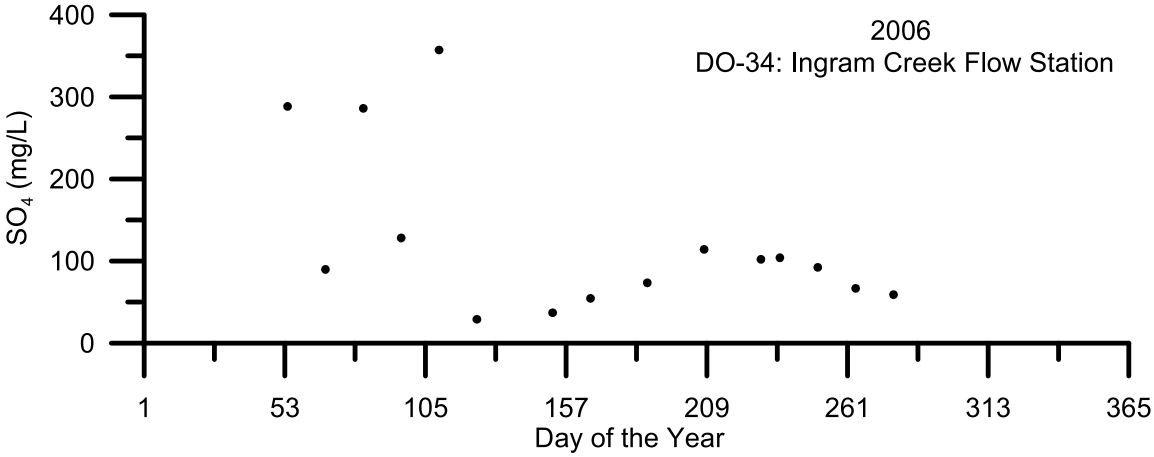

2007
DO-30: TID Lat 6 & 7 at River Rd.
SO4 (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

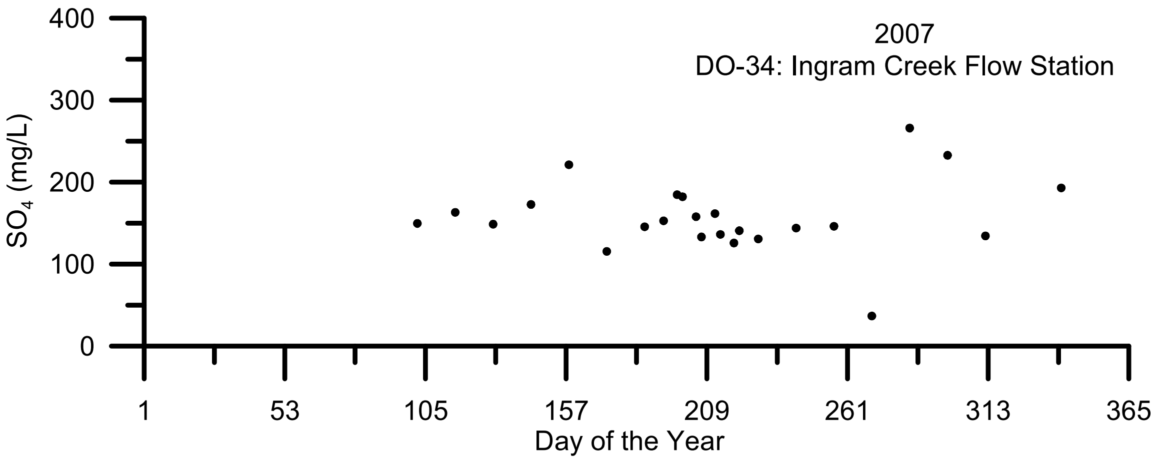

2005
DO-33: Hospital Creek
SO_4 (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

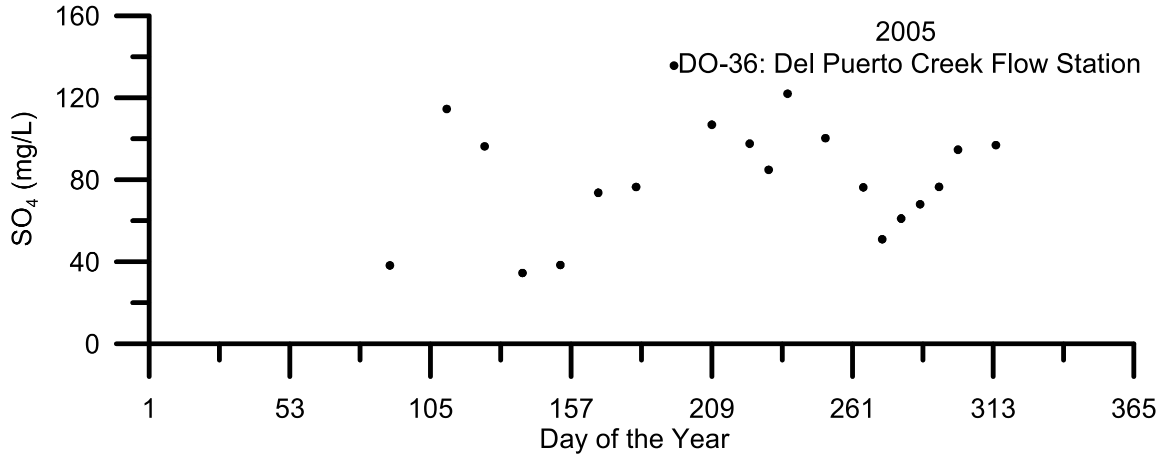

2006
DO-33: Hospital Creek
SO_4 (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

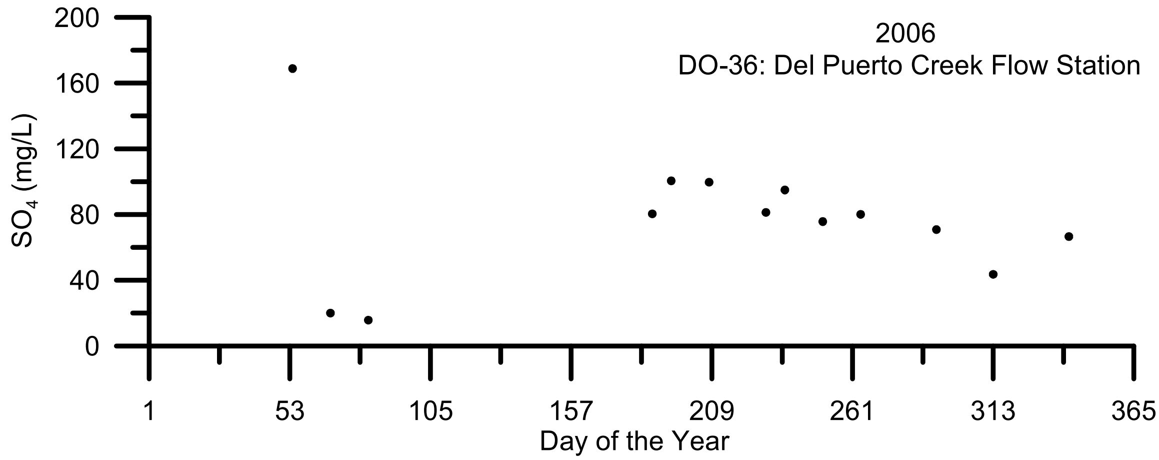

2007
DO-33: Hospital Creek
SO_4 (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

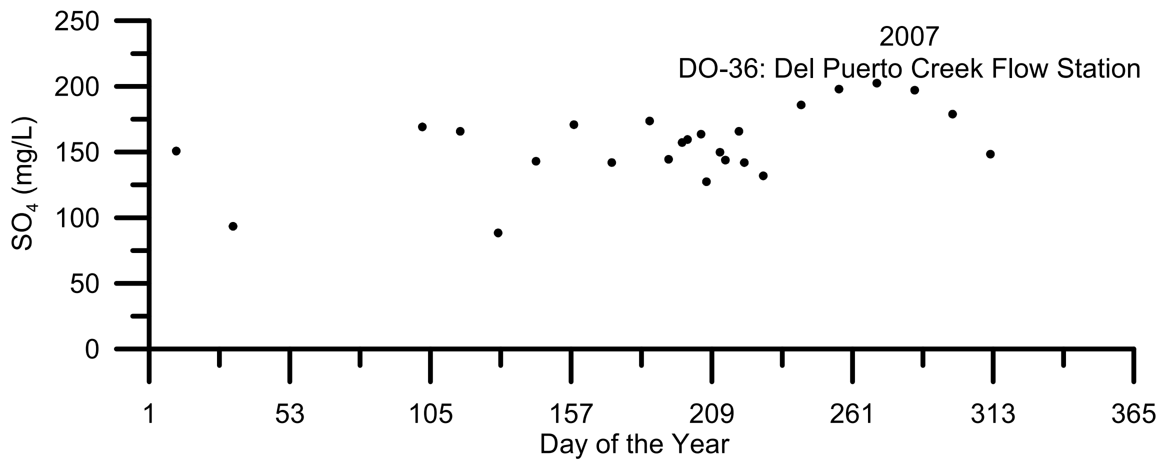

400
300
200
100
0
SO_4 (mg/L)
1
53
105
157
209
261
313
365
Day of the Year
2005
DO-34: Ingram Creek Flow Station

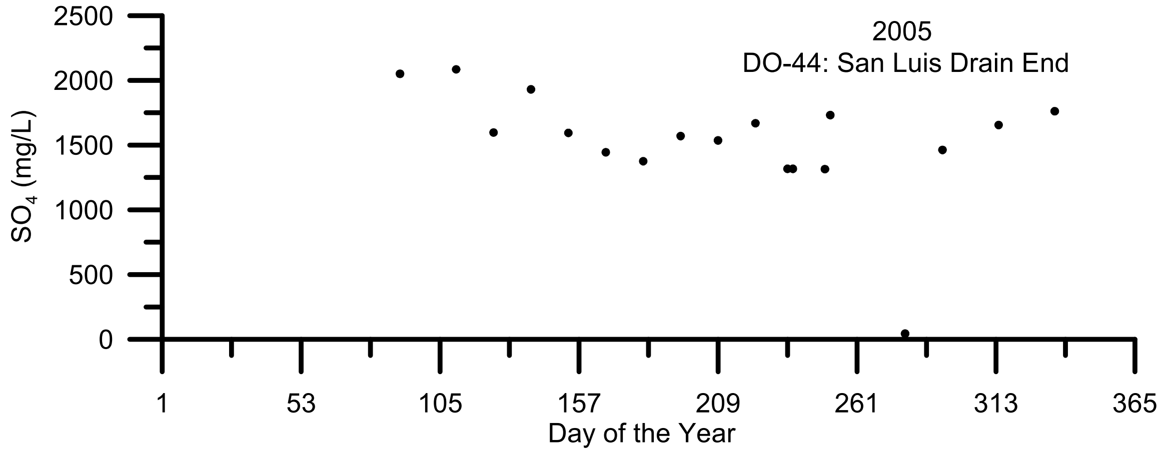

400
300
200
100
0
SO_4 (mg/L)
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-34: Ingram Creek Flow Station

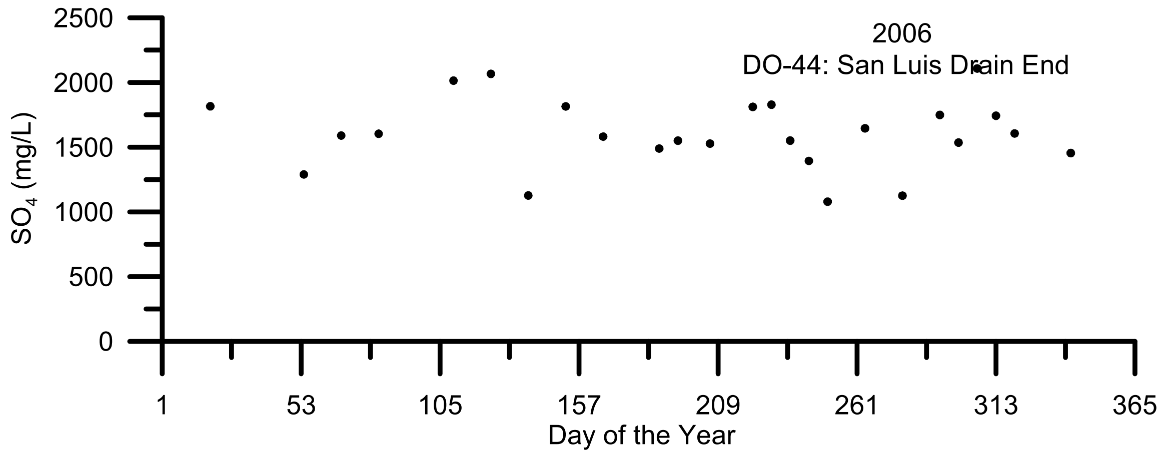

400
300
200
100
0
SO_4 (mg/L)
1
53
105
157
209
261
313
365
Day of the Year
2007
DO-34: Ingram Creek Flow Station

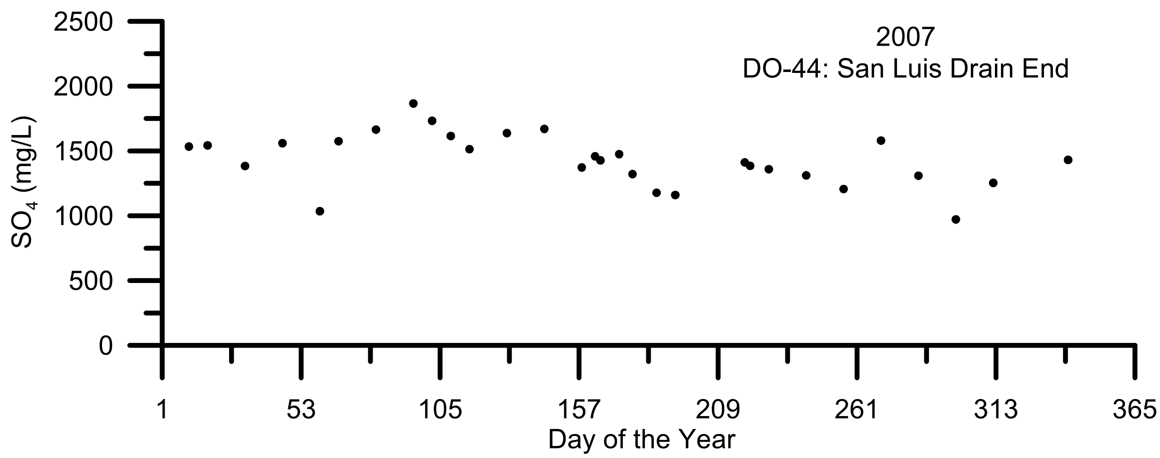

2005
DO-36: Del Puerto Creek Flow Station
SO4 (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

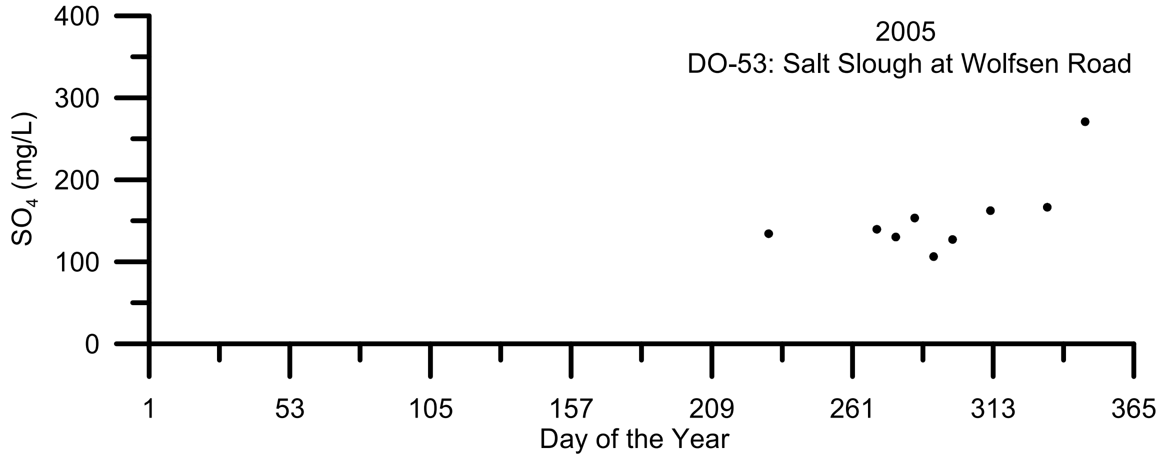

2006
DO-36: Del Puerto Creek Flow Station
SO4 (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

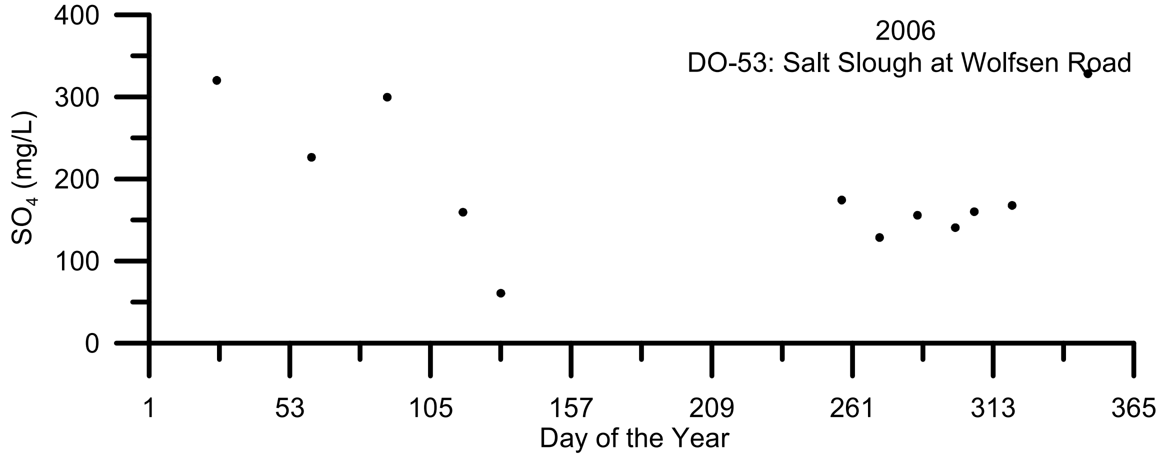

2007
DO-36: Del Puerto Creek Flow Station
SO4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

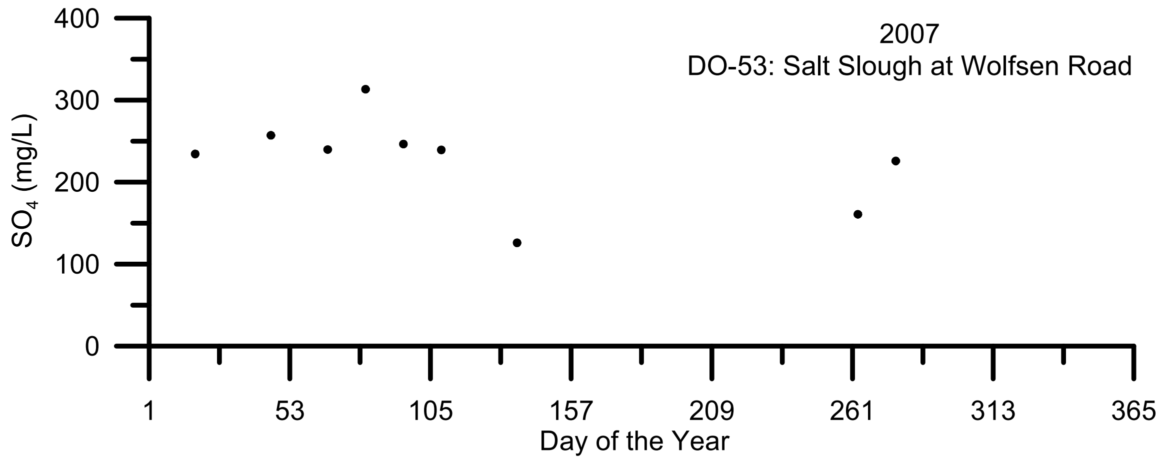

2005
DO-44: San Luis Drain End
SO4 (mg/L)
2500
2000
1500
1000
500
0
1
53
105
157
209
261
313
365
Day of the Year

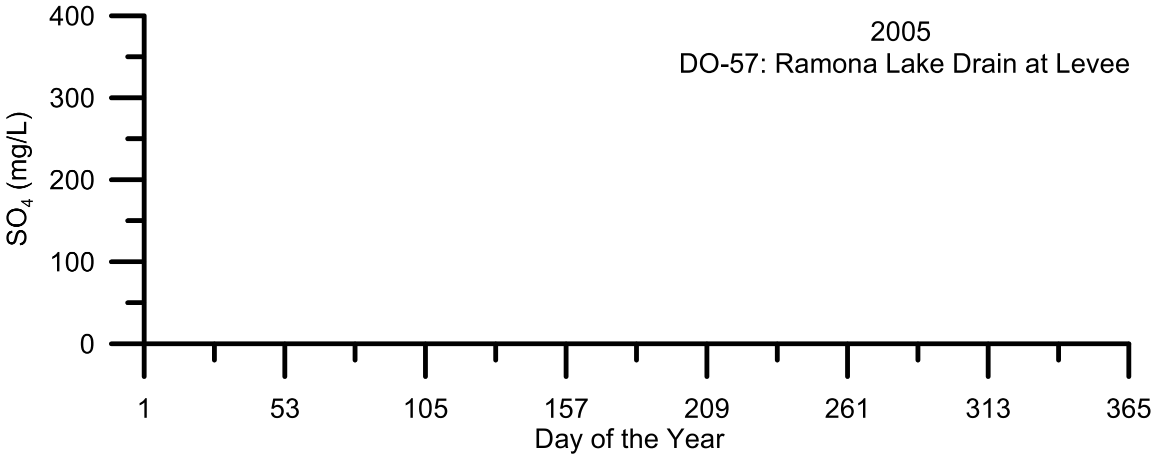

2006
DO-44: San Luis Drain End
SO4 (mg/L)
2500
2000
1500
1000
500
0
1
53
105
157
209
261
313
365
Day of the Year

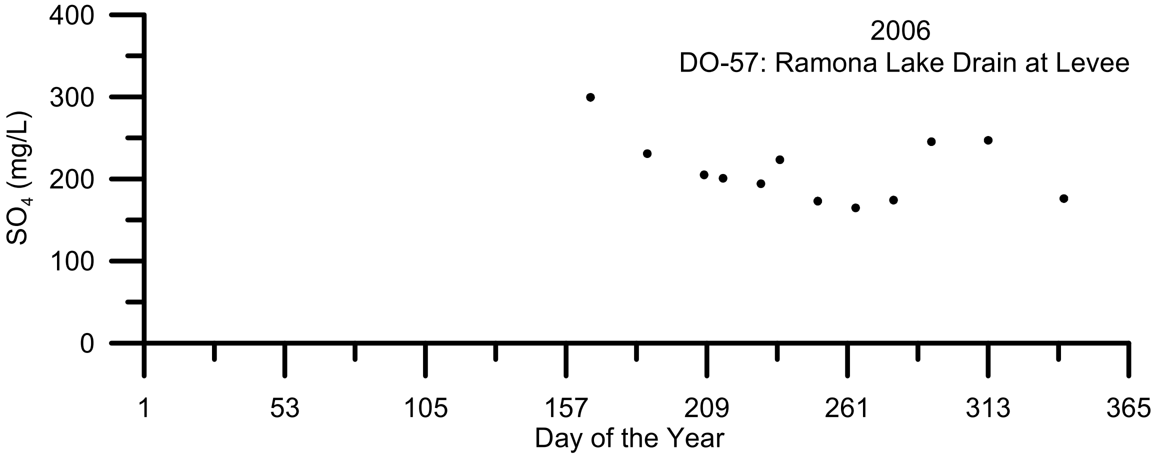

2007
DO-44: San Luis Drain End
SO4 (mg/L)
2500
2000
1500
1000
500
0
1
53
105
157
209
261
313
365
Day of the Year

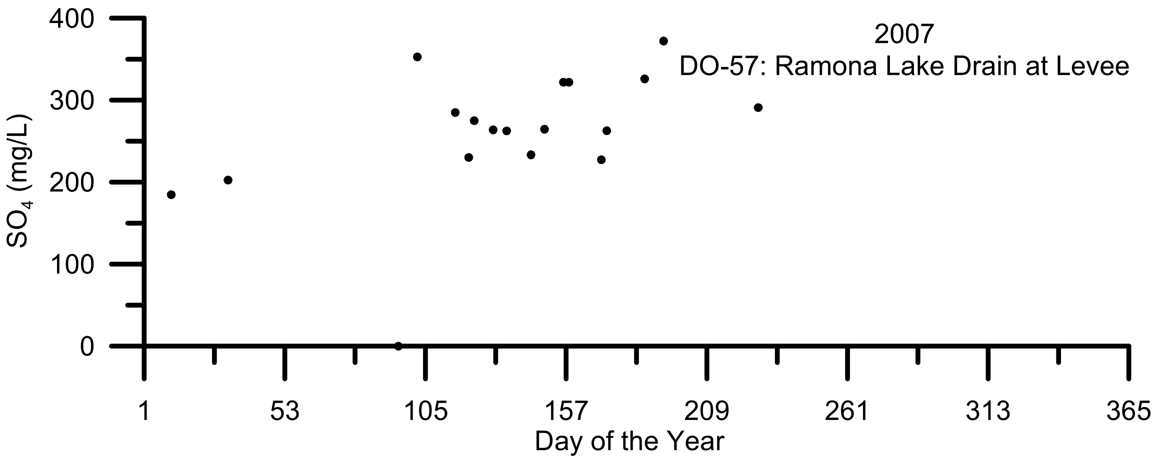

2005
DO-53: Salt Slough at Wolfsen Road
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

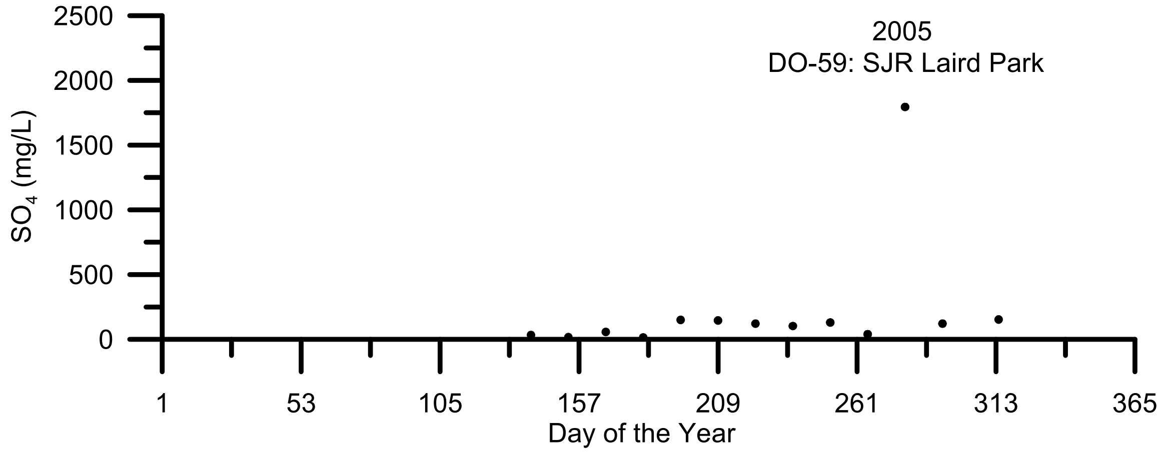

2006
DO-53: Salt Slough at Wolfsen Road
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

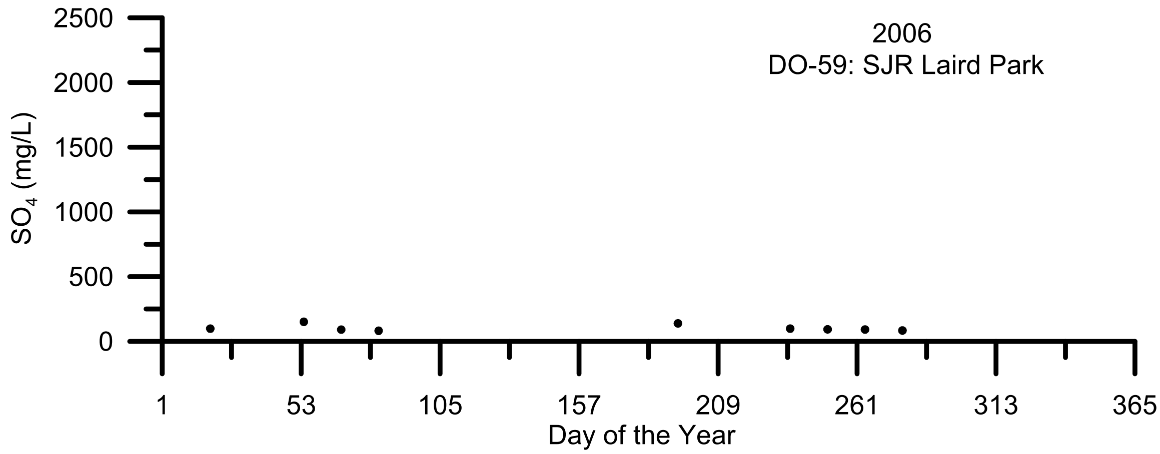

2007
DO-53: Salt Slough at Wolfsen Road
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

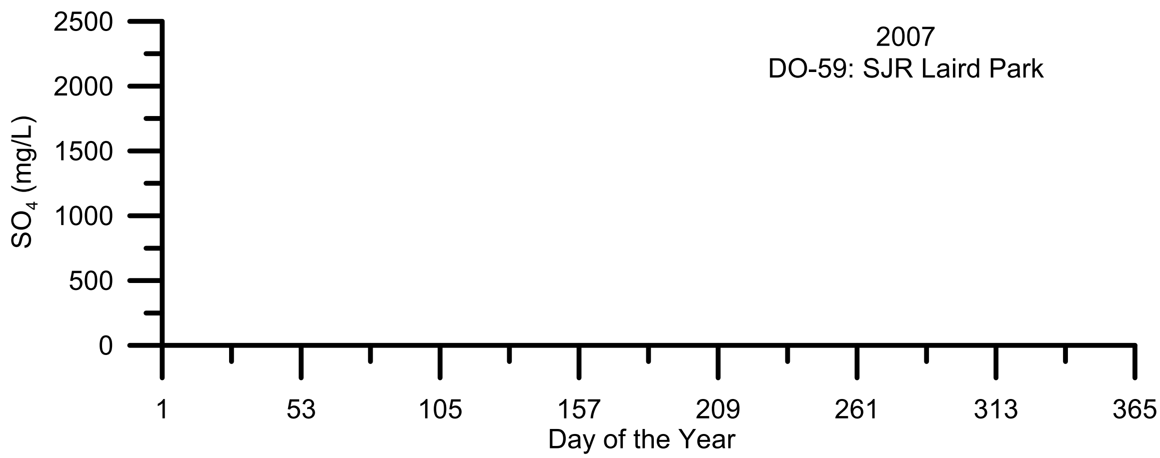

2005
DO-57: Ramona Lake Drain at Levee
SO4 (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

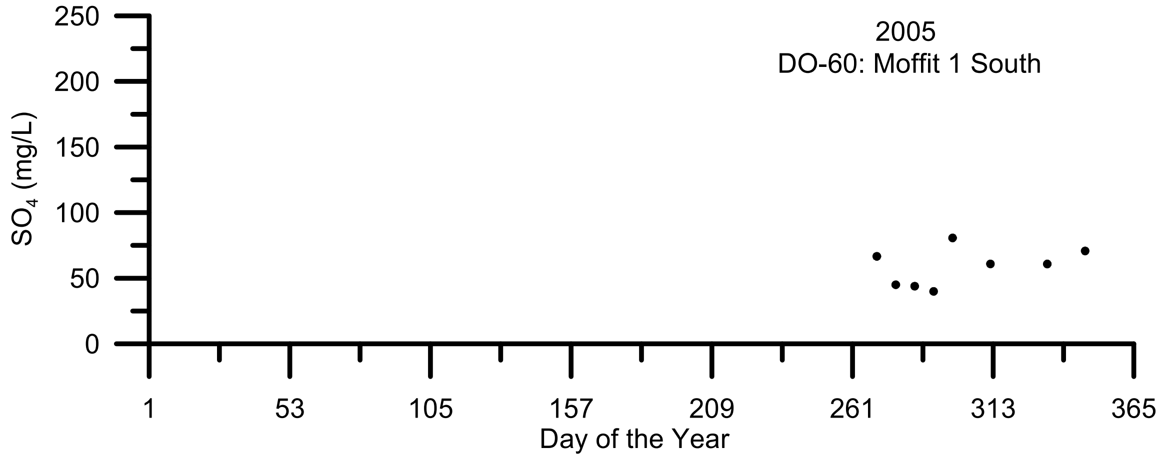

2006
DO-57: Ramona Lake Drain at Levee
SO4 (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

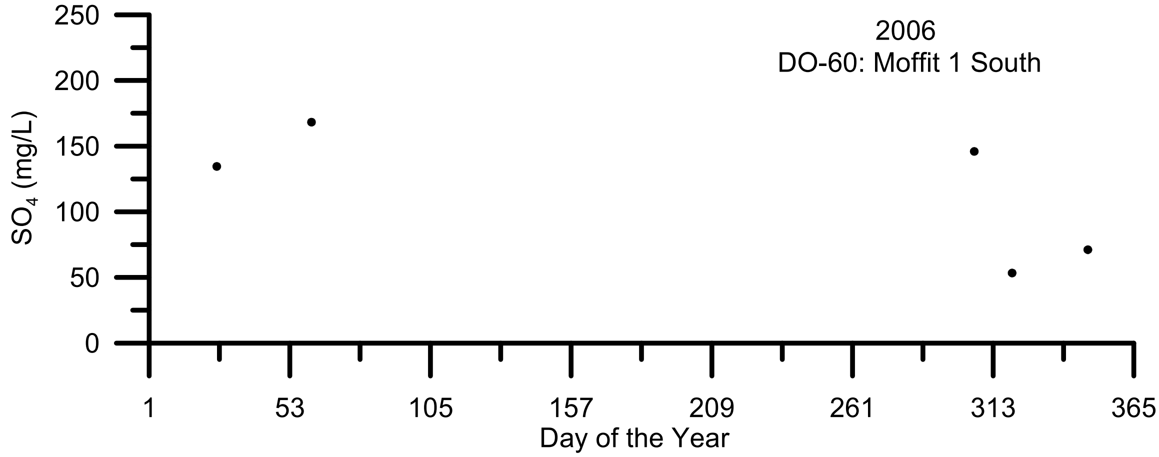

2007
DO-57: Ramona Lake Drain at Levee
SO4 (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

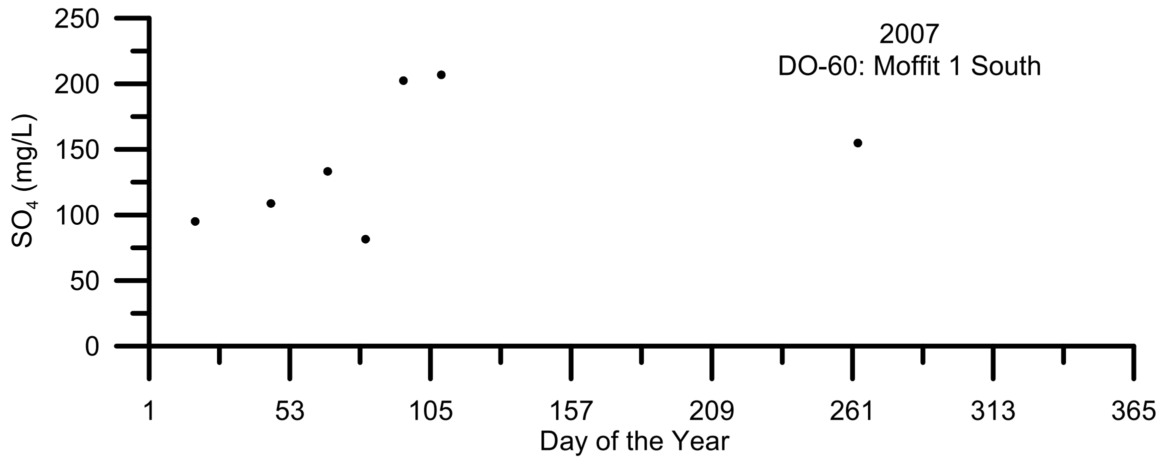

2005
DO-59: SJR Laird Park
SO4 (mg/L)
0
500
1000
1500
2000
2500
1
53
105
157
209
261
313
365
Day of the Year

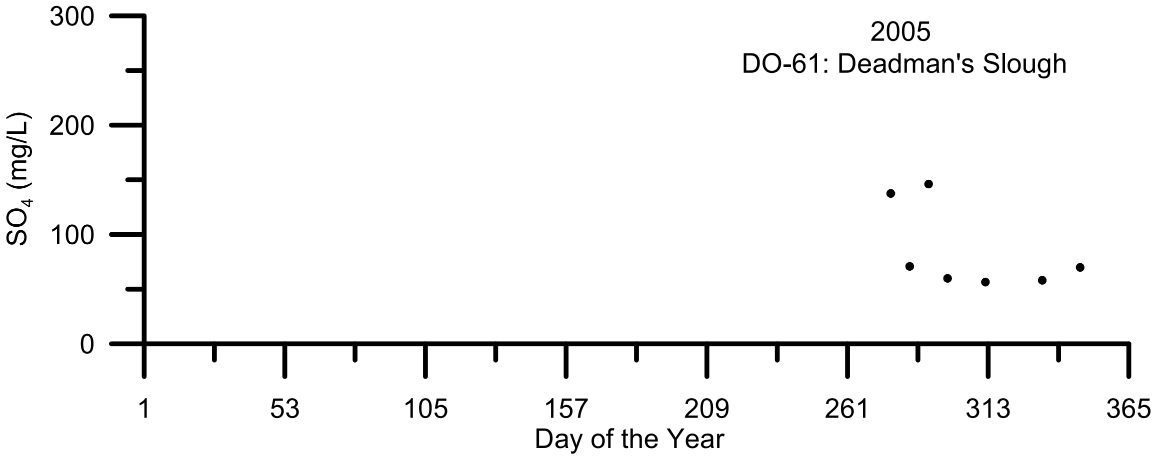

2006
DO-59: SJR Laird Park
SO4 (mg/L)
0
500
1000
1500
2000
2500
1
53
105
157
209
261
313
365
Day of the Year

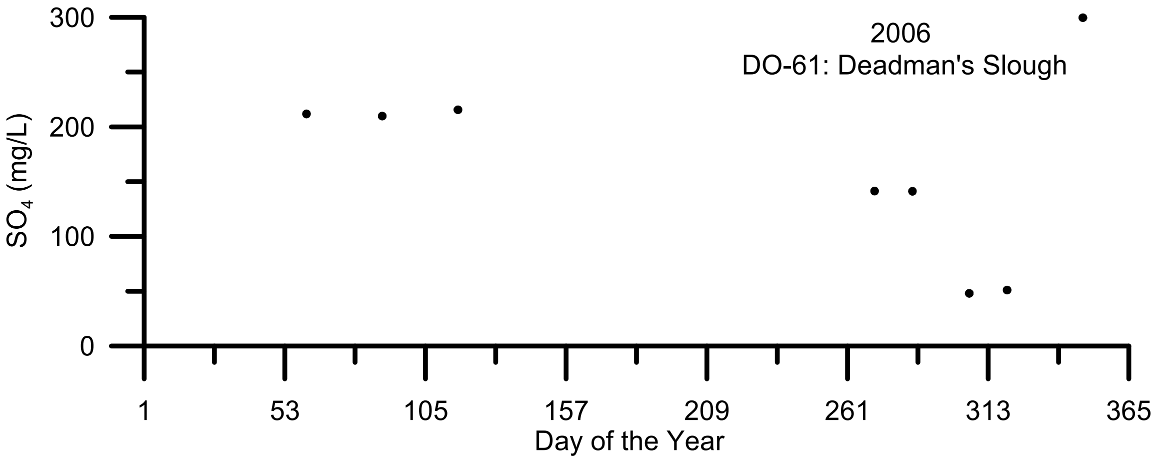

2007
DO-59: SJR Laird Park
SO4 (mg/L)
0
500
1000
1500
2000
2500
1
53
105
157
209
261
313
365
Day of the Year

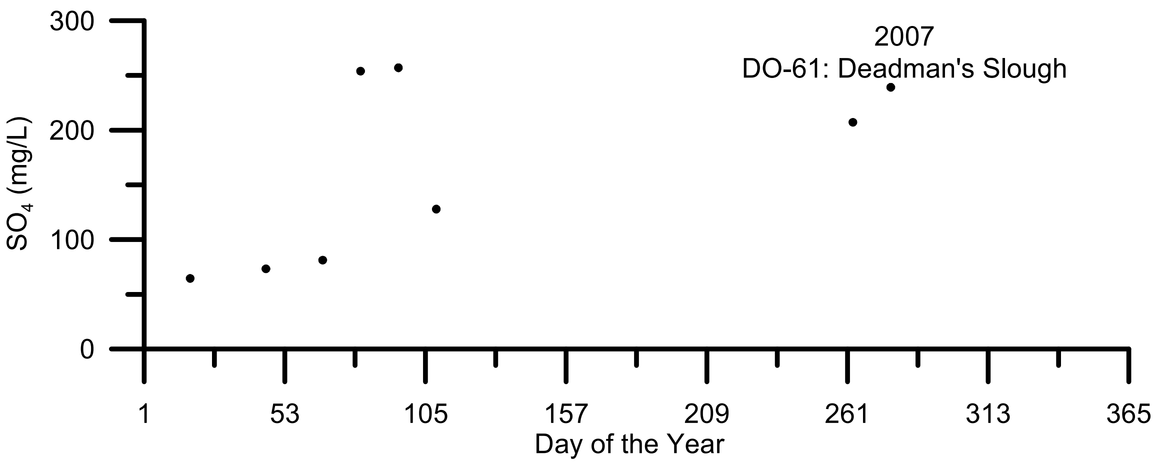

2005
DO-60: Moffit 1 South
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

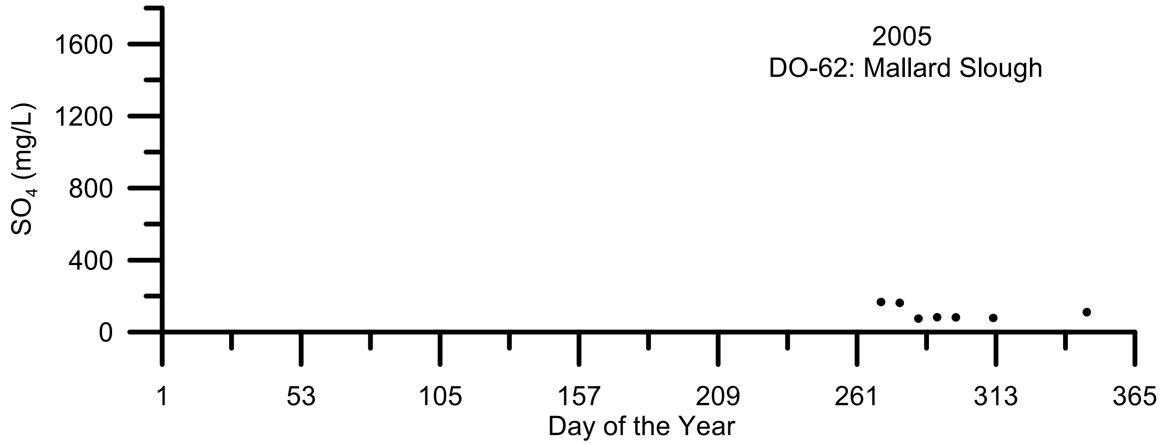

2006
DO-60: Moffit 1 South
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

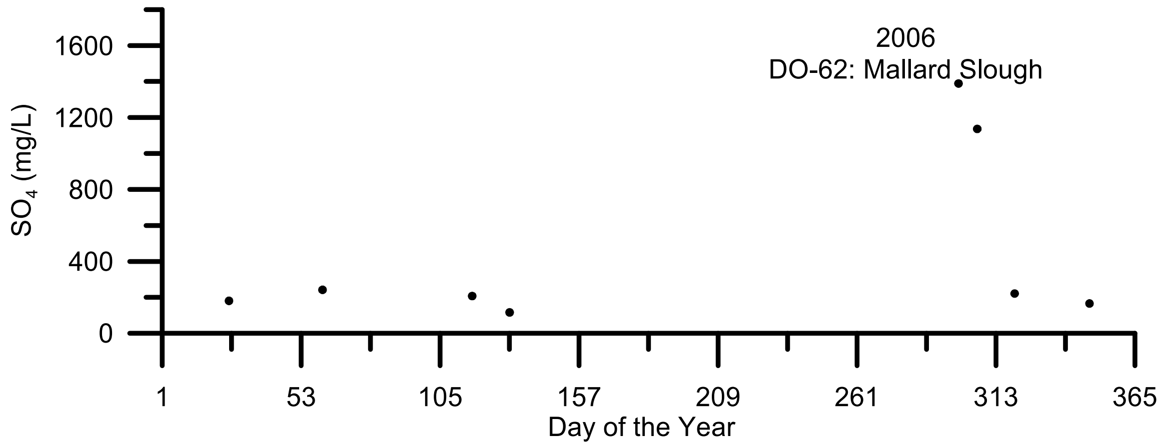

2007
DO-60: Moffit 1 South
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

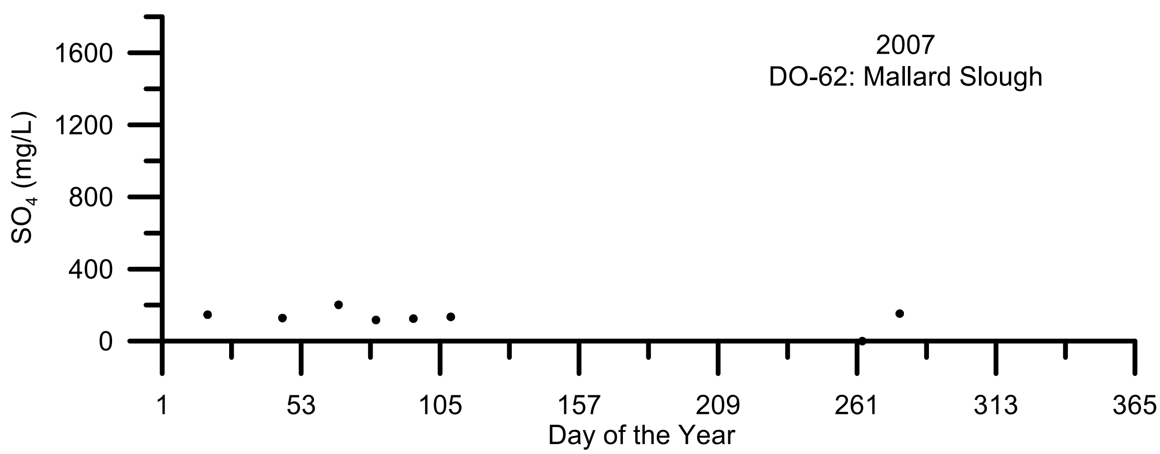

2005
DO-61: Deadman's Slough
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

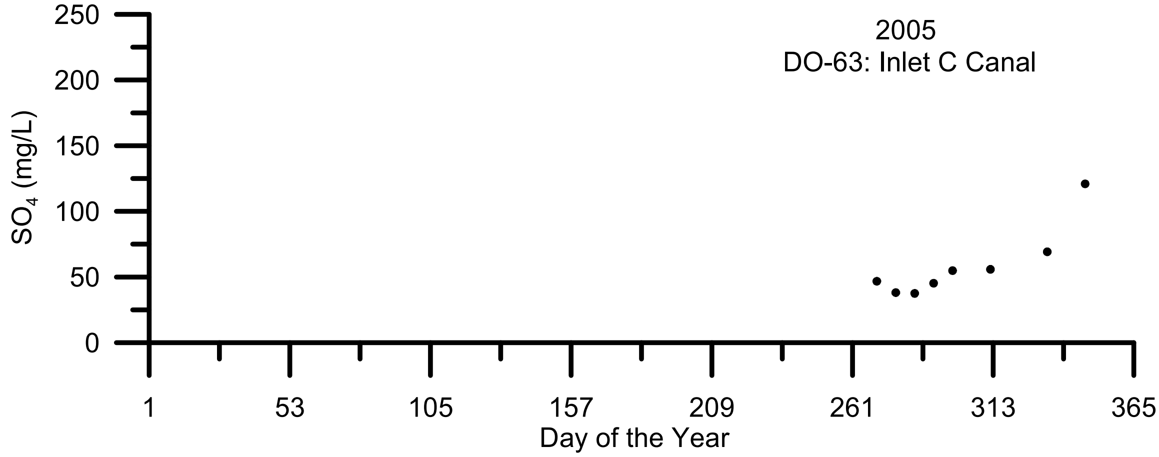

2006
DO-61: Deadman's Slough
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-61: Deadman's Slough
SO4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

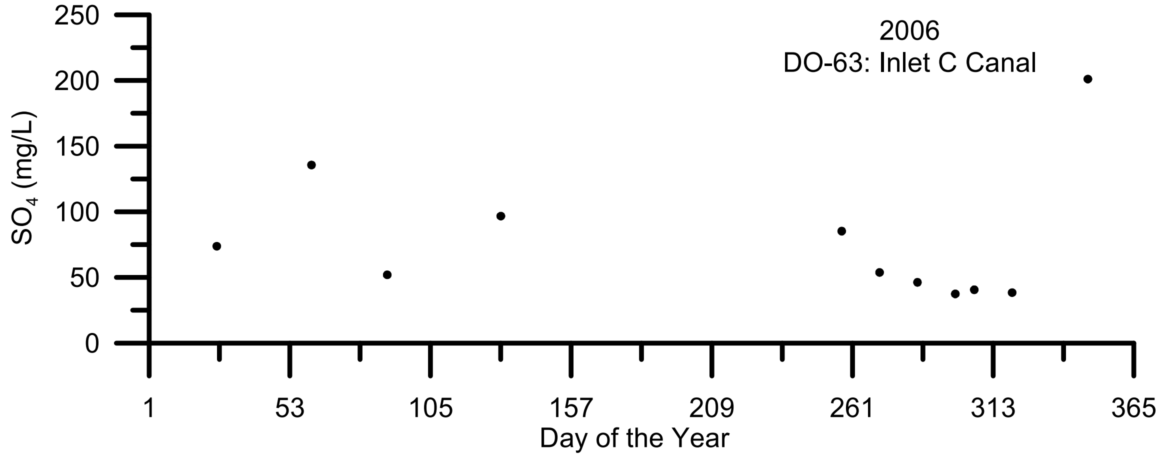

2005
DO-62: Mallard Slough
SO_4 (mg/L)
1600
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-62: Mallard Slough
SO_4 (mg/L)
1600
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year

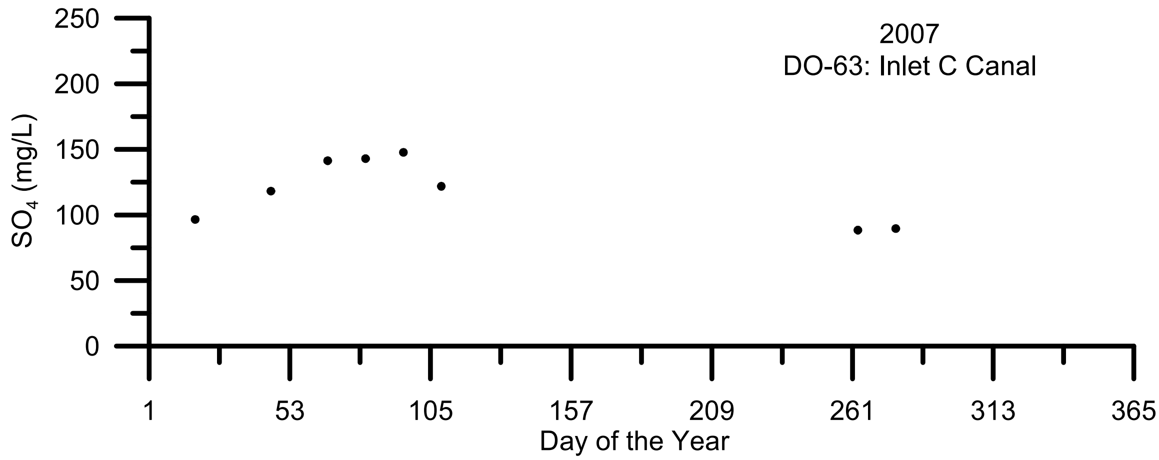

2007
DO-62: Mallard Slough
SO_4 (mg/L)
1600
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year



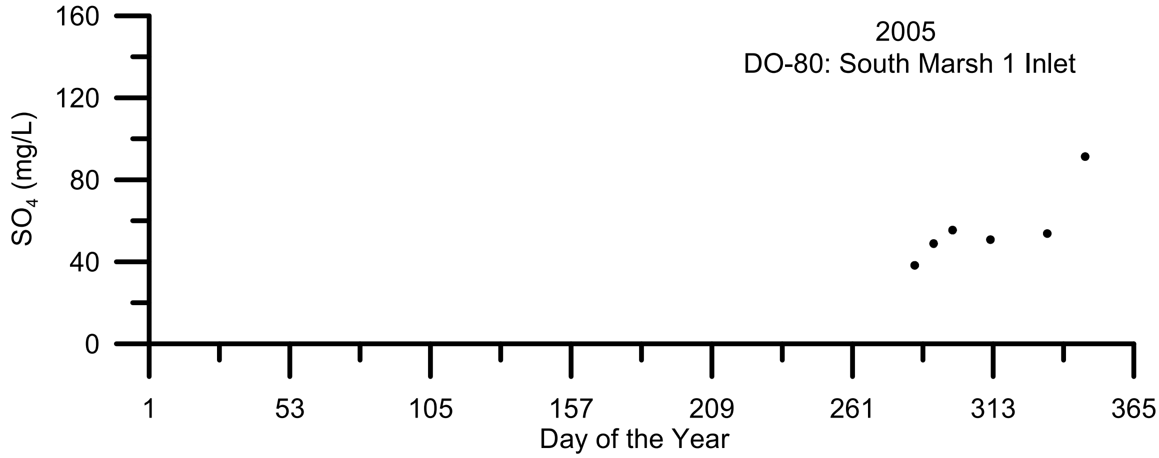
2005
DO-63: Inlet C Canal
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

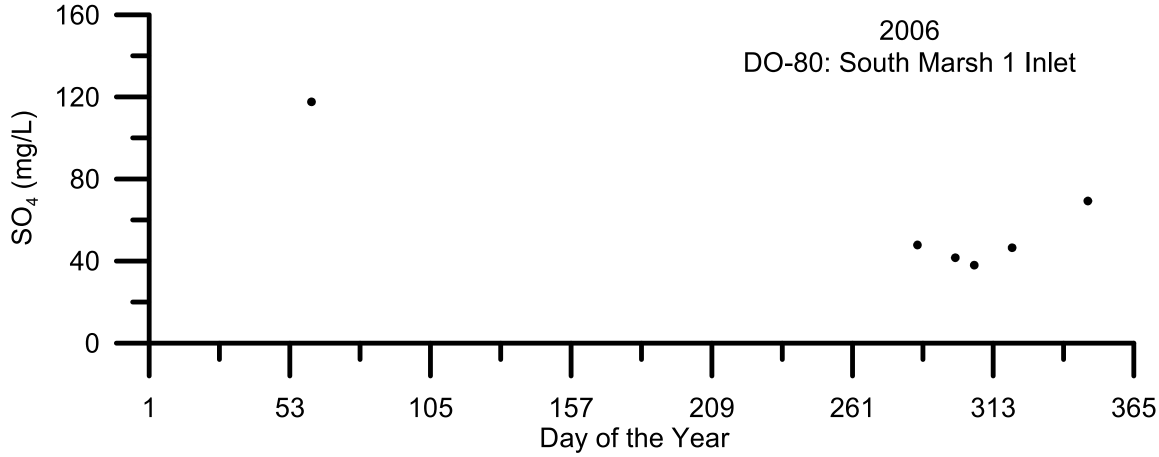


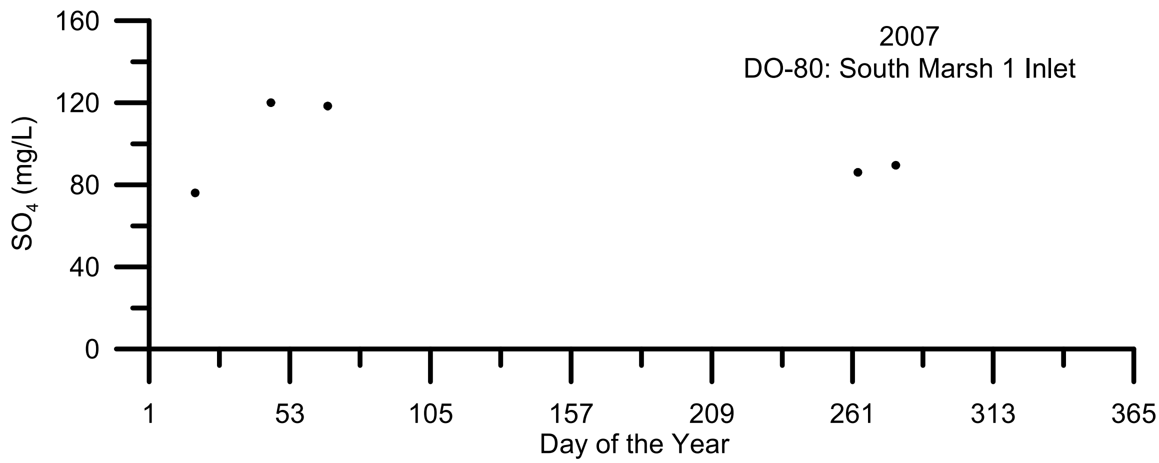
2006
DO-63: Inlet C Canal
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

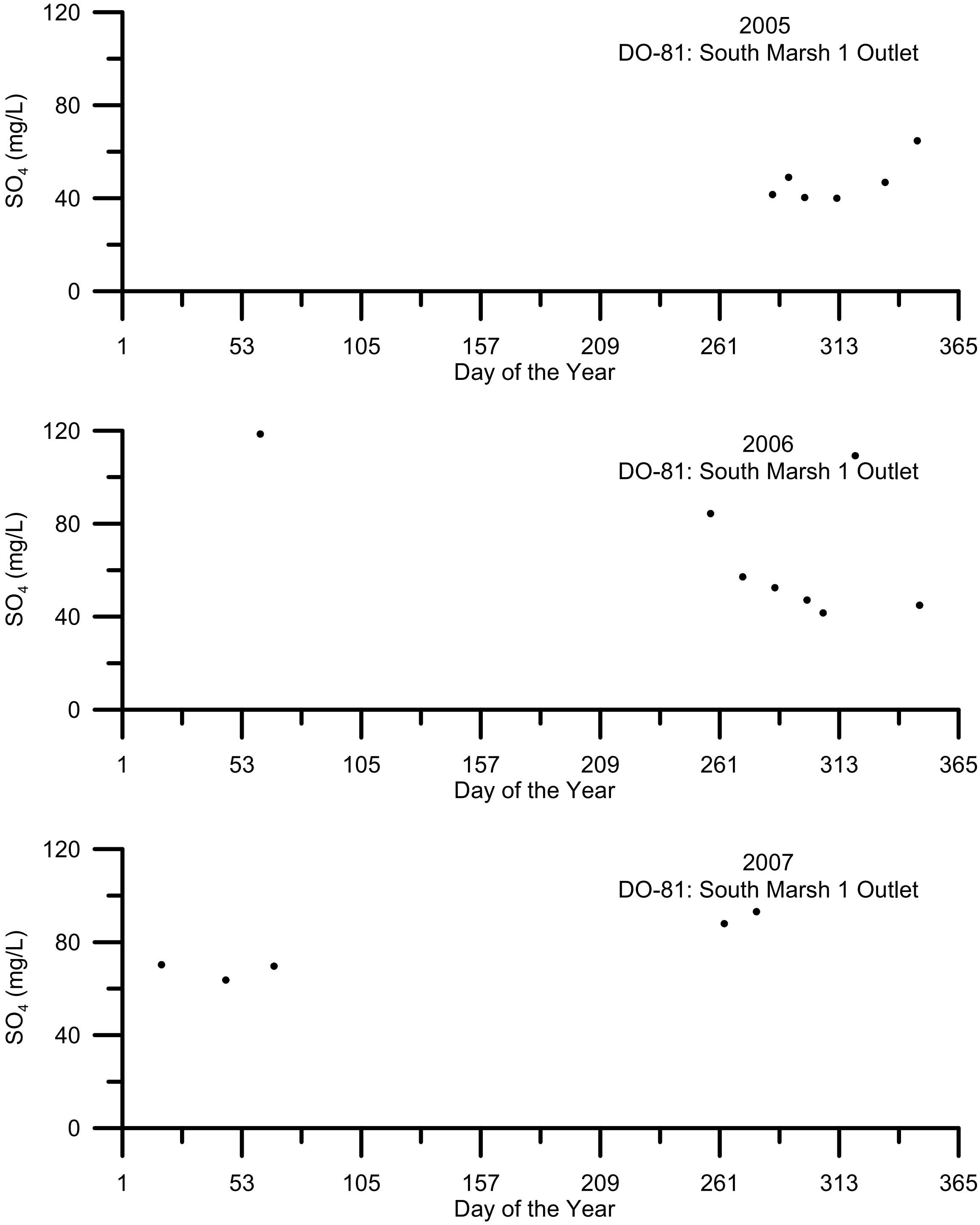


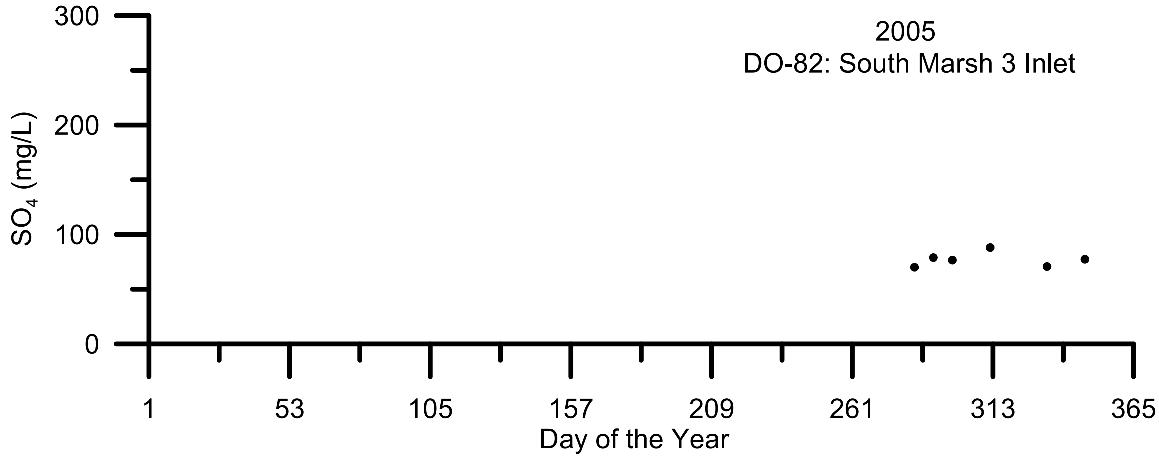
2007
DO-63: Inlet C Canal
SO_4 (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

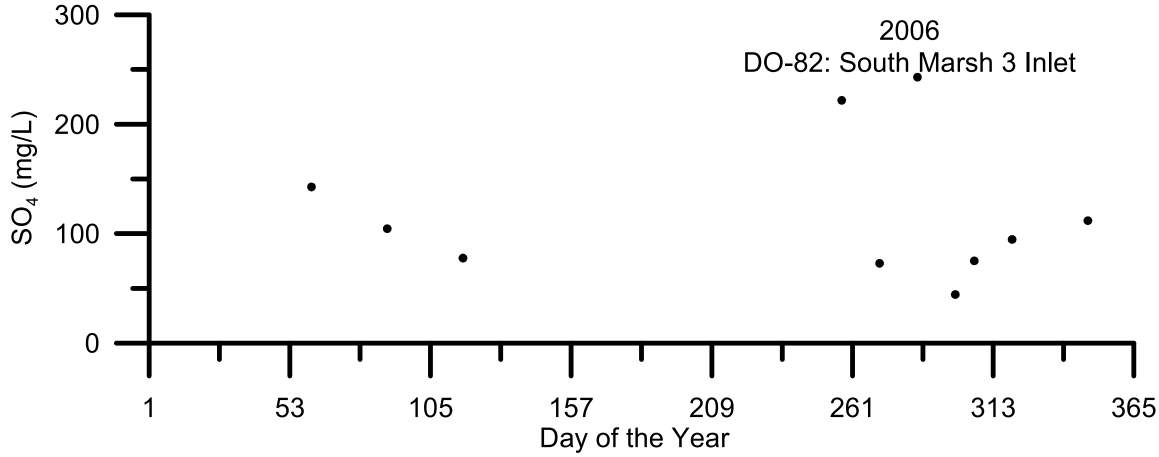

2005
DO-80: South Marsh 1 Inlet
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

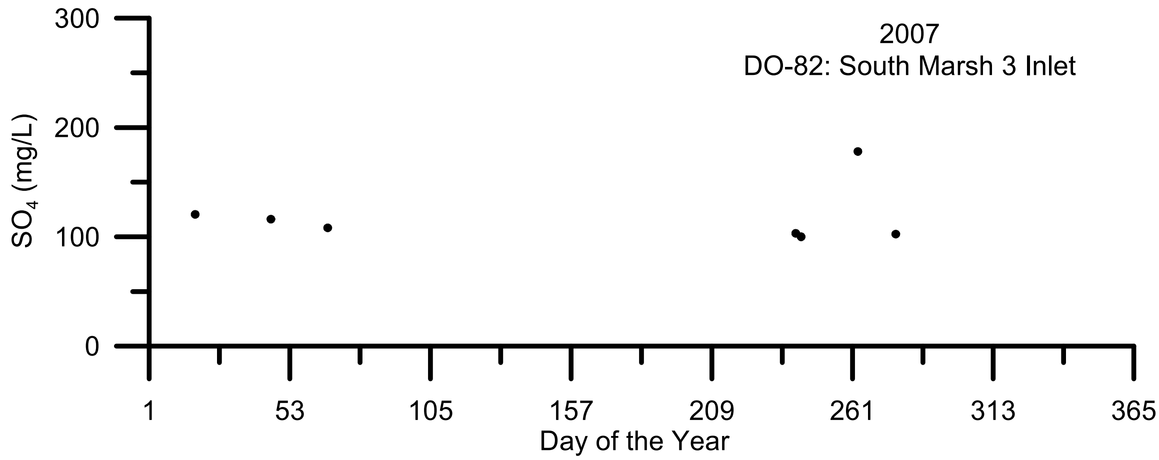

2006
DO-80: South Marsh 1 Inlet
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

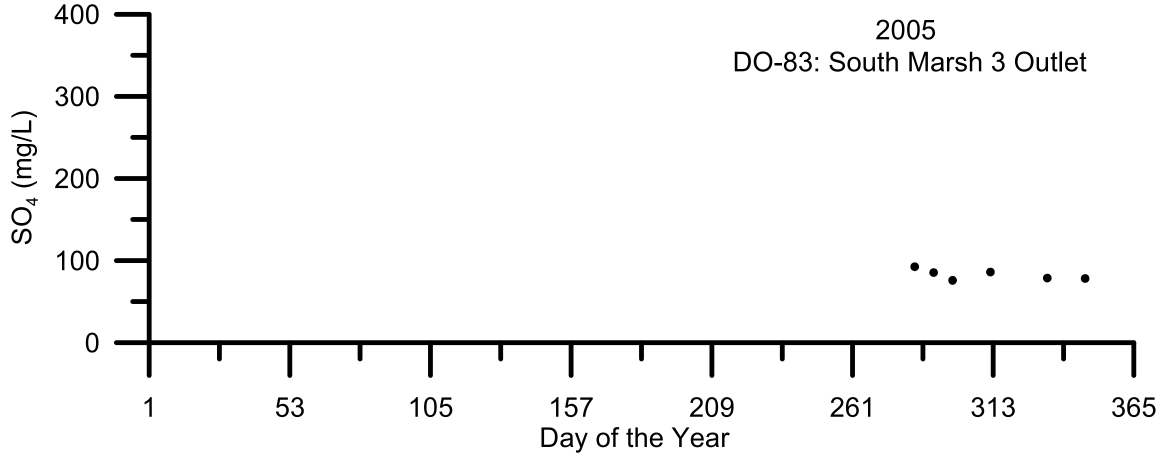

2007
DO-80: South Marsh 1 Inlet
SO4 (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

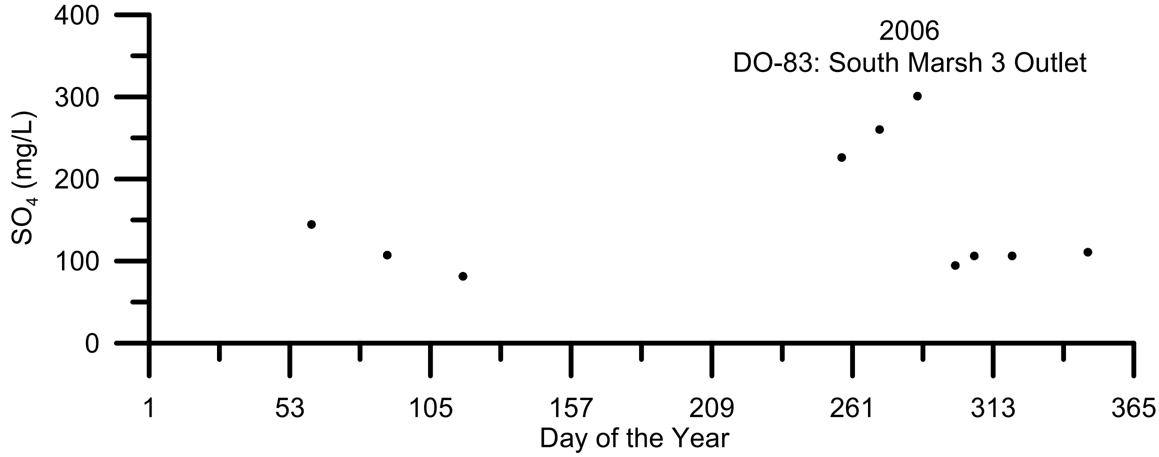

120
80
40
0
SO4 (mg/L)
2005
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year
120
80
40
0
SO4 (mg/L)
2006
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year
120
80
40
0
SO4 (mg/L)
2007
DO-81: South Marsh 1 Outlet
1
53
105
157
209
261
313
365
Day of the Year

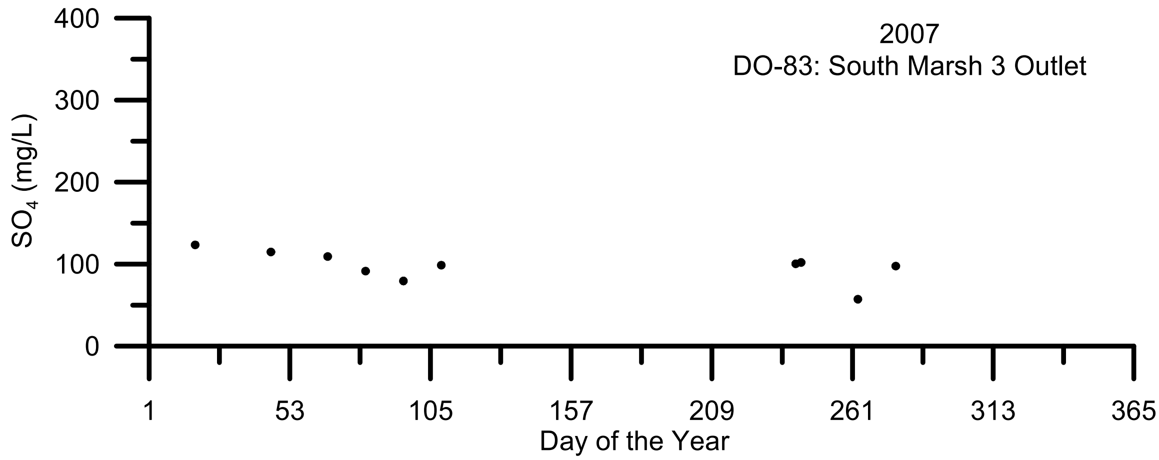

2005
DO-82: South Marsh 3 Inlet
SO_4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

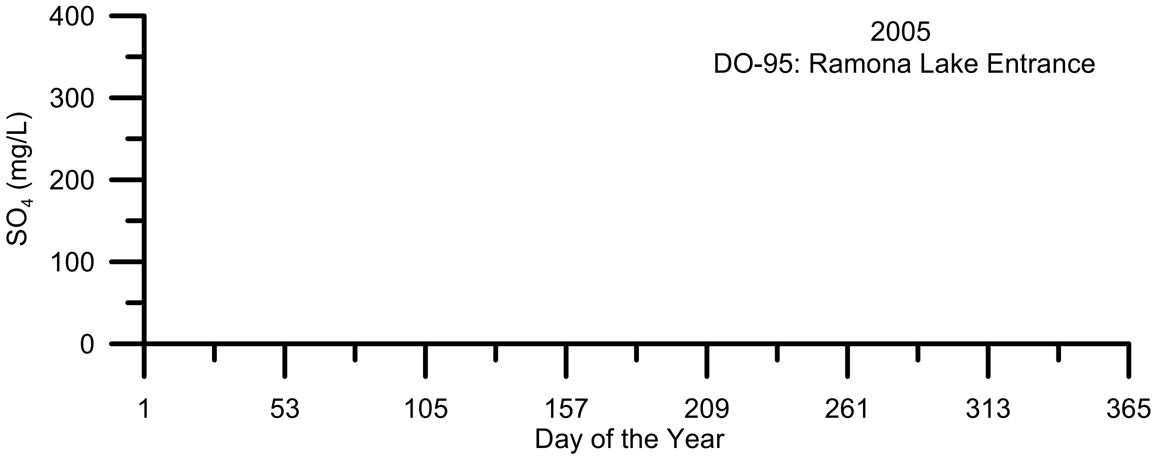

2006
DO-82: South Marsh 3 Inlet
SO_4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-82: South Marsh 3 Inlet
SO_4 (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

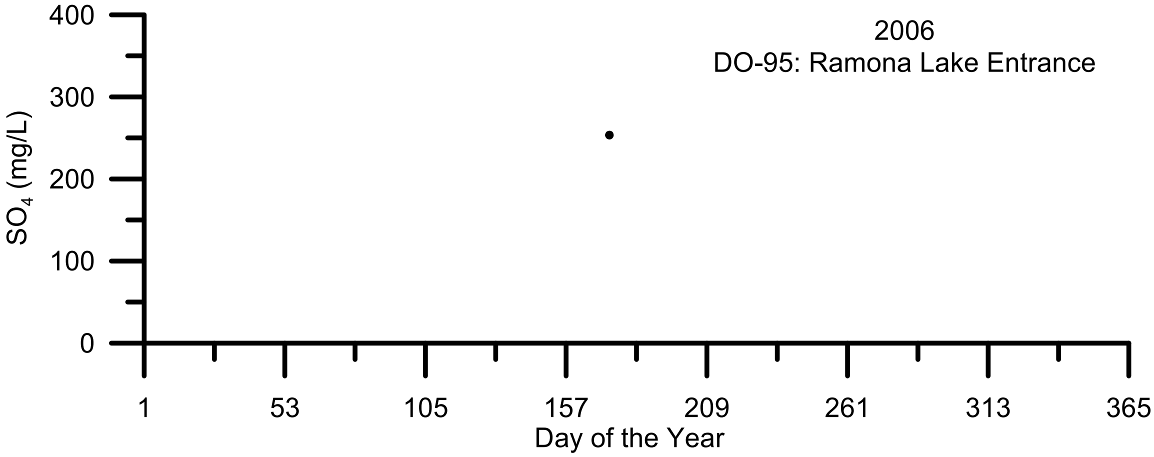

2005
DO-83: South Marsh 3 Outlet
SO4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
SO4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

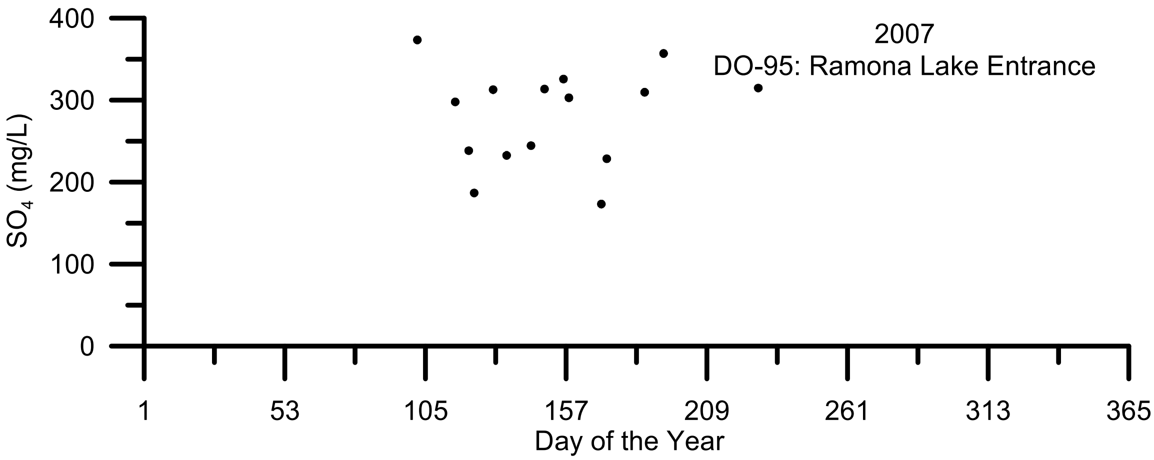

2007
DO-83: South Marsh 3 Outlet
SO4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



2005
DO-95: Ramona Lake Entrance
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Lake Entrance
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Lake Entrance
SO_4 (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Sodium Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of sodium (Na) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at $4^{\circ}C$.

Ion chromatography was utilized for measuring Na^+ using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (ASTM D6919-03). The reportable limit for this method is 0.05 mg/L Na^+ .

Results/Discussion

Samples were measured ranging from 0.0-1043 mg/L Na. The average concentration of Na in water samples collected was 159.31 mg/L Na. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

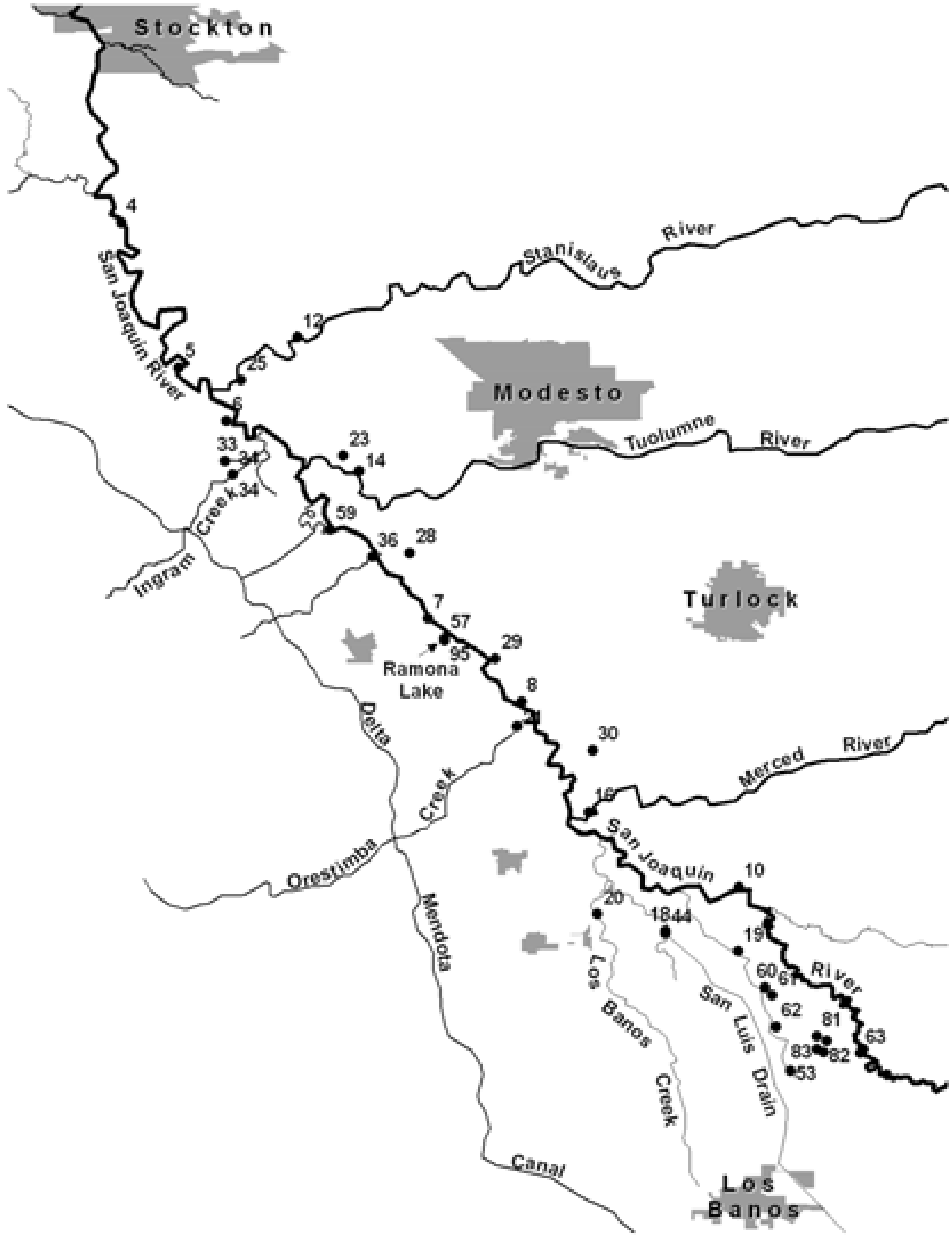
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

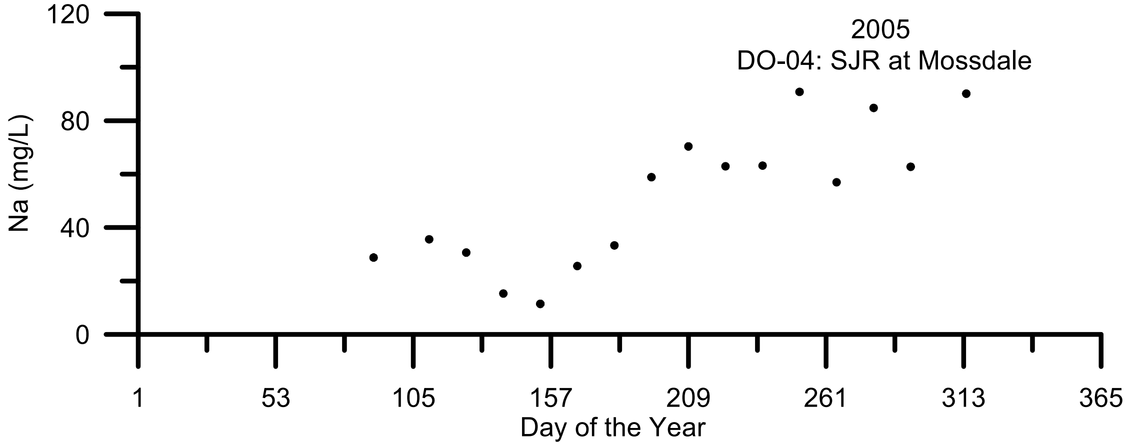
Table 1: EERP Sampling Site List

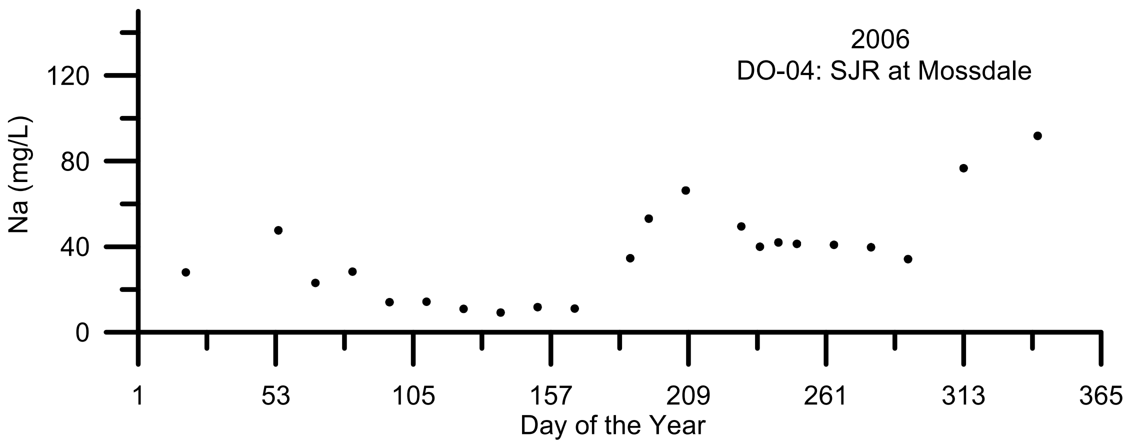
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

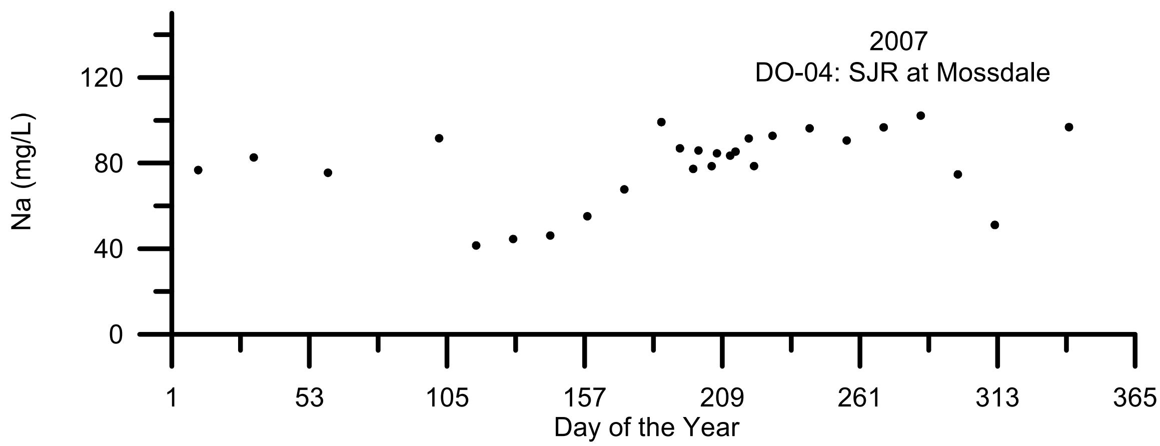
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

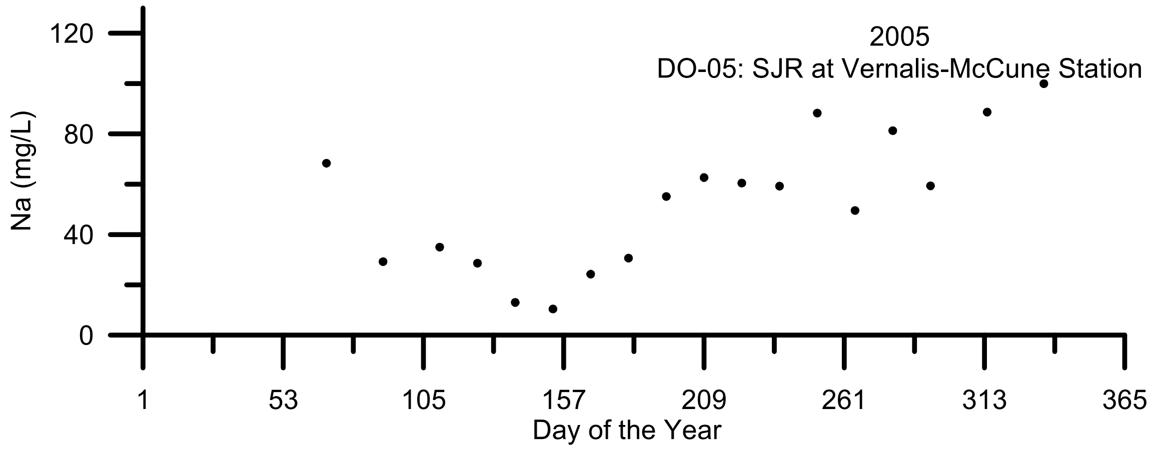


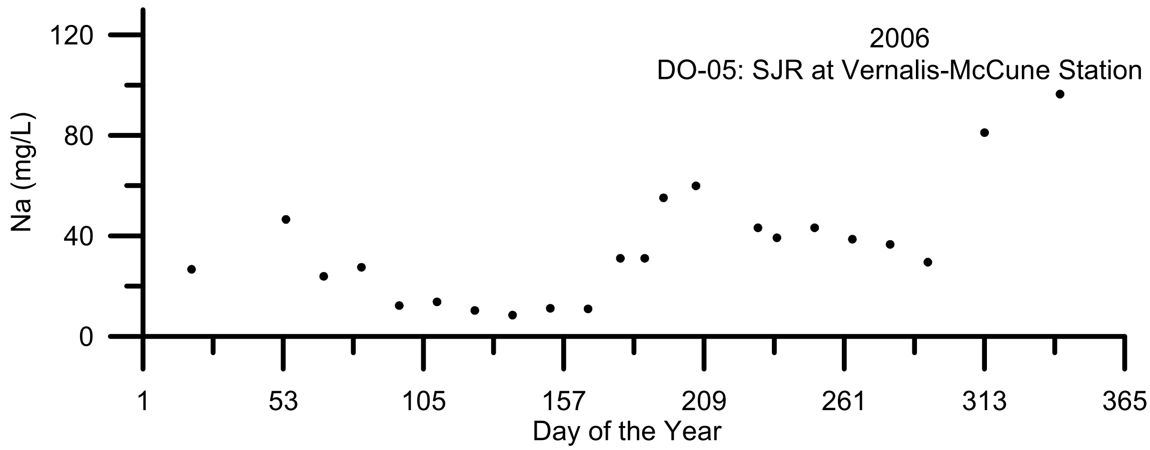
Figures 2 -103: Temporal Plots of Na By Site ID

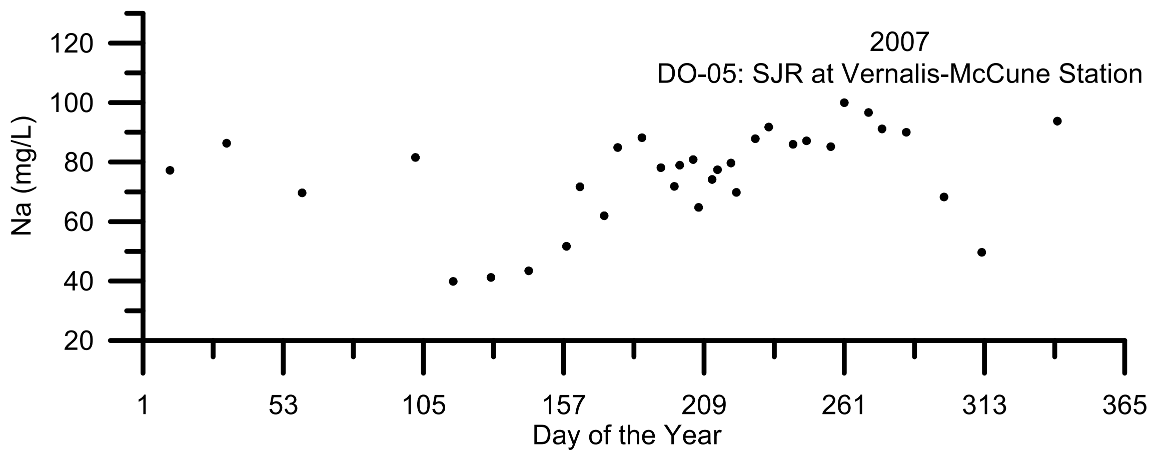


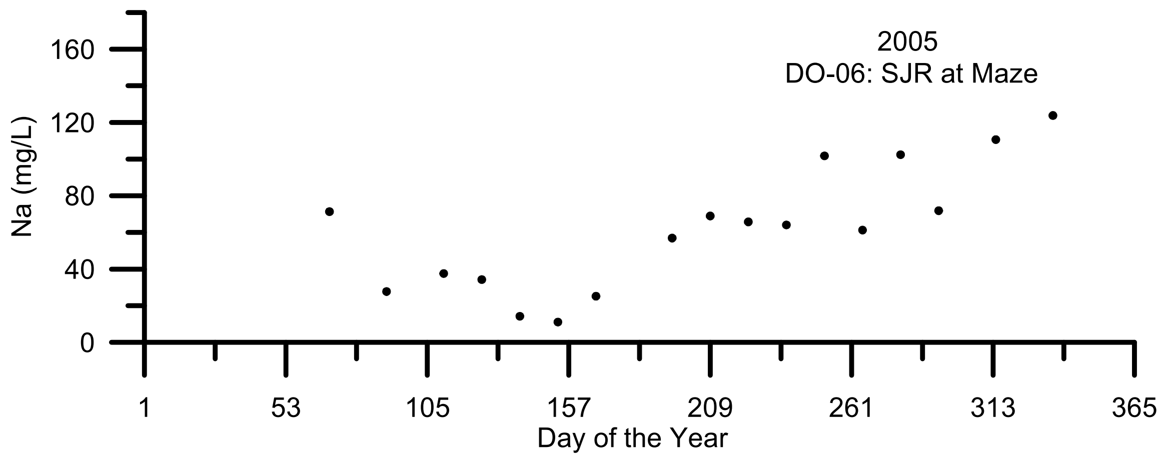


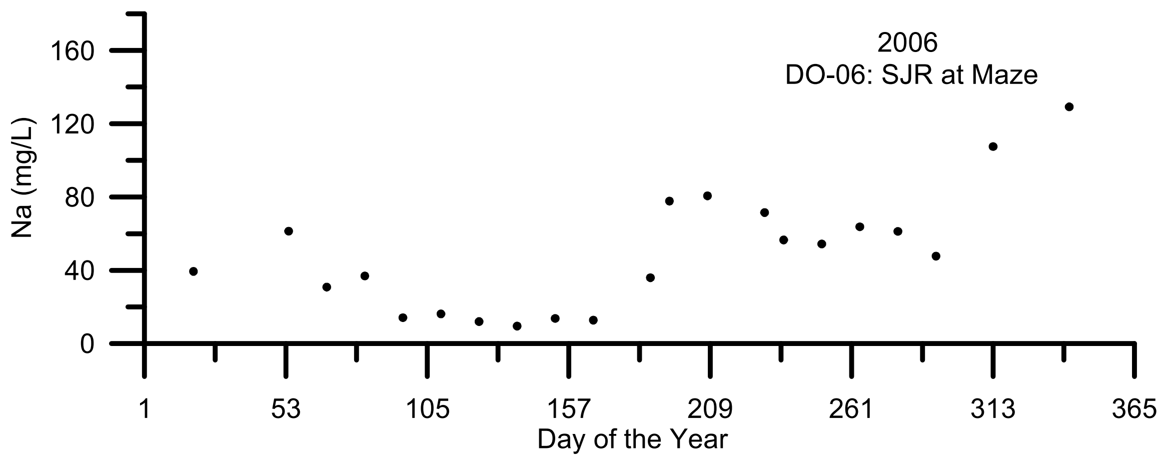


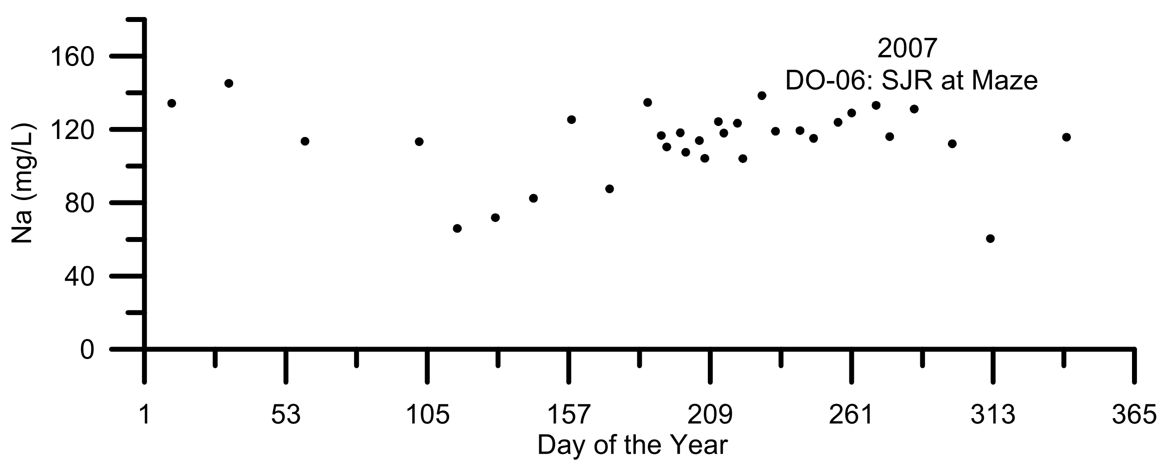

2005
DO-05: SJR at Vernalis-McCune Station
Na (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

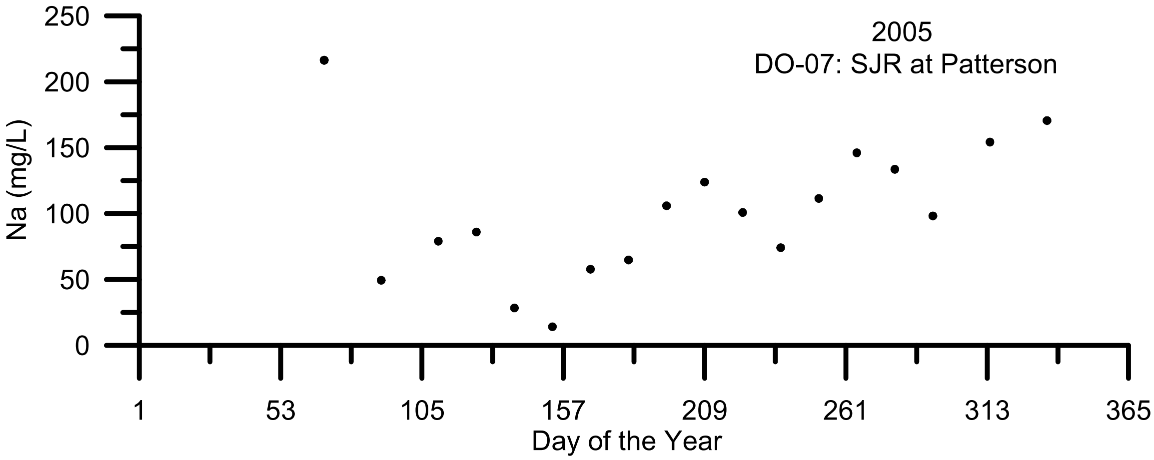

2006
DO-05: SJR at Vernalis-McCune Station
Na (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

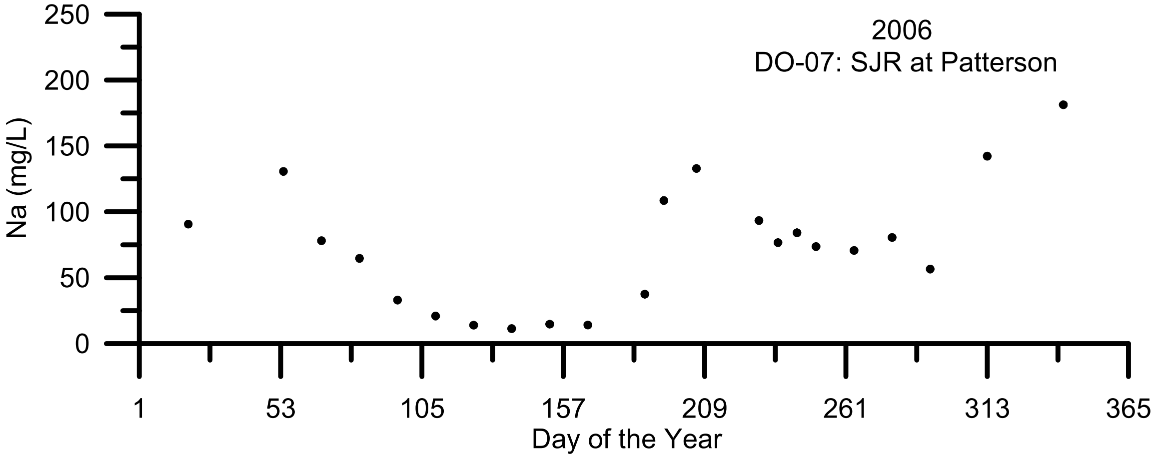

2007
DO-05: SJR at Vernalis-McCune Station
Na (mg/L)
20
40
60
80
100
120
1
53
105
157
209
261
313
365
Day of the Year

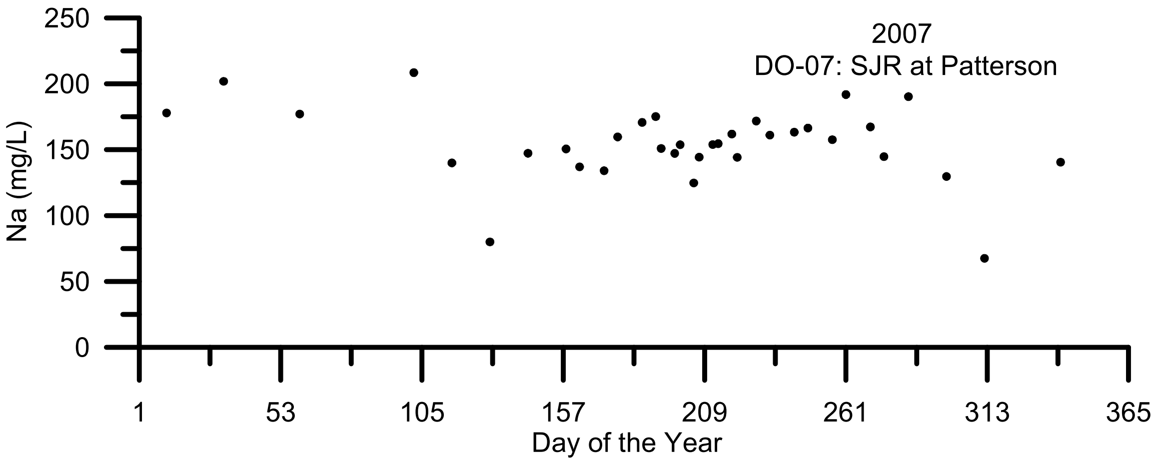

2005
DO-06: SJR at Maze
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

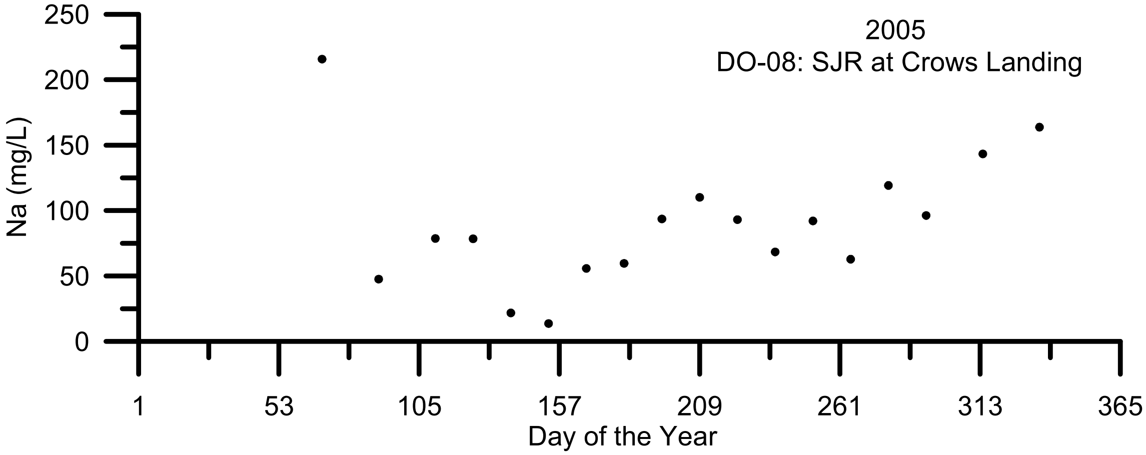

2006
DO-06: SJR at Maze
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

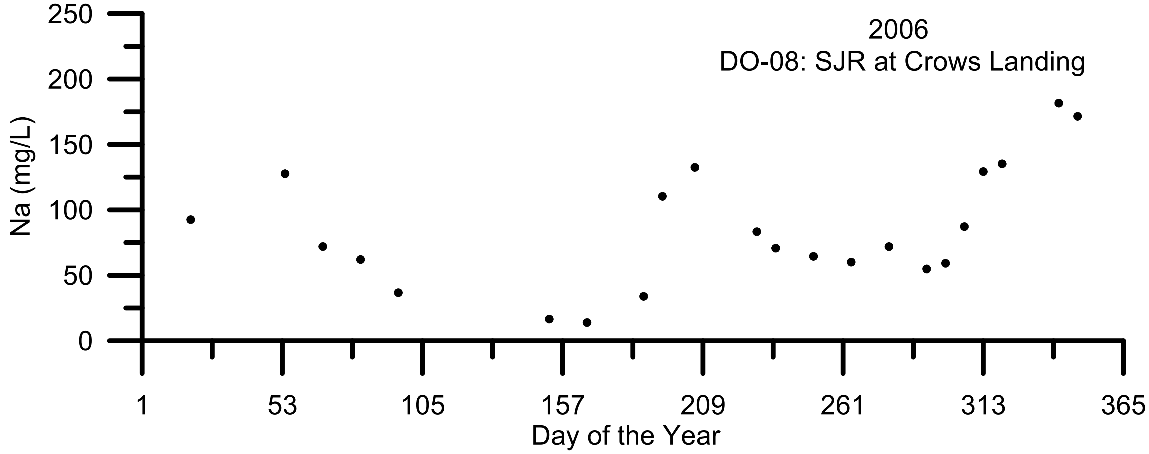

2007
DO-06: SJR at Maze
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

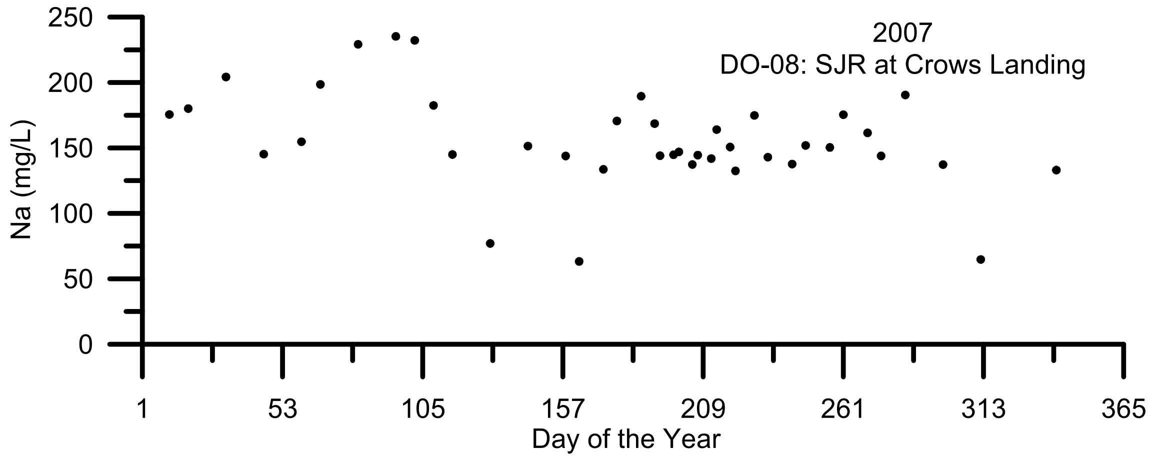

2005
DO-07: SJR at Patterson
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

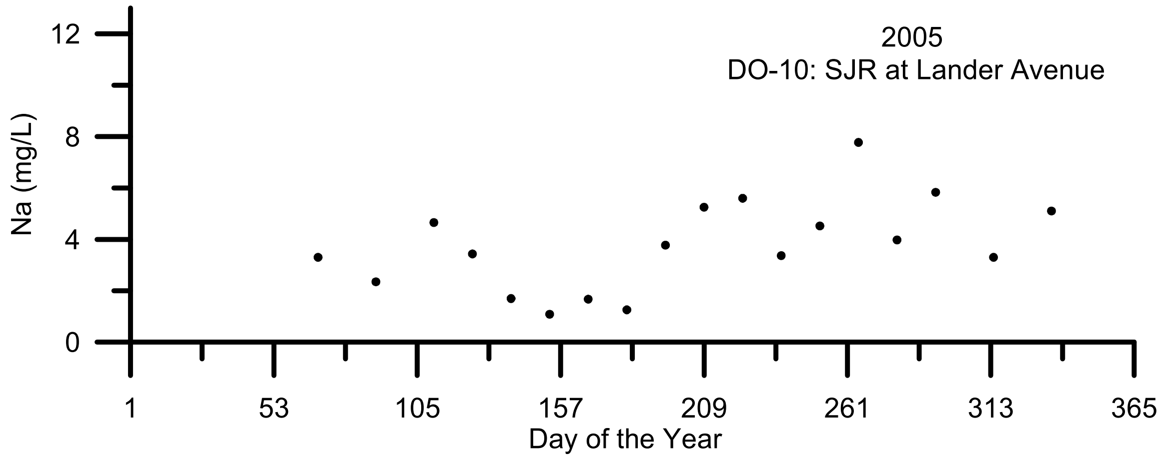

2006
DO-07: SJR at Patterson
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

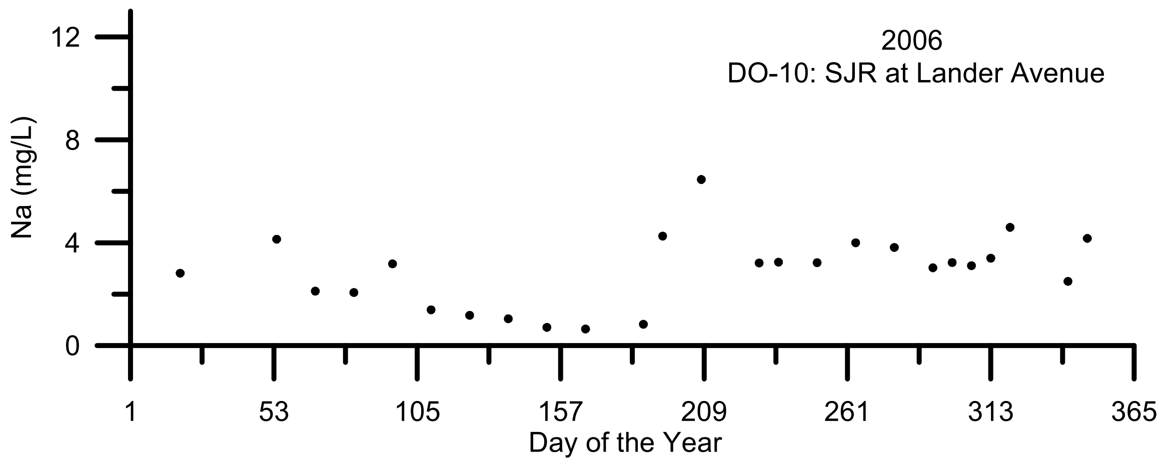

2007
DO-07: SJR at Patterson
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

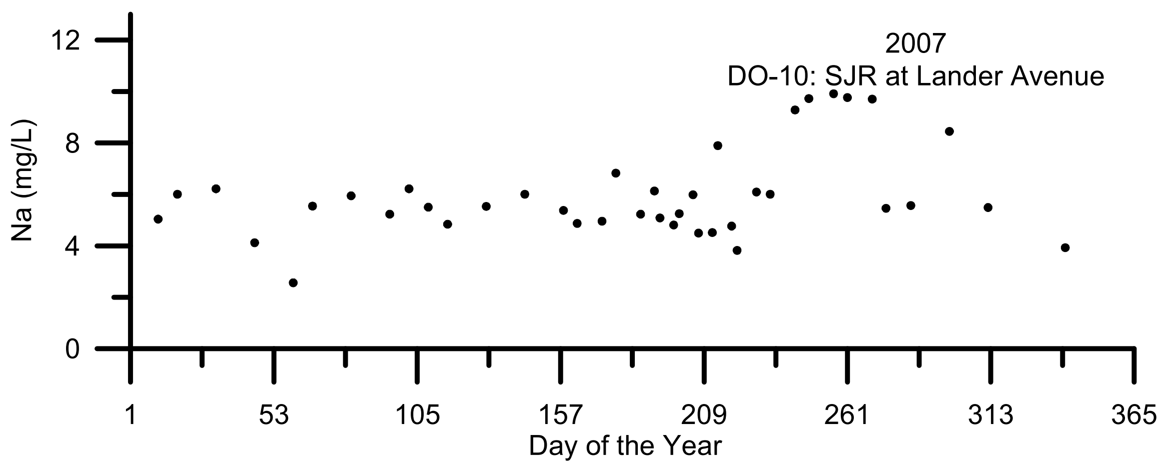

2005
DO-08: SJR at Crows Landing
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

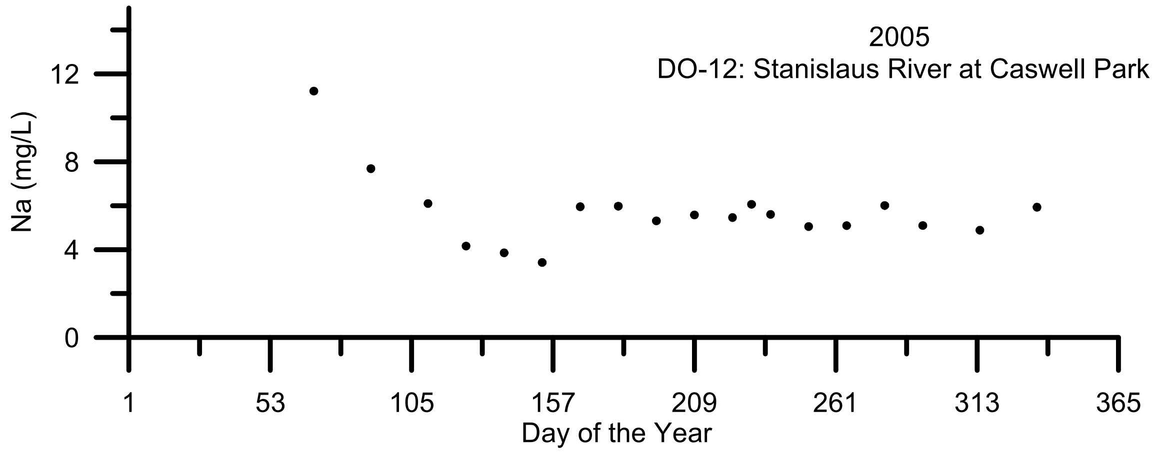

2006
DO-08: SJR at Crows Landing
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

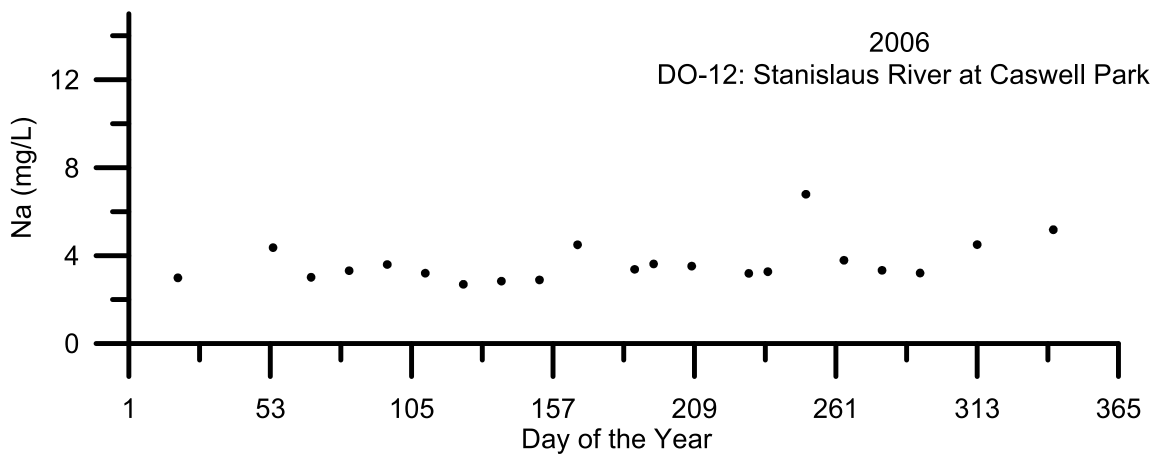

2007
DO-08: SJR at Crows Landing
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

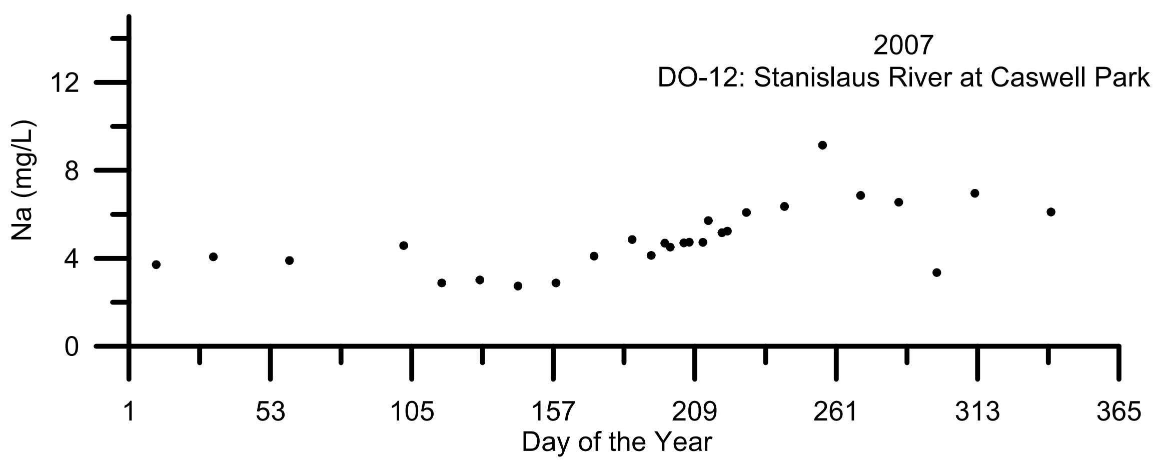

2005
DO-10: SJR at Lander Avenue
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

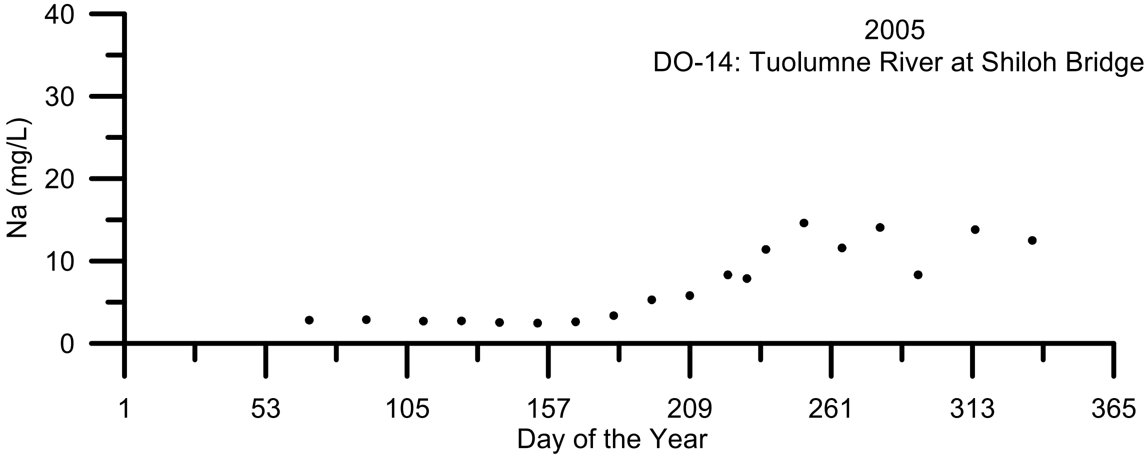

2006
DO-10: SJR at Lander Avenue
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

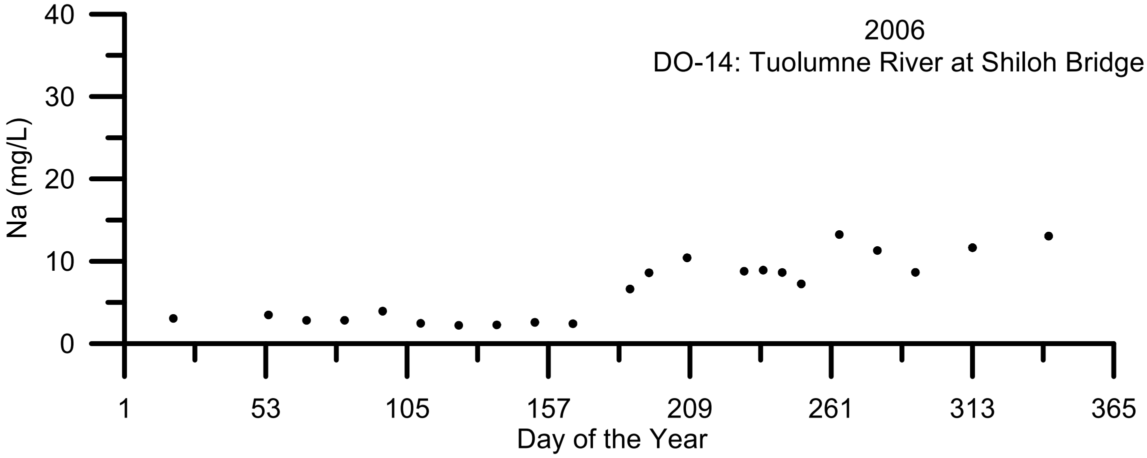

2007
DO-10: SJR at Lander Avenue
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

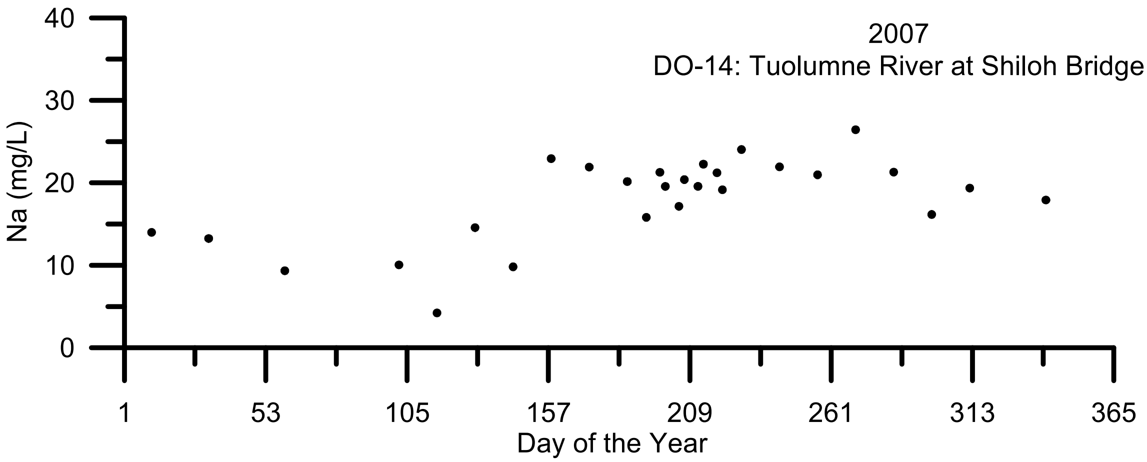

2005
DO-12: Stanislaus River at Caswell Park
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

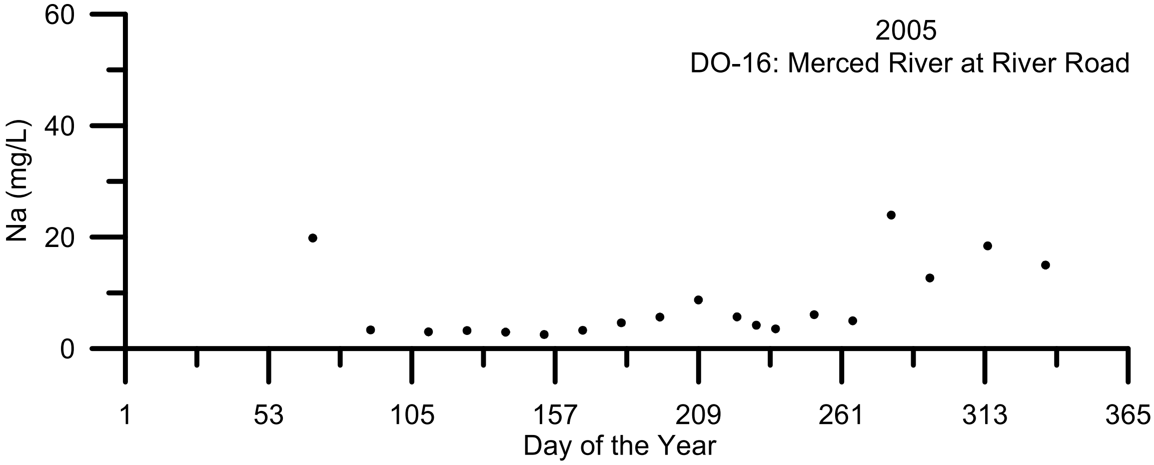

2006
DO-12: Stanislaus River at Caswell Park
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

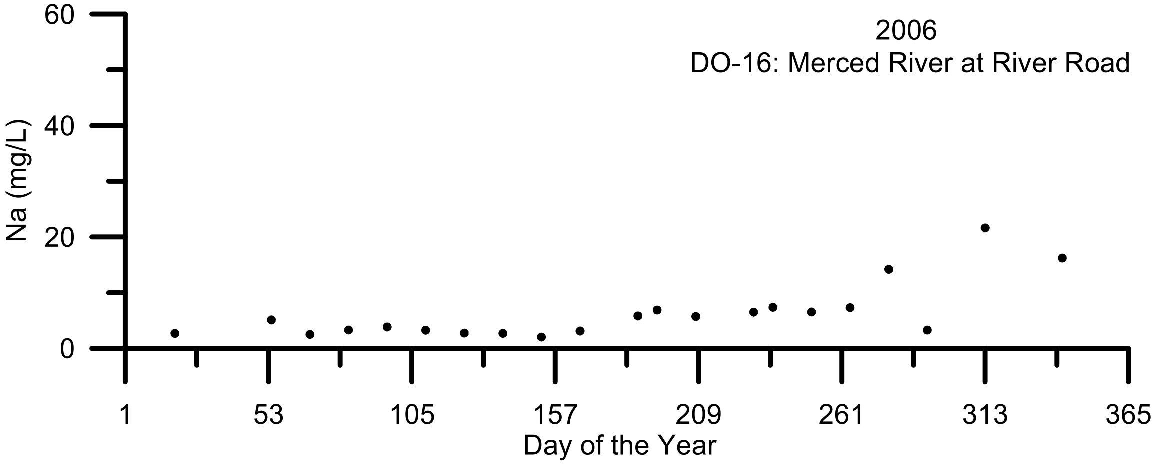

2007
DO-12: Stanislaus River at Caswell Park
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

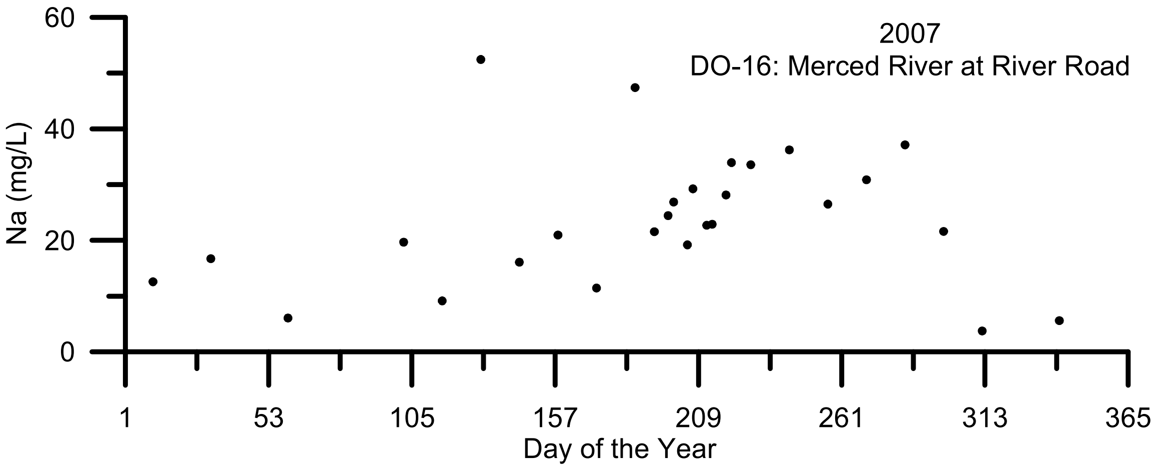

2005
DO-14: Tuolumne River at Shiloh Bridge
Na (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

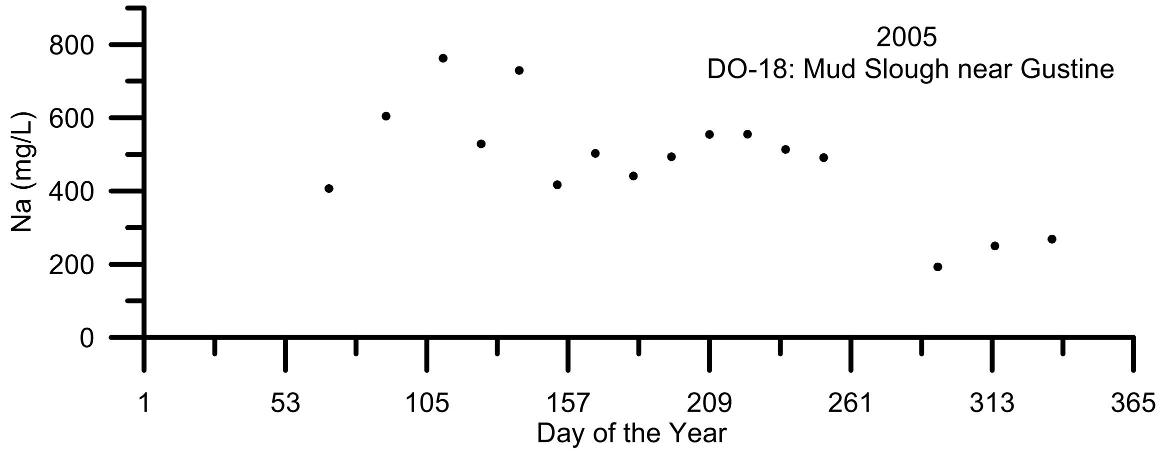

2006
DO-14: Tuolumne River at Shiloh Bridge
Na (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

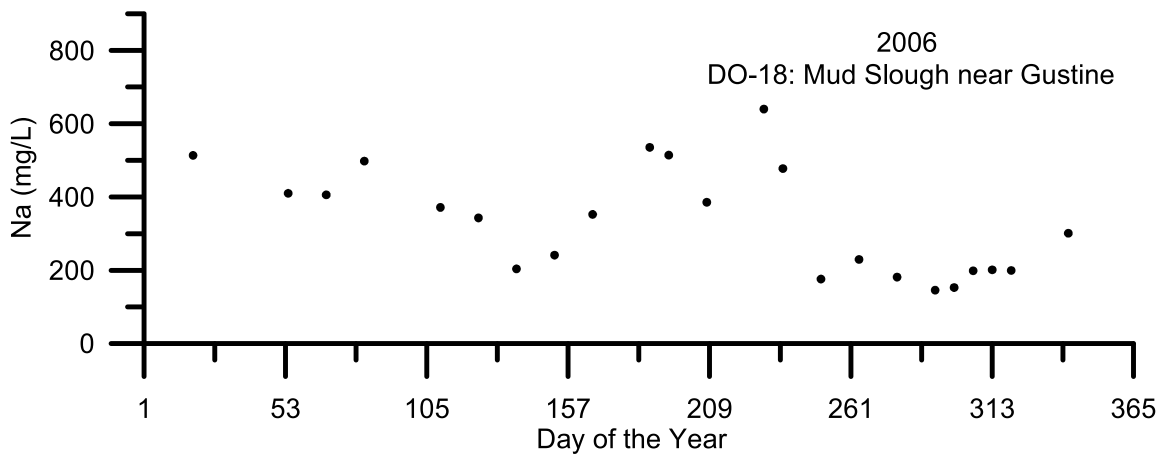

2007
DO-14: Tuolumne River at Shiloh Bridge
Na (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

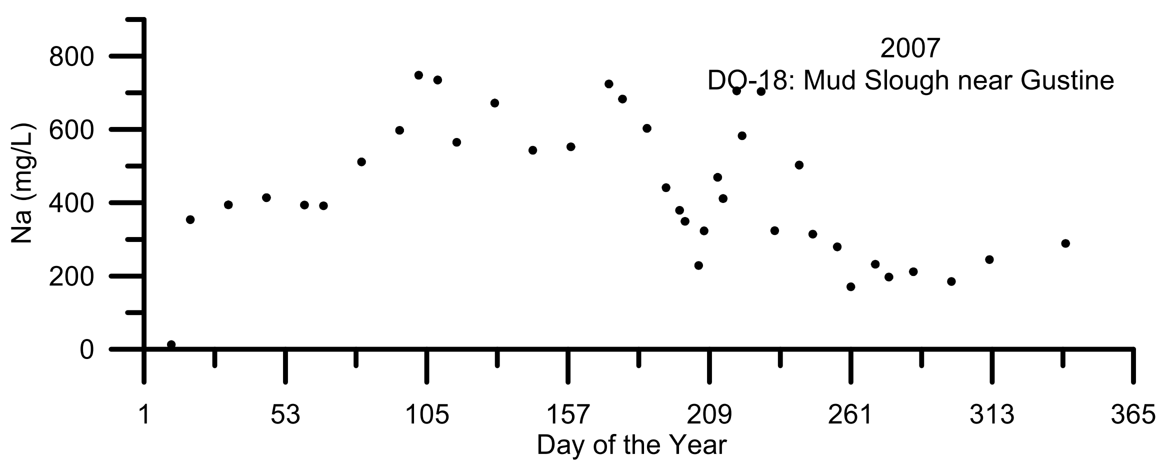

2005
DO-16: Merced River at River Road
Na (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

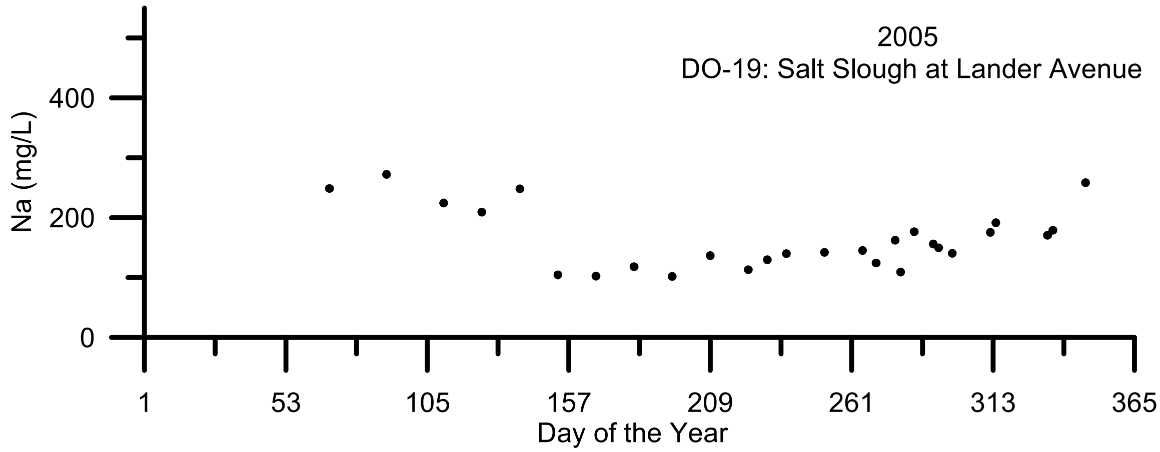

2006
DO-16: Merced River at River Road
Na (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

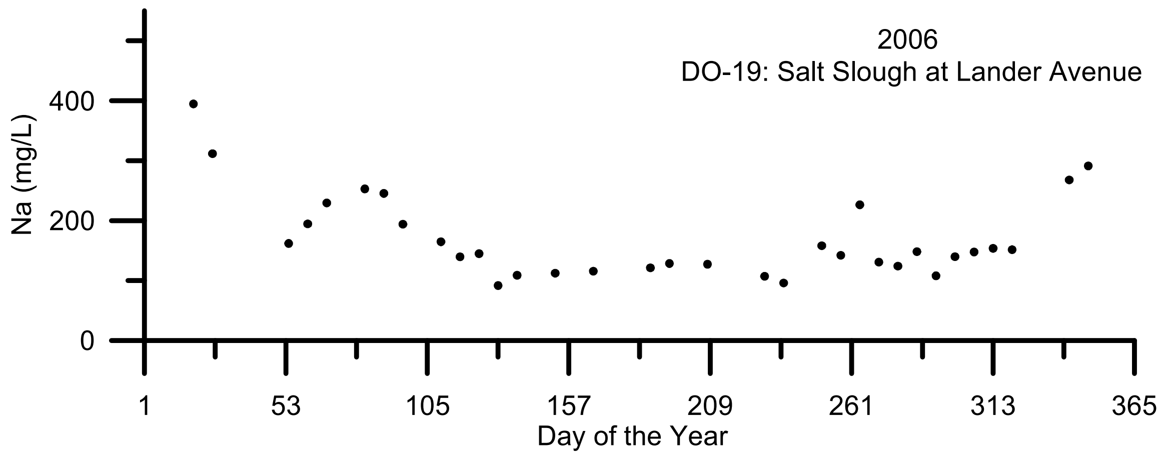

2007
DO-16: Merced River at River Road
Na (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

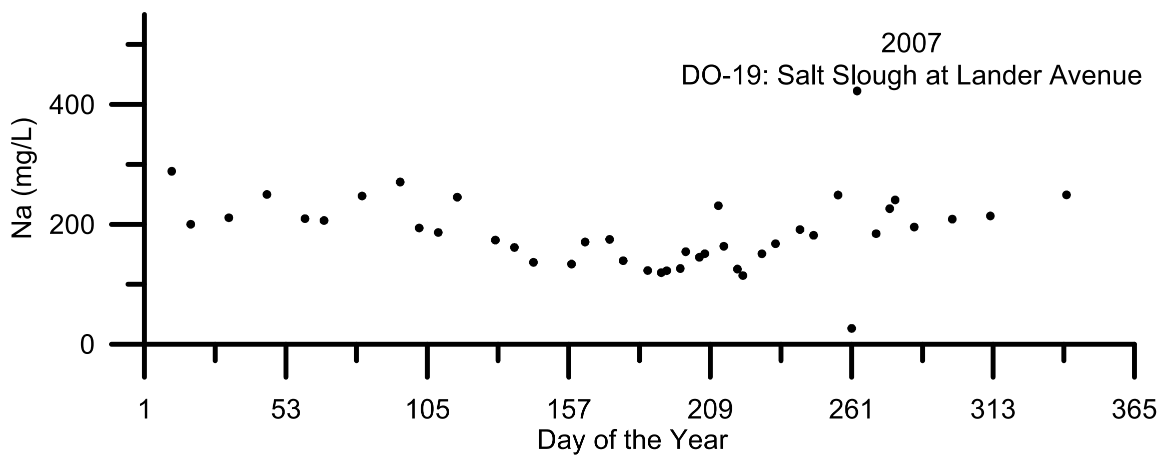

2005
DO-18: Mud Slough near Gustine
Na (mg/L)
0
200
400
600
800
1
53
105
157
209
261
313
365
Day of the Year

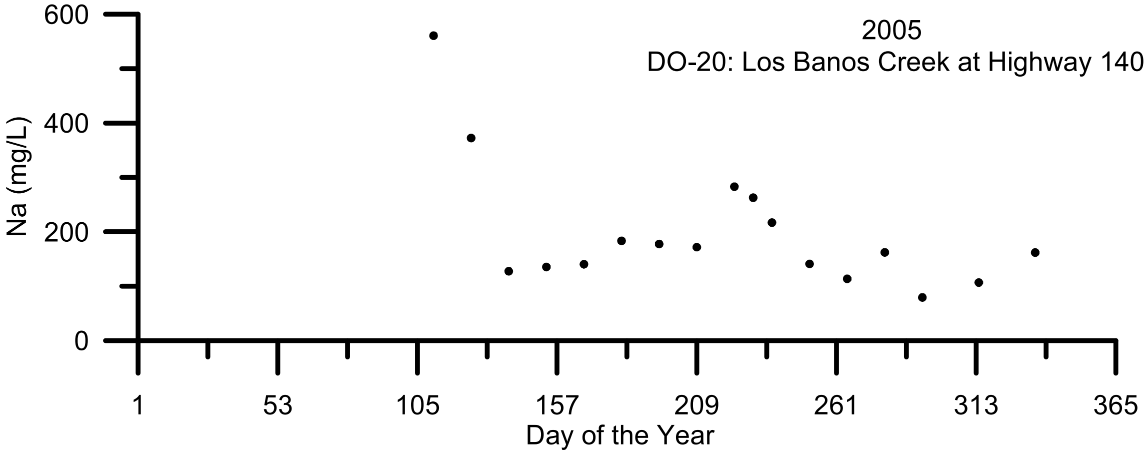

2006
DO-18: Mud Slough near Gustine
Na (mg/L)
0
200
400
600
800
1
53
105
157
209
261
313
365
Day of the Year

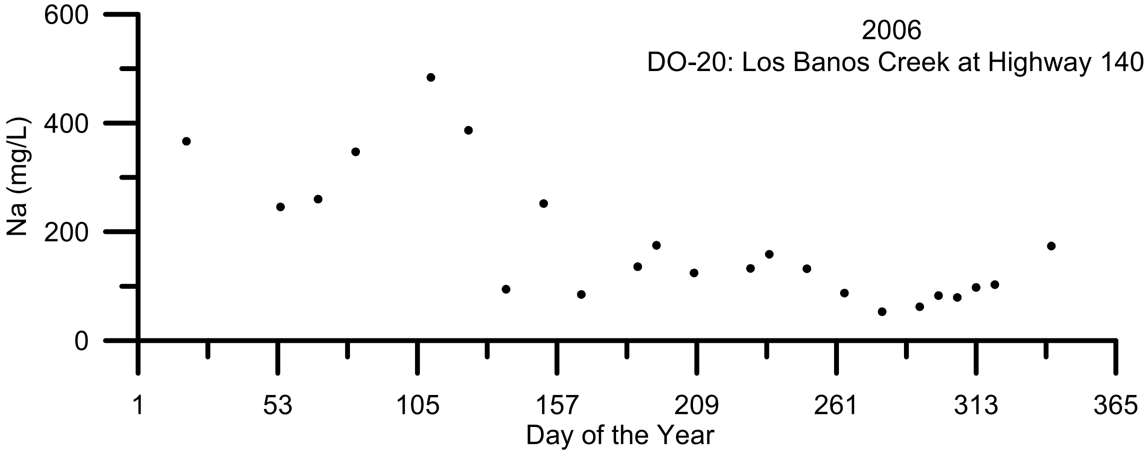

2007
DO-18: Mud Slough near Gustine
Na (mg/L)
0
200
400
600
800
1
53
105
157
209
261
313
365
Day of the Year

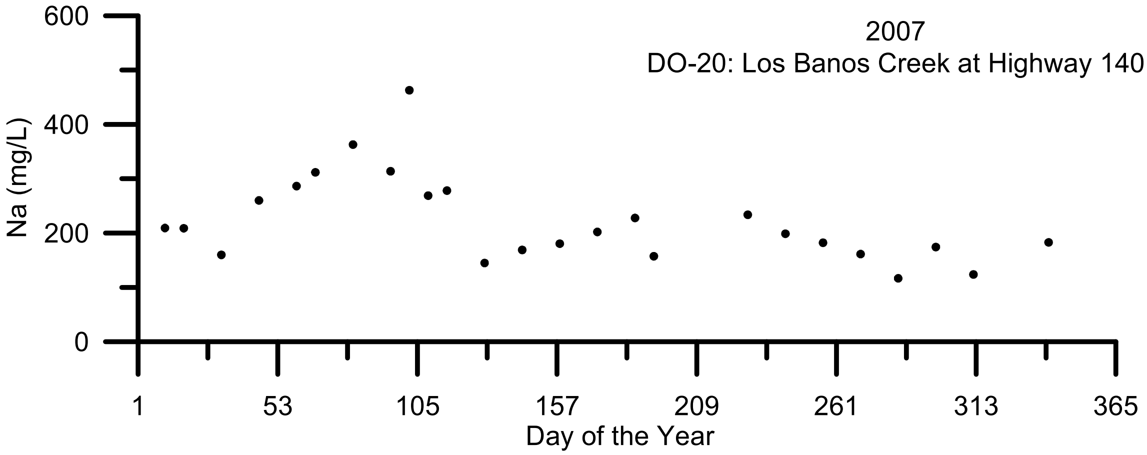

2005
DO-19: Salt Slough at Lander Avenue
Na (mg/L)
0
200
400
1
53
105
157
209
261
313
365
Day of the Year

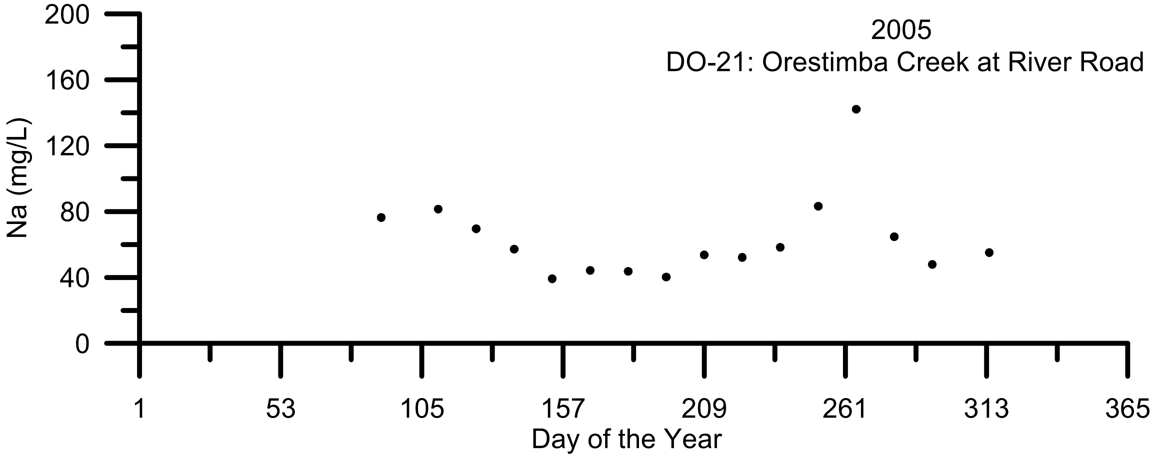

2006
DO-19: Salt Slough at Lander Avenue
Na (mg/L)
0
200
400
1
53
105
157
209
261
313
365
Day of the Year

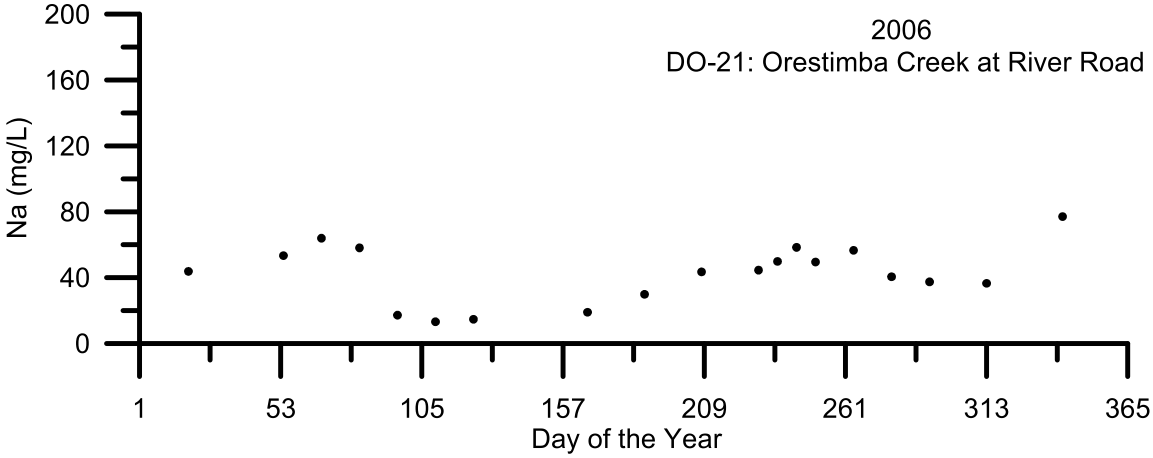

2007
DO-19: Salt Slough at Lander Avenue
Na (mg/L)
0
200
400
1
53
105
157
209
261
313
365
Day of the Year

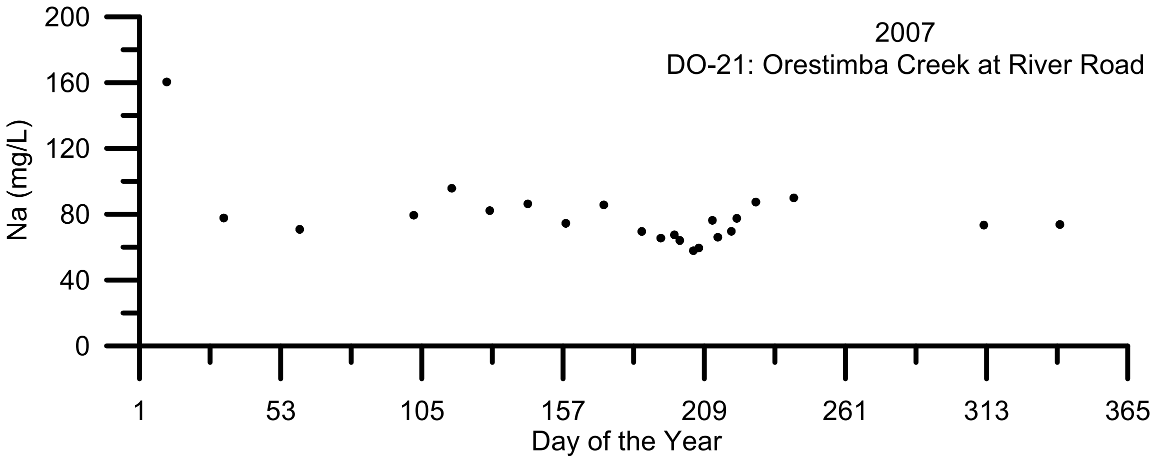

2005
DO-20: Los Banos Creek at Highway 140
Na (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

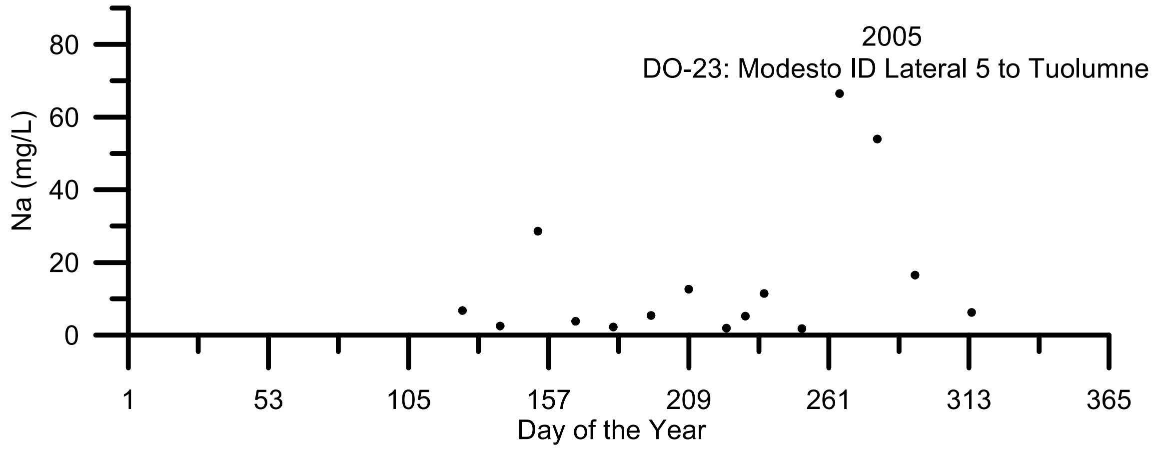

2006
DO-20: Los Banos Creek at Highway 140
Na (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

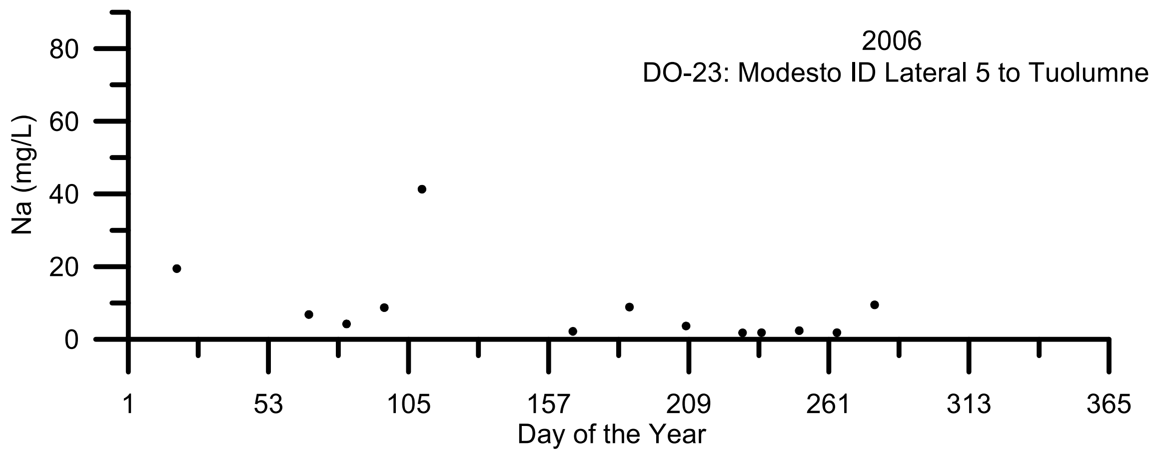

2007
DO-20: Los Banos Creek at Highway 140
Na (mg/L)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

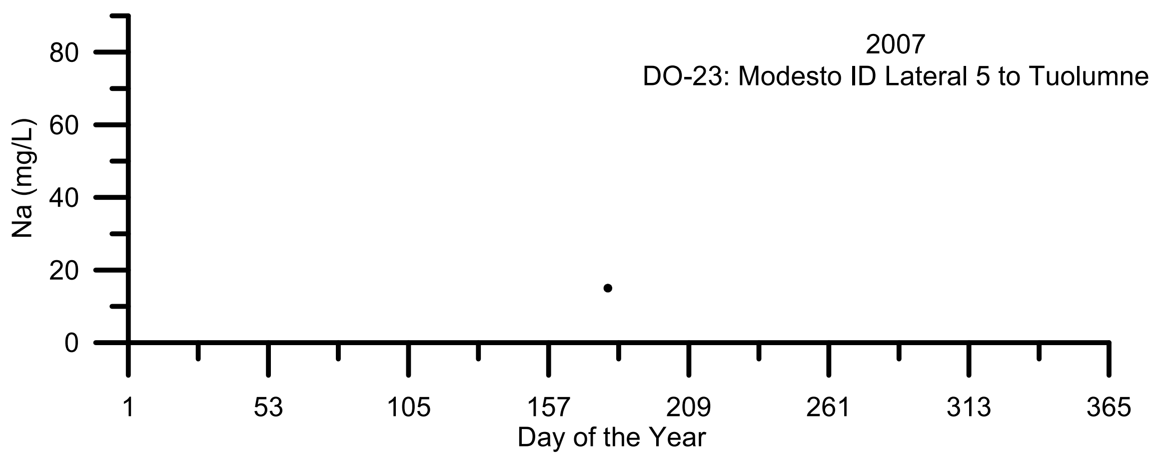

2005
DO-21: Orestimba Creek at River Road
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

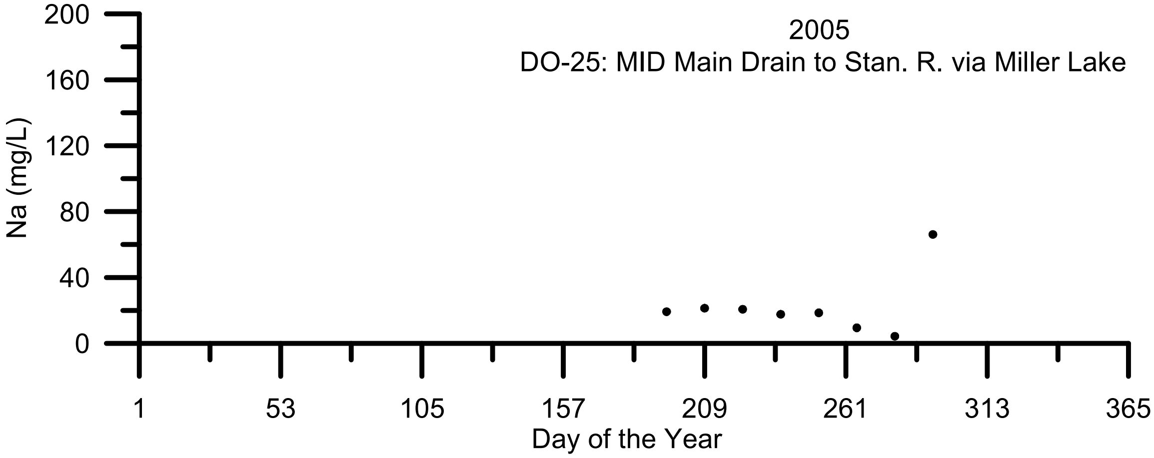

2006
DO-21: Orestimba Creek at River Road
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

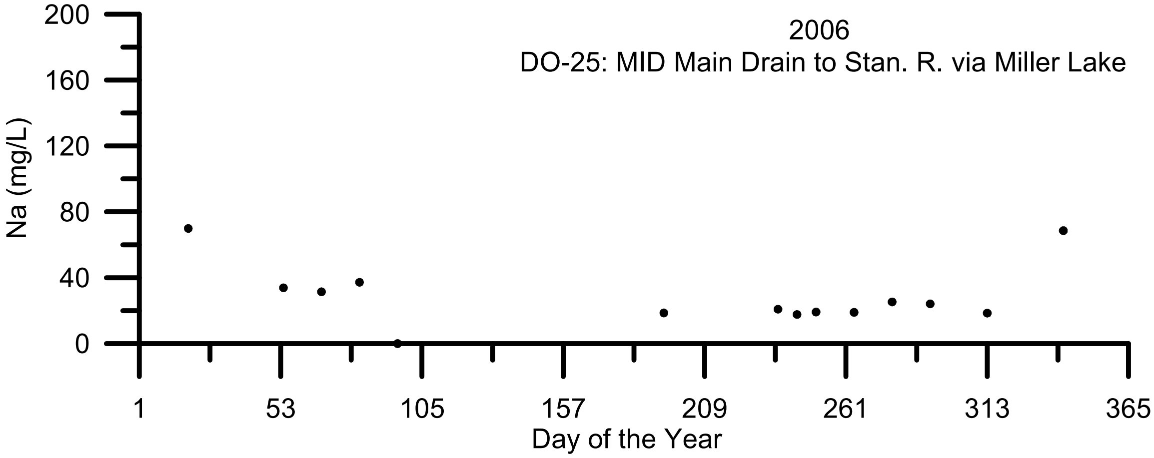

2007
DO-21: Orestimba Creek at River Road
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

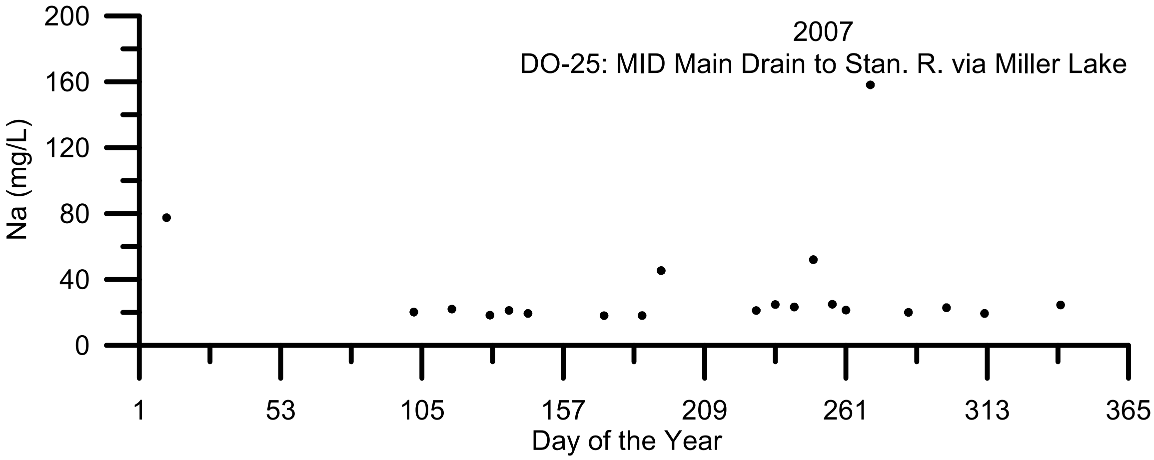

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Na (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

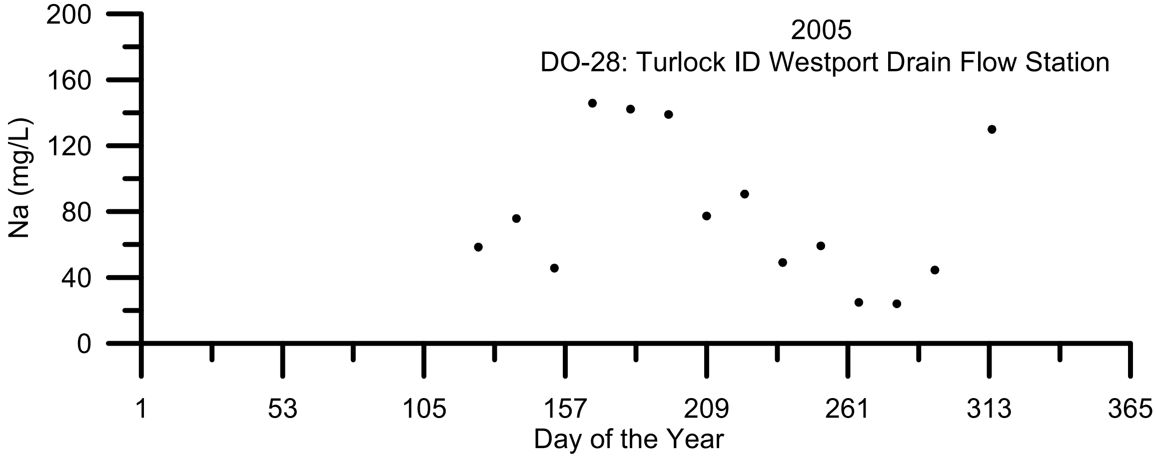

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Na (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

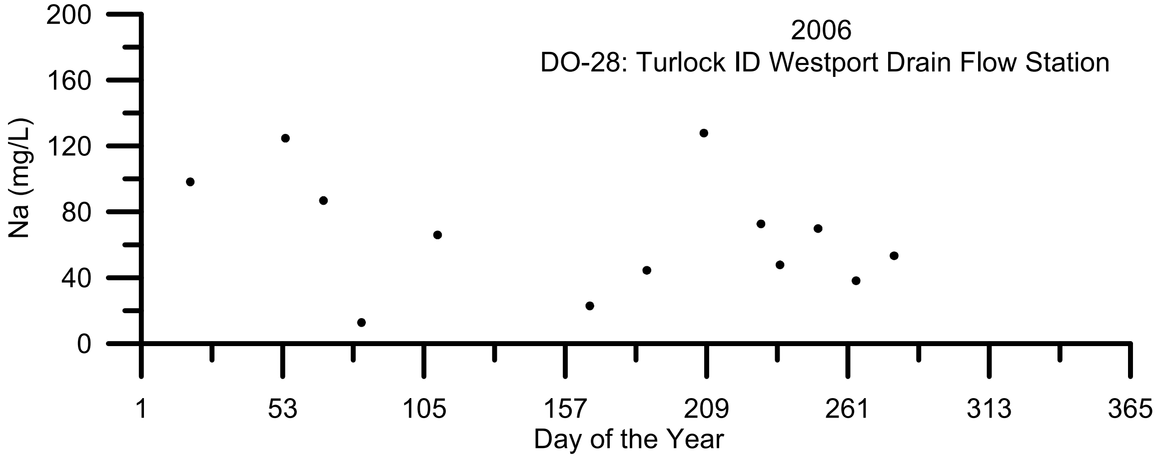

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Na (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

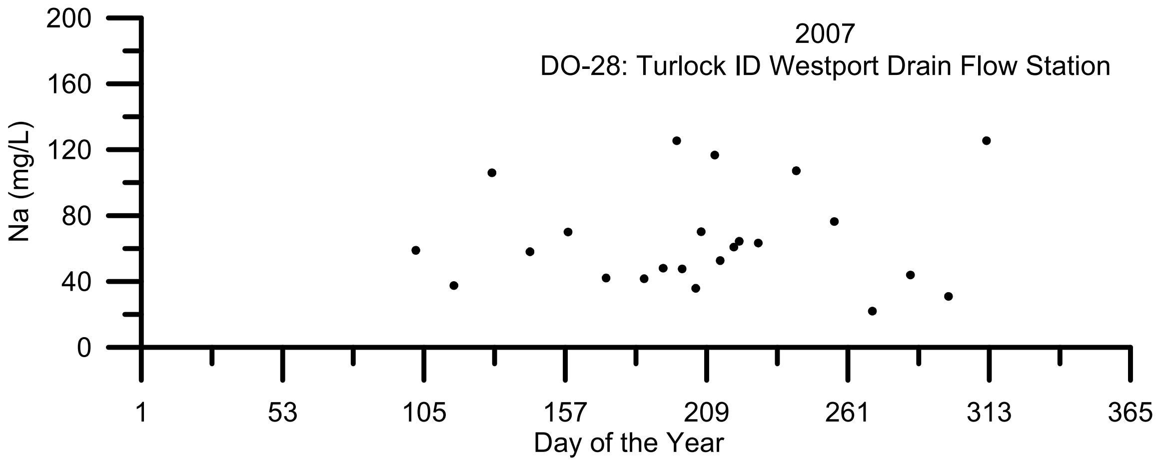

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

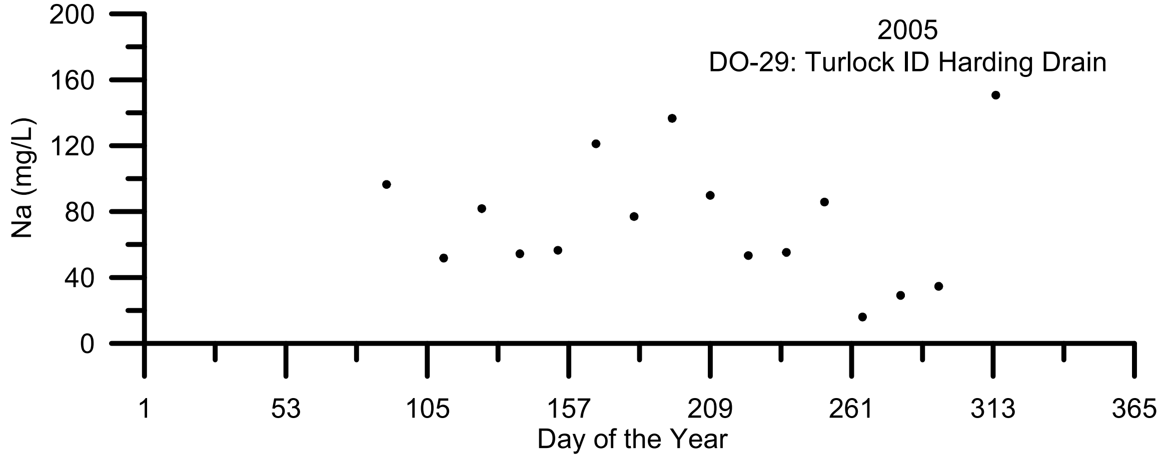

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

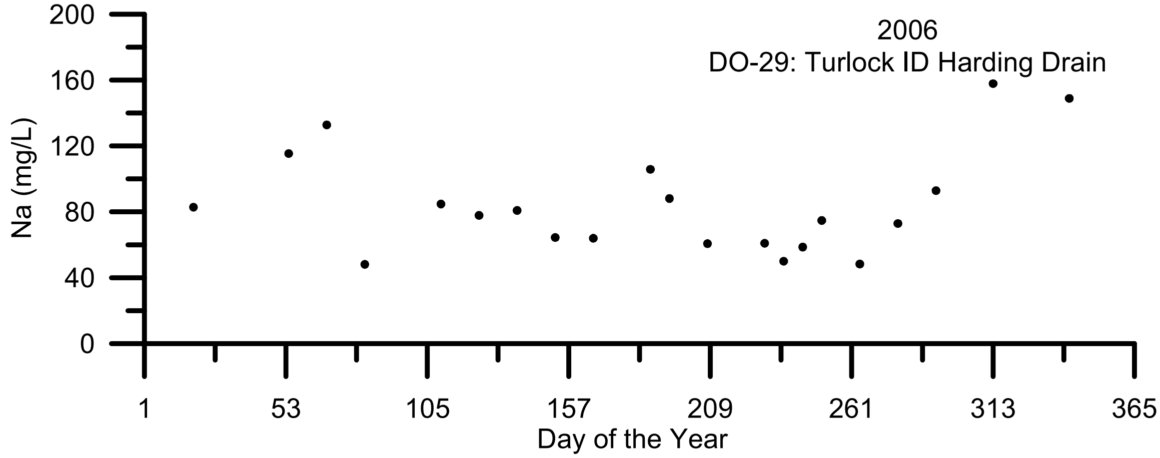

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

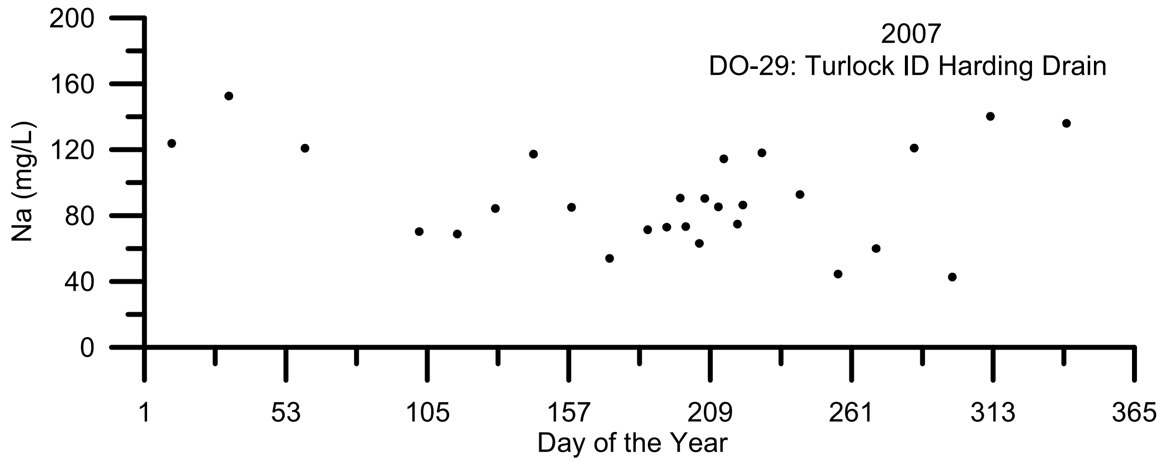

2005
DO-28: Turlock ID Westport Drain Flow Station
Na (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

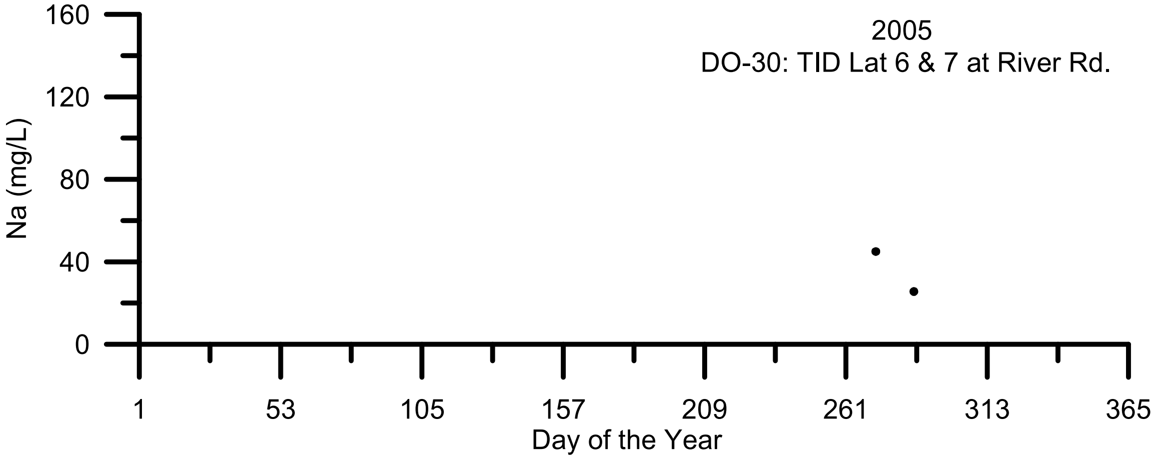

2006
DO-28: Turlock ID Westport Drain Flow Station
Na (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

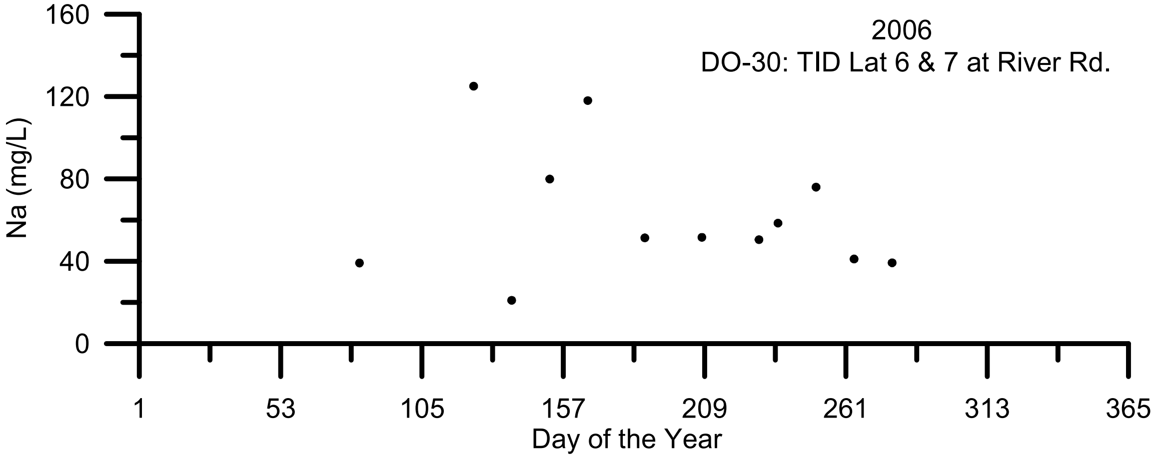

2007
DO-28: Turlock ID Westport Drain Flow Station
Na (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

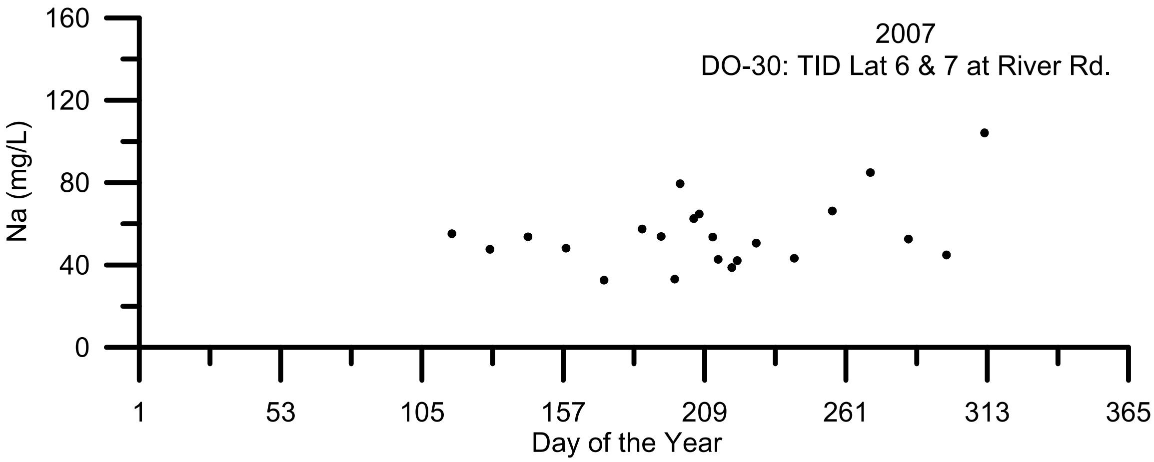

2005
DO-29: Turlock ID Harding Drain
Na (mg/L)
Day of the Year
200
160
120
80
40
0
1
53
105
157
209
261
313
365

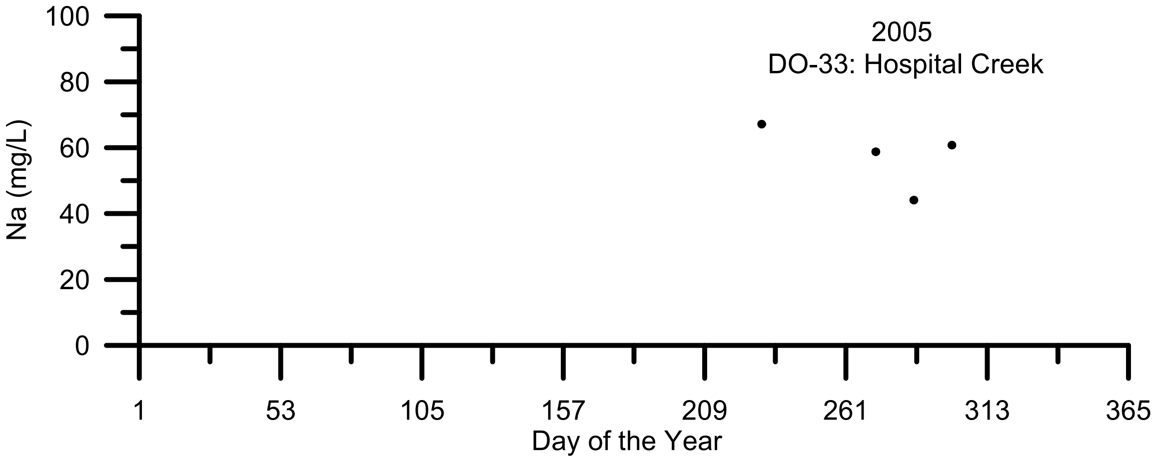

2006
DO-29: Turlock ID Harding Drain
Na (mg/L)
Day of the Year
200
160
120
80
40
0
1
53
105
157
209
261
313
365

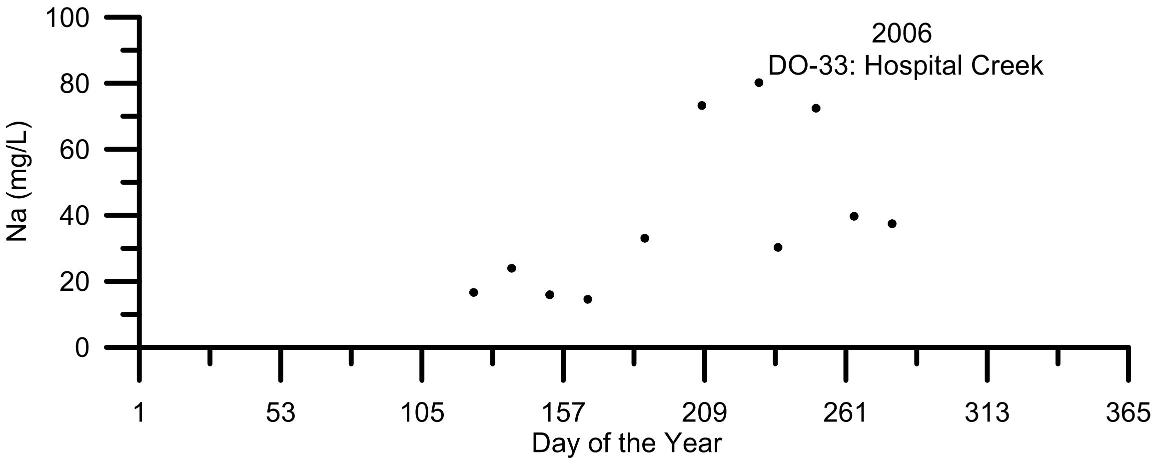

2007
DO-29: Turlock ID Harding Drain
Na (mg/L)
Day of the Year
200
160
120
80
40
0
1
53
105
157
209
261
313
365

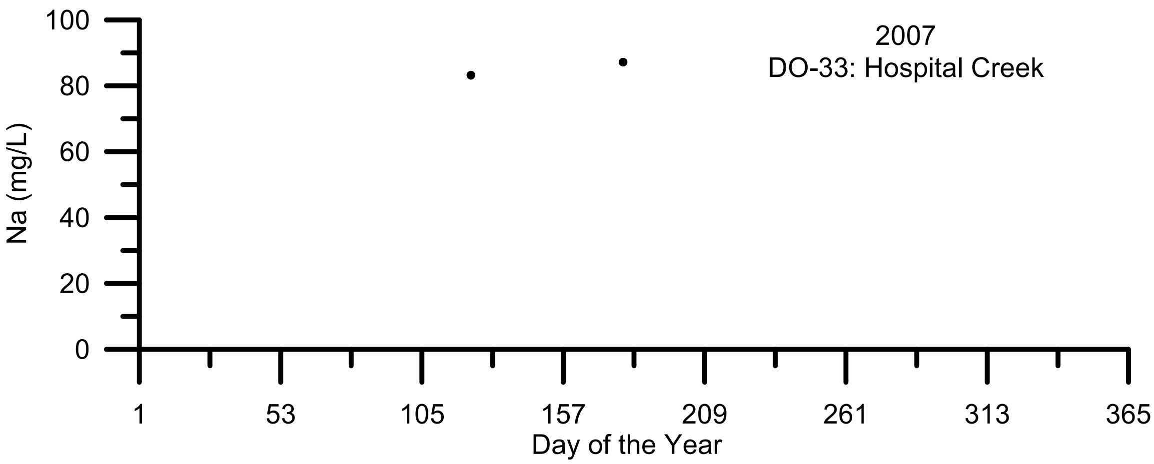

2005
DO-30: TID Lat 6 & 7 at River Rd.
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

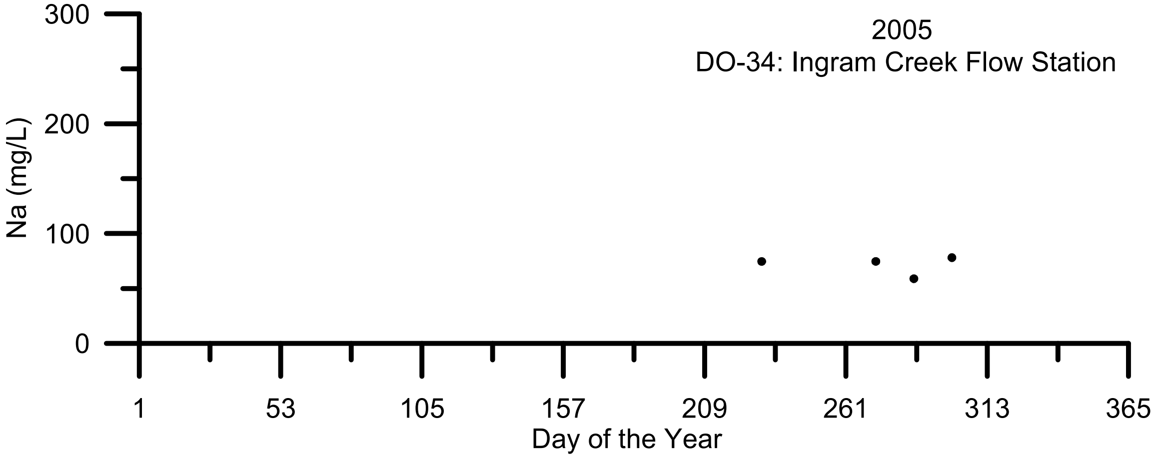

2006
DO-30: TID Lat 6 & 7 at River Rd.
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

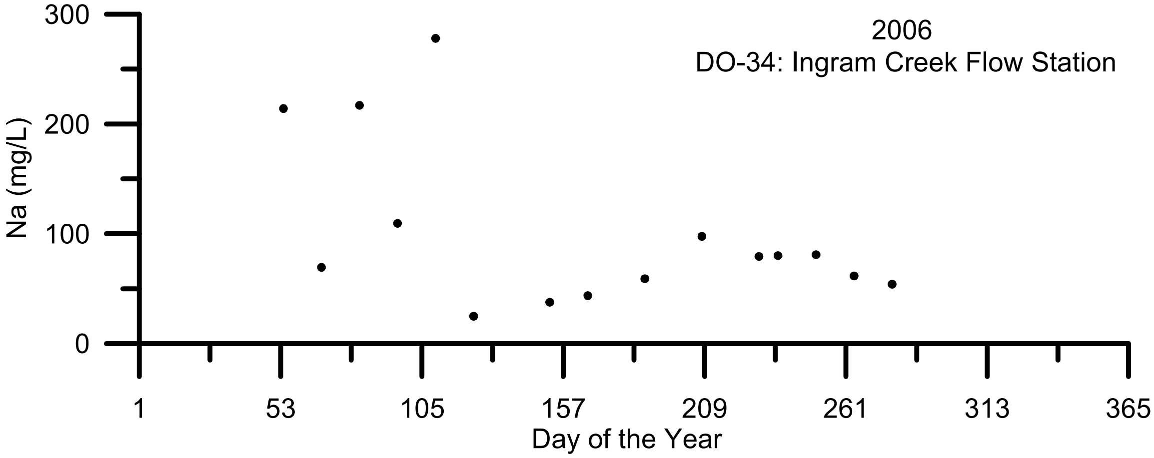

2007
DO-30: TID Lat 6 & 7 at River Rd.
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

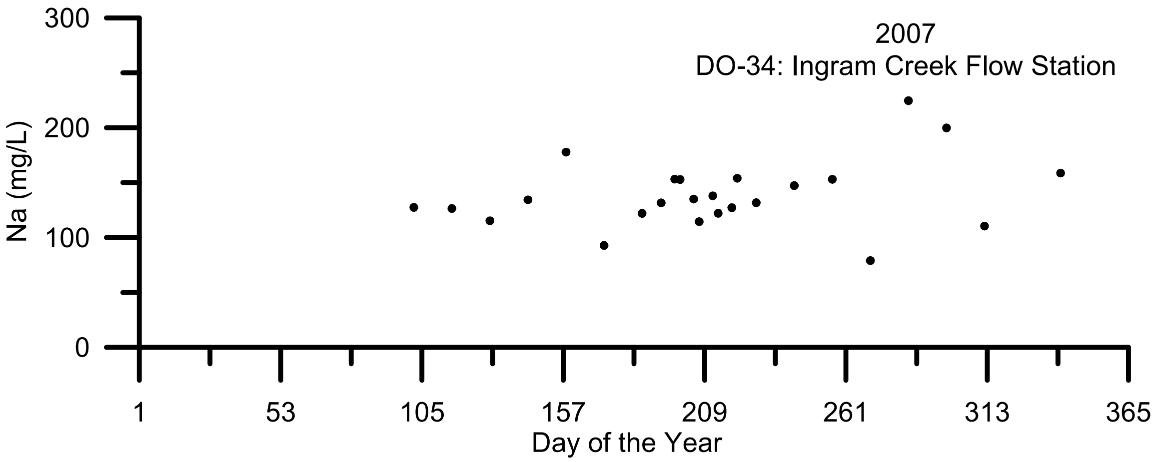

2005
DO-33: Hospital Creek
Na (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

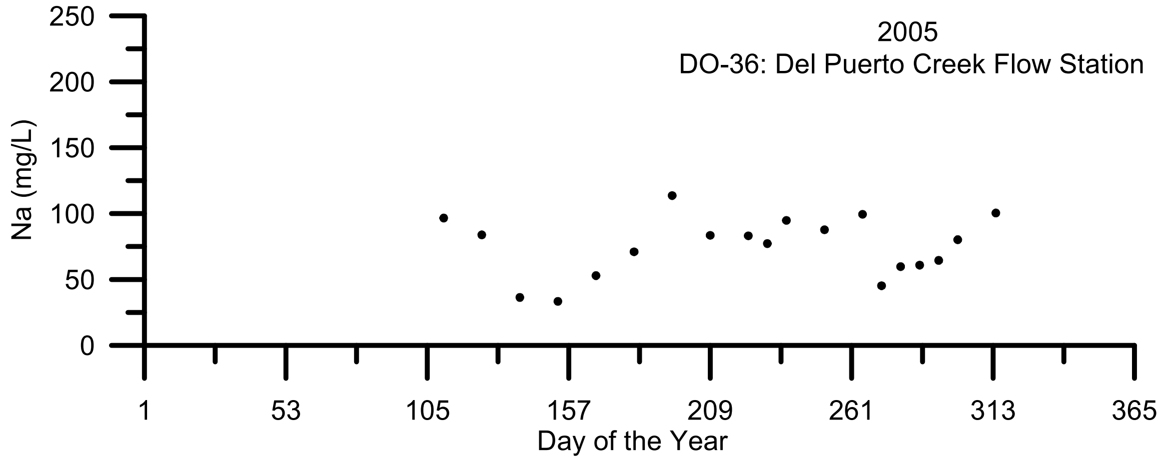

2006
DO-33: Hospital Creek
Na (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

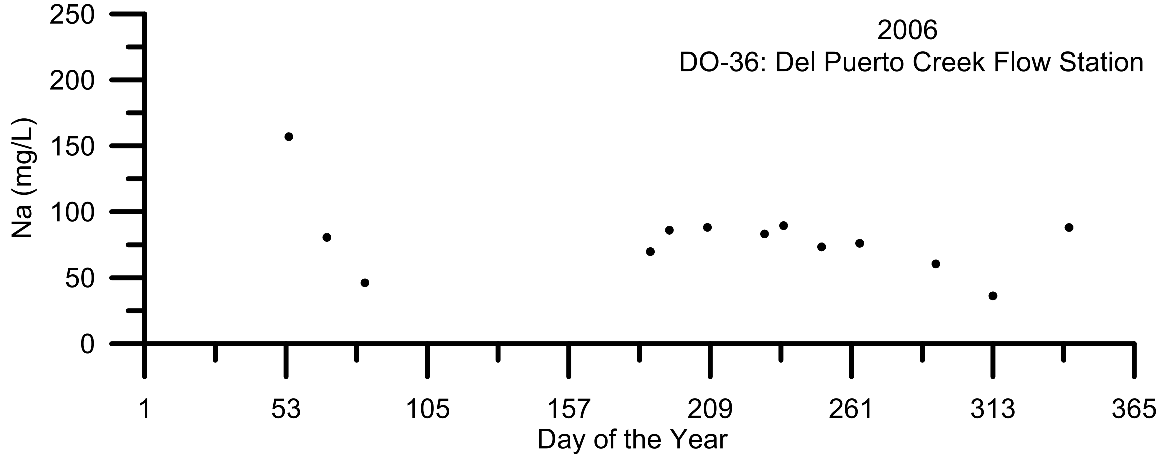

2007
DO-33: Hospital Creek
Na (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

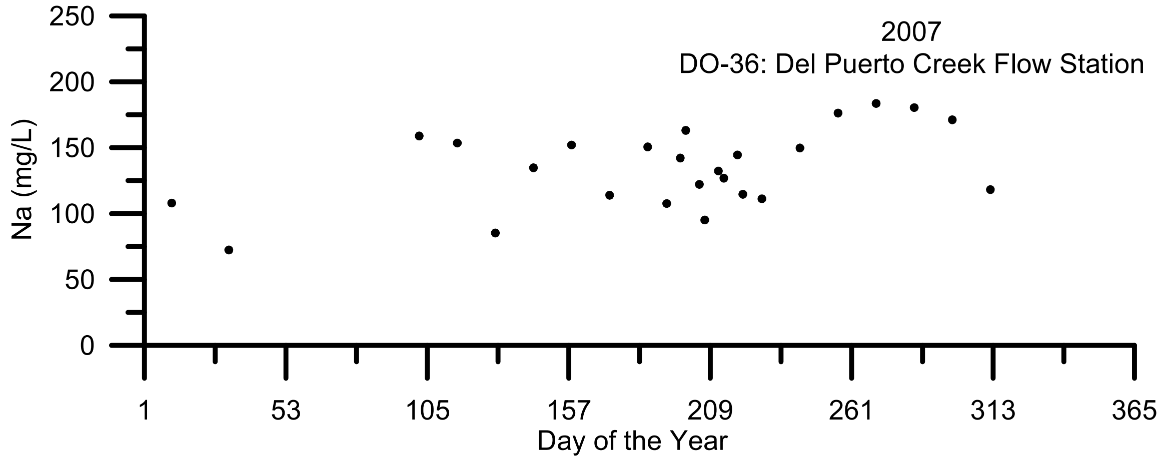

2005
DO-34: Ingram Creek Flow Station
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

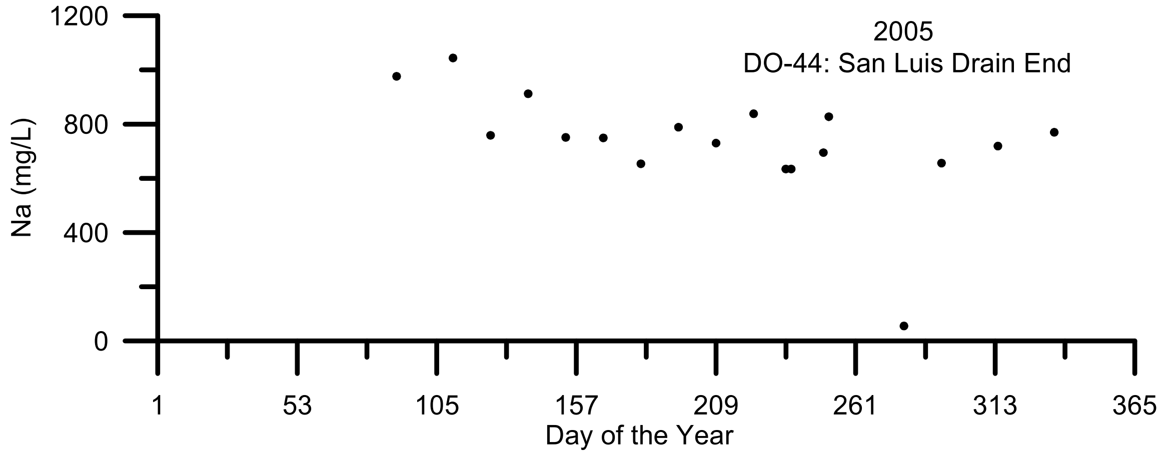

2006
DO-34: Ingram Creek Flow Station
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

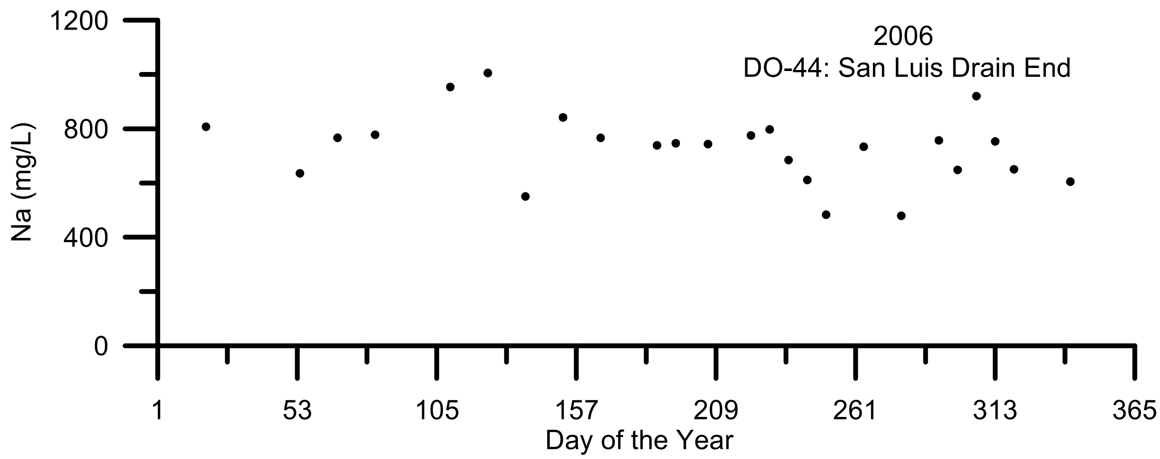

2007
DO-34: Ingram Creek Flow Station
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

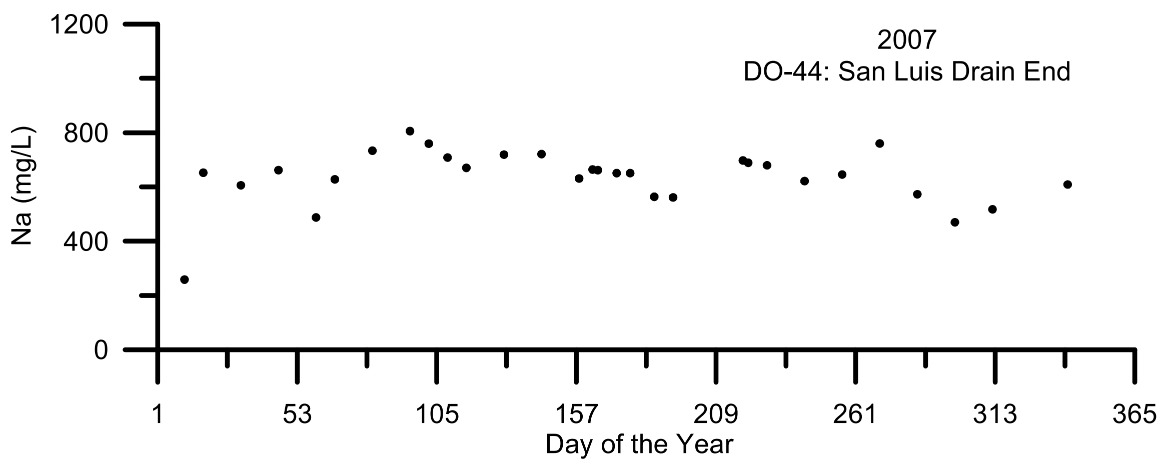

2005
DO-36: Del Puerto Creek Flow Station
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

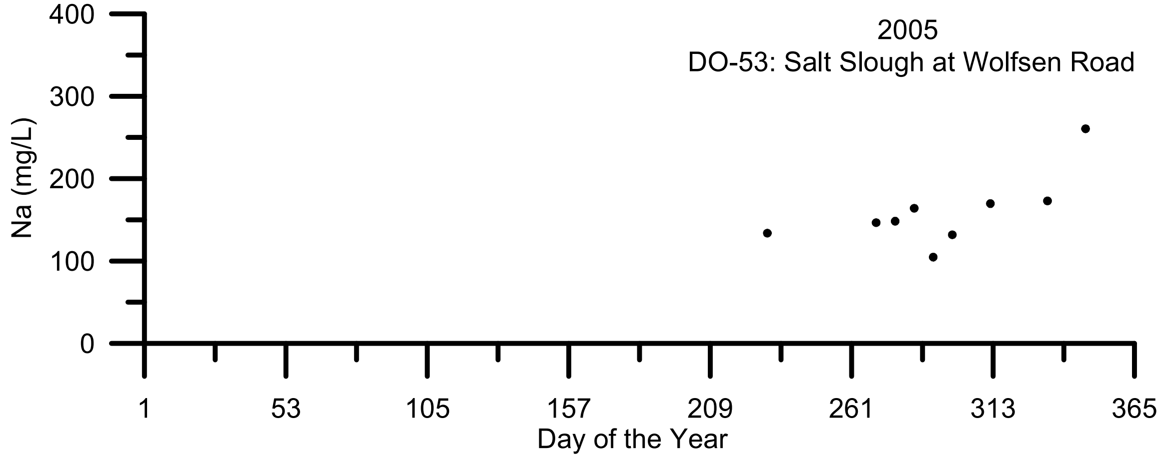

2006
DO-36: Del Puerto Creek Flow Station
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

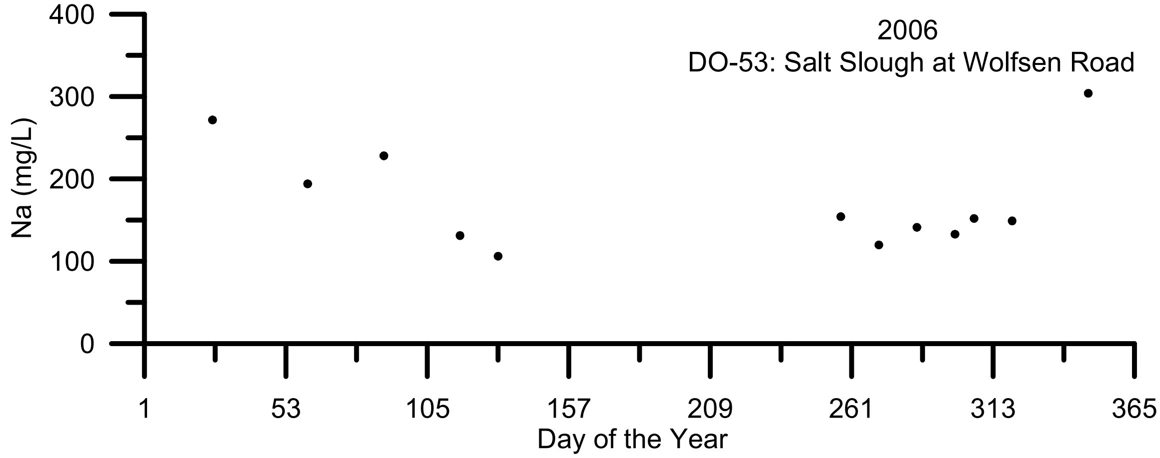

2007
DO-36: Del Puerto Creek Flow Station
Na (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

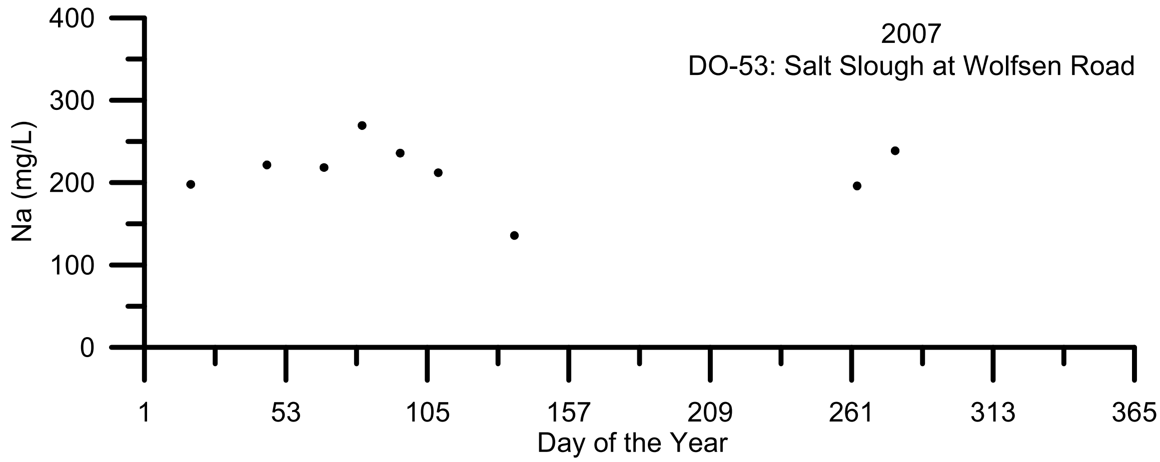

2005
DO-44: San Luis Drain End
Na (mg/L)
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year

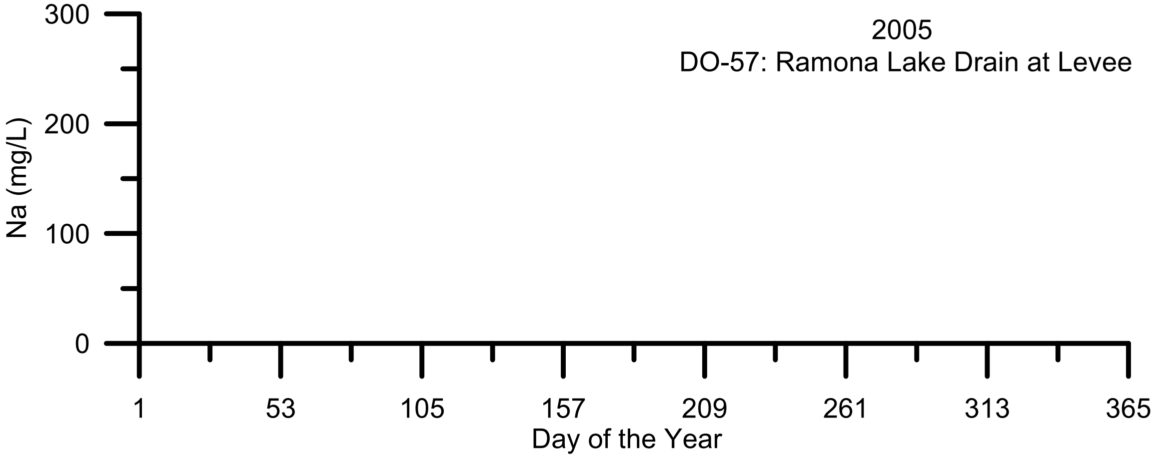

2006
DO-44: San Luis Drain End
Na (mg/L)
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year

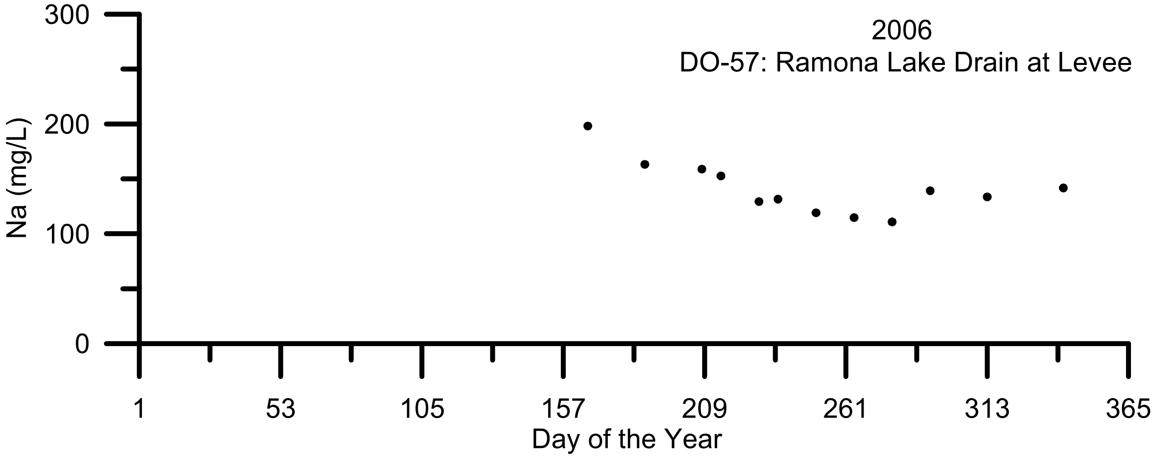

2007
DO-44: San Luis Drain End
Na (mg/L)
1200
800
400
0
1
53
105
157
209
261
313
365
Day of the Year

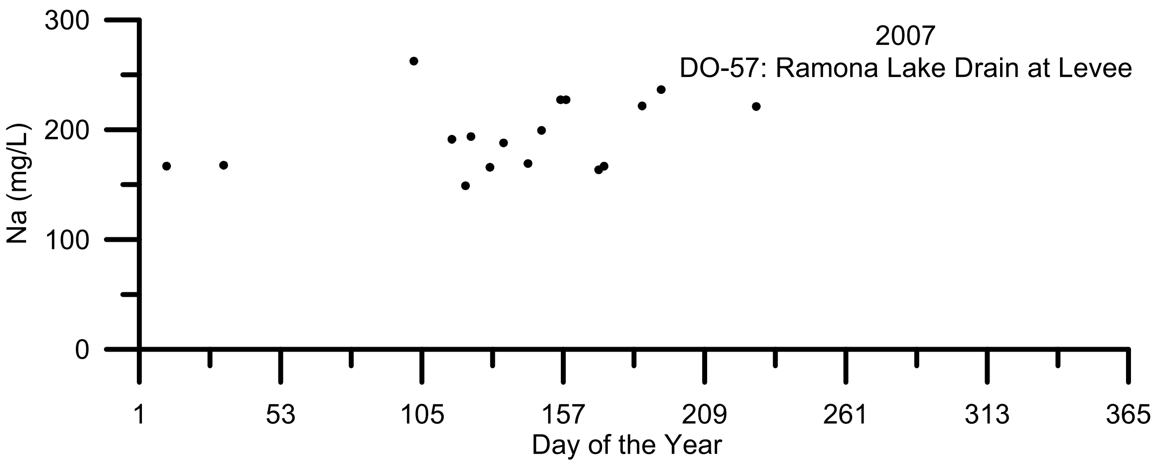

2005
DO-53: Salt Slough at Wolfsen Road
Na (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

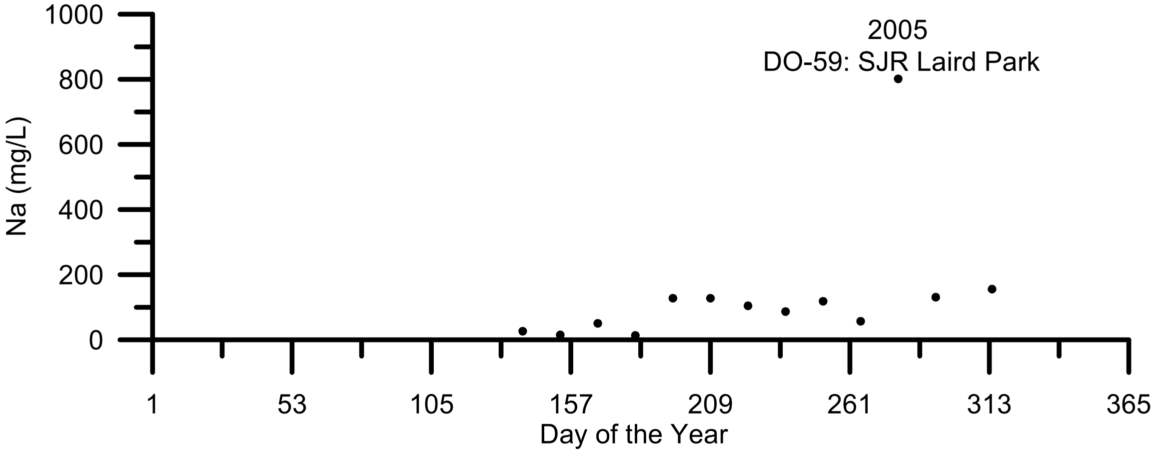

2006
DO-53: Salt Slough at Wolfsen Road
Na (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

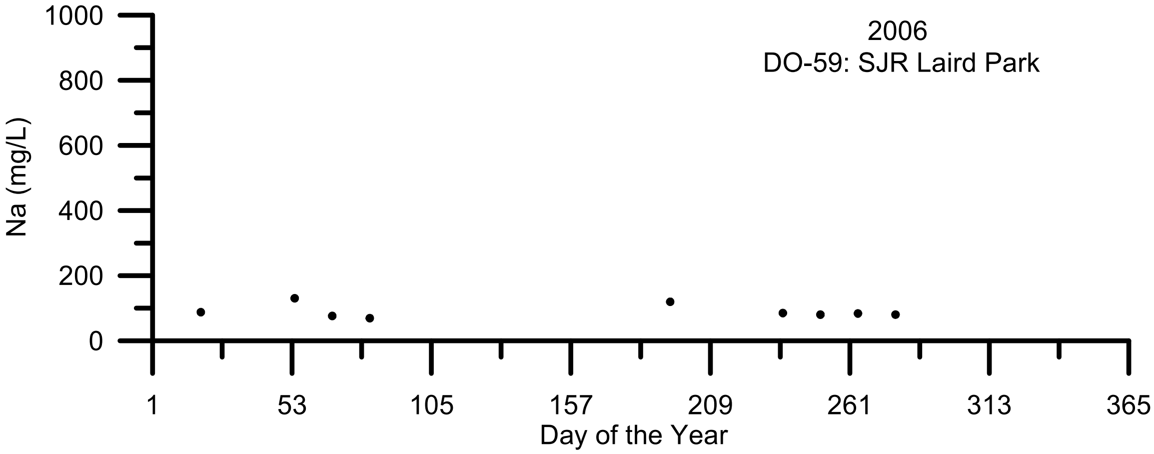

2007
DO-53: Salt Slough at Wolfsen Road
Na (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

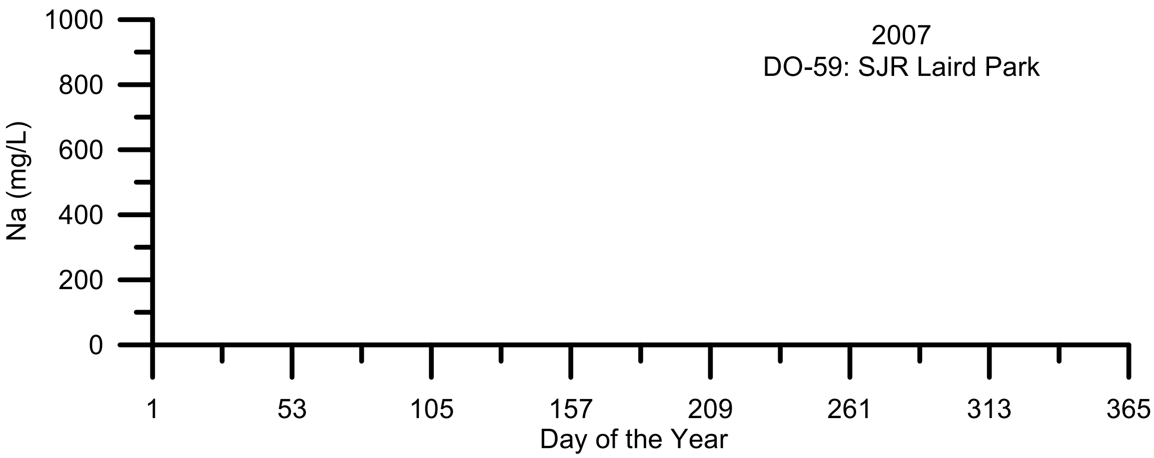

2005
DO-57: Ramona Lake Drain at Levee
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

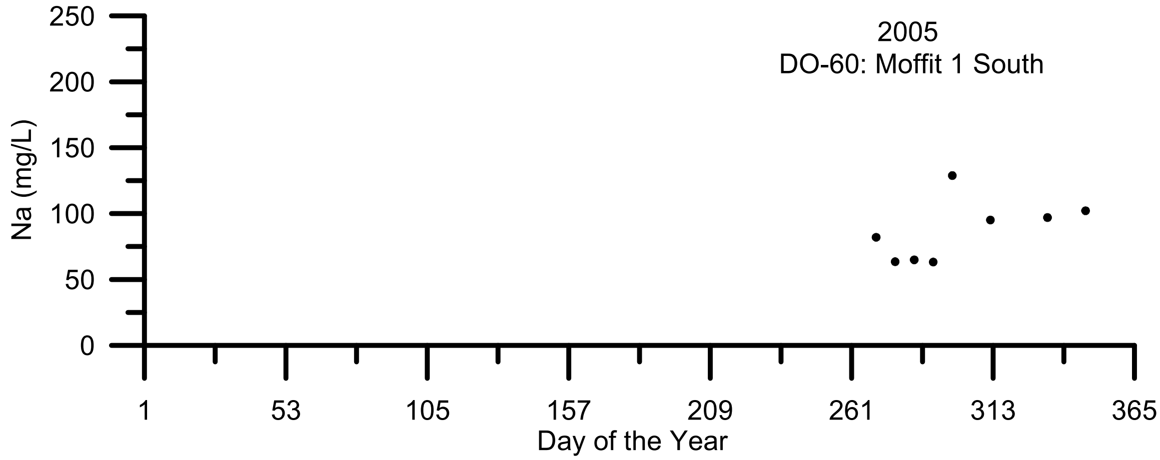

2006
DO-57: Ramona Lake Drain at Levee
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

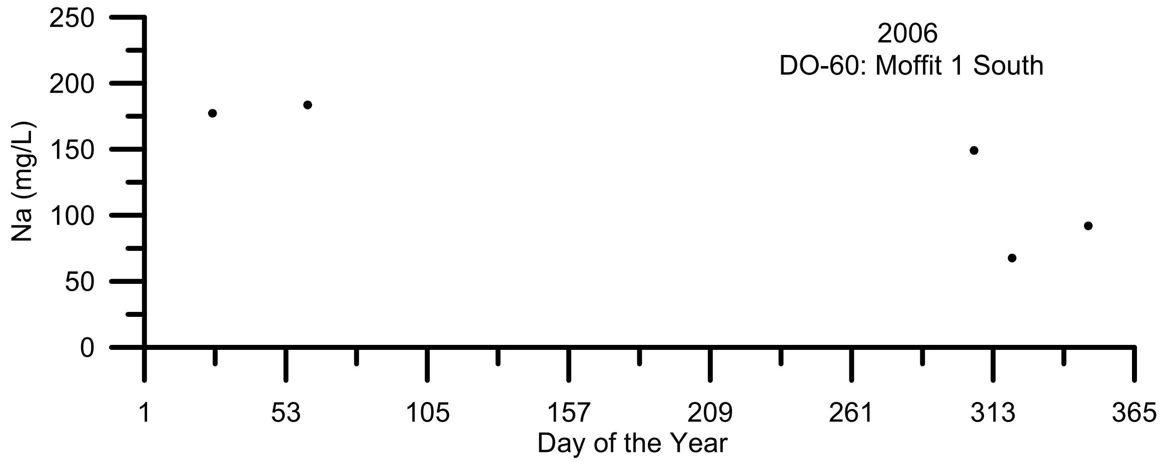

2007
DO-57: Ramona Lake Drain at Levee
Na (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

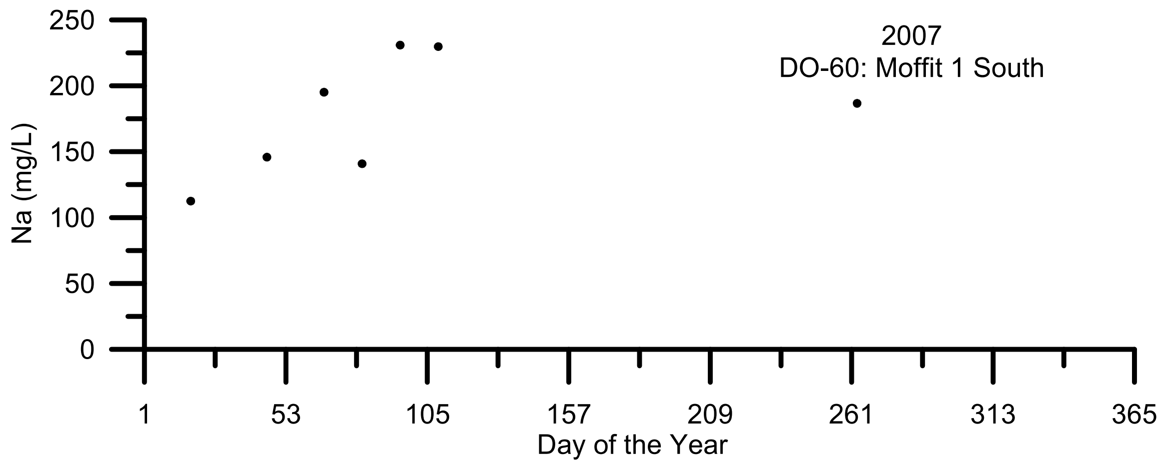

2005
DO-59: SJR Laird Park
Na (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

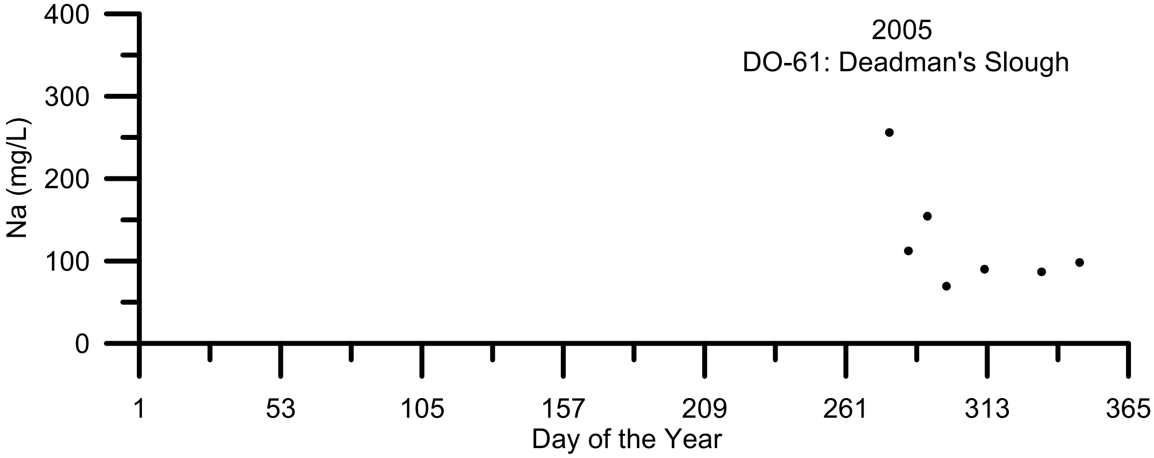

2006
DO-59: SJR Laird Park
Na (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

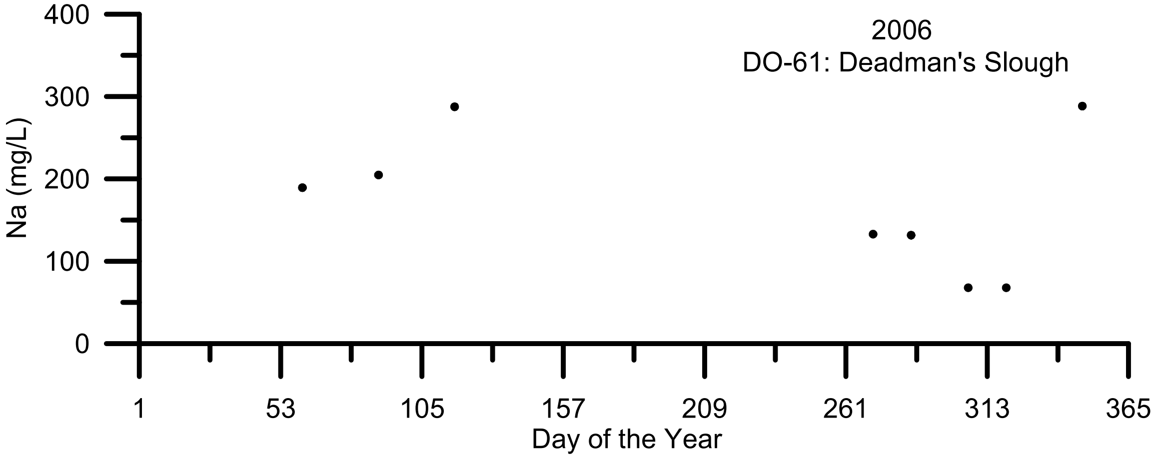

2007
DO-59: SJR Laird Park
Na (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

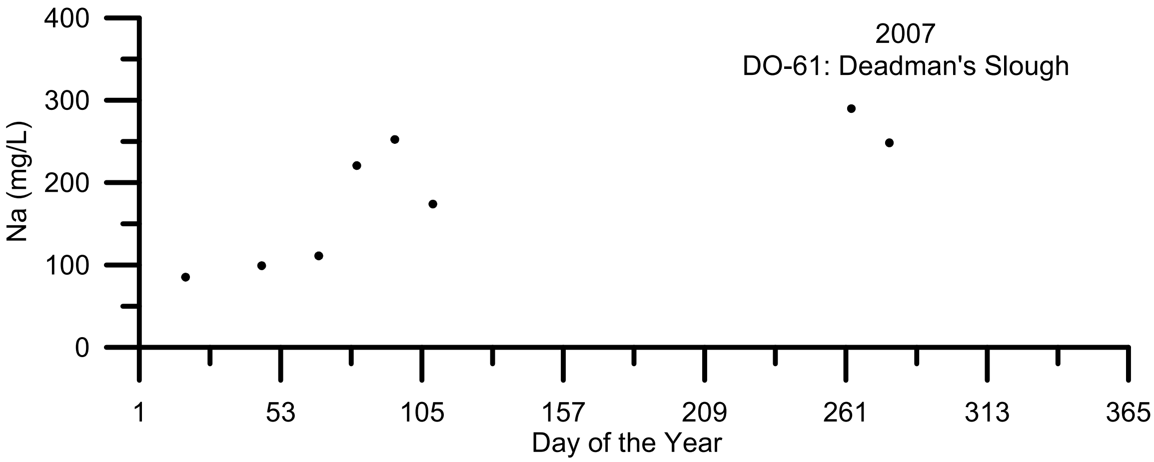

2005
DO-60: Moffit 1 South
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

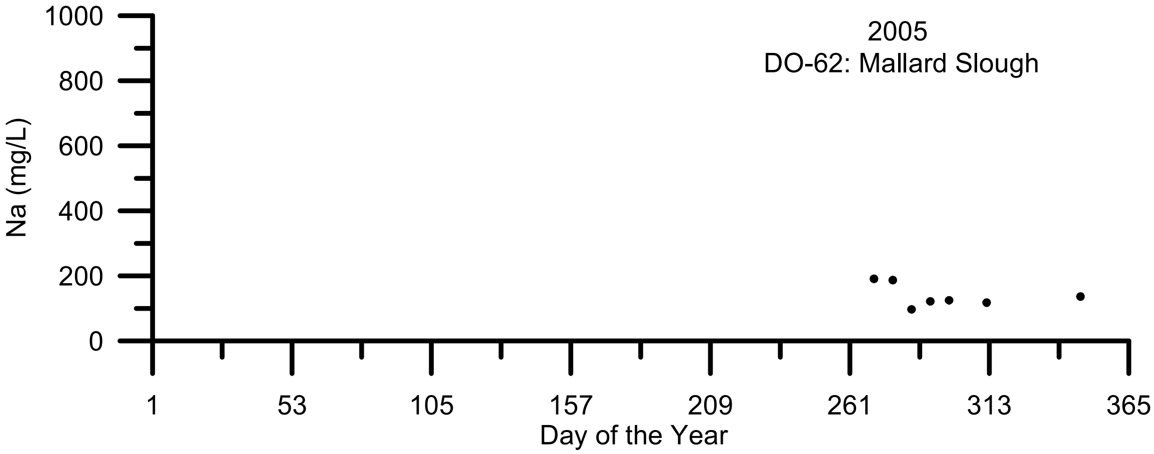

2006
DO-60: Moffit 1 South
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-60: Moffit 1 South
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

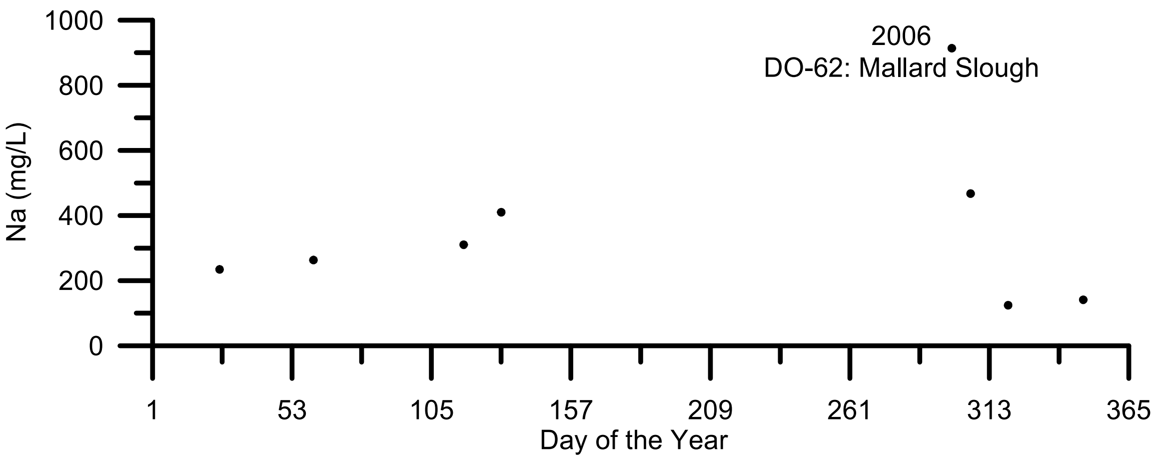

2005
DO-61: Deadman's Slough
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-61: Deadman's Slough
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

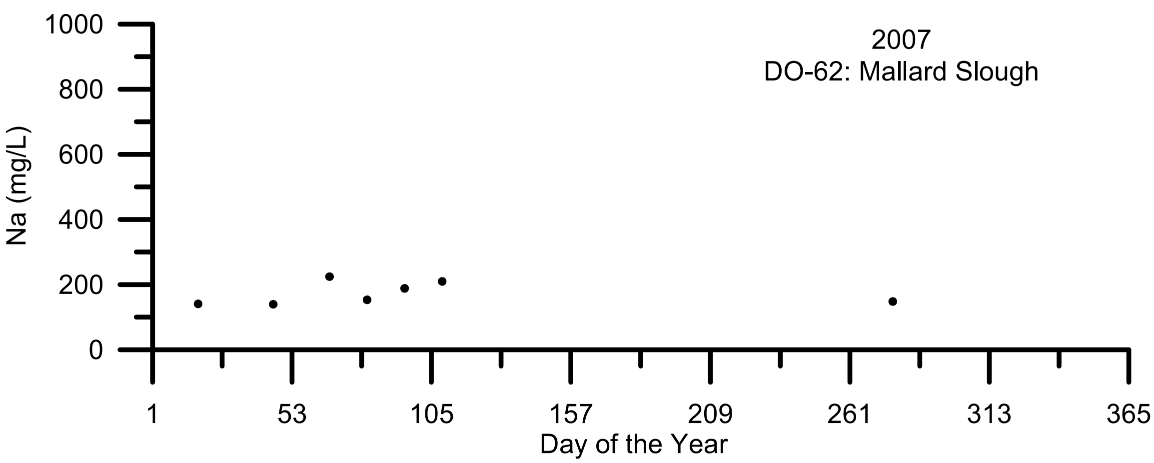

2007
DO-61: Deadman's Slough
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



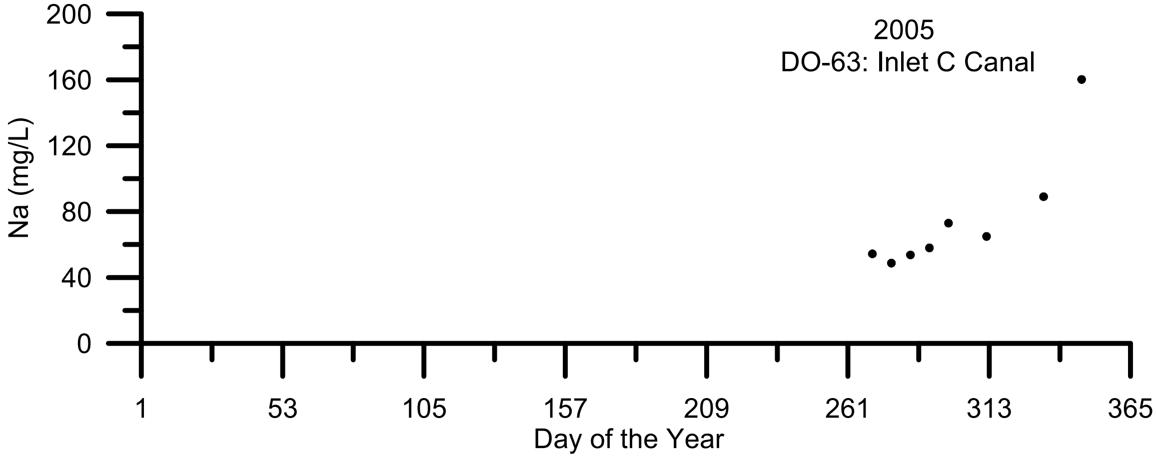
2005
DO-62: Mallard Slough
Na (mg/L)
0
200
400
600
800
1000
1
53
105
157
209
261
313
365
Day of the Year

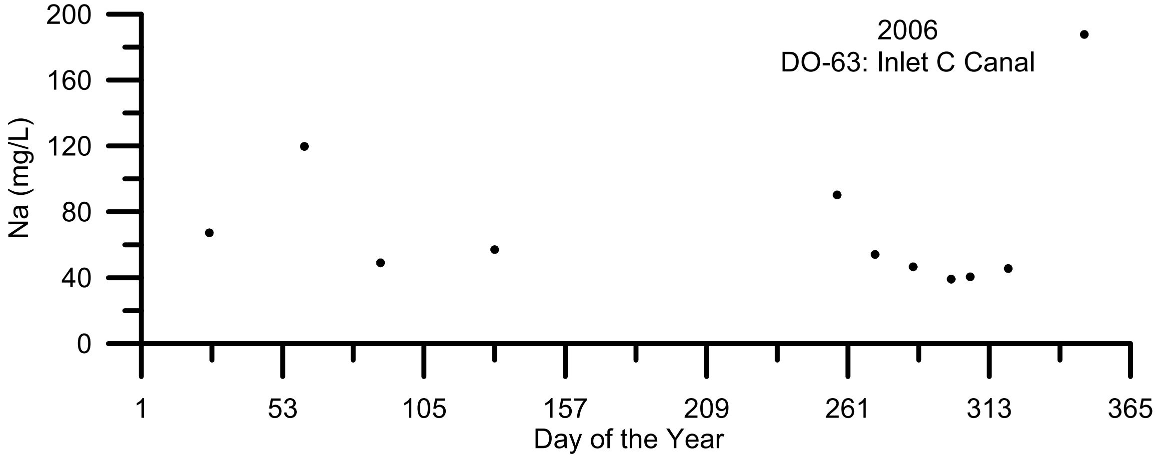


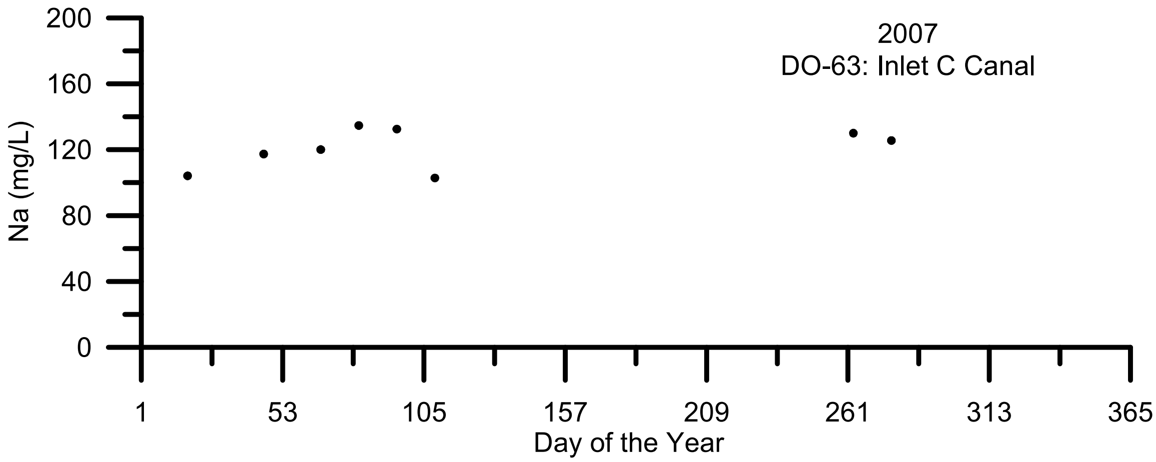
2006
DO-62: Mallard Slough
Na (mg/L)
0
200
400
600
800
1000
1
53
105
157
209
261
313
365
Day of the Year

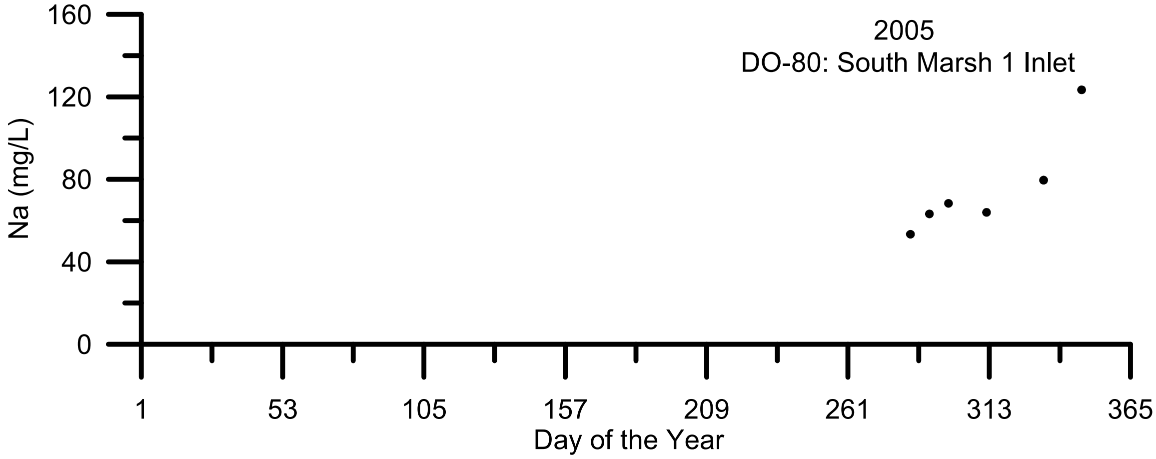


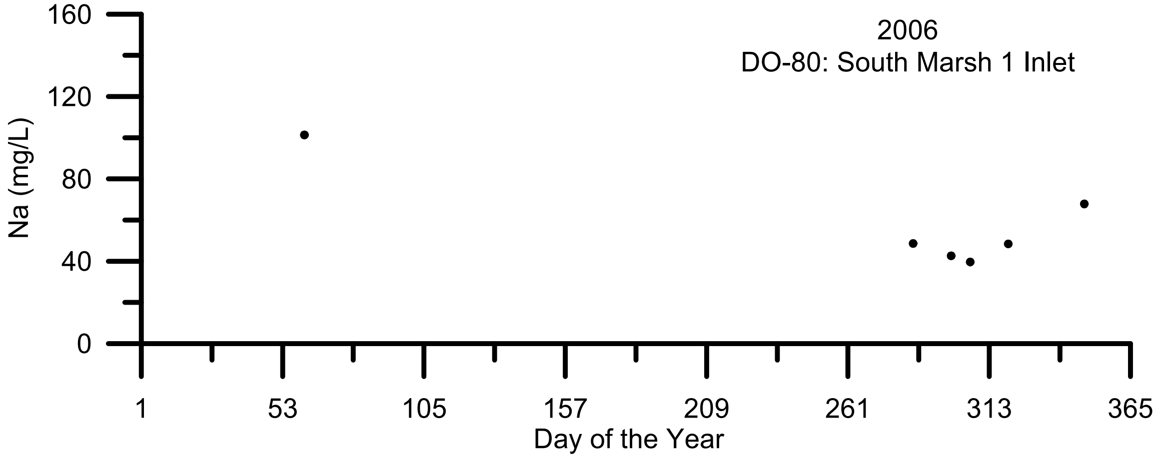
2007
DO-62: Mallard Slough
Na (mg/L)
0
200
400
600
800
1000
1
53
105
157
209
261
313
365
Day of the Year

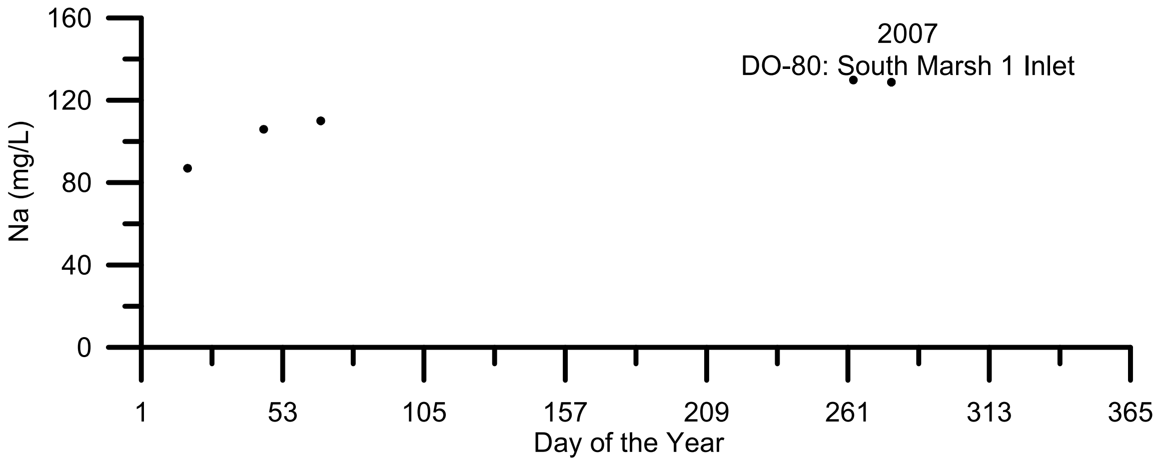

2005
DO-63: Inlet C Canal
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

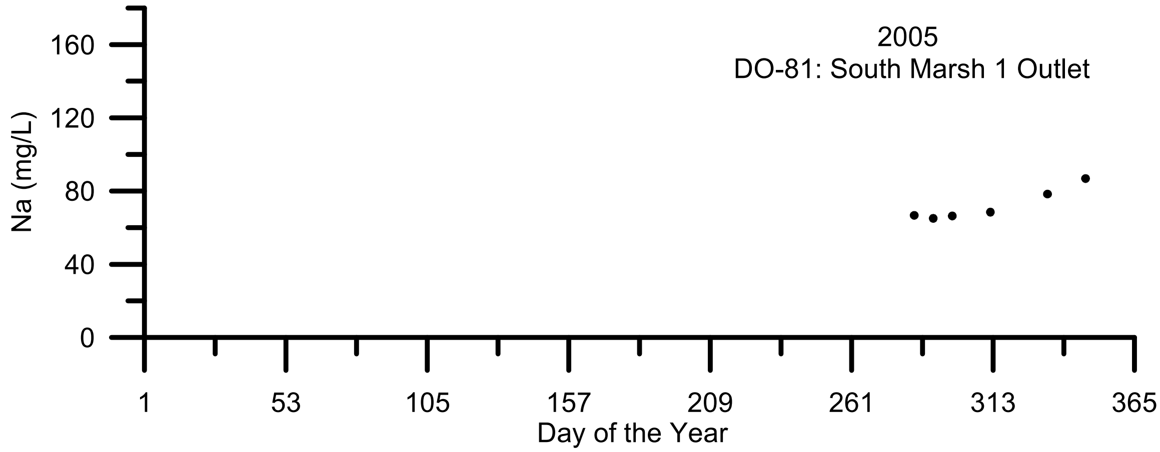

2006
DO-63: Inlet C Canal
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

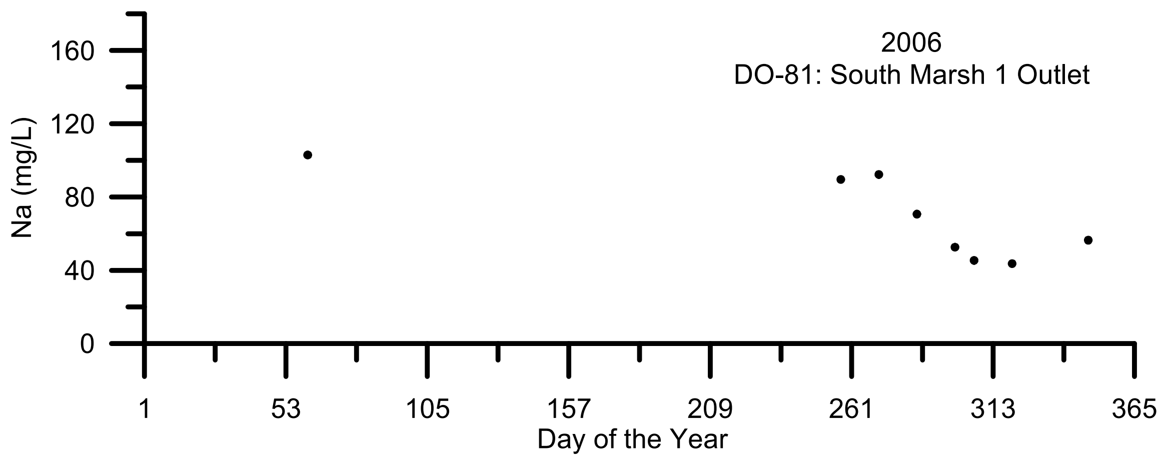

2007
DO-63: Inlet C Canal
Na (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

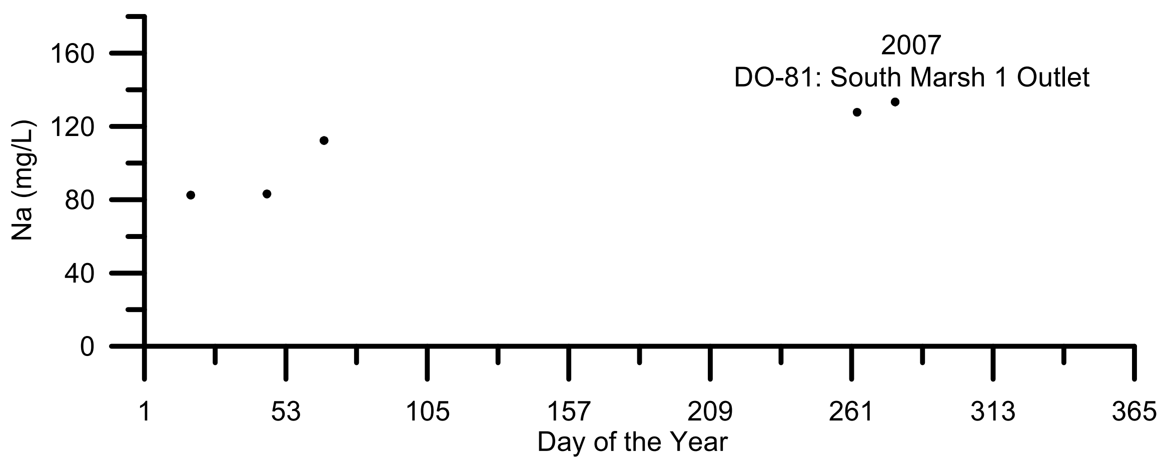

2005
DO-80: South Marsh 1 Inlet
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

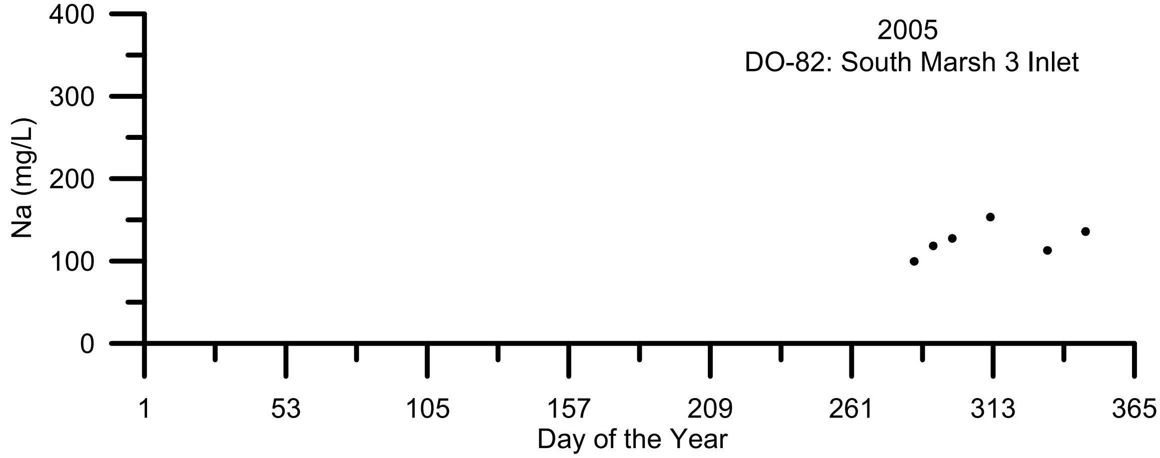

2006
DO-80: South Marsh 1 Inlet
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

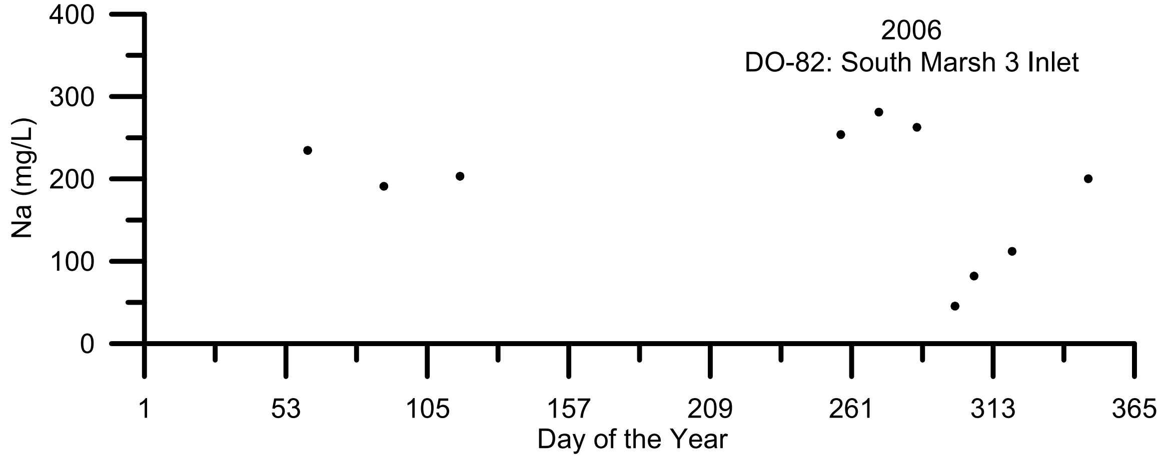

2007
DO-80: South Marsh 1 Inlet
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

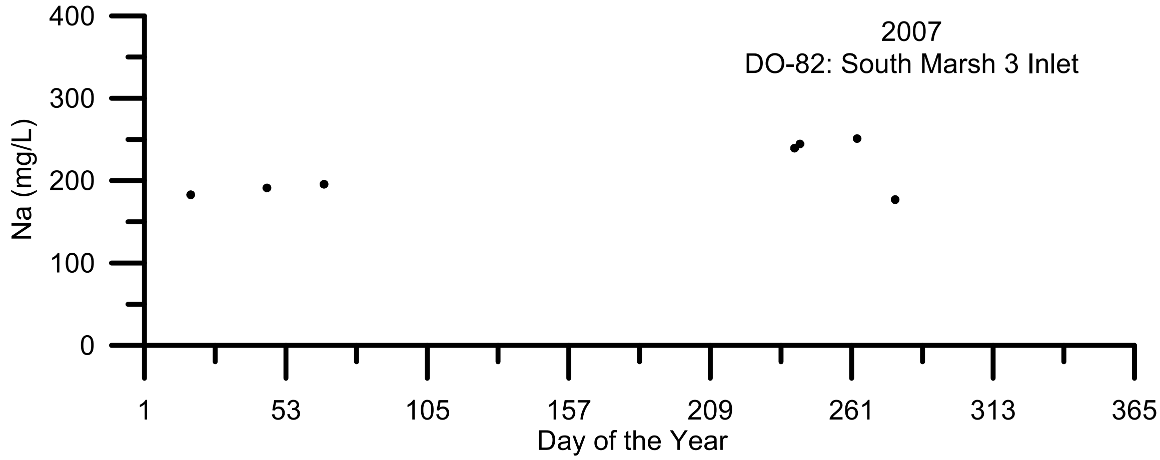

2005
DO-81: South Marsh 1 Outlet
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

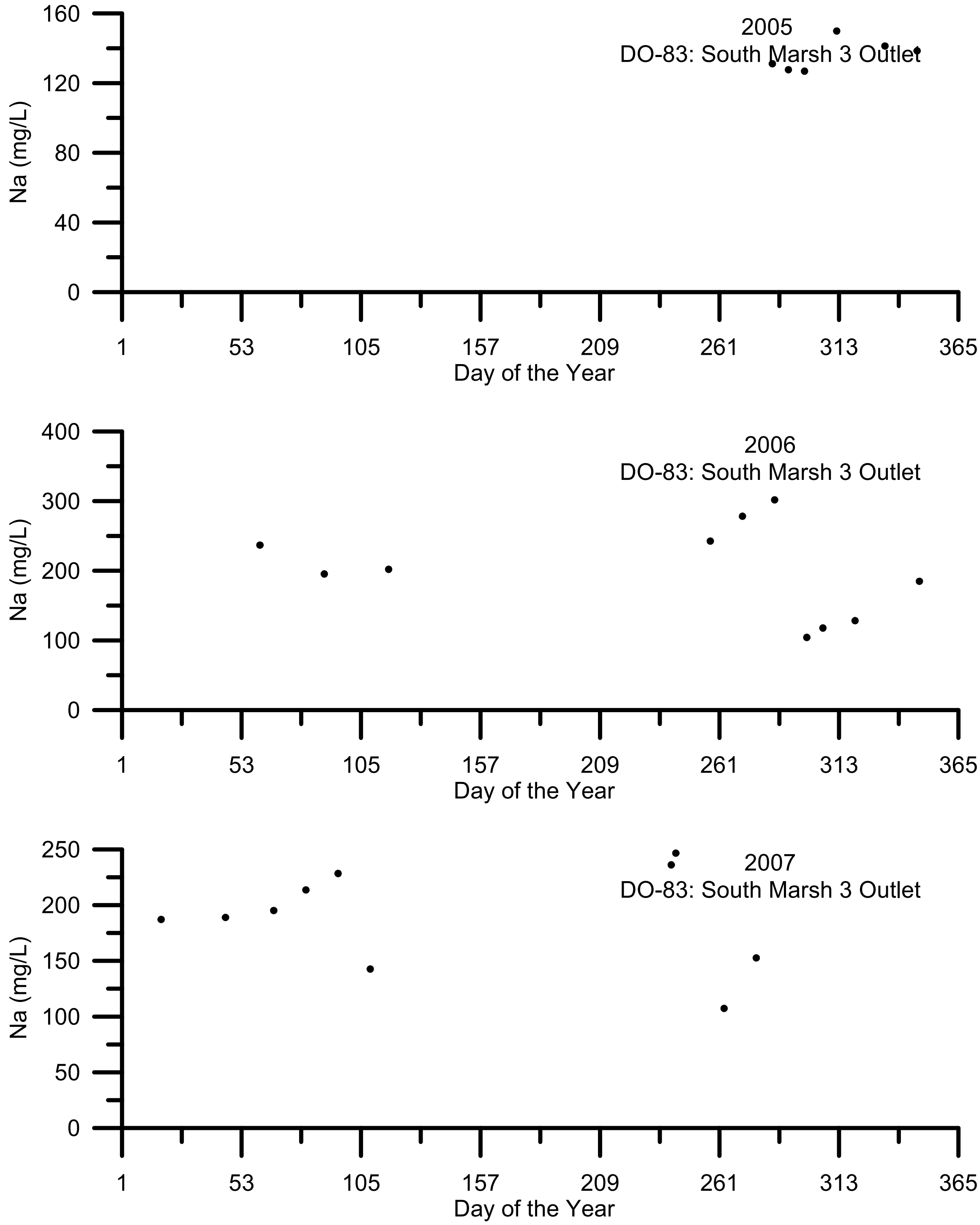

2006
DO-81: South Marsh 1 Outlet
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-81: South Marsh 1 Outlet
Na (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

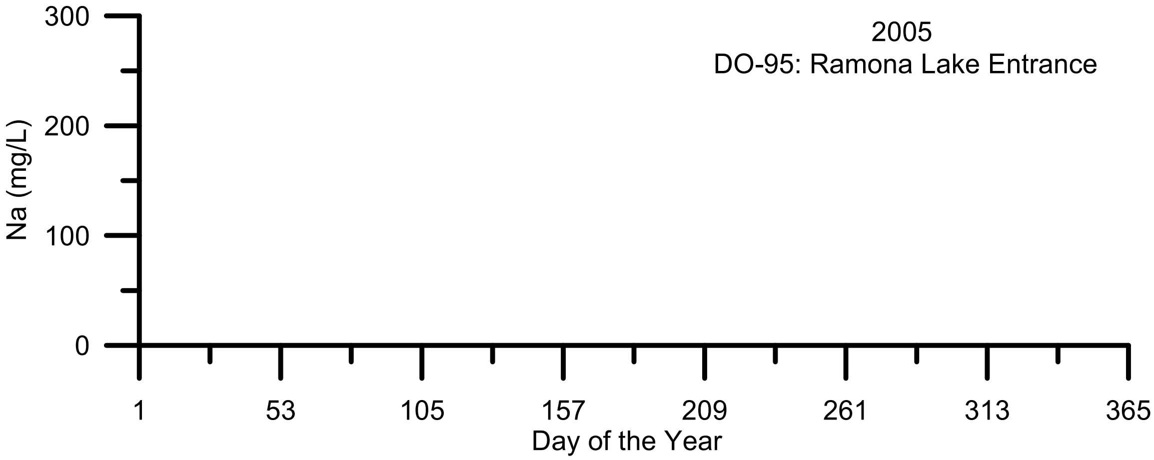

2005
DO-82: South Marsh 3 Inlet
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

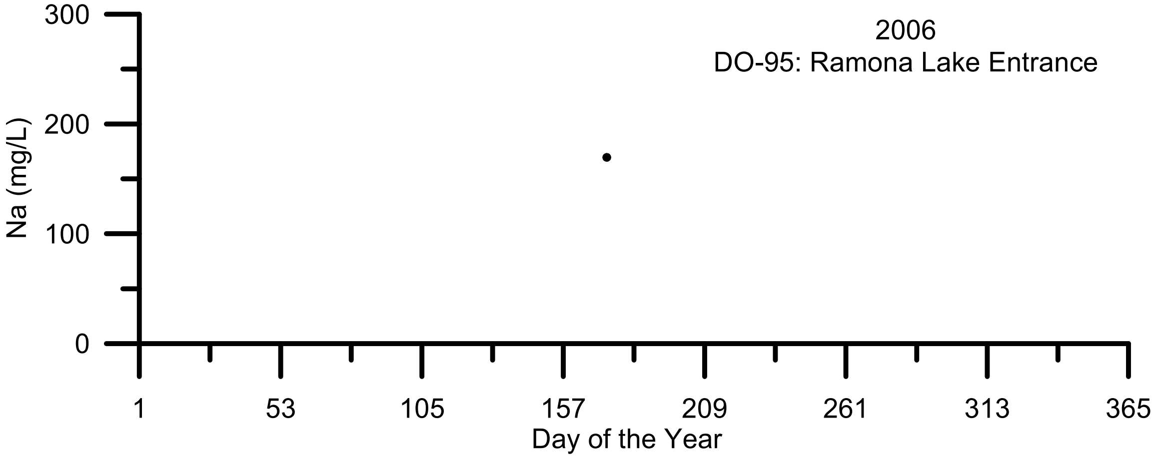

2006
DO-82: South Marsh 3 Inlet
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

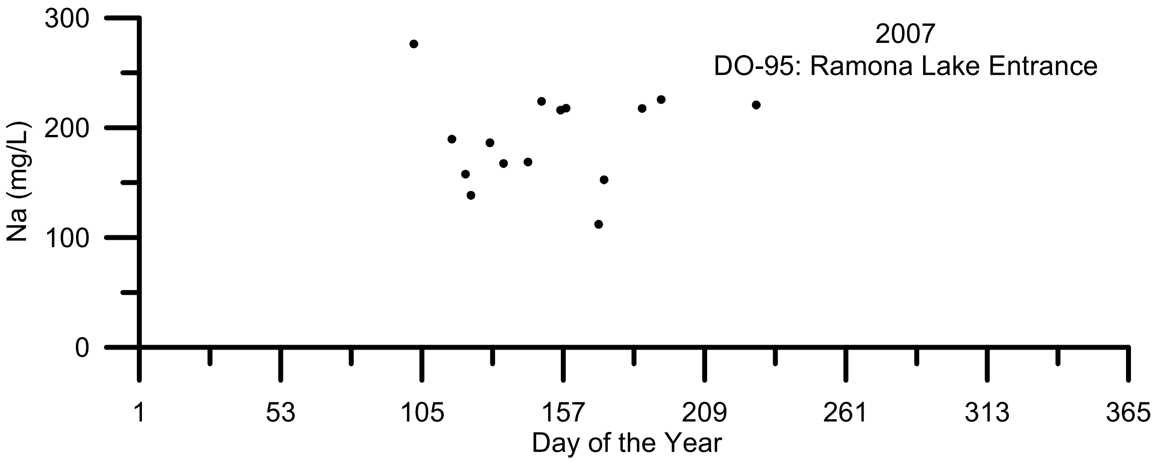

2007
DO-82: South Marsh 3 Inlet
Na (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



2005
DO-83: South Marsh 3 Outlet
Na (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-83: South Marsh 3 Outlet
Na (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year
2007
DO-83: South Marsh 3 Outlet
Na (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Na (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Na (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Na (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Potassium Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of potassium (K) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at $4^{\circ}C$.

Ion chromatography was utilized for measuring K^+ using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (ASTM D6919-03). The reportable limit for this method is 0.05 mg/L K^{2+}.

Results/Discussion

Samples were measured ranging from 0.0-54.7 mg/L K. The average concentration of K in water samples collected was 5.24 mg/L K. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

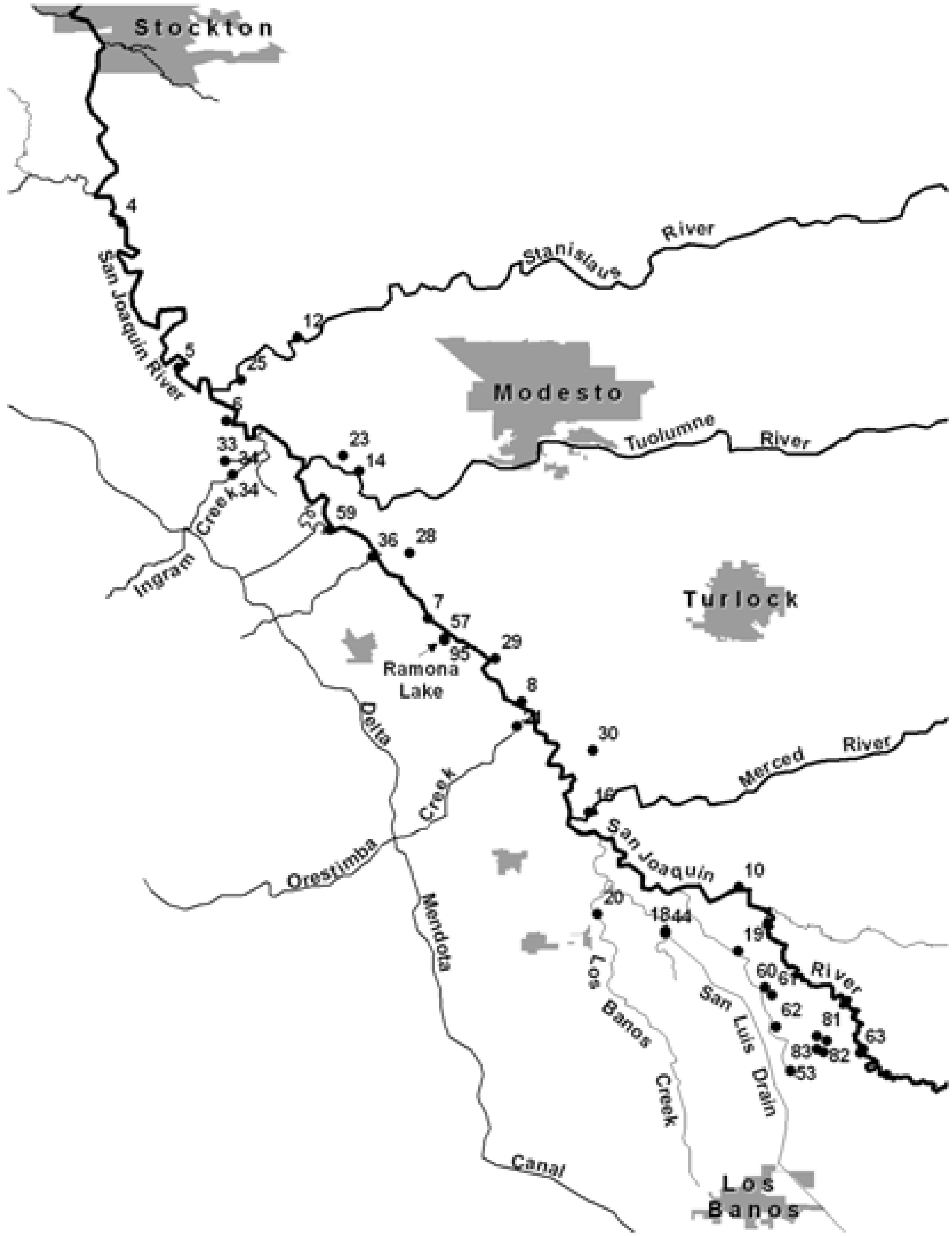
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

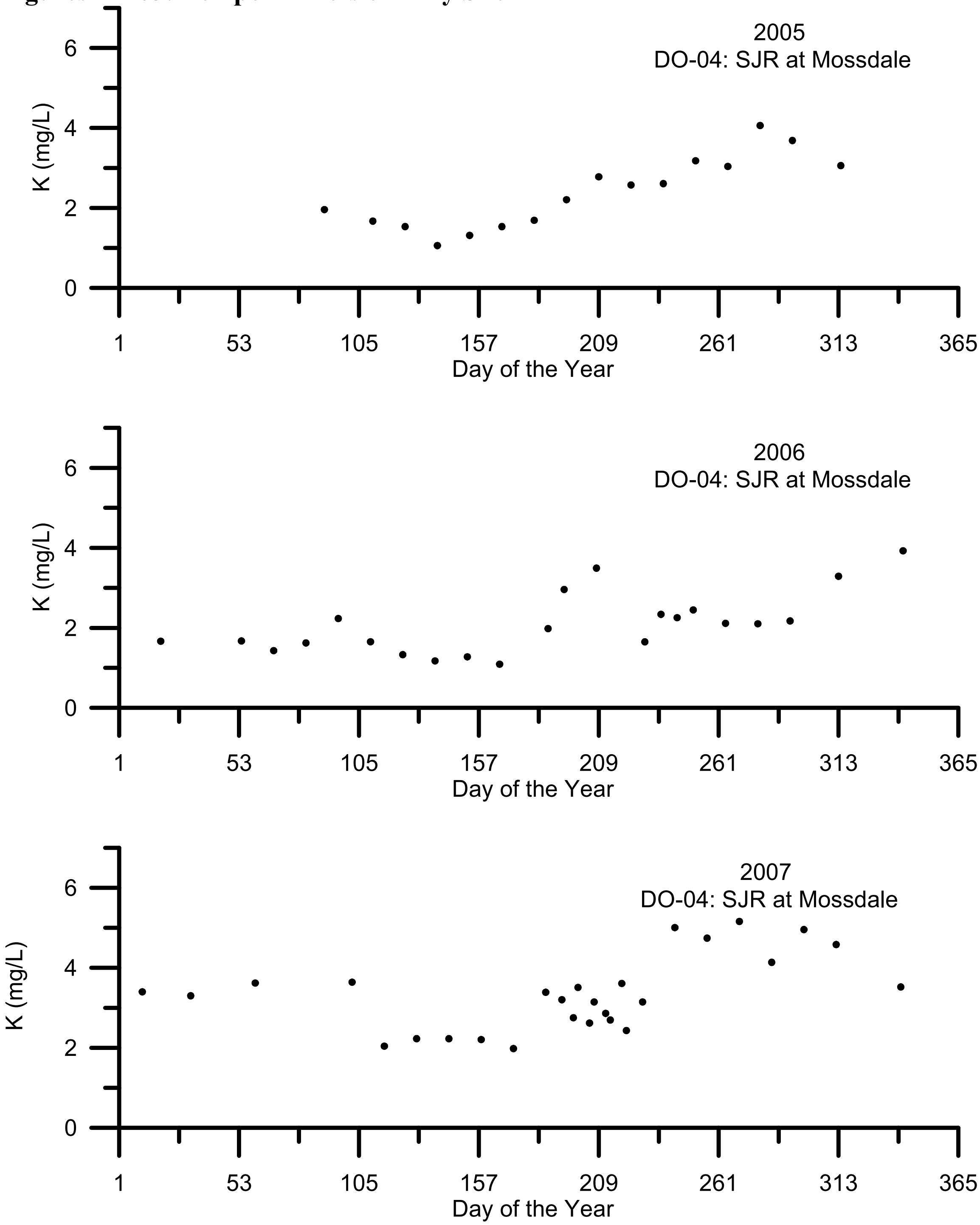
Table 1: EERP Sampling Site List

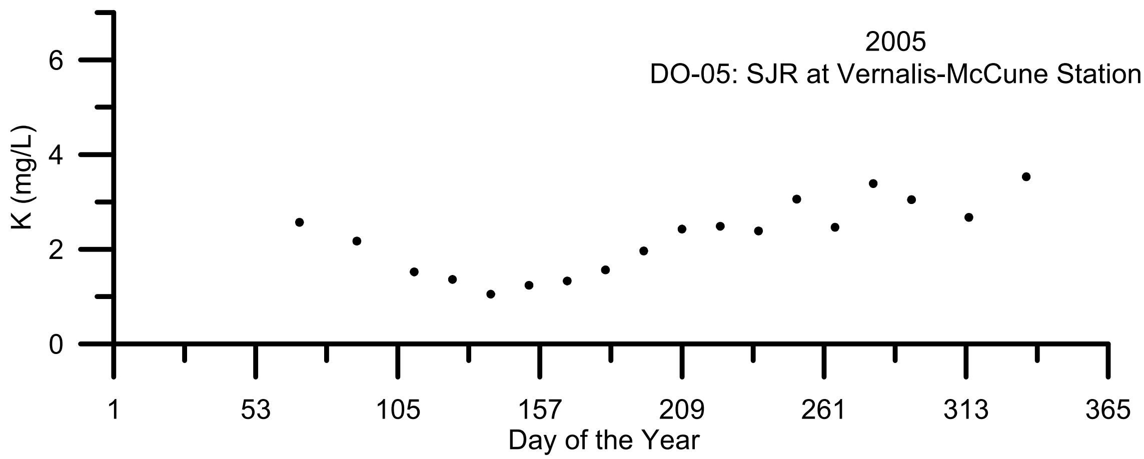
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

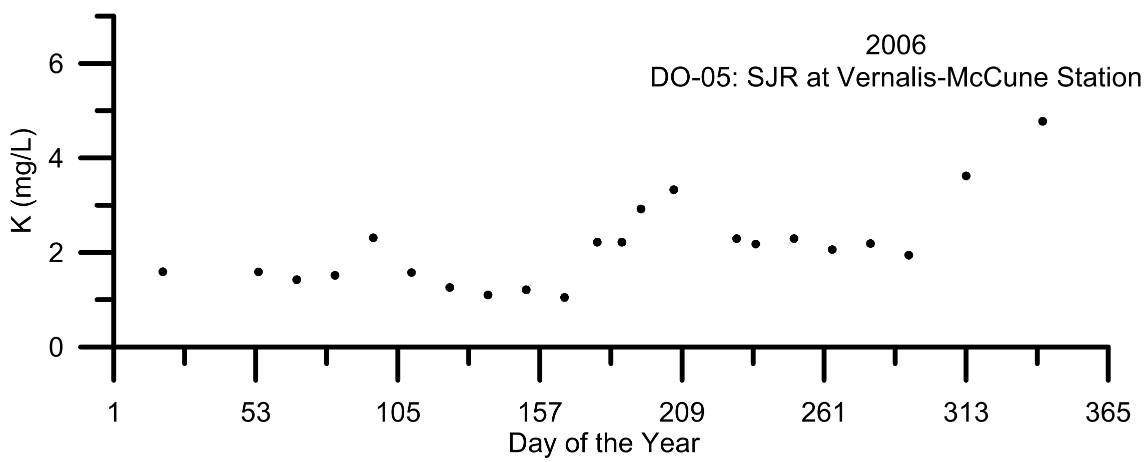


Figures 2 -103: Temporal Plots of K By Site ID

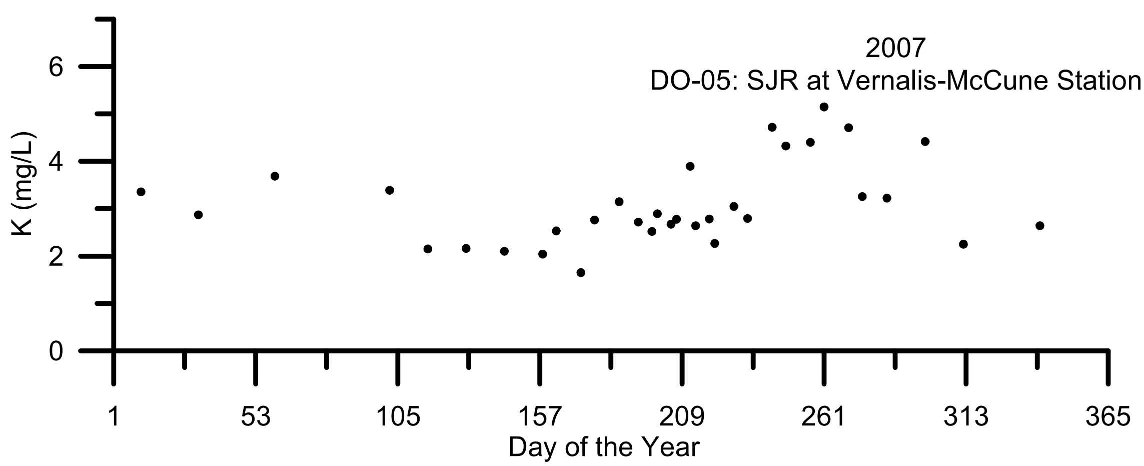




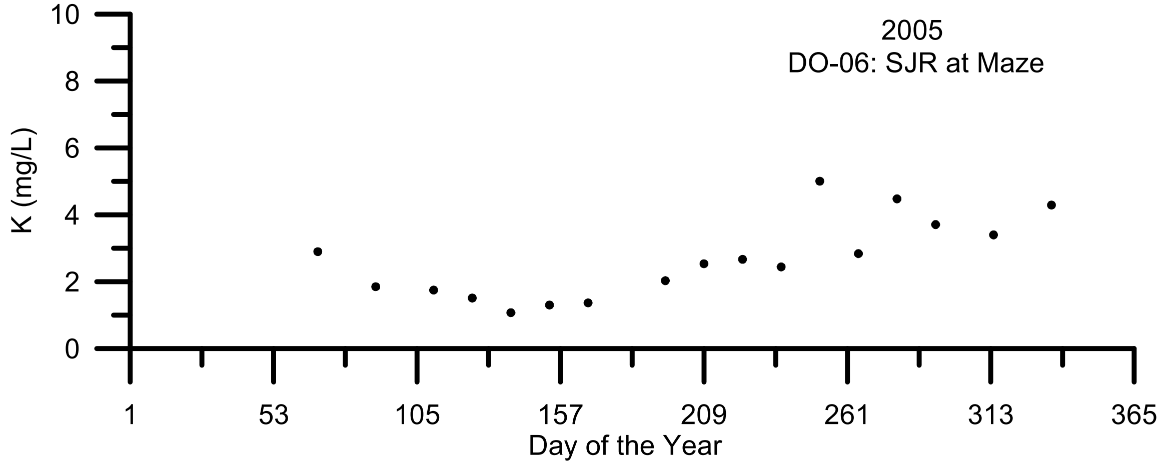
2005
DO-05: SJR at Vernalis-McCune Station
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

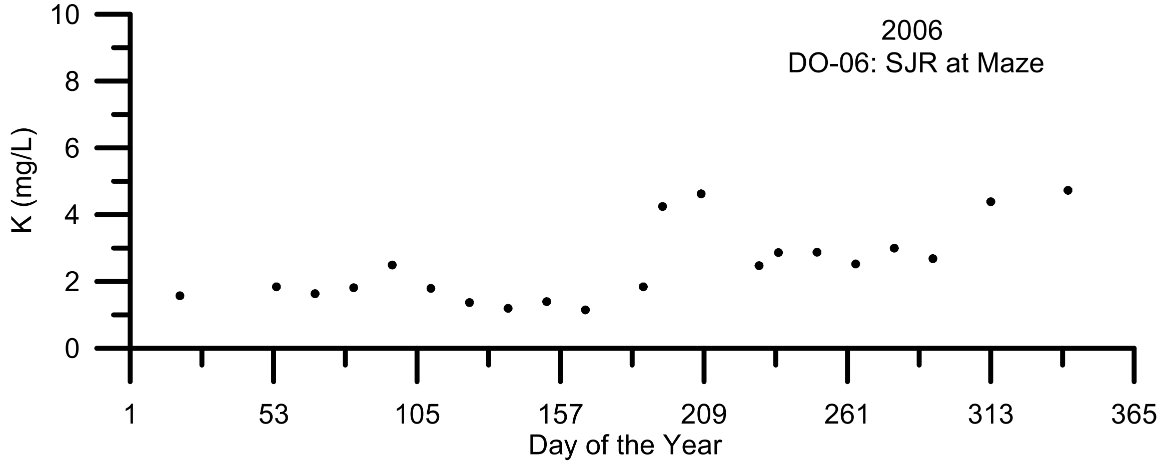


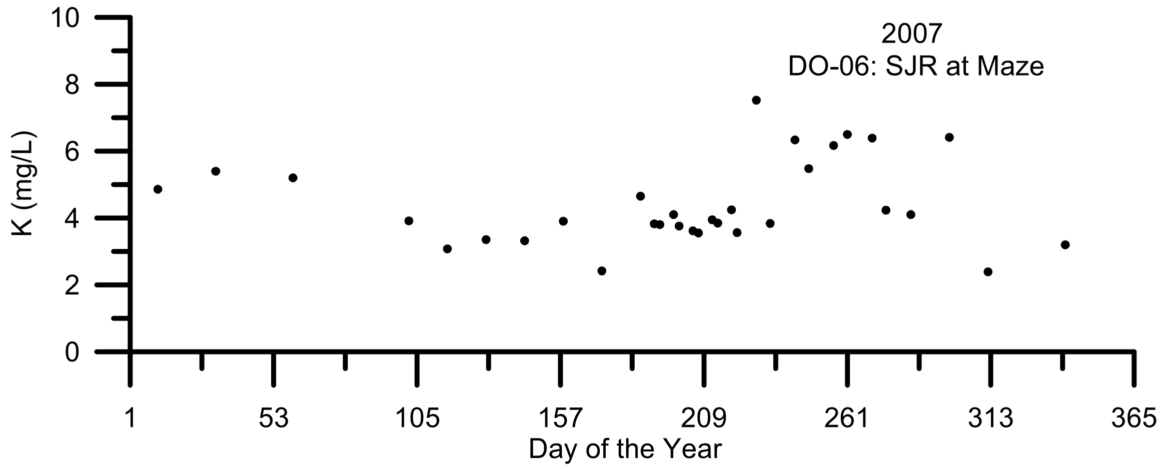
2006
DO-05: SJR at Vernalis-McCune Station
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

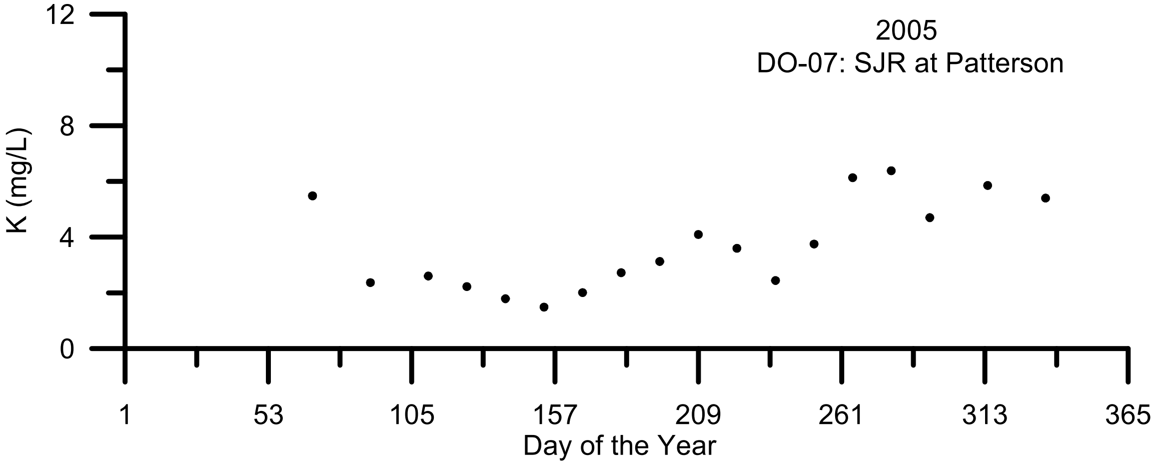


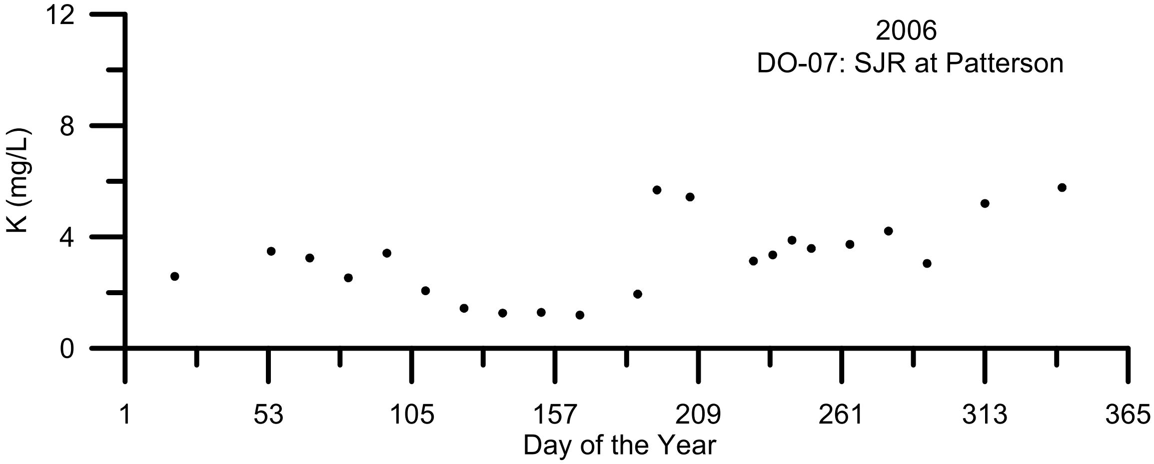
2007
DO-05: SJR at Vernalis-McCune Station
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

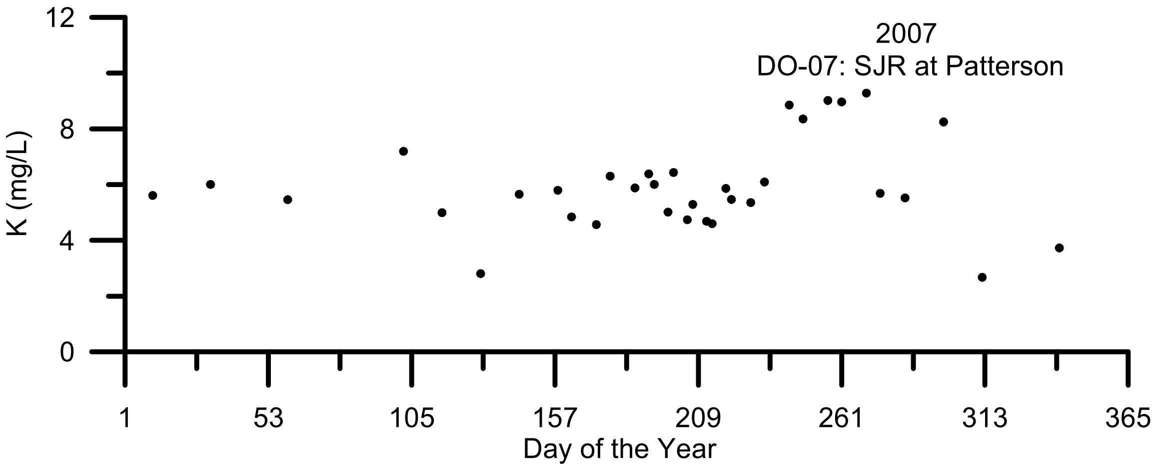

2005
DO-06: SJR at Maze
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

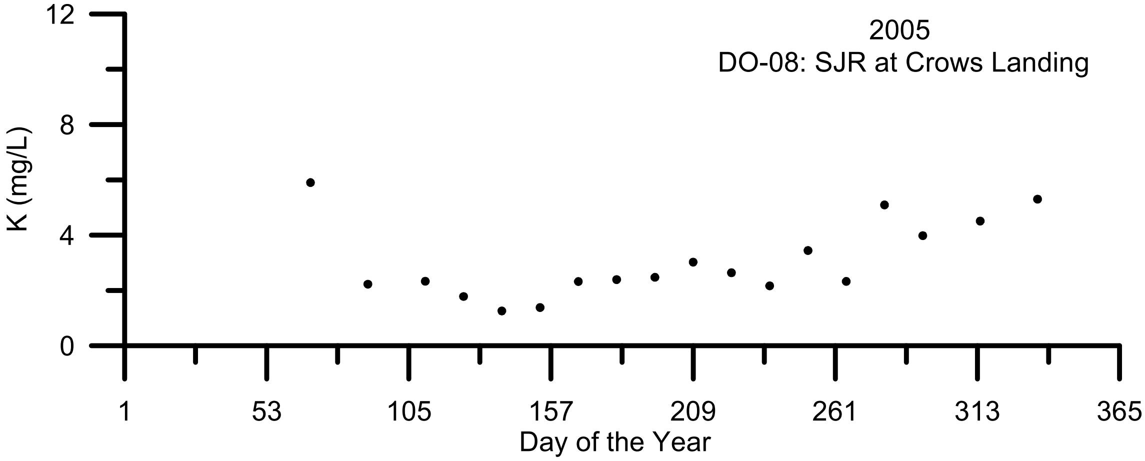

2006
DO-06: SJR at Maze
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

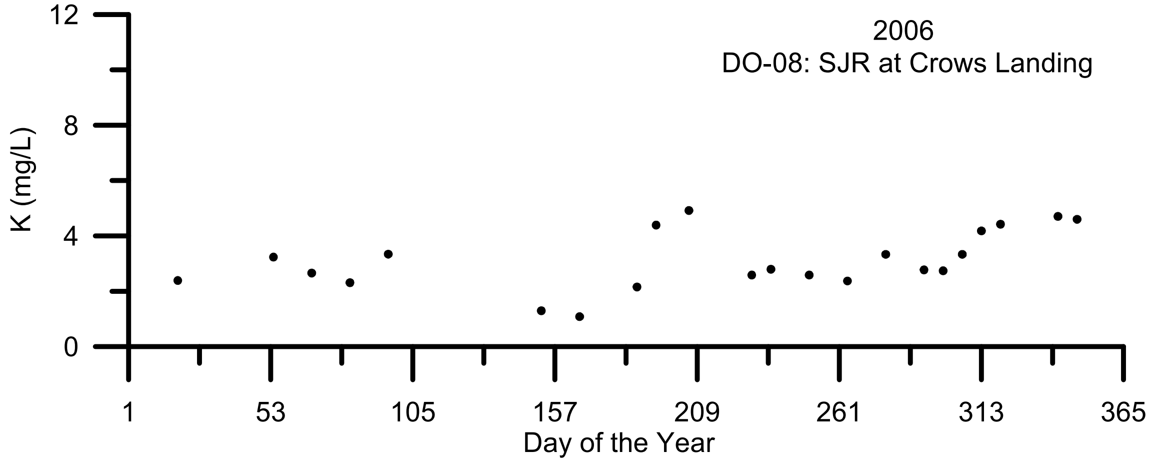

2007
DO-06: SJR at Maze
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

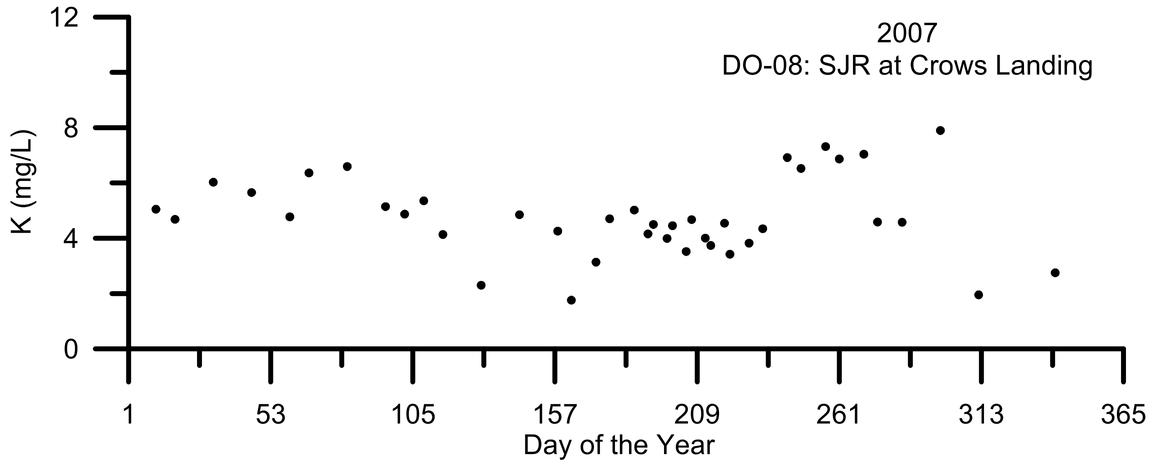

2005
DO-07: SJR at Patterson
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

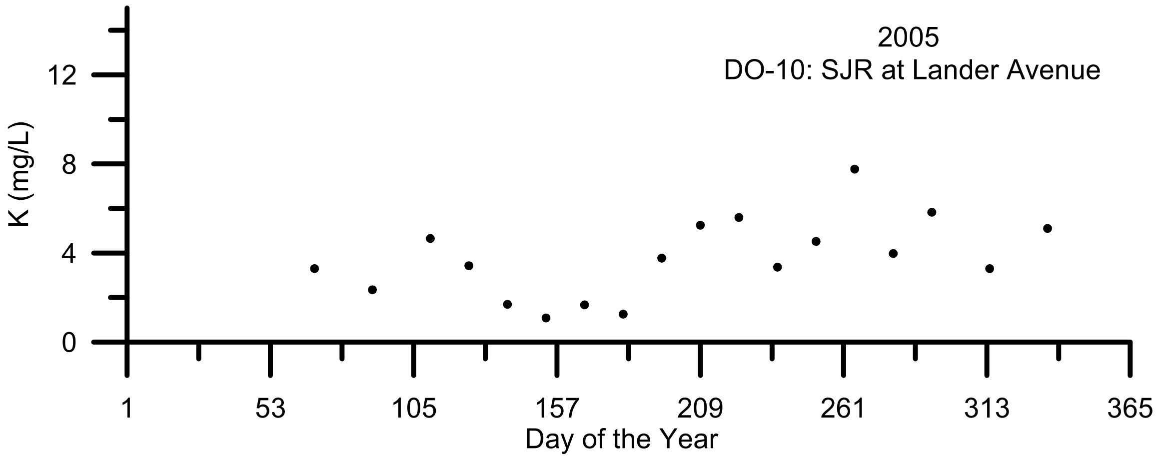

2006
DO-07: SJR at Patterson
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

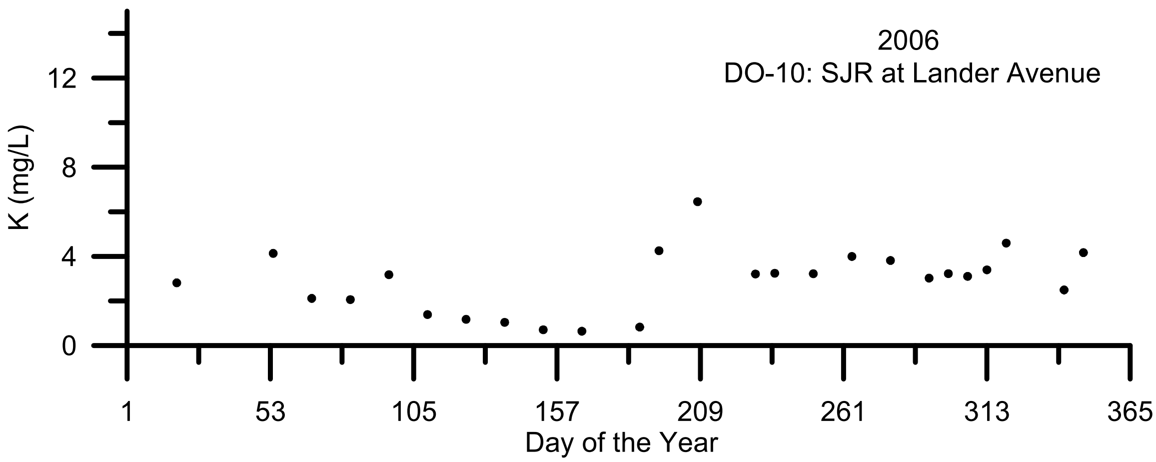

2007
DO-07: SJR at Patterson
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

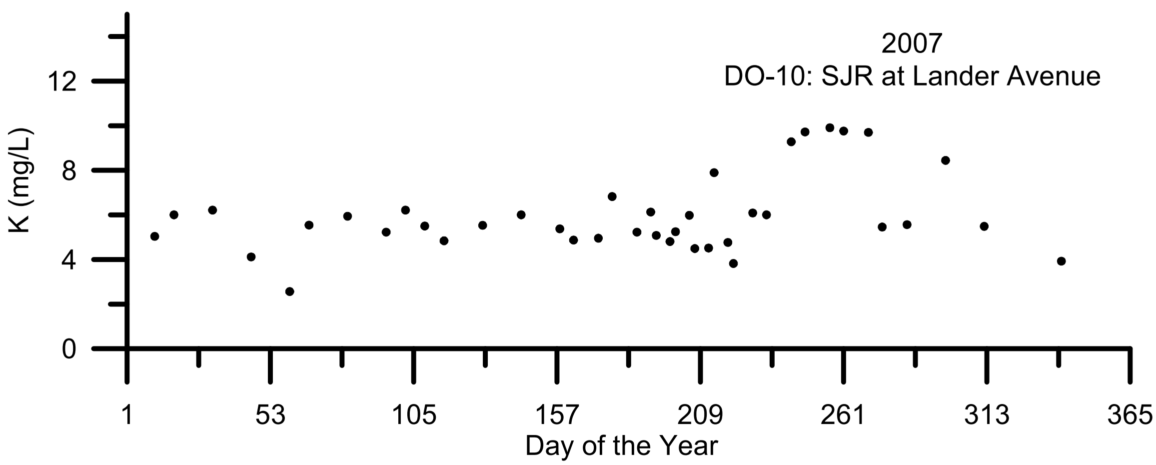

2005
DO-08: SJR at Crows Landing
K (mg/L)
Day of the Year

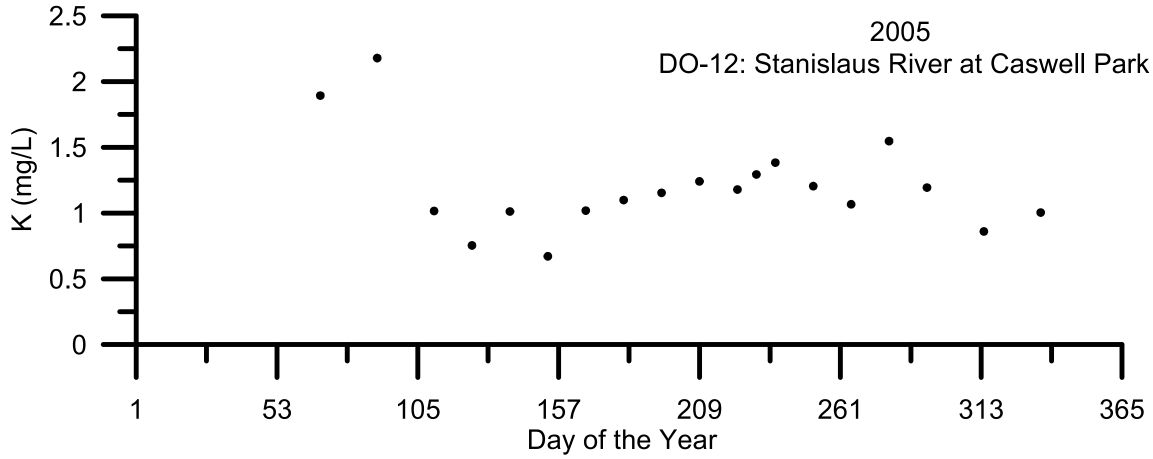

2006
DO-08: SJR at Crows Landing
K (mg/L)
Day of the Year

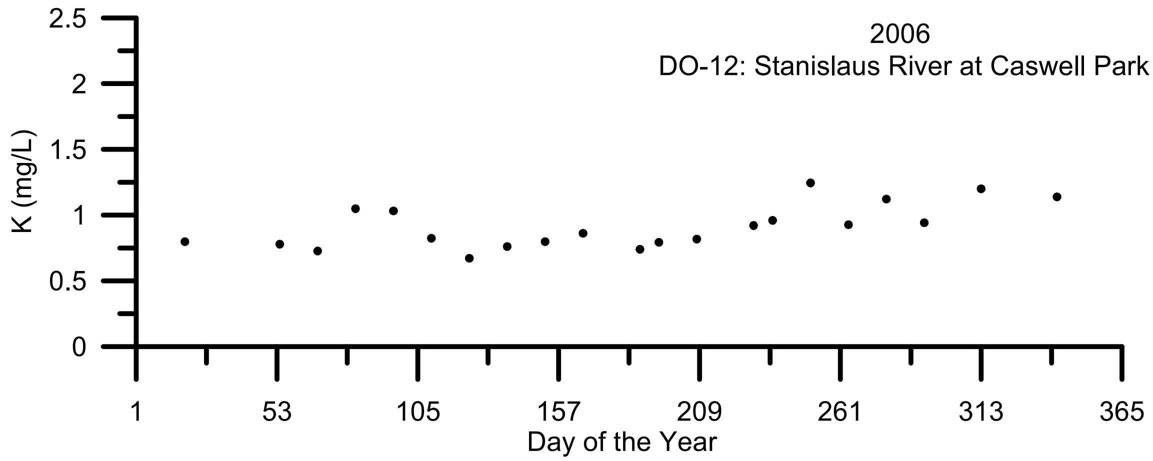

2007
DO-08: SJR at Crows Landing
K (mg/L)
Day of the Year

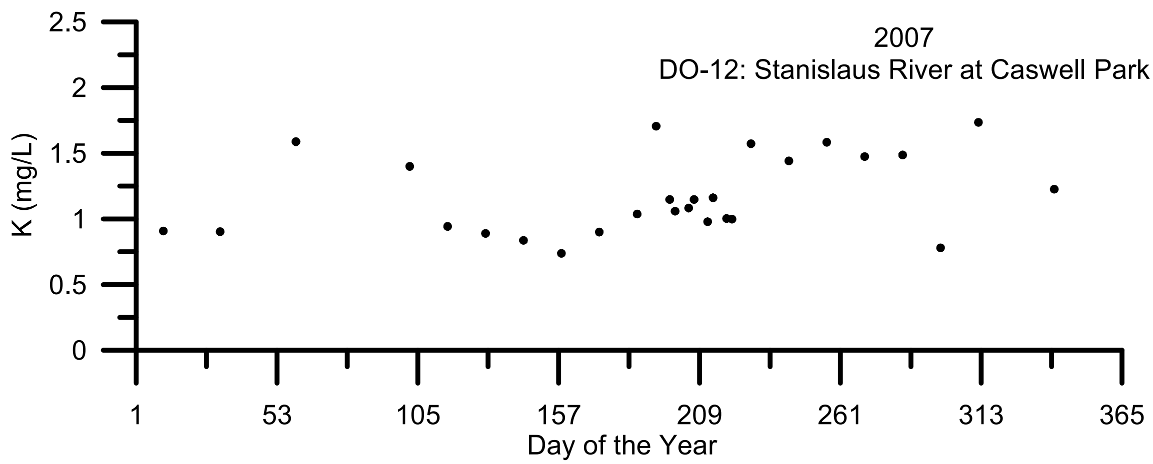

2005
DO-10: SJR at Lander Avenue
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

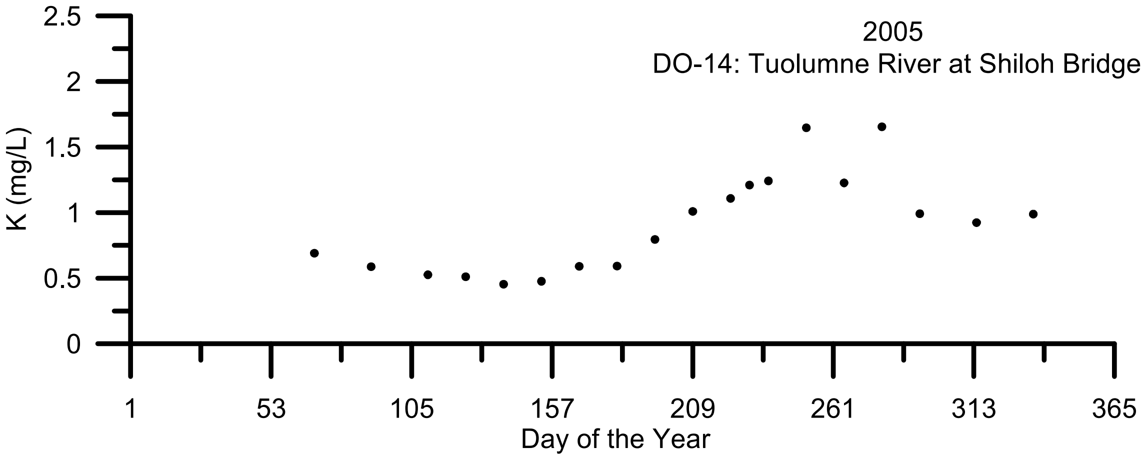

2006
DO-10: SJR at Lander Avenue
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

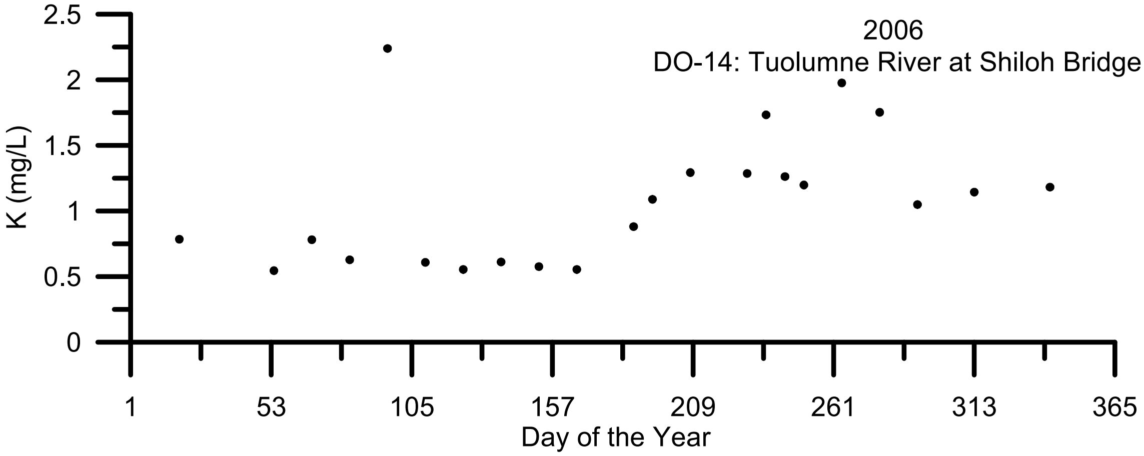

2007
DO-10: SJR at Lander Avenue
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

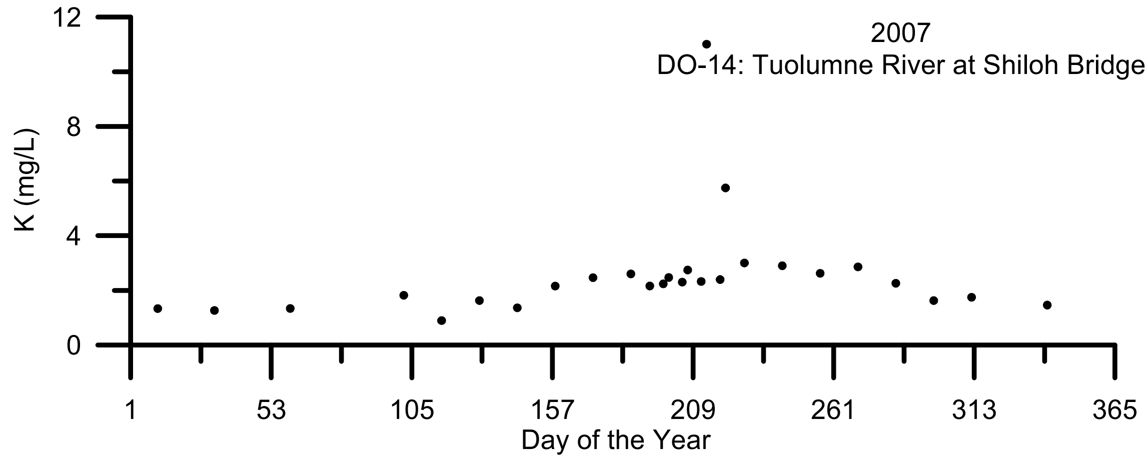

2005
DO-12: Stanislaus River at Caswell Park
K (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

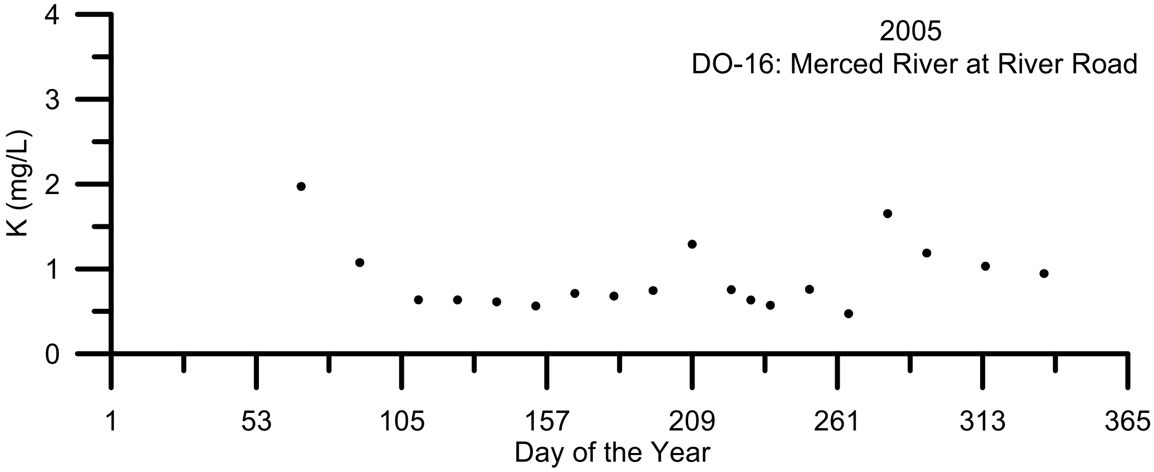

2006
DO-12: Stanislaus River at Caswell Park
K (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

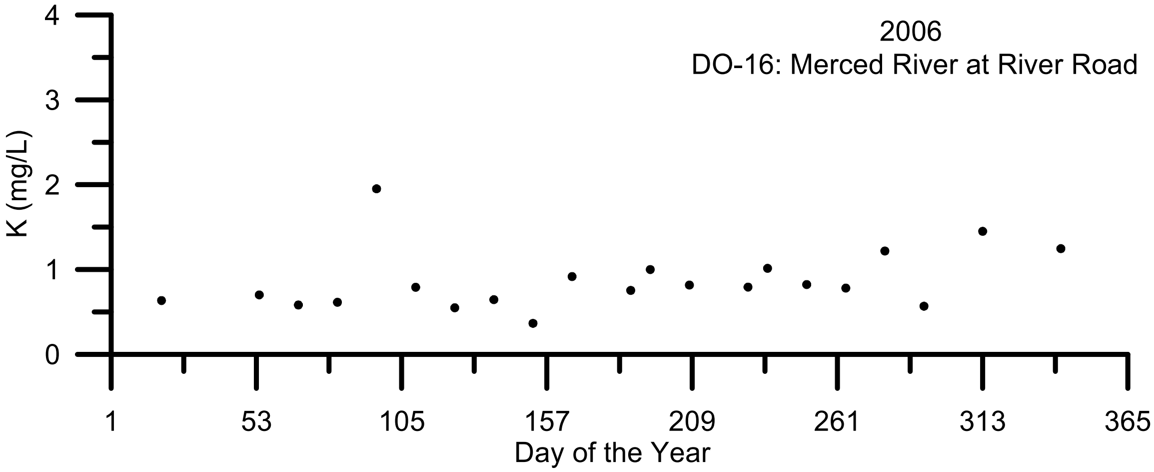

2007
DO-12: Stanislaus River at Caswell Park
K (mg/L)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

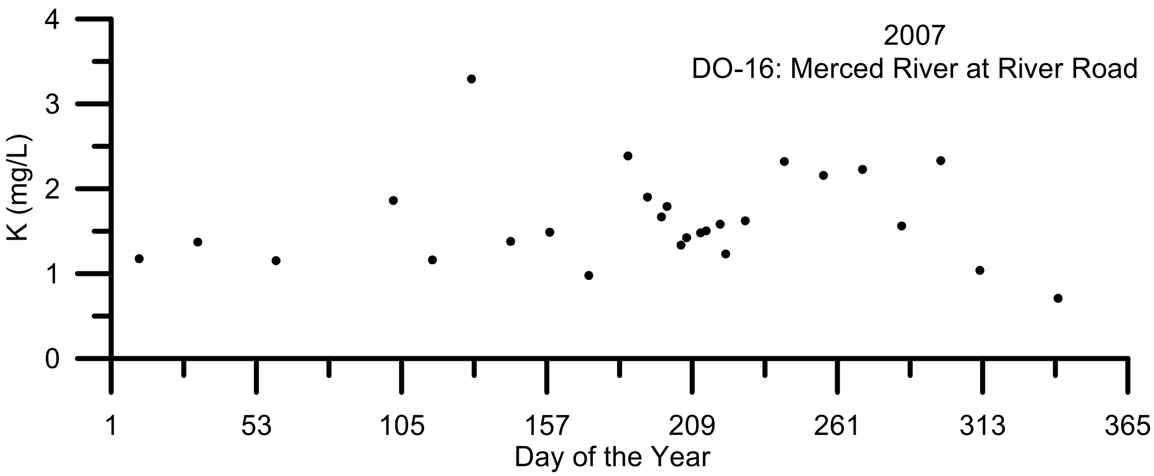

2005
DO-14: Tuolumne River at Shiloh Bridge
K (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

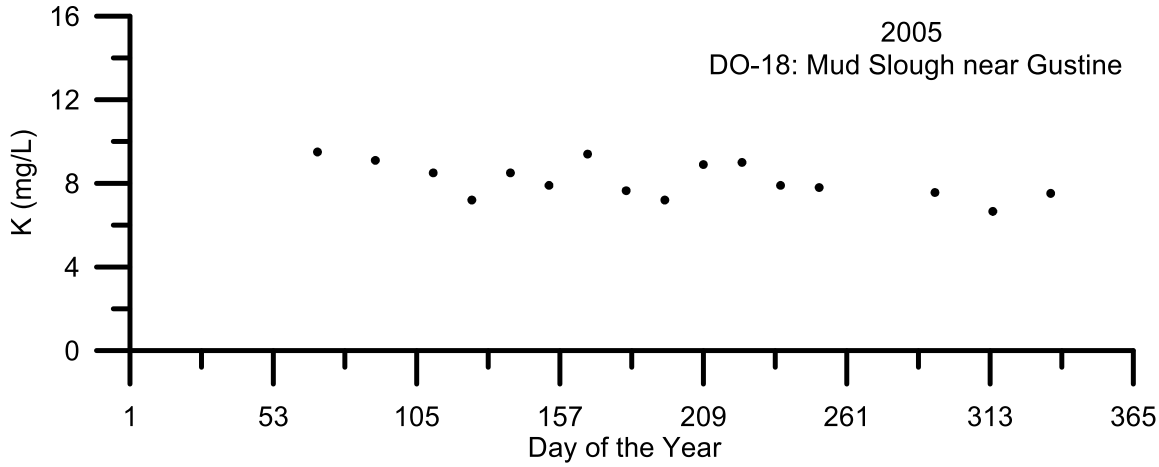

2006
DO-14: Tuolumne River at Shiloh Bridge
K (mg/L)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

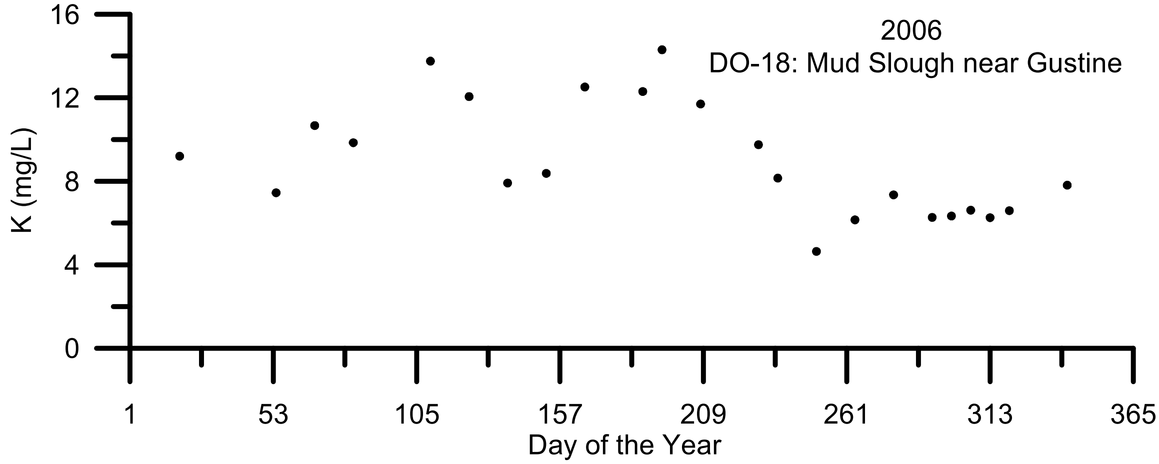

2007
DO-14: Tuolumne River at Shiloh Bridge
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

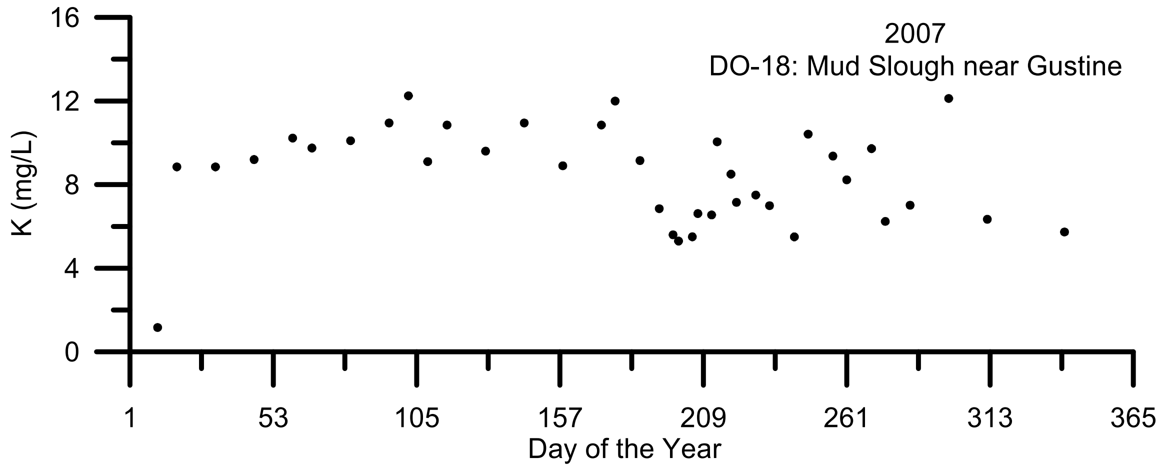

2005
DO-16: Merced River at River Road
K (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

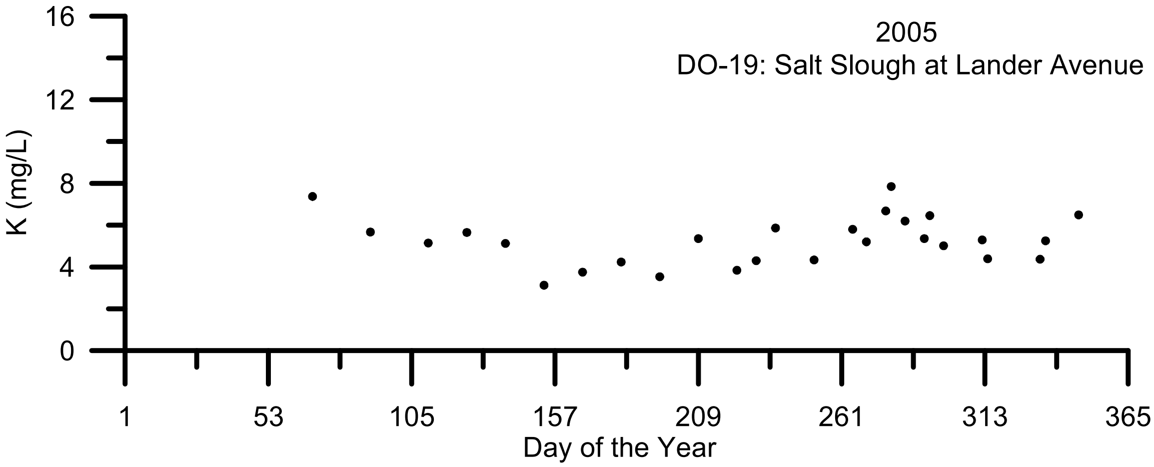

2006
DO-16: Merced River at River Road
K (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

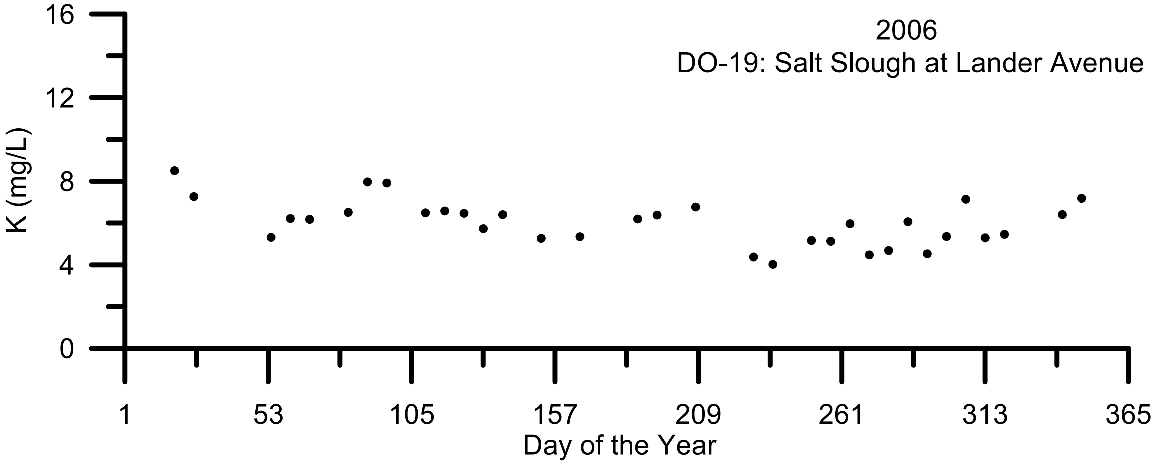

2007
DO-16: Merced River at River Road
K (mg/L)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

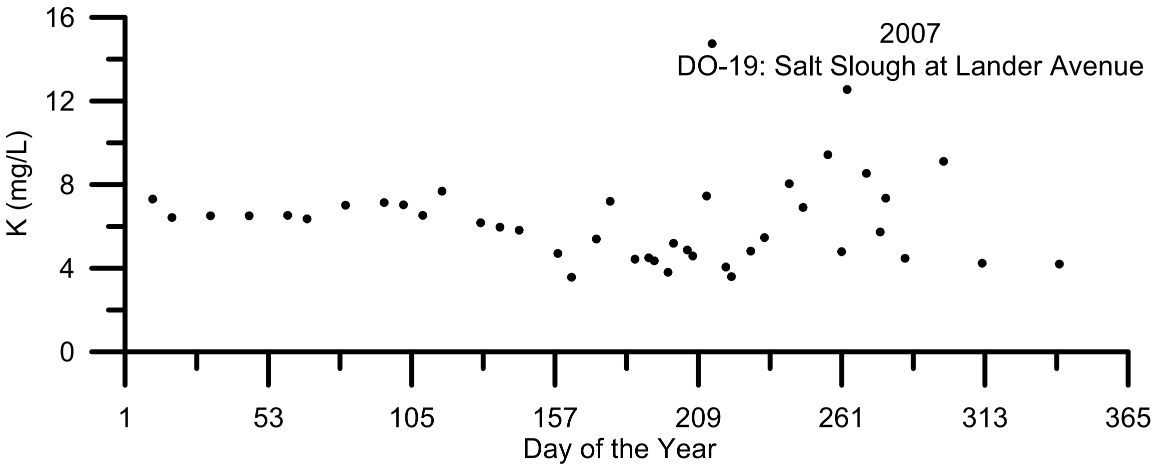

2005
DO-18: Mud Slough near Gustine
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

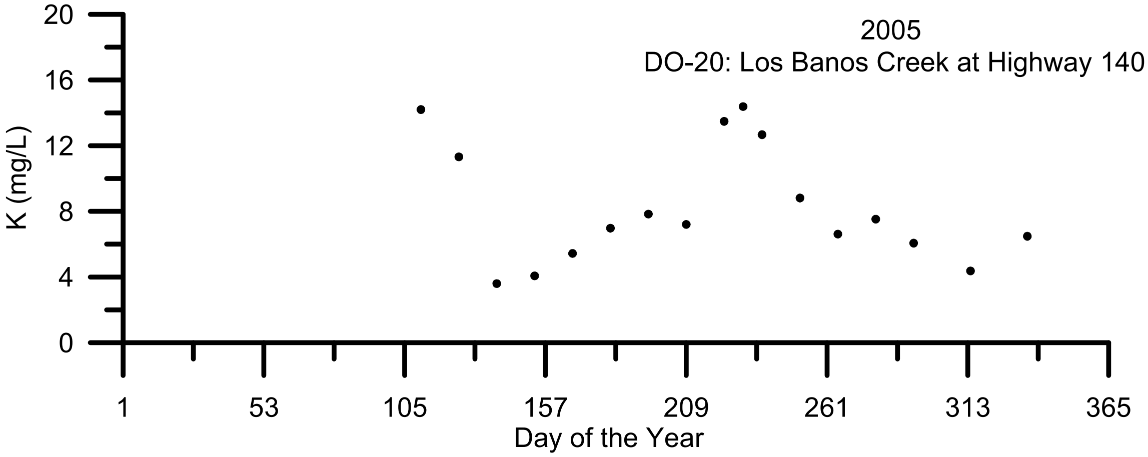

2006
DO-18: Mud Slough near Gustine
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

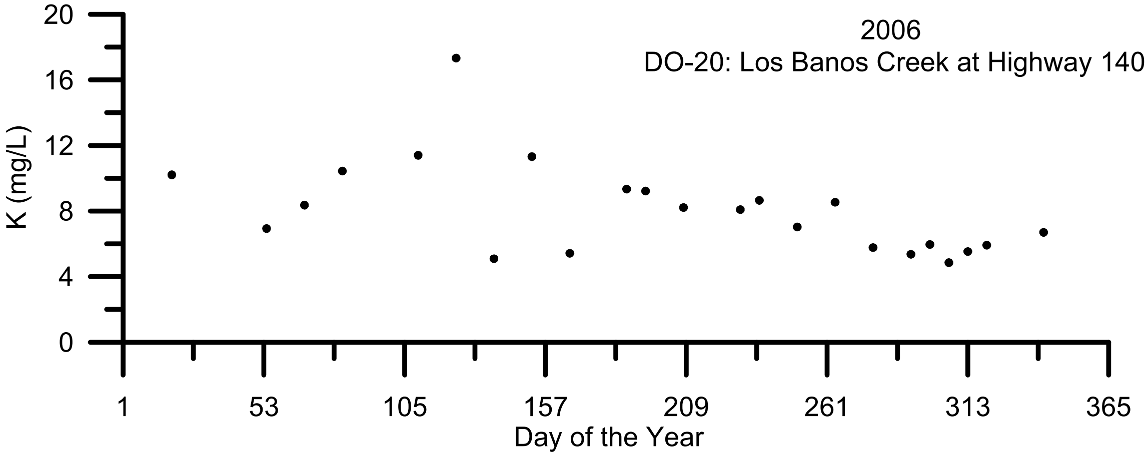

2007
DO-18: Mud Slough near Gustine
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

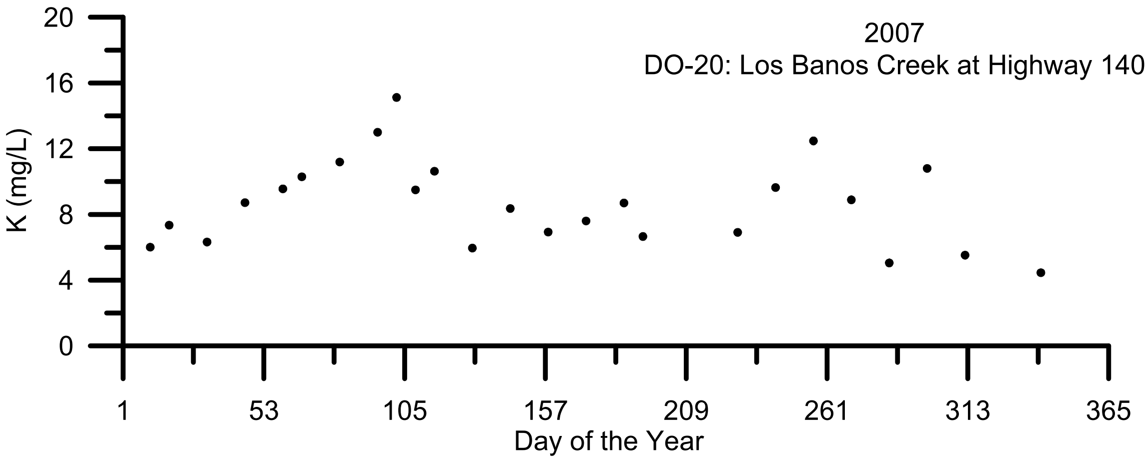

2005
DO-19: Salt Slough at Lander Avenue
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

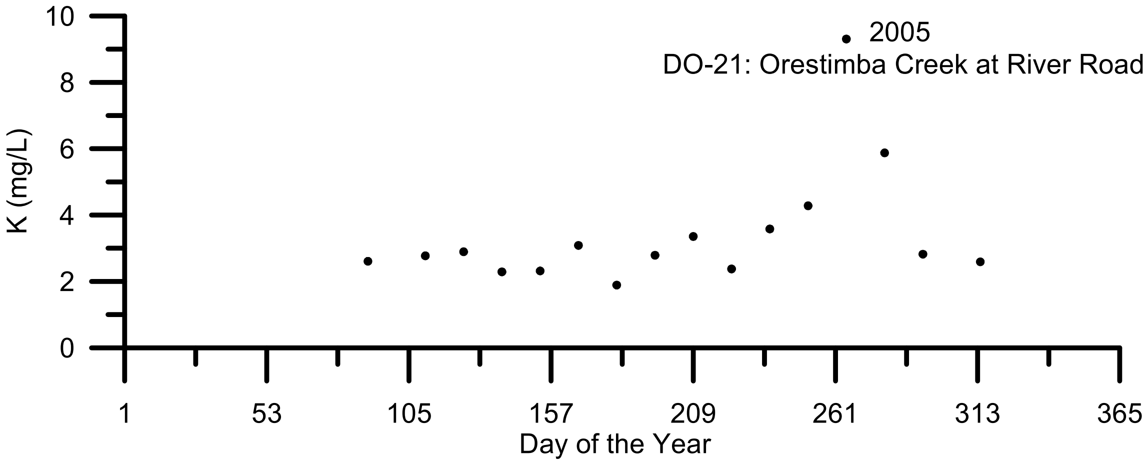

2006
DO-19: Salt Slough at Lander Avenue
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

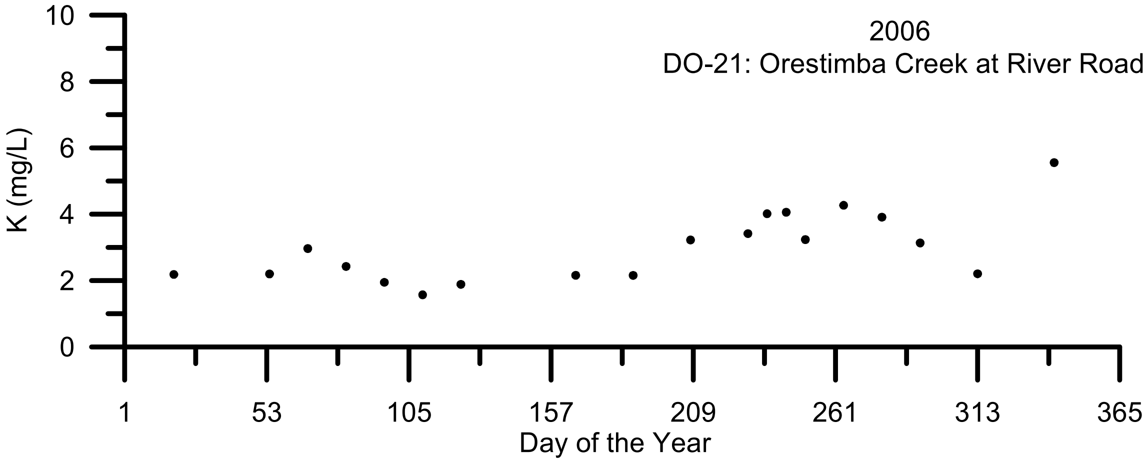

2007
DO-19: Salt Slough at Lander Avenue
K (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

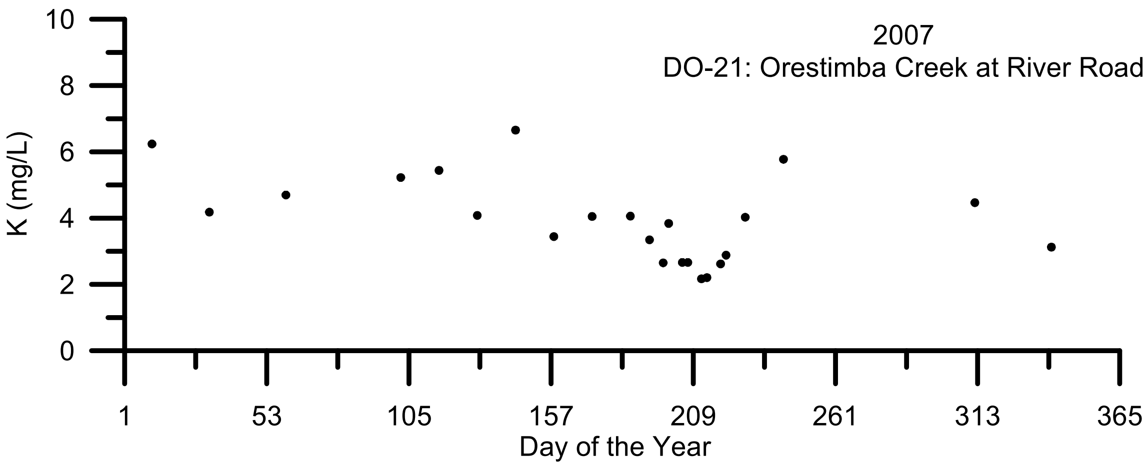

2005
DO-20: Los Banos Creek at Highway 140
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

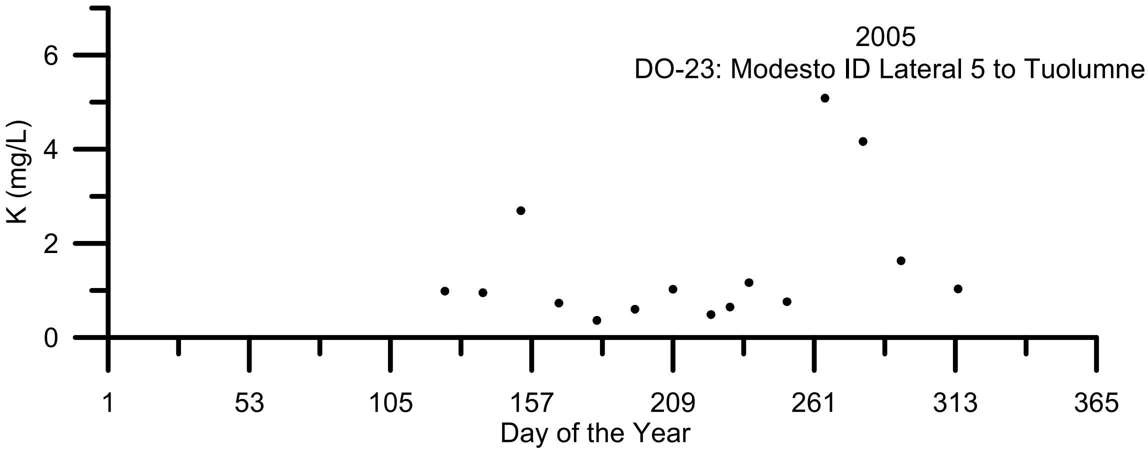

2006
DO-20: Los Banos Creek at Highway 140
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

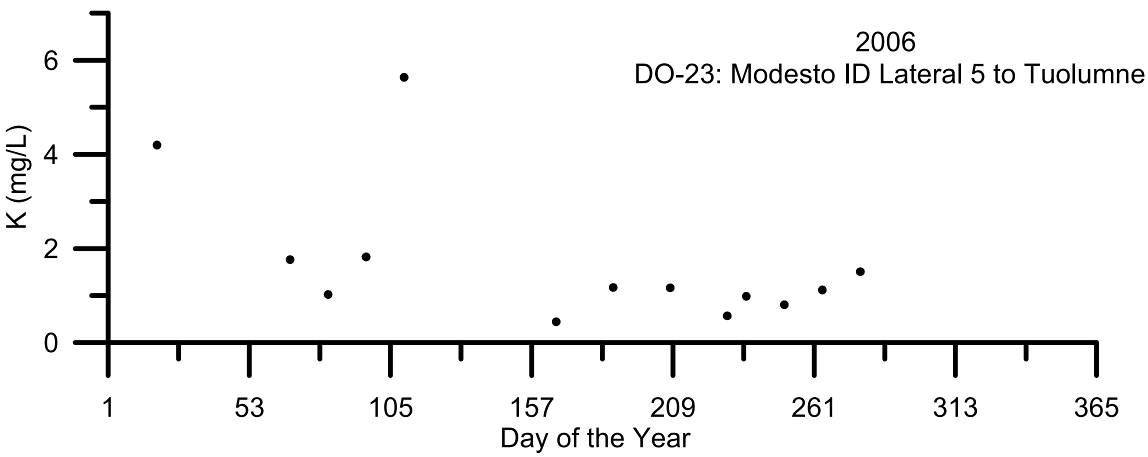

2007
DO-20: Los Banos Creek at Highway 140
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

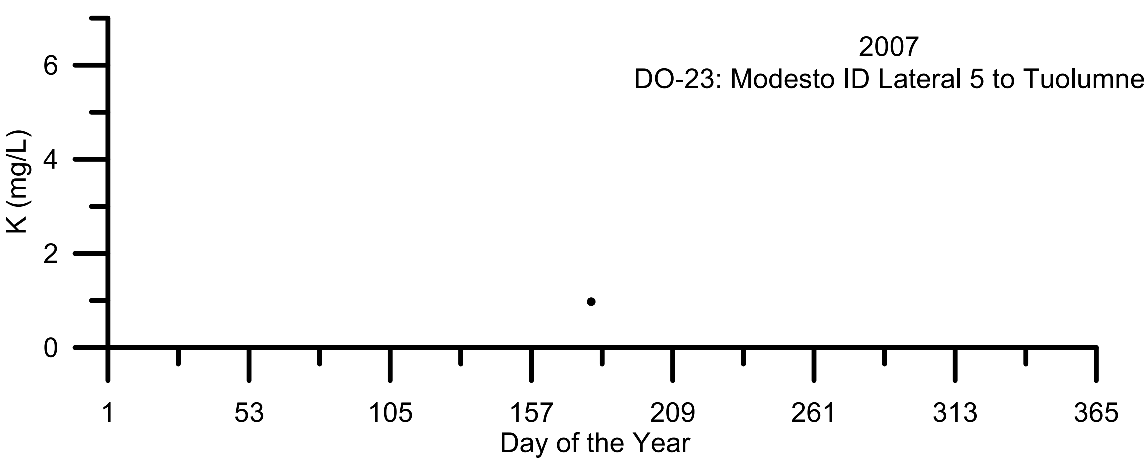

2005
DO-21: Orestimba Creek at River Road
K (mg/L)
Day of the Year

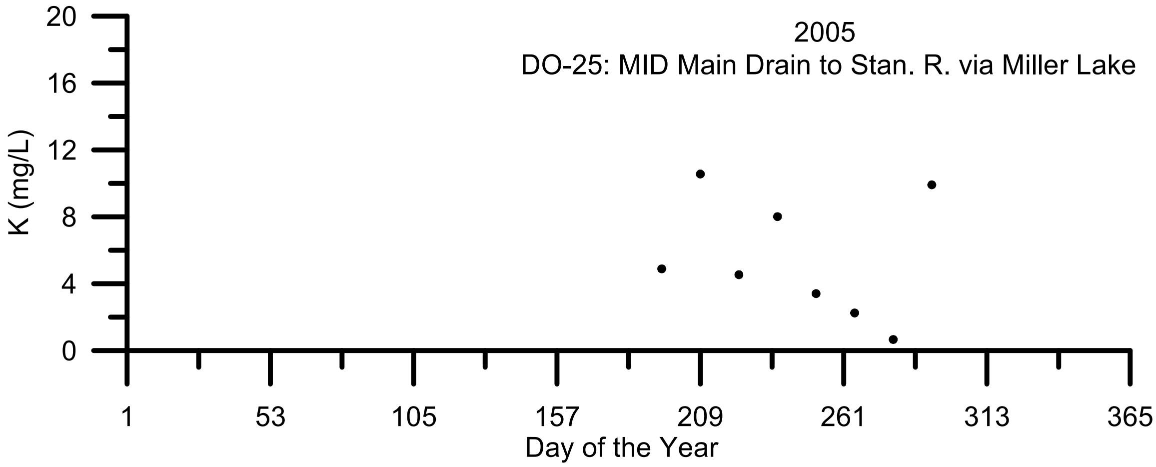

2006
DO-21: Orestimba Creek at River Road
K (mg/L)
Day of the Year

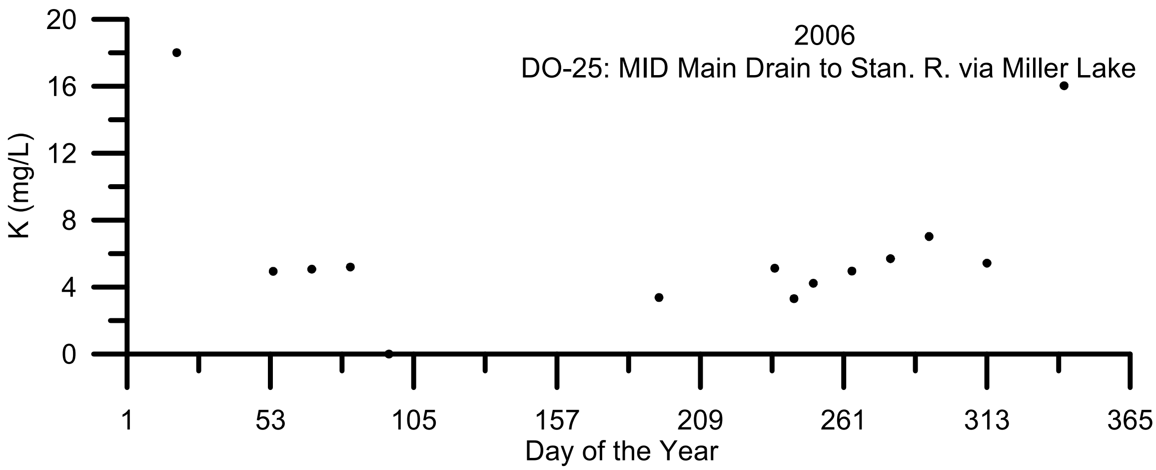

2007
DO-21: Orestimba Creek at River Road
K (mg/L)
Day of the Year

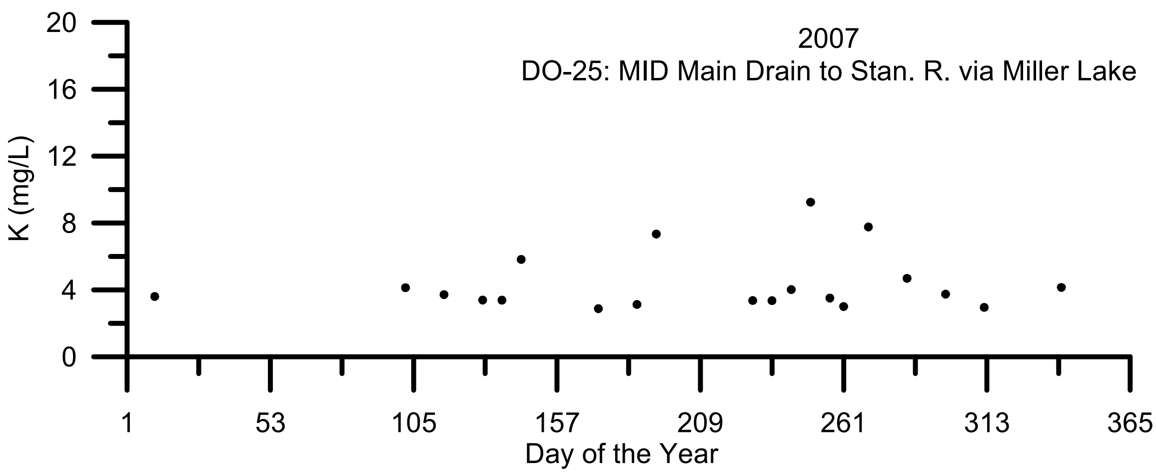

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

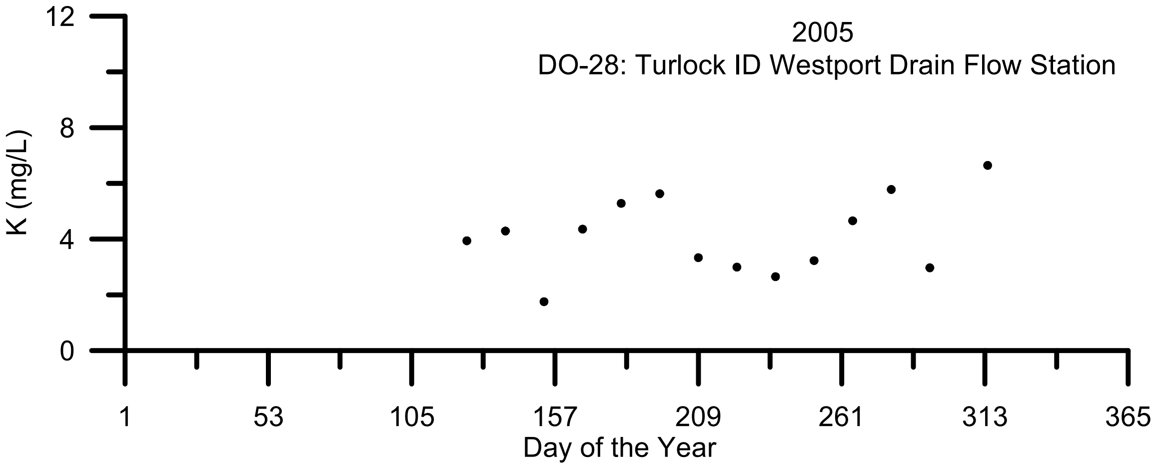

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

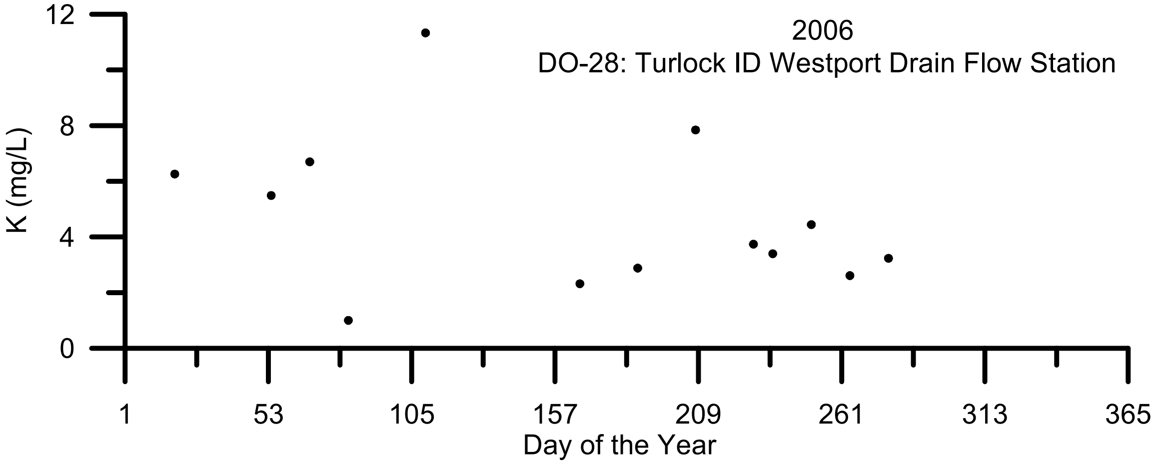

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
K (mg/L)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

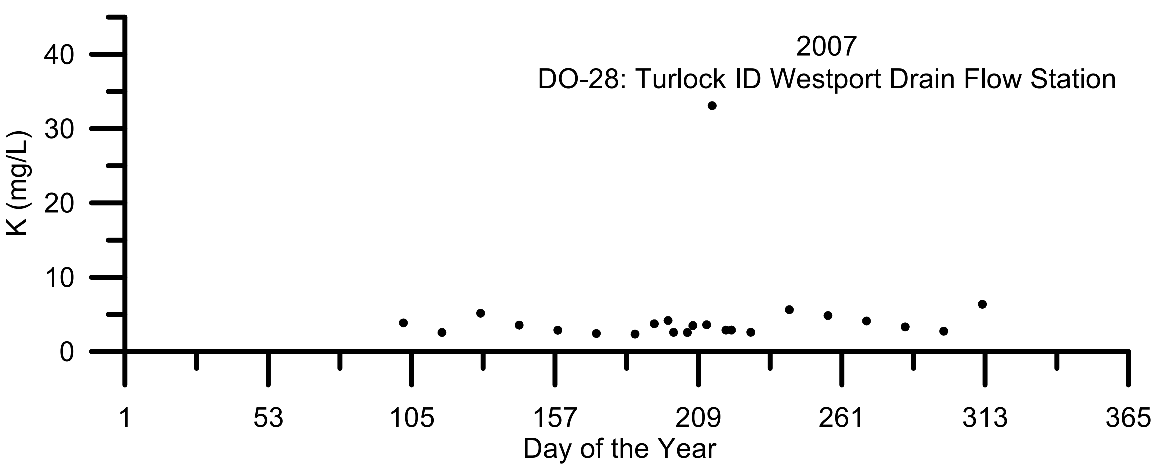

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

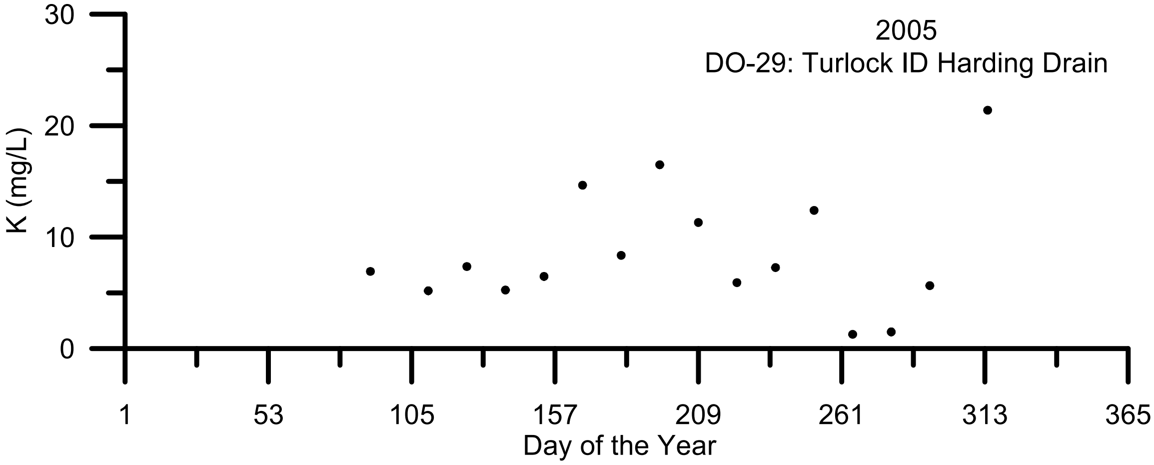

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

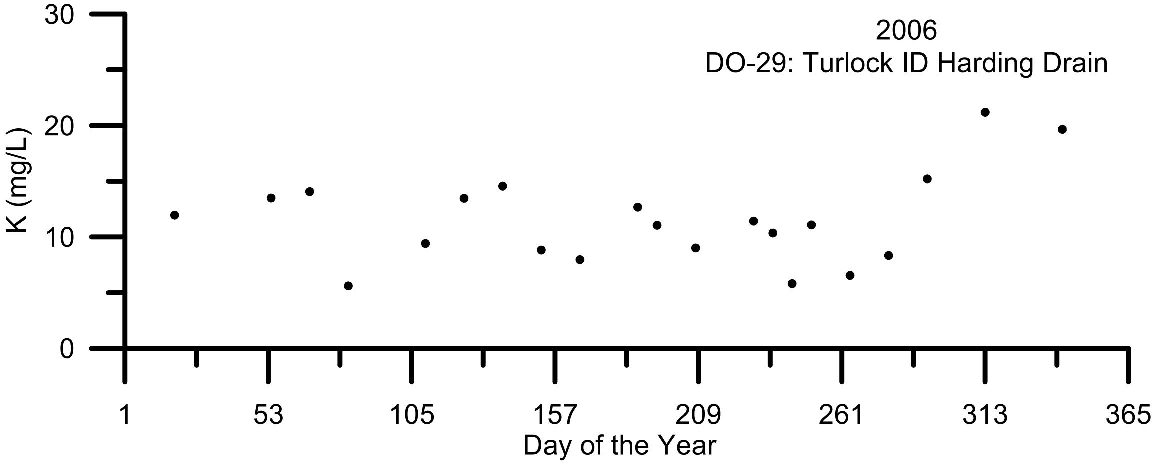

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
K (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

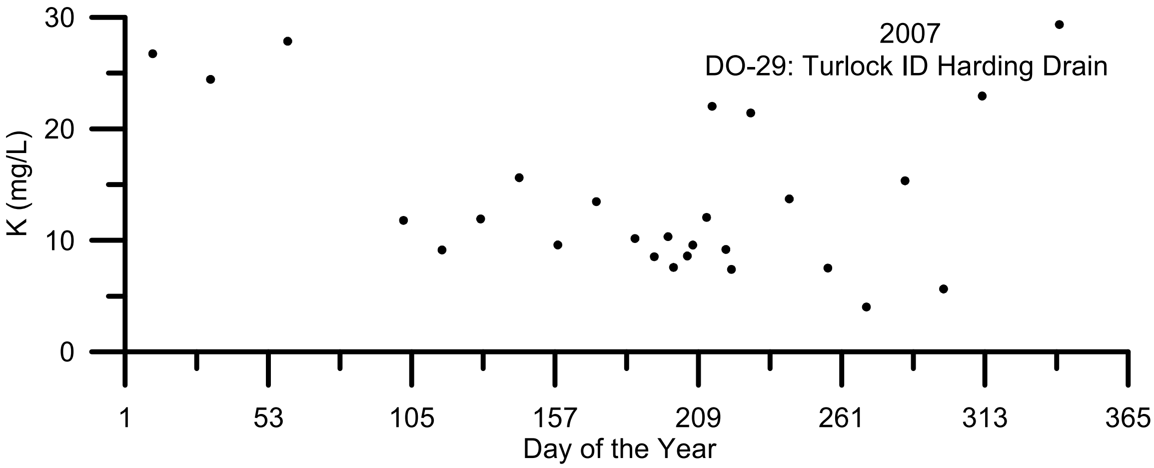

2005
DO-28: Turlock ID Westport Drain Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

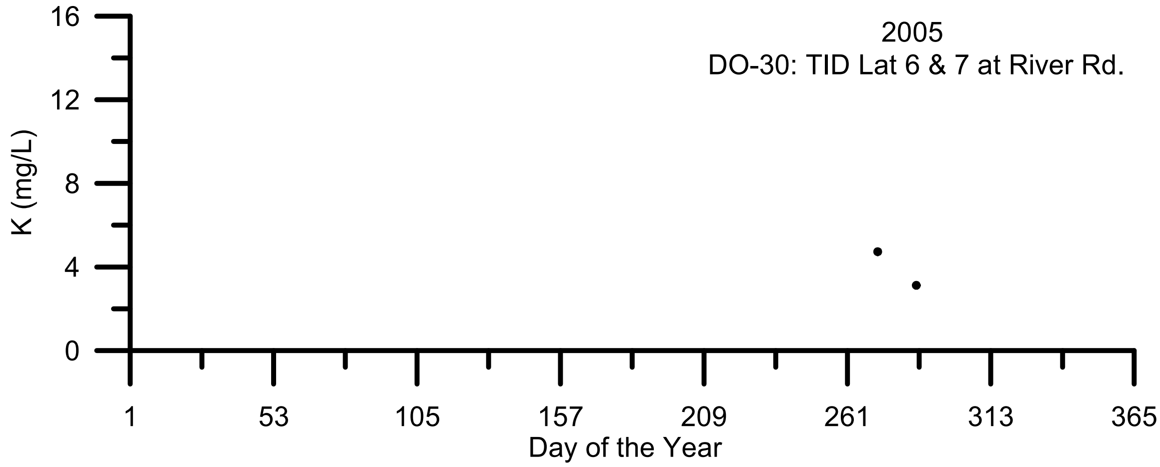

2006
DO-28: Turlock ID Westport Drain Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

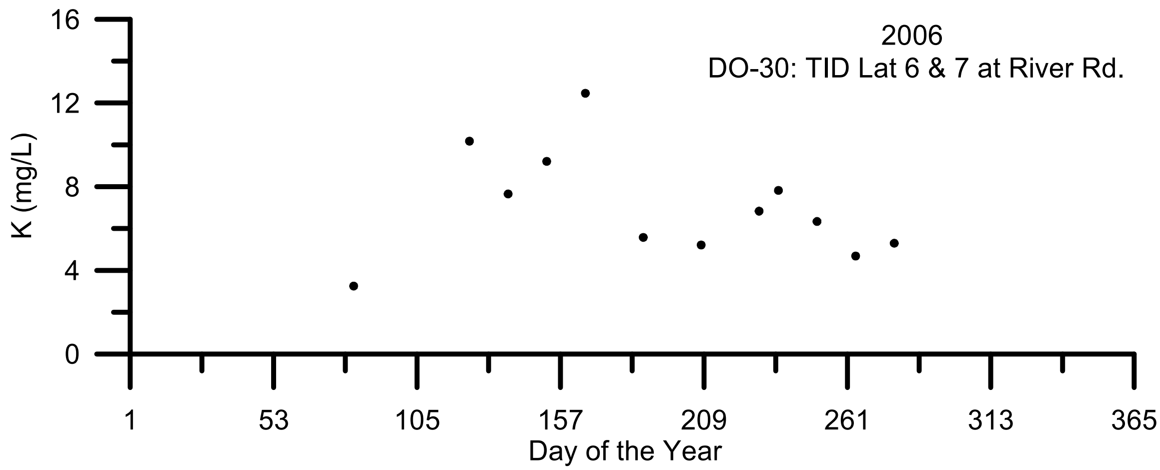

2007
DO-28: Turlock ID Westport Drain Flow Station
K (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

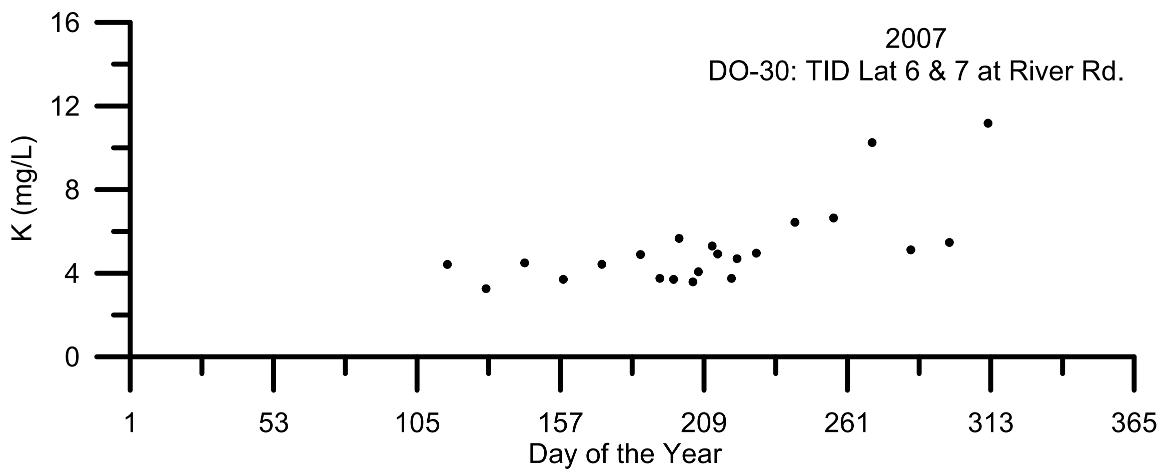

2005
DO-29: Turlock ID Harding Drain
K (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

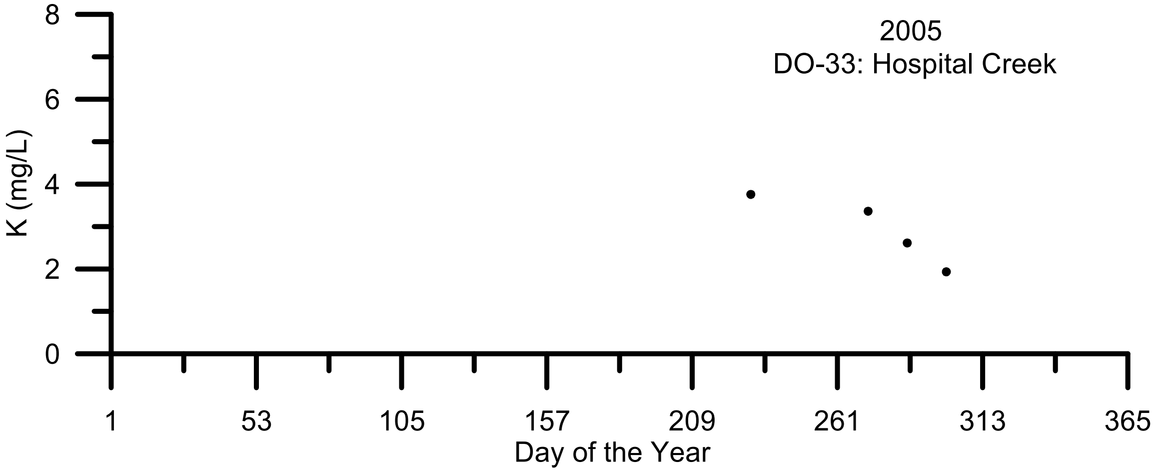

2006
DO-29: Turlock ID Harding Drain
K (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

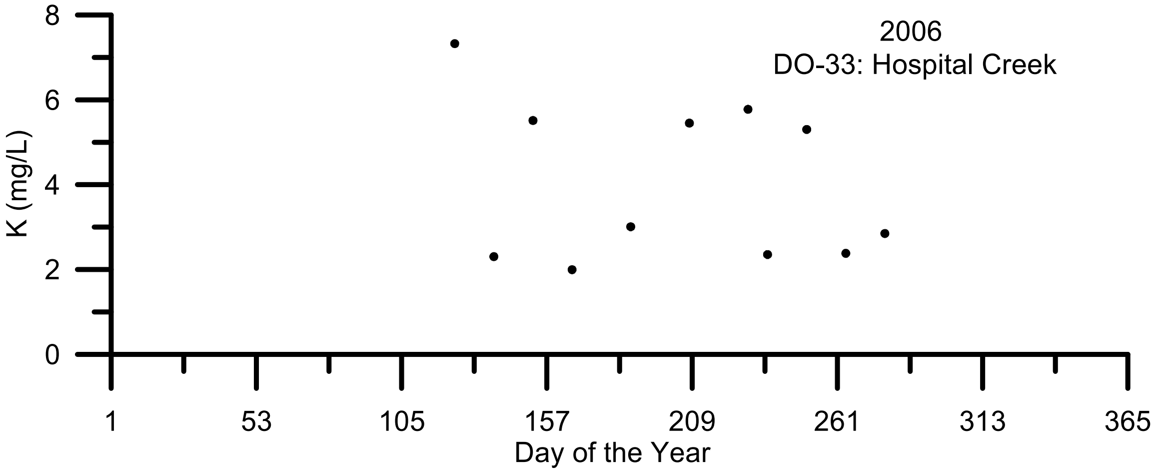

2007
DO-29: Turlock ID Harding Drain
K (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

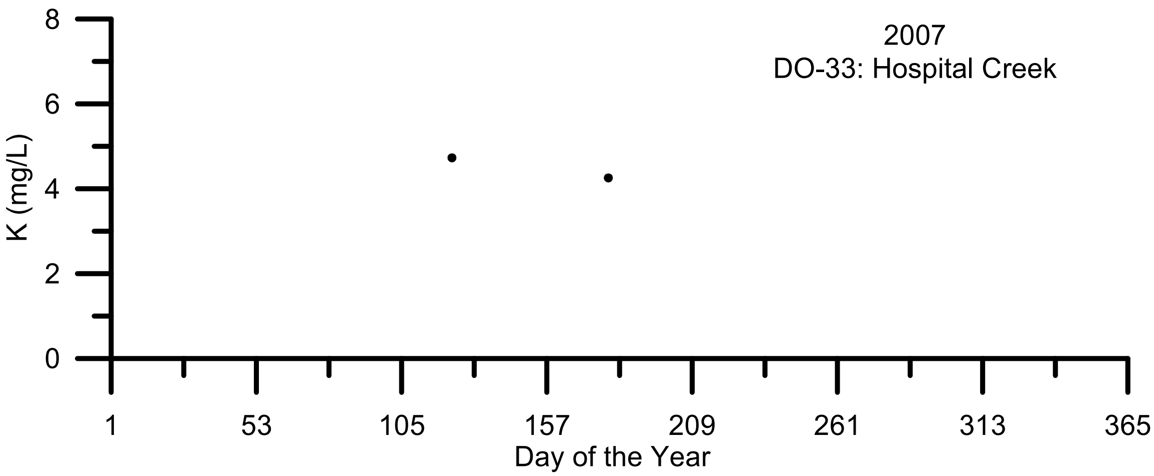

2005
DO-30: TID Lat 6 & 7 at River Rd.
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

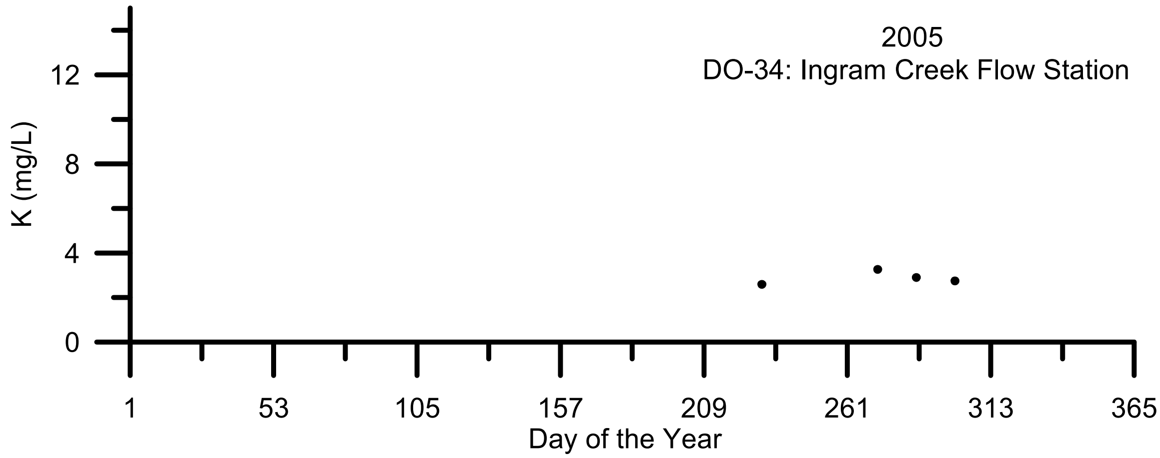

2006
DO-30: TID Lat 6 & 7 at River Rd.
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

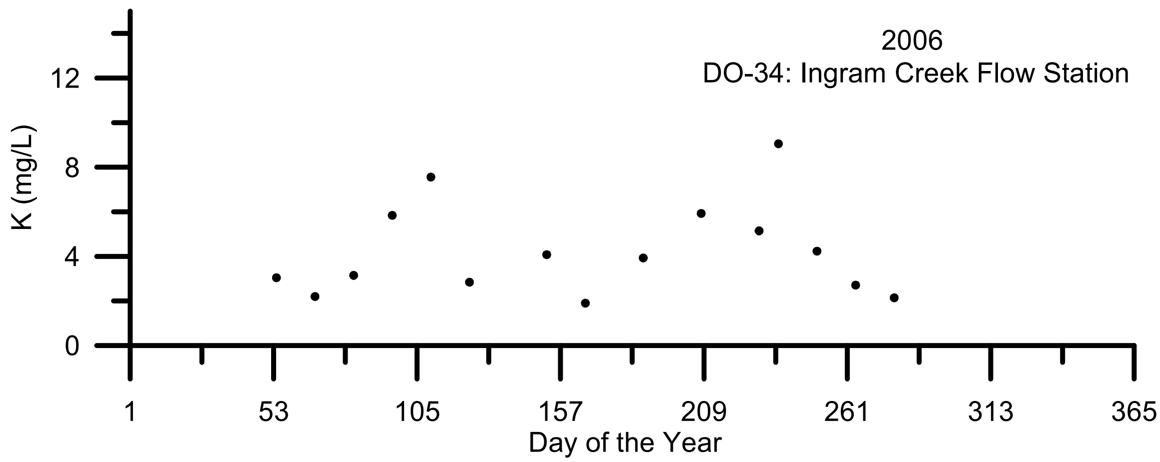

2007
DO-30: TID Lat 6 & 7 at River Rd.
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

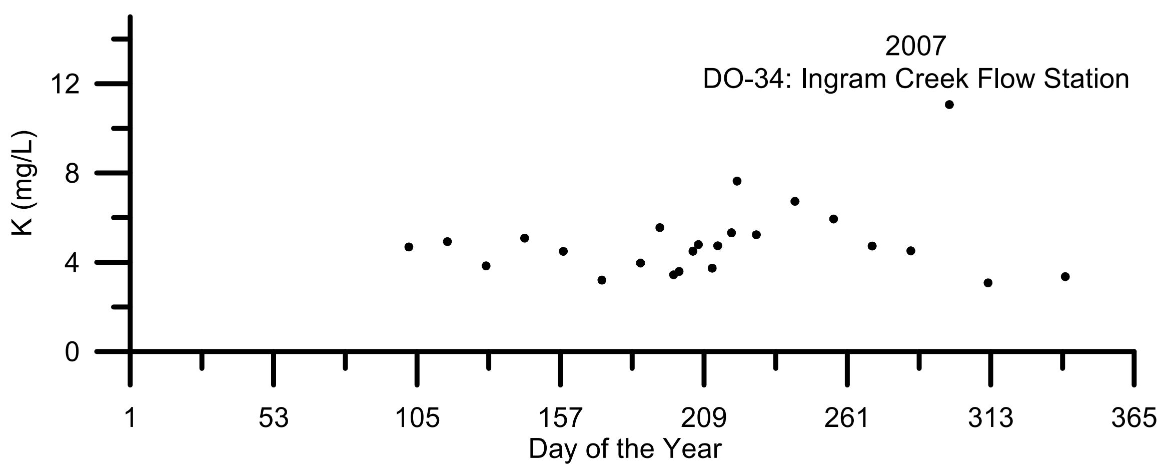

2005
DO-33: Hospital Creek
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

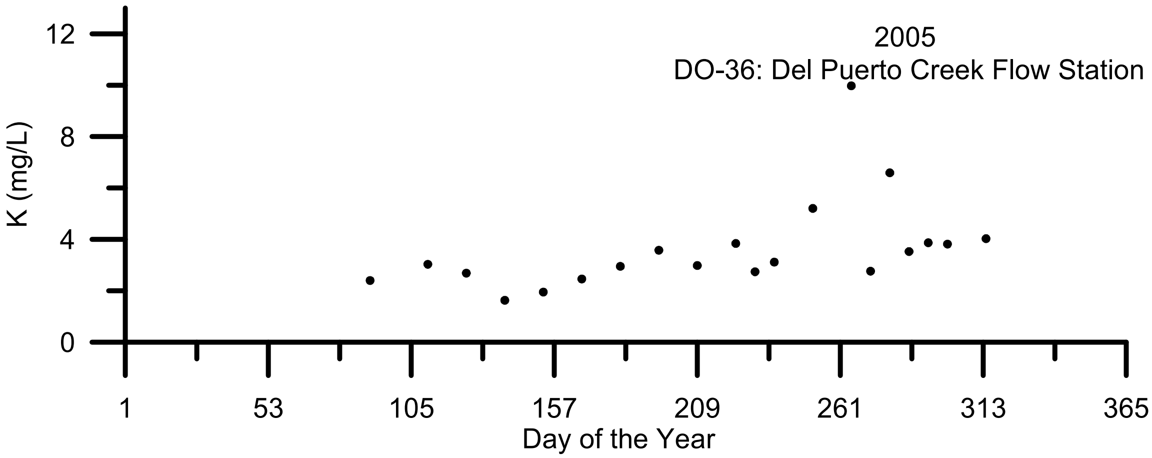

2006
DO-33: Hospital Creek
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

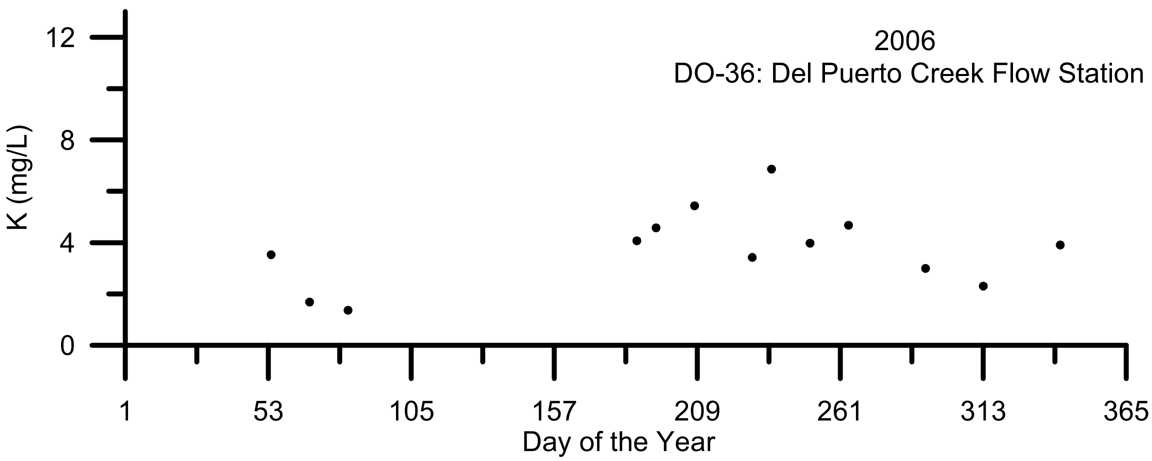

2007
DO-33: Hospital Creek
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

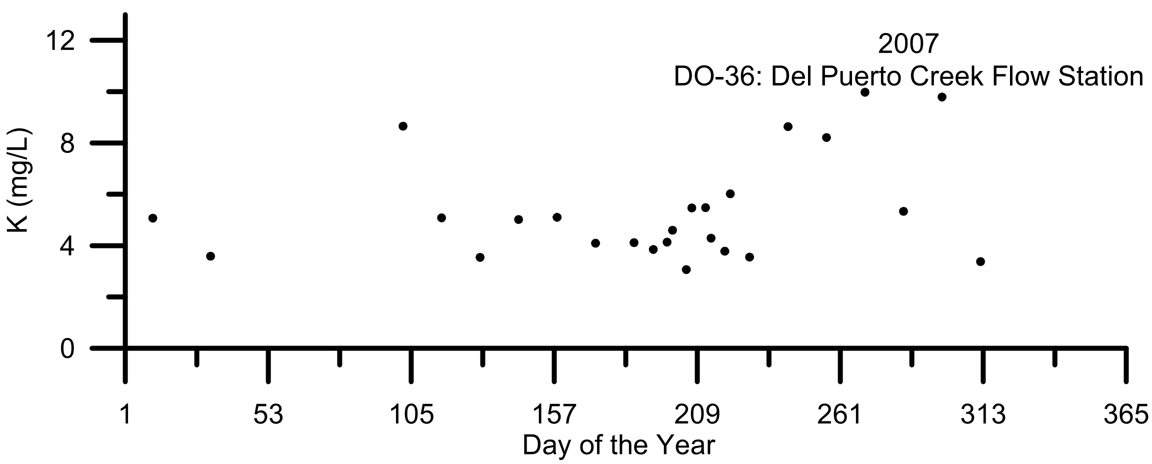

2005
DO-34: Ingram Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

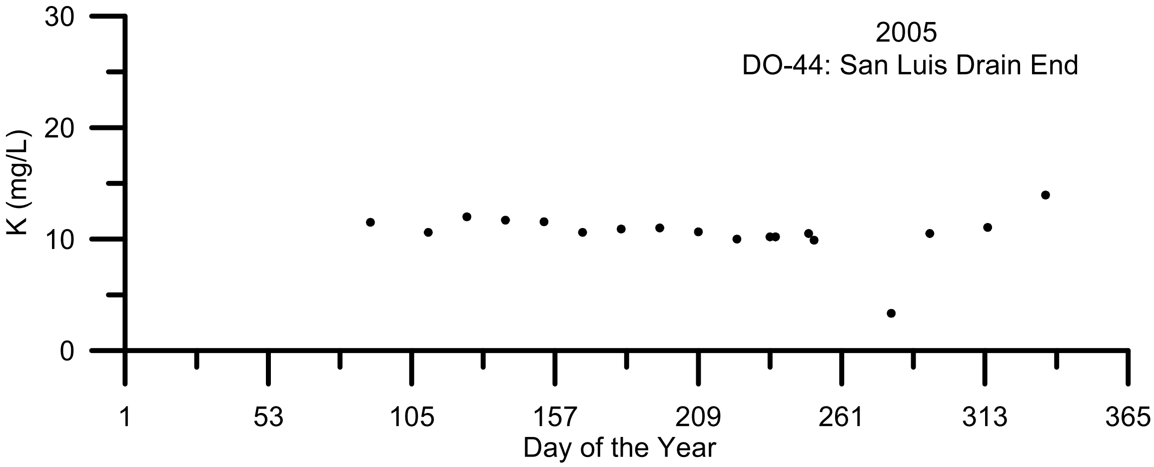

2006
DO-34: Ingram Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

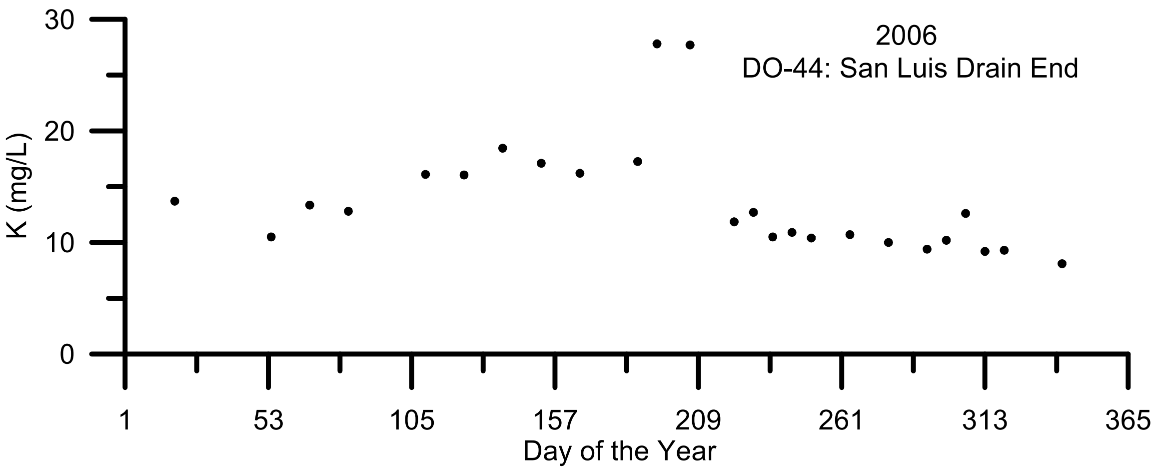

2007
DO-34: Ingram Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

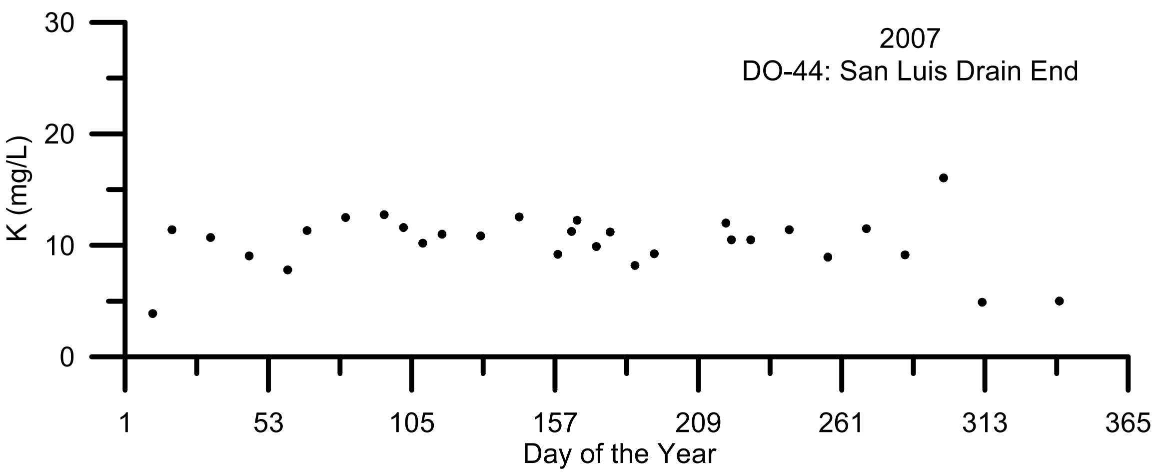

2005
DO-36: Del Puerto Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

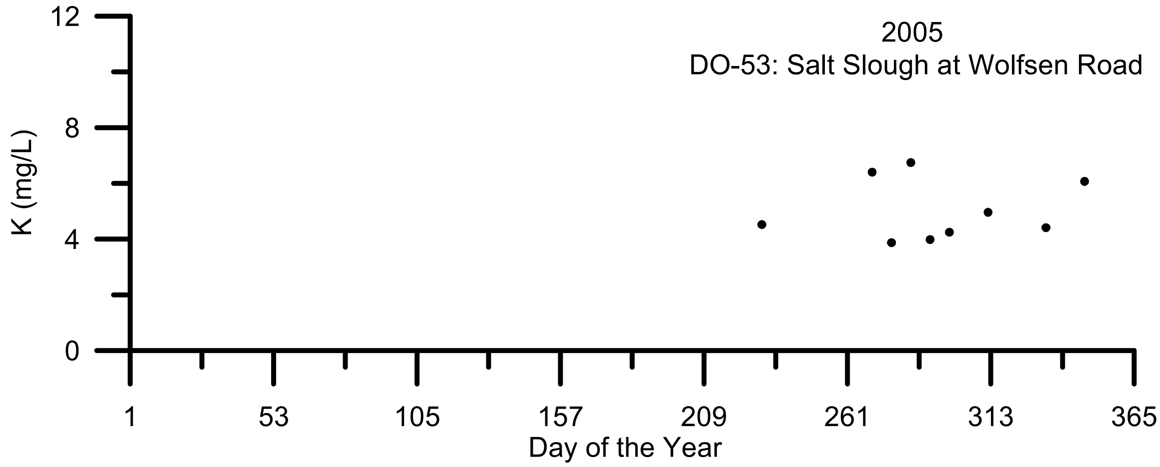

2006
DO-36: Del Puerto Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

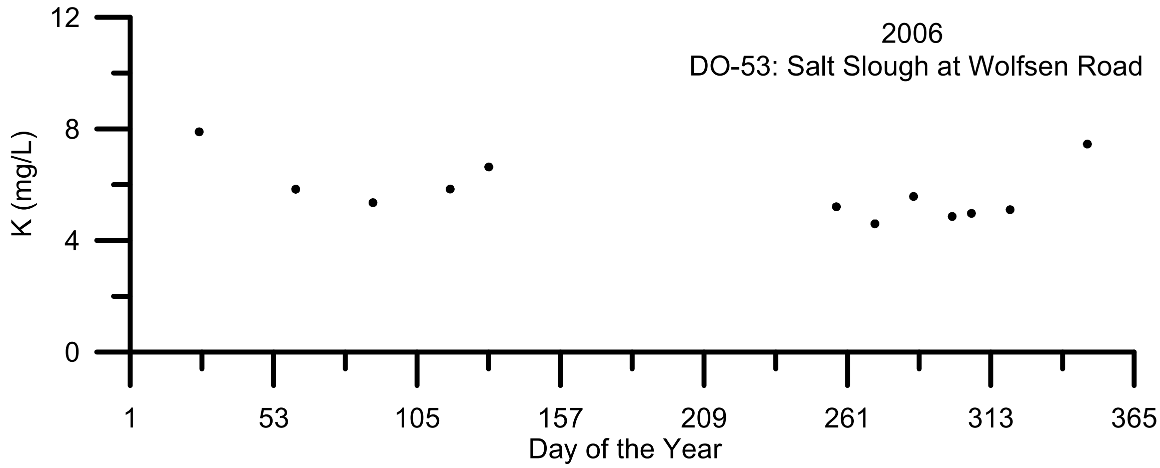

2007
DO-36: Del Puerto Creek Flow Station
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

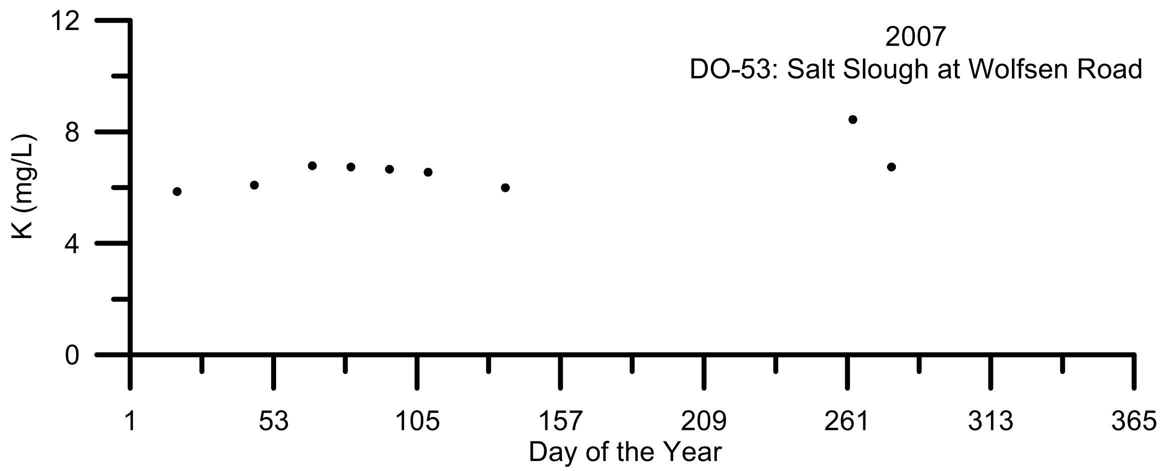

2005
DO-44: San Luis Drain End
K (mg/L)
Day of the Year
30
20
10
0
1
53
105
157
209
261
313
365

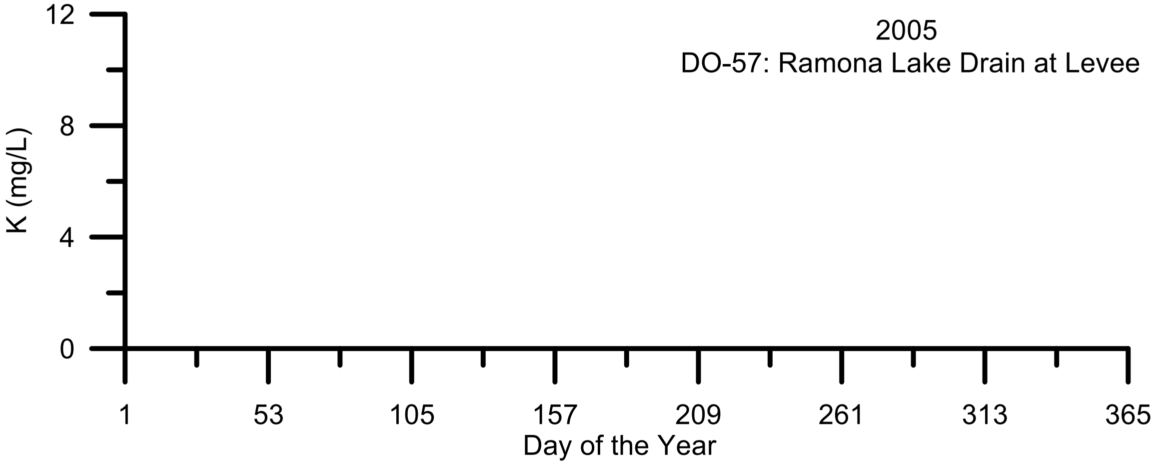

2006
DO-44: San Luis Drain End
K (mg/L)
Day of the Year
30
20
10
0
1
53
105
157
209
261
313
365

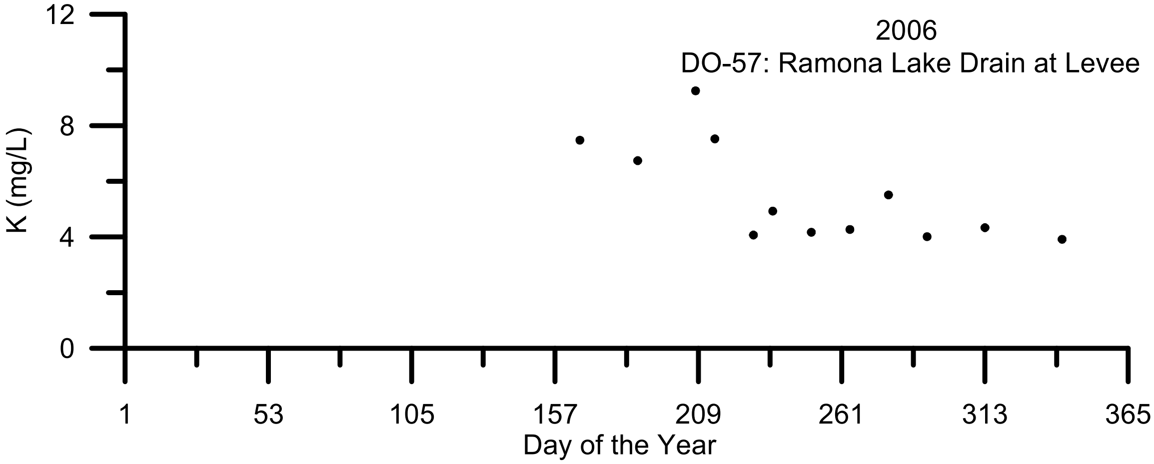

2007
DO-44: San Luis Drain End
K (mg/L)
Day of the Year
30
20
10
0
1
53
105
157
209
261
313
365

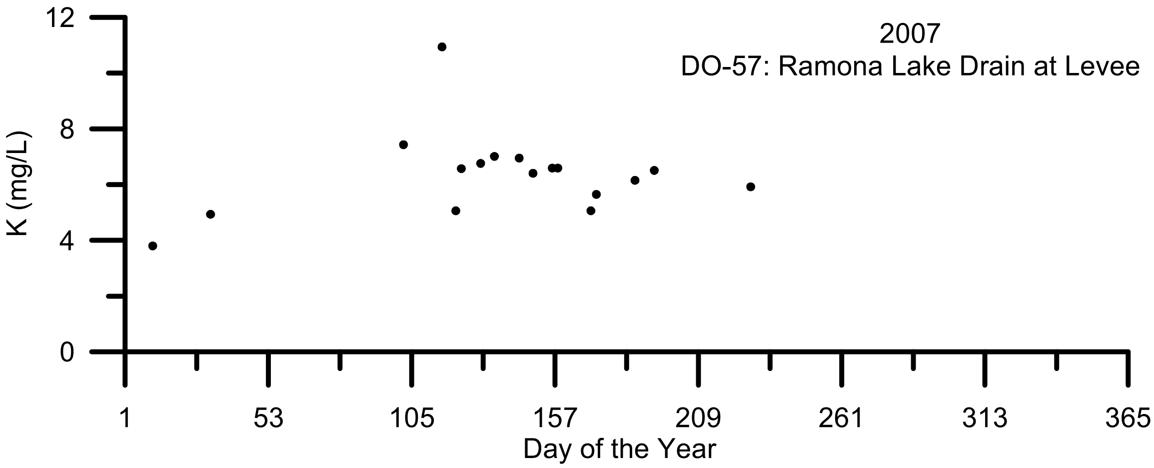

2005
DO-53: Salt Slough at Wolfsen Road
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

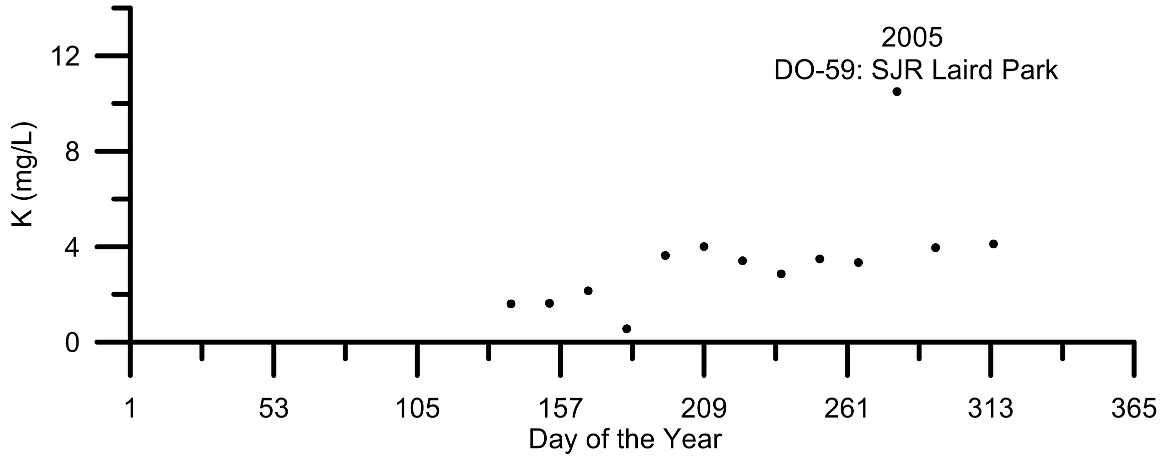

2006
DO-53: Salt Slough at Wolfsen Road
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

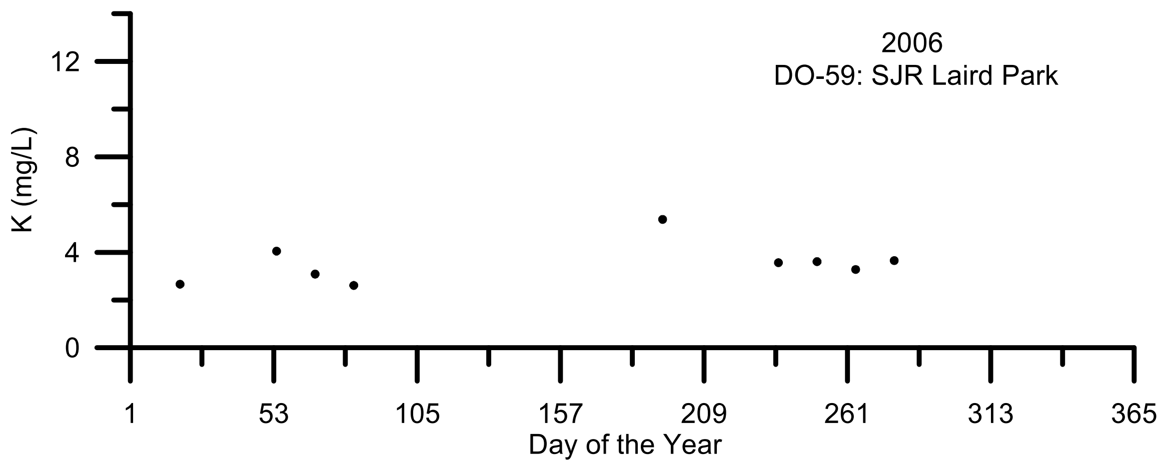

2007
DO-53: Salt Slough at Wolfsen Road
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

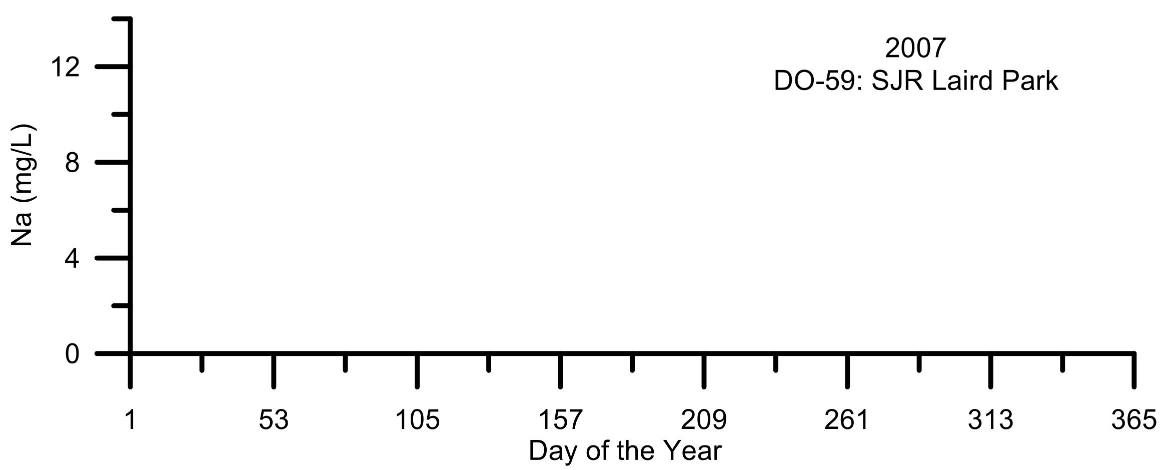

2005
DO-57: Ramona Lake Drain at Levee
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

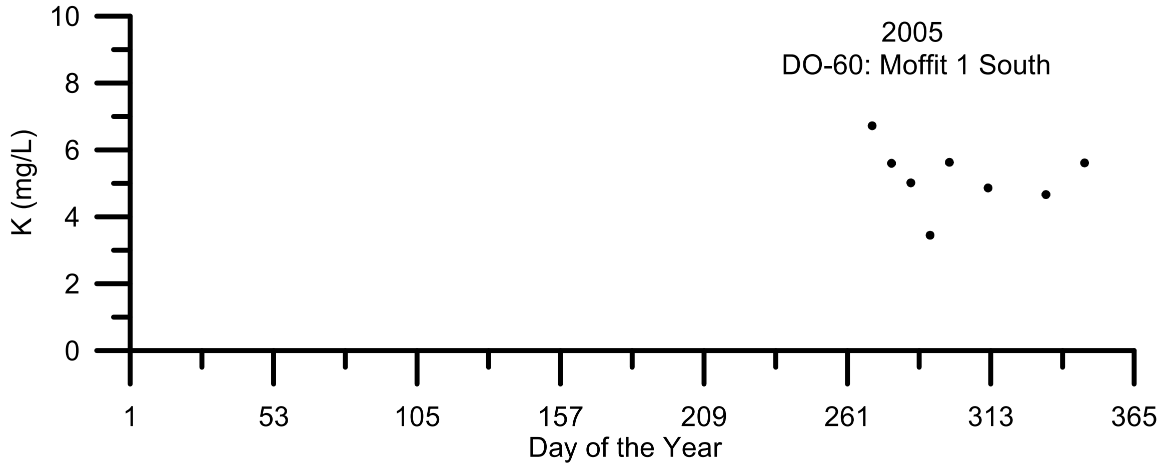

2006
DO-57: Ramona Lake Drain at Levee
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

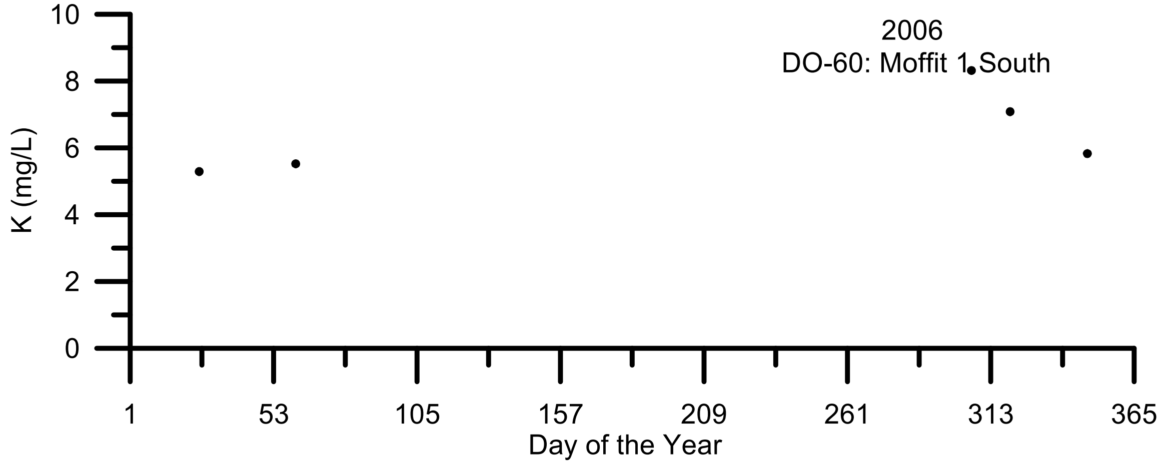

2007
DO-57: Ramona Lake Drain at Levee
K (mg/L)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

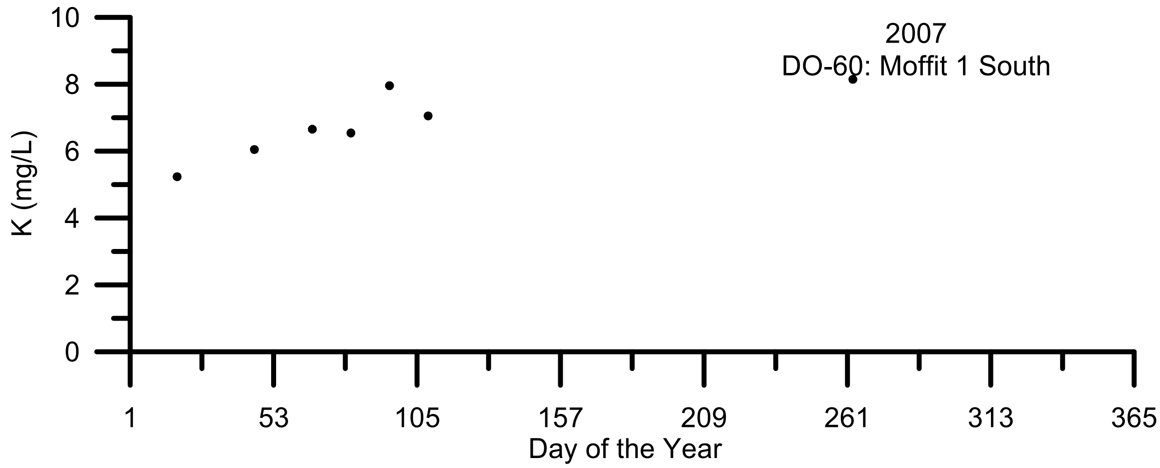

2005
DO-59: SJR Laird Park
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

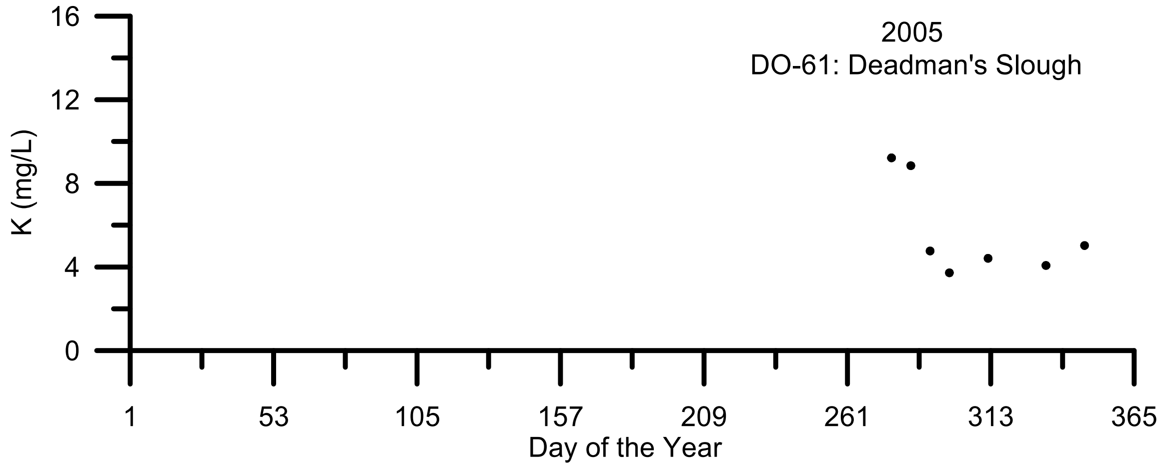

2006
DO-59: SJR Laird Park
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

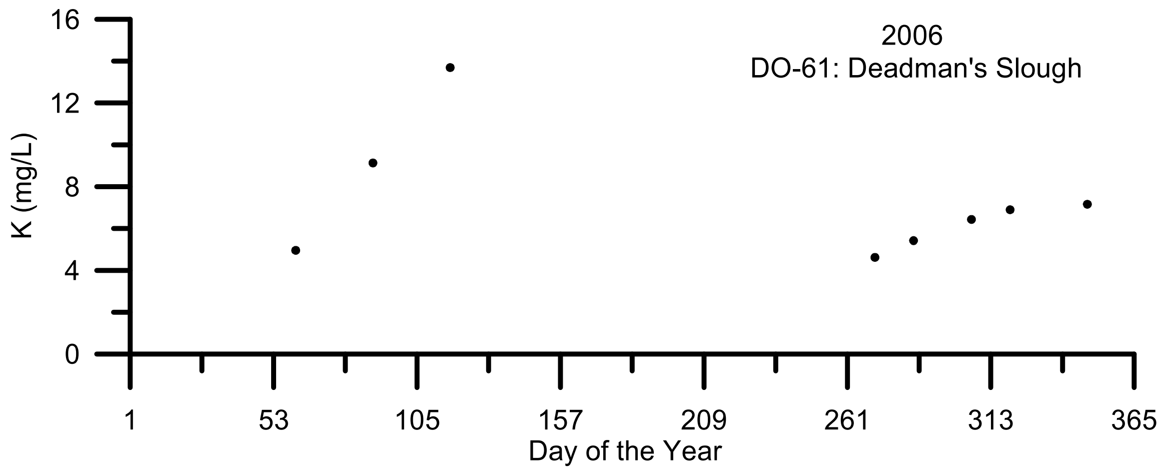

2007
DO-59: SJR Laird Park
Na (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

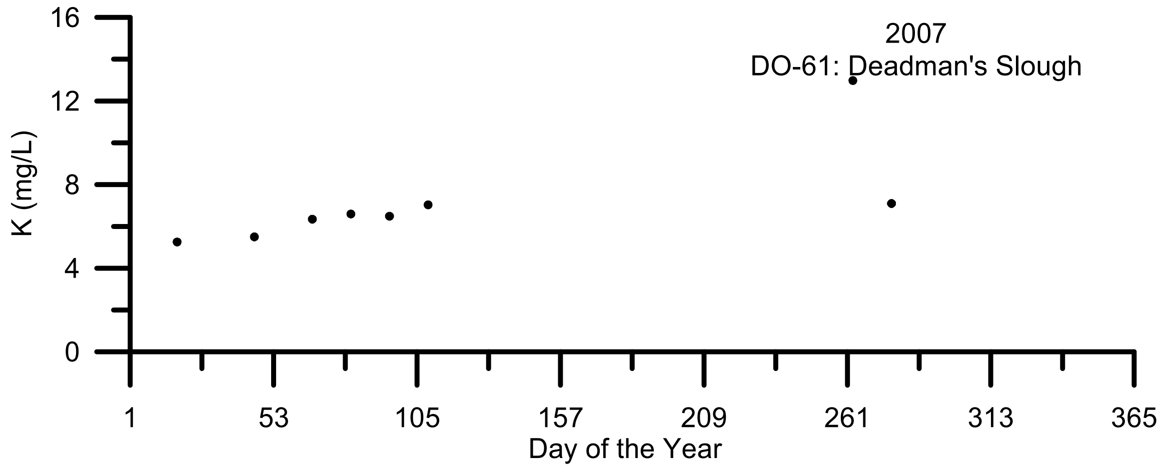

2005
DO-60: Moffit 1 South
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

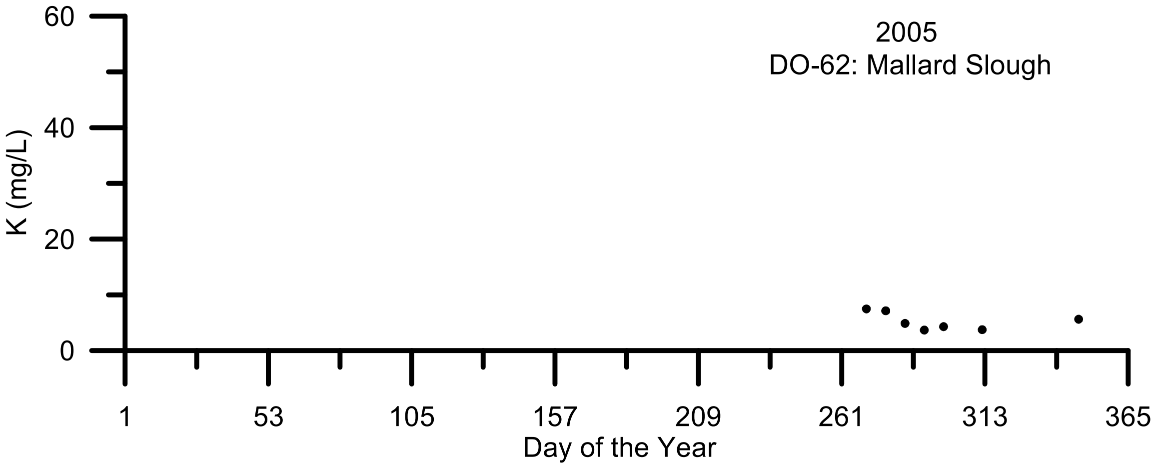

2006
DO-60: Moffit 1 South
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

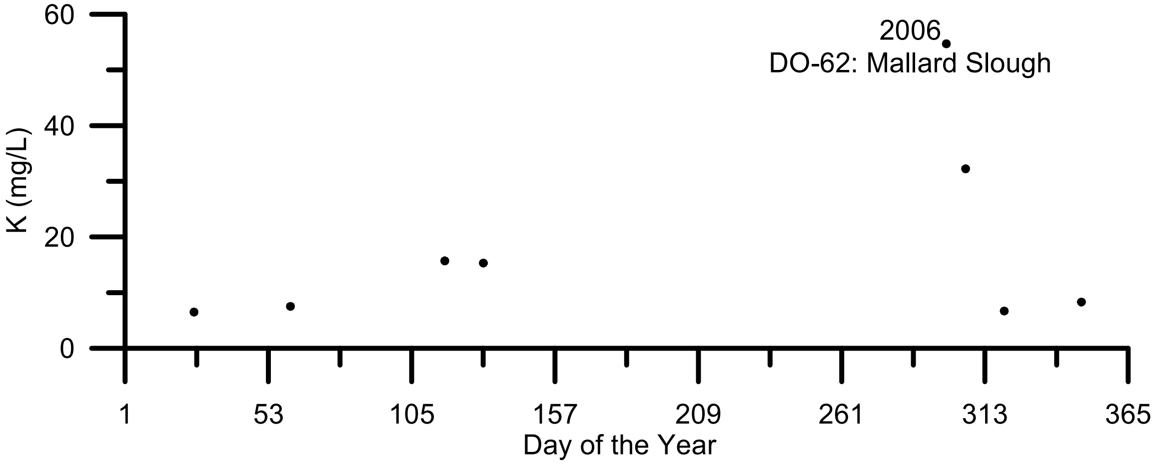

2007
DO-60: Moffit 1 South
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

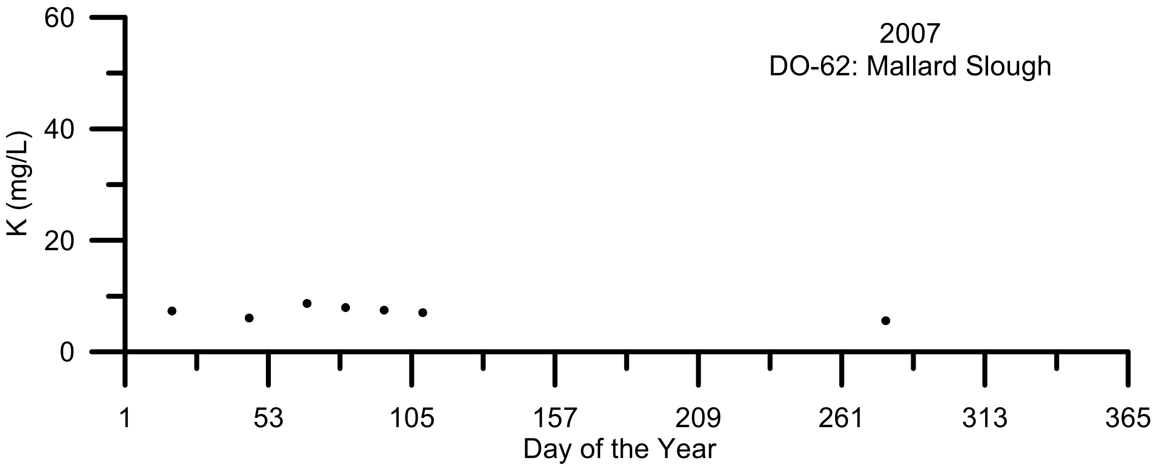

2005
DO-61: Deadman's Slough
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

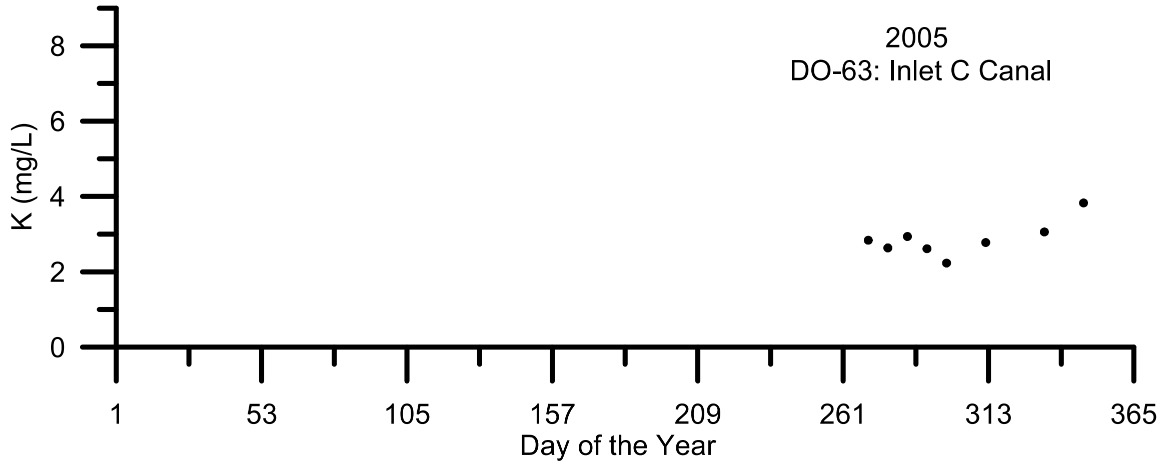

2006
DO-61: Deadman's Slough
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

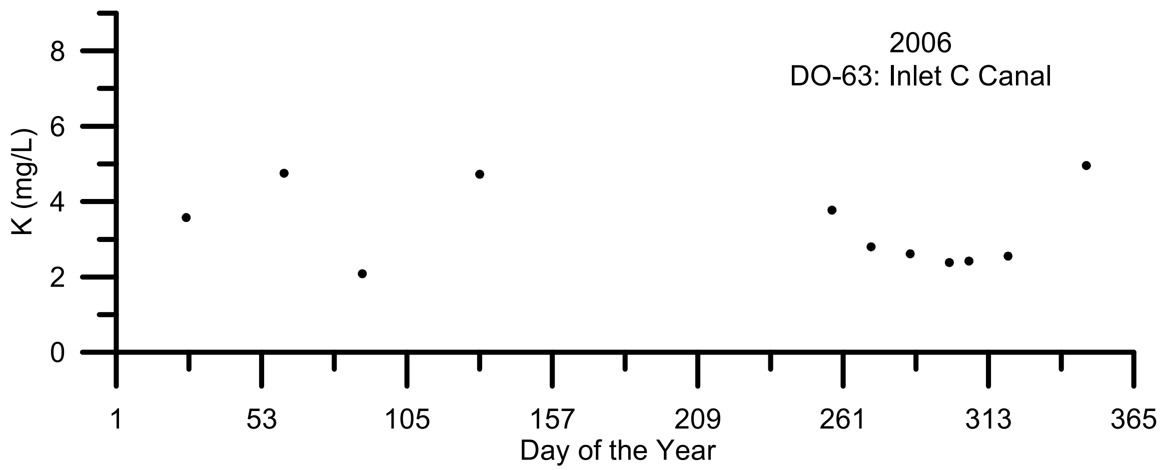

2007
DO-61: Deadman's Slough
K (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

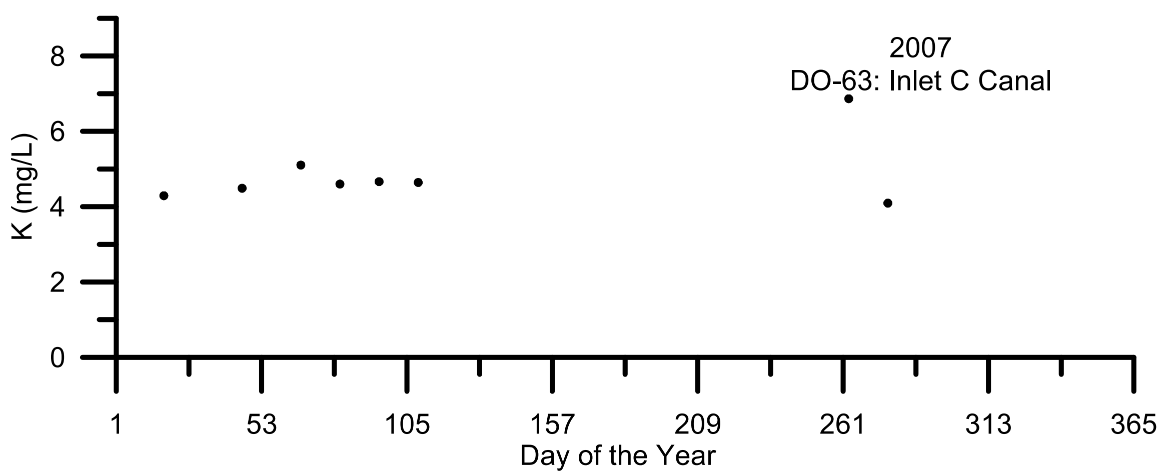

2005
DO-62: Mallard Slough
K (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

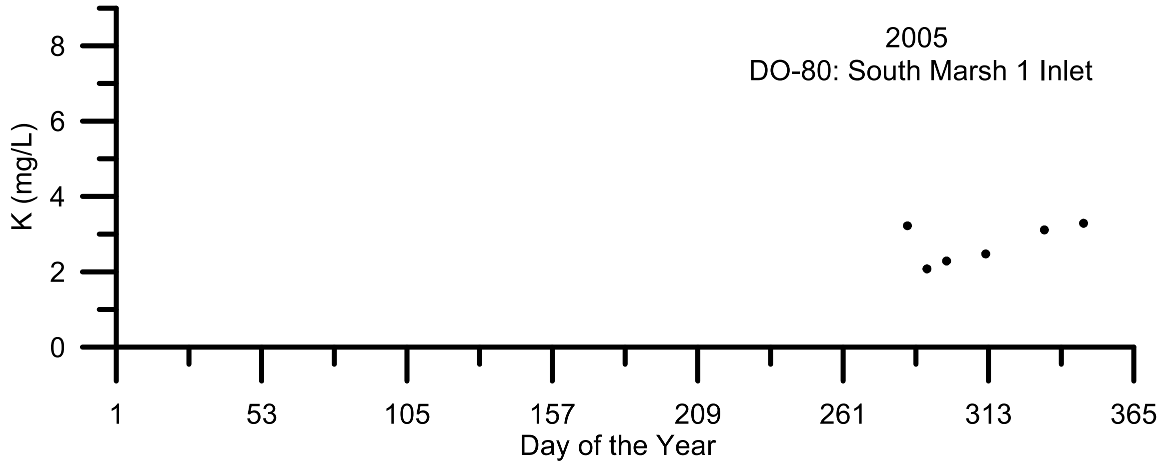

2006
DO-62: Mallard Slough
K (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

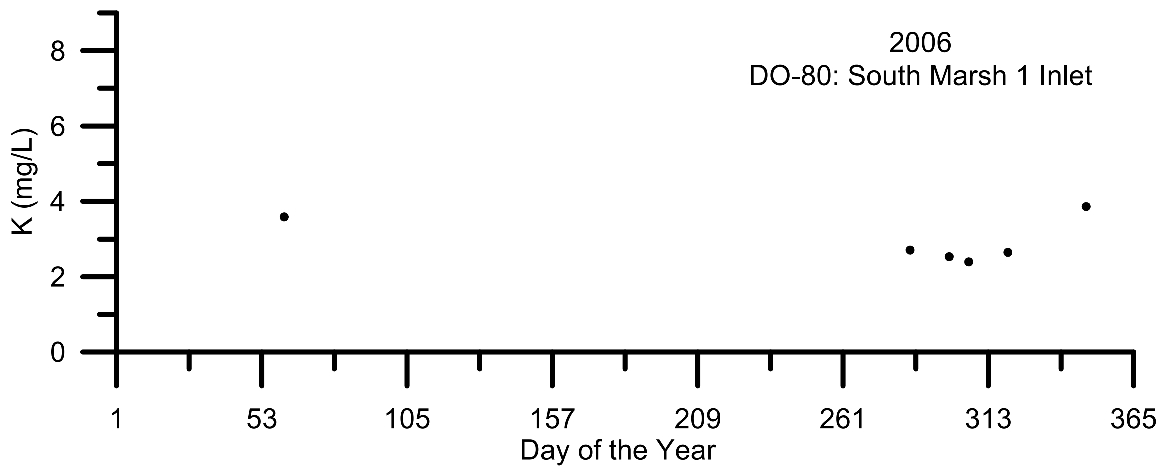

2007
DO-62: Mallard Slough
K (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

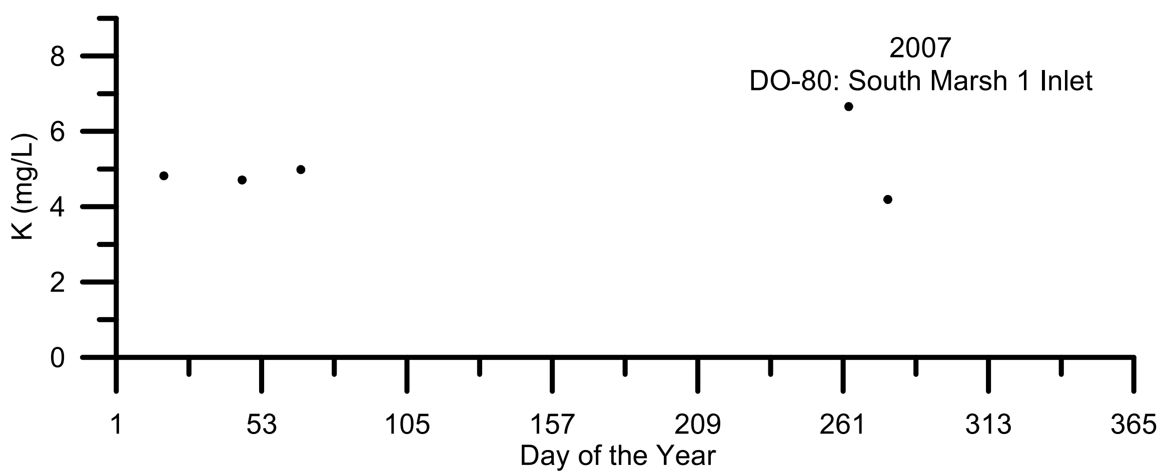

2005
DO-63: Inlet C Canal
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

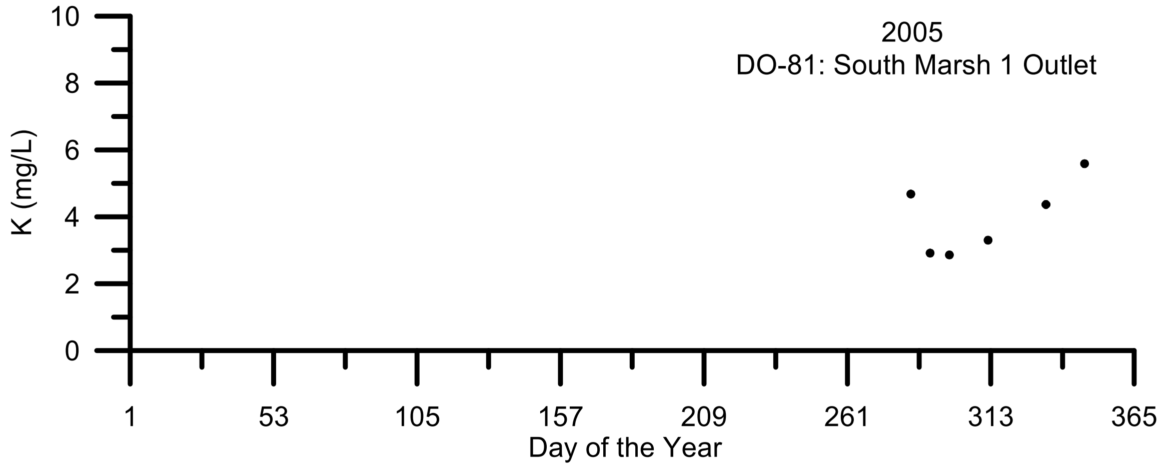

2006
DO-63: Inlet C Canal
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

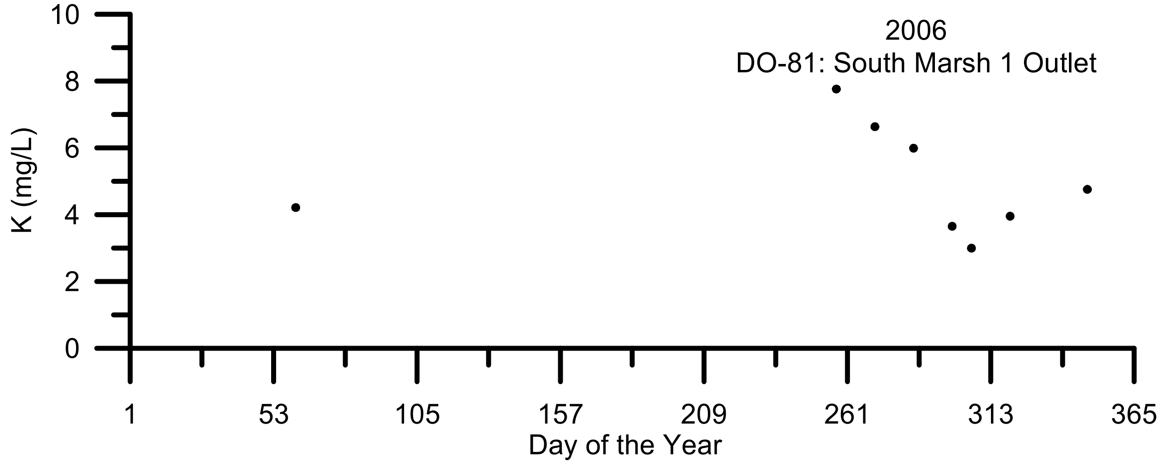

2007
DO-63: Inlet C Canal
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

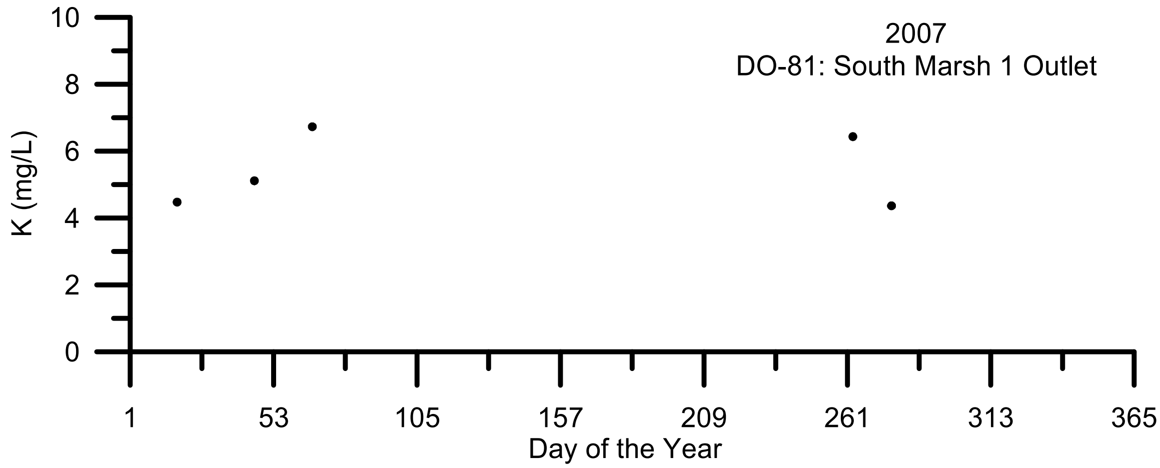

2005
DO-80: South Marsh 1 Inlet
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

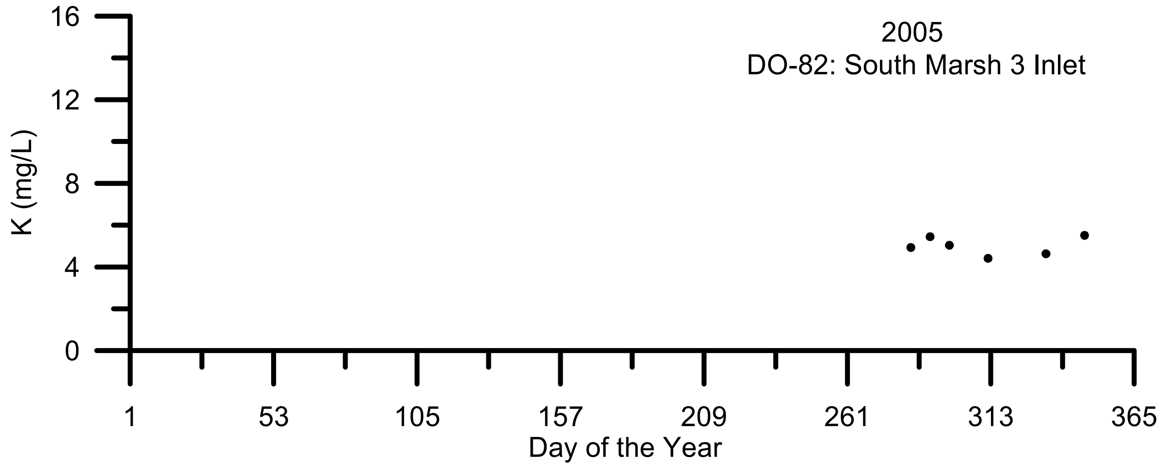

2006
DO-80: South Marsh 1 Inlet
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

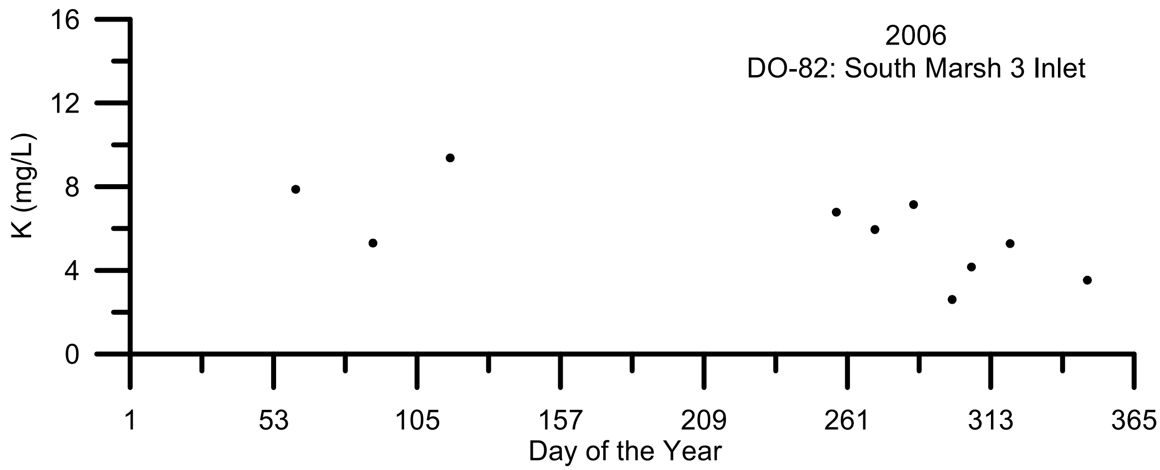

2007
DO-80: South Marsh 1 Inlet
K (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

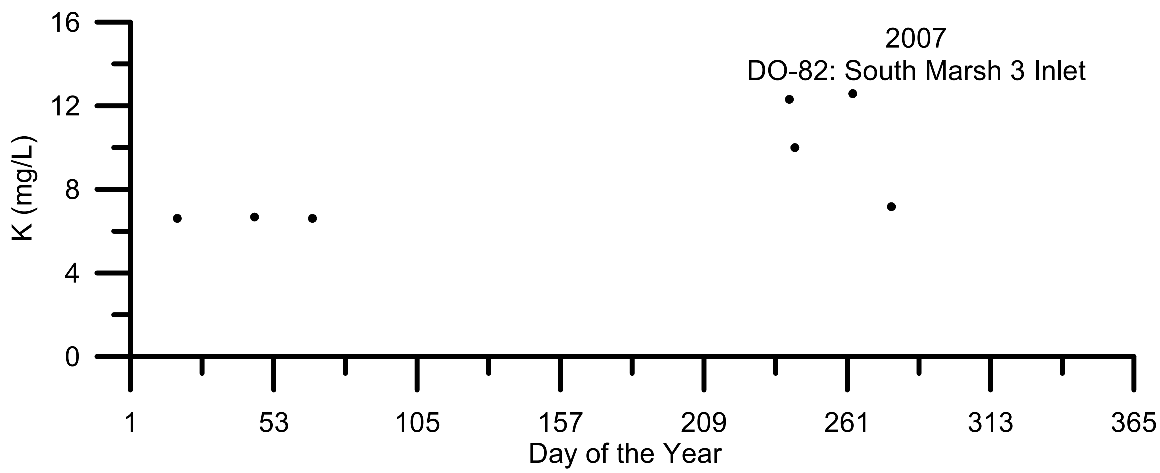

2005
DO-81: South Marsh 1 Outlet
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

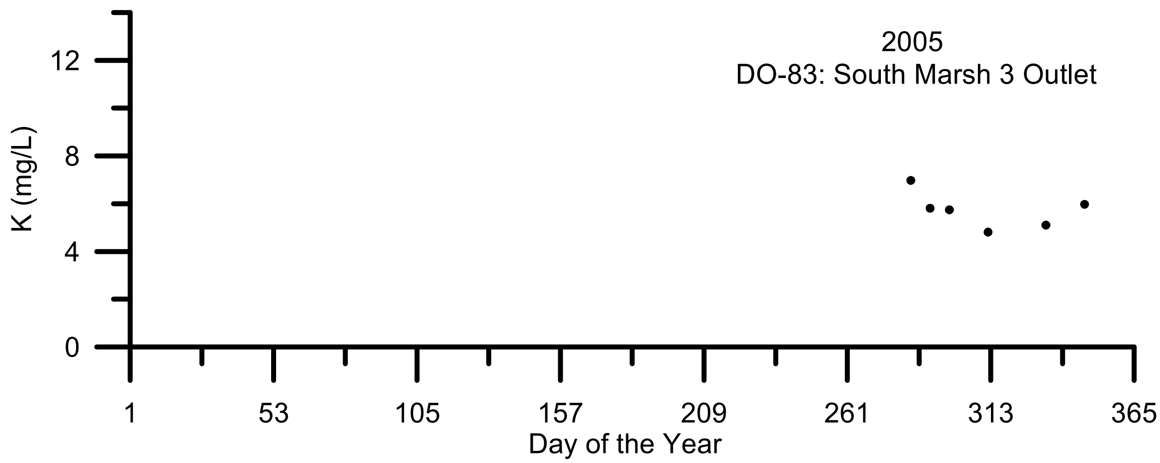

2006
DO-81: South Marsh 1 Outlet
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

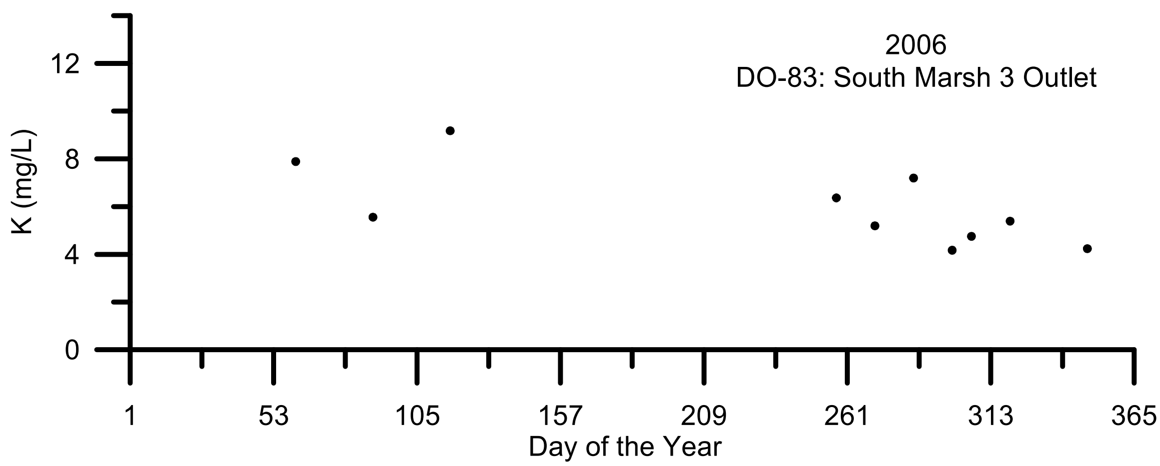

2007
DO-81: South Marsh 1 Outlet
K (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

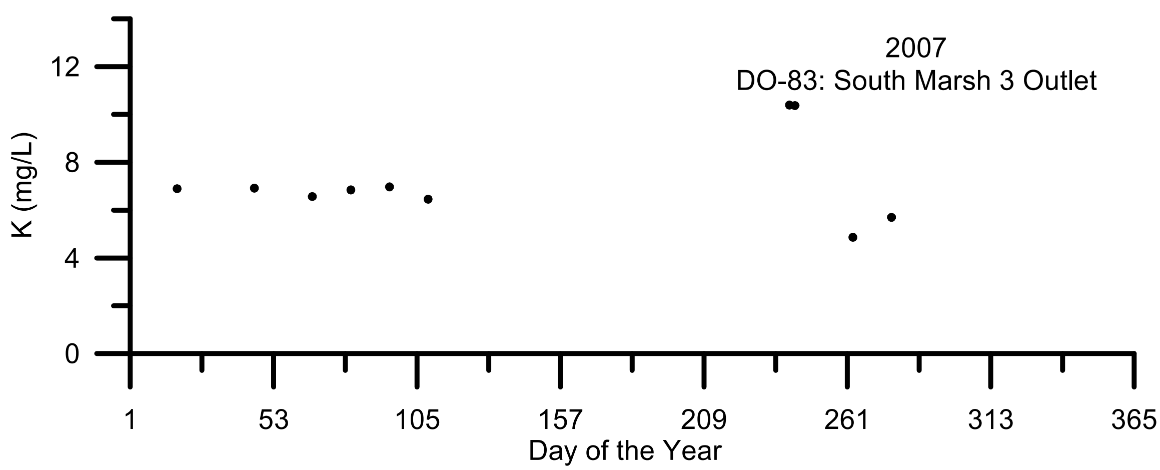

2005
DO-82: South Marsh 3 Inlet
K (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

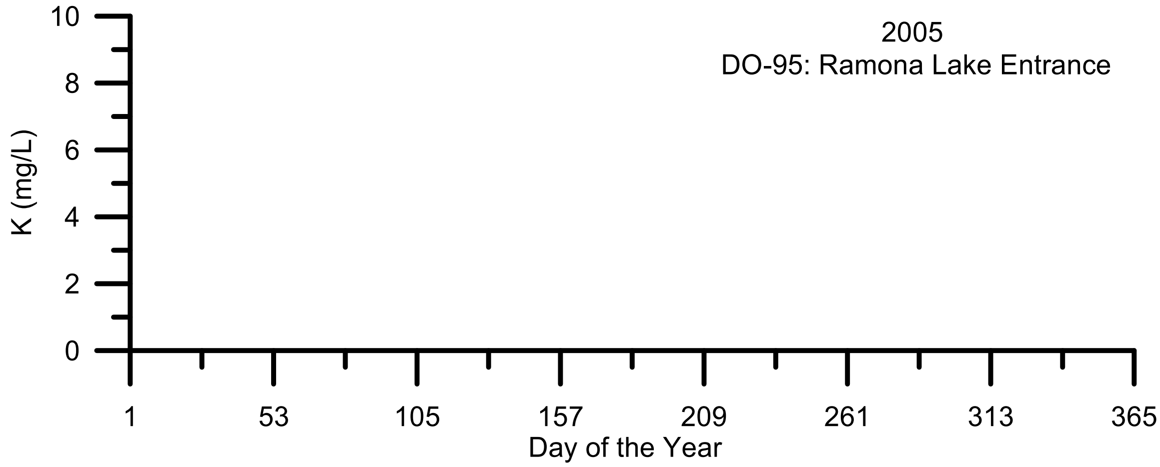

2006
DO-82: South Marsh 3 Inlet
K (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

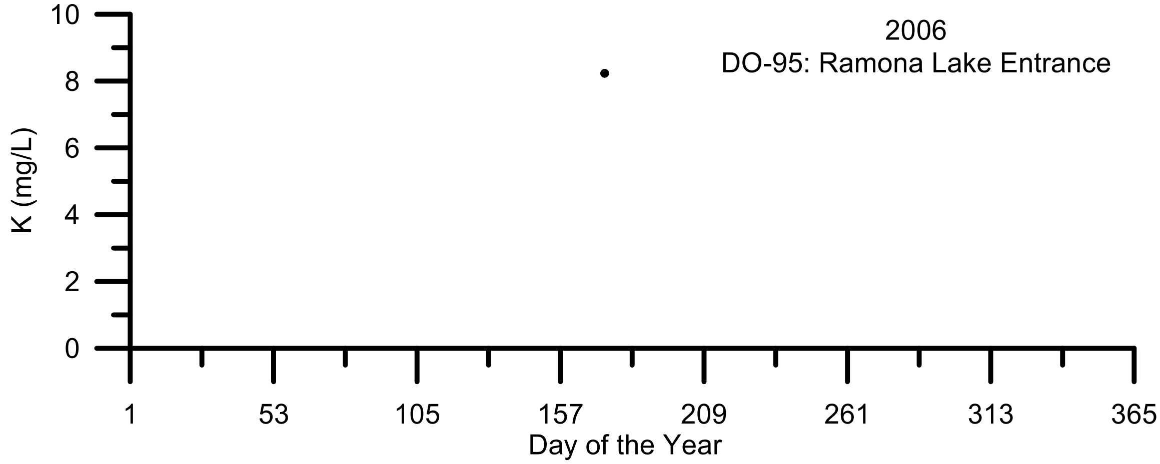

2007
DO-82: South Marsh 3 Inlet
K (mg/L)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

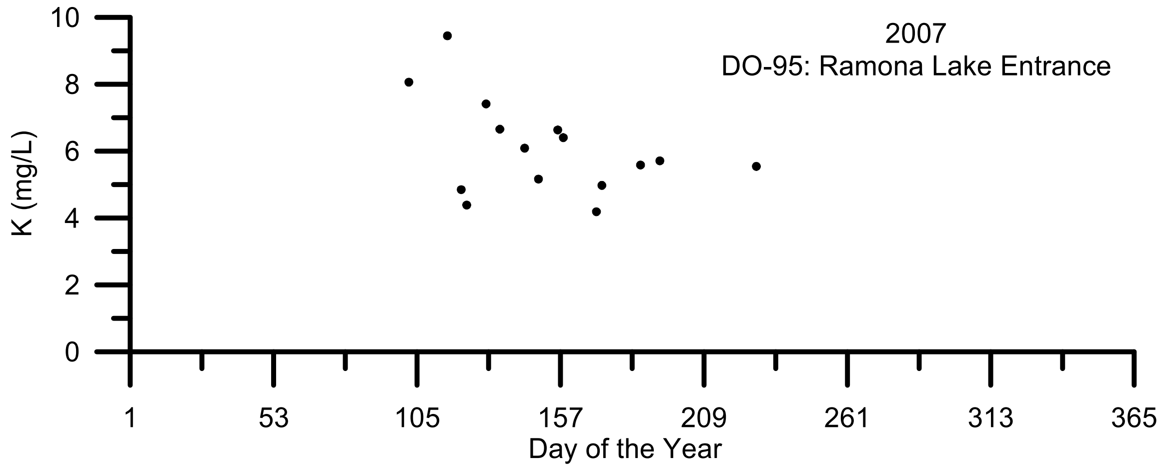

2005
DO-83: South Marsh 3 Outlet
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
K (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
K (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
K (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
K (mg/L)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Nitrate Data from the Upstream San Joaquin River

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Randy Dahlgren[2]
Jeremy Hanlon[1]
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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of dissolved nitrate (NO_3-N) data analyzed by the UCD Dahlgren laboratory from 2005-2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples for NO_3-N and ammonia (Soluble NO_3-N and Soluble NH_3-N) were transported from the EERP laboratory to the UCD laboratory where they were filtered through a pre-rinsed, 0.22 µm polycarbonate membrane (Millipore Isopore^{TM}), and then stored at -20°C until NO_3-N analysis could be completed.

NO_3-N and Soluble NH_3-N were quantified simultaneously using an automated membrane diffusion/conductivity detection method (Carlson, 1978, 1986; Carlson et al., 1990). The limit of detection for this method was 50 ppb N.

Results/Discussion

With each set of NO_3-N field samples analyzed in the UCD laboratory, quality assurance samples including a field duplicate, a trip blank, and lab blanks were also analyzed. 100% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Five proficiency check samples were analyzed for NO_3-N in the EERP laboratory during 2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.0-36.4 mg/L NO_3-N. The average concentration of NO_3-N in water samples collected was 3.55 mg/L NO_3-N. NO_3-N was also analyzed by the EERP laboratory on the same water samples starting in the summer of 2007, and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.983 (Spier et al, 2008). NO3-N samples measured by EERP have about 89.3% as much NO3-N as the same samples measured by UCD (Figure 2).

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Carlson, R.M., R. Cabrera, J. Paul, J. Quick and R.Y. Evans. 1990. Rapid direct determination of ammonium and nitrate in soil and plant tissue extracts. Comm. Soil Sci. Plant Anal. 21:1519-1530.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Spier, C., Burks, R., Borglin, S.E. (2008) Comparison of Methods for Analyzing Ammonia, Nitrate and Total Nitrogen, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

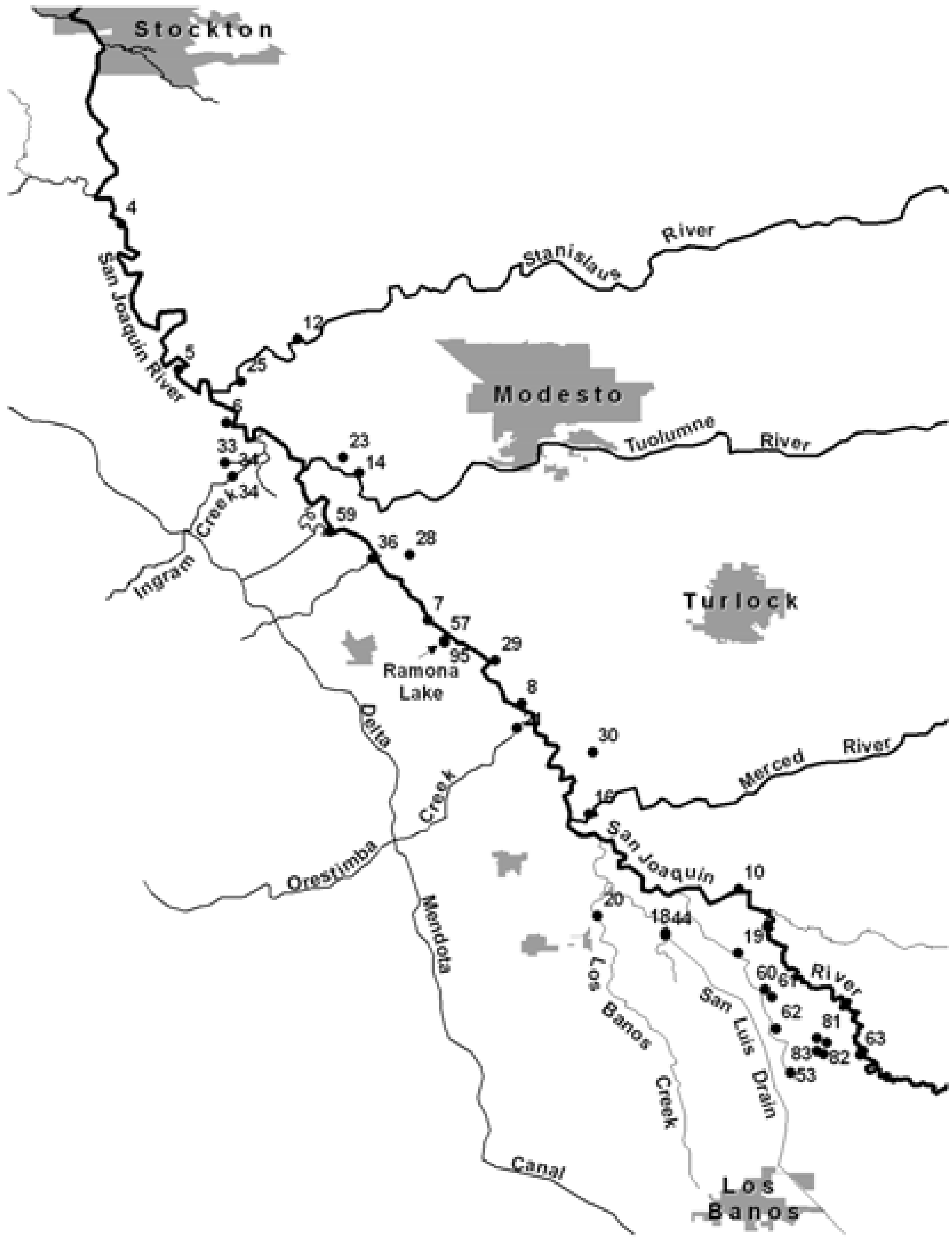
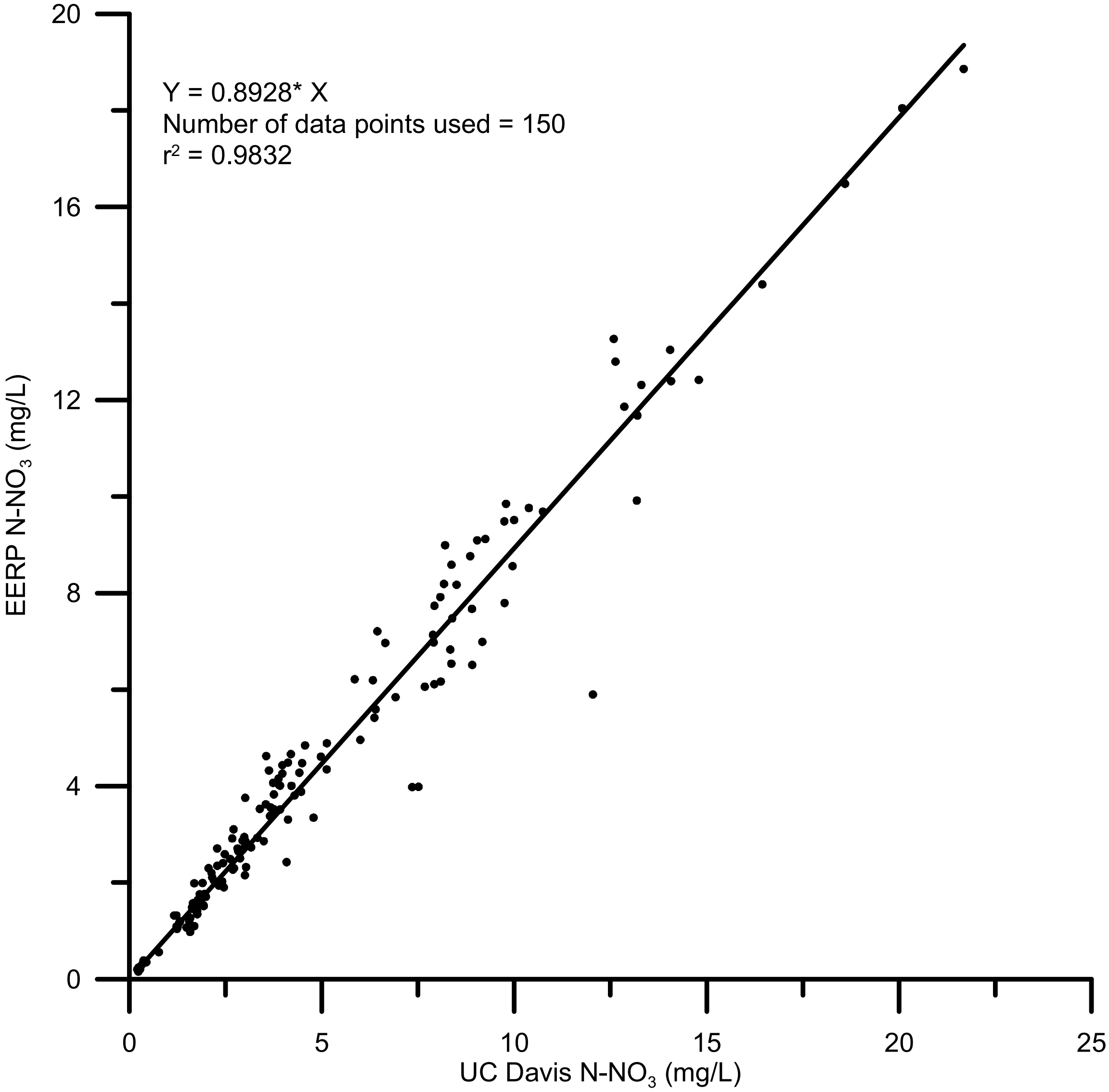
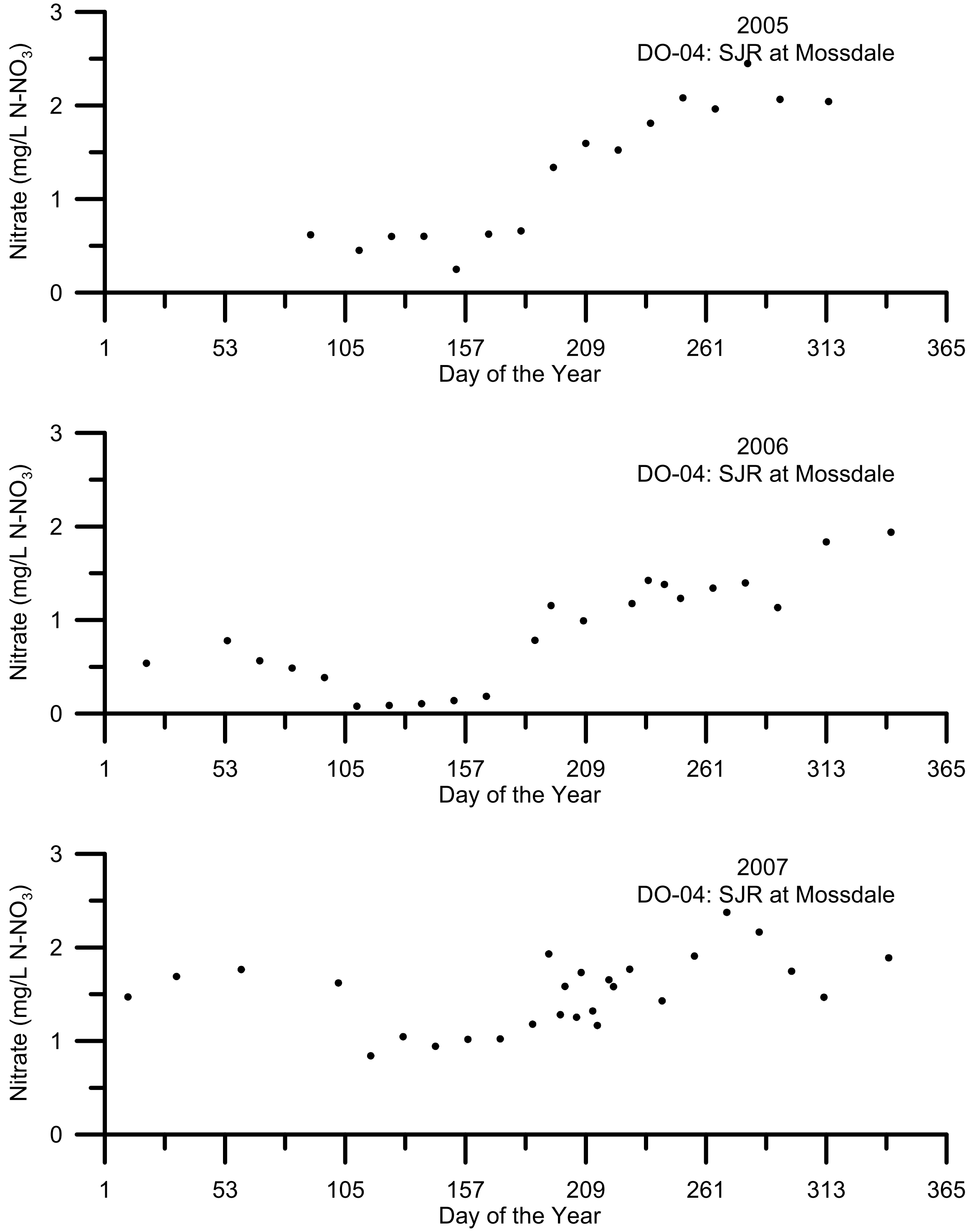
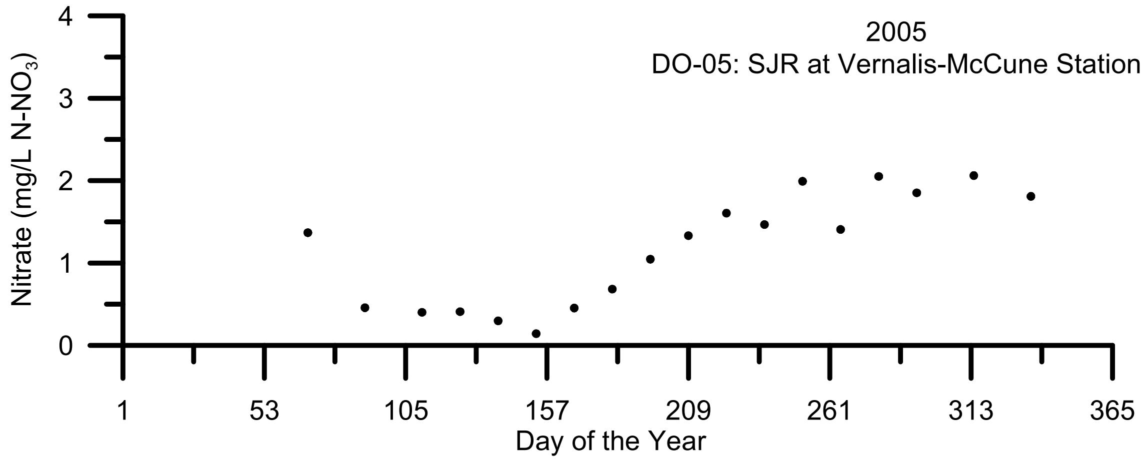


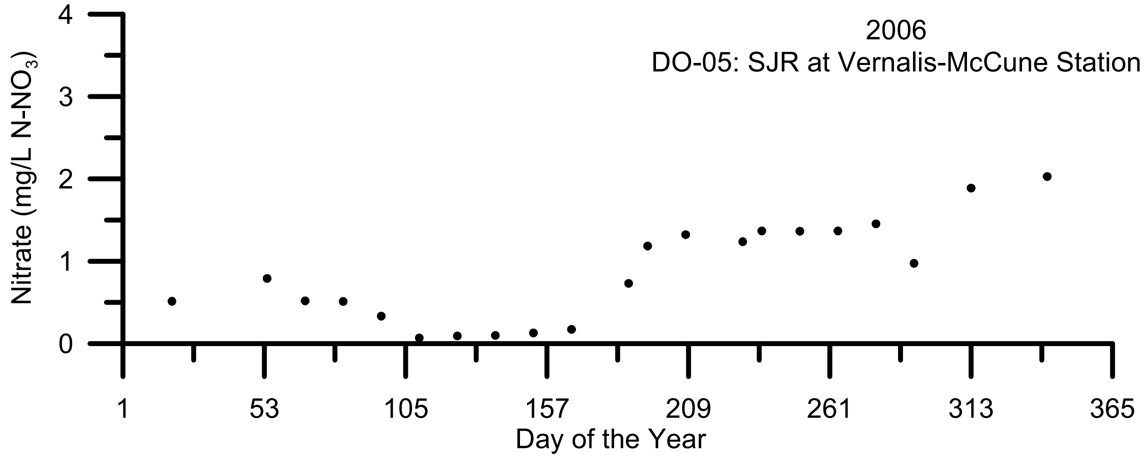
Figure 2: UCD vs EERP Timberline Plot of NO_3-N.

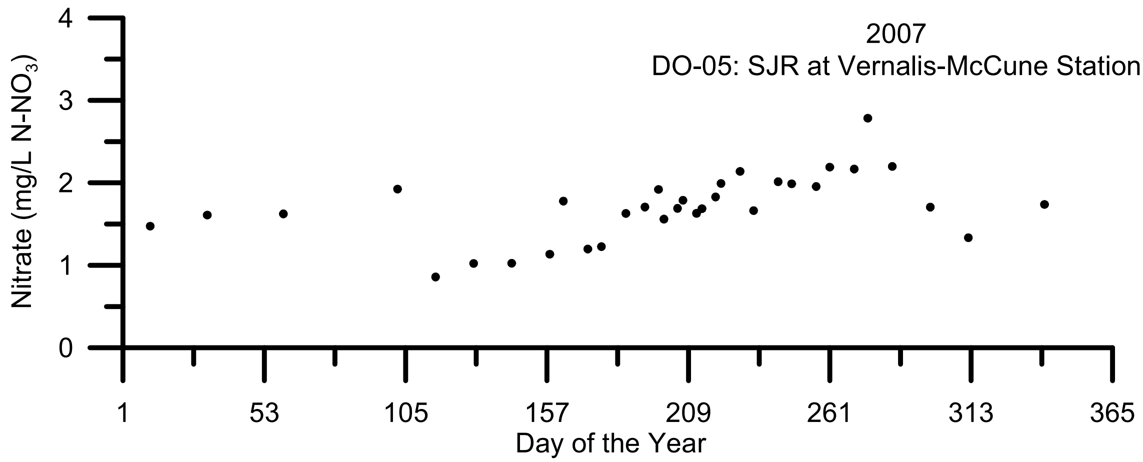


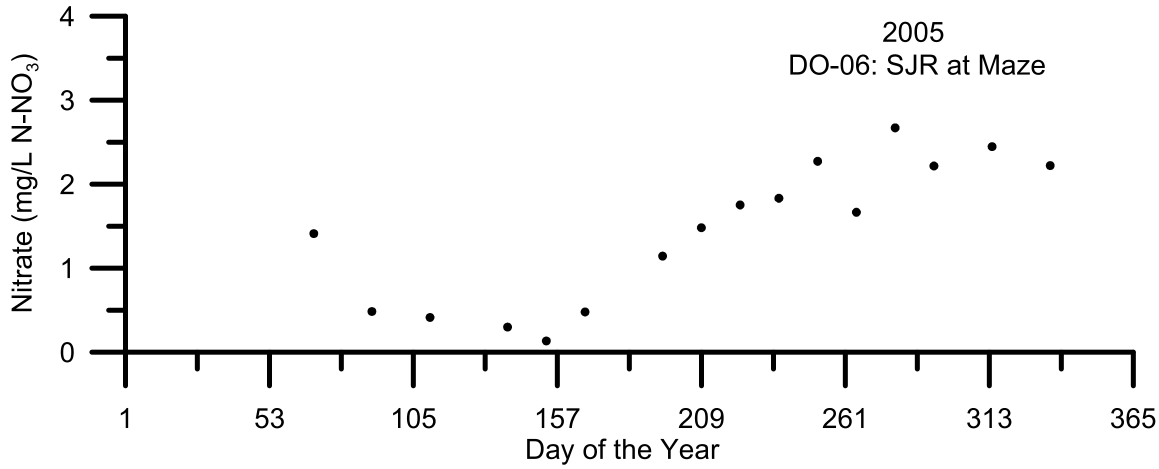
Figures 2 -103: Temporal Plots of Dissolved NO_3-N By Site ID

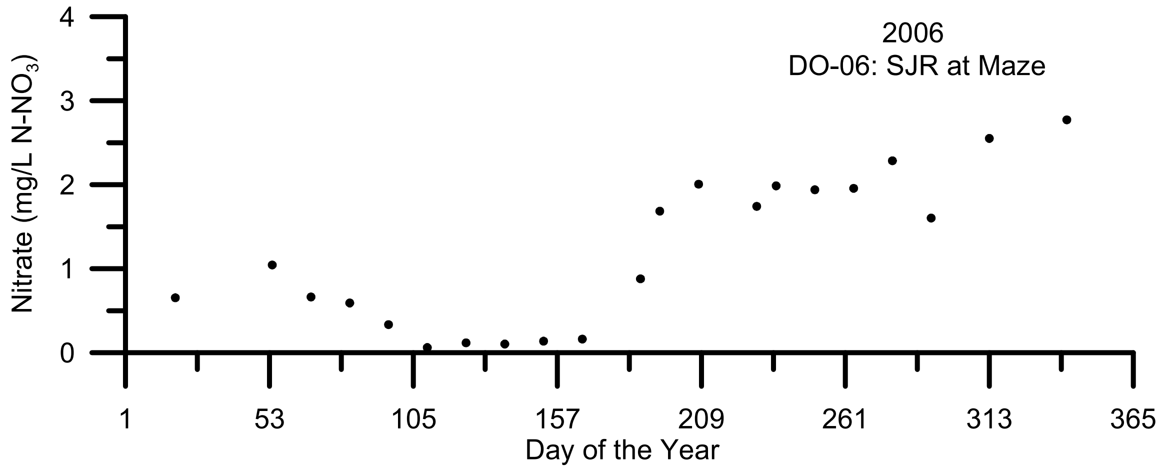


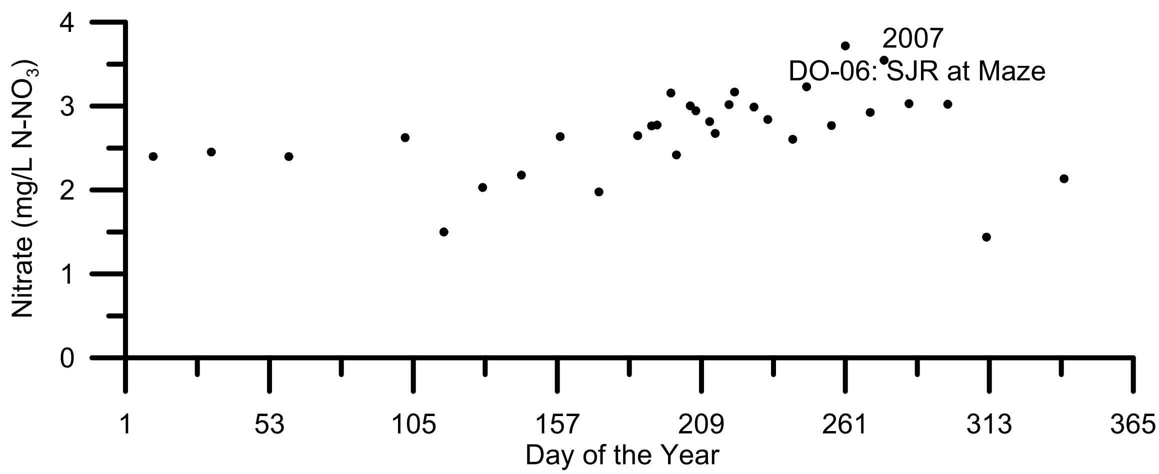

2005
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

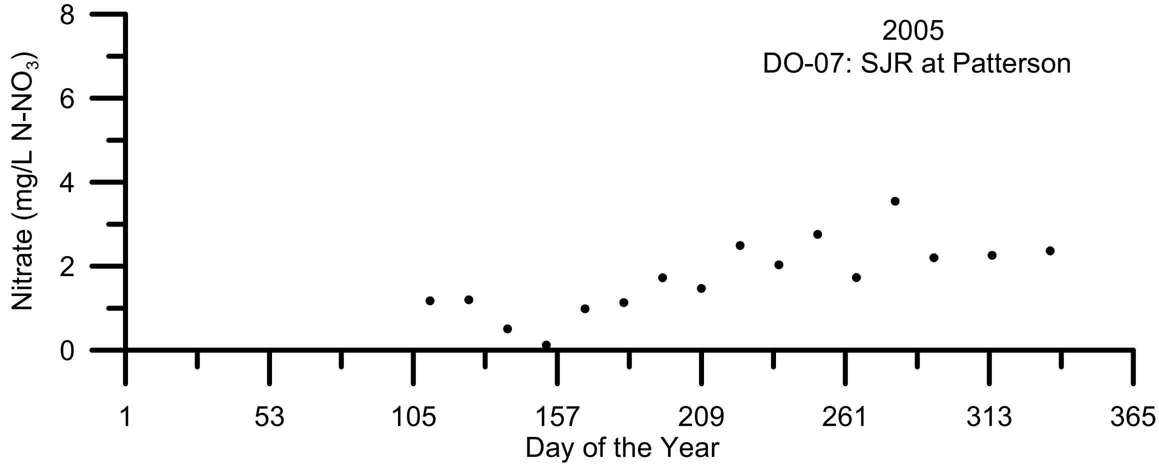

2006
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

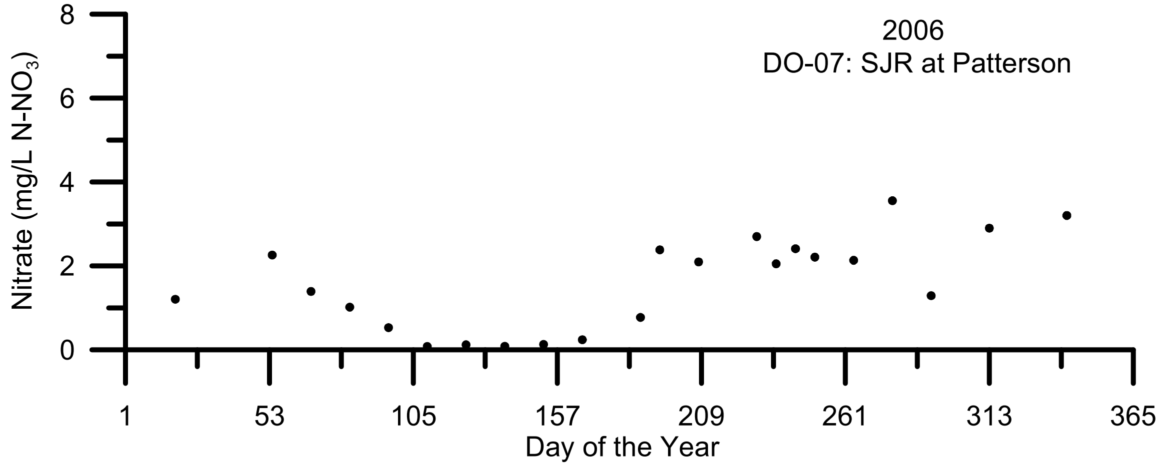

2007
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

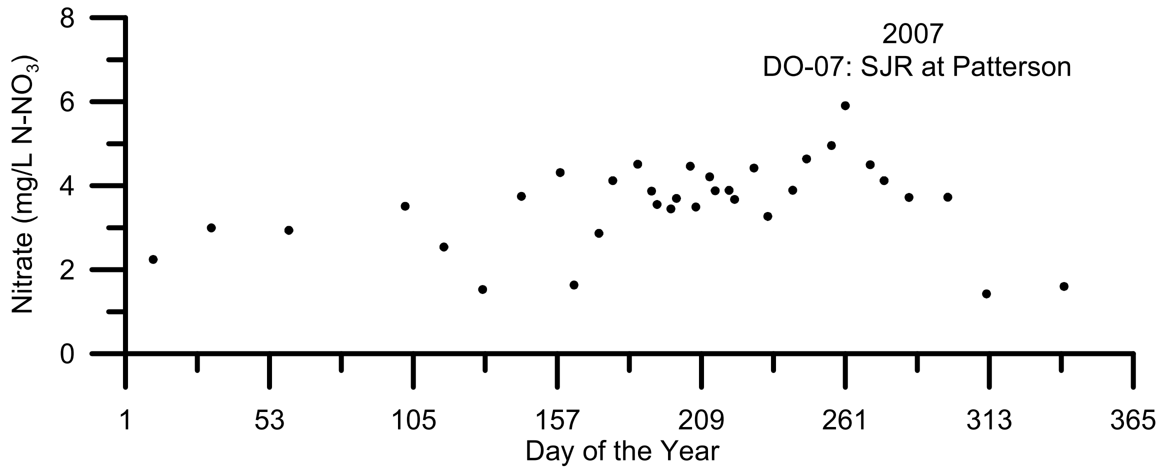

2005
DO-06: SJR at Maze
Nitrate (mg/L N-NO3)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365

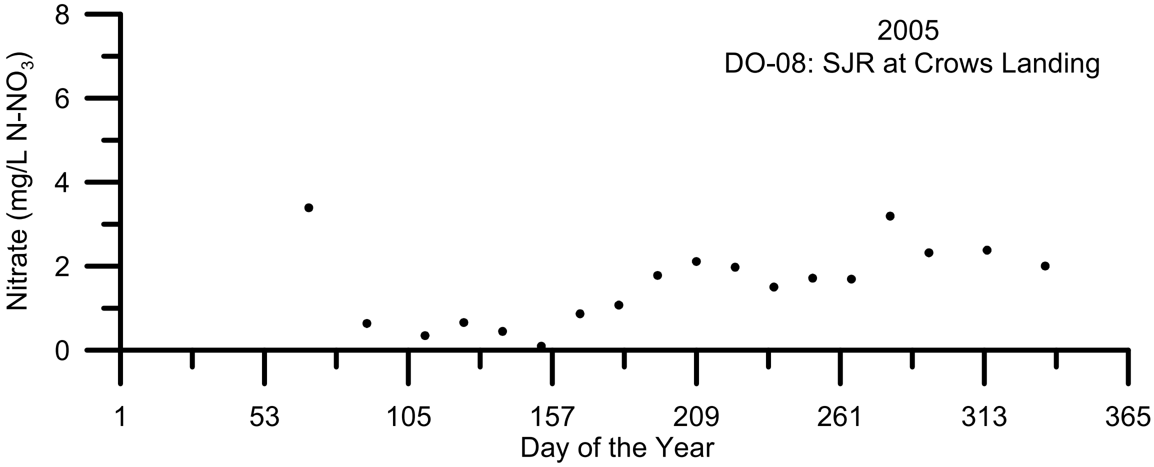

2006
DO-06: SJR at Maze
Nitrate (mg/L N-NO3)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365


2007
DO-06: SJR at Maze
Nitrate (mg/L N-NO3)
Day of the Year
0
1
2
3
4
1
53
105
157
209
261
313
365

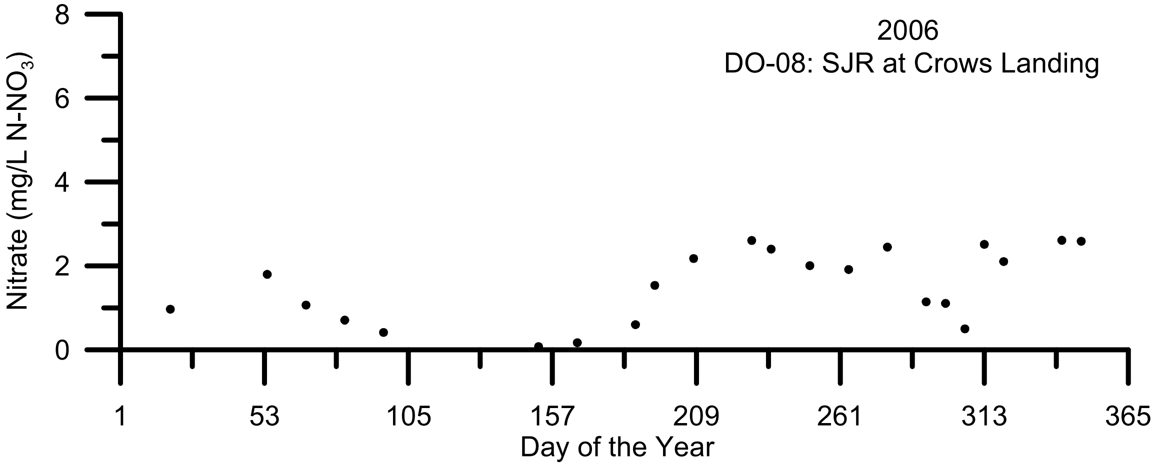

2005
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

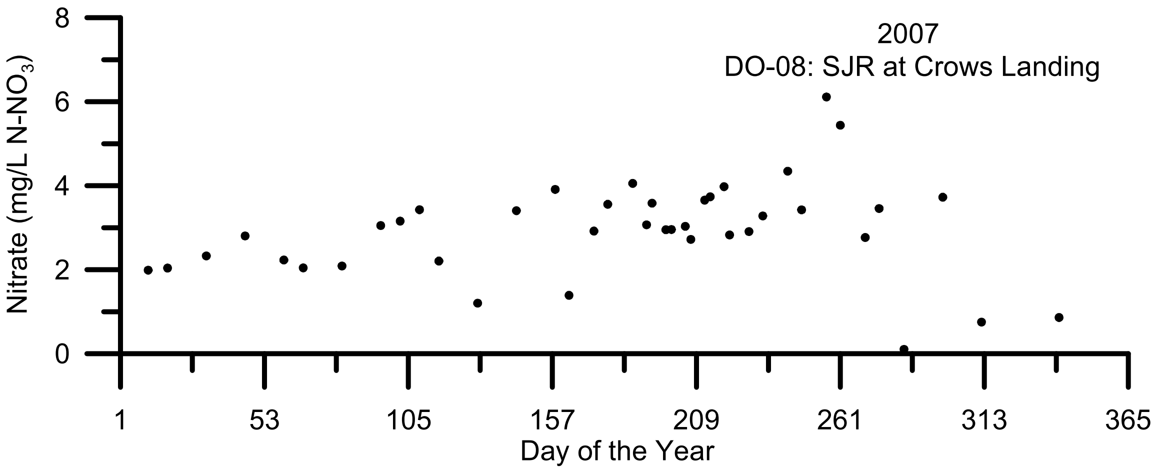

2007
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year



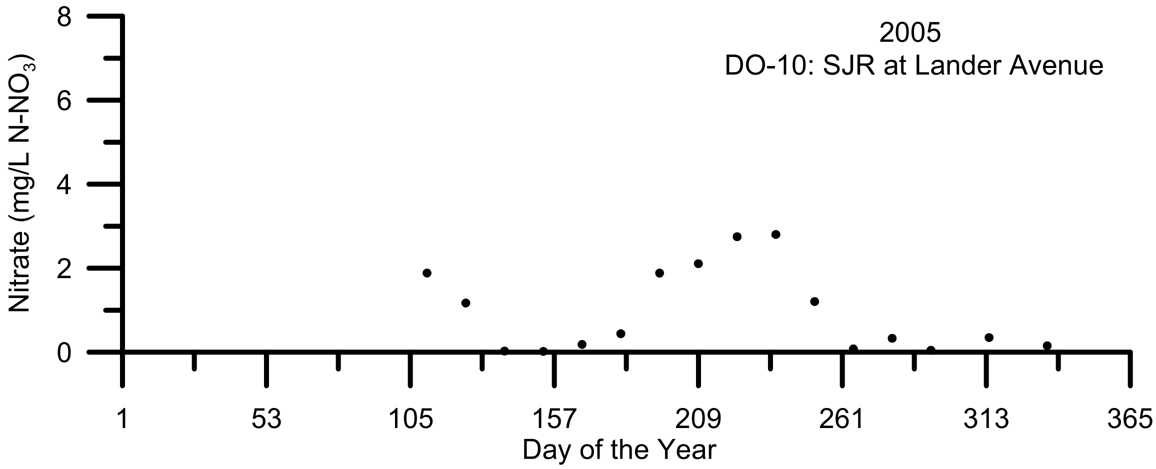
2005
DO-08: SJR at Crows Landing
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

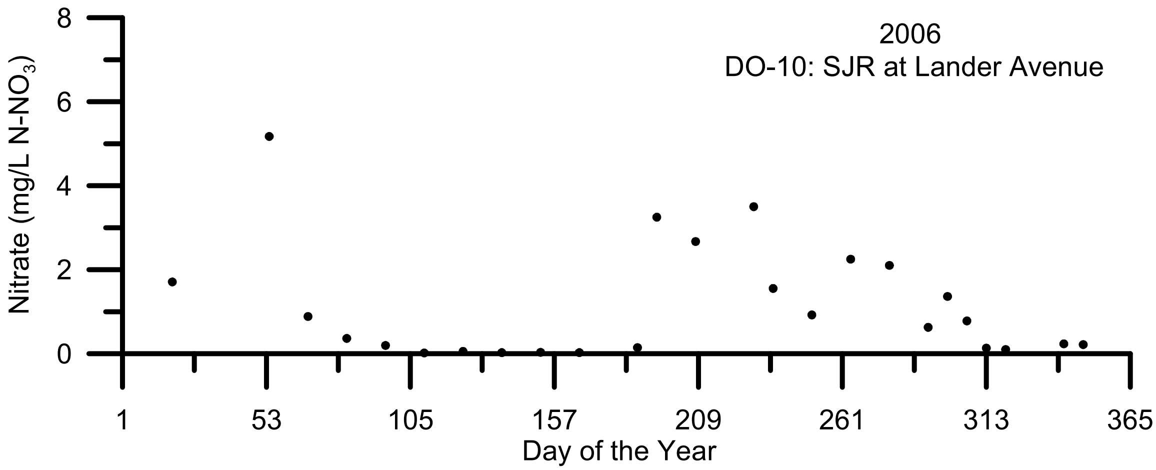


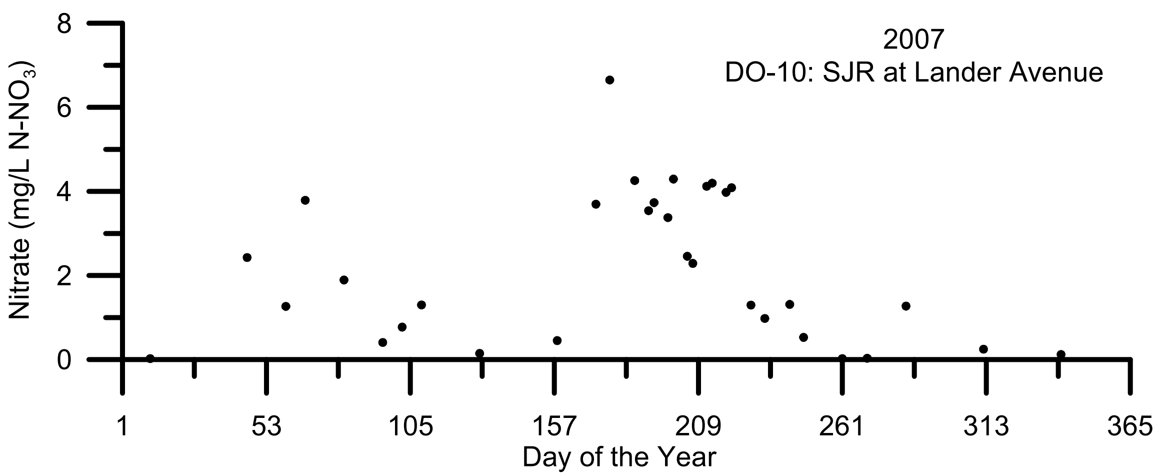
2006
DO-08: SJR at Crows Landing
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

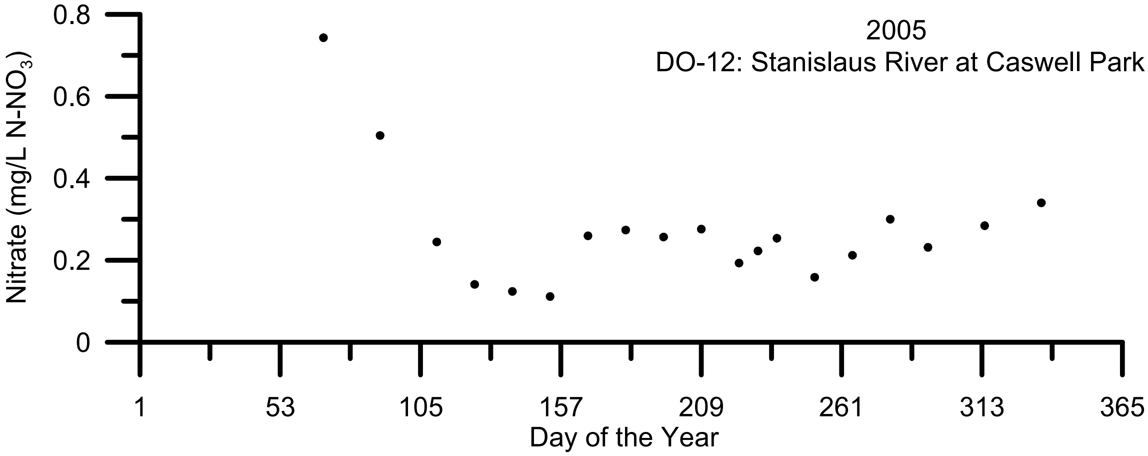


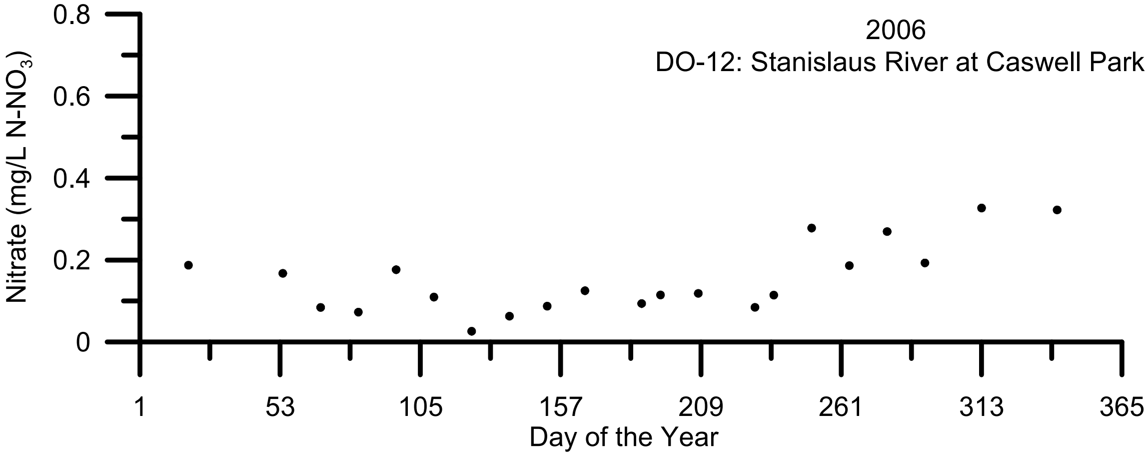
2007
DO-08: SJR at Crows Landing
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

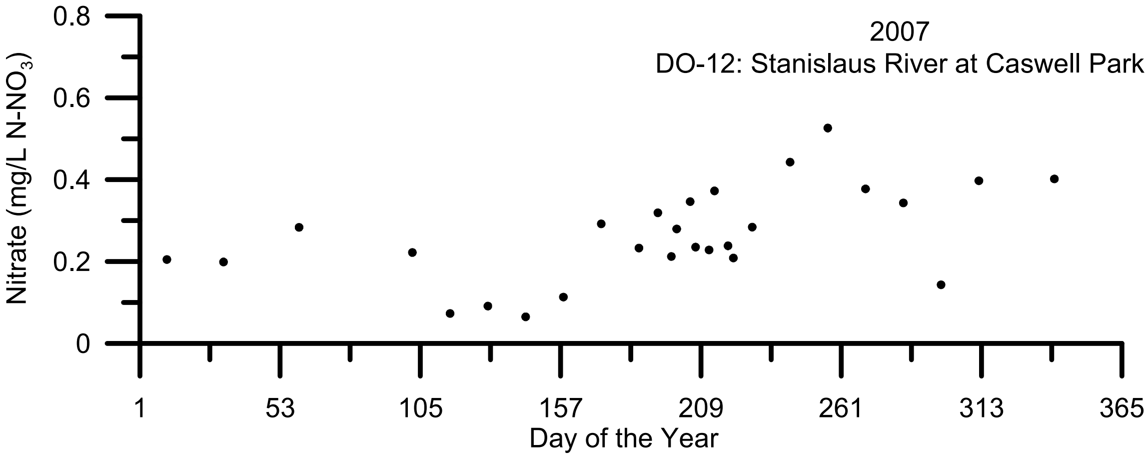

2005
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO_3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

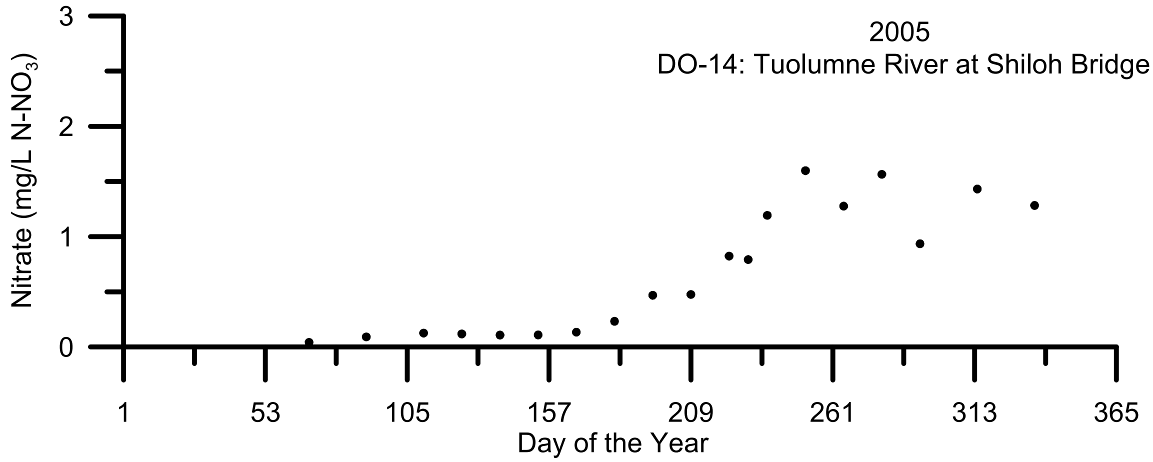

2006
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO_3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

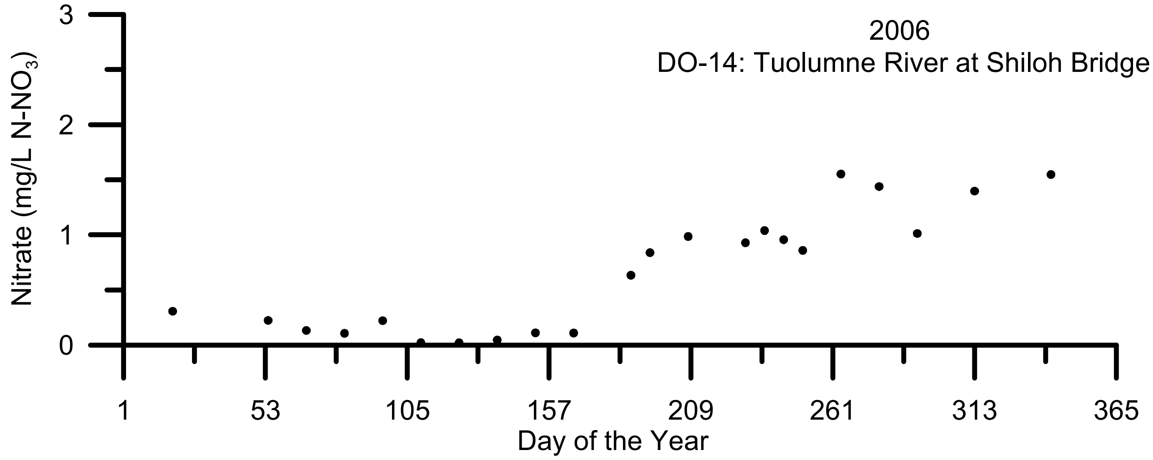

2007
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO_3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

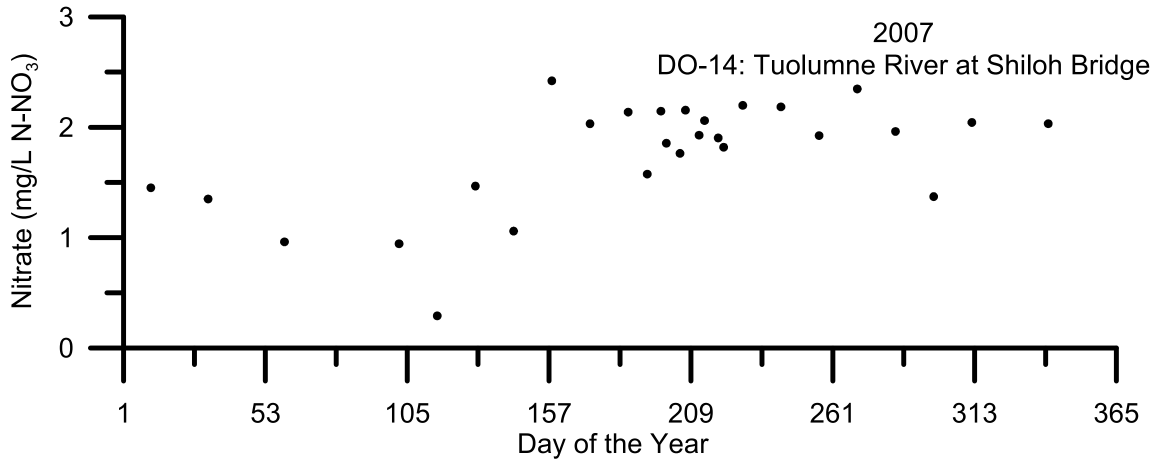

2005
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO_3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

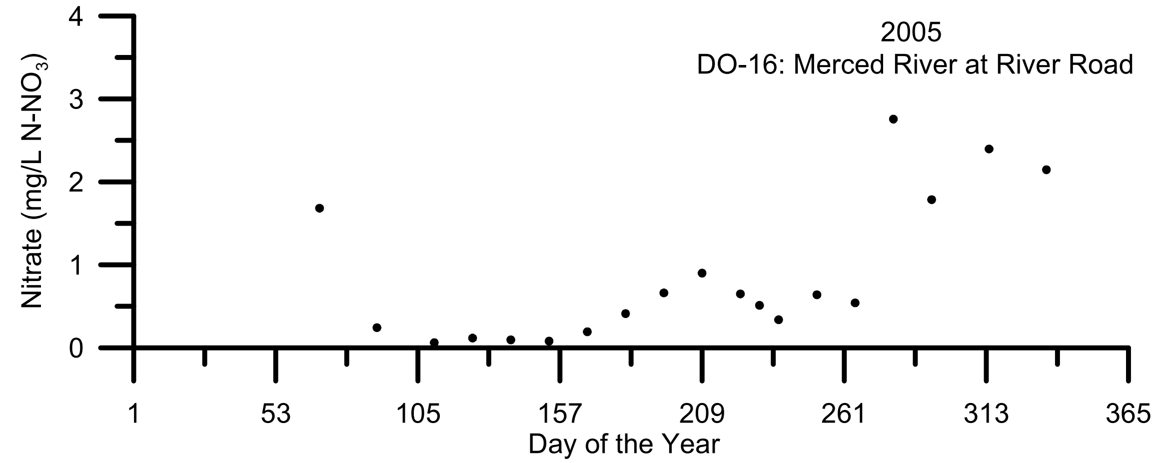

2006
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO_3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

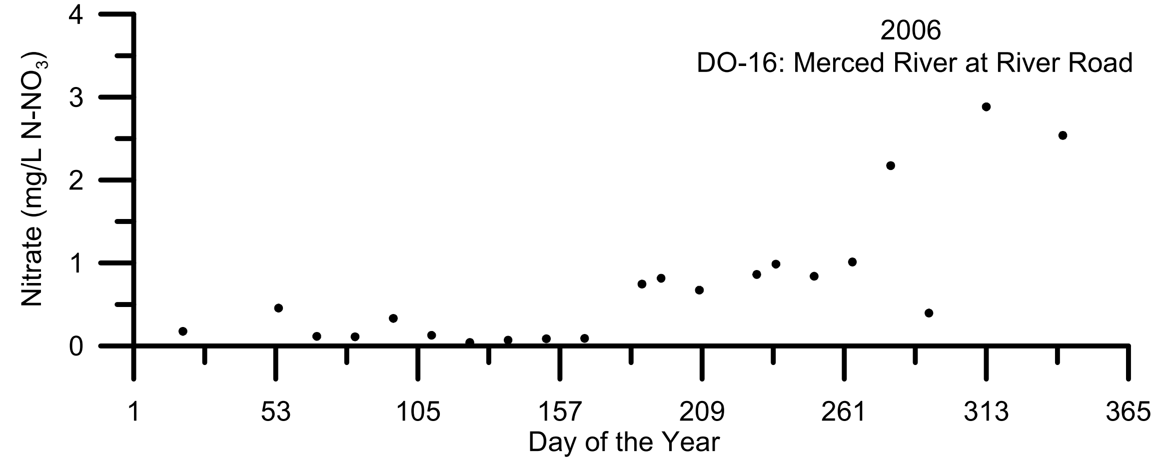

2007
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO_3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

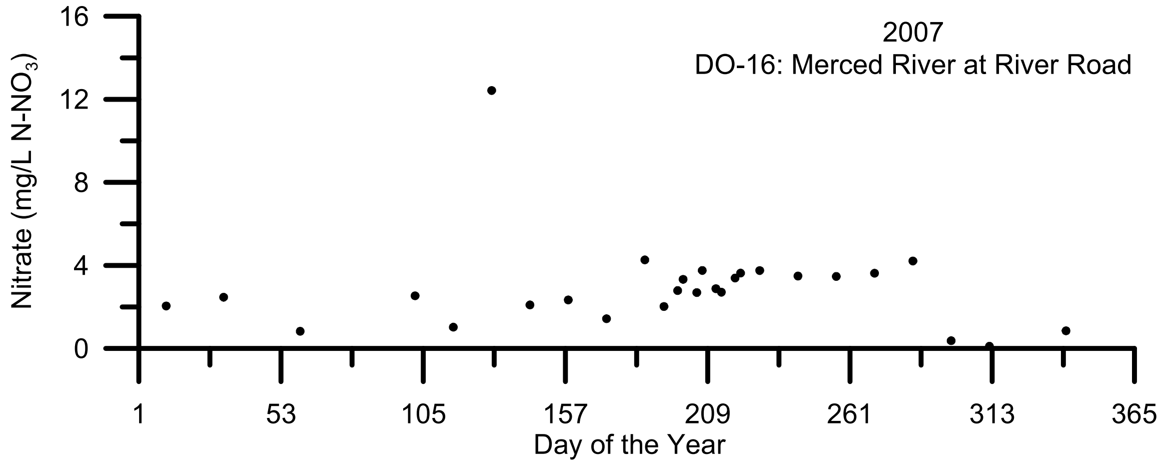

2005
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO$_3$)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

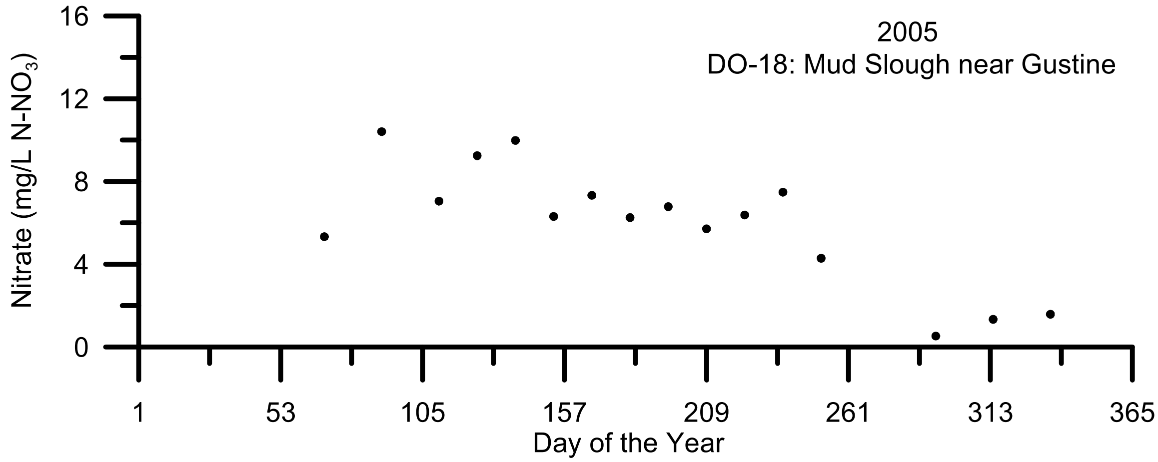

2006
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO$_3$)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

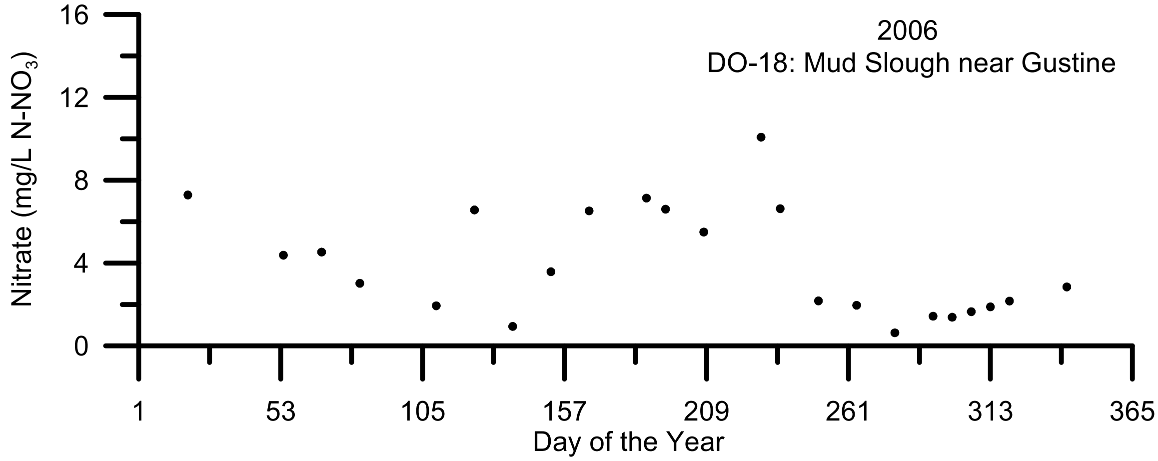

2007
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO$_3$)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

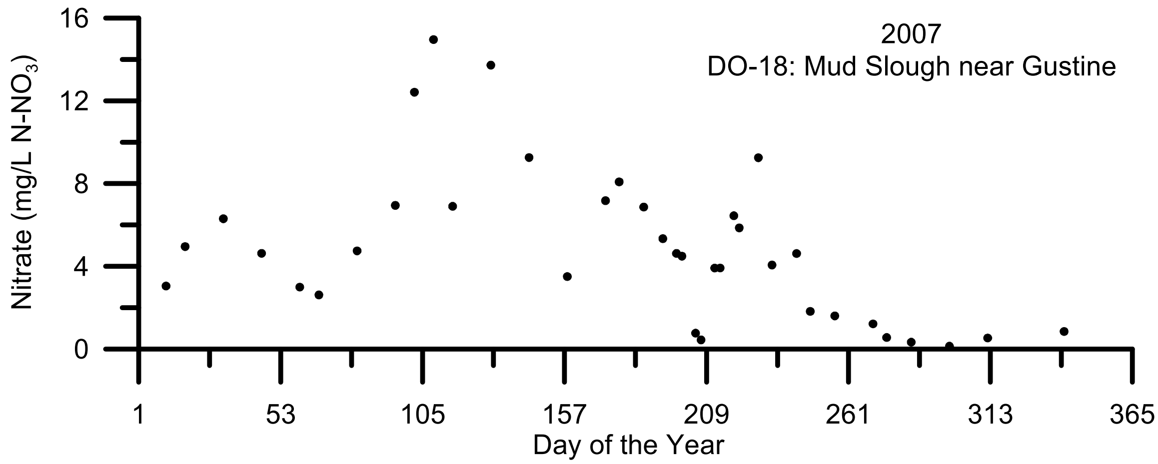

2005
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

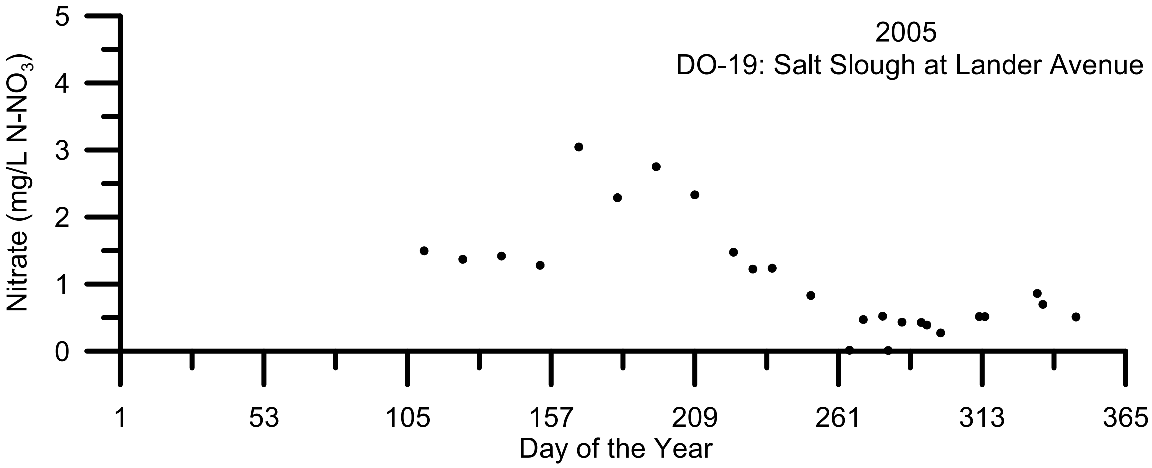

2006
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

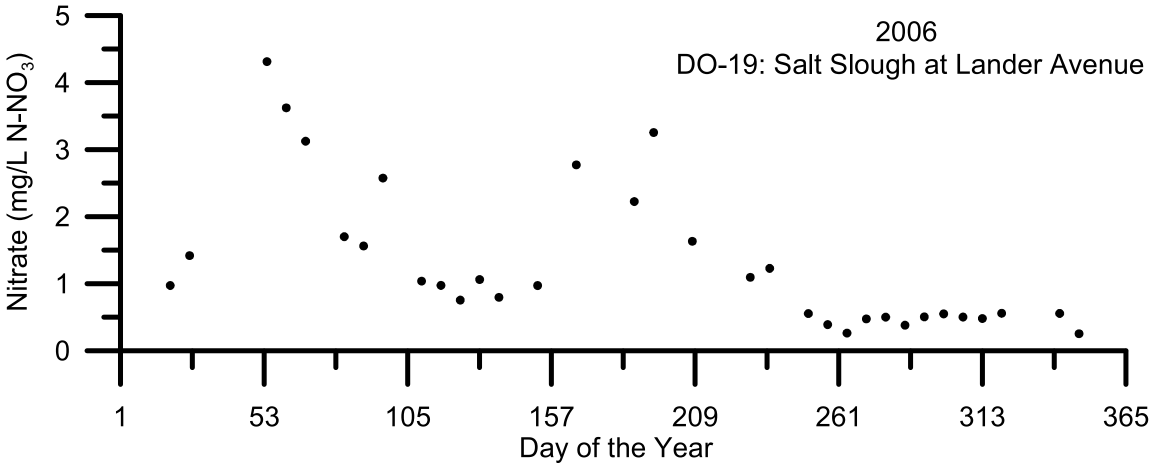

2007
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

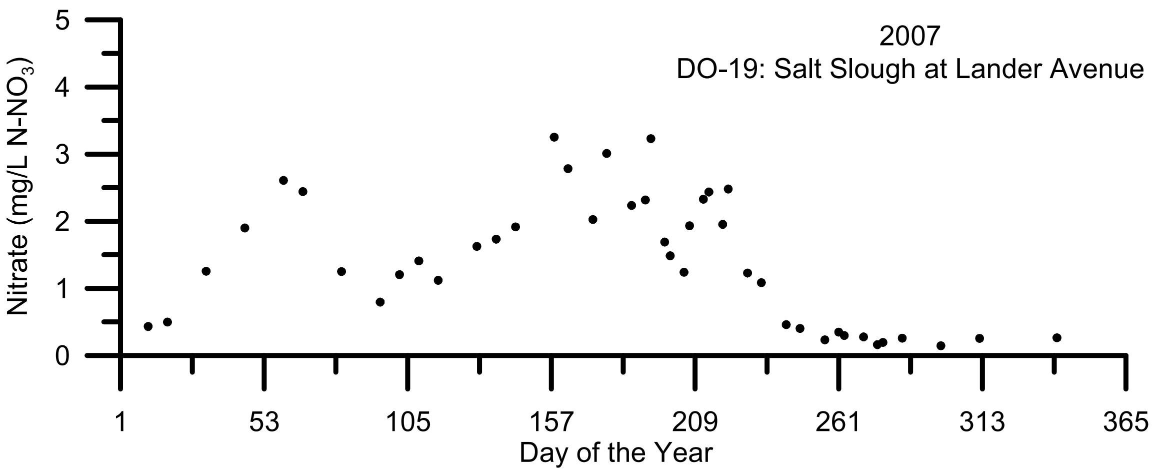

2005
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO_3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

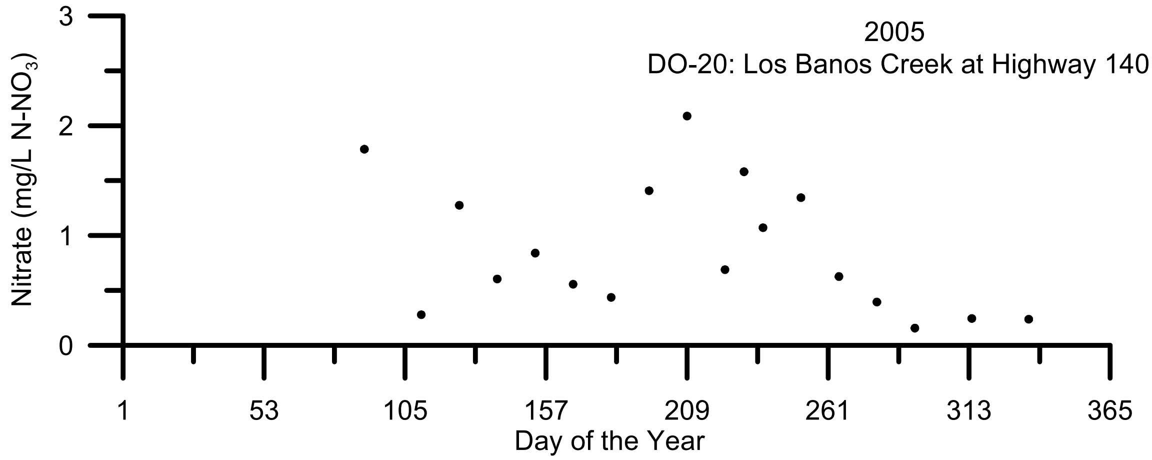

2006
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO_3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

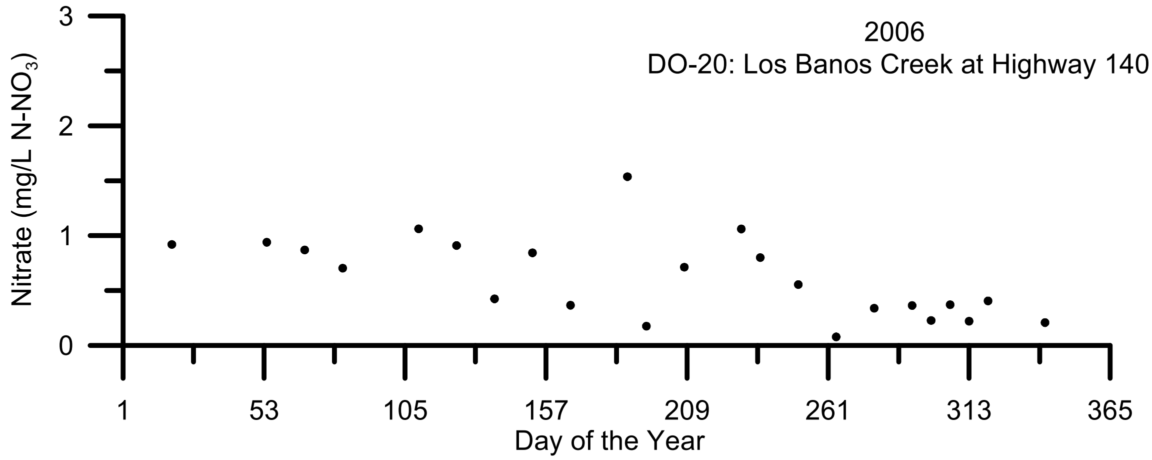

2007
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO_3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

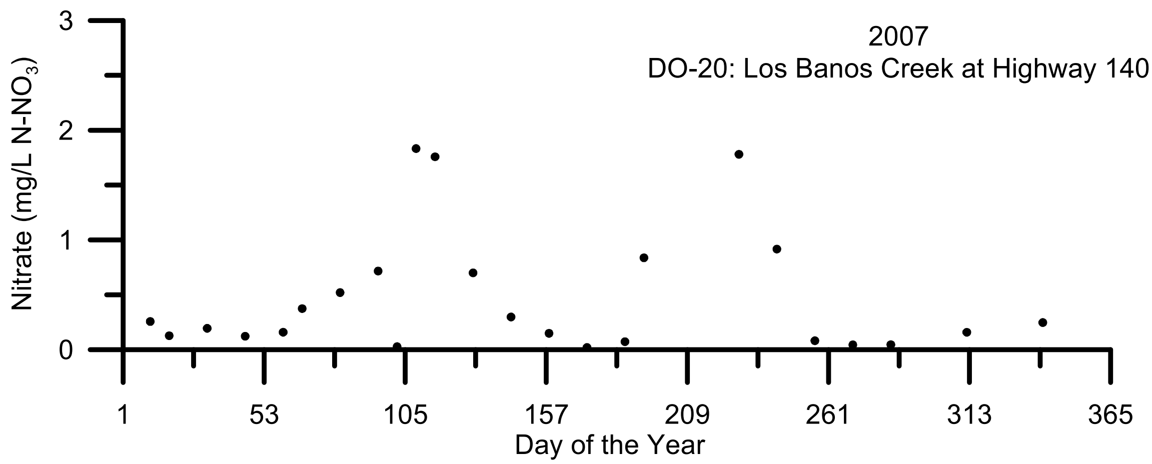

2005
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

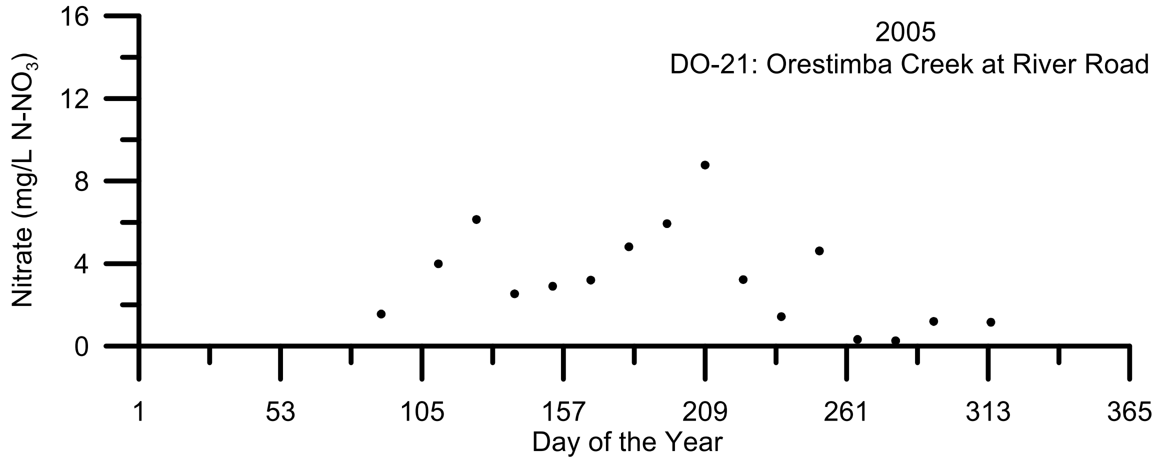

2006
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

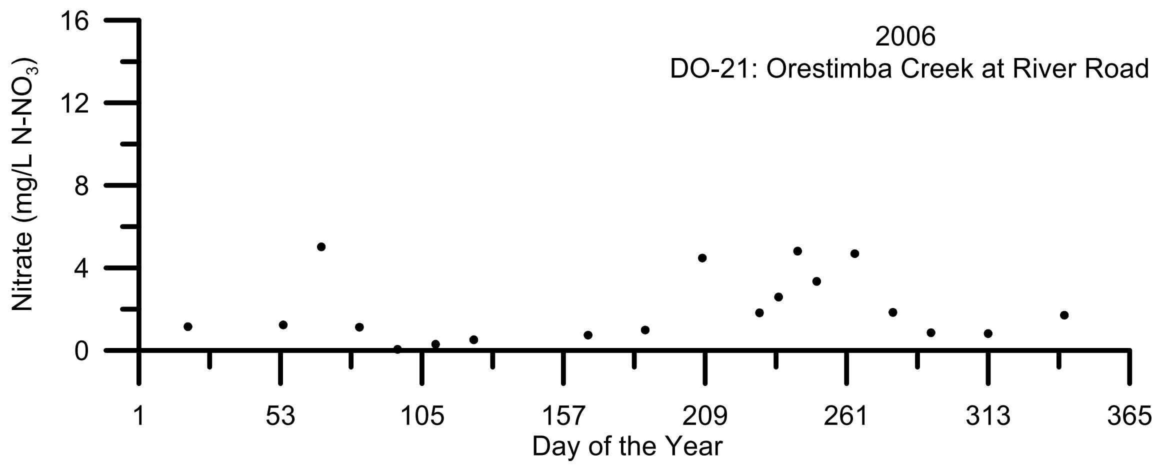

2007
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

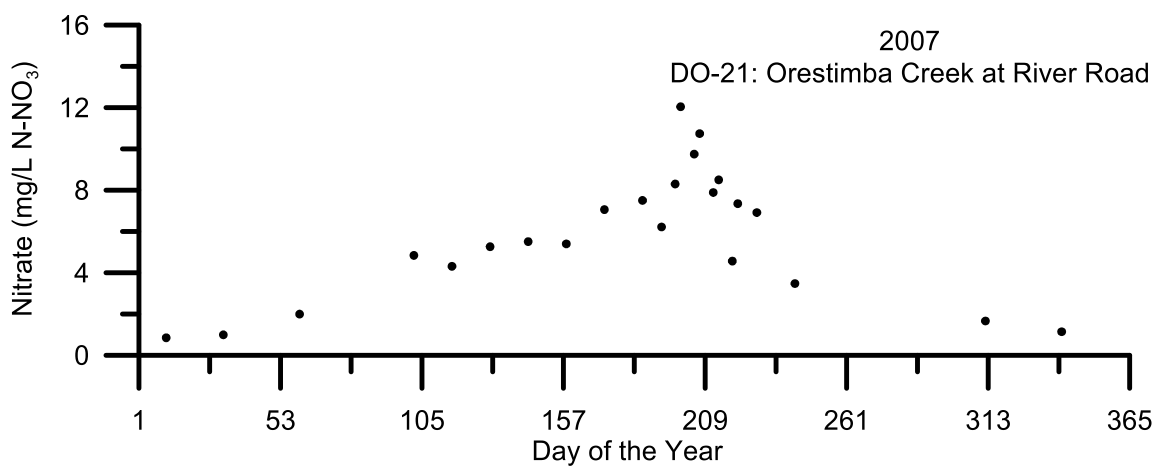

2005
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

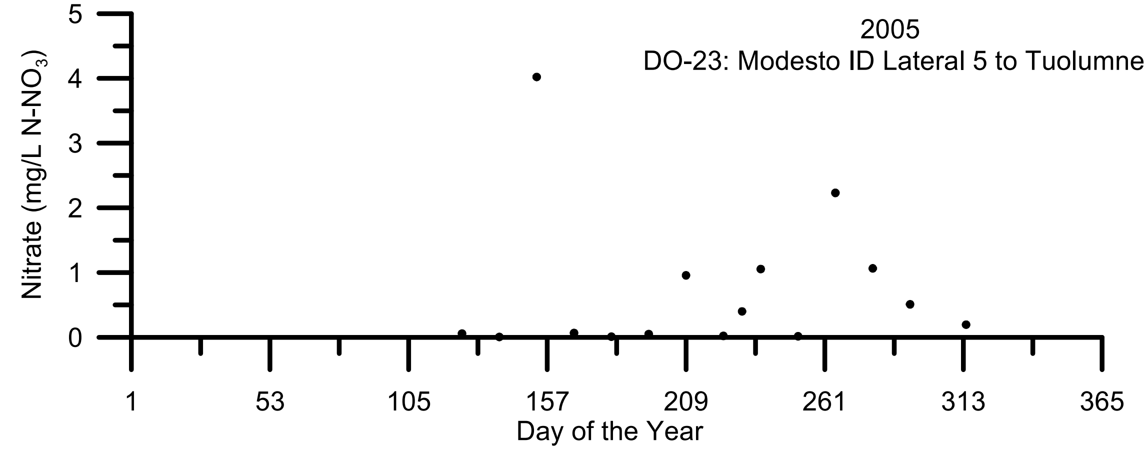

2006
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

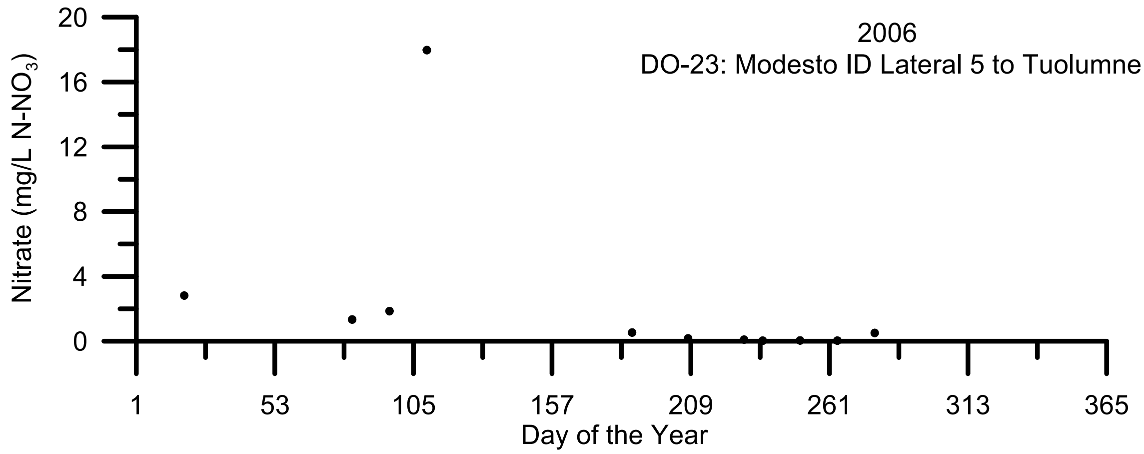

2007
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

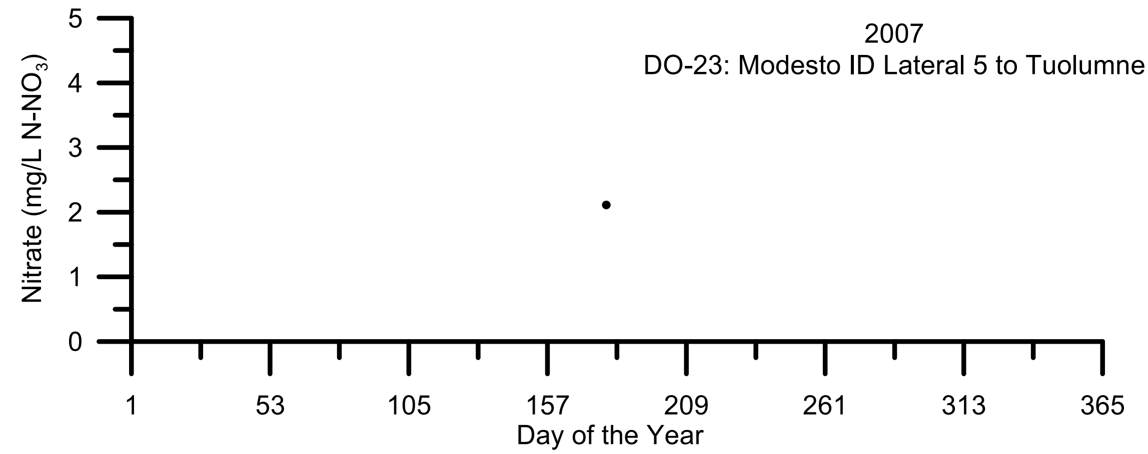

2005
DO-21: Orestimba Creek at River Road
Nitrate (mg/L N-NO3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

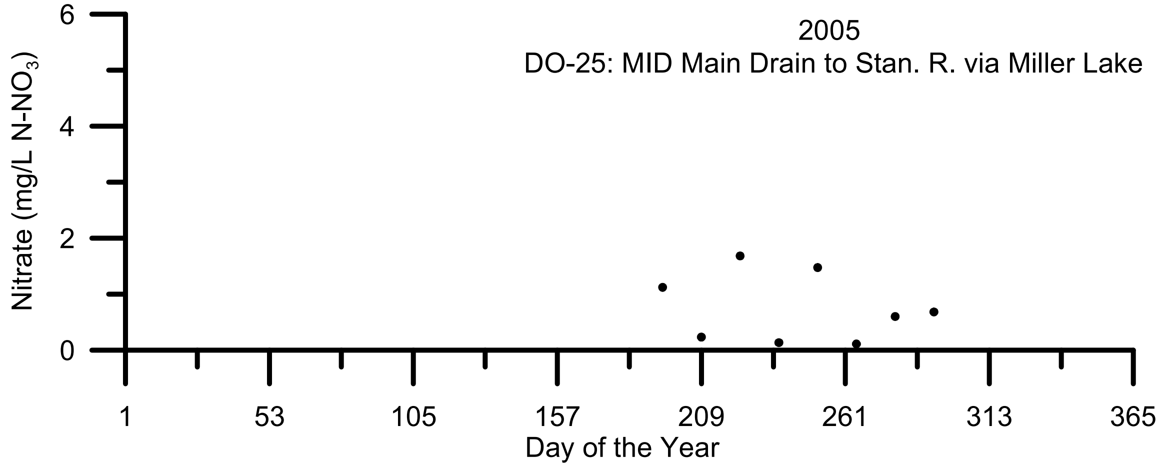

2006
DO-21: Orestimba Creek at River Road
Nitrate (mg/L N-NO3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

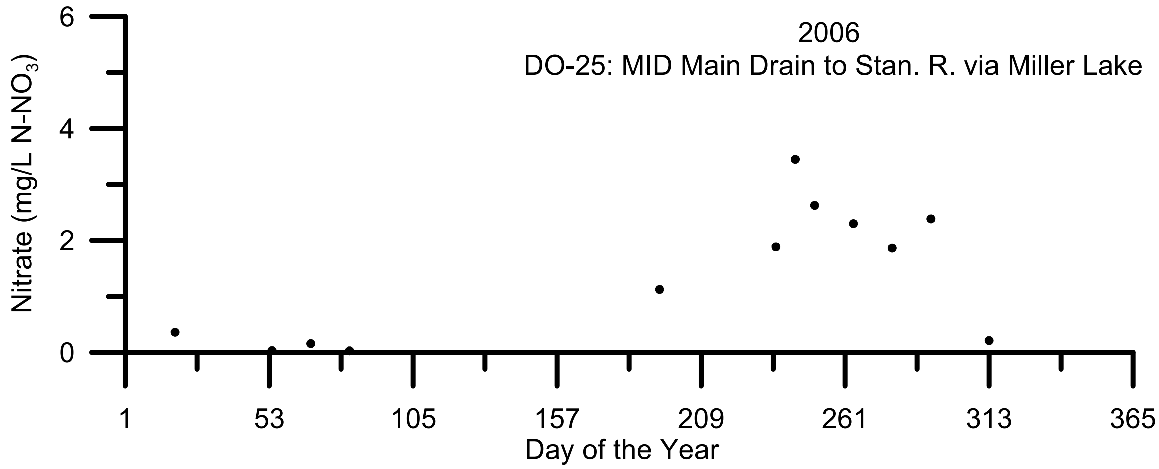

2007
DO-21: Orestimba Creek at River Road
Nitrate (mg/L N-NO3)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

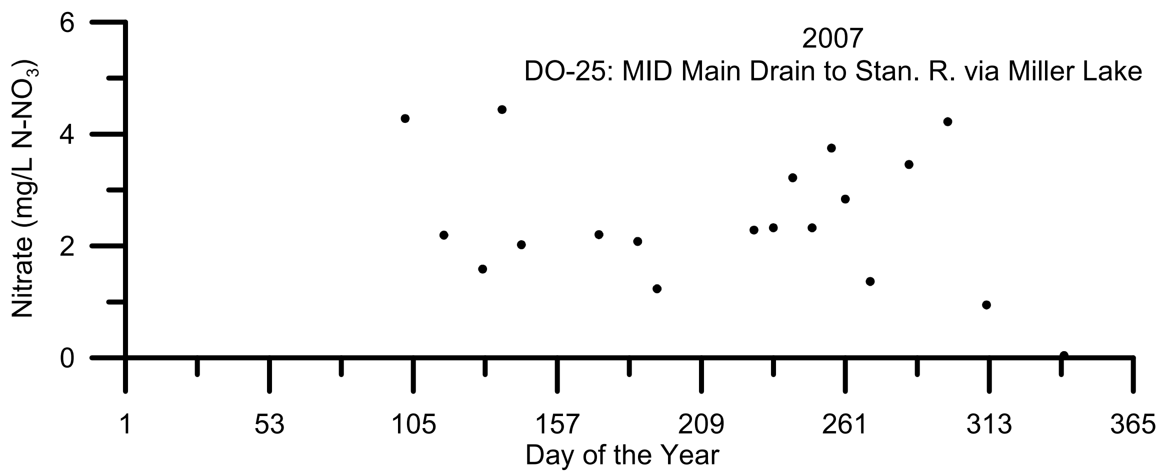

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

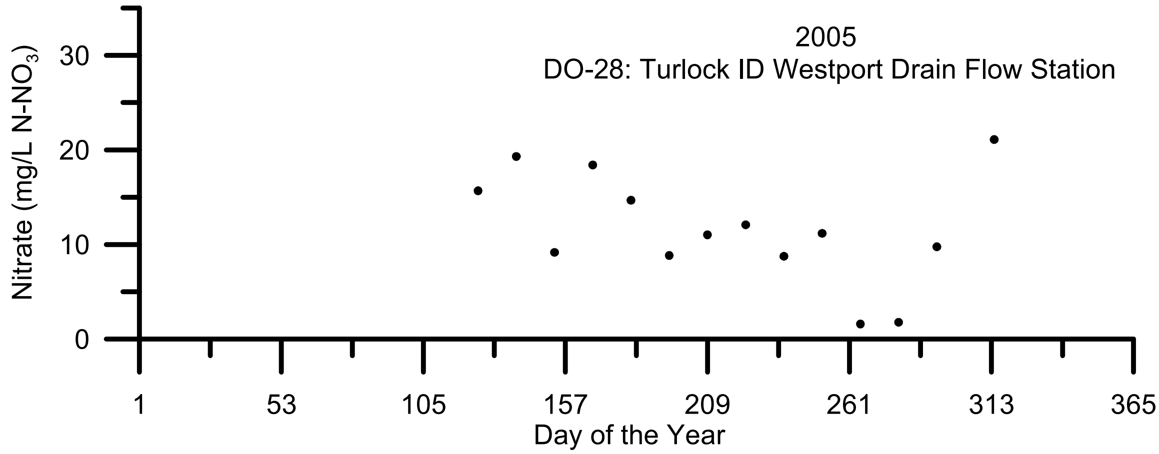

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO$_3$)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

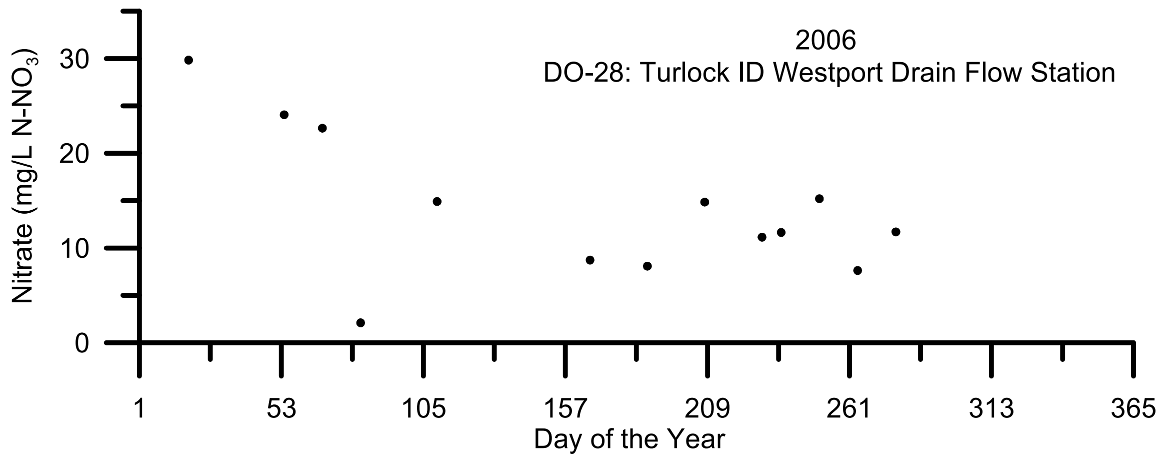

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

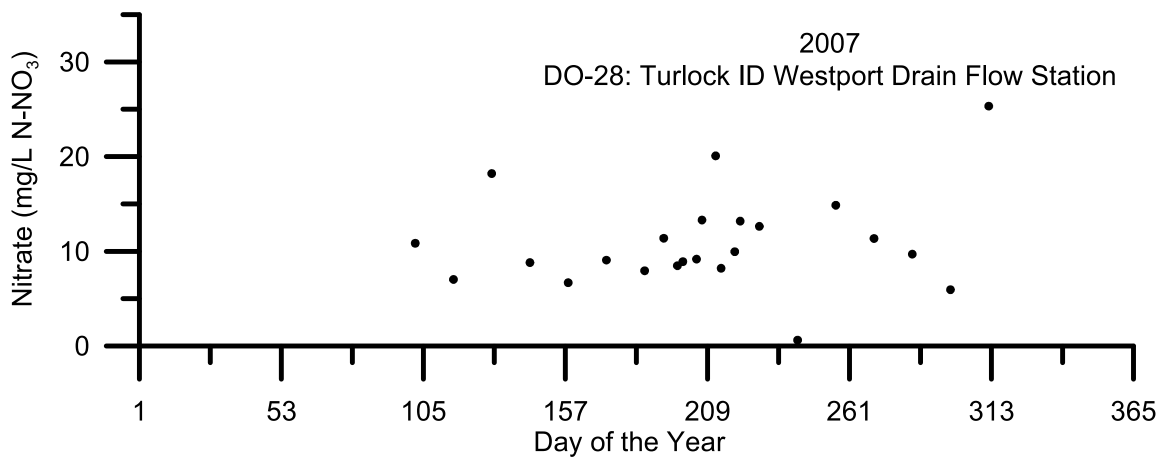

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

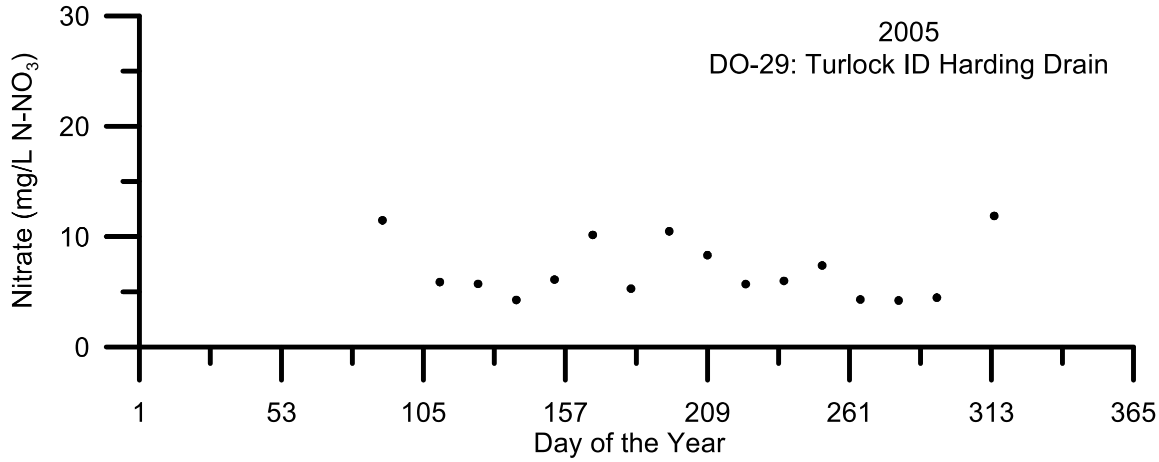

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

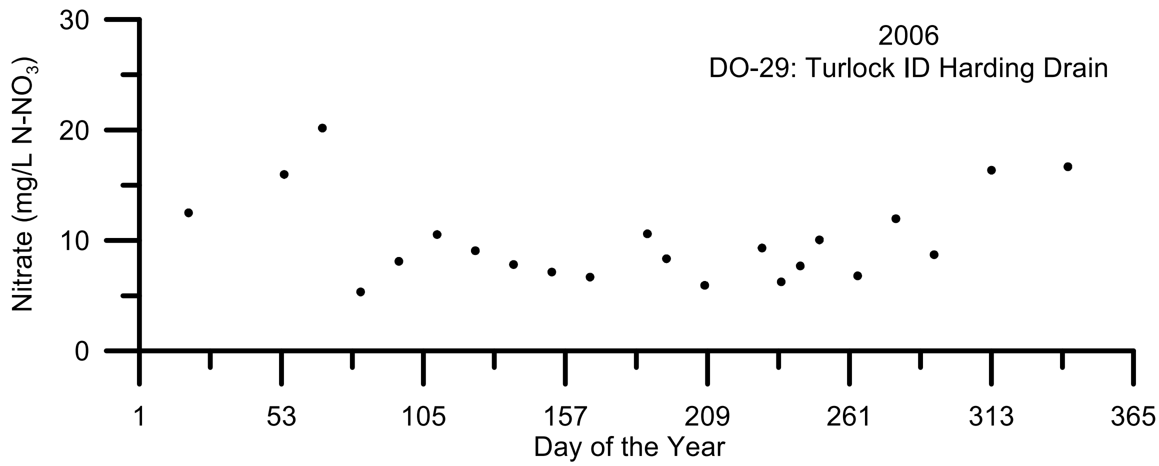

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

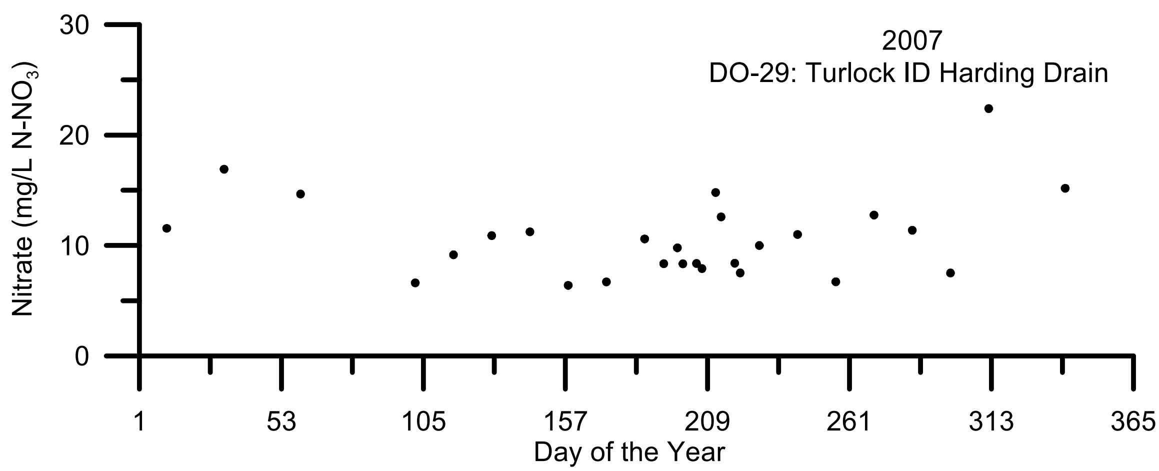

2005
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO_3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

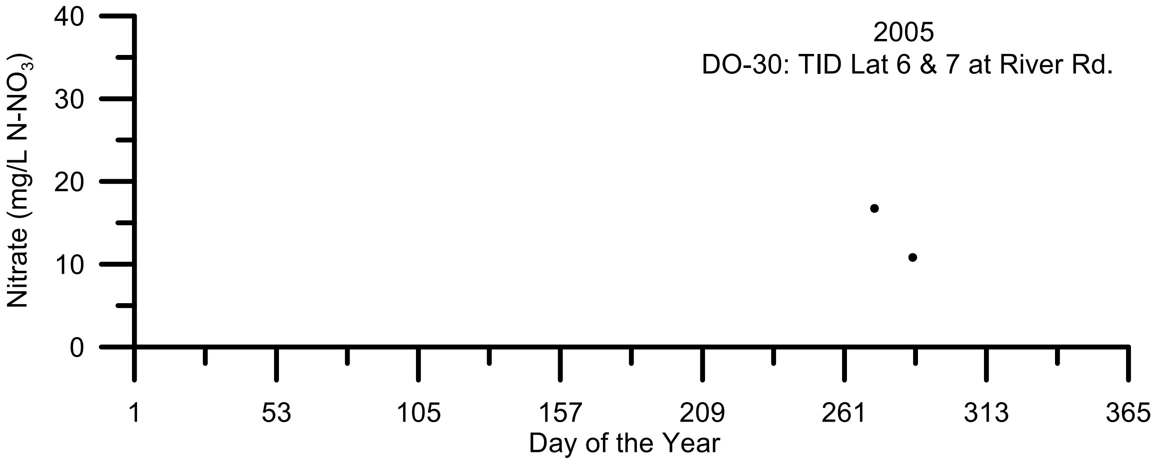

2006
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO_3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

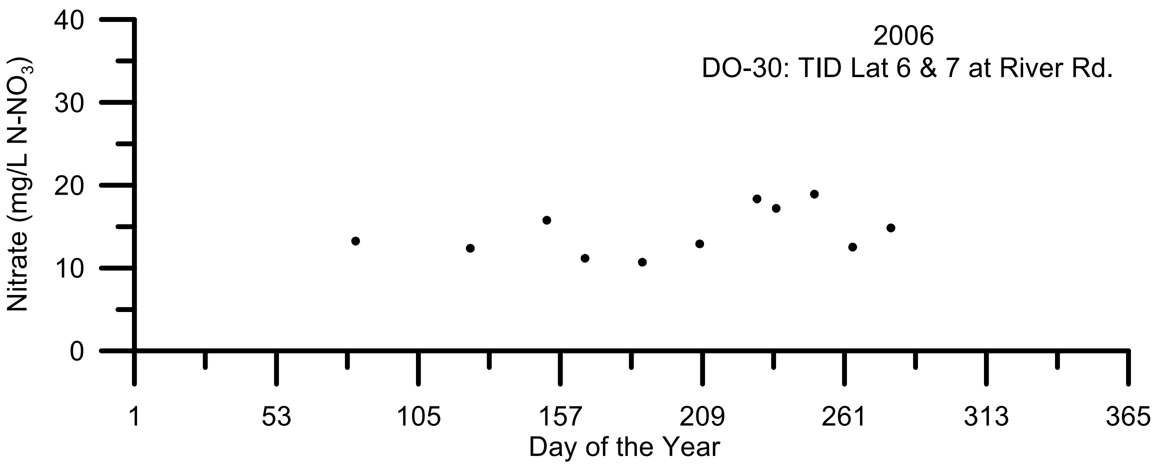

2007
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO_3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

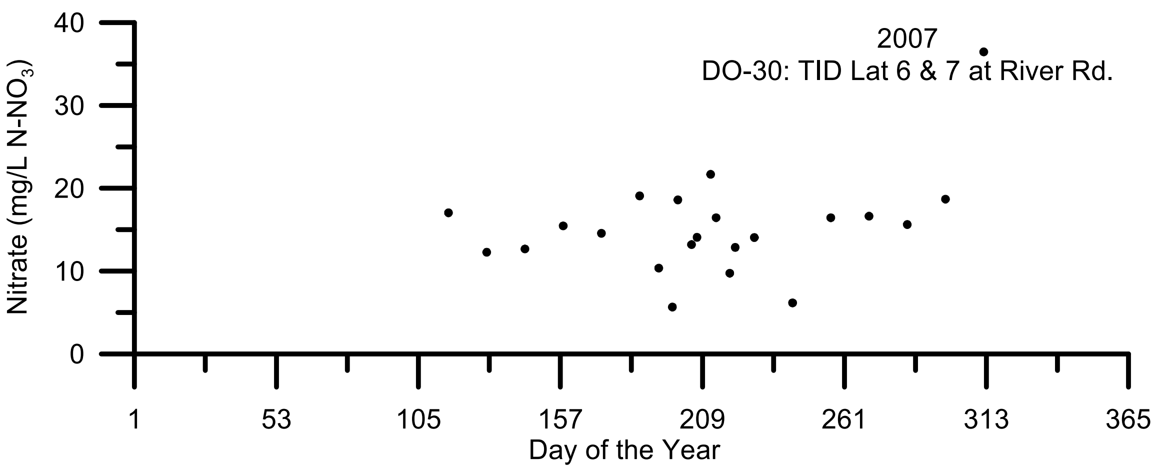

2005
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

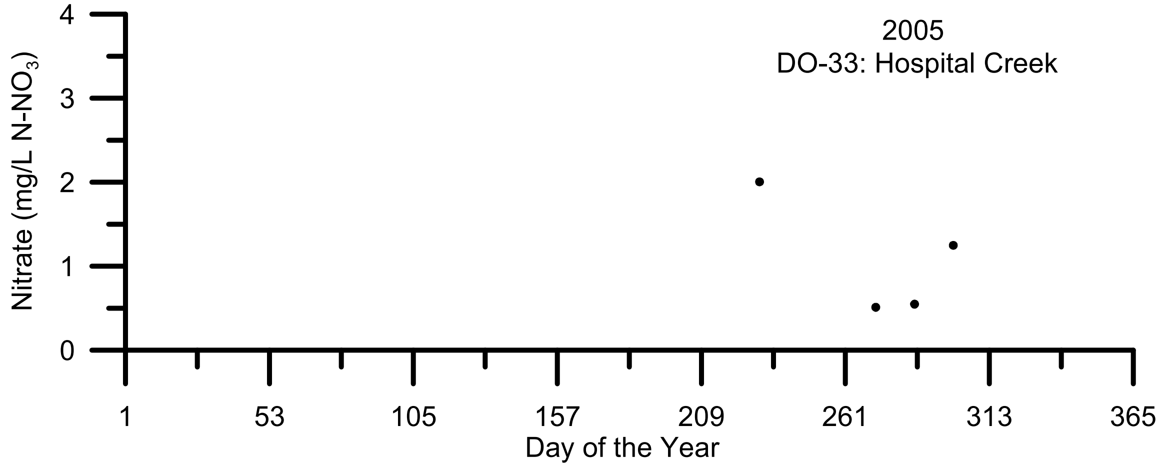

2006
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

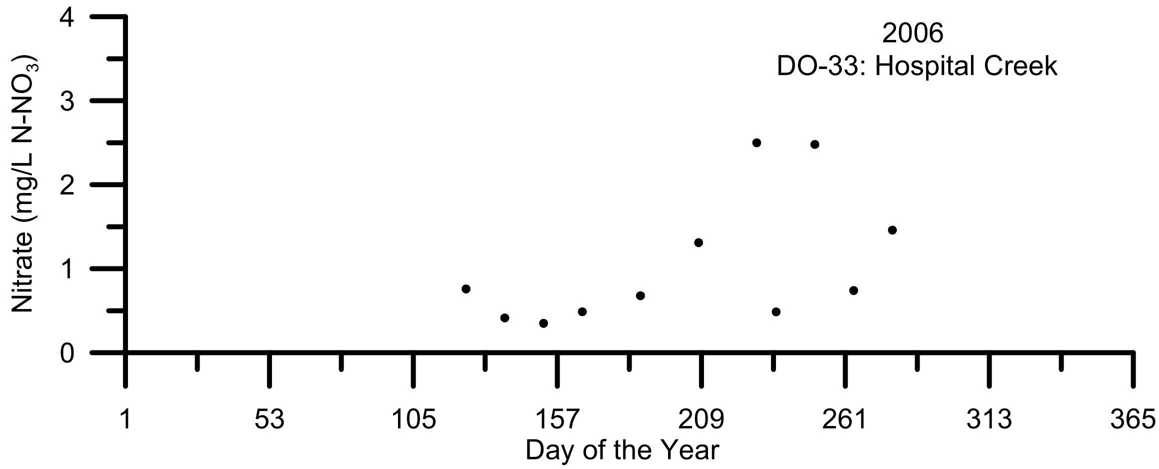

2007
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

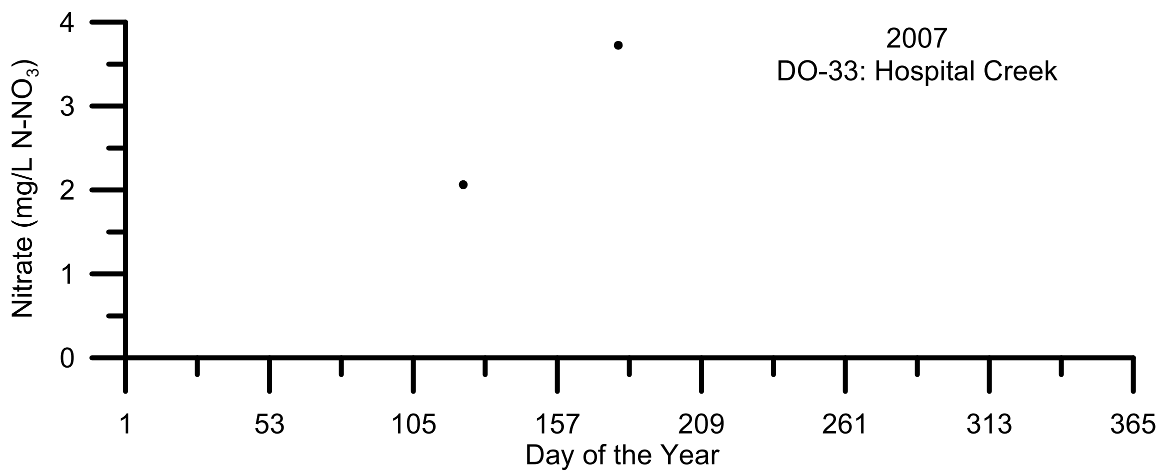

2005
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO$_3$)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

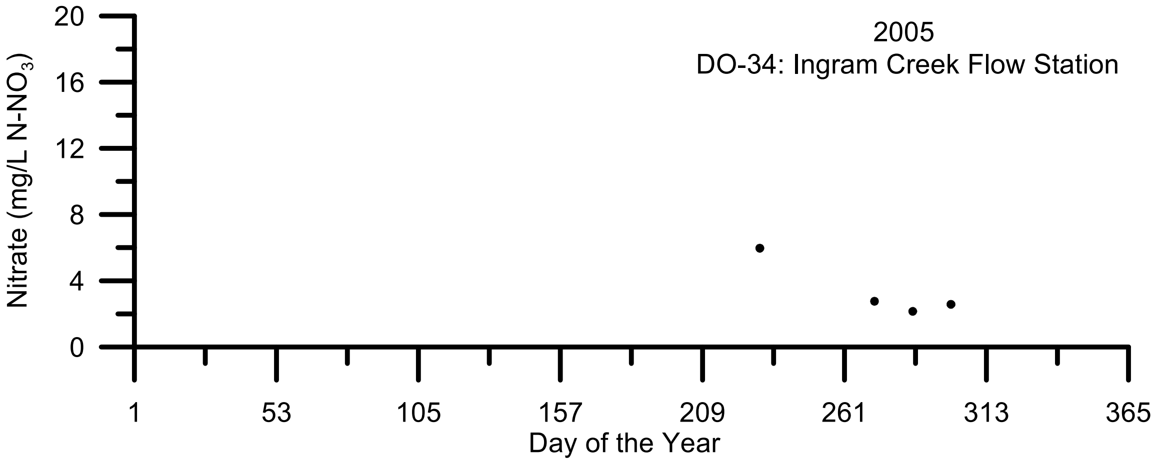

2006
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO$_3$)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

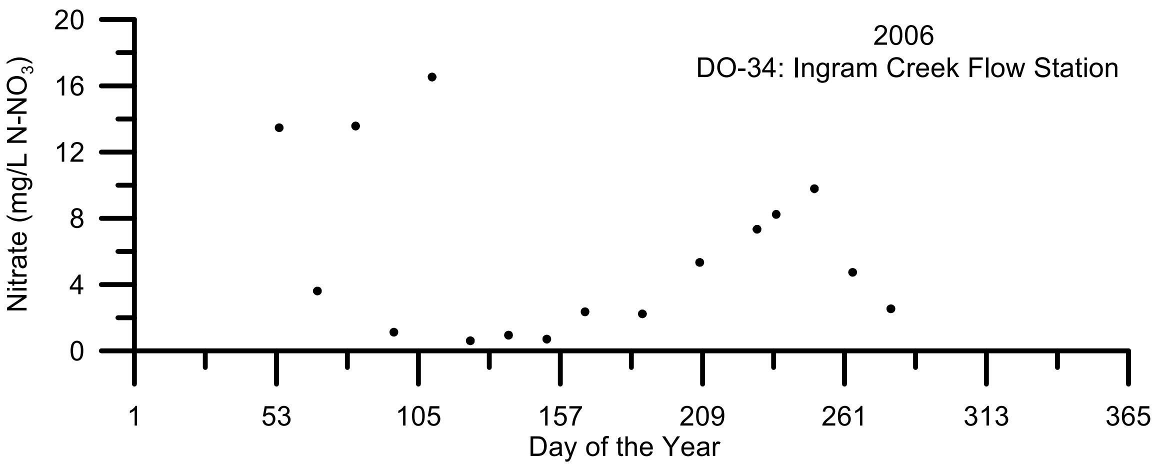

2007
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO$_3$)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

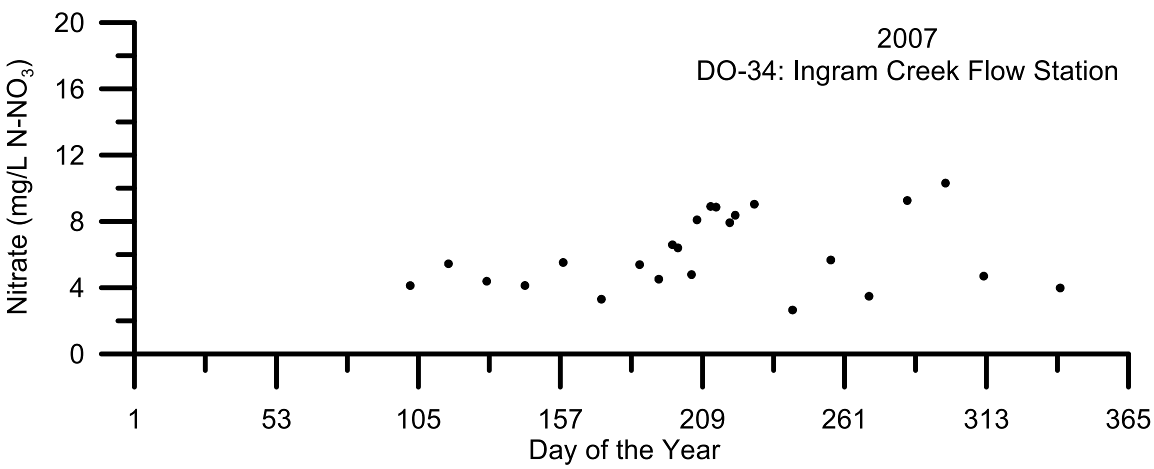

2005
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

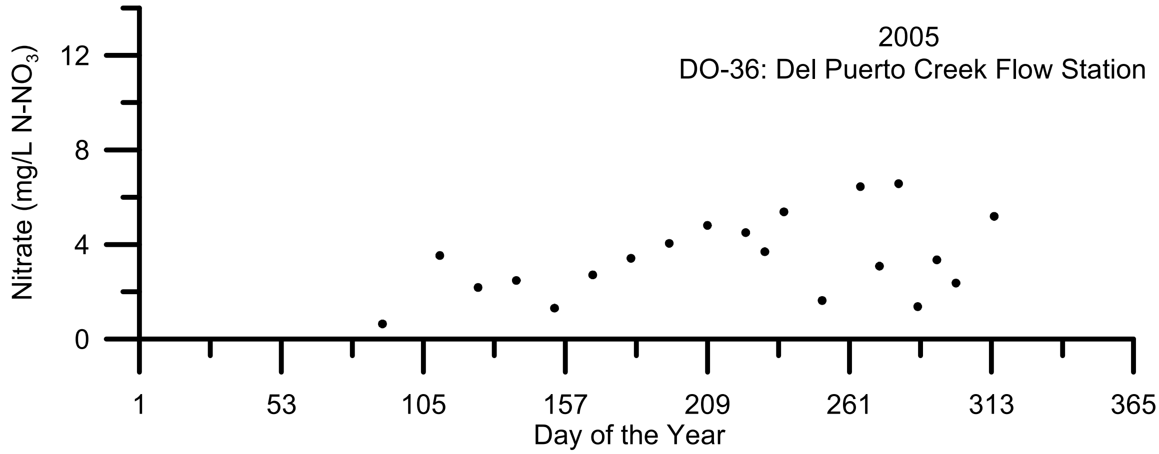

2006
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

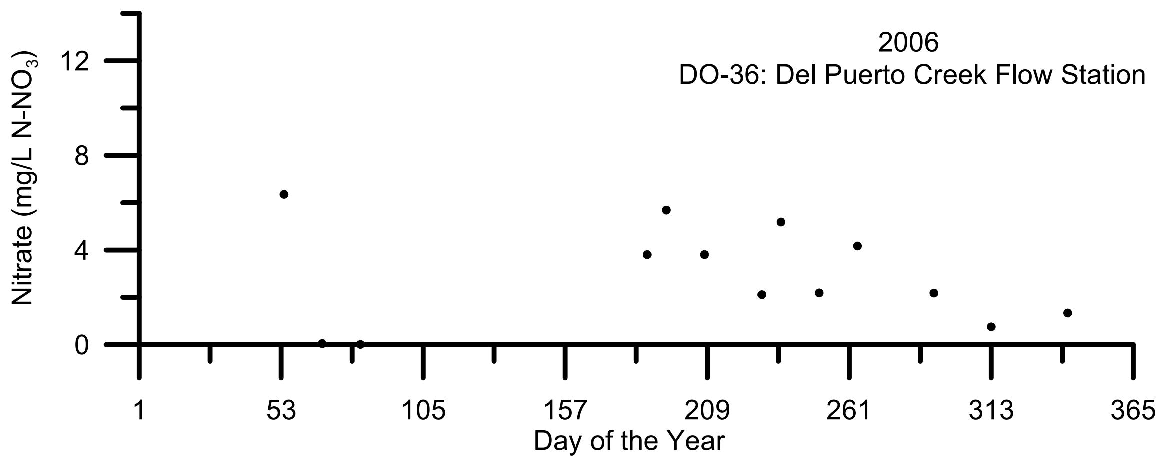

2007
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

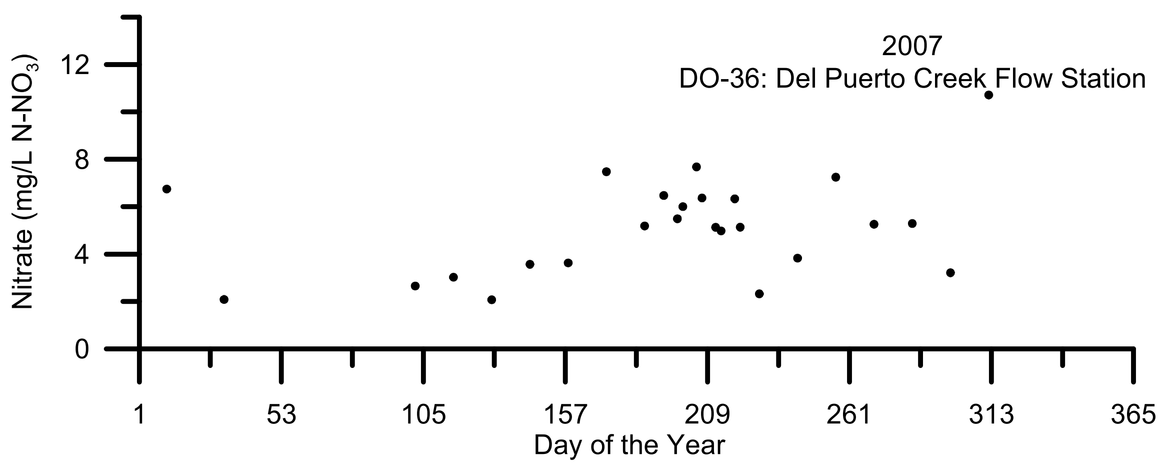

2005
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

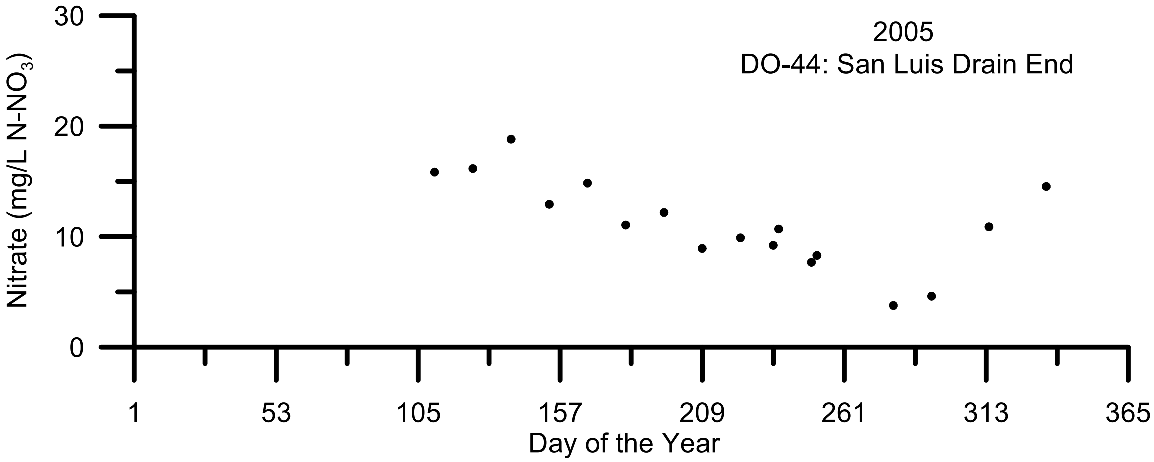

2006
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

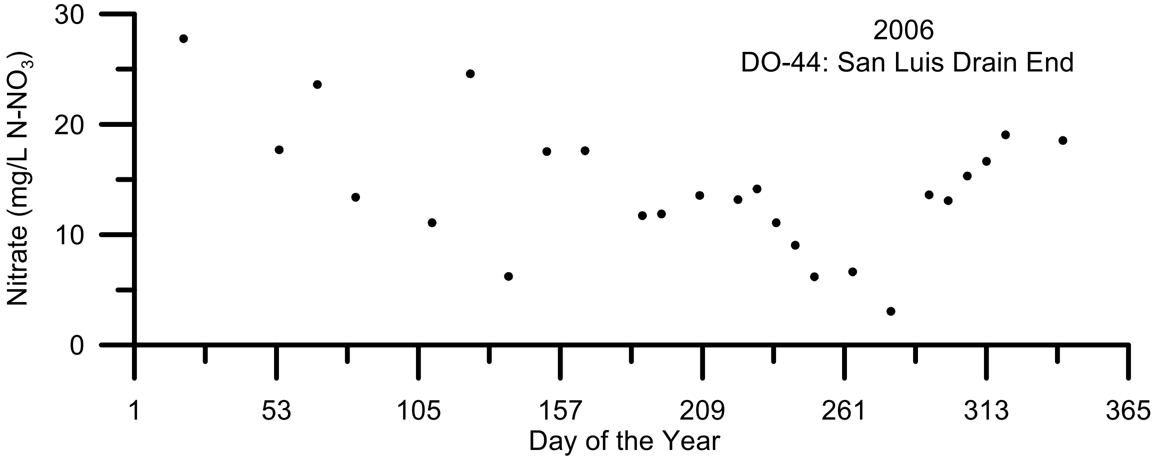

2007
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

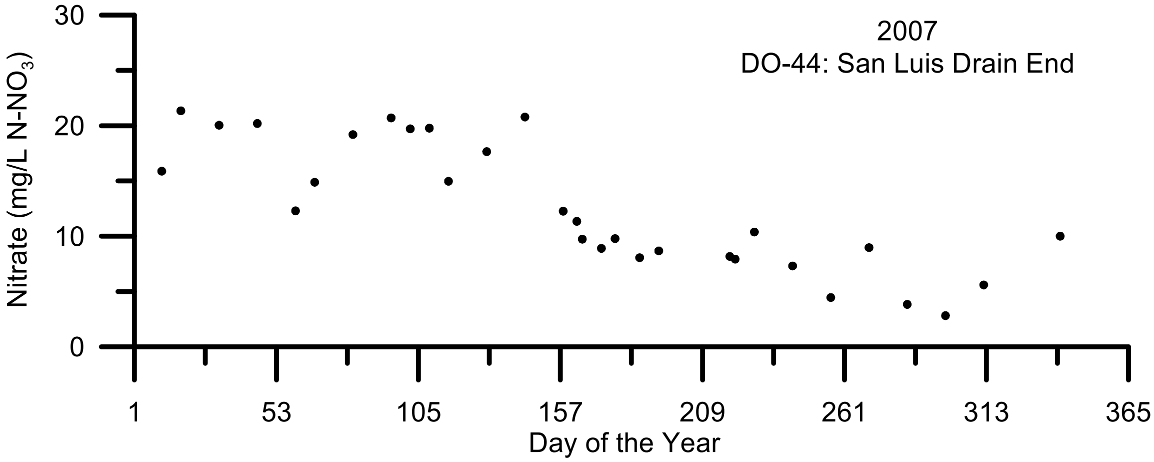

2005
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO$_3$)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

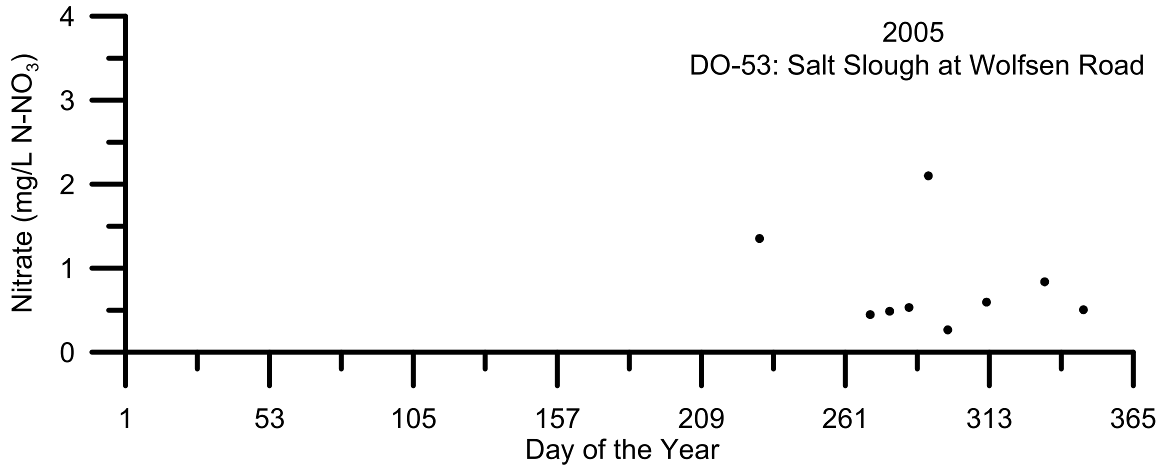

2006
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO$_3$)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO$_3$)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

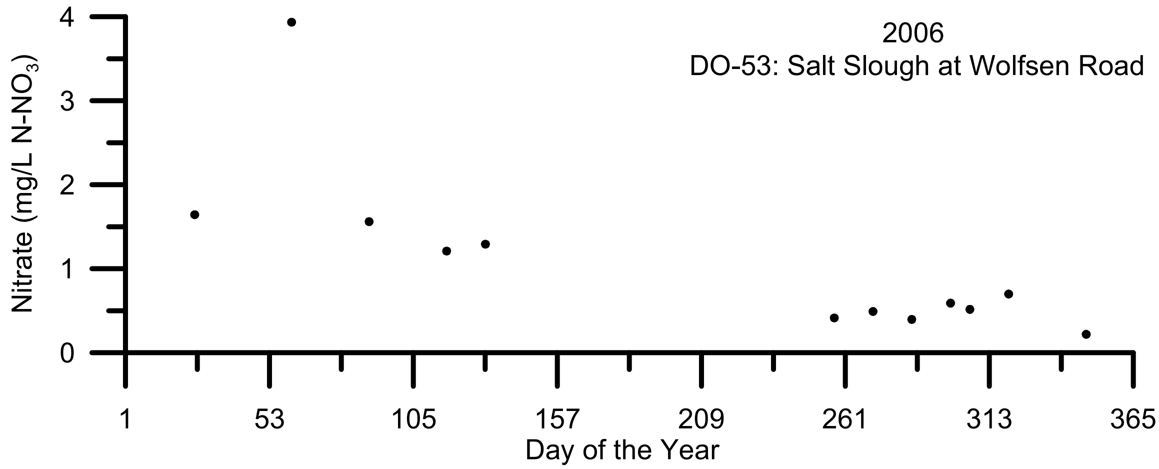

2005
DO-44: San Luis Drain End
Nitrate (mg/L N-NO$_3$)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-44: San Luis Drain End
Nitrate (mg/L N-NO$_3$)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

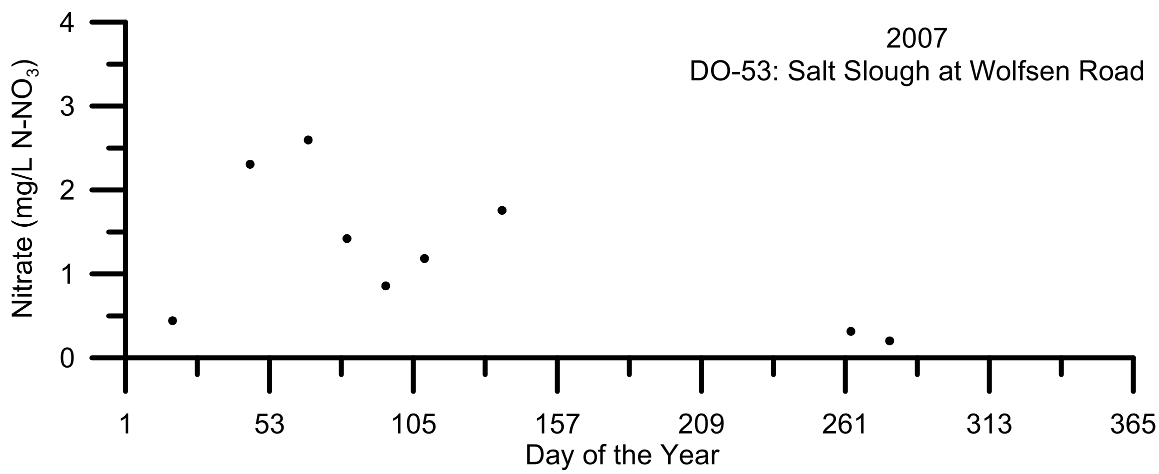

2007
DO-44: San Luis Drain End
Nitrate (mg/L N-NO$_3$)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year



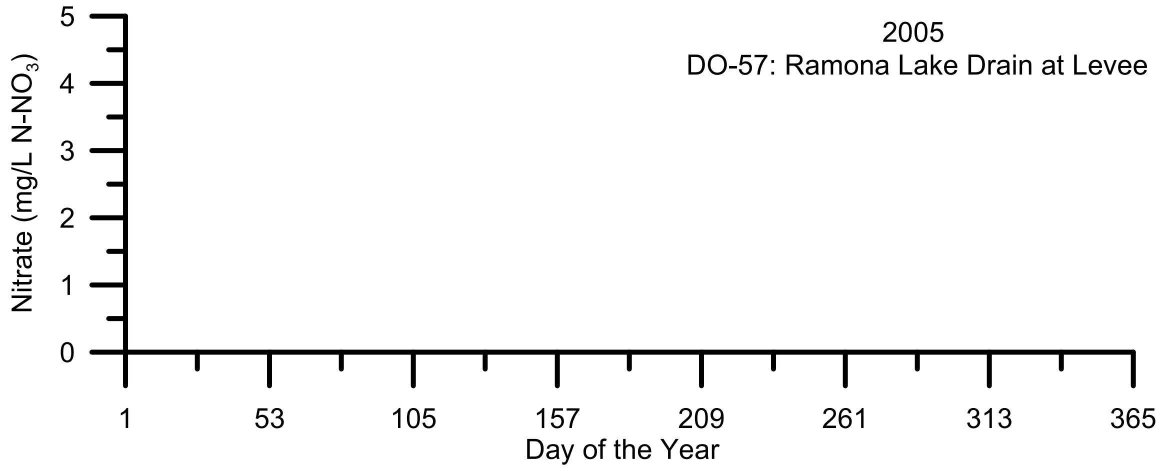
2005
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

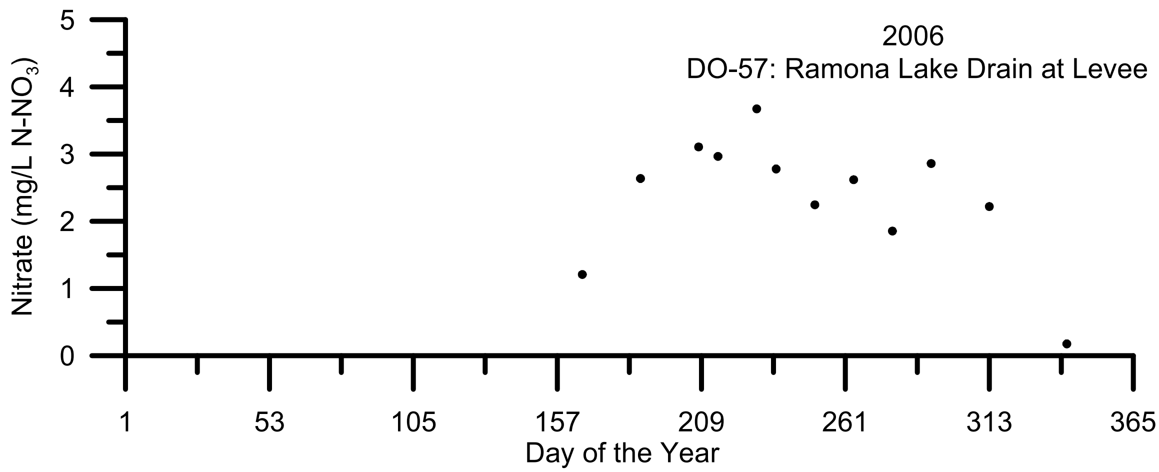


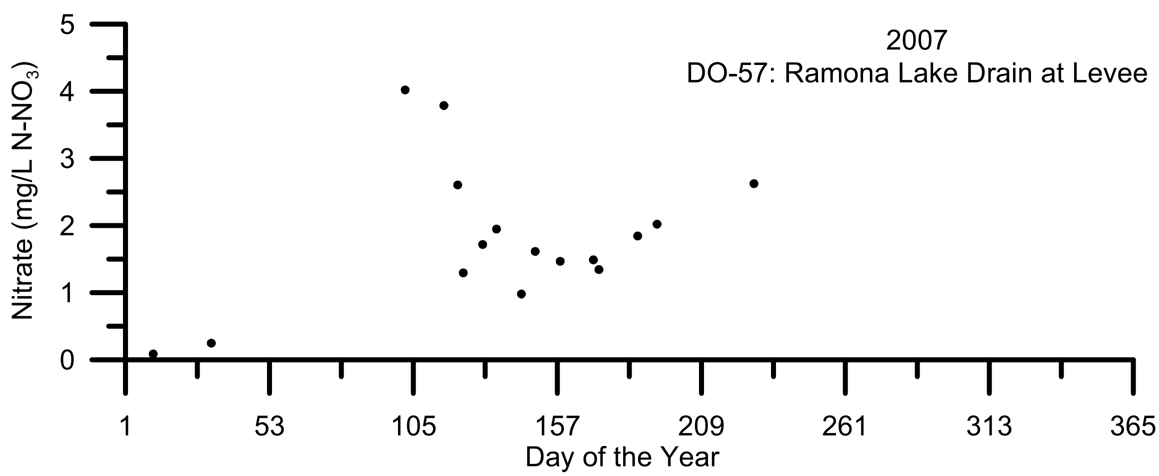
2006
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

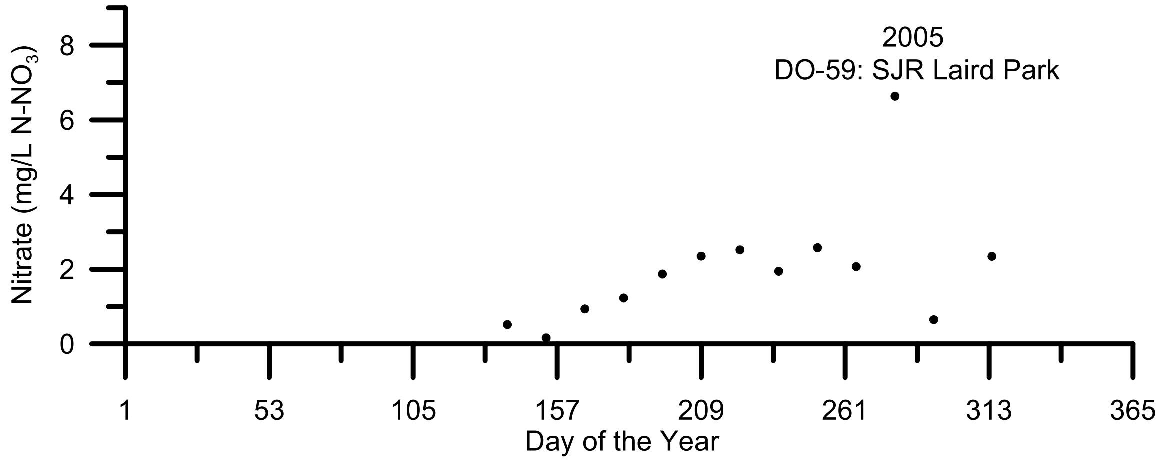


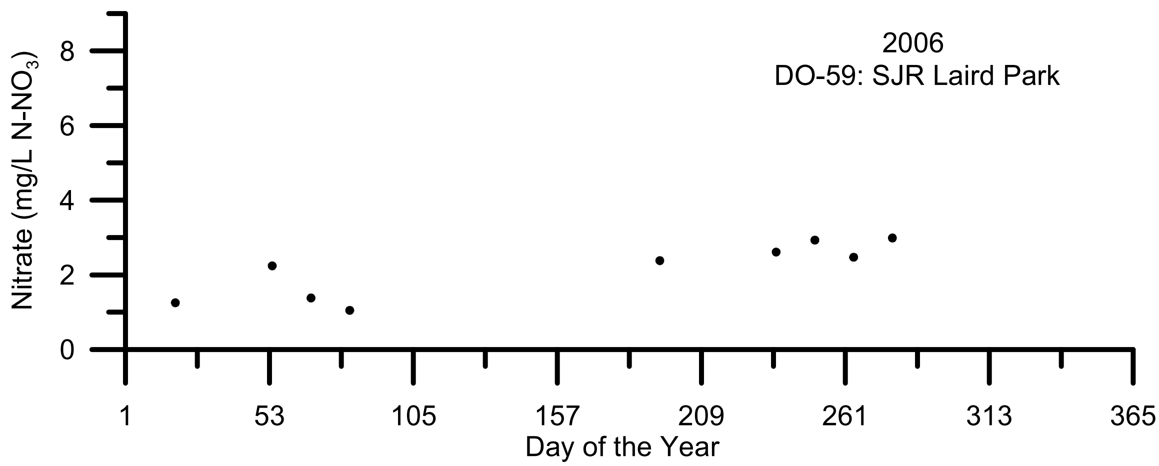
2007
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

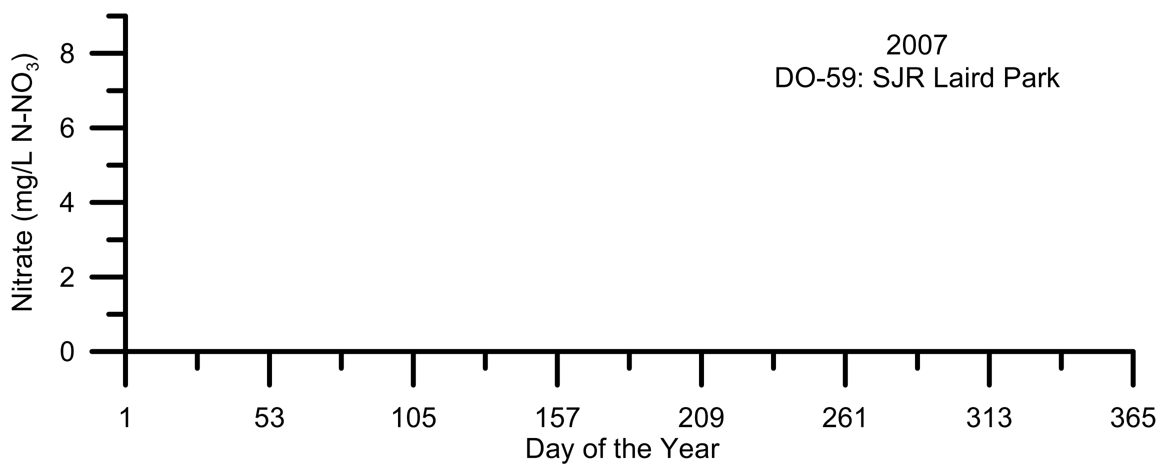

2005
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

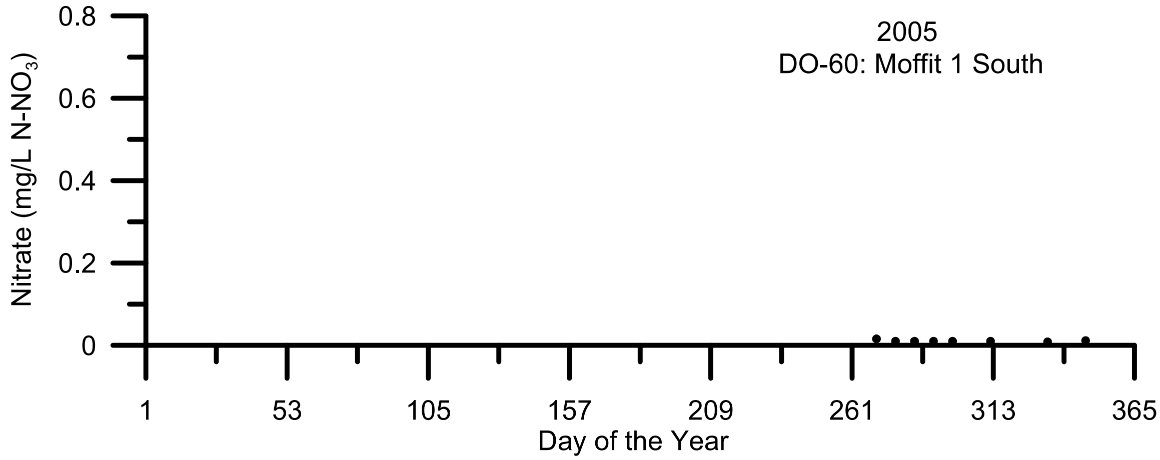

2006
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

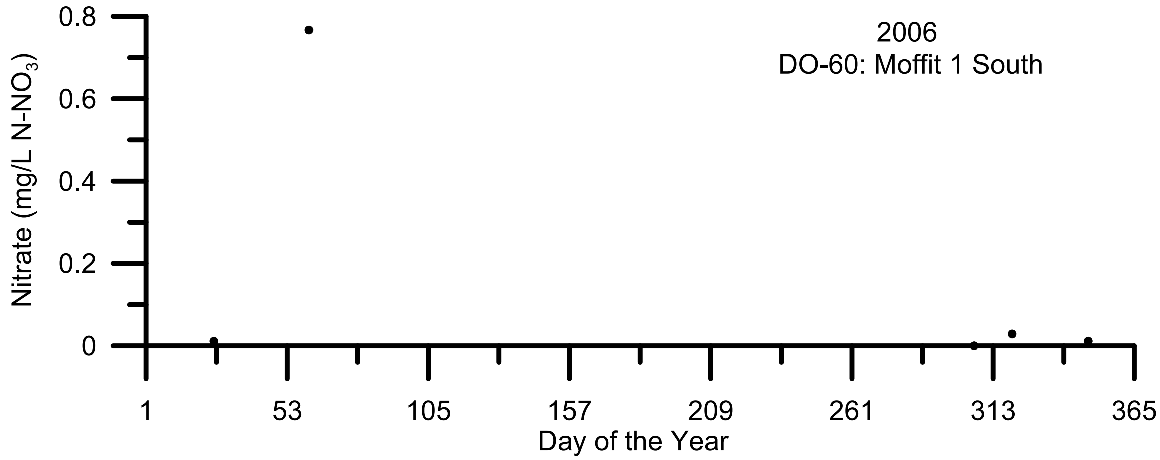

2007
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

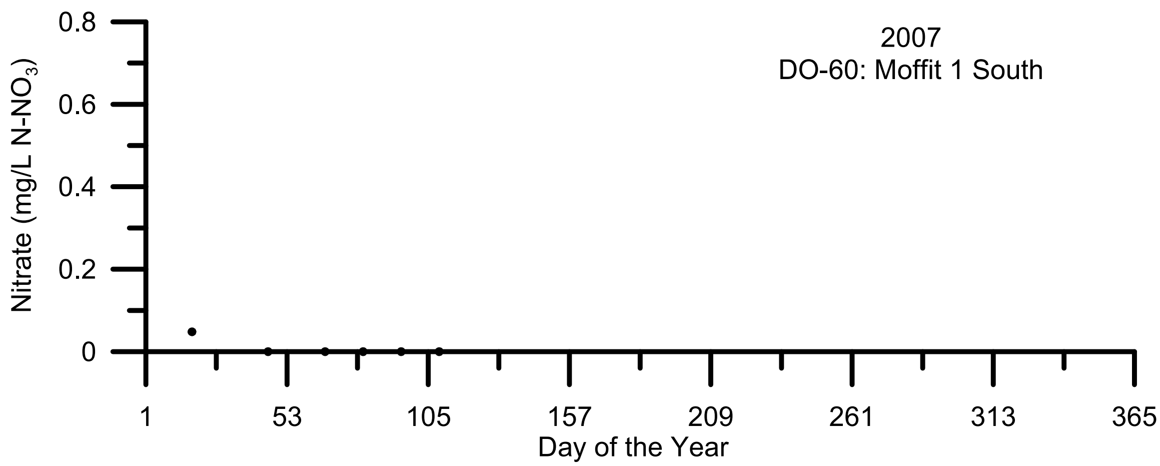

2005
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

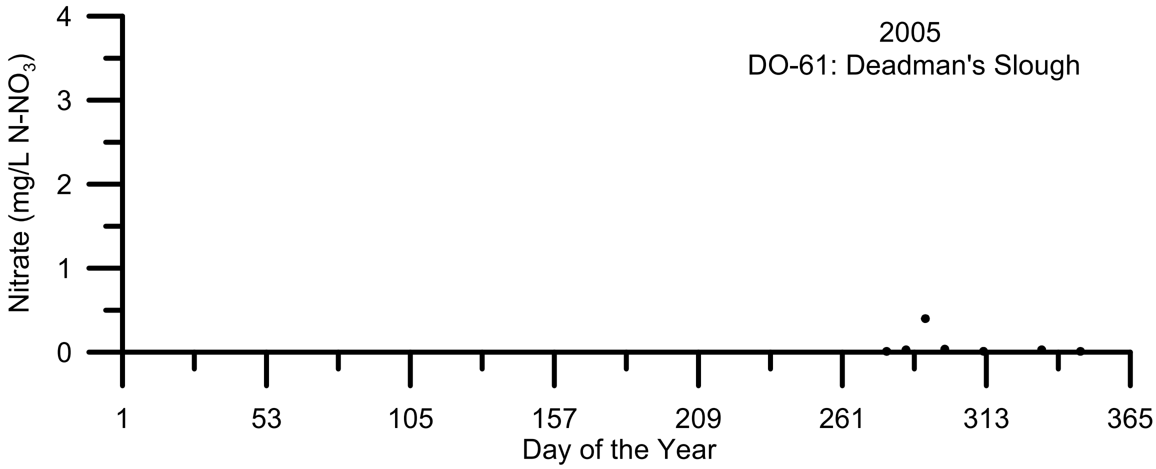

2006
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

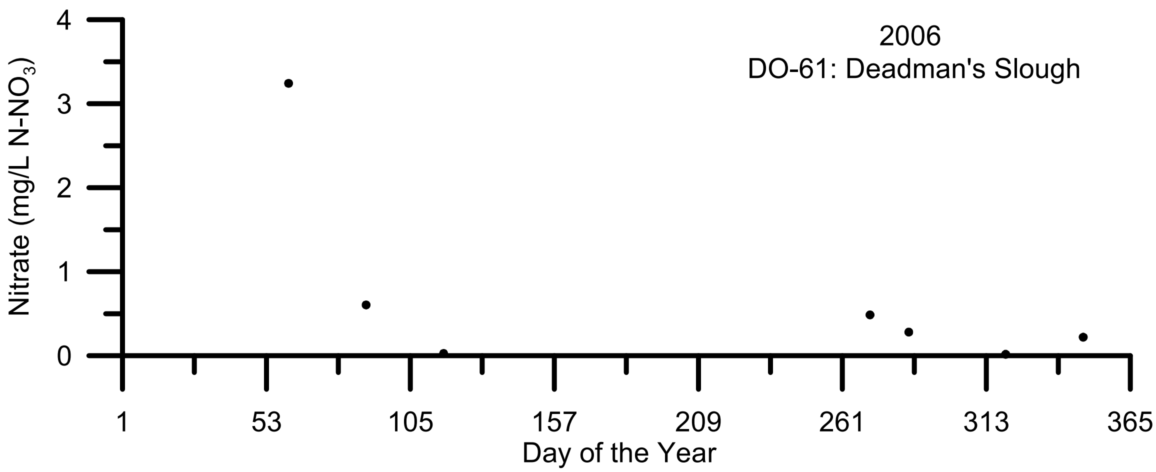

2007
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

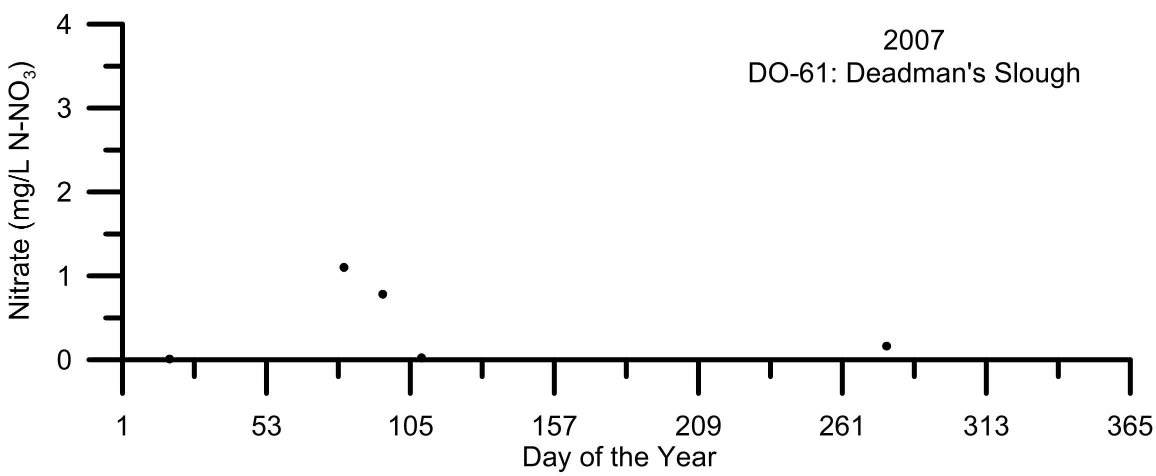

2005
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

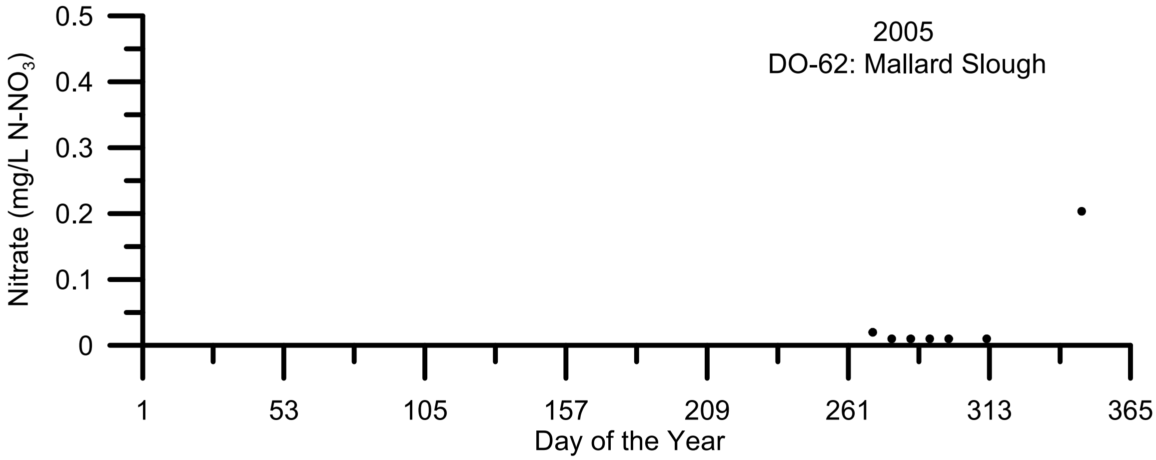

2006
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

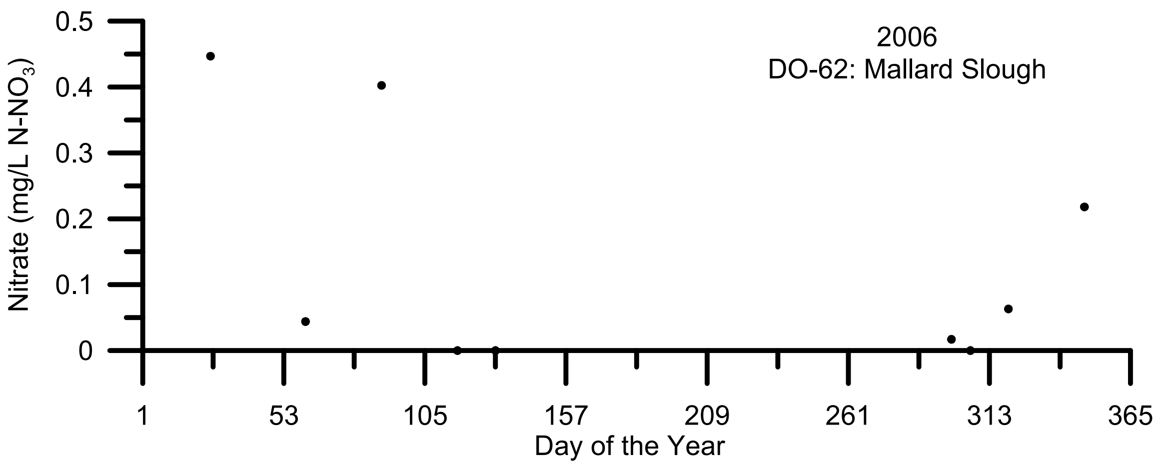

2007
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

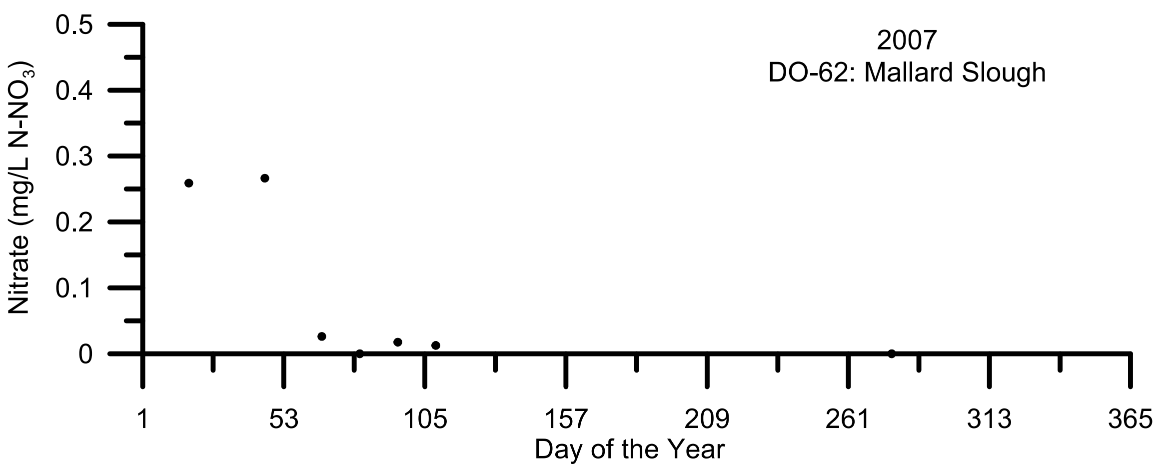

2005
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

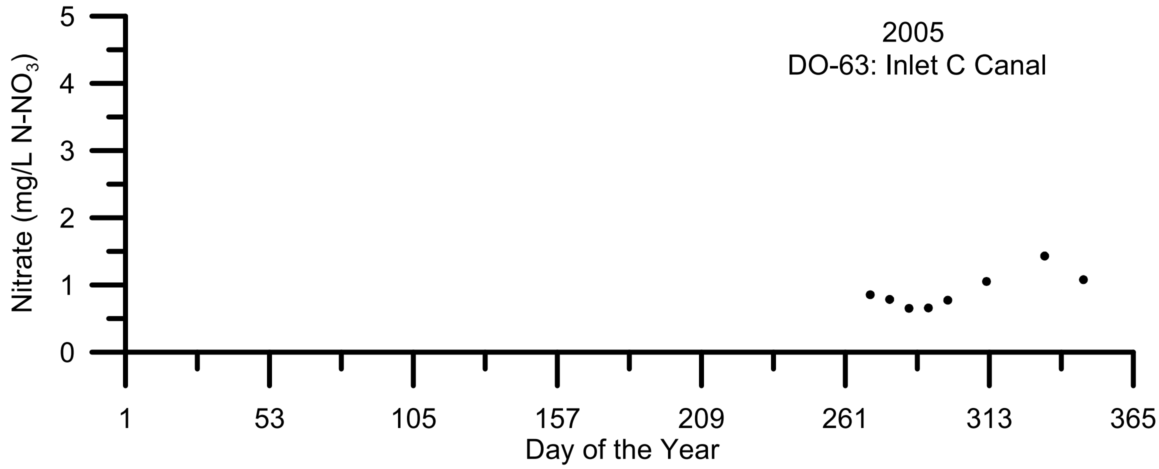

2006
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

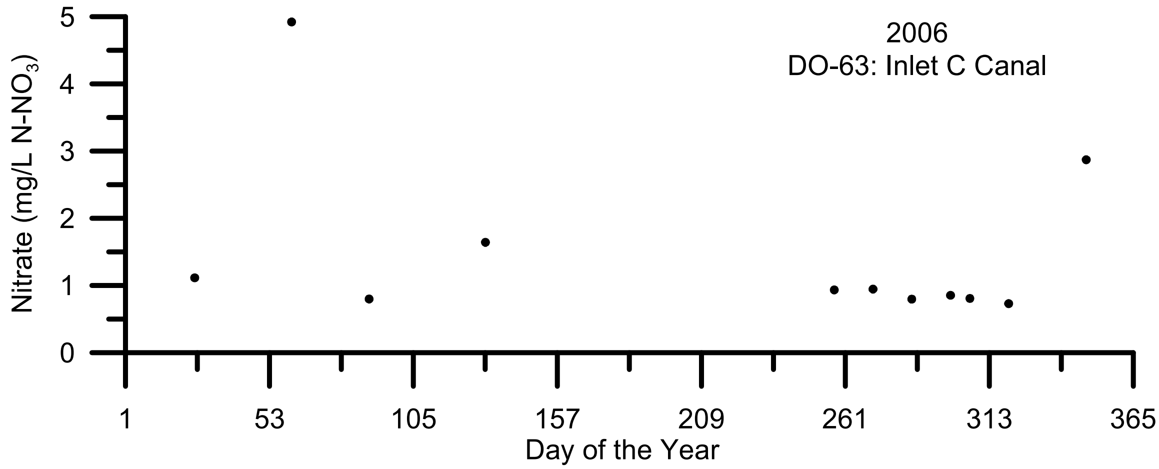

2007
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

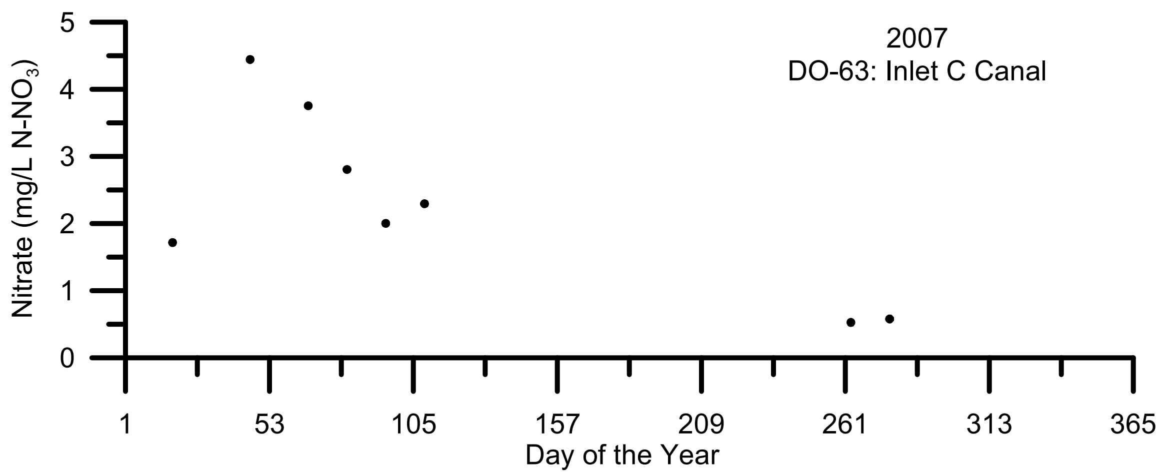

2005
DO-62: Mallard Slough
Nitrate (mg/L N-NO3)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

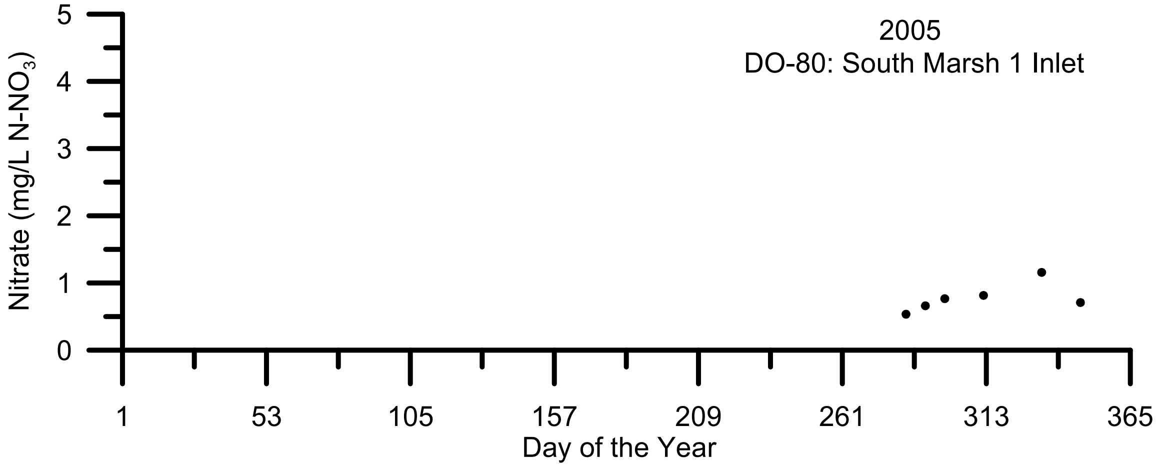

2006
DO-62: Mallard Slough
Nitrate (mg/L N-NO3)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

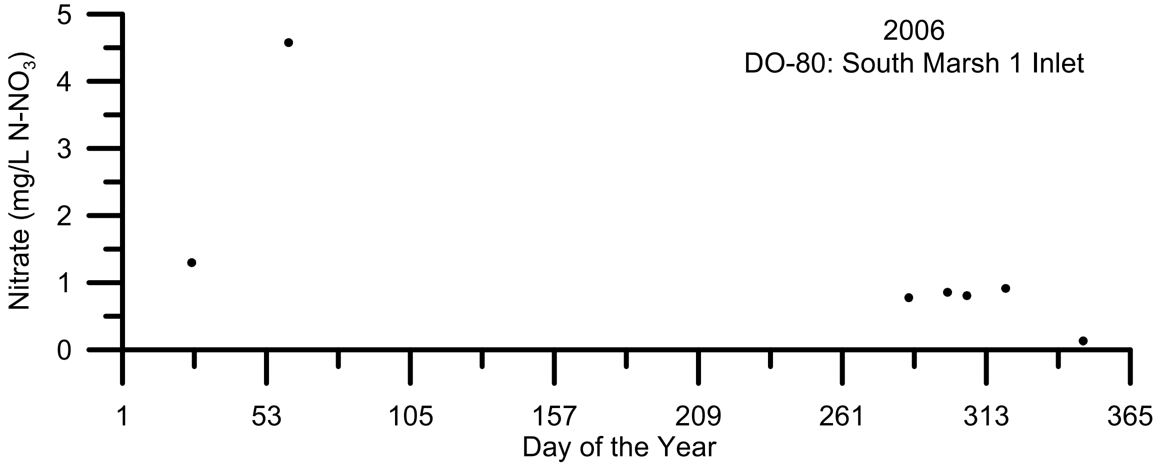

2007
DO-62: Mallard Slough
Nitrate (mg/L N-NO3)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

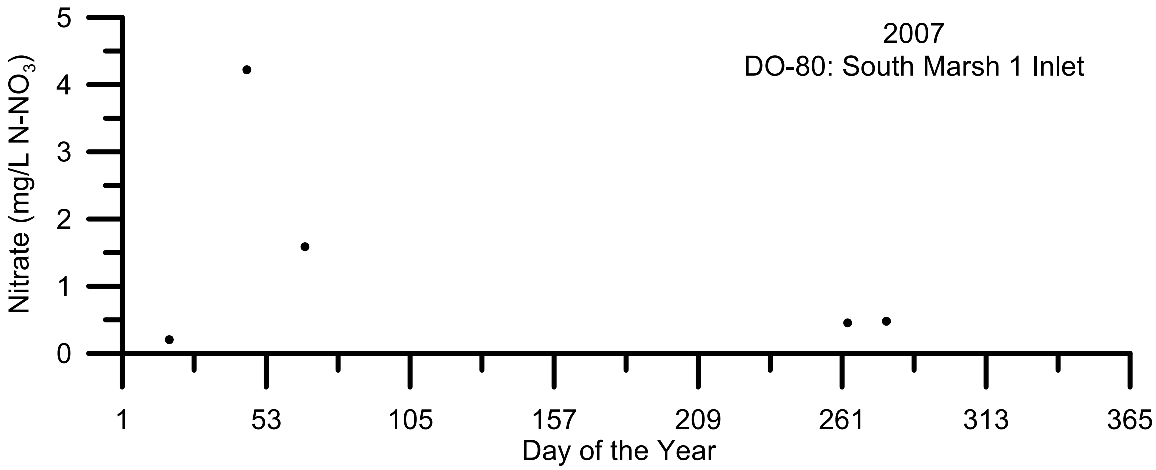

2005
DO-63: Inlet C Canal
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

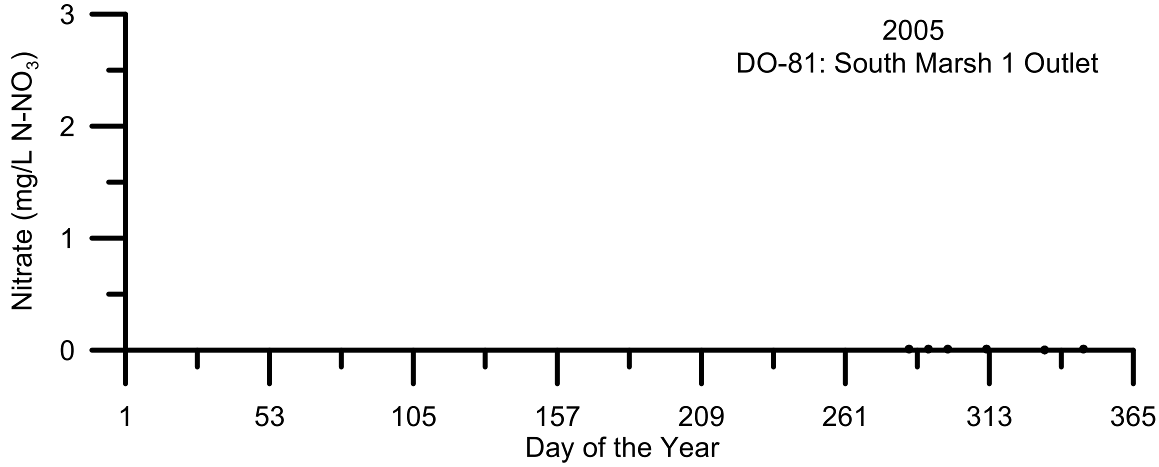

2006
DO-63: Inlet C Canal
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

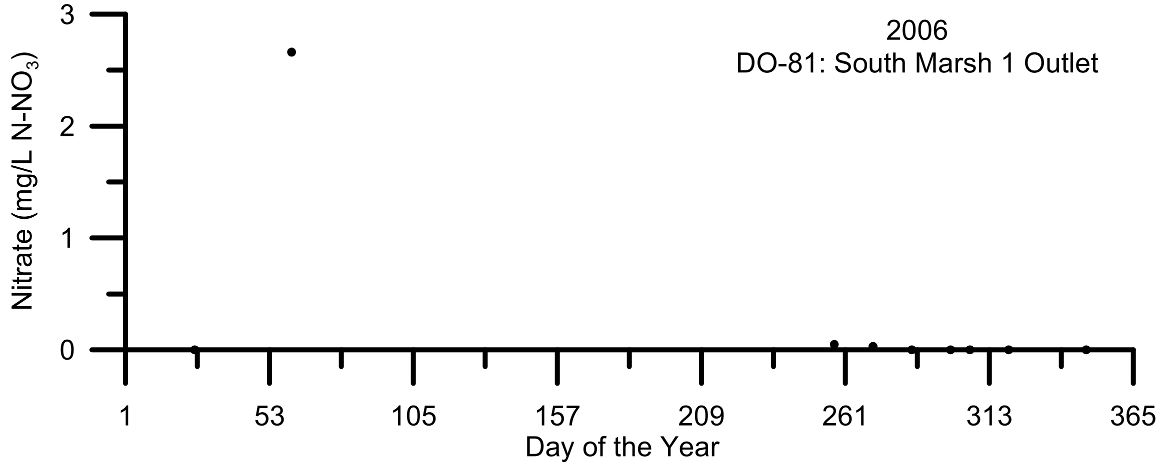

2007
DO-63: Inlet C Canal
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

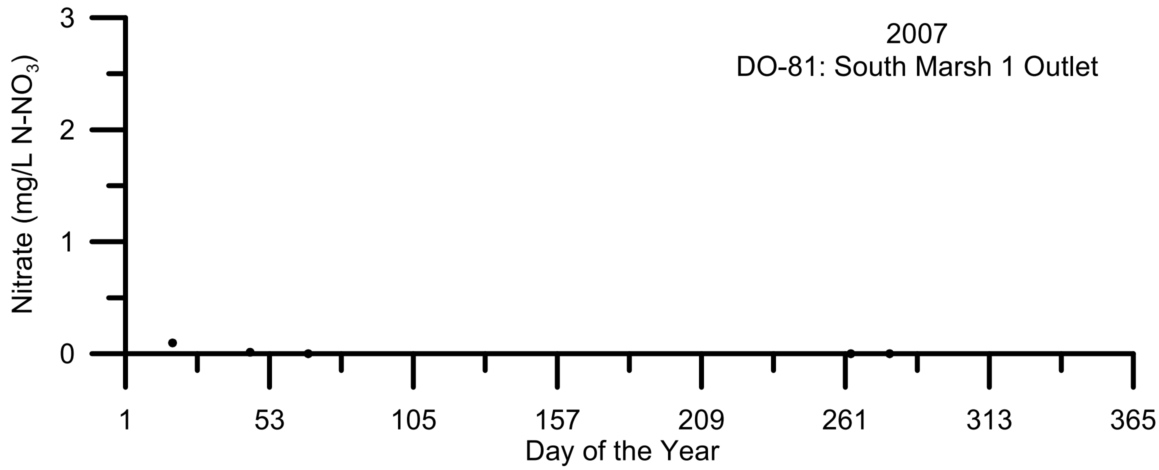

2005
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

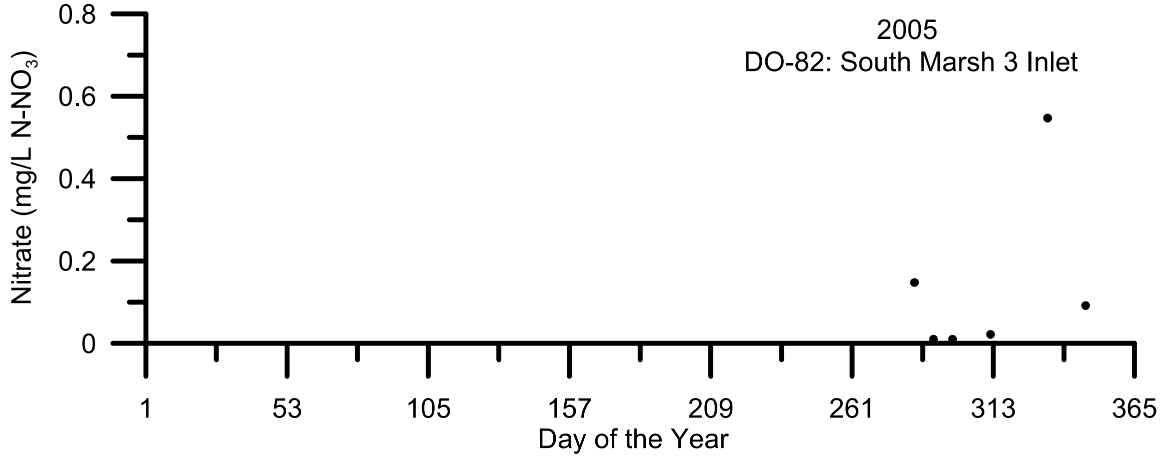

2006
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

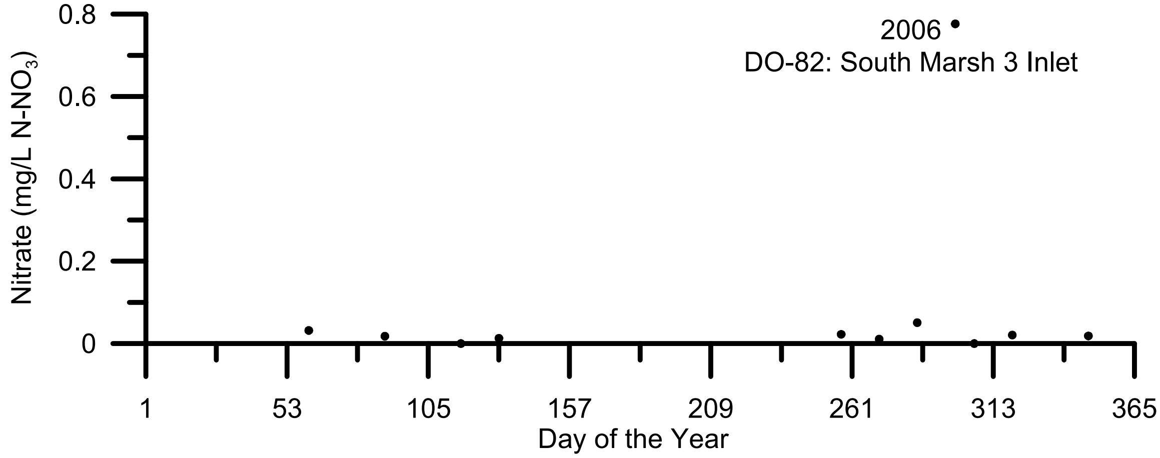

2007
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

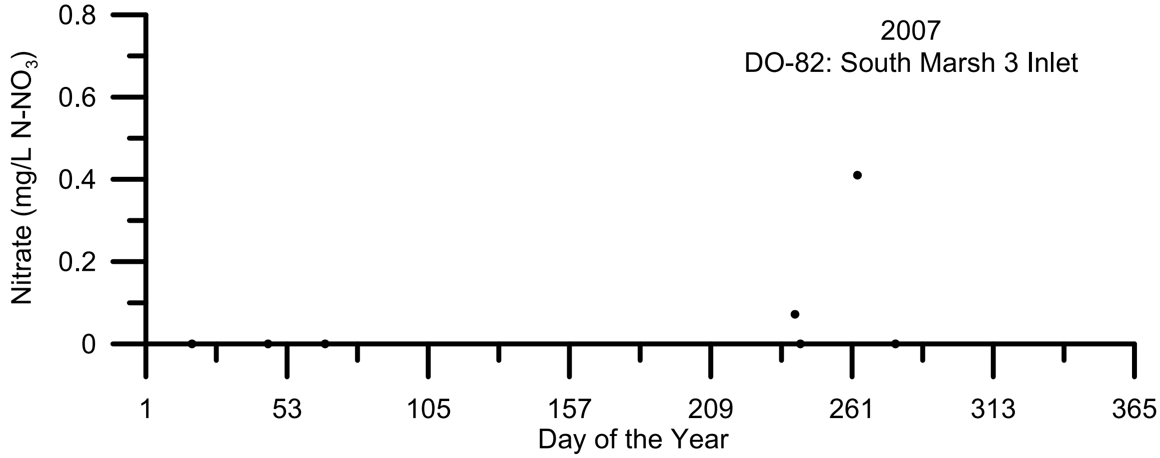

2005
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO_3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

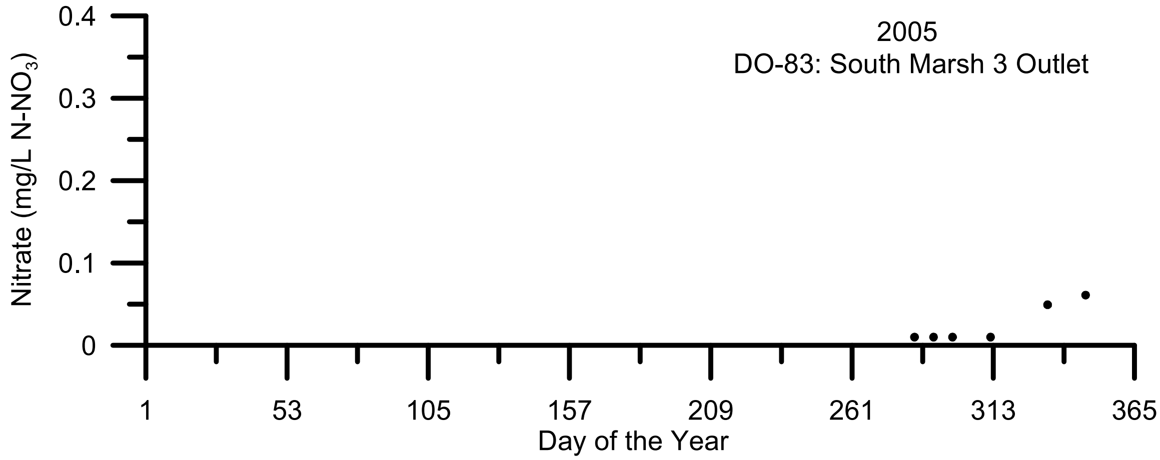

2006
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO_3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

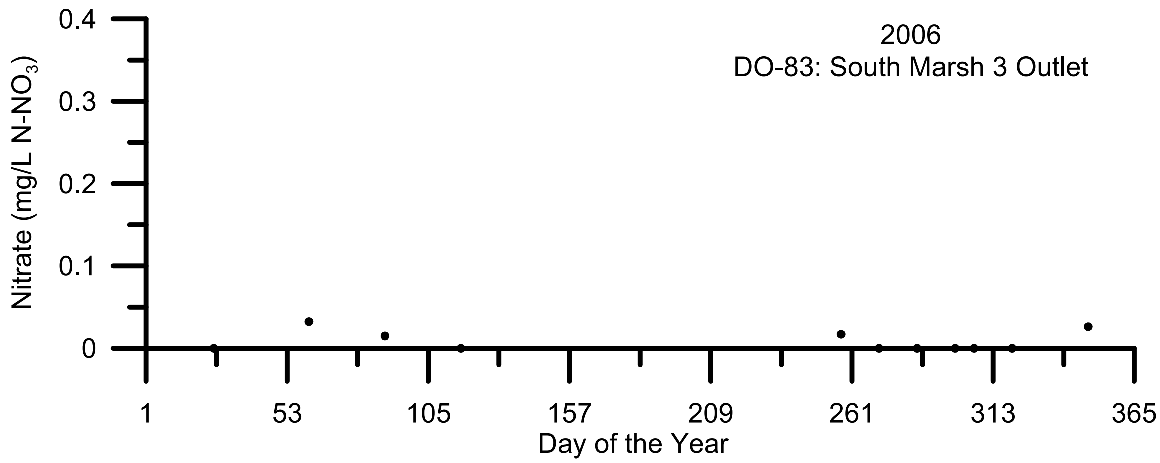

2007
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO_3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

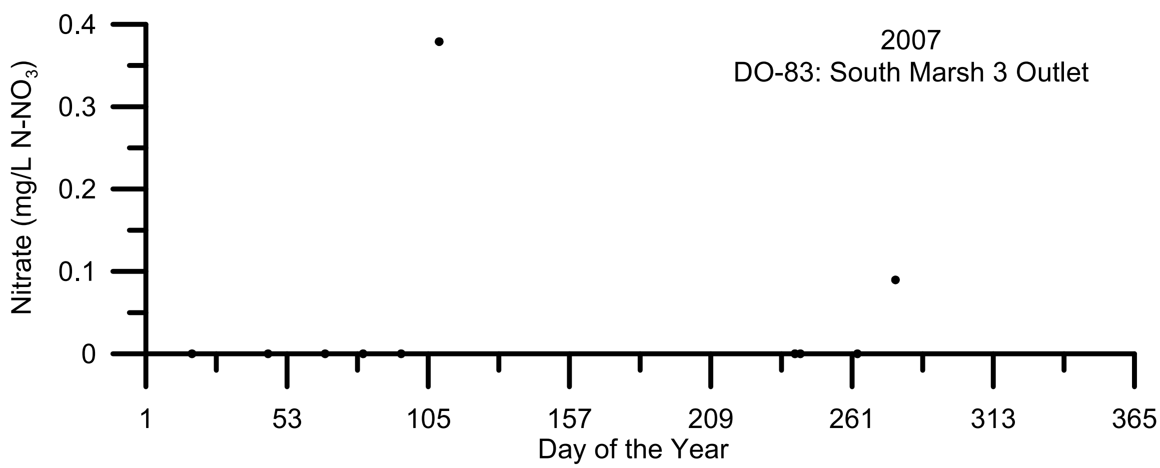

2005
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

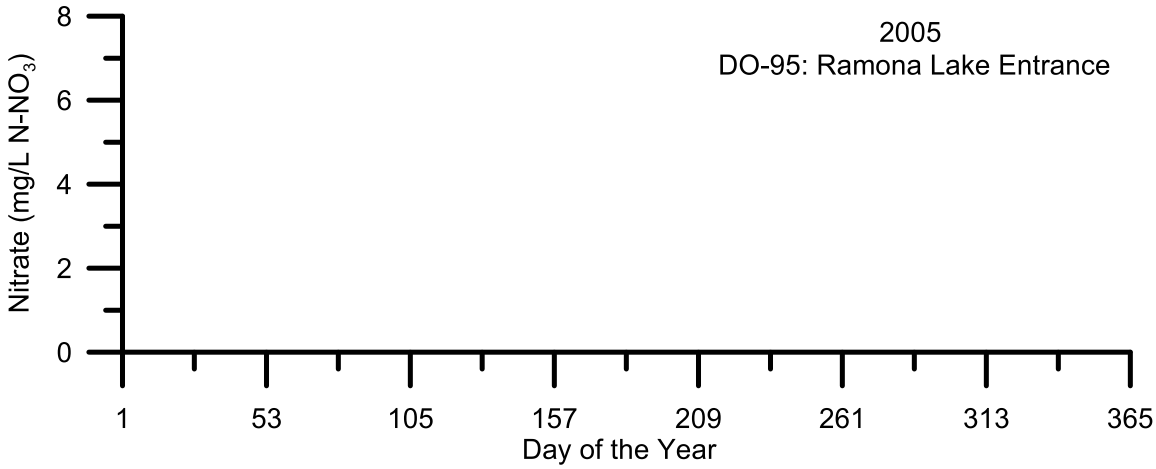

2006
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

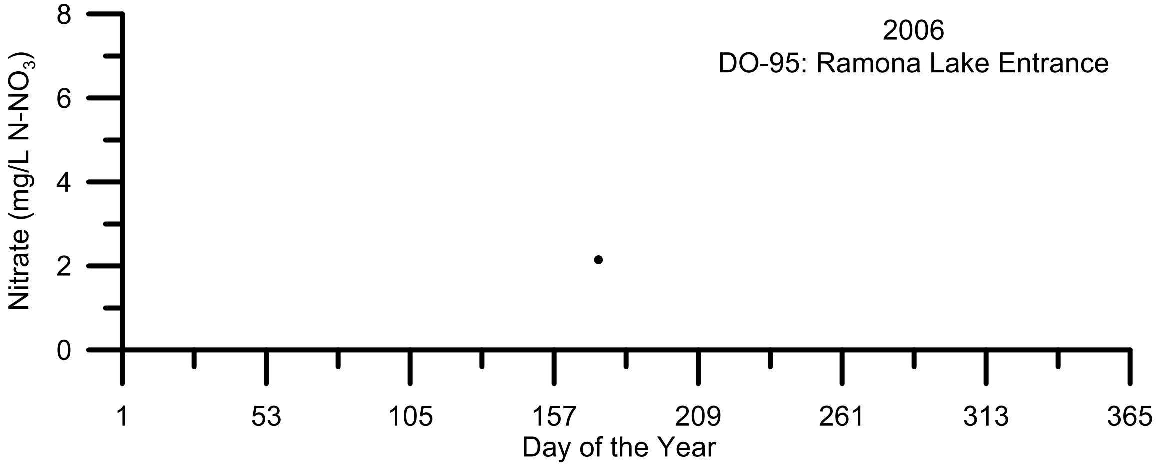

2007
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

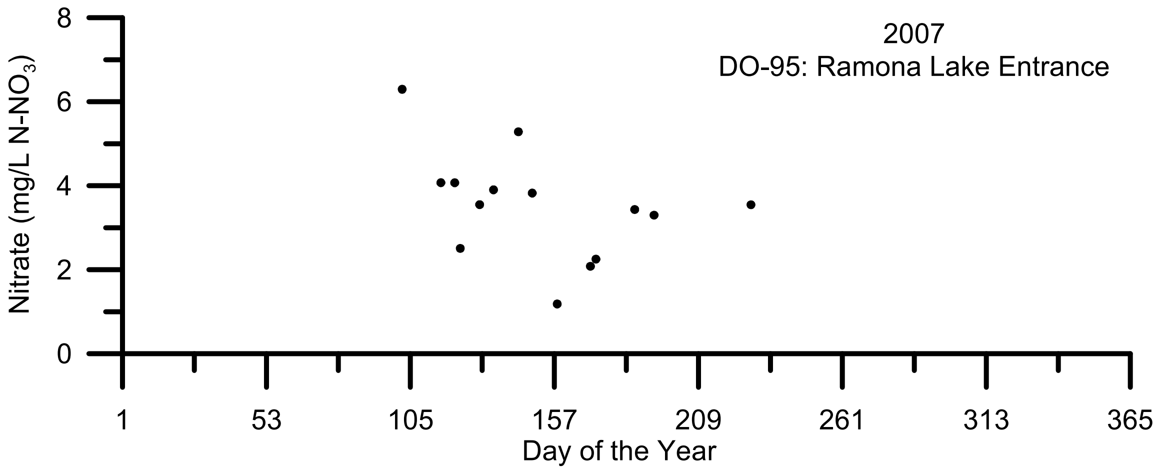

2005
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO$_3$)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO$_3$)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO$_3$)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Magnesium Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Stockton, CA 95211

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of magnesium (Mg) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at $4^{\circ}C$.

Ion chromatography was utilized for measuring Mg^{2+} using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (ASTM D6919-03). The reportable limit for this method is 0.08 mg/L Mg^{2+} .

Results/Discussion

Samples were measured ranging from 0.0-957.3 mg/L Mg. The average concentration of Mg in samples collected was 29.7 mg/L Mg. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

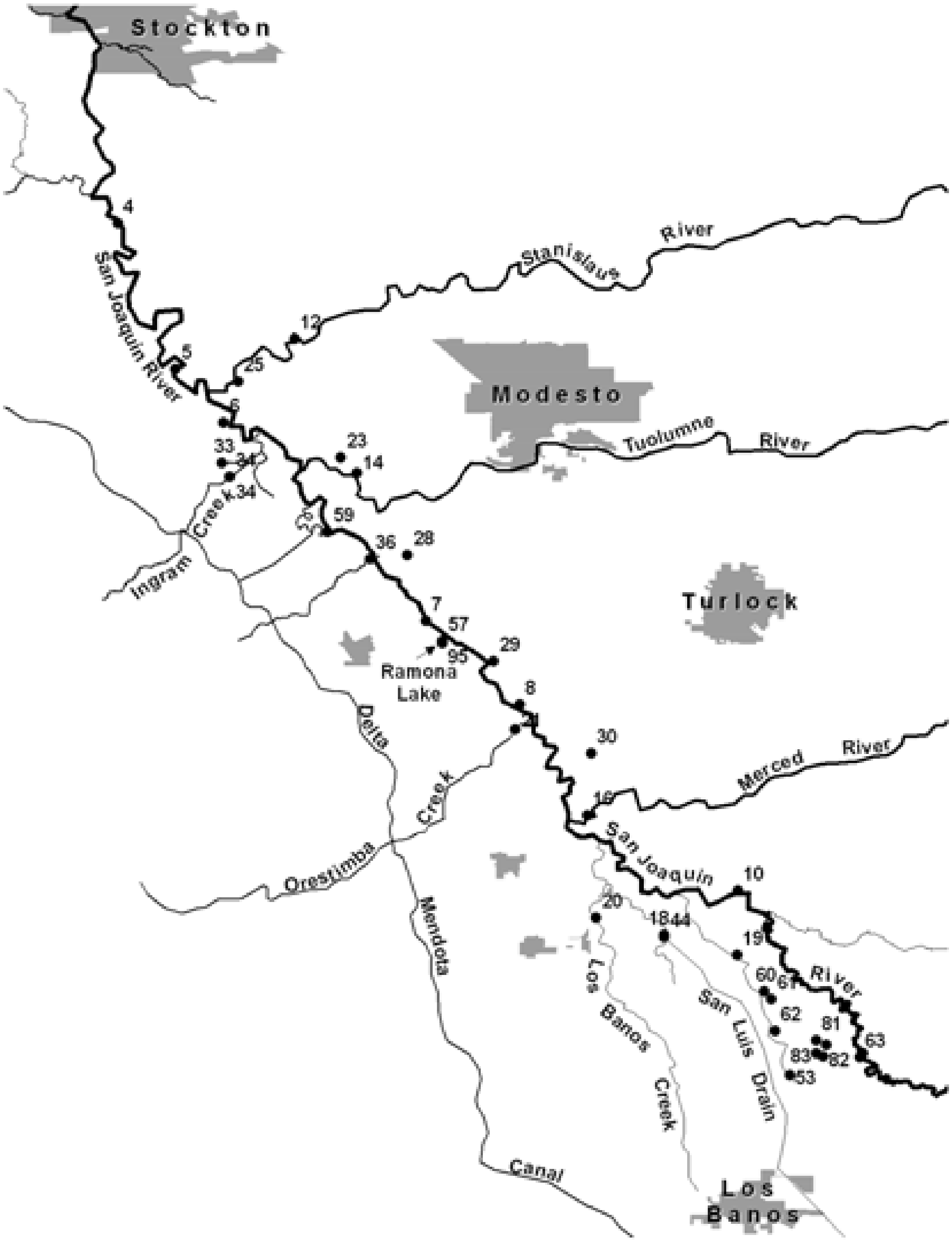
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

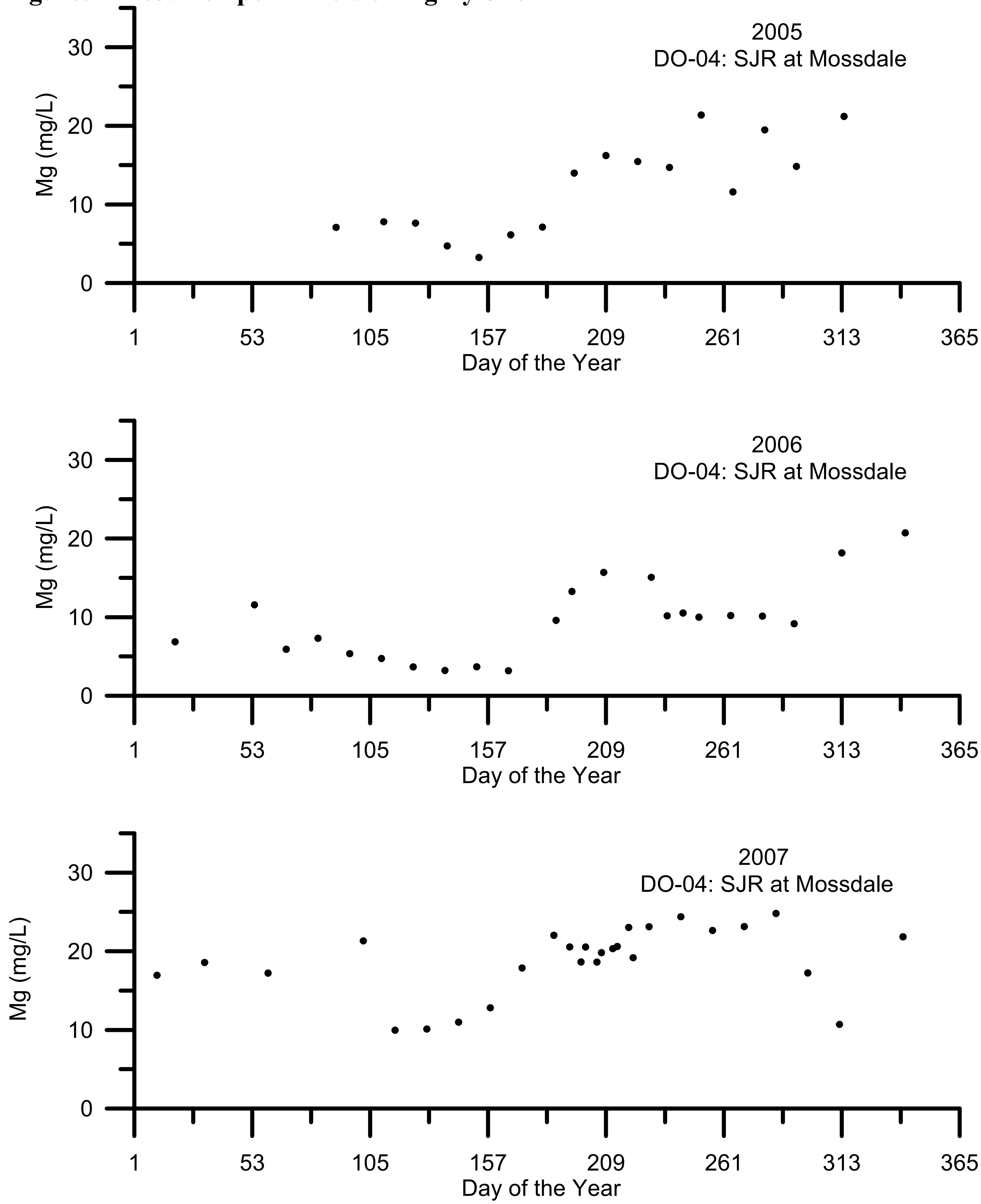
Table 1: EERP Sampling Site List

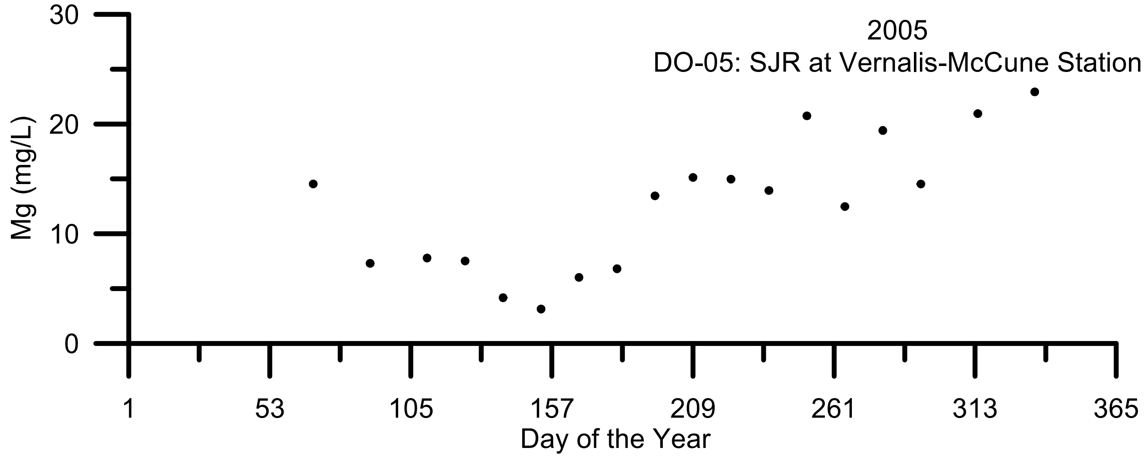
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

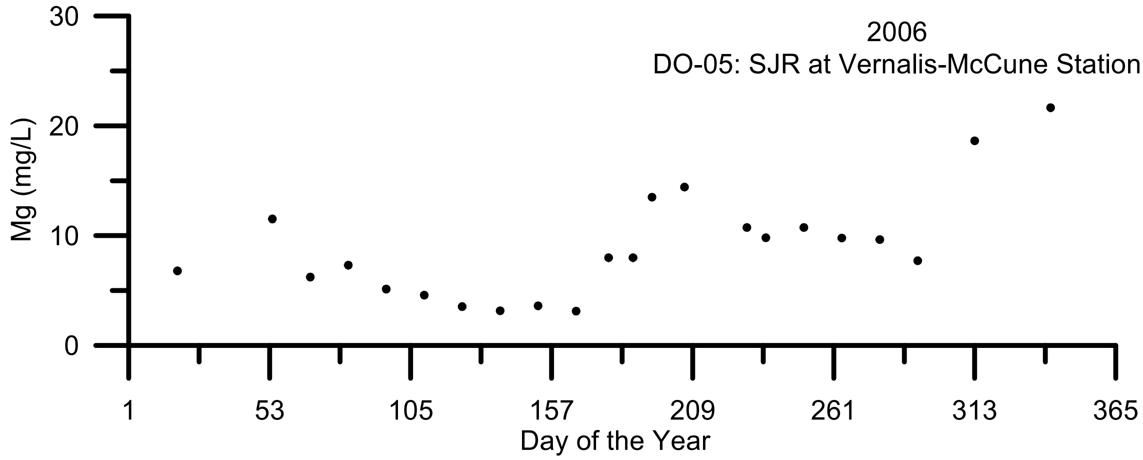
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

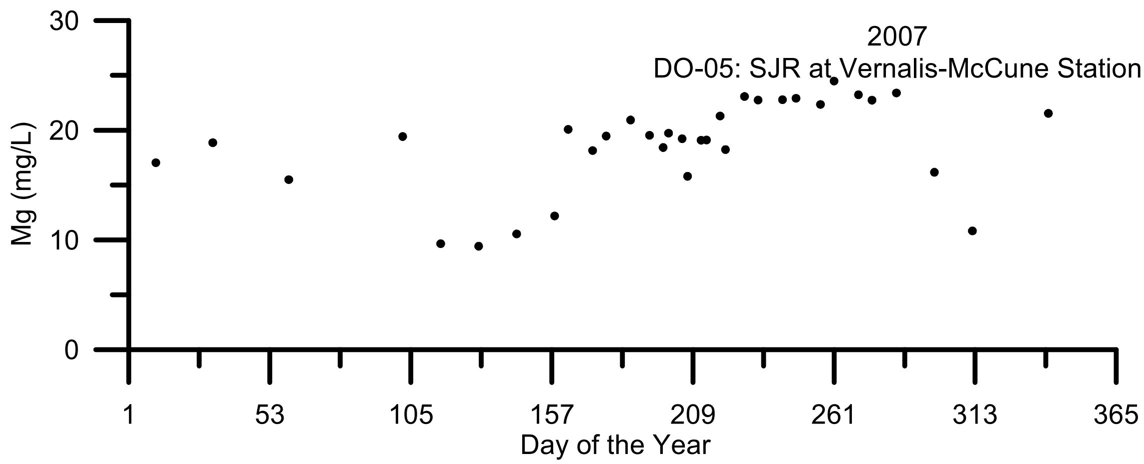


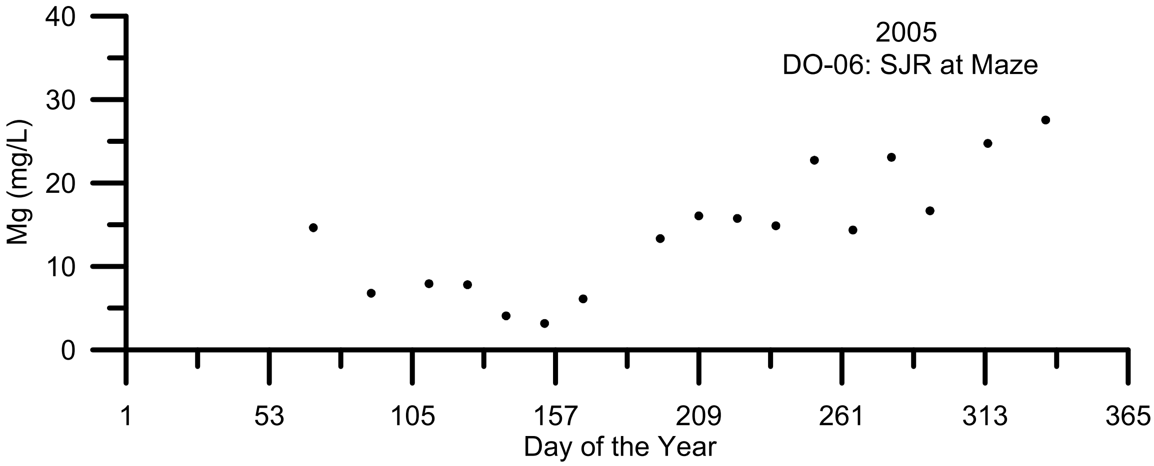
Figures 2 -103: Temporal Plots of Mg By Site ID

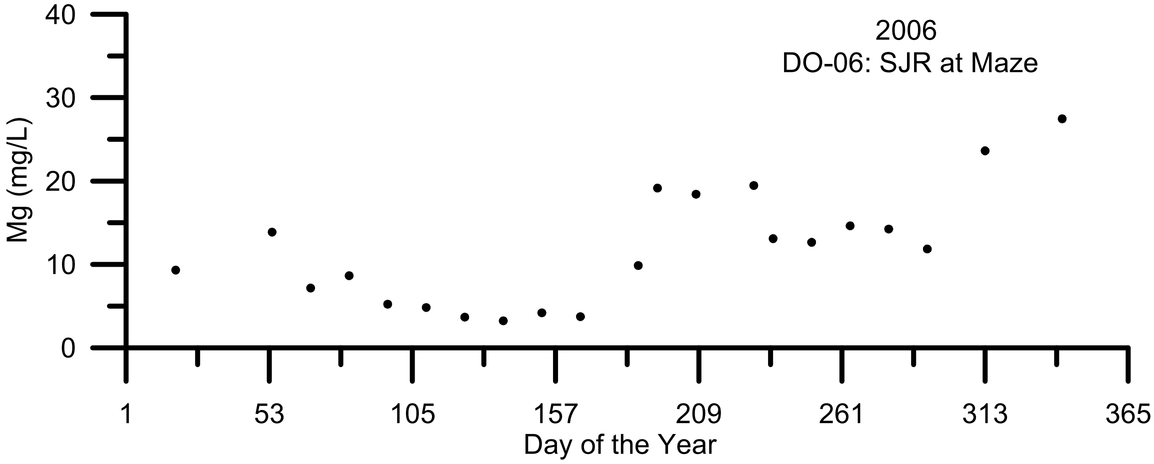


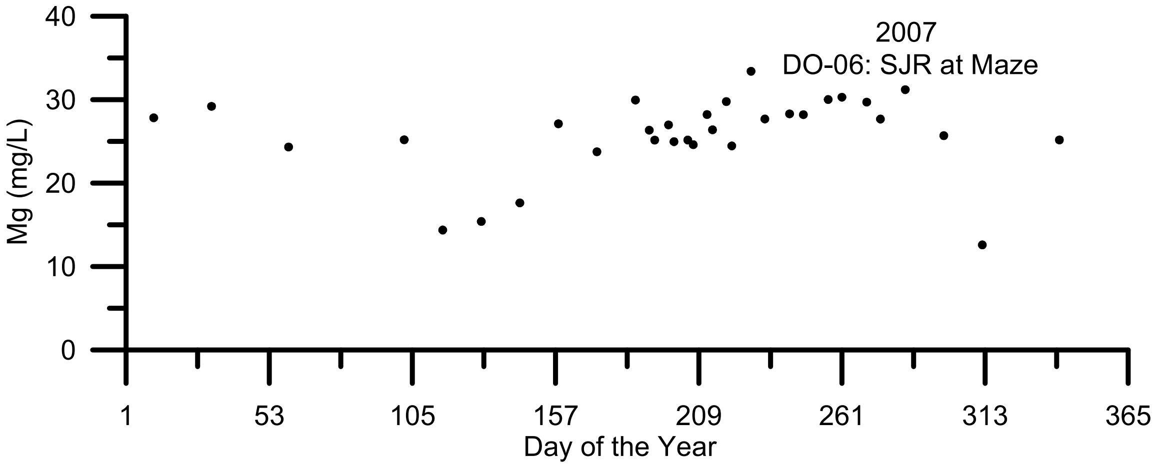

2005
DO-05: SJR at Vernalis-McCune Station
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

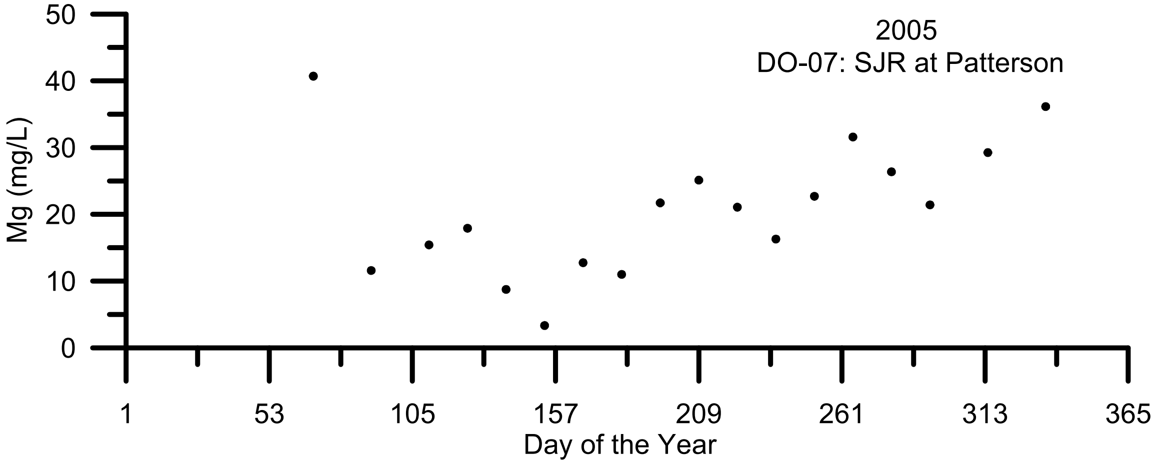

2006
DO-05: SJR at Vernalis-McCune Station
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

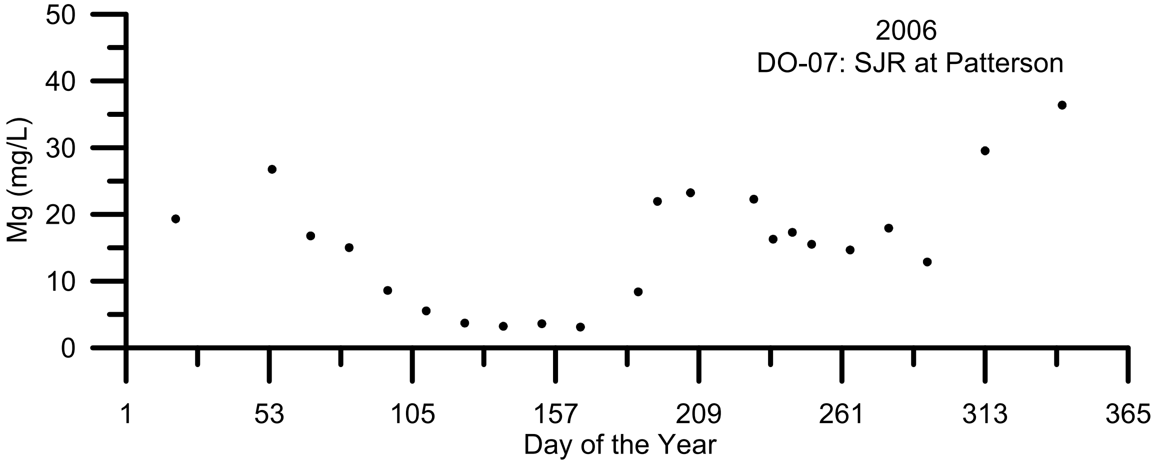

2007
DO-05: SJR at Vernalis-McCune Station
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

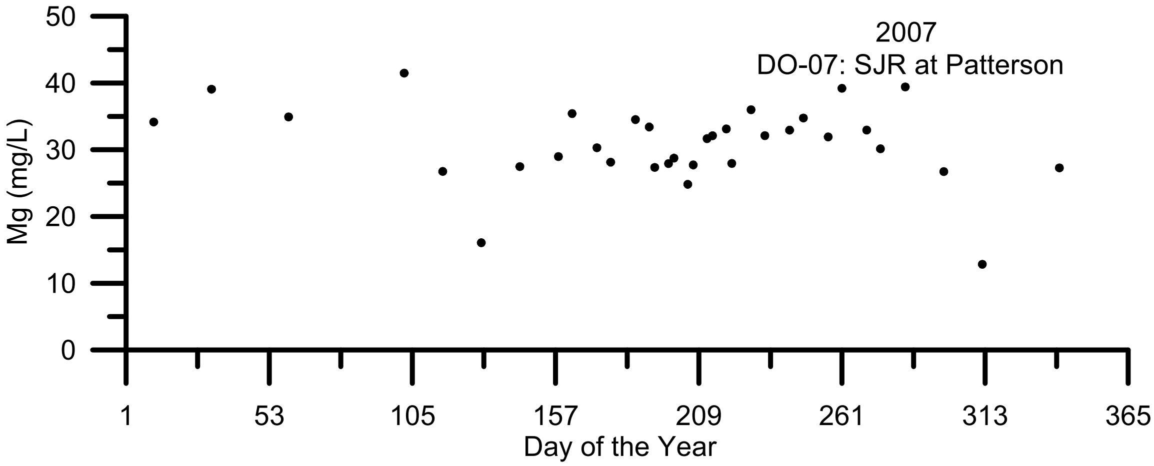

2005
DO-06: SJR at Maze
Mg (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

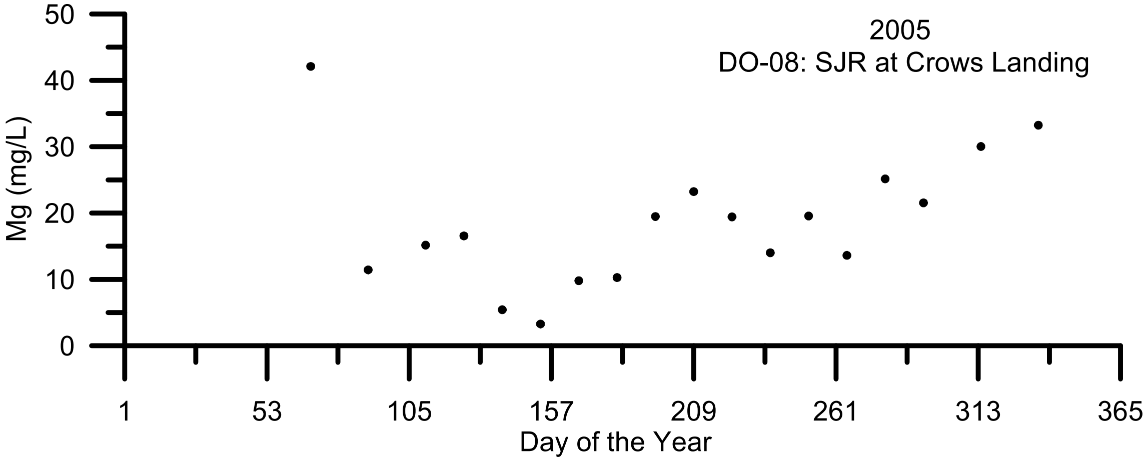

2006
DO-06: SJR at Maze
Mg (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

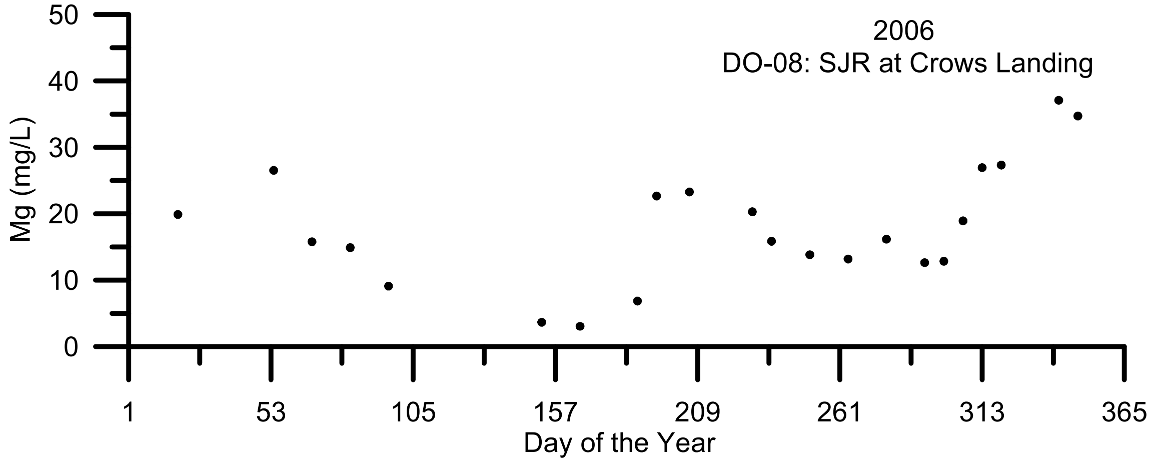

2007
DO-06: SJR at Maze
Mg (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

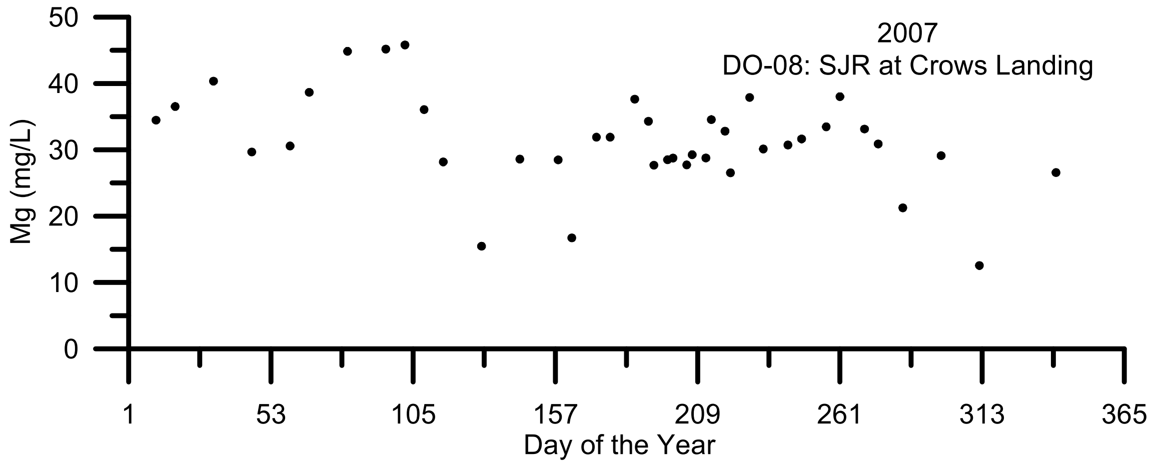

2005
DO-07: SJR at Patterson
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

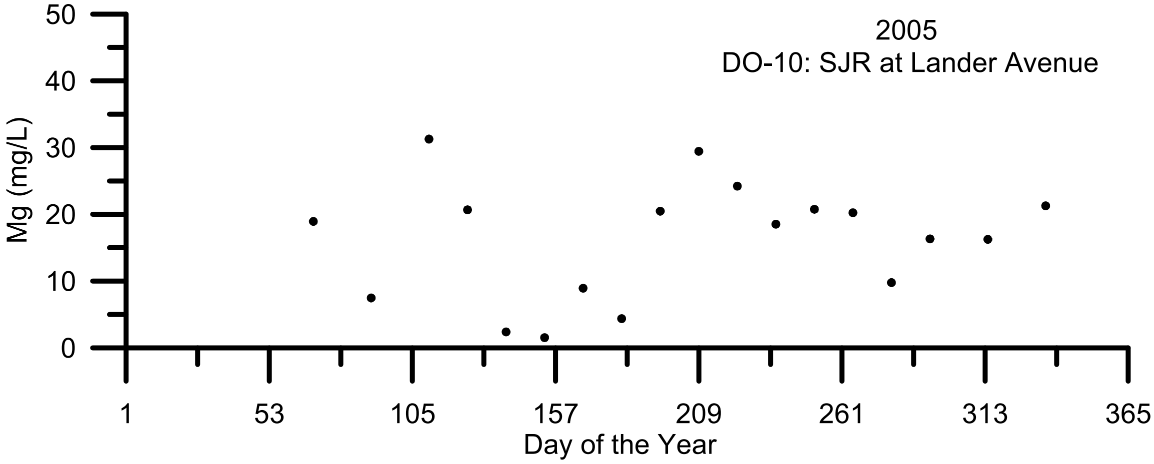

2006
DO-07: SJR at Patterson
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

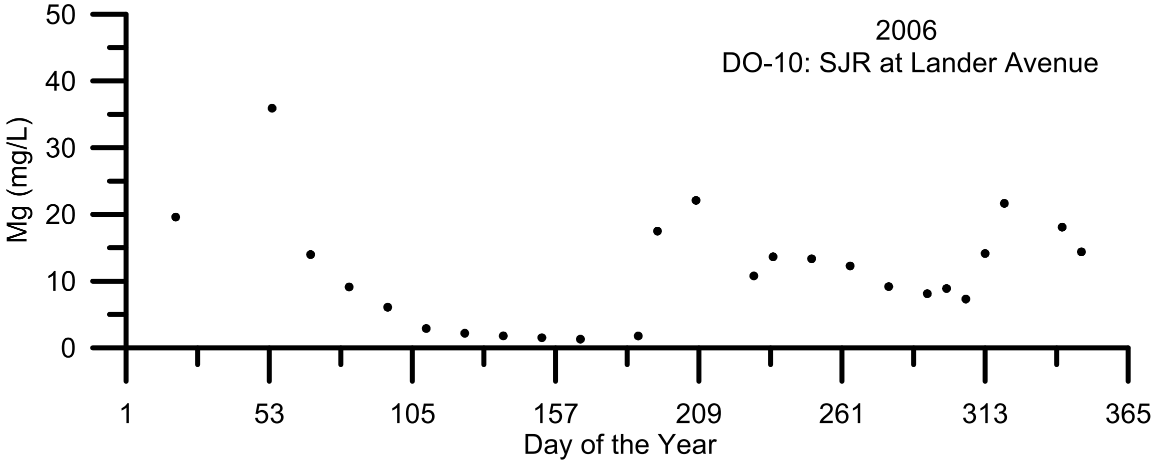

2007
DO-07: SJR at Patterson
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

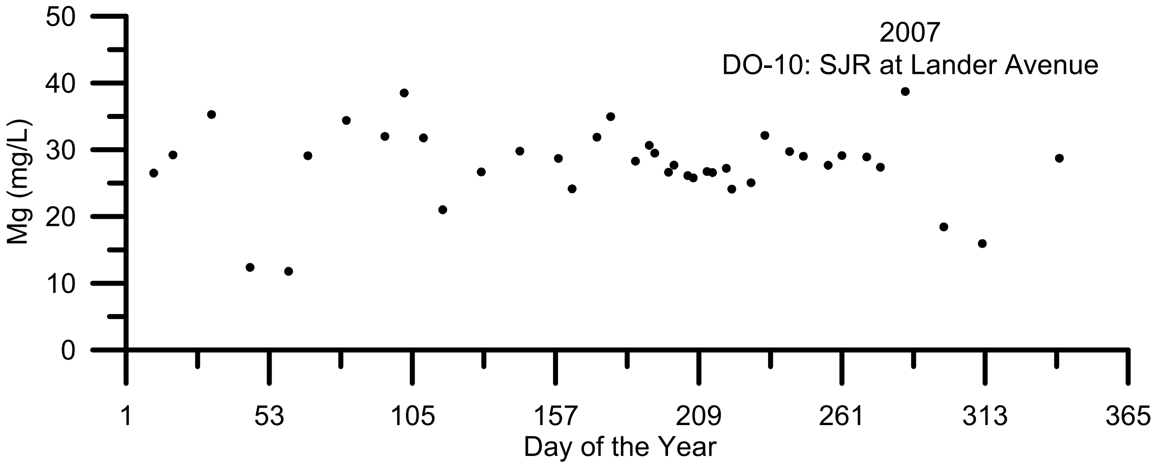

2005
DO-08: SJR at Crows Landing
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

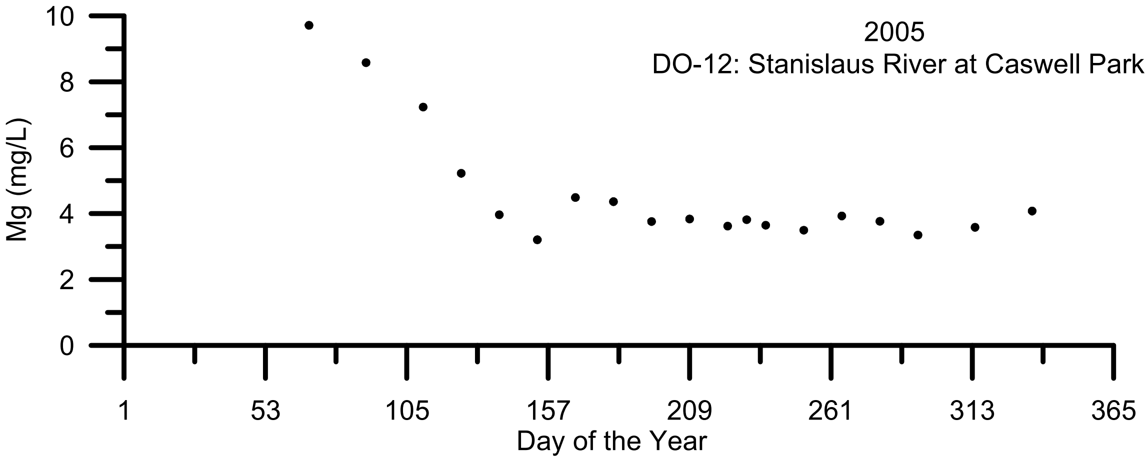

2006
DO-08: SJR at Crows Landing
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

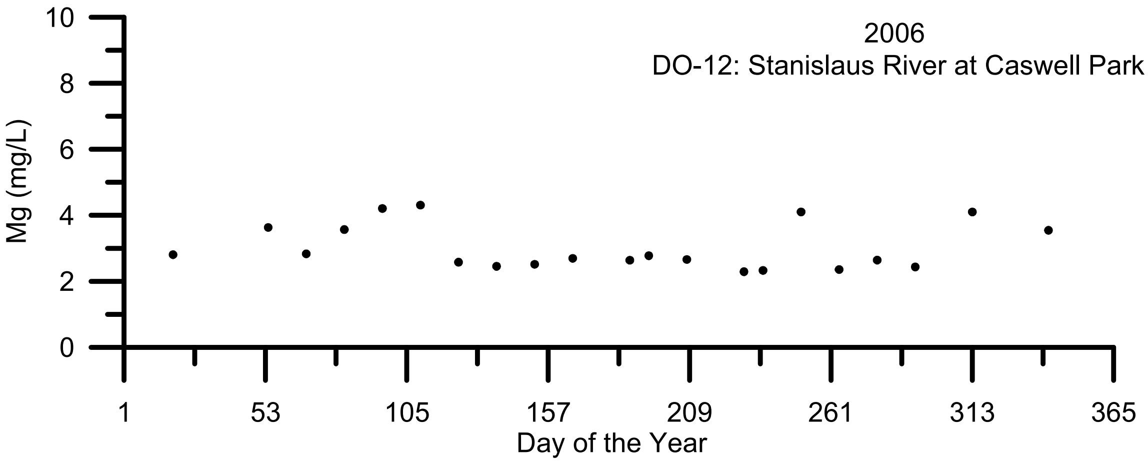

2007
DO-08: SJR at Crows Landing
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

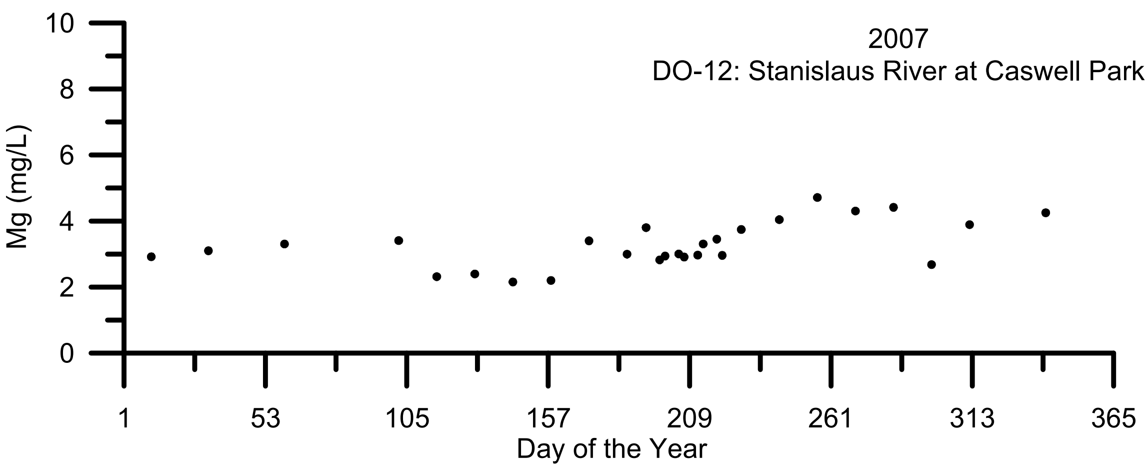

2005
DO-10: SJR at Lander Avenue
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

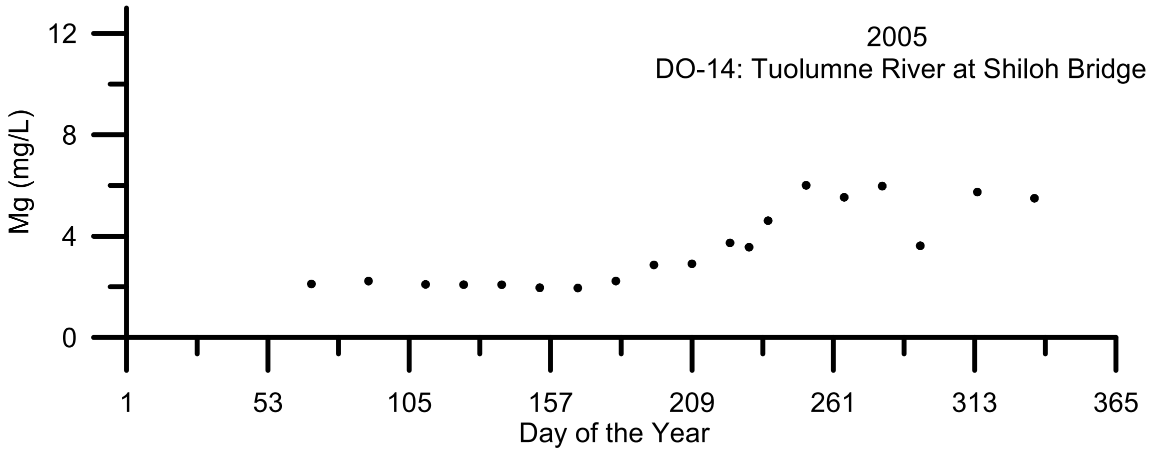

2006
DO-10: SJR at Lander Avenue
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

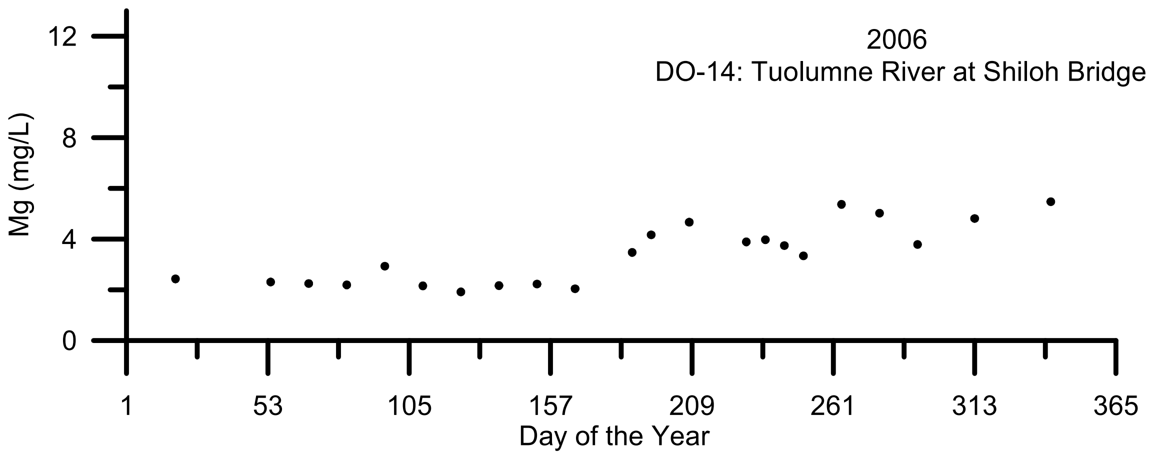

2007
DO-10: SJR at Lander Avenue
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

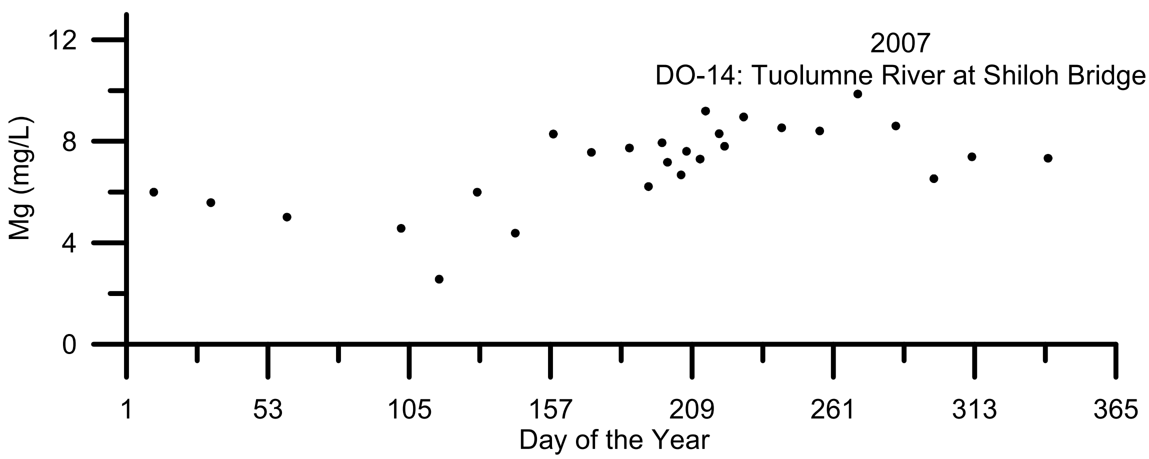

2005
DO-12: Stanislaus River at Caswell Park
Mg (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

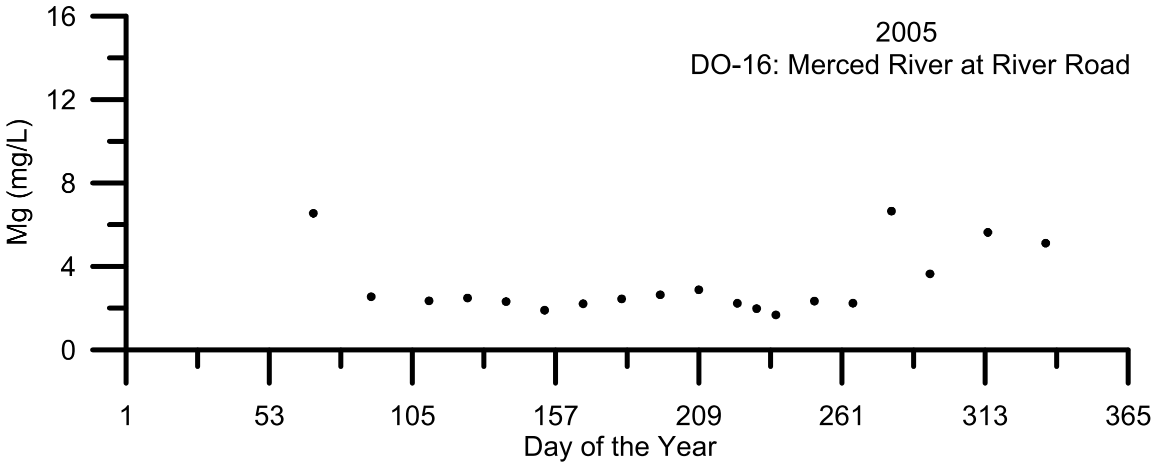

2006
DO-12: Stanislaus River at Caswell Park
Mg (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

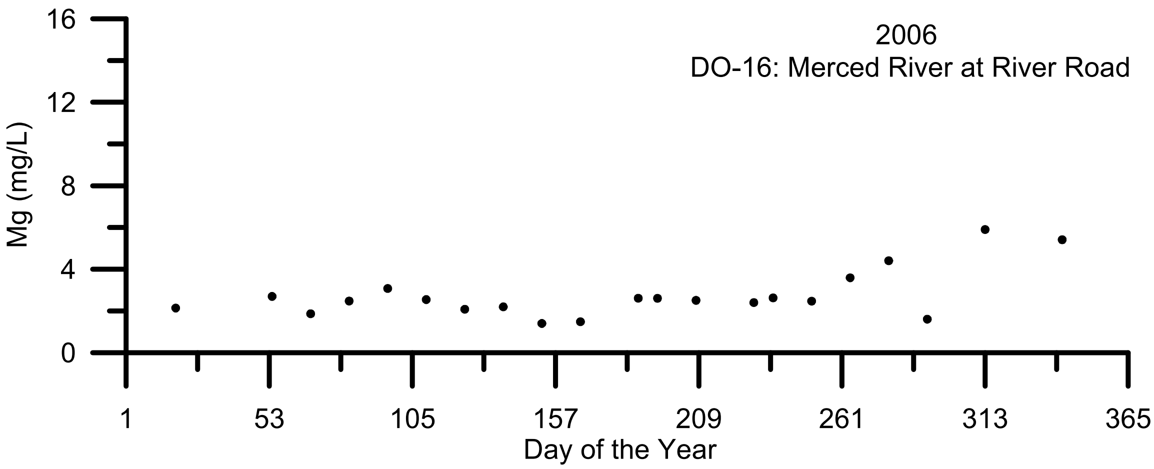

2007
DO-12: Stanislaus River at Caswell Park
Mg (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

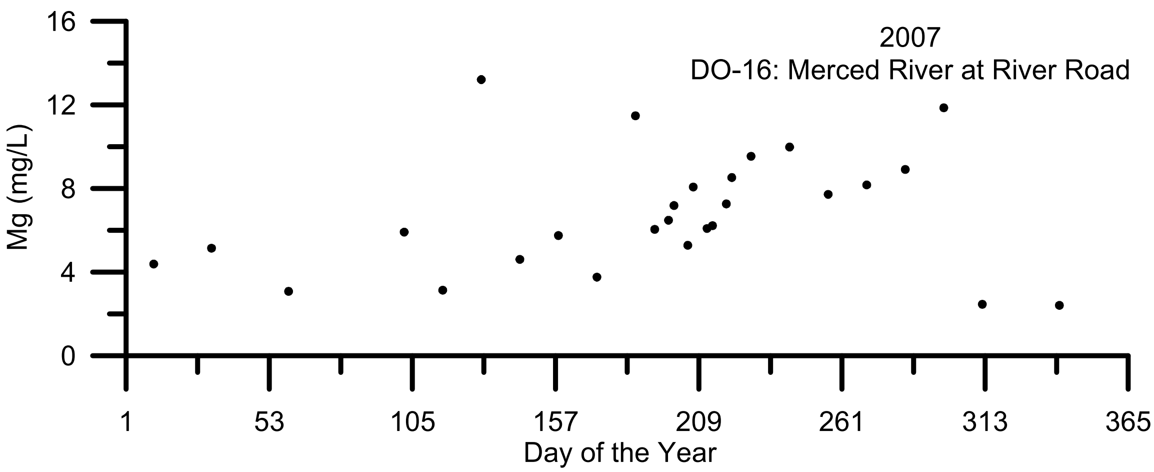

2005
DO-14: Tuolumne River at Shiloh Bridge
Mg (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

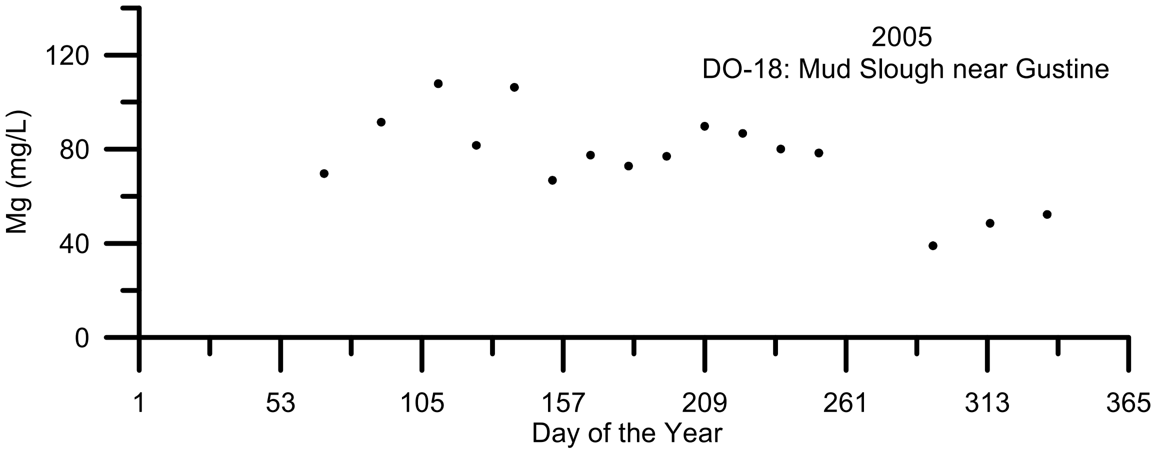

2006
DO-14: Tuolumne River at Shiloh Bridge
Mg (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

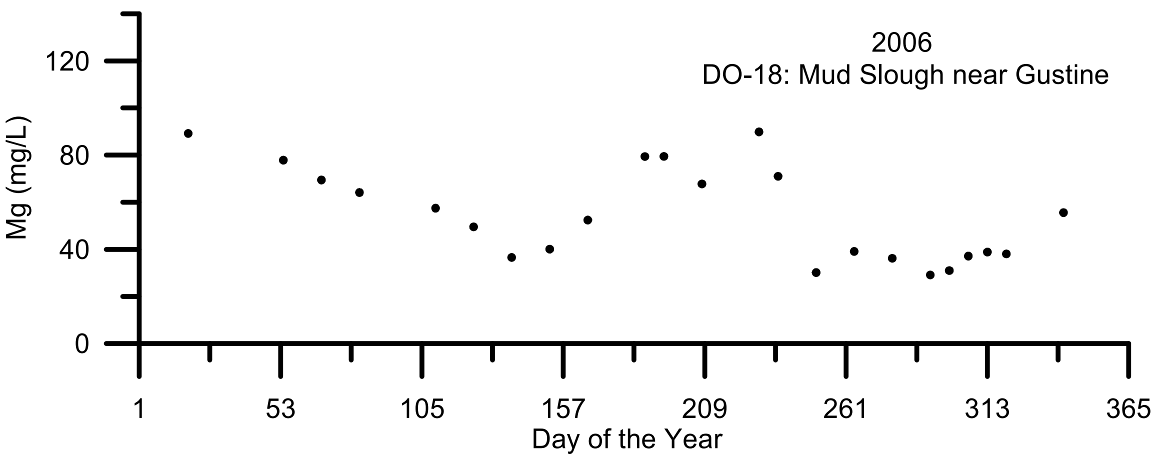

2007
DO-14: Tuolumne River at Shiloh Bridge
Mg (mg/L)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

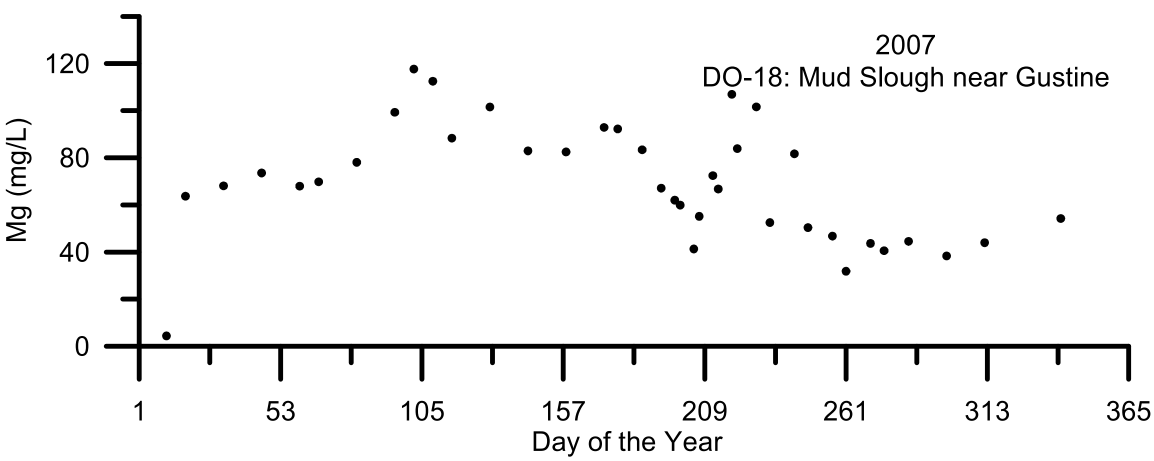

2005
DO-16: Merced River at River Road
Mg (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

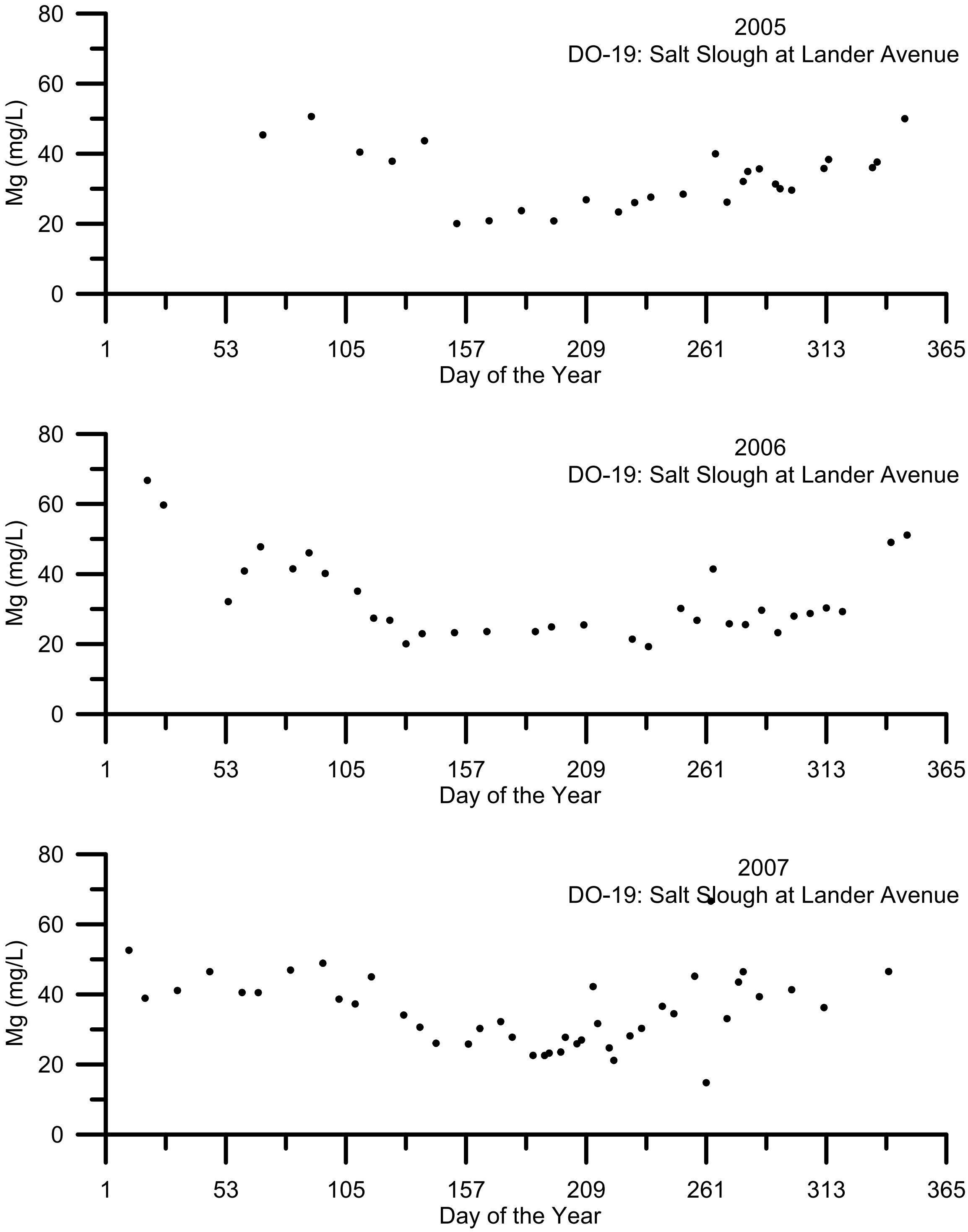

2006
DO-16: Merced River at River Road
Mg (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

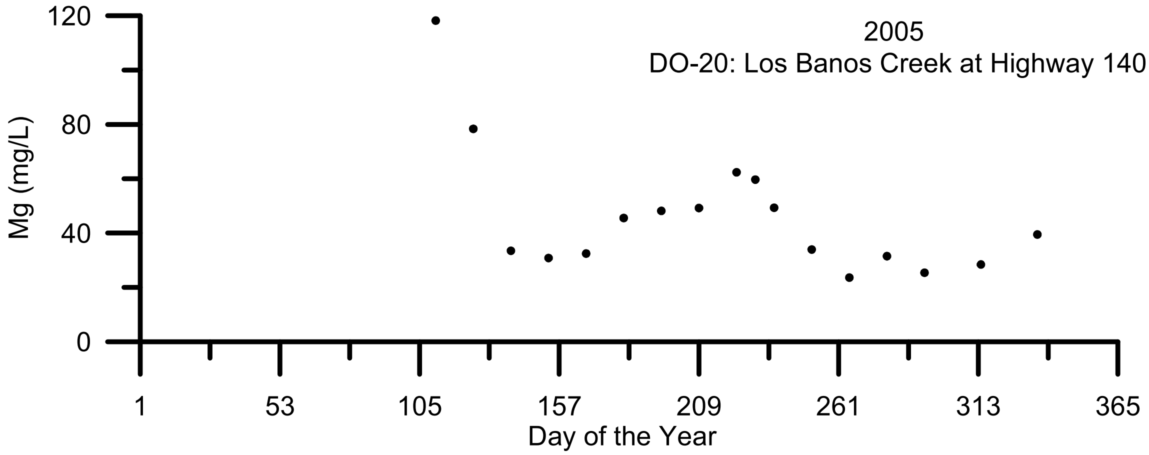

2007
DO-16: Merced River at River Road
Mg (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

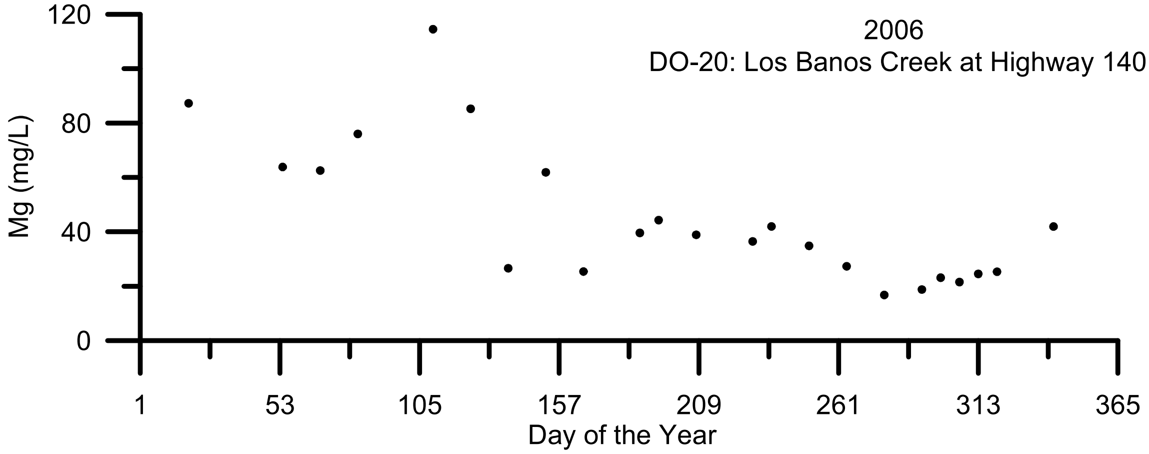

2005
DO-18: Mud Slough near Gustine
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

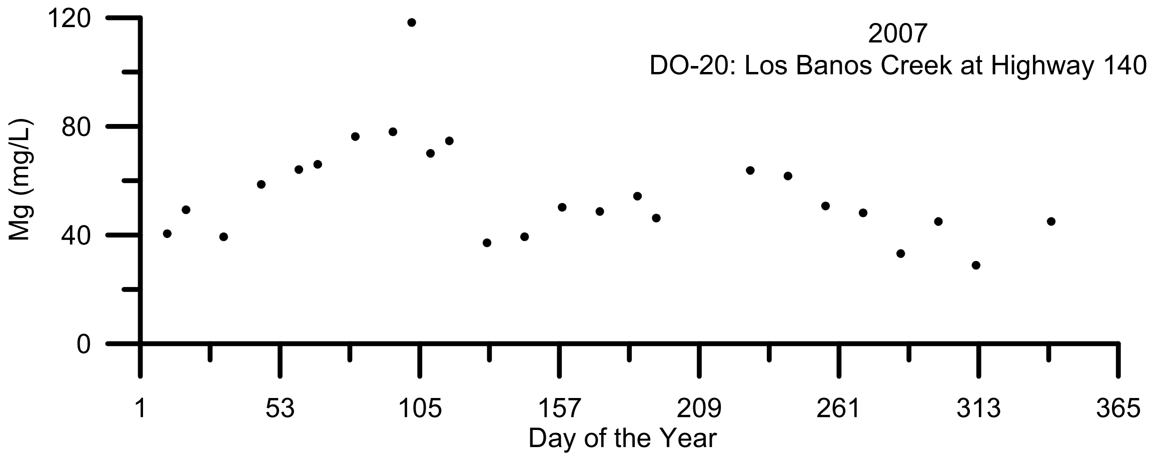

2006
DO-18: Mud Slough near Gustine
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

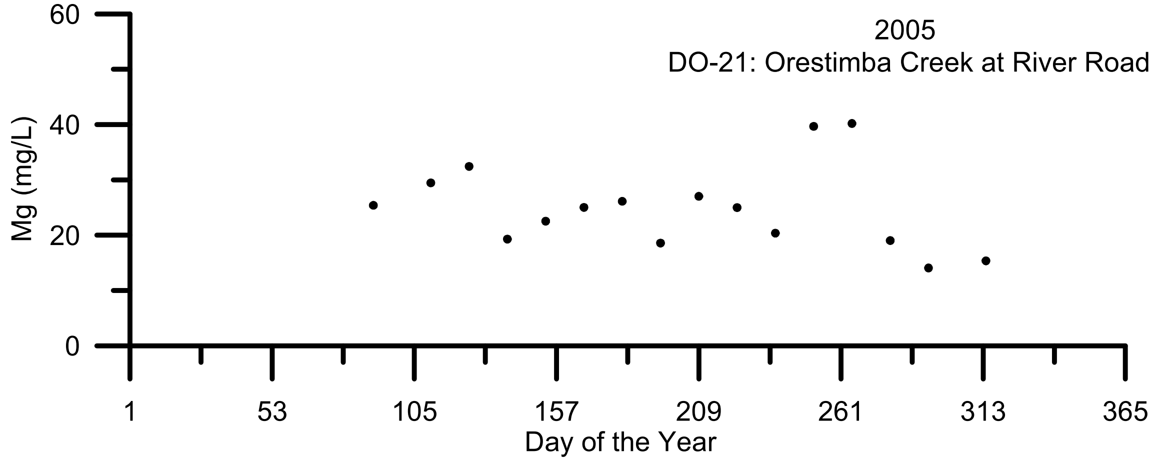

2007
DO-18: Mud Slough near Gustine
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

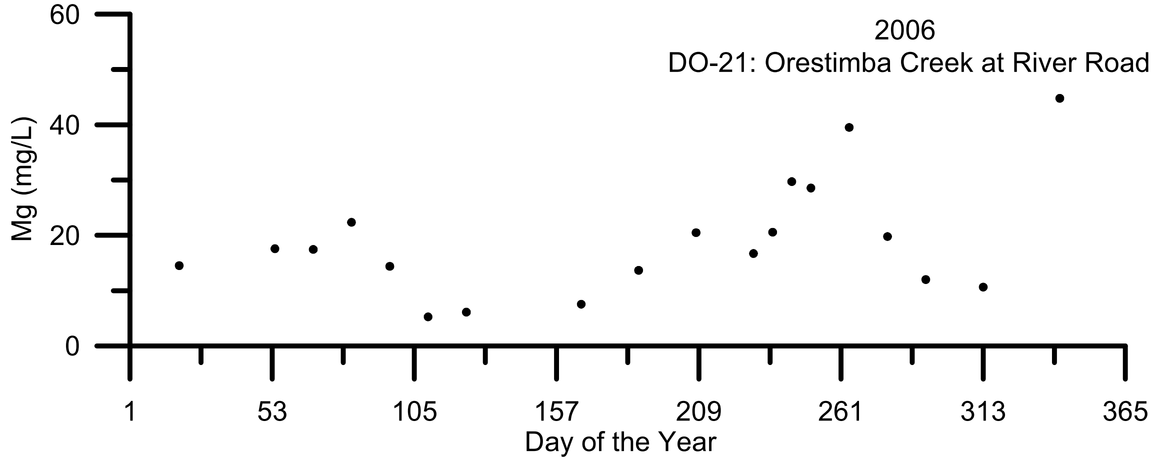

2005
DO-19: Salt Slough at Lander Avenue
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-19: Salt Slough at Lander Avenue
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year
2007
DO-19: Salt Slough at Lander Avenue
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

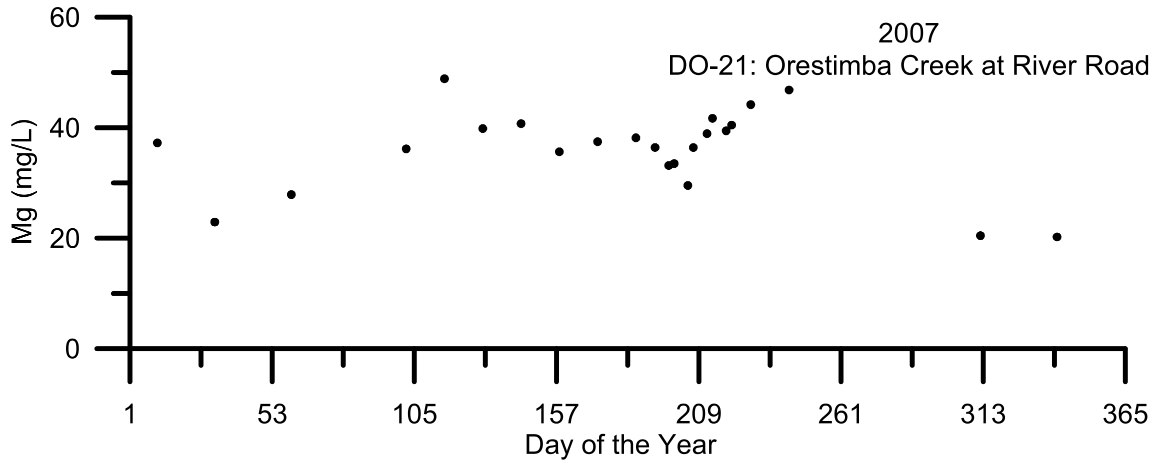

2005
DO-20: Los Banos Creek at Highway 140
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

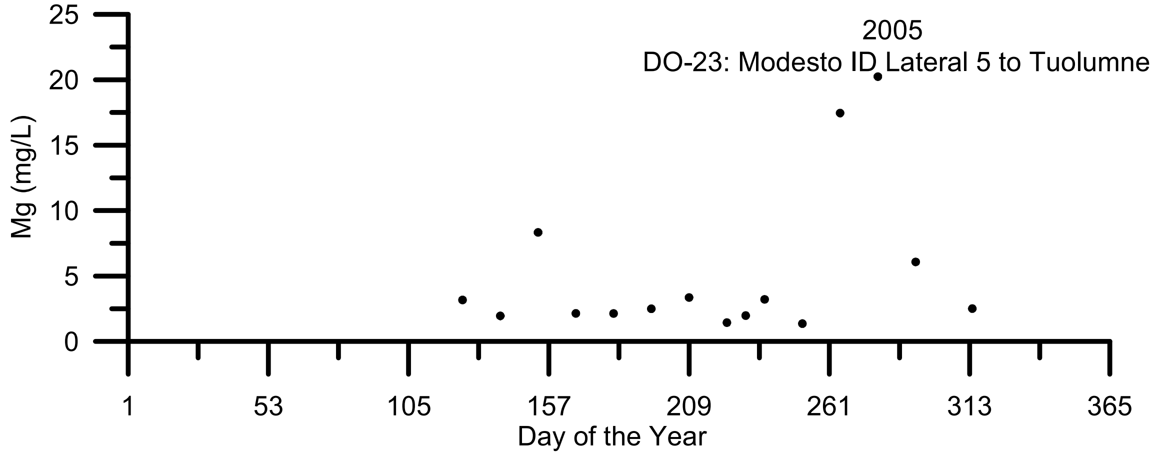

2006
DO-20: Los Banos Creek at Highway 140
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

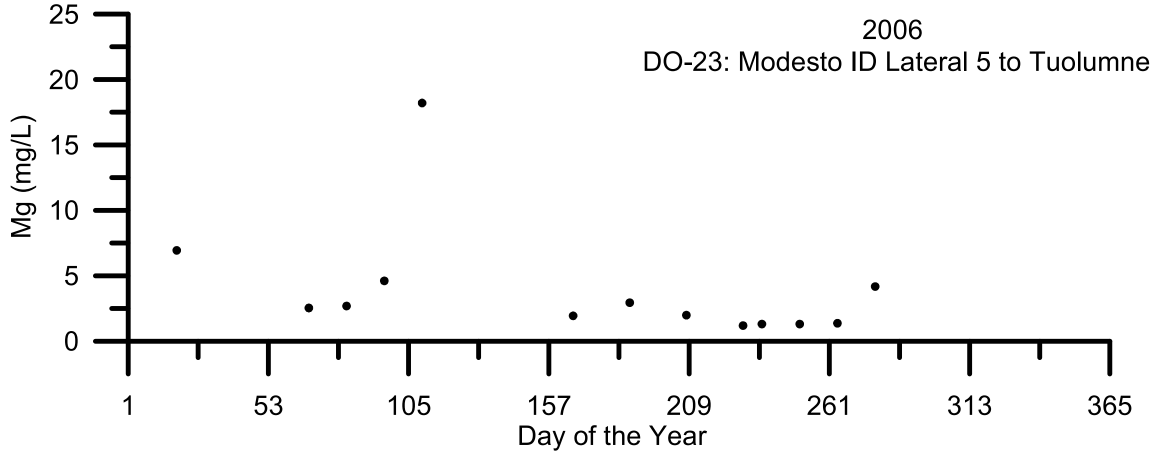

2007
DO-20: Los Banos Creek at Highway 140
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

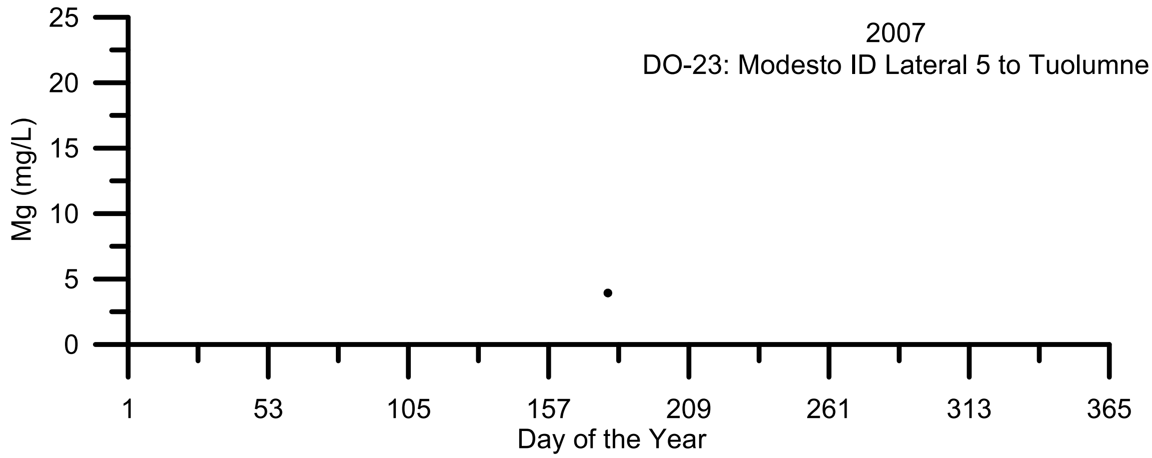

2005
DO-21: Orestimba Creek at River Road
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

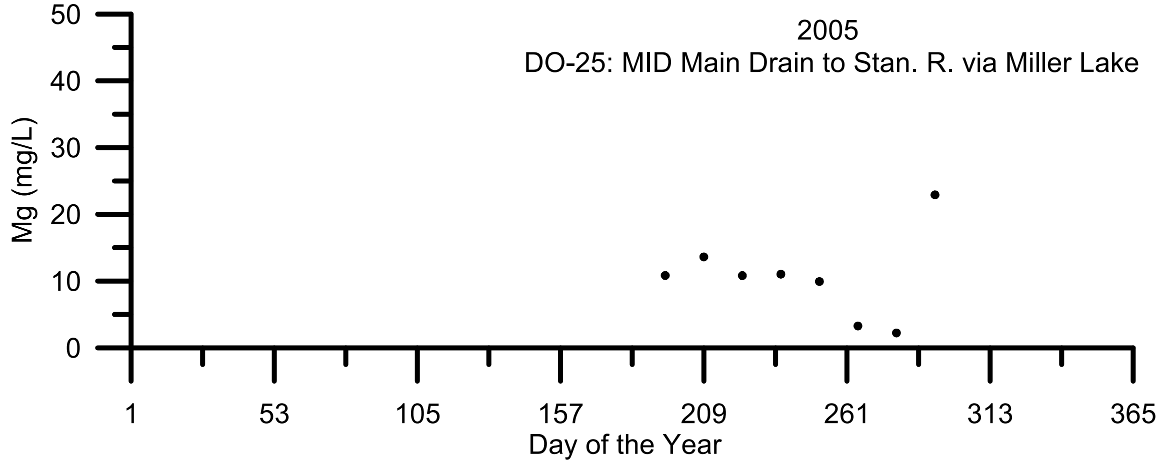

2006
DO-21: Orestimba Creek at River Road
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

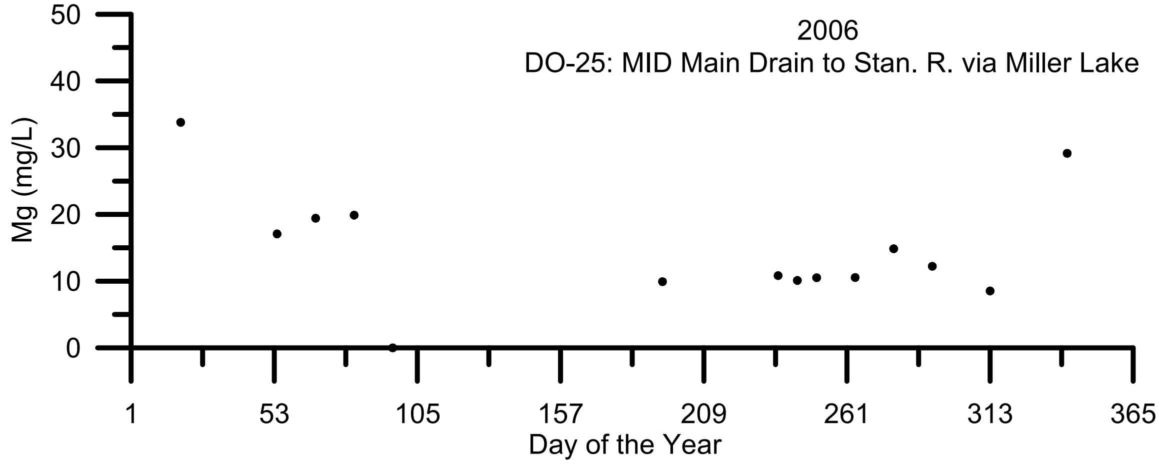

2007
DO-21: Orestimba Creek at River Road
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

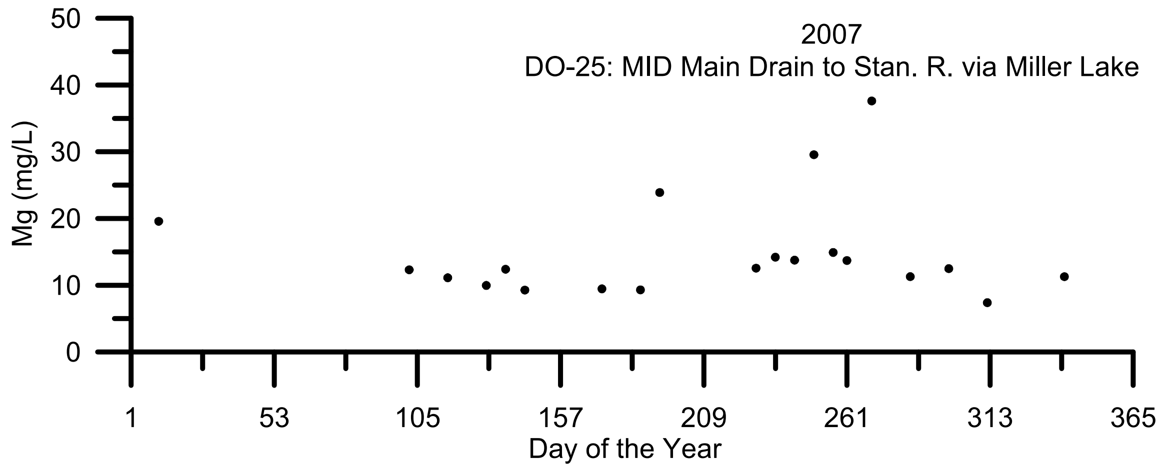

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Mg (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365

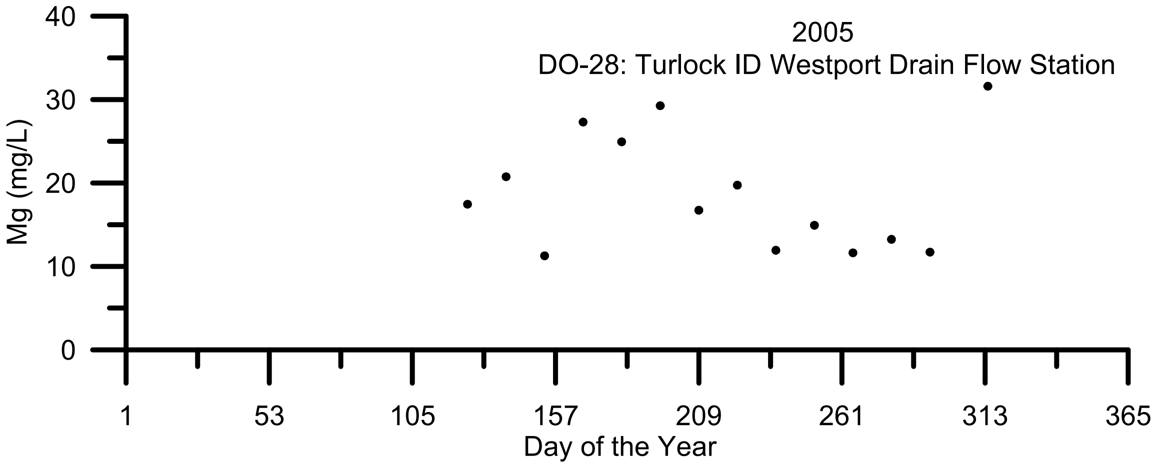

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Mg (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365

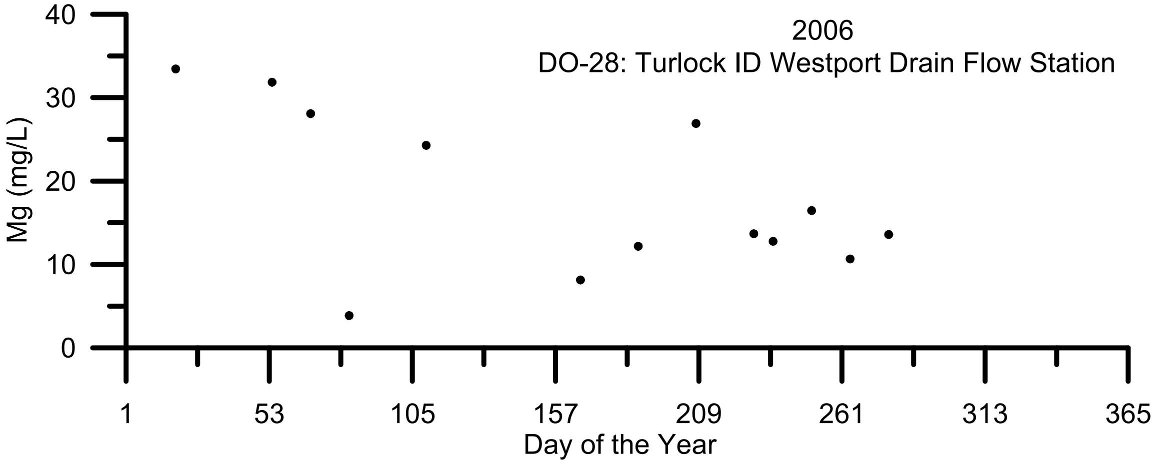

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Mg (mg/L)
Day of the Year
0
5
10
15
20
25
1
53
105
157
209
261
313
365

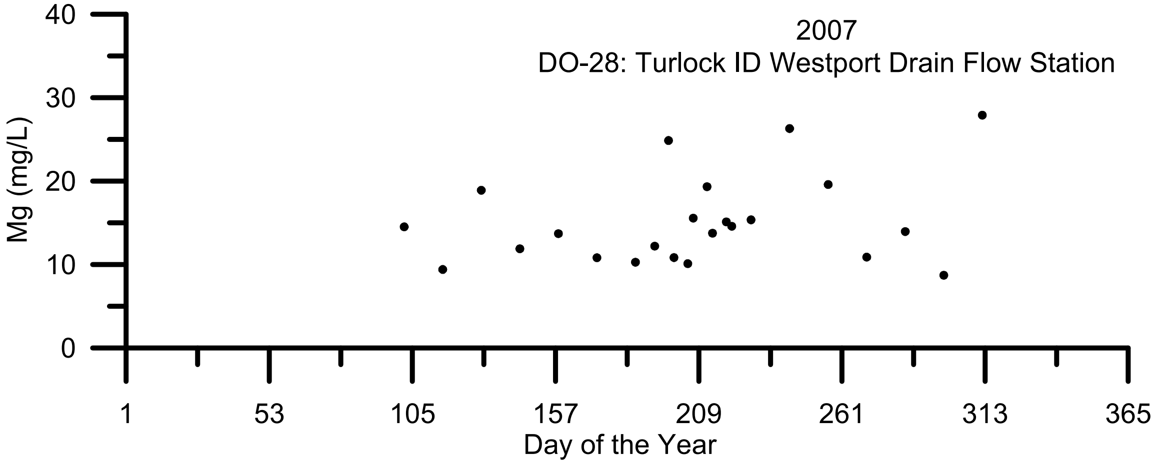

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

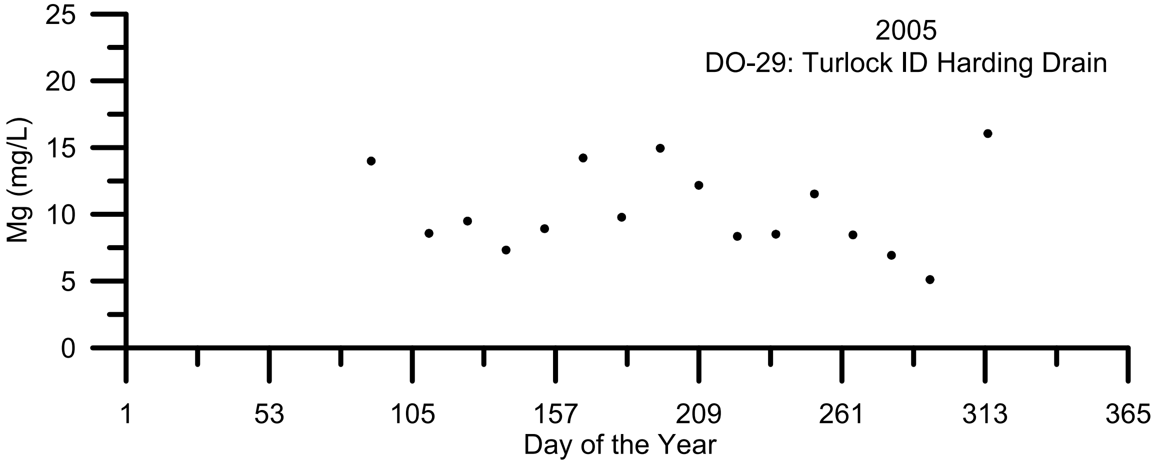

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

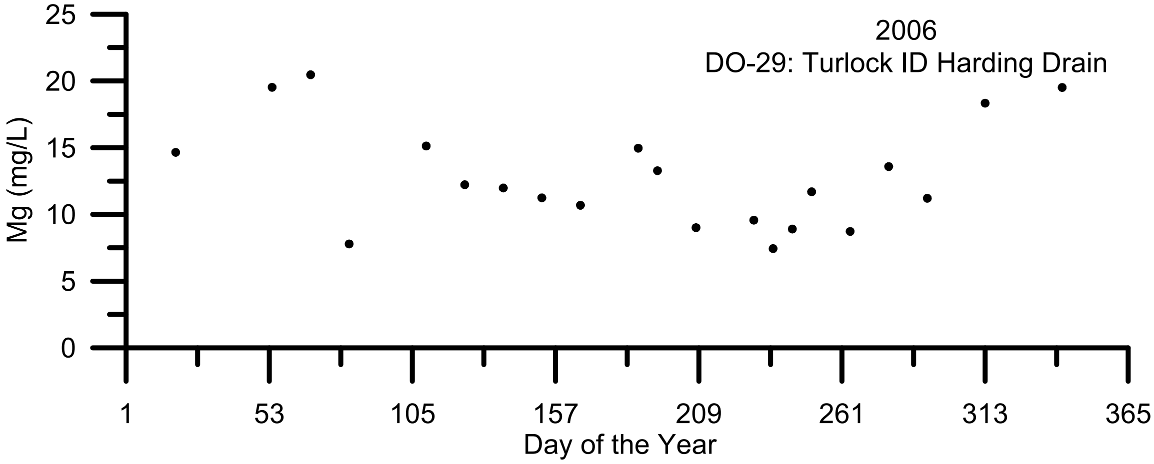

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

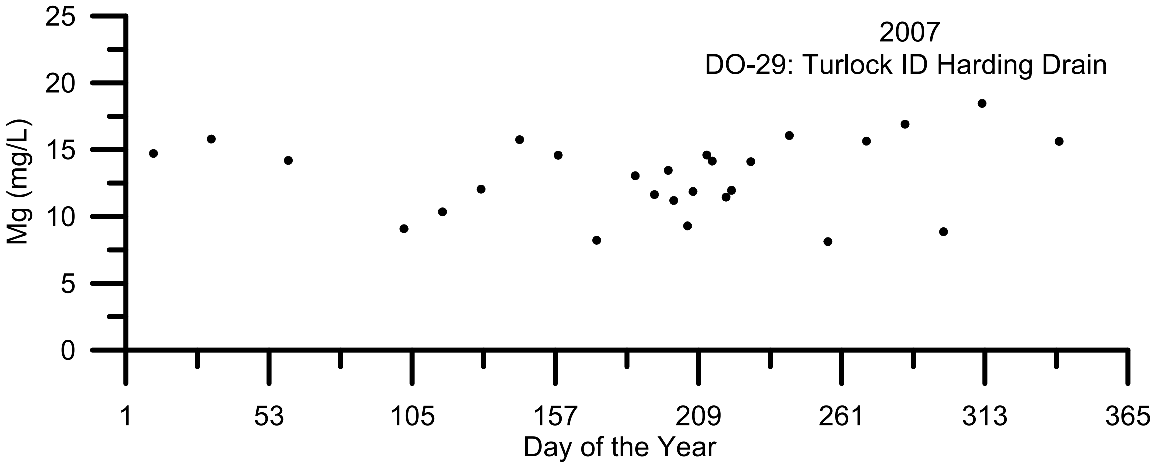

2005
DO-28: Turlock ID Westport Drain Flow Station
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

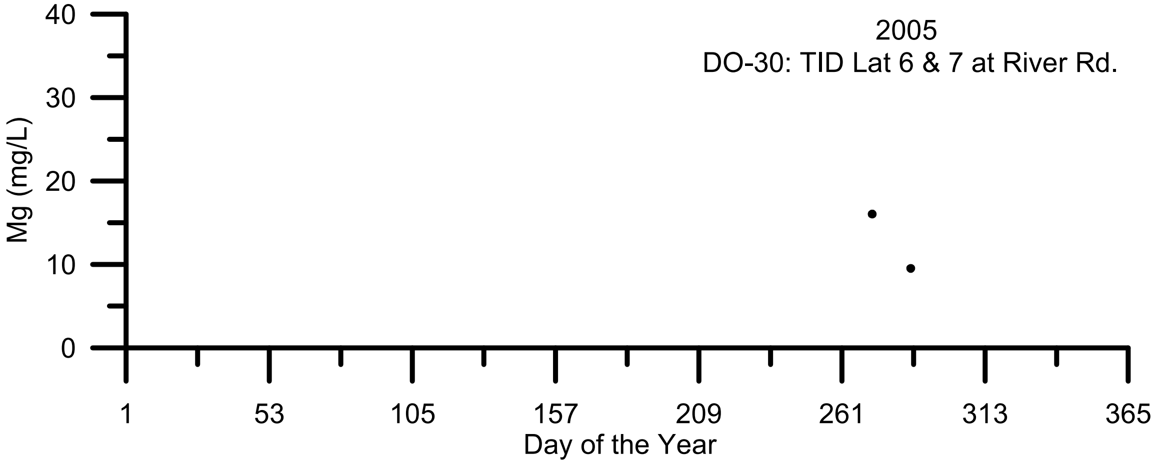

2006
DO-28: Turlock ID Westport Drain Flow Station
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

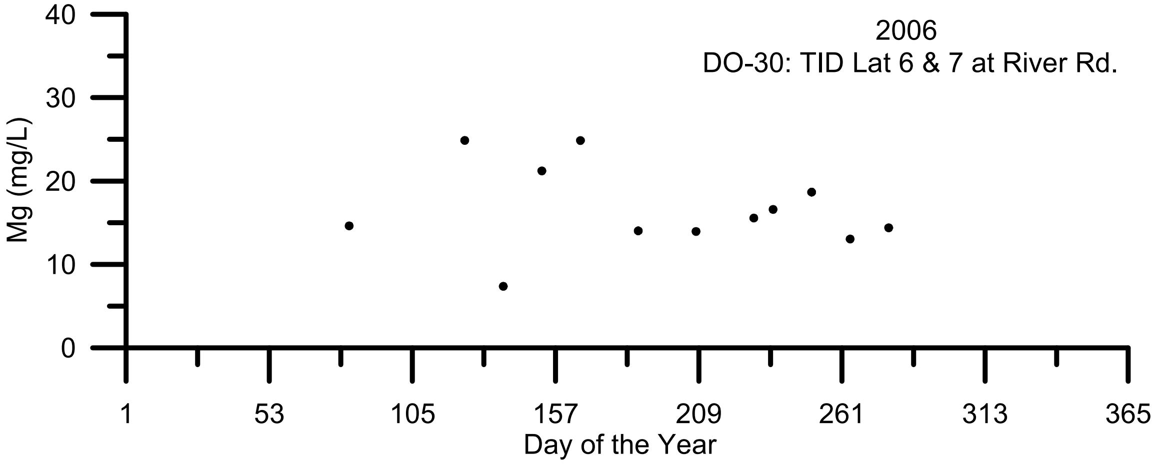

2007
DO-28: Turlock ID Westport Drain Flow Station
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

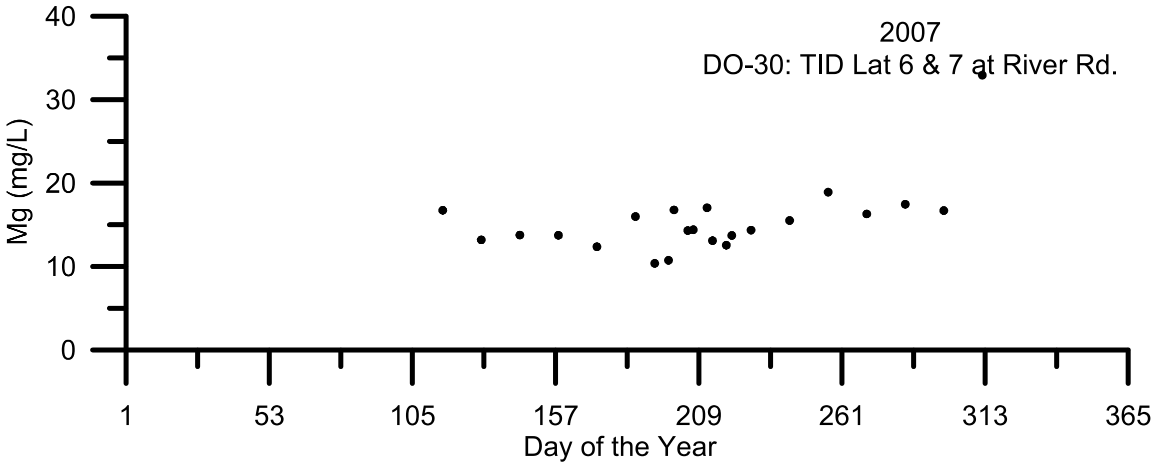

2005
DO-29: Turlock ID Harding Drain
Mg (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

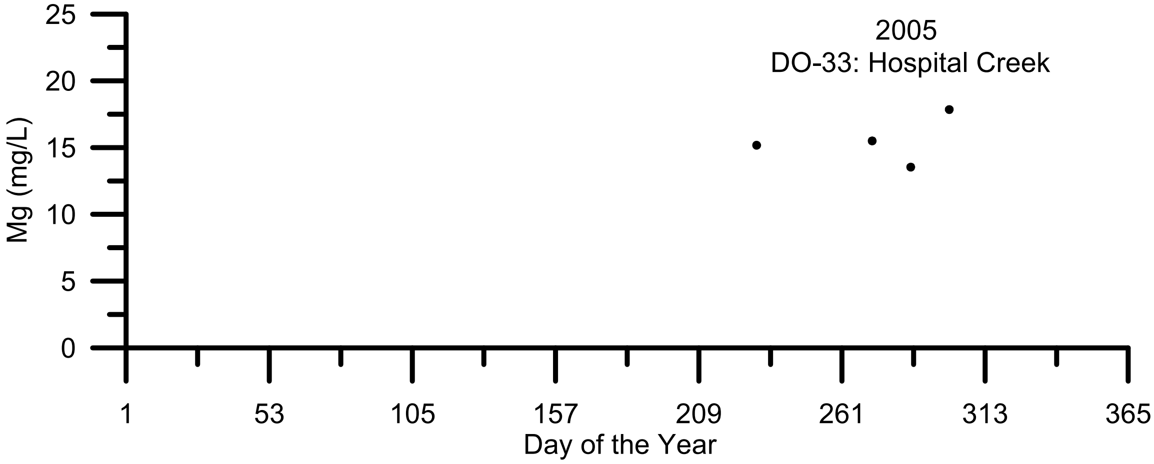

2006
DO-29: Turlock ID Harding Drain
Mg (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

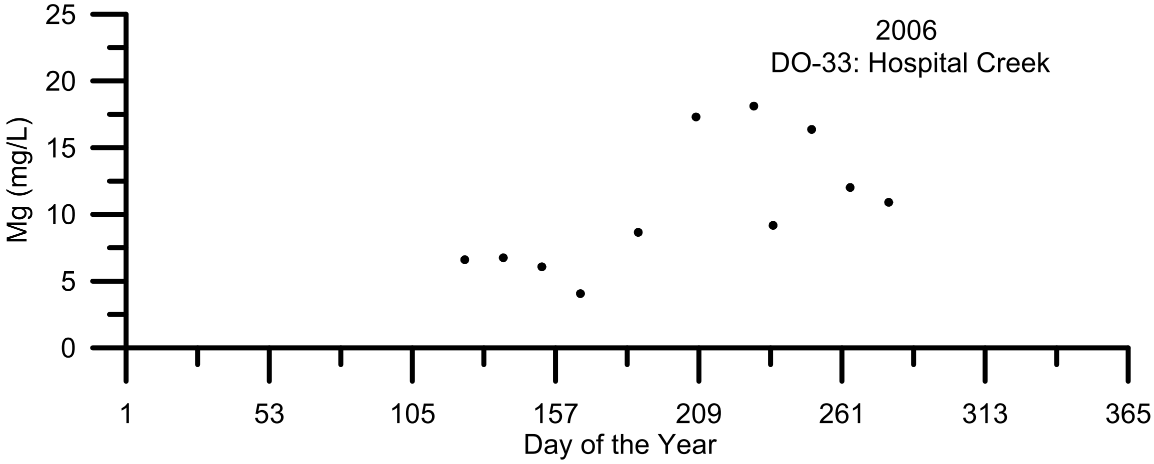

2007
DO-29: Turlock ID Harding Drain
Mg (mg/L)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

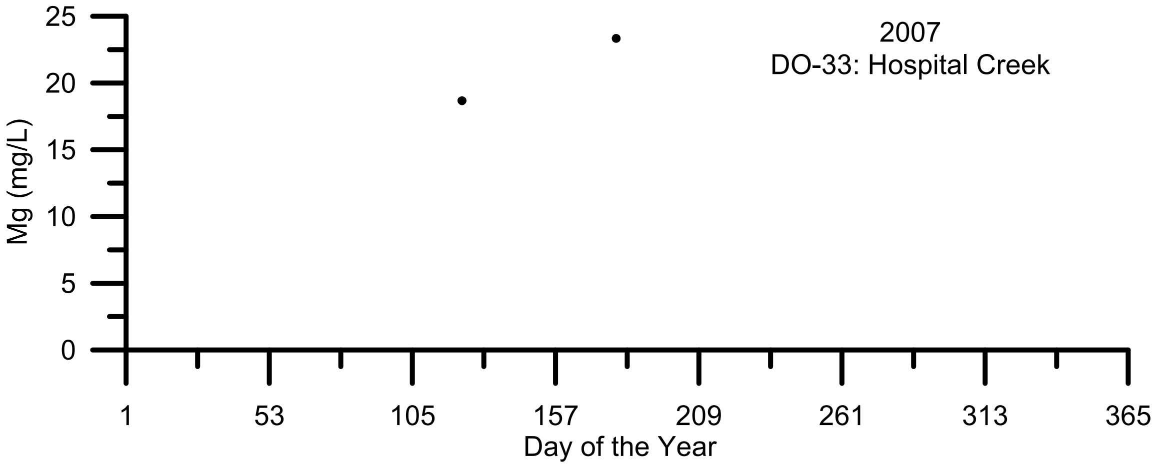

2005
DO-30: TID Lat 6 & 7 at River Rd.
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

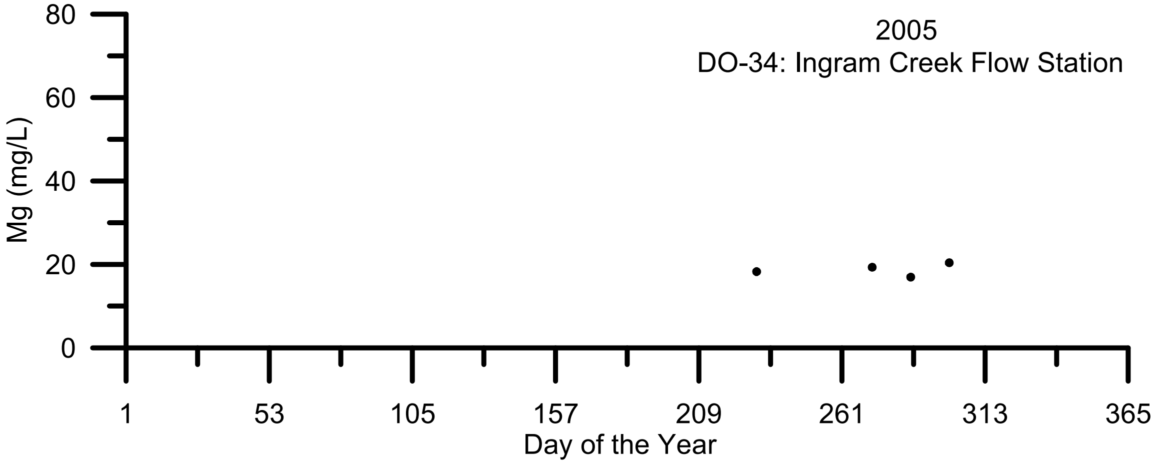

2006
DO-30: TID Lat 6 & 7 at River Rd.
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

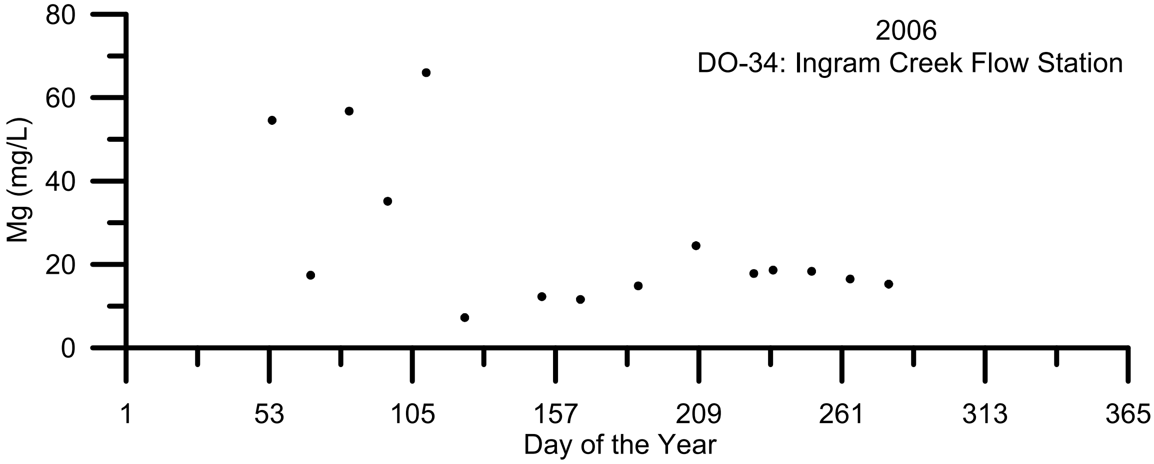

2007
DO-30: TID Lat 6 & 7 at River Rd.
Mg (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

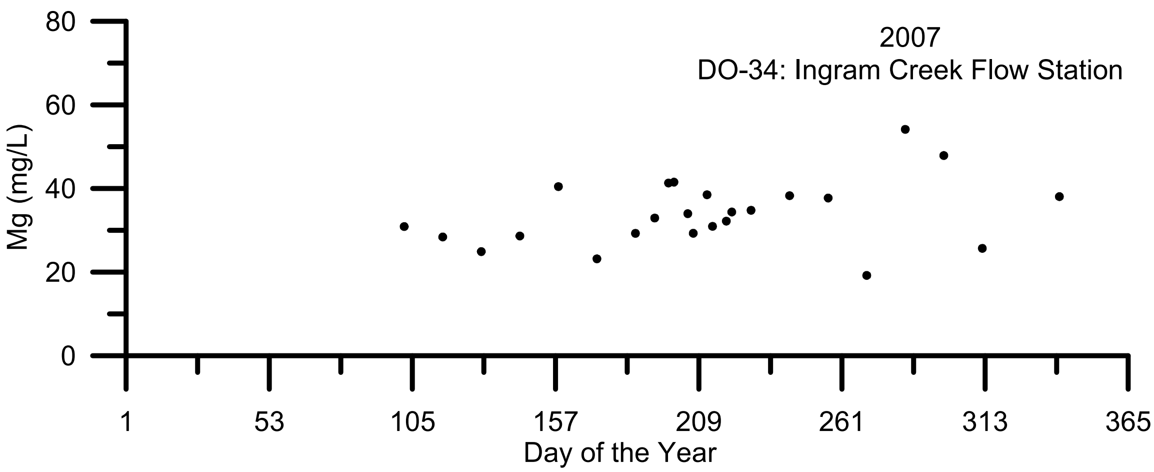

2005
DO-33: Hospital Creek
Mg (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

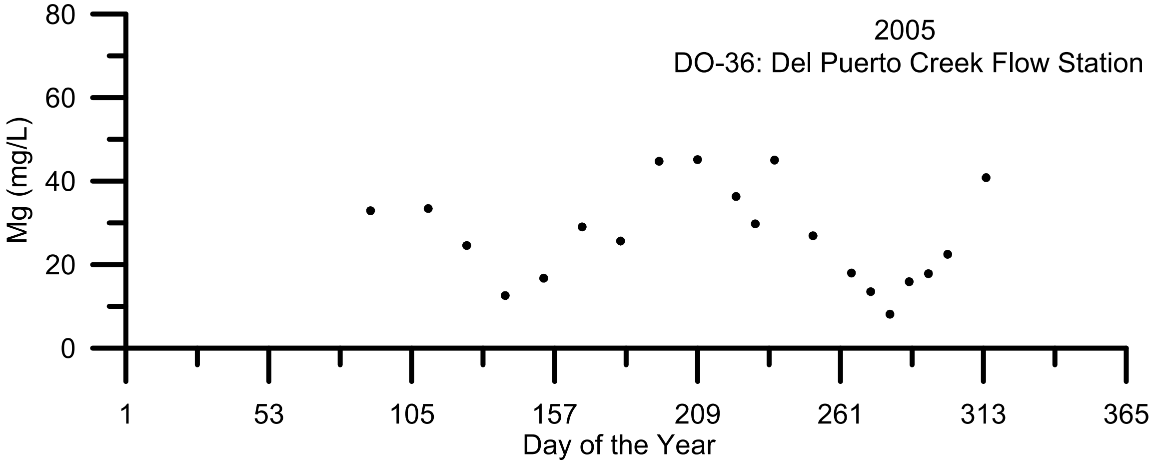

2006
DO-33: Hospital Creek
Mg (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

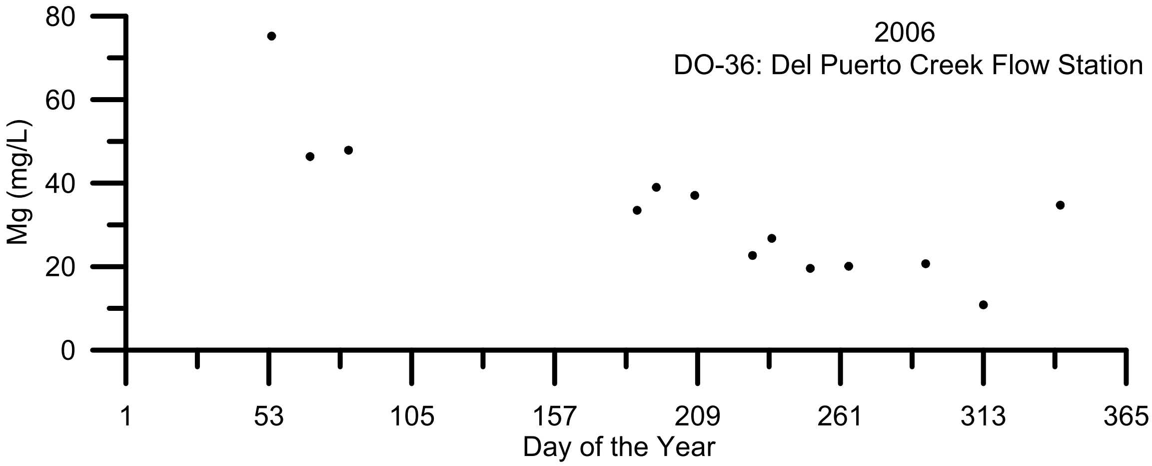

2007
DO-33: Hospital Creek
Mg (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

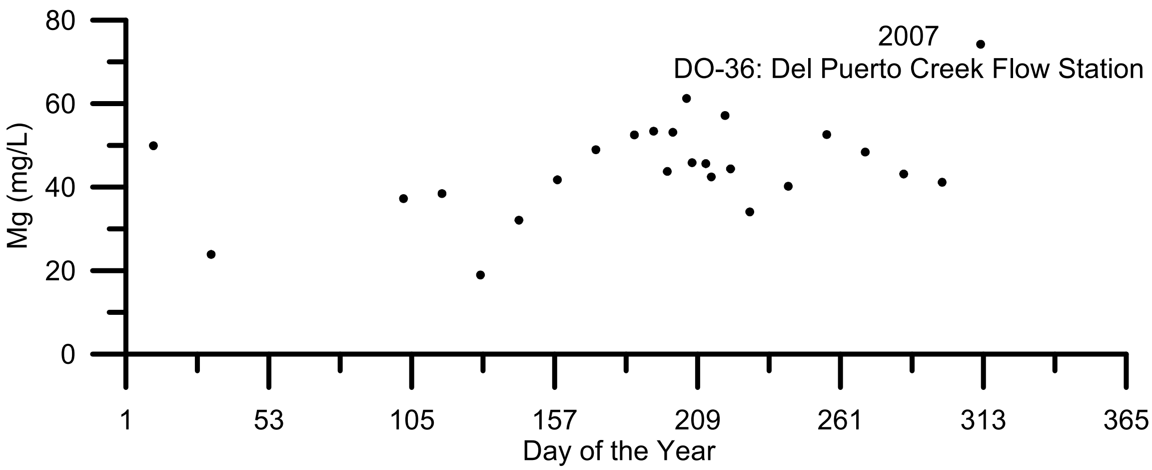

2005
DO-34: Ingram Creek Flow Station
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

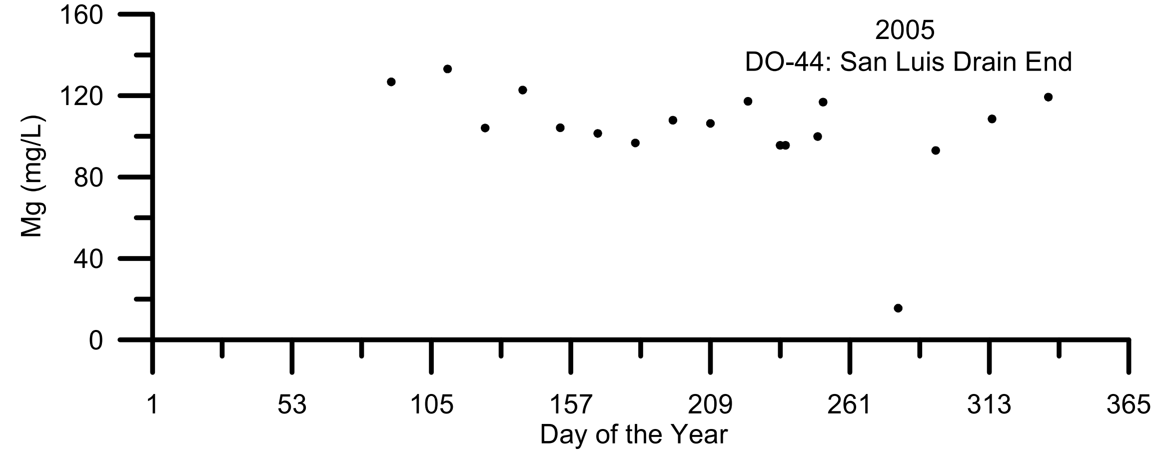

2006
DO-34: Ingram Creek Flow Station
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

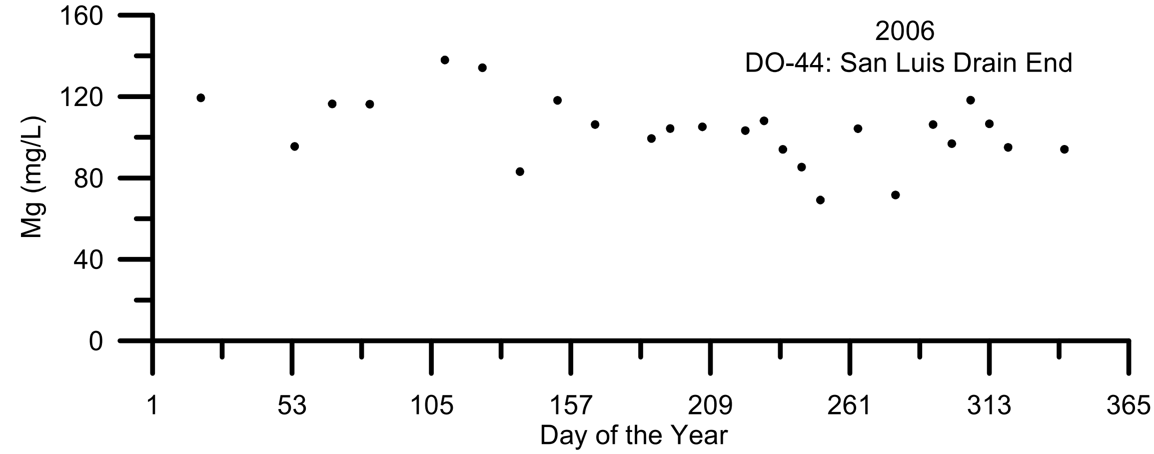

2007
DO-34: Ingram Creek Flow Station
Mg (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

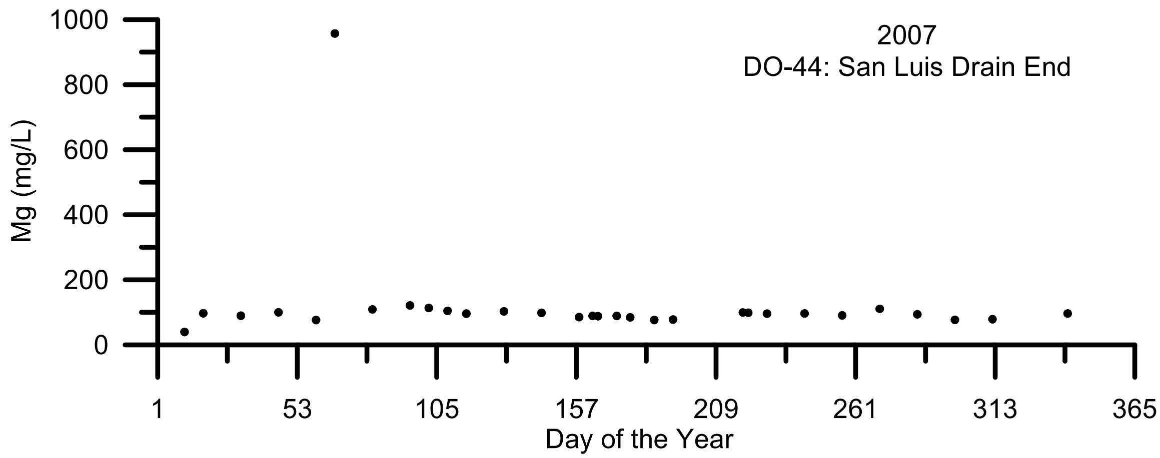

2005
DO-36: Del Puerto Creek Flow Station
Mg (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

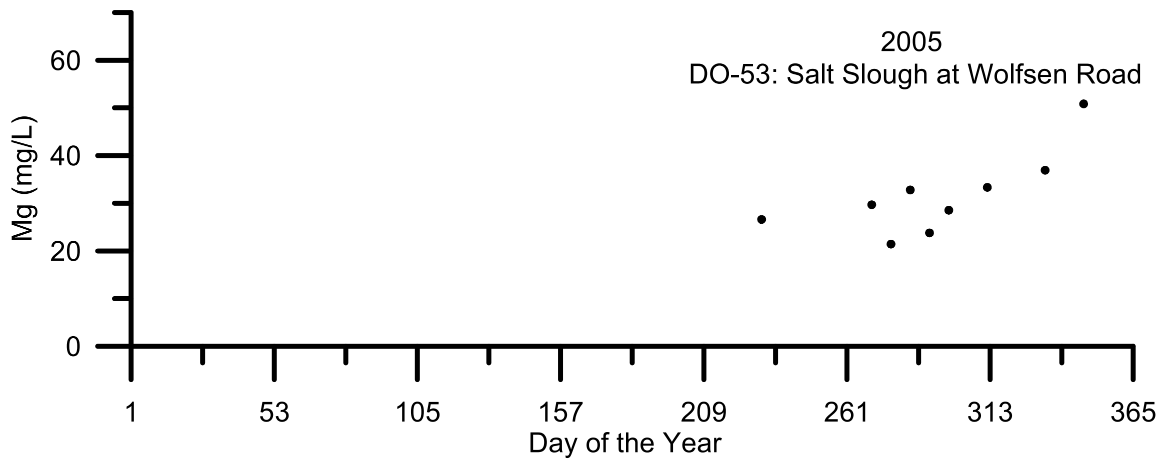

2006
DO-36: Del Puerto Creek Flow Station
Mg (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

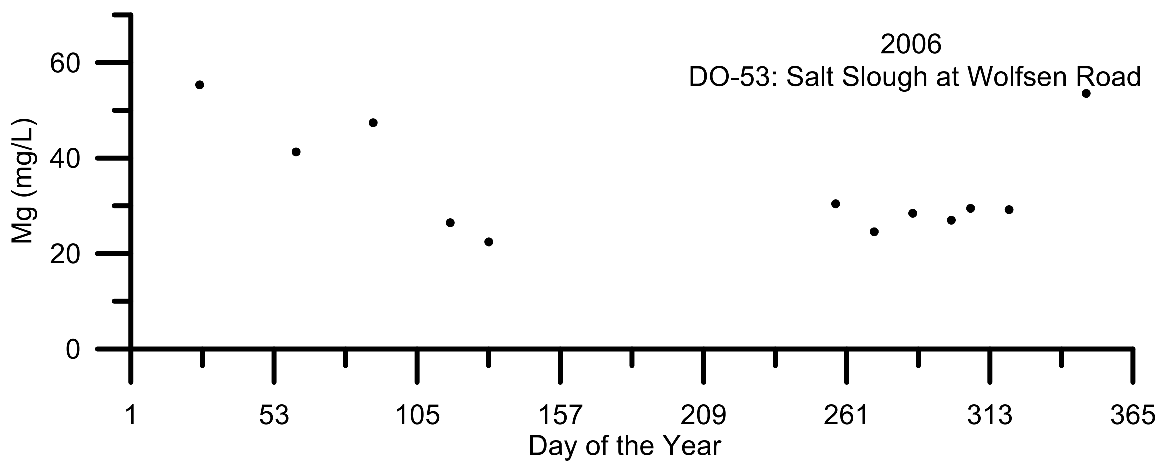

2007
DO-36: Del Puerto Creek Flow Station
Mg (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

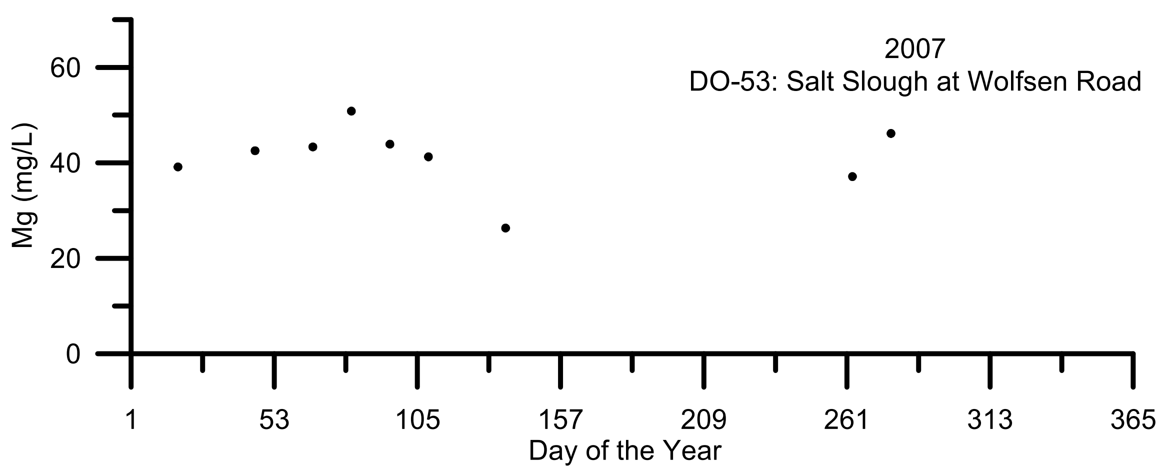

2005
DO-44: San Luis Drain End
Mg (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

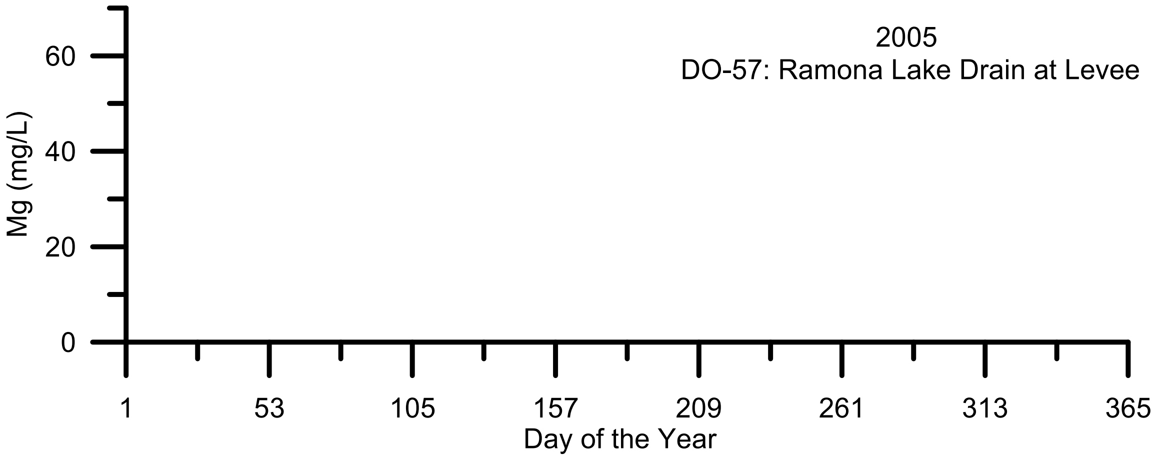

2006
DO-44: San Luis Drain End
Mg (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

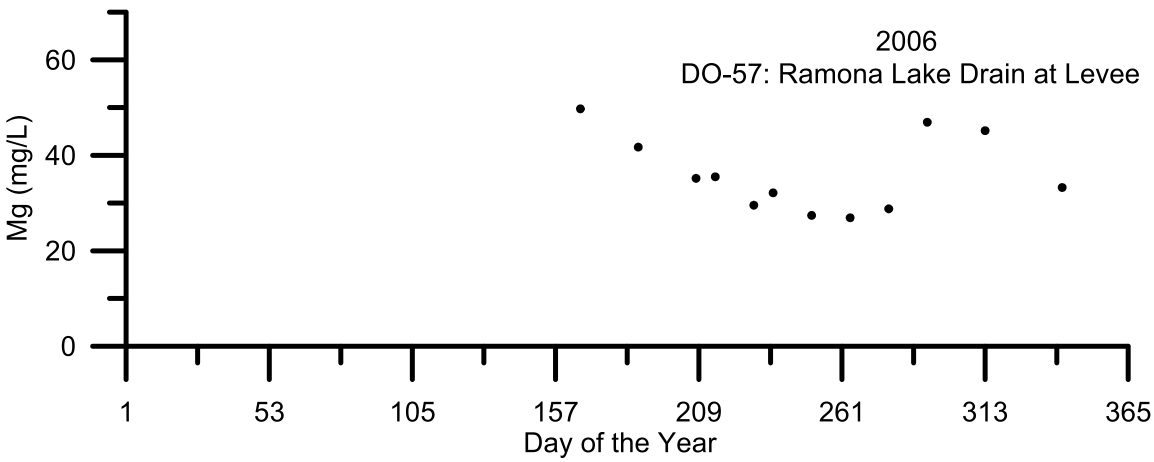

2007
DO-44: San Luis Drain End
Mg (mg/L)
0
200
400
600
800
1000
1
53
105
157
209
261
313
365
Day of the Year

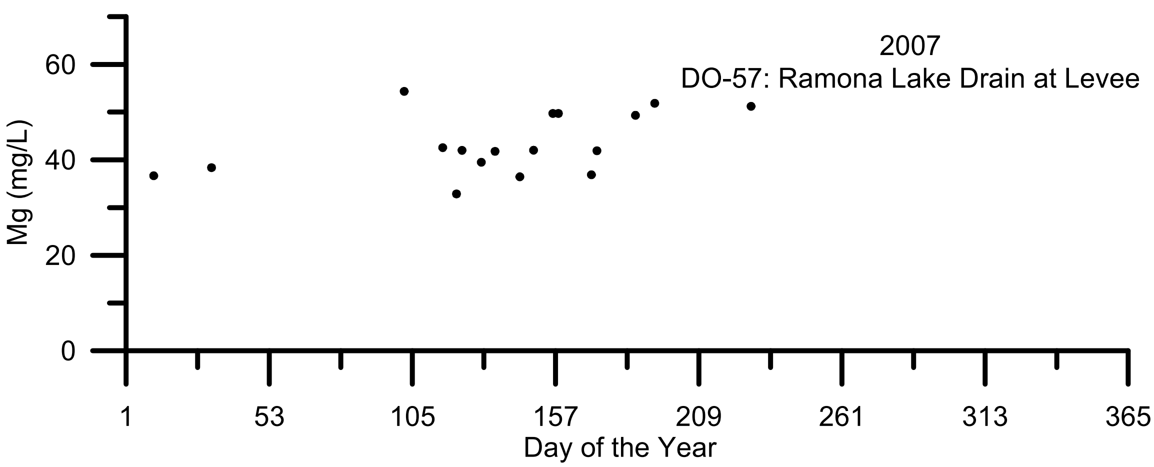

2005
DO-53: Salt Slough at Wolfsen Road
Mg (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365

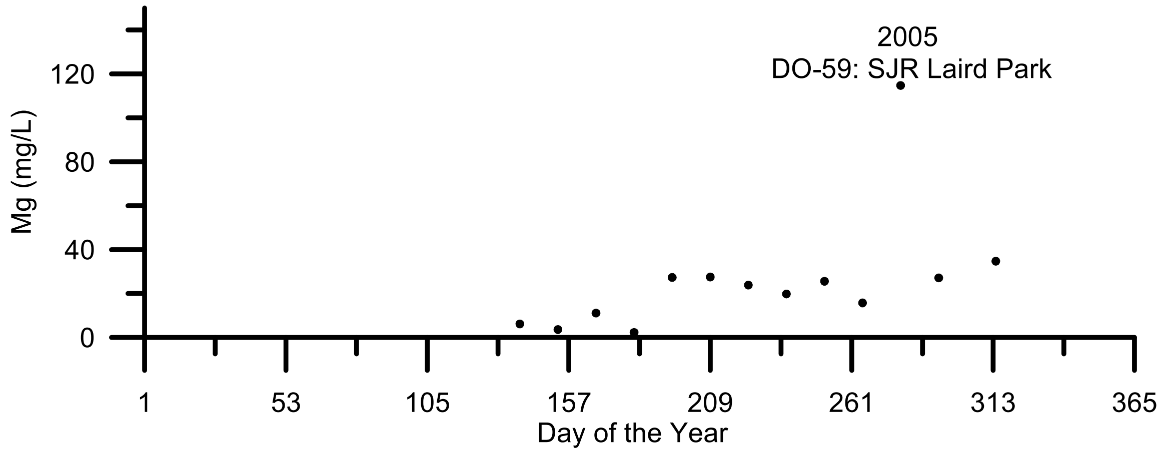

2006
DO-53: Salt Slough at Wolfsen Road
Mg (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365

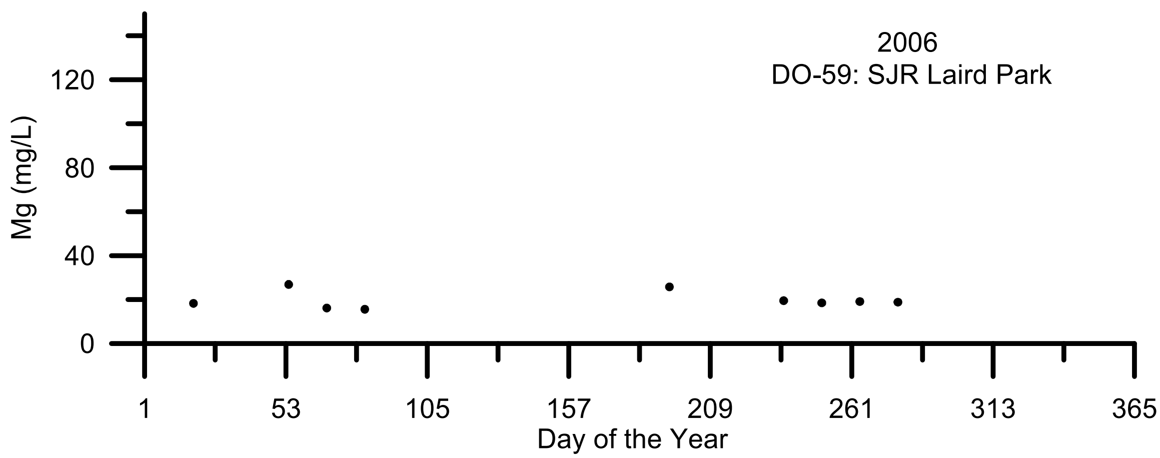

2007
DO-53: Salt Slough at Wolfsen Road
Mg (mg/L)
Day of the Year
0
20
40
60
1
53
105
157
209
261
313
365

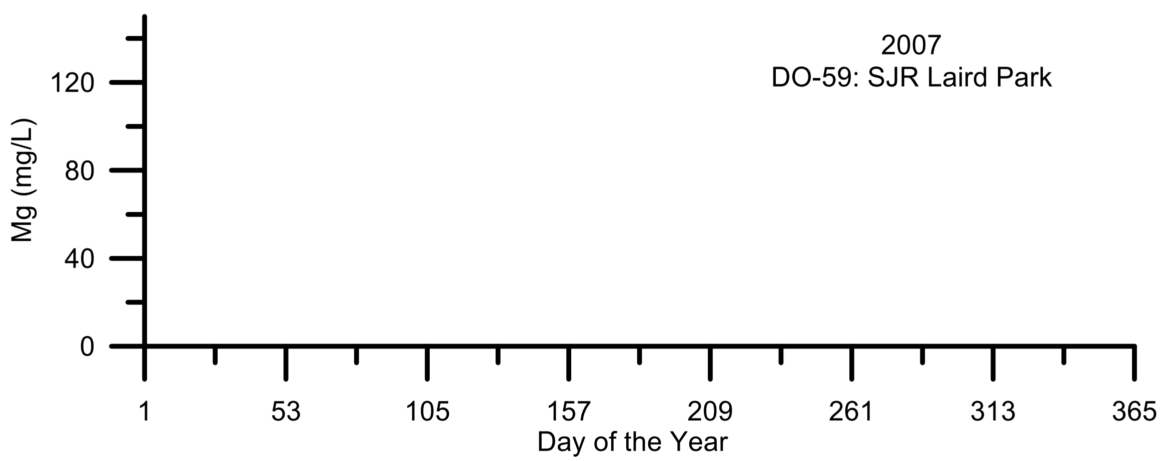

2005
DO-57: Ramona Lake Drain at Levee
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

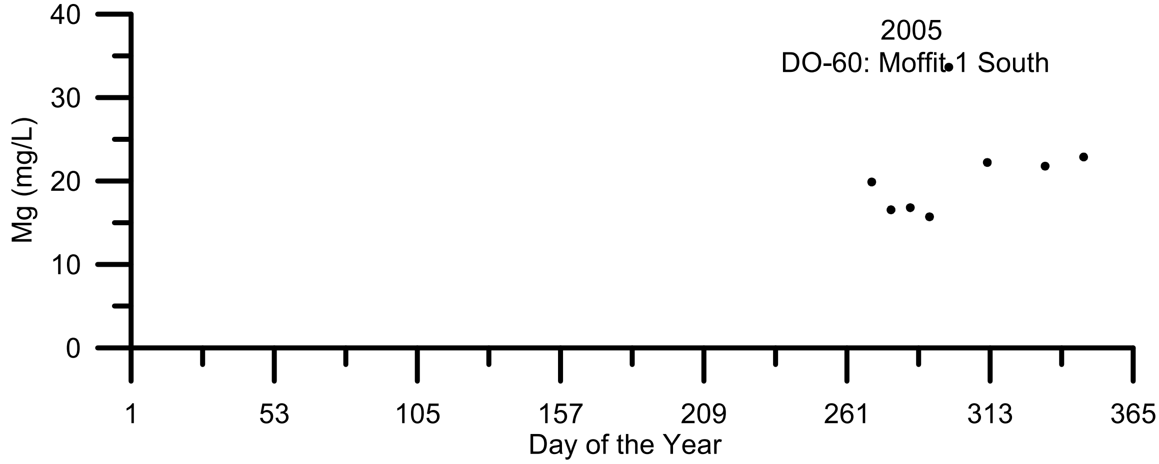

2006
DO-57: Ramona Lake Drain at Levee
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-57: Ramona Lake Drain at Levee
Mg (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

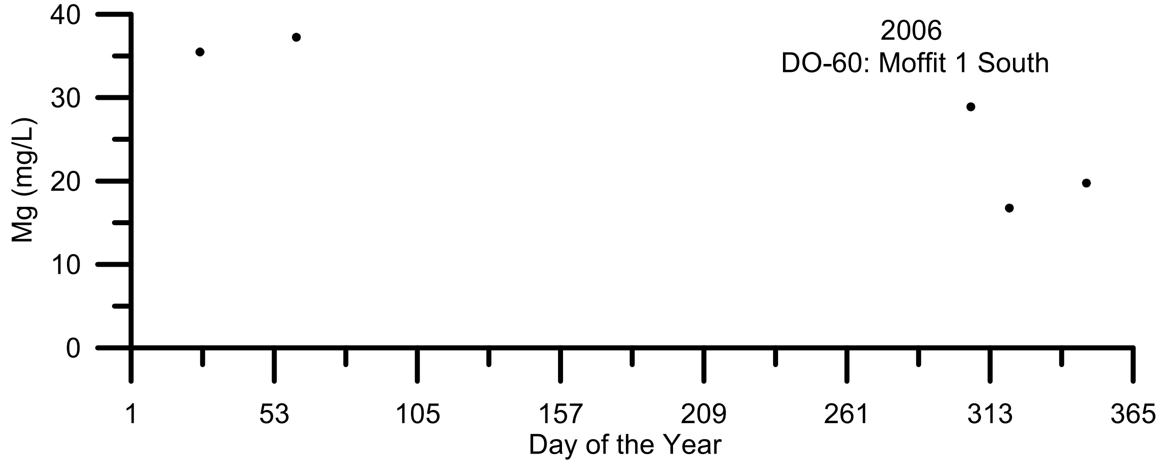

2005
DO-59: SJR Laird Park
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-59: SJR Laird Park
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

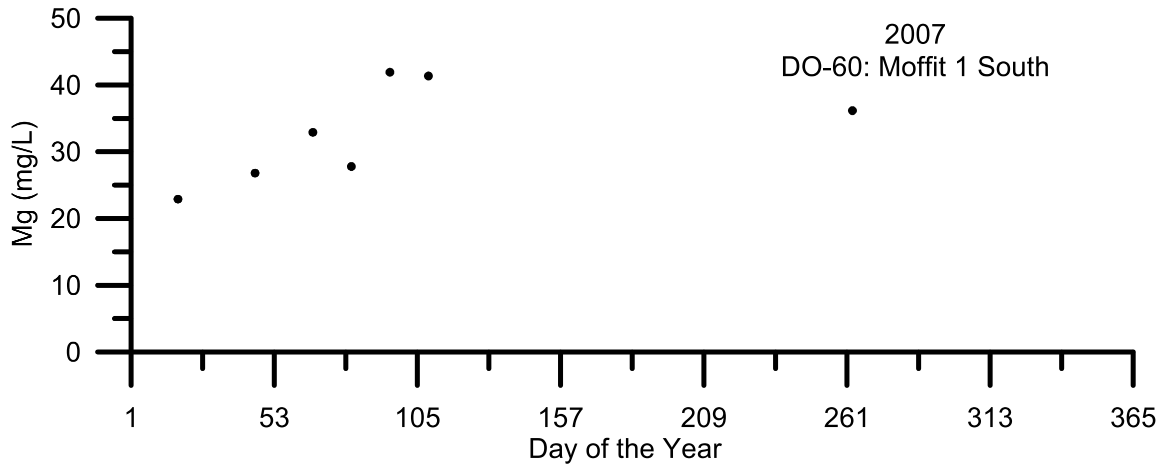

2007
DO-59: SJR Laird Park
Mg (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year



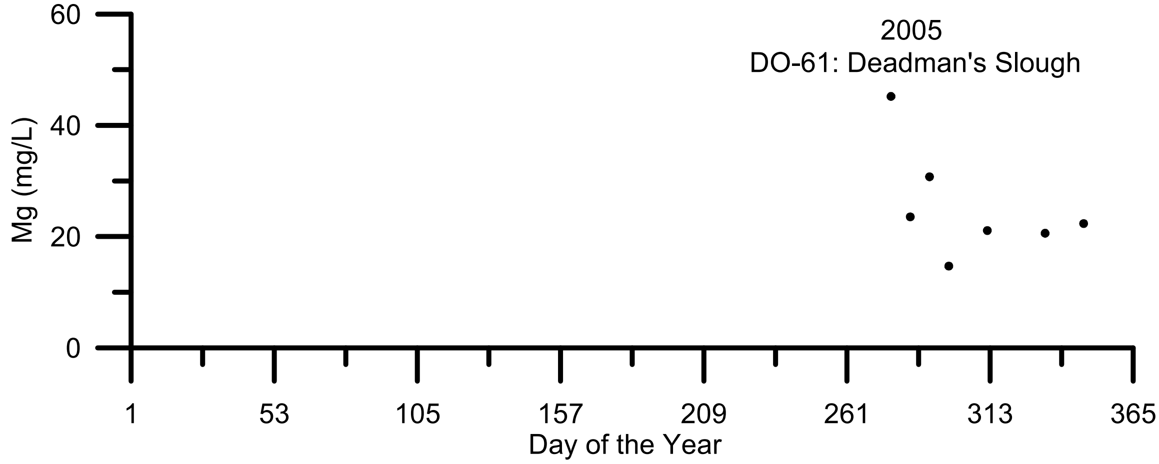
2005
DO-60: Moffit 1 South
Mg (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

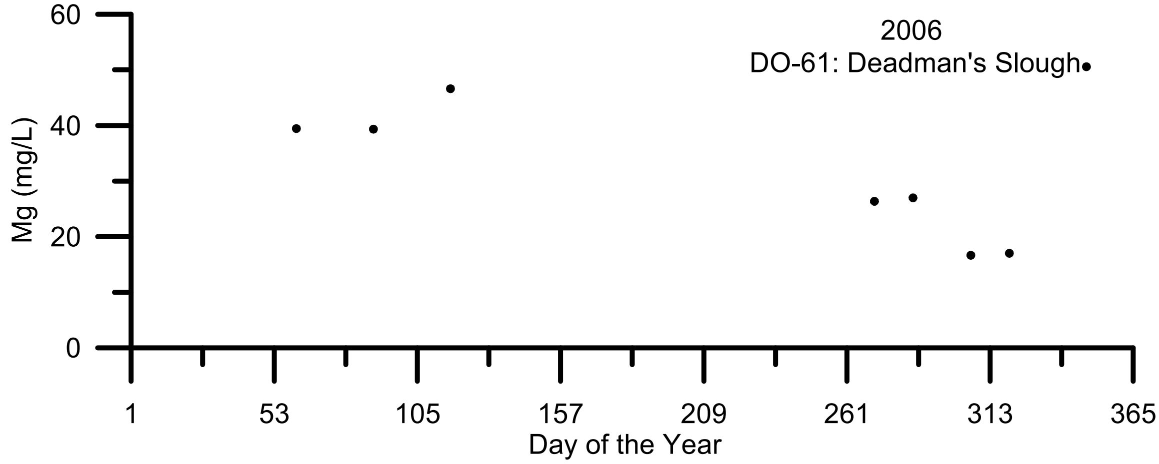


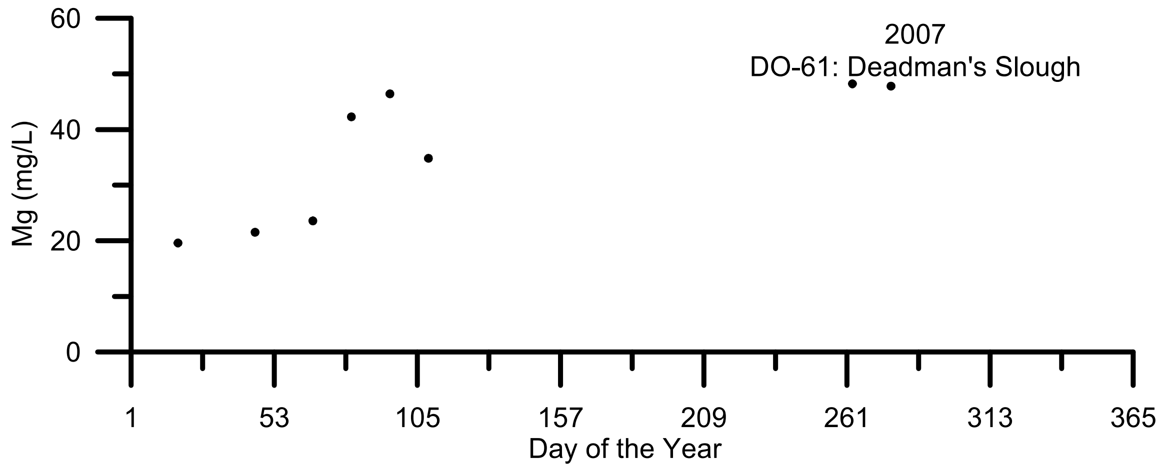
2006
DO-60: Moffit 1 South
Mg (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

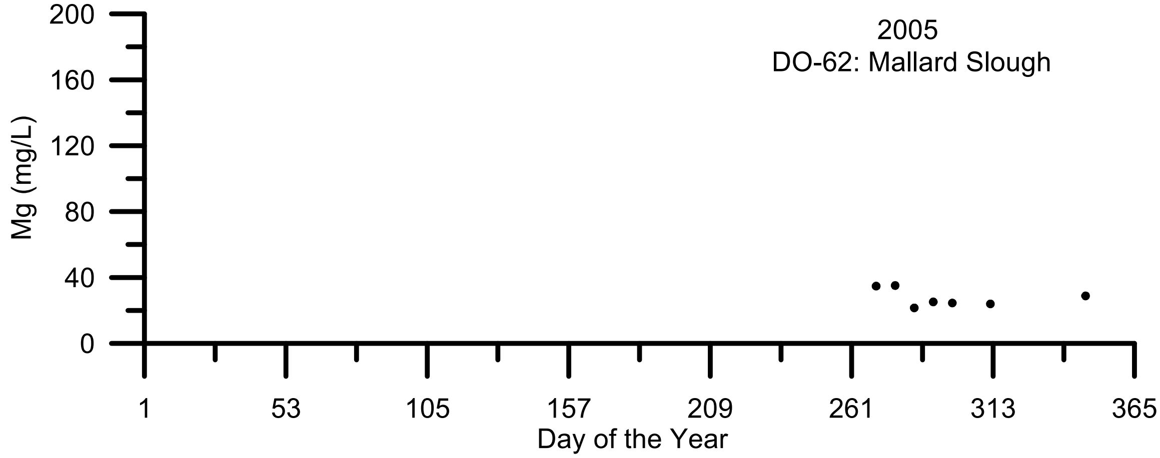


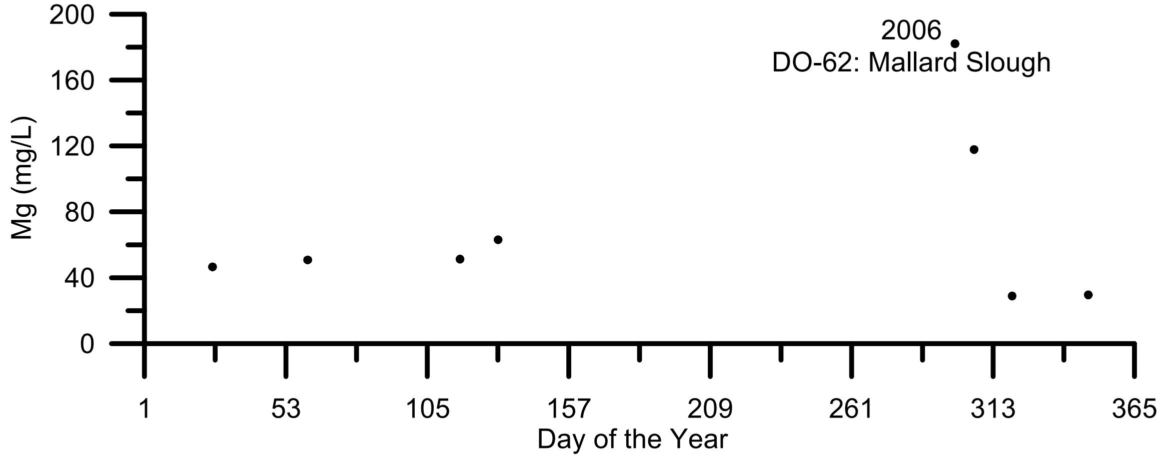
2007
DO-60: Moffit 1 South
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

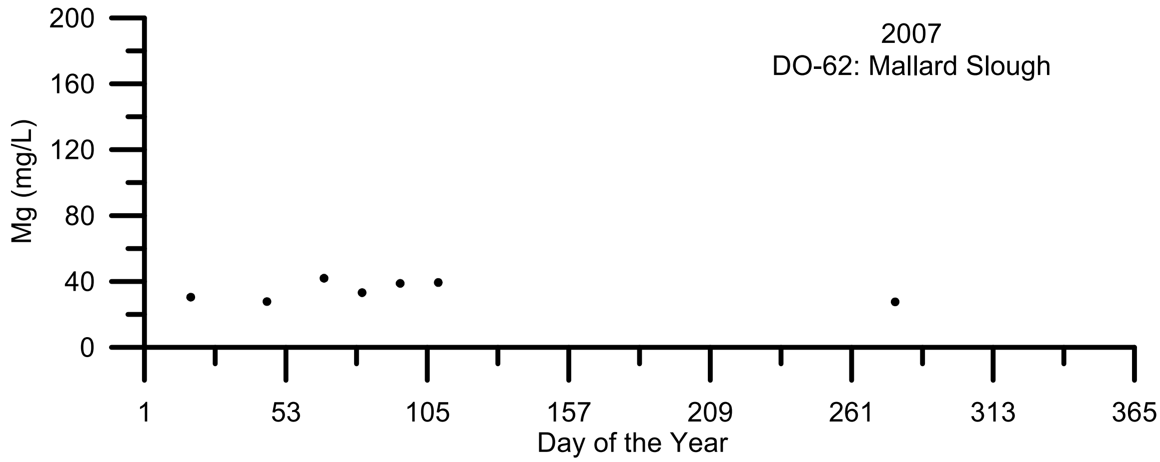

2005
DO-61: Deadman's Slough
Mg (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

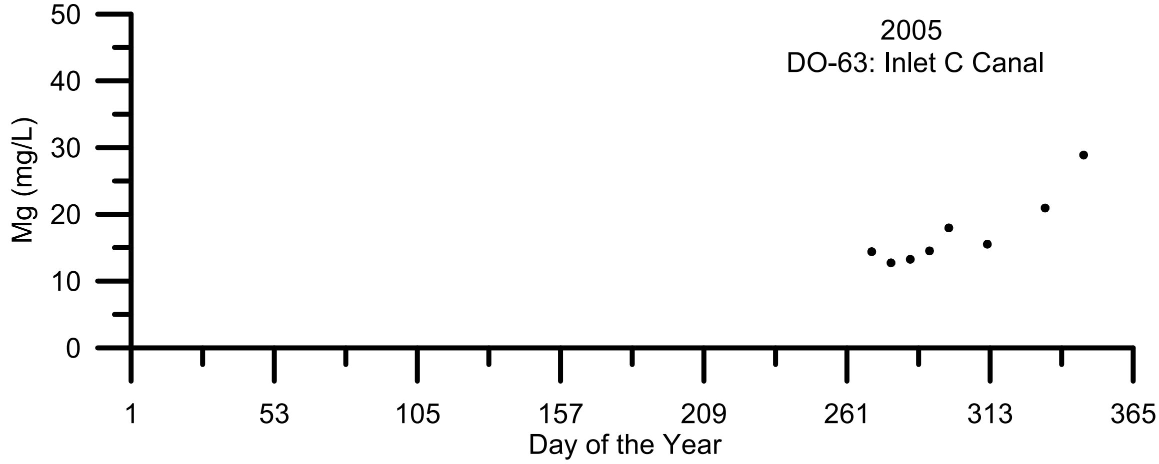

2006
DO-61: Deadman's Slough
Mg (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

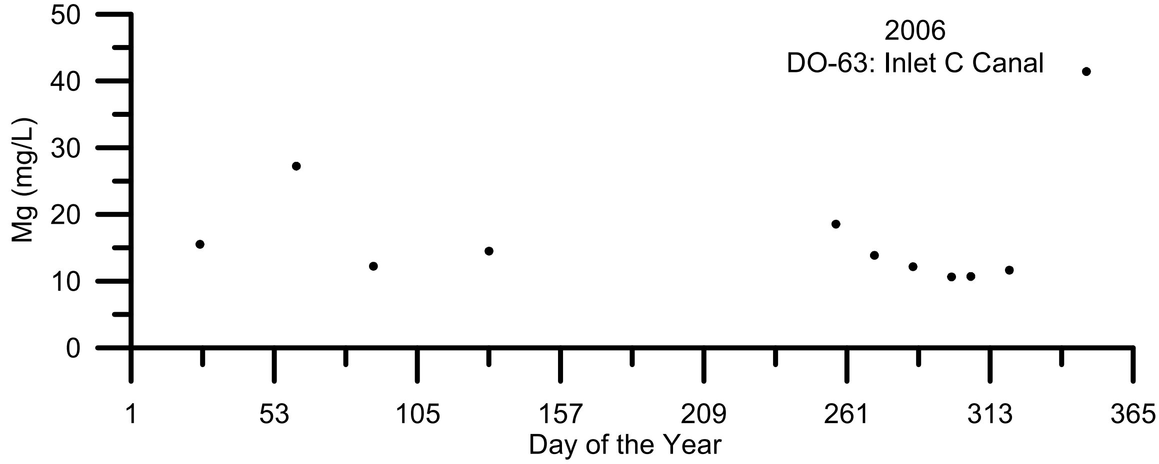

2007
DO-61: Deadman's Slough
Mg (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

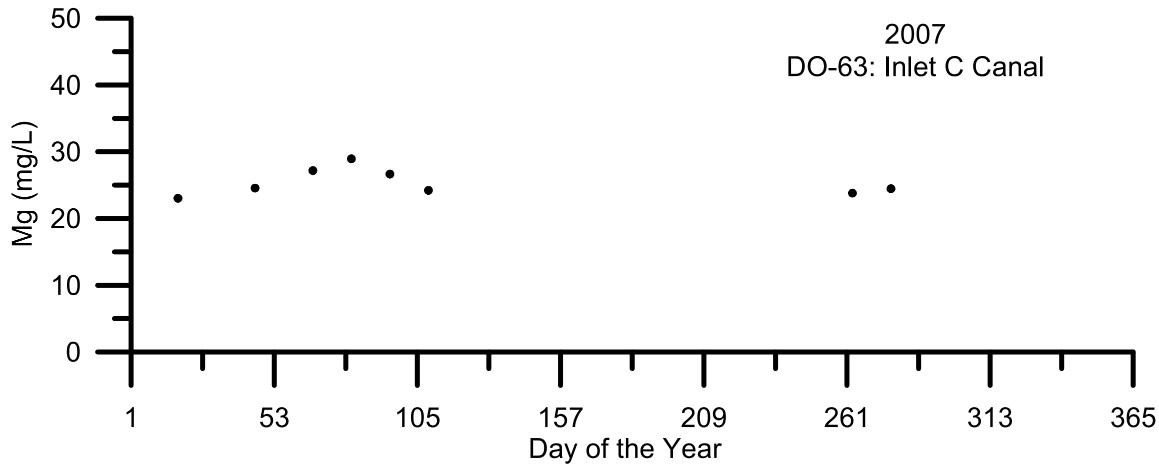

2005
DO-62: Mallard Slough
Mg (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

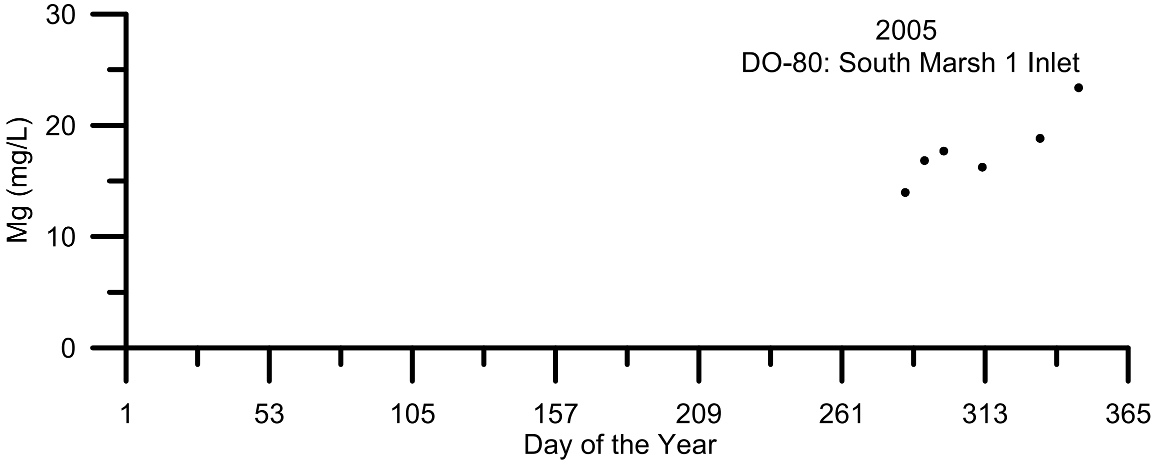

2006
DO-62: Mallard Slough
Mg (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

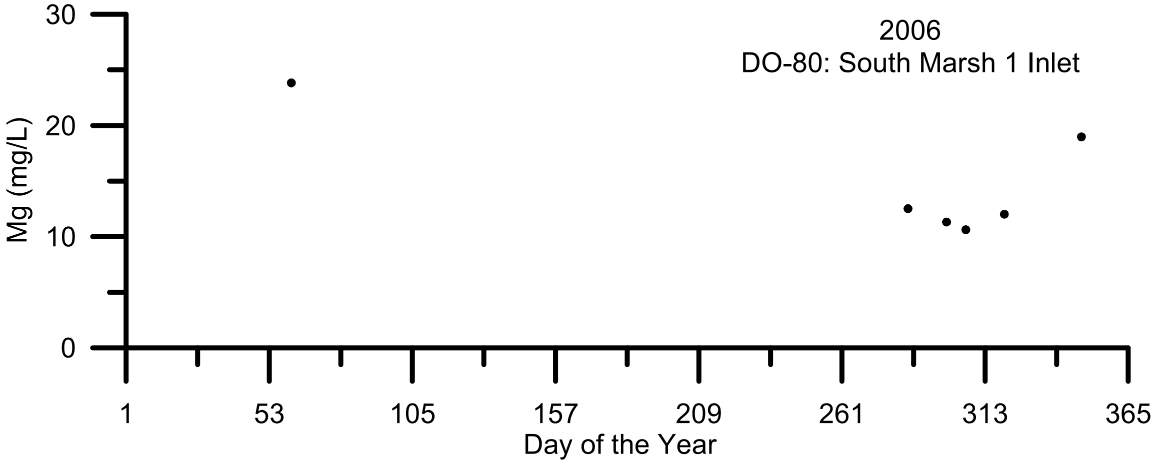

2007
DO-62: Mallard Slough
Mg (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

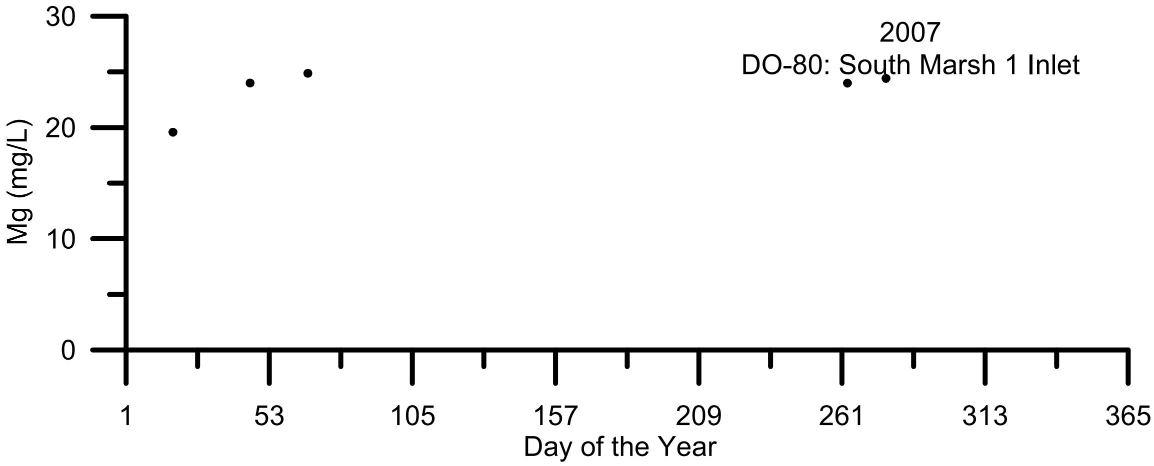

2005
DO-63: Inlet C Canal
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

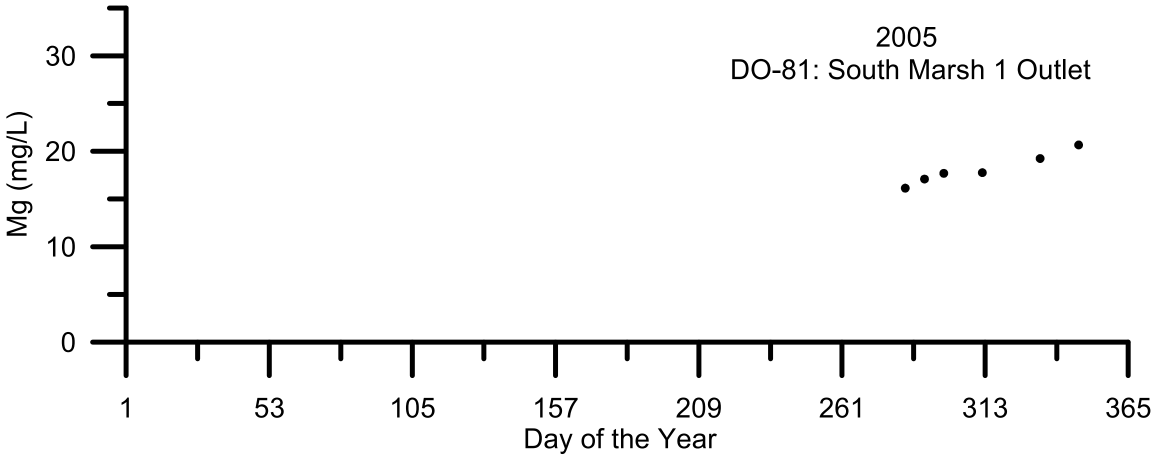

2006
DO-63: Inlet C Canal
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

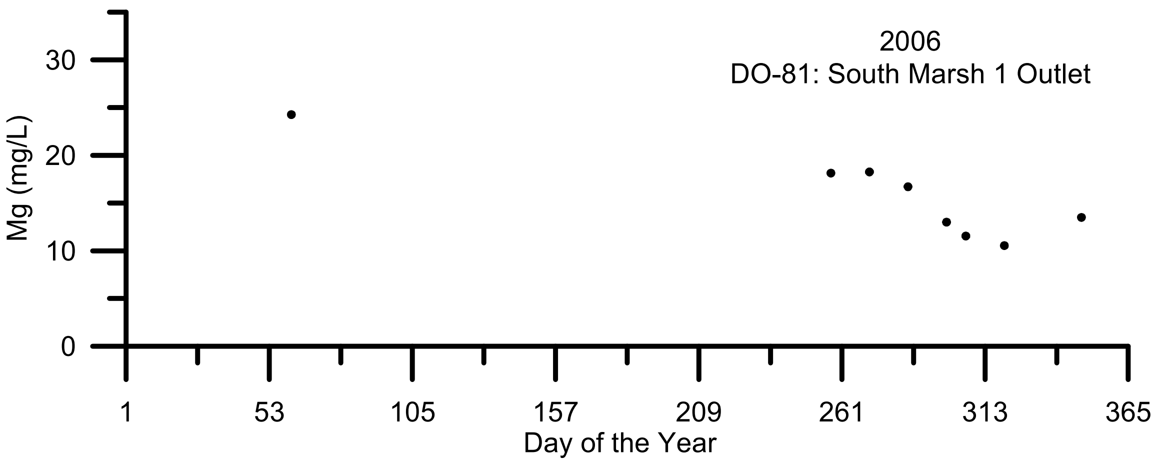

2007
DO-63: Inlet C Canal
Mg (mg/L)
Day of the Year
0
10
20
30
40
50
1
53
105
157
209
261
313
365

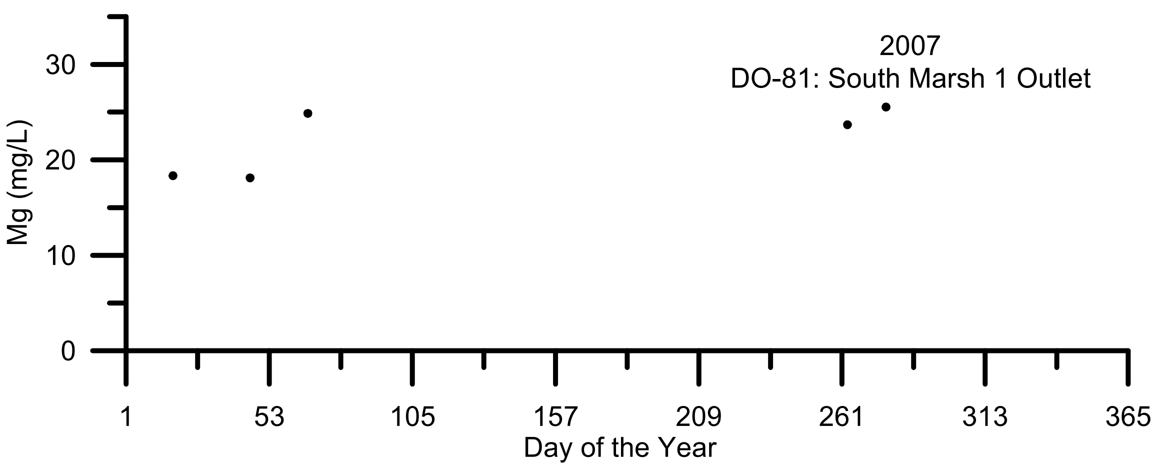

2005
DO-80: South Marsh 1 Inlet
Mg (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

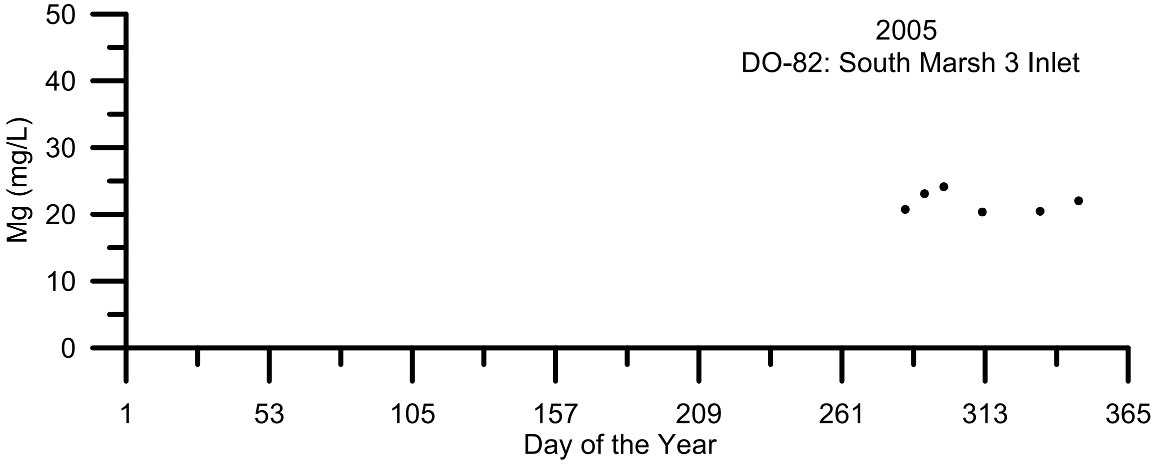

2006
DO-80: South Marsh 1 Inlet
Mg (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

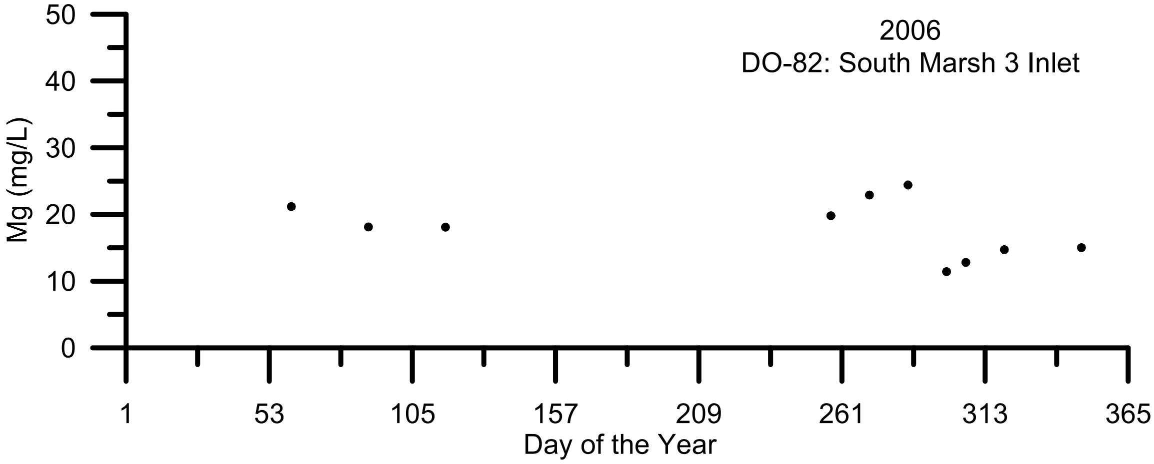

2007
DO-80: South Marsh 1 Inlet
Mg (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

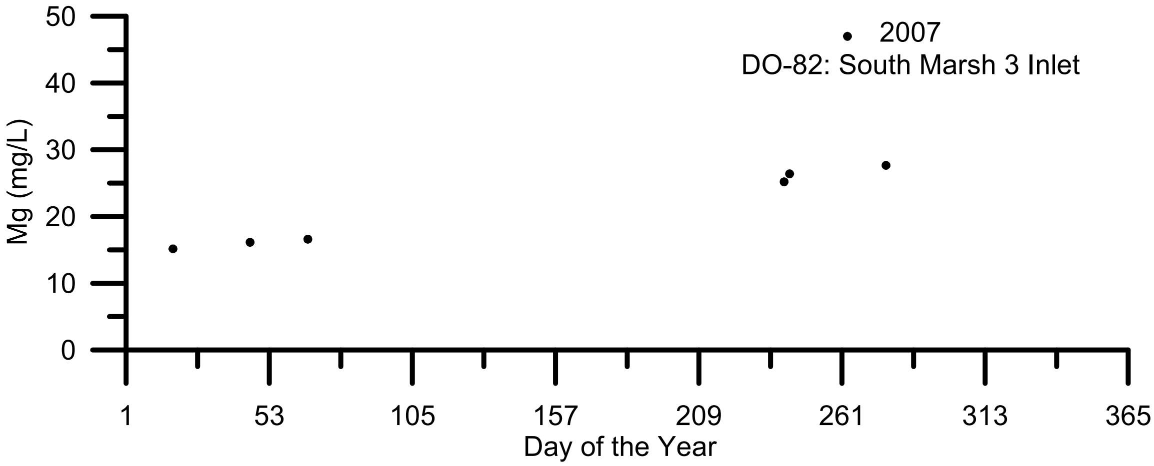

2005
DO-81: South Marsh 1 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

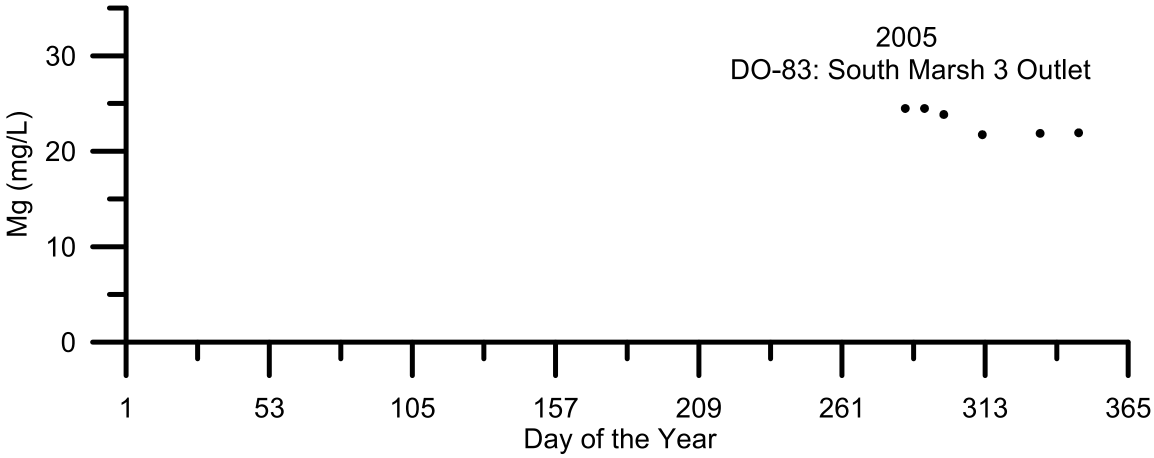

2006
DO-81: South Marsh 1 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

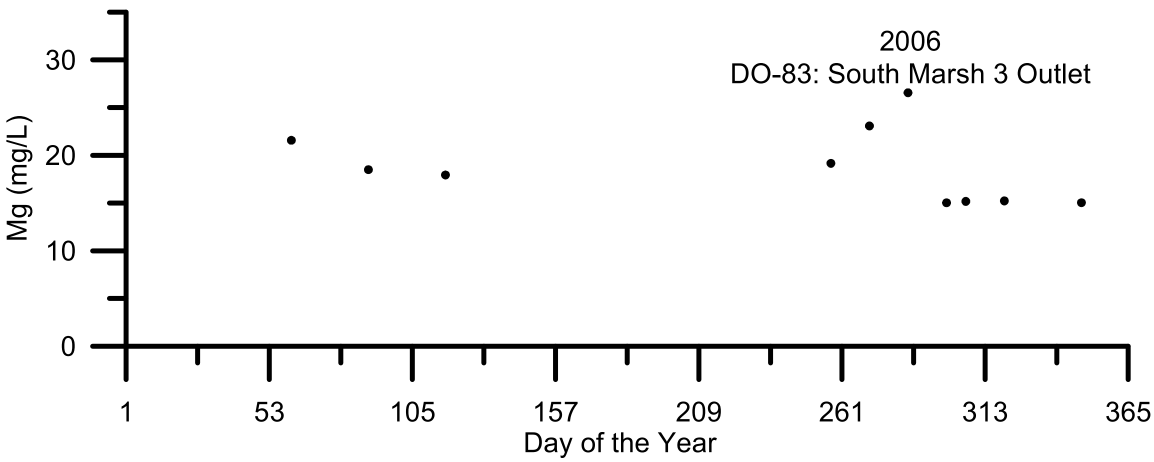

2007
DO-81: South Marsh 1 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

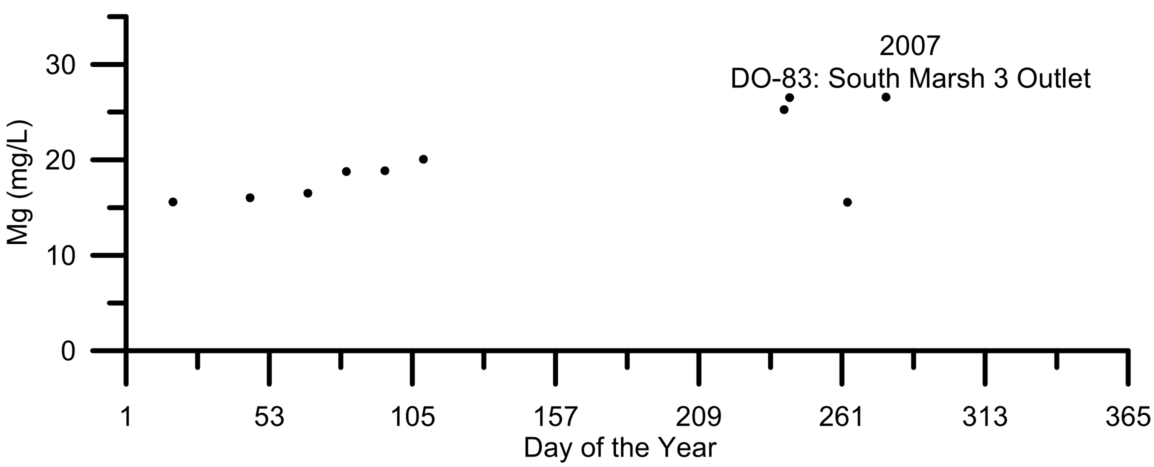

2005
DO-82: South Marsh 3 Inlet
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

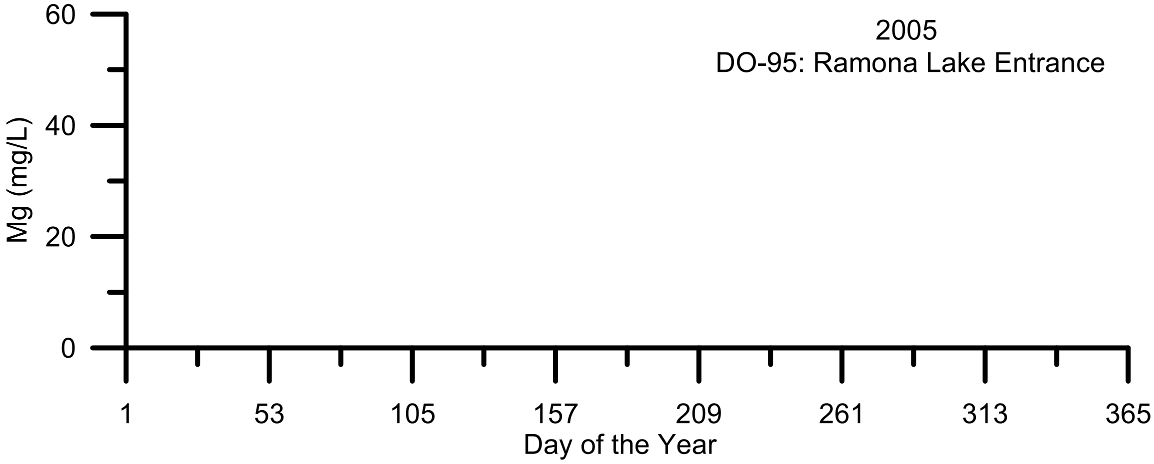

2006
DO-82: South Marsh 3 Inlet
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

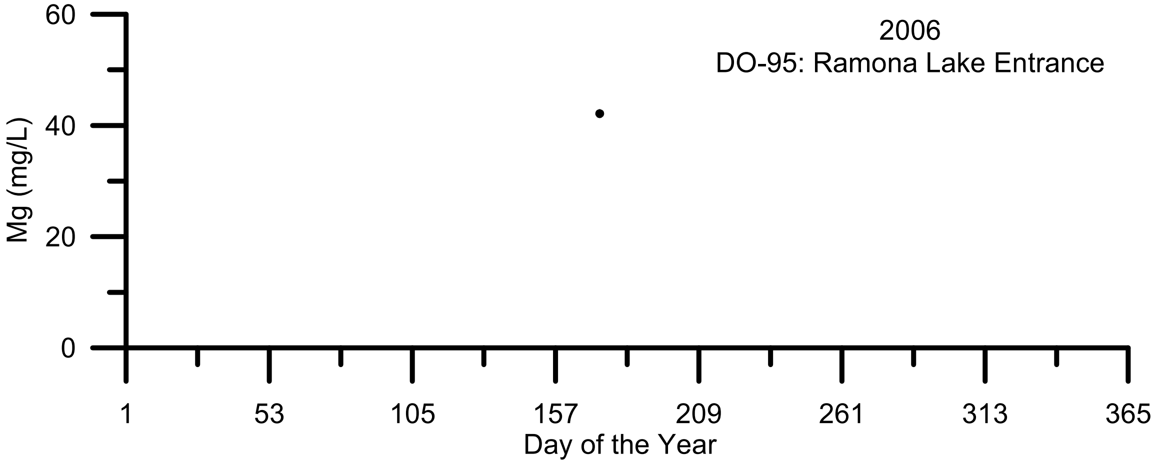

2007
DO-82: South Marsh 3 Inlet
Mg (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

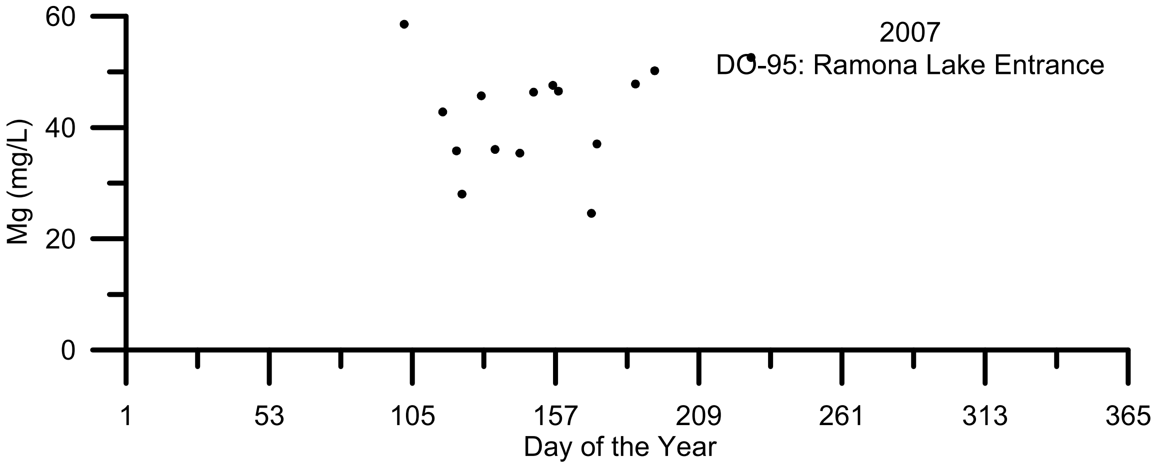

2005
DO-83: South Marsh 3 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Mg (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year


60
40
20
0
Mg (mg/L)
2005
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year


60
40
20
0
Mg (mg/L)
2006
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year


60
40
20
0
Mg (mg/L)
2007
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Dissolved Phosphate Data from the Upstream San Joaquin River

Chelsea Spier[1]
Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of dissolved ortho-phosphate-phosphorus (PO_4-P) for data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples for PO_4-P were transported from the EERP laboratory to the UCD laboraroty where they were filtered through a pre-rinsed, 0.22 µm polycarbonate membrane (Millipore Isopore^{TM}), and then stored at $-20^{o}C$ until ammonia analysis could be completed.

PO_4-P was determined on the filtrate using the stannous chloride method. SM 4500-P.D (APHA,2005). The limit of detection for this method is approximately 3 ppb PO_4-P in clean water using a 1 cm cell for measurement.

Results/Discussion

With each set of PO_4-P field samples analyzed in the UCD laboratory, quality assurance samples including a field duplicate, a trip blank, and lab blanks were also analyzed. Between 2005 and 2007, 93.5% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Four out of five proficiency check samples analyzed for PO_4-P in the UCD laboratory during 2006 and 2007 were found to be within the acceptable range. Samples were measured ranging from 0.0-5.31 mg/L PO_4-P. The average concentration of PO_4-P in samples collected was 0.21 mg/L PO_4-P. PO_4-P was also analyzed by the EERP laboratory on all of the same water samples, and has a high correlation to values measured by UCD. When all data points measured by the two labs are compared they have r^2=0.849, and both labs have almost the same recovery rate, EERP measured 99.94% of PO_4-P as UCD (Figure 2). In general PO_4-P was lowest during the summer months and peaks were found most often during the wet season.

References

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Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

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Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

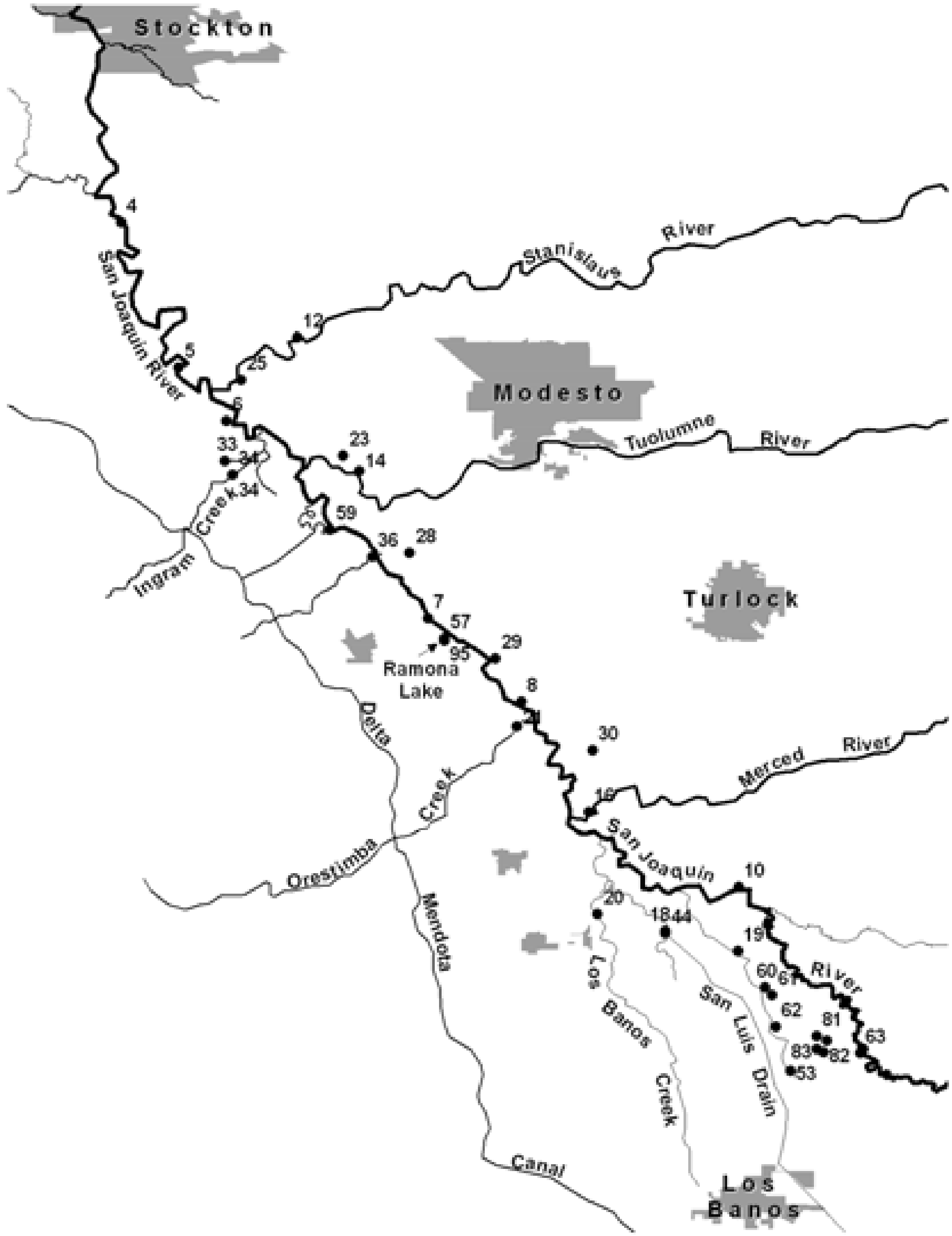
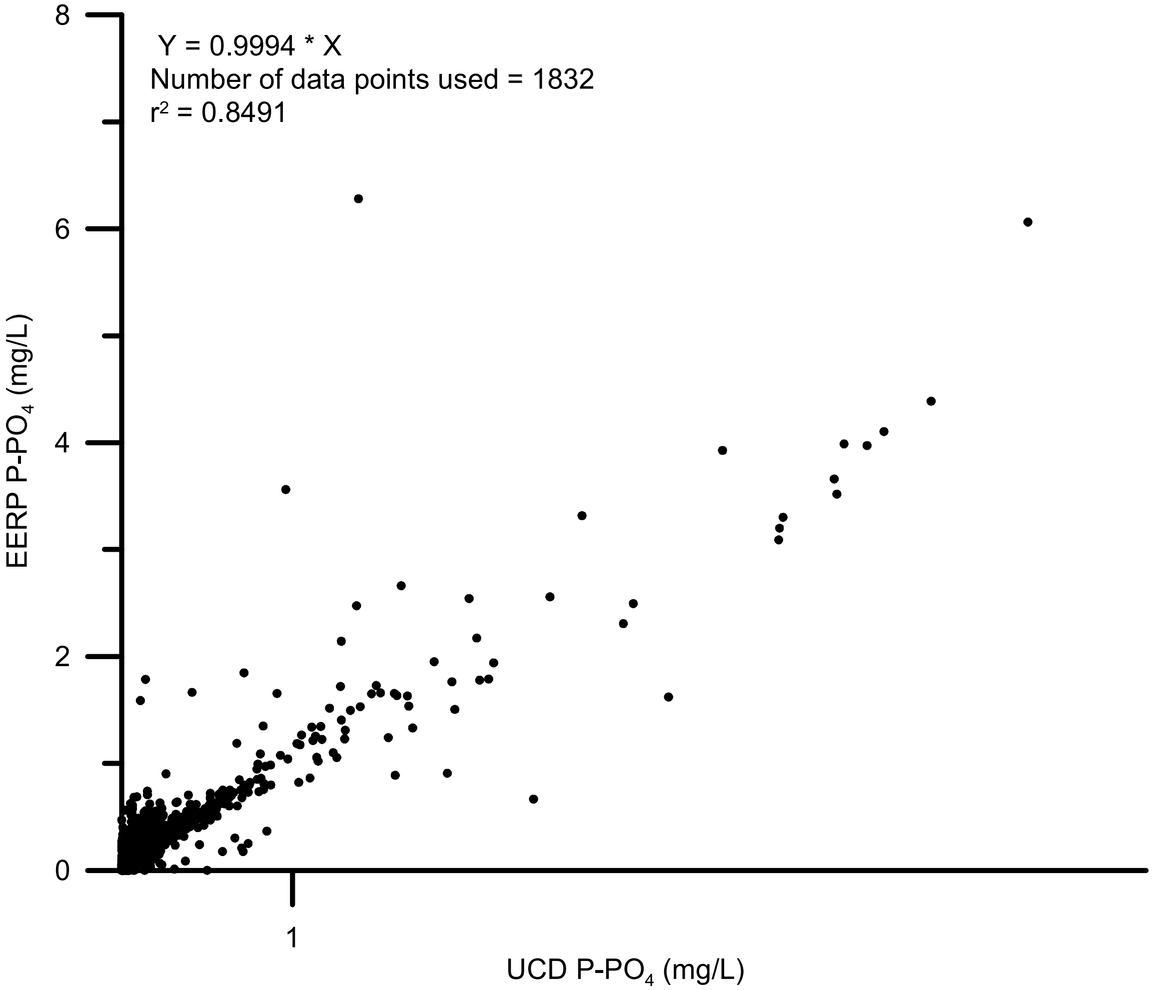
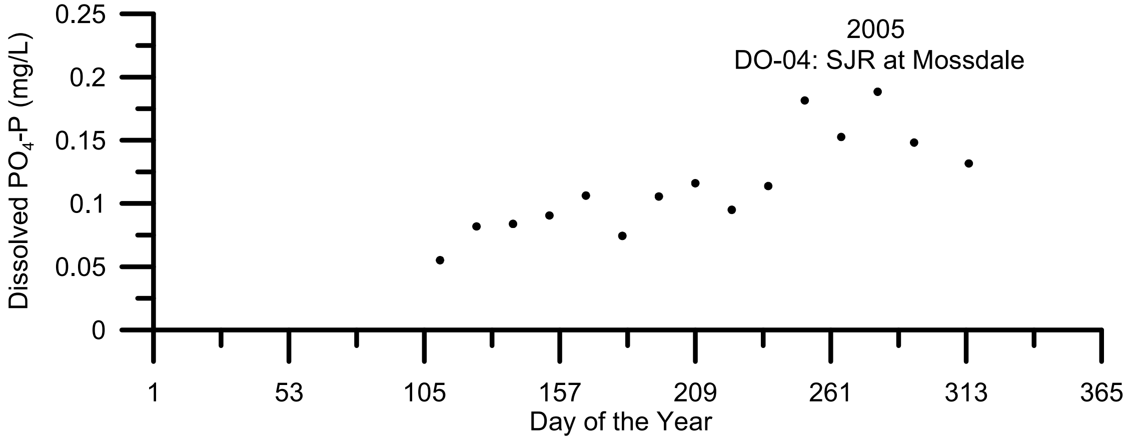
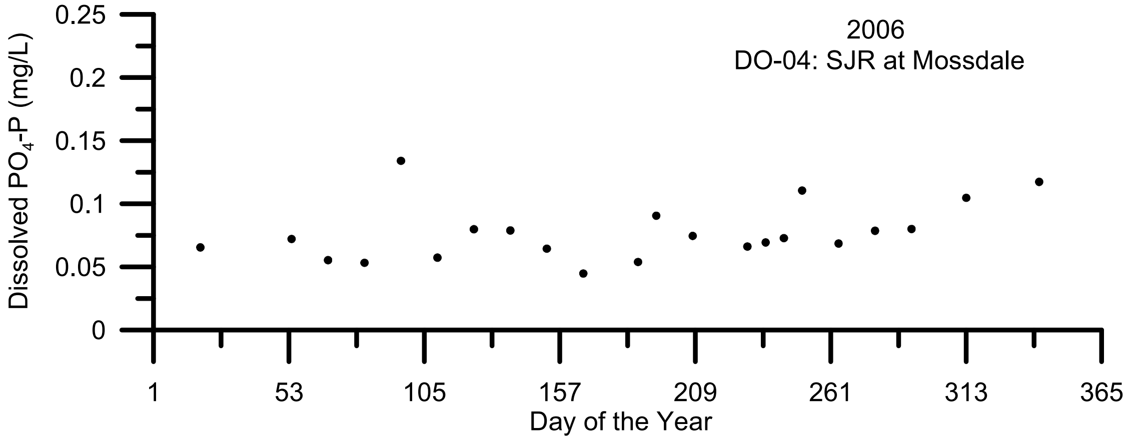


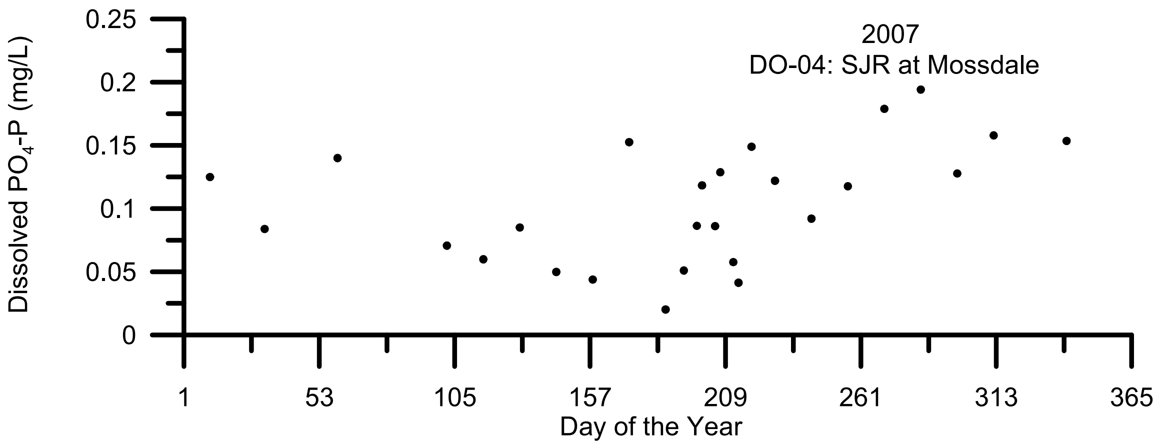
Figure 2: EERP vs UCD PO4-P Data from 2005-2007.

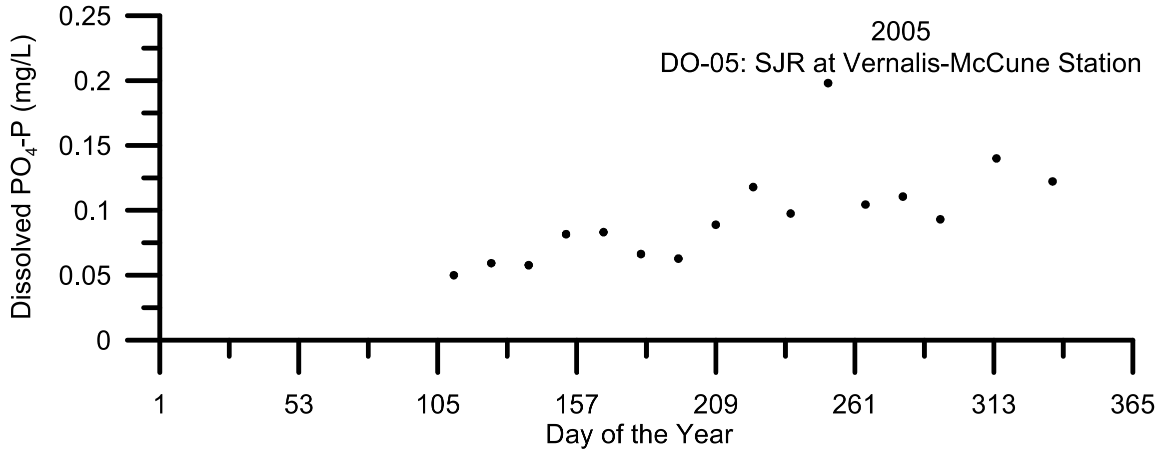


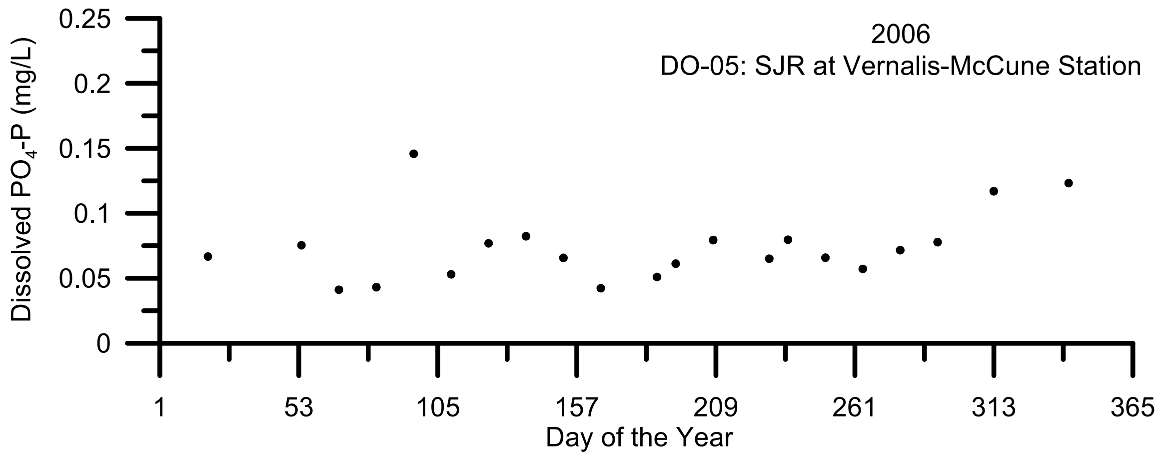
Figures 3 -104: Temporal Plots of Dissolved PO_4-P By Site ID

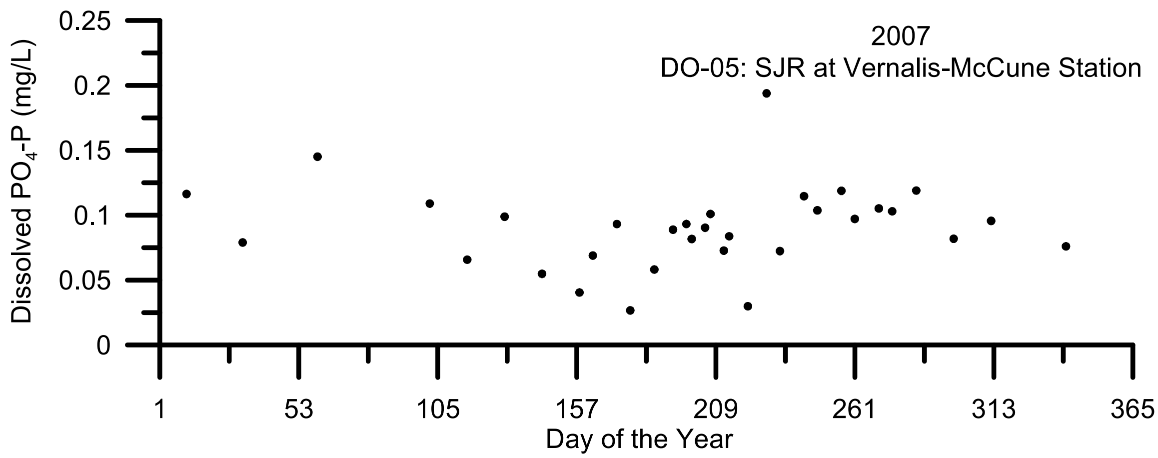


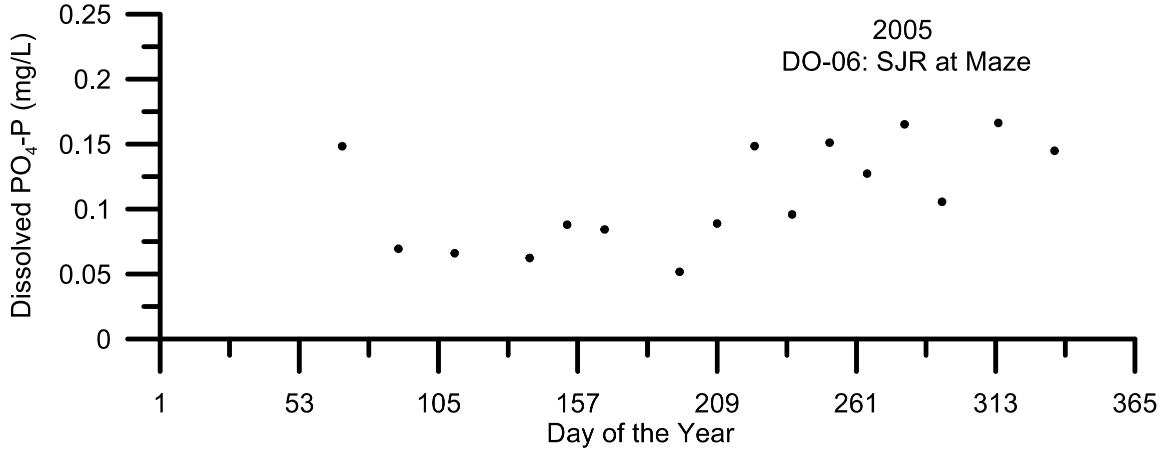


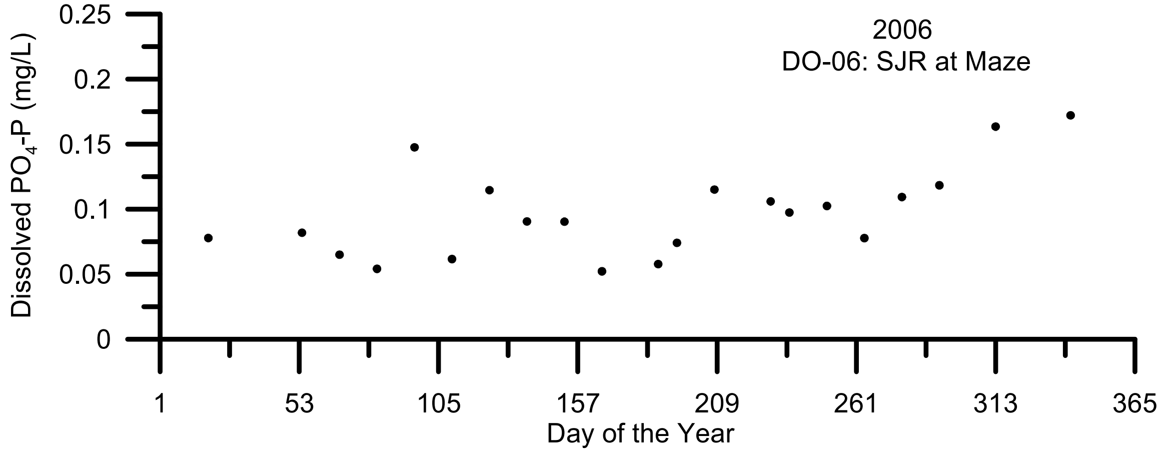


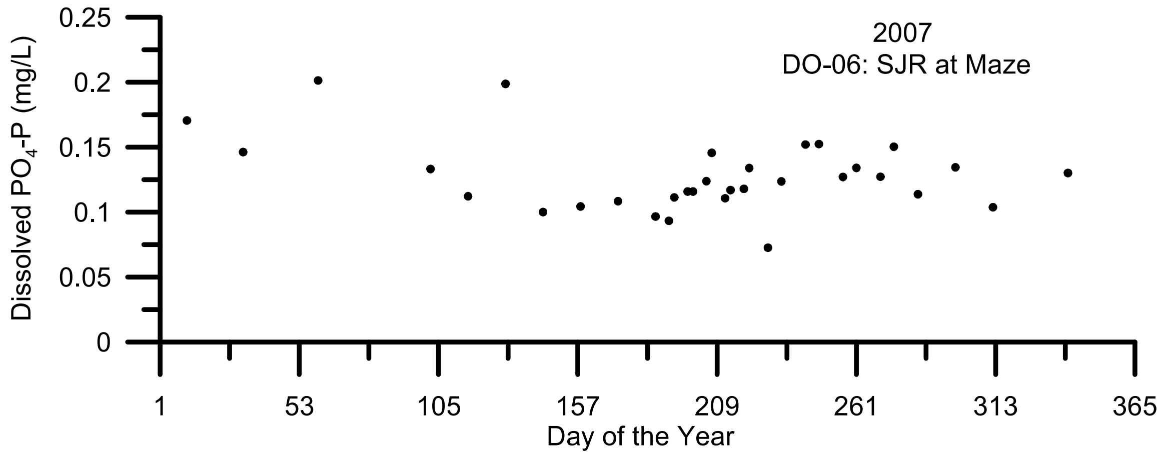

2005
DO-05: SJR at Vernalis-McCune Station
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

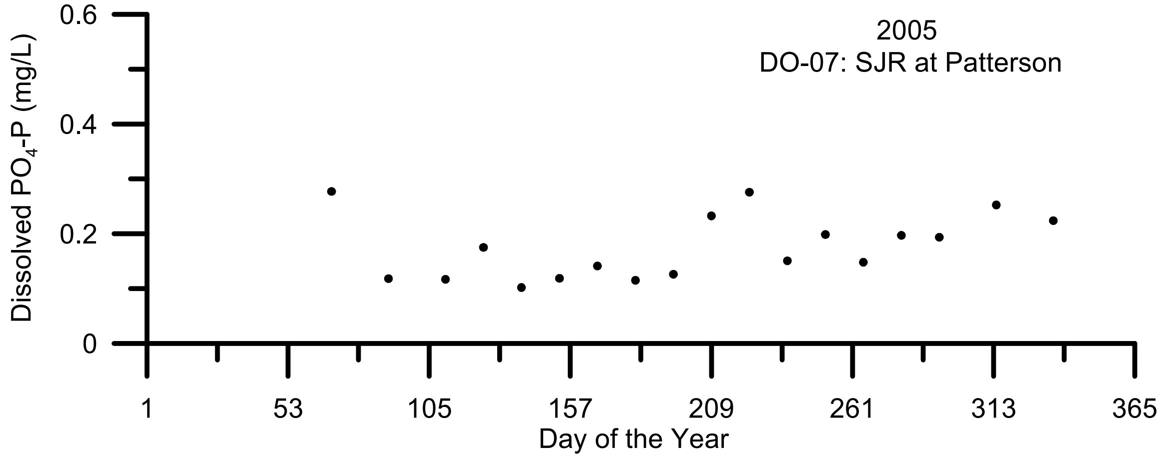

2006
DO-05: SJR at Vernalis-McCune Station
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

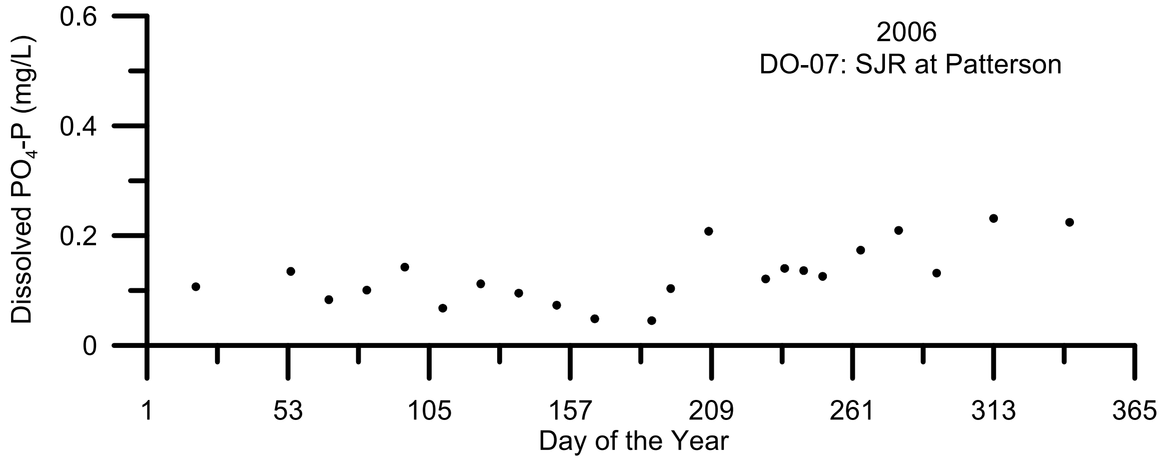

2007
DO-05: SJR at Vernalis-McCune Station
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

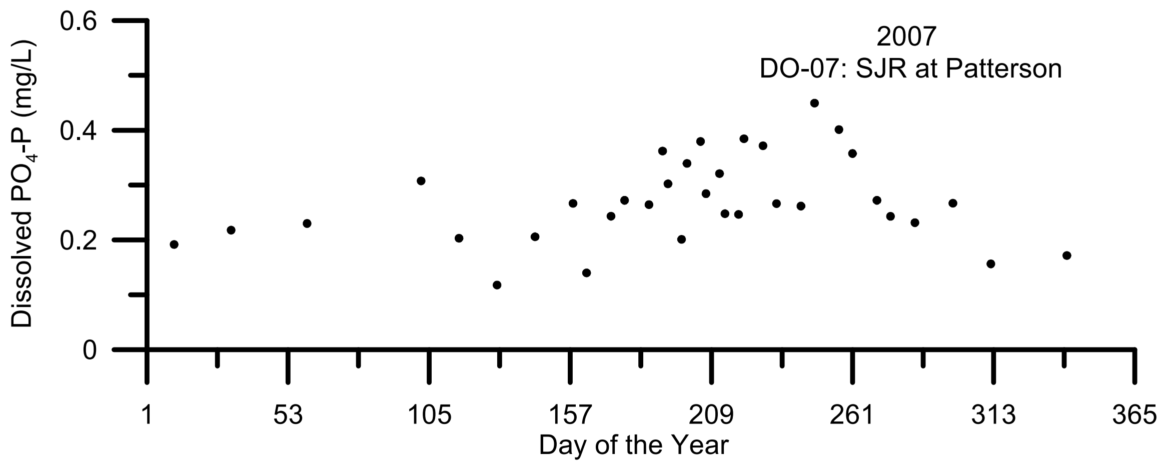

2005
DO-06: SJR at Maze
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

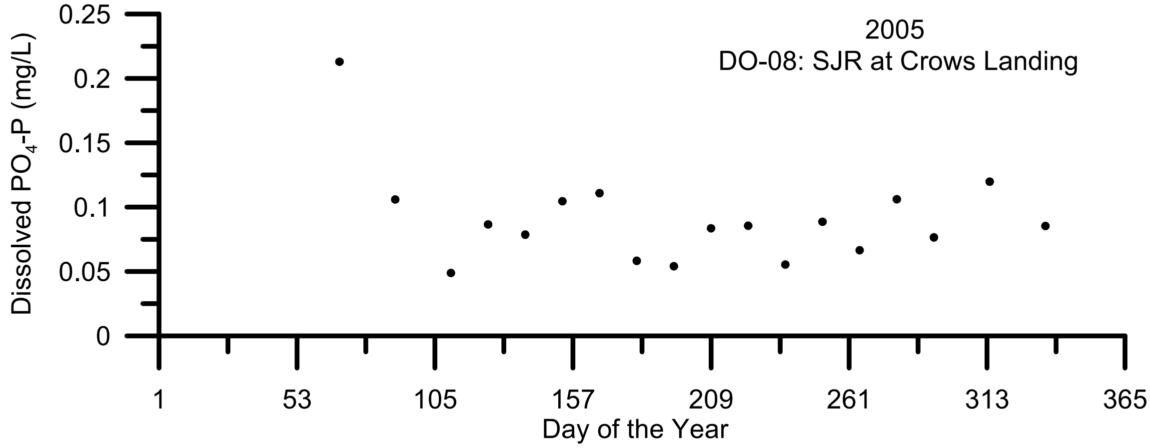

2006
DO-06: SJR at Maze
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

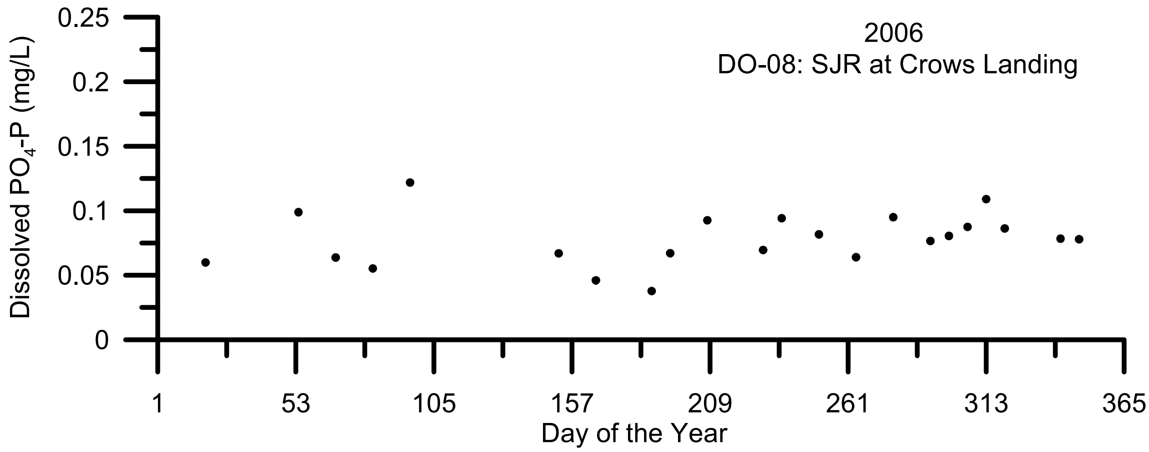

2005
DO-07: SJR at Patterson
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

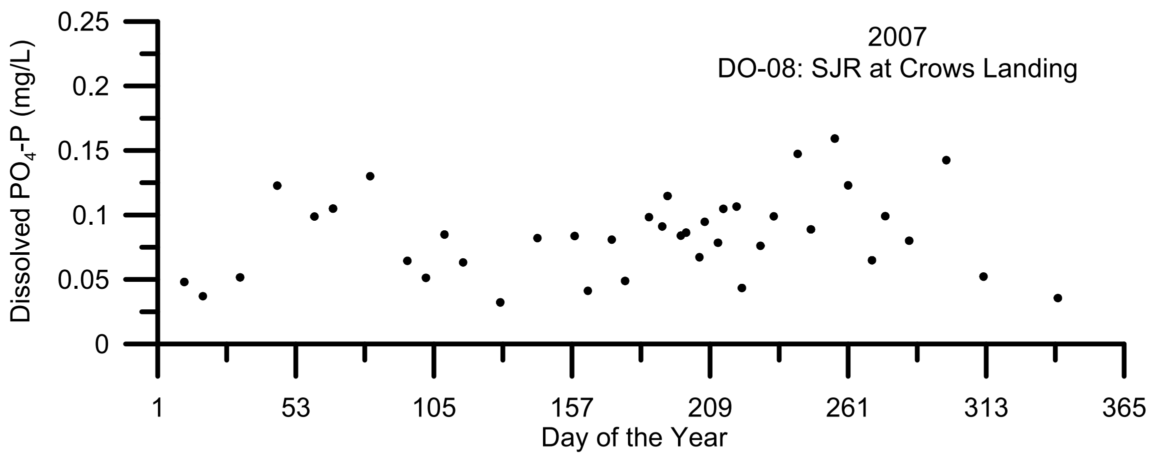

2007
DO-07: SJR at Patterson
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year



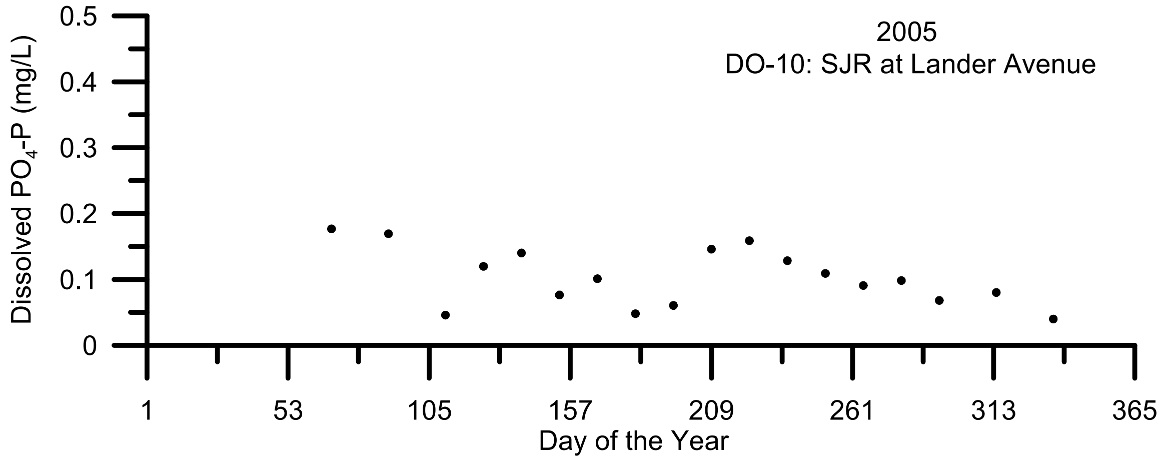
2005
DO-08: SJR at Crows Landing
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-08: SJR at Crows Landing
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-08: SJR at Crows Landing
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-10: SJR at Lander Avenue
Dissolved PO4-P (mg/L)
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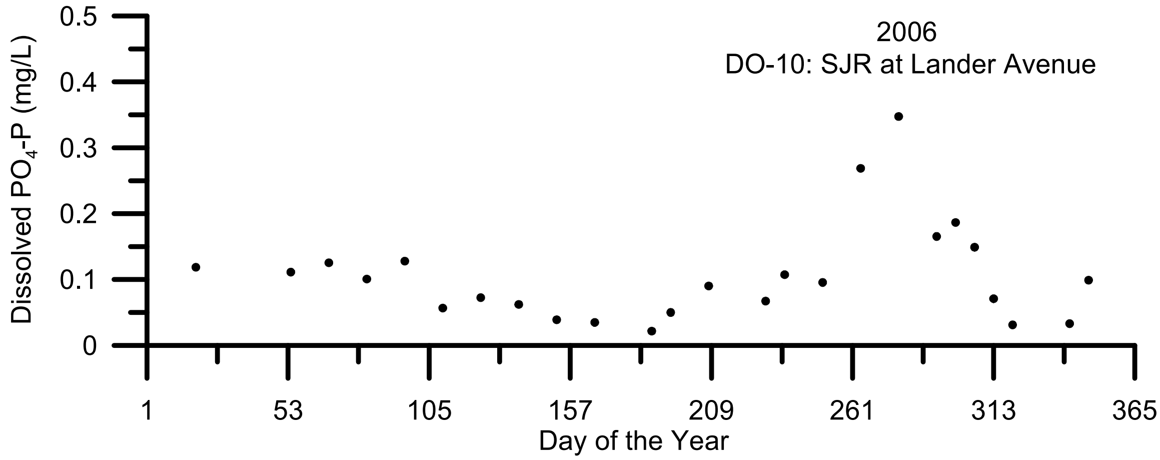
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-10: SJR at Lander Avenue
Dissolved PO4-P (mg/L)
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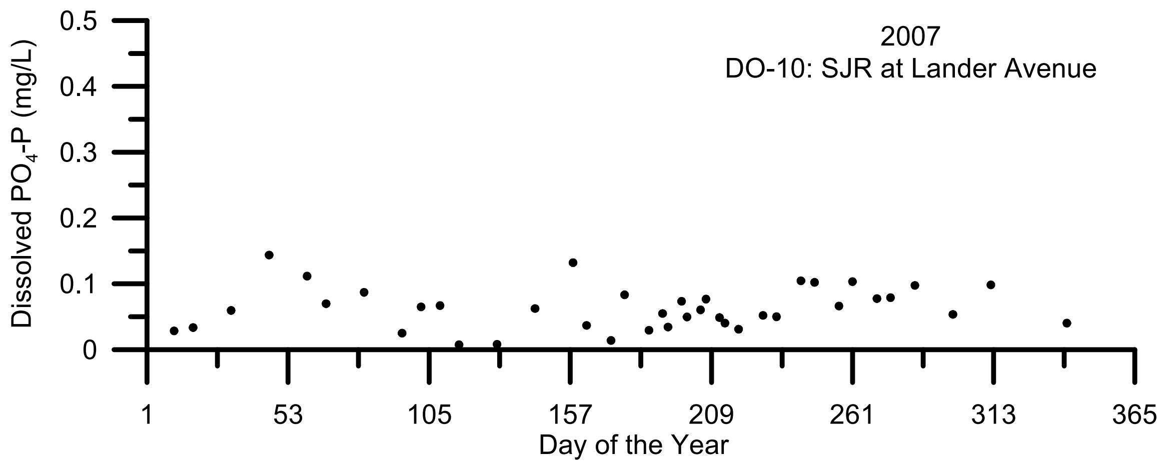
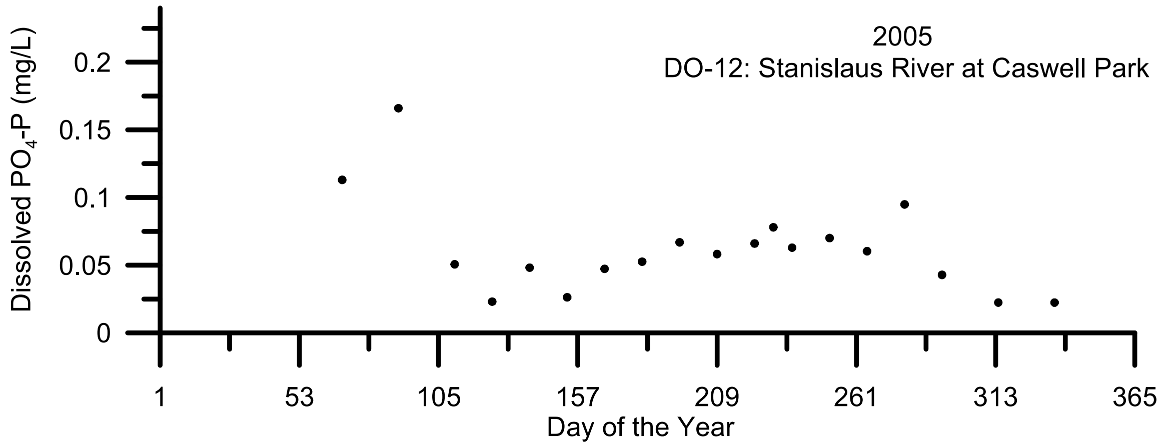
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-10: SJR at Lander Avenue
Dissolved PO4-P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus River at Caswell Park
Dissolved PO_4-P (mg/L)
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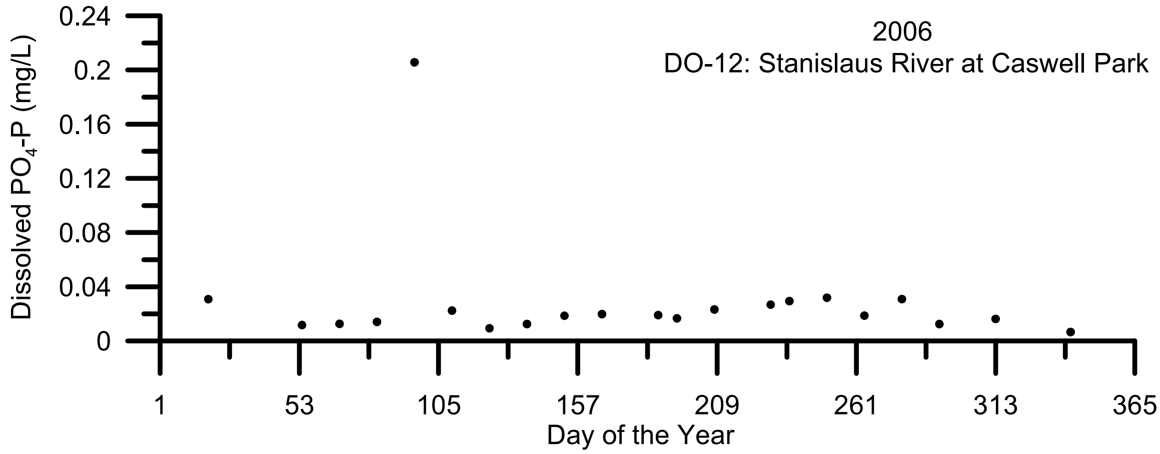
0.1
0.15
0.2
1
53
105
157
209
261
313
365
Day of the Year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Dissolved PO_4-P (mg/L)
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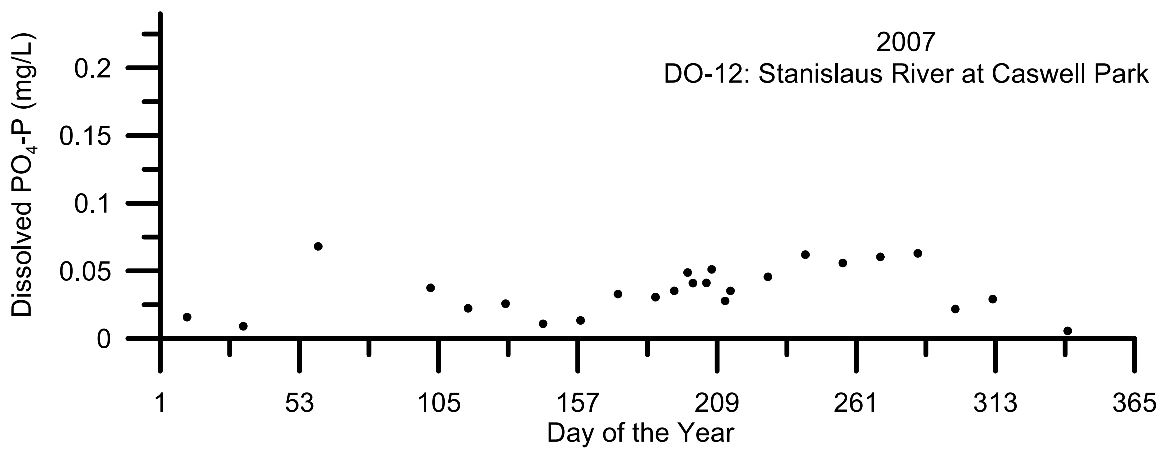
0.04
0.08
0.12
0.16
0.2
0.24
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-12: Stanislaus River at Caswell Park
Dissolved PO_4-P (mg/L)
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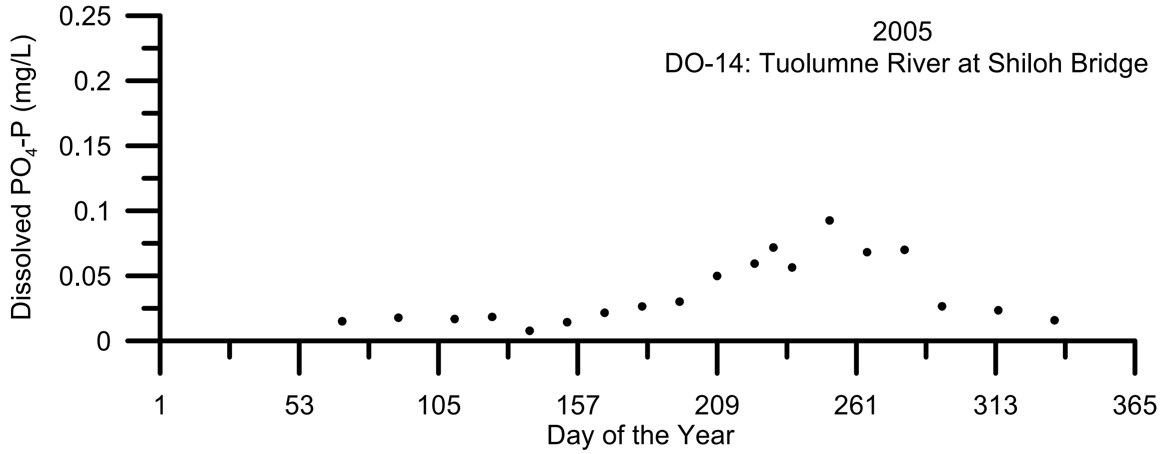
0.05
0.1
0.15
0.2
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-14: Tuolumne River at Shiloh Bridge
Dissolved PO4-P (mg/L)
0.25
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0.15
0.1
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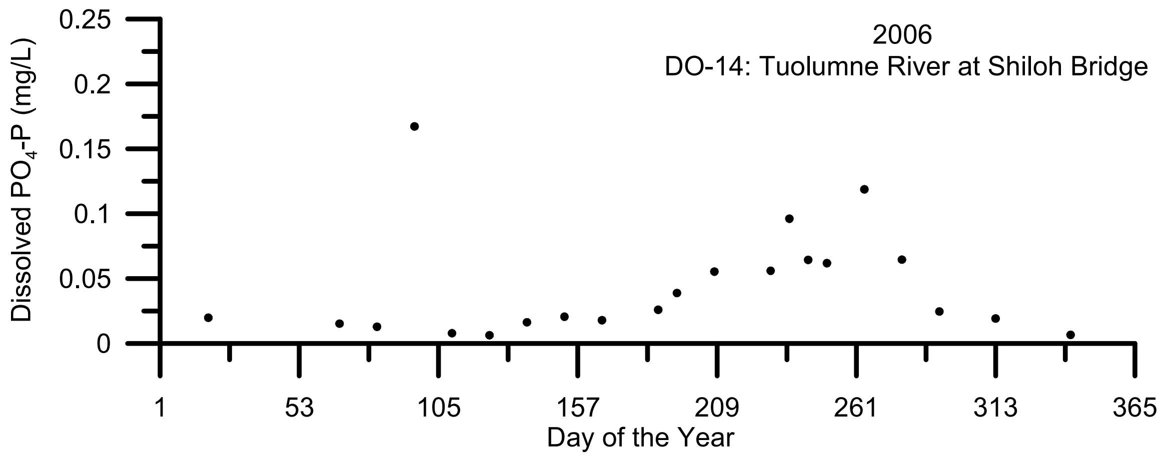
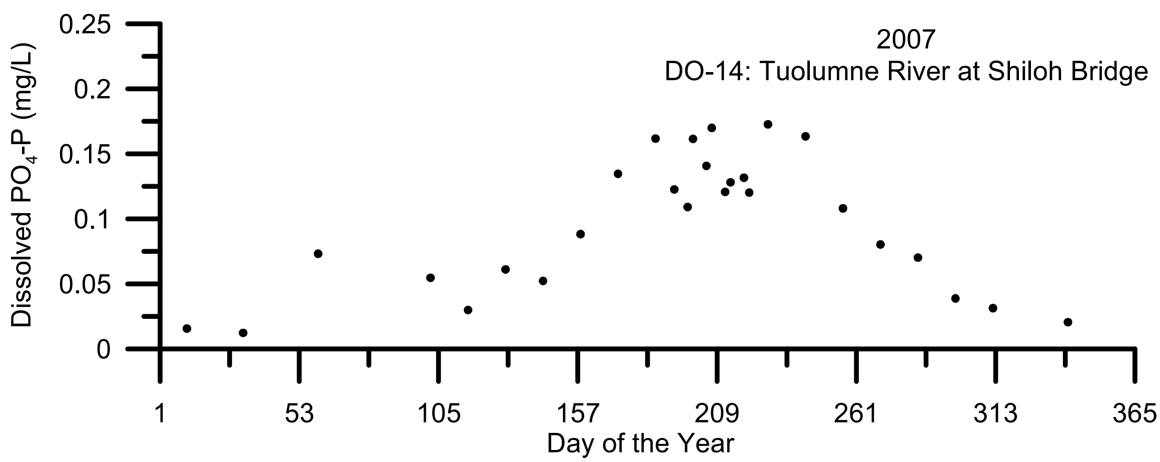
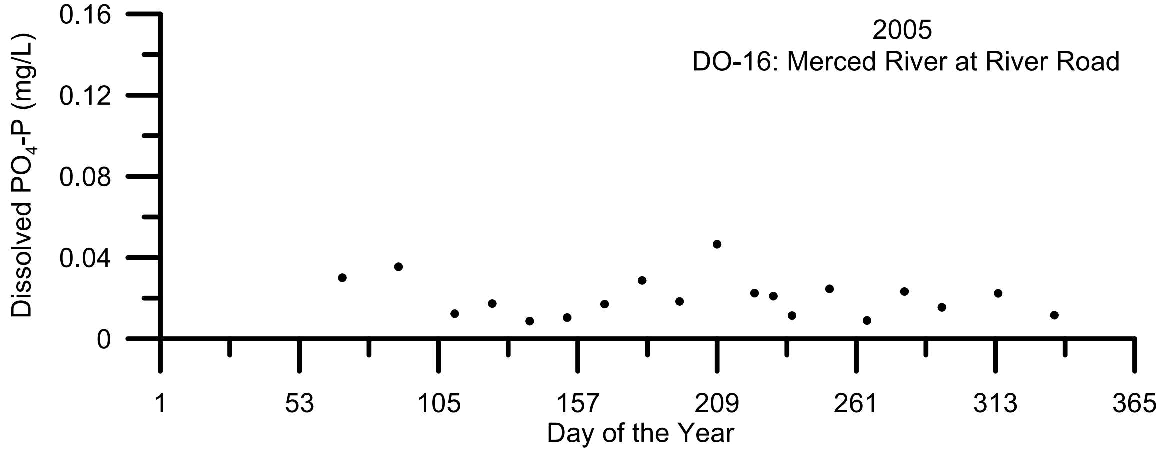
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-14: Tuolumne River at Shiloh Bridge
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-14: Tuolumne River at Shiloh Bridge
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
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Dissolved PO4-P (mg/L)
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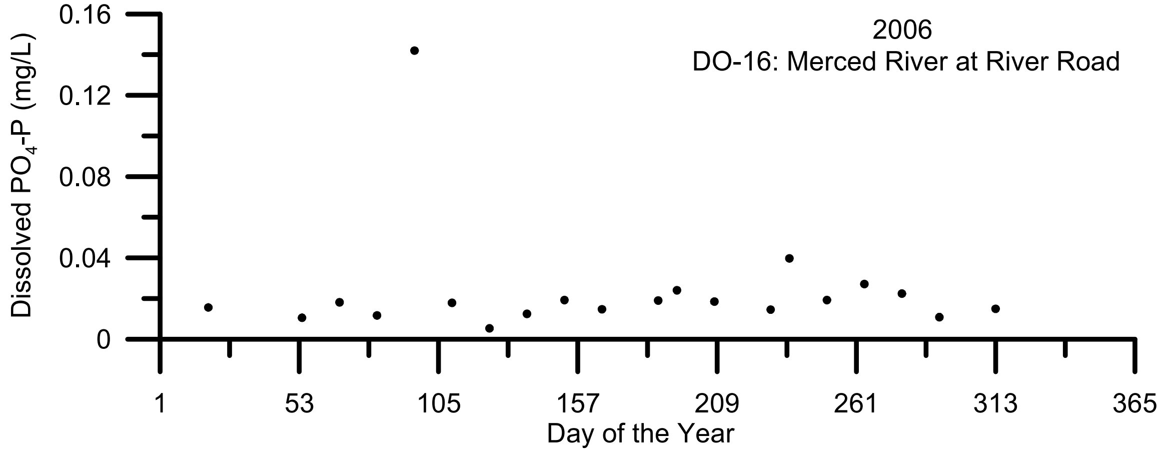
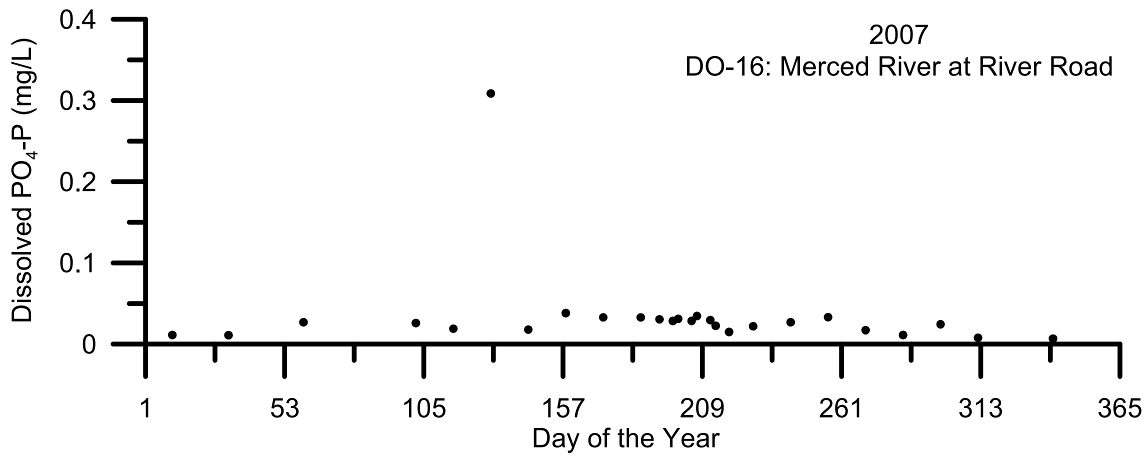
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-16: Merced River at River Road
Dissolved PO4-P (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-16: Merced River at River Road
Dissolved PO4-P (mg/L)
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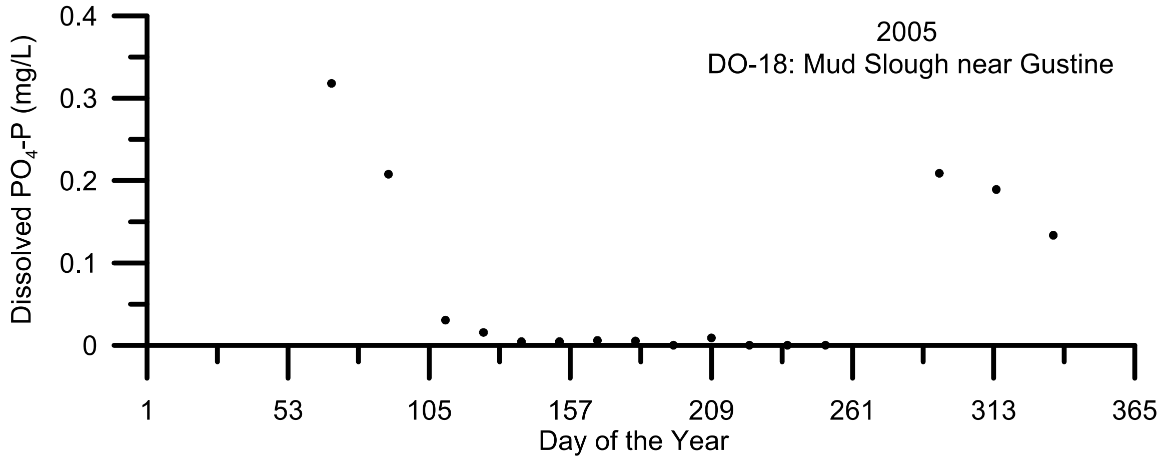
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-18: Mud Slough near Gustine
Dissolved PO4-P (mg/L)
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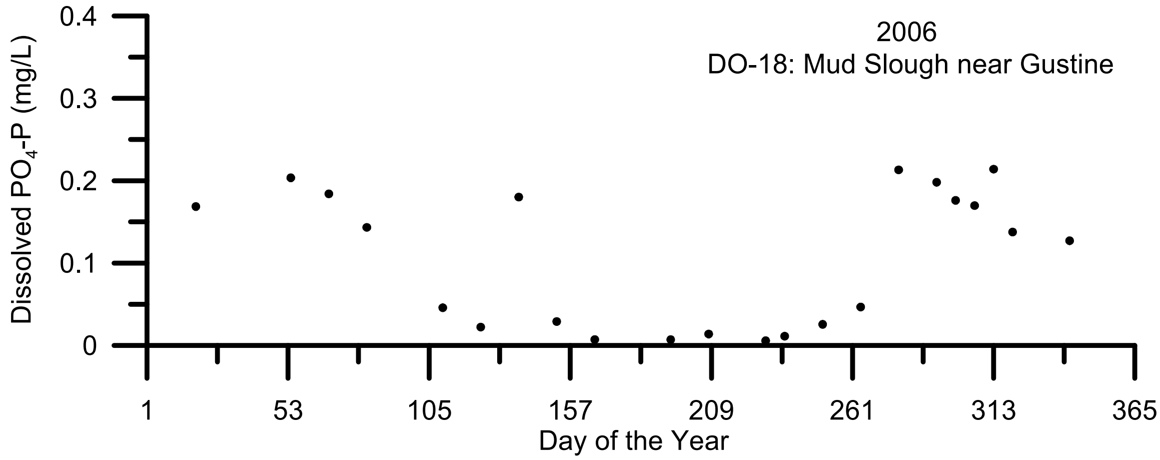
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-18: Mud Slough near Gustine
Dissolved PO4-P (mg/L)
0.4
0.3
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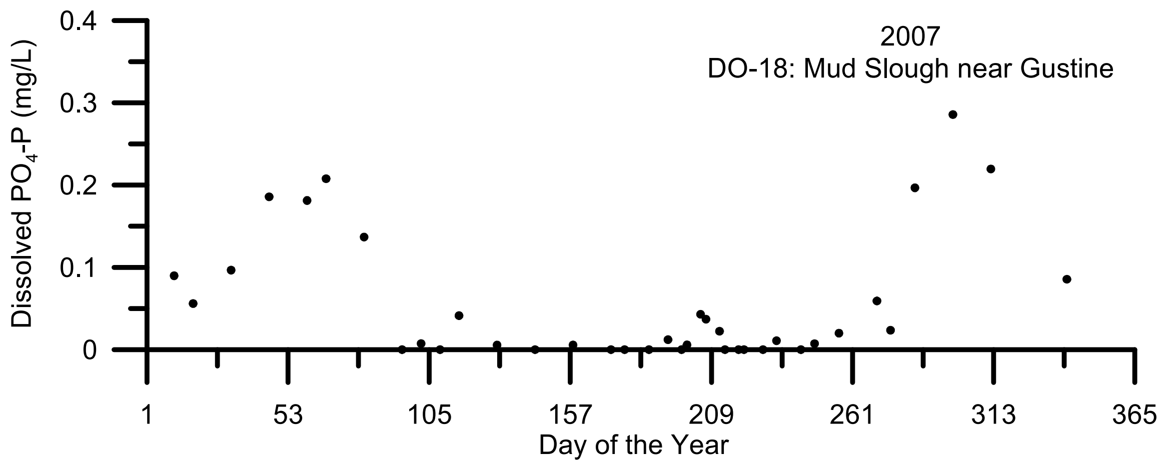
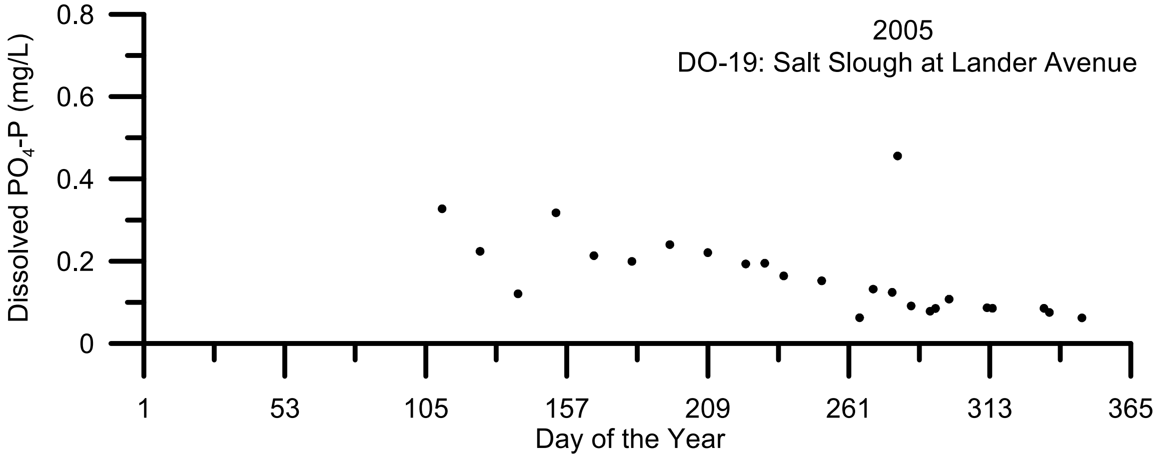
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-18: Mud Slough near Gustine
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year



2005
DO-19: Salt Slough at Lander Avenue
Dissolved PO4-P (mg/L)
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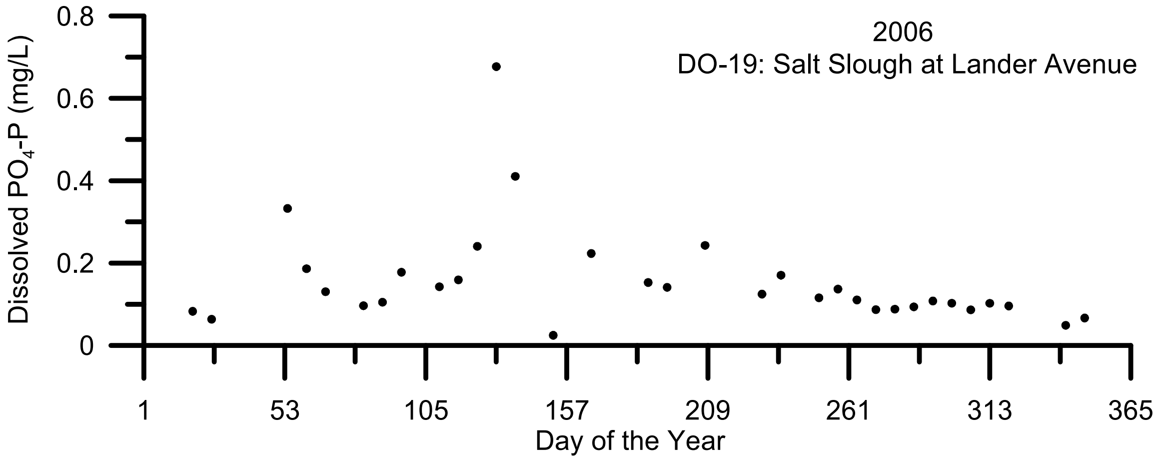
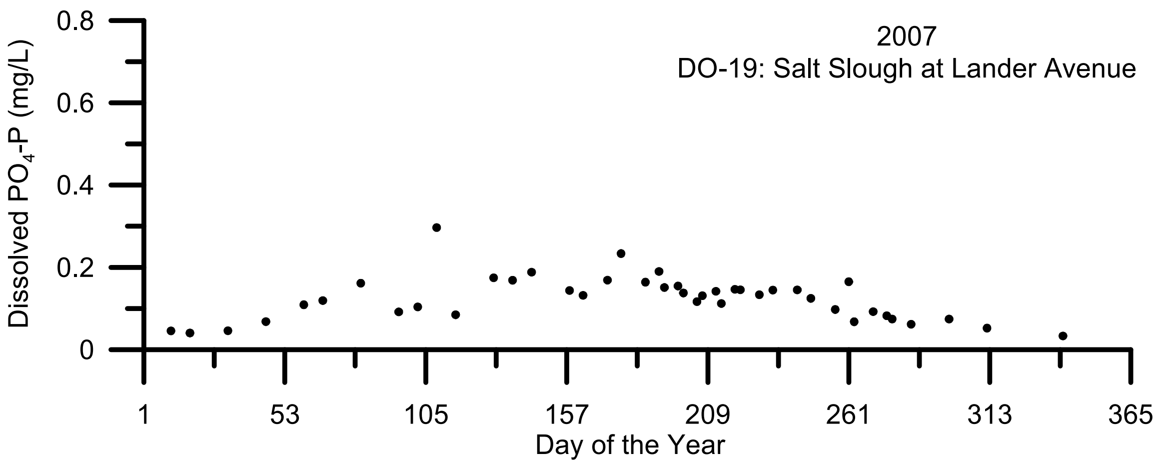
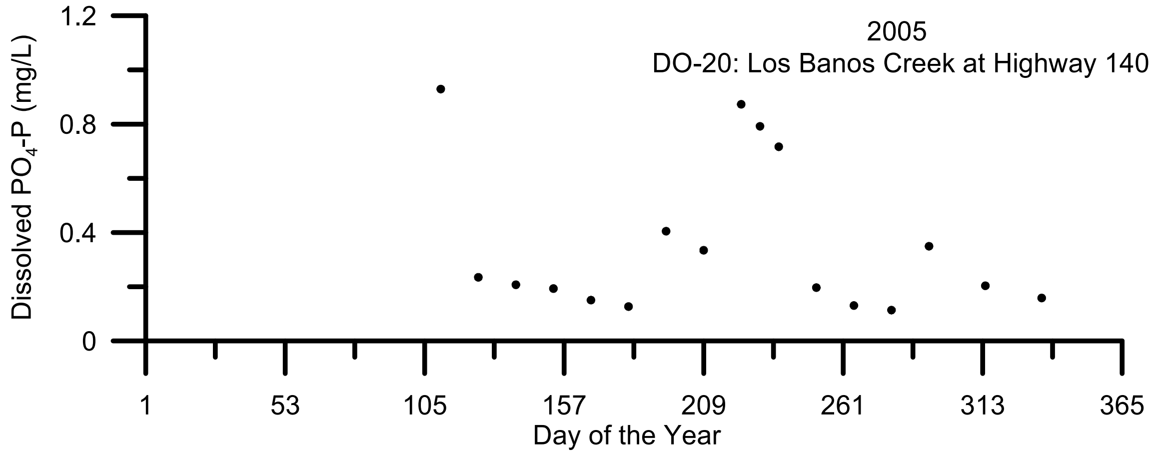
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

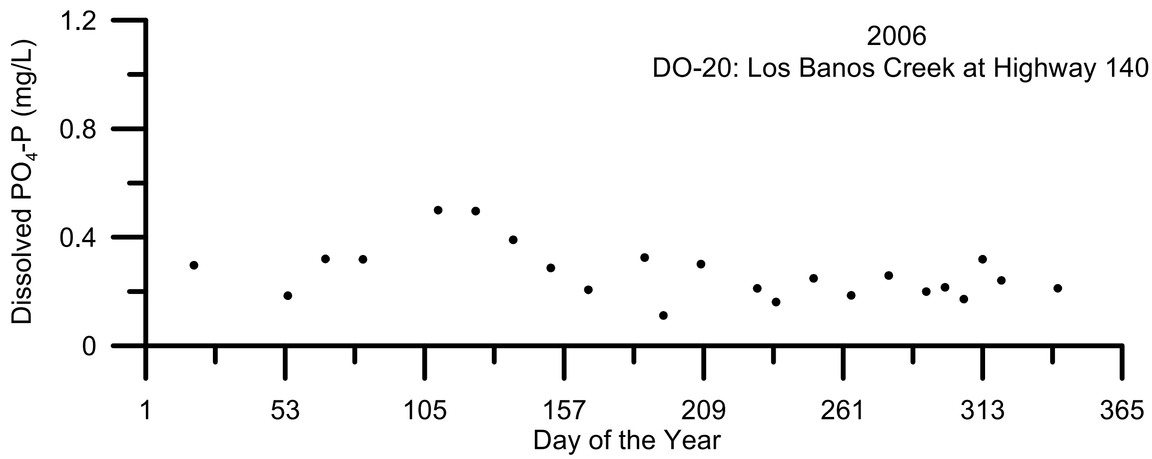


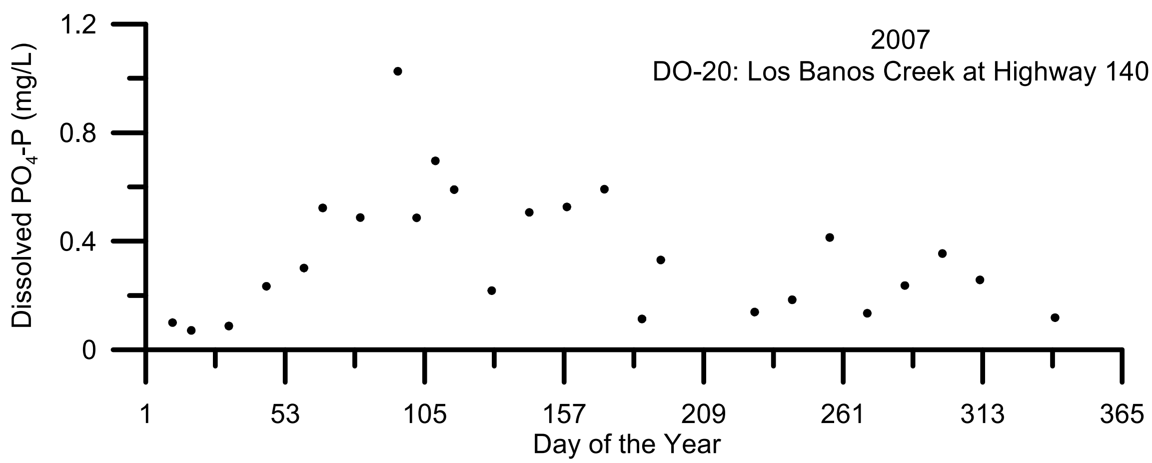
2006
DO-19: Salt Slough at Lander Avenue
Dissolved PO4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

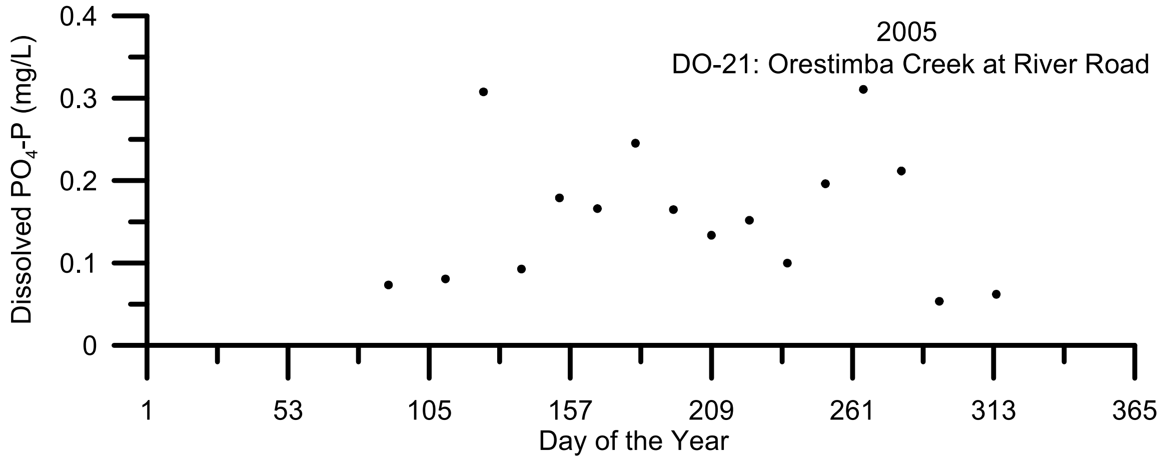


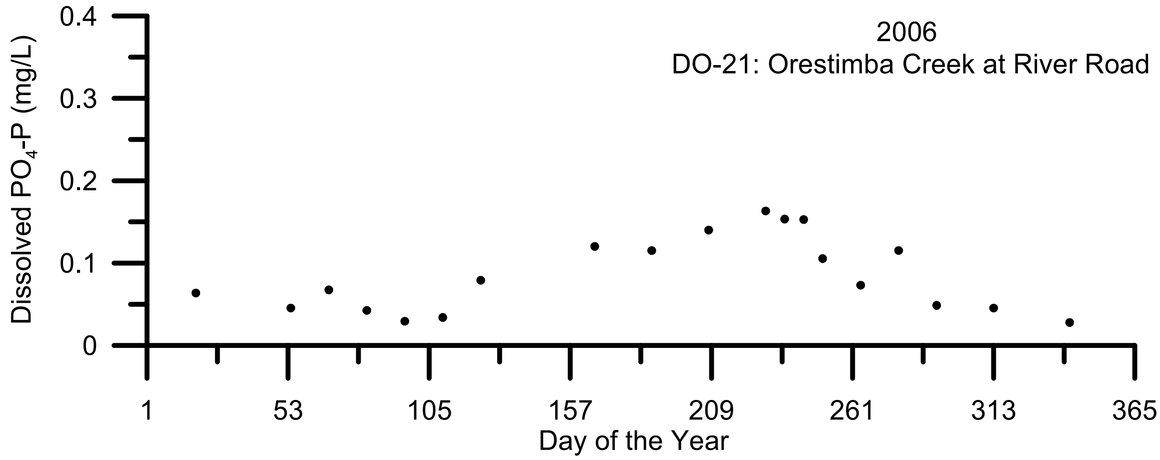
2007
DO-19: Salt Slough at Lander Avenue
Dissolved PO4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

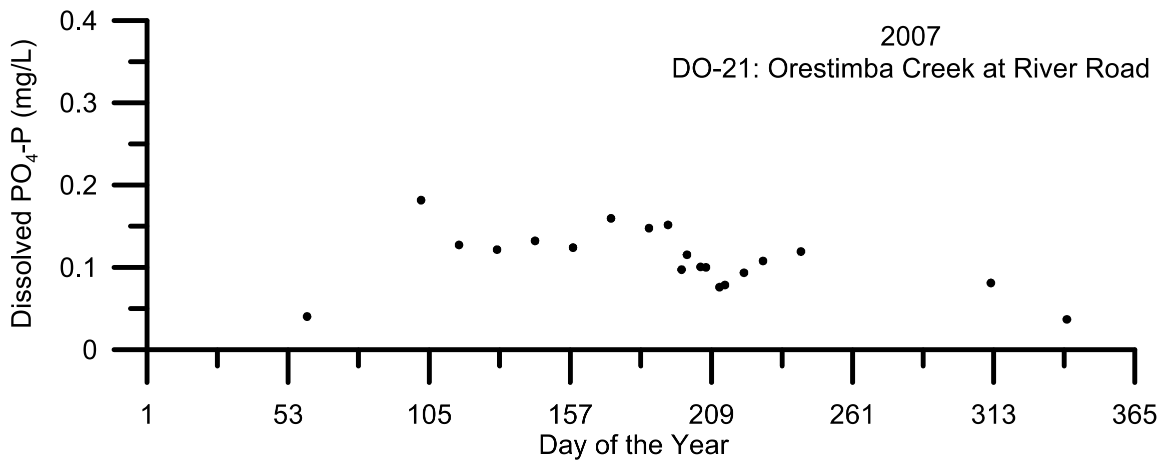

2005
DO-20: Los Banos Creek at Highway 140
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

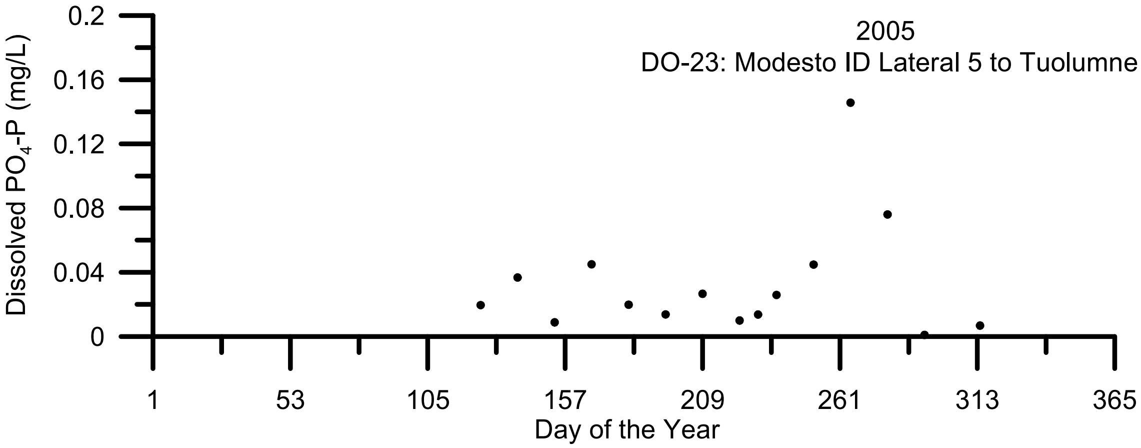

2006
DO-20: Los Banos Creek at Highway 140
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

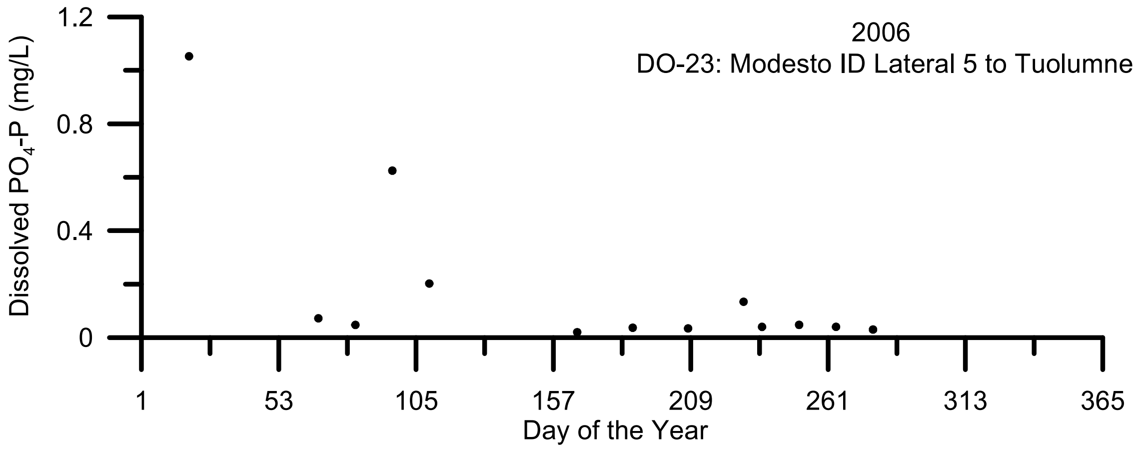

2007
DO-20: Los Banos Creek at Highway 140
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

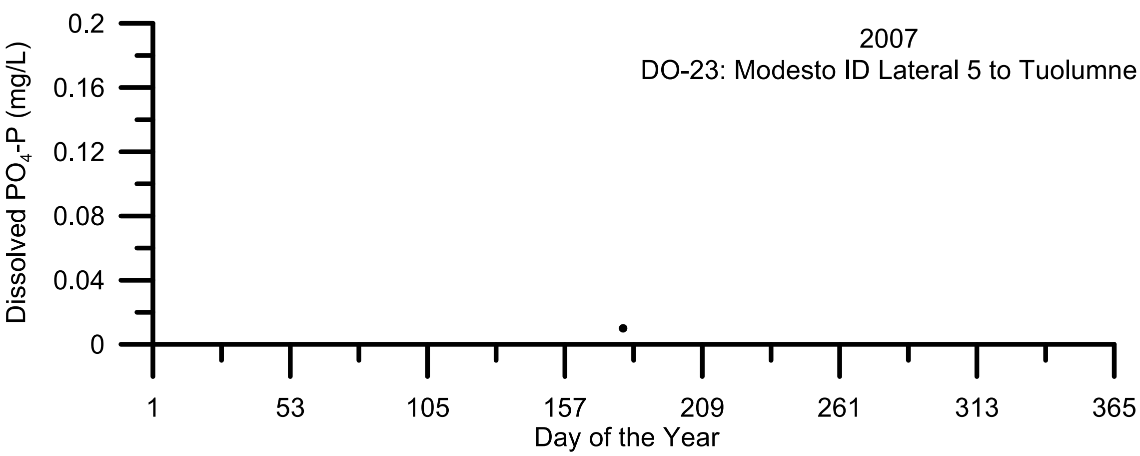

2005
DO-21: Orestimba Creek at River Road
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

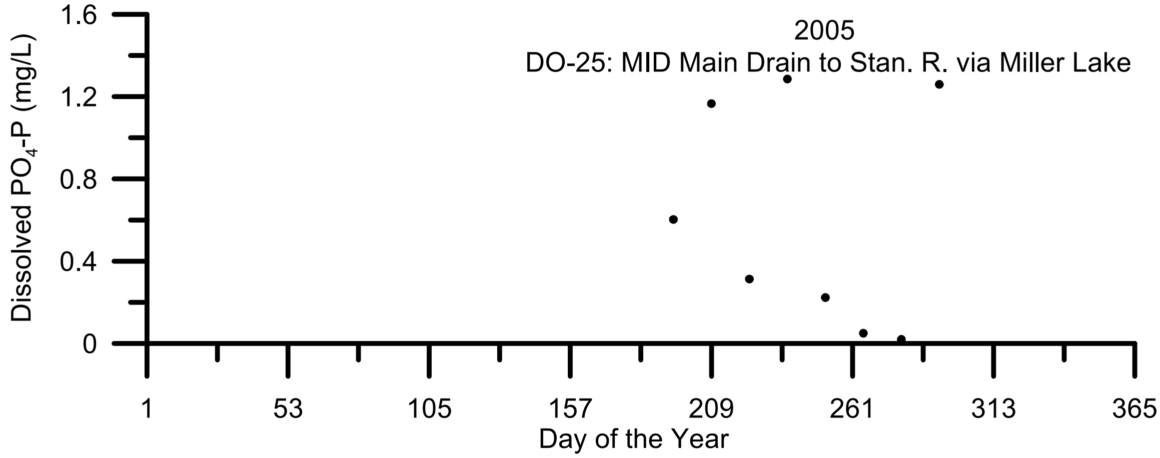

2006
DO-21: Orestimba Creek at River Road
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

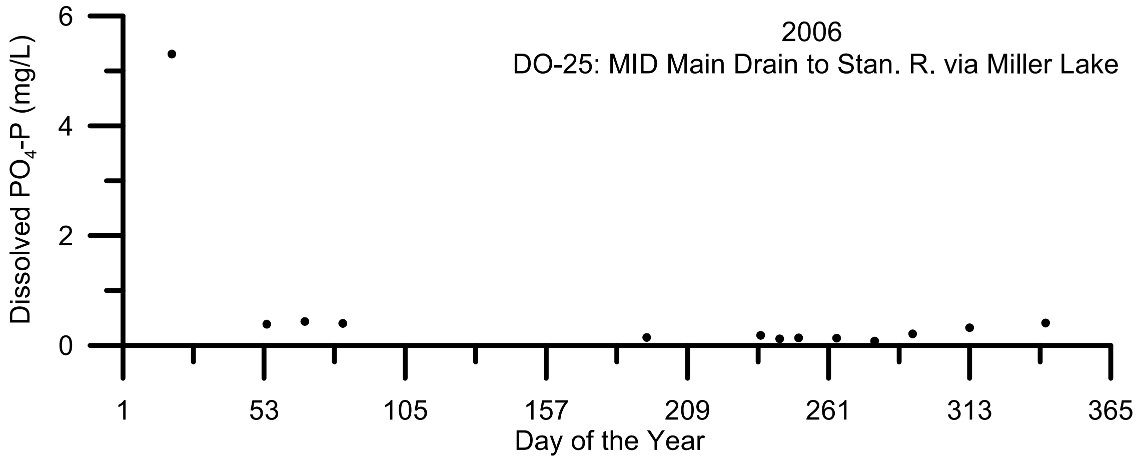

2007
DO-21: Orestimba Creek at River Road
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

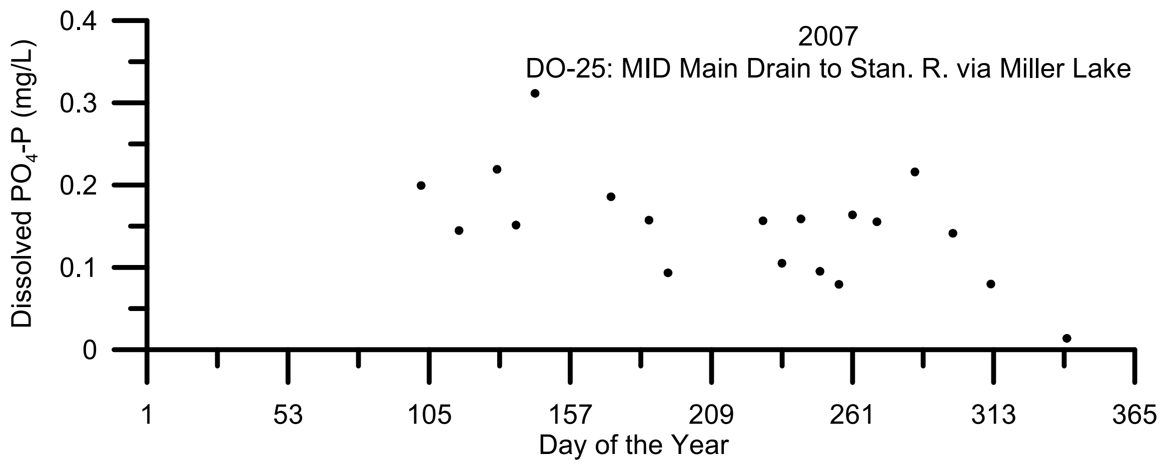

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved PO4-P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

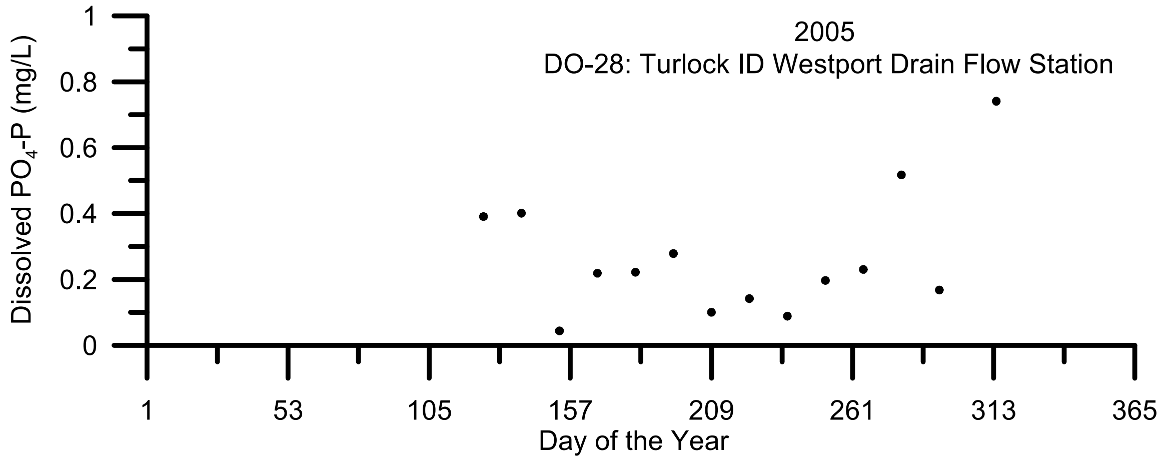

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved PO4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

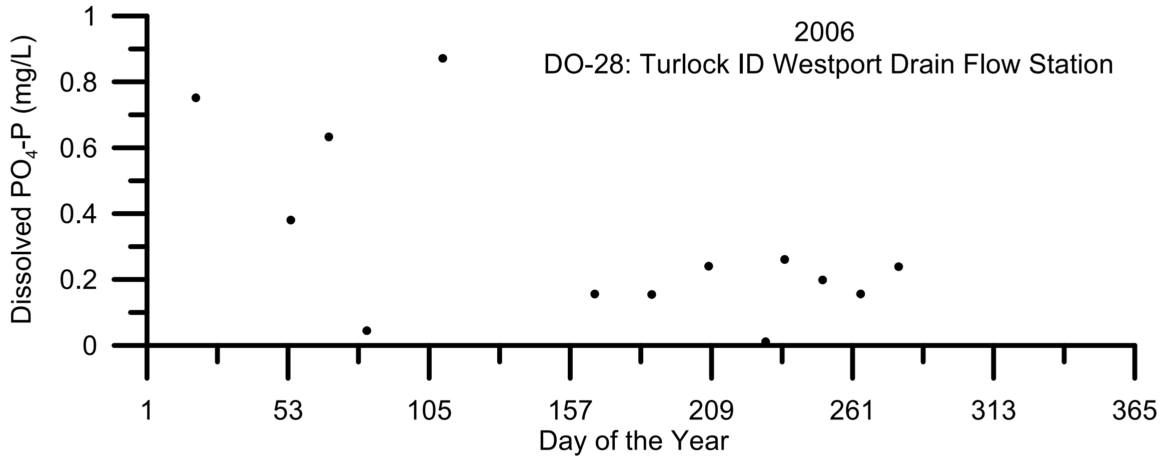

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved PO4-P (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

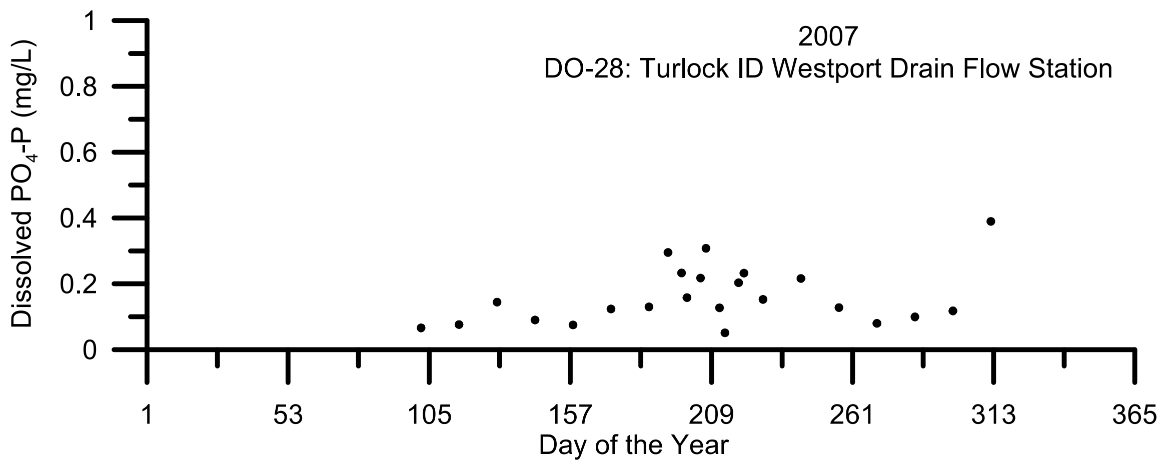

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved PO4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

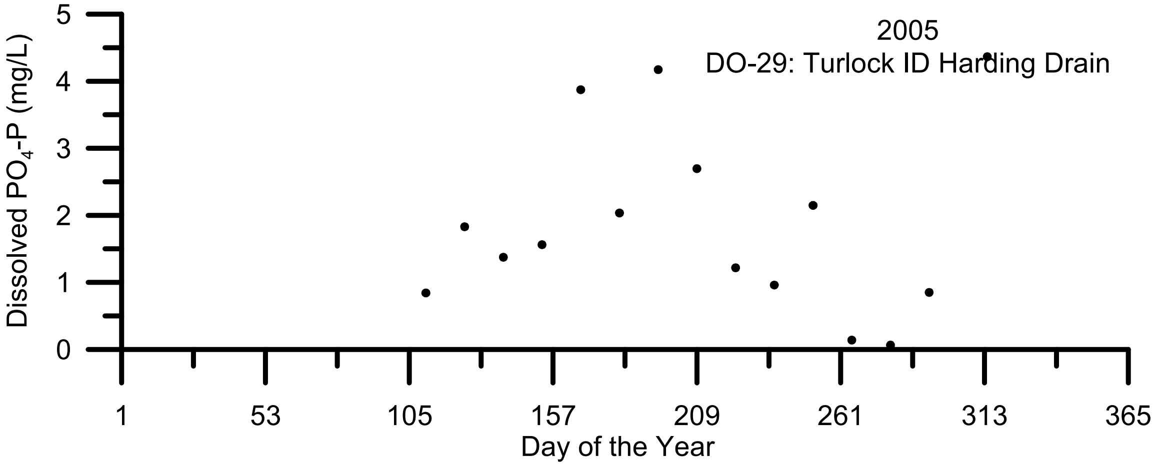

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved PO4-P (mg/L)
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

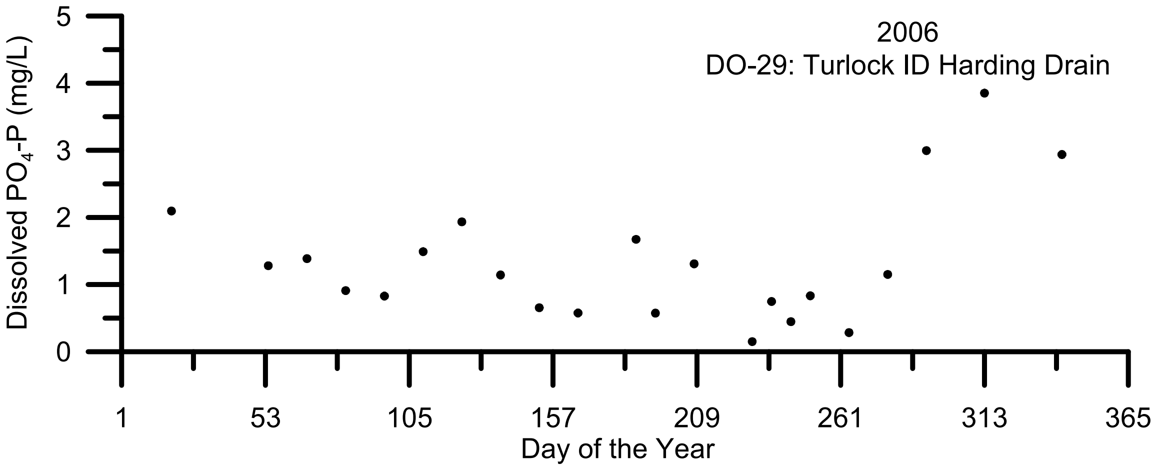

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

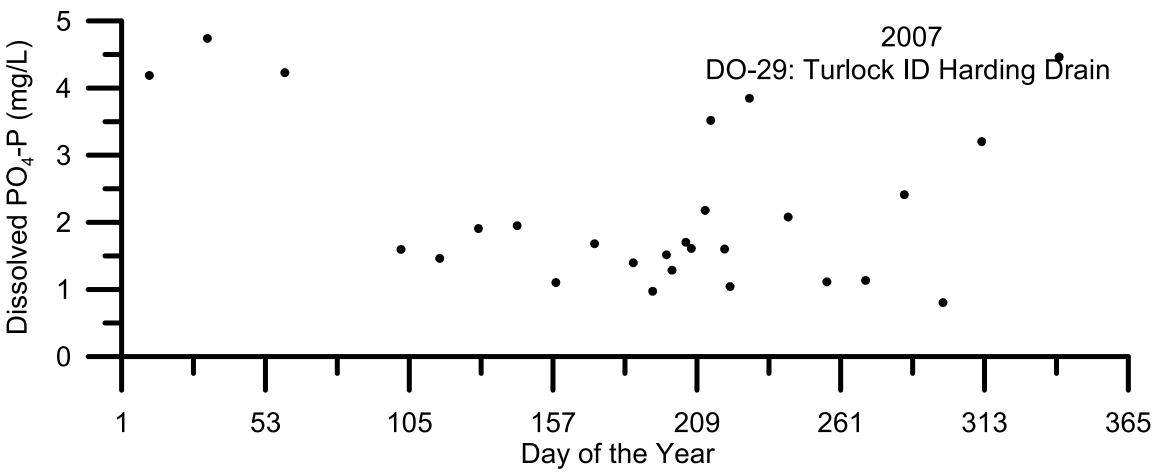

2005
DO-28: Turlock ID Westport Drain Flow Station
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

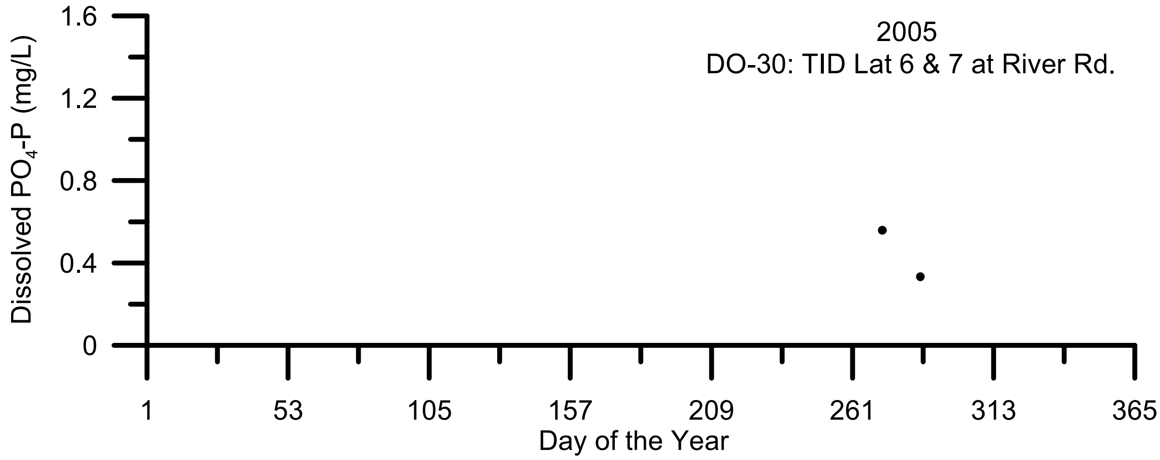

2006
DO-28: Turlock ID Westport Drain Flow Station
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-28: Turlock ID Westport Drain Flow Station
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

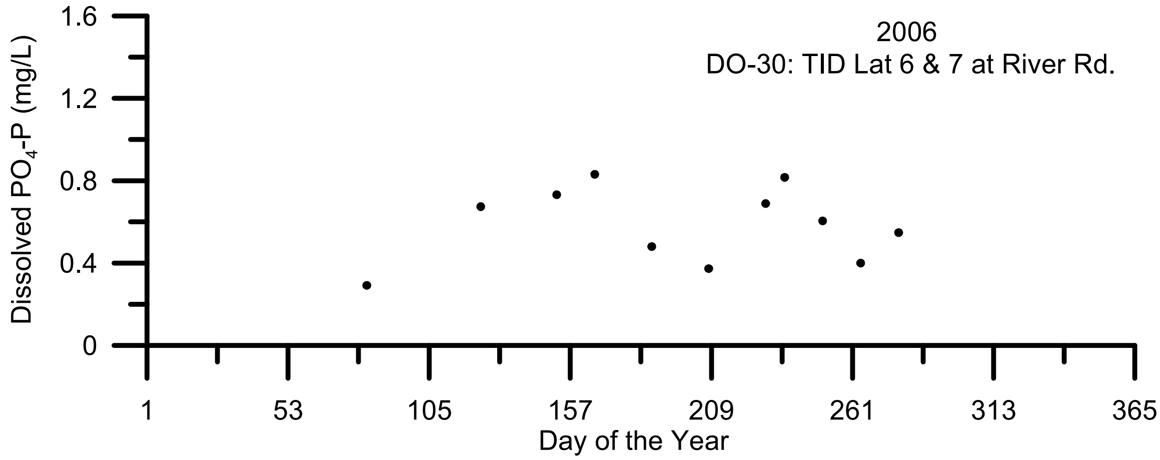

2005
DO-29: Turlock ID Harding Drain
Dissolved PO_4-P (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-29: Turlock ID Harding Drain
Dissolved PO_4-P (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

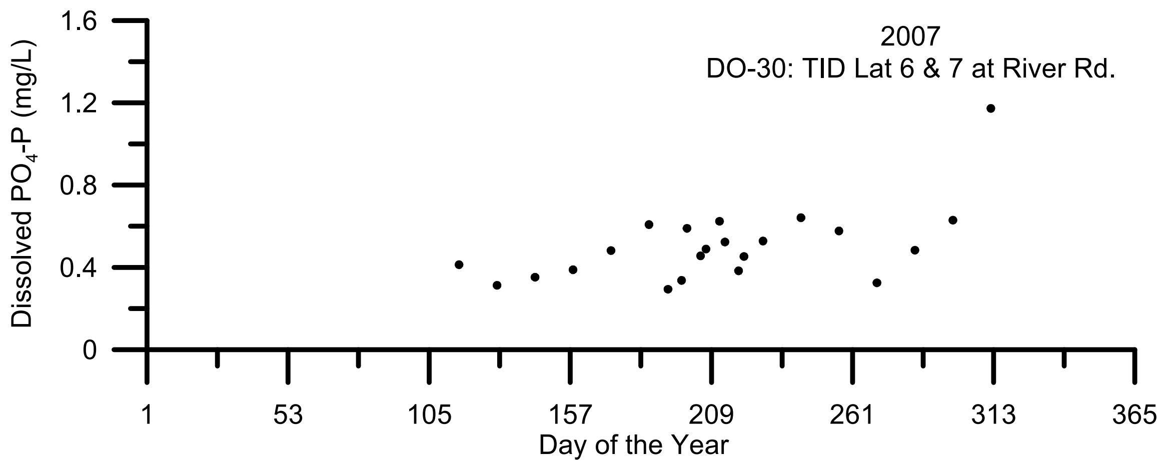

2007
DO-29: Turlock ID Harding Drain
Dissolved PO_4-P (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year



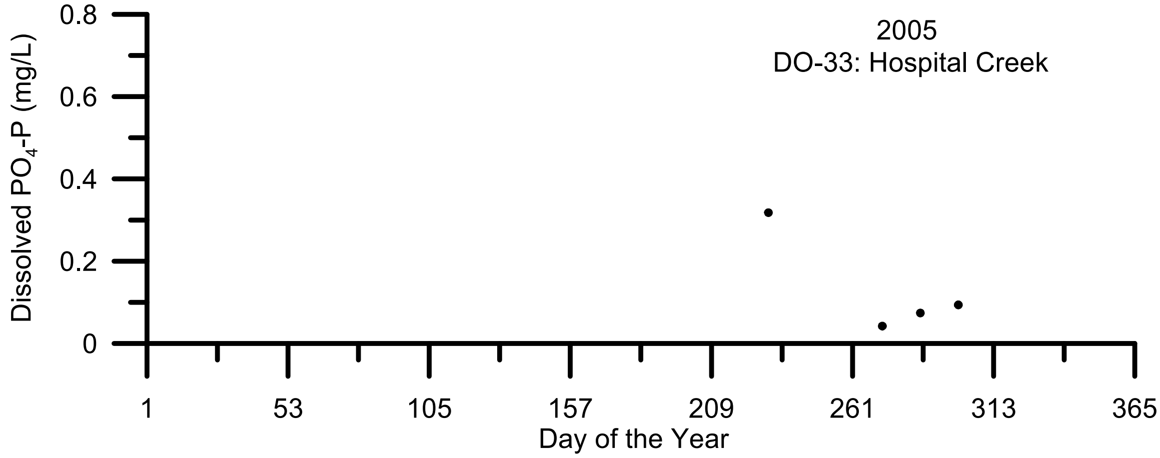
2005
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved PO4-P (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

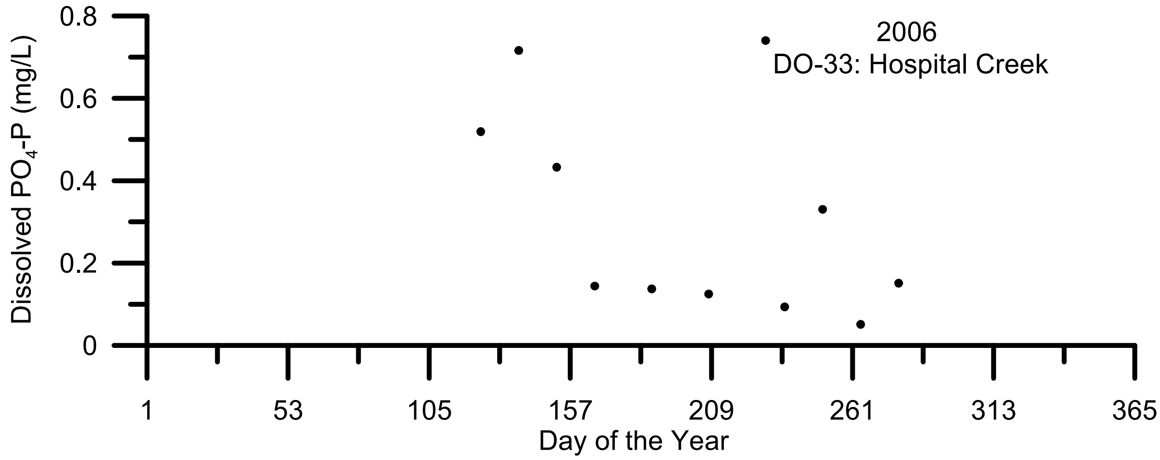


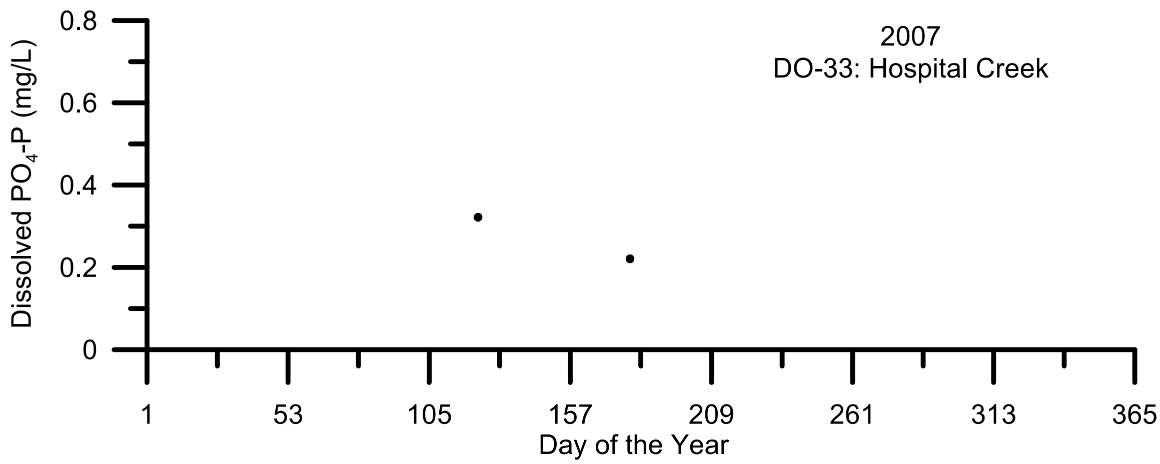
2006
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved PO4-P (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

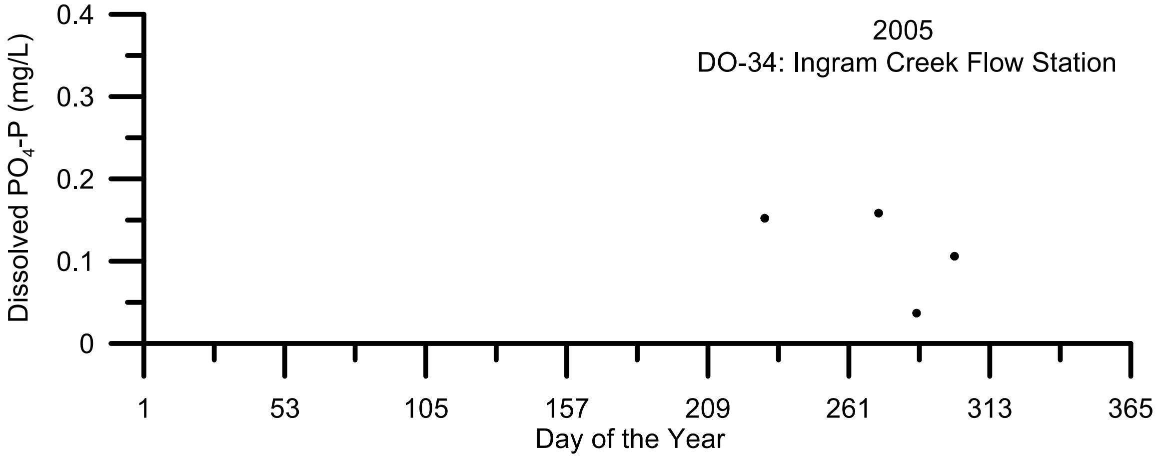


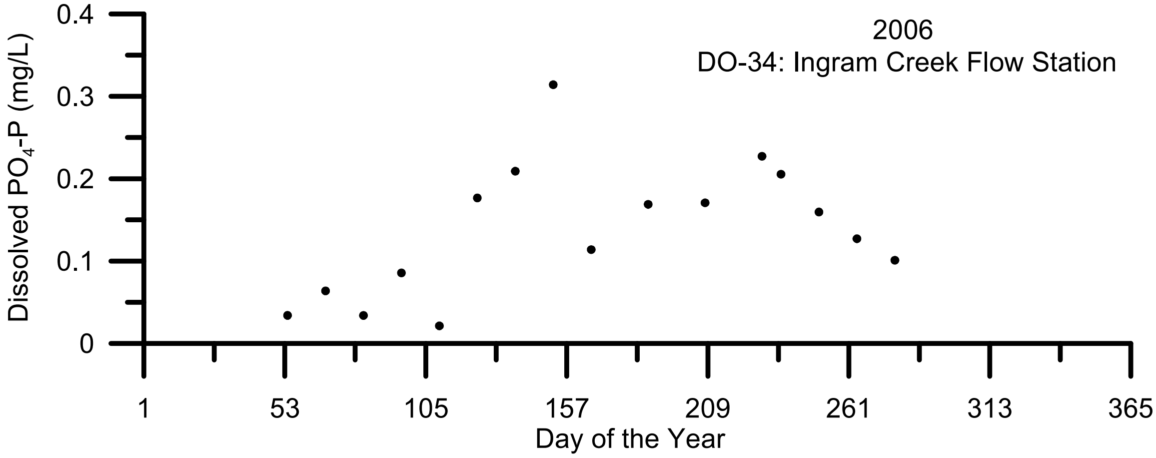
2007
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved PO4-P (mg/L)
0
0.4
0.8
1.2
1.6
1
53
105
157
209
261
313
365
Day of the Year

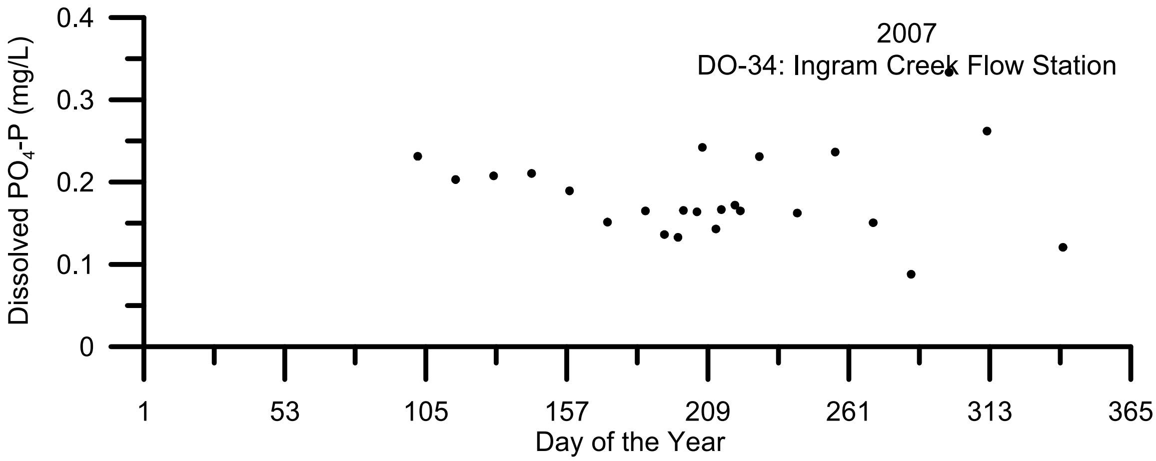

2005
DO-33: Hospital Creek
Dissolved PO_4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

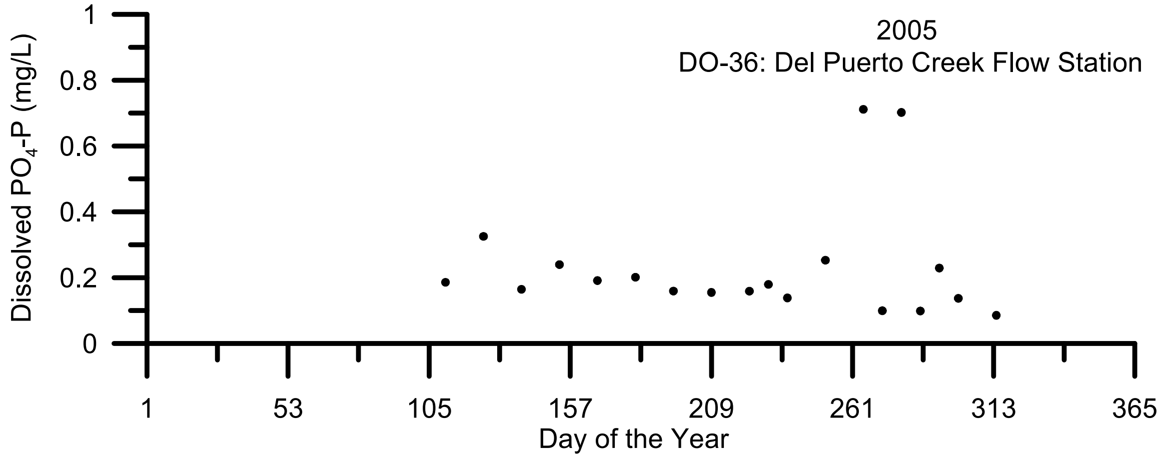

2006
DO-33: Hospital Creek
Dissolved PO_4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

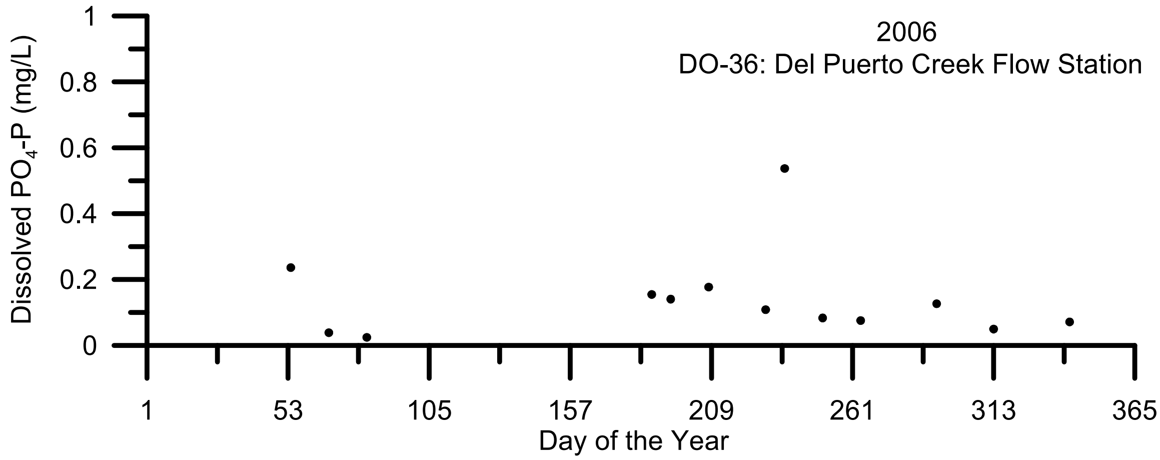

2007
DO-33: Hospital Creek
Dissolved PO_4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

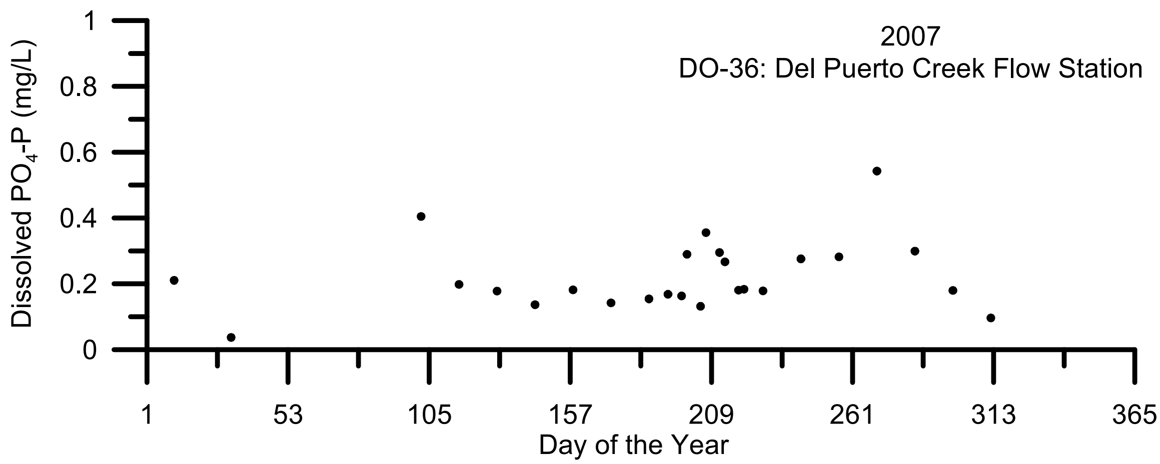

2005
DO-34: Ingram Creek Flow Station
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

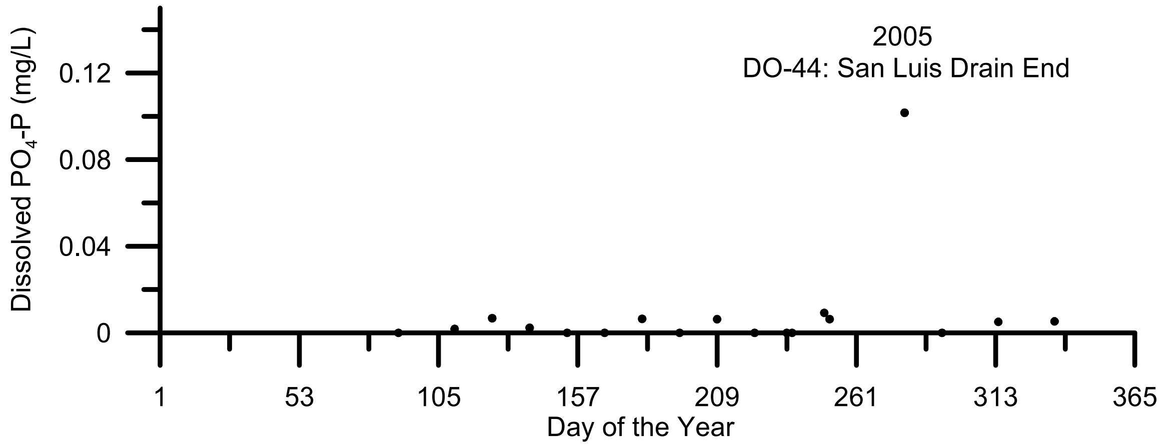

2006
DO-34: Ingram Creek Flow Station
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

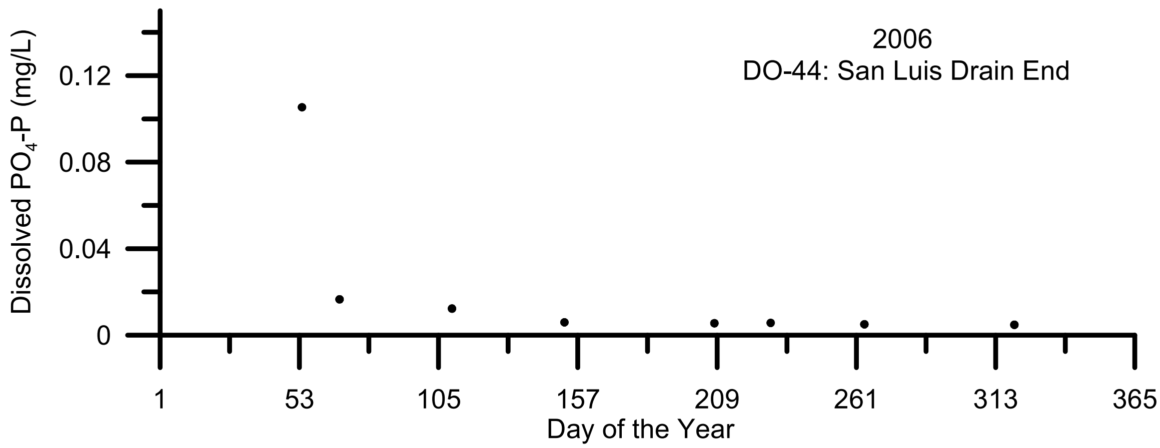

2007
DO-34: Ingram Creek Flow Station
Dissolved PO4-P (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

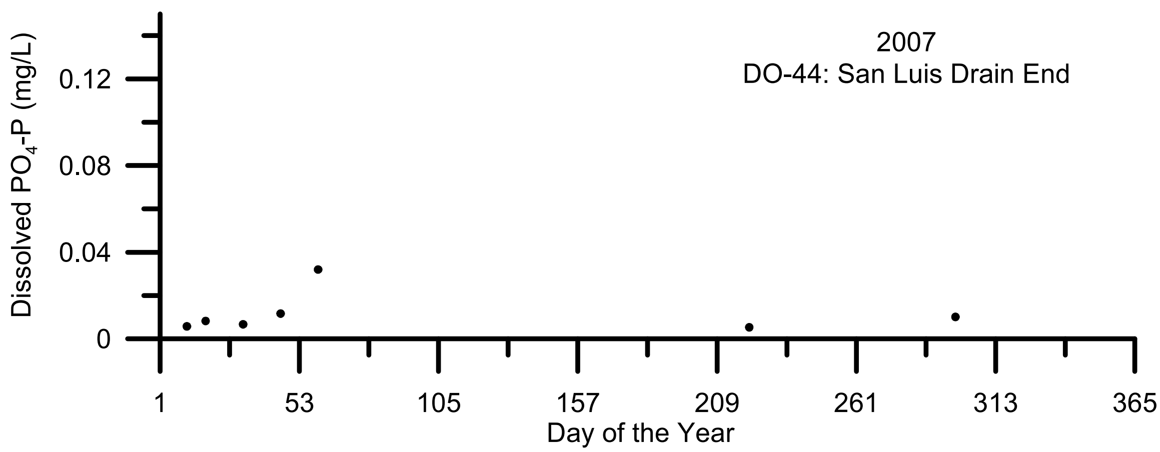

2005
DO-36: Del Puerto Creek Flow Station
Dissolved PO4-P (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

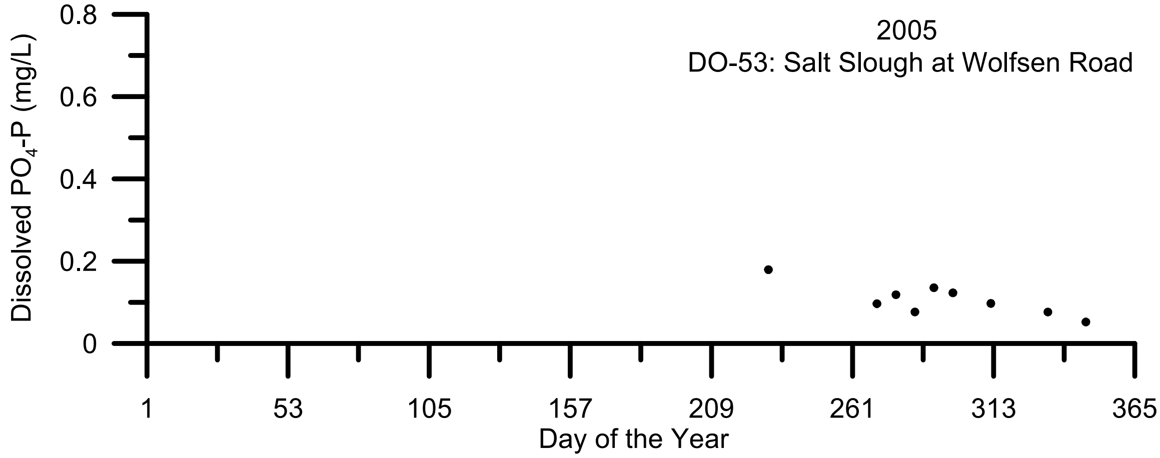

2006
DO-36: Del Puerto Creek Flow Station
Dissolved PO4-P (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

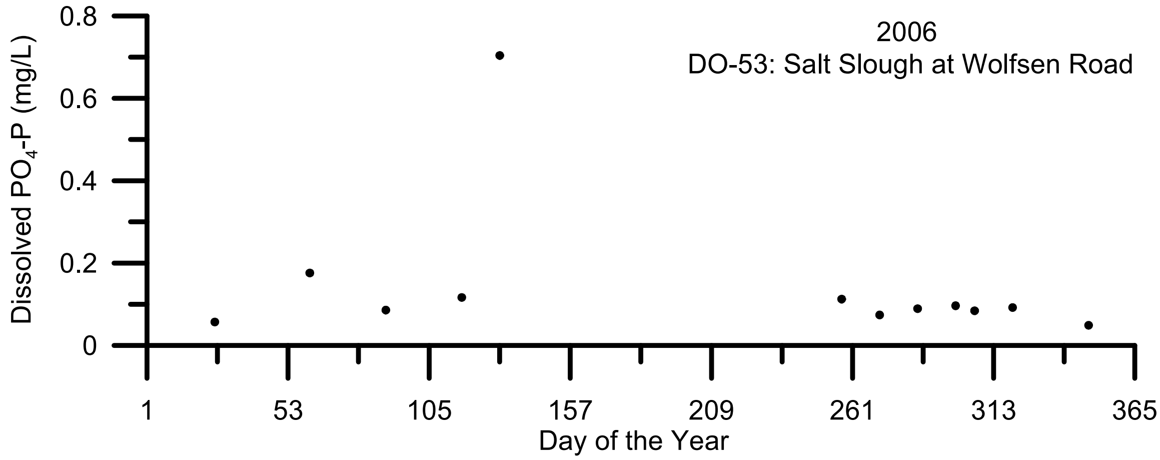

2007
DO-36: Del Puerto Creek Flow Station
Dissolved PO4-P (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

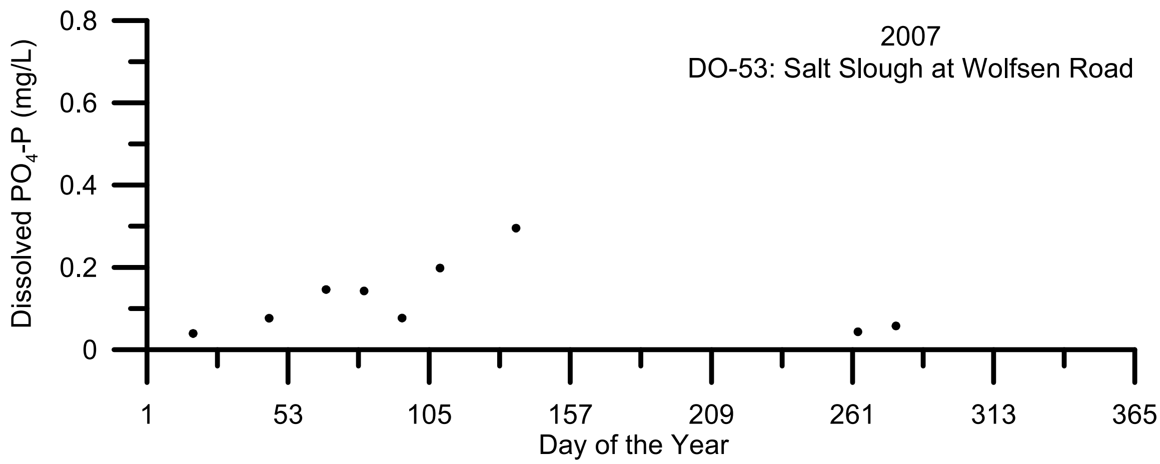

2005
DO-44: San Luis Drain End
Dissolved PO_4-P (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

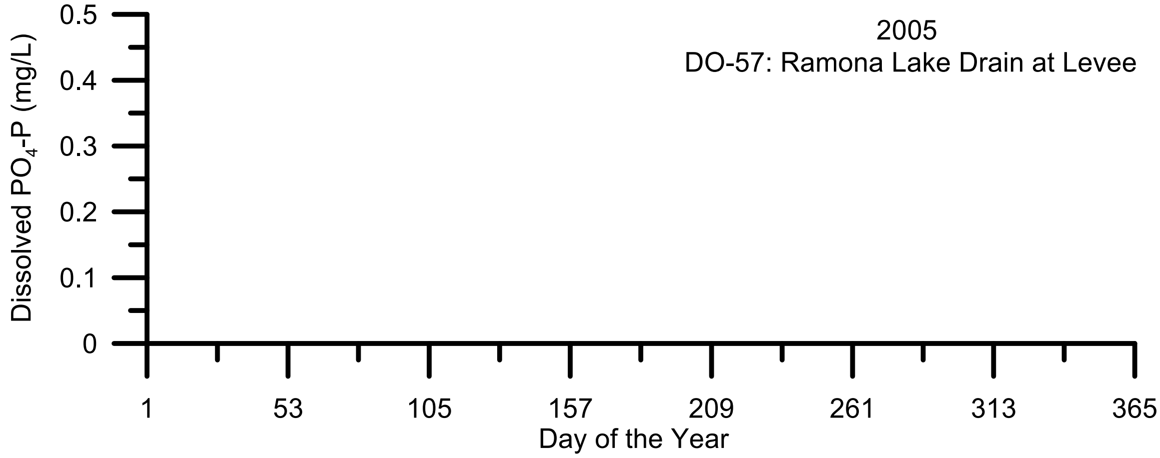

2006
DO-44: San Luis Drain End
Dissolved PO_4-P (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

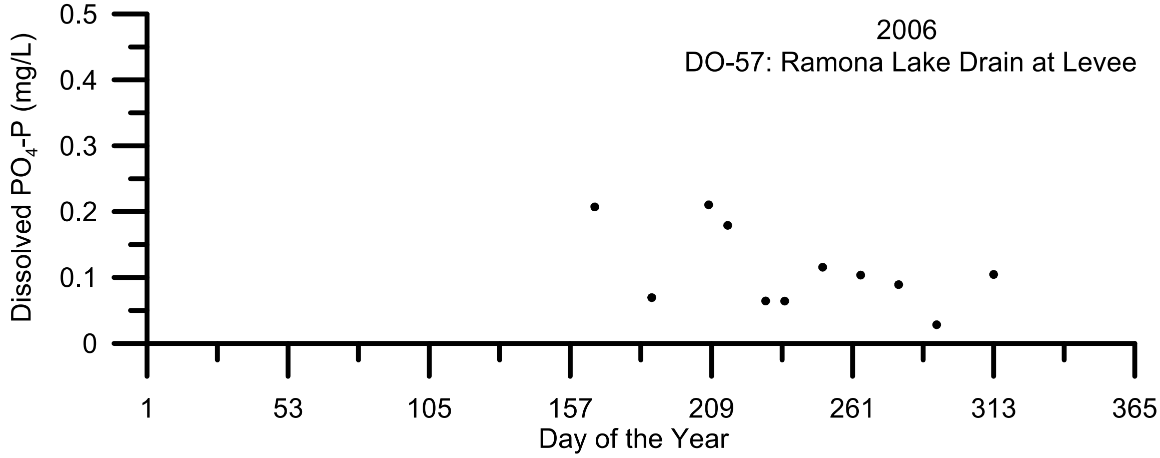

2007
DO-44: San Luis Drain End
Dissolved PO_4-P (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

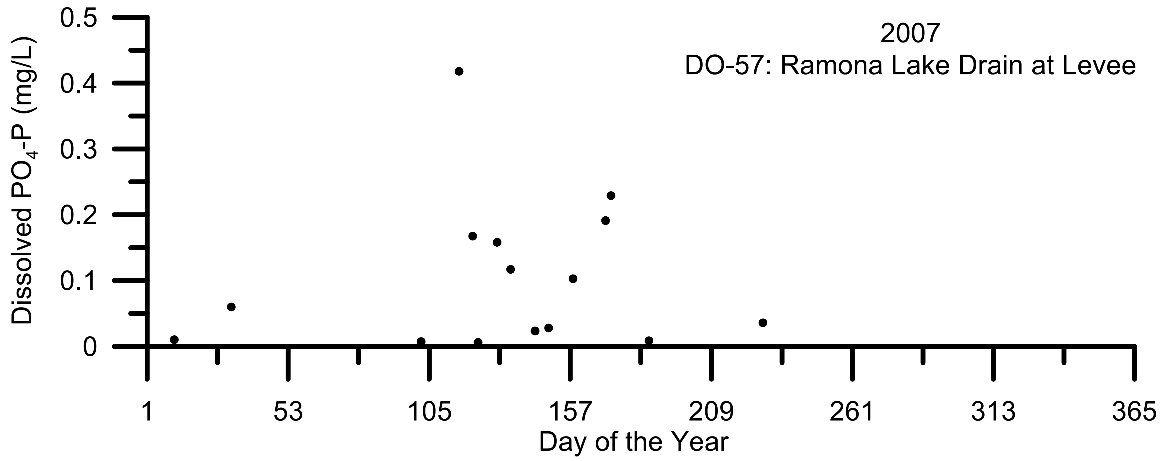

2005
DO-53: Salt Slough at Wolfsen Road
Dissolved PO4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

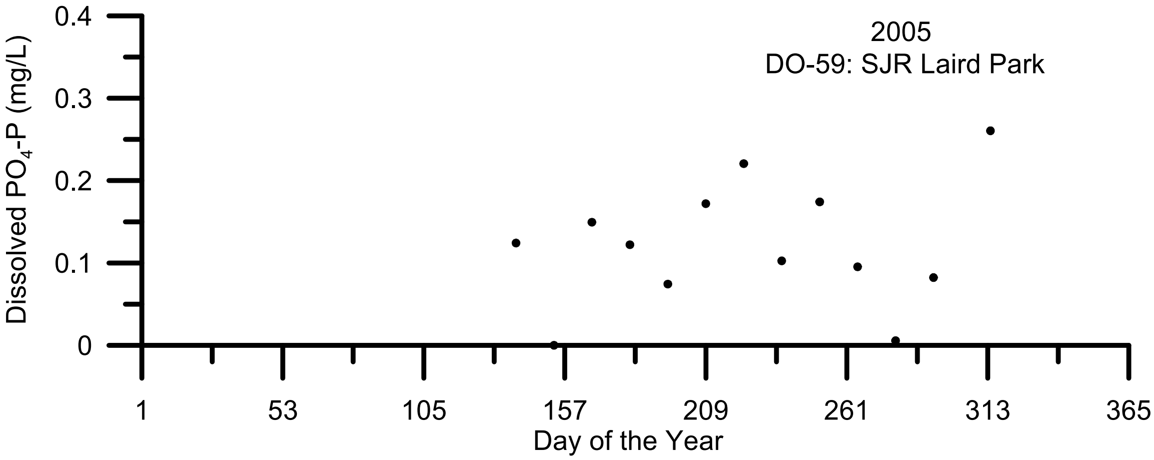

2006
DO-53: Salt Slough at Wolfsen Road
Dissolved PO4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

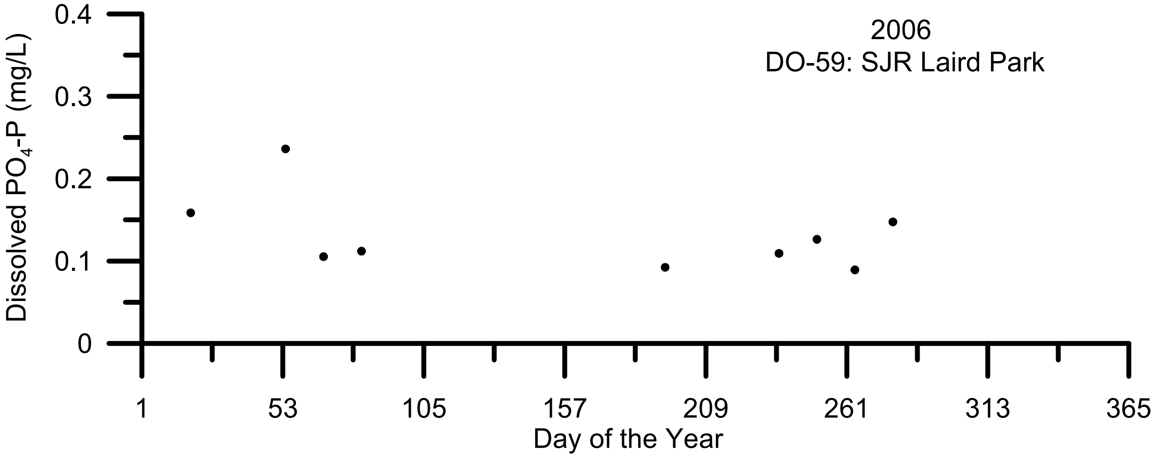

2007
DO-53: Salt Slough at Wolfsen Road
Dissolved PO4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

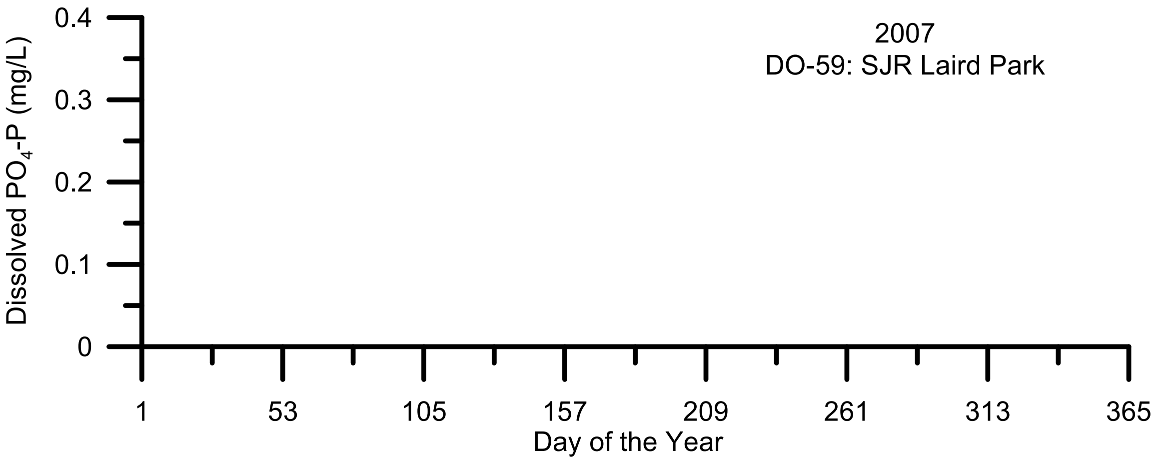

2005
DO-57: Ramona Lake Drain at Levee
Dissolved PO_4-P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

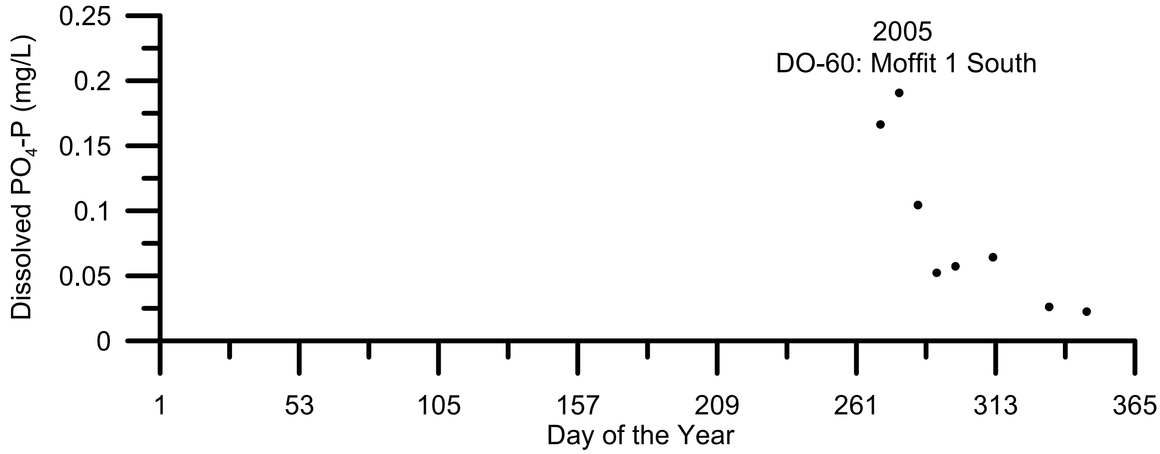

2006
DO-57: Ramona Lake Drain at Levee
Dissolved PO_4-P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

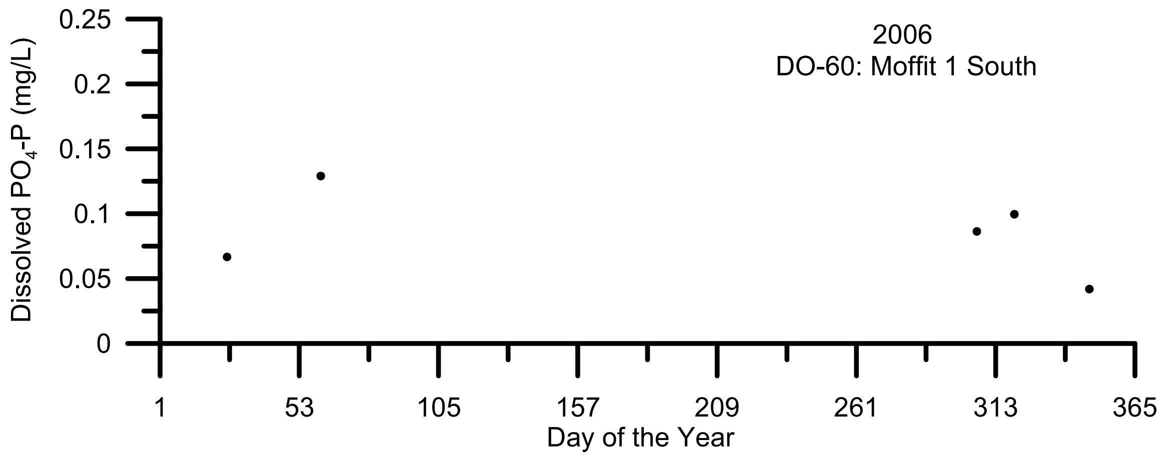

2007
DO-57: Ramona Lake Drain at Levee
Dissolved PO_4-P (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

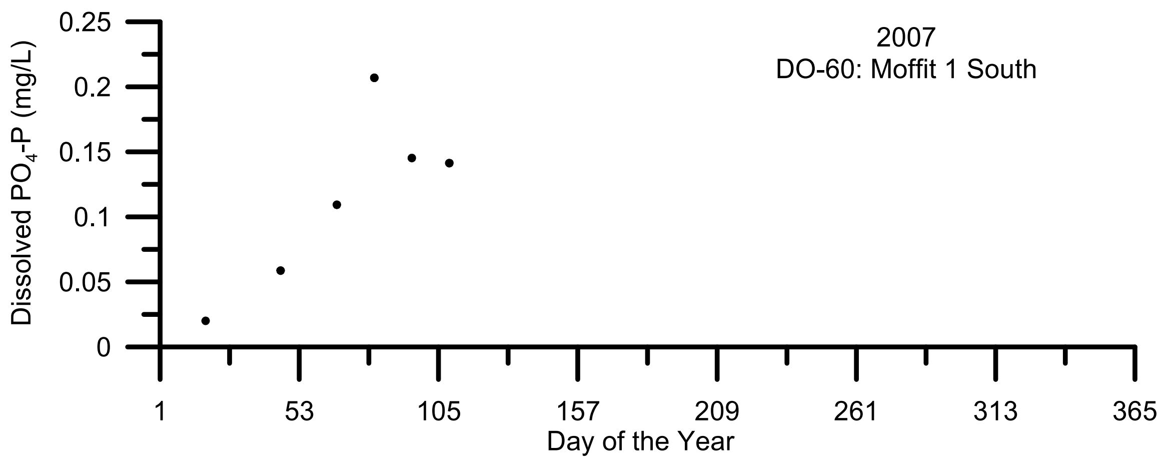

2005
DO-59: SJR Laird Park
Dissolved PO4-P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

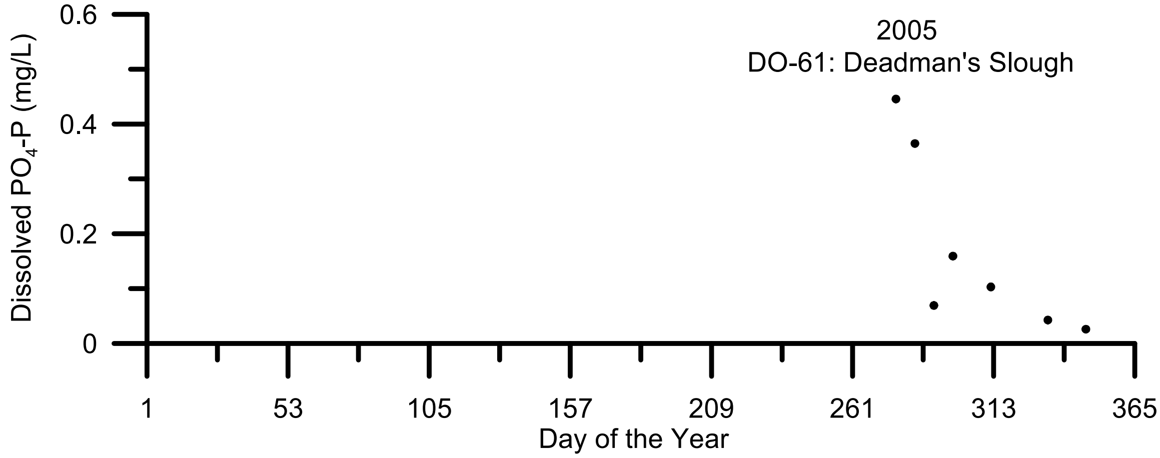

2006
DO-59: SJR Laird Park
Dissolved PO4-P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

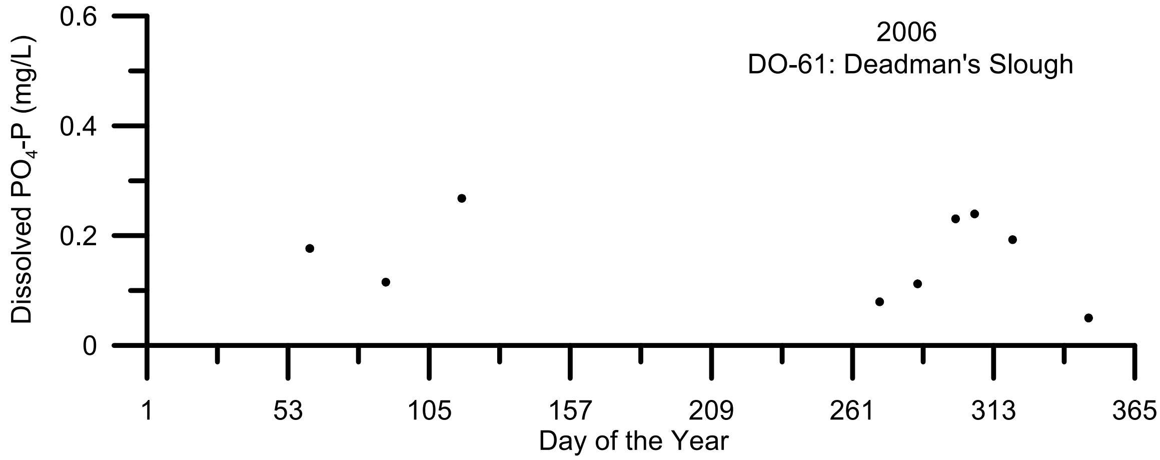

2007
DO-59: SJR Laird Park
Dissolved PO4-P (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

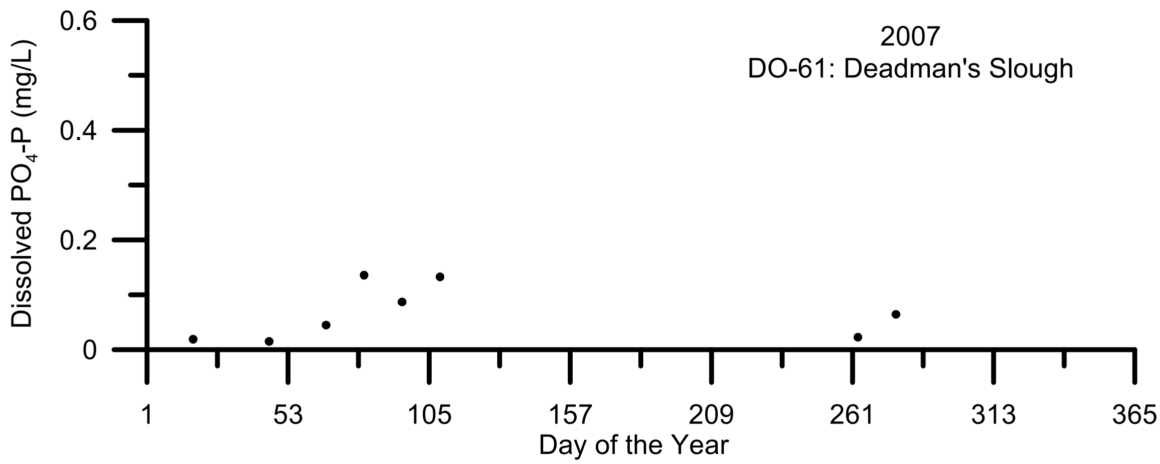

2005
DO-60: Moffit 1 South
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

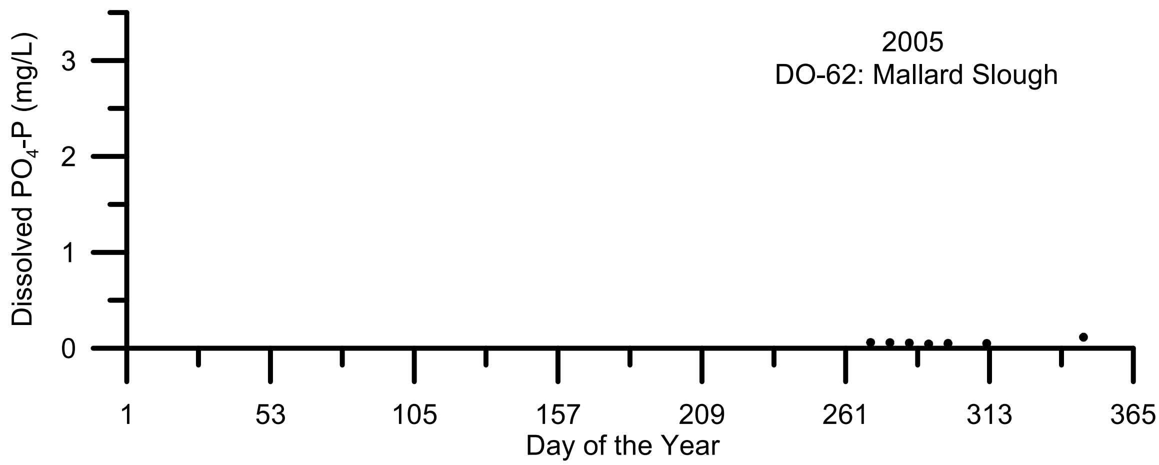

2006
DO-60: Moffit 1 South
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

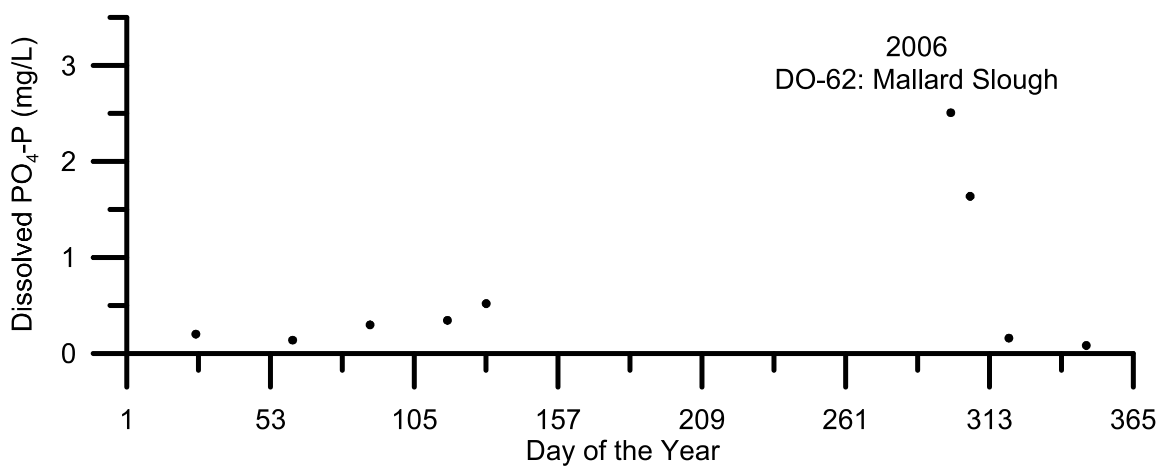

2007
DO-60: Moffit 1 South
Dissolved PO_4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

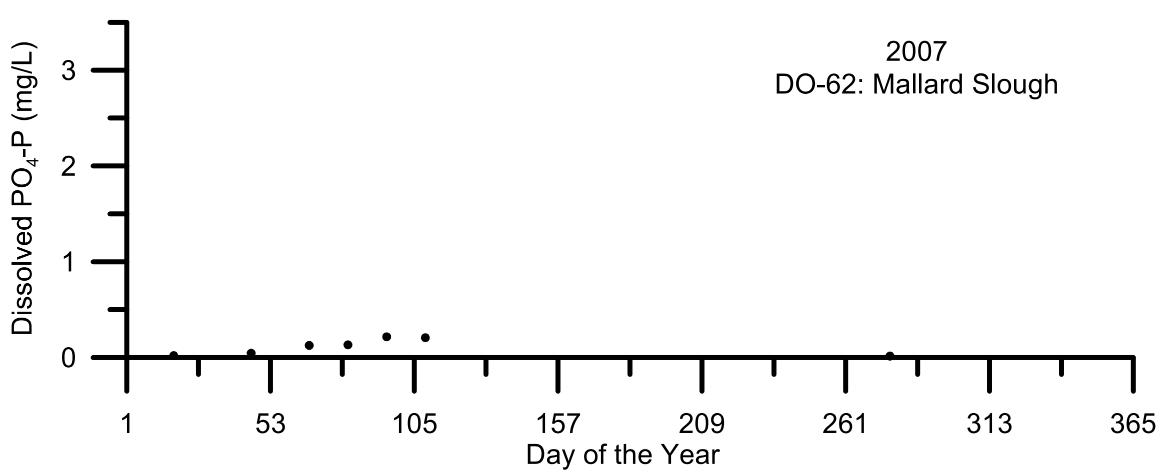

2005
DO-61: Deadman's Slough
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

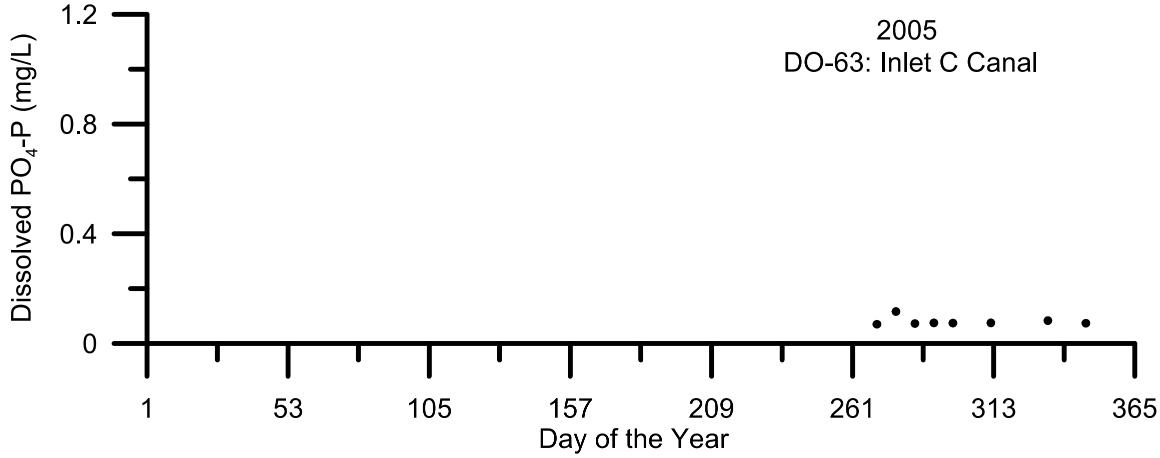

2006
DO-61: Deadman's Slough
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

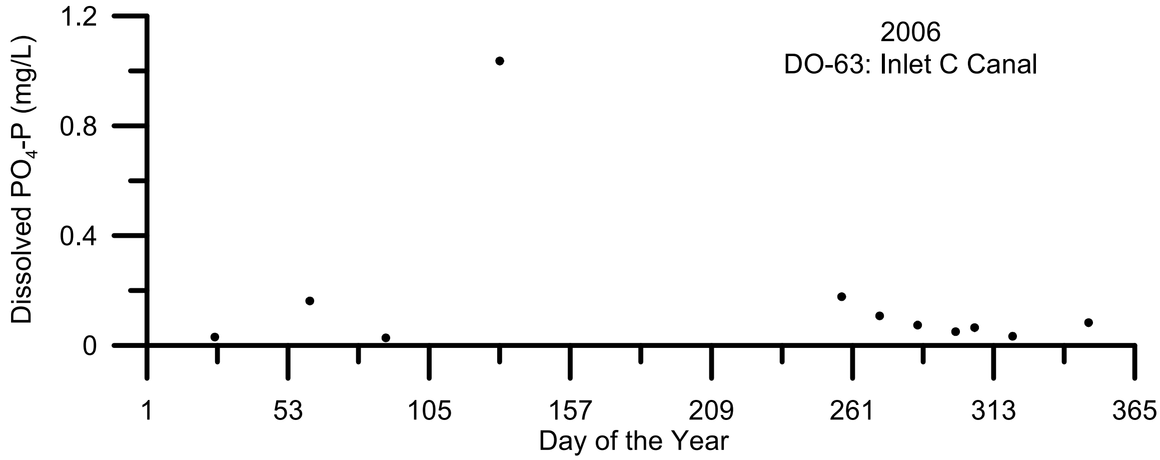

2007
DO-61: Deadman's Slough
Dissolved PO4-P (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

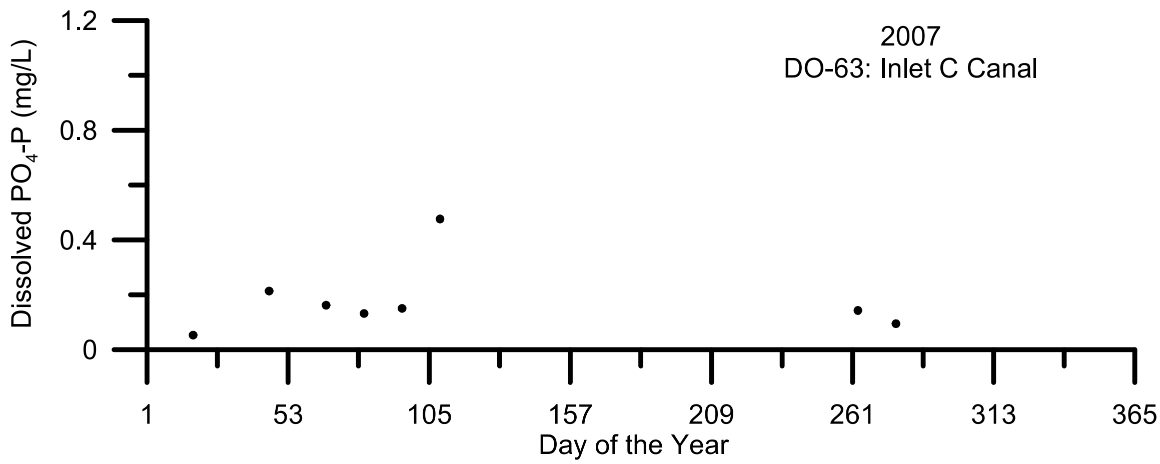

2005
DO-62: Mallard Slough
Dissolved PO4-P (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

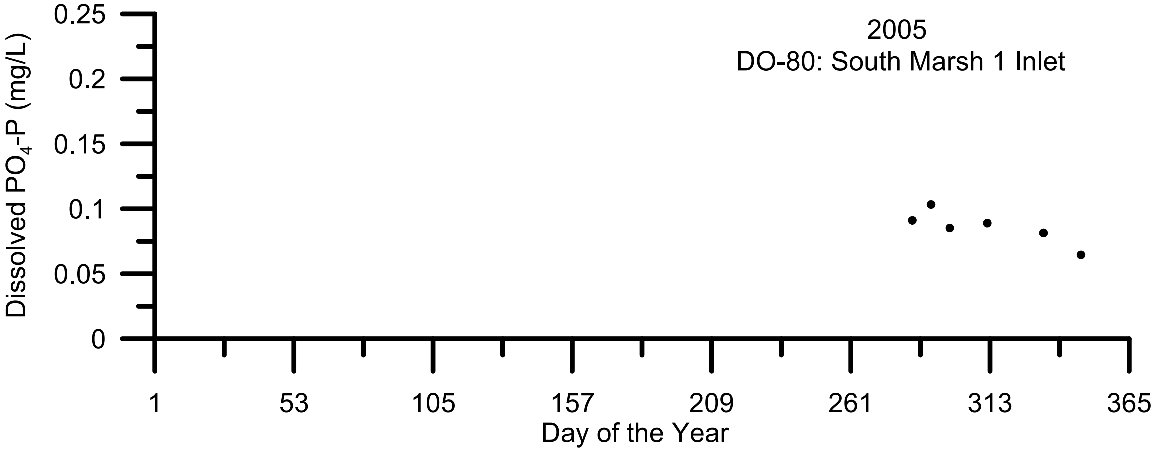

2006
DO-62: Mallard Slough
Dissolved PO4-P (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

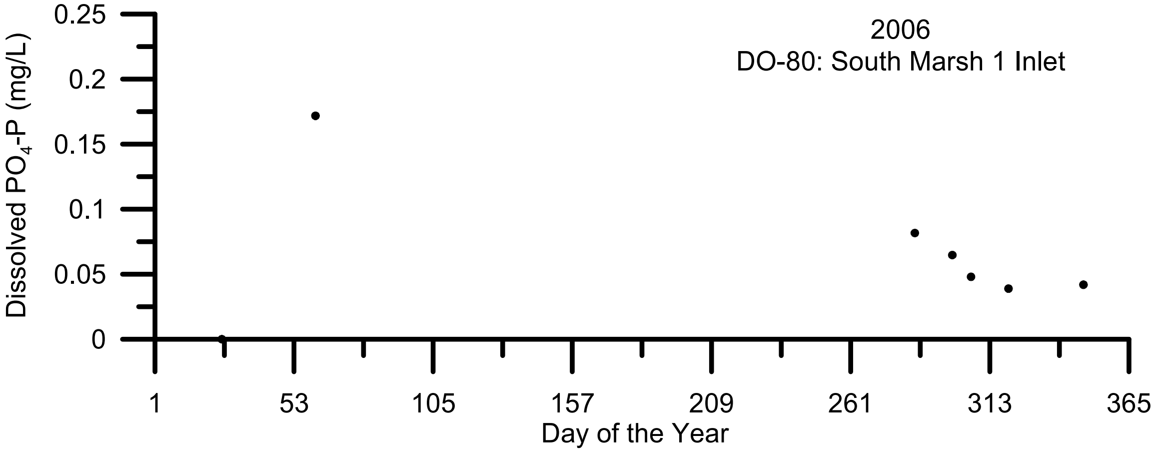

2007
DO-62: Mallard Slough
Dissolved PO4-P (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

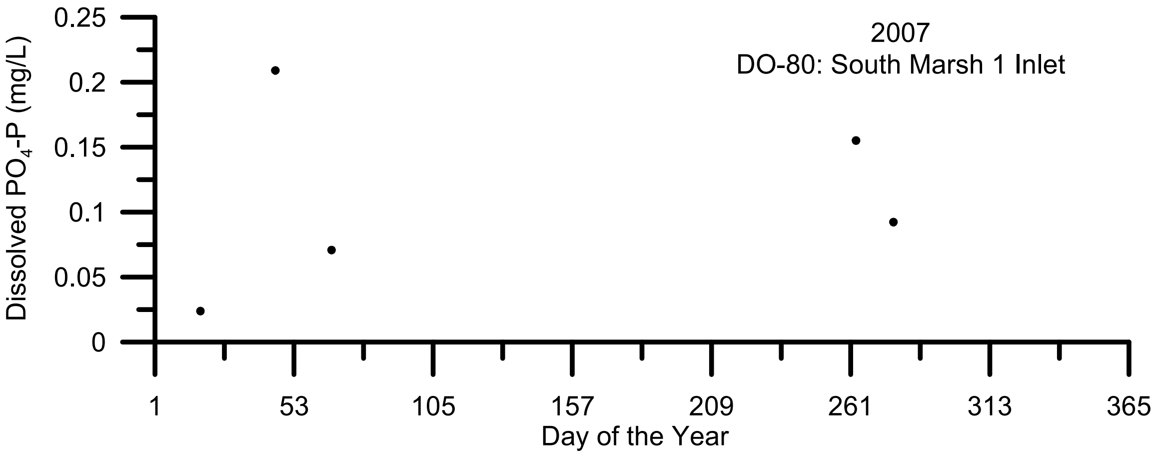

2005
DO-63: Inlet C Canal
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

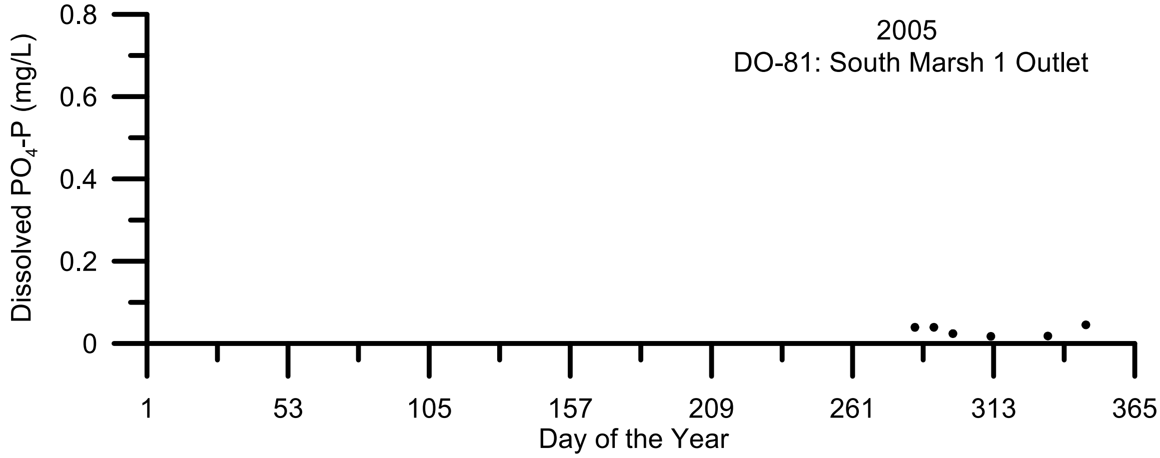

2006
DO-63: Inlet C Canal
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

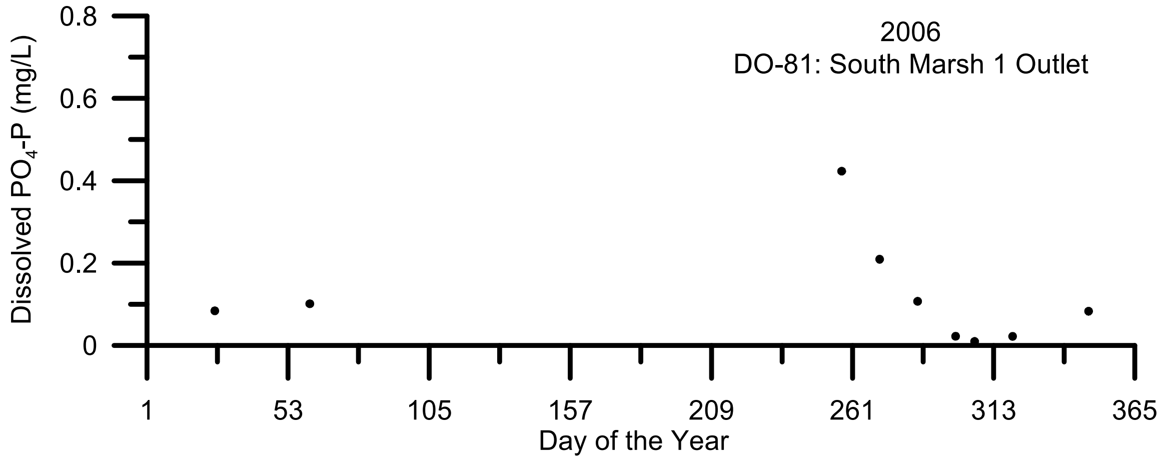

2007
DO-63: Inlet C Canal
Dissolved PO_4-P (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

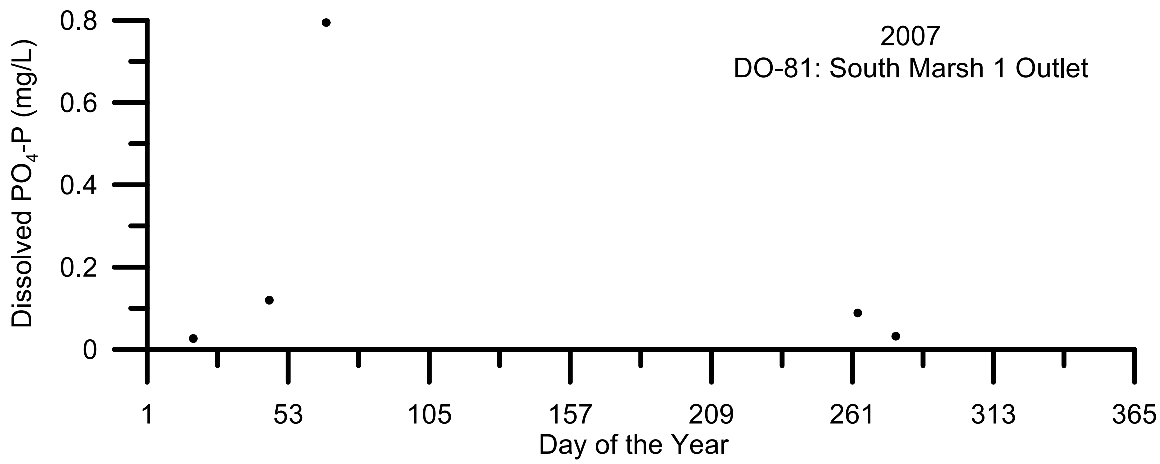

2005
DO-80: South Marsh 1 Inlet
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year

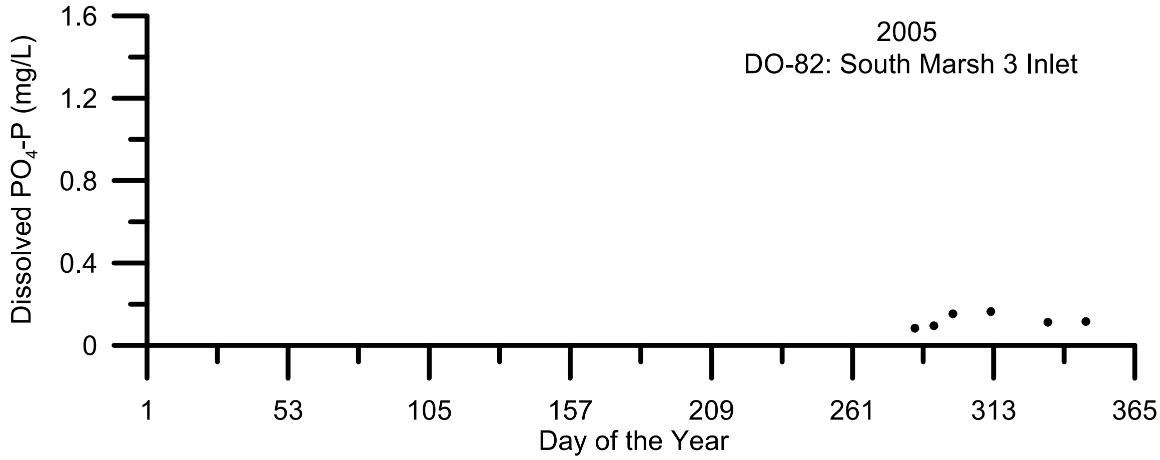

2006
DO-80: South Marsh 1 Inlet
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-80: South Marsh 1 Inlet
Dissolved PO4-P (mg/L)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-81: South Marsh 1 Outlet
Dissolved PO_4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-81: South Marsh 1 Outlet
Dissolved PO_4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-81: South Marsh 1 Outlet
Dissolved PO_4-P (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-82: South Marsh 3 Inlet
Dissolved PO_4-P (mg/L)
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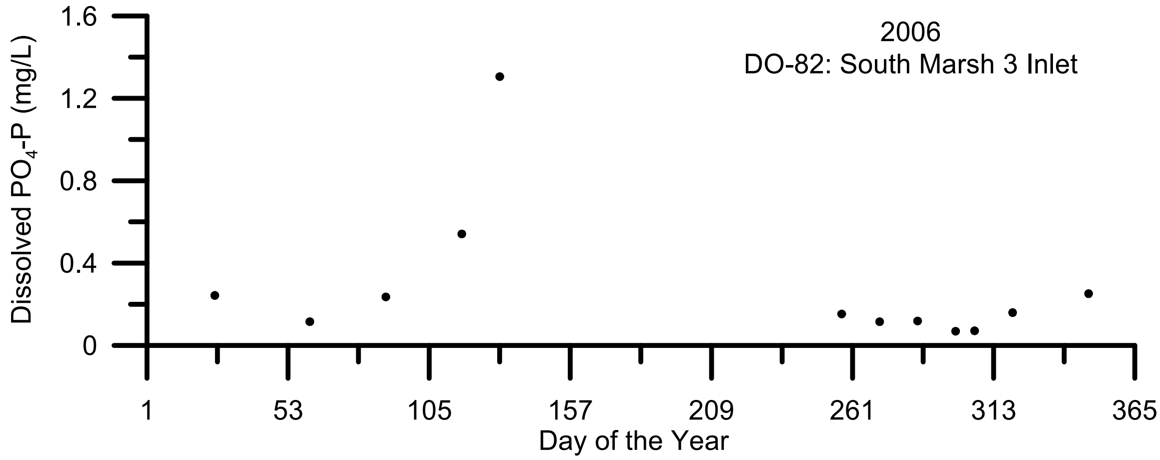
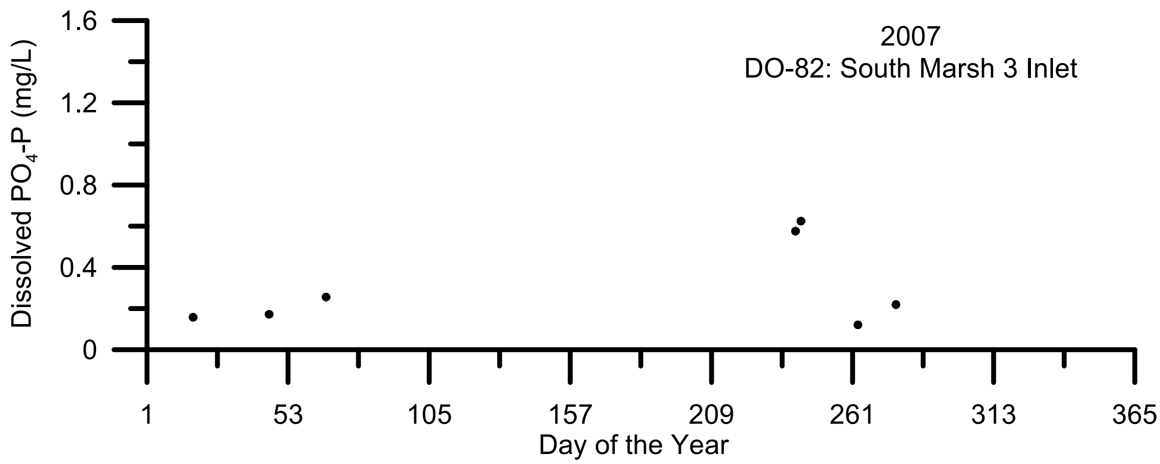
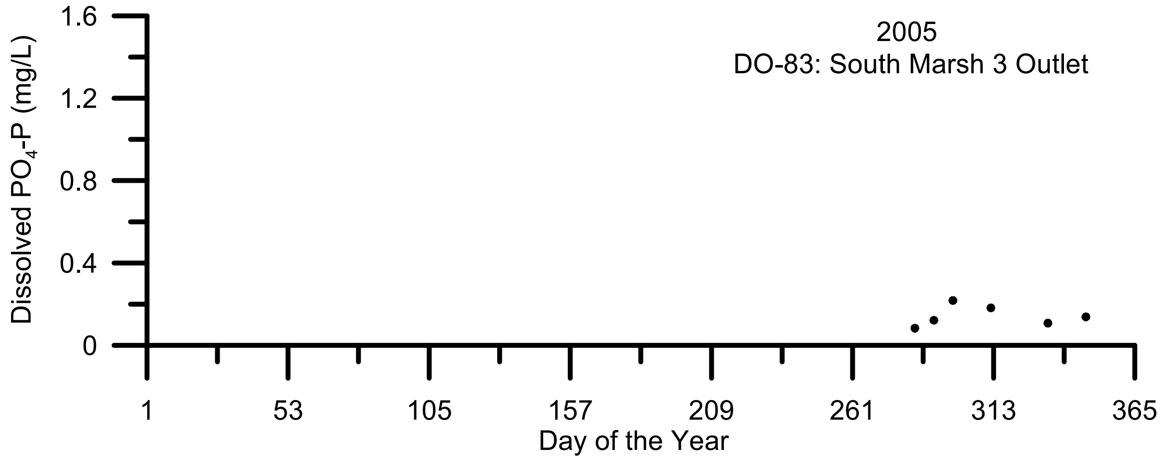
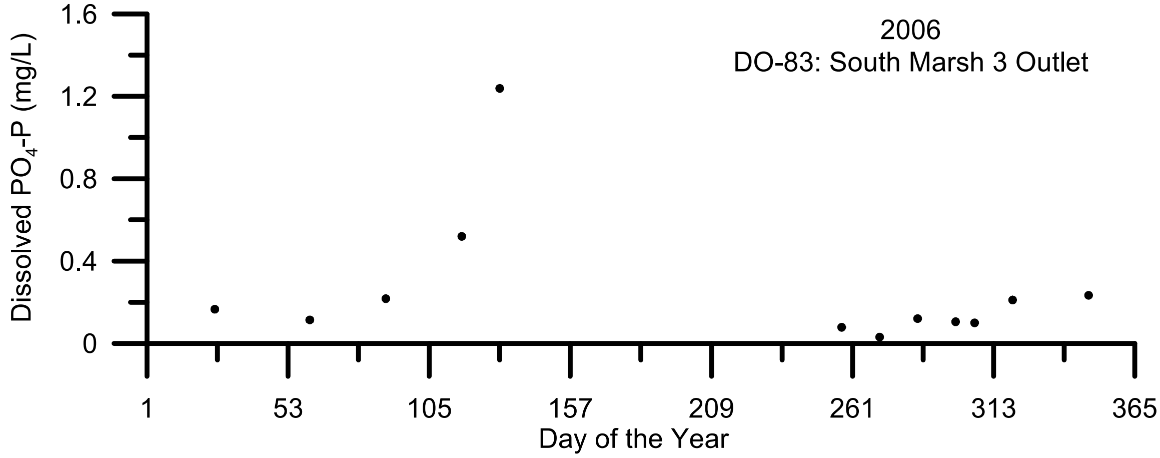
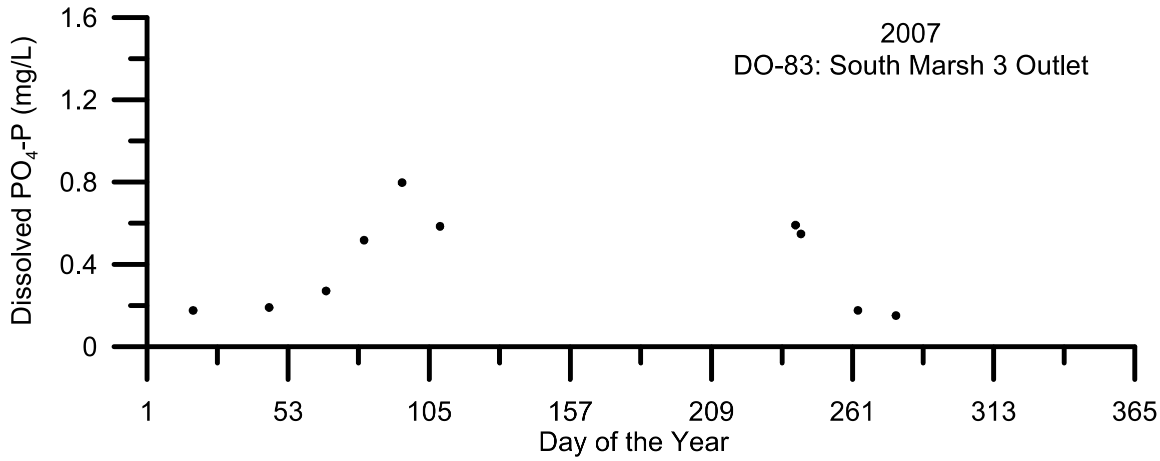
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

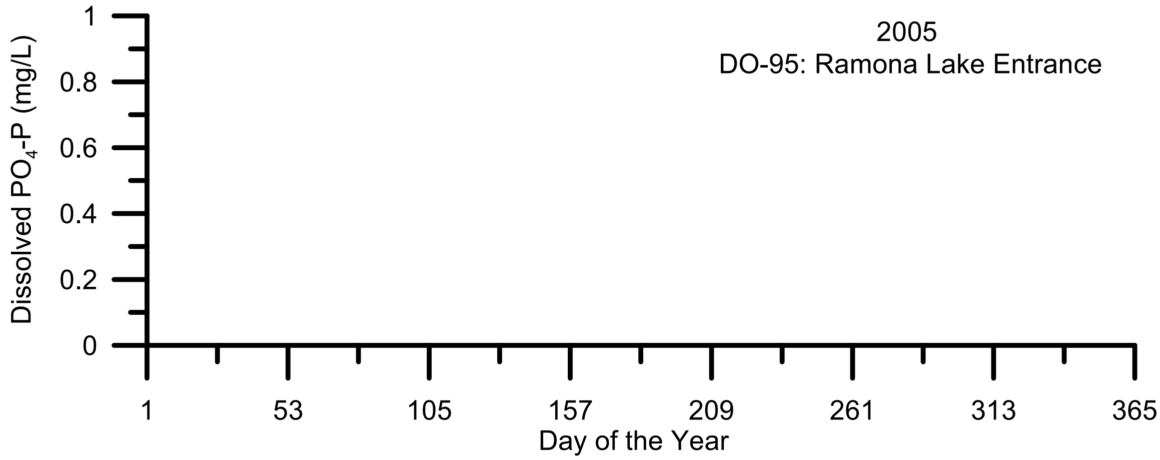

2006
DO-82: South Marsh 3 Inlet
Dissolved PO_4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

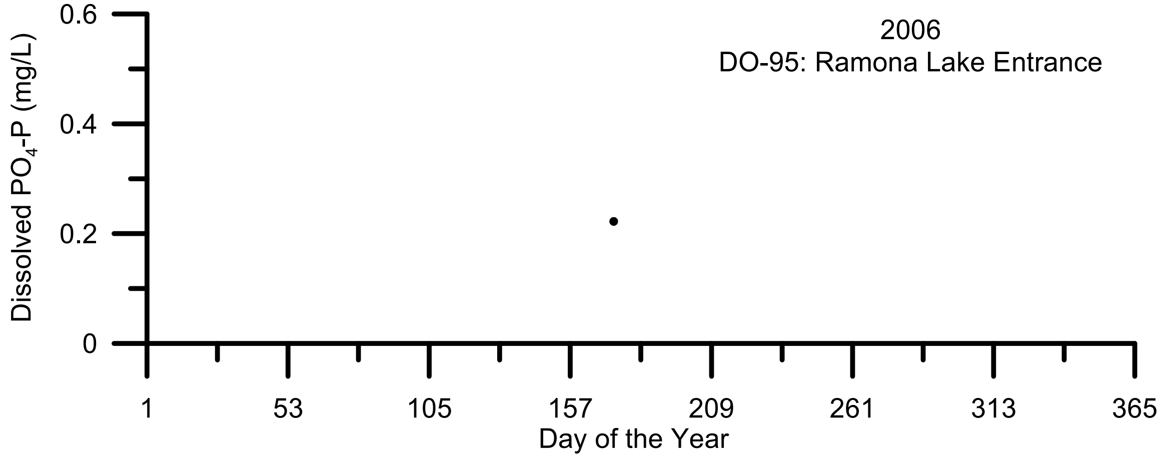

2007
DO-82: South Marsh 3 Inlet
Dissolved PO_4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

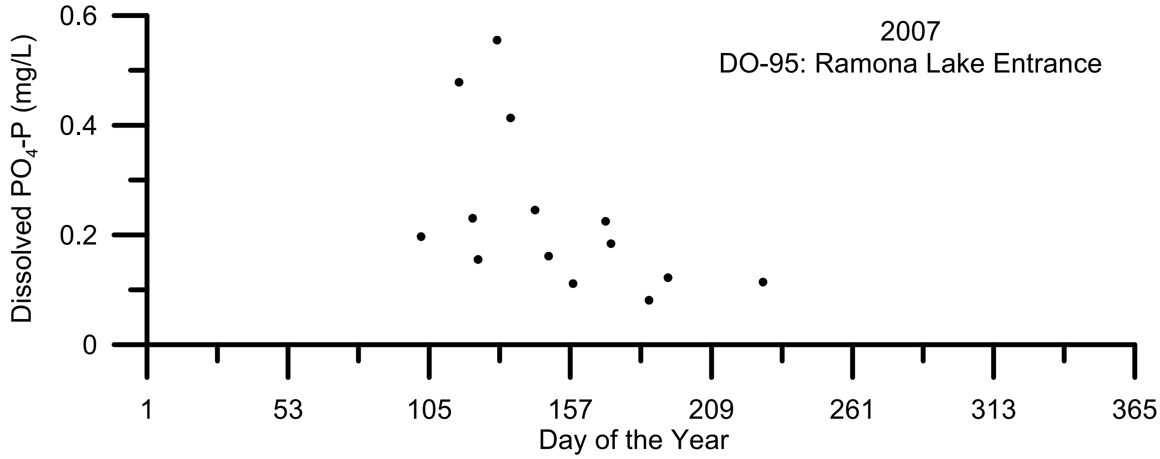

2005
DO-83: South Marsh 3 Outlet
Dissolved PO4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Dissolved PO4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Dissolved PO4-P (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Dissolved PO4-P (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Dissolved Ammonia Data from the Upstream San Joaquin River

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Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of dissolved ammonia-nitrogen (NH_3-N) for data analyzed by the UCD Dahlgren laboratory between 2005-2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples for NO_3-N and NH_3-N were transported from the EERP laboratory to the UCD laboratory, where they were filtered through a pre-rinsed, 0.22 μm polycarbonate membrane (Millipore Isopore™), and then stored at -20°C until NH_3-N analysis could be completed.

NO_3-N and Soluble NH_3-N were quantified simultaneously using an automated membrane diffusion/conductivity detection method (Carlson, 1978, 1986; Carlson et al., 1990). The limit of detection for this method was 50 ppb N.

Results/Discussion

With each set of NH_3-N field samples analyzed in the UCD laboratory, quality assurance samples including a field duplicate, a trip blank, and lab blanks were also analyzed. 95.02% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Four proficiency check samples were analyzed for NH_3-N in the UCD laboratory during 2005-2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.0-21.76 mg/L NH_3-N. The average concentration of NH_3-N in samples collected was 0.17 mg/L NH_3-N. NH_3-N was also analyzed at EERP starting in the summer of 2007, on the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.956 (Spier et al, 2008). NH3-N samples measured by EERP have about 91.1% as much NH3-N as the same samples measured by UCD (Figure 2). NH3-N was had low concentrations for most of the year with spikes appearing in the summer months for several sites.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Carlson, R.M., R. Cabrera, J. Paul, J. Quick and R.Y. Evans. 1990. Rapid direct determination of ammonium and nitrate in soil and plant tissue extracts. Comm. Soil Sci. Plant Anal. 21:1519-1530.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Spier, C., Burks, R., Borglin, S.E. (2008) Comparison of Methods for Analyzing Ammonia, Nitrate and Total Nitrogen, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

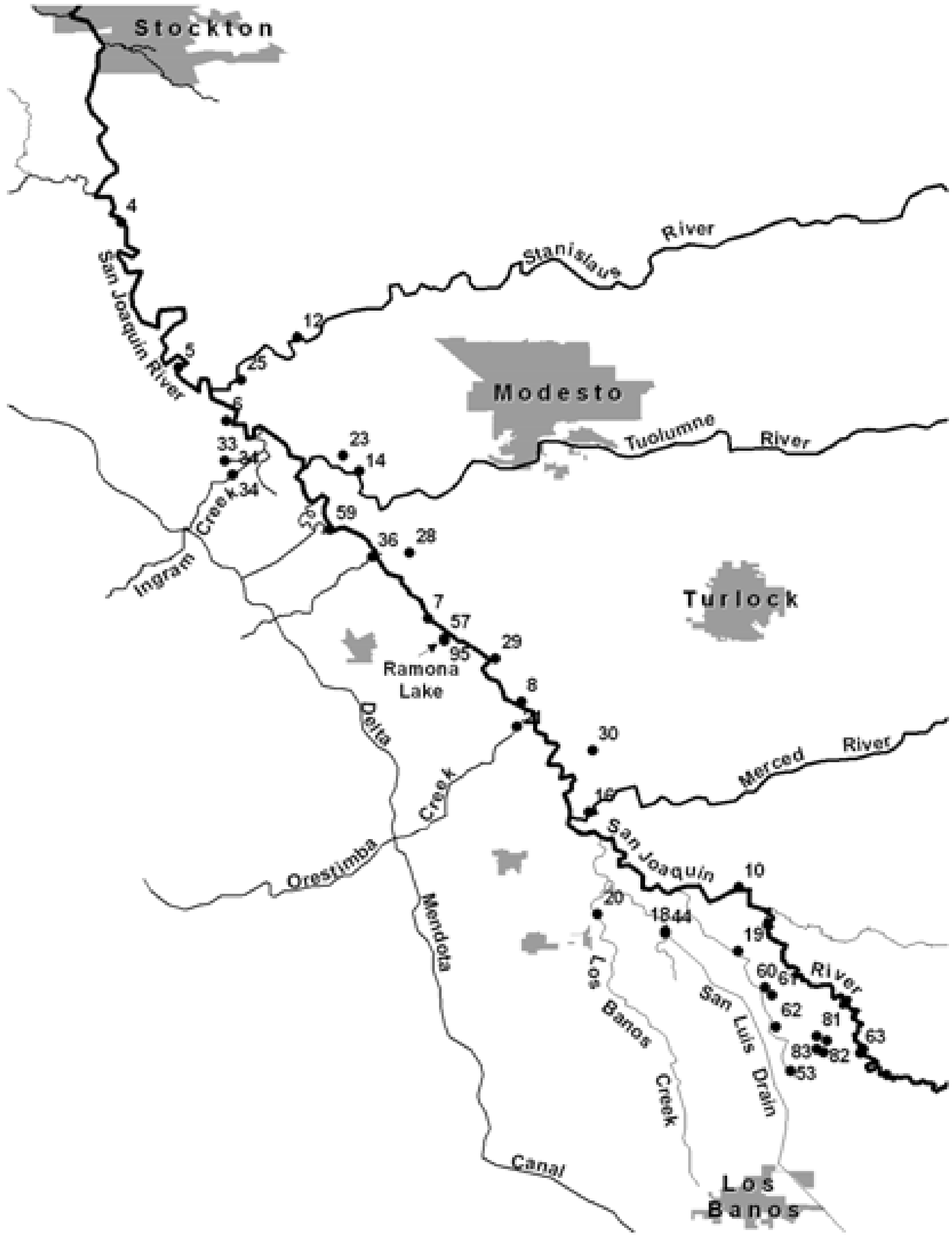
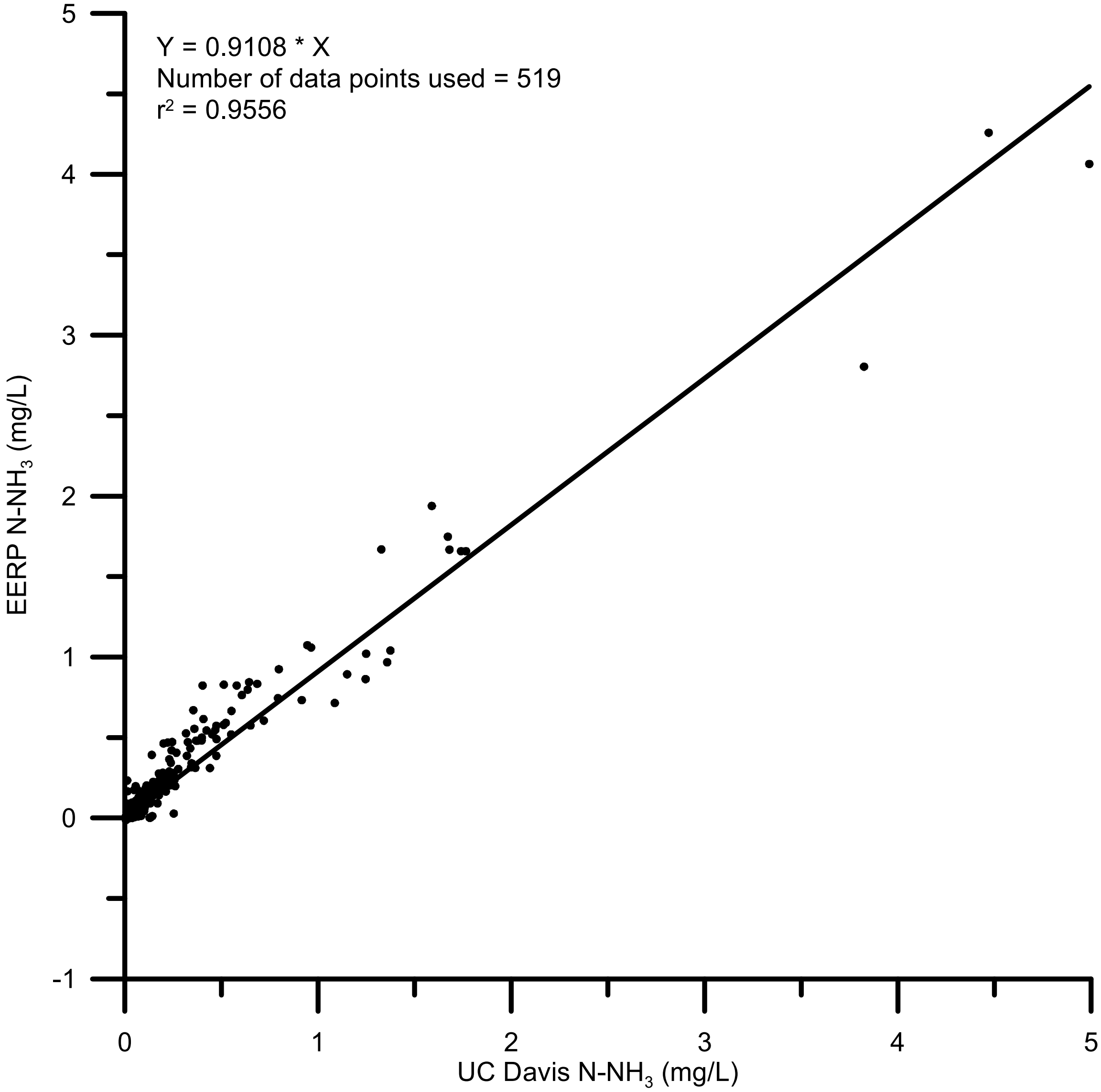
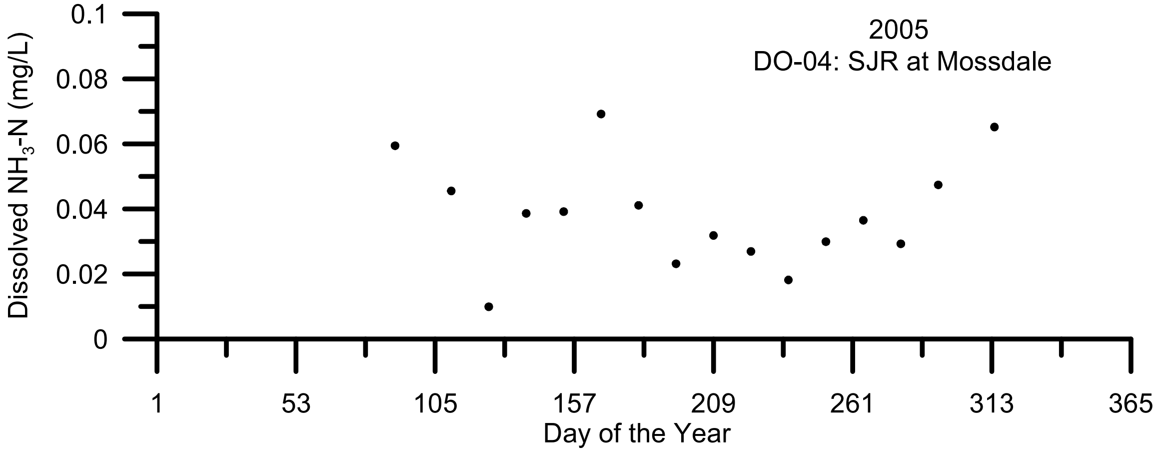
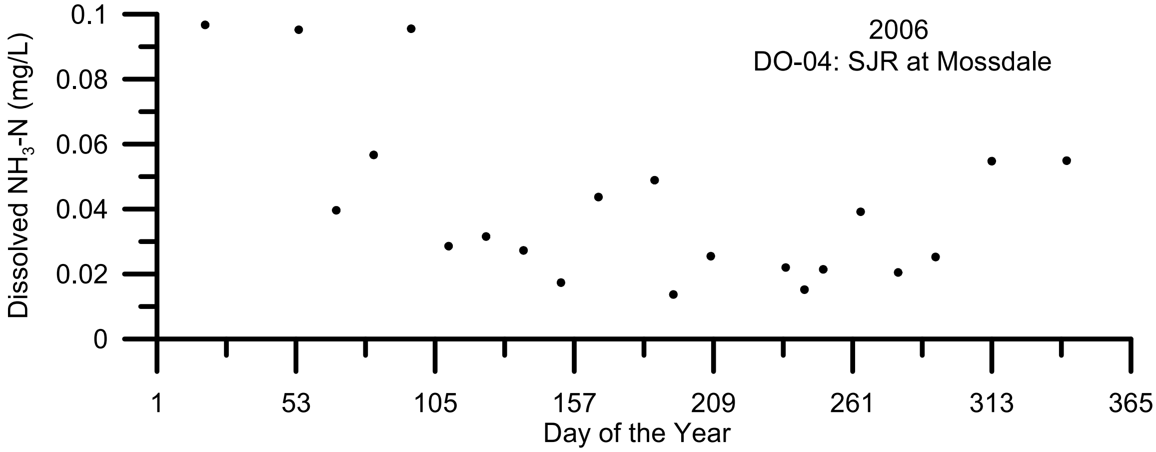


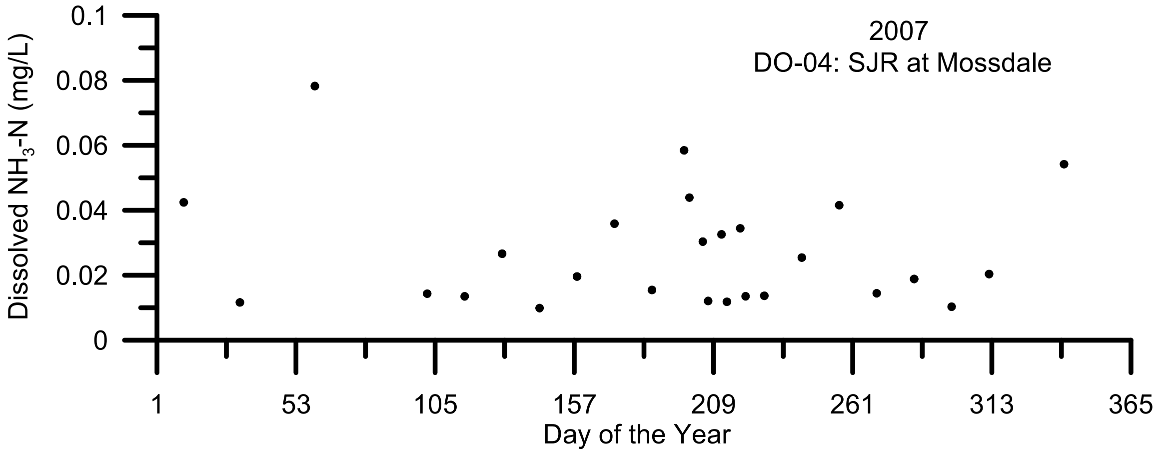
Figure 2: UCD vs EERP Timberline Plot of NH_3-N .

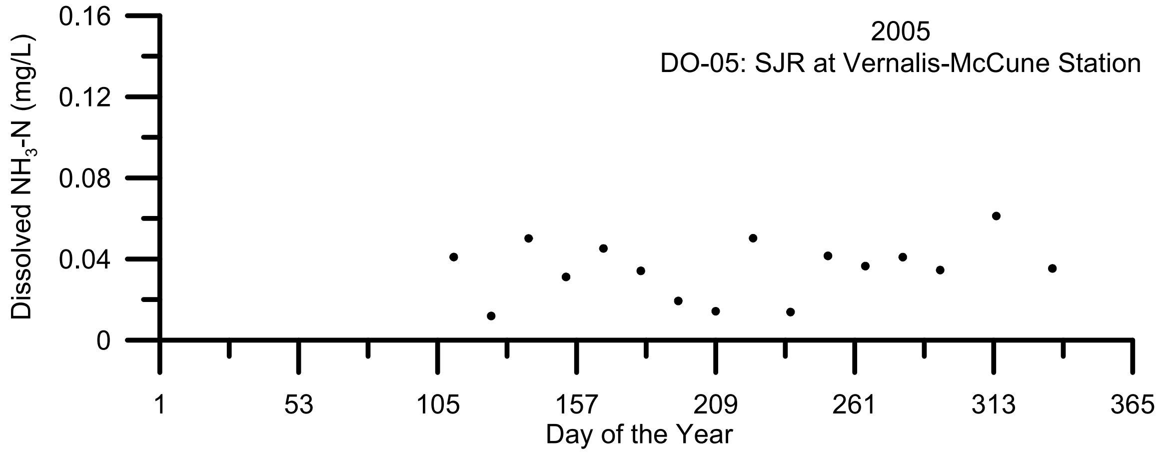


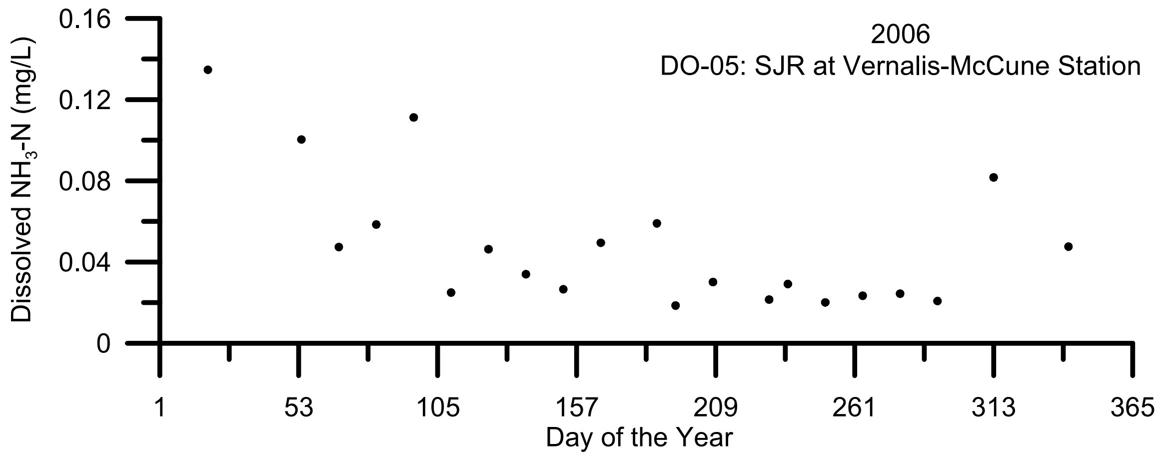
Figures 3 -104: Temporal Plots of Dissolved NH_3-N By Site ID

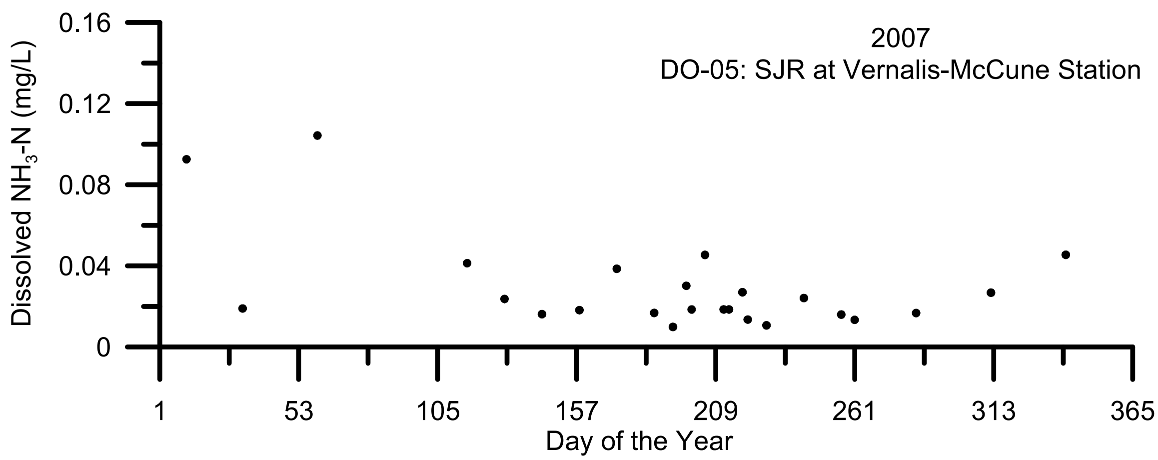


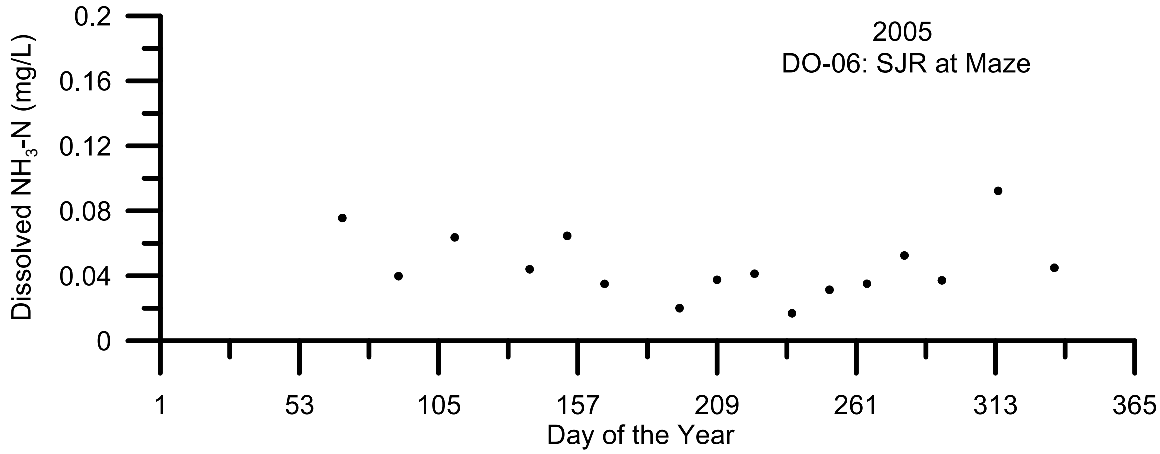


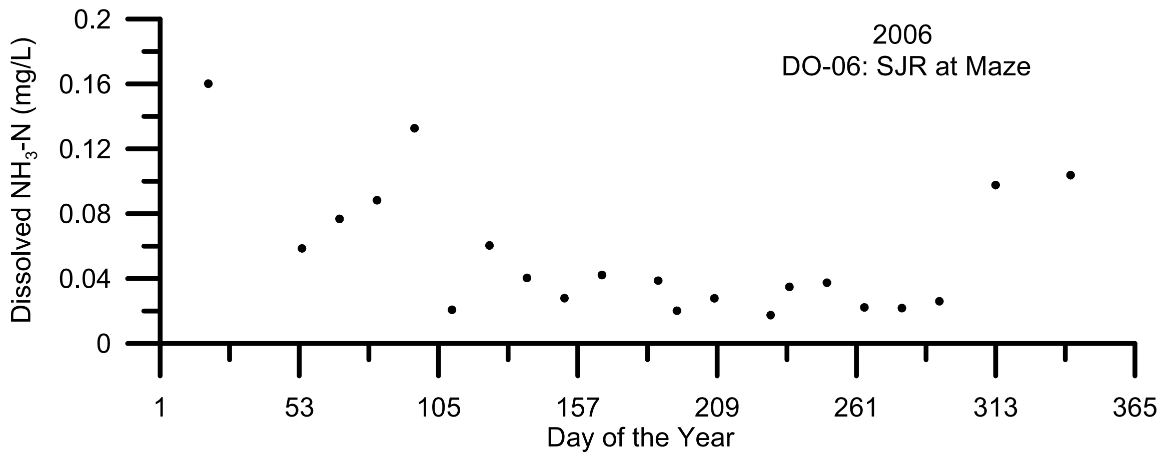


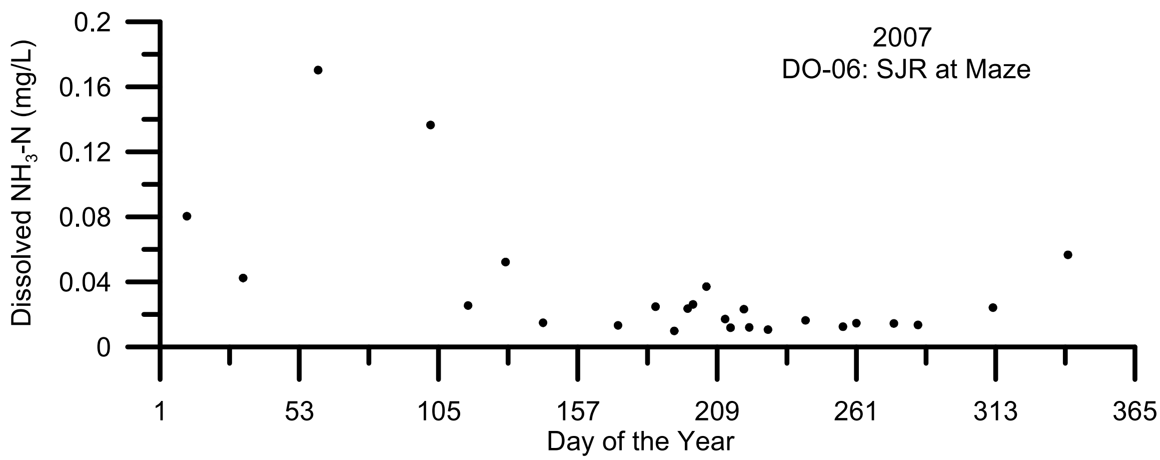

2005
DO-05: SJR at Vernalis-McCune Station
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

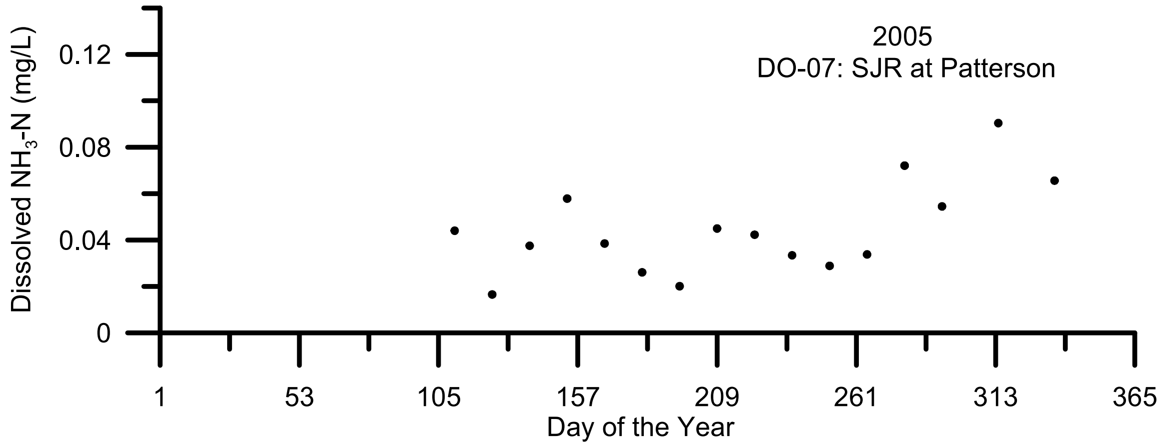

2006
DO-05: SJR at Vernalis-McCune Station
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

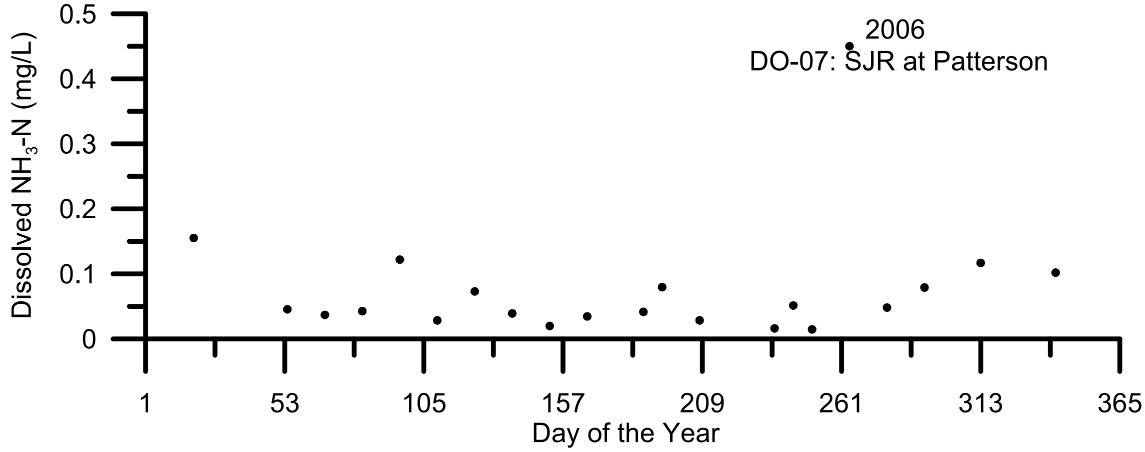

2007
DO-05: SJR at Vernalis-McCune Station
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

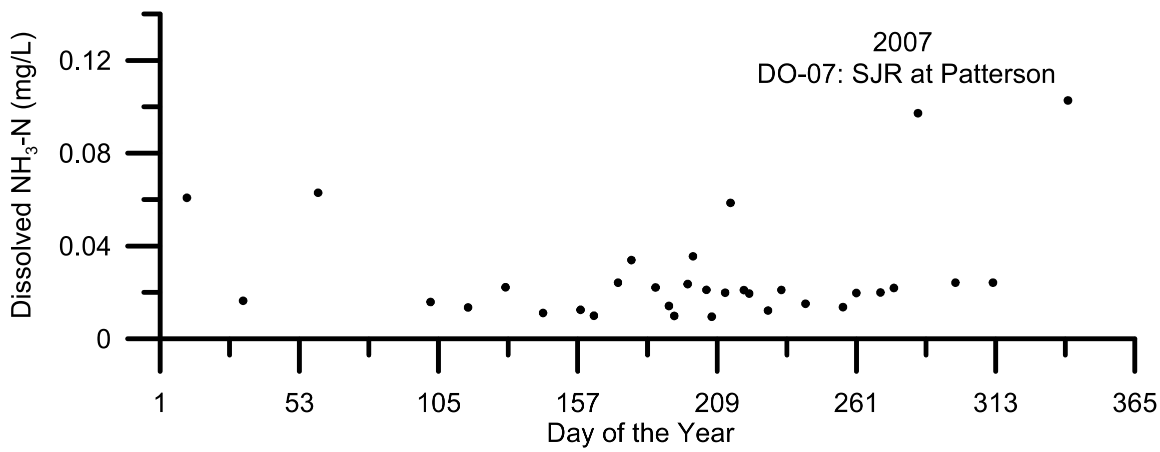

2005
DO-06: SJR at Maze
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

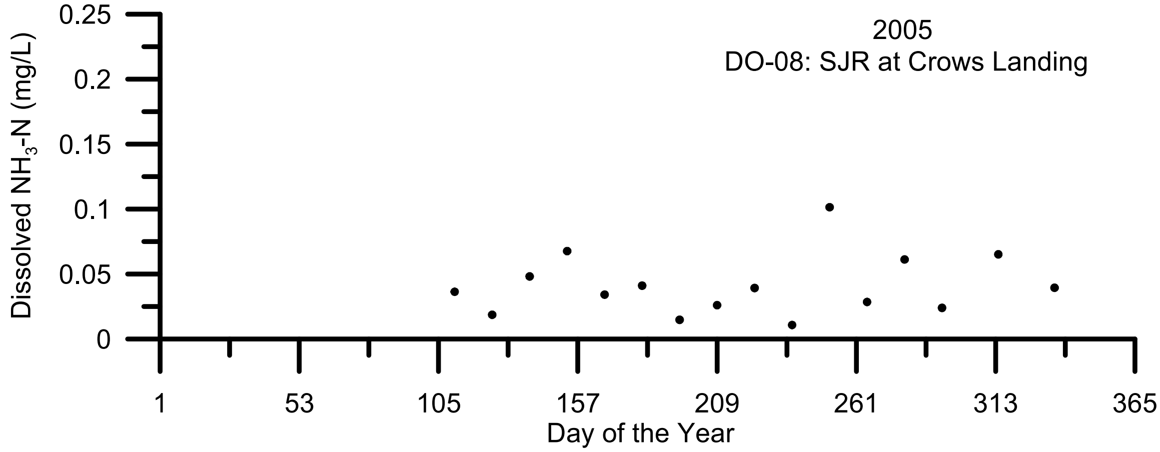

2006
DO-06: SJR at Maze
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

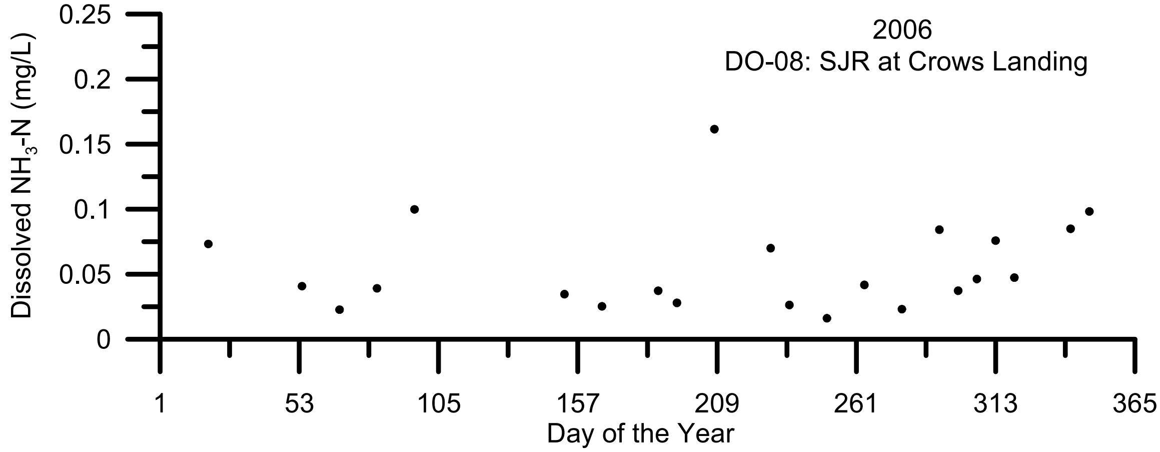

2007
DO-06: SJR at Maze
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

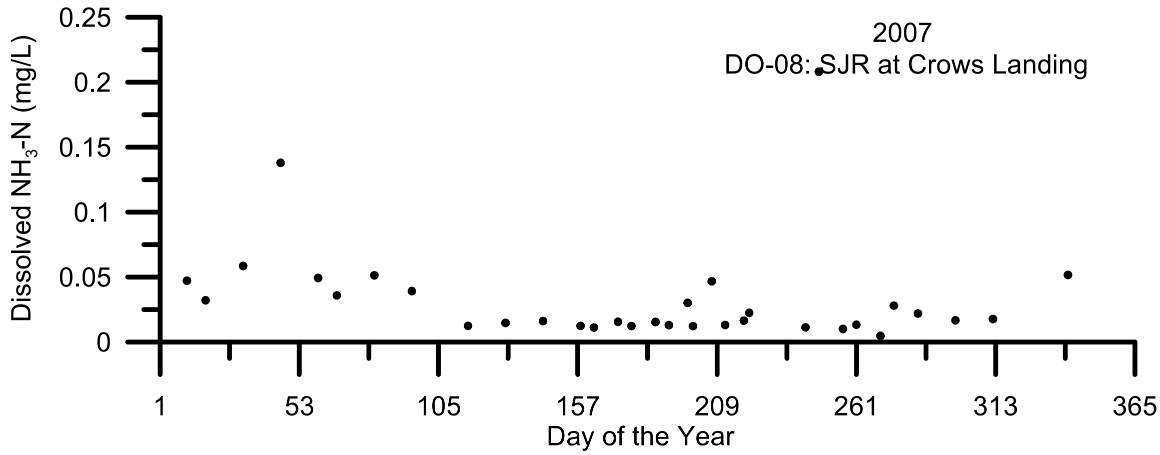

2005
DO-07: SJR at Patterson
Dissolved NH_3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

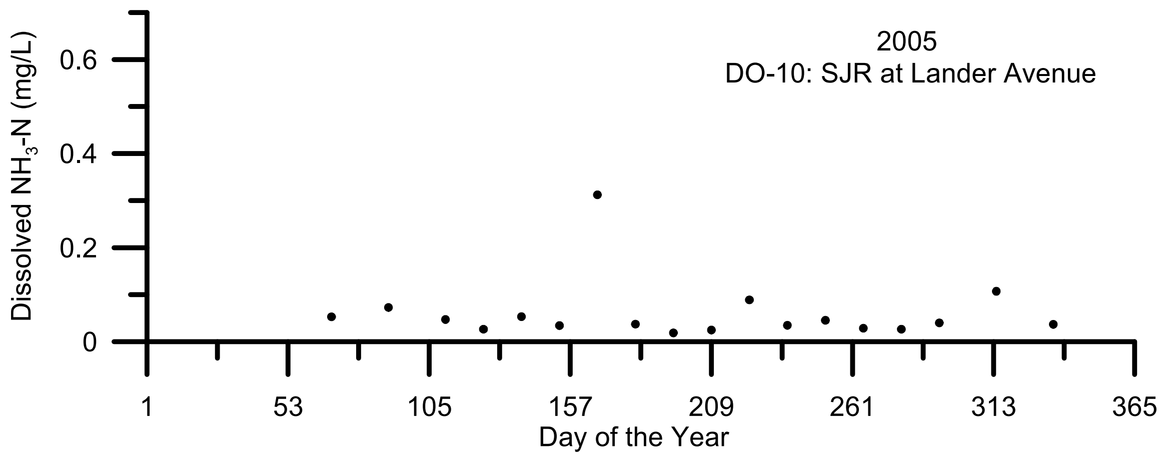

2006
DO-07: SJR at Patterson
Dissolved NH_3-N (mg/L)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

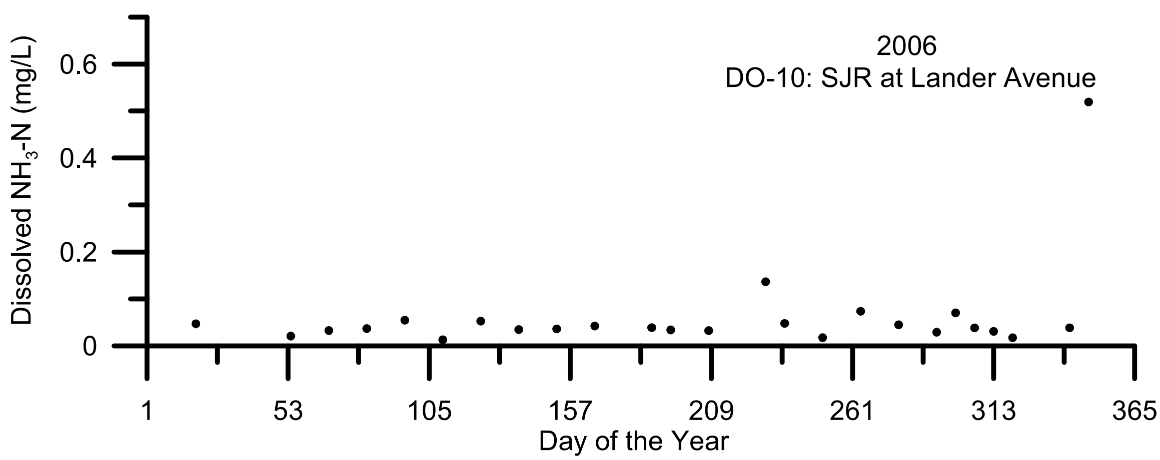

2007
DO-07: SJR at Patterson
Dissolved NH_3-N (mg/L)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

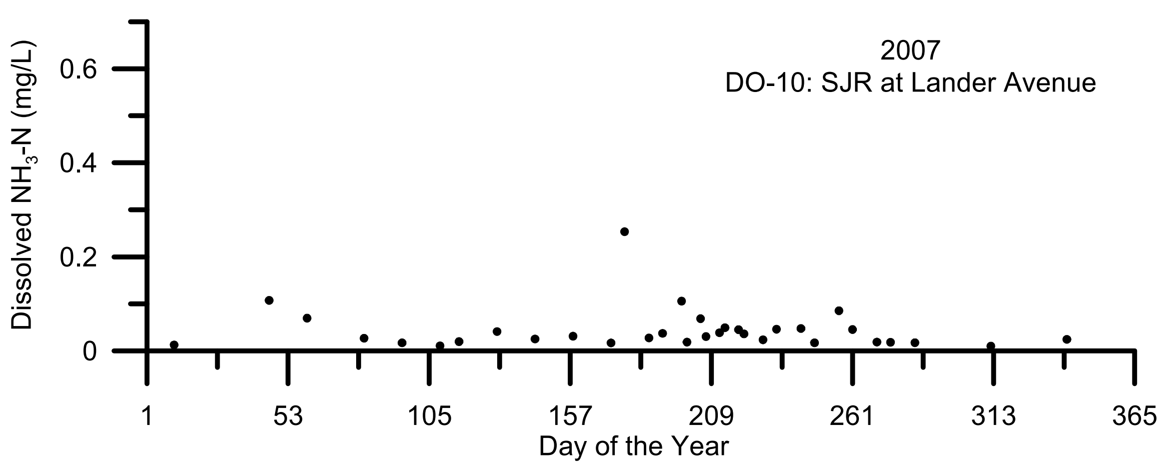

0.25
0.2
0.15
0.1
0.05
0
Dissolved NH_3-N (mg/L)
2005
DO-08: SJR at Crows Landing
1
53
105
157
209
261
313
365
Day of the Year

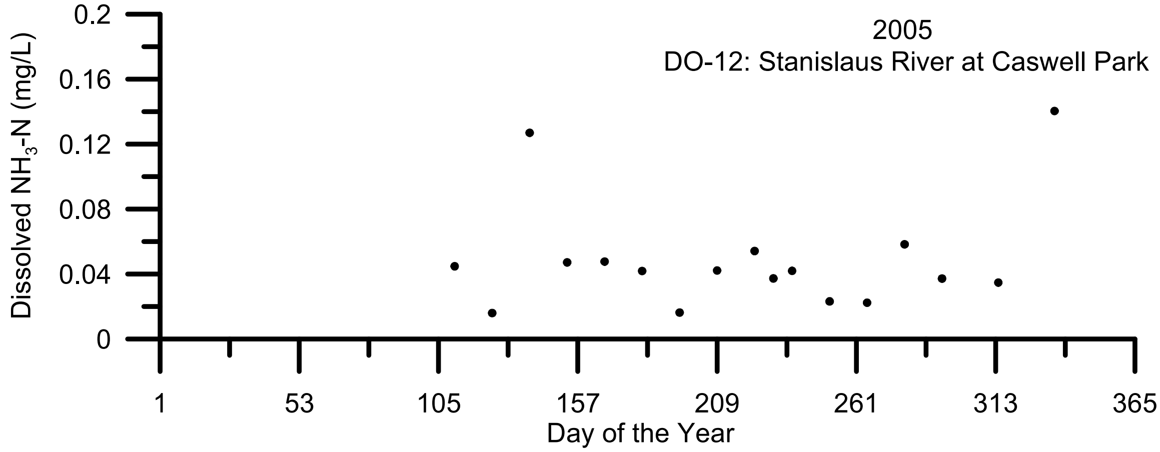

0.25
0.2
0.15
0.1
0.05
0
Dissolved NH_3-N (mg/L)
2006
DO-08: SJR at Crows Landing
1
53
105
157
209
261
313
365
Day of the Year

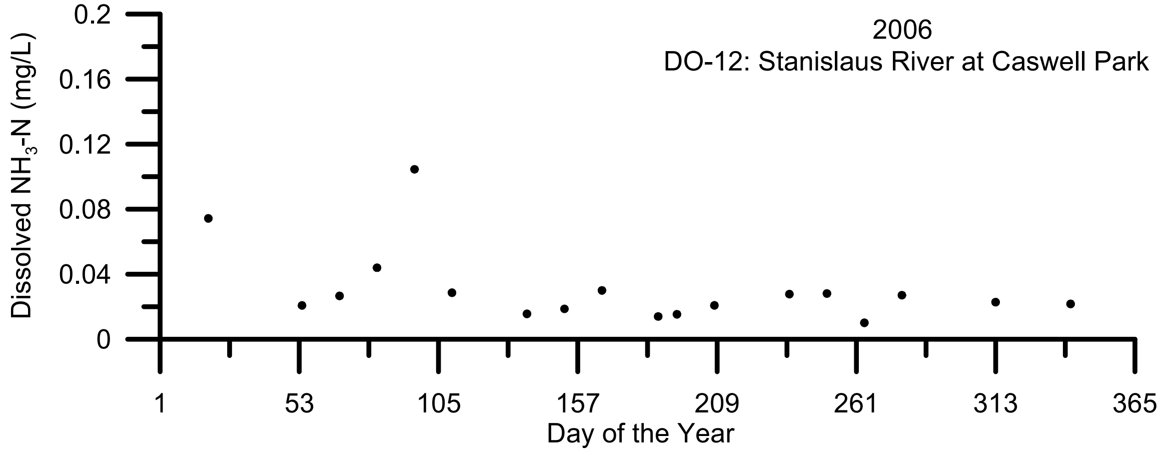

0.25
0.2
0.15
0.1
0.05
0
Dissolved NH_3-N (mg/L)
2007
DO-08: SJR at Crows Landing
1
53
105
157
209
261
313
365
Day of the Year

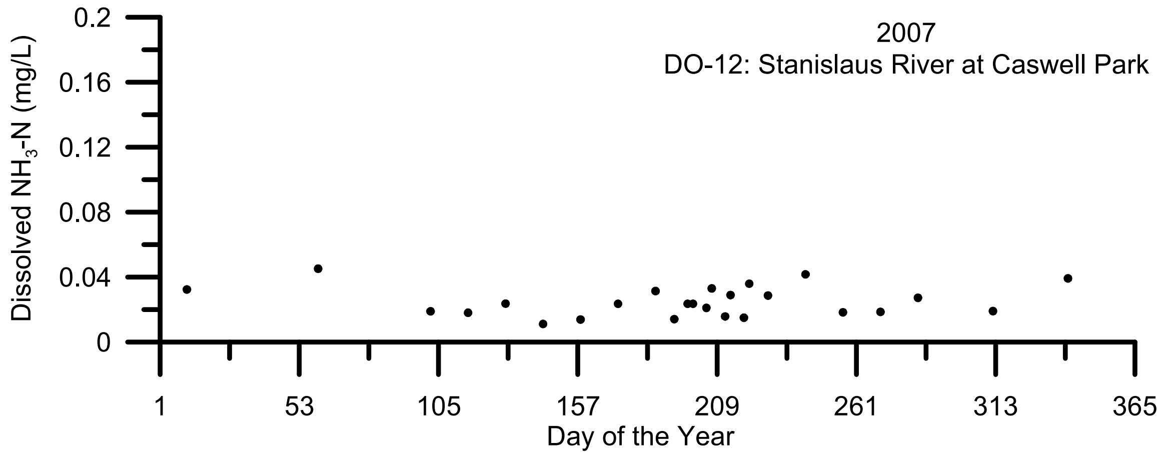

2005
DO-10: SJR at Lander Avenue
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

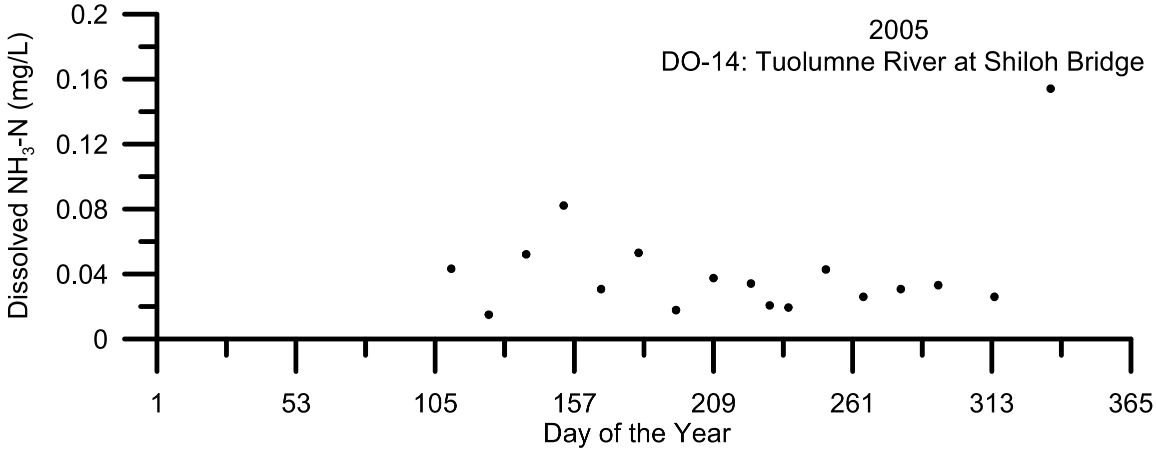

2006
DO-10: SJR at Lander Avenue
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

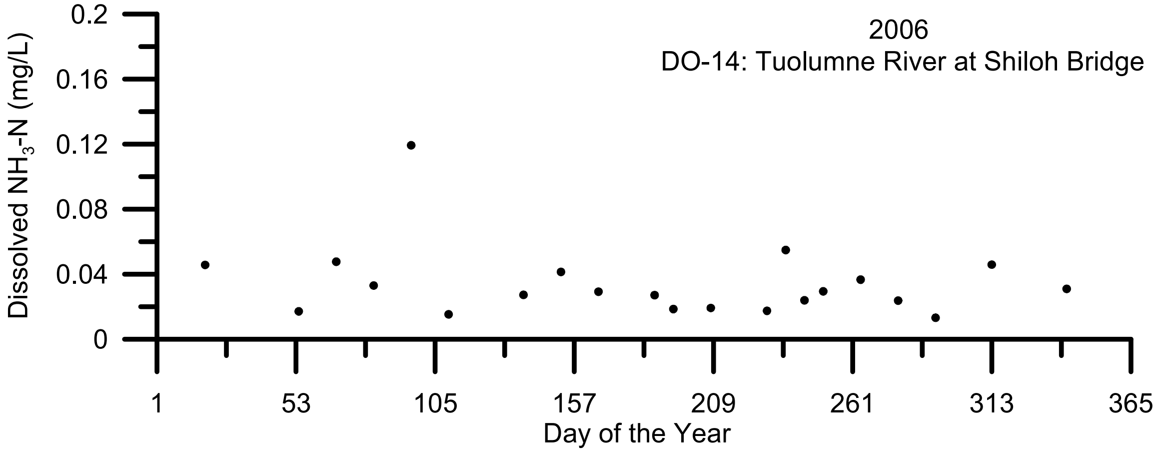

2007
DO-10: SJR at Lander Avenue
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year

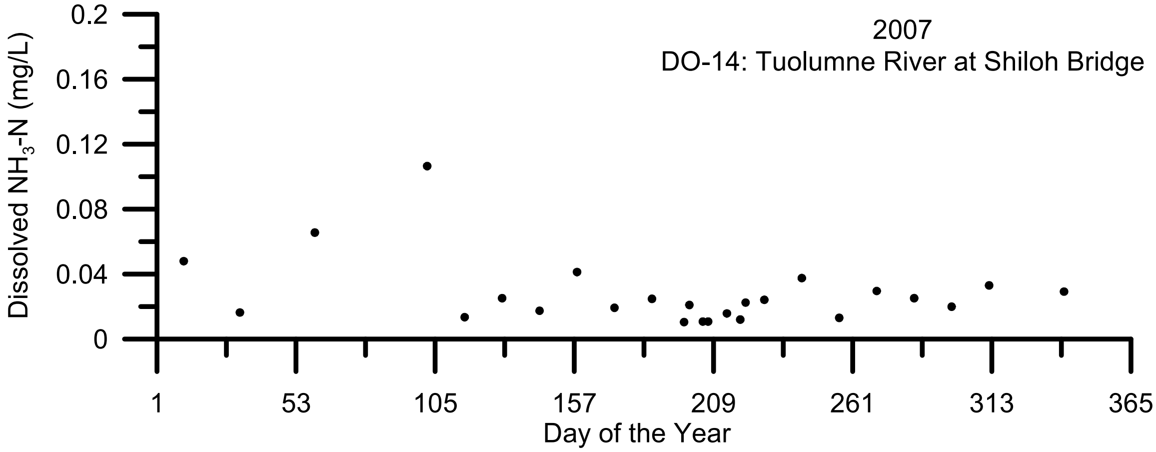

2005
DO-12: Stanislaus River at Caswell Park
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

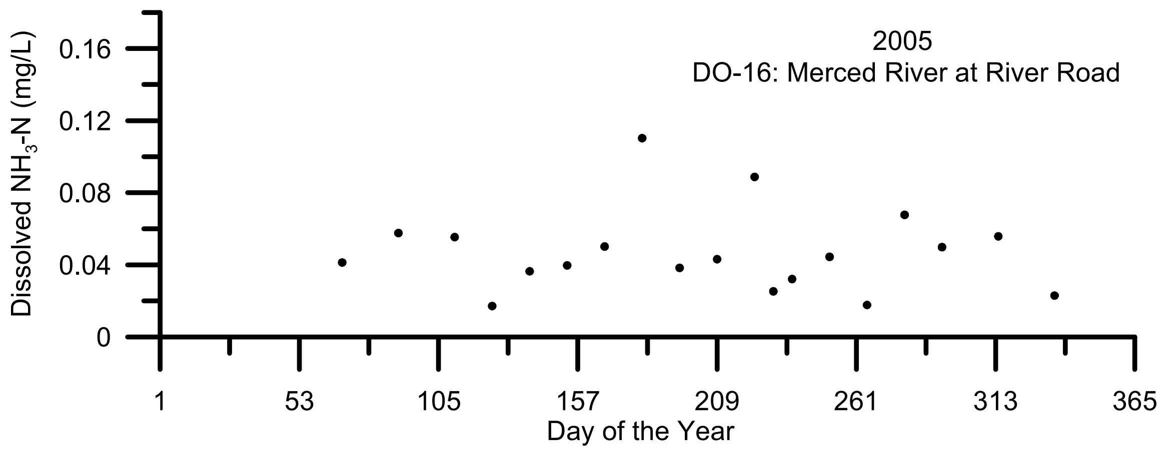

2006
DO-12: Stanislaus River at Caswell Park
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

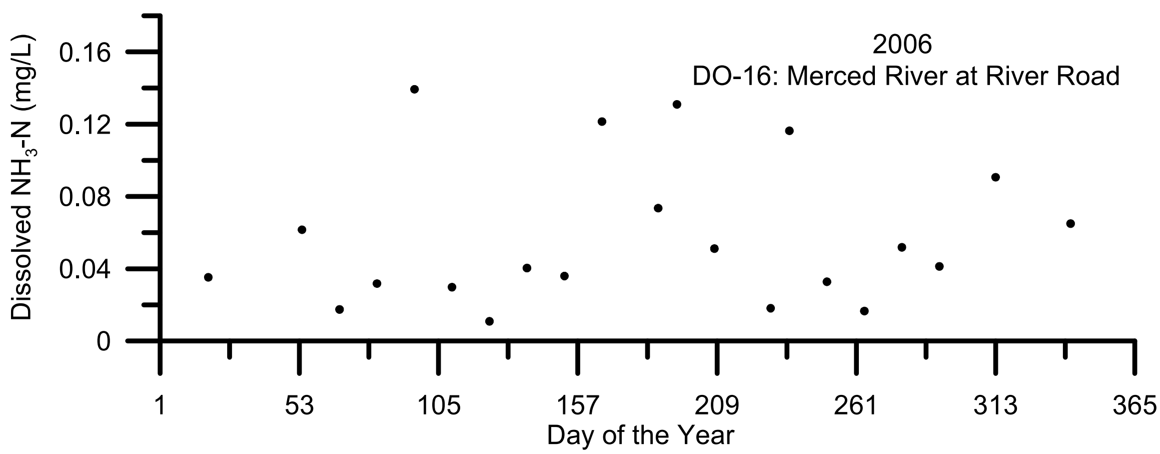

2007
DO-12: Stanislaus River at Caswell Park
Dissolved NH_3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

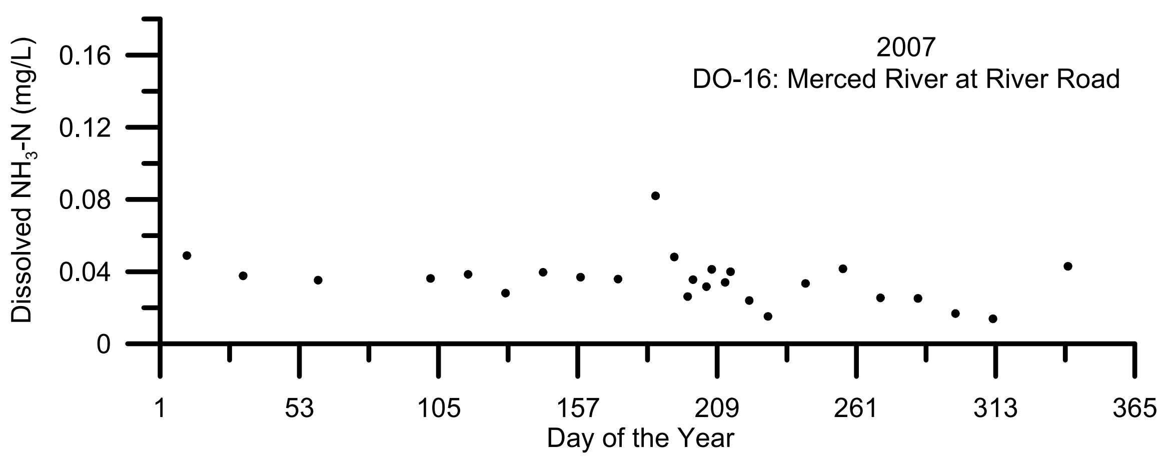

2005
DO-14: Tuolumne River at Shiloh Bridge
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

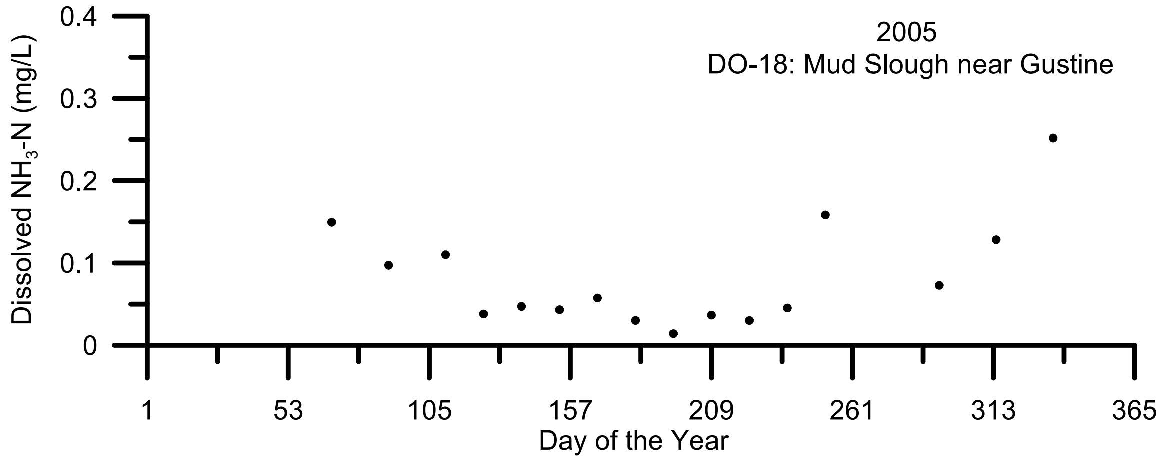

2006
DO-14: Tuolumne River at Shiloh Bridge
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

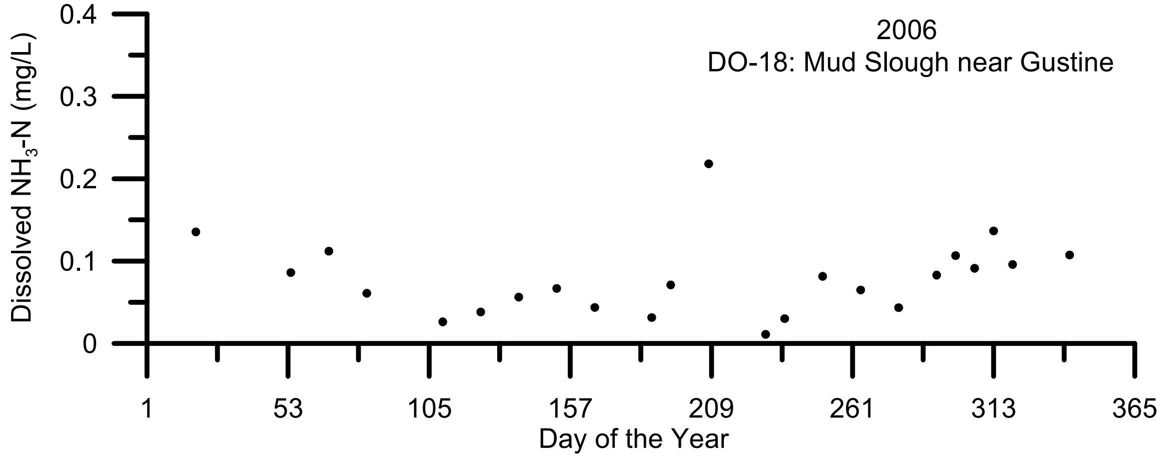

2007
DO-14: Tuolumne River at Shiloh Bridge
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

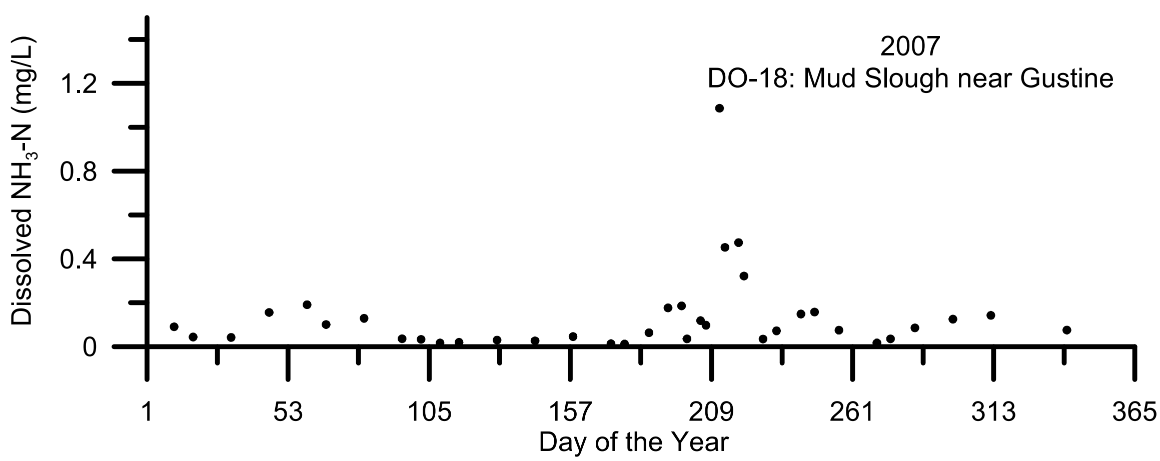

2005
DO-16: Merced River at River Road
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

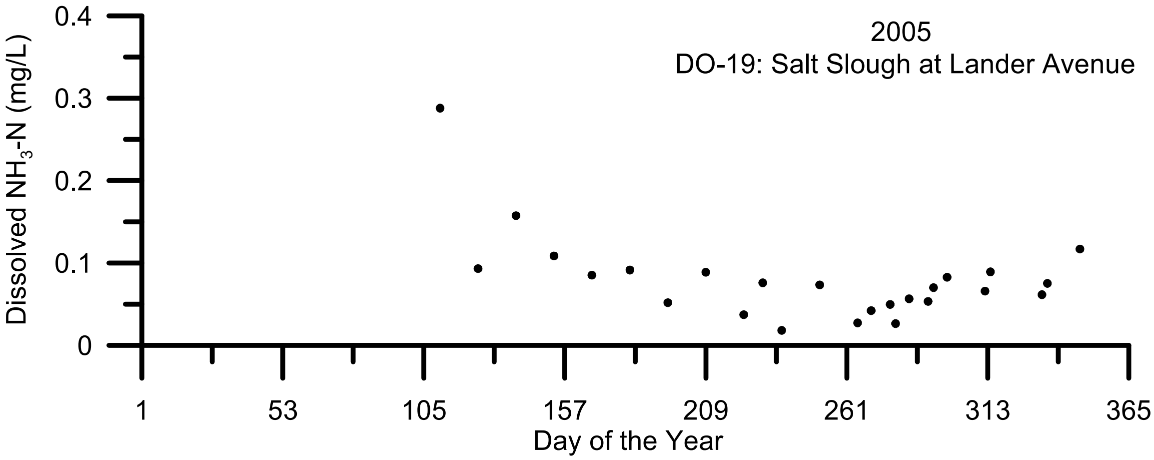

2006
DO-16: Merced River at River Road
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

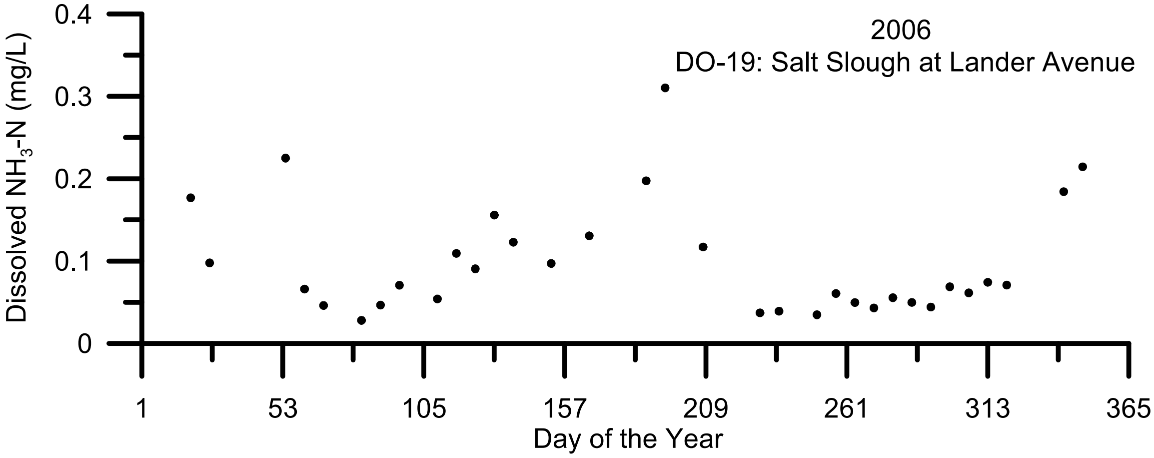

2007
DO-16: Merced River at River Road
Dissolved NH3-N (mg/L)
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

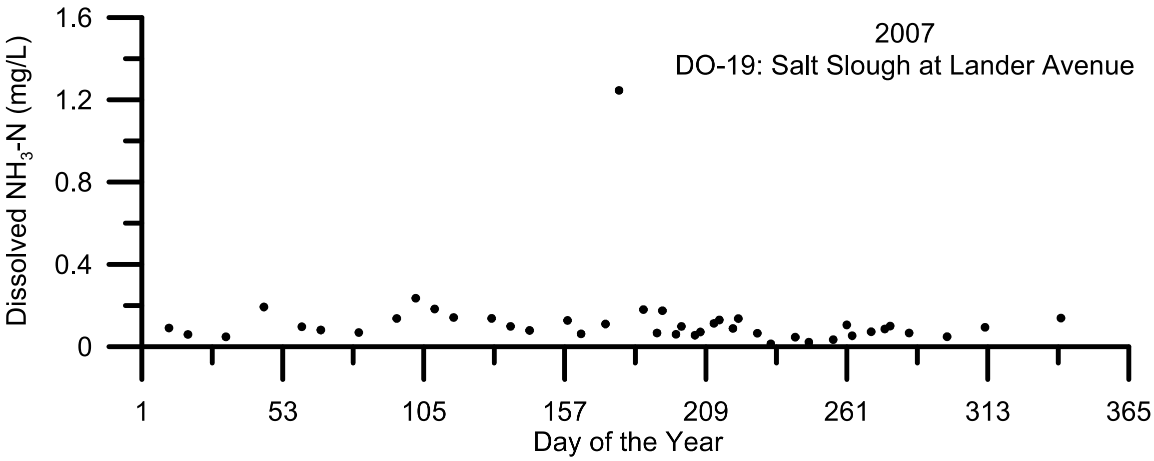

2005
DO-18: Mud Slough near Gustine
Dissolved NH_3-N (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

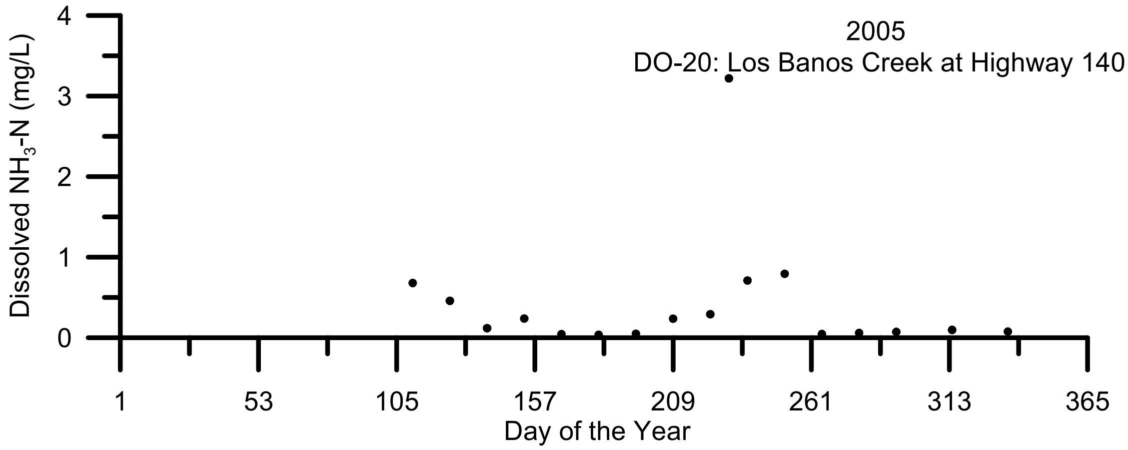

2006
DO-18: Mud Slough near Gustine
Dissolved NH_3-N (mg/L)
0
0.1
0.2
0.3
0.4
1
53
105
157
209
261
313
365
Day of the Year

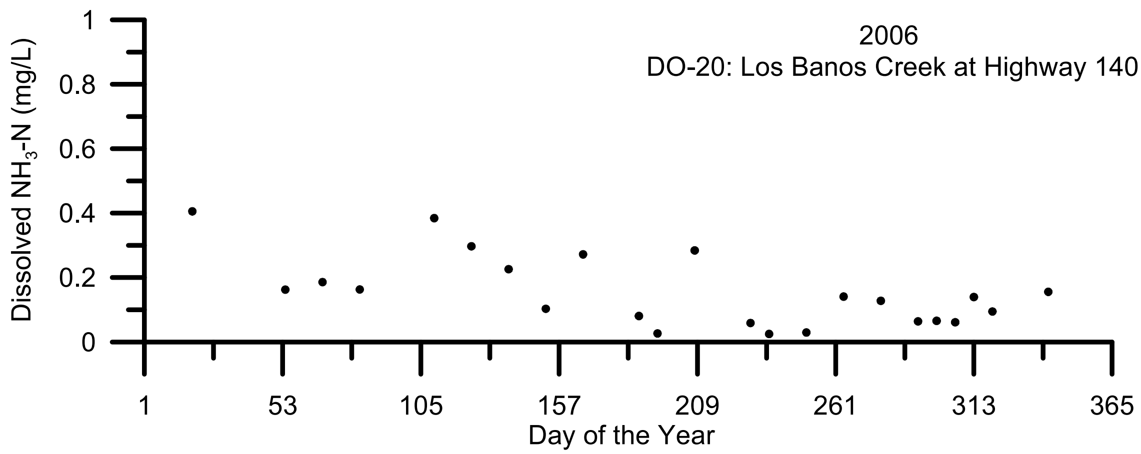

2007
DO-18: Mud Slough near Gustine
Dissolved NH_3-N (mg/L)
0
0.4
0.8
1.2
1
53
105
157
209
261
313
365
Day of the Year

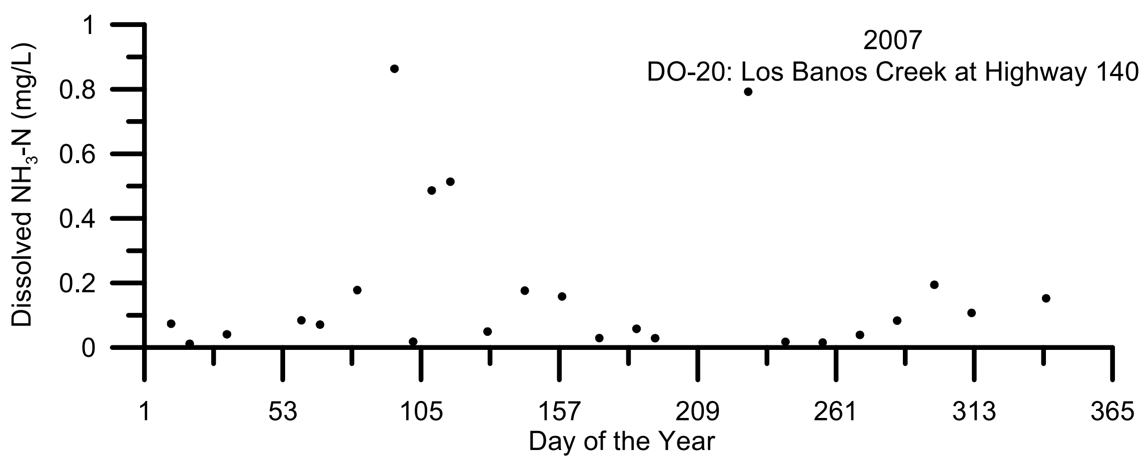

2005
DO-19: Salt Slough at Lander Avenue
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

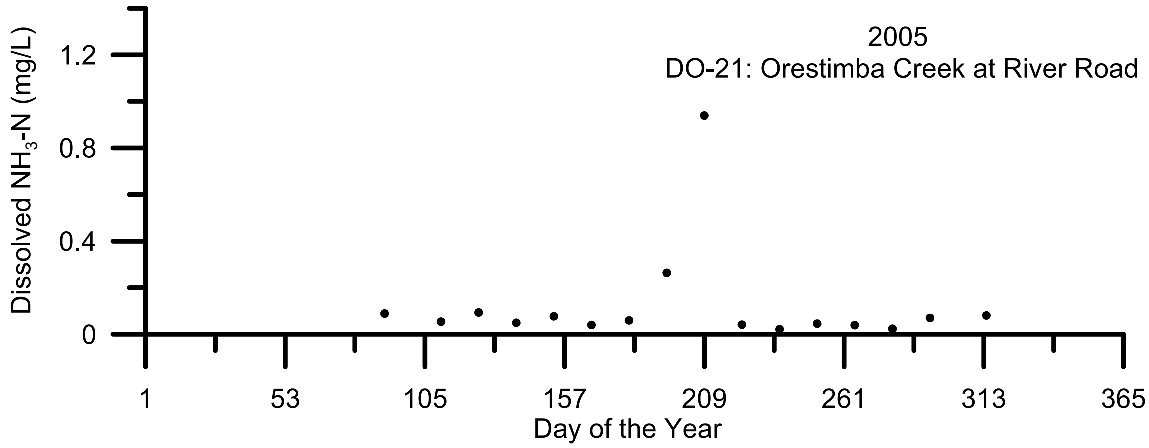

2006
DO-19: Salt Slough at Lander Avenue
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

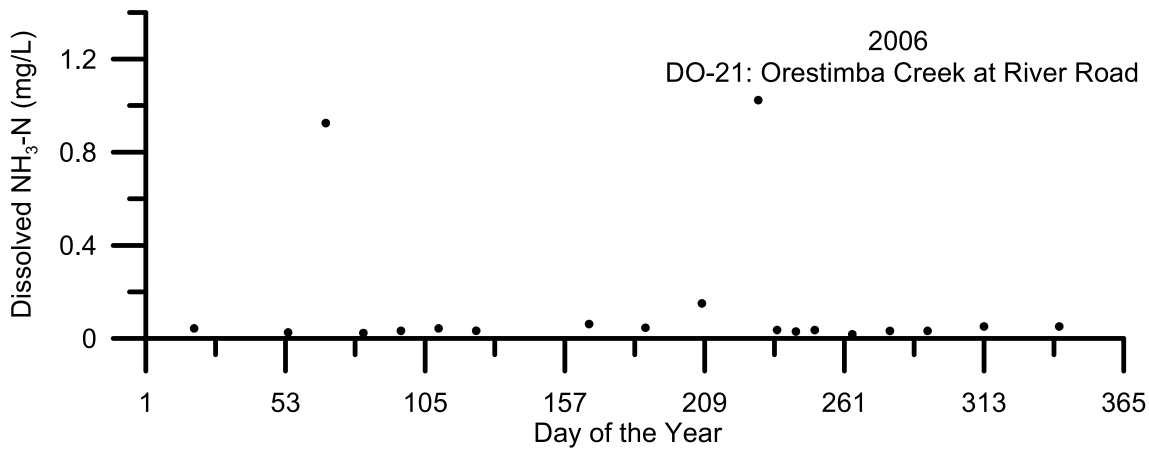

2007
DO-19: Salt Slough at Lander Avenue
Dissolved NH_3-N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

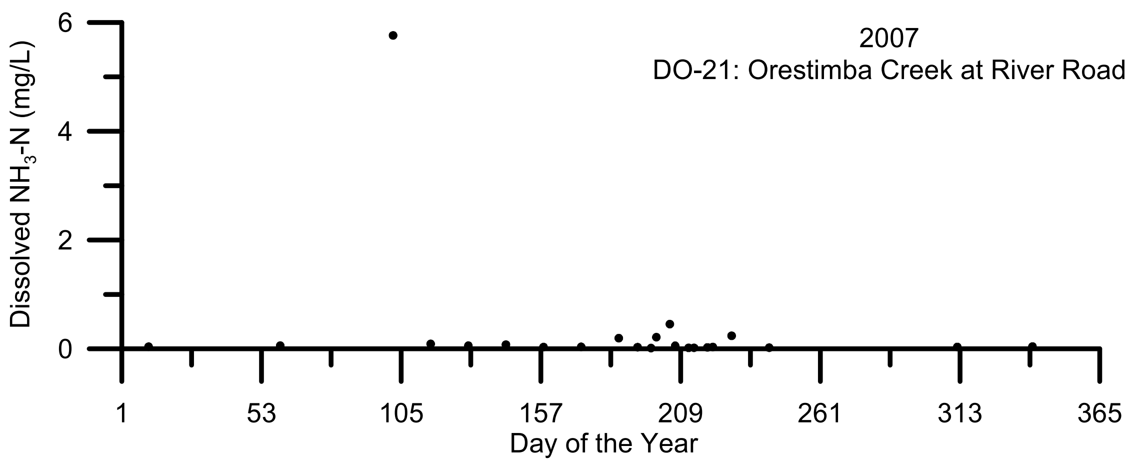

2005
DO-20: Los Banos Creek at Highway 140
Dissolved NH_3-N (mg/L)
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

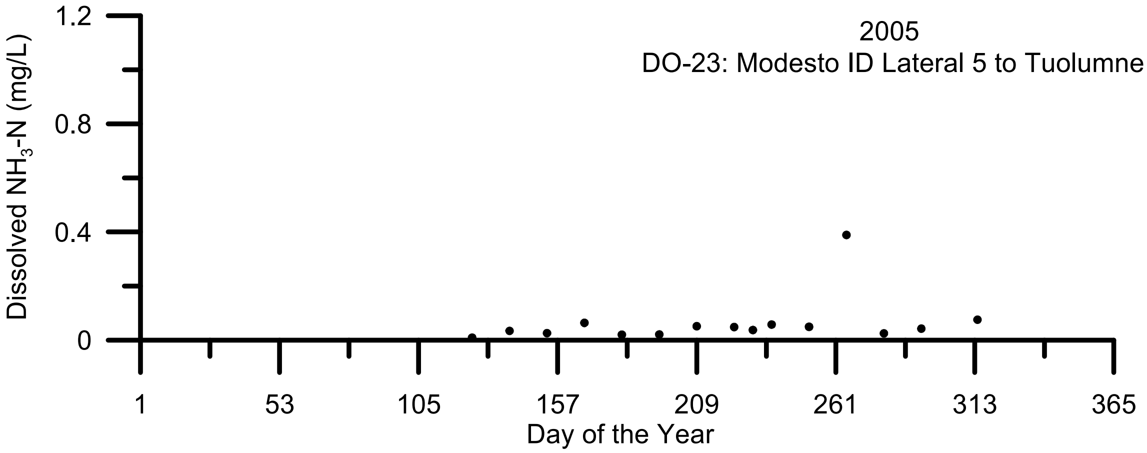

2006
DO-20: Los Banos Creek at Highway 140
Dissolved NH_3-N (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

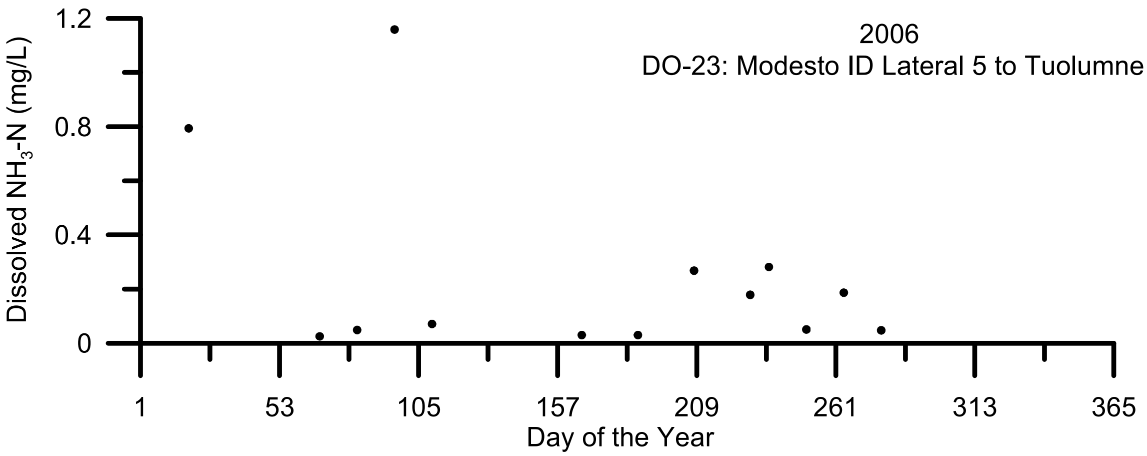

2007
DO-20: Los Banos Creek at Highway 140
Dissolved NH_3-N (mg/L)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

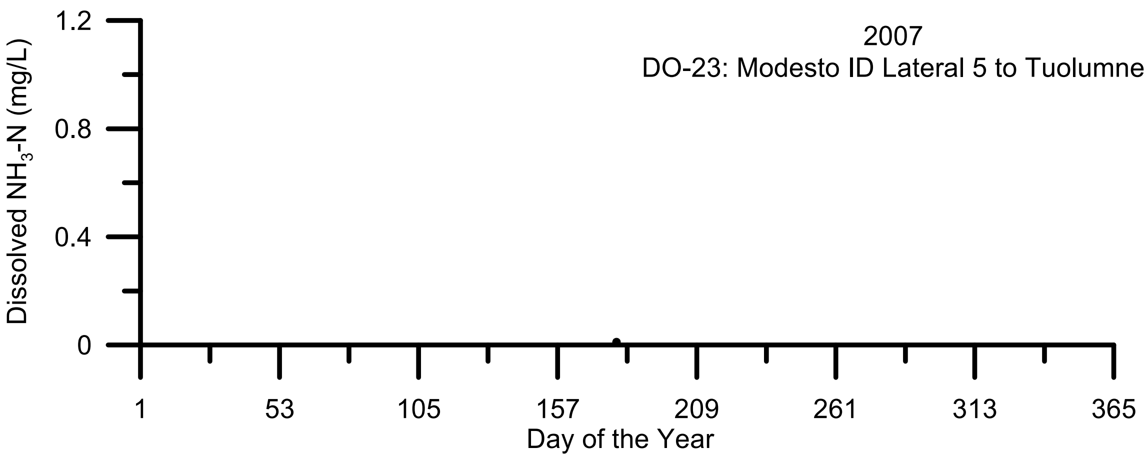

2005
DO-21: Orestimba Creek at River Road
Dissolved NH3-N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

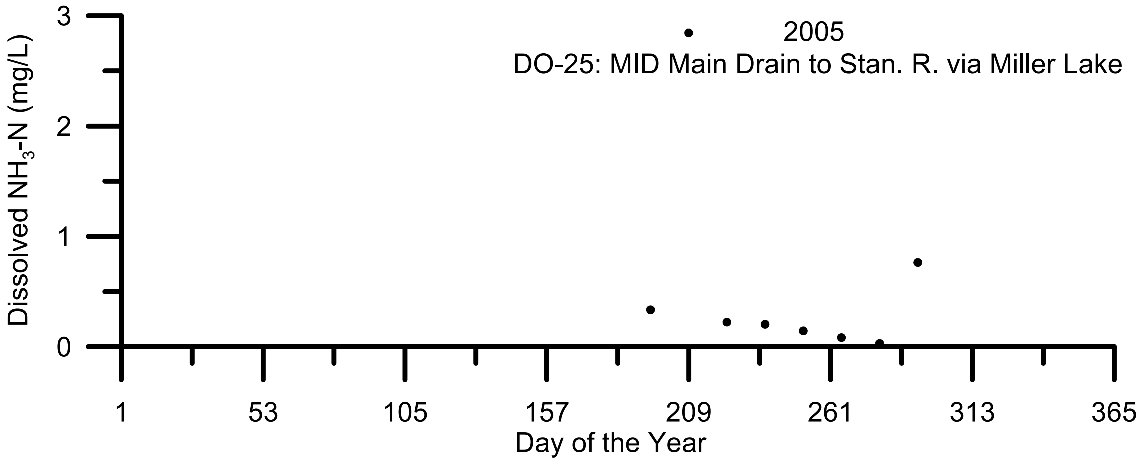

2006
DO-21: Orestimba Creek at River Road
Dissolved NH3-N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

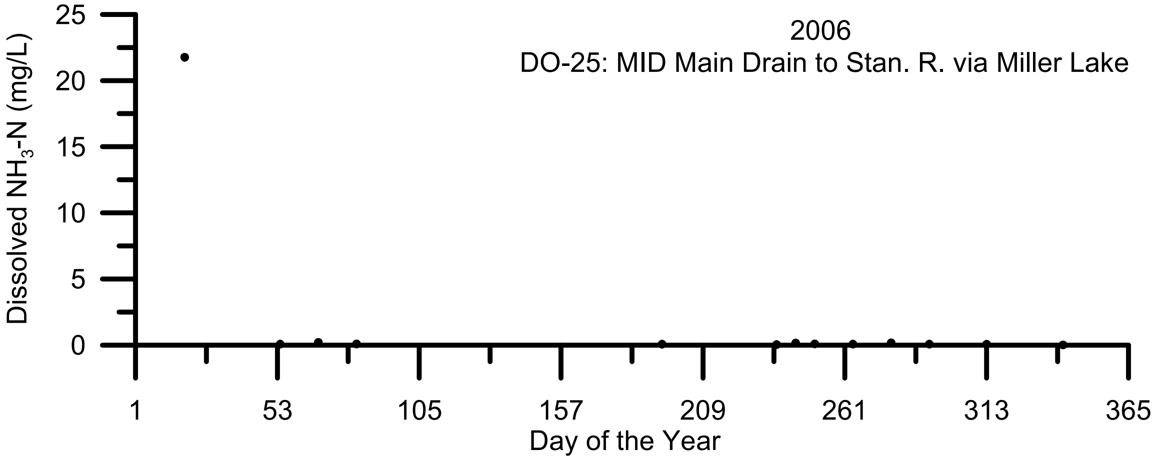

2007
DO-21: Orestimba Creek at River Road
Dissolved NH3-N (mg/L)
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

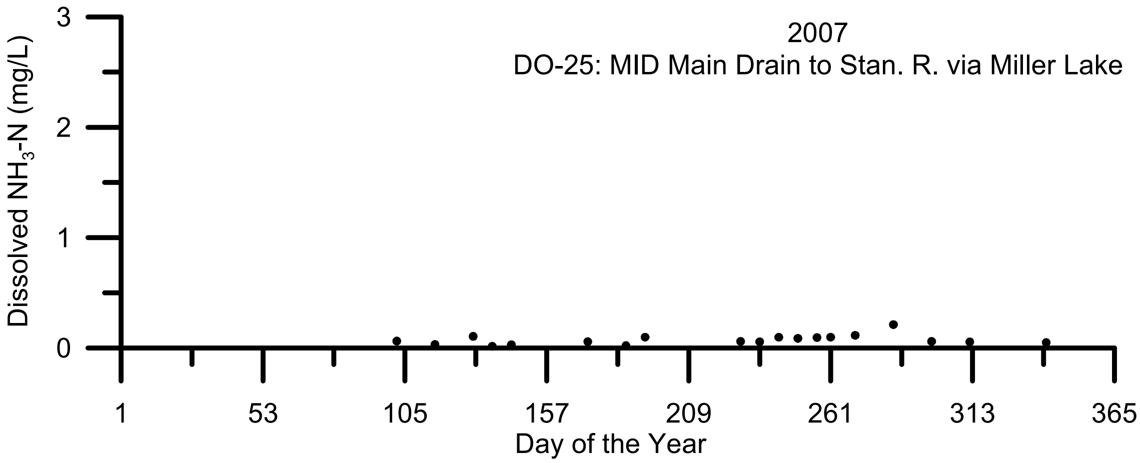

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved NH_3-N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

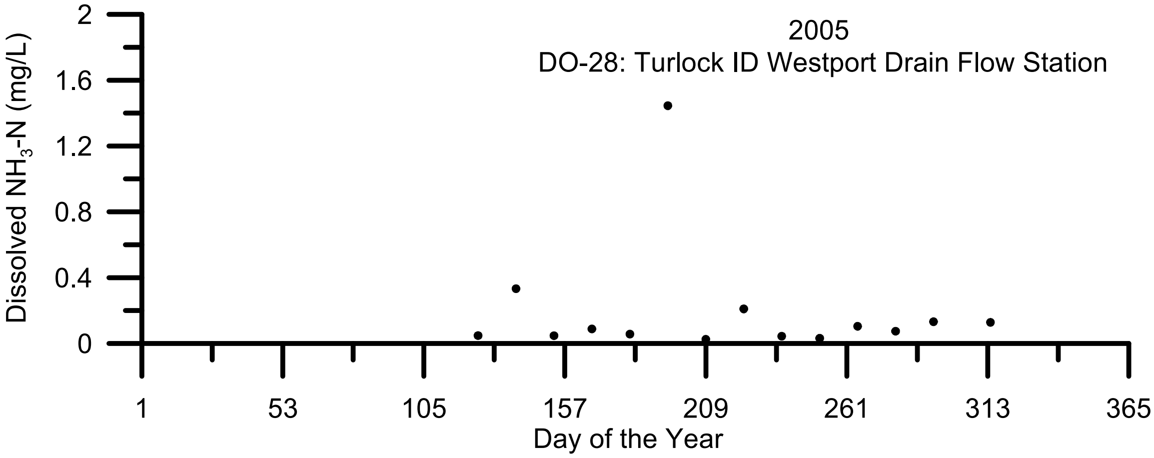

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved NH_3-N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

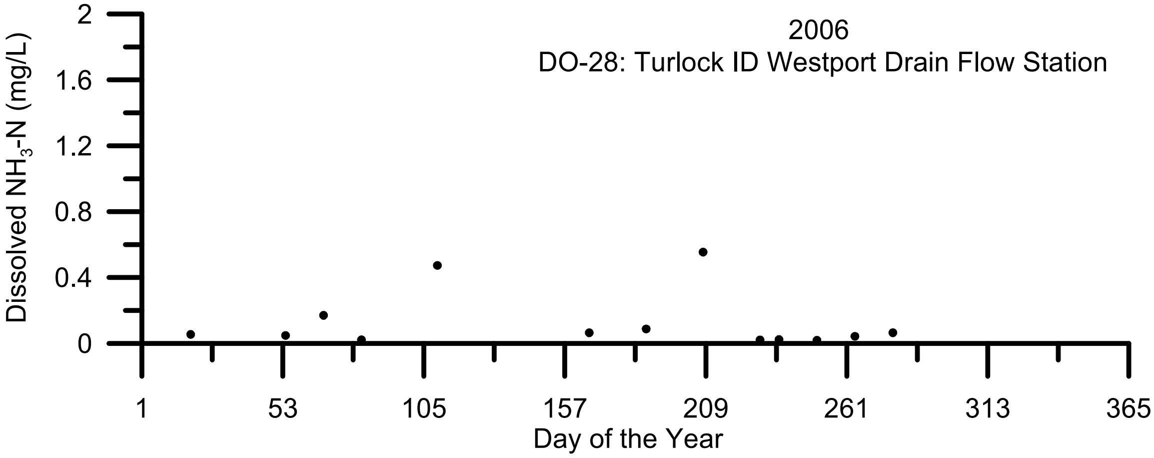

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved NH_3-N (mg/L)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

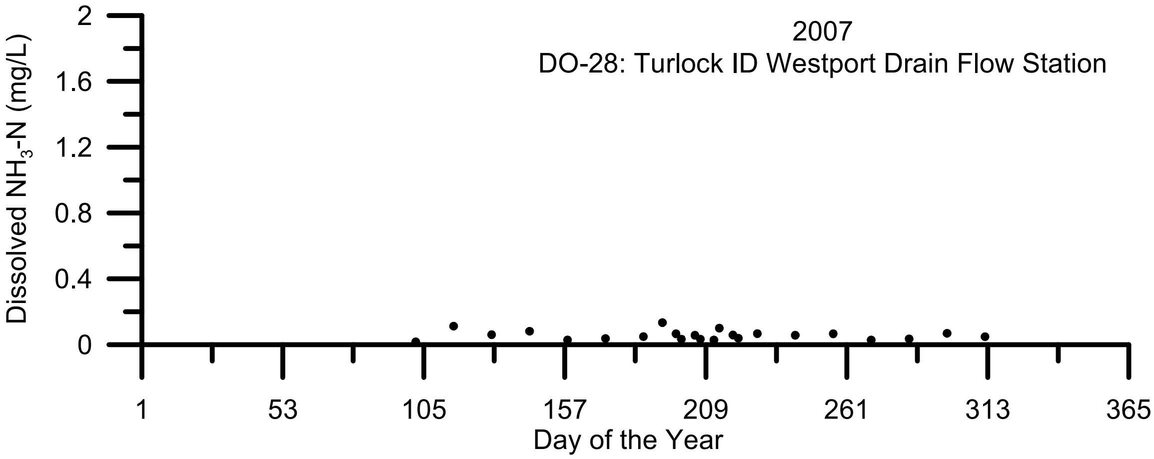

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved NH_3-N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

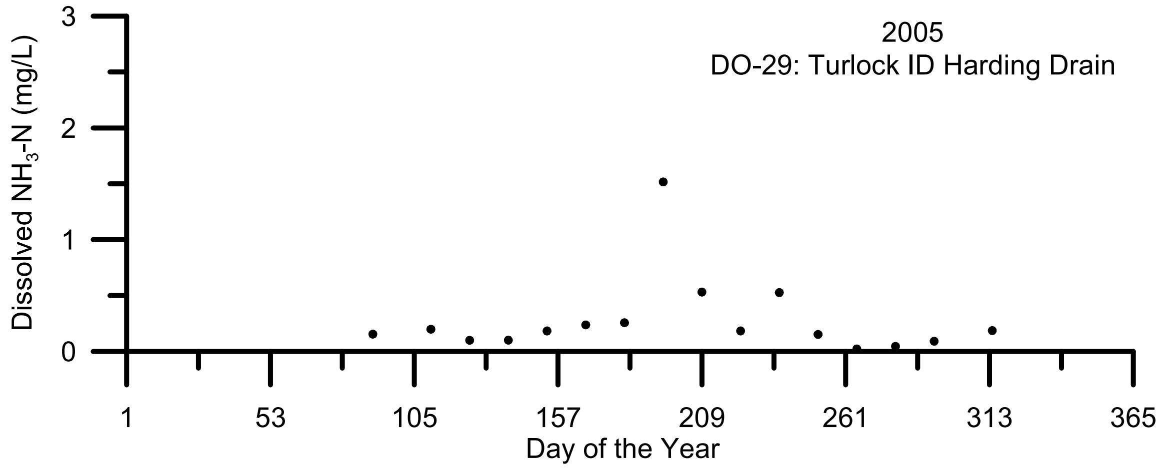

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved NH_3-N (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

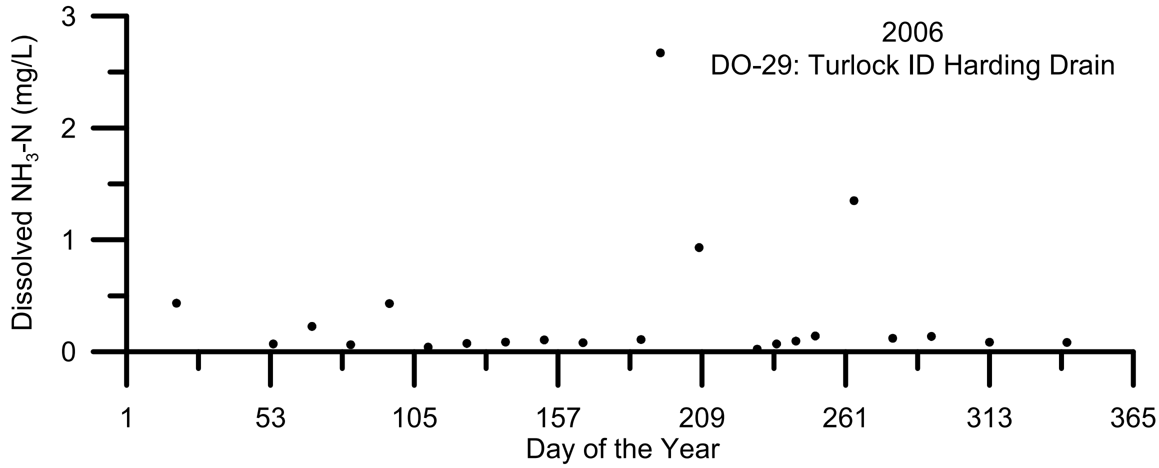

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved NH_3-N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

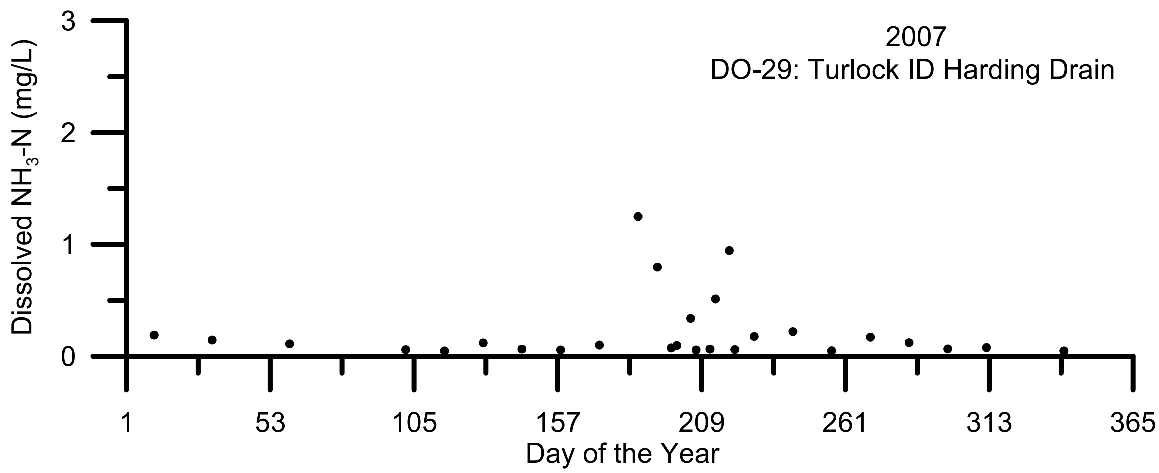

2005
DO-28: Turlock ID Westport Drain Flow Station
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

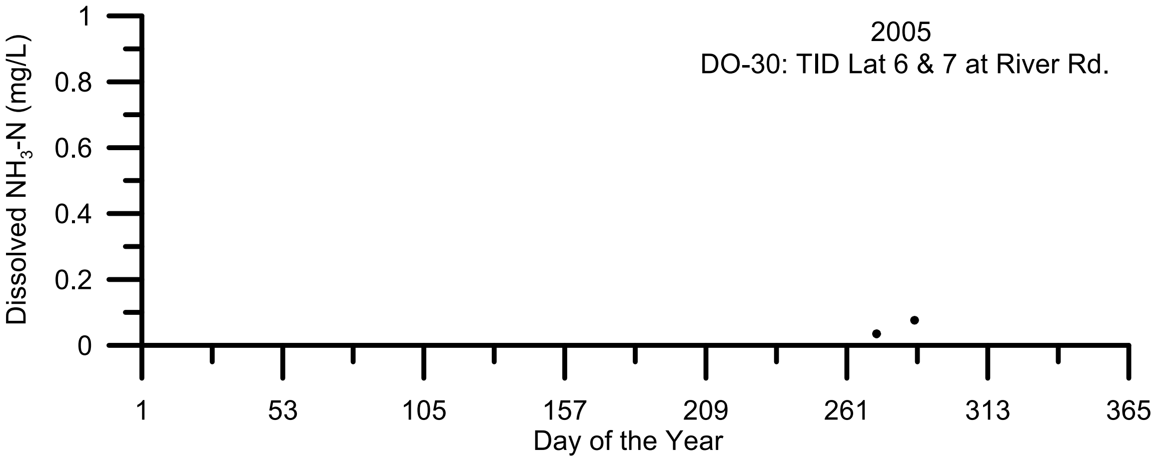

2006
DO-28: Turlock ID Westport Drain Flow Station
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

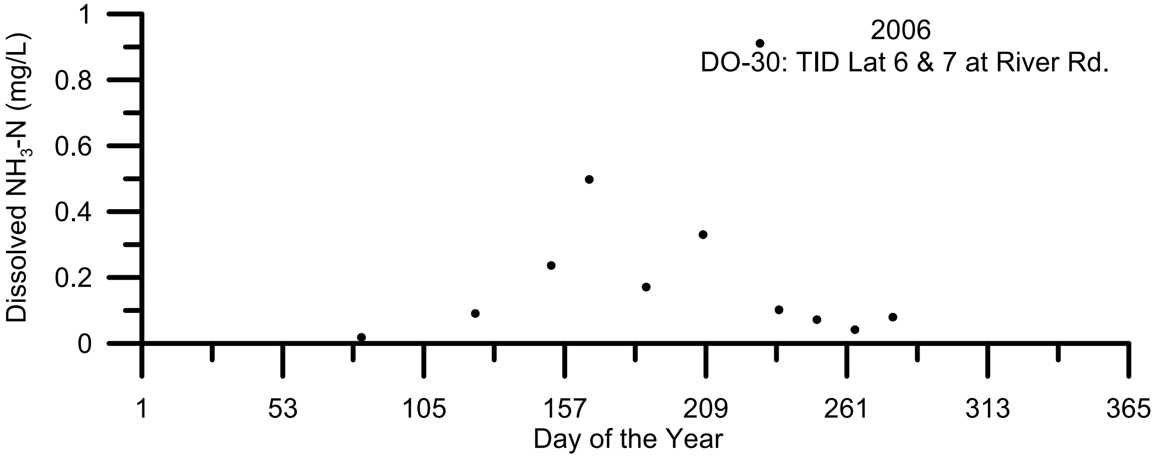

2007
DO-28: Turlock ID Westport Drain Flow Station
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

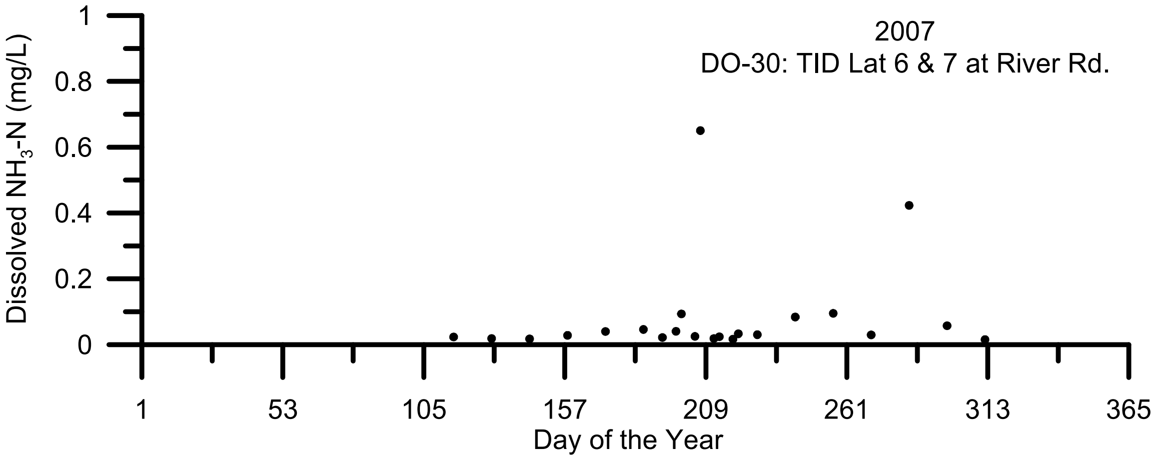

2005
DO-29: Turlock ID Harding Drain
Dissolved NH3-N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

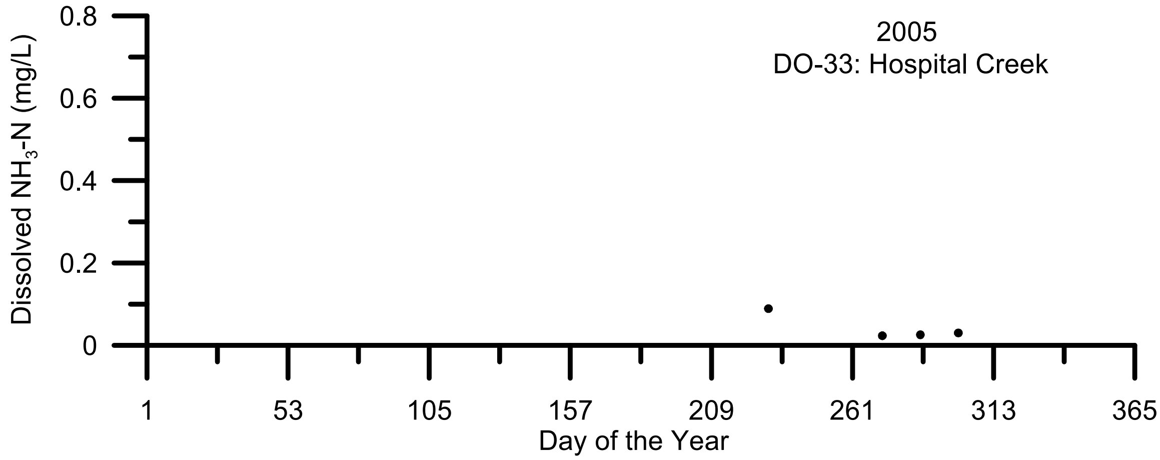

2006
DO-29: Turlock ID Harding Drain
Dissolved NH3-N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

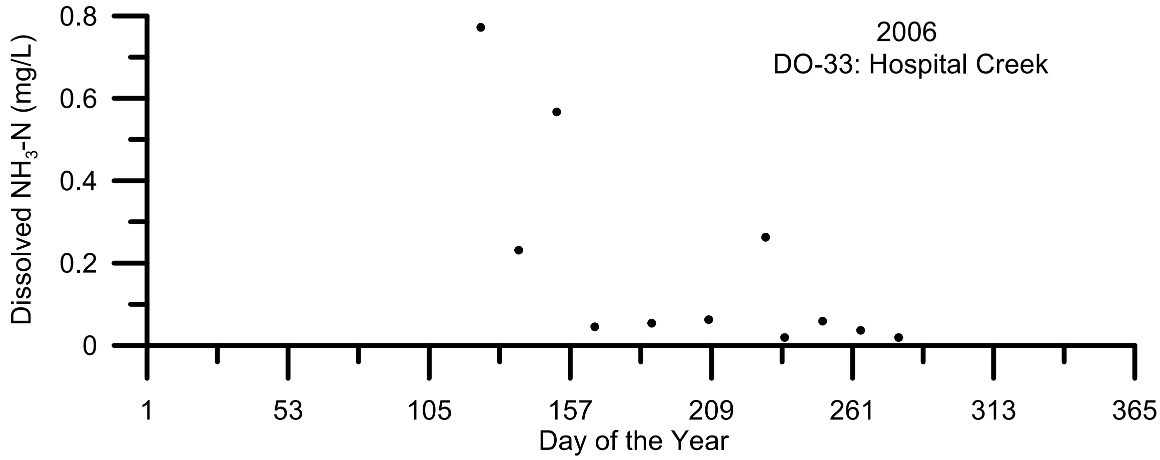

2007
DO-29: Turlock ID Harding Drain
Dissolved NH3-N (mg/L)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

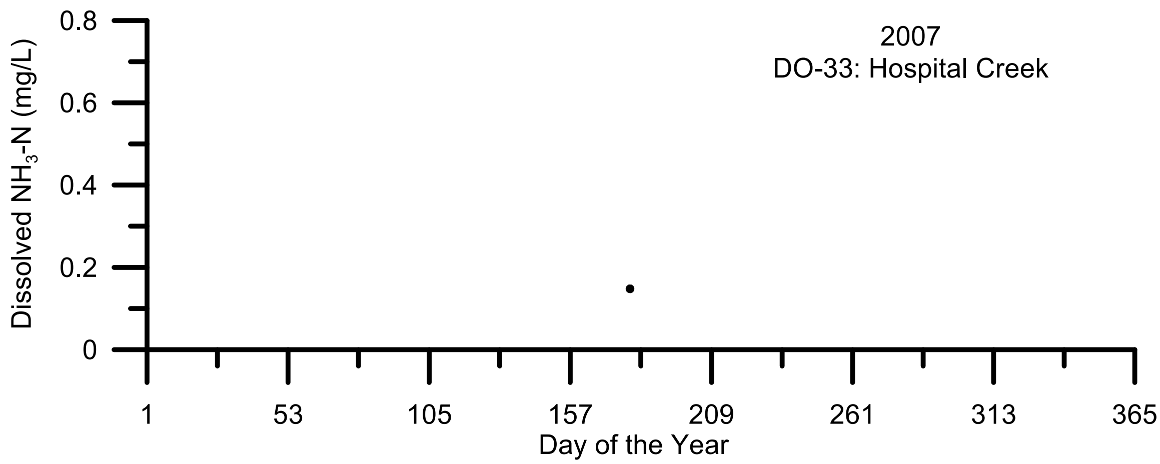

2005
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

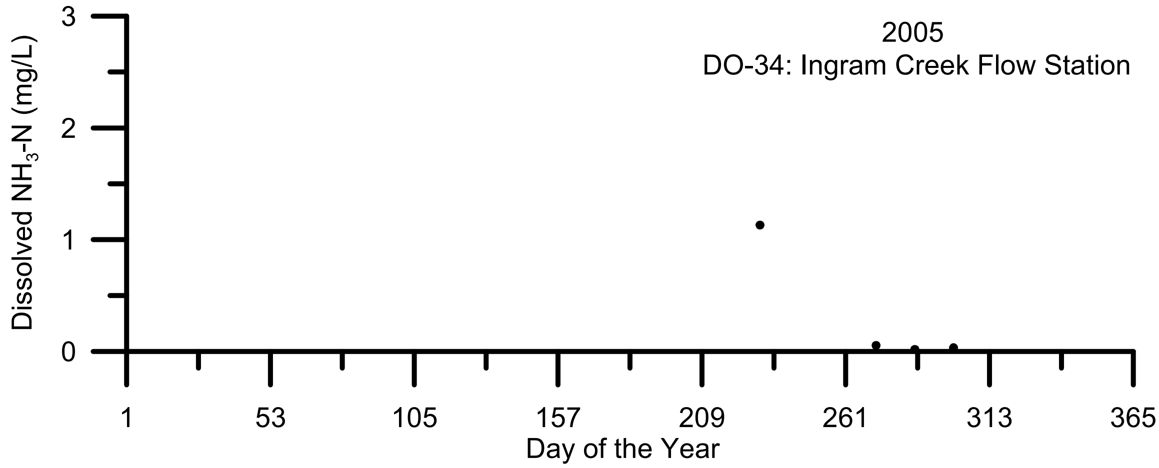

2006
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

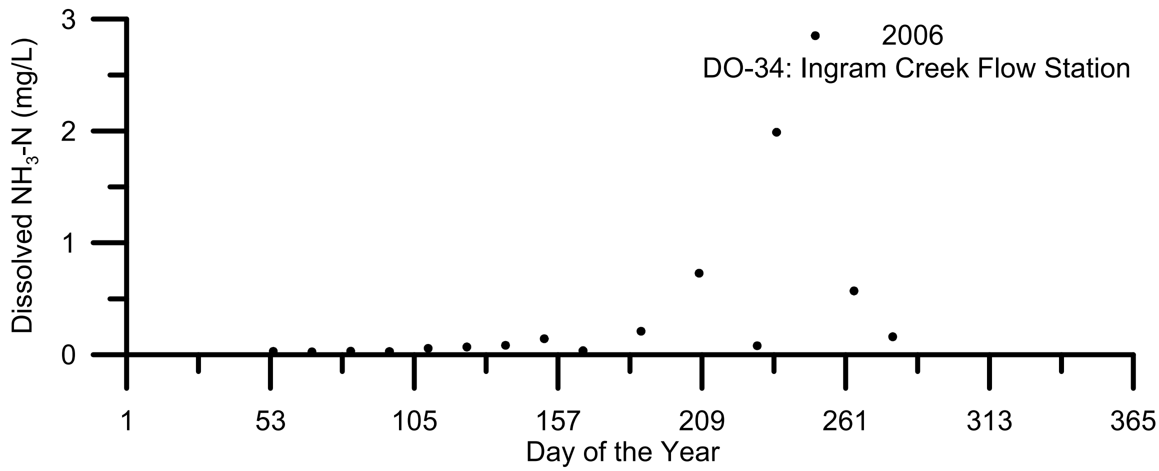

2007
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

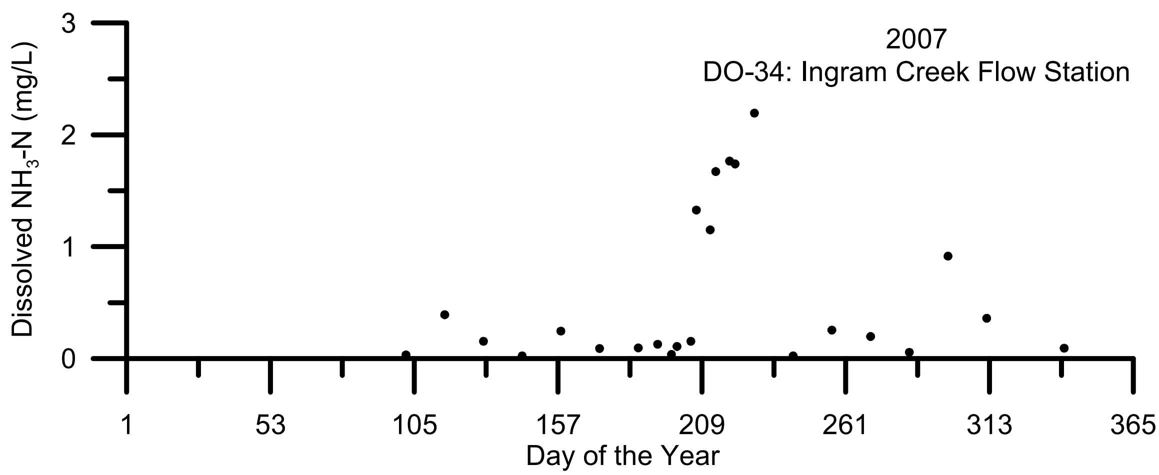

2005
DO-33: Hospital Creek
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

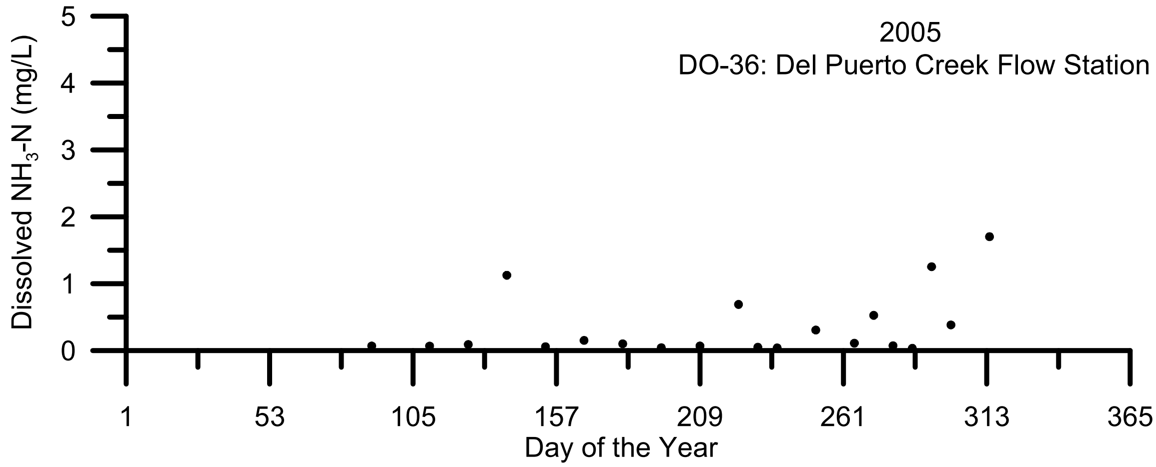

2006
DO-33: Hospital Creek
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-33: Hospital Creek
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

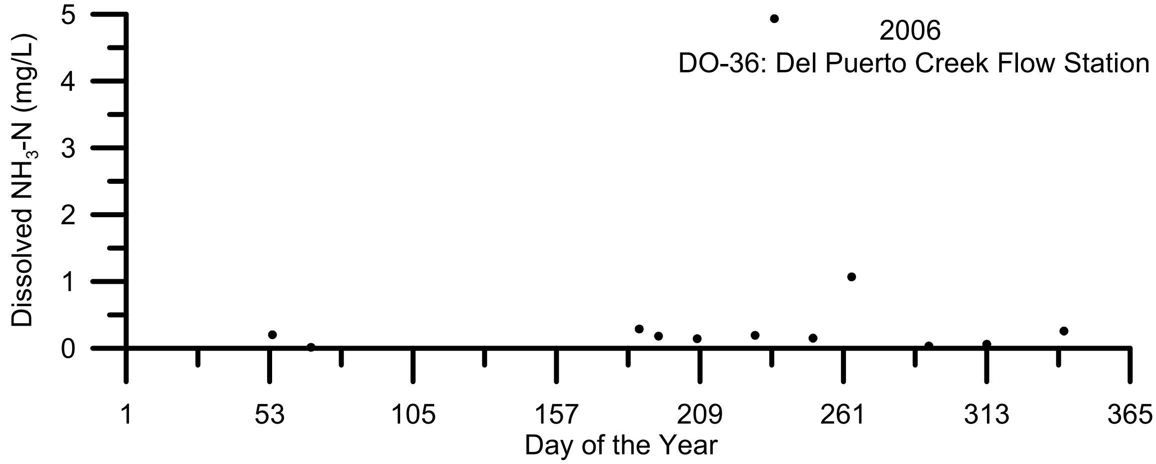

2005
DO-34: Ingram Creek Flow Station
Dissolved NH3-N (mg/L)
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-34: Ingram Creek Flow Station
Dissolved NH3-N (mg/L)
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

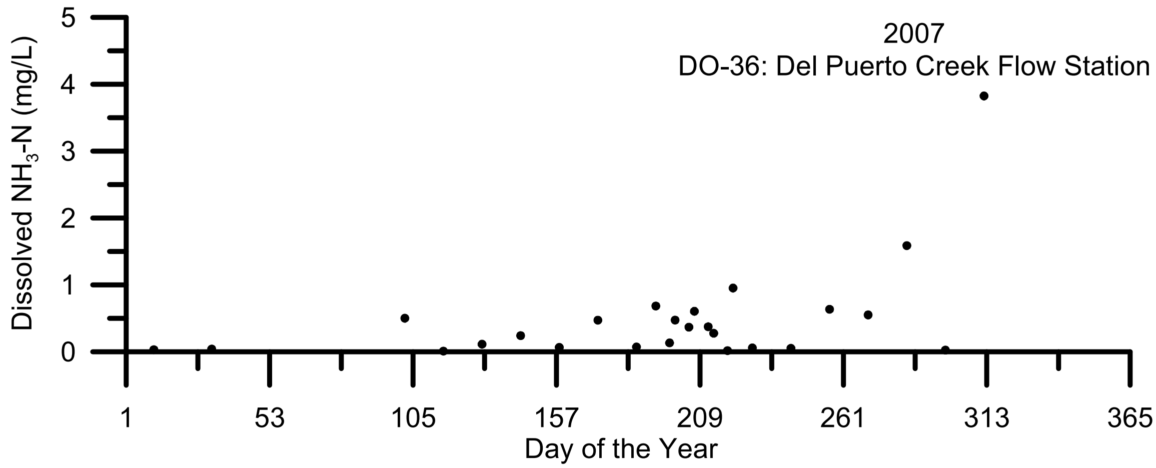

2007
DO-34: Ingram Creek Flow Station
Dissolved NH3-N (mg/L)
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year



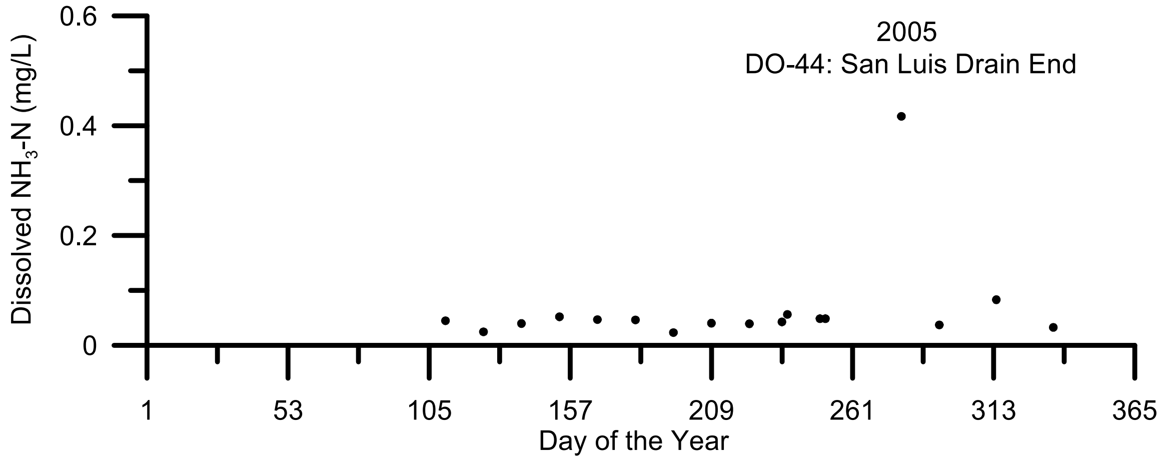
2005
DO-36: Del Puerto Creek Flow Station
Dissolved NH3-N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

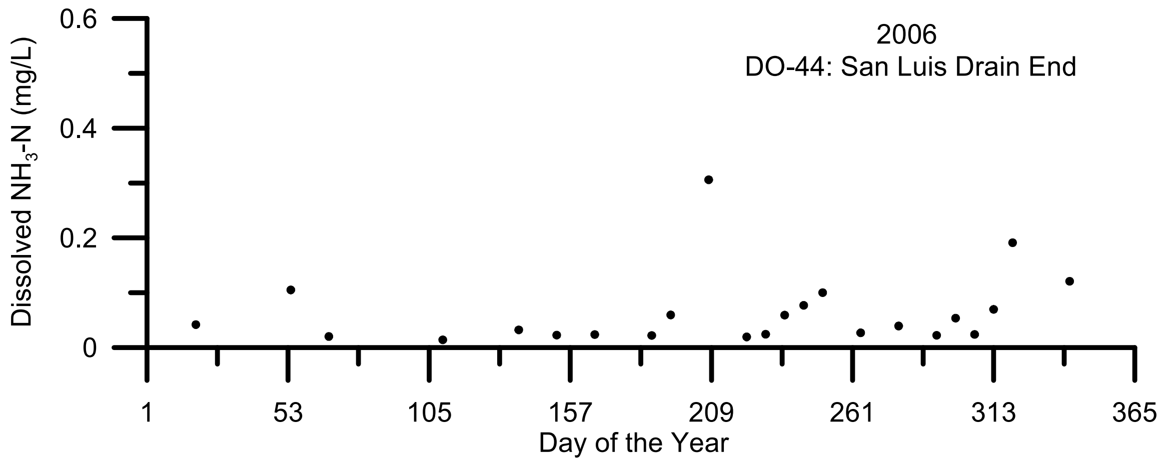


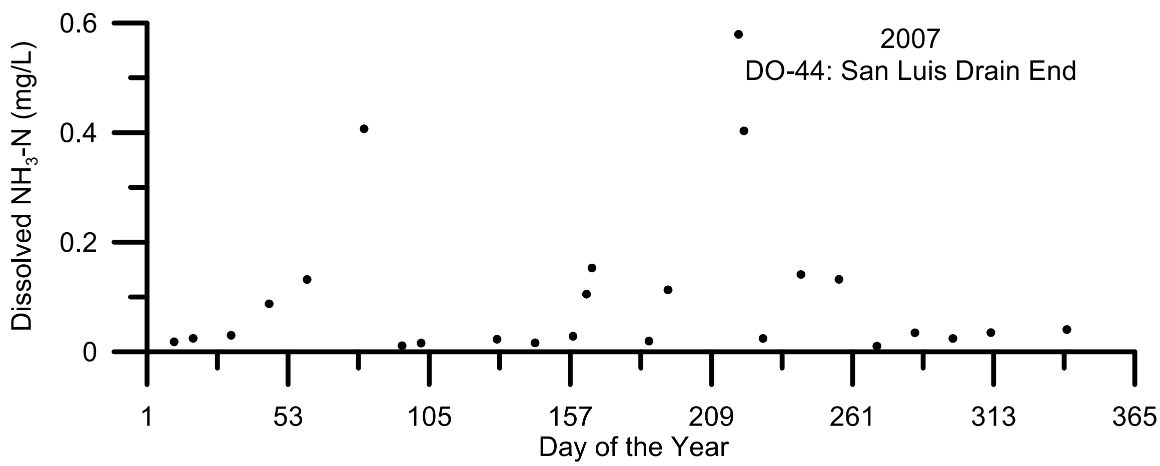
2006
DO-36: Del Puerto Creek Flow Station
Dissolved NH3-N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

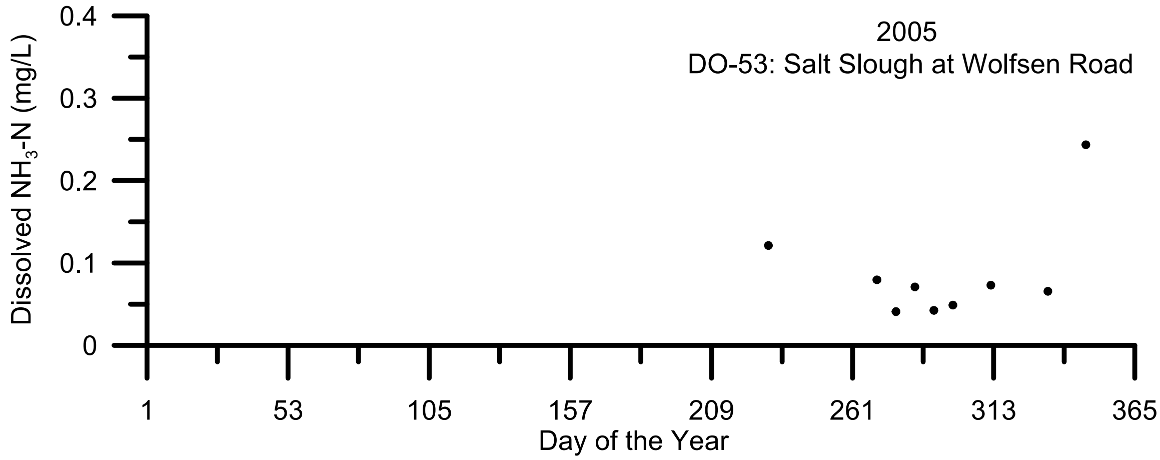


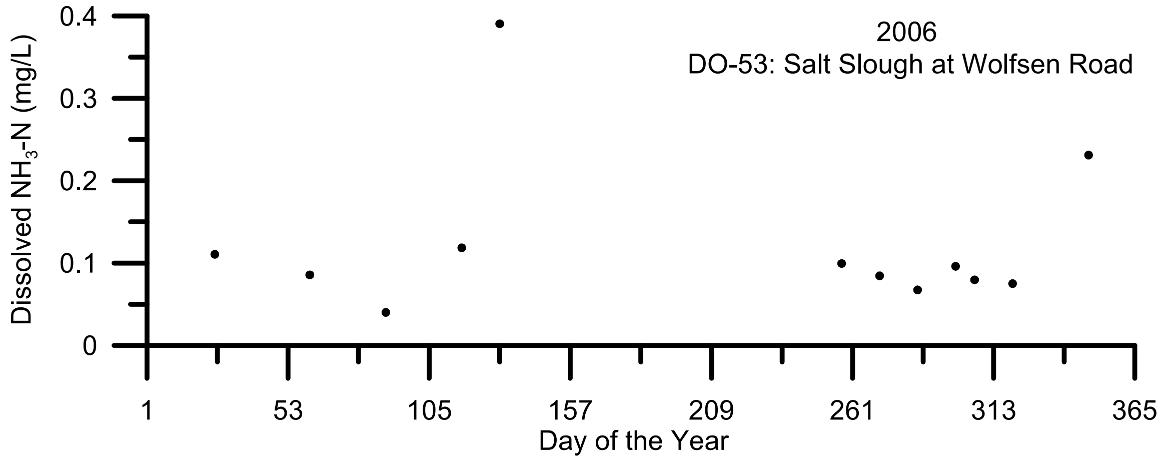
2007
DO-36: Del Puerto Creek Flow Station
Dissolved NH3-N (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

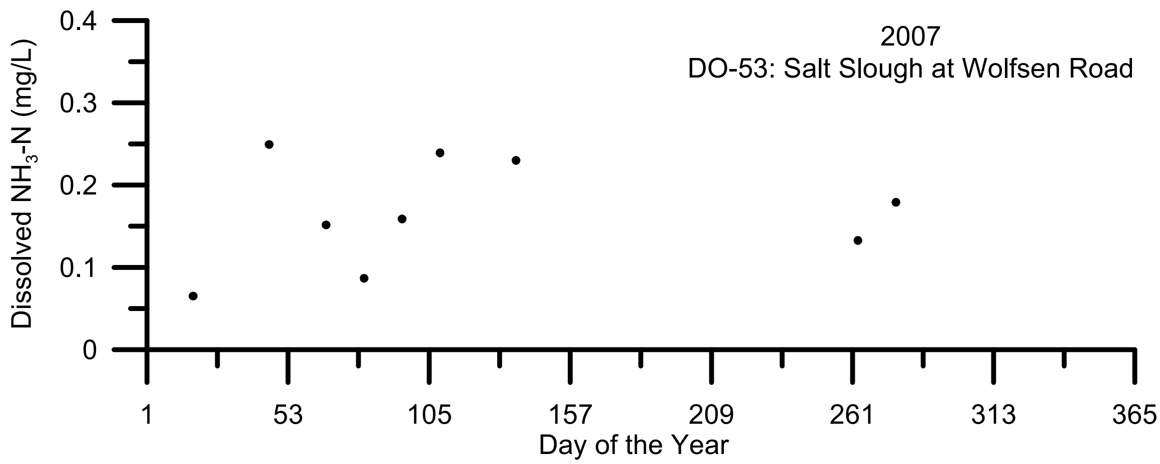

2005
DO-44: San Luis Drain End
Dissolved NH_3-N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

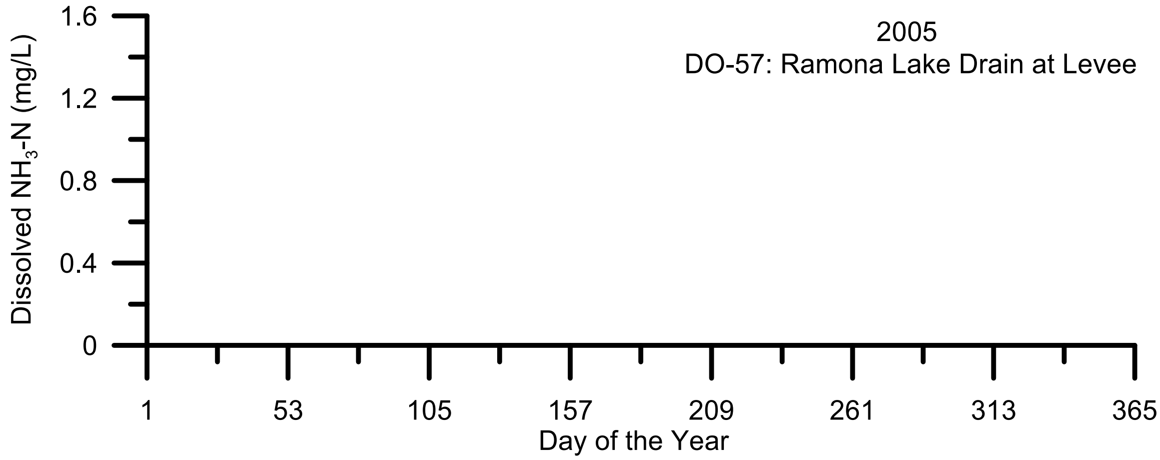

2006
DO-44: San Luis Drain End
Dissolved NH_3-N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

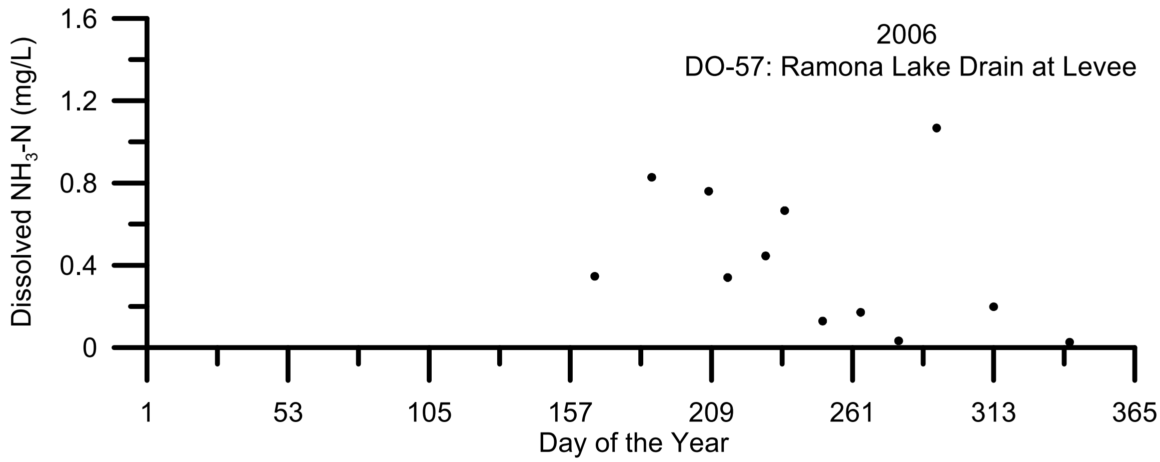

2007
DO-44: San Luis Drain End
Dissolved NH_3-N (mg/L)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

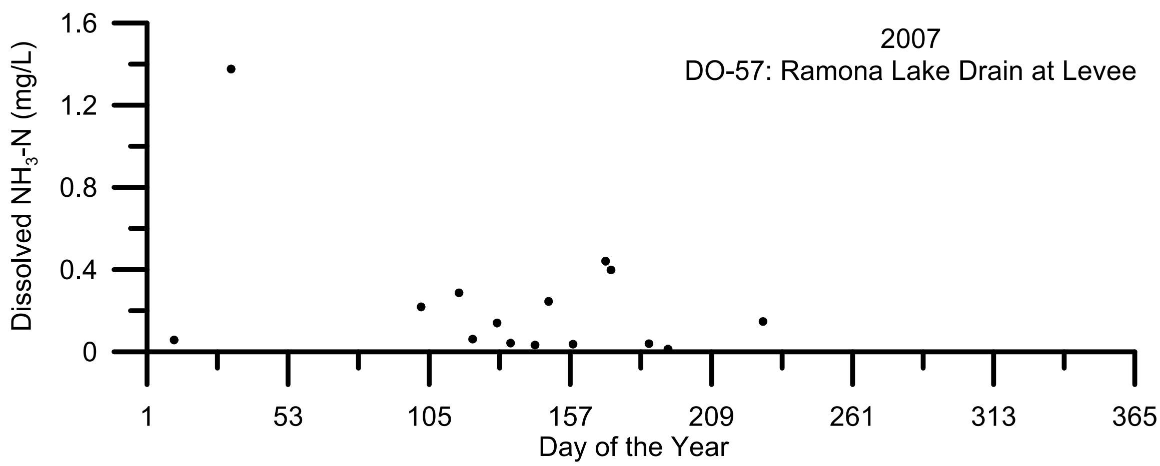

2005
DO-53: Salt Slough at Wolfsen Road
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

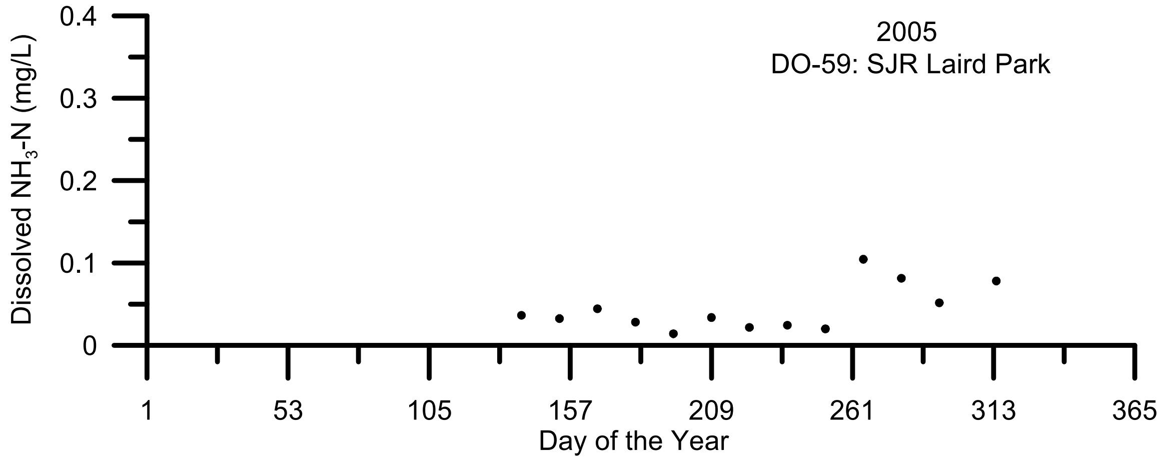

2006
DO-53: Salt Slough at Wolfsen Road
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

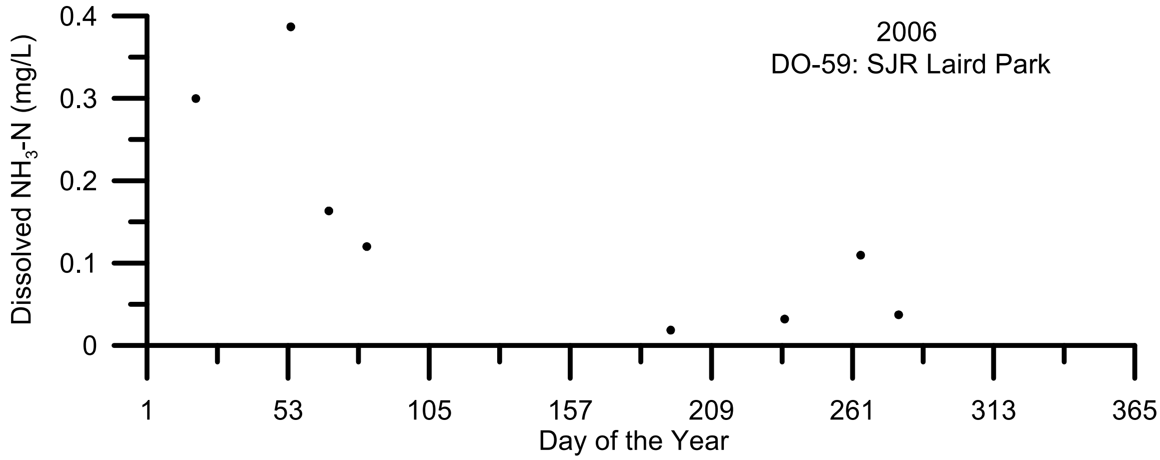

2007
DO-53: Salt Slough at Wolfsen Road
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

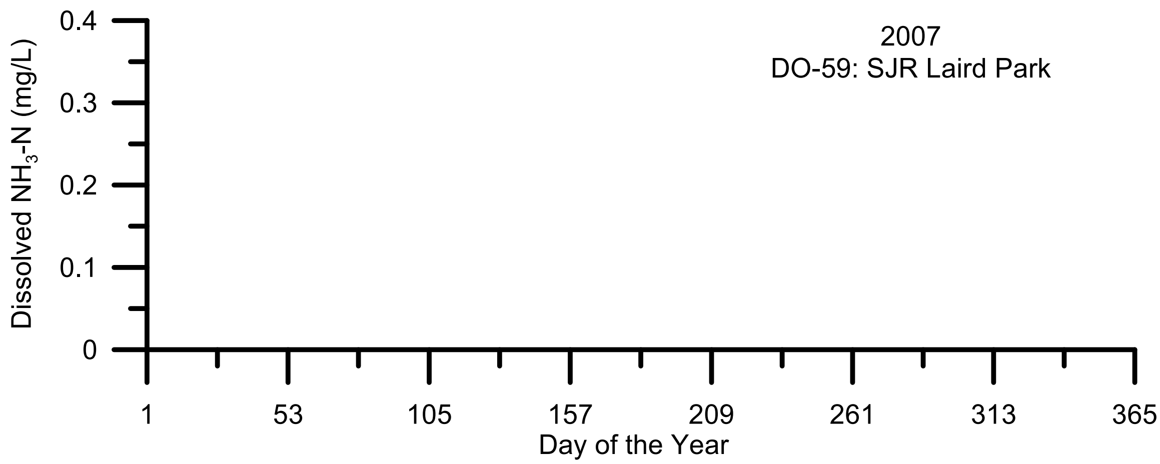

2005
DO-57: Ramona Lake Drain at Levee
Dissolved NH3-N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

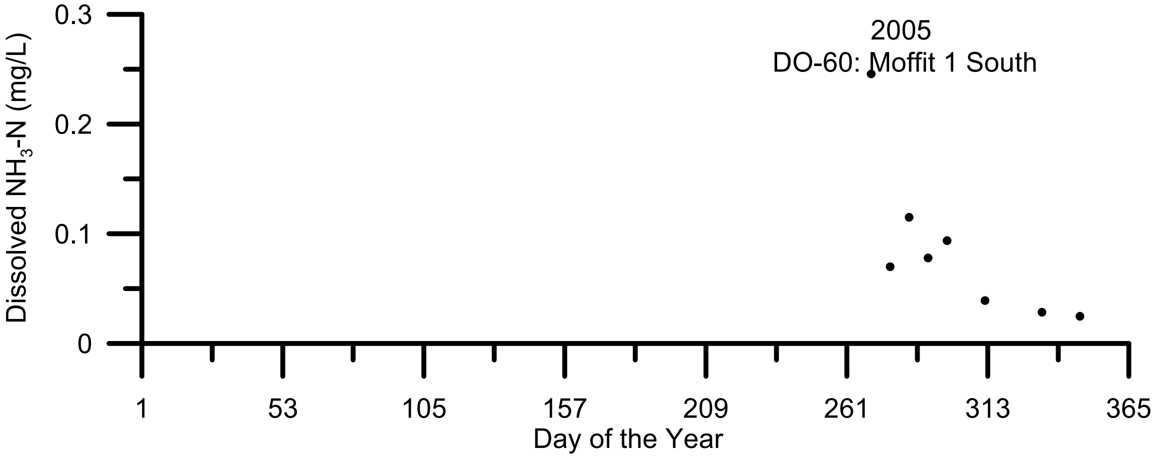

2006
DO-57: Ramona Lake Drain at Levee
Dissolved NH3-N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

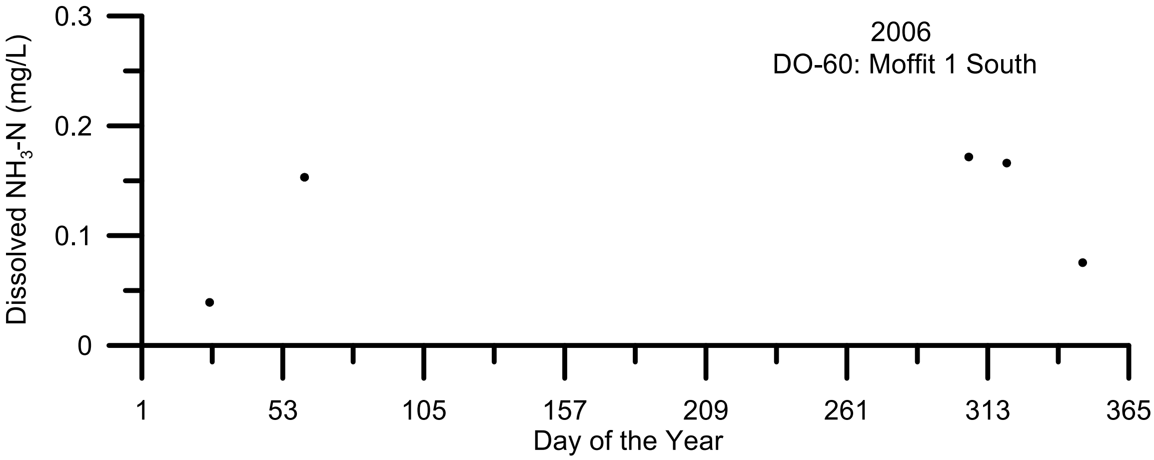

2007
DO-57: Ramona Lake Drain at Levee
Dissolved NH3-N (mg/L)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

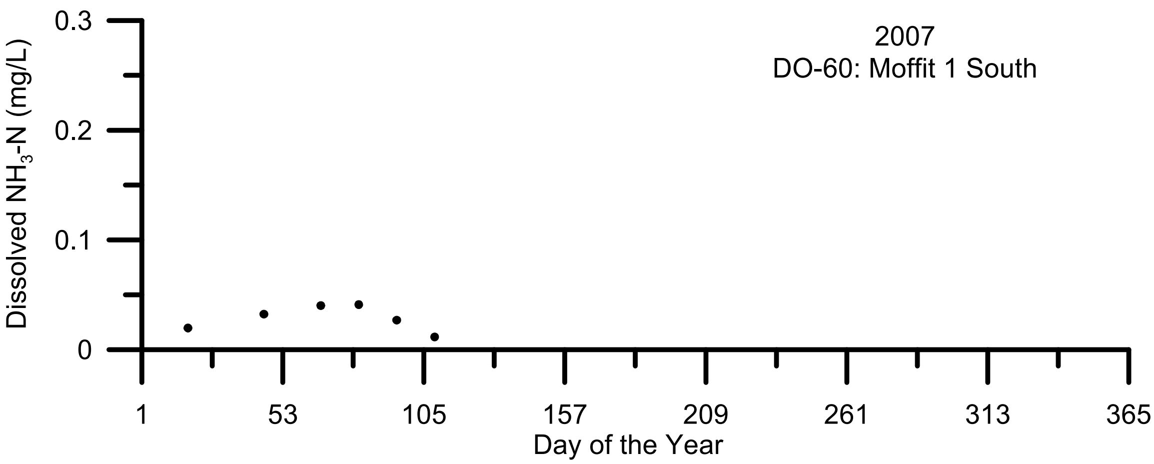

2005
DO-59: SJR Laird Park
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

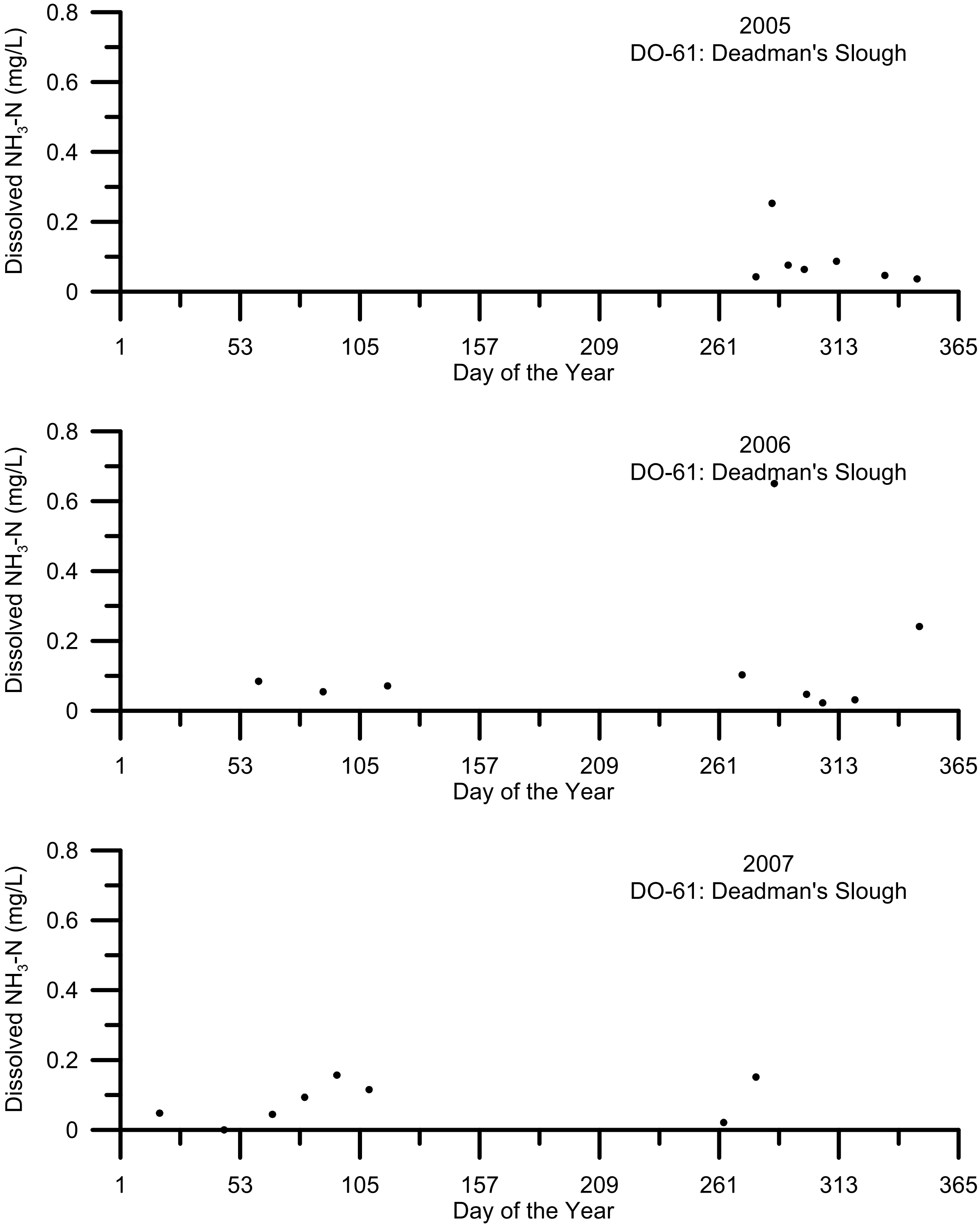

2006
DO-59: SJR Laird Park
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

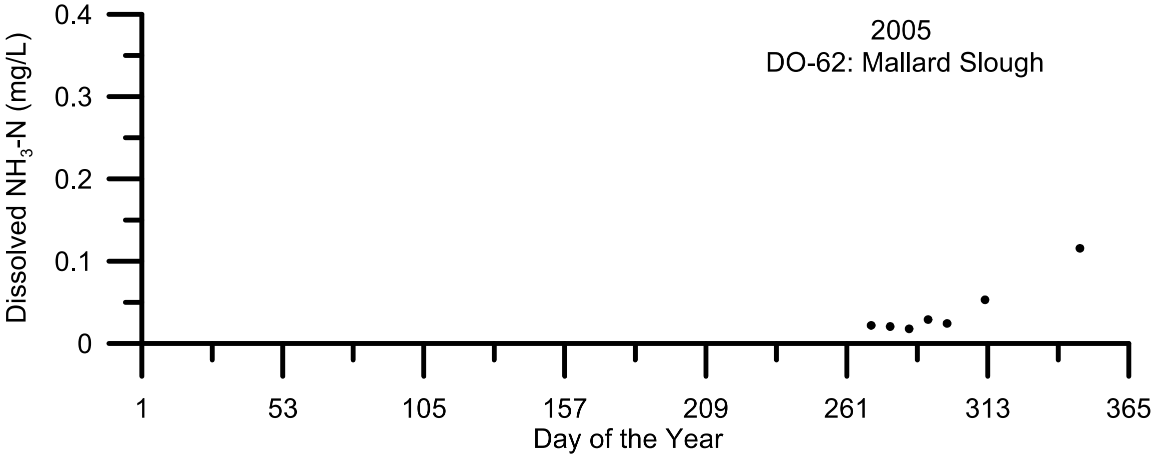

2007
DO-59: SJR Laird Park
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

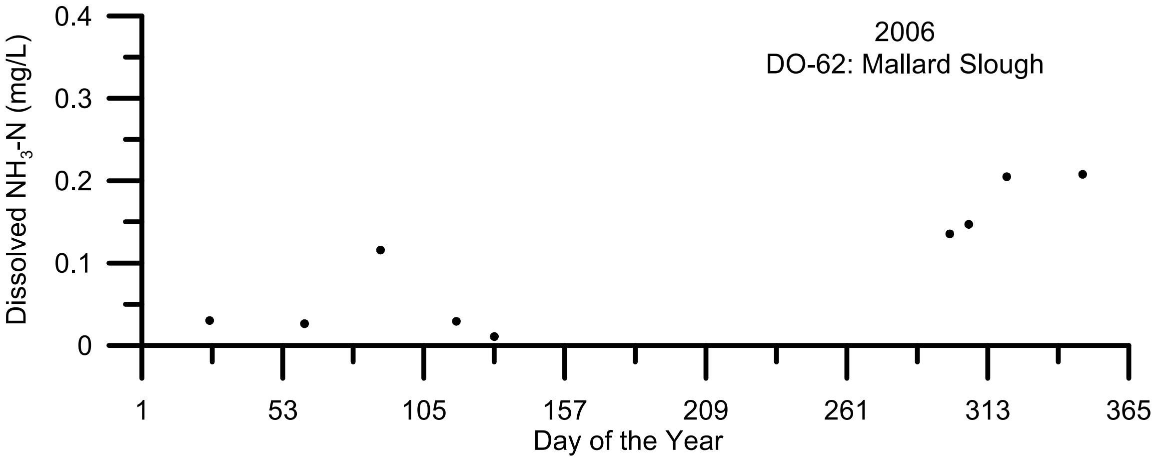

2005
DO-60: Moffit 1 South
Dissolved NH_3-N (mg/L)
0
0.1
0.2
0.3
Day of the Year
1
53
105
157
209
261
313
365

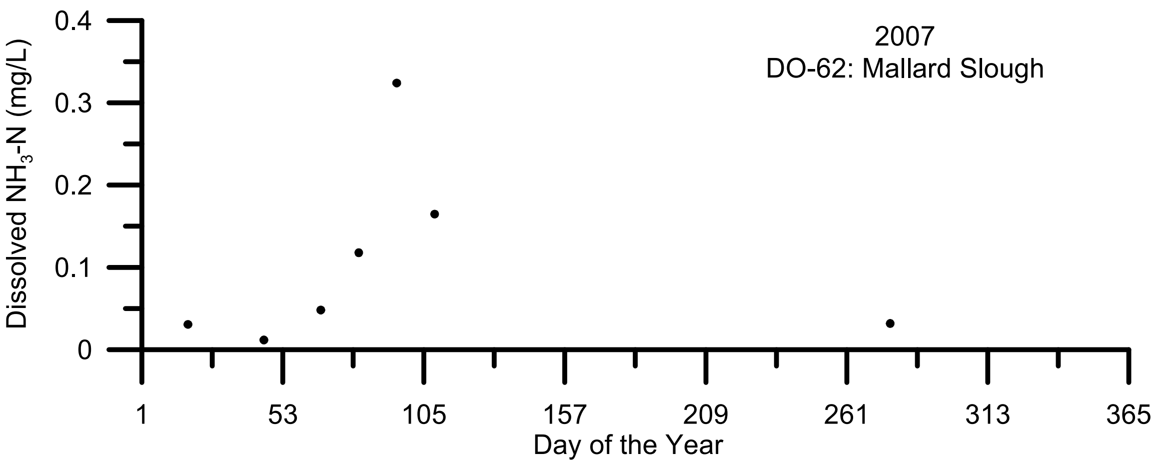

2006
DO-60: Moffit 1 South
Dissolved NH_3-N (mg/L)
0
0.1
0.2
0.3
Day of the Year
1
53
105
157
209
261
313
365

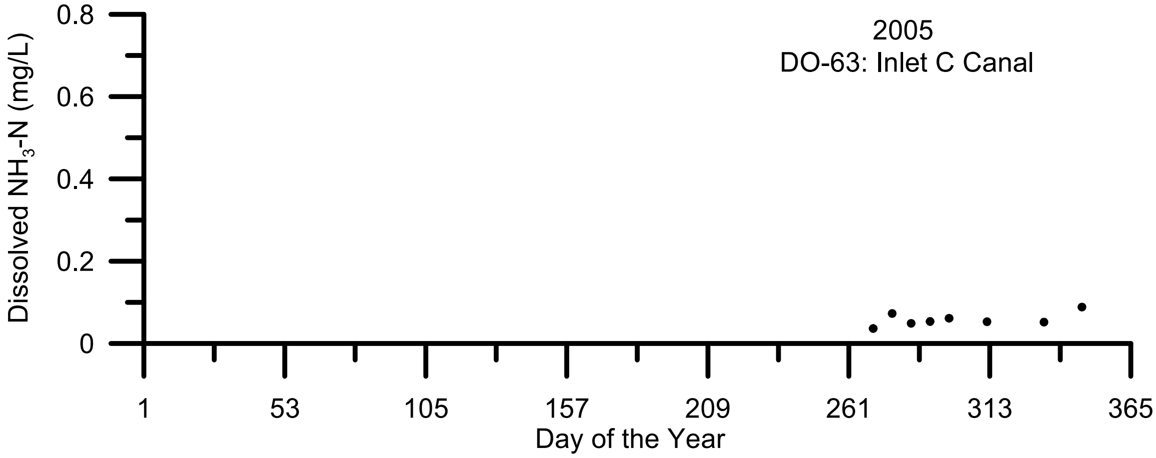

2007
DO-60: Moffit 1 South
Dissolved NH_3-N (mg/L)
0
0.1
0.2
0.3
Day of the Year
1
53
105
157
209
261
313
365

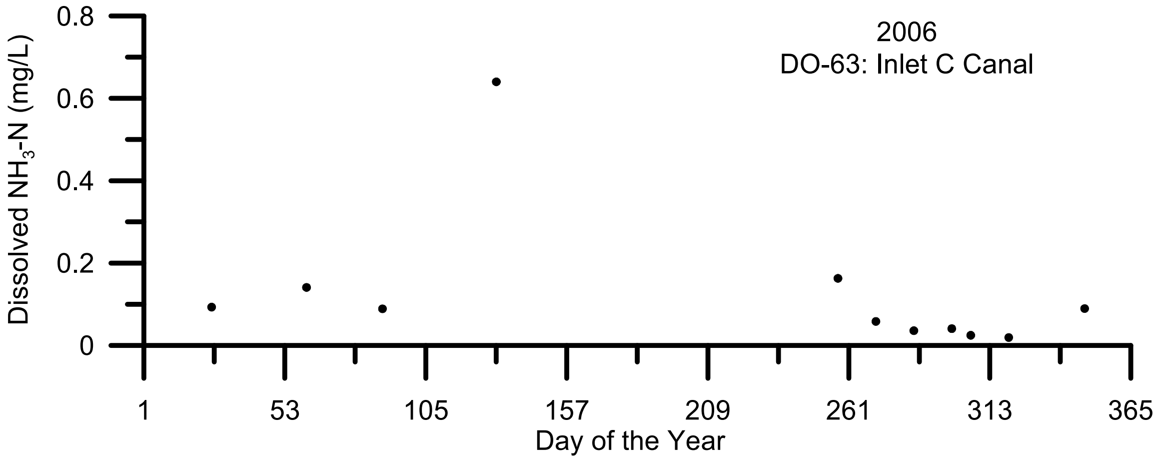

2005
DO-61: Deadman's Slough
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-61: Deadman's Slough
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year
2007
DO-61: Deadman's Slough
Dissolved NH3-N (mg/L)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

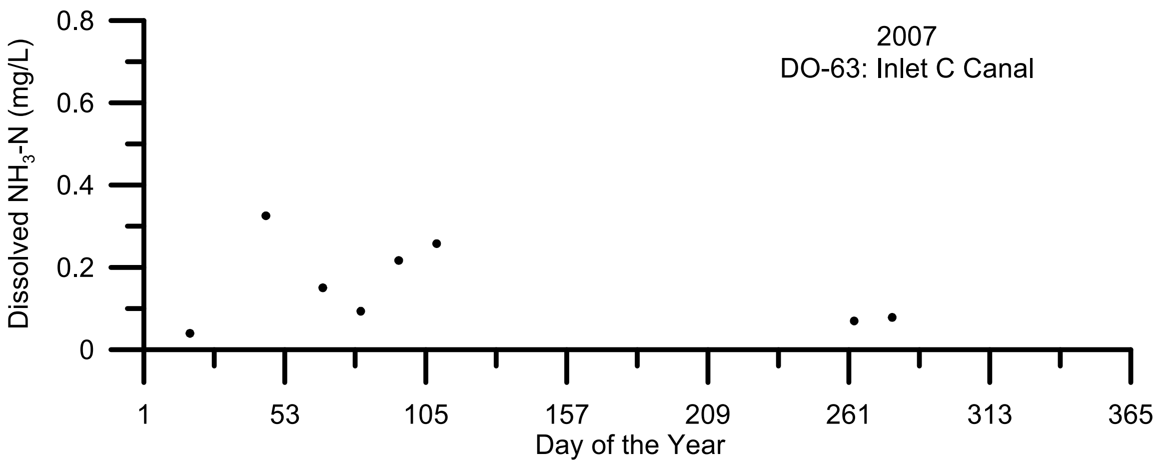

2005
DO-62: Mallard Slough
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

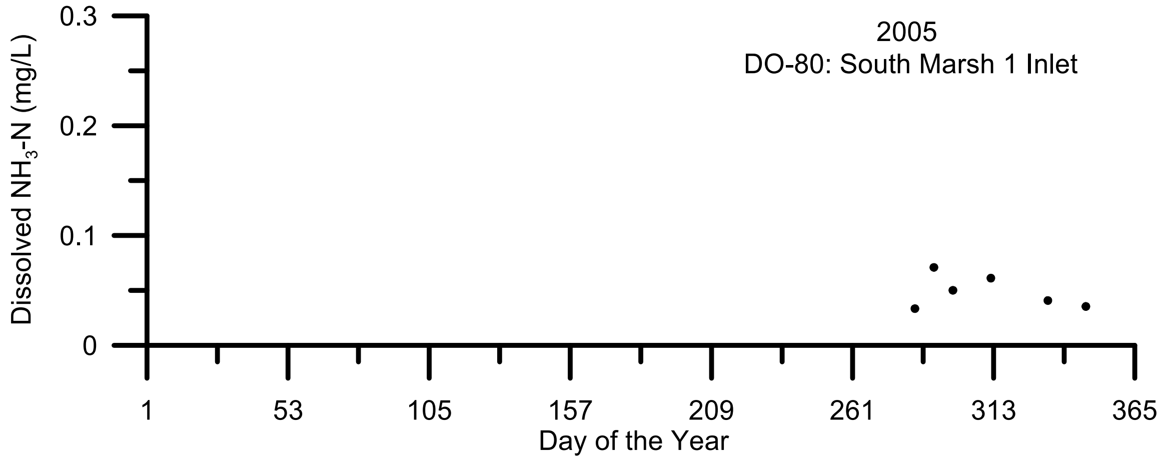

2006
DO-62: Mallard Slough
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

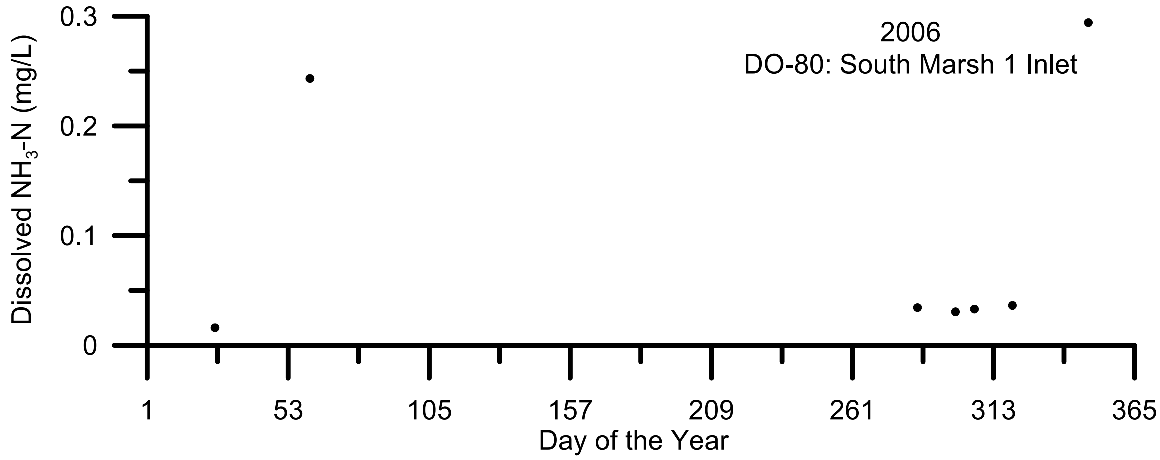

2007
DO-62: Mallard Slough
Dissolved NH_3-N (mg/L)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

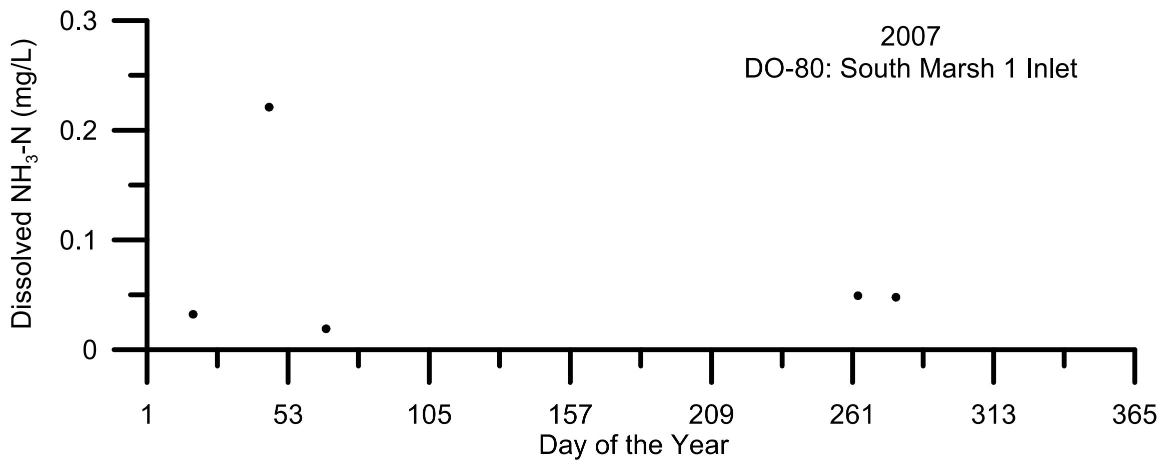

2005
DO-63: Inlet C Canal
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

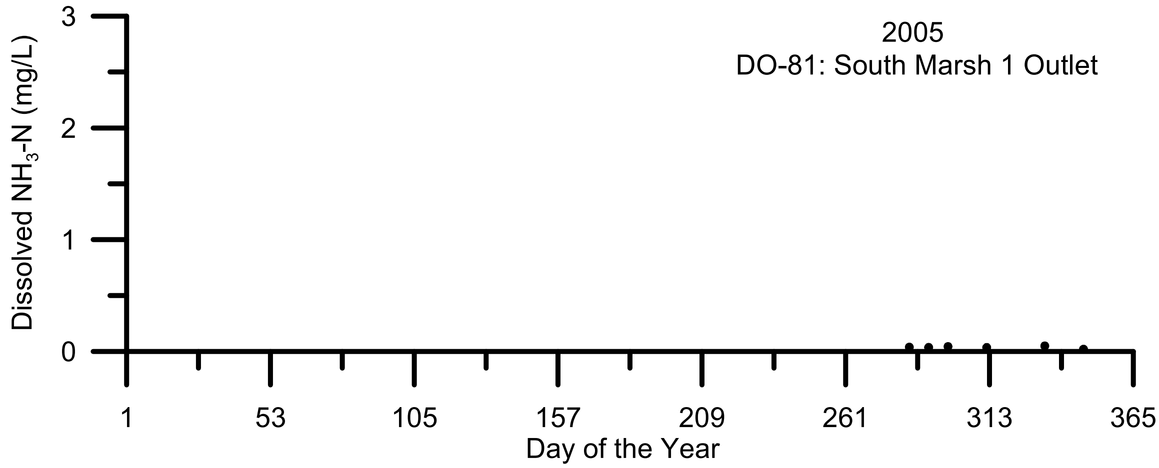

2006
DO-63: Inlet C Canal
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

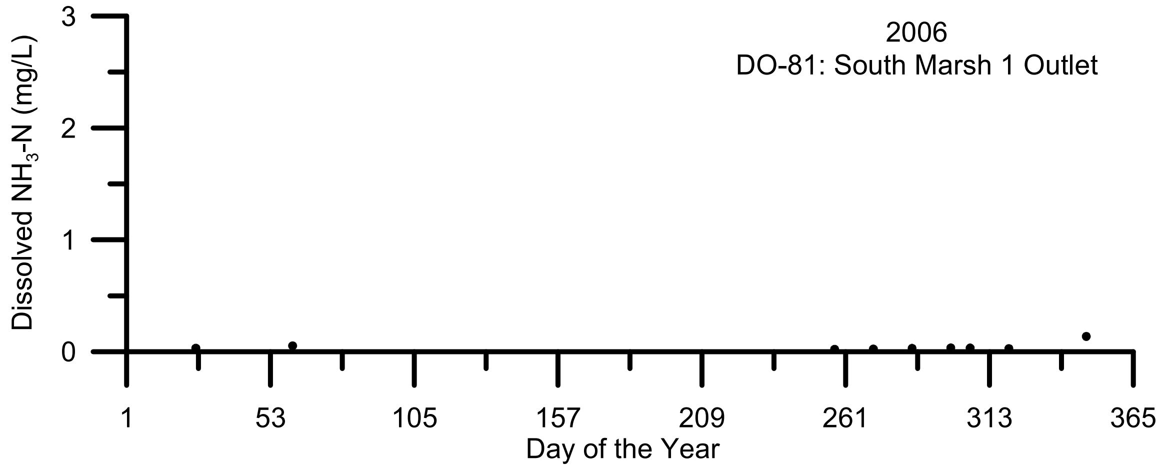

2007
DO-63: Inlet C Canal
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

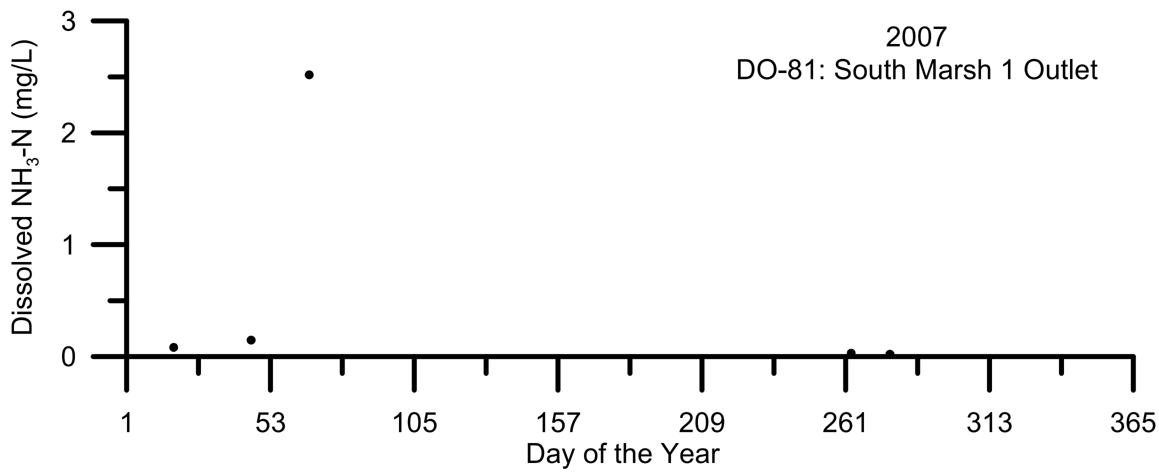

0.3
0.2
0.1
0
Dissolved NH_3-N (mg/L)
2005
DO-80: South Marsh 1 Inlet
1
53
105
157
209
261
313
365
Day of the Year

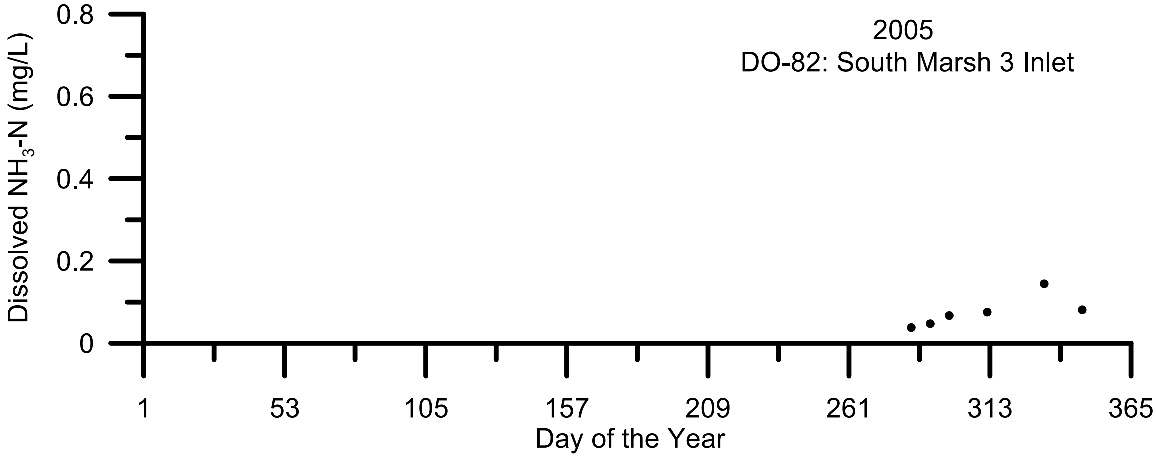

0.3
0.2
0.1
0
Dissolved NH_3-N (mg/L)
2006
DO-80: South Marsh 1 Inlet
1
53
105
157
209
261
313
365
Day of the Year

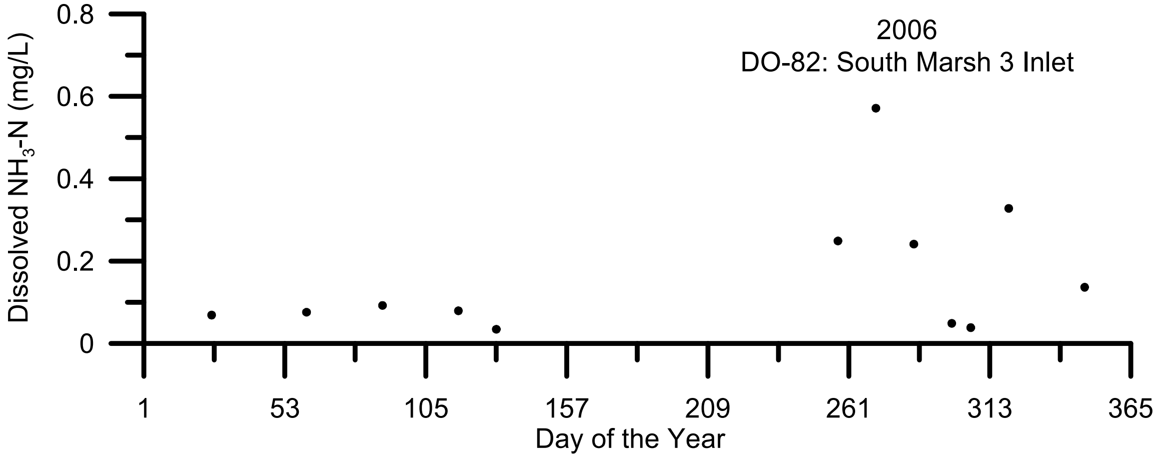

0.3
0.2
0.1
0
Dissolved NH_3-N (mg/L)
2007
DO-80: South Marsh 1 Inlet
1
53
105
157
209
261
313
365
Day of the Year

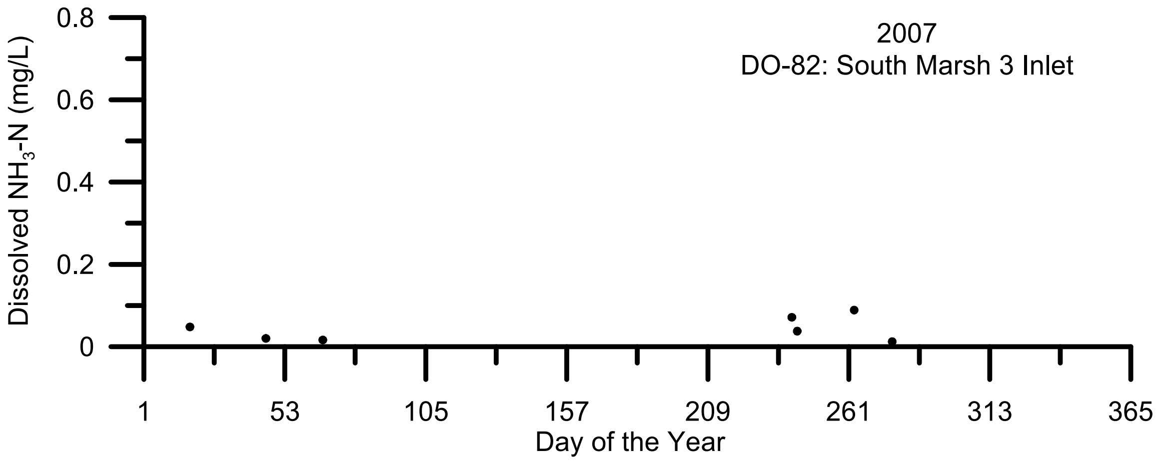

2005
DO-81: South Marsh 1 Outlet
Dissolved NH3-N (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

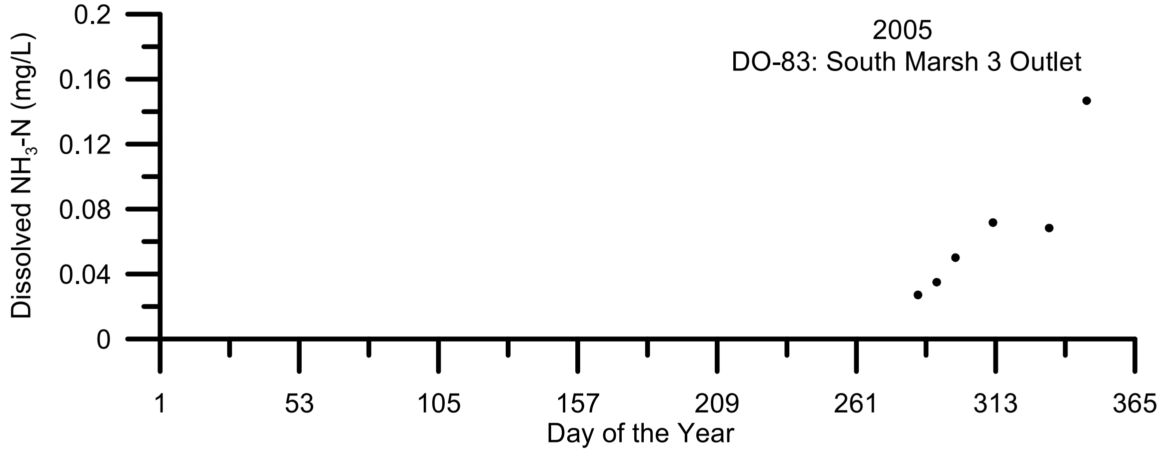

2006
DO-81: South Marsh 1 Outlet
Dissolved NH3-N (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

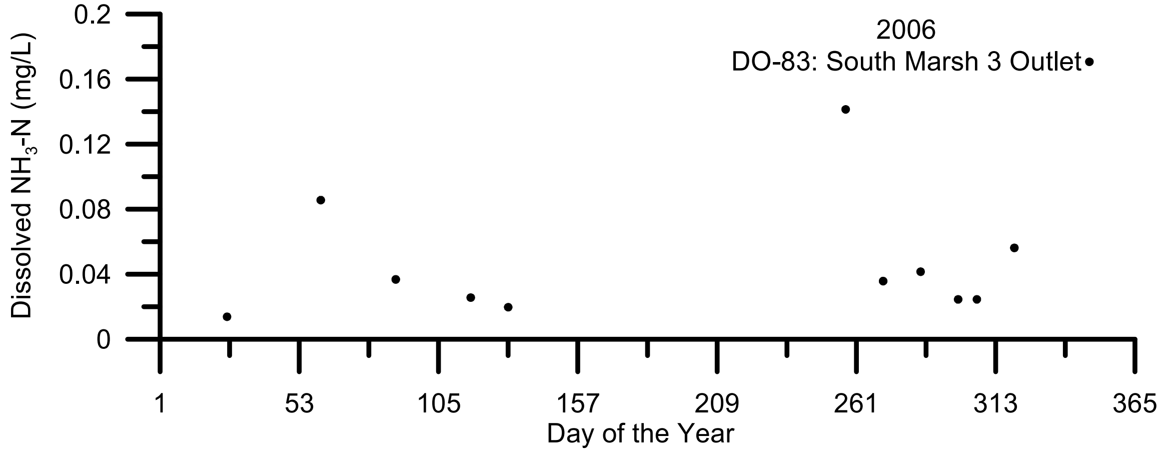

2007
DO-81: South Marsh 1 Outlet
Dissolved NH3-N (mg/L)
Day of the Year
0
1
2
3
1
53
105
157
209
261
313
365

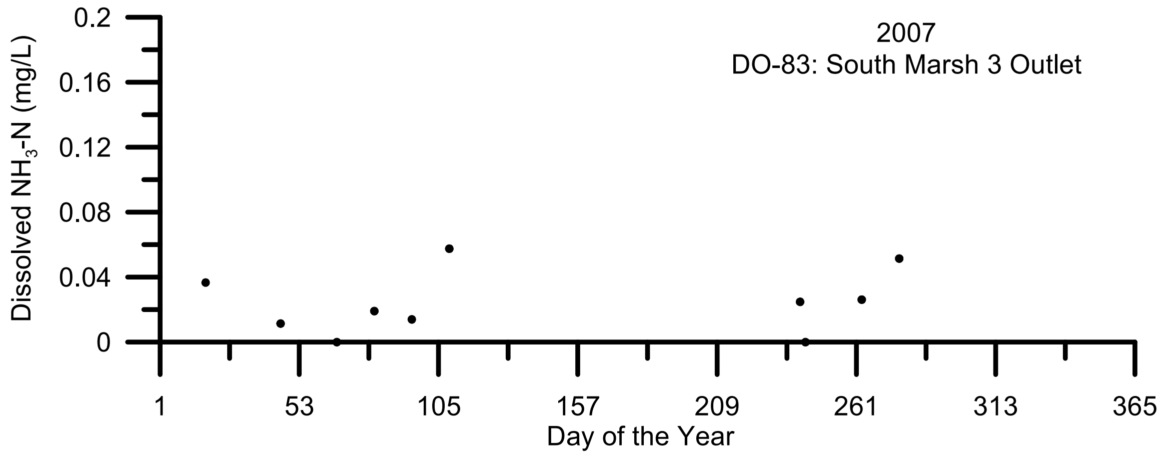

2005
DO-82: South Marsh 3 Inlet
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

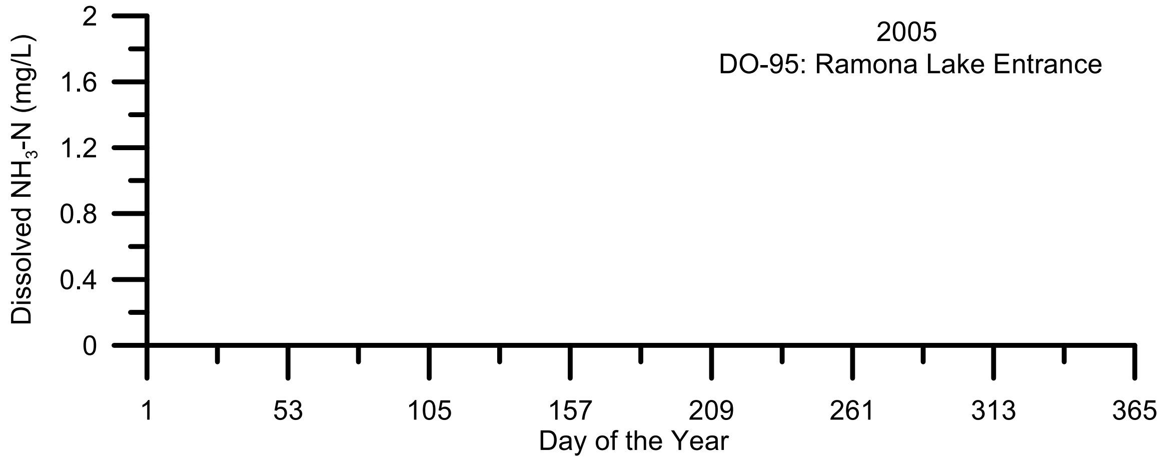

2006
DO-82: South Marsh 3 Inlet
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

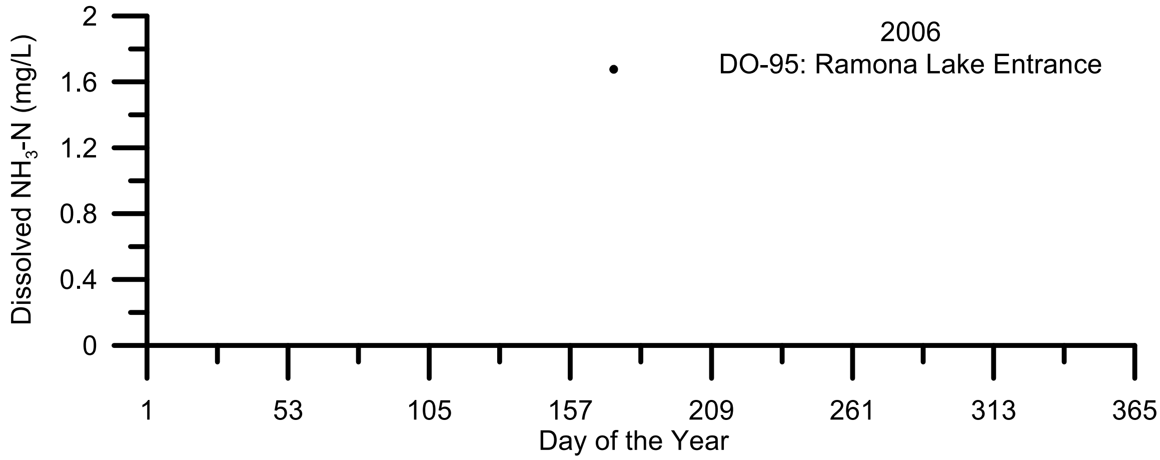

2007
DO-82: South Marsh 3 Inlet
Dissolved NH_3-N (mg/L)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

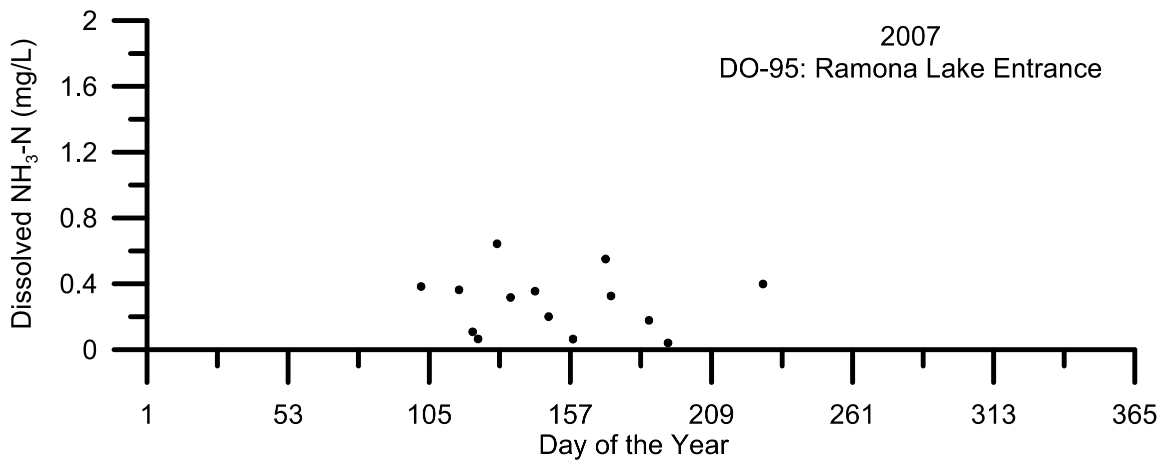

2005
DO-83: South Marsh 3 Outlet
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Dissolved NH3-N (mg/L)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Dissolved NH3-N (mg/L)
2
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Chlorine Data from the Upstream San Joaquin River

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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of chlorine (Cl) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at 4°C.

Ion chromatography was utilized for measuring Cl^- using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (SM-4110 B). The reportable limit for this method is 0.02 mg/L Cl^- .

Results/Discussion

Samples were measured ranging from 0.0-966.0 mg/L Cl. The average concentration of Cl in samples collected was 143.7 mg/L Cl. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA.

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

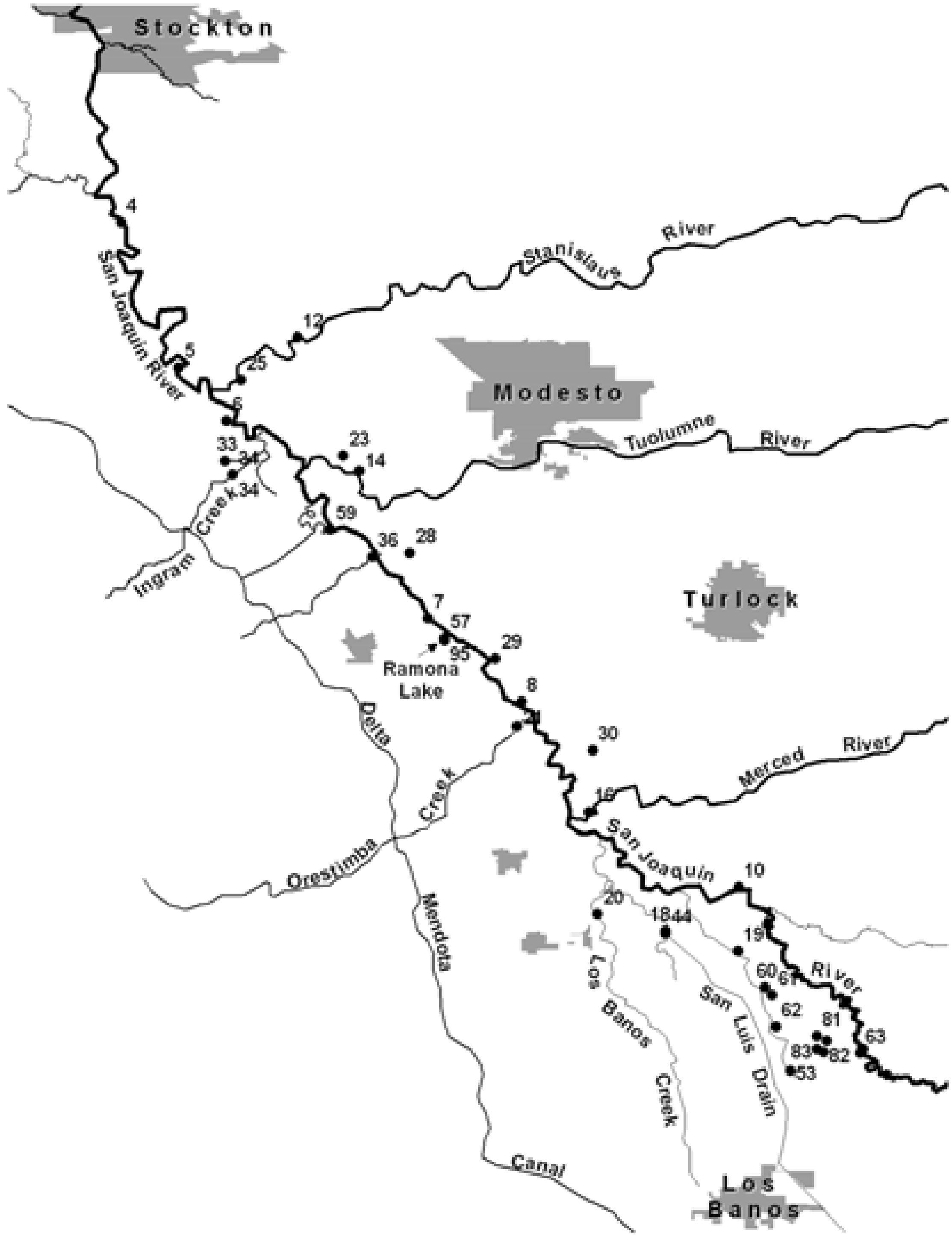
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

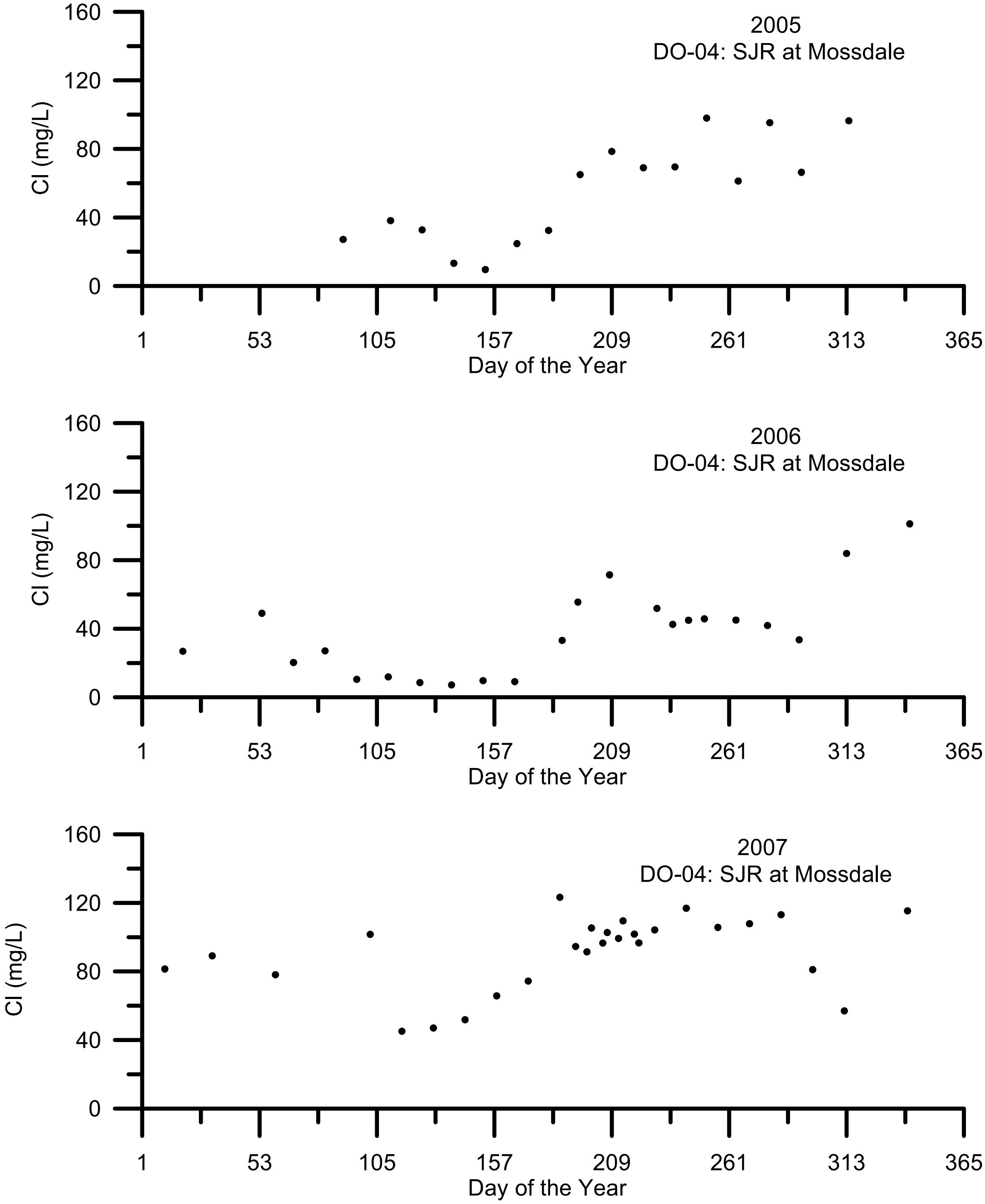
Table 1: EERP Sampling Site List

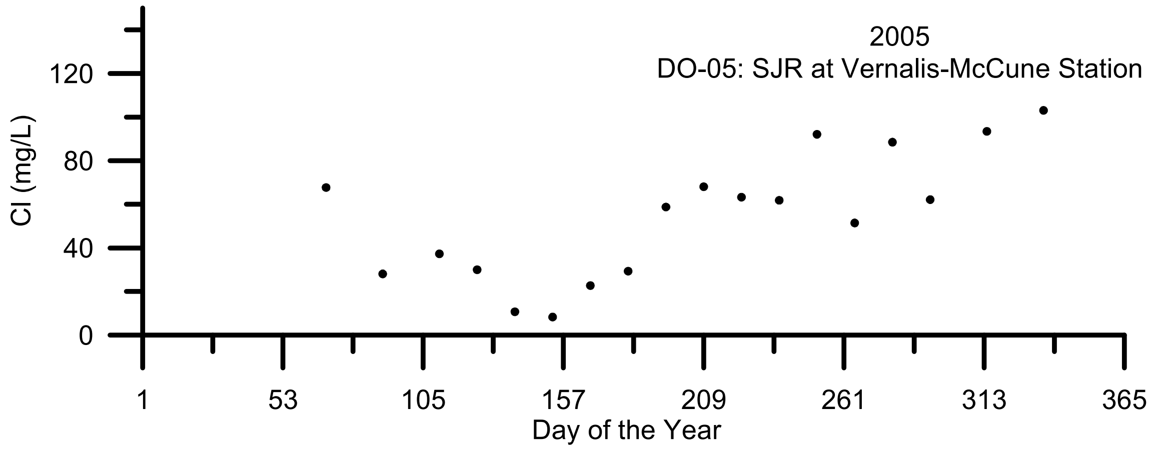
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

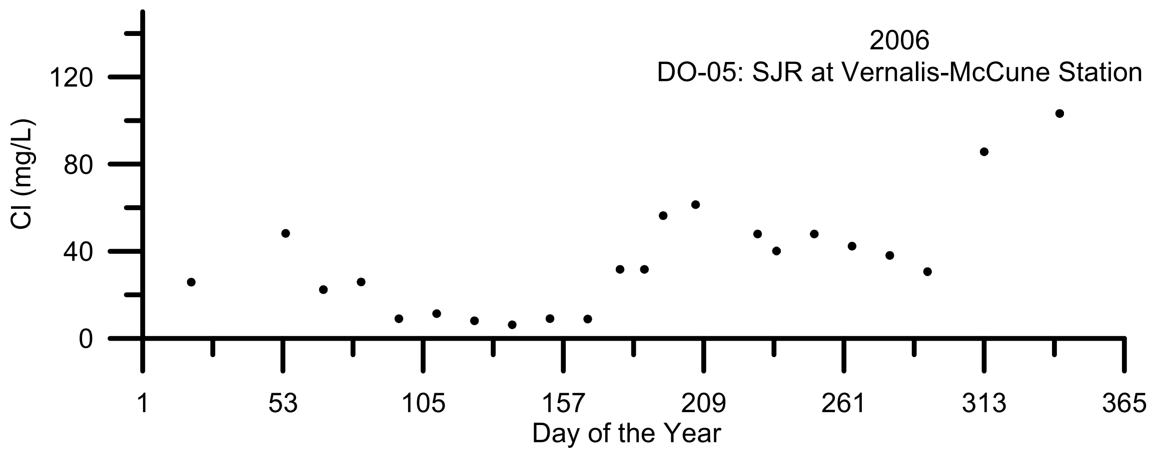
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

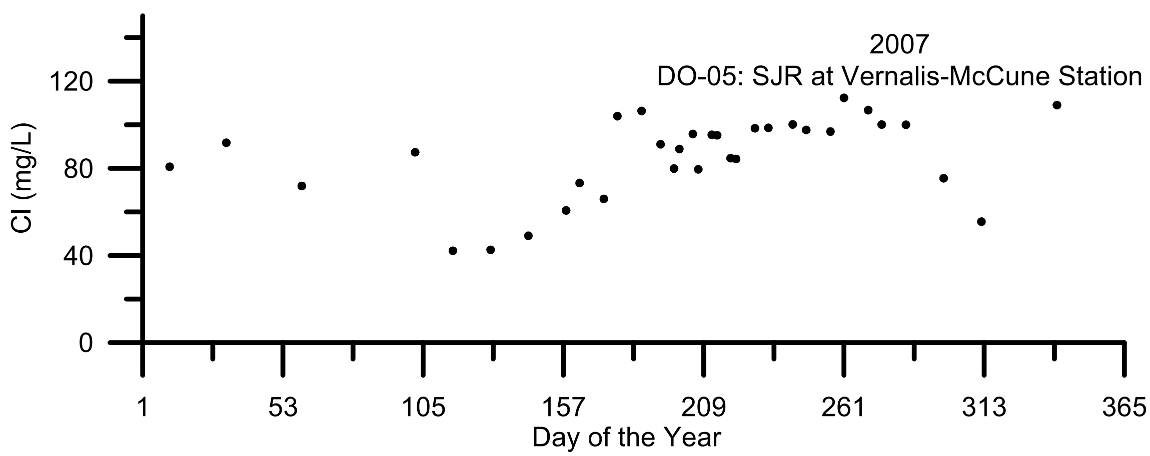


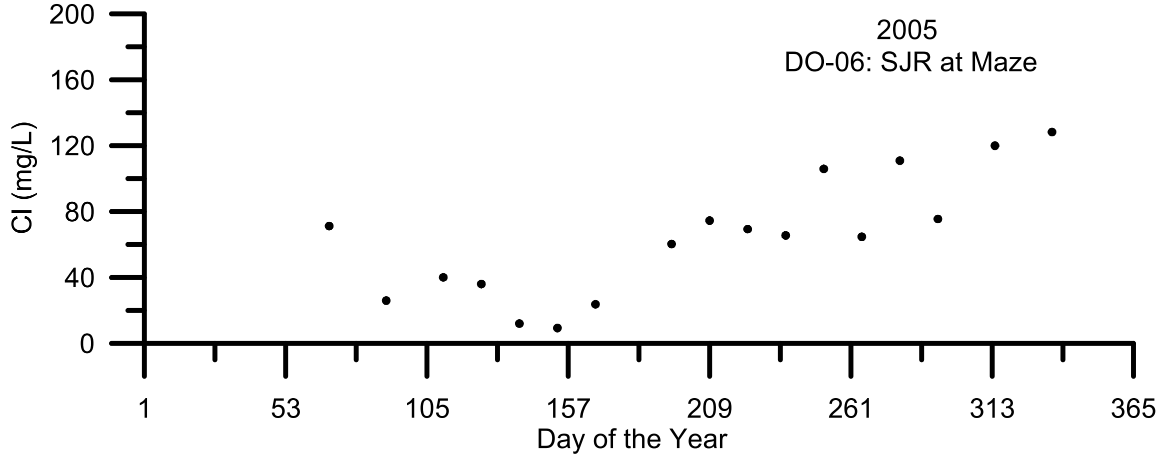
Figures 2 -103: Temporal Plots of Cl By Site ID

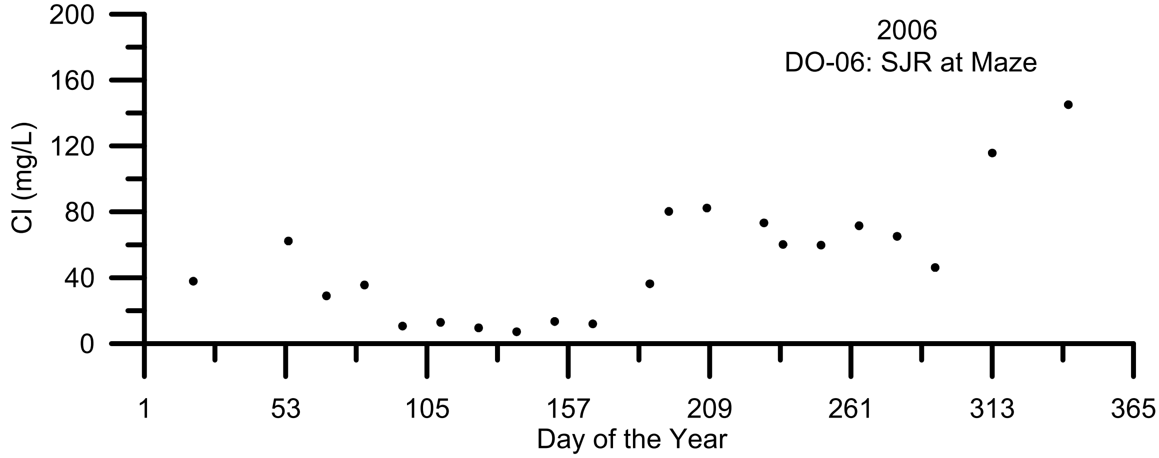


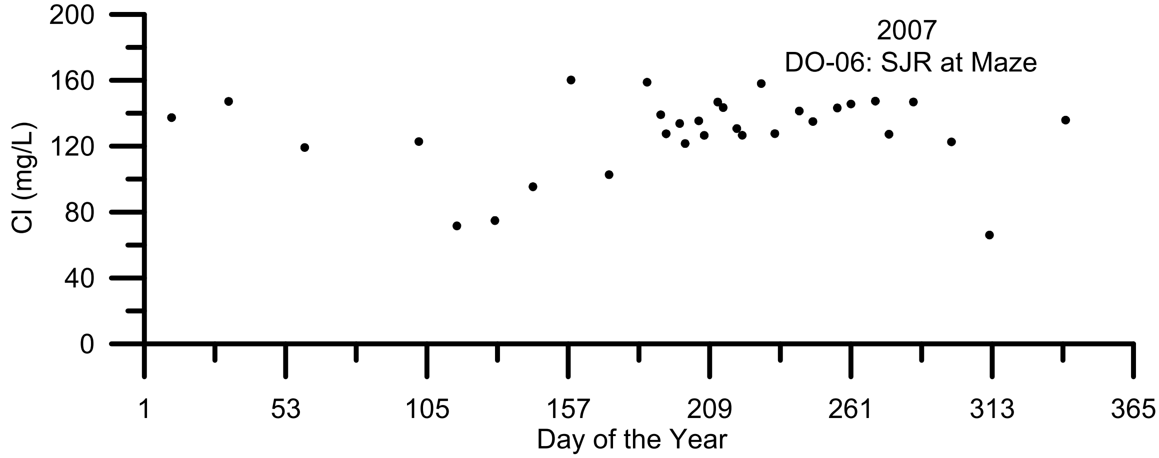

2005
DO-05: SJR at Vernalis-McCune Station
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

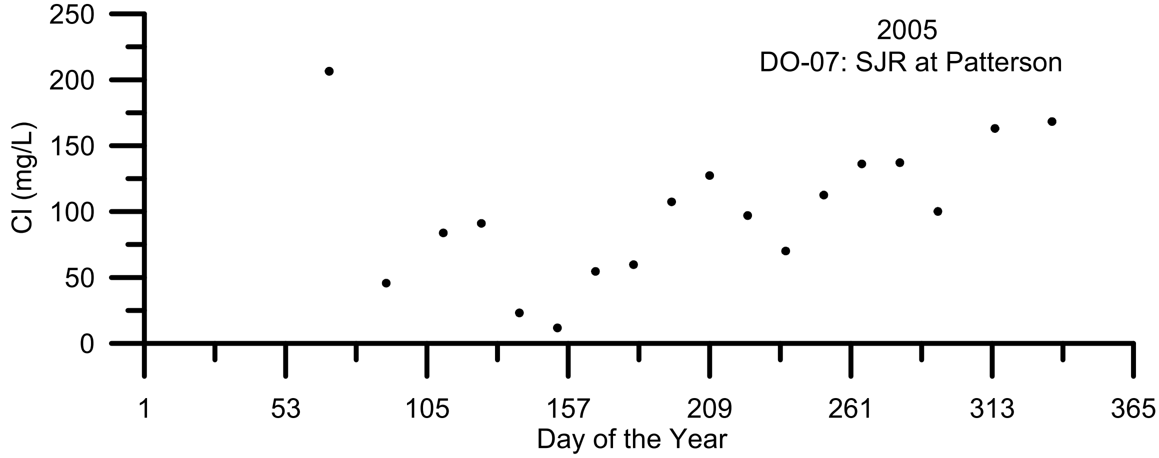

2006
DO-05: SJR at Vernalis-McCune Station
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

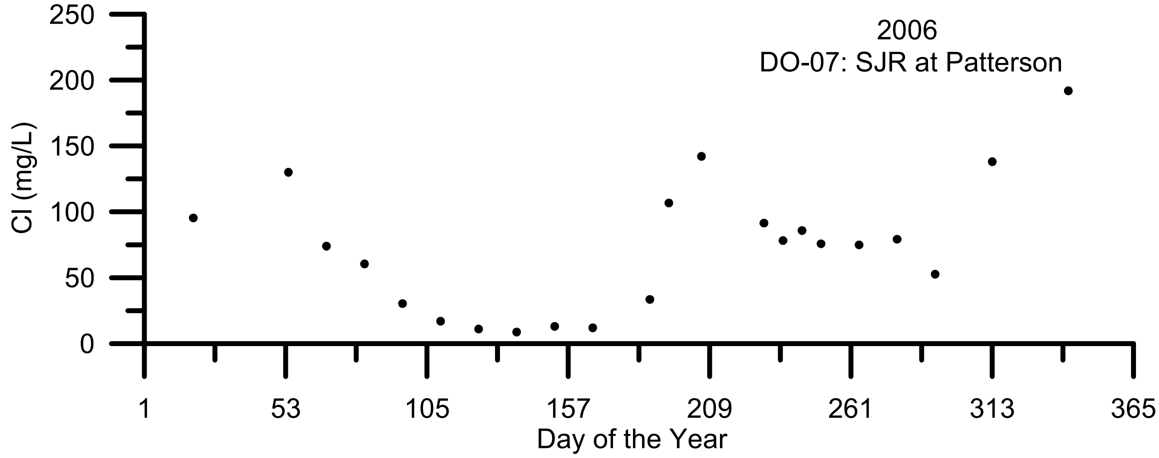

2007
DO-05: SJR at Vernalis-McCune Station
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

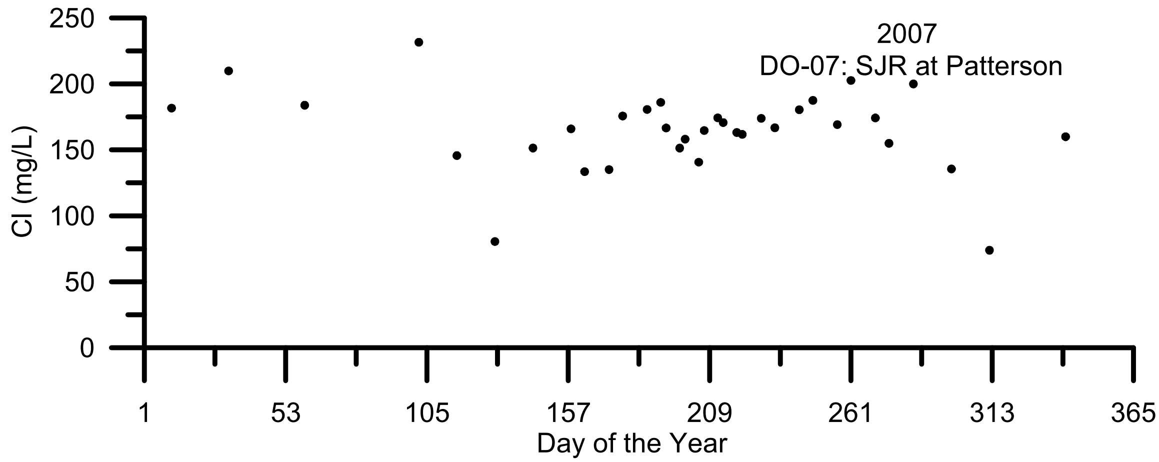

2005
DO-06: SJR at Maze
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

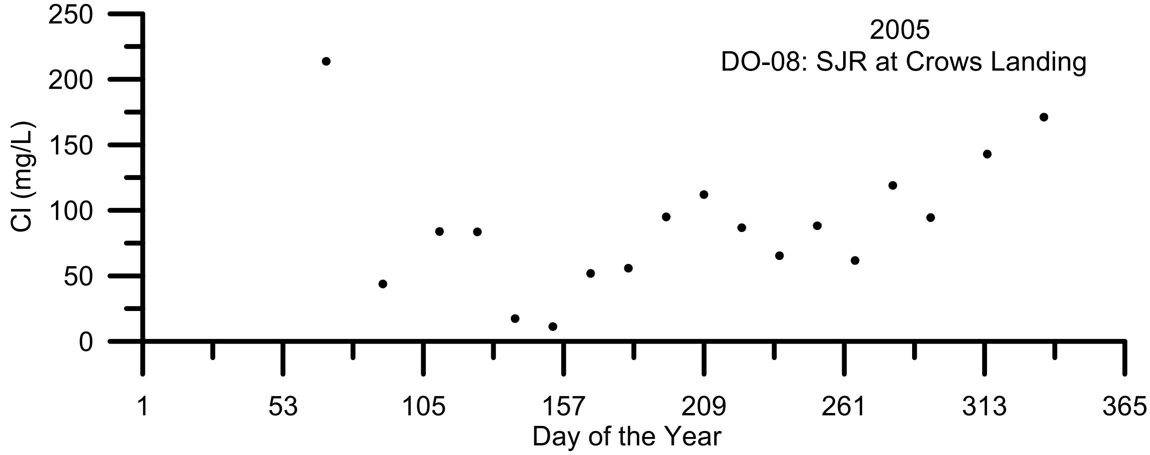

2006
DO-06: SJR at Maze
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

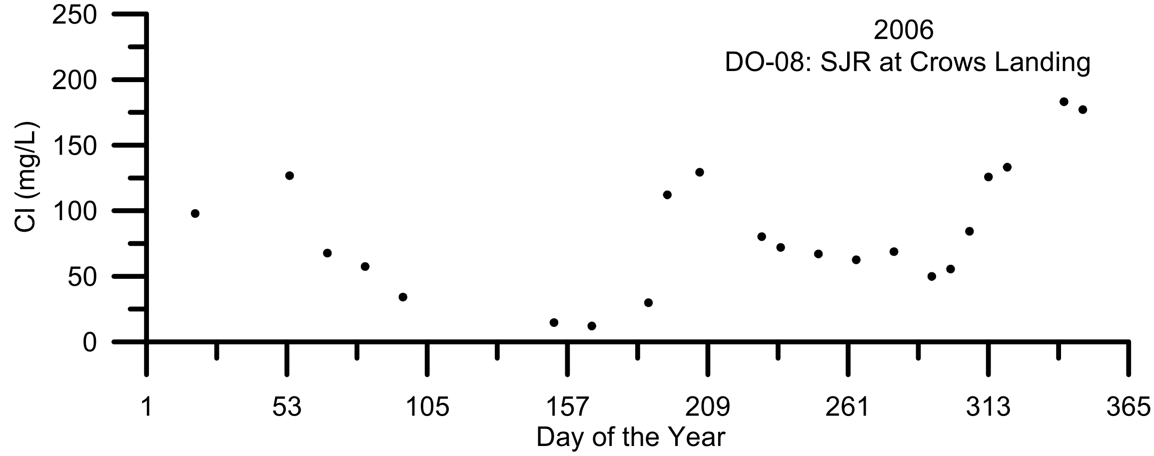

2007
DO-06: SJR at Maze
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

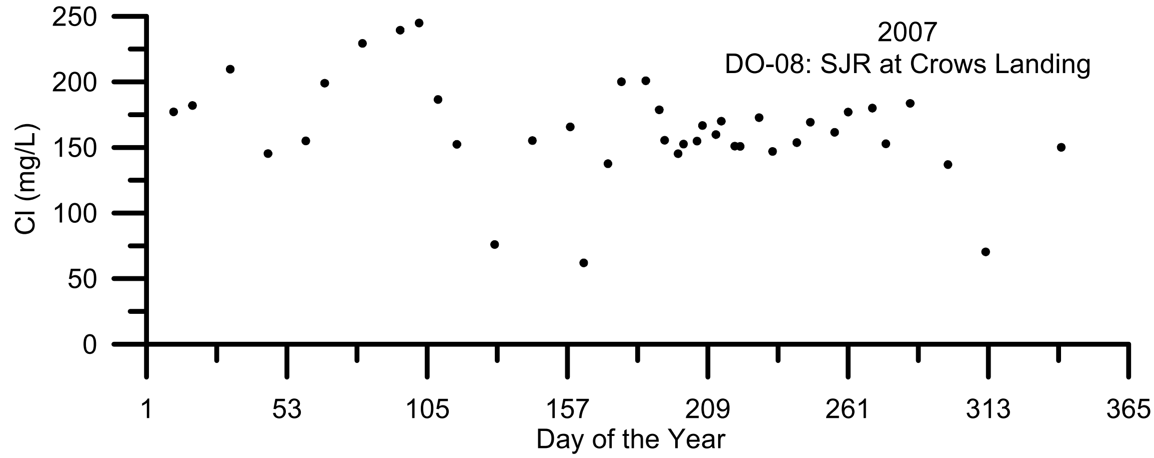

2005
DO-07: SJR at Patterson
Cl (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

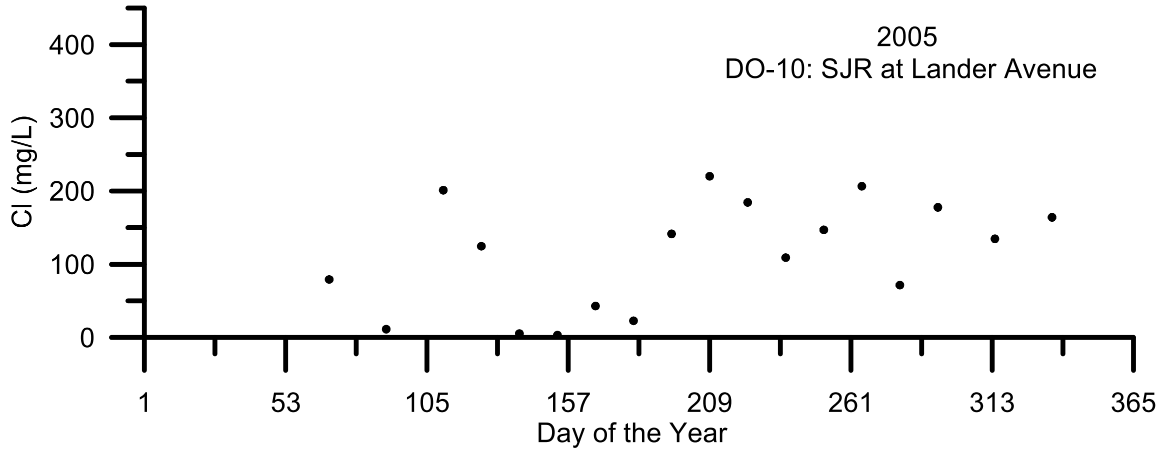

2006
DO-07: SJR at Patterson
Cl (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

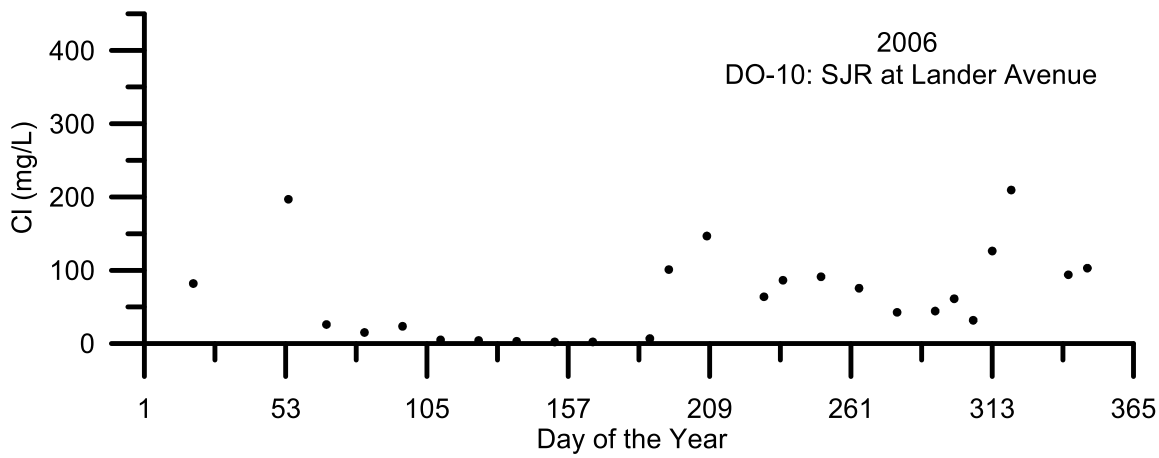

2007
DO-07: SJR at Patterson
Cl (mg/L)
250
200
150
100
50
0
1
53
105
157
209
261
313
365
Day of the Year

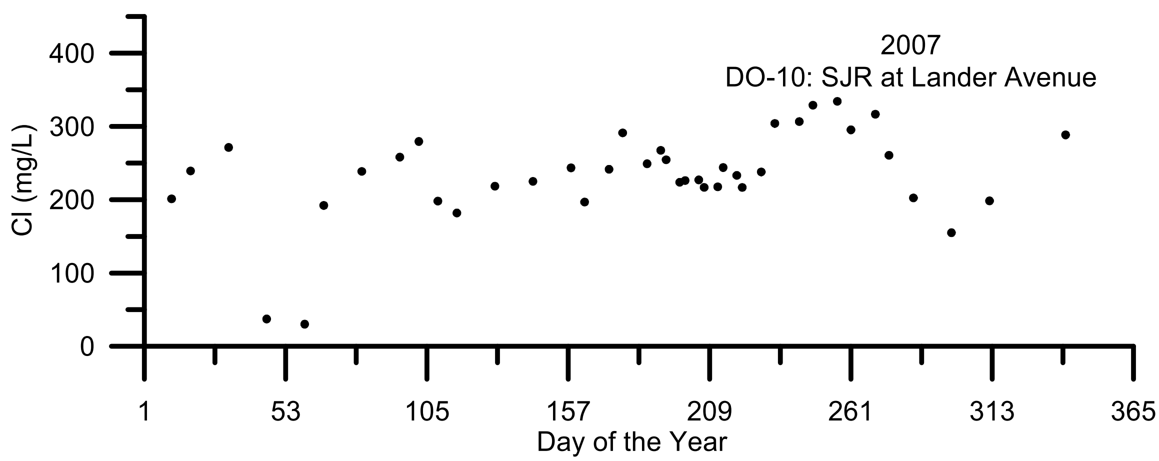

2005
DO-08: SJR at Crows Landing
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

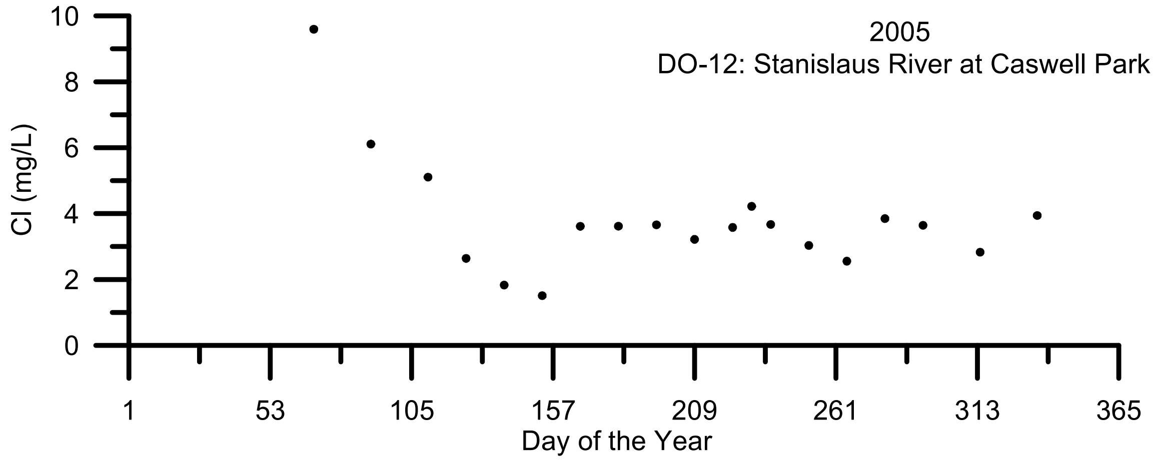

2006
DO-08: SJR at Crows Landing
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

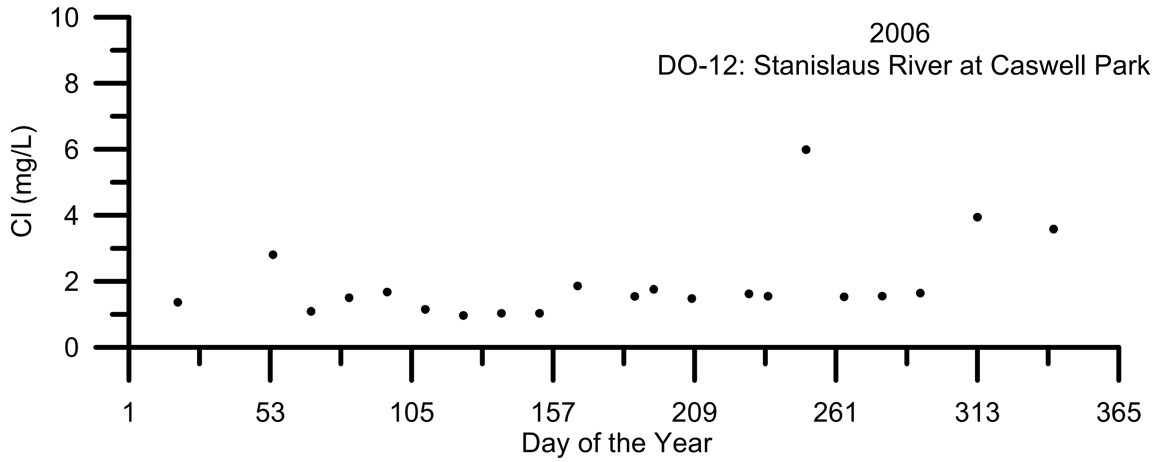

2007
DO-08: SJR at Crows Landing
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

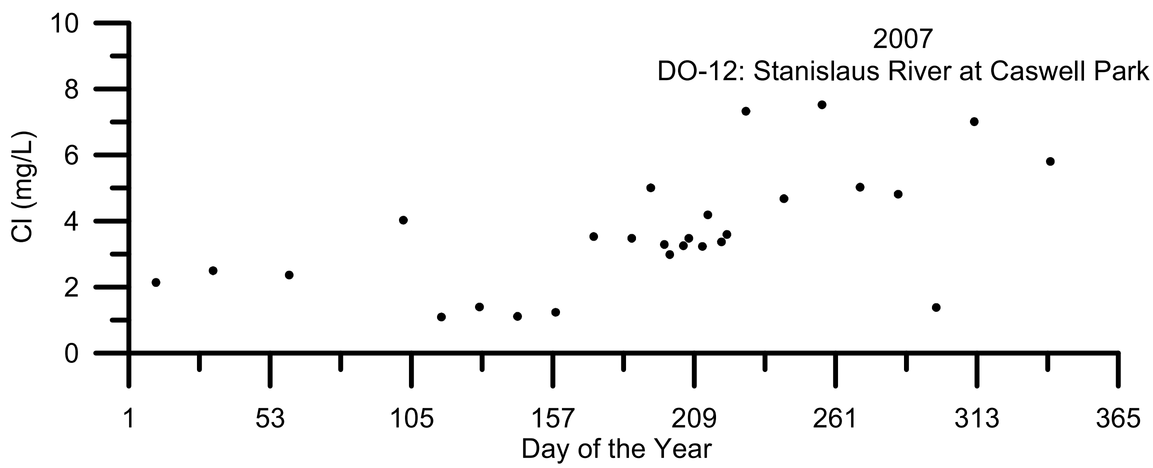

2005
DO-10: SJR at Lander Avenue
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

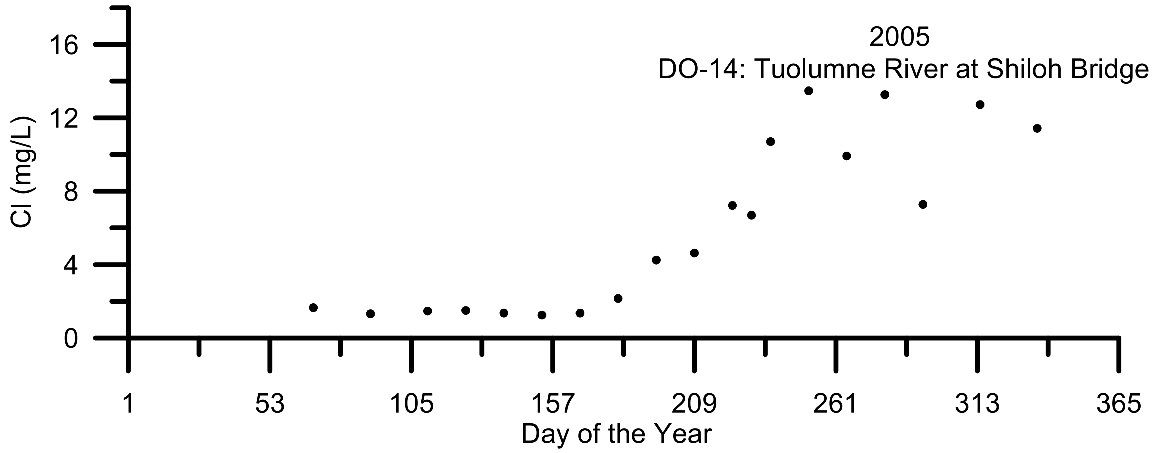

2006
DO-10: SJR at Lander Avenue
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

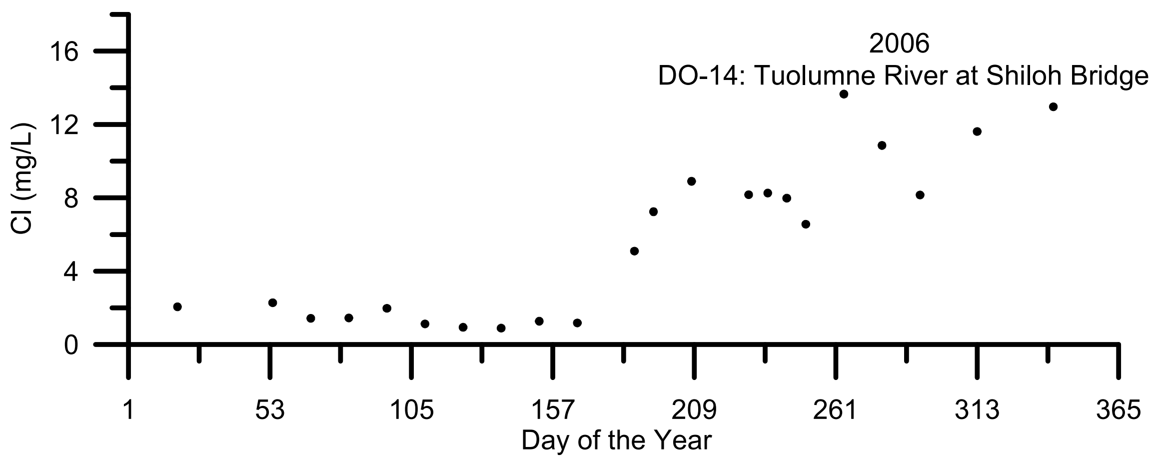

2007
DO-10: SJR at Lander Avenue
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

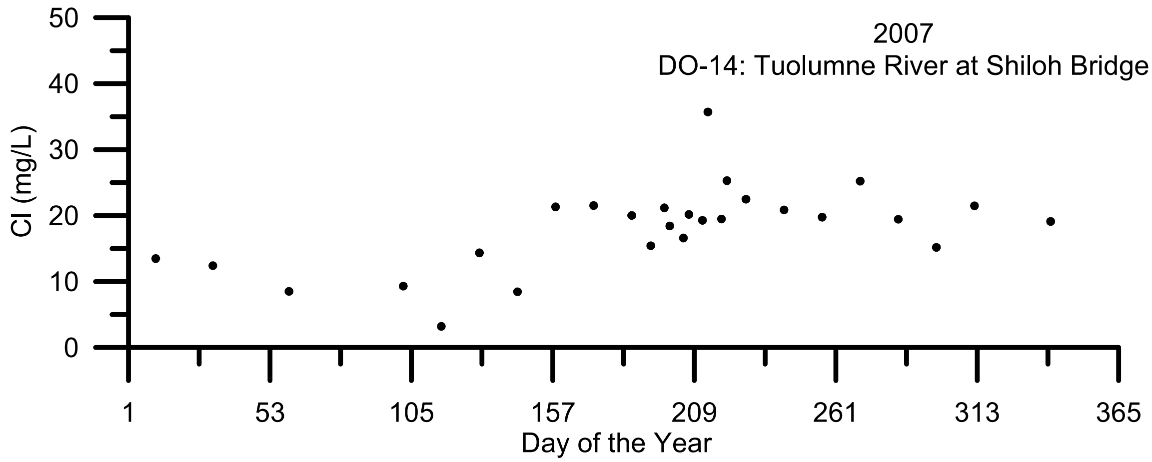

2005
DO-12: Stanislaus River at Caswell Park
Cl (mg/L)
Day of the Year

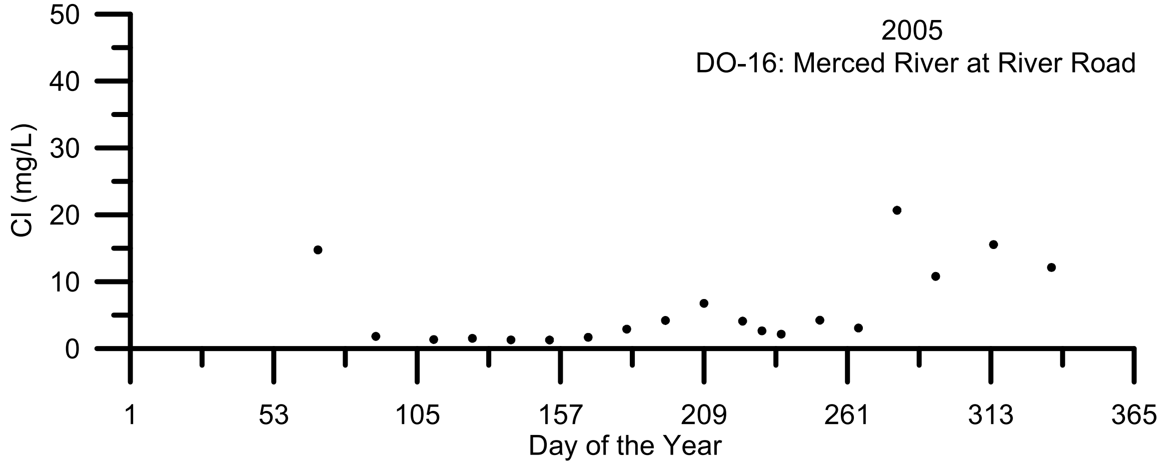

2006
DO-12: Stanislaus River at Caswell Park
Cl (mg/L)
Day of the Year


2007
DO-12: Stanislaus River at Caswell Park
Cl (mg/L)
Day of the Year

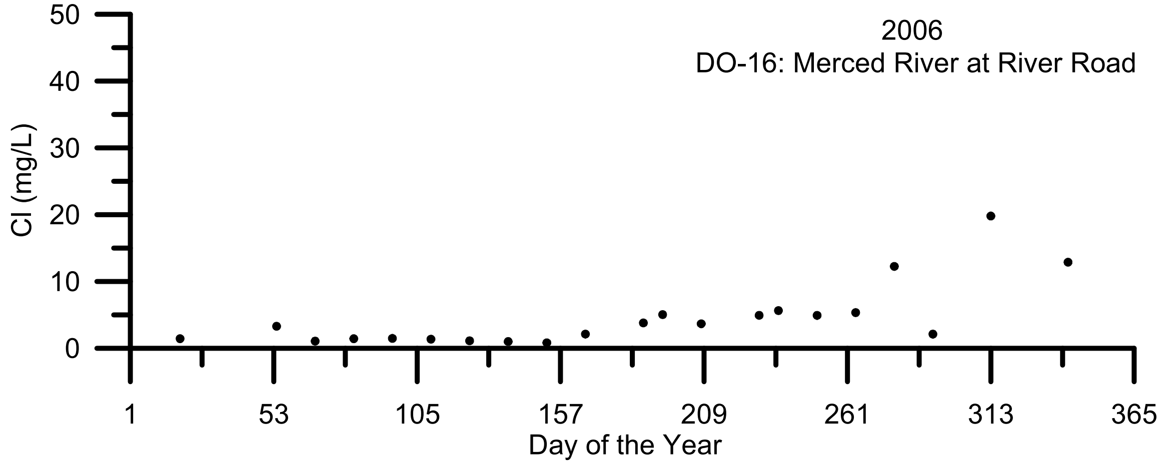

2005
DO-14: Tuolumne River at Shiloh Bridge
Cl (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-14: Tuolumne River at Shiloh Bridge
Cl (mg/L)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

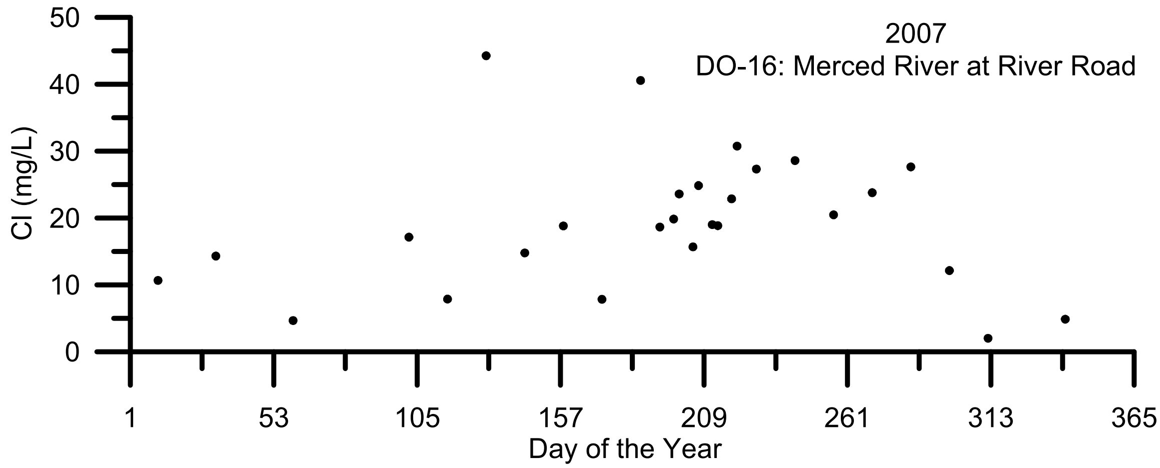

2007
DO-14: Tuolumne River at Shiloh Bridge
Cl (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year



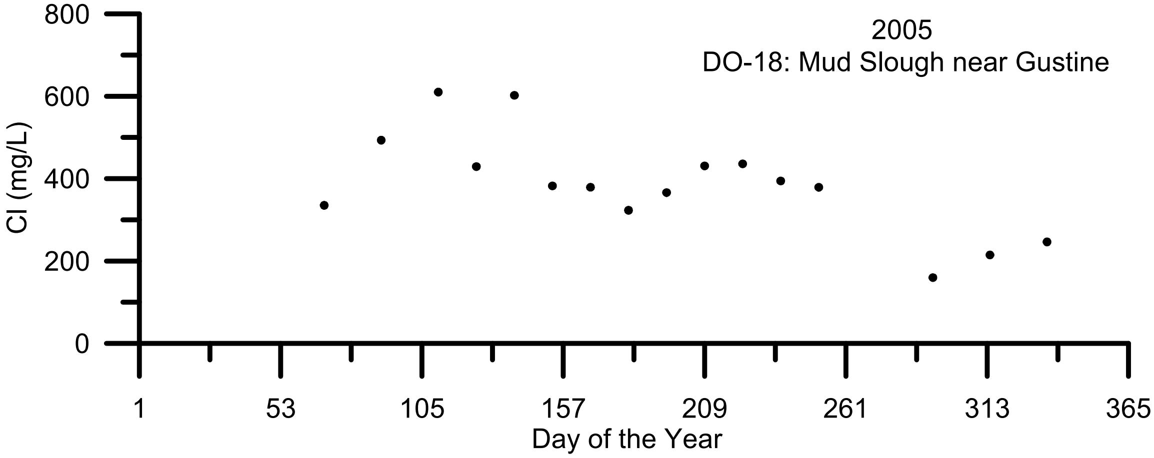
2005
DO-16: Merced River at River Road
Cl (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

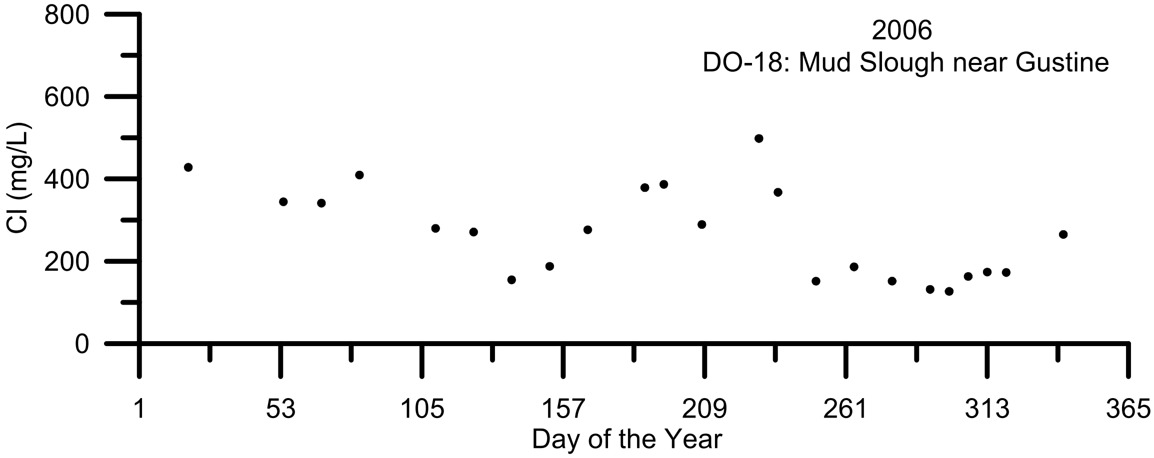


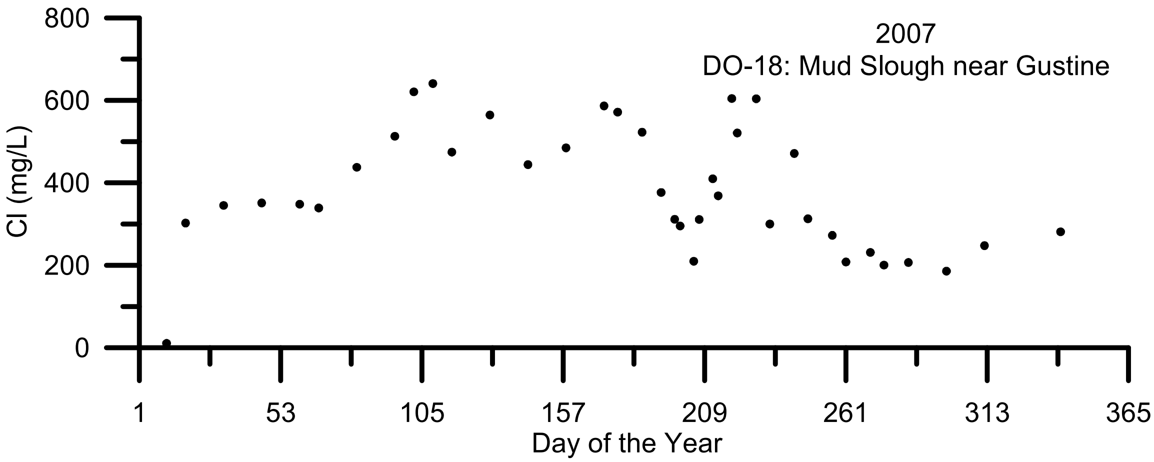
2006
DO-16: Merced River at River Road
Cl (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

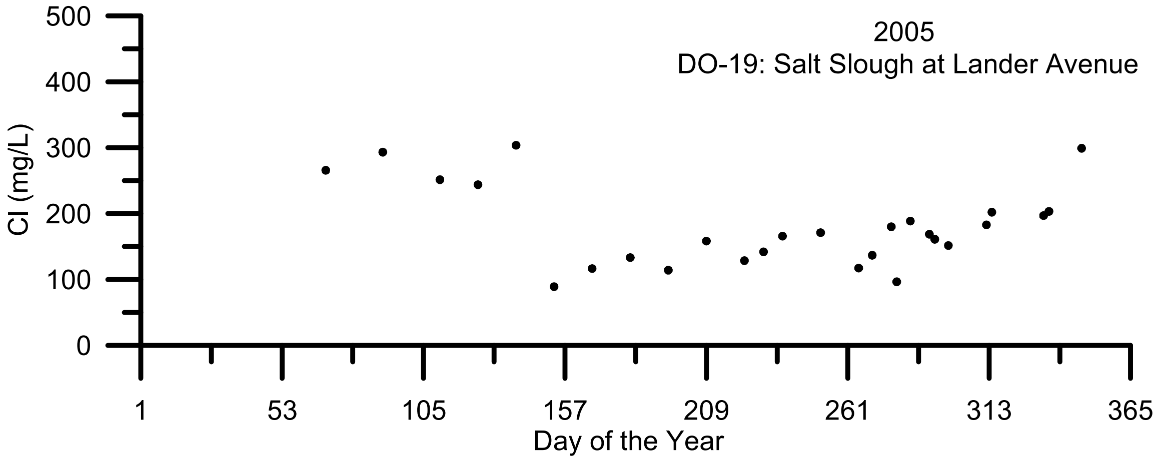


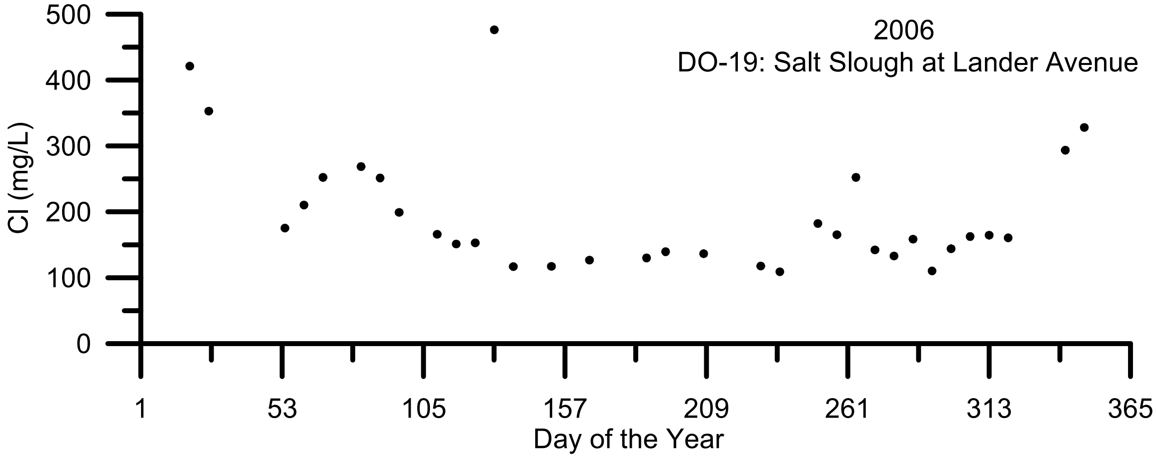
2007
DO-16: Merced River at River Road
Cl (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

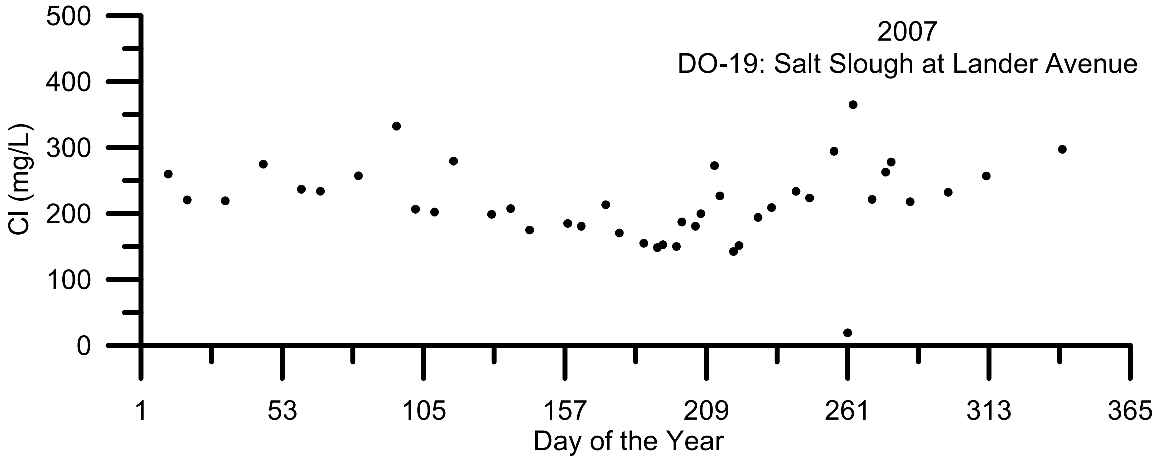

2005
DO-18: Mud Slough near Gustine
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

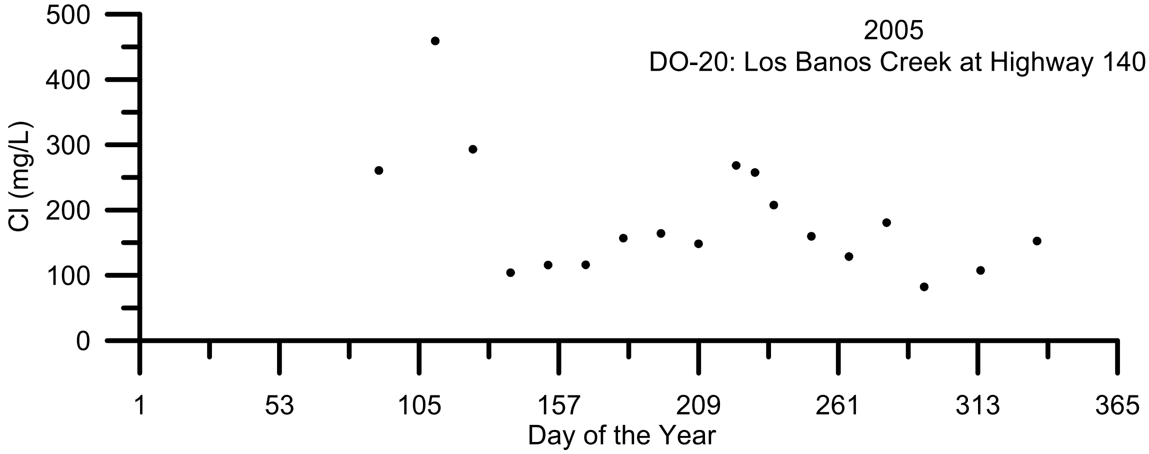

2006
DO-18: Mud Slough near Gustine
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

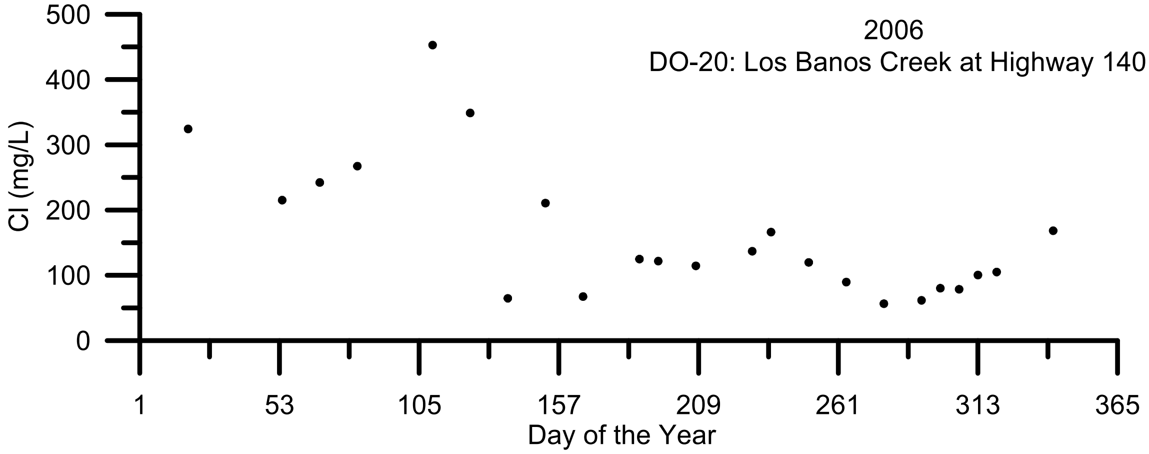

2007
DO-18: Mud Slough near Gustine
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

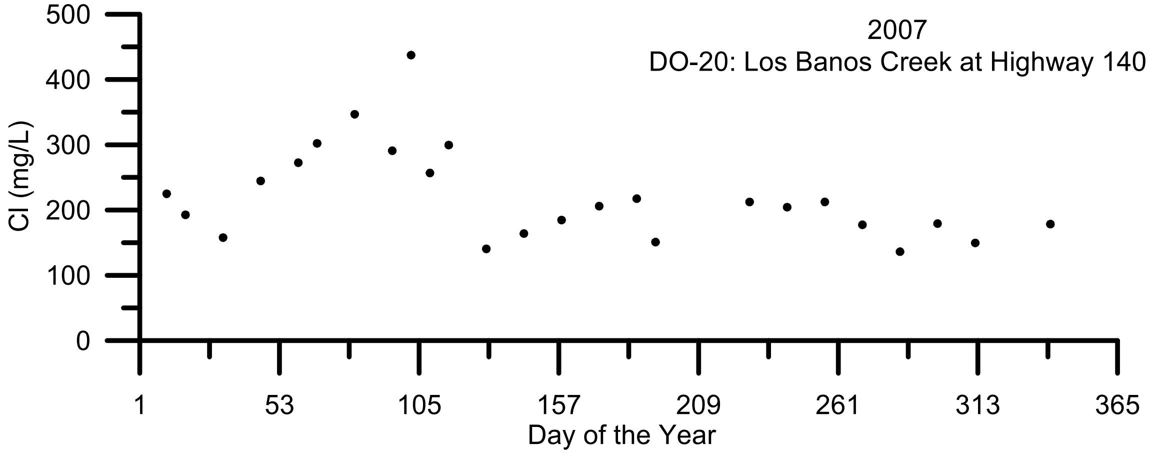

2005
DO-19: Salt Slough at Lander Avenue
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

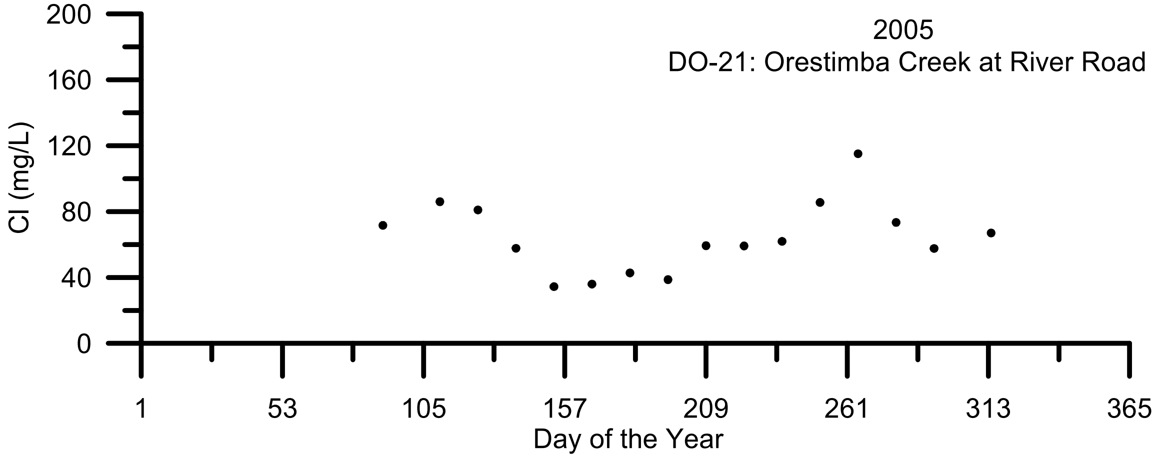

2006
DO-19: Salt Slough at Lander Avenue
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

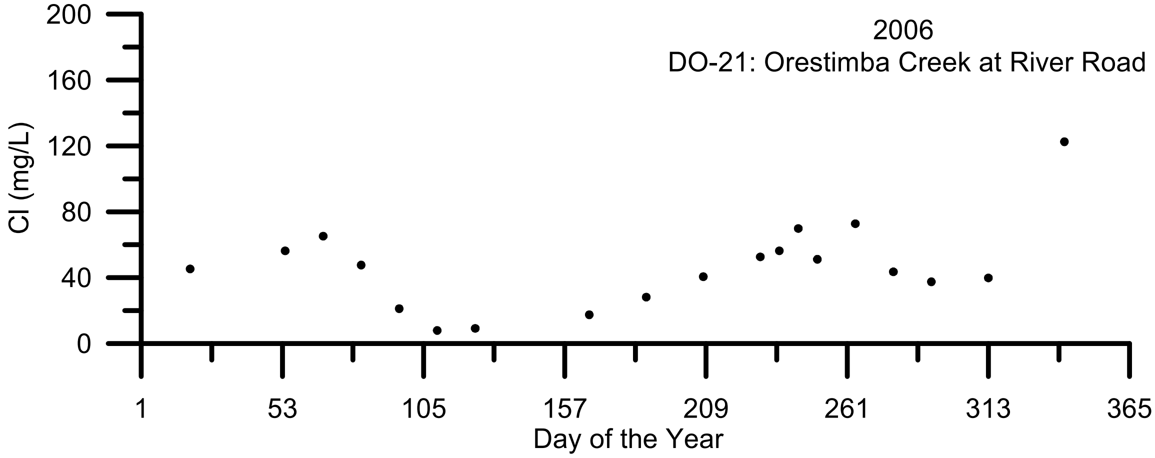

2007
DO-19: Salt Slough at Lander Avenue
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

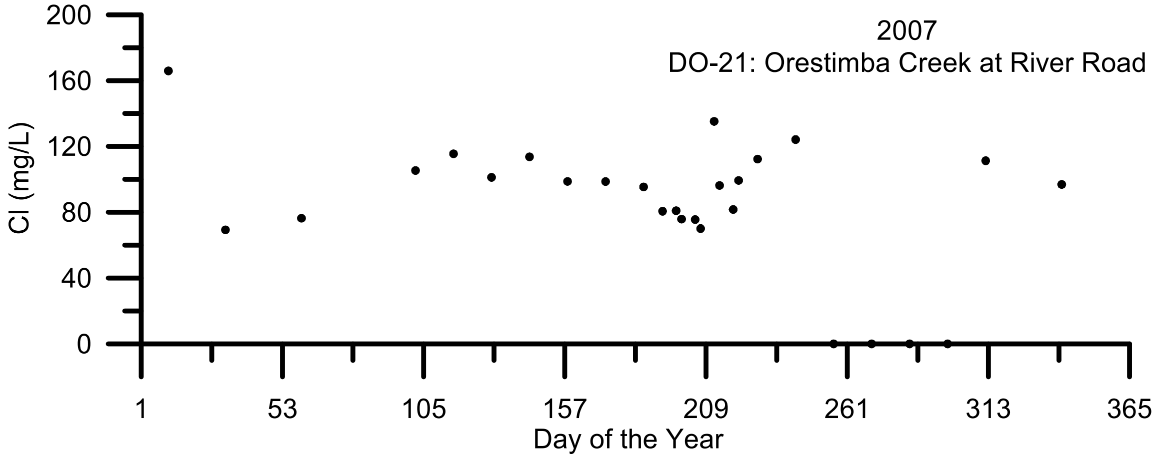

2005
DO-20: Los Banos Creek at Highway 140
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

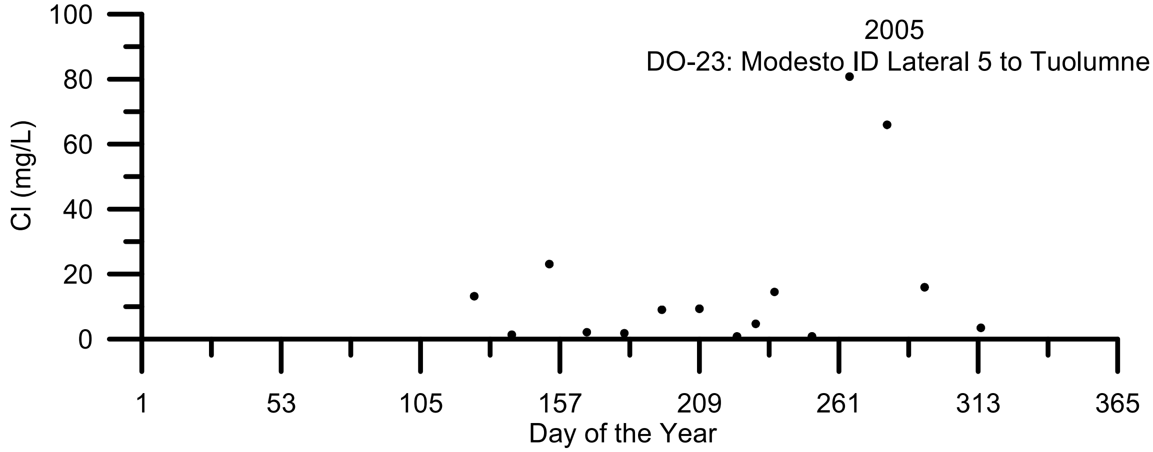

2006
DO-20: Los Banos Creek at Highway 140
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

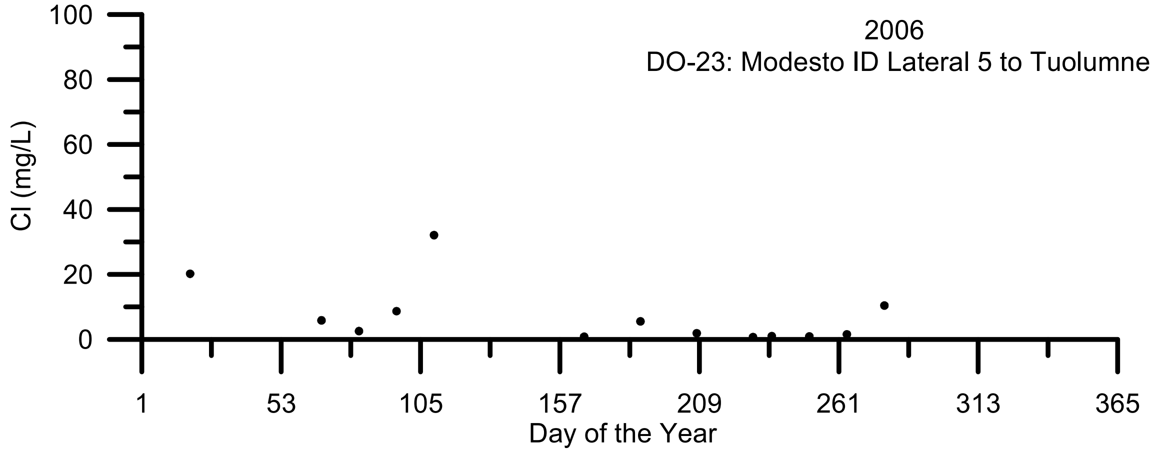

2007
DO-20: Los Banos Creek at Highway 140
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

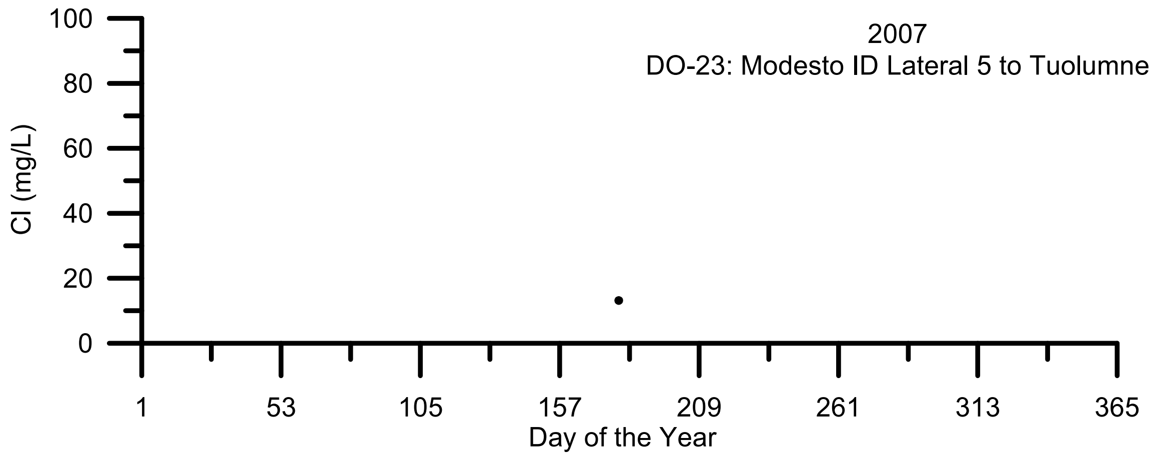

2005
DO-21: Orestimba Creek at River Road
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

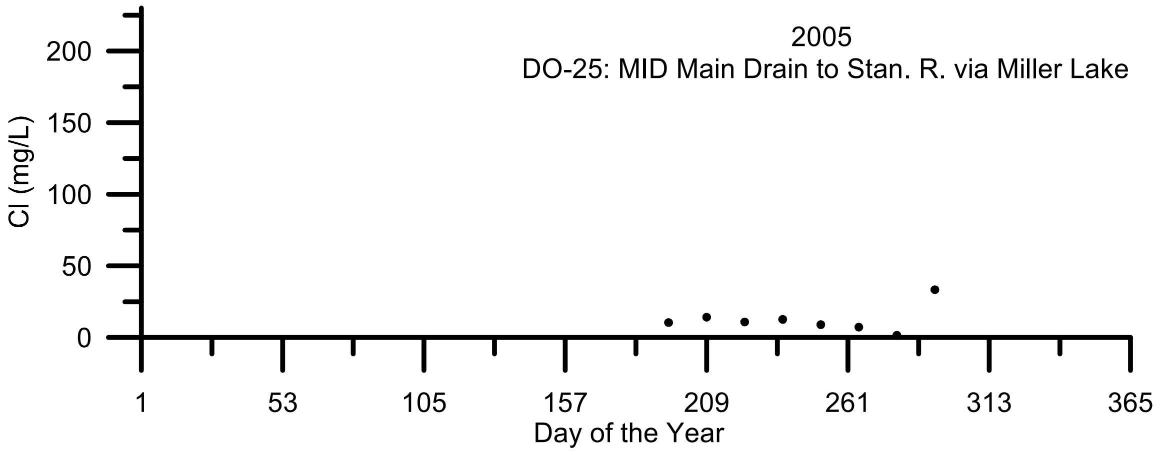

2006
DO-21: Orestimba Creek at River Road
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

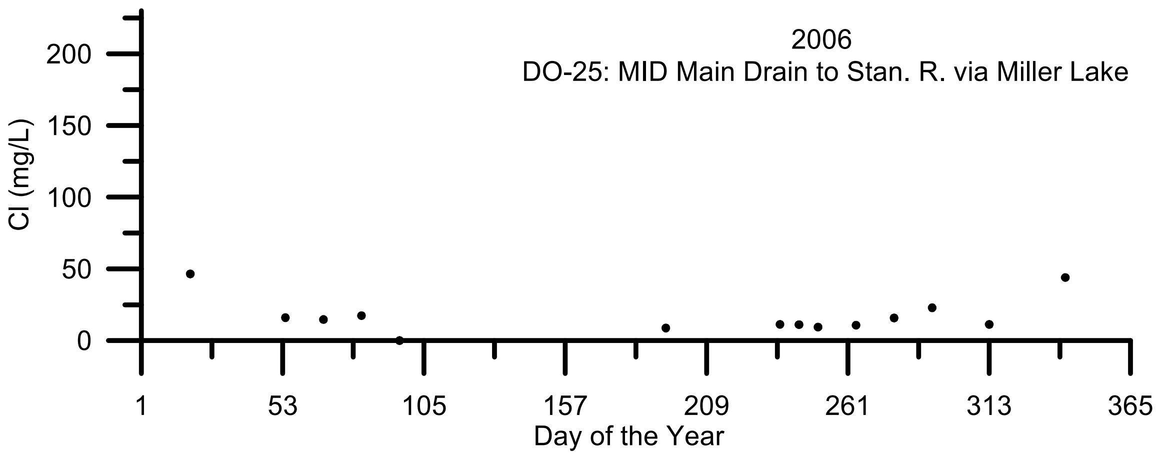

2007
DO-21: Orestimba Creek at River Road
Cl (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

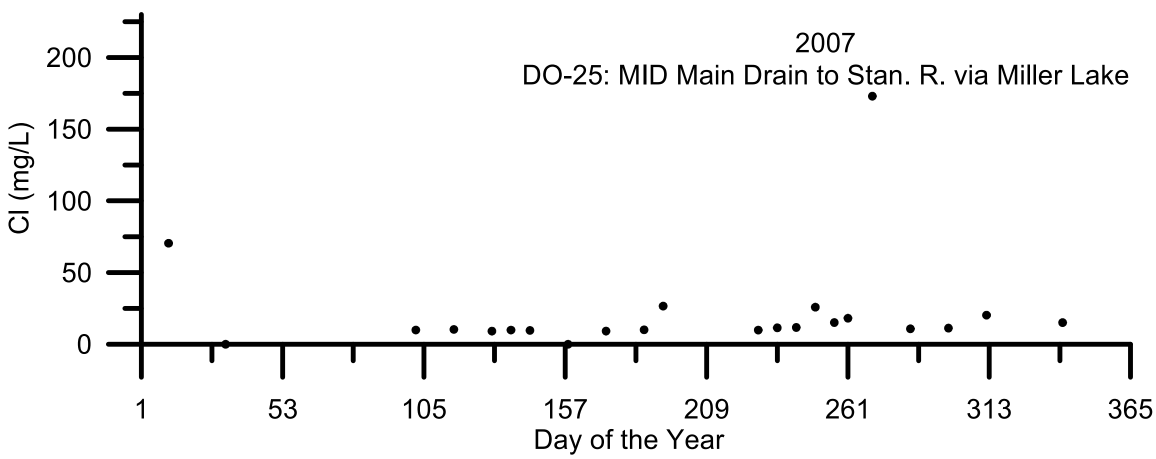

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Cl (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

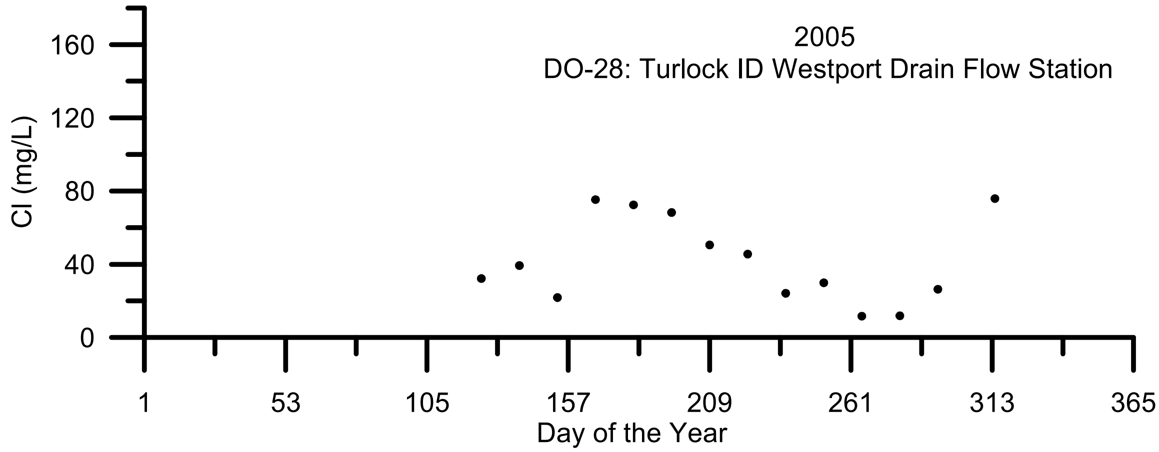

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Cl (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

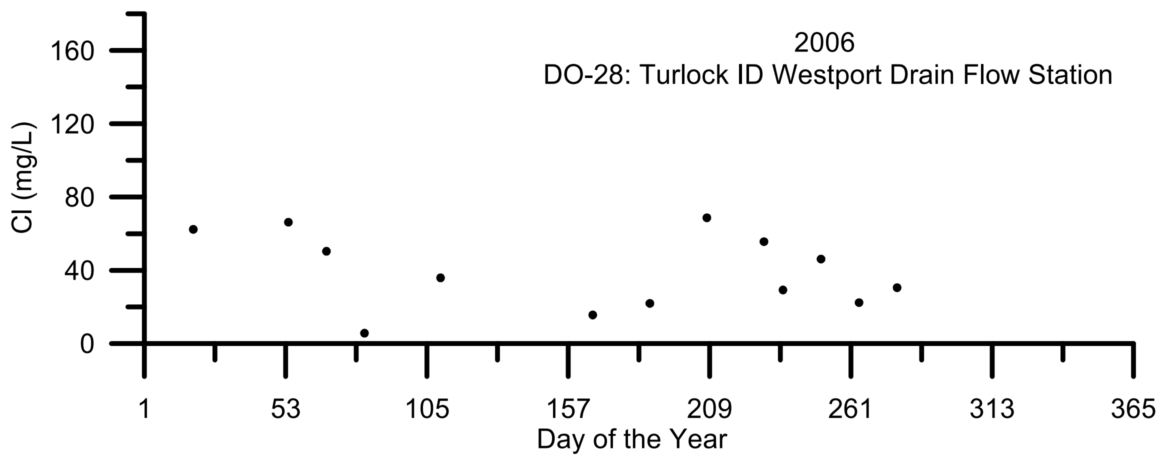

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Cl (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

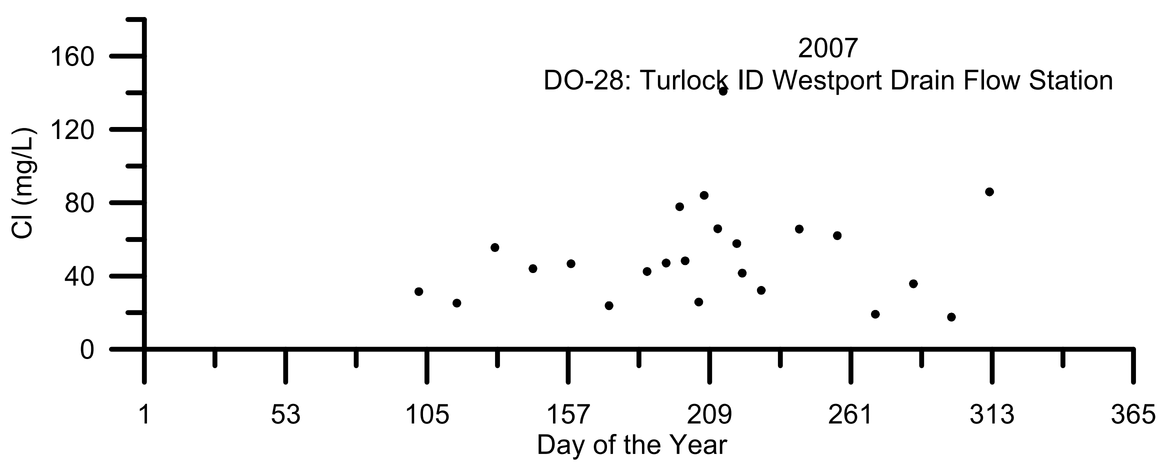

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

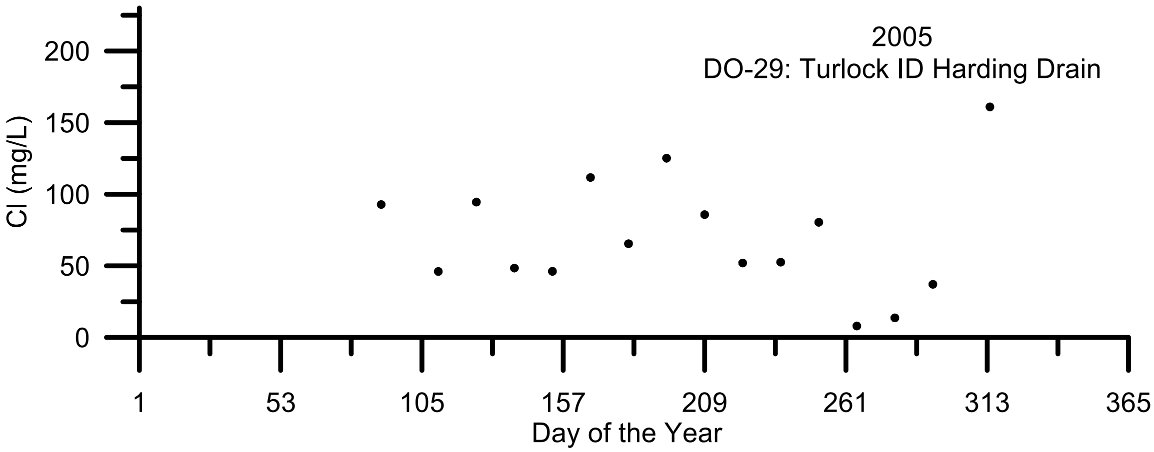

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

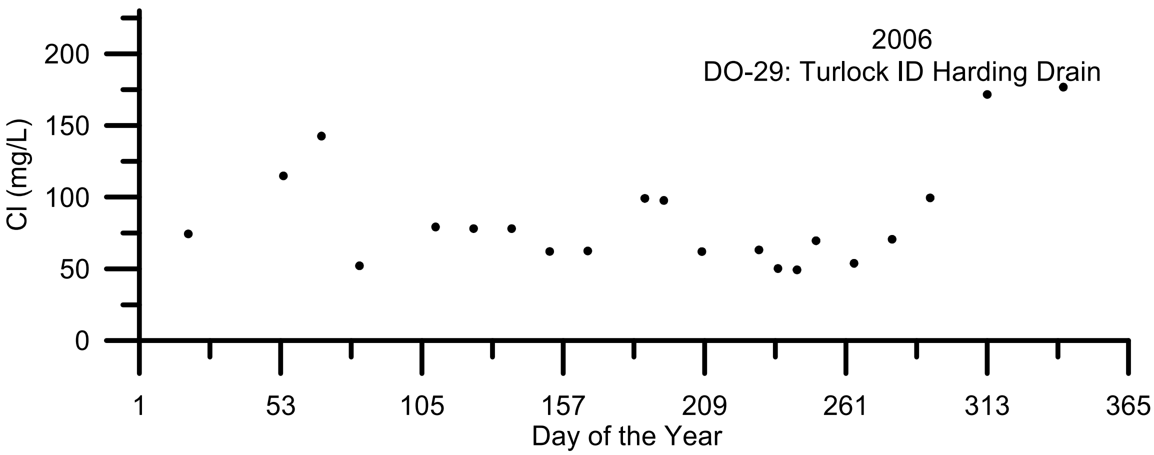

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

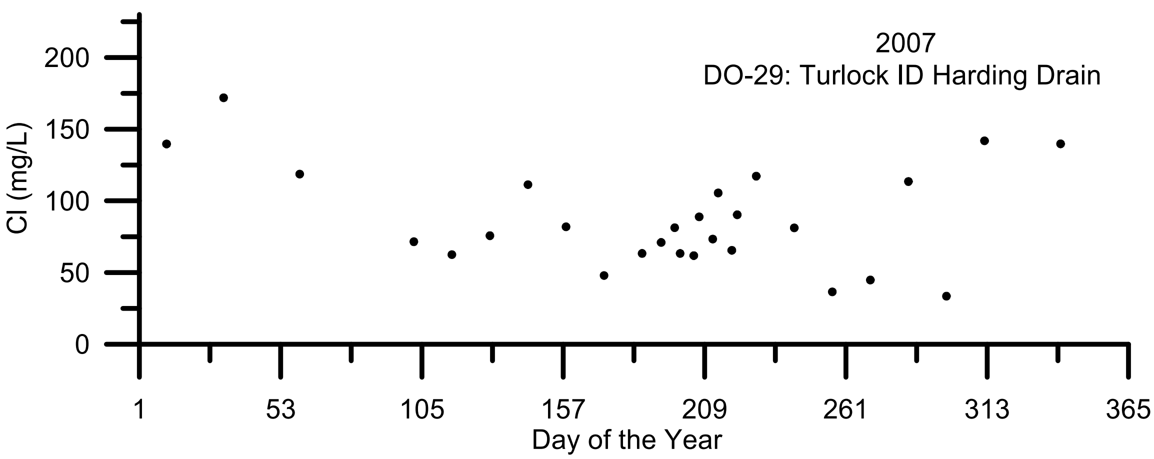

2005
DO-28: Turlock ID Westport Drain Flow Station
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

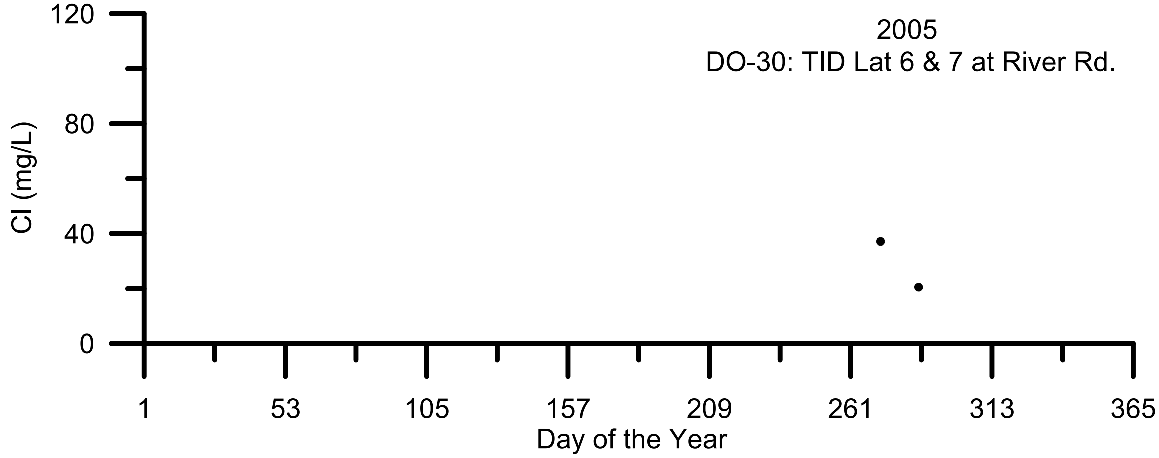

2006
DO-28: Turlock ID Westport Drain Flow Station
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

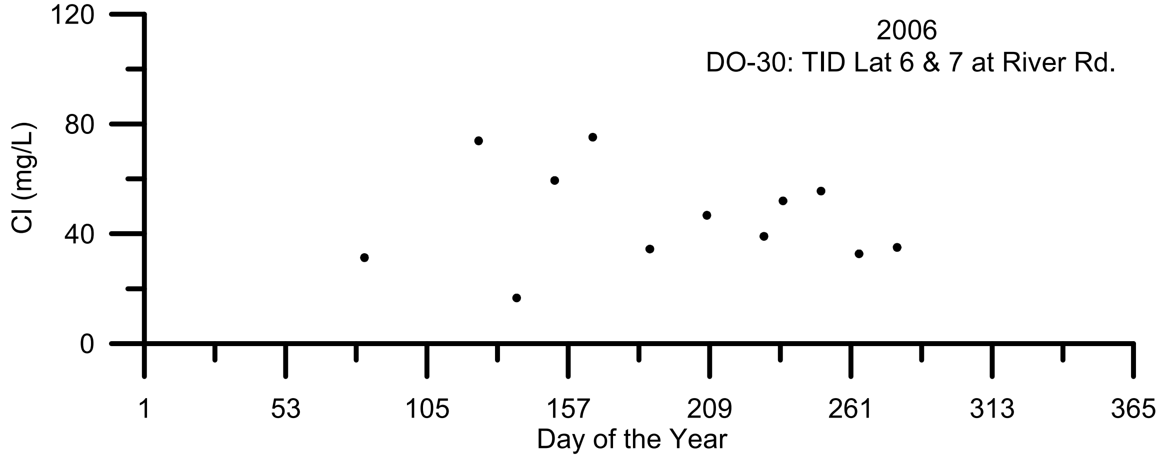

2007
DO-28: Turlock ID Westport Drain Flow Station
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

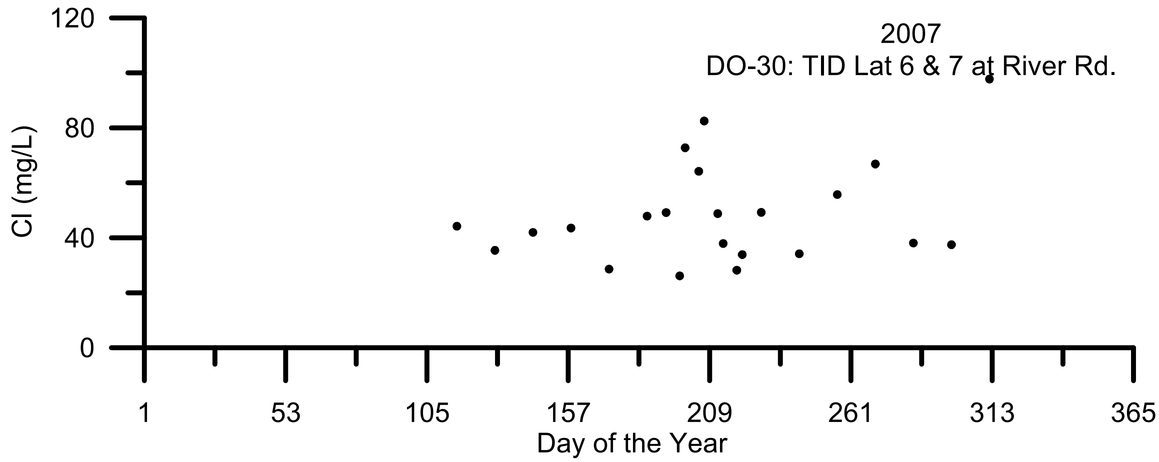

2005
DO-29: Turlock ID Harding Drain
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

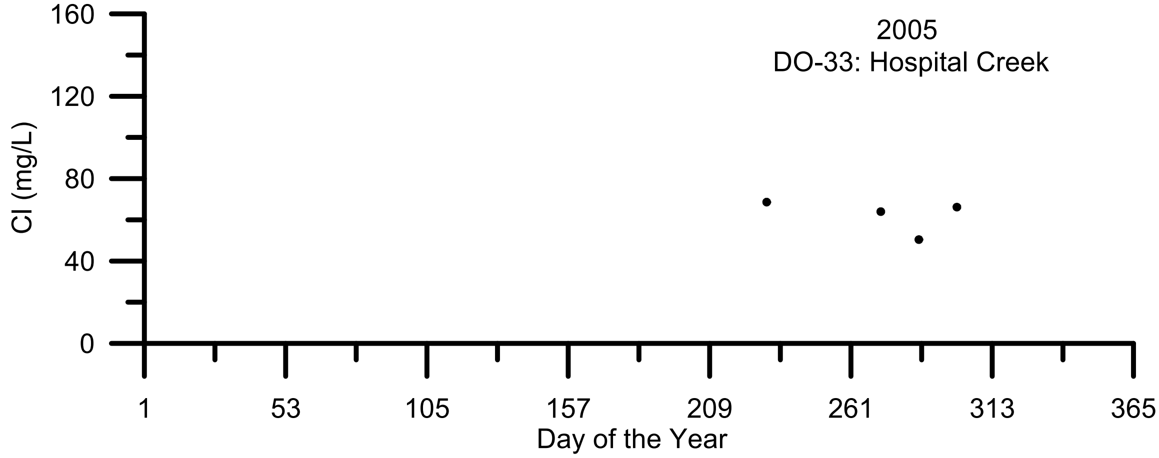

2006
DO-29: Turlock ID Harding Drain
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

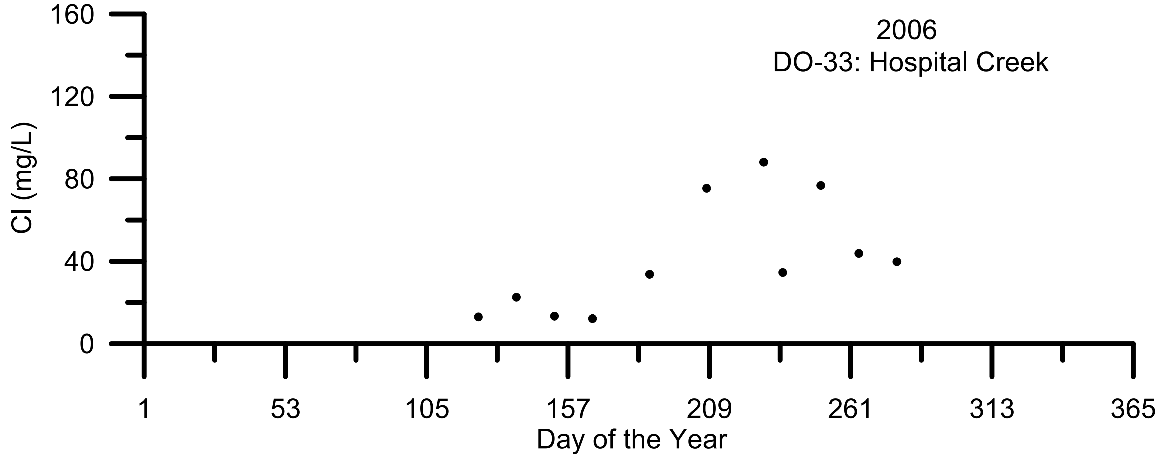

2007
DO-29: Turlock ID Harding Drain
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

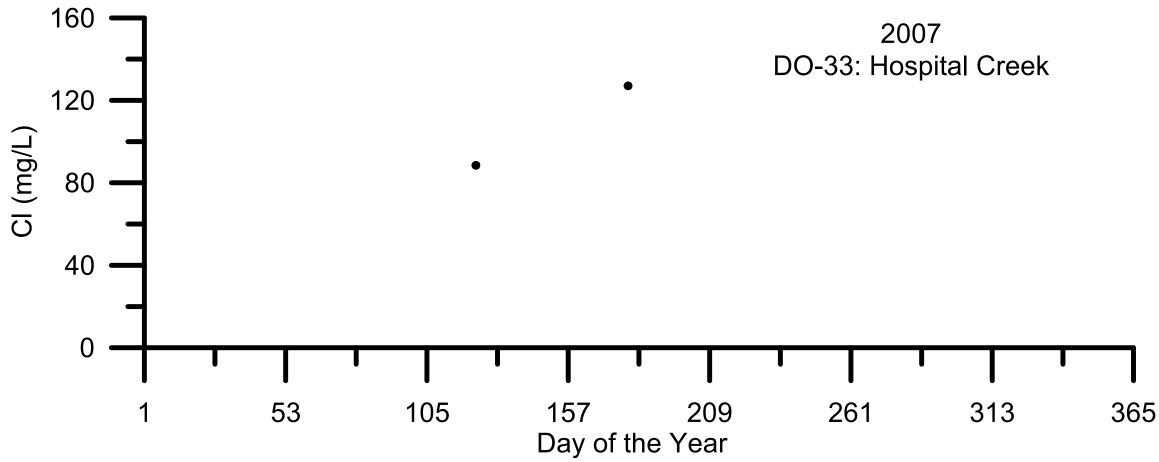

2005
DO-30: TID Lat 6 & 7 at River Rd.
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

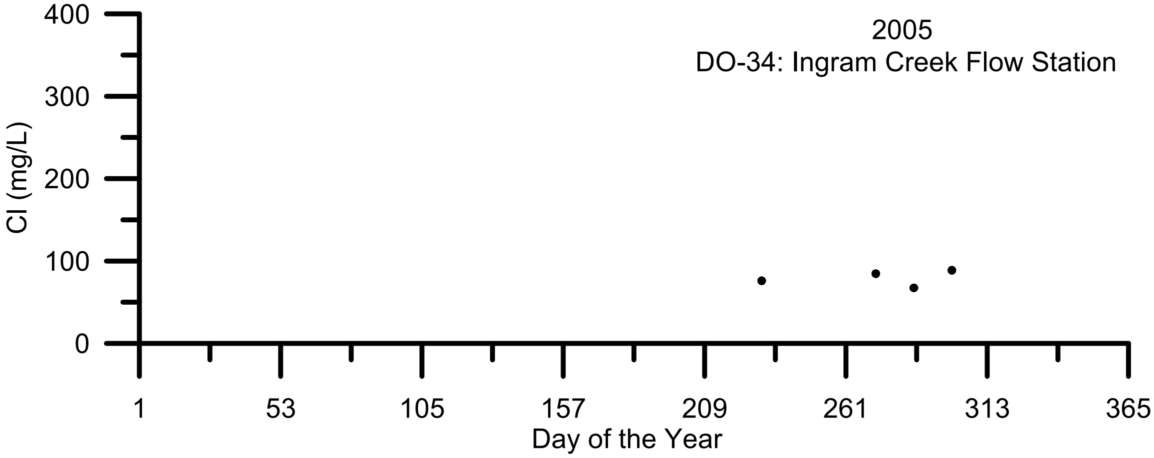

2006
DO-30: TID Lat 6 & 7 at River Rd.
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

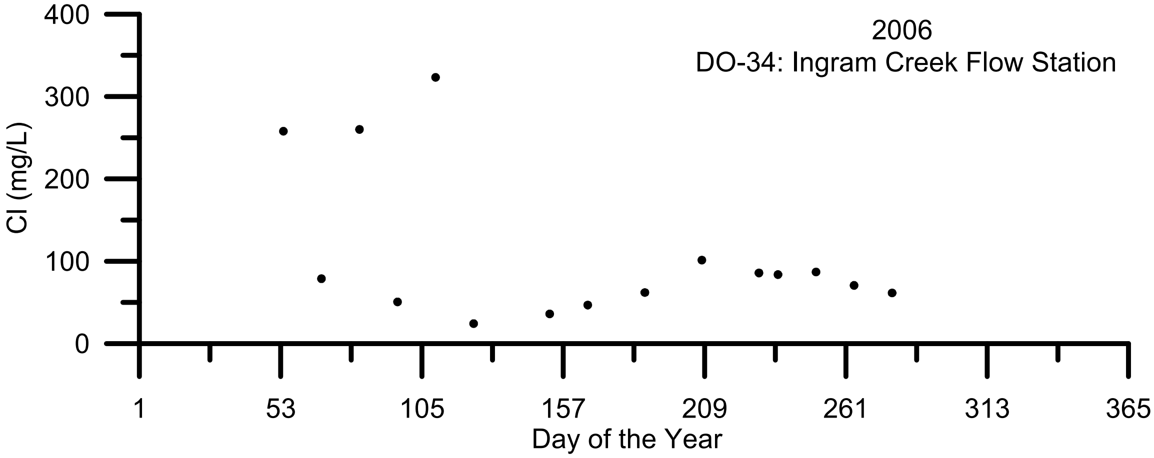

2007
DO-30: TID Lat 6 & 7 at River Rd.
Cl (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

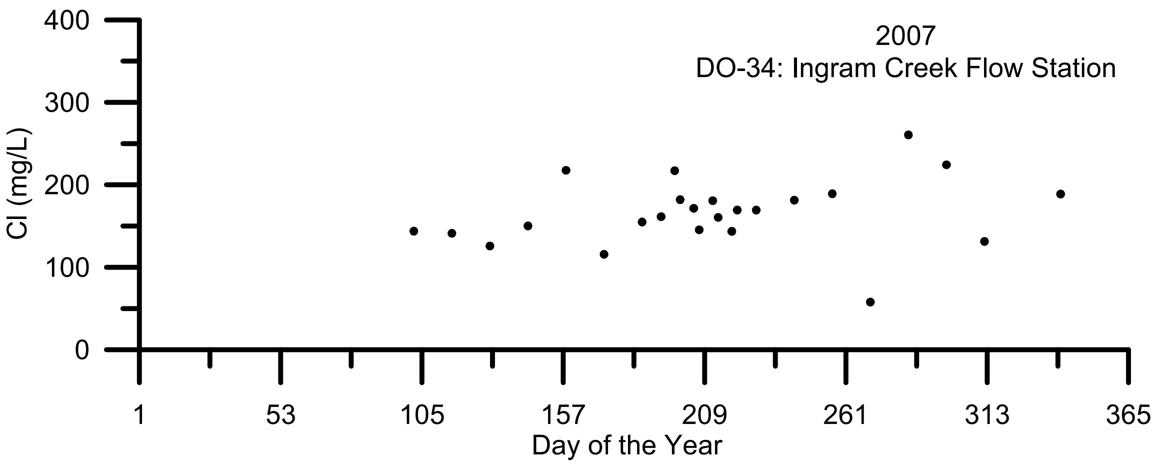

2005
DO-33: Hospital Creek
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

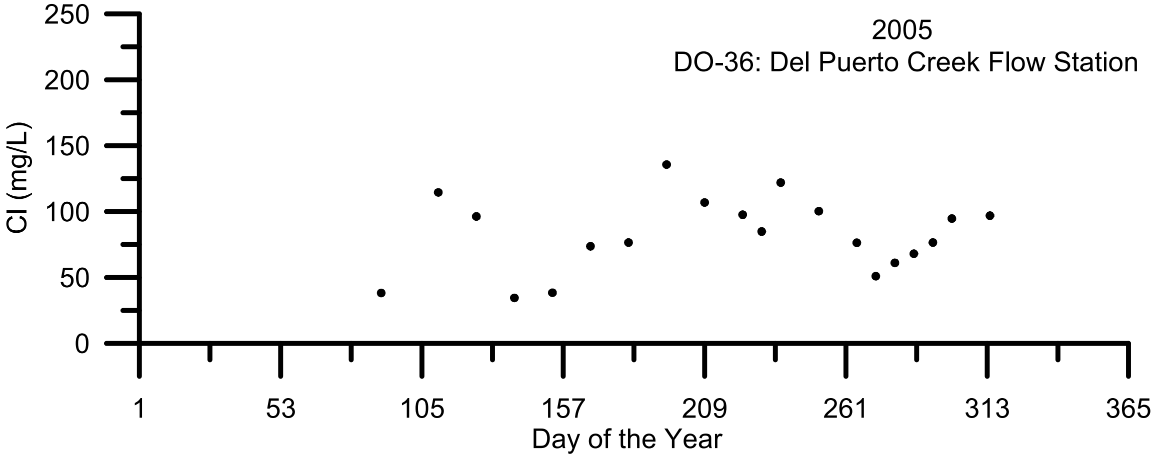

2006
DO-33: Hospital Creek
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

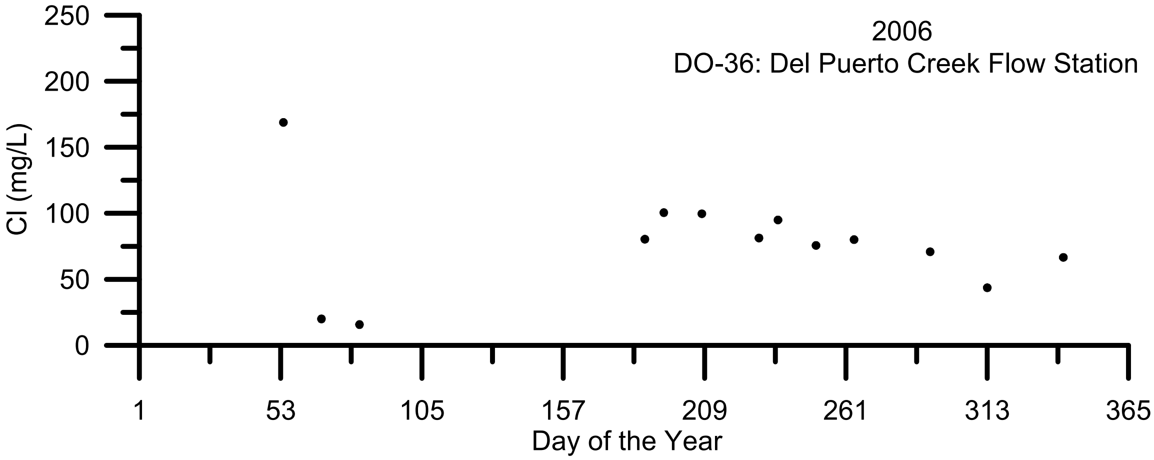

2007
DO-33: Hospital Creek
Cl (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

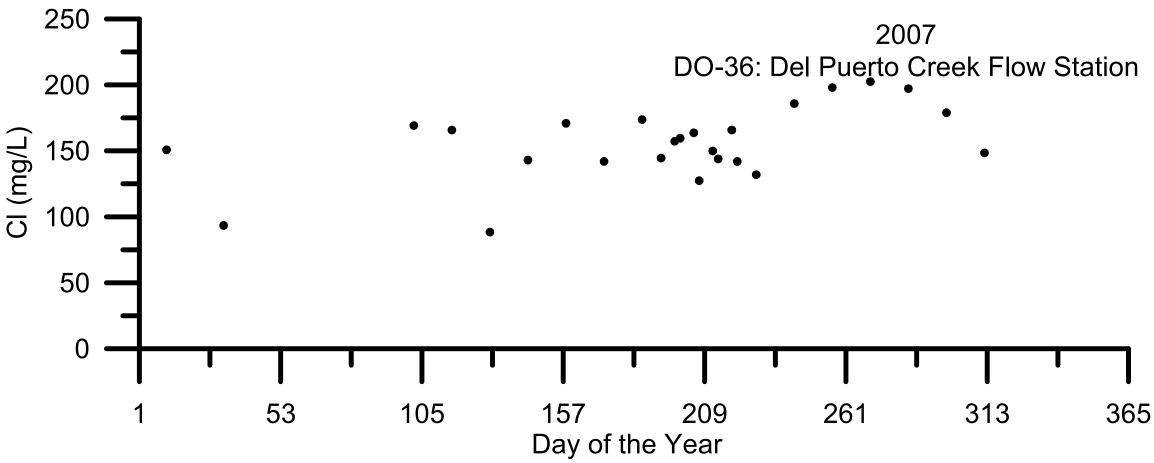

2005
DO-34: Ingram Creek Flow Station
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

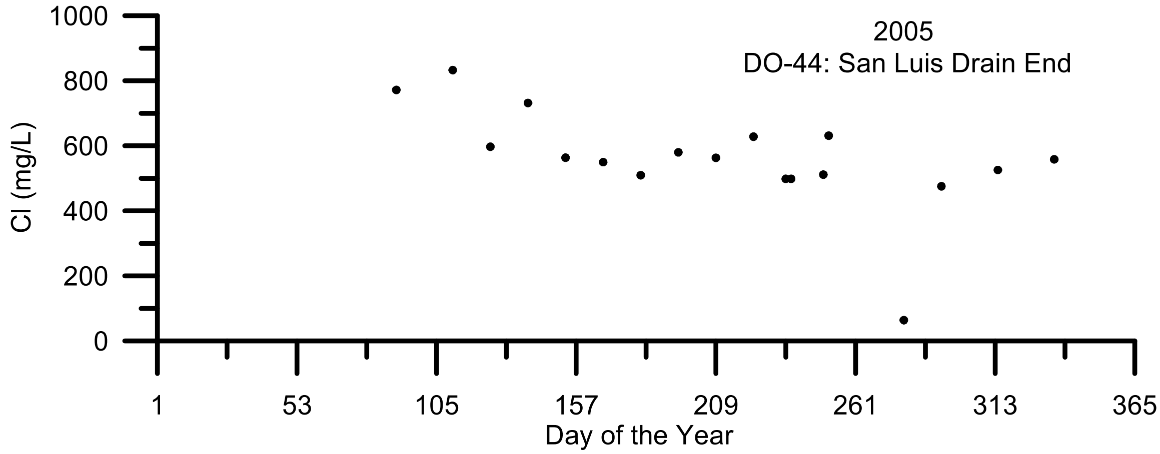

2006
DO-34: Ingram Creek Flow Station
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

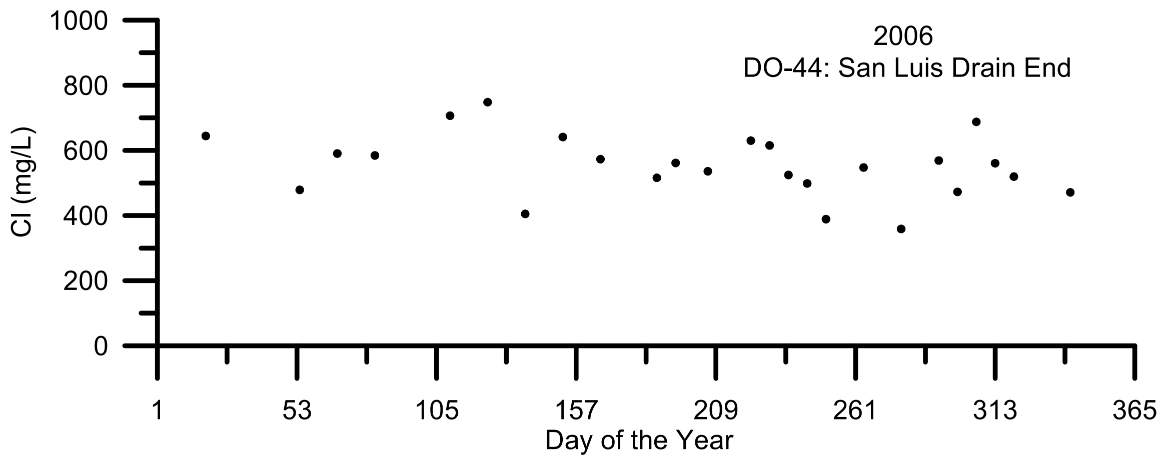

2007
DO-34: Ingram Creek Flow Station
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

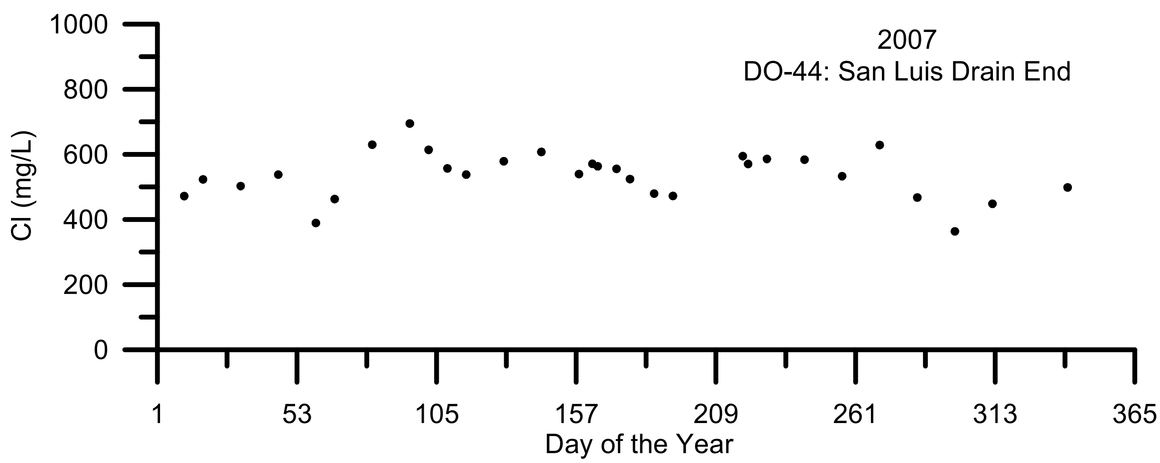

2005
DO-36: Del Puerto Creek Flow Station
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

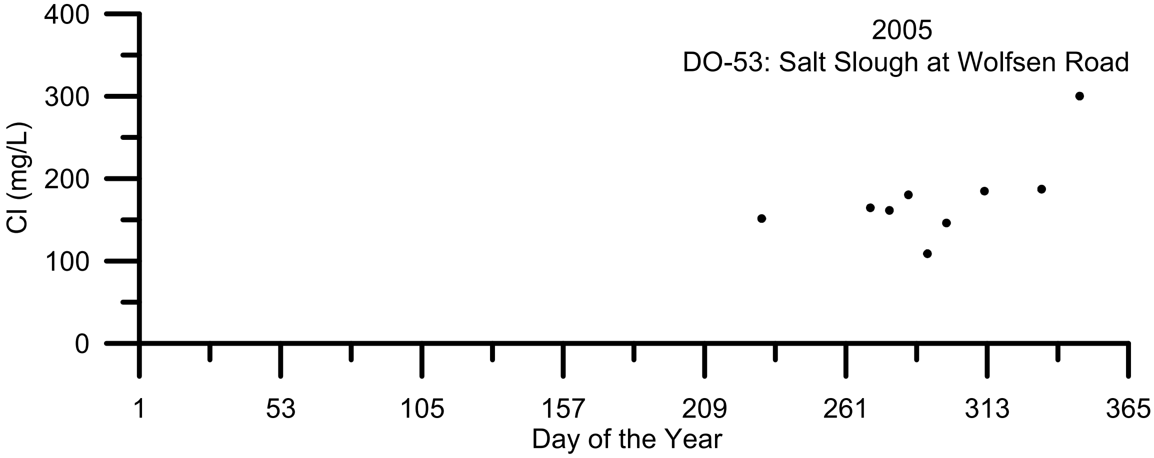

2006
DO-36: Del Puerto Creek Flow Station
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

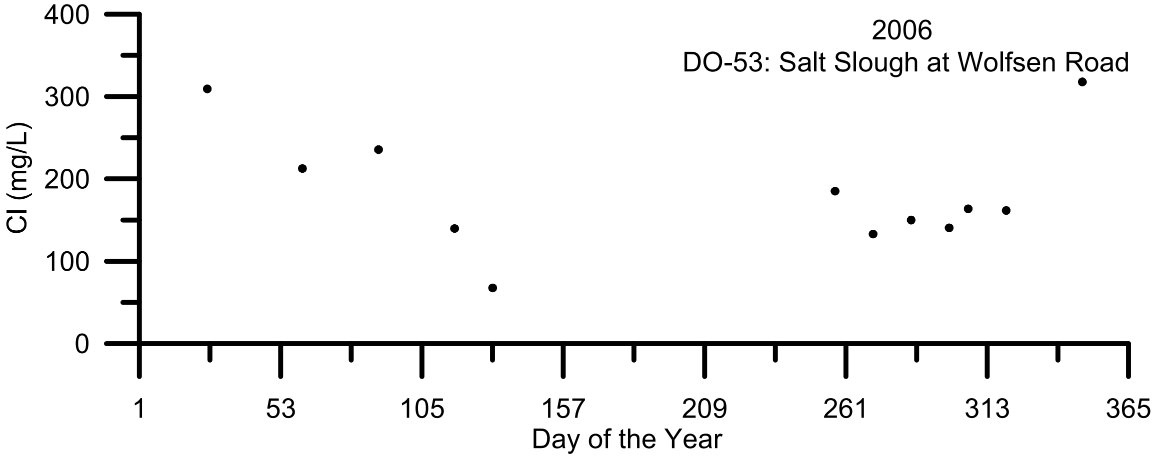

2007
DO-36: Del Puerto Creek Flow Station
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

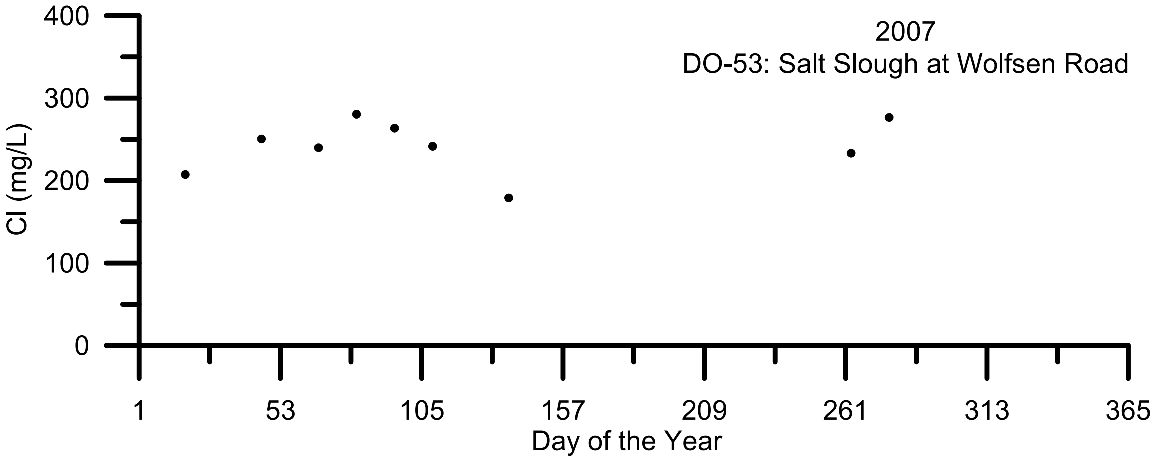

2005
DO-44: San Luis Drain End
Cl (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

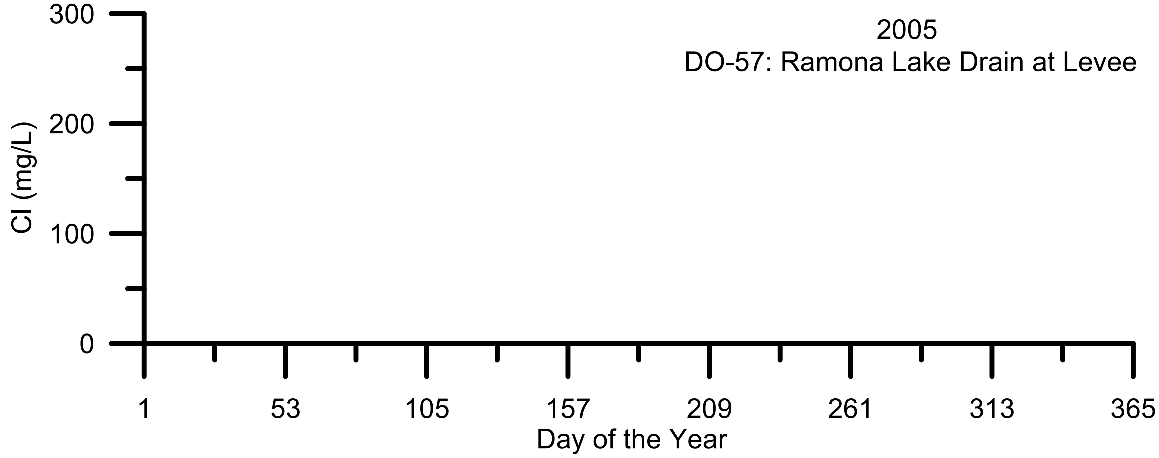

2006
DO-44: San Luis Drain End
Cl (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

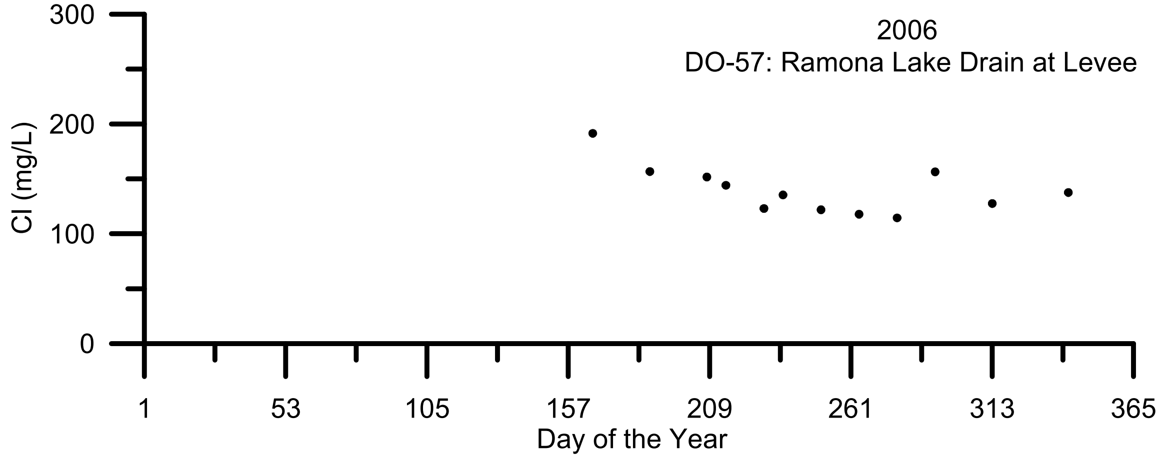

2007
DO-44: San Luis Drain End
Cl (mg/L)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

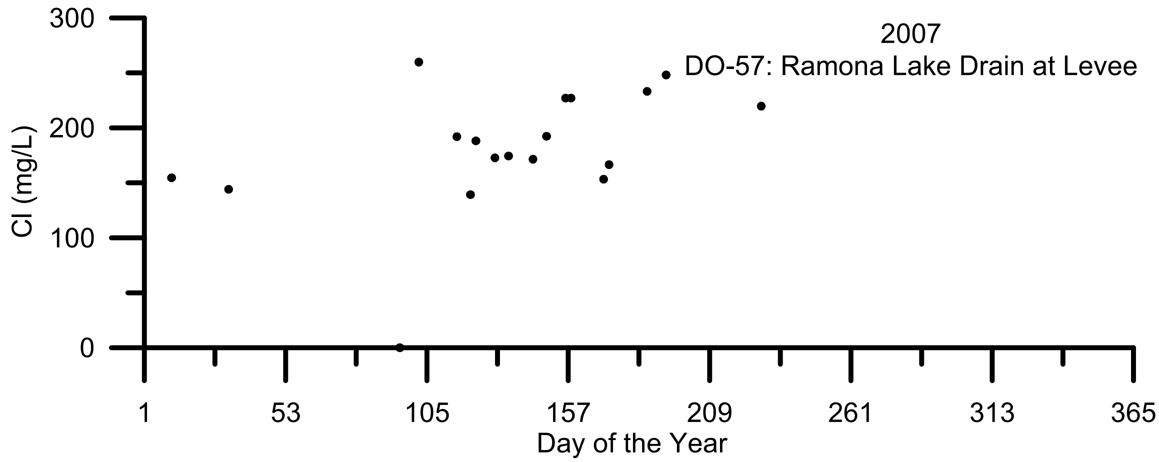

2005
DO-53: Salt Slough at Wolfsen Road
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

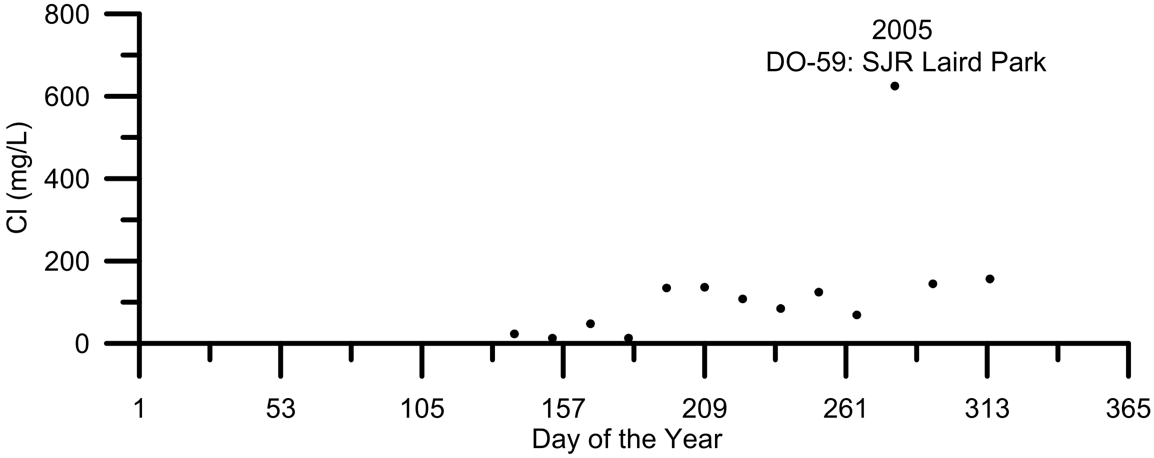

2006
DO-53: Salt Slough at Wolfsen Road
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

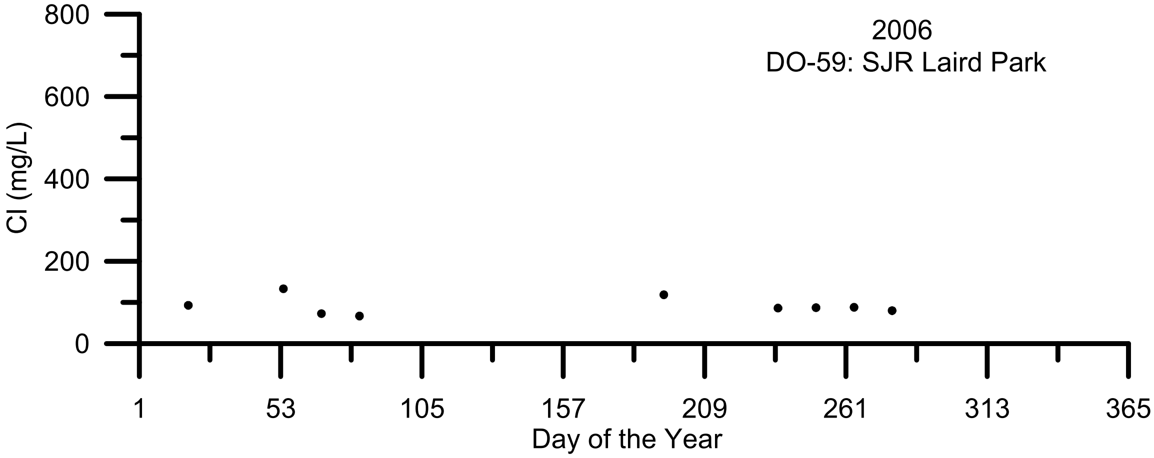

2007
DO-53: Salt Slough at Wolfsen Road
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

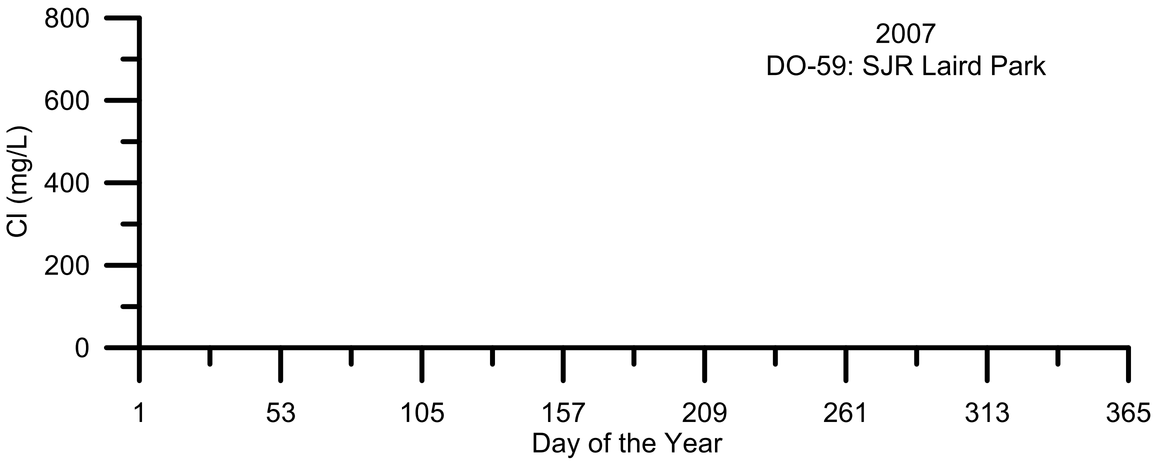

2005
DO-57: Ramona Lake Drain at Levee
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

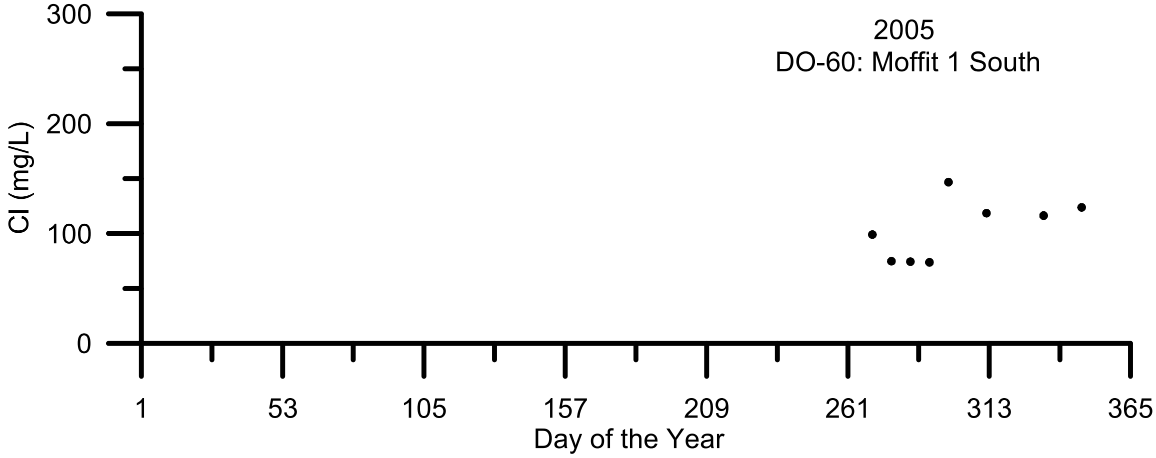

2006
DO-57: Ramona Lake Drain at Levee
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

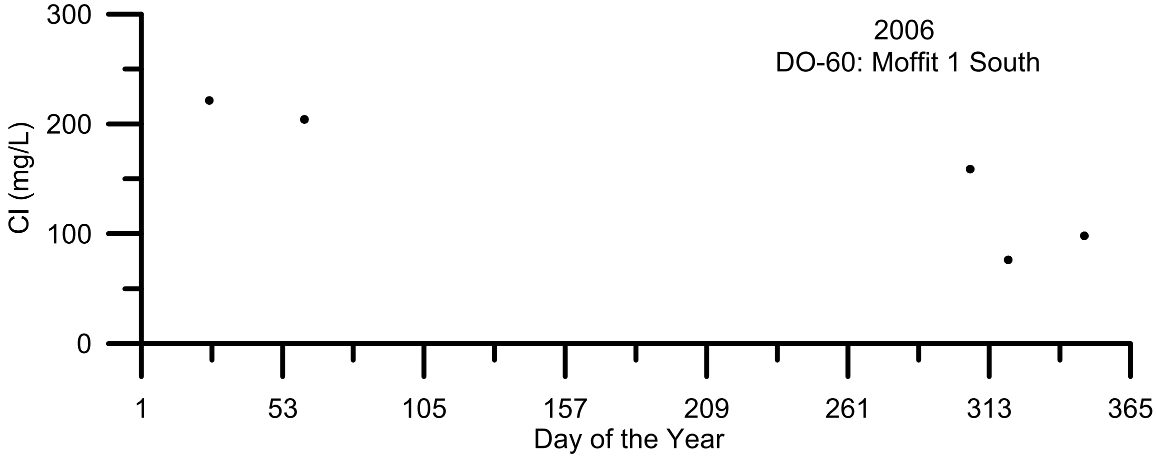

2007
DO-57: Ramona Lake Drain at Levee
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

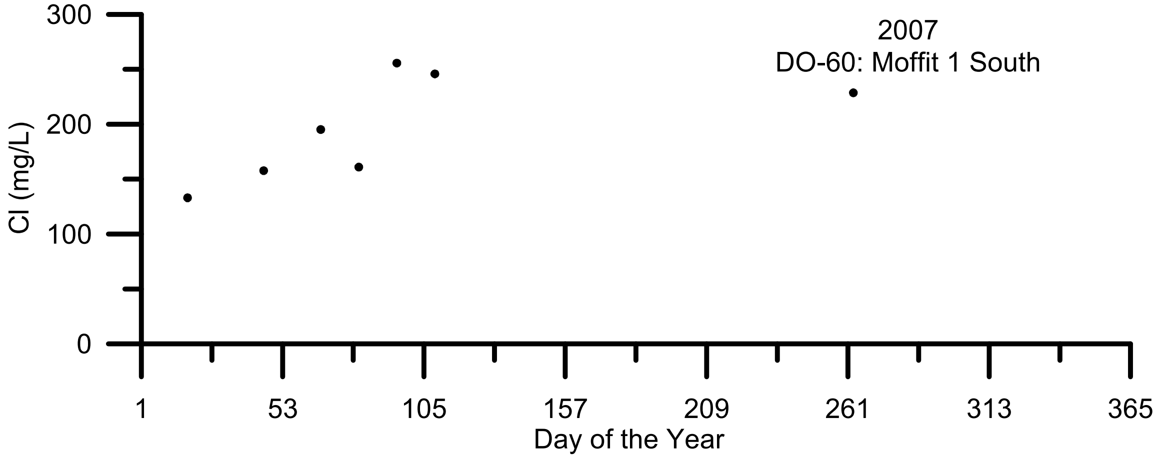

2005
DO-59: SJR Laird Park
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

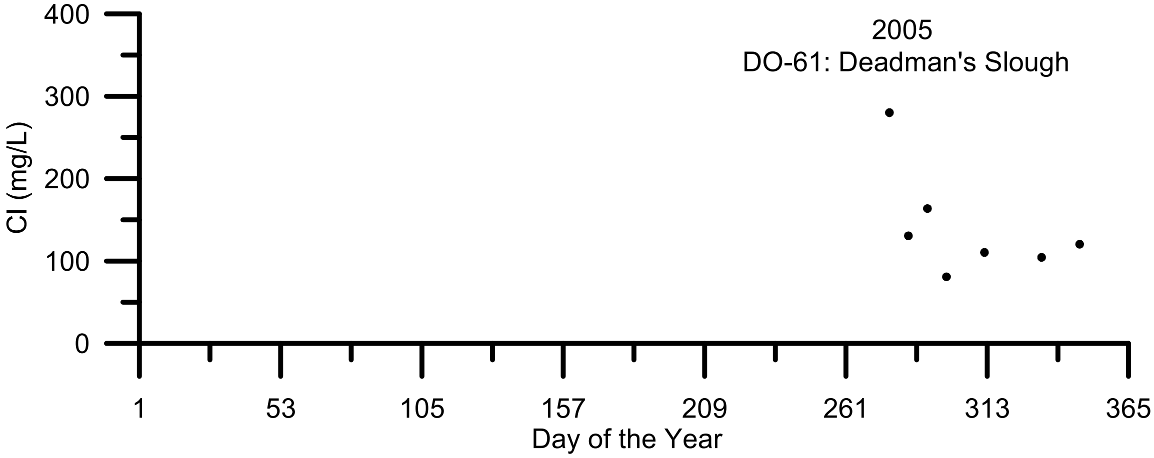

2006
DO-59: SJR Laird Park
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

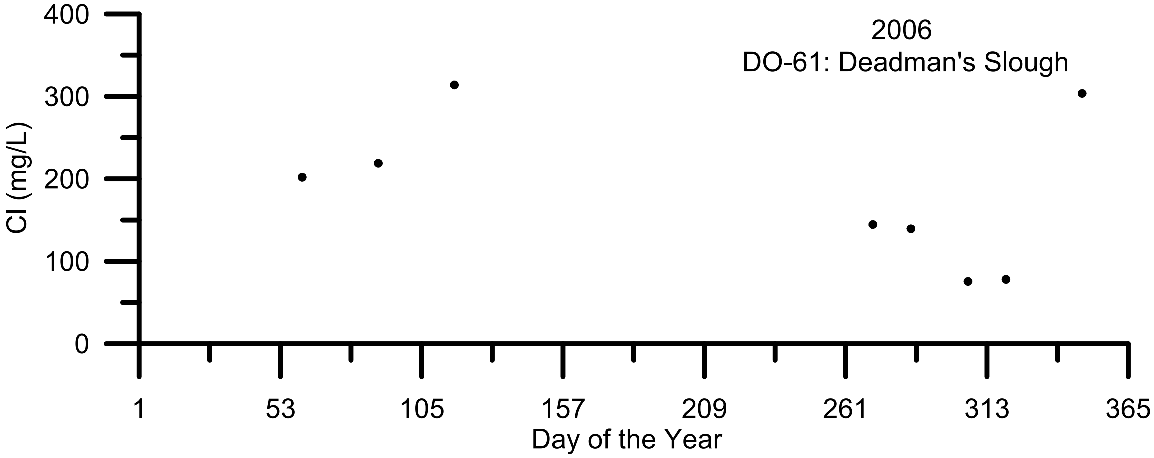

2007
DO-59: SJR Laird Park
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

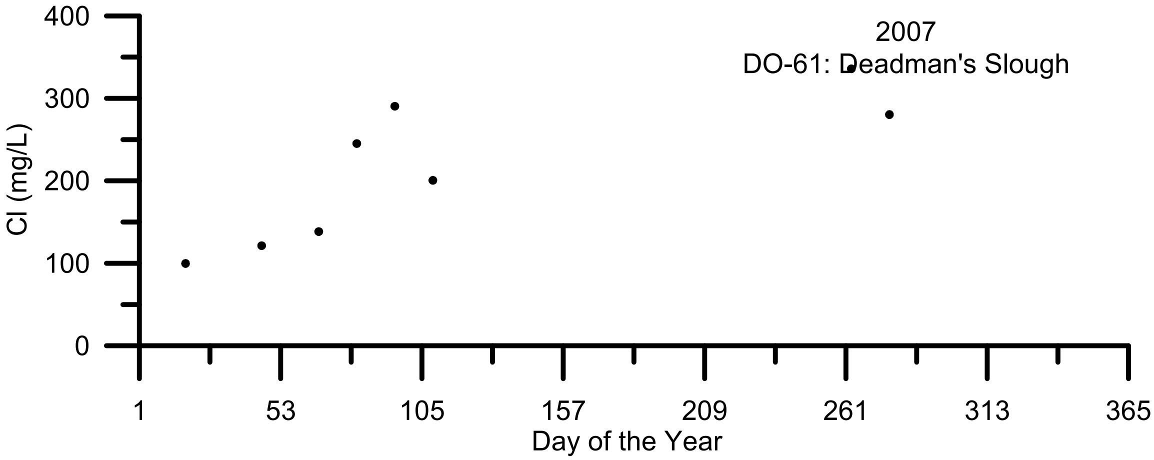

2005
DO-60: Moffit 1 South
Cl (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

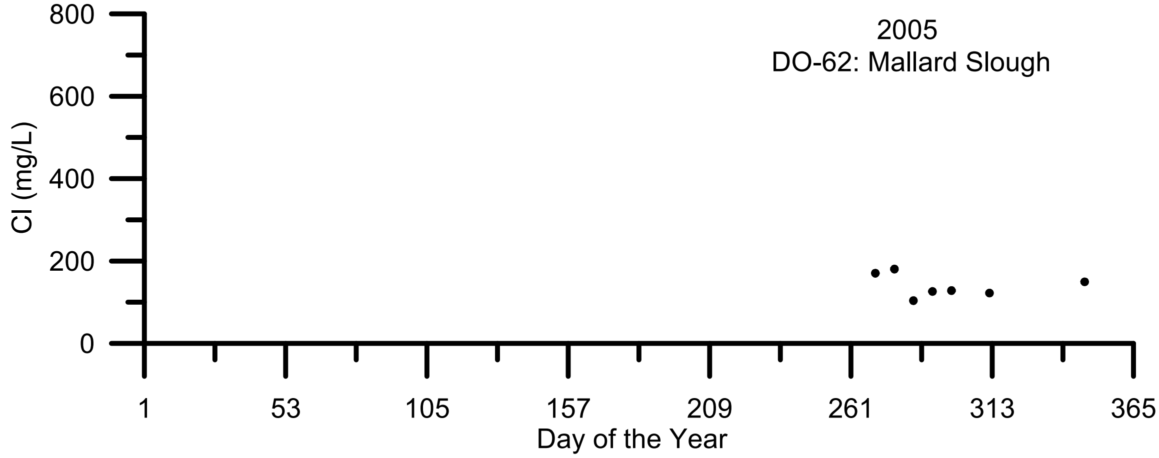

2006
DO-60: Moffit 1 South
Cl (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

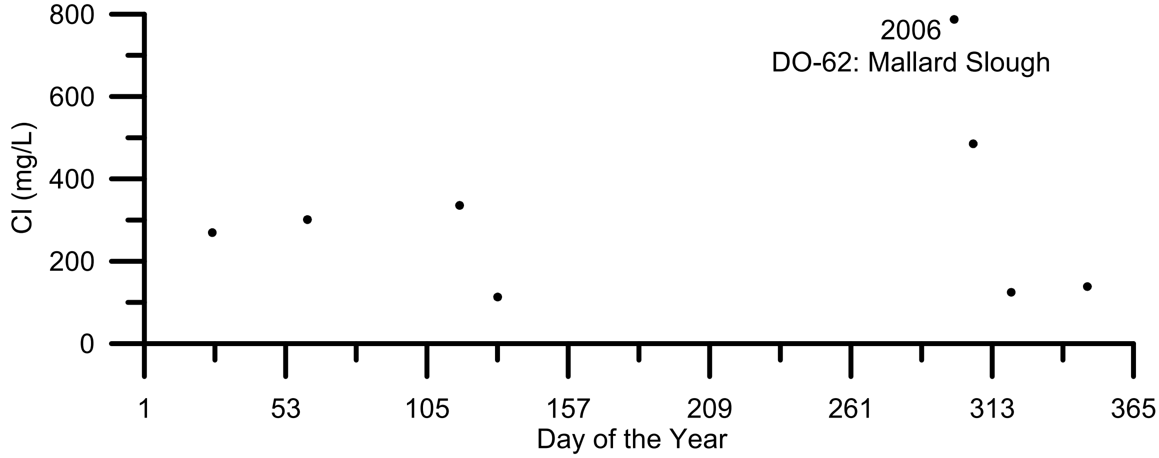

2007
DO-60: Moffit 1 South
Cl (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

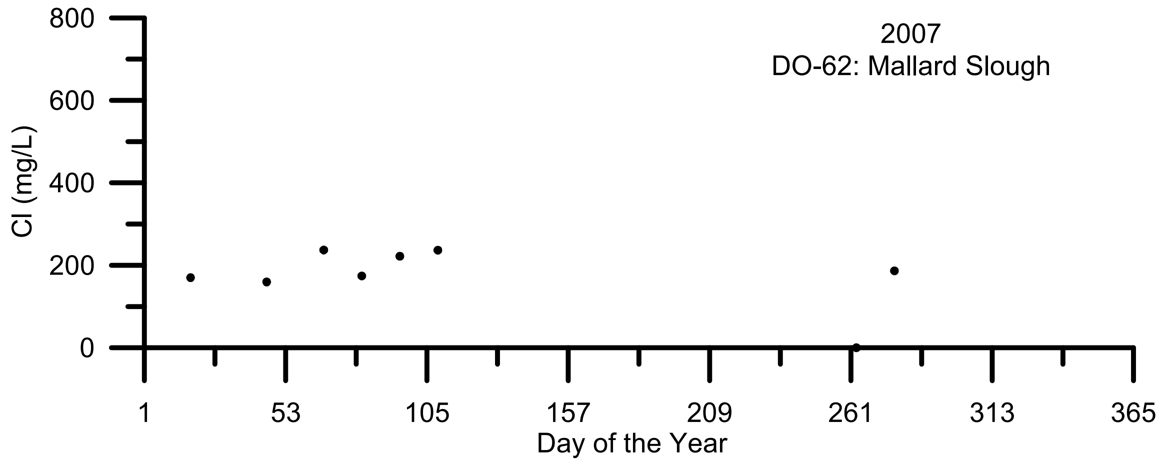

2005
DO-61: Deadman's Slough
Cl (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

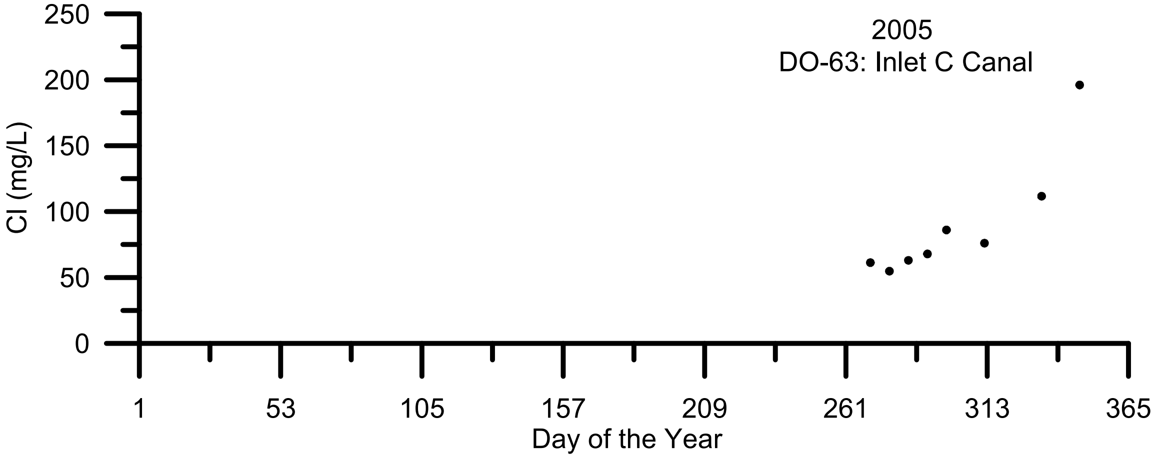

2006
DO-61: Deadman's Slough
Cl (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

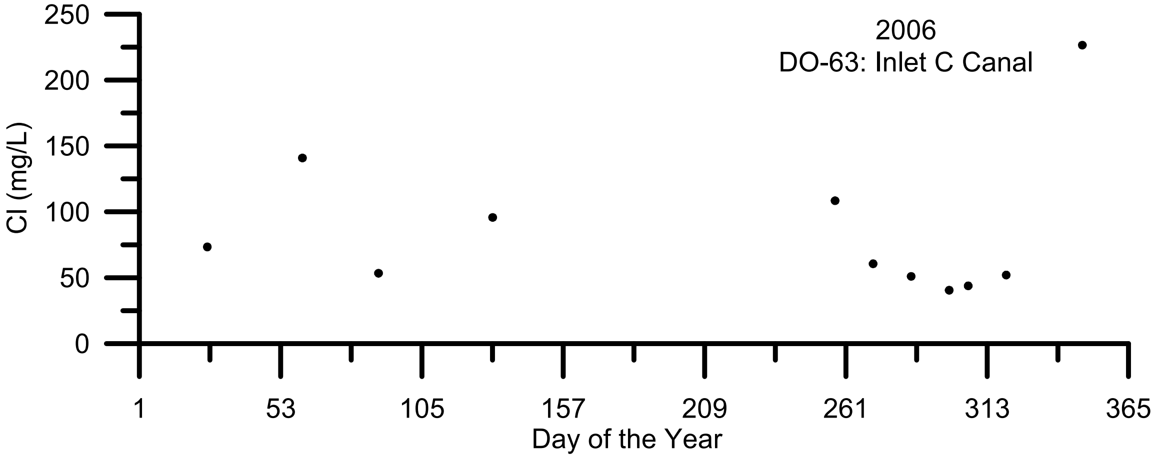

2007
DO-61: Deadman's Slough
Cl (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

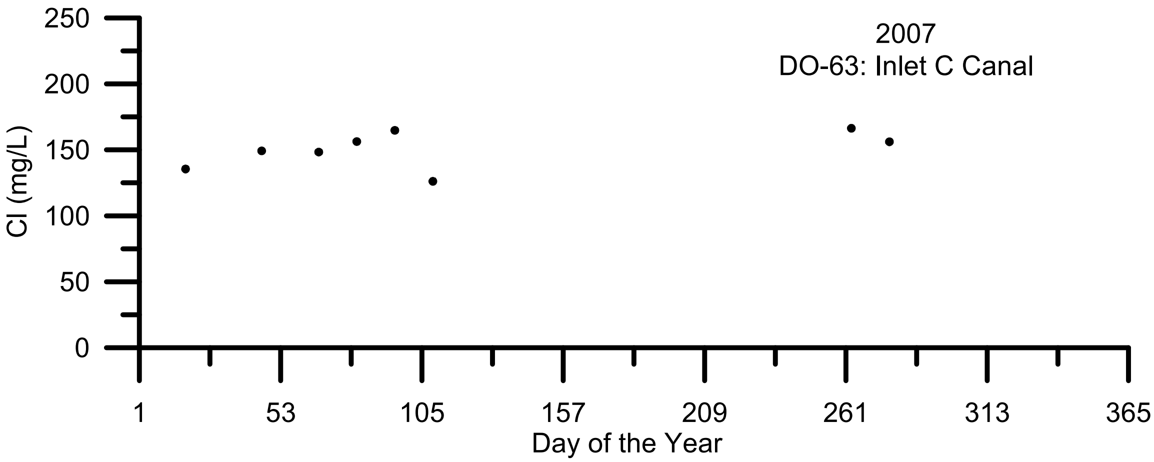

2005
DO-62: Mallard Slough
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

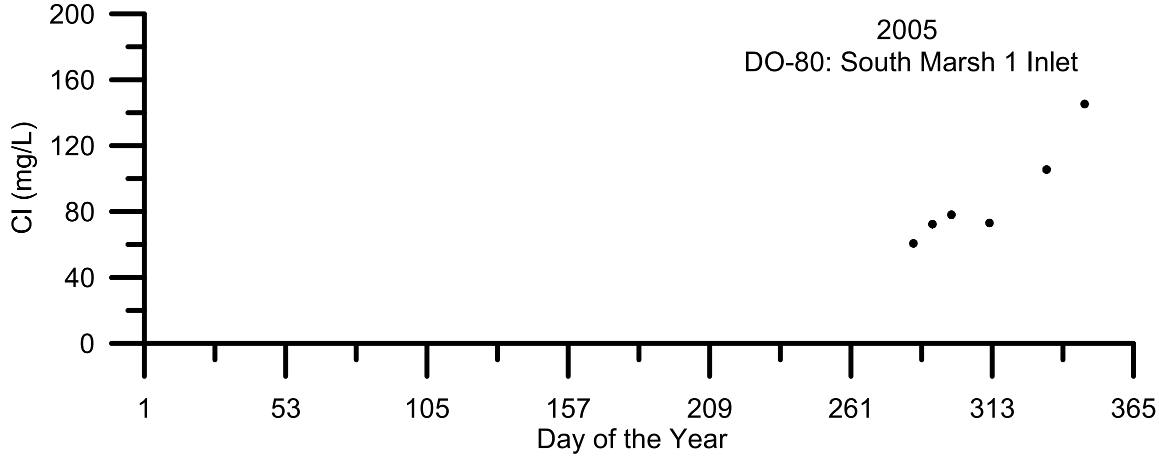

2006
DO-62: Mallard Slough
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

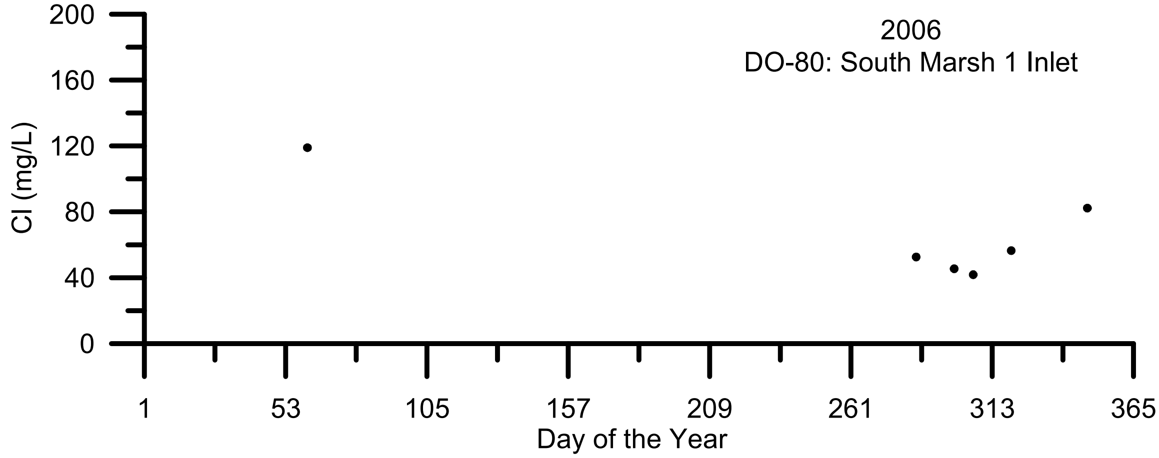

2007
DO-62: Mallard Slough
Cl (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

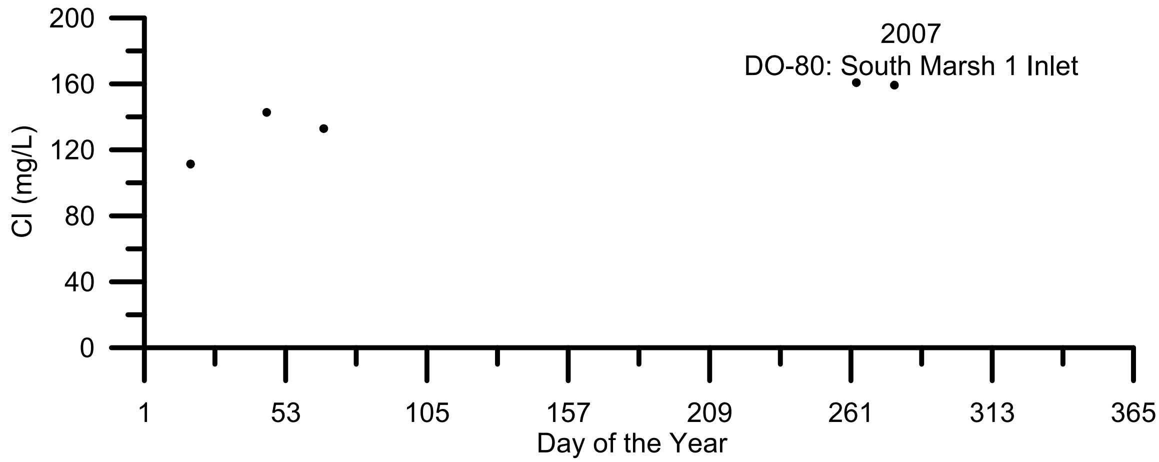

2005
DO-63: Inlet C Canal
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

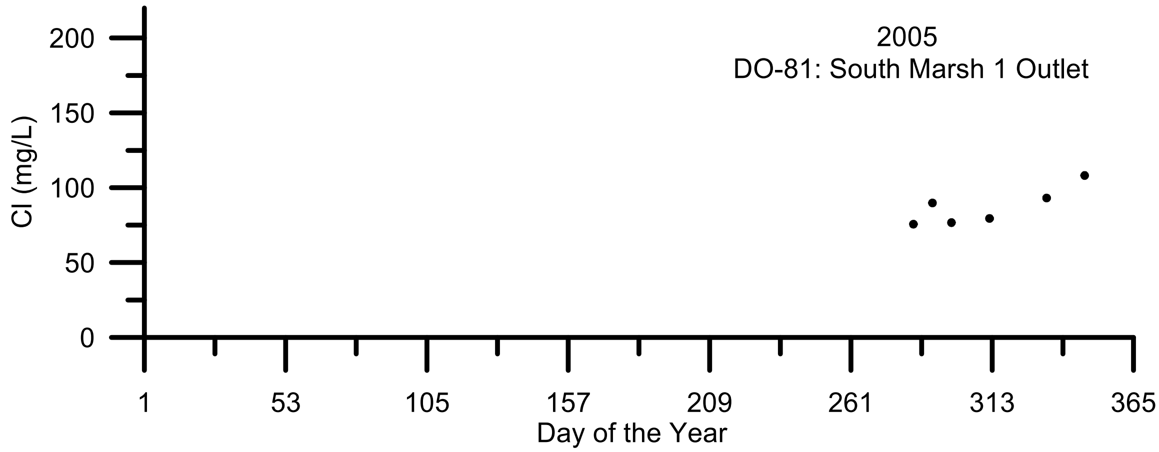

2006
DO-63: Inlet C Canal
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

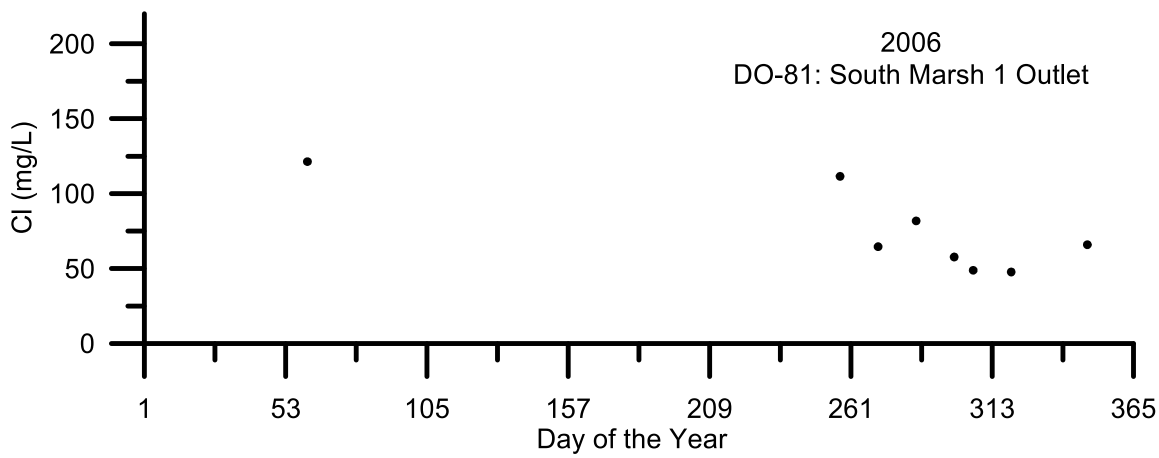

2007
DO-63: Inlet C Canal
Cl (mg/L)
0
50
100
150
200
250
1
53
105
157
209
261
313
365
Day of the Year

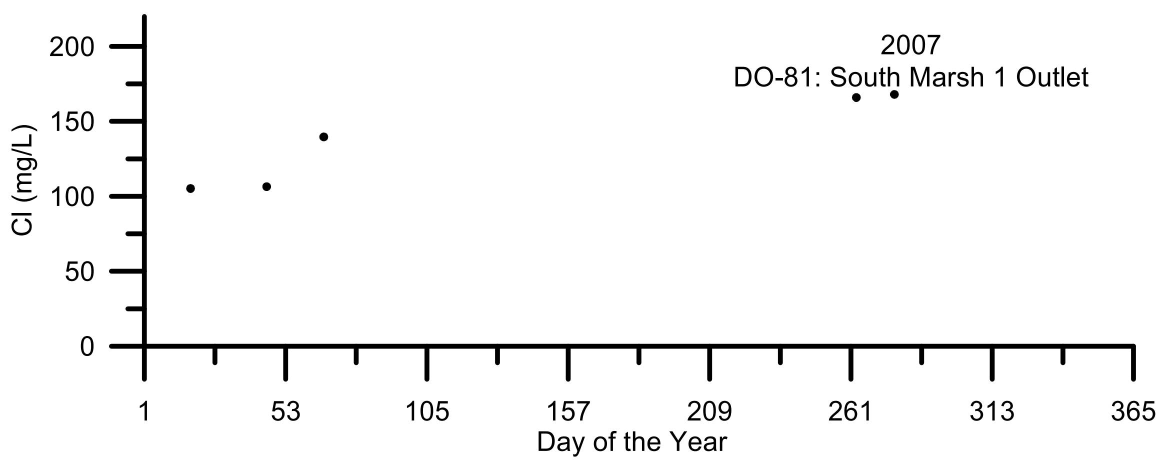

2005
DO-80: South Marsh 1 Inlet
Cl (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

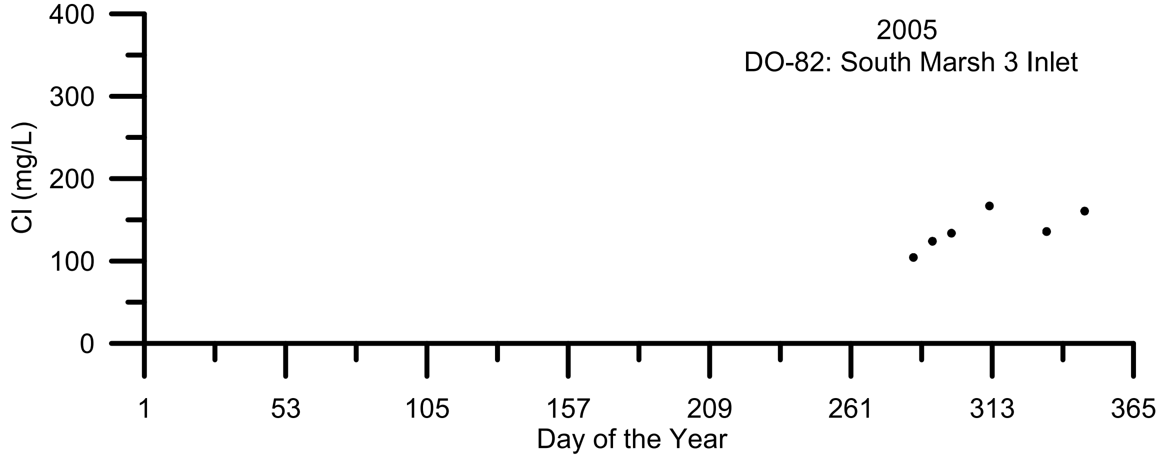

2006
DO-80: South Marsh 1 Inlet
Cl (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

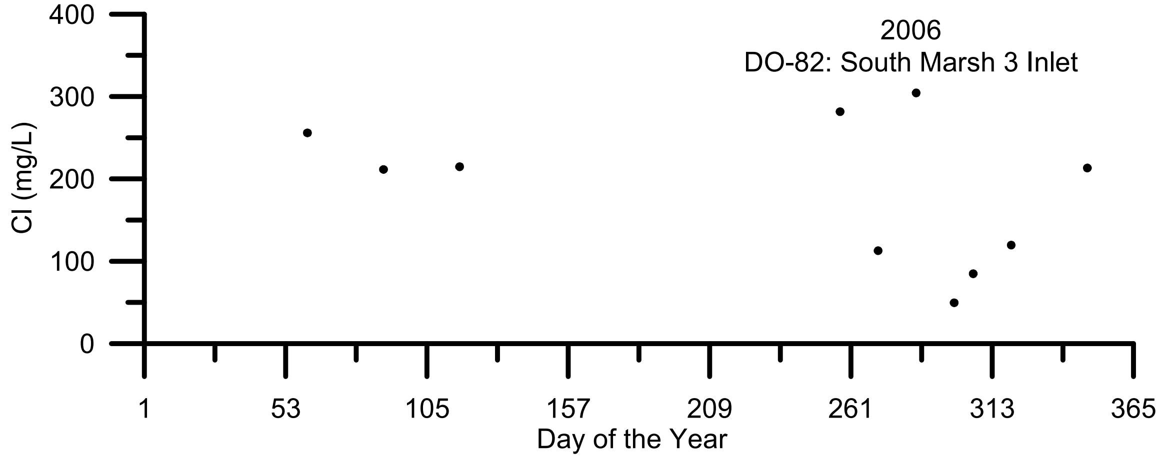

2007
DO-80: South Marsh 1 Inlet
Cl (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

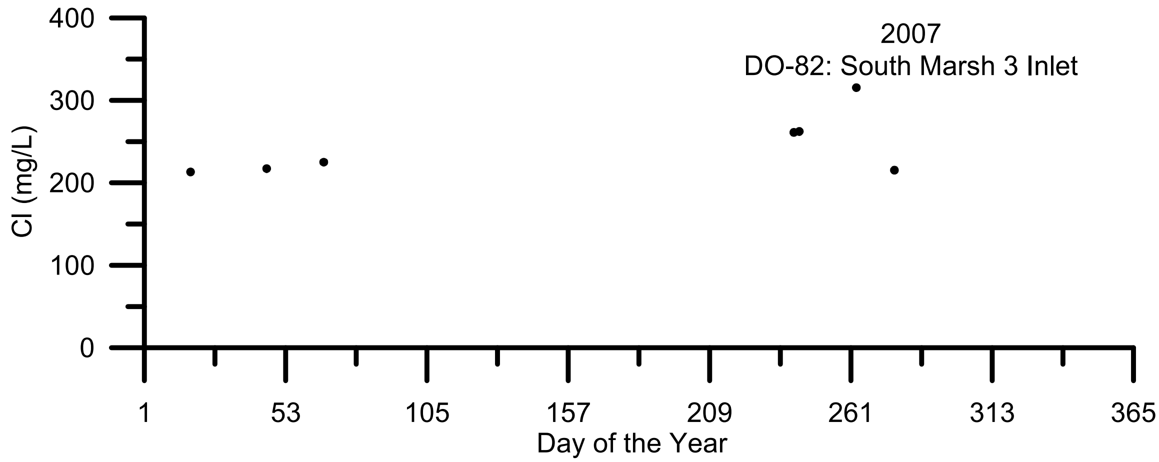

2005
DO-81: South Marsh 1 Outlet
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

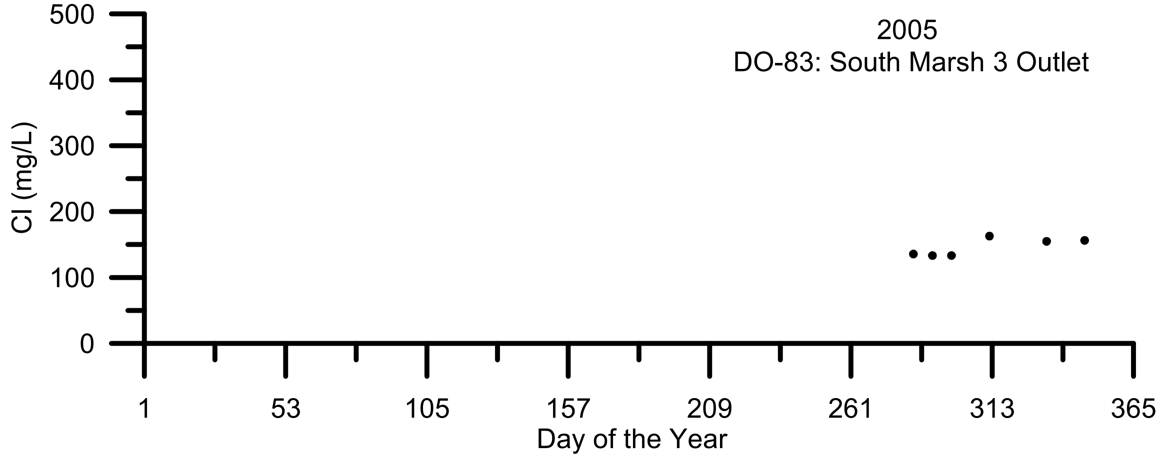

2006
DO-81: South Marsh 1 Outlet
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

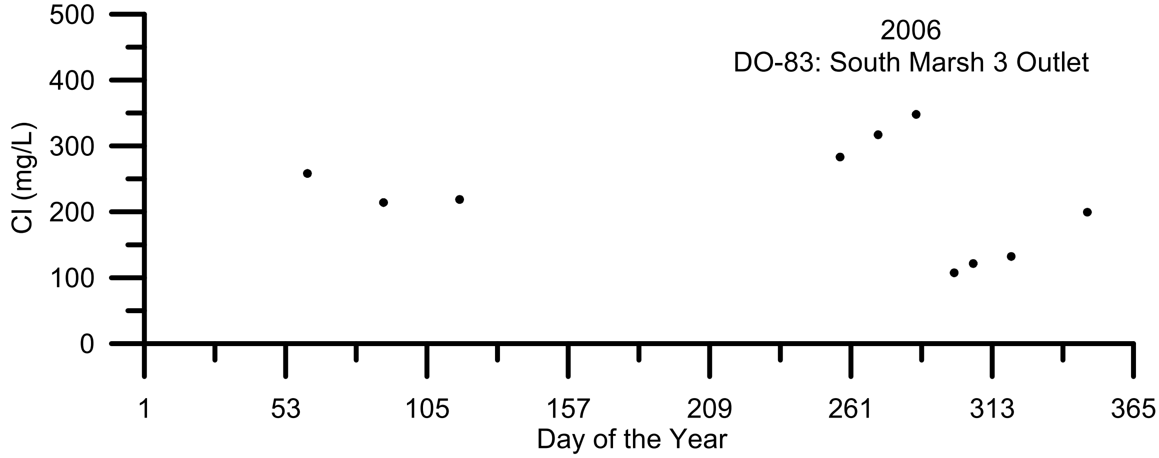

2007
DO-81: South Marsh 1 Outlet
Cl (mg/L)
0
50
100
150
200
1
53
105
157
209
261
313
365
Day of the Year

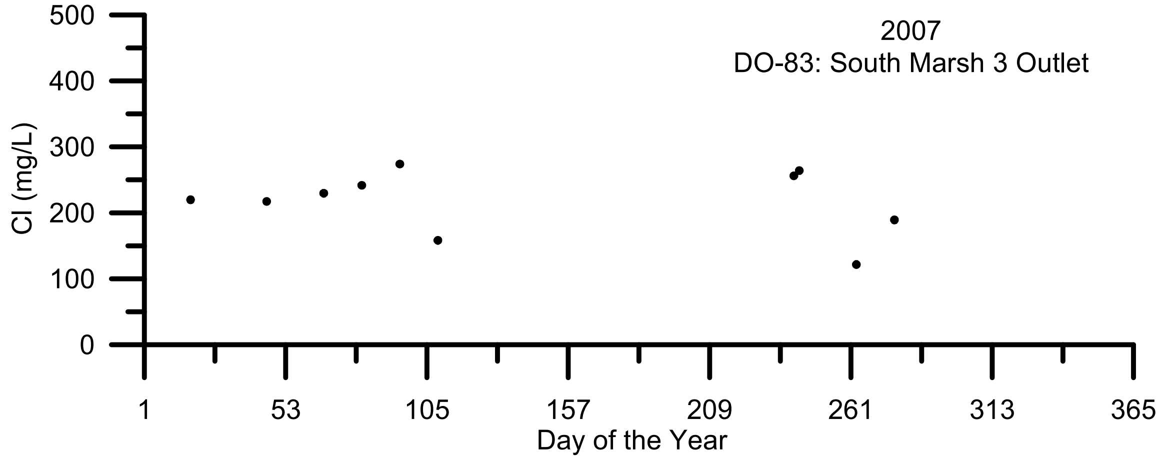

2005
DO-82: South Marsh 3 Inlet
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

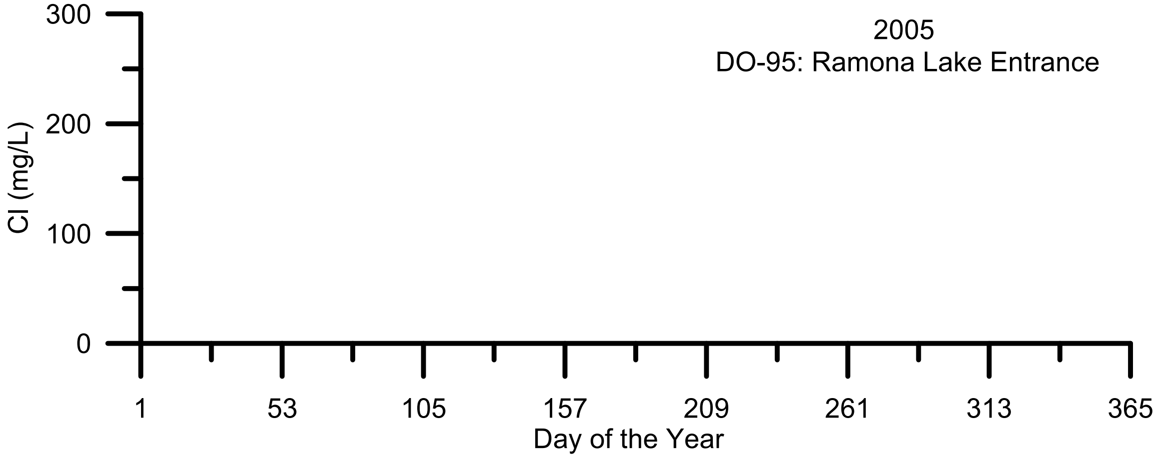

2006
DO-82: South Marsh 3 Inlet
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-82: South Marsh 3 Inlet
Cl (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

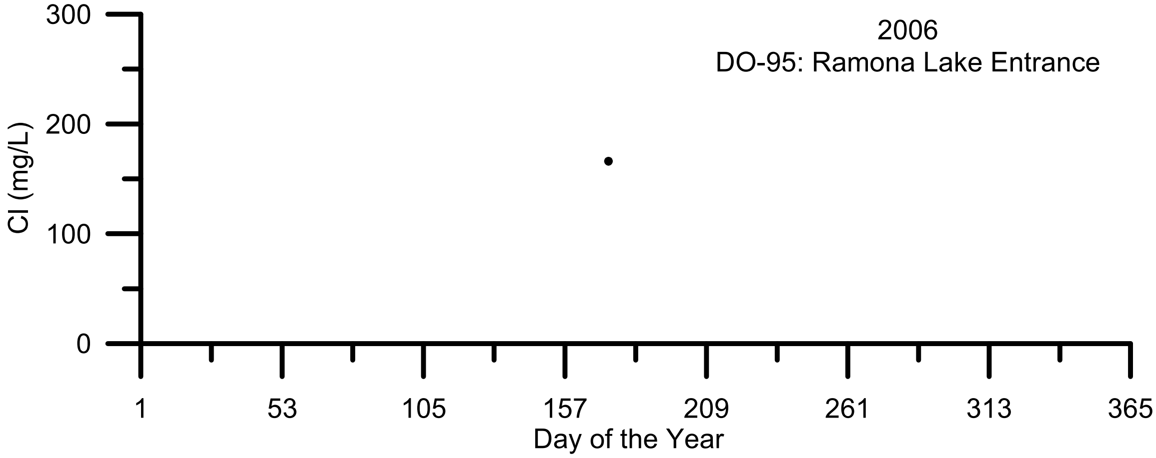

2005
DO-83: South Marsh 3 Outlet
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year

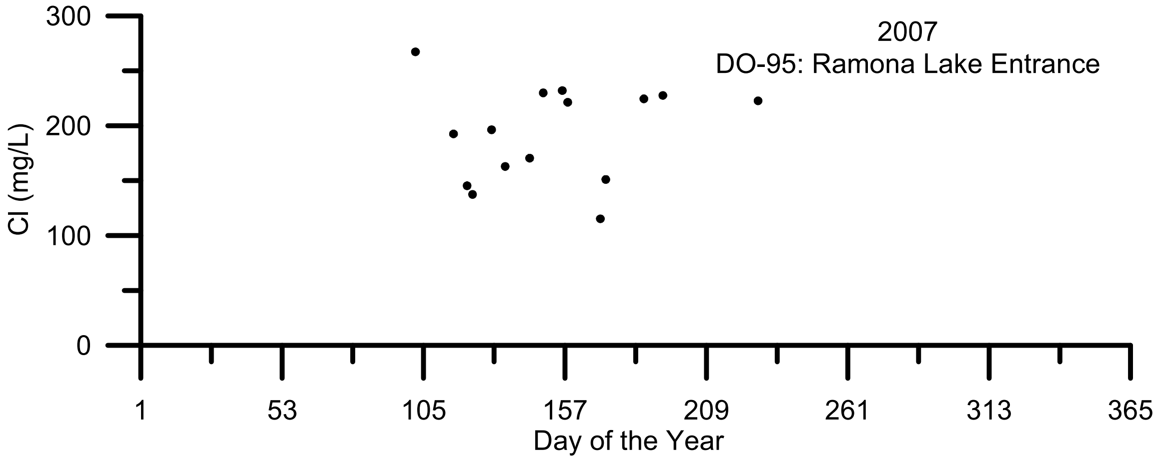

2007
DO-83: South Marsh 3 Outlet
Cl (mg/L)
0
100
200
300
400
500
1
53
105
157
209
261
313
365
Day of the Year



2005
DO-95: Ramona Lake Entrance
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Lake Entrance
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Lake Entrance
Cl (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Calcium Data from the Upstream San Joaquin River

***Chelsea Spier*[1]**
***Remie Burks*[1]**
***Sharon Borglin*[1]**
***Randy Dahlgren*[2]**
***Jeremy Hanlon*[1]**
***Justin Graham*[1]**
***William Stringfellow*[1]**

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report includes temporal graphs of calcium (Ca) data analyzed by the UCD Dahlgren laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were transported from the EERP laboratory to the UCD laboratory for analysis, during this time period samples were stored in coolers at $4^{\circ}C$.

Ion chromatography was utilized for measuring Ca^{2+} using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA) (ASTM D6919-03). The reportable limit for this method is 0.08 mg/L Ca^{2+} .

Results/Discussion

Samples were measured ranging from 0.0-490.9 mg/L Ca. The average concentration of Ca in samples collected was 66.9 mg/L Ca. These temporal plots (Figures 3-104) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

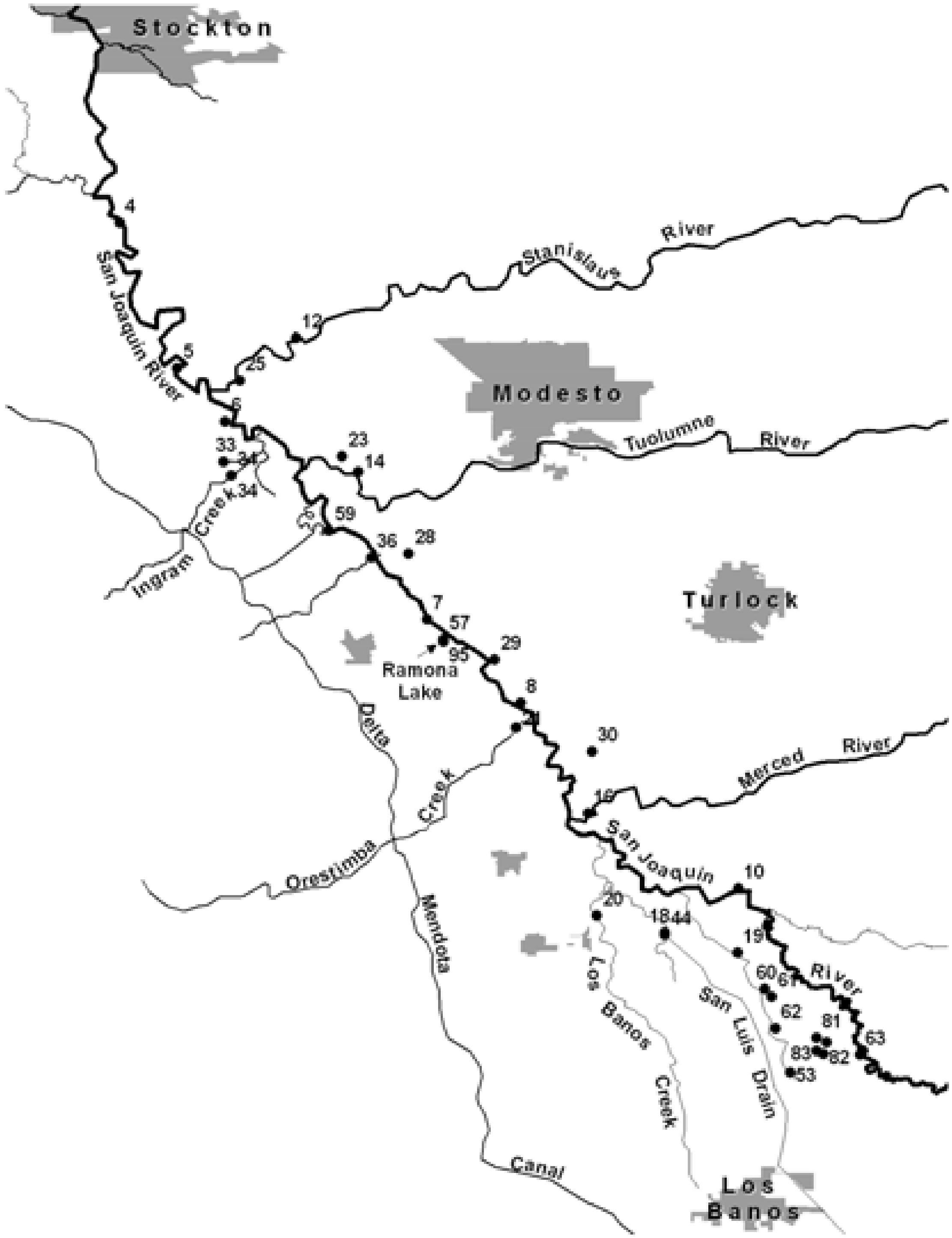
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

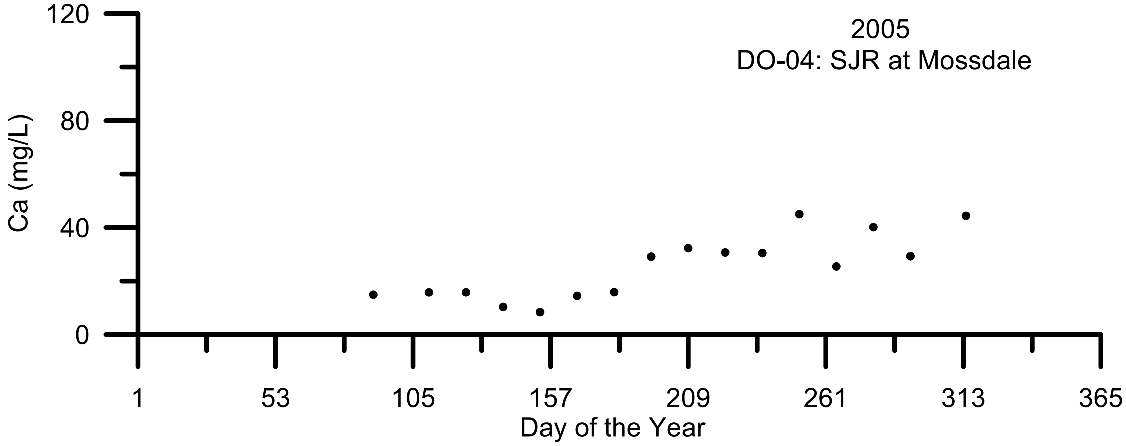
Table 1: EERP Sampling Site List

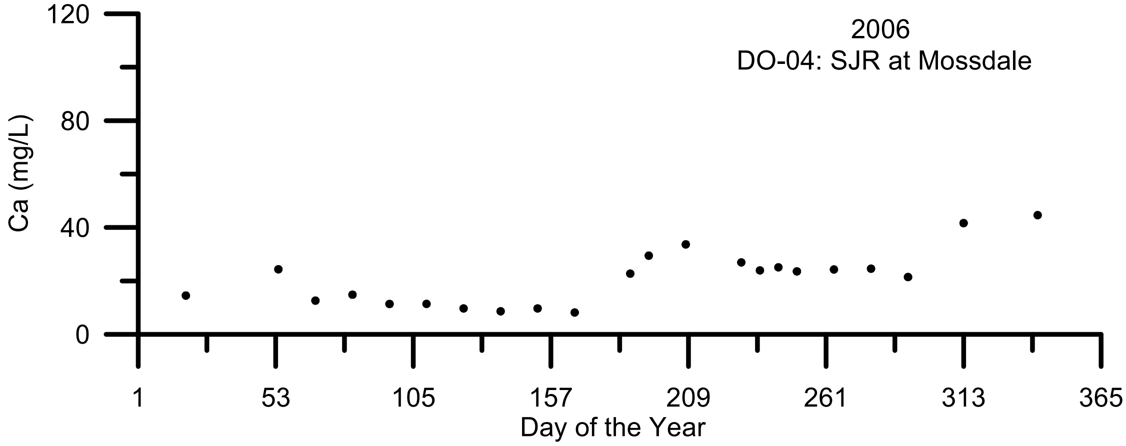
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

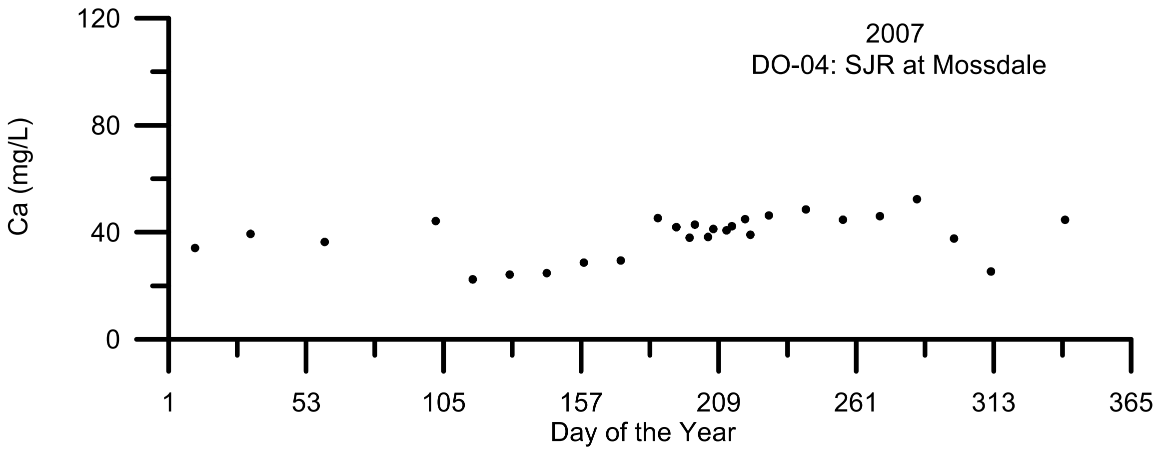
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

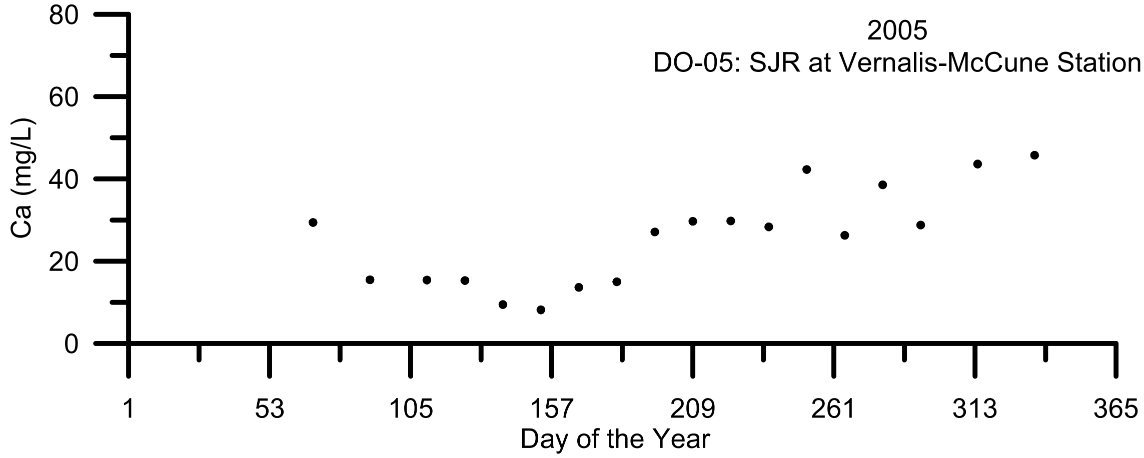


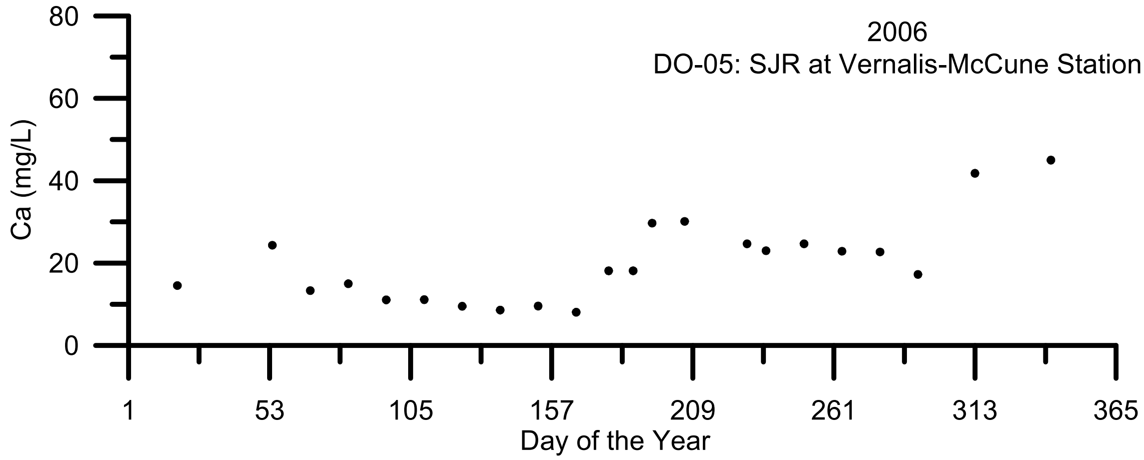
Figures 2 -103: Temporal Plots of Ca By Site ID

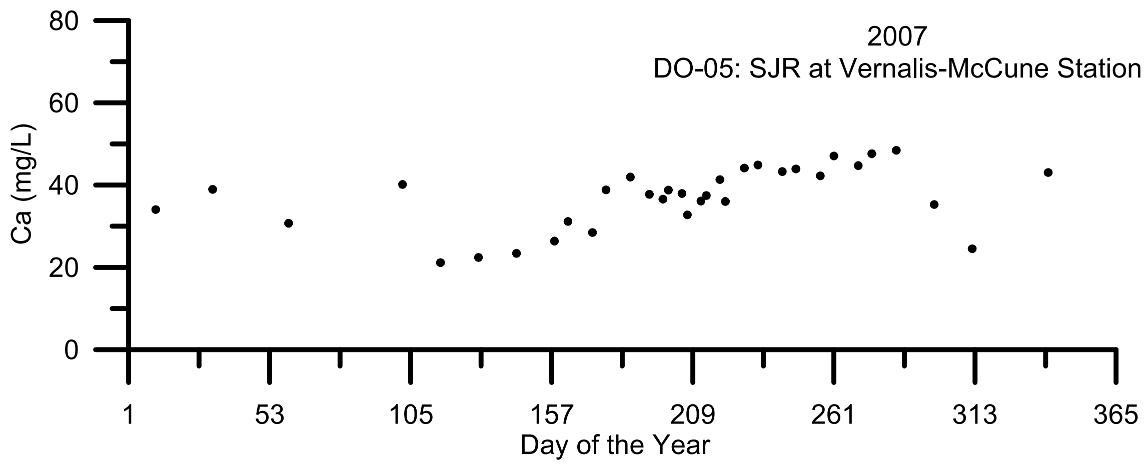


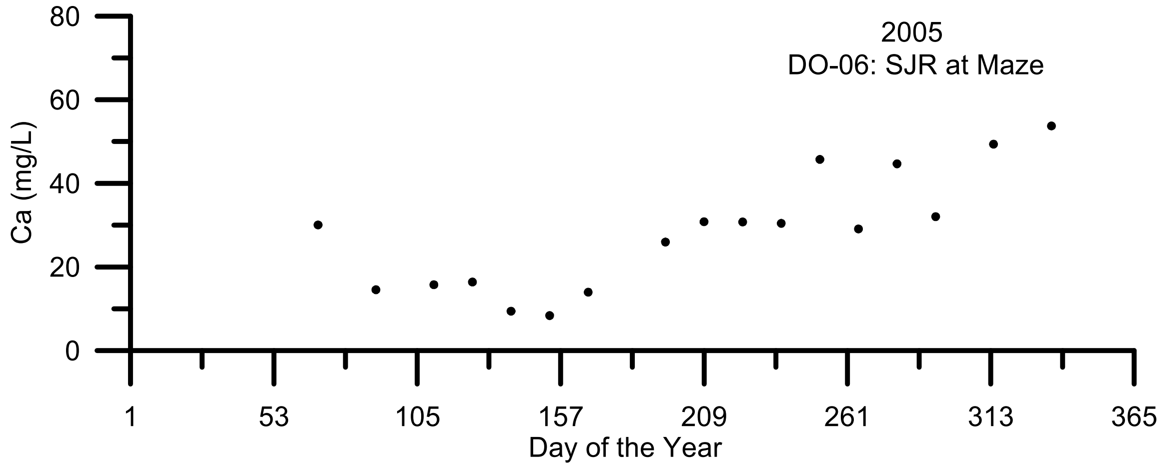


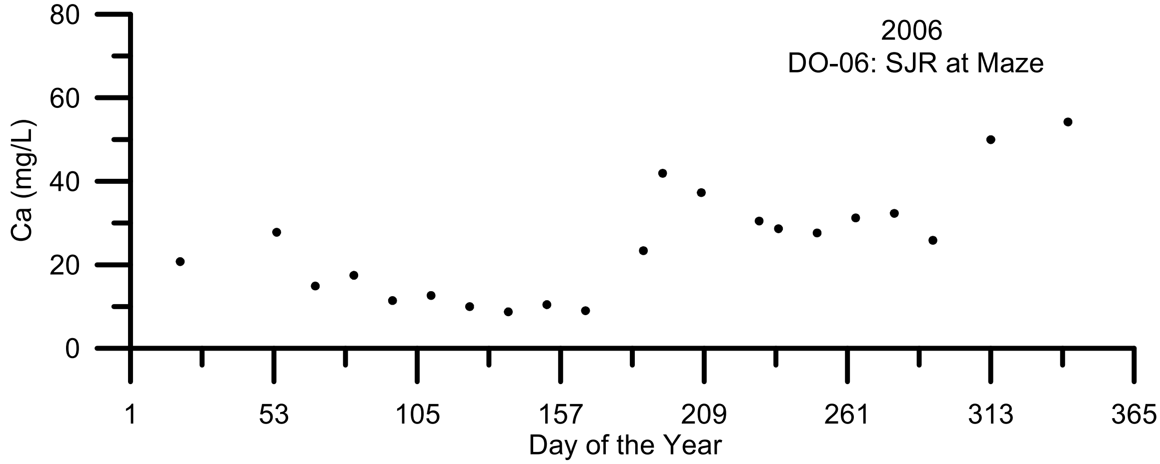


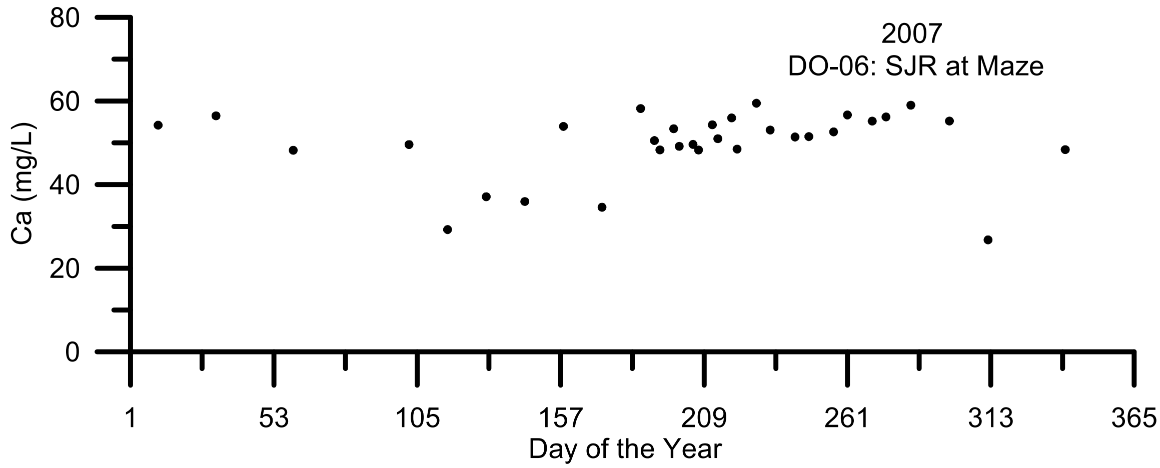

2005
DO-05: SJR at Vernalis-McCune Station
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

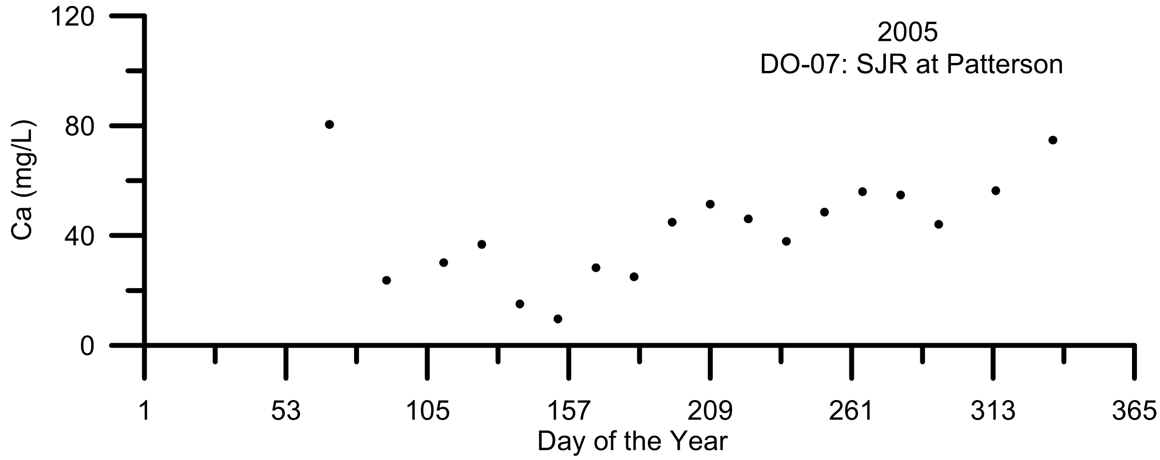

2006
DO-05: SJR at Vernalis-McCune Station
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

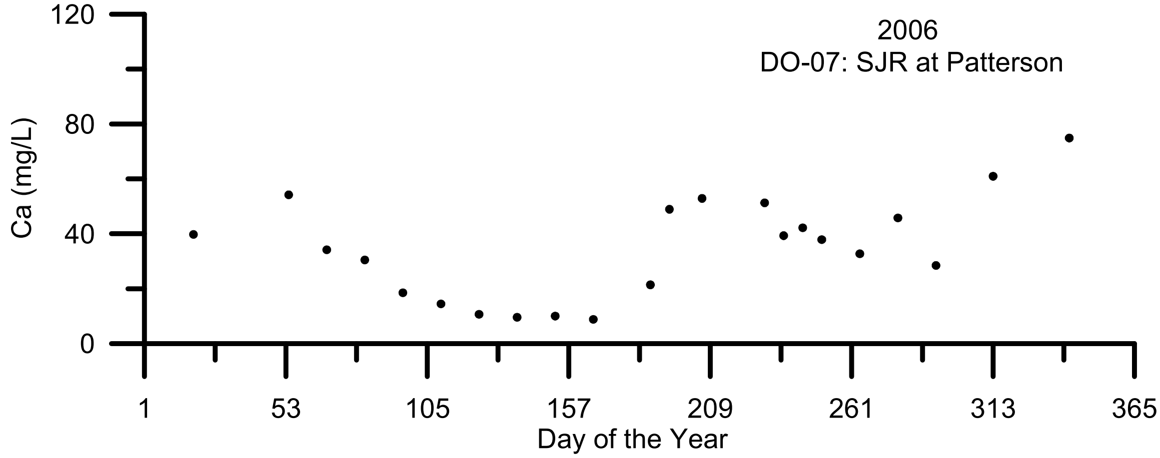

2007
DO-05: SJR at Vernalis-McCune Station
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

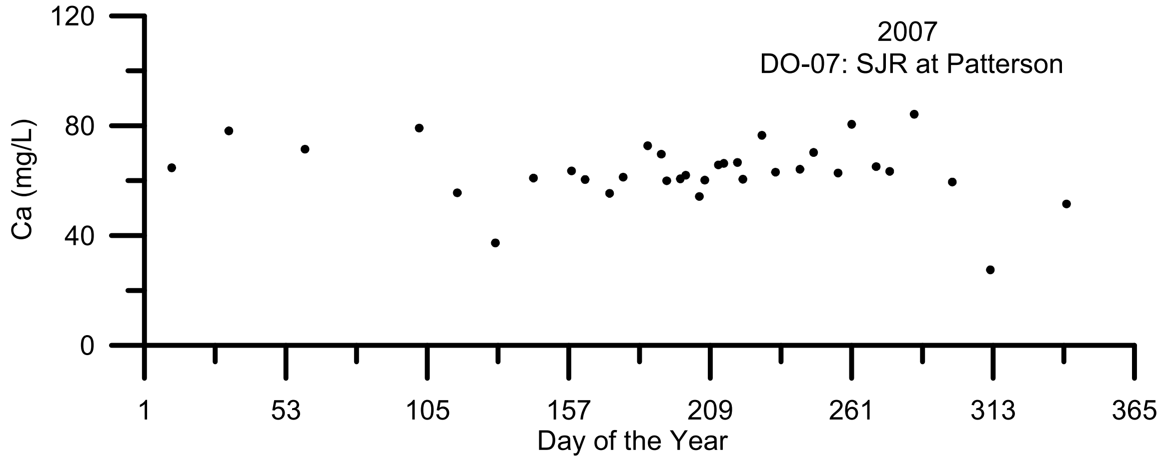

2005
DO-06: SJR at Maze
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

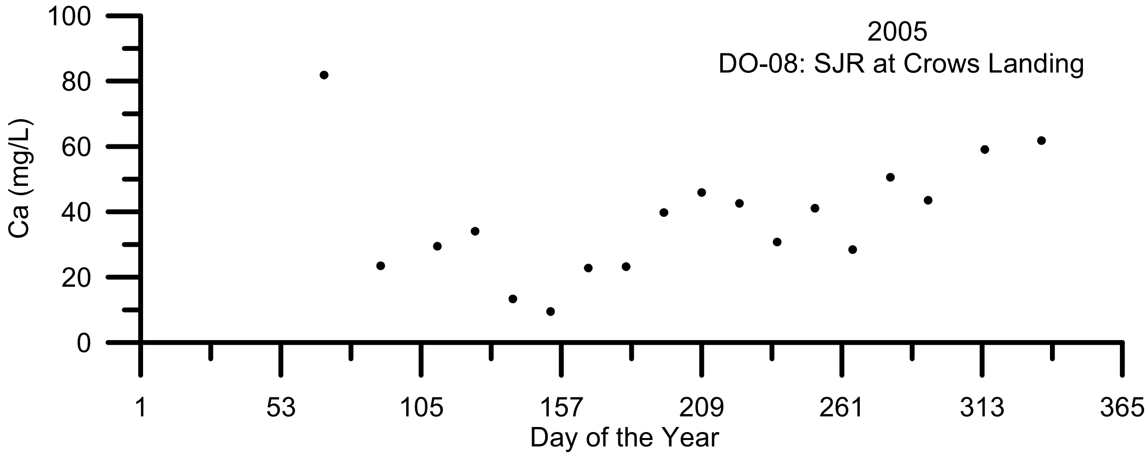

2006
DO-06: SJR at Maze
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

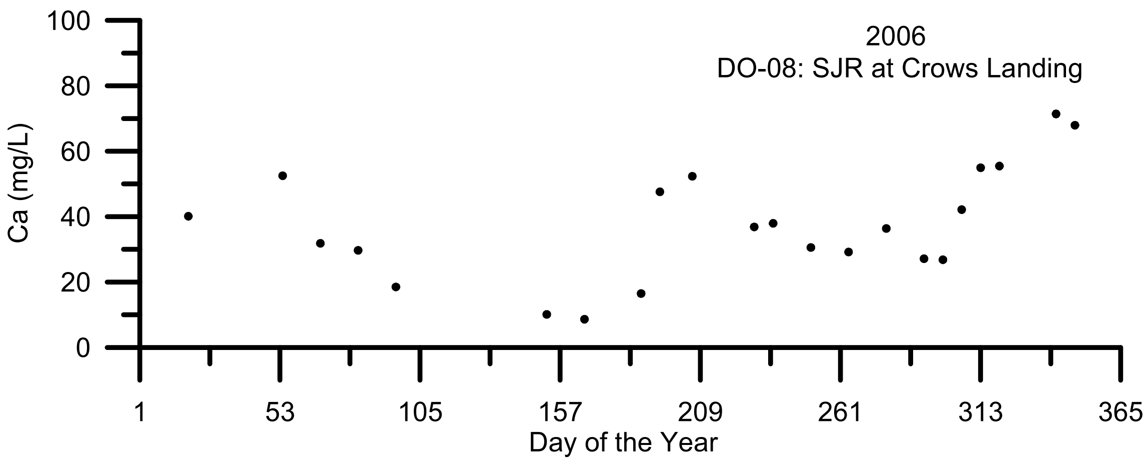

2007
DO-06: SJR at Maze
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

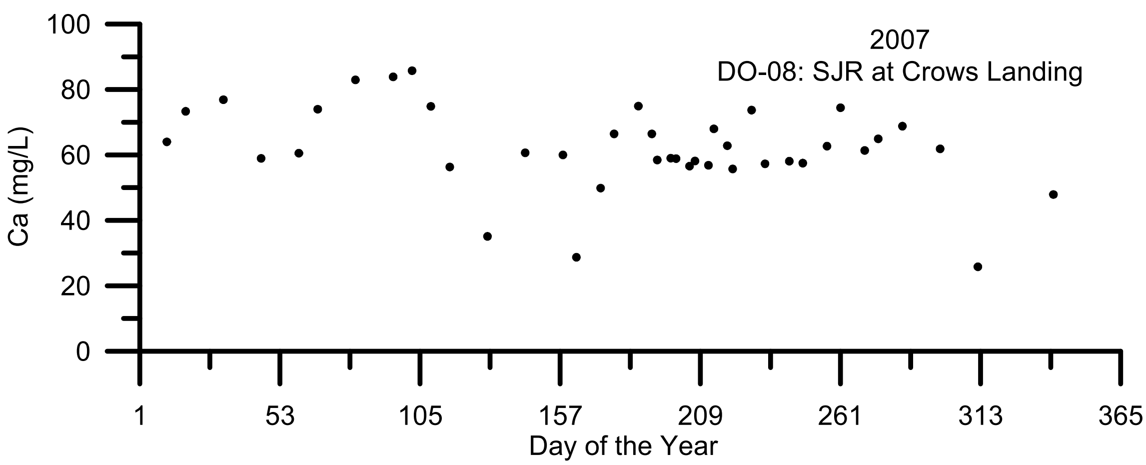

2005
DO-07: SJR at Patterson
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

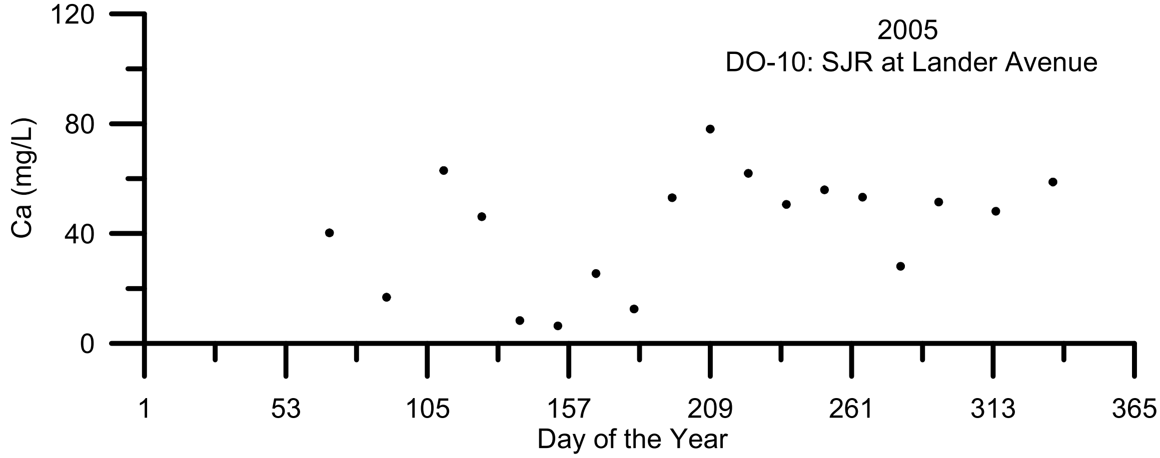

2006
DO-07: SJR at Patterson
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

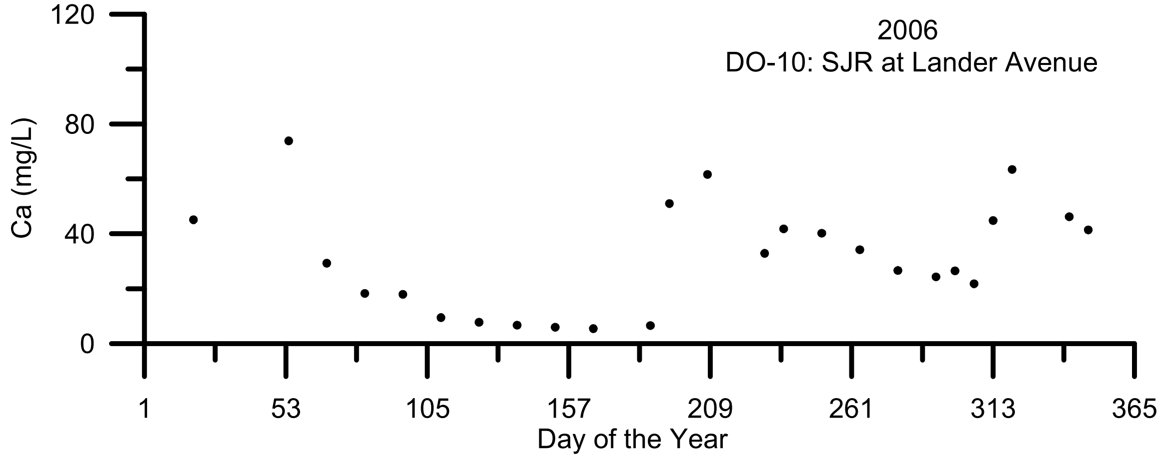

2007
DO-07: SJR at Patterson
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

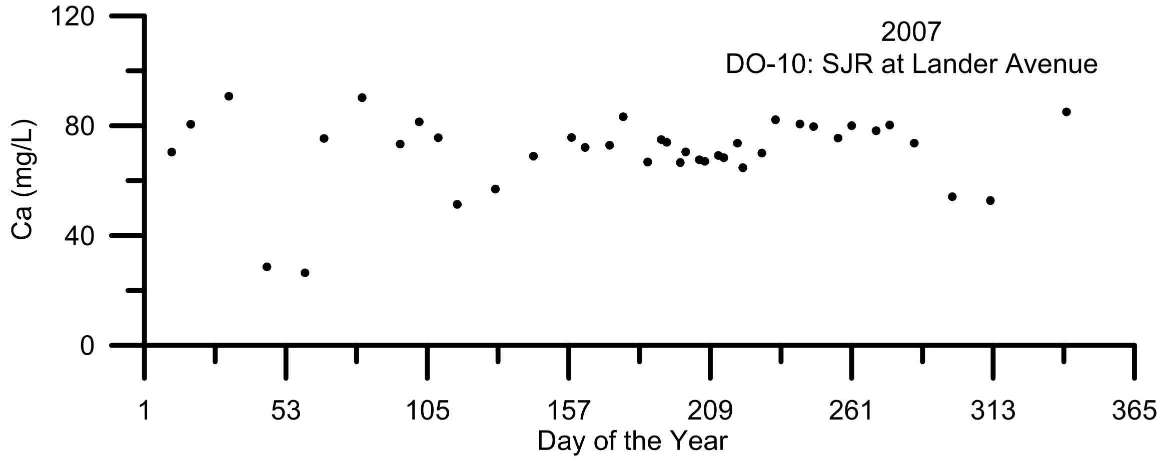

2005
DO-08: SJR at Crows Landing
Ca (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

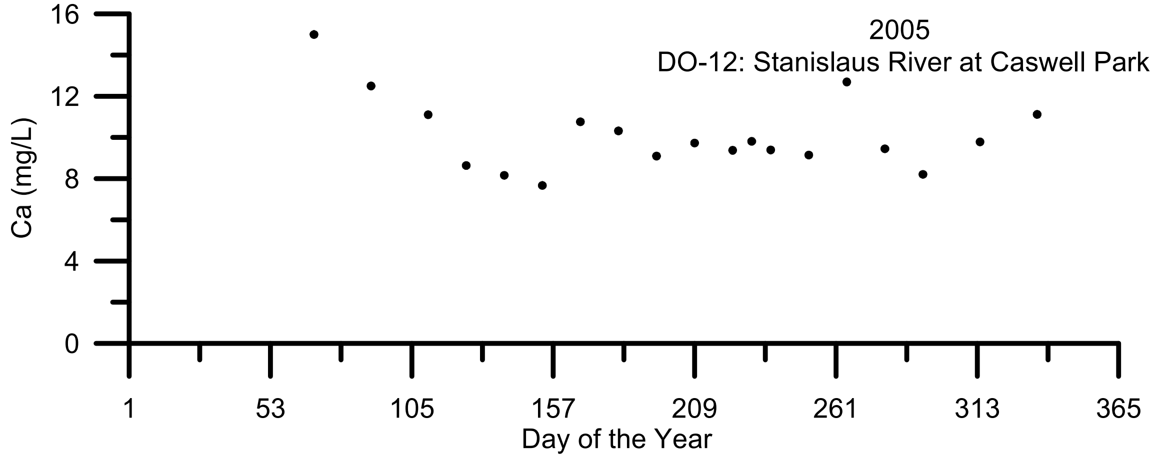

2006
DO-08: SJR at Crows Landing
Ca (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

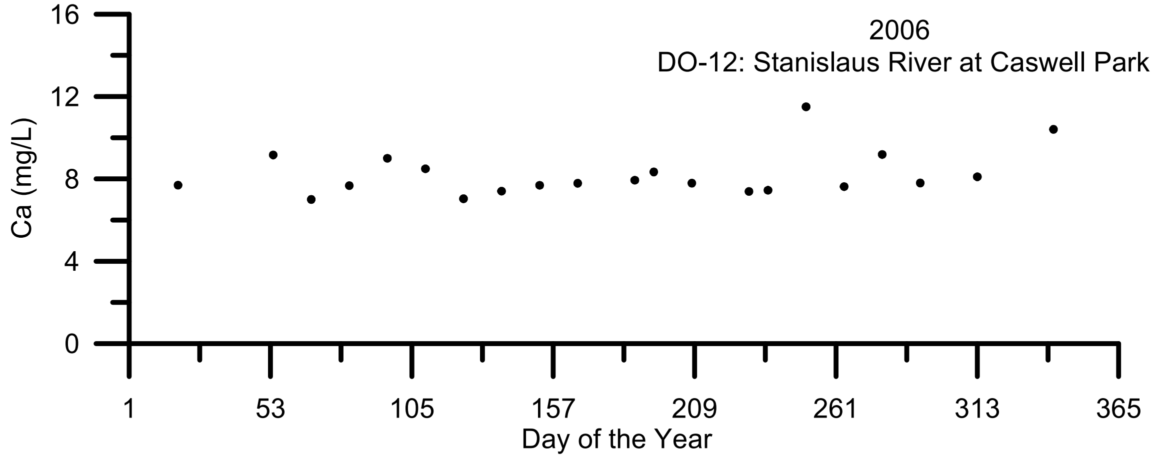

2007
DO-08: SJR at Crows Landing
Ca (mg/L)
Day of the Year
0
20
40
60
80
100
1
53
105
157
209
261
313
365

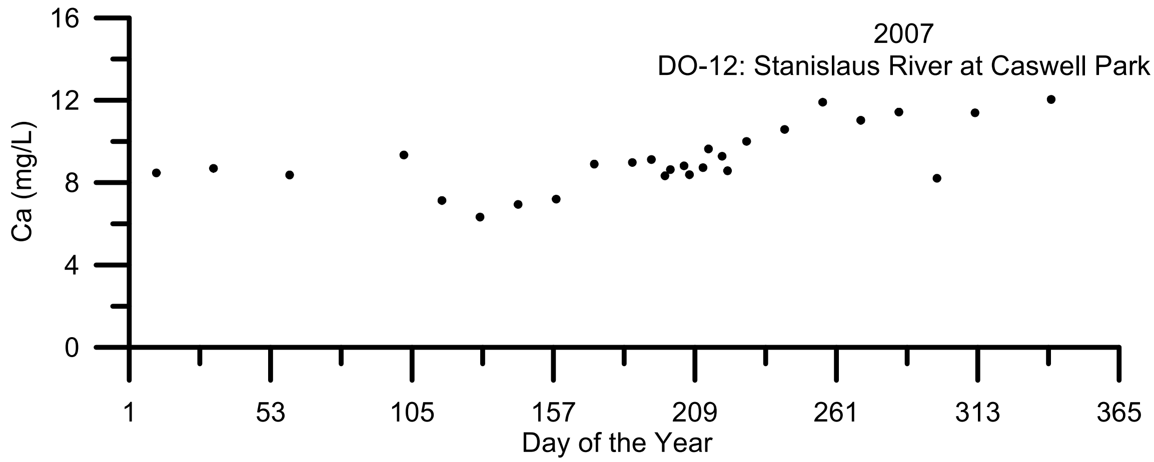

2005
DO-10: SJR at Lander Avenue
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

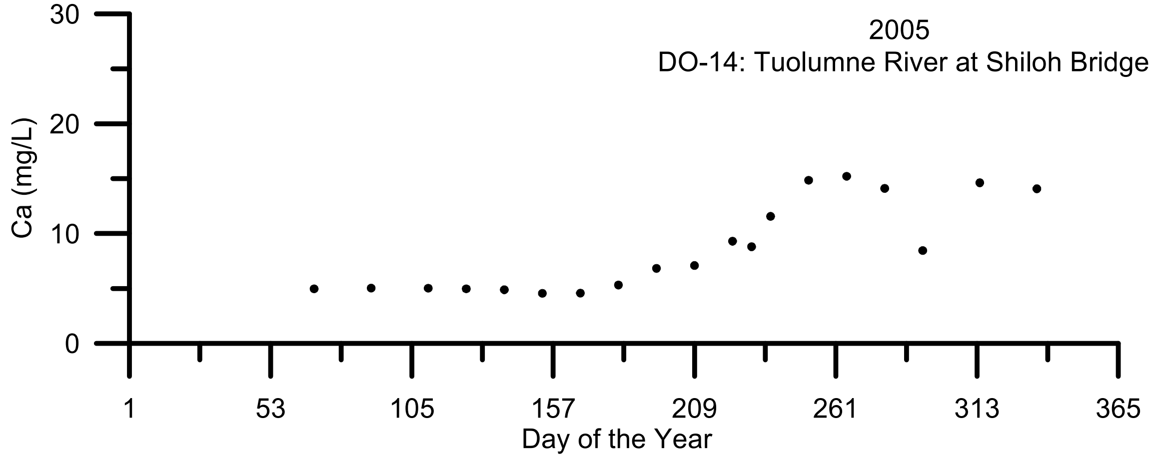

2006
DO-10: SJR at Lander Avenue
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

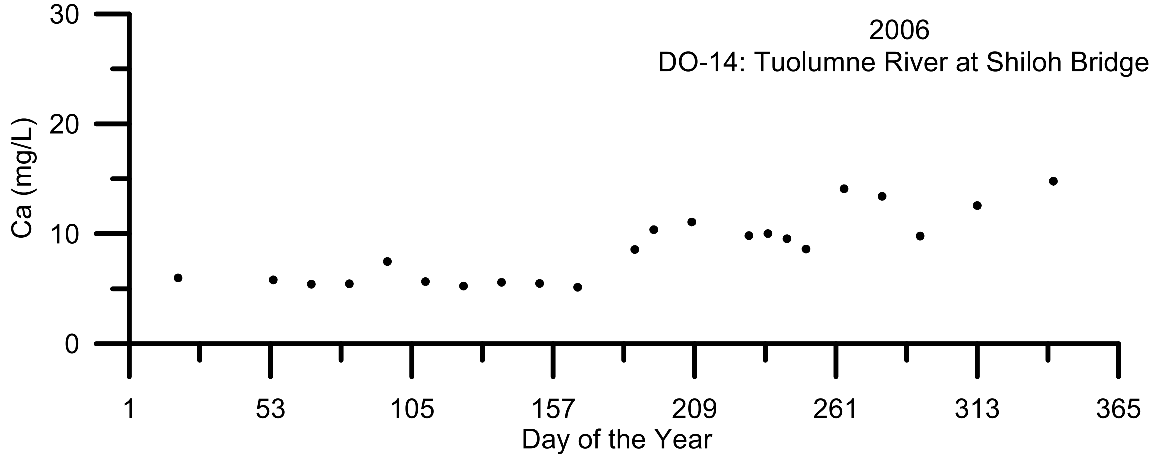

2007
DO-10: SJR at Lander Avenue
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

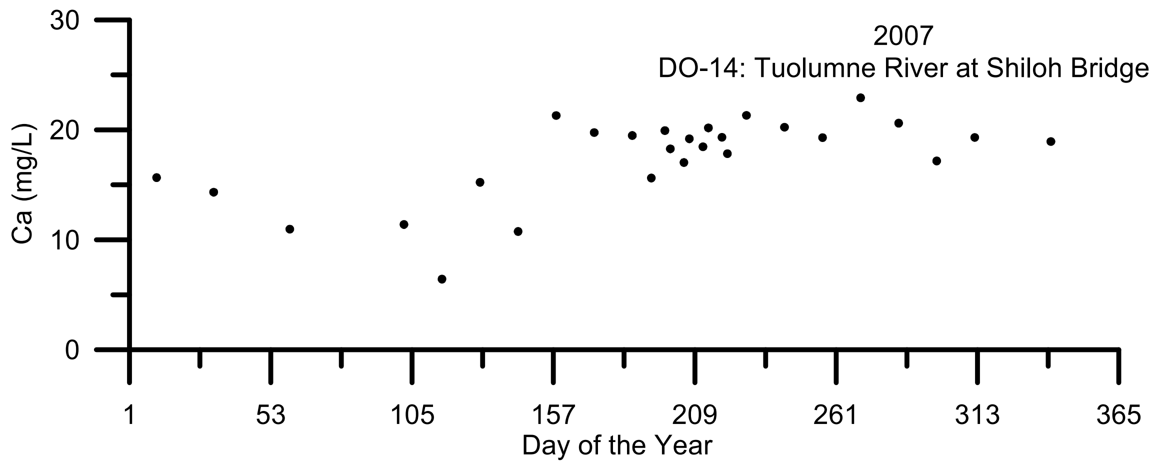

2005
DO-12: Stanislaus River at Caswell Park
Ca (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

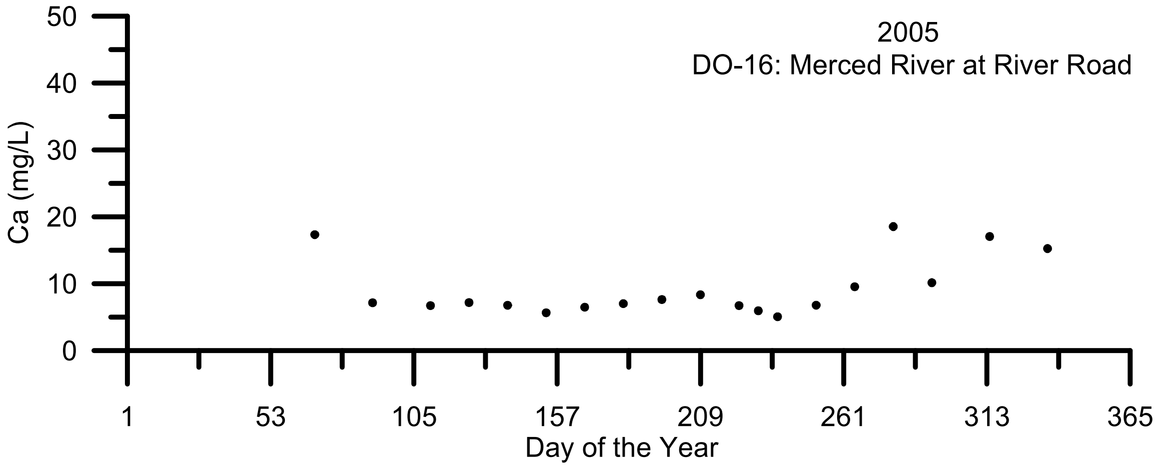

2006
DO-12: Stanislaus River at Caswell Park
Ca (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

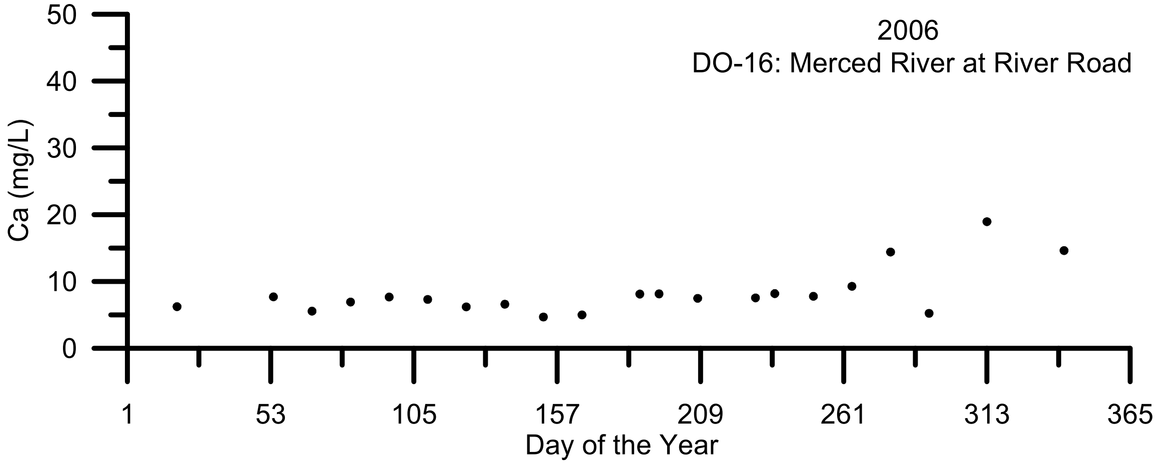

2007
DO-12: Stanislaus River at Caswell Park
Ca (mg/L)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

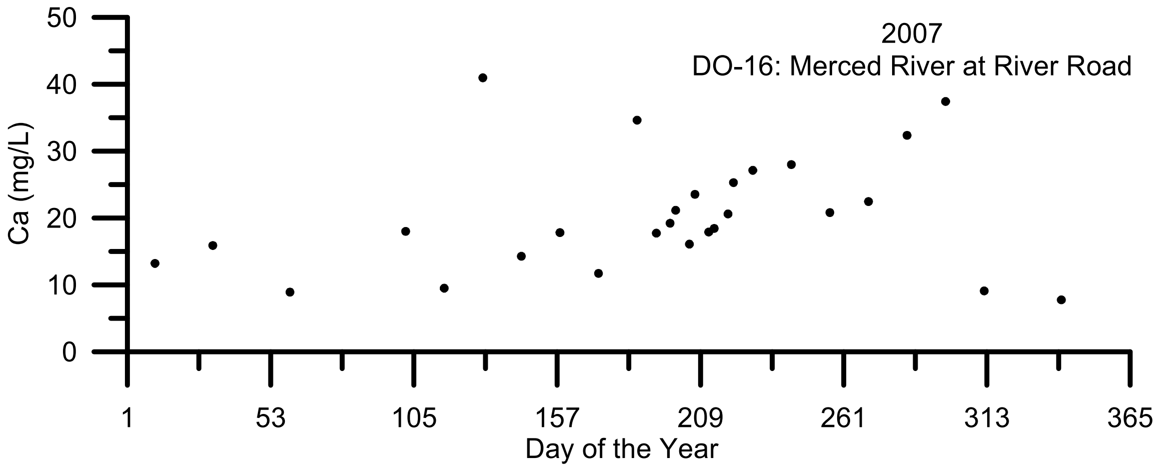

2005
DO-14: Tuolumne River at Shiloh Bridge
Ca (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

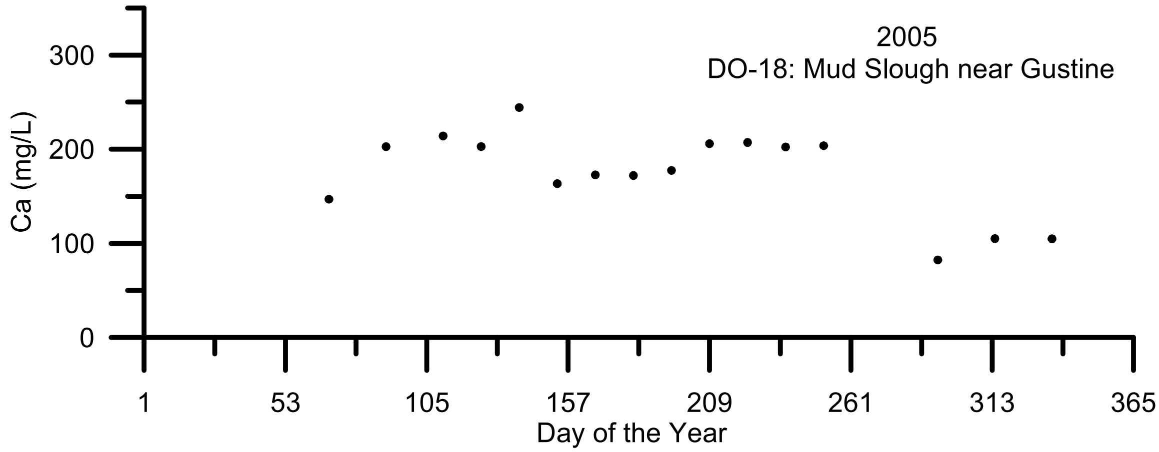

2006
DO-14: Tuolumne River at Shiloh Bridge
Ca (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

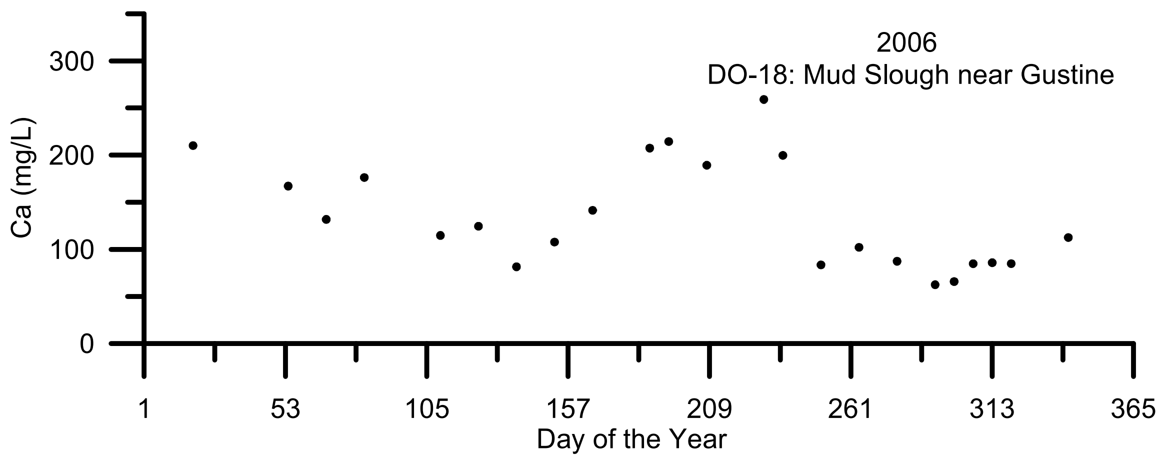

2007
DO-14: Tuolumne River at Shiloh Bridge
Ca (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

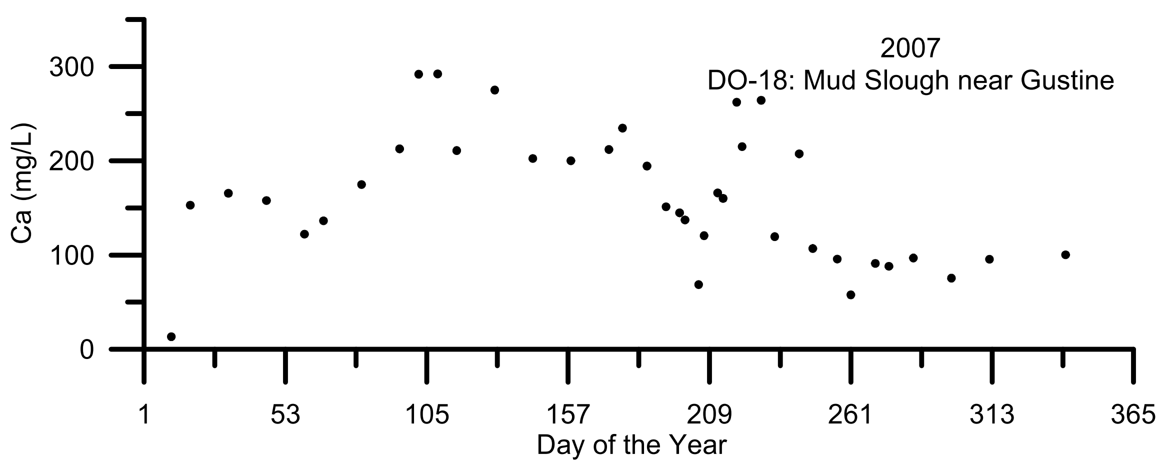

2005
DO-16: Merced River at River Road
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

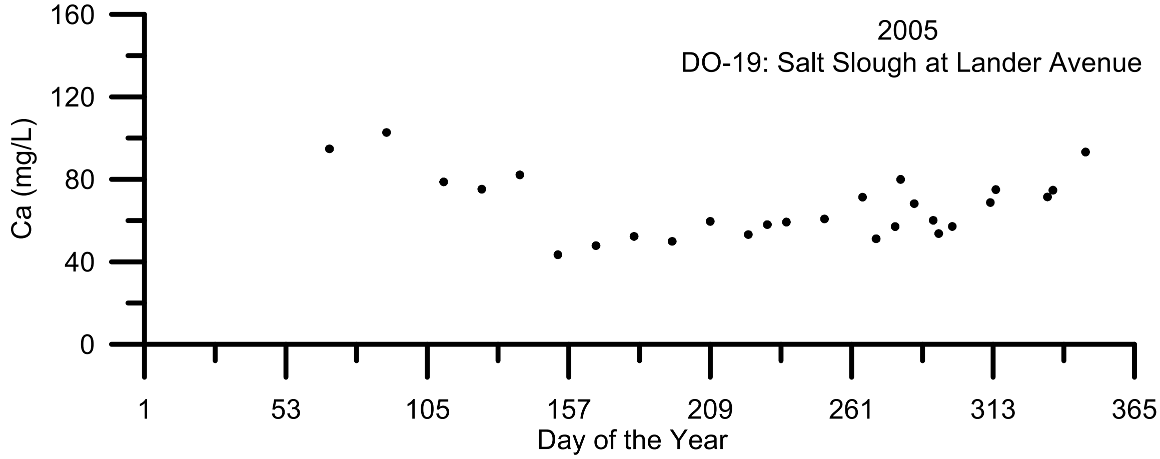

2006
DO-16: Merced River at River Road
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

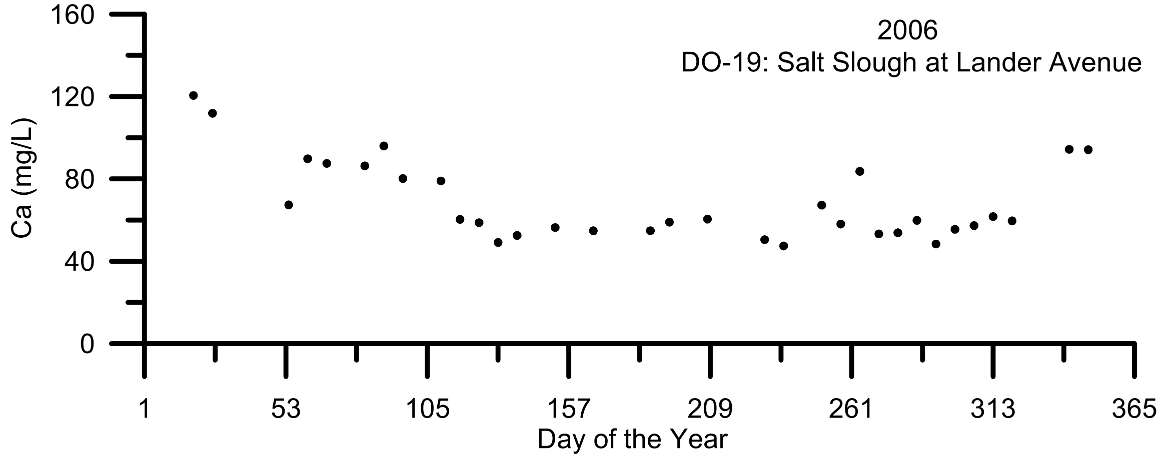

2007
DO-16: Merced River at River Road
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

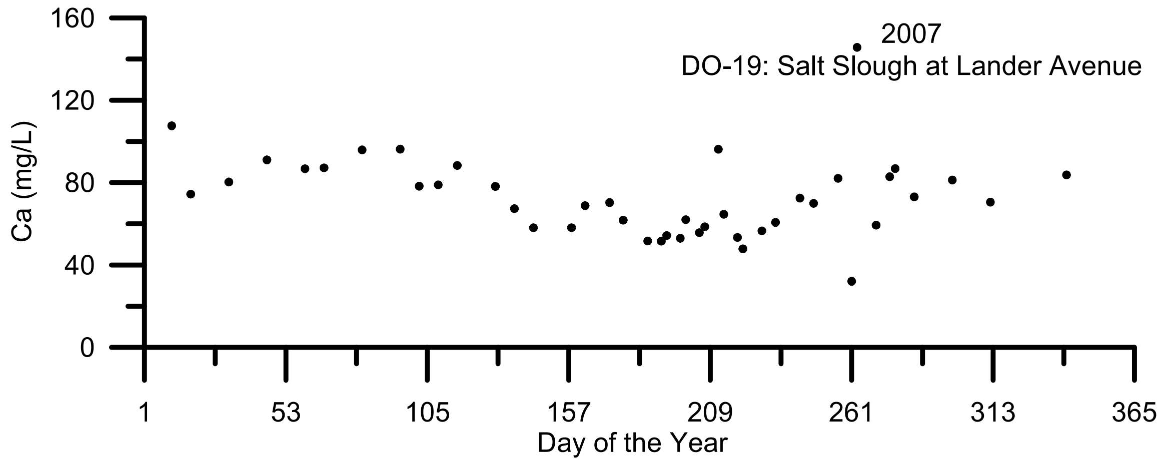

2005
DO-18: Mud Slough near Gustine
Ca (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

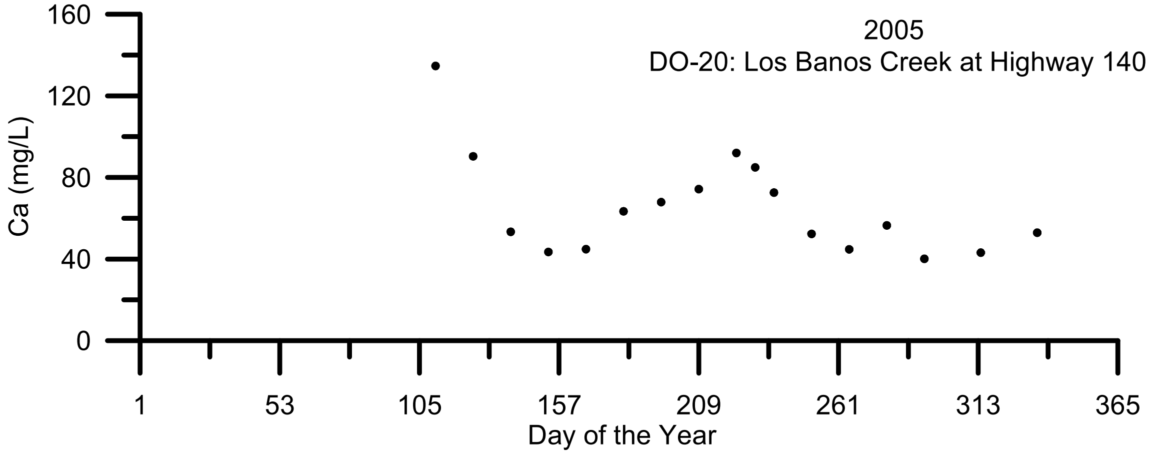

2006
DO-18: Mud Slough near Gustine
Ca (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

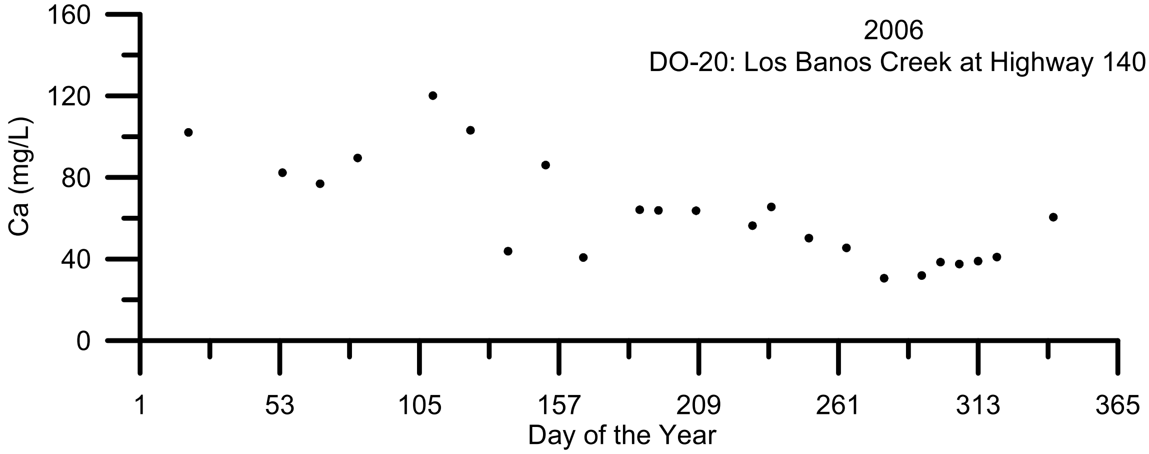

2007
DO-18: Mud Slough near Gustine
Ca (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

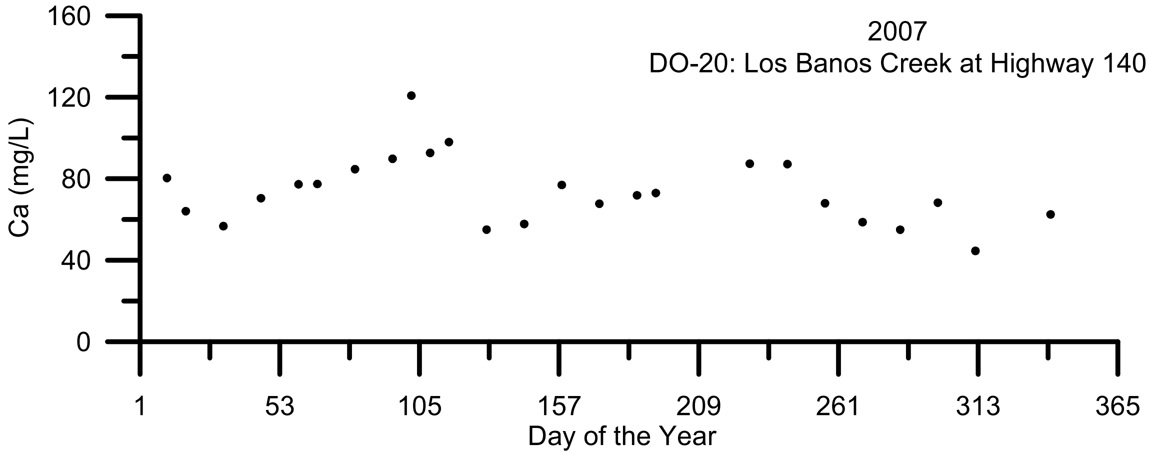

2005
DO-19: Salt Slough at Lander Avenue
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

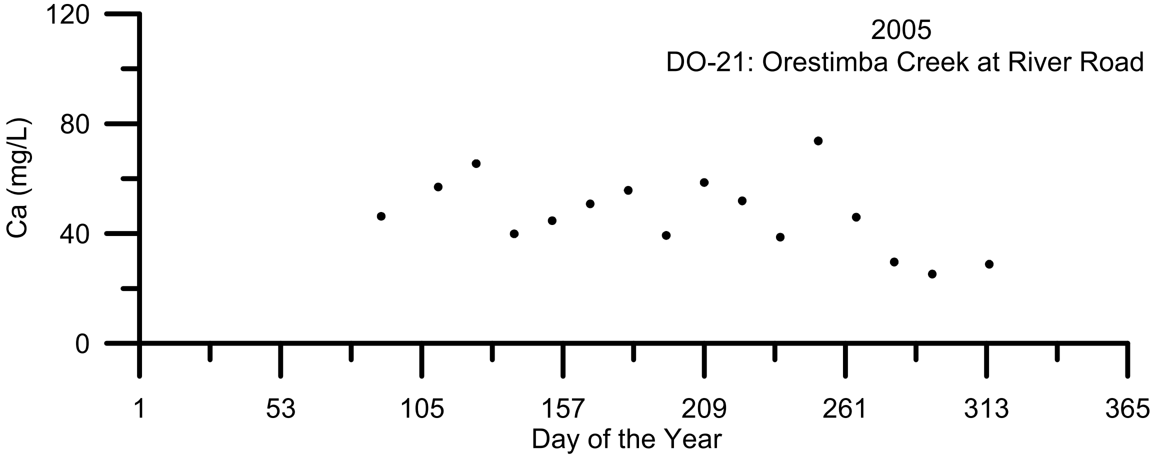

2006
DO-19: Salt Slough at Lander Avenue
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

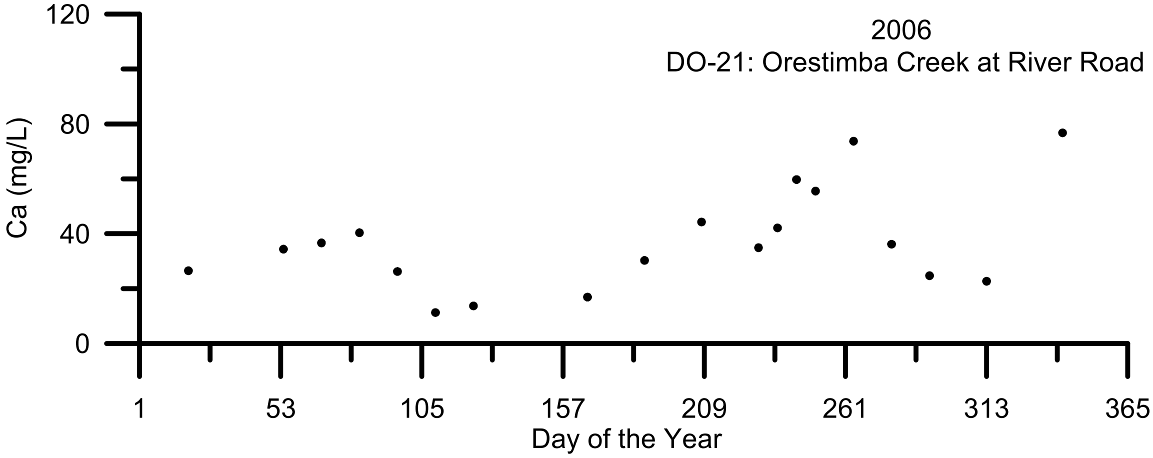

2007
DO-19: Salt Slough at Lander Avenue
Ca (mg/L)
0
40
80
120
160
1
53
105
157
209
261
313
365
Day of the Year

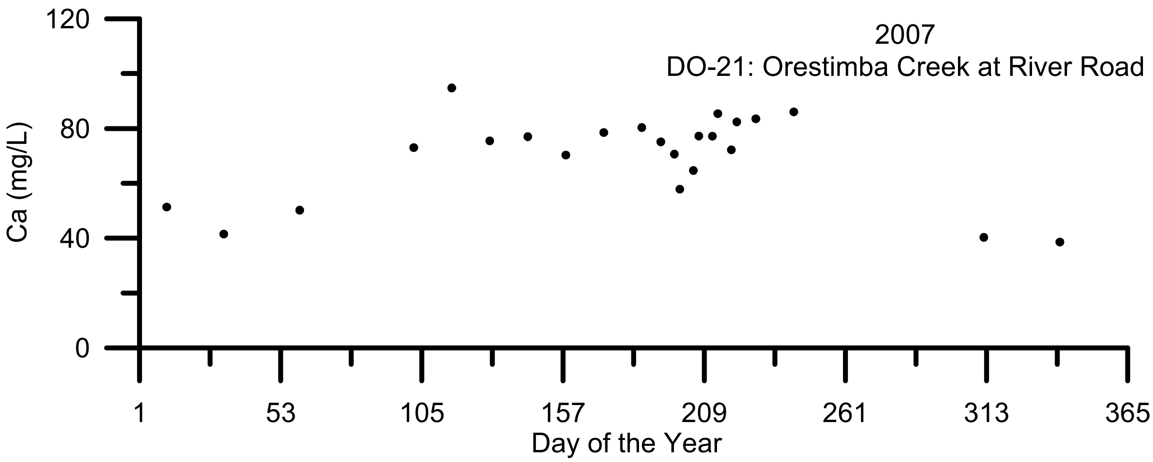

2005
DO-20: Los Banos Creek at Highway 140
Ca (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

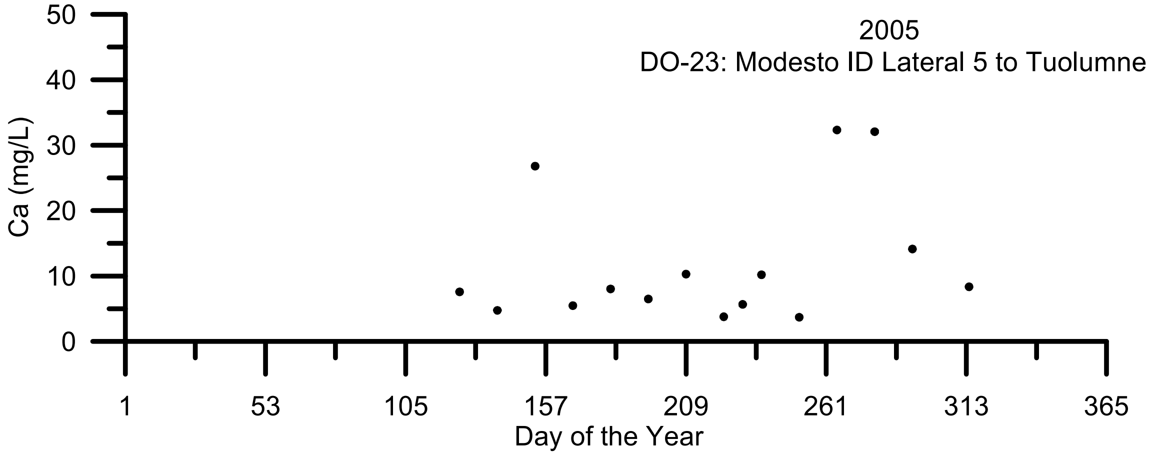

2006
DO-20: Los Banos Creek at Highway 140
Ca (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

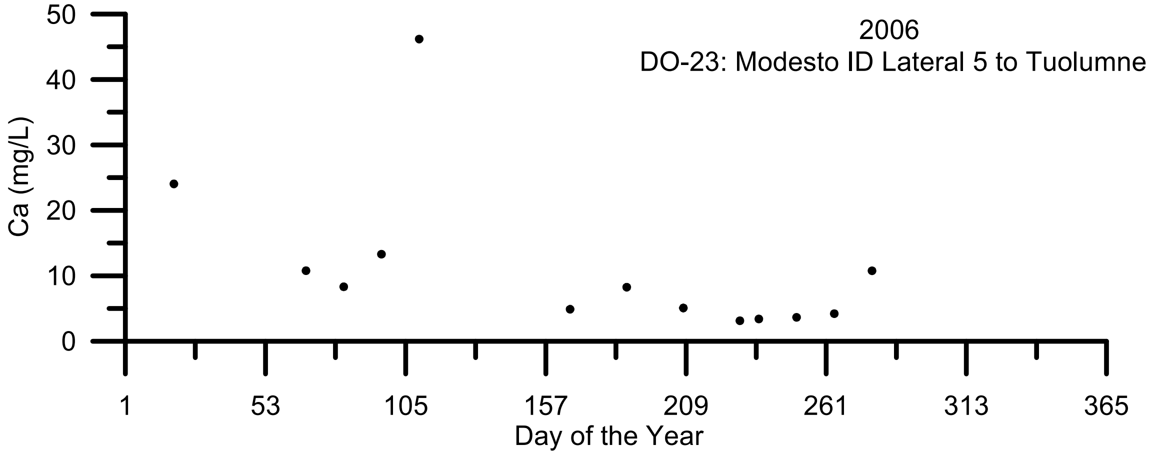

2007
DO-20: Los Banos Creek at Highway 140
Ca (mg/L)
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

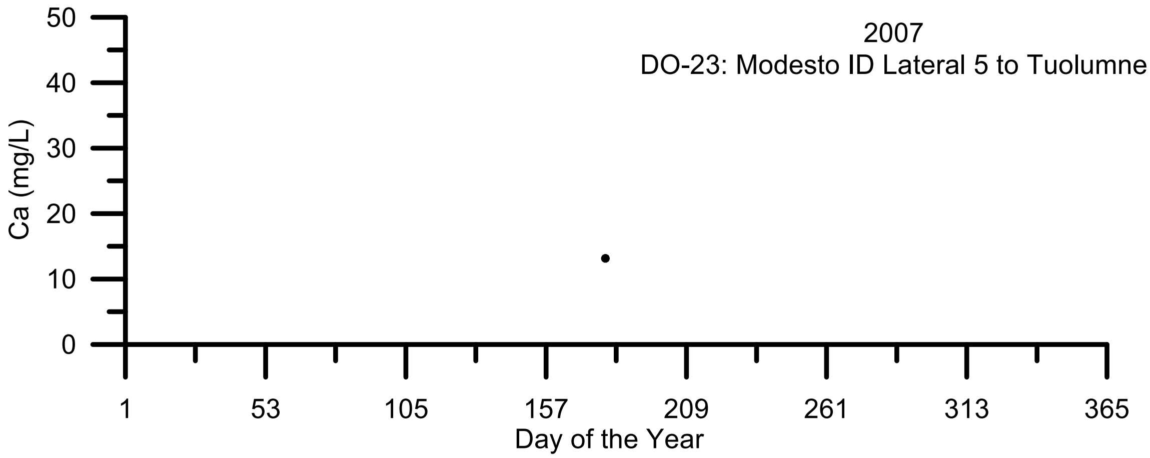

2005
DO-21: Orestimba Creek at River Road
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

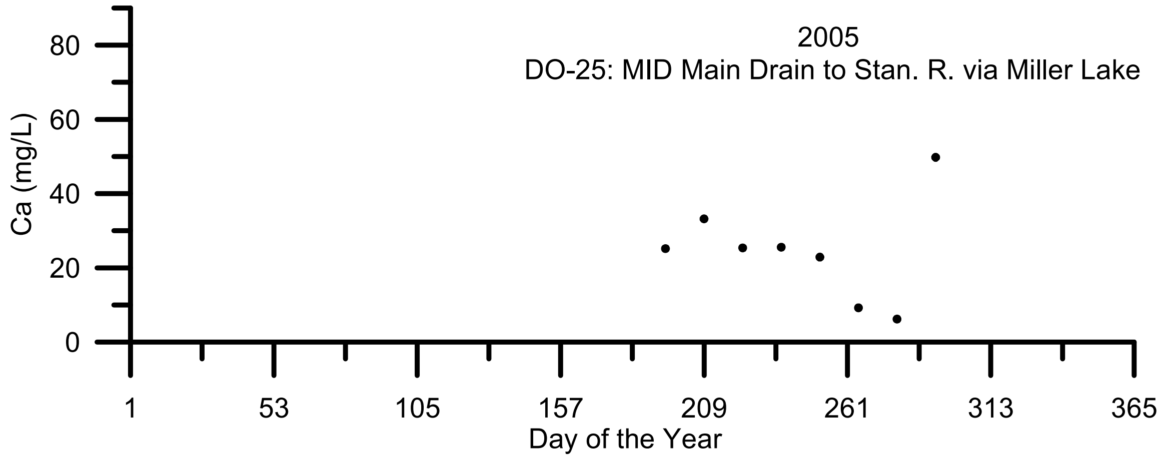

2006
DO-21: Orestimba Creek at River Road
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

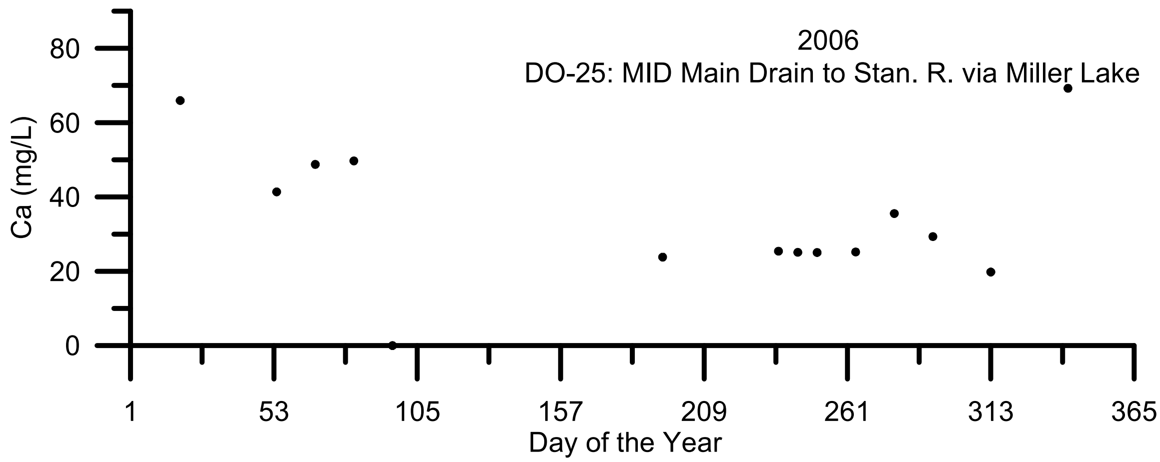

2007
DO-21: Orestimba Creek at River Road
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

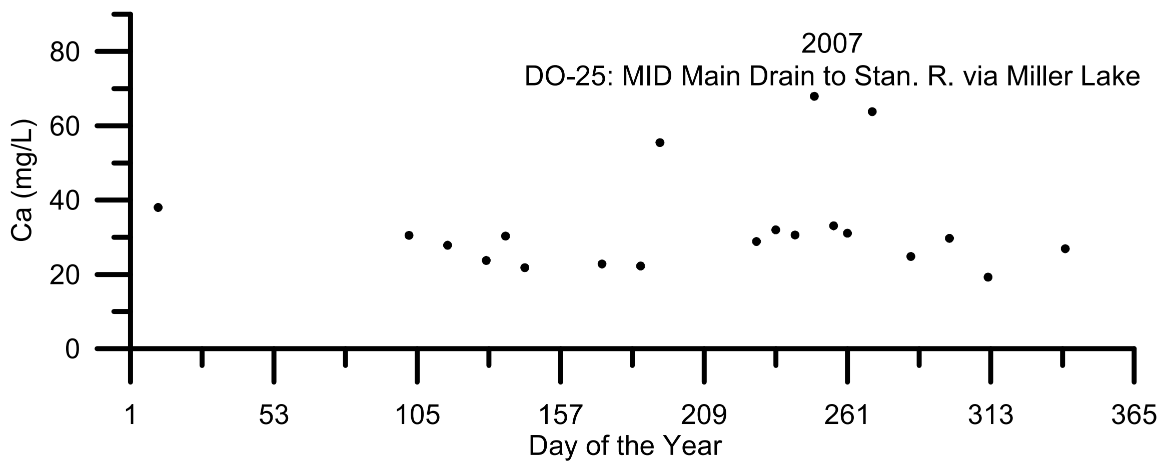

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

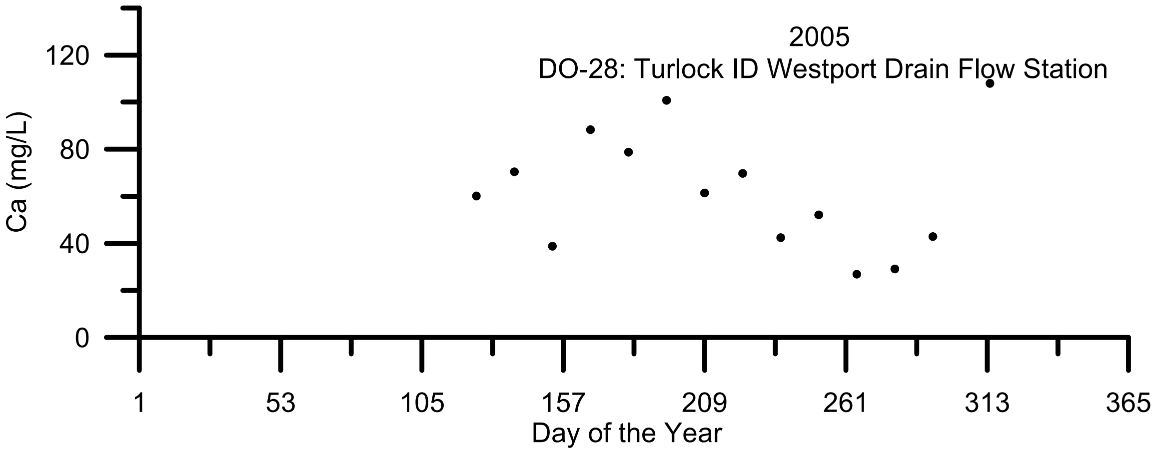

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

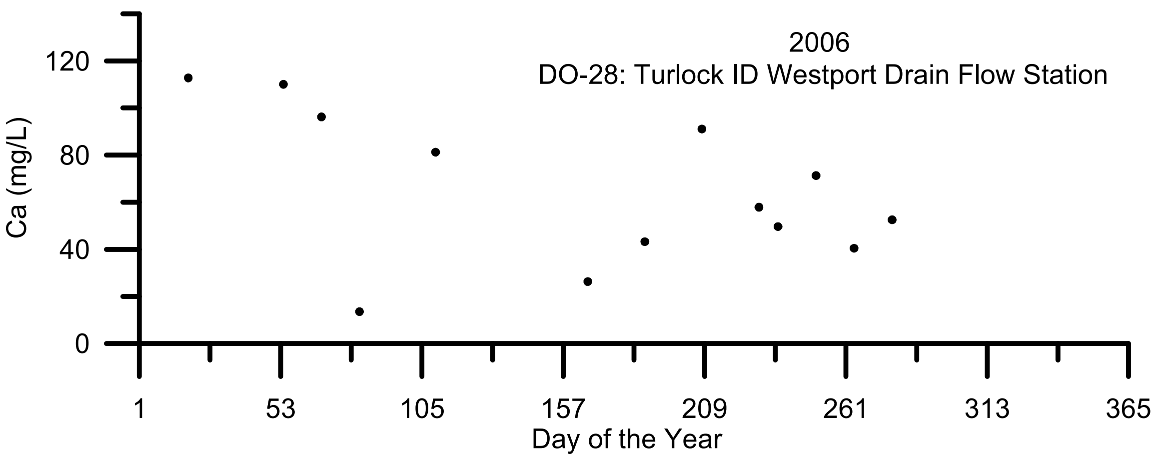

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Ca (mg/L)
0
10
20
30
40
50
1
53
105
157
209
261
313
365
Day of the Year

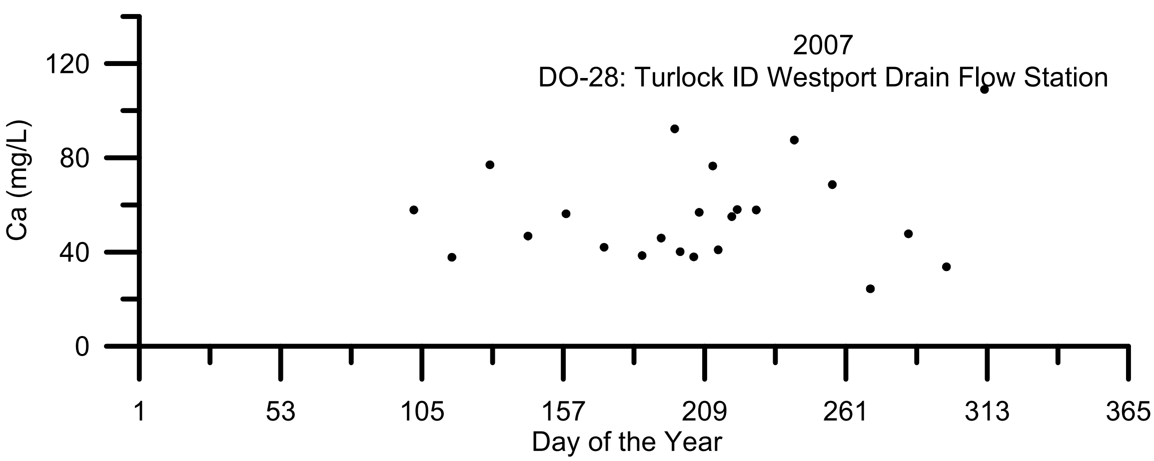

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

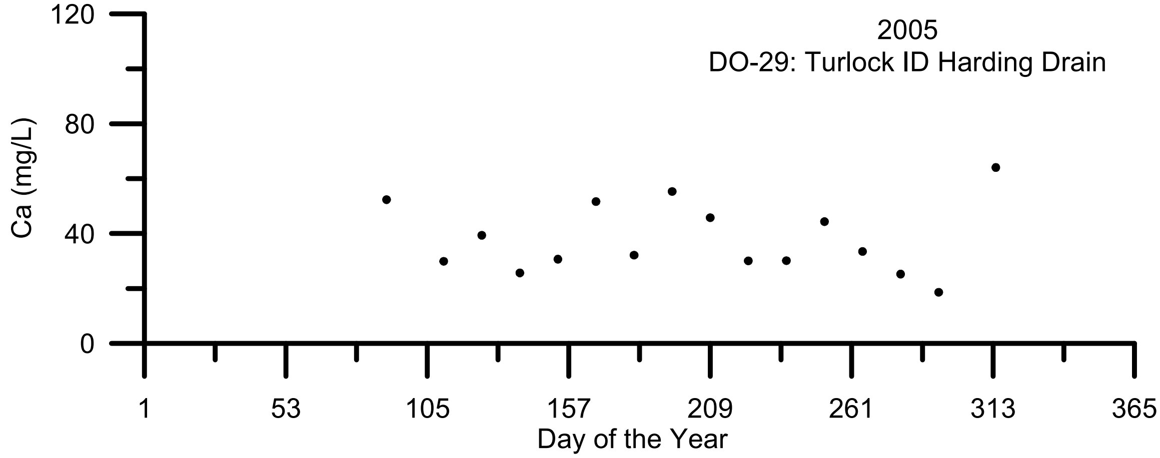

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

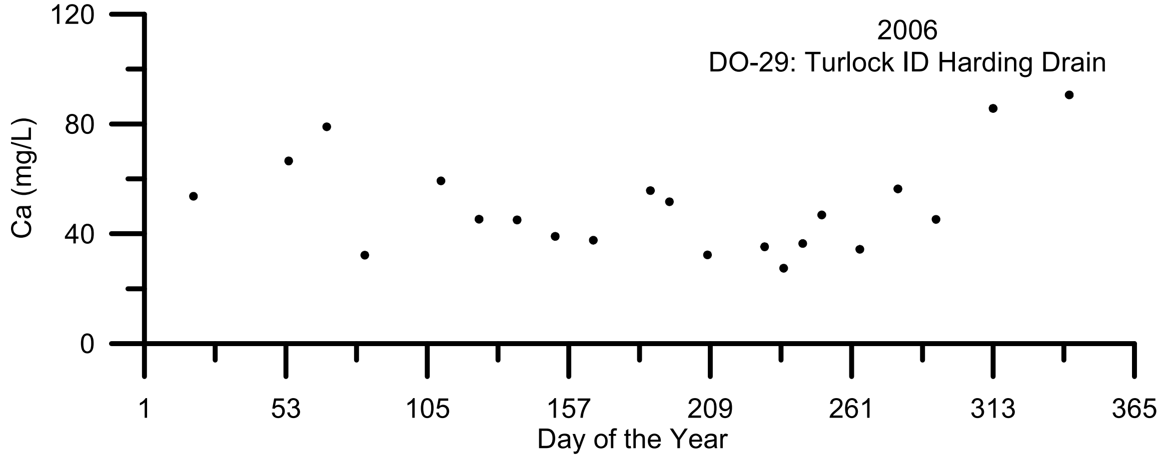

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Ca (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

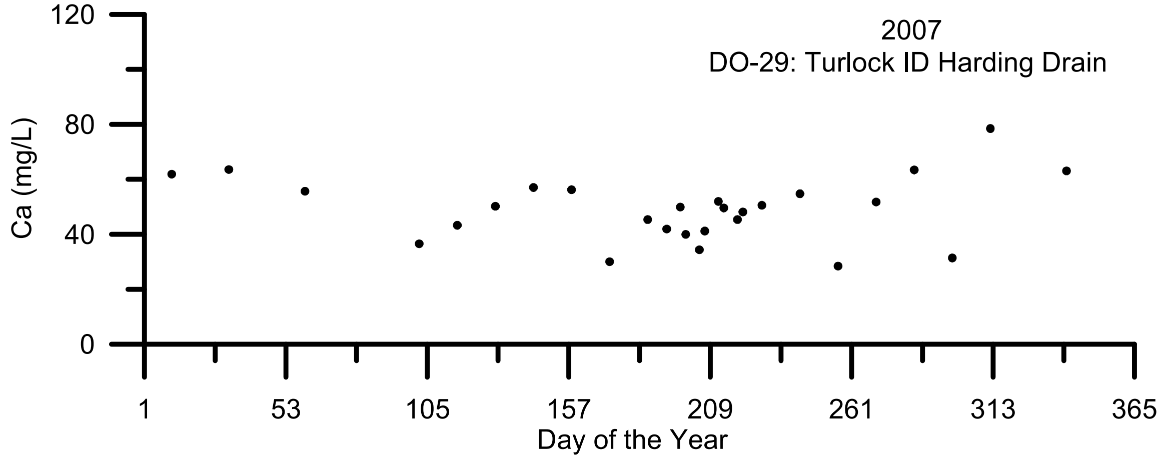

2005
DO-28: Turlock ID Westport Drain Flow Station
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

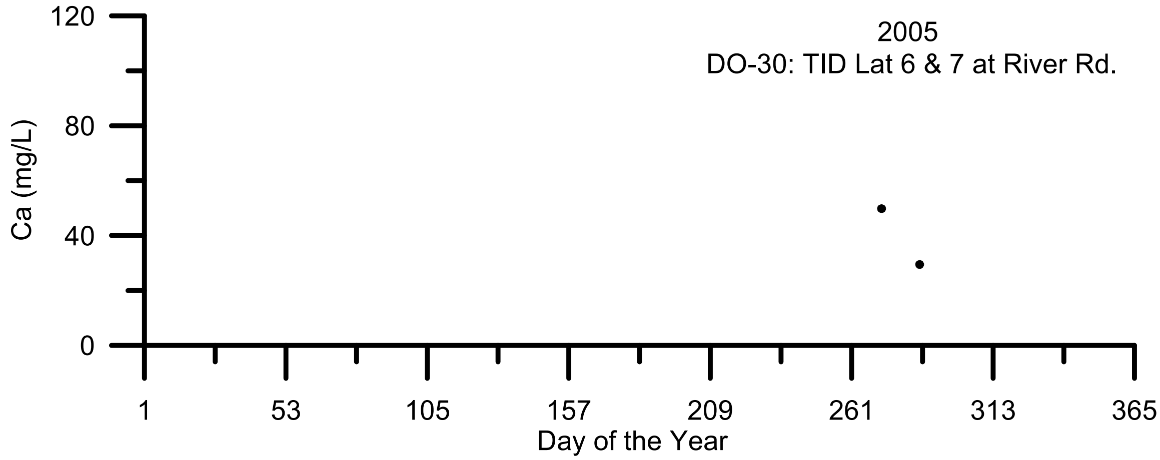

2006
DO-28: Turlock ID Westport Drain Flow Station
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

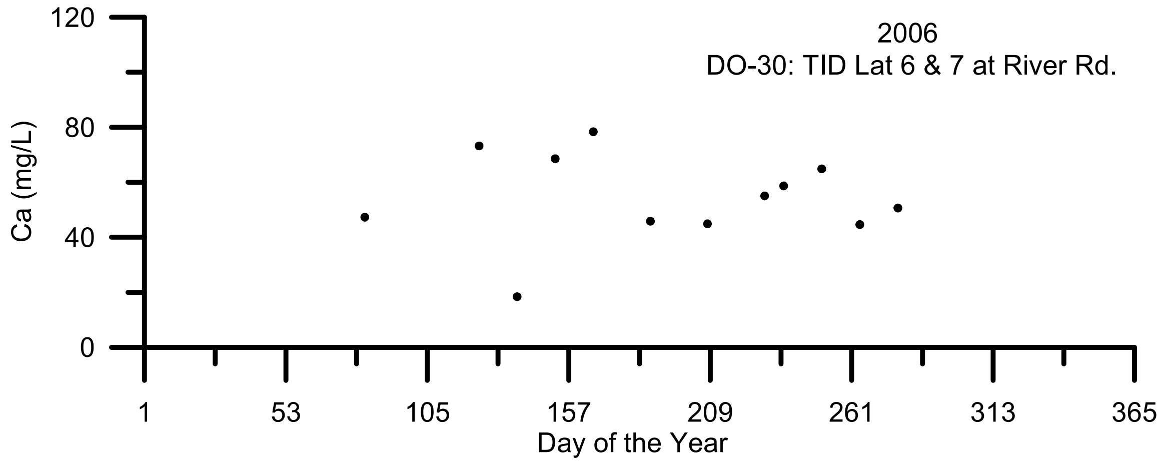

2007
DO-28: Turlock ID Westport Drain Flow Station
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

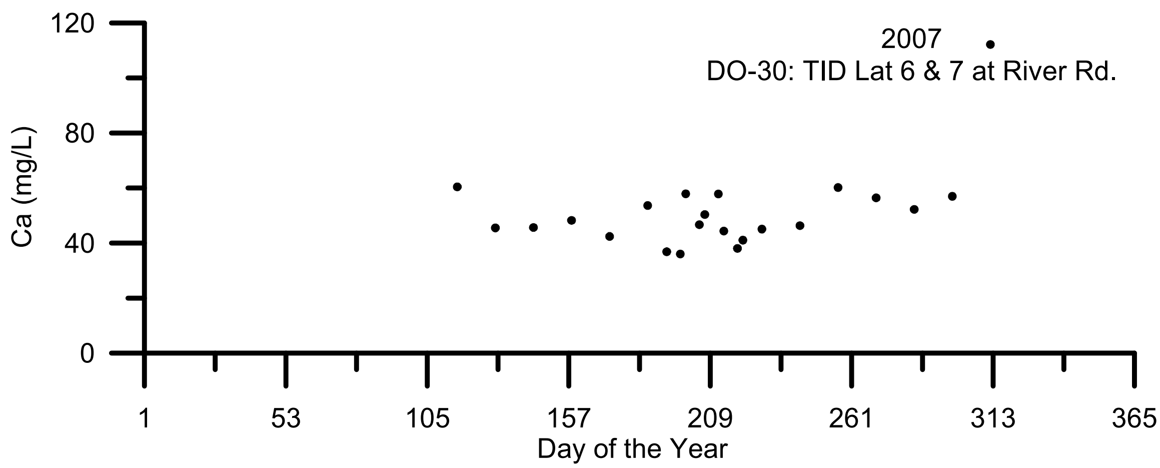

2005
DO-29: Turlock ID Harding Drain
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

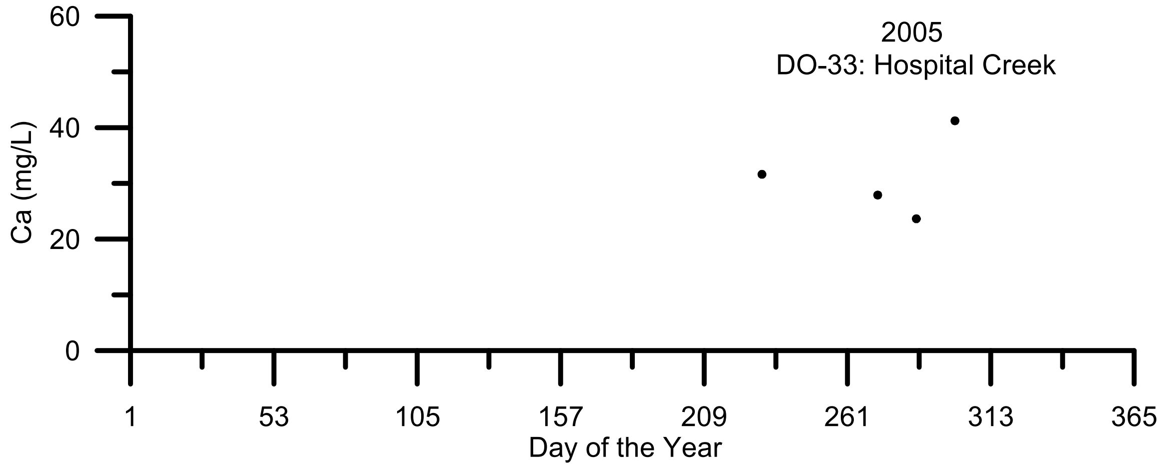

2006
DO-29: Turlock ID Harding Drain
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

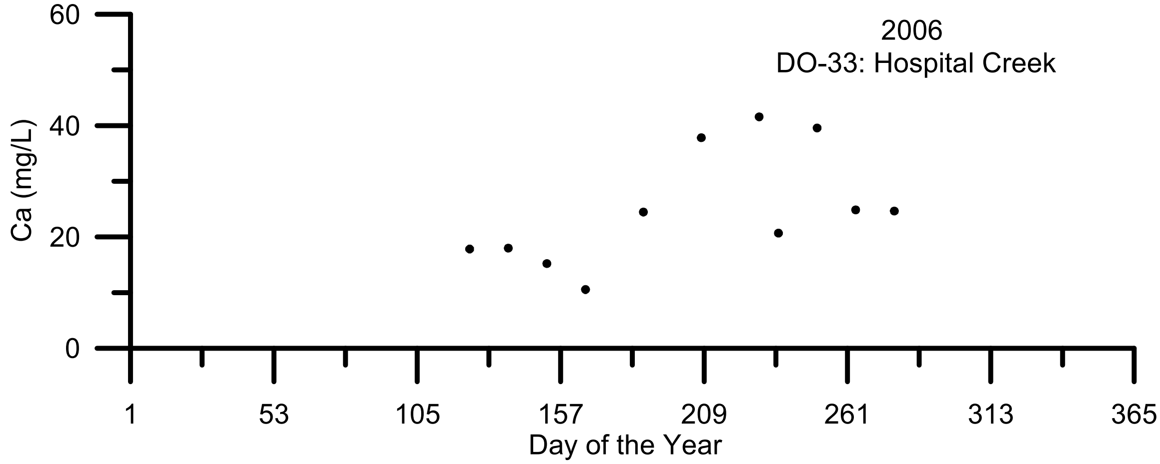

2007
DO-29: Turlock ID Harding Drain
Ca (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

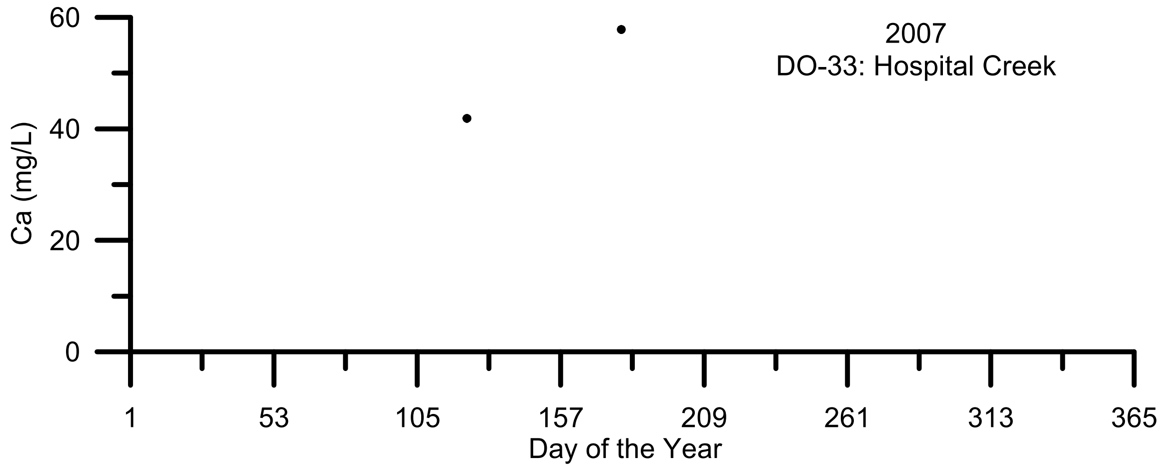

2005
DO-30: TID Lat 6 & 7 at River Rd.
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

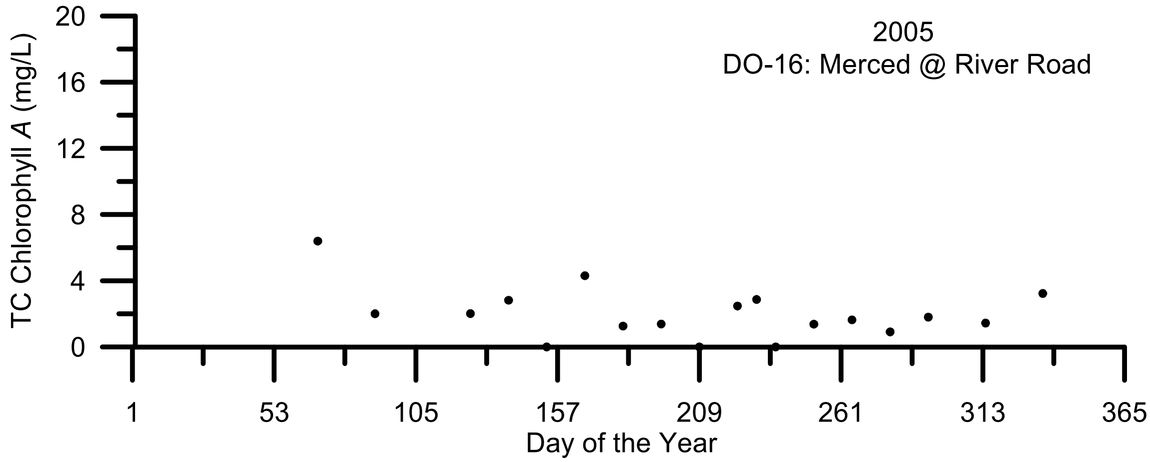

2006
DO-30: TID Lat 6 & 7 at River Rd.
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

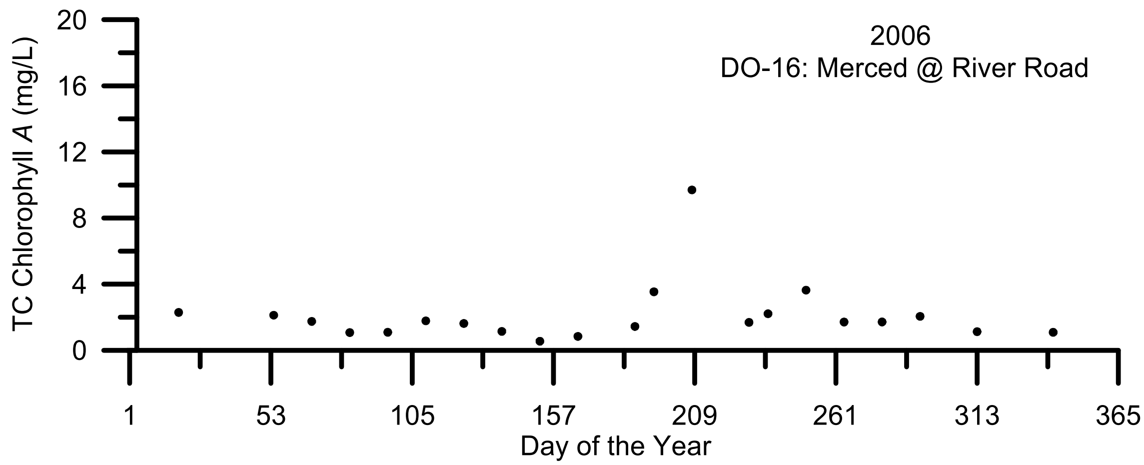

2007
DO-30: TID Lat 6 & 7 at River Rd.
Ca (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

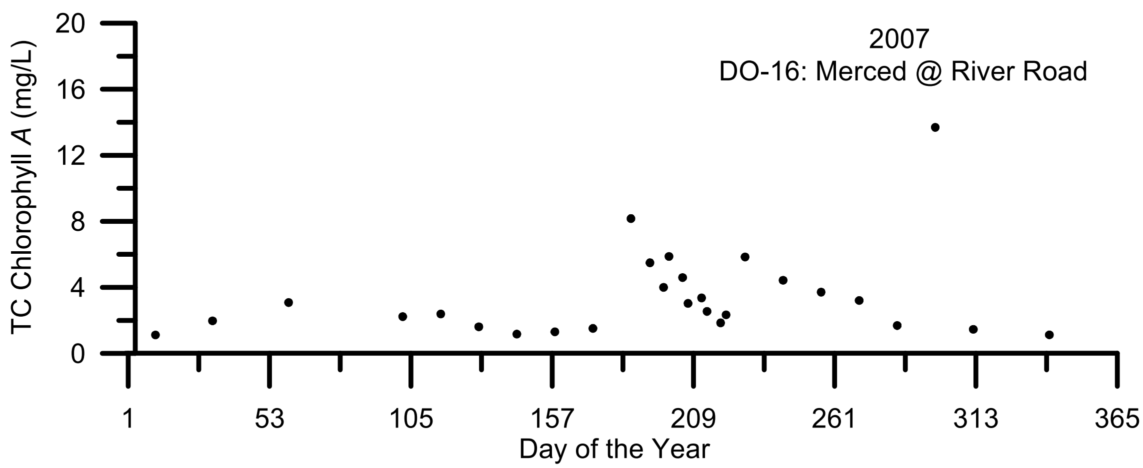

2005
DO-33: Hospital Creek
Ca (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

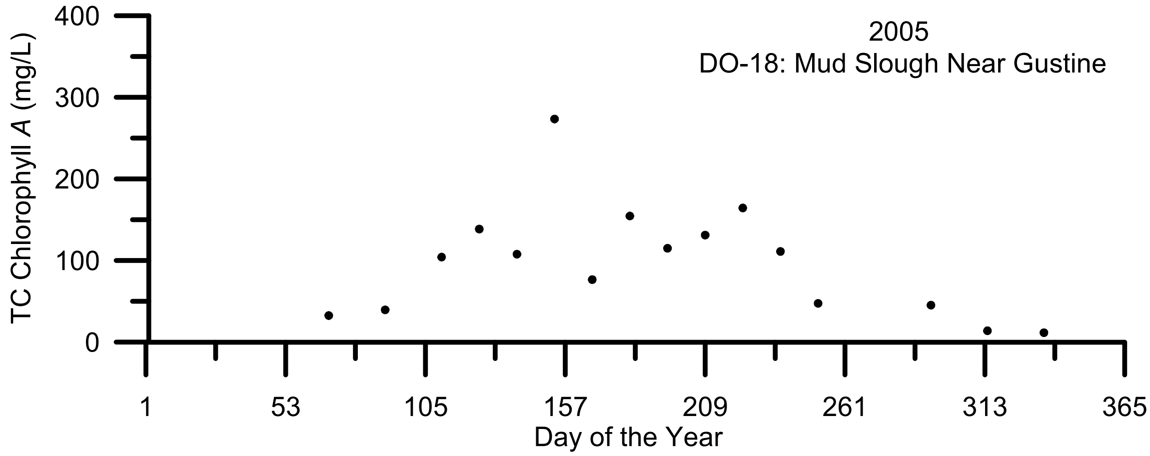

2006
DO-33: Hospital Creek
Ca (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

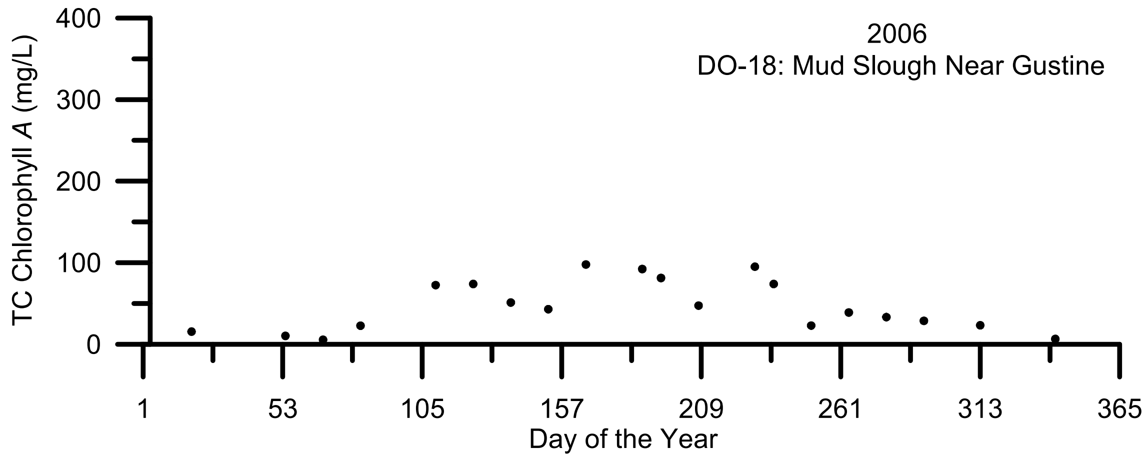

2007
DO-33: Hospital Creek
Ca (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

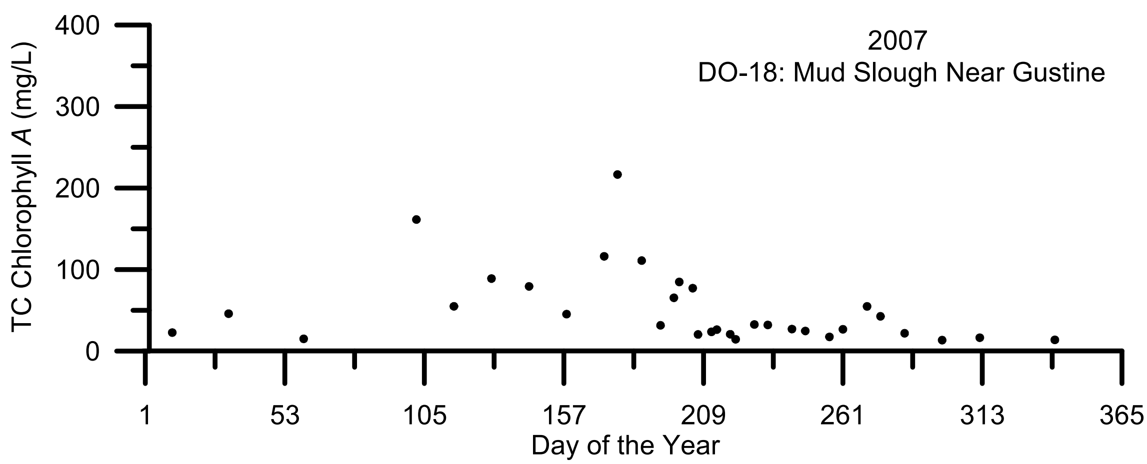

2005
DO-16: Merced @ River Road
TC Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

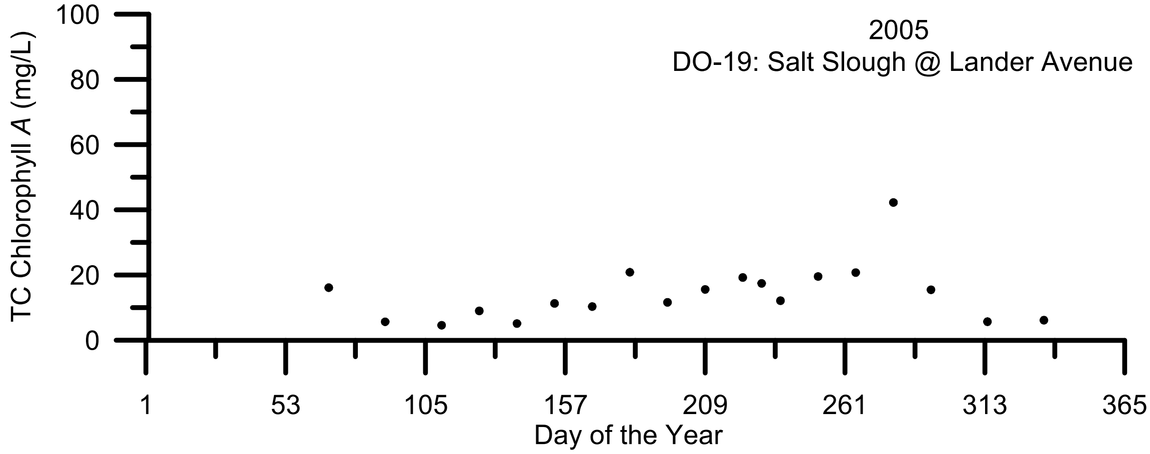

2006
DO-16: Merced @ River Road
TC Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

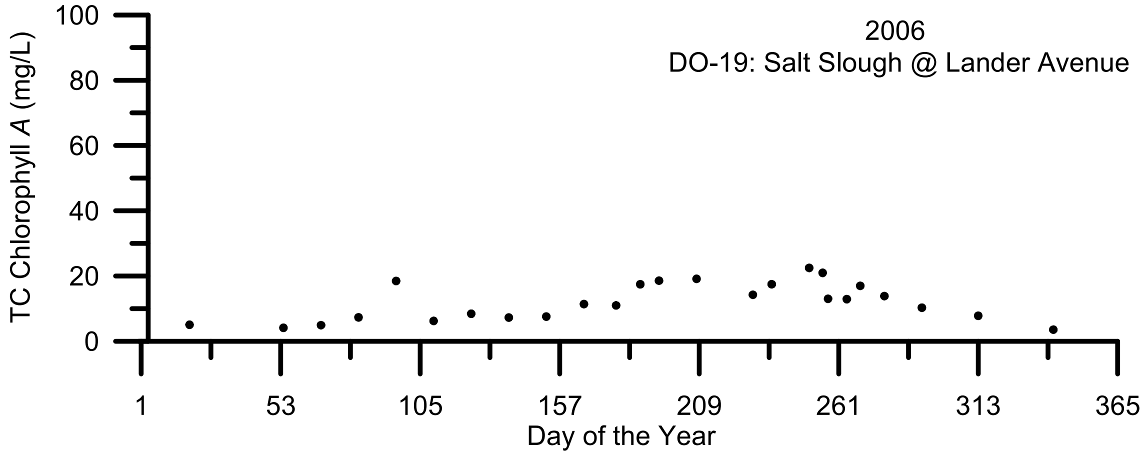

2007
DO-16: Merced @ River Road
TC Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

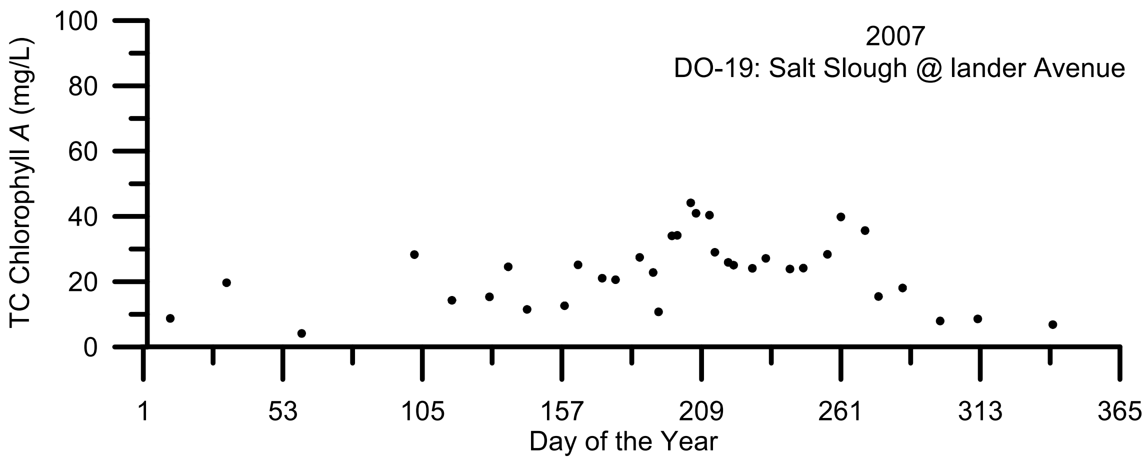

2005
DO-18: Mud Slough Near Gustine
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

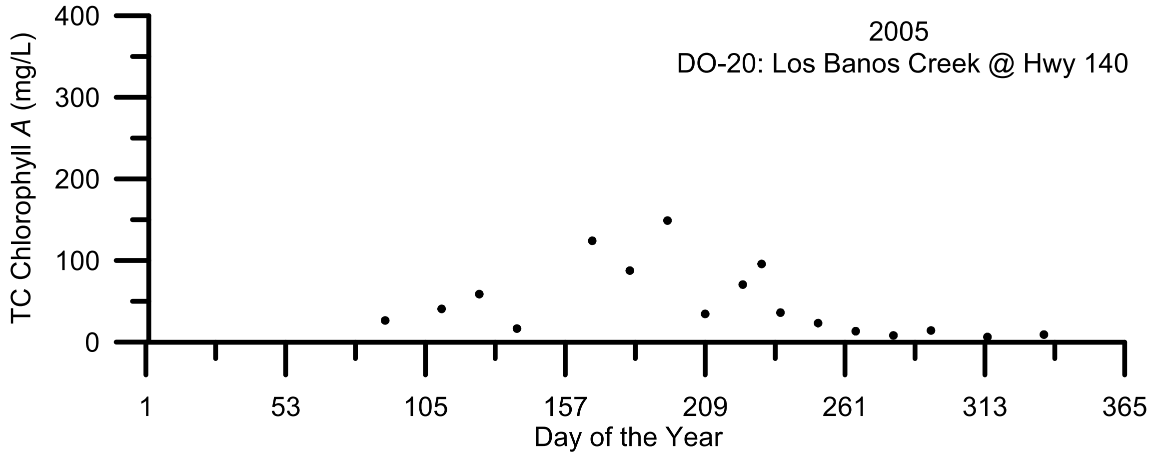

2006
DO-18: Mud Slough Near Gustine
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

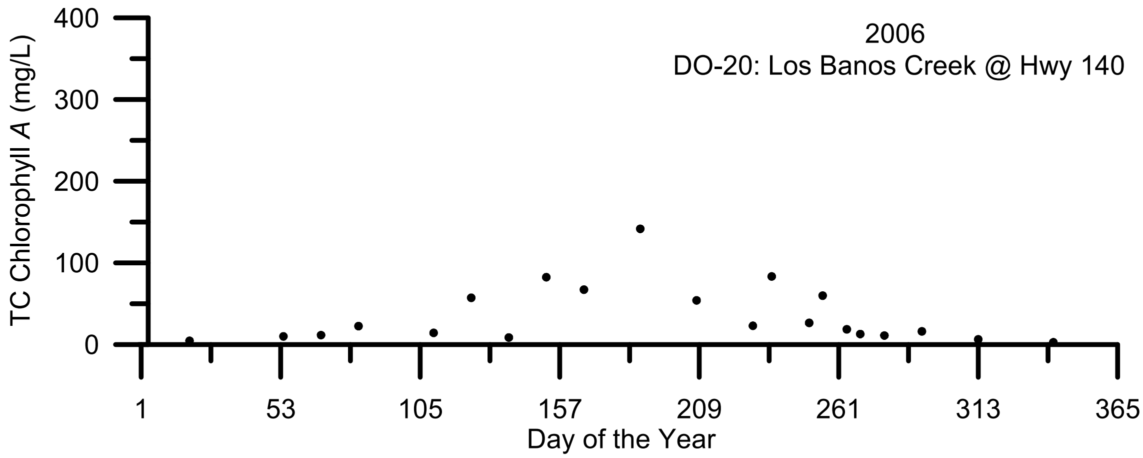

2007
DO-18: Mud Slough Near Gustine
TC Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

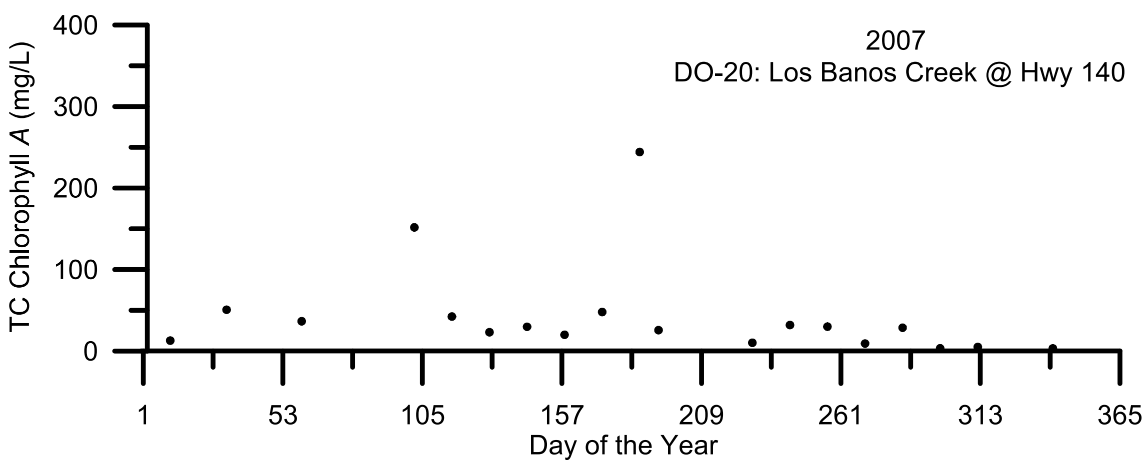

2005
DO-19: Salt Slough @ Lander Avenue
TC Chlorophyll *A* (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

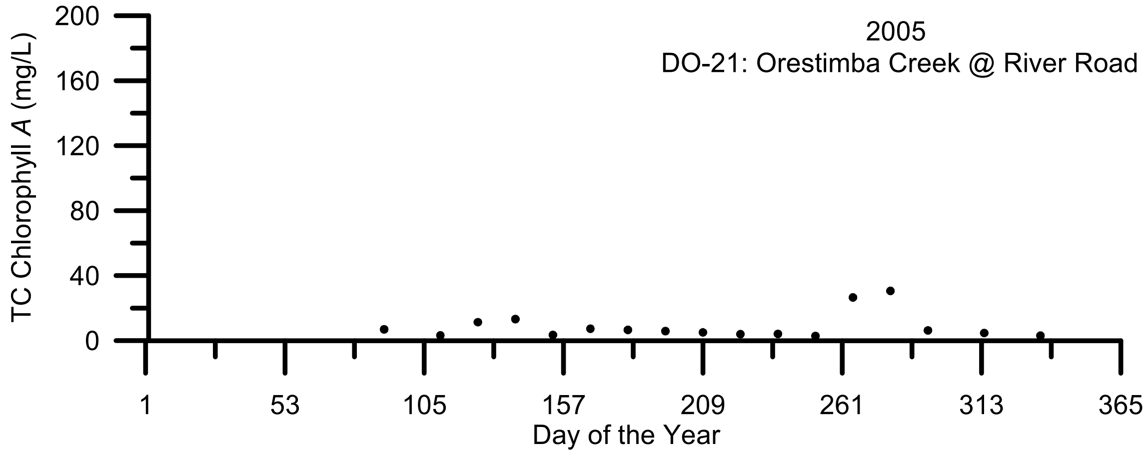

2006
DO-19: Salt Slough @ Lander Avenue
TC Chlorophyll *A* (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

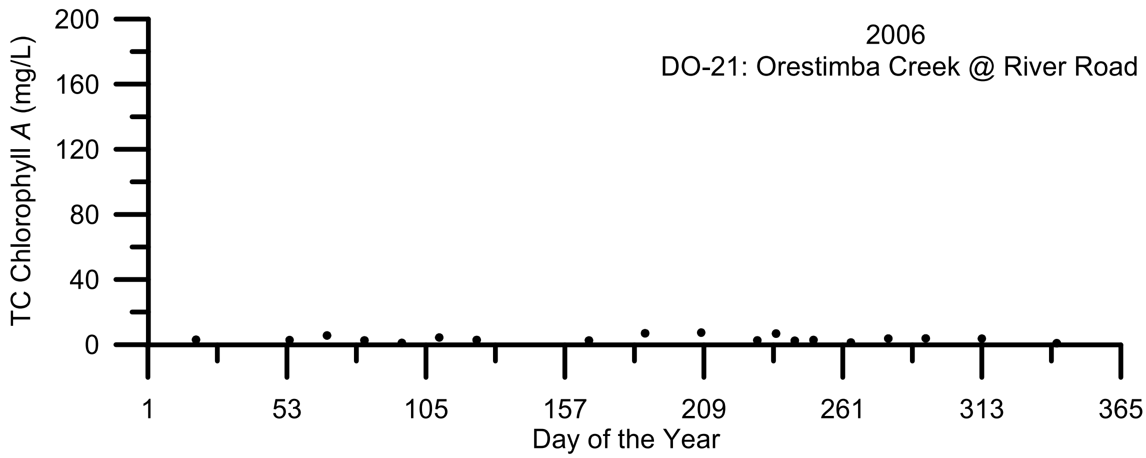

2007
DO-19: Salt Slough @ lander Avenue
TC Chlorophyll *A* (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

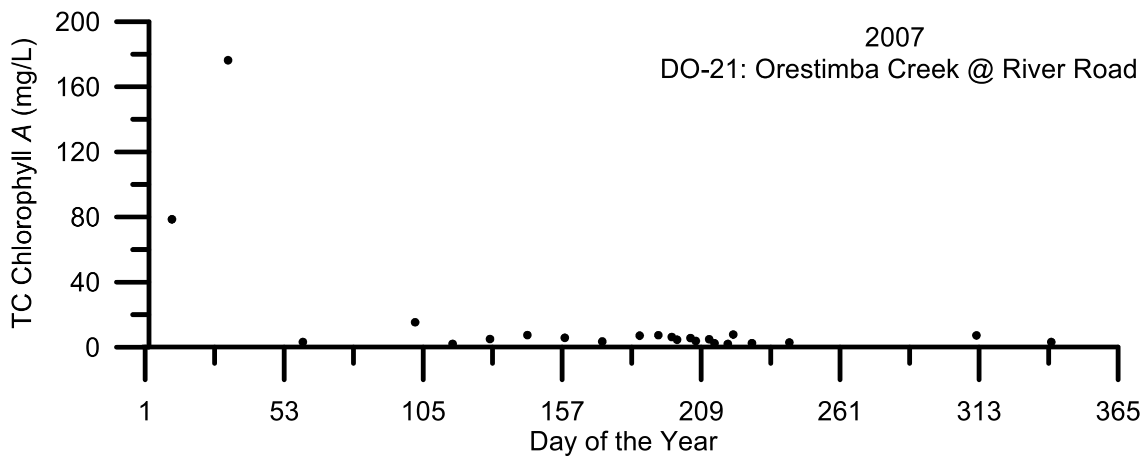

2005
DO-20: Los Banos Creek @ Hwy 140
TC Chlorophyll A (mg/L)
Day of the Year

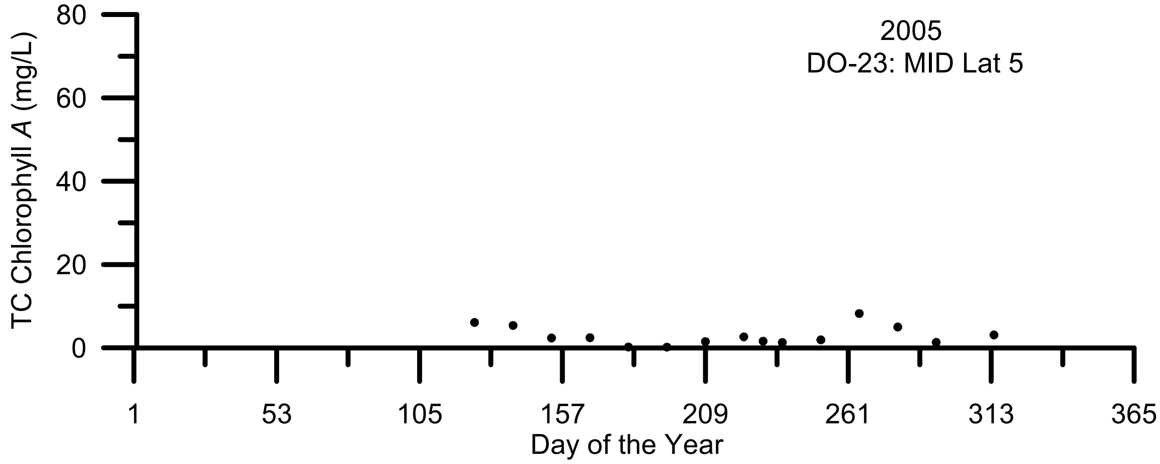

2006
DO-20: Los Banos Creek @ Hwy 140
TC Chlorophyll A (mg/L)
Day of the Year

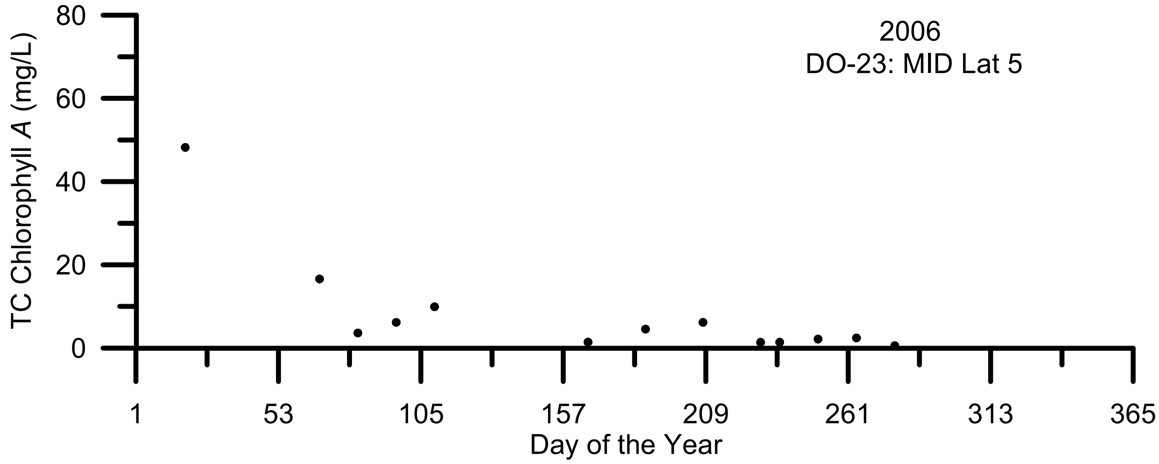

2007
DO-20: Los Banos Creek @ Hwy 140
TC Chlorophyll A (mg/L)
Day of the Year

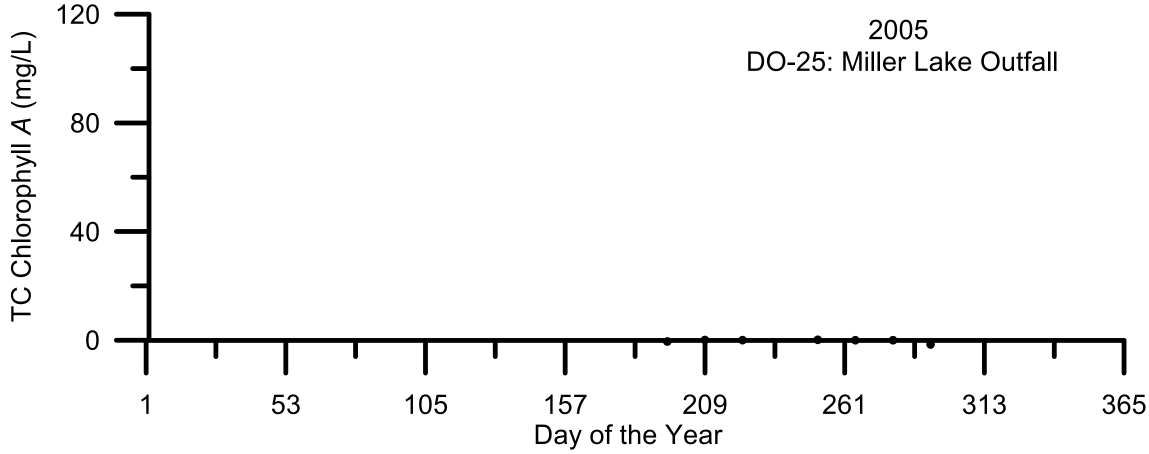

2005
DO-21: Orestimba Creek @ River Road
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

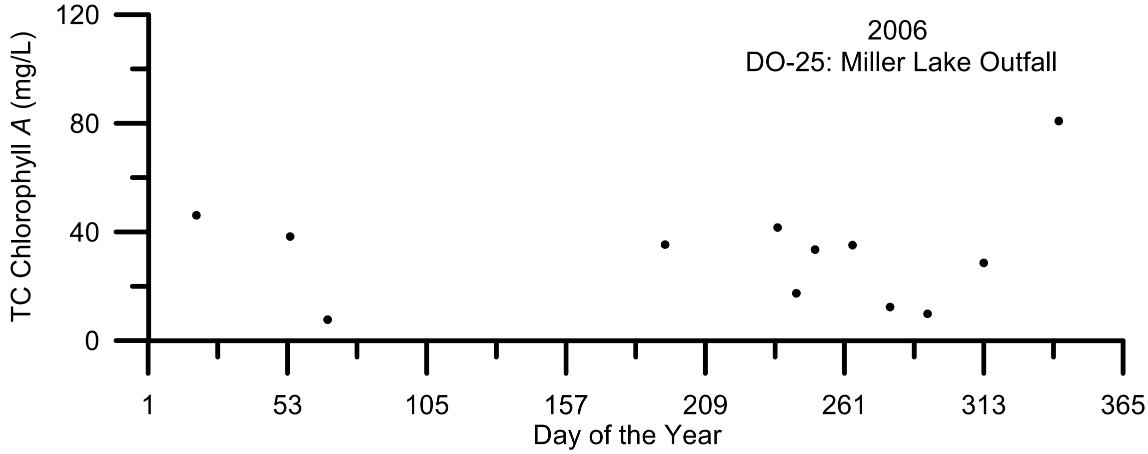

2006
DO-21: Orestimba Creek @ River Road
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

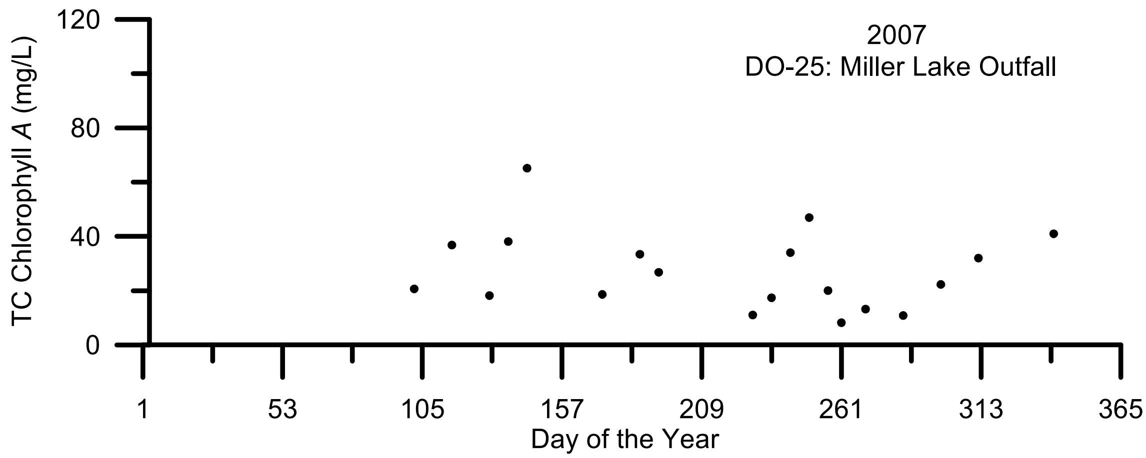

2007
DO-21: Orestimba Creek @ River Road
TC Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

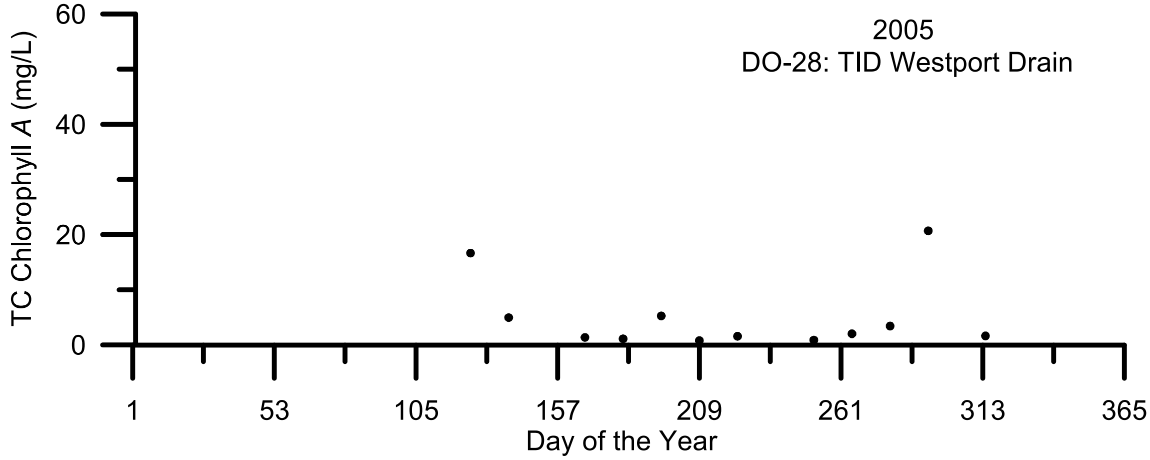

2005
DO-23: MID Lat 5
TC Chlorophyll A (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

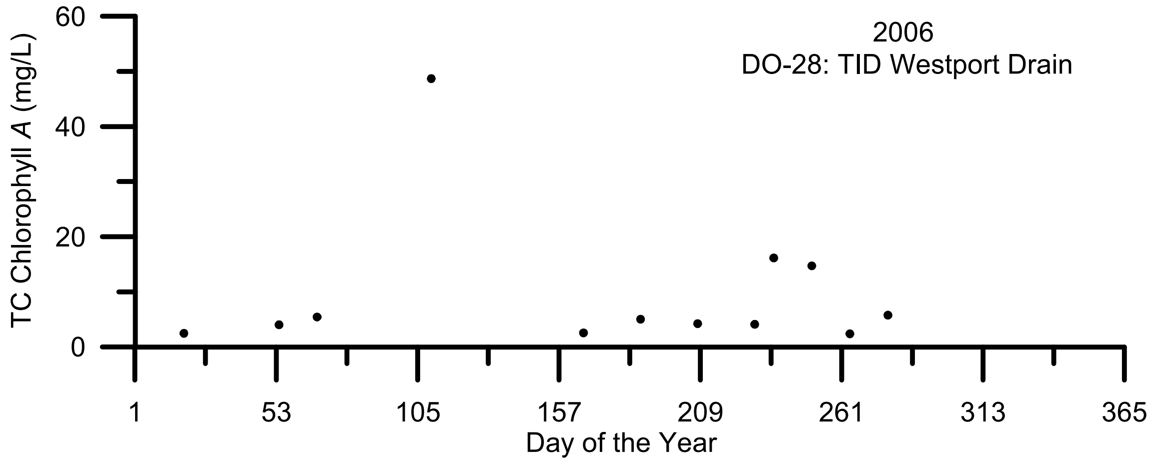

2006
DO-23: MID Lat 5
TC Chlorophyll A (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

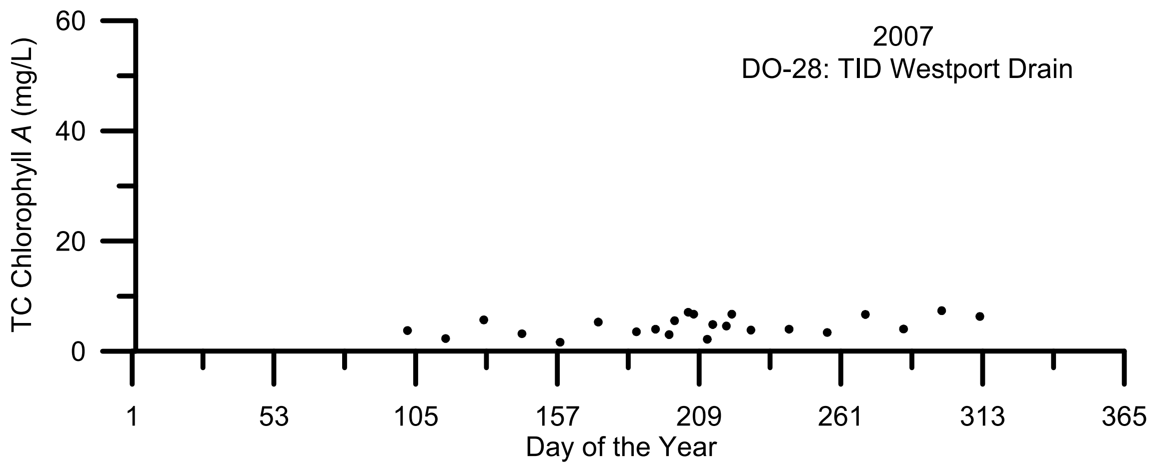

2005
DO-25: Miller Lake Outfall
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

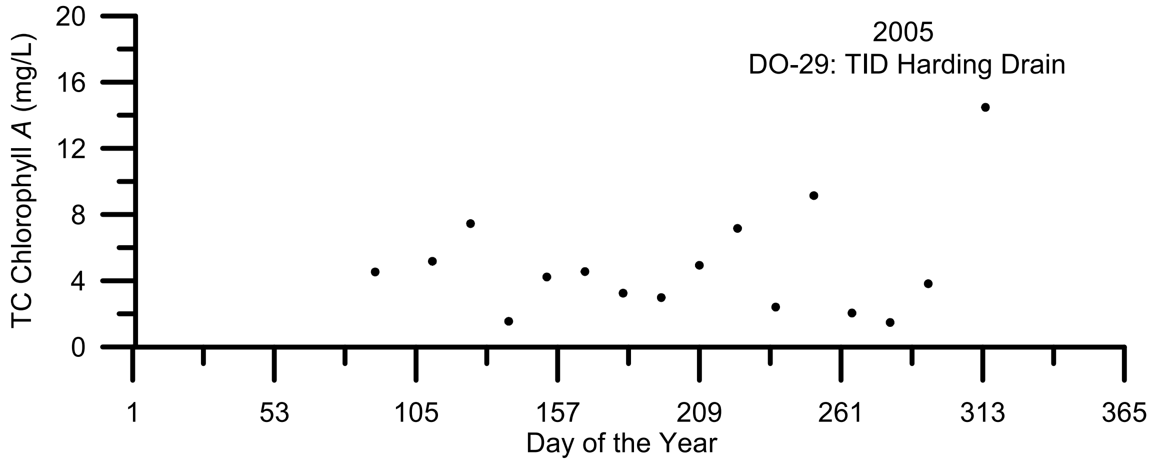

2006
DO-25: Miller Lake Outfall
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

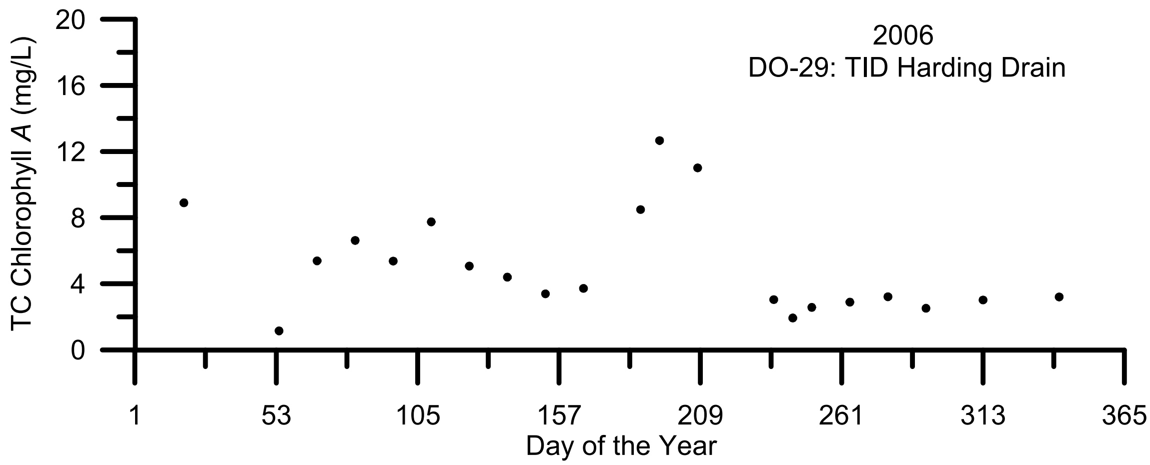

2007
DO-25: Miller Lake Outfall
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

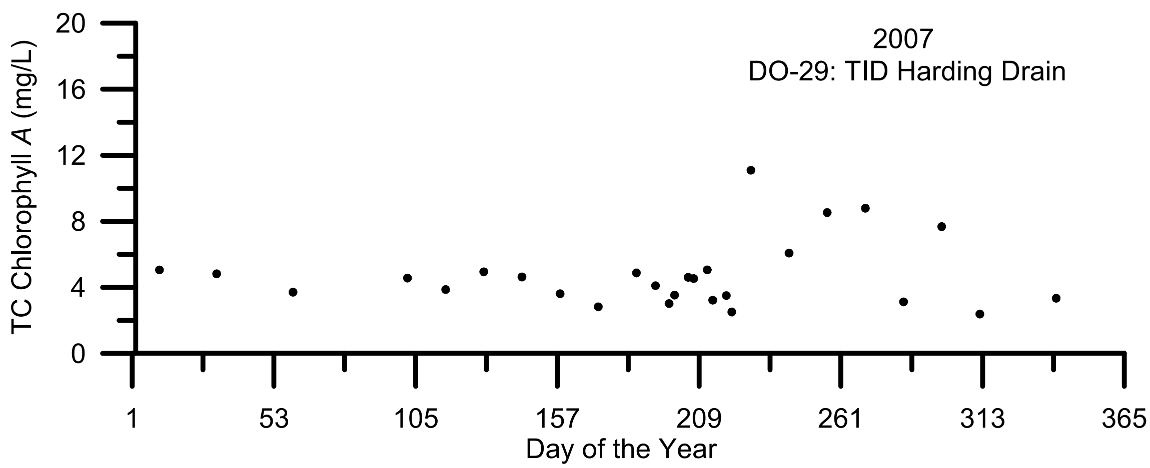

2005
DO-28: TID Westport Drain
TC Chlorophyll *A* (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

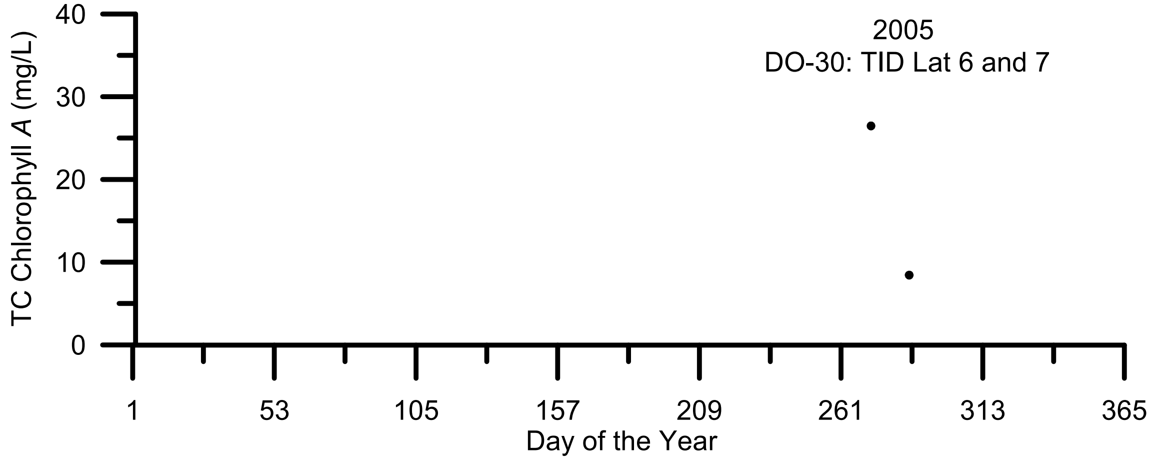

2006
DO-28: TID Westport Drain
TC Chlorophyll *A* (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-28: TID Westport Drain
TC Chlorophyll *A* (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

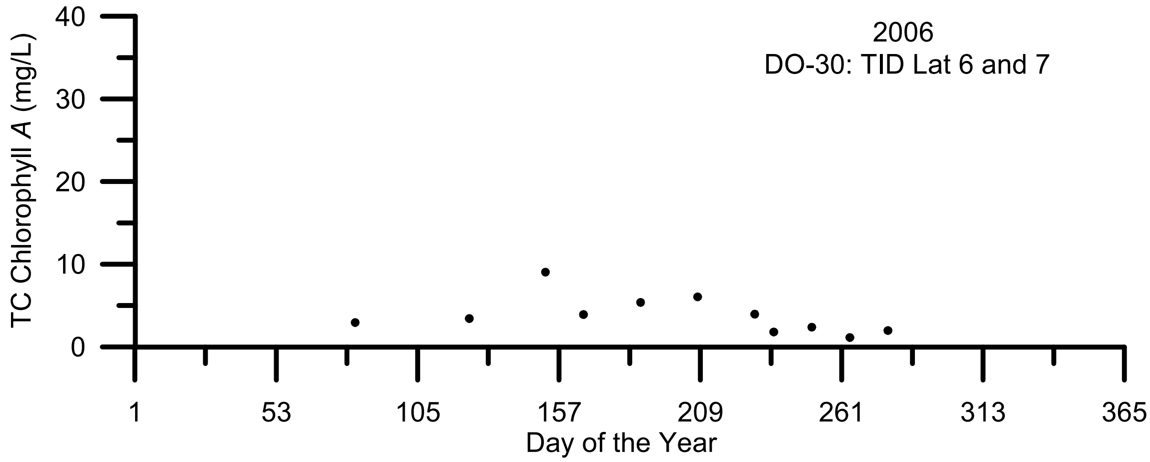

2005
DO-29: TID Harding Drain
TC Chlorophyll A (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365


2006
DO-29: TID Harding Drain
TC Chlorophyll A (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

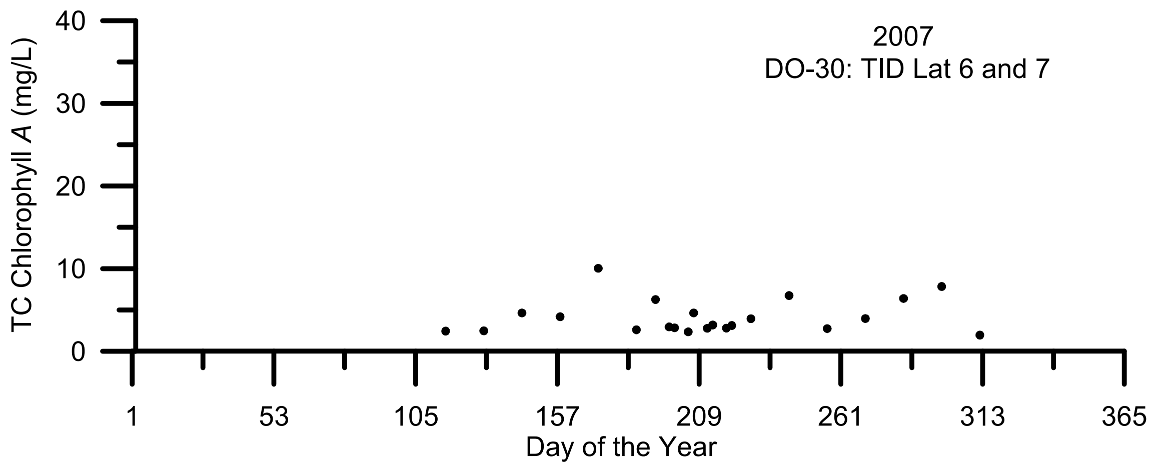

2007
DO-29: TID Harding Drain
TC Chlorophyll A (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365



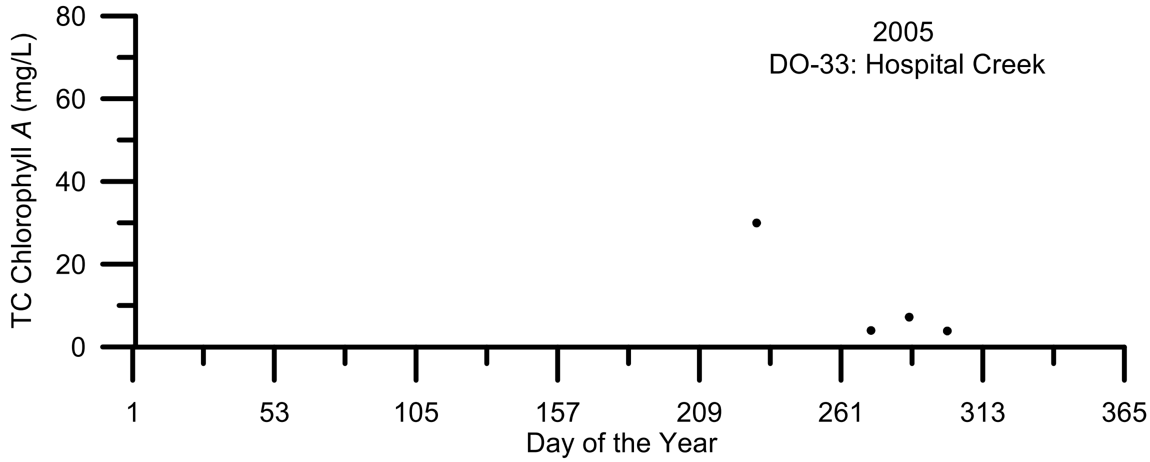
2005
DO-30: TID Lat 6 and 7
TC Chlorophyll A (mg/L)
Day of the Year

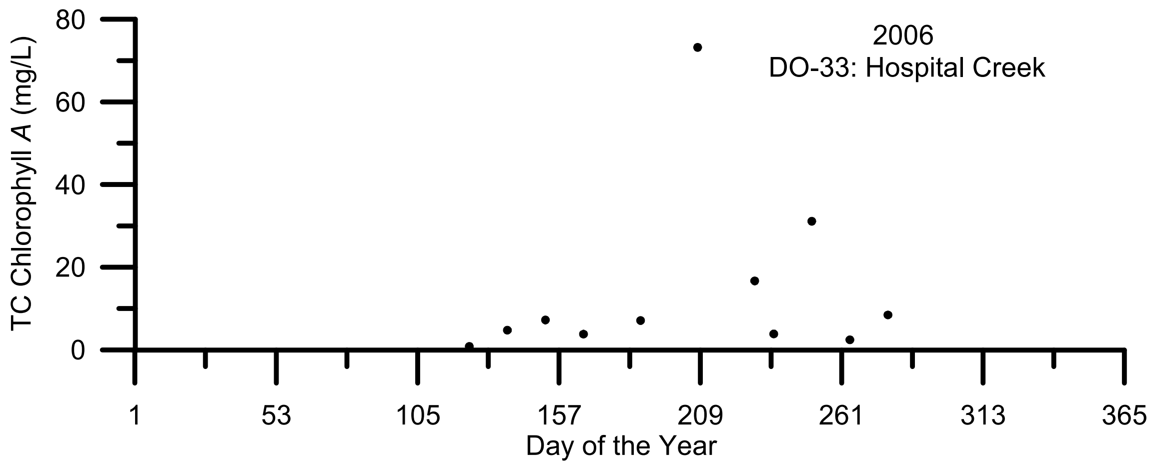


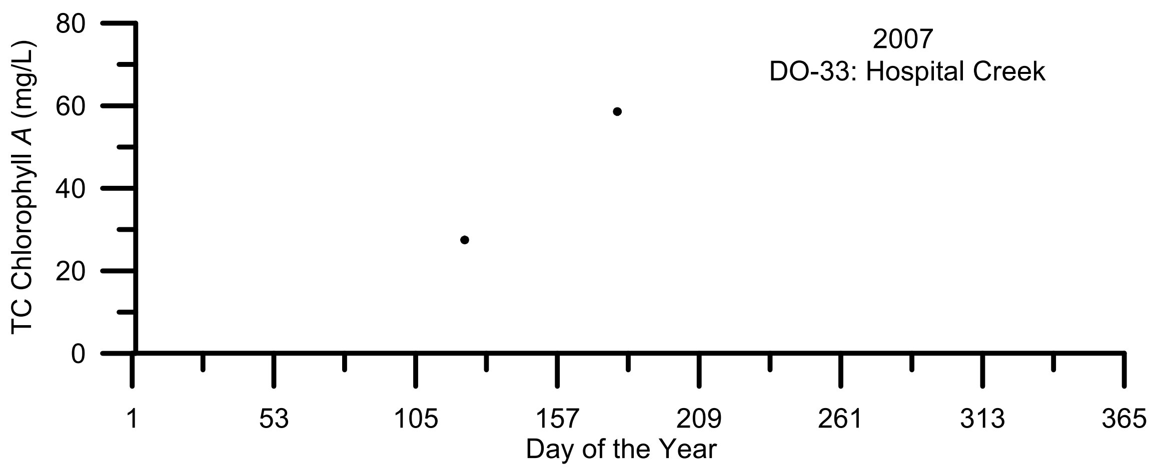
2006
DO-30: TID Lat 6 and 7
TC Chlorophyll A (mg/L)
Day of the Year

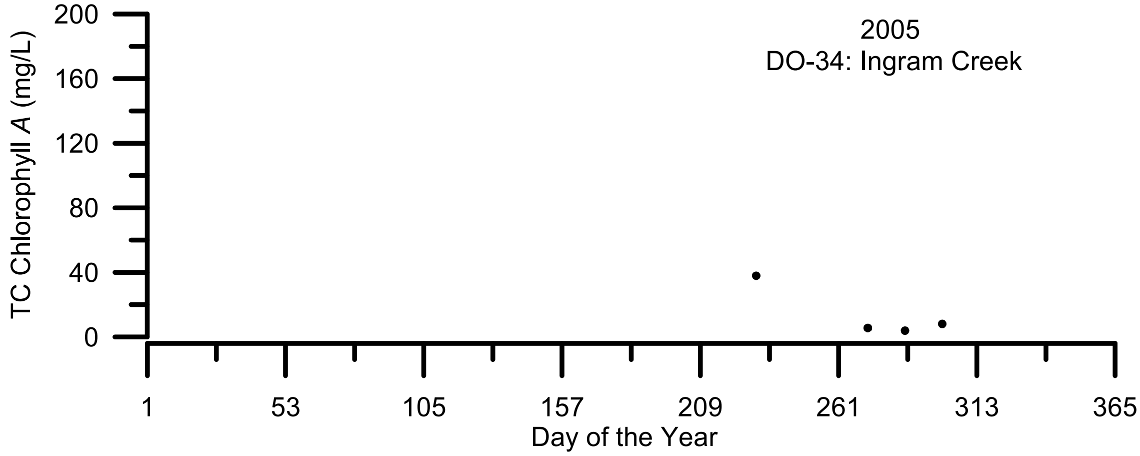


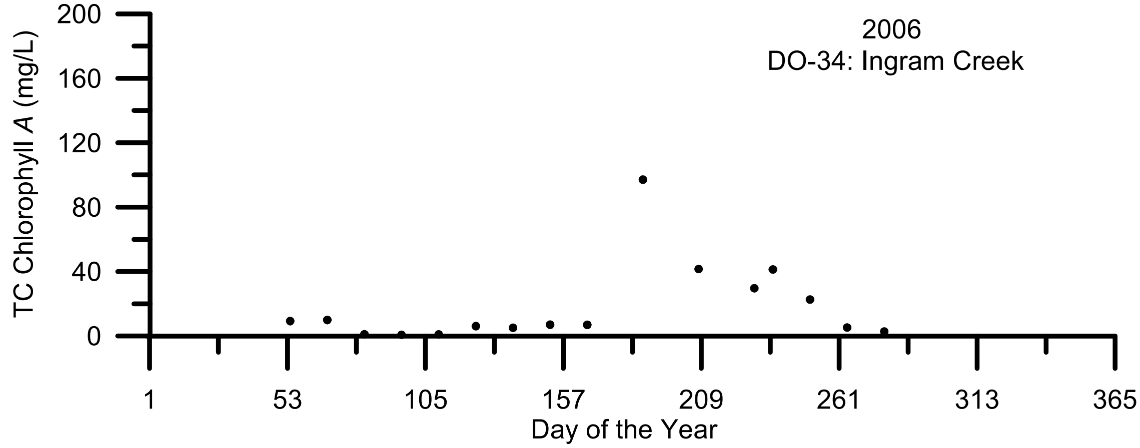
2007
DO-30: TID Lat 6 and 7
TC Chlorophyll A (mg/L)
Day of the Year

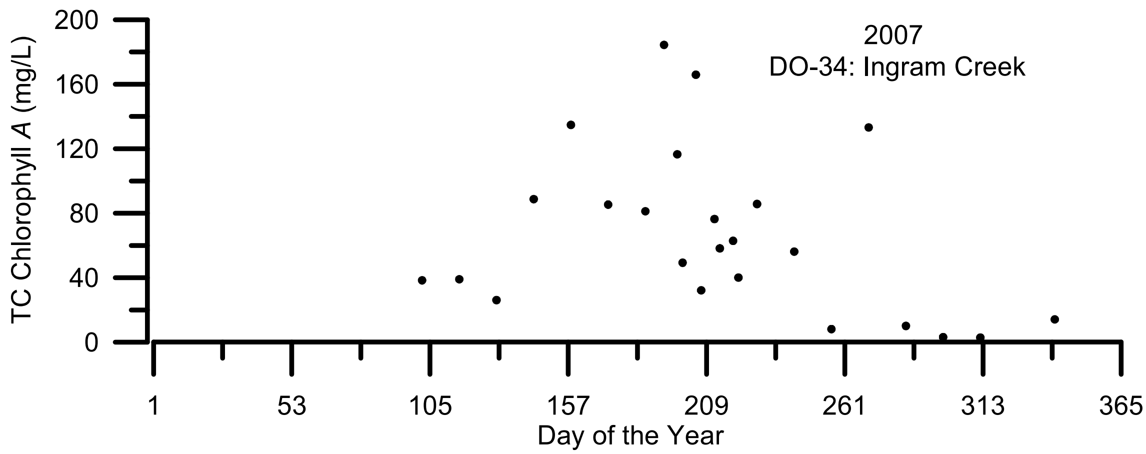

2005
DO-33: Hospital Creek
TC Chlorophyll A (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

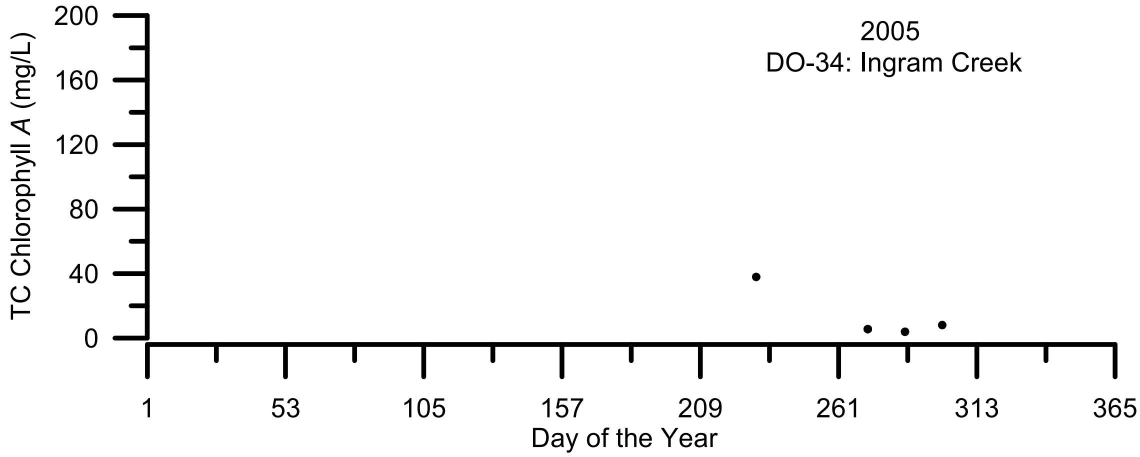

2006
DO-33: Hospital Creek
TC Chlorophyll A (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

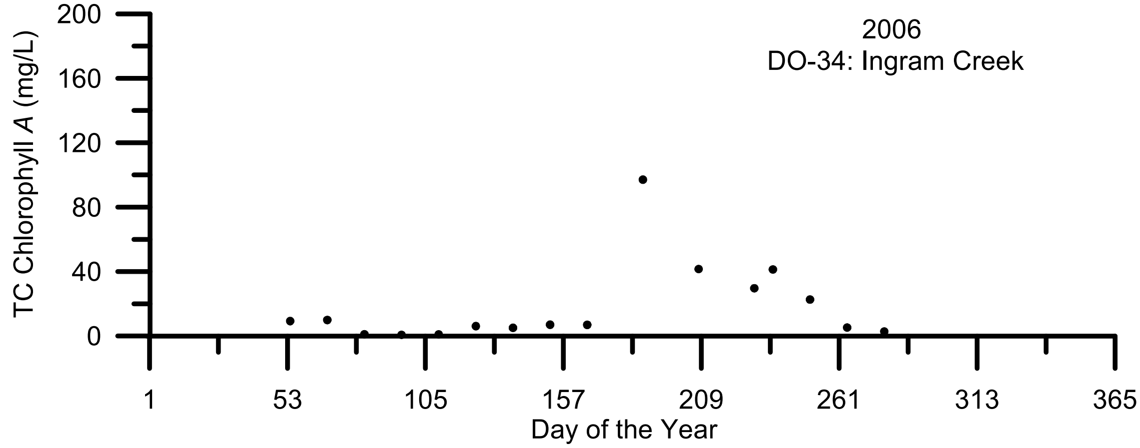

2007
DO-33: Hospital Creek
TC Chlorophyll A (mg/L)
0
20
40
60
80
1
53
105
157
209
261
313
365
Day of the Year

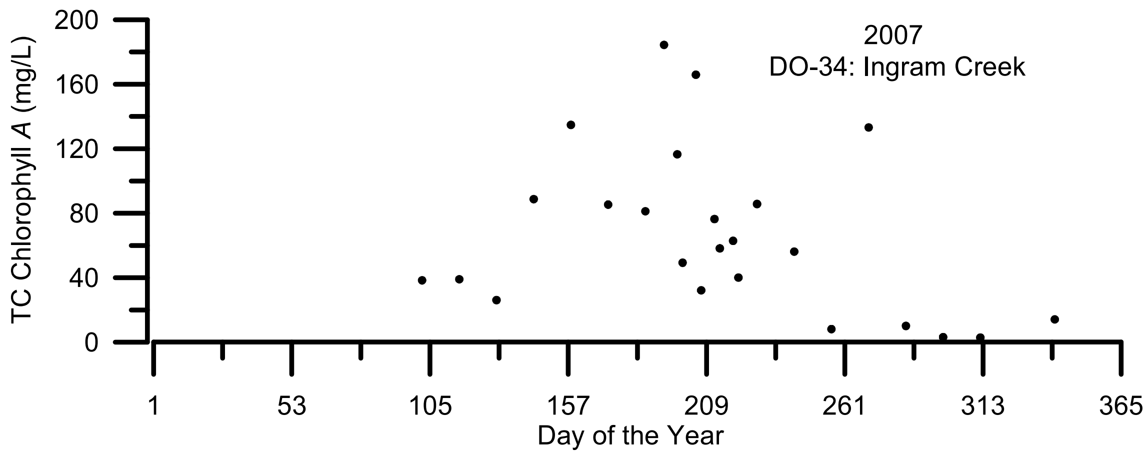

2005
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

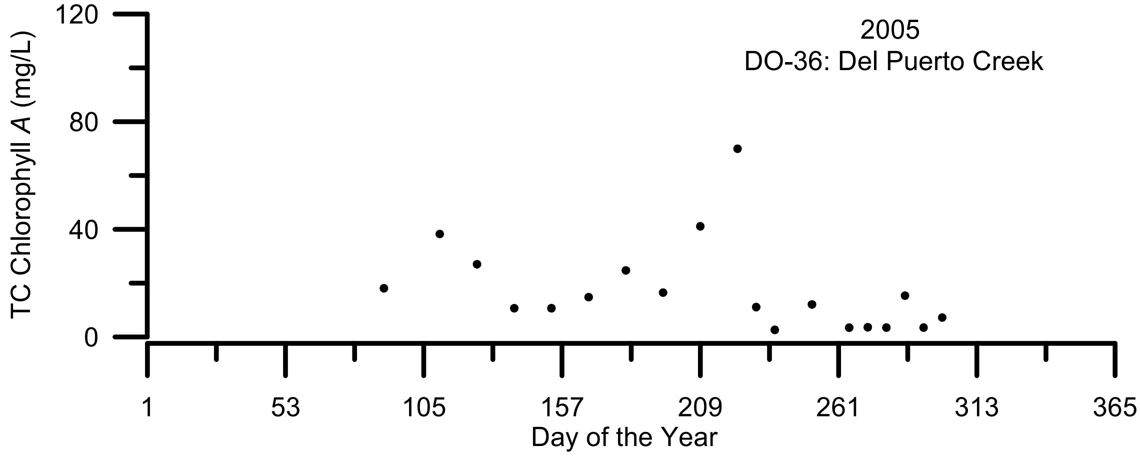

2006
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

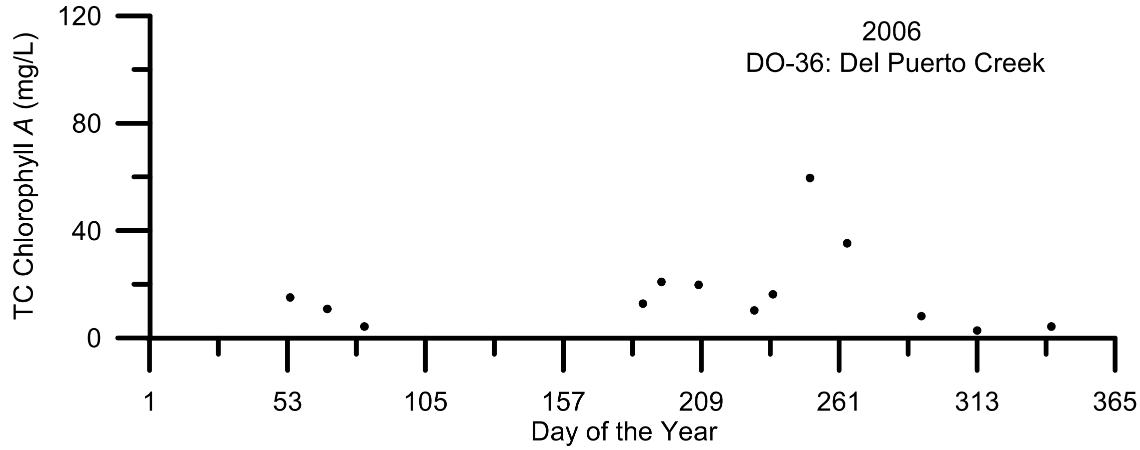

2005
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
Day of the Year


2006
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
Day of the Year

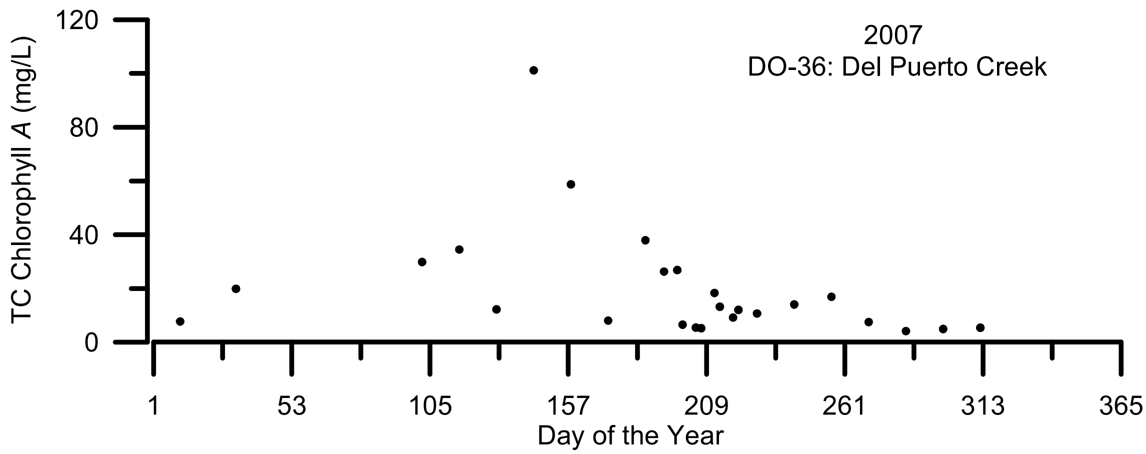

2007
DO-34: Ingram Creek
TC Chlorophyll A (mg/L)
Day of the Year



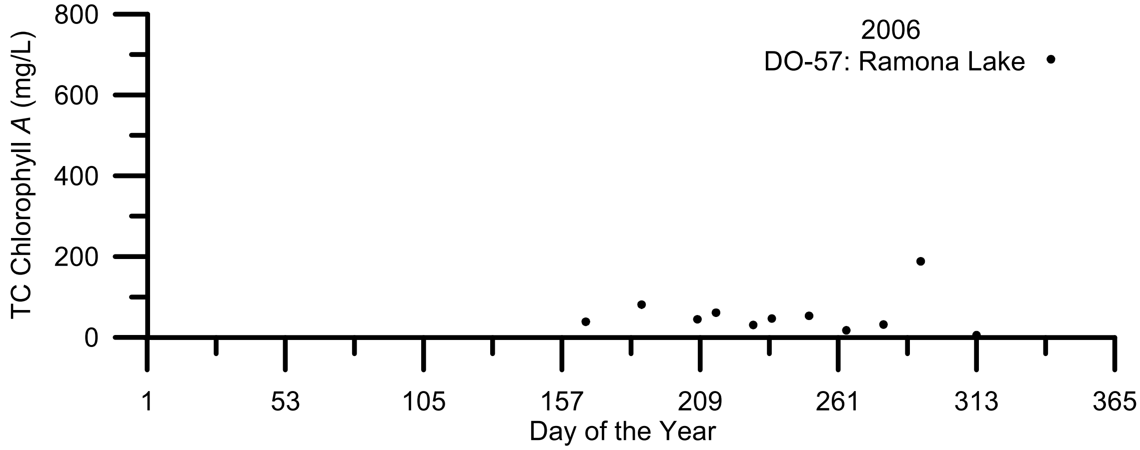
2005
DO-36: Del Puerto Creek
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

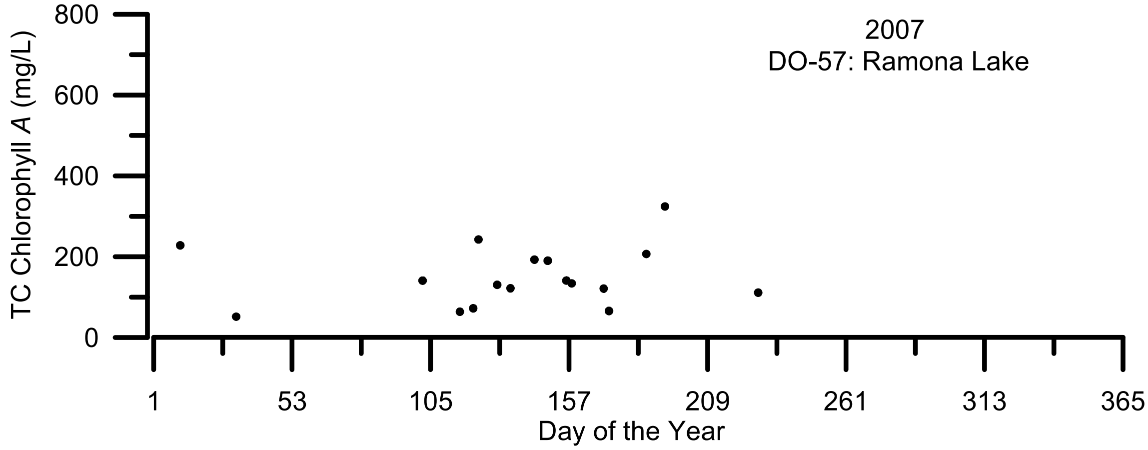


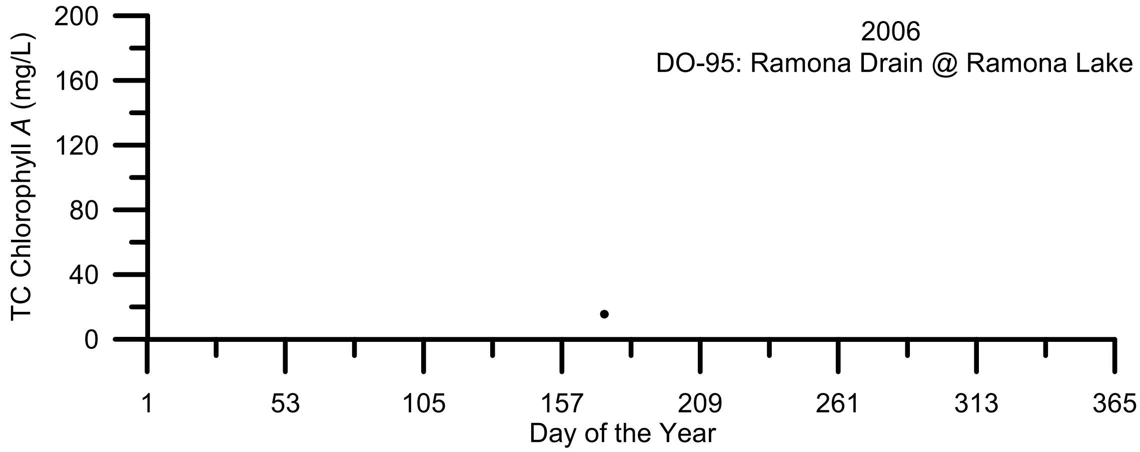
2006
DO-36: Del Puerto Creek
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

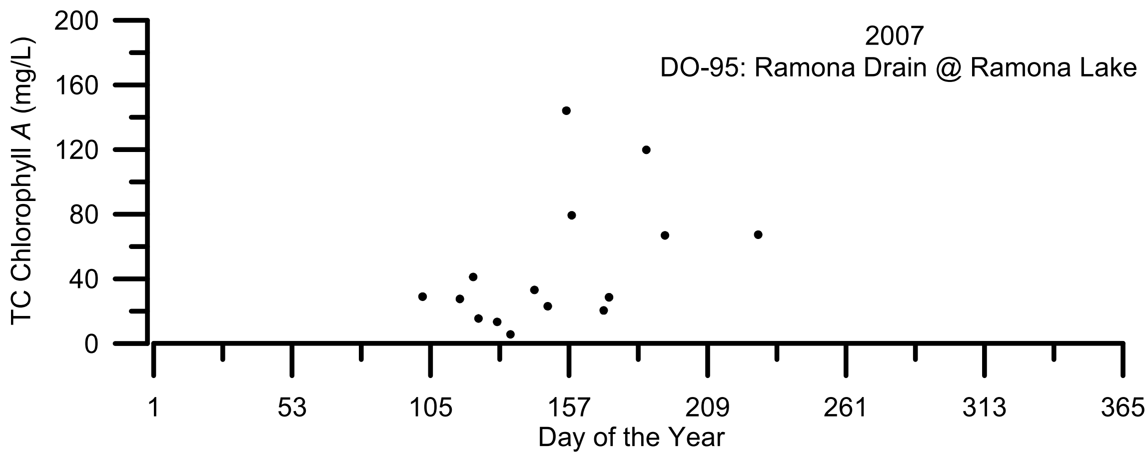


2007
DO-36: Del Puerto Creek
TC Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-57: Ramona Lake
TC Chlorophyll A (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-57: Ramona Lake
TC Chlorophyll A (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


200
160
120
80
40
0
TC Chlorophyll A (mg/L)
2006
DO-95: Ramona Drain @ Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year


200
160
120
80
40
0
TC Chlorophyll A (mg/L)
2007
DO-95: Ramona Drain @ Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year

Standard Methods Pheophyton Extract Data for the San Joaquin River Watershed 2005-2007

Remie Burks
Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

Environmental Engineering Research Program
School of Engineering and Computer Science
University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total pheophyton concentration as determined by Standard Methods for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per the *EERP Field Protocol Book*. Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements. Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at $4^{\circ}C$ until filtering. Chlorophyll-a (chl-a) and pheophytin-a (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin-Elmer Lambda 35 spectrophotometer (Wellesley, MA) using a 5 cm path length (Borglin, et al 2008).

Results and Discussion

Pheophyton was analyzed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). No standard solutions for this analysis were available so only duplicates and blanks could be analyzed to insure uniformity and accuracy in the application of the method and for those two QA parameters, there was an 82.03% passage rate for this analysis.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

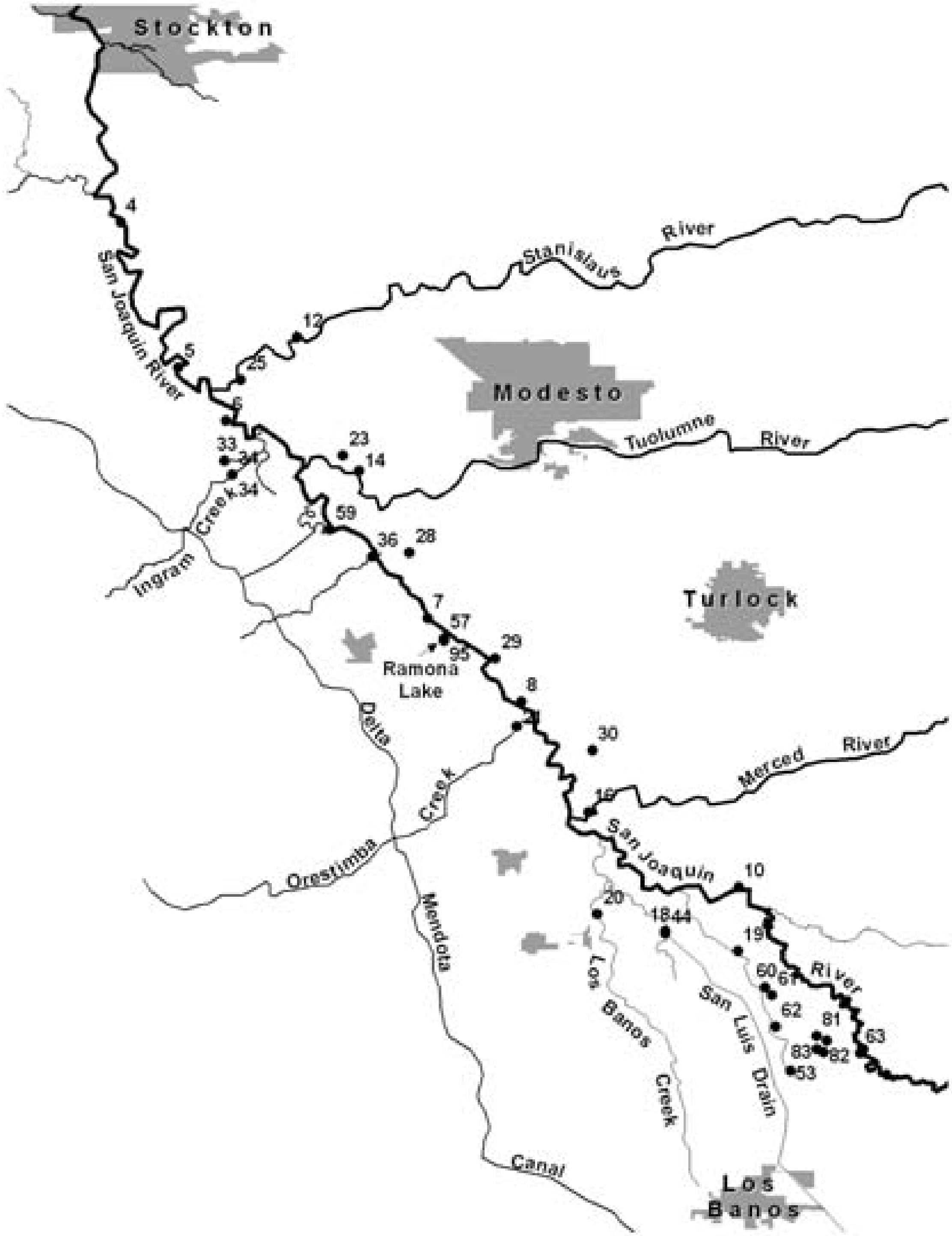
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

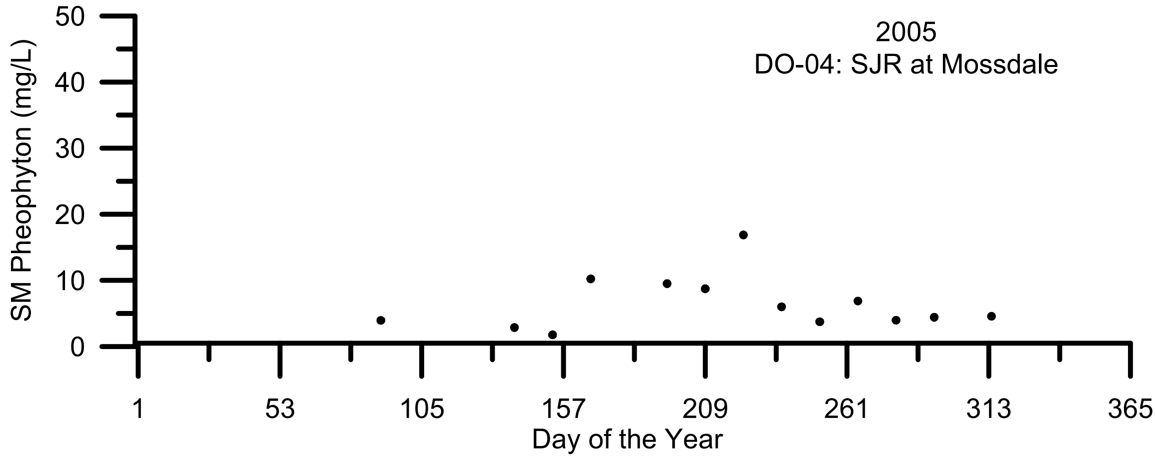
Table 1: EERP Sampling Site List

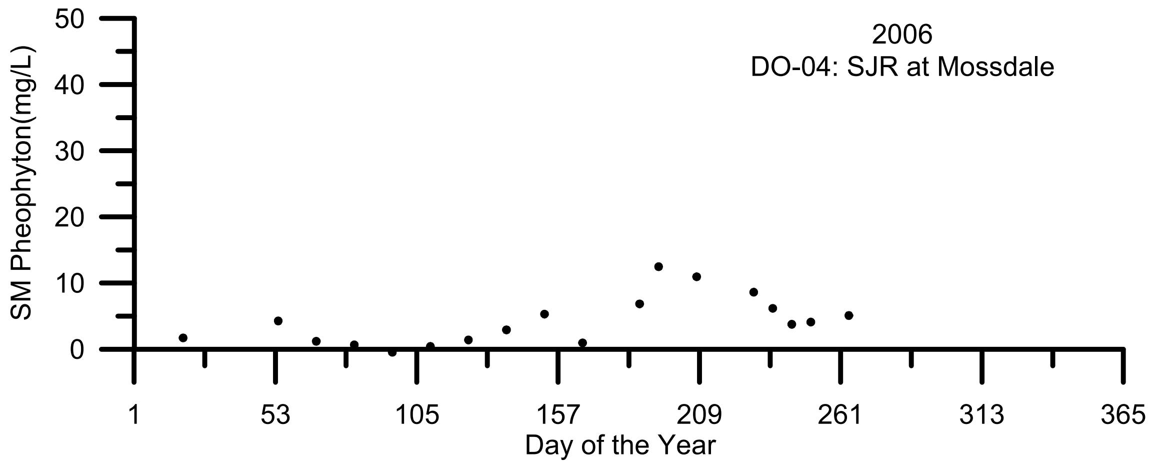
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

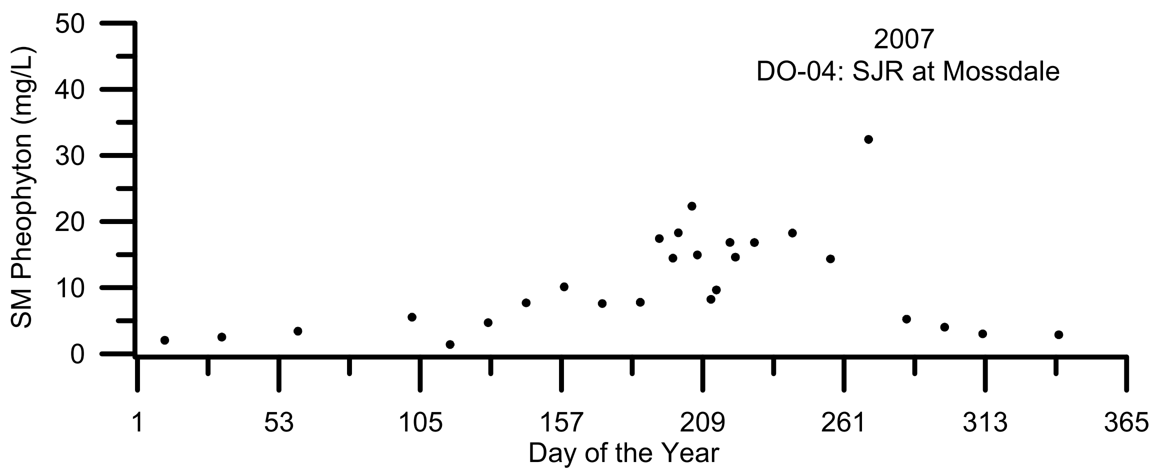
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

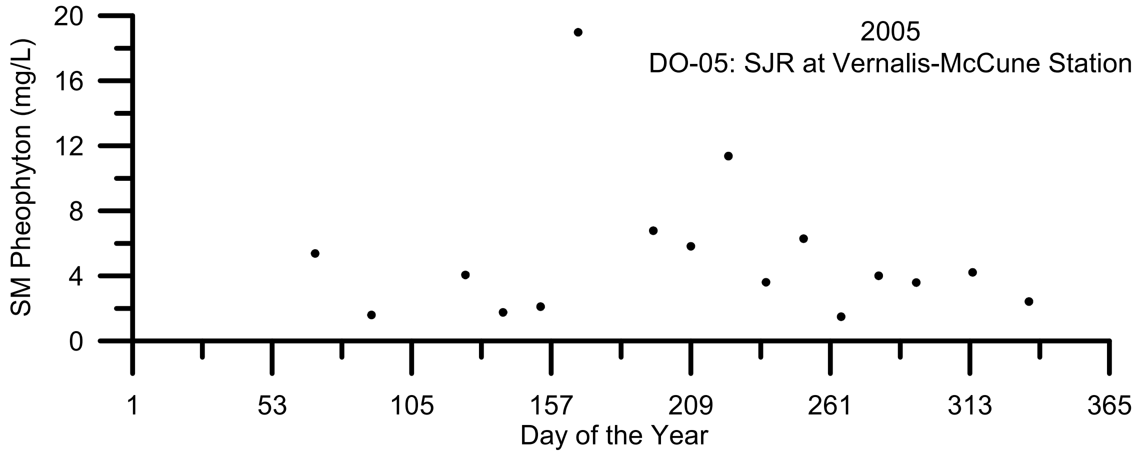


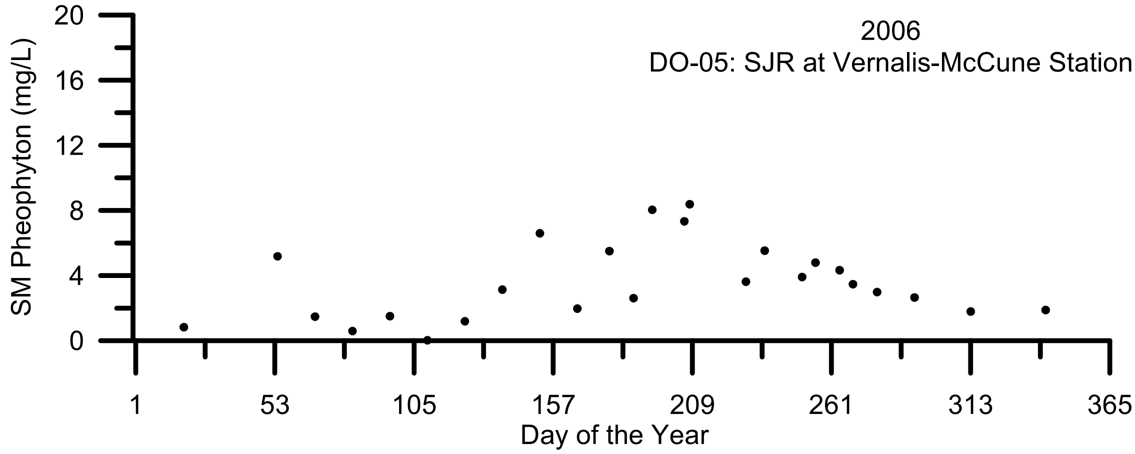
Figures 2 -72: Temporal Plots of SM Pheophyton Concentration By Site ID

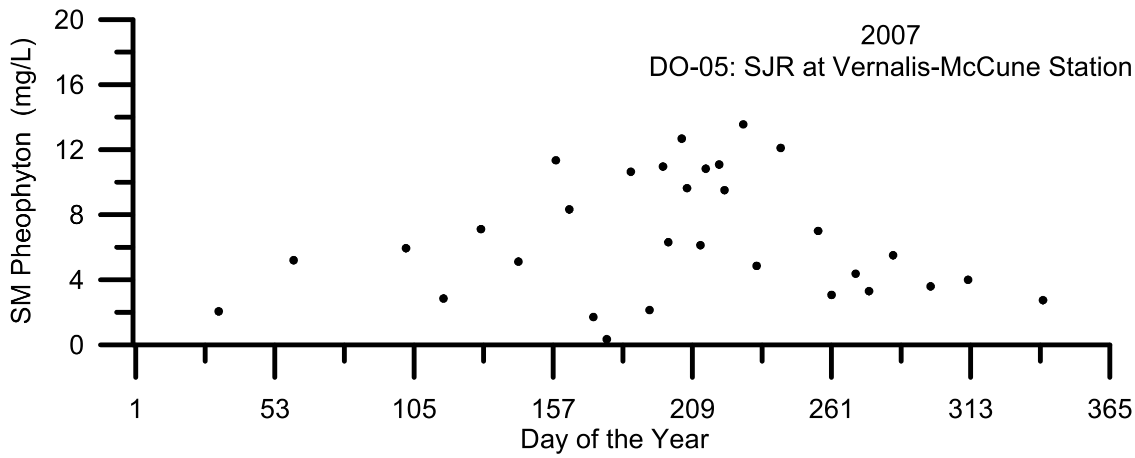

2005
DO-04: SJR at Mossdale
SM Pheophyton (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

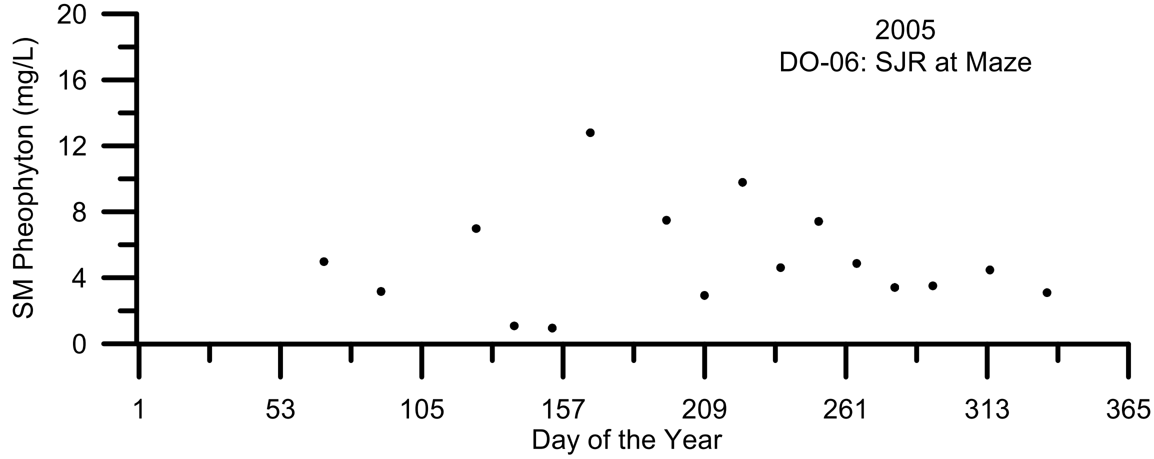

2006
DO-04: SJR at Mossdale
SM Pheophyton(mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

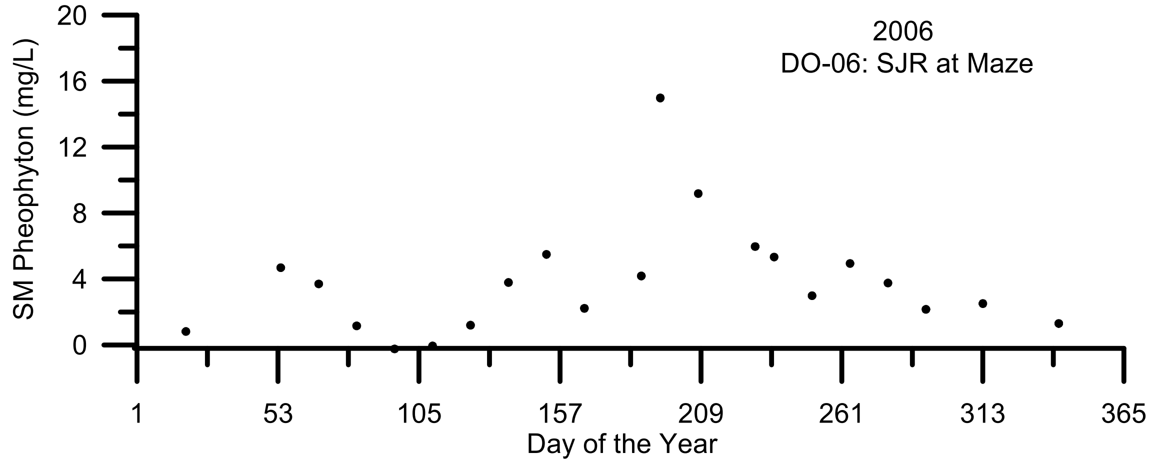

2007
DO-04: SJR at Mossdale
SM Pheophyton (mg/L)
50
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

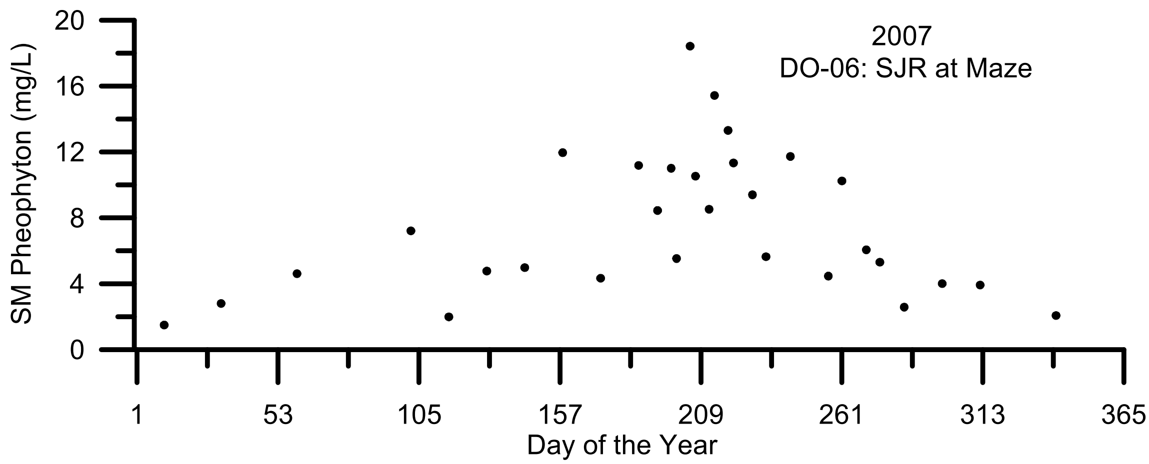

2005
DO-05: SJR at Vernalis-McCune Station
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

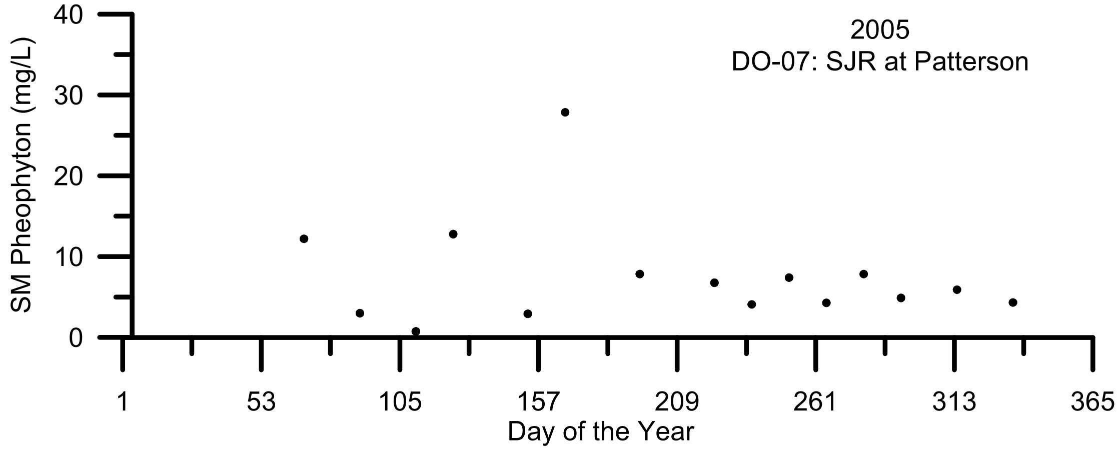

2006
DO-05: SJR at Vernalis-McCune Station
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

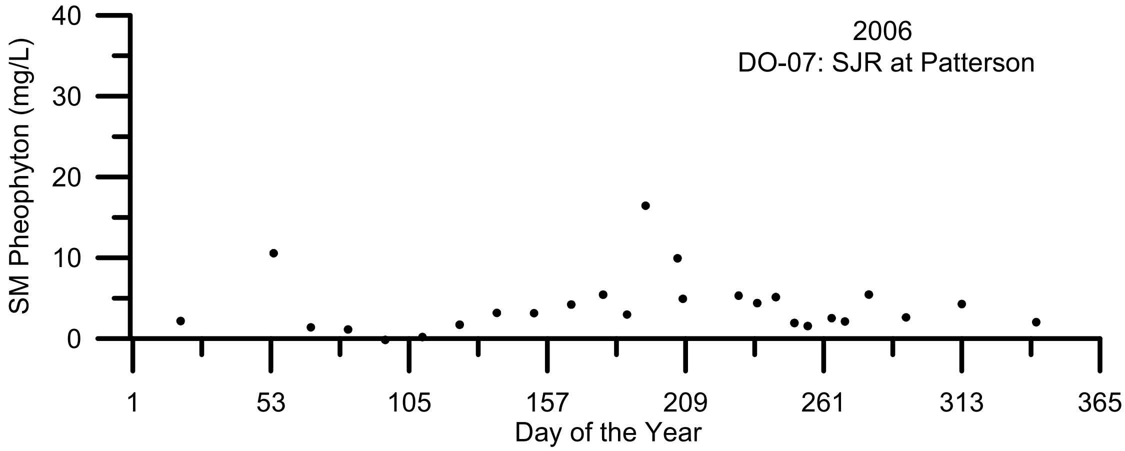

2007
DO-05: SJR at Vernalis-McCune Station
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

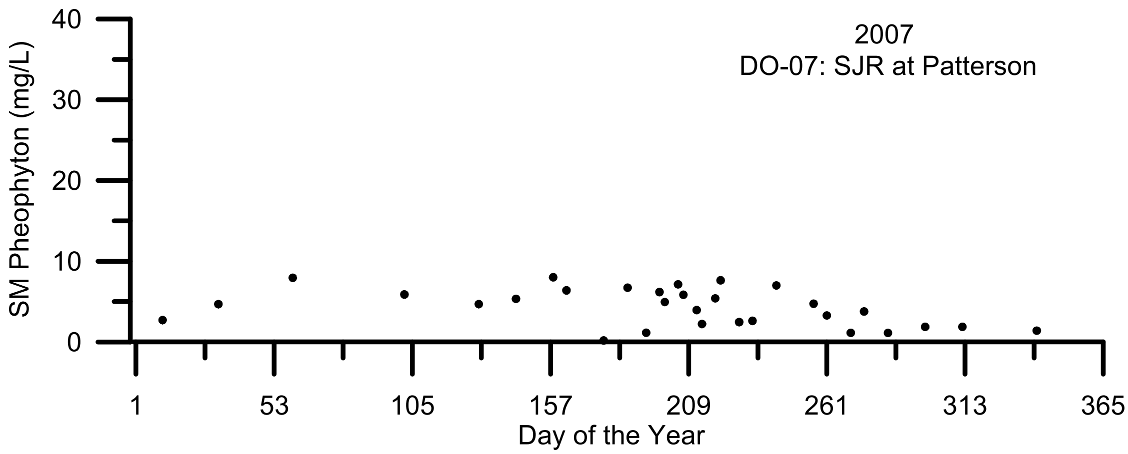

2005
DO-06: SJR at Maze
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

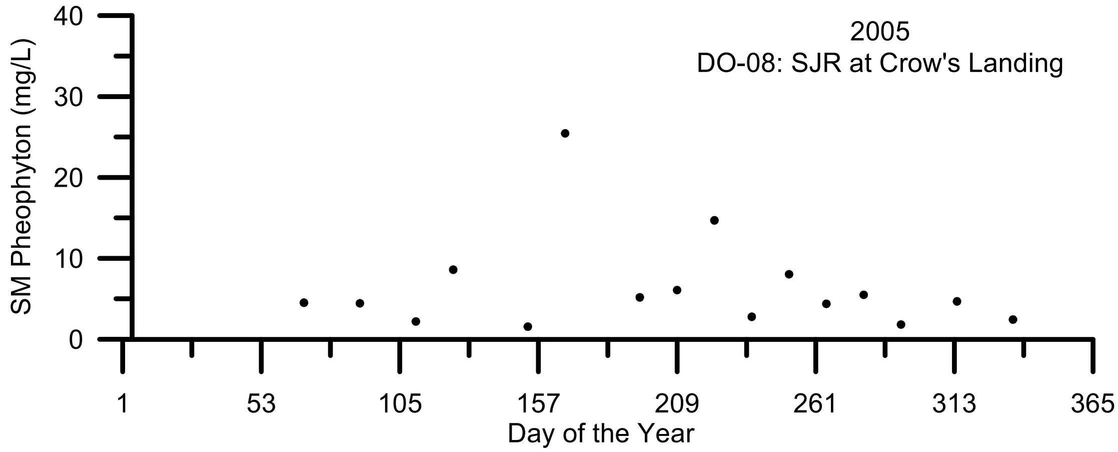

2006
DO-06: SJR at Maze
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

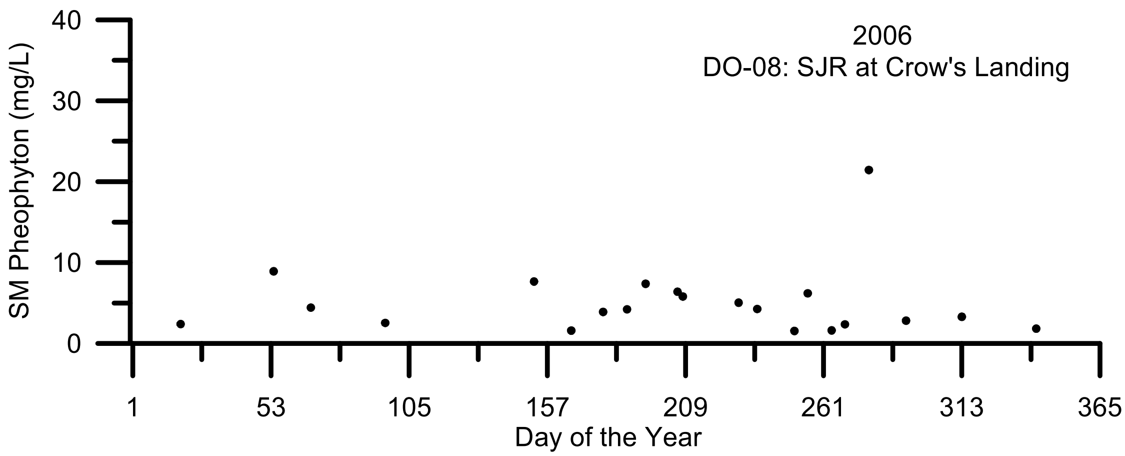

2007
DO-06: SJR at Maze
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

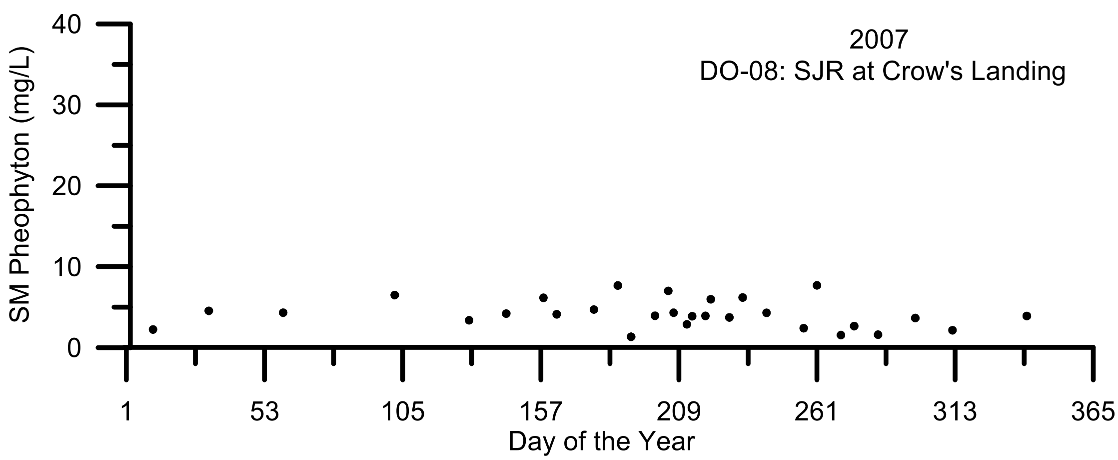

2005
DO-07: SJR at Patterson
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

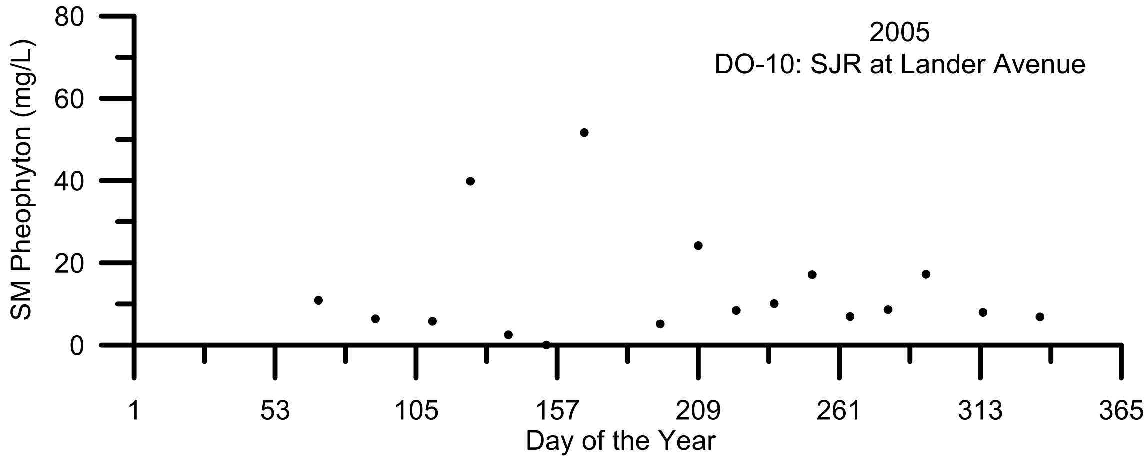

2006
DO-07: SJR at Patterson
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

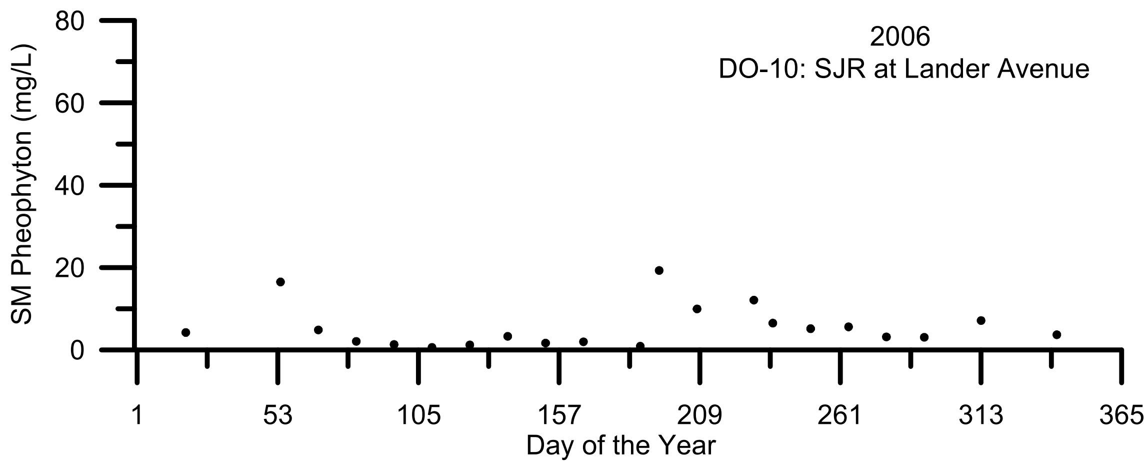

2007
DO-07: SJR at Patterson
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

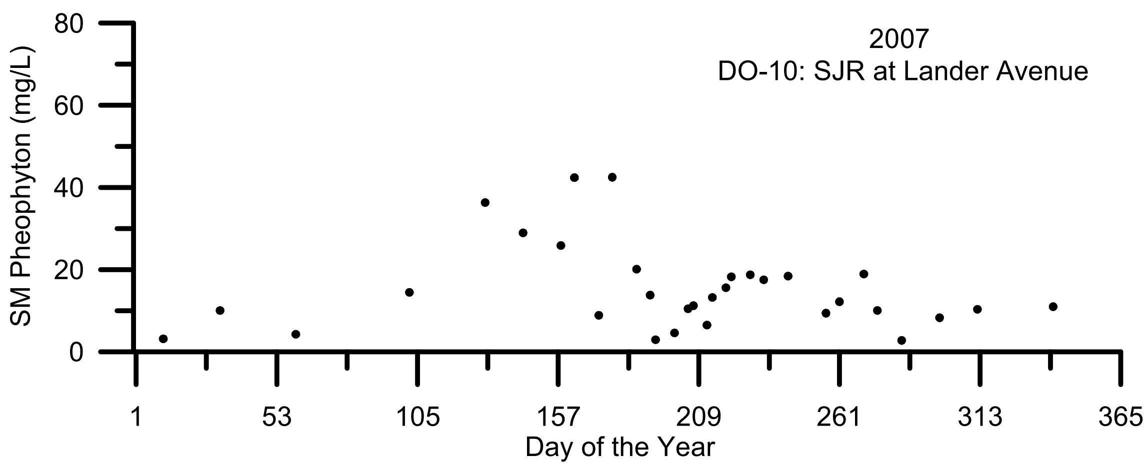

2005
DO-08: SJR at Crow's Landing
SM Pheophyton (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

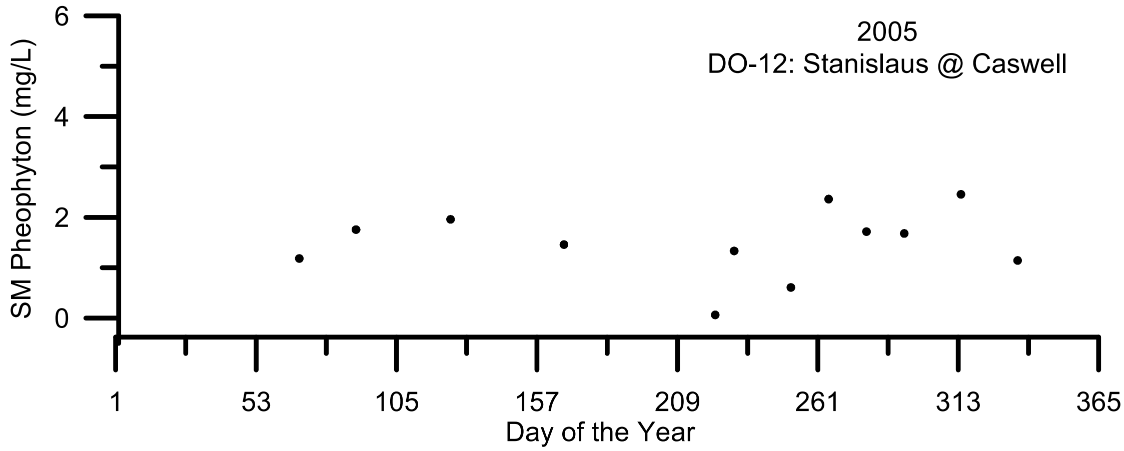

2006
DO-08: SJR at Crow's Landing
SM Pheophyton (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365


2007
DO-08: SJR at Crow's Landing
SM Pheophyton (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

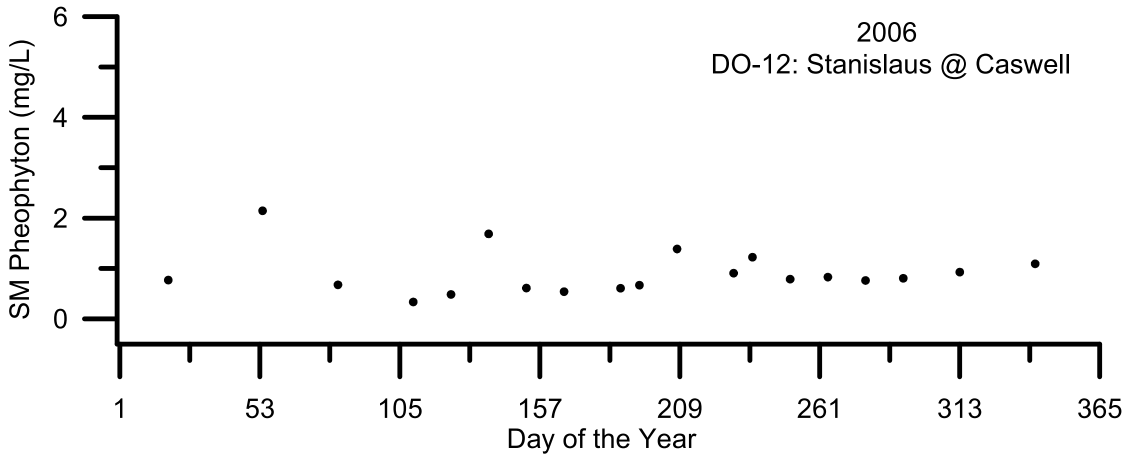

2005
DO-10: SJR at Lander Avenue
SM Pheophyton (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-10: SJR at Lander Avenue
SM Pheophyton (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

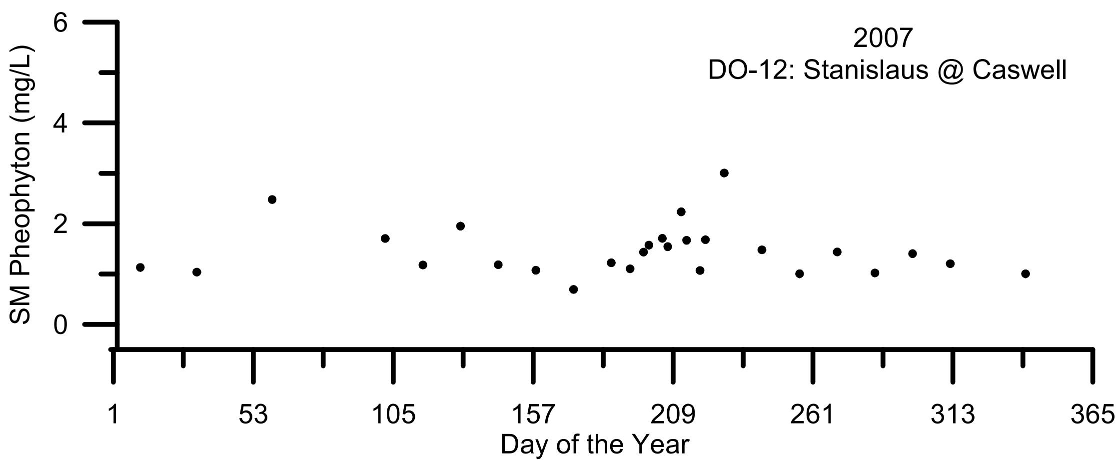

2007
DO-10: SJR at Lander Avenue
SM Pheophyton (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



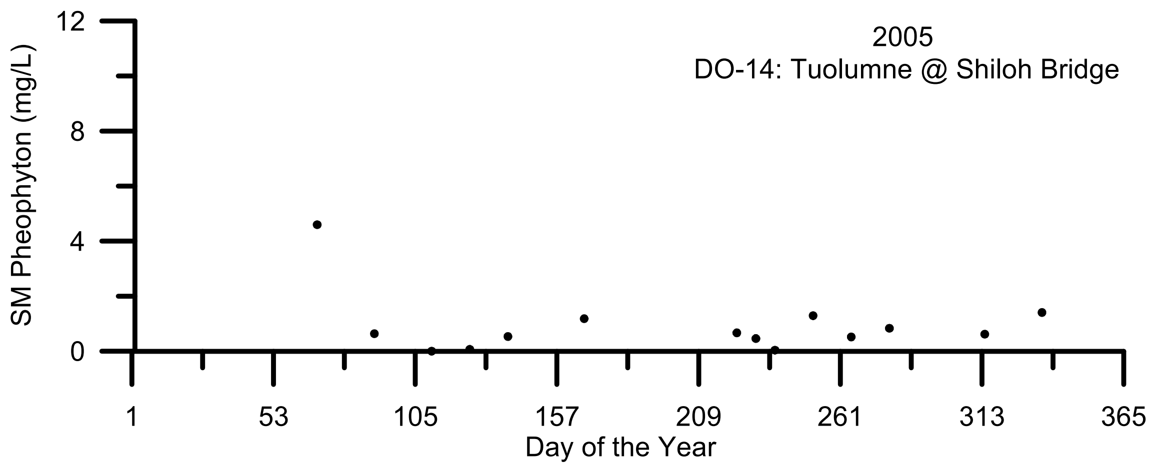
2005
DO-12: Stanislaus @ Caswell
SM Pheophyton (mg/L)
Day of the Year



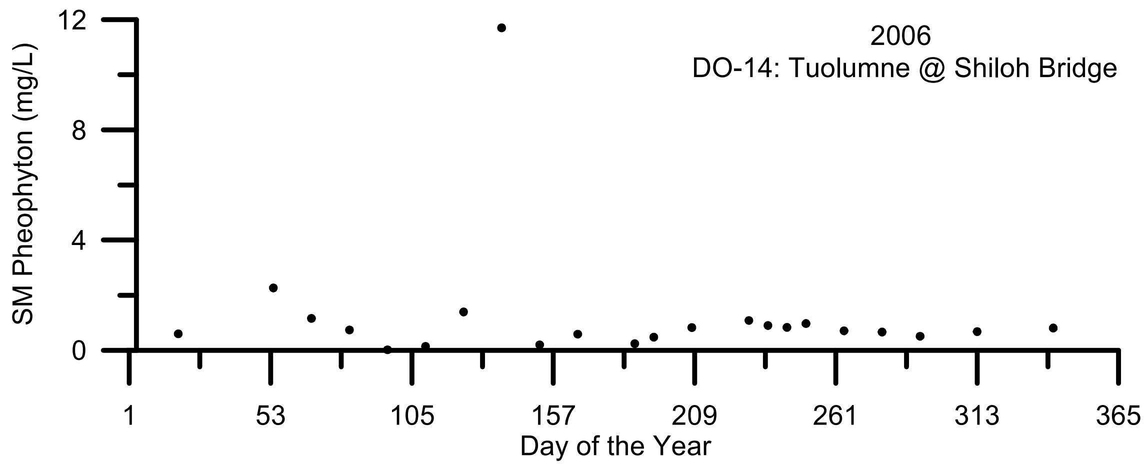
2006
DO-12: Stanislaus @ Caswell
SM Pheophyton (mg/L)
Day of the Year



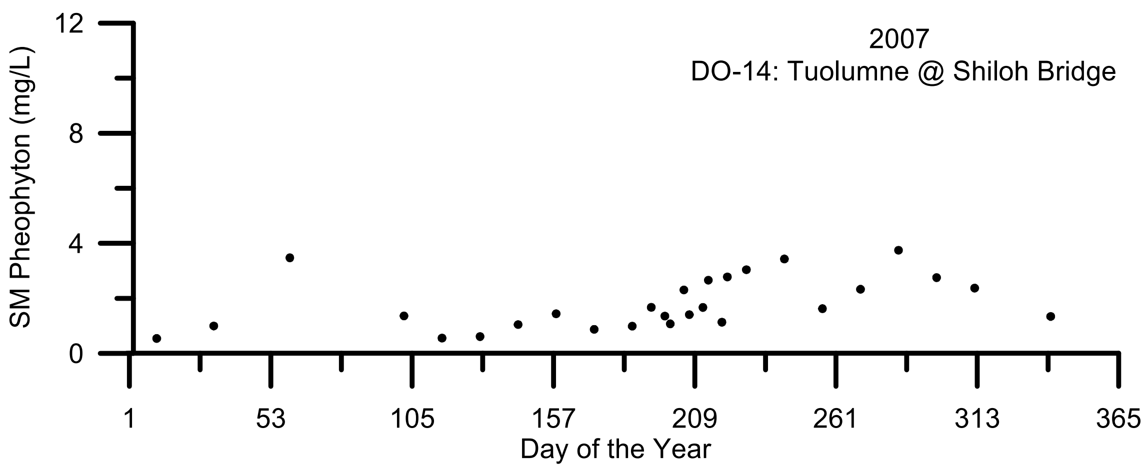
2007
DO-12: Stanislaus @ Caswell
SM Pheophyton (mg/L)
Day of the Year



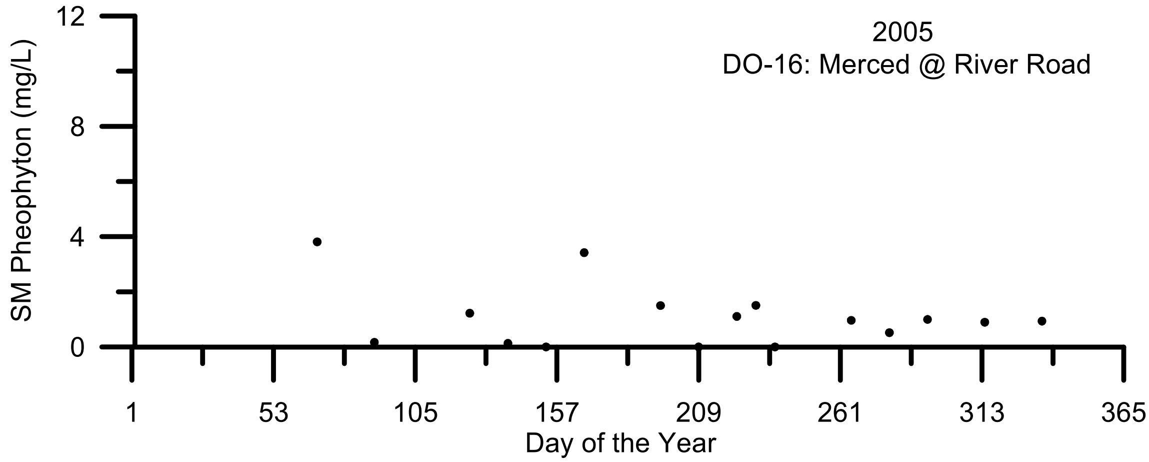
2005
DO-14: Tuolumne @ Shiloh Bridge
SM Pheophyton (mg/L)
Day of the Year



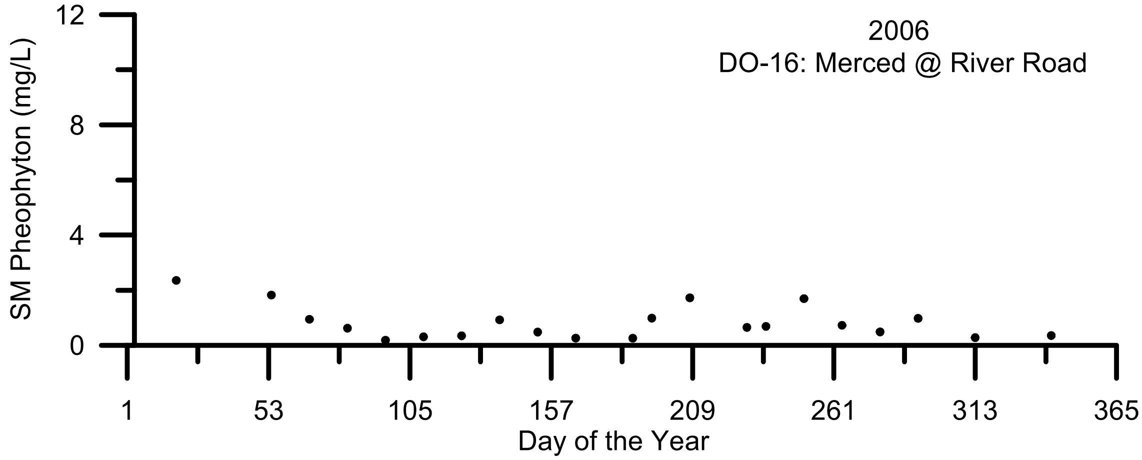
2006
DO-14: Tuolumne @ Shiloh Bridge
SM Pheophyton (mg/L)
Day of the Year



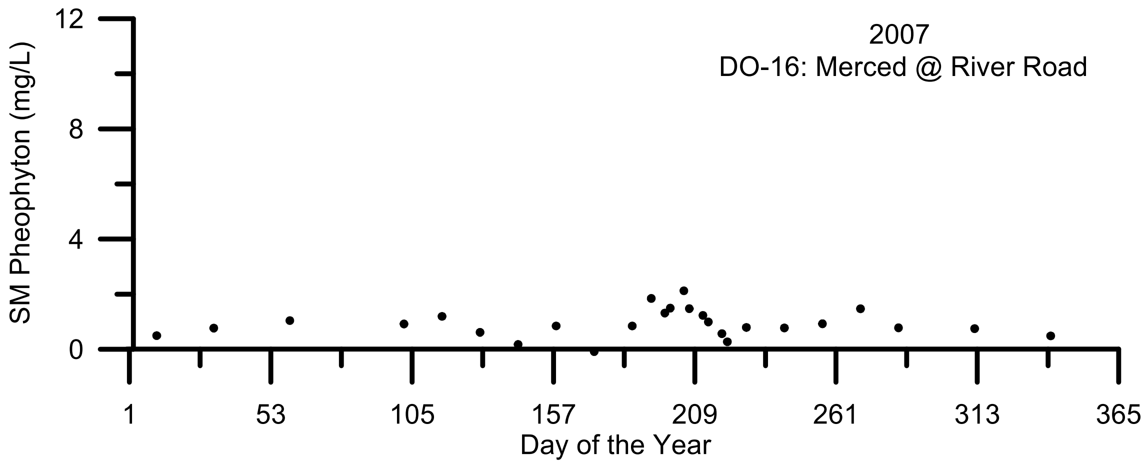
2007
DO-14: Tuolumne @ Shiloh Bridge
SM Pheophyton (mg/L)
Day of the Year



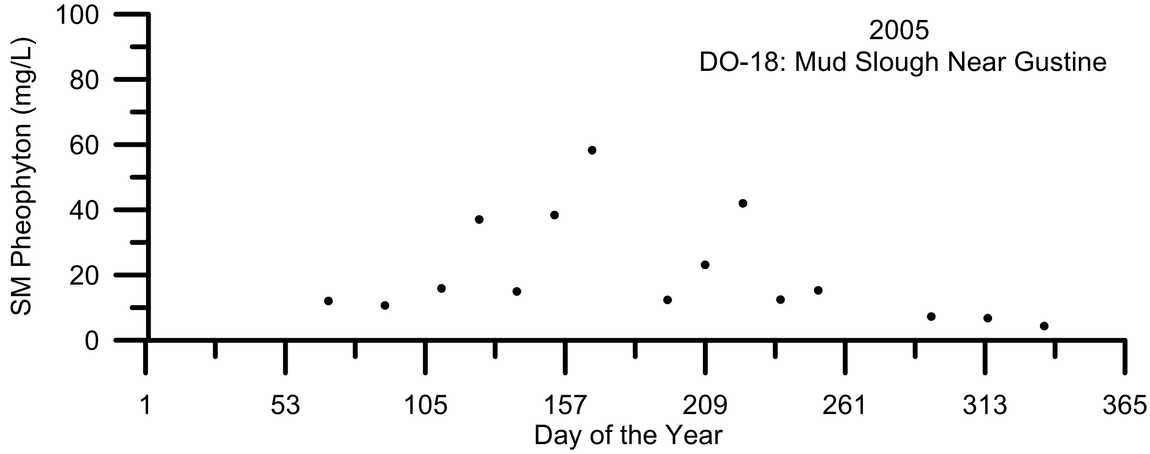
2005
DO-16: Merced @ River Road
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
1
53
105
157
209
261
313
365



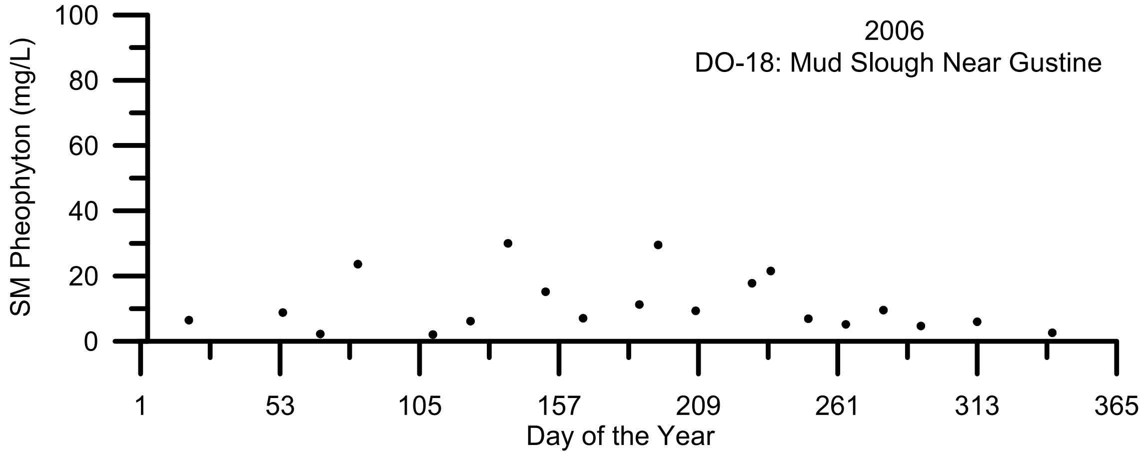
2006
DO-16: Merced @ River Road
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
1
53
105
157
209
261
313
365



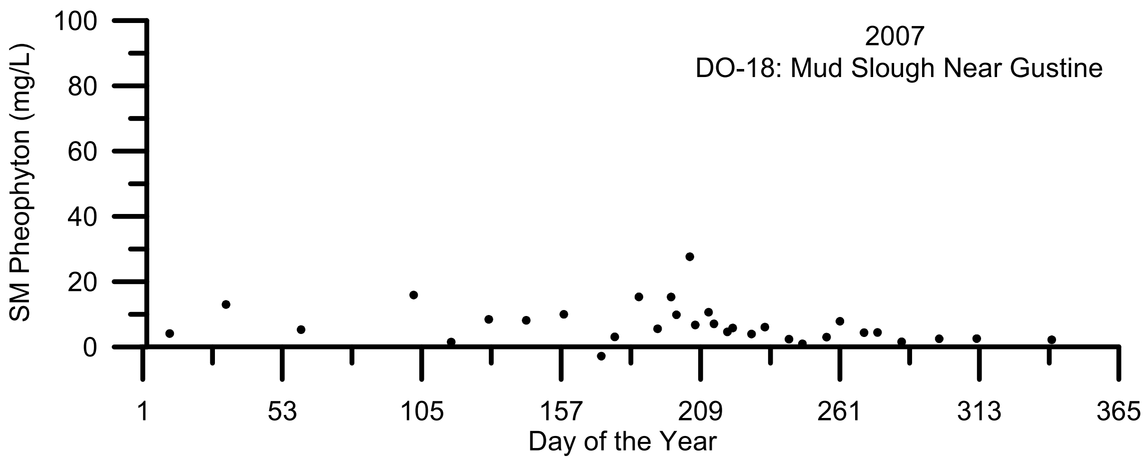
2007
DO-16: Merced @ River Road
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
1
53
105
157
209
261
313
365



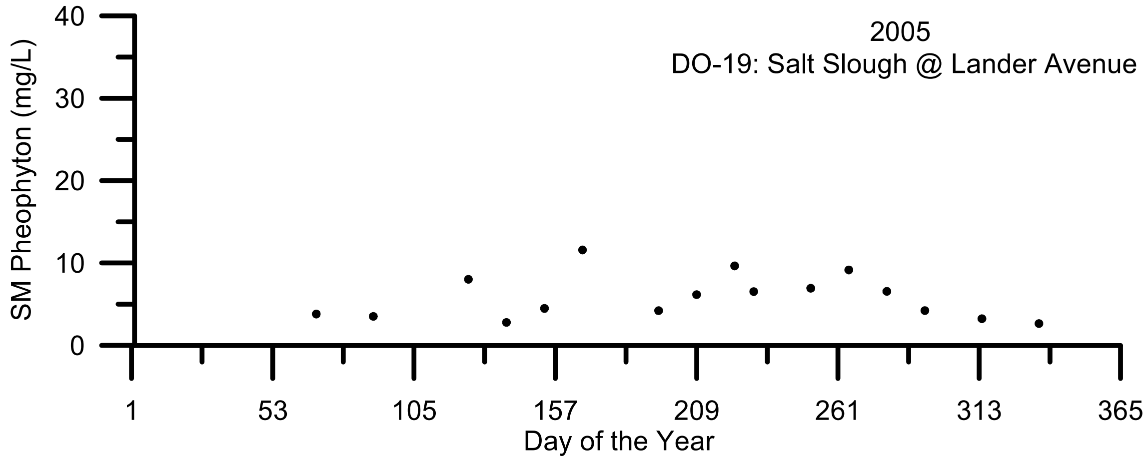
2005
DO-18: Mud Slough Near Gustine
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

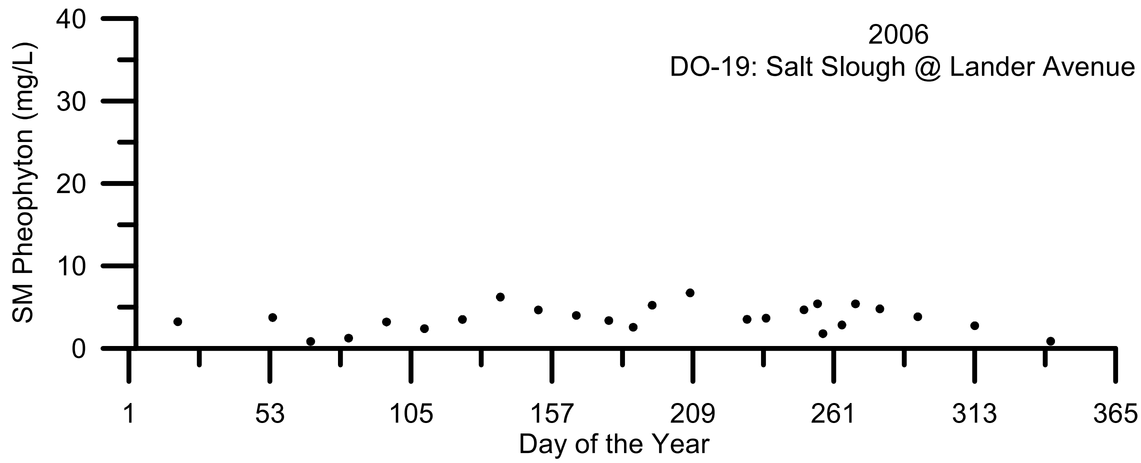


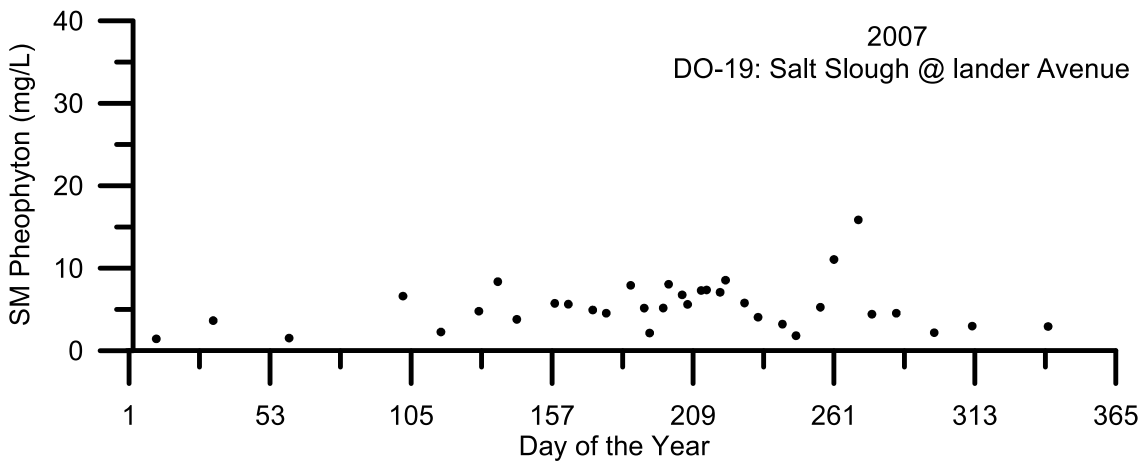
2006
DO-18: Mud Slough Near Gustine
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

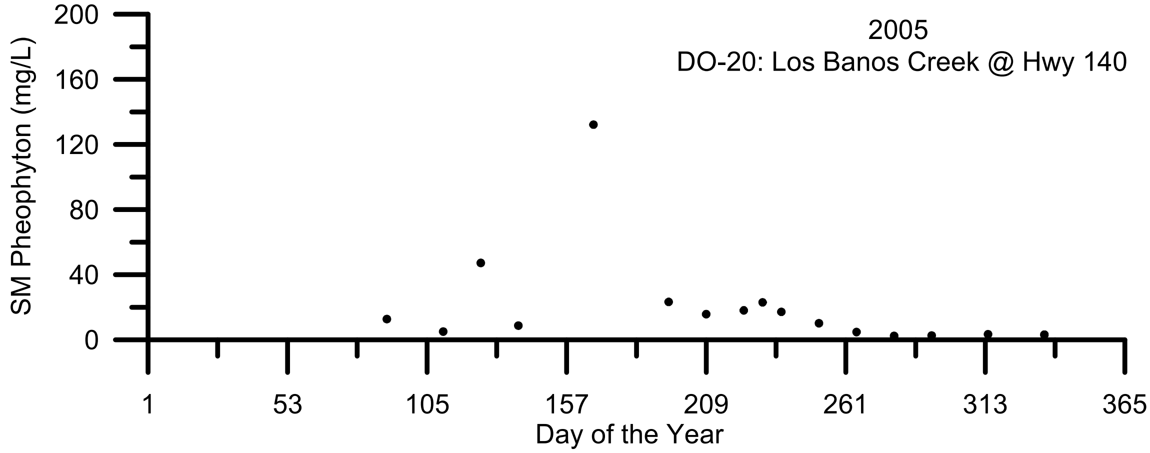


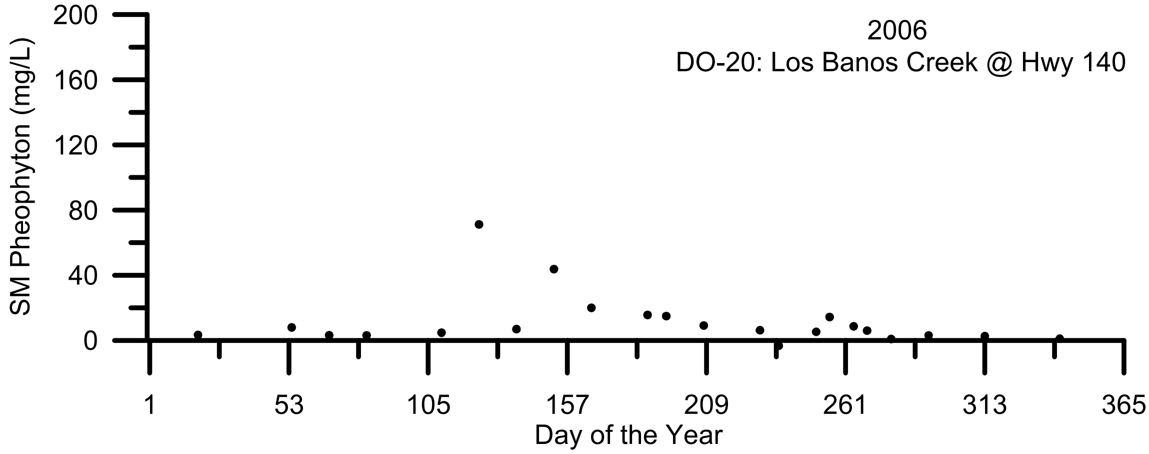
2007
DO-18: Mud Slough Near Gustine
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

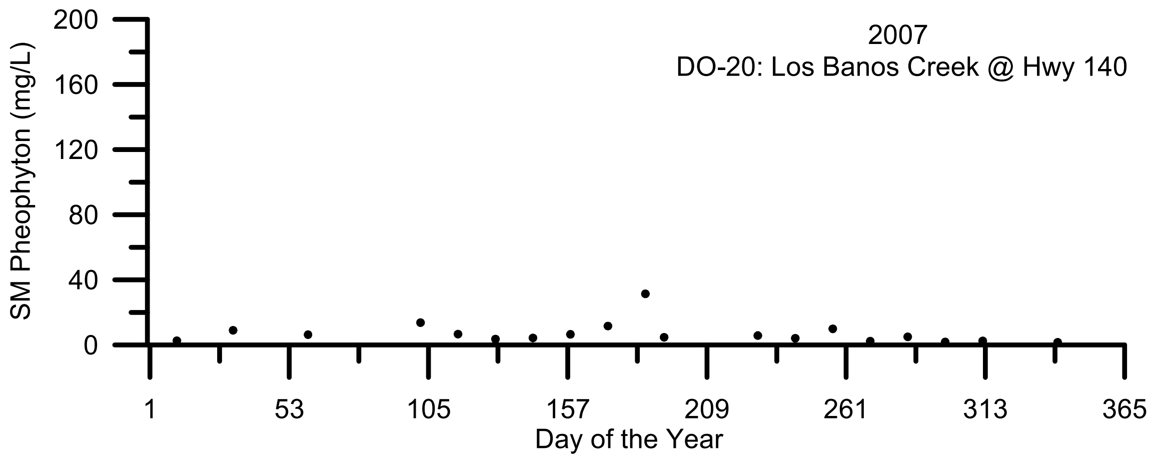

2005
DO-19: Salt Slough @ Lander Avenue
SM Pheophyton (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

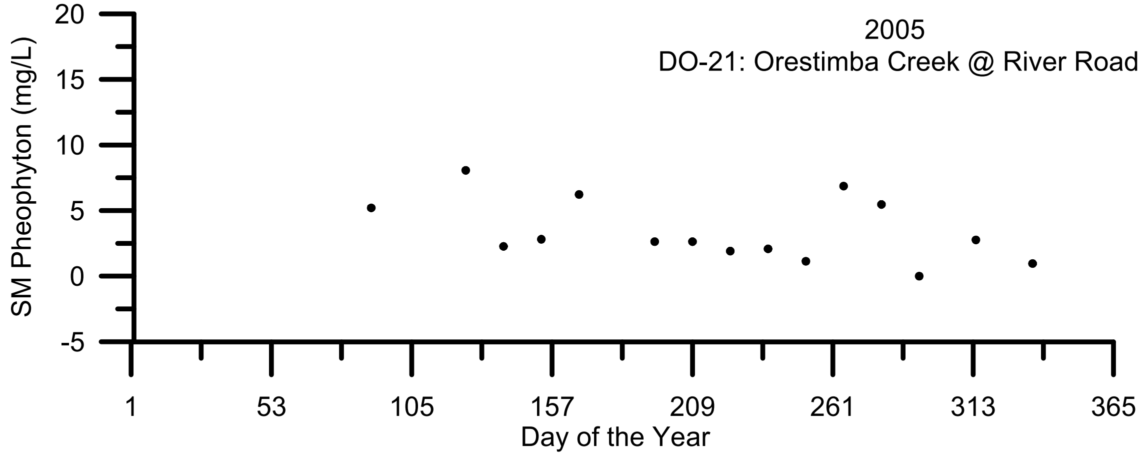

2006
DO-19: Salt Slough @ Lander Avenue
SM Pheophyton (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

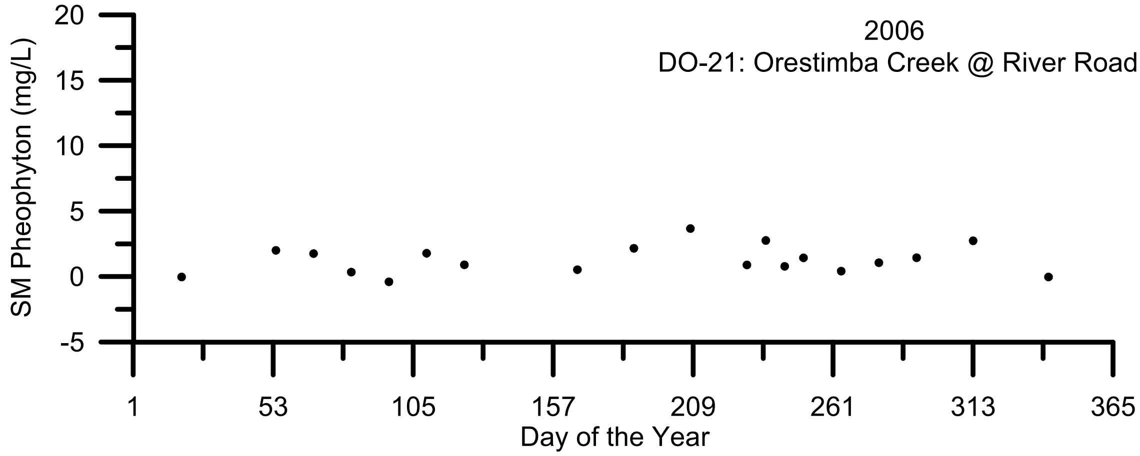

2007
DO-19: Salt Slough @ lander Avenue
SM Pheophyton (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

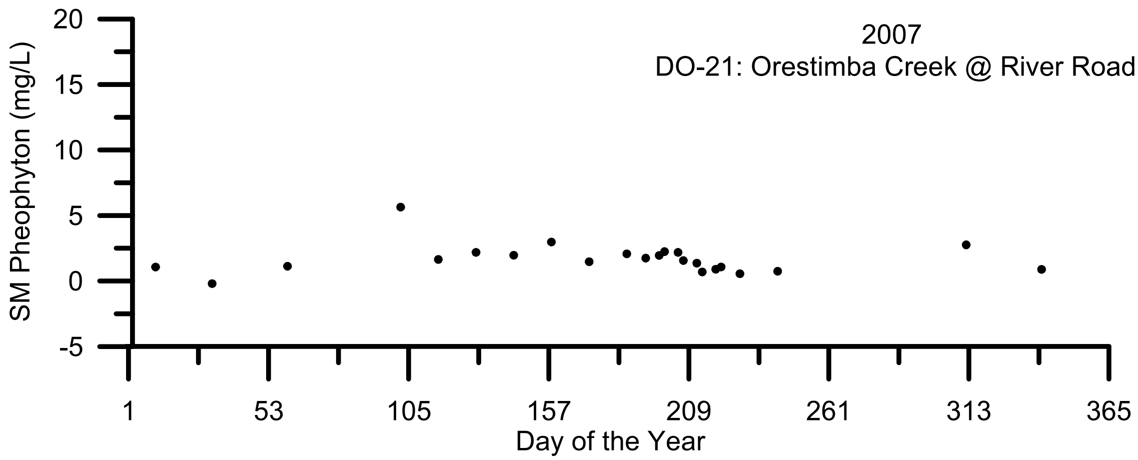

2005
DO-20: Los Banos Creek @ Hwy 140
SM Pheophyton (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

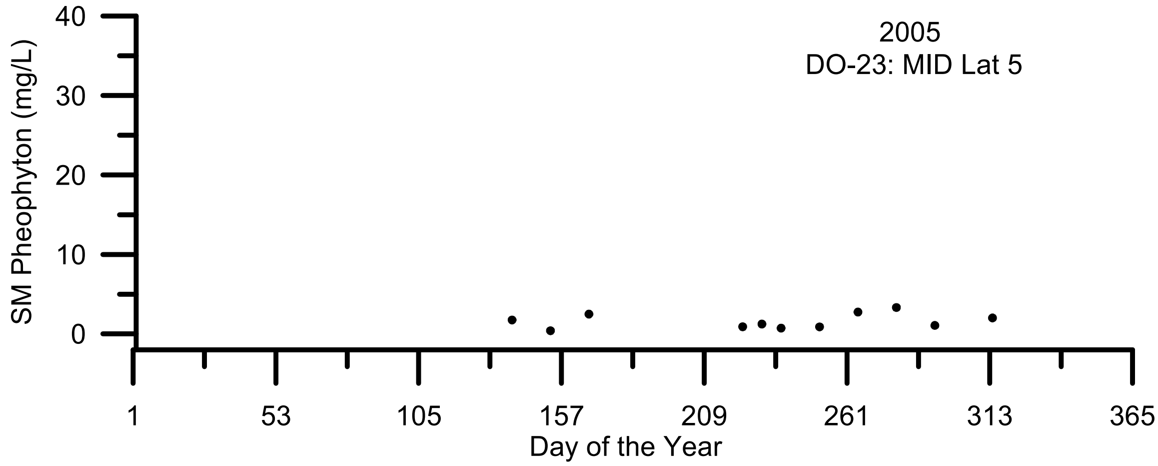

2006
DO-20: Los Banos Creek @ Hwy 140
SM Pheophyton (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

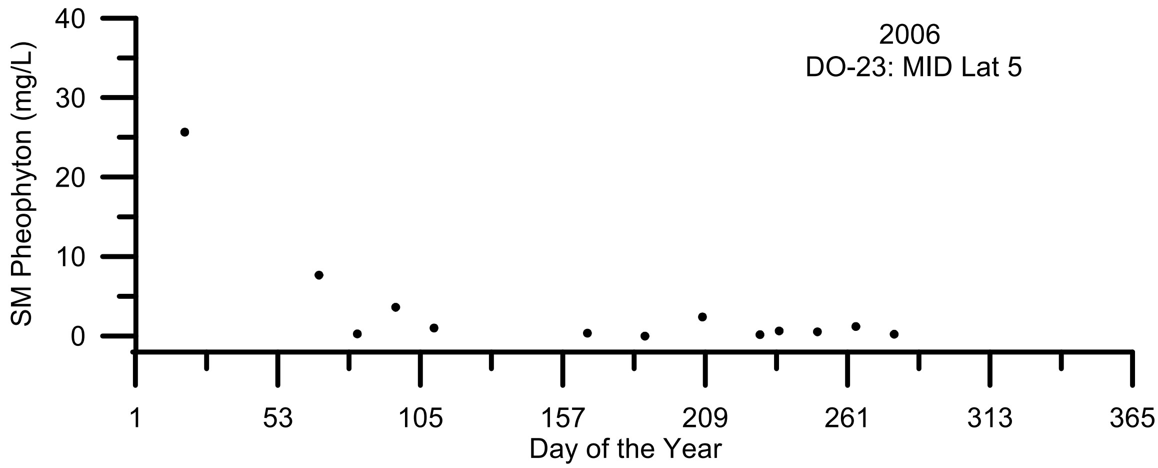

2007
DO-20: Los Banos Creek @ Hwy 140
SM Pheophyton (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

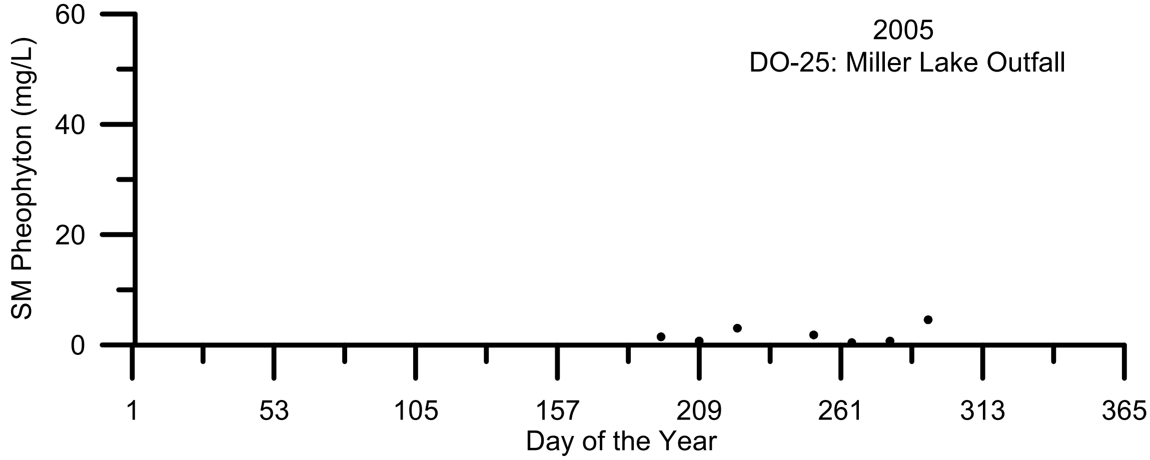

2005
DO-21: Orestimba Creek @ River Road
SM Pheophyton (mg/L)
Day of the Year

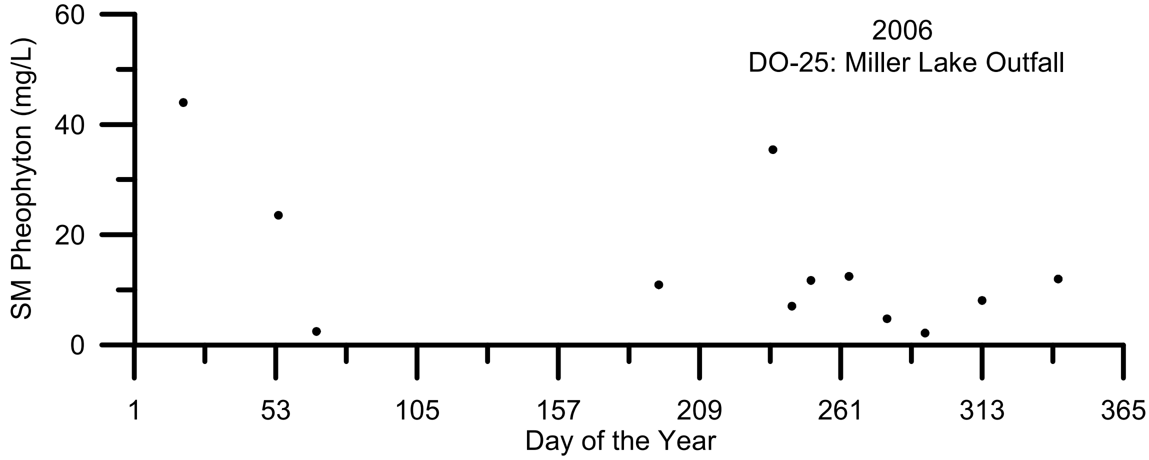

2006
DO-21: Orestimba Creek @ River Road
SM Pheophyton (mg/L)
Day of the Year

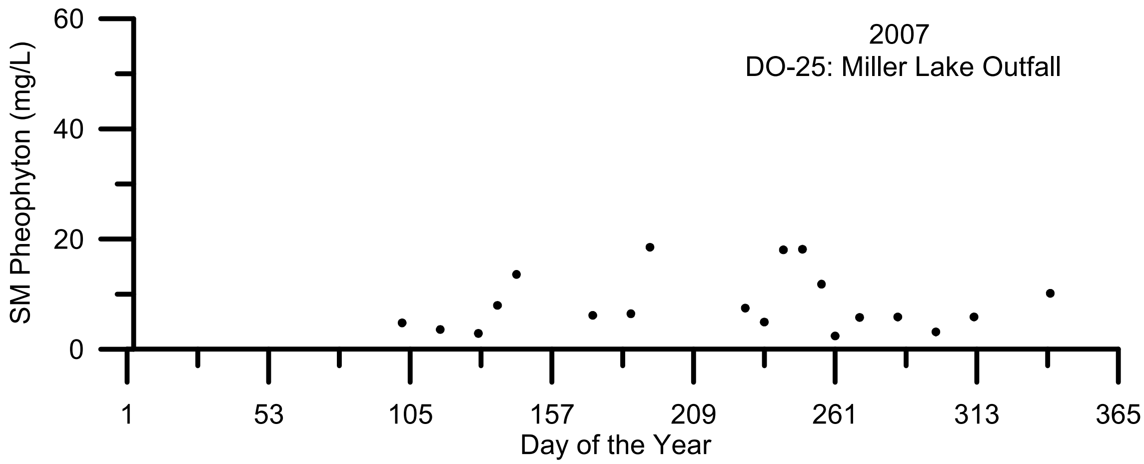

2007
DO-21: Orestimba Creek @ River Road
SM Pheophyton (mg/L)
Day of the Year

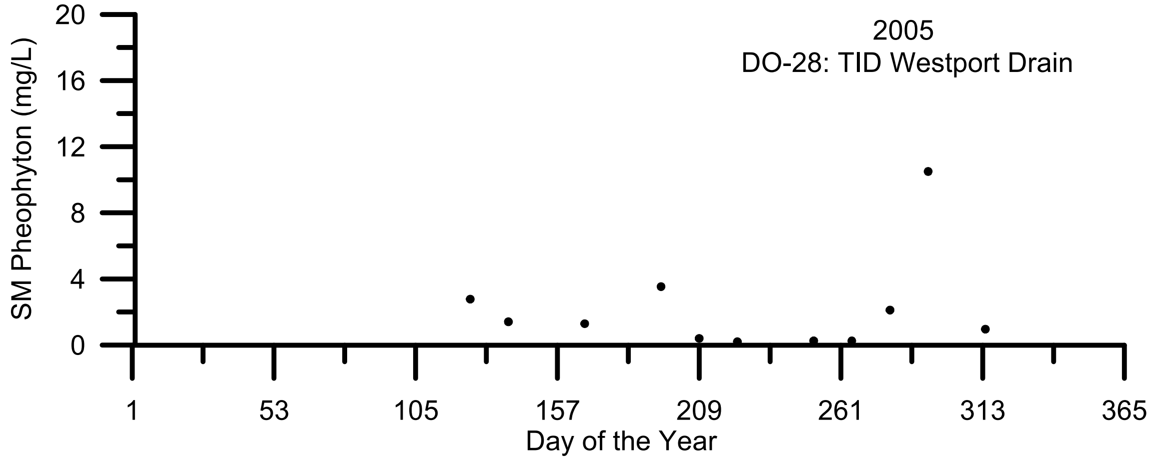

2005
DO-23: MID Lat 5
SM Pheophyton (mg/L)
Day of the Year
40
30
20
10
0
1
53
105
157
209
261
313
365

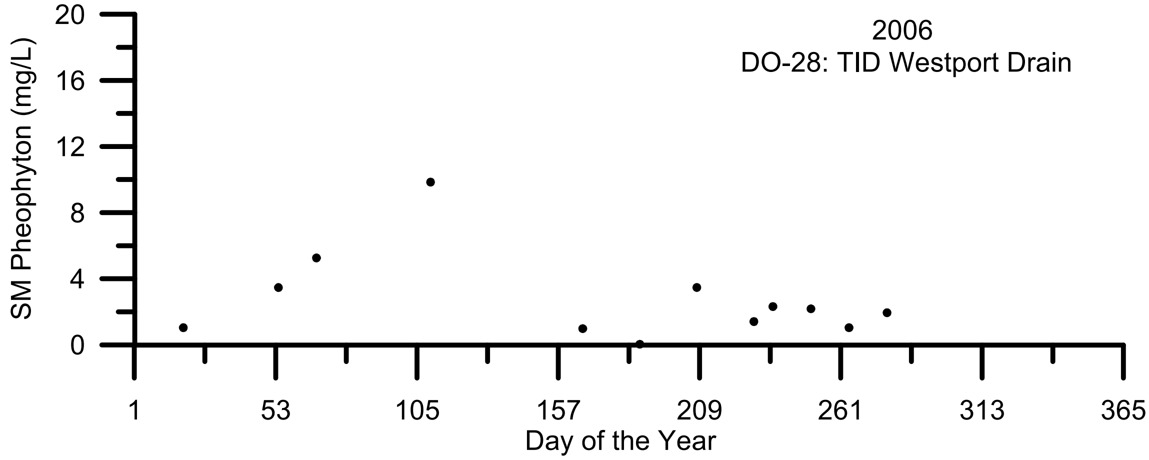

2006
DO-23: MID Lat 5
SM Pheophyton (mg/L)
Day of the Year
40
30
20
10
0
1
53
105
157
209
261
313
365

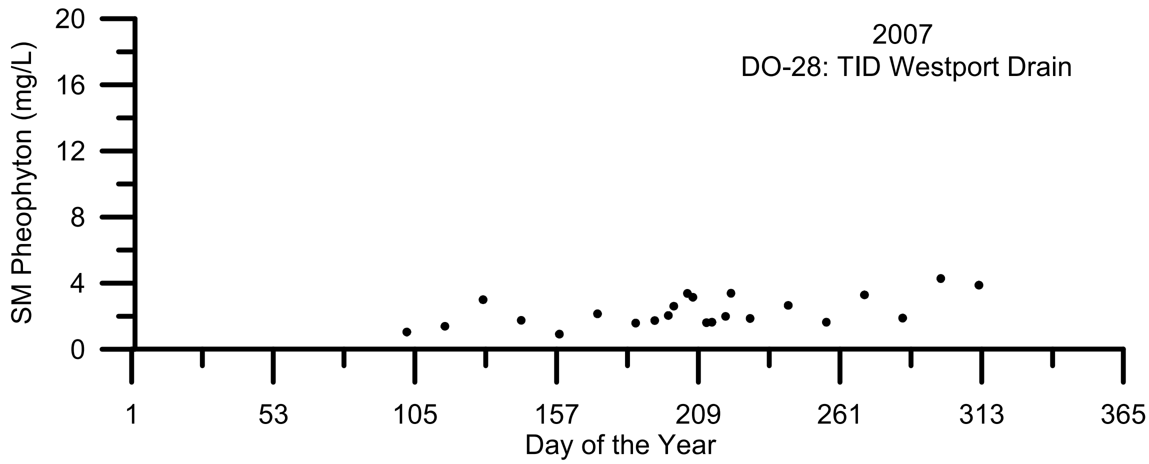

2005
DO-25: Miller Lake Outfall
SM Pheophyton (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

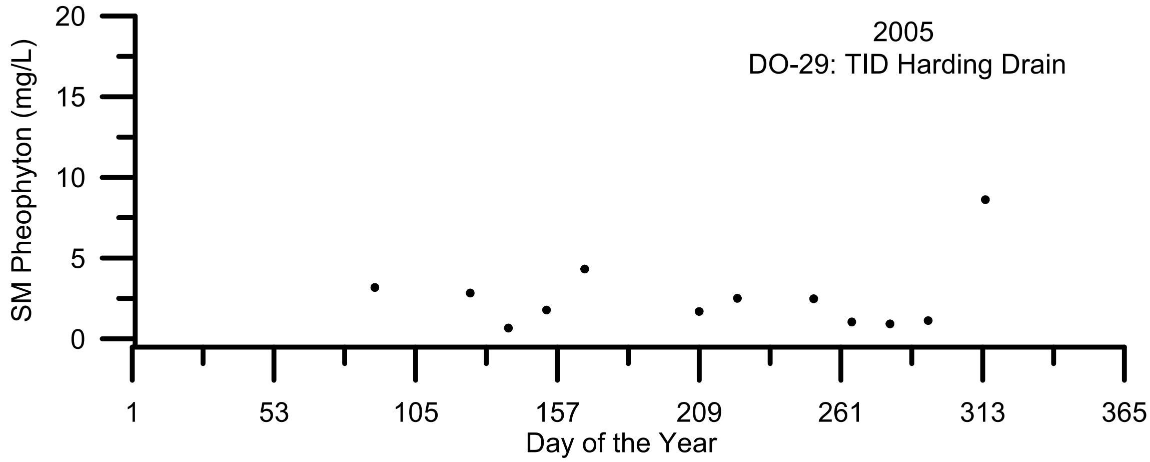

2006
DO-25: Miller Lake Outfall
SM Pheophyton (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

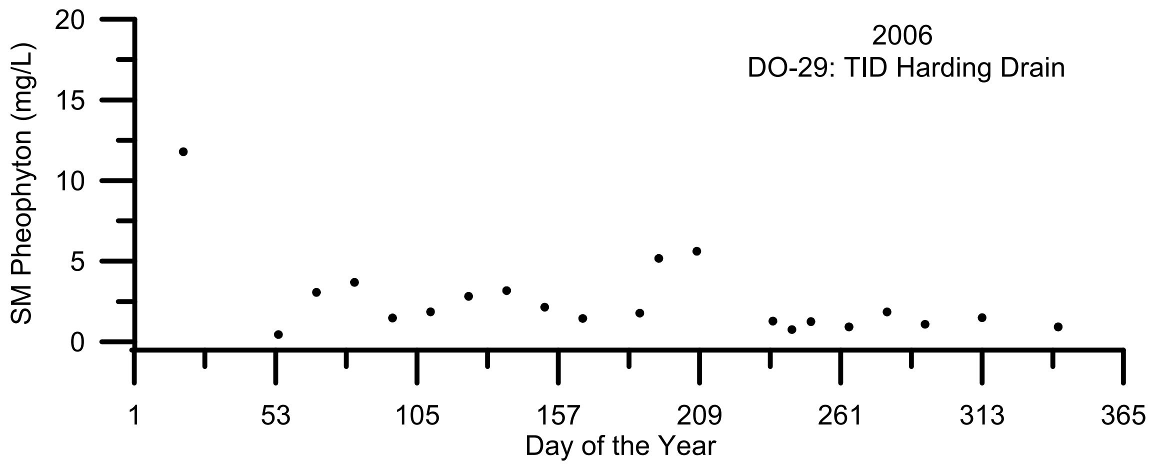

2007
DO-25: Miller Lake Outfall
SM Pheophyton (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

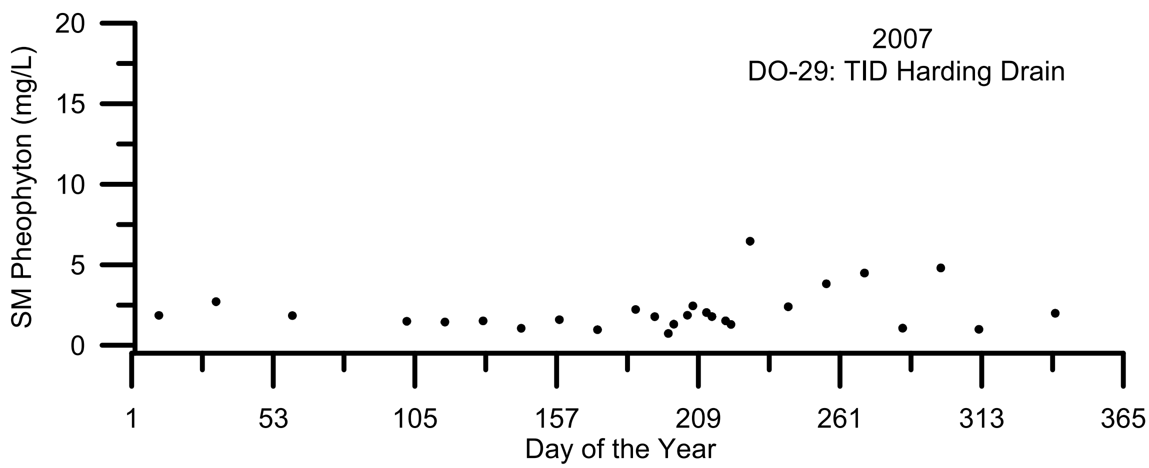

2005
DO-28: TID Westport Drain
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

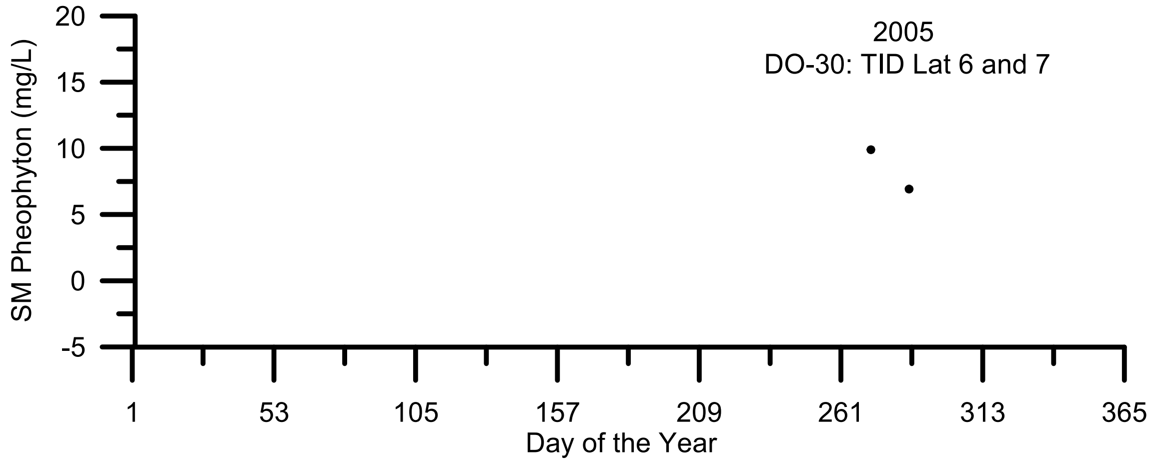

2006
DO-28: TID Westport Drain
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

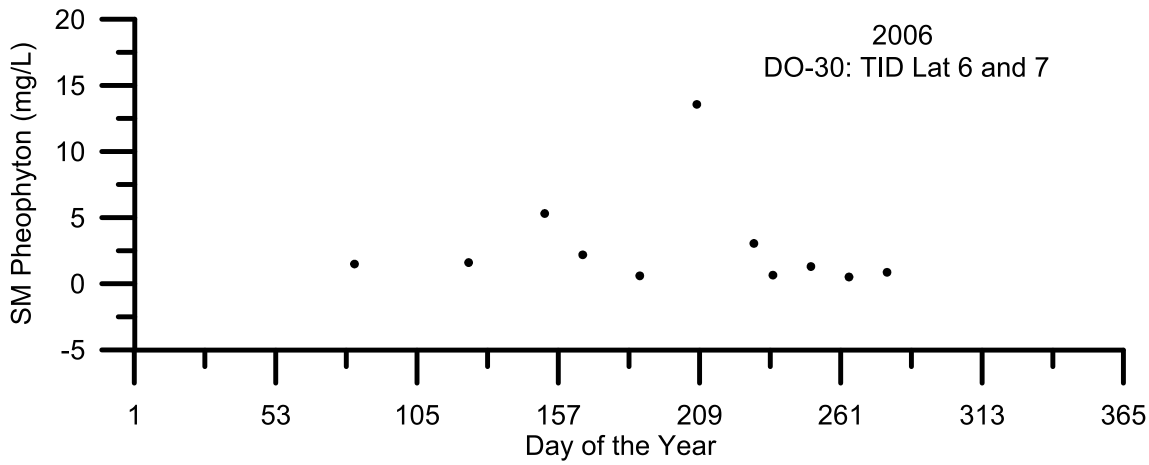

2007
DO-28: TID Westport Drain
SM Pheophyton (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

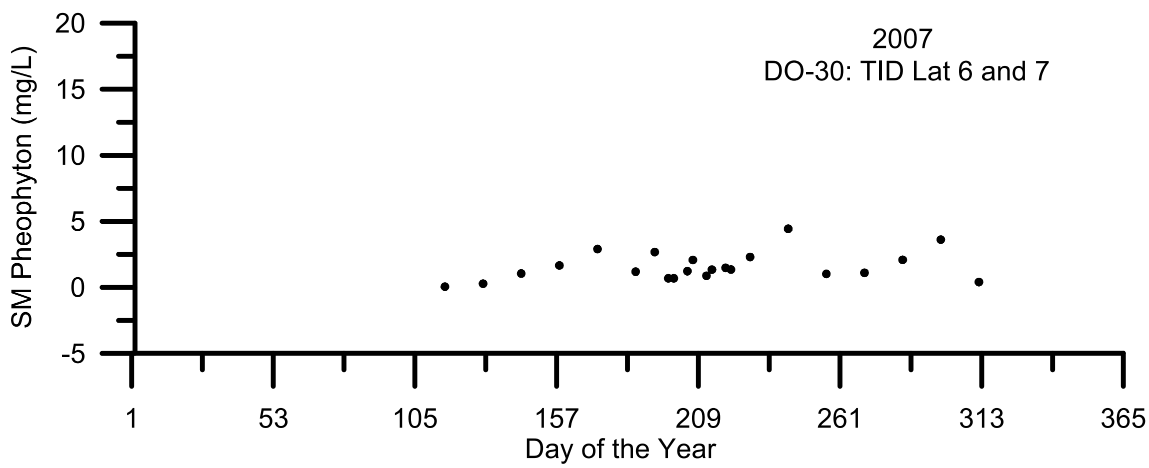

2005
DO-29: TID Harding Drain
SM Pheophyton (mg/L)
Day of the Year
0
5
10
15
20
1
53
105
157
209
261
313
365

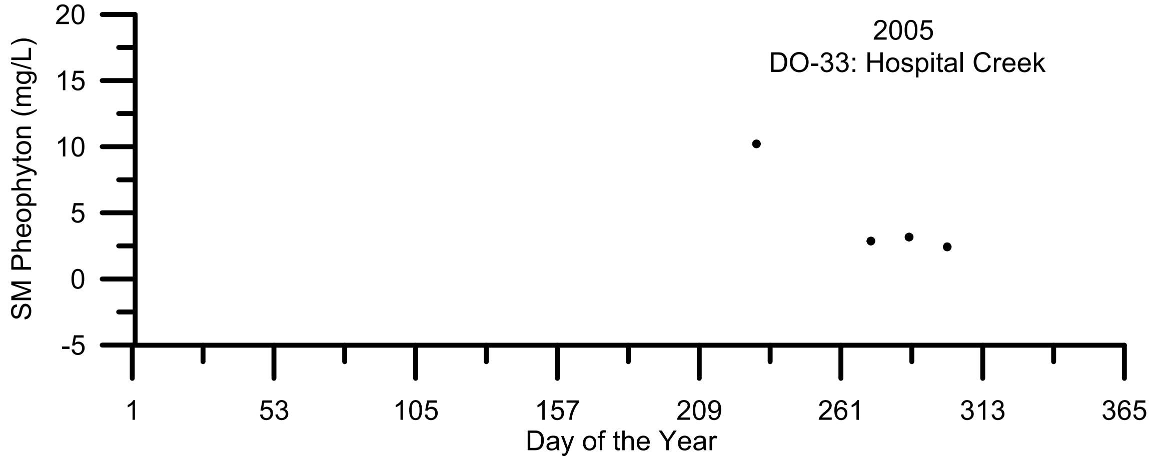

2006
DO-29: TID Harding Drain
SM Pheophyton (mg/L)
Day of the Year
0
5
10
15
20
1
53
105
157
209
261
313
365

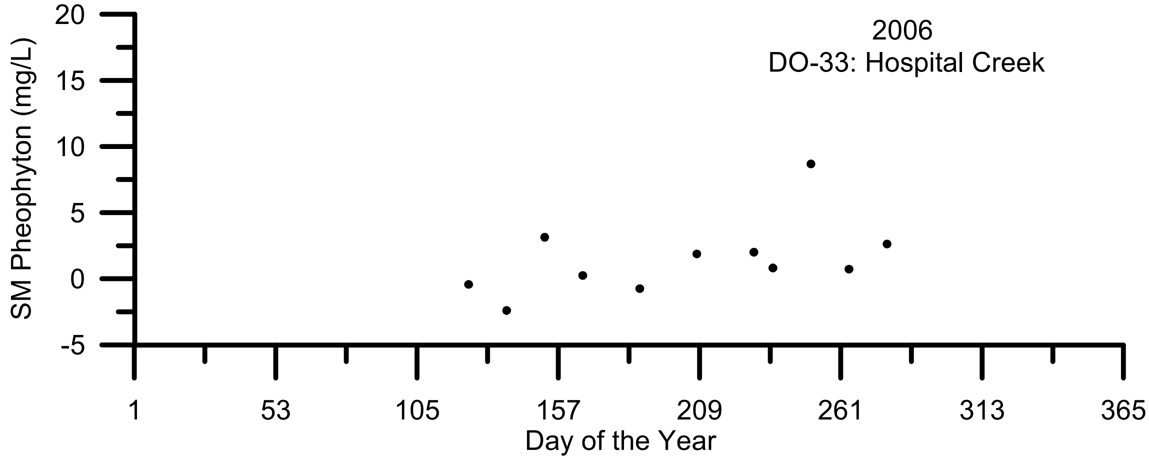

2007
DO-29: TID Harding Drain
SM Pheophyton (mg/L)
Day of the Year
0
5
10
15
20
1
53
105
157
209
261
313
365

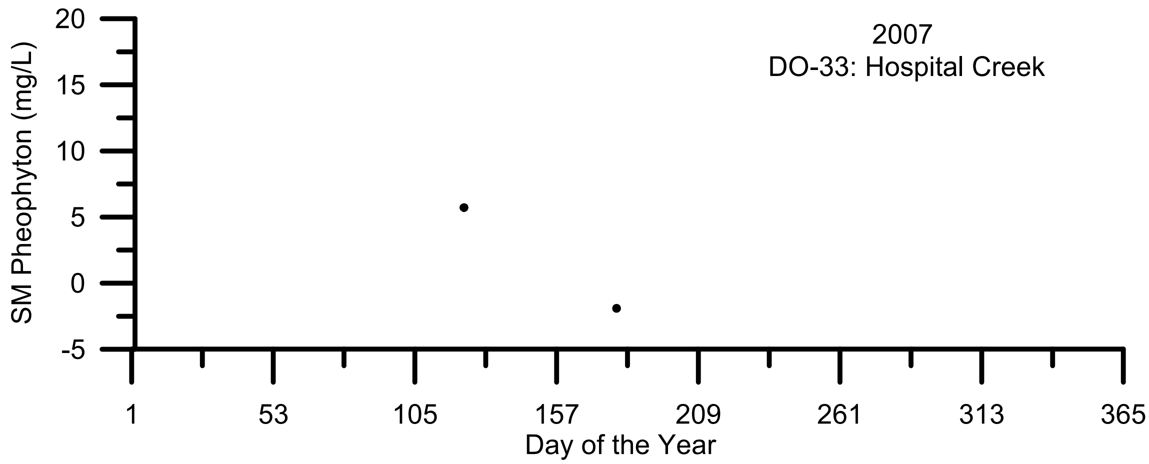

2005
DO-30: TID Lat 6 and 7
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

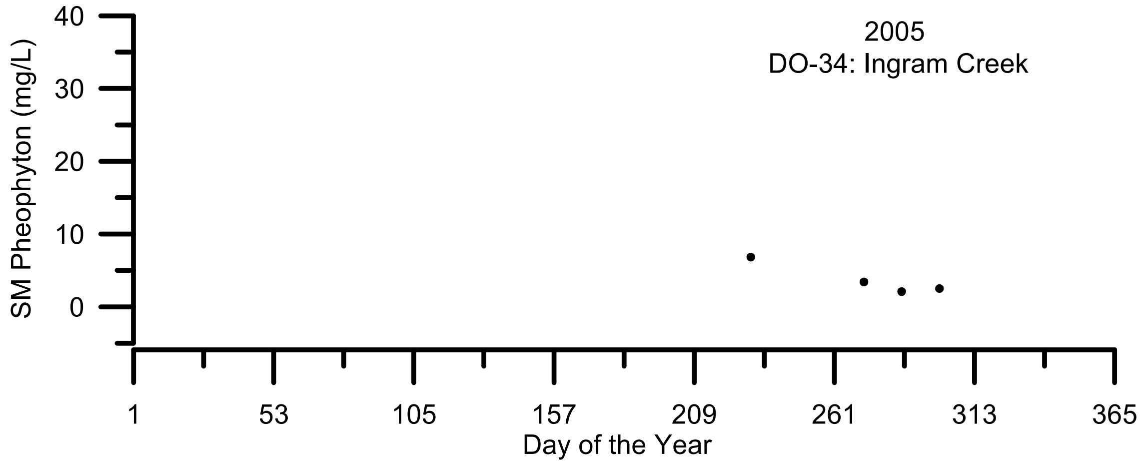

2006
DO-30: TID Lat 6 and 7
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

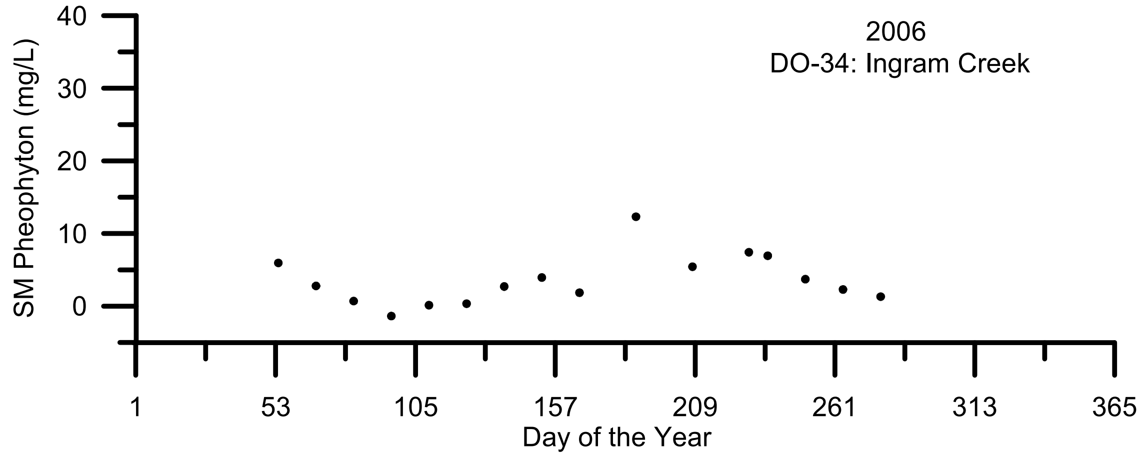

2007
DO-30: TID Lat 6 and 7
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

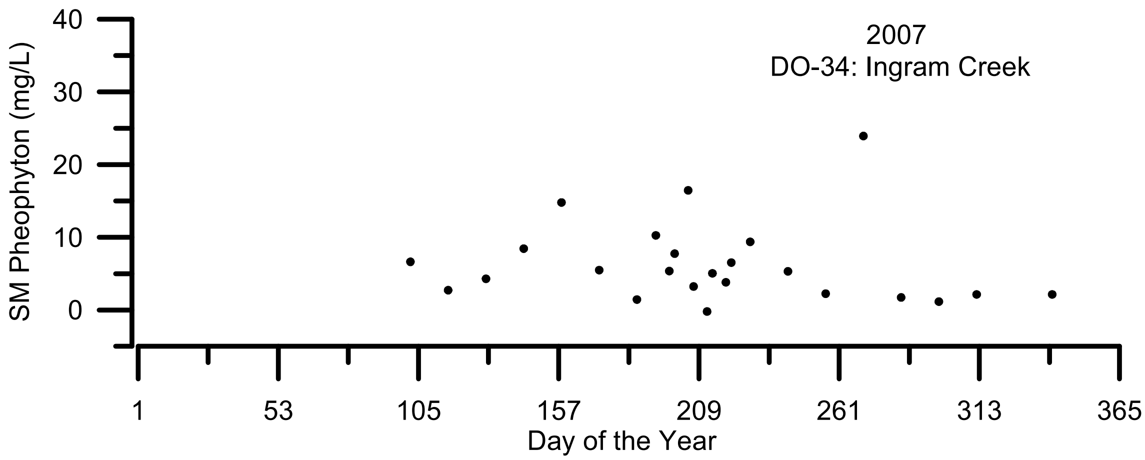

2005
DO-33: Hospital Creek
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

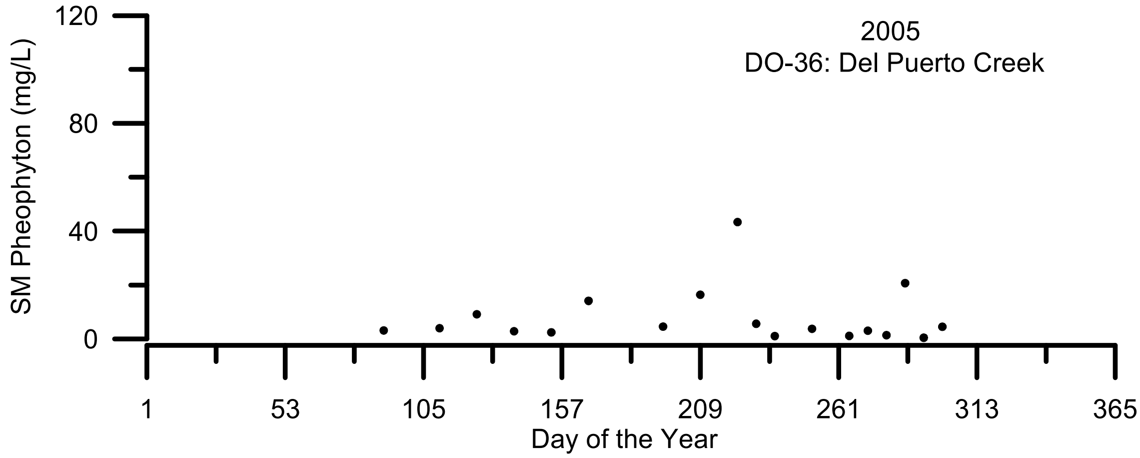

2006
DO-33: Hospital Creek
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

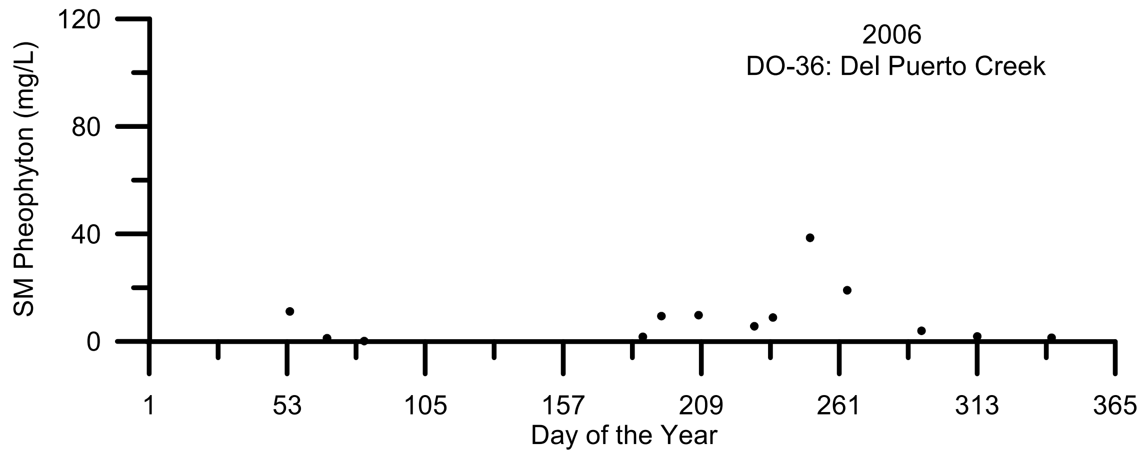

2007
DO-33: Hospital Creek
SM Pheophyton (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

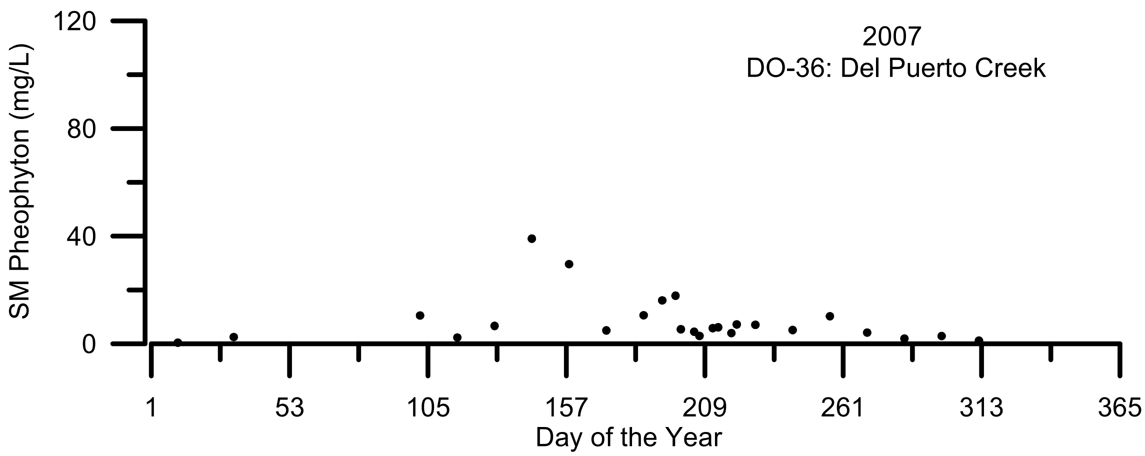

2005
DO-34: Ingram Creek
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

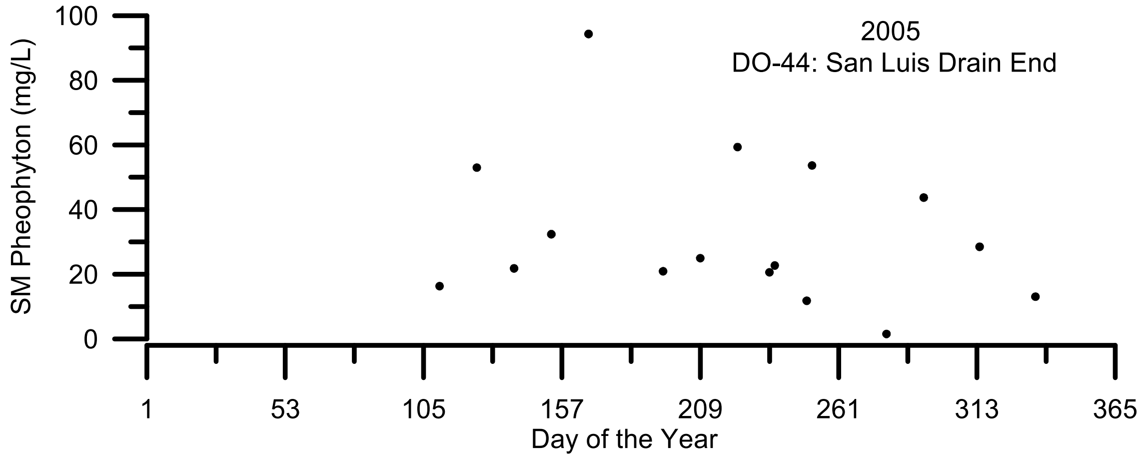

2006
DO-34: Ingram Creek
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

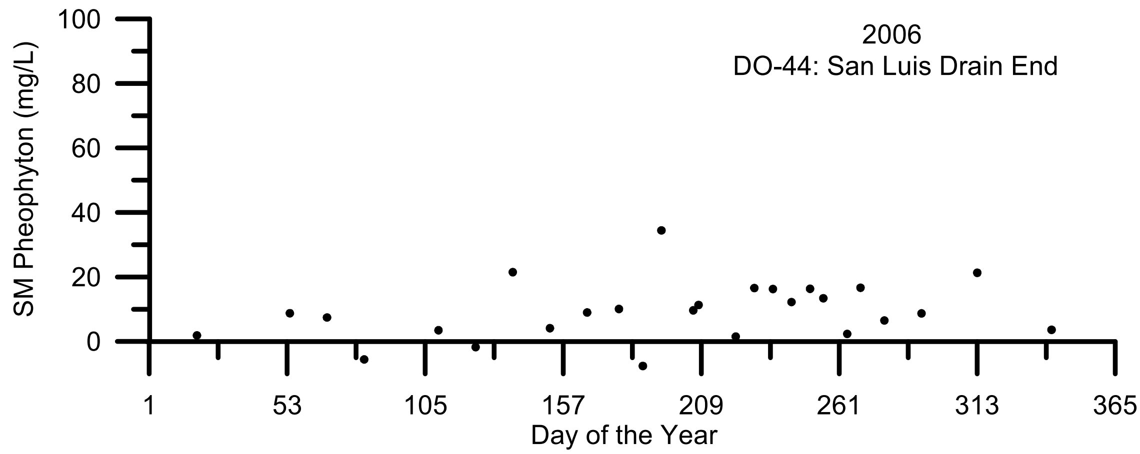

2007
DO-34: Ingram Creek
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

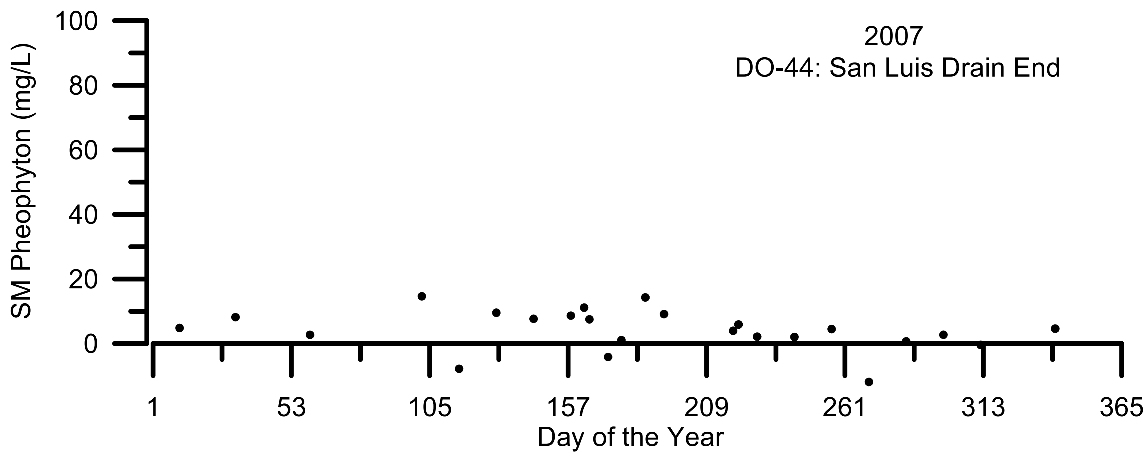

2005
DO-36: Del Puerto Creek
SM Pheophyton (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

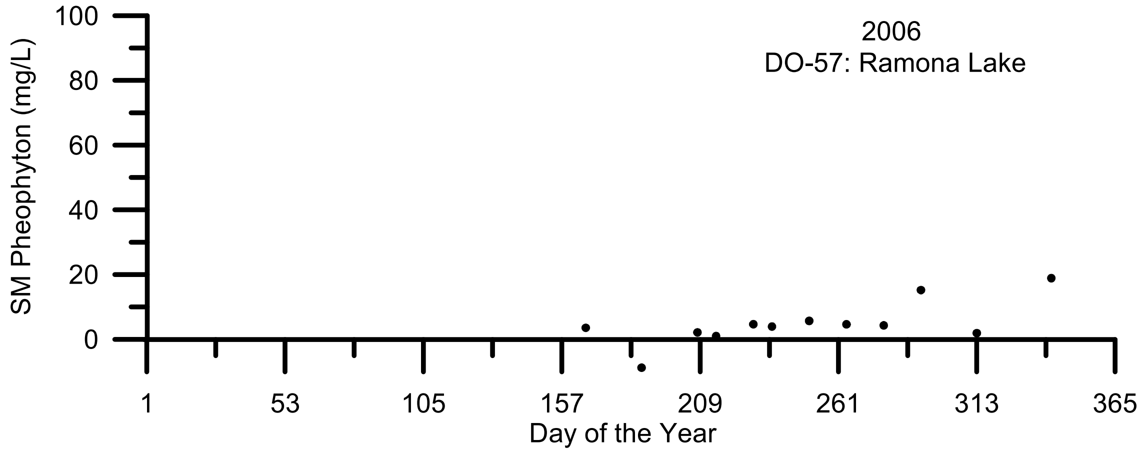

2006
DO-36: Del Puerto Creek
SM Pheophyton (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-36: Del Puerto Creek
SM Pheophyton (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

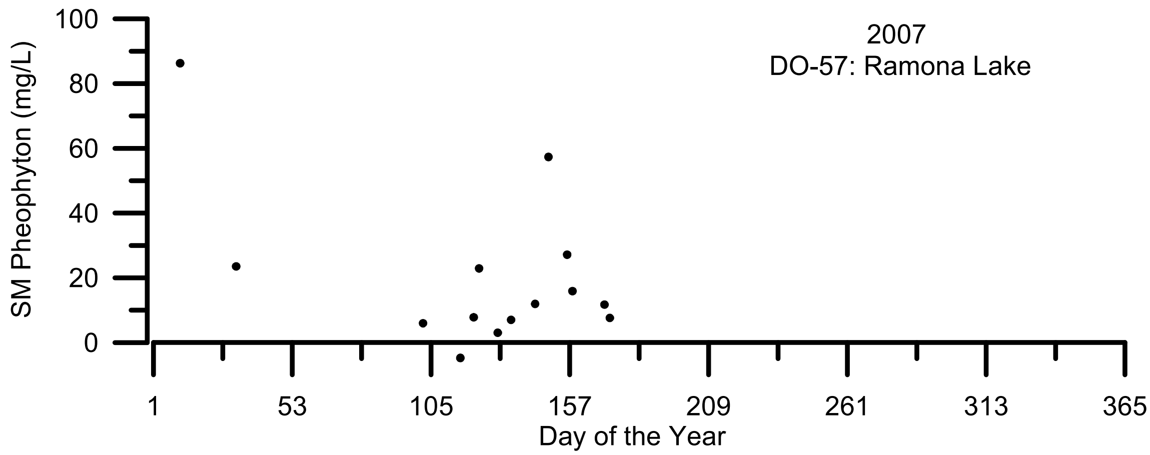

2005
DO-44: San Luis Drain End
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-44: San Luis Drain End
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

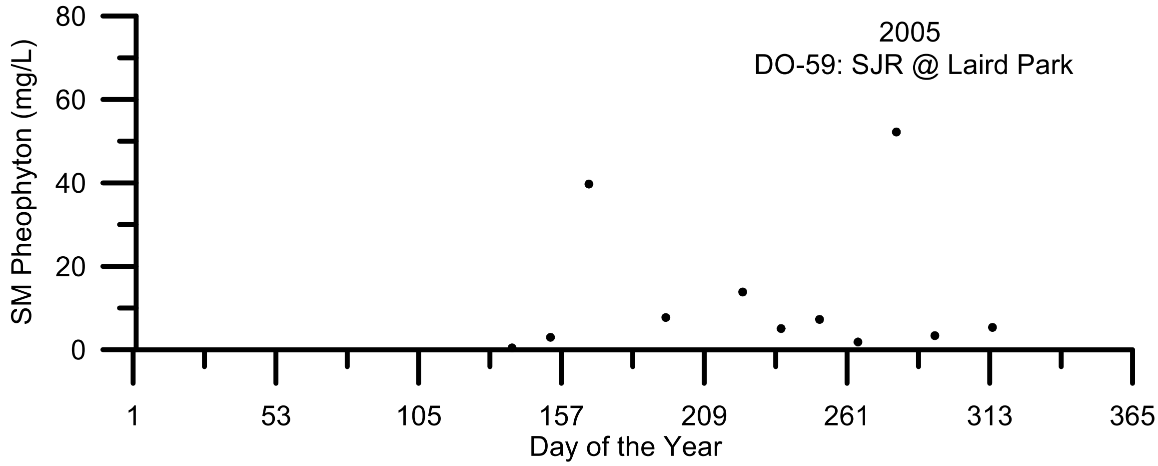

2007
DO-44: San Luis Drain End
SM Pheophyton (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



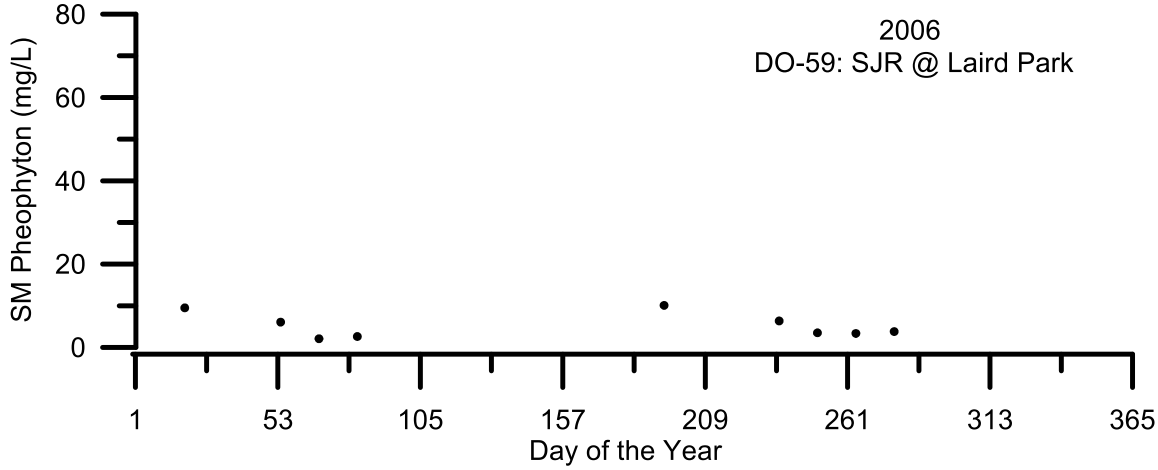
2006
DO-57: Ramona Lake
SM Pheophyton (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year



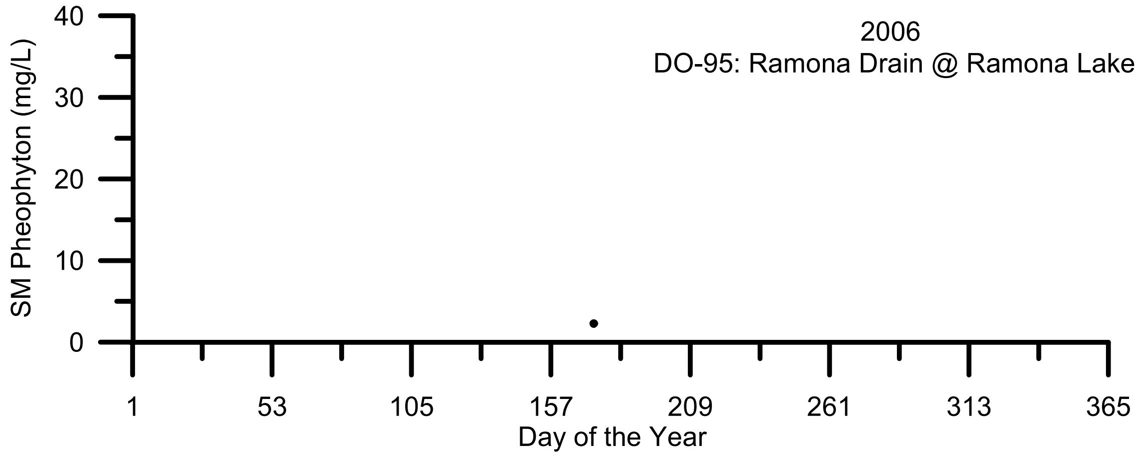
2007
DO-57: Ramona Lake
SM Pheophyton (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year



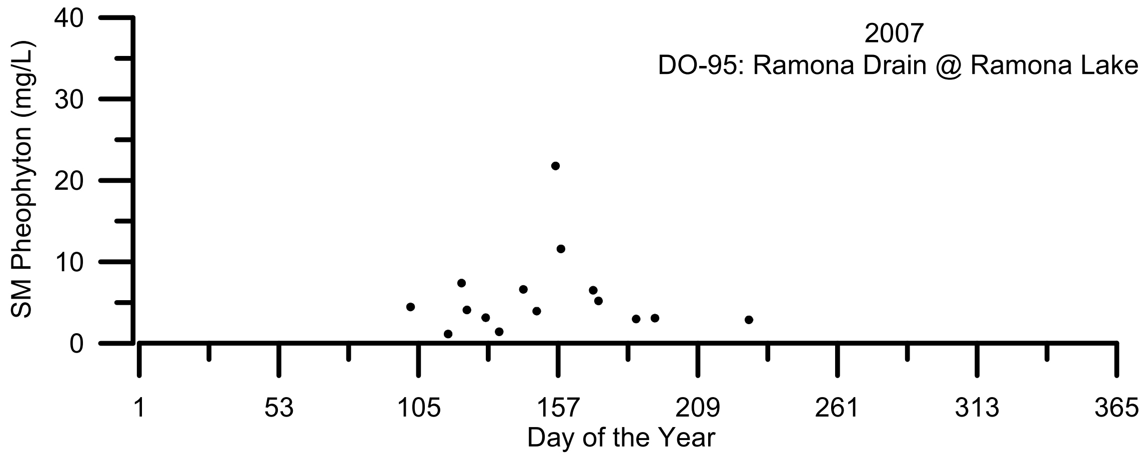
2005
DO-59: SJR @ Laird Park
SM Pheophyton (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-59: SJR @ Laird Park
SM Pheophyton (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Drain @ Ramona Lake
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Drain @ Ramona Lake
SM Pheophyton (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

UNIVERSITY OF THE PACIFIC
Environmental Engineering Research Program

Standard Methods Chlorophyll *A* Extract Data for the San Joaquin River Watershed 2005-2007

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Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

Environmental Engineering Research Program
School of Engineering and Computer Science
University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of total chlorophyll *A* concentration as determined by Standard Methods for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per the *EERP Field Protocol Book*. Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements. Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at 4°C until filtering. Chlorophyll-a (chl-a) and pheophytin-a (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin-Elmer Lambda 35 spectrophotometer (Wellesley, MA) using a 5 cm path length (Borglin, et al 2008).

Results and Discussion

Chlorophyll was analyzed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). No standard solutions for this analysis were available so only duplicates and blanks could be analyzed to insure uniformity and accuracy in the application of the method and for those two QA parameters, there was an 86.26% passage rate for this analysis.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

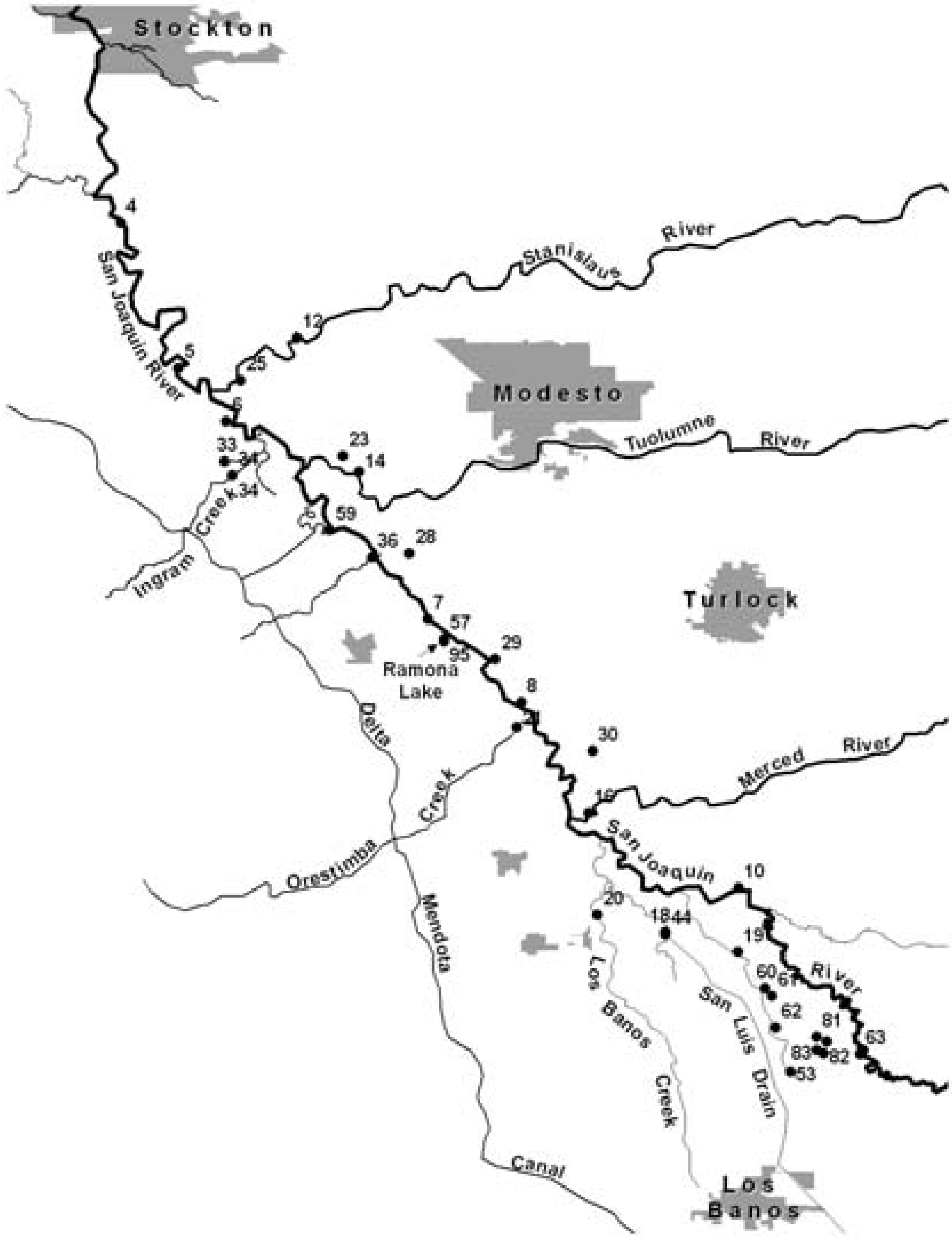
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

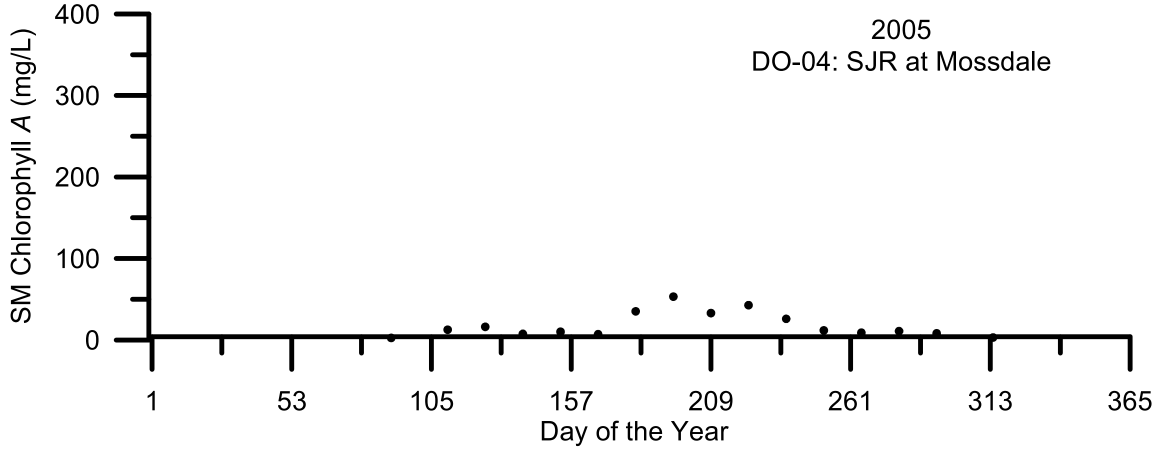
Table 1: EERP Sampling Site List

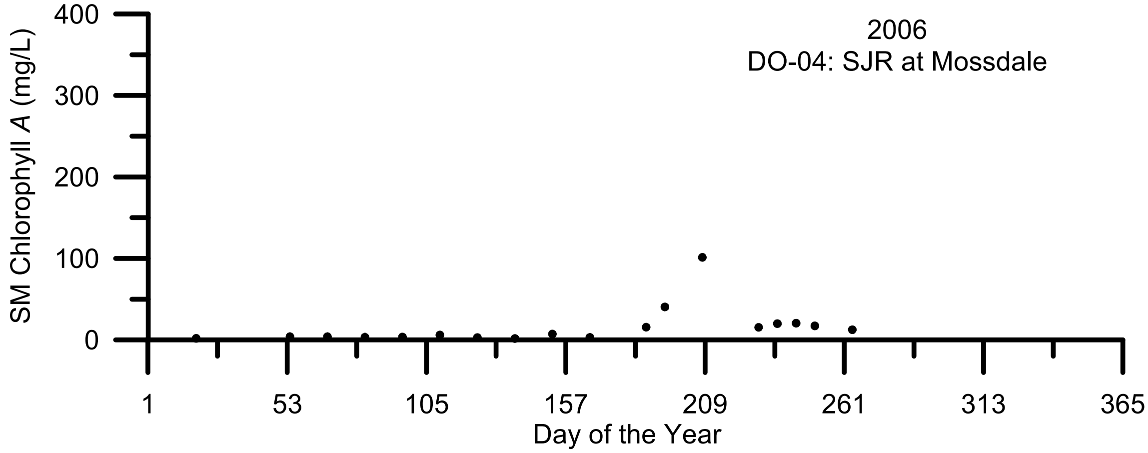
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

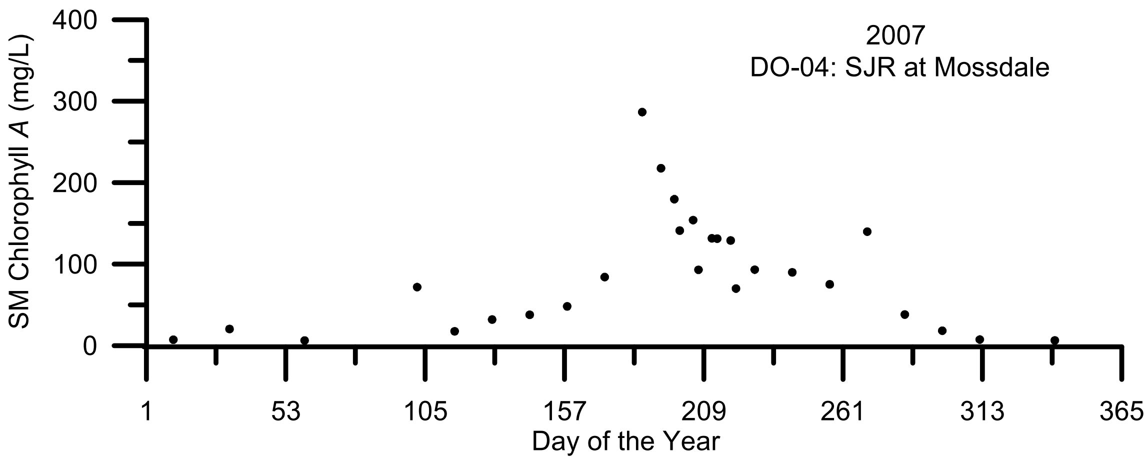
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

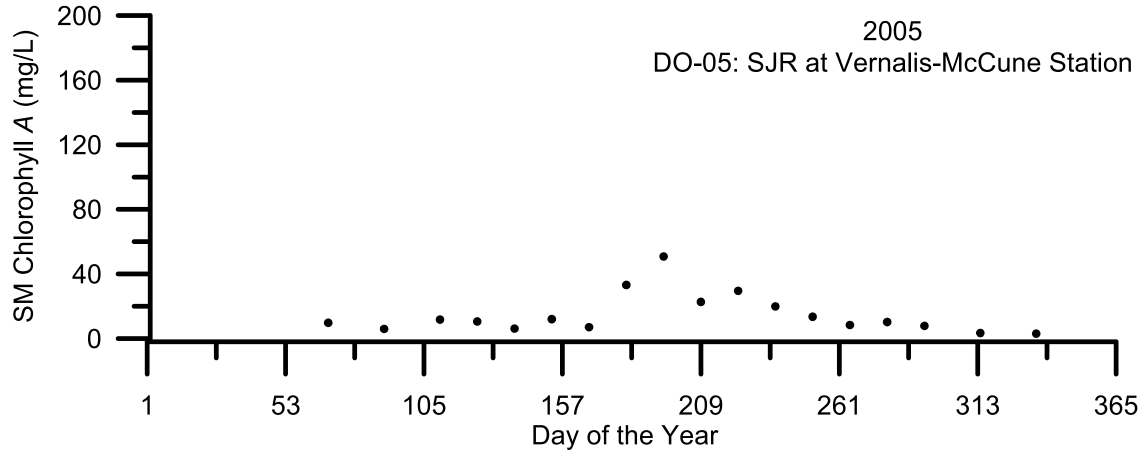


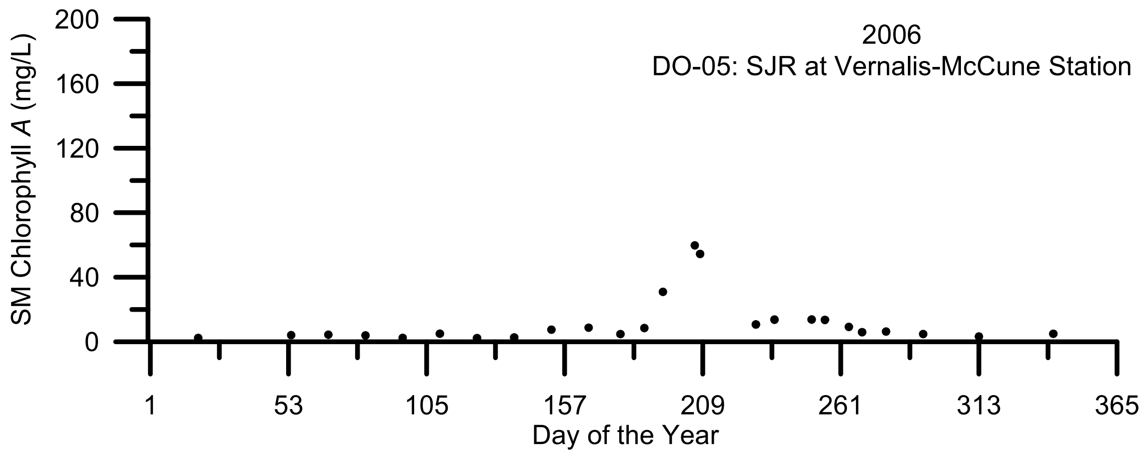
Figures 2 -72: Temporal Plots of SM Chlorophyll *A* Concentration By Site ID

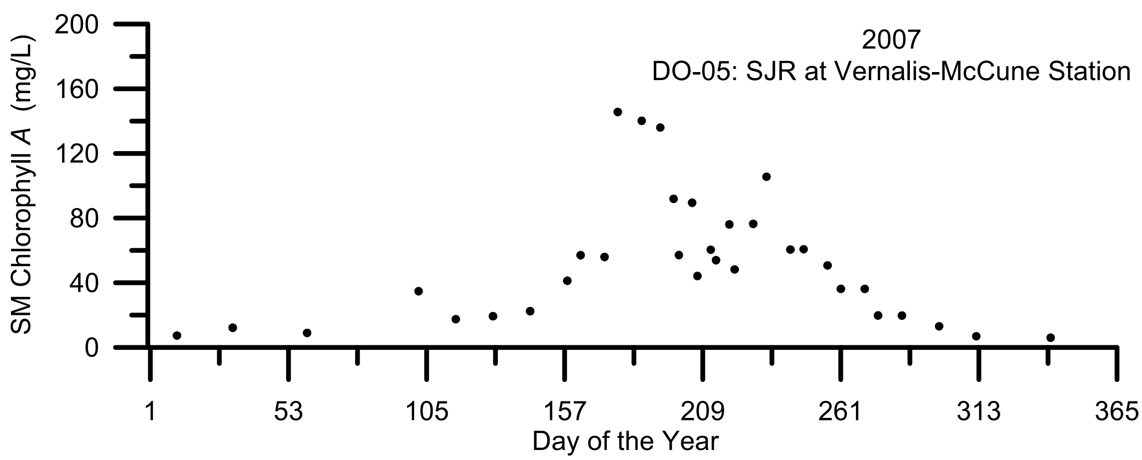


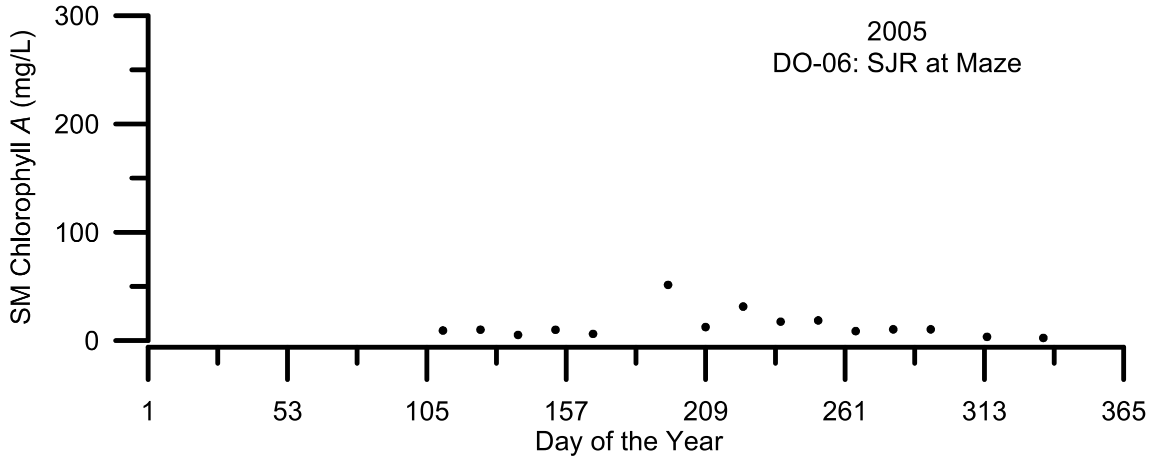


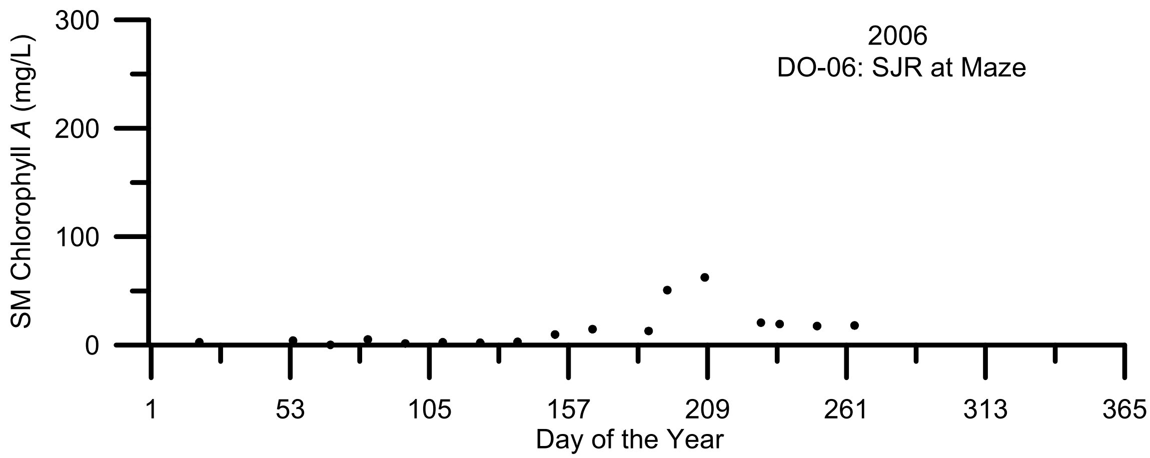


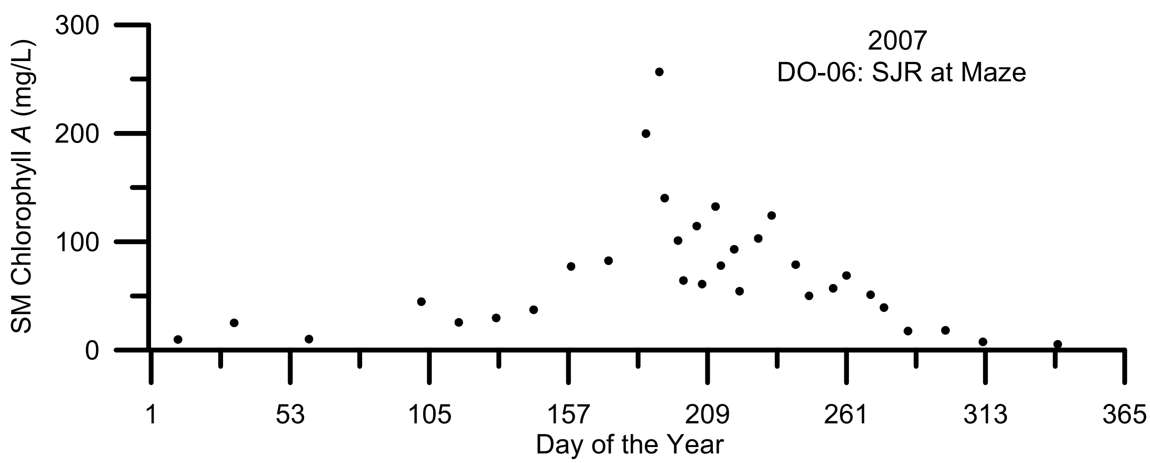

2005
DO-05: SJR at Vernalis-McCune Station
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

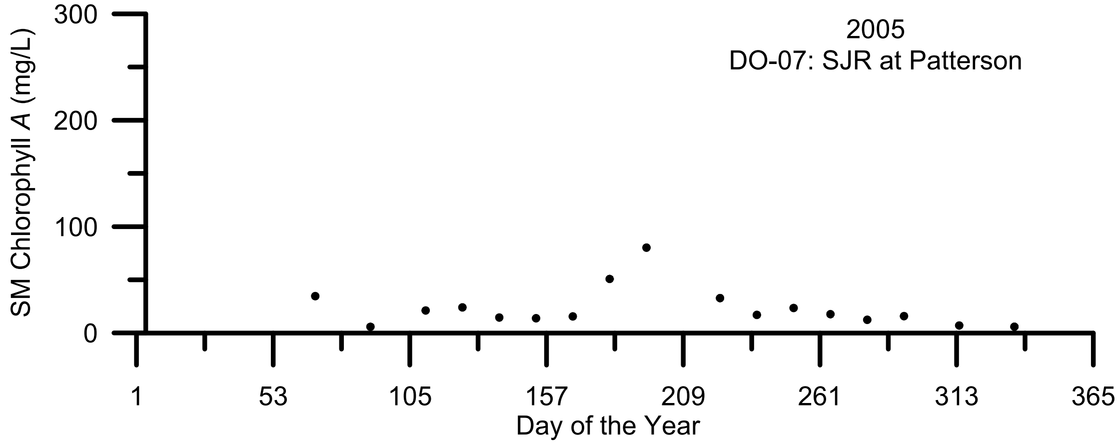

2006
DO-05: SJR at Vernalis-McCune Station
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

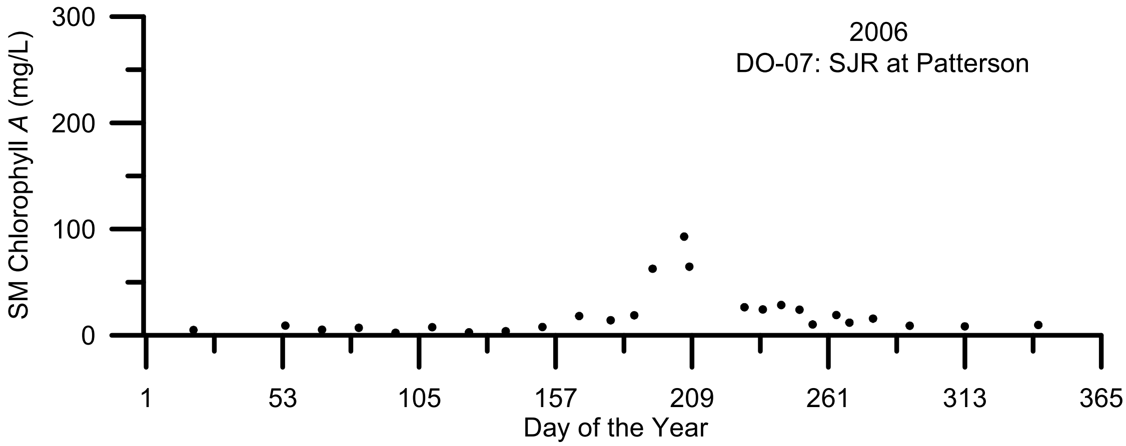

2007
DO-05: SJR at Vernalis-McCune Station
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

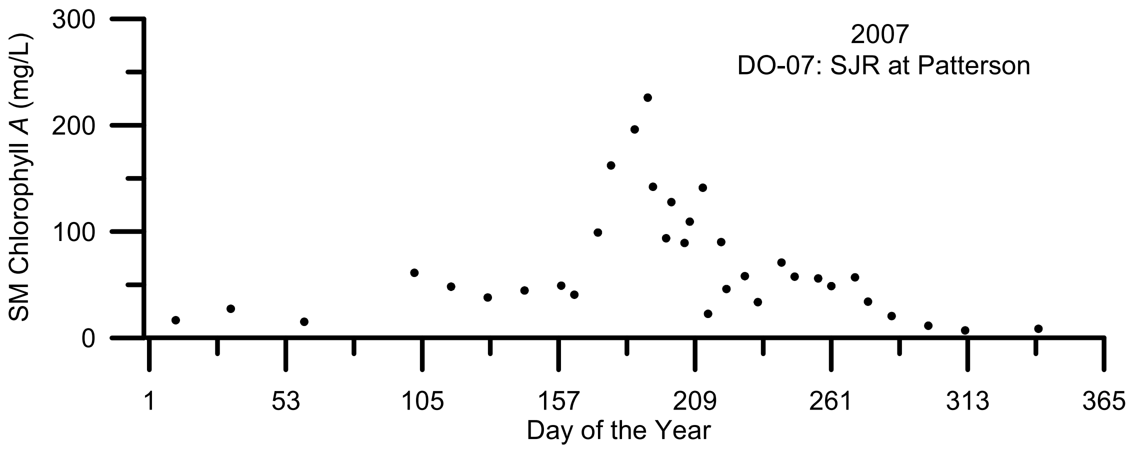

2005
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

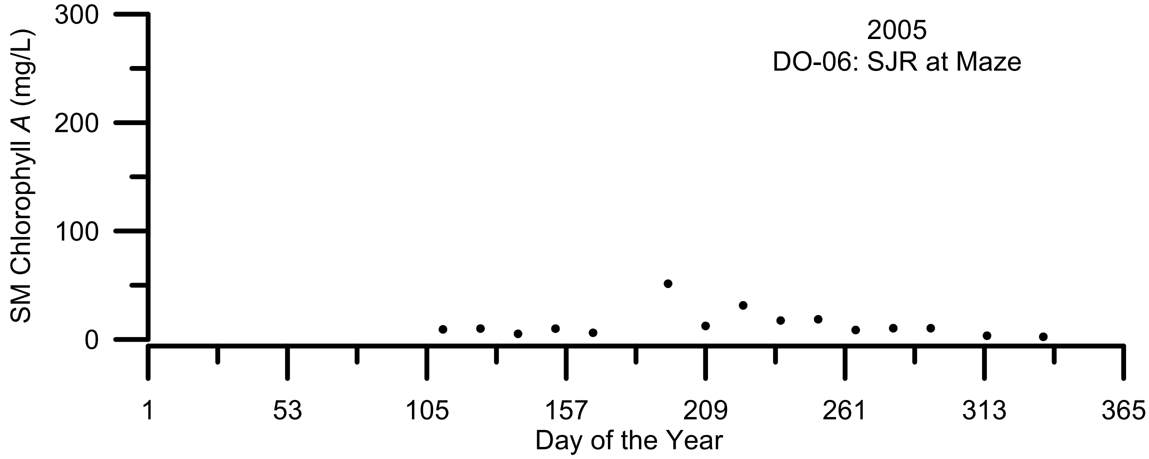

2006
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

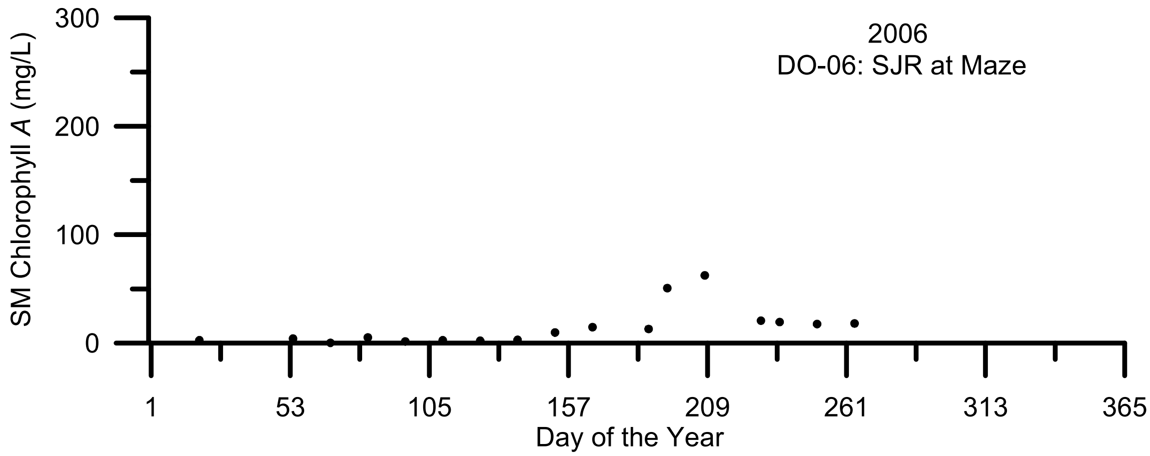

2007
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

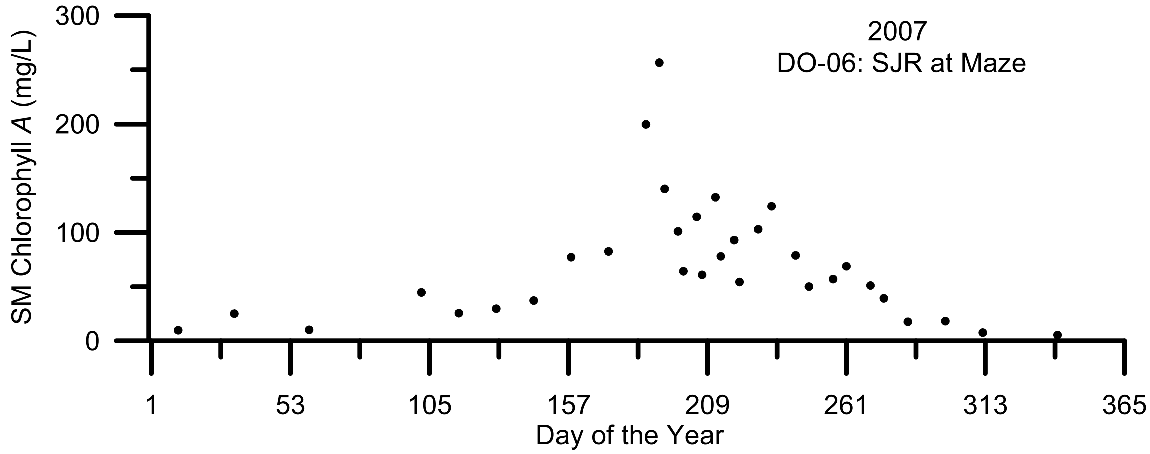

2005
DO-07: SJR at Patterson
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

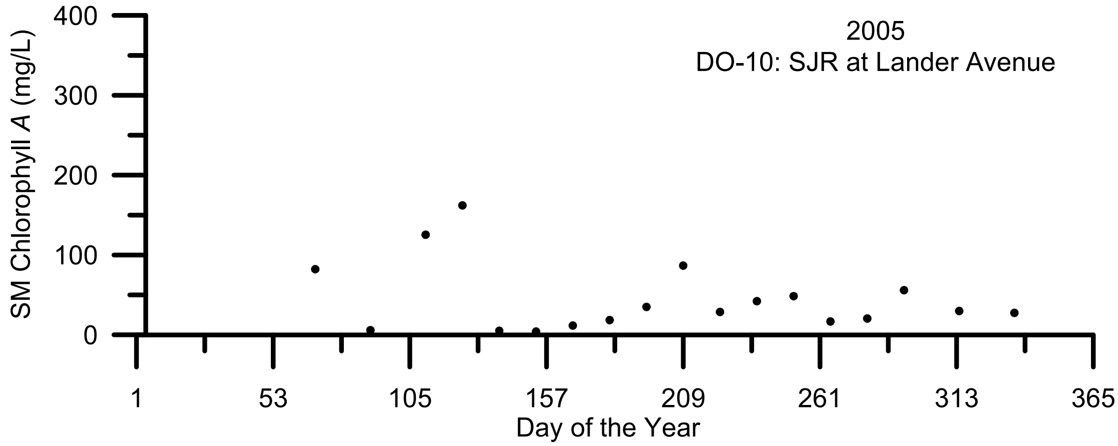

2006
DO-07: SJR at Patterson
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

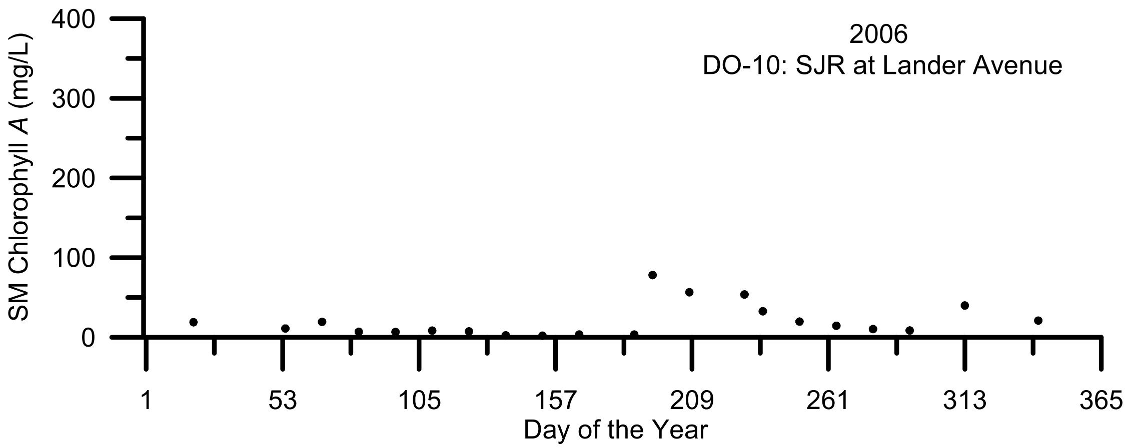

2007
DO-07: SJR at Patterson
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

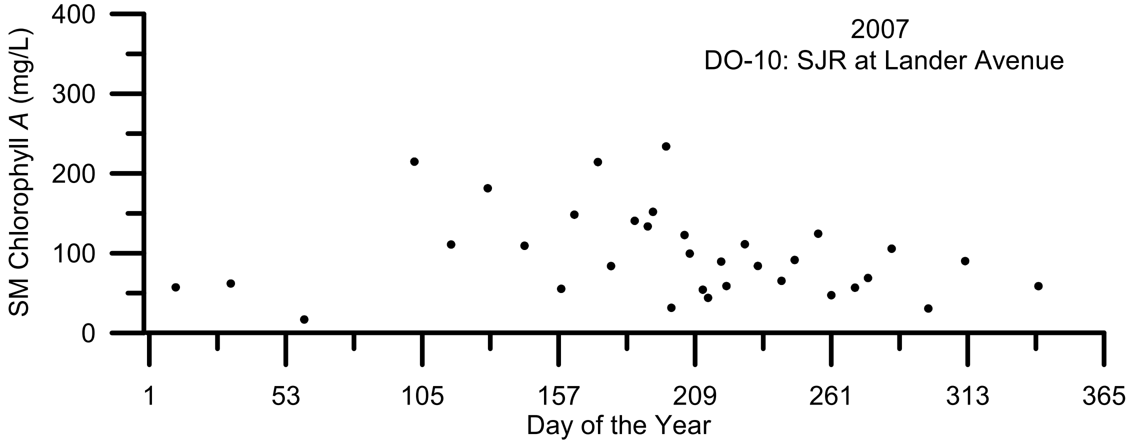

2005
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

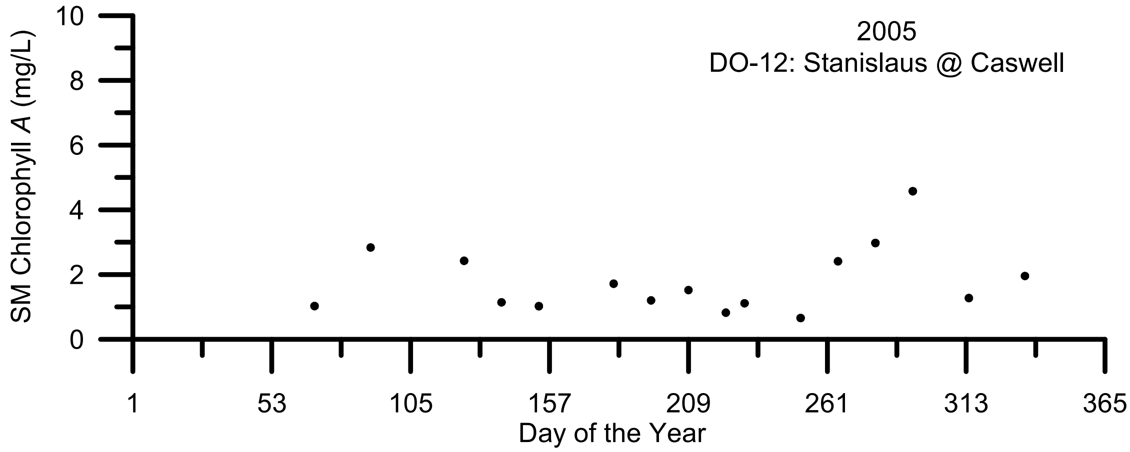

2006
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

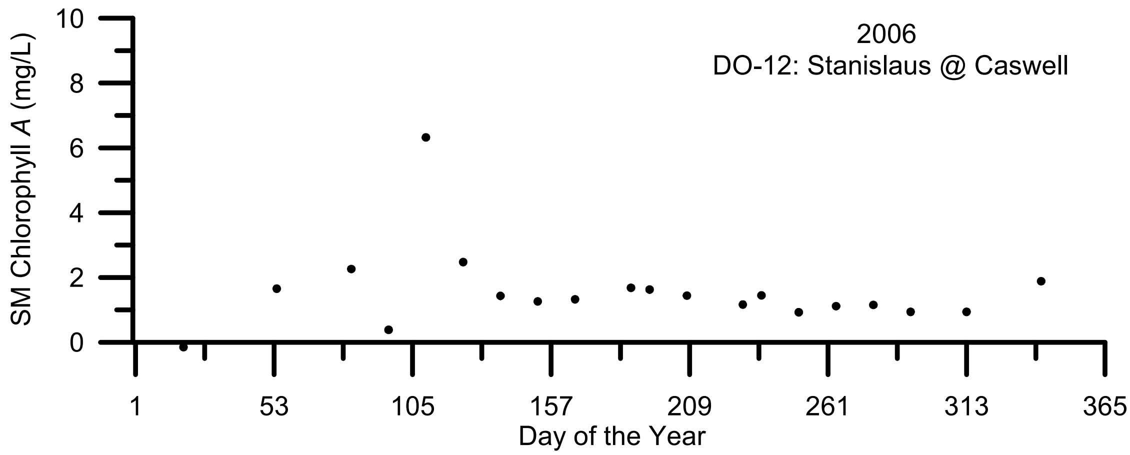

2007
DO-06: SJR at Maze
SM Chlorophyll A (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

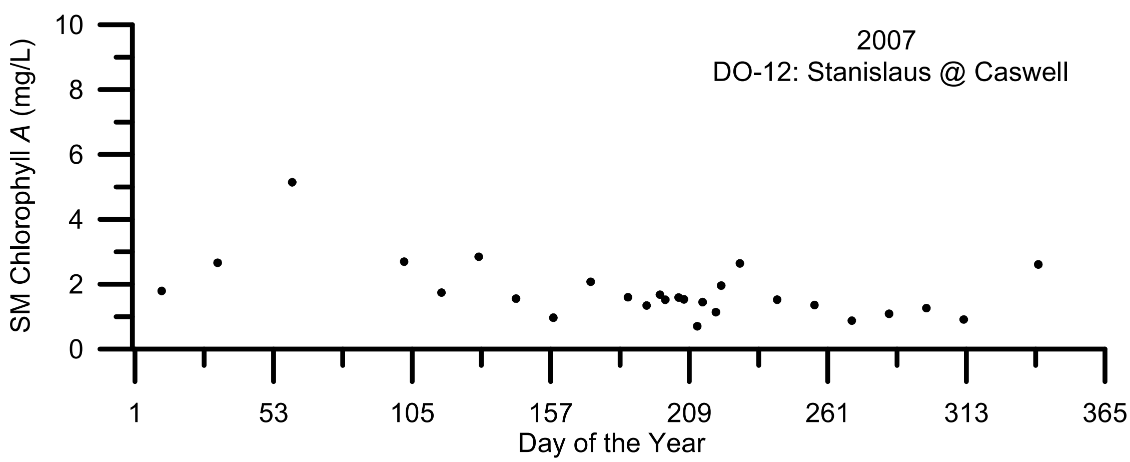

2005
DO-10: SJR at Lander Avenue
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

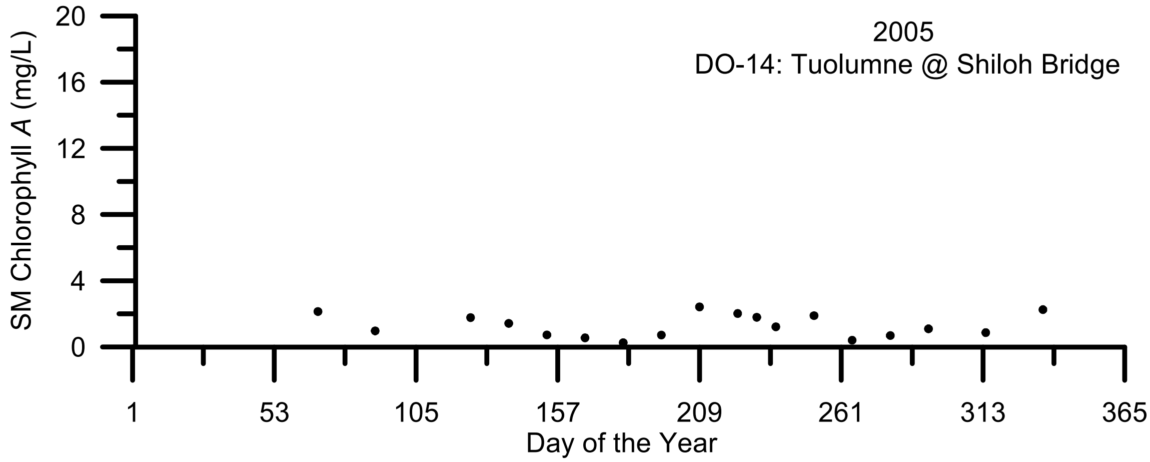

2006
DO-10: SJR at Lander Avenue
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

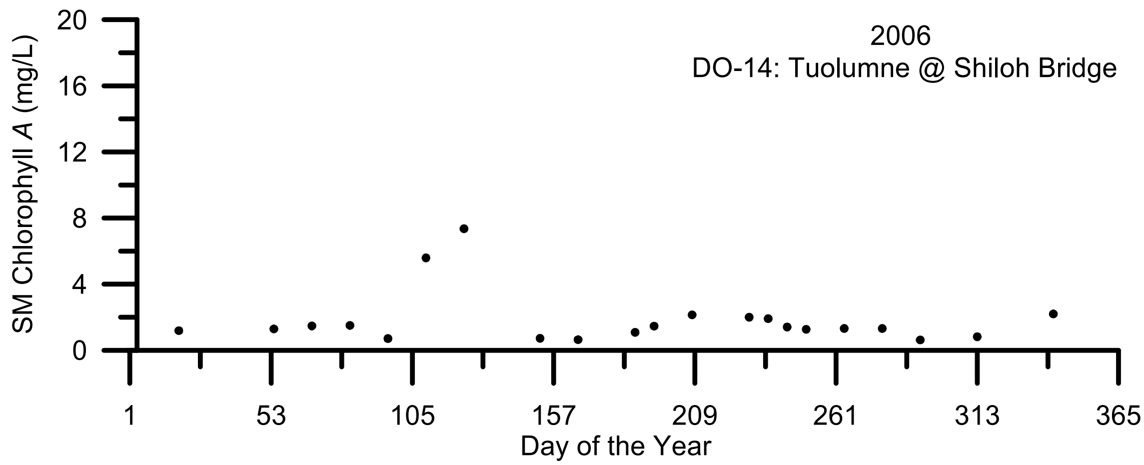

2007
DO-10: SJR at Lander Avenue
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

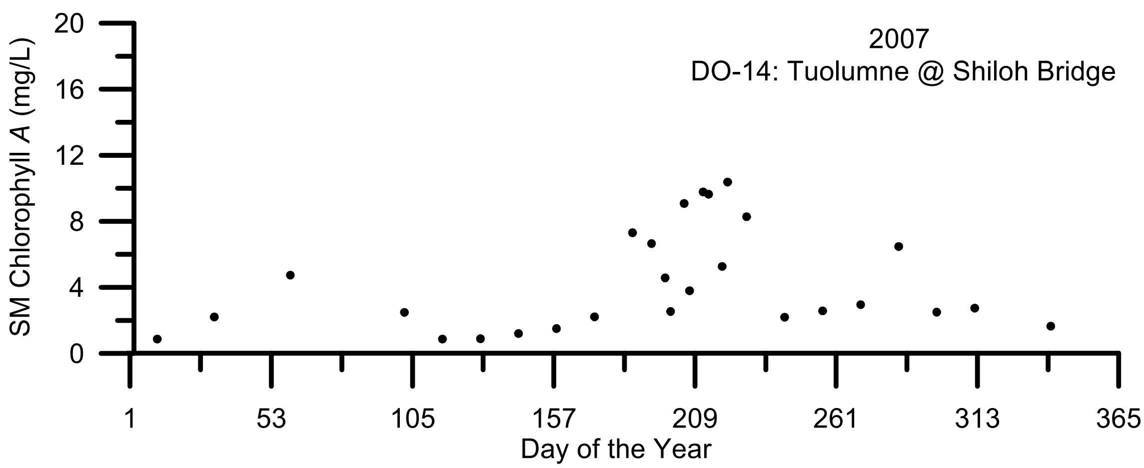

2005
DO-12: Stanislaus @ Caswell
SM Chlorophyll A (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

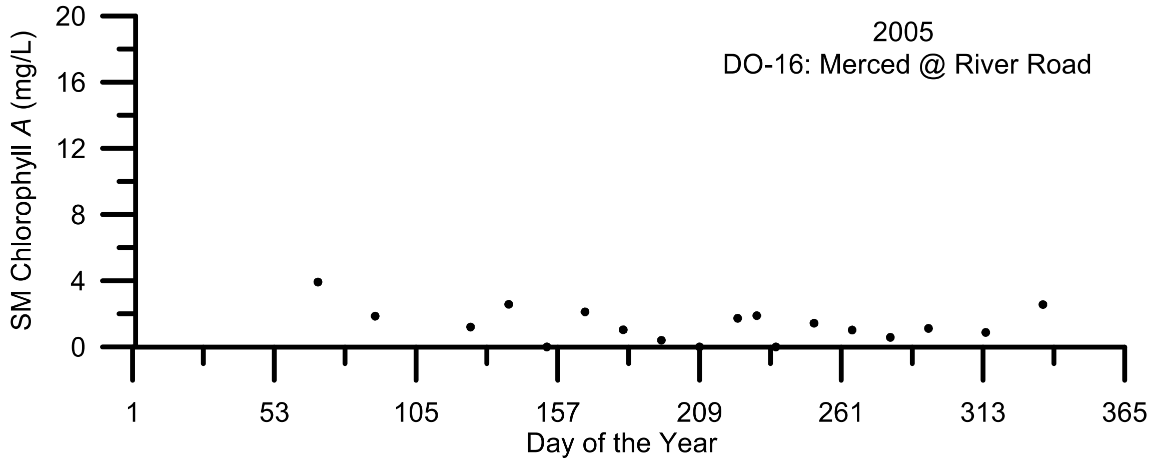

2006
DO-12: Stanislaus @ Caswell
SM Chlorophyll A (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-12: Stanislaus @ Caswell
SM Chlorophyll A (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

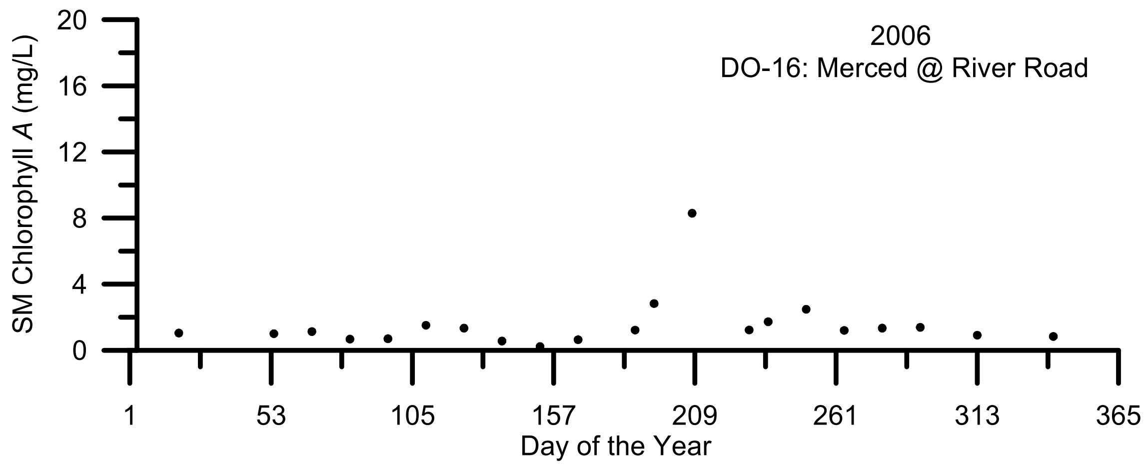

2005
DO-14: Tuolumne @ Shiloh Bridge
SM Chlorophyll A (mg/L)
Day of the Year


2006
DO-14: Tuolumne @ Shiloh Bridge
SM Chlorophyll A (mg/L)
Day of the Year

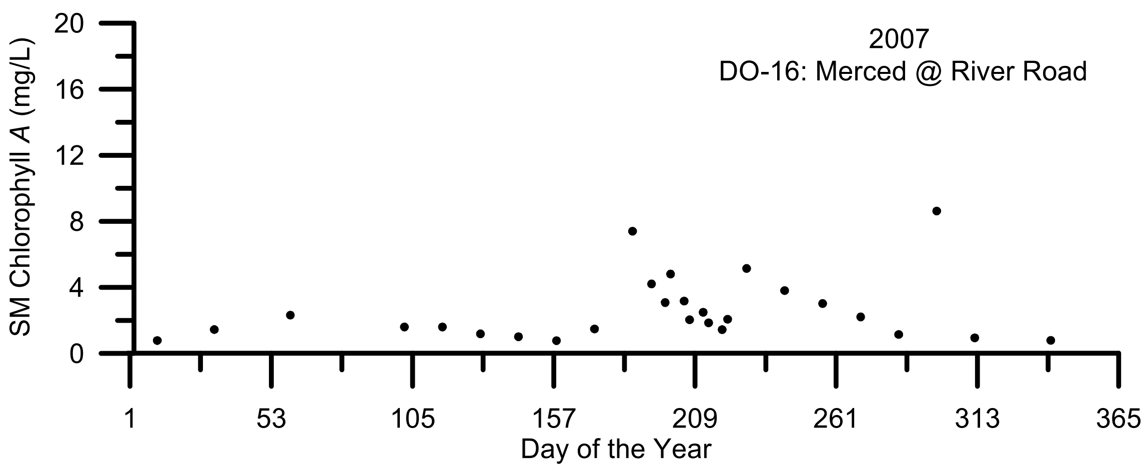

2007
DO-14: Tuolumne @ Shiloh Bridge
SM Chlorophyll A (mg/L)
Day of the Year



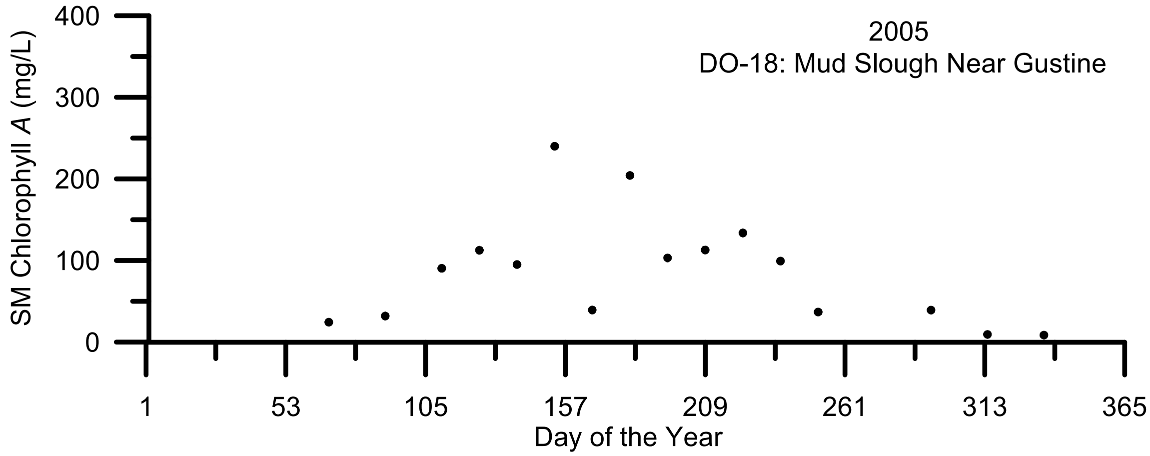
2005
DO-16: Merced @ River Road
SM Chlorophyll A (mg/L)
Day of the Year

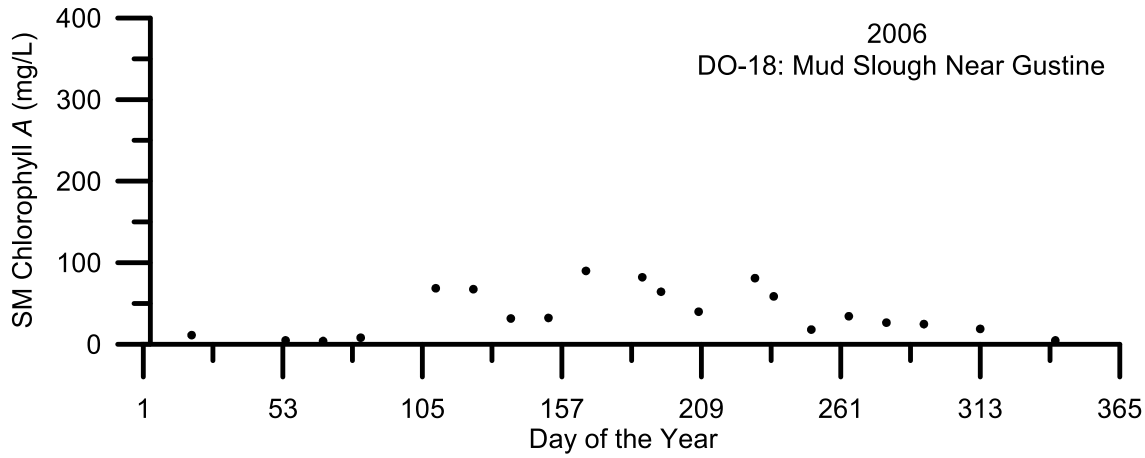


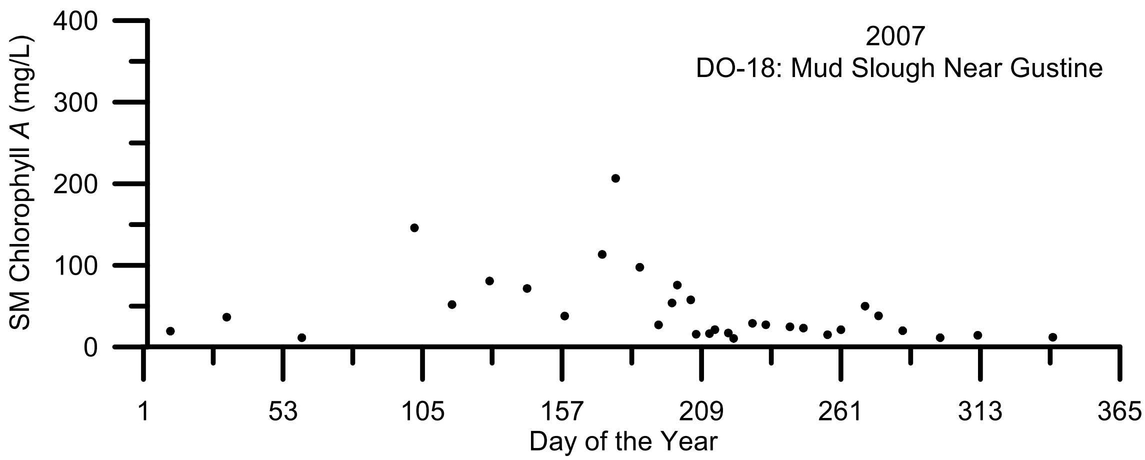
2006
DO-16: Merced @ River Road
SM Chlorophyll A (mg/L)
Day of the Year

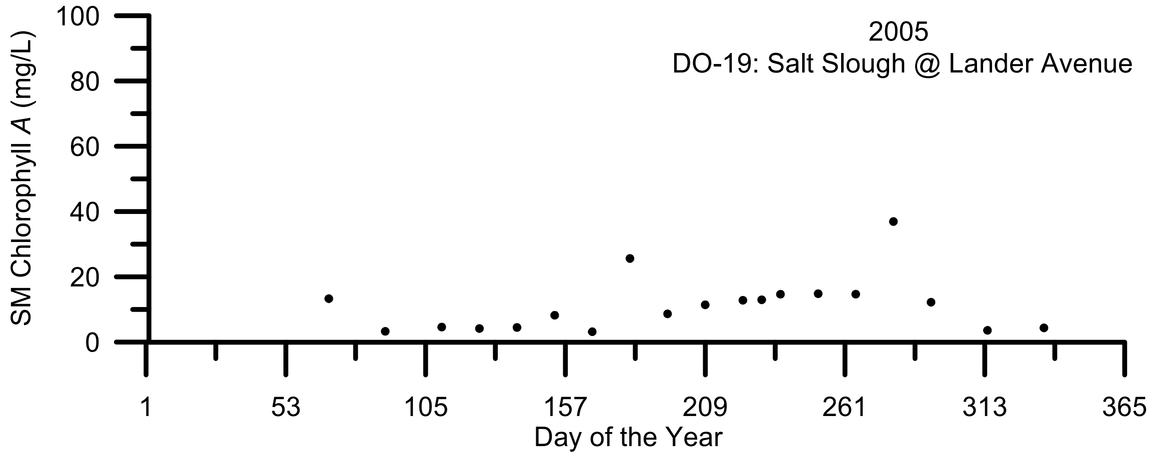


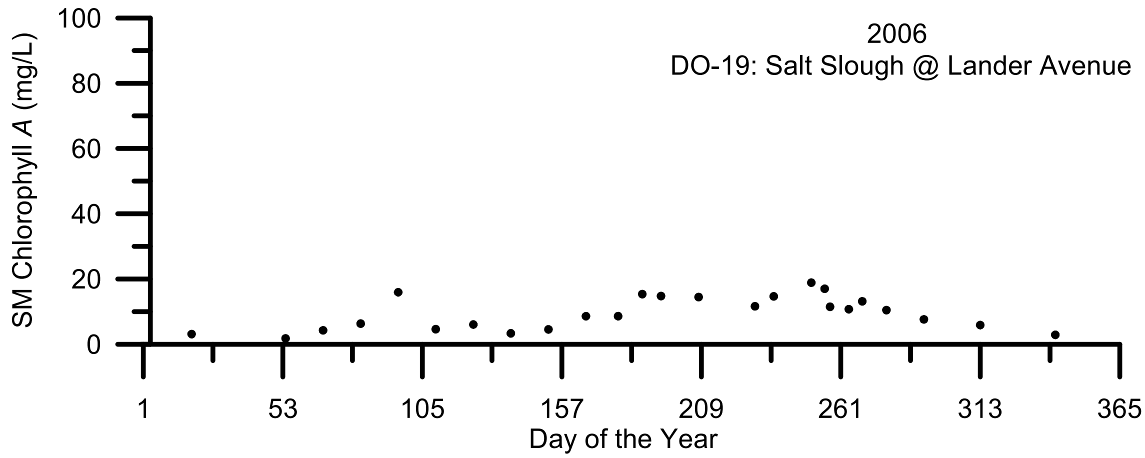
2007
DO-16: Merced @ River Road
SM Chlorophyll A (mg/L)
Day of the Year

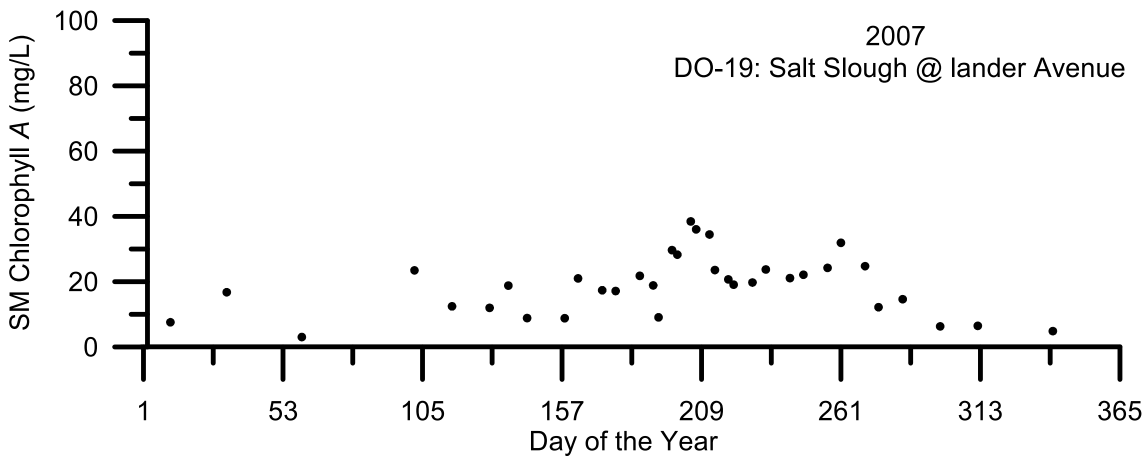

2005
DO-18: Mud Slough Near Gustine
SM Chlorophyll A (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

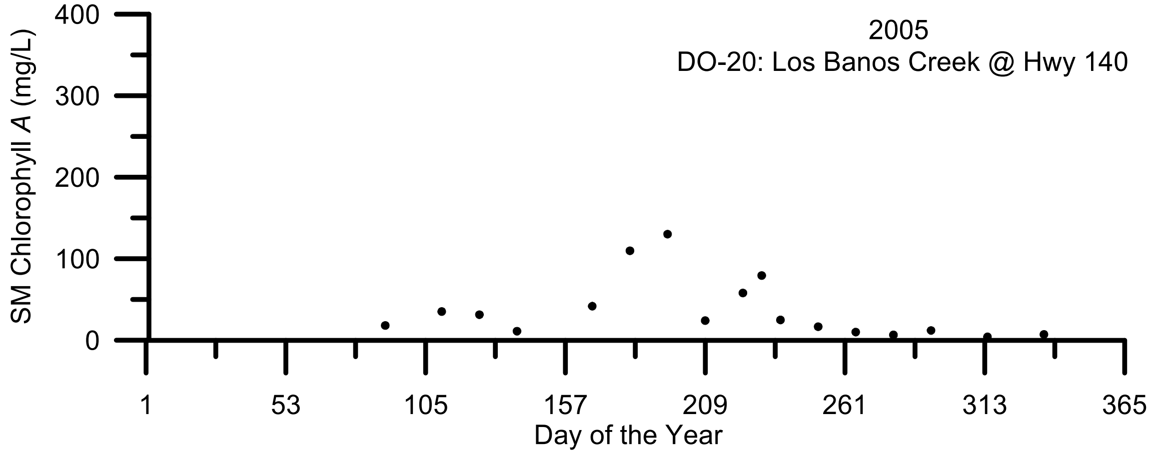

2006
DO-18: Mud Slough Near Gustine
SM Chlorophyll A (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

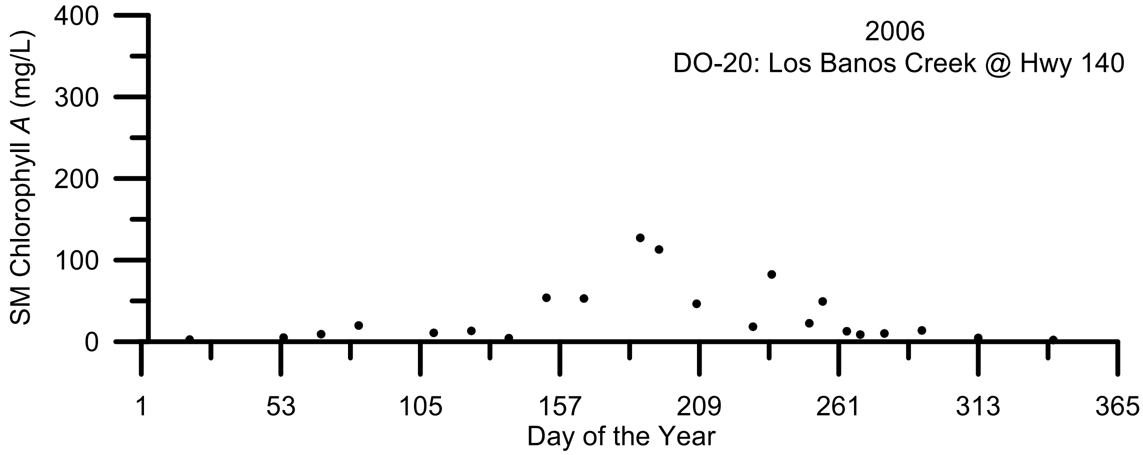

2007
DO-18: Mud Slough Near Gustine
SM Chlorophyll A (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

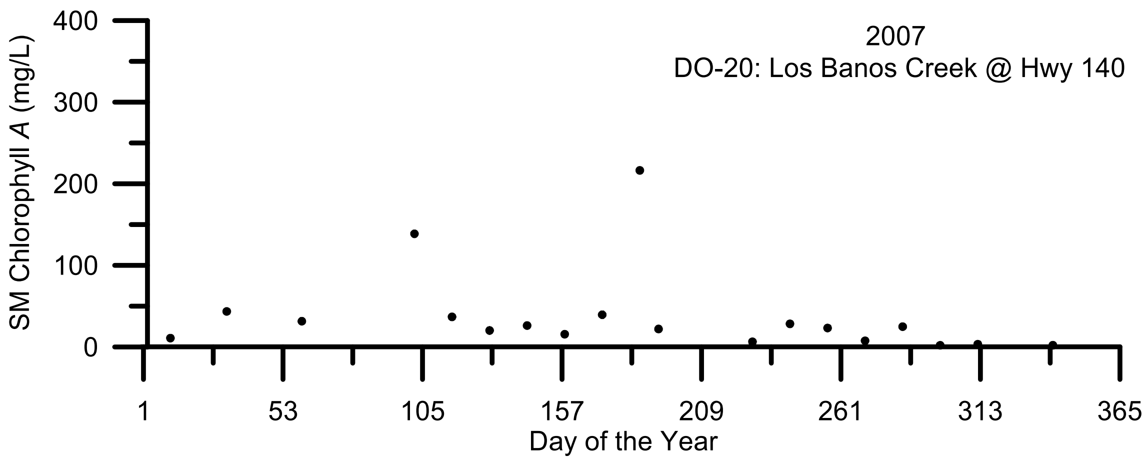

2005
DO-19: Salt Slough @ Lander Avenue
SM Chlorophyll A (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

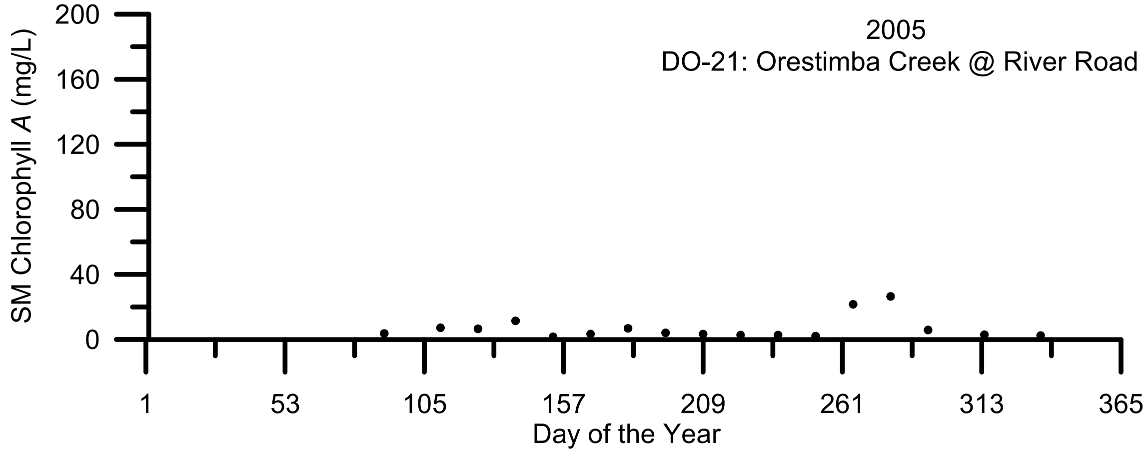

2006
DO-19: Salt Slough @ Lander Avenue
SM Chlorophyll A (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

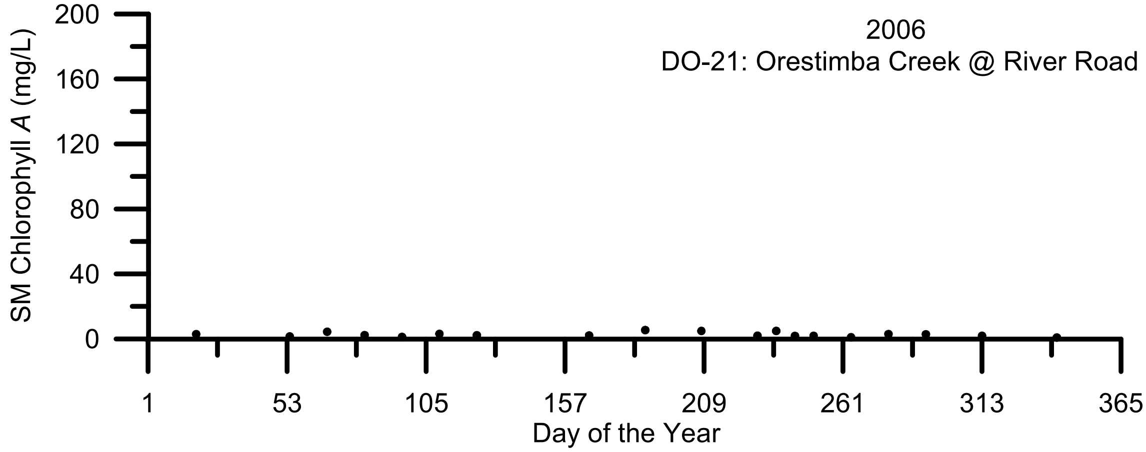

2007
DO-19: Salt Slough @ lander Avenue
SM Chlorophyll A (mg/L)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

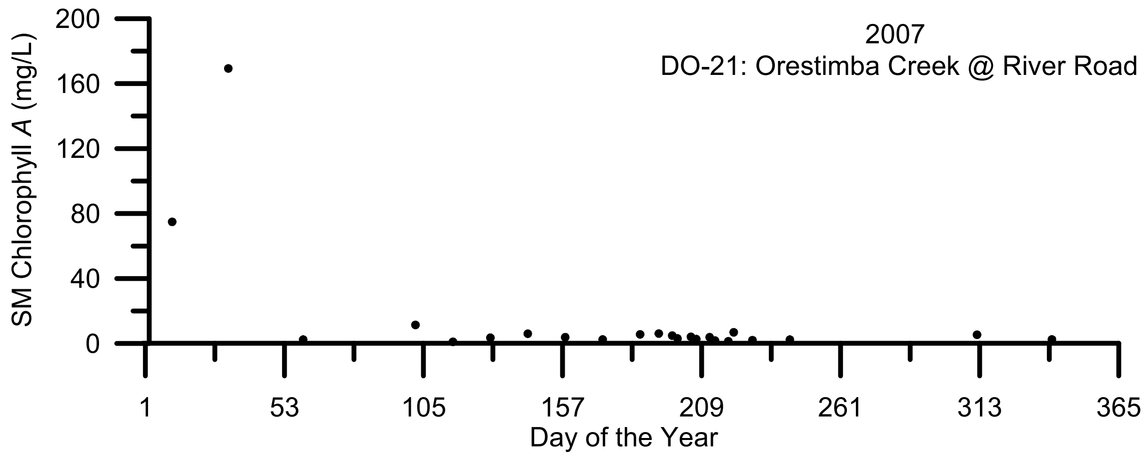

2005
DO-20: Los Banos Creek @ Hwy 140
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

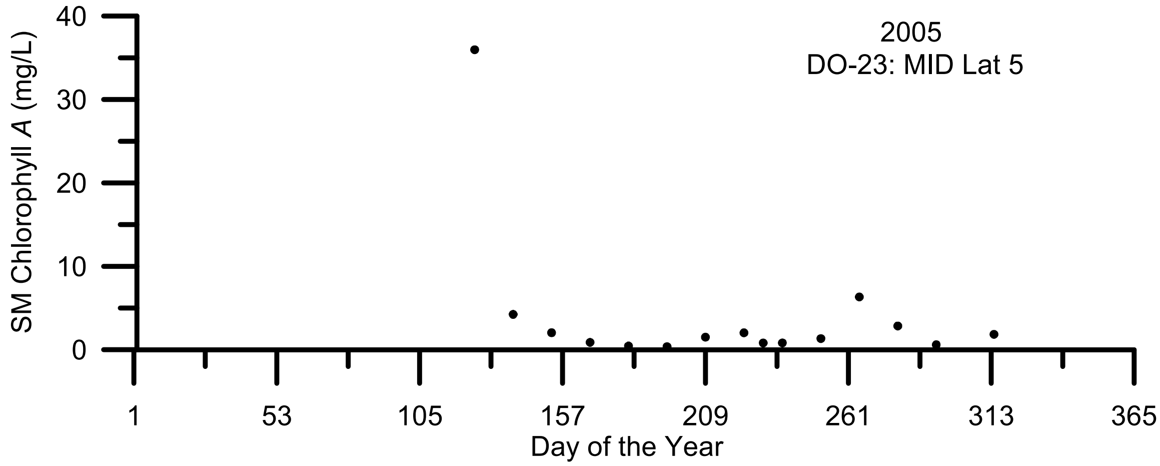

2006
DO-20: Los Banos Creek @ Hwy 140
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

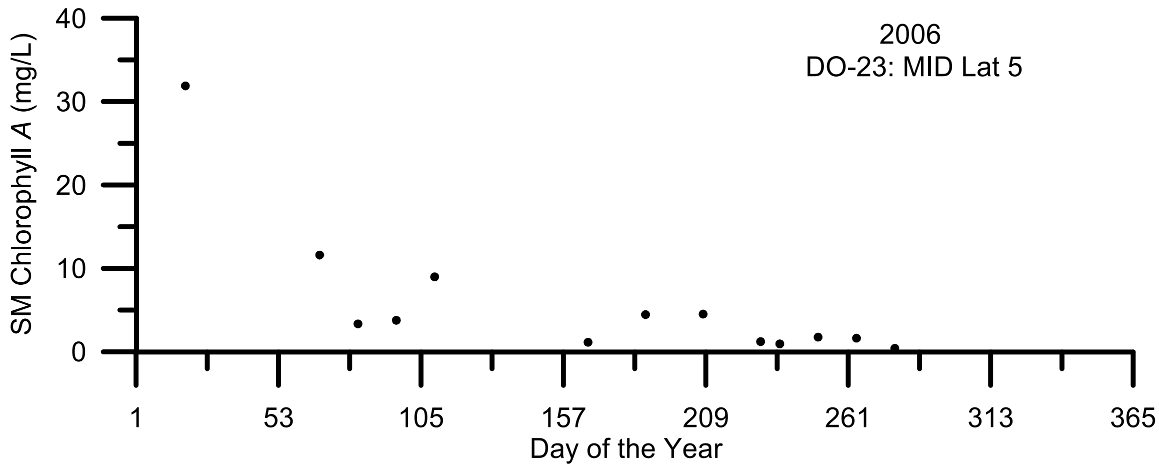

2007
DO-20: Los Banos Creek @ Hwy 140
SM Chlorophyll A (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

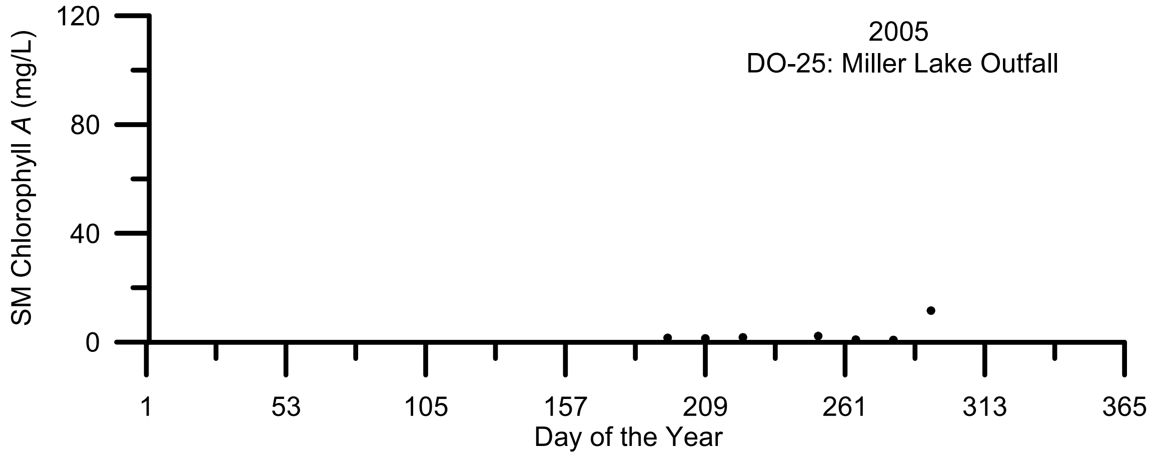

2005
DO-21: Orestimba Creek @ River Road
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-21: Orestimba Creek @ River Road
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

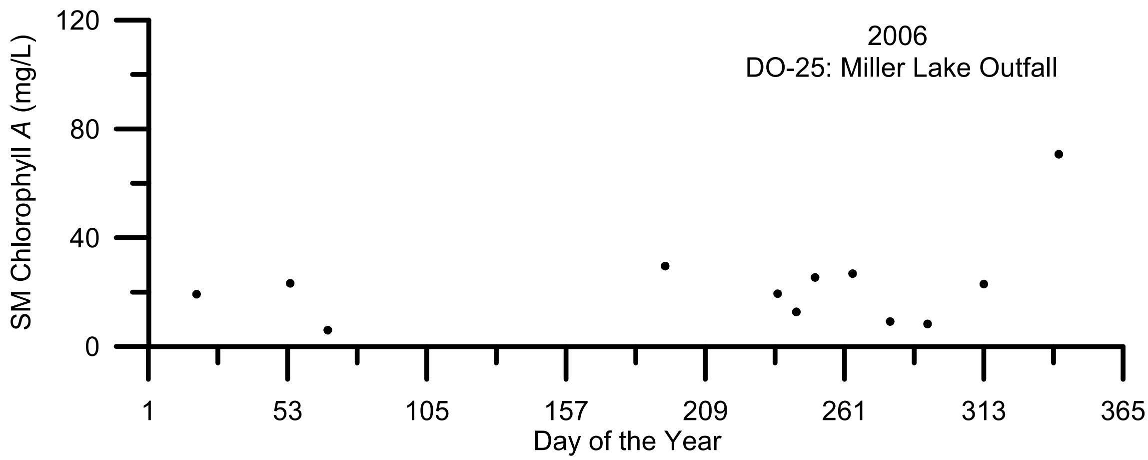

2007
DO-21: Orestimba Creek @ River Road
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-23: MID Lat 5
SM Chlorophyll A (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

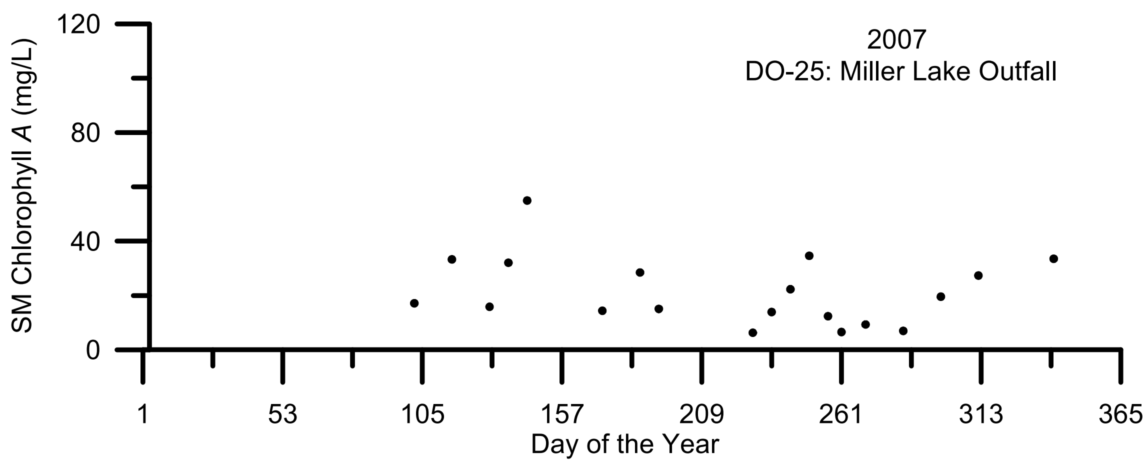

2006
DO-23: MID Lat 5
SM Chlorophyll A (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year



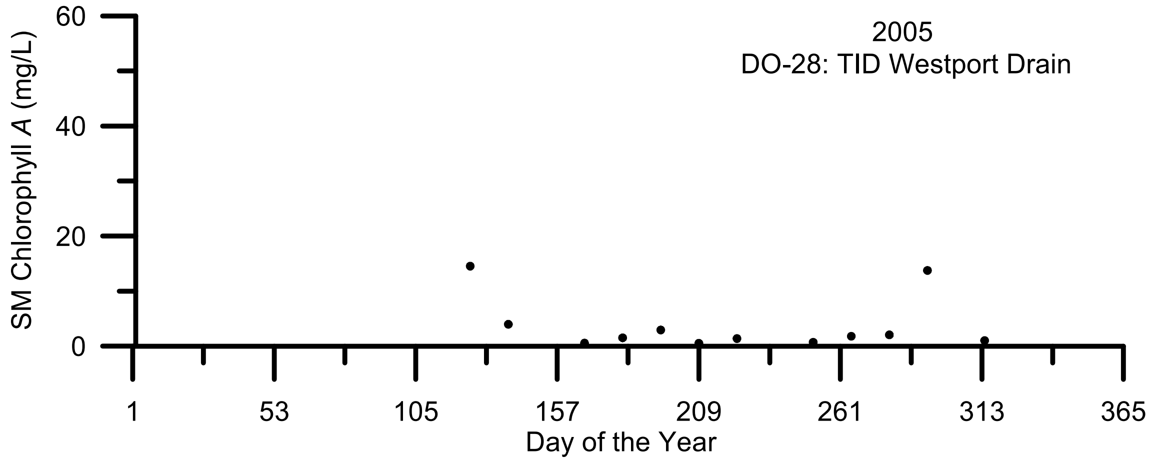
120
80
40
0
SM Chlorophyll A (mg/L)
2005
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

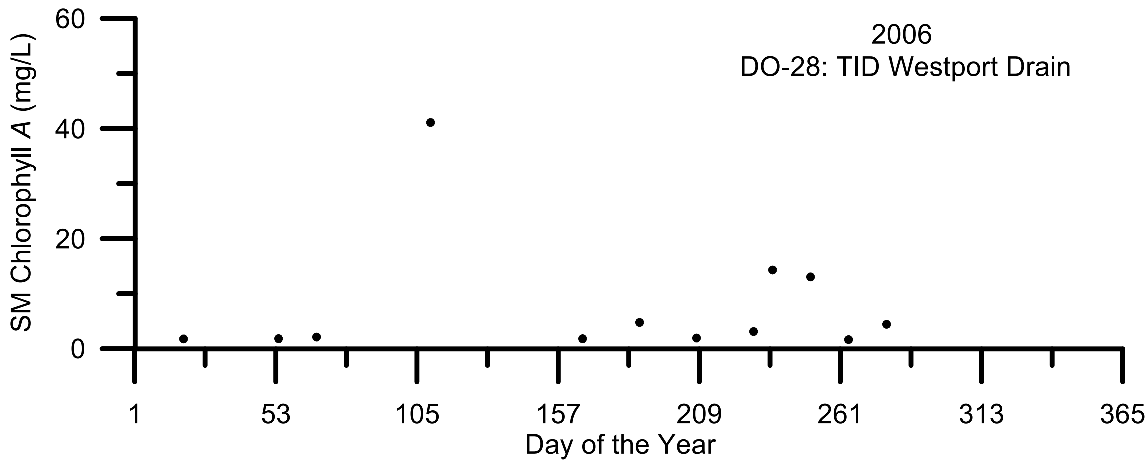


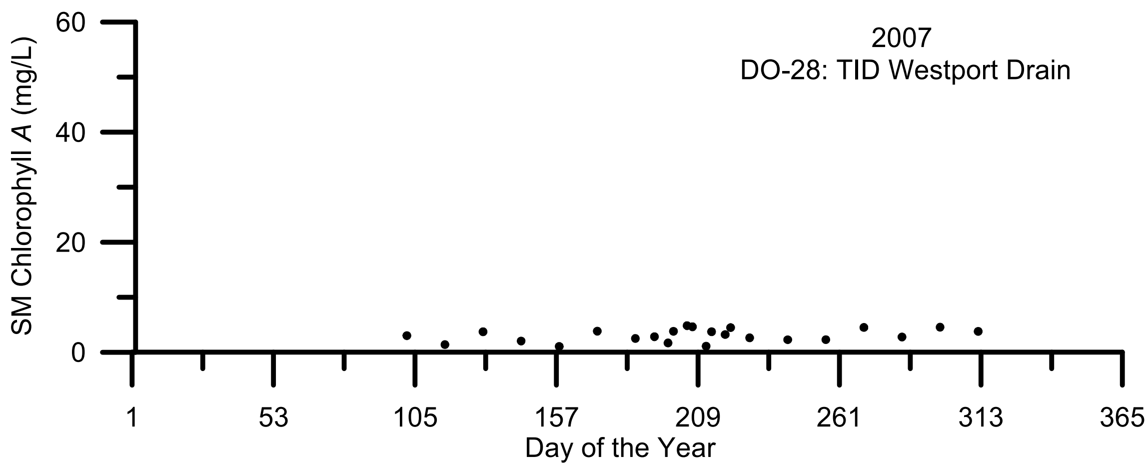
120
80
40
0
SM Chlorophyll A (mg/L)
2006
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

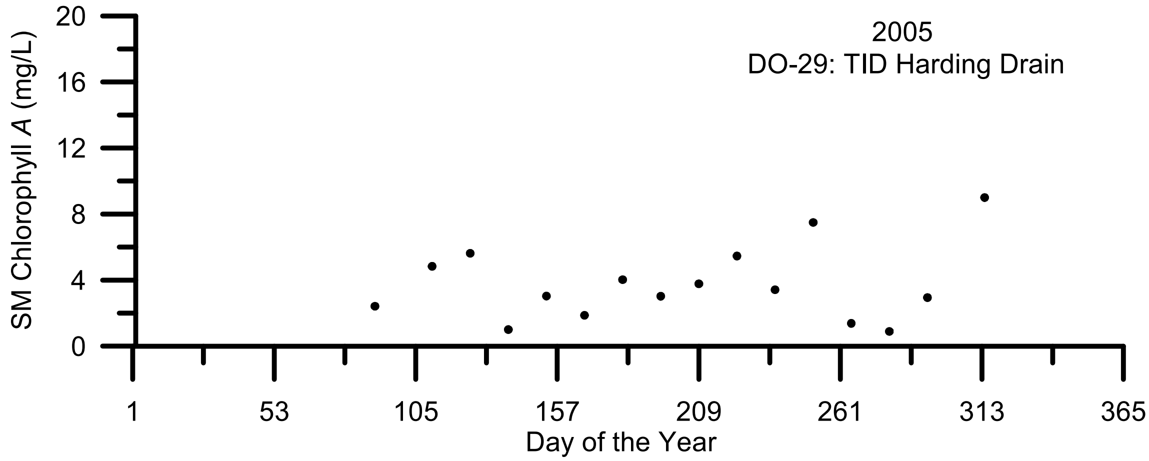


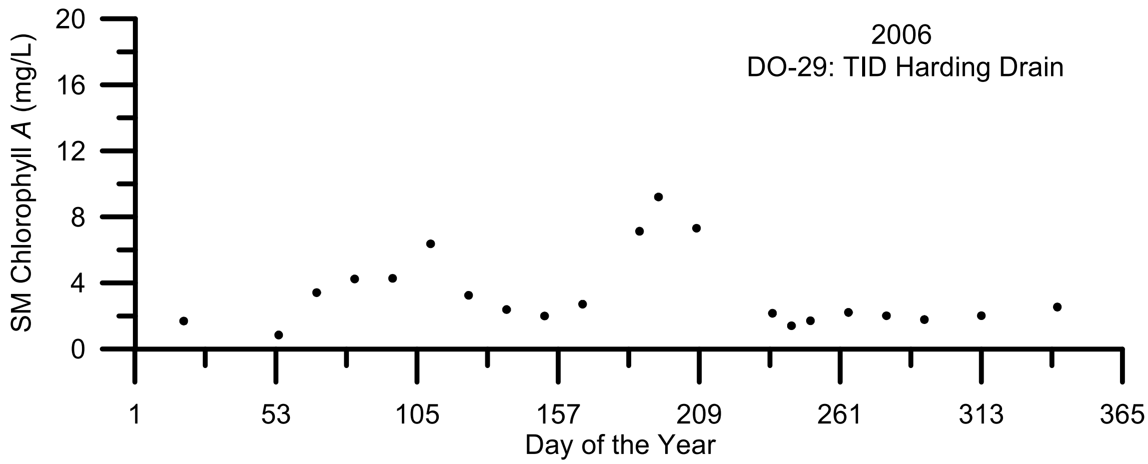
120
80
40
0
SM Chlorophyll A (mg/L)
2007
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

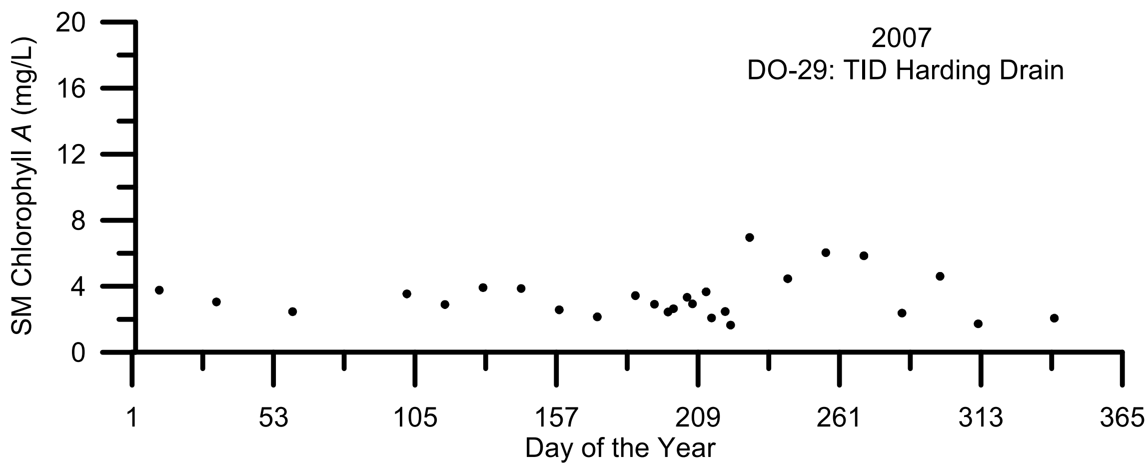

2005
DO-28: TID Westport Drain
SM Chlorophyll A (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

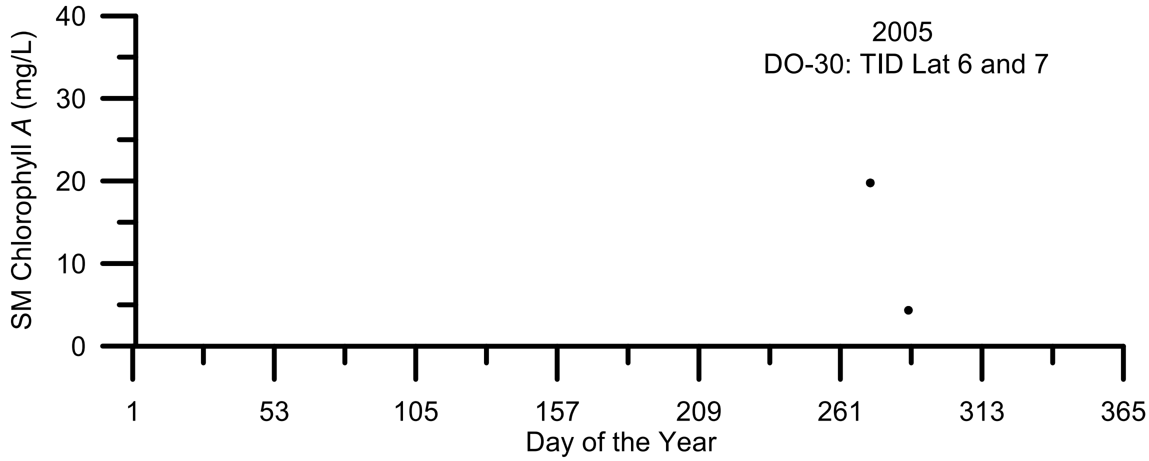

2006
DO-28: TID Westport Drain
SM Chlorophyll A (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-28: TID Westport Drain
SM Chlorophyll A (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

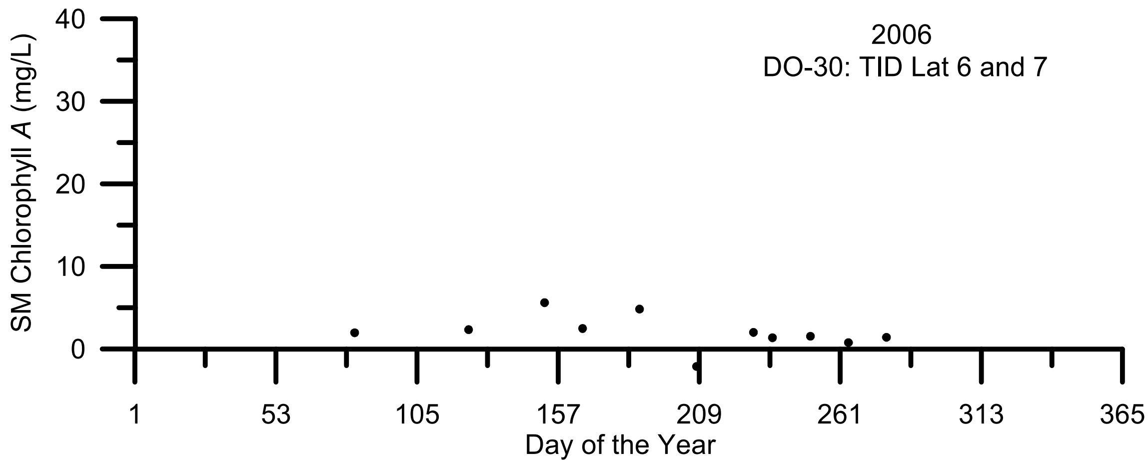

2005
DO-29: TID Harding Drain
SM Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-29: TID Harding Drain
SM Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

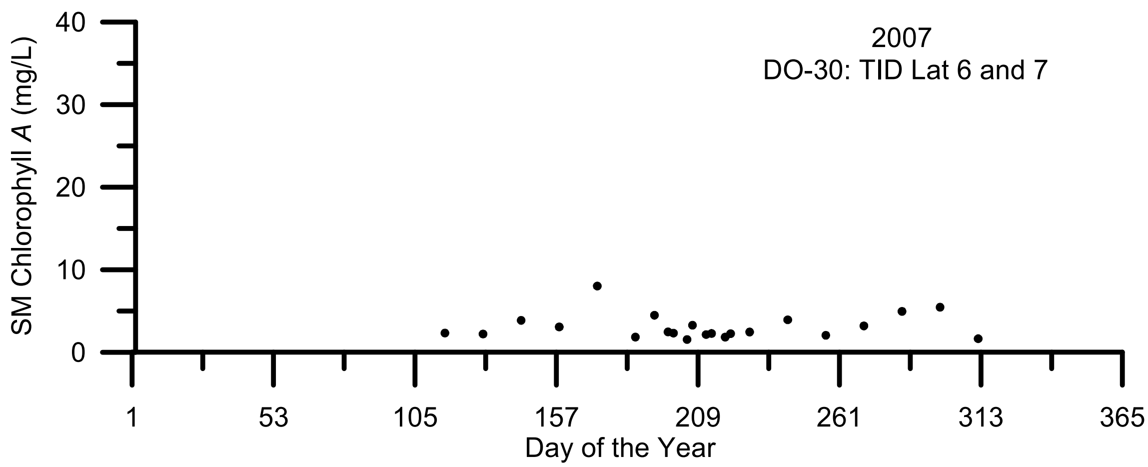

2007
DO-29: TID Harding Drain
SM Chlorophyll A (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year



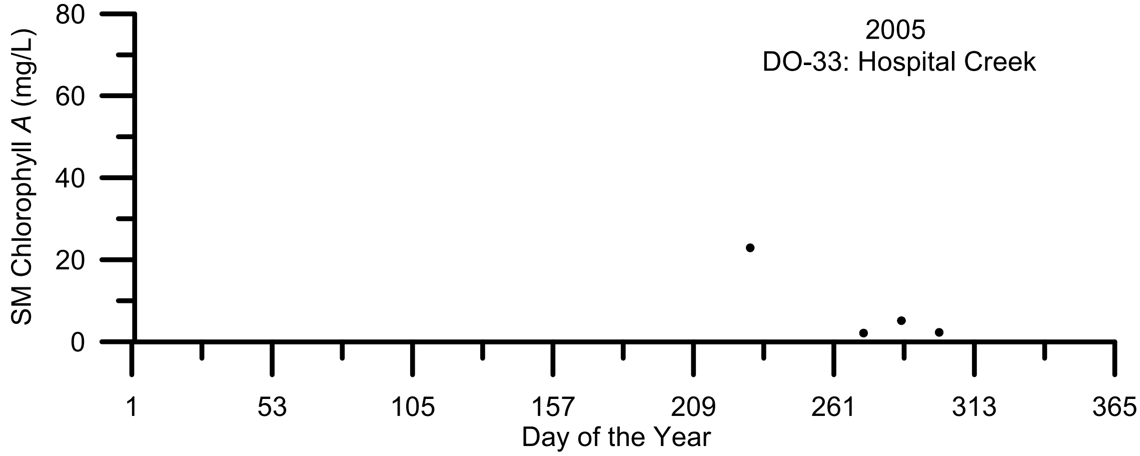
2005
DO-30: TID Lat 6 and 7
SM Chlorophyll A (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

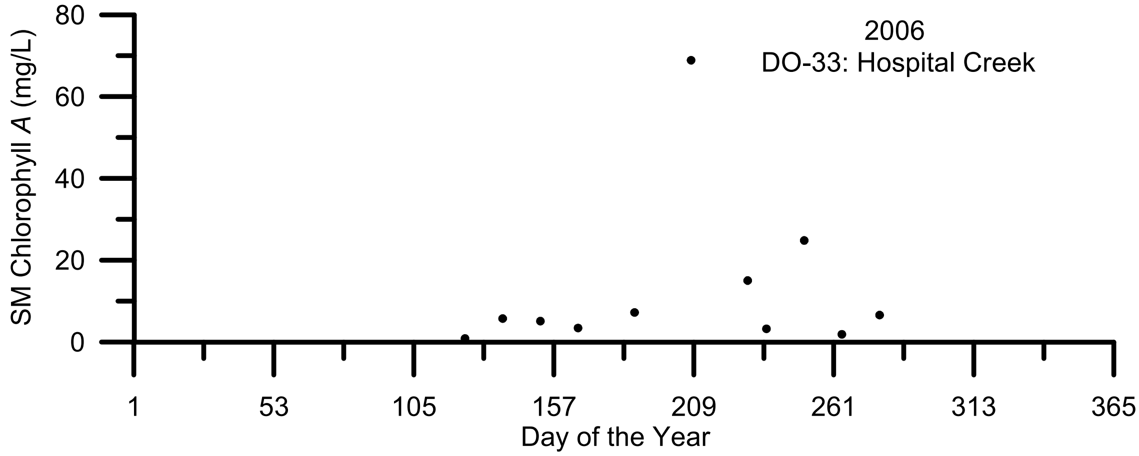


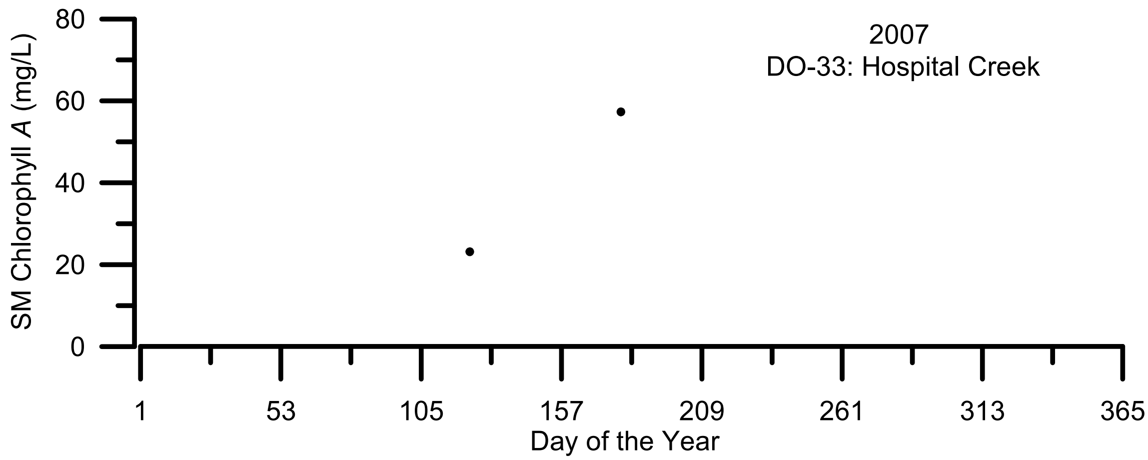
2006
DO-30: TID Lat 6 and 7
SM Chlorophyll A (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

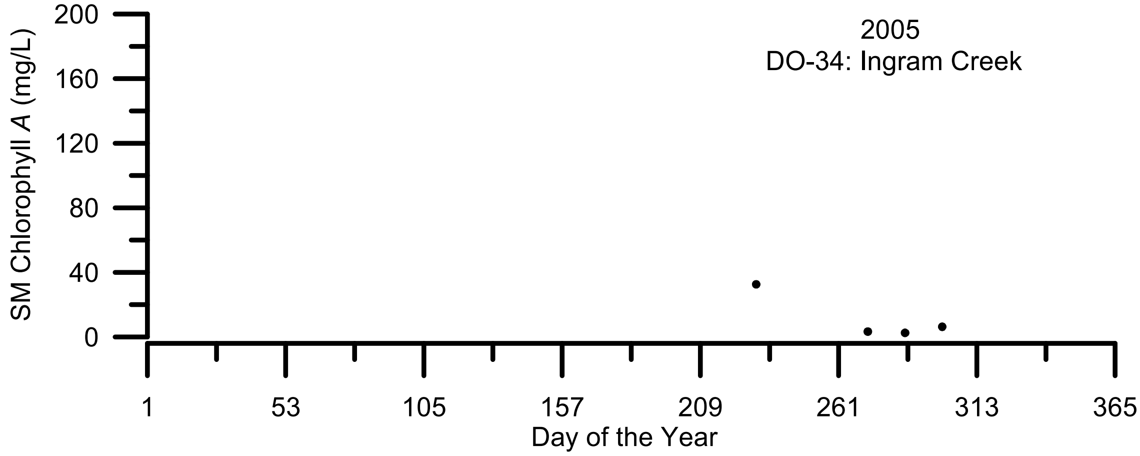


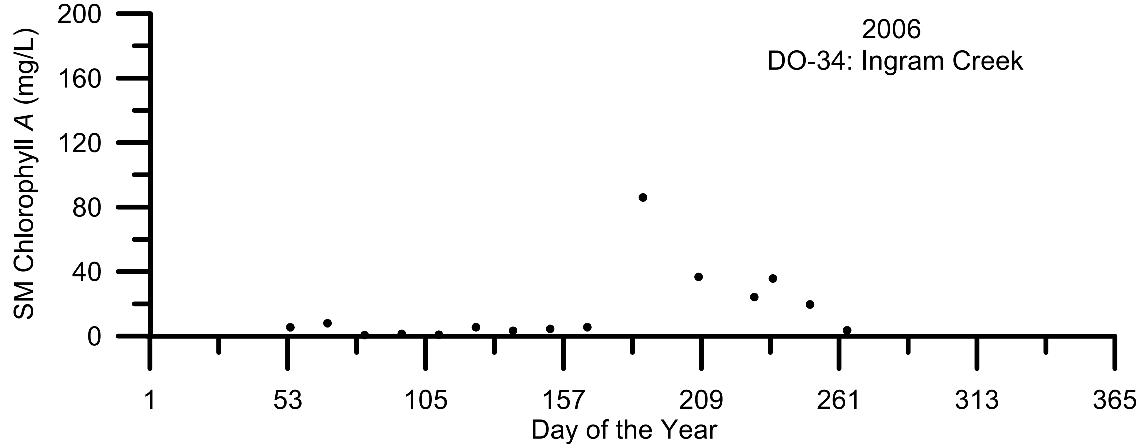
2007
DO-30: TID Lat 6 and 7
SM Chlorophyll A (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

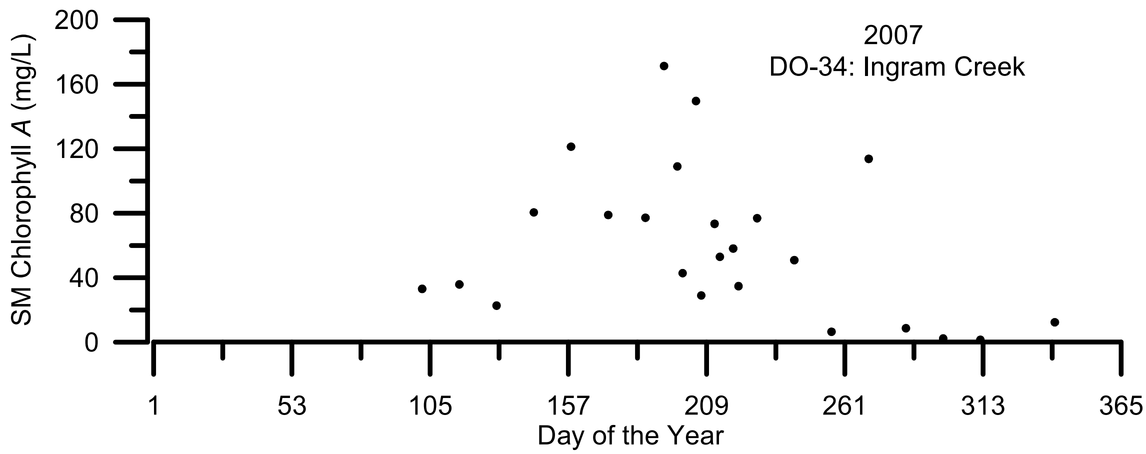

2005
DO-33: Hospital Creek
SM Chlorophyll A (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

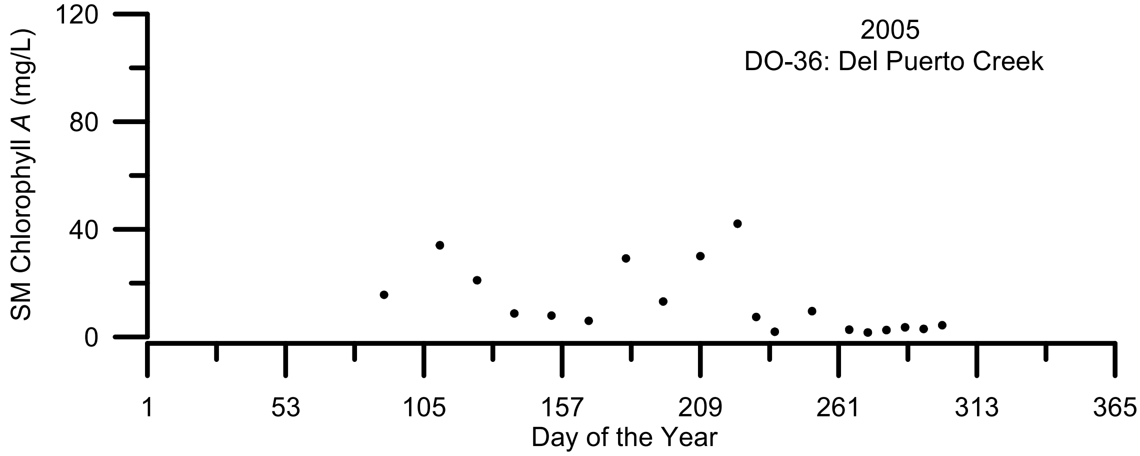

2006
DO-33: Hospital Creek
SM Chlorophyll A (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-33: Hospital Creek
SM Chlorophyll A (mg/L)
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

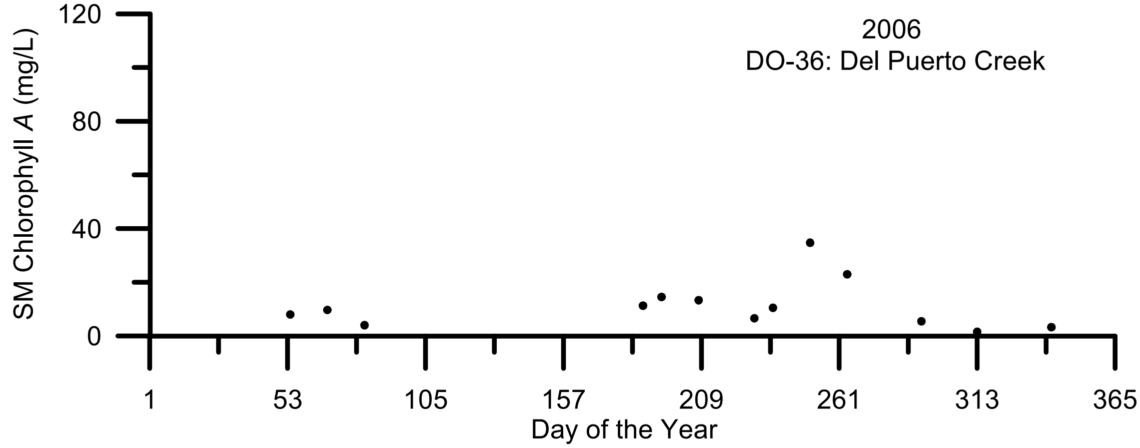

2005
DO-34: Ingram Creek
SM Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-34: Ingram Creek
SM Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

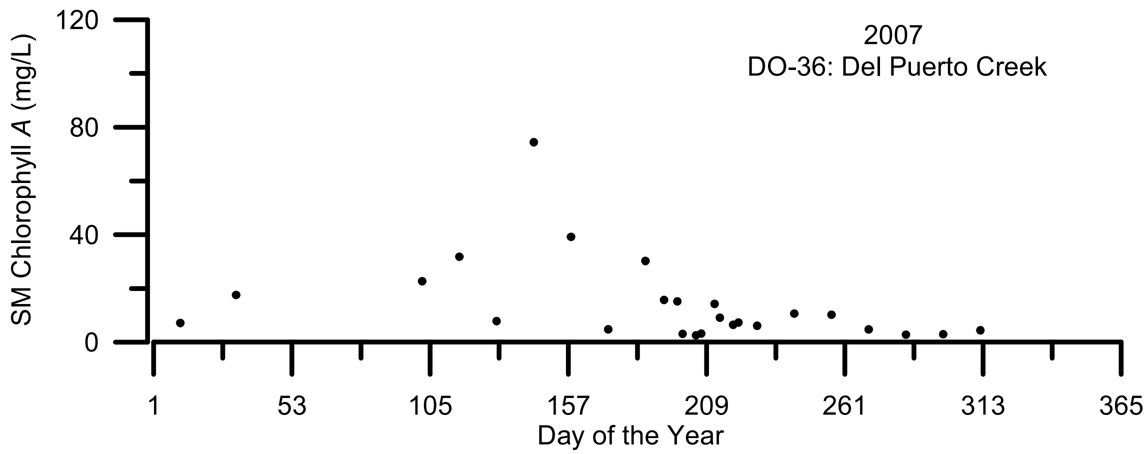

2007
DO-34: Ingram Creek
SM Chlorophyll A (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year



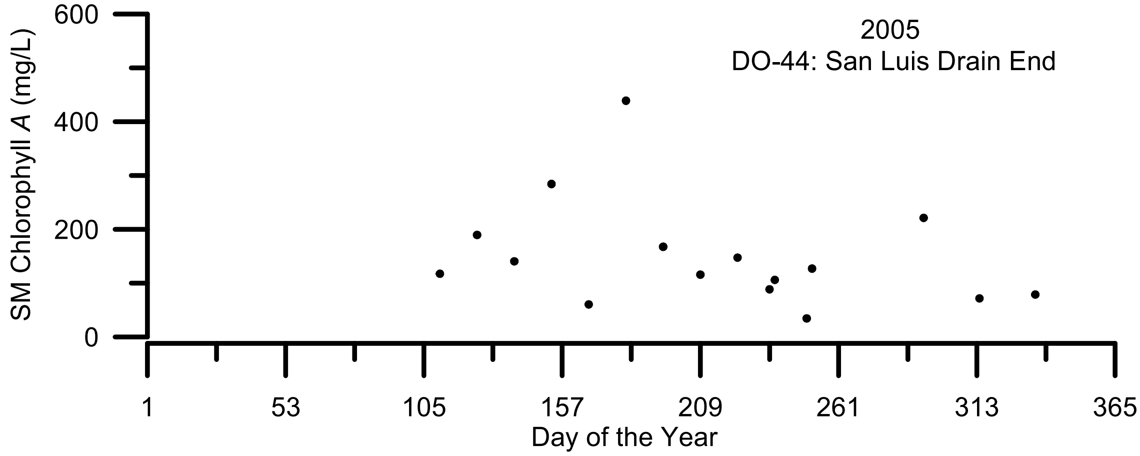
2005
DO-36: Del Puerto Creek
SM Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

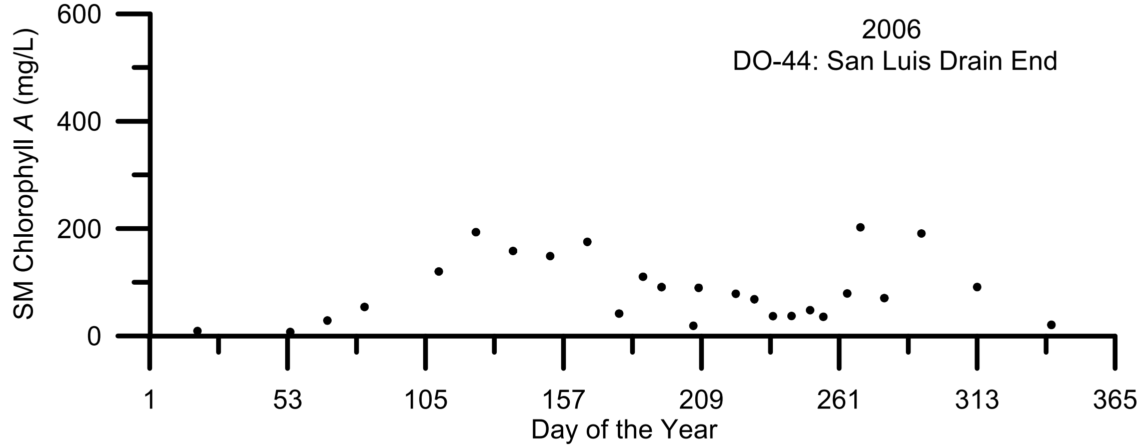


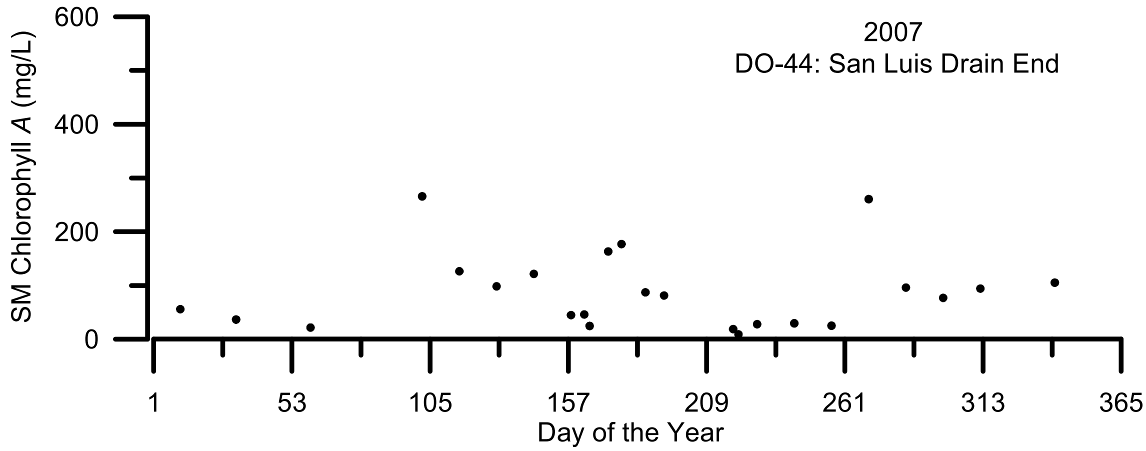
2006
DO-36: Del Puerto Creek
SM Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

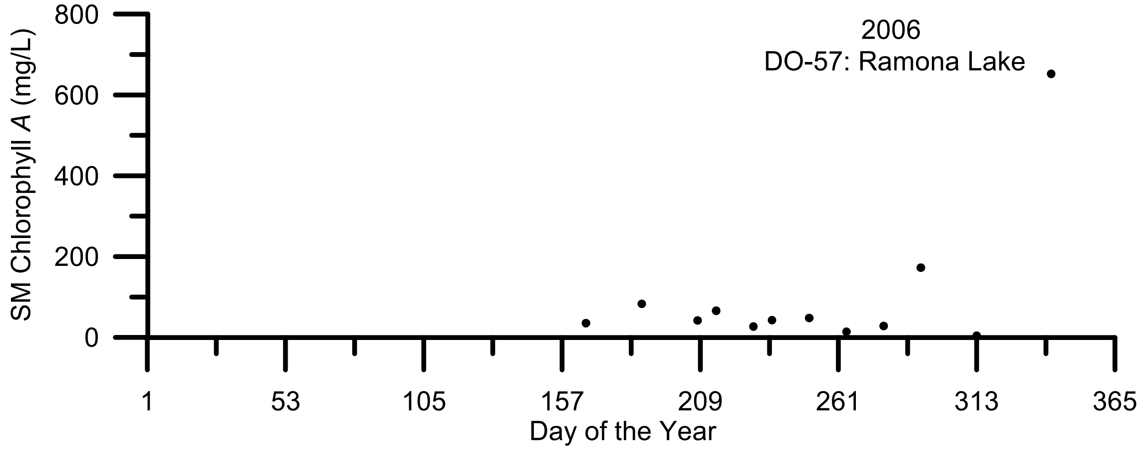


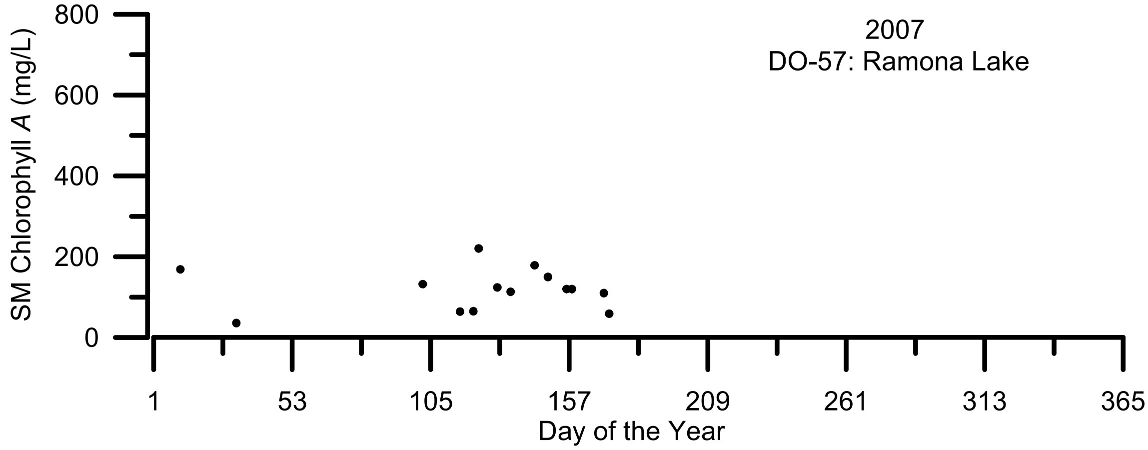
2007
DO-36: Del Puerto Creek
SM Chlorophyll A (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

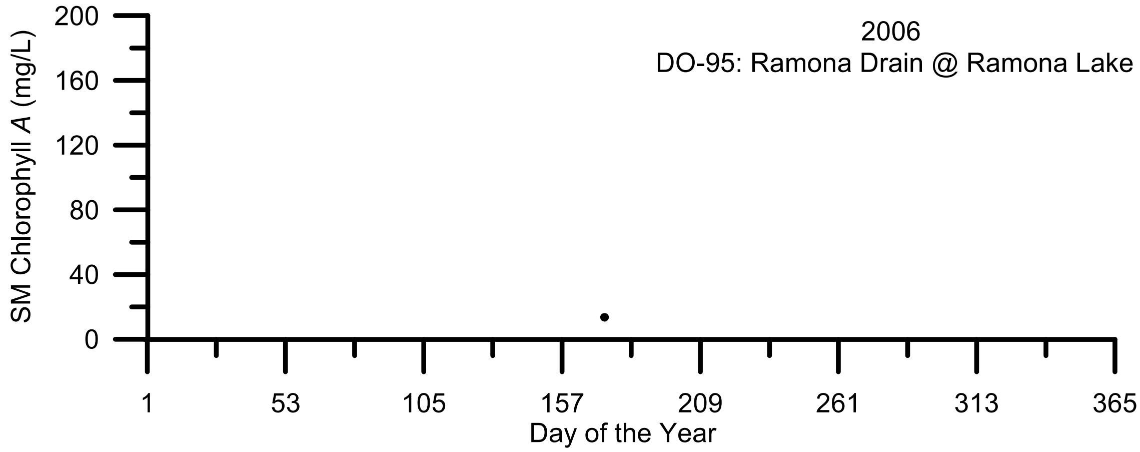

2005
DO-44: San Luis Drain End
SM Chlorophyll A (mg/L)
Day of the Year
600
400
200
0
1
53
105
157
209
261
313
365

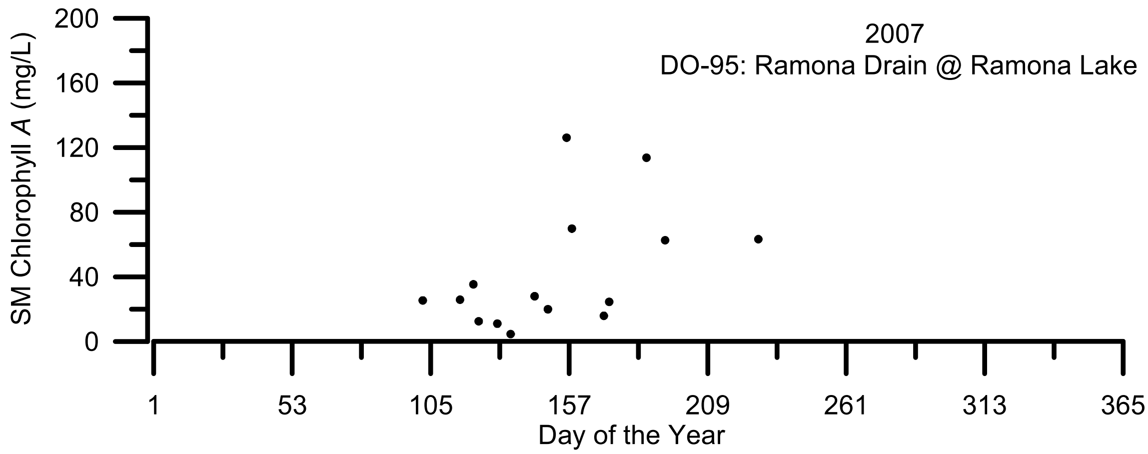

2006
DO-44: San Luis Drain End
SM Chlorophyll A (mg/L)
Day of the Year
600
400
200
0
1
53
105
157
209
261
313
365


2007
DO-44: San Luis Drain End
SM Chlorophyll A (mg/L)
Day of the Year
600
400
200
0
1
53
105
157
209
261
313
365


2006
DO-57: Ramona Lake
SM Chlorophyll A (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-57: Ramona Lake
SM Chlorophyll A (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
SM Chlorophyll A (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year

Standard Methods Algal Pigments Extract Data for the San Joaquin River Watershed 2005-2007

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February 2008

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University of the Pacific
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Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of algal pigment concentration for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per the *EERP Field Protocol Book*. Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements. Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to collection of a depth-integrated sample. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling. All bottle numbers, meter readings, and time in and out of the sample site were recorded in the field notebook.

Samples were received by the laboratory the same day they were sampled, logged in and inspected for damage, and stored at 4°C until filtering. Chlorophyll-a (chl-a) and pheophytin-a (pha-a) were extracted and analyzed using UV absorption as described in SM 10200 H (APHA, 2005). Both the trichromatic chl-a and the pha-a methods were used for quantification. Approximately 1000 mL of samples were filtered using a vacuum filtration onto a Whatman GF/F filter within 24 hours of sample collection. The sample was kept in the dark during storage and filtration. After the water was removed saturated $MgCO_3$ was applied to the sample on the filter and the filter was stored at -20°C for up to 21 days before analysis. Extraction was performed by grinding the filter with a Teflon tissue grinder in acetone saturated with 10% by weight $MgCO_3$. The extracted sample was centrifuged for 20 minutes at 2000 rpm and the chl-a and pha-a was quantified by measurement of the supernatant on a Perkin-Elmer Lambda 35 spectrophotometer (Wellesley, MA) using a 5 cm path length (Borglin, et al 2008).

Results and Discussion

Chlorophyll was analyzed routinely over the years 2005-2007 with no modification to the standard method (APHA, 2005). No standard solutions for this analysis were available so only duplicates and blanks could be analyzed to insure uniformity and accuracy in the application of the method and for those two QA parameters, there was an 86.07% passage rate for this analysis.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

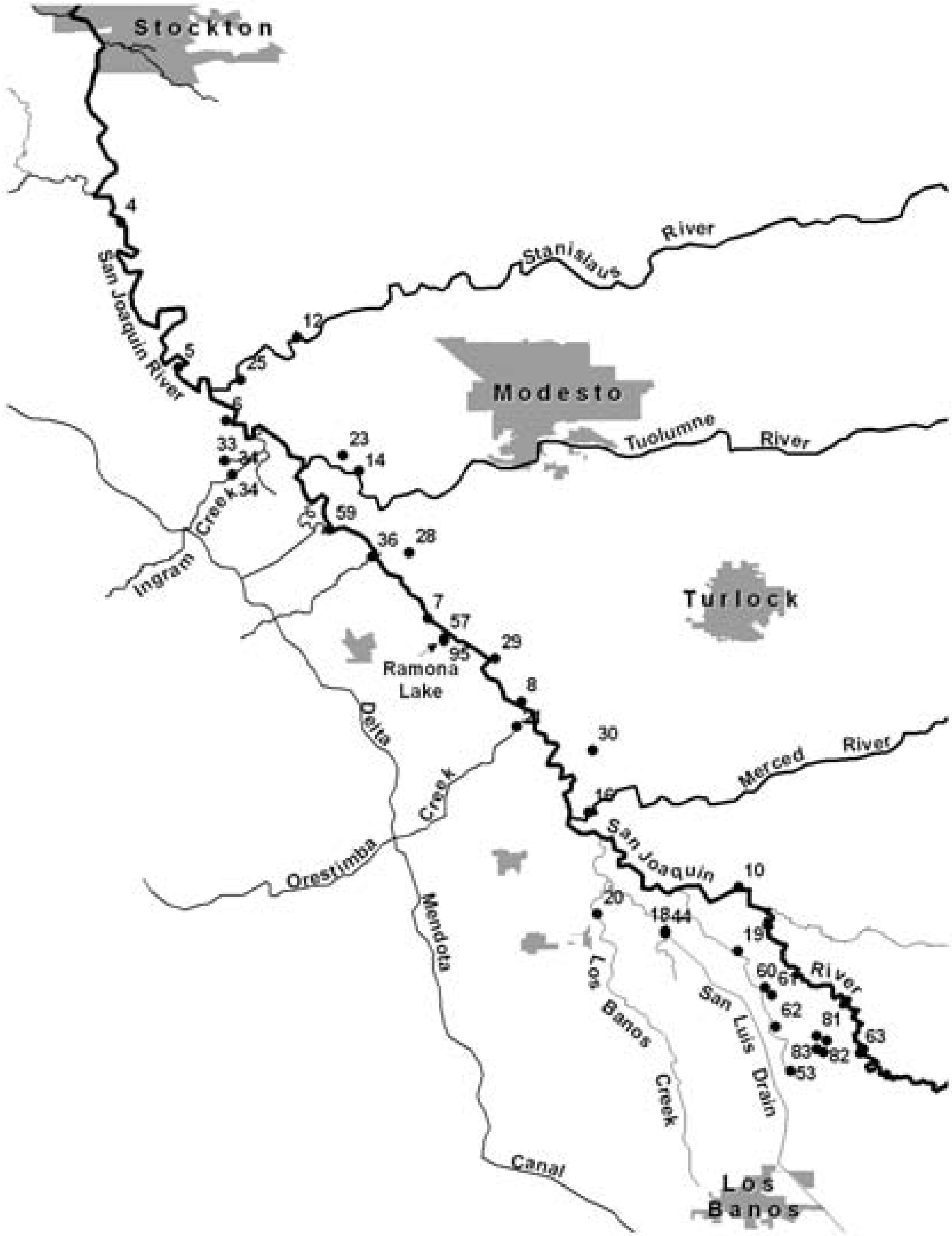
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

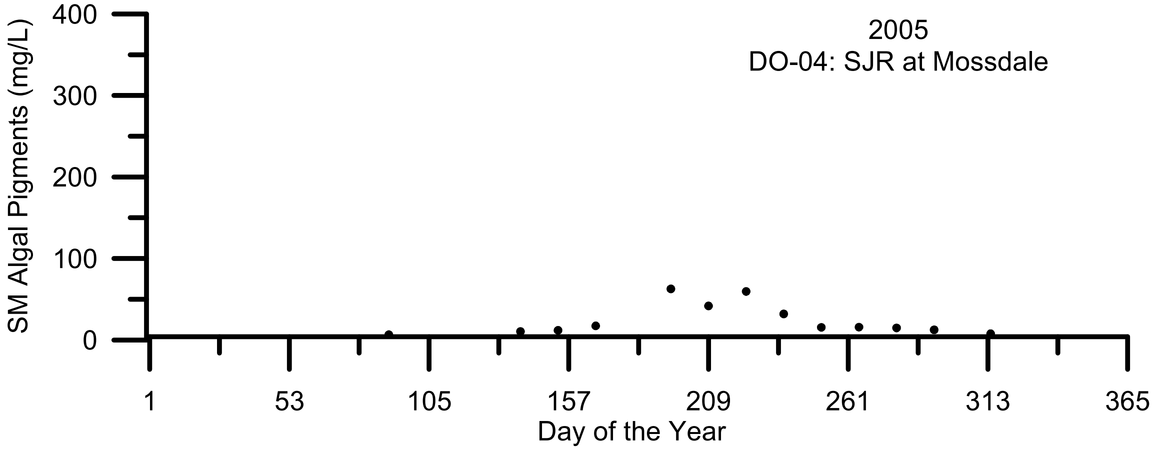
Table 1: EERP Sampling Site List

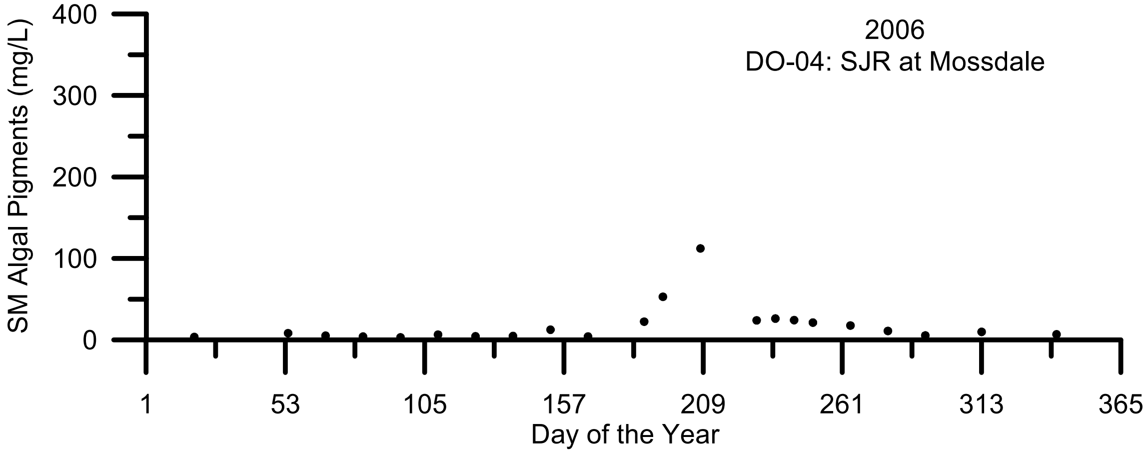
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

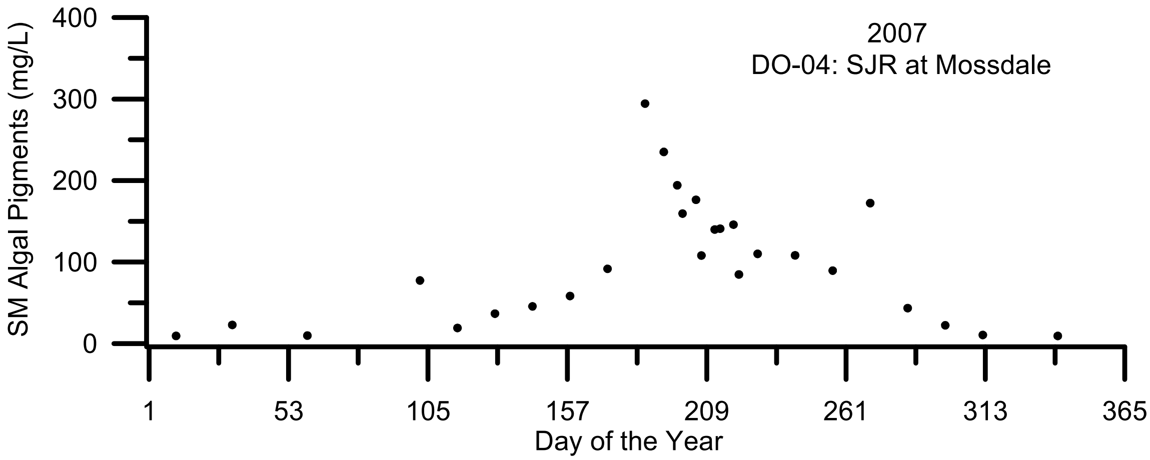
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

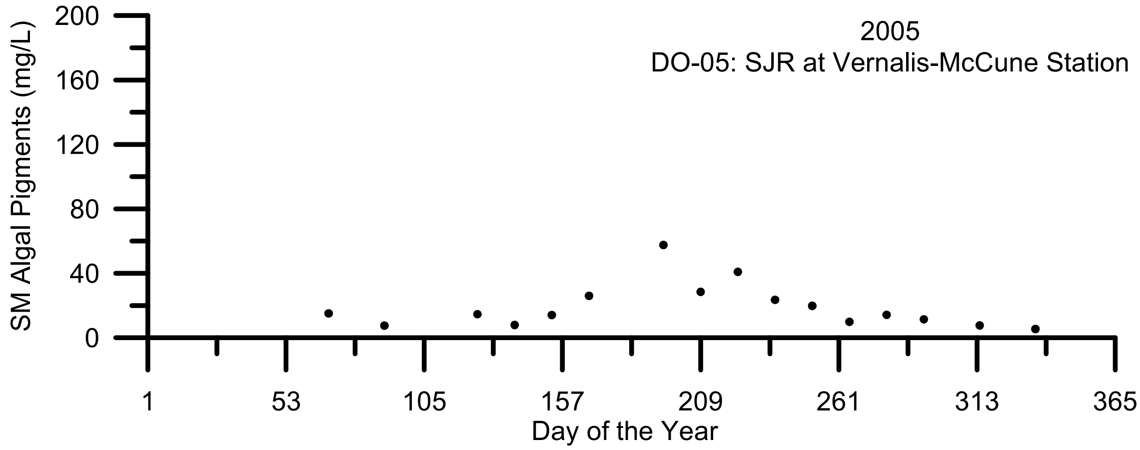


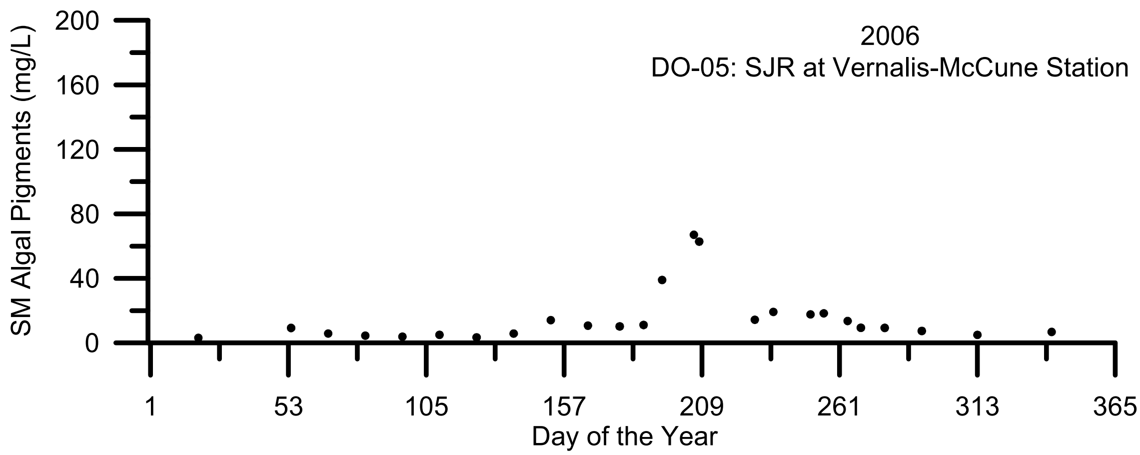
Figures 2 -71: Temporal Plots of SM Algal Pigment Concentration By Site ID

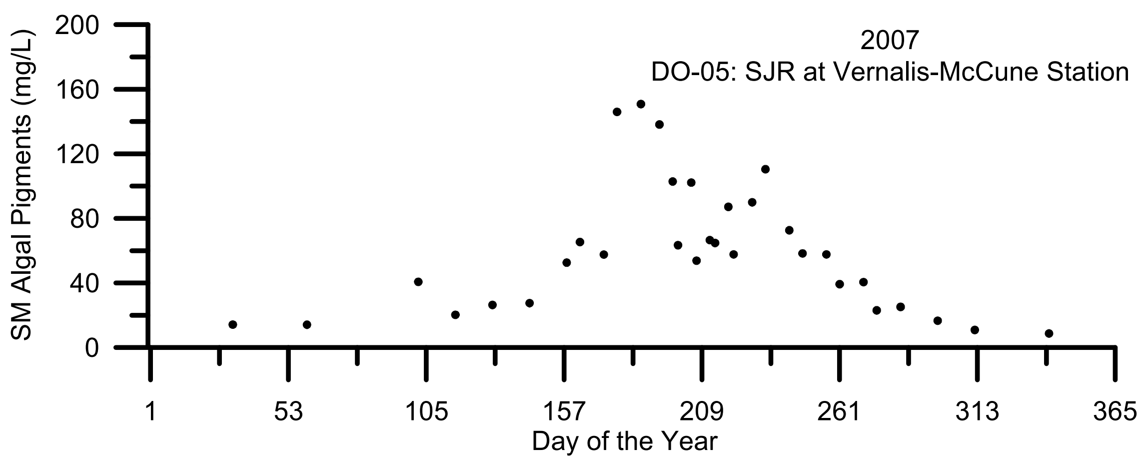


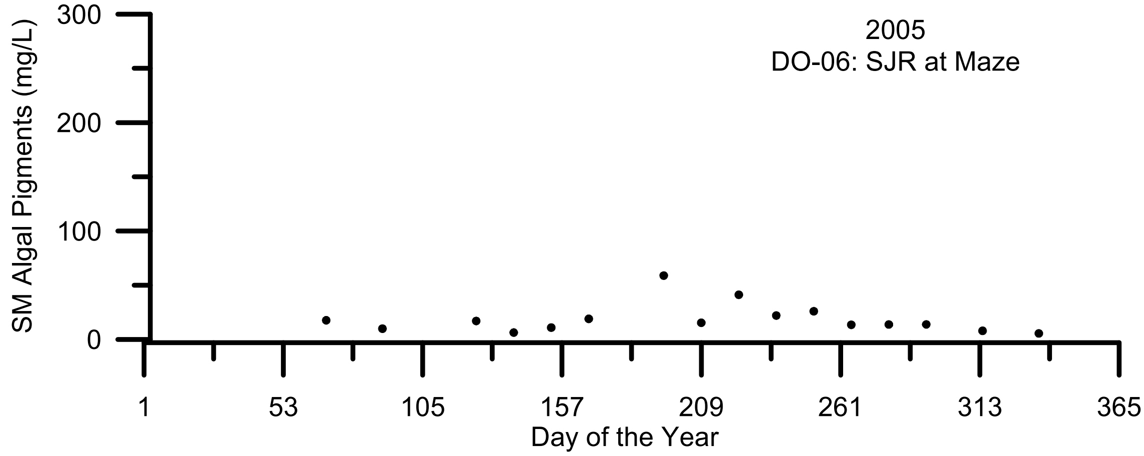


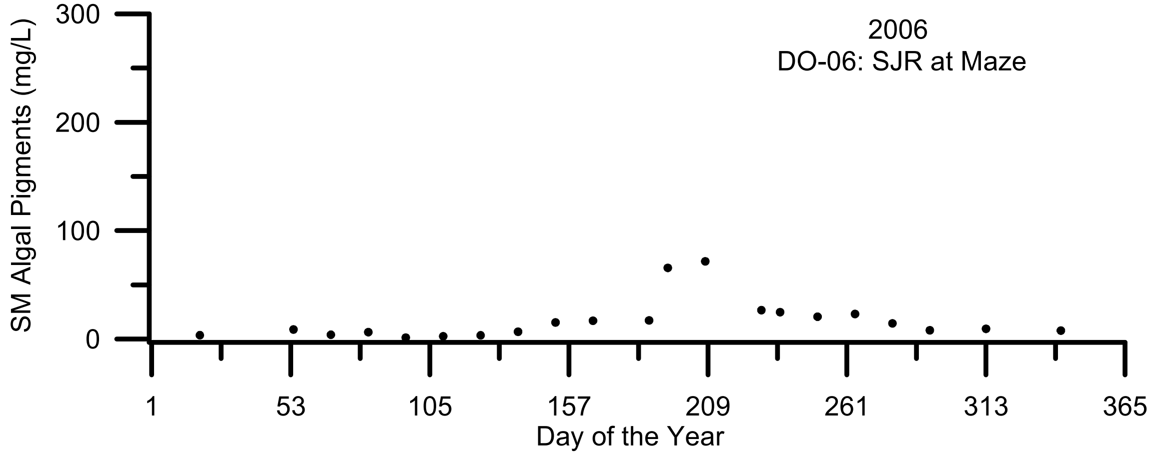


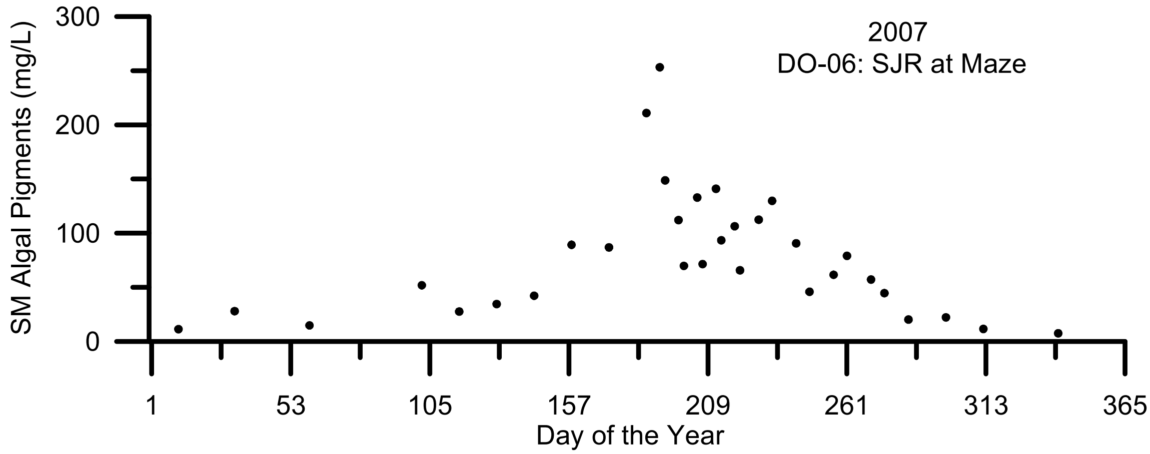

2005
DO-05: SJR at Vernalis-McCune Station
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

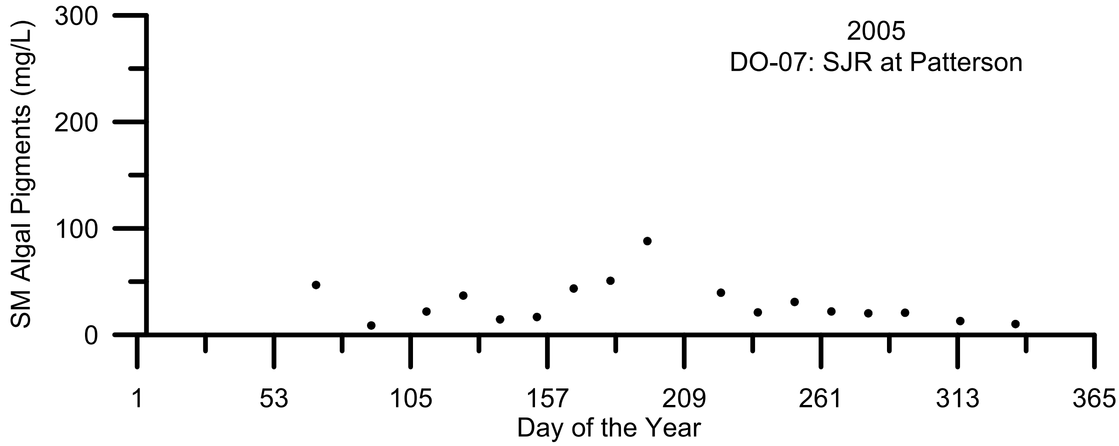

2006
DO-05: SJR at Vernalis-McCune Station
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

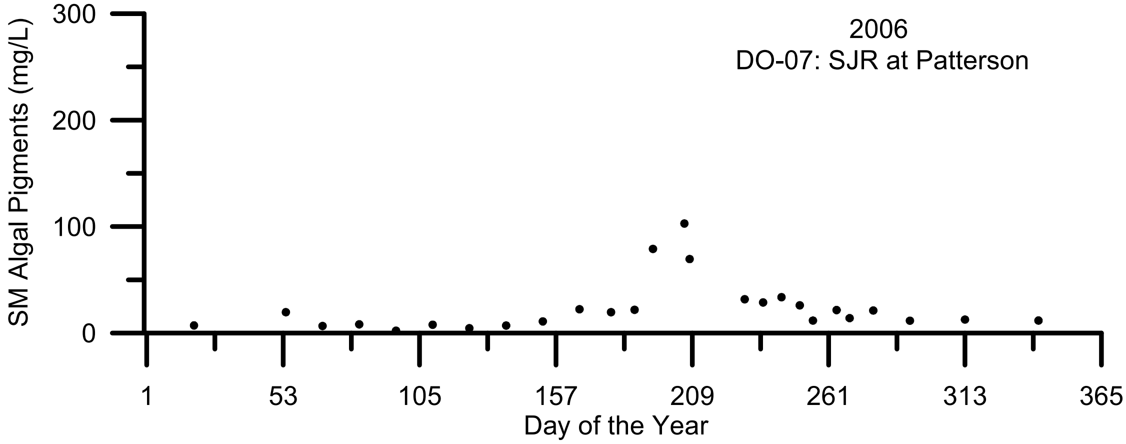

2007
DO-05: SJR at Vernalis-McCune Station
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

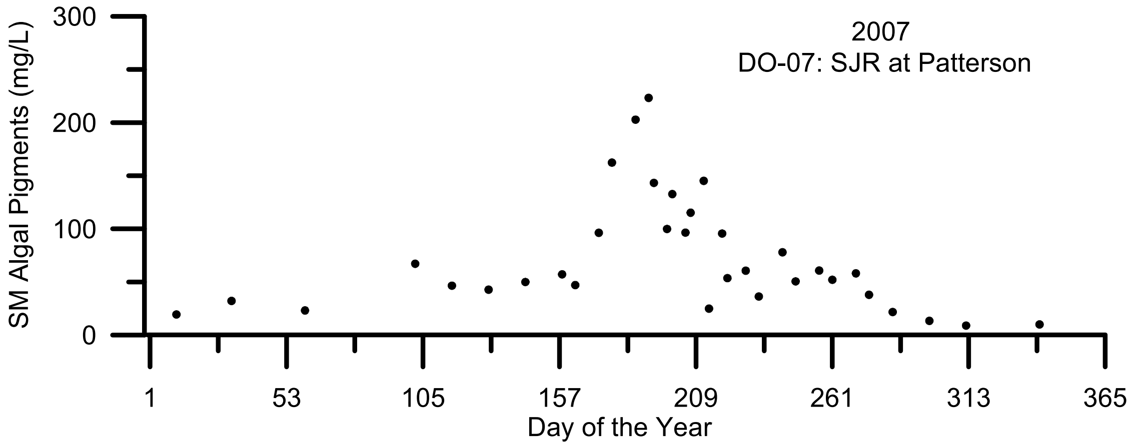

2005
DO-06: SJR at Maze
SM Algal Pigments (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

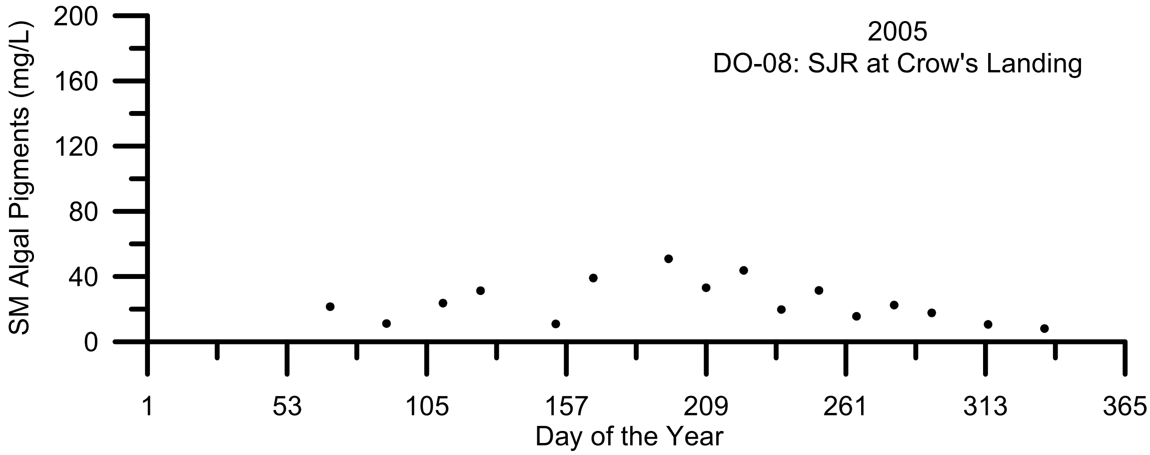

2006
DO-06: SJR at Maze
SM Algal Pigments (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
SM Algal Pigments (mg/L)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

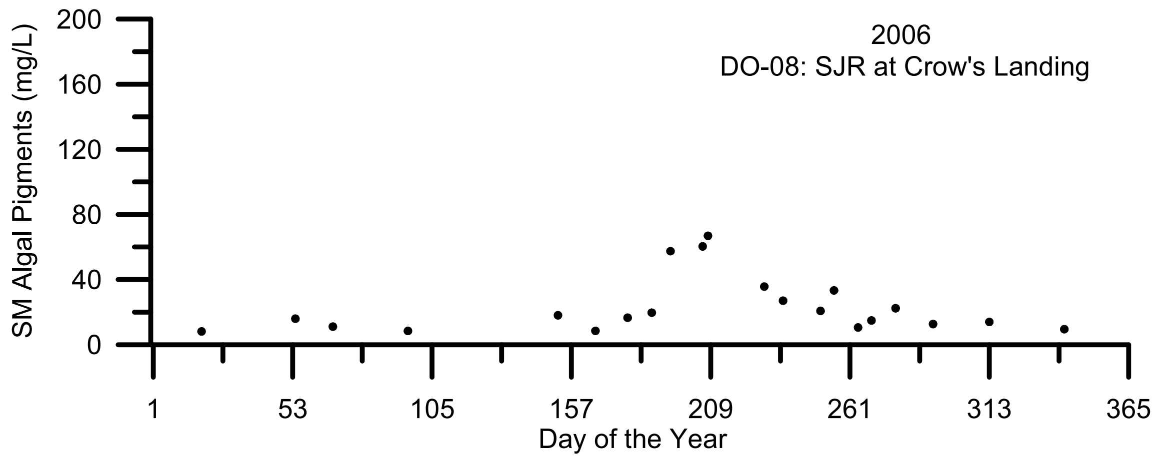

2005
DO-07: SJR at Patterson
SM Algal Pigments (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
SM Algal Pigments (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year

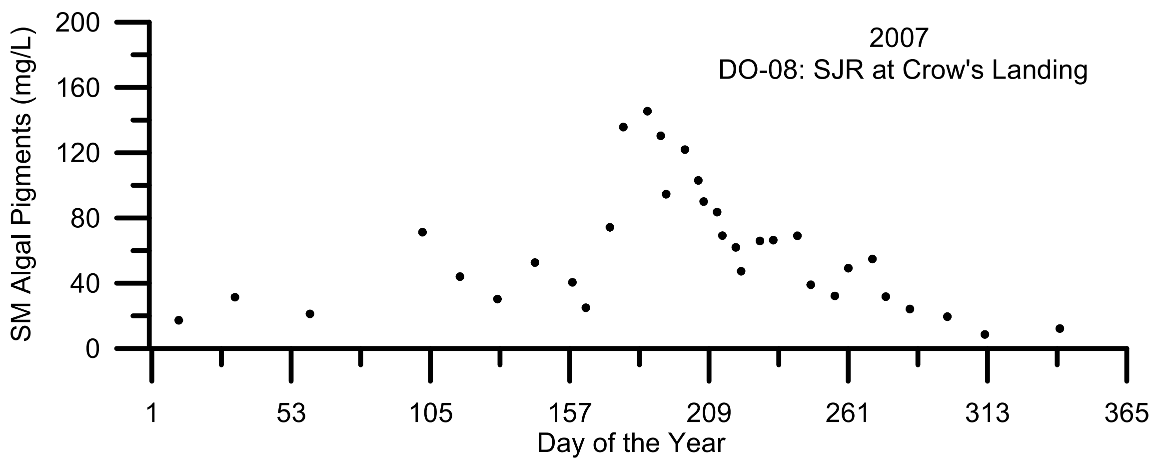

2007
DO-07: SJR at Patterson
SM Algal Pigments (mg/L)
0
100
200
300
1
53
105
157
209
261
313
365
Day of the Year



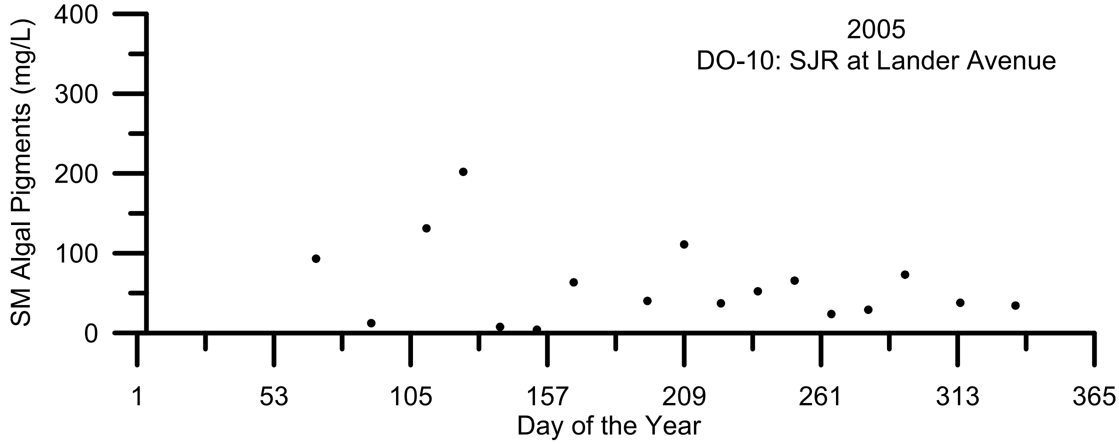
2005
DO-08: SJR at Crow's Landing
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

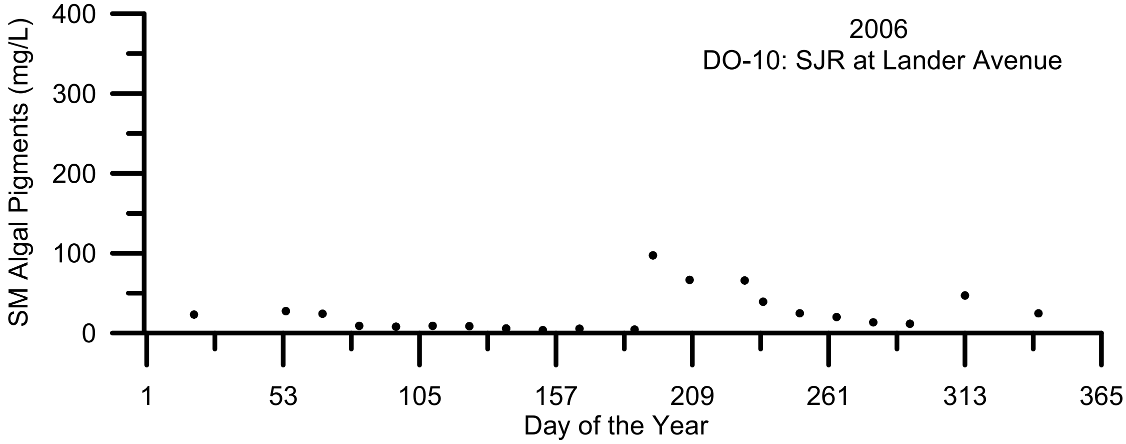


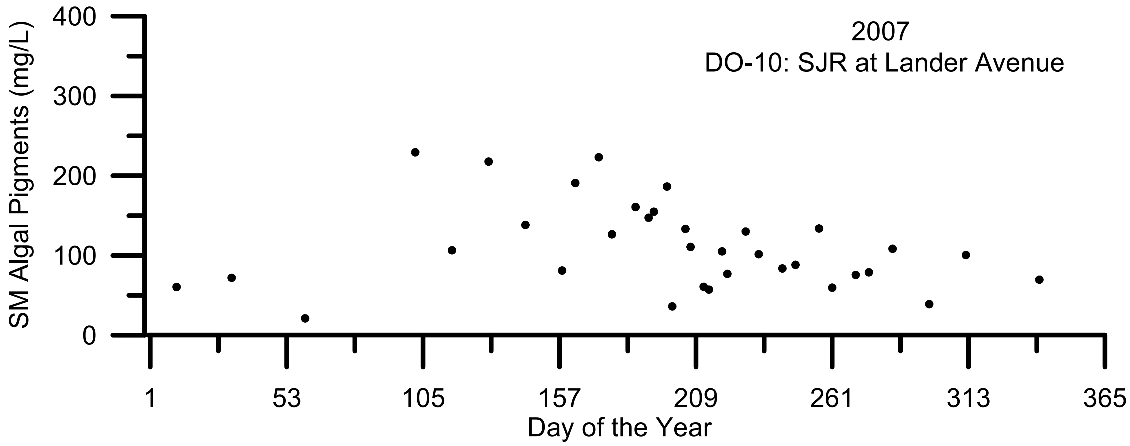
2006
DO-08: SJR at Crow's Landing
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

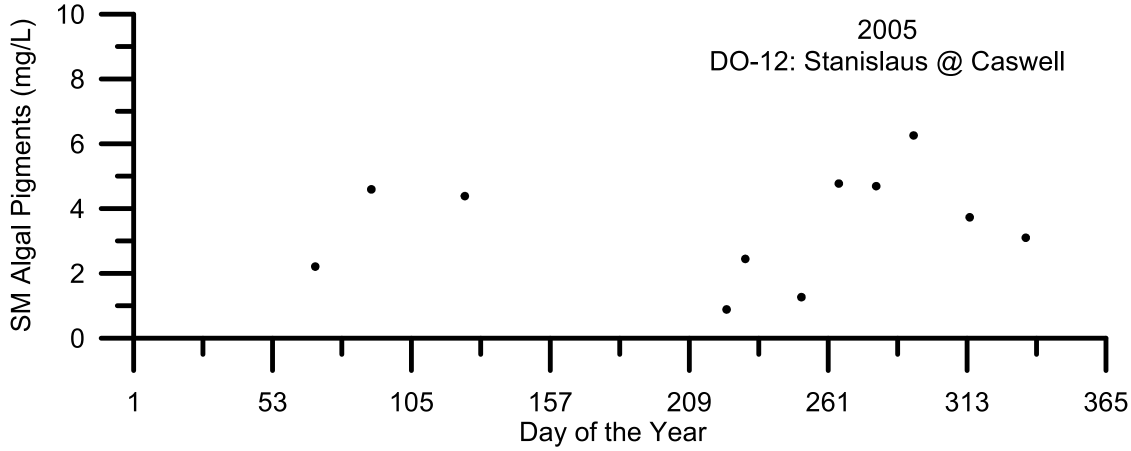


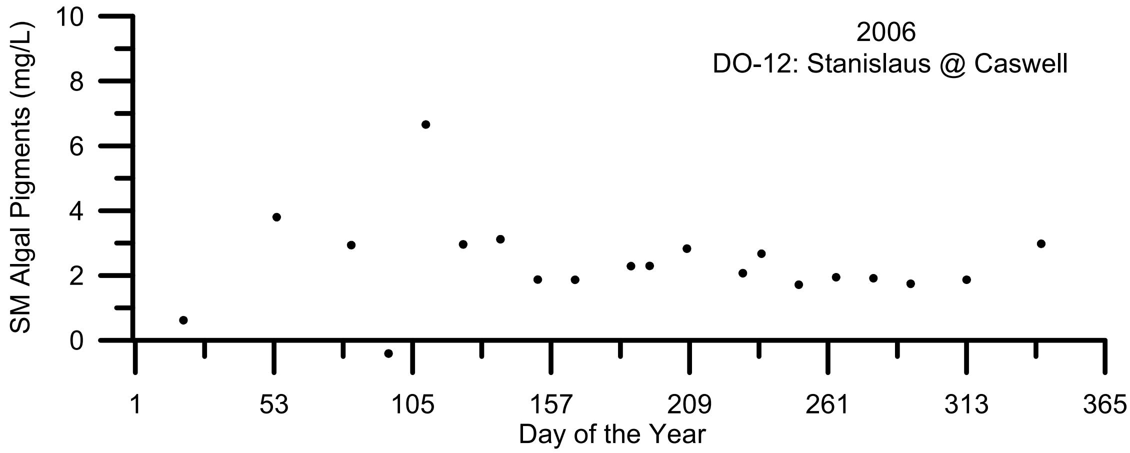
2007
DO-08: SJR at Crow's Landing
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

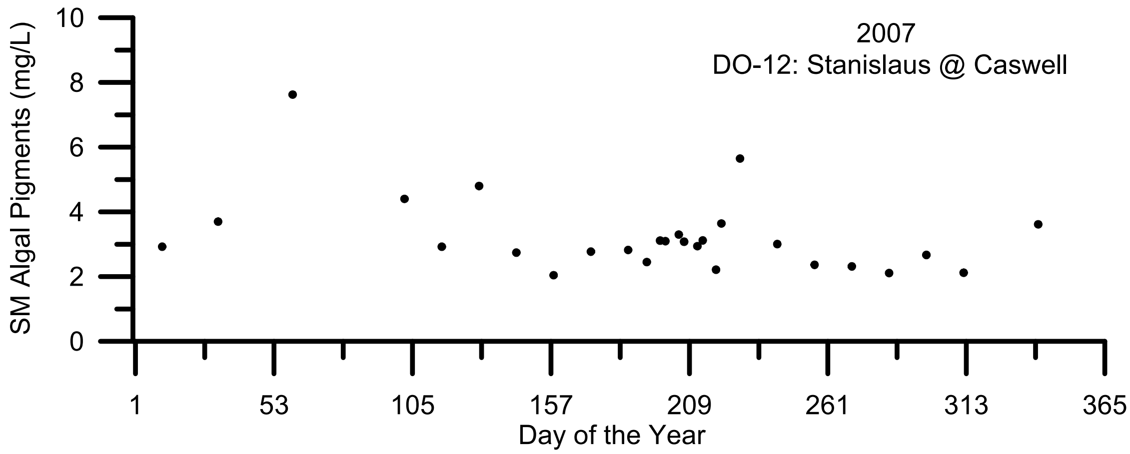

2005
DO-10: SJR at Lander Avenue
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

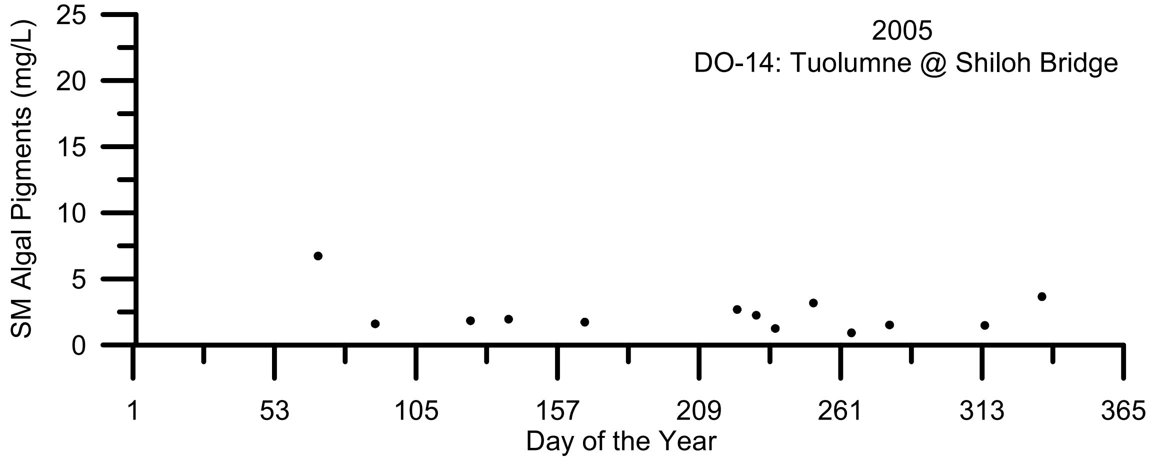

2006
DO-10: SJR at Lander Avenue
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

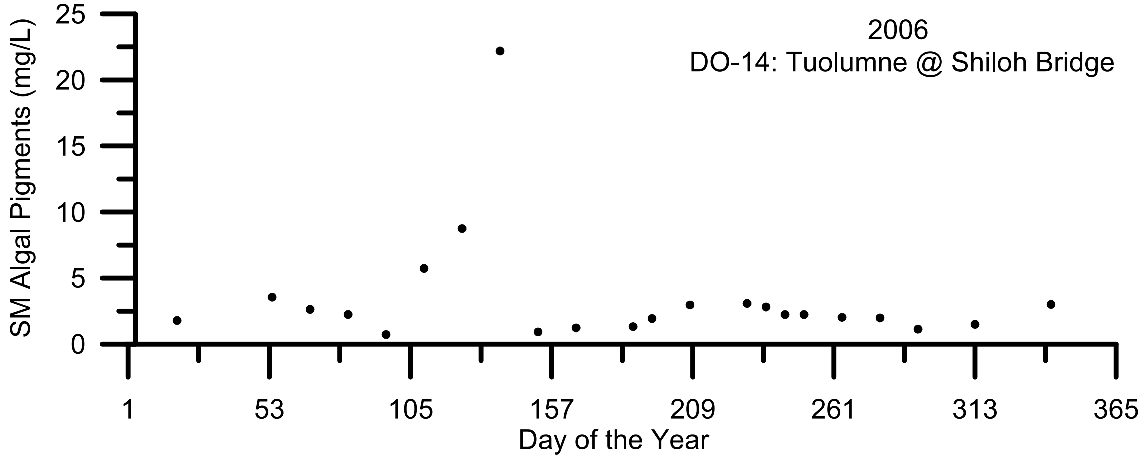

2007
DO-10: SJR at Lander Avenue
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

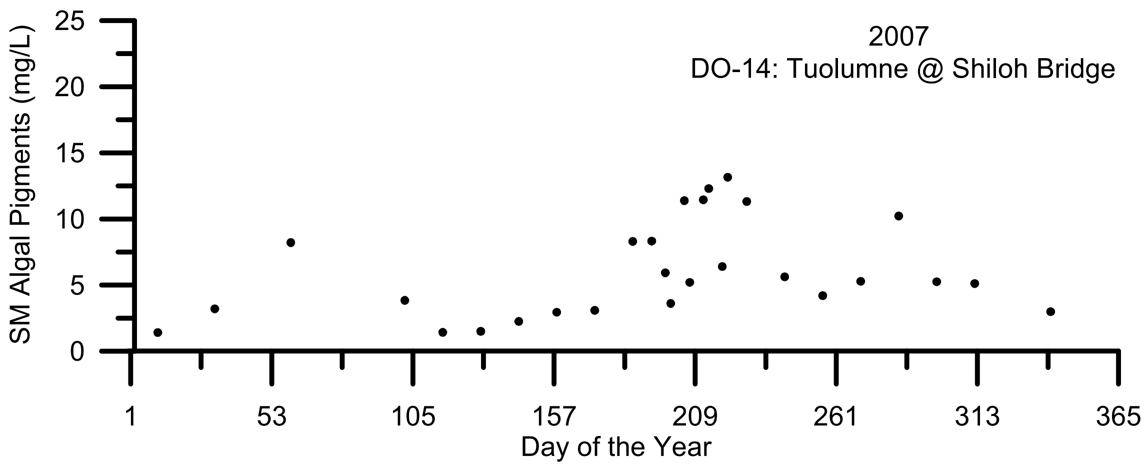

2005
DO-12: Stanislaus @ Caswell
SM Algal Pigments (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

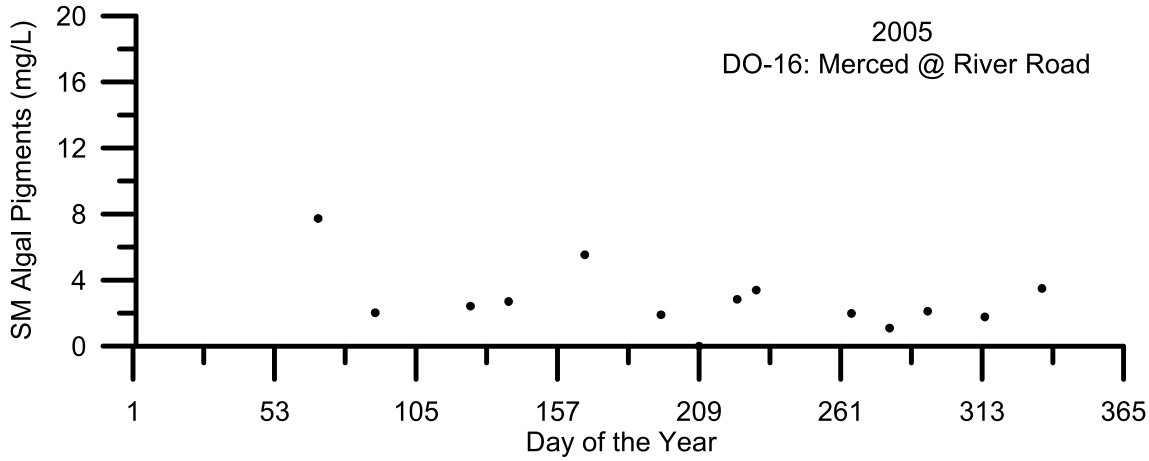

2006
DO-12: Stanislaus @ Caswell
SM Algal Pigments (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

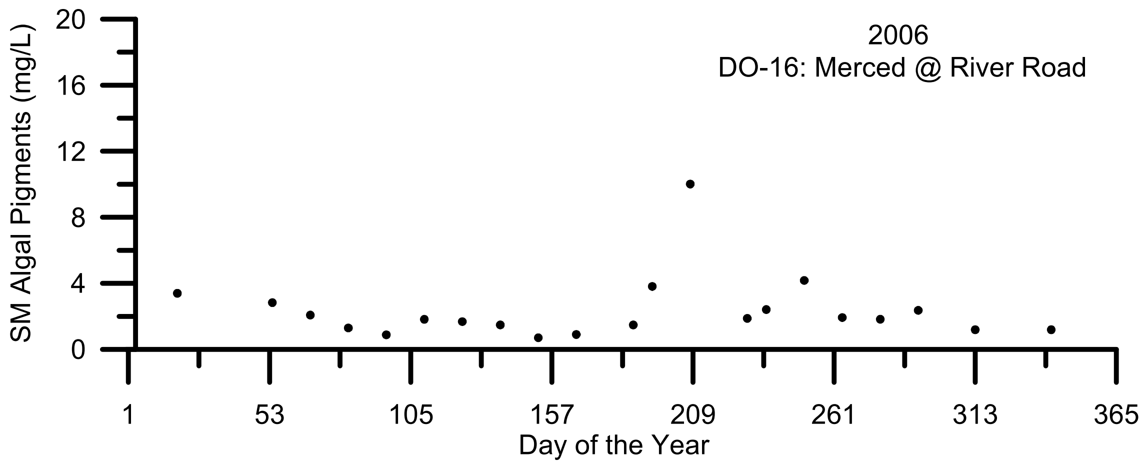

2007
DO-12: Stanislaus @ Caswell
SM Algal Pigments (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

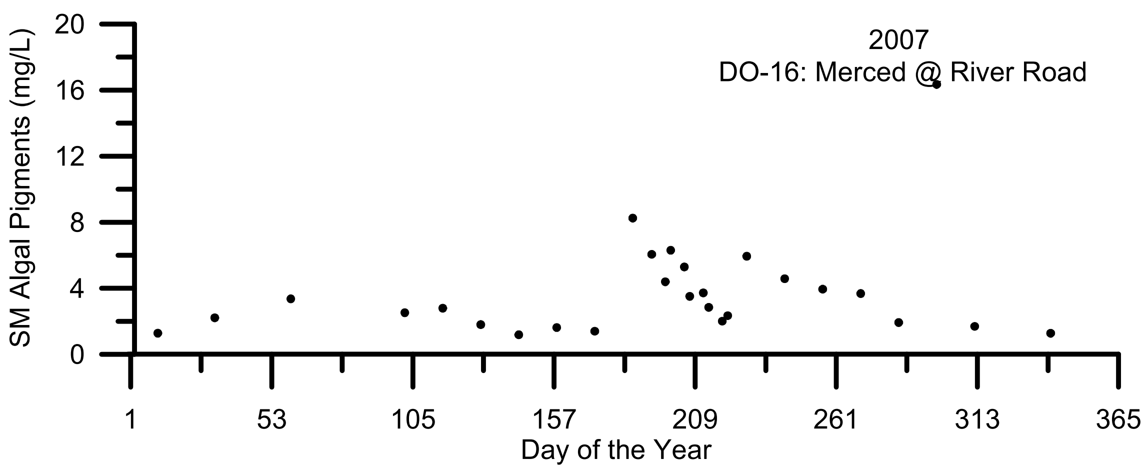

2005
DO-14: Tuolumne @ Shiloh Bridge
SM Algal Pigments (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

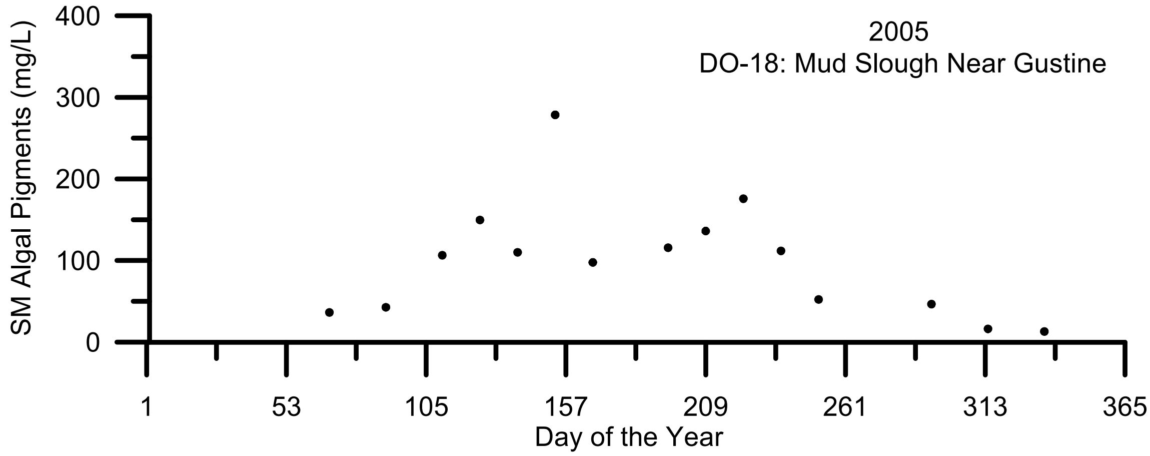

2006
DO-14: Tuolumne @ Shiloh Bridge
SM Algal Pigments (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

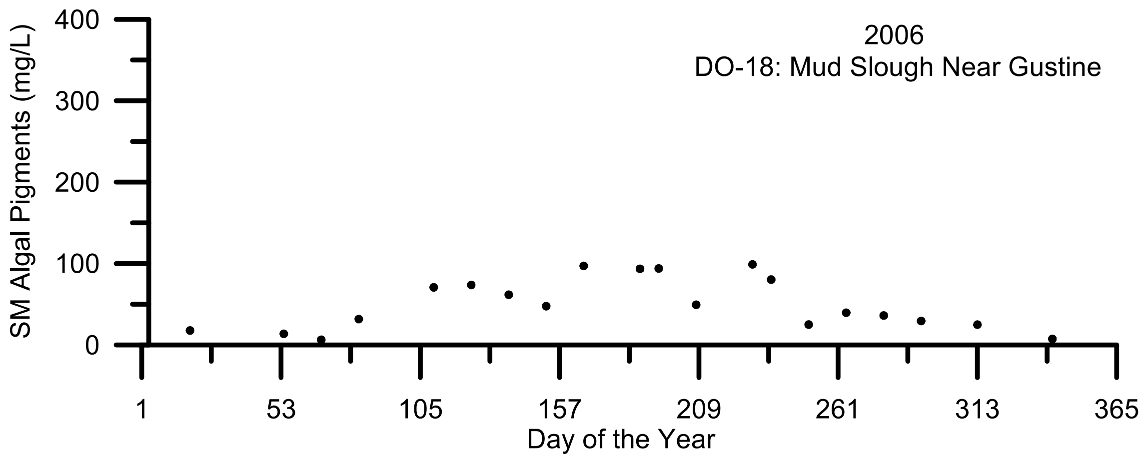

2007
DO-14: Tuolumne @ Shiloh Bridge
SM Algal Pigments (mg/L)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

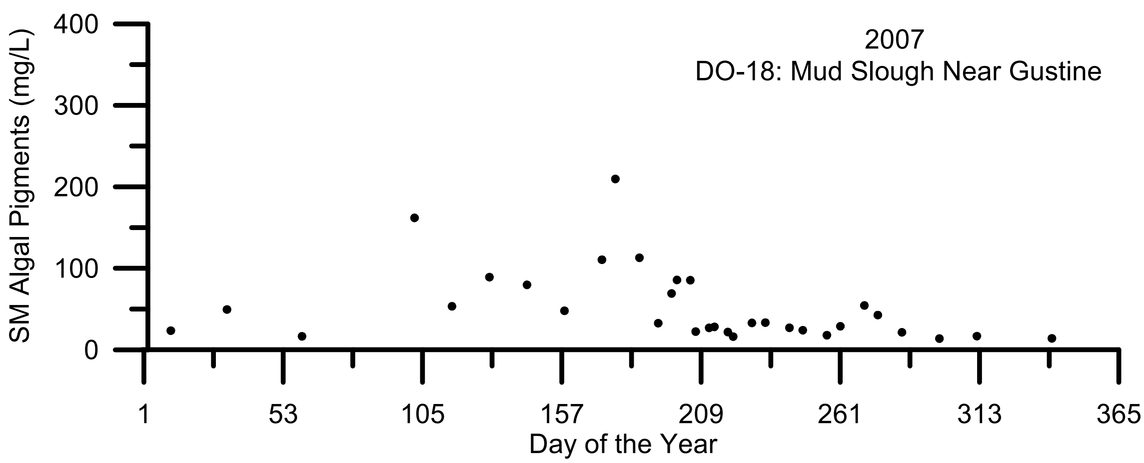

2005
DO-16: Merced @ River Road
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

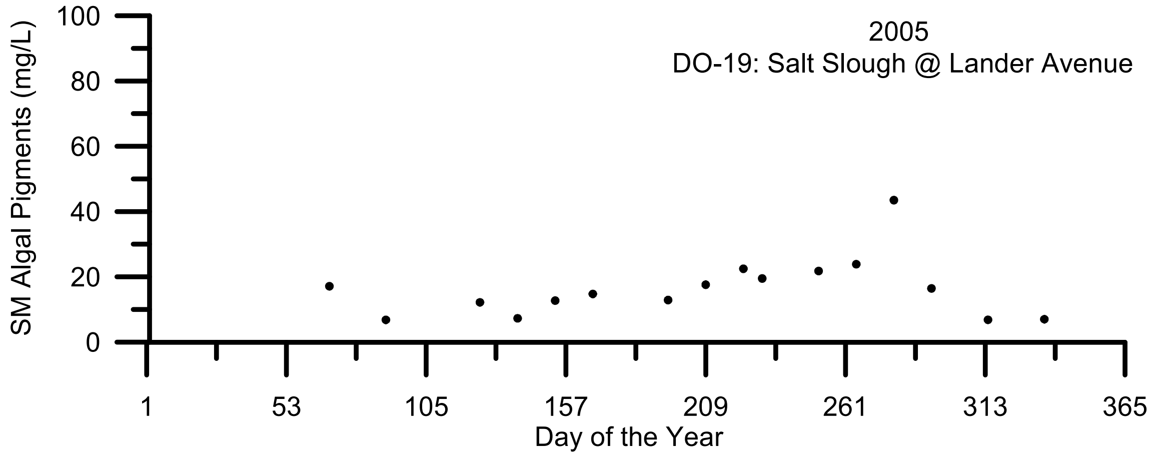

2006
DO-16: Merced @ River Road
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

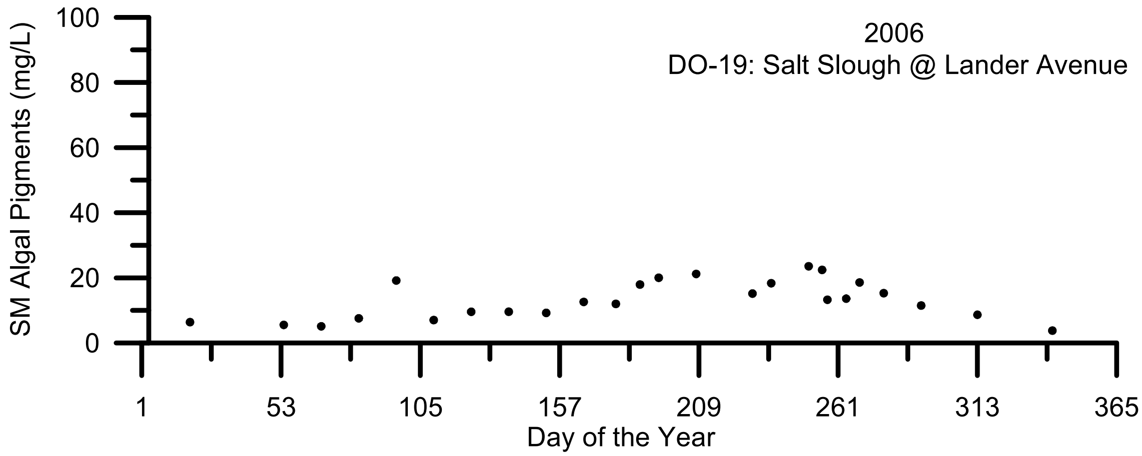

2007
DO-16: Merced @ River Road
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

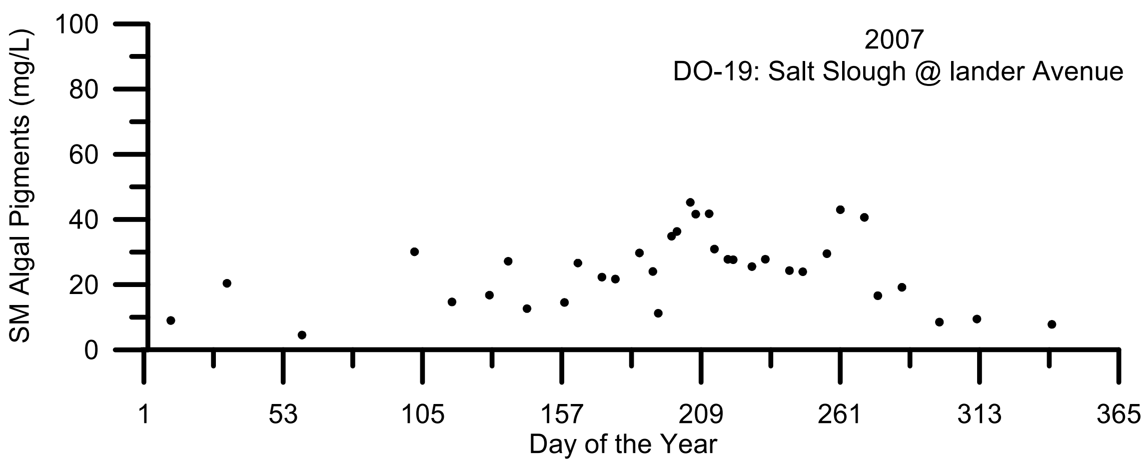

2005
DO-18: Mud Slough Near Gustine
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

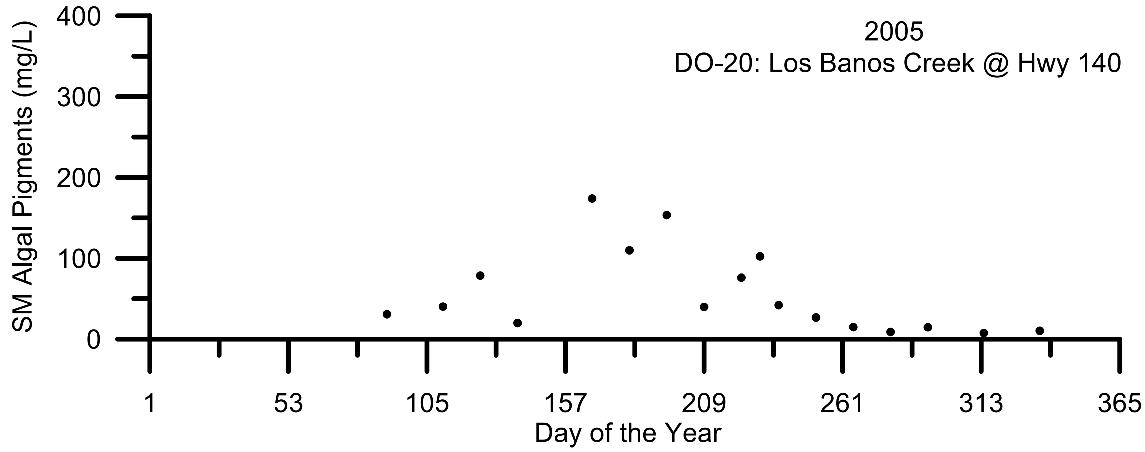

2006
DO-18: Mud Slough Near Gustine
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

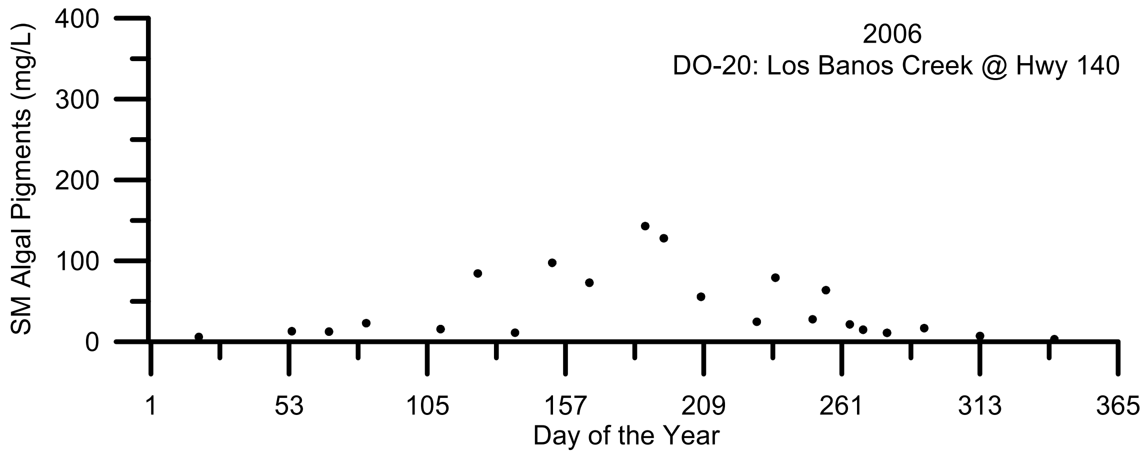

2007
DO-18: Mud Slough Near Gustine
SM Algal Pigments (mg/L)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

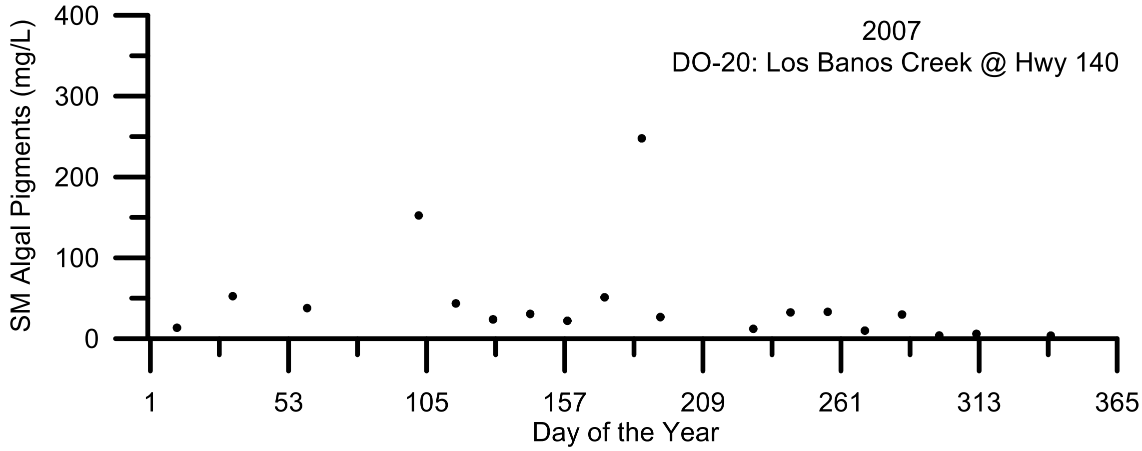

2005
DO-19: Salt Slough @ Lander Avenue
SM Algal Pigments (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

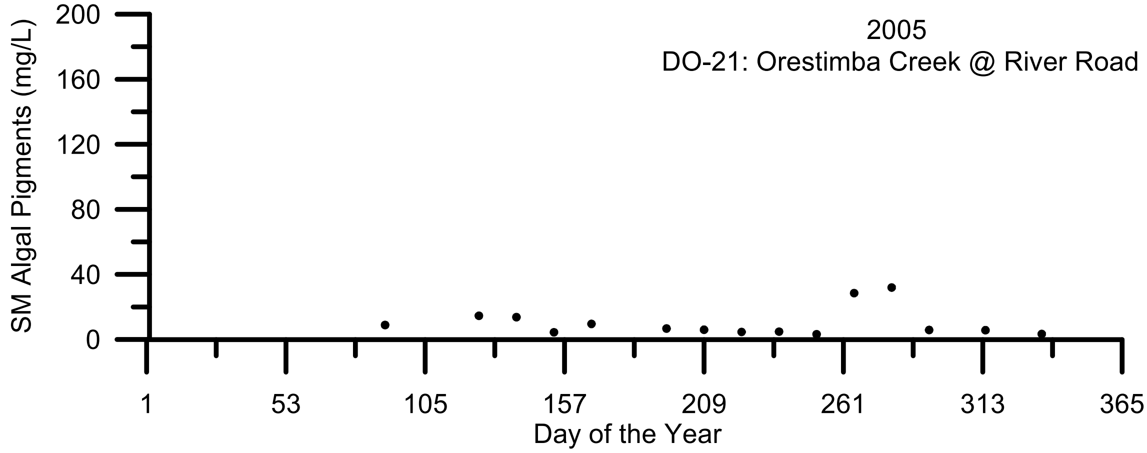

2006
DO-19: Salt Slough @ Lander Avenue
SM Algal Pigments (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

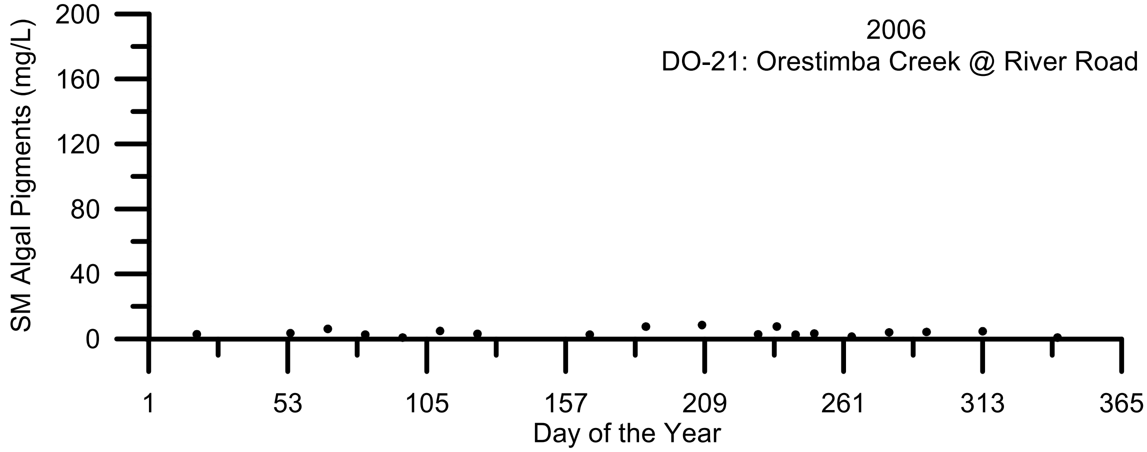

2007
DO-19: Salt Slough @ lander Avenue
SM Algal Pigments (mg/L)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

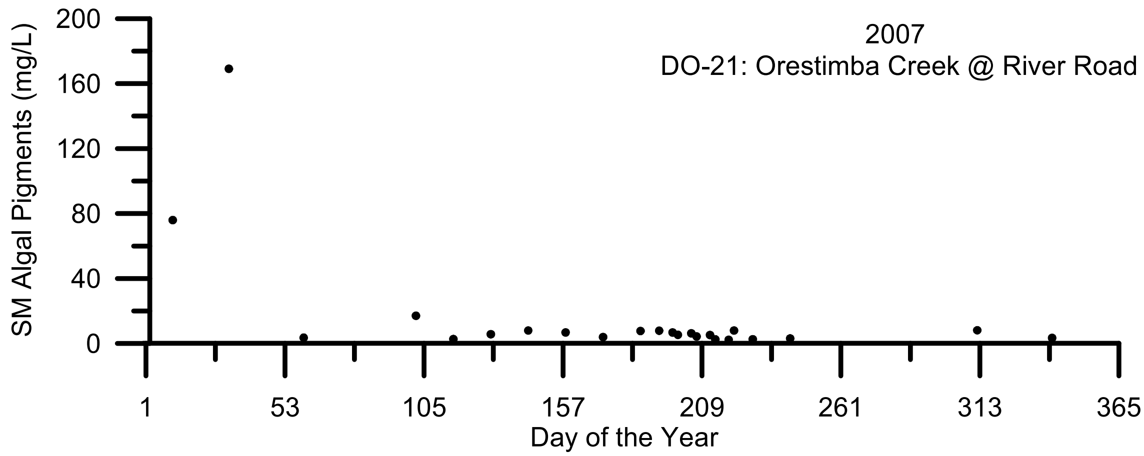

2005
DO-20: Los Banos Creek @ Hwy 140
SM Algal Pigments (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

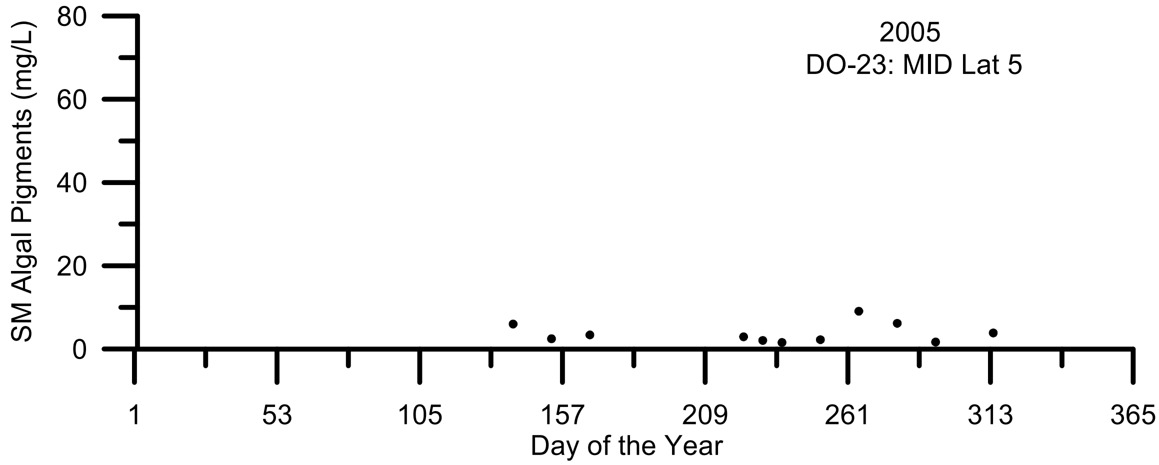

2006
DO-20: Los Banos Creek @ Hwy 140
SM Algal Pigments (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

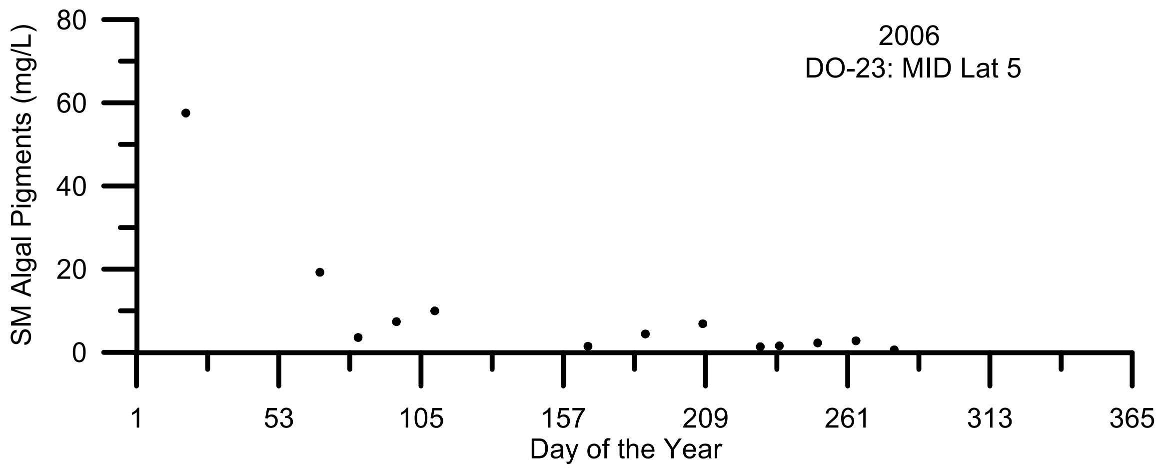

2007
DO-20: Los Banos Creek @ Hwy 140
SM Algal Pigments (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

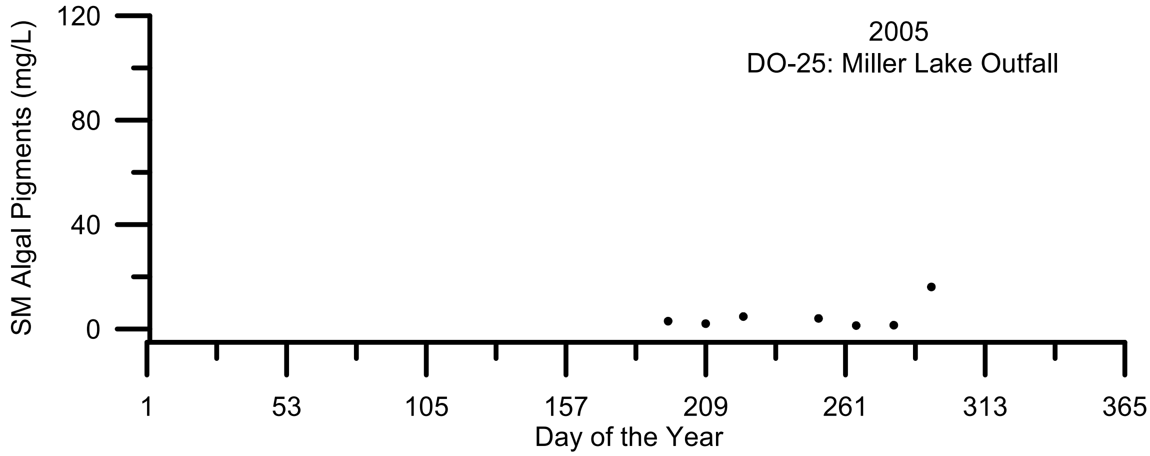

2005
DO-21: Orestimba Creek @ River Road
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

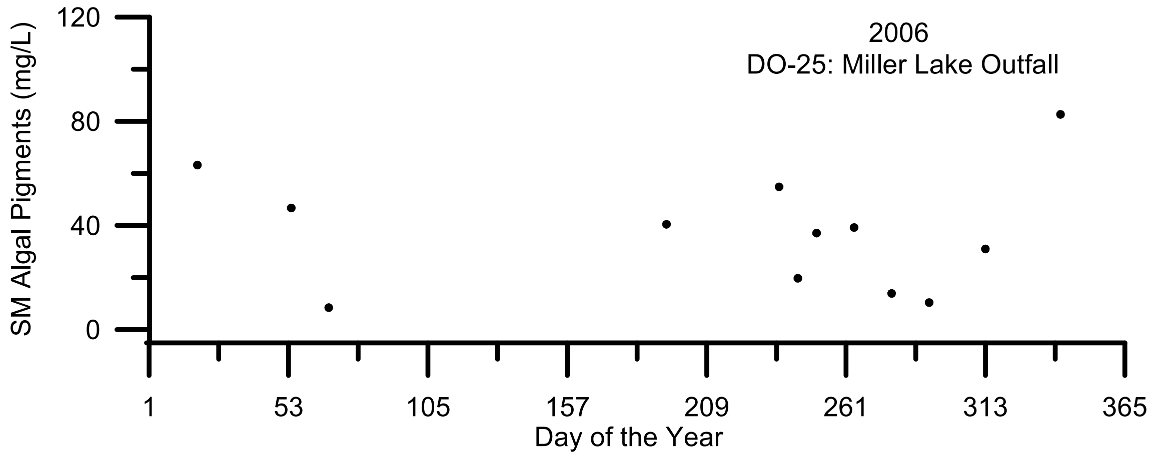

2006
DO-21: Orestimba Creek @ River Road
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

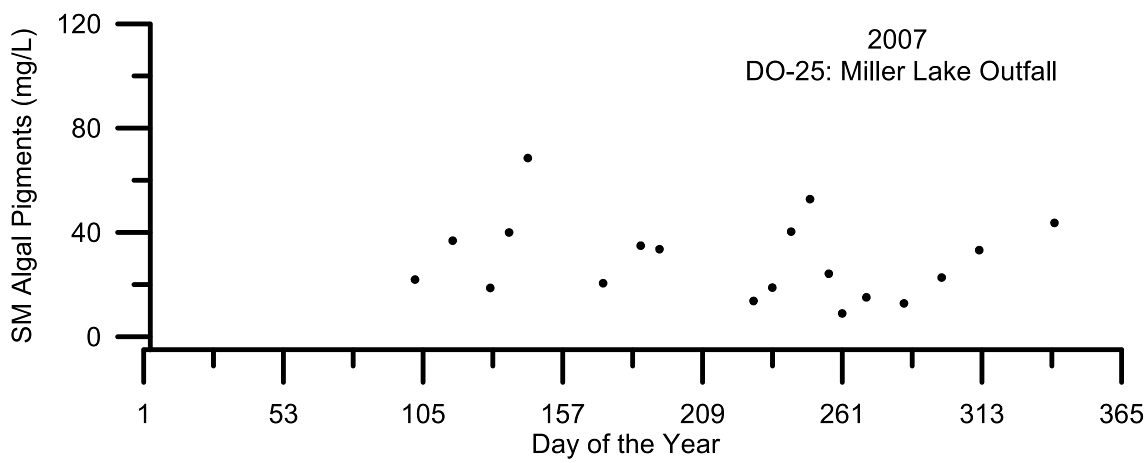

2007
DO-21: Orestimba Creek @ River Road
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

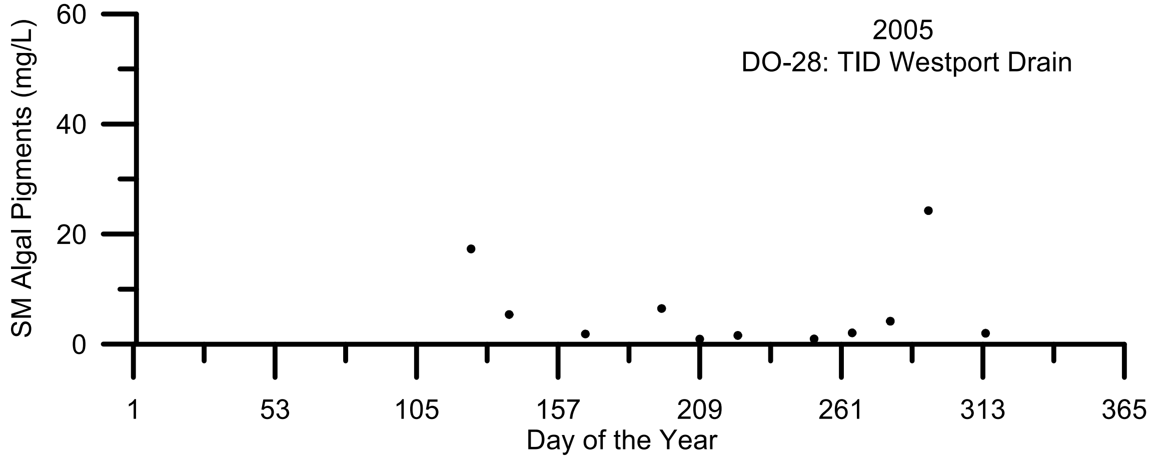

SM Algal Pigments (mg/L)
80
60
40
20
0
2005
DO-23: MID Lat 5
1
53
105
157
209
261
313
365
Day of the Year


SM Algal Pigments (mg/L)
80
60
40
20
0
2006
DO-23: MID Lat 5
1
53
105
157
209
261
313
365
Day of the Year

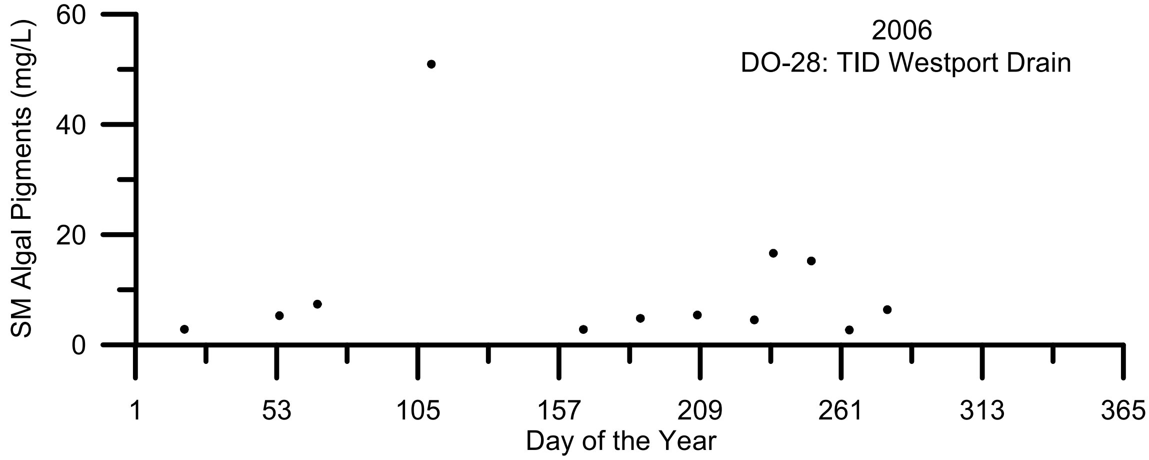

2005
DO-25: Miller Lake Outfall
SM Algal Pigments (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-25: Miller Lake Outfall
SM Algal Pigments (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

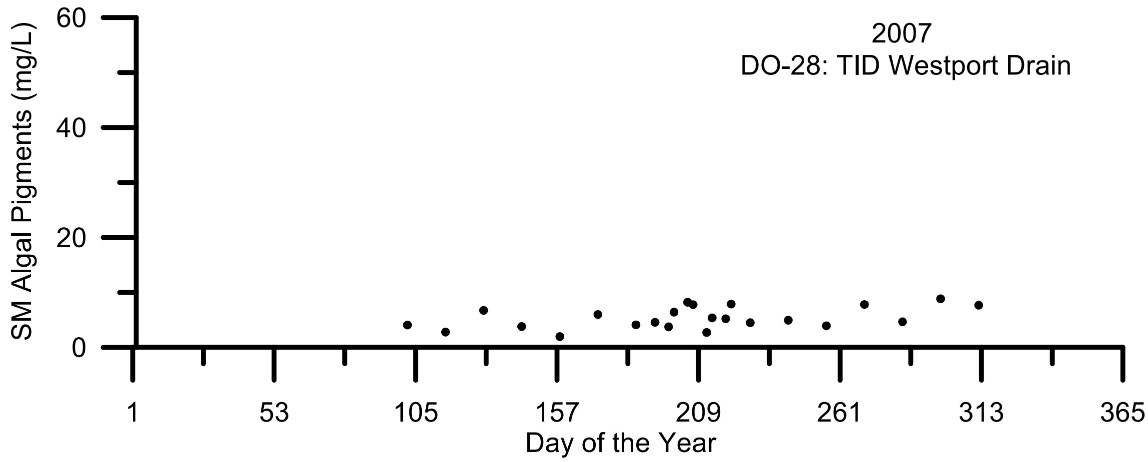

2007
DO-25: Miller Lake Outfall
SM Algal Pigments (mg/L)
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year



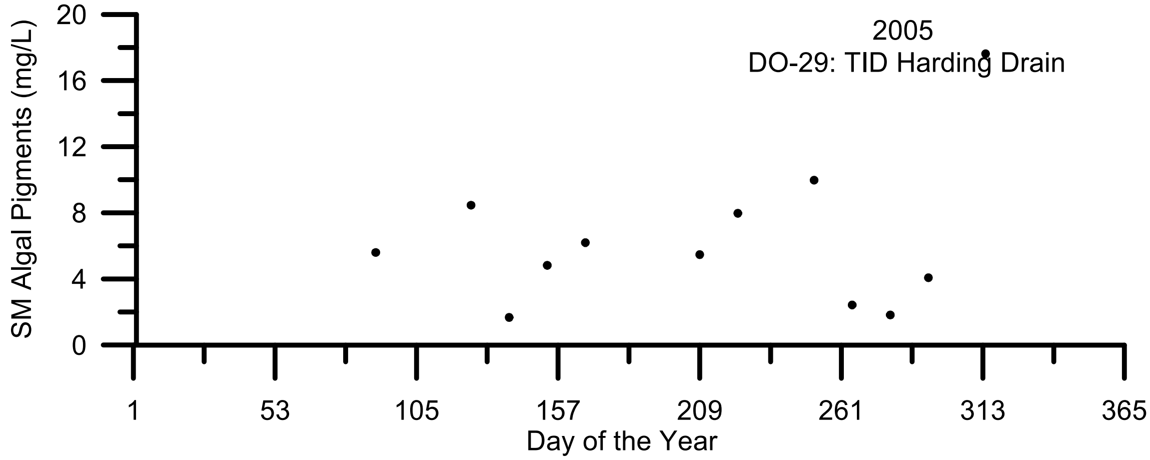
2005
DO-28: TID Westport Drain
SM Algal Pigments (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

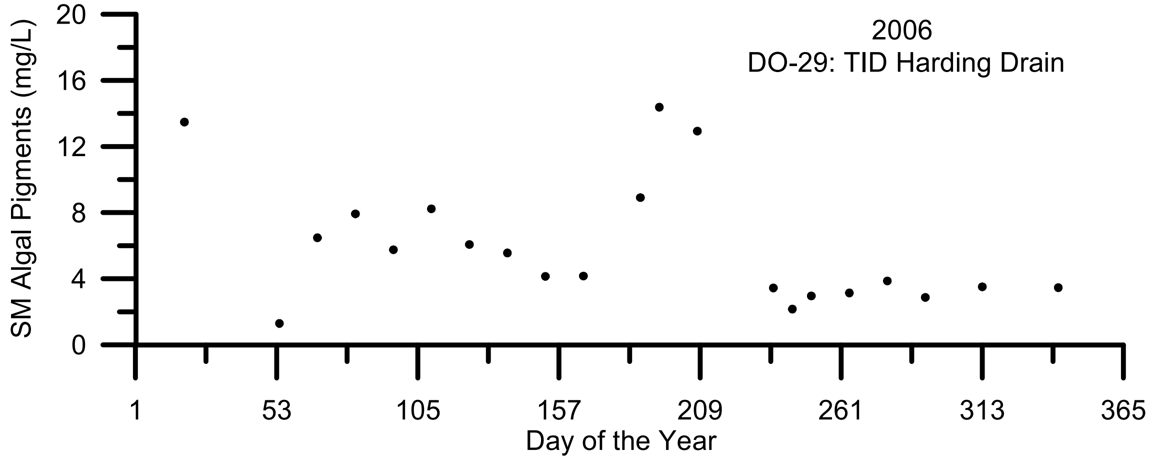


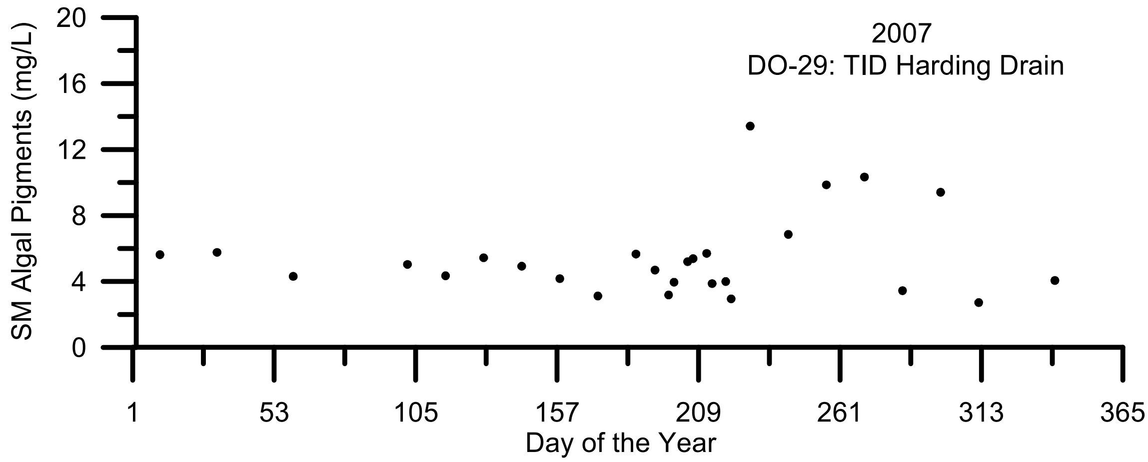
2006
DO-28: TID Westport Drain
SM Algal Pigments (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

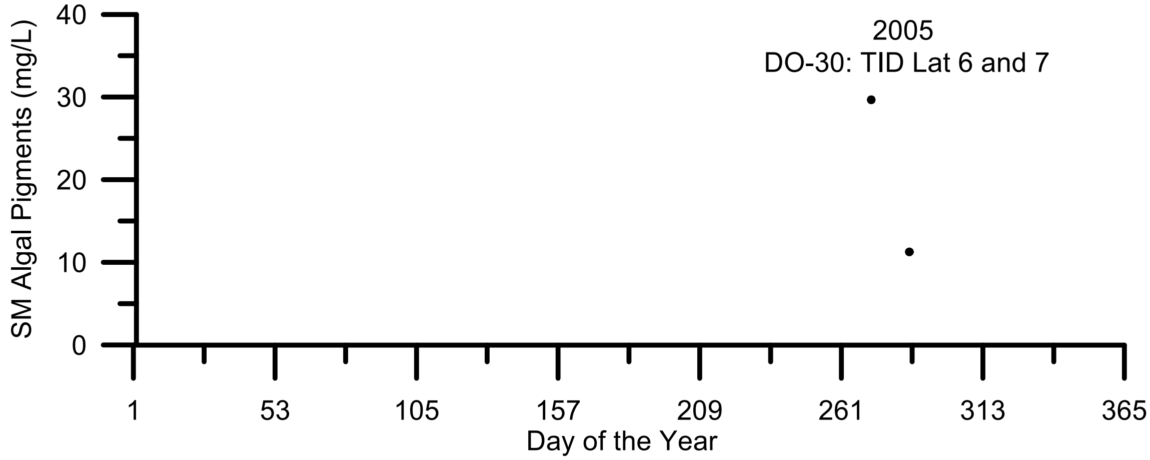


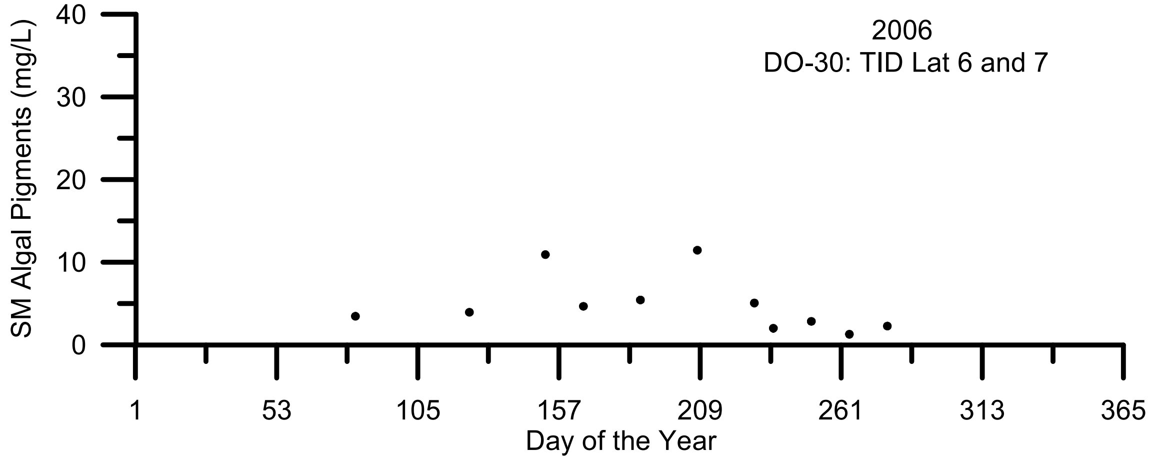
2007
DO-28: TID Westport Drain
SM Algal Pigments (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

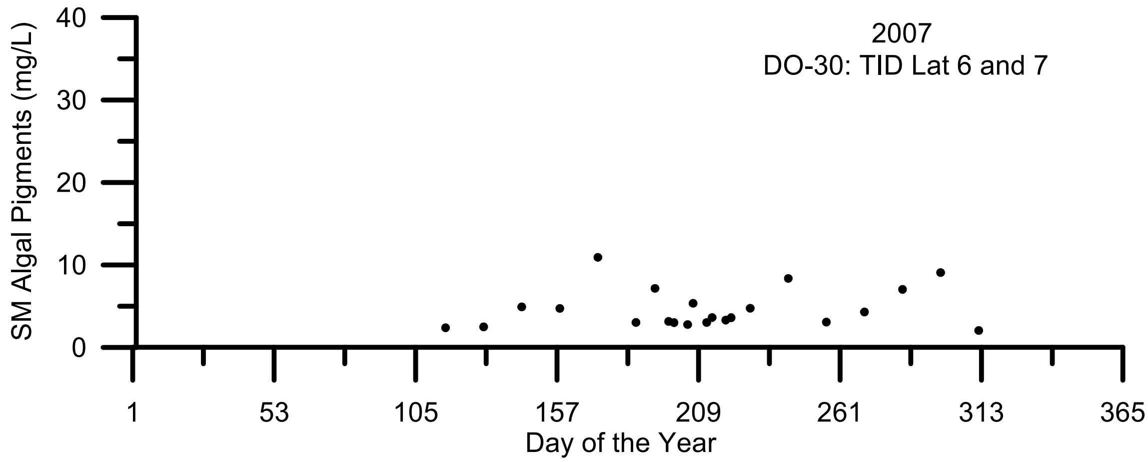

2005
DO-29: TID Harding Drain
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

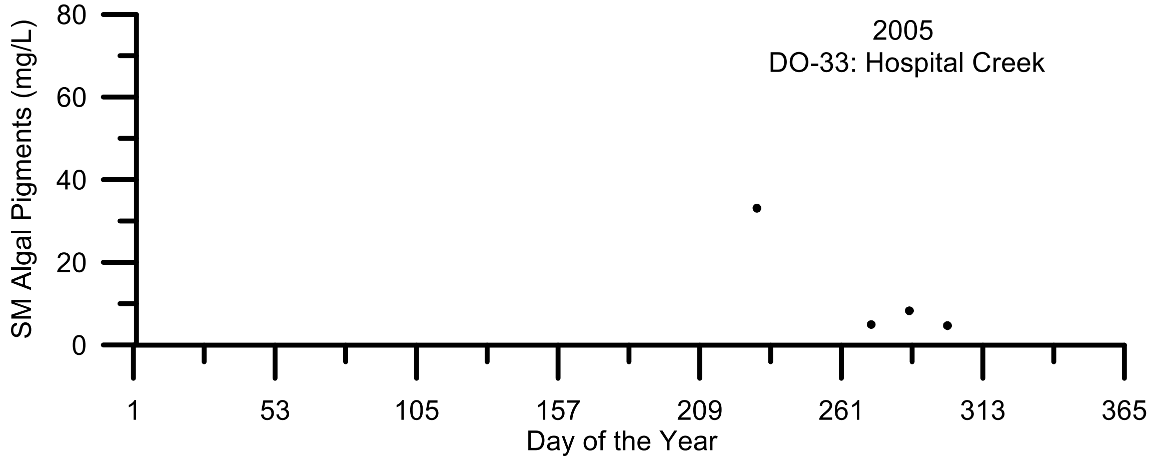

2006
DO-29: TID Harding Drain
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

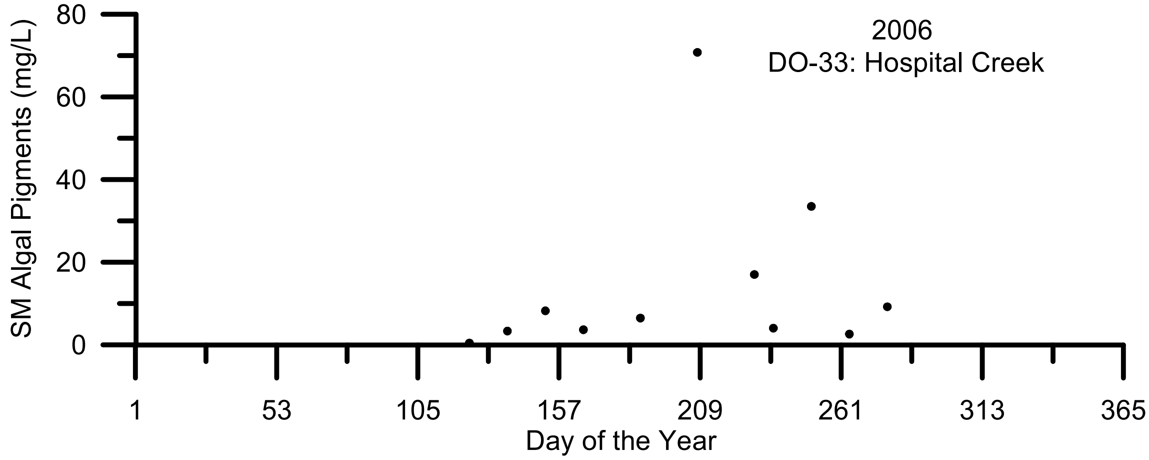

2007
DO-29: TID Harding Drain
SM Algal Pigments (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

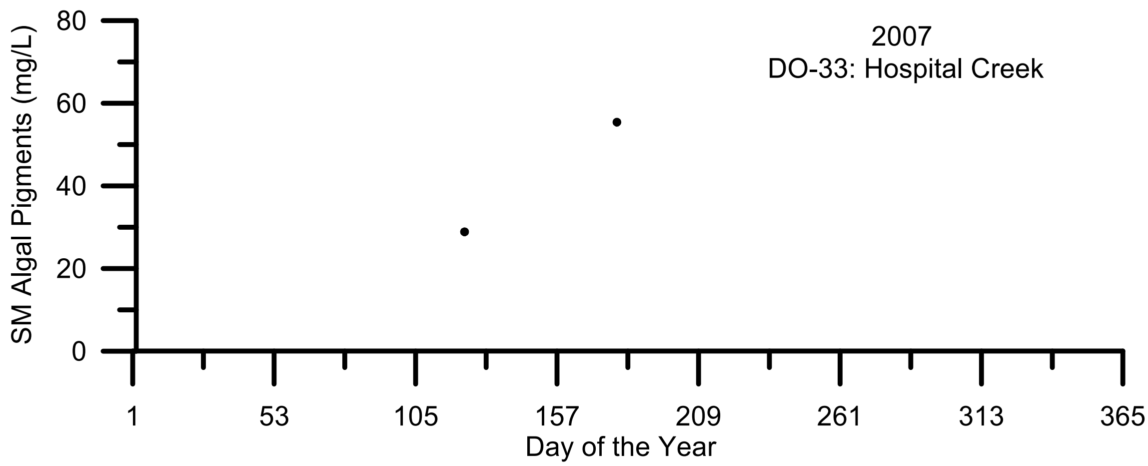

2005
DO-30: TID Lat 6 and 7
SM Algal Pigments (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

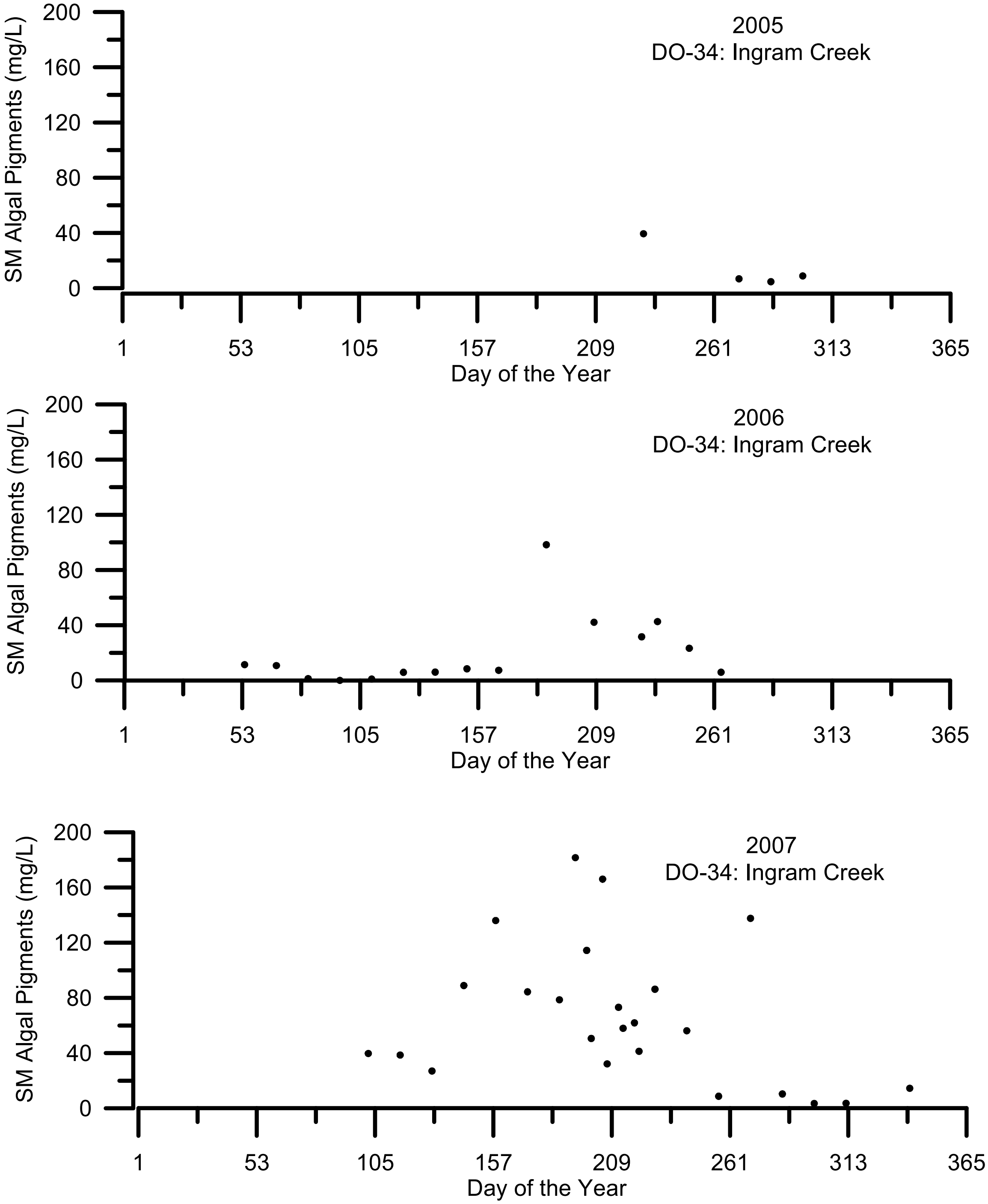

2006
DO-30: TID Lat 6 and 7
SM Algal Pigments (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-30: TID Lat 6 and 7
SM Algal Pigments (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

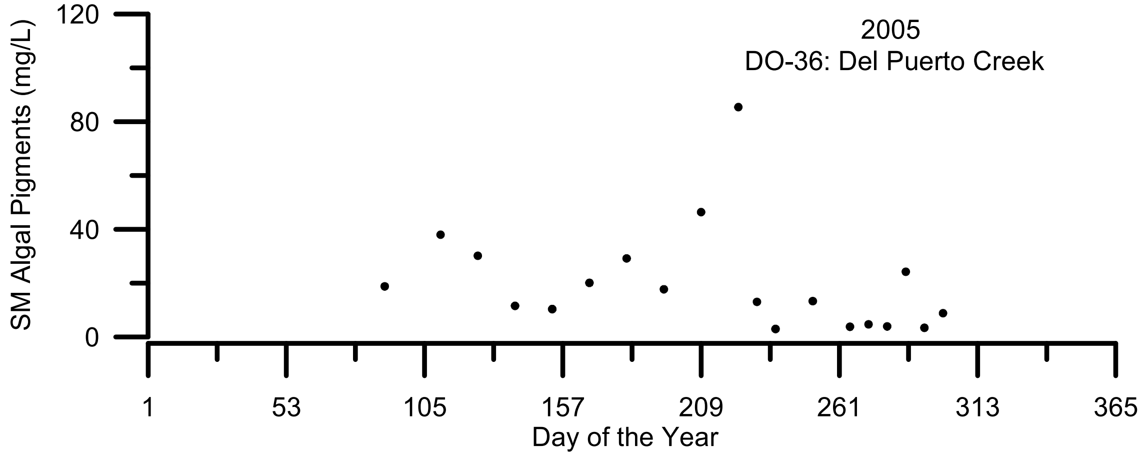

2005
DO-33: Hospital Creek
SM Algal Pigments (mg/L)
Day of the Year

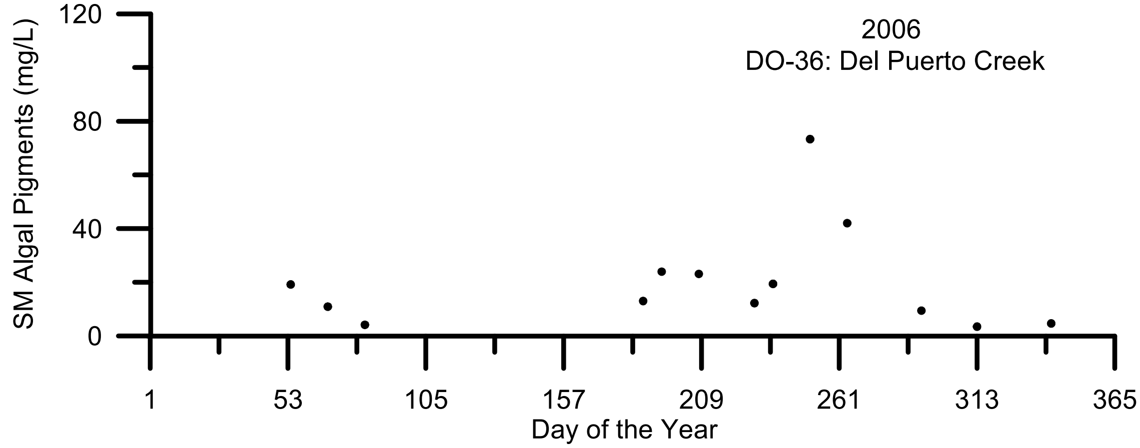

2006
DO-33: Hospital Creek
SM Algal Pigments (mg/L)
Day of the Year

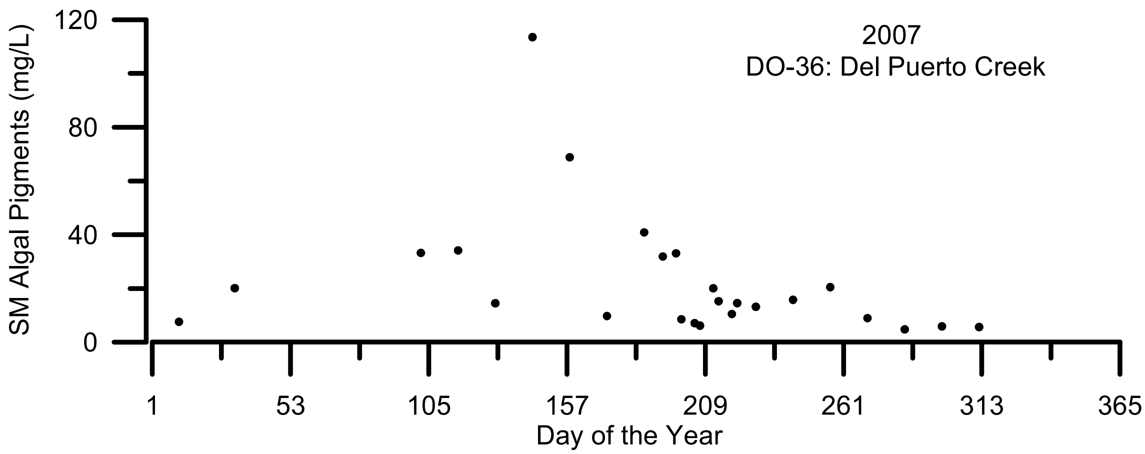

2007
DO-33: Hospital Creek
SM Algal Pigments (mg/L)
Day of the Year

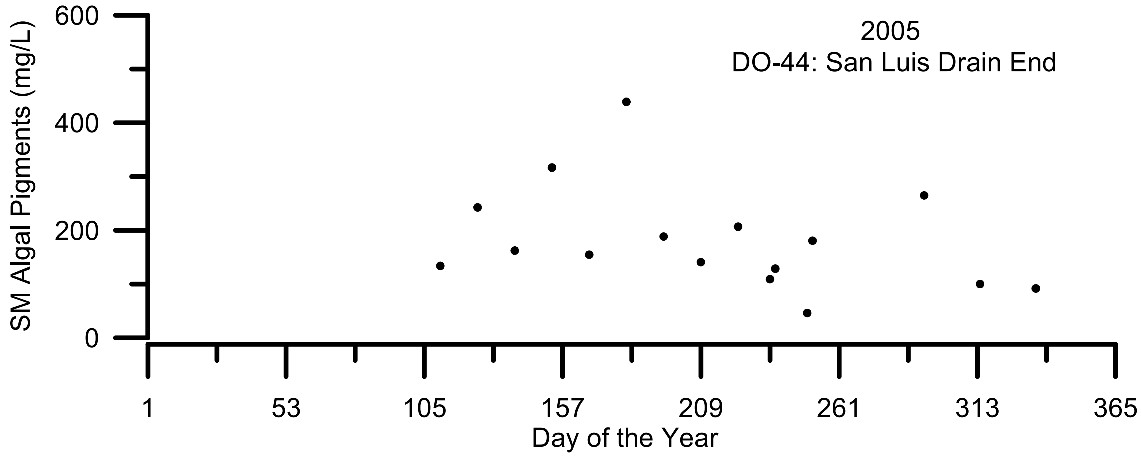


2005
DO-34: Ingram Creek
SM Algal Pigments (mg/L)
0
40
80
120
160
200
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-34: Ingram Creek
2007
DO-34: Ingram Creek

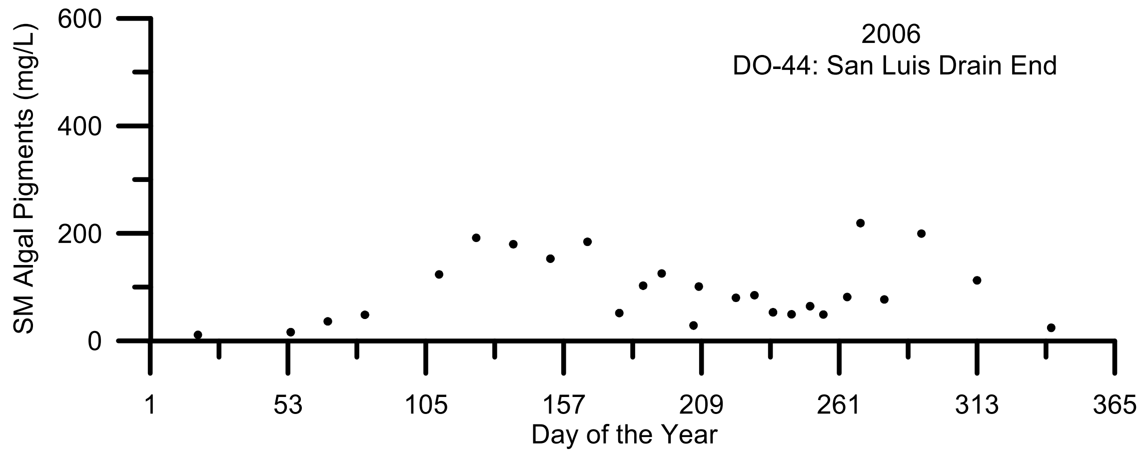

2005
DO-36: Del Puerto Creek
SM Algal Pigments (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-36: Del Puerto Creek
SM Algal Pigments (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year

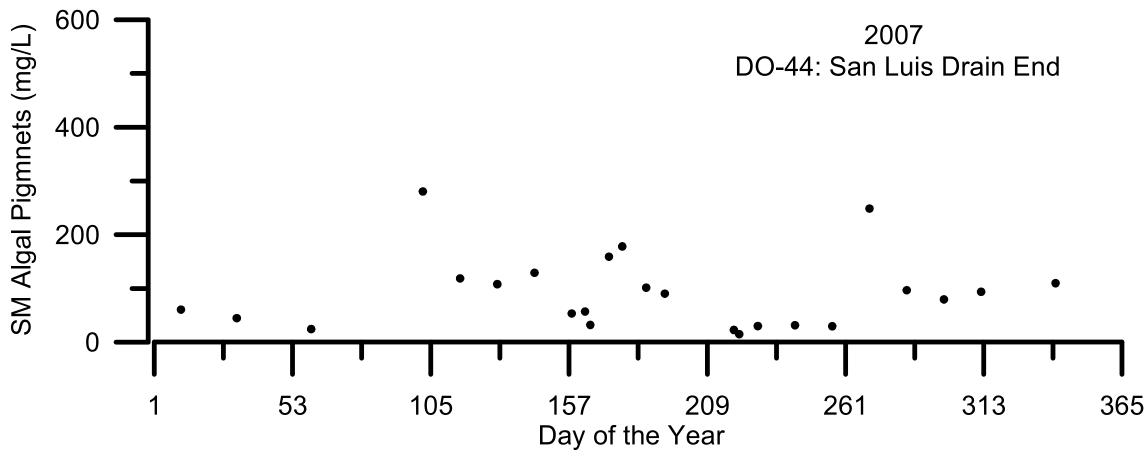

2007
DO-36: Del Puerto Creek
SM Algal Pigments (mg/L)
0
40
80
120
1
53
105
157
209
261
313
365
Day of the Year



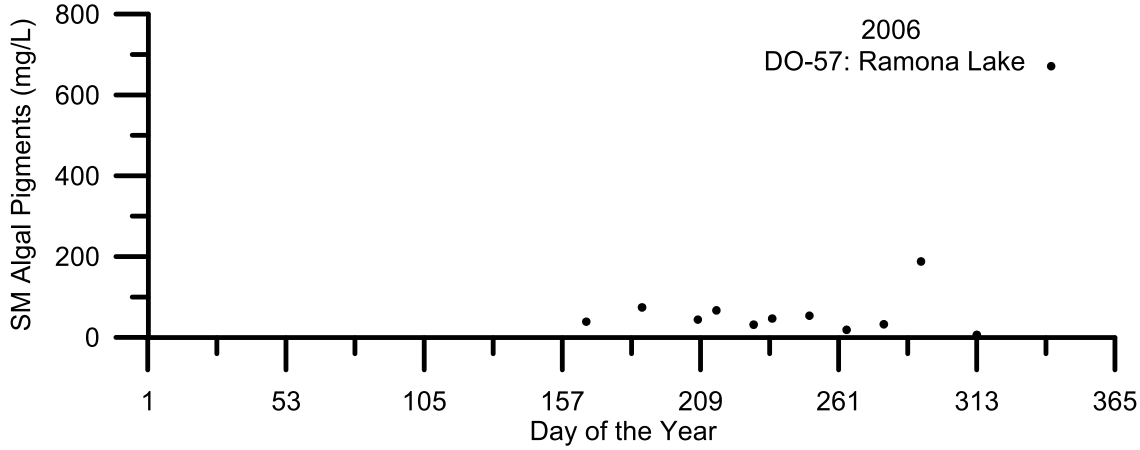
2005
DO-44: San Luis Drain End
SM Algal Pigments (mg/L)
0
200
400
600
1
53
105
157
209
261
313
365
Day of the Year

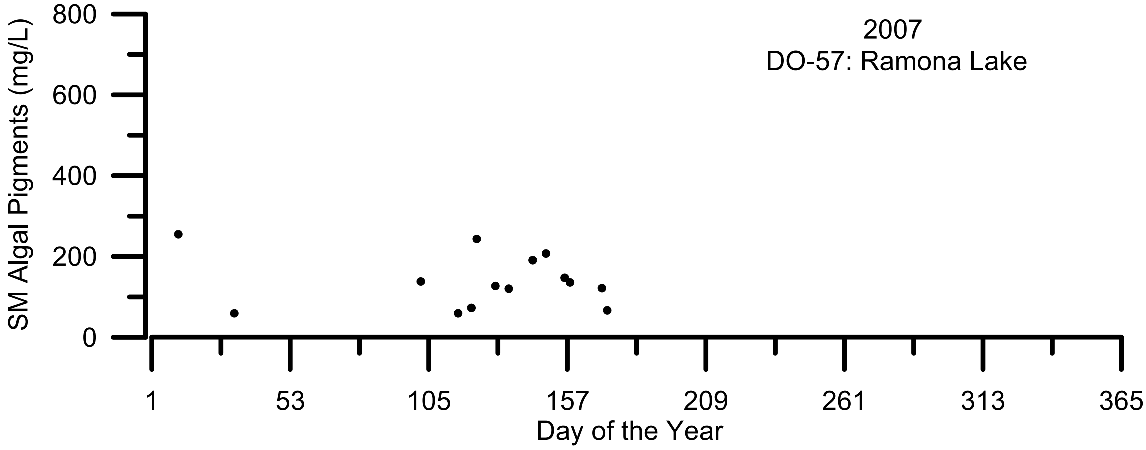


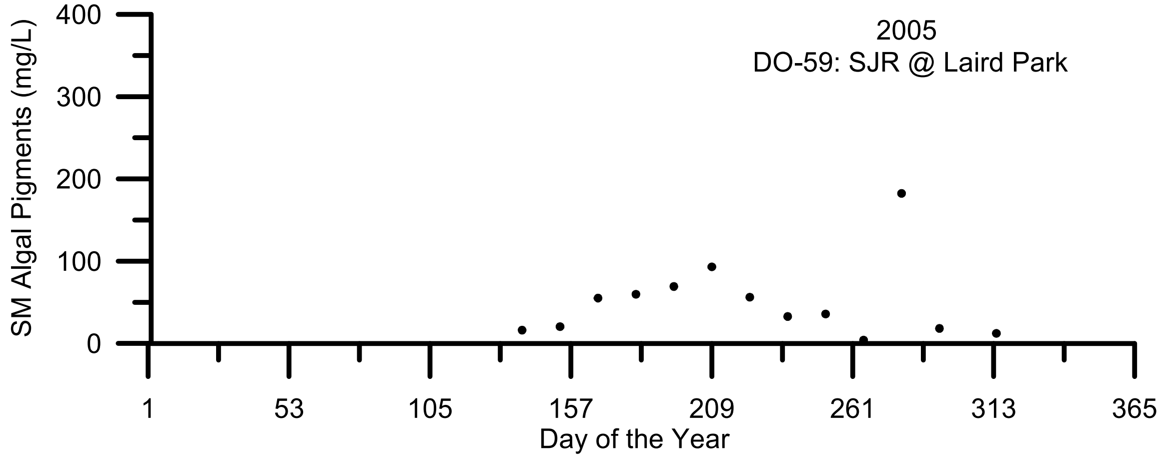
2006
DO-44: San Luis Drain End
SM Algal Pigments (mg/L)
0
200
400
600
1
53
105
157
209
261
313
365
Day of the Year

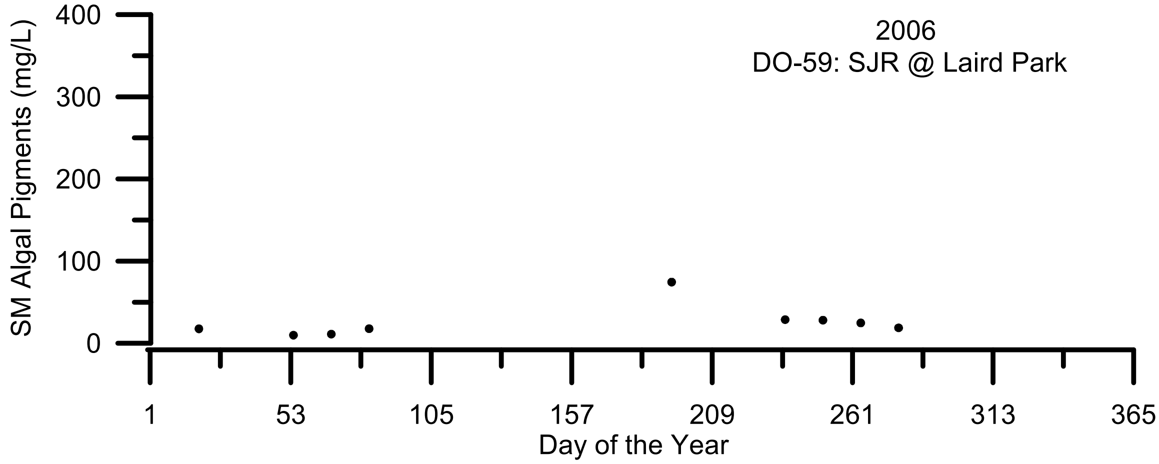


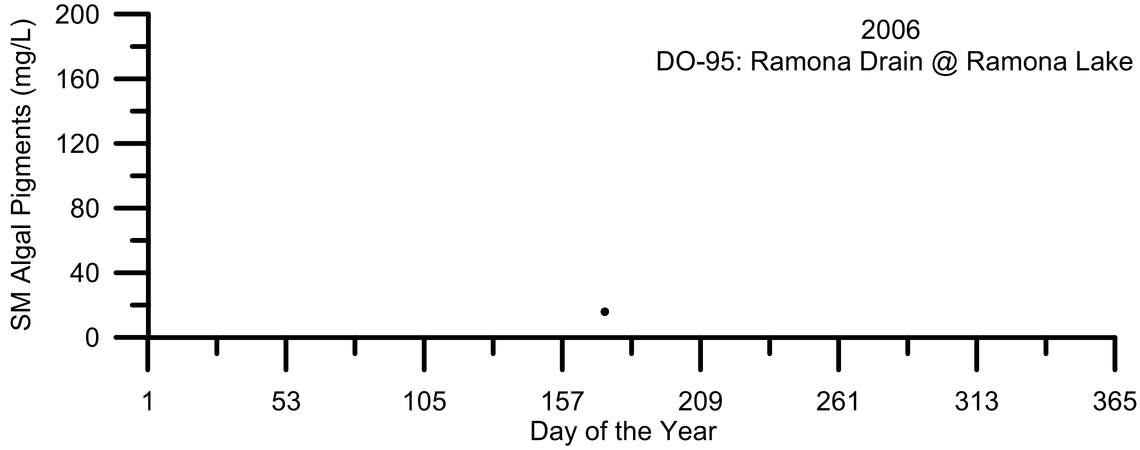
2007
DO-44: San Luis Drain End
SM Algal Pigmnets (mg/L)
0
200
400
600
1
53
105
157
209
261
313
365
Day of the Year

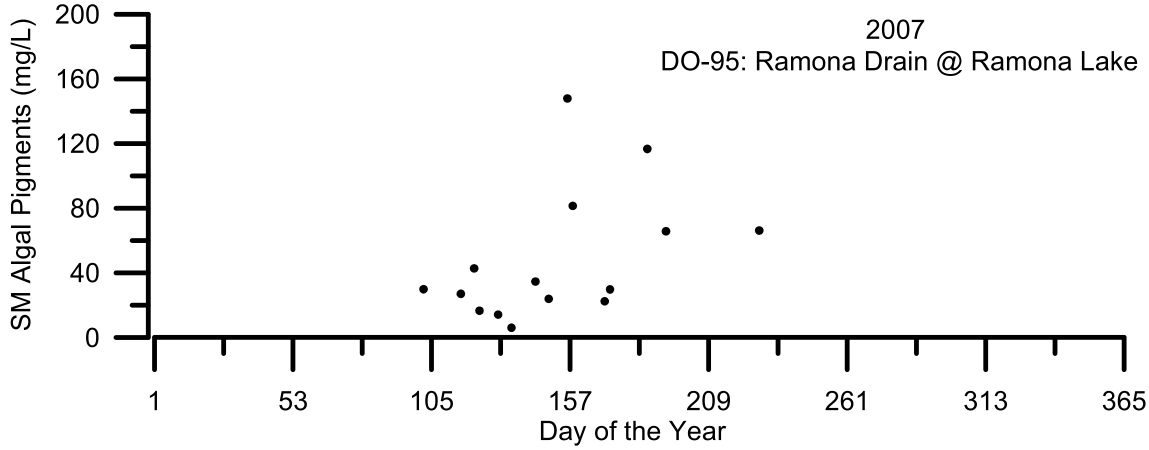

2006
DO-57: Ramona Lake
SM Algal Pigments (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-57: Ramona Lake
SM Algal Pigments (mg/L)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-59: SJR @ Laird Park
SM Algal Pigments (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-59: SJR @ Laird Park
SM Algal Pigments (mg/L)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
SM Algal Pigments (mg/L)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

In-Vivo Chlorophyll Fluorescence Measurements in the San Joaquin River Watershed 2005-2007

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Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab.

Chlorophyll fluorescence was measured *in-vivo* at every sampling location during each sampling event and is a relative measurement of the chlorophyll-a concentration and thus, phytoplankton biomass at each site.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area. The day before sample collection YSI Sonde units were calibrated at EERP following procedures in the YSI 6-Series Environmental Monitoring Systems Handbook (YSI Inc., Yellow Springs, CO). The sonde has several probes which were calibrated independently. Each sampling day, the sonde was recalibrated for dissolved oxygen at the first site to correct for ambient barometric pressure. At each sampling location, water quality data was collected for at least 2 minutes using a sonde deployed in the sample water and programmed to measure and record every parameter every four seconds, providing a statistically significant sample size ($n > 30$). The data from the sonde was also recorded in the field notebook. The parameters measured by the sonde at each site included time, temperature (°C), specific conductance (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO), DO concentration (mg/L), DO charge, depth (ft), pH, oxidation-reduction potential (mV), turbidity (NTU), chlorophyll content (µg/L), fluorescence (%), and barometric pressure (mmHg). The samples were stored at 4°C after collection and returned to the lab for analysis.

Results and Discussion

Chlorophyll fluorescence data was collected routinely over the years 2005-2007 three different YSI Sonde 6600 units. Outlying points were excluded from the final data set and were often caused by attached plants or algae blocking the probe and inflating the %

fluorescence value. Additionally, no standard solution for calibrating this parameter was available so no QA data could be gathered to insure proper functioning of the probe, however, lab measurements of chlorophyll concentrations could and did serve as checks of these measurements.

References

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Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

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American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

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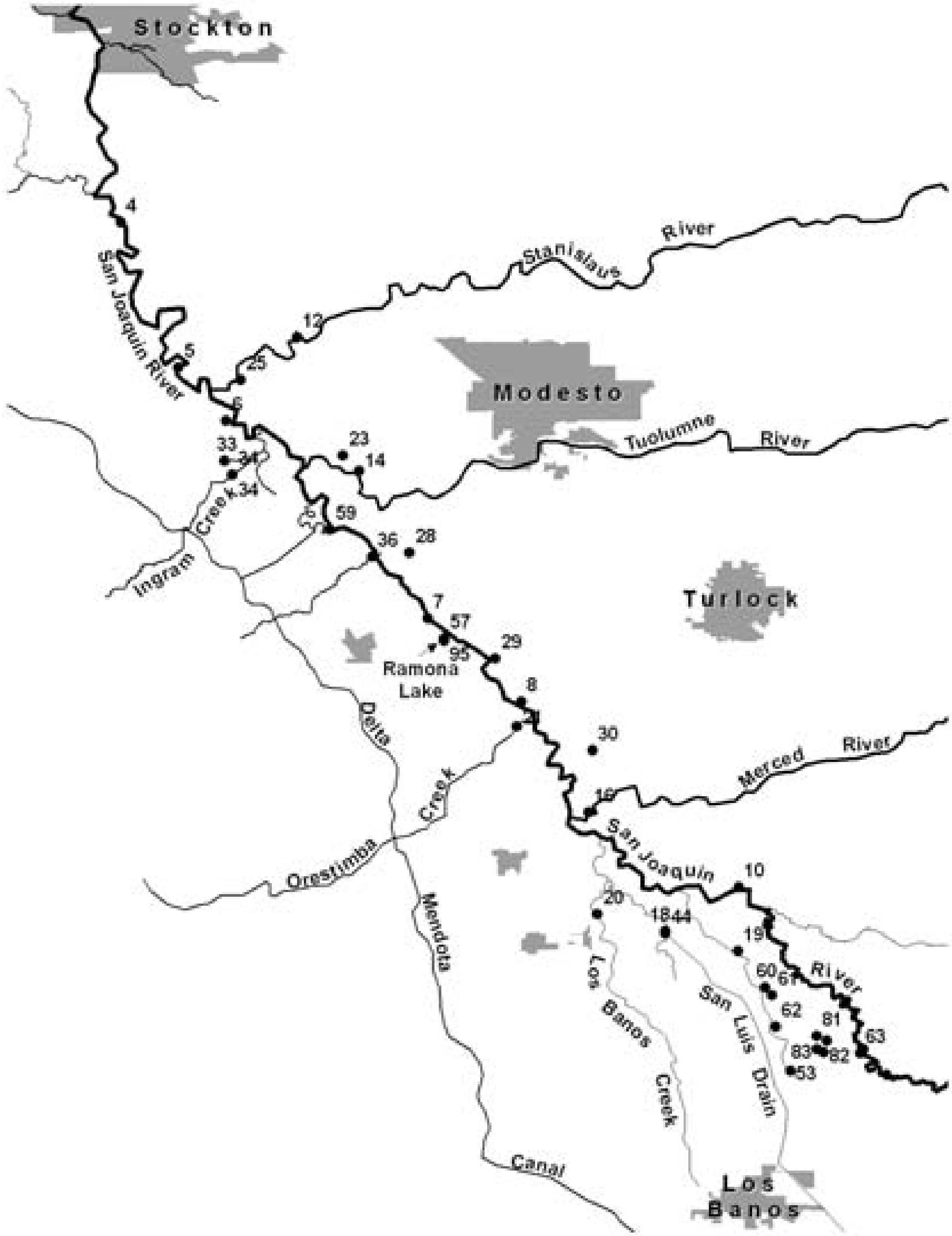
YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

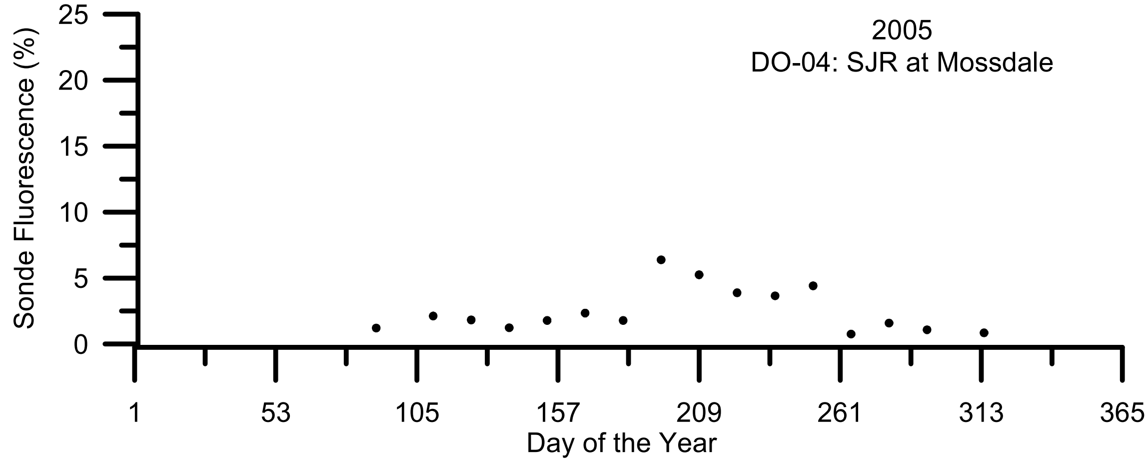
Table 1: EERP Sampling Site List

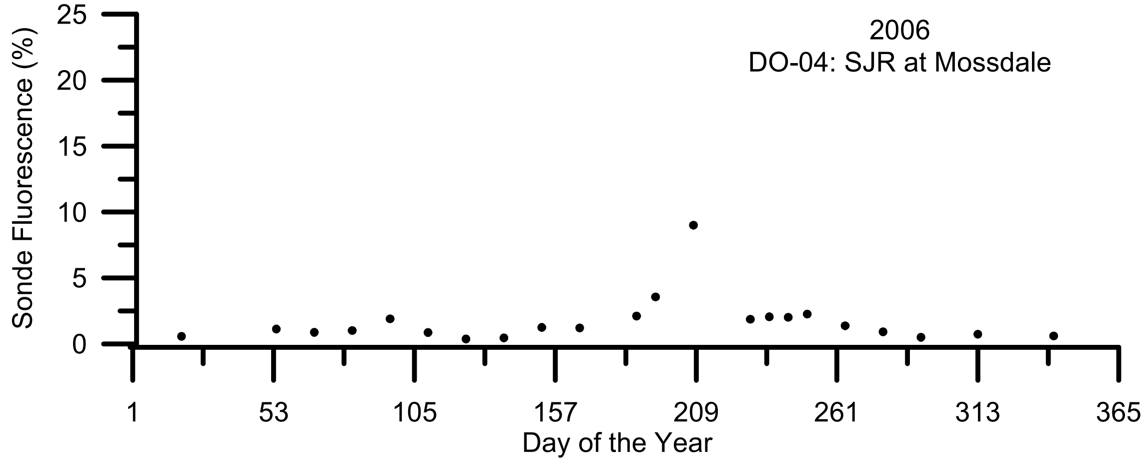
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

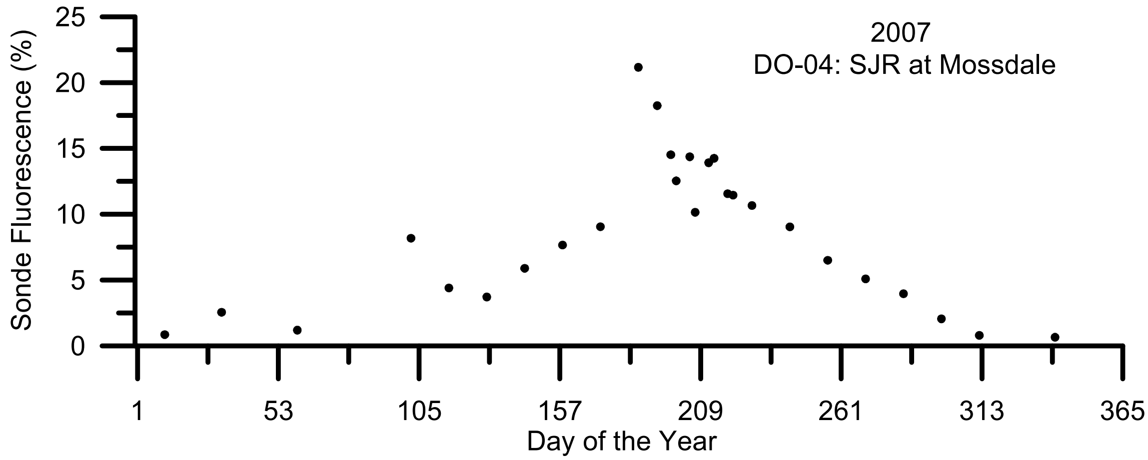
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

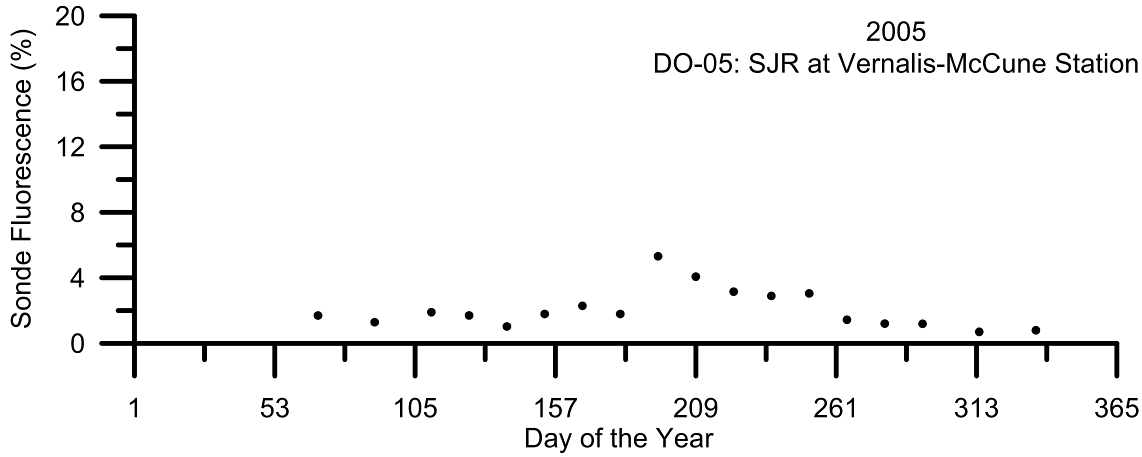


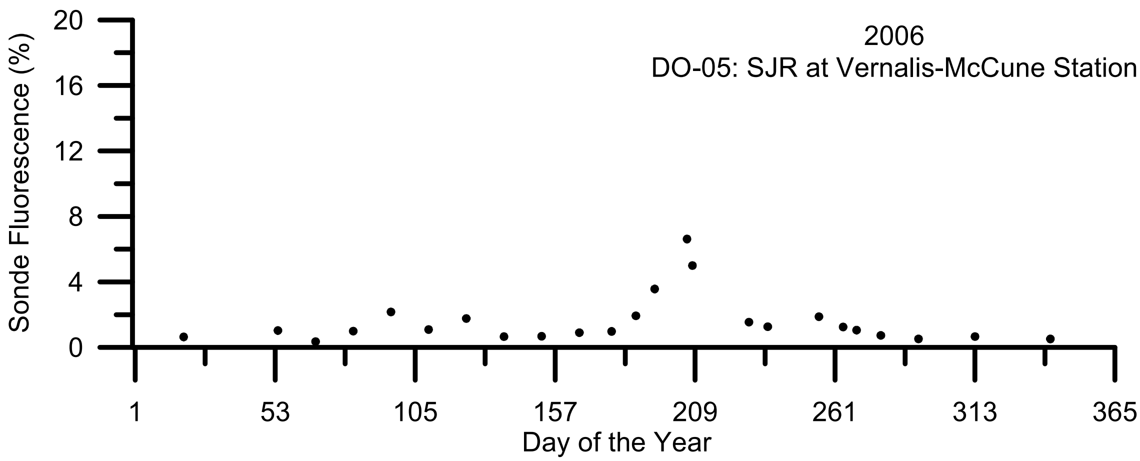
Figures 2 -101: Temporal Plots of Chlorophyll Fluorescence By Site ID

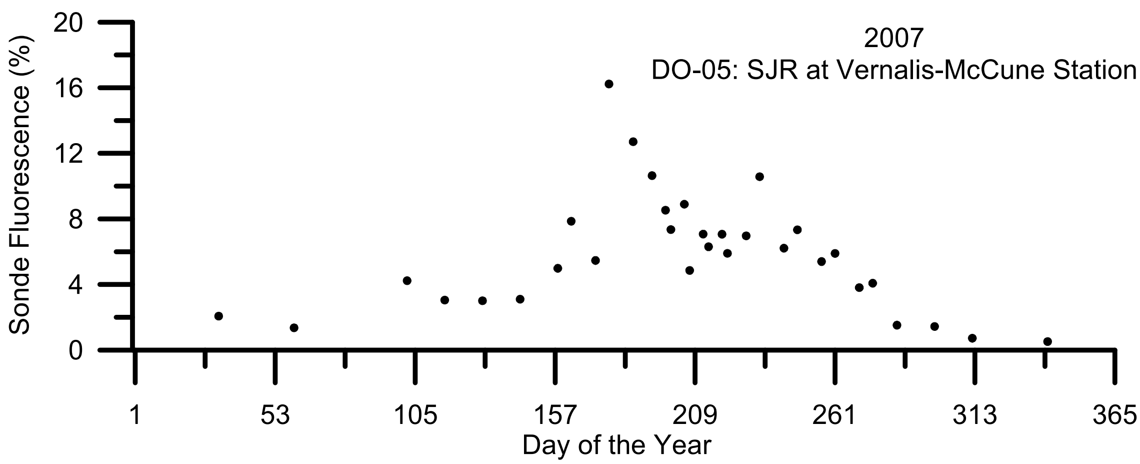


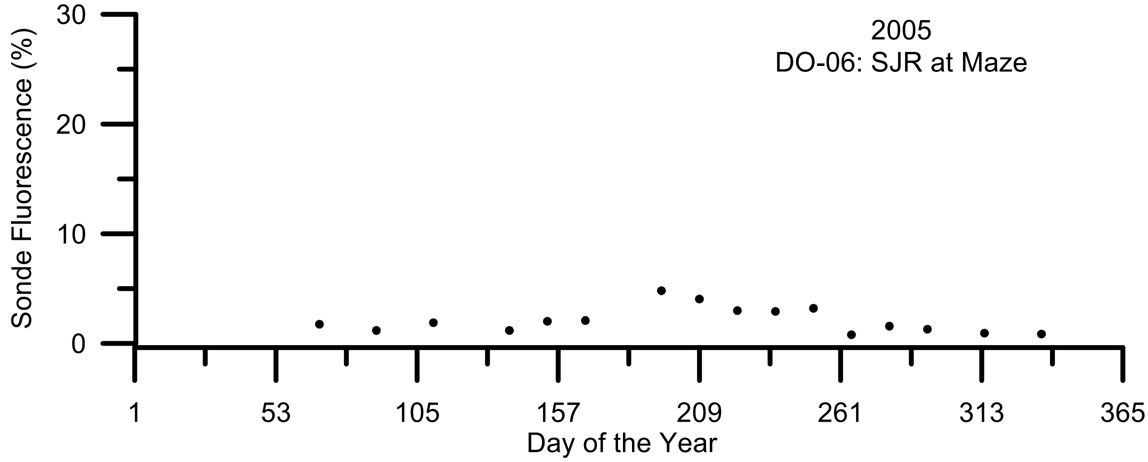


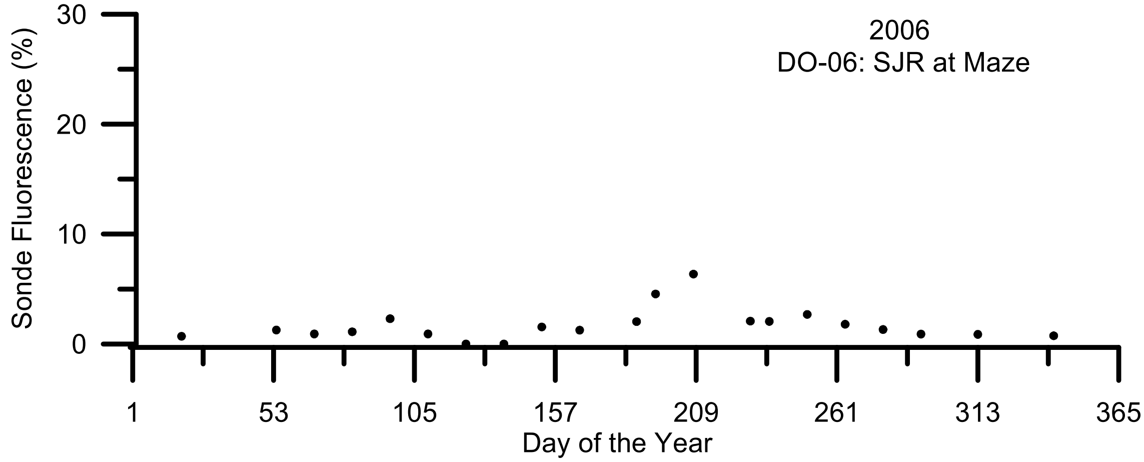


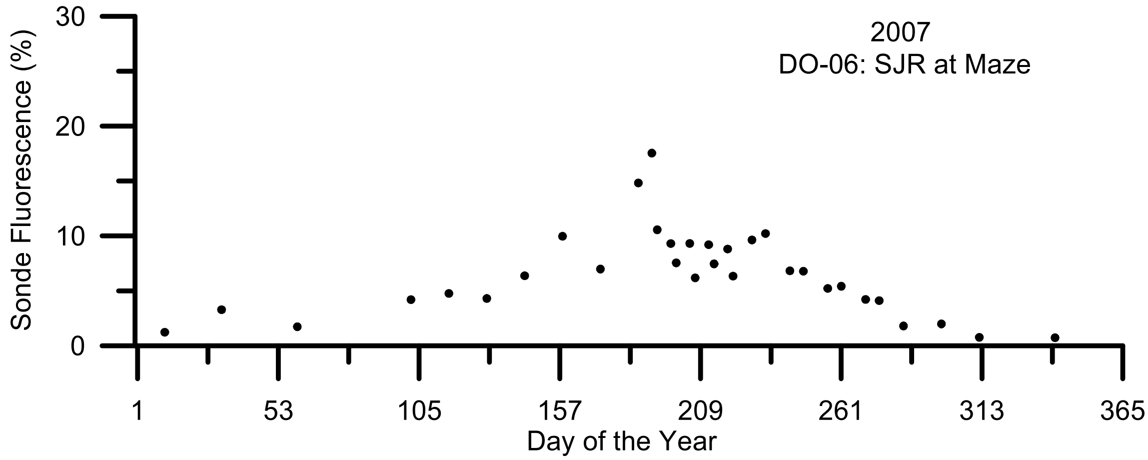

2005
DO-05: SJR at Vernalis-McCune Station
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

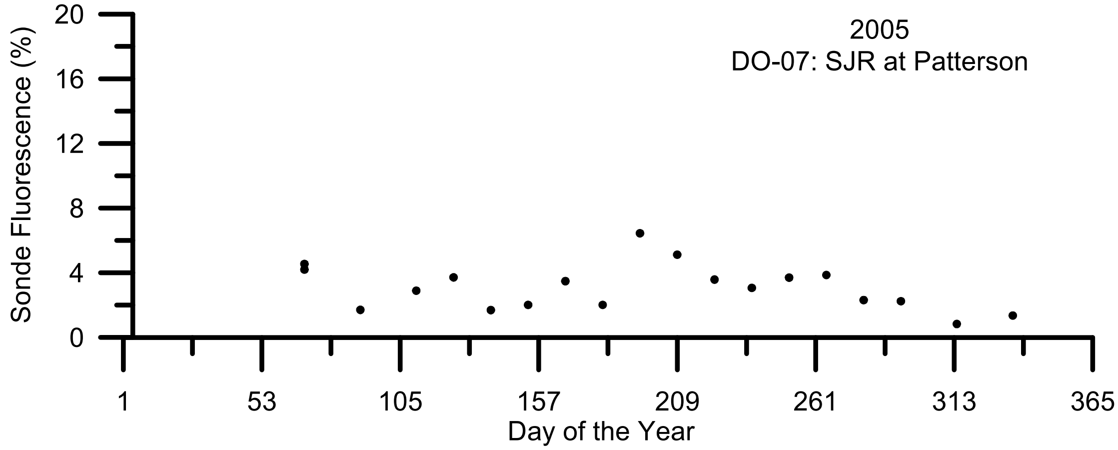

2006
DO-05: SJR at Vernalis-McCune Station
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

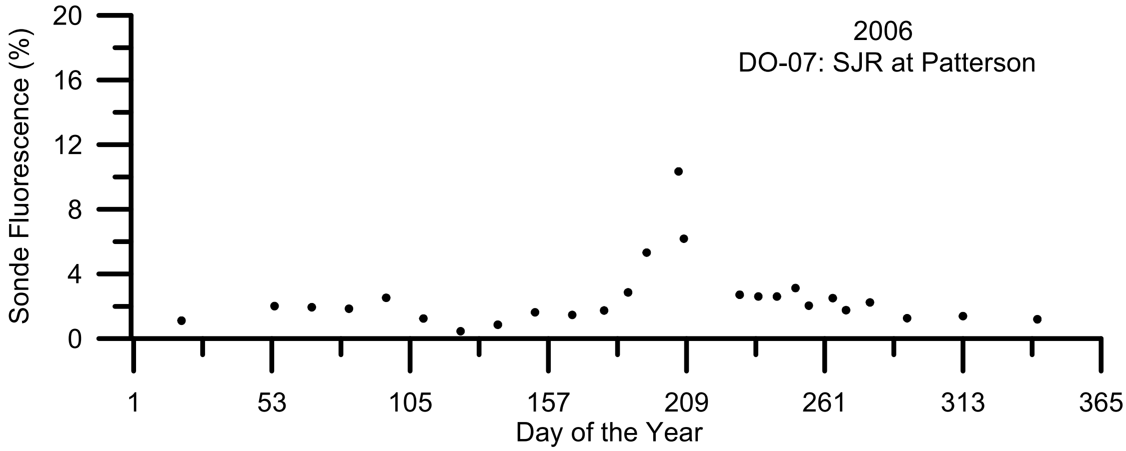

2007
DO-05: SJR at Vernalis-McCune Station
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

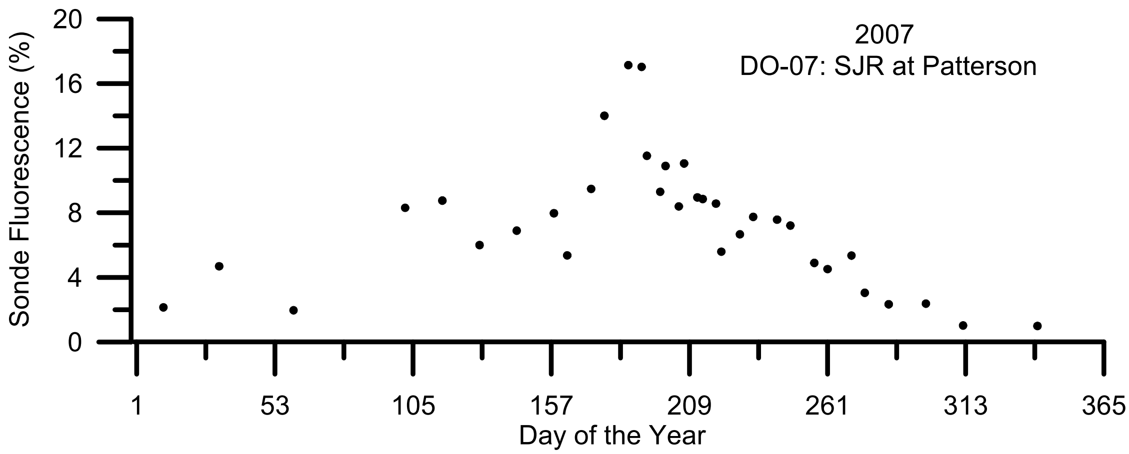

2005
DO-06: SJR at Maze
Sonde Fluorescence (%)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

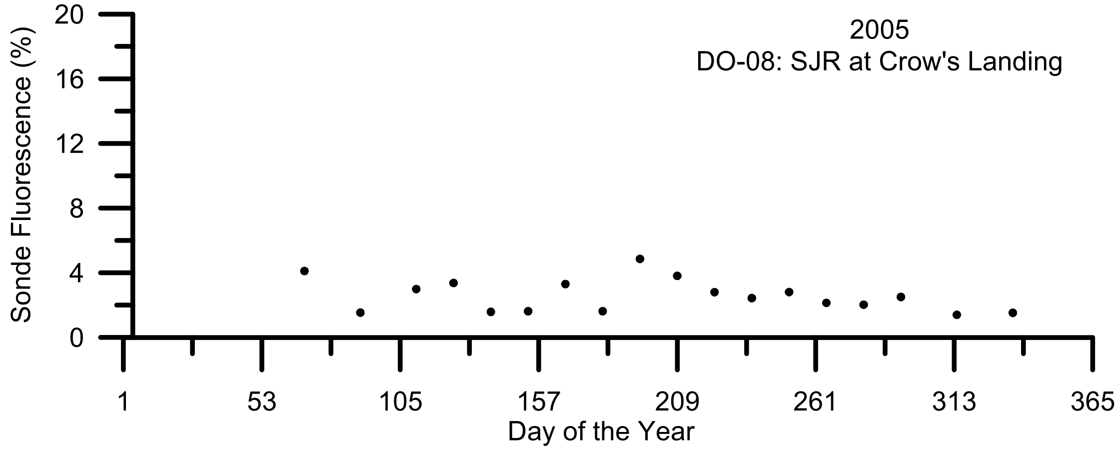

2006
DO-06: SJR at Maze
Sonde Fluorescence (%)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
Sonde Fluorescence (%)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

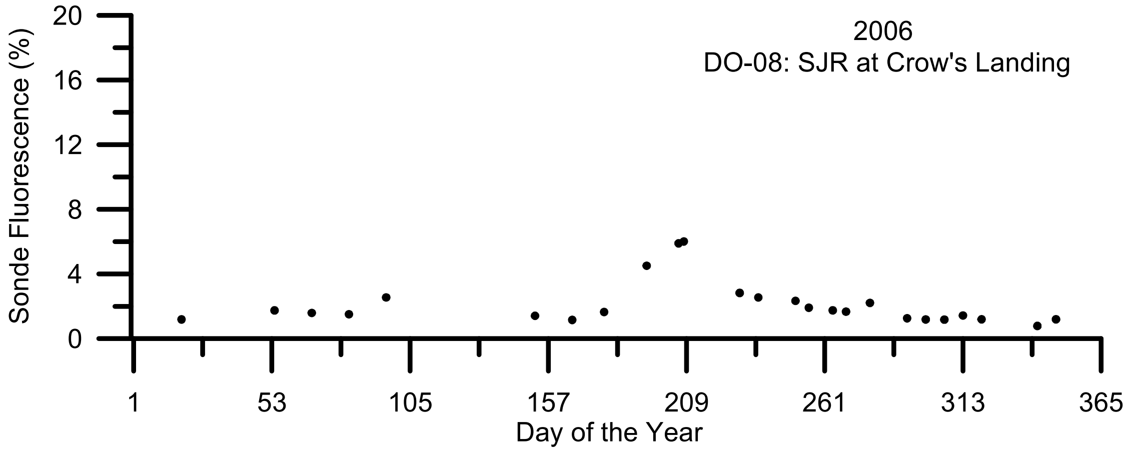

2005
DO-07: SJR at Patterson
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

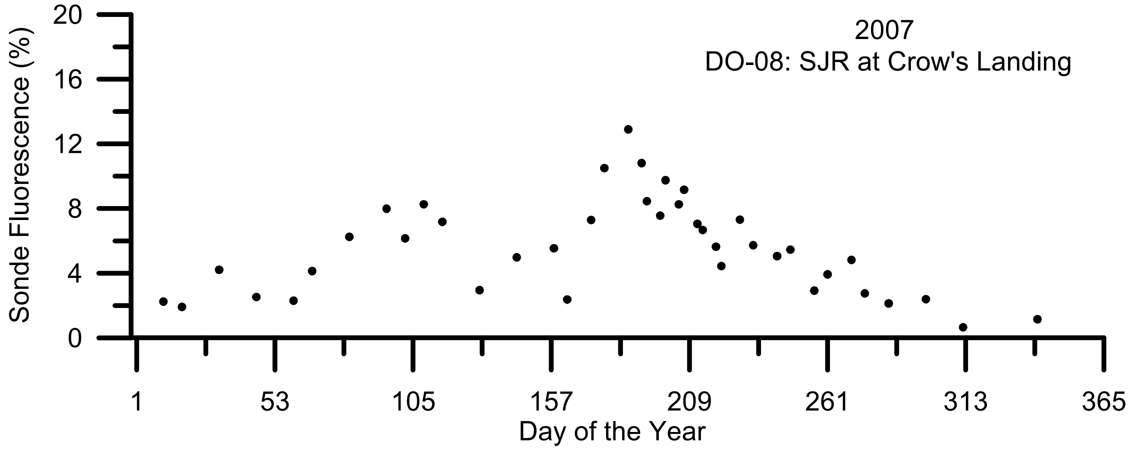

2007
DO-07: SJR at Patterson
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year



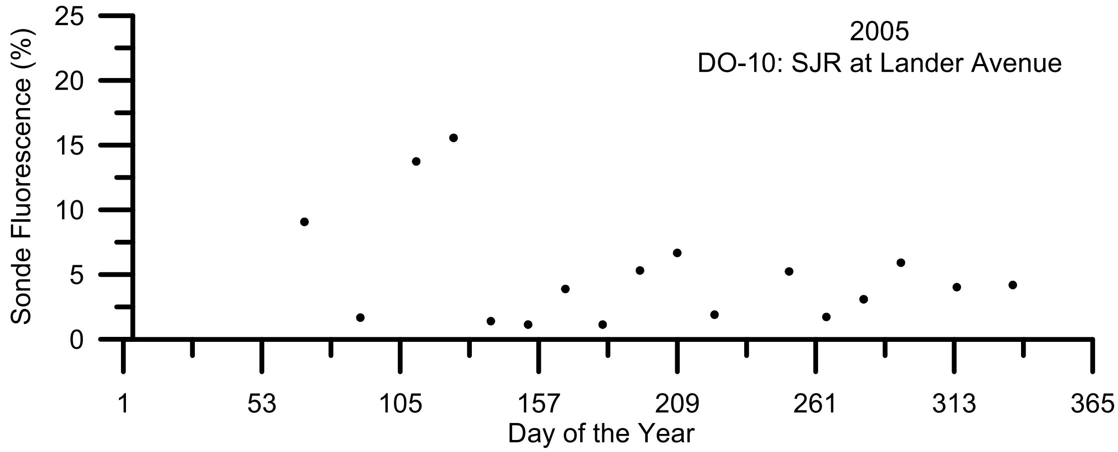
2005
DO-08: SJR at Crow's Landing
Sonde Fluorescence (%)
Day of the Year



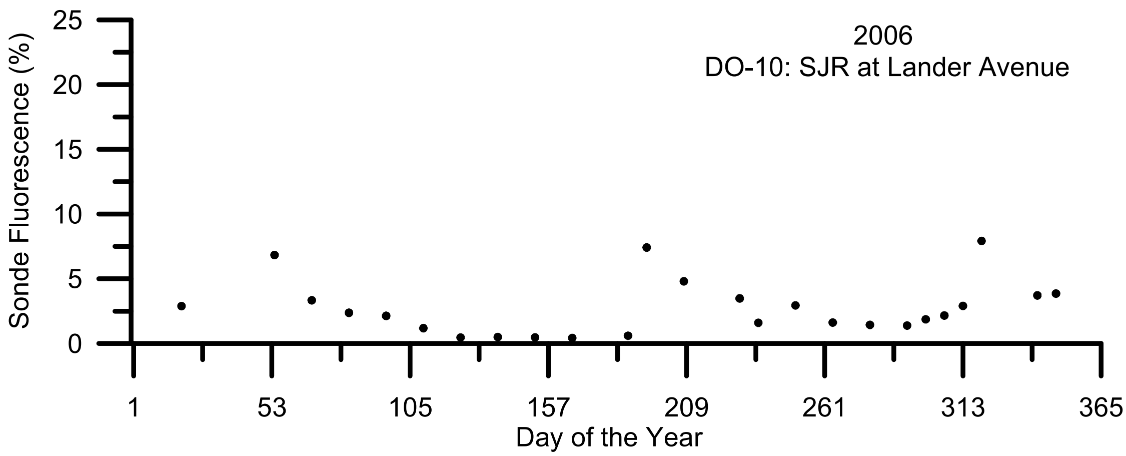
2006
DO-08: SJR at Crow's Landing
Sonde Fluorescence (%)
Day of the Year



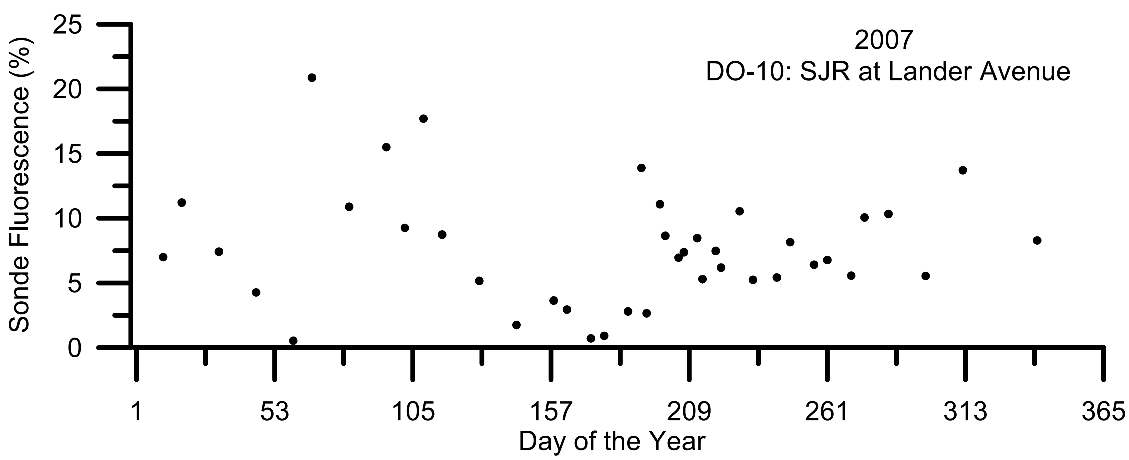
2007
DO-08: SJR at Crow's Landing
Sonde Fluorescence (%)
Day of the Year



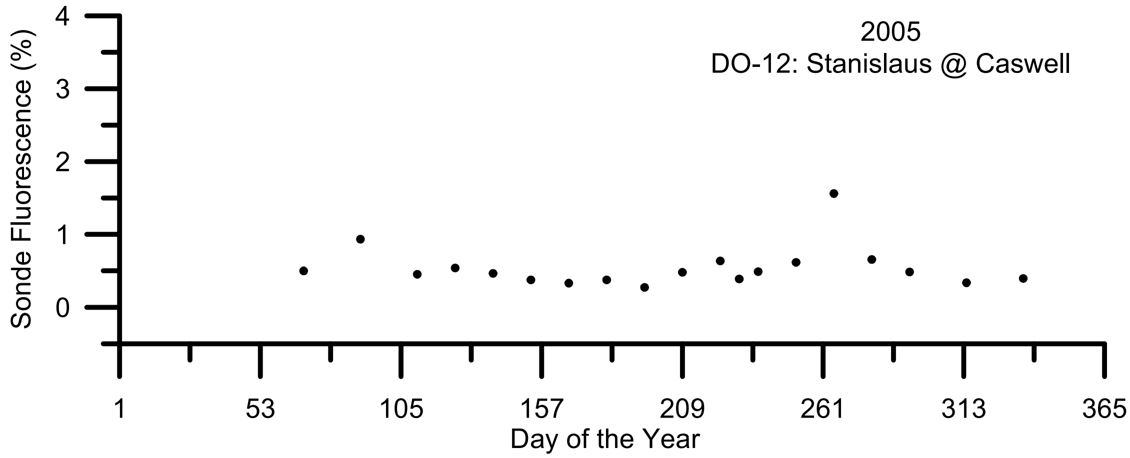
2005
DO-10: SJR at Lander Avenue
Sonde Fluorescence (%)
Day of the Year

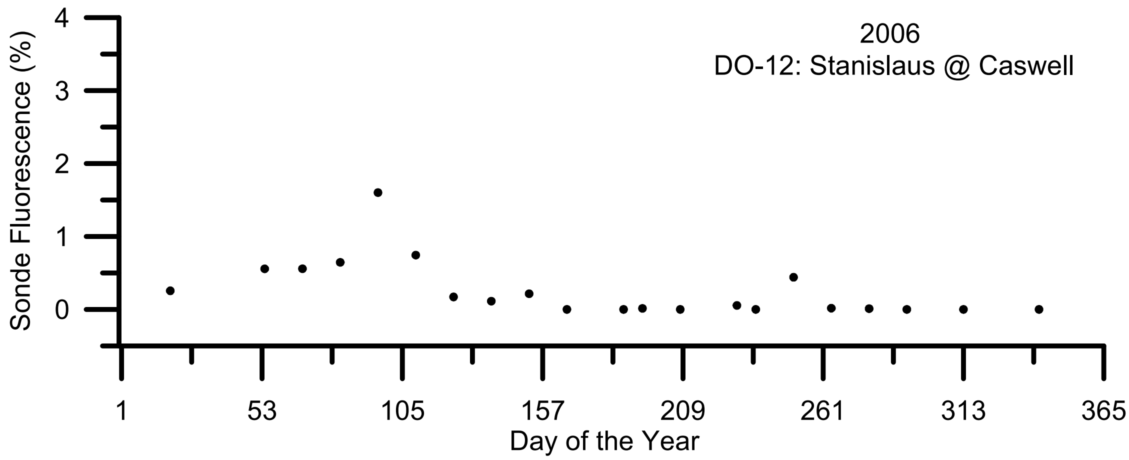


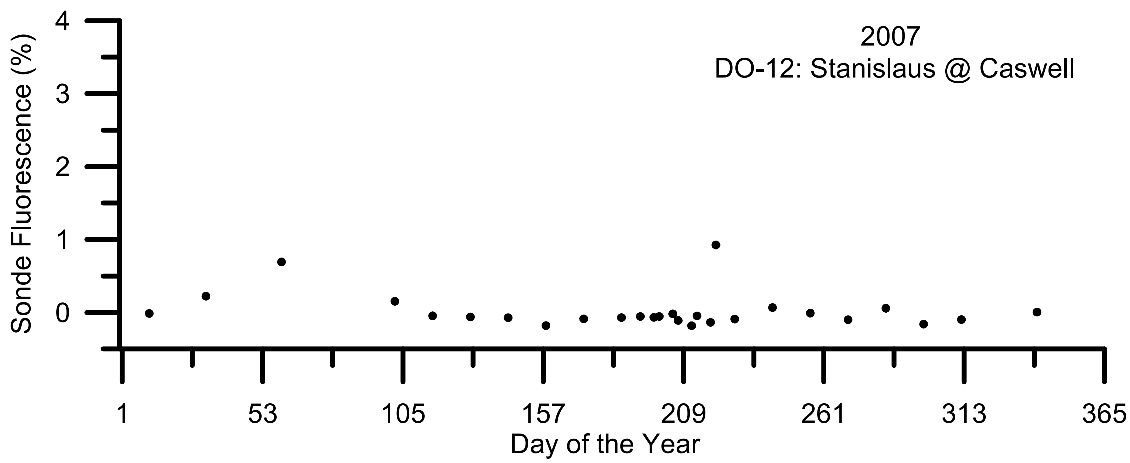
2006
DO-10: SJR at Lander Avenue
Sonde Fluorescence (%)
Day of the Year

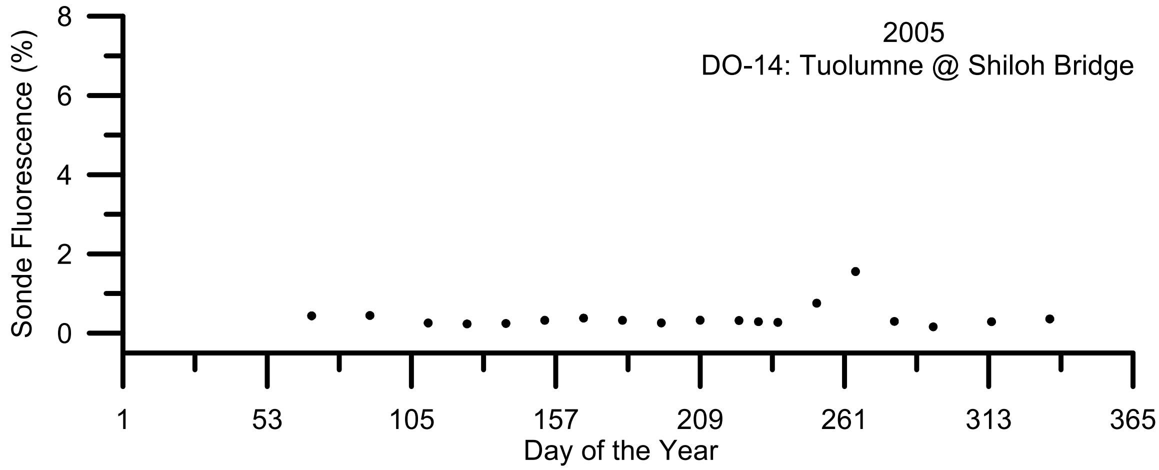


2007
DO-10: SJR at Lander Avenue
Sonde Fluorescence (%)
Day of the Year

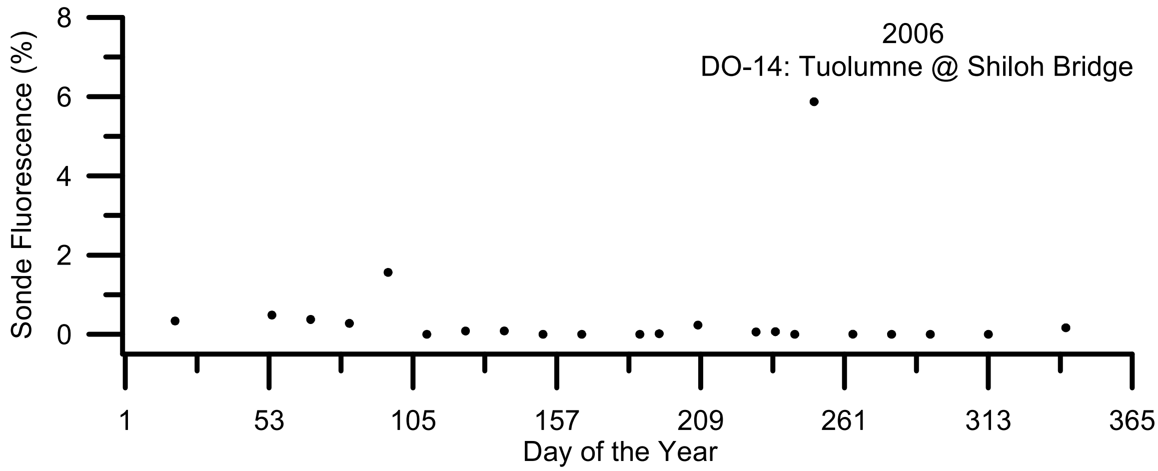

2005
DO-12: Stanislaus @ Caswell
Sonde Fluorescence (%)
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus @ Caswell
Sonde Fluorescence (%)
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

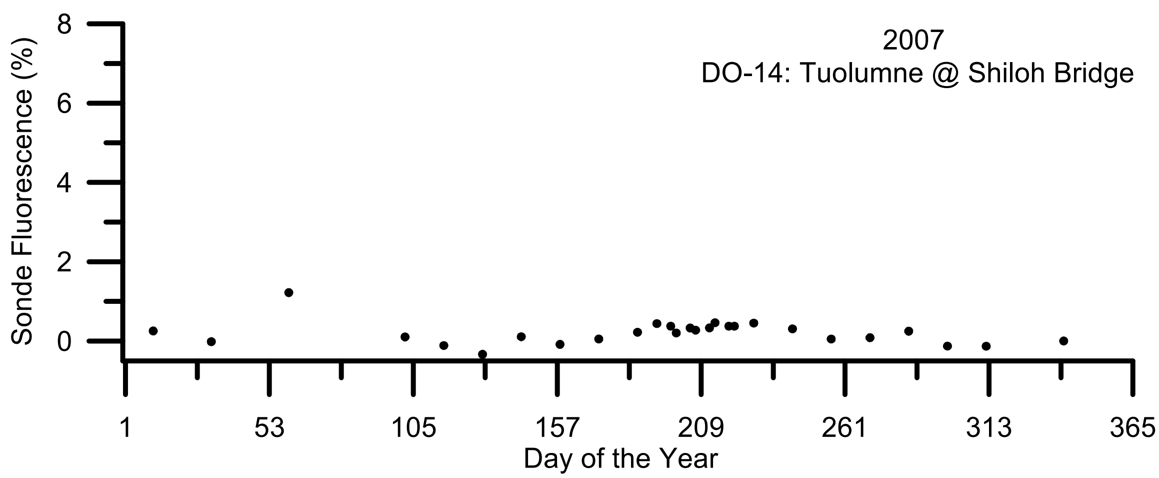

2007
DO-12: Stanislaus @ Caswell
Sonde Fluorescence (%)
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year



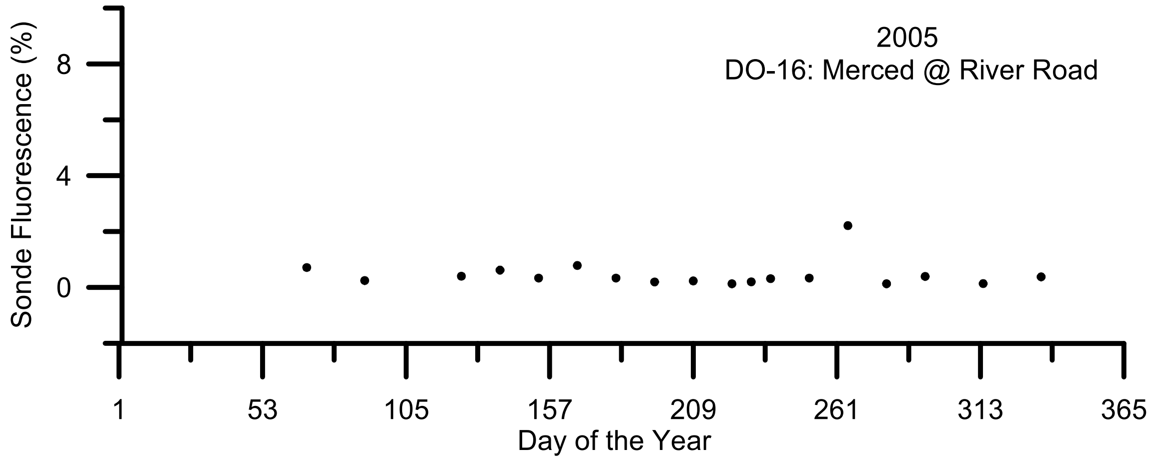
2005
DO-14: Tuolumne @ Shiloh Bridge
Sonde Fluorescence (%)
Day of the Year



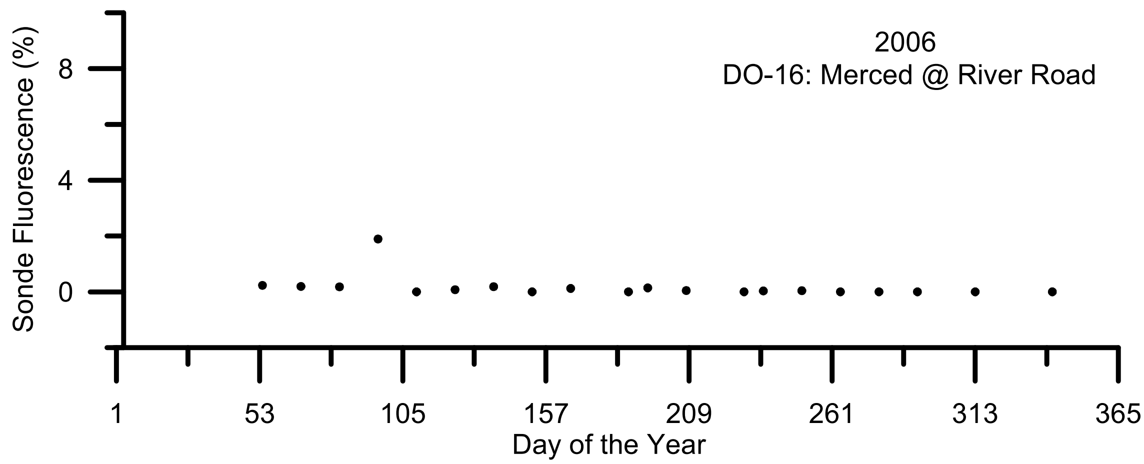
2006
DO-14: Tuolumne @ Shiloh Bridge
Sonde Fluorescence (%)
Day of the Year



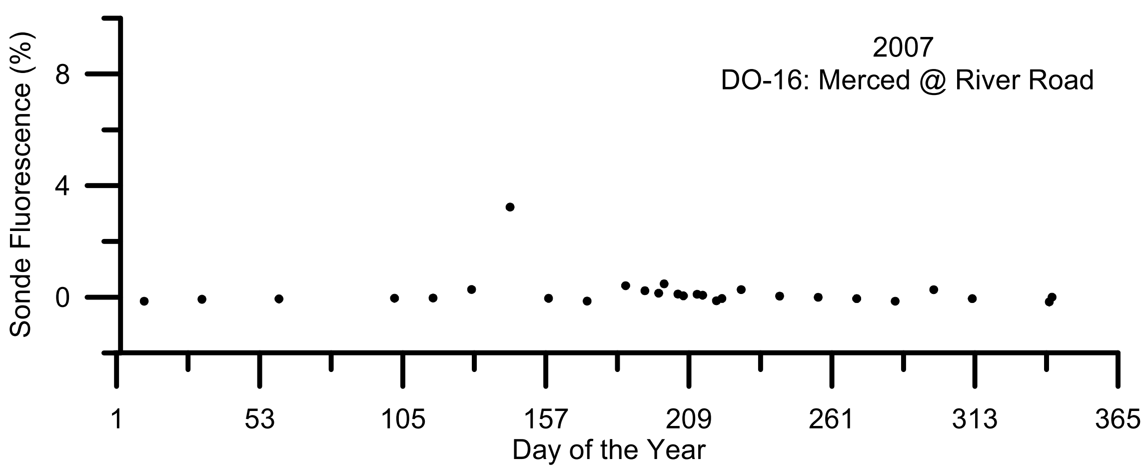
2007
DO-14: Tuolumne @ Shiloh Bridge
Sonde Fluorescence (%)
Day of the Year



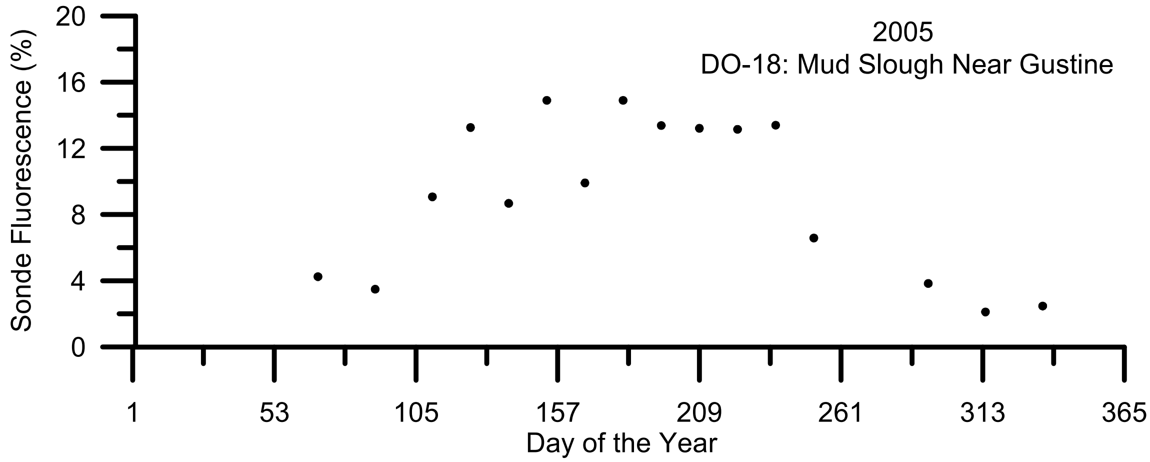
2005
DO-16: Merced @ River Road
Sonde Fluorescence (%)
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

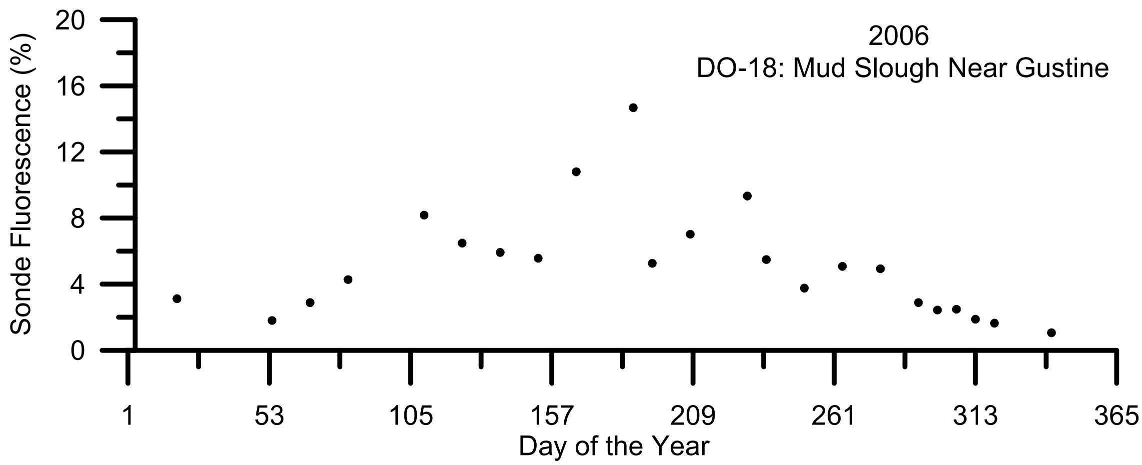


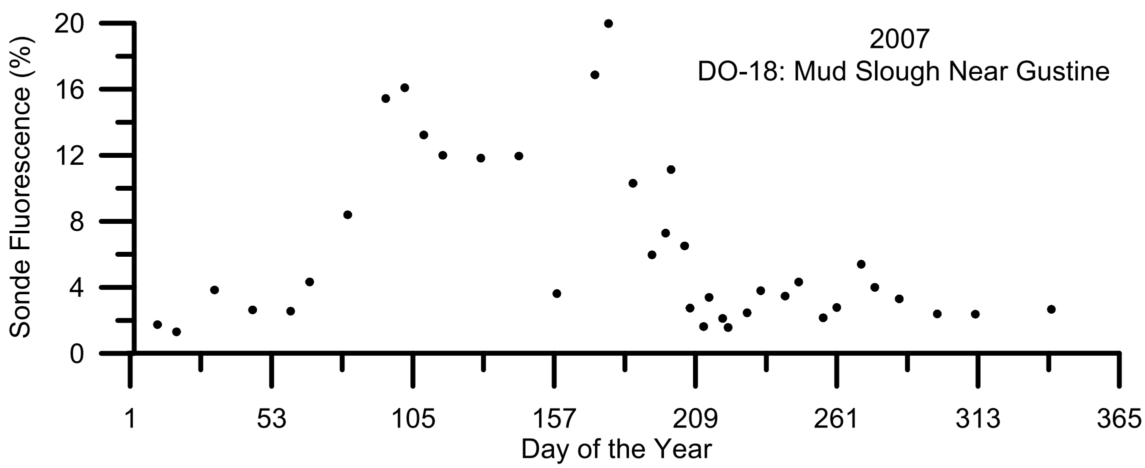
2006
DO-16: Merced @ River Road
Sonde Fluorescence (%)
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

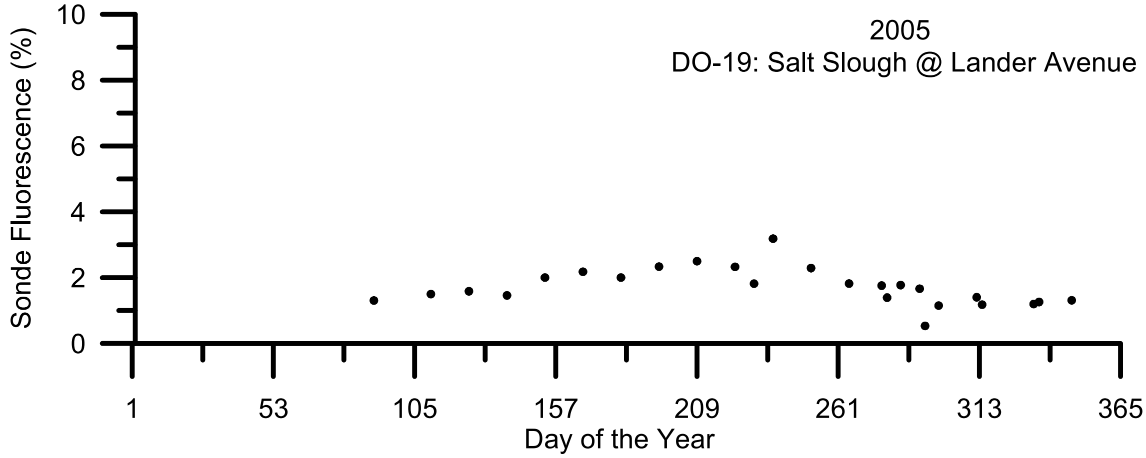


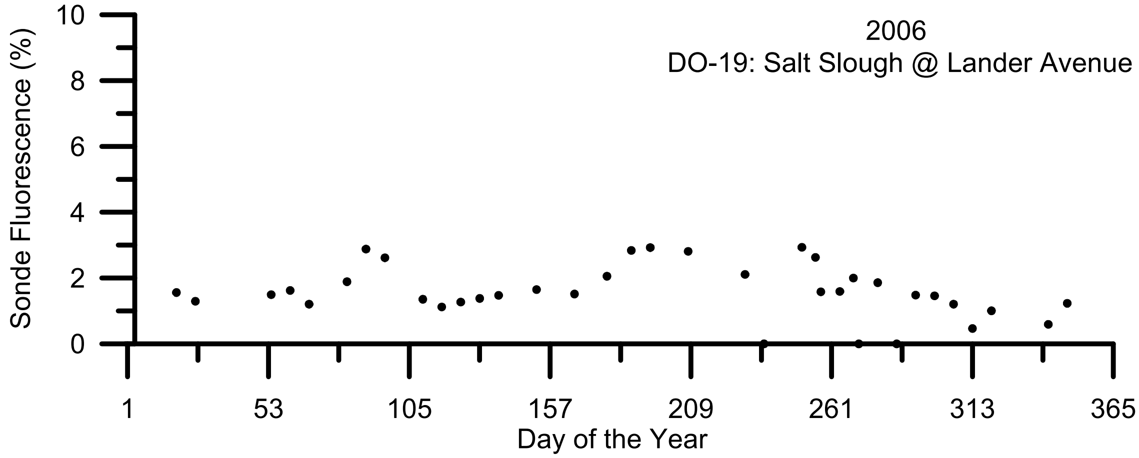
2007
DO-16: Merced @ River Road
Sonde Fluorescence (%)
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

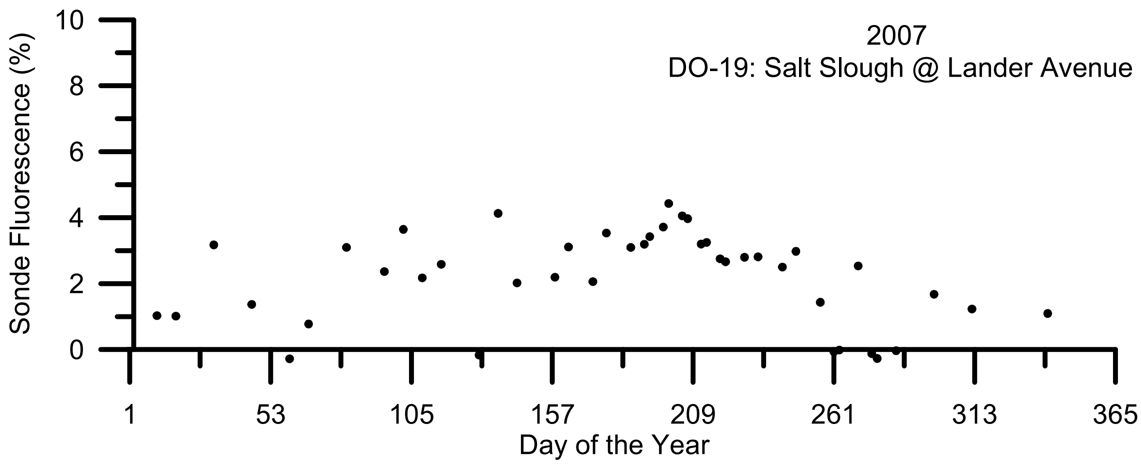

2005
DO-18: Mud Slough Near Gustine
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

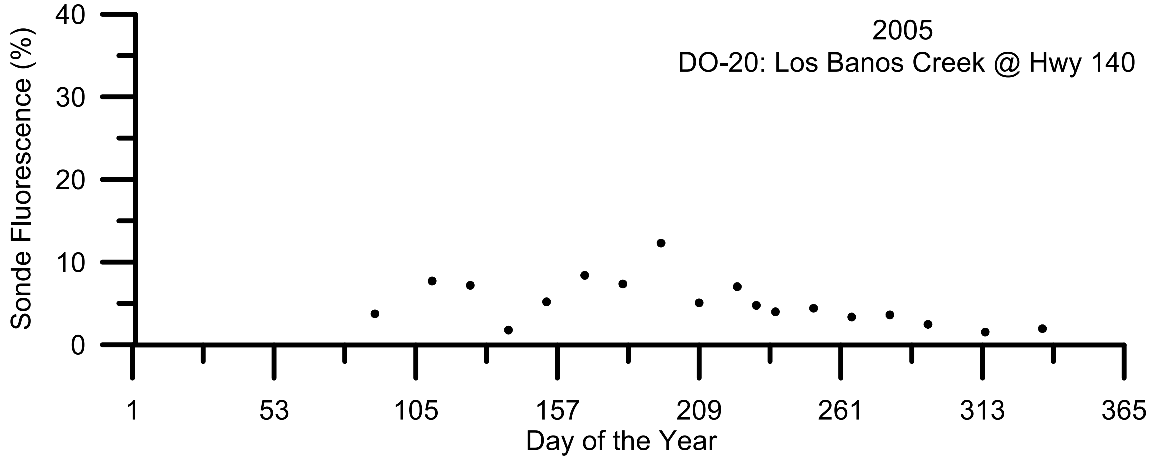

2006
DO-18: Mud Slough Near Gustine
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

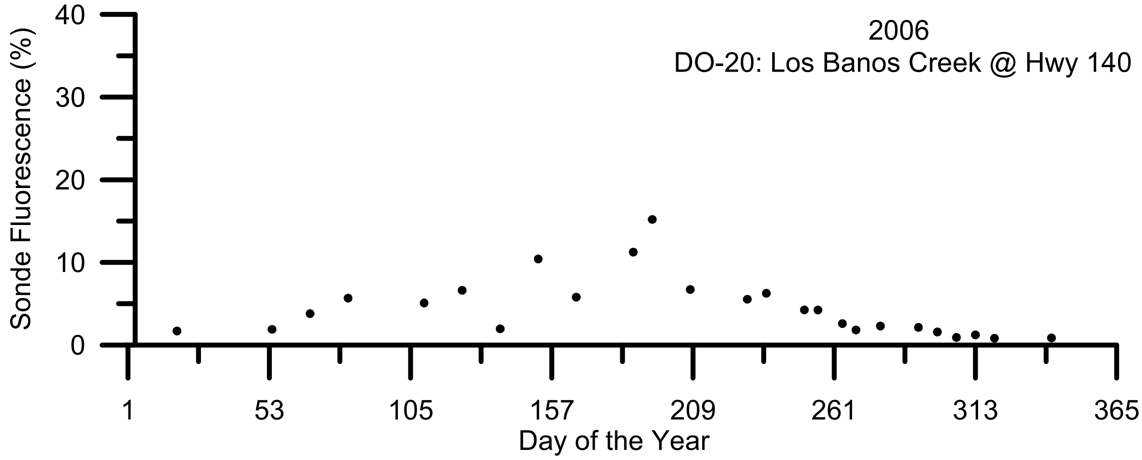

2007
DO-18: Mud Slough Near Gustine
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

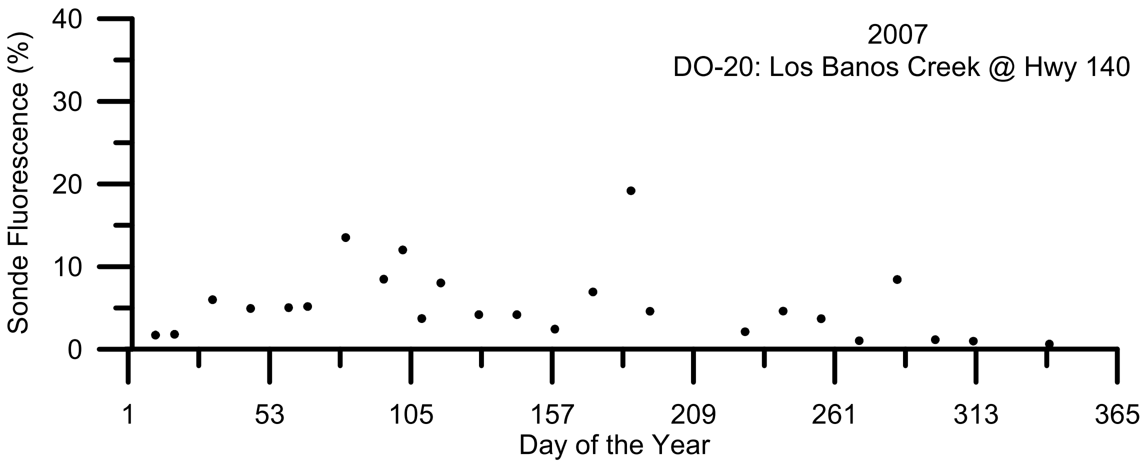

2005
DO-19: Salt Slough @ Lander Avenue
Sonde Fluorescence (%)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

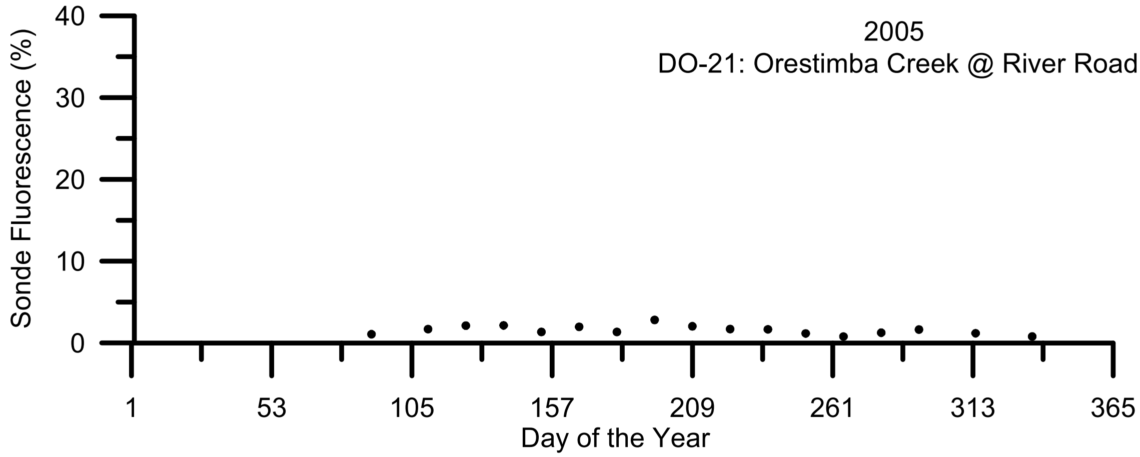

2006
DO-19: Salt Slough @ Lander Avenue
Sonde Fluorescence (%)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

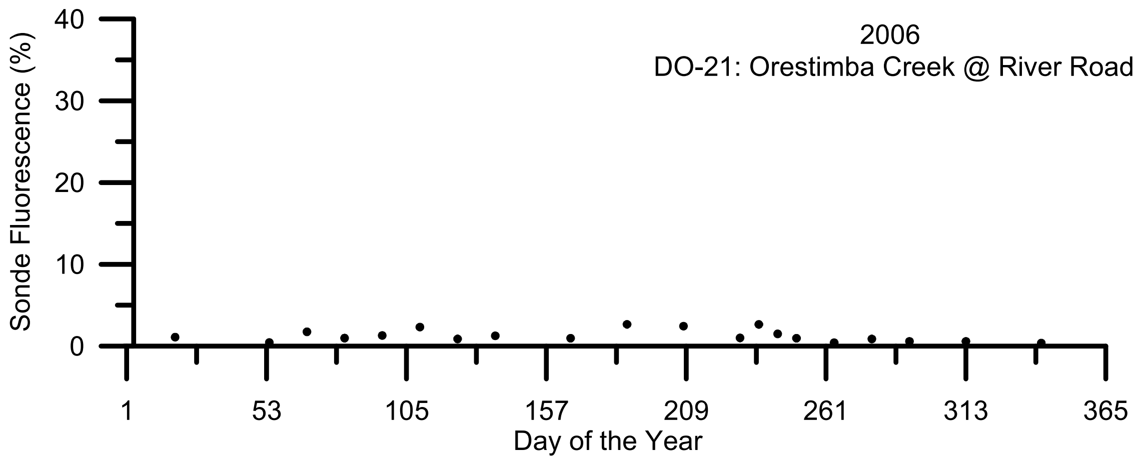

2007
DO-19: Salt Slough @ Lander Avenue
Sonde Fluorescence (%)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

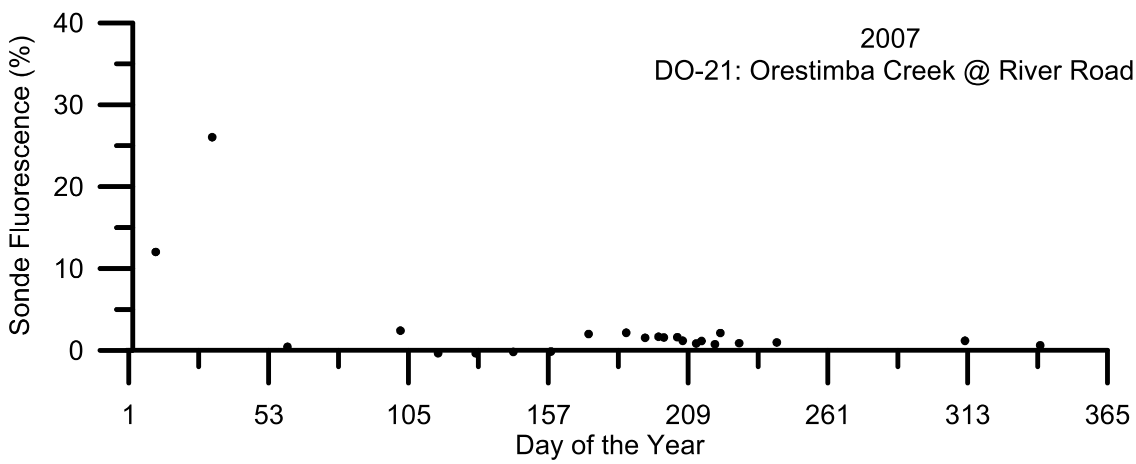

2005
DO-20: Los Banos Creek @ Hwy 140
Sonde Fluorescence (%)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

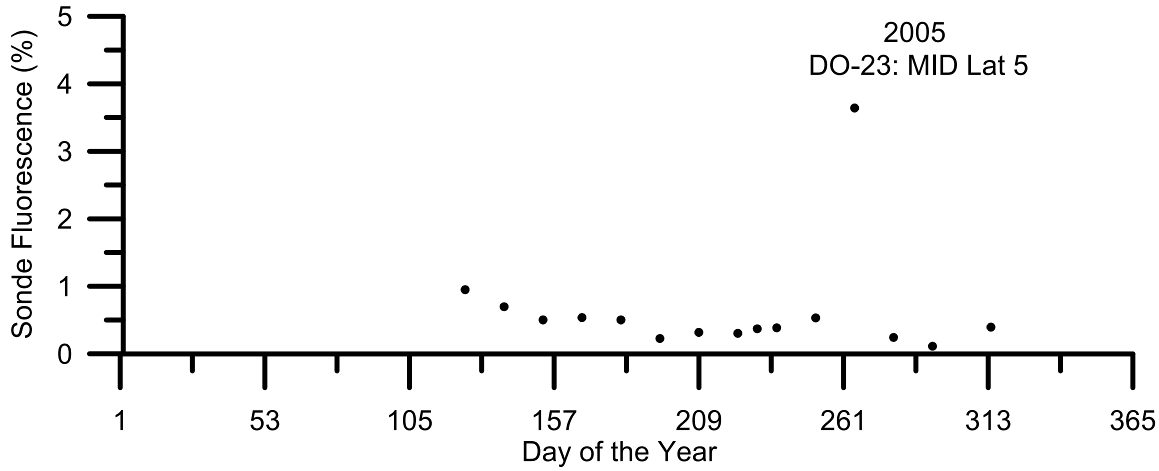

2006
DO-20: Los Banos Creek @ Hwy 140
Sonde Fluorescence (%)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

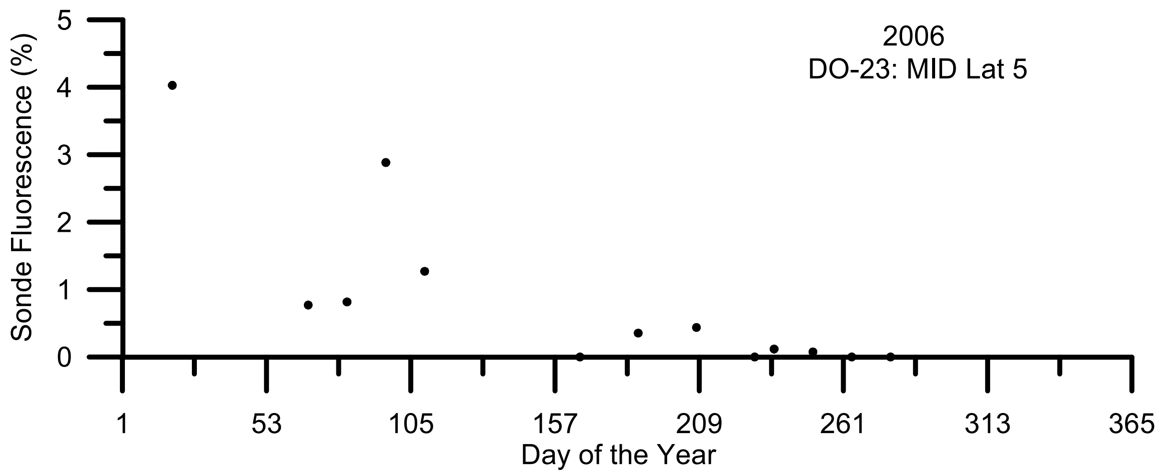

2007
DO-20: Los Banos Creek @ Hwy 140
Sonde Fluorescence (%)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

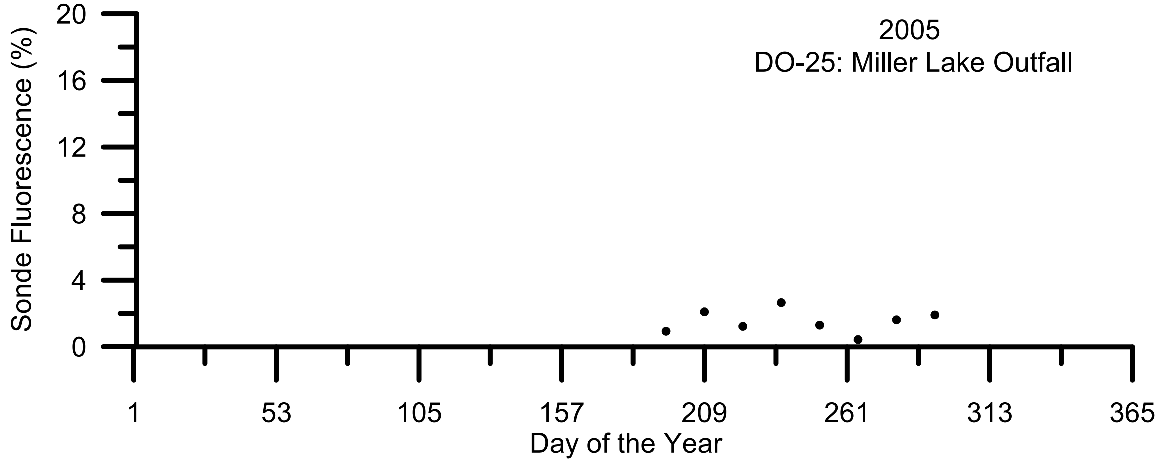

2005
DO-21: Orestimba Creek @ River Road
Sonde Fluorescence (%)
Day of the Year

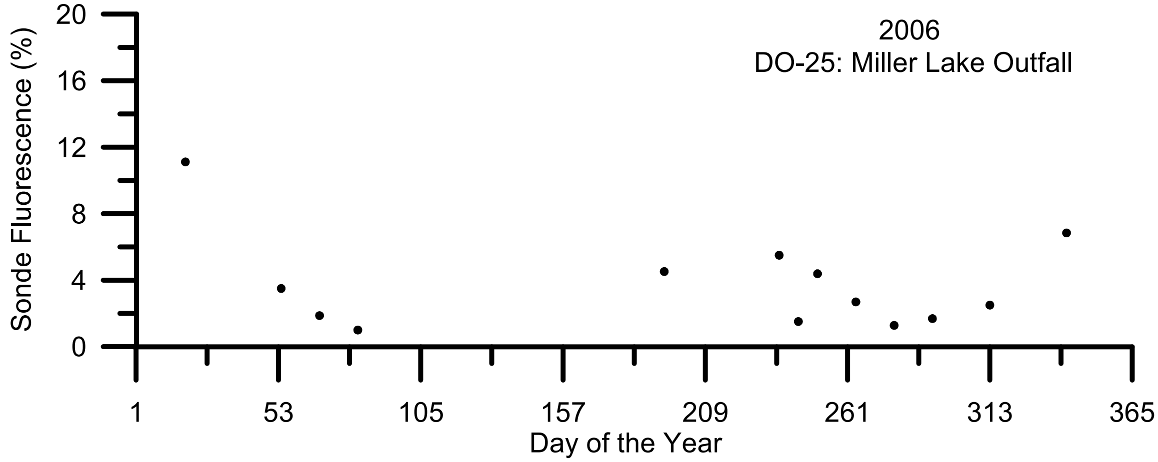

2006
DO-21: Orestimba Creek @ River Road
Sonde Fluorescence (%)
Day of the Year

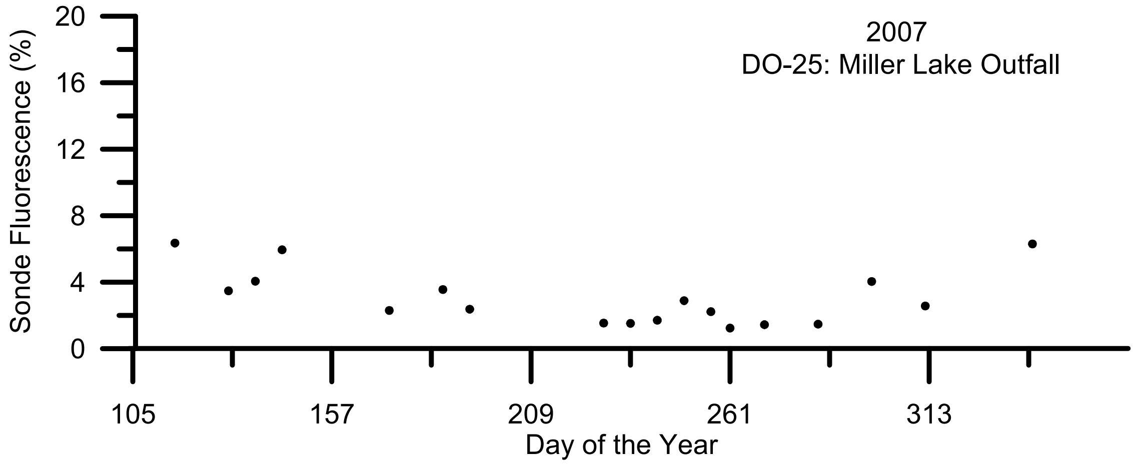

2007
DO-21: Orestimba Creek @ River Road
Sonde Fluorescence (%)
Day of the Year

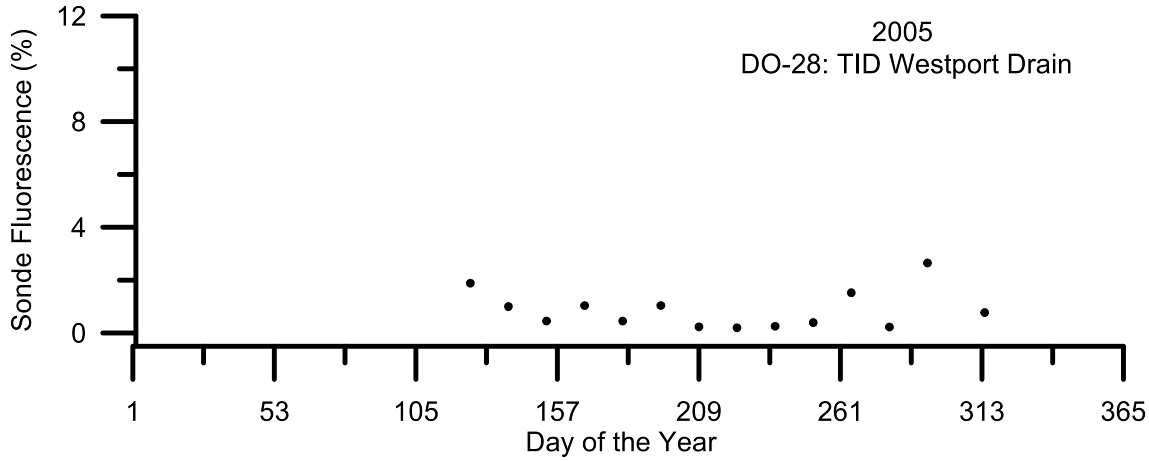

2005
DO-23: MID Lat 5
Sonde Fluorescence (%)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

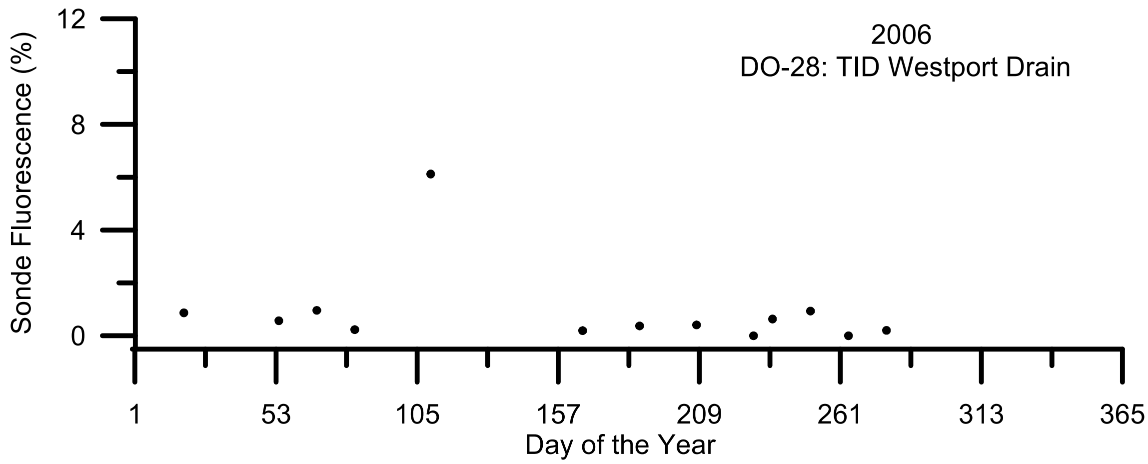

2006
DO-23: MID Lat 5
Sonde Fluorescence (%)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

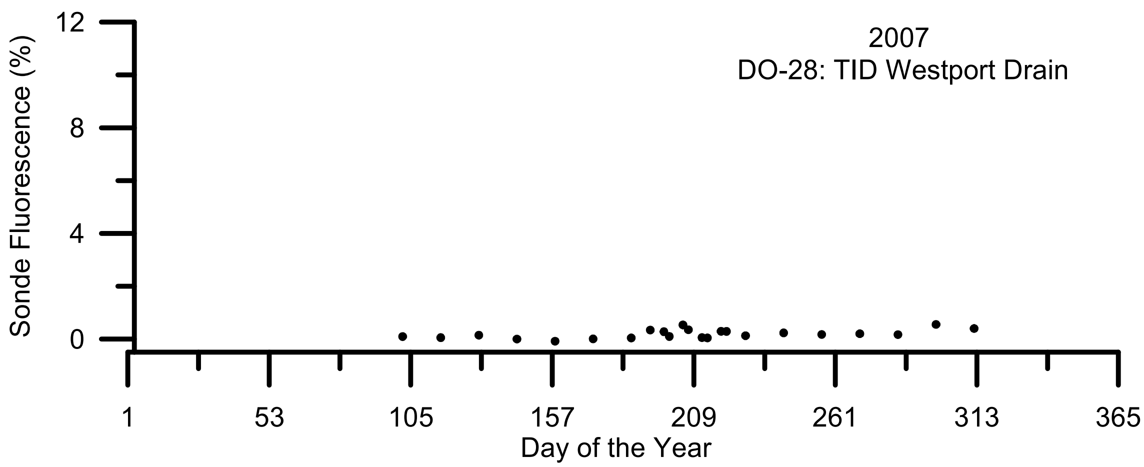

2005
DO-25: Miller Lake Outfall
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

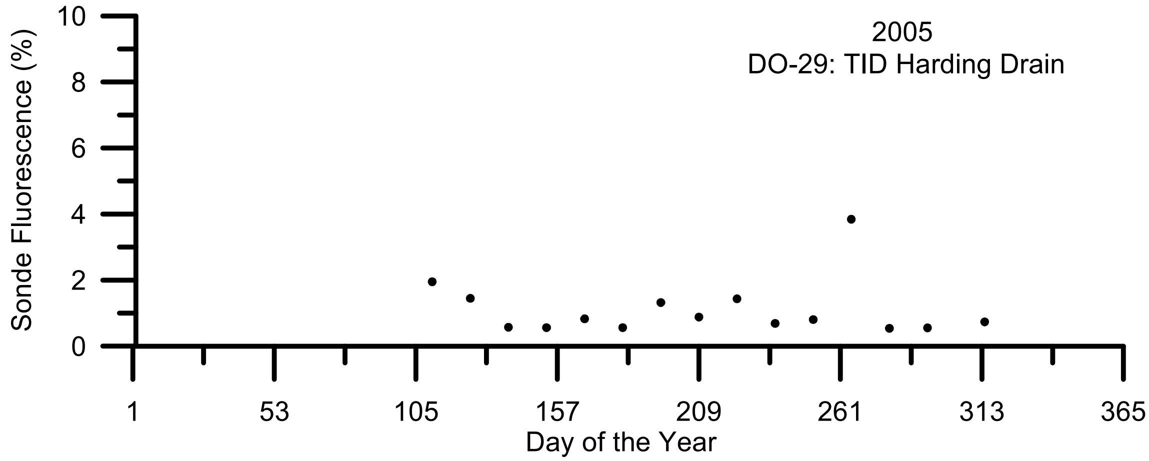

2006
DO-25: Miller Lake Outfall
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

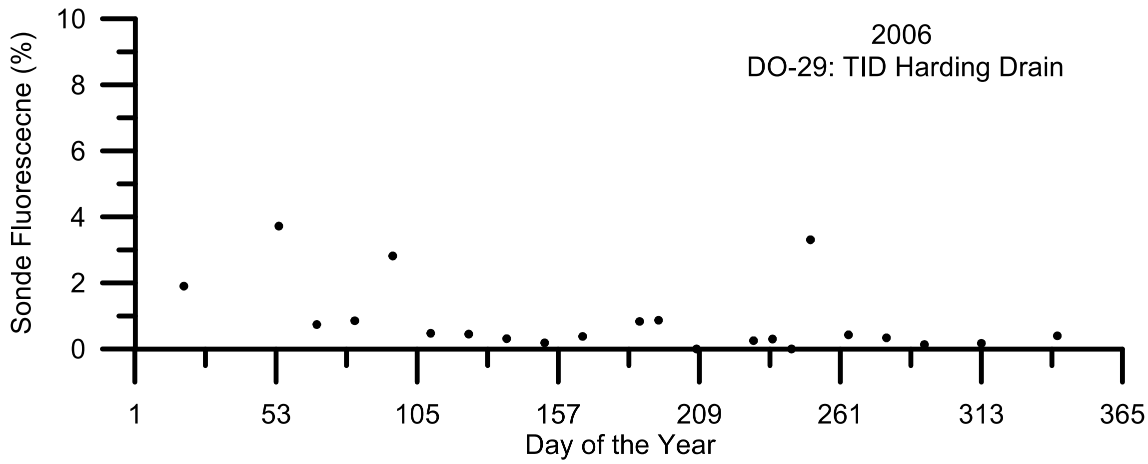

2007
DO-25: Miller Lake Outfall
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
105
157
209
261
313

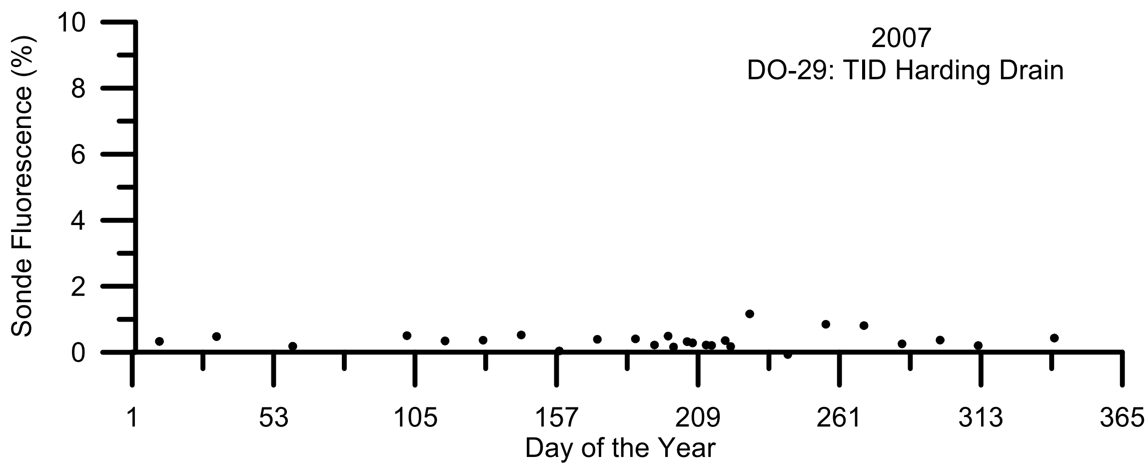

2005
DO-28: TID Westport Drain
Sonde Fluorescence (%)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

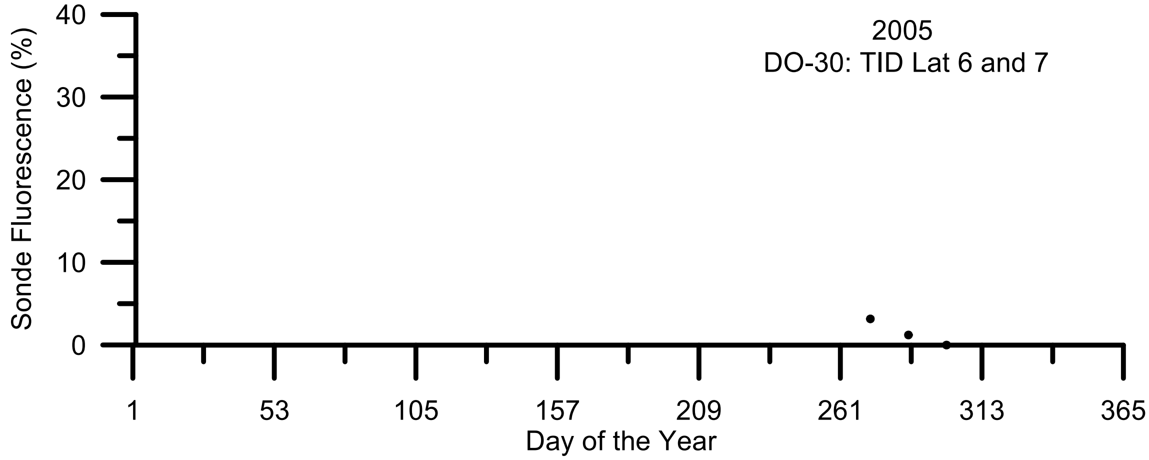

2006
DO-28: TID Westport Drain
Sonde Fluorescence (%)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

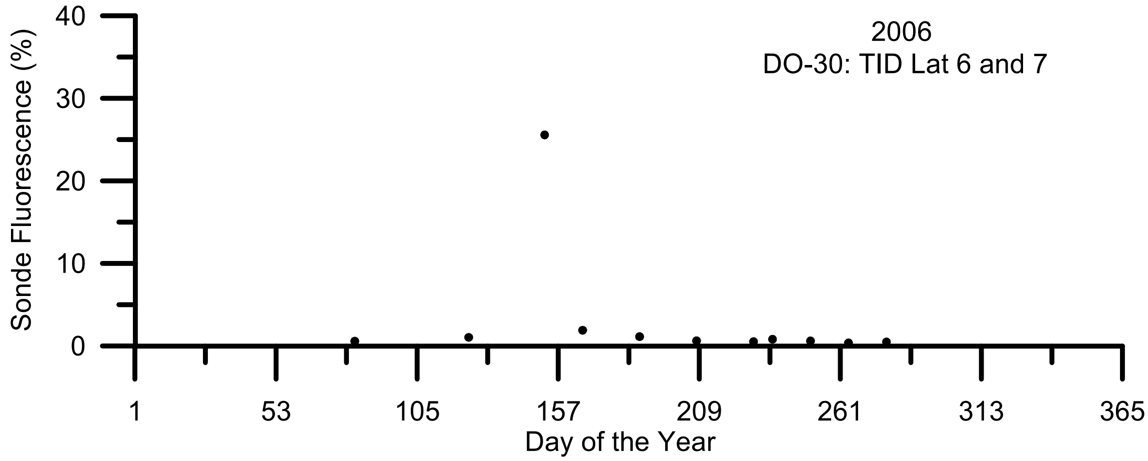

2007
DO-28: TID Westport Drain
Sonde Fluorescence (%)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

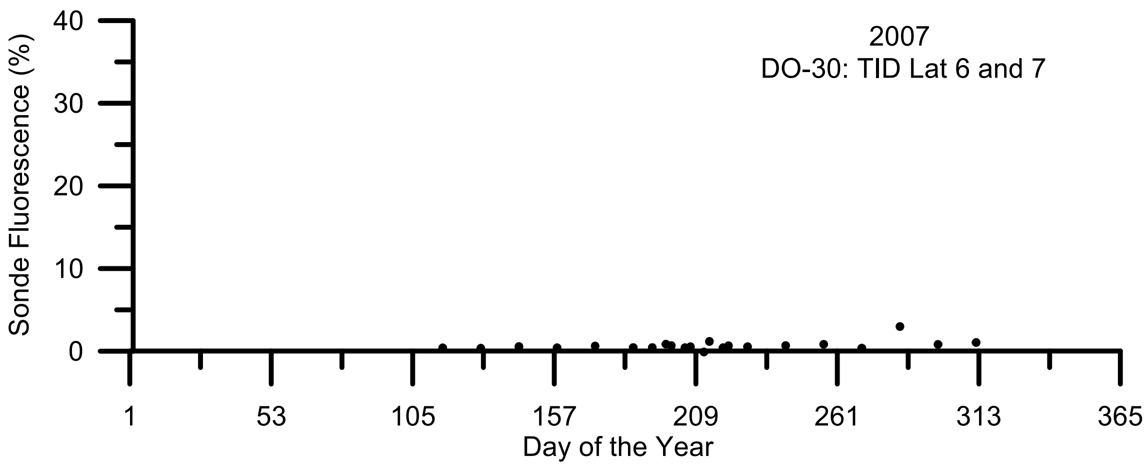

2005
DO-29: TID Harding Drain
Sonde Fluorescence (%)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

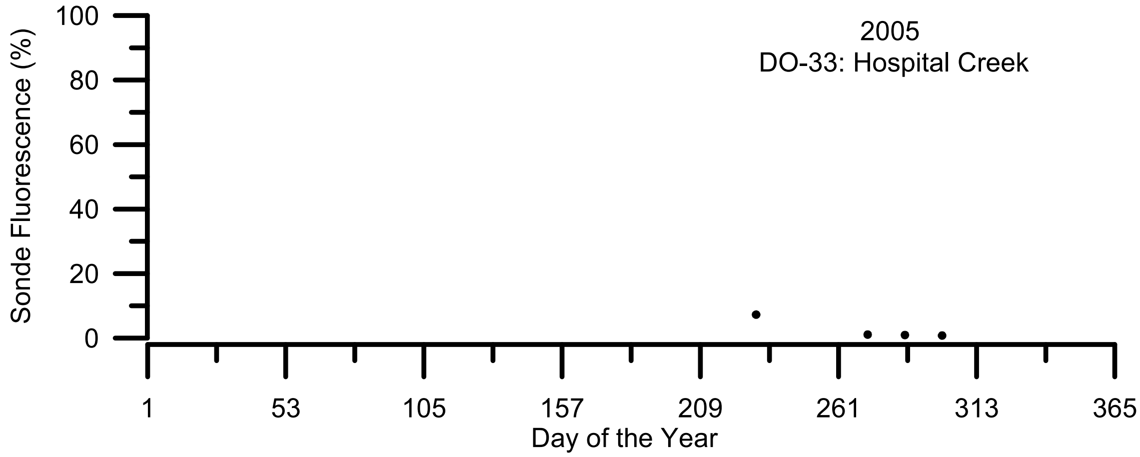

2006
DO-29: TID Harding Drain
Sonde Fluorescecne (%)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

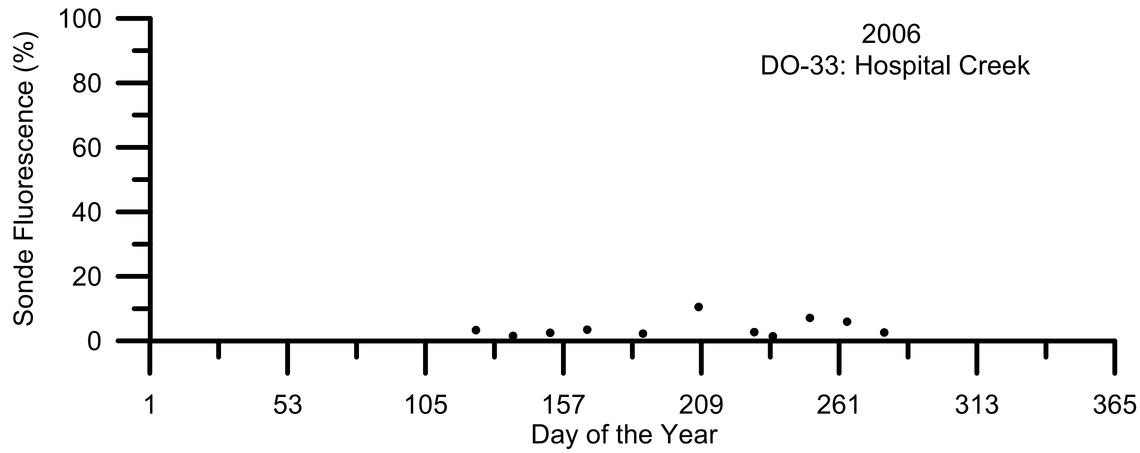

2007
DO-29: TID Harding Drain
Sonde Fluorescence (%)
10
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

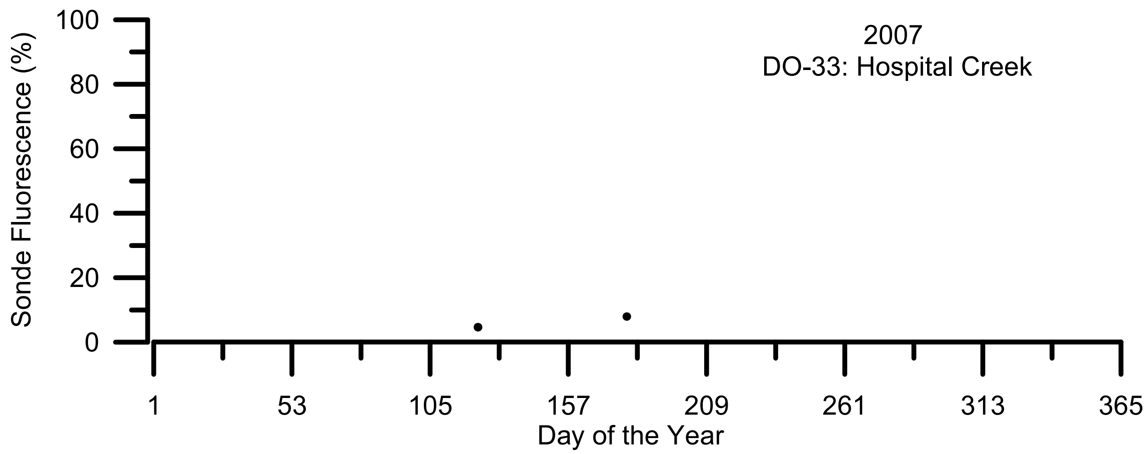

2005
DO-30: TID Lat 6 and 7
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

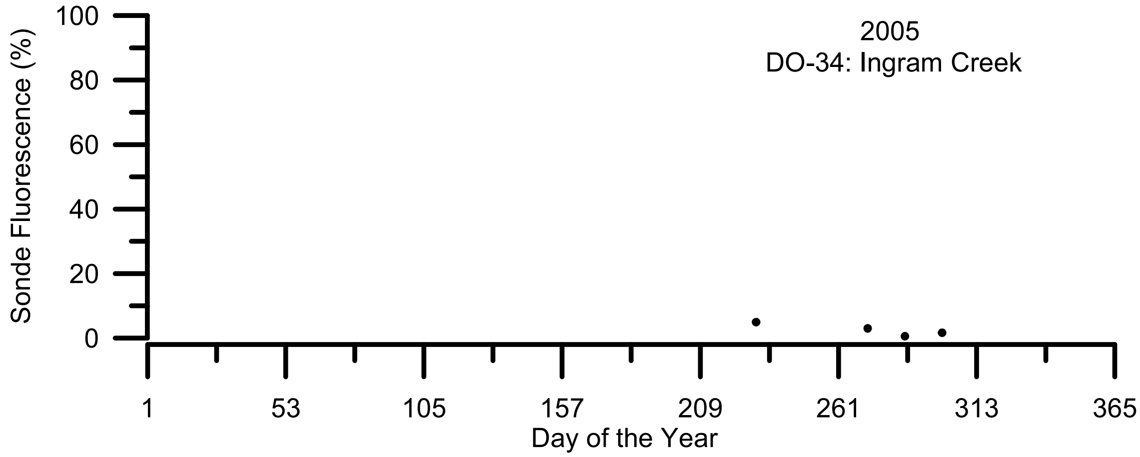

2006
DO-30: TID Lat 6 and 7
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

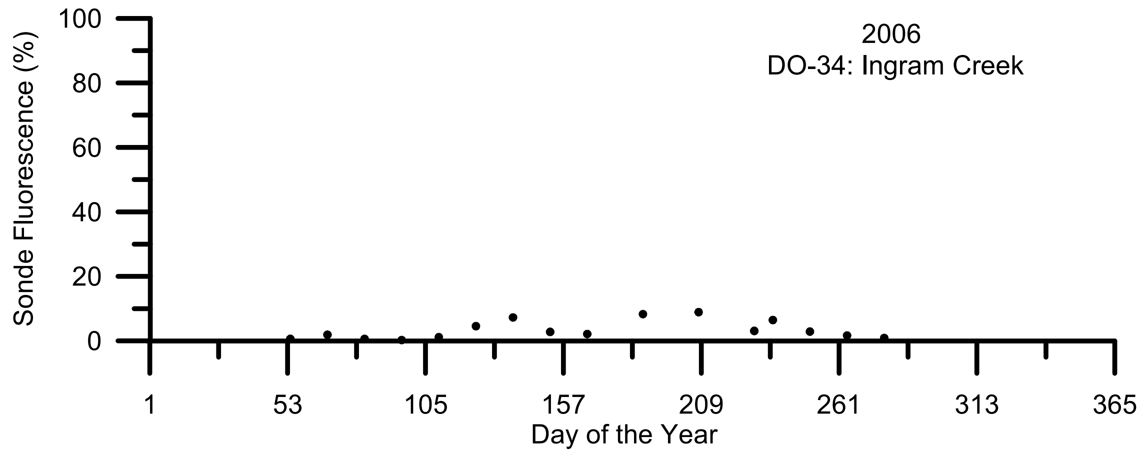

2007
DO-30: TID Lat 6 and 7
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

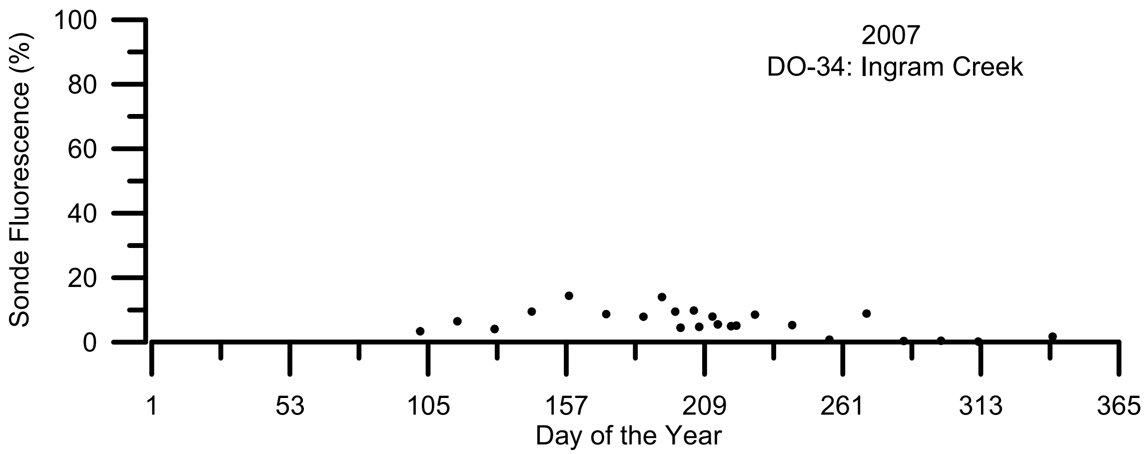

2005
DO-33: Hospital Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

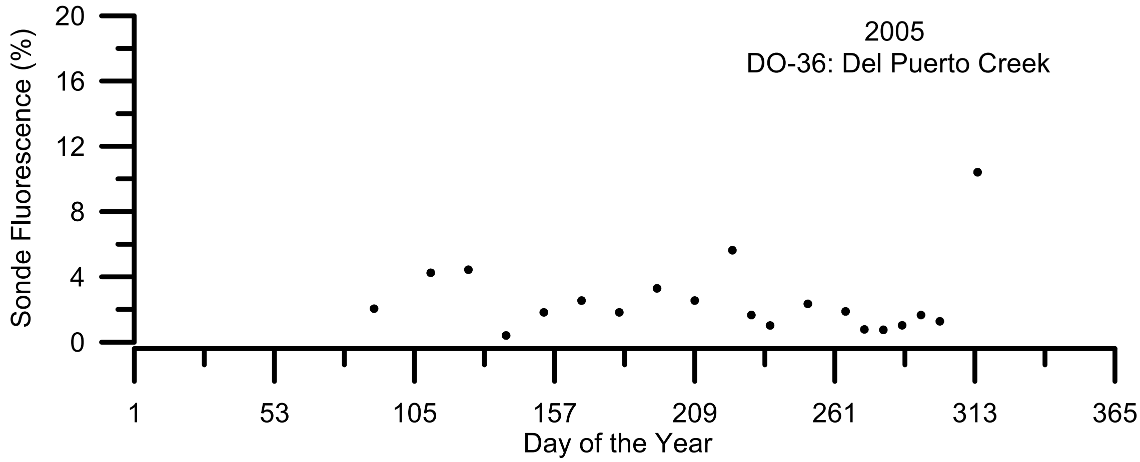

2006
DO-33: Hospital Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

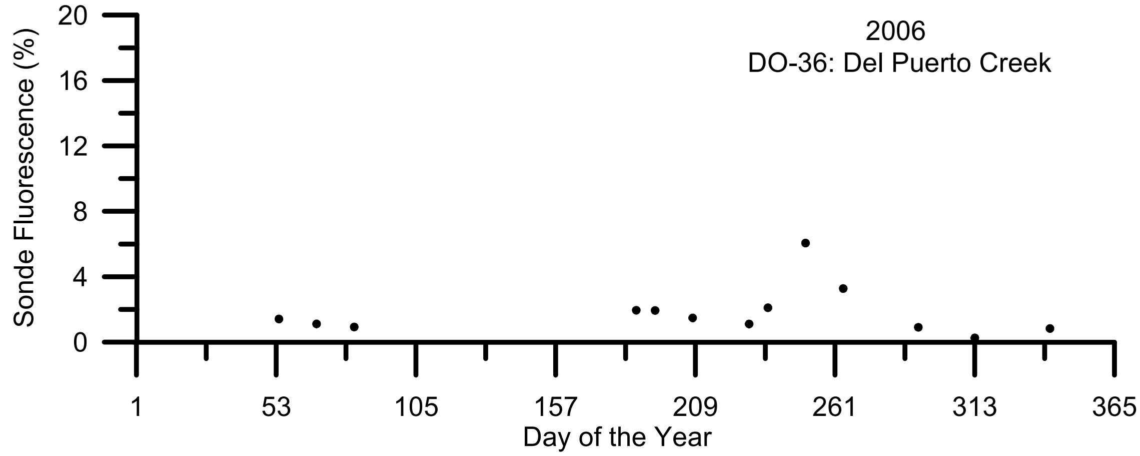

2007
DO-33: Hospital Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

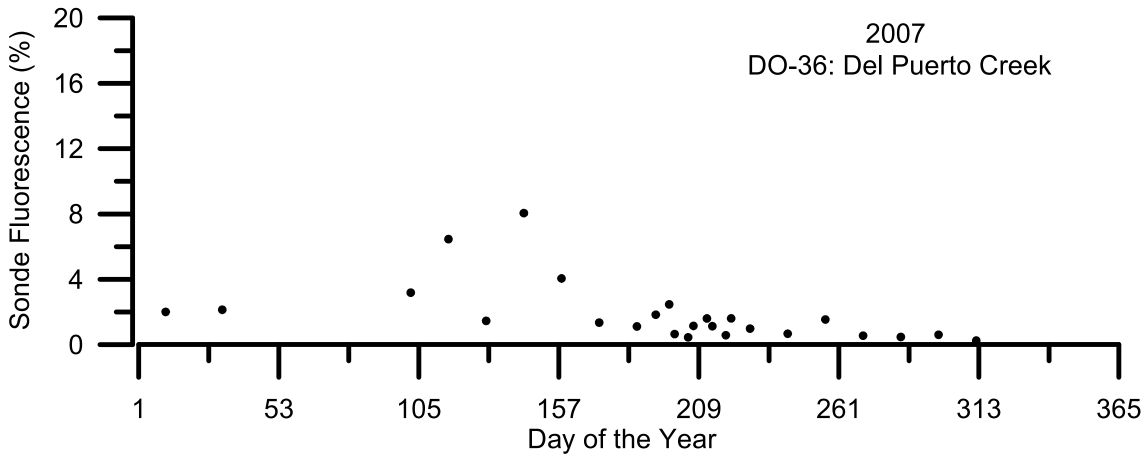

2005
DO-34: Ingram Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

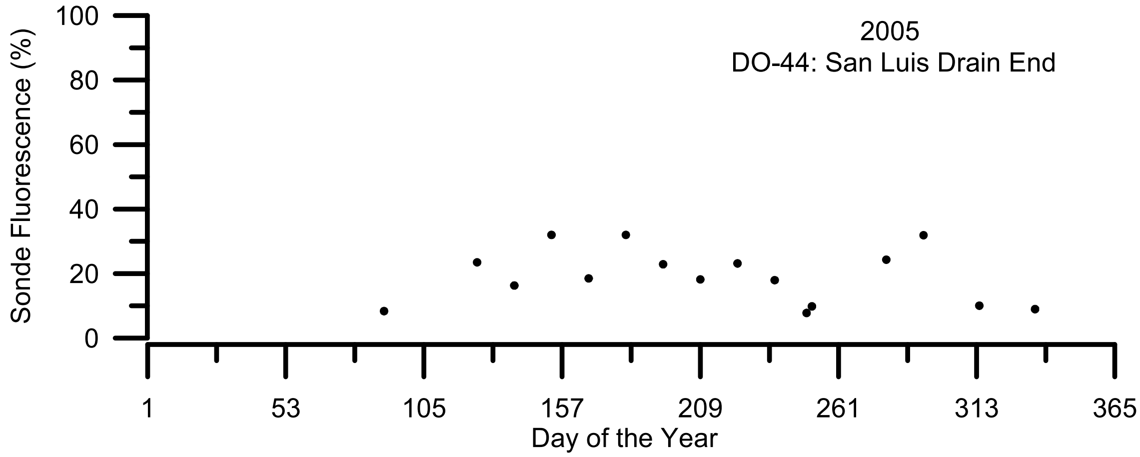

2006
DO-34: Ingram Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

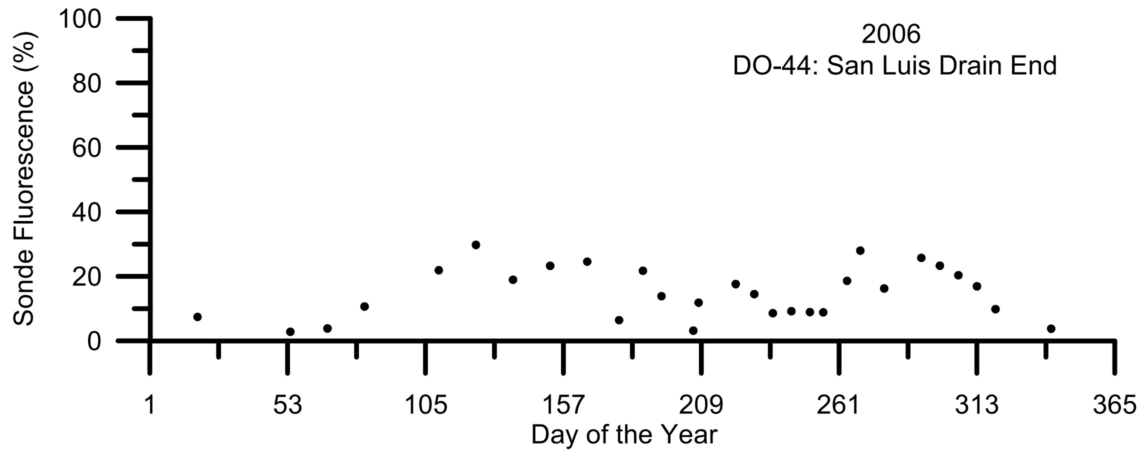

2007
DO-34: Ingram Creek
Sonde Fluorescence (%)
100
80
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

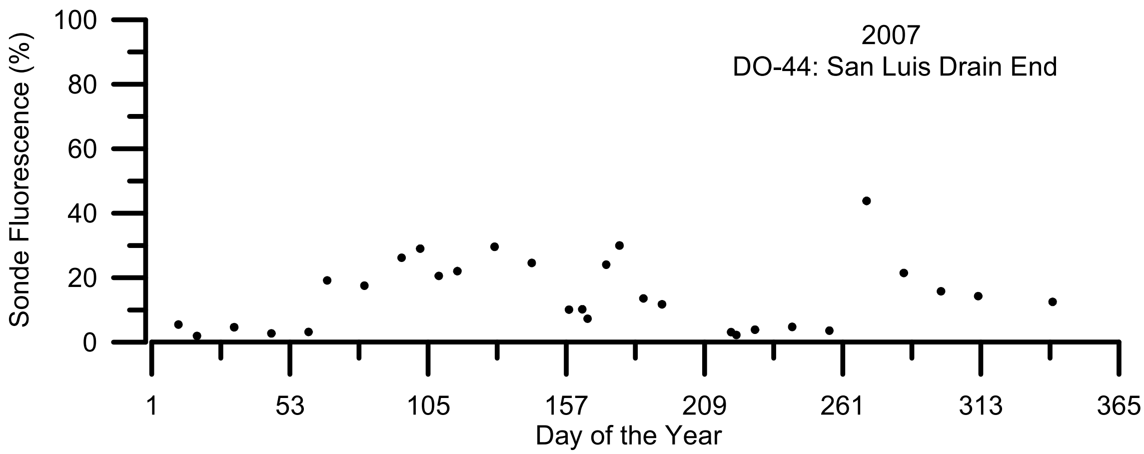

2005
DO-36: Del Puerto Creek
Sonde Fluorescence (%)
Day of the Year

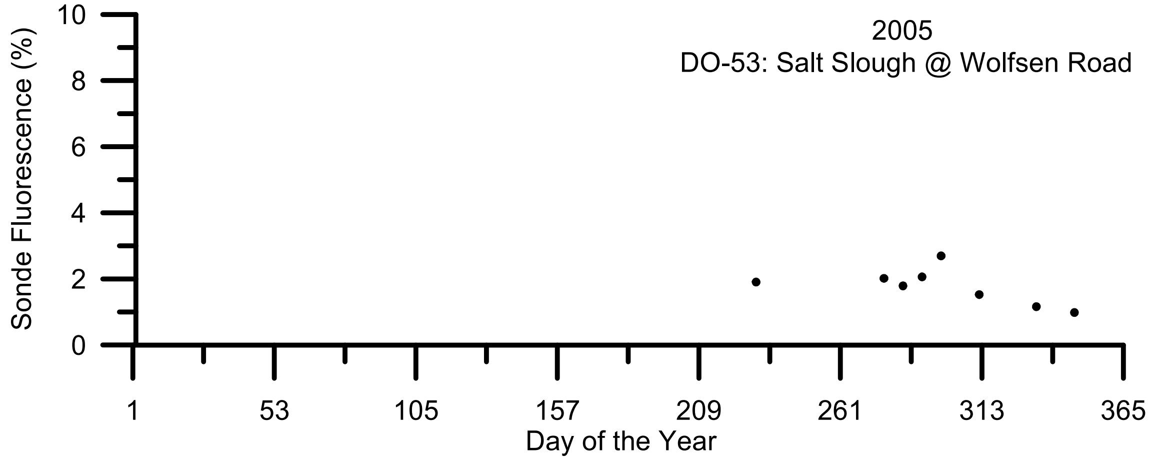

2006
DO-36: Del Puerto Creek
Sonde Fluorescence (%)
Day of the Year

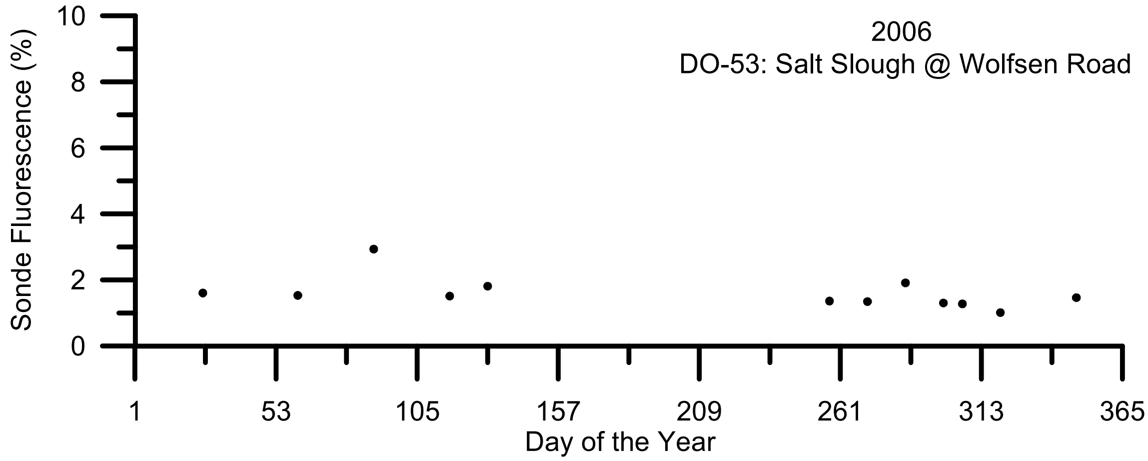

2007
DO-36: Del Puerto Creek
Sonde Fluorescence (%)
Day of the Year

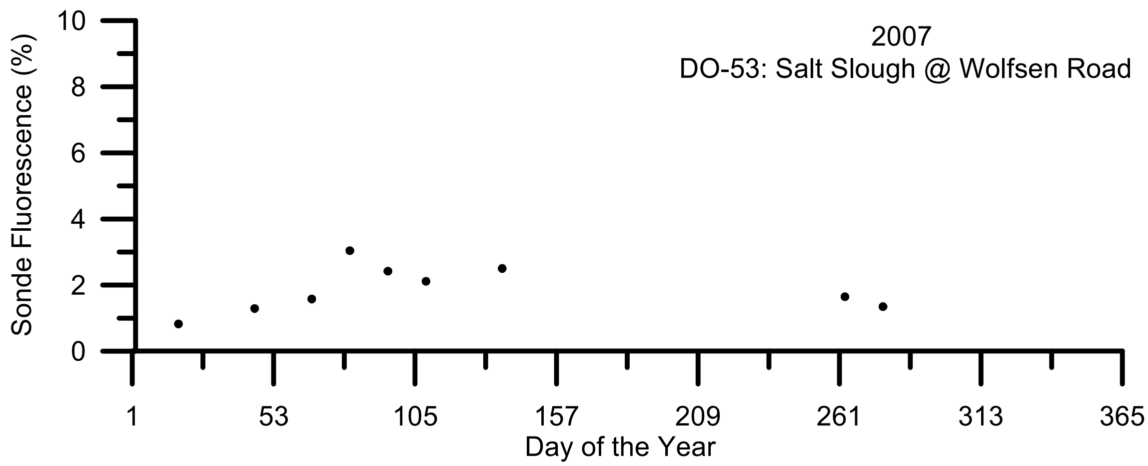

2005
DO-44: San Luis Drain End
Sonde Fluorescence (%)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

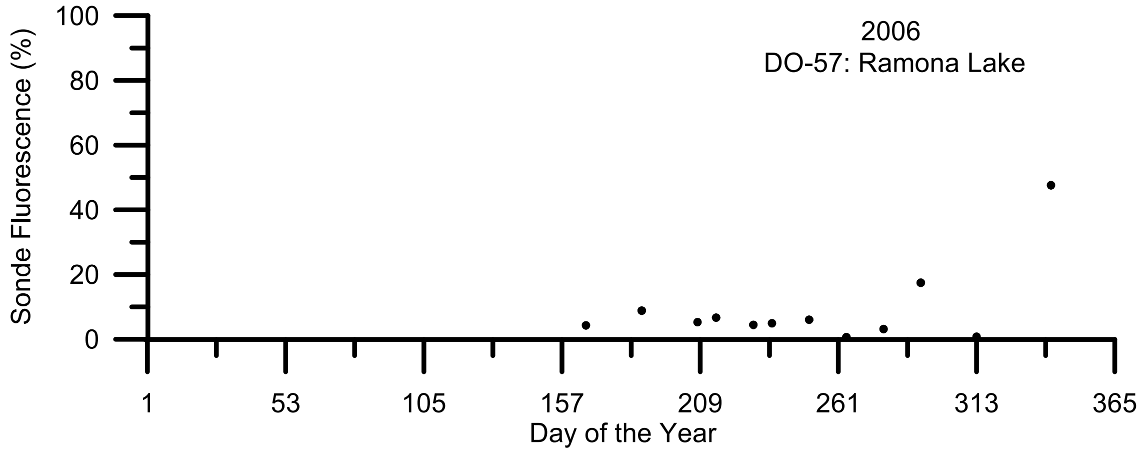

2006
DO-44: San Luis Drain End
Sonde Fluorescence (%)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

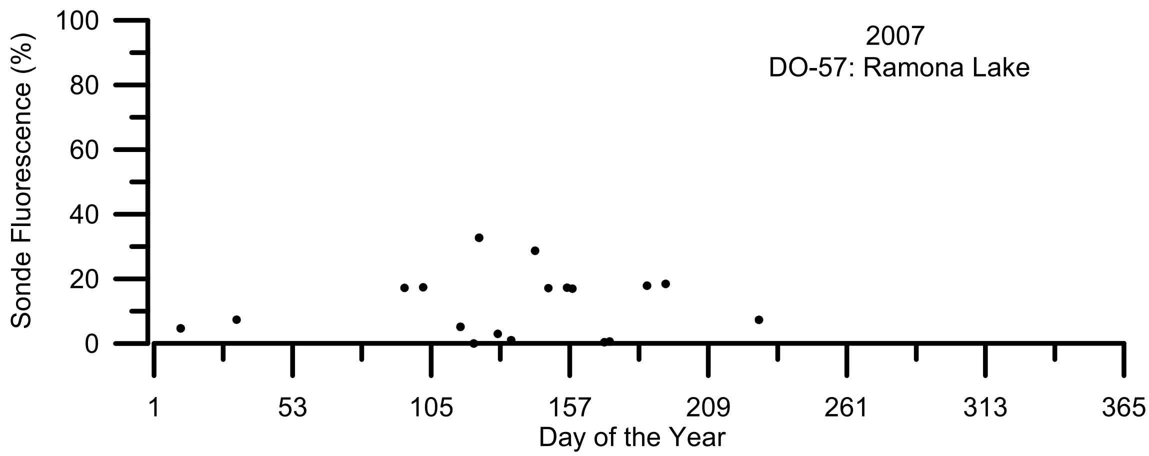

2007
DO-44: San Luis Drain End
Sonde Fluorescence (%)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

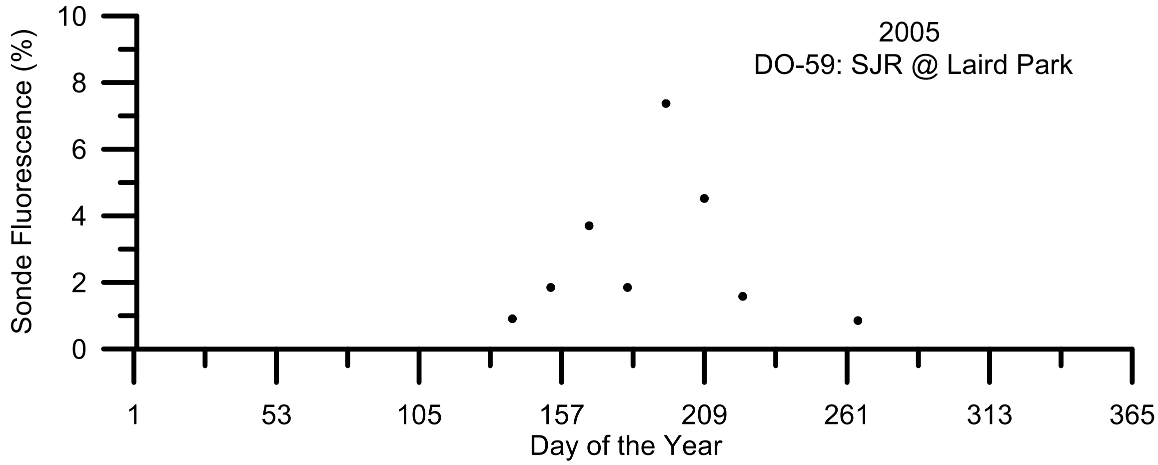

2005
DO-53: Salt Slough @ Wolfsen Road
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-53: Salt Slough @ Wolfsen Road
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

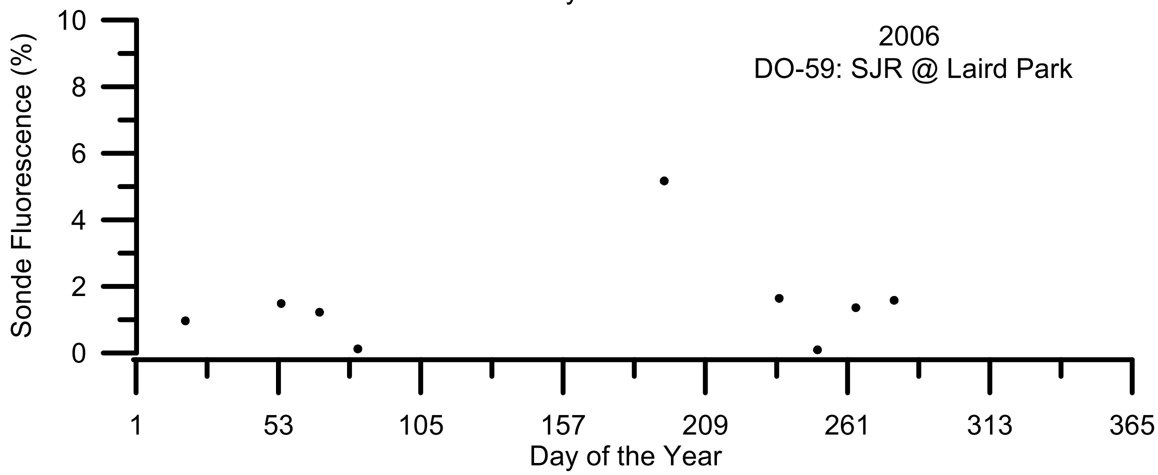

2007
DO-53: Salt Slough @ Wolfsen Road
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-57: Ramona Lake
Sonde Fluorescence (%)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

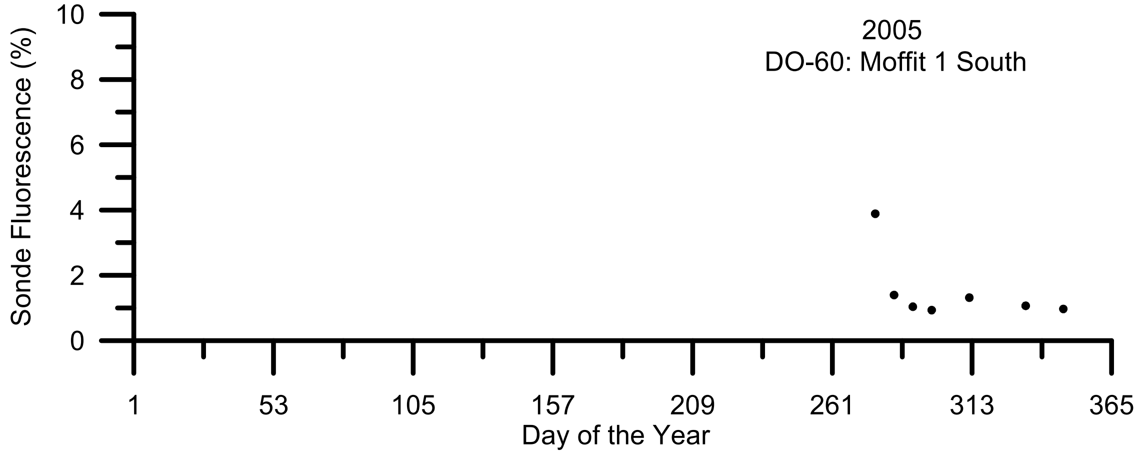

2007
DO-57: Ramona Lake
Sonde Fluorescence (%)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

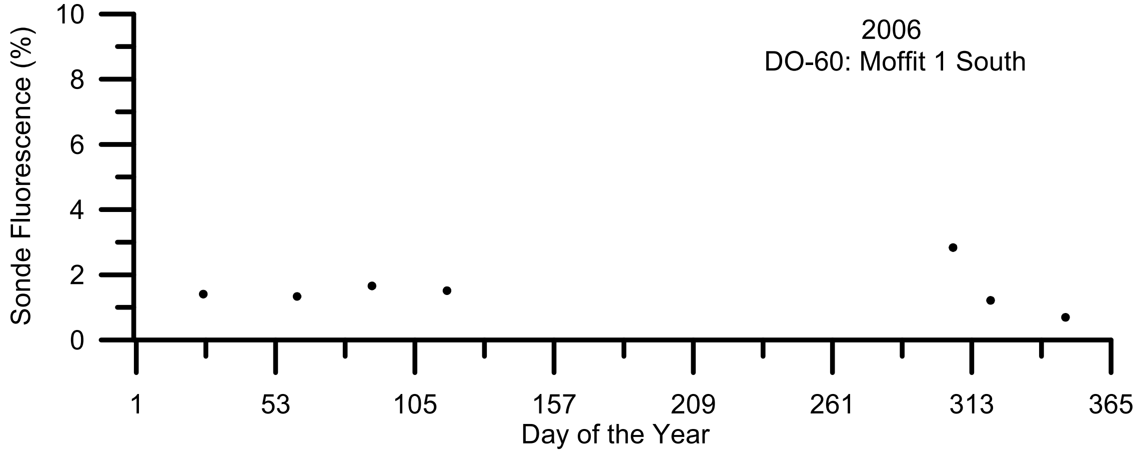


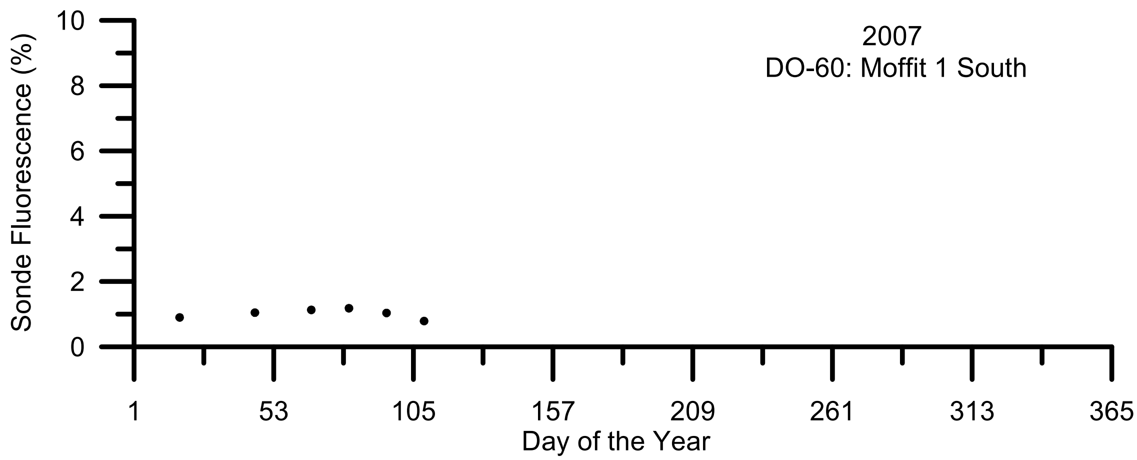
2005
DO-59: SJR @ Laird Park
Sonde Fluorescence (%)
Day of the Year

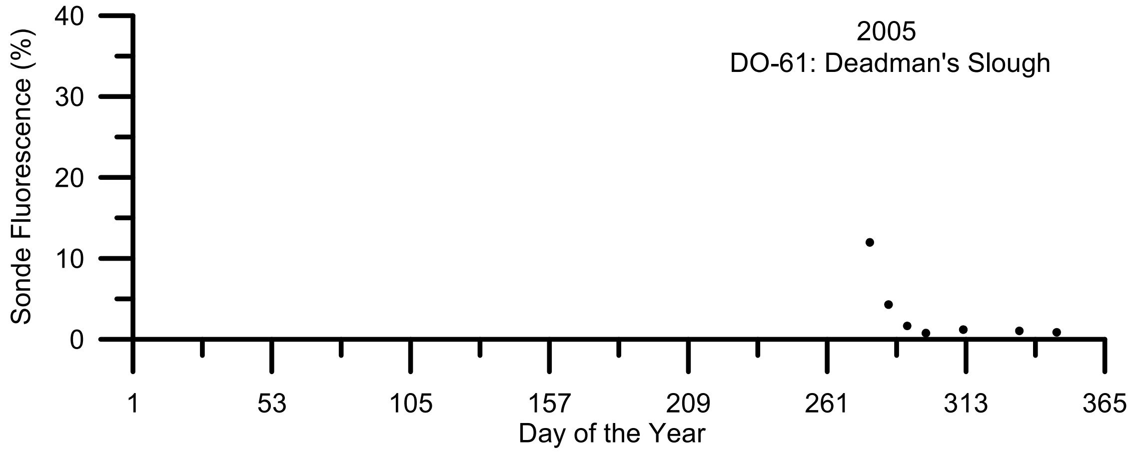


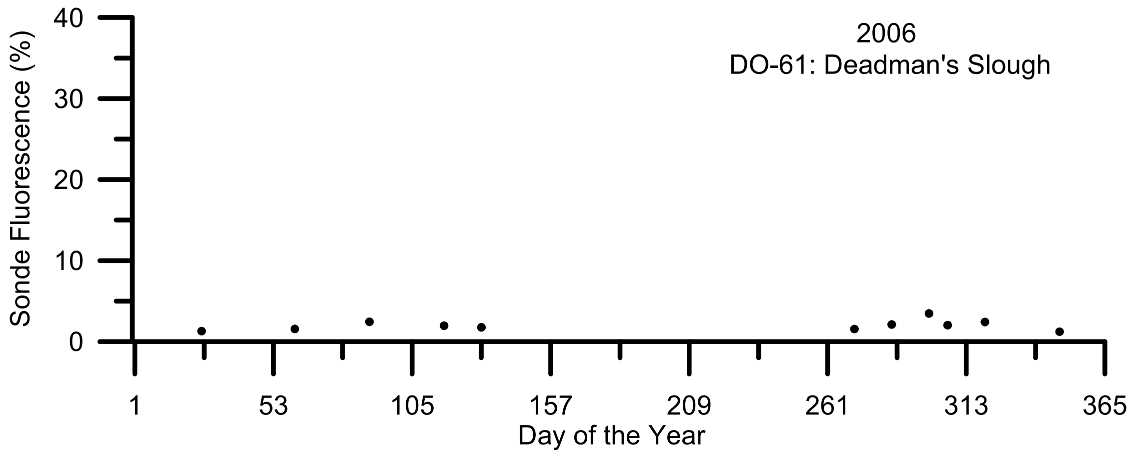
2006
DO-59: SJR @ Laird Park
Sonde Fluorescence (%)
Day of the Year

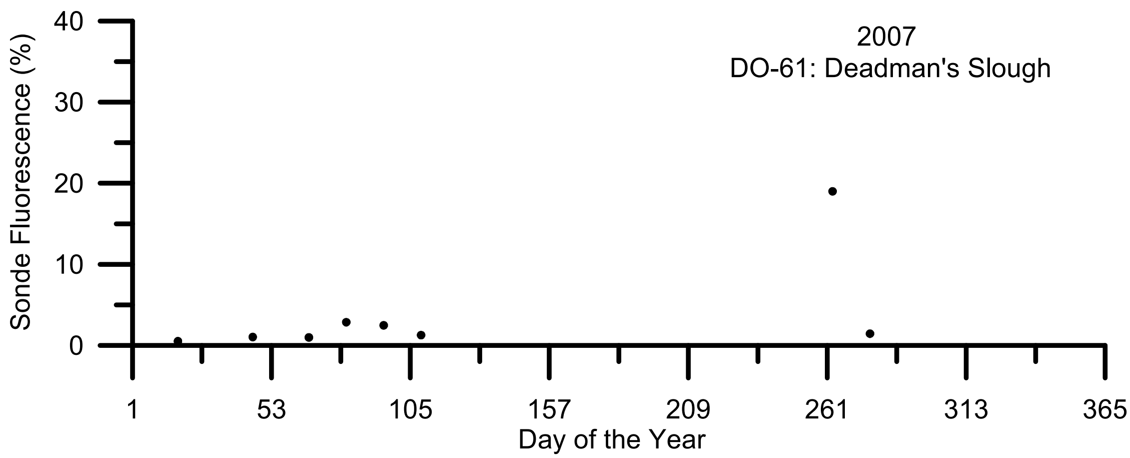

2005
DO-60: Moffit 1 South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

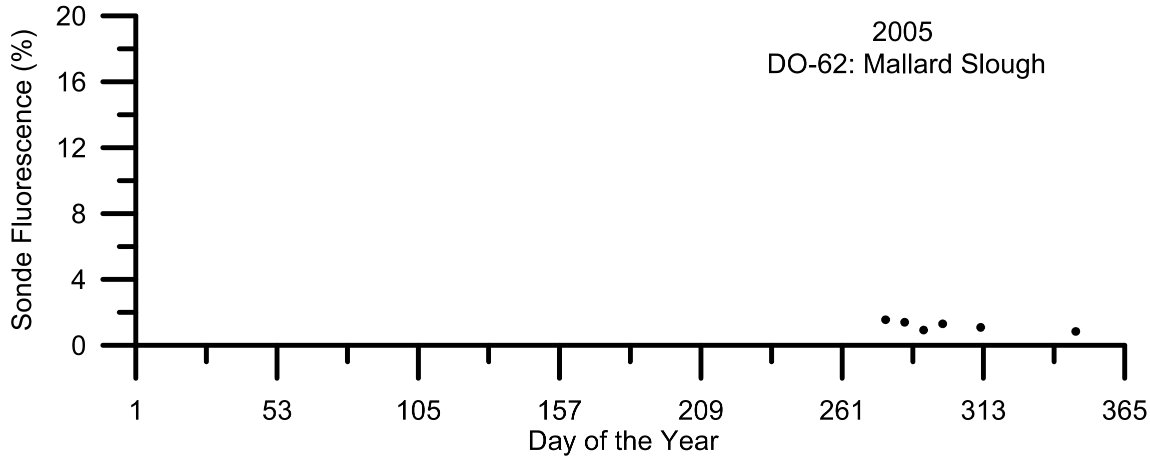

2006
DO-60: Moffit 1 South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

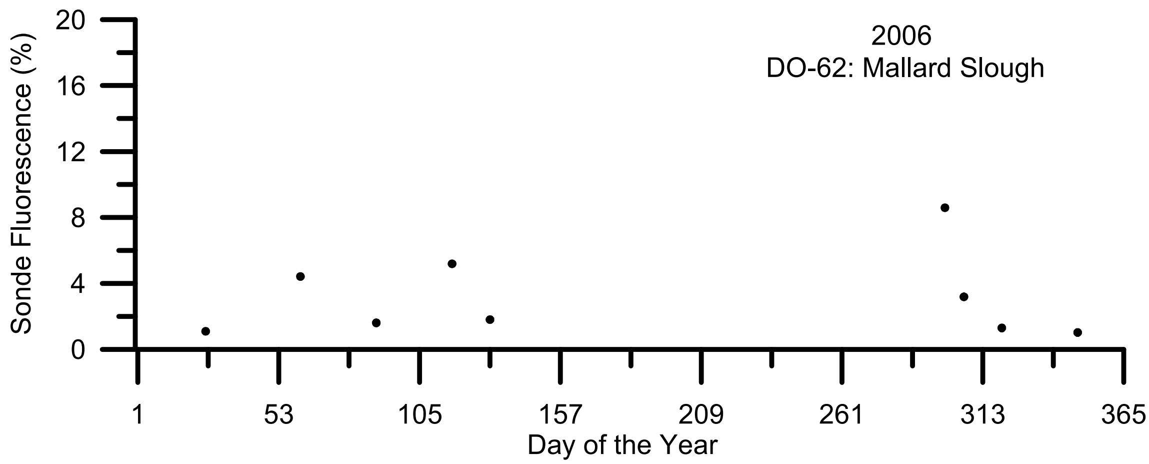

2007
DO-60: Moffit 1 South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

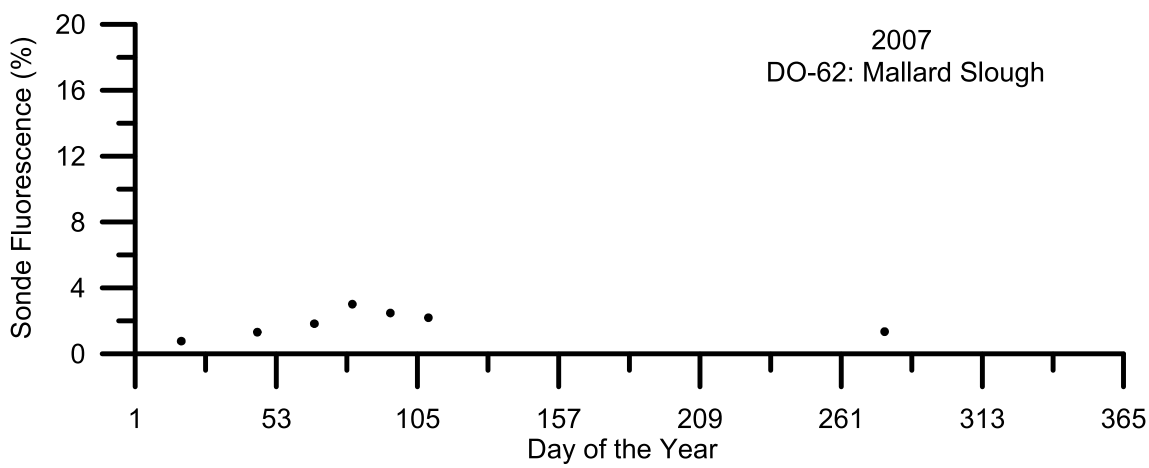

2005
DO-61: Deadman's Slough
Sonde Fluorescence (%)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

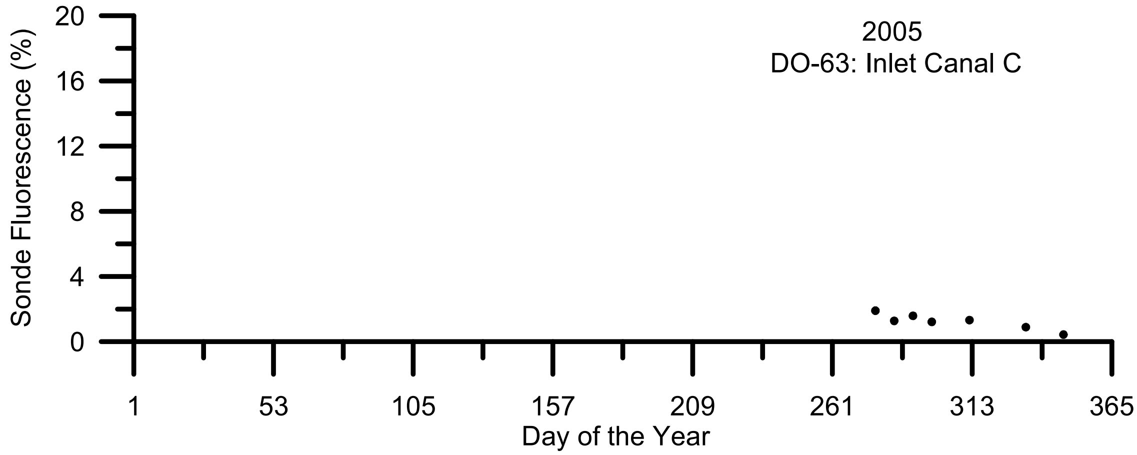

2006
DO-61: Deadman's Slough
Sonde Fluorescence (%)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

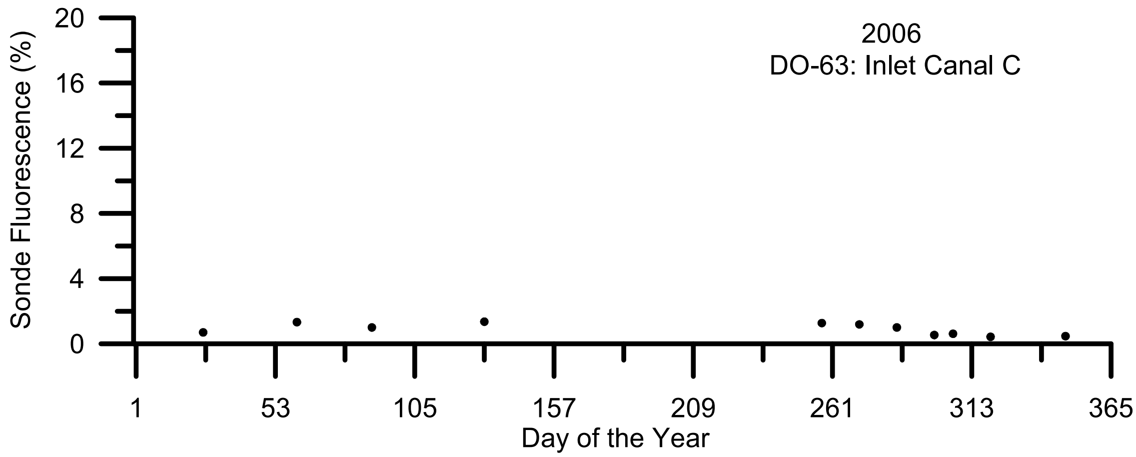

2007
DO-61: Deadman's Slough
Sonde Fluorescence (%)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

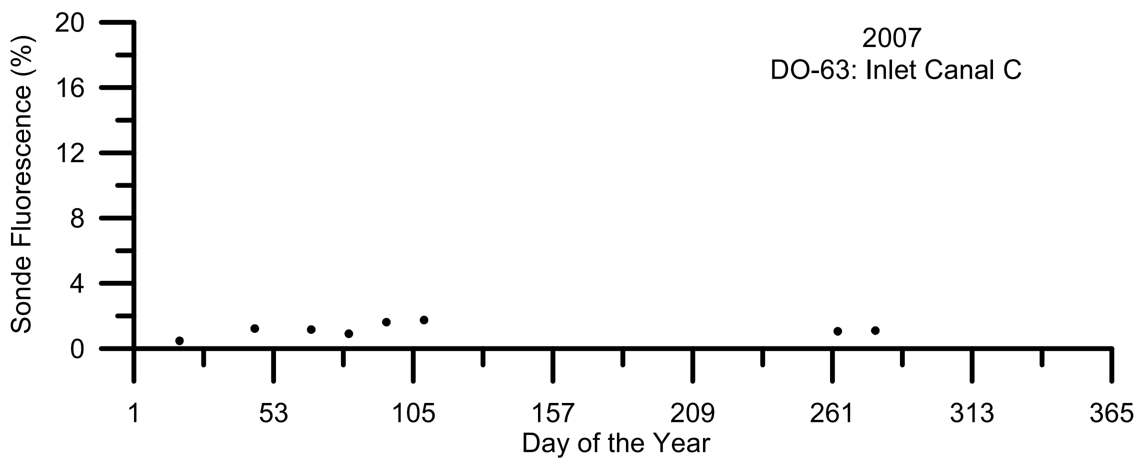

2005
DO-62: Mallard Slough
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

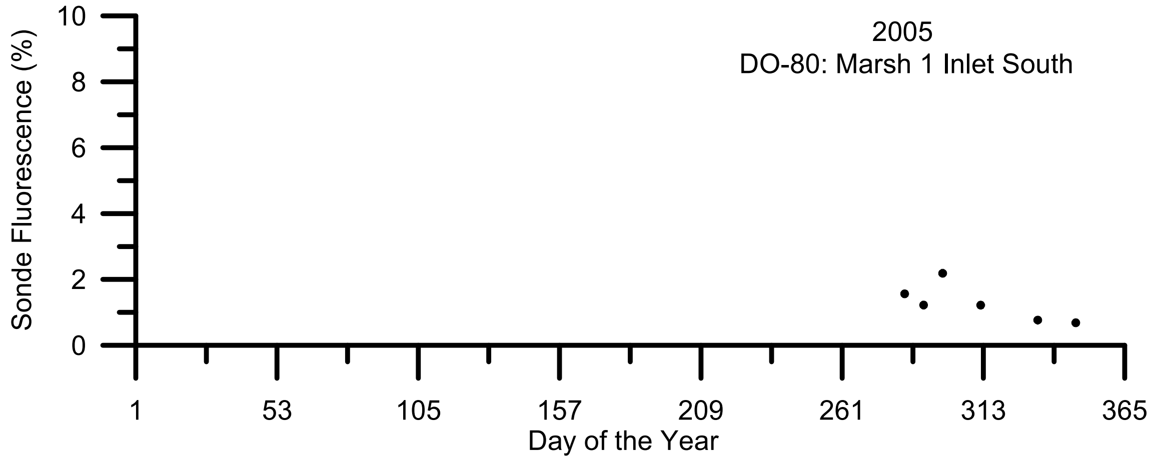

2006
DO-62: Mallard Slough
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

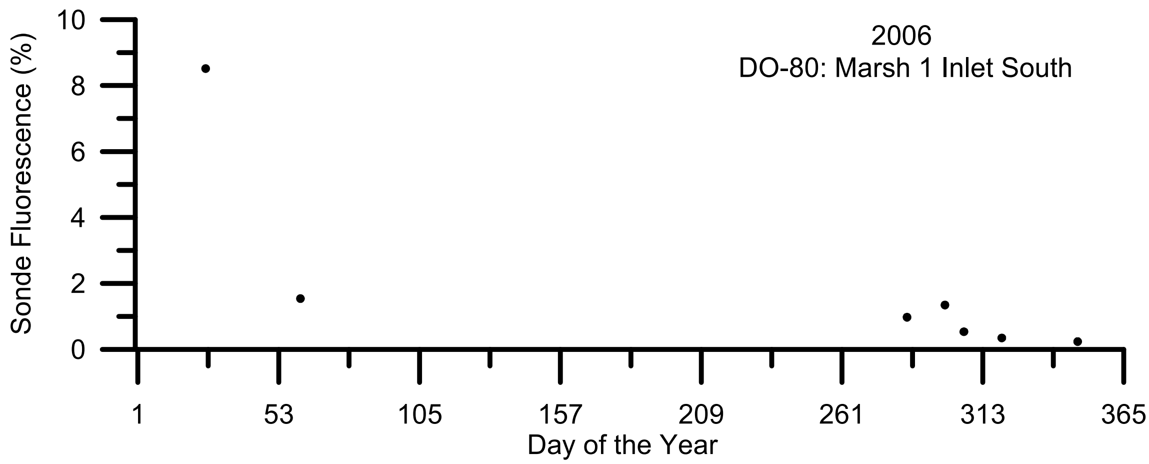

2007
DO-62: Mallard Slough
Sonde Fluorescence (%)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

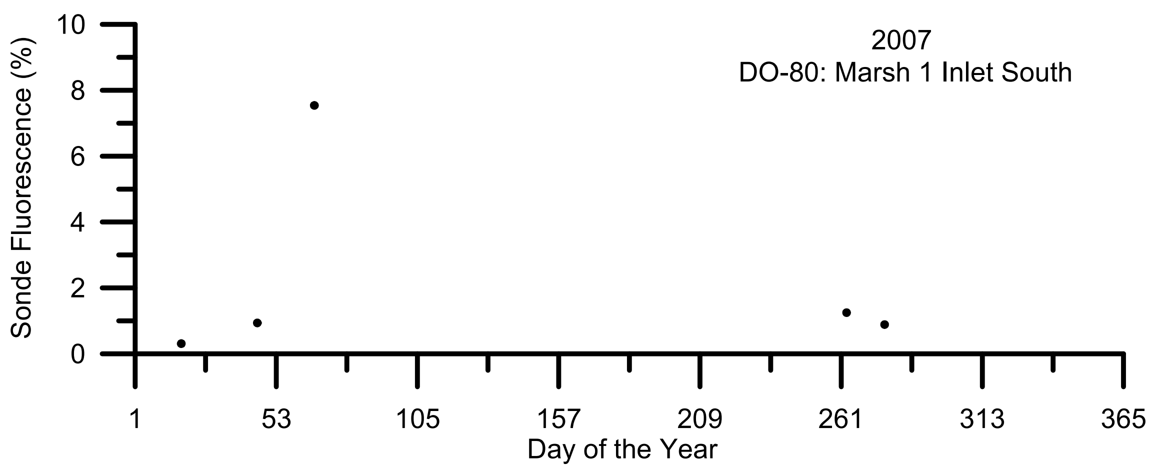

2005
DO-63: Inlet Canal C
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

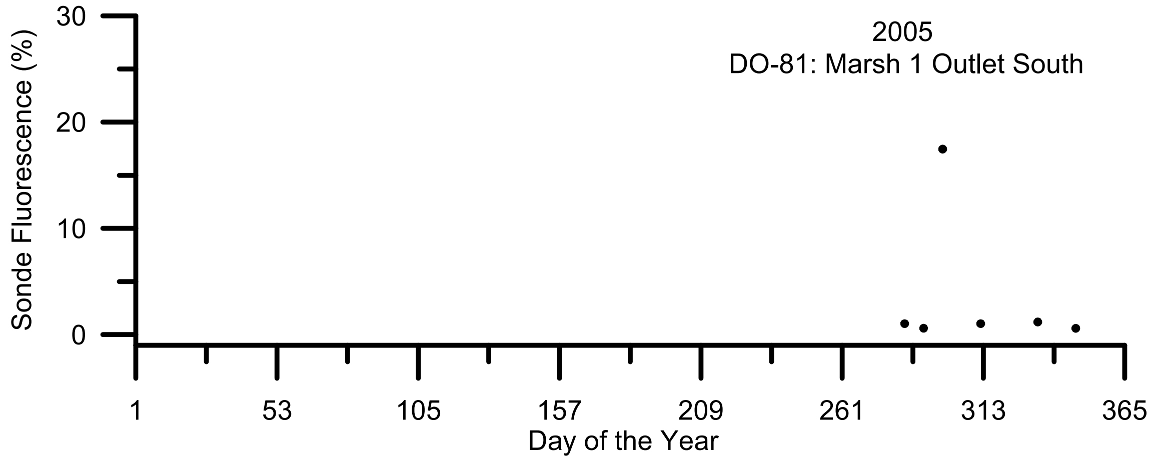

2006
DO-63: Inlet Canal C
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

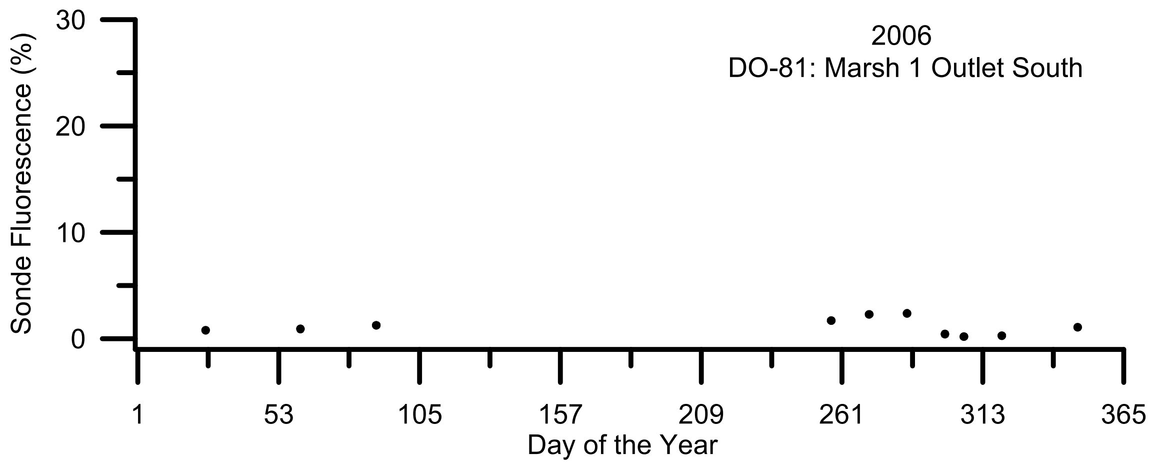

2007
DO-63: Inlet Canal C
Sonde Fluorescence (%)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

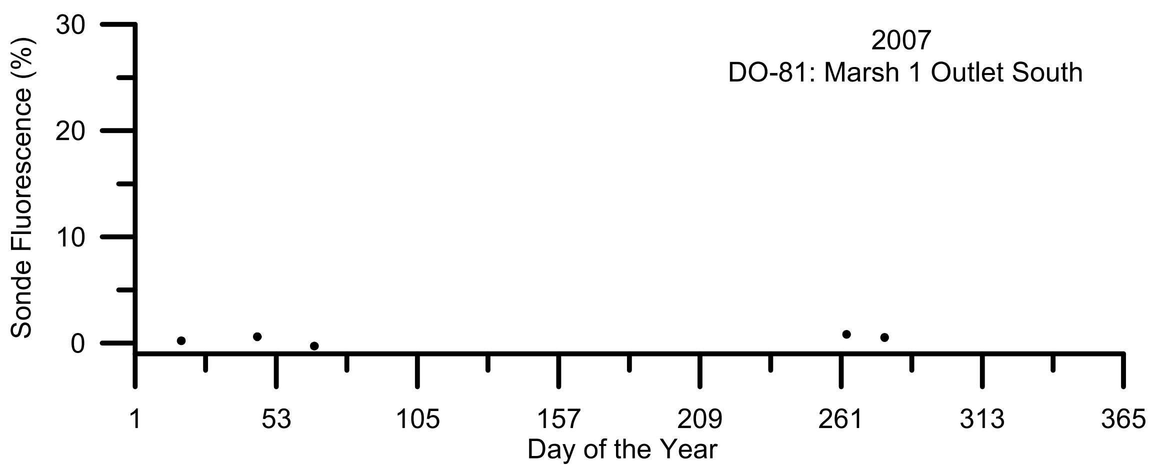

2005
DO-80: Marsh 1 Inlet South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

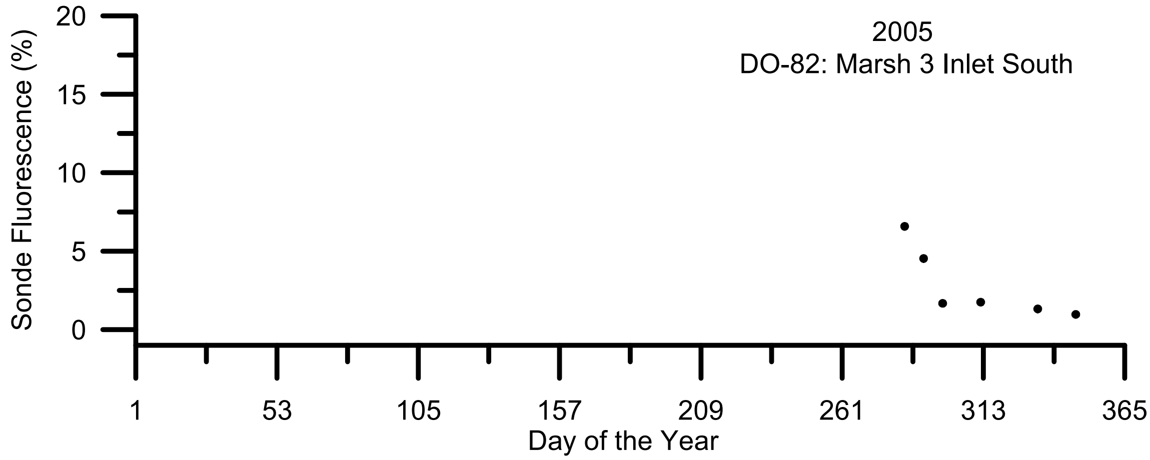

2006
DO-80: Marsh 1 Inlet South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

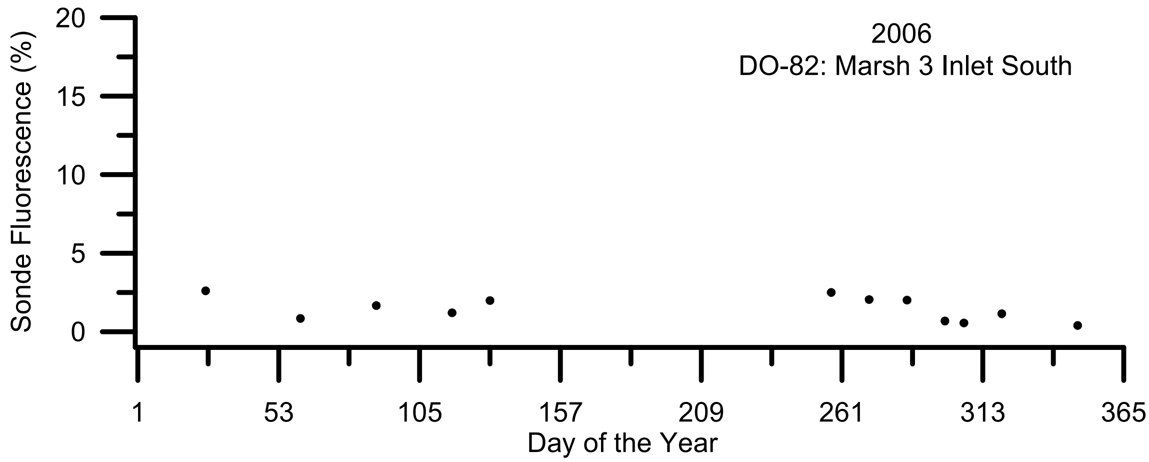

2007
DO-80: Marsh 1 Inlet South
Sonde Fluorescence (%)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

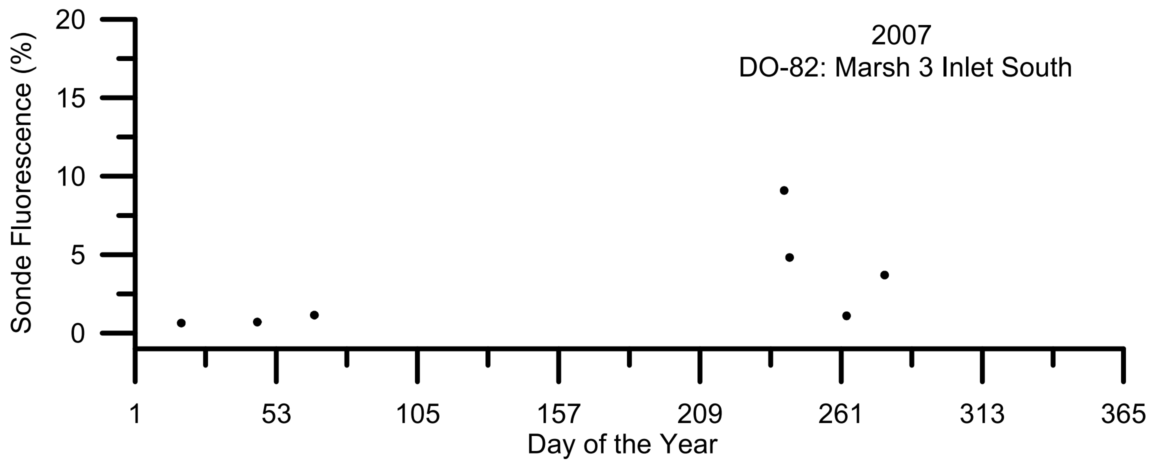

2005
DO-81: Marsh 1 Outlet South
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
1
53
105
157
209
261
313
365

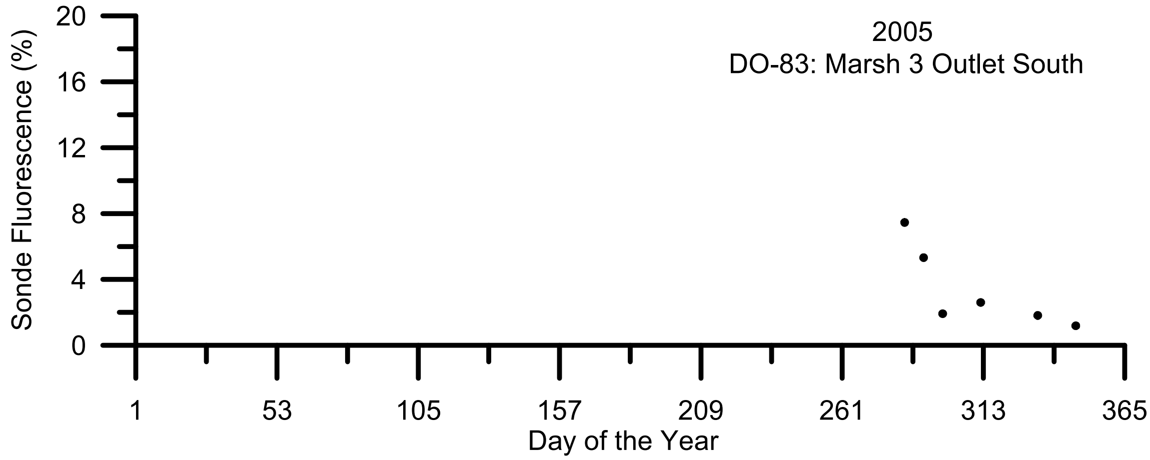

2006
DO-81: Marsh 1 Outlet South
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
1
53
105
157
209
261
313
365

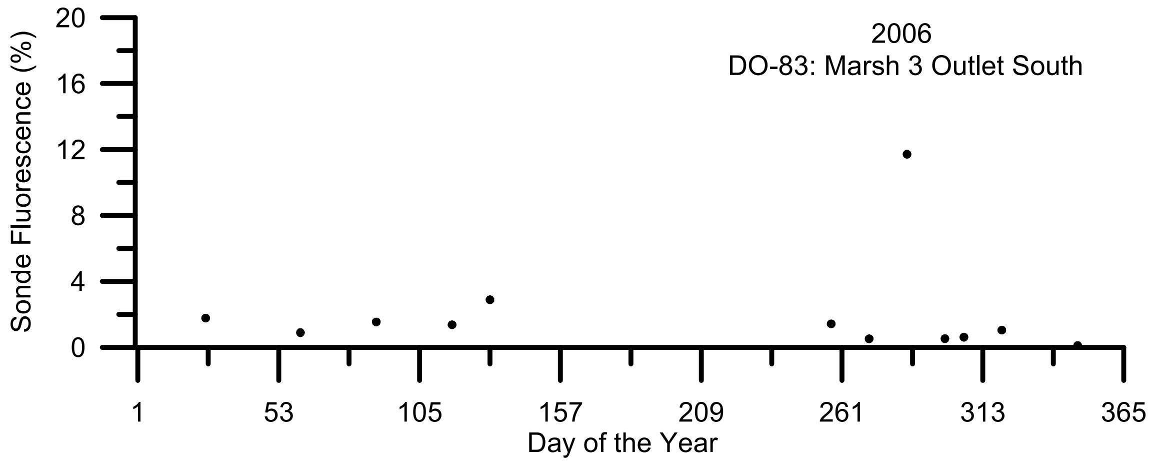

2007
DO-81: Marsh 1 Outlet South
Sonde Fluorescence (%)
Day of the Year
0
10
20
30
1
53
105
157
209
261
313
365

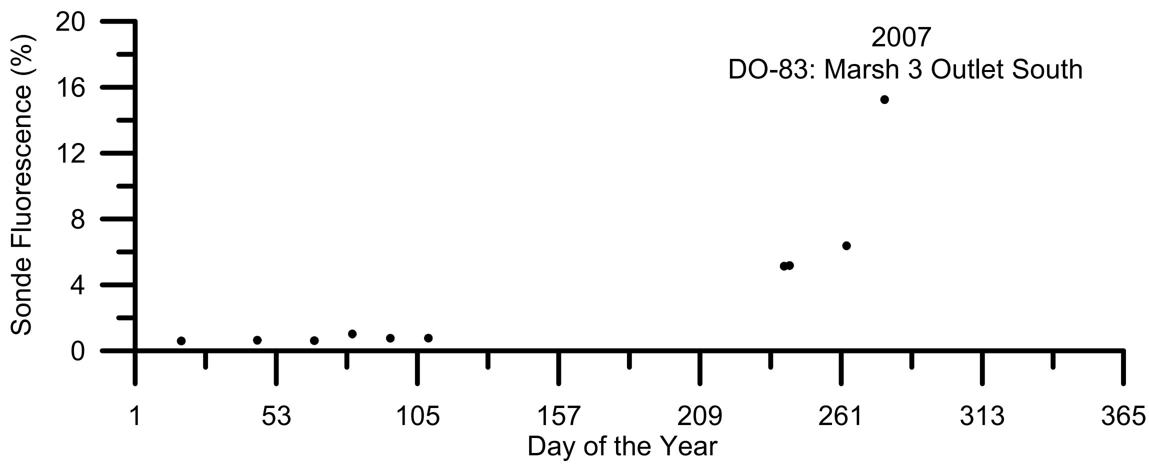

2005
DO-82: Marsh 3 Inlet South
Sonde Fluorescence (%)
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

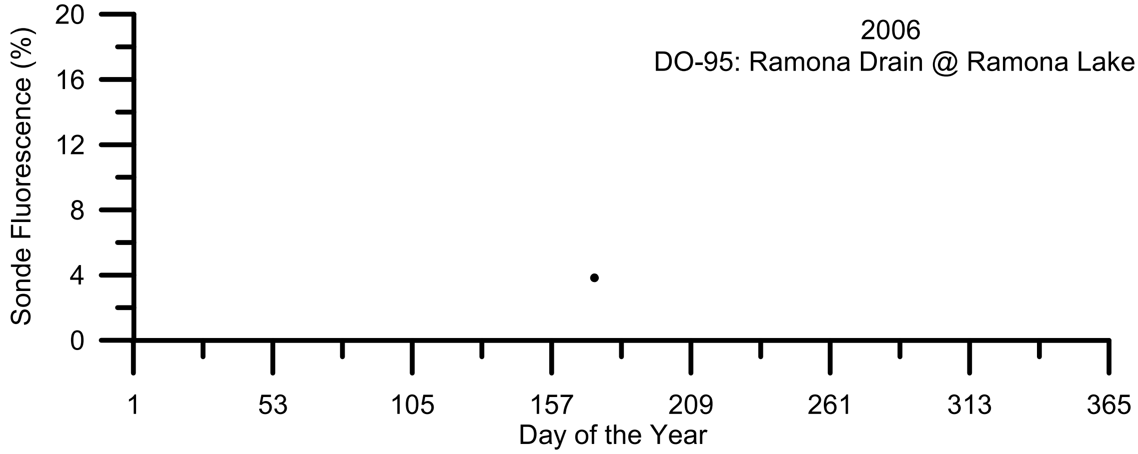

2006
DO-82: Marsh 3 Inlet South
Sonde Fluorescence (%)
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

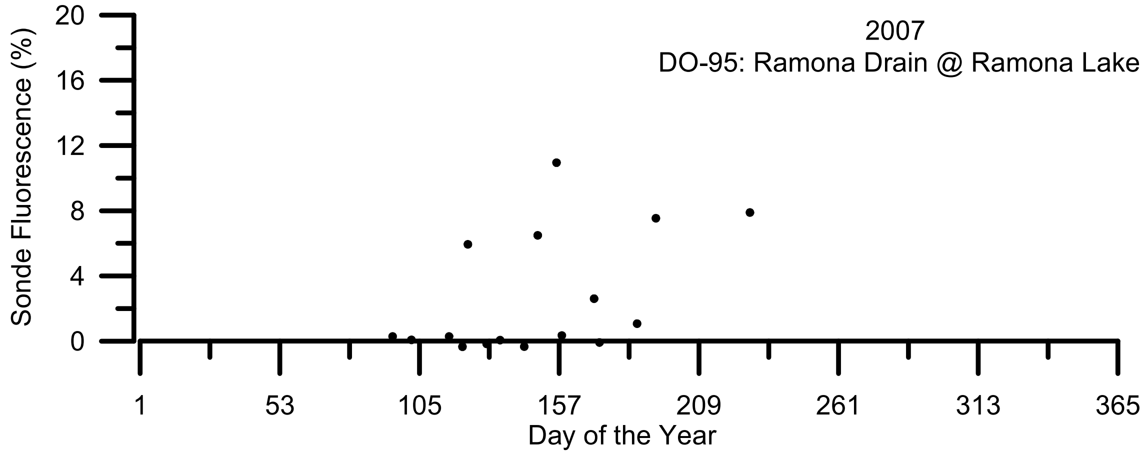

2007
DO-82: Marsh 3 Inlet South
Sonde Fluorescence (%)
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-83: Marsh 3 Outlet South
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
Sonde Fluorescence (%)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Dissolved Organic Carbon Concentrations in the San Joaquin River Watershed 2005-2007

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February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of dissolved organic carbon (DOC) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Filtered water samples were analyzed for dissolved organic carbon (DOC) on a Teledyne-Tekmar Apollo 9000 (Mason, OH) by high temperature combustion according to SM 5310 B (APHA, 2005) and quantified on using a NDIR detector. DOC samples were preserved < pH 2 with concentrated H_3PO_4 and stored at 4°C until analysis. The limit of detection for DOC is 1.00mg/L C.

Results and Discussion

Dissolved organic Carbon (DOC) analysis was preformed routinely over the years 2005-2007 using two different Apollo 9000HS instruments. This analysis had a 98.94% passing rate for all QA parameters over the three year period (Borglin et. al., 2008).

These high sensitivity instruments are challenging to maintain and on a few occasions sample sets were analyzed by outside laboratories due to malfunctions of the instrument that could not be repaired within the holding time for these samples.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

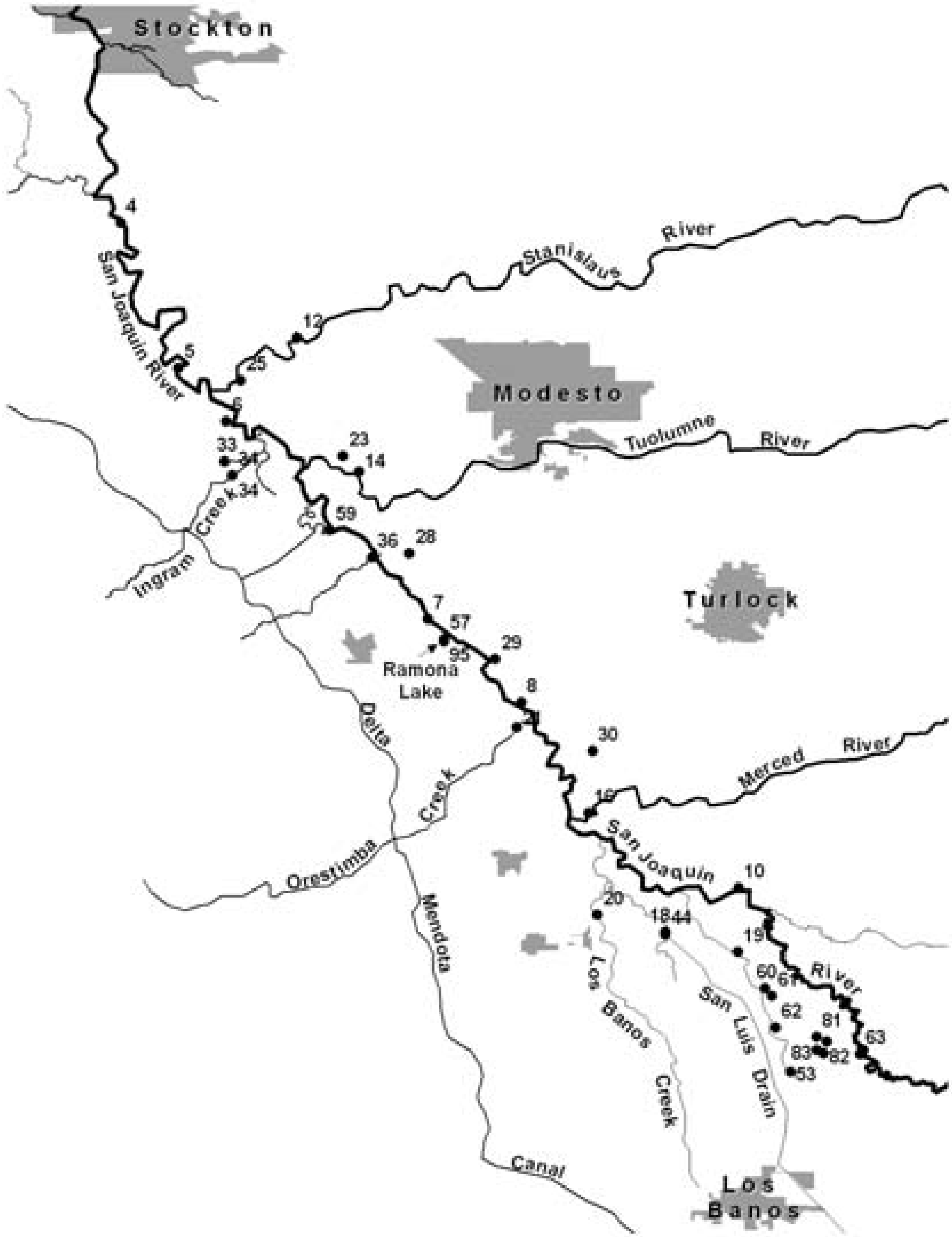
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

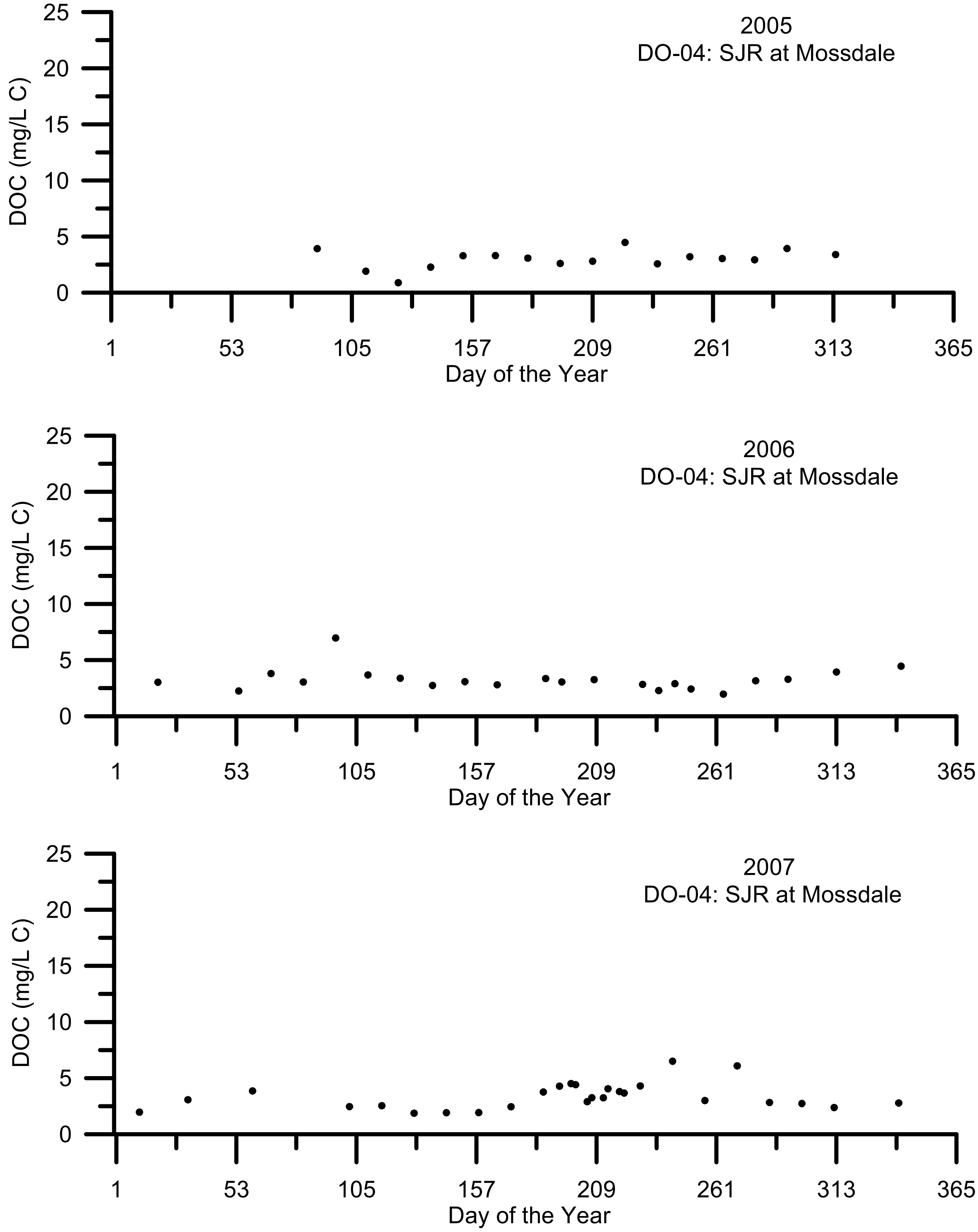
Table 1: EERP Sampling Site List

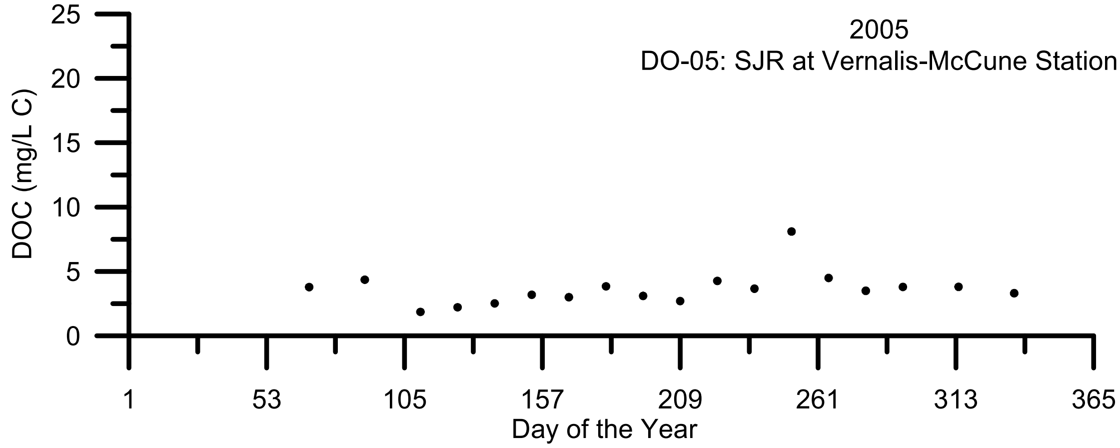
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

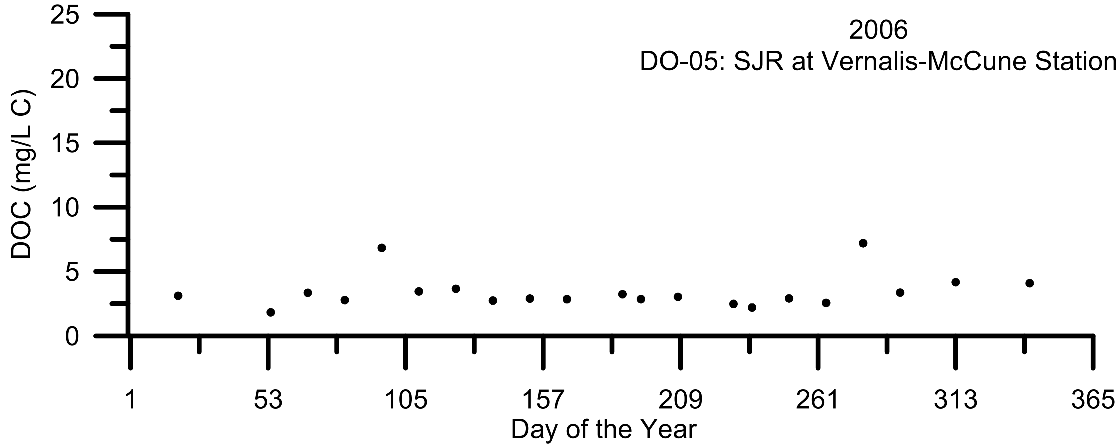
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

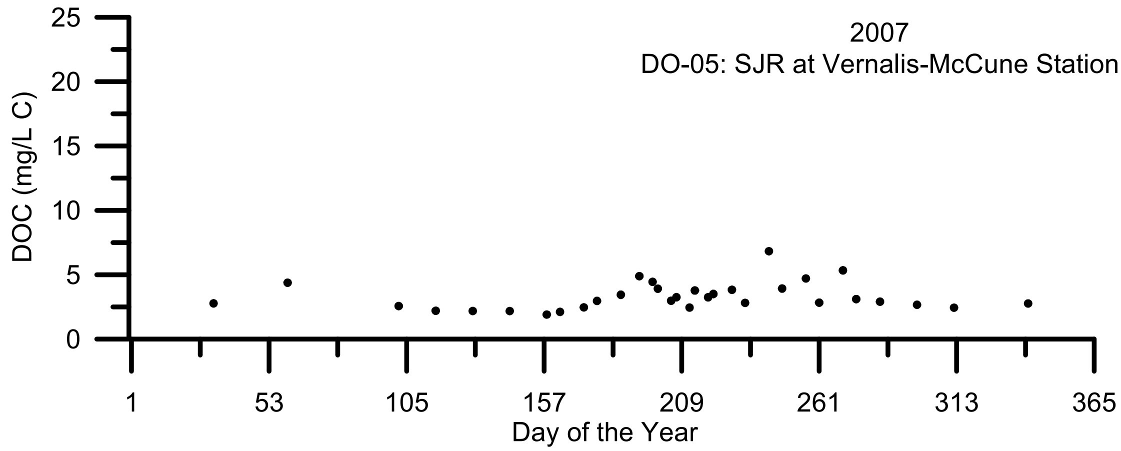


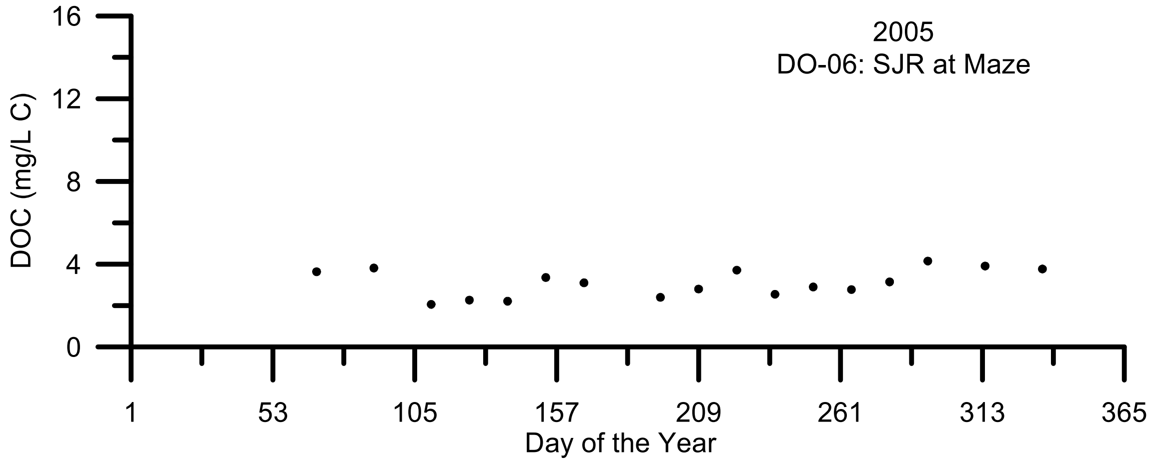
Figures 2 -101: Temporal Plots of DOC Concentrations By Site ID

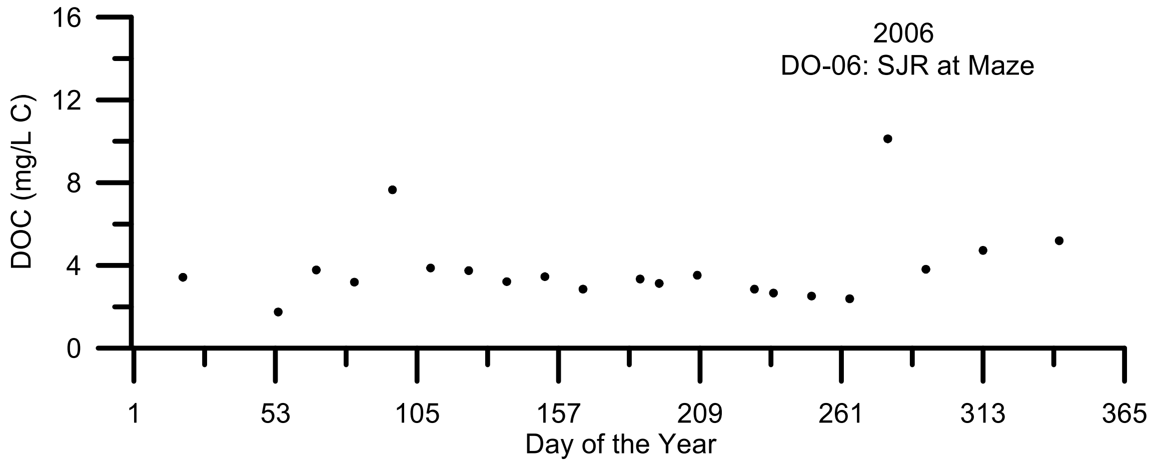


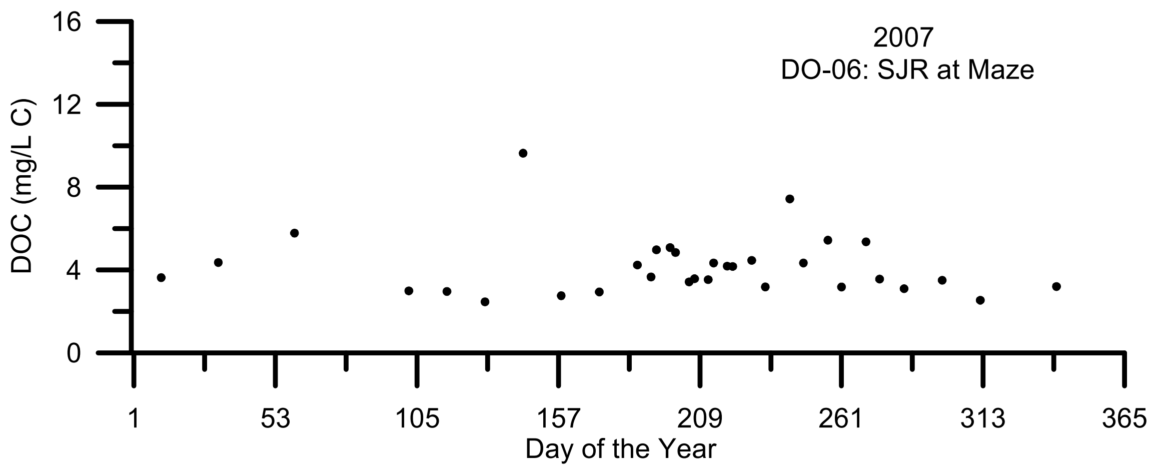

2005
DO-05: SJR at Vernalis-McCune Station
DOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

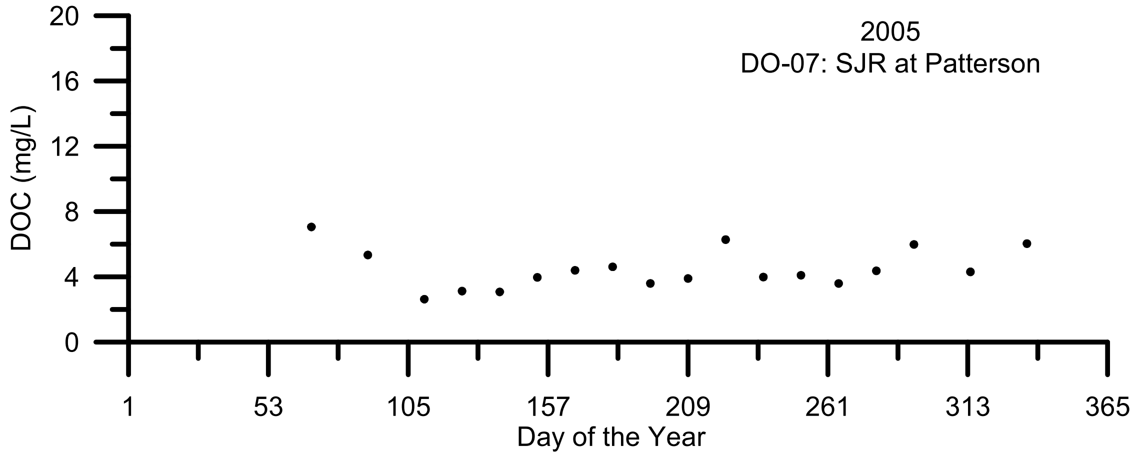

2006
DO-05: SJR at Vernalis-McCune Station
DOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

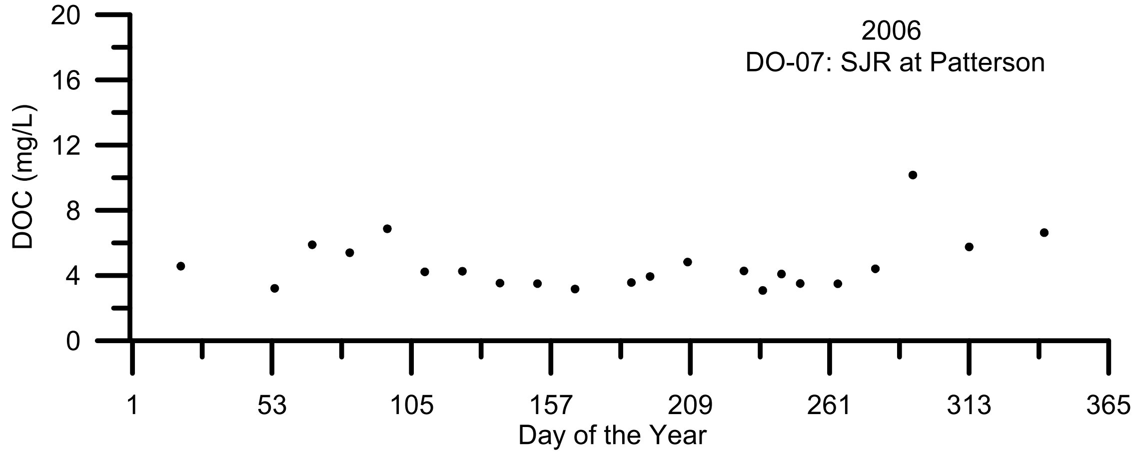

2007
DO-05: SJR at Vernalis-McCune Station
DOC (mg/L C)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

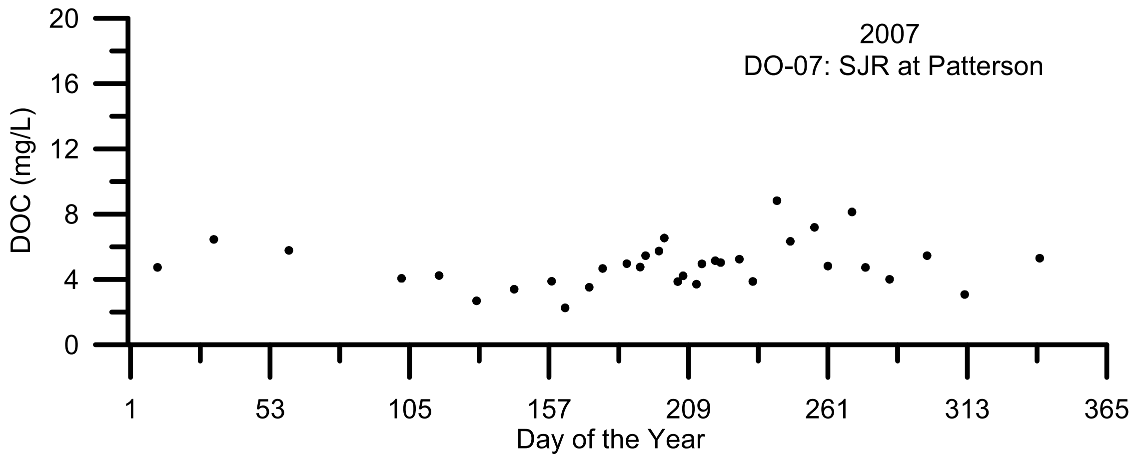

2005
DO-06: SJR at Maze
DOC (mg/L C)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

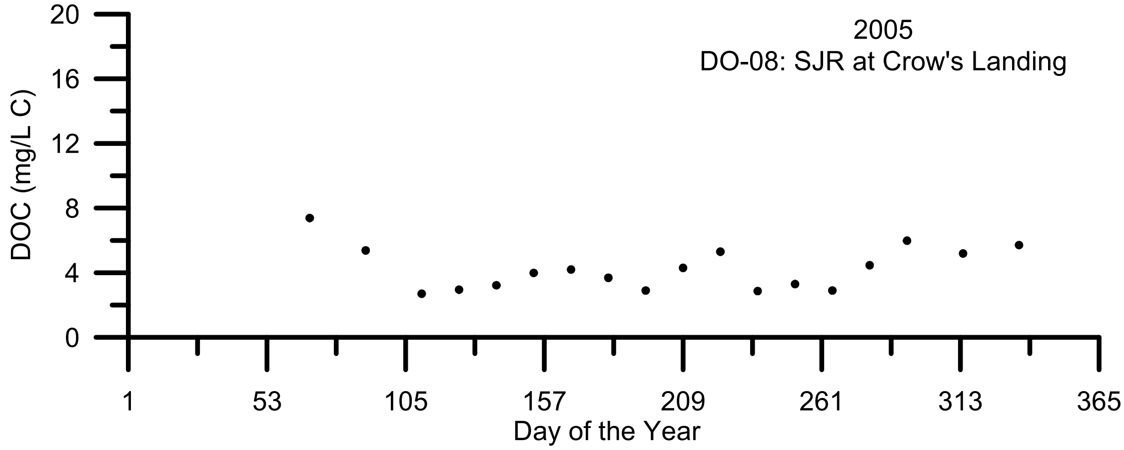

2006
DO-06: SJR at Maze
DOC (mg/L C)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

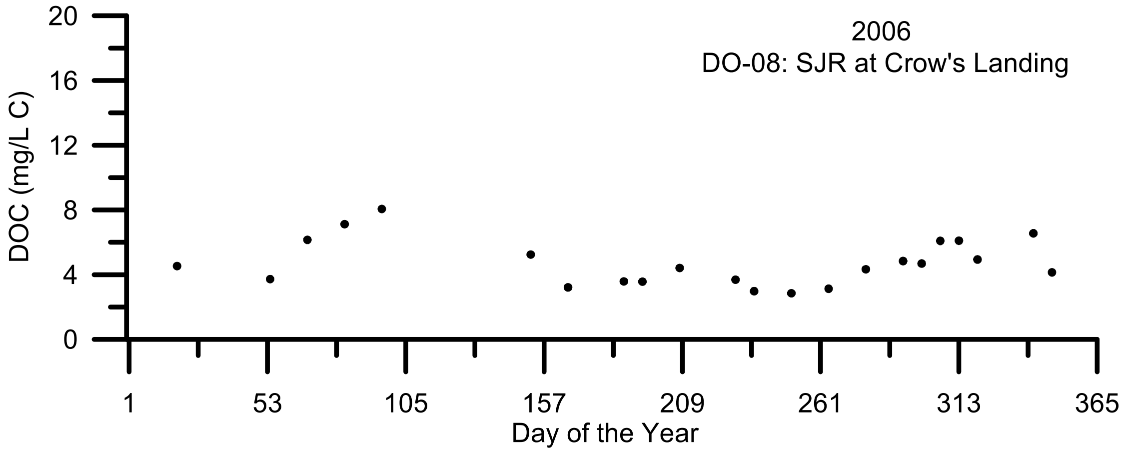

2007
DO-06: SJR at Maze
DOC (mg/L C)
Day of the Year
0
4
8
12
16
1
53
105
157
209
261
313
365

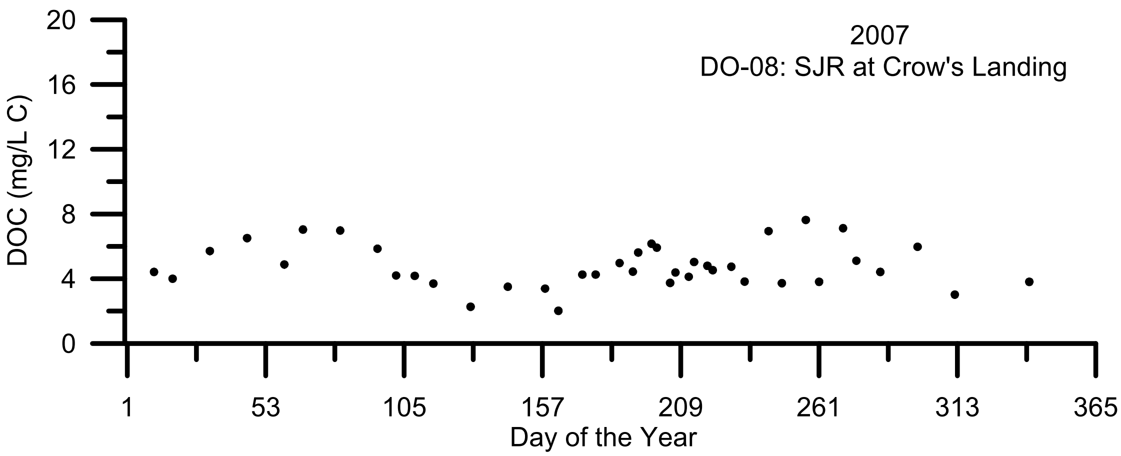

2005
DO-07: SJR at Patterson
DOC (mg/L)
Day of the Year

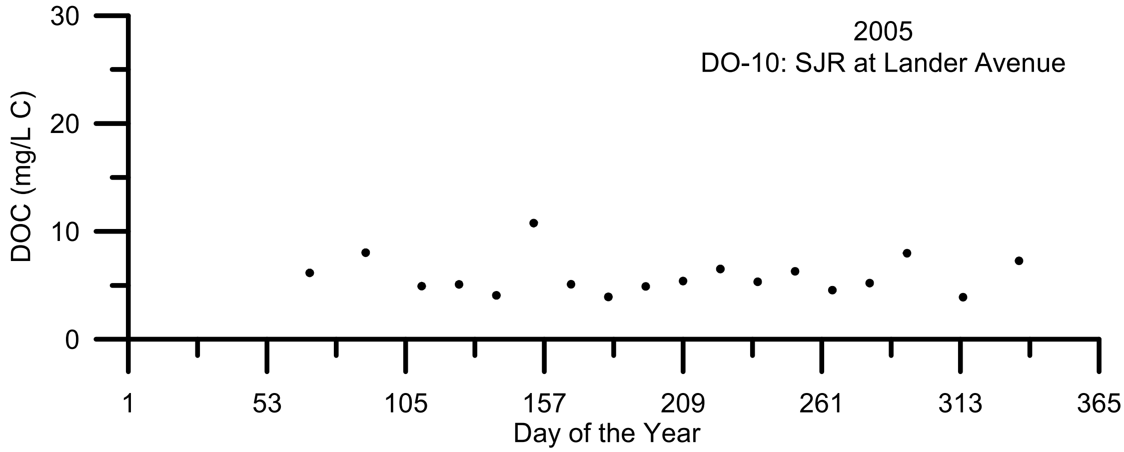

2006
DO-07: SJR at Patterson
DOC (mg/L)
Day of the Year

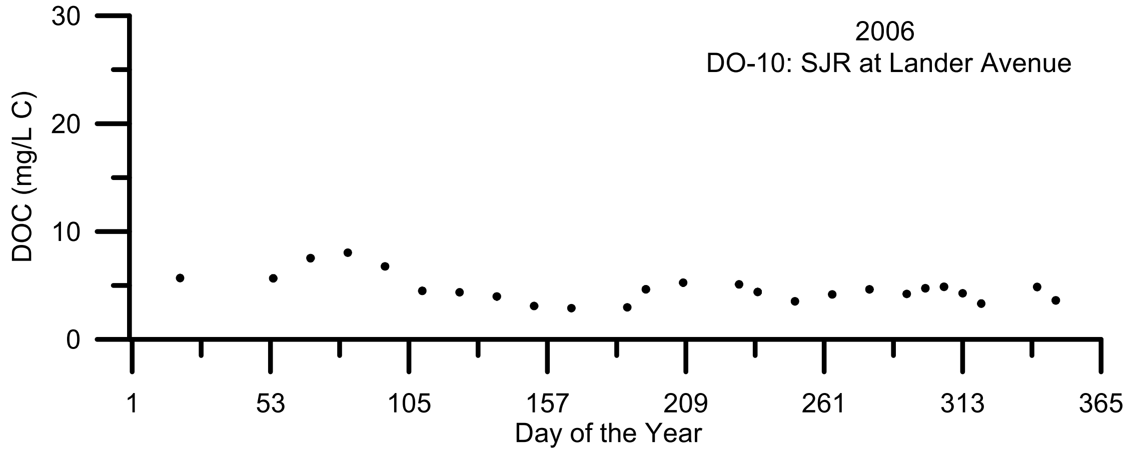

2007
DO-07: SJR at Patterson
DOC (mg/L)
Day of the Year

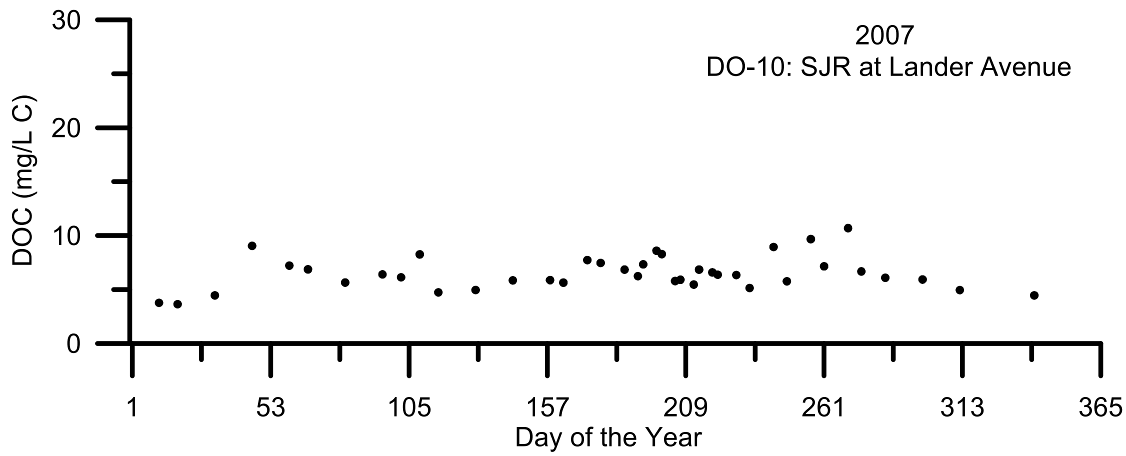

2005
DO-08: SJR at Crow's Landing
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

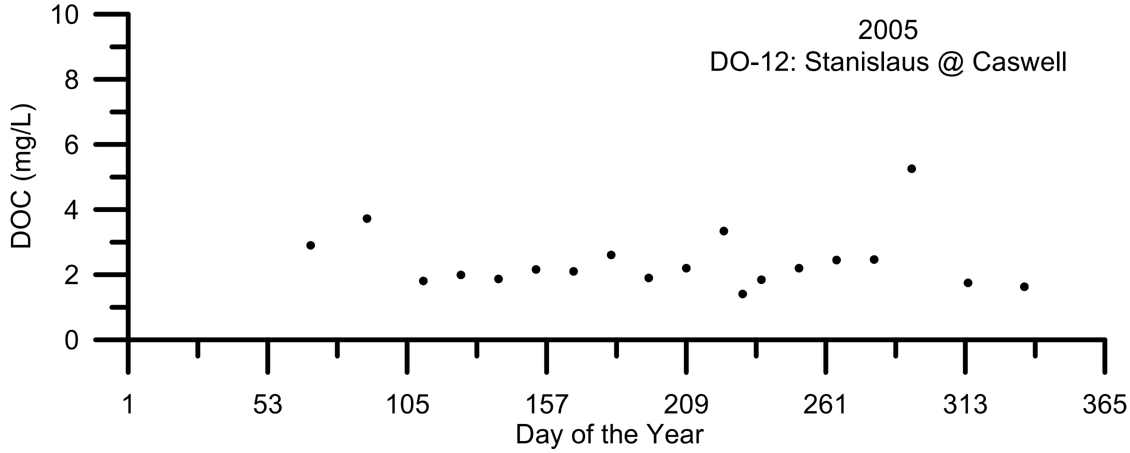

2006
DO-08: SJR at Crow's Landing
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

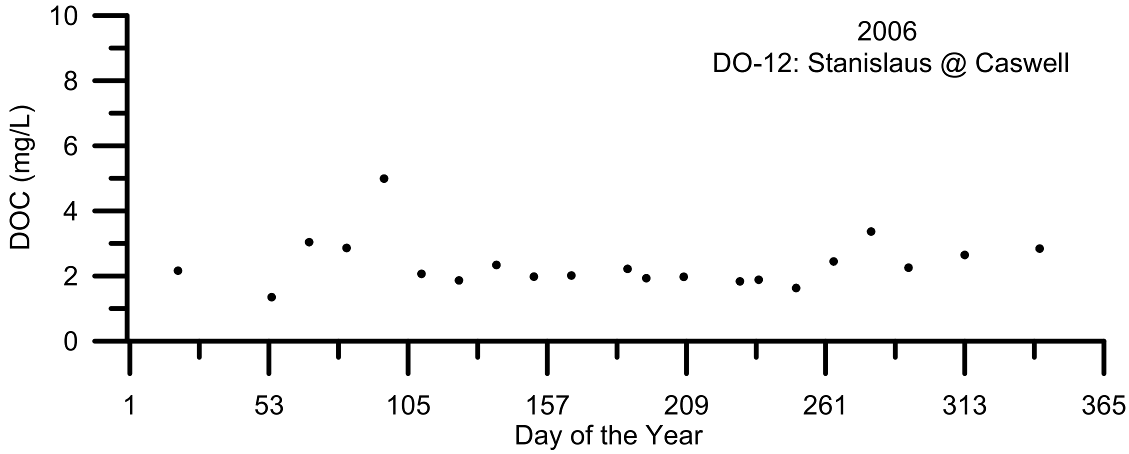

2007
DO-08: SJR at Crow's Landing
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

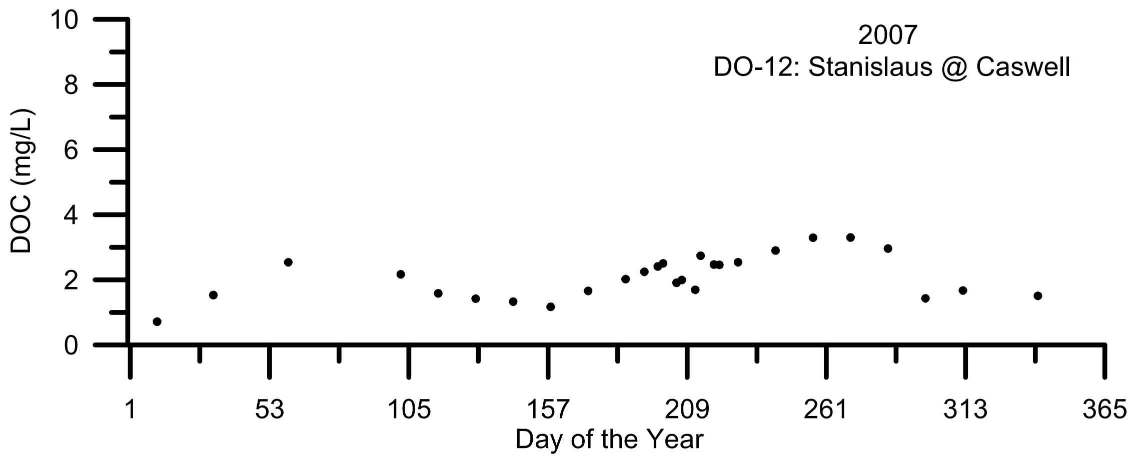

2005
DO-10: SJR at Lander Avenue
DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

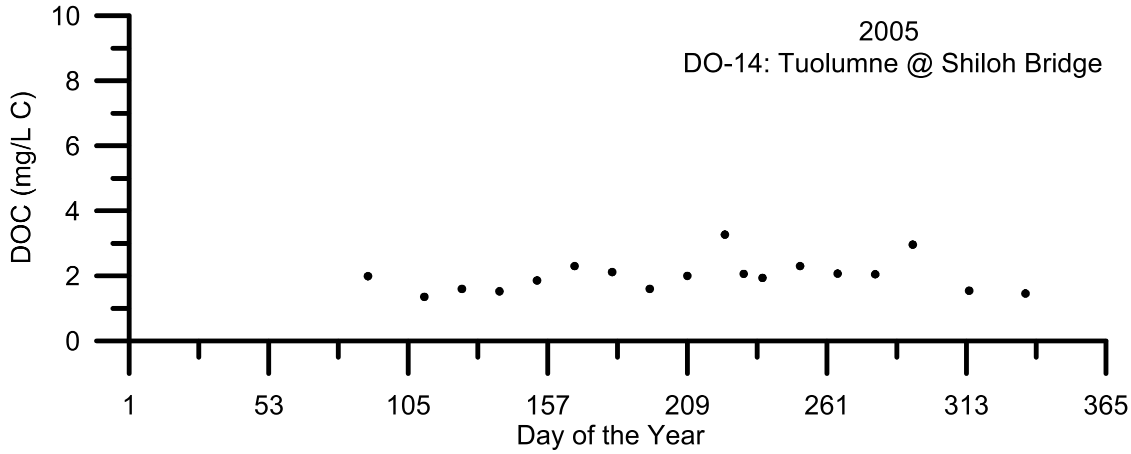

2006
DO-10: SJR at Lander Avenue
DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

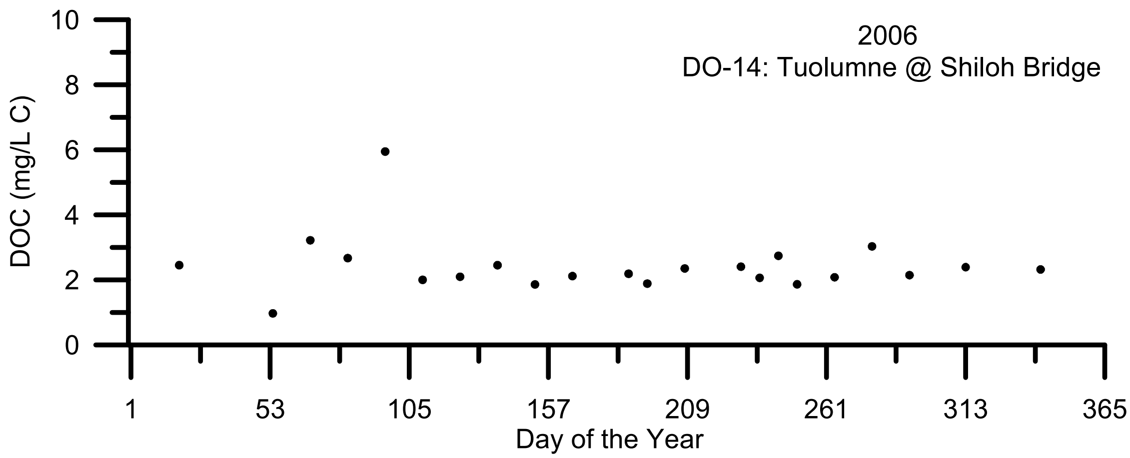

2007
DO-10: SJR at Lander Avenue
DOC (mg/L C)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

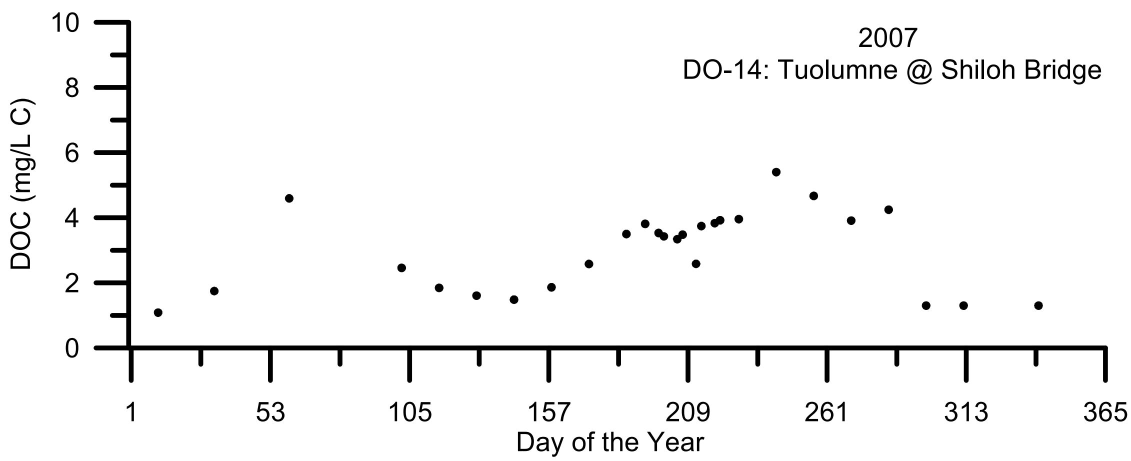

2005
DO-12: Stanislaus @ Caswell
DOC (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

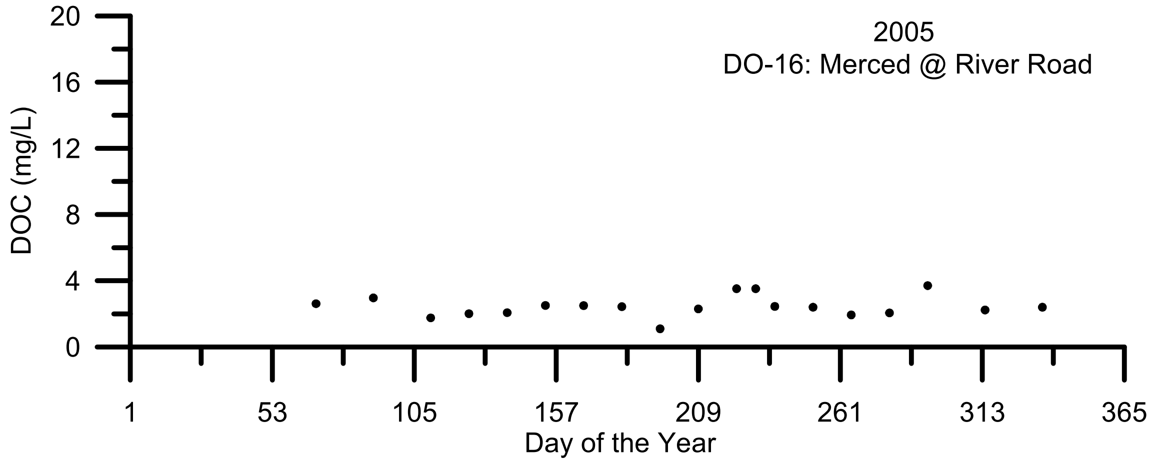

2006
DO-12: Stanislaus @ Caswell
DOC (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

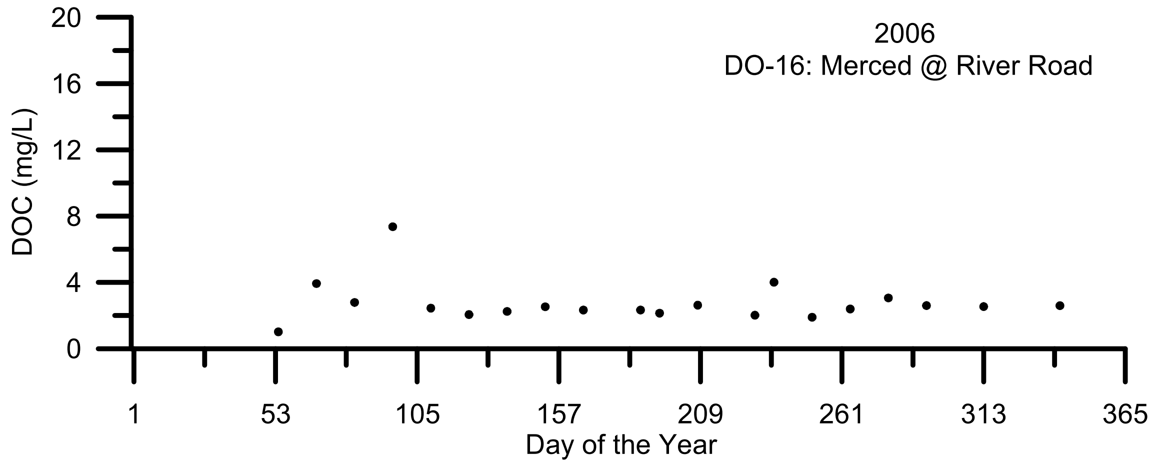

2007
DO-12: Stanislaus @ Caswell
DOC (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

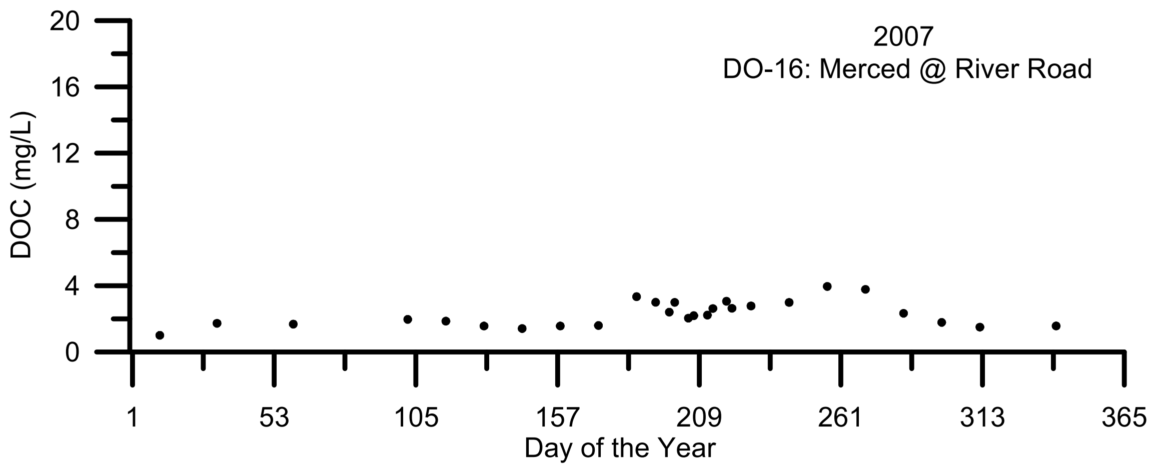

2005
DO-14: Tuolumne @ Shiloh Bridge
DOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

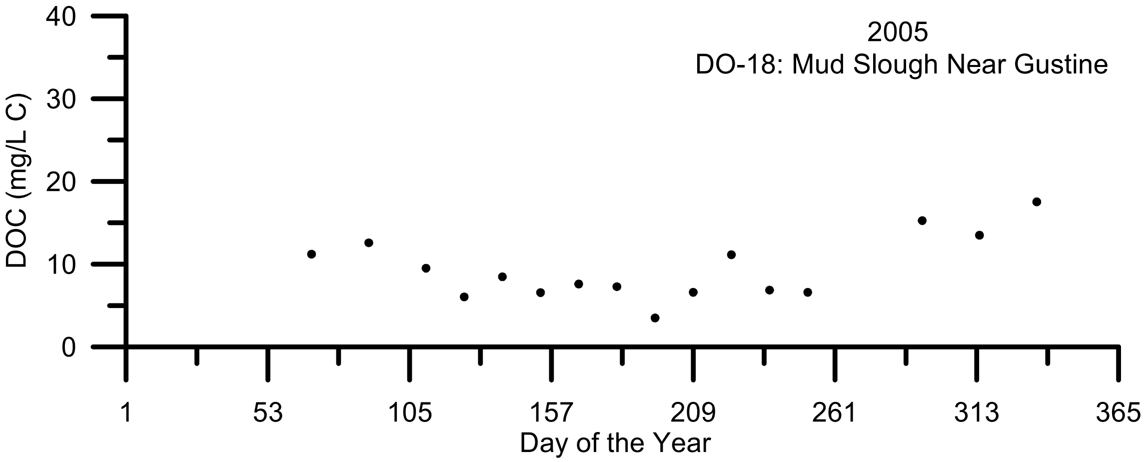

2006
DO-14: Tuolumne @ Shiloh Bridge
DOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

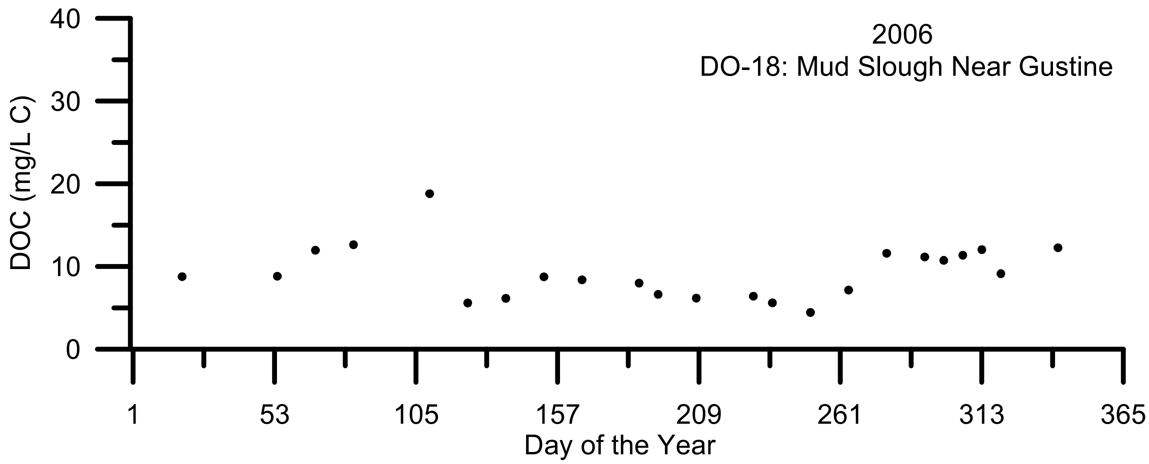

2007
DO-14: Tuolumne @ Shiloh Bridge
DOC (mg/L C)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

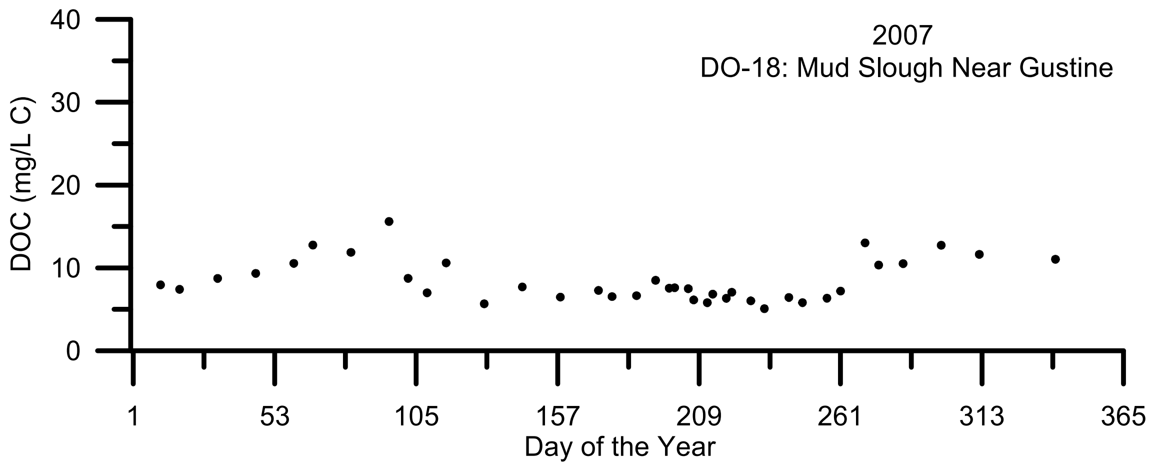

2005
DO-16: Merced @ River Road
DOC (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

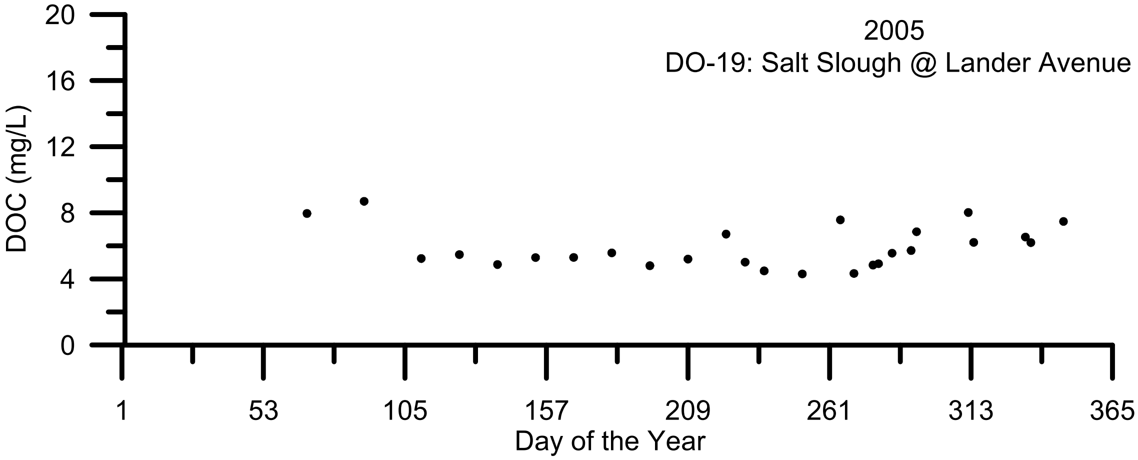

2006
DO-16: Merced @ River Road
DOC (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

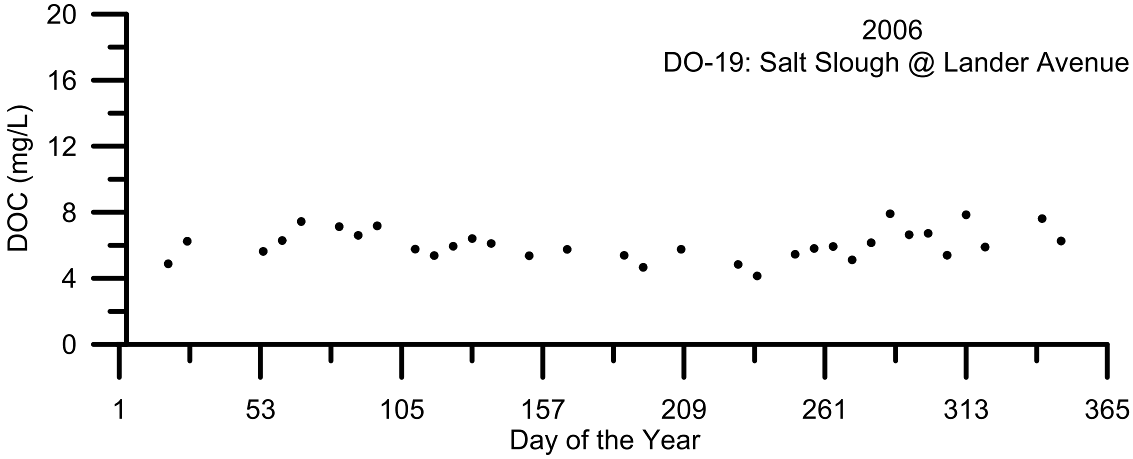

2007
DO-16: Merced @ River Road
DOC (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

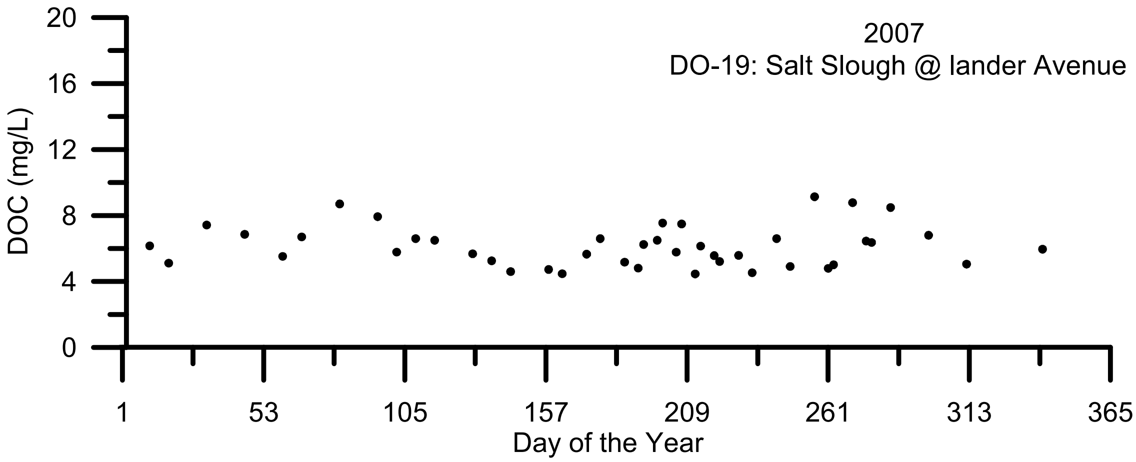

2005
DO-18: Mud Slough Near Gustine
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

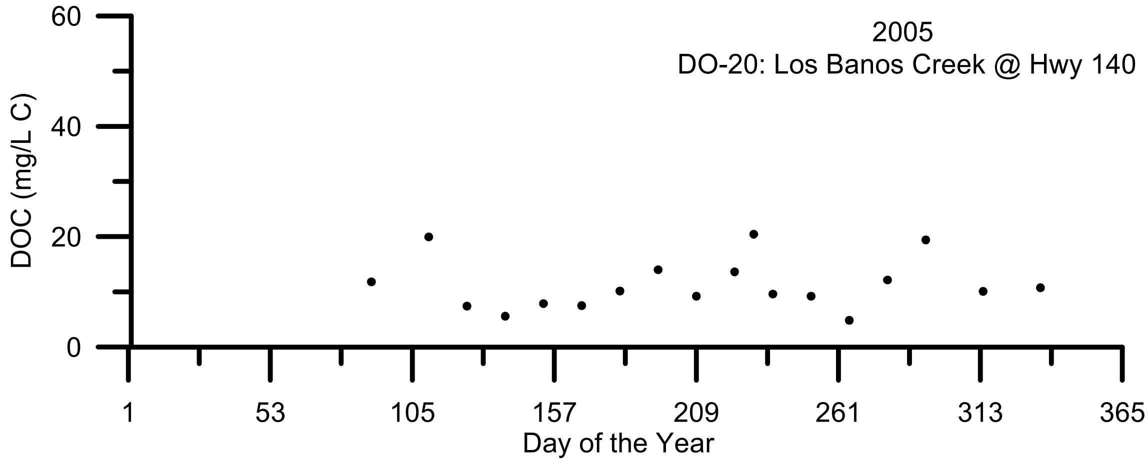

2006
DO-18: Mud Slough Near Gustine
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

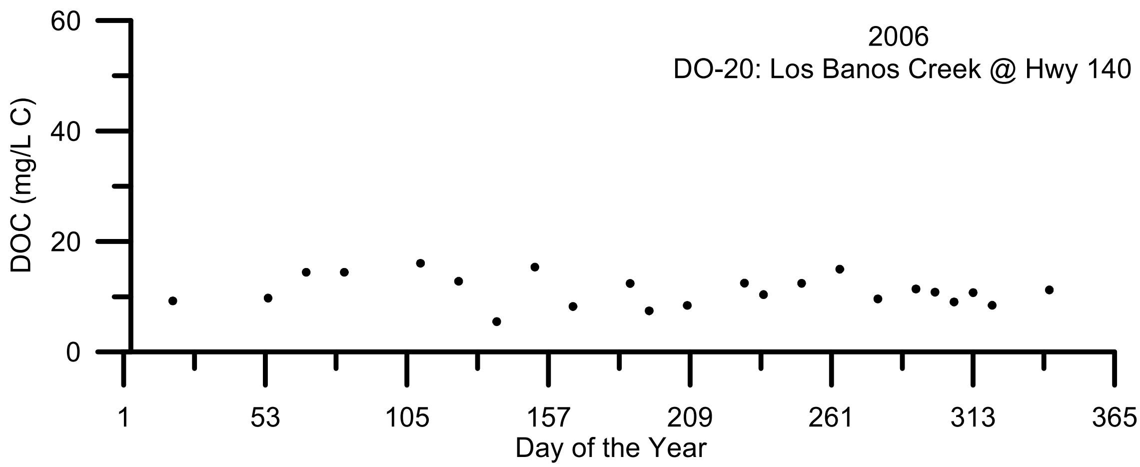

2007
DO-18: Mud Slough Near Gustine
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

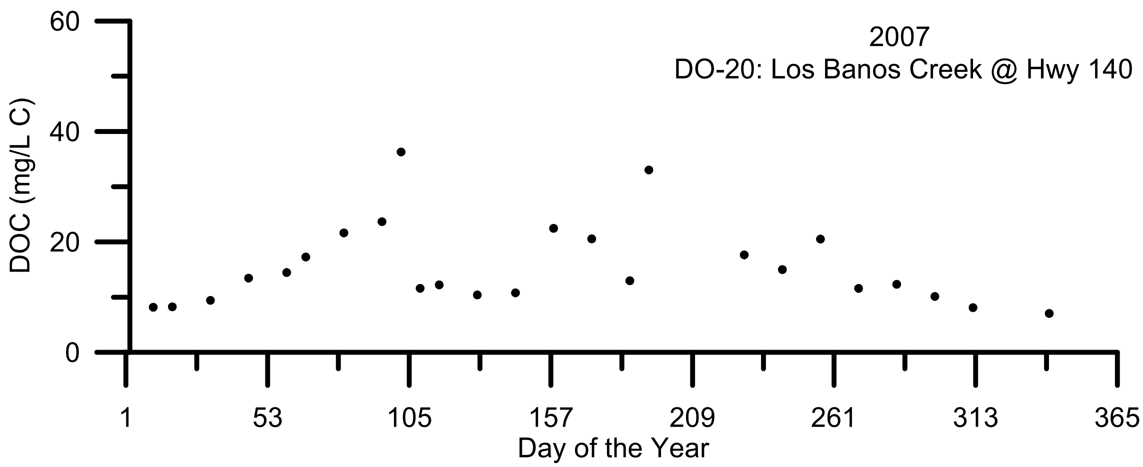

2005
DO-19: Salt Slough @ Lander Avenue
DOC (mg/L)
Day of the Year

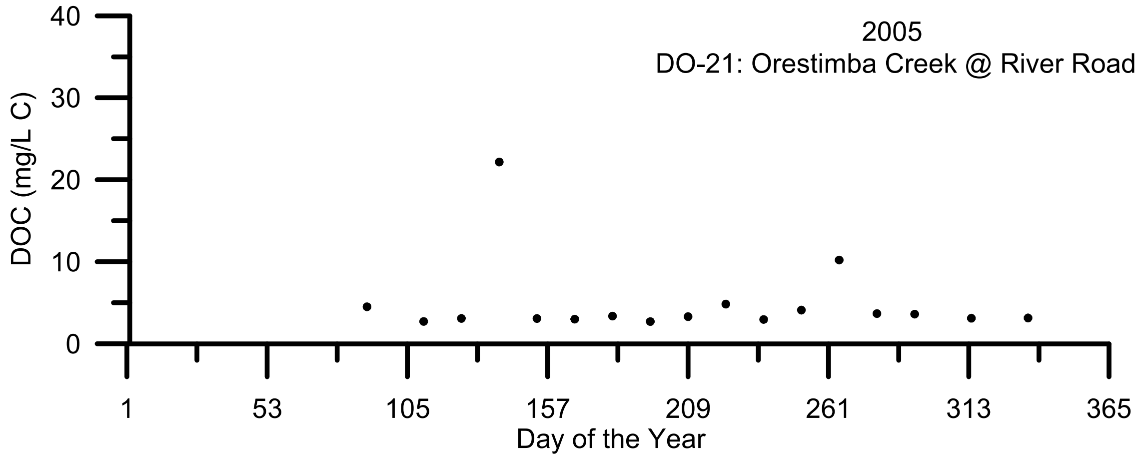

2006
DO-19: Salt Slough @ Lander Avenue
DOC (mg/L)
Day of the Year

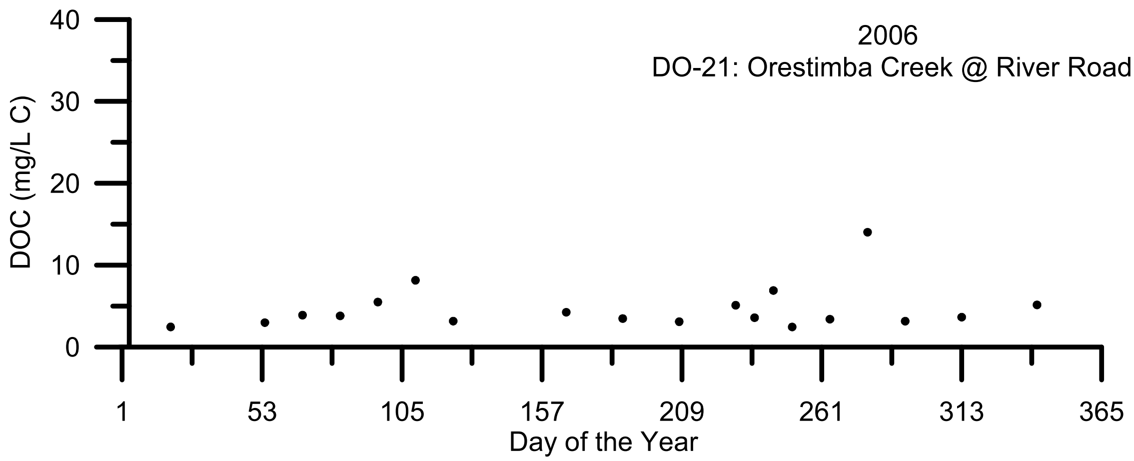

2007
DO-19: Salt Slough @ lander Avenue
DOC (mg/L)
Day of the Year

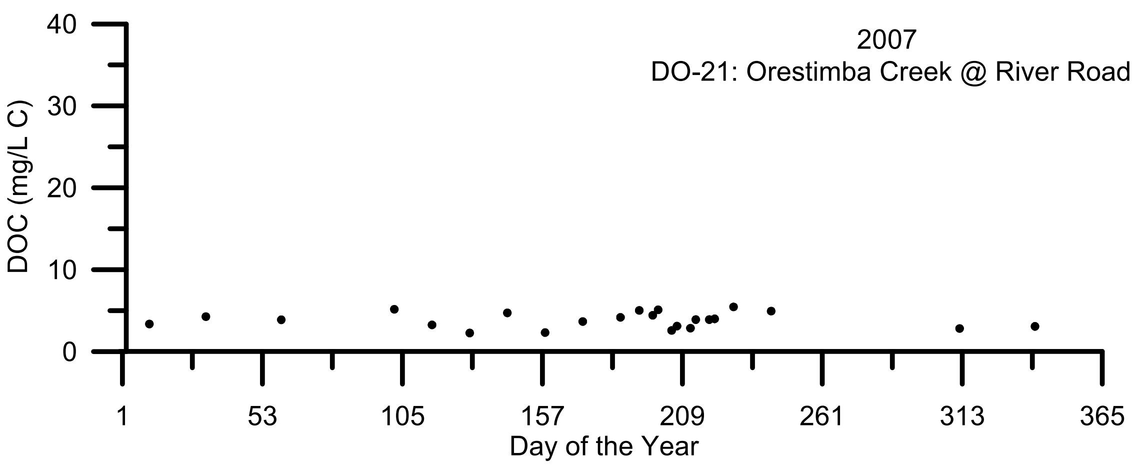

2005
DO-20: Los Banos Creek @ Hwy 140
DOC (mg/L C)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

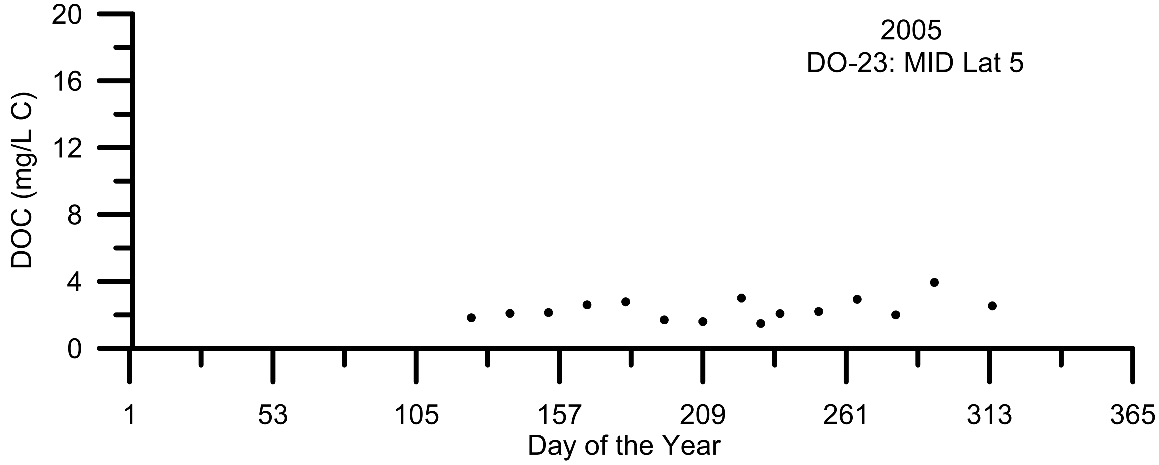

2006
DO-20: Los Banos Creek @ Hwy 140
DOC (mg/L C)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

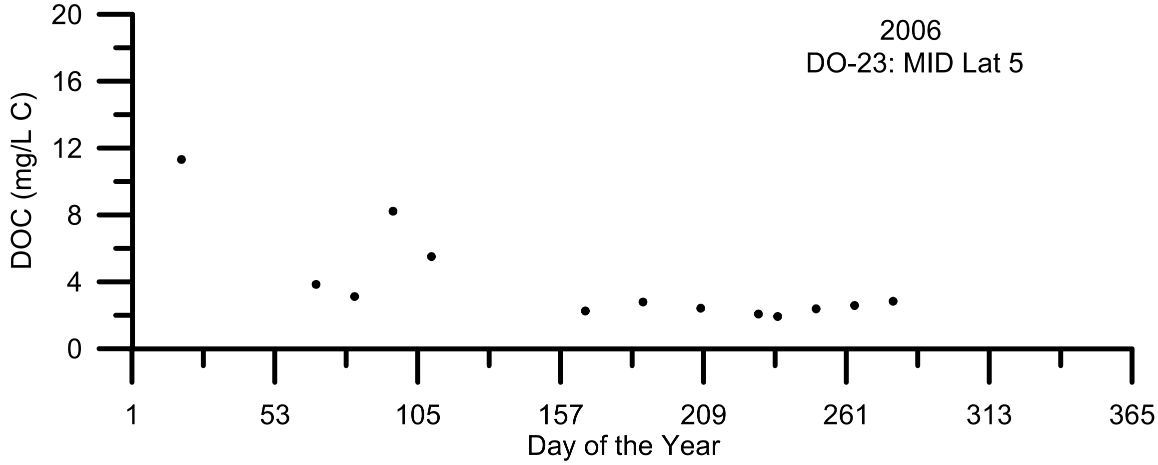

2007
DO-20: Los Banos Creek @ Hwy 140
DOC (mg/L C)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

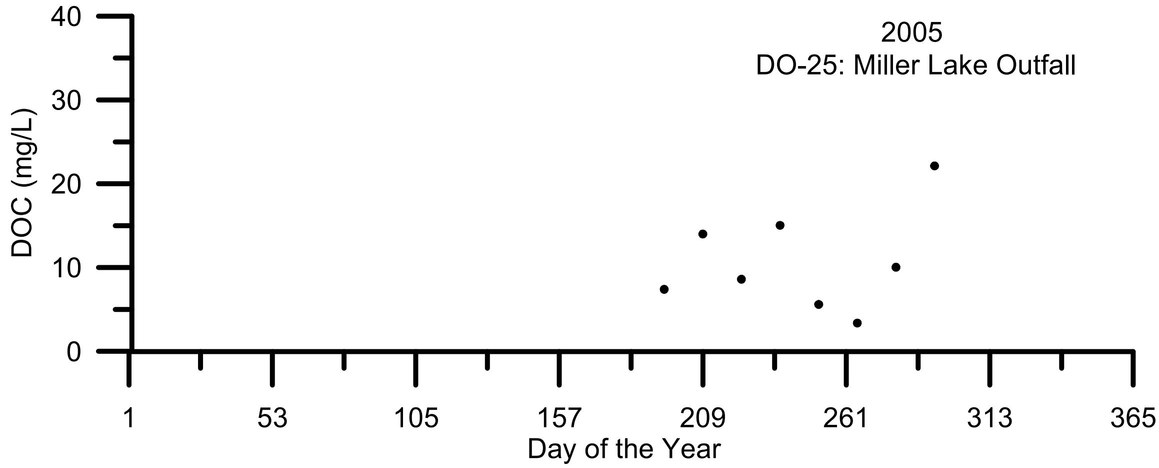

2005
DO-21: Orestimba Creek @ River Road
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

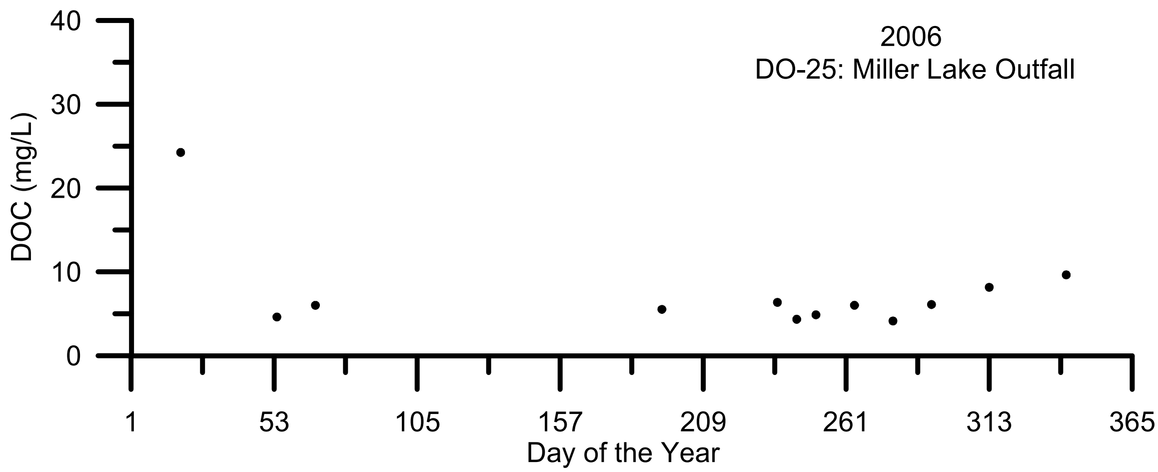

2006
DO-21: Orestimba Creek @ River Road
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

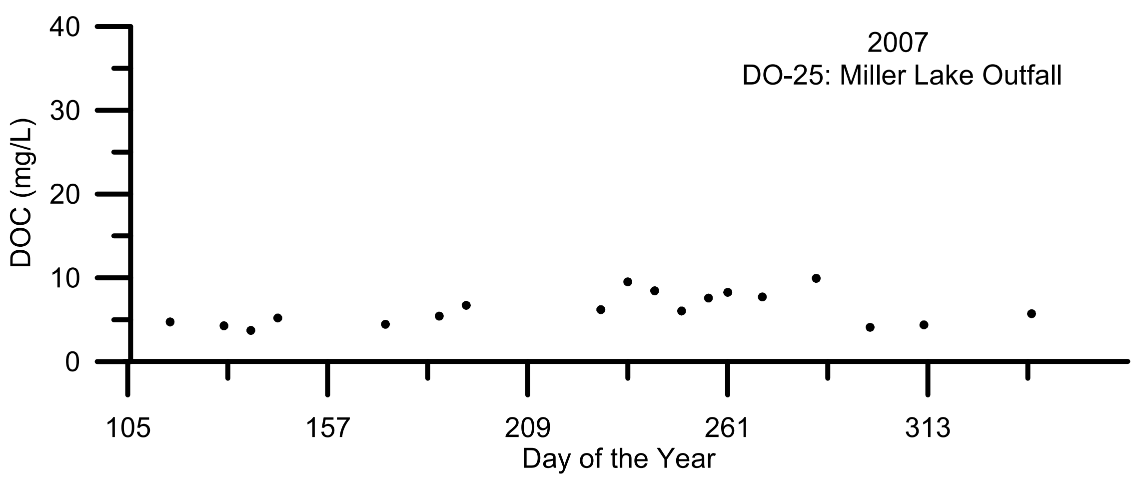

2007
DO-21: Orestimba Creek @ River Road
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

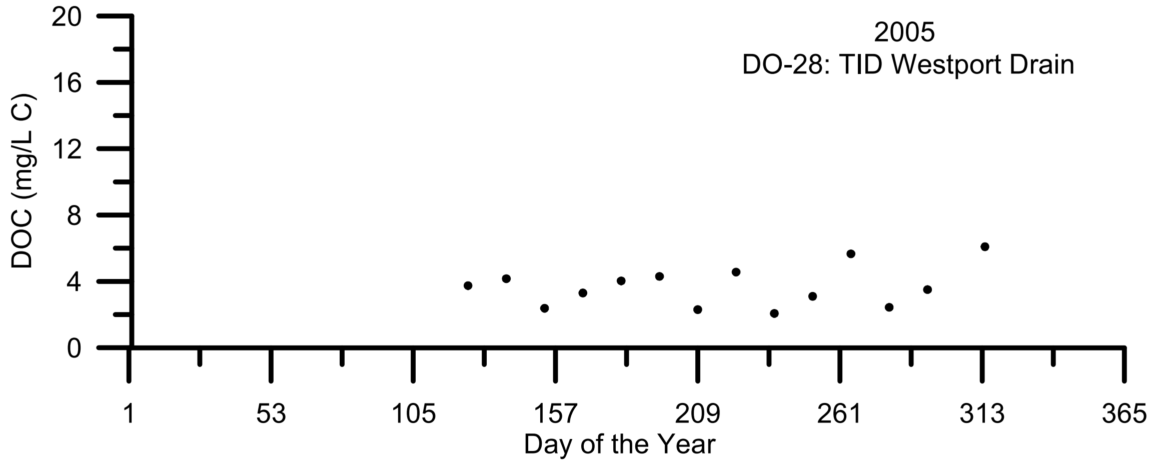

2005
DO-23: MID Lat 5
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

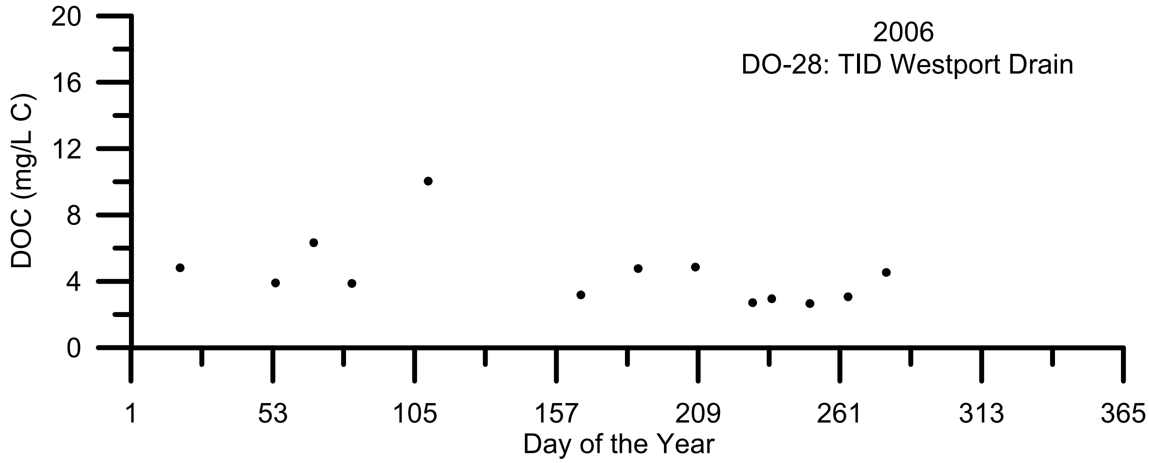

2006
DO-23: MID Lat 5
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

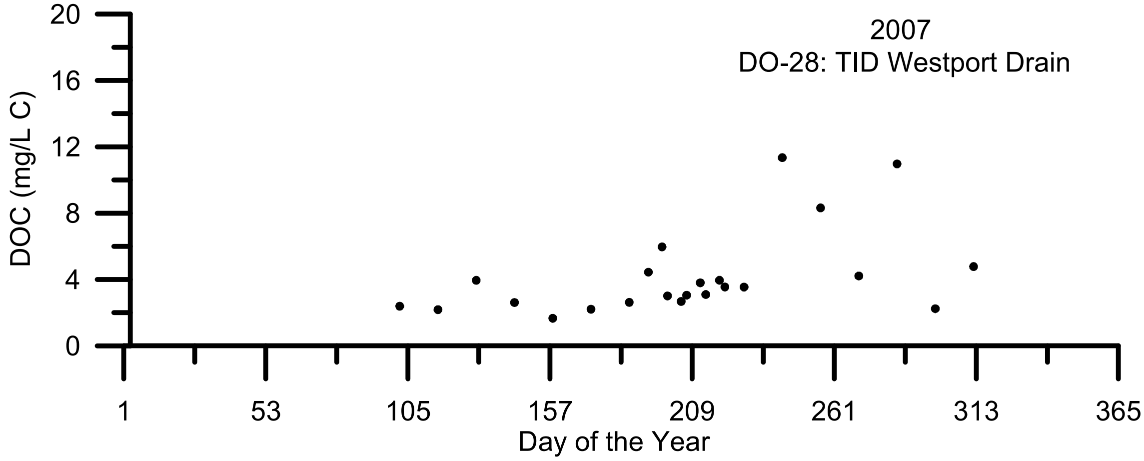

2005
DO-25: Miller Lake Outfall
DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

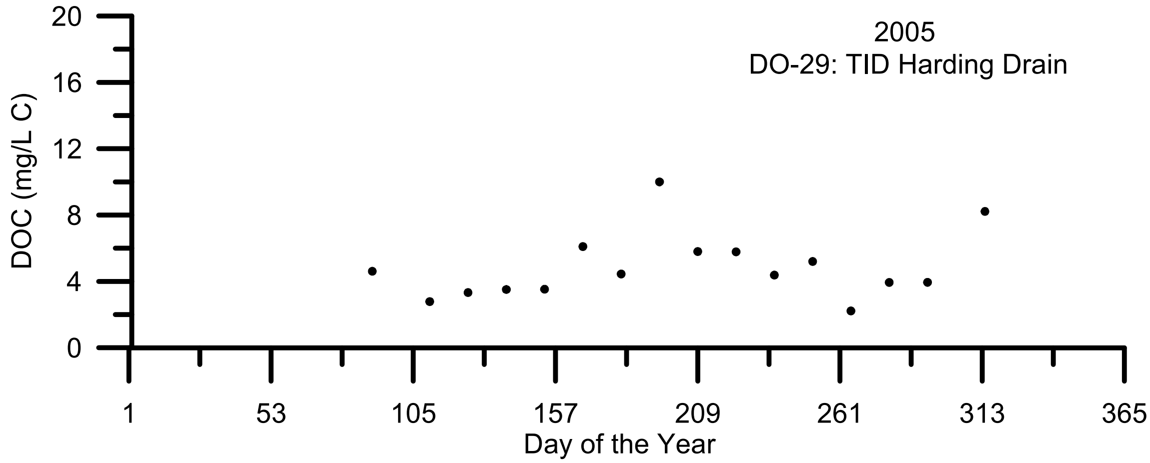

2006
DO-25: Miller Lake Outfall
DOC (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

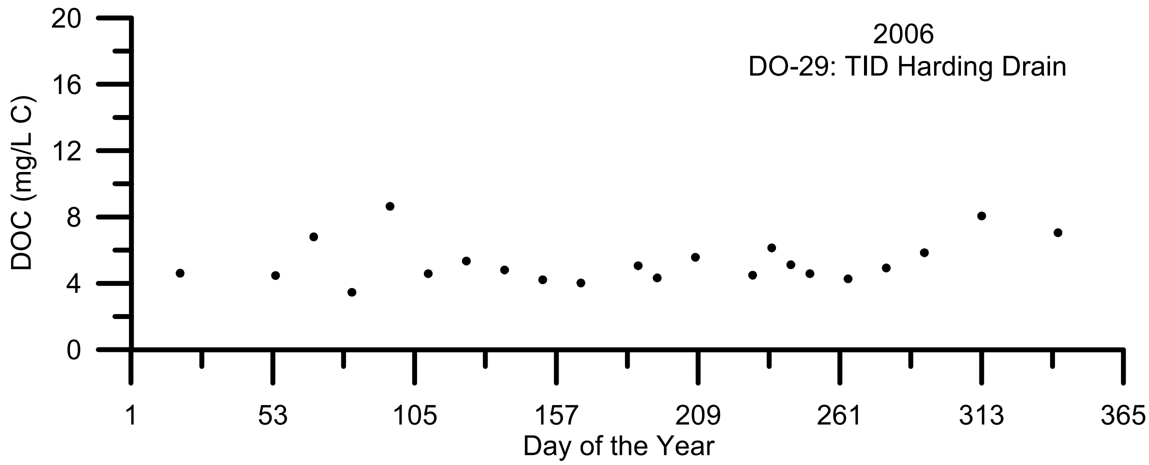

2007
DO-25: Miller Lake Outfall
DOC (mg/L)
0
10
20
30
40
105
157
209
261
313
Day of the Year

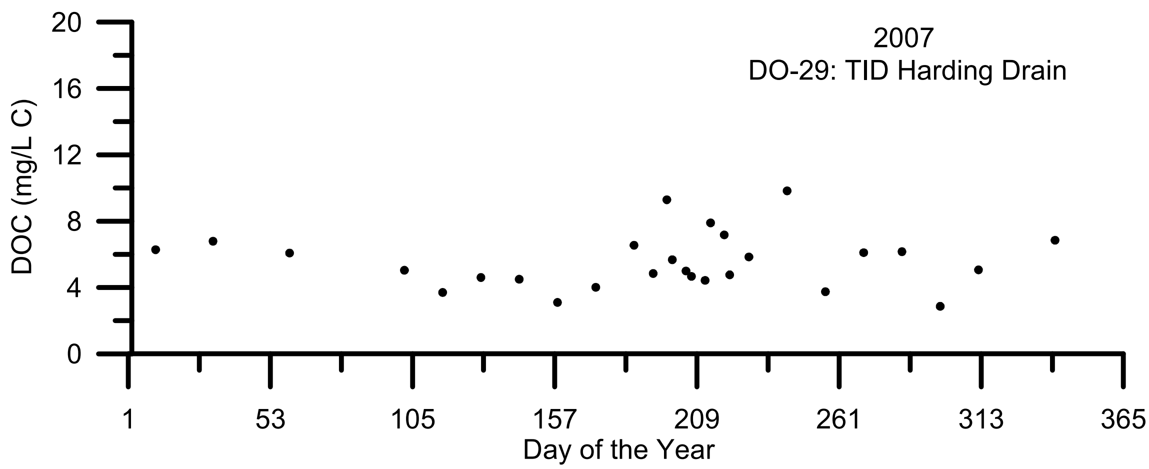

2005
DO-28: TID Westport Drain
DOC (mg/L C)
Day of the Year

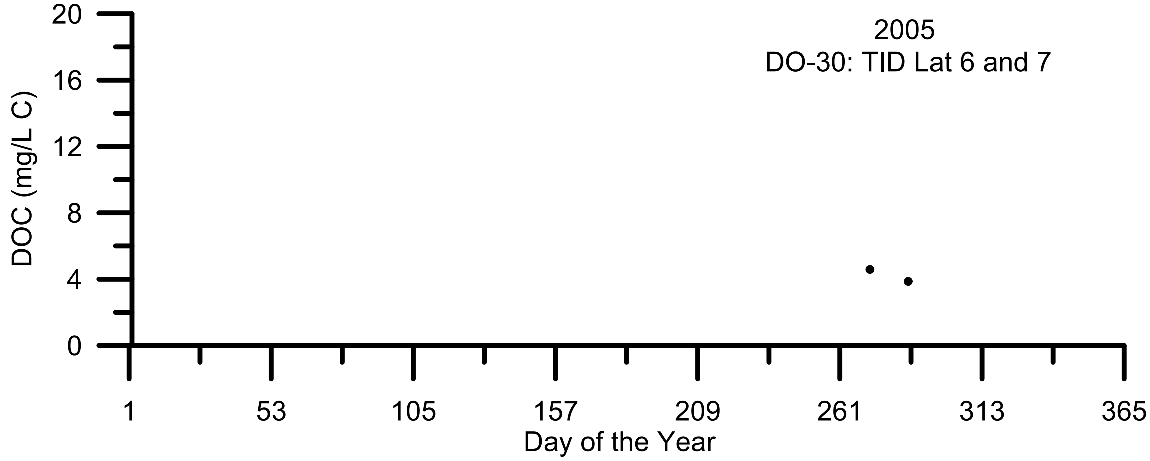

2006
DO-28: TID Westport Drain
DOC (mg/L C)
Day of the Year

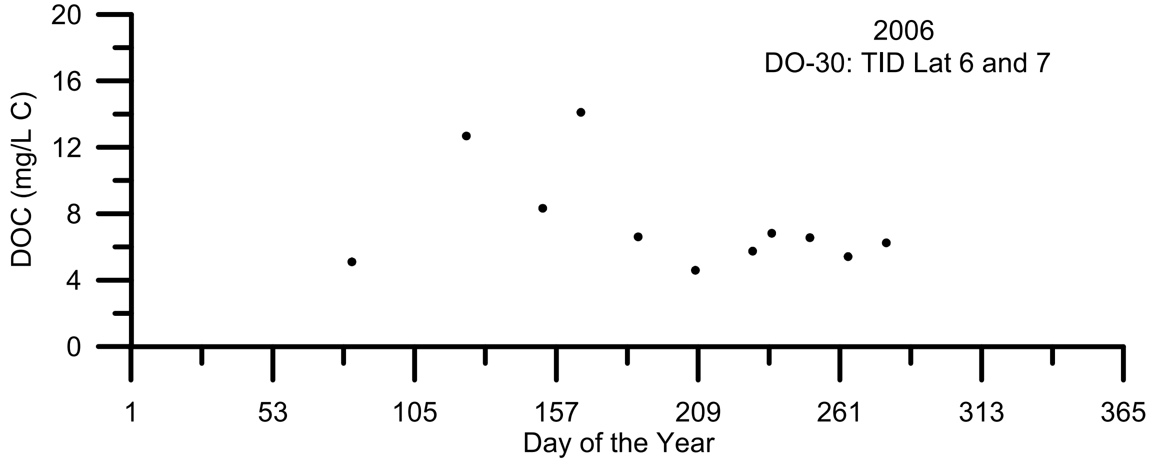

2007
DO-28: TID Westport Drain
DOC (mg/L C)
Day of the Year

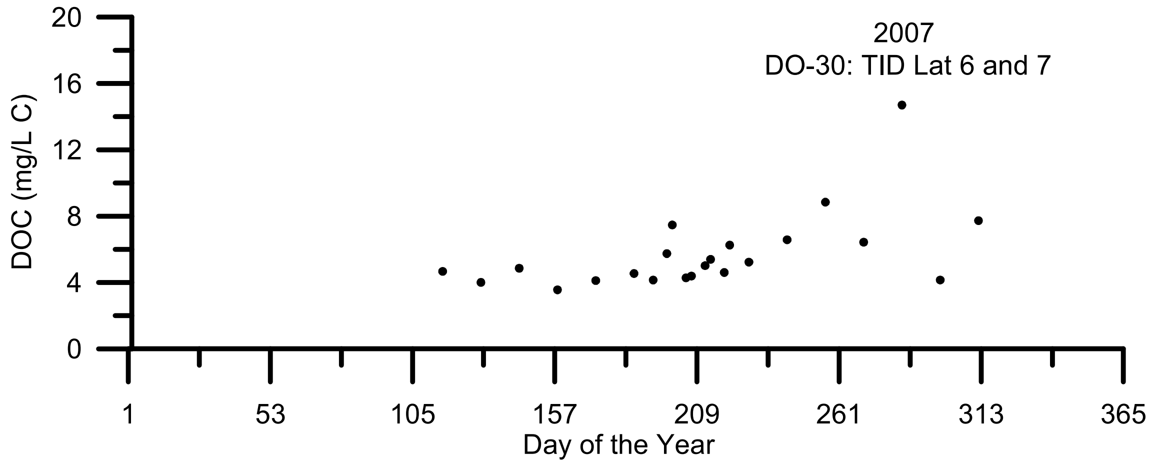

2005
DO-29: TID Harding Drain
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

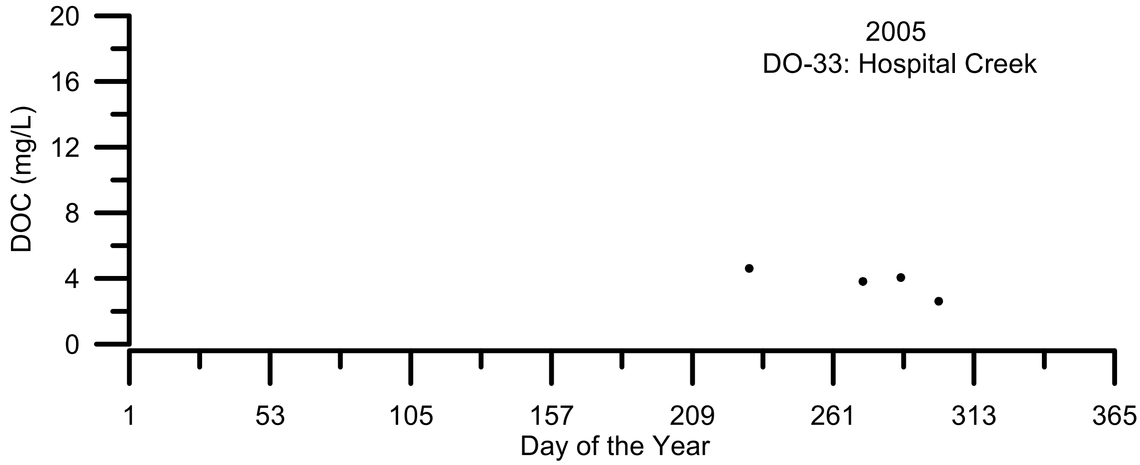

2006
DO-29: TID Harding Drain
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

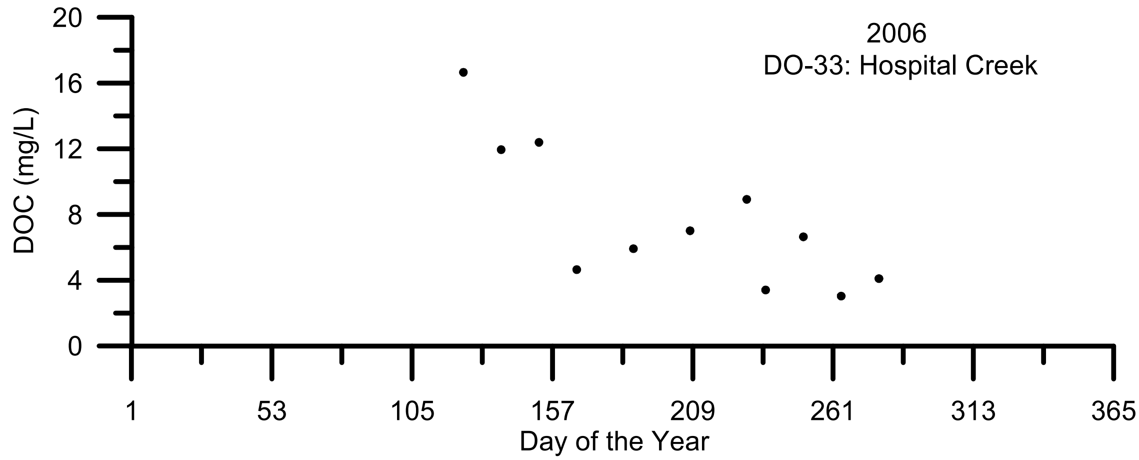

2007
DO-29: TID Harding Drain
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

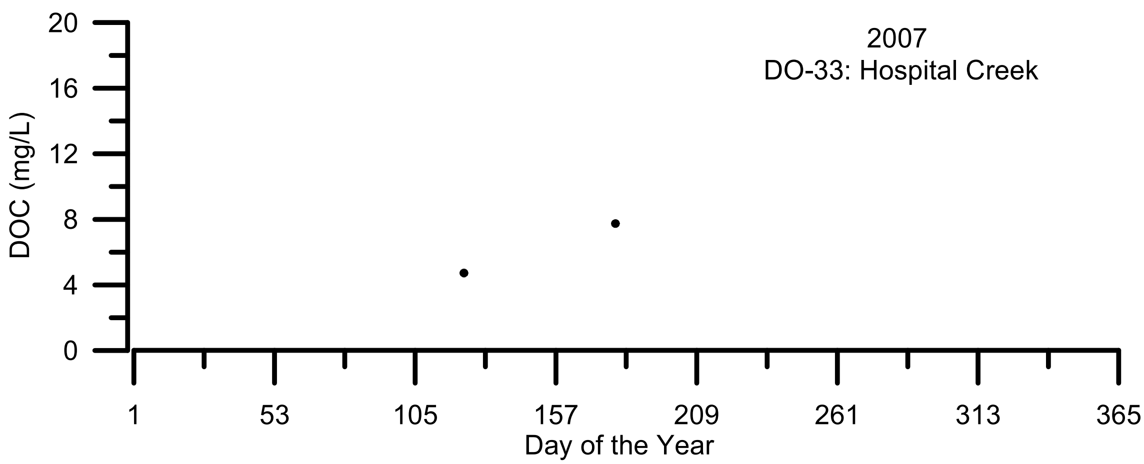

2005
DO-30: TID Lat 6 and 7
DOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

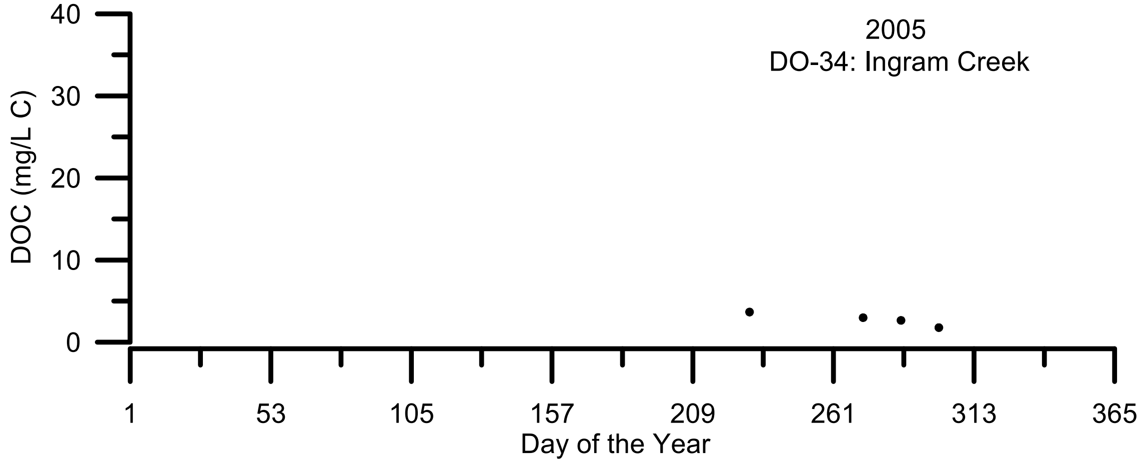

2006
DO-30: TID Lat 6 and 7
DOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

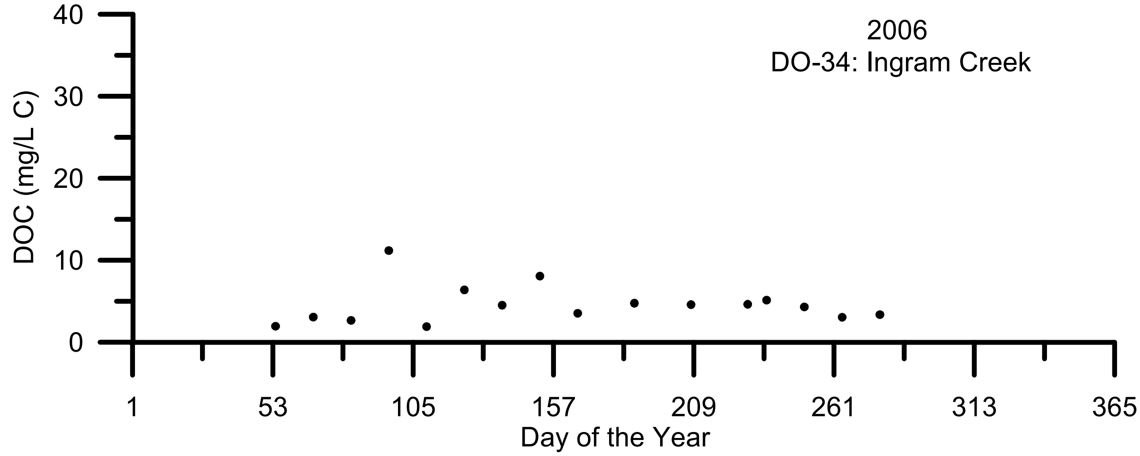

2007
DO-30: TID Lat 6 and 7
DOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

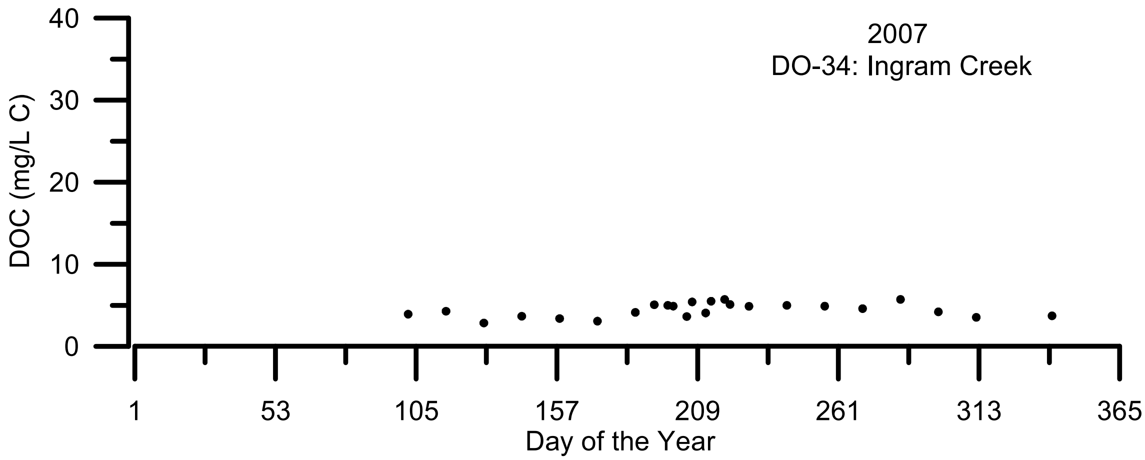

20
16
12
8
4
0
DOC (mg/L)
2005
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

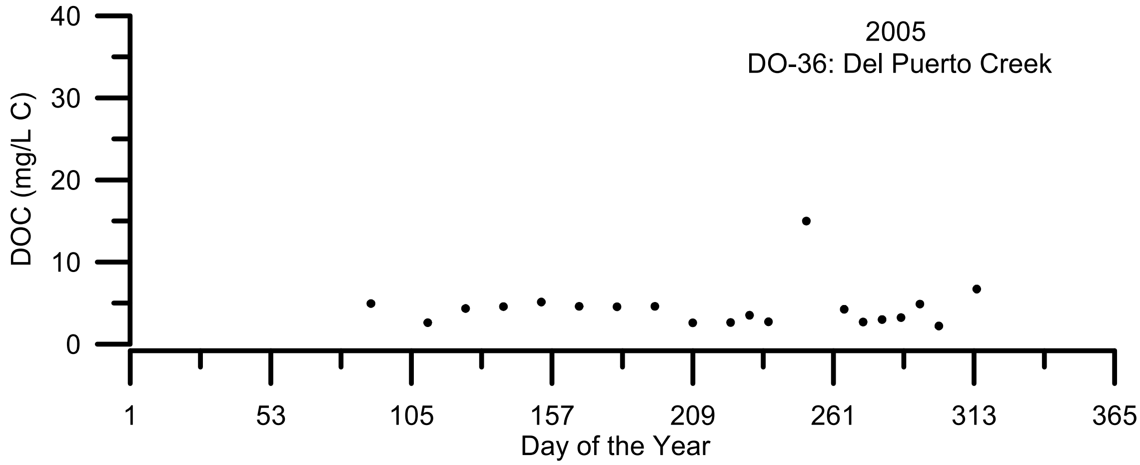

20
16
12
8
4
0
DOC (mg/L)
2006
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

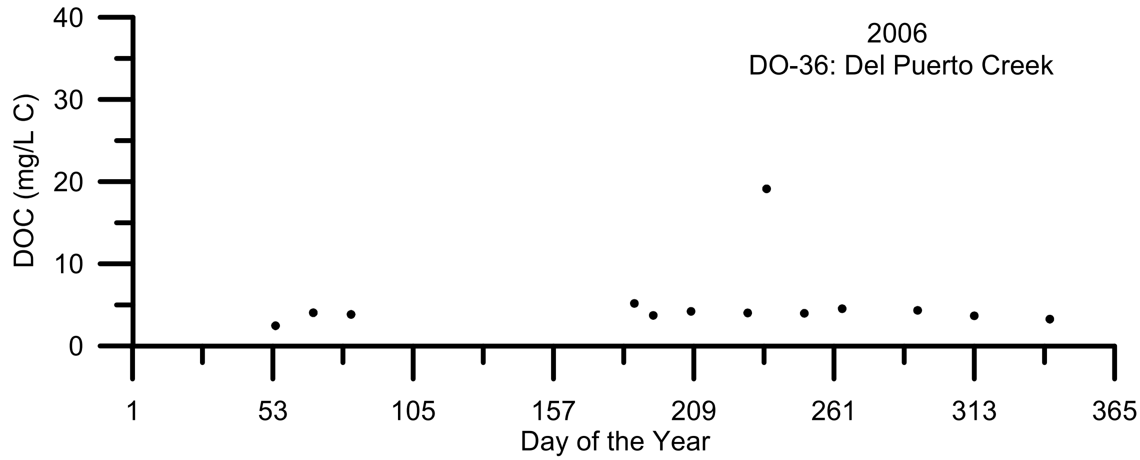

20
16
12
8
4
0
DOC (mg/L)
2007
DO-33: Hospital Creek
1
53
105
157
209
261
313
365
Day of the Year

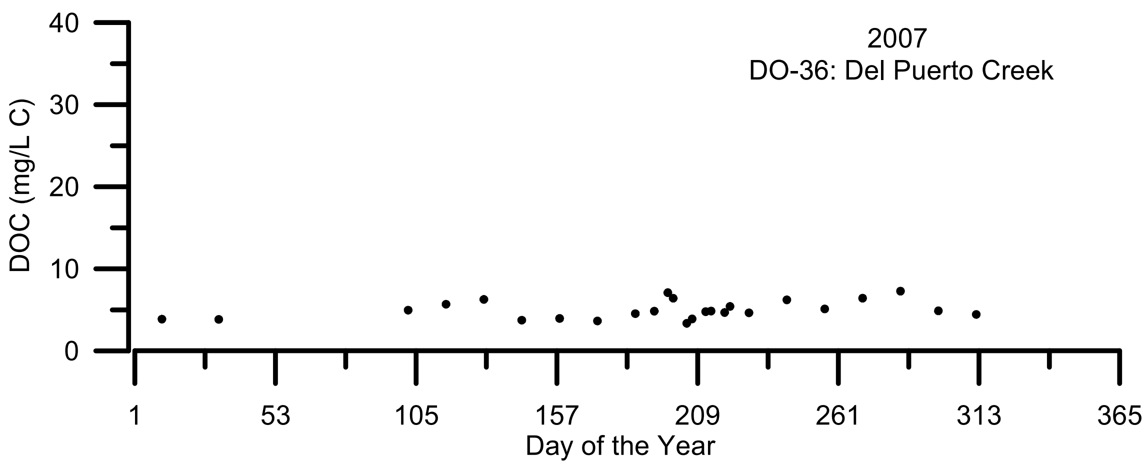

2005
DO-34: Ingram Creek
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

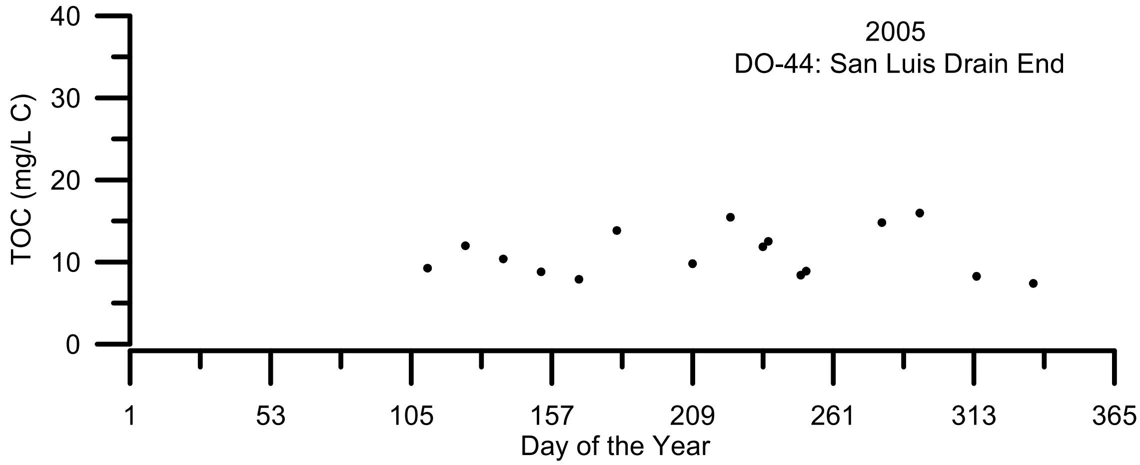

2006
DO-34: Ingram Creek
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

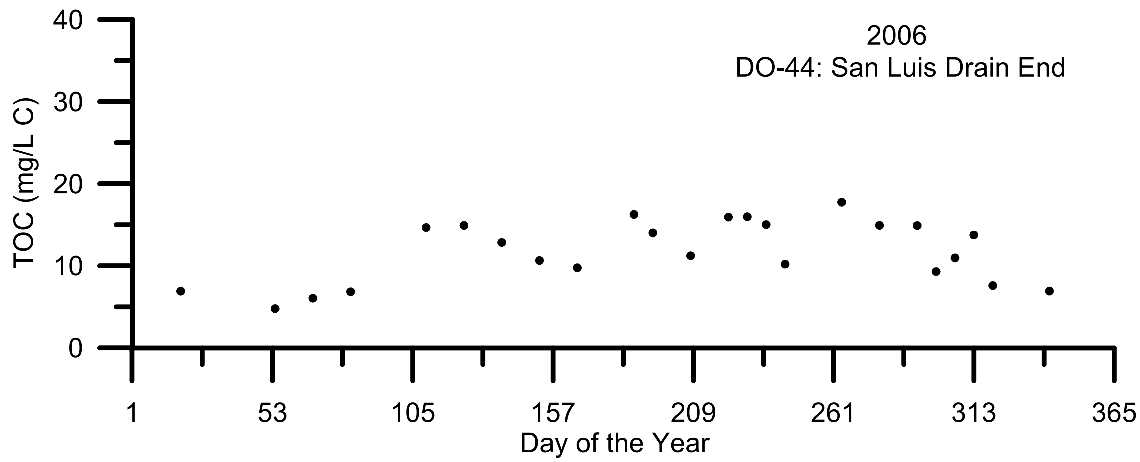

2007
DO-34: Ingram Creek
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

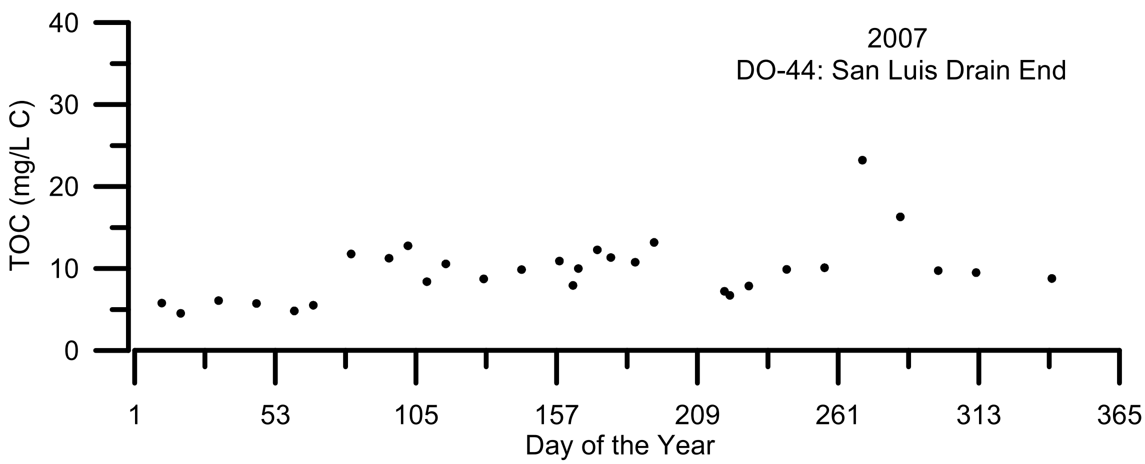

2005
DO-36: Del Puerto Creek
DOC (mg/L C)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

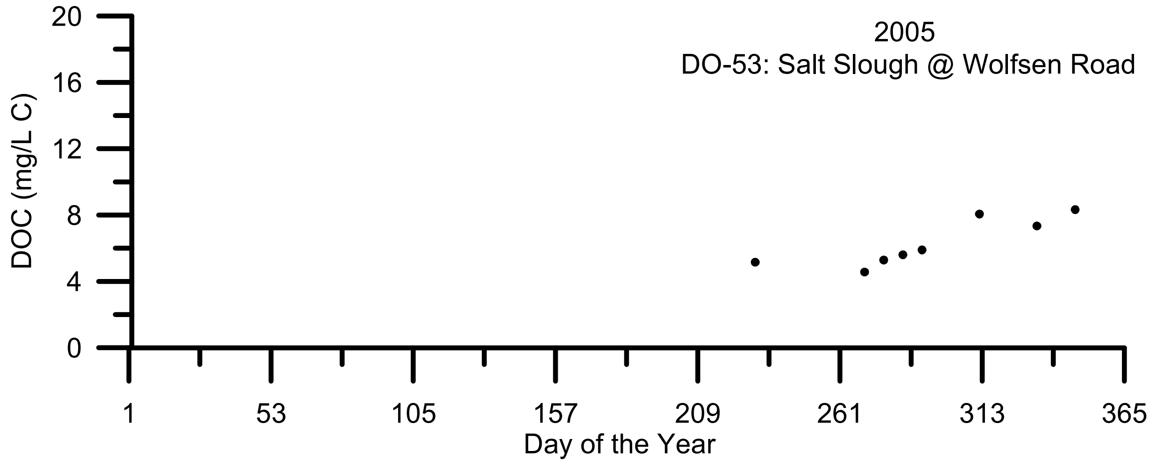

2006
DO-36: Del Puerto Creek
DOC (mg/L C)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

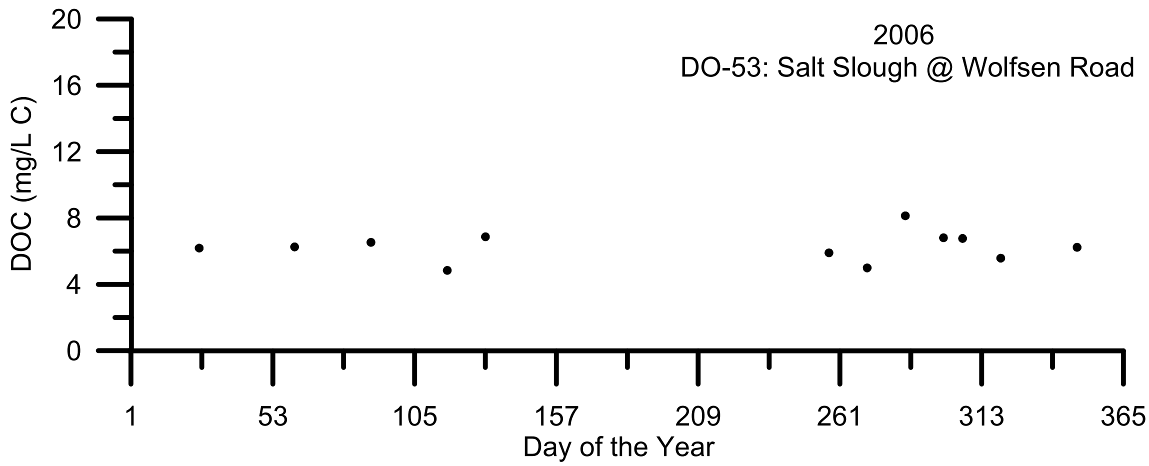

2007
DO-36: Del Puerto Creek
DOC (mg/L C)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

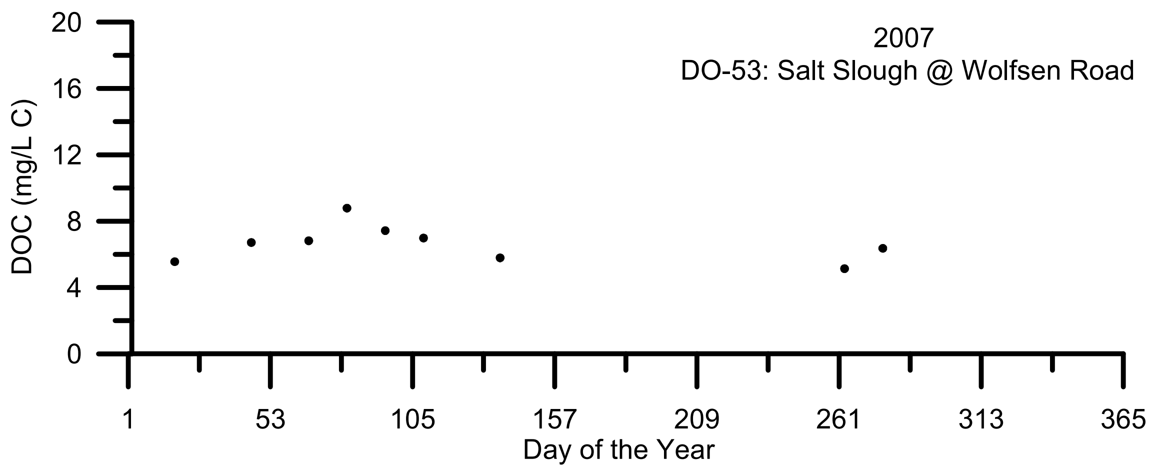

2005
DO-44: San Luis Drain End
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

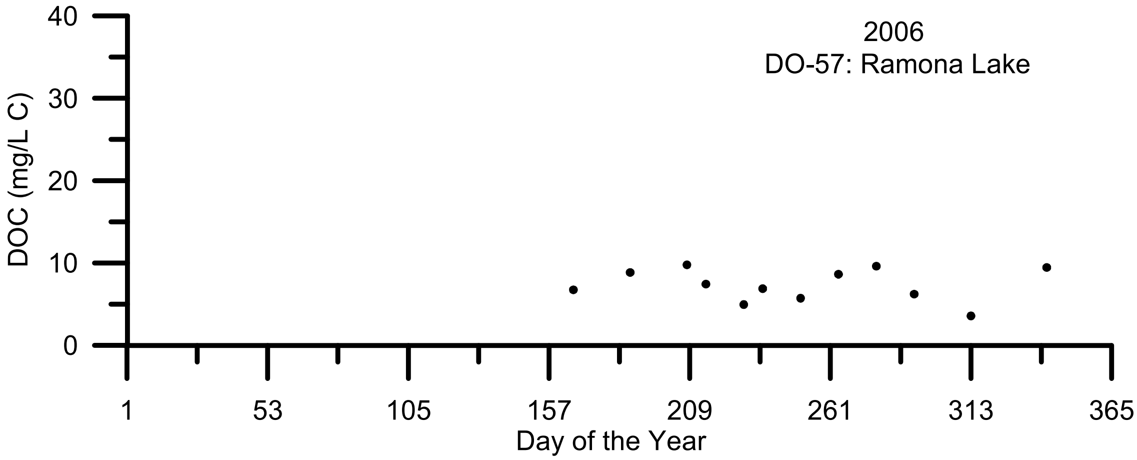

2006
DO-44: San Luis Drain End
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

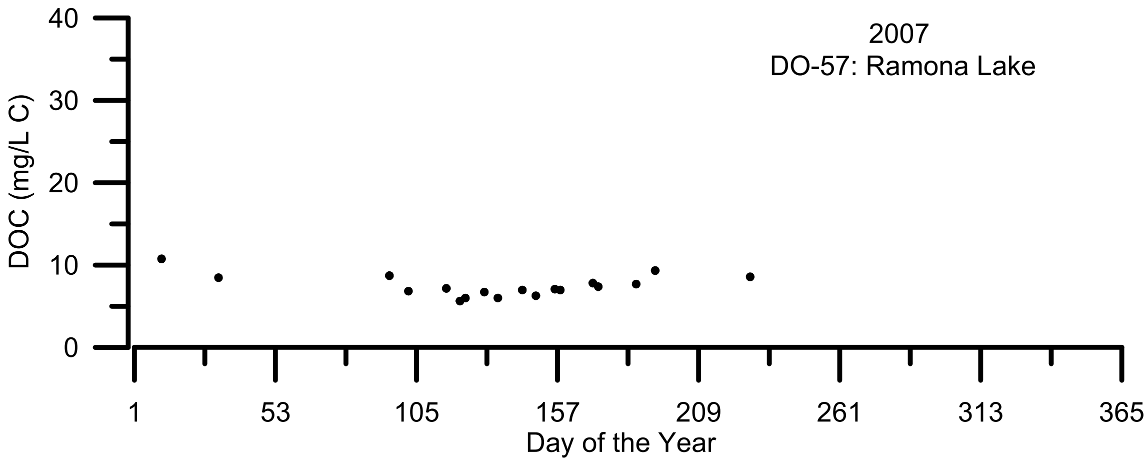

2007
DO-44: San Luis Drain End
TOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

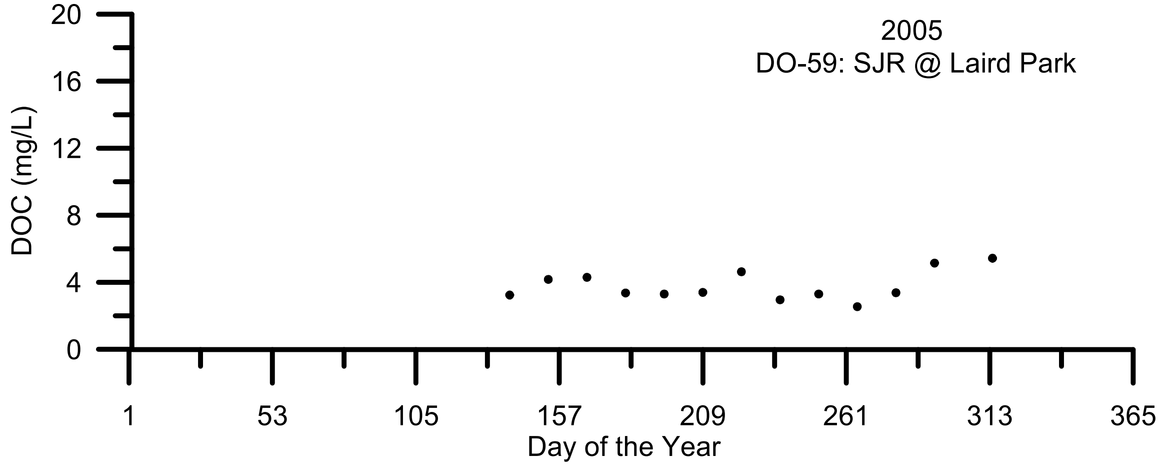

2005
DO-53: Salt Slough @ Wolfsen Road
DOC (mg/L C)
Day of the Year

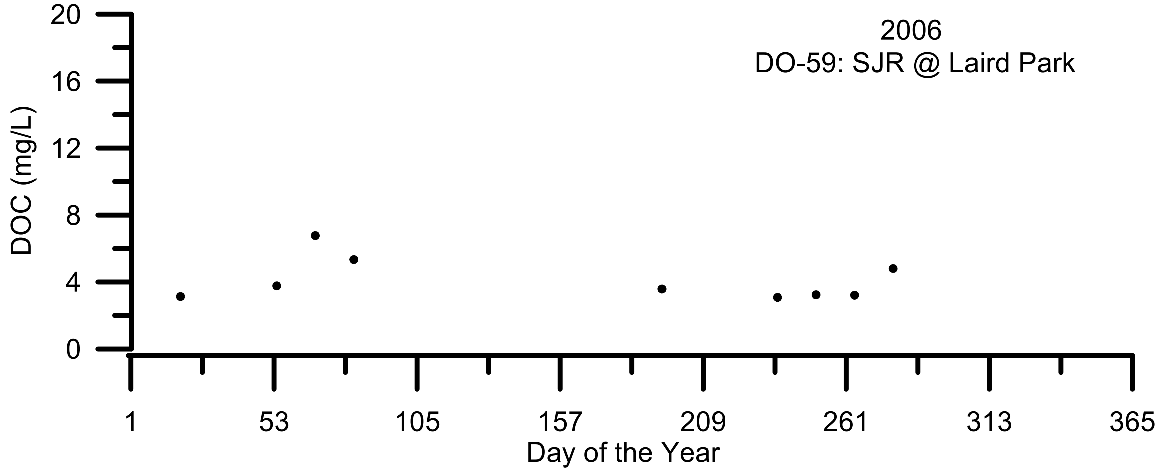

2006
DO-53: Salt Slough @ Wolfsen Road
DOC (mg/L C)
Day of the Year

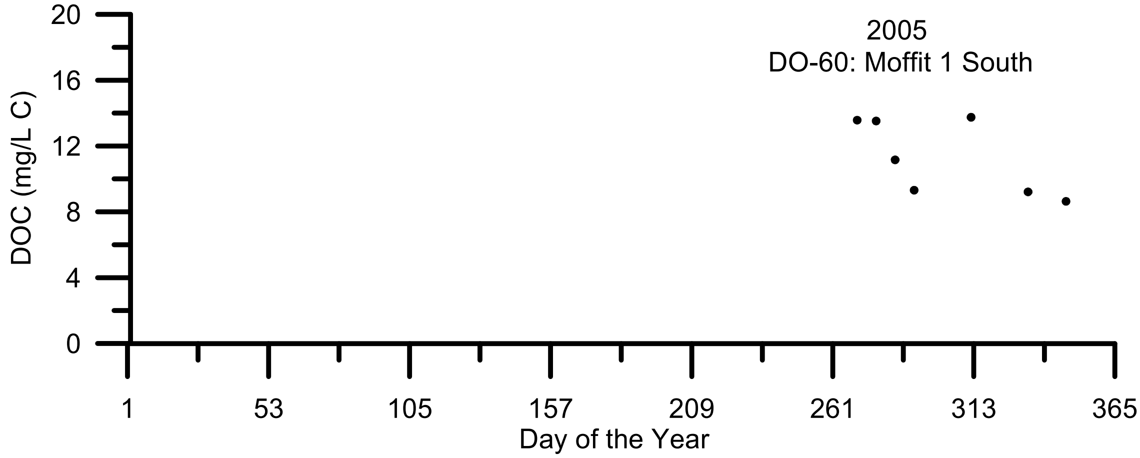

2007
DO-53: Salt Slough @ Wolfsen Road
DOC (mg/L C)
Day of the Year

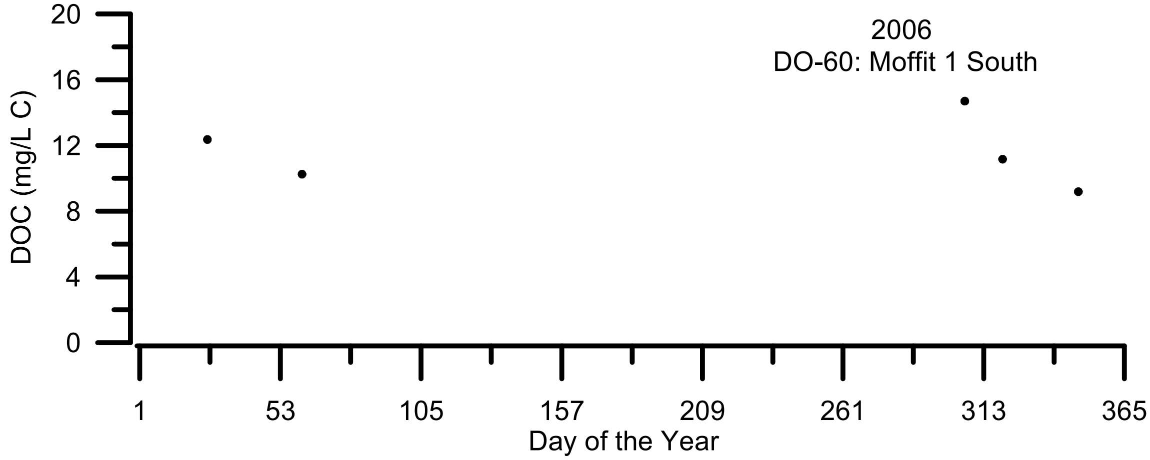

2006
DO-57: Ramona Lake
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

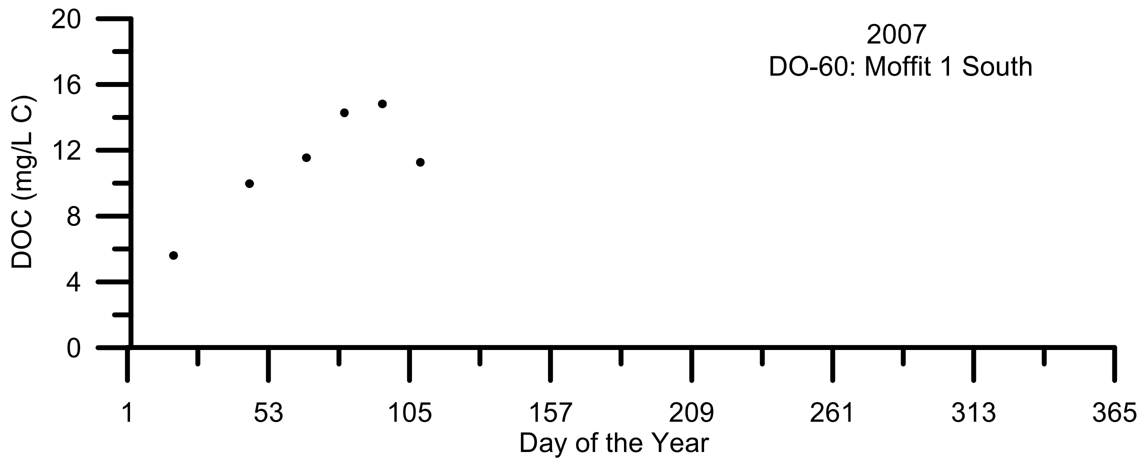

2007
DO-57: Ramona Lake
DOC (mg/L C)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

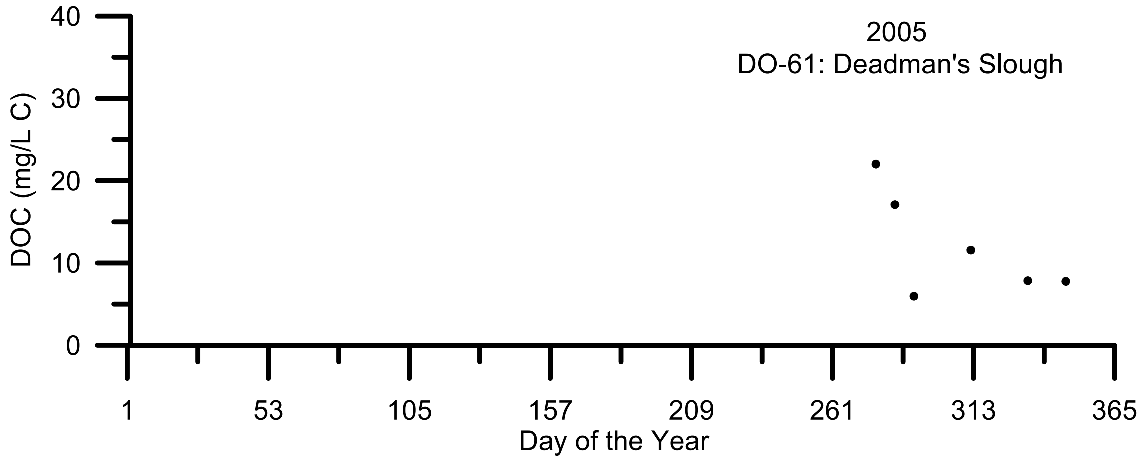

2005
DO-59: SJR @ Laird Park
DOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

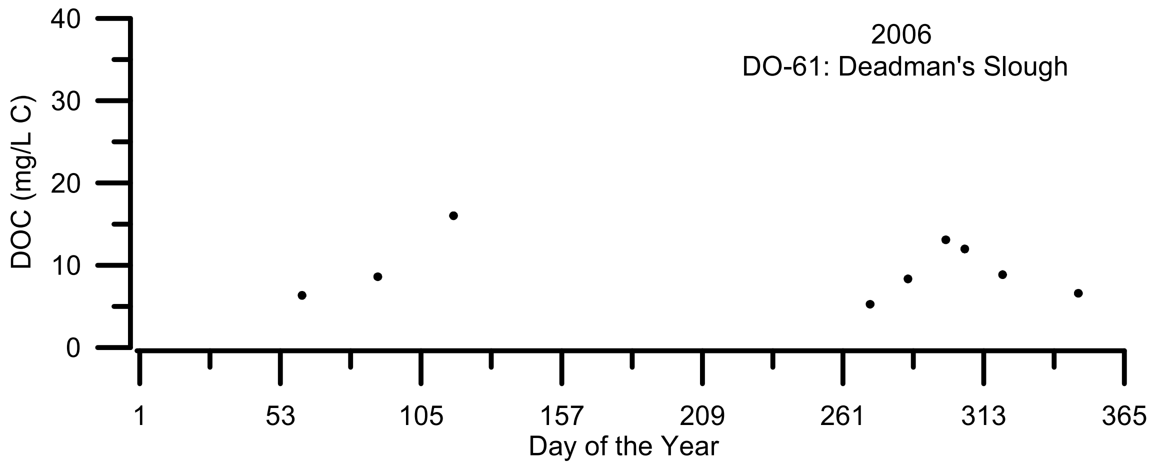

2006
DO-59: SJR @ Laird Park
DOC (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

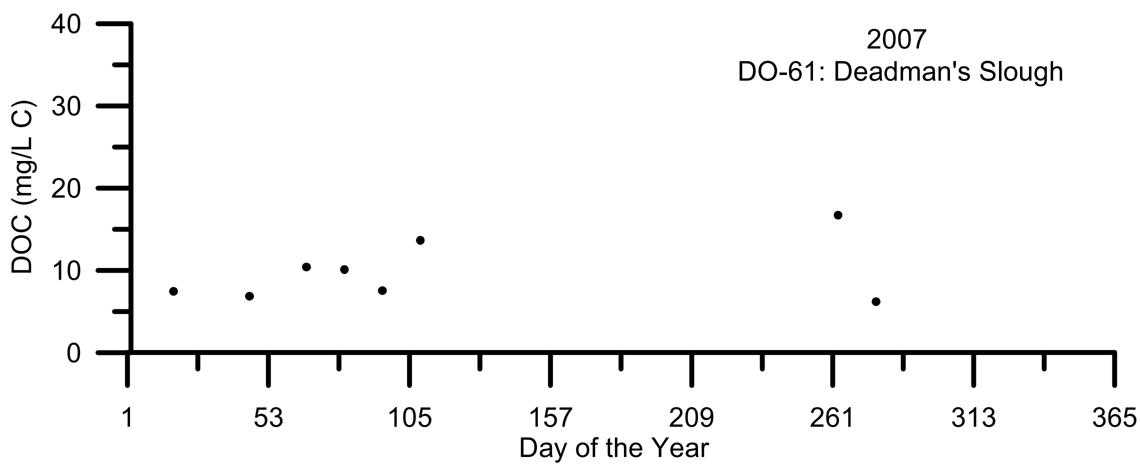

2005
DO-60: Moffit 1 South
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

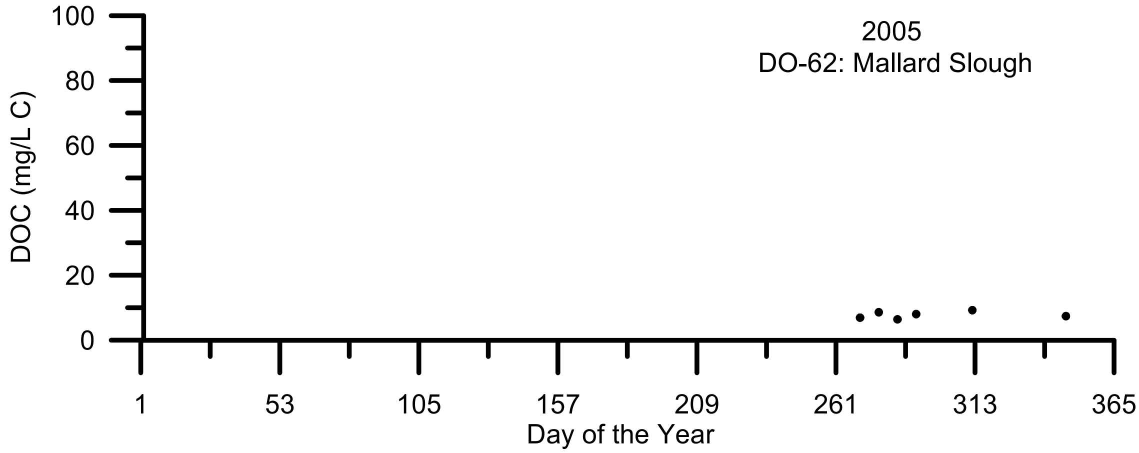

2006
DO-60: Moffit 1 South
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

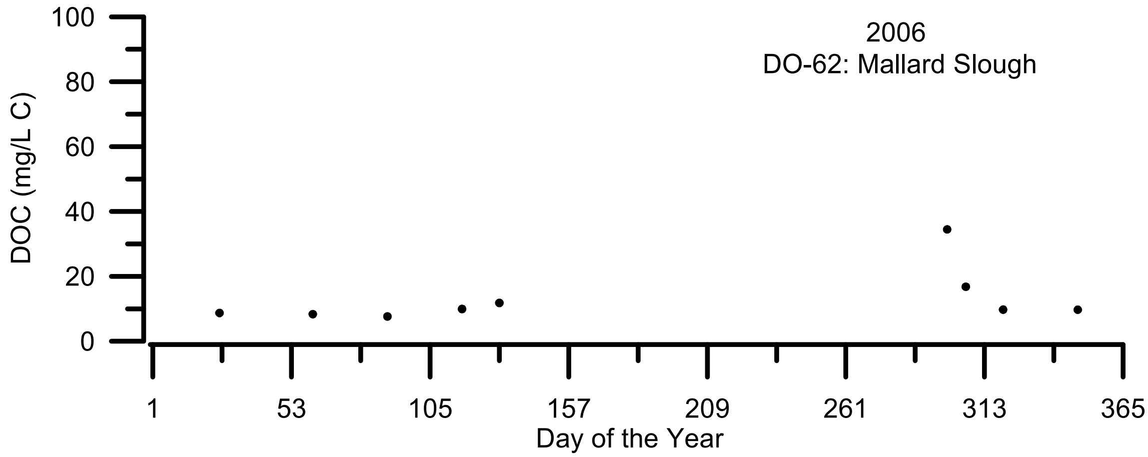

2007
DO-60: Moffit 1 South
DOC (mg/L C)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

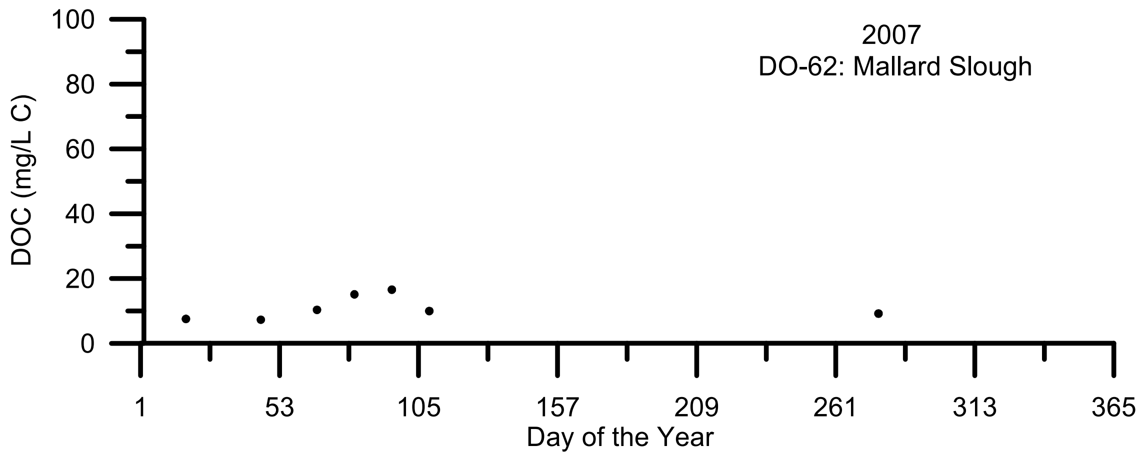

2005
DO-61: Deadman's Slough
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

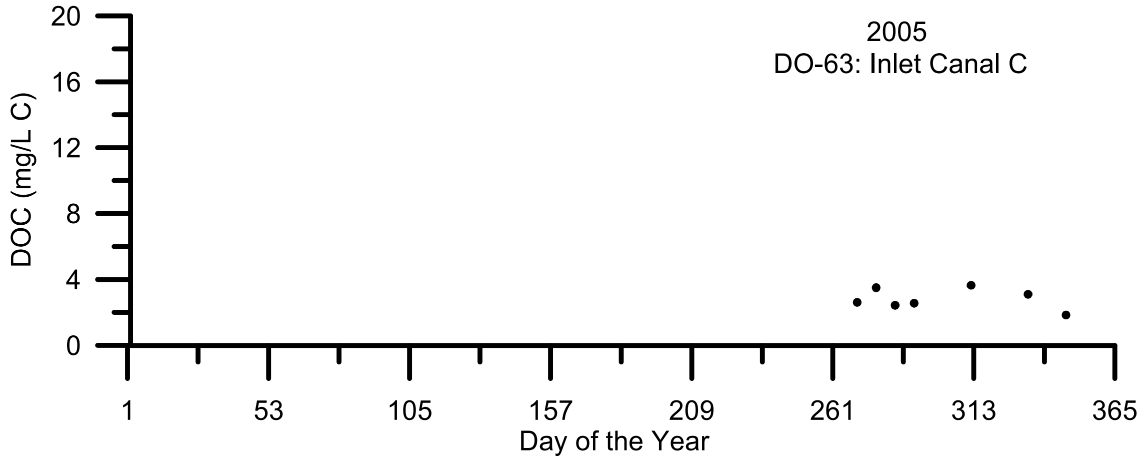

2006
DO-61: Deadman's Slough
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-61: Deadman's Slough
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

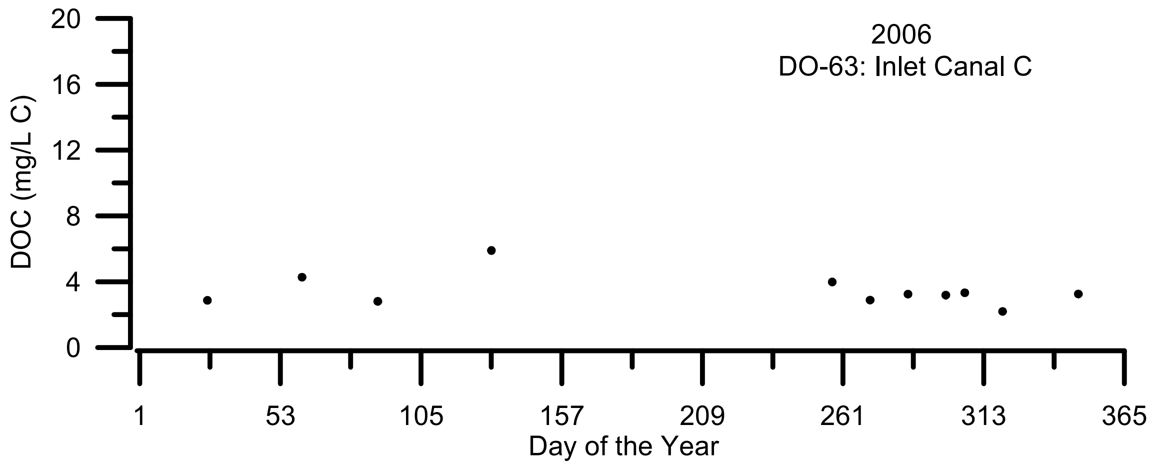

2005
DO-62: Mallard Slough
DOC (mg/L C)
Day of the Year
100
80
60
40
20
0
1
53
105
157
209
261
313
365


2006
DO-62: Mallard Slough
DOC (mg/L C)
Day of the Year
100
80
60
40
20
0
1
53
105
157
209
261
313
365

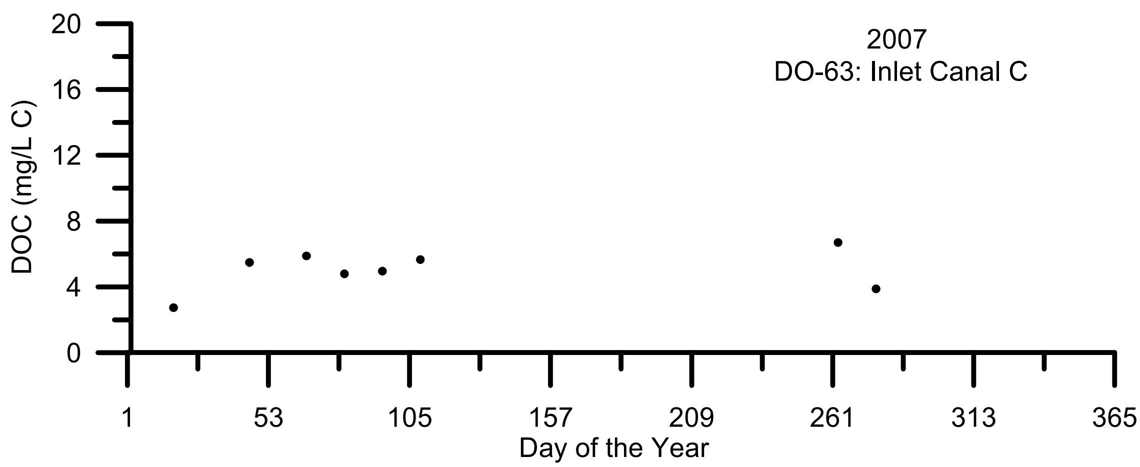

2007
DO-62: Mallard Slough
DOC (mg/L C)
Day of the Year
100
80
60
40
20
0
1
53
105
157
209
261
313
365



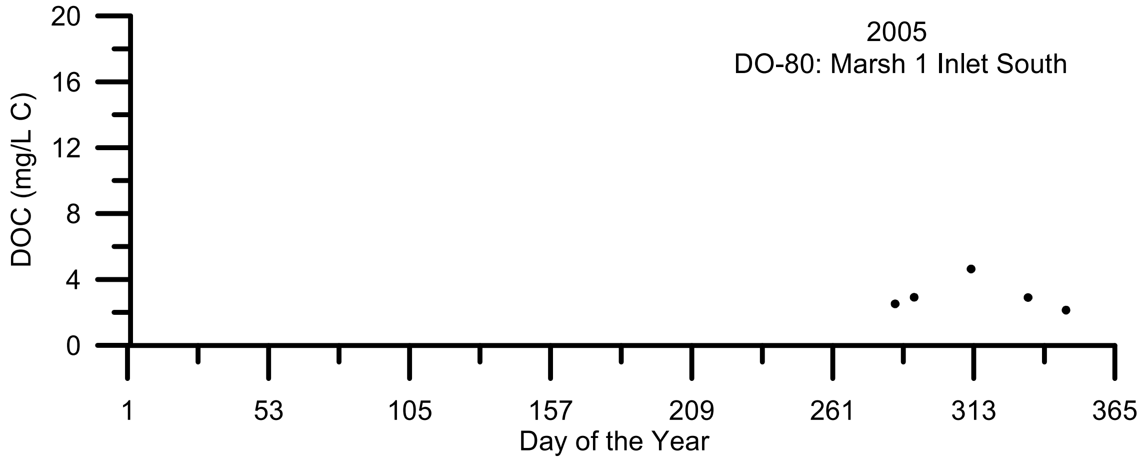
2005
DO-63: Inlet Canal C
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

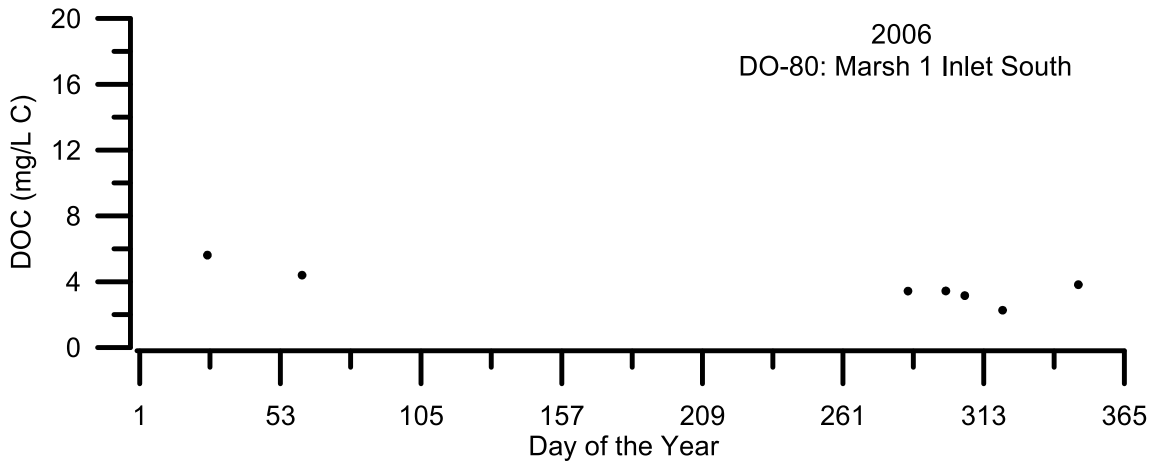


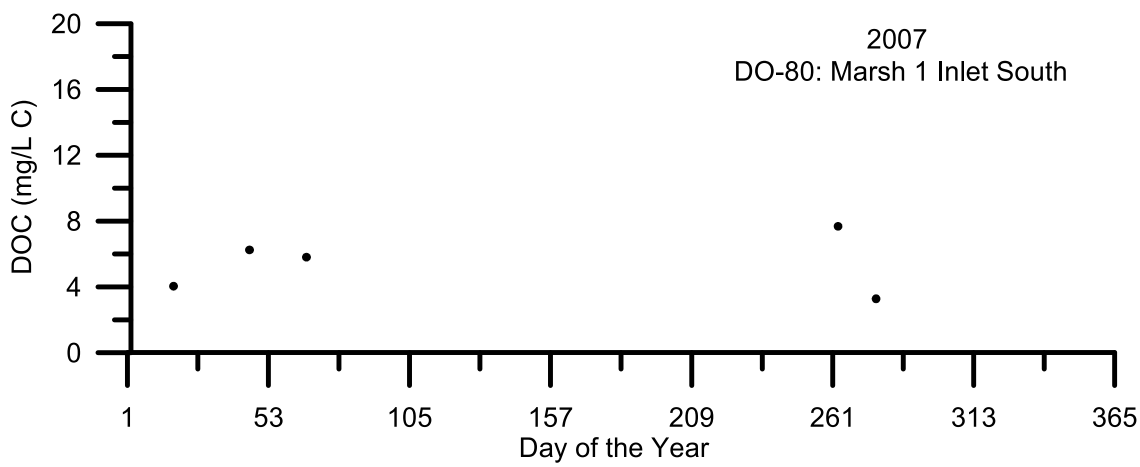
2006
DO-63: Inlet Canal C
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

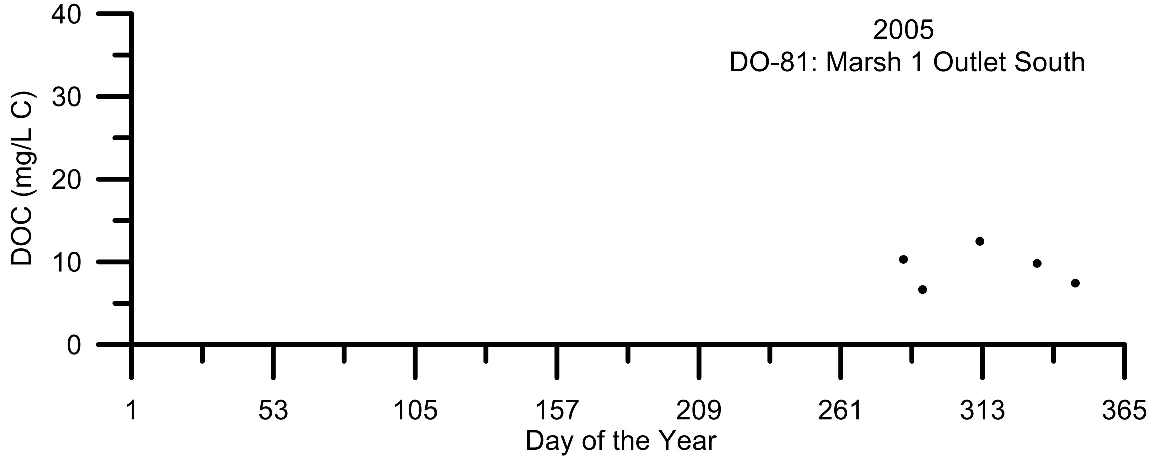


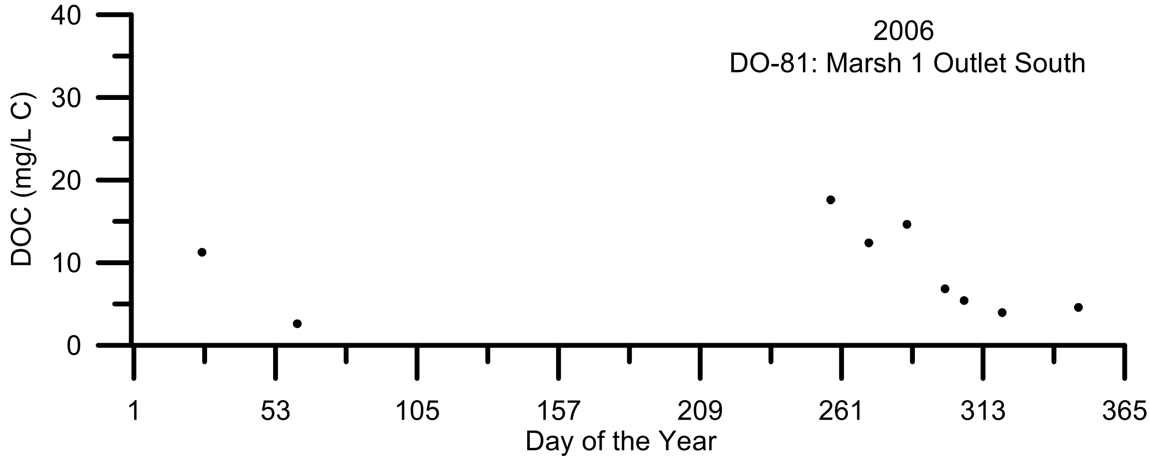
2007
DO-63: Inlet Canal C
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

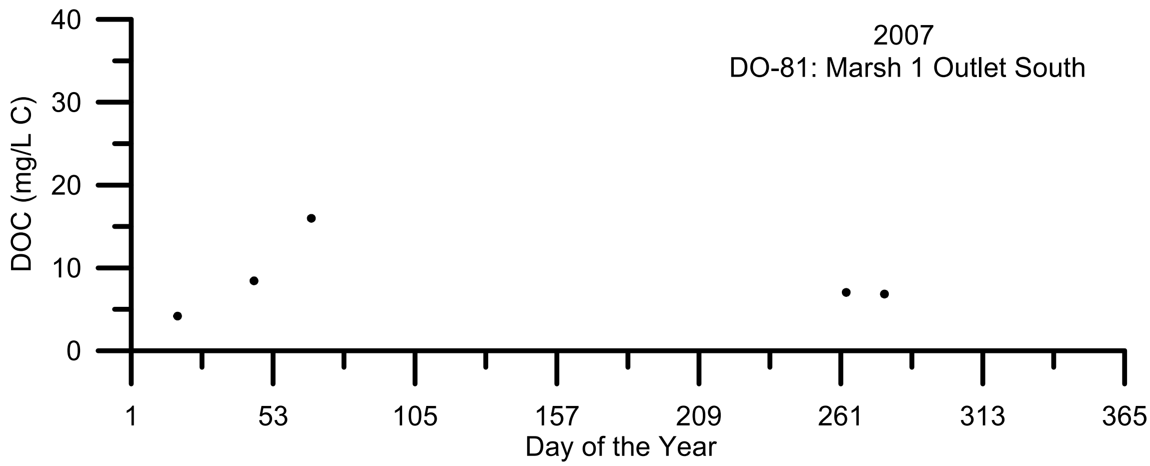

2005
DO-80: Marsh 1 Inlet South
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

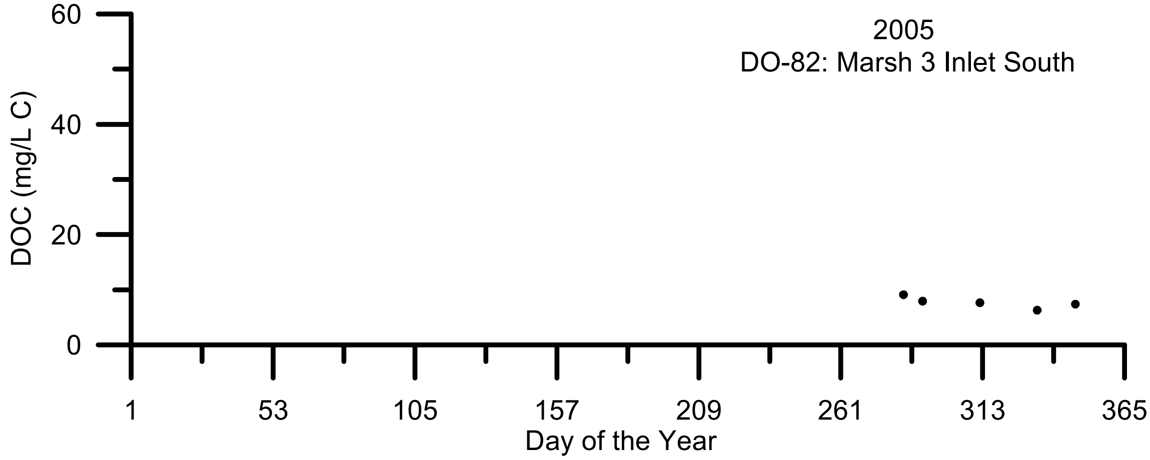

2006
DO-80: Marsh 1 Inlet South
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

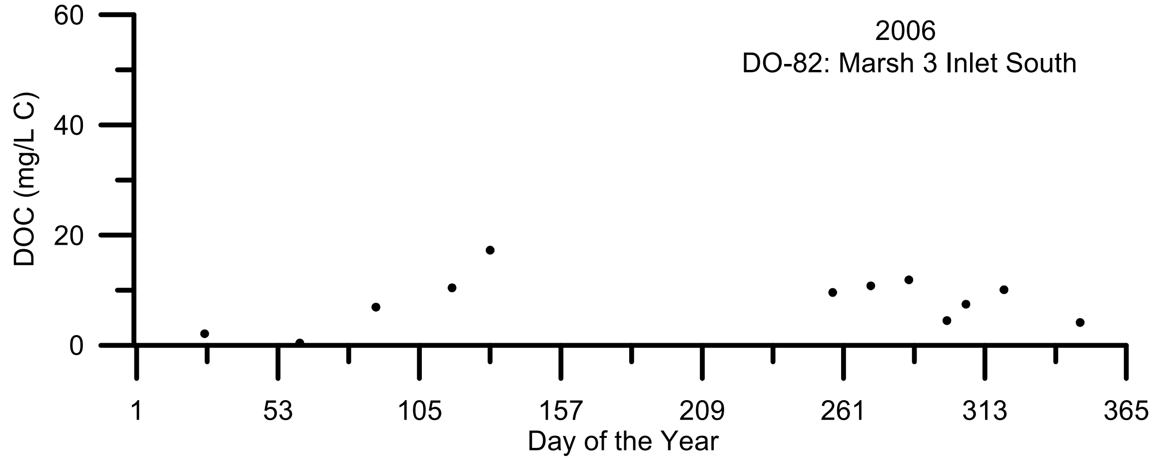

2007
DO-80: Marsh 1 Inlet South
DOC (mg/L C)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

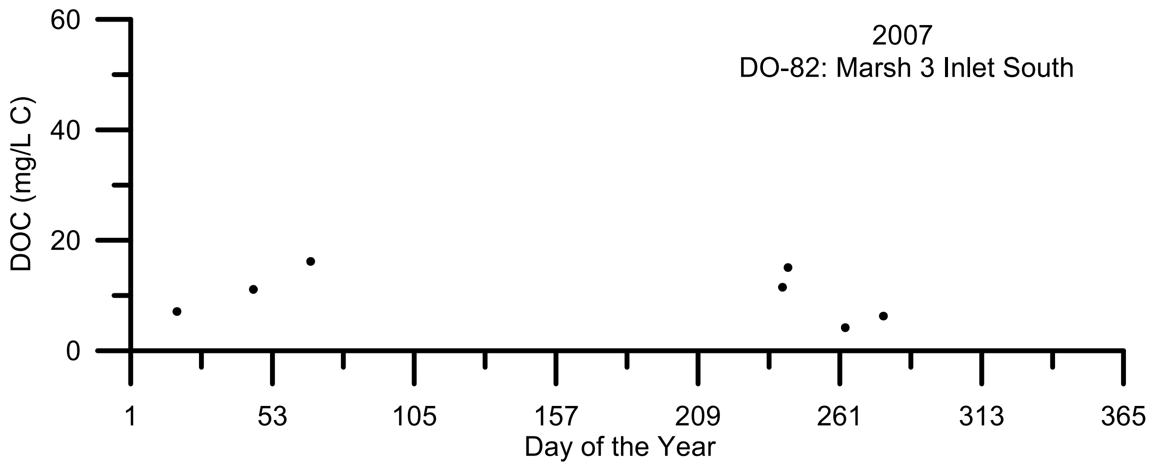

2005
DO-81: Marsh 1 Outlet South
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

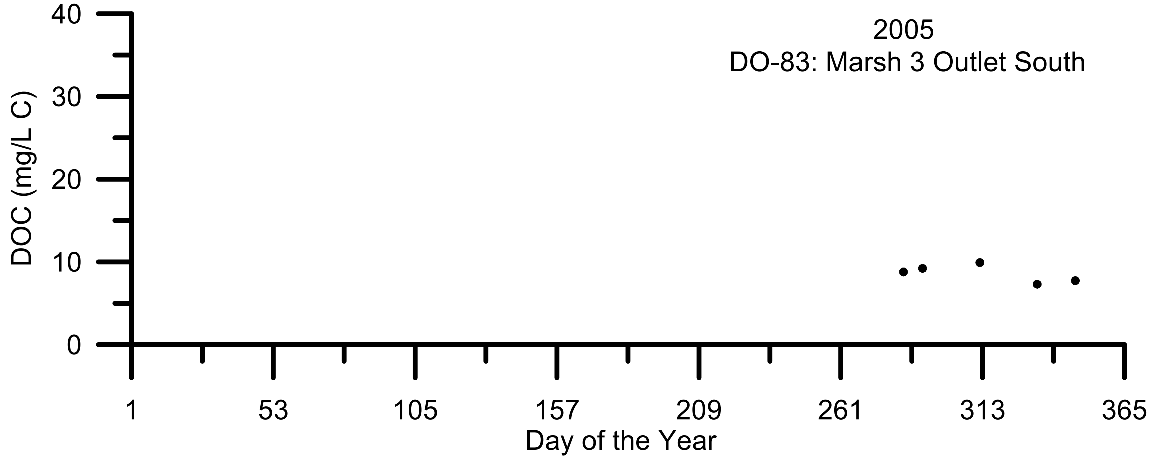

2006
DO-81: Marsh 1 Outlet South
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

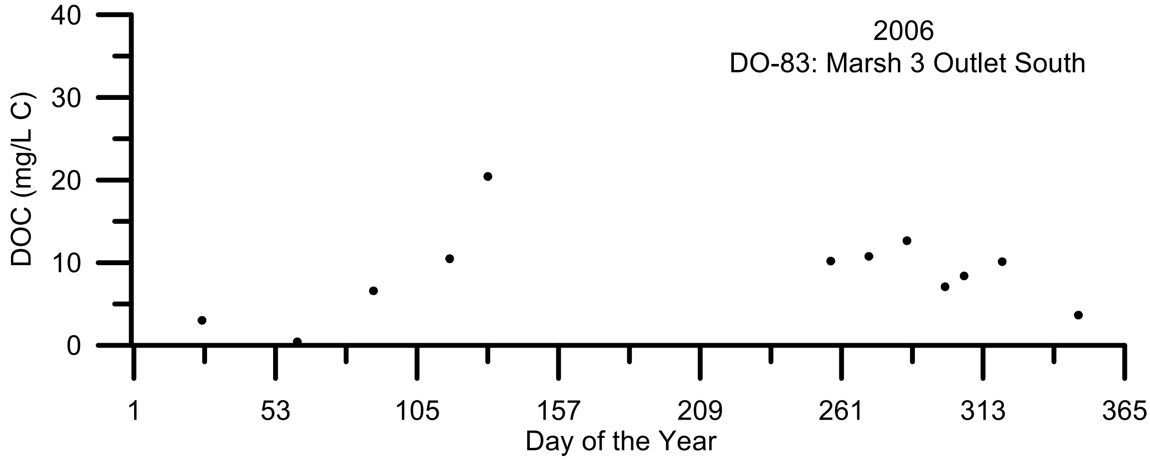

2007
DO-81: Marsh 1 Outlet South
DOC (mg/L C)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

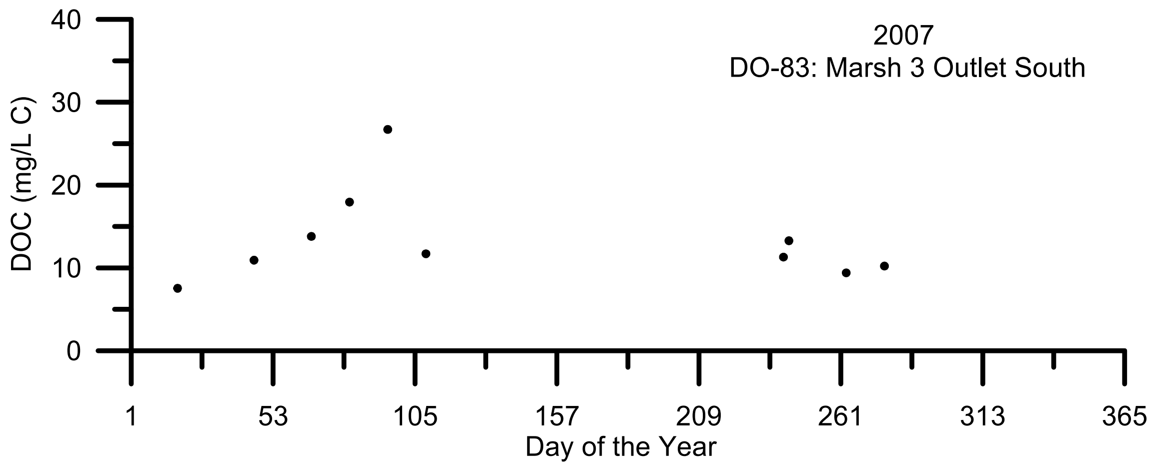

2005
DO-82: Marsh 3 Inlet South
DOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

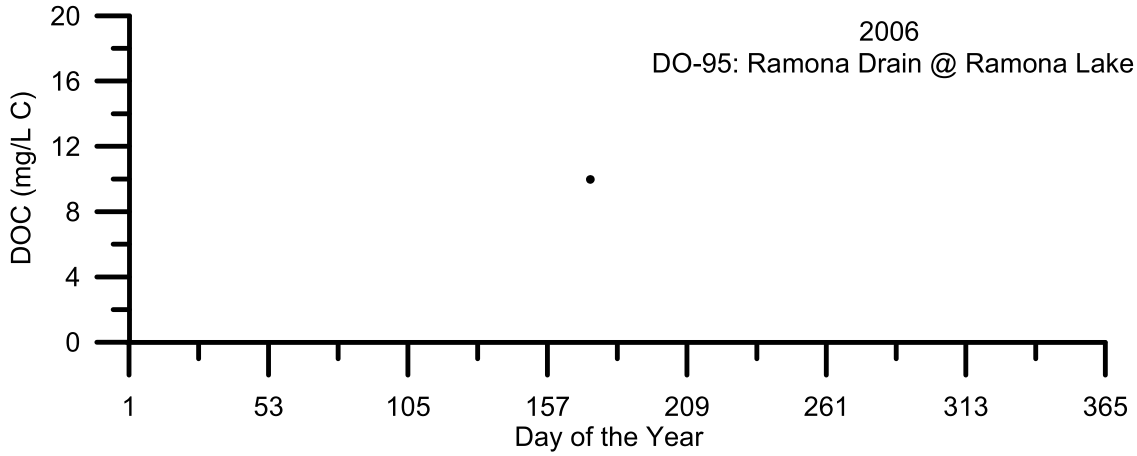

2006
DO-82: Marsh 3 Inlet South
DOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

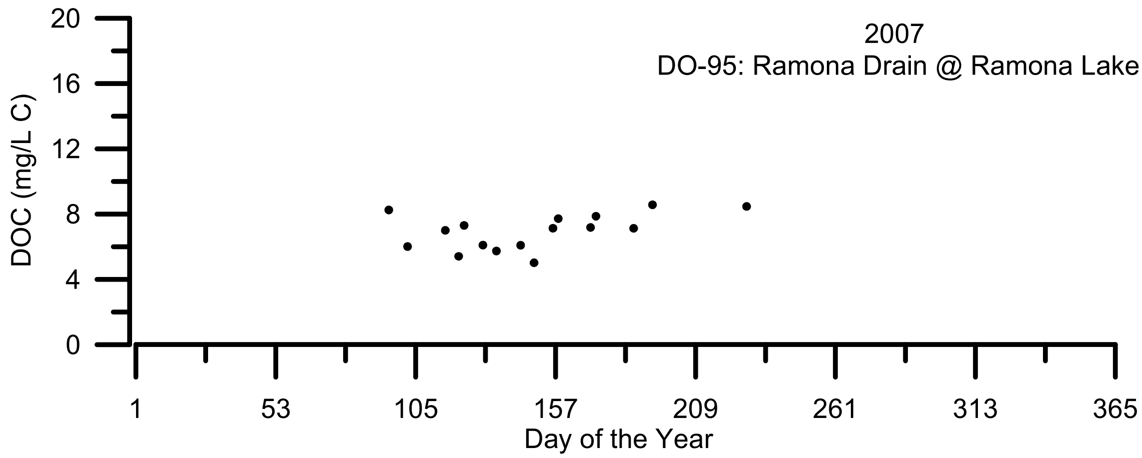

2007
DO-82: Marsh 3 Inlet South
DOC (mg/L C)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-83: Marsh 3 Outlet South
DOC (mg/L C)
Day of the Year


2006
DO-83: Marsh 3 Outlet South
DOC (mg/L C)
Day of the Year


2007
DO-83: Marsh 3 Outlet South
DOC (mg/L C)
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
DOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
DOC (mg/L C)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

UNIVERSITY OF THE PACIFIC
Environmental Engineering Research Program

Analysis of Carbonaceous Biochemical Oxygen Demand in the San Joaquin River Watershed 2005-2007

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William Stringfellow

February 2008

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Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of carbonaceous biochemical oxygen demand (CBOD) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at $4^{\circ}C$ until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Unfiltered samples were analyzed for Biochemical oxygen demand (BOD) by Standard Method (SM) 5210 B (APHA, 2005) with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set will be consistent with prior studies. BOD was measured without seed, as in previous studies. Initial and final dissolved oxygen was measured using a calibrated YSI 5000 DO meter equipped with a YSI 5010 BOD probe (Yellow Springs, OH) and calibrated by Winkler titration according to SM 10200 H (APHA, 2005). In addition, Carbonaceous BOD (CBOD) was determined by adding 0.16 mg of nitrification inhibitor (N-serve, HACH, Loveland, CO) to a duplicate sample set. The resulting CBOD was subtracted from the total BOD to determine the Nitrogenous BOD (NBOD). The limit of detection for BOD, CBOD and NBOD is 1.0mg/L.

Results and Discussion

Carbonaceous biochemical oxygen demand (CBOD) analysis was preformed routinely over the three year period with the 10-day modification of the standard method (Borglin et. al., 2008). A 96.31% passing rate for all QA parameters over the three years was observed and few (2 total) proficiency check samples were analyzed and for our modified method, a 100% passing rate was seen (Borglin et. al., 2008). Additional problems with particular sampling sets occurred due to equipment failure (incubator and DO meter) causing those sample sets to be excluded from our final compiled data.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

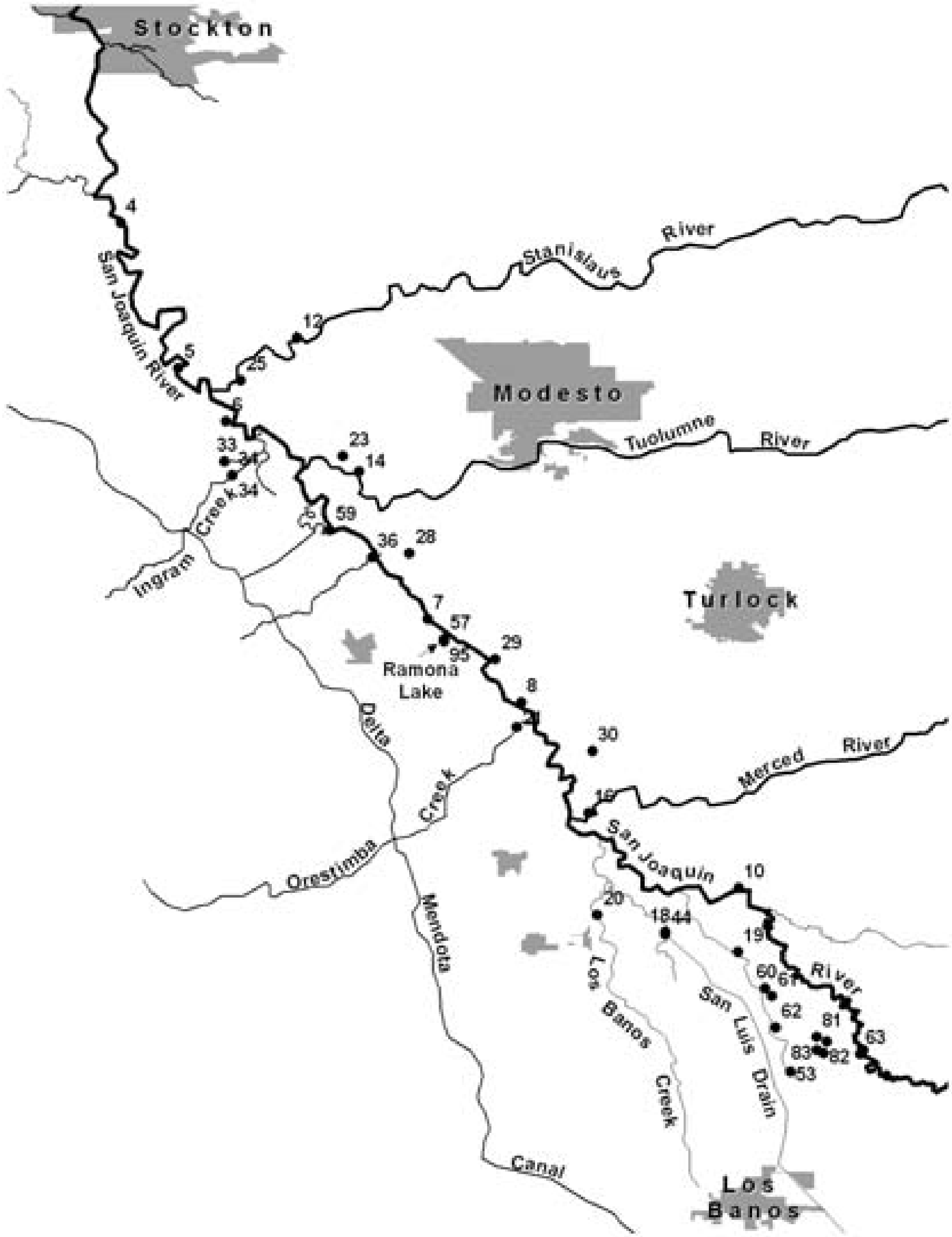
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

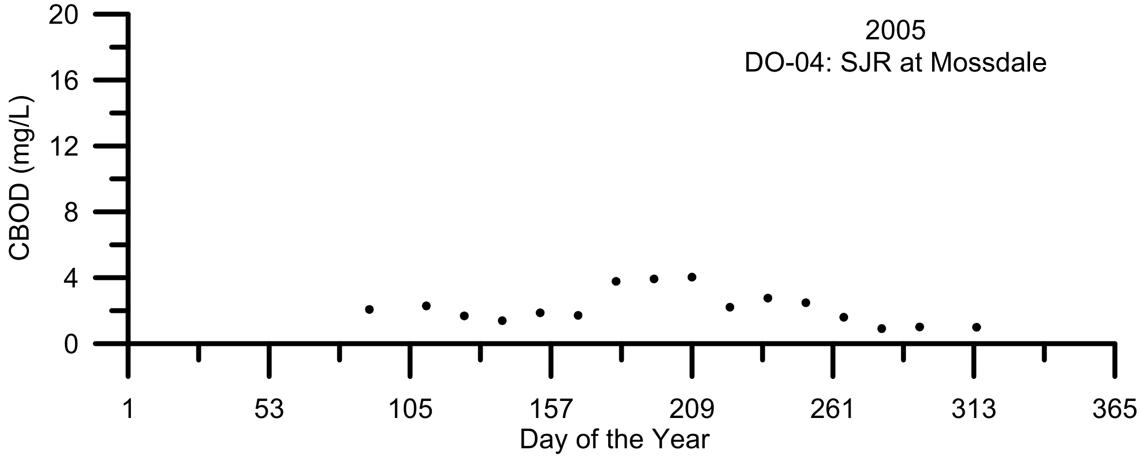
Table 1: EERP Sampling Site List

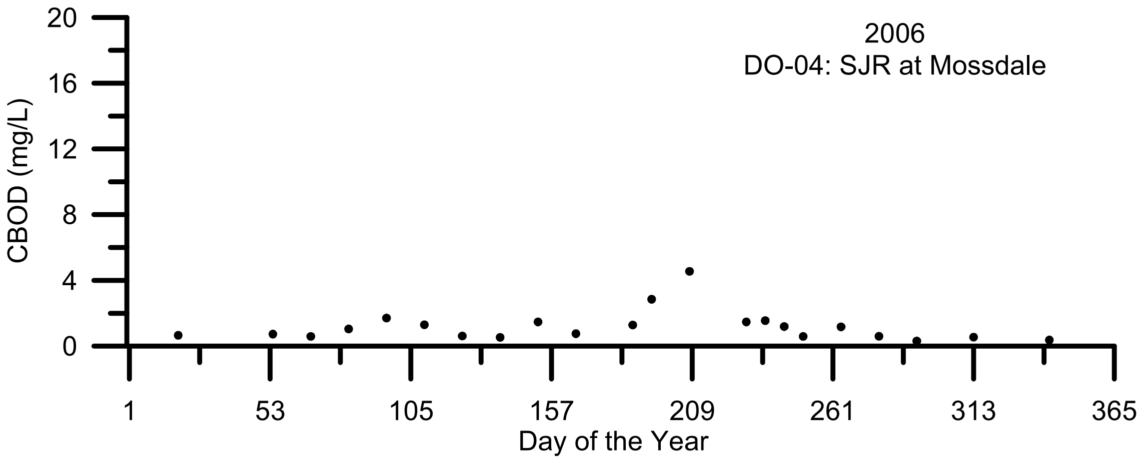
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

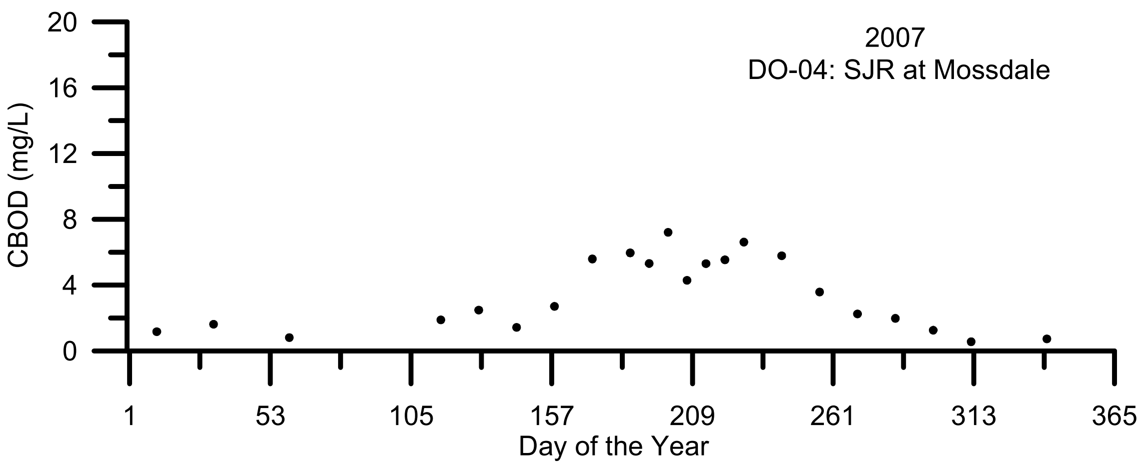
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

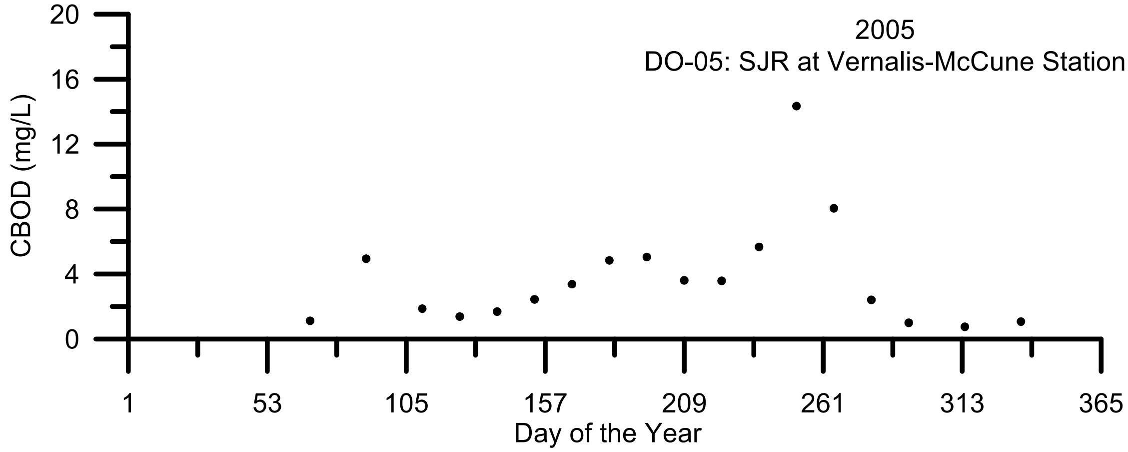


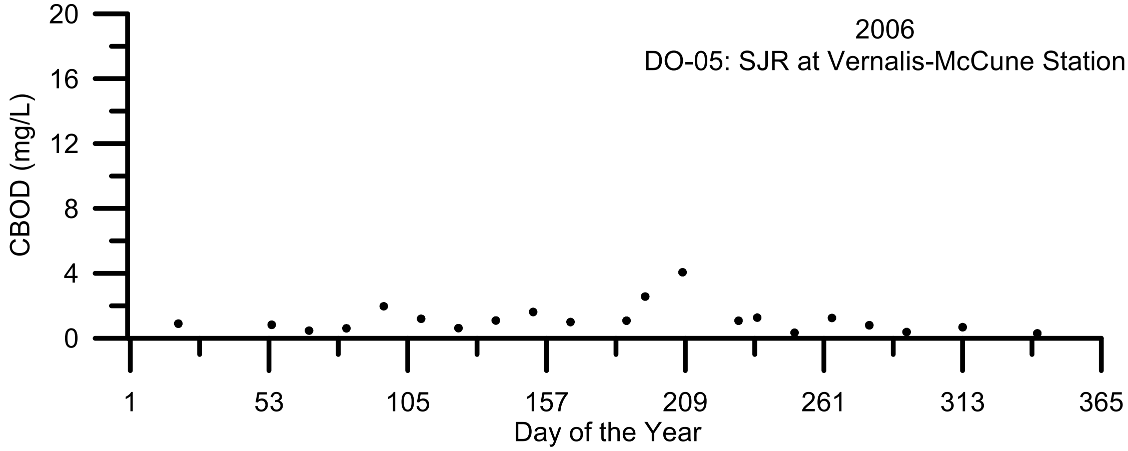
Figures 2 -101: Temporal Plots of CBOD By Site ID

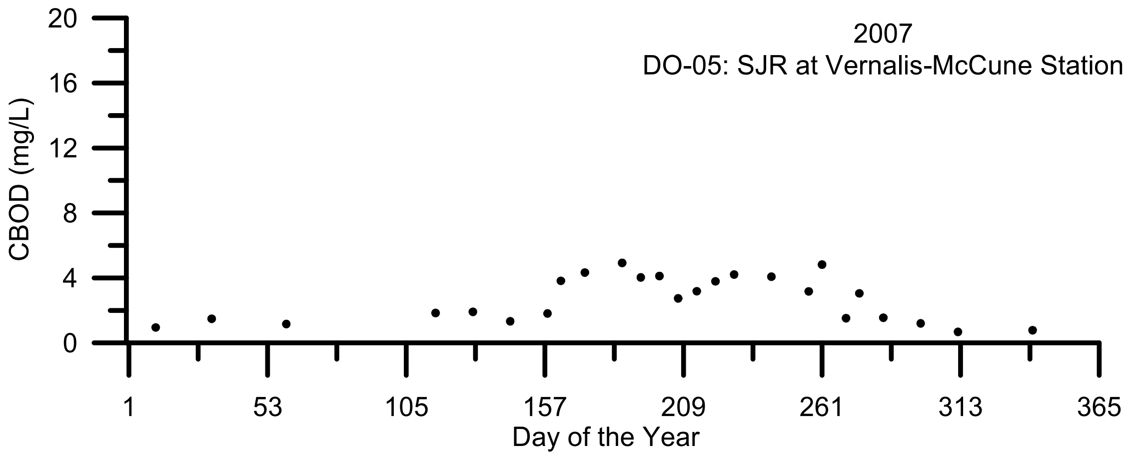


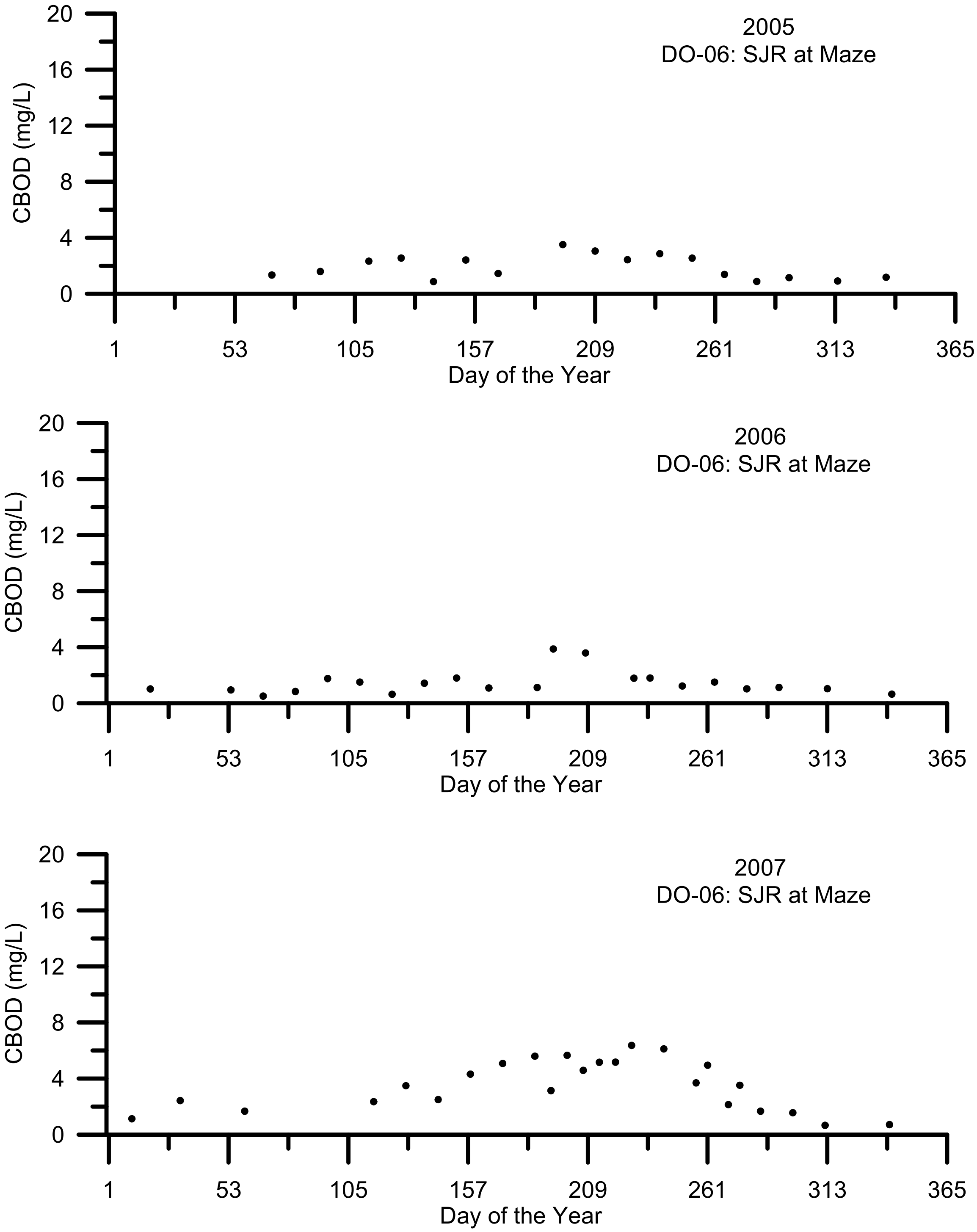




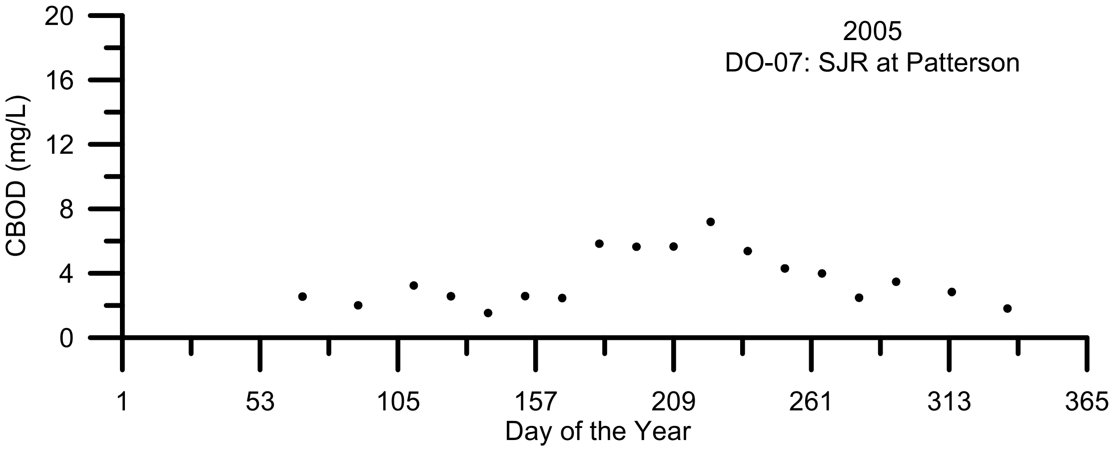

2005
DO-05: SJR at Vernalis-McCune Station
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

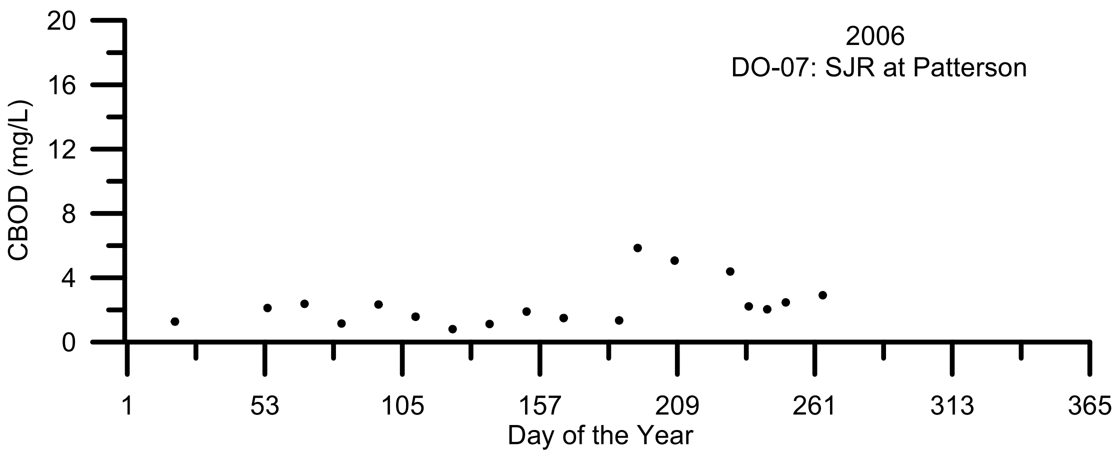

2006
DO-05: SJR at Vernalis-McCune Station
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

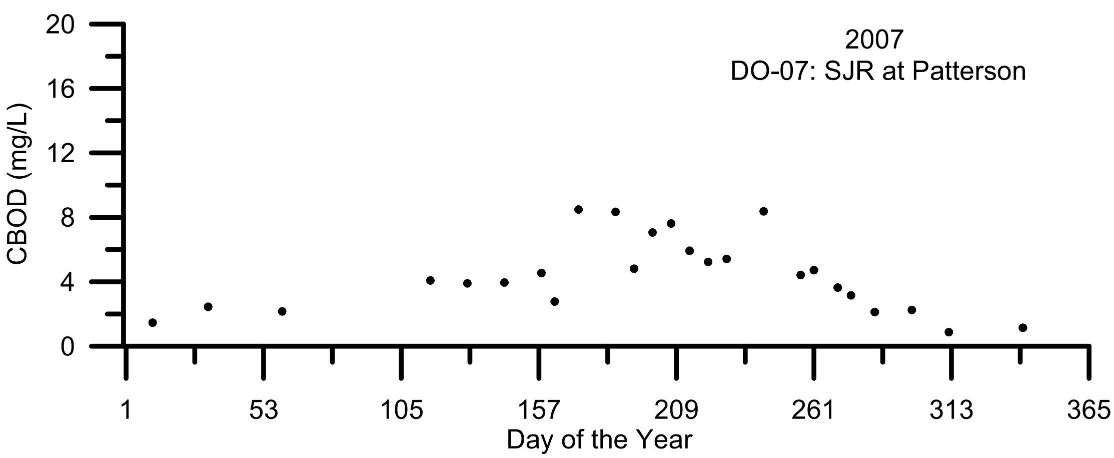

2007
DO-05: SJR at Vernalis-McCune Station
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

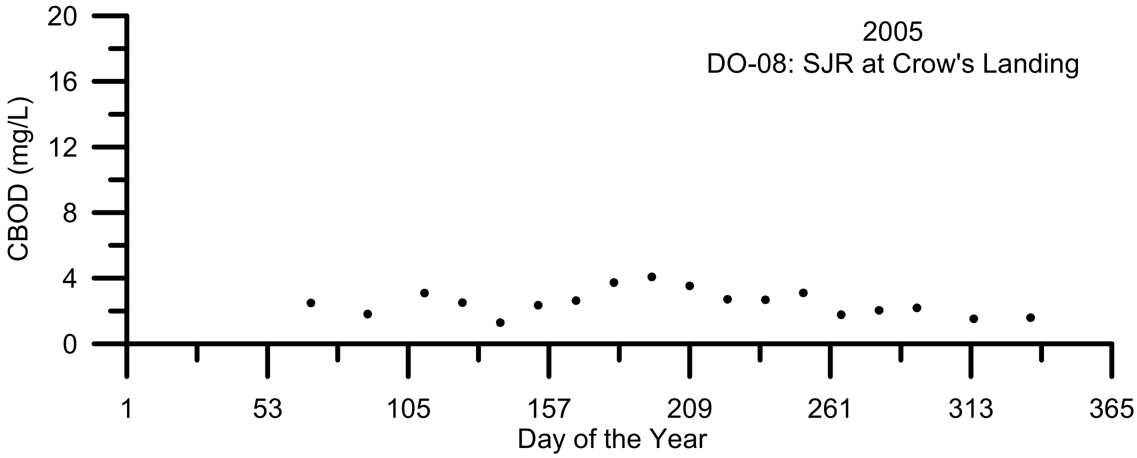


2005
DO-06: SJR at Maze
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year
2006
DO-06: SJR at Maze
CBOD (mg/L)
Day of the Year
2007
DO-06: SJR at Maze
CBOD (mg/L)
Day of the Year


2005
DO-07: SJR at Patterson
CBOD (mg/L)
Day of the Year


2006
DO-07: SJR at Patterson
CBOD (mg/L)
Day of the Year


2007
DO-07: SJR at Patterson
CBOD (mg/L)
Day of the Year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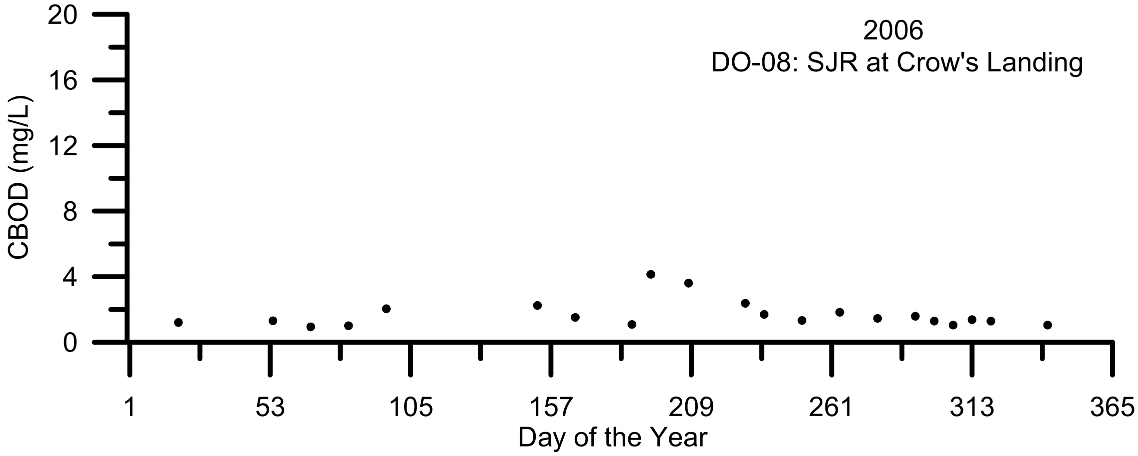
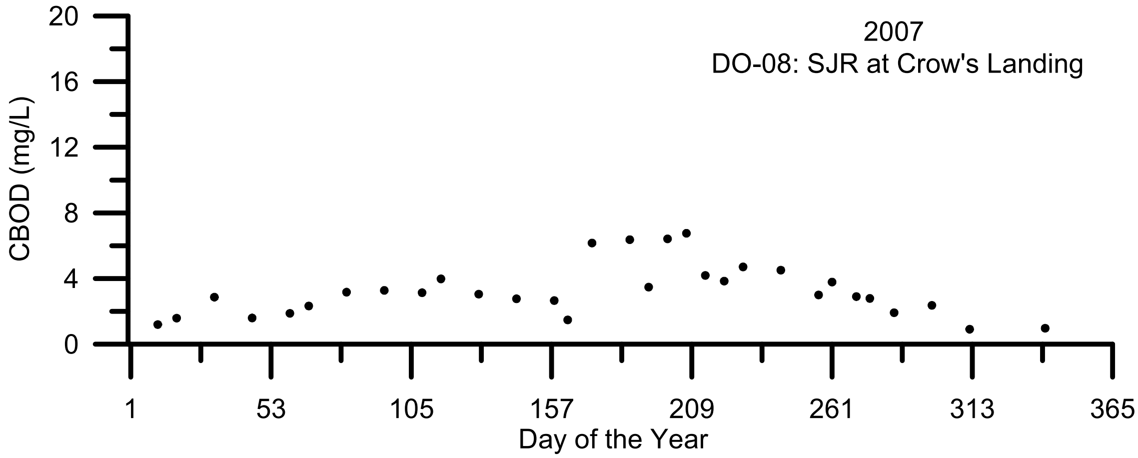
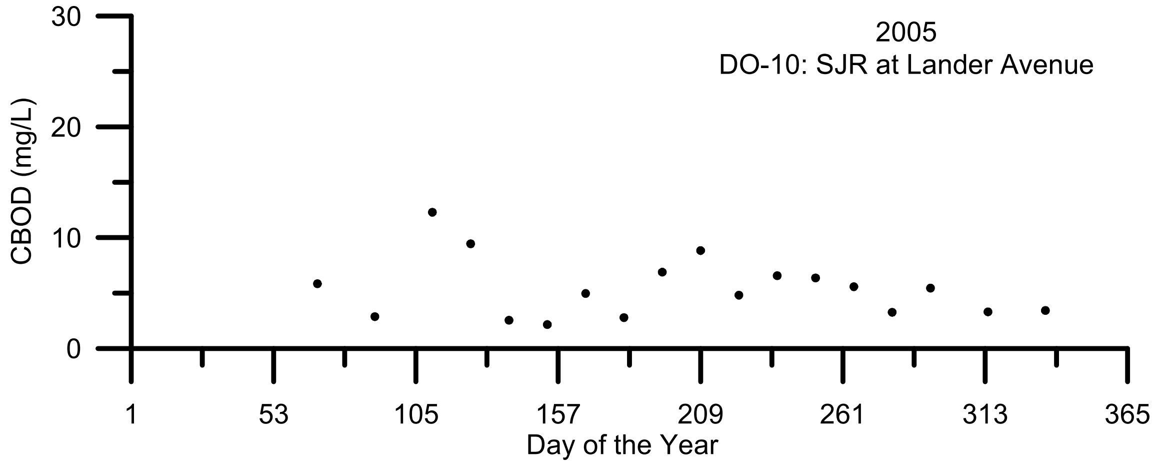
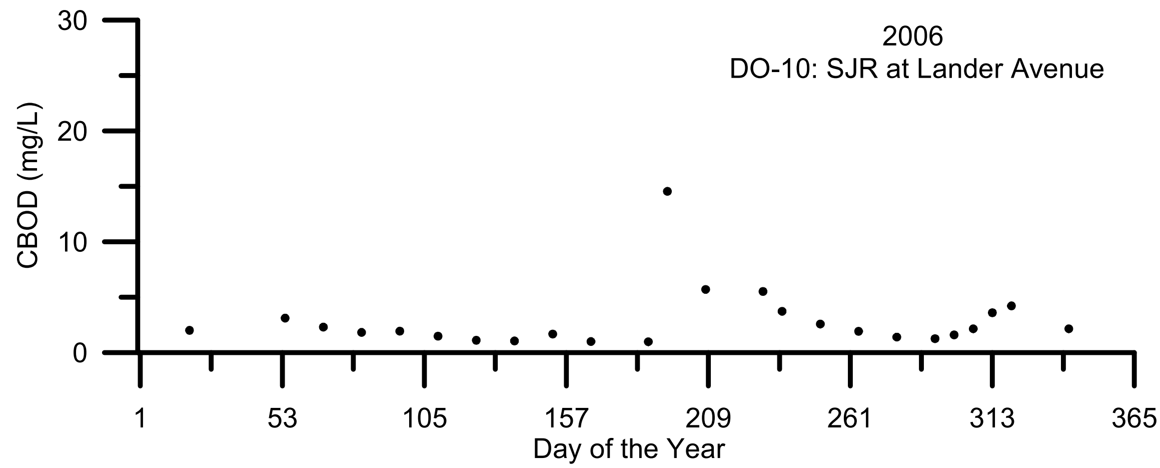
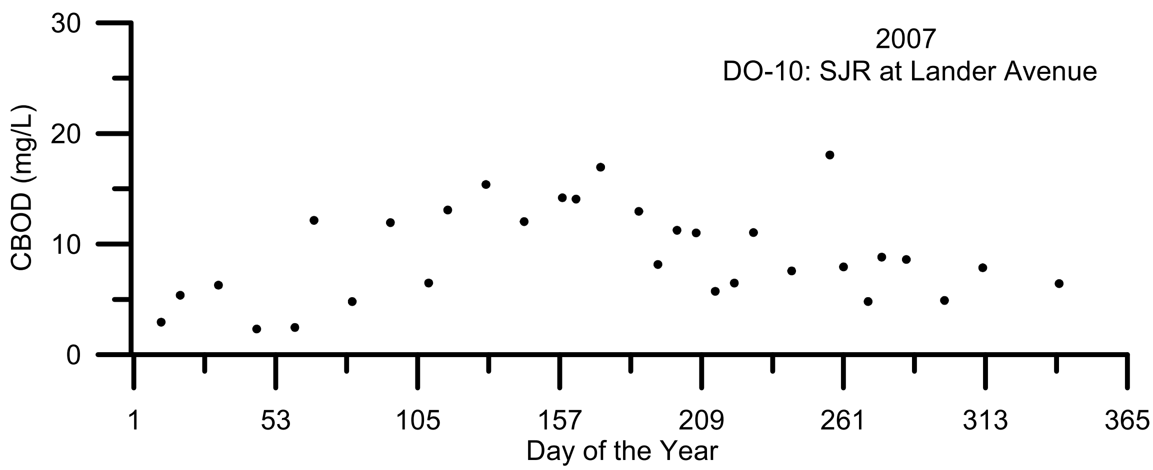
DO-08: SJR at Crow's Landing
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

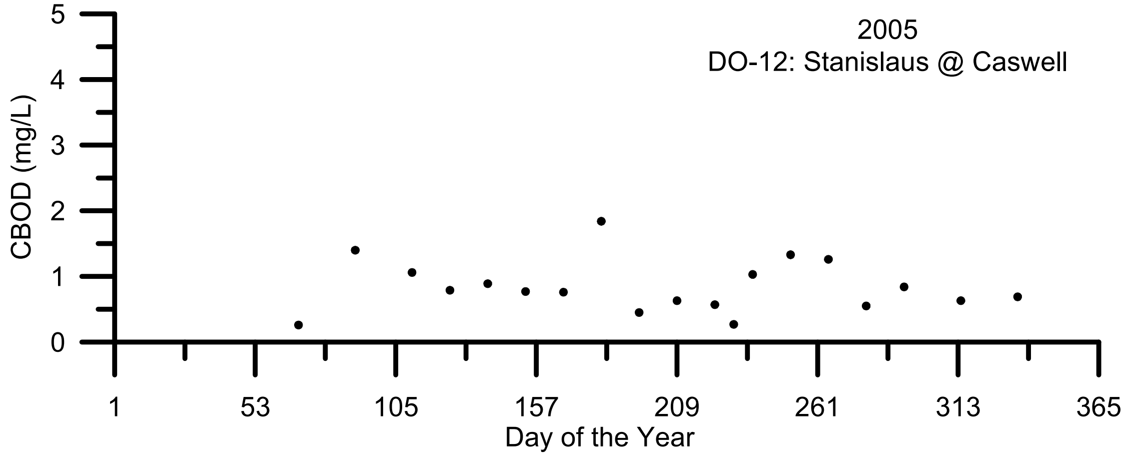

2006
DO-08: SJR at Crow's Landing
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

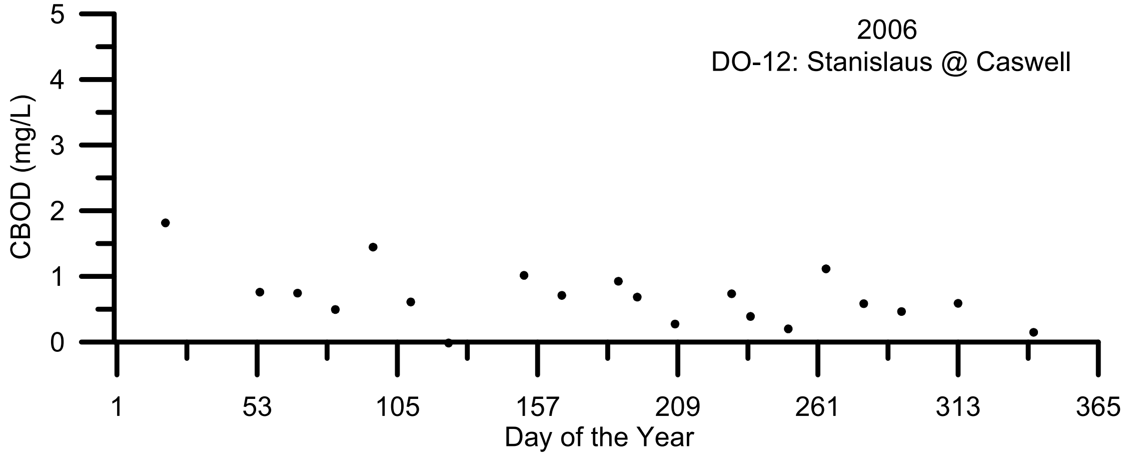

2007
DO-08: SJR at Crow's Landing
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

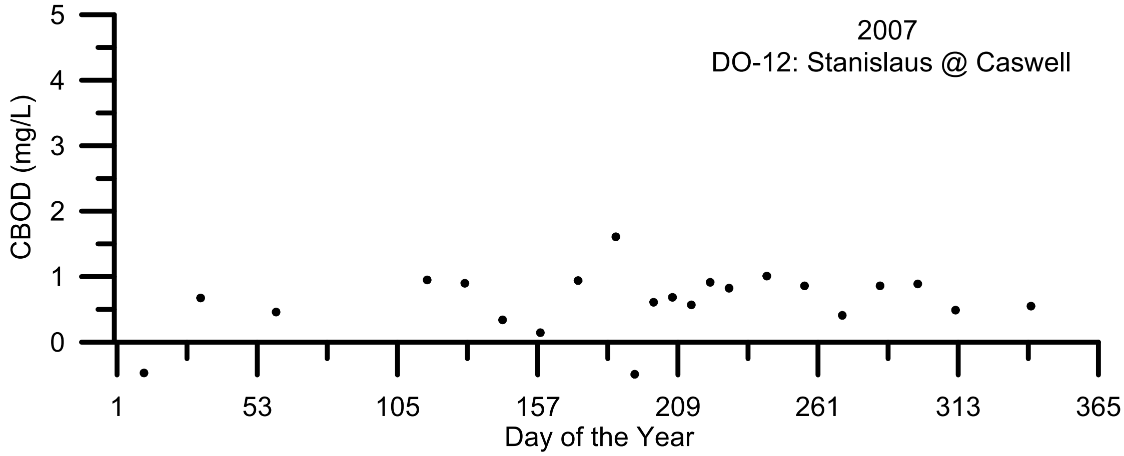

2005
DO-10: SJR at Lander Avenue
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

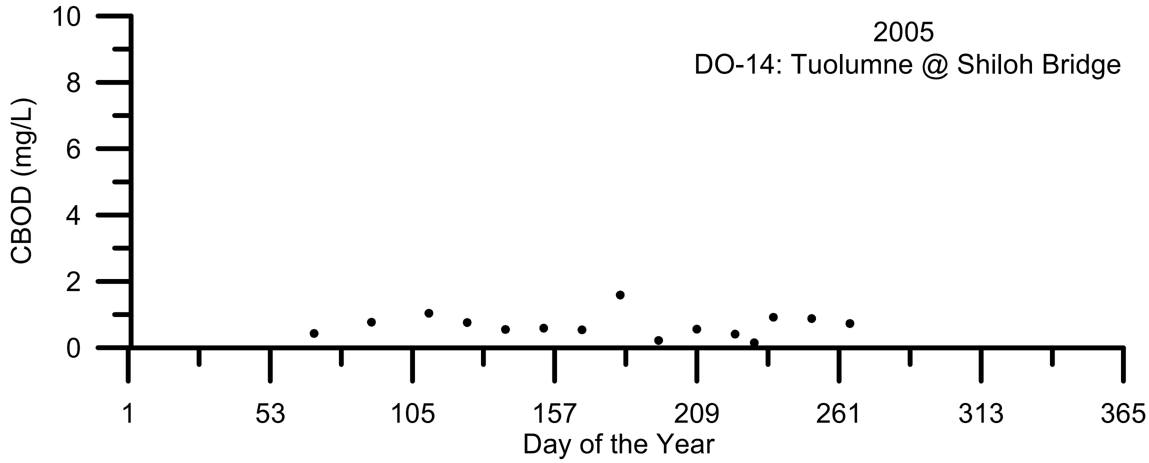

2006
DO-10: SJR at Lander Avenue
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

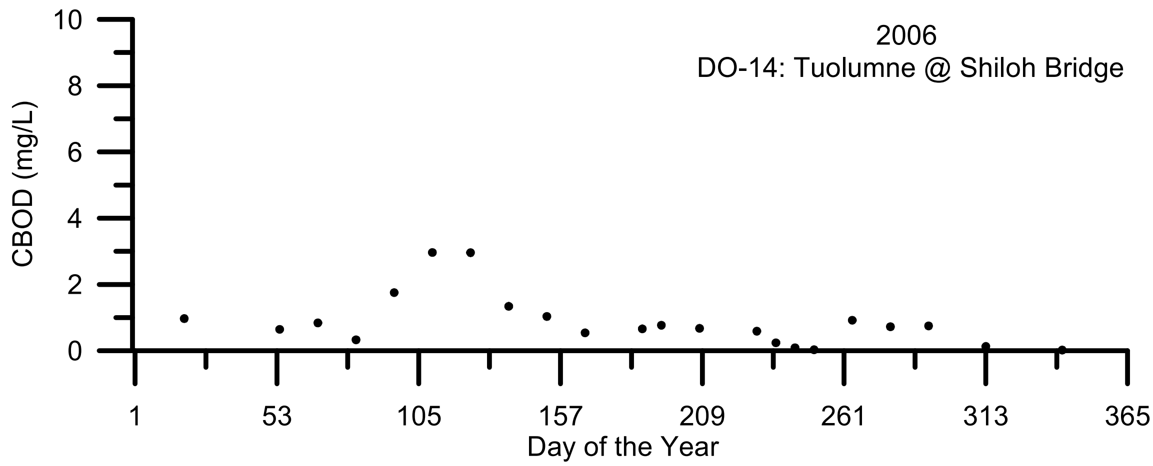

2007
DO-10: SJR at Lander Avenue
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-12: Stanislaus @ Caswell
CBOD (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus @ Caswell
CBOD (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-12: Stanislaus @ Caswell
CBOD (mg/L)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-14: Tuolumne @ Shiloh Bridge
CBOD (mg/L)
Day of the Year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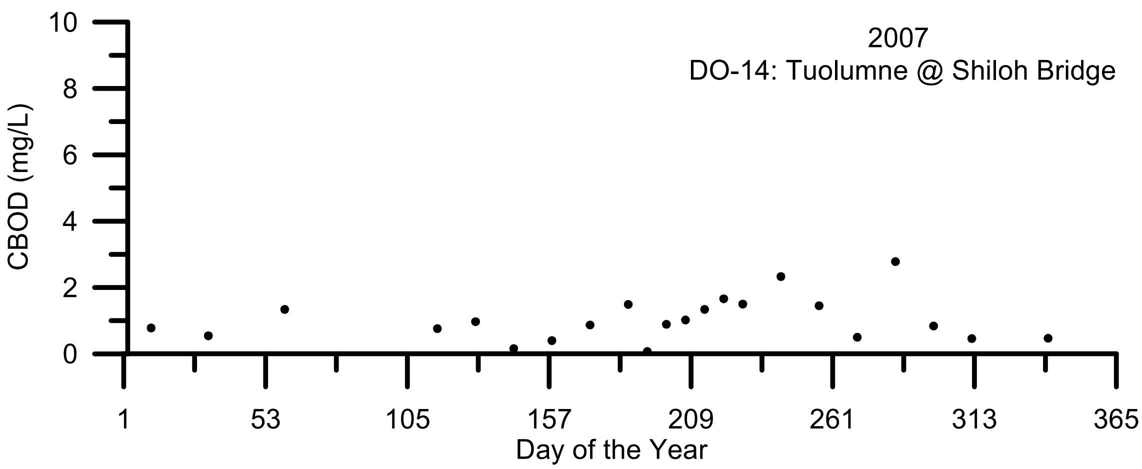
DO-14: Tuolumne @ Shiloh Bridge
CBOD (mg/L)
Day of the Year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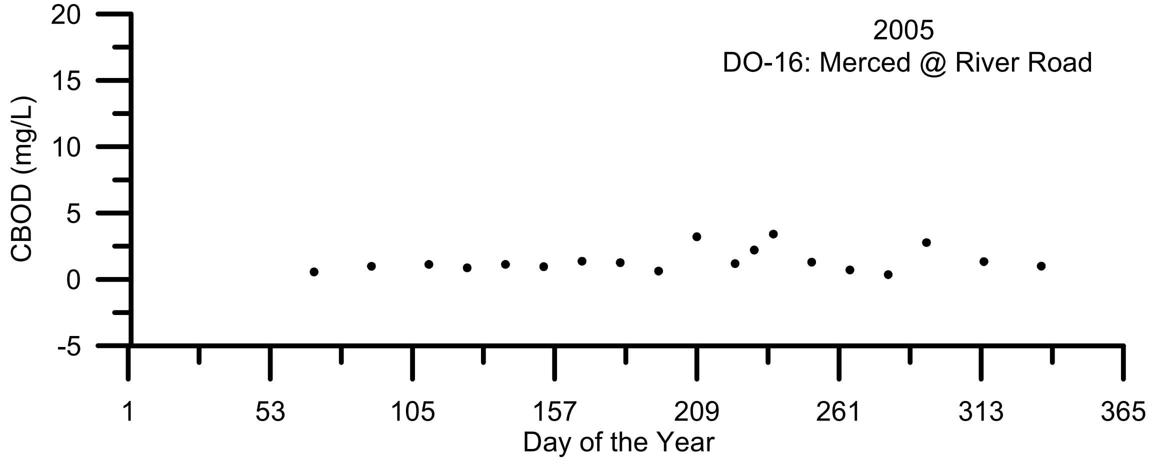
DO-14: Tuolumne @ Shiloh Bridge
CBOD (mg/L)
Day of the Year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DO-16: Merced @ River Road
CBOD (mg/L)
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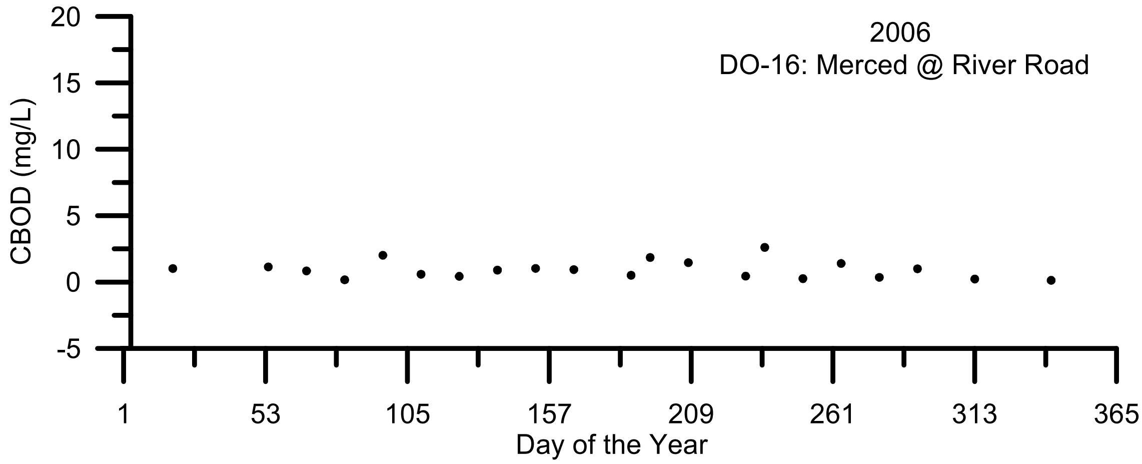
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year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DO-16: Merced @ River Road
CBOD (mg/L)
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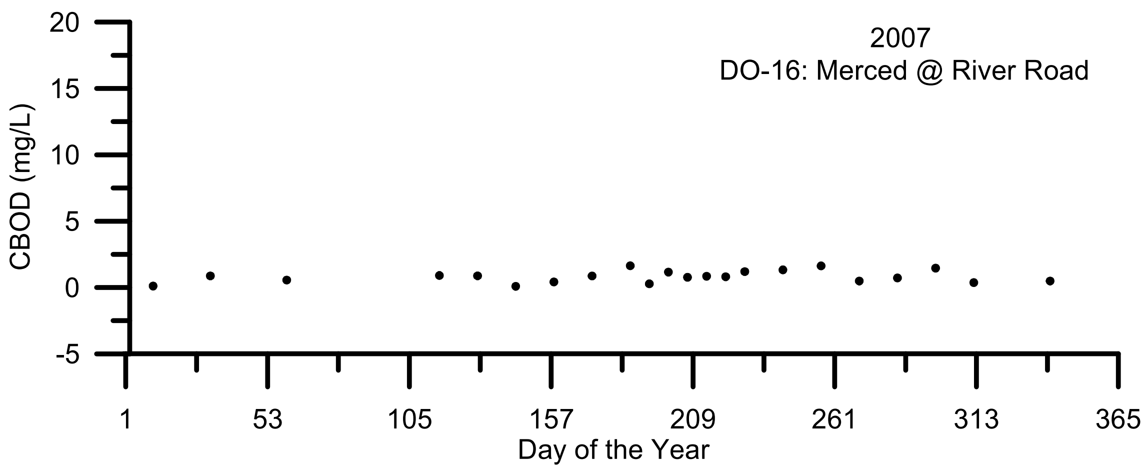
365
Day of the Year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DO-16: Merced @ River Road
CBOD (mg/L)
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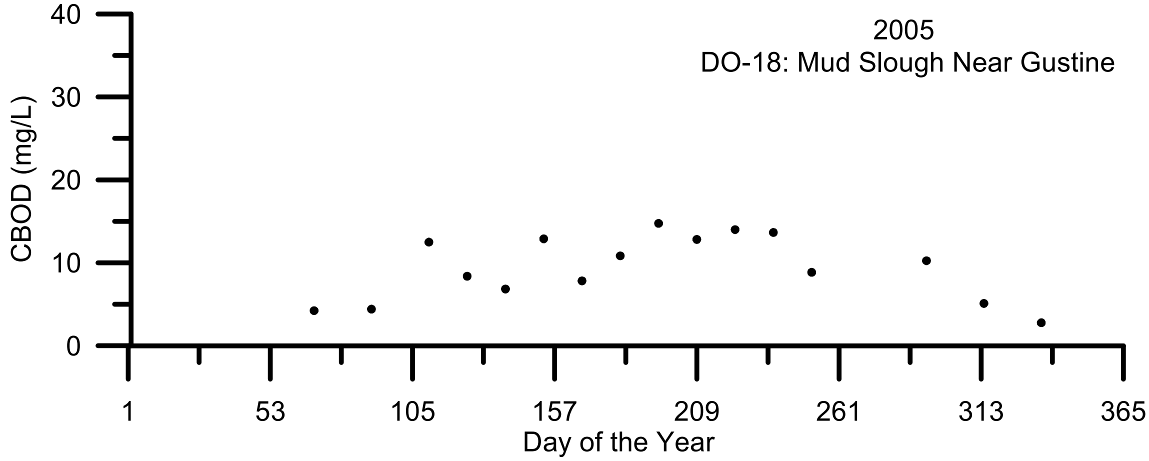
313
365
Day of the Year


2005
DO-18: Mud Slough Near Gustine
CBOD (mg/L)
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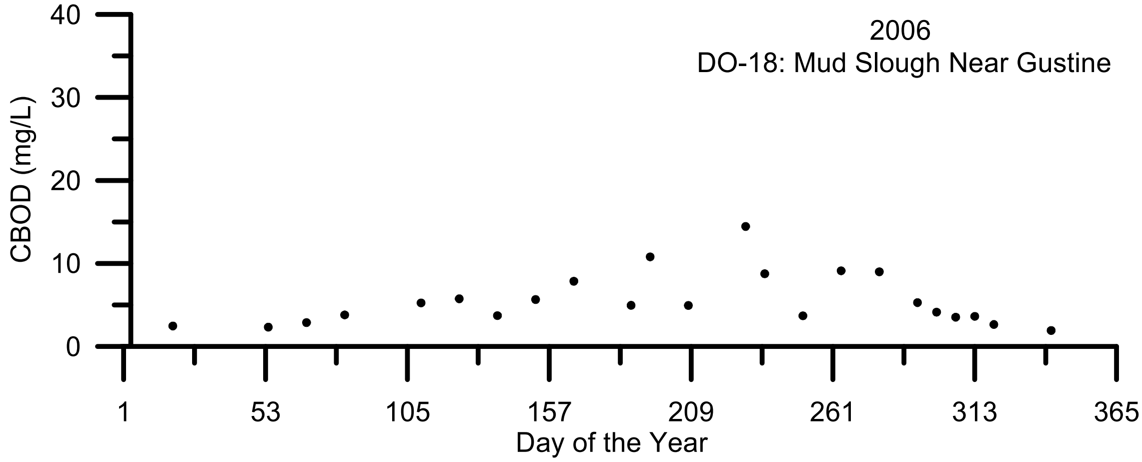
261
313
365
Day of the Year


2006
DO-18: Mud Slough Near Gustine
CBOD (mg/L)
40
30
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10
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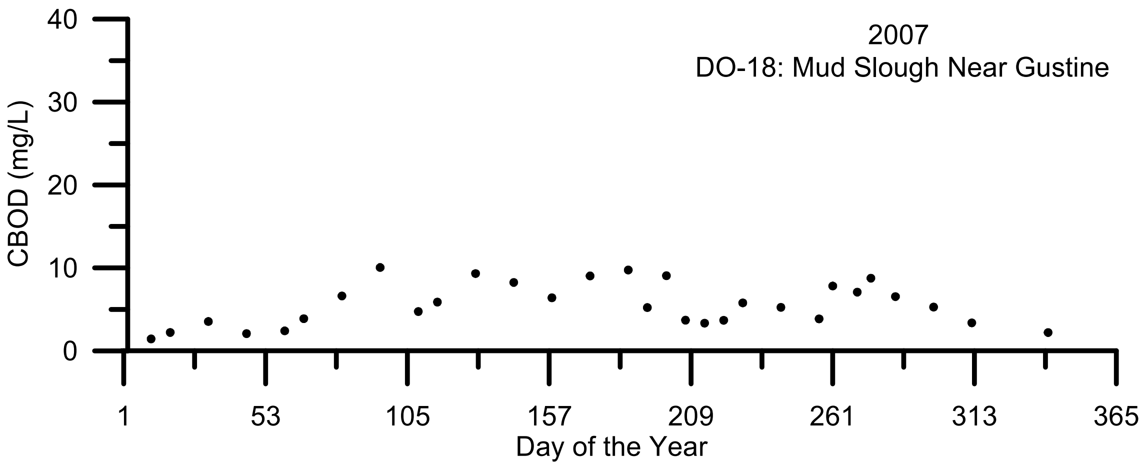
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-18: Mud Slough Near Gustine
CBOD (mg/L)
40
30
20
10
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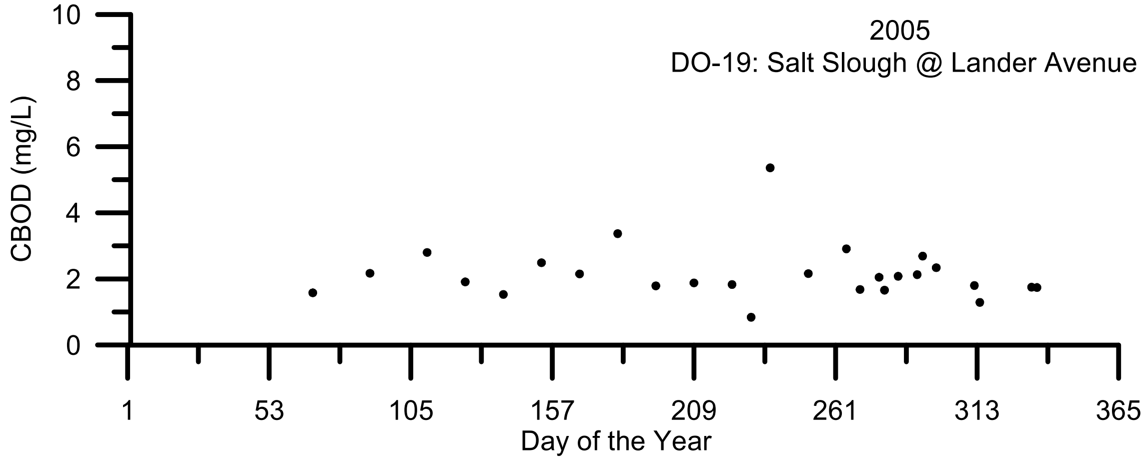
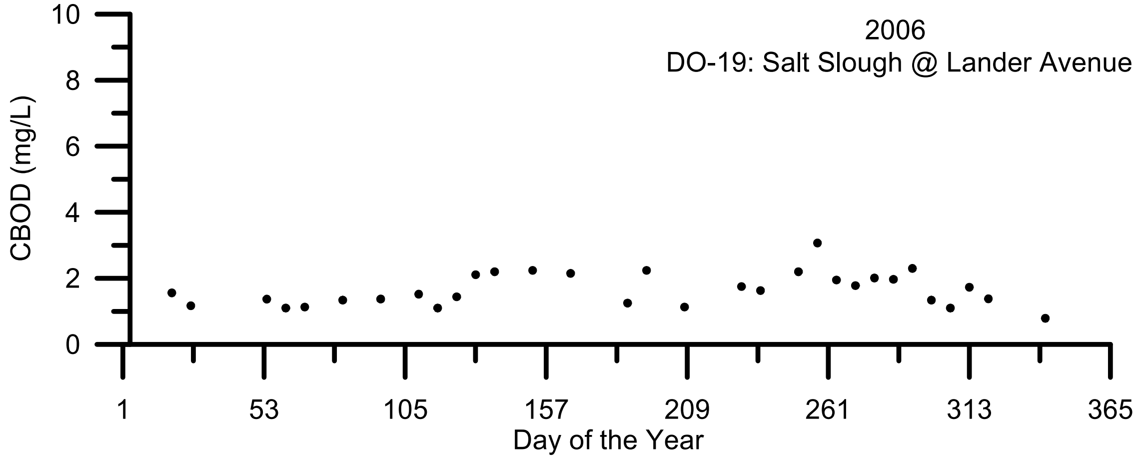
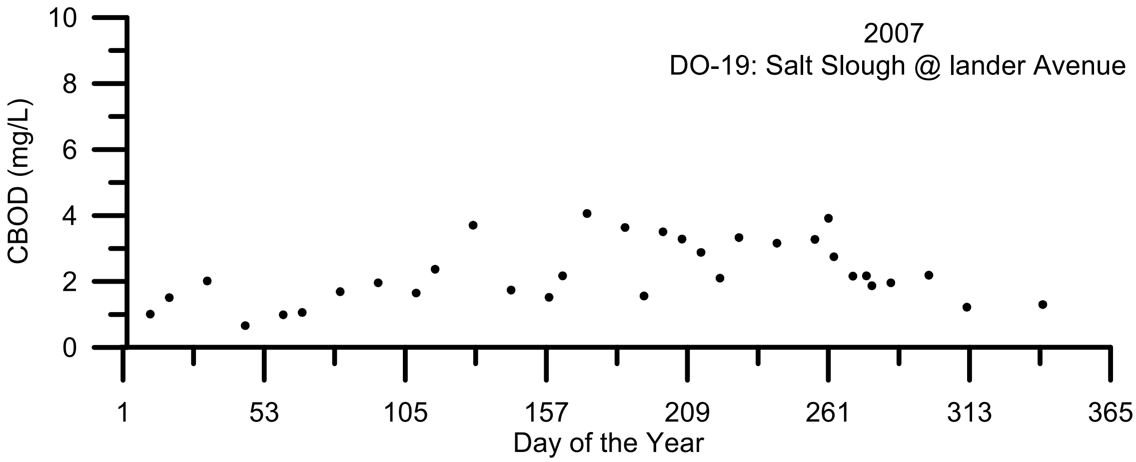
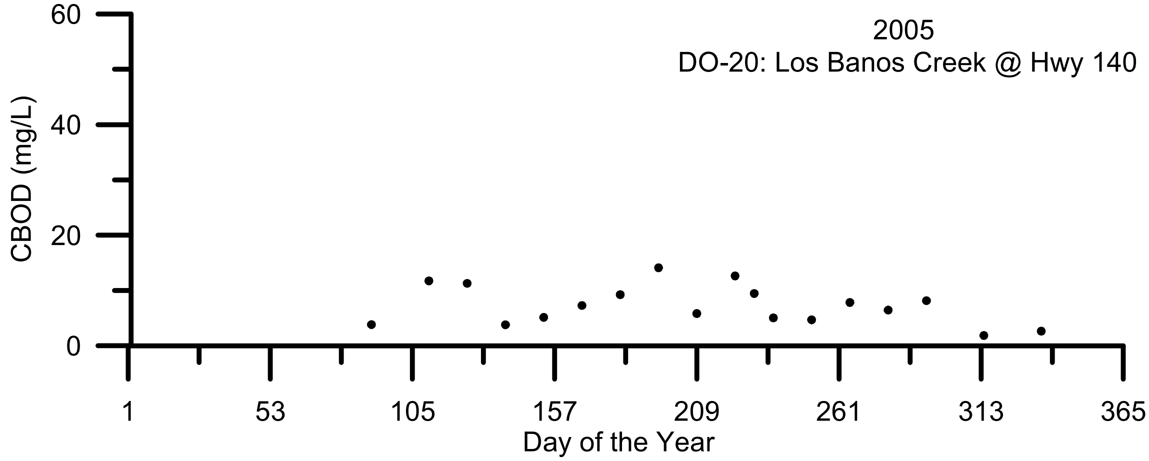
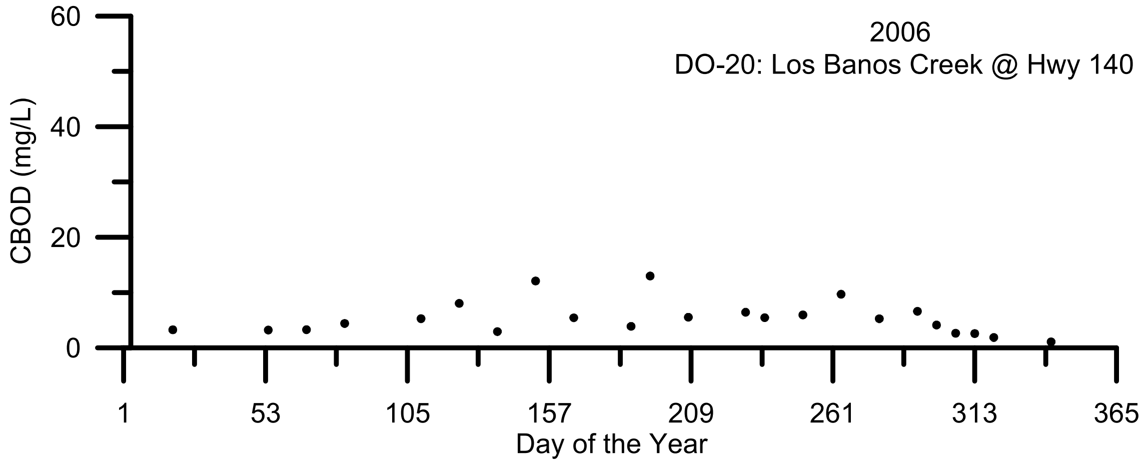
53
105
157
209
261
313
365
Day of the Year

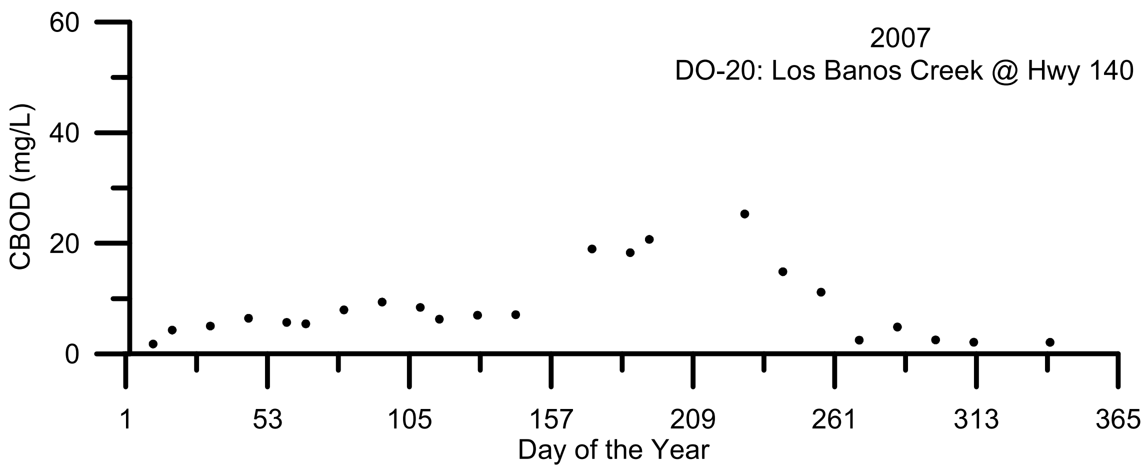

2005
DO-19: Salt Slough @ Lander Avenue
CBOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

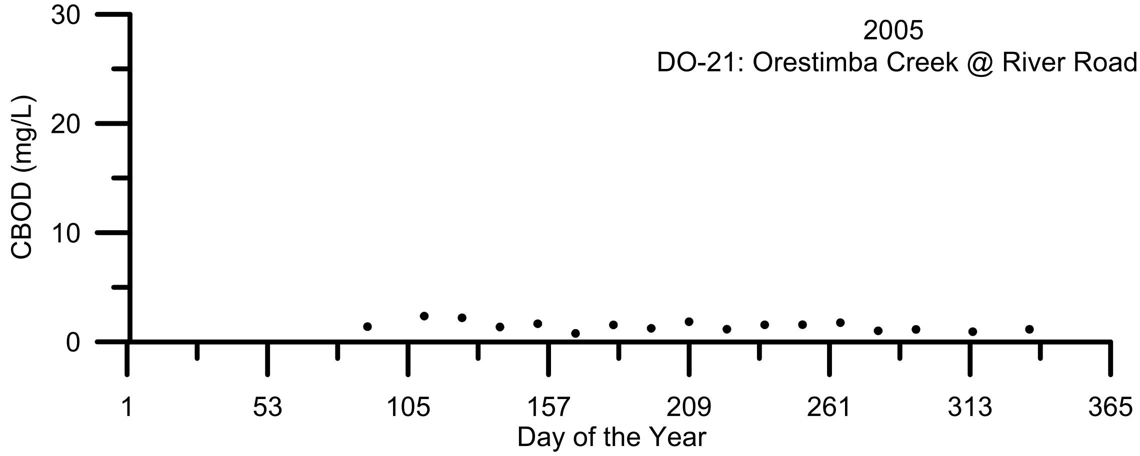

2006
DO-19: Salt Slough @ Lander Avenue
CBOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

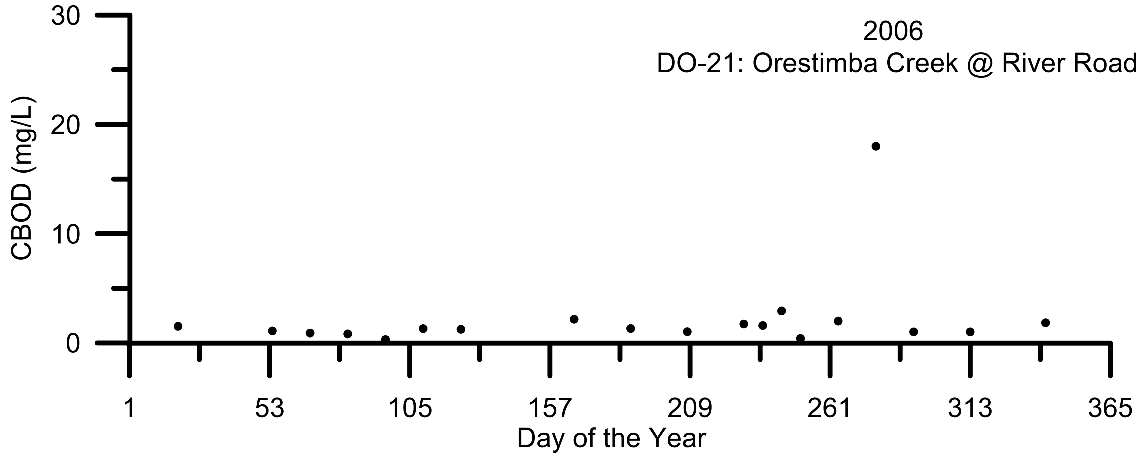

2007
DO-19: Salt Slough @ lander Avenue
CBOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

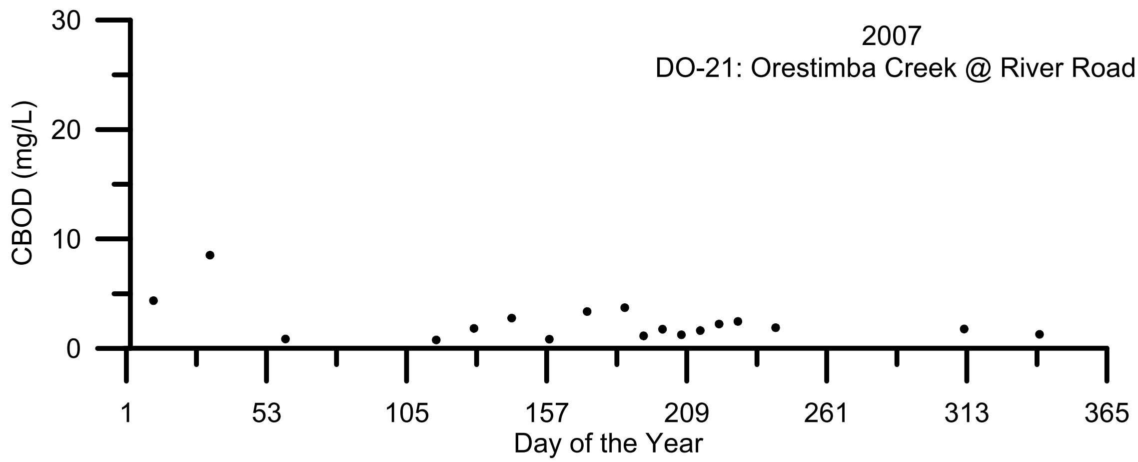

2005
DO-20: Los Banos Creek @ Hwy 140
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

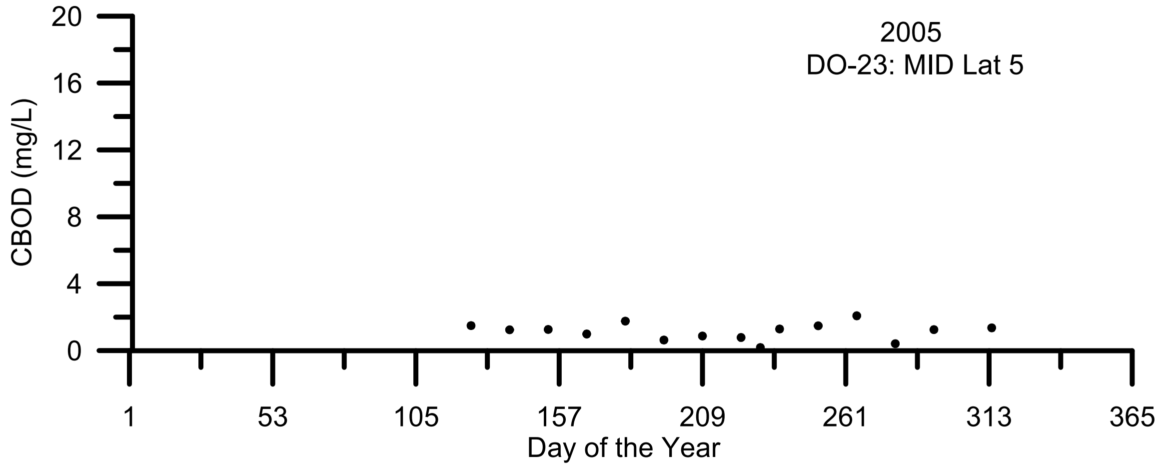

2006
DO-20: Los Banos Creek @ Hwy 140
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-20: Los Banos Creek @ Hwy 140
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

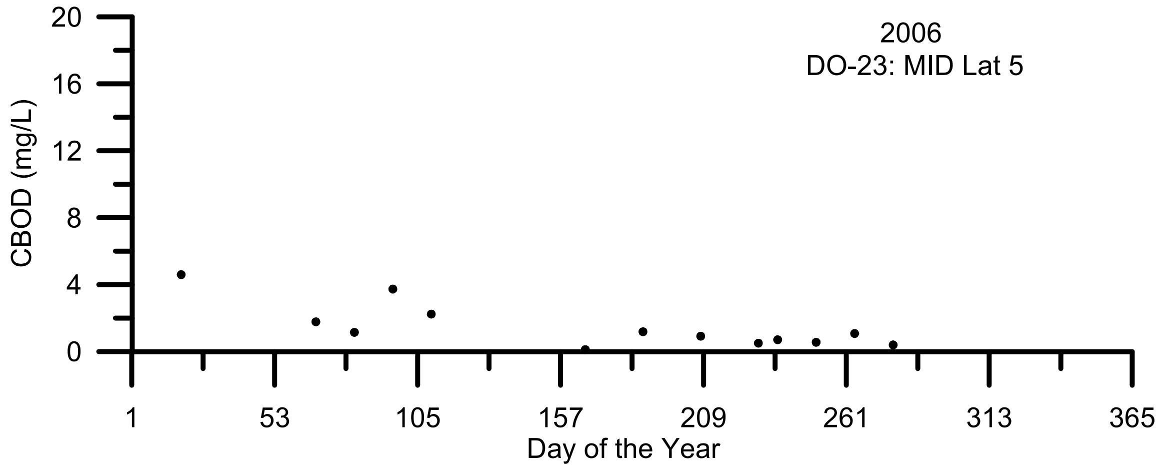

2005
DO-21: Orestimba Creek @ River Road
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-21: Orestimba Creek @ River Road
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

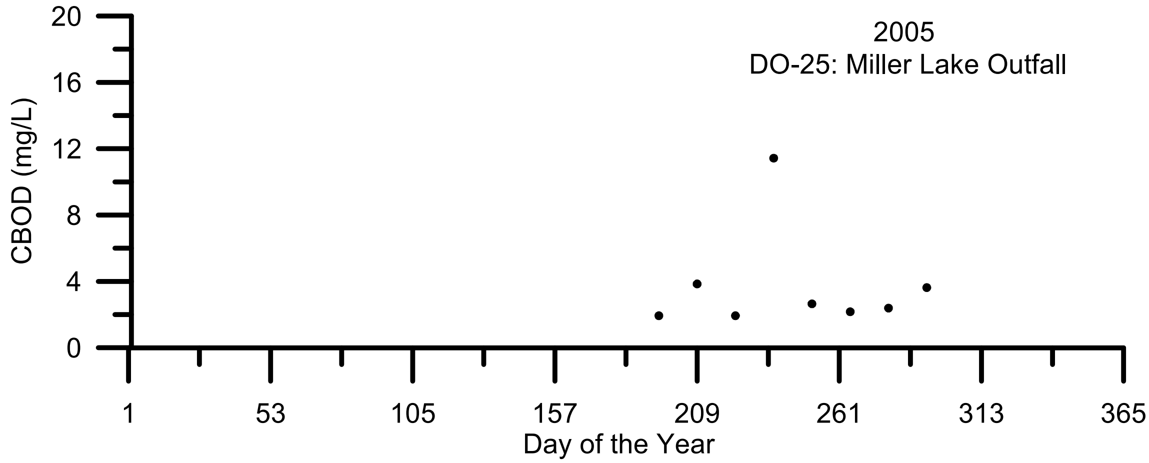

2007
DO-21: Orestimba Creek @ River Road
CBOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

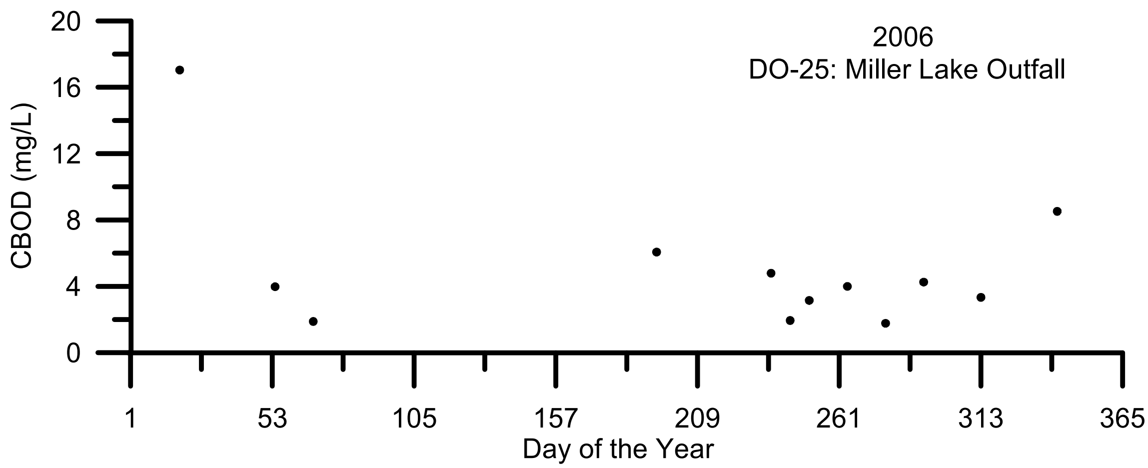


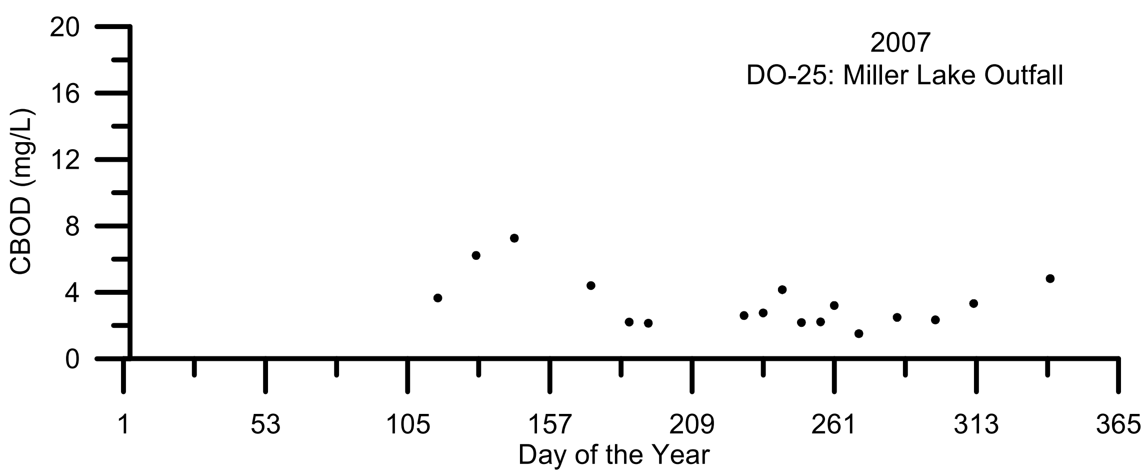
2005
DO-23: MID Lat 5
CBOD (mg/L)
Day of the Year

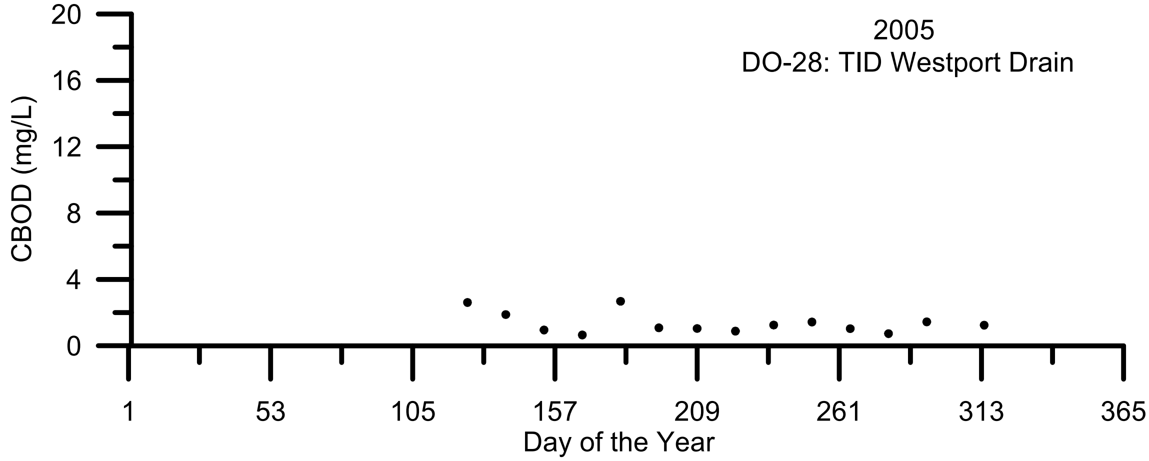


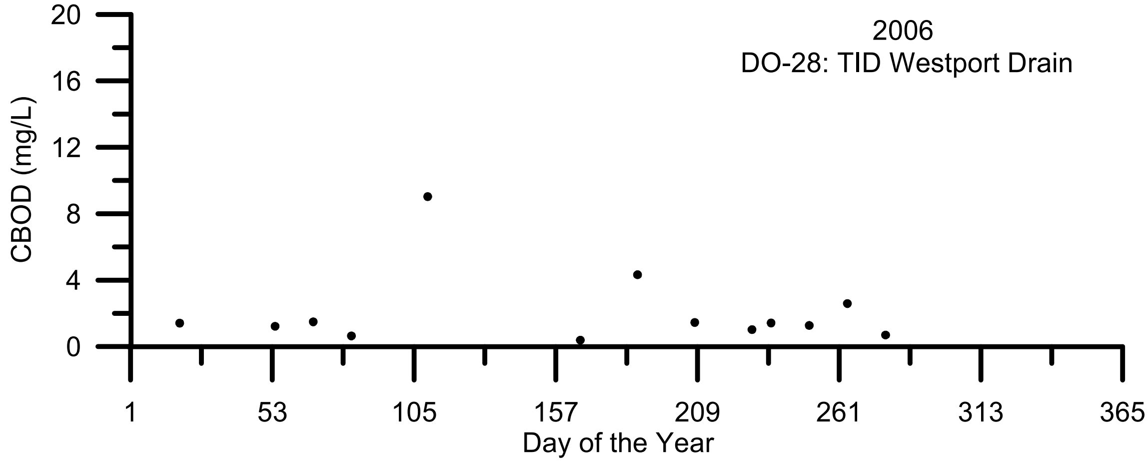
2006
DO-23: MID Lat 5
CBOD (mg/L)
Day of the Year

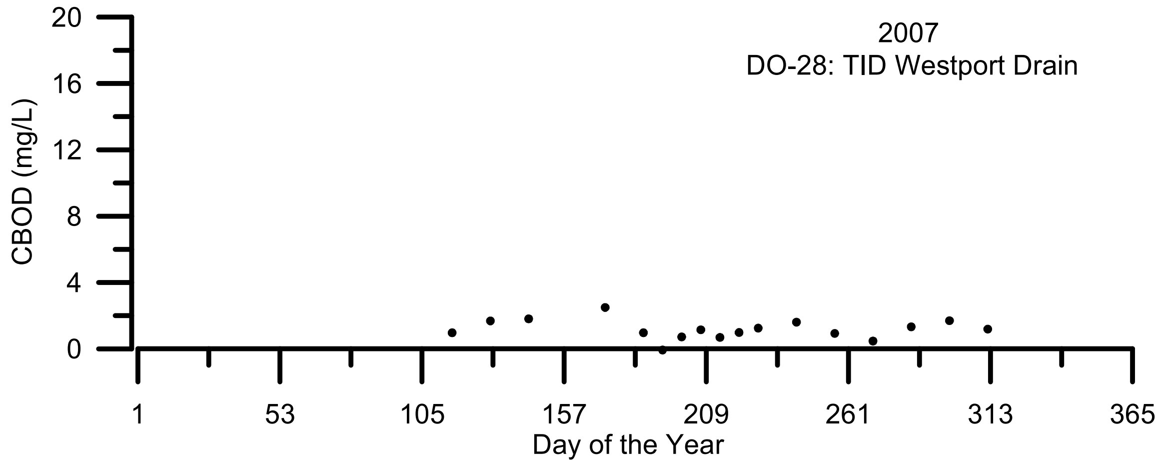

2005
DO-25: Miller Lake Outfall
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

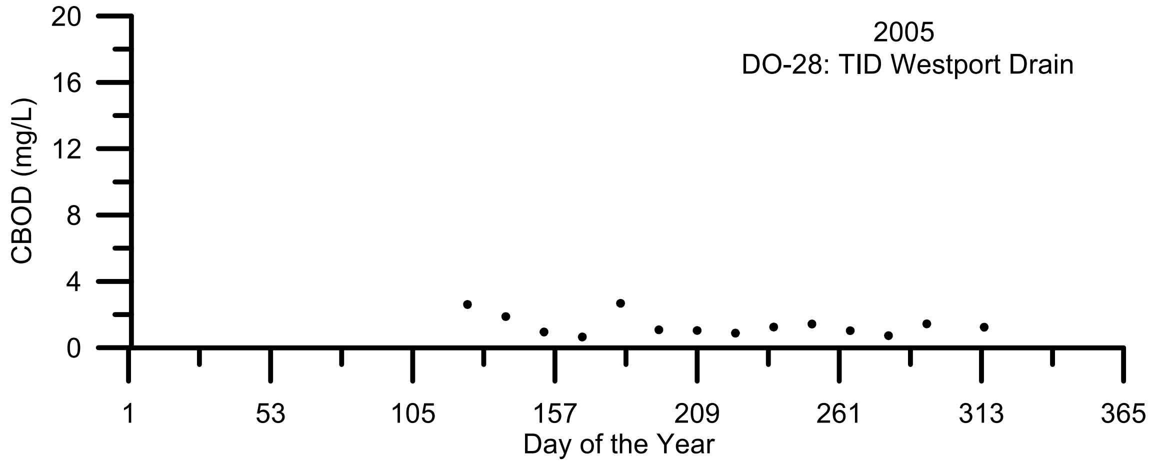

2006
DO-25: Miller Lake Outfall
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

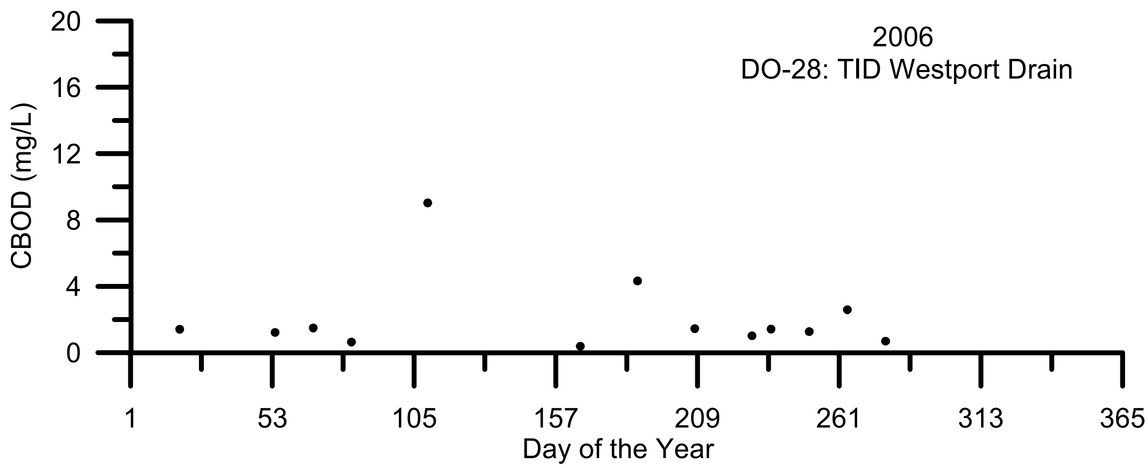

2007
DO-25: Miller Lake Outfall
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

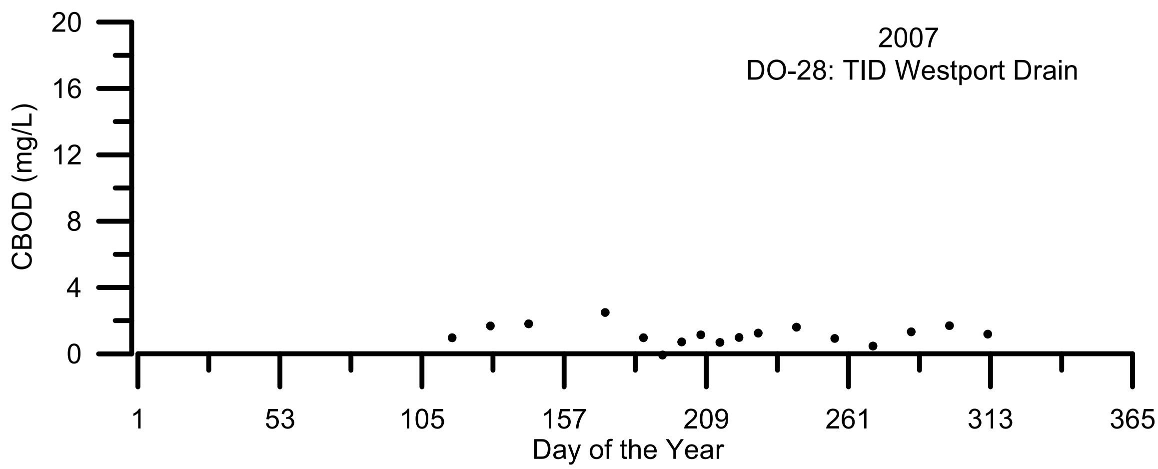

2005
DO-28: TID Westport Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

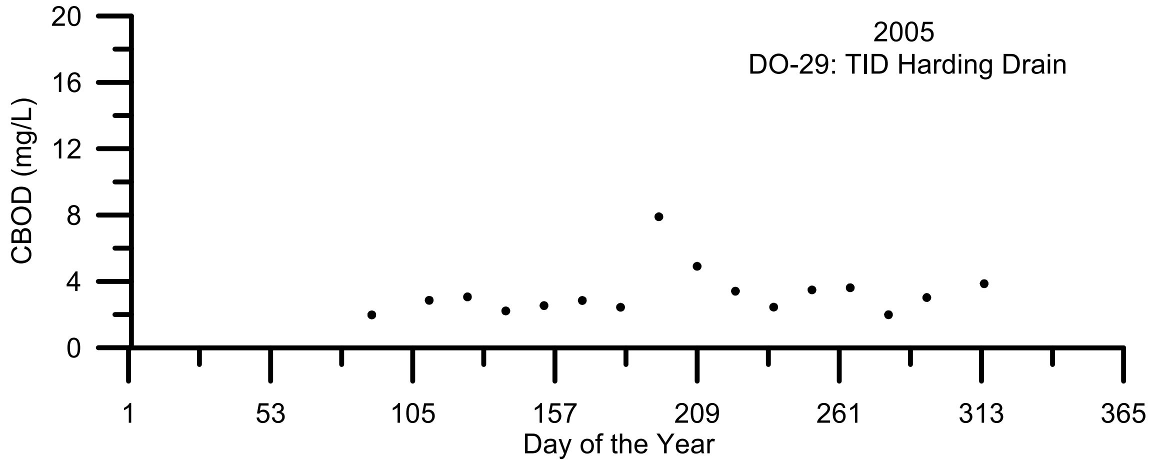

2006
DO-28: TID Westport Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

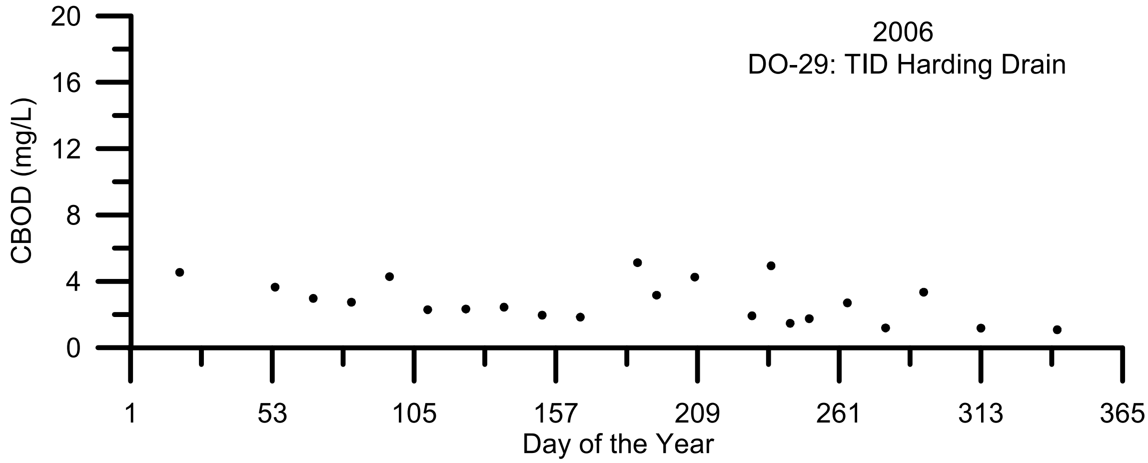

2007
DO-28: TID Westport Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

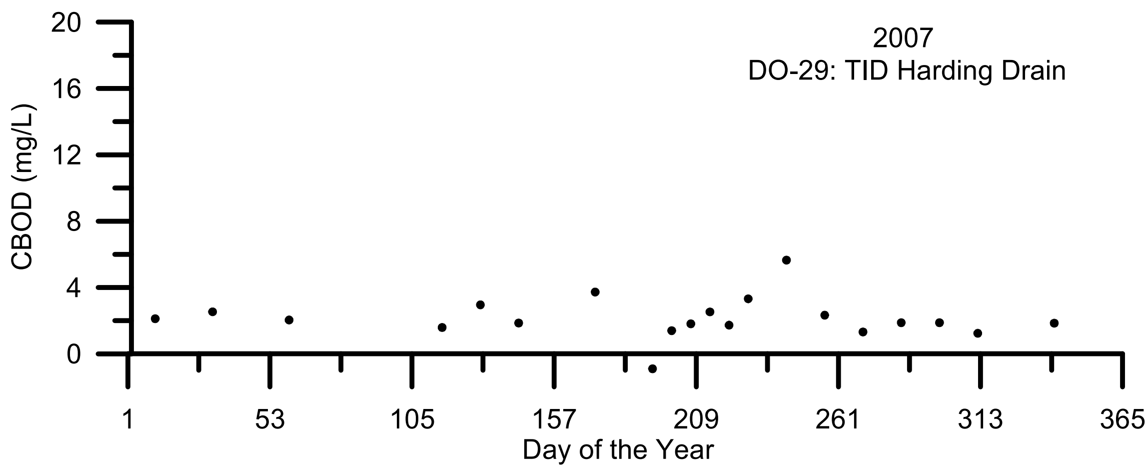

2005
DO-28: TID Westport Drain
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

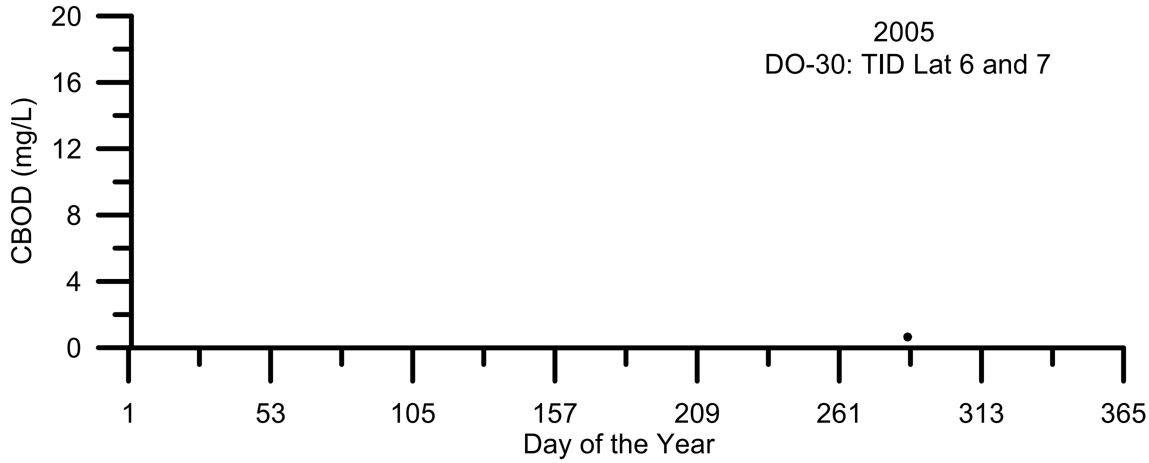

2006
DO-28: TID Westport Drain
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

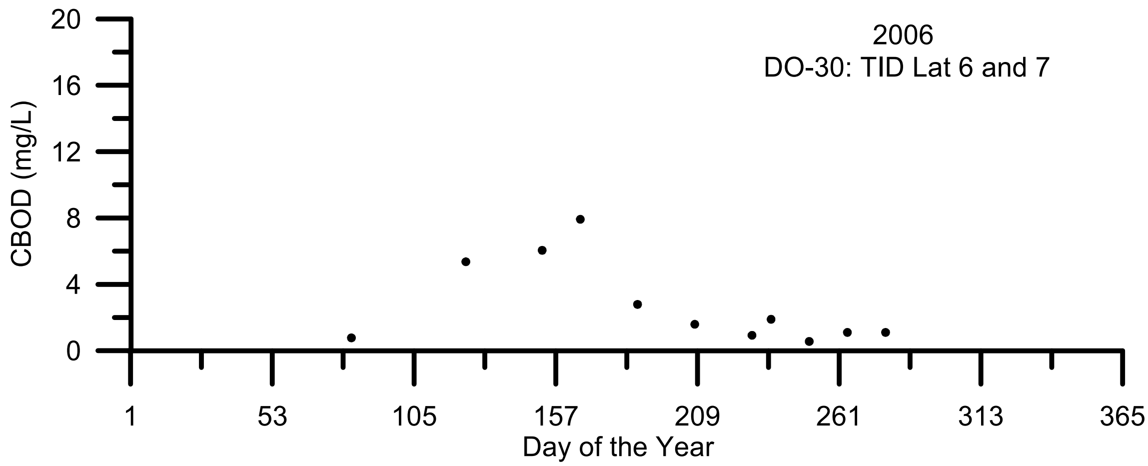

2007
DO-28: TID Westport Drain
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

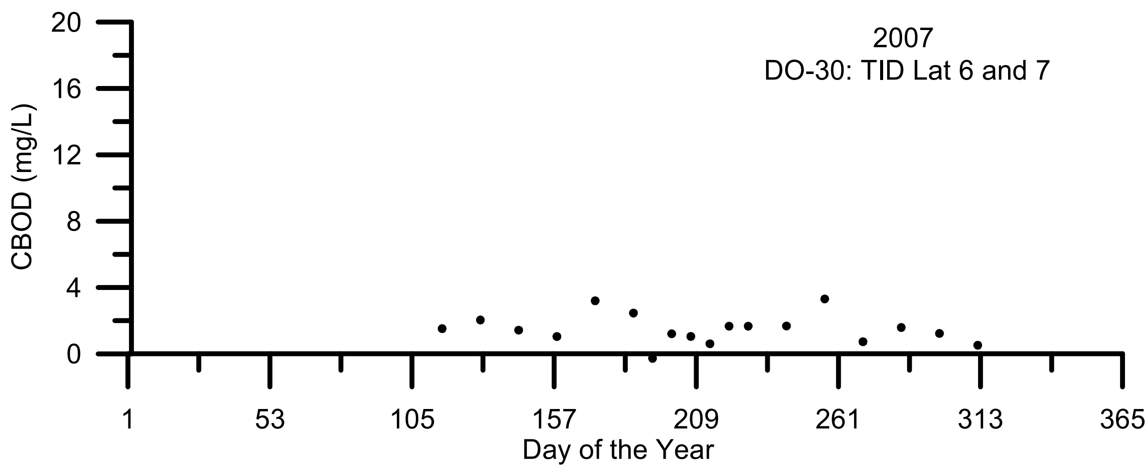

2005
DO-29: TID Harding Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

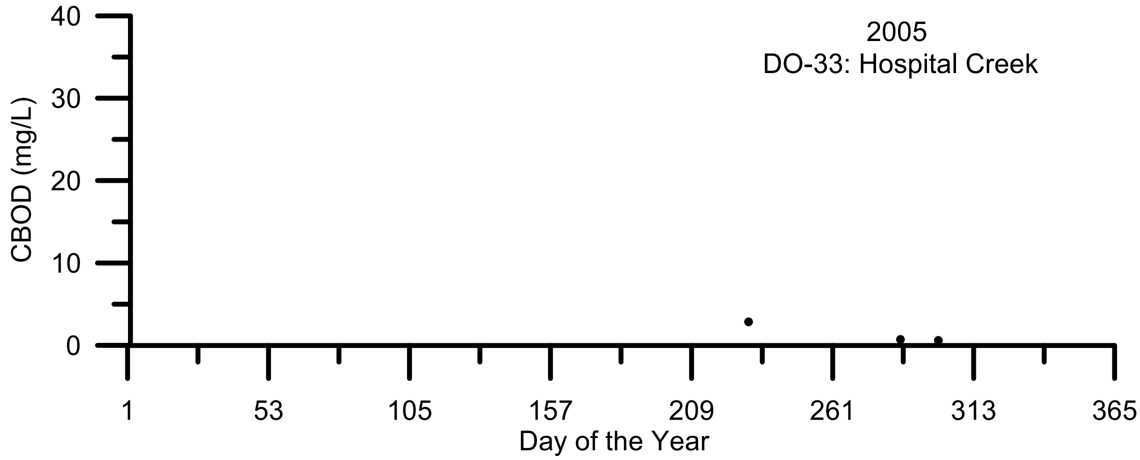

2006
DO-29: TID Harding Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

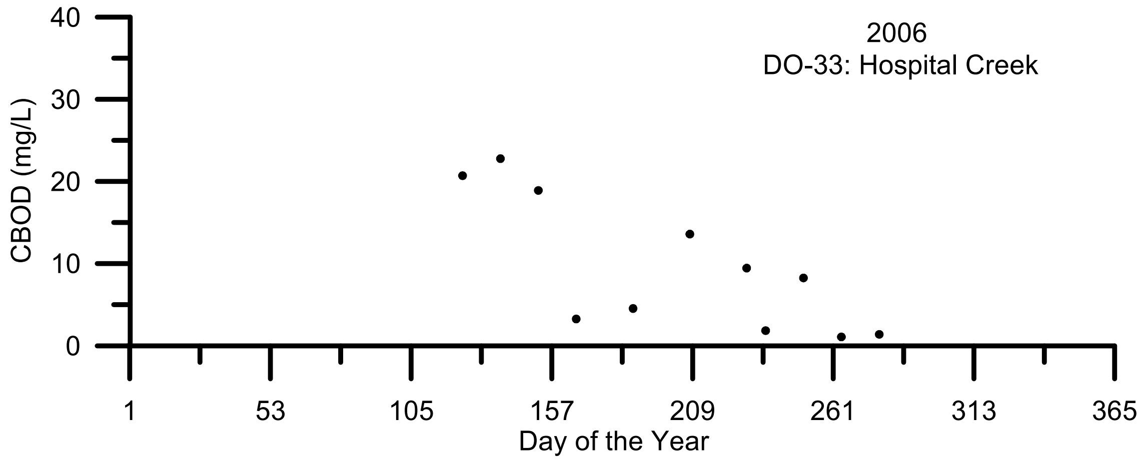

2007
DO-29: TID Harding Drain
CBOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

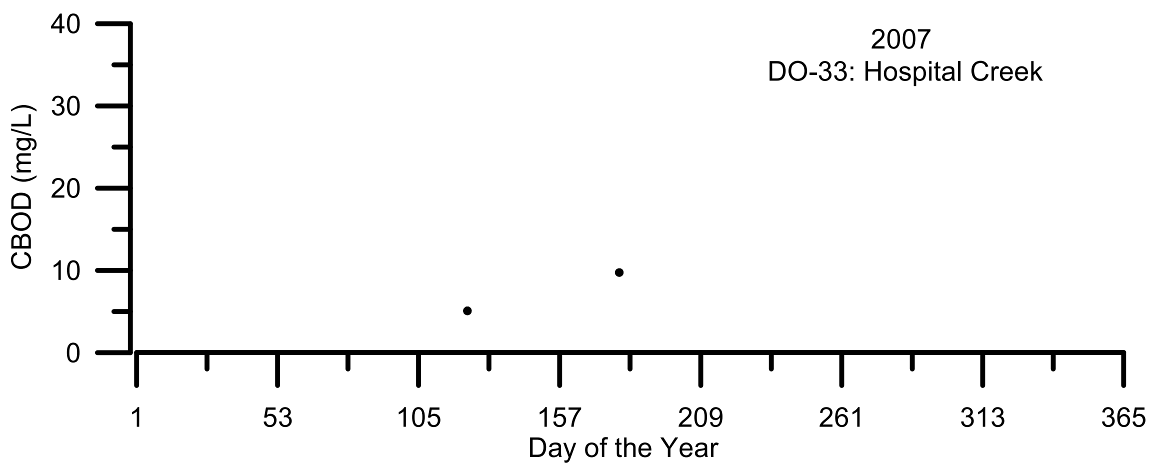

2005
DO-30: TID Lat 6 and 7
CBOD (mg/L)
Day of the Year

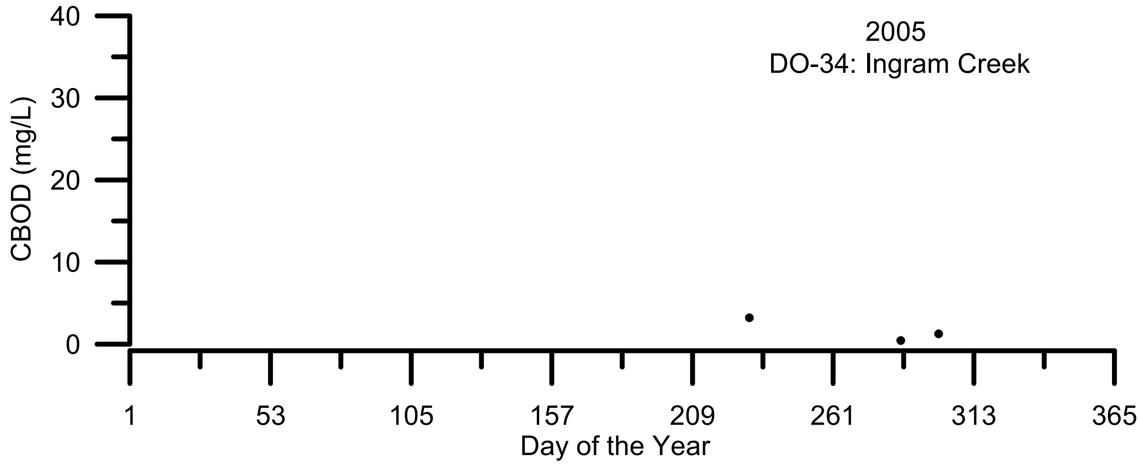

2006
DO-30: TID Lat 6 and 7
CBOD (mg/L)
Day of the Year

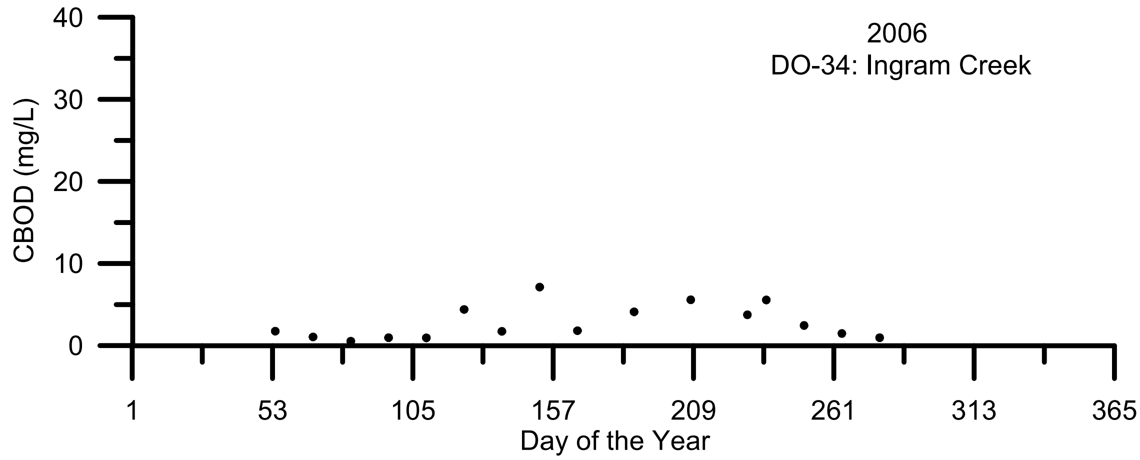

2007
DO-30: TID Lat 6 and 7
CBOD (mg/L)
Day of the Year

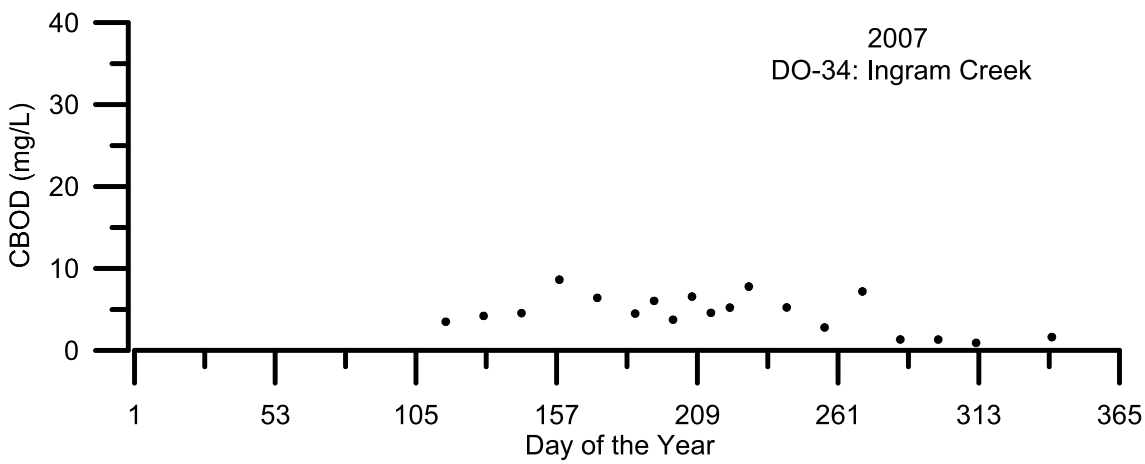

2005
DO-33: Hospital Creek
CBOD (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

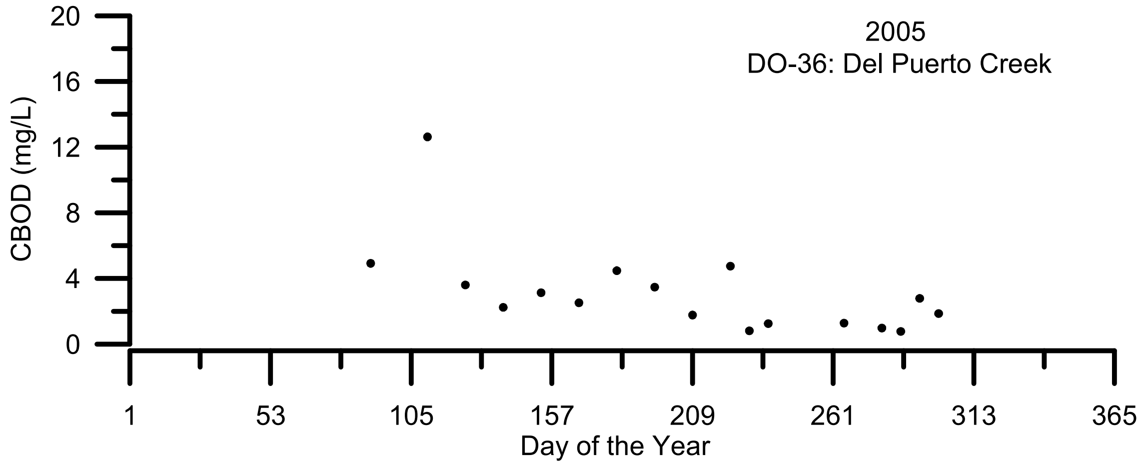

2006
DO-33: Hospital Creek
CBOD (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

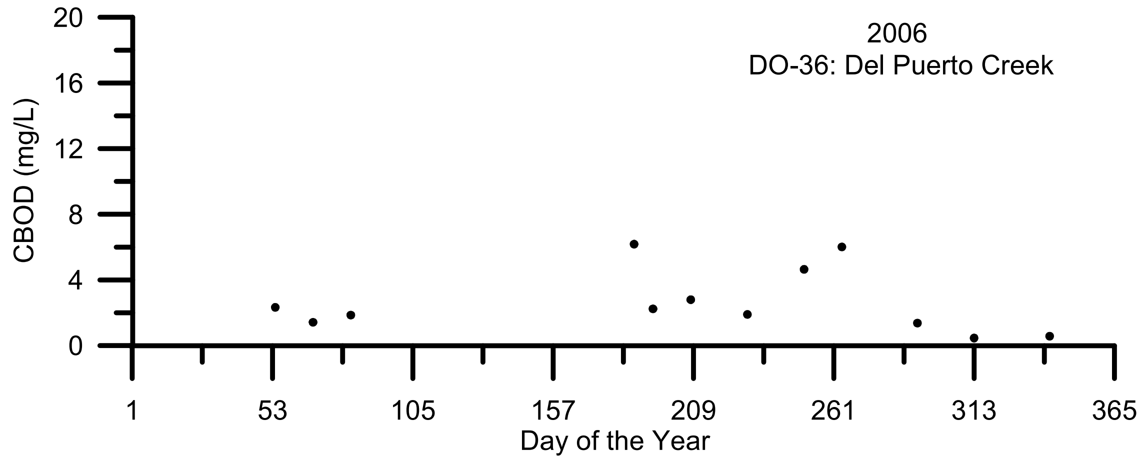

2007
DO-33: Hospital Creek
CBOD (mg/L)
Day of the Year
0
10
20
30
40
1
53
105
157
209
261
313
365

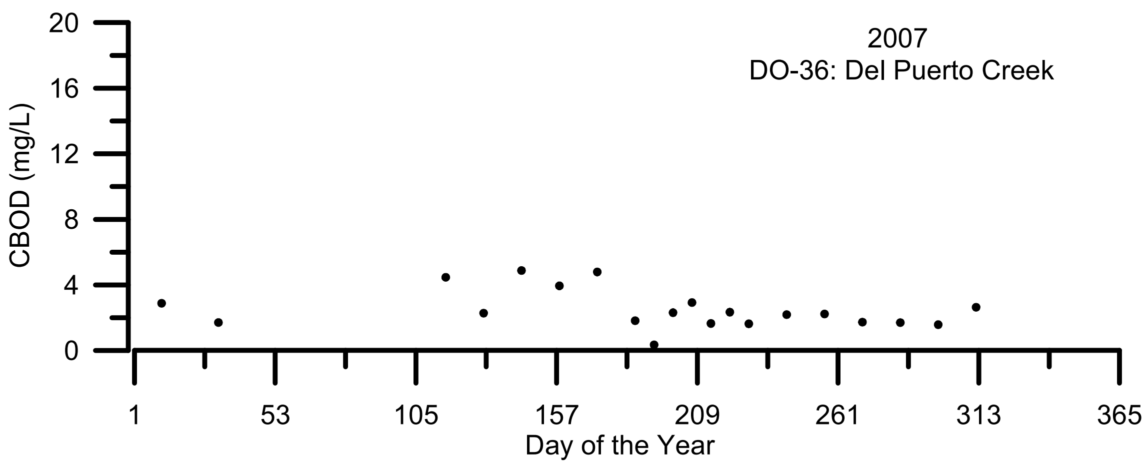

2005
DO-34: Ingram Creek
CBOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

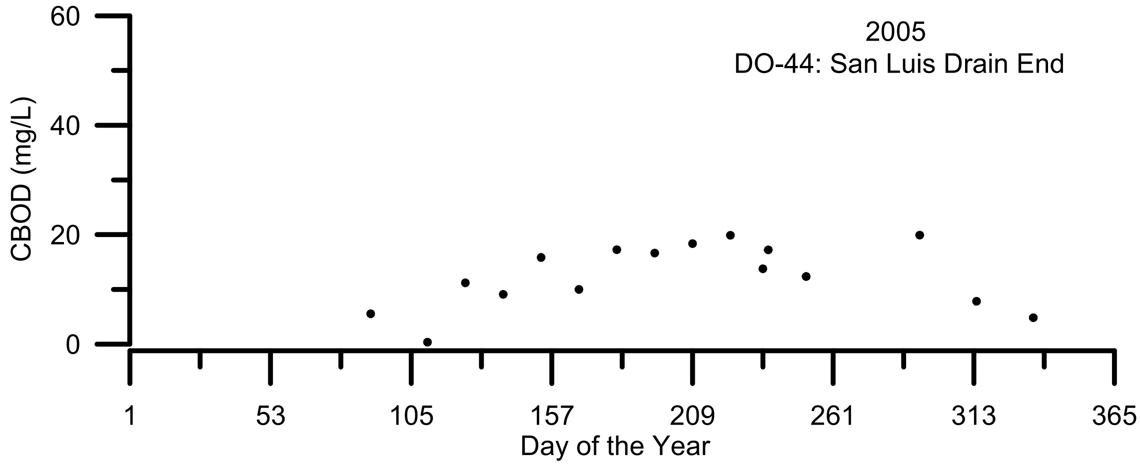

2006
DO-34: Ingram Creek
CBOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

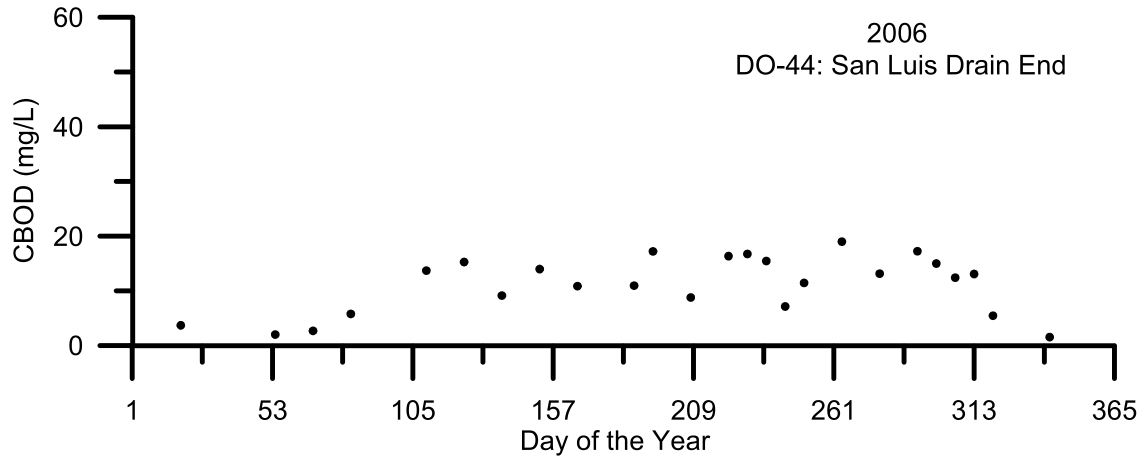

2007
DO-34: Ingram Creek
CBOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

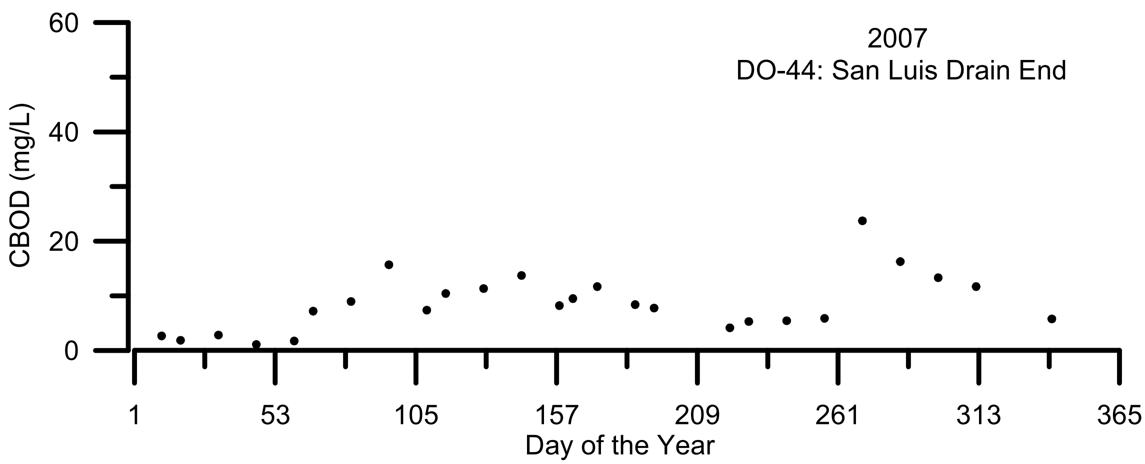

2005
DO-36: Del Puerto Creek
CBOD (mg/L)
Day of the Year

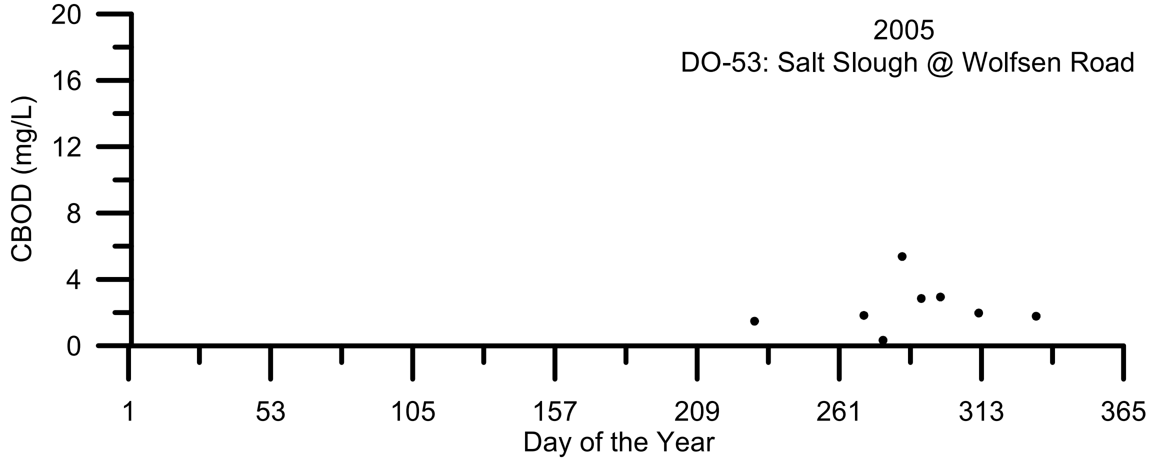

2006
DO-36: Del Puerto Creek
CBOD (mg/L)
Day of the Year

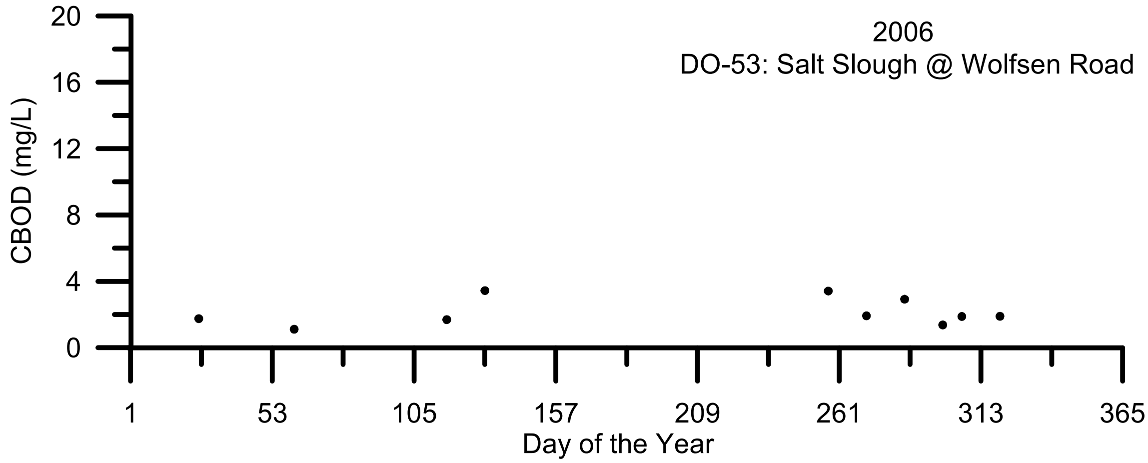

2007
DO-36: Del Puerto Creek
CBOD (mg/L)
Day of the Year

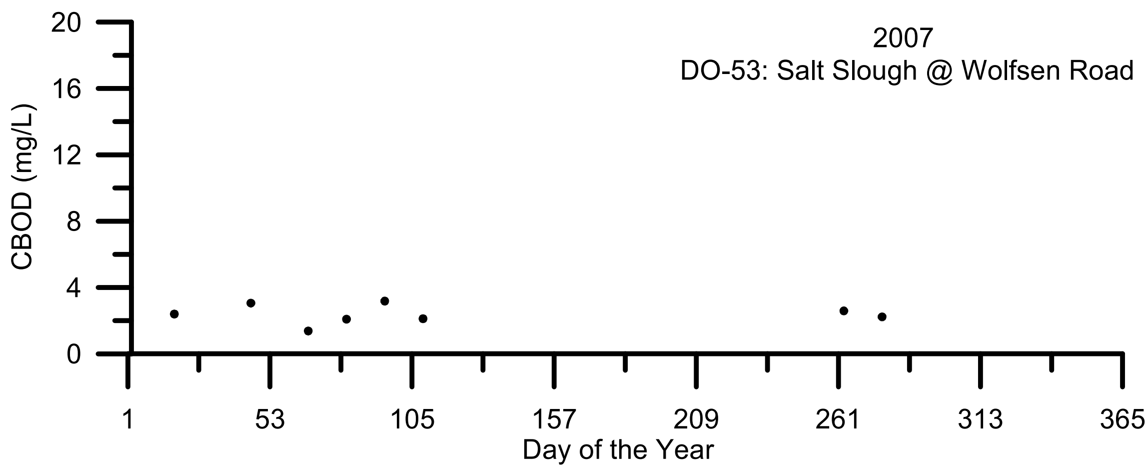

2005
DO-44: San Luis Drain End
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

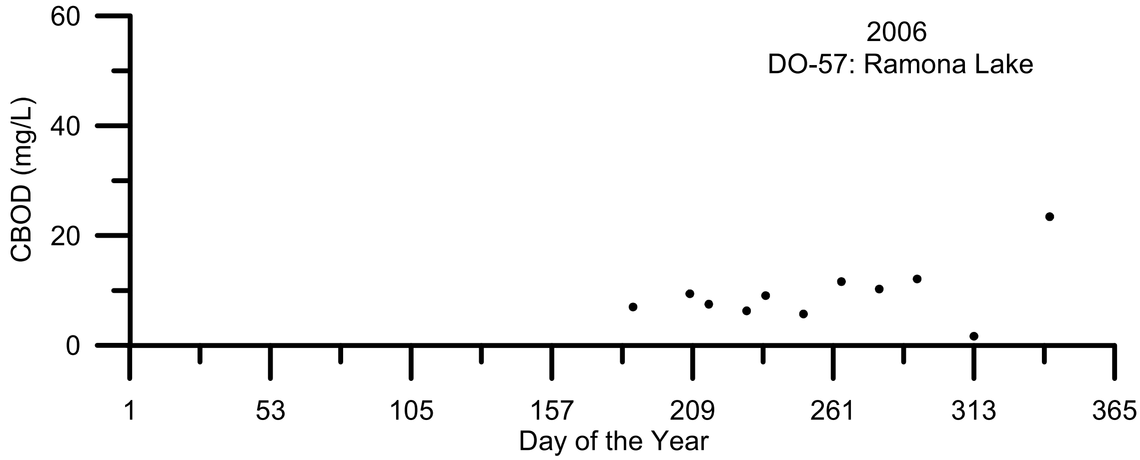

2006
DO-44: San Luis Drain End
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

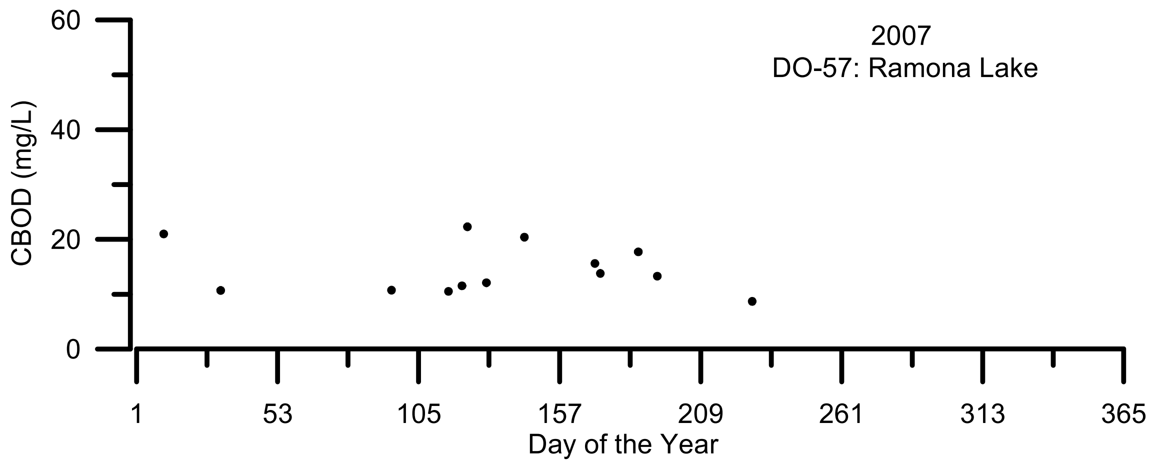

2007
DO-44: San Luis Drain End
CBOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

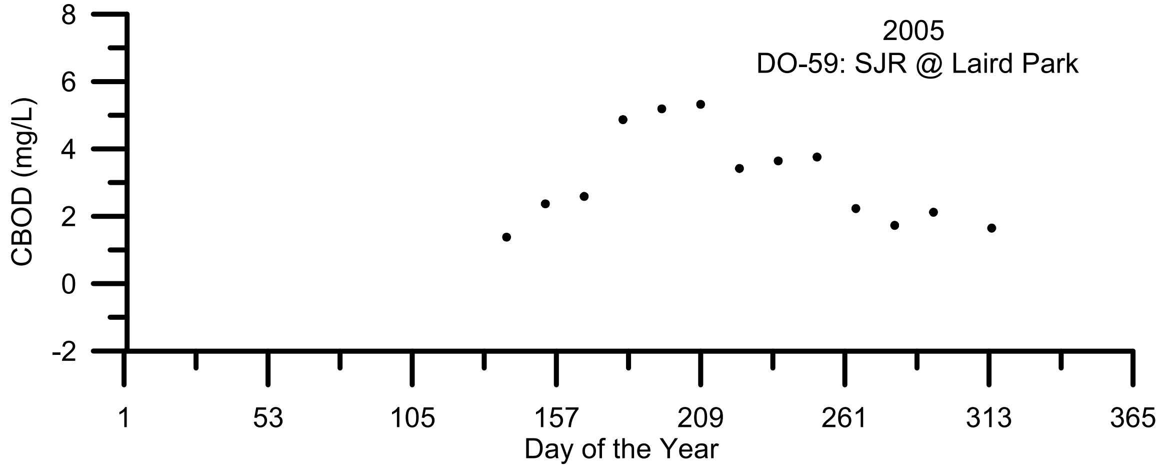

2005
DO-53: Salt Slough @ Wolfsen Road
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

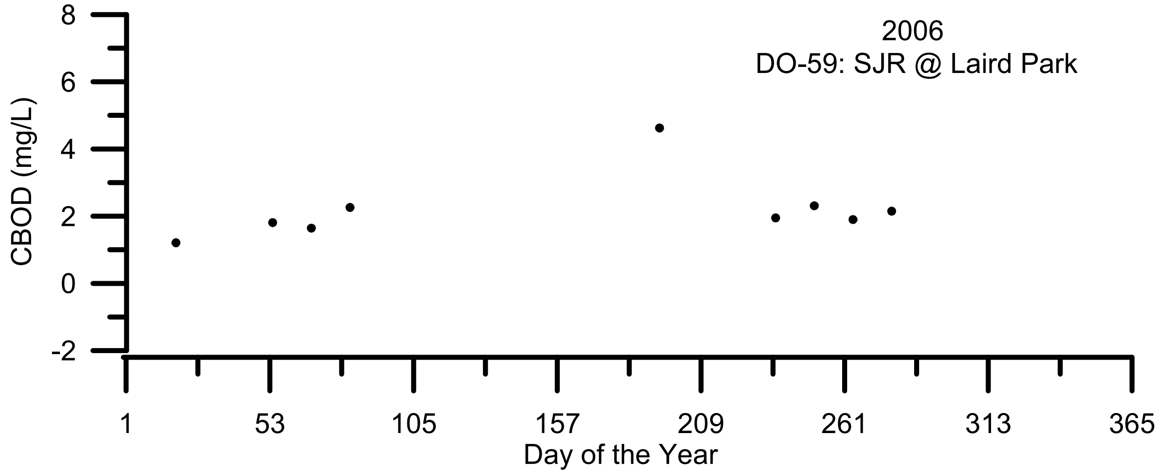

2006
DO-53: Salt Slough @ Wolfsen Road
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

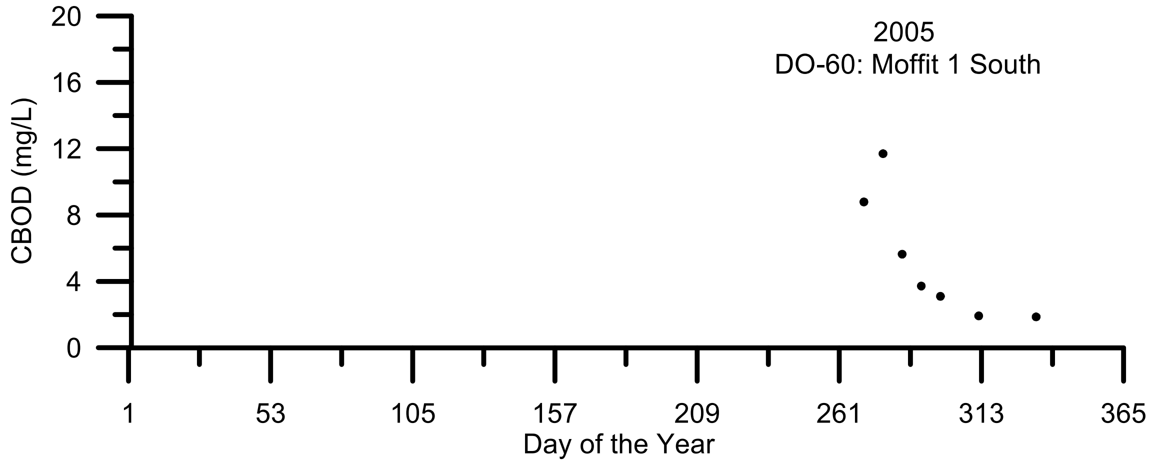

2007
DO-53: Salt Slough @ Wolfsen Road
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

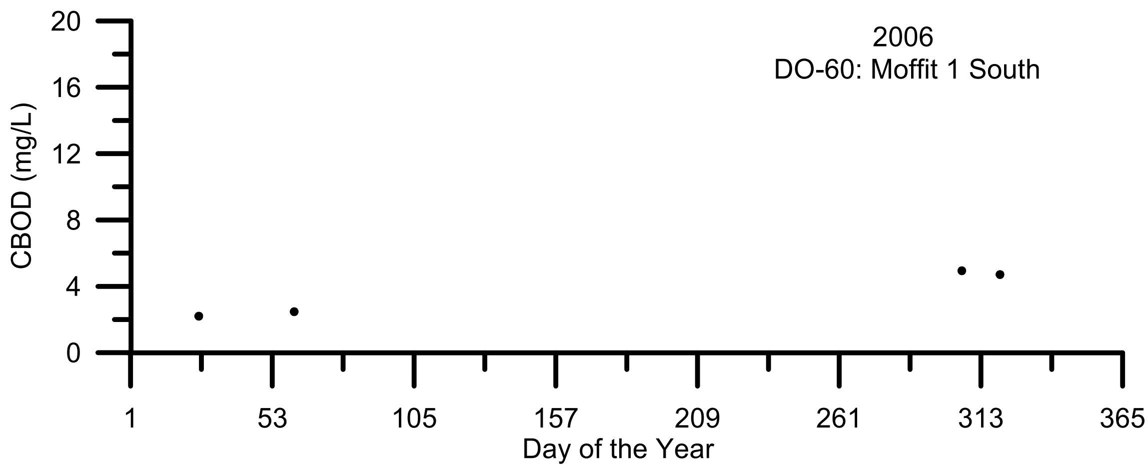

60
40
20
0
CBOD (mg/L)
2006
DO-57: Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year

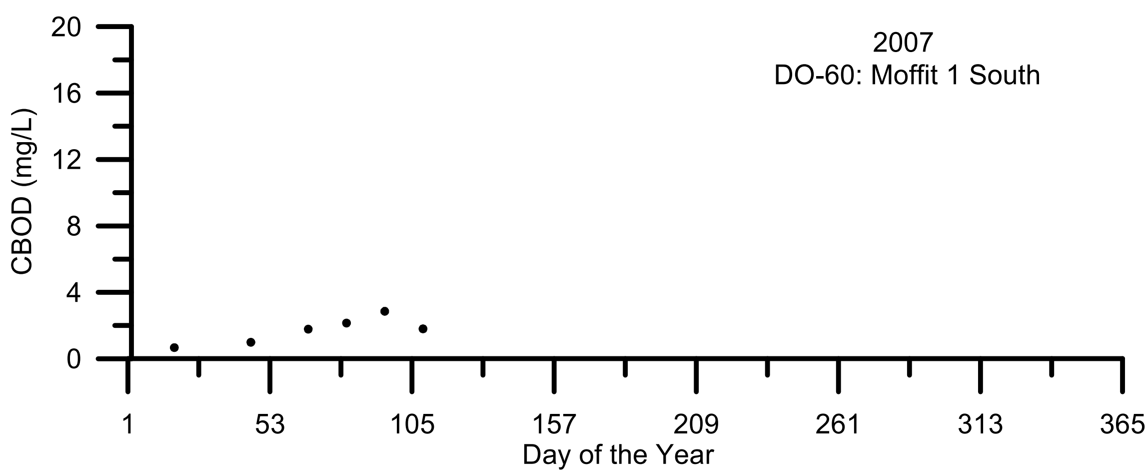

60
40
20
0
CBOD (mg/L)
2007
DO-57: Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year

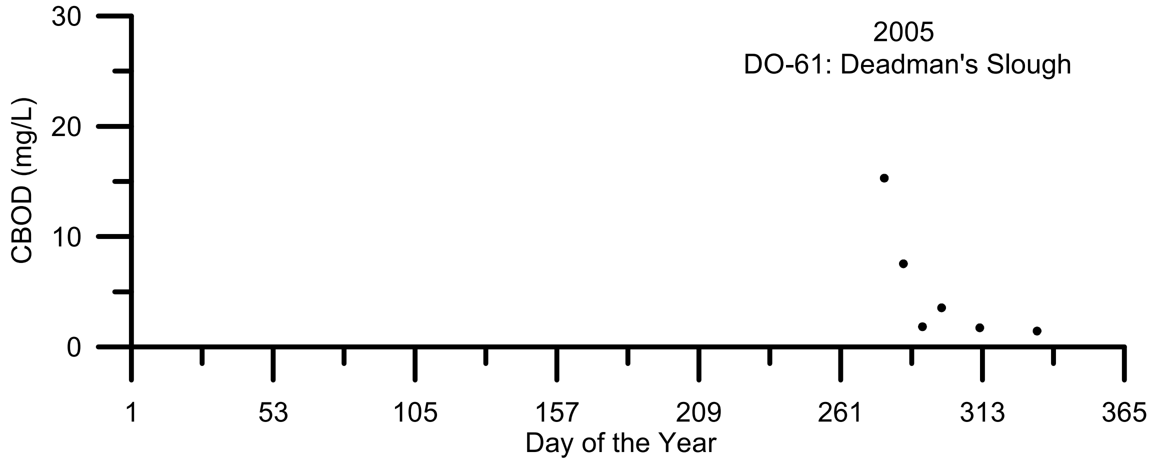

2005
DO-59: SJR @ Laird Park
CBOD (mg/L)
8
6
4
2
0
-2
1
53
105
157
209
261
313
365
Day of the Year

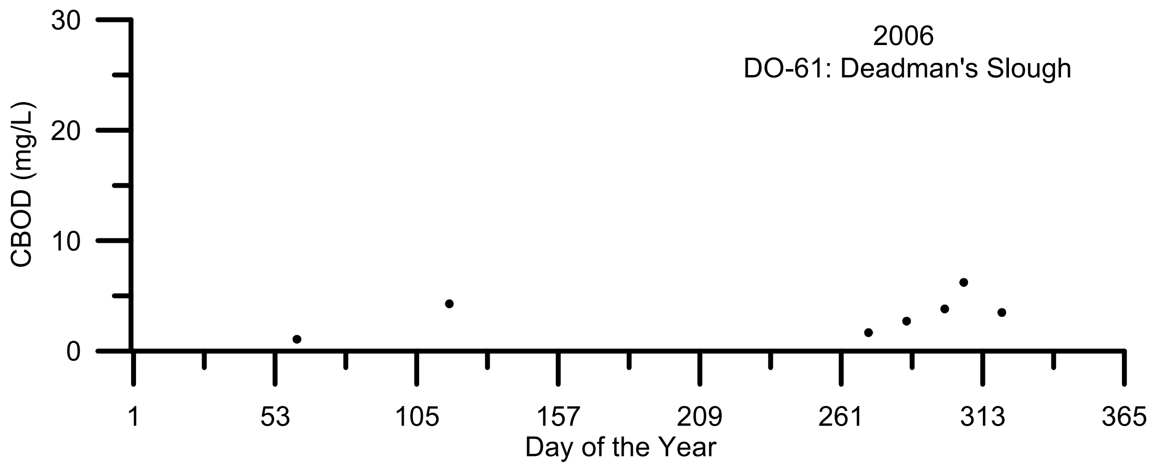

2006
DO-59: SJR @ Laird Park
CBOD (mg/L)
8
6
4
2
0
-2
1
53
105
157
209
261
313
365
Day of the Year

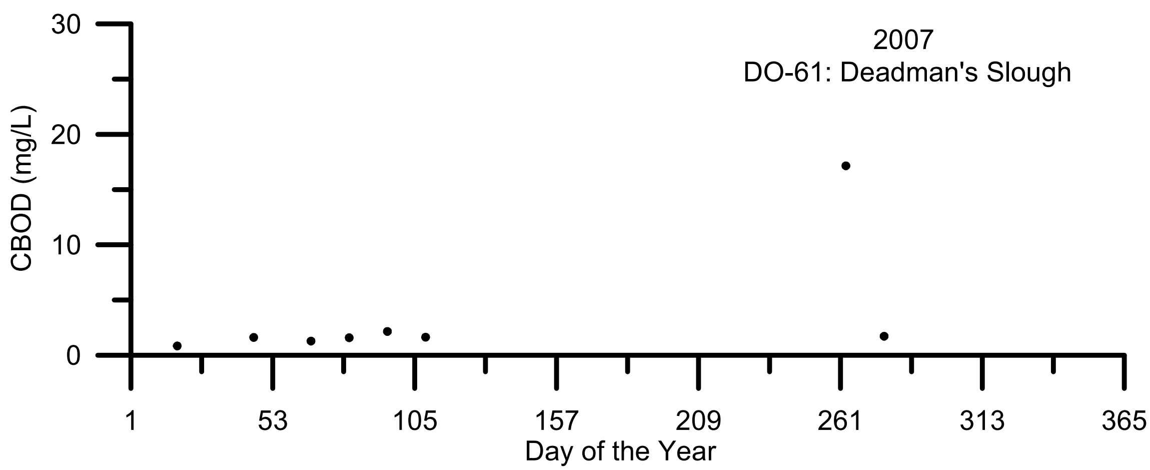

2005
DO-60: Moffit 1 South
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

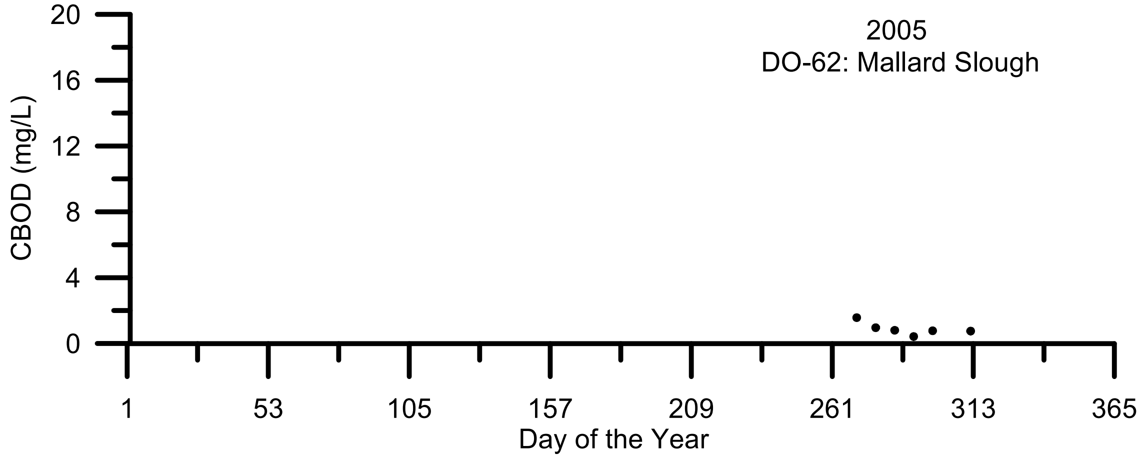

2006
DO-60: Moffit 1 South
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

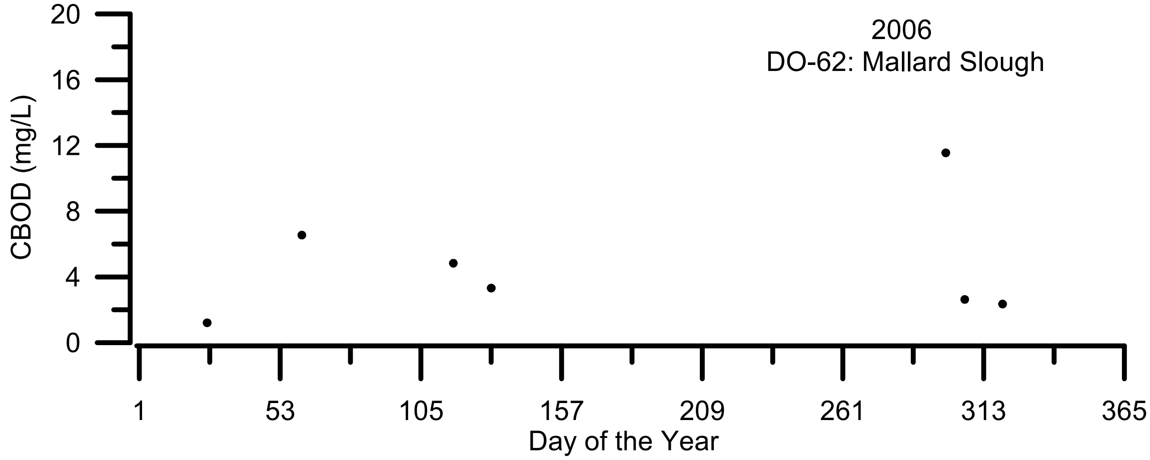

2007
DO-60: Moffit 1 South
CBOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

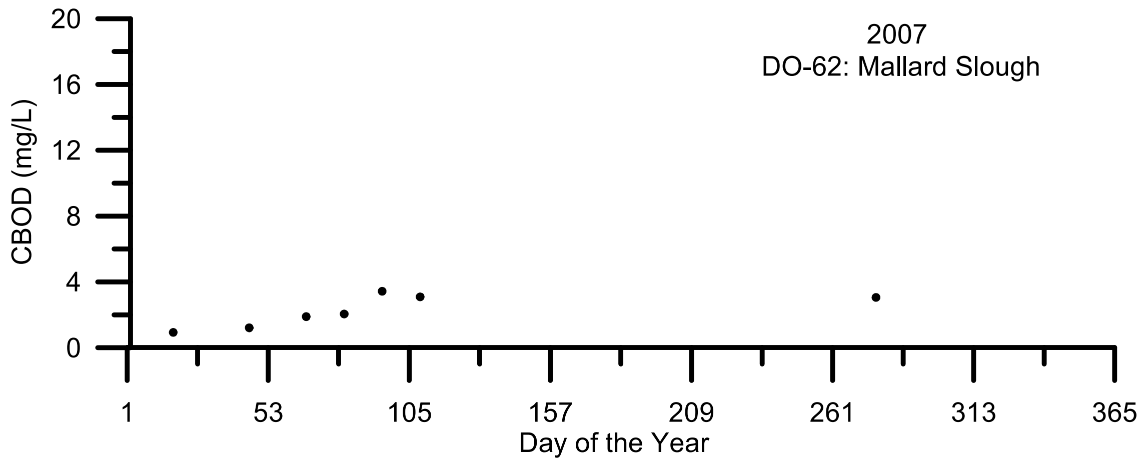

2005
DO-61: Deadman's Slough
CBOD (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

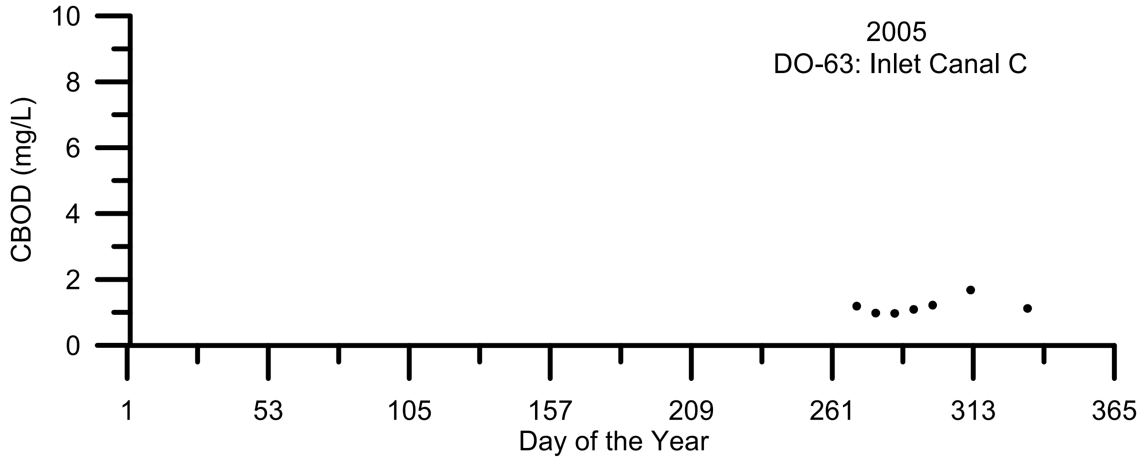

2006
DO-61: Deadman's Slough
CBOD (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

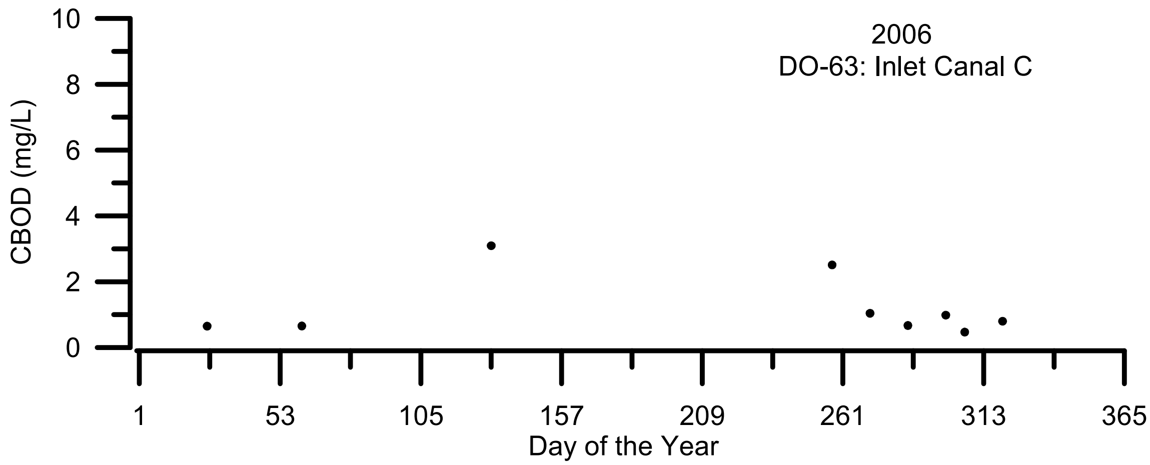

2007
DO-61: Deadman's Slough
CBOD (mg/L)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

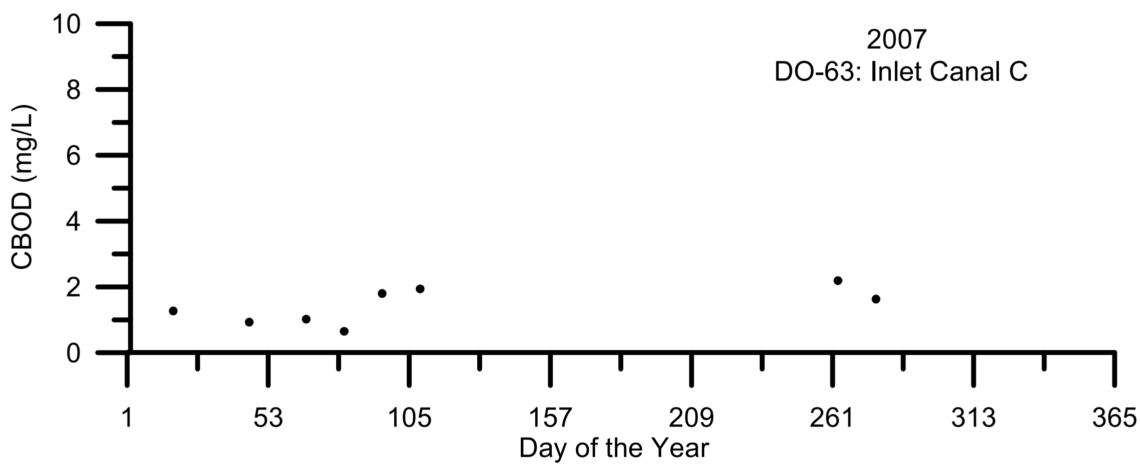

2005
DO-62: Mallard Slough
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

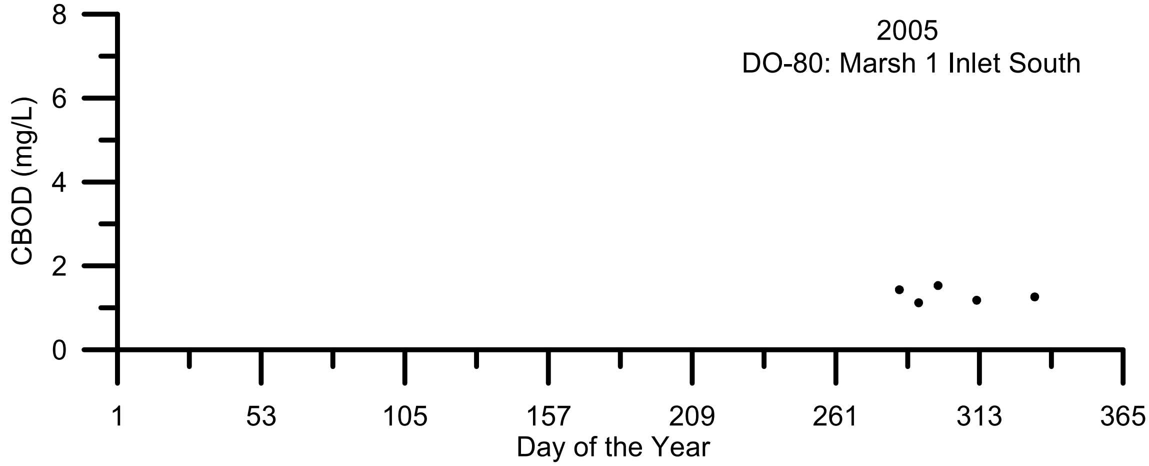

2006
DO-62: Mallard Slough
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

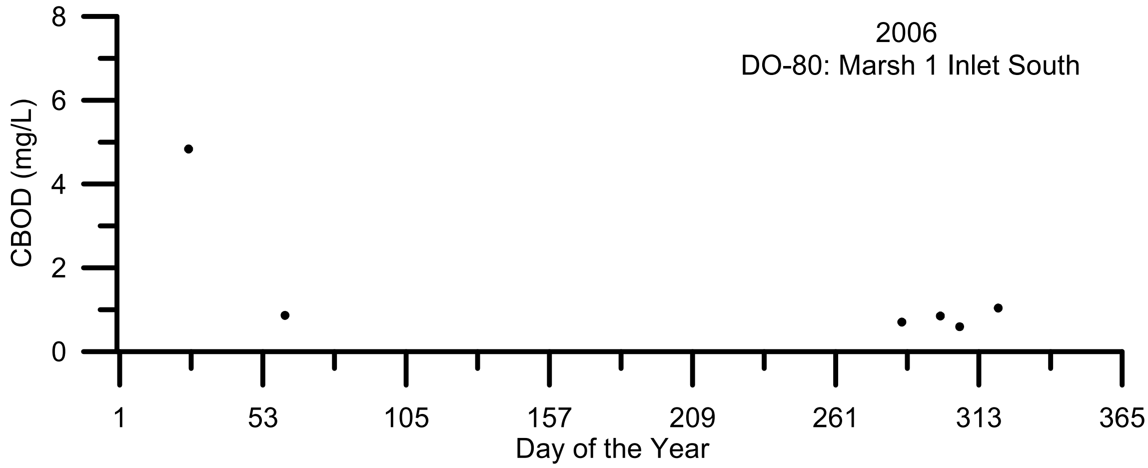

2007
DO-62: Mallard Slough
CBOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

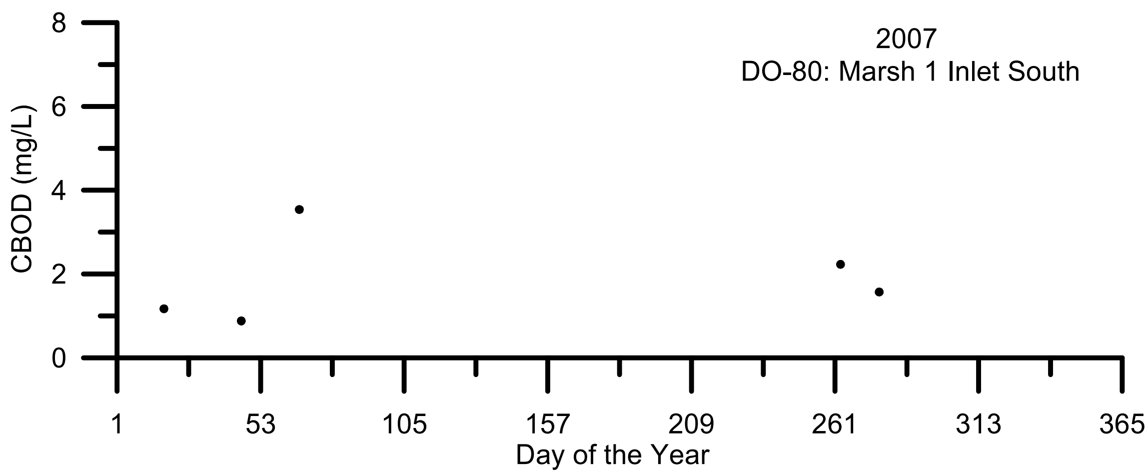

10
8
6
4
2
0
CBOD (mg/L)
2005
DO-63: Inlet Canal C
1
53
105
157
209
261
313
365
Day of the Year

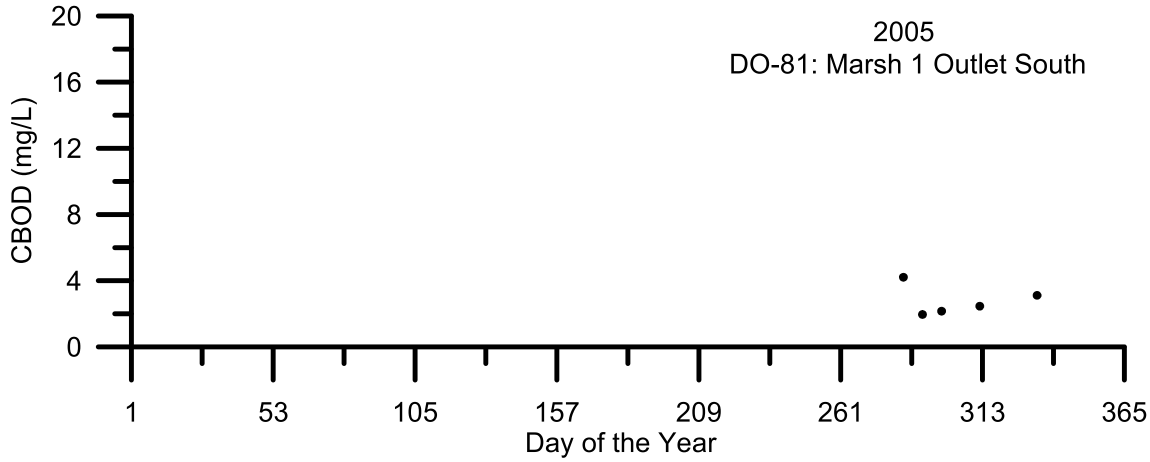

10
8
6
4
2
0
CBOD (mg/L)
2006
DO-63: Inlet Canal C
1
53
105
157
209
261
313
365
Day of the Year

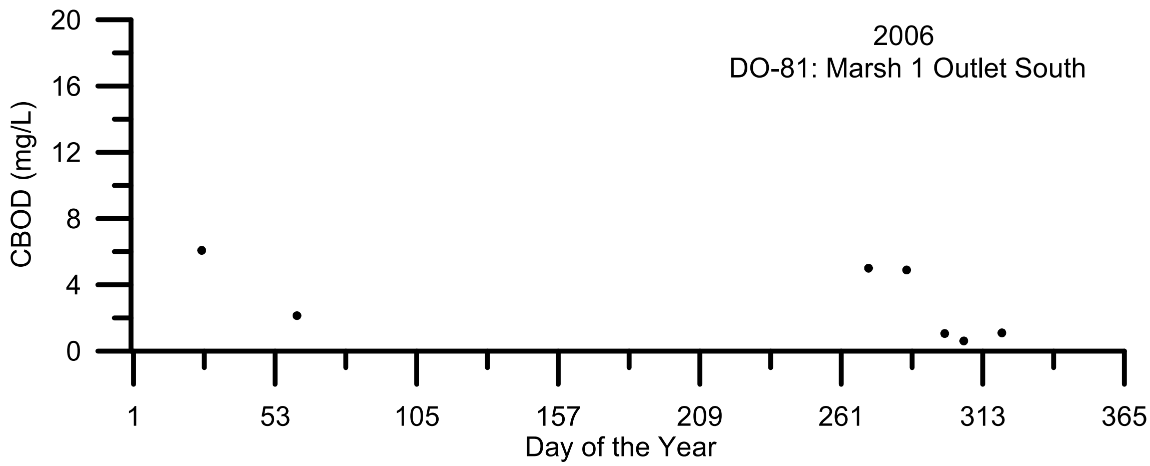

10
8
6
4
2
0
CBOD (mg/L)
2007
DO-63: Inlet Canal C
1
53
105
157
209
261
313
365
Day of the Year

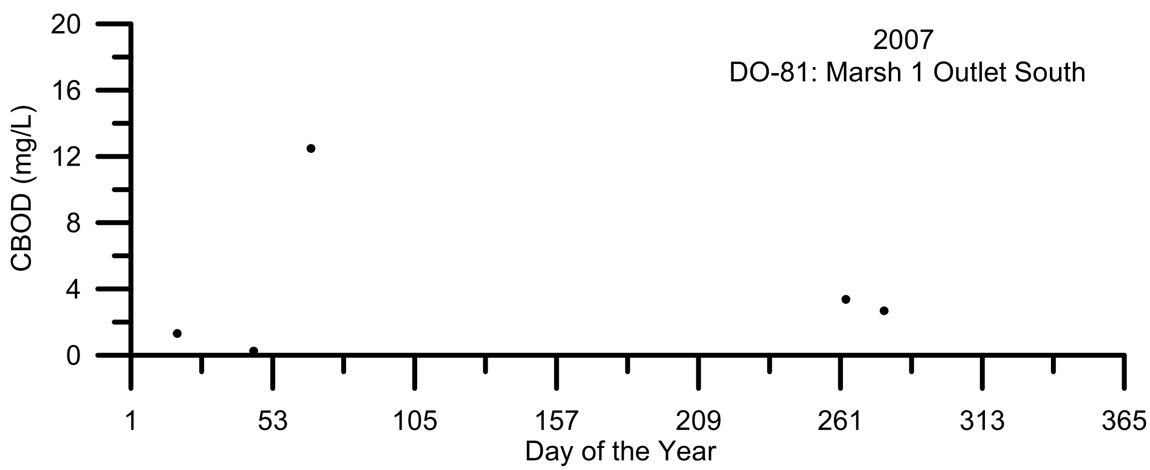

2005
DO-80: Marsh 1 Inlet South
CBOD (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

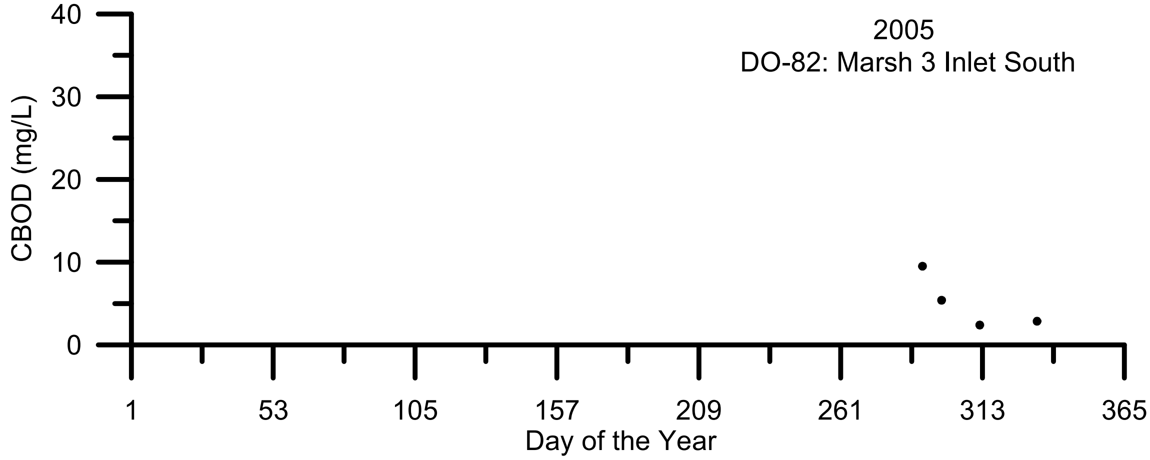

2006
DO-80: Marsh 1 Inlet South
CBOD (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

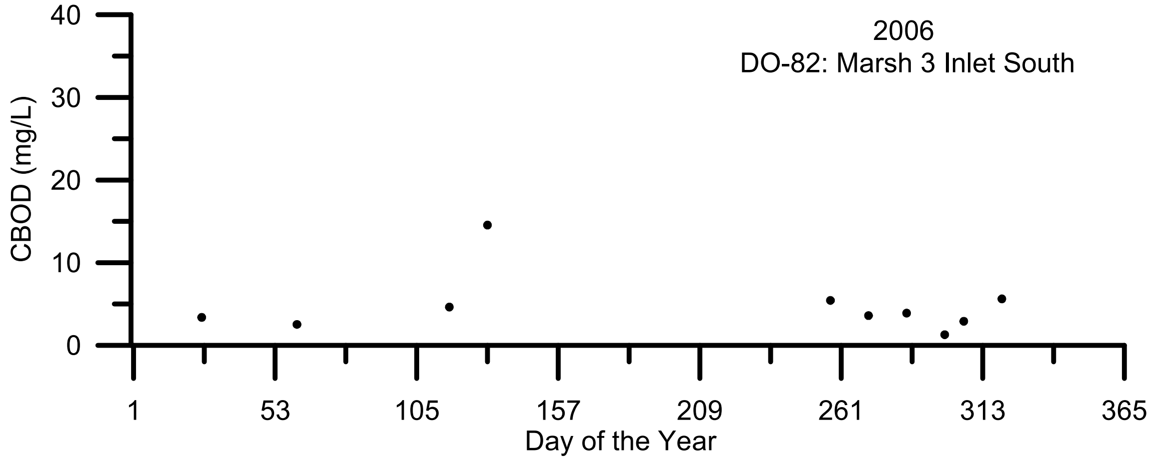

2007
DO-80: Marsh 1 Inlet South
CBOD (mg/L)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

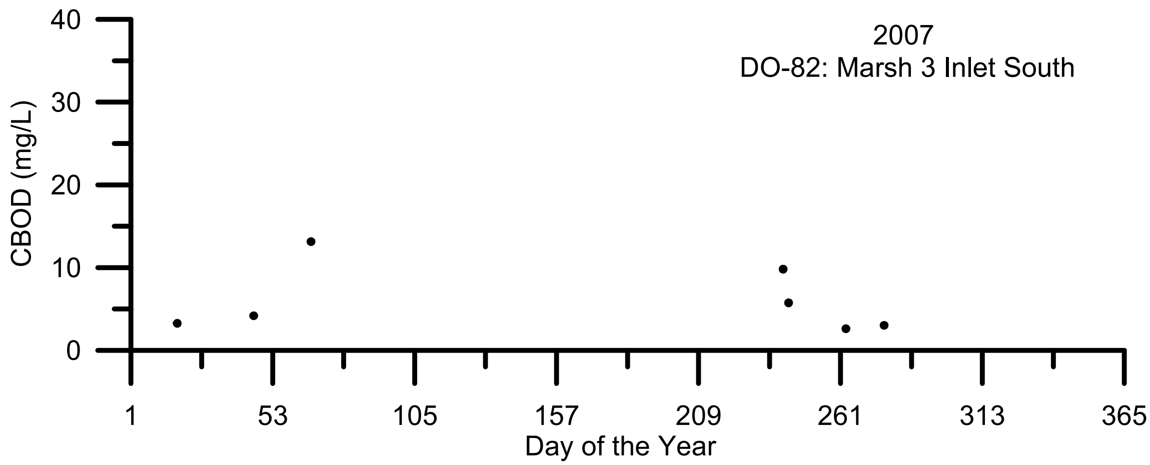

2005
DO-81: Marsh 1 Outlet South
CBOD (mg/L)
Day of the Year

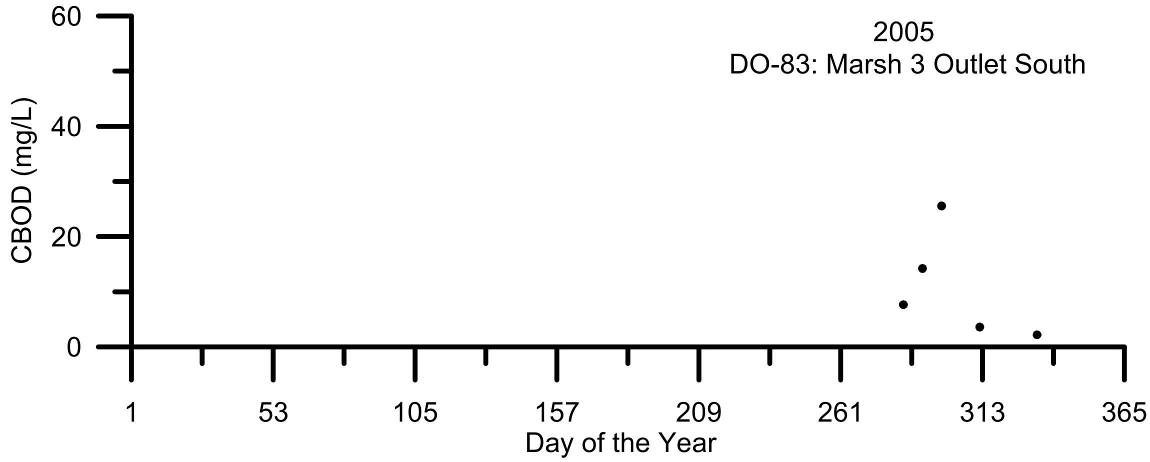

2006
DO-81: Marsh 1 Outlet South
CBOD (mg/L)
Day of the Year

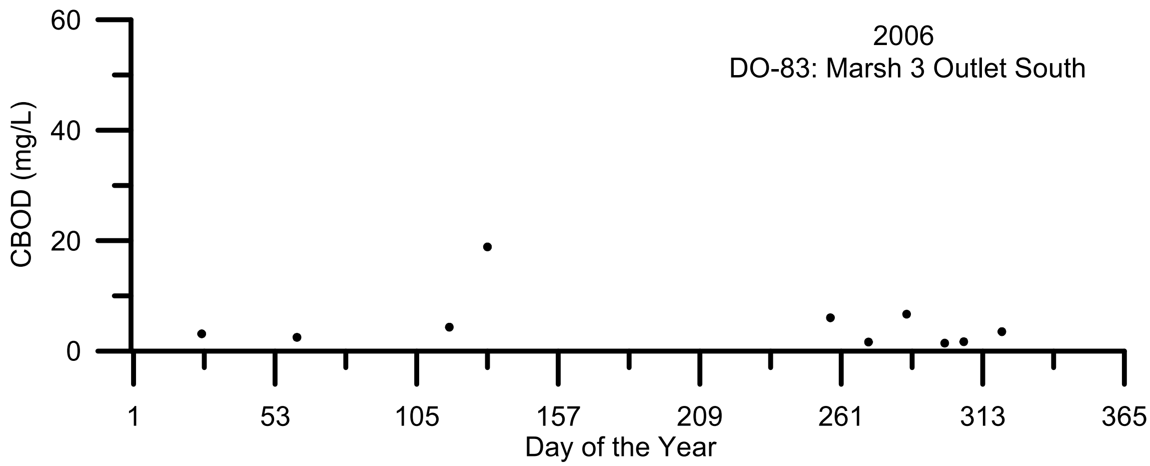

2007
DO-81: Marsh 1 Outlet South
CBOD (mg/L)
Day of the Year

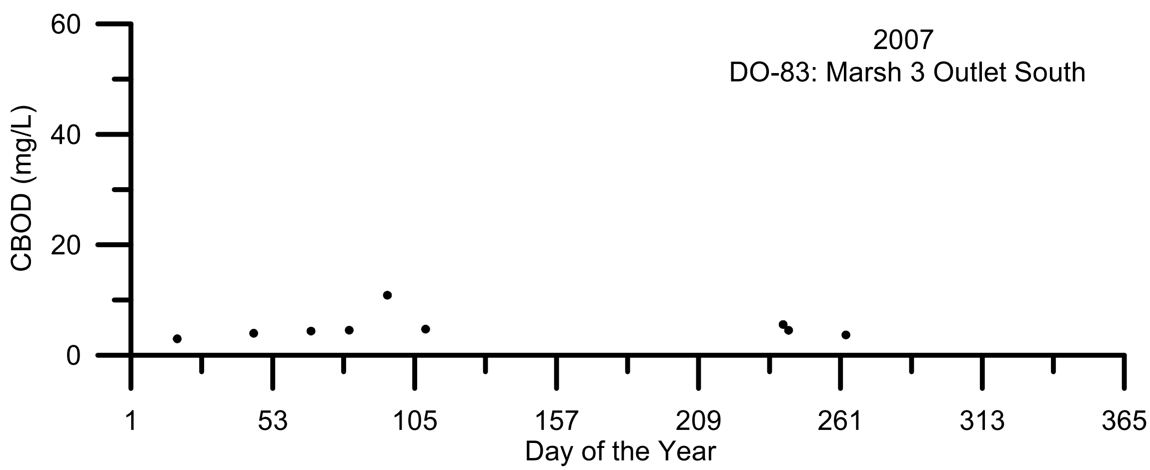

2005
DO-82: Marsh 3 Inlet South
CBOD (mg/L)
Day of the Year

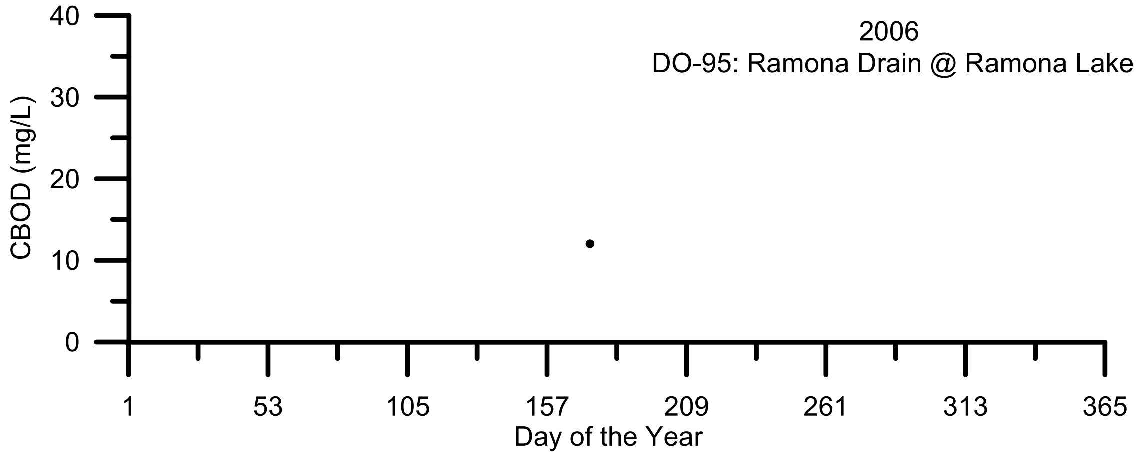

2006
DO-82: Marsh 3 Inlet South
CBOD (mg/L)
Day of the Year


2007
DO-82: Marsh 3 Inlet South
CBOD (mg/L)
Day of the Year

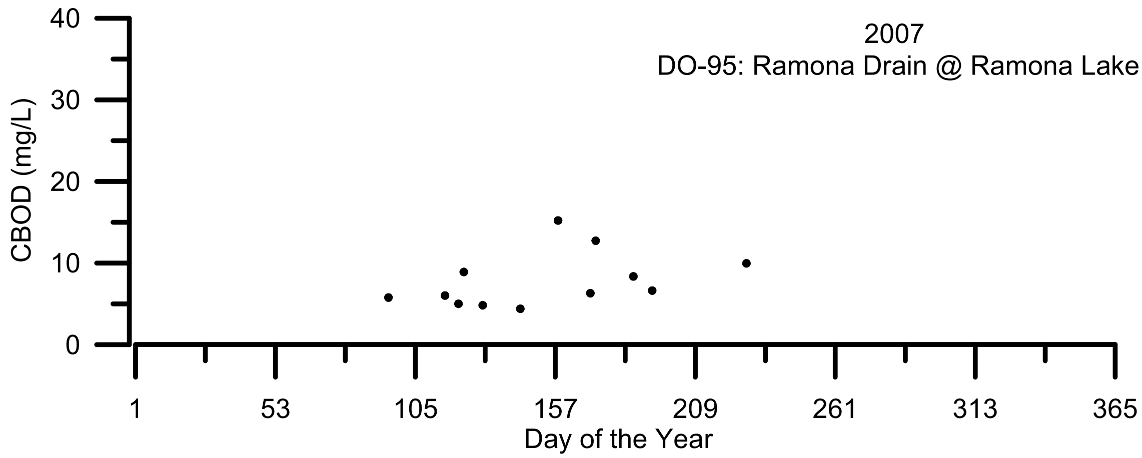

2005
DO-83: Marsh 3 Outlet South
CBOD (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
CBOD (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
CBOD (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year



2006
DO-95: Ramona Drain @ Ramona Lake
CBOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-95: Ramona Drain @ Ramona Lake
CBOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Biochemical Oxygen Demand in the San Joaquin River Watershed 2005-2007

Remie Burks
Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

Environmental Engineering Research Program
University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of biochemical oxygen demand (BOD) for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at 4°C until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Unfiltered samples were analyzed for Biochemical oxygen demand (BOD) by Standard Method (SM) 5210 B (APHA, 2005) with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set will be consistent with prior studies. BOD was measured without seed, as in previous studies. Initial and final dissolved oxygen was measured using a calibrated YSI 5000 DO meter equipped with a YSI 5010 BOD probe (Yellow Springs, OH) and calibrated by Winkler titration according to SM 10200 H (APHA, 2005). In addition, Carbonaceous BOD (CBOD) was determined by adding 0.16 mg of nitrification inhibitor (N-serve, HACH, Loveland, CO) to a duplicate sample set. The resulting CBOD was subtracted from the total BOD to determine the Nitrogenous BOD (NBOD). The limit of detection for BOD, CBOD and NBOD is 1.0mg/L.

Results and Discussion

This analysis was preformed routinely over the three year period with the 10-day modification of the standard method. A 97.5% passing rate for all QA parameters over the three years was observed and few (2 total) proficiency check samples were analyzed and for our modified method, a 100% passing rate was seen (Borglin et. al., 2008). Additional problems with particular sampling sets occurred due to equipment failure (incubator and DO meter) causing those sample sets to be excluded from our final compiled data.

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

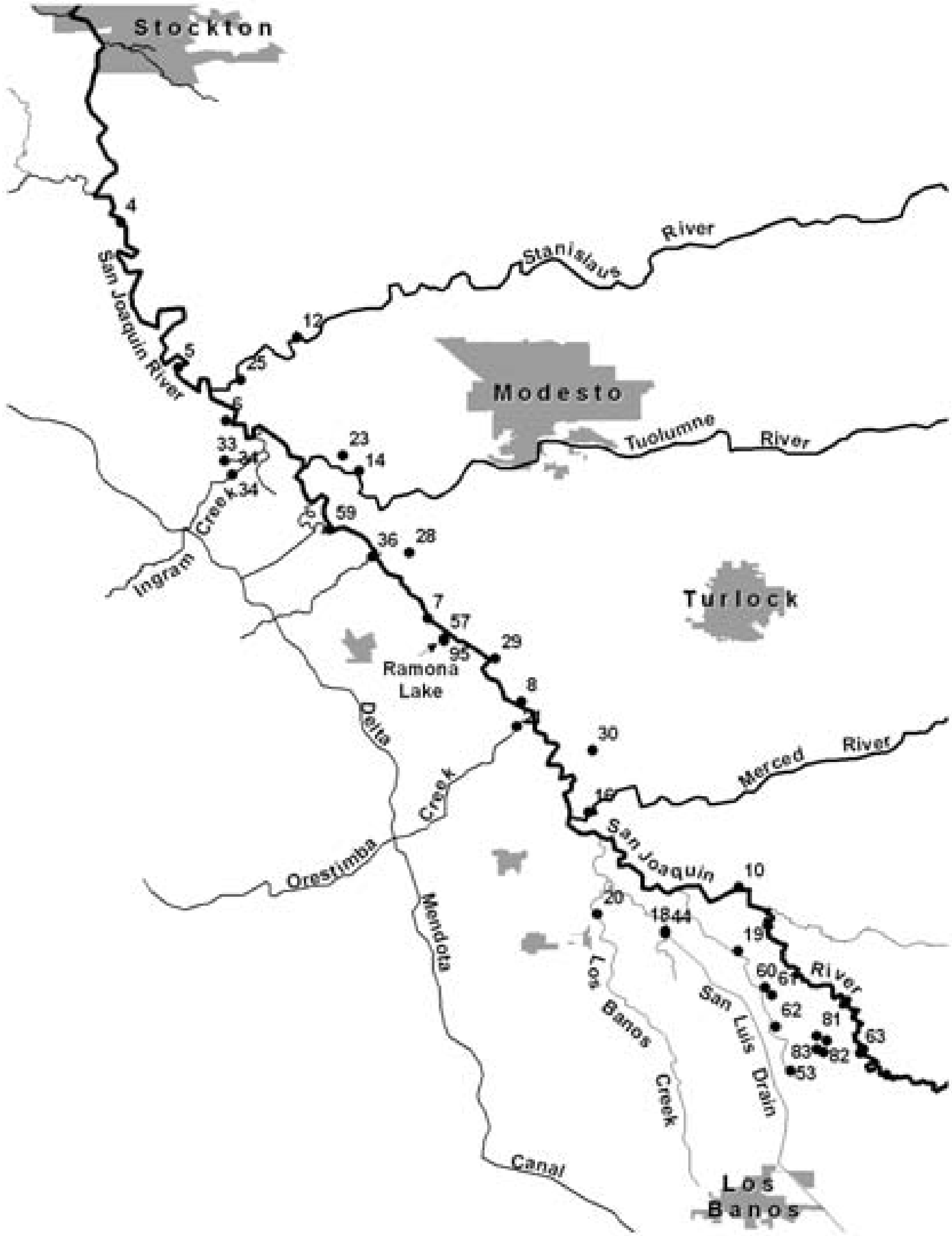
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

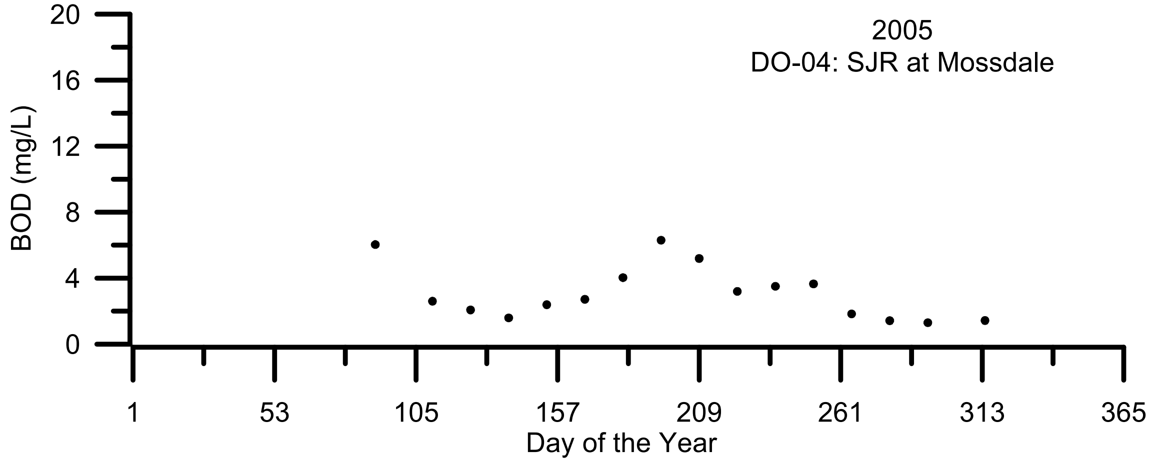
Table 1: EERP Sampling Site List

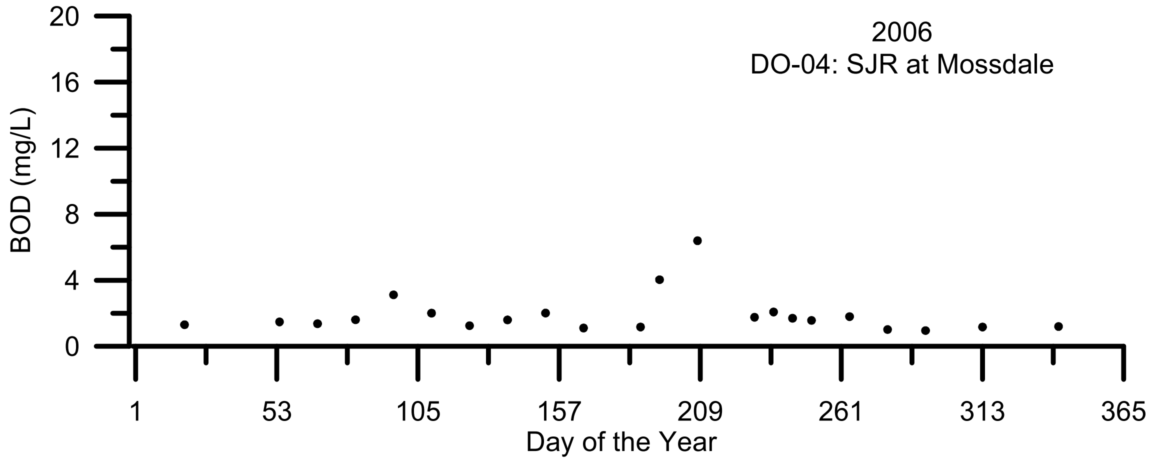
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

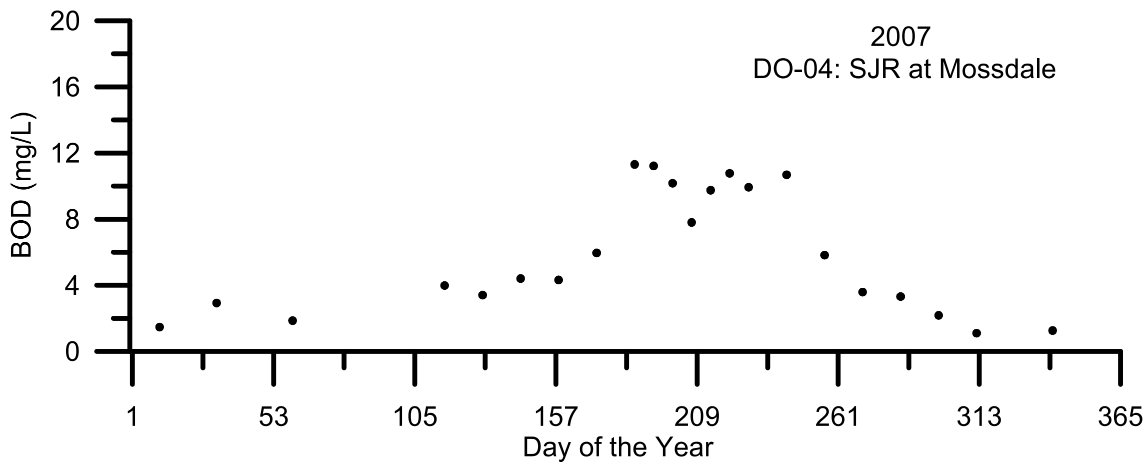
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

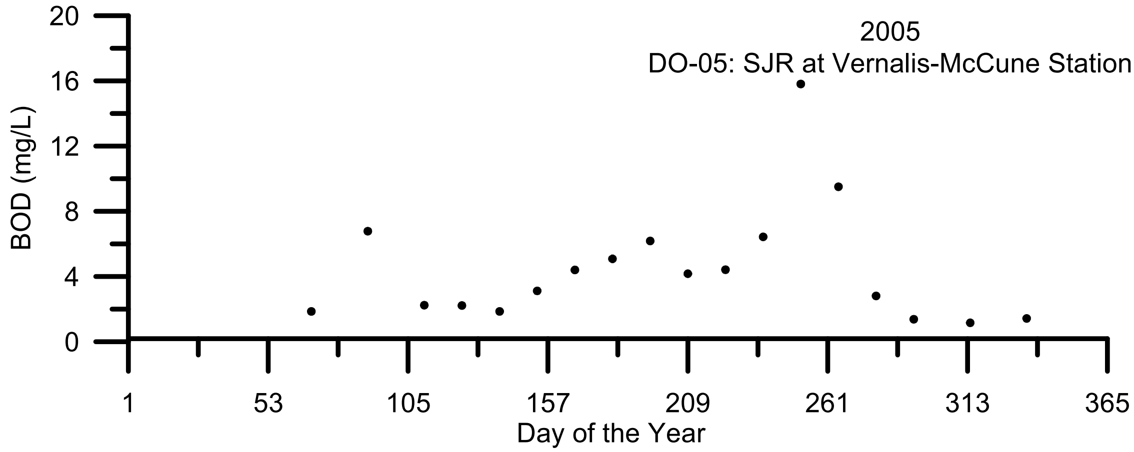


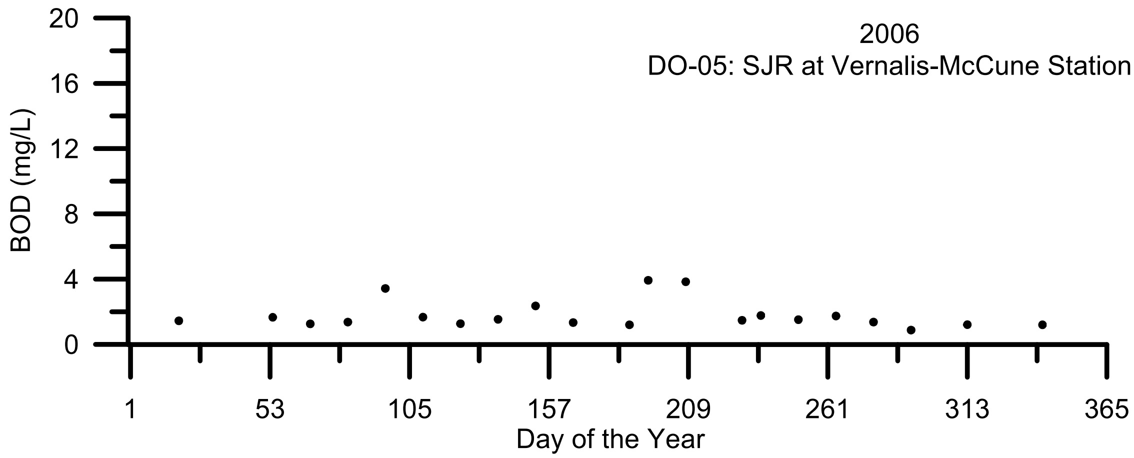
Figures 2 -101: Temporal Plots of BOD By Site ID

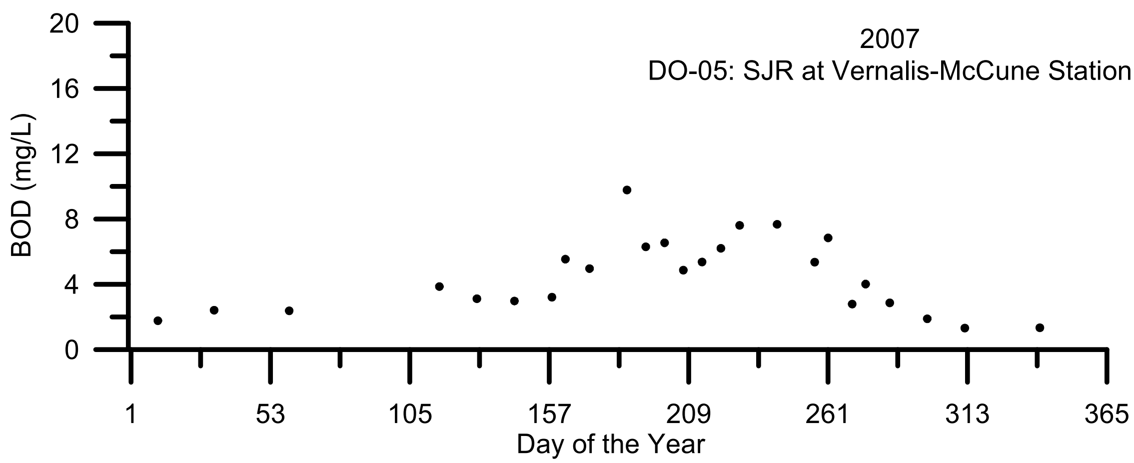


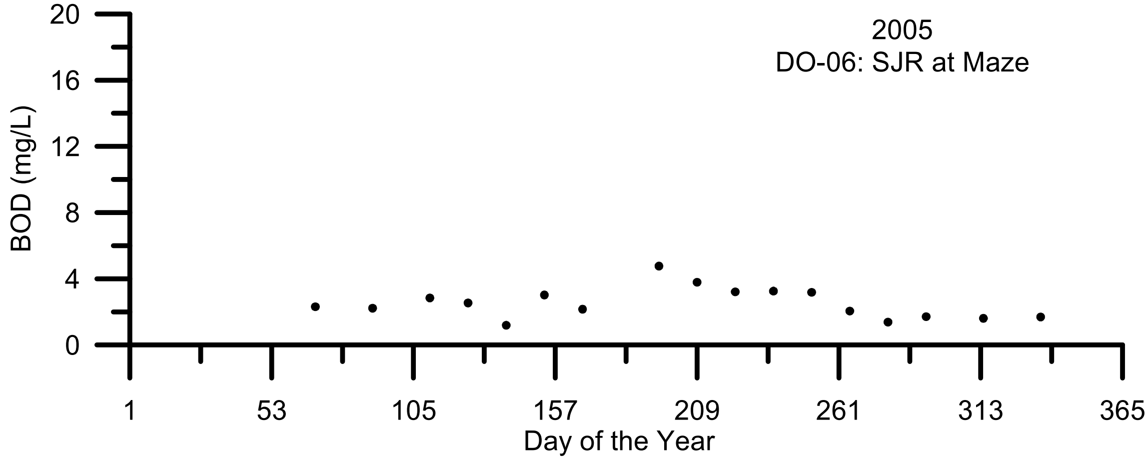


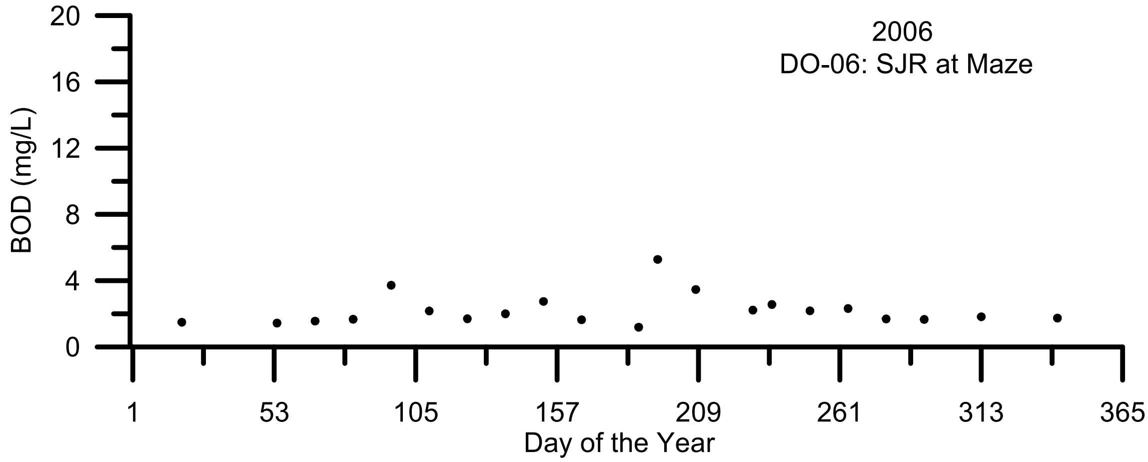


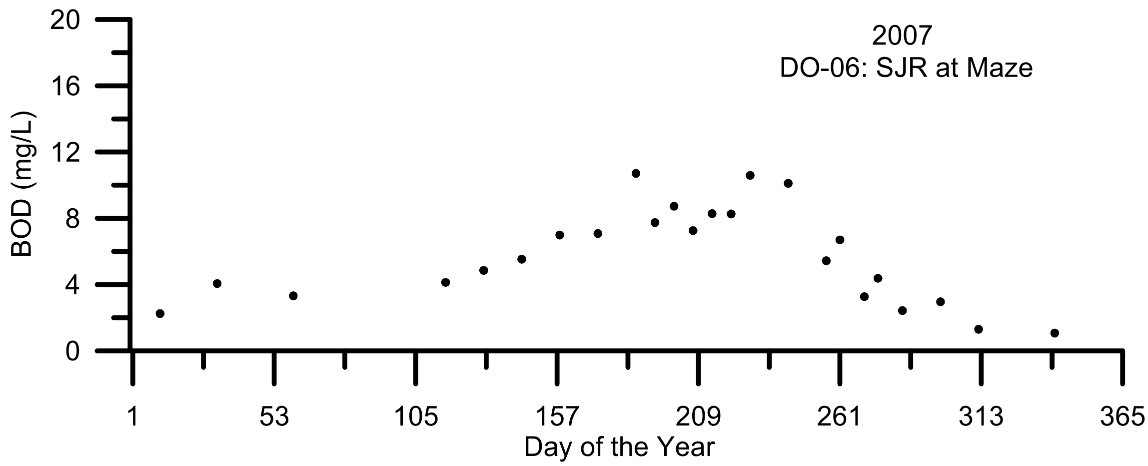

2005
DO-05: SJR at Vernalis-McCune Station
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

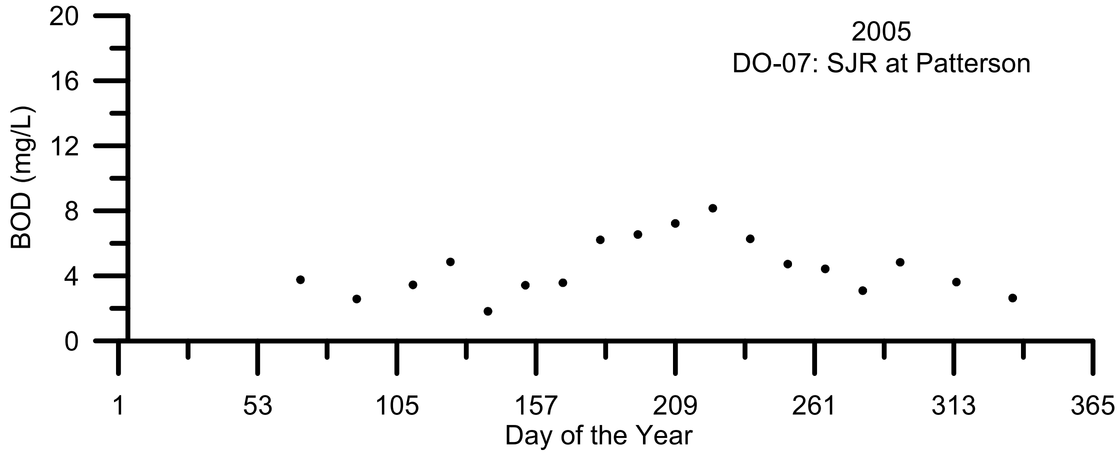

2006
DO-05: SJR at Vernalis-McCune Station
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

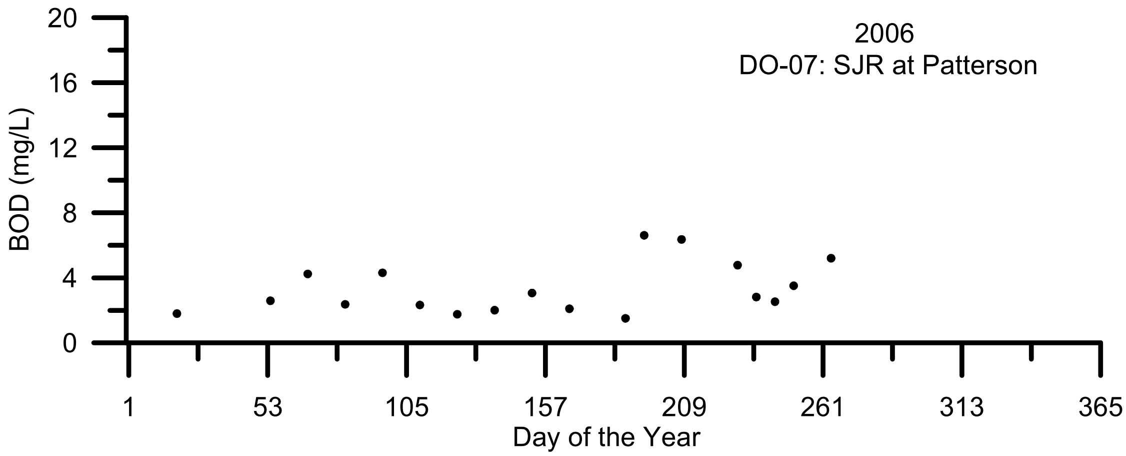

2007
DO-05: SJR at Vernalis-McCune Station
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

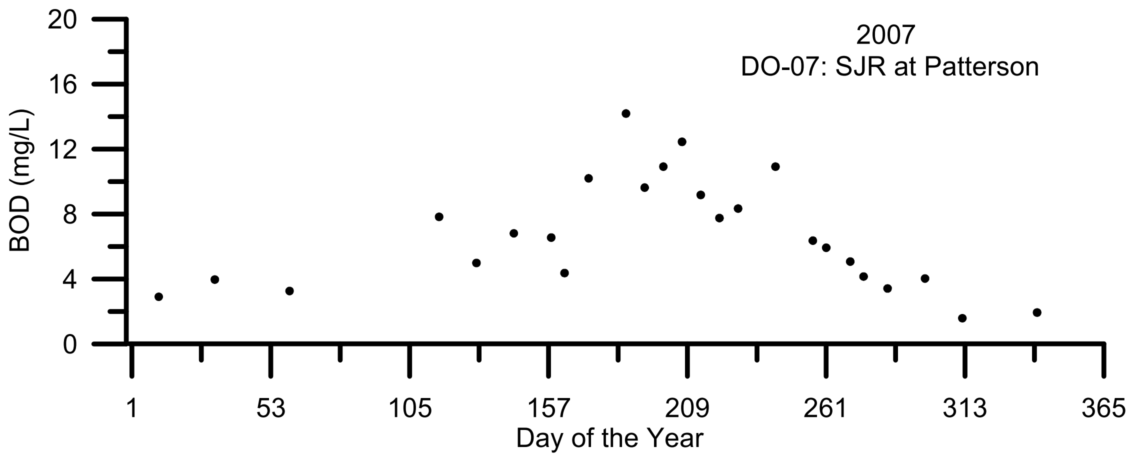

2005
DO-06: SJR at Maze
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

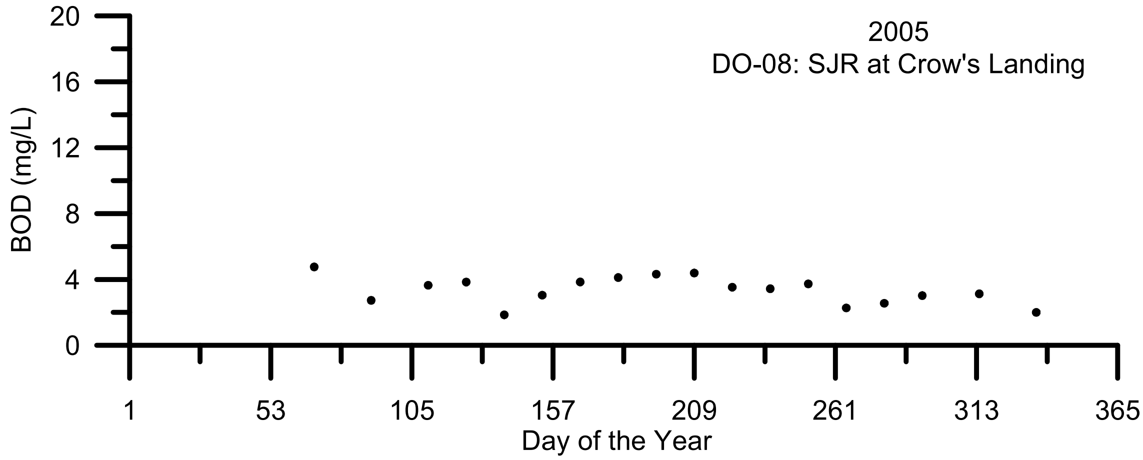

2006
DO-06: SJR at Maze
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

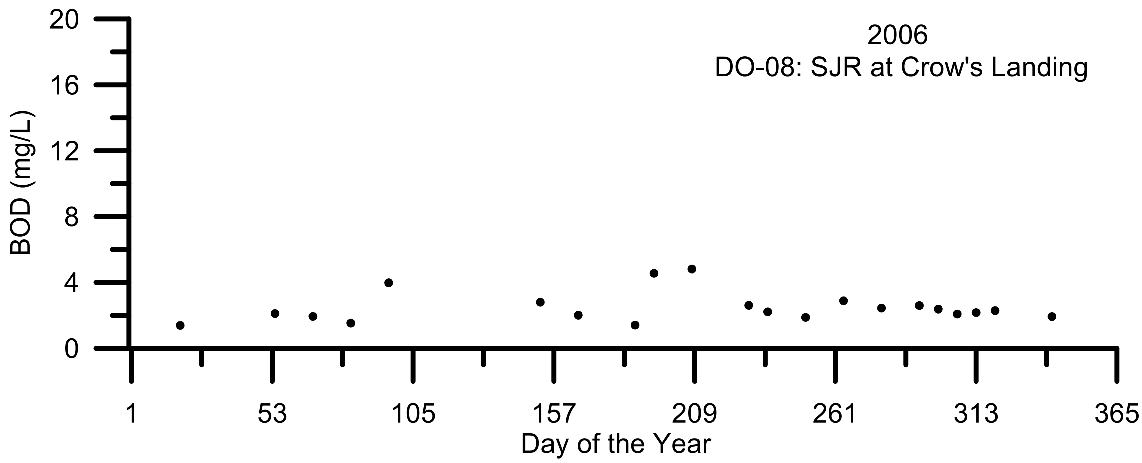

2007
DO-06: SJR at Maze
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

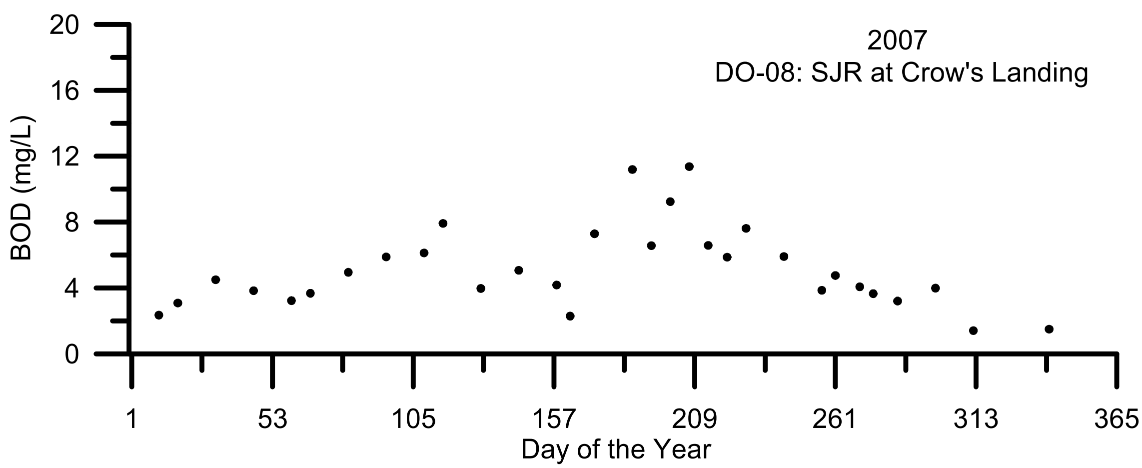

2005
DO-07: SJR at Patterson
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

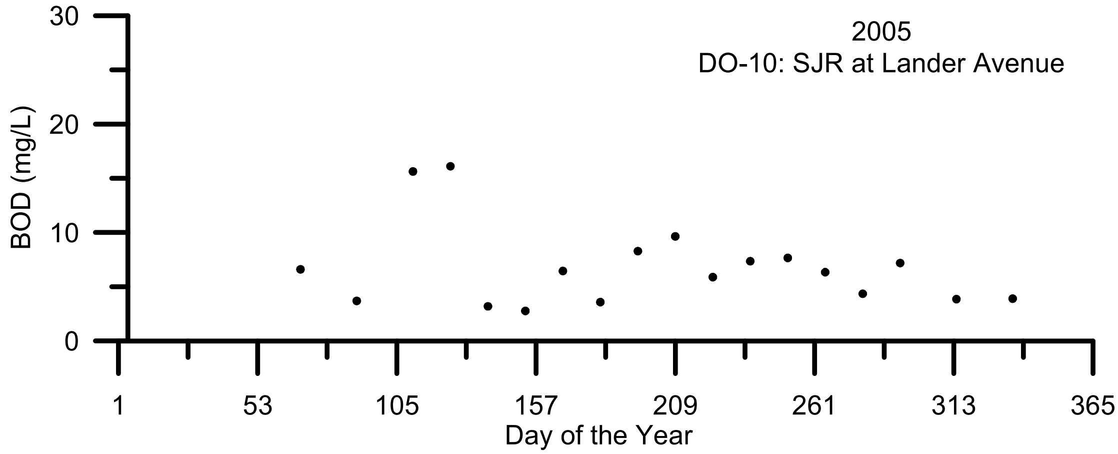

2006
DO-07: SJR at Patterson
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

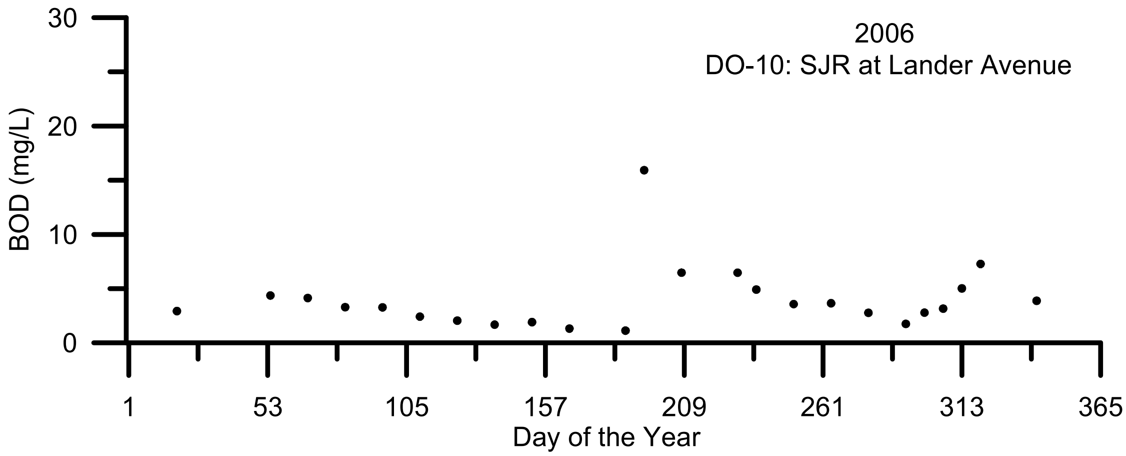

2007
DO-07: SJR at Patterson
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

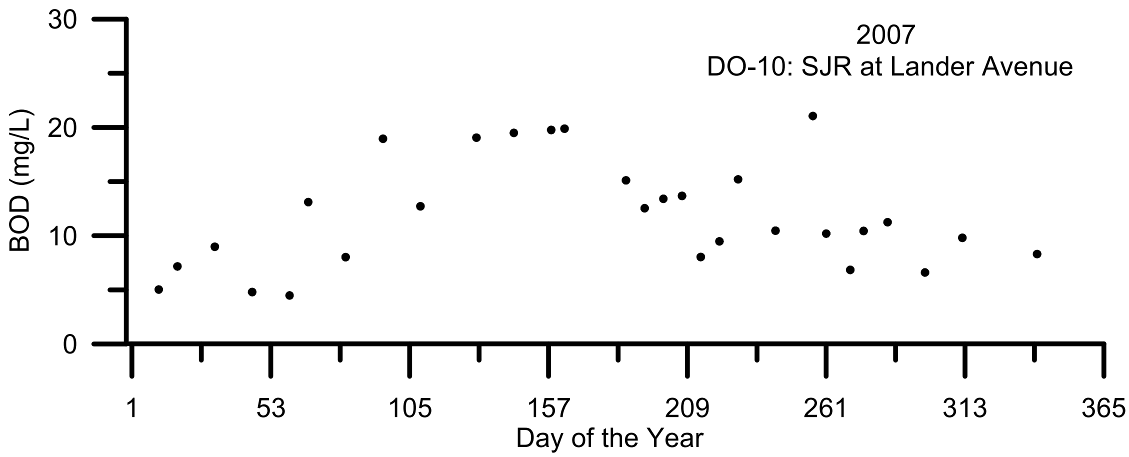

2005
DO-08: SJR at Crow's Landing
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

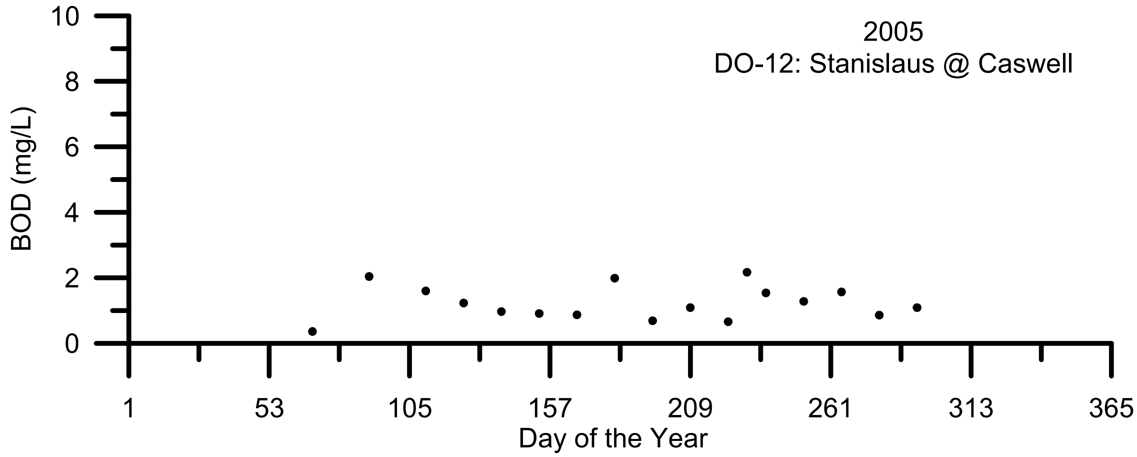

2006
DO-08: SJR at Crow's Landing
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

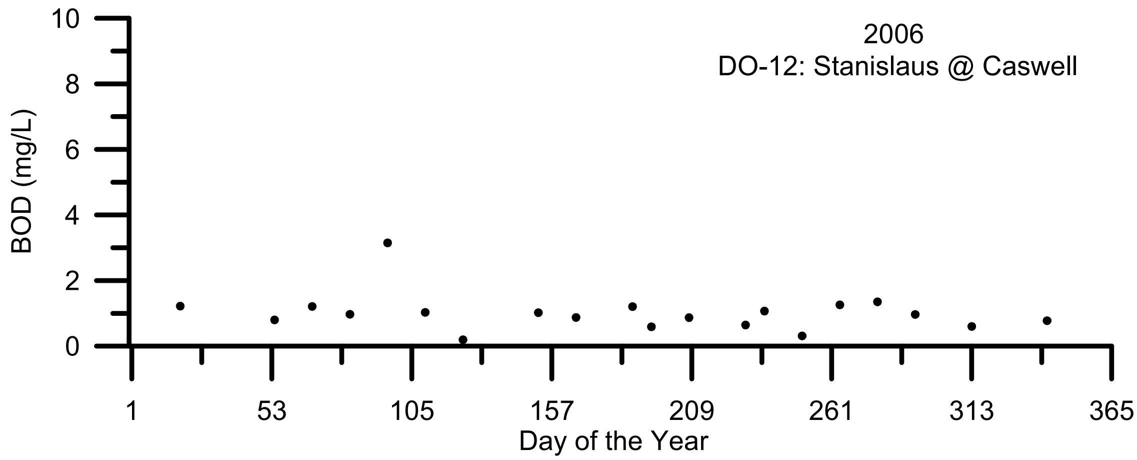

2007
DO-08: SJR at Crow's Landing
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

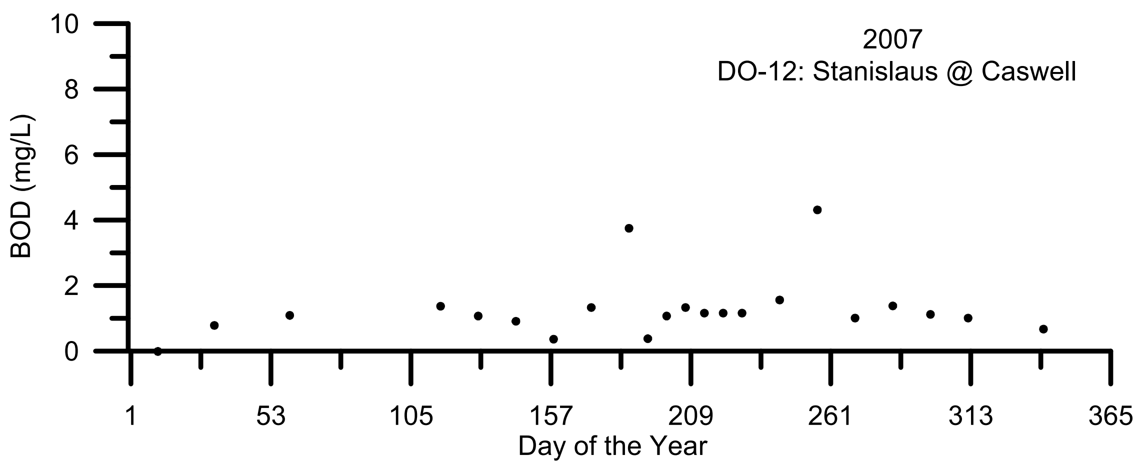

30
20
10
0
BOD (mg/L)
2005
DO-10: SJR at Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year

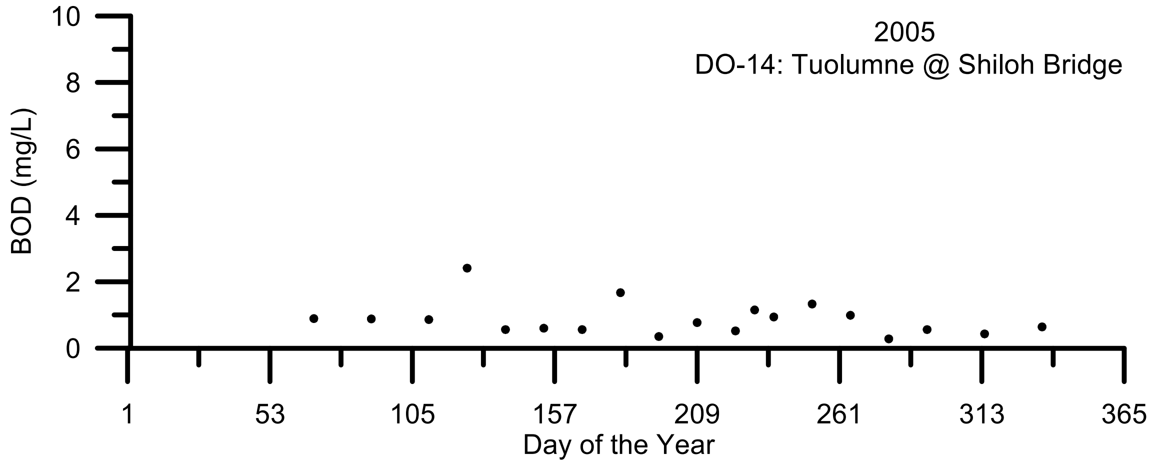

30
20
10
0
BOD (mg/L)
2006
DO-10: SJR at Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year


30
20
10
0
BOD (mg/L)
2007
DO-10: SJR at Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year

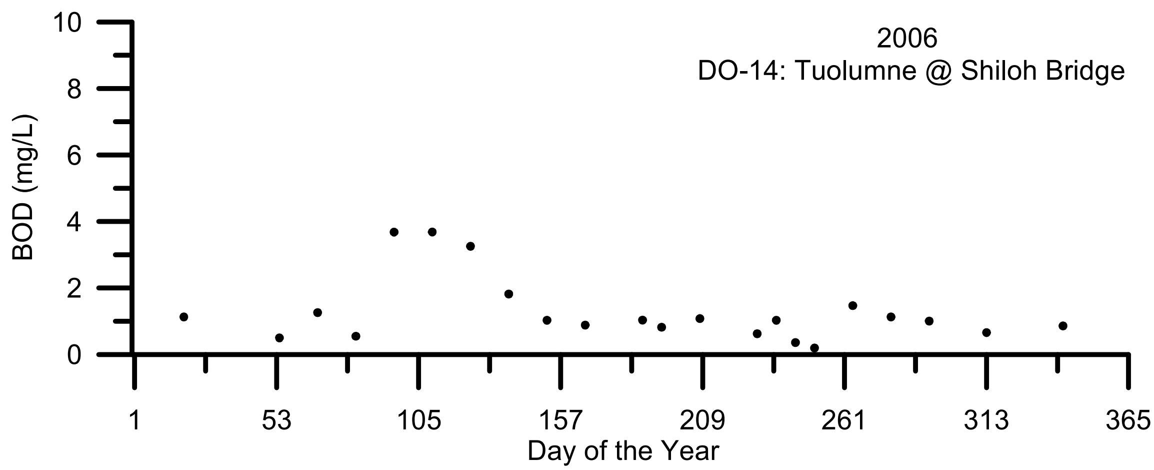

2005
DO-12: Stanislaus @ Caswell
BOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus @ Caswell
BOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

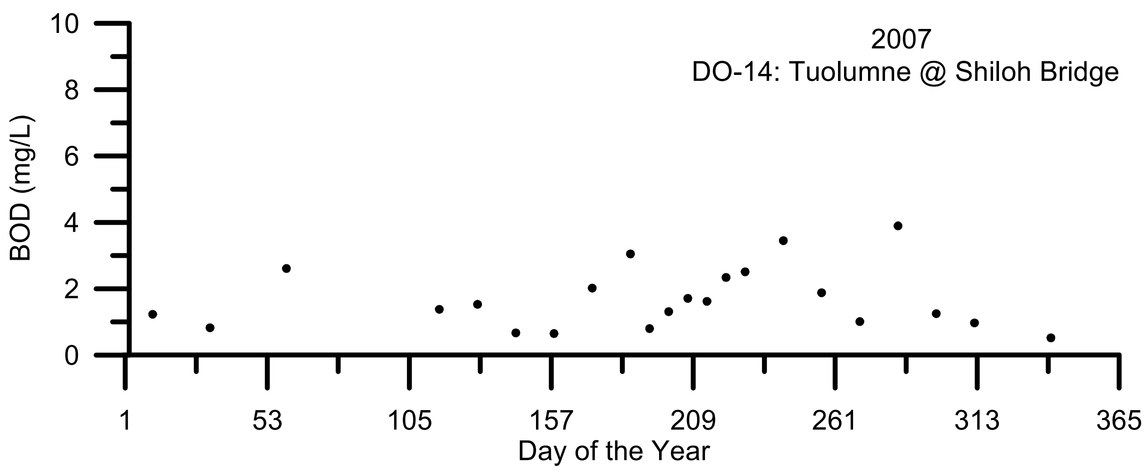

2007
DO-12: Stanislaus @ Caswell
BOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year



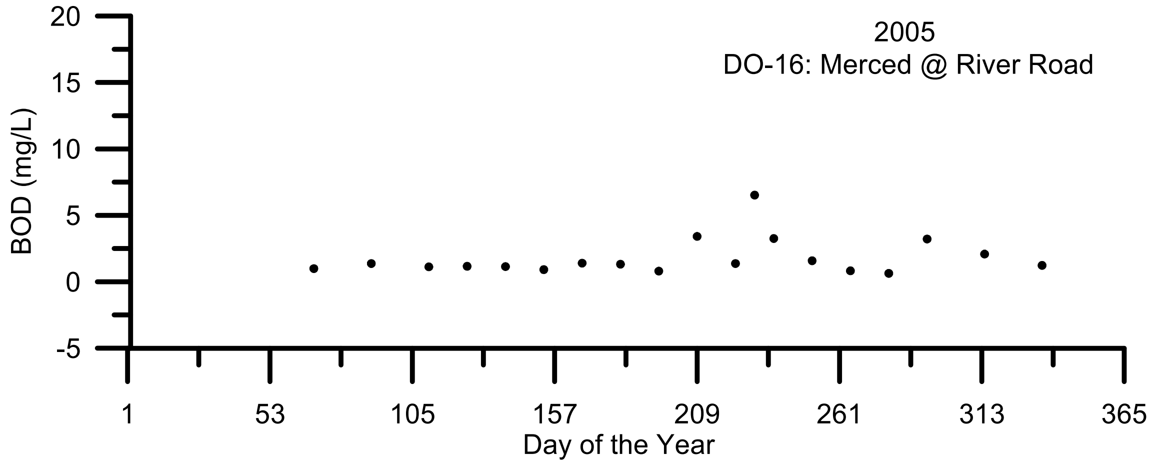
2005
DO-14: Tuolumne @ Shiloh Bridge
BOD (mg/L)
Day of the Year

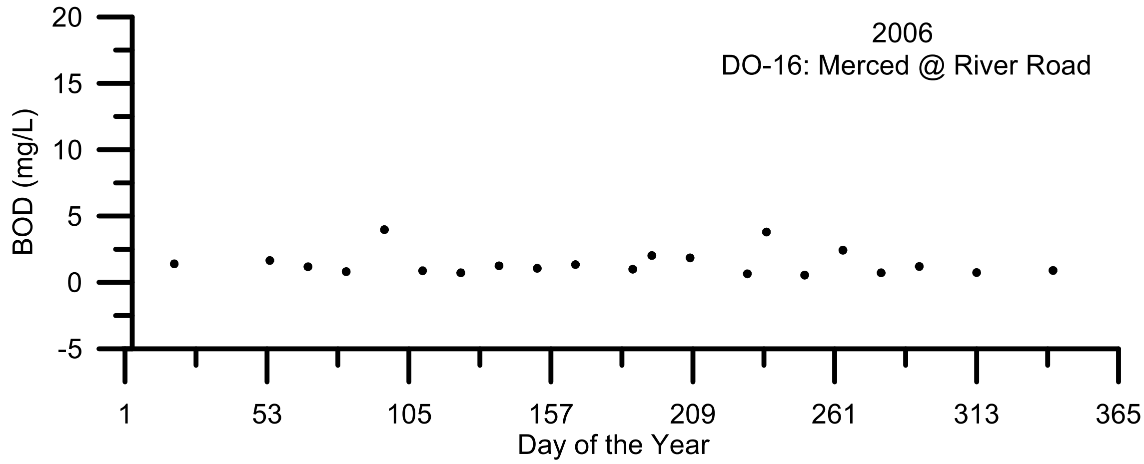


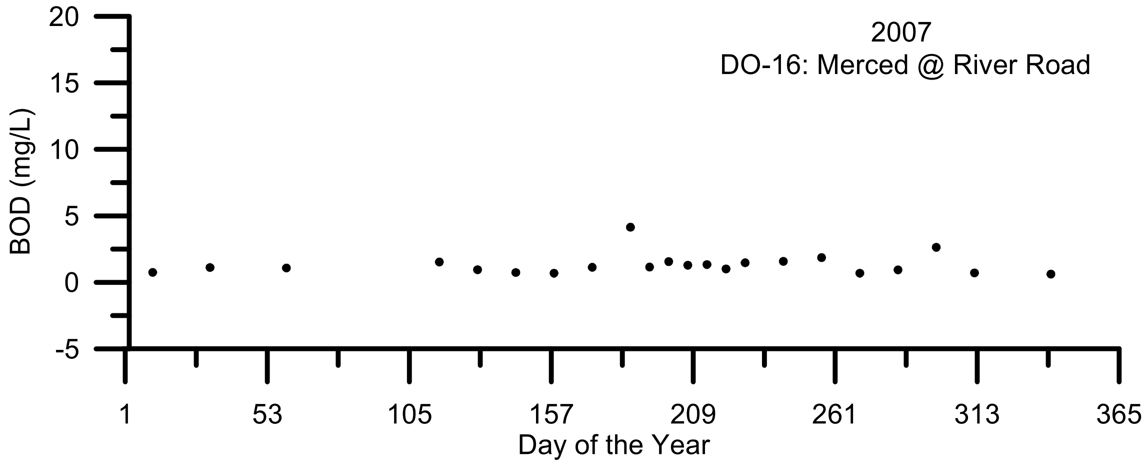
2006
DO-14: Tuolumne @ Shiloh Bridge
BOD (mg/L)
Day of the Year

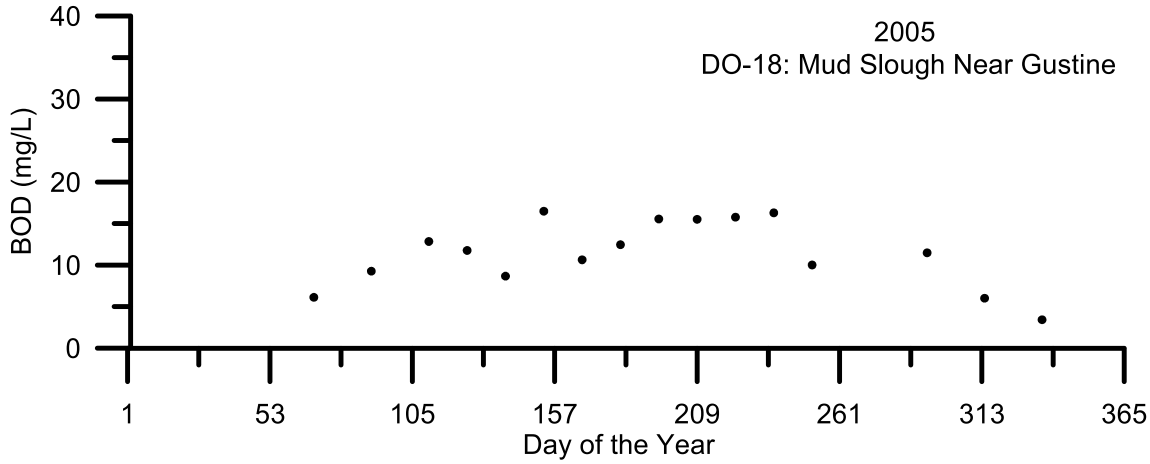


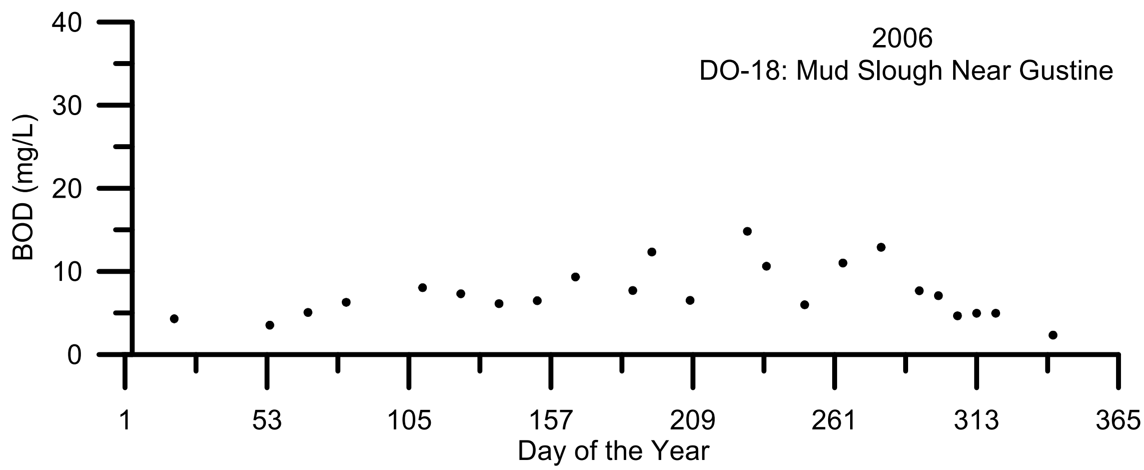
2007
DO-14: Tuolumne @ Shiloh Bridge
BOD (mg/L)
Day of the Year

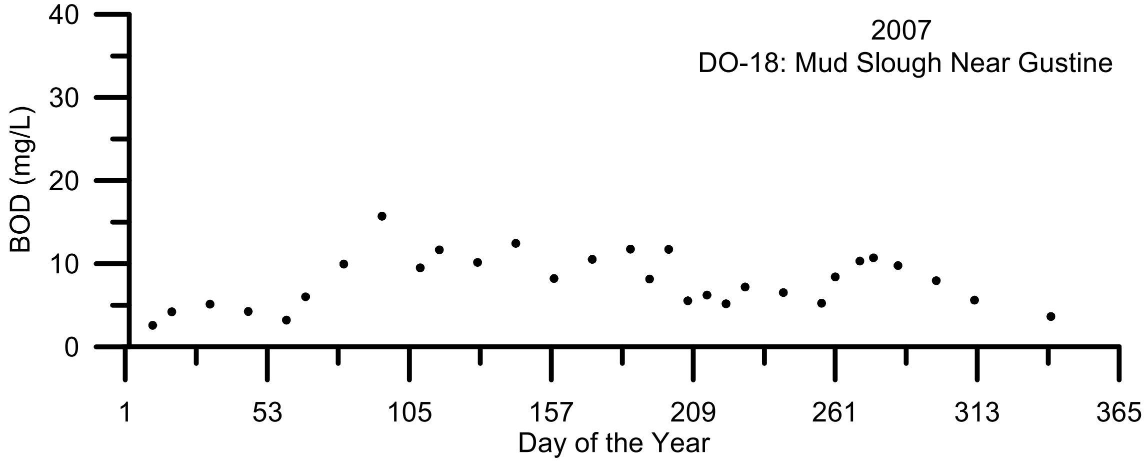

2005
DO-16: Merced @ River Road
BOD (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

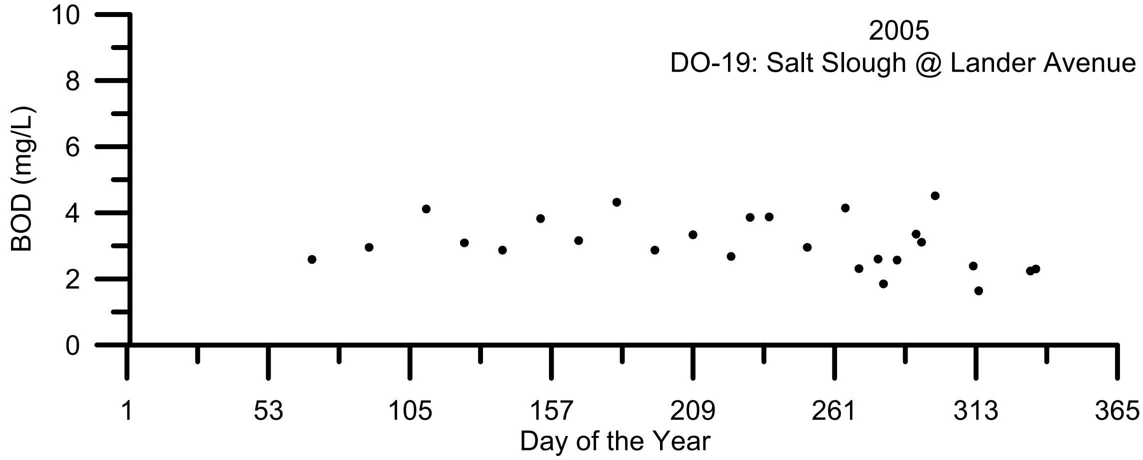

2006
DO-16: Merced @ River Road
BOD (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

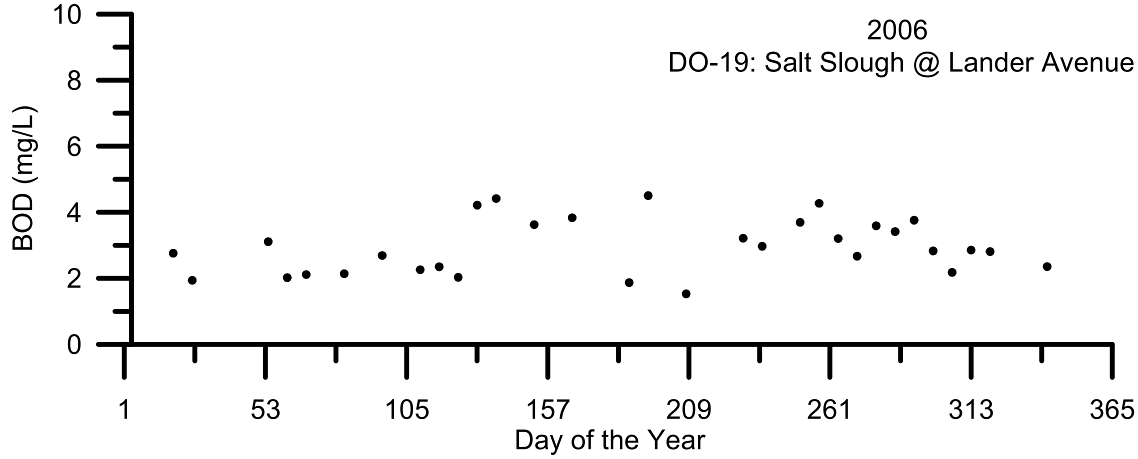

2007
DO-16: Merced @ River Road
BOD (mg/L)
20
15
10
5
0
-5
1
53
105
157
209
261
313
365
Day of the Year

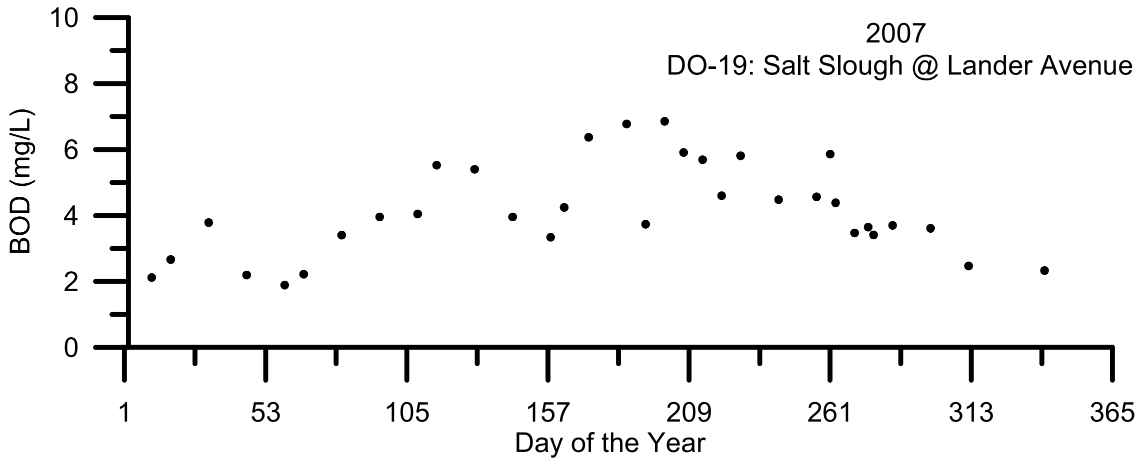

2005
DO-18: Mud Slough Near Gustine
BOD (mg/L)
Day of the Year

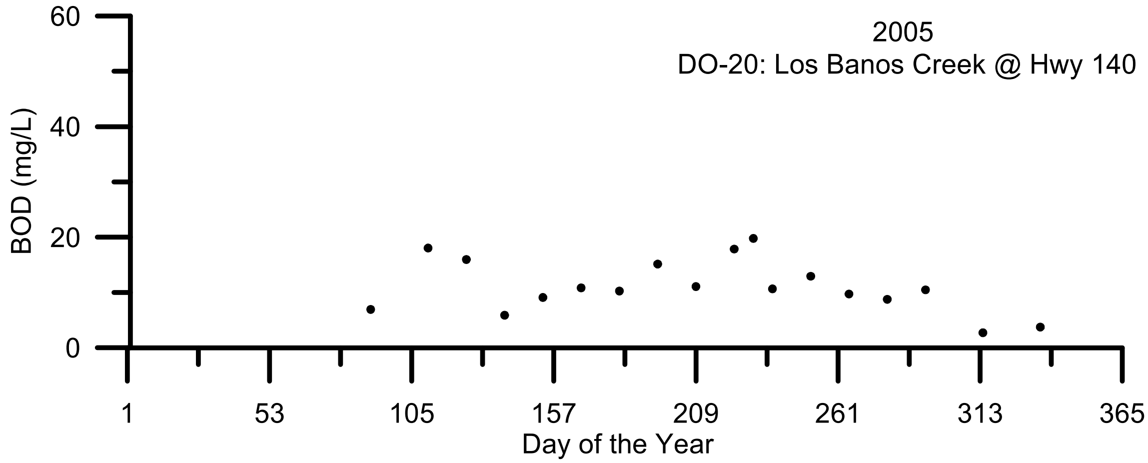

2006
DO-18: Mud Slough Near Gustine
BOD (mg/L)
Day of the Year

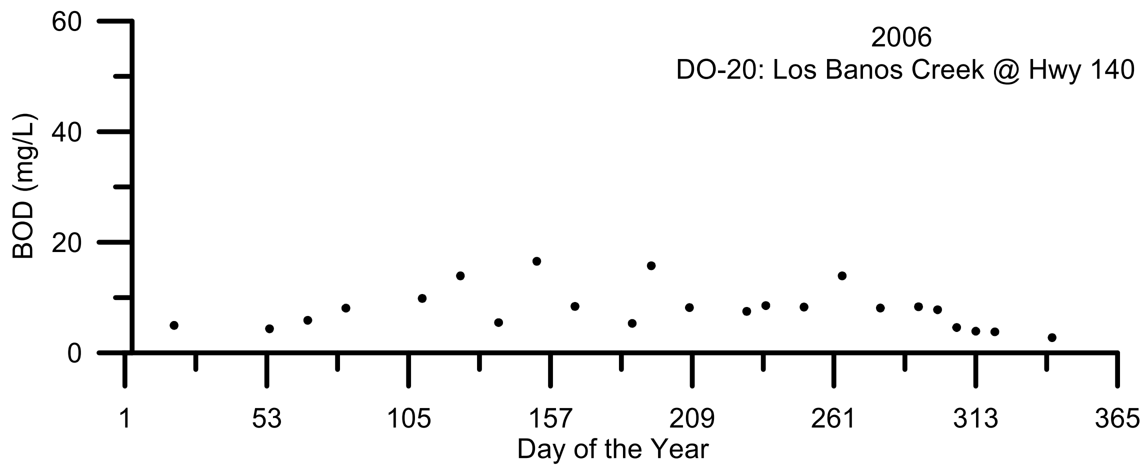

2007
DO-18: Mud Slough Near Gustine
BOD (mg/L)
Day of the Year

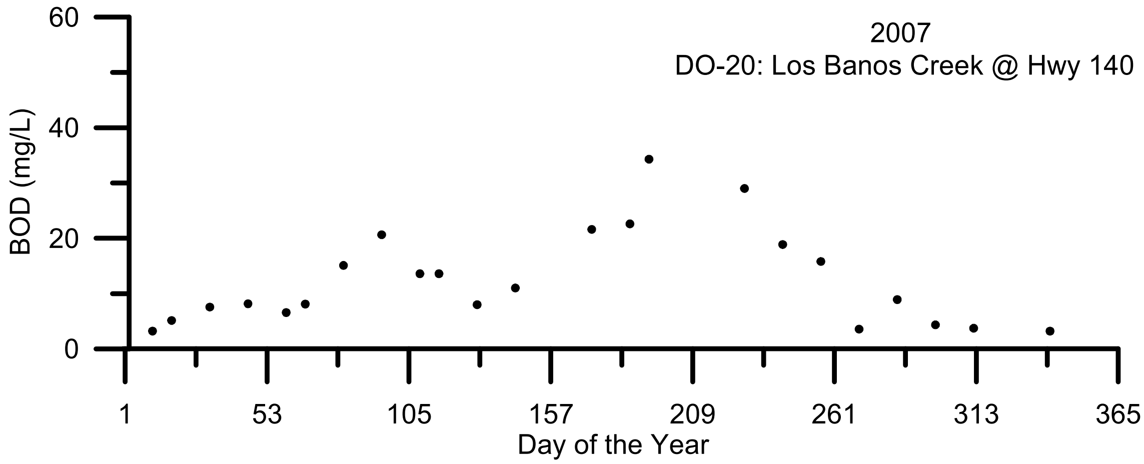

2005
DO-19: Salt Slough @ Lander Avenue
BOD (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

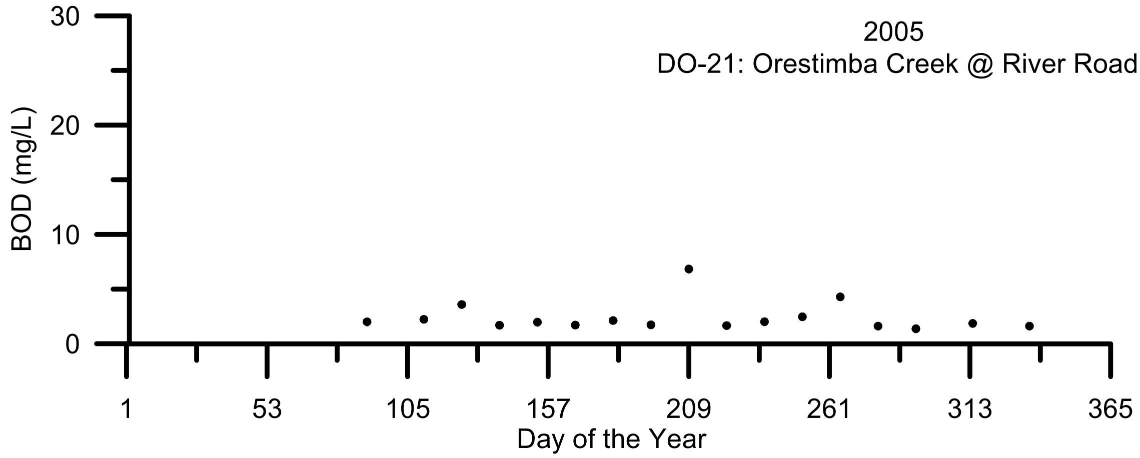

2006
DO-19: Salt Slough @ Lander Avenue
BOD (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

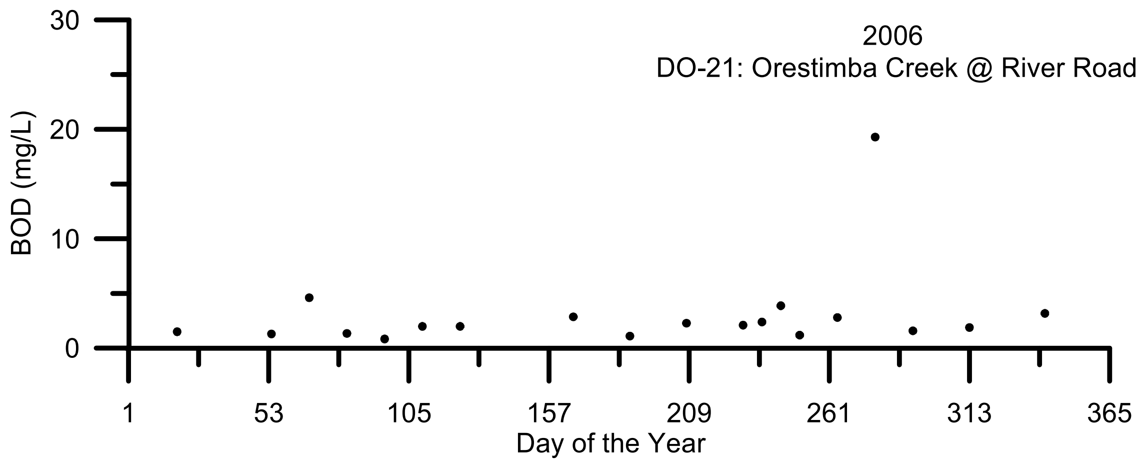

2007
DO-19: Salt Slough @ Lander Avenue
BOD (mg/L)
Day of the Year
0
2
4
6
8
10
1
53
105
157
209
261
313
365

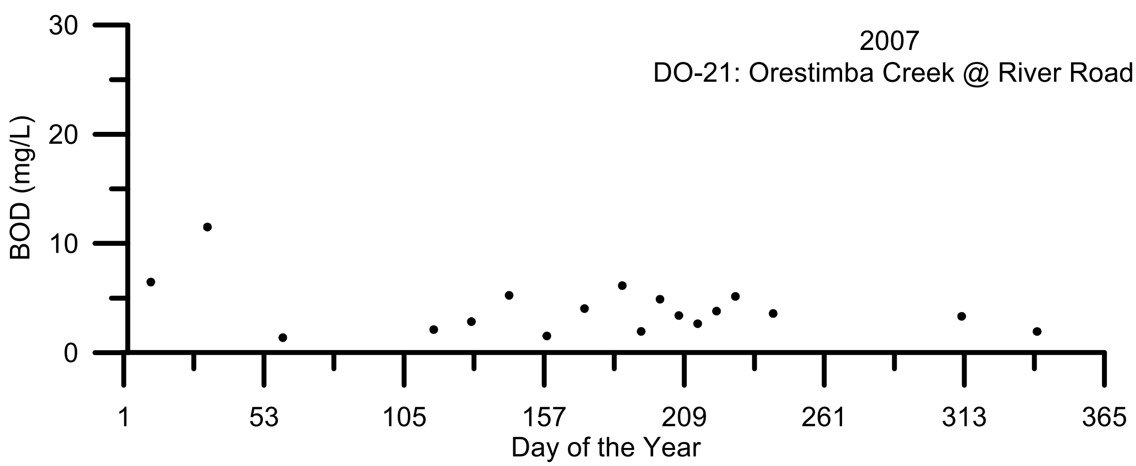

60
40
20
0
BOD (mg/L)
2005
DO-20: Los Banos Creek @ Hwy 140
1
53
105
157
209
261
313
365
Day of the Year

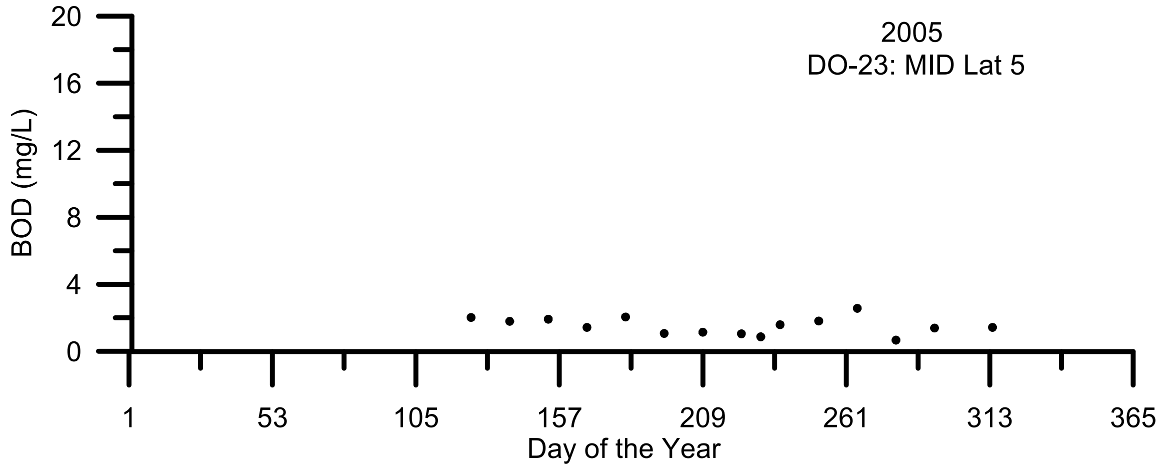

60
40
20
0
BOD (mg/L)
2006
DO-20: Los Banos Creek @ Hwy 140
1
53
105
157
209
261
313
365
Day of the Year

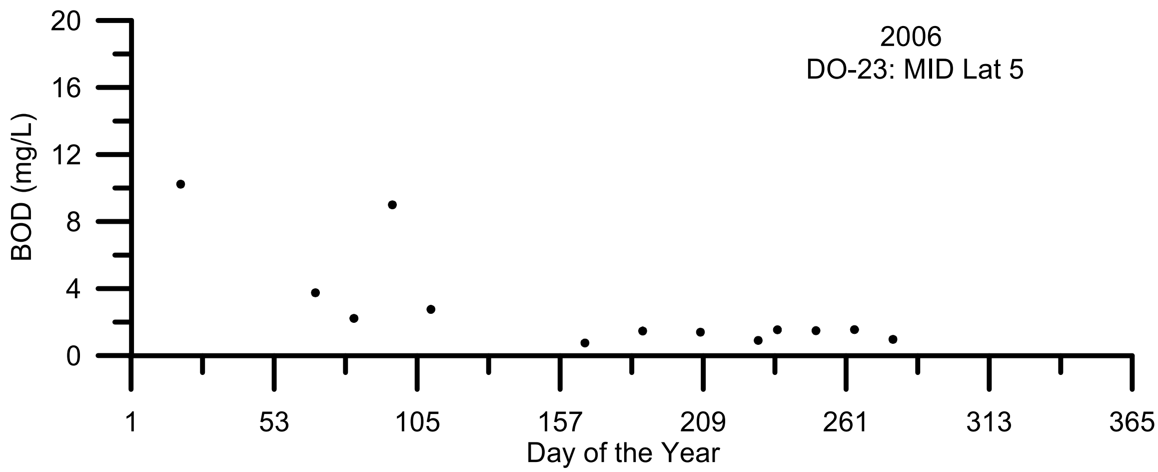

60
40
20
0
BOD (mg/L)
2007
DO-20: Los Banos Creek @ Hwy 140
1
53
105
157
209
261
313
365
Day of the Year

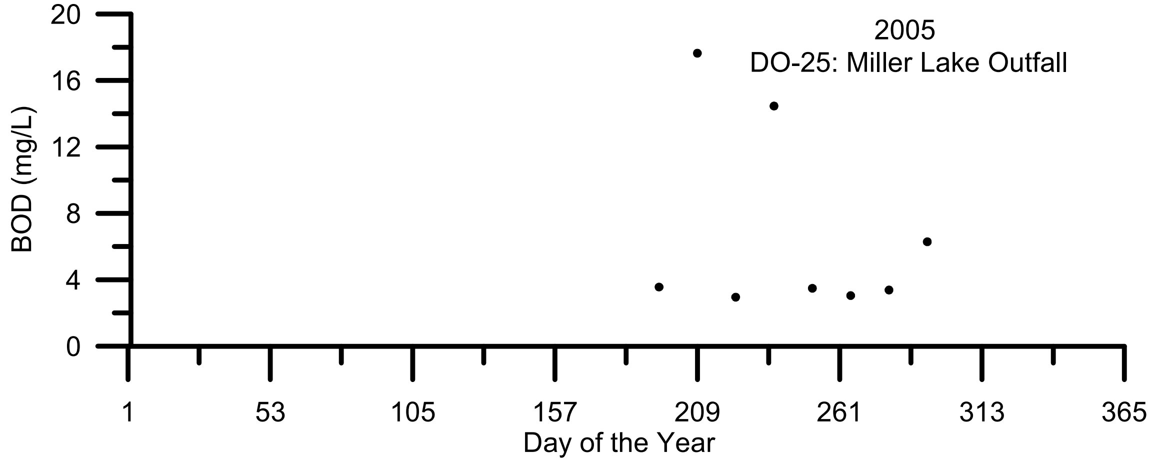

2005
DO-21: Orestimba Creek @ River Road
BOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

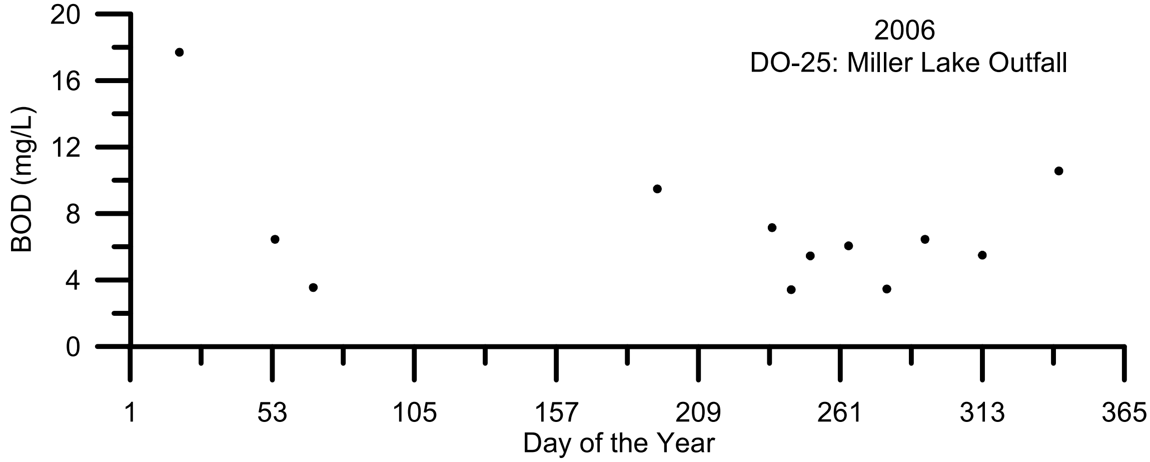

2006
DO-21: Orestimba Creek @ River Road
BOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

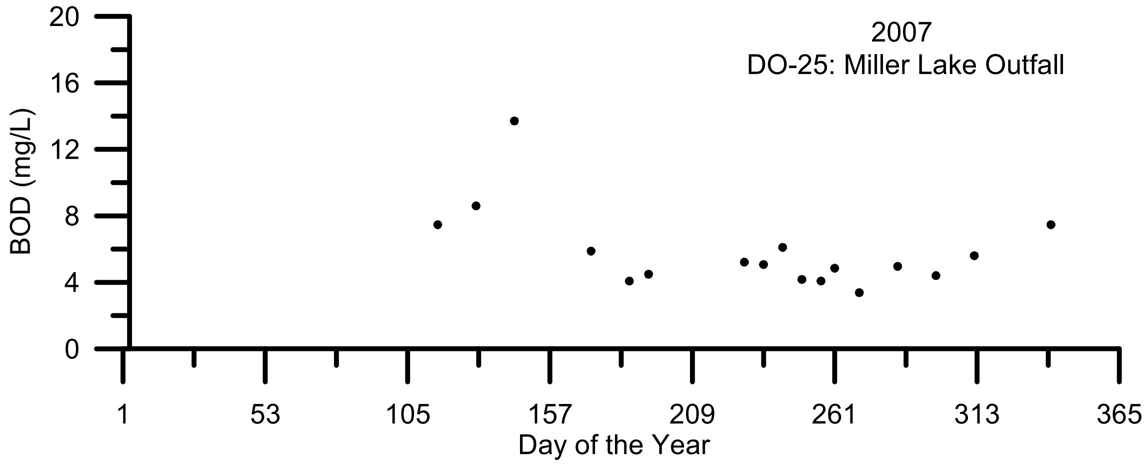

2007
DO-21: Orestimba Creek @ River Road
BOD (mg/L)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

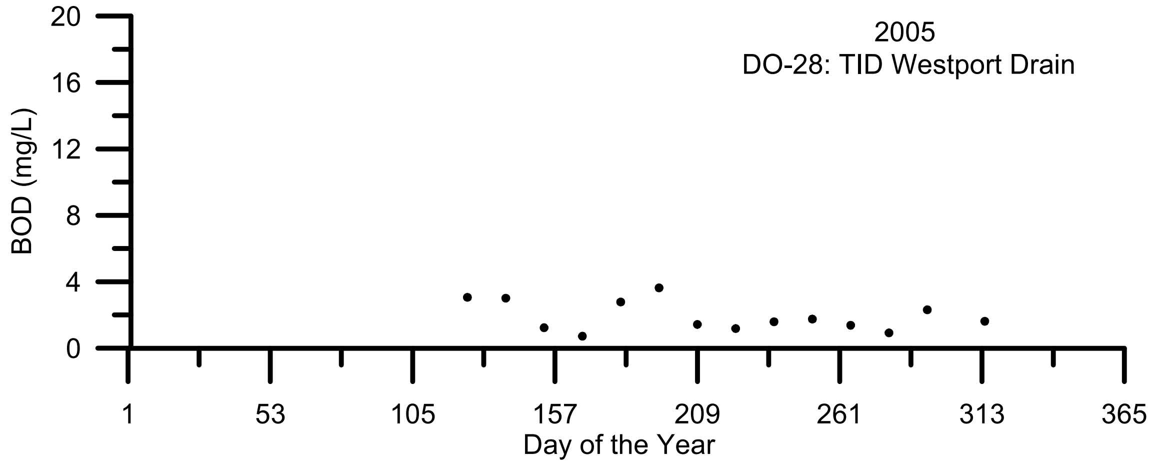

2005
DO-23: MID Lat 5
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

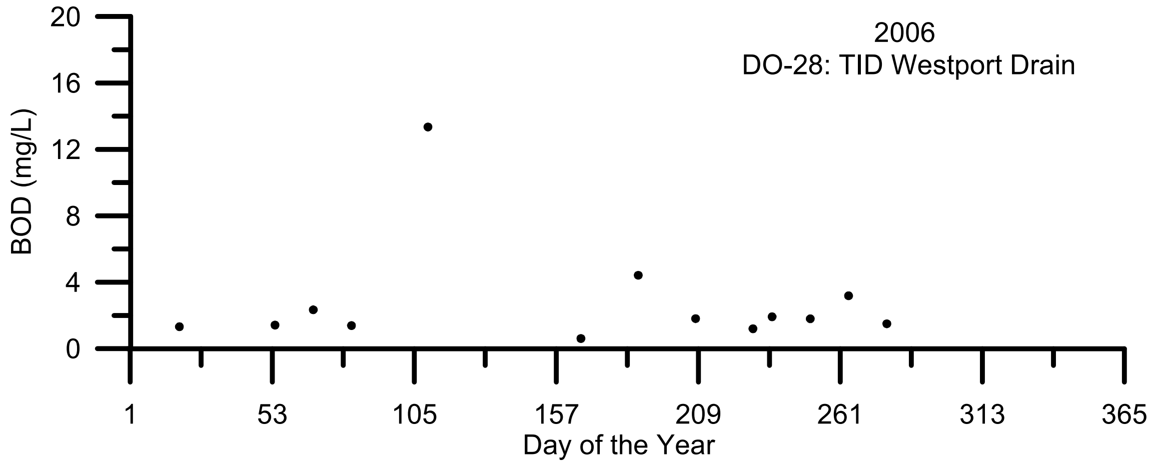

2006
DO-23: MID Lat 5
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

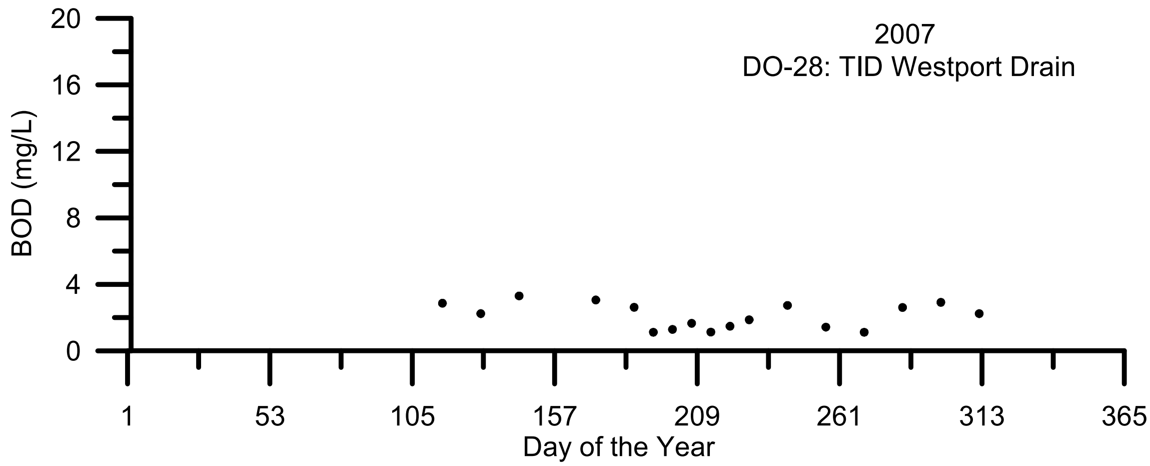

2005
DO-25: Miller Lake Outfall
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

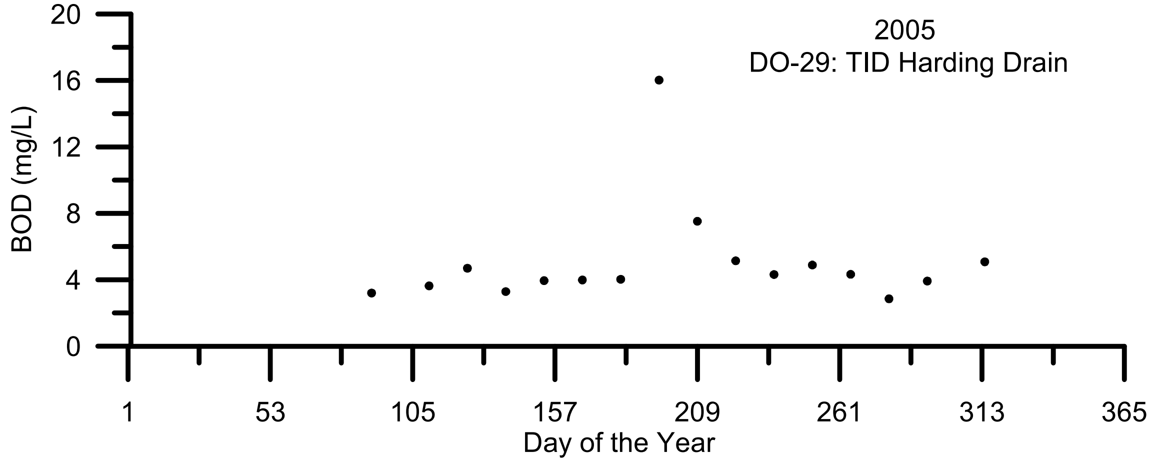

2006
DO-25: Miller Lake Outfall
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

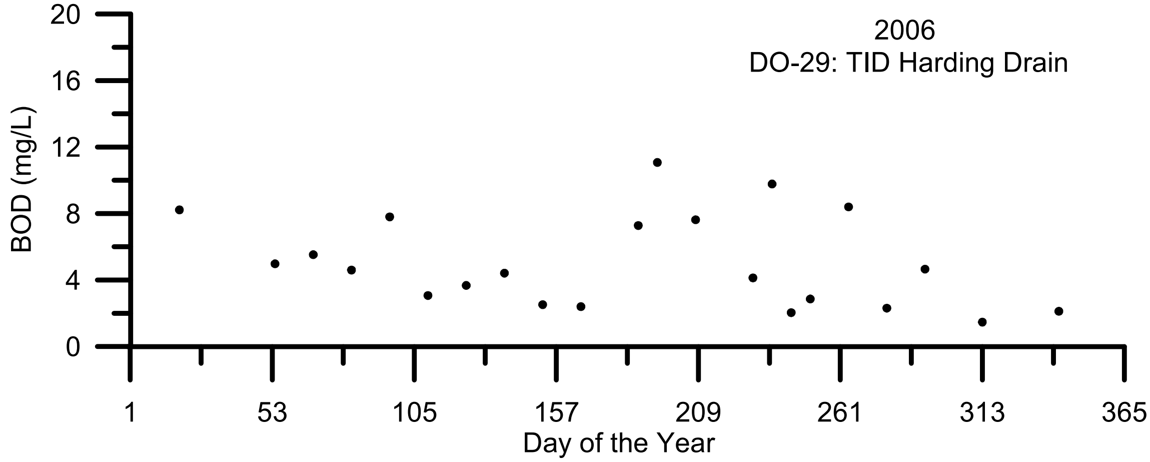

2007
DO-25: Miller Lake Outfall
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

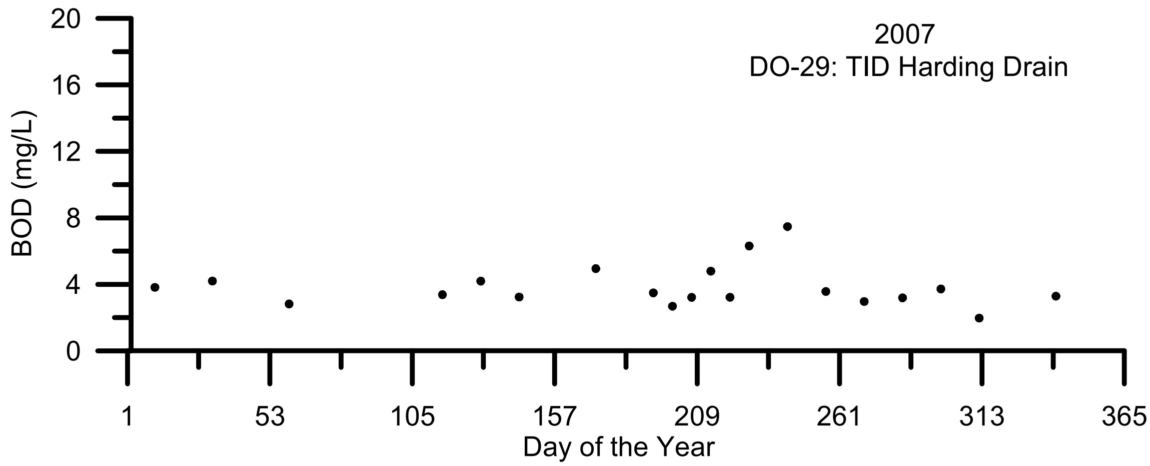

2005
DO-28: TID Westport Drain
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

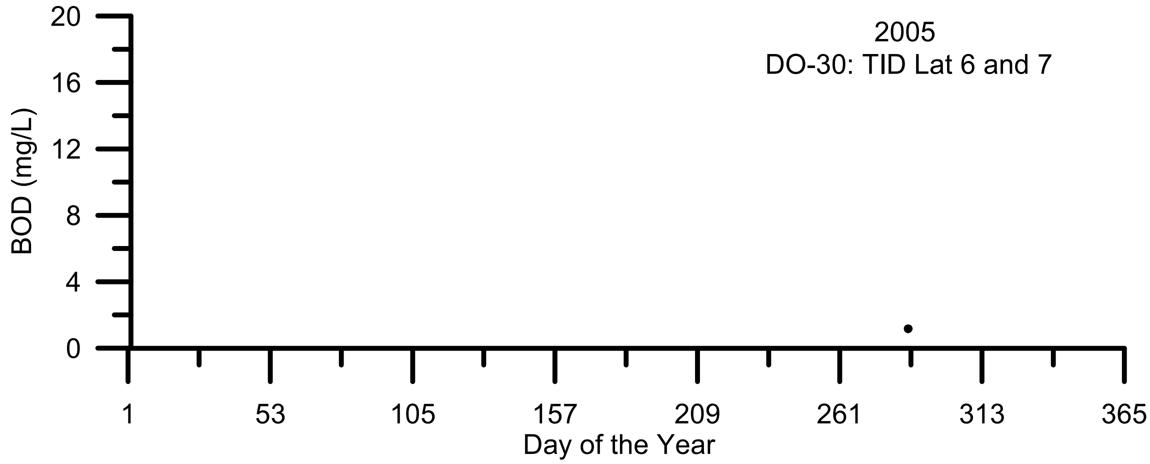

2006
DO-28: TID Westport Drain
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

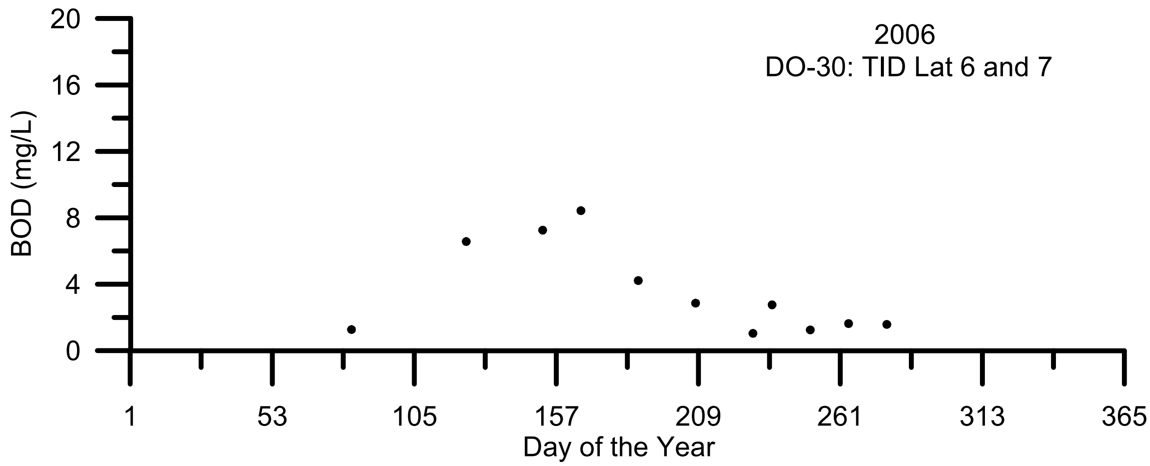

2007
DO-28: TID Westport Drain
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

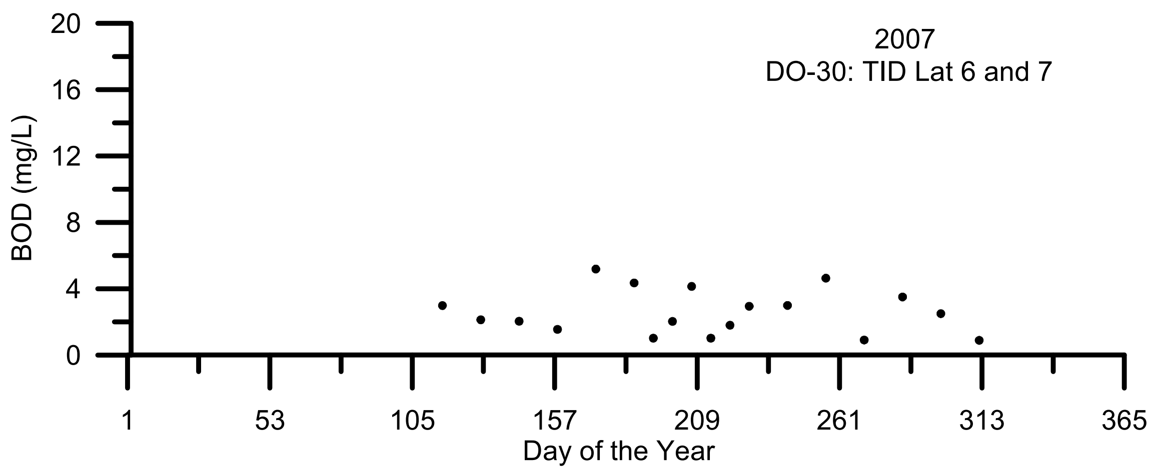

2005
DO-29: TID Harding Drain
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

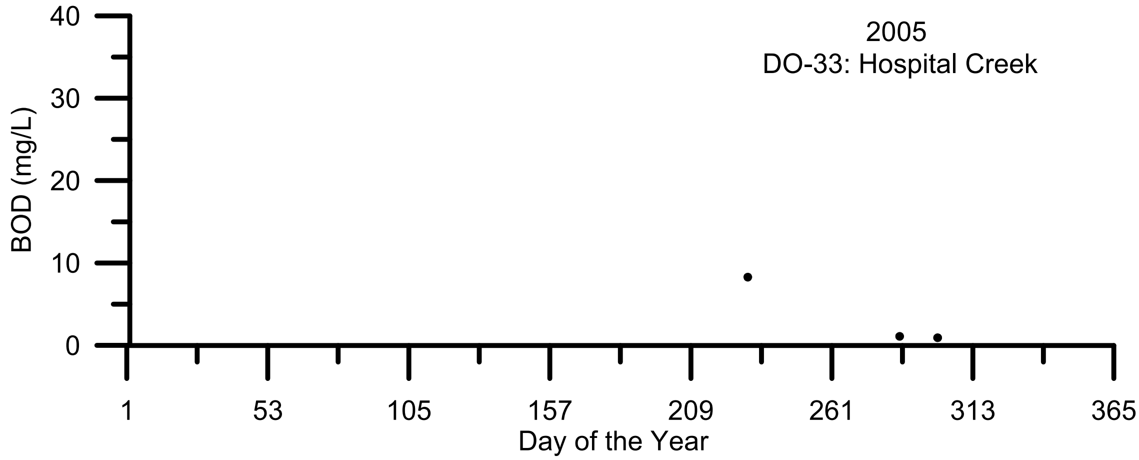

2006
DO-29: TID Harding Drain
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

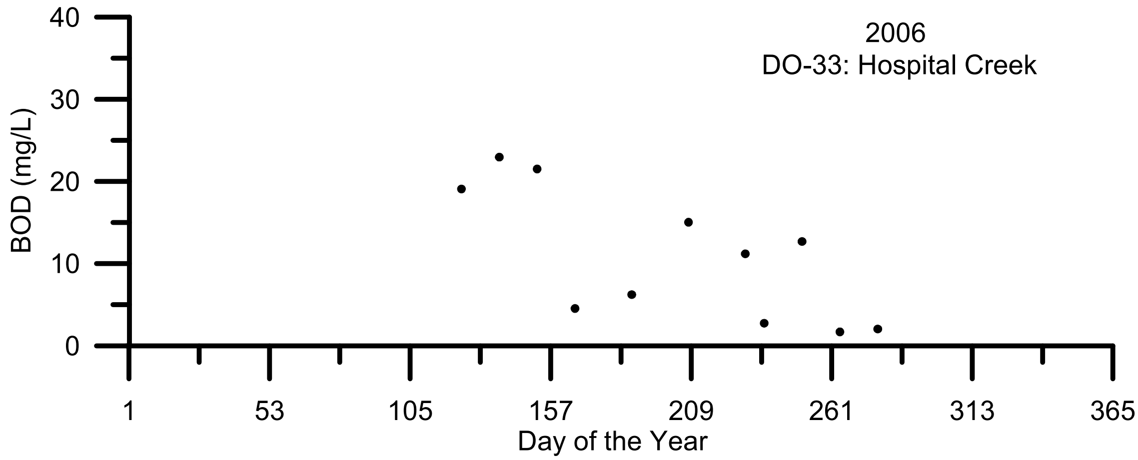

2007
DO-29: TID Harding Drain
BOD (mg/L)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

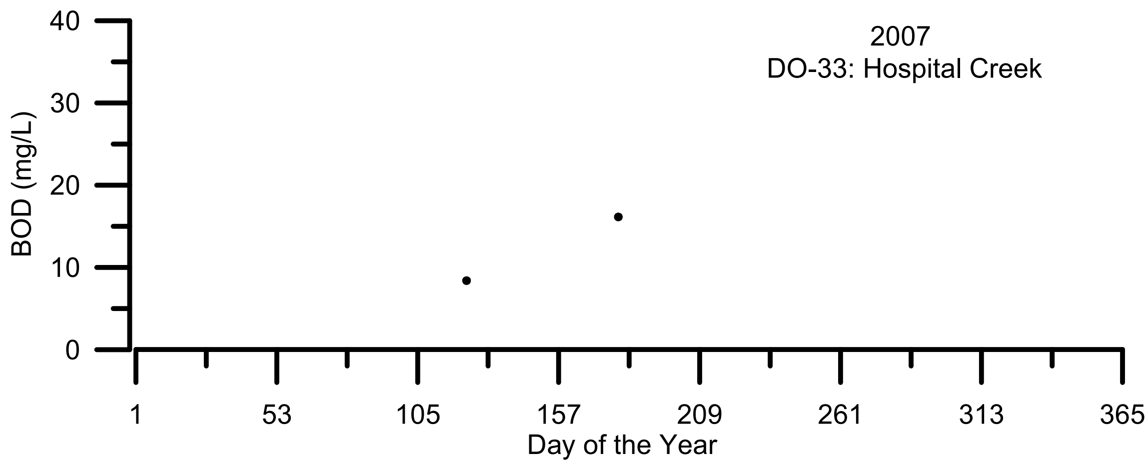

2005
DO-30: TID Lat 6 and 7
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

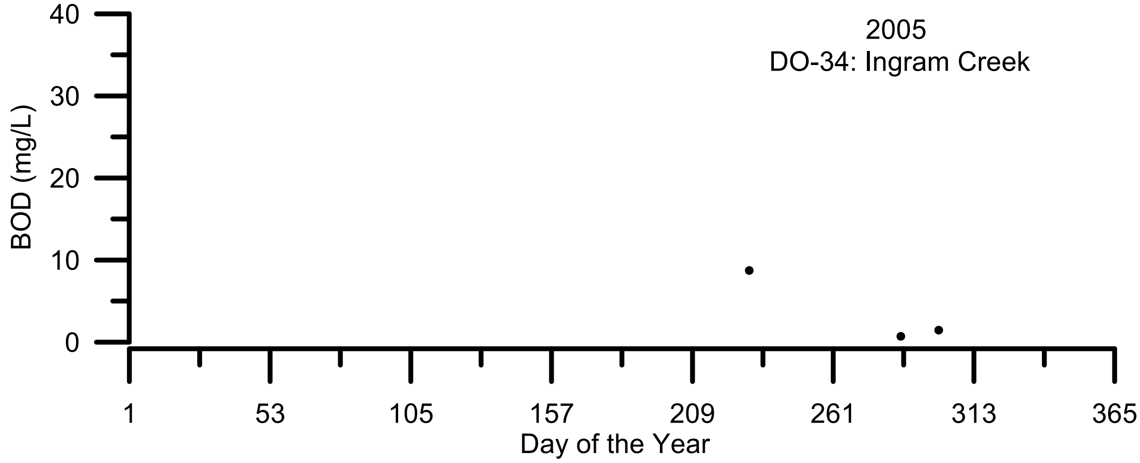

2006
DO-30: TID Lat 6 and 7
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

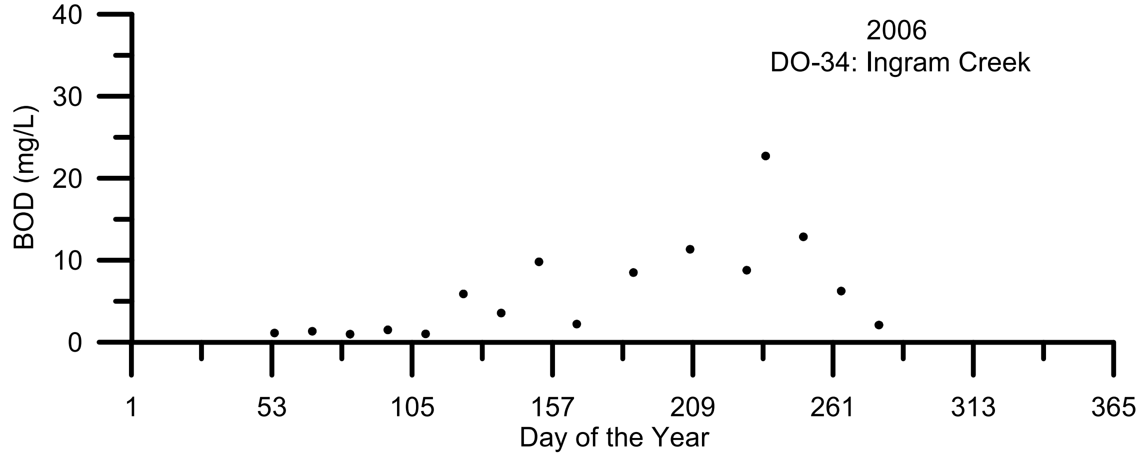

2007
DO-30: TID Lat 6 and 7
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

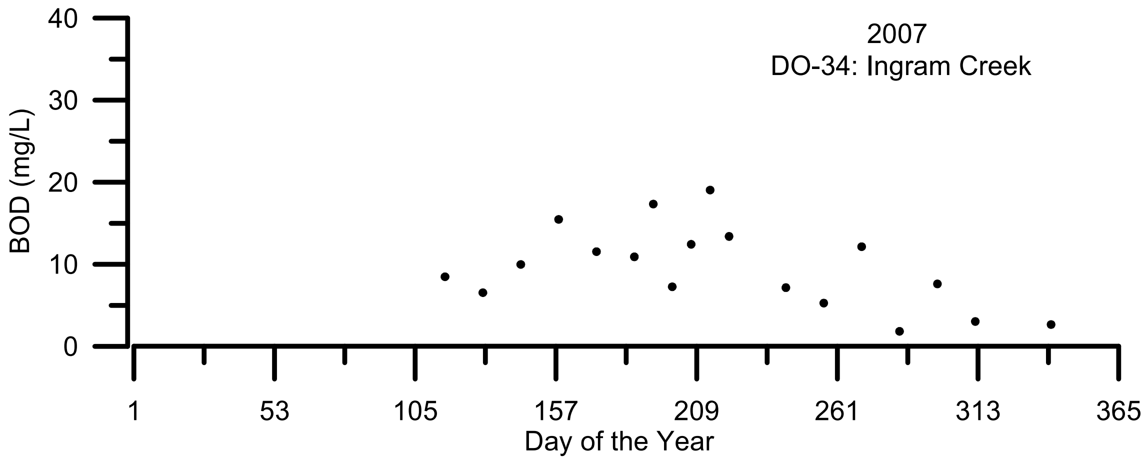

2005
DO-33: Hospital Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

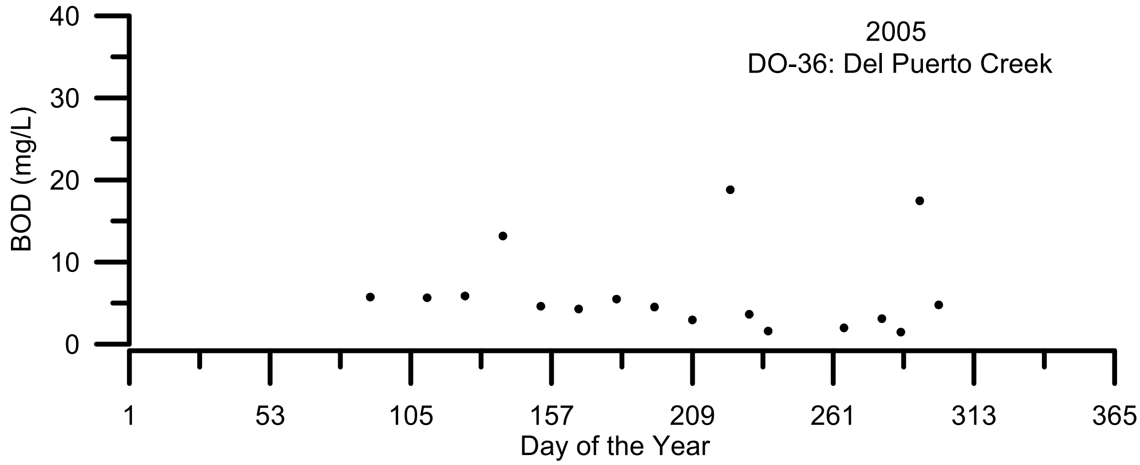

2006
DO-33: Hospital Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

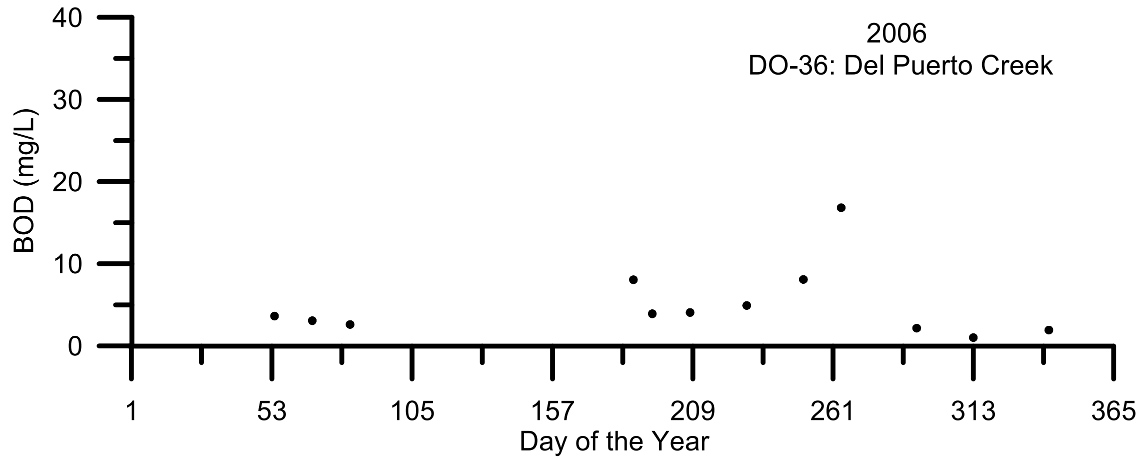

2007
DO-33: Hospital Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

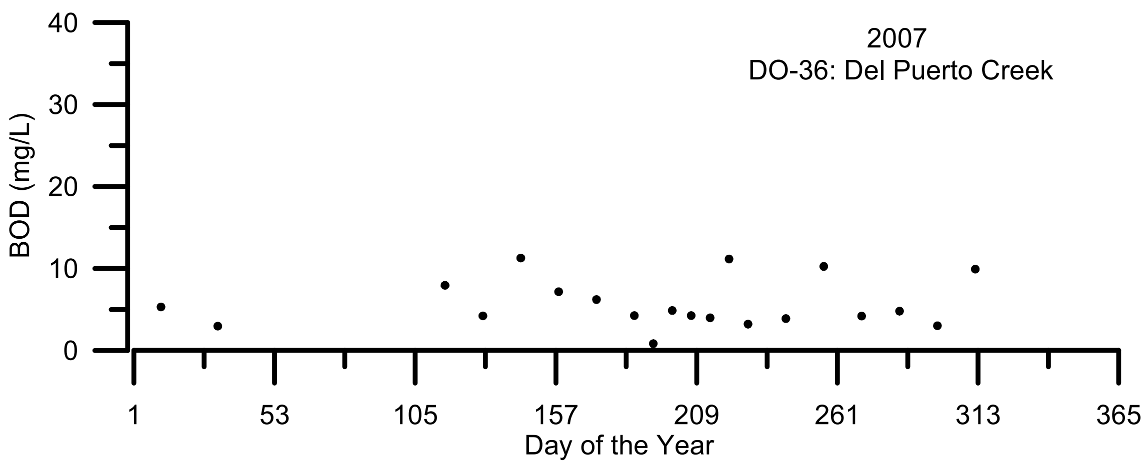

2005
DO-34: Ingram Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

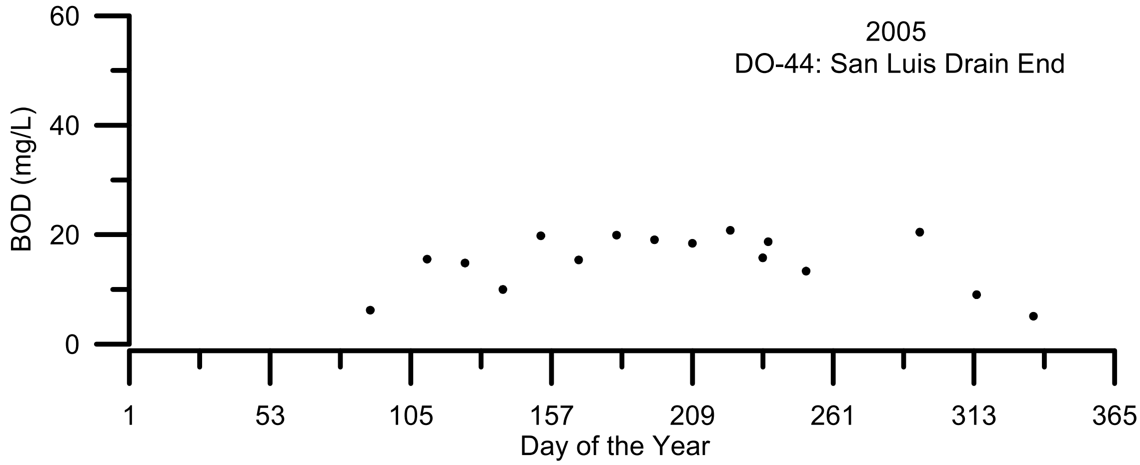

2006
DO-34: Ingram Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

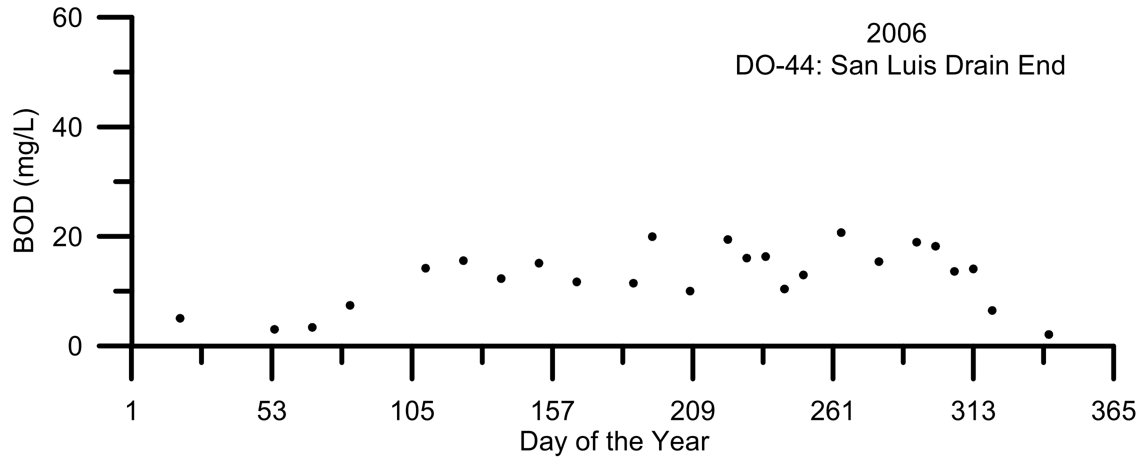

2007
DO-34: Ingram Creek
BOD (mg/L)
40
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

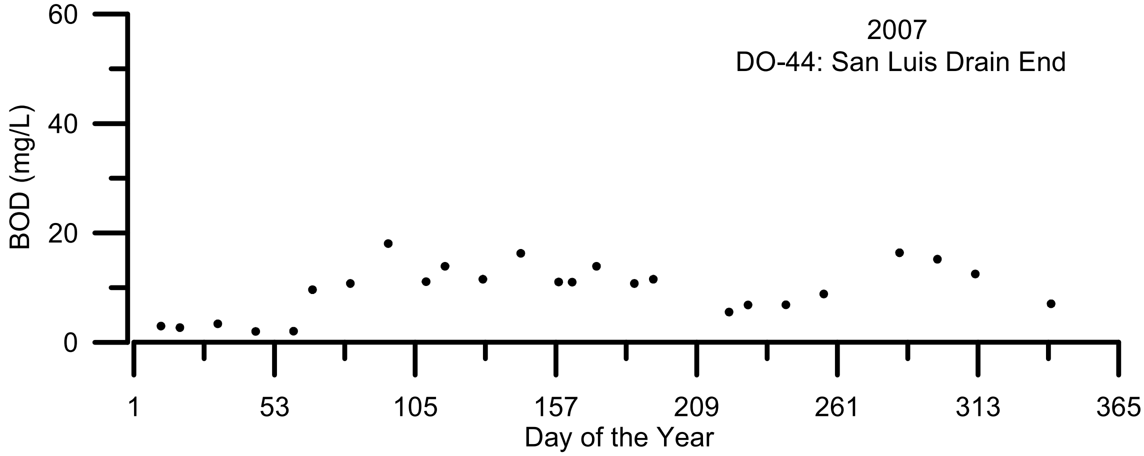

2005
DO-36: Del Puerto Creek
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

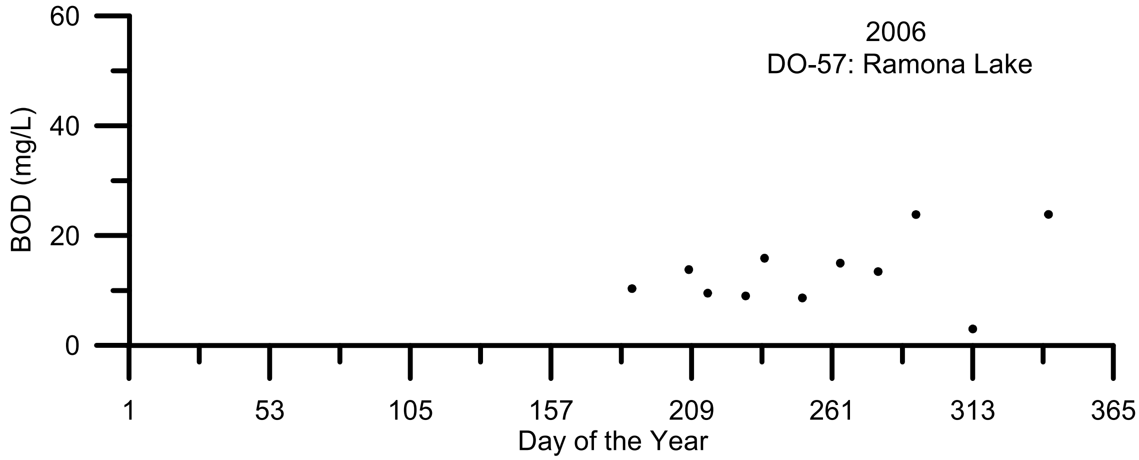

2006
DO-36: Del Puerto Creek
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

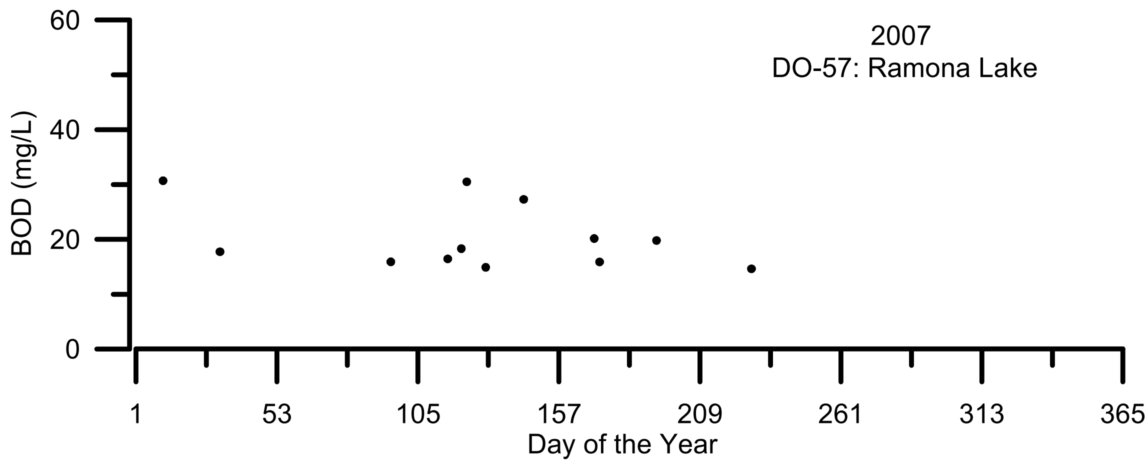

2007
DO-36: Del Puerto Creek
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

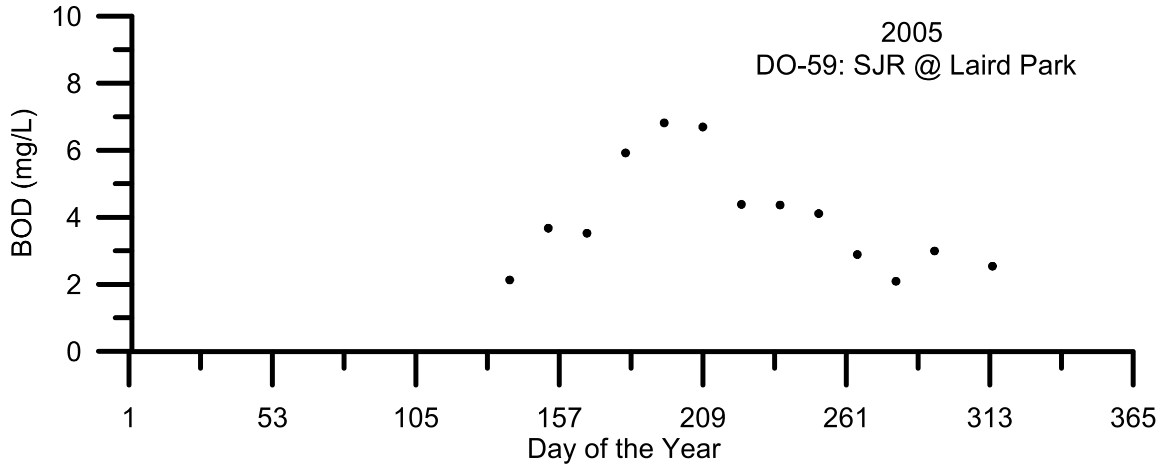

2005
DO-44: San Luis Drain End
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

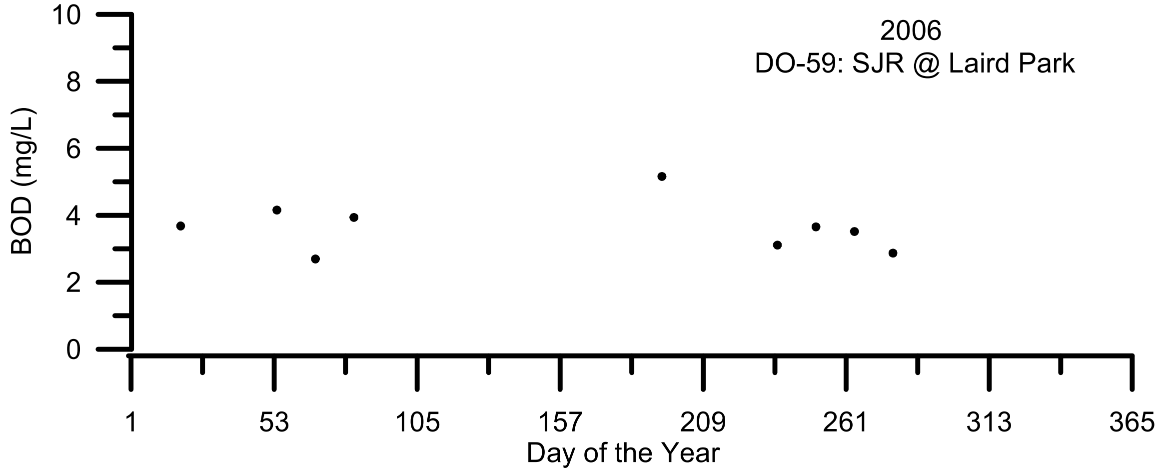

2006
DO-44: San Luis Drain End
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

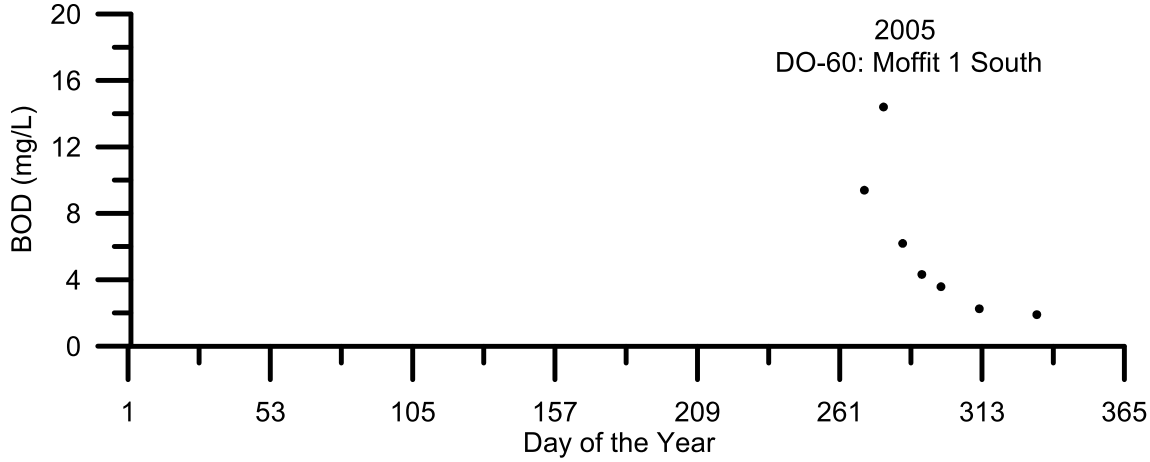

2007
DO-44: San Luis Drain End
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

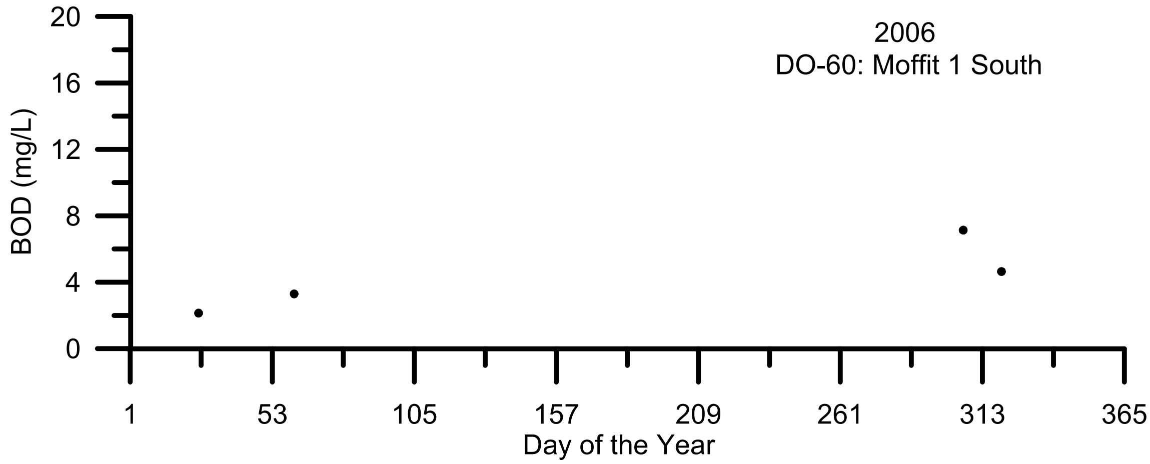

2006
DO-57: Ramona Lake
BOD (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

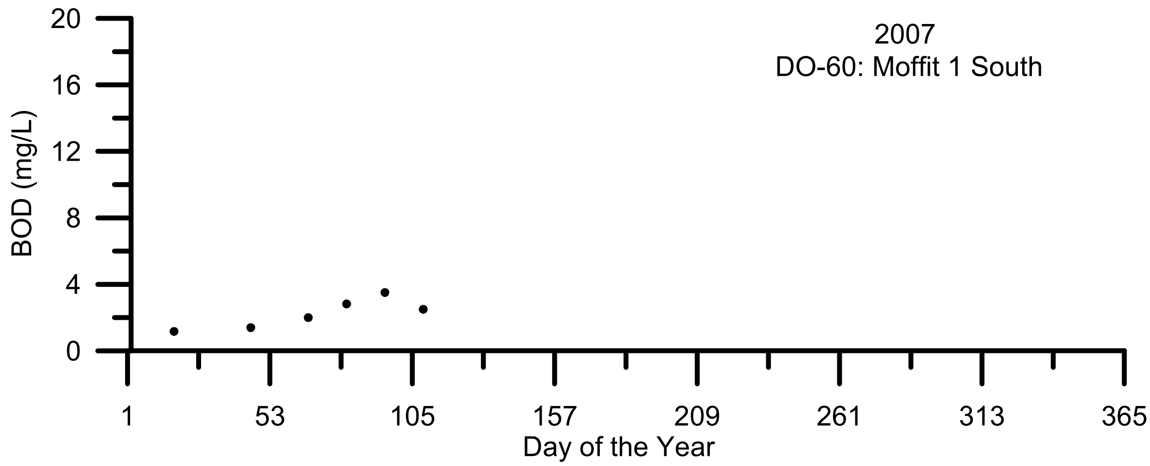

2007
DO-57: Ramona Lake
BOD (mg/L)
0
20
40
60
1
53
105
157
209
261
313
365
Day of the Year

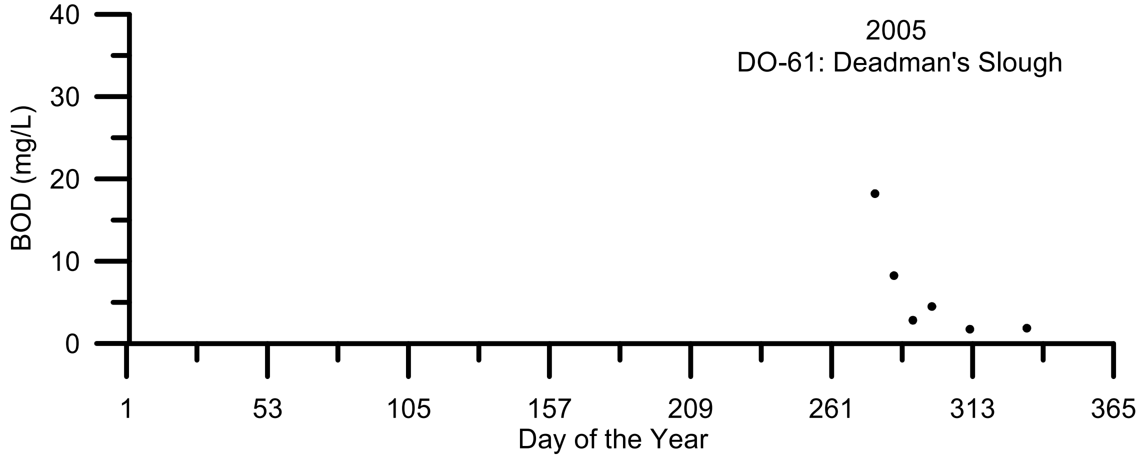

2005
DO-59: SJR @ Laird Park
BOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

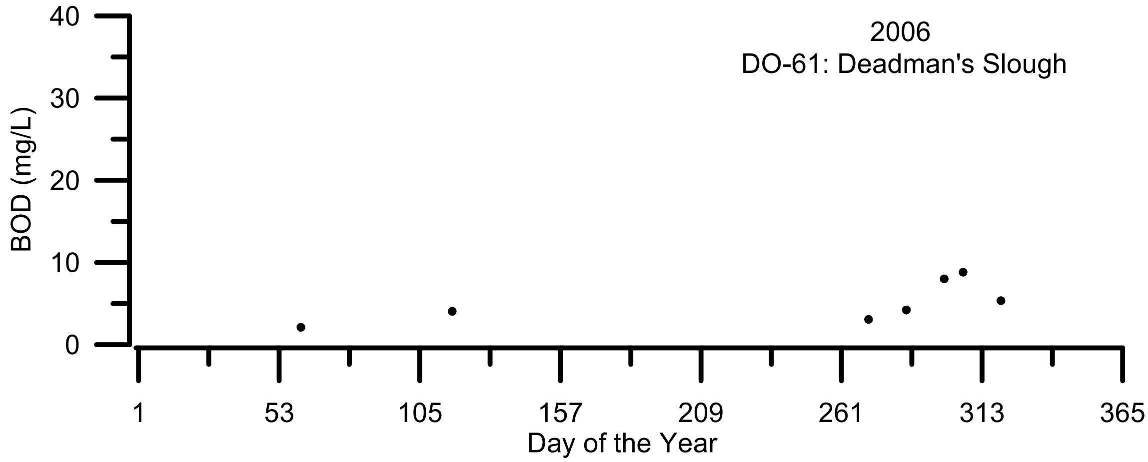

2006
DO-59: SJR @ Laird Park
BOD (mg/L)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

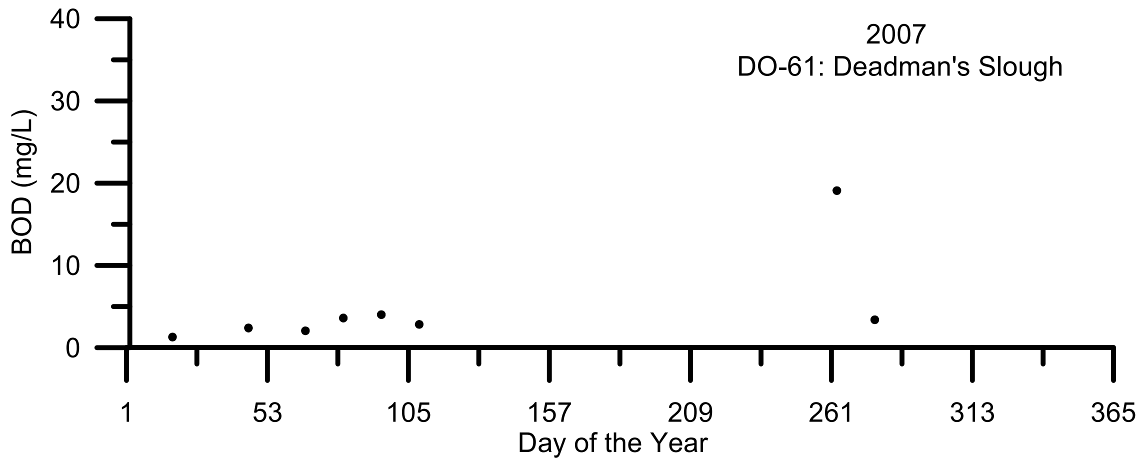

2005
DO-60: Moffit 1 South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

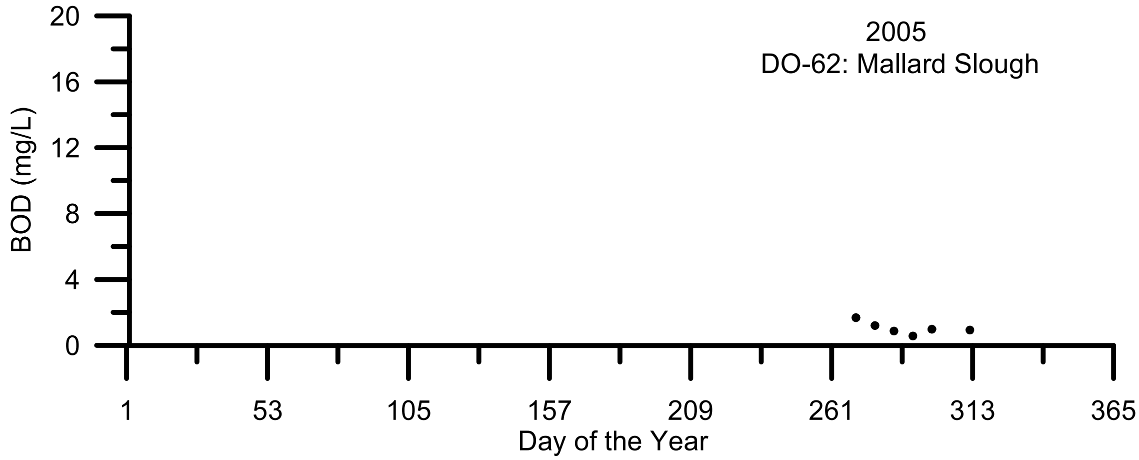

2006
DO-60: Moffit 1 South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

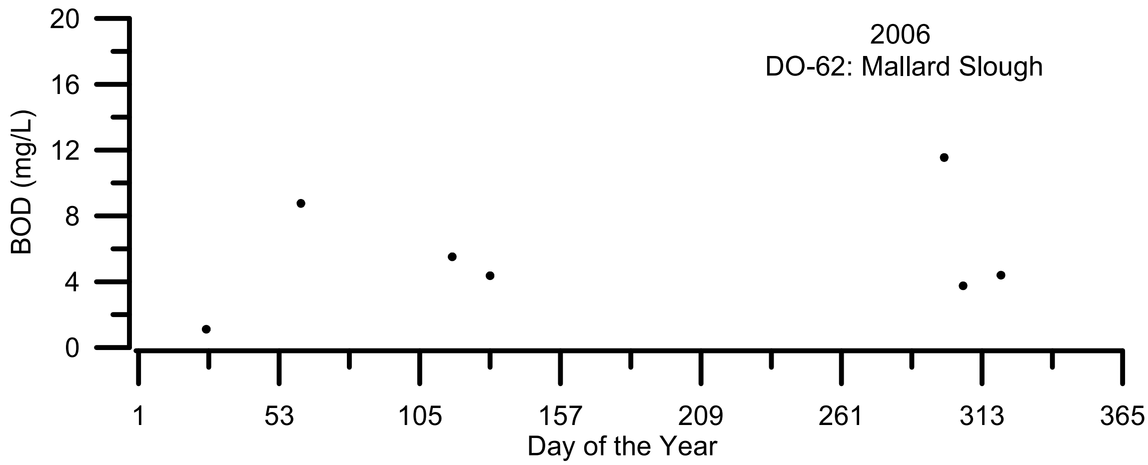

2007
DO-60: Moffit 1 South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

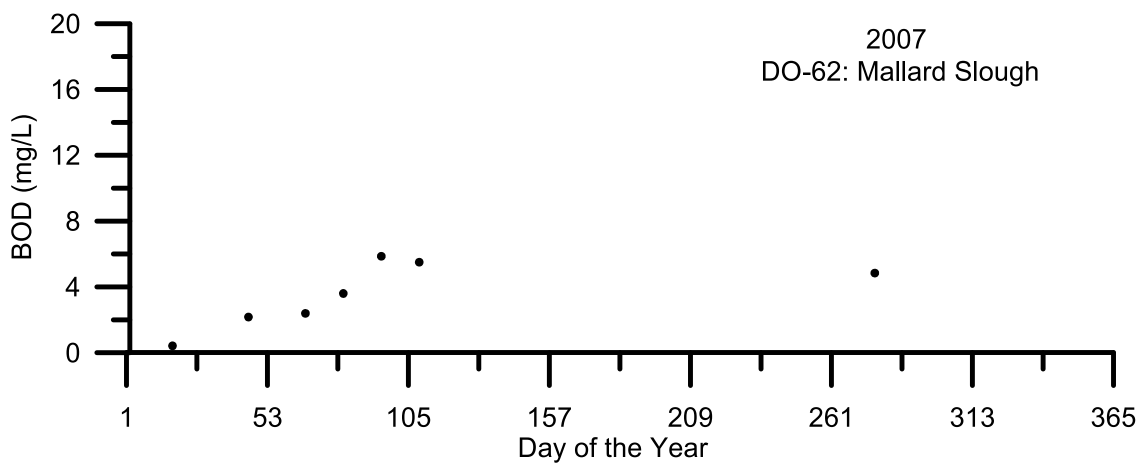

2005
DO-61: Deadman's Slough
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

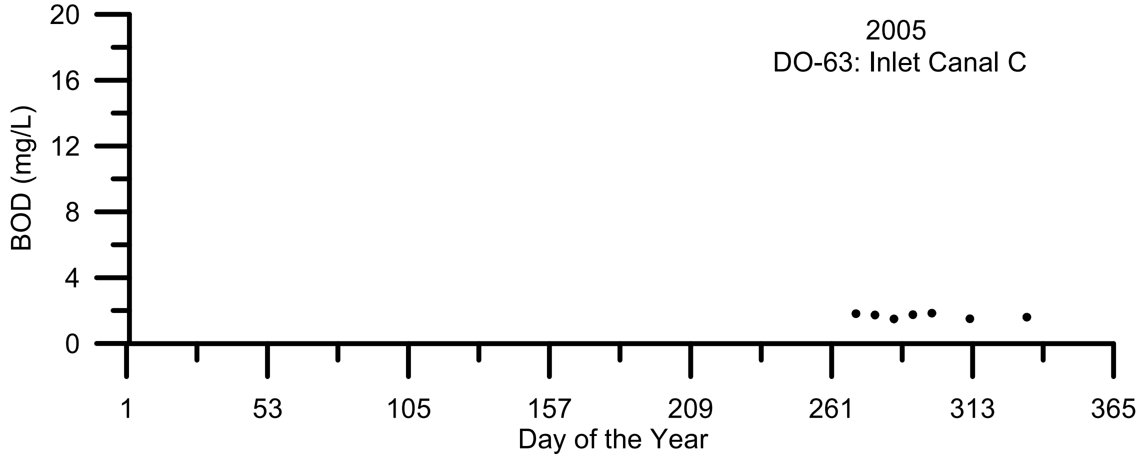

2006
DO-61: Deadman's Slough
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

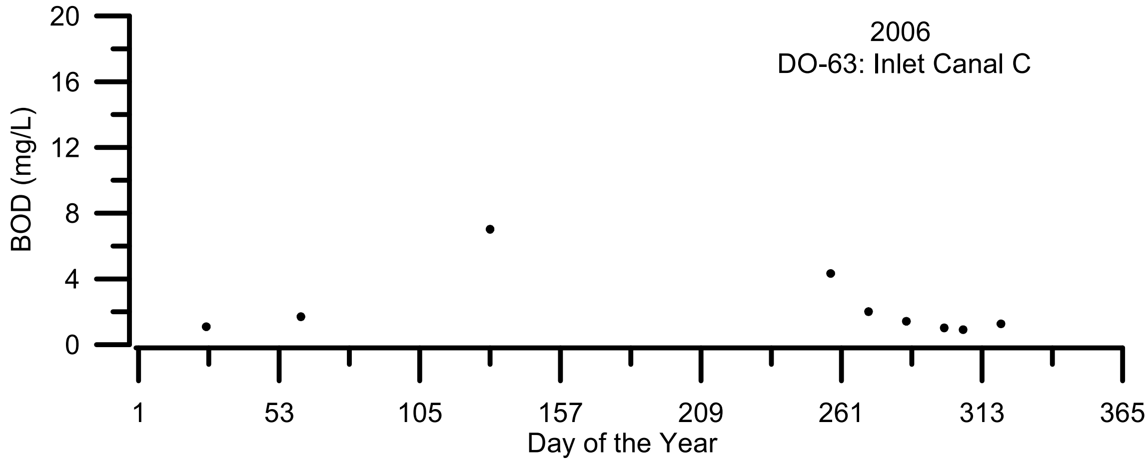

2007
DO-61: Deadman's Slough
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

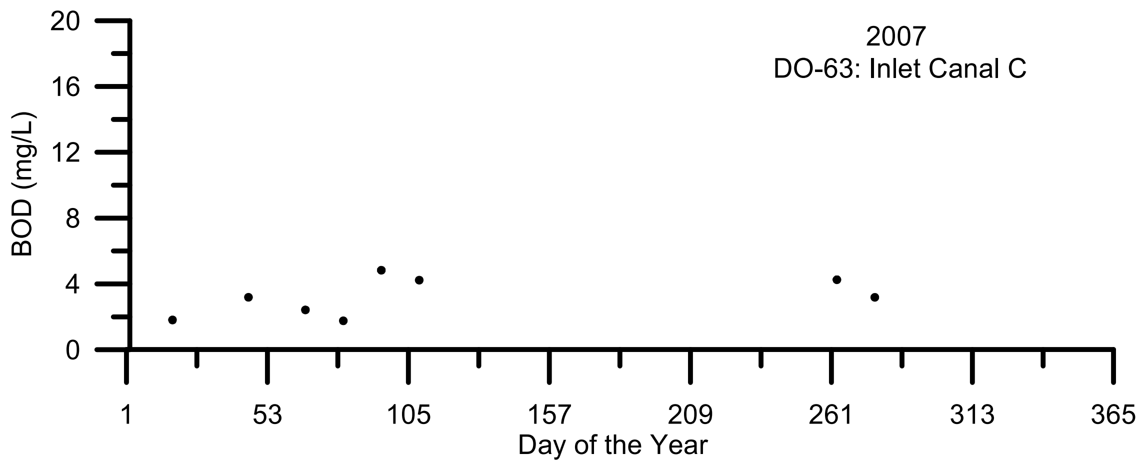

2005
DO-62: Mallard Slough
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

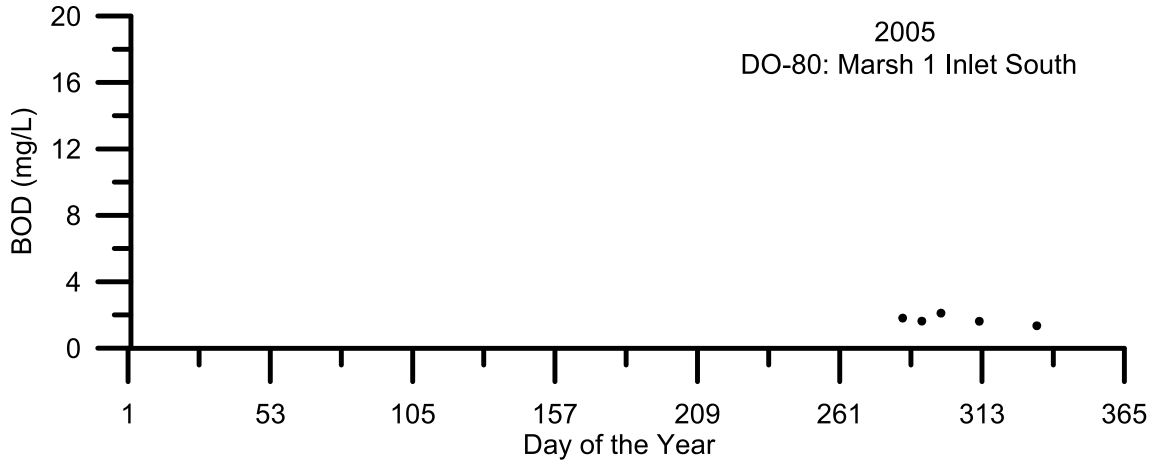

2006
DO-62: Mallard Slough
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

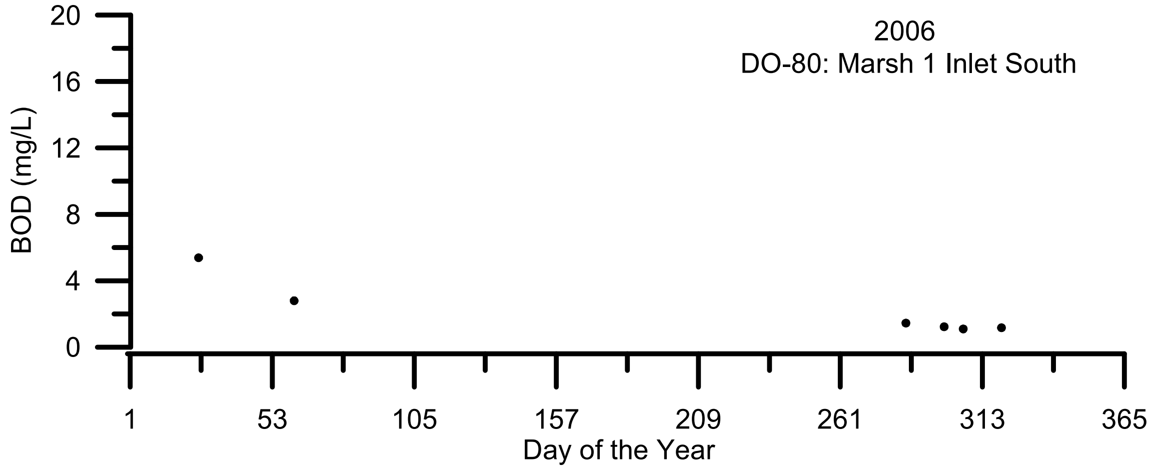

2007
DO-62: Mallard Slough
BOD (mg/L)
Day of the Year
0
4
8
12
16
20
1
53
105
157
209
261
313
365

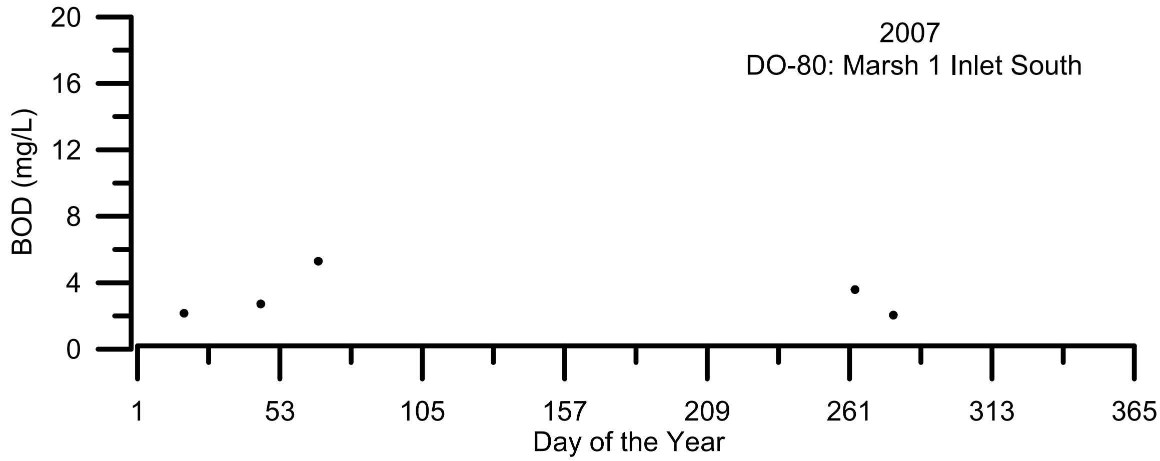

2005
DO-63: Inlet Canal C
BOD (mg/L)
Day of the Year
20
16
12
8
4
0
1
53
105
157
209
261
313
365

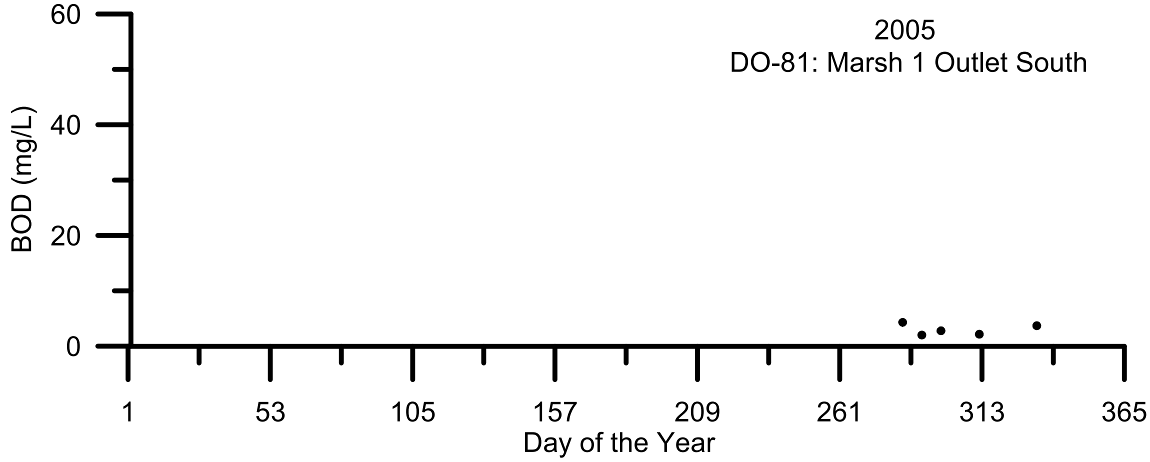

2006
DO-63: Inlet Canal C
BOD (mg/L)
Day of the Year
20
16
12
8
4
0
1
53
105
157
209
261
313
365

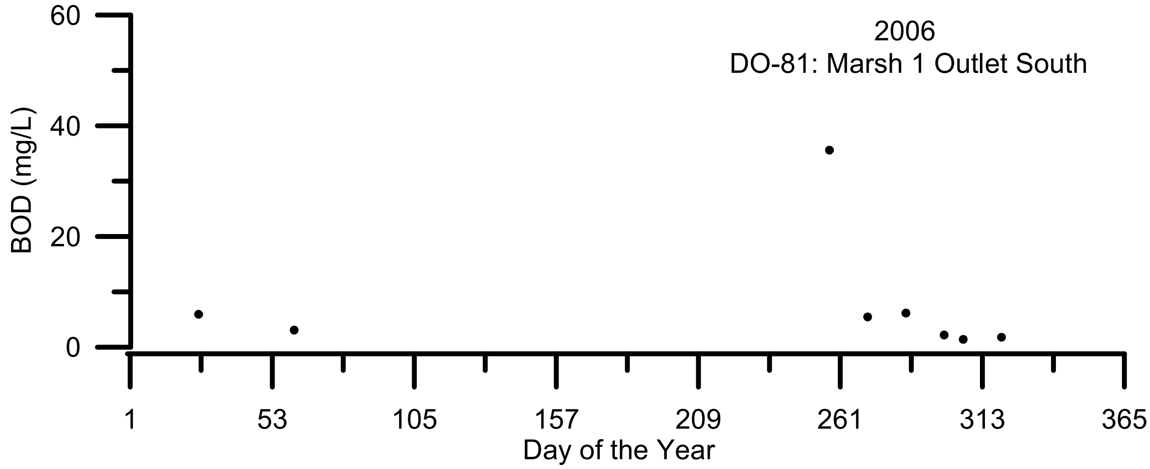

2007
DO-63: Inlet Canal C
BOD (mg/L)
Day of the Year
20
16
12
8
4
0
1
53
105
157
209
261
313
365

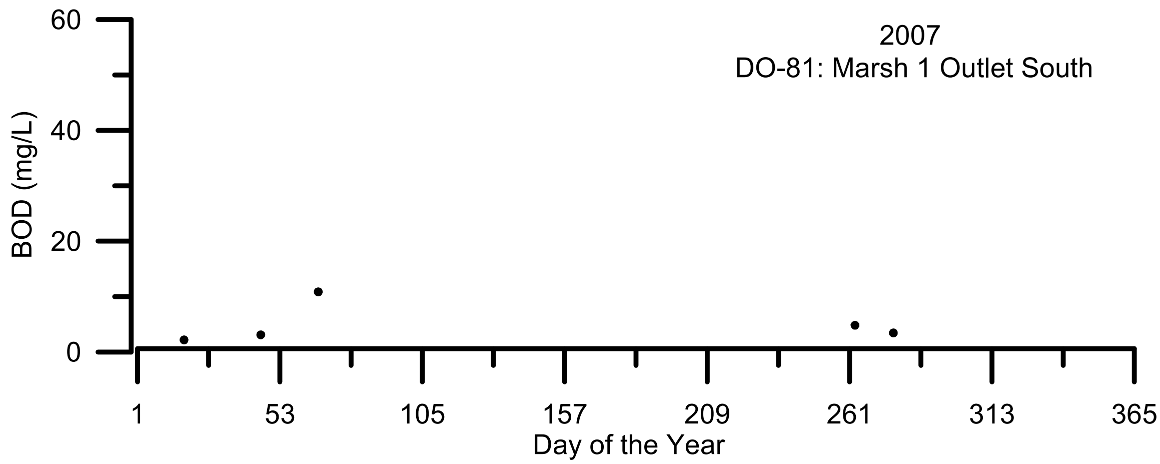

2005
DO-80: Marsh 1 Inlet South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

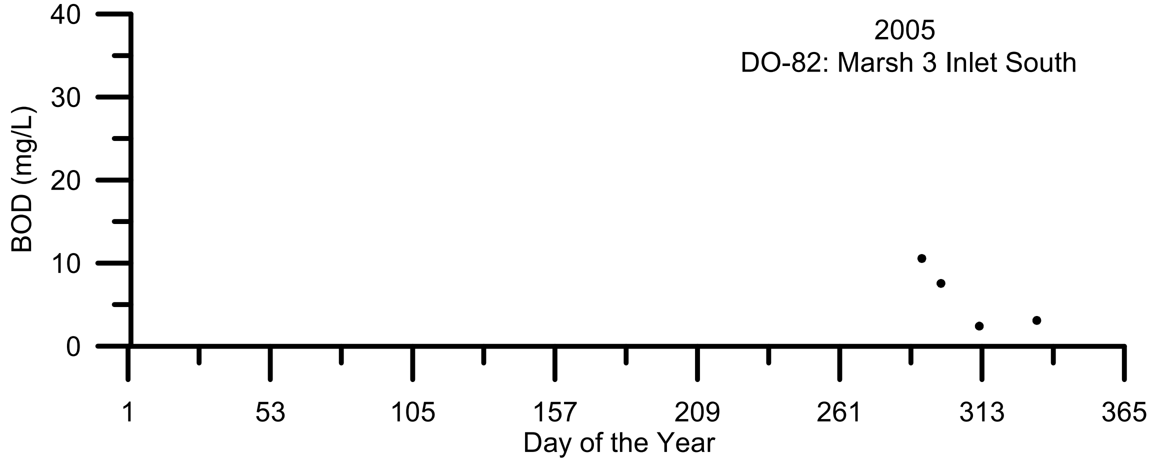

2006
DO-80: Marsh 1 Inlet South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-80: Marsh 1 Inlet South
BOD (mg/L)
20
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

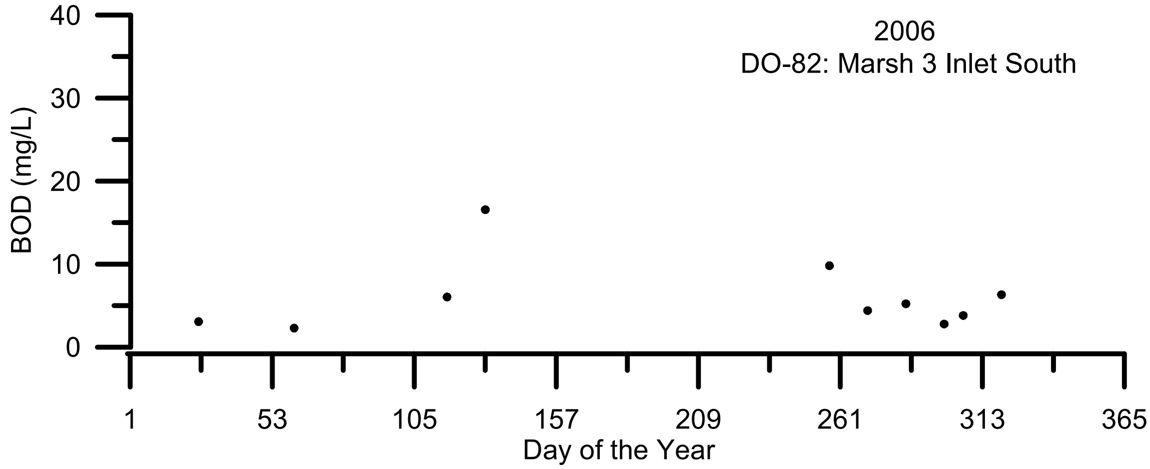

2005
DO-81: Marsh 1 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-81: Marsh 1 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year

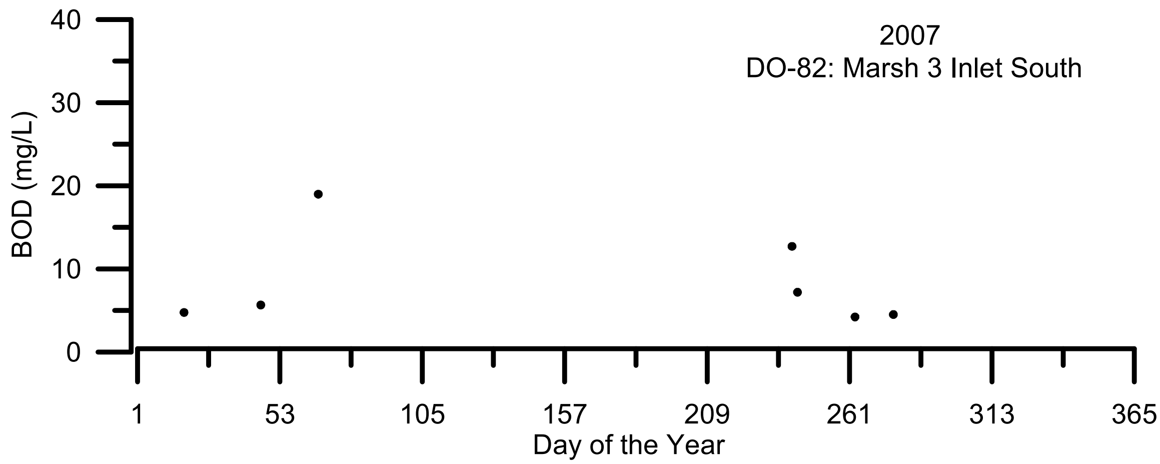

2007
DO-81: Marsh 1 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year



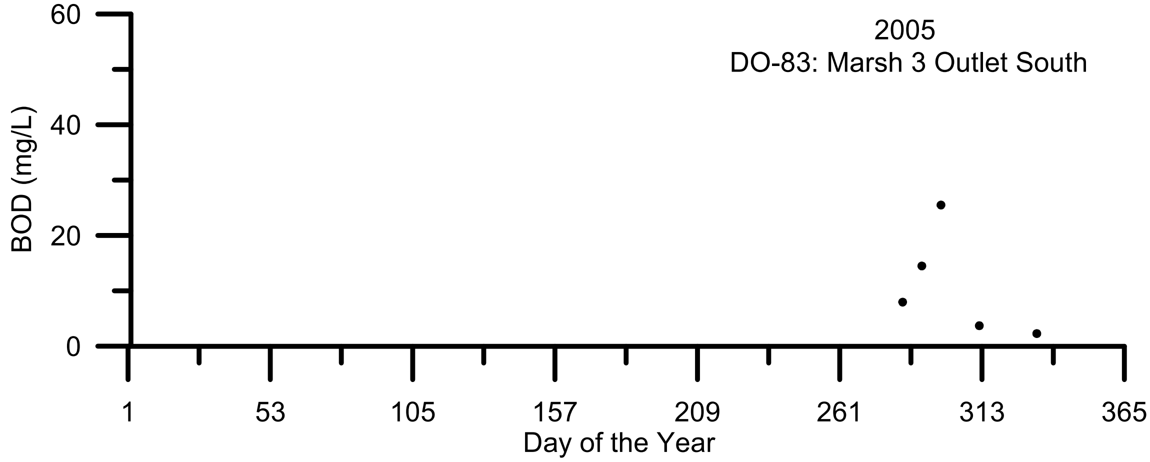
2005
DO-82: Marsh 3 Inlet South
BOD (mg/L)
Day of the Year

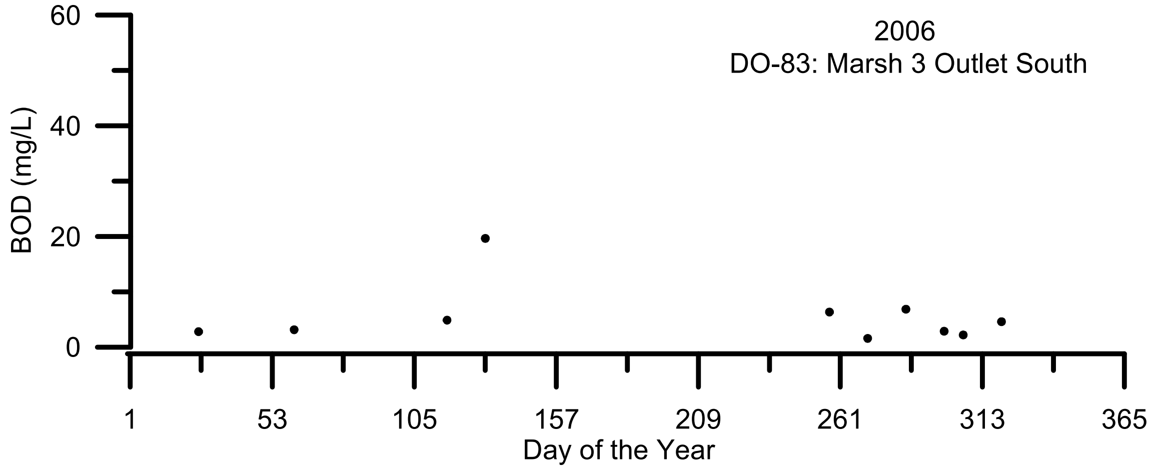


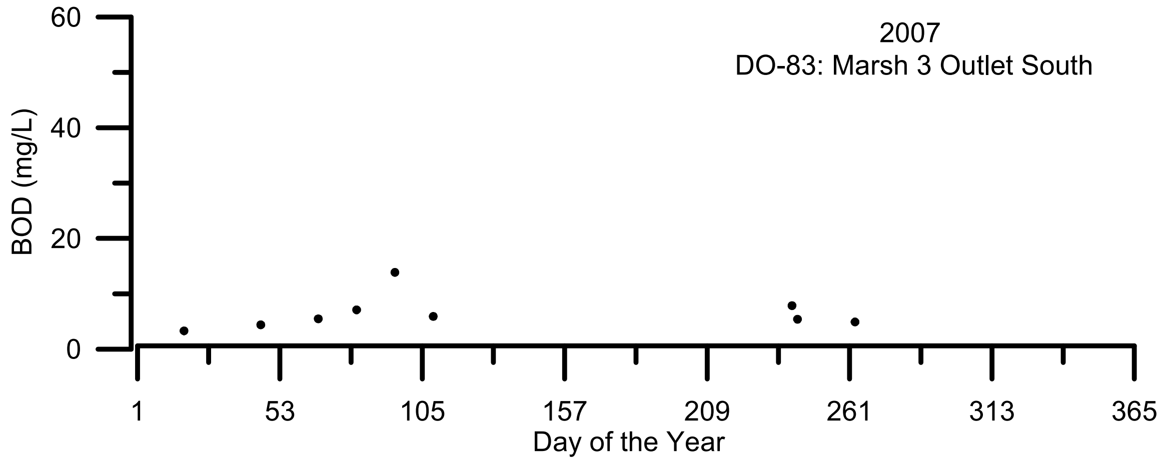
2006
DO-82: Marsh 3 Inlet South
BOD (mg/L)
Day of the Year

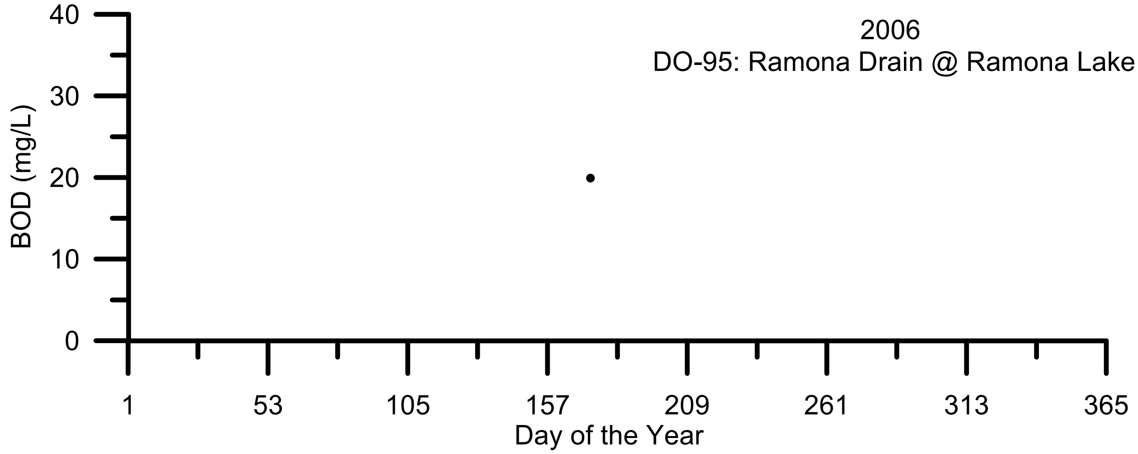


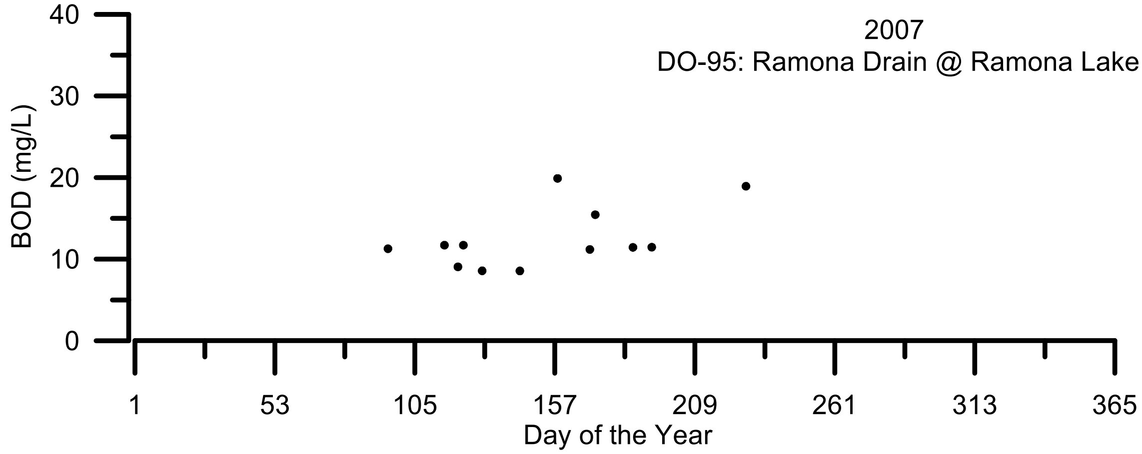
2007
DO-82: Marsh 3 Inlet South
BOD (mg/L)
Day of the Year


2005
DO-83: Marsh 3 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: Marsh 3 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: Marsh 3 Outlet South
BOD (mg/L)
60
40
20
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Drain @ Ramona Lake
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Drain @ Ramona Lake
BOD (mg/L)
0
10
20
30
40
1
53
105
157
209
261
313
365
Day of the Year

Analysis of Grab Sample Alkalinity Measurements in the San Joaquin River Watershed 2005-2007

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Chelsea Spier
Sharon Borglin
Jeremy Hanlon
Justin Graham
William Stringfellow

February 2008

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University of the Pacific
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Stockton CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 sampling locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of Alkalinity for all sites sampled in the SJR from 2005-2007.

Methods

Field sampling consisted of collecting water samples, measuring water quality with a YSI Sonde 6600 with MDS650 hand-held display, and recording of field conditions at sites within the study area per *EERP Field Protocol Book* (Graham, 2008).

Water samples were collected in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN) in accordance with requirements for different lab analysis and volume requirements.

Samples were immediately stored at $4^{\circ}C$ after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the lab on the day of sampling.

Samples were received by the laboratory the same day they were sampled and stored at $4^{\circ}C$ until filtering and analysis. Samples were collected, preserved, stored, and analyzed by methods outlined in *Standard Methods for the Analysis of Water and Wastewater*, (APHA, 2005, 1998). Alkalinity was measured on samples within 24 hours of sample collection by titration of a 50 mL sample with 0.02 N H_2SO_4 to an endpoint of pH 8.3 and 4.5. The limit of detection for this method is 2.0 mg/L $CaCO_3$.

Results and Discussion

This analysis was preformed routinely over the three year period with no modification to the method and a 100% passing rate on Proficiency check samples as well as a 99.7% passing rate for all QA parameters over the three year period (Borglin et. al., 2008).

References

Stringfellow, W.T., et al., (2008), *Evaluation of Vegetated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley*, University of the Pacific, Stockton, CA

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008), *EERP Field Protocol Book*, University of the Pacific, Stockton, CA.

Borglin, S., W. Stringfellow, J. Hanlon. (2005), Standard *Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project*, LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

American Public Health Association, (2005), *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, Washington, D.C.

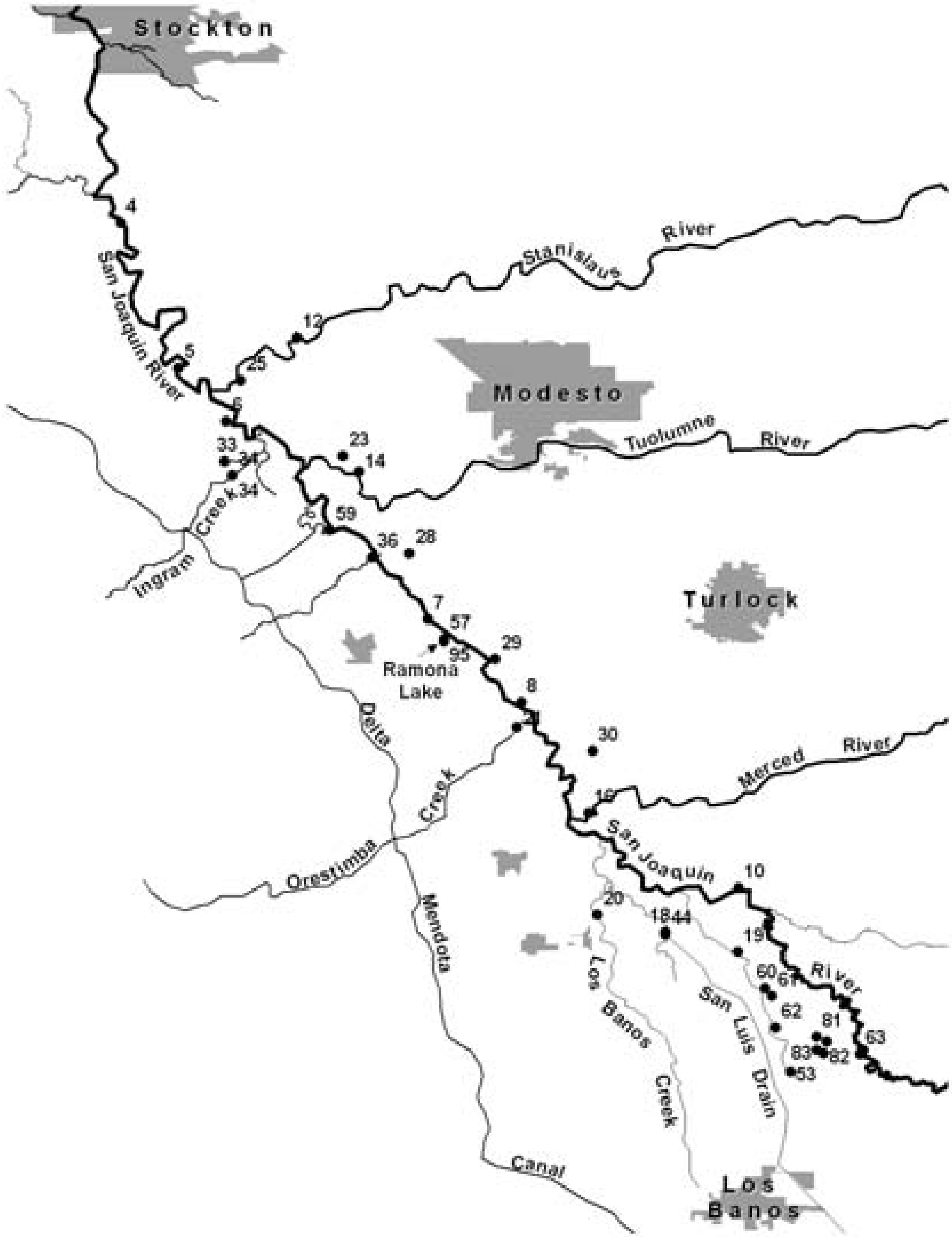
Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008*) EERP Lab Protocol Book*, University of the Pacific, Stockton, CA.

YSI Environmental Operations Manual, (2005), 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

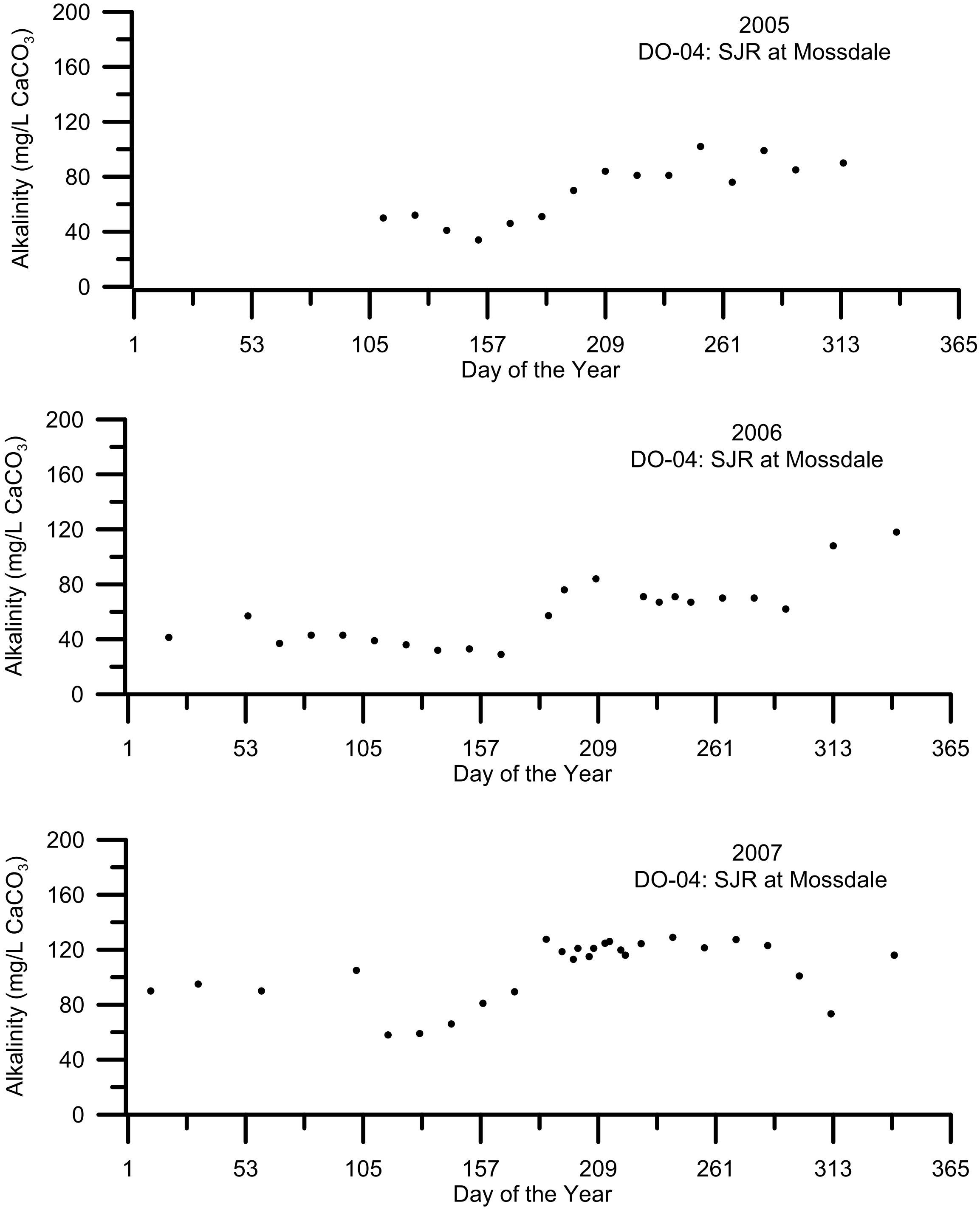
Table 1: EERP Sampling Site List

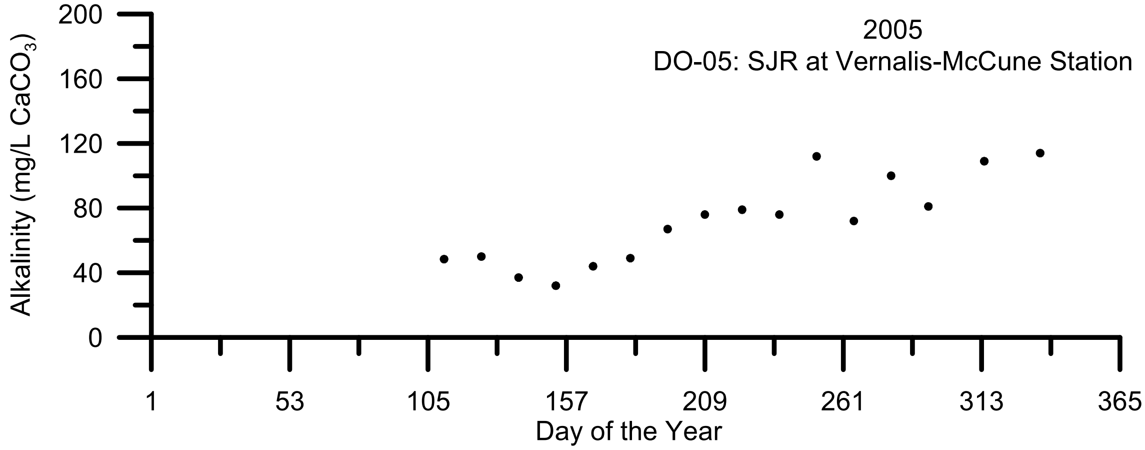
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

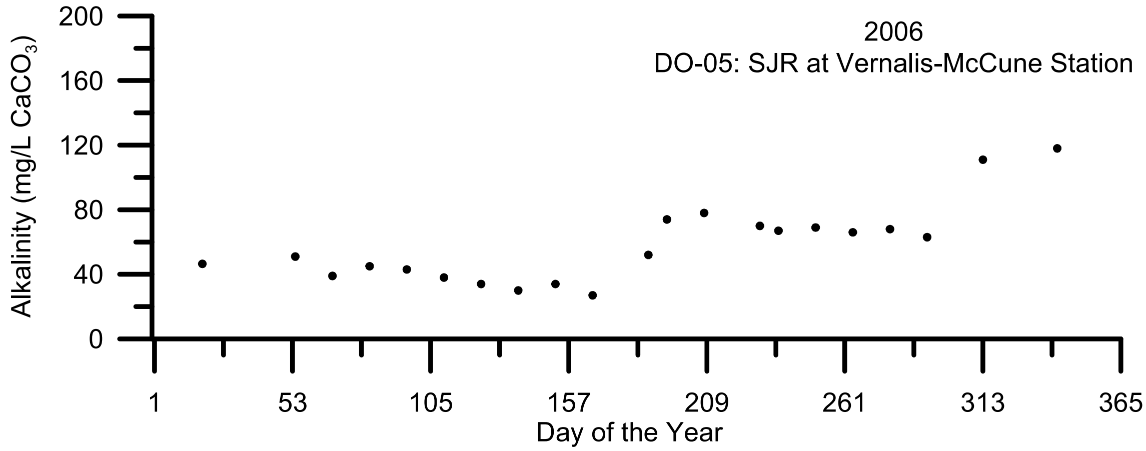
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

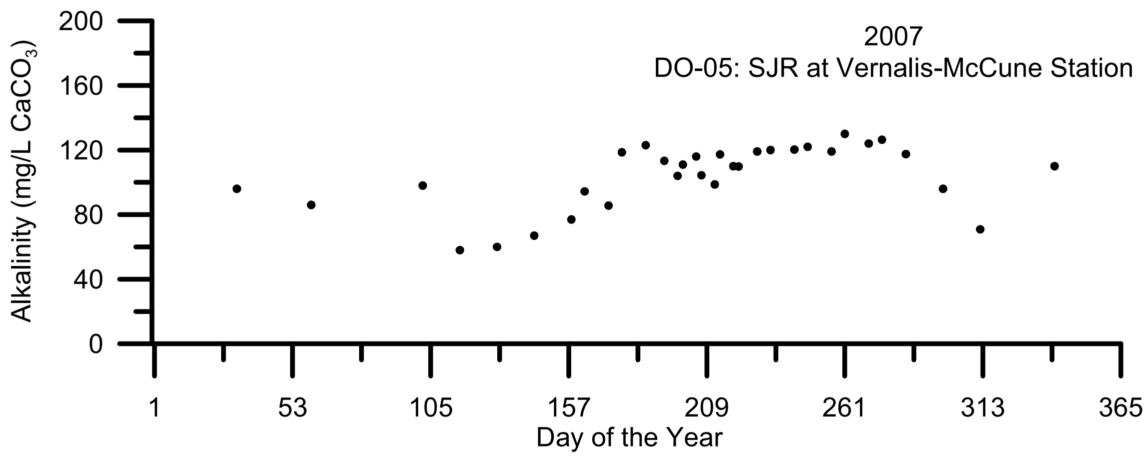


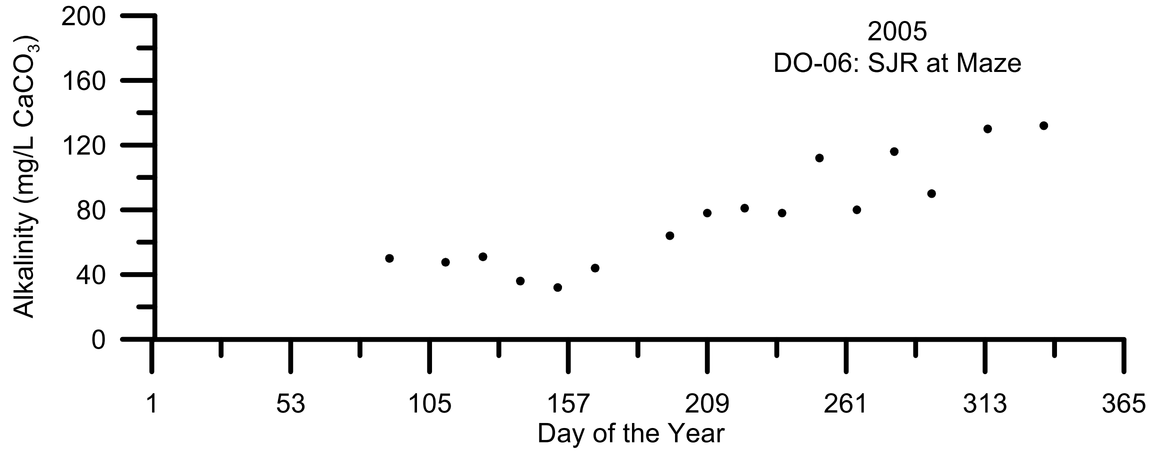
Figures 2 -101: Temporal Plots of Sample Alkalinity By Site ID

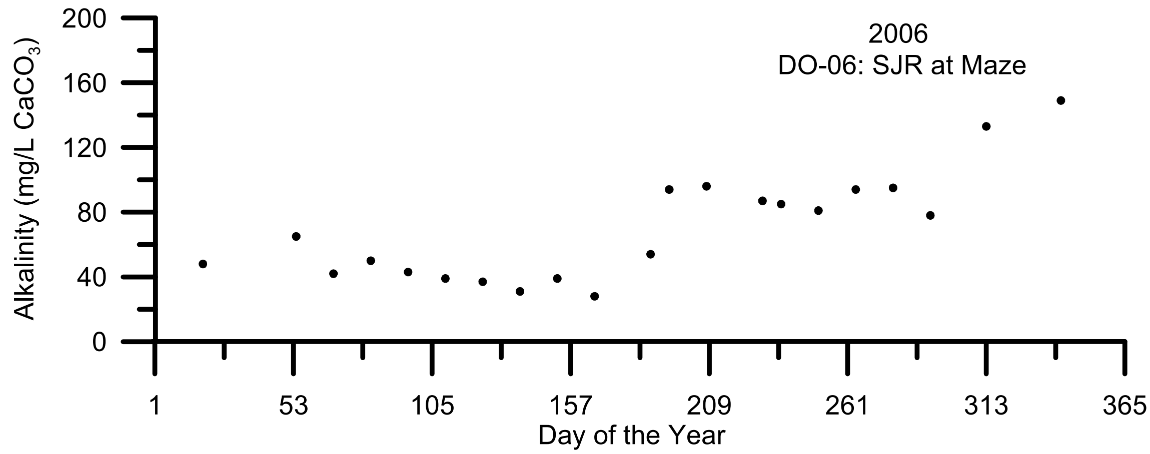


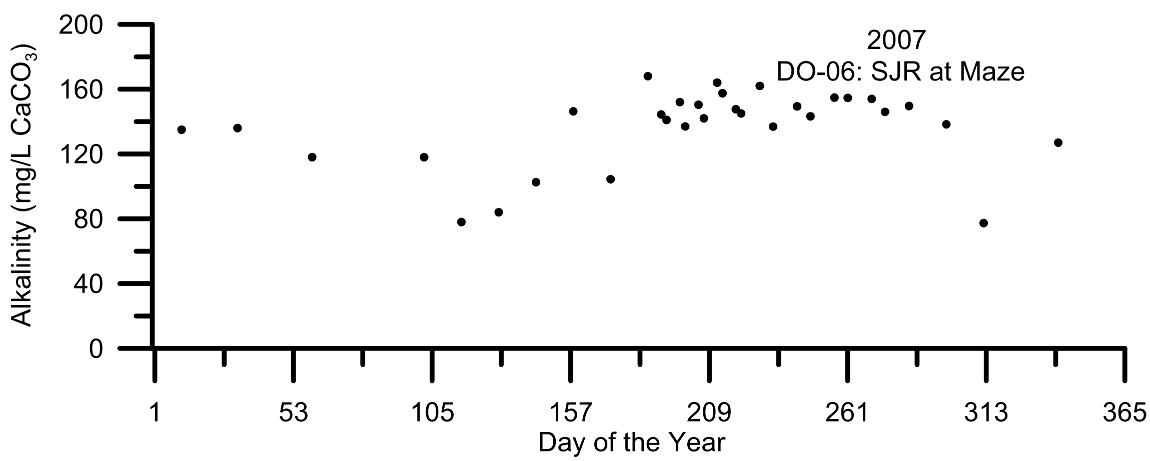

2005
DO-05: SJR at Vernalis-McCune Station
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

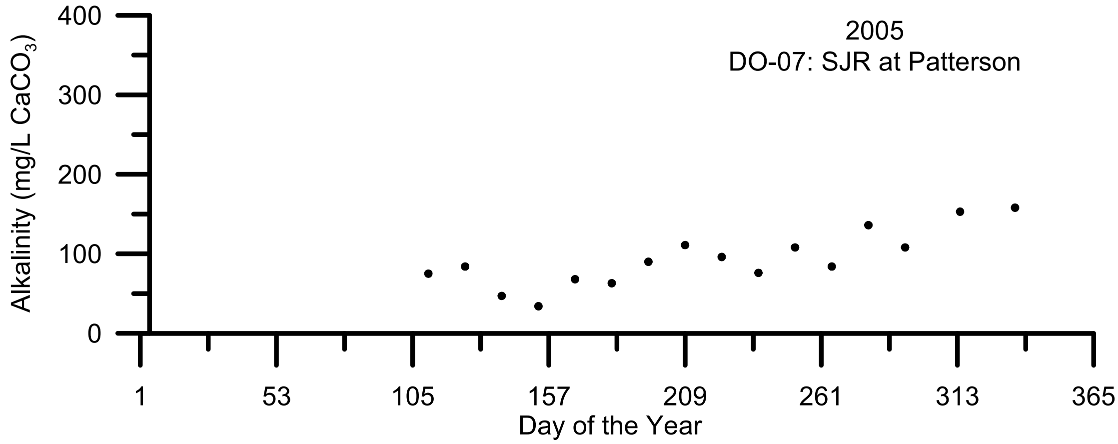

2006
DO-05: SJR at Vernalis-McCune Station
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-05: SJR at Vernalis-McCune Station
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

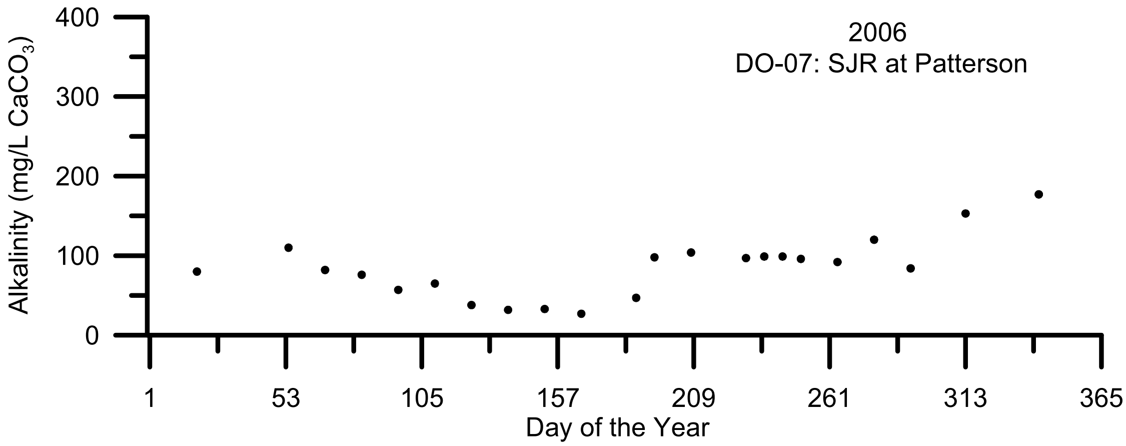

2005
DO-06: SJR at Maze
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-06: SJR at Maze
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

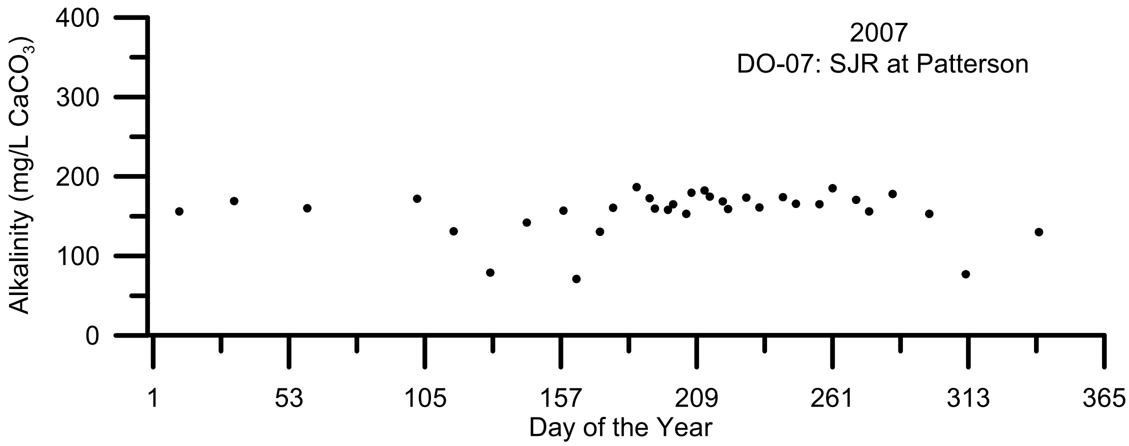

2007
DO-06: SJR at Maze
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year



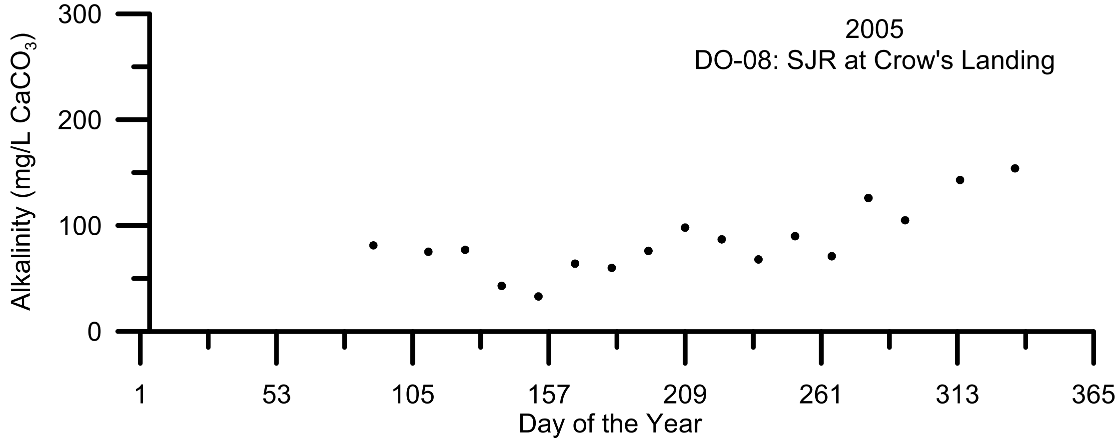
2005
DO-07: SJR at Patterson
Alkalinity (mg/L CaCO3)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

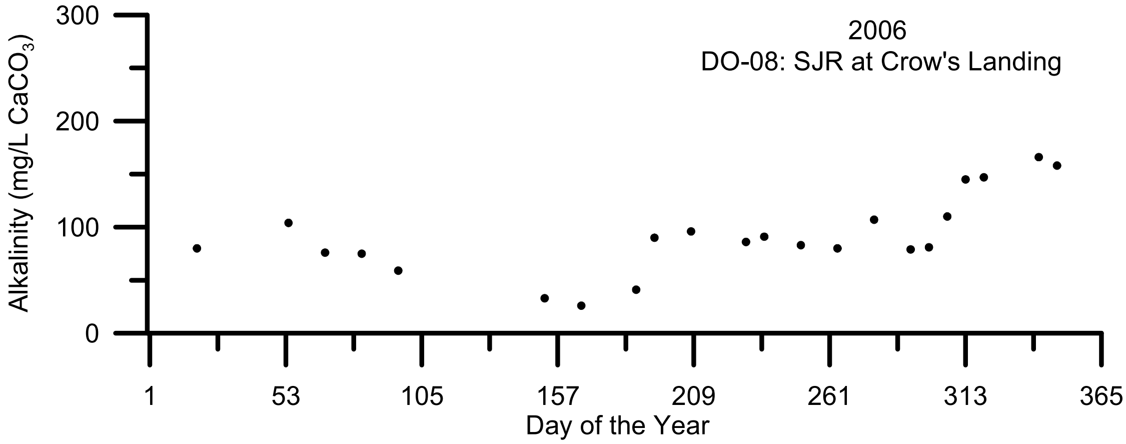


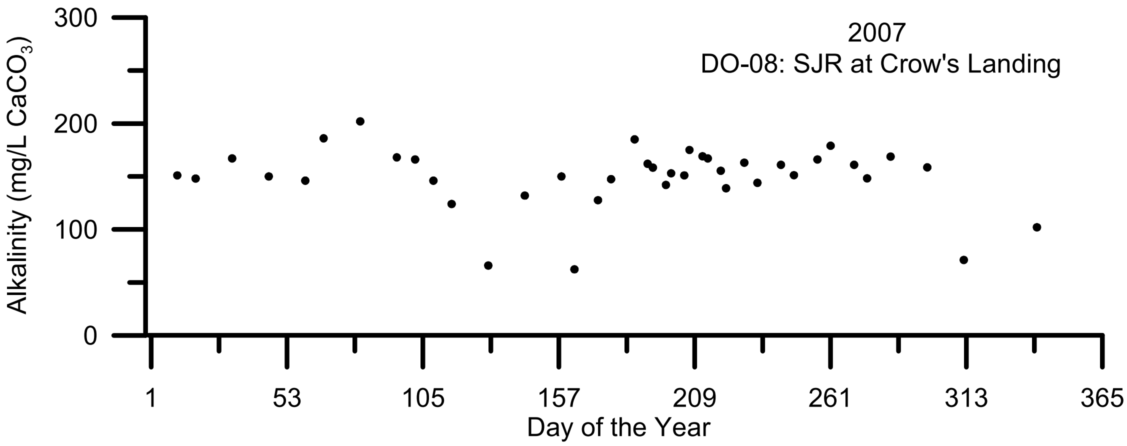
2006
DO-07: SJR at Patterson
Alkalinity (mg/L CaCO3)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

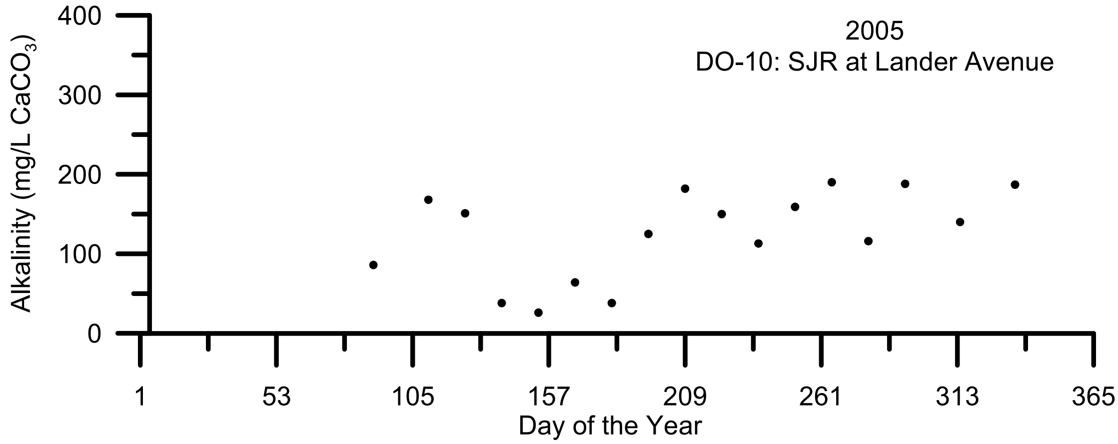


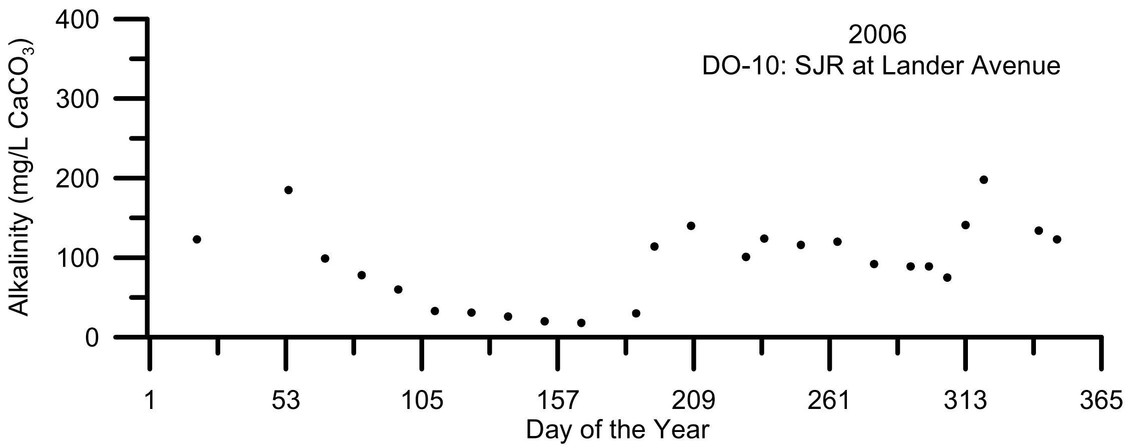
2007
DO-07: SJR at Patterson
Alkalinity (mg/L CaCO3)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

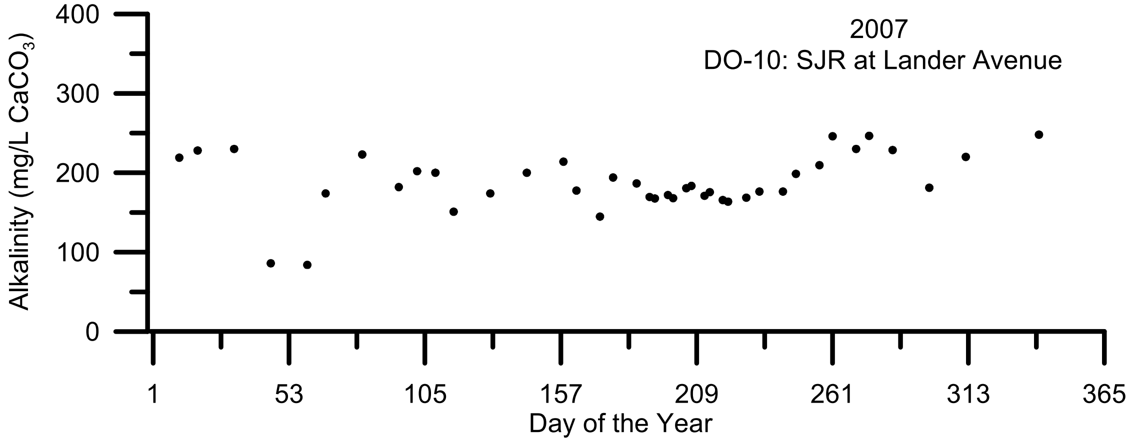

2005
DO-08: SJR at Crow's Landing
Alkalinity (mg/L CaCO3)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

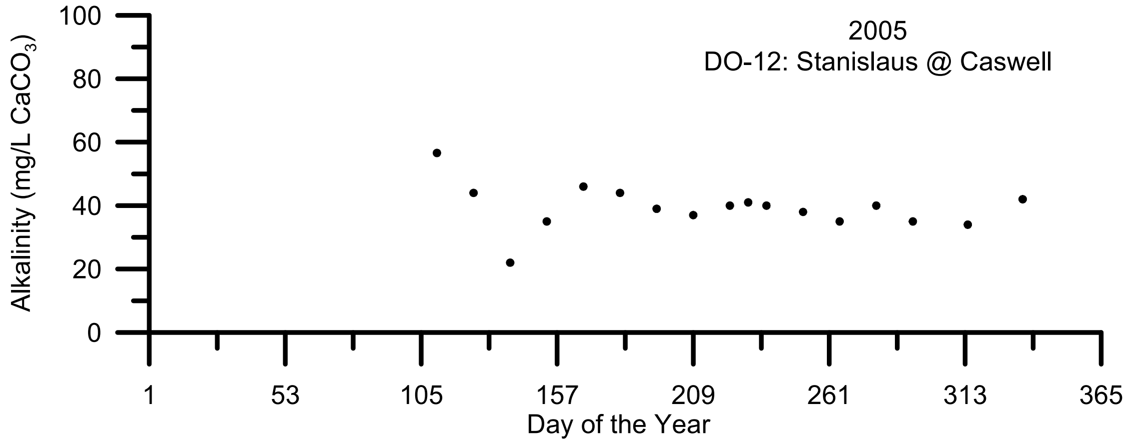

2006
DO-08: SJR at Crow's Landing
Alkalinity (mg/L CaCO3)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

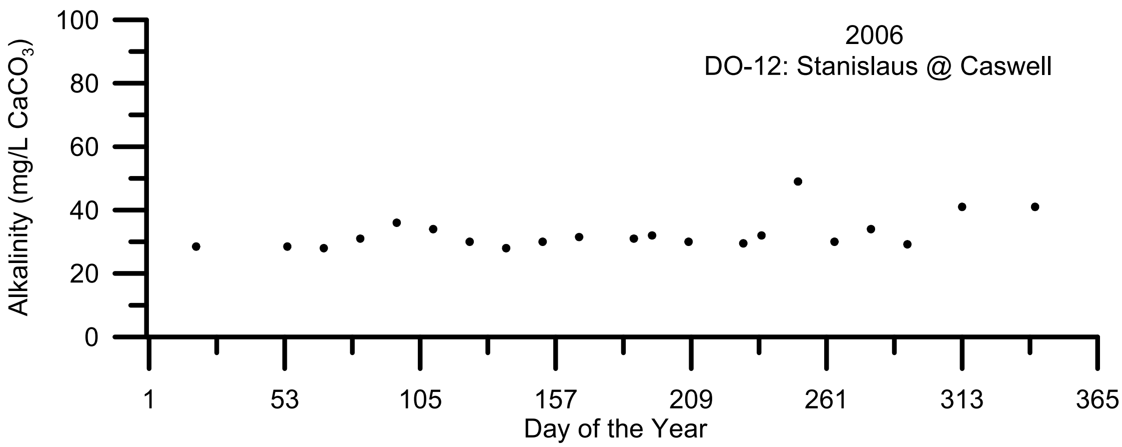

2007
DO-08: SJR at Crow's Landing
Alkalinity (mg/L CaCO3)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

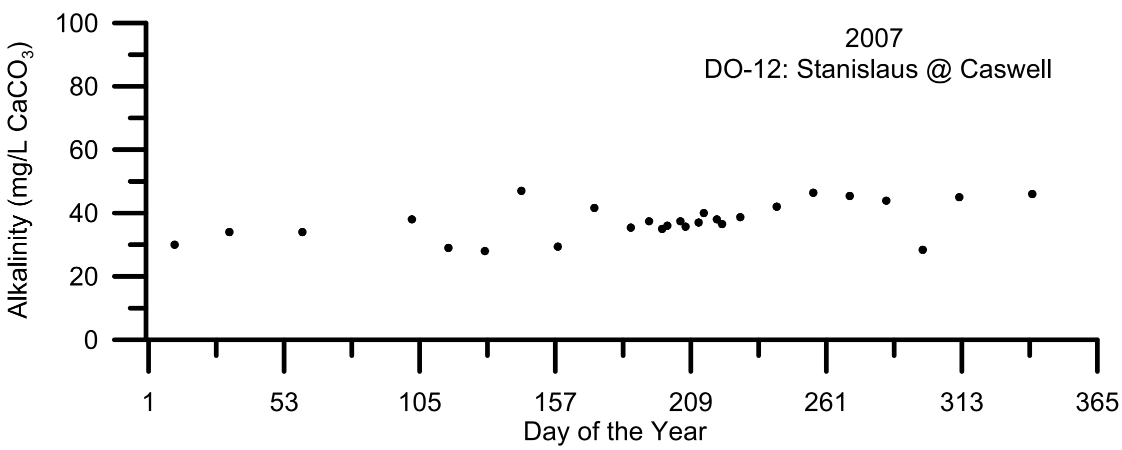

2005
DO-10: SJR at Lander Avenue
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

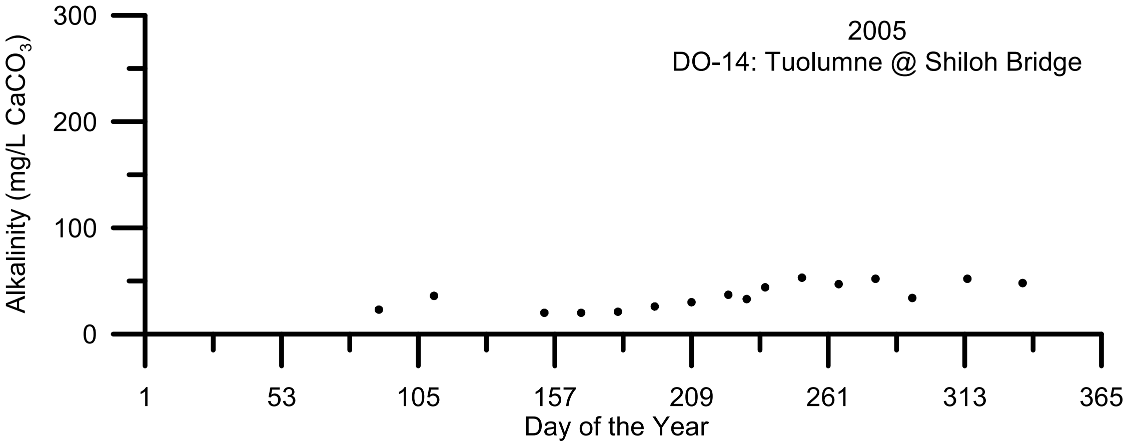

2006
DO-10: SJR at Lander Avenue
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

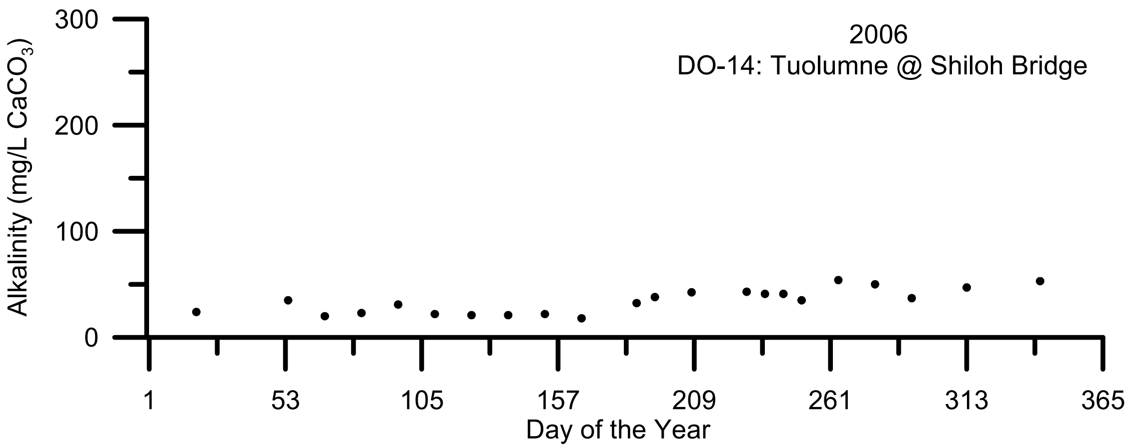

2007
DO-10: SJR at Lander Avenue
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

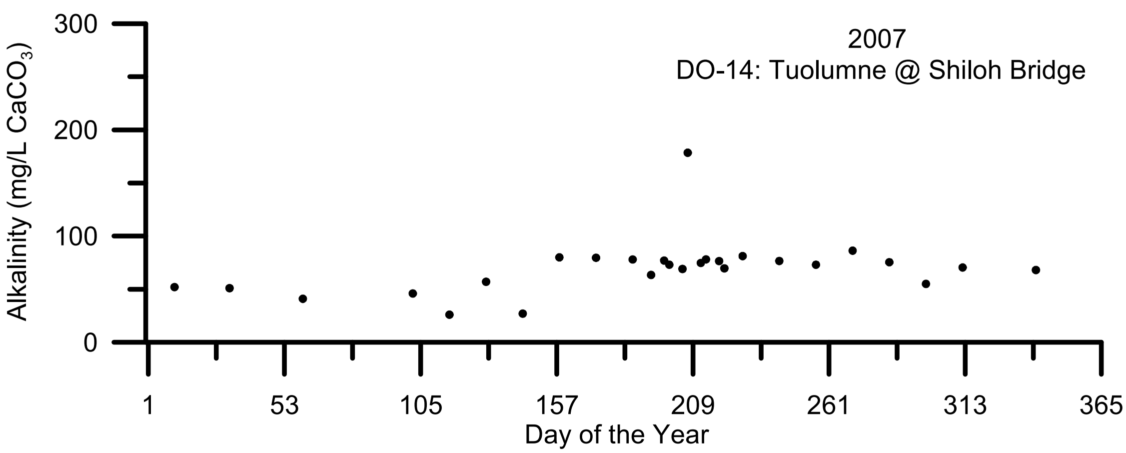

2005
DO-12: Stanislaus @ Caswell
Alkalinity (mg/L $CaCO_3$)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

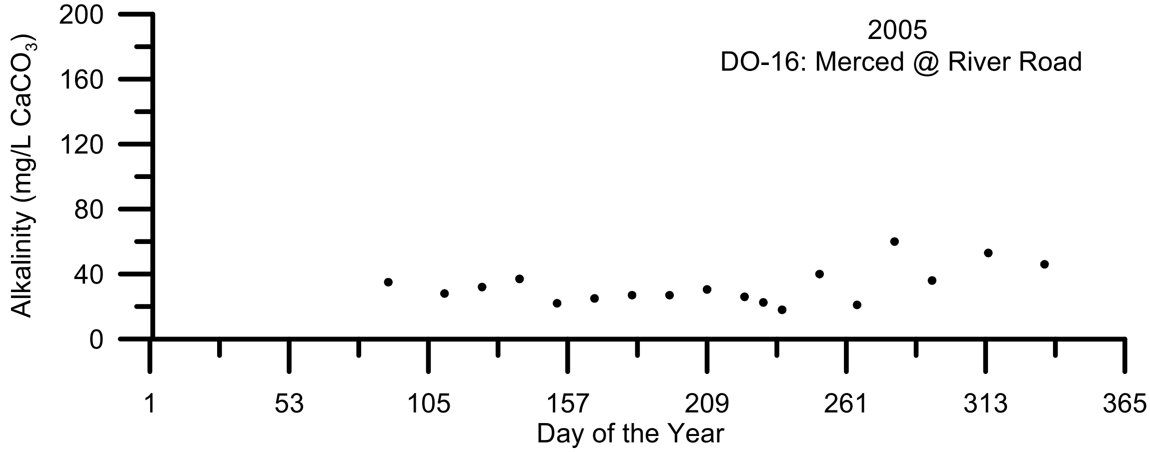

2006
DO-12: Stanislaus @ Caswell
Alkalinity (mg/L $CaCO_3$)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

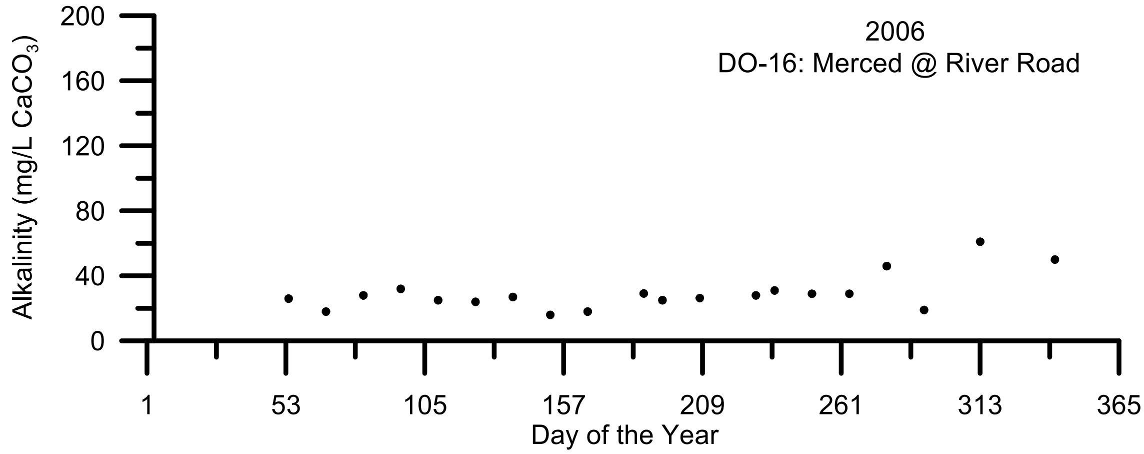

2007
DO-12: Stanislaus @ Caswell
Alkalinity (mg/L $CaCO_3$)
0
20
40
60
80
100
1
53
105
157
209
261
313
365
Day of the Year

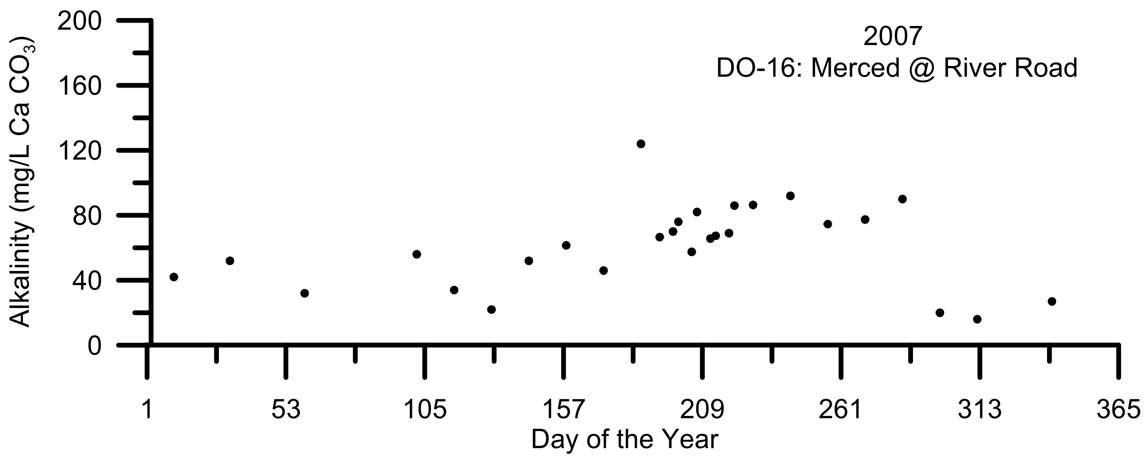

2005
DO-14: Tuolumne @ Shiloh Bridge
Alkalinity (mg/L $CaCO_3$)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

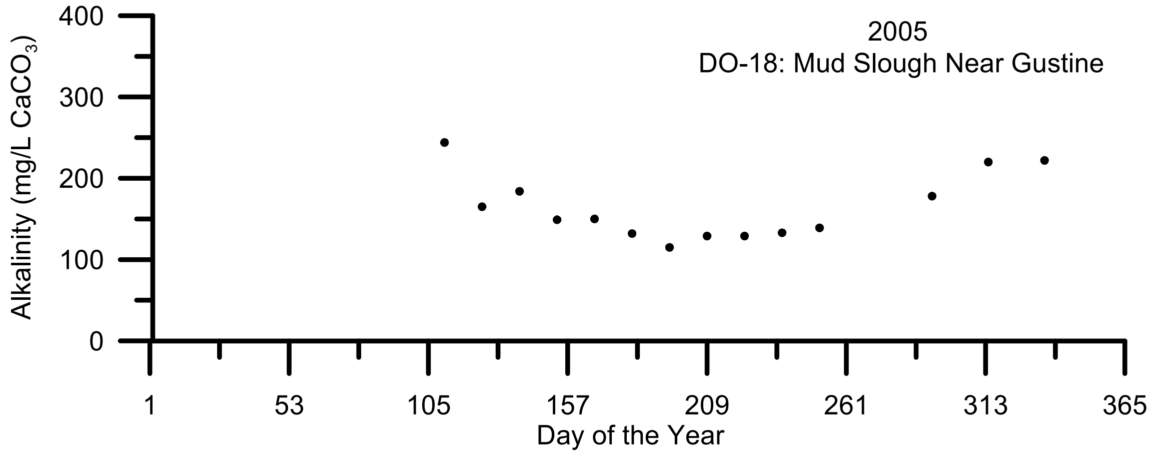

2006
DO-14: Tuolumne @ Shiloh Bridge
Alkalinity (mg/L $CaCO_3$)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

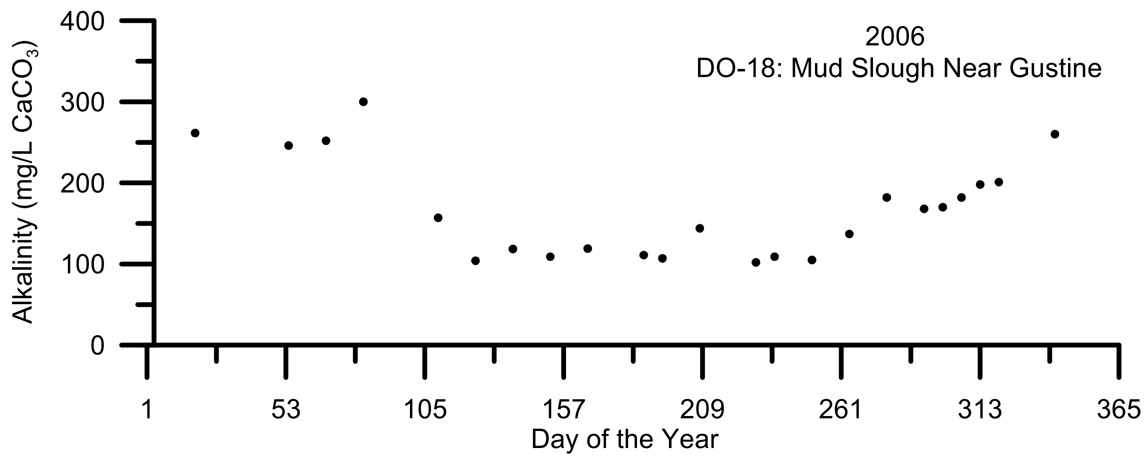

2007
DO-14: Tuolumne @ Shiloh Bridge
Alkalinity (mg/L $CaCO_3$)
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

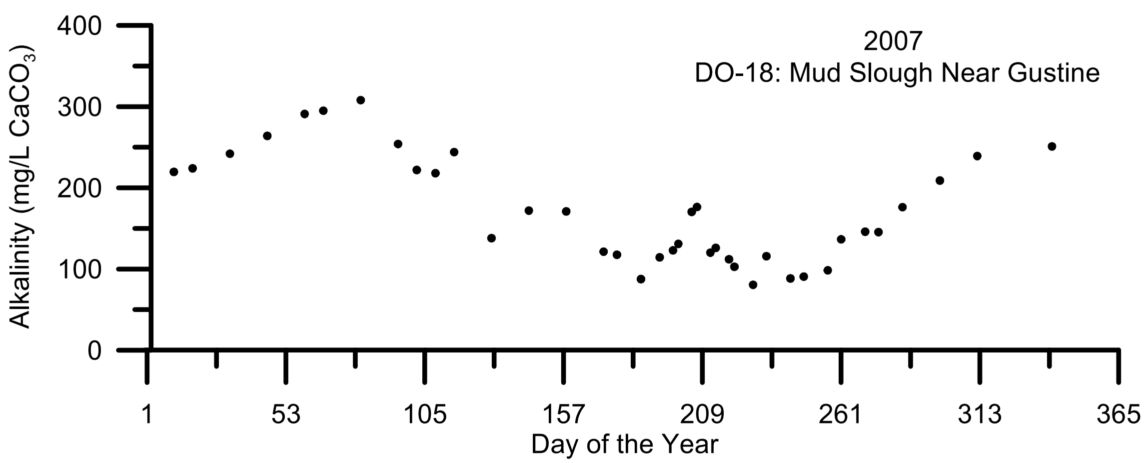

2005
DO-16: Merced @ River Road
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

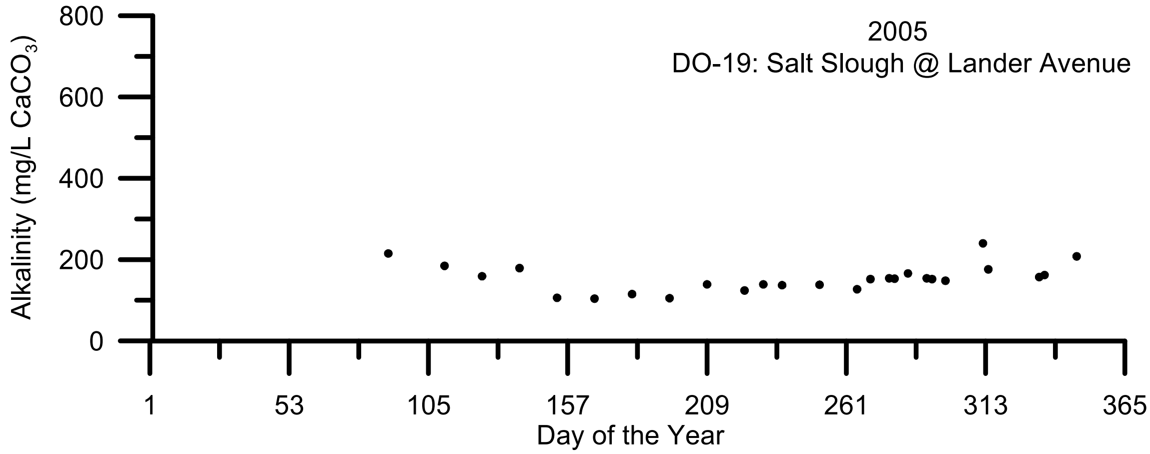

2006
DO-16: Merced @ River Road
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-16: Merced @ River Road
Alkalinity (mg/L Ca CO_3)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

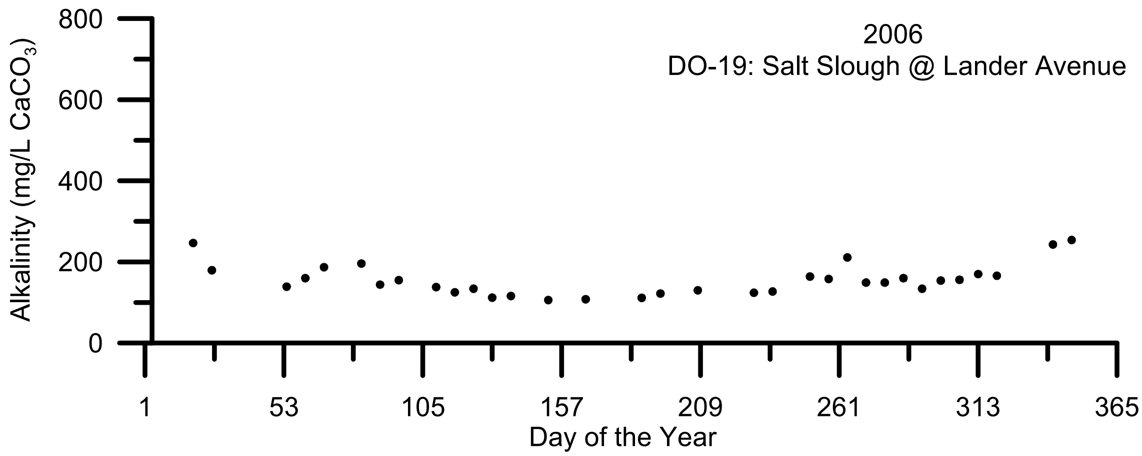

2005
DO-18: Mud Slough Near Gustine
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-18: Mud Slough Near Gustine
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

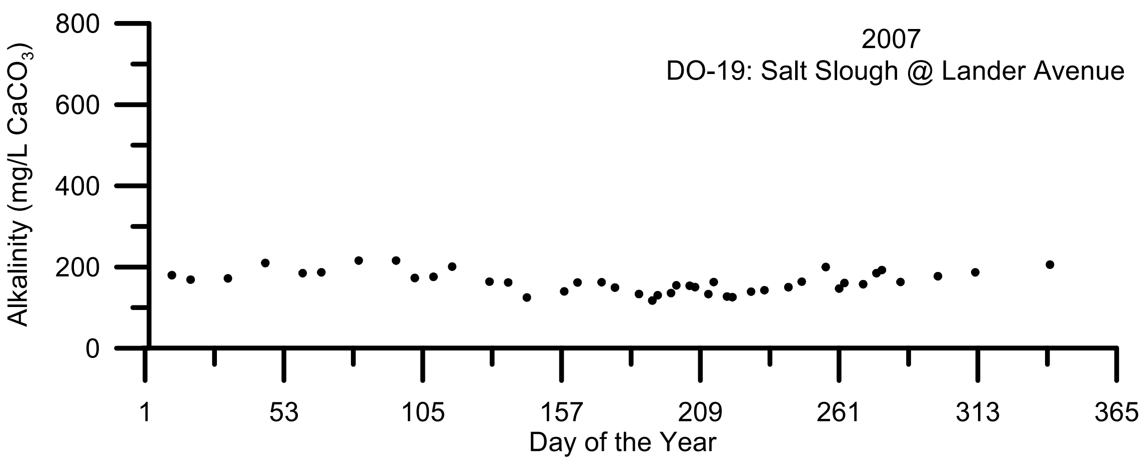

2007
DO-18: Mud Slough Near Gustine
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



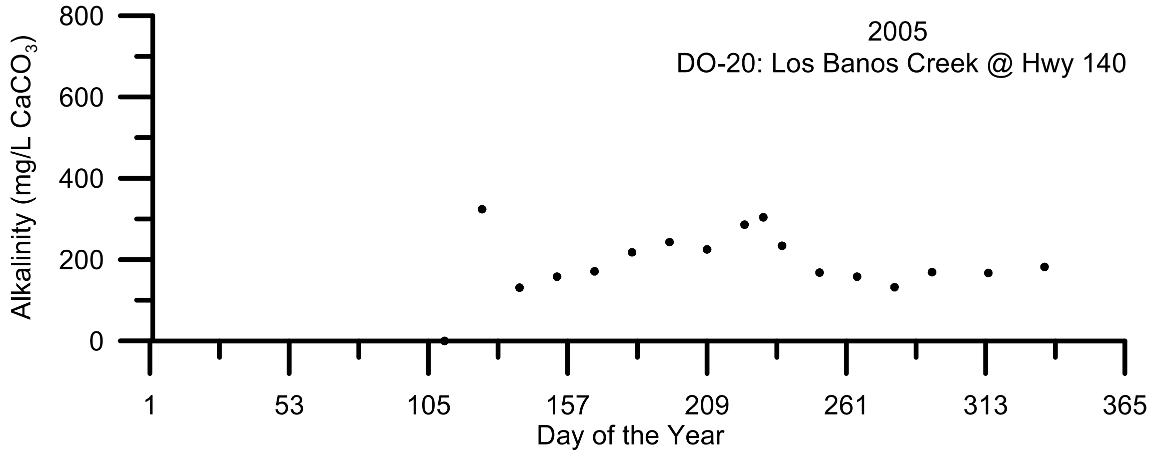
800
600
400
200
0
Alkalinity (mg/L $CaCO_3$)
2005
DO-19: Salt Slough @ Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year

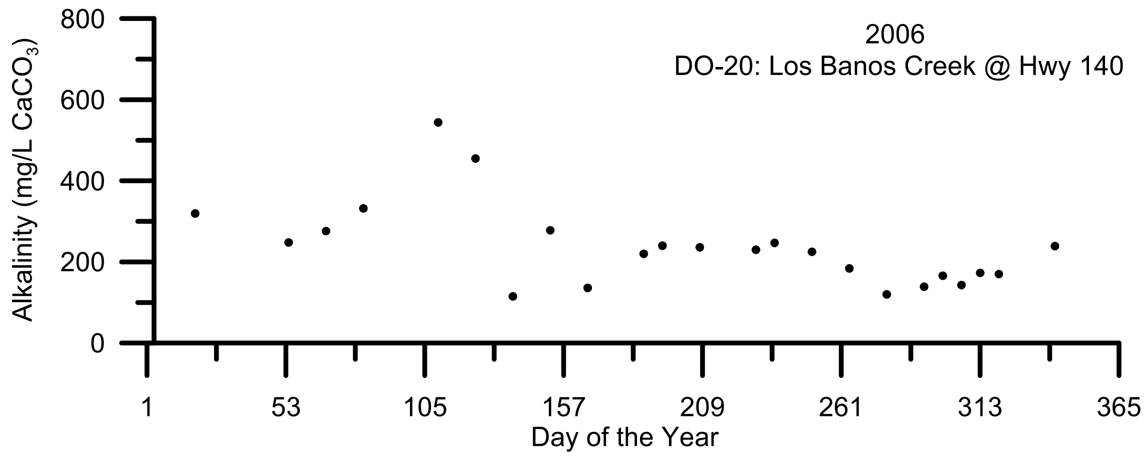


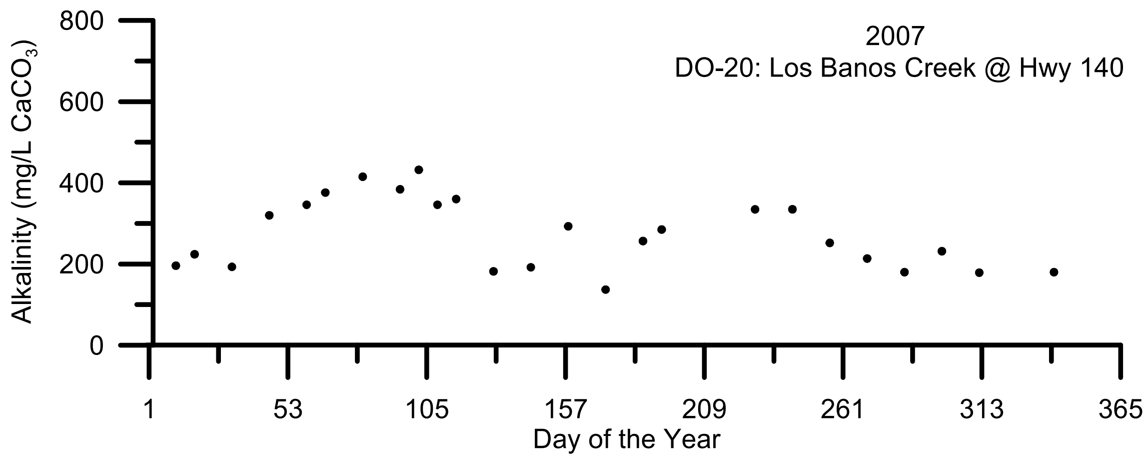
800
600
400
200
0
Alkalinity (mg/L $CaCO_3$)
2006
DO-19: Salt Slough @ Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year

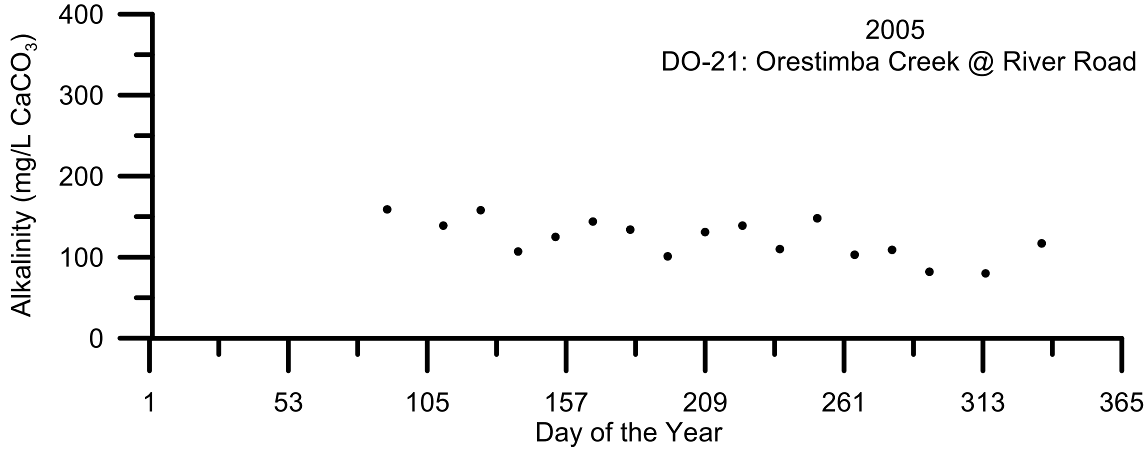


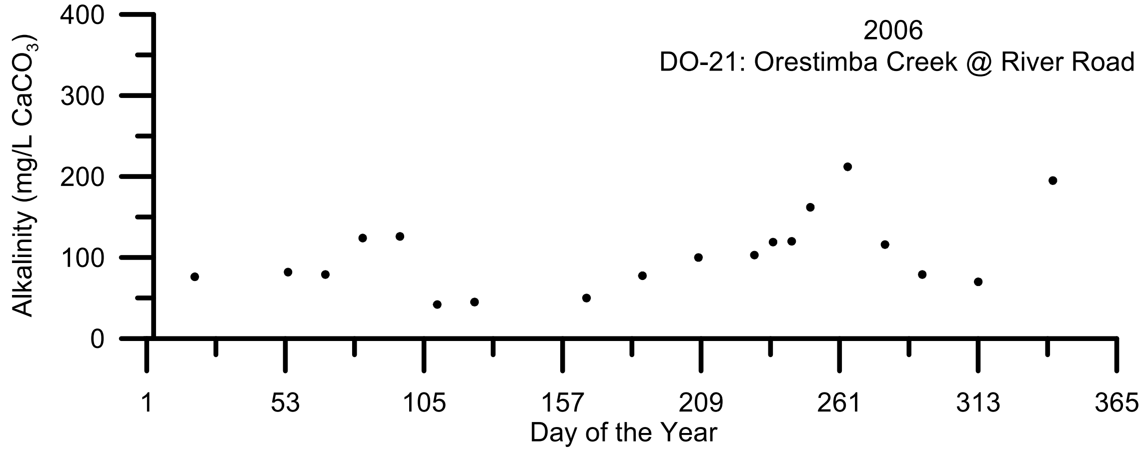
800
600
400
200
0
Alkalinity (mg/L $CaCO_3$)
2007
DO-19: Salt Slough @ Lander Avenue
1
53
105
157
209
261
313
365
Day of the Year

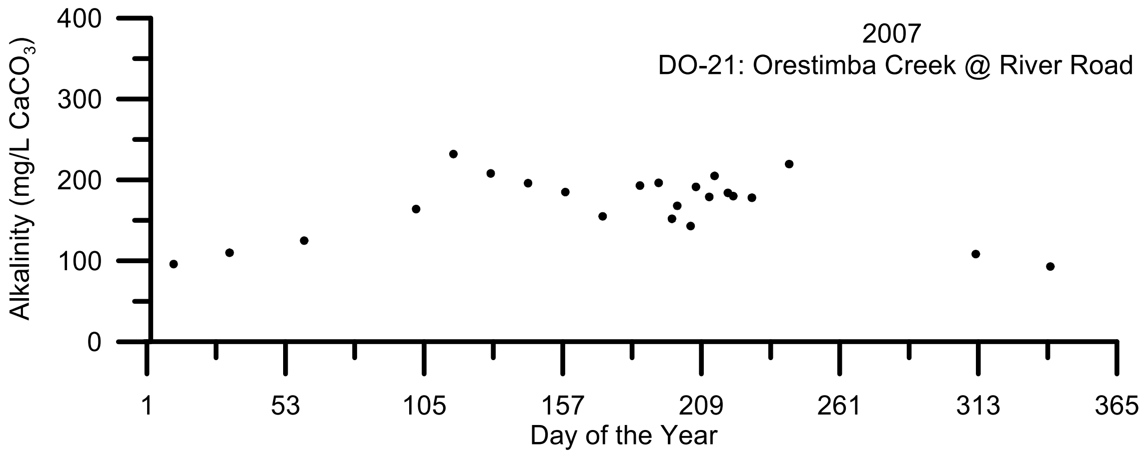

2005
DO-20: Los Banos Creek @ Hwy 140
Alkalinity (mg/L CaCO3)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

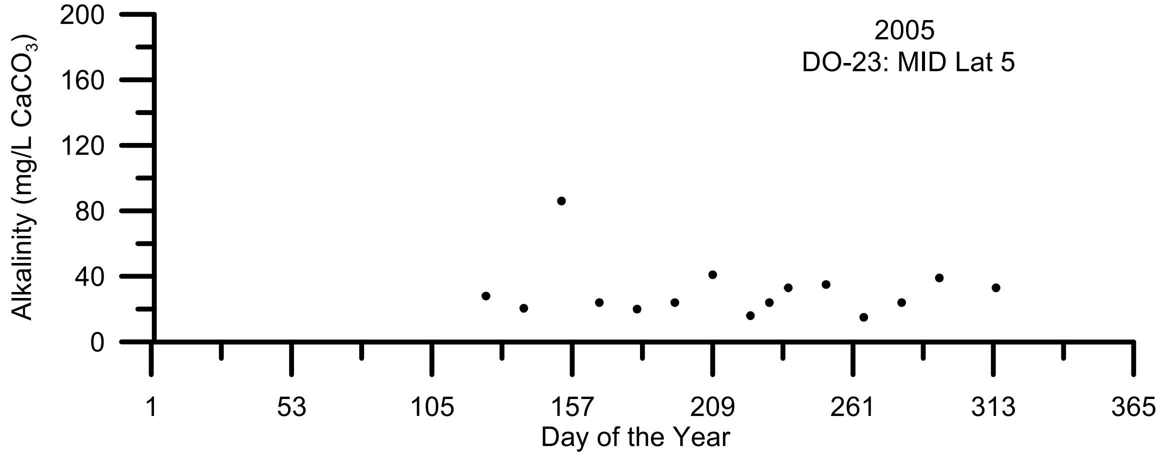

2006
DO-20: Los Banos Creek @ Hwy 140
Alkalinity (mg/L CaCO3)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

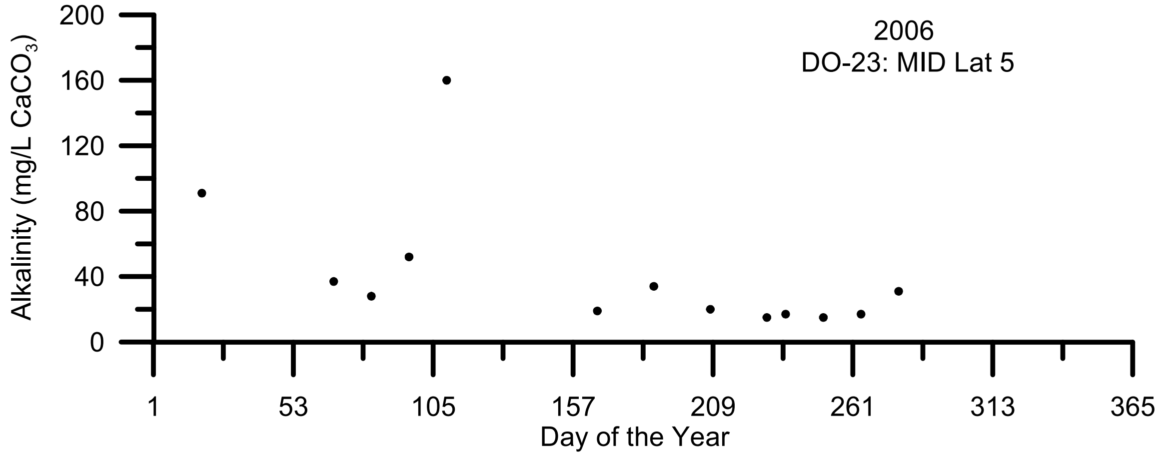

2007
DO-20: Los Banos Creek @ Hwy 140
Alkalinity (mg/L CaCO3)
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

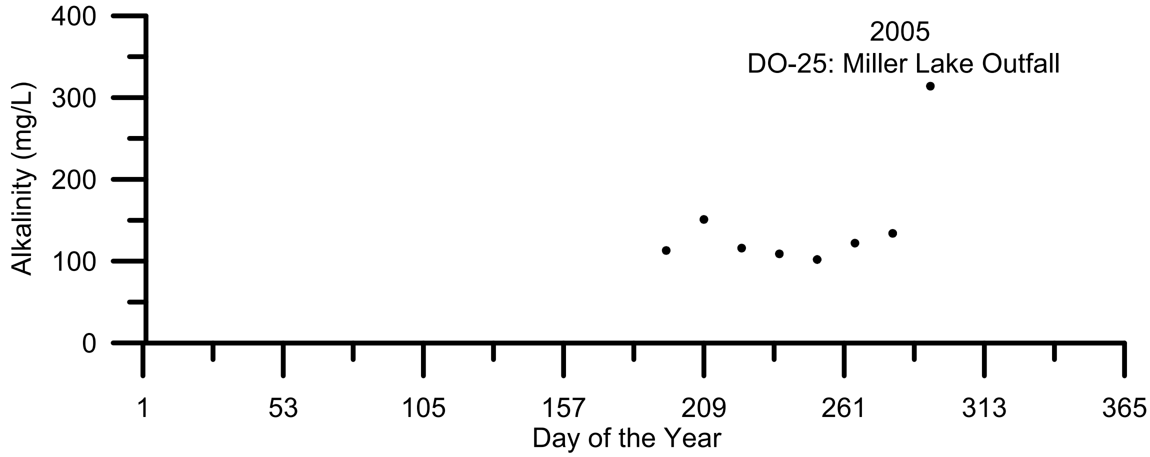

2005
DO-21: Orestimba Creek @ River Road
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

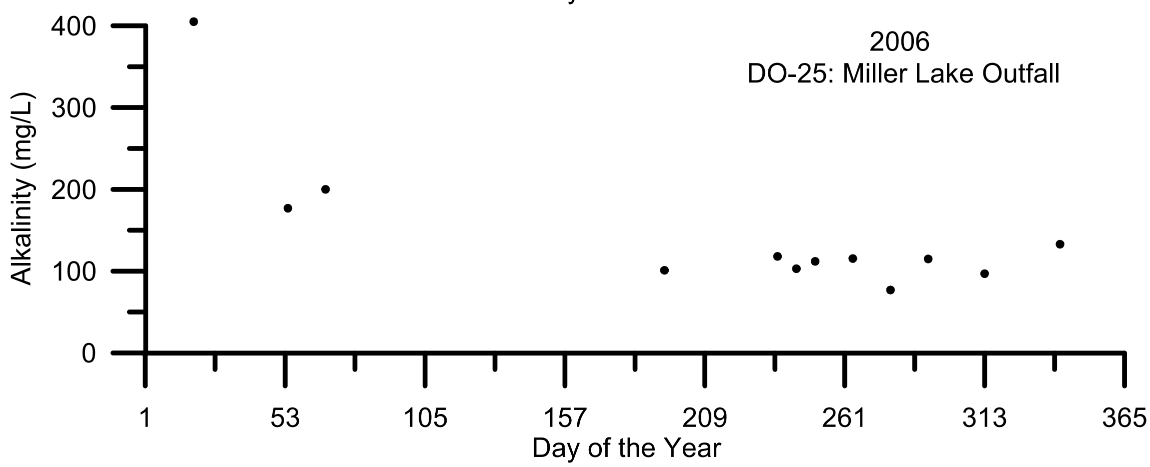

2006
DO-21: Orestimba Creek @ River Road
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

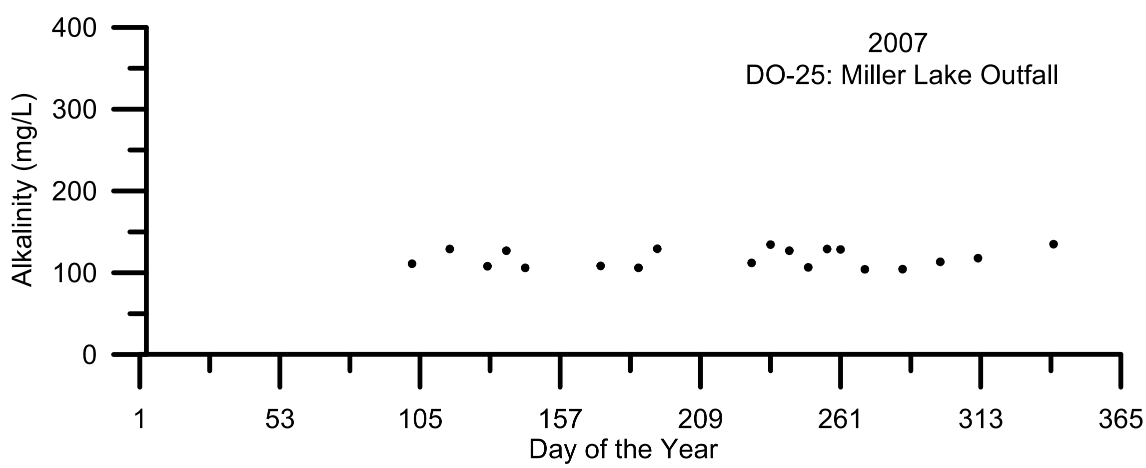

2007
DO-21: Orestimba Creek @ River Road
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

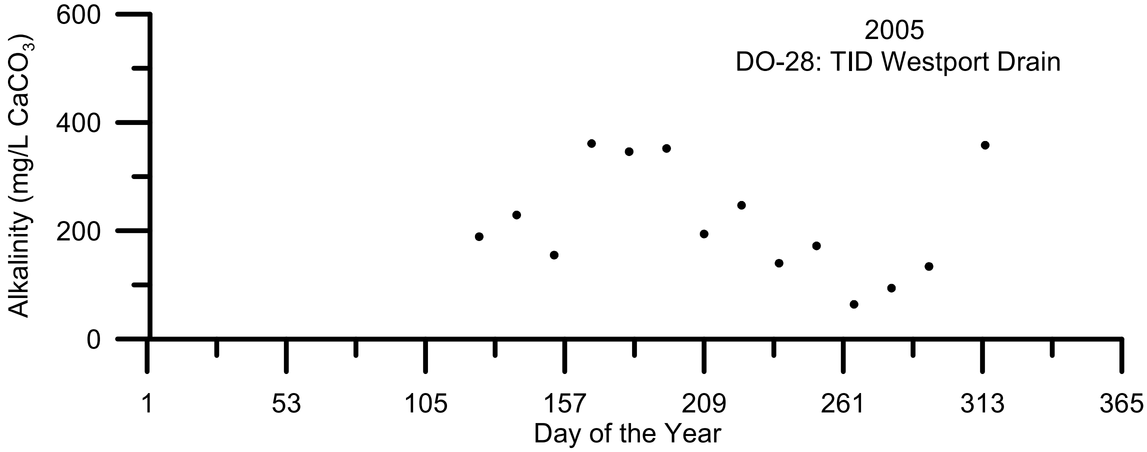

200
160
120
80
40
0
Alkalinity (mg/L CaCO3)
2005
DO-23: MID Lat 5
1
53
105
157
209
261
313
365
Day of the Year

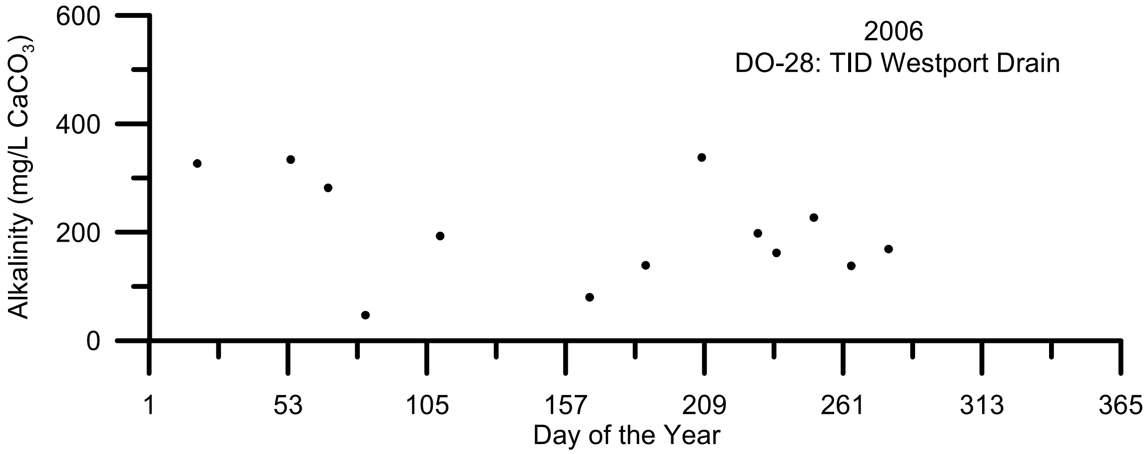

200
160
120
80
40
0
Alkalinity (mg/L CaCO3)
2006
DO-23: MID Lat 5
1
53
105
157
209
261
313
365
Day of the Year

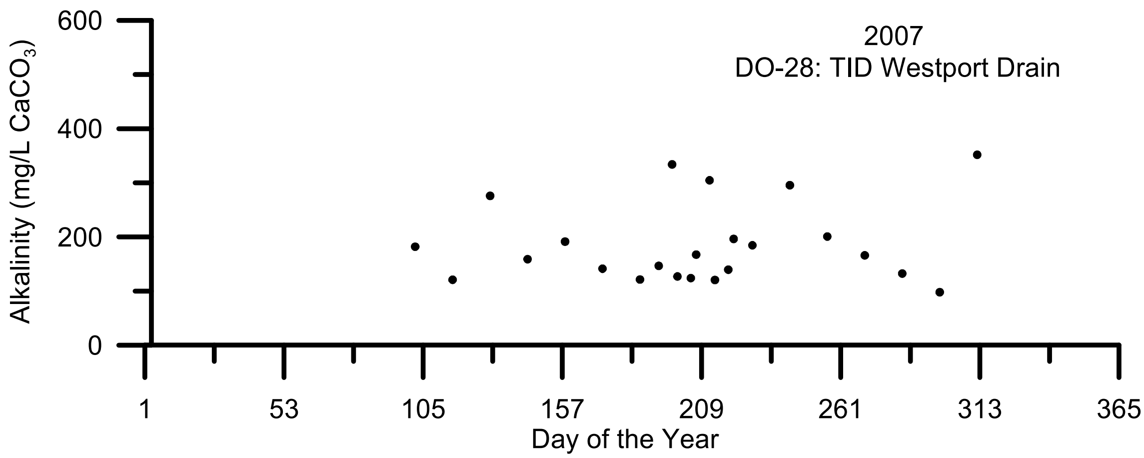

400
300
200
100
0
Alkalinity (mg/L)
2005
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

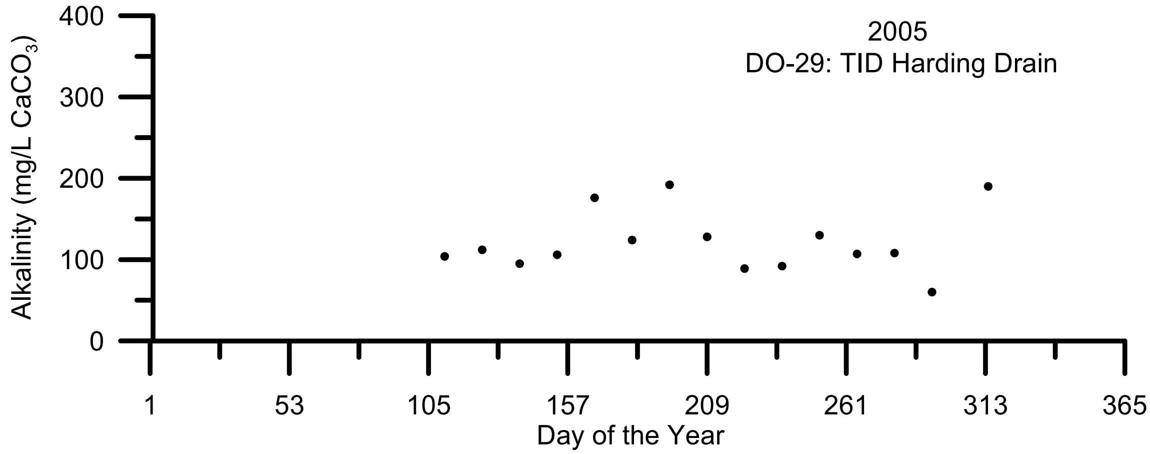

400
300
200
100
0
Alkalinity (mg/L)
2006
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

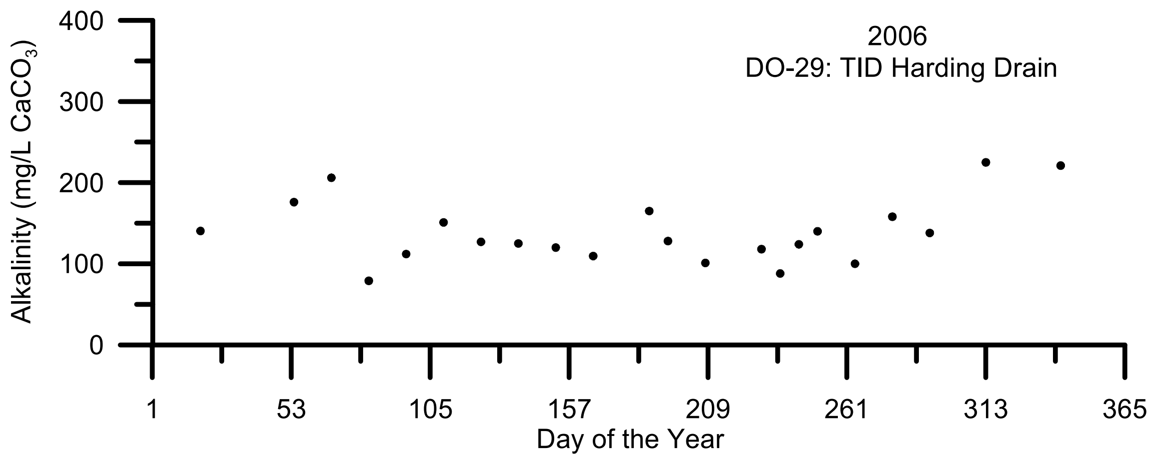

400
300
200
100
0
Alkalinity (mg/L)
2007
DO-25: Miller Lake Outfall
1
53
105
157
209
261
313
365
Day of the Year

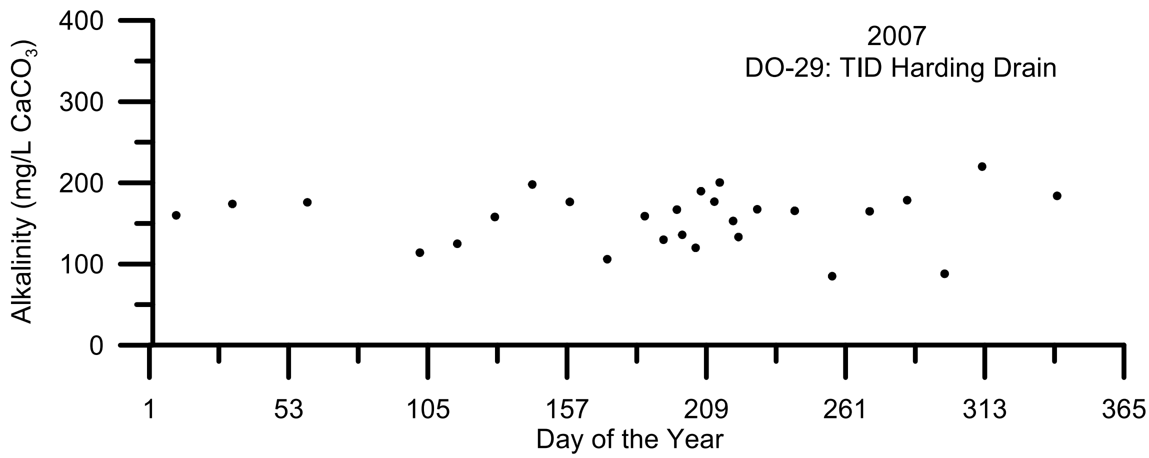

2005
DO-28: TID Westport Drain
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

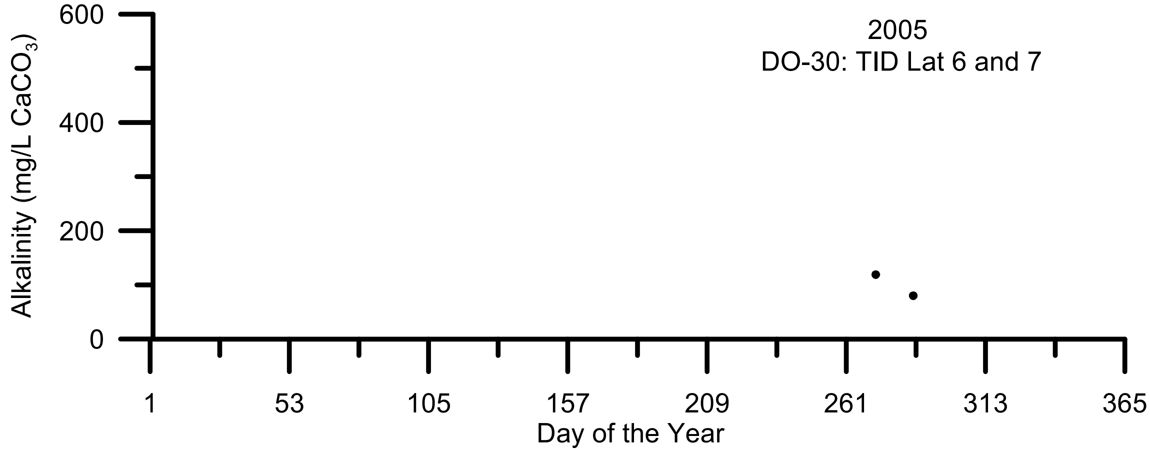

2006
DO-28: TID Westport Drain
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

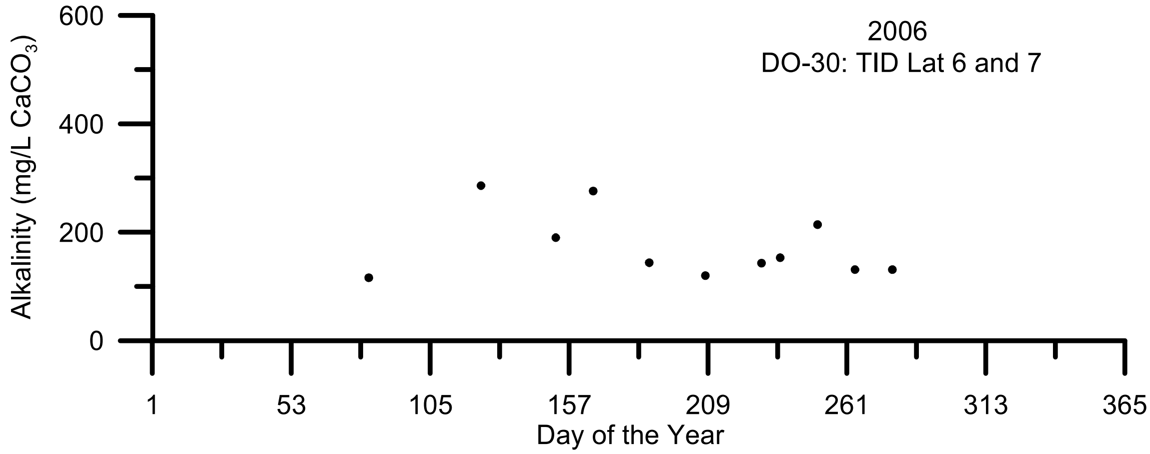

2007
DO-28: TID Westport Drain
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

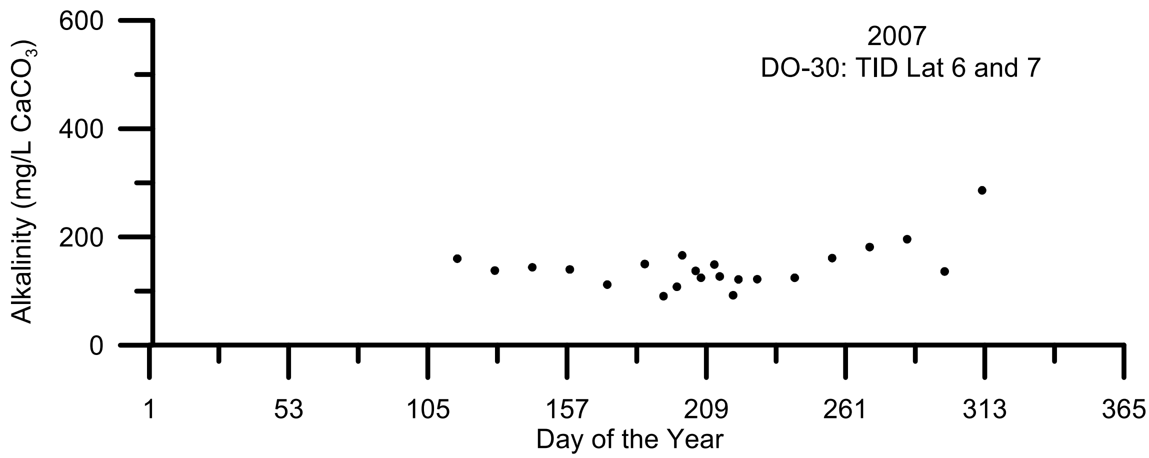

2005
DO-29: TID Harding Drain
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

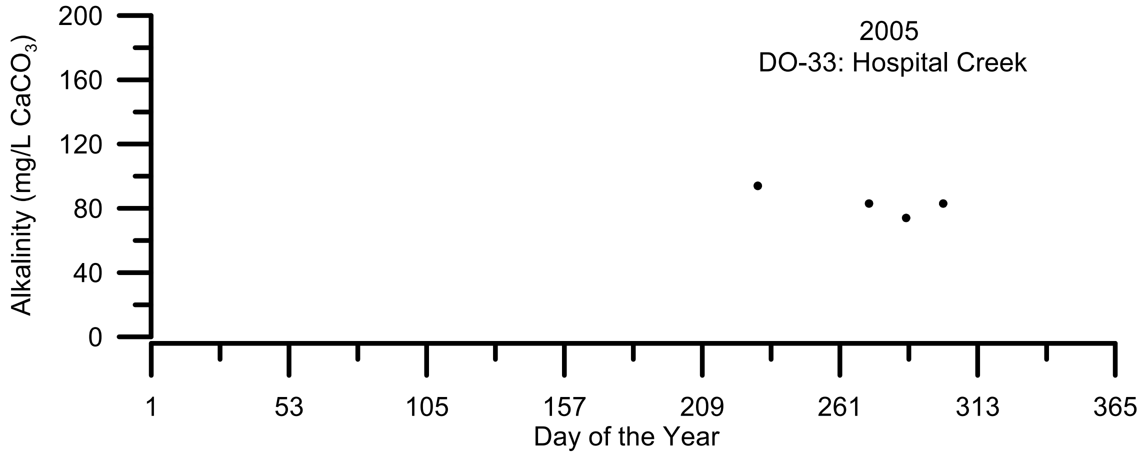

2006
DO-29: TID Harding Drain
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

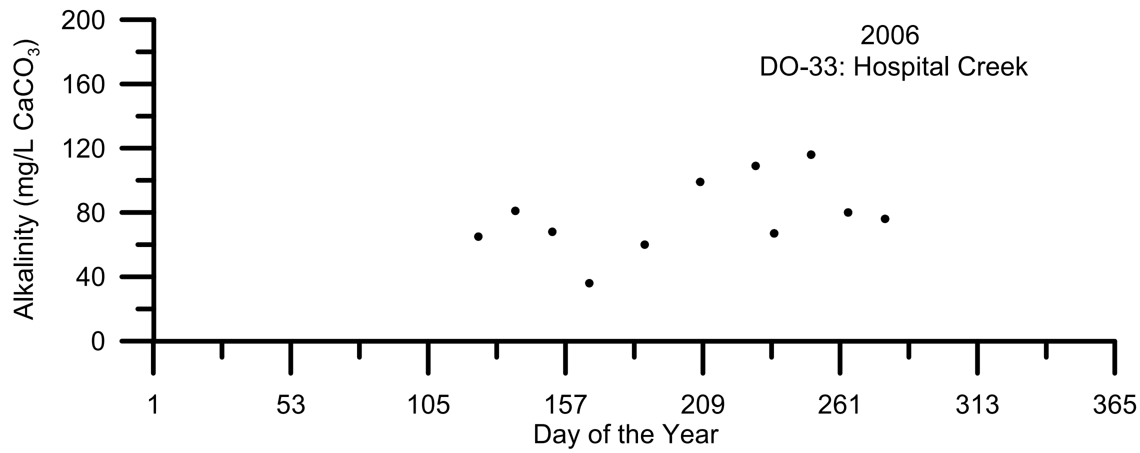

2007
DO-29: TID Harding Drain
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

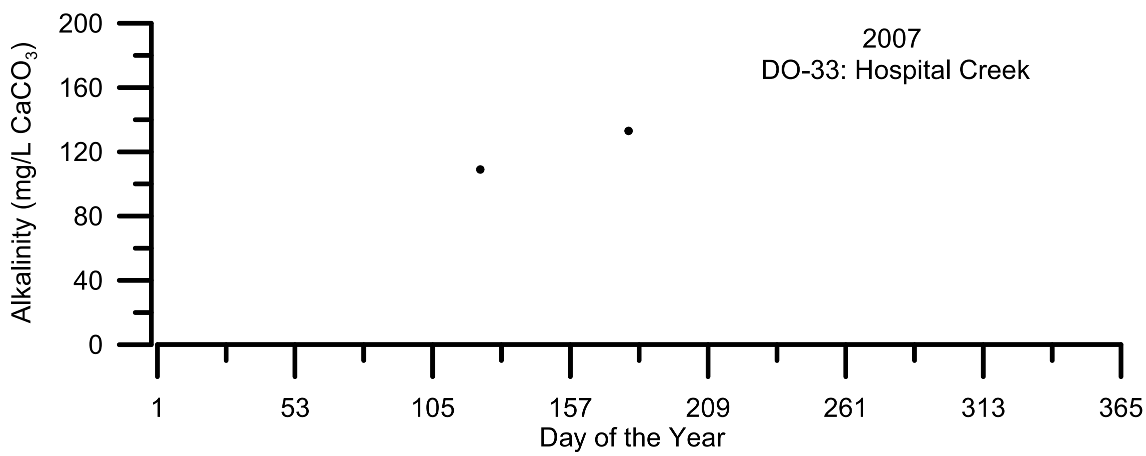

2005
DO-30: TID Lat 6 and 7
Alkalinity (mg/L CaCO3)
Day of the Year
0
200
400
600
1
53
105
157
209
261
313
365

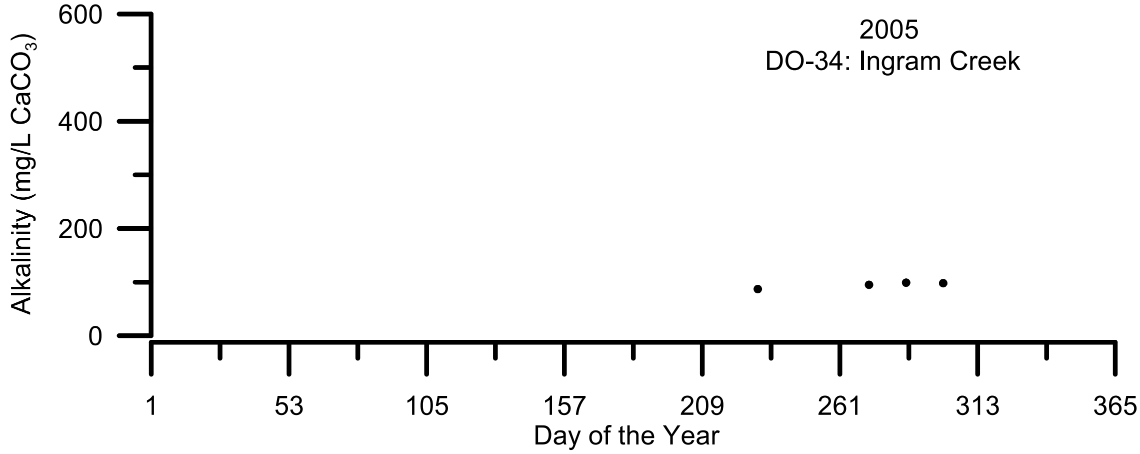

2006
DO-30: TID Lat 6 and 7
Alkalinity (mg/L CaCO3)
Day of the Year
0
200
400
600
1
53
105
157
209
261
313
365

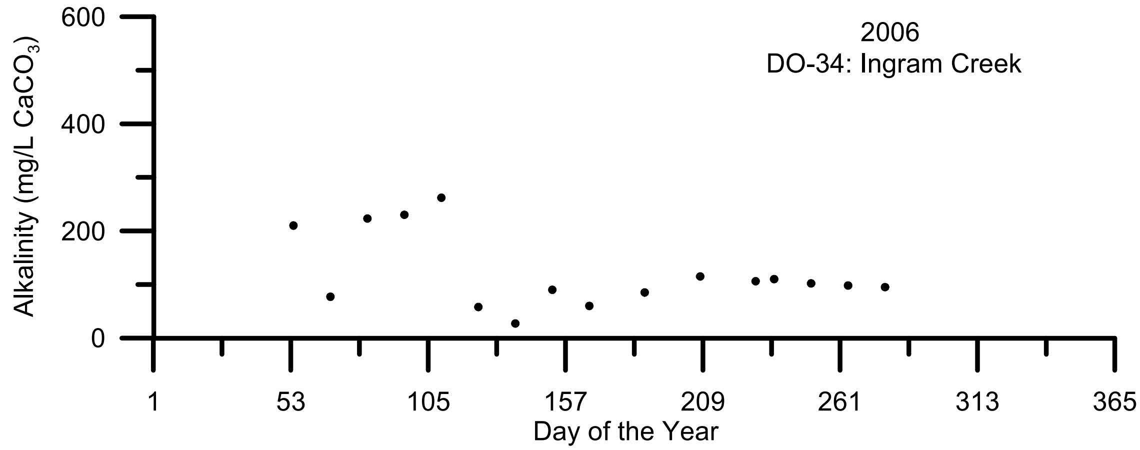

2007
DO-30: TID Lat 6 and 7
Alkalinity (mg/L CaCO3)
Day of the Year
0
200
400
600
1
53
105
157
209
261
313
365

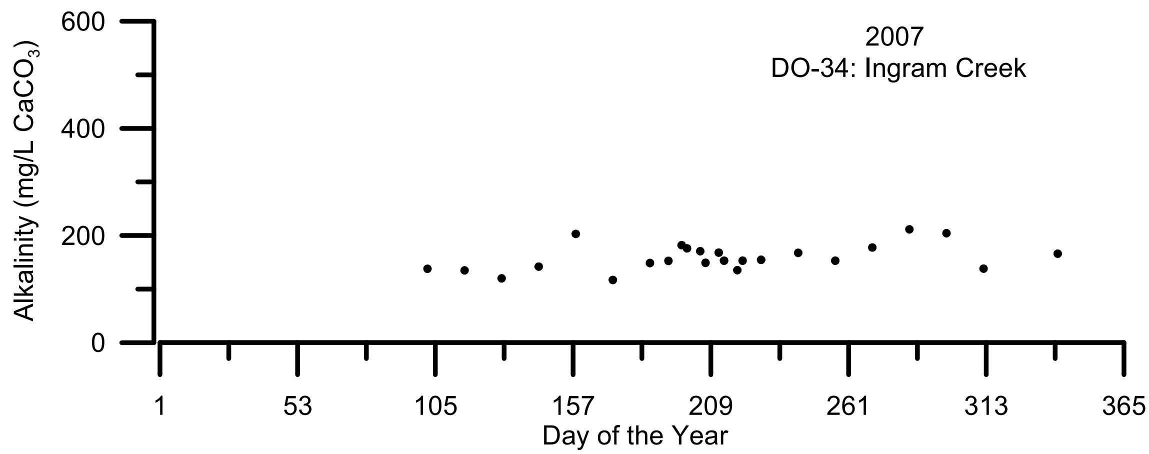

2005
DO-33: Hospital Creek
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

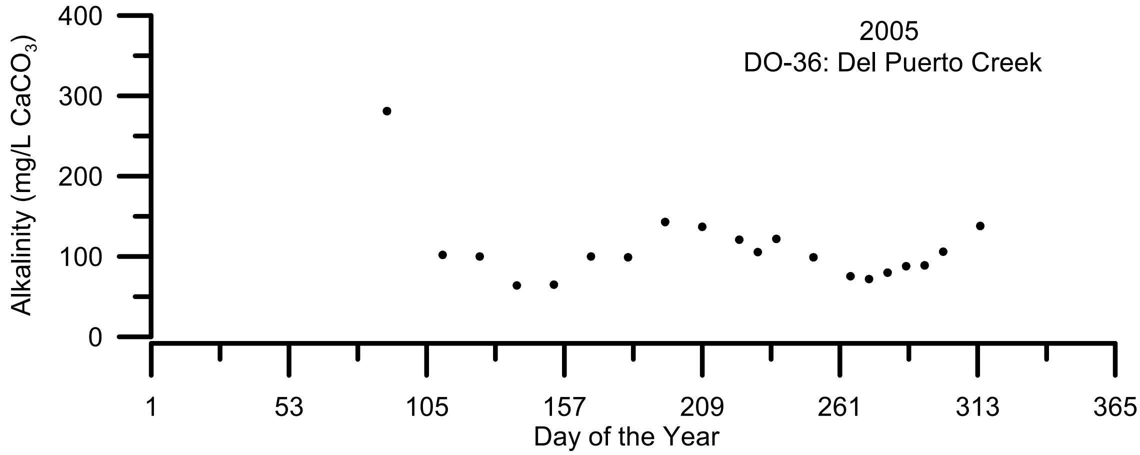

2006
DO-33: Hospital Creek
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

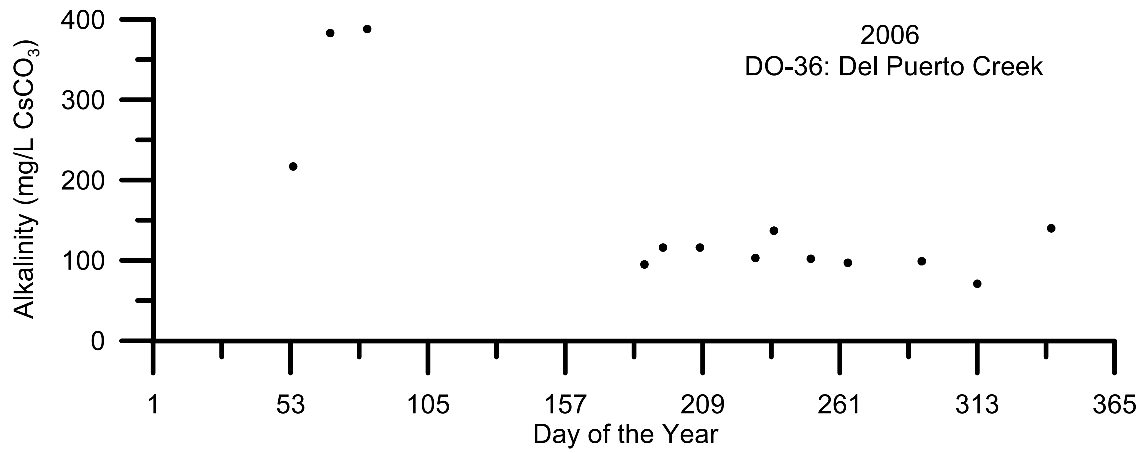

2007
DO-33: Hospital Creek
Alkalinity (mg/L $CaCO_3$)
200
160
120
80
40
0
1
53
105
157
209
261
313
365
Day of the Year

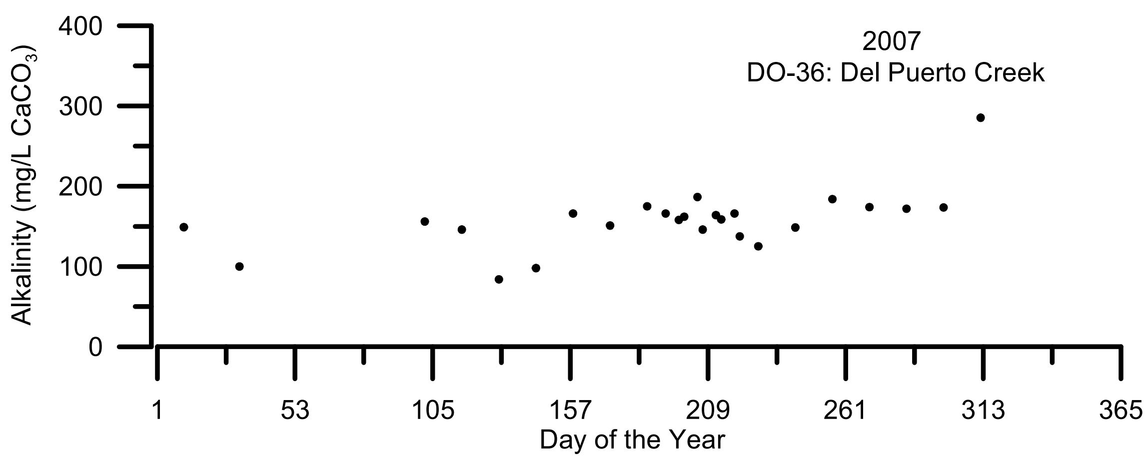

2005
DO-34: Ingram Creek
Alkalinity (mg/L $CaCO_3$)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

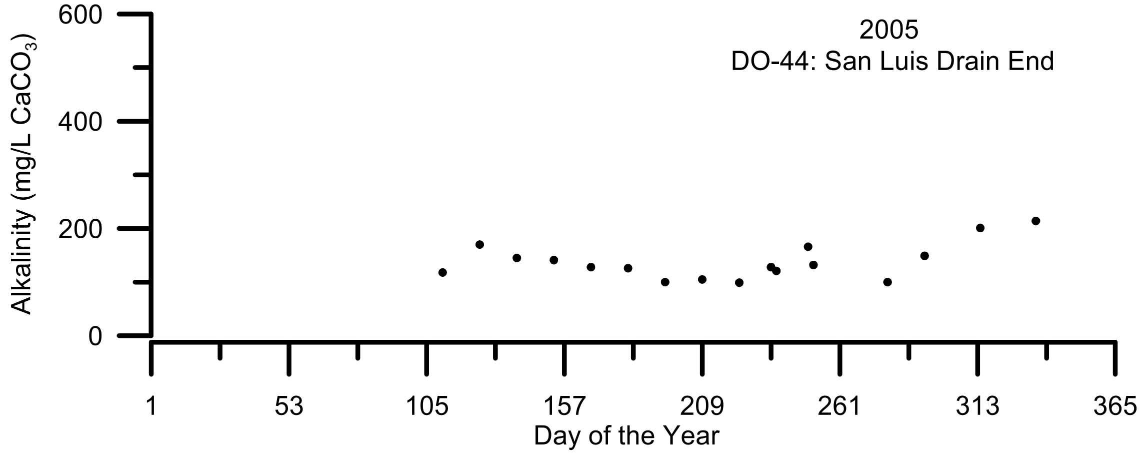

2006
DO-34: Ingram Creek
Alkalinity (mg/L $CaCO_3$)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

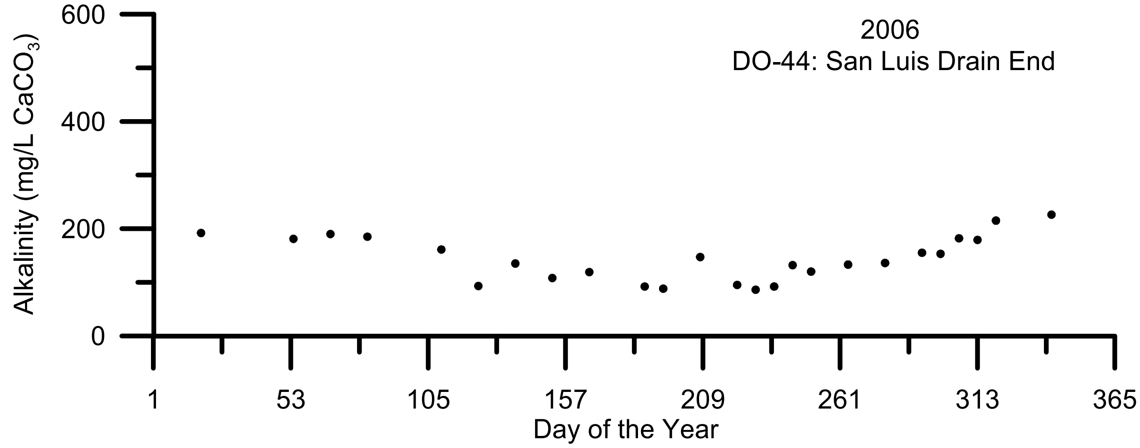

2007
DO-34: Ingram Creek
Alkalinity (mg/L $CaCO_3$)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

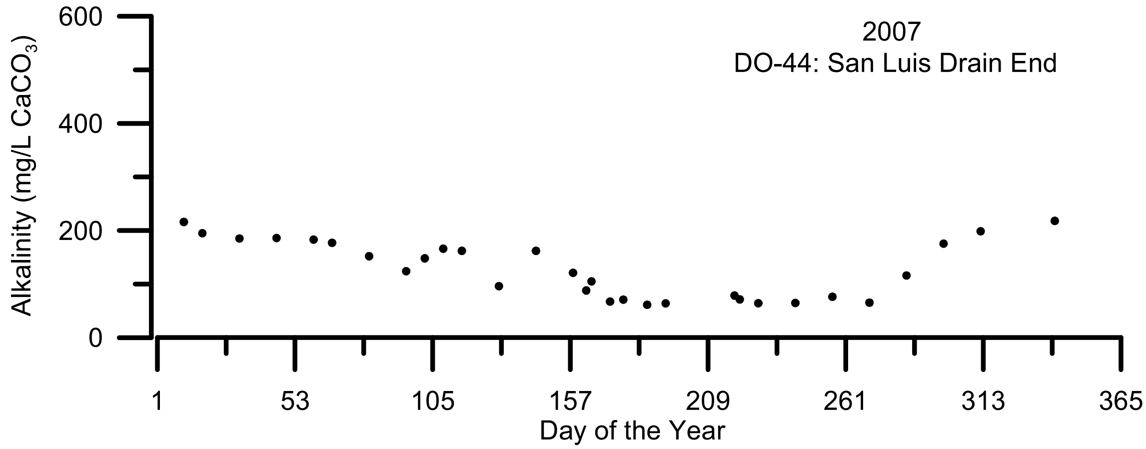

2005
DO-36: Del Puerto Creek
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

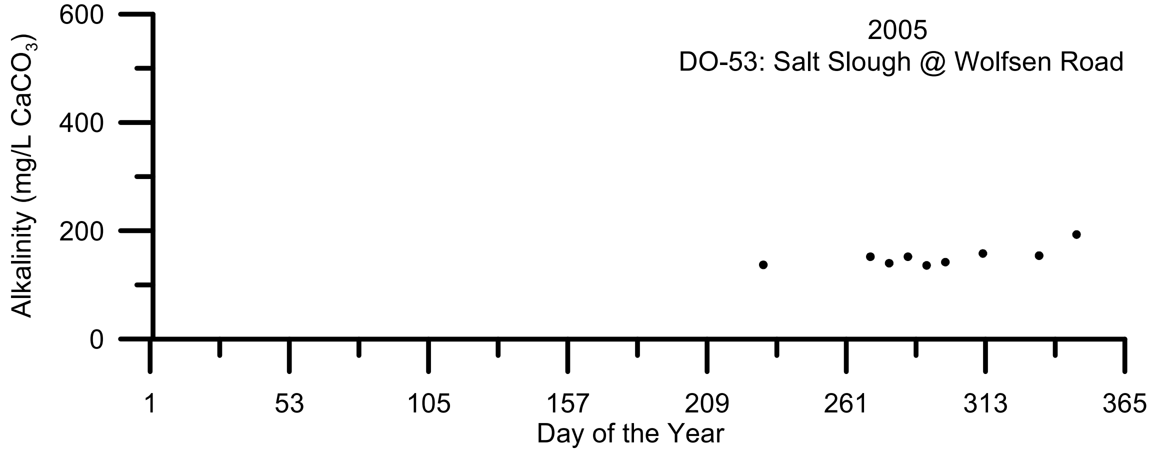

2006
DO-36: Del Puerto Creek
Alkalinity (mg/L CsCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

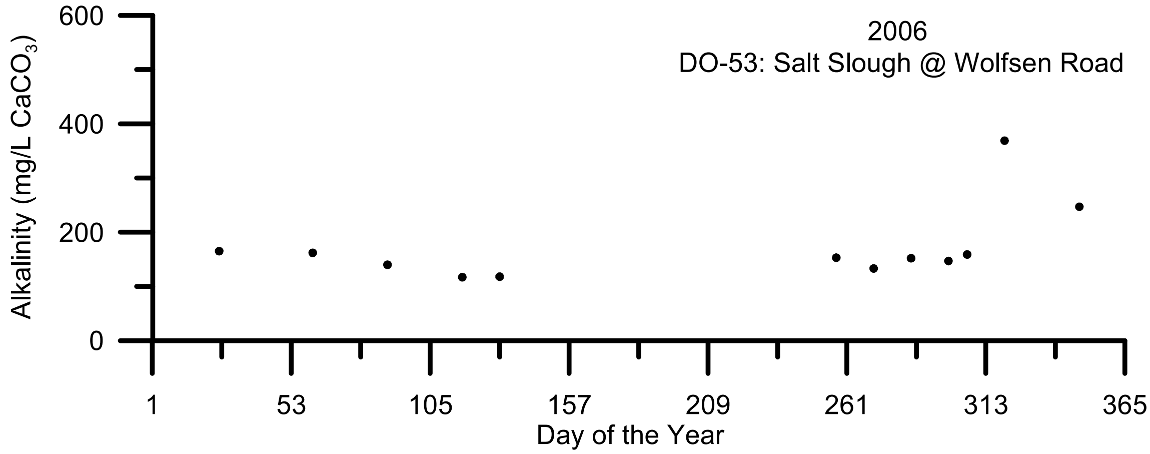

2007
DO-36: Del Puerto Creek
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

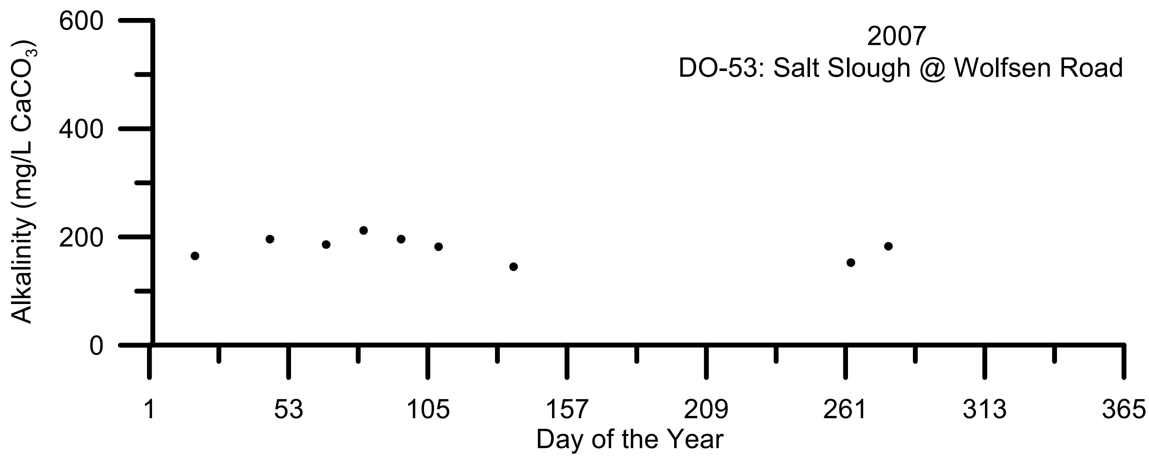

Alkalinity (mg/L $CaCO_3$)
600
400
200
0
2005
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

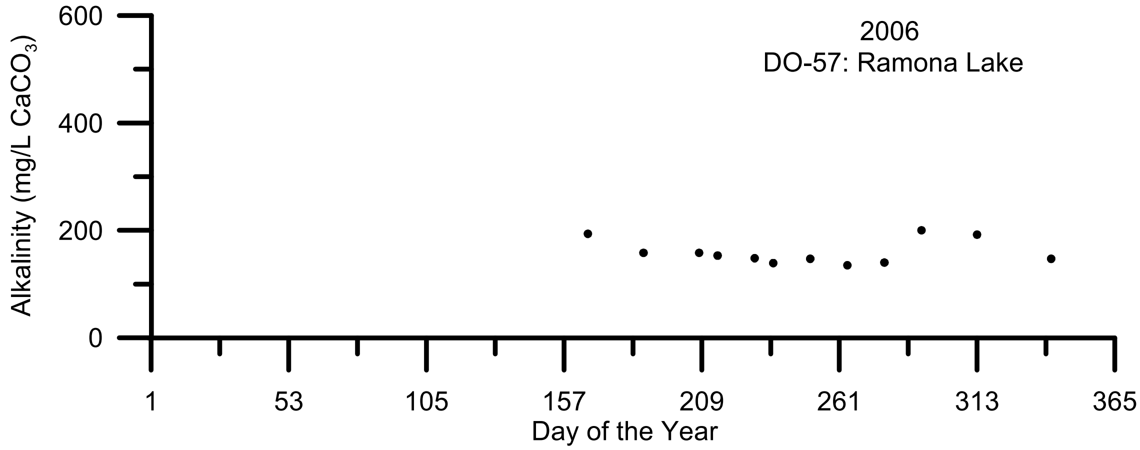

Alkalinity (mg/L $CaCO_3$)
600
400
200
0
2006
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

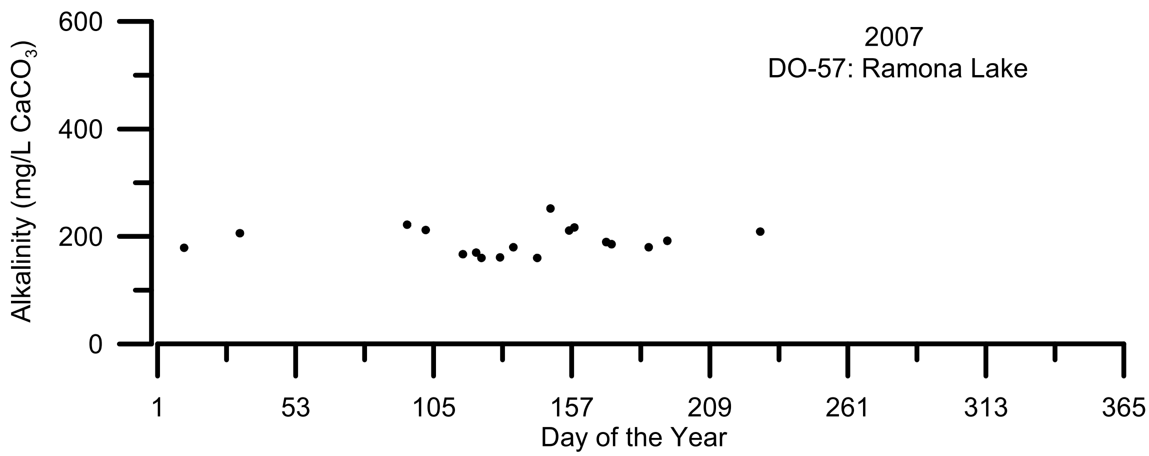

Alkalinity (mg/L $CaCO_3$)
600
400
200
0
2007
DO-44: San Luis Drain End
1
53
105
157
209
261
313
365
Day of the Year

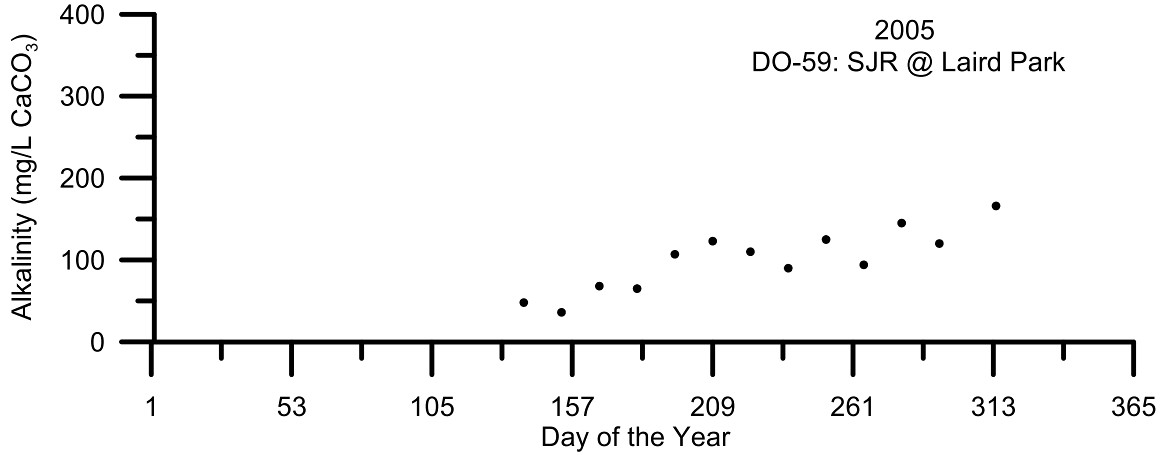

600
400
200
0
Alkalinity (mg/L CaCO3)
2005
DO-53: Salt Slough @ Wolfsen Road
1
53
105
157
209
261
313
365
Day of the Year

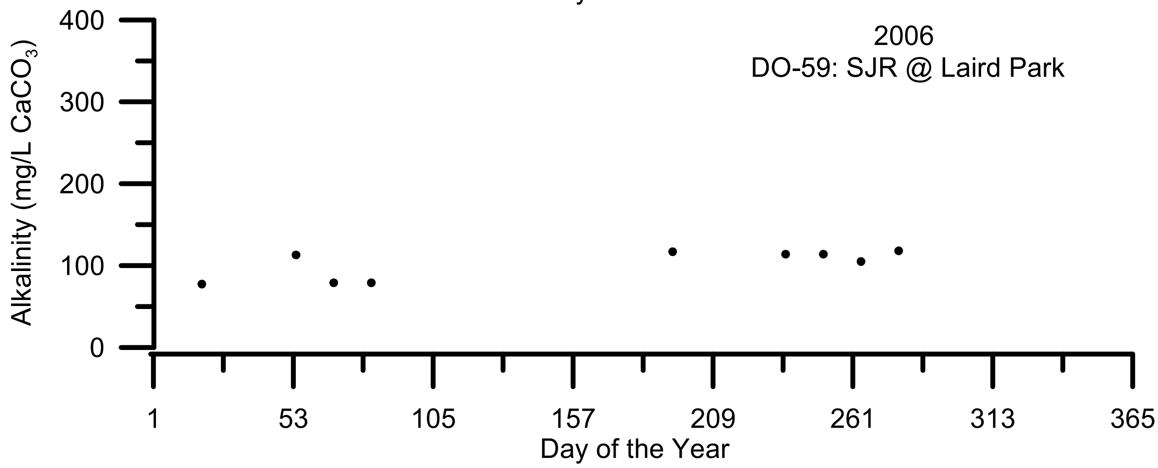

600
400
200
0
Alkalinity (mg/L CaCO3)
2006
DO-53: Salt Slough @ Wolfsen Road
1
53
105
157
209
261
313
365
Day of the Year

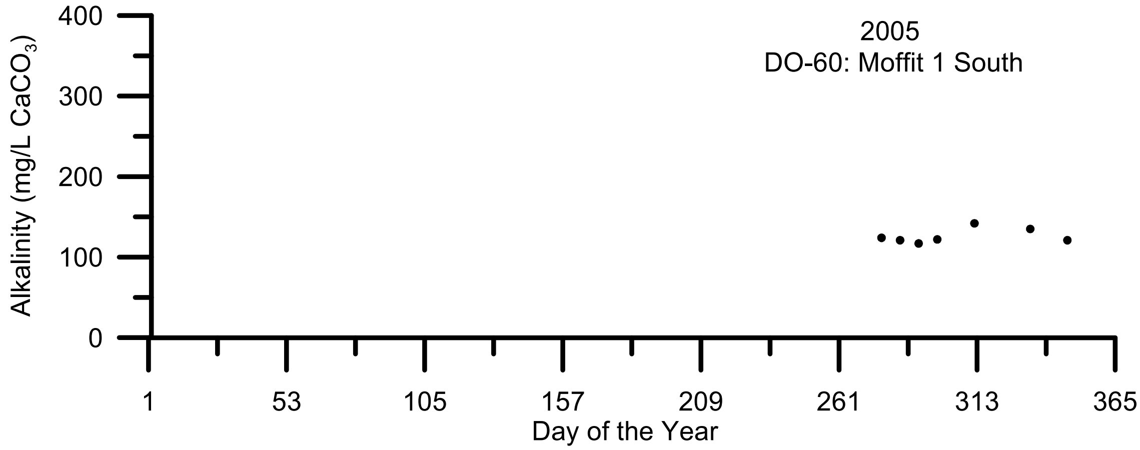

600
400
200
0
Alkalinity (mg/L CaCO3)
2007
DO-53: Salt Slough @ Wolfsen Road
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-57: Ramona Lake
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

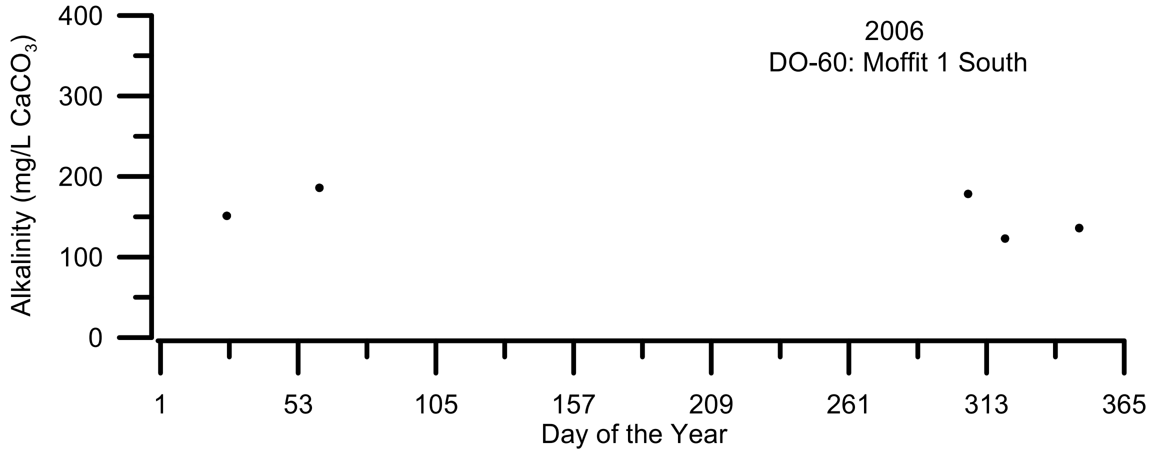

2007
DO-57: Ramona Lake
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-59: SJR @ Laird Park
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year

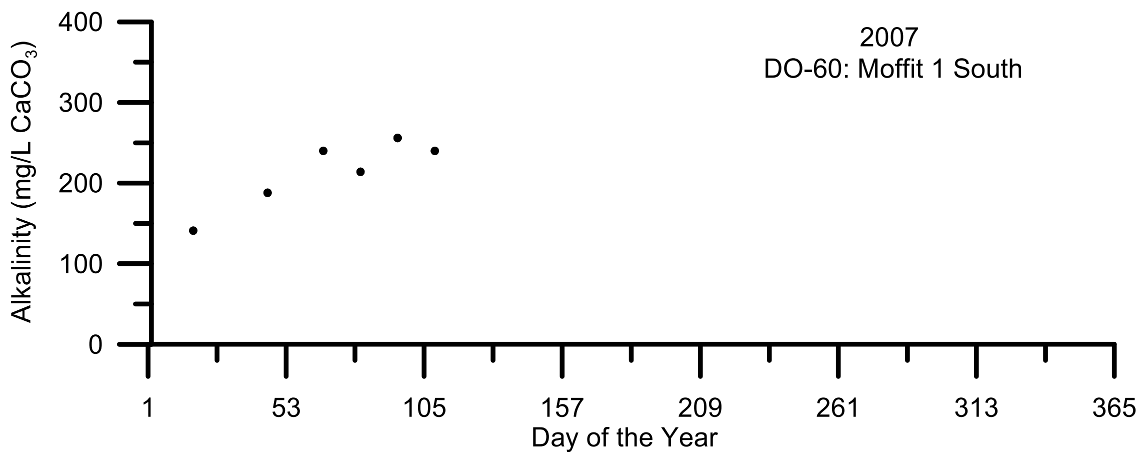

2006
DO-59: SJR @ Laird Park
Alkalinity (mg/L $CaCO_3$)
0
100
200
300
400
1
53
105
157
209
261
313
365
Day of the Year



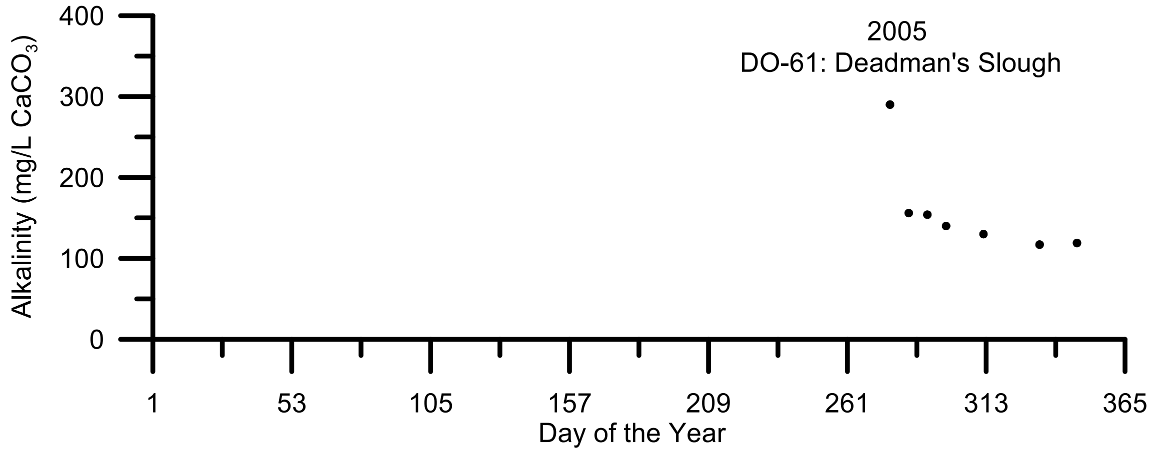
2005
DO-60: Moffit 1 South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

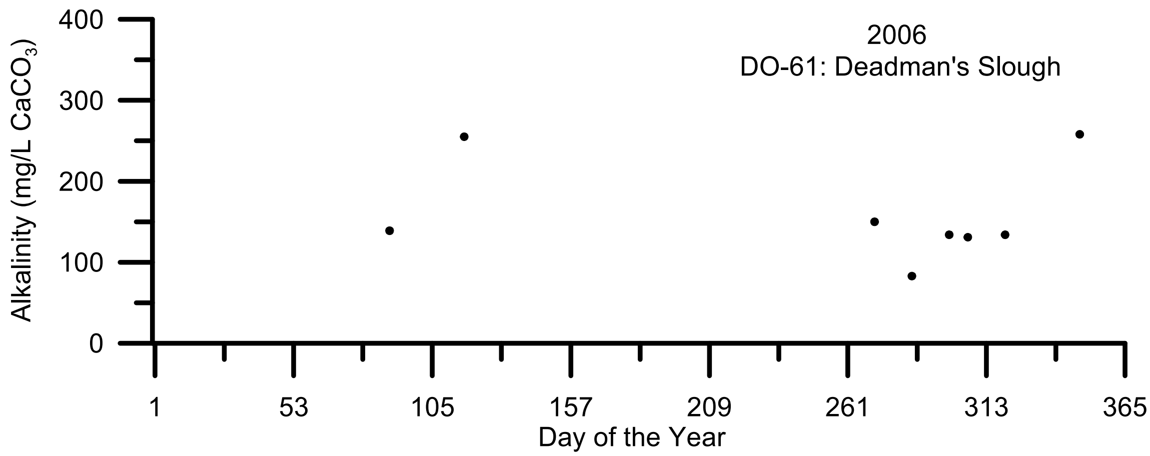


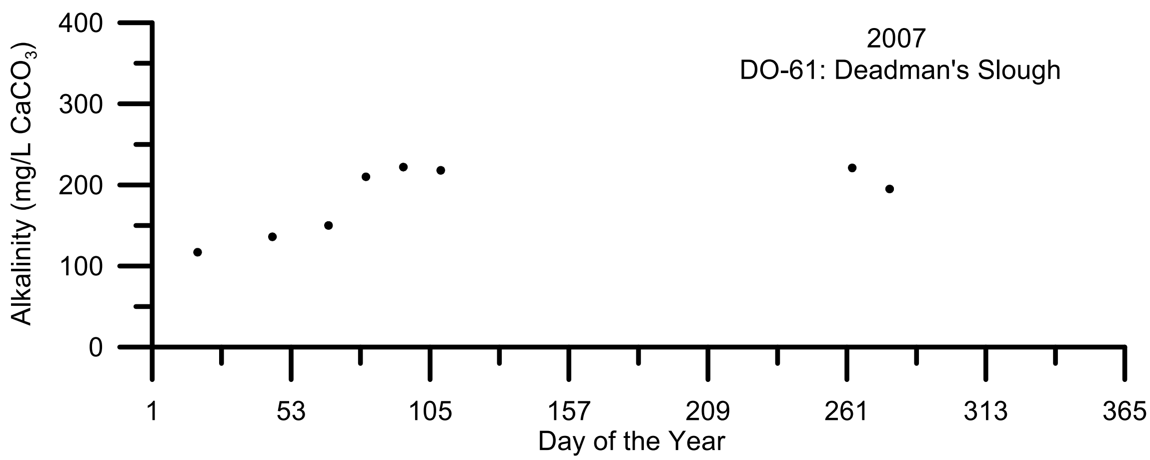
2006
DO-60: Moffit 1 South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

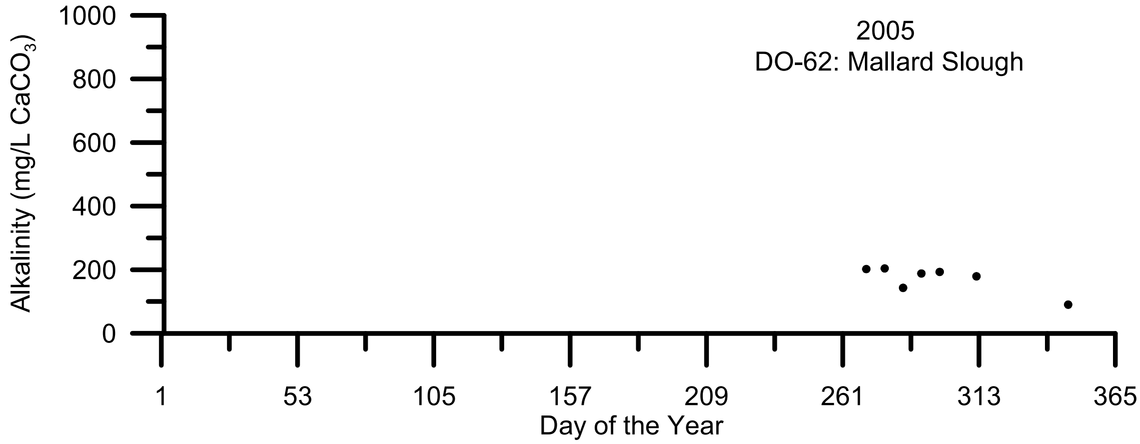


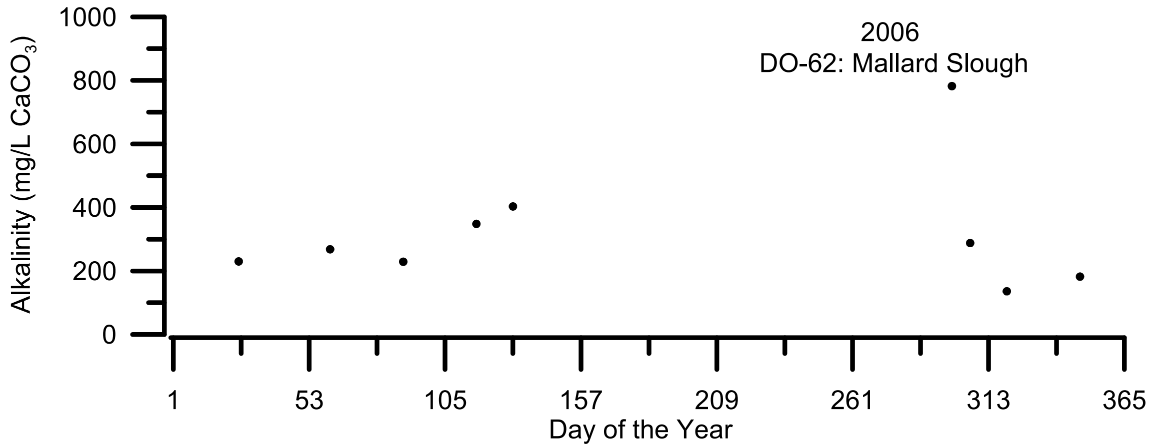
2007
DO-60: Moffit 1 South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

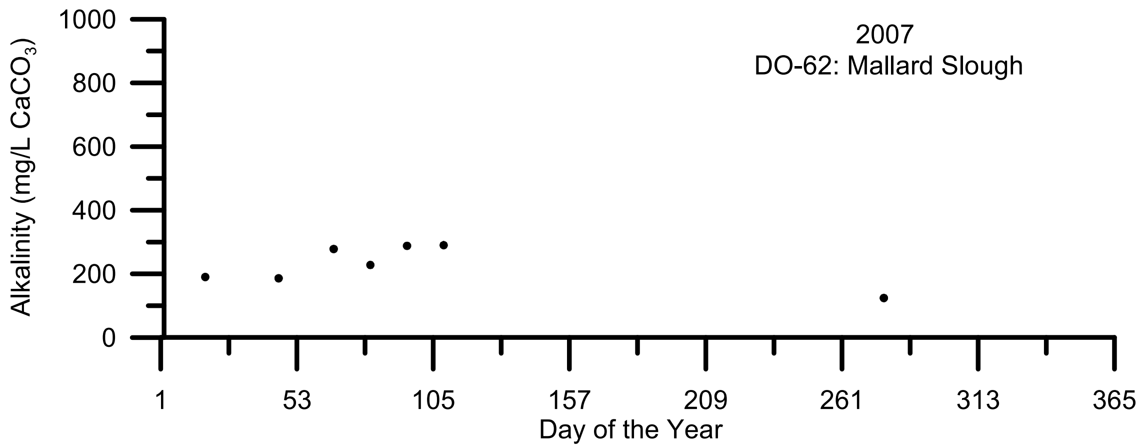

2005
DO-61: Deadman's Slough
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

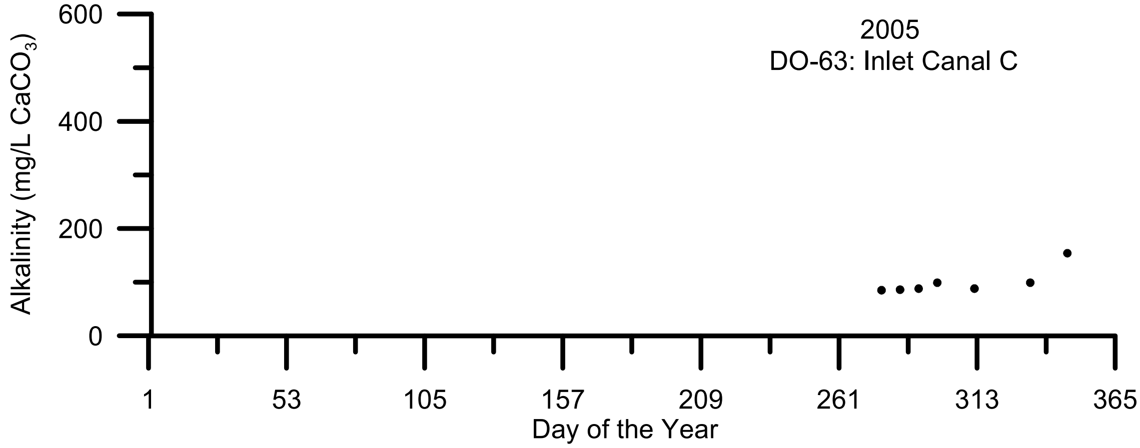

2006
DO-61: Deadman's Slough
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

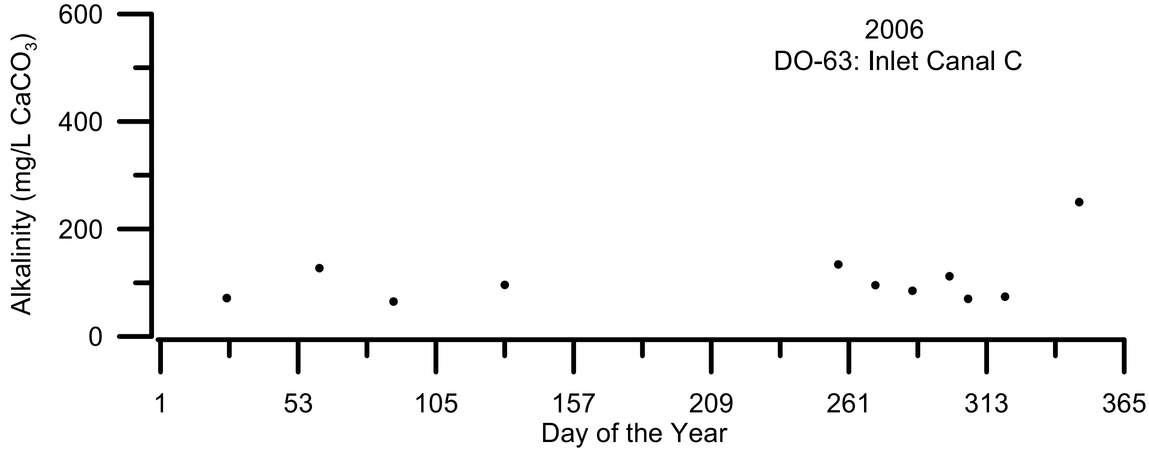

2007
DO-61: Deadman's Slough
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

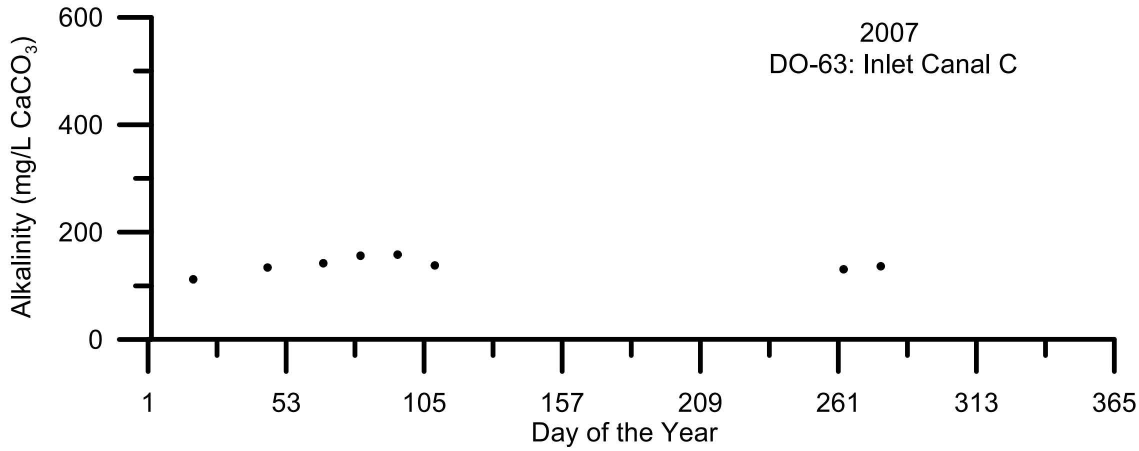

2005
DO-62: Mallard Slough
Alkalinity (mg/L CaCO3)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

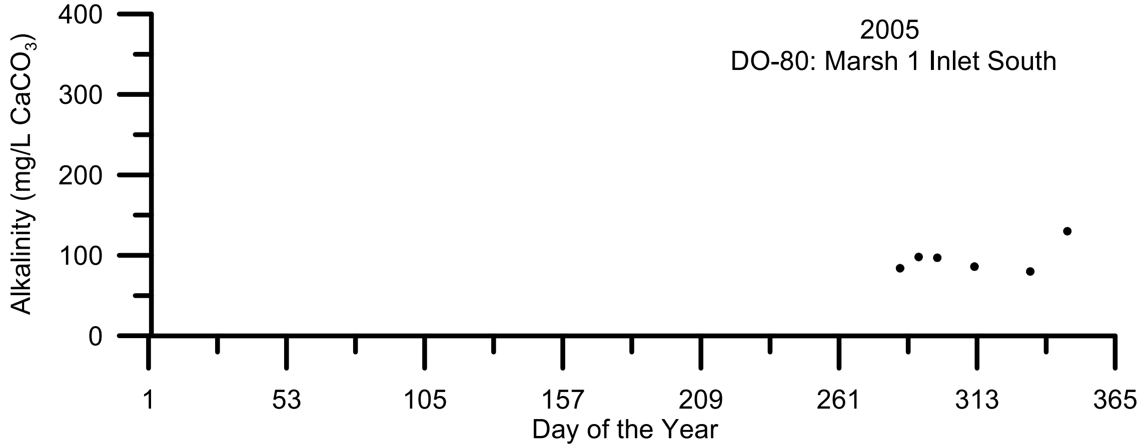

2006
DO-62: Mallard Slough
Alkalinity (mg/L CaCO3)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-62: Mallard Slough
Alkalinity (mg/L CaCO3)
1000
800
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

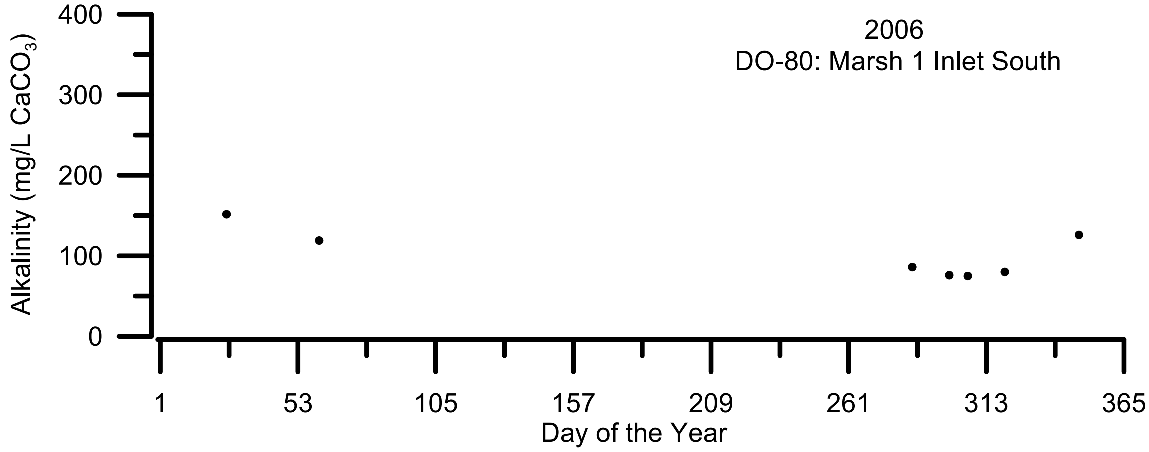

2005
DO-63: Inlet Canal C
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-63: Inlet Canal C
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year

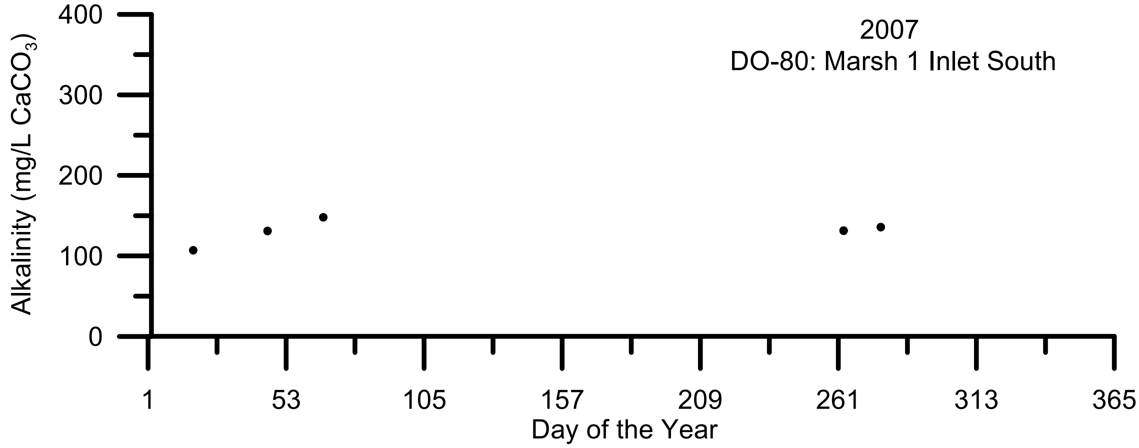

2007
DO-63: Inlet Canal C
Alkalinity (mg/L CaCO3)
600
400
200
0
1
53
105
157
209
261
313
365
Day of the Year



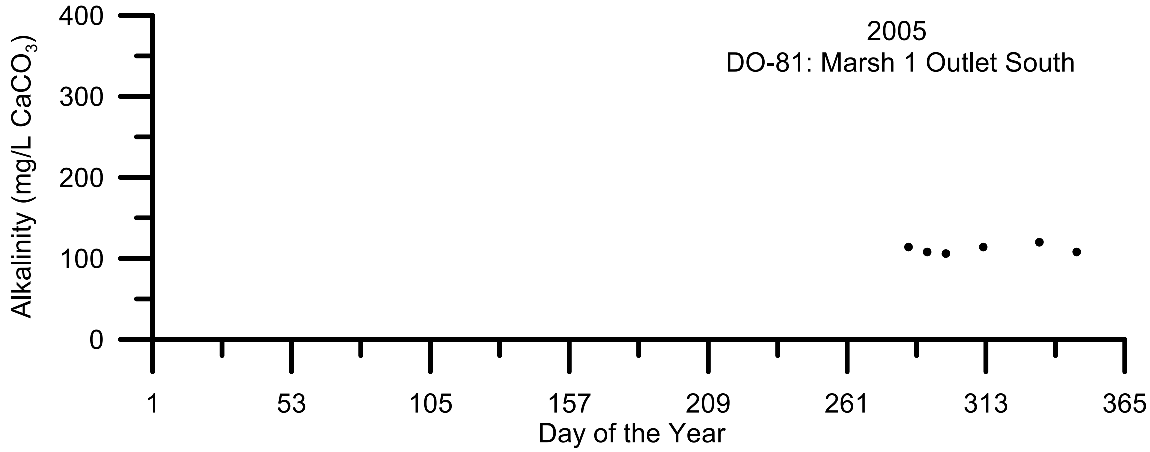
2005
DO-80: Marsh 1 Inlet South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

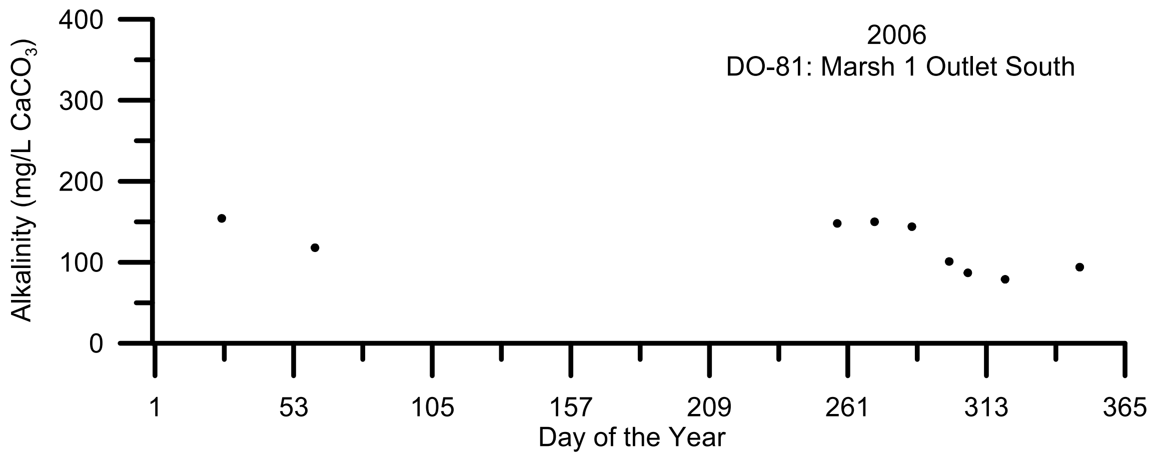


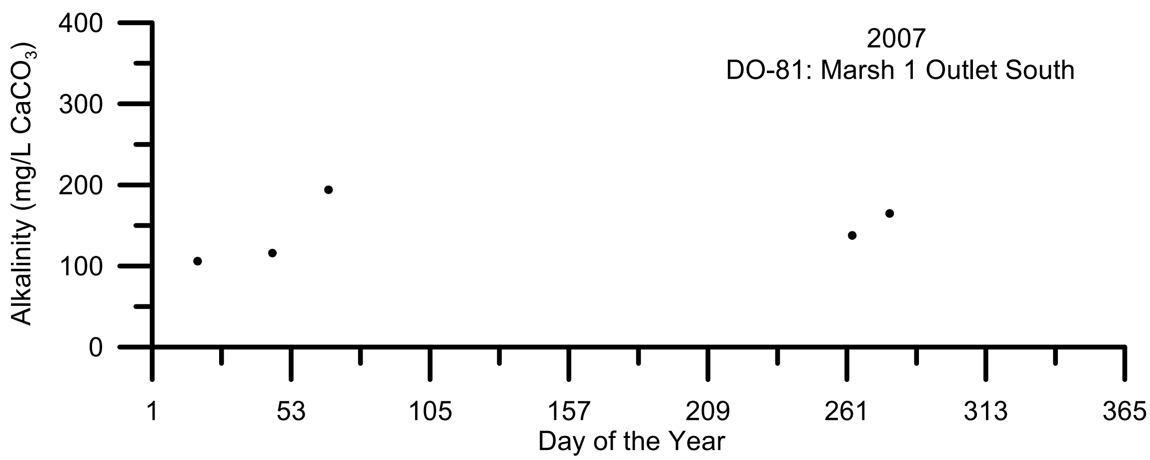
2006
DO-80: Marsh 1 Inlet South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

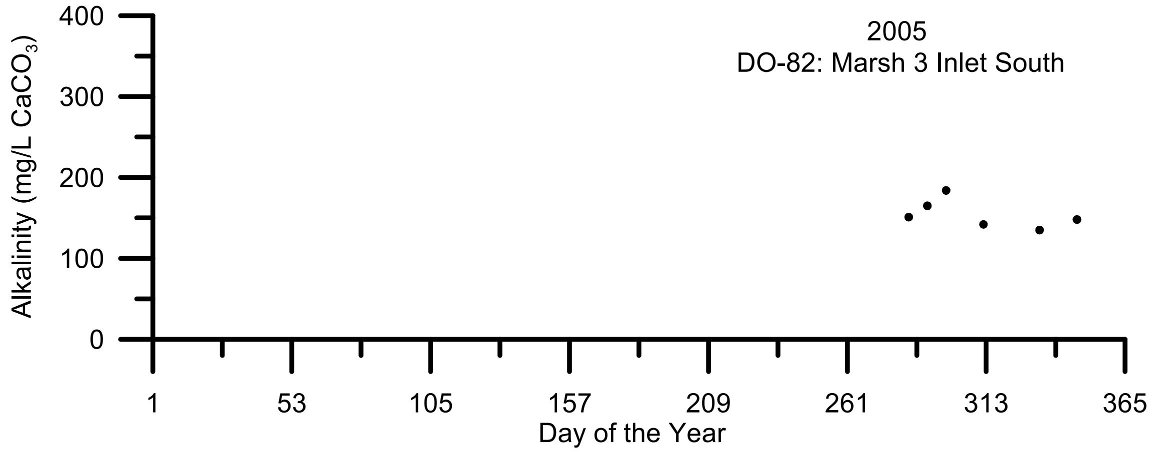


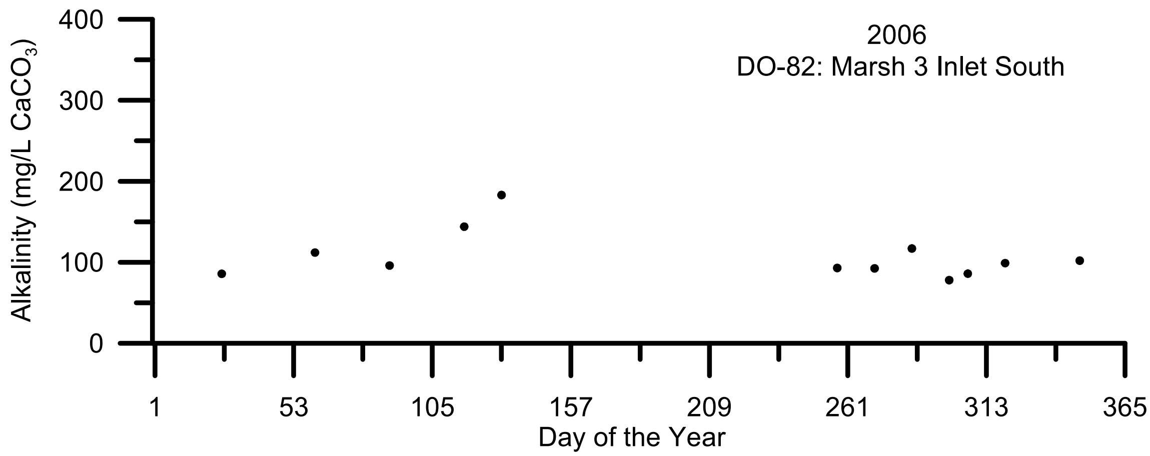
2007
DO-80: Marsh 1 Inlet South
Alkalinity (mg/L CaCO3)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

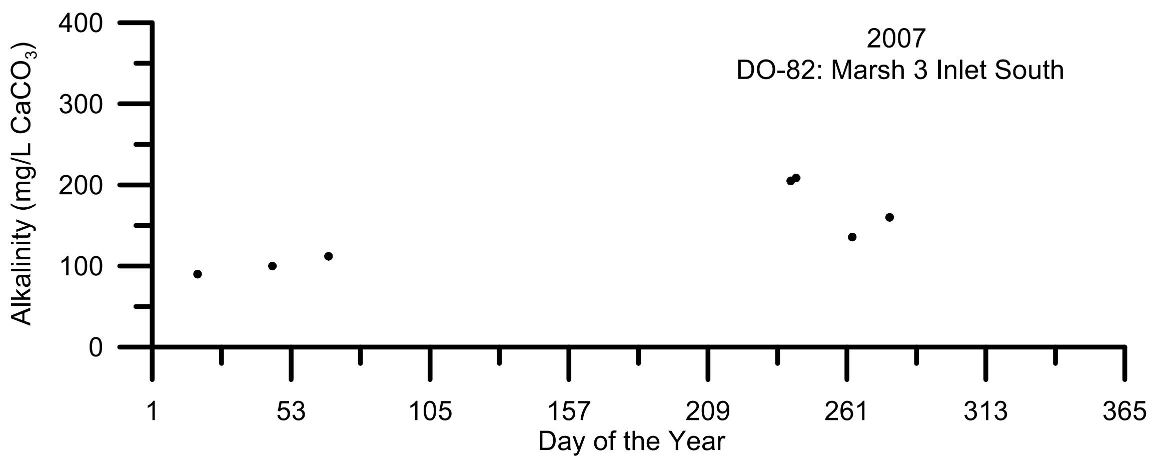

2005
DO-81: Marsh 1 Outlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

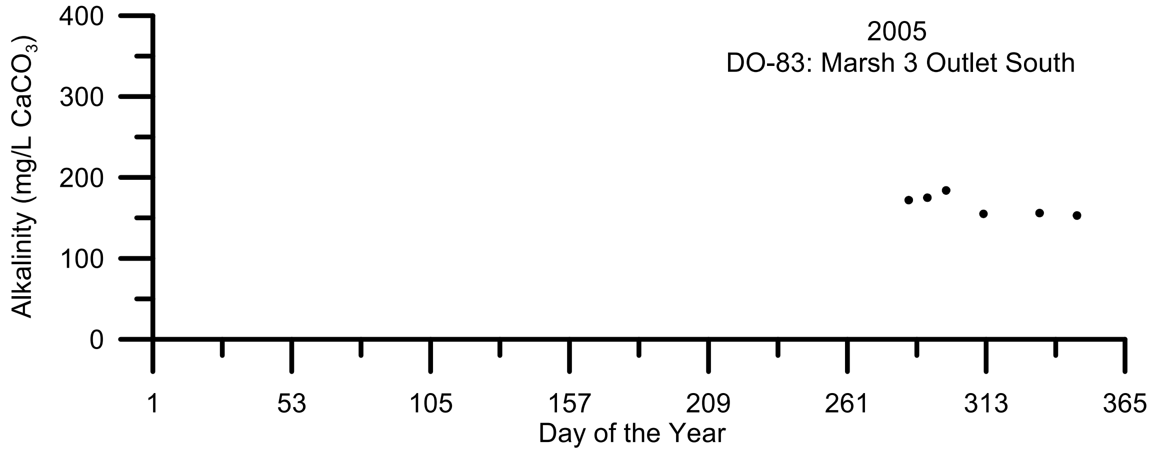

2006
DO-81: Marsh 1 Outlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

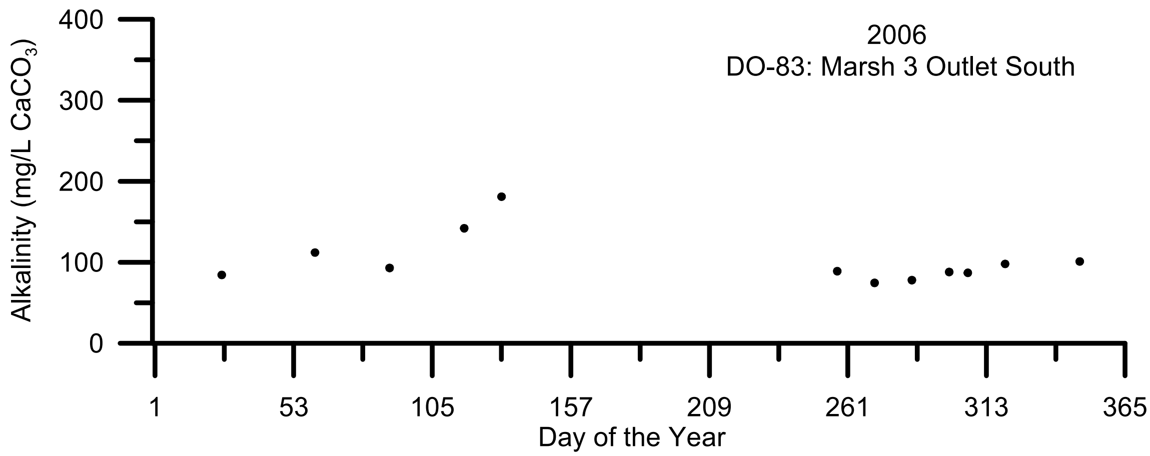

2007
DO-81: Marsh 1 Outlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

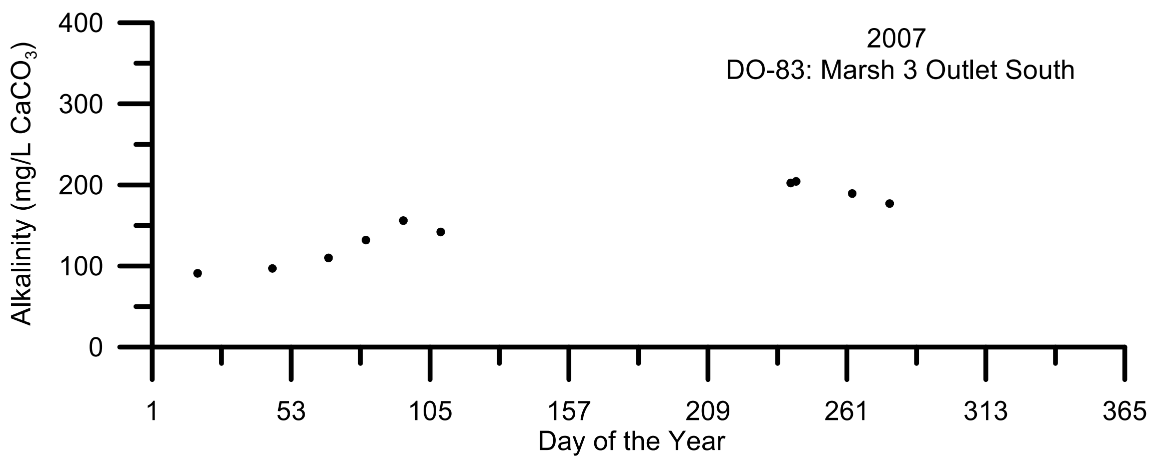

2005
DO-82: Marsh 3 Inlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

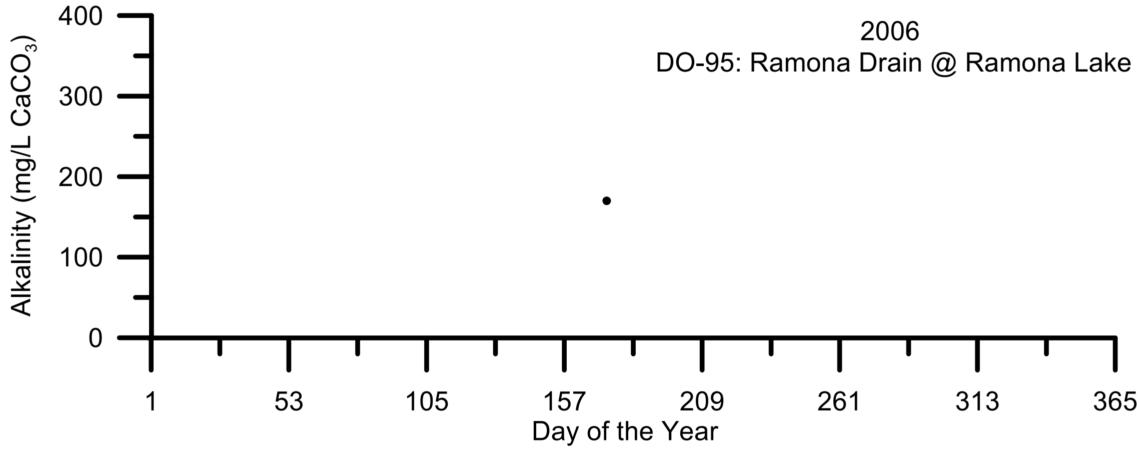

2006
DO-82: Marsh 3 Inlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year

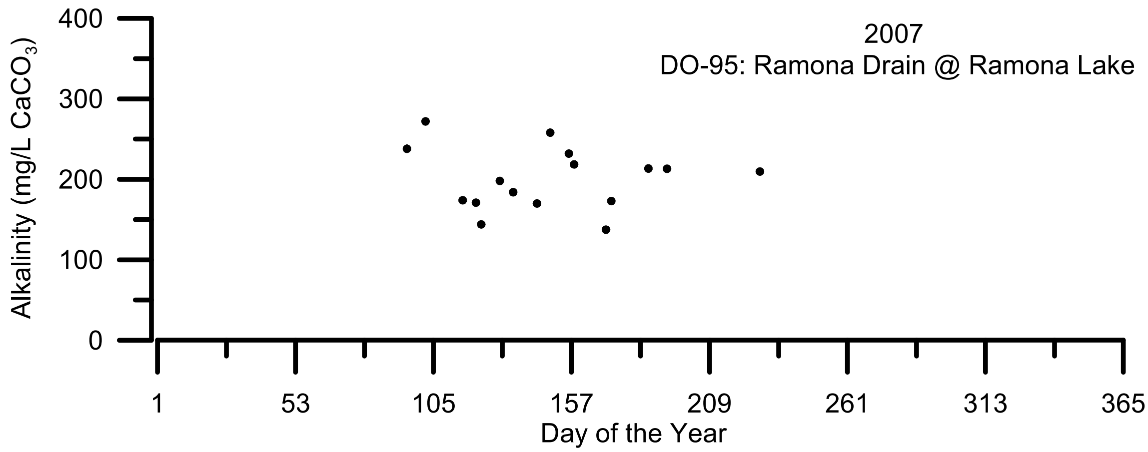

2007
DO-82: Marsh 3 Inlet South
Alkalinity (mg/L $CaCO_3$)
400
300
200
100
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-83: Marsh 3 Outlet South
Alkalinity (mg/L CaCO3)
Day of the Year
0
100
200
300
400
1
53
105
157
209
261
313
365


2006
DO-83: Marsh 3 Outlet South
Alkalinity (mg/L CaCO3)
Day of the Year
0
100
200
300
400
1
53
105
157
209
261
313
365


2007
DO-83: Marsh 3 Outlet South
Alkalinity (mg/L CaCO3)
Day of the Year
0
100
200
300
400
1
53
105
157
209
261
313
365


400
300
200
100
0
Alkalinity (mg/L $CaCO_3$)
2006
DO-95: Ramona Drain @ Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year


400
300
200
100
0
Alkalinity (mg/L $CaCO_3$)
2007
DO-95: Ramona Drain @ Ramona Lake
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Nitrate Data from the Upstream San Joaquin River

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***Remie Burks*[1]**
***Sharon Borglin*[1]**
***Randy Dahlgren*[2]**
***Jeremy Hanlon*[1]**
***Justin Graham*[1]**
***William Stringfellow*[1]**

February 2008

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Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of nitrate-nitrogen (NO_3-N) data analyzed by the EERP laboratory starting in the summer of 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were filtered through 47mm Whatman GF/F filters (0.7µm pore size) to remove filterable solids, and were then alquotted and stored at -20°C until NO_3-N analysis could be completed.

Starting in 2007 NO_3-N was quantified using the TL-2800 ammonia analyzer made by Timberline Instruments (Boulder, CO). Sample was mixed with caustic solution (to pH 11-13) and was passed through a reducing zinc cartridge to convert all NO_3-N to NH_3^-. NH_3 (g) diffused across as gas-permeable membrane and was dissolved in a buffer solution. The dissolution of NH_3 (g) in the buffer causes a change in conductivity which can be correlated to NH_3 (g). The Timberline instrument automates the mixing of the caustic solution with the sample, reduction of NO_3 to NH_3 by passing the sample through the zinc cartridge, and pumping of the buffer solution through the gas permeable membrane. The resulting peak is proportional to the ammonia-nitrogen (NH_3-N) and the NO_3-N combined and thus the NH_3-N must be subtracted from the combined value to give you the NO_3-N concentration. Nitrite-nitrogen (NO_2-N) is also included in the NO_3-N value but NO2-N concentrations are negligible in our samples (Borglin et al, 2008) and (Carlson, 1990). The reportable limit for this method is 0.08 mg/L NO_3-N.

Results/Discussion

With each set of NO_3-N field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. 100% of all quality assurance samples were within a passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Three proficiency check samples were analyzed for NO_3-N in the EERP laboratory during 2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.01-18.86 mg/L NO_3-N. The average concentration of NO_3-N in samples collected was 4.58 mg/L NO_3-N. NO_3-N was also analyzed at UC Davis on all of the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.983 (Spier et al, 2008). NO3-N samples measured by EERP have about 89.3% as much NO3-N as the same samples measured by UCD (Figure 2).

EERP used to measure NO_3-N using the Cd reduction method (SM 4500-NO3 E). This method had many factors that are variable depending on the operator, and is no longer used by EERP to measure NO_3-N. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

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Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List

DO Number	Site Name	Type
4	SJR at Mossdale	Core sites
5	SJR at Vernalis-McCune Station (River Club)	Core sites, BMP
6	SJR at Maze	Core sites, BMP
7	SJR at Patterson	Core sites, BMP
8	SJR at Crows Landing	Core sites, BMP
10	SJR at Lander Avenue	Core sites
12	Stanislaus River at Caswell Park	Core sites
14	Tuolumne River at Shiloh Bridge	Core sites
16	Merced River at River Road	Core sites
18	Mud Slough near Gustine	Core sites, Wetland
19	Salt Slough at Lander Avenue	Core sites, Wetland
20	Los Banos Creek Flow Station	Core sites, Wetland
21	Orestimba Creek at River Road	Core sites, BMP
23	Modesto ID Lateral 5 to Tuolumne	Core sites
25	Modesto ID Main Drain to Stan. R. via Miller Lake	Core sites
28	Turlock ID Westport Drain Flow station	Core sites
29	Turlock ID Harding Drain	Core sites
30	Turlock ID Lateral 6 & 7 at Levee	Core sites
33	Hospital Creek	Intermittent, BMP
34	Ingram Creek	Core sites, BMP
36	Del Puerto Creek Flow Station	Core sites, BMP
44	San Luis Drain End	Core sites
53	Salt Slough at Wolfsen Road	Wetland
57	Ramona Lake Drain	Core sites, BMP
59	SJR Laird Park	Core sites
60	Moffit 1 South	Wetland
61	Deadman's Slough	Wetland
62	Mallard Slough	Wetland
63	Inlet C Canal	Wetland
80	South Marsh-1-Inlet	Wetland
81	South Marsh-1-Outlet	Wetland
82	South Marsh-3-Inlet	Wetland
83	South Marsh-3-Outlet	Wetland
95	Ramona drain at Ramona Lake	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

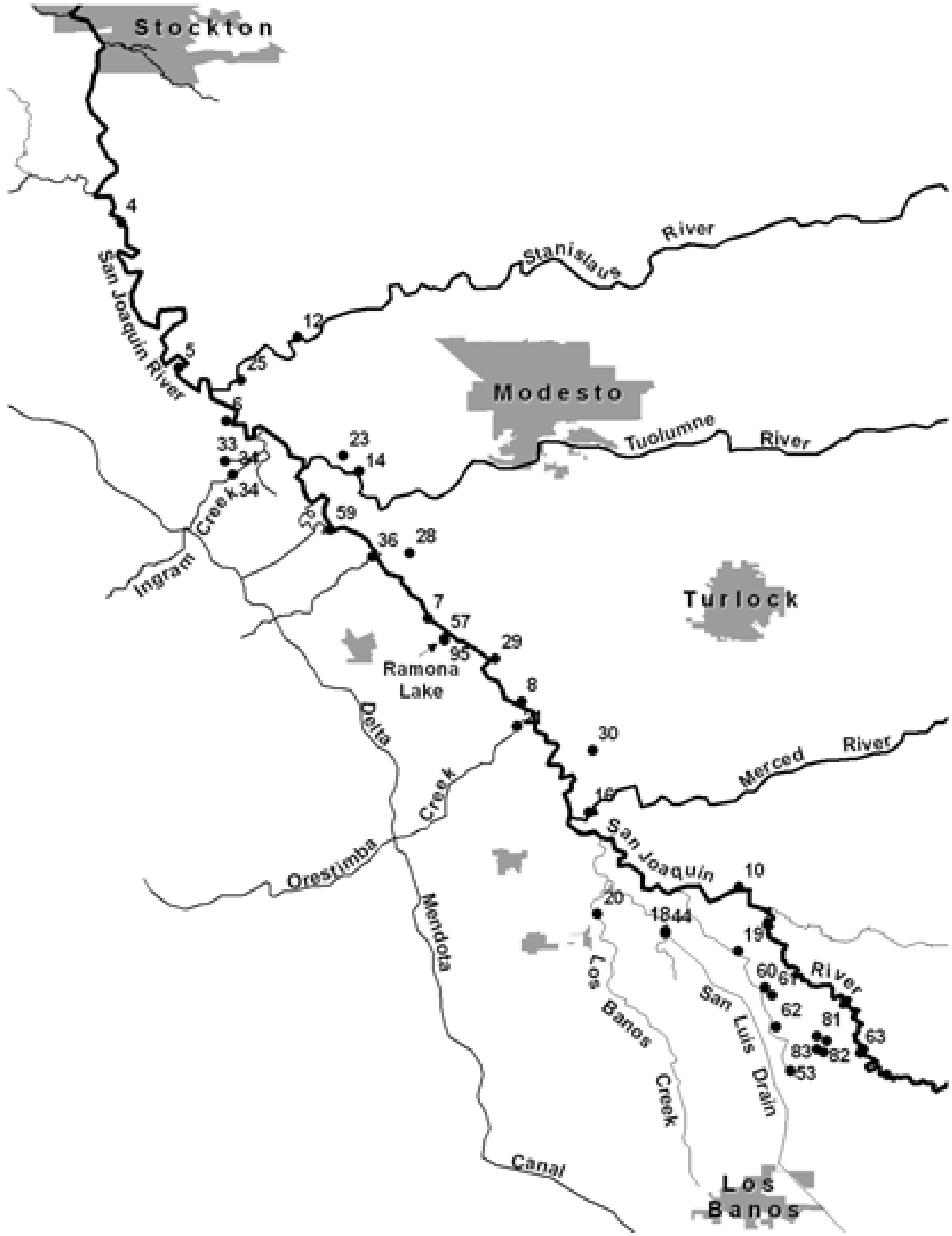
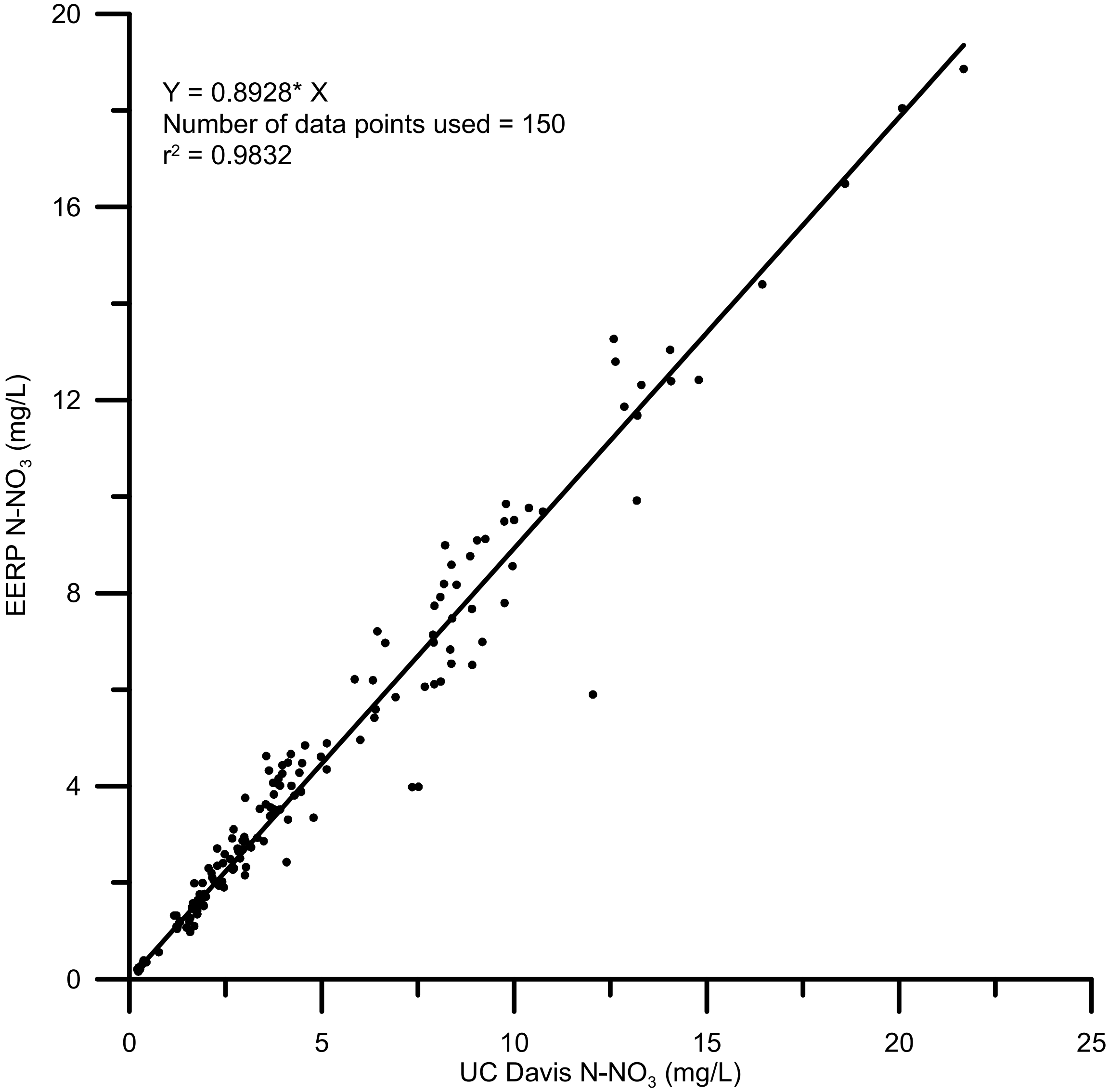
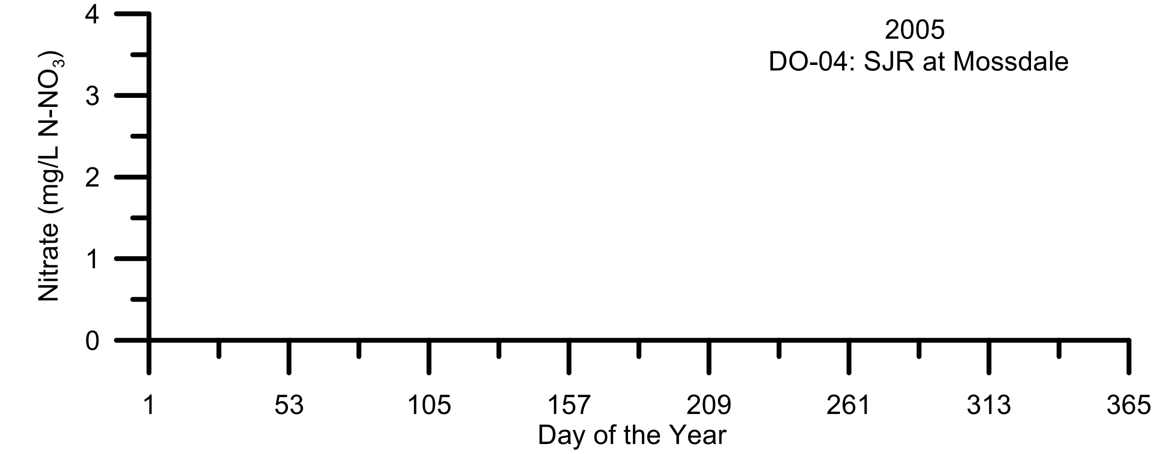
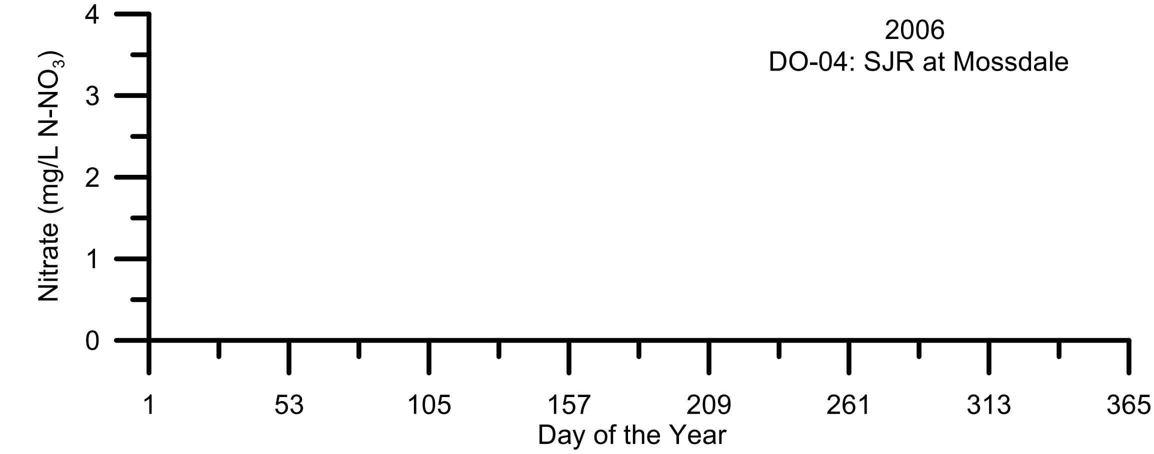


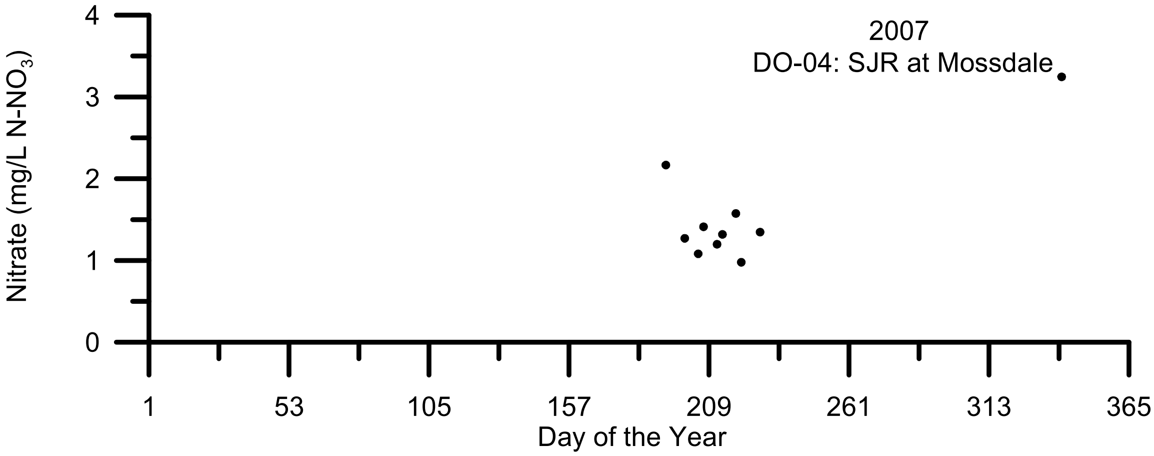
Figure 2: UCD vs EERP Timberline Plot of NO_3-N.

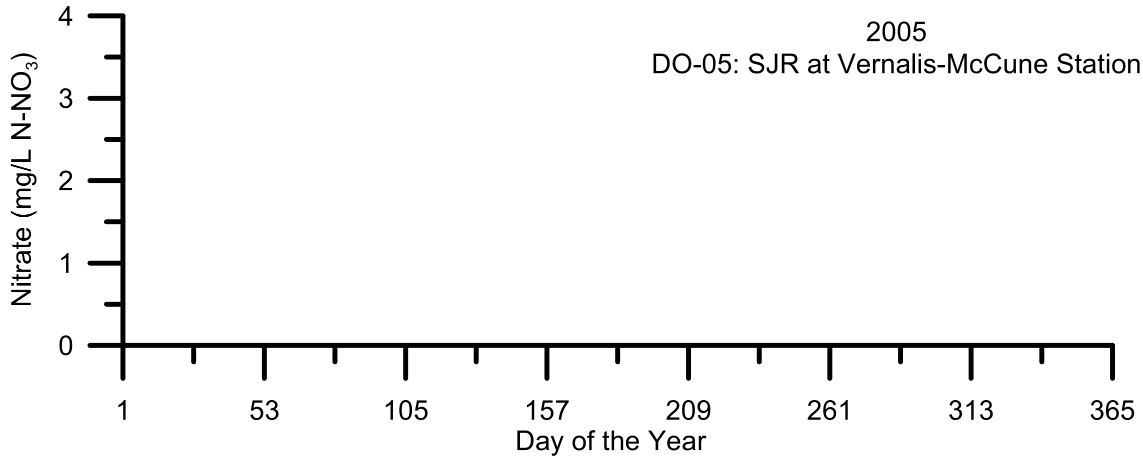


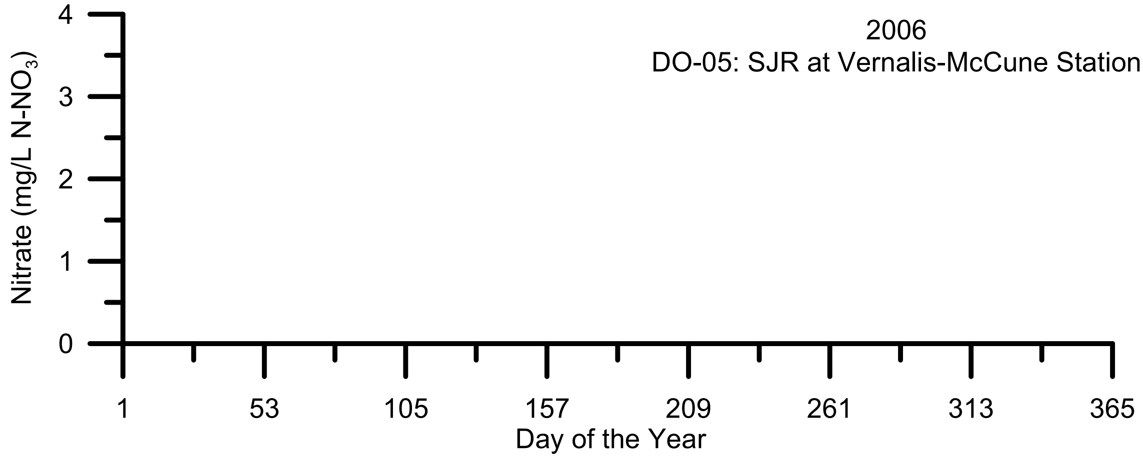
Figures 3 -104: Temporal Plots of Dissolved NO_3-N By Site ID

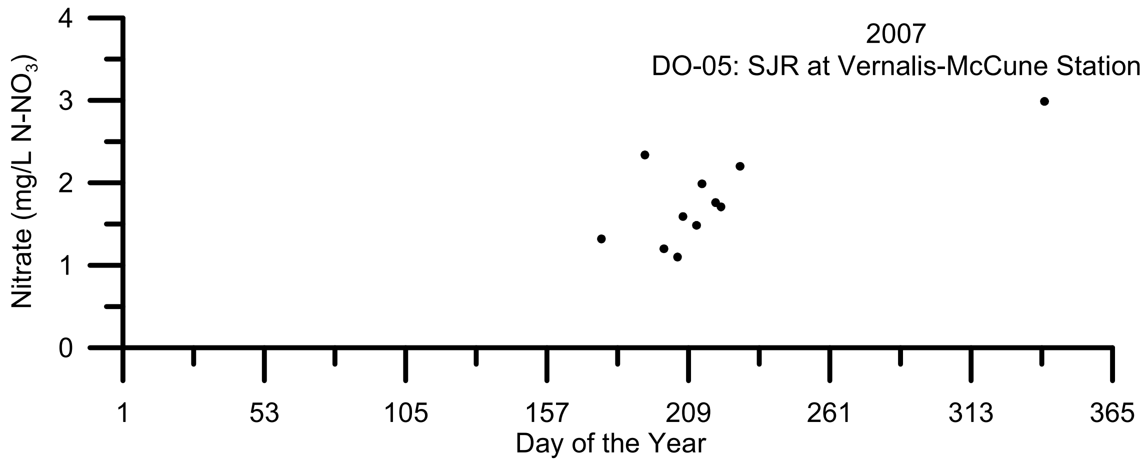


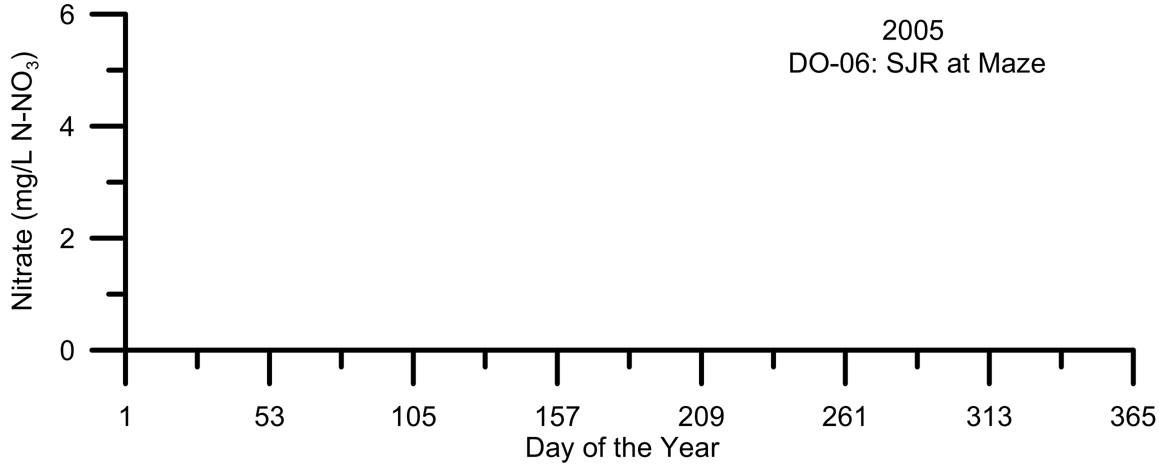


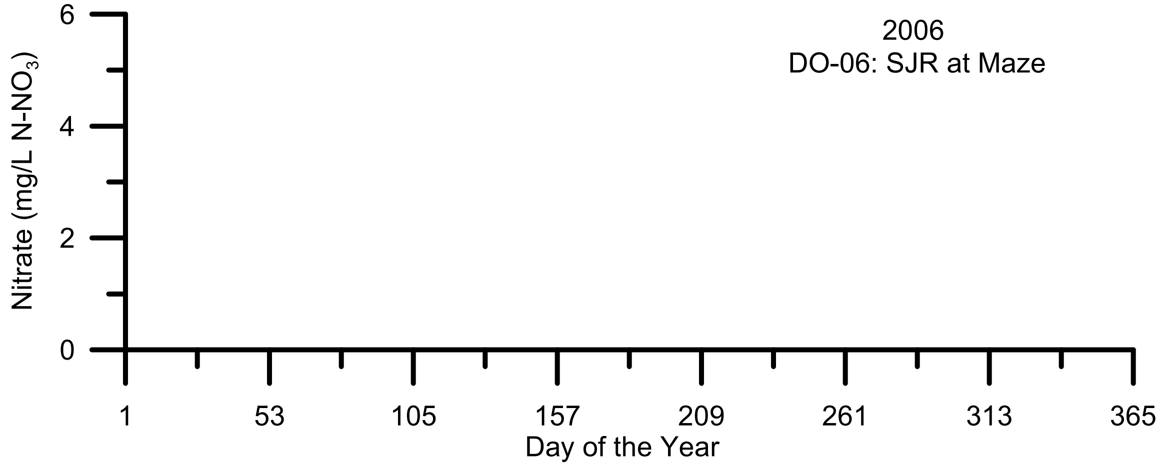


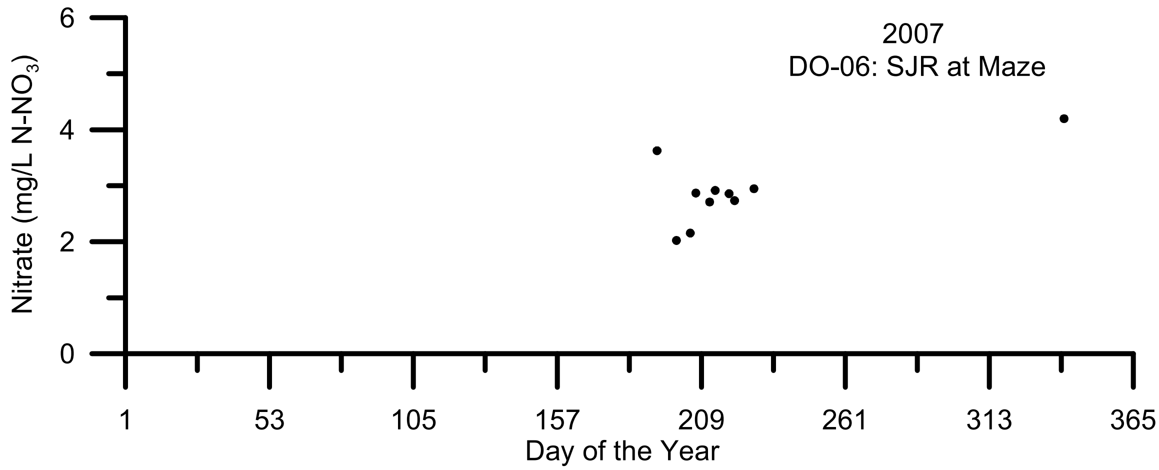

2005
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

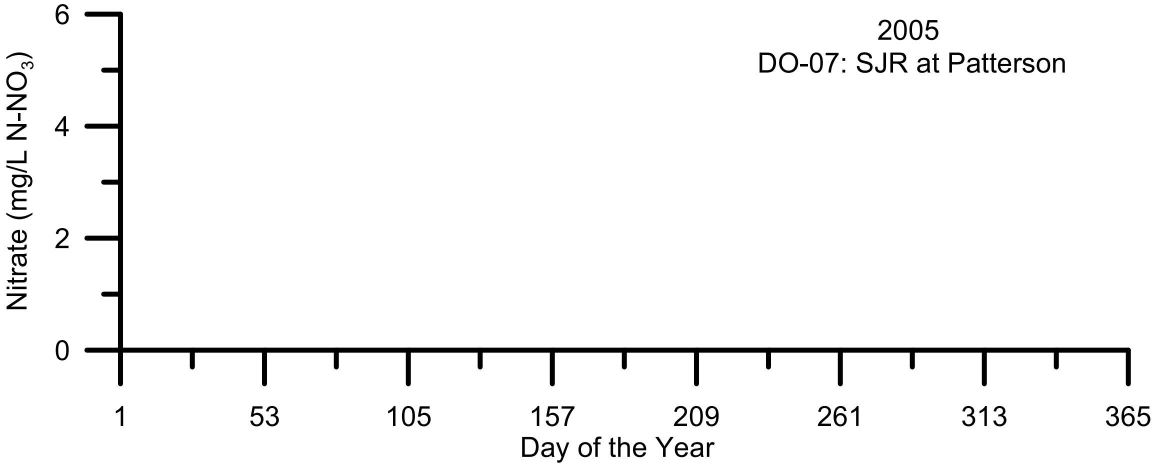

2006
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

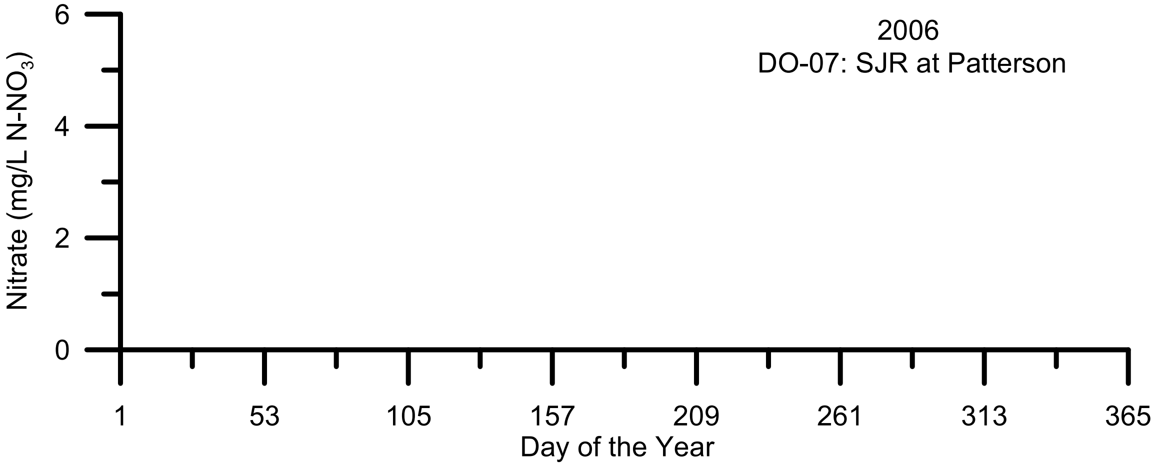

2007
DO-05: SJR at Vernalis-McCune Station
Nitrate (mg/L N-NO$_3$)
0
1
2
3
4
1
53
105
157
209
261
313
365
Day of the Year

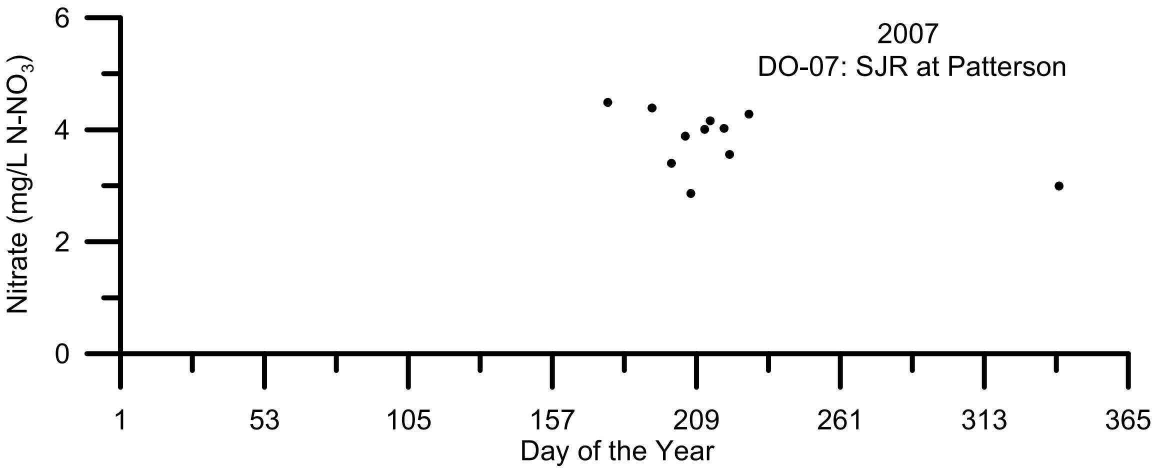

2005
DO-06: SJR at Maze
Nitrate (mg/L N-NO$_3$)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

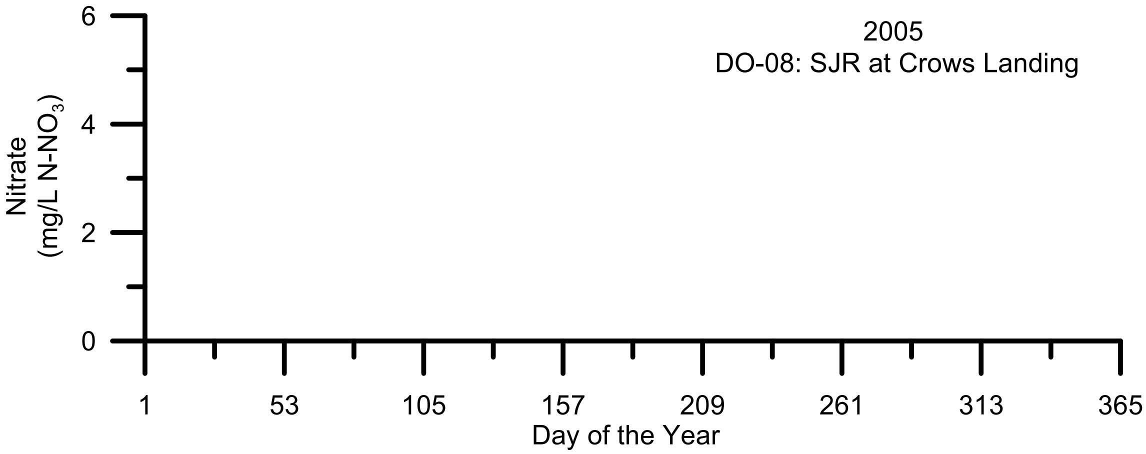

2006
DO-06: SJR at Maze
Nitrate (mg/L N-NO$_3$)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

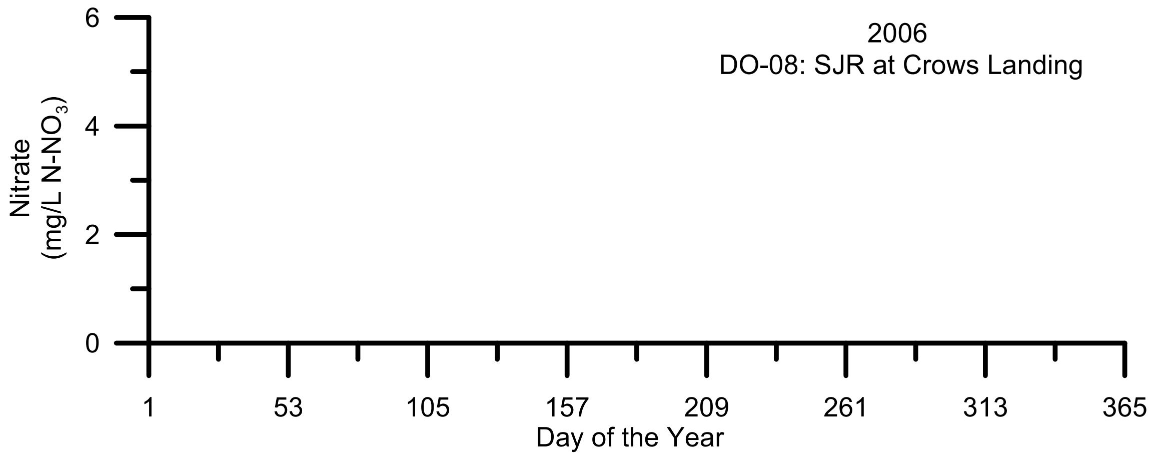

2007
DO-06: SJR at Maze
Nitrate (mg/L N-NO$_3$)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

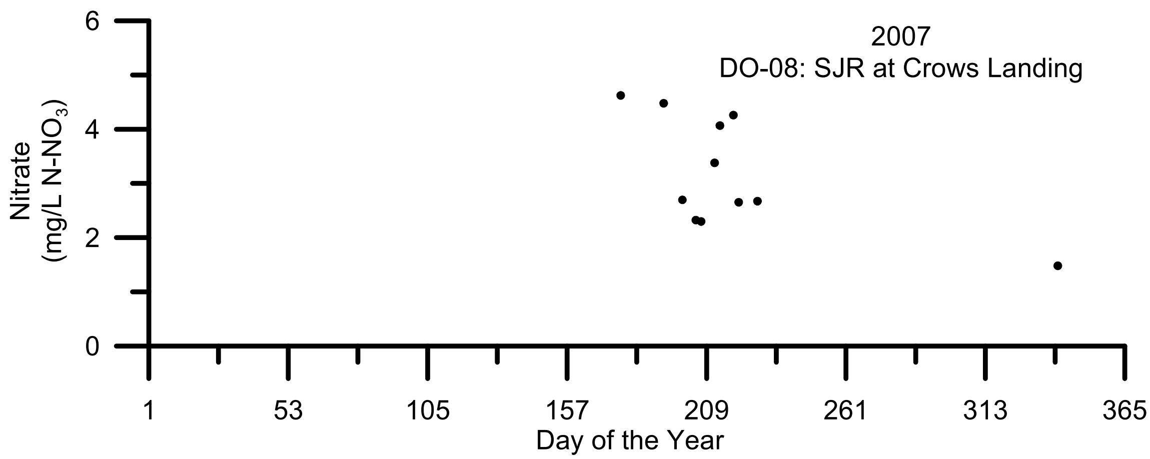

2005
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

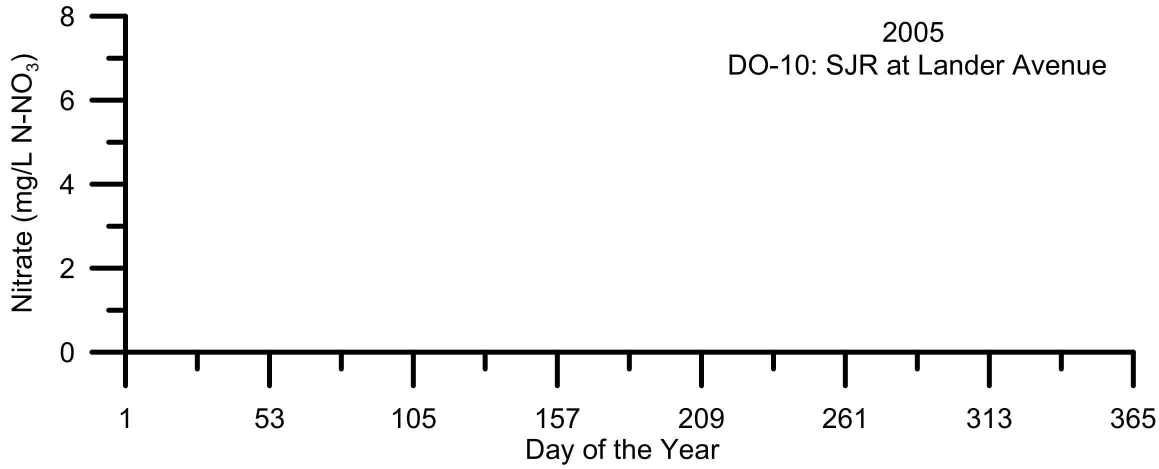

2006
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

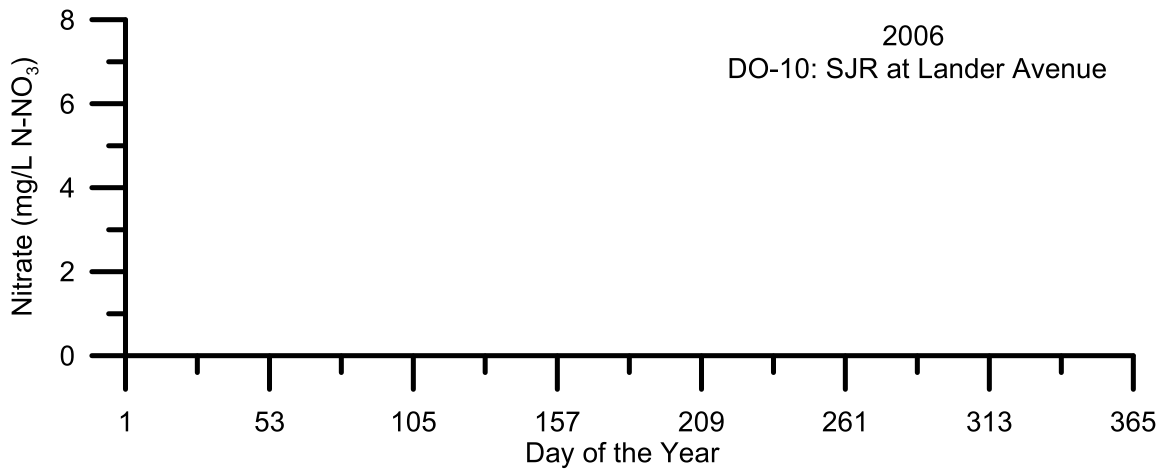

2007
DO-07: SJR at Patterson
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

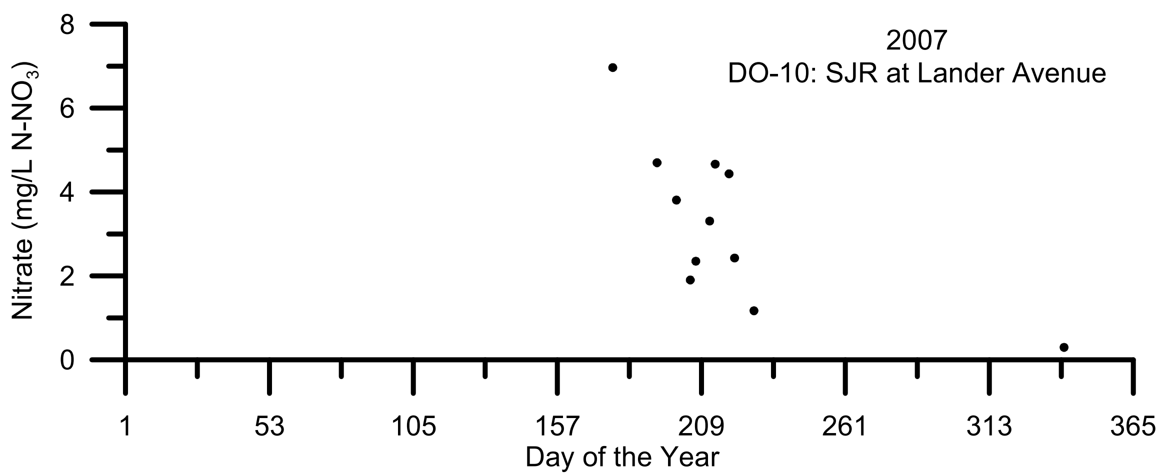

2005
DO-08: SJR at Crows Landing
Nitrate
(mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

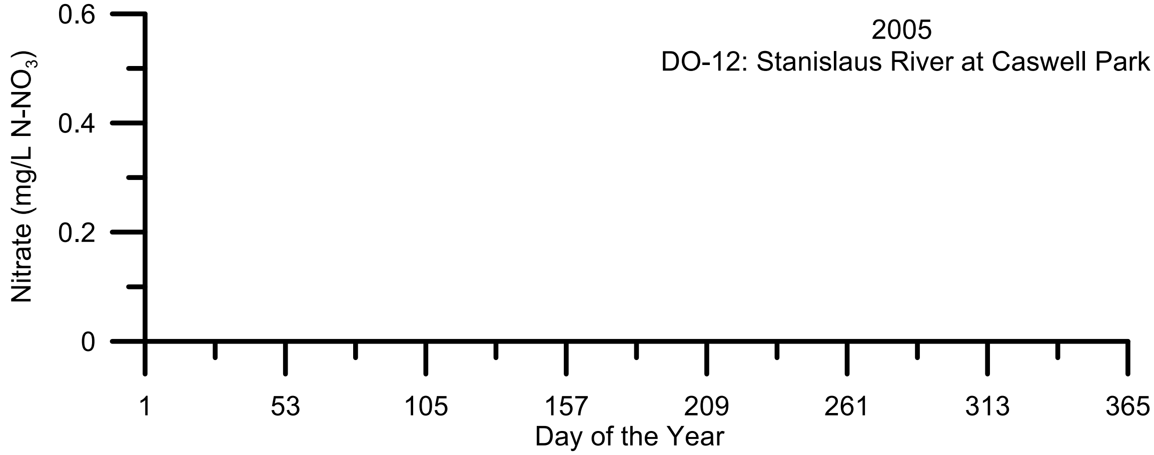

2006
DO-08: SJR at Crows Landing
Nitrate
(mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

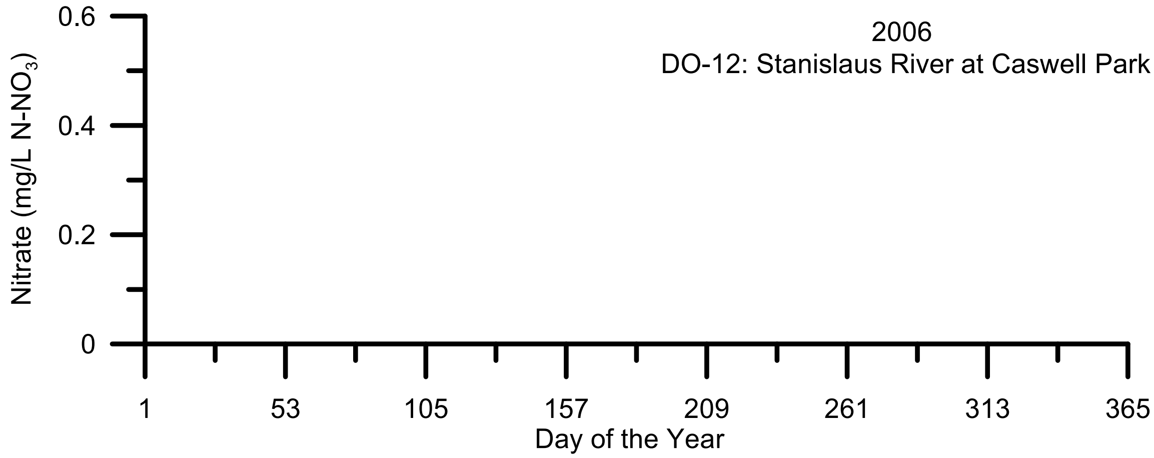

2007
DO-08: SJR at Crows Landing
Nitrate
(mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

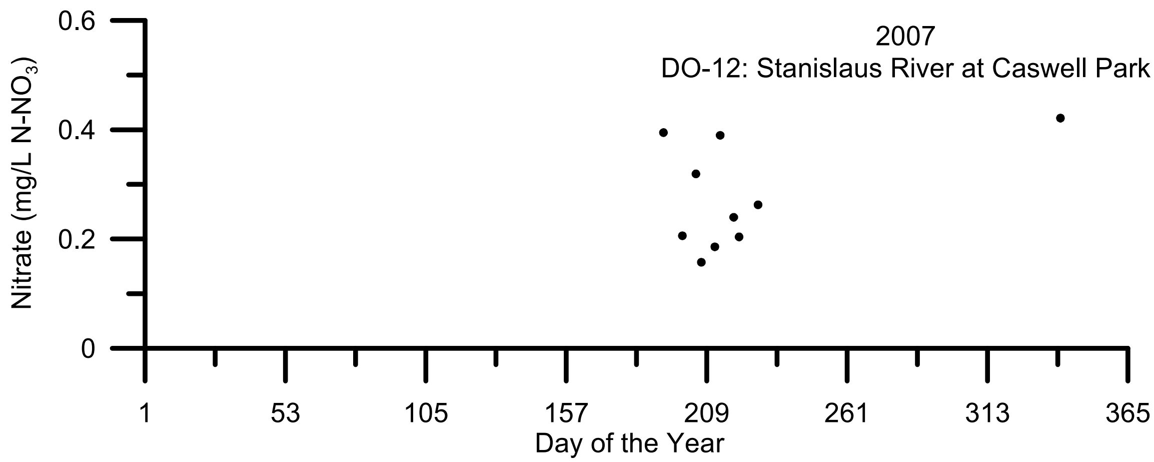

2005
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

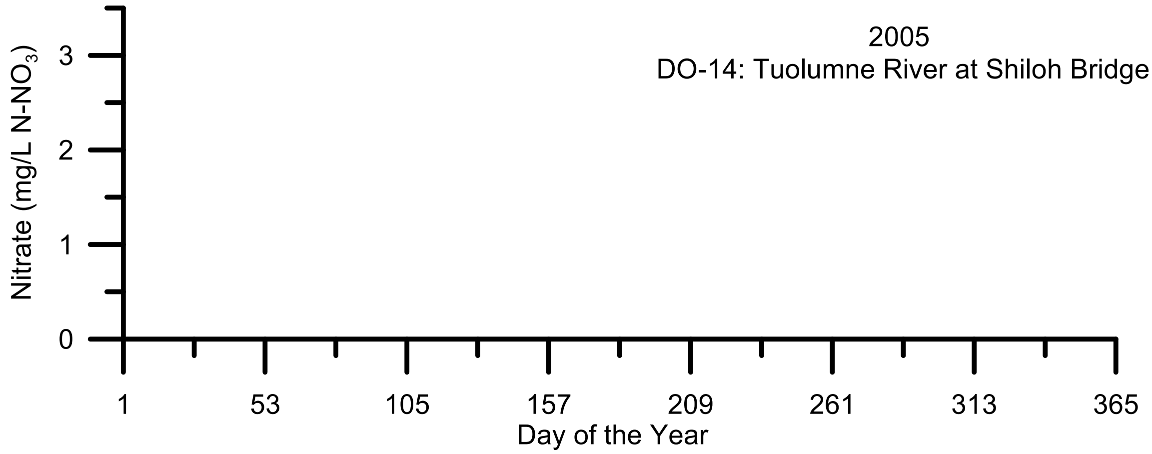

2006
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

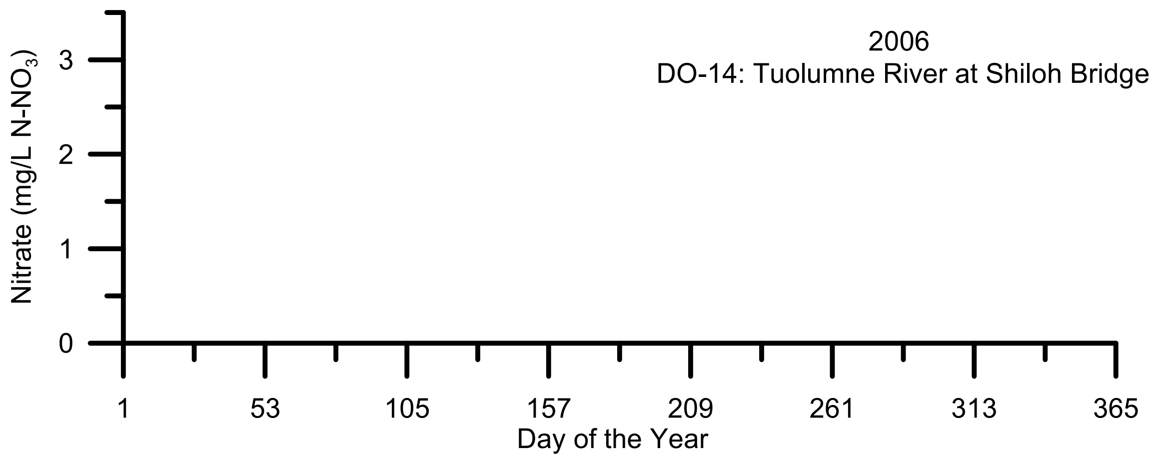

2007
DO-10: SJR at Lander Avenue
Nitrate (mg/L N-NO3)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

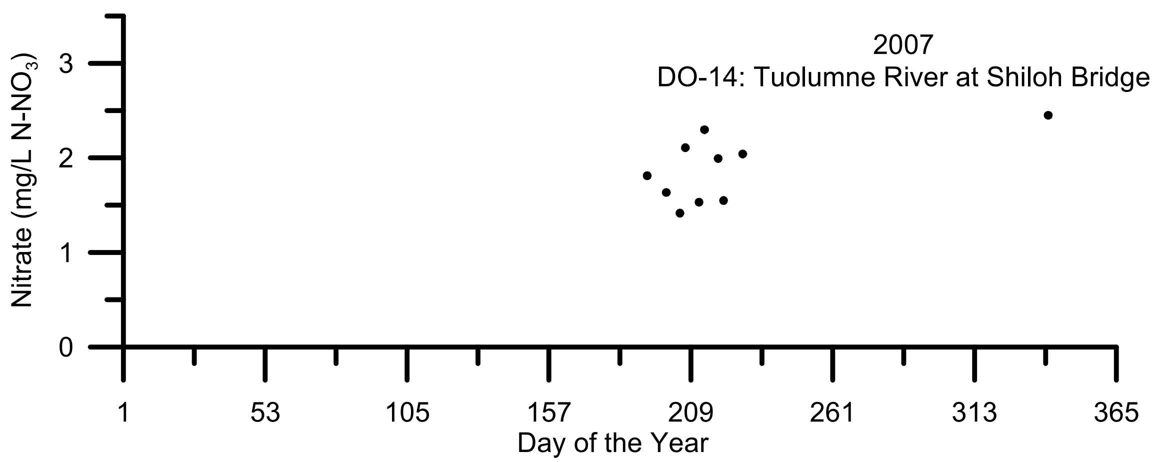

2005
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

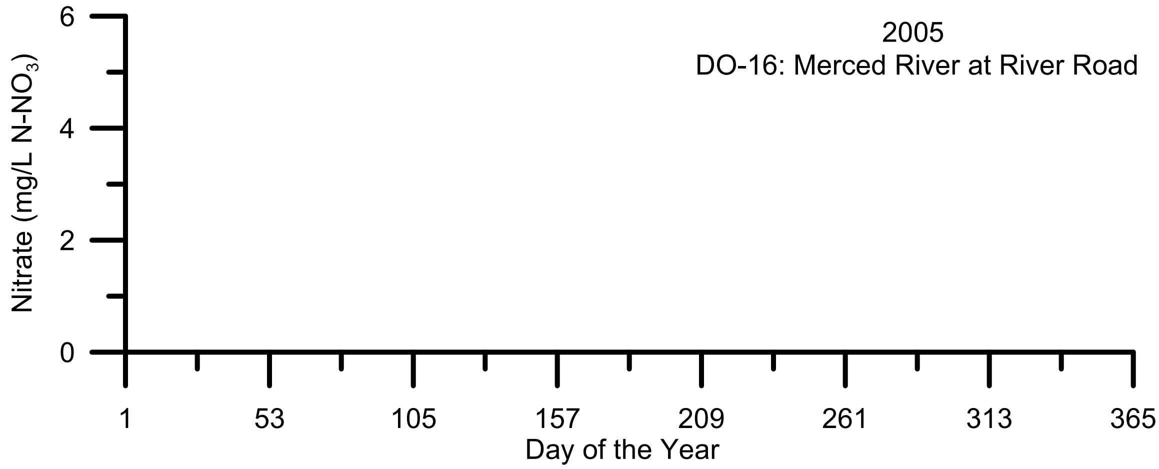

2006
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

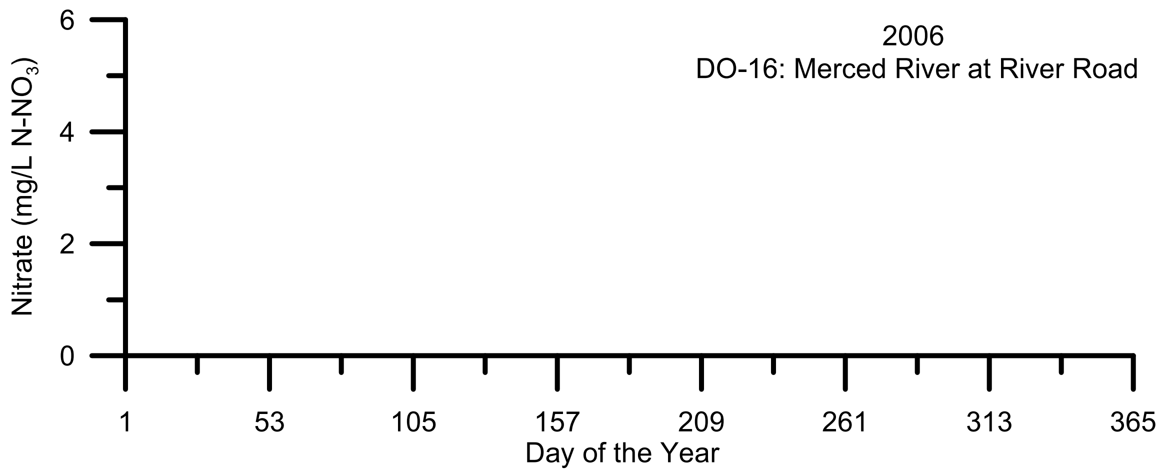

2007
DO-12: Stanislaus River at Caswell Park
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

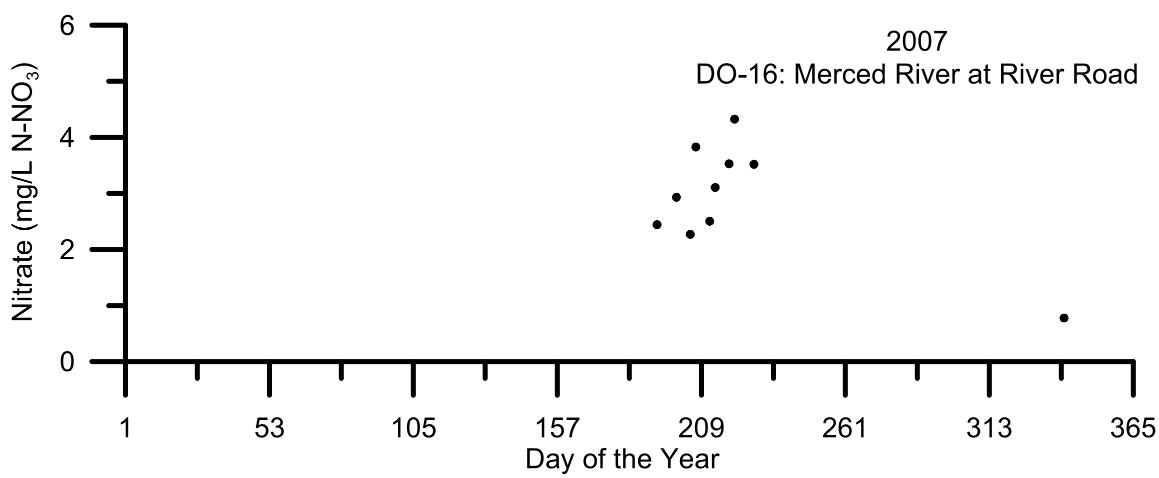

2005
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

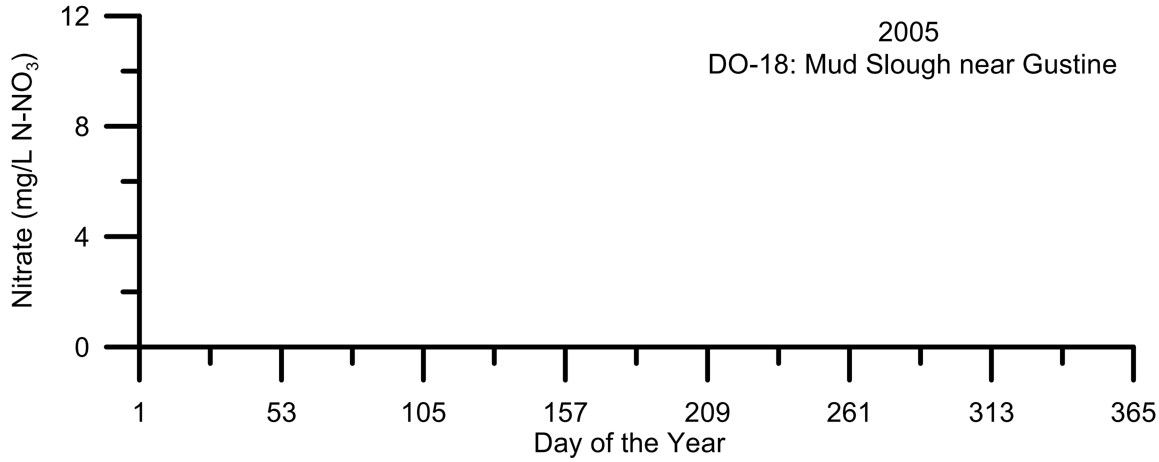

2006
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

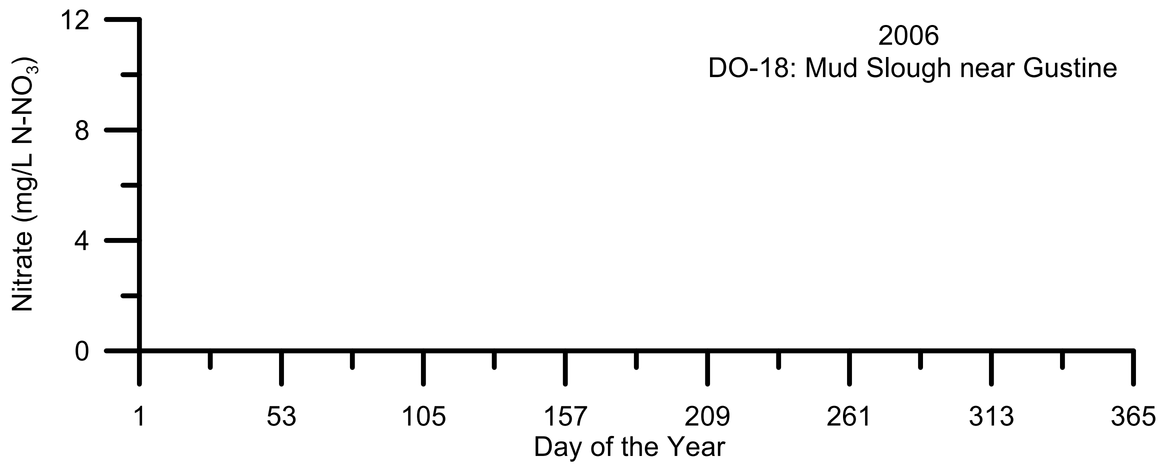

2007
DO-14: Tuolumne River at Shiloh Bridge
Nitrate (mg/L N-NO3)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

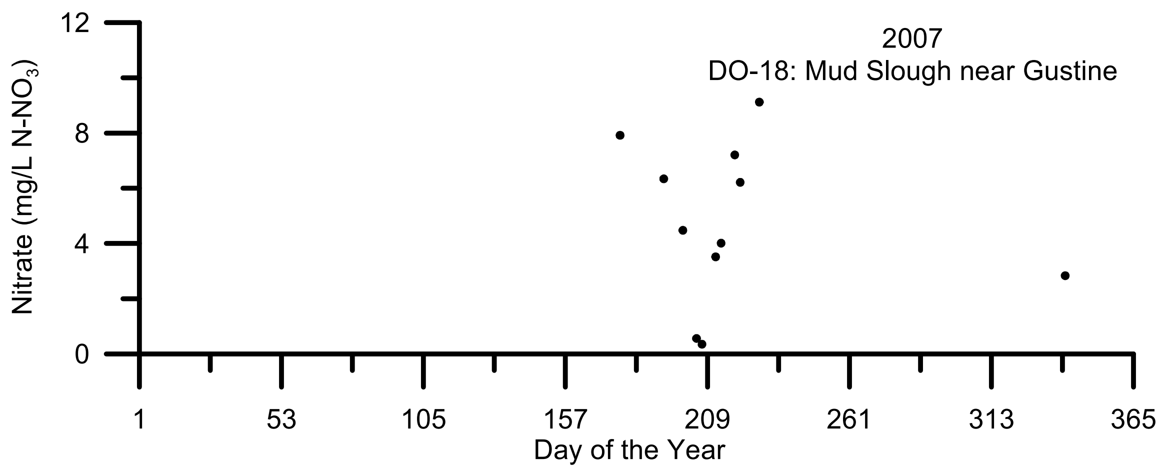

2005
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

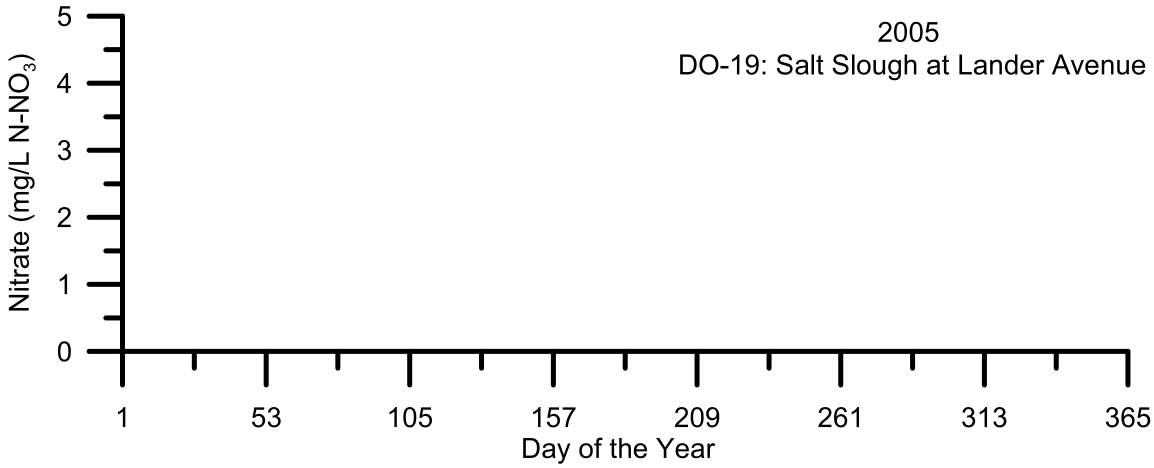

2006
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

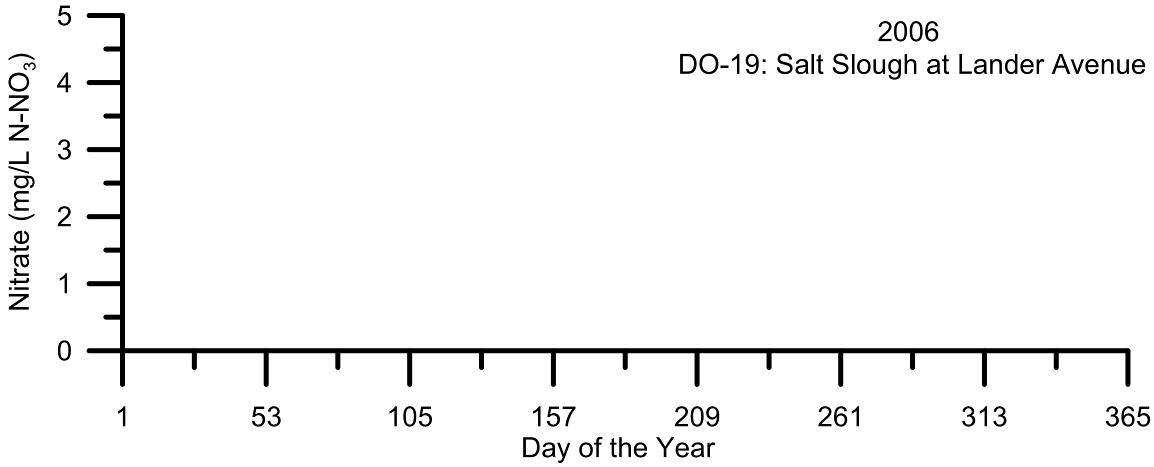

2007
DO-16: Merced River at River Road
Nitrate (mg/L N-NO3)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

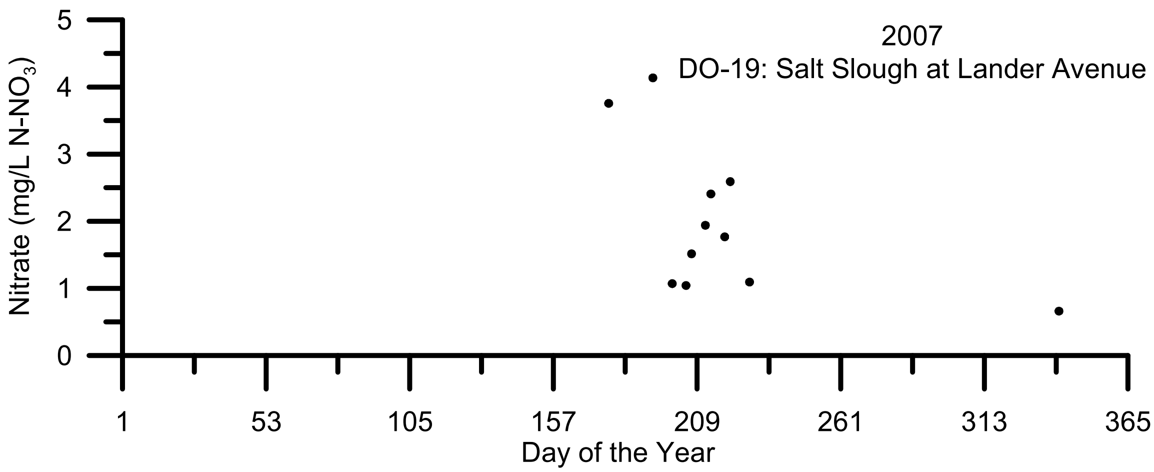

2005
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

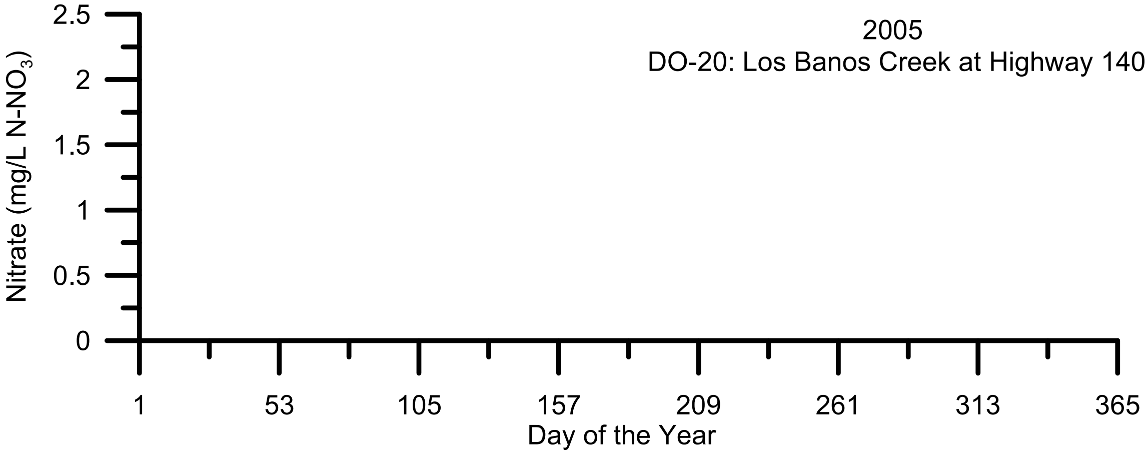

2006
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

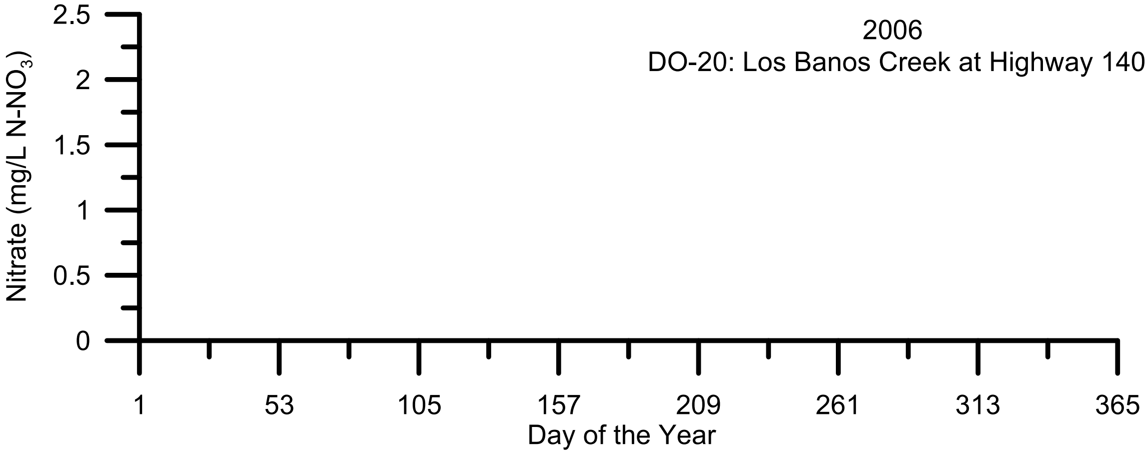

2007
DO-18: Mud Slough near Gustine
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

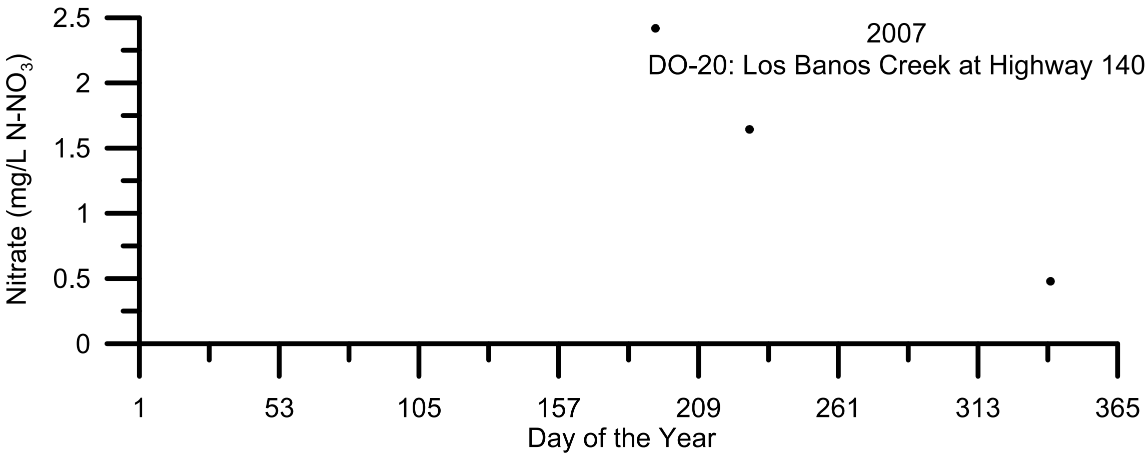

2005
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

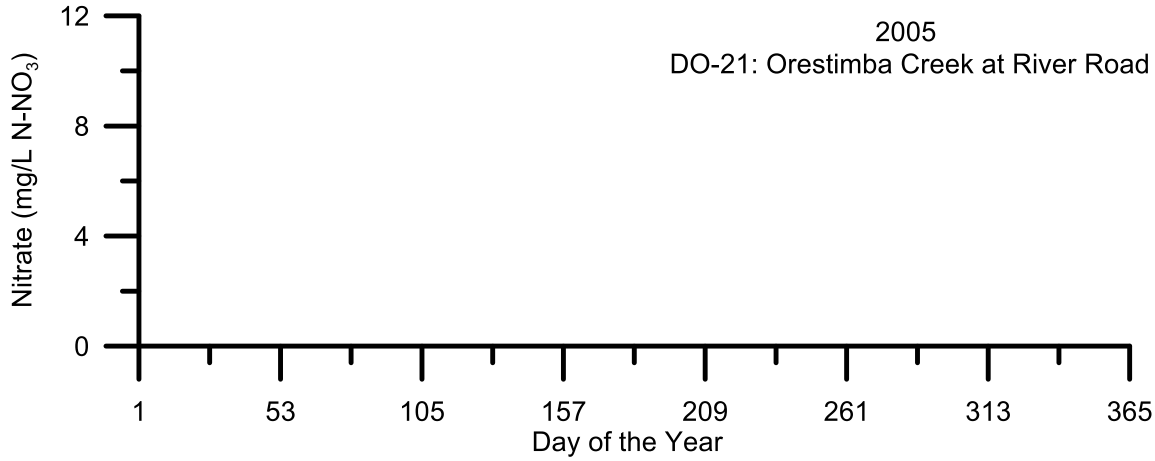

2006
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

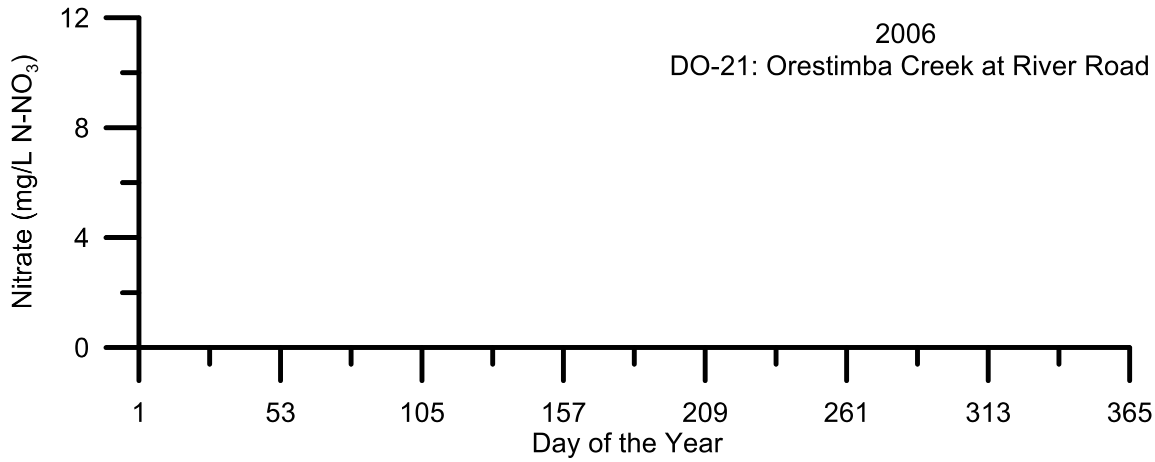

2007
DO-19: Salt Slough at Lander Avenue
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

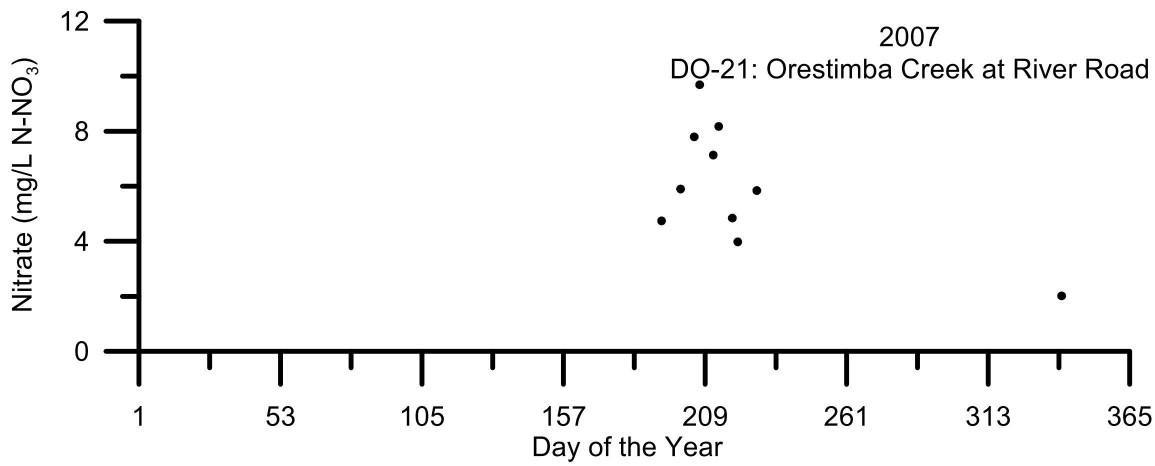

2005
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

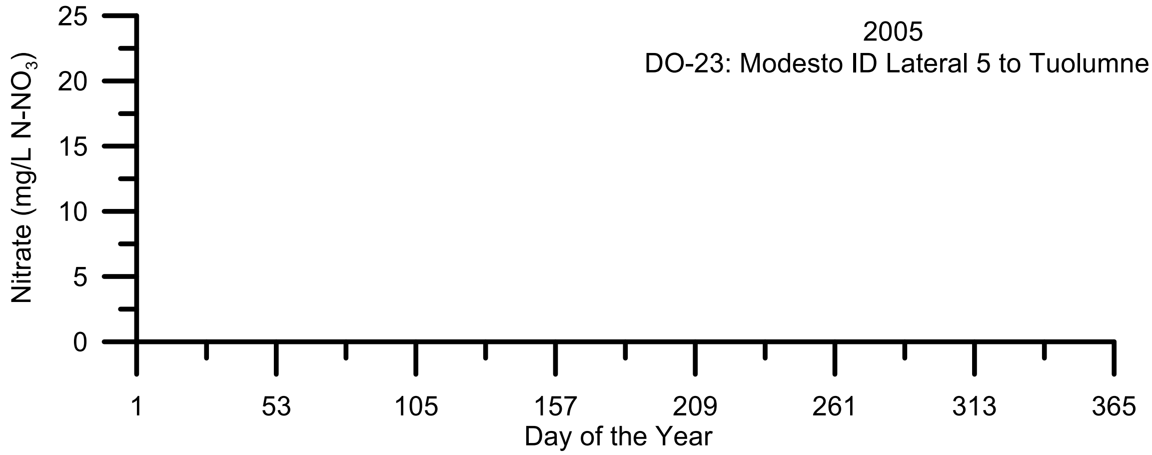

2006
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

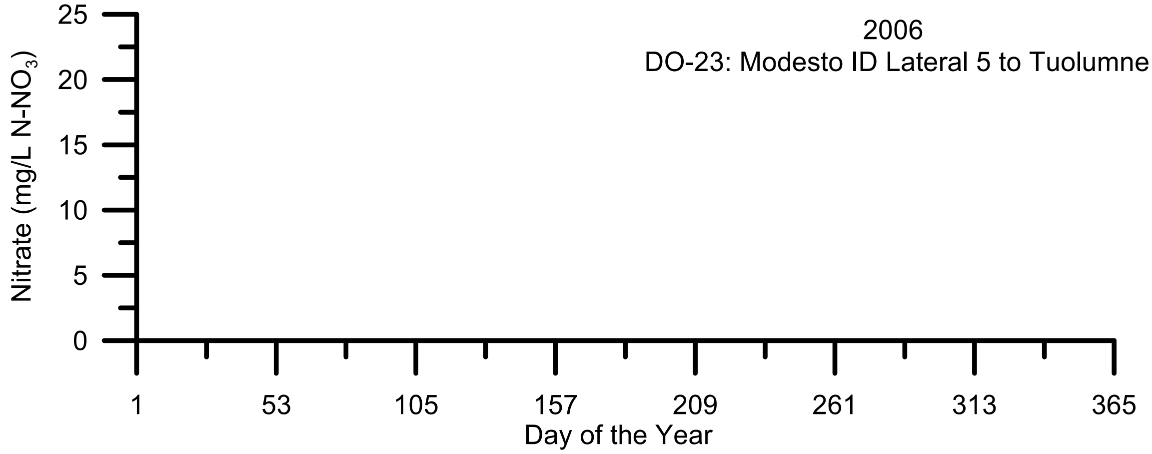

2007
DO-20: Los Banos Creek at Highway 140
Nitrate (mg/L N-NO3)
0
0.5
1
1.5
2
2.5
1
53
105
157
209
261
313
365
Day of the Year

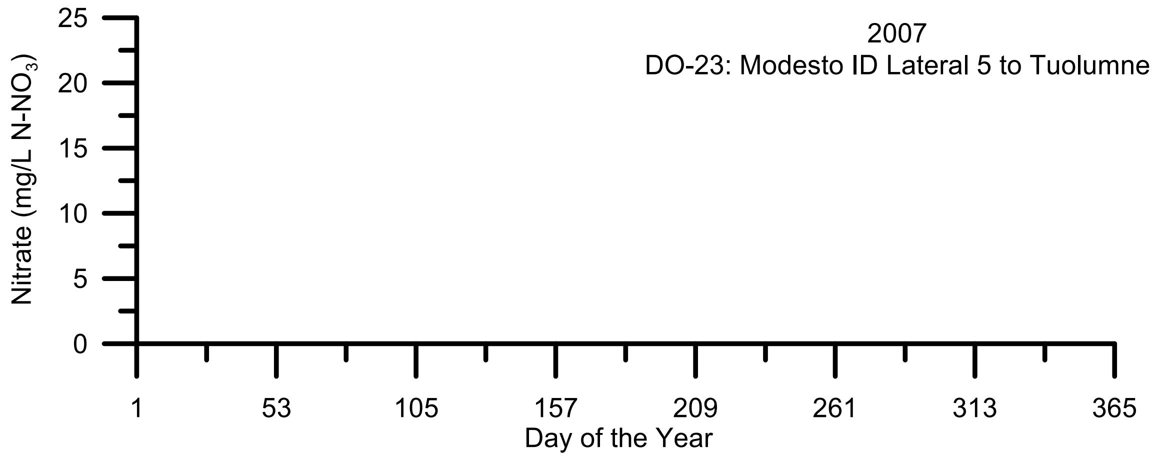

12
8
4
0
Nitrate (mg/L N-NO$_3$)
2005
DO-21: Orestimba Creek at River Road
1
53
105
157
209
261
313
365
Day of the Year

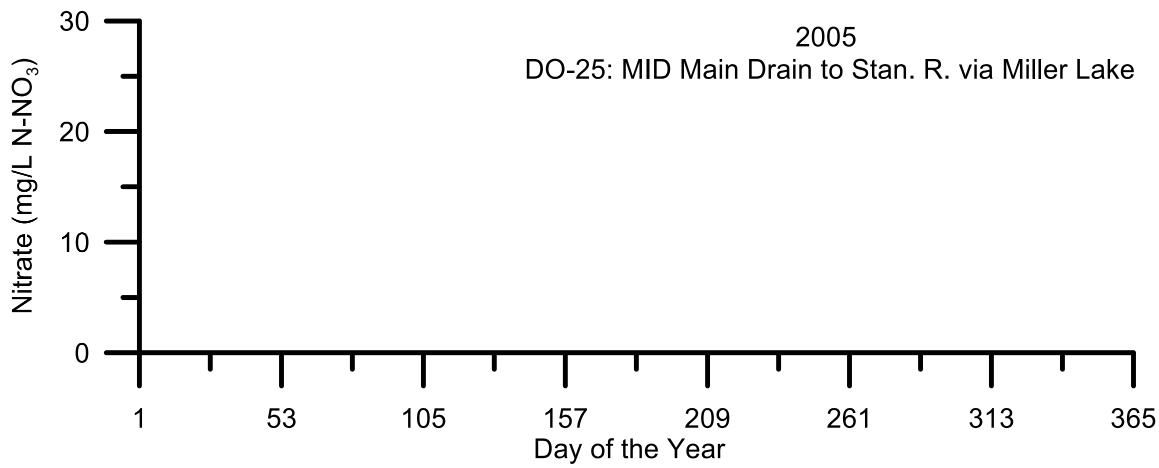

12
8
4
0
Nitrate (mg/L N-NO$_3$)
2006
DO-21: Orestimba Creek at River Road
1
53
105
157
209
261
313
365
Day of the Year

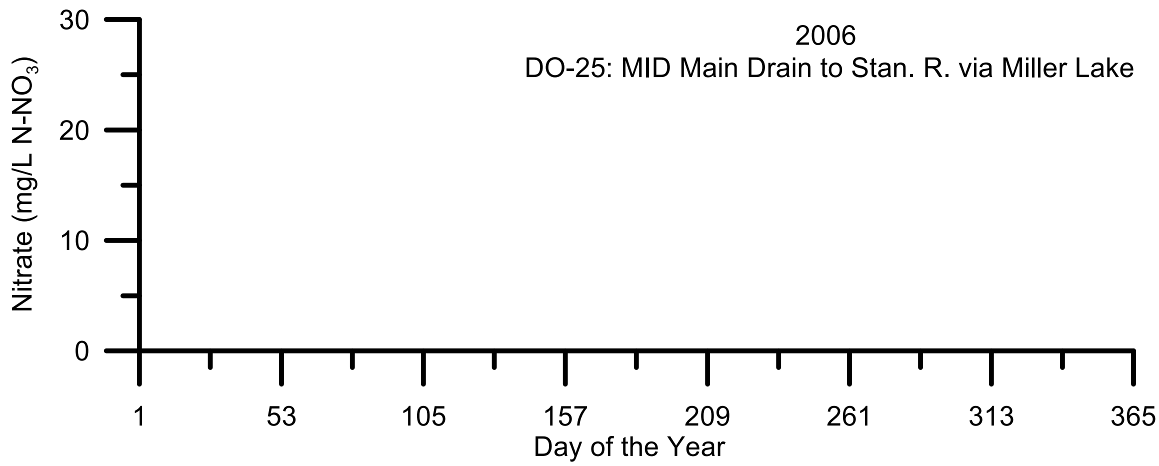

12
8
4
0
Nitrate (mg/L N-NO$_3$)
2007
DO-21: Orestimba Creek at River Road
1
53
105
157
209
261
313
365
Day of the Year

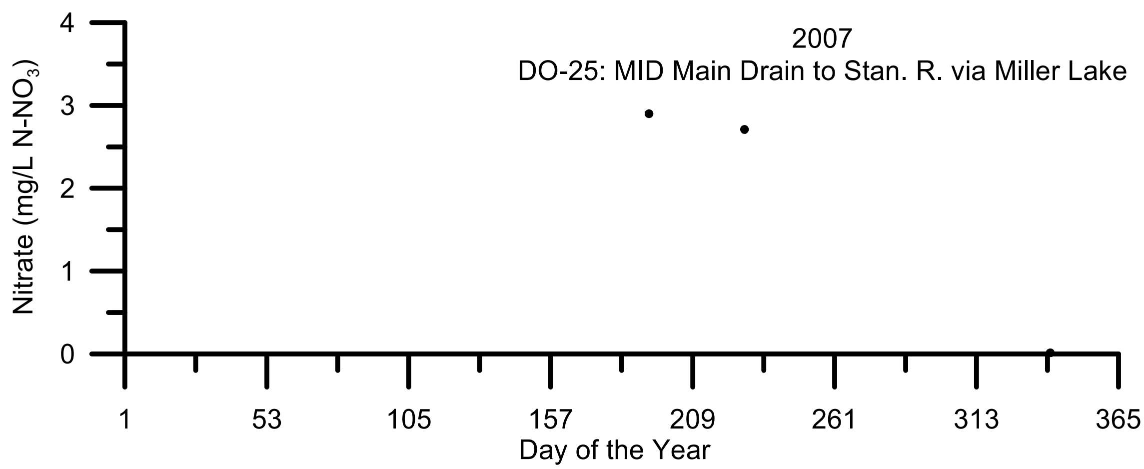

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

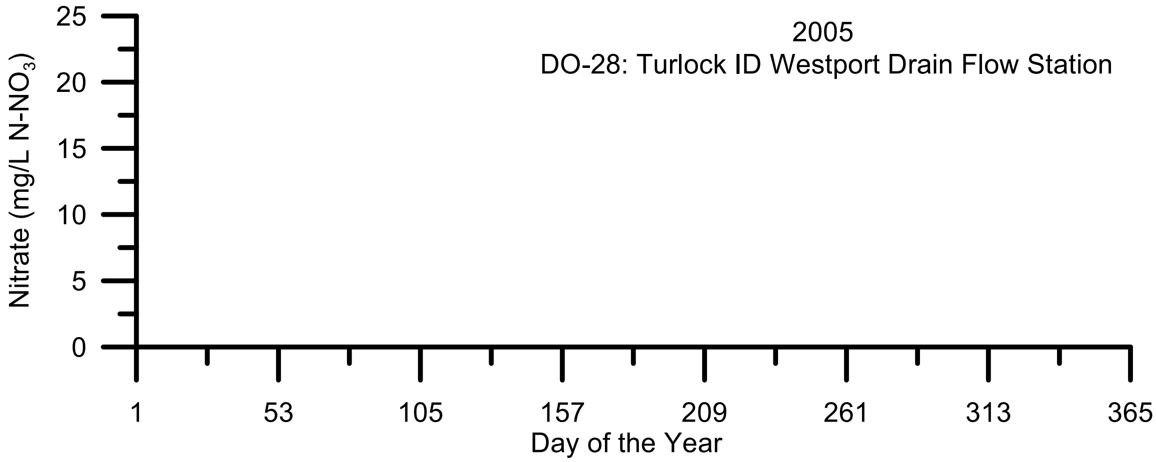

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

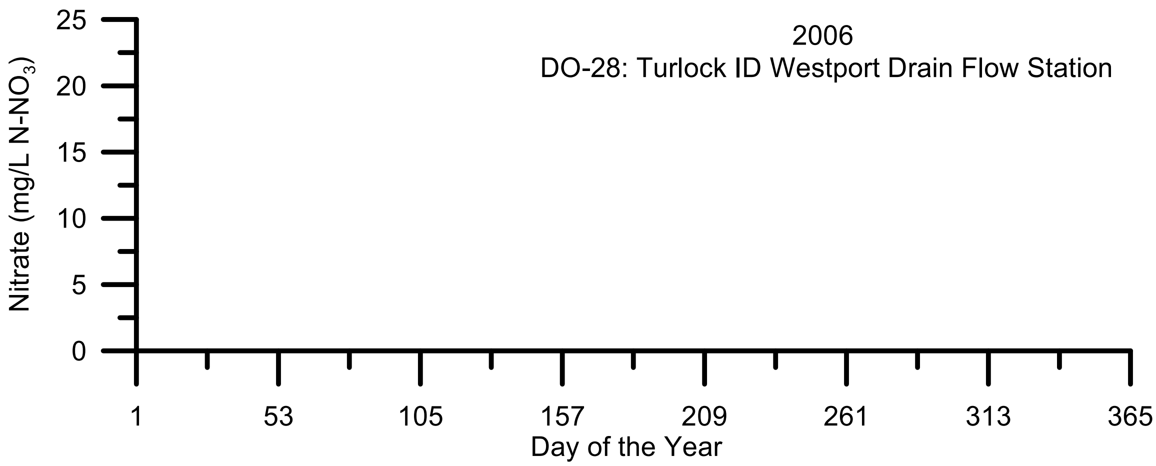

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

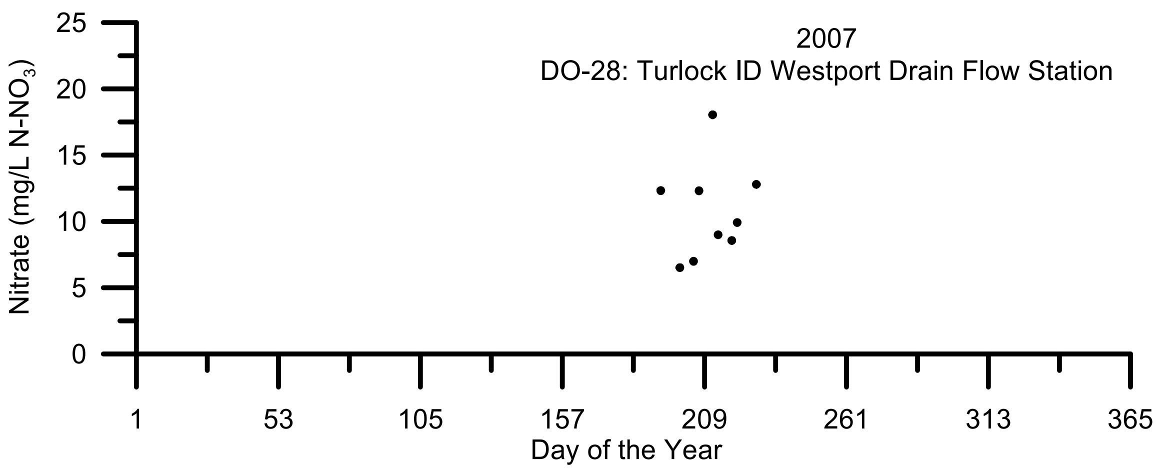

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

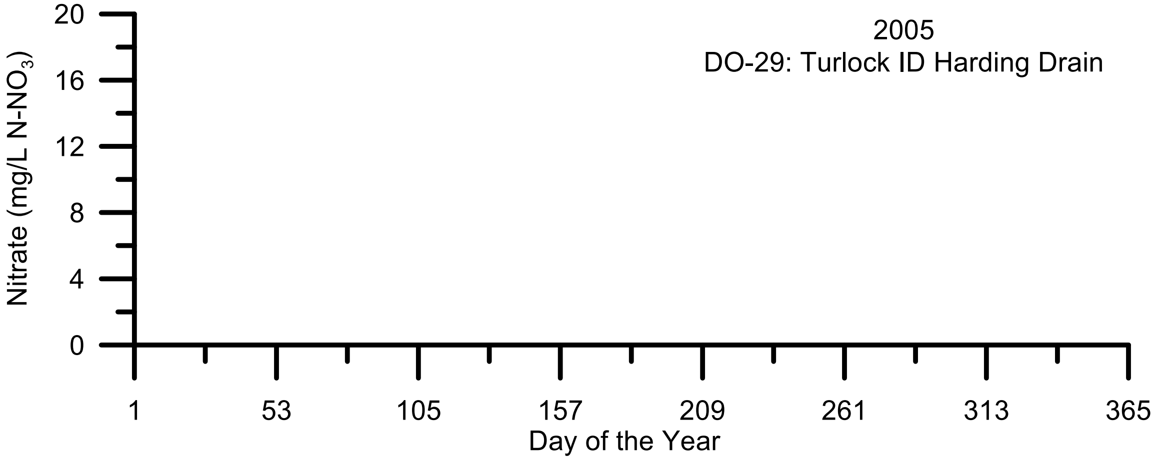

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

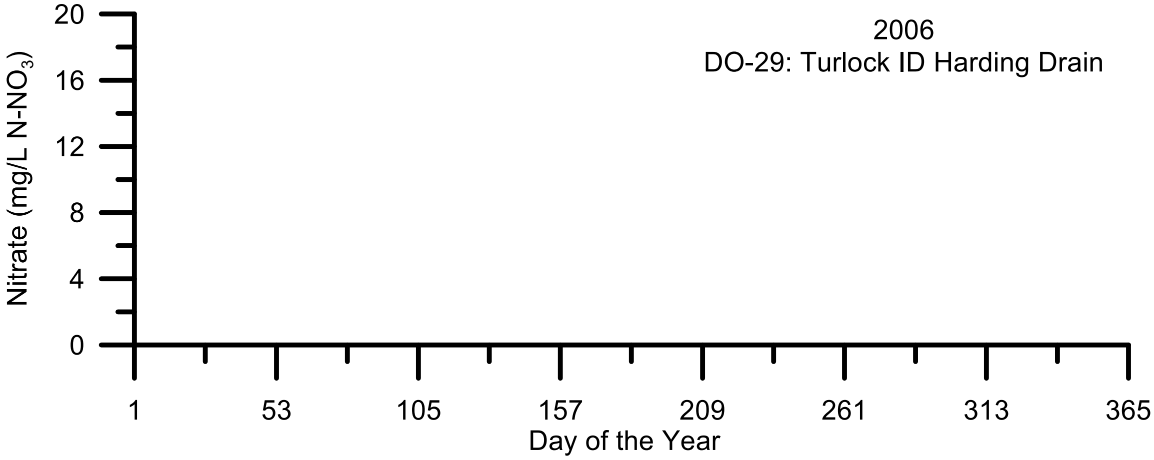

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Nitrate (mg/L N-NO3)
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

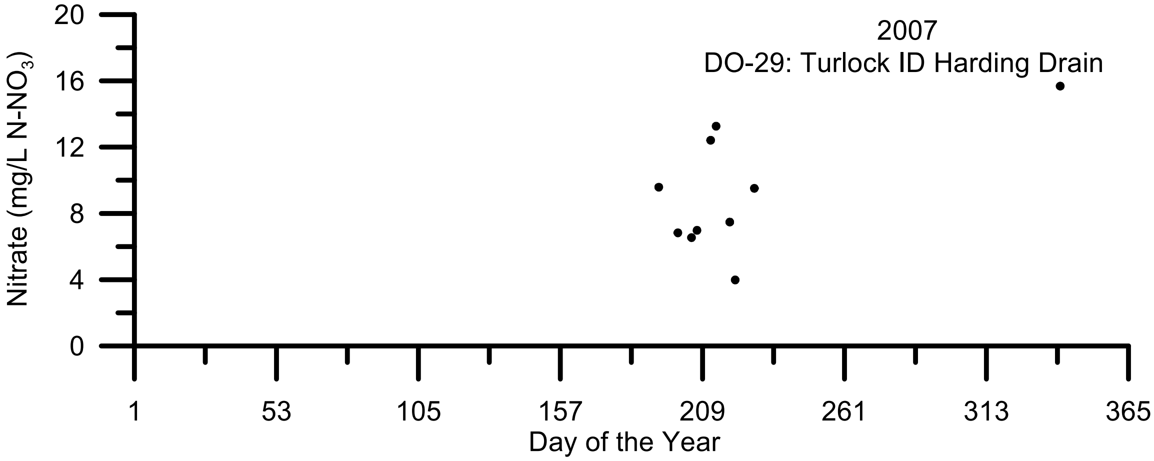

2005
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO$_3$)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

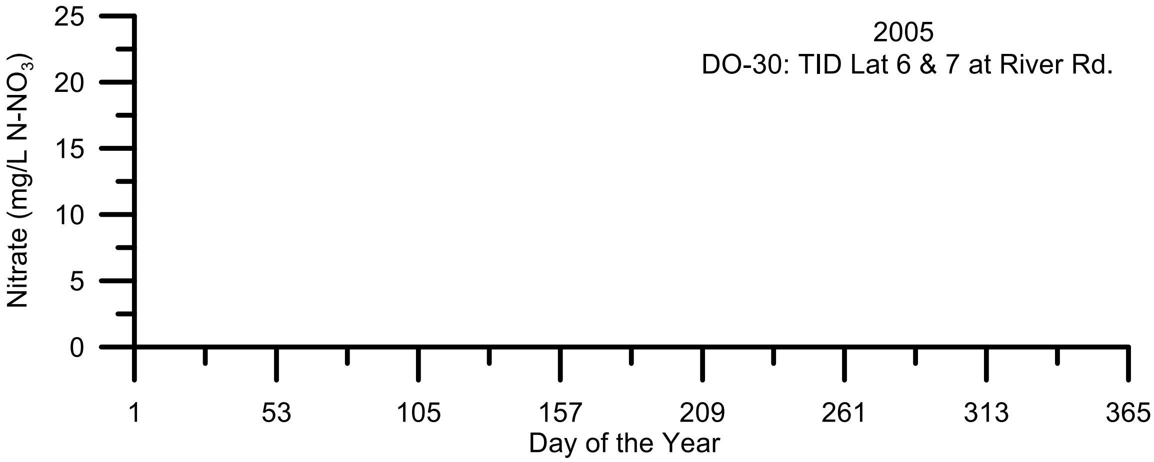

2006
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO$_3$)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

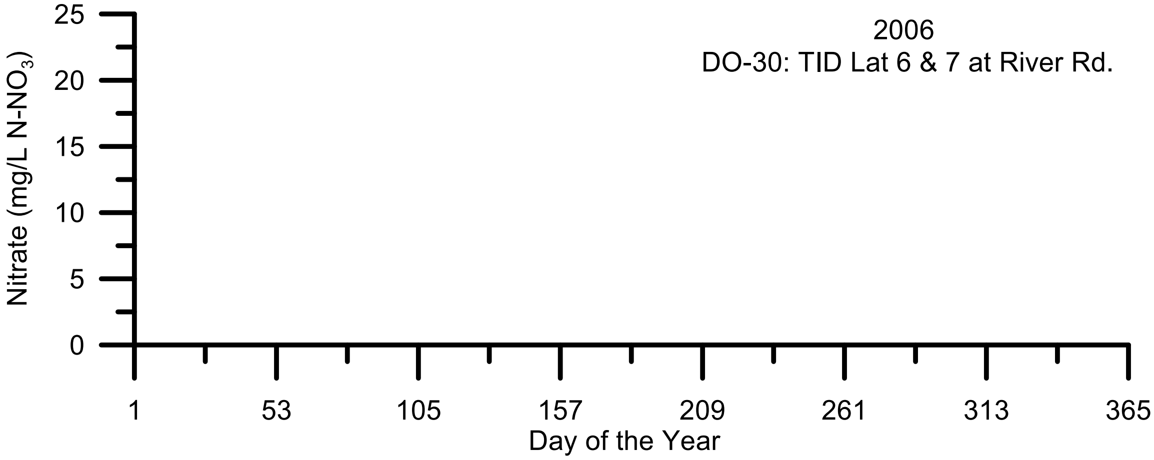

2007
DO-28: Turlock ID Westport Drain Flow Station
Nitrate (mg/L N-NO$_3$)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

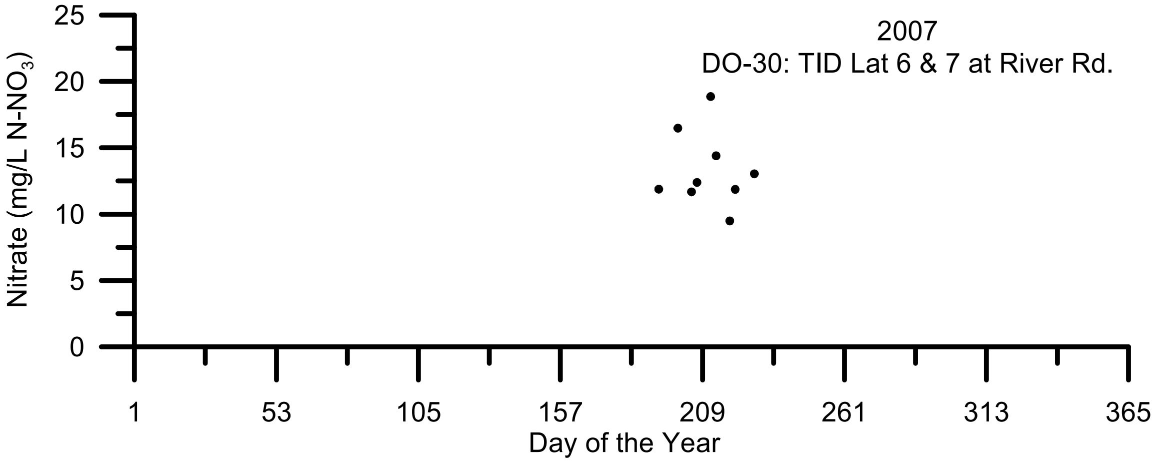

2005
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

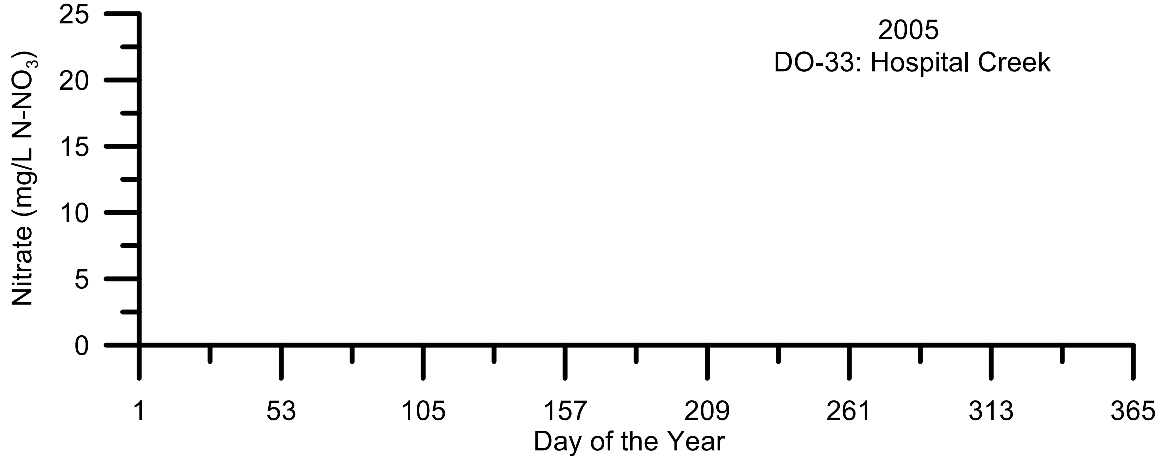

2006
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

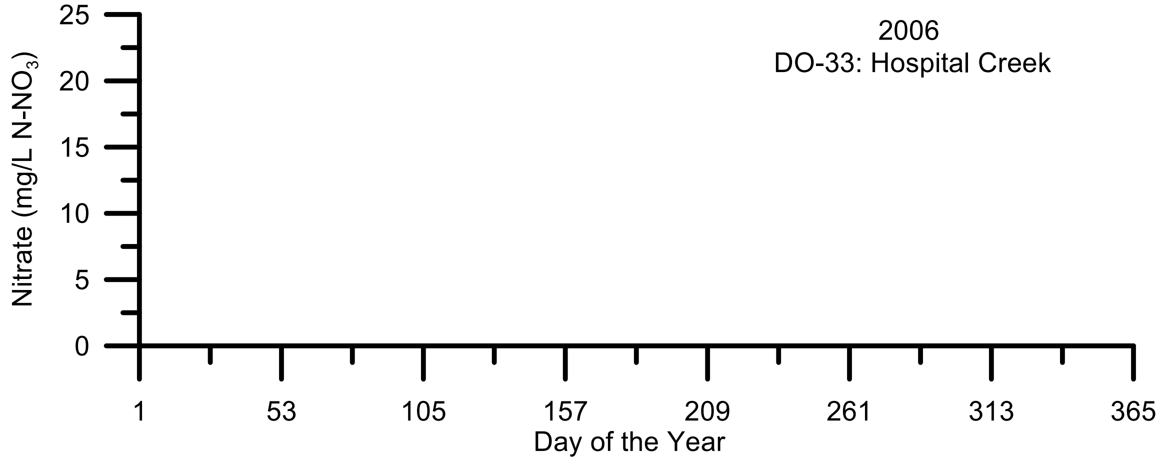

2007
DO-29: Turlock ID Harding Drain
Nitrate (mg/L N-NO3)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

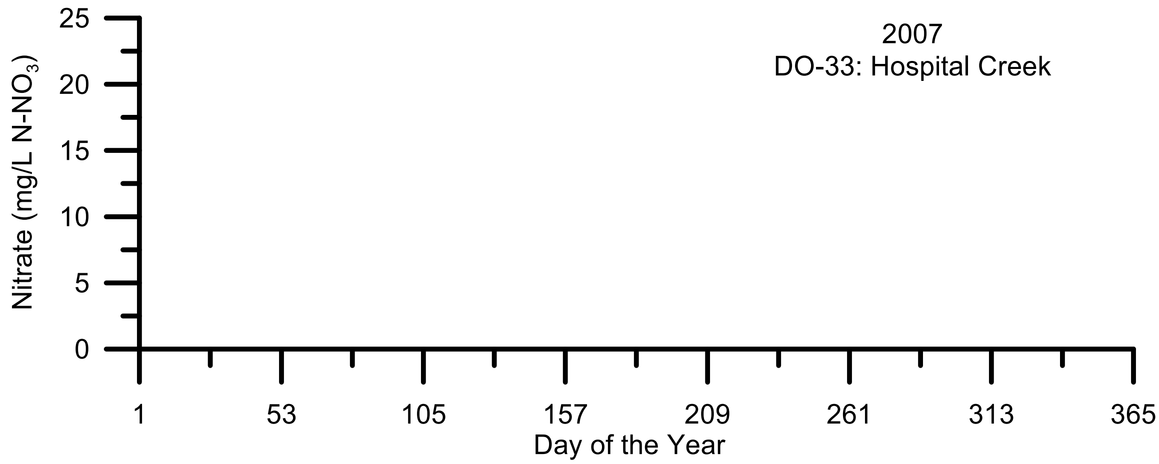

2005
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

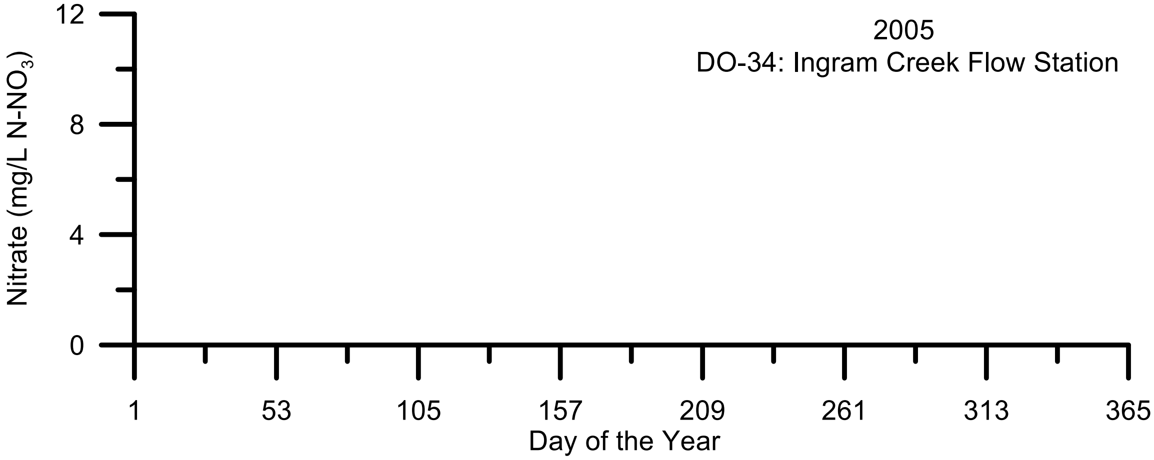

2006
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

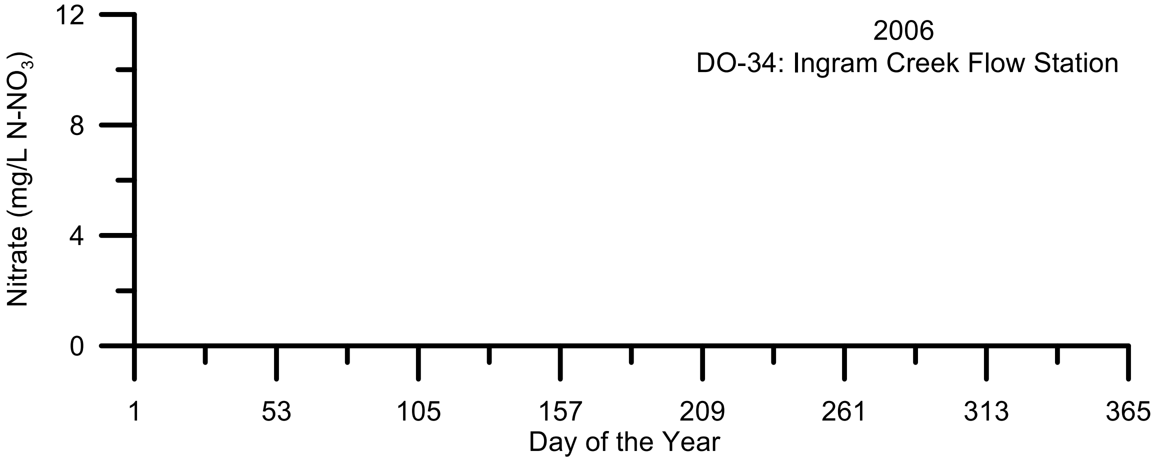

2007
DO-30: TID Lat 6 & 7 at River Rd.
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

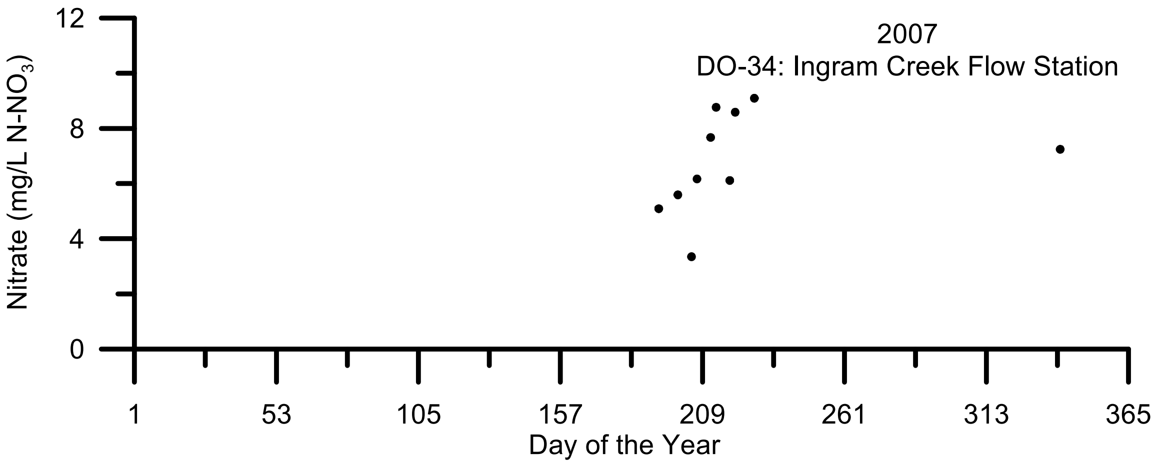

2005
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

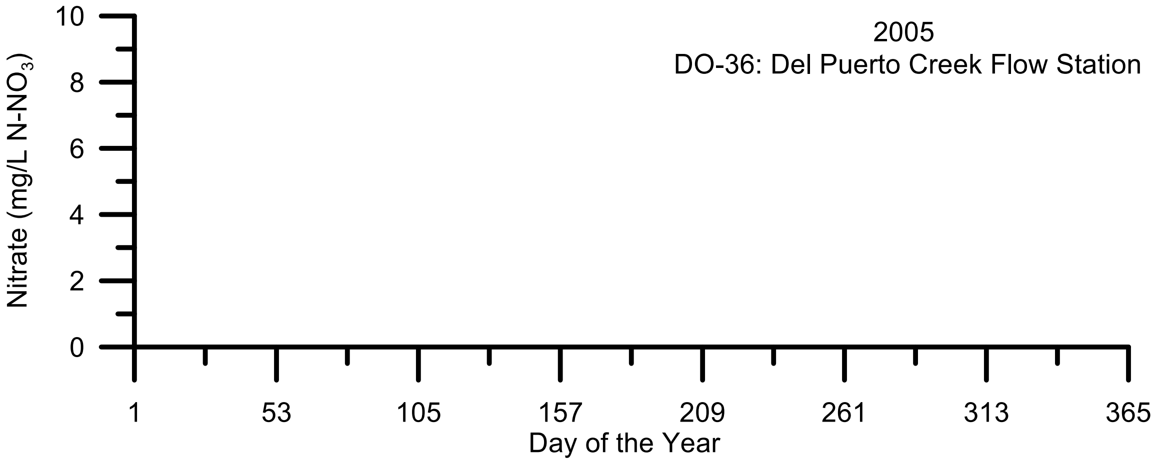

2006
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

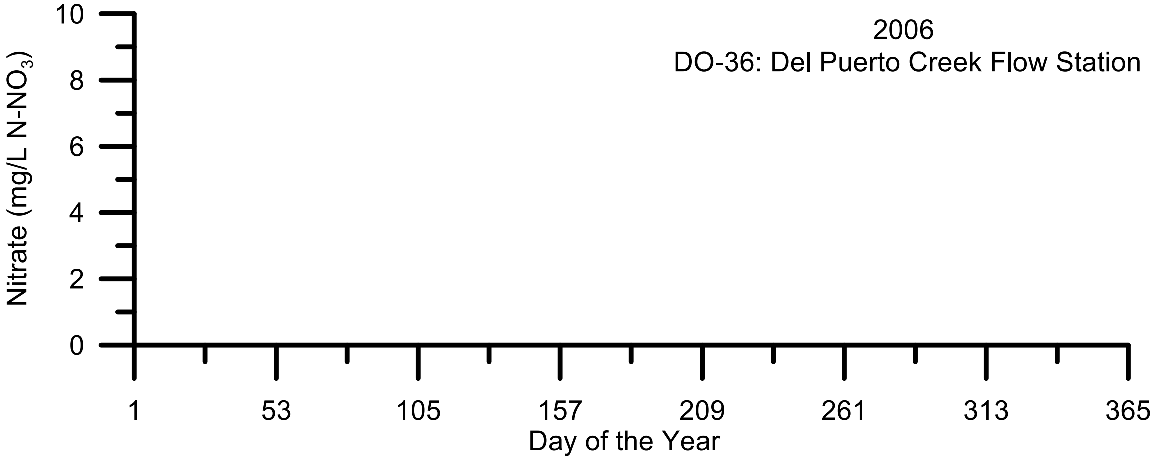

2007
DO-33: Hospital Creek
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

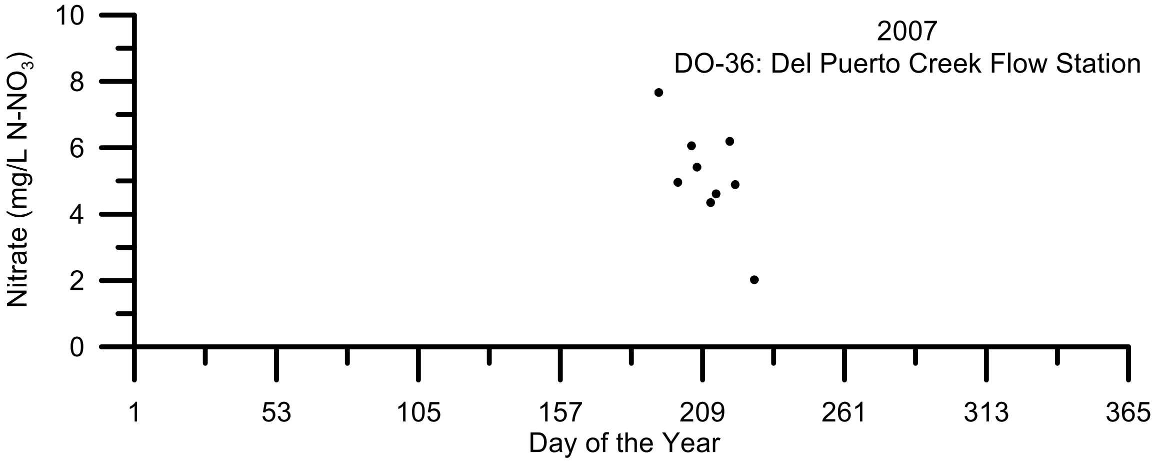

2005
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

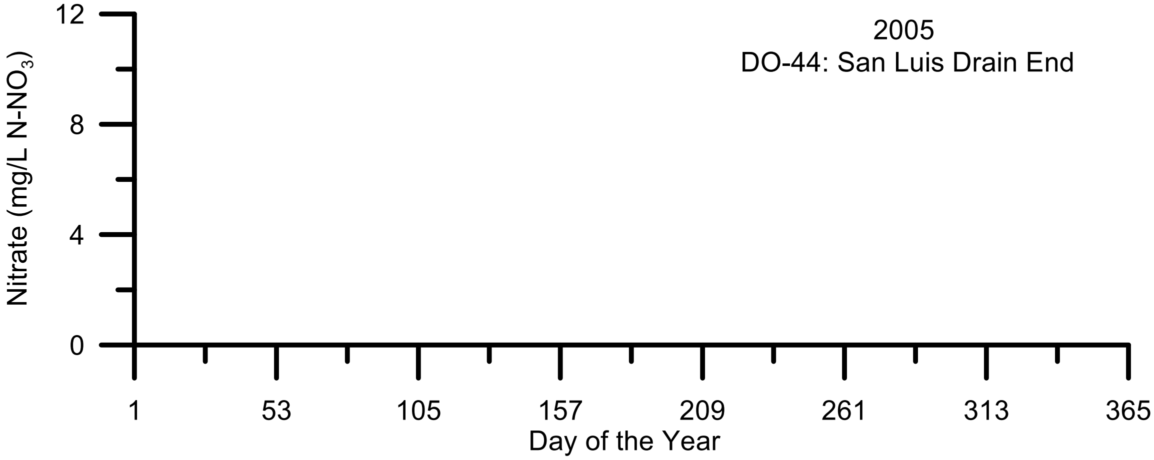

2006
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

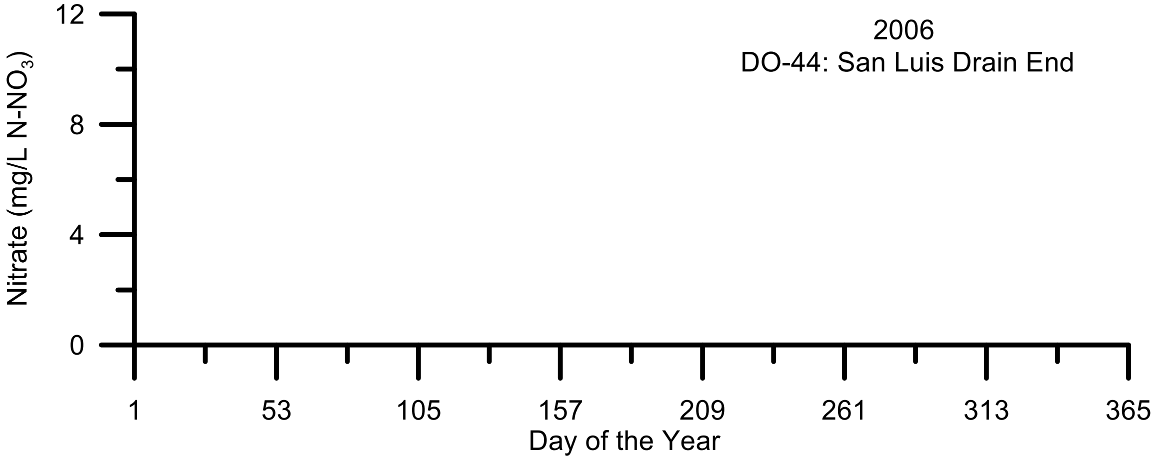

2007
DO-34: Ingram Creek Flow Station
Nitrate (mg/L N-NO3)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

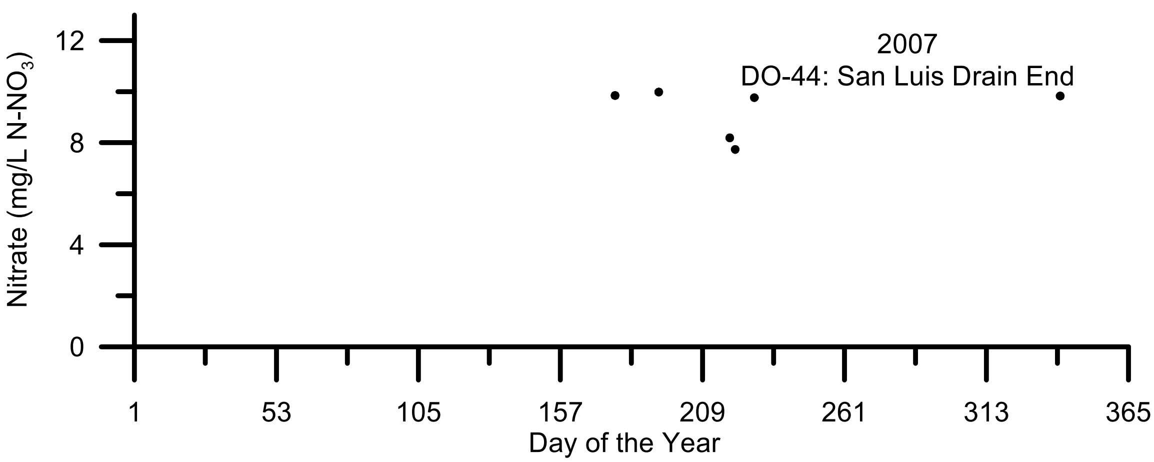

2005
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO3)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

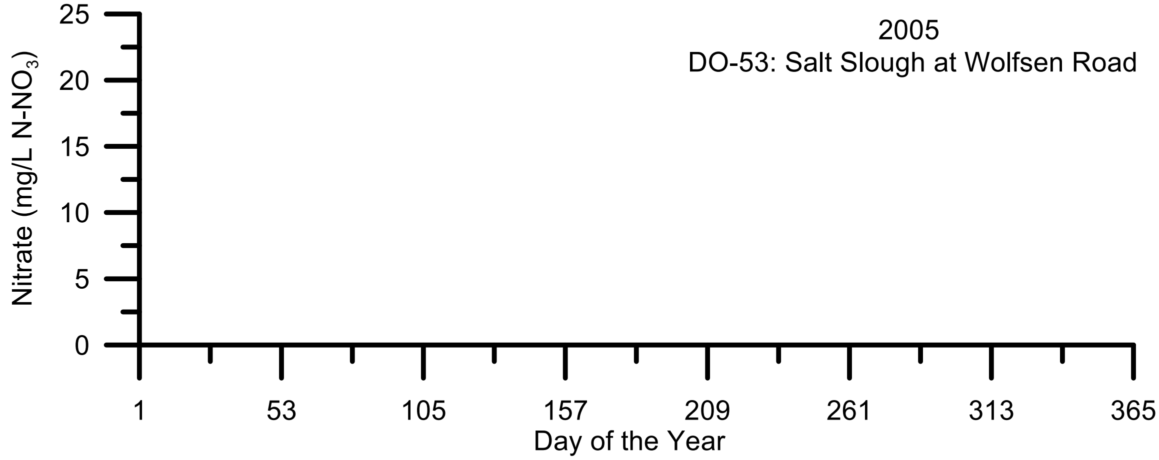

2006
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO3)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

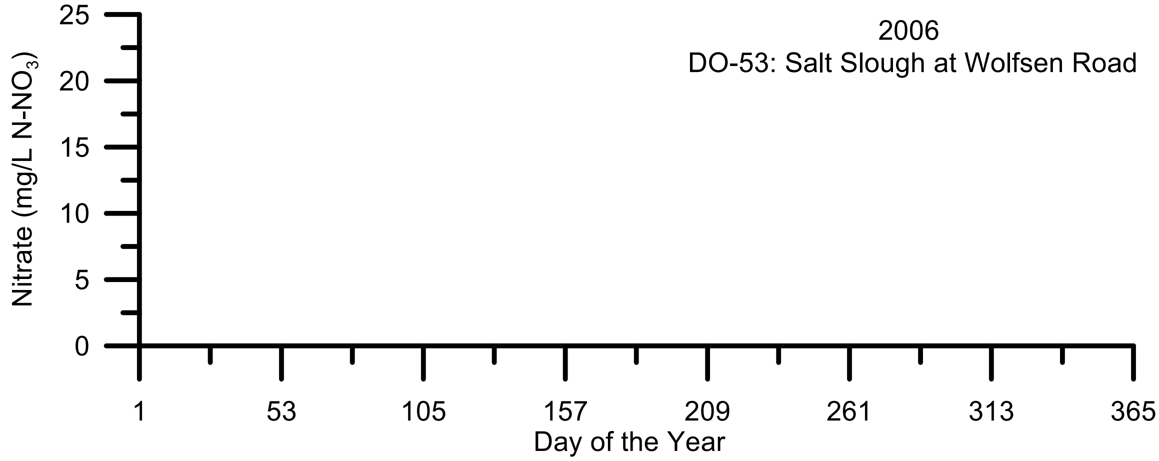

2007
DO-36: Del Puerto Creek Flow Station
Nitrate (mg/L N-NO3)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

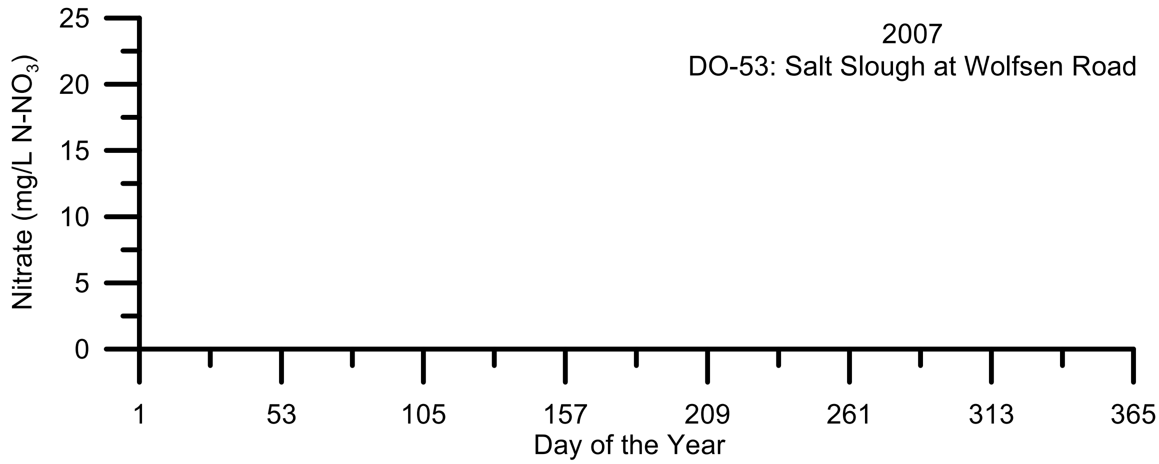

2005
DO-44: San Luis Drain End
Nitrate (mg/L N-NO3)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

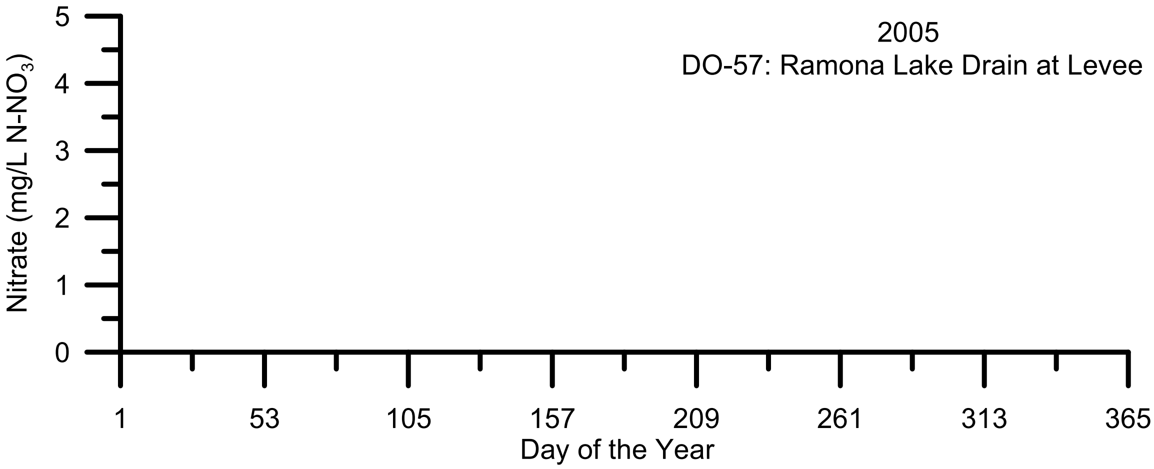

2006
DO-44: San Luis Drain End
Nitrate (mg/L N-NO3)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

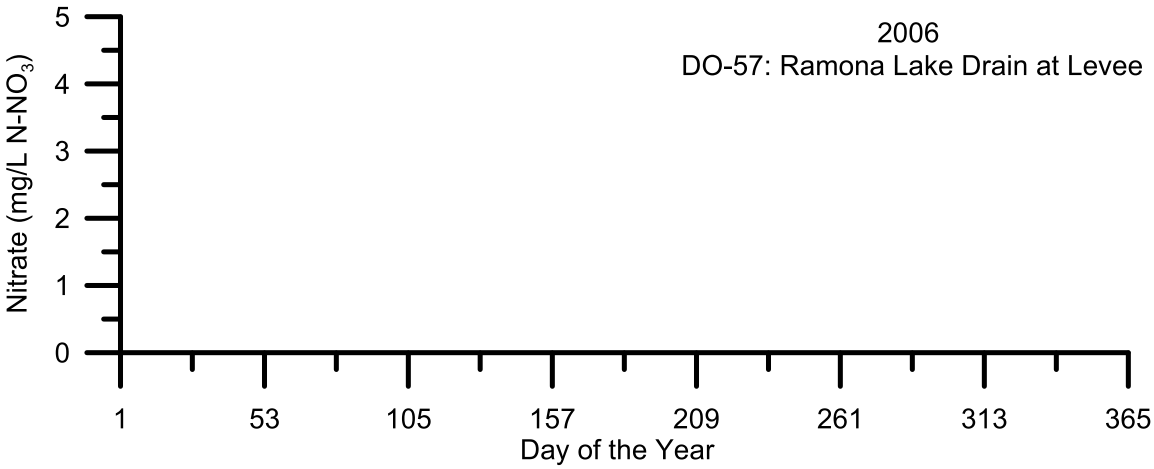

2007
DO-44: San Luis Drain End
Nitrate (mg/L N-NO3)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

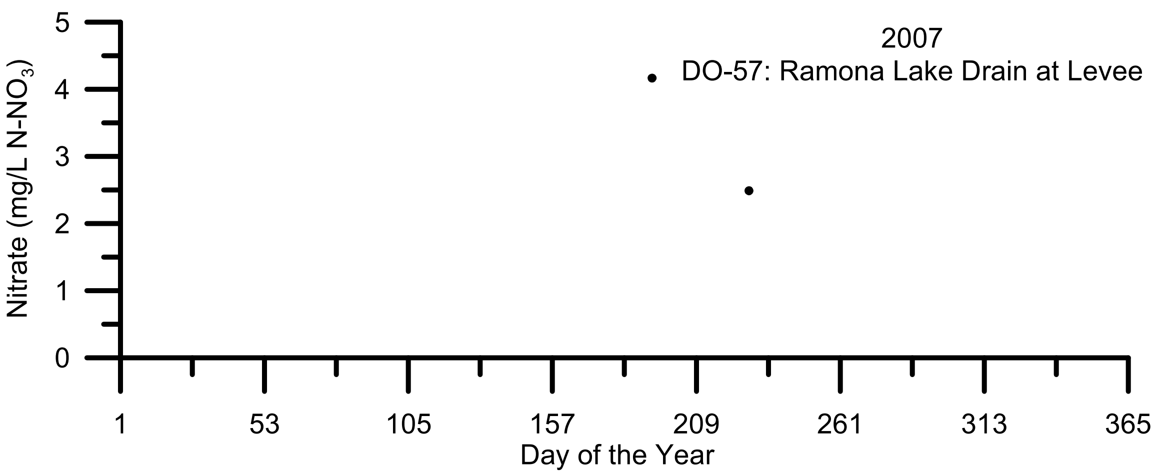

2005
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO_3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

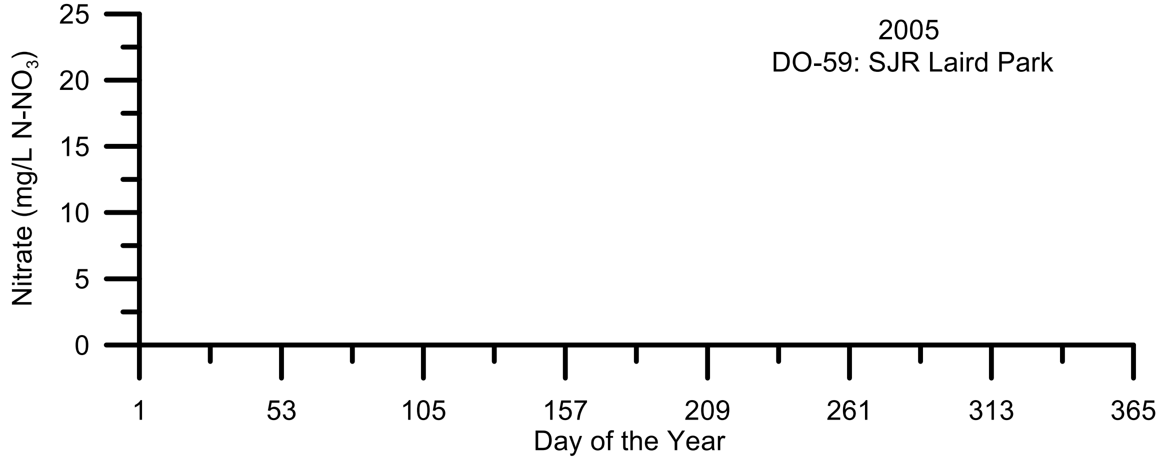

2006
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO_3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

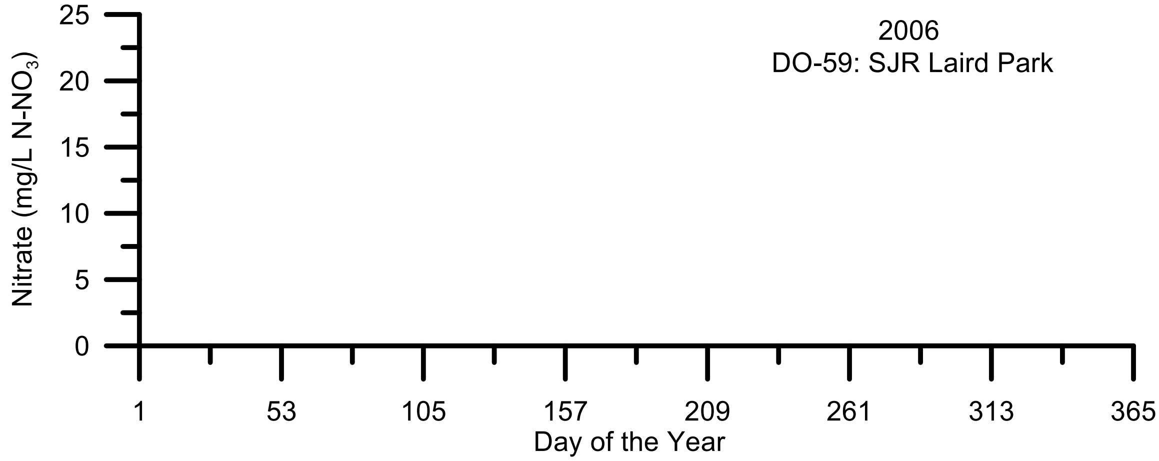

2007
DO-53: Salt Slough at Wolfsen Road
Nitrate (mg/L N-NO_3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

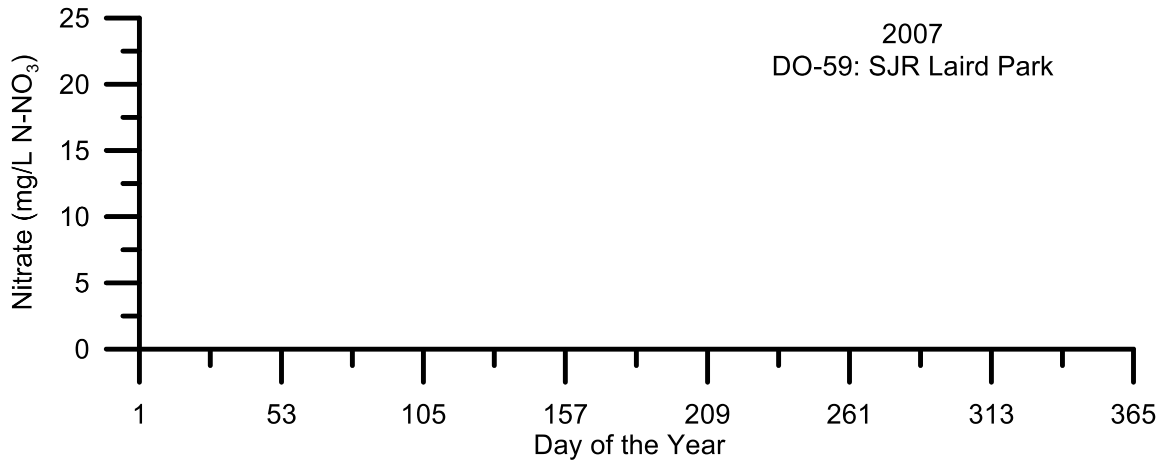

2005
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

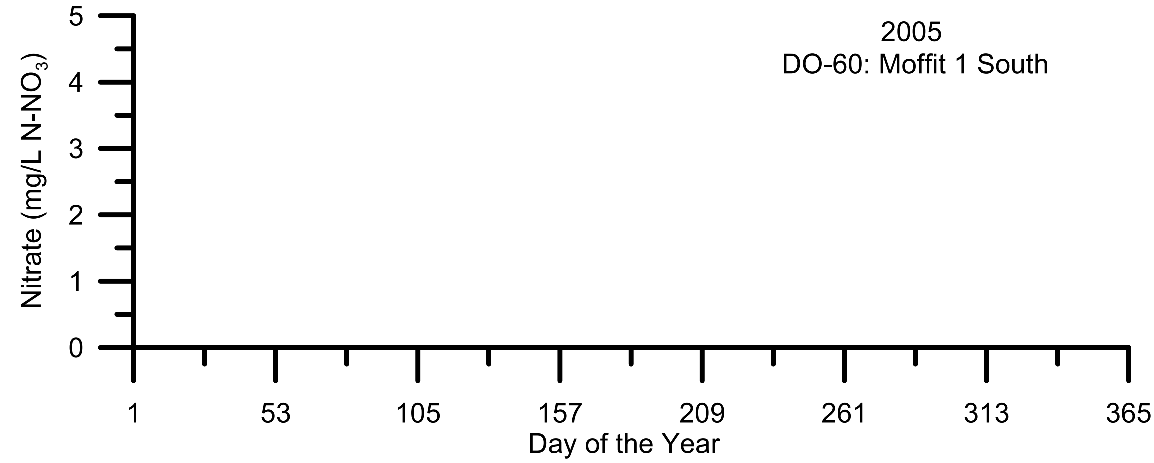

2006
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-57: Ramona Lake Drain at Levee
Nitrate (mg/L N-NO3)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

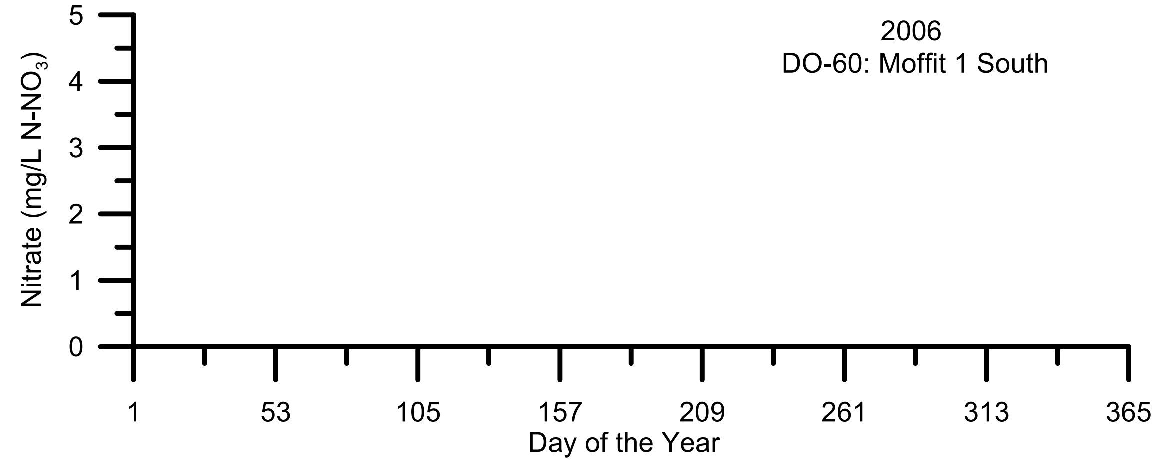

2005
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

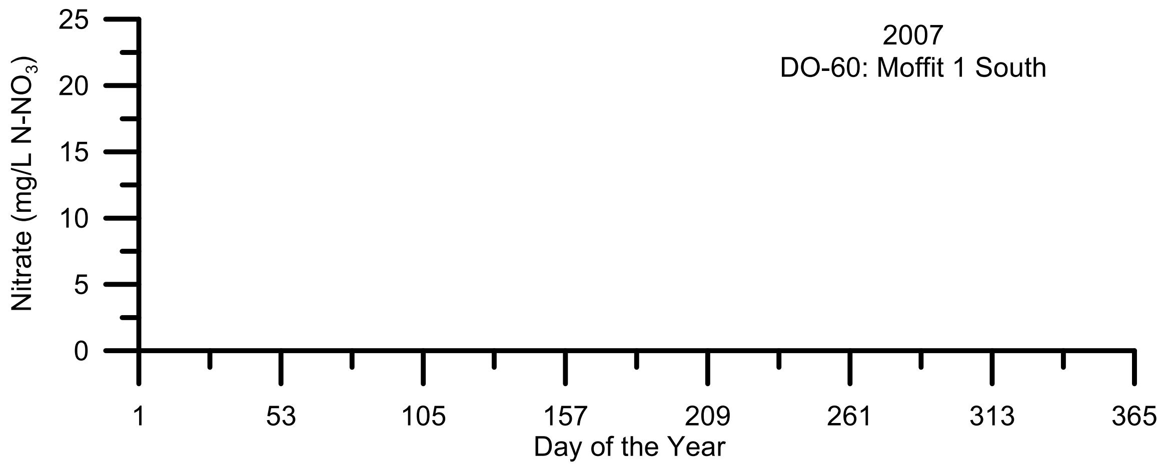

2007
DO-59: SJR Laird Park
Nitrate (mg/L N-NO3)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year



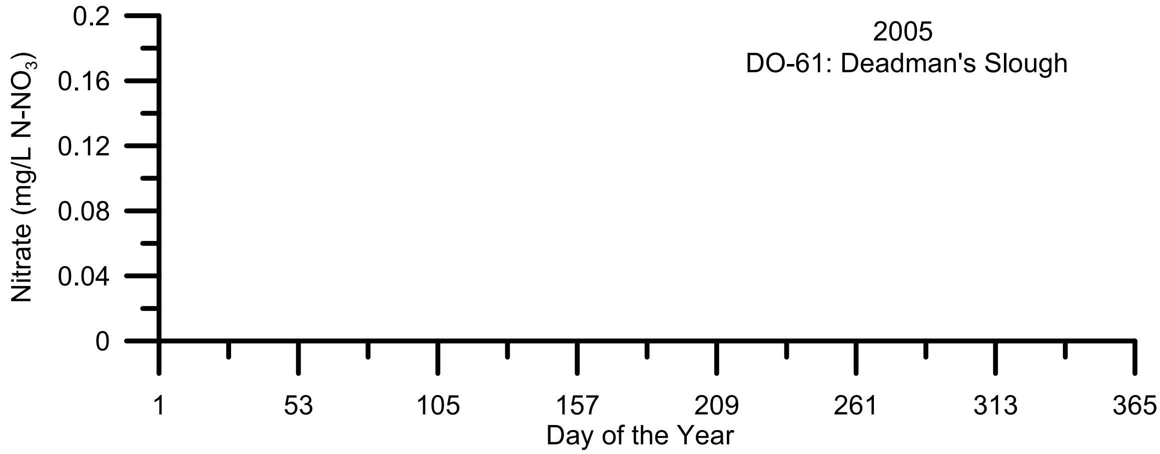
2005
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

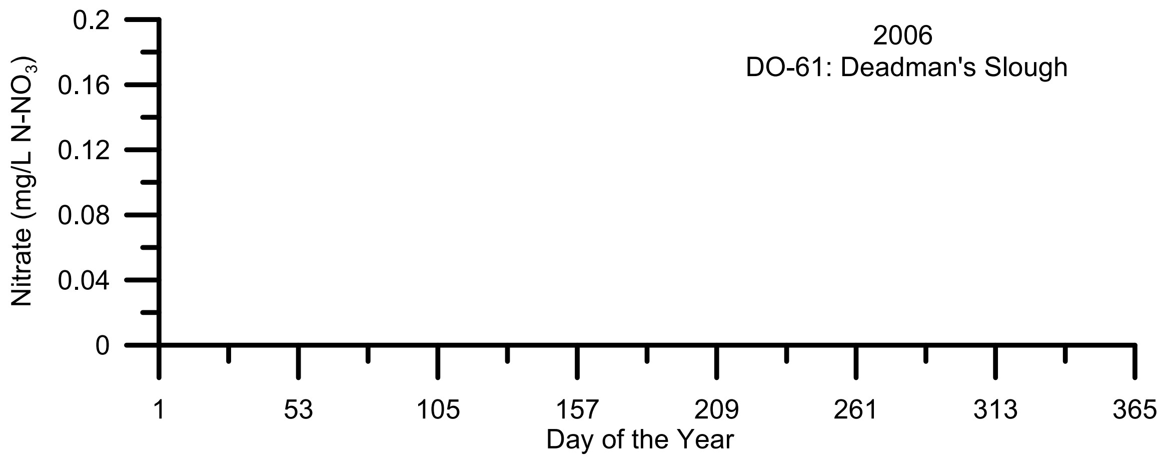


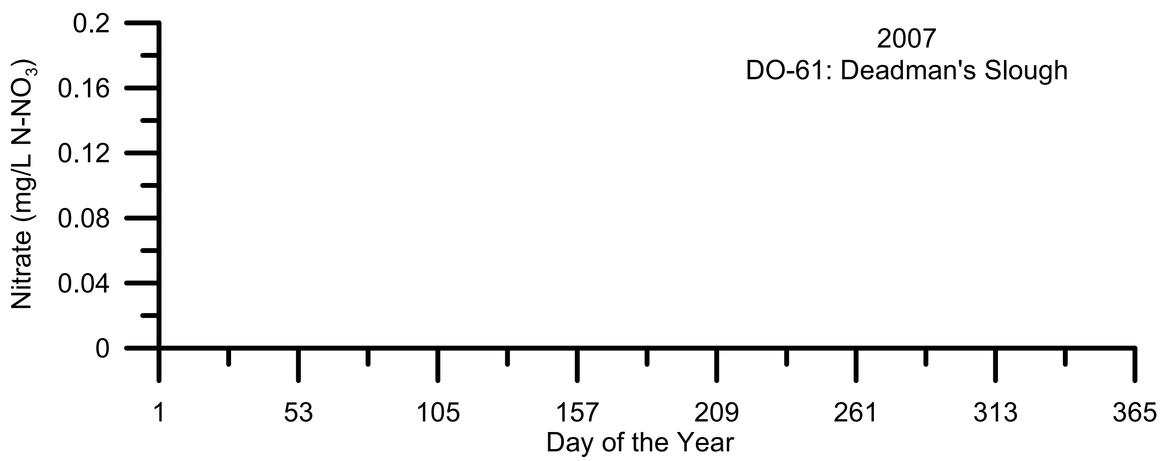
2006
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

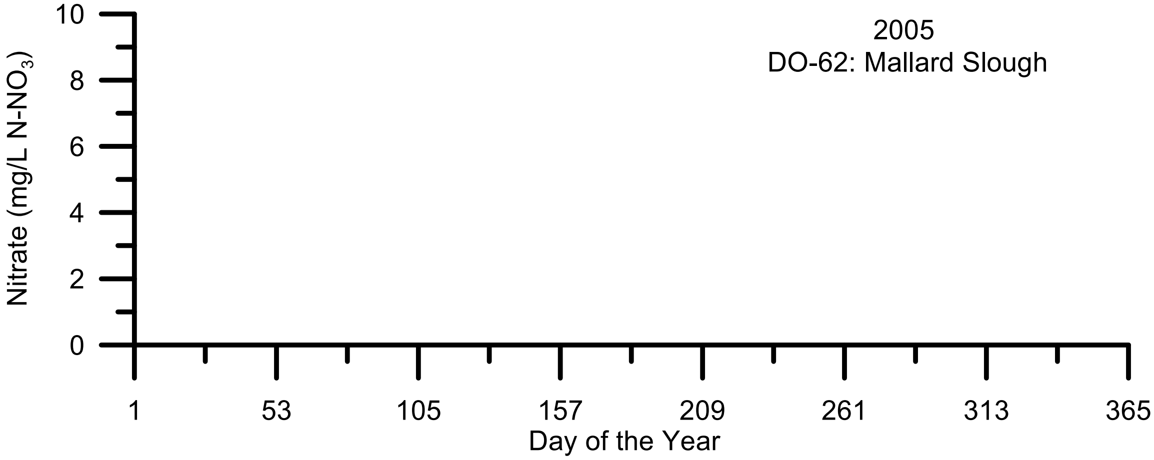


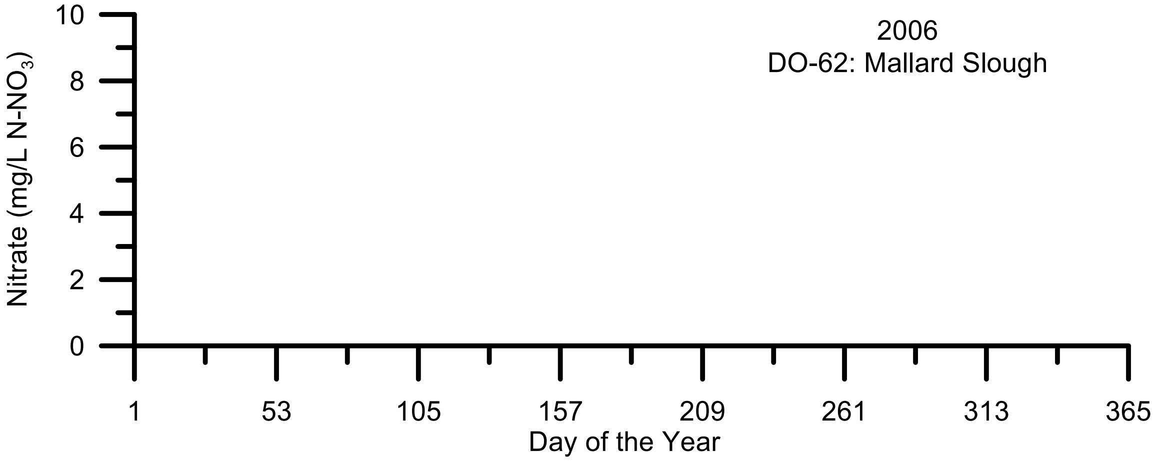
2007
DO-60: Moffit 1 South
Nitrate (mg/L N-NO3)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

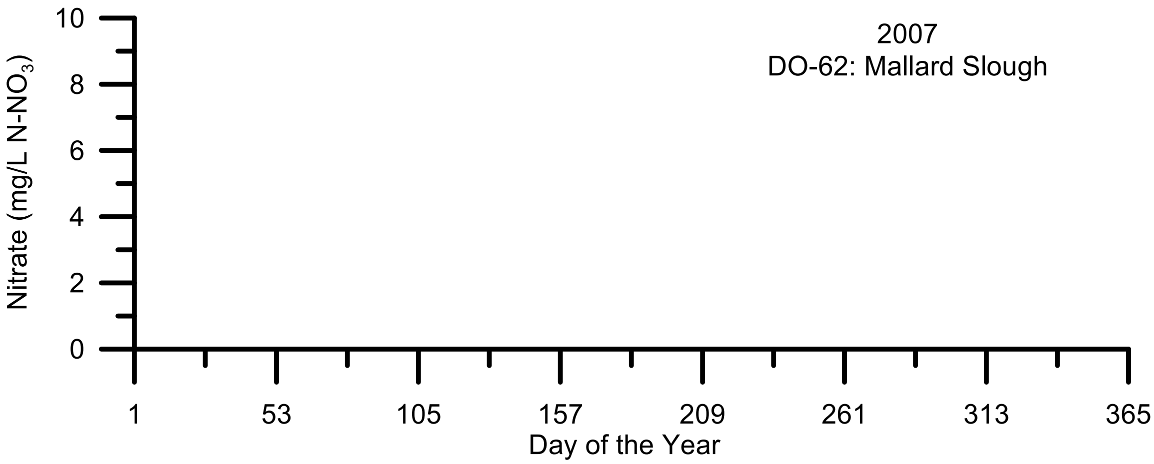

2005
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

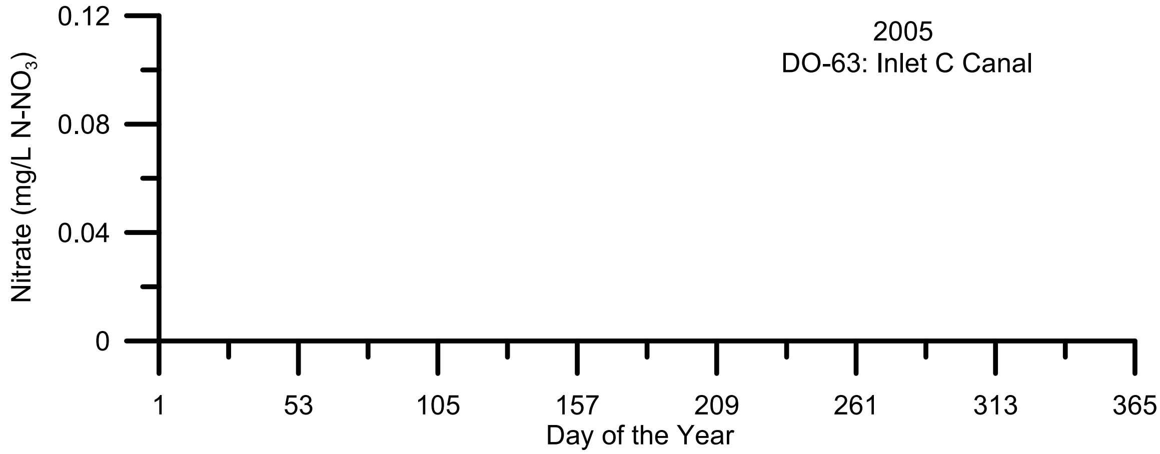

2006
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-61: Deadman's Slough
Nitrate (mg/L N-NO3)
0.2
0.16
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

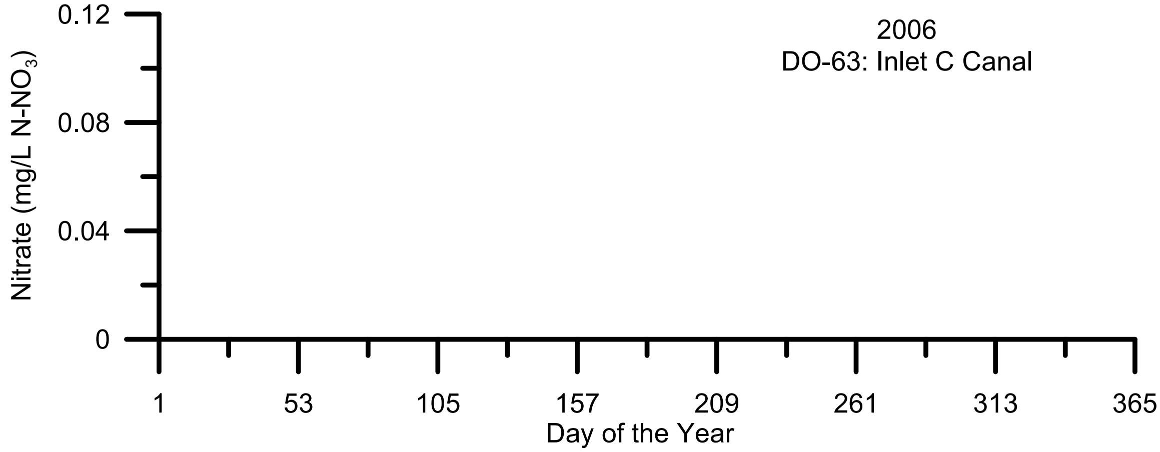

2005
DO-62: Mallard Slough
Nitrate (mg/L N-NO$_3$)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-62: Mallard Slough
Nitrate (mg/L N-NO$_3$)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

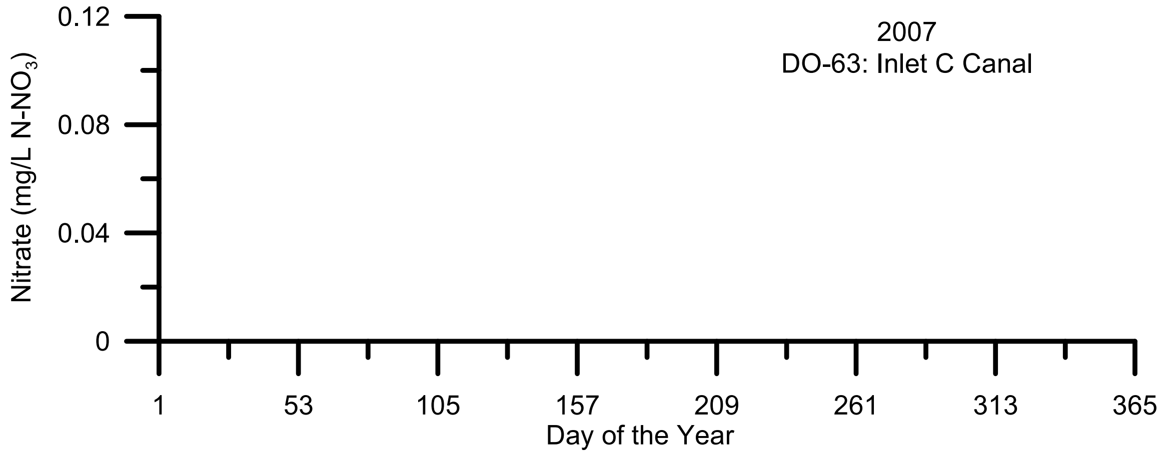

2007
DO-62: Mallard Slough
Nitrate (mg/L N-NO$_3$)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year



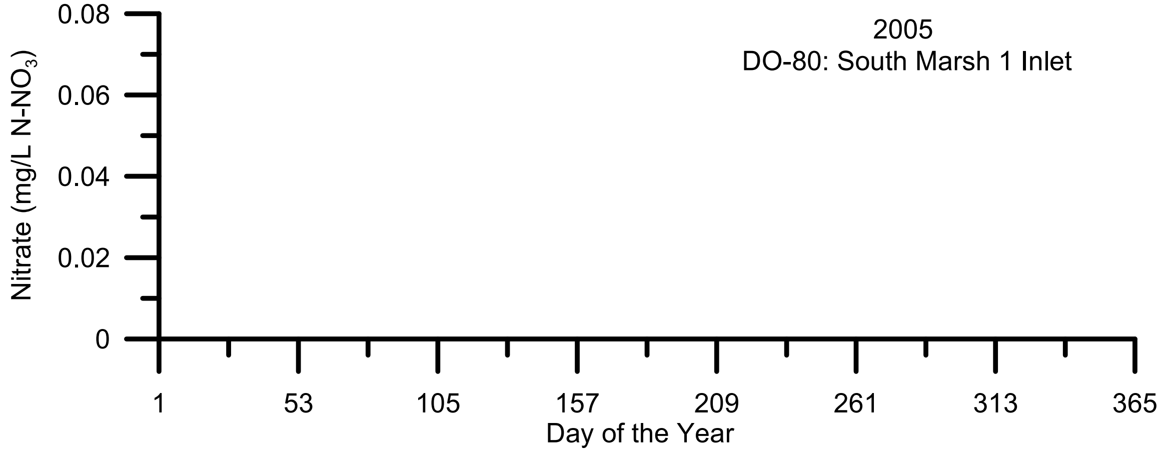
2005
DO-63: Inlet C Canal
Nitrate (mg/L N-NO$_3$)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

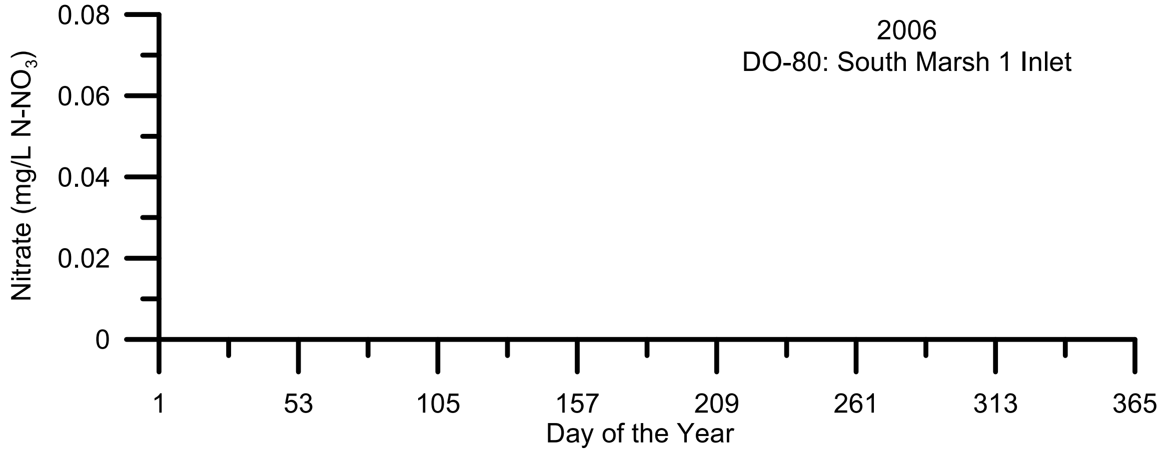


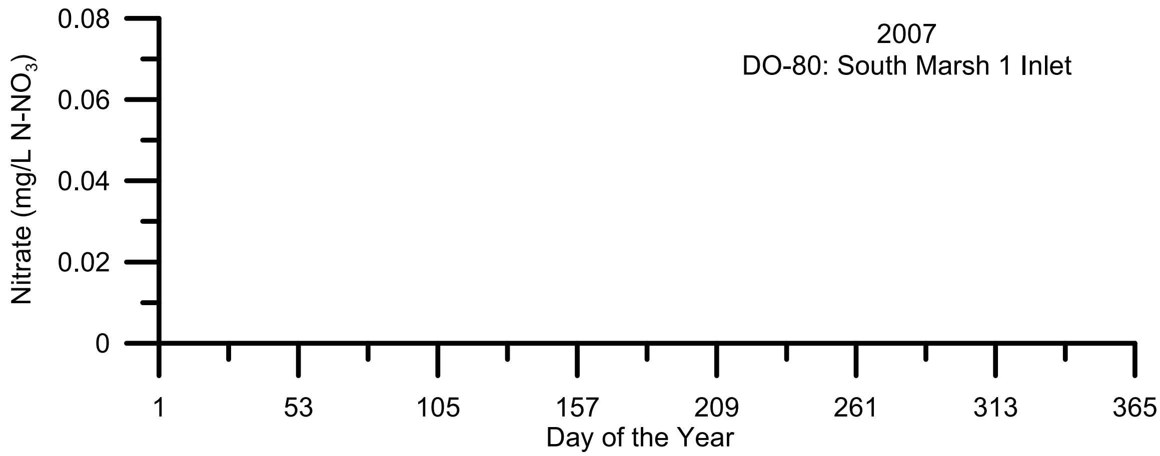
2006
DO-63: Inlet C Canal
Nitrate (mg/L N-NO$_3$)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

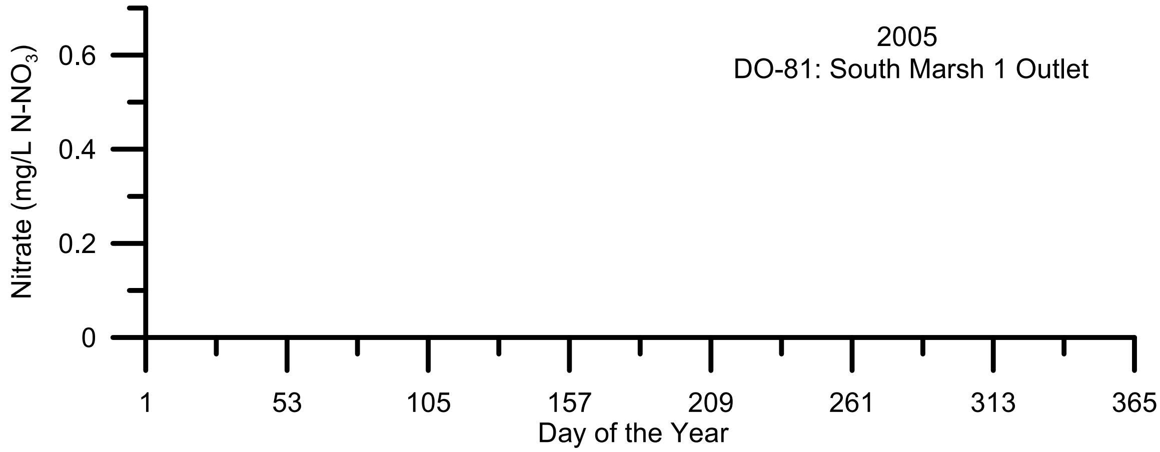


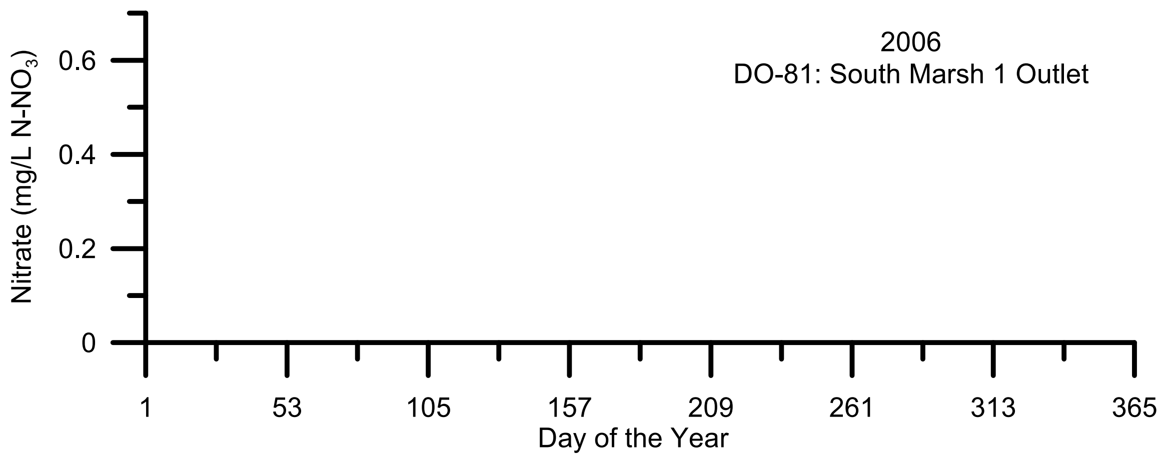
2007
DO-63: Inlet C Canal
Nitrate (mg/L N-NO$_3$)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

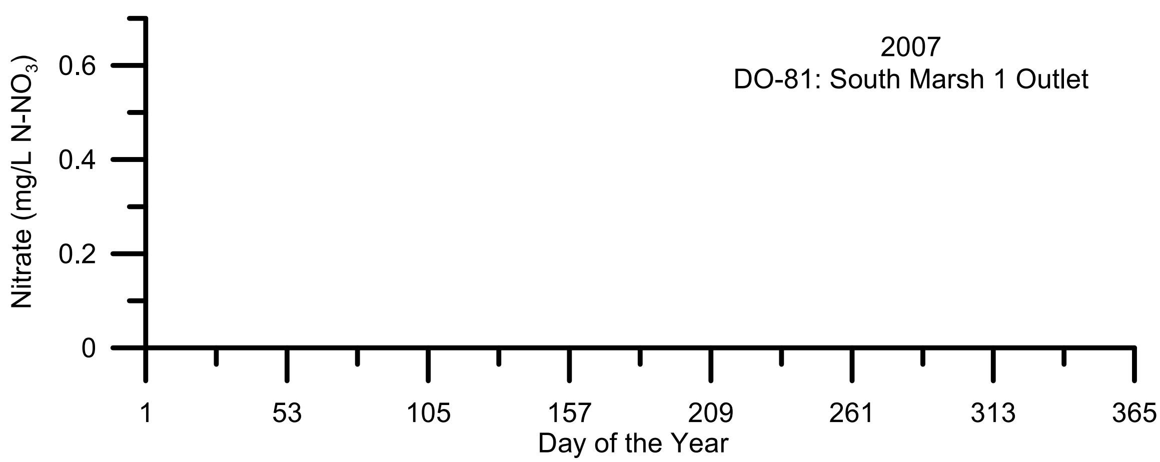

2005
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO$_3$)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

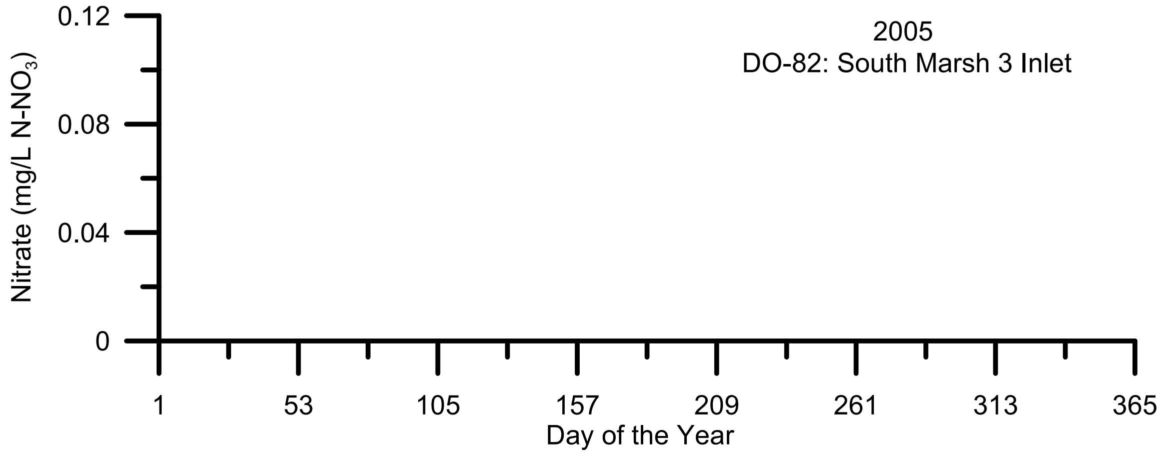

2006
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO$_3$)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

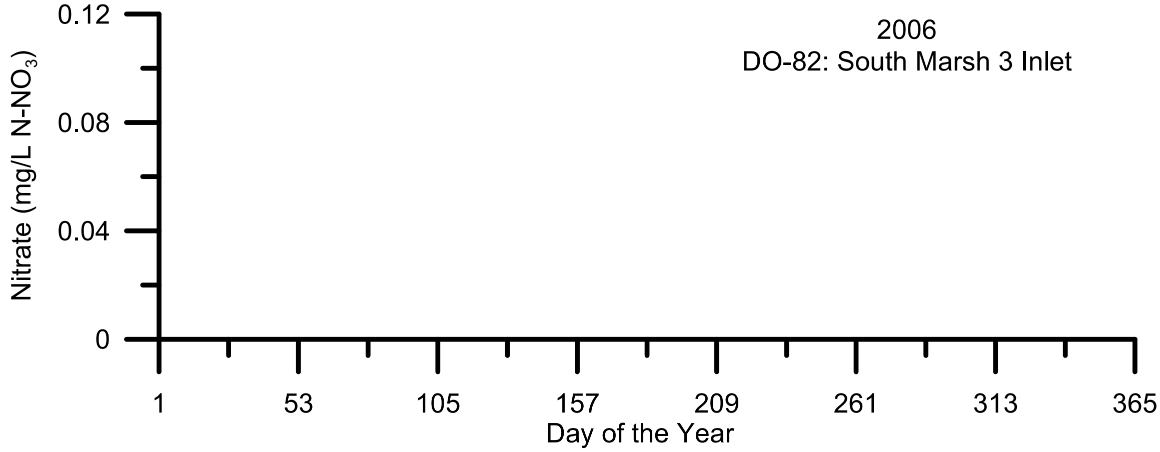

2007
DO-80: South Marsh 1 Inlet
Nitrate (mg/L N-NO$_3$)
0.08
0.06
0.04
0.02
0
1
53
105
157
209
261
313
365
Day of the Year

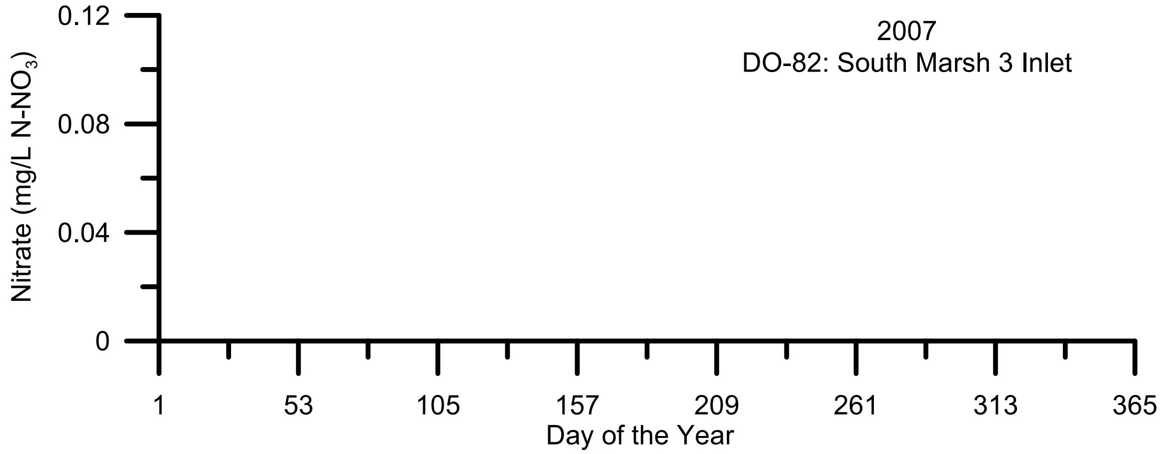

2005
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

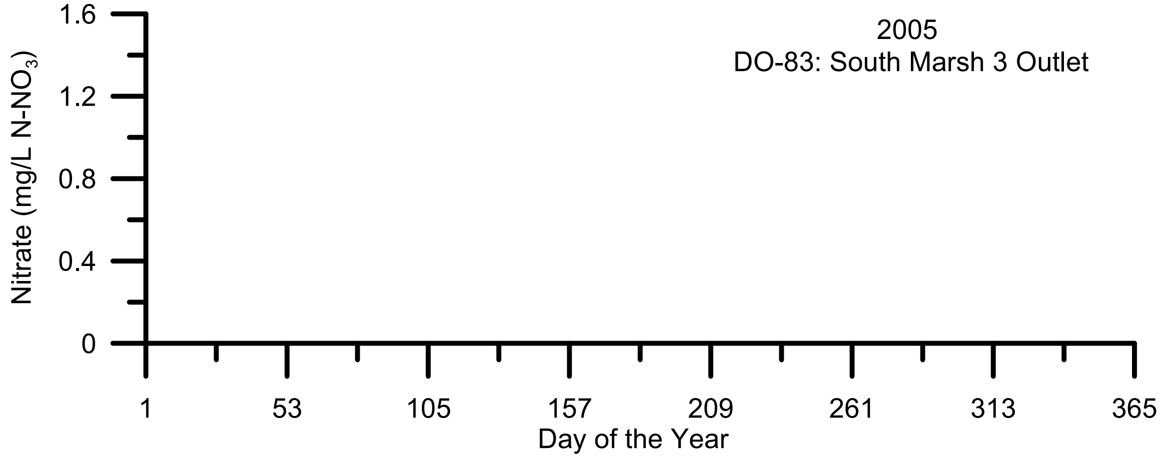

2006
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

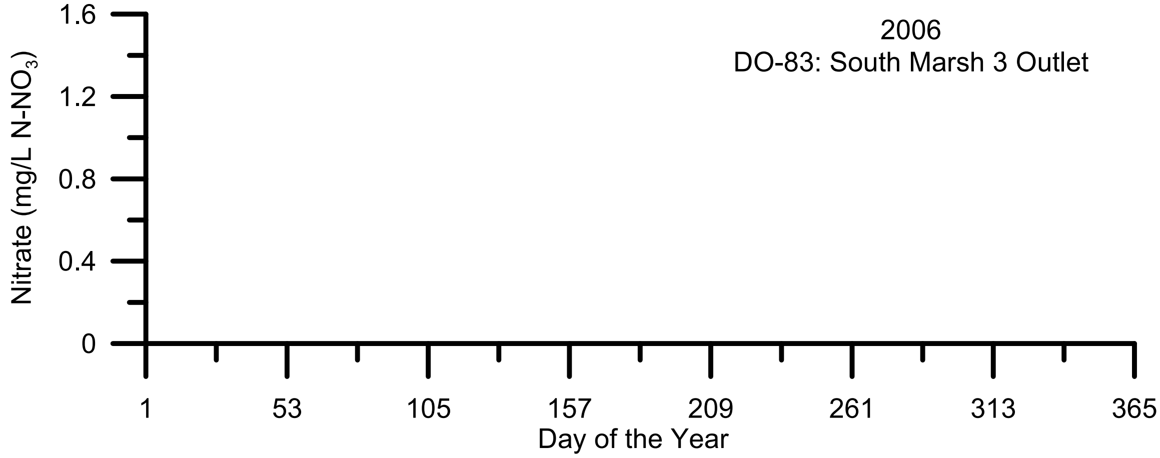

2007
DO-81: South Marsh 1 Outlet
Nitrate (mg/L N-NO3)
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

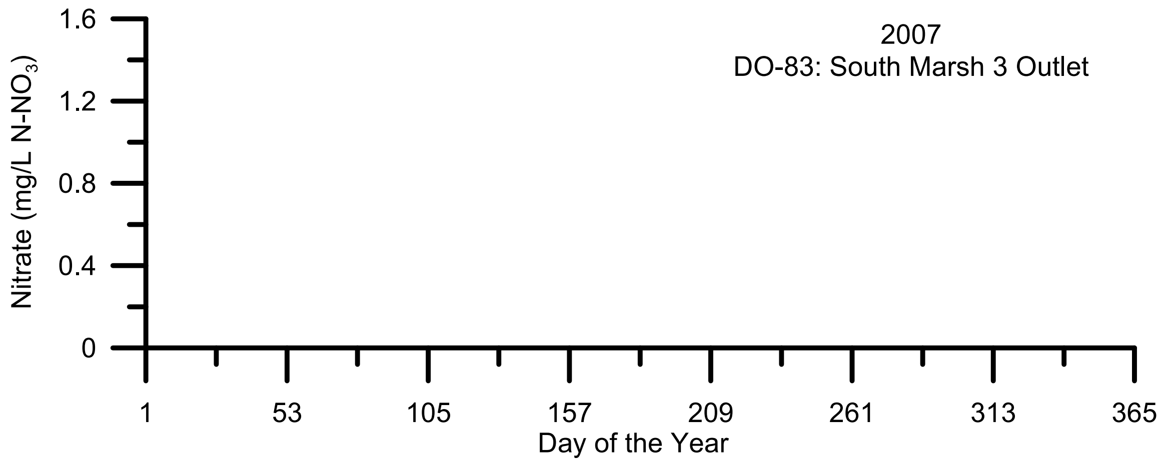

2005
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

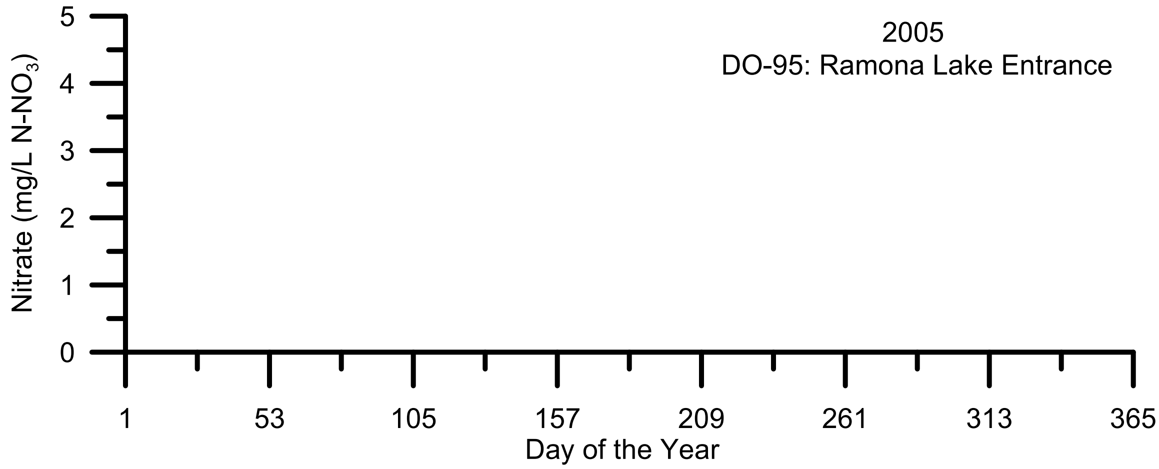

2006
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

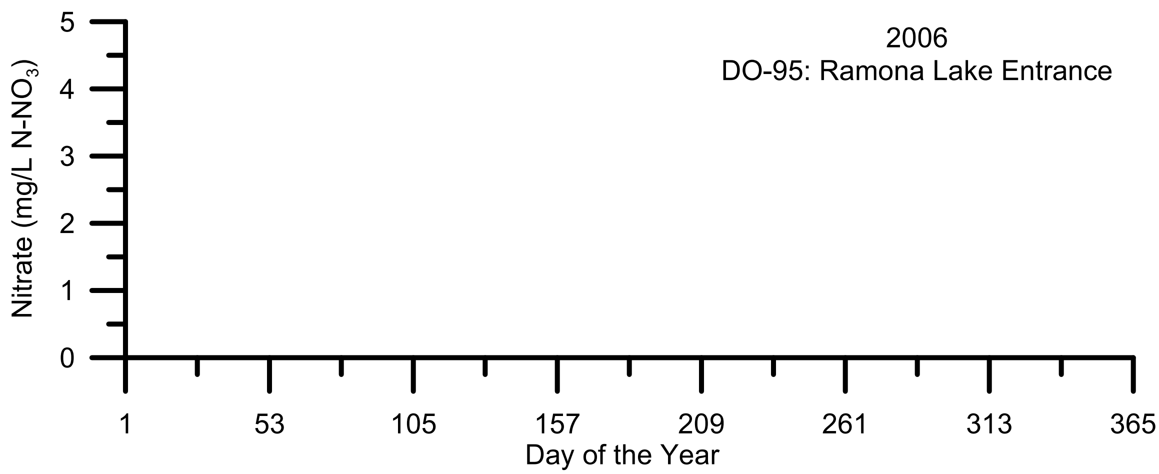

2007
DO-82: South Marsh 3 Inlet
Nitrate (mg/L N-NO3)
0.12
0.08
0.04
0
1
53
105
157
209
261
313
365
Day of the Year

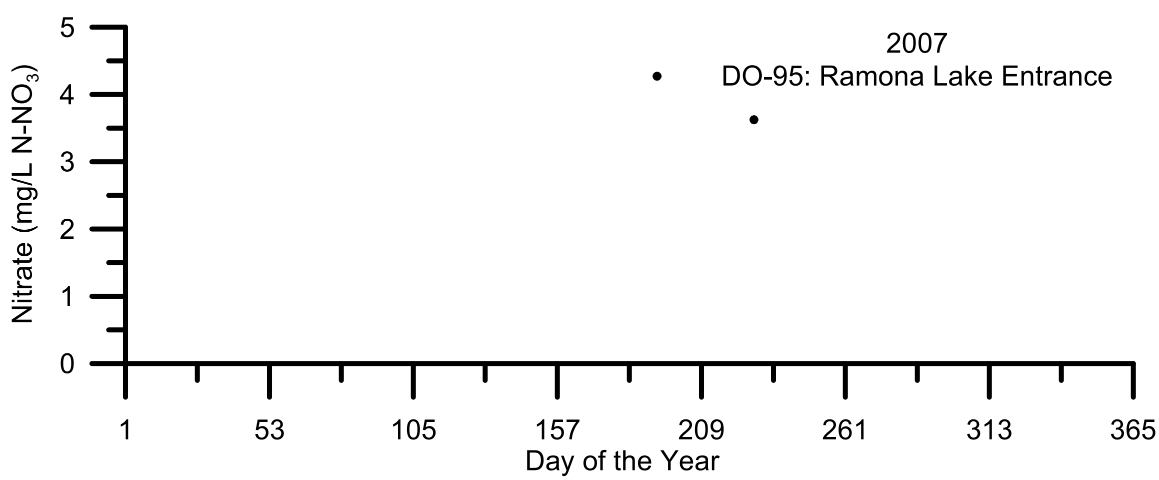

2005
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Nitrate (mg/L N-NO$_3$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO3)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO3)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Nitrate (mg/L N-NO3)
5
4
3
2
1
0
1
53
105
157
209
261
313
365
Day of the Year

Temporal Plots of 2005-2007 Dissolved Silica Data from the Upstream San Joaquin River

Chelsea Spier[1]
Remie Burks[1]
Sharon Borglin[1]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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School of Engineering & Computer Sciences
University of the Pacific
3601 Pacific Avenue, Sears Hall
Stockton, CA 95211

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of dissolved silica (SiO_2-Si) data analyzed by the EERP laboratory starting in April of 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham et al, 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were filtered through 45µm pore size plastic syringe filters and 10 mL disposable plastic syringes (Henke Sass Wolf, Tuttlingen, Germany) to remove filterable solids. Samples were then alquotted and stored at 4°C until SiO_2-Si analysis could be completed. All SiO_2-Si samples were collected and stored in plastic containers. Samples were analyzed within 28 days of collection.

SiO_2-Si concentration was determined using a modified Heteropoly Blue molybdosilicate method SM 4500-SiO_2 D (APHA, 2005) and (Borglin et al, 2008) using Hach reagents (Loveland, CO) and light absorbance measurements were taken at both 650nm and 815nm. The reportable limit for this method is 0.05 mg/L SiO_2-Si (Borglin et al, 2008).

Results/Discussion

With each set of SiO_2-Si field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. 100% of all quality assurance samples were within a passing range (Borglin et al, 2008). Samples were measured ranging from 0.05-26.3 mg/L SiO_2-Si. The average concentration of SiO2-Si in samples collected was 7.39 mg/L SiO_2-Si. In general SiO_2-Si was lowest during April and May and increased over the rest of the year.

These temporal plots (Figures 2-103) created an easy visual way to find outliers and double check data entry for possible mistakes.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

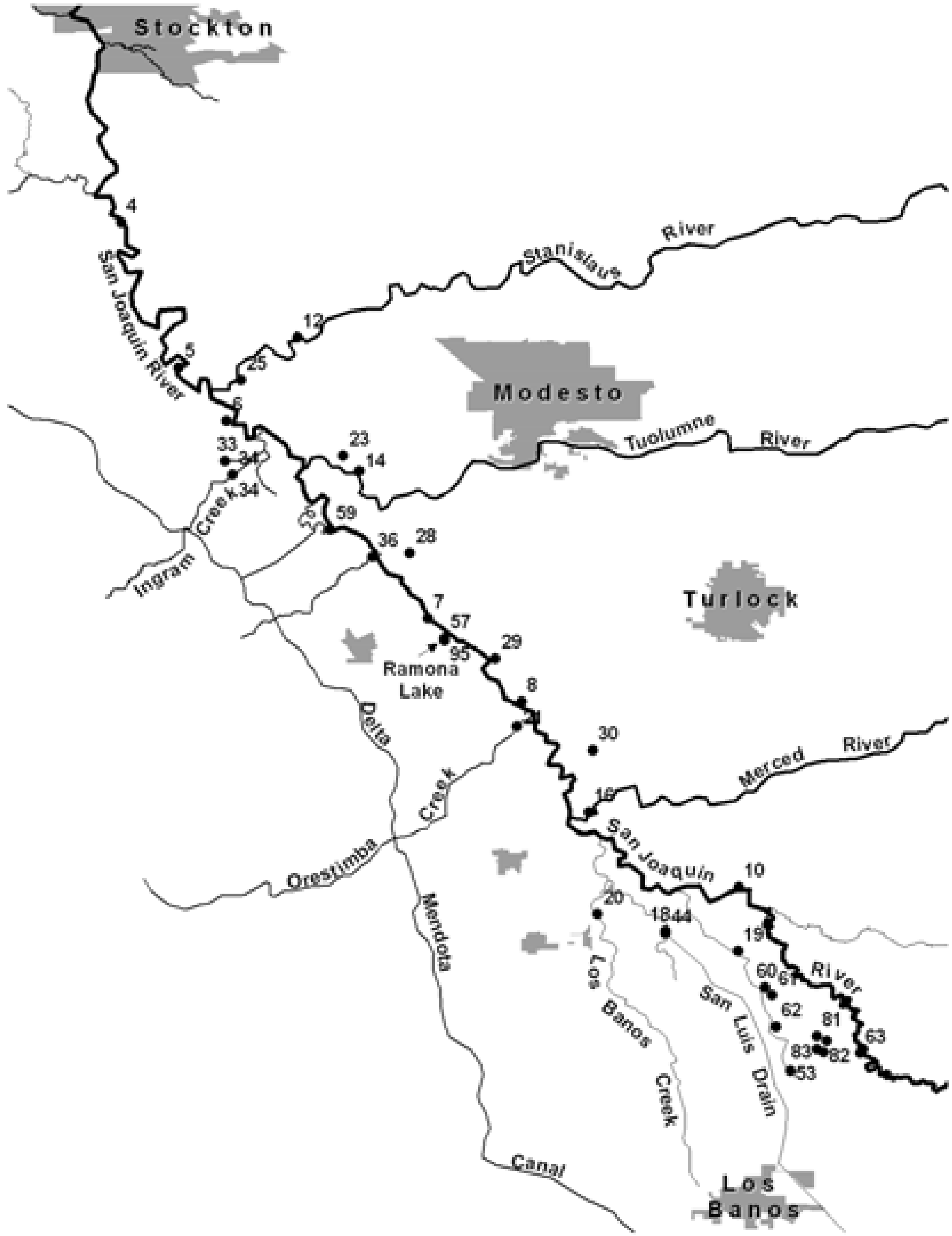
Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

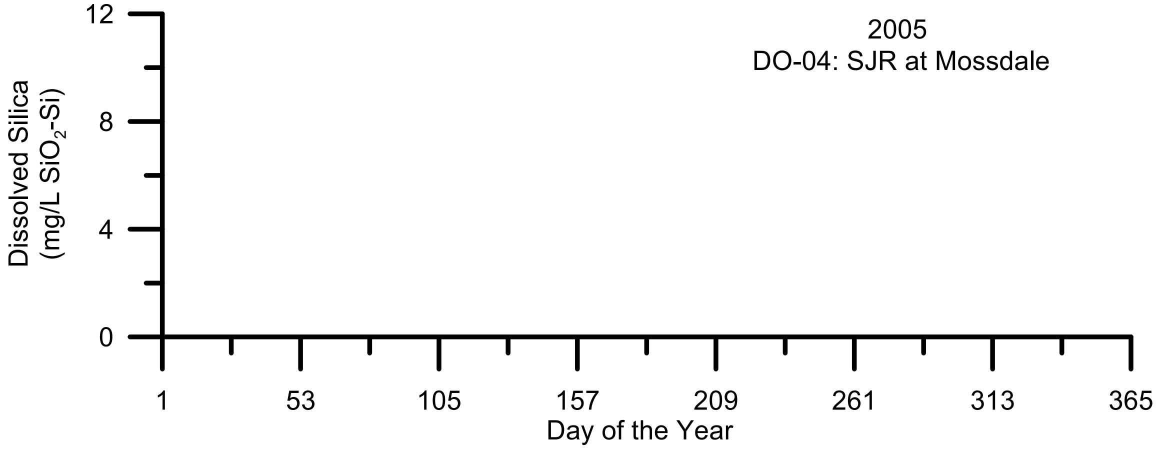
Table 1: EERP Sampling Site List

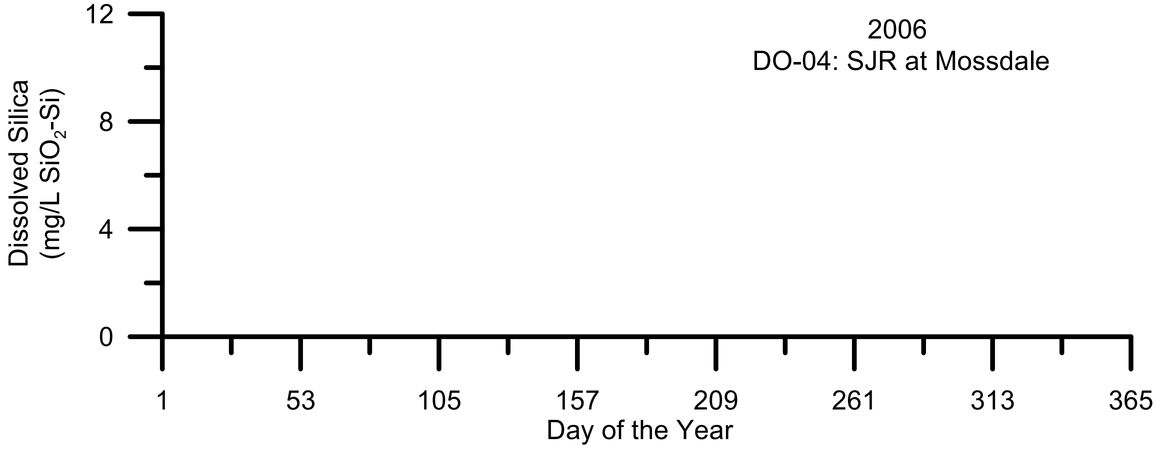
DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

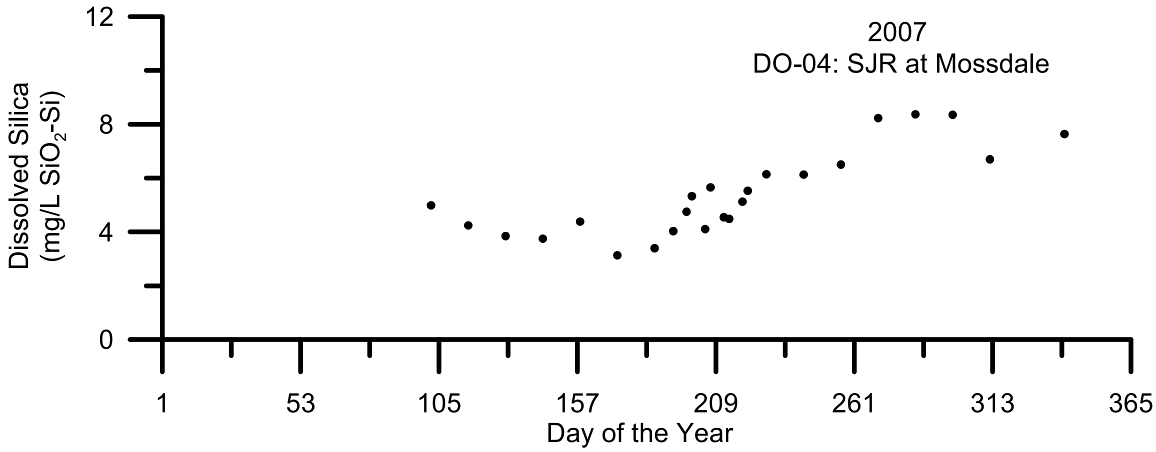
Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries

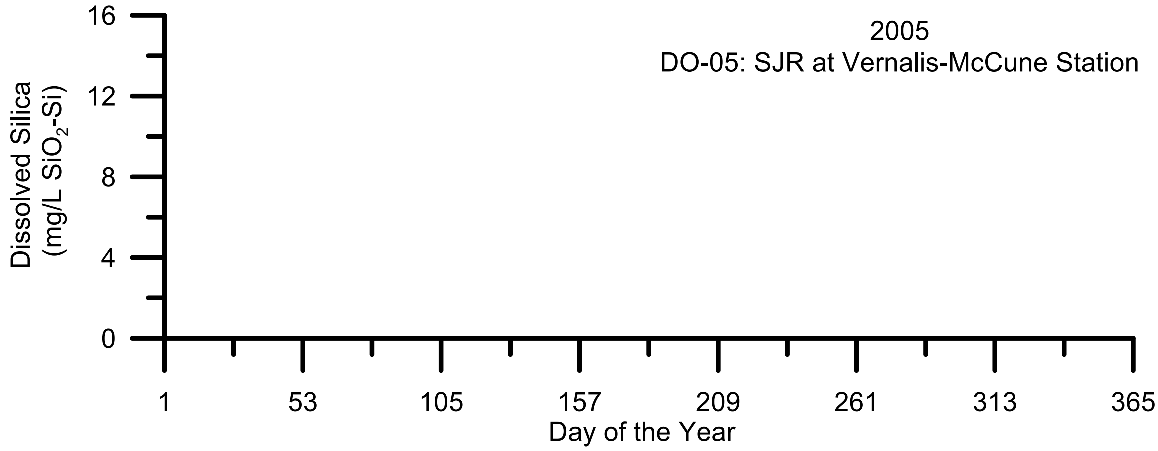


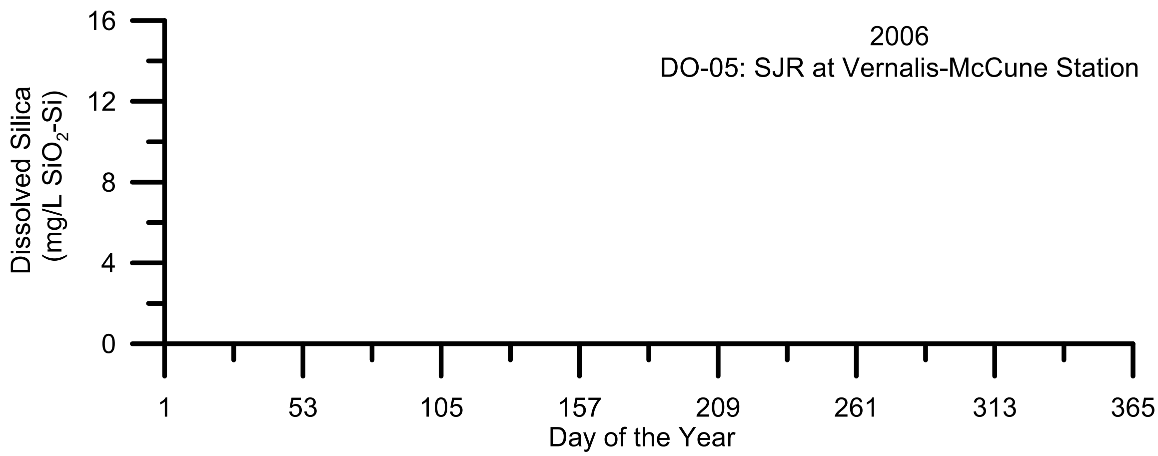
Figures 2 -103: Temporal Plots of SiO_2-Si By Site ID

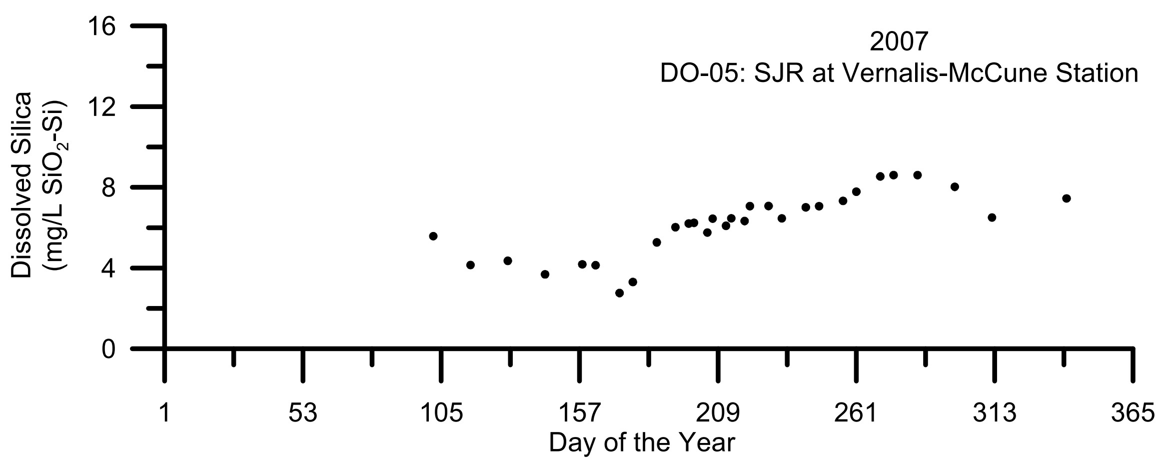


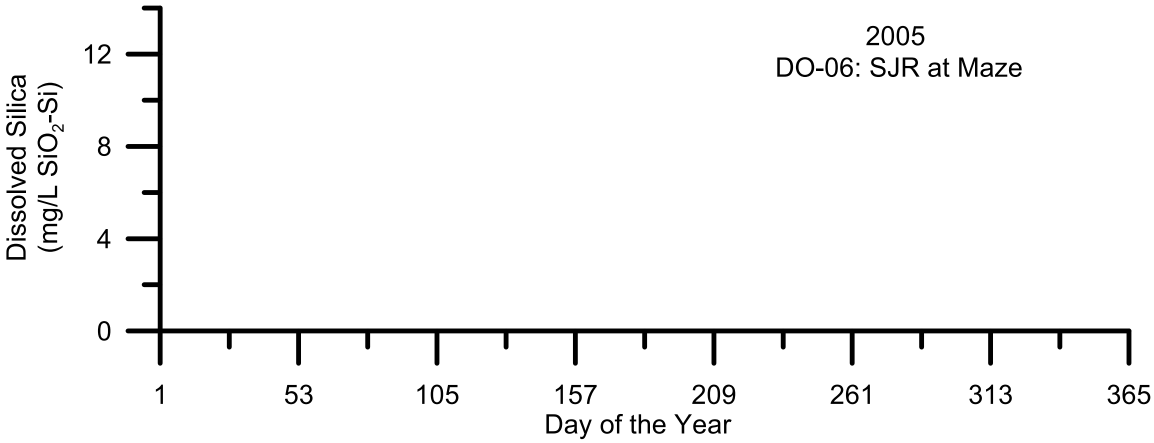


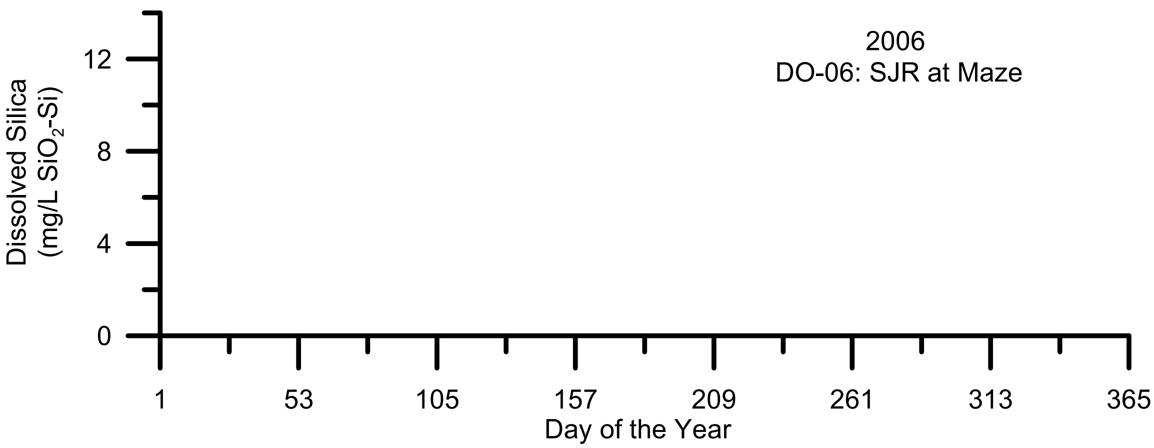


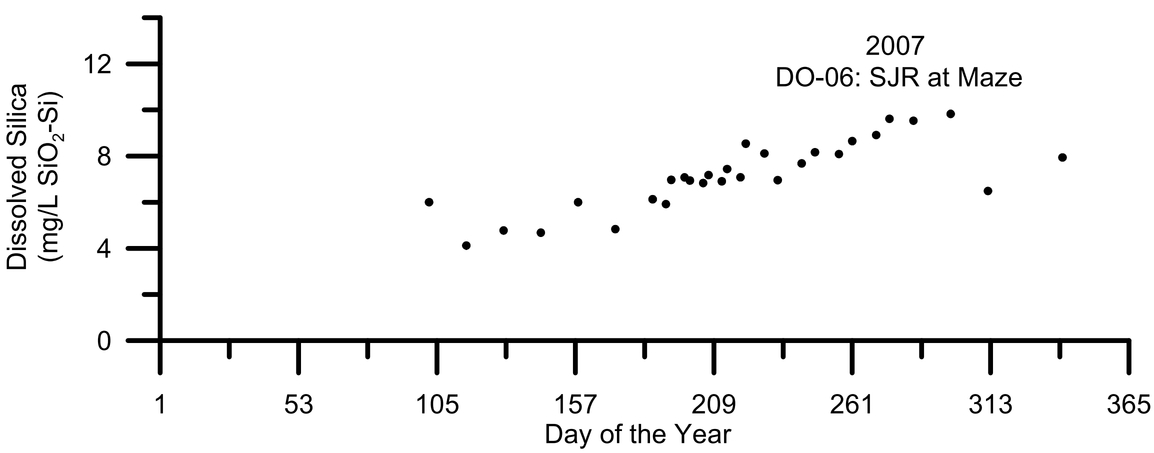

2005
DO-05: SJR at Vernalis-McCune Station
Dissolved Silica
(mg/L SiO_2-Si)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

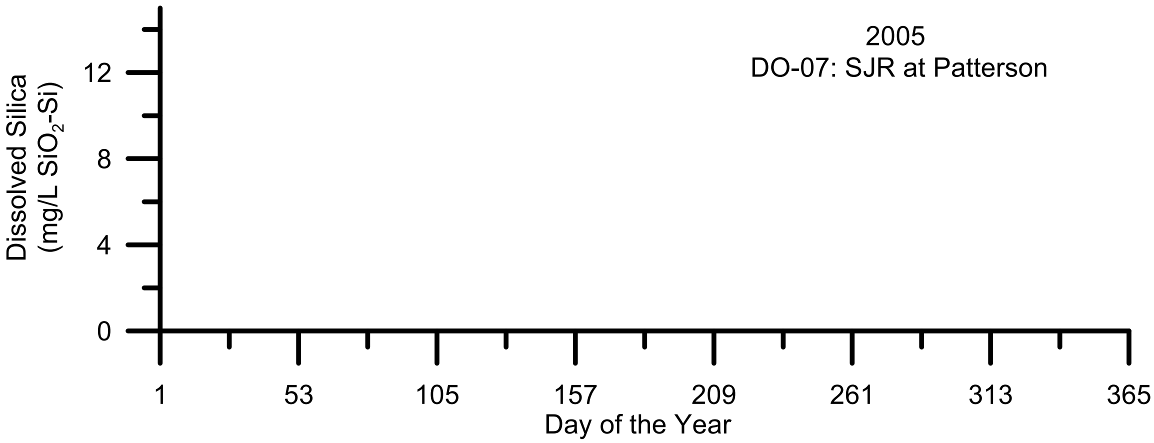

2006
DO-05: SJR at Vernalis-McCune Station
Dissolved Silica
(mg/L SiO_2-Si)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

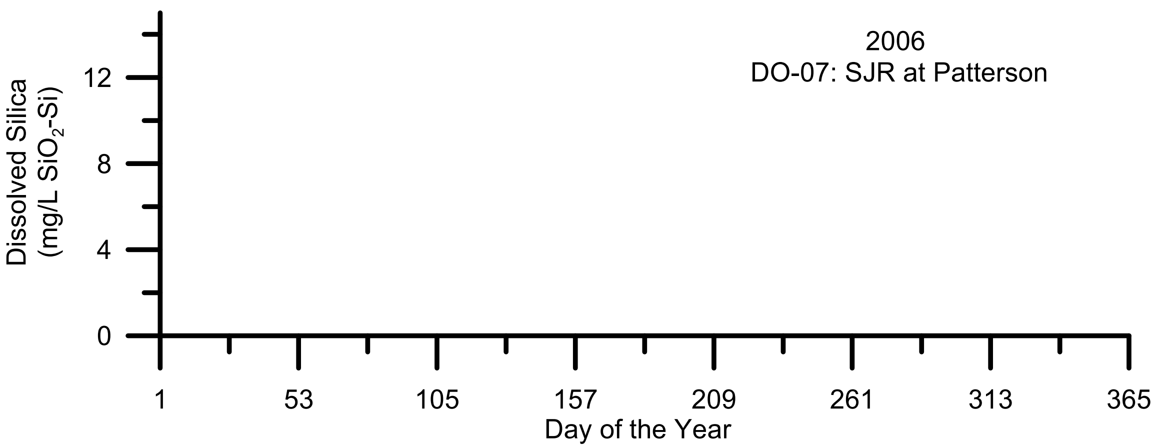

2007
DO-05: SJR at Vernalis-McCune Station
Dissolved Silica
(mg/L SiO_2-Si)
16
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

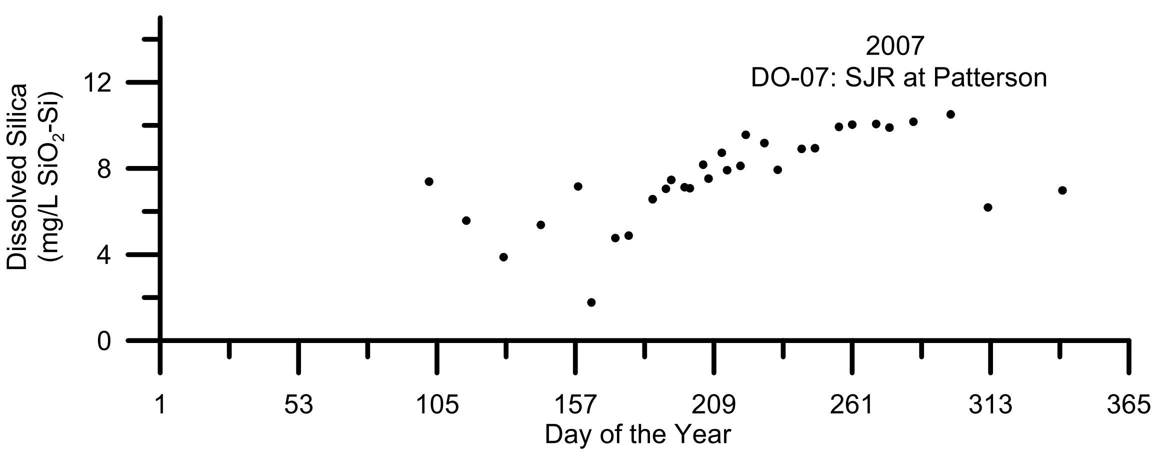

2005
DO-06: SJR at Maze
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

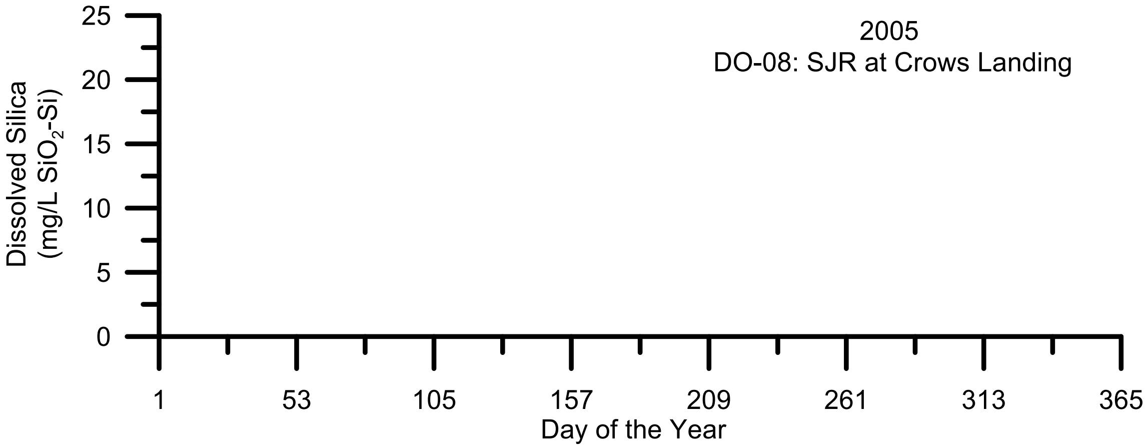

2006
DO-06: SJR at Maze
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

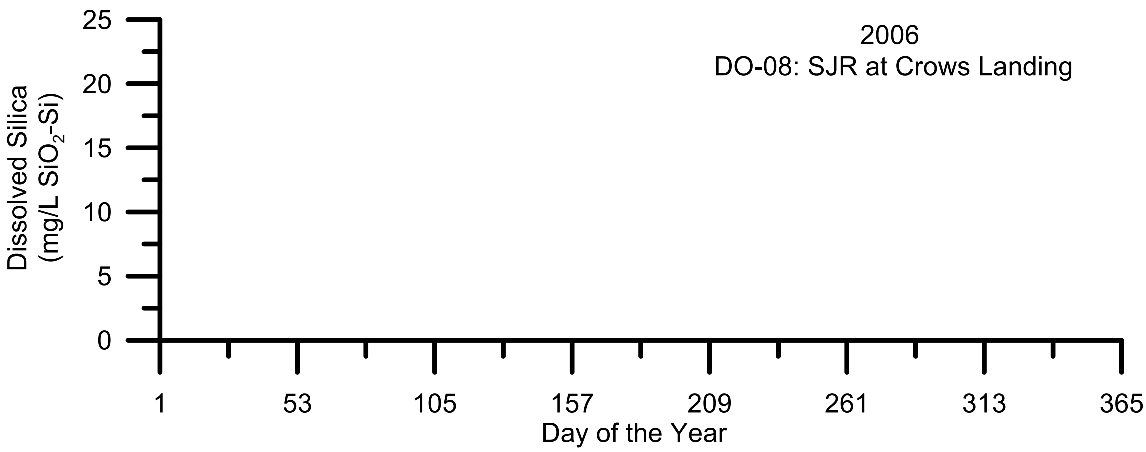

2005
DO-07: SJR at Patterson
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-07: SJR at Patterson
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

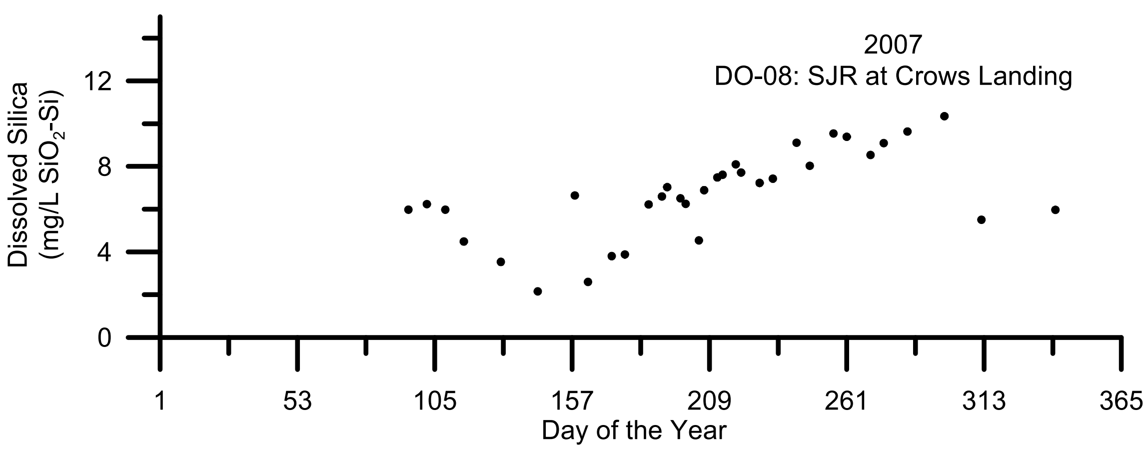

2007
DO-07: SJR at Patterson
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year



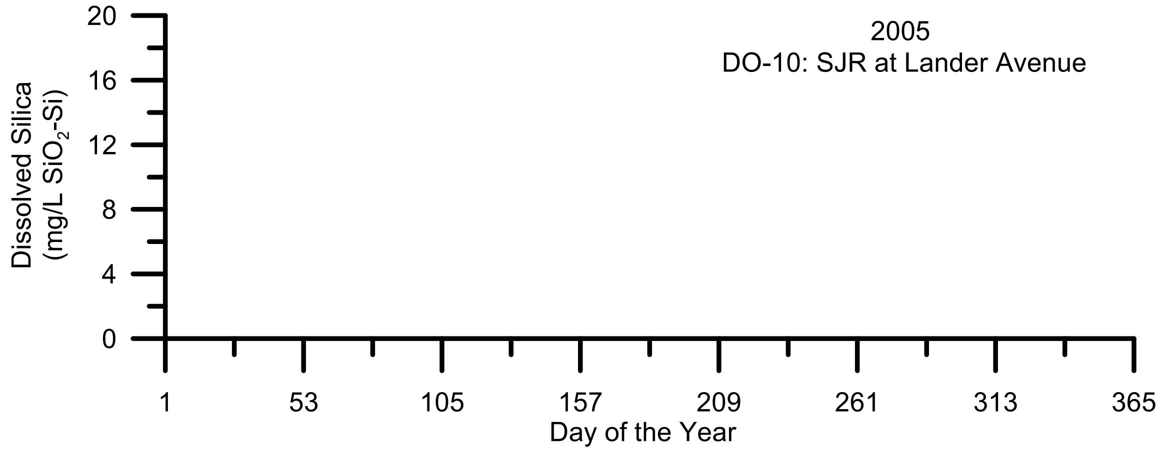
2005
DO-08: SJR at Crows Landing
Dissolved Silica
(mg/L SiO_2-Si)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

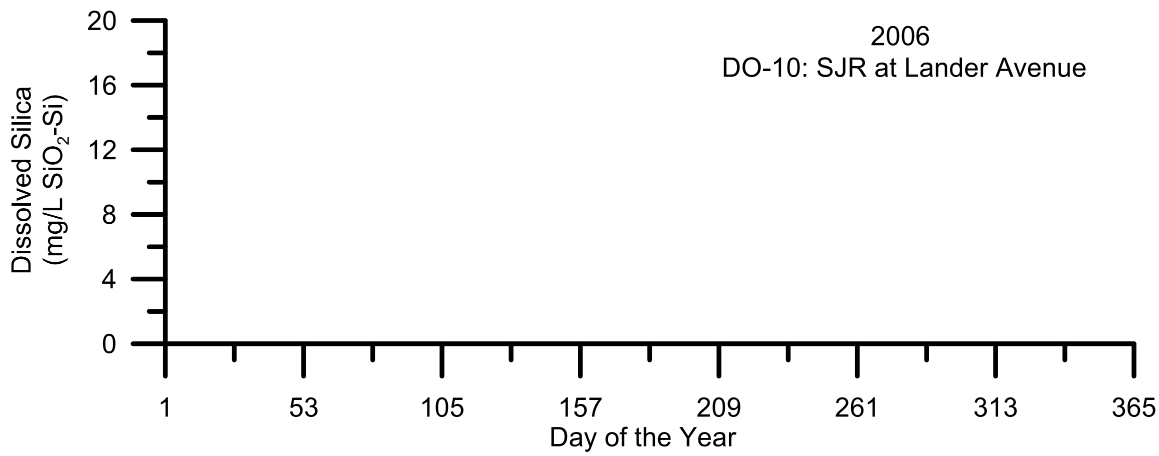


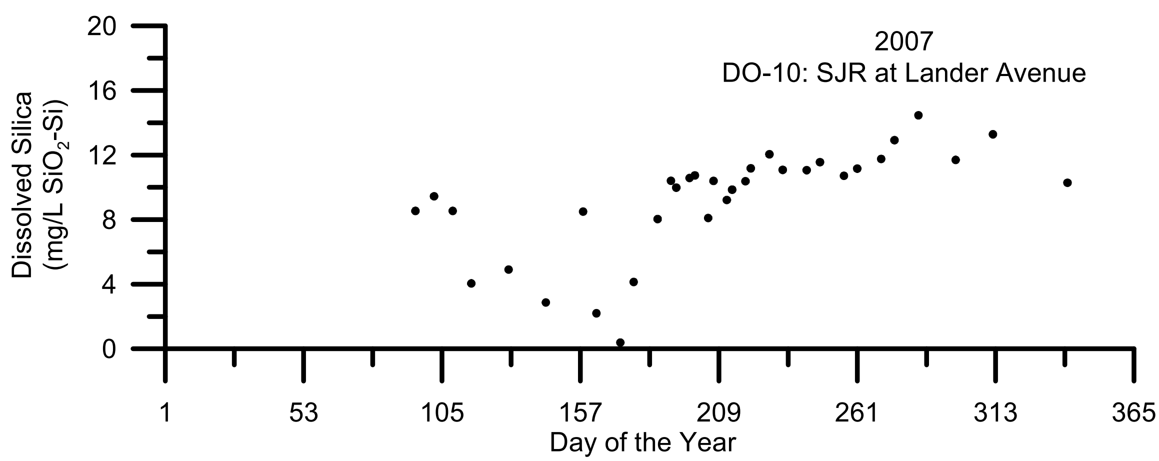
2006
DO-08: SJR at Crows Landing
Dissolved Silica
(mg/L SiO_2-Si)
25
20
15
10
5
0
1
53
105
157
209
261
313
365
Day of the Year

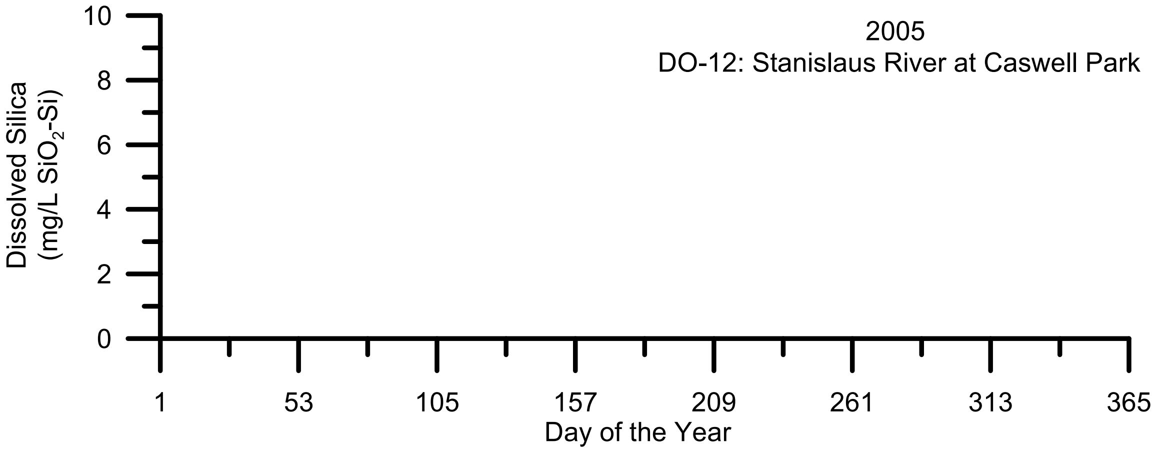


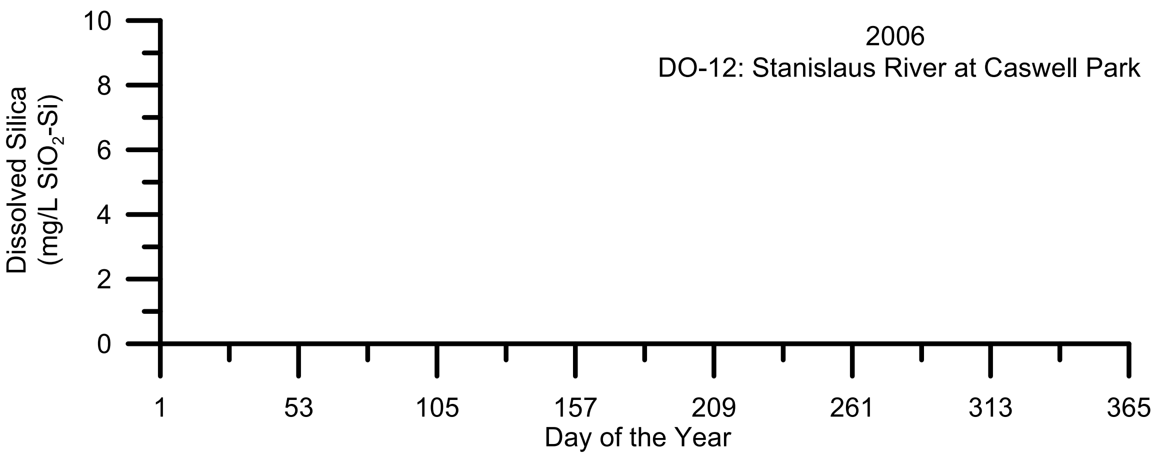
2007
DO-08: SJR at Crows Landing
Dissolved Silica
(mg/L SiO_2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

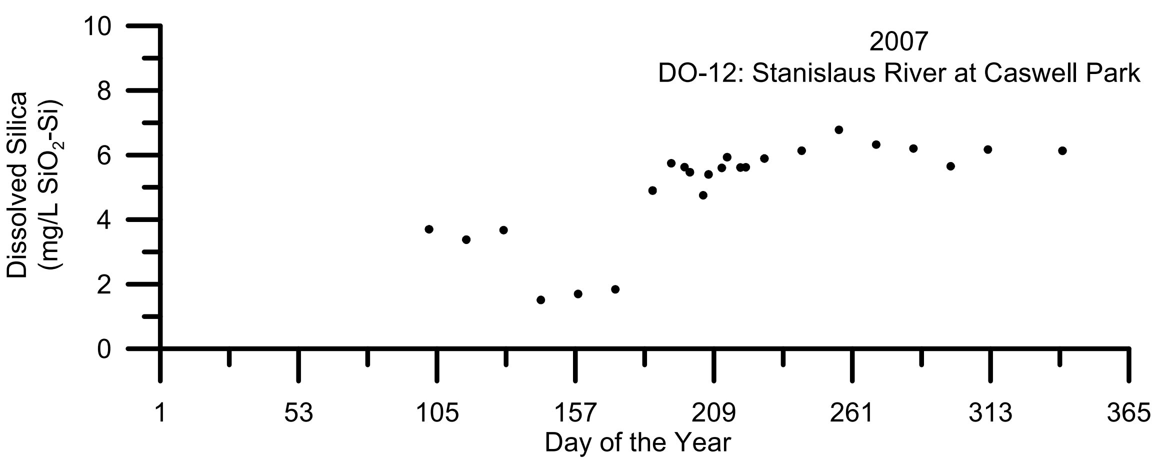

2005
DO-10: SJR at Lander Avenue
Dissolved Silica (mg/L SiO_2-Si)
Day of the Year

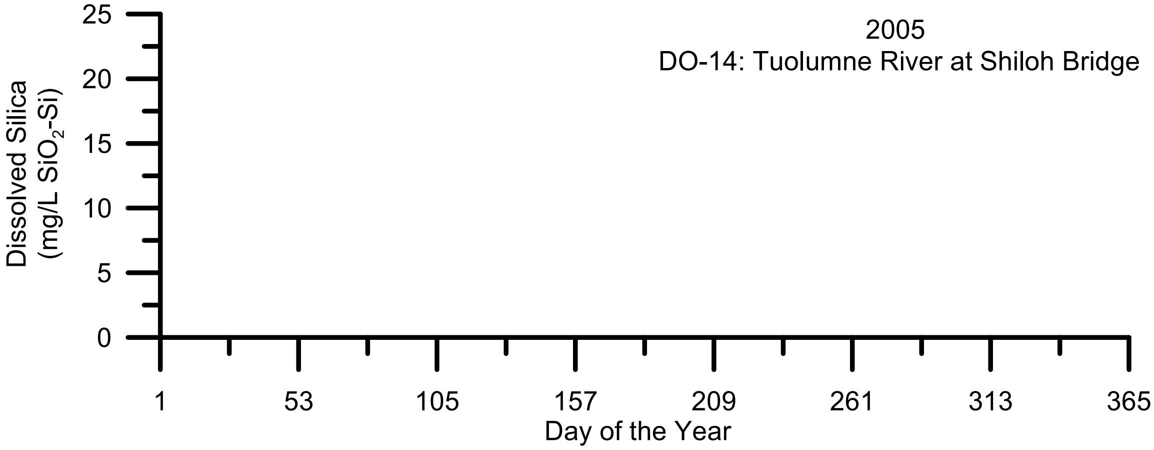

2006
DO-10: SJR at Lander Avenue
Dissolved Silica (mg/L SiO_2-Si)
Day of the Year

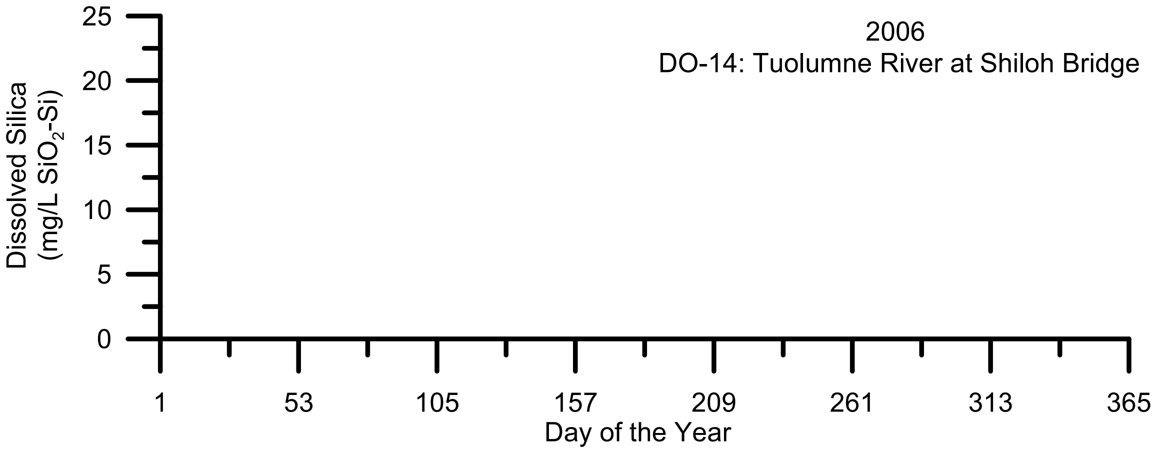

2007
DO-10: SJR at Lander Avenue
Dissolved Silica (mg/L SiO_2-Si)
Day of the Year

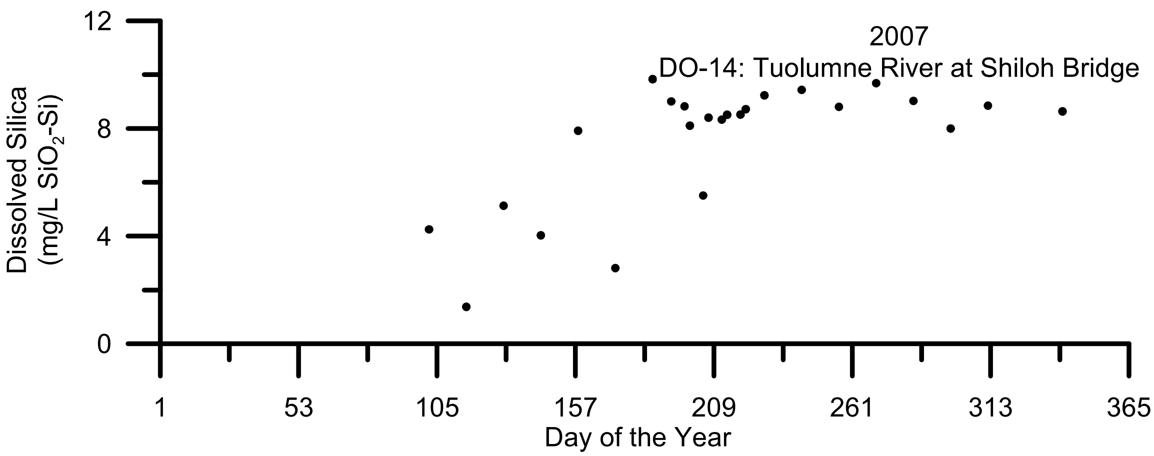

2005
DO-12: Stanislaus River at Caswell Park
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

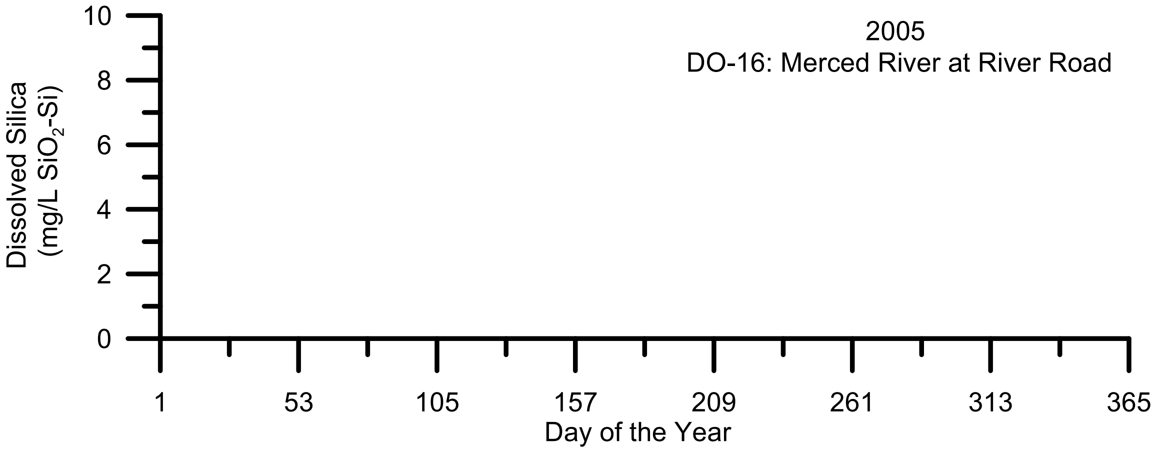

2006
DO-12: Stanislaus River at Caswell Park
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

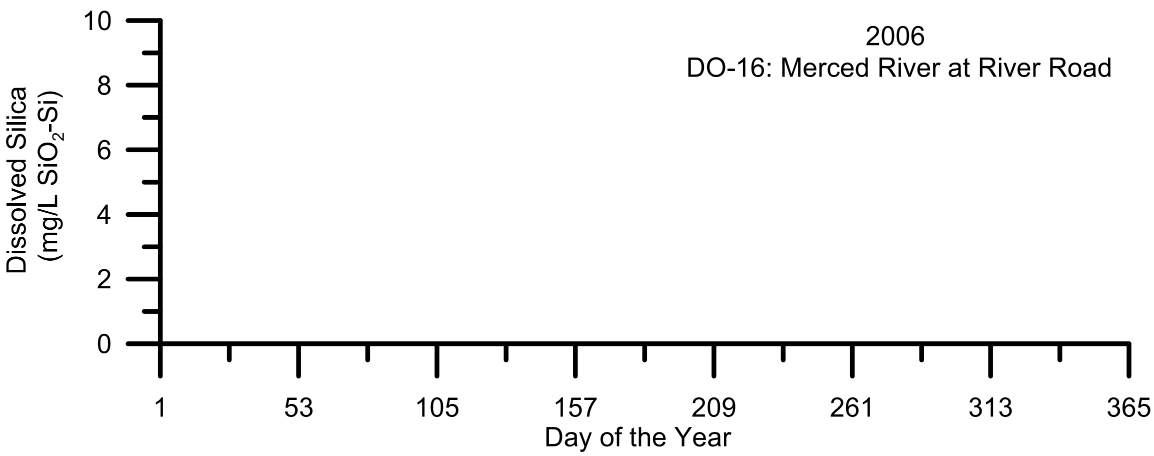

2007
DO-12: Stanislaus River at Caswell Park
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

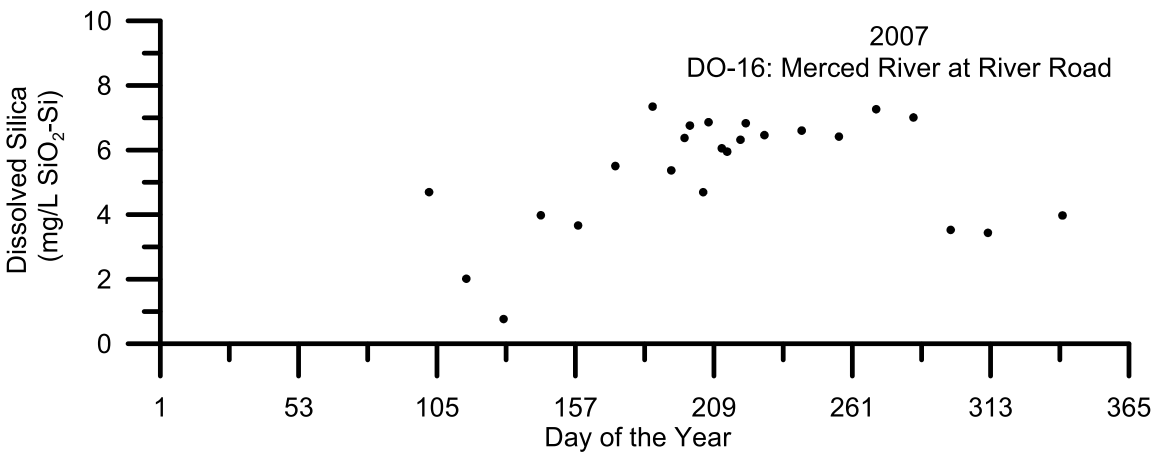

2005
DO-14: Tuolumne River at Shiloh Bridge
Dissolved Silica
(mg/L SiO2-Si)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

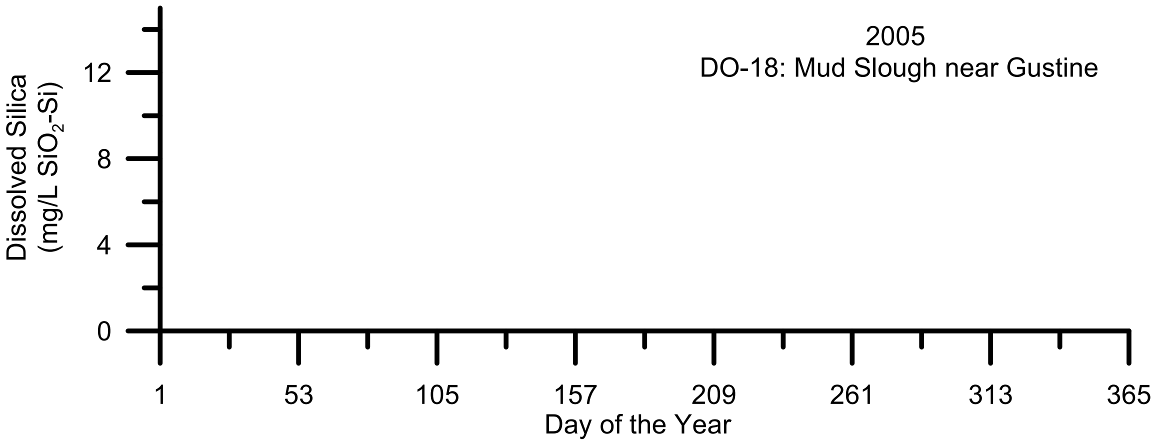

2006
DO-14: Tuolumne River at Shiloh Bridge
Dissolved Silica
(mg/L SiO2-Si)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

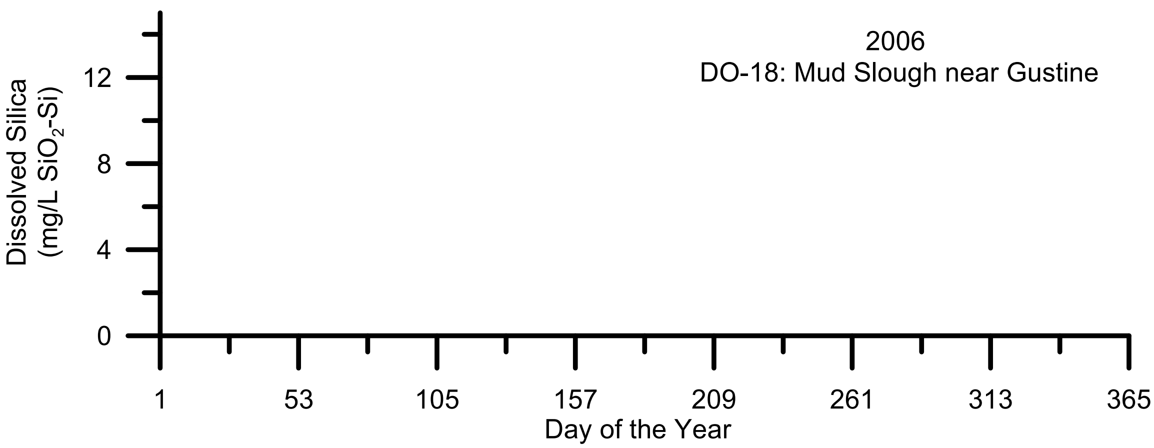

2007
DO-14: Tuolumne River at Shiloh Bridge
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

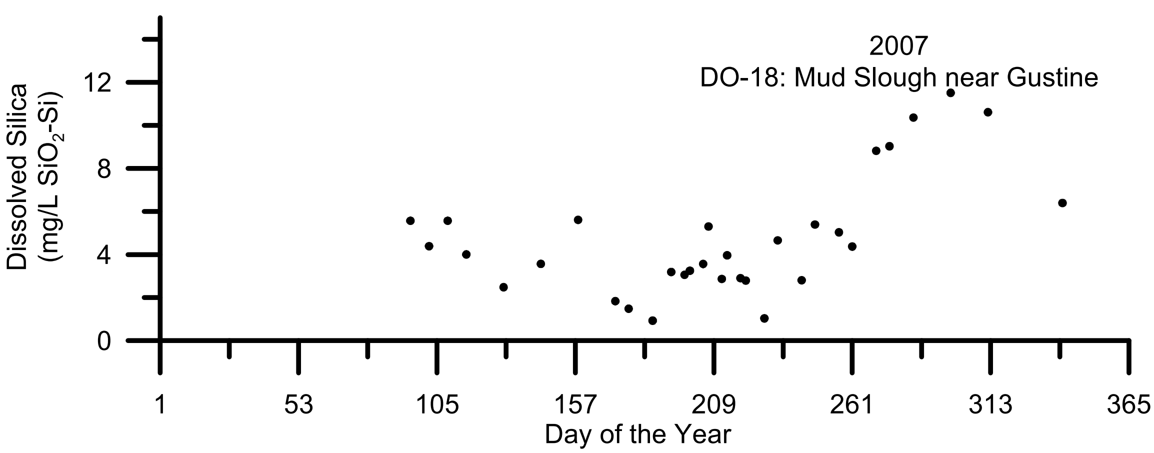

2005
DO-16: Merced River at River Road
Dissolved Silica
(mg/L SiO2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

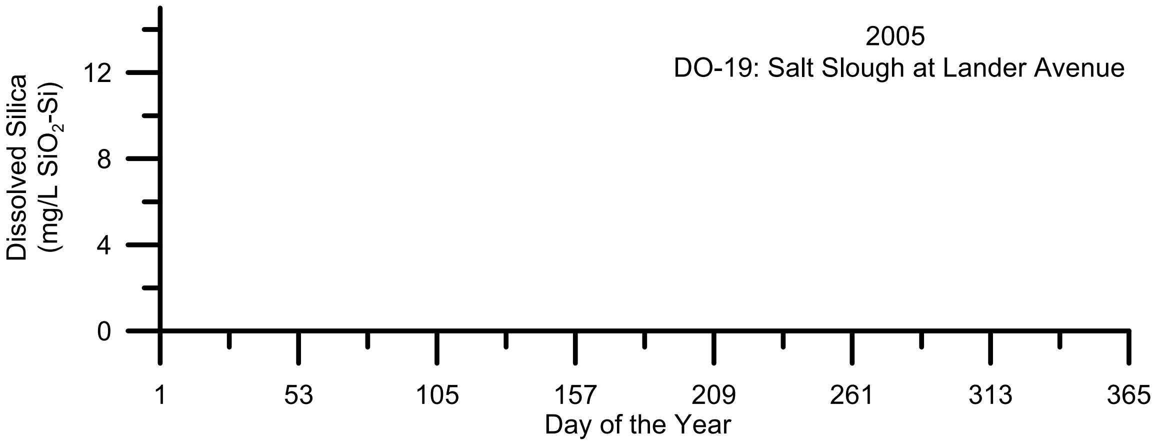

2006
DO-16: Merced River at River Road
Dissolved Silica
(mg/L SiO2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

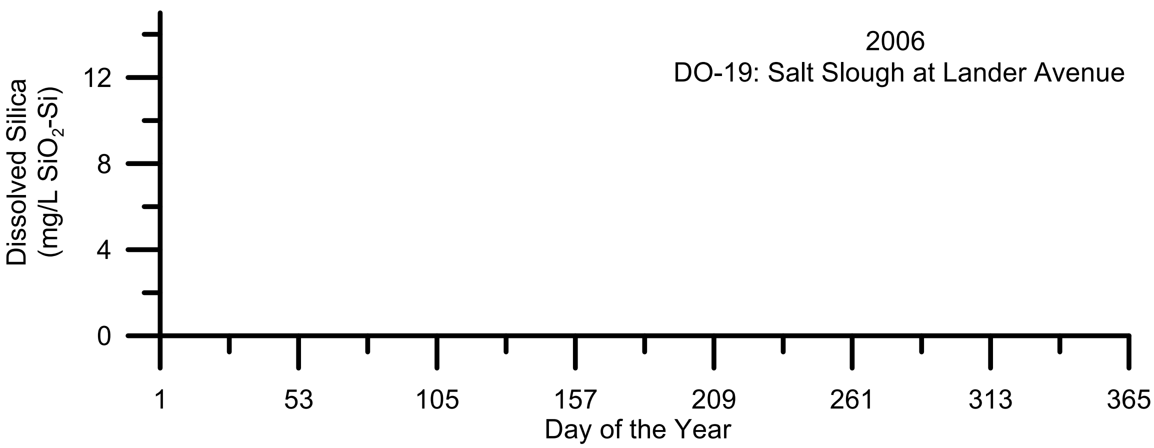

2007
DO-16: Merced River at River Road
Dissolved Silica
(mg/L SiO2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

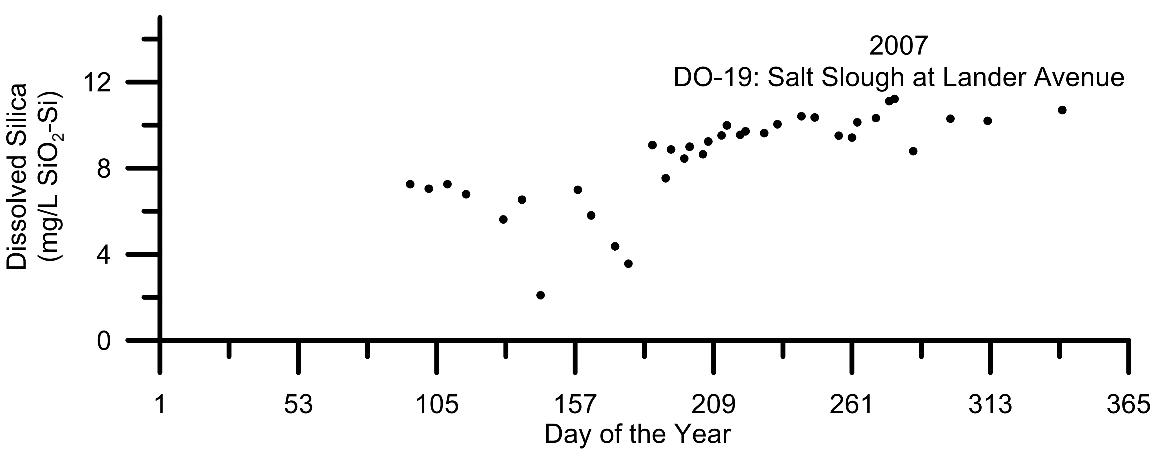

2005
DO-18: Mud Slough near Gustine
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

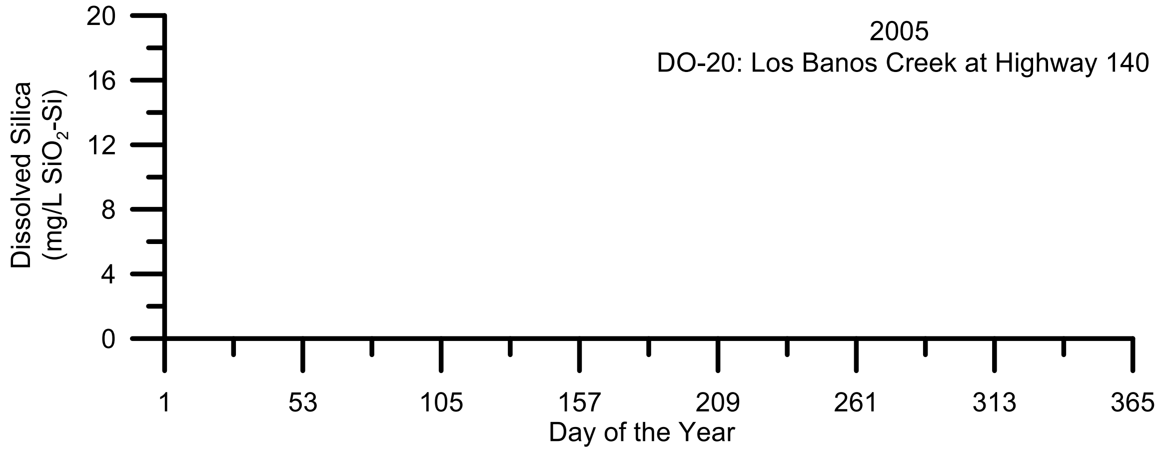

2006
DO-18: Mud Slough near Gustine
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

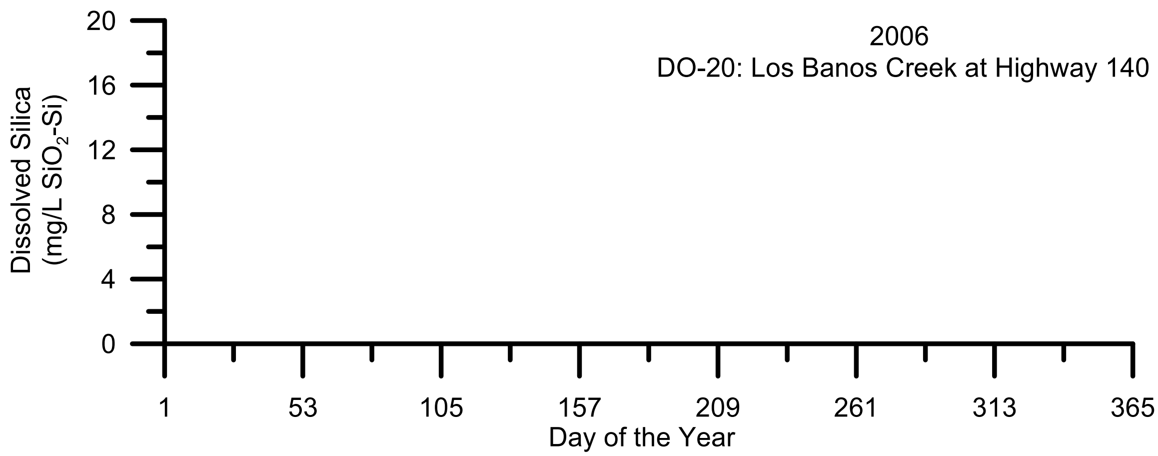

2007
DO-18: Mud Slough near Gustine
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

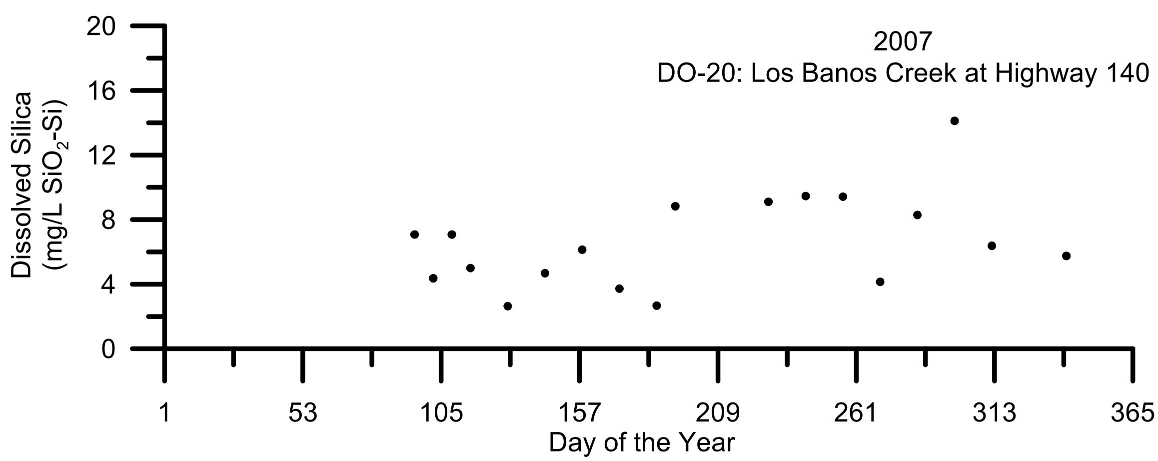

2005
DO-19: Salt Slough at Lander Avenue
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

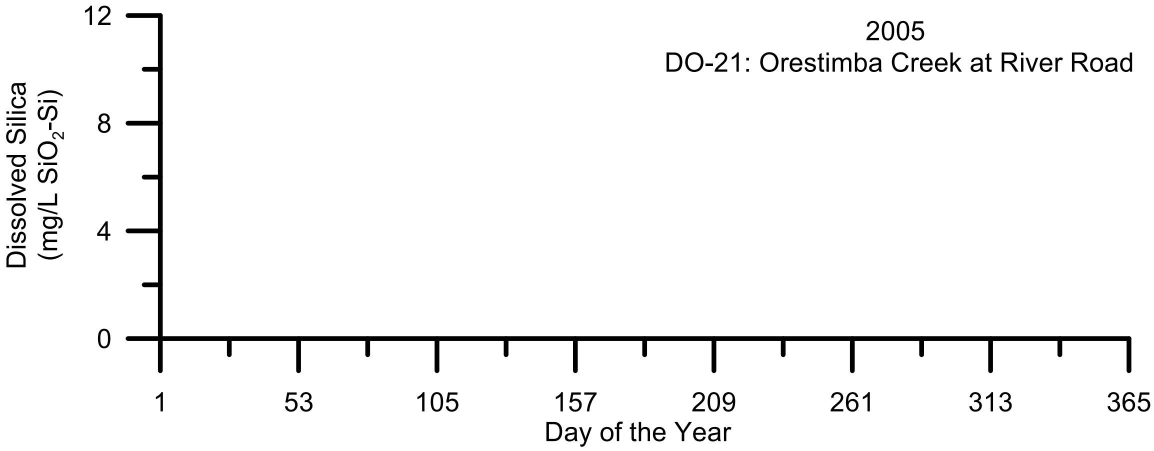

2006
DO-19: Salt Slough at Lander Avenue
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

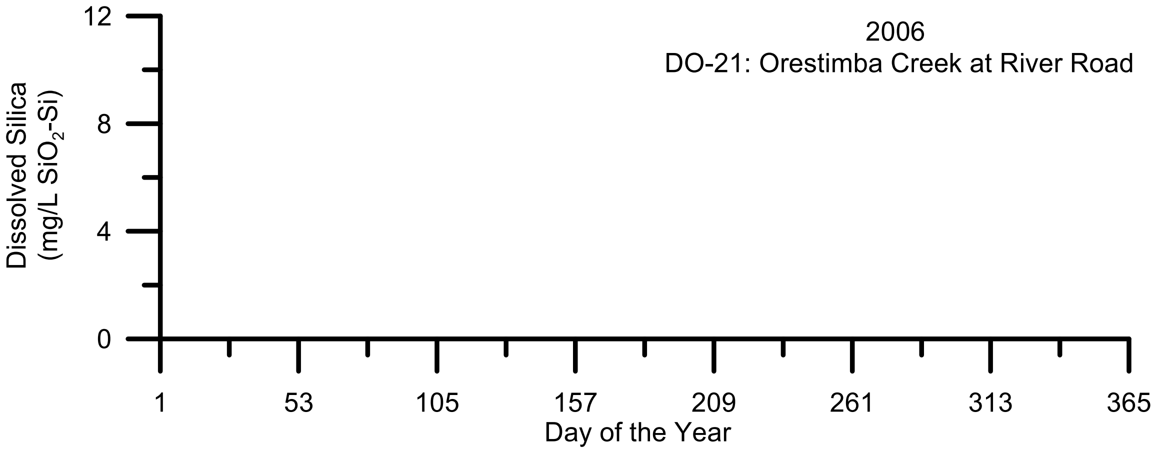

2007
DO-19: Salt Slough at Lander Avenue
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

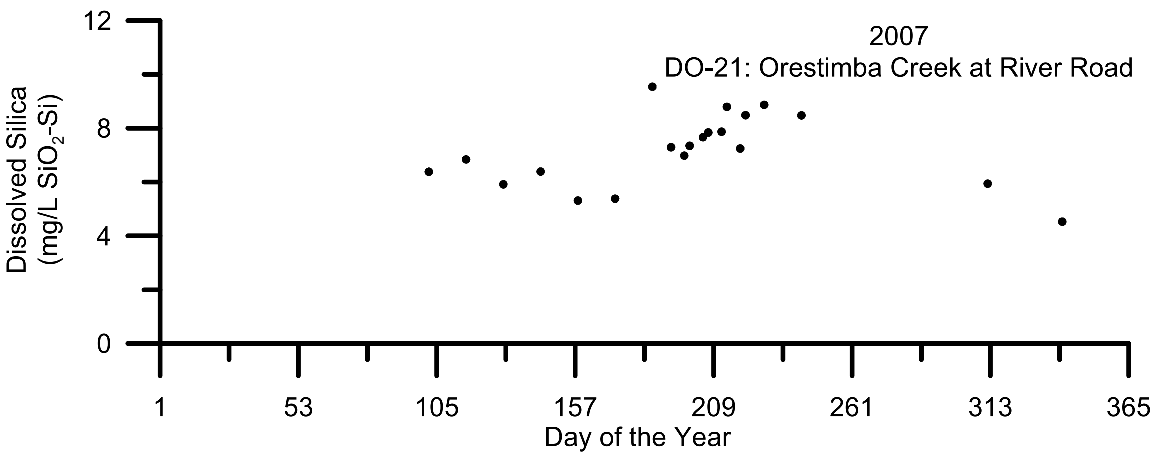

2005
DO-20: Los Banos Creek at Highway 140
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

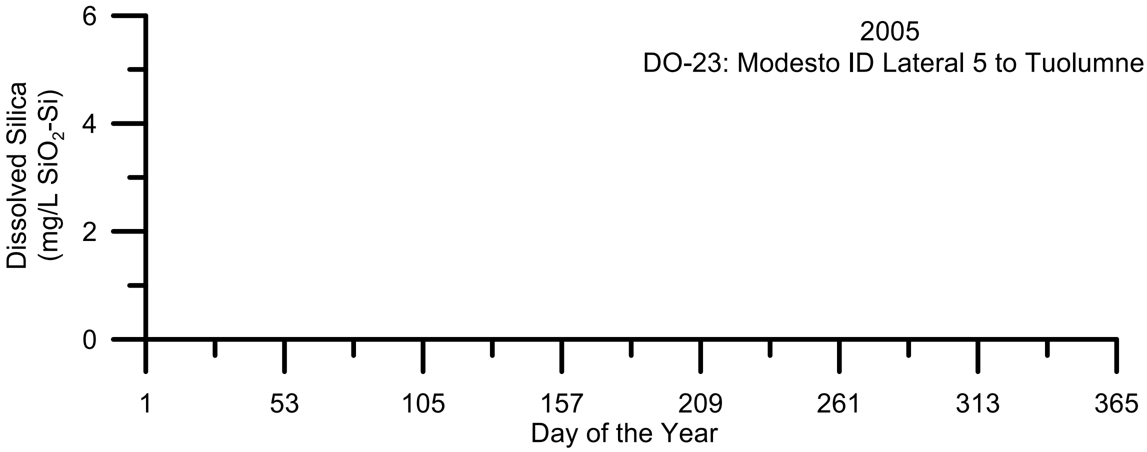

2006
DO-20: Los Banos Creek at Highway 140
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

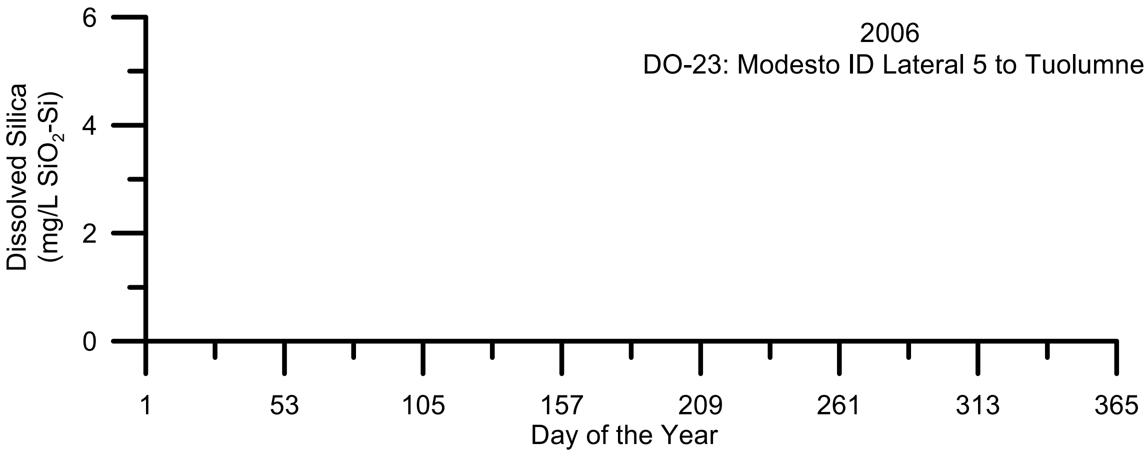

2007
DO-20: Los Banos Creek at Highway 140
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

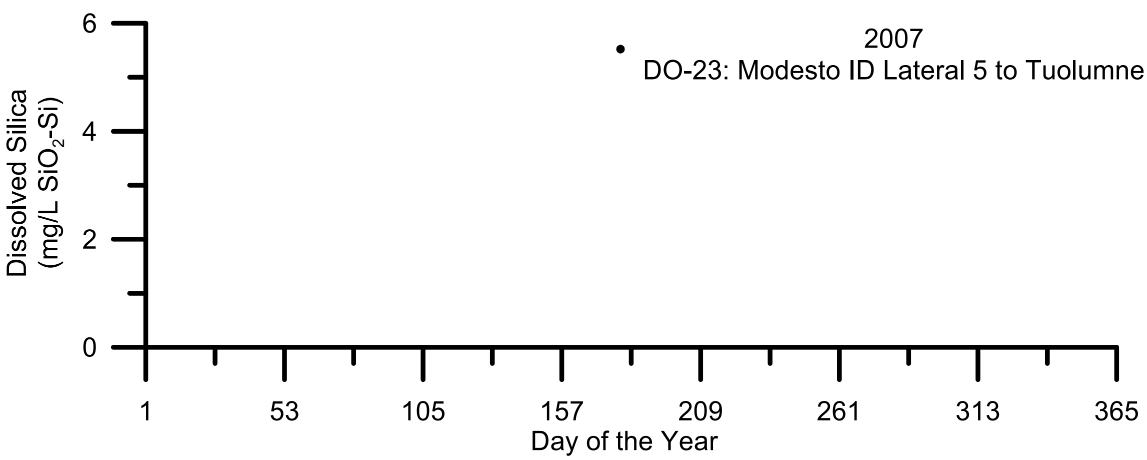

2005
DO-21: Orestimba Creek at River Road
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

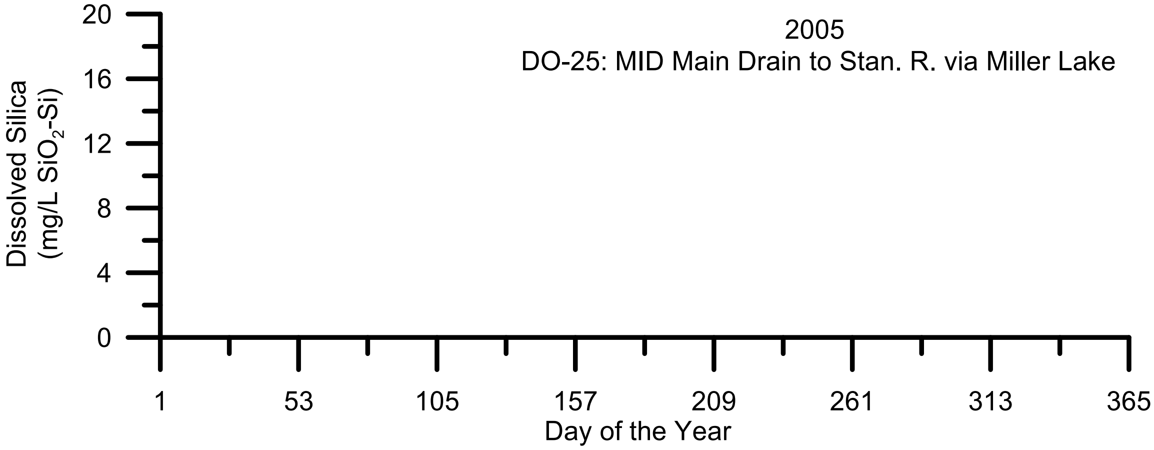

2006
DO-21: Orestimba Creek at River Road
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

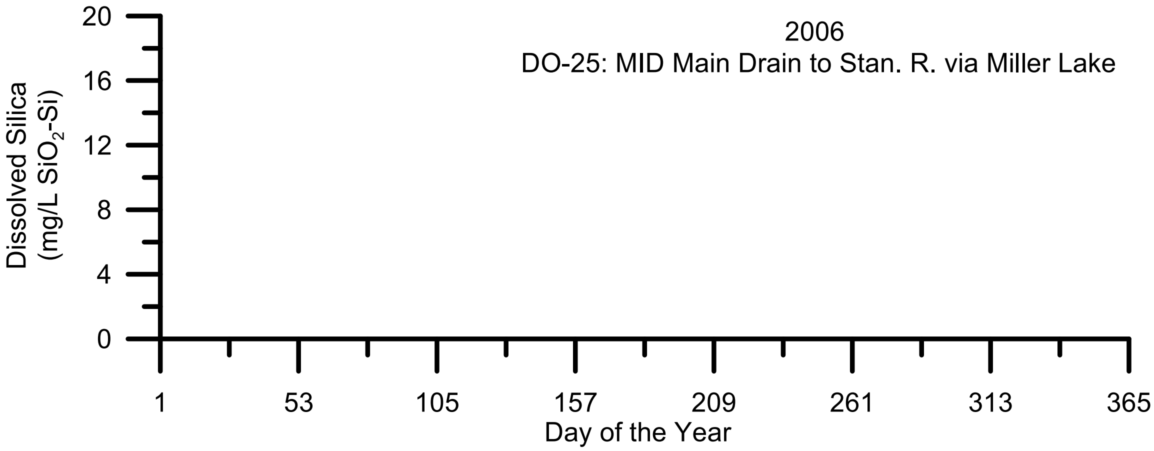

2007
DO-21: Orestimba Creek at River Road
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

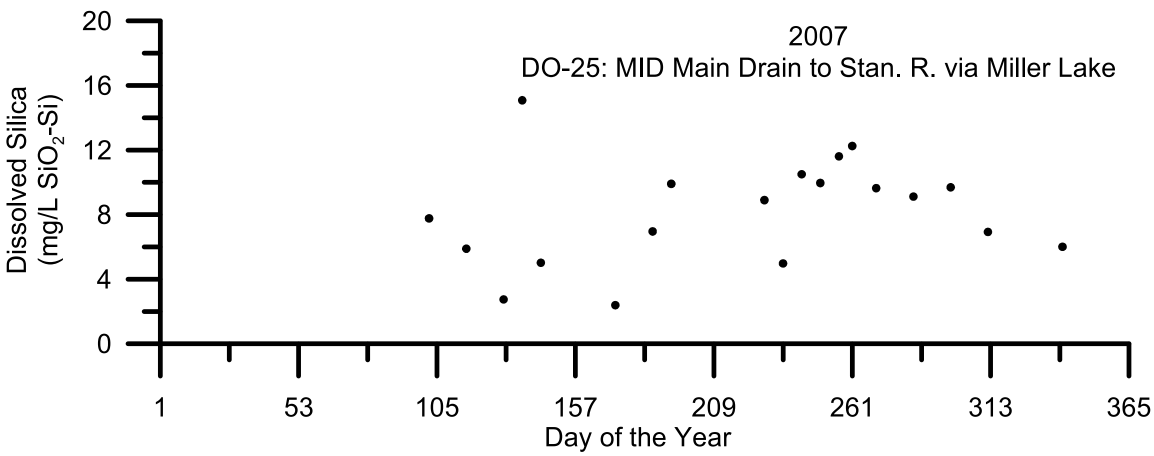

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Silica (mg/L SiO2-Si)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

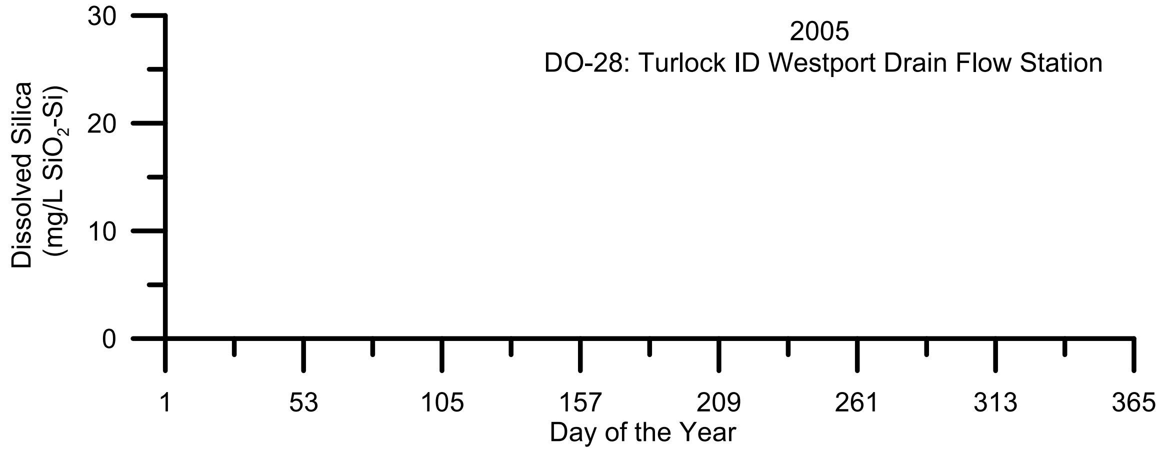

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Silica (mg/L SiO2-Si)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

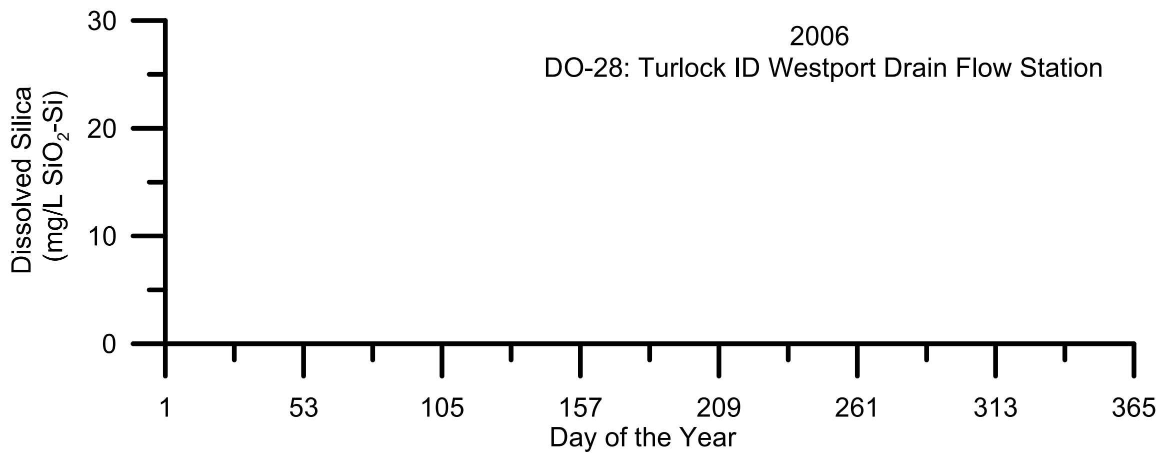

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Silica (mg/L SiO2-Si)
0
2
4
6
1
53
105
157
209
261
313
365
Day of the Year

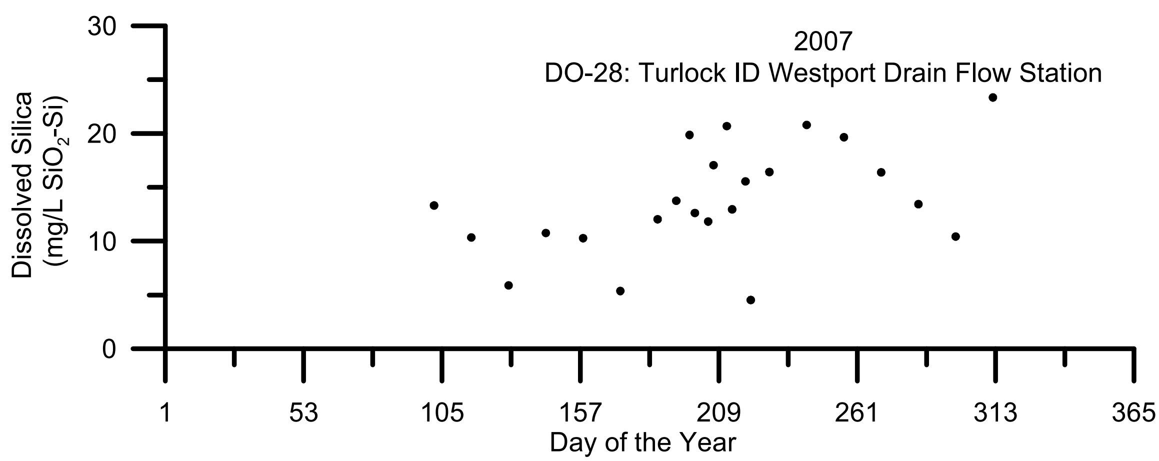

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

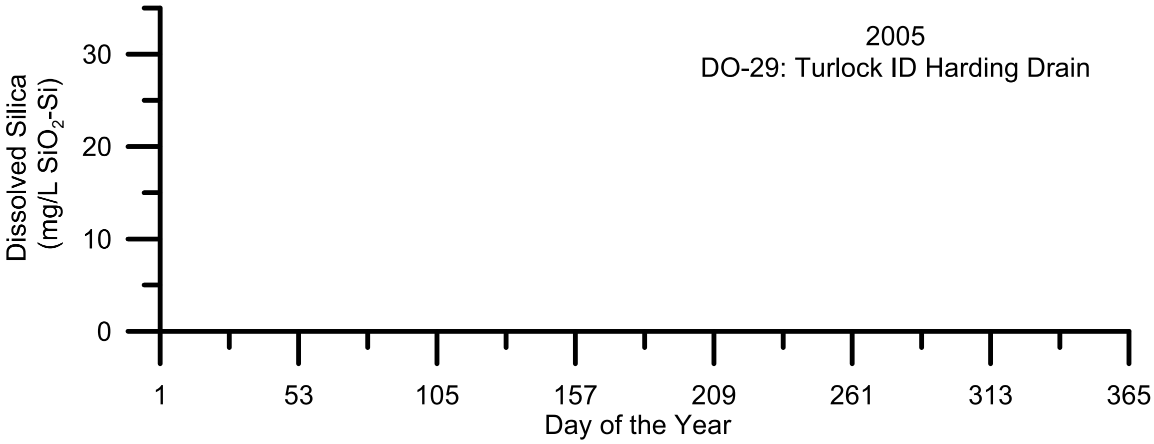

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

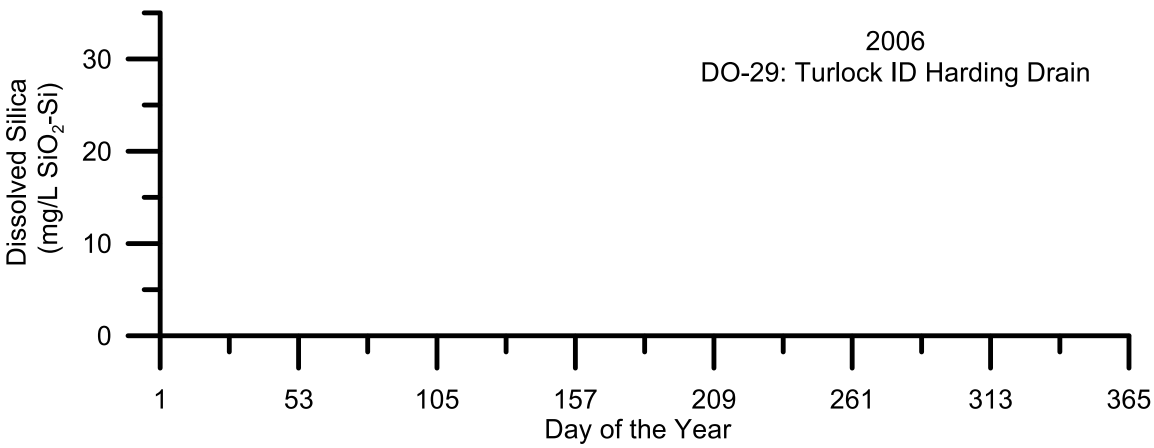

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year

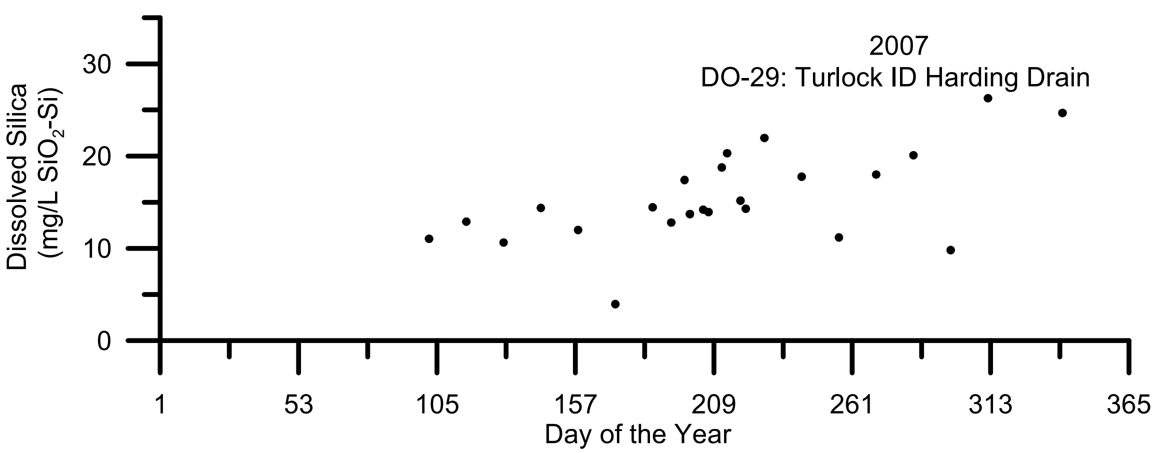

2005
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

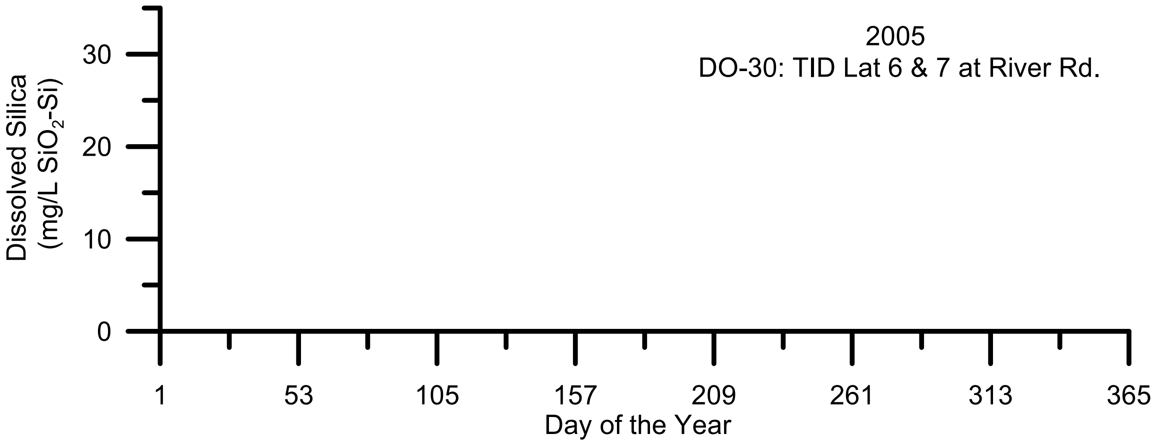

2006
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

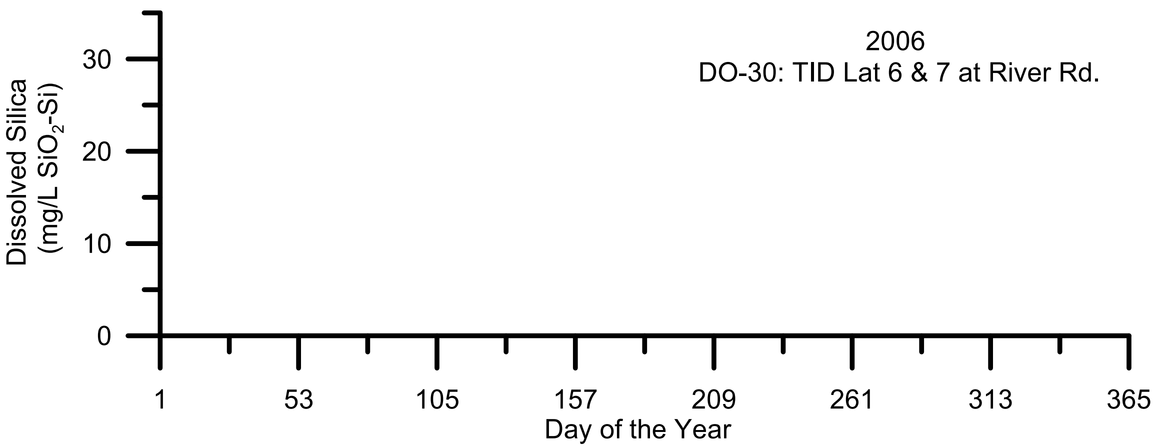

2005
DO-29: Turlock ID Harding Drain
Dissolved Silica
(mg/L SiO_2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-29: Turlock ID Harding Drain
Dissolved Silica
(mg/L SiO_2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

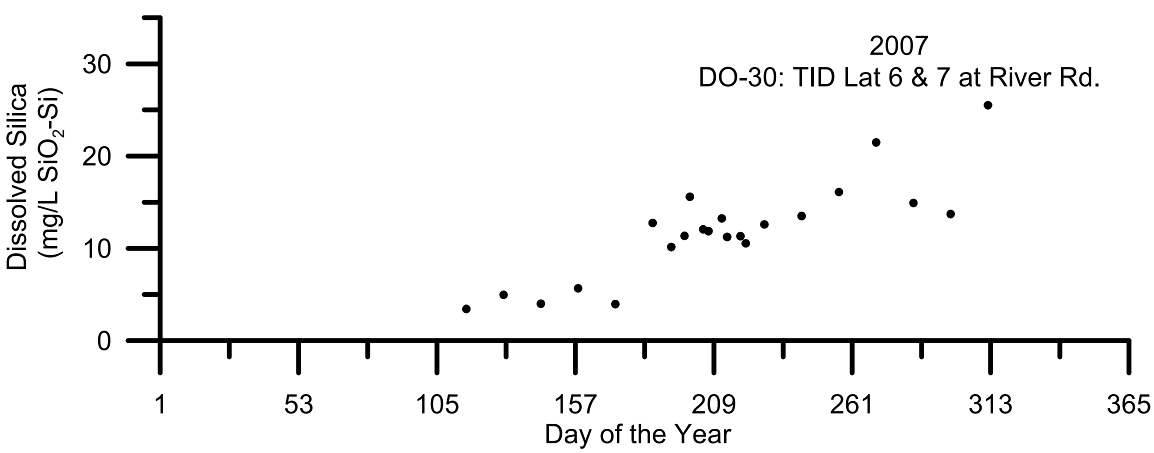

2007
DO-29: Turlock ID Harding Drain
Dissolved Silica
(mg/L SiO_2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year



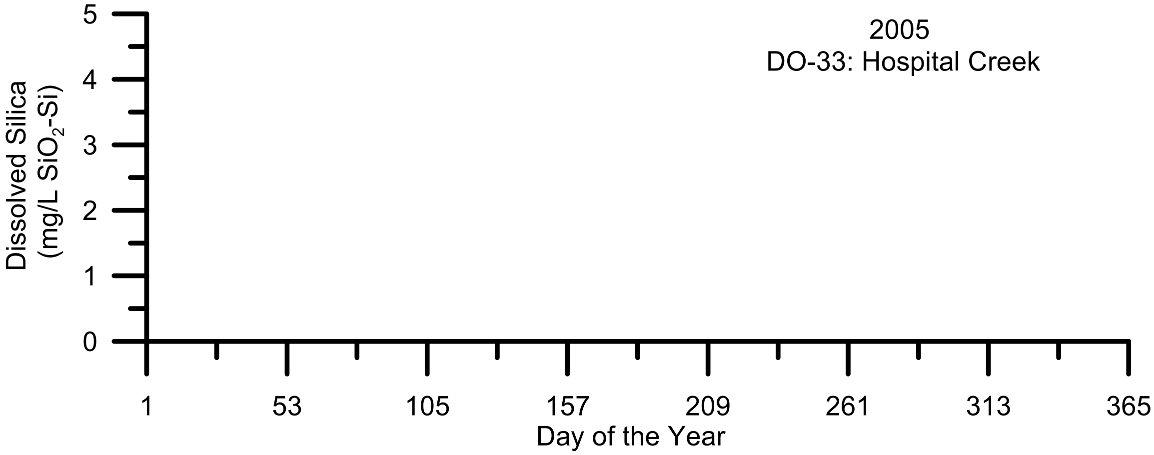
2005
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Silica
(mg/L SiO2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

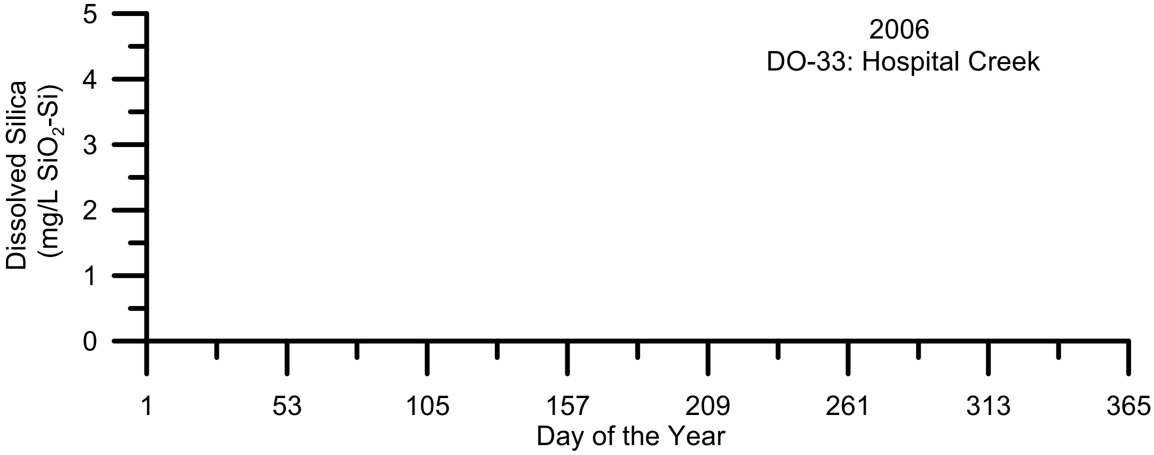


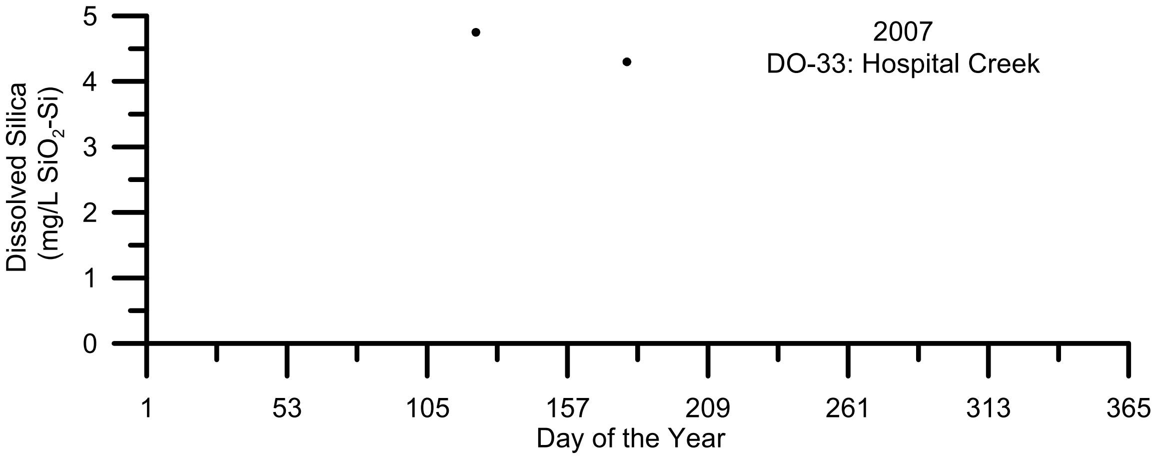
2006
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Silica
(mg/L SiO2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

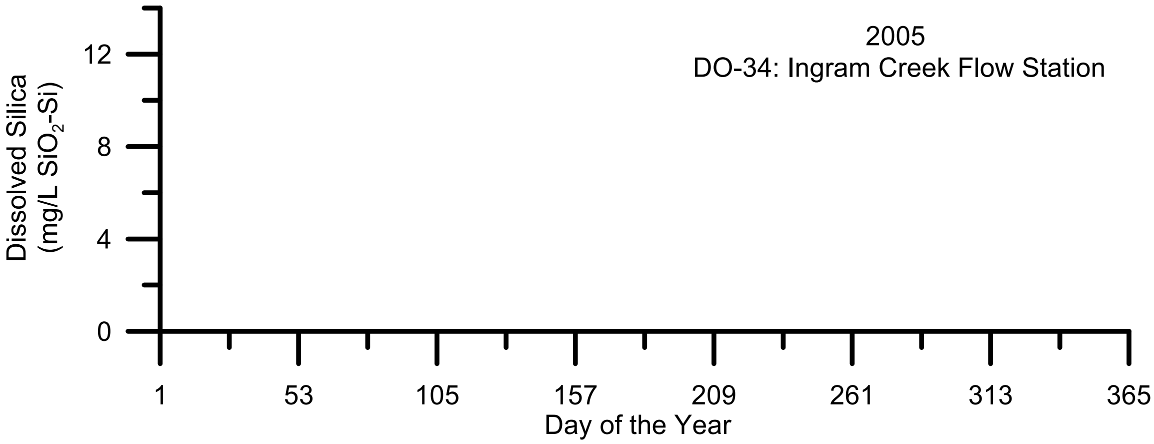


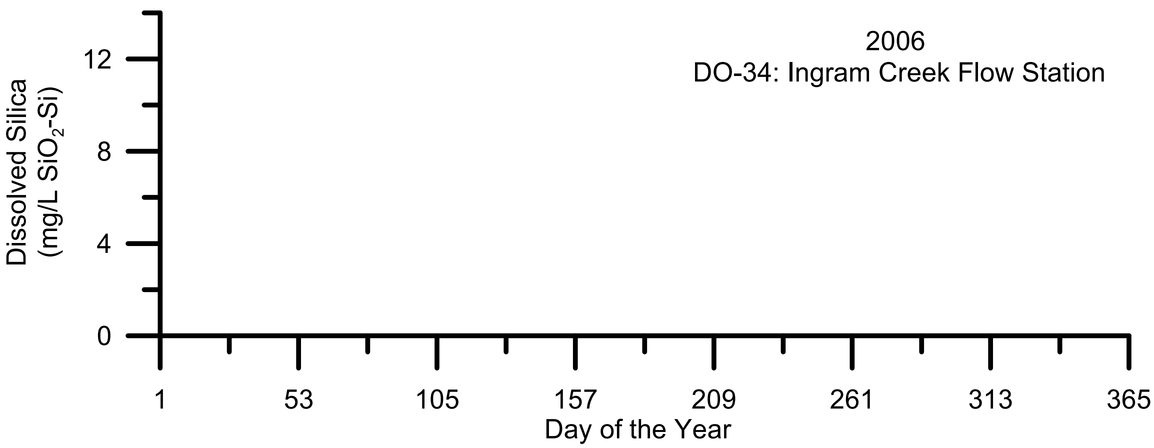
2007
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Silica
(mg/L SiO2-Si)
0
10
20
30
1
53
105
157
209
261
313
365
Day of the Year

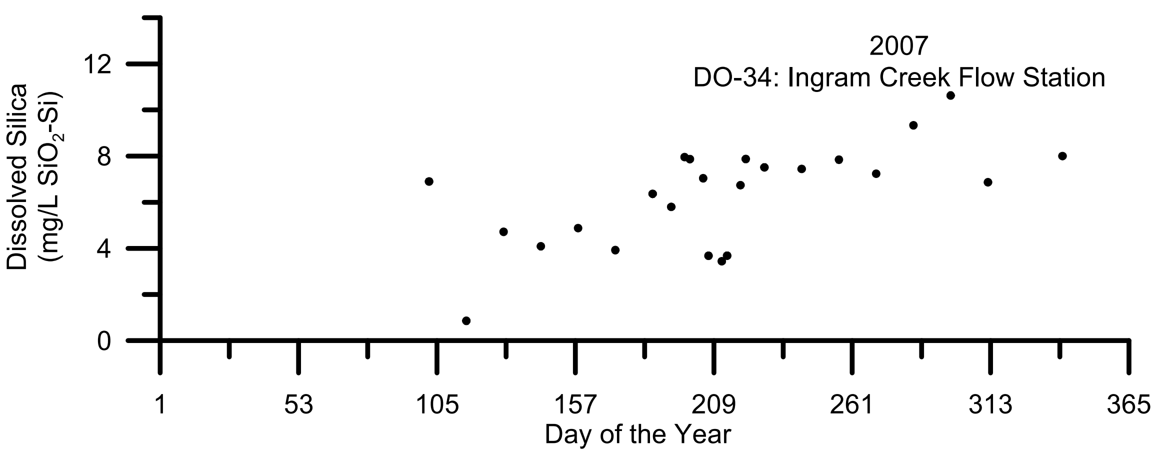

2005
DO-33: Hospital Creek
Dissolved Silica
(mg/L SiO2-Si)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

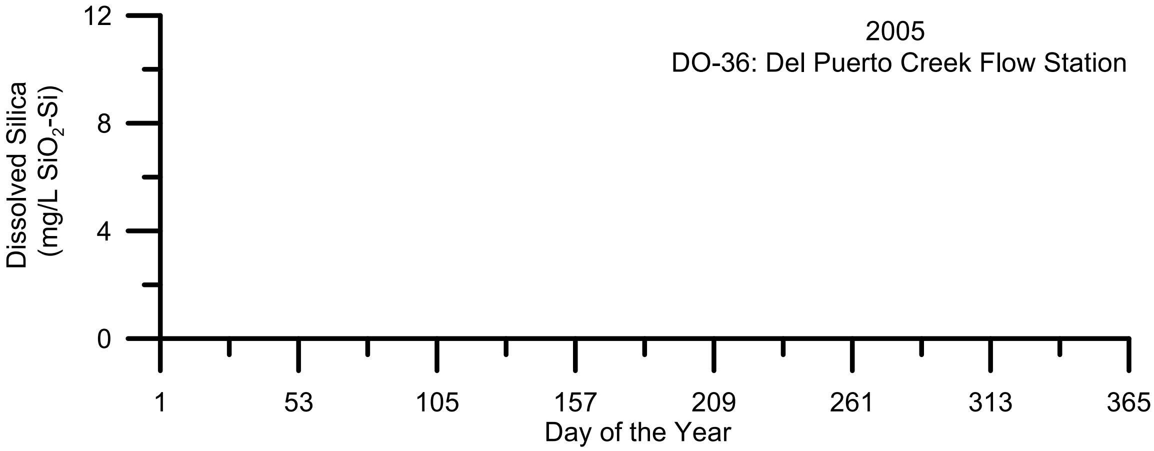

2006
DO-33: Hospital Creek
Dissolved Silica
(mg/L SiO2-Si)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

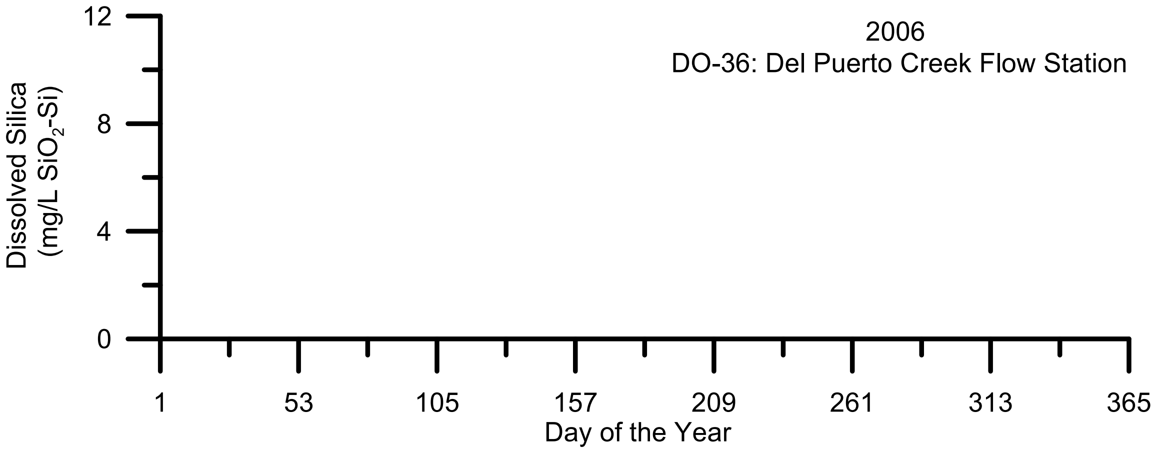

2007
DO-33: Hospital Creek
Dissolved Silica
(mg/L SiO2-Si)
0
1
2
3
4
5
1
53
105
157
209
261
313
365
Day of the Year

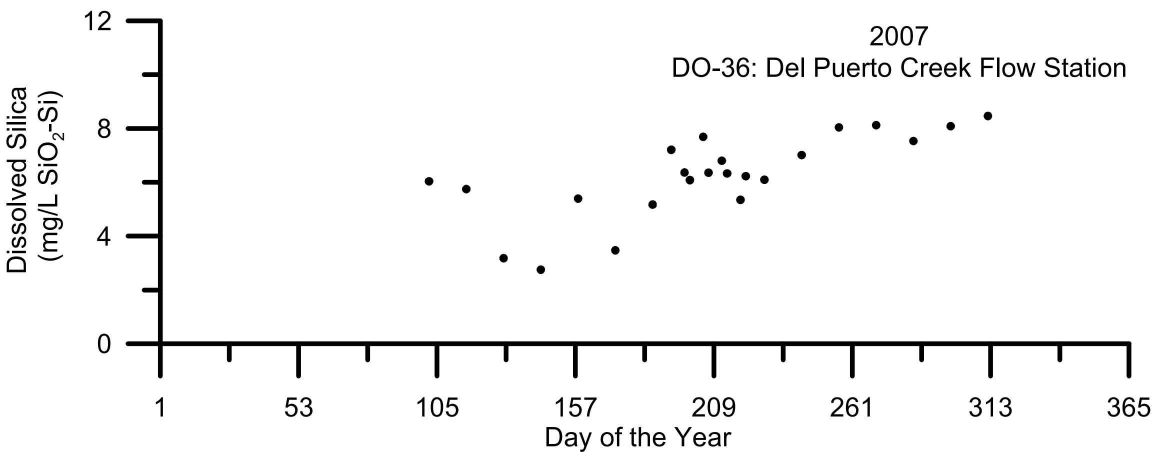

2005
DO-34: Ingram Creek Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

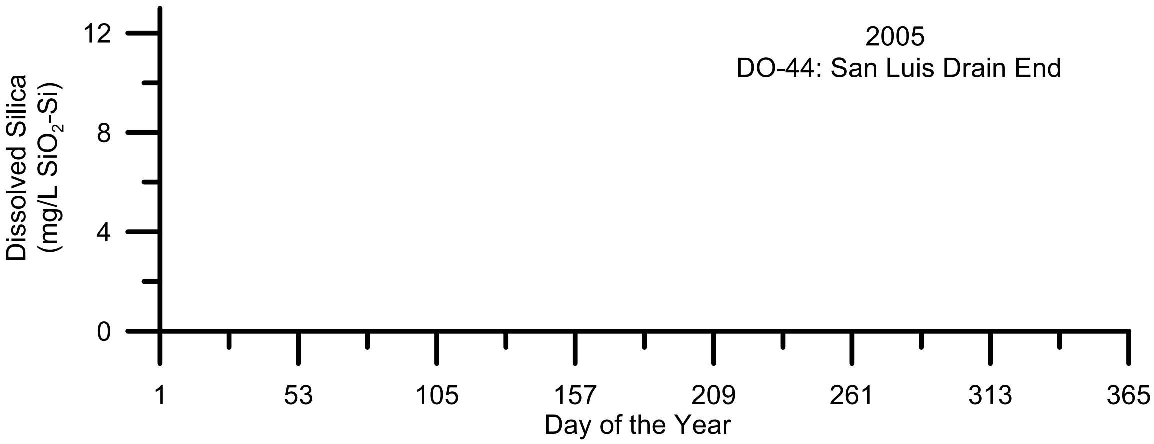

2006
DO-34: Ingram Creek Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

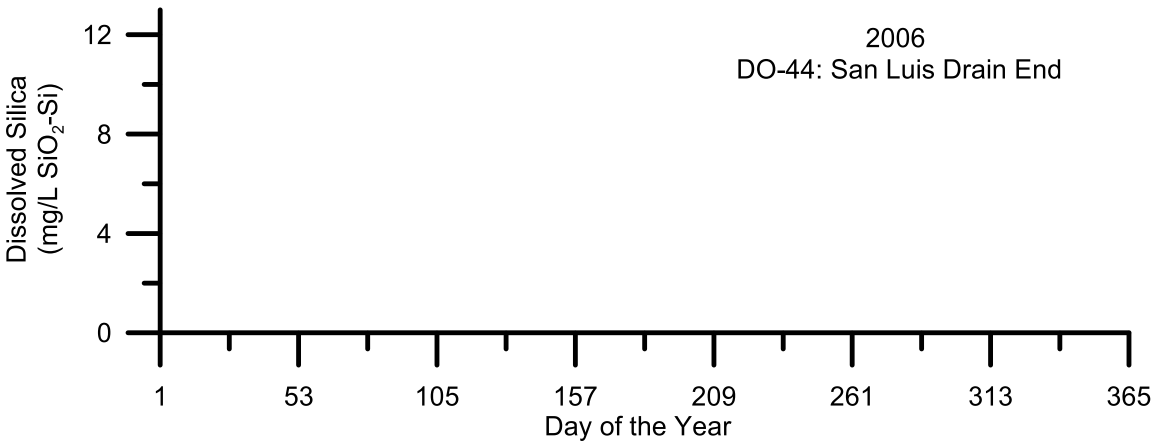

2007
DO-34: Ingram Creek Flow Station
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

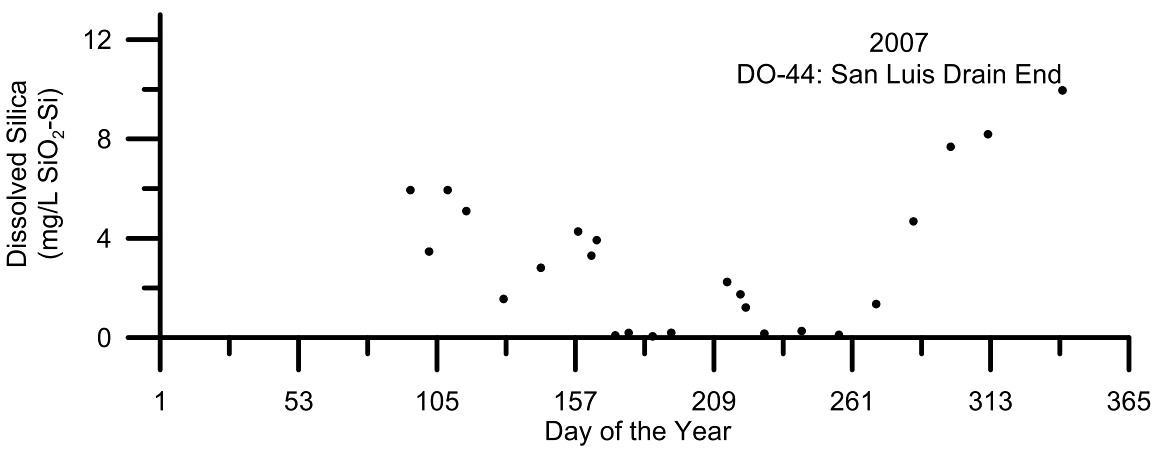

2005
DO-36: Del Puerto Creek Flow Station
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

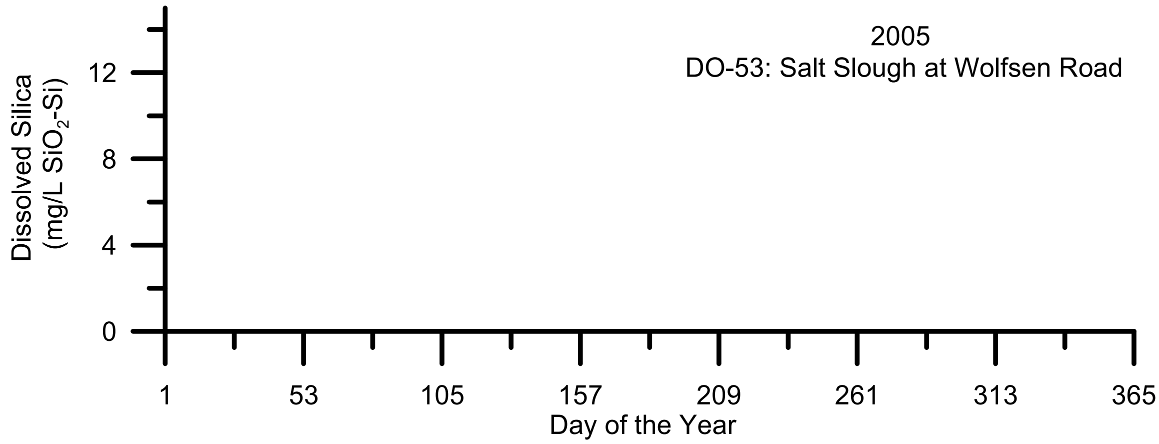

2006
DO-36: Del Puerto Creek Flow Station
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

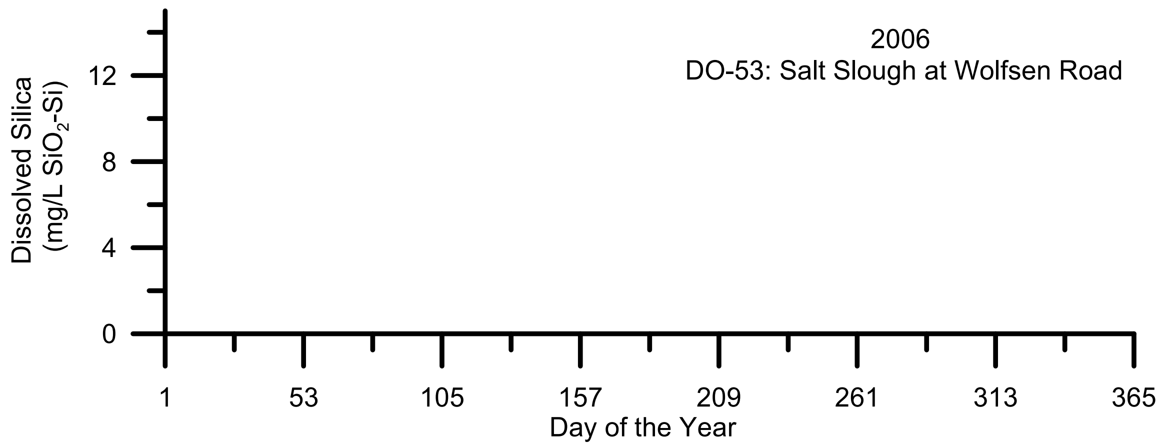

2007
DO-36: Del Puerto Creek Flow Station
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

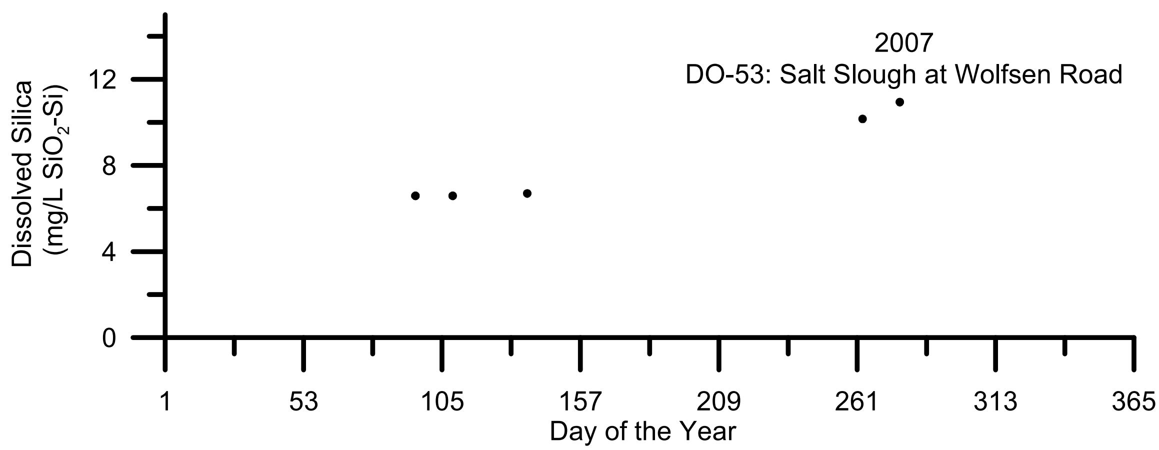

2005
DO-44: San Luis Drain End
Dissolved Silica
(mg/L SiO_2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

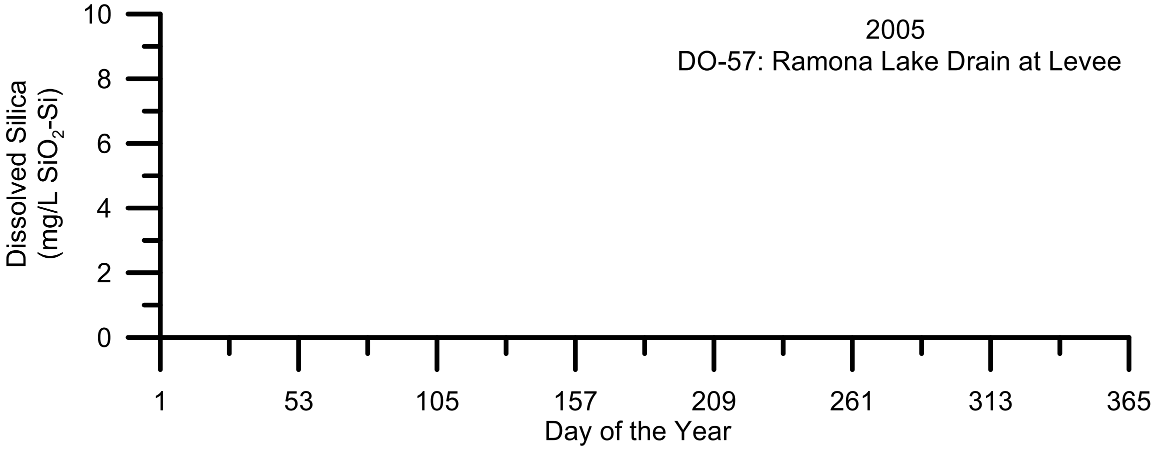

2006
DO-44: San Luis Drain End
Dissolved Silica
(mg/L SiO_2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

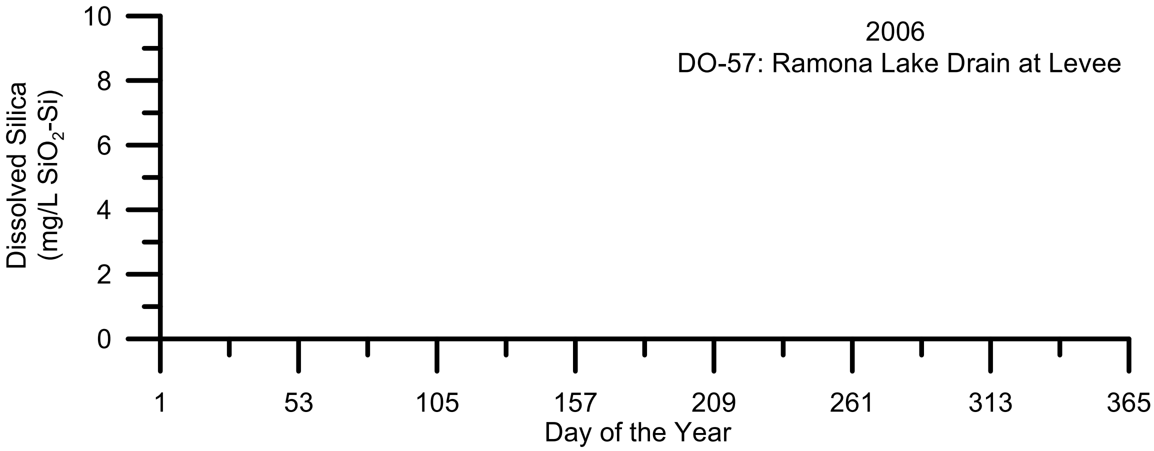

2007
DO-44: San Luis Drain End
Dissolved Silica
(mg/L SiO_2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

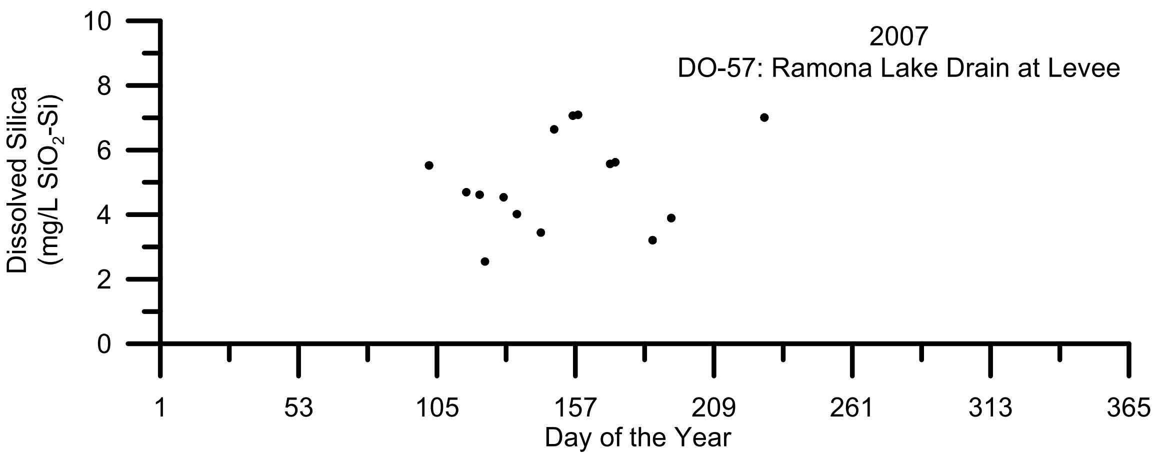

2005
DO-53: Salt Slough at Wolfsen Road
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

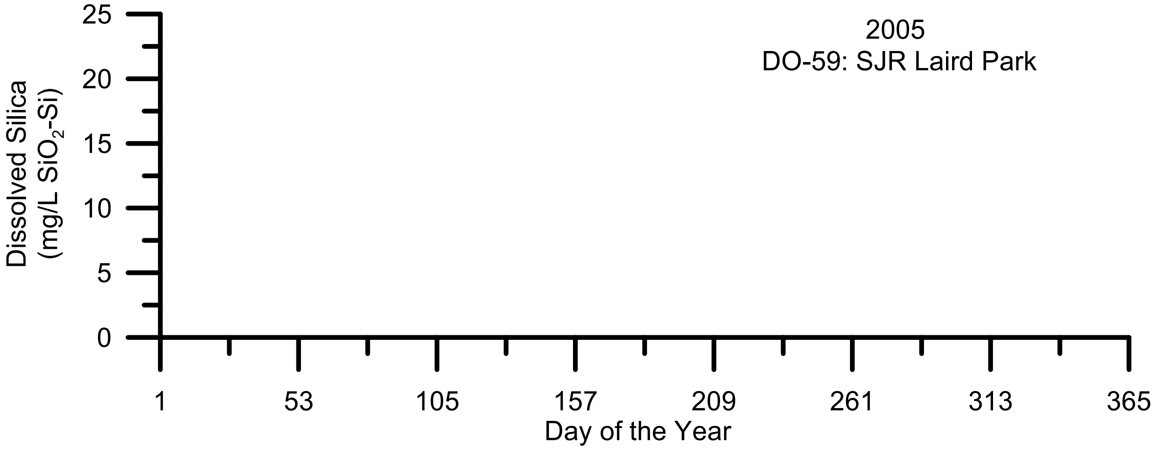

2006
DO-53: Salt Slough at Wolfsen Road
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

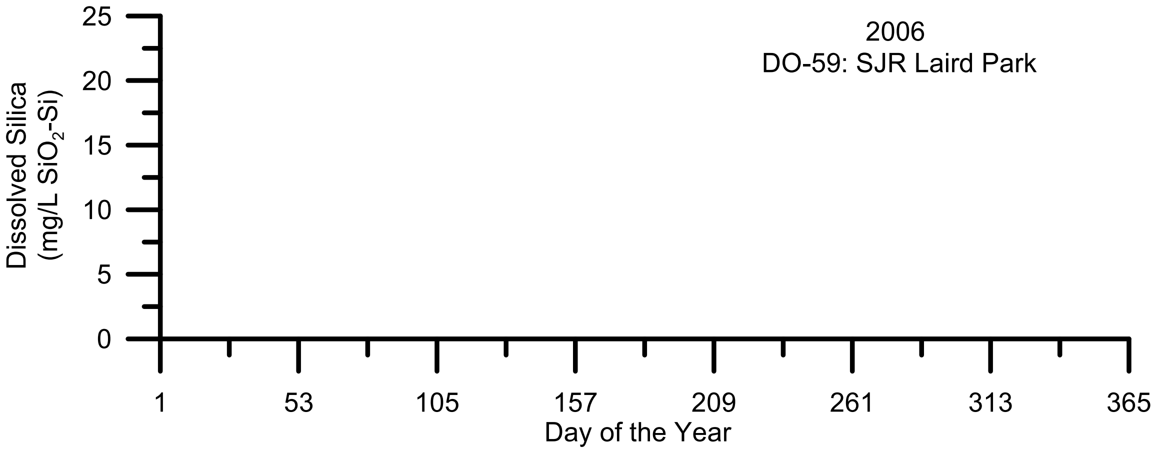

2007
DO-53: Salt Slough at Wolfsen Road
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

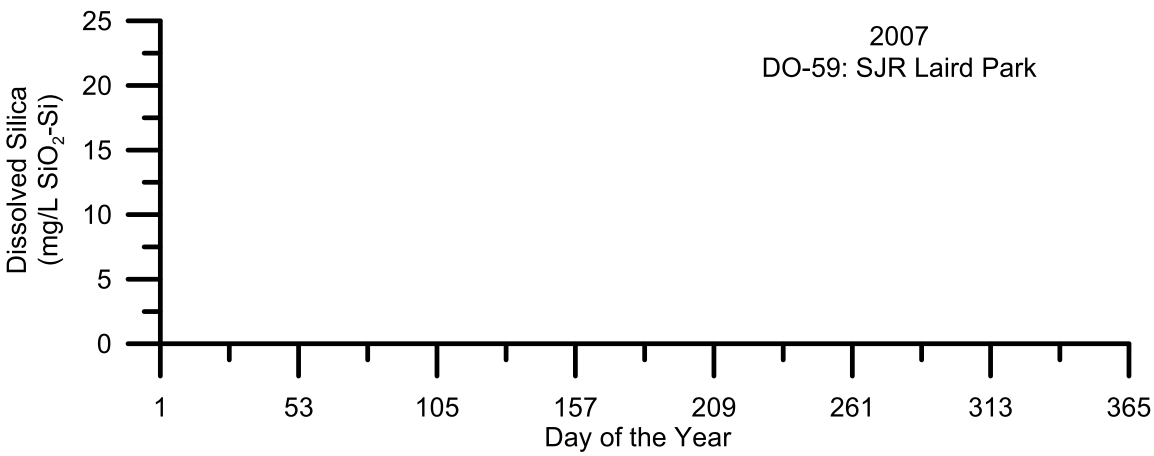

2005
DO-57: Ramona Lake Drain at Levee
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

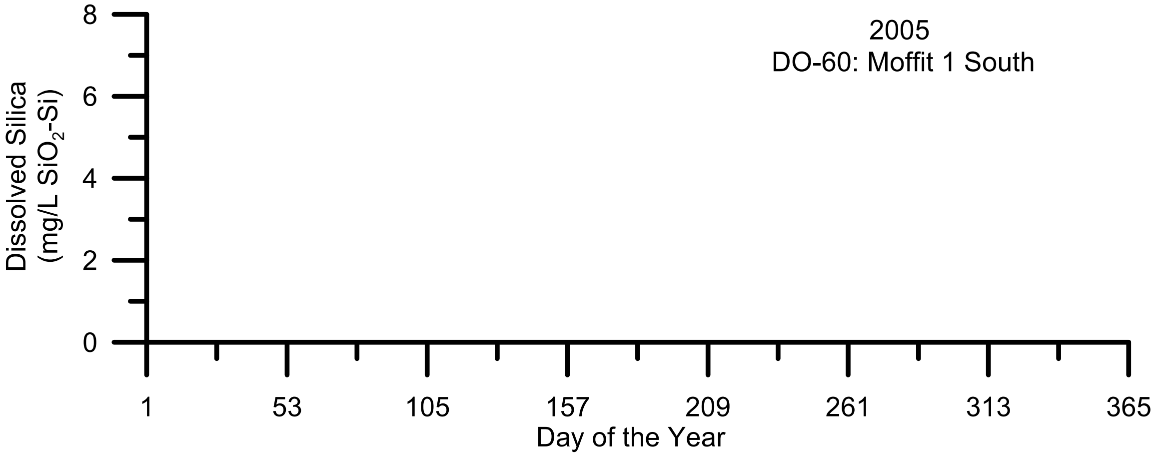

2006
DO-57: Ramona Lake Drain at Levee
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

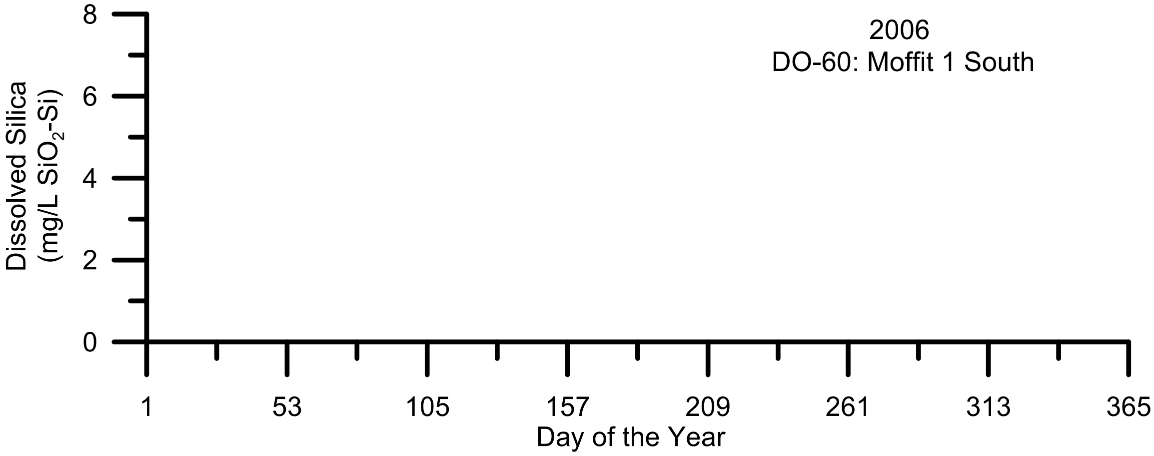

2007
DO-57: Ramona Lake Drain at Levee
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

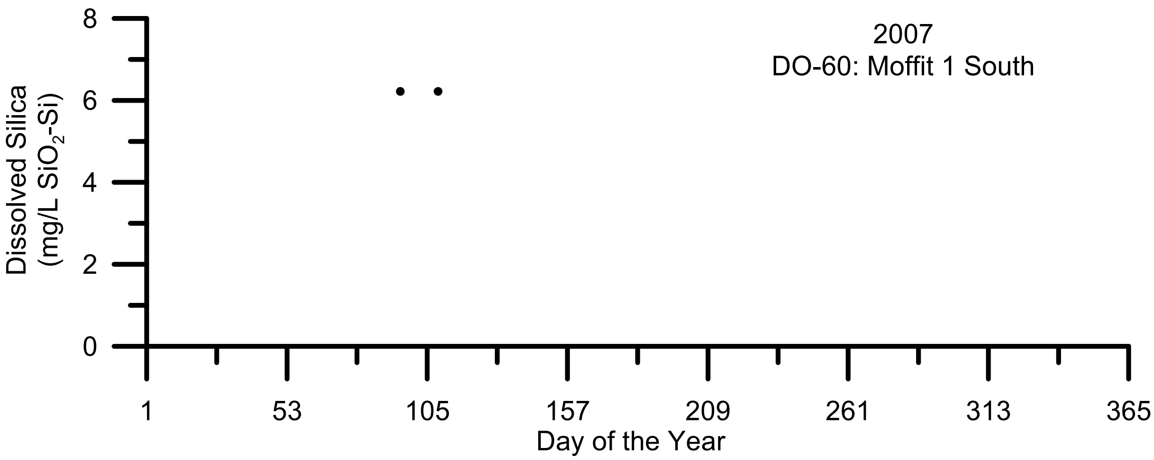

2005
DO-59: SJR Laird Park
Dissolved Silica
(mg/L SiO2-Si)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

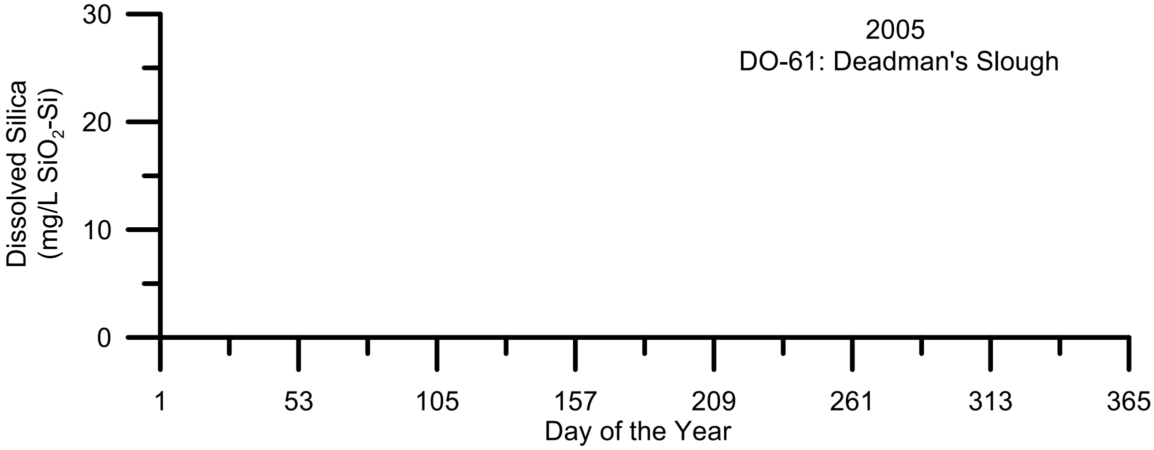

2006
DO-59: SJR Laird Park
Dissolved Silica
(mg/L SiO2-Si)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

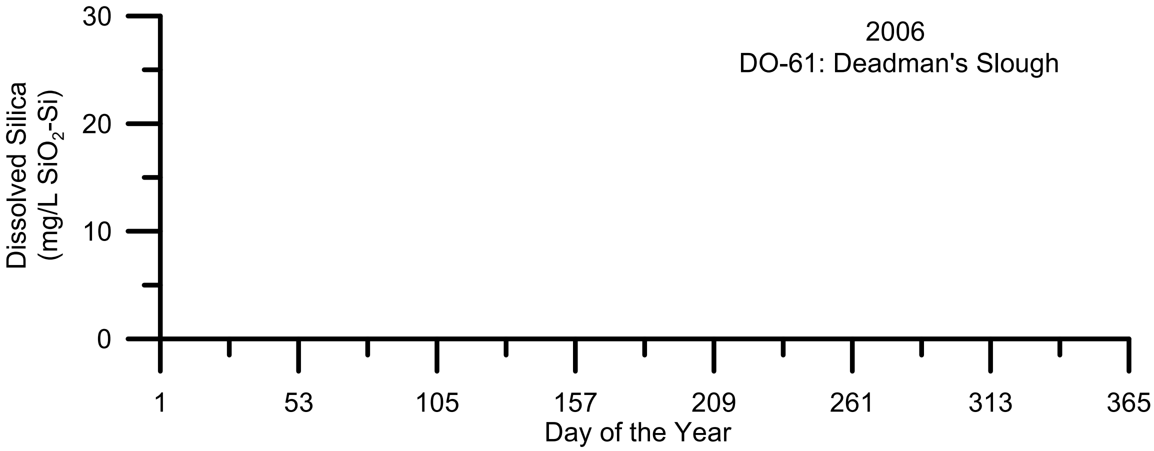

2007
DO-59: SJR Laird Park
Dissolved Silica
(mg/L SiO2-Si)
0
5
10
15
20
25
1
53
105
157
209
261
313
365
Day of the Year

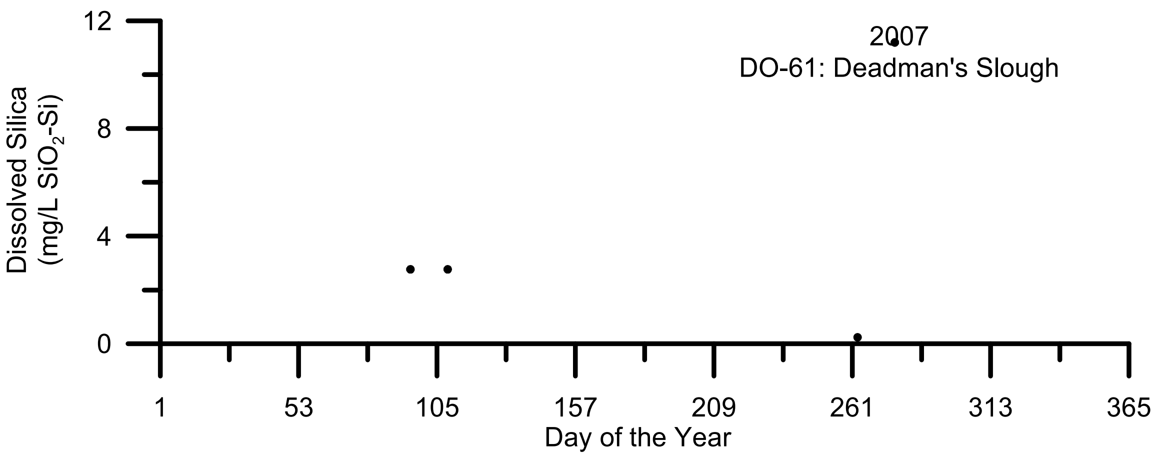

2005
DO-60: Moffit 1 South
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

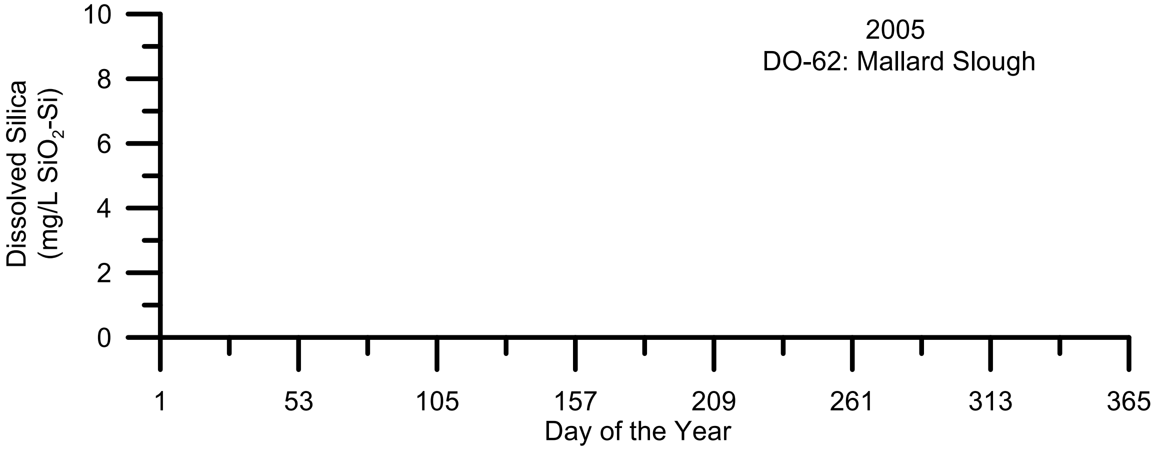

2006
DO-60: Moffit 1 South
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

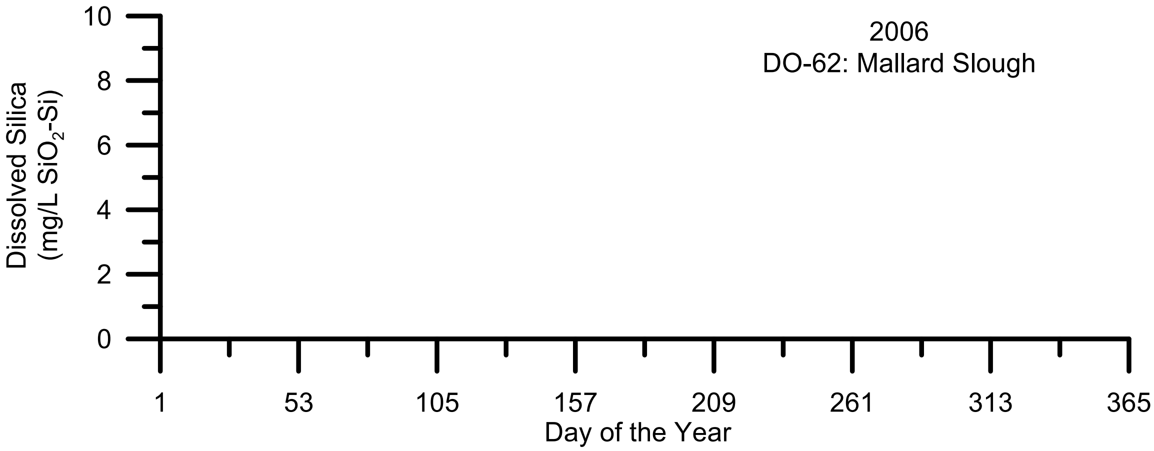

2007
DO-60: Moffit 1 South
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

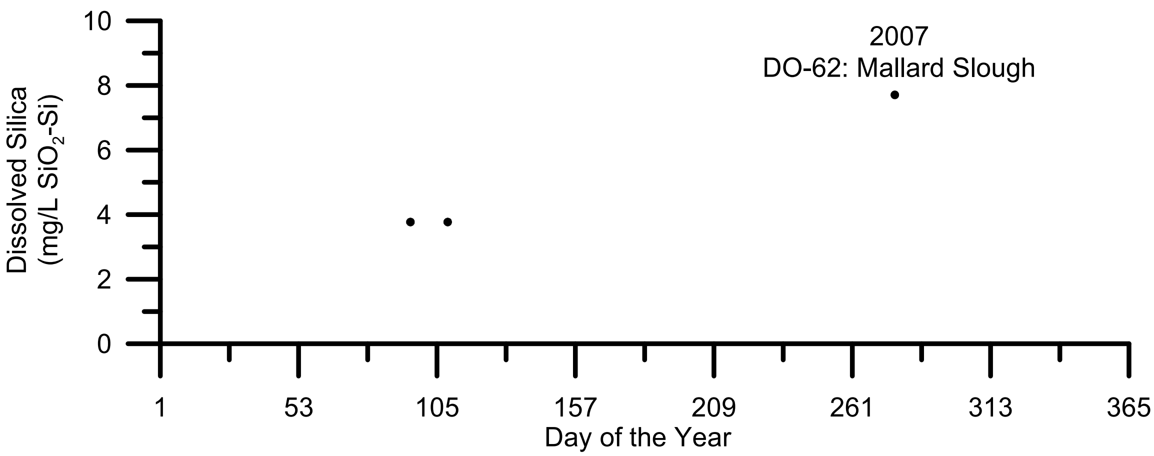

2005
DO-61: Deadman's Slough
Dissolved Silica
(mg/L SiO_2-Si)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

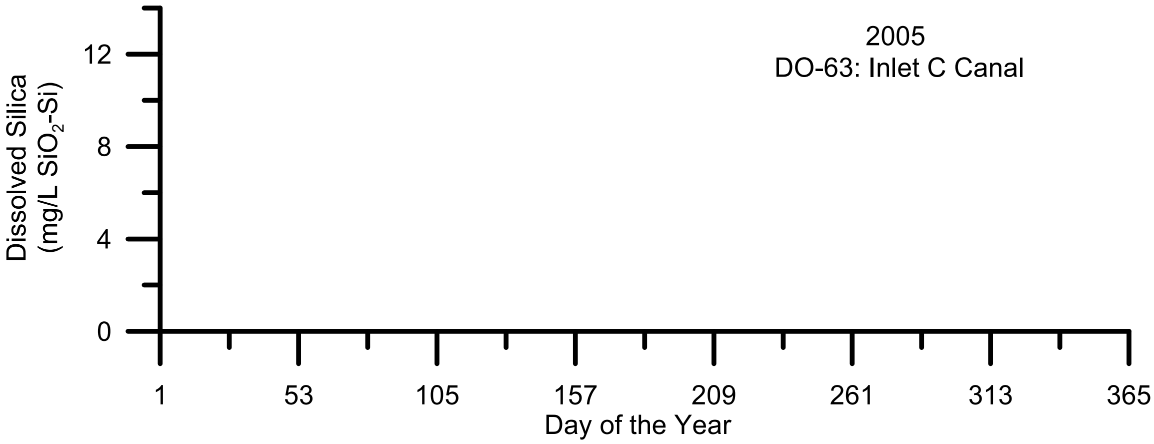

2006
DO-61: Deadman's Slough
Dissolved Silica
(mg/L SiO_2-Si)
30
20
10
0
1
53
105
157
209
261
313
365
Day of the Year

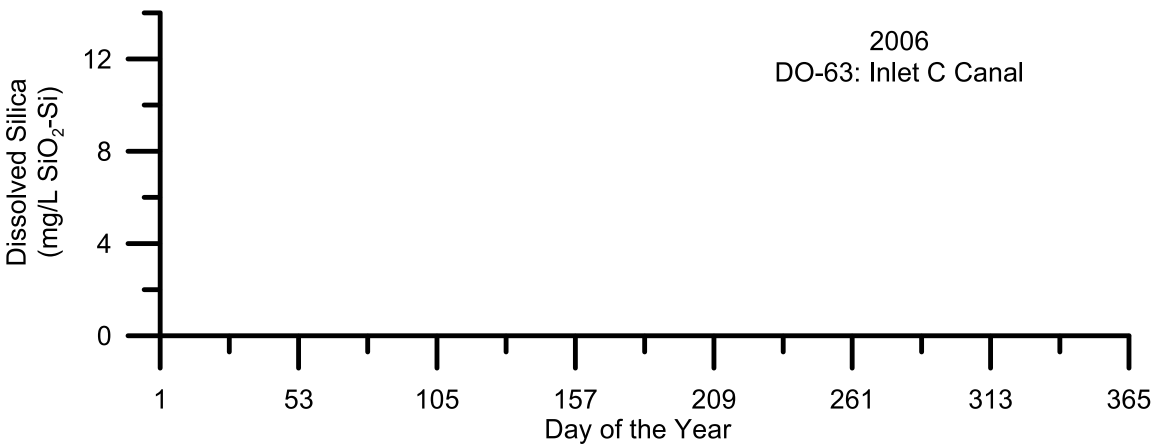

2007
DO-61: Deadman's Slough
Dissolved Silica
(mg/L SiO_2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

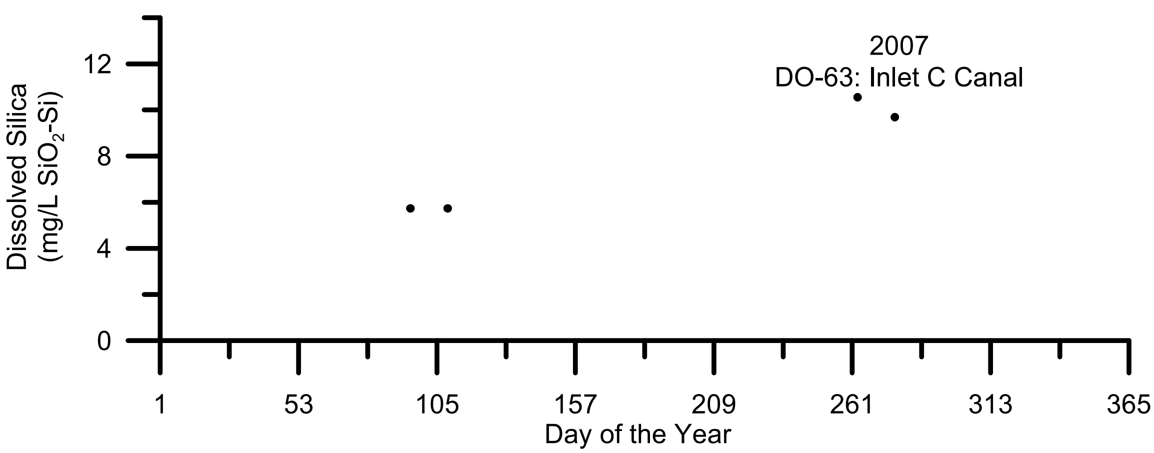

2005
DO-62: Mallard Slough
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

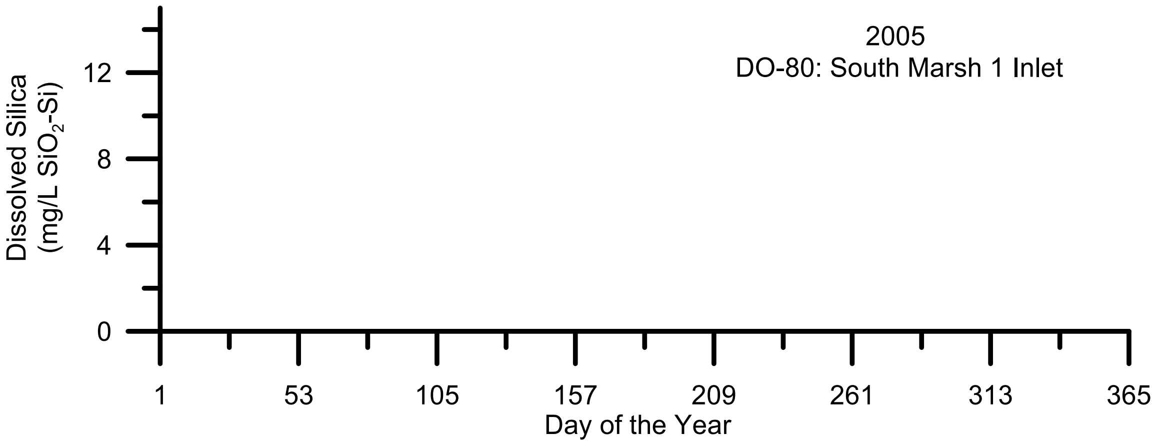

2006
DO-62: Mallard Slough
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

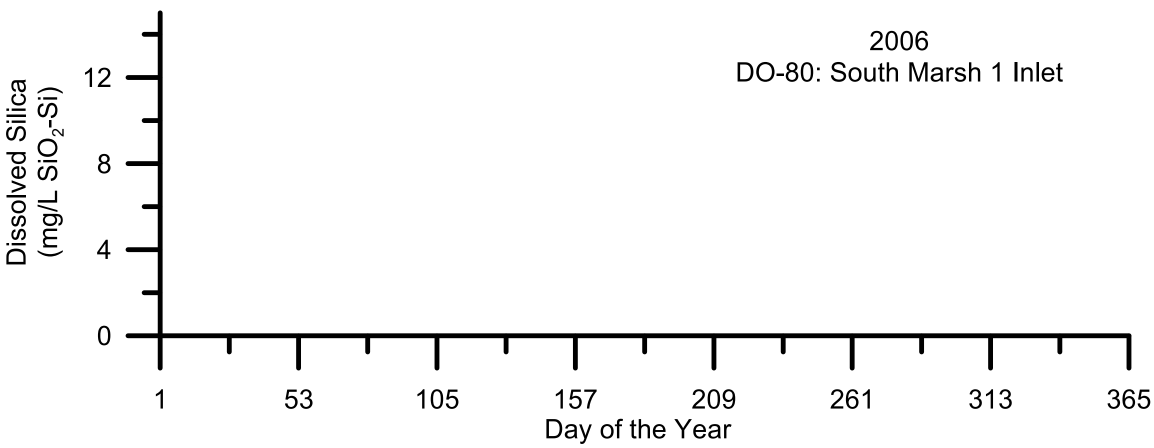

2007
DO-62: Mallard Slough
Dissolved Silica
(mg/L SiO_2-Si)
0
2
4
6
8
10
1
53
105
157
209
261
313
365
Day of the Year

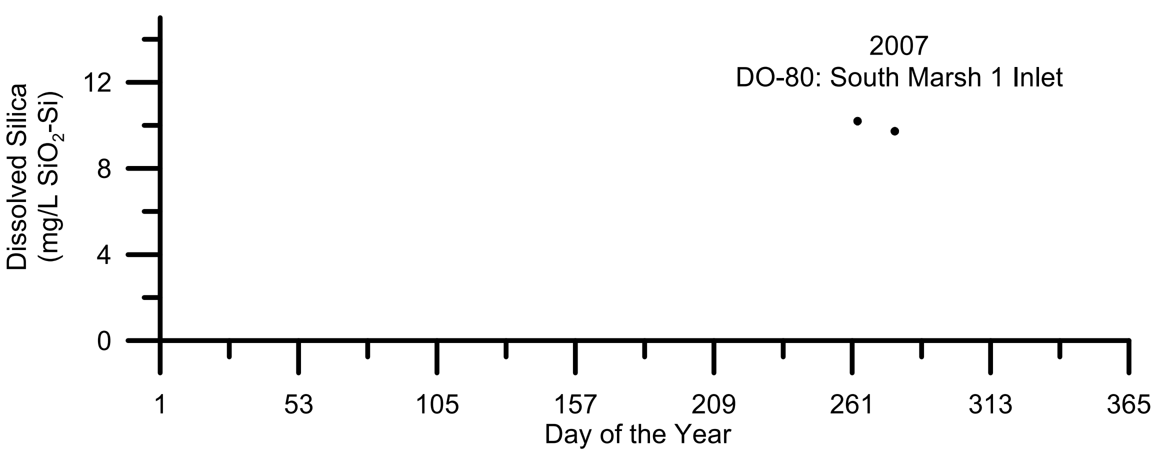

2005
DO-63: Inlet C Canal
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

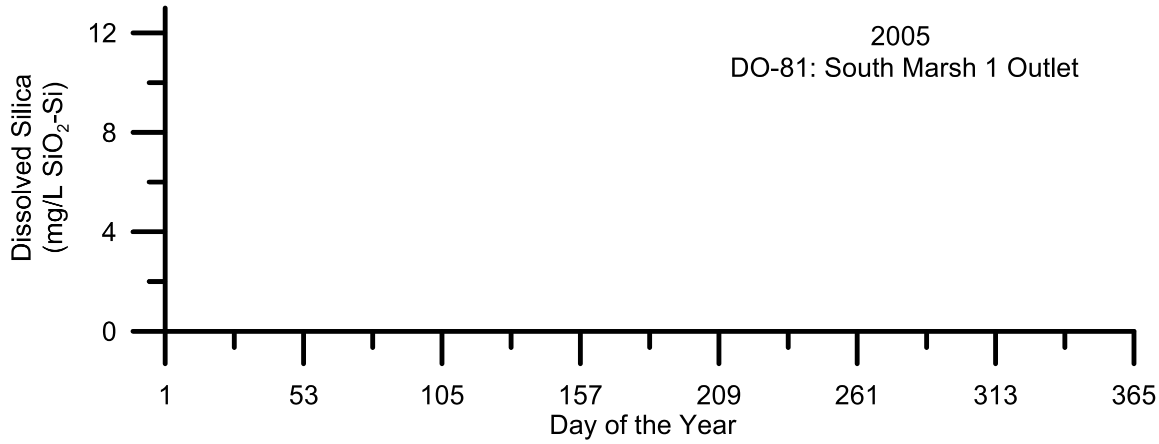

2006
DO-63: Inlet C Canal
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

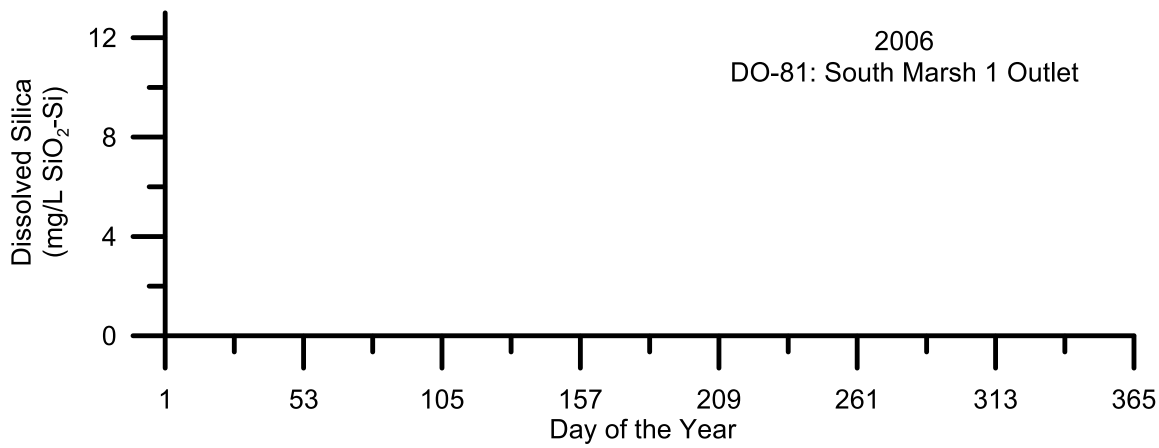

2007
DO-63: Inlet C Canal
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

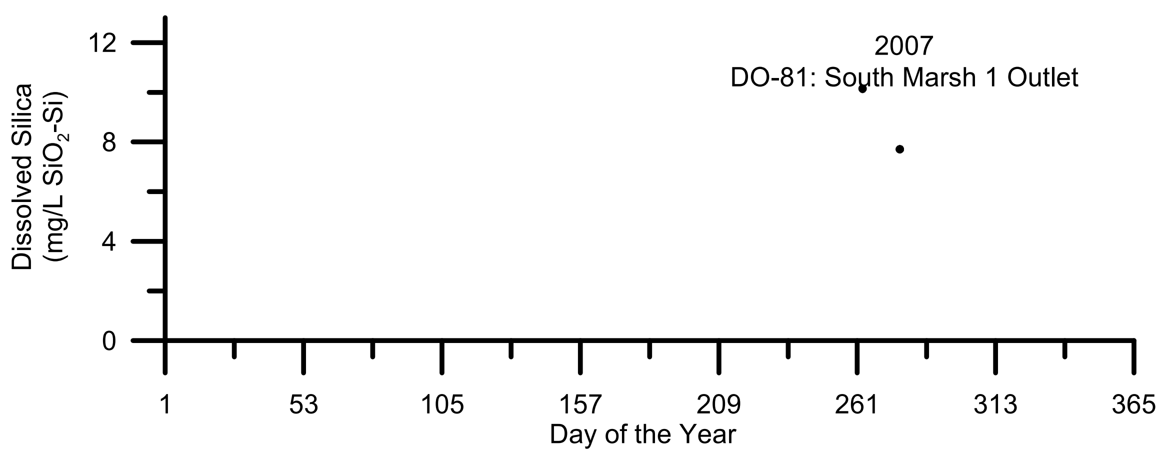

2005
DO-80: South Marsh 1 Inlet
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

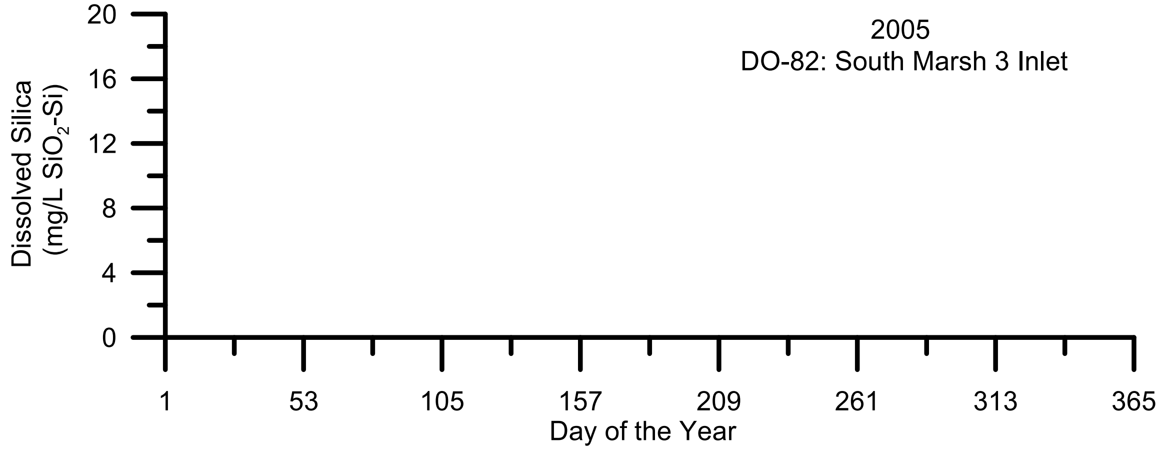

2006
DO-80: South Marsh 1 Inlet
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

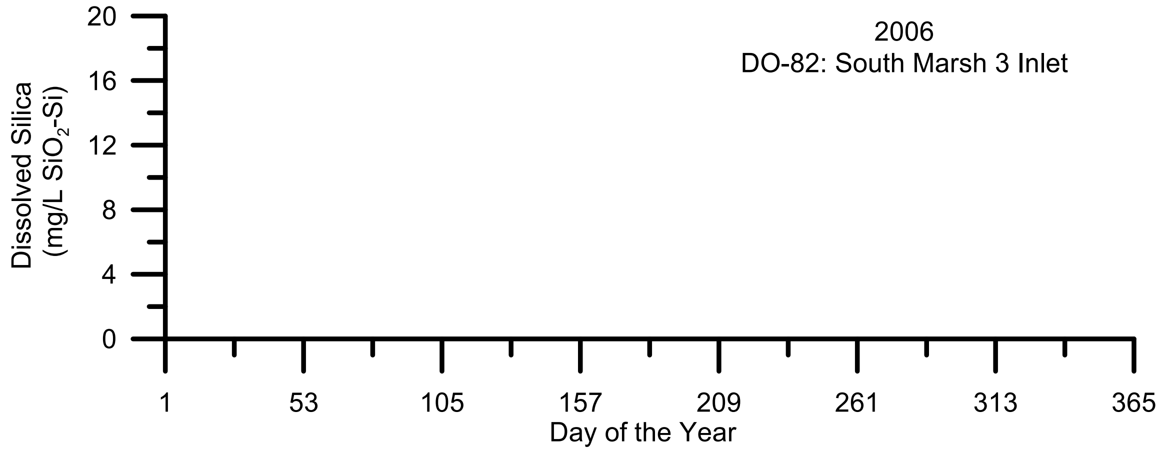

2007
DO-80: South Marsh 1 Inlet
Dissolved Silica
(mg/L SiO2-Si)
0
4
8
12
1
53
105
157
209
261
313
365
Day of the Year

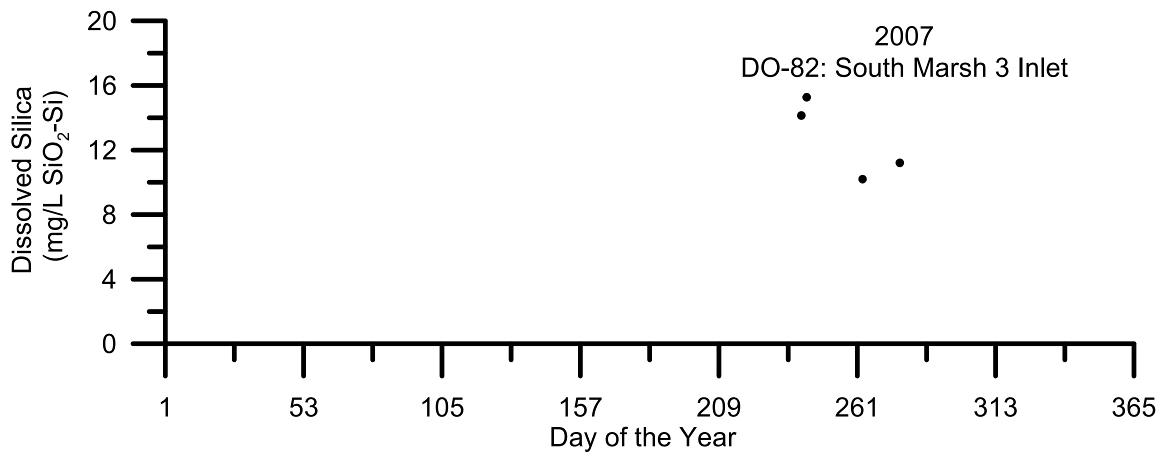

2005
DO-81: South Marsh 1 Outlet
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

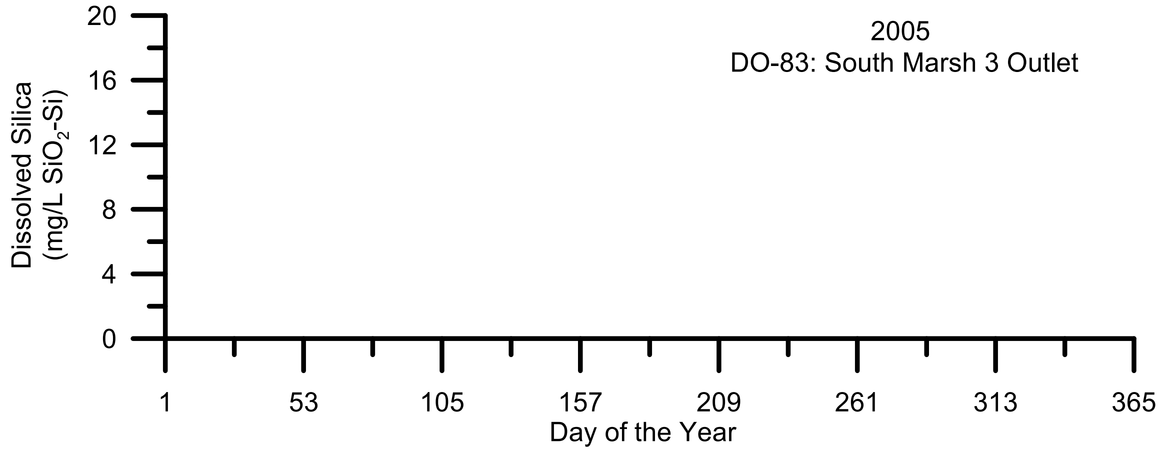

2006
DO-81: South Marsh 1 Outlet
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

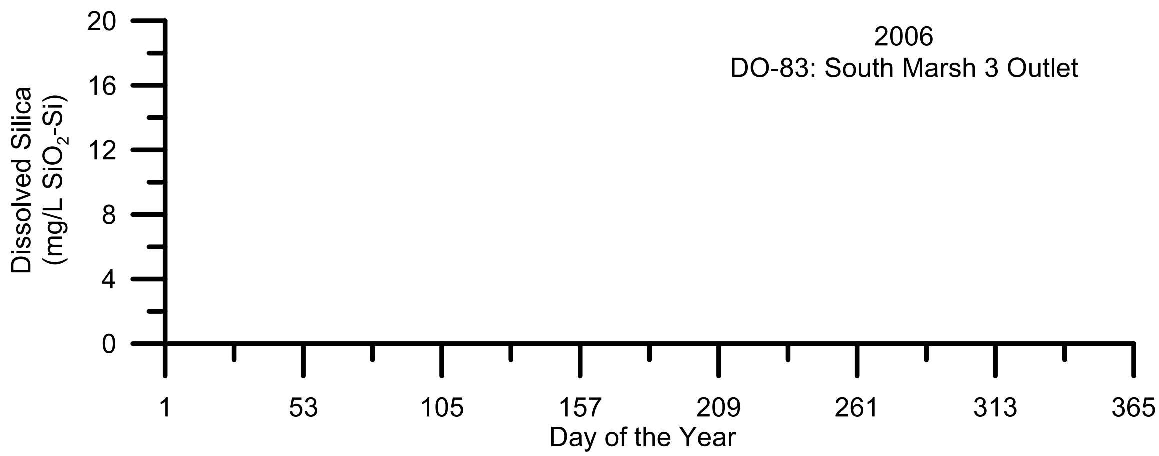

2007
DO-81: South Marsh 1 Outlet
Dissolved Silica
(mg/L SiO2-Si)
12
8
4
0
1
53
105
157
209
261
313
365
Day of the Year

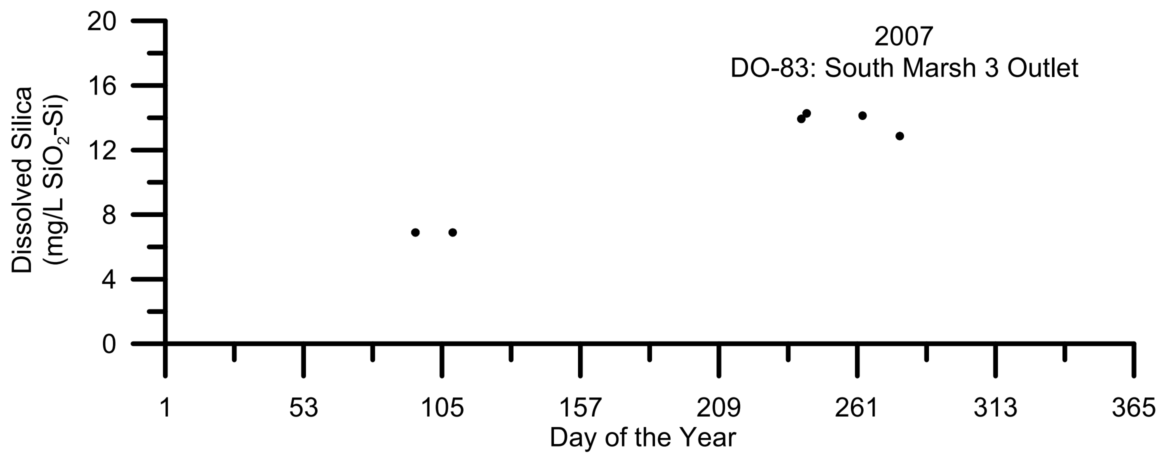

2005
DO-82: South Marsh 3 Inlet
Dissolved Silica (mg/L SiO2-Si)
Day of the Year

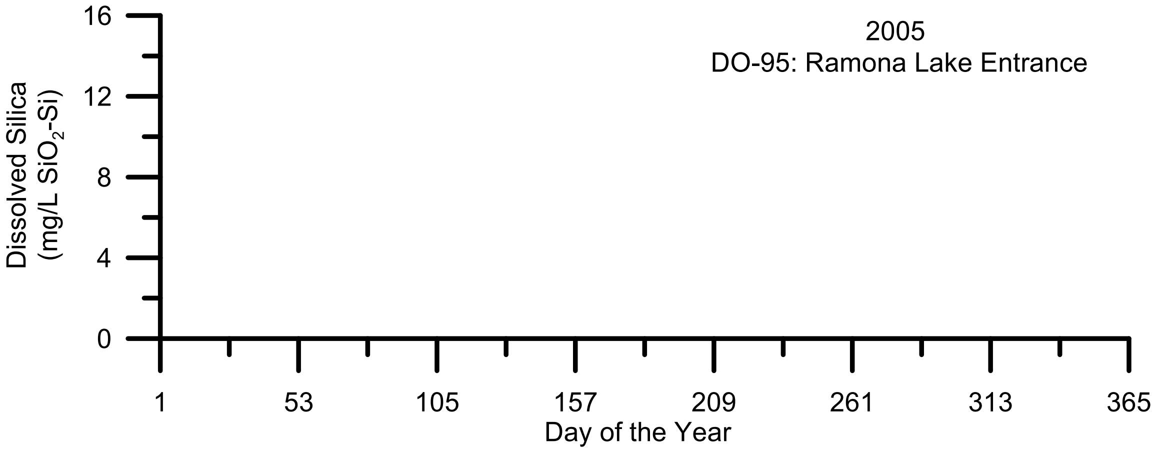

2006
DO-82: South Marsh 3 Inlet
Dissolved Silica (mg/L SiO2-Si)
Day of the Year

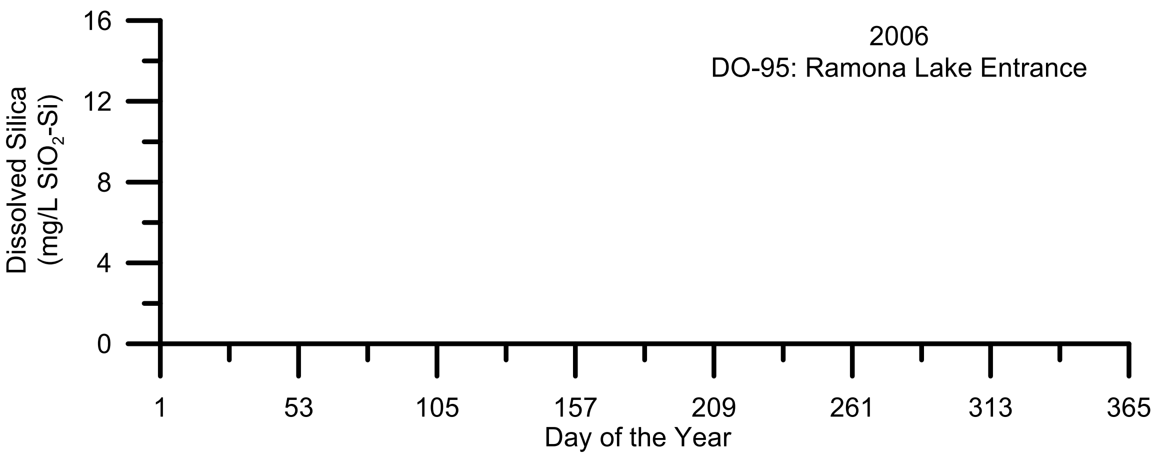

2007
DO-82: South Marsh 3 Inlet
Dissolved Silica (mg/L SiO2-Si)
Day of the Year

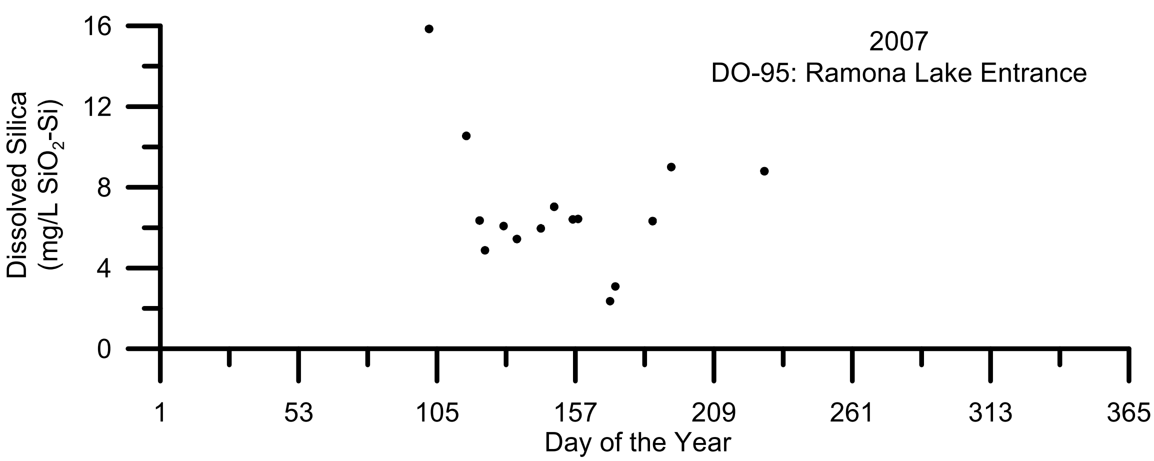

2005
DO-83: South Marsh 3 Outlet
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-83: South Marsh 3 Outlet
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-83: South Marsh 3 Outlet
Dissolved Silica
(mg/L SiO_2-Si)
0
4
8
12
16
20
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-95: Ramona Lake Entrance
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-95: Ramona Lake Entrance
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-95: Ramona Lake Entrance
Dissolved Silica (mg/L SiO_2-Si)
0
4
8
12
16
1
53
105
157
209
261
313
365
Day of the Year

UNIVERSITY OF THE PACIFIC
Environmental Engineering Research Program

Temporal Plots of 2005-2007 Dissolved Phosphate Data from the Upstream San Joaquin River

Chelsea Spier[1]
Remie Burks[1]
Sharon Borglin[1]
Randy Dahlgren[2]
Jeremy Hanlon[1]
Justin Graham[1]
William Stringfellow[1]

February 2008

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Stockton, CA 95211

[2]UC Davis, Davis, CA

Introduction

The San Joaquin River (SJR) supports one of the most productive agricultural regions in the world and its productivity is heavily dependant on irrigated agriculture. A consequence of irrigated agriculture is the production of return flows conveyed down gradient drains that eventually discharge to surface waters. Agricultural drainage may have significant nutrient load and can impact algae growth and general water quality in the SJR. Individual farmers and agricultural organizations, such as drainage authorities, are in need of tools to manage the environmental impacts of agricultural activities (Stringfellow, 2008).

For the years 2005 through 2007, sites throughout the San Joaquin Valley watershed were sampled to assess the overall water quality in the region. One thousand nine hundred and ninety-six (1996) individual surface water samples were collected and analyzed and WQ was assessed at 113 locations in the SJR basin (Borglin et al., 2008). Samples were processed and analyzed by the Environmental Engineering Research Program (EERP) laboratory at the University of the Pacific as well as at the University of California, Davis, Dahlgren Lab. This report presents temporal plots of dissolved ortho-phosphate-phosphorus (PO_4-P) data analyzed by the EERP laboratory between 2005 and 2007.

Methods

Depth integrated field samples were colleted during 2005-2007 in the upper San Joaquin River in accordance with EERP Field Standard Operating Procedures Protocol Book (Graham et al, 2008). Water samples were colleted in glass 1000 mL bottles (Wheaton Science Products, Millville, NJ), 1000 mL HDPE Trace-Clean narrow mouth plastic bottles (VWR International), 250 mL HDPE Trace-Clean wide mouth plastic bottles (VWR International) as well as 40 mL trace clean vials with PTFE septa (IChem, Rockwood, TN). Bottles were labeled with the appropriate sample number, site name and sampling date. All bottles were rinsed with sample water prior to sample collection. Some sites required a bucket to collect sample water because of accessibility from a high bridge or platform. For these sites, the bucket was pre-rinsed with sample water and sample bottles were filled using a rinsed funnel. Care was taken to distribute water simultaneously to all sample bottles (rather than sequentially). Samples were immediately stored at 4°C after sampling (cooler temperature was recorded in the lab upon delivery) and transported to the EERP lab on the day of sampling.

Within 24 hours of collection samples were filtered through 47mm Whatman GF/F filters (0.7µm pore size) to remove filterable solids, and were then alquotted and stored at -20°C until PO_4-P analysis could be completed.

PO_4-P was quantified in filtered samples by the ascorbic acid method adapted from SM 4500-P-E (APHA, 2005) using Hach PhosVer3 packets (Loveland, CO). Light absorbance at 890 nm was measured using the PerkinElmer Lambda 35 UV/VIS Spectrometer (Shelton, CT). The reportable limit for this method was 0.05 mg/L PO_4-P.

Results/Discussion

With each set of PO_4-P field samples analyzed in the EERP laboratory, quality assurance samples including a lab duplicate, field duplicate, matrix spike, matrix spike duplicate, calibration check standards, laboratory control standard, trip blank, and lab blanks were also analyzed. Between 2005 and 2007, 99.7% of all quality assurance samples were within passing range (Borglin et al, 2008). Proficiency check samples, standards with unknown concentration to the laboratory analyst, were run approximately twice a year. Five proficiency check samples were analyzed for PO_4-P in the EERP laboratory during 2006 and 2007, and all of these samples were found to be within the acceptable range. Samples were measured ranging from 0.0-6.06 mg/L PO_4-P. The average concentration of PO_4-P in samples collected was 0.25 mg/L PO_4-P. PO_4-P was also analyzed at UC Davis on all of the same water samples and has a high correlation to values measured by EERP. When all data points measured by the two labs are compared they have r^2=0.849, and both labs have almost the same recovery rate, EERP measured 99.94% of PO_4-P as UCD (Figure 2). In general PO_4-P was lowest during the summer months and peaks were found most often during the wet season.

One problem that occurred with this analysis was PO_4-P values were sometimes found to be slightly higher then the measured total phosphorus (Tot-P) values. When this happened one or both of these analyses were re-run. This problem occurred most often in samples with high PO_4-P and Tot-P which required dilutions. Because of this problem all PO_4-P and Tot-P dilutions are now run in triplicate to reduce the potential for dilution errors. These temporal plots (Figures 3-104) as well as plotting EERP data against UCD's data (Figure 2) created an easy visual way to find outliers and double check data entry for possible mistakes. For the purpose of these plots any data points that were slightly negative were changed to 0.

References

American Public Health Association (APHA). 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

Borglin, S., W. Stringfellow, J. Hanlon. 2005. Standard Operating Procedures for the Up-Stream Dissolved Oxygen TMDL Project. LBNL/Pub-937.

Borglin, S., Burks, R., Hanlon, J., Graham, J., Spier, C., Stringfellow, W., and Dahlgren, R., (2008) Methods overview, quality assurance, and quality control, University of the Pacific, Stockton, CA

Borglin, S.E., Burks, R.D., Hanlon, J.S., Stringfellow, W.T. (2008) EERP Lab Protocol Book, University of the Pacific, Stockton, CA.

Graham, J., Hanlon, J.S., Stringfellow, W.T., (2008) EERP Field Protocol Book, University of the Pacific, Stockton, CA.

Stringfellow, W.T., et al., (2008) Evaluation of Vegitated Ditches, Ponds, and Wetlands as BMPs for Mitigating the Water Quality Impact of Irrigated Agriculture in the San Joaquin Valley, University of the Pacific, Stockton, CA

YSI Environmental Operations Manual (2005) 6-Series Environmental Monitoring Systems, Yellow Springs, OH.

Table 1: EERP Sampling Site List.

DO Number	Site Name	Type
4	**SJR at Mossdale**	Core sites
5	**SJR at Vernalis-McCune Station (River Club)**	Core sites, BMP
6	**SJR at Maze**	Core sites, BMP
7	**SJR at Patterson**	Core sites, BMP
8	**SJR at Crows Landing**	Core sites, BMP
10	**SJR at Lander Avenue**	Core sites
12	**Stanislaus River at Caswell Park**	Core sites
14	**Tuolumne River at Shiloh Bridge**	Core sites
16	**Merced River at River Road**	Core sites
18	**Mud Slough near Gustine**	Core sites, Wetland
19	**Salt Slough at Lander Avenue**	Core sites, Wetland
20	**Los Banos Creek Flow Station**	Core sites, Wetland
21	**Orestimba Creek at River Road**	Core sites, BMP
23	**Modesto ID Lateral 5 to Tuolumne**	Core sites
25	**Modesto ID Main Drain to Stan. R. via Miller Lake**	Core sites
28	**Turlock ID Westport Drain Flow station**	Core sites
29	**Turlock ID Harding Drain**	Core sites
30	**Turlock ID Lateral 6 & 7 at Levee**	Core sites
33	**Hospital Creek**	Intermittent, BMP
34	**Ingram Creek**	Core sites, BMP
36	**Del Puerto Creek Flow Station**	Core sites, BMP
44	**San Luis Drain End**	Core sites
53	**Salt Slough at Wolfsen Road**	Wetland
57	**Ramona Lake Drain**	Core sites, BMP
59	**SJR Laird Park**	Core sites
60	**Moffit 1 South**	Wetland
61	**Deadman's Slough**	Wetland
62	**Mallard Slough**	Wetland
63	**Inlet C Canal**	Wetland
80	**South Marsh-1-Inlet**	Wetland
81	**South Marsh-1-Outlet**	Wetland
82	**South Marsh-3-Inlet**	Wetland
83	**South Marsh-3-Outlet**	Wetland
95	**Ramona drain at Ramona Lake**	BMP, Intermittent

Figure 1: EERP Sampling Site Map of SJR Watershed and Tributaries.

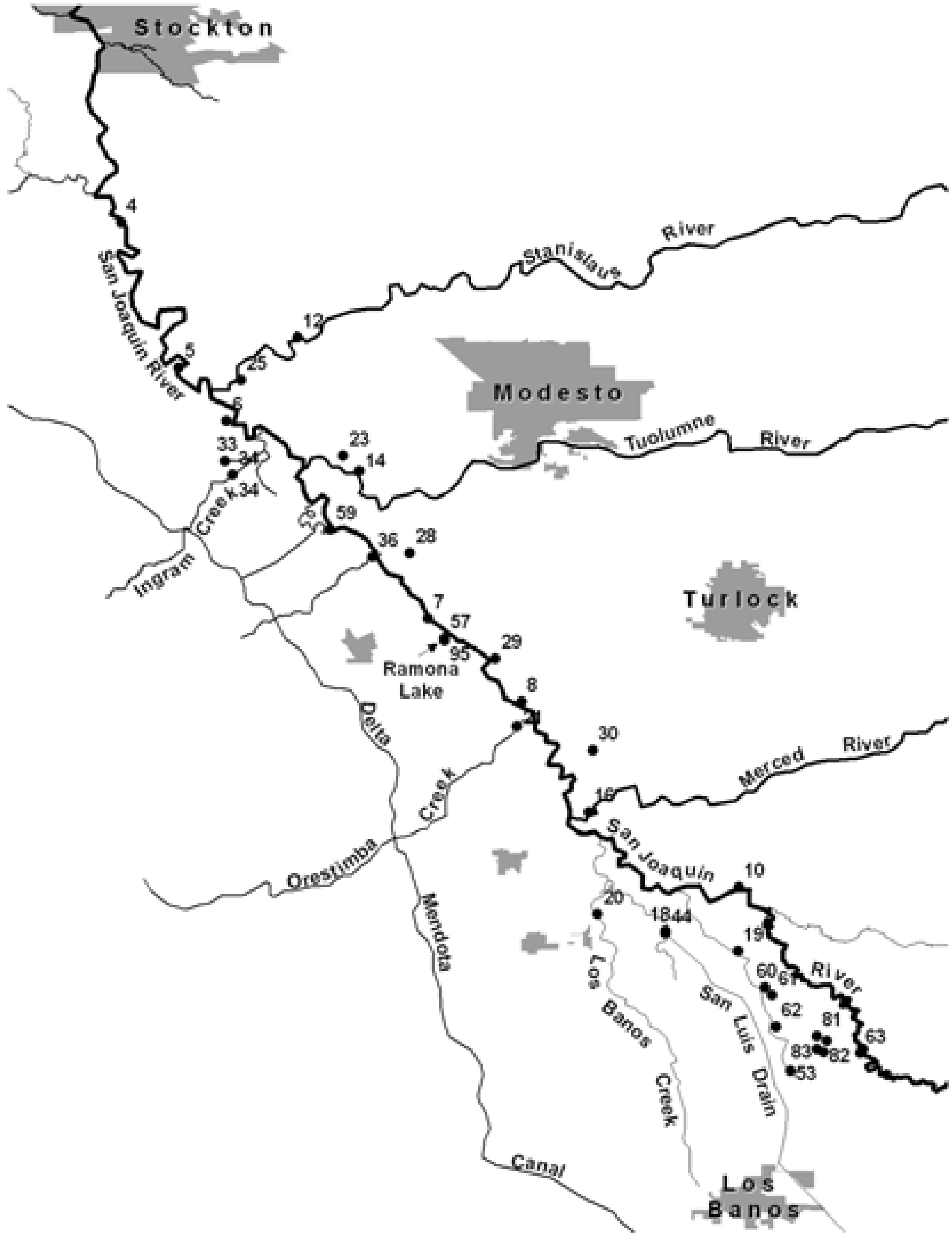
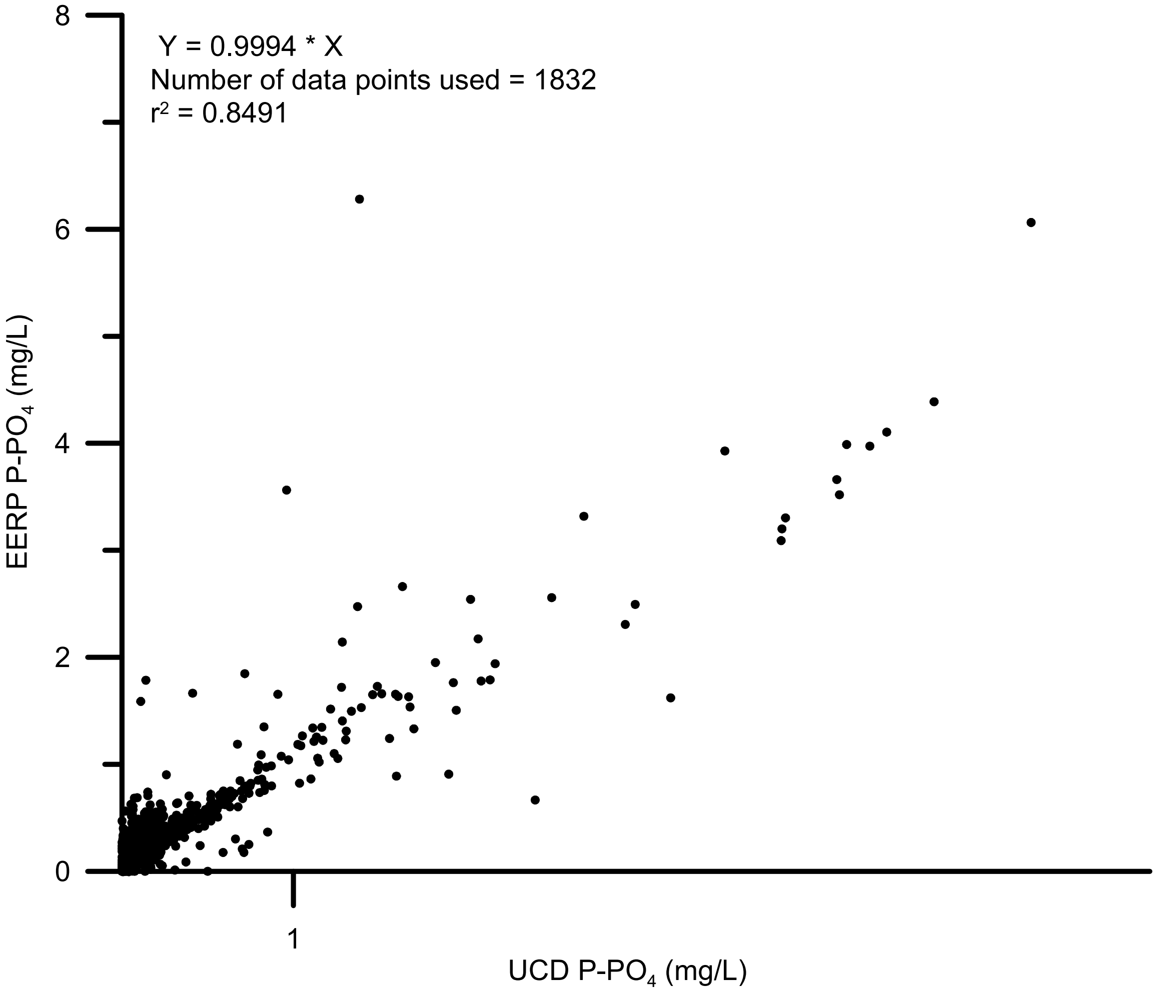
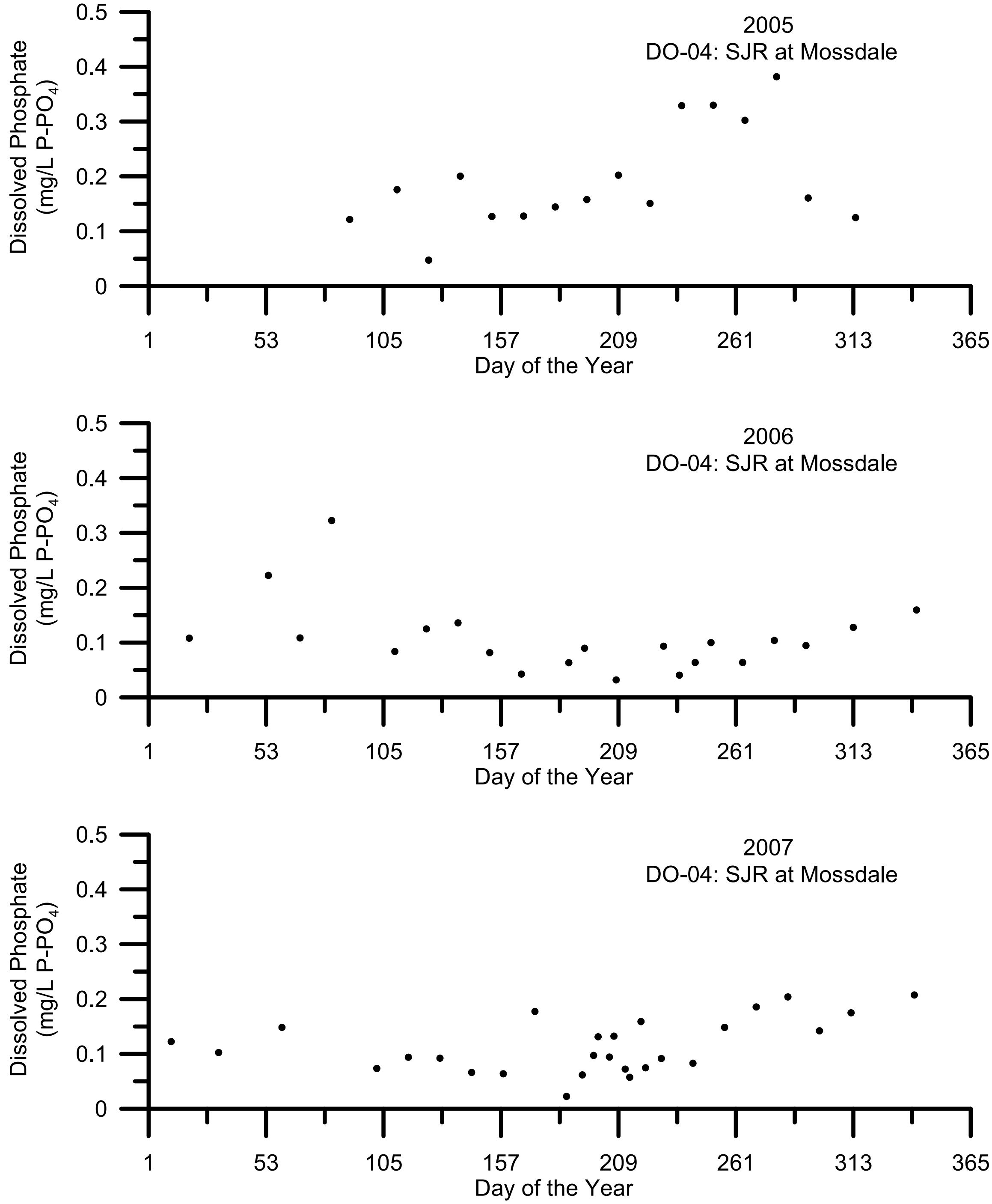
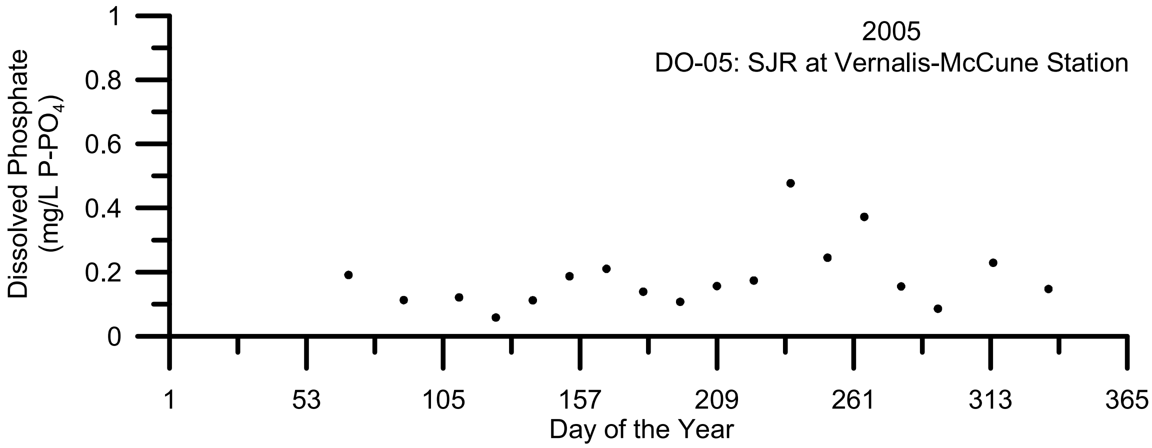


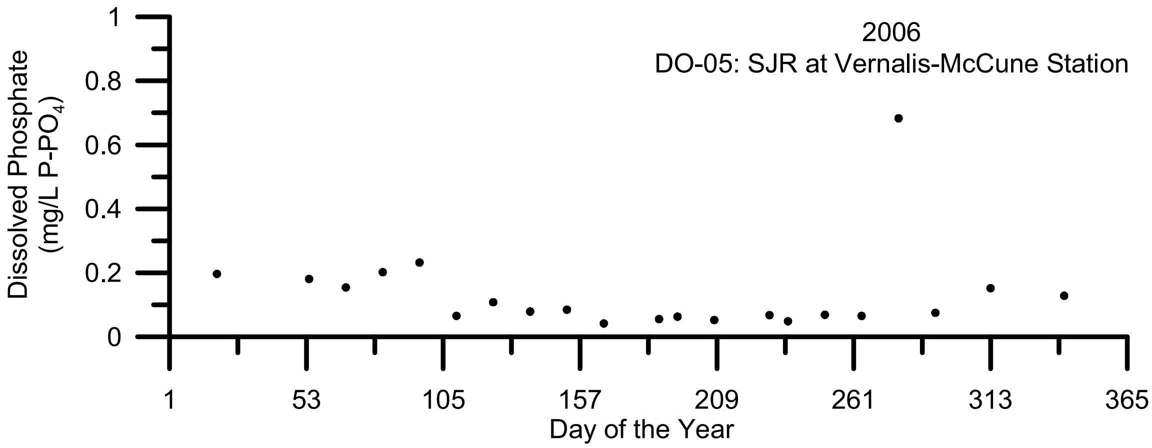
Figure 2: EERP vs UCD PO4-P Data from 2005-2007.

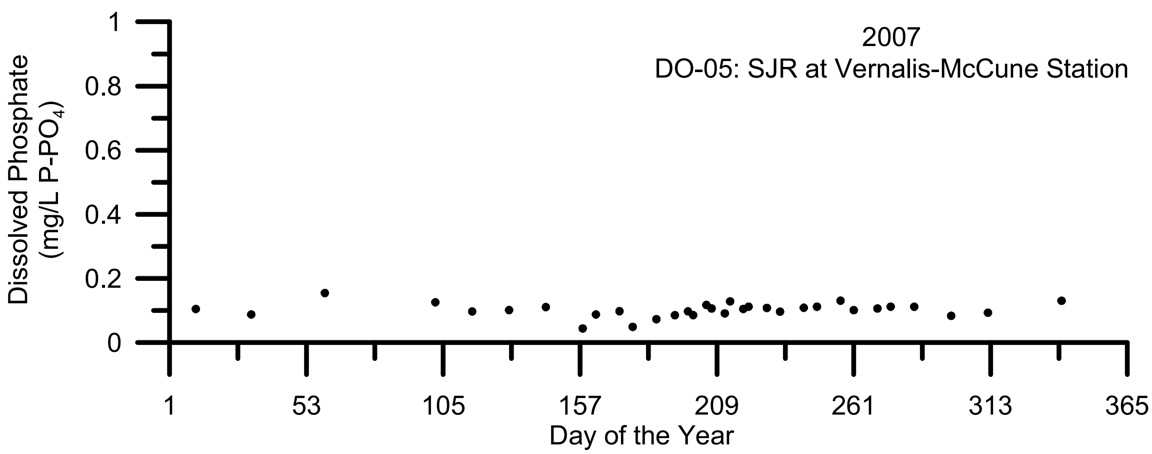


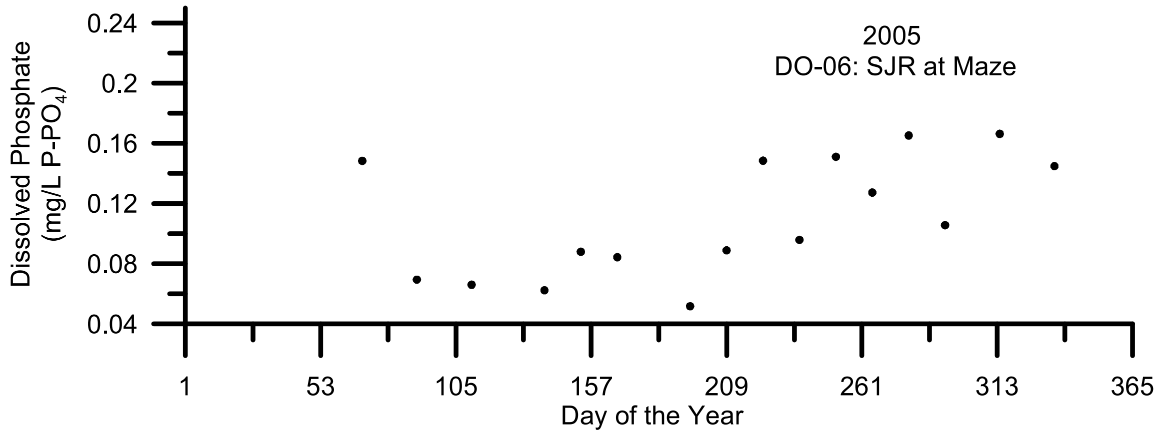
Figures 3 -104: Temporal Plots of PO4-P By Site ID Analyzed by the EERP Laboratory.

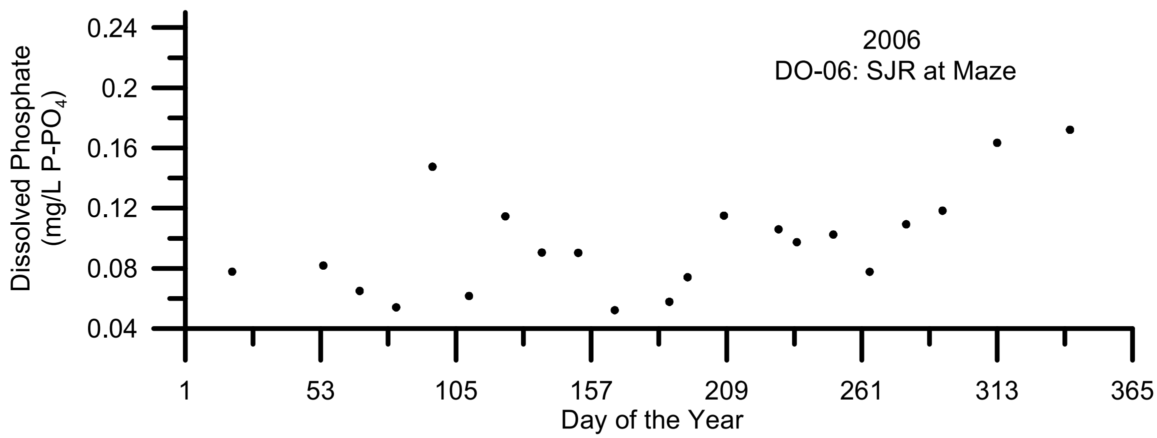


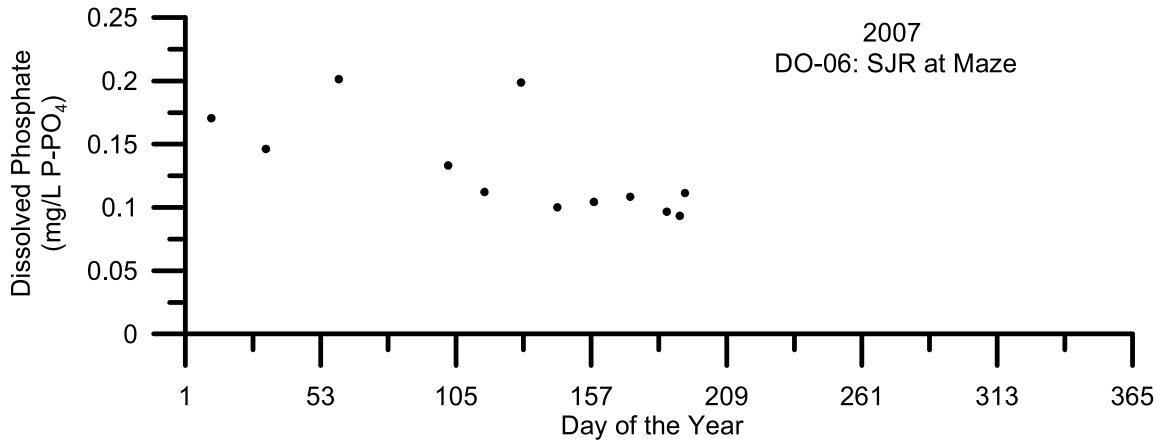

2005
DO-05: SJR at Vernalis-McCune Station
Dissolved Phosphate
(mg/L P-PO$_4$)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

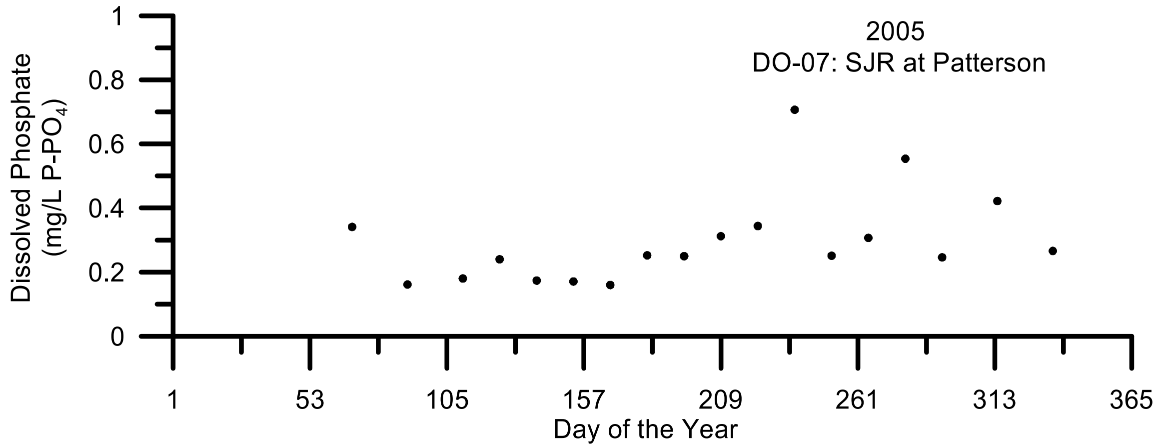

2006
DO-05: SJR at Vernalis-McCune Station
Dissolved Phosphate
(mg/L P-PO$_4$)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

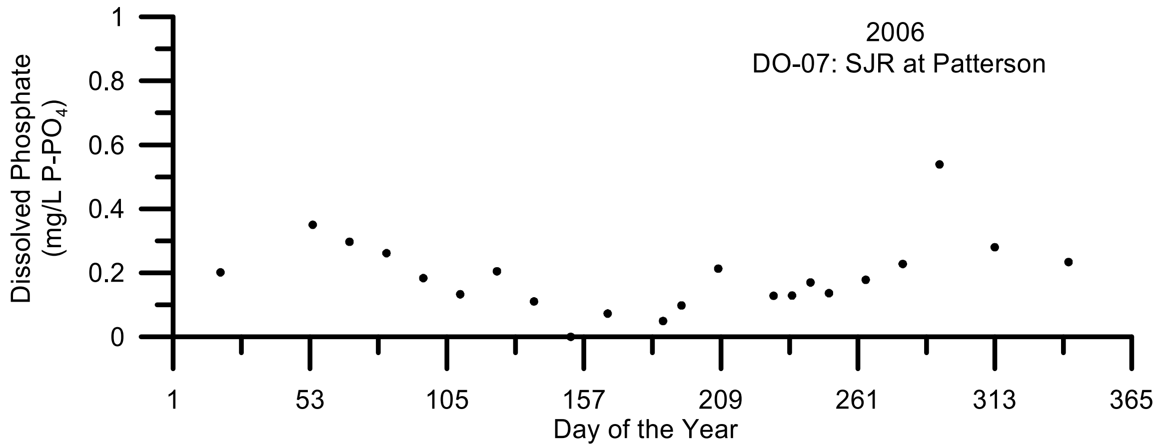

2007
DO-05: SJR at Vernalis-McCune Station
Dissolved Phosphate
(mg/L P-PO$_4$)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-06: SJR at Maze
Dissolved Phosphate
(mg/L P-PO_4)
0.24
0.2
0.16
0.12
0.08
0.04
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-06: SJR at Maze
Dissolved Phosphate
(mg/L P-PO_4)
0.24
0.2
0.16
0.12
0.08
0.04
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-06: SJR at Maze
Dissolved Phosphate
(mg/L P-PO_4)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-07: SJR at Patterson
Dissolved Phosphate
(mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year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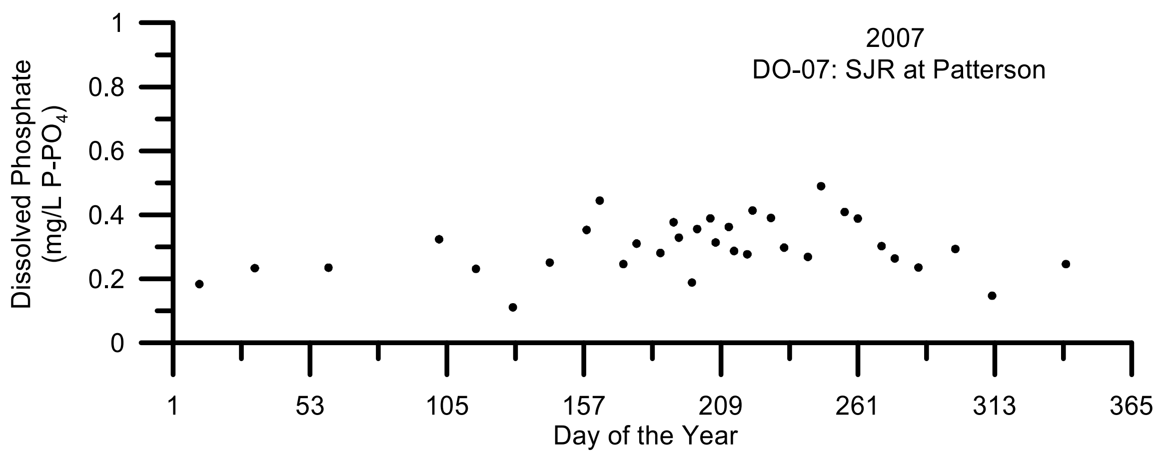
DO-07: SJR at Patterson
Dissolved Phosphate
(mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year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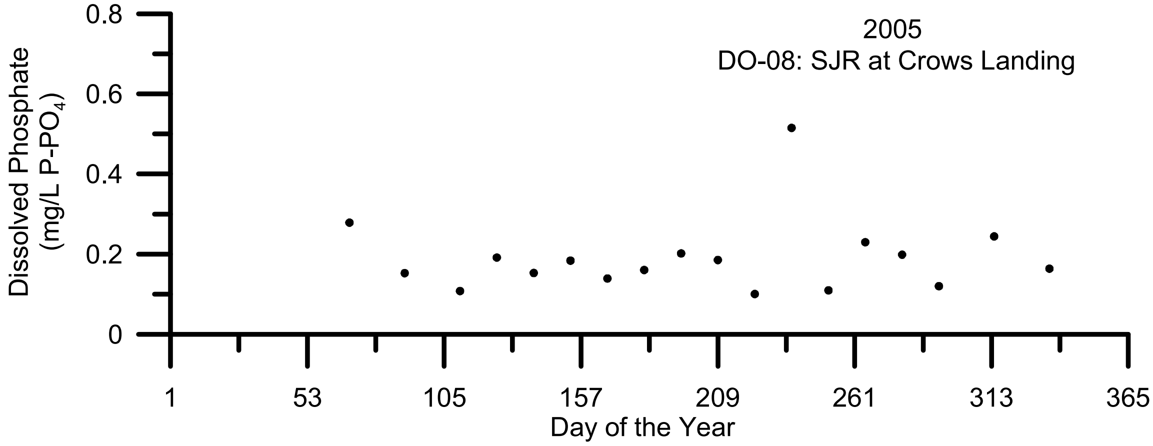
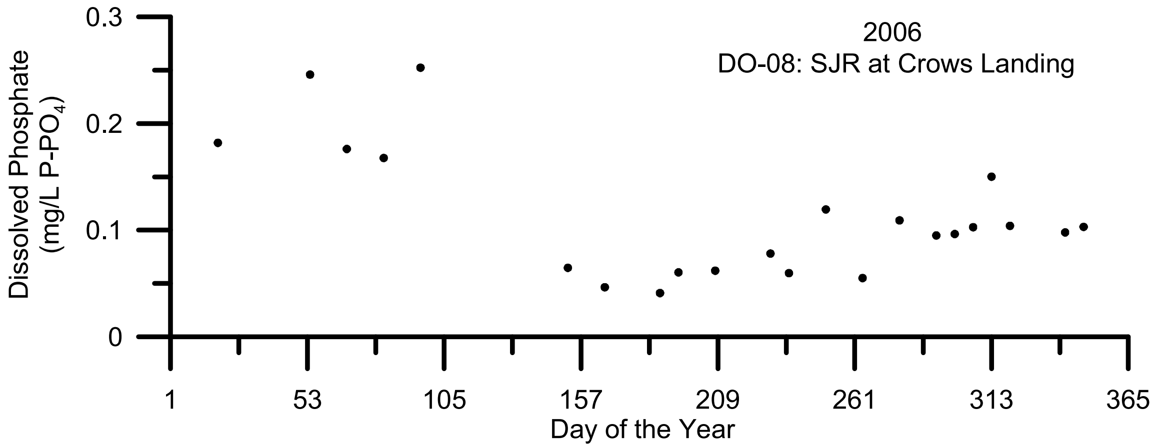
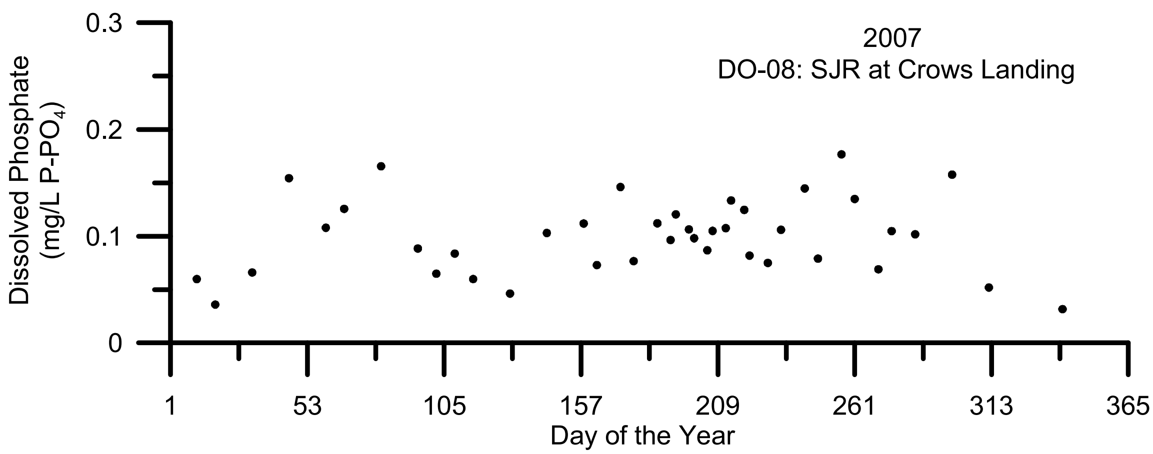
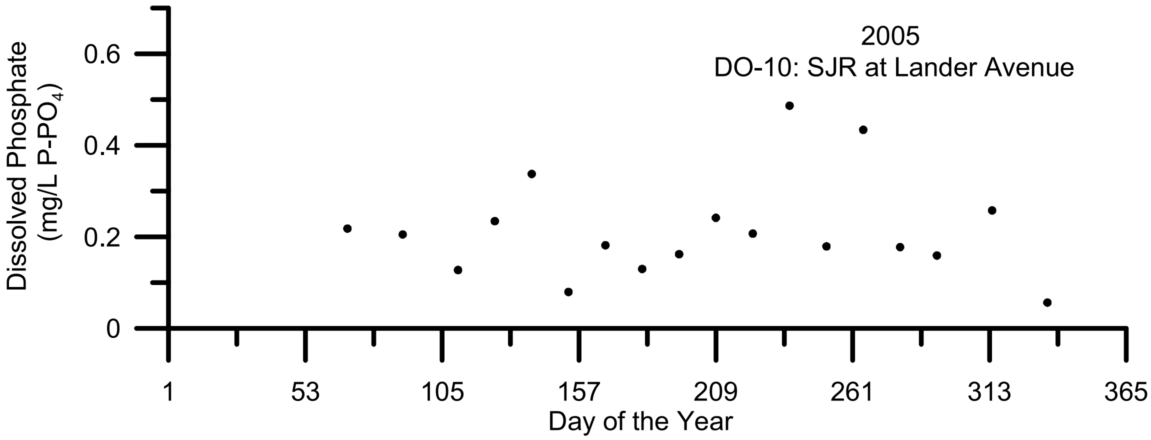
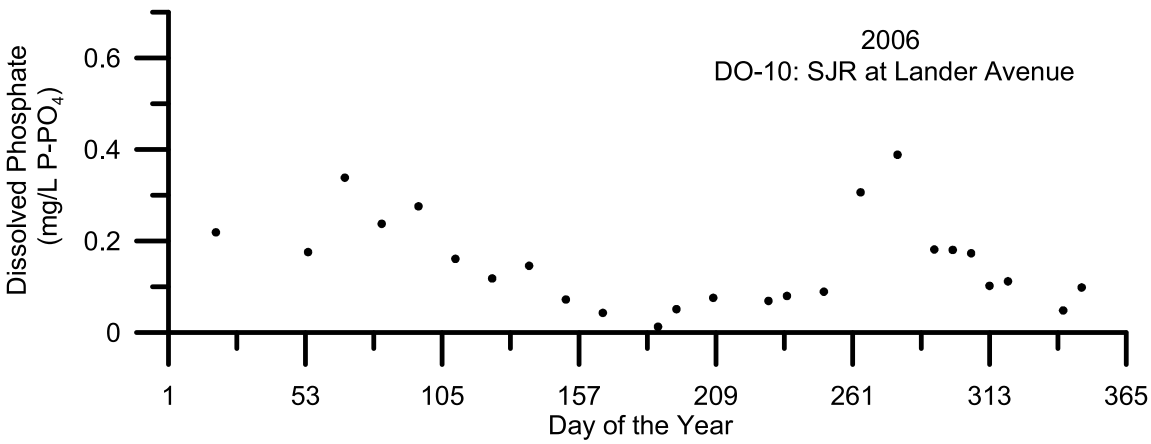
DO-07: SJR at Patterson
Dissolved Phosphate
(mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-08: SJR at Crows Landing
Dissolved Phosphate
(mg/L P-PO4)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-08: SJR at Crows Landing
Dissolved Phosphate
(mg/L P-PO4)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-08: SJR at Crows Landing
Dissolved Phosphate
(mg/L P-PO4)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-10: SJR at Lander Avenue
Dissolved Phosphate
(mg/L P-PO4)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year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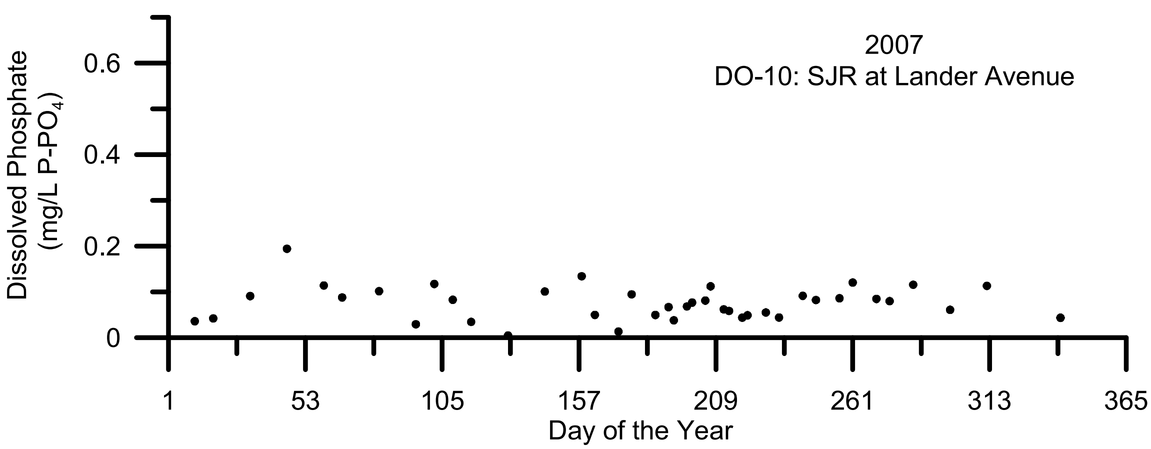
Dissolved Phosphate
(mg/L P-PO4)
0
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year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DO-10: SJR at Lander Avenue
Dissolved Phosphate
(mg/L P-PO4)
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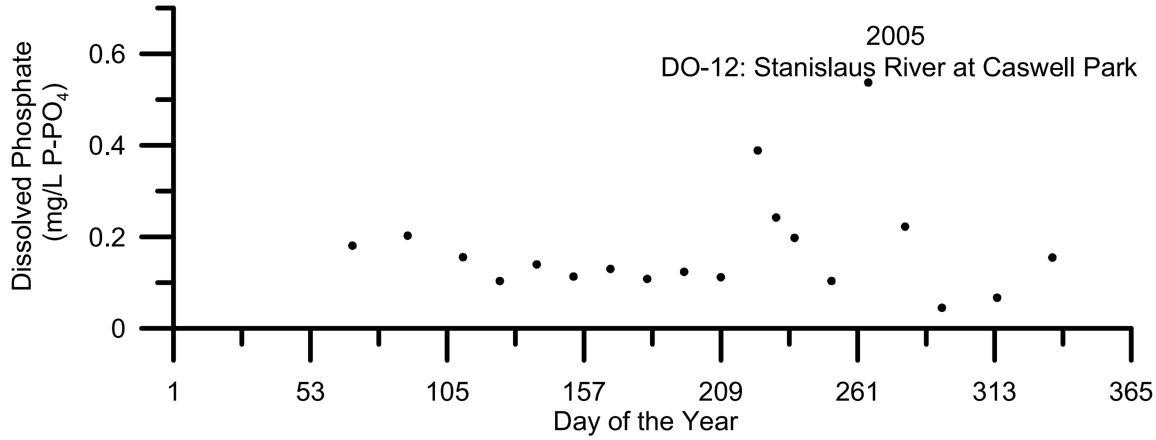
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year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DO-12: Stanislaus River at Caswell Park
Dissolved Phosphate
(mg/L P-PO4)
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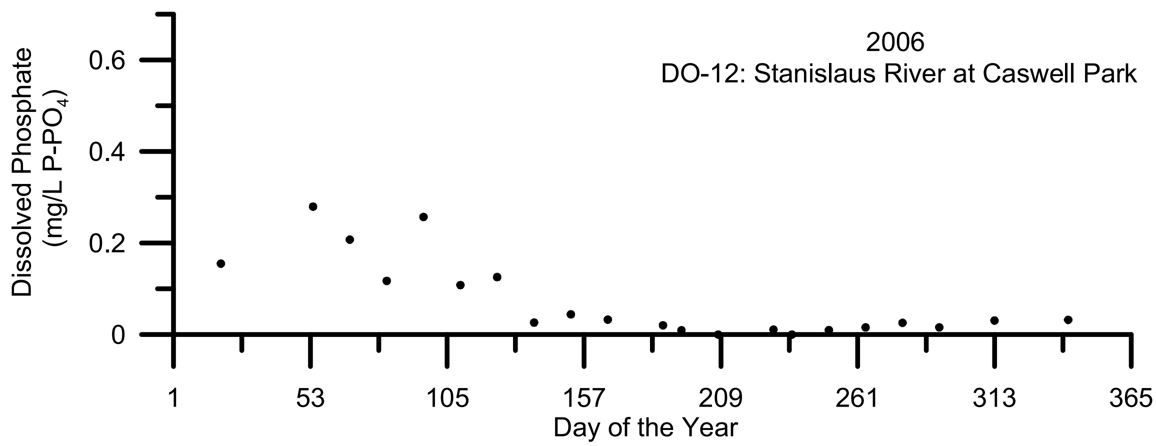
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-12: Stanislaus River at Caswell Park
Dissolved Phosphate
(mg/L P-PO4)
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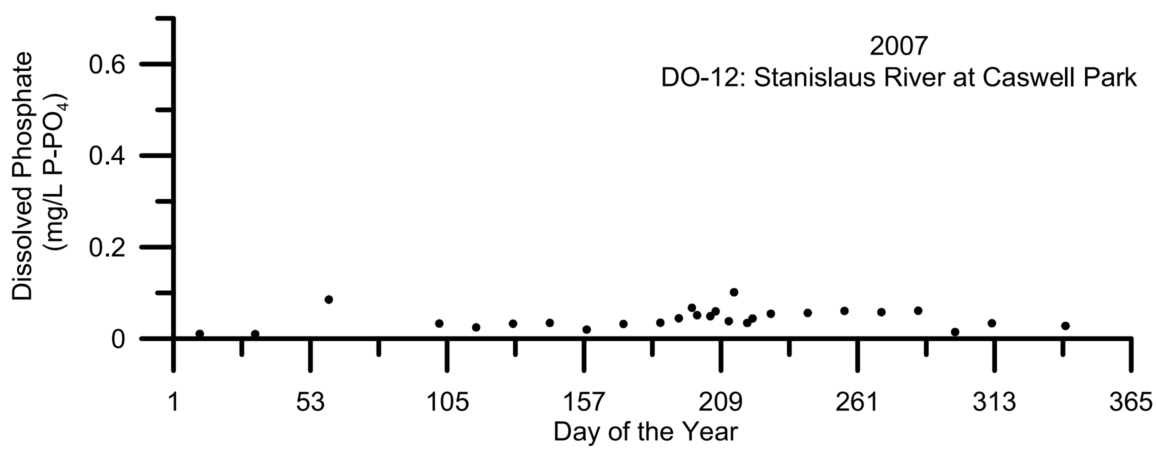
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year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DO-12: Stanislaus River at Caswell Park
Dissolved Phosphate
(mg/L P-PO4)
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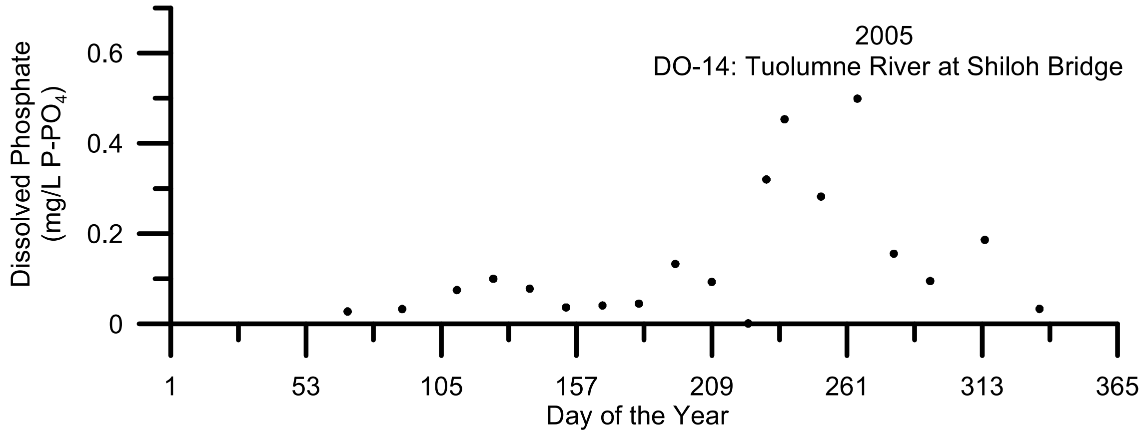
0.2
0.4
0.6
1
53
105
157
209
261
313
365
Day of the Year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Dissolved Phosphate
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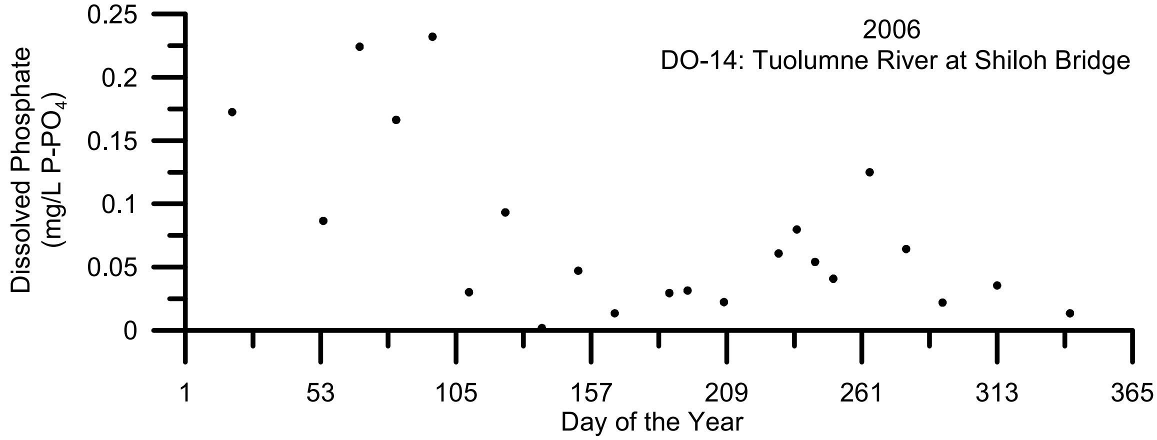
53
105
157
209
261
313
365
Day of the Year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Dissolved Phosphate
(mg/L P-PO_4)
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0.05
0
1
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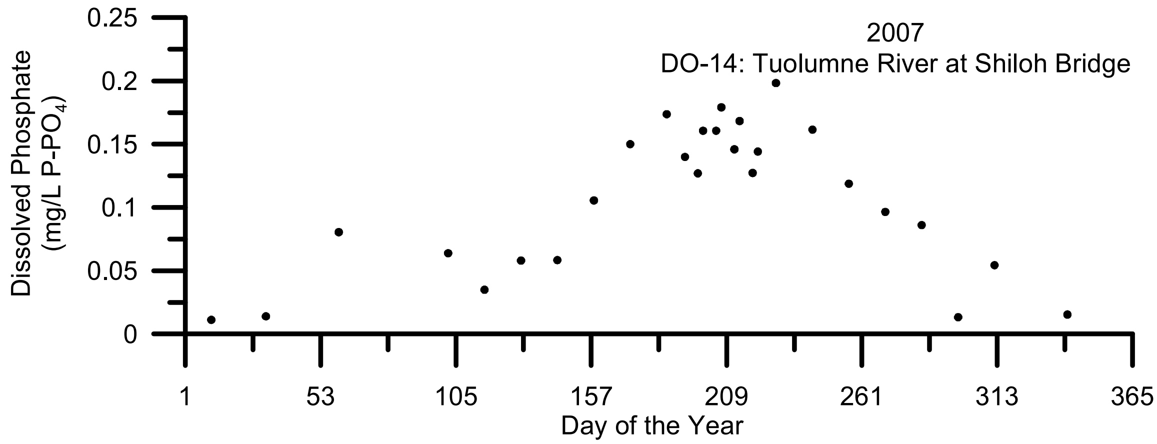
157
209
261
313
365
Day of the Year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DO-14: Tuolumne River at Shiloh Bridge
Dissolved Phosphate
(mg/L P-PO_4)
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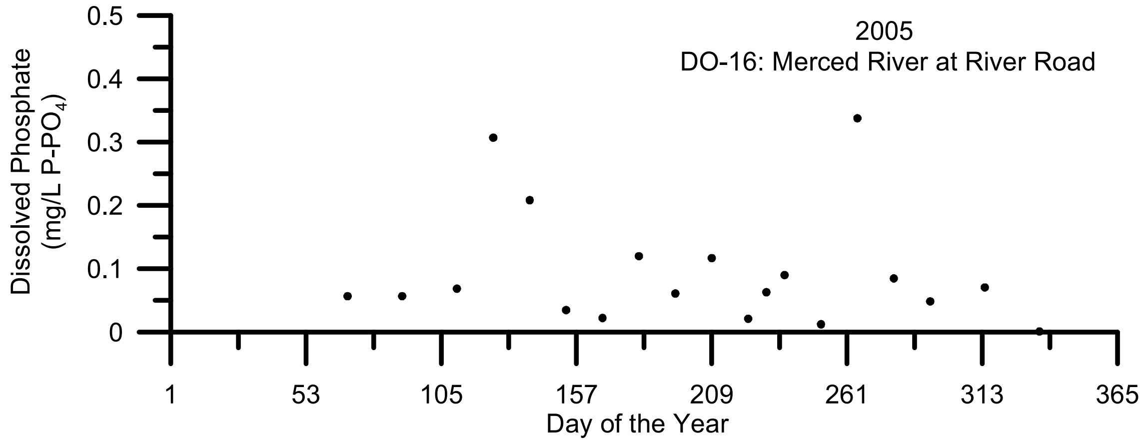
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-16: Merced River at River Road
Dissolved Phosphate (mg/L P-PO_4)
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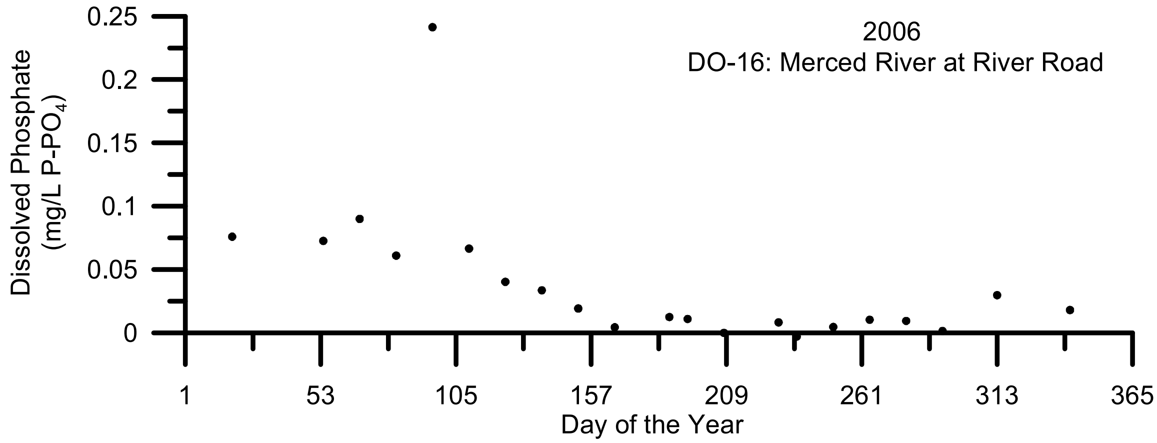
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year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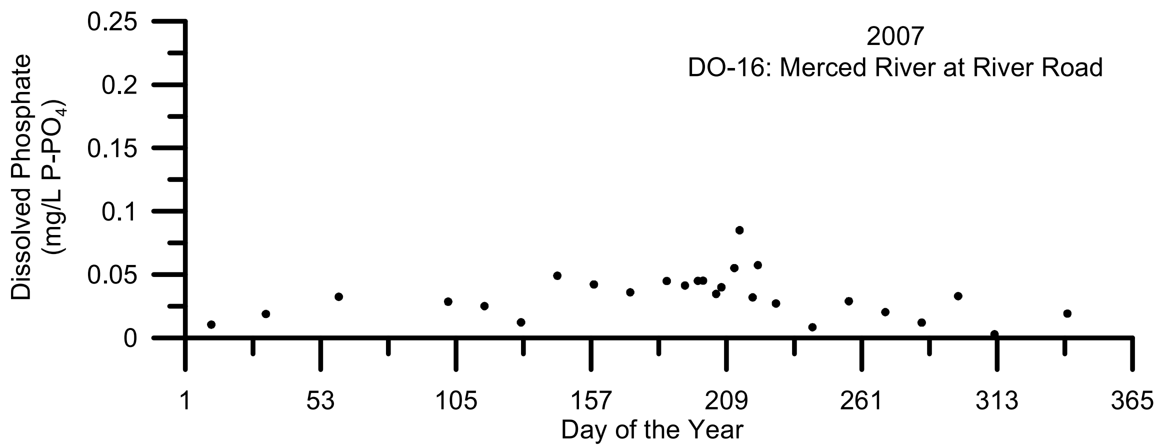
DO-16: Merced River at River Road
Dissolved Phosphate (mg/L P-PO_4)
0.25
0.2
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year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DO-16: Merced River at River Road
Dissolved Phosphate (mg/L P-PO_4)
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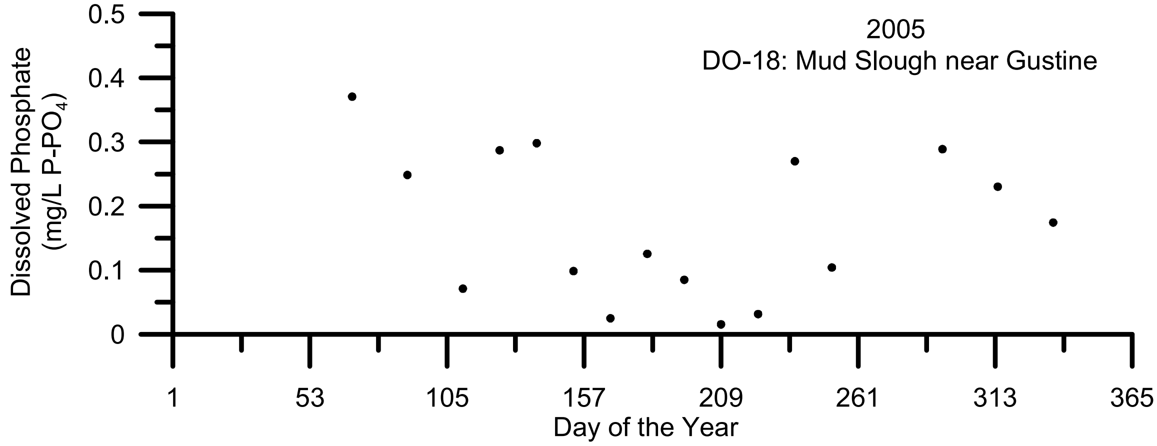
0.15
0.1
0.05
0
1
53
105
157
209
261
313
365
Day of the Year


2005
DO-18: Mud Slough near Gustine
Dissolved Phosphate
(mg/L P-PO4)
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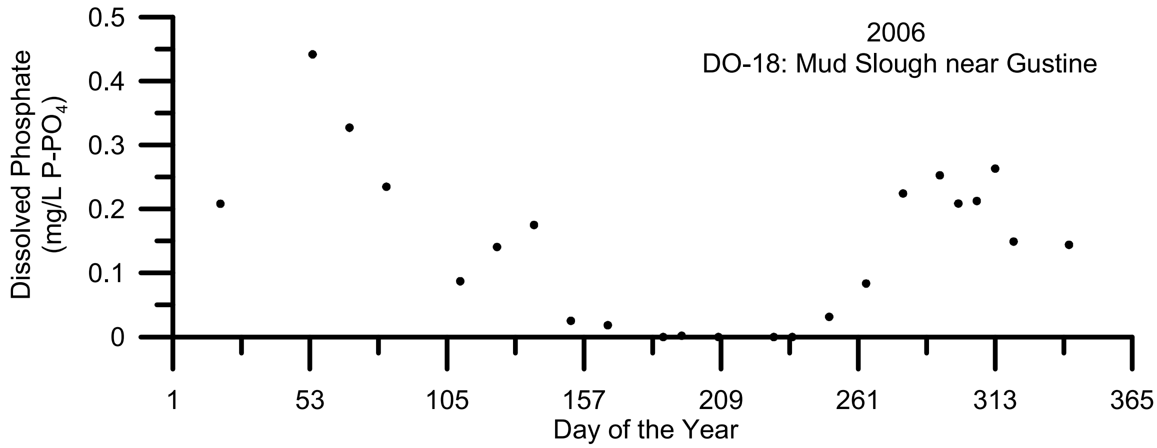
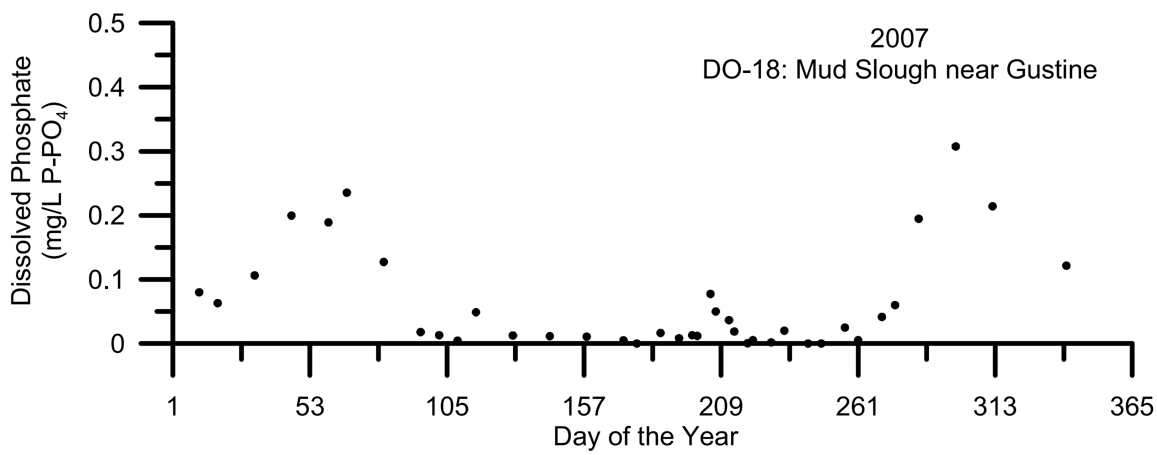
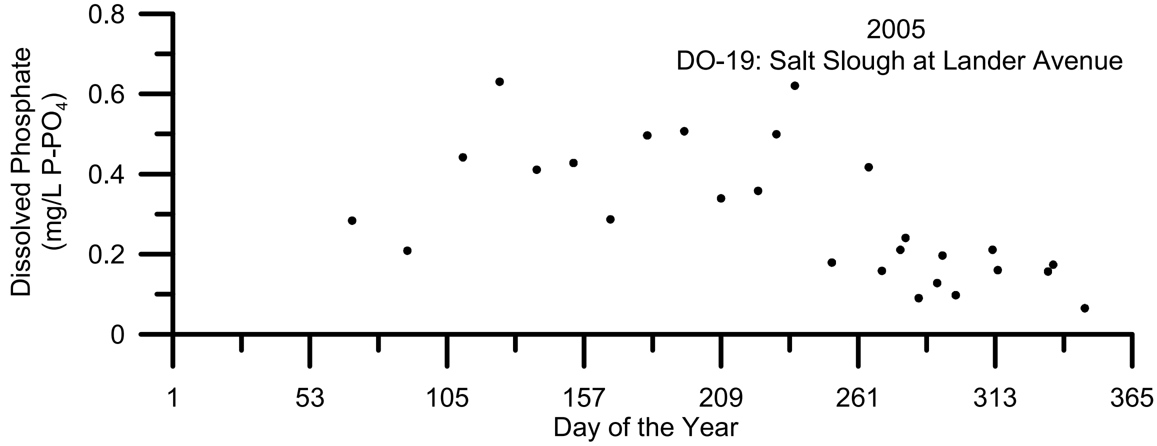
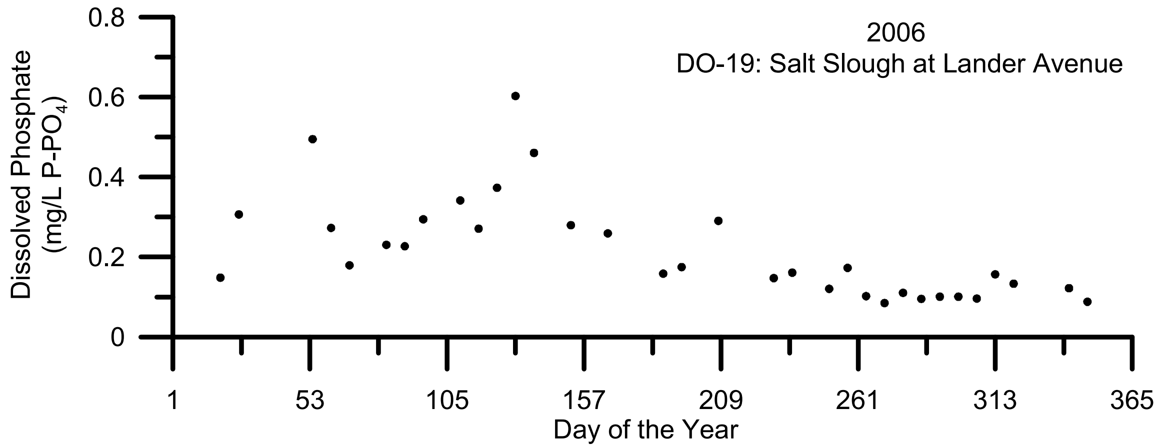
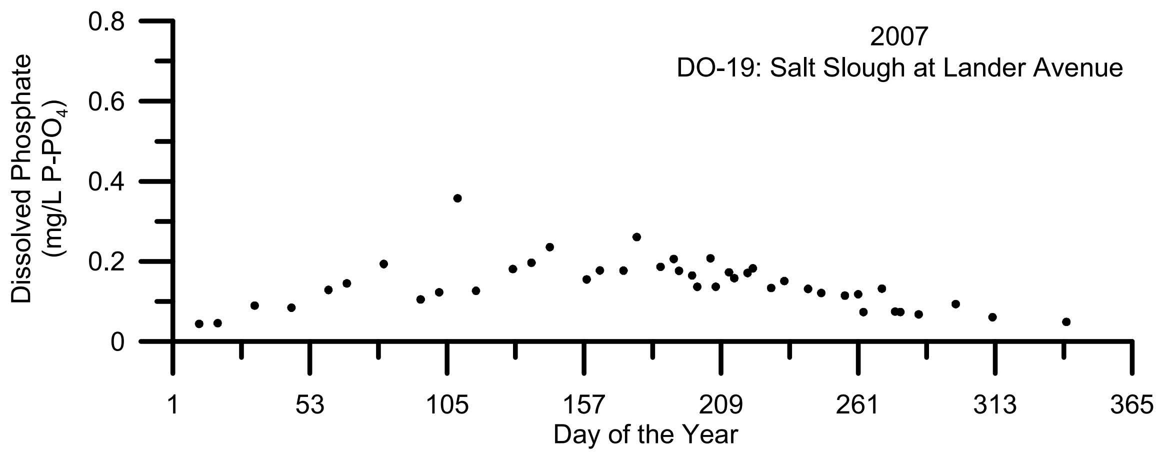
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

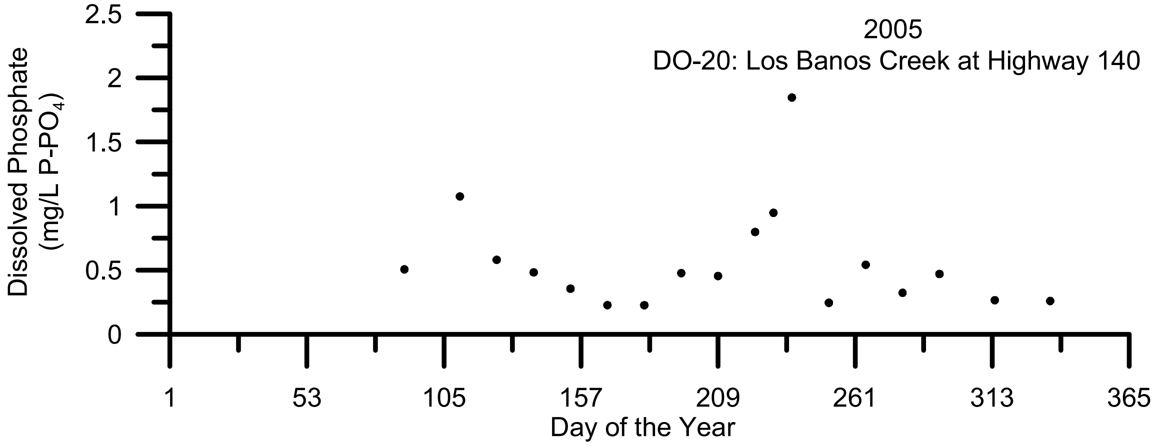

2006
DO-18: Mud Slough near Gustine
Dissolved Phosphate
(mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

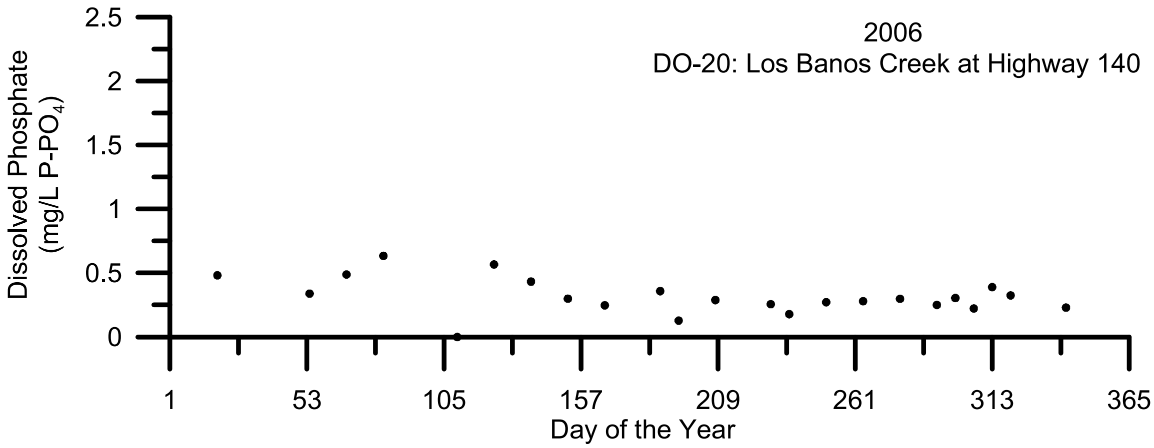

2007
DO-18: Mud Slough near Gustine
Dissolved Phosphate
(mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

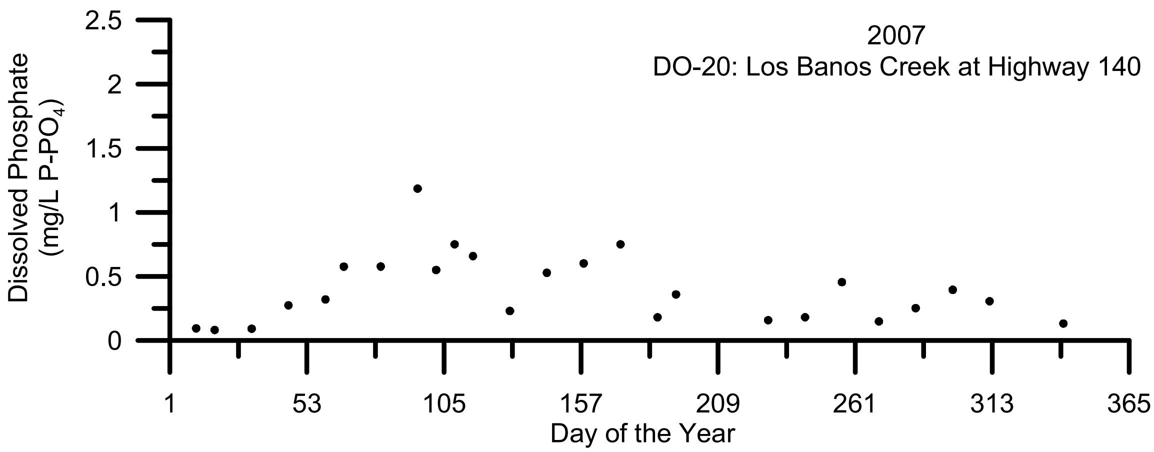

2005
DO-19: Salt Slough at Lander Avenue
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

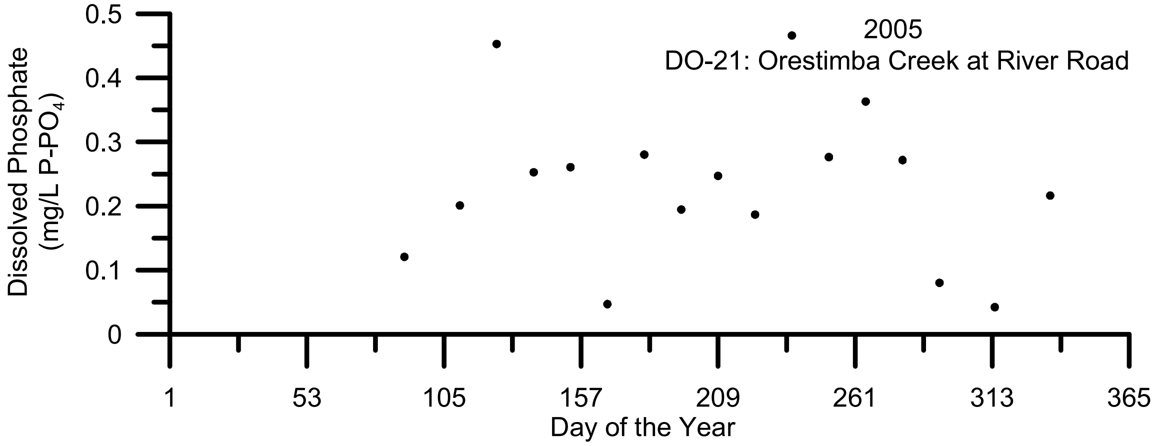

2006
DO-19: Salt Slough at Lander Avenue
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

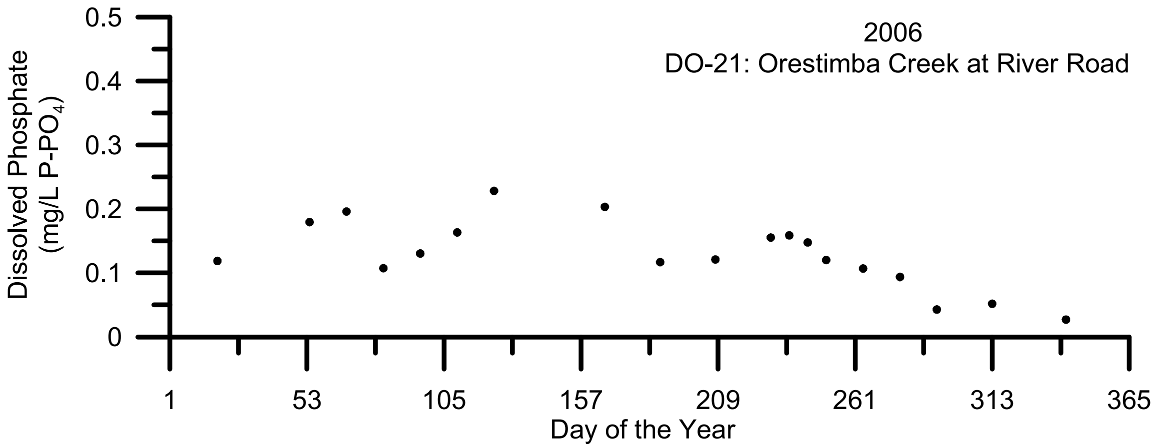

2007
DO-19: Salt Slough at Lander Avenue
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

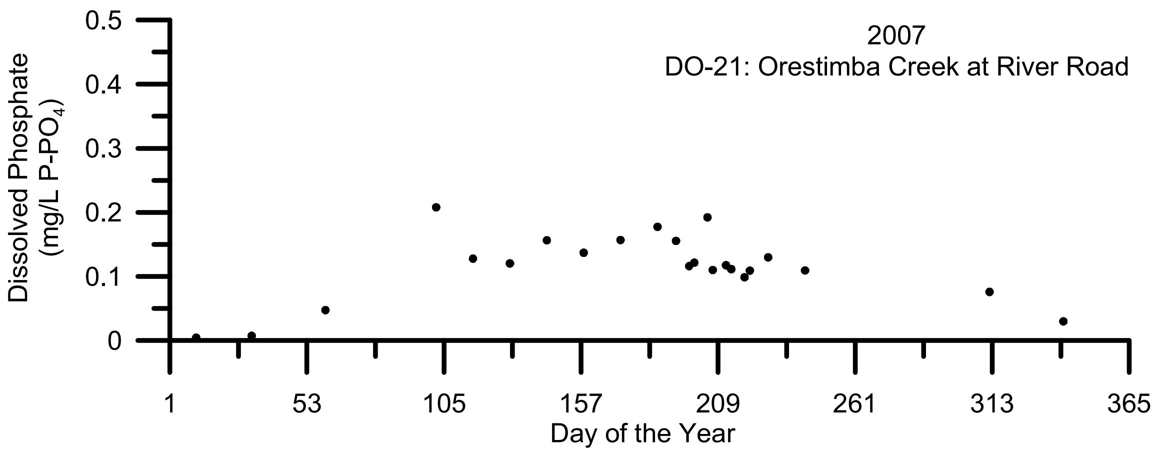

2005
DO-20: Los Banos Creek at Highway 140
Dissolved Phosphate
(mg/L P-PO4)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

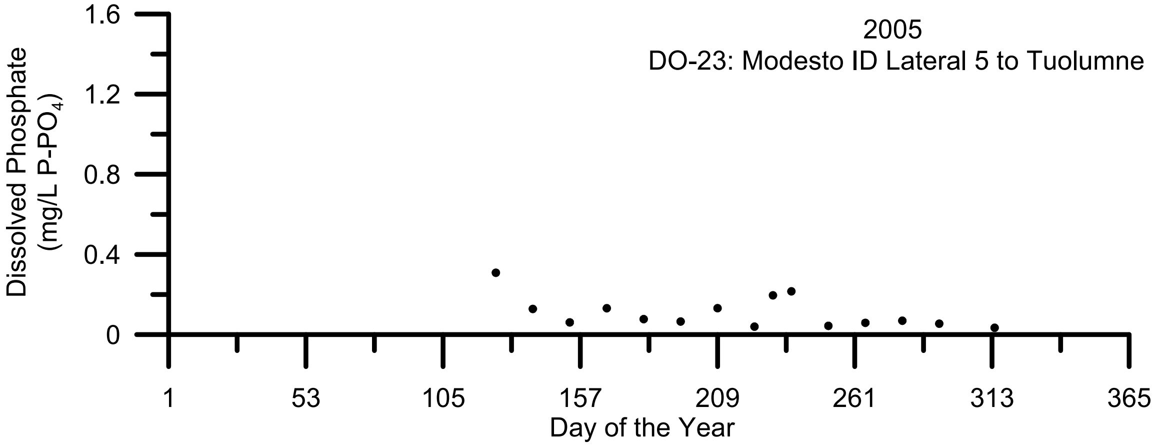

2006
DO-20: Los Banos Creek at Highway 140
Dissolved Phosphate
(mg/L P-PO4)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

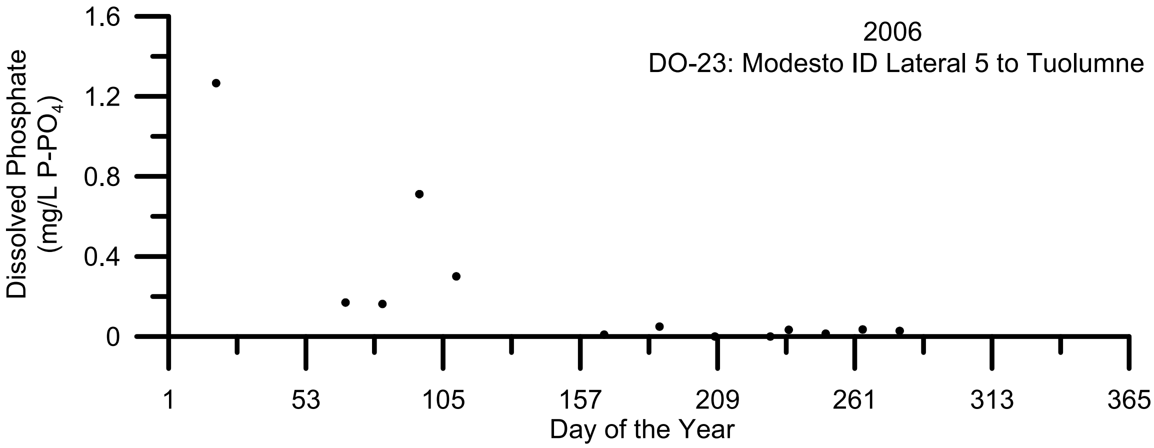

2007
DO-20: Los Banos Creek at Highway 140
Dissolved Phosphate
(mg/L P-PO4)
2.5
2
1.5
1
0.5
0
1
53
105
157
209
261
313
365
Day of the Year

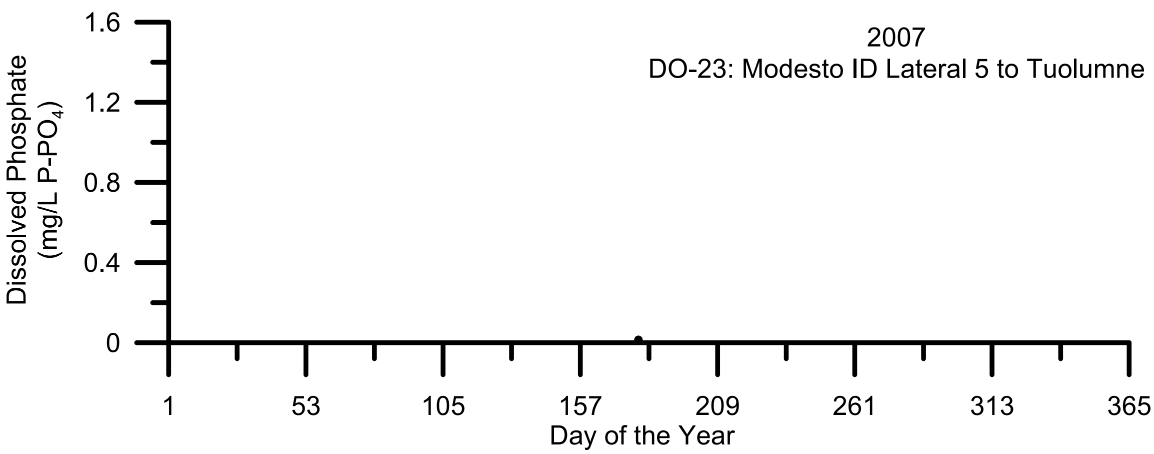

2005
DO-21: Orestimba Creek at River Road
Dissolved Phosphate
(mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

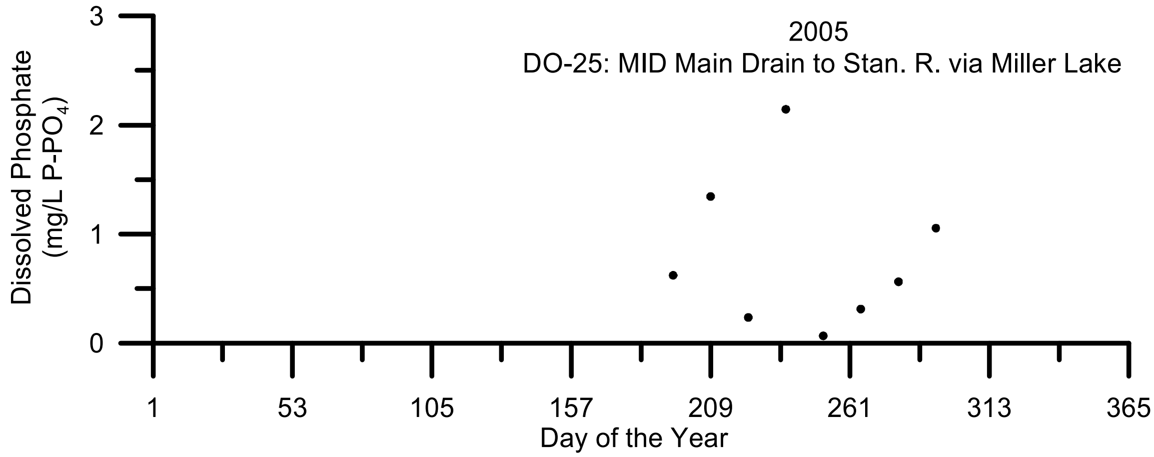

2006
DO-21: Orestimba Creek at River Road
Dissolved Phosphate
(mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

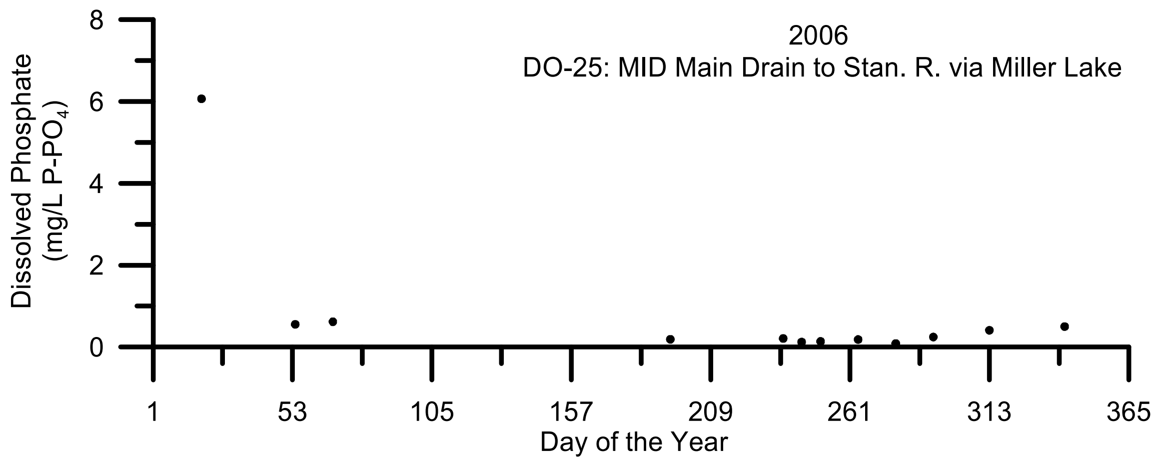

2007
DO-21: Orestimba Creek at River Road
Dissolved Phosphate
(mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

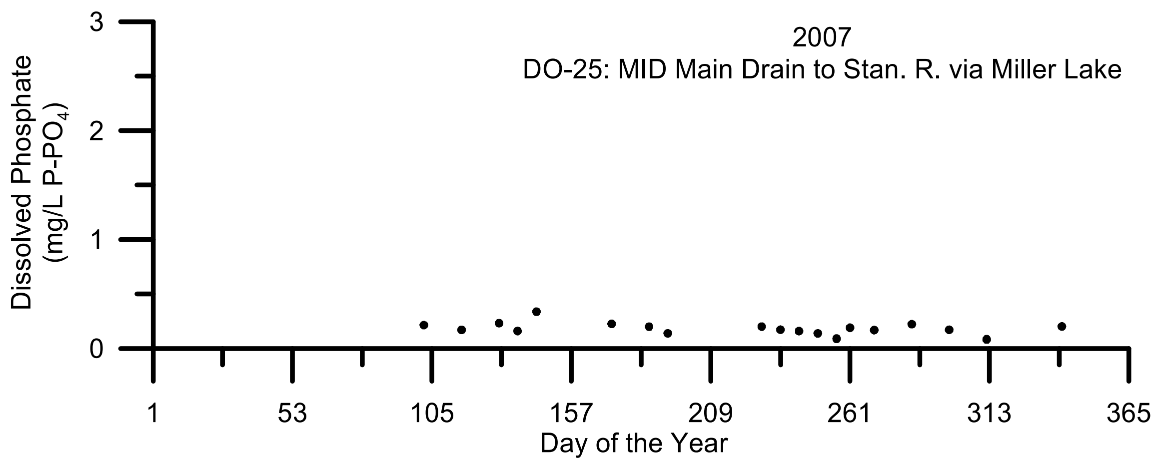

2005
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Phosphate
(mg/L P-PO$_4$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

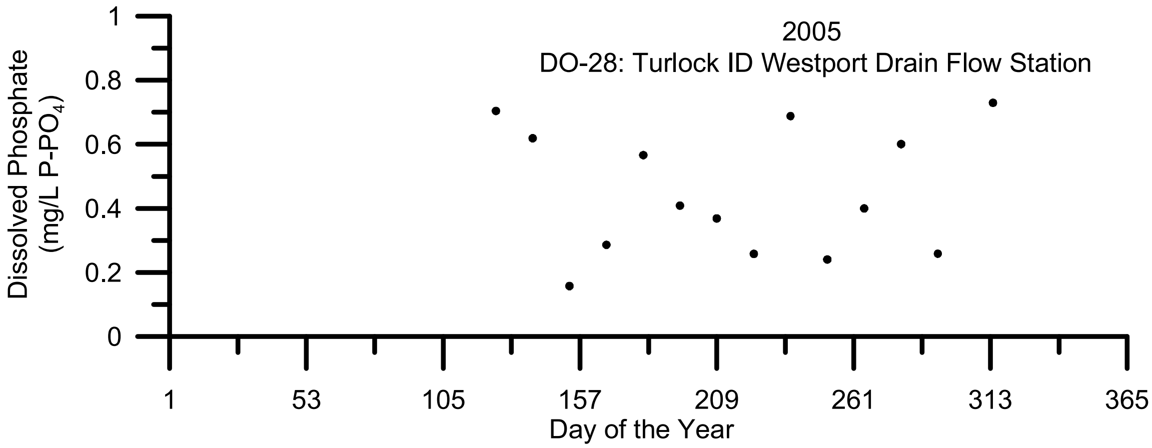

2006
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Phosphate
(mg/L P-PO$_4$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

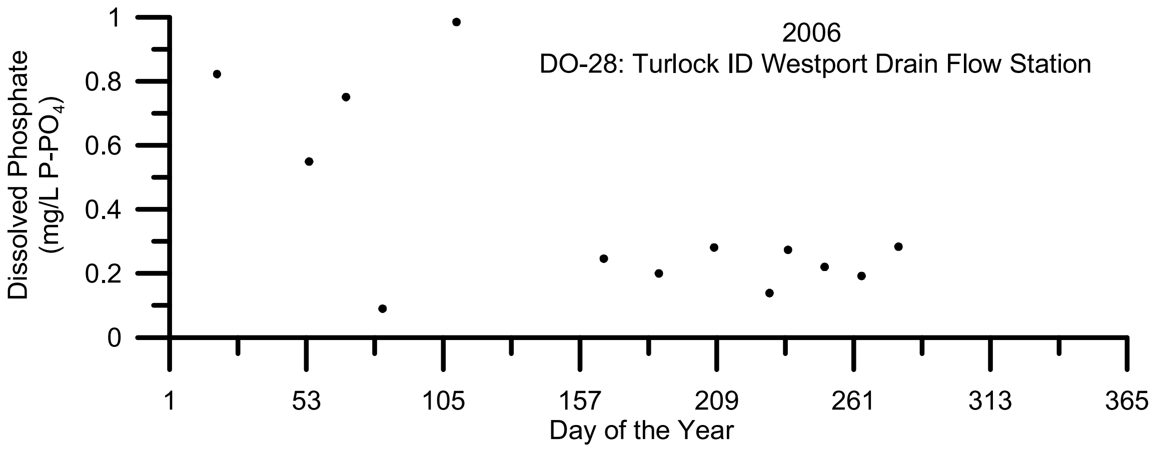

2007
DO-23: Modesto ID Lateral 5 to Tuolumne
Dissolved Phosphate
(mg/L P-PO$_4$)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

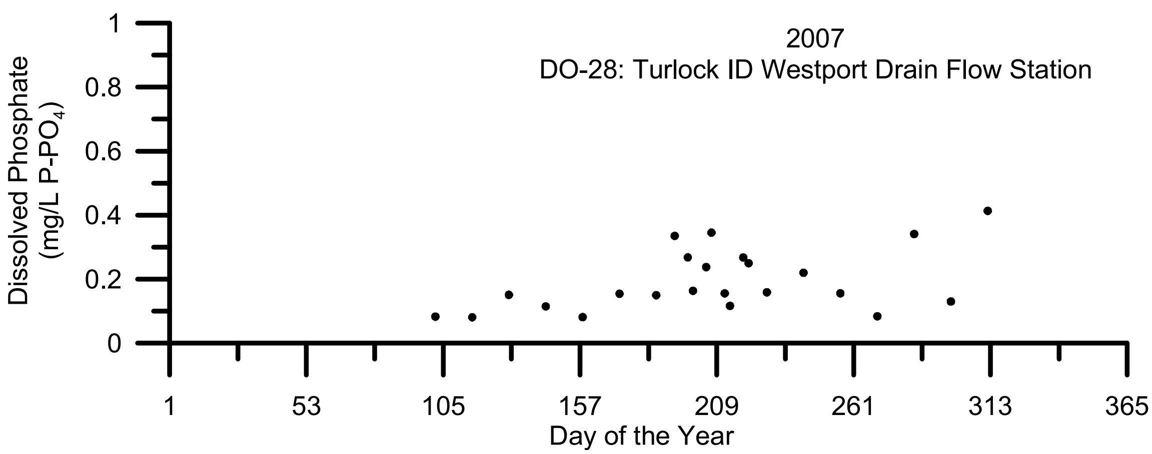

2005
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Phosphate
(mg/L P-PO_4)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

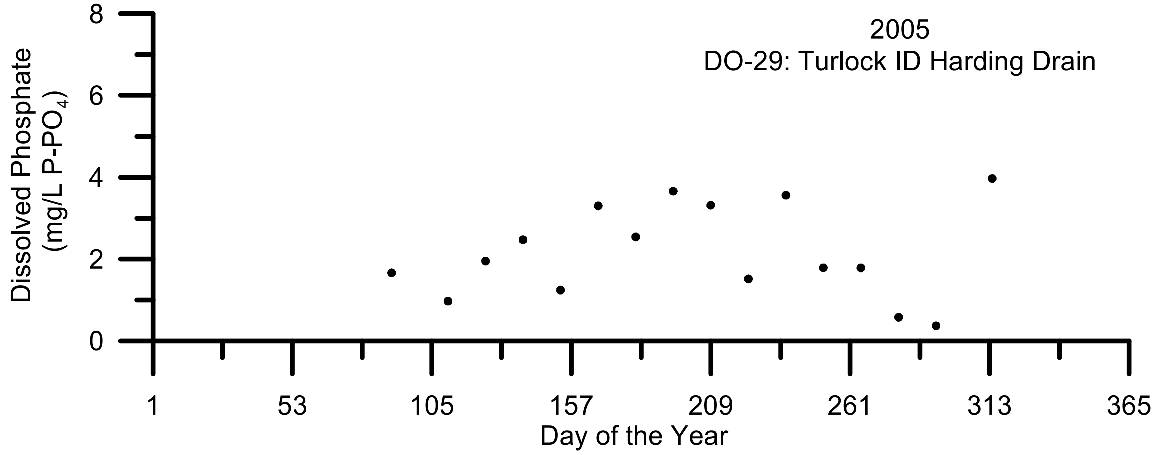

2006
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Phosphate
(mg/L P-PO_4)
0
2
4
6
8
1
53
105
157
209
261
313
365
Day of the Year

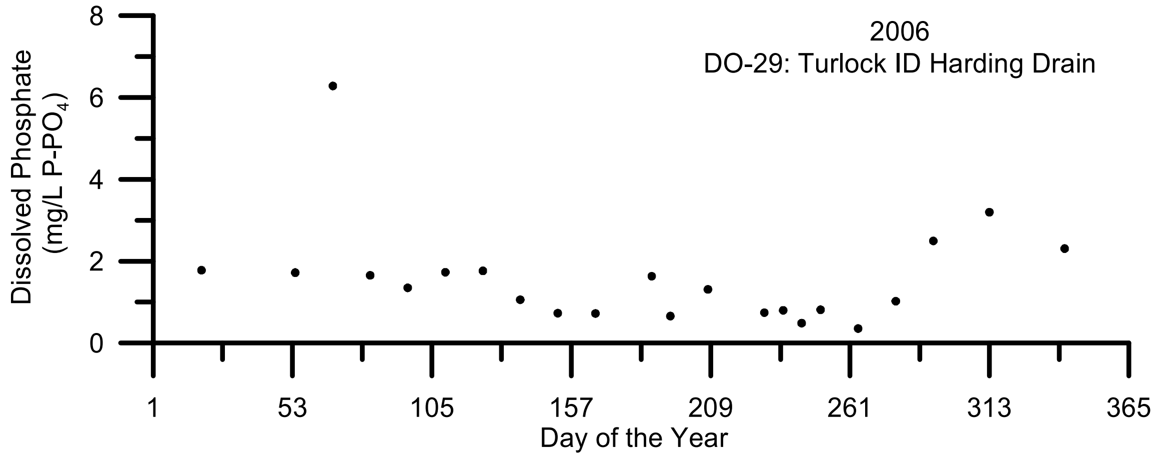

2007
DO-25: MID Main Drain to Stan. R. via Miller Lake
Dissolved Phosphate
(mg/L P-PO_4)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

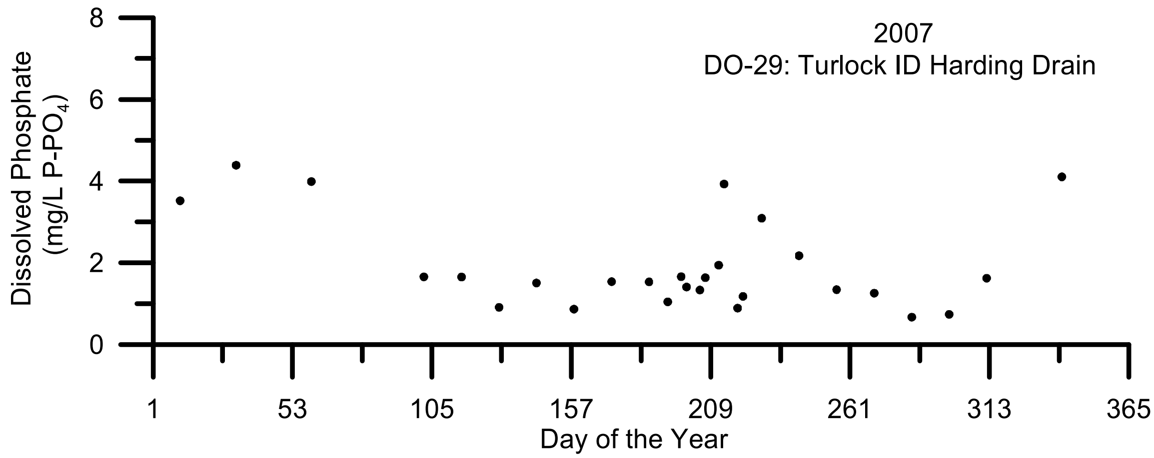

2005
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Phosphate (mg/L P-PO_4)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

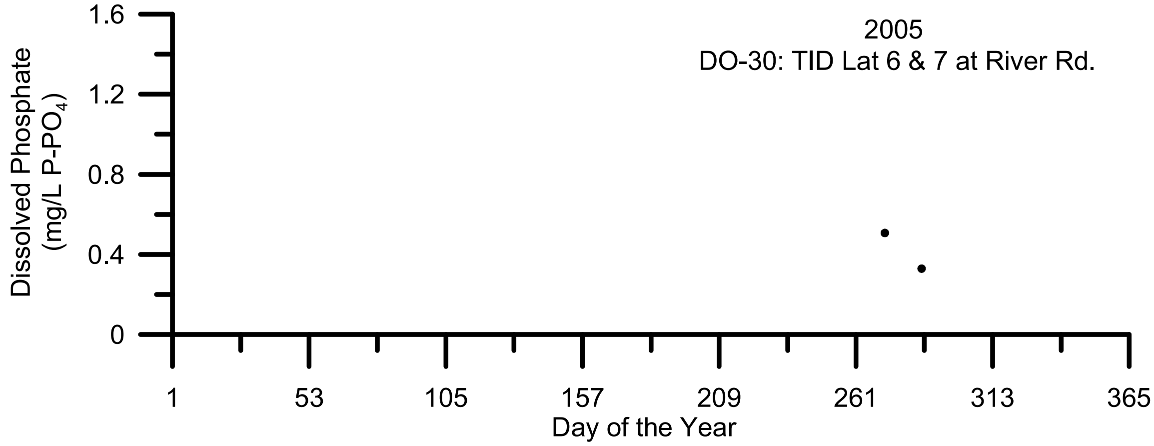

2006
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Phosphate (mg/L P-PO_4)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

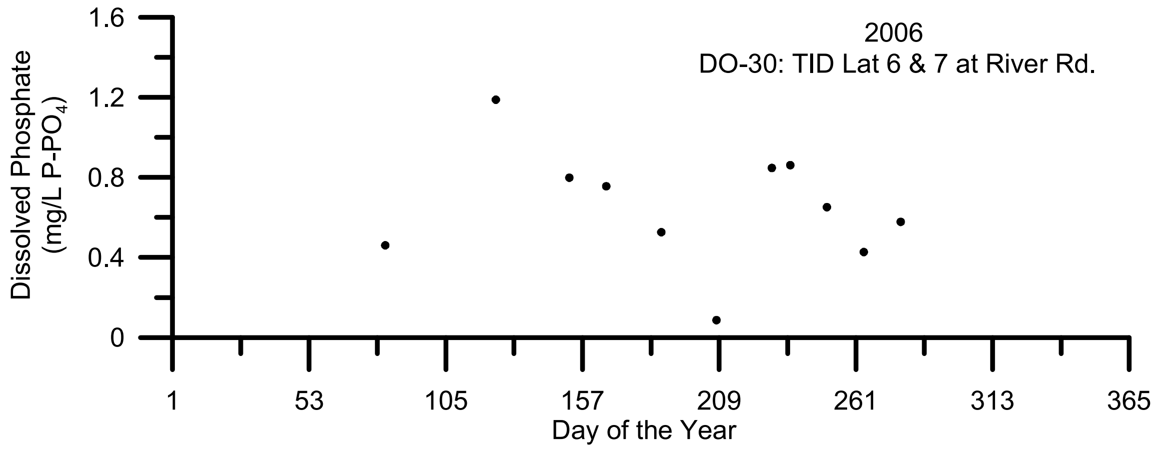

2007
DO-28: Turlock ID Westport Drain Flow Station
Dissolved Phosphate (mg/L P-PO_4)
0
0.2
0.4
0.6
0.8
1
1
53
105
157
209
261
313
365
Day of the Year

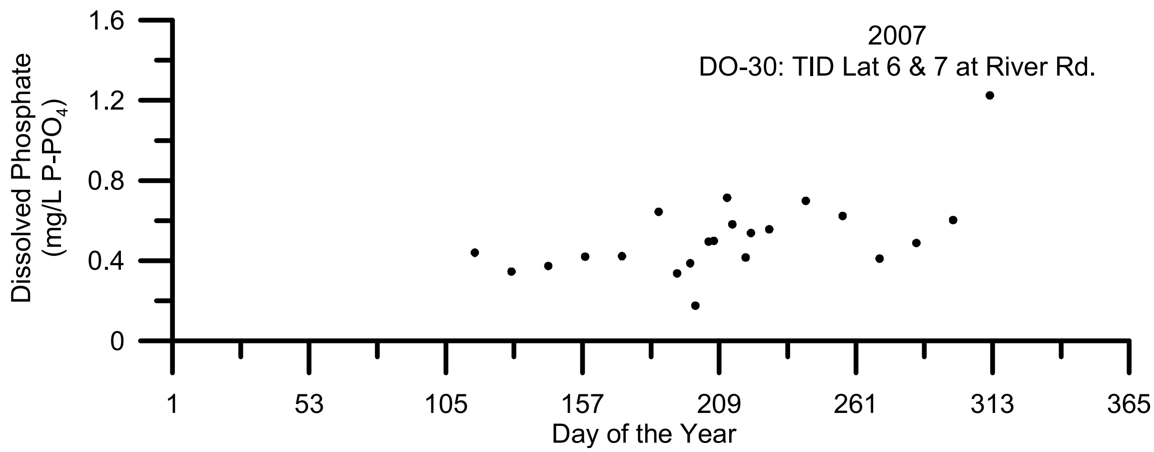

2005
DO-29: Turlock ID Harding Drain
Dissolved Phosphate
(mg/L P-PO4)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

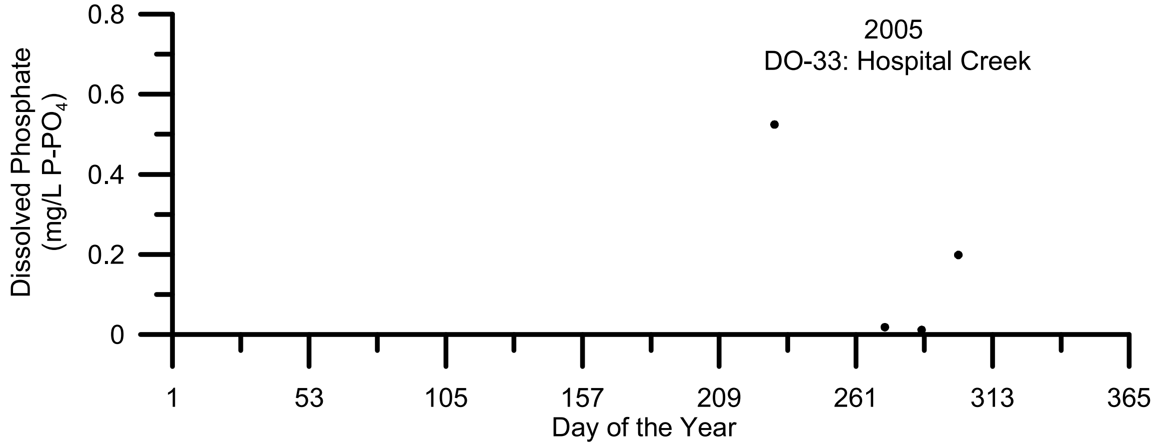

2006
DO-29: Turlock ID Harding Drain
Dissolved Phosphate
(mg/L P-PO4)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

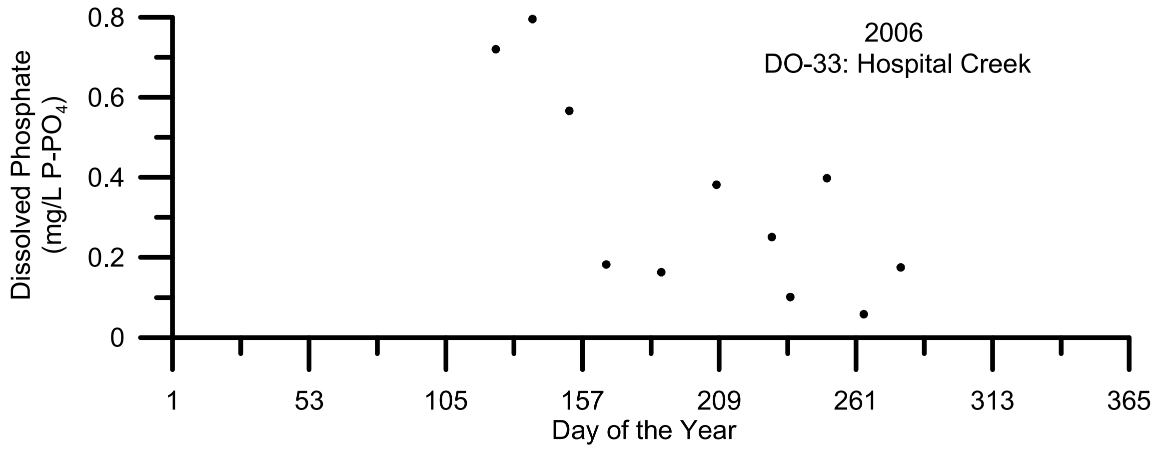

2007
DO-29: Turlock ID Harding Drain
Dissolved Phosphate
(mg/L P-PO4)
8
6
4
2
0
1
53
105
157
209
261
313
365
Day of the Year

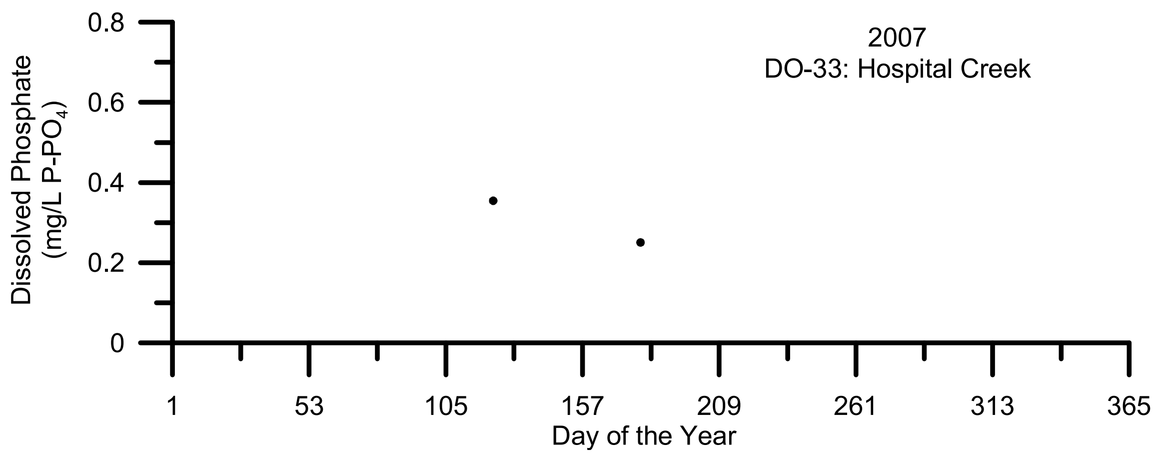

2005
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Phosphate (mg/L P-PO4)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365

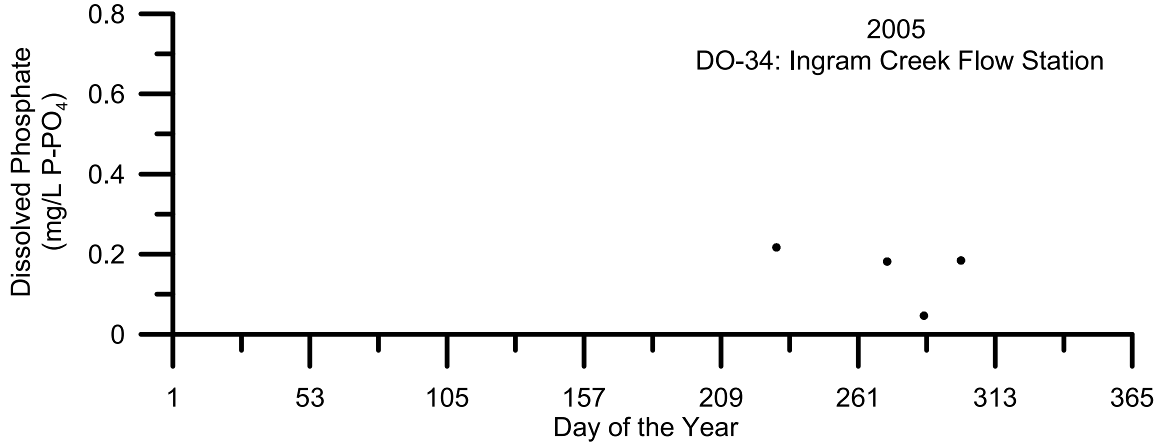

2006
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Phosphate (mg/L P-PO4)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365


2007
DO-30: TID Lat 6 & 7 at River Rd.
Dissolved Phosphate (mg/L P-PO4)
Day of the Year
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365

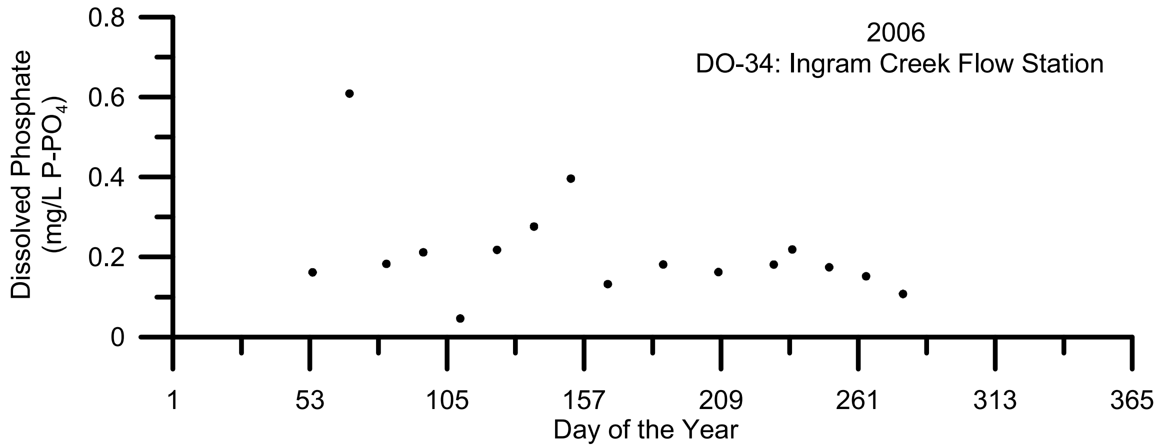

2005
DO-33: Hospital Creek
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-33: Hospital Creek
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

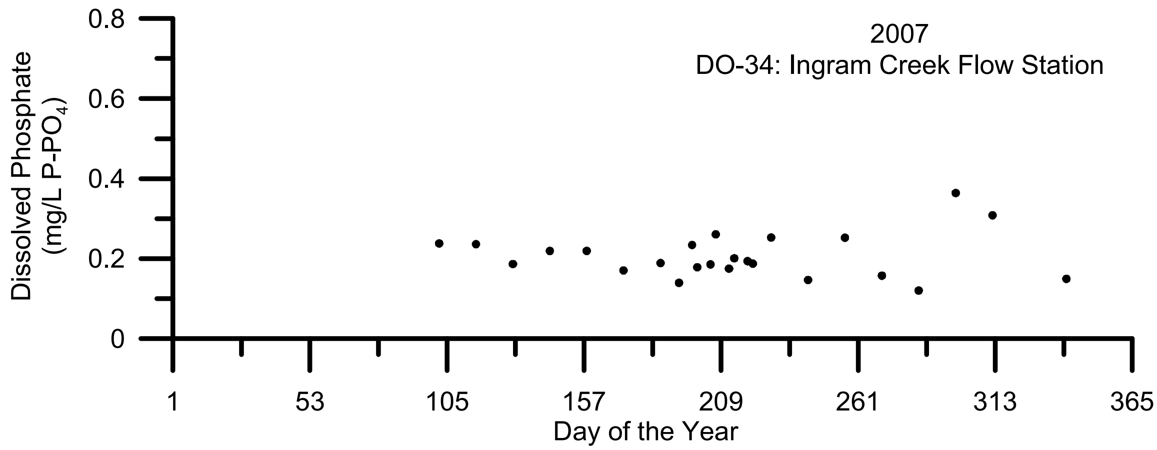

2007
DO-33: Hospital Creek
Dissolved Phosphate
(mg/L P-PO$_4$)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year



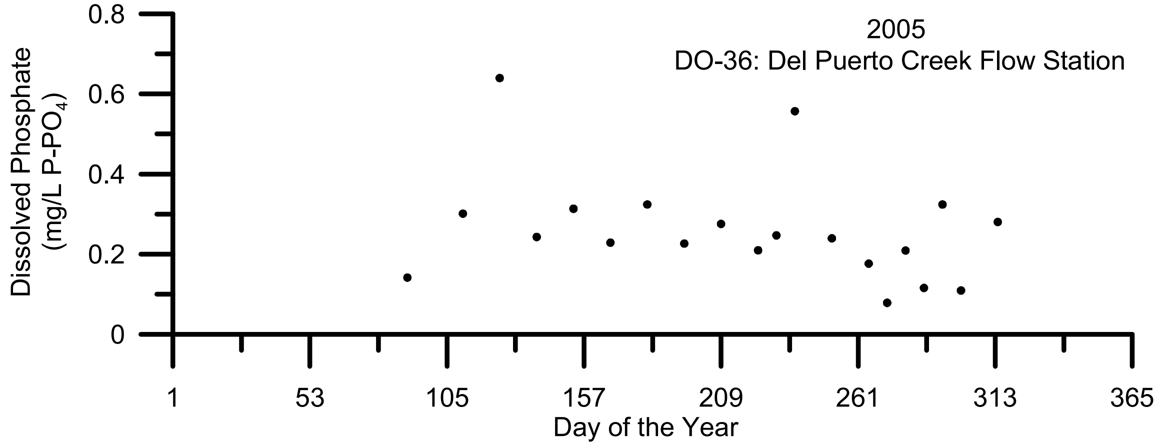
2005
DO-34: Ingram Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

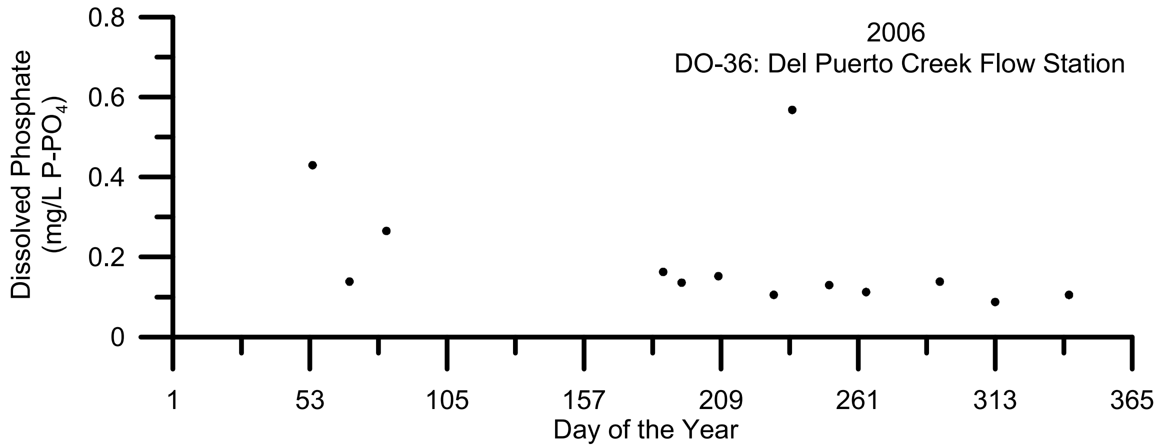


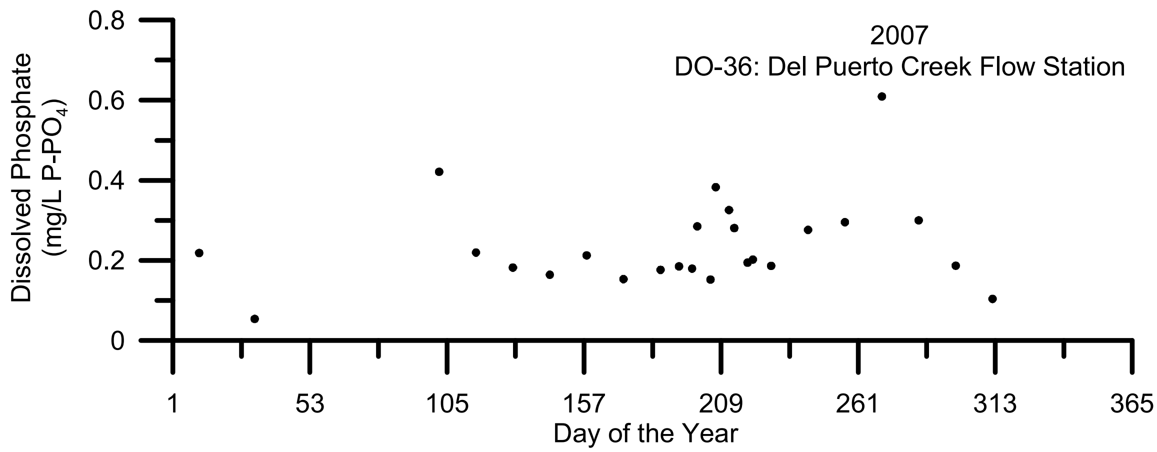
2006
DO-34: Ingram Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

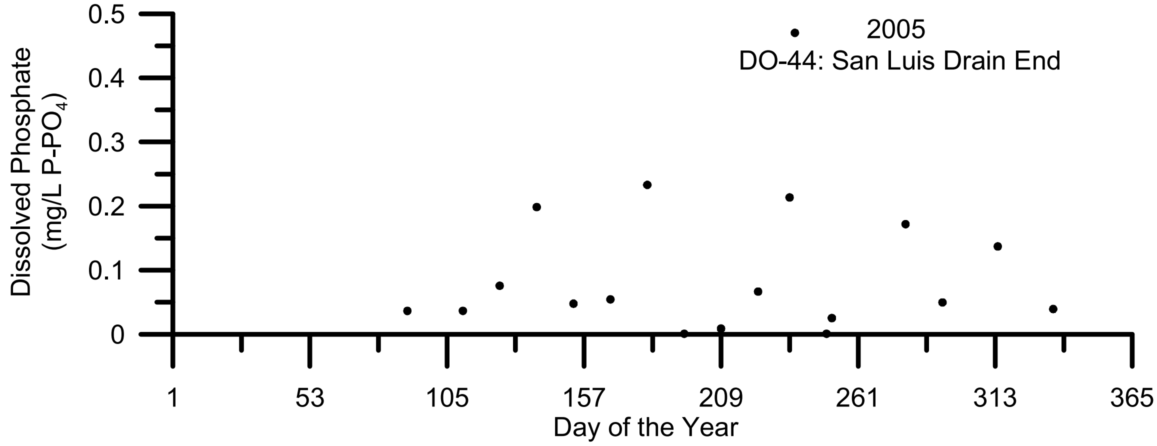


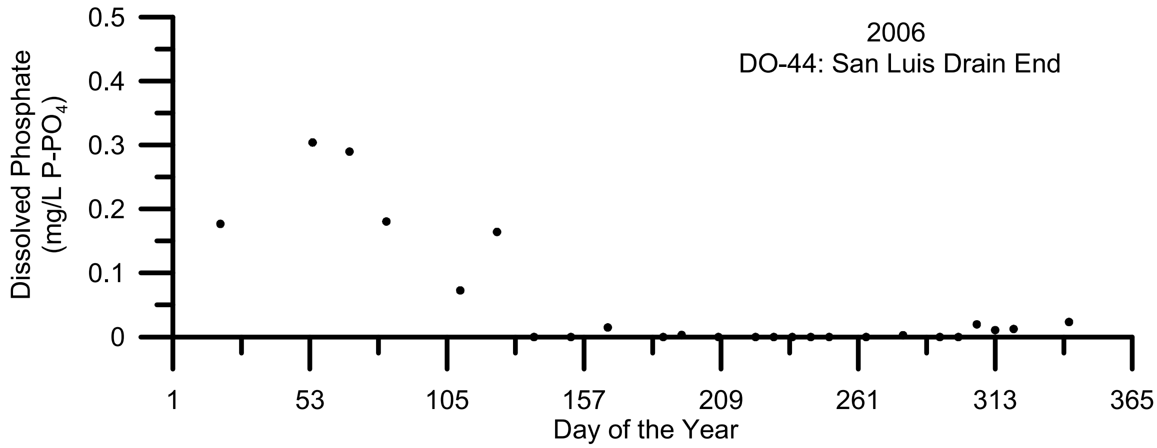
2007
DO-34: Ingram Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

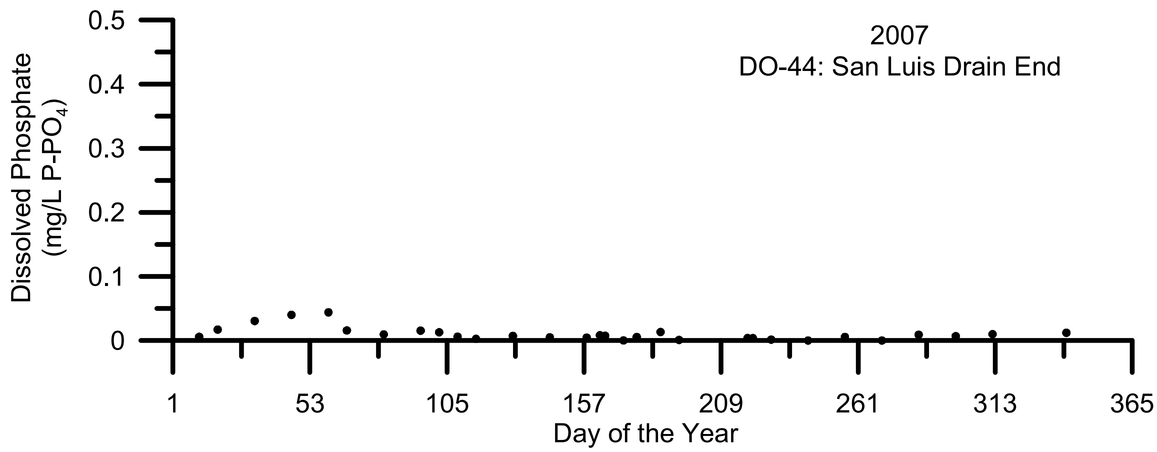

2005
DO-36: Del Puerto Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

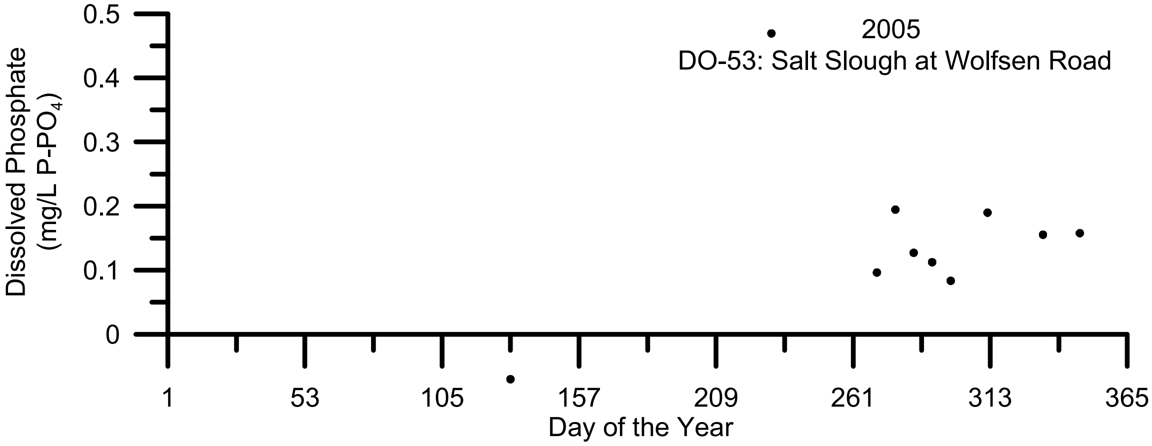

2006
DO-36: Del Puerto Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

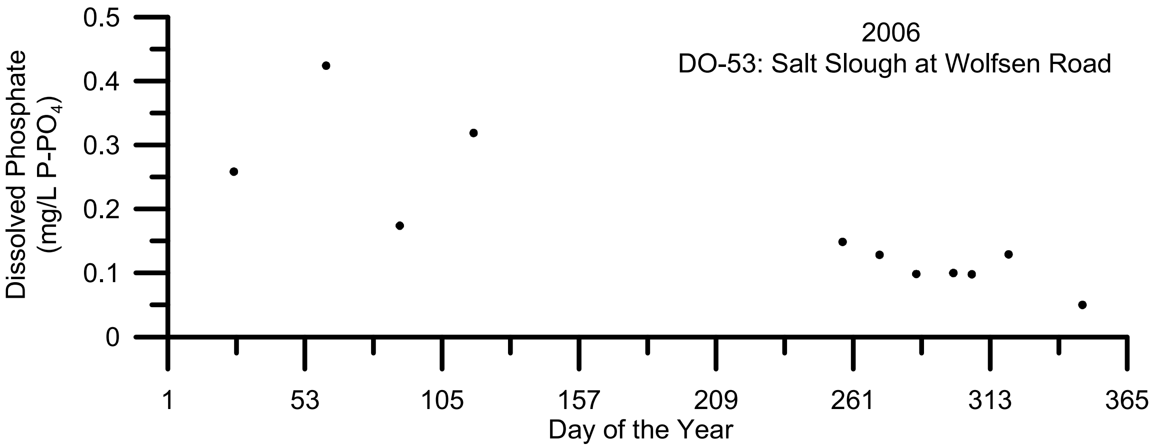

2007
DO-36: Del Puerto Creek Flow Station
Dissolved Phosphate (mg/L P-PO4)
0
0.2
0.4
0.6
0.8
1
53
105
157
209
261
313
365
Day of the Year

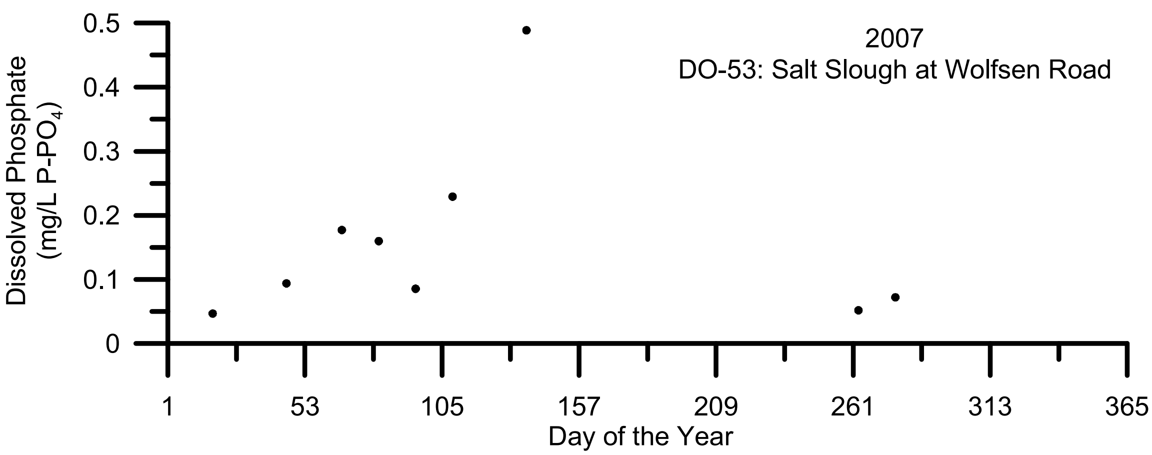

2005
DO-44: San Luis Drain End
Dissolved Phosphate (mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

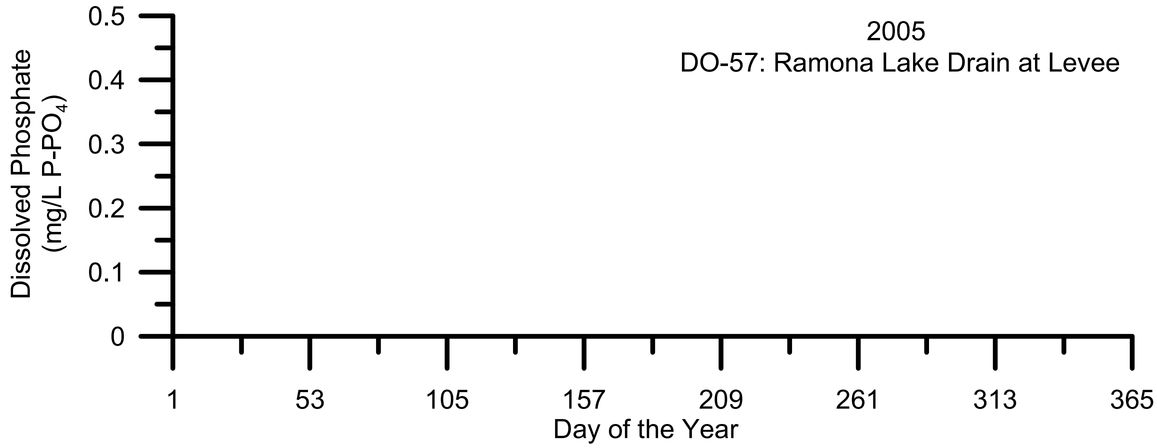

2006
DO-44: San Luis Drain End
Dissolved Phosphate (mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

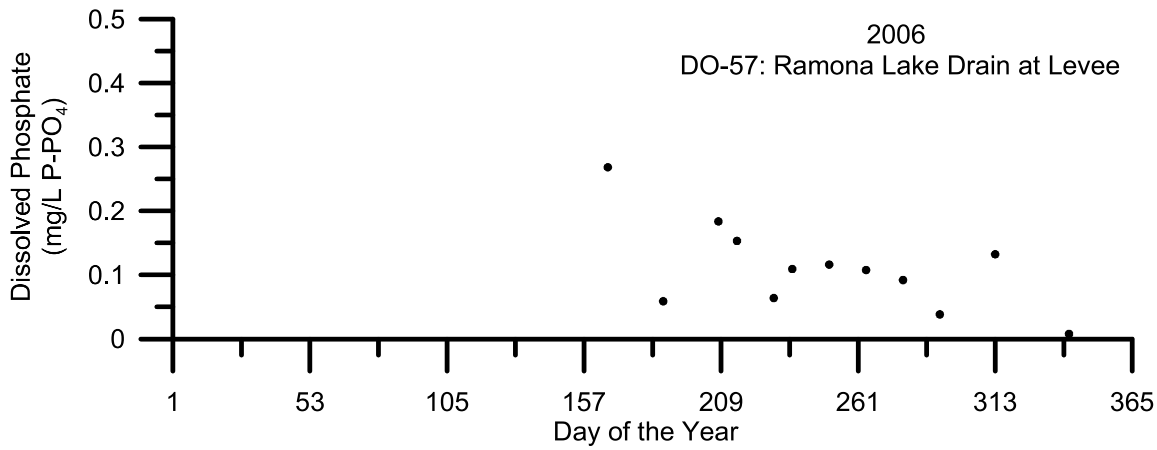

2007
DO-44: San Luis Drain End
Dissolved Phosphate (mg/L P-PO$_4$)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

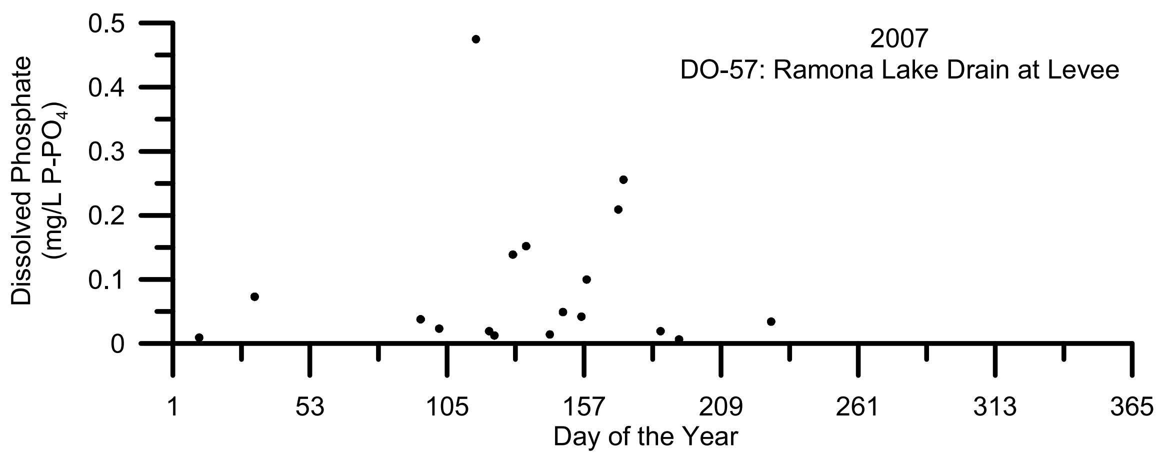

2005
DO-53: Salt Slough at Wolfsen Road
Dissolved Phosphate (mg/L P-PO$_4$)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

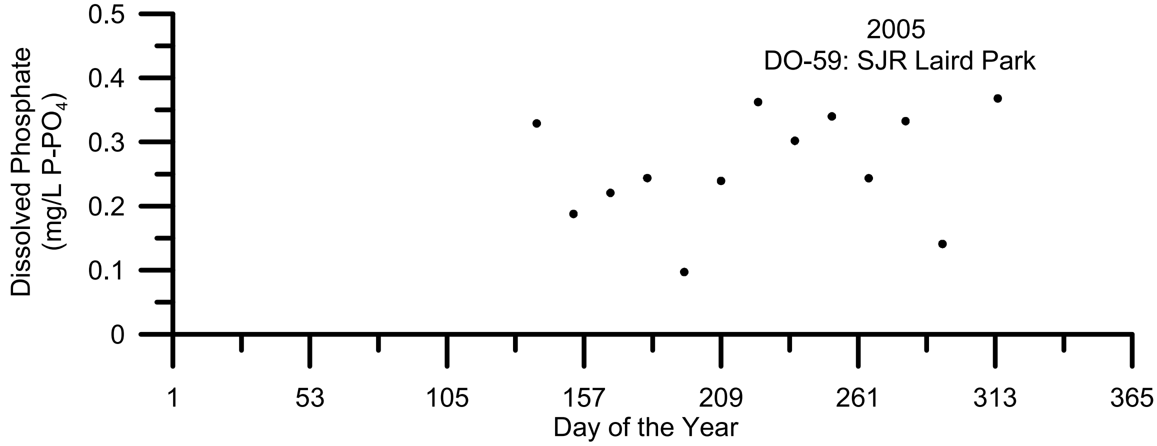

2006
DO-53: Salt Slough at Wolfsen Road
Dissolved Phosphate (mg/L P-PO$_4$)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

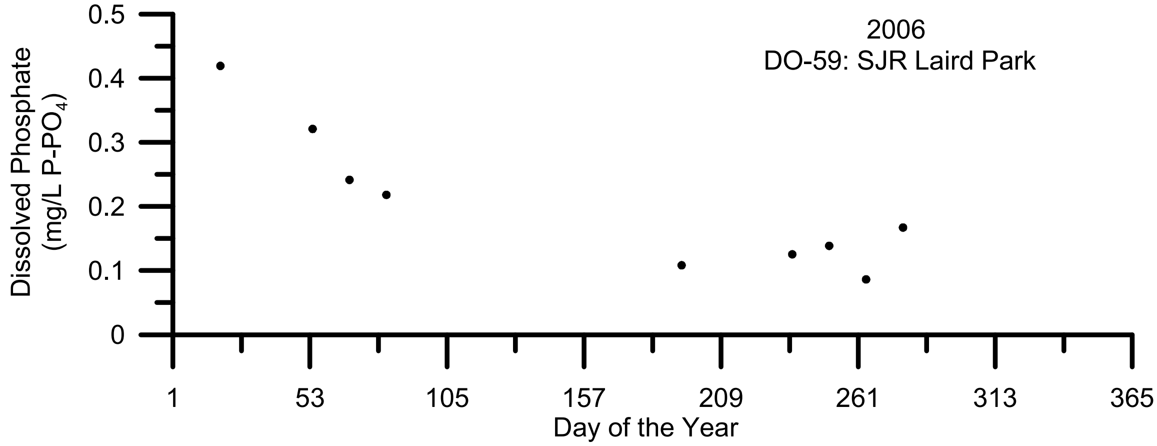

2007
DO-53: Salt Slough at Wolfsen Road
Dissolved Phosphate (mg/L P-PO$_4$)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

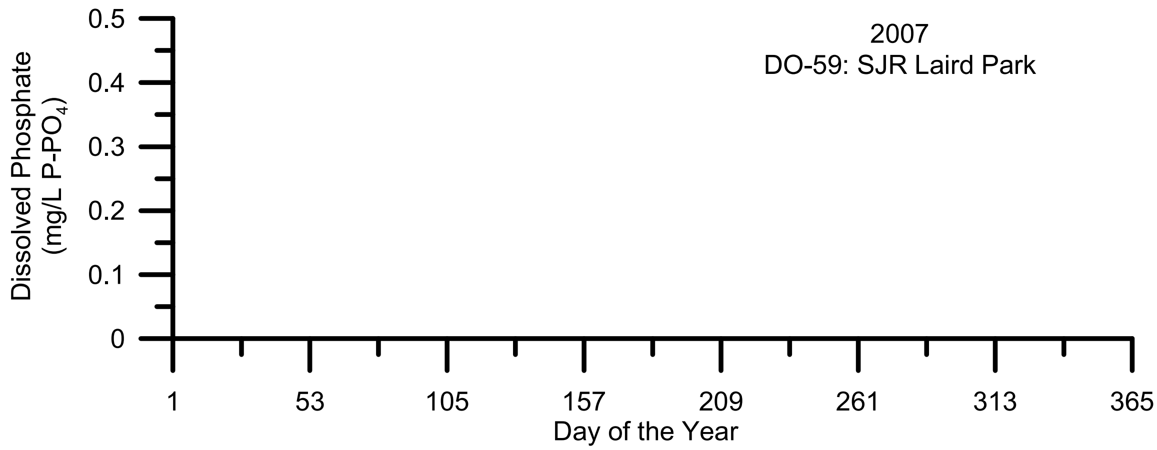

2005
DO-57: Ramona Lake Drain at Levee
Dissolved Phosphate (mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

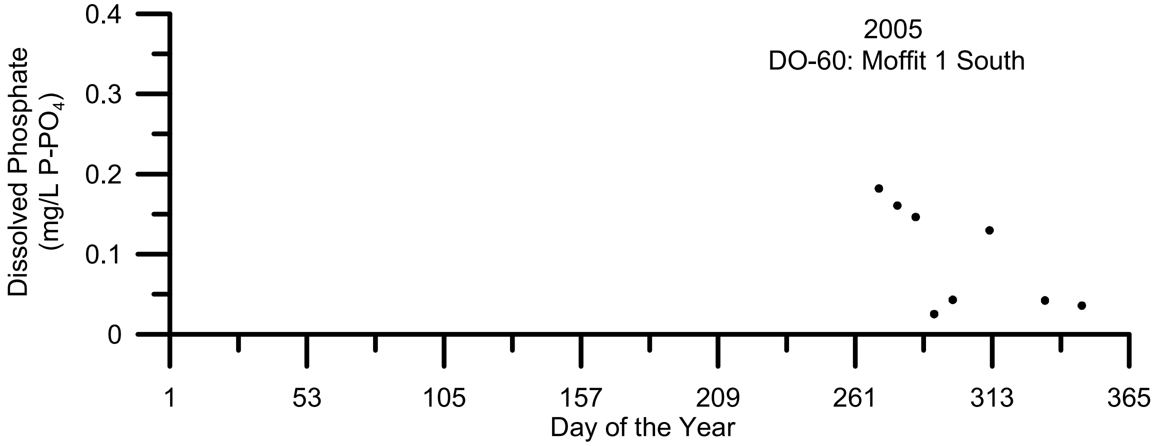

2006
DO-57: Ramona Lake Drain at Levee
Dissolved Phosphate (mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

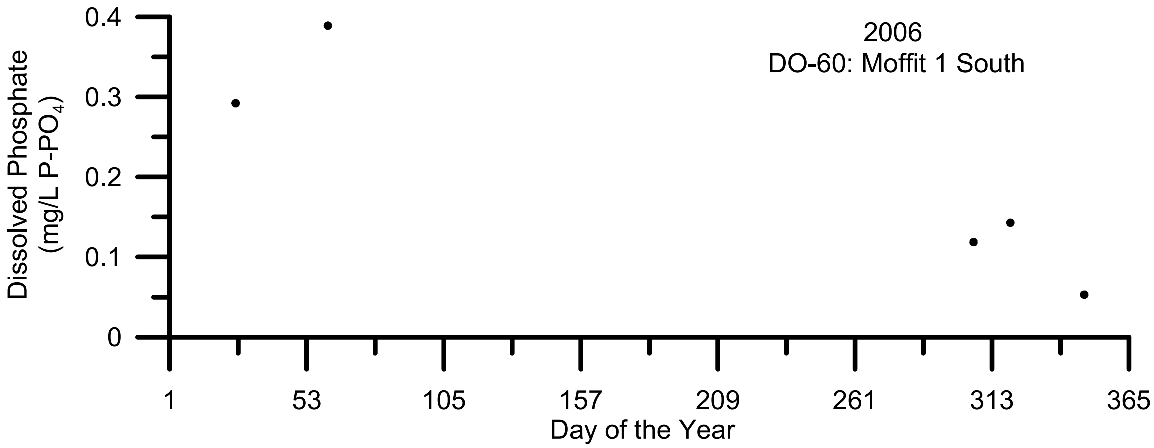

2007
DO-57: Ramona Lake Drain at Levee
Dissolved Phosphate (mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

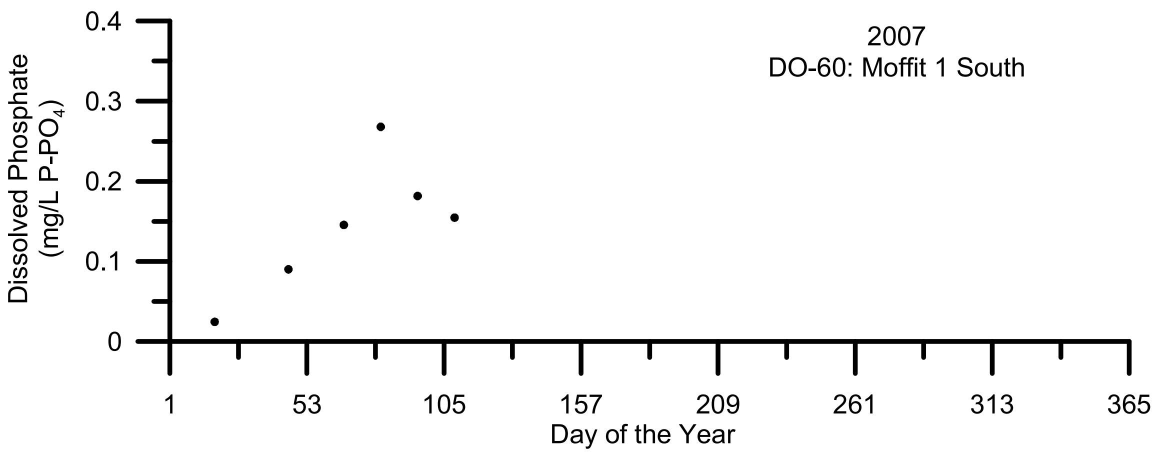

2005
DO-59: SJR Laird Park
Dissolved Phosphate (mg/L P-PO4)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

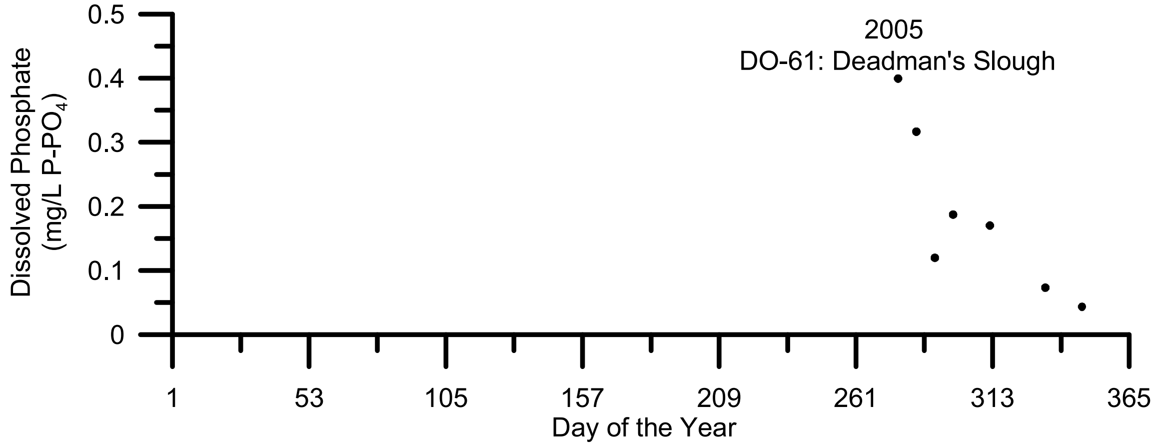

2006
DO-59: SJR Laird Park
Dissolved Phosphate (mg/L P-PO4)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

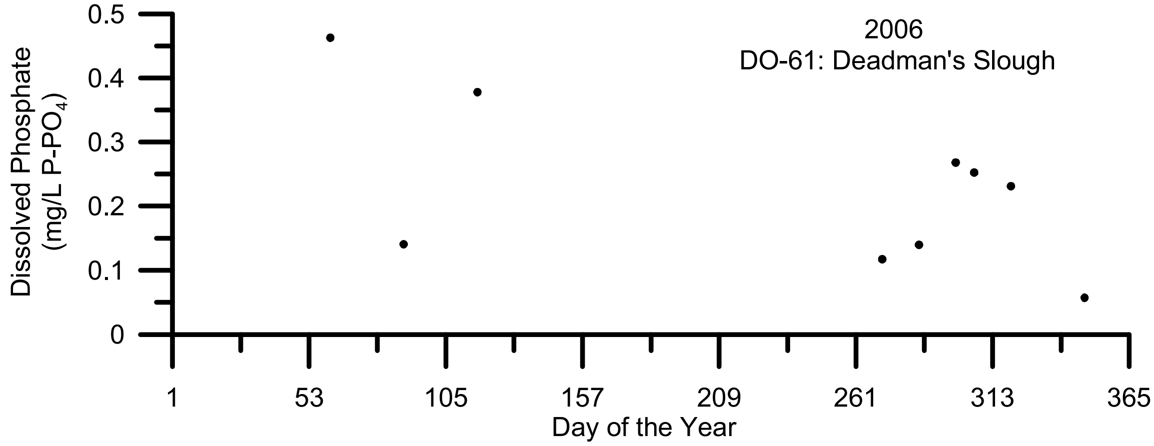

2007
DO-59: SJR Laird Park
Dissolved Phosphate (mg/L P-PO4)
0
0.1
0.2
0.3
0.4
0.5
1
53
105
157
209
261
313
365
Day of the Year

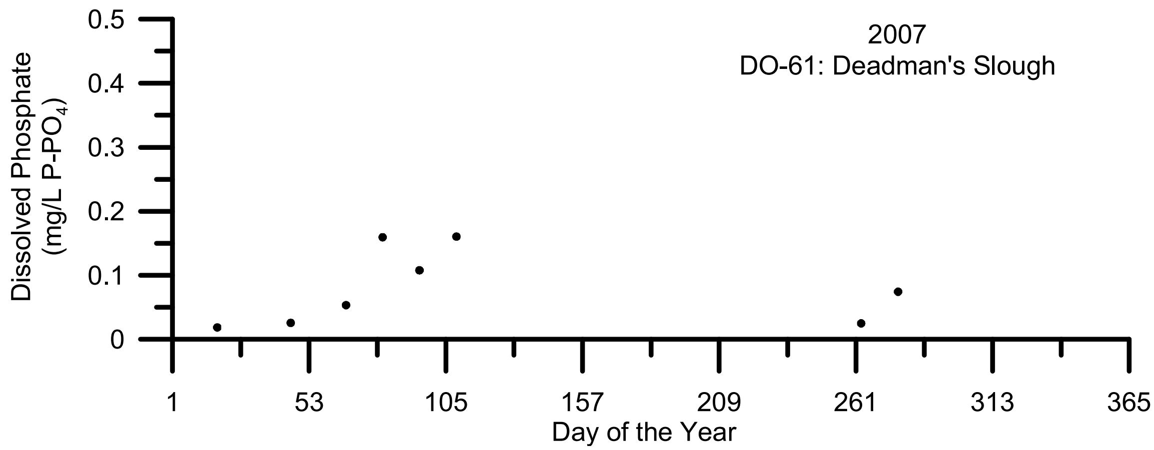

2005
DO-60: Moffit 1 South
Dissolved Phosphate
(mg/L P-PO4)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

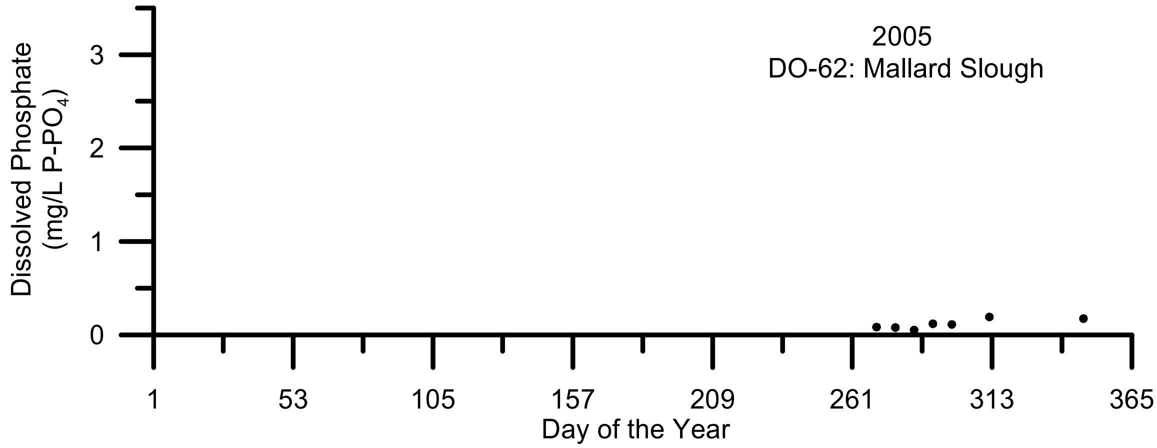

2006
DO-60: Moffit 1 South
Dissolved Phosphate
(mg/L P-PO4)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

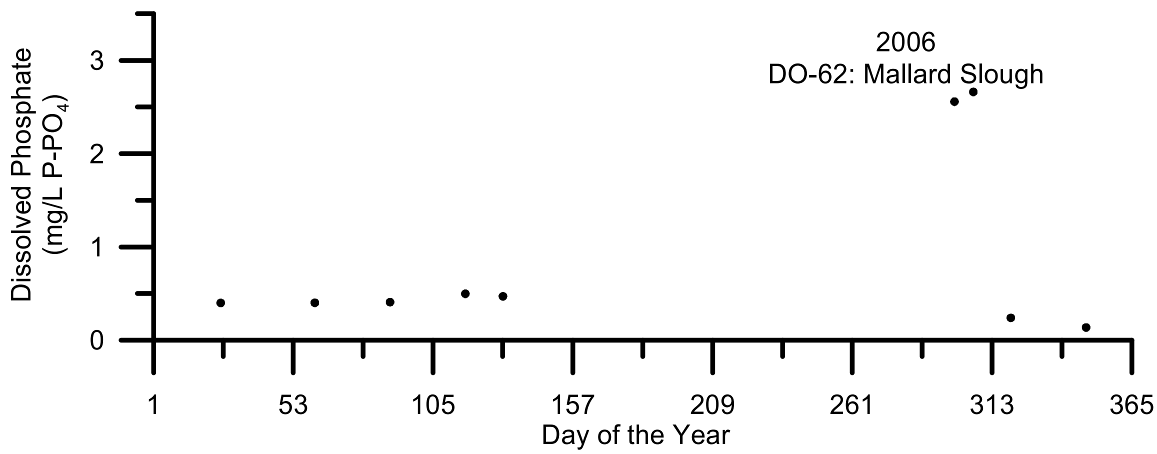

2007
DO-60: Moffit 1 South
Dissolved Phosphate
(mg/L P-PO4)
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

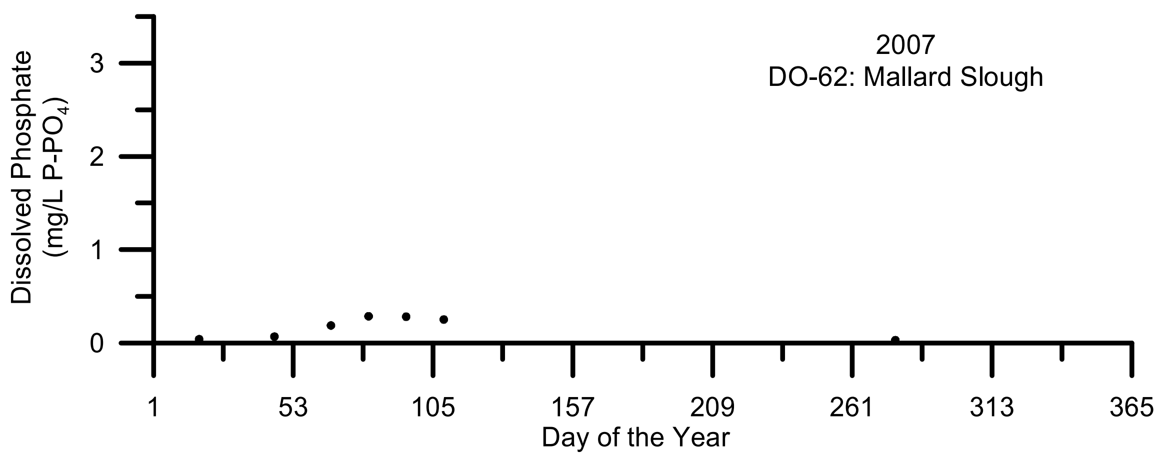

2005
DO-61: Deadman's Slough
Dissolved Phosphate
(mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

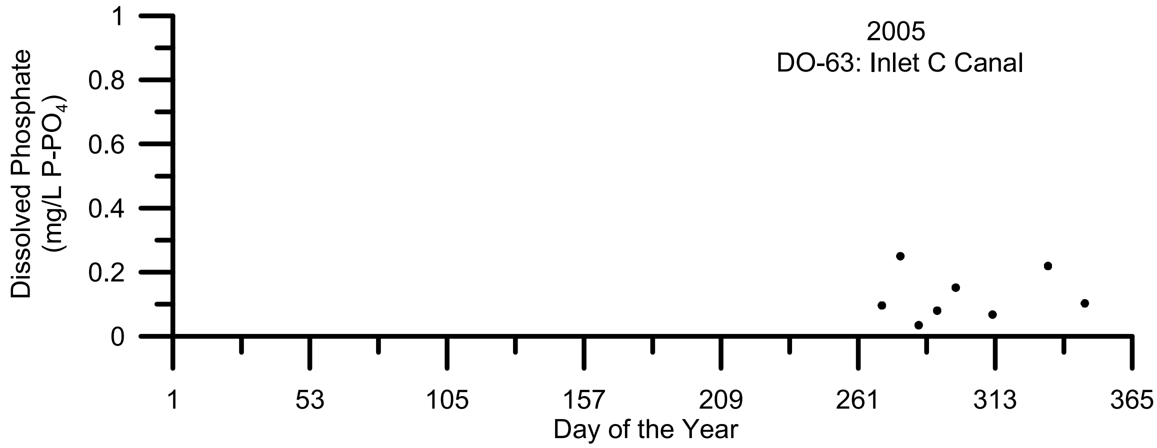

2006
DO-61: Deadman's Slough
Dissolved Phosphate
(mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

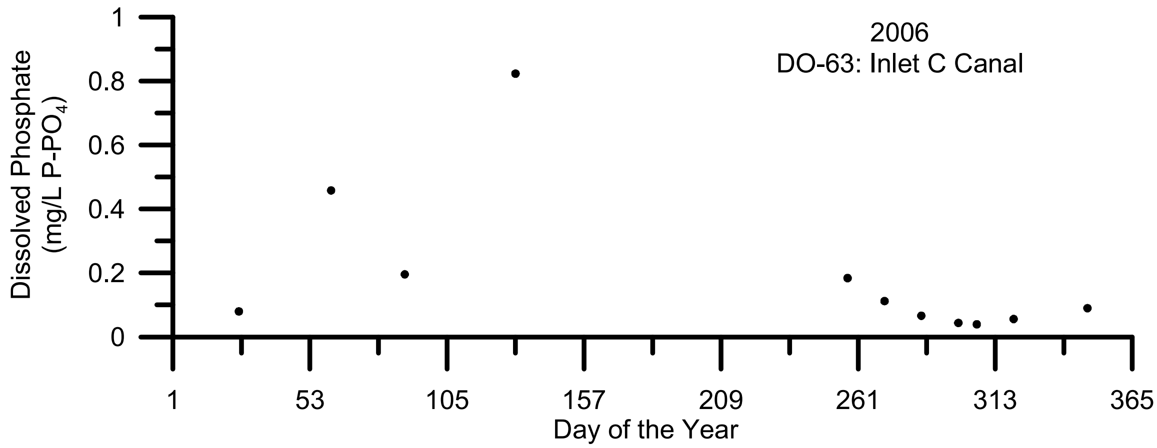

2007
DO-61: Deadman's Slough
Dissolved Phosphate
(mg/L P-PO4)
0.5
0.4
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

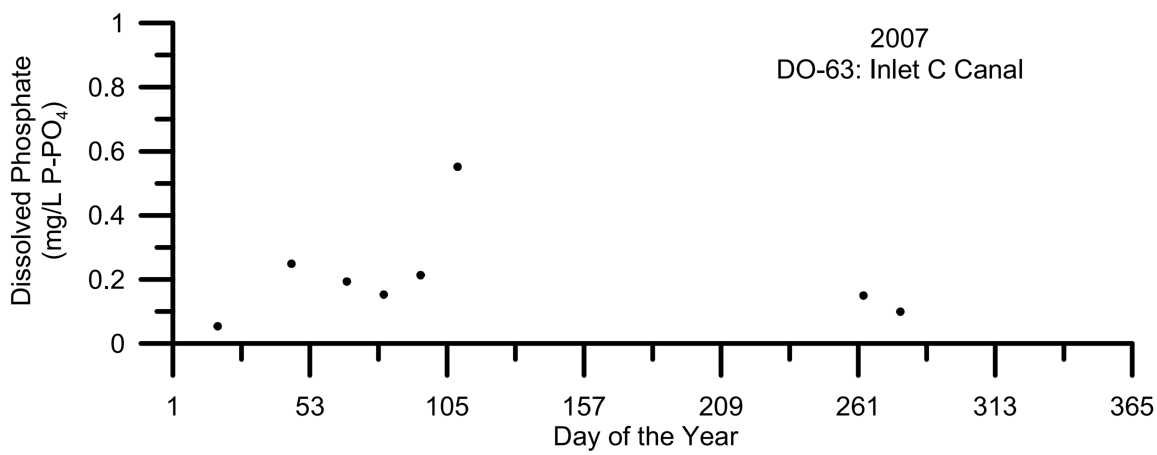

2005
DO-62: Mallard Slough
Dissolved Phosphate
(mg/L P-PO4)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

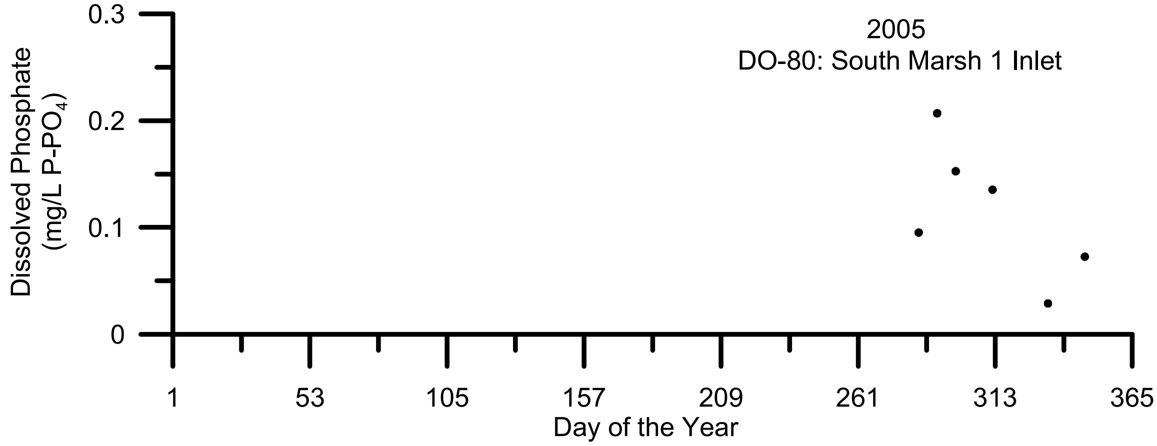

2006
DO-62: Mallard Slough
Dissolved Phosphate
(mg/L P-PO4)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

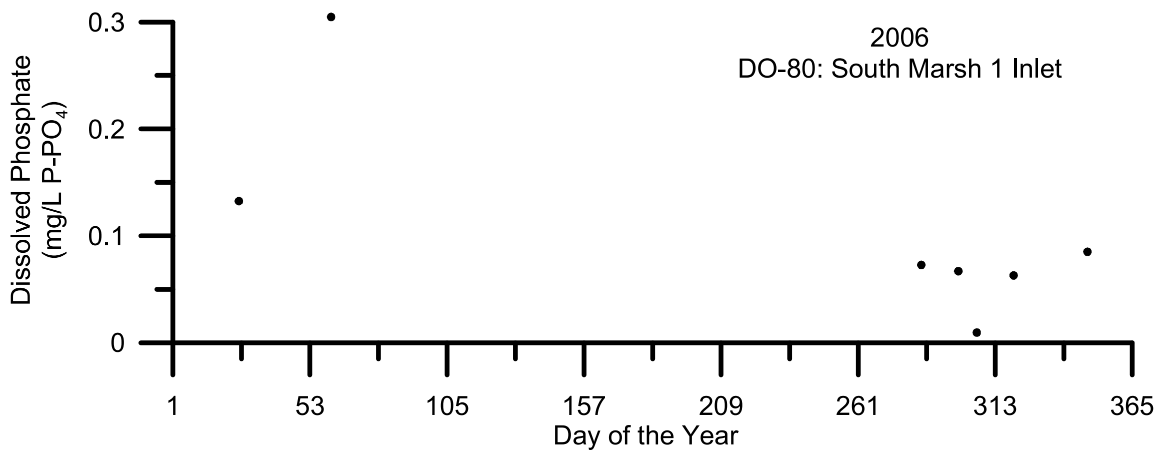

2007
DO-62: Mallard Slough
Dissolved Phosphate
(mg/L P-PO4)
0
1
2
3
1
53
105
157
209
261
313
365
Day of the Year

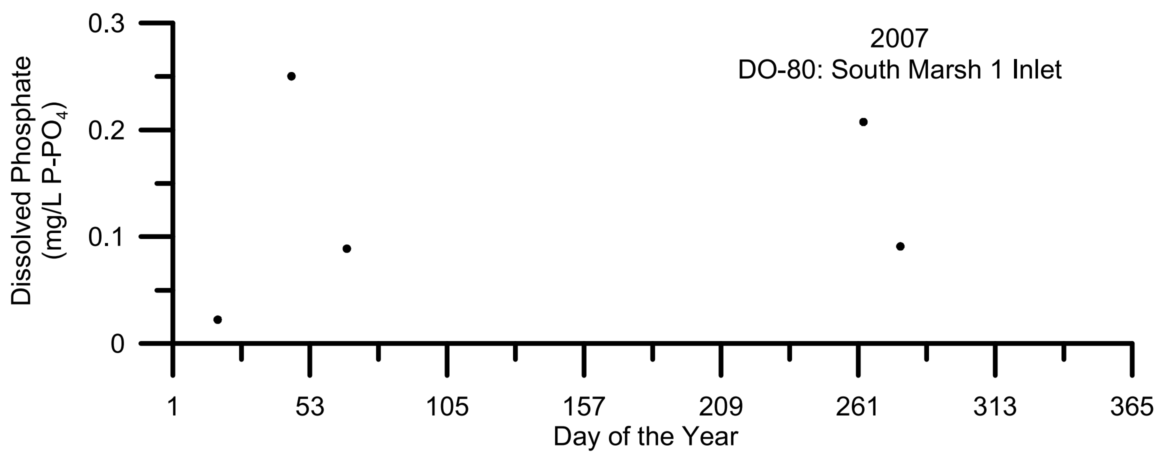

2005
DO-63: Inlet C Canal
Dissolved Phosphate
(mg/L P-PO$_4$)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

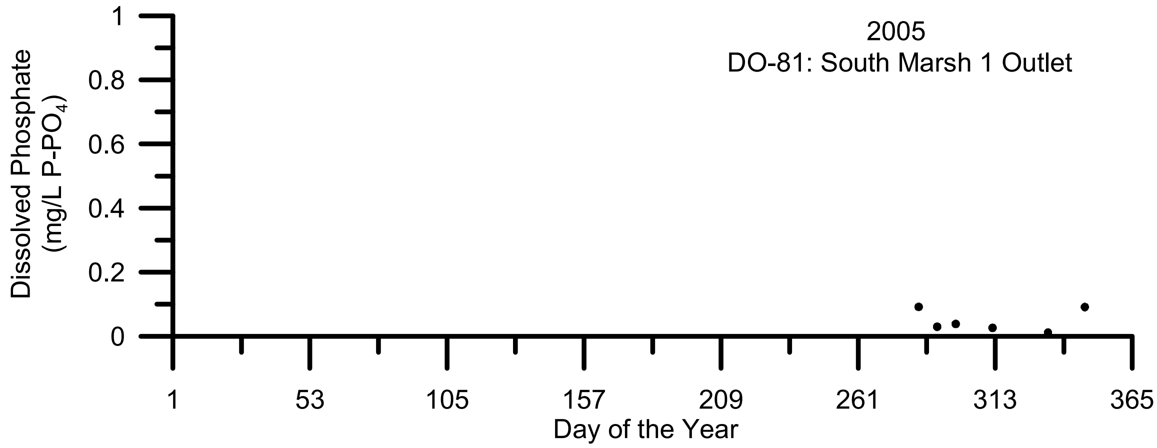

2006
DO-63: Inlet C Canal
Dissolved Phosphate
(mg/L P-PO$_4$)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

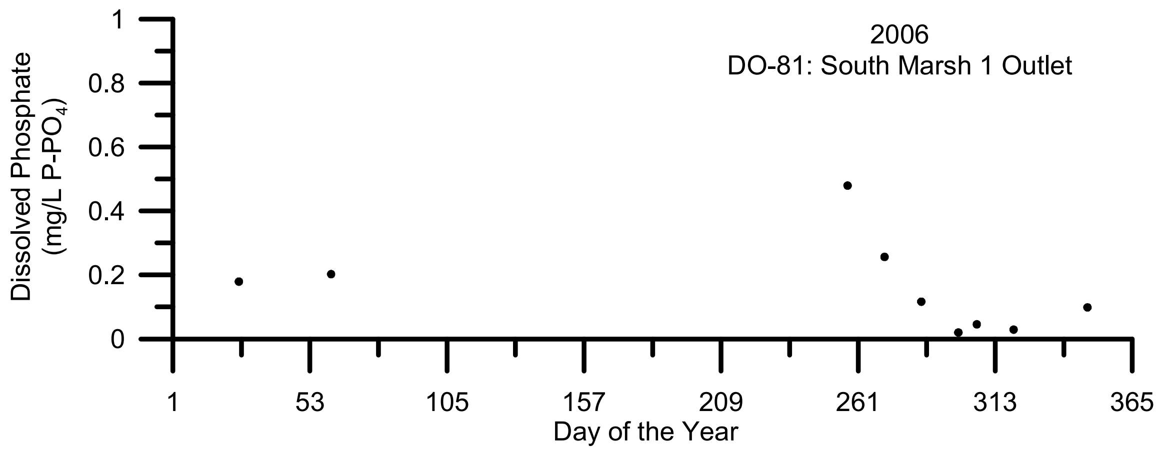

2007
DO-63: Inlet C Canal
Dissolved Phosphate
(mg/L P-PO$_4$)
Day of the Year
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365

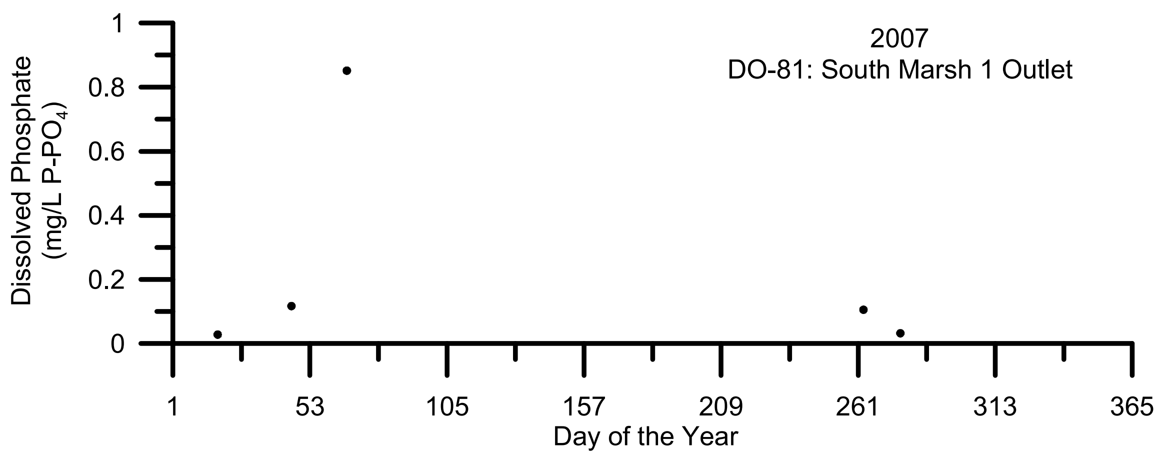

2005
DO-80: South Marsh 1 Inlet
Dissolved Phosphate (mg/L P-PO4)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

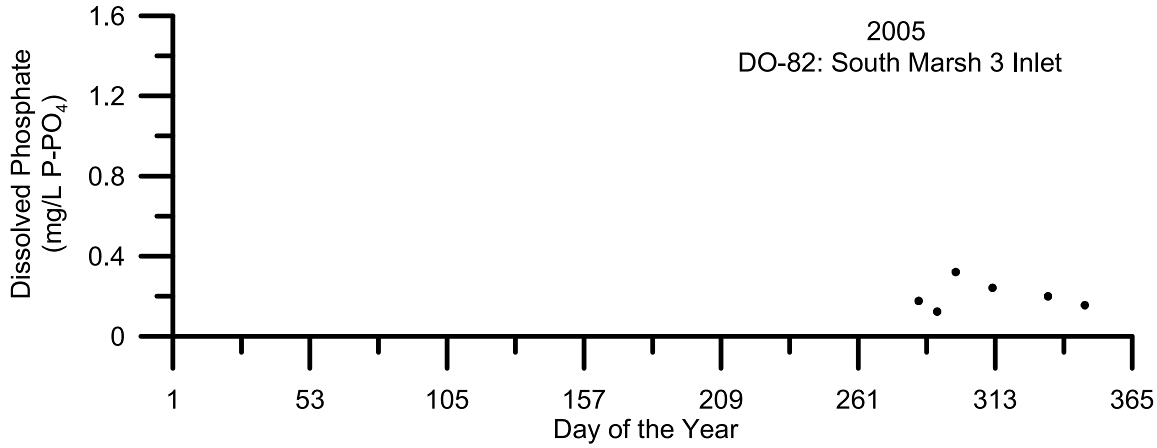

2006
DO-80: South Marsh 1 Inlet
Dissolved Phosphate (mg/L P-PO4)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

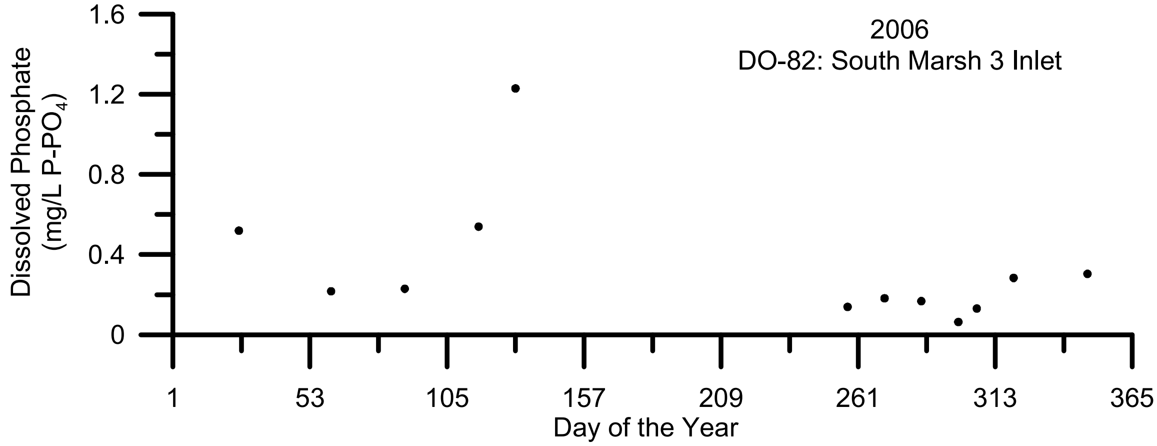

2007
DO-80: South Marsh 1 Inlet
Dissolved Phosphate (mg/L P-PO4)
0.3
0.2
0.1
0
1
53
105
157
209
261
313
365
Day of the Year

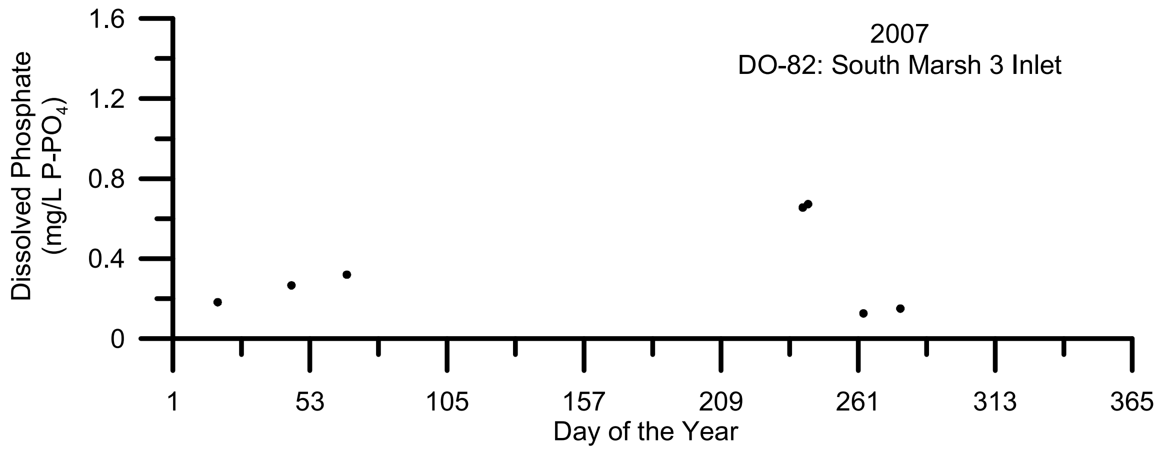

2005
DO-81: South Marsh 1 Outlet
Dissolved Phosphate (mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

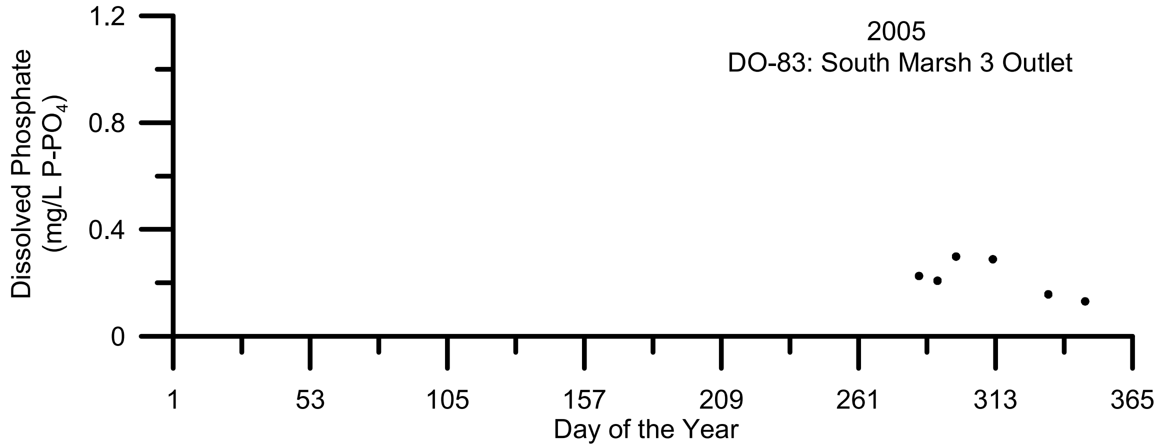

2006
DO-81: South Marsh 1 Outlet
Dissolved Phosphate (mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year


2007
DO-81: South Marsh 1 Outlet
Dissolved Phosphate (mg/L P-PO4)
1
0.8
0.6
0.4
0.2
0
1
53
105
157
209
261
313
365
Day of the Year

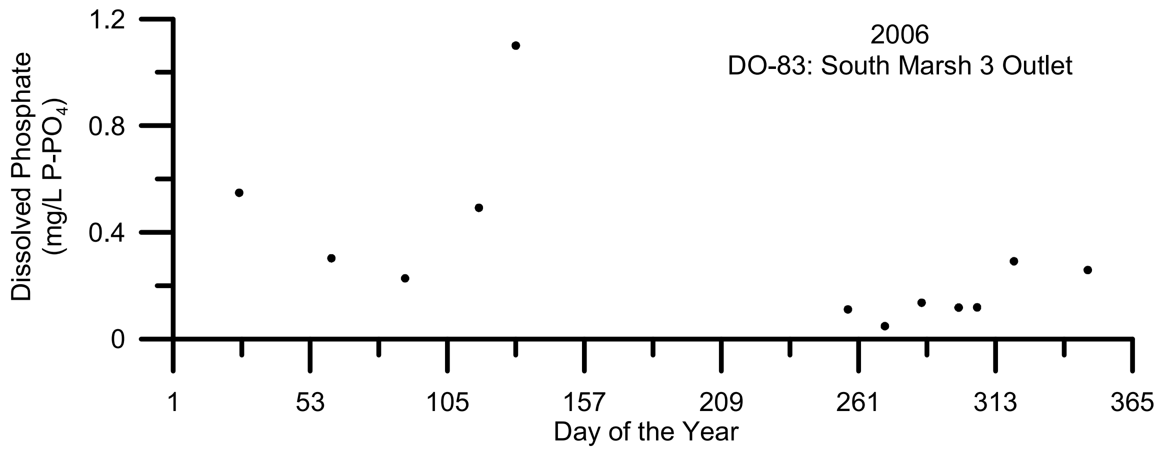

2005
DO-82: South Marsh 3 Inlet
Dissolved Phosphate
(mg/L P-PO4)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


2006
DO-82: South Marsh 3 Inlet
Dissolved Phosphate
(mg/L P-PO4)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

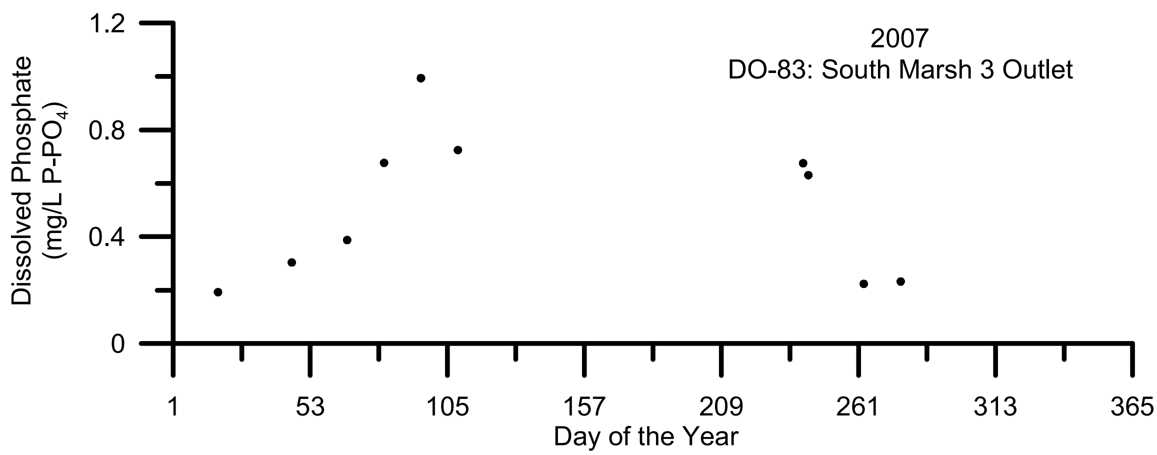

2007
DO-82: South Marsh 3 Inlet
Dissolved Phosphate
(mg/L P-PO4)
1.6
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



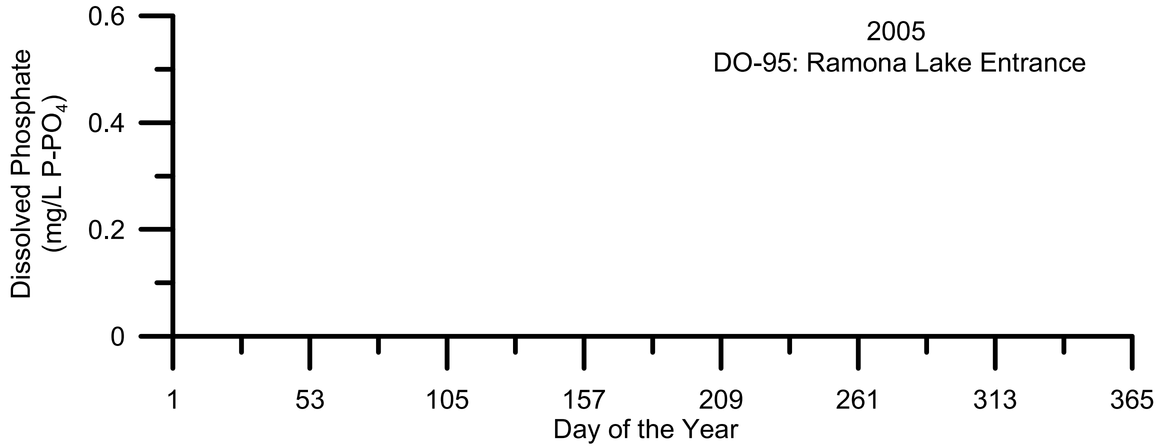
2005
DO-83: South Marsh 3 Outlet
Dissolved Phosphate (mg/L P-PO4)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year

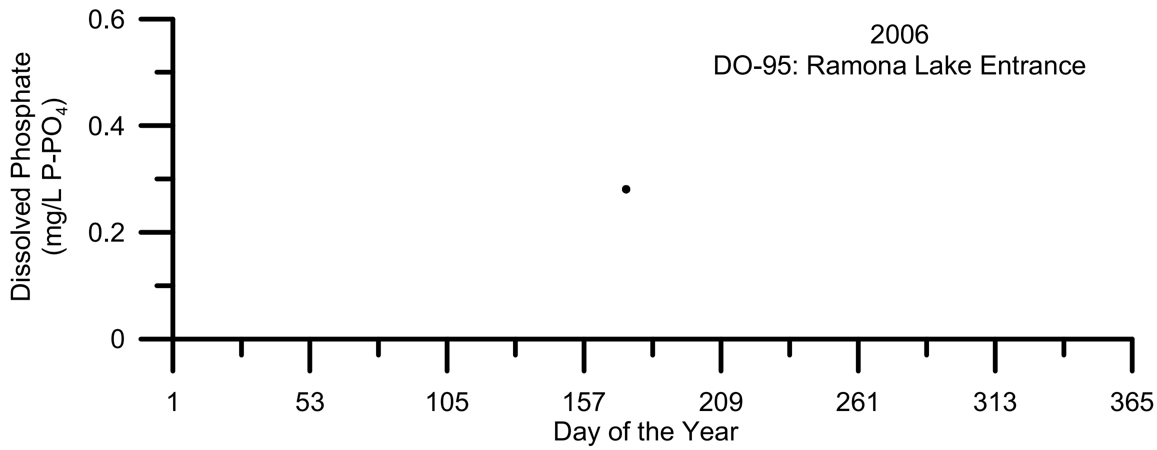


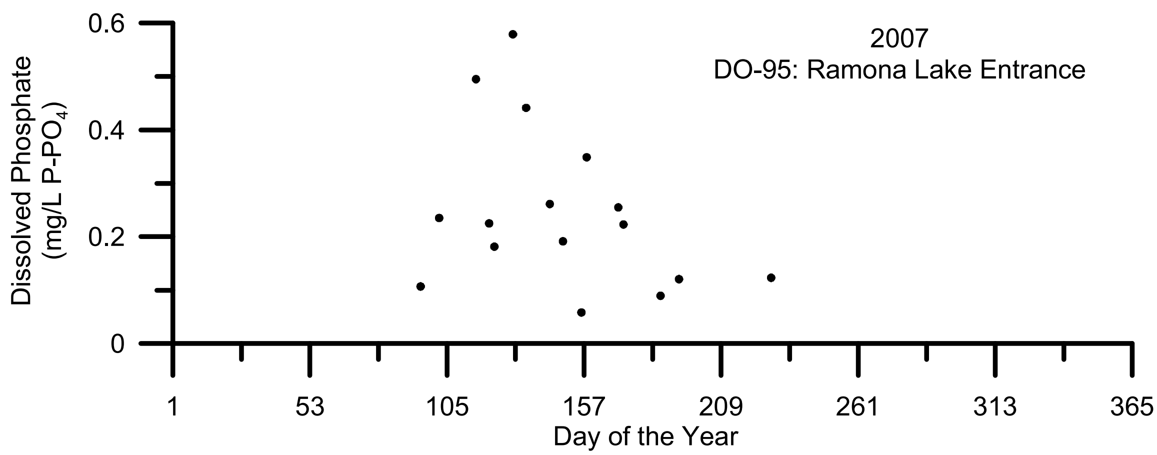
2006
DO-83: South Marsh 3 Outlet
Dissolved Phosphate (mg/L P-PO4)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year



2007
DO-83: South Marsh 3 Outlet
Dissolved Phosphate (mg/L P-PO4)
1.2
0.8
0.4
0
1
53
105
157
209
261
313
365
Day of the Year


0.6
0.4
0.2
0
Dissolved Phosphate (mg/L P-PO$_4$)
2005
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year


0.6
0.4
0.2
0
Dissolved Phosphate (mg/L P-PO$_4$)
2006
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year


0.6
0.4
0.2
0
Dissolved Phosphate (mg/L P-PO$_4$)
2007
DO-95: Ramona Lake Entrance
1
53
105
157
209
261
313
365
Day of the Year

Appendix J

Statistical Comparison of Water Quality Indicator Data for Agricultural Drainage Sites Located West of the San Joaquin River

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William T. Stringfellow

March 2008

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Stockton, CA 95211

Objective

The purpose of this work is to statistically compare the water quality indicator results from various agricultural drainage sites located west of the San Joaquin River (SJR) and determine if significant similarities/differences exist between these sites.

Methods

Data was analyzed using JMP statistical software. Standard unpaired parametric (t-test) analyses comparing data from twenty-eight agricultural drain sites located west of the SJR (Table 1) were done. The hypothesis tested in these comparisons is:

H_0: There is no significant difference in the water quality data means of these sites.

H_1: There is a significant difference in the water quality data means of these sites.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 5% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, etc.), with different letters assigned to means that are statistically different. While the letters A, B, C, etc. are used to designate statistically different water quality data means for each analysis, data for each water quality indicator are compared separately, so the same letter designations between different water quality indicator comparisons do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative. The JMP output – including boxplots for each water quality parameter compared – are in the Analyses section of this document.

Results

Data was analyzed for several water quality indicators including total phosphorous (total P), soluble phosphate, total nitrogen (total N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_4-N), chlorophyll *a*, algal pigment, total organic carbon (TOC), dissolved organic carbon (DOC), biochemical oxygen demand (BOD), mineral suspended solids (MSS), and specific conductivity. Similarities in the t-test results between the sites were seen for:

1. total P and soluble phosphate
2. total N and NO_3-N
3. chlorophyll *a*, algal pigment, and BOD
4. TOC and DOC

No similarities between the t-test results for MSS, specific conductivity, or NH_4-N and any other indicator data were seen. Results from the statistical comparison of water quality indicator data for soluble phosphate, NO_3-N, and chlorophyll *a* indicate that significant differences exist between some of the sites, and are shown in Figures 1 – 5; and Tables 2 – 6. T-test grouping of the sample means for these indicators are discussed by referring to eight major sampling sites (DO site numbers 18, 19, 20, 21, 34, 36, 44, and 57), and including four additional sites that proved to be unique for one or more t-test indicator groupings (DO site numbers 31, 32, 33, and 62). The other sixteen sites, while not included in the results discussion, were included in all of the analyses and grouped with one or more of the discussed t-test sample mean groups.

Figure 1 shows a boxplot and Table 2 the results of the t-test analysis of the soluble phosphate data means. The analysis indicates that site DO-20 (Los Banos Creek Flow Station) has significantly more soluble phosphate than the other seven major sampling sites, and similar amounts as sites DO-33 and 62. Site DO-20 also has significantly more total P than the other seven major sampling sites, and similar amounts as sites DO-32 and 33 (Analysis 10).

Figure 2 shows a boxplot and Table 3 the results of the t-test analysis of the NO_3-N data means. The analysis indicates that site DO-44 (San Luis Drain End) has significantly more soluble phosphate than the other seven major sampling sites, and similar amounts as site DO-31. A similar result is seen for total N (Analysis 7).

Figure 3 shows a boxplot and Table 4 the results of the t-test analysis of the chlorophyll *a* data means. The analysis indicates that site DO-44 (San Luis Drain End) has significantly more chlorophyll *a* than all other sites, and site DO-57 (Ramona Lake Drain) has significantly more chlorophyll *a* than all sites except DO-44. A similar result is seen for algal pigment, with sites DO-57 and 44 having significantly more algal pigment than the other major sampling sites, and similar amounts as site DO-32 (Analysis 12). A similar result is also seen for BOD, with site DO-57 having significantly more BOD than the other major sampling sites, and site DO-44 having significantly more BOD than the other major sampling site except site DO-57 (Analysis 11). Interestingly, site DO-31 has much lower chlorophyll *a*, algal pigment, and BOD sample averages than all other sites, although statistically it groups with other low-average sites.

Figure 4 shows a boxplot and Table 5 the results of the t-test analysis of the TOC data means. The analysis indicates that site DO-20 (Los Banos Creek Flow Station) has significantly more TOC than the other major sampling sites, and similar amounts as site DO-32. A similar result is seen for DOC, with site DO-20 having significantly more DOC than the other major sampling sites (Analysis 6).

Figure 5 shows a boxplot and Table 6 the results of the t-test analysis of the NH_4-N data means. The analysis indicates that site DO-32 (El Solyo WD – Grayson Drain) has significantly more soluble phosphate than all other sampling sites. Sites DO-34 (Ingram Creek) and 36 (Del Puerto Creek Flow Station) have significantly more NH_4-N than the other major sampling sites except site DO-57, which groups with both higher- and lower-average NH_4-N sites.

Conclusions

A statistical comparison of water quality indicator data, including total P, soluble phosphate, total N, NO_3-N, NH_4-N, chlorophyll *a*, algal pigment, TOC, DOC, BOD, MSS, and specific conductivity, for agricultural drain sites located west of the SJR show that significant differences exist between many of the eight major sites (DO site numbers 18, 19, 20, 21, 34, 36, 44, and 57). However, there are also little to no significant differences between some sites. Some conclusions that can be made based on the analyses in this report include:

1. A statistical comparison of the sample means for soluble phosphate (Figure 1; Table 2) and total P yields three groupings of major west drain sites. Site DO-20 (Los Banos Creek Flow Station) comprises the first group, containing significantly more soluble phosphate and total P than the second group (DO site numbers 36, 34, 19, 21, 57, and 18), which all have significantly more soluble phosphate and total P than the third group, site DO-44.

2. A statistical comparison of the sample means for NO_3-N (Figure 2; Table 3) yields three groupings of major west drain sites. The first group is comprised of site DO-44 (San Luis Drain End), and has significantly more NO_3-N than all other major sites; the second group is comprised of sites DO-34, 18, 36, and 21, and has significantly more NO_3-N than the remaining sites; the third group is comprised of sites DO-57, 19, and 20, and are not significantly different from one another. The t-test results were similar for total N, with five groupings including: (1) site DO-44, which has significantly more total N than all other major sites; (2) site DO-34; (3) sites DO-18 and 36; (4) sites DO-21 and 57; and (5) sites DO-20 and 19.

3. A statistical comparison of the sample means for chlorophyll *a* (Figure 3; Table 4) yields four groupings of major west drain sites. The first group is comprised of site DO-44 (San Luis Drain End), and has significantly more chlorophyll *a* than all other sites; the second group is comprised of site DO-57, and has significantly more chlorophyll *a* than all sites except DO-44; the third group is comprised of sites DO-18, 20, and 34, and has significantly more chlorophyll *a* than all other sites except DO-44 and 57; and the fourth group is comprised of the remaining sites (DO-36, 21, 19), and are not significantly different from one another. The t-test results were similar for algal pigment, with four groupings including: (1) sites DO-57 and 44, which have significantly more algal pigment than all other major sites; (2) sites DO-18, 20, and 34; (3) sites DO-36 and 19; and (4) site DO-21.

4. A statistical comparison of the sample means for TOC (Figure 4; Table 5) yields three groupings of major west drain sites. The first group is comprised of site DO-20 (Los Banos Creek Flow Station), and has significantly more TOC than all other major sites; the second group is comprised of sites DO-57, 18, and 44, and has significantly more TOC than all sites except DO-20; and the fourth group is comprised of the remaining sites (DO-34, 19, 36, 21), and are not significantly different from one another. The t-test results were similar for DOC, with three groupings including: (1) site DO-20, which has significantly more DOC than all other major sites; (2) sites DO-57, 18, 44, and 19; and (3) sites DO-34, 36, and 21.

5. A statistical comparison of the sample means for NH_4-N (Figure 5; Table 6) yields one grouping of major east drain sites, as there were few significant differences between any of the sites.

Table 1: Sites used for this study.

Site Name	DO Site No.	Location
Mud Slough near Gustine	18	Lat. 37.26250 Long. -120.90555
Salt Slough at Lander Avenue	19	Lat. 37.24795 Long. -120.85194
Los Banos Creek at Hwy. 140	20	Lat. 37.27546 Long. -120.95532
'estimba Creek at River Rd. near Crows Landi	21	Lat. 37.41396 Long. -121.01488
BCID – New Jerusalem Drain	31	
El Solyo WD – Grayson Drain	32	
Hospital Creek	33	
Ingram Creek	34	Lat. 37.60026 Long. -121.22506
Westley Wasteway Flow Station	35	
Del Puerto Creek Flow Station	36	Lat. 37.53947 Long. -121.12206
Marshall Road Drain	38	
Salado Creek Flow Station	39	
San Luis Drain End	44	Lat. 37.26090 Long. -120.90520
Mud Slough at Gun Club Road	46	
Salt Slough at Sand Dam	52	
Salt Slough at Wolfsen Road	53	
Ramona Lake Drain at Levee	57	Lat. 37.47881 Long. -121.06850
Moffit 1 South	60	
Deadman's Slough	61	
Mallard Slough	62	
Moran Drain	64	
Spanish Grant Drain	65	
ESWD Maze Blvd. Drain	66	
Newman Wasteway at Brazo Road	67	
S. Lake Basin	68	
Ramona Lake Entrance	95	
Hollow Tree Drain	129	
Marshall Road Reservoir Entrance	130	

Figure 1: Boxplot of soluble phosphate results.

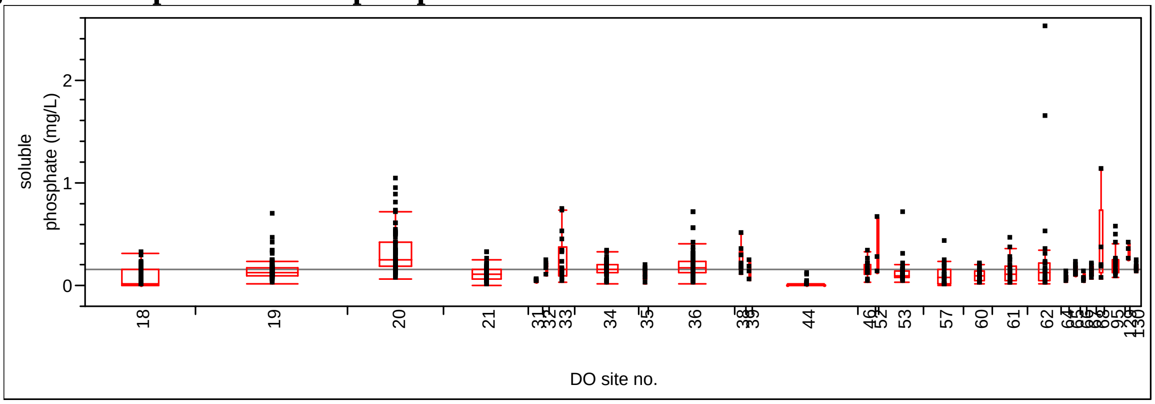


Table 2: Statistical analysis of soluble phosphate data, student's t-test comparison of all pairs of agricultural drain sites west of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site														Mean (mg/L)
68	A	B												0.3802
52	A	B	C	D										0.3477
129	A	B	C	D	E	F								0.3283
20	A													0.3251
62	A	B		D										0.3076
33	A	B	C	D	E									0.2643
38	A	B	C	D	E	F	G		I					0.2435
95		B	C	D	E	F	G							0.2327
36			C		E	F	G	H						0.2045
130			C		E	F	G	H	I	J	K		M	0.1743
32			C	D	E	F	G	H	I	J	K		M	0.1732
34						F	G	H	I	J				0.1614
46			C		E	F	G	H	I	J	K		M	0.1566
39			C	D	E	F	G	H	I	J	K	L	M	0.1503
65			C		E	F	G	H	I	J	K		M	0.1466
19									I	J			M	0.1452
61							G	H	I	J	K		M	0.1334
67					E	F	G	H	I	J	K		M	0.1314
53									I	J	K		M	0.1262
35							G	H	I	J	K	L	M	0.1134
21										J	K		M	0.1094
57										J	K		M	0.0997
60										J	K		M	0.0943
64								H		J	K	L	M	0.0750
18											K			0.0727
66							G	H	I	J	K	L	M	0.0675
31											K	L	M	0.0429
44												L		0.0059

Figure 2: Boxplot of NO3-N results.

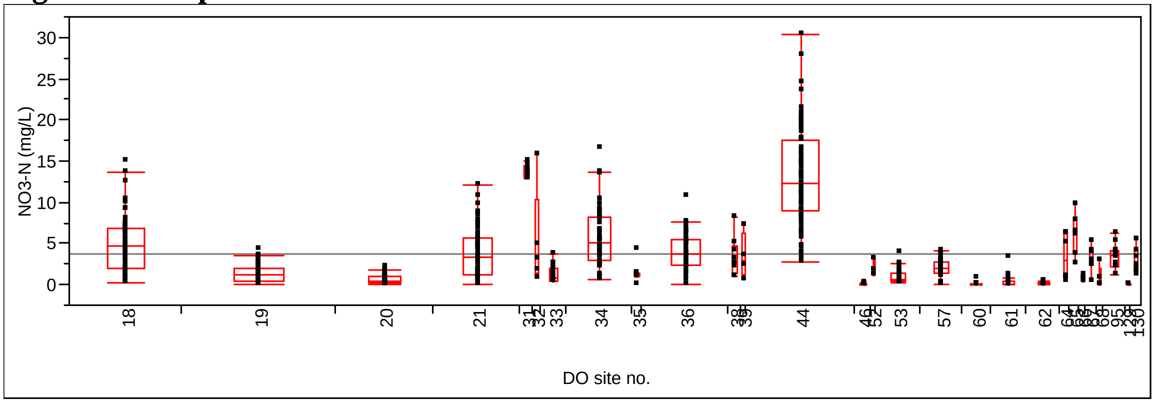


Table 3: Statistical analysis of NO3-N data, student's t-test comparison of all pairs of agricultural drain sites west of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site											Mean (mg/L)
31	A										13.78
44	A										13.05
34		B									5.74
65		B	C	D							5.74
32		B	C	D	E	F					5.29
18		B	C		E						4.82
36			C	D	E	F					4.04
21				D		F					3.84
39		B	C	D	E	F	G	H	I		3.44
95			C	D	E	F	G				3.43
38			C	D	E	F	G	H			3.41
64			C	D	E	F	G	H	I		3.29
67			C	D	E	F	G	H	I		3.01
130					E	F	G	H	I		2.86
52			C	D	E	F	G	H	I	J	2.09
57							G	H	I		2.05
35							G	H	I	J	1.50
33								H	I	J	1.28
19									I	J	1.28
53									I	J	1.04
68							G	H	I	J	0.80
66							G	H	I	J	0.75
20										J	0.62
61										J	0.31
62										J	0.09
46										J	0.06
60										J	0.05
129								H	I	J	0.02

Figure 3: Boxplot of chlorophyll *a* results.

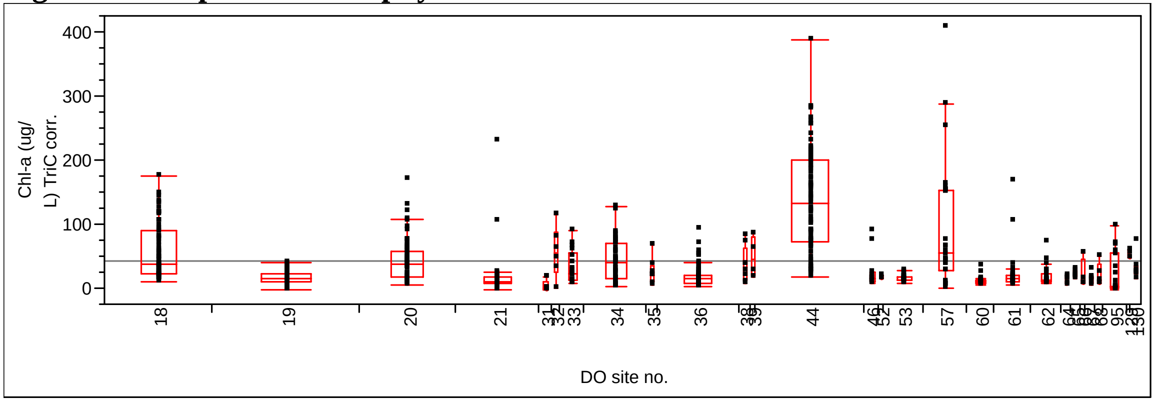


Table 4: Statistical analysis of chlorophyll *a* data, student's t-test comparison of all pairs of agricultural drain sites west of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site							Mean (µg/L)
44	A						136.05
57		B					94.19
18			C				56.95
32			C	D	E		56.05
129		B	C	D	E	F	53.81
39			C	D	E	F	47.81
20				D			43.26
34			C	D	E		41.85
38			C	D	E	F	36.54
33				D	E	F	33.55
130			C	D	E	F	31.94
46				D	E	F	27.00
35				D	E	F	25.10
61					E	F	24.60
95				D	E	F	24.03
65				D	E	F	21.61
66			C	D	E	F	21.19
68			C	D	E	F	21.01
62						F	18.98
36						F	18.34
52			C	D	E	F	16.51
21						F	16.33
19						F	16.32
53						F	15.00
67				D	E	F	14.52
64				D	E	F	13.55
60						F	11.90
31						F	3.28

Figure 4: Boxplot of TOC results.

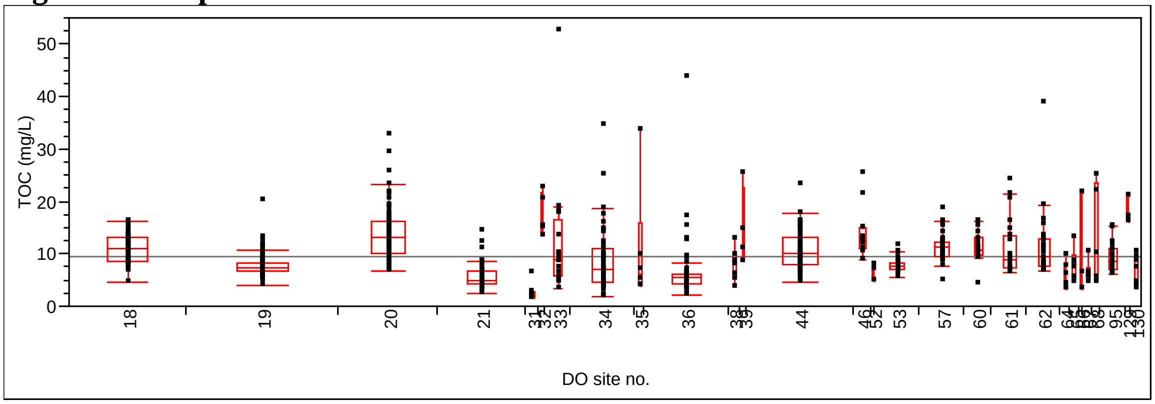


Table 5: Statistical analysis of TOC data, student's t-test comparison of all pairs of agricultural drain sites west of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site												Mean (mg/L)
129	A											18.10
32	A											17.34
39	A	B	C	D								14.94
46	A	B	C									14.07
20	A	B										13.97
68	A	B	C	D	E							13.40
33		B	C	D								12.47
62			C	D	E	F						11.65
57			C	D	E	F	G					11.38
60			C	D	E	F	G					11.30
61			C	D	E	F	G					11.15
18				D	E	F	G					11.05
44				D	E	F	G					10.64
35		B	C	D	E	F	G	H				10.56
66		B	C	D	E	F	G	H	I	J		10.46
95					E	F	G	H				9.38
34								H				8.75
65						F	G	H	I	J		7.92
53								H	I			7.77
38							G	H	I	J		7.75
19								H	I			7.69
130								H	I	J	K	6.75
52						F	G	H	I	J	K	6.65
36									I	J		6.56
67								H	I	J	K	6.43
64								H	I	J	K	5.74
21										J	K	5.62
31											K	2.57

Figure 5: Boxplot of NH_4-N results.

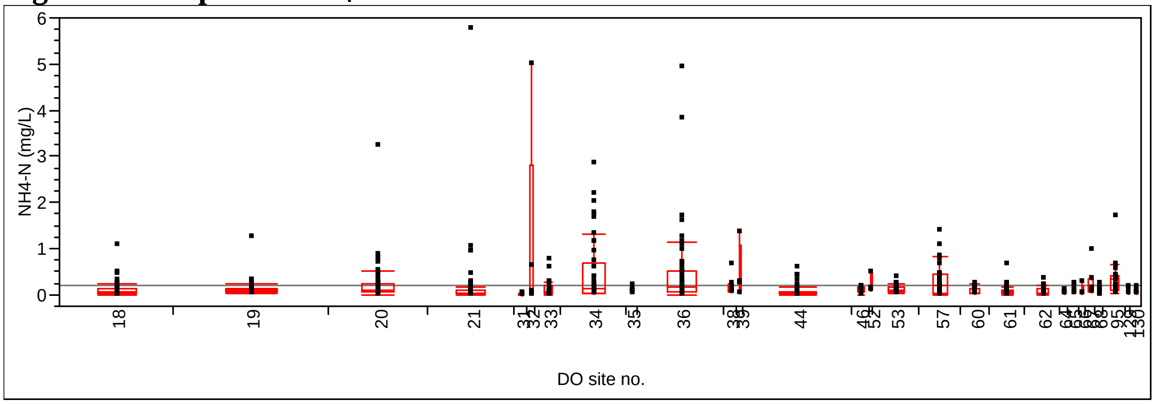


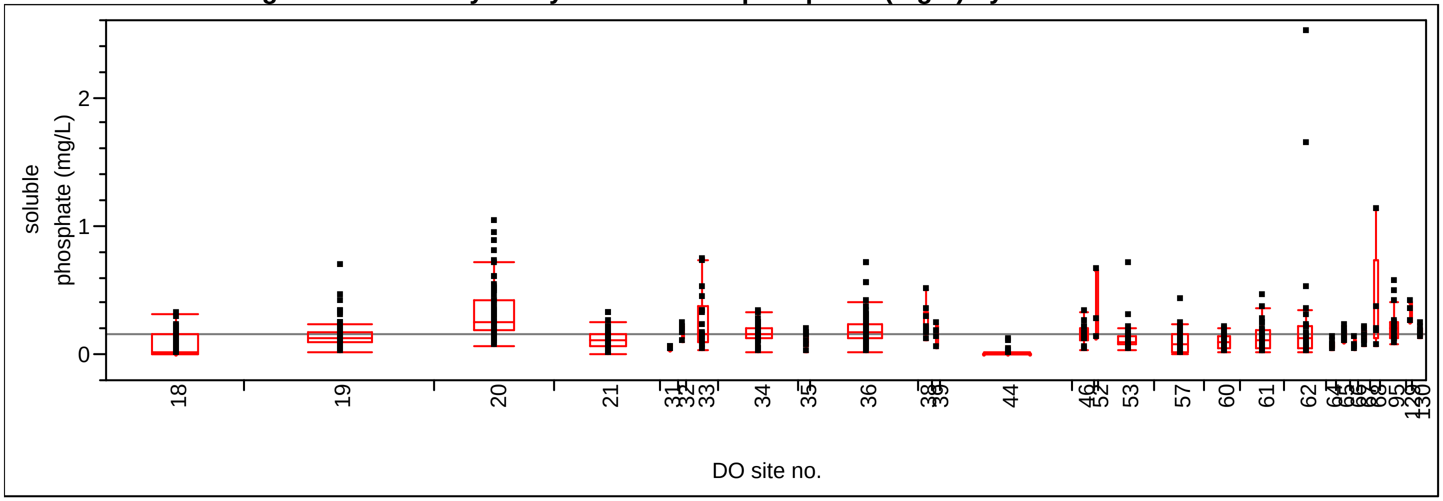
Table 6: Statistical analysis of NH_4-N data, student's t-test comparison of all pairs of agricultural drain sites west of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site							Mean
32	A						1.1416
34		B					0.4896
39		B	C	D	E	F	0.4720
36		B					0.4596
95		B	C				0.3782
57		B	C	D			0.3059
67		B	C	D	E	F	0.2623
52		B	C	D	E	F	0.2350
20			C	D	E		0.2311
21			C	D	E	F	0.2105
38		B	C	D	E	F	0.1760
33			C	D	E	F	0.1440
65		B	C	D	E	F	0.1336
53			C	D	E	F	0.1254
46			C	D	E	F	0.1115
18					E	F	0.1065
61			C	D	E	F	0.1054
129		B	C	D	E	F	0.1053
19					E	F	0.1043
68		B	C	D	E	F	0.0970
66		B	C	D	E	F	0.0900
35			C	D	E	F	0.0900
62				D	E	F	0.0839
60			C	D	E	F	0.0780
44						F	0.0713
130			C	D	E	F	0.0629
64			C	D	E	F	0.0570
31			C	D	E	F	0.0062

Analyses 1 - 12: Data from the Statistical Comparison of Water Quality Indicators for Agricultural Drains Located West of the SJR

Analysis 1: West Drain Sites Soluble Phosphate

Figure 1-1: Oneway Analysis of soluble phosphate (mg/L) by DO site number



Missing Rows 55

Table 1-1: Soluble phosphate mean comparisons for each pair using Student's t-test.

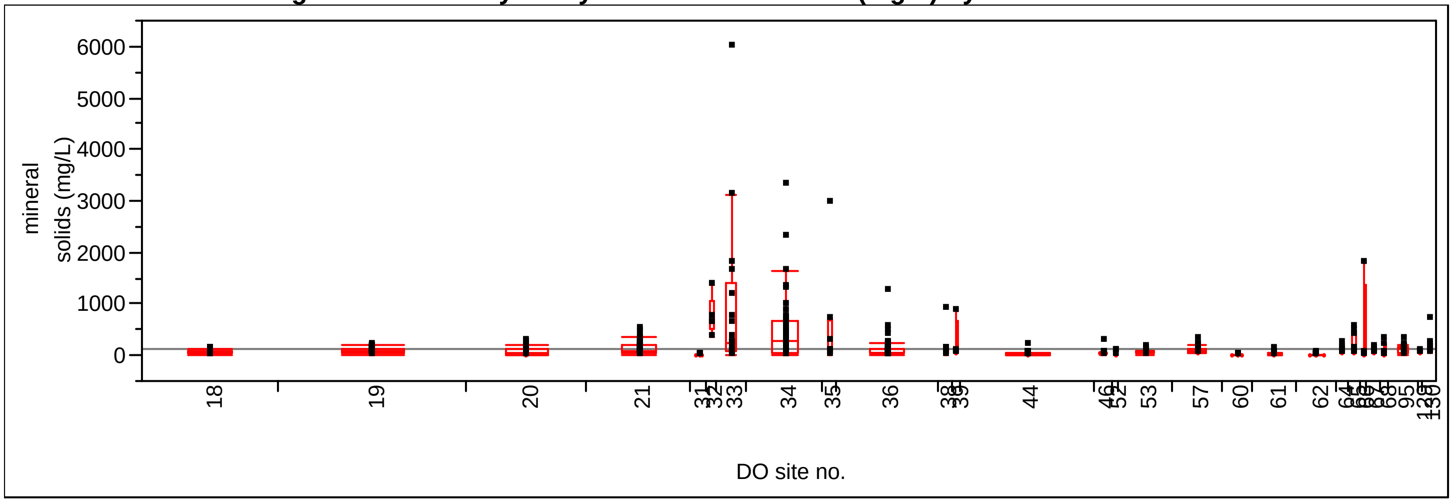
t	Alpha
1.96340	0.05

Level														Mean (mg/L)
68	A	B												0.38020000
52	A	B	C	D										0.34766667
129	A	B	C	D	E	F								0.32833333
20	A													0.32506061
62	A	B		D										0.30760870
33	A	B	C	D	E									0.26429412
38	A	B	C	D	E	F	G		I					0.24350000
95		B	C	D	E	F	G							0.23273333
36			C		E	F	G	H						0.20453448
130			C		E	F	G	H	I	J	K		M	0.17428571
32			C	D	E	F	G	H	I	J	K		M	0.17320000
34						F	G	H	I	J				0.16138636
46			C		E	F	G	H	I	J	K		M	0.15663636
39			C	D	E	F	G	H	I	J	K	L	M	0.15025000
65			C		E	F	G	H	I	J	K		M	0.14657143
19									I	J			M	0.14522330
61							G	H	I	J	K		M	0.13341667
67					E	F	G	H	I	J	K		M	0.13142857
53									I	J	K		M	0.12616667
35							G	H	I	J	K	L	M	0.11342857
21										J	K		M	0.10936207
57										J	K		M	0.09967857
60										J	K		M	0.09426316
64								H		J	K	L	M	0.07500000
18											K			0.07269737
66							G	H	I	J	K	L	M	0.06750000
31											K	L	M	0.04288889
44												L		0.00589041

Levels not connected by same letter are significantly different.

Analysis 2: West Drain Sites Mineral Suspended Solids

Figure 2-1: Oneway Analysis of mineral solids (mg/L) by DO site number.



Missing Rows 54

Table 2-1: Mineral suspended solids mean comparisons for each pair using Student's t-test.

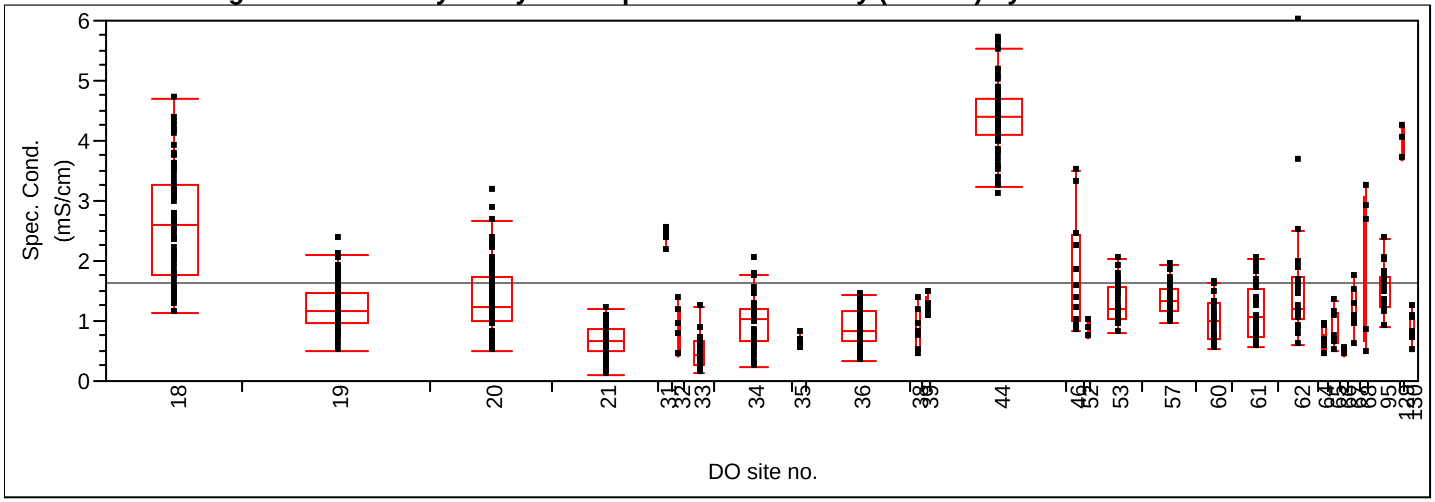
t	Alpha
1.96339	0.05

Level								Mean (mg/L)
33	A							973.15059
32	A	B						750.04600
35		B	C					591.97000
34		B	C	D				504.12349
66		B	C	D	E			466.16000
39			C	D	E	F	G	258.28250
65				D	E	F	G	252.61429
130					E	F	G	216.14286
38					E	F	G	173.69125
21						F		139.59534
95					E	F	G	117.64250
36						F	G	117.40105
64					E	F	G	113.11667
68					E	F	G	111.42400
57						F	G	102.41143
67					E	F	G	89.26286
19						F	G	84.51076
20						F	G	69.98612
53						F	G	68.62800
46						F	G	57.43100
52					E	F	G	51.47000
18						F	G	50.98566
129					E	F	G	46.37667
44							G	28.73173
61						F	G	23.71542
62						F	G	8.24304
31						F	G	4.89222
60						F	G	1.64000

Levels not connected by same letter are significantly different.

Analysis 3: West Drain Sites Specific Conductivity

Figure 3-1: Oneway Analysis of specific conductivity (mS/cm) by DO site number.



Missing Rows 40

Table 3-1: Specific conductivity mean comparisons for each pair using Student's t-test.
Means Comparisons

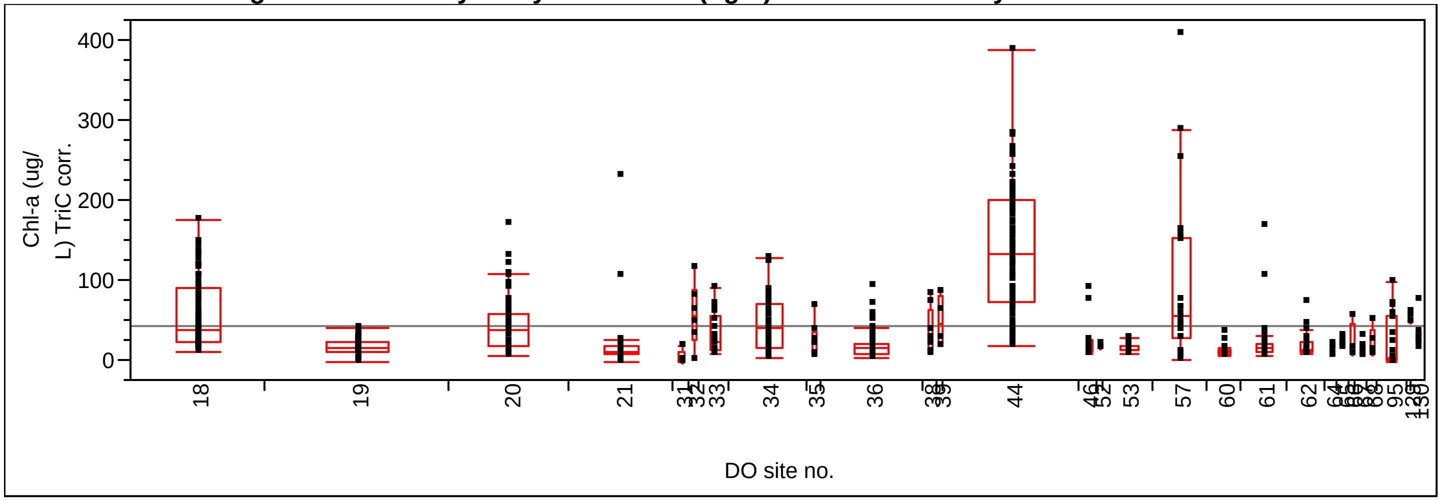
t	Alpha
1.96333	0.05

Level															Mean (mS/cm)
44	A														4.4010789
129	A														3.9900000
18		B													2.6426753
31		B	C												2.4231250
68			C	D											2.0206000
46				D	E										1.8310909
62				D	E	F									1.6296364
95				D	E	F	G								1.5460000
20						F	G	H							1.3705441
57						F	G	H							1.3575667
53							G	H	I						1.3107931
39					E	F	G	H	I	J	K	L			1.2450000
19								H	I		K				1.2281238
67							G	H	I	J	K	L	M		1.1554286
61								H	I	J	K				1.1502692
60									I	J	K	L	M		1.0018000
34										J		L	M		0.9823409
36												L	M		0.8763448
52								H	I	J	K	L	M	N	0.8720000
130									I	J	K	L	M	N	0.8700000
65									I	J	K	L	M	N	0.8655714
32									I	J	K	L	M	N	0.8491667
38										J	K	L	M	N	0.8477143
64										J		L	M	N	0.7395000
21														N	0.6680333
35												L	M	N	0.6420000
33														N	0.4946471
66													M	N	0.4875000

Levels not connected by same letter are significantly different.

Analysis 4: West Drain Sites Chlorophyll *a*

Figure 4-1: Oneway analysis of Chl-a (ug/L) TriC corrected by DO site number.



Missing Rows 37

Table 4-1: Chlorophyll *a* mean comparisons for each pair using Student's t-test.

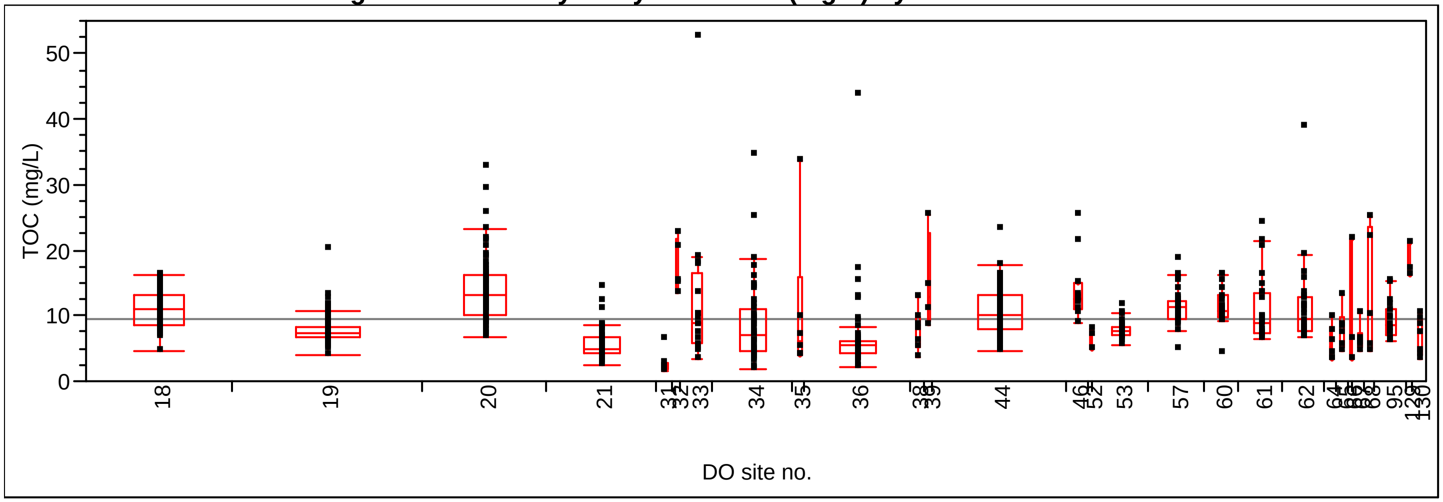
t	Alpha
1.96331	0.05

Level							Mean (μg/L)
44	A						136.04519
57		B					94.18933
18			C				56.94961
32			C	D	E		56.04667
129		B	C	D	E	F	53.80667
39			C	D	E	F	47.81000
20				D			43.25868
34			C	D	E		41.84864
38			C	D	E	F	36.54125
33				D	E	F	33.55412
130			C	D	E	F	31.93714
46				D	E	F	26.99818
35				D	E	F	25.10000
61					E	F	24.59538
95				D	E	F	24.02765
65				D	E	F	21.60571
66			C	D	E	F	21.19000
68			C	D	E	F	21.01200
62						F	18.98091
36						F	18.33690
52			C	D	E	F	16.50667
21						F	16.33117
19						F	16.32305
53						F	15.00310
67				D	E	F	14.51857
64				D	E	F	13.55000
60						F	11.90450
31						F	3.28333

Levels not connected by same letter are significantly different.

Analysis 5: West Drain Sites TOC

Figure 5-1: Oneway analysis of TOC (mg/L) by DO site number.



Missing Rows 69

Table 5-1: TOC mean comparisons for each pair using Student's t-test.

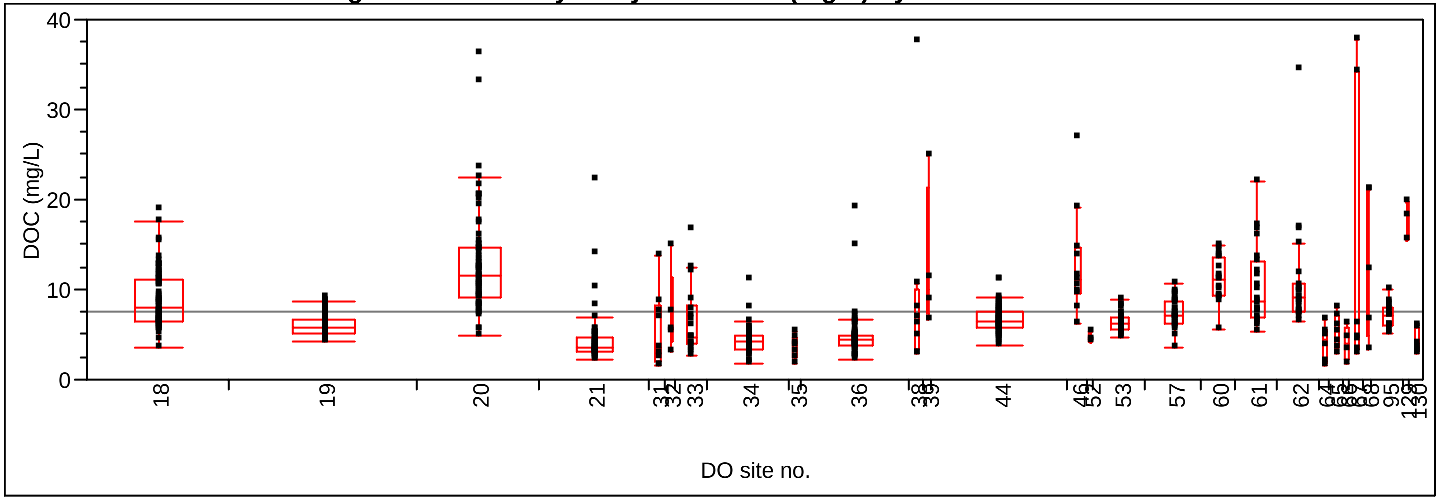
t	Alpha
1.96347	0.05

Level												Mean (mg/L)
129	A											18.100667
32	A											17.341000
39	A	B	C	D								14.935750
46	A	B	C									14.068545
20	A	B										13.965692
68	A	B	C	D	E							13.399800
33		B	C	D								12.469813
62			C	D	E	F						11.645000
57			C	D	E	F	G					11.383233
60			C	D	E	F	G					11.295444
61			C	D	E	F	G					11.148609
18				D	E	F	G					11.051494
44				D	E	F	G					10.643803
35		B	C	D	E	F	G	H				10.560833
66		B	C	D	E	F	G	H	I	J		10.463333
95					E	F	G	H				9.380529
34								H				8.748349
65						F	G	H	I	J		7.919833
53								H	I			7.774138
38							G	H	I	J		7.753143
19								H	I			7.694020
130								H	I	J	K	6.754429
52						F	G	H	I	J	K	6.645000
36									I	J		6.555893
67								H	I	J	K	6.428000
64								H	I	J	K	5.735000
21										J	K	5.618310
31											K	2.568375

Levels not connected by same letter are significantly different.

Analysis 6: West Drain Sites DOC

Figure 6-1: Oneway analysis of DOC (mg/L) by DO site number.



Missing Rows 54

Table 6-1: DOC mean comparisons for each pair using Student's t-test.

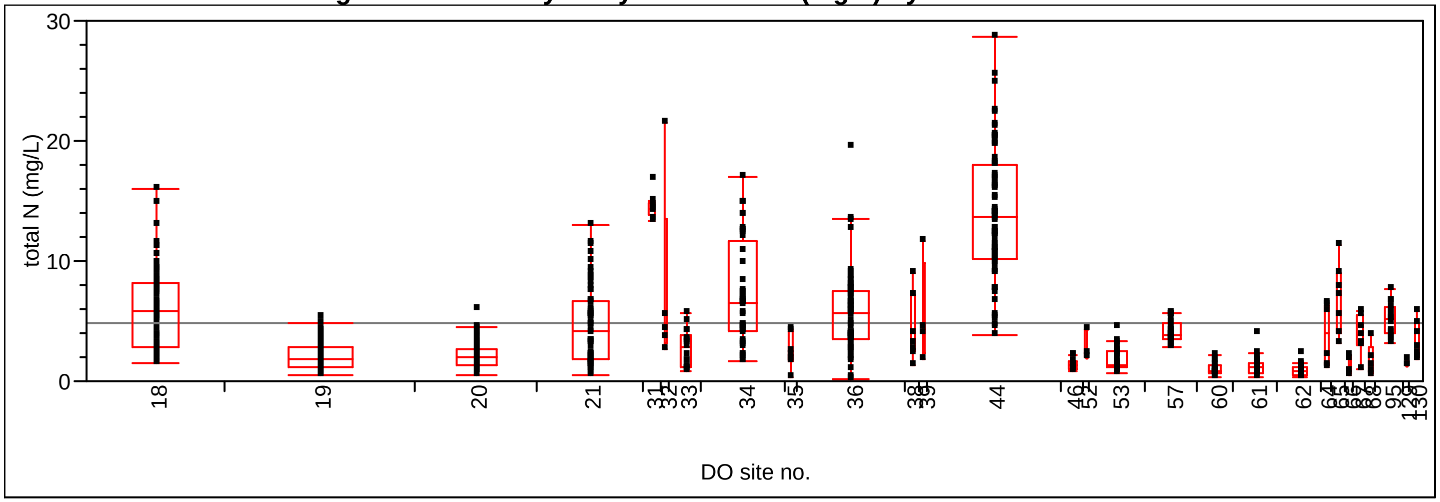
t	Alpha
1.96339	0.05

Level												Mean (mg/L)
129	A											17.822000
67	A	B	C									13.374857
39	A	B	C									12.903500
68	A	B	C									12.894400
20		B										12.847000
46		B	C									12.820182
60		B	C									11.350000
62			C									10.902364
61			C	D								10.272739
38			C	D	E							10.016625
18				D	E	F						8.871688
57					E	F	G					7.409667
32				D	E	F	G	H	I	J	K	7.298000
95					E	F	G		I			7.114941
44							G		I			6.635603
33							G	H	I	J		6.603000
53							G	H	I	J		6.375310
19							G		I	J		6.042647
31							G	H	I	J	K	5.475222
65							G	H	I	J	K	5.320000
36								H			K	4.828569
52						F	G	H	I	J	K	4.664000
21											K	4.403305
34											K	4.328250
130								H	I	J	K	4.074000
64								H	I	J	K	4.002833
66							G	H	I	J	K	3.985000
35								H		J	K	3.567429

Levels not connected by same letter are significantly different.

Analysis 7: West Drain Sites Total N

Figure 7-1: Oneway analysis of total N (mg/L) by DO site number.



Missing Rows 63

Table 7-1: Total N mean comparisons for each pair using Student's t-test.

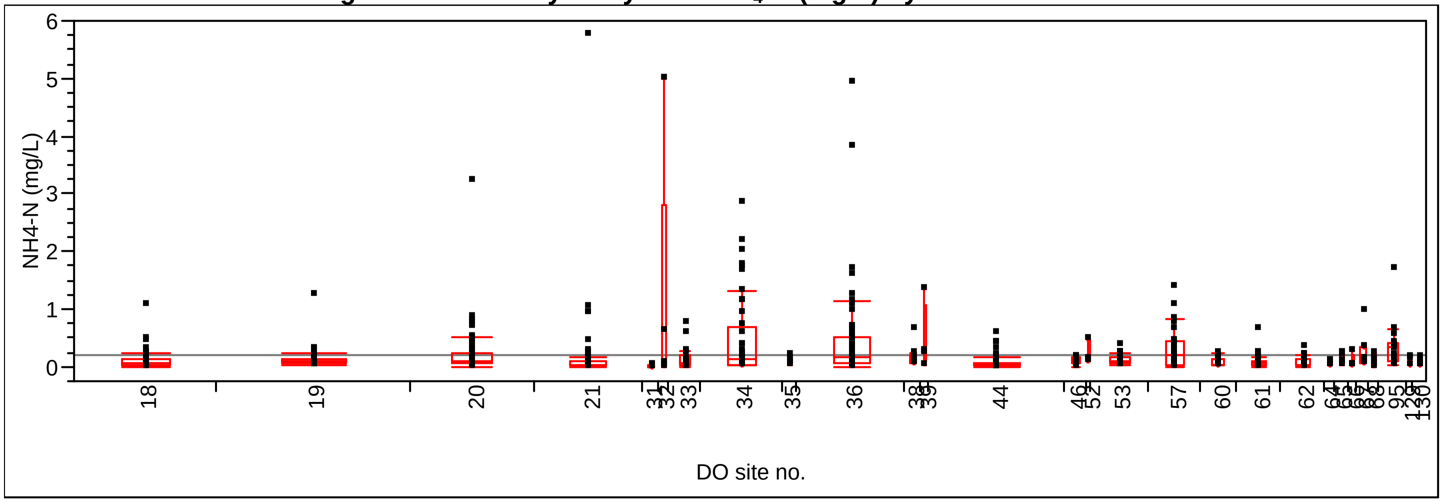
t	Alpha
1.96344	0.05

Level														Mean (mg/L)
31	A													14.500222
44	A													13.992181
32		B	C											7.528600
34		B												7.361659
65		B	C	D		F								6.841571
18			C	D	E									6.035622
36			C	D	E									5.753281
39		B	C	D	E	F	G	H	I					5.506000
95			C	D	E	F	G							5.173733
21						F	G	H						4.686140
38			C	D	E	F	G	H	I	J				4.604250
57							G	H	I	J				4.099286
64				D	E	F	G	H	I	J	K			3.894167
67				D	E	F	G	H	I	J	K			3.825000
130							G	H	I	J	K	L		3.360429
52					E		G	H	I	J	K	L	M	2.847667
33									I	J	K	L	M	2.704059
35								H	I	J	K	L	M	2.422571
20											K	L	M	2.167462
19											K	L	M	2.034158
53											K	L	M	1.763967
68									I	J	K	L	M	1.687600
129								H	I	J	K	L	M	1.499667
46											K	L	M	1.394909
66										J	K	L	M	1.370000
61												L	M	1.246125
60												L	M	0.950526
62													M	0.884348

Levels not connected by same letter are significantly different.

Analysis 8: West Drain Sites NH_4-N

Figure 8-1: Oneway analysis of NH_4-N (mg/L) by DO site number.



Missing Rows 55

Table 8-1: NH_4-N mean comparisons for each pair using Student's t-test.

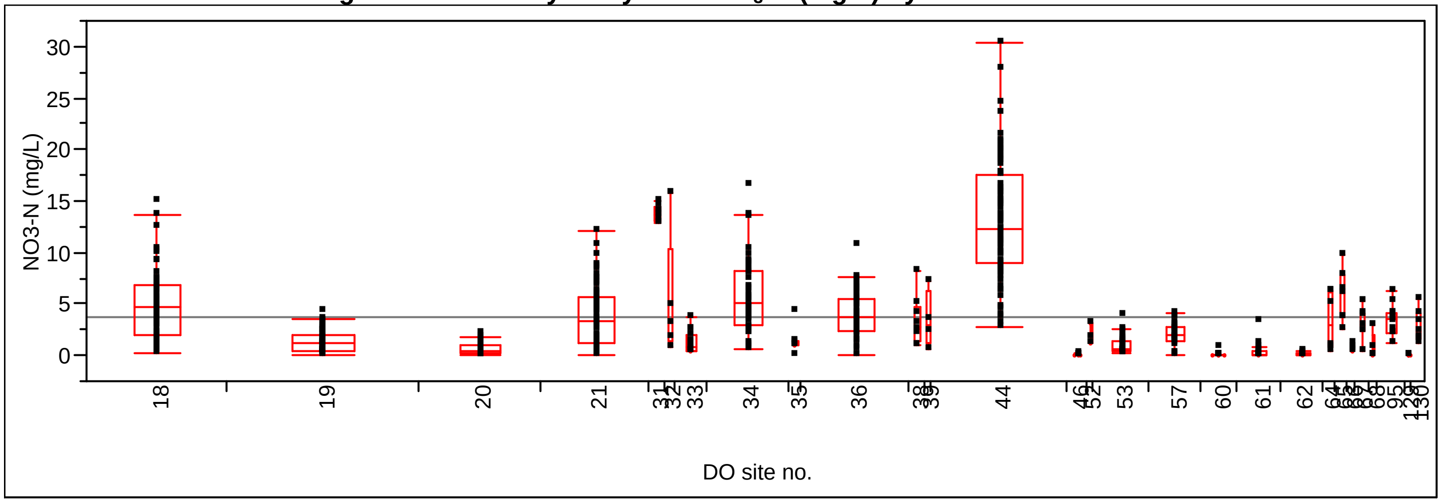
t	Alpha
1.96340	0.05

Level							Mean (mg/L)
32	A						1.1416000
34		B					0.4895682
39		B	C	D	E	F	0.4720000
36		B					0.4596207
95		B	C				0.3782000
57		B	C	D			0.3058571
67		B	C	D	E	F	0.2622857
52		B	C	D	E	F	0.2350000
20			C	D	E		0.2310606
21			C	D	E	F	0.2104828
38		B	C	D	E	F	0.1760000
33			C	D	E	F	0.1440000
65		B	C	D	E	F	0.1335714
53			C	D	E	F	0.1254333
46			C	D	E	F	0.1114545
18					E	F	0.1065395
61			C	D	E	F	0.1053750
129		B	C	D	E	F	0.1053333
19					E	F	0.1042816
68		B	C	D	E	F	0.0970000
66		B	C	D	E	F	0.0900000
35			C	D	E	F	0.0900000
62				D	E	F	0.0839130
60			C	D	E	F	0.0780000
44						F	0.0713014
130			C	D	E	F	0.0628571
64			C	D	E	F	0.0570000
31			C	D	E	F	0.0062222

Levels not connected by same letter are significantly different.

Analysis 9: West Drain Sites NO_3-N Analysis

Figure 9-1: Oneway analysis of NO_3-N (mg/L) by DO site number.



Missing Rows 55

Table 9-1: NO_3-N mean comparisons for each pair using Student's t-test.

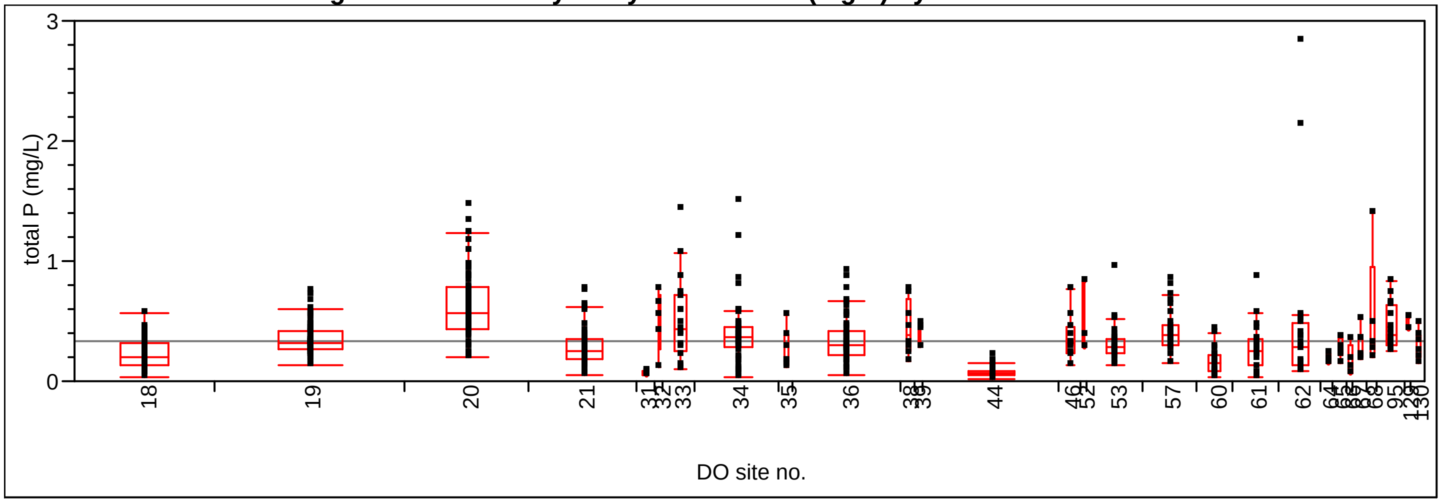
t	Alpha
1.96340	0.05

Level											Mean (mg/L)
31	A										13.776444
44	A										13.048808
34		B									5.736909
65		B	C	D							5.735000
32		B	C	D	E	F					5.291400
18		B	C		E						4.824553
36			C	D	E	F					4.038397
21				D		F					3.836310
39		B	C	D	E	F	G	H	I		3.436750
95			C	D	E	F	G				3.429733
38			C	D	E	F	G	H			3.412000
64			C	D	E	F	G	H	I		3.294333
67			C	D	E	F	G	H	I		3.005143
130					E	F	G	H	I		2.860143
52			C	D	E	F	G	H	I	J	2.091333
57							G	H	I		2.051964
35							G	H	I	J	1.498143
33								H	I	J	1.280471
19									I	J	1.277456
53									I	J	1.039333
68							G	H	I	J	0.797000
66							G	H	I	J	0.745000
20										J	0.623379
61										J	0.312083
62										J	0.088783
46										J	0.055182
60										J	0.050421
129								H	I	J	0.023667

Levels not connected by same letter are significantly different.

Analysis 10: West Drain Sites Total P

Figure 10-1: Oneway analysis of total P (mg/L) by DO site number.



Missing Rows 63

Table 10-1: Total P mean comparisons for each pair using Student's t-test.

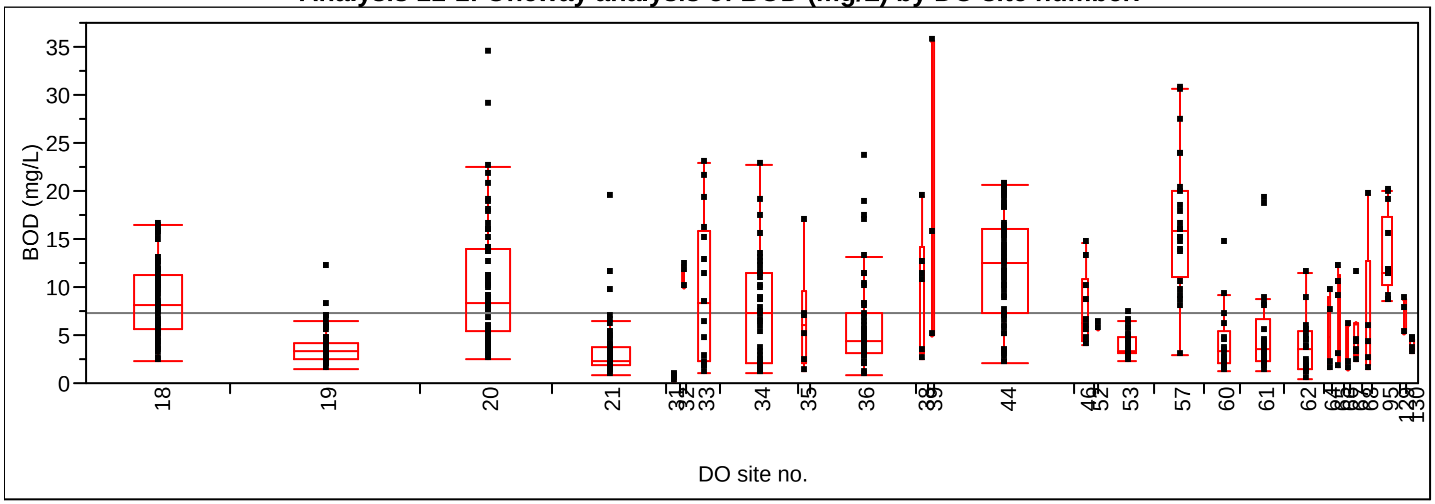
t	Alpha
1.96344	0.05

Level														Mean (mg/L)
20	A													0.62336923
68	A	B	C		E									0.53380000
33	A	B												0.51723529
52	A	B	C	D	E	F	G							0.50433333
129	A	B	C	D	E	F	G		I					0.50033333
32	A	B	C	D	E	F								0.50020000
62		B			E									0.46108696
95		B	C		E	F								0.44913333
38		B	C	D	E	F	G		I					0.43500000
57		B	C	D	E	F								0.41789286
39	A	B	C	D	E	F	G	H	I	J				0.41575000
34		B	C	D	E	F			I					0.39900000
46		B	C	D	E	F	G		I	J				0.36045455
19			C	D		F	G		I	J				0.34801980
36			C	D		F	G		I	J				0.34217544
130			C	D	E	F	G	H	I	J	K			0.31285714
53				D			G	H	I	J				0.31250000
67			C	D	E	F	G	H	I	J	K			0.29014286
21							G	H		J				0.28505263
61							G	H		J	K			0.27104167
65				D		F	G	H	I	J	K	L		0.26785714
35				D		F	G	H	I	J	K	L		0.25628571
18								H			K			0.22124324
64								H		J	K	L	M	0.18316667
66								H	I	J	K	L	M	0.17750000
60											K	L	M	0.16657895
44													M	0.07544444
31												L	M	0.06600000

Levels not connected by same letter are significantly different.

Analysis 11: West Drain Sites BOD

Analysis 11-1: Oneway analysis of BOD (mg/L) by DO site number.



Missing Rows 143

Table 11-1: BOD mean comparisons for each pair using Student's t-test.

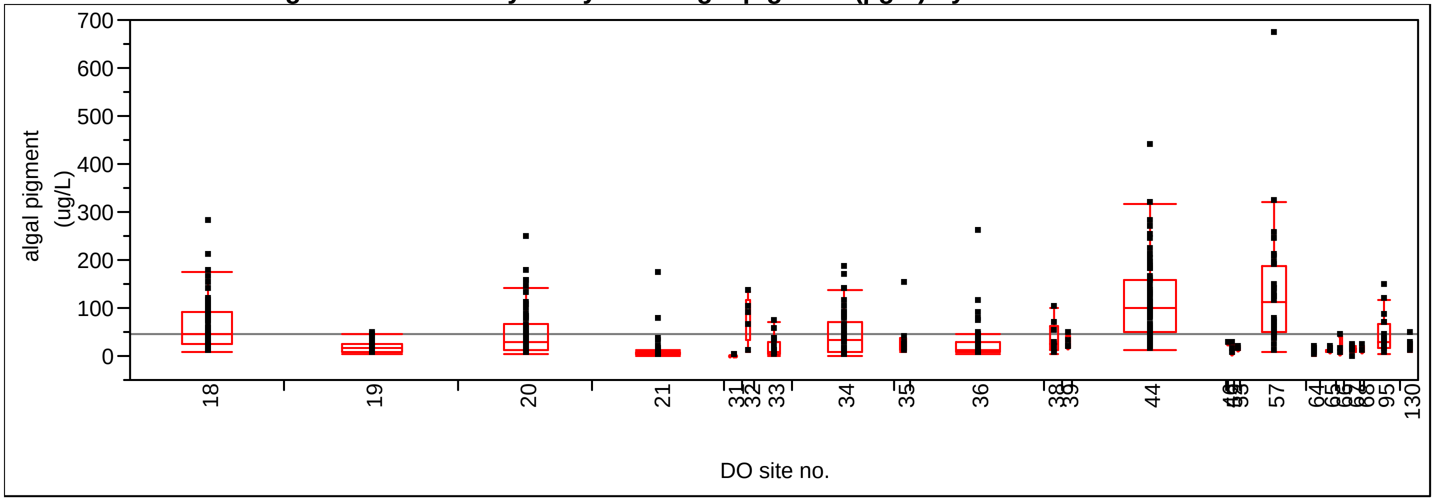
t	Alpha
1.96390	0.05

Level															Mean (mg/L)
39	A		C												18.690000
57	A	B													16.515417
95			C	D	E										13.013077
44				D											12.046515
32		B		D	E	F	G		I						11.270000
20					E	F									10.335238
38				D	E	F	G	H	I						9.923333
33				D	E	F	G								9.700625
18							G	H							8.552210
34							G	H	I	J					7.662703
46						F	G	H	I	J	K				7.657000
129				D	E	F	G	H	I	J	K	L	M		7.260000
65						F	G	H	I	J	K	L	M		7.190000
68						F	G	H	I	J	K	L	M		6.694000
35						F	G	H	I	J	K	L	M		6.568333
36									I	J	K	L			6.124400
52						F	G	H	I	J	K	L	M	N	5.920000
61										J	K	L	M		5.314286
64							G	H	I	J	K	L	M	N	5.120000
67								H		J	K	L	M	N	4.850000
60											K	L	M	N	4.265882
130										J	K	L	M	N	4.040000
53												L	M	N	4.024615
62												L	M	N	3.749474
19													M	N	3.590889
21													M	N	3.355000
66										J	K	L	M	N	3.190000
31														N	0.615000

Levels not connected by same letter are significantly different.

Analysis 12: West Drain Sites Algal Pigment

Figure 12-1: Oneway analysis of algal pigment (µg/L) by DO site number.



Missing Rows 216

Table 12-1: Algal pigment mean comparisons for each pair using Student's t-test.

t	Alpha
1.96441	0.05

Level								Mean (µg/L)
57	A							132.90724
44	A	B						113.90746
32		B	C					77.83800
18			C					62.06881
20			C	D				46.81776
95			C	D	E	F		46.33875
34			C	D	E			44.35614
35			C	D	E	F	G	38.82429
38			C	D	E	F	G	37.24875
39			C	D	E	F	G	27.37000
36					E	F	G	25.29362
46		B	C	D	E	F	G	23.97000
130			C	D	E	F	G	22.99857
66			C	D	E	F	G	19.39667
19						F	G	18.91513
33					E	F	G	17.32941
68			C	D	E	F	G	13.95000
53			C	D	E	F	G	13.74000
52			C	D	E	F	G	13.23333
67				D	E	F	G	11.63857
65				D	E	F	G	11.51286
21							G	10.38491
64				D	E	F	G	9.40167
31							G	0.31250

Levels not connected by same letter are significantly different.

Appendix K

Statistical Comparison of Water Quality Indicator Data for Agricultural Drainage Sites Located East of the San Joaquin River

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Objective

The purpose of this work is to statistically compare the water quality indicator data from various agricultural drainage sites located east of the San Joaquin River (SJR) and determine if significant similarities/differences exist between these sites.

Methods

Data was analyzed using JMP statistical software. Standard unpaired parametric (t-test) analyses comparing data from eight agricultural drain sites located east of the SJR were done (Table 1). The hypothesis tested in these comparisons is:

H_0: There is no significant difference in the water quality data means of these sites.

H_1: There is a significant difference in the water quality data means of these sites.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 5% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C, etc.), with different letters assigned to means that are statistically different. While the letters A, B, C, etc. are used to designate statistically different water quality data means for each analysis, data for each water quality indicator are compared separately, so the same letter designations between different water quality indicator comparisons do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative. The JMP output – including boxplots for each water quality parameter compared – are in the Analyses section of this document.

Results

Data was analyzed for several water quality indicators including total phosphorous (total P), soluble phosphate, total nitrogen (total N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_4-N), chlorophyll *a*, algal pigment, total organic carbon (TOC), dissolved organic carbon (DOC), biochemical oxygen demand (BOD), mineral suspended solids (MSS), and specific conductivity. Similarities in the t-test results between the sites were seen for:

1. total P and soluble phosphate
2. total N and NO_3-N
3. chlorophyll *a*, algal pigment, TOC, DOC, and BOD

No similarities between the t-test results for MSS, specific conductivity, or NH_4-N and any other indicator data were seen. Results from the statistical comparison of water quality indicator data for soluble phosphate, NO_3-N, and chlorophyll *a* indicate that significant differences exist between some of the sites, and are shown in Figures 1, 2, 3, and 4 and Tables 2, 3, 4, and 5.

Figure 1 shows a boxplot and Table 2 the results of the t-test analysis of the soluble phosphate data means. The analysis indicates that site DO-29 has significantly more soluble phosphate than the other sites analyzed. Site DO-29 also has significantly more total P than the other sites (Analysis 10).

Figure 2 shows a boxplot and Table 3 the results of the t-test analysis of the NO_3-N data means. The analysis indicates that site DO-30 has significantly more NO_3-N than all other sites; site DO-28 has significantly more NO_3-N than all sites except DO-30; site DO-29 has significantly more NO_3-N than all sites except DO-28 and 30; and that no significant differences exist between the remaining sites. A similar result is seen for total N (Analysis 7).

Figure 3 shows a boxplot and Table 4 the results of the t-test analysis of the chlorophyll *a* data means. The analysis indicates that site DO-25 has significantly more chlorophyll *a* than all the other sites. The same result is seen for algal pigment data (appendix I). Site DO-25 also has the highest average TOC, DOC, and BOD although the differences are not statistically significant for all sites (Analyses 5, 6, and 11).

Figure 4 shows a boxplot and Table 4 the results of the t-test analysis of the NH_4-N data means. The analysis indicates that no significant differences exist in the NH_4-N data means of any of the sites.

T-test results also show that little or no significant differences exist between some of the sites analyzed for all water quality indicators. Specifically, the t-test results were used to determine if sites with a large number of samples (including sites DO-23, 25, 28, 29, and 30) were significantly different from sites with a small number of samples (including sites DO-22, 27, and 135). No significant differences were found between site DO-23 and (1) site DO-22 for all water quality indicators; (2) site DO-27 for all water quality indicators except MSS; (3) site DO-135 for all water quality indicators except MSS and DOC. In addition, no significant differences were seen between site DO-25 and site DO-135 for all water quality indicators except chlorophyll *a* and algal pigment.

Conclusions

A statistical comparison of water quality indicator data, including total P, soluble phosphate, total N, NO_3-N, NH_4-N, chlorophyll *a*, algal pigment, TOC, DOC, BOD, MSS, and specific conductivity, for agricultural drain sites located east of the SJR show that significant differences exist between many of the sites. However, there are also little to no significant differences between some sites. Some conclusions that can be made based on the analyses in this report include:

1. A statistical comparison of the sample means for soluble phosphate (Figure 1; Table 2) and total P yields two groupings of east drain sites. Site DO-29 (Harding Drain) comprises the first group, containing significantly more soluble phosphate and total P than the second group, which includes all the other east drain sites.
2. A statistical comparison of the sample means for NO_3-N (Figure 2; Table 3) and total N yields four groupings of east drain sites. The first group is comprised of site DO-30 (SJR Levee), and has significantly more NO_3-N and total N than all other sites; the second group is comprised of site DO-28 (Westport Drain), and has significantly more NO_3-N and total N than all sites except DO-30; the third group is comprised of site DO-29 (Harding Drain), and has significantly more

NO_3-N than all other sites except DO-28 and 30; and the fourth group is comprised of the remaining sites, and are not significantly different from one another.

3. A statistical comparison of the sample means for chlorophyll *a* (Figure 3; Table 4) and algal pigment yields two groupings of east drain sites. The first group is comprised of site DO-25 (Main Drain to the Stanislaus River), and has significantly more chlorophyll *a* and algal pigment than the second group, which includes all the other east drain sites.
4. A statistical comparison of the sample means for NH_4-N (Figure 4; Table 5) yields one grouping of east drain sites, as there were no significant differences between any of the sites.
5. No significant differences were found between the data means of all analyzed water quality indicators for site DO-23 and 22.
6. No significant differences were found between the data means of all analyzed water quality indicators except MSS for site DO-23 and 27.
7. No significant differences were found between the data means of all analyzed water quality indicators except MSS and DOC for site DO-23 and 135.
8. No significant differences were found between the data means of all analyzed water quality indicators except chlorophyll a and algal pigment for site DO-25 and 135.

Table 1: Sites used for this study.

Site Name	DO Site No.
Modesto ID Lateral 4 to SJR	22
Modesto ID Lateral 5 to Tuolumne	23
D Main Drain to Stanislaus River via Miller Lake	25
Turlock ID Lateral 2 to SJR	27
Turlock ID Westport Drain Flow Station	28
Turlock ID Harding Drain	29
TID Laterals 6 & 7 at SJR Levee	30
MID Main Drain Spill	135

Figure 1: Boxplot of soluble phosphate results.

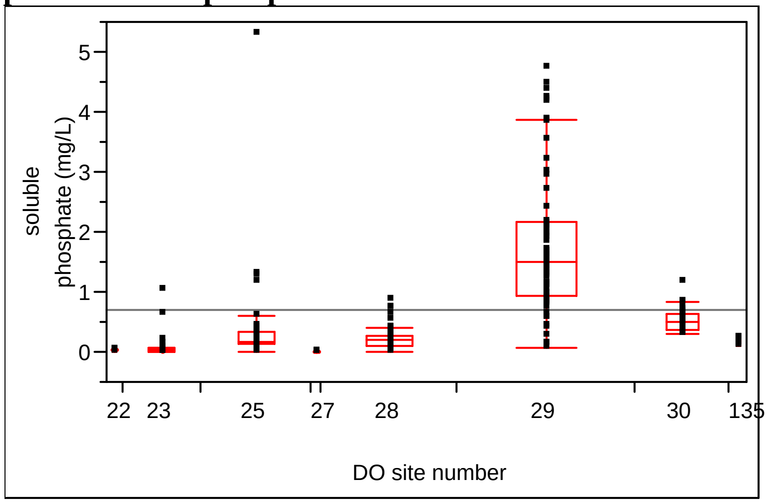


Table 2: Statistical analysis of soluble phosphate data, student's t-test comparison of all pairs of agricultural drain sites east of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site				Mean (mg/L)
29	A			1.7929
30		B		0.5252
25		B	C	0.4007
28		B	C	0.2309
135		B	C	0.1858
23			C	0.0997
22		B	C	0.0297
27		B	C	0.0043

Figure 2: Boxplot of NO_3-N results.

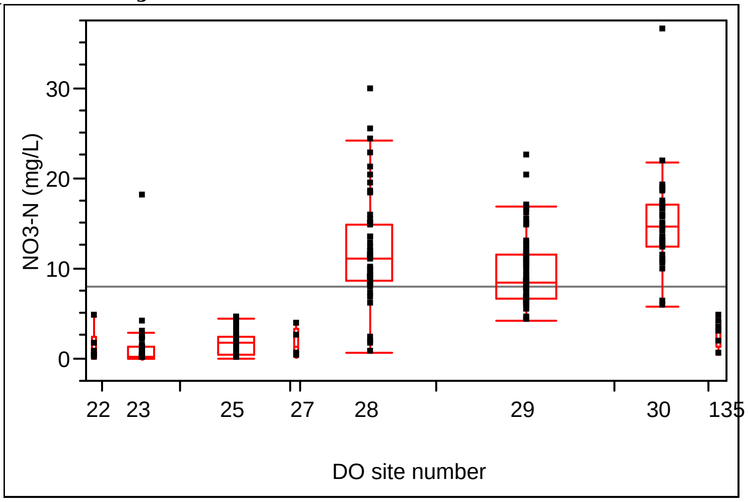


Table 3: Statistical analysis of NO_3-N data, student's t-test comparison of all pairs of agricultural drain sites east of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site					Mean (mg/L)
30	A				14.95
28		B			11.95
29			C		9.56
135				D	2.80
25				D	1.73
27				D	1.62
23				D	1.32
22				D	1.19

Figure 3: Boxplot of chlorophyll *a* results

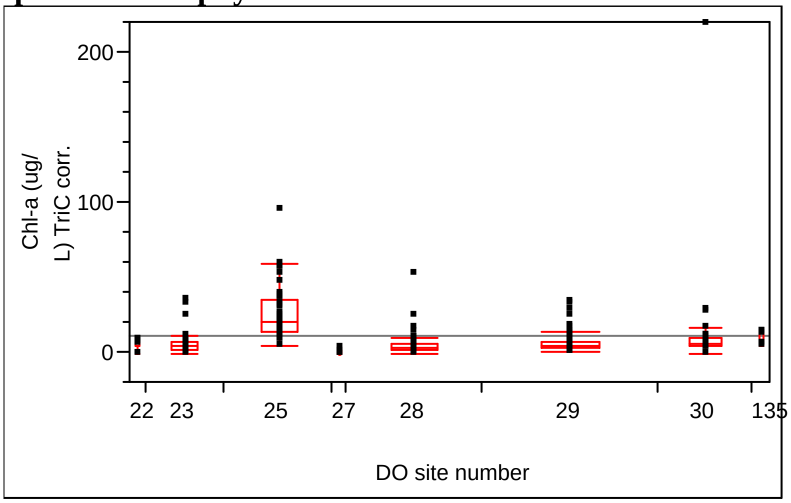


Table 4: Statistical analysis of chlorophyll *a* data, student's t-test comparison of all pairs of agricultural drain sites east of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site				Mean
25	A			25.64
30		B		13.11
135		B	C	9.10
29		B	C	6.31
23		B	C	6.09
22		B	C	5.94
28			C	4.88
27		B	C	0.25

Figure 4: Boxplot of NH_4-N results.

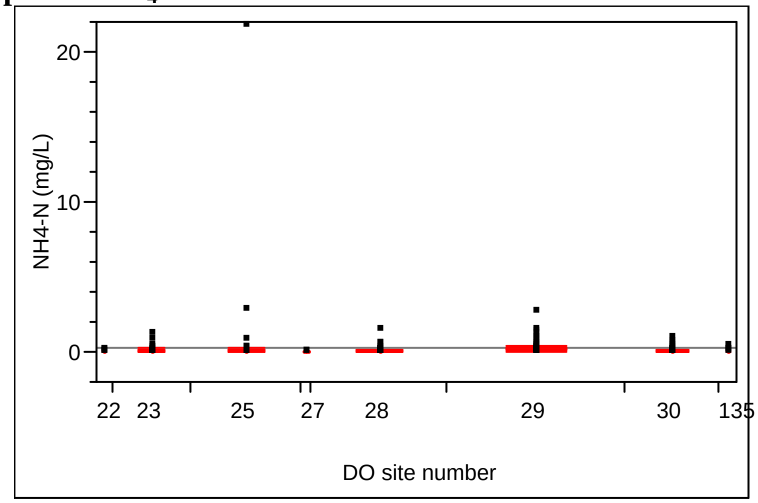


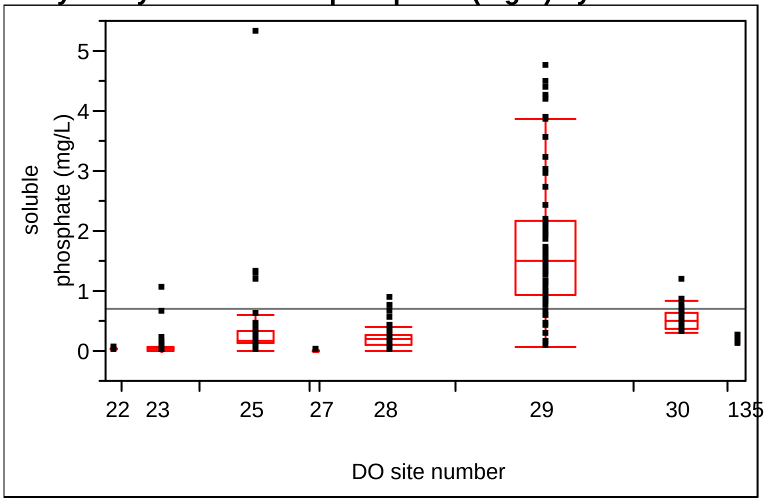
Table 5: Statistical analysis of NH_4-N data, student's t-test comparison of all pairs of agricultural drain sites east of the SJR. Statistically similar averages are grouped by letter designation. Major/unique sites are indicated by colored boxes. Sites not indicated by colored boxes are not significantly different from the indicated sites for nearly all water quality indicators.

Site		Mean
25	A	0.7207
29	A	0.2758
23	A	0.1428
30	A	0.1283
135	A	0.1273
28	A	0.1136
22	A	0.0550
27	A	0.0168

Analyses 1 - 12: Data from the Statistical Comparison of Water Quality Indicators for Agricultural Drains Located East of the SJR

Analysis 1: East Drain Sites Soluble Phosphate

Oneway Analysis of soluble phosphate (mg/L) by DO site number



Missing Rows 22

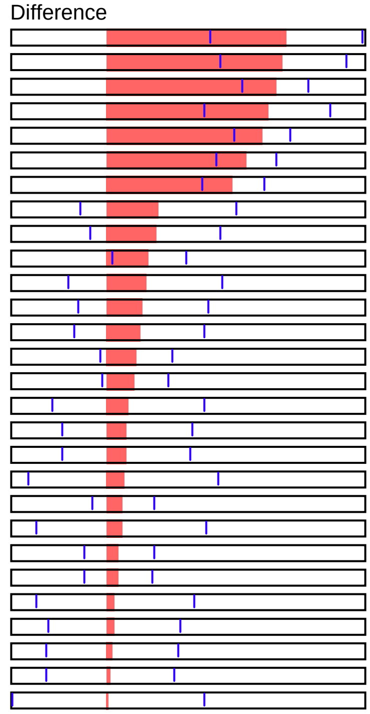
Comparisons for each pair using Student's t

t	Alpha
1.97047	0.05

Level			Mean (mg/L)
29	A		1.7928769
30	B		0.5251429
25	B	C	0.4006500
28	B	C	0.2308600
135	B	C	0.1858333
23		C	0.0996552
22	B	C	0.0296667
27	B	C	0.0042500

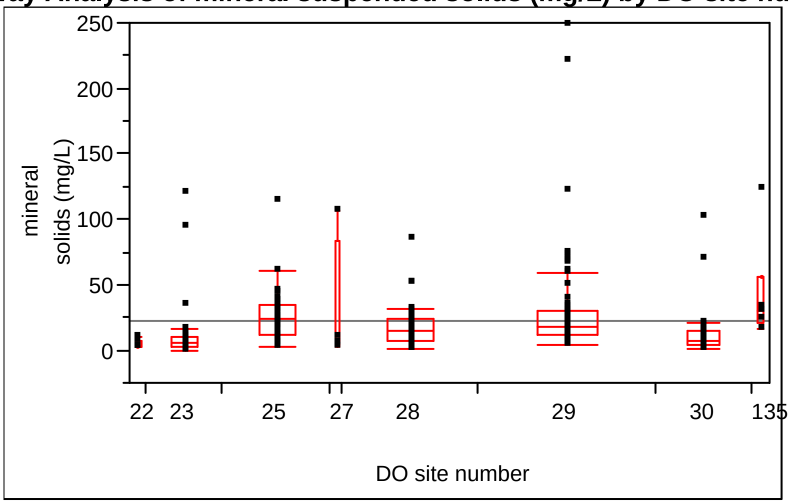
Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
29	27	1.788627	1.03234	2.544912	<.0001
29	22	1.763210	1.13682	2.389600	<.0001
29	23	1.693222	1.36539	2.021057	<.0001
29	135	1.607044	0.98065	2.233433	<.0001
29	28	1.562017	1.28586	1.838173	<.0001
29	25	1.392227	1.09720	1.687250	<.0001
29	30	1.267734	0.95994	1.575526	<.0001
30	27	0.520893	-0.25395	1.295740	0.1866
30	22	0.495476	-0.15320	1.144155	0.1337
30	23	0.425488	0.05685	0.794130	0.0239
25	27	0.396400	-0.37346	1.166264	0.3114
25	22	0.370983	-0.27174	1.013702	0.2566
30	135	0.339310	-0.30937	0.987989	0.3038
25	23	0.300995	-0.05705	0.659044	0.0990
30	28	0.294283	-0.02926	0.617830	0.0744
28	27	0.226610	-0.53622	0.989443	0.5589
25	135	0.214817	-0.42790	0.857535	0.5108
28	22	0.201193	-0.43309	0.835473	0.5326
135	27	0.181583	-0.76605	1.129220	0.7061
25	28	0.169790	-0.14164	0.481215	0.2838
135	22	0.156167	-0.69143	1.003759	0.7169
28	23	0.131205	-0.21147	0.473876	0.4513
30	25	0.124493	-0.21530	0.464286	0.4711
23	27	0.095405	-0.68762	0.878430	0.8105
135	23	0.086178	-0.57225	0.744604	0.7967
23	22	0.069989	-0.58844	0.728415	0.8343
28	135	0.045027	-0.58925	0.679307	0.8889
22	27	0.025417	-0.92222	0.973054	0.9579



Analysis 2: East Drain Sites Mineral Suspended Solids

Oneway Analysis of mineral suspended solids (mg/L) by DO site number



Missing Rows 32

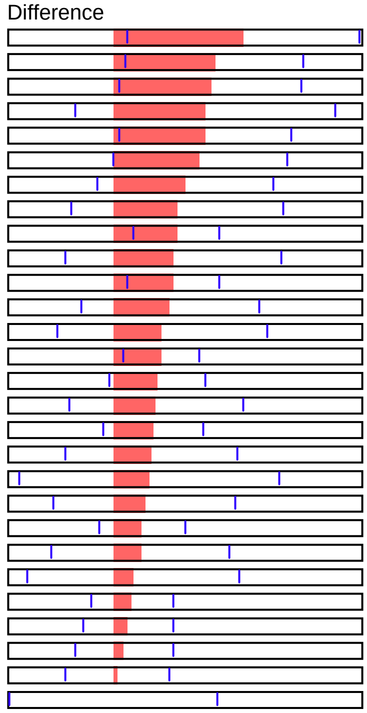
Comparisons for each pair using Student's t

t	Alpha
1.97096	0.05

Level				Mean (mg/L)
135	A	B		42.455000
27	A	B	C	31.635000
29	A			31.421613
25	A	B	C	25.780263
28		B	C	17.286875
23			C	14.015556
30			C	12.892059
22			C	4.681667

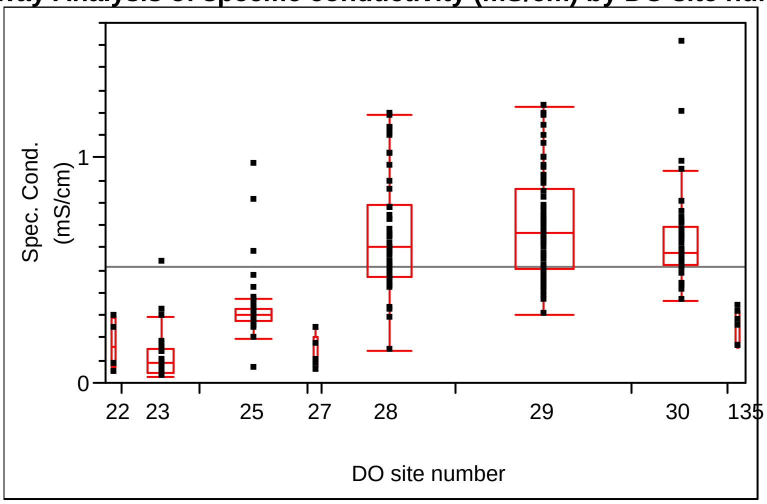
Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
135	22	37.77333	4.0756	71.47107	0.0282
135	30	29.56294	3.7180	55.40793	0.0252
135	23	28.43944	2.0967	54.78218	0.0345
27	22	26.95333	-10.7219	64.62855	0.1600
29	22	26.73995	1.7857	51.69419	0.0358
135	28	25.16813	-0.1052	50.44143	0.0510
25	22	21.09860	-4.5415	46.73873	0.1063
27	30	18.74294	-12.1091	49.59497	0.2325
29	30	18.52955	6.0740	30.98507	0.0037
27	23	17.61944	-13.6507	48.88962	0.2680
29	23	17.40606	3.9481	30.86400	0.0115
135	25	16.67474	-8.9654	42.31487	0.2013
27	28	14.34813	-16.0266	44.72286	0.3529
29	28	14.13474	2.9135	25.35599	0.0138
25	30	12.88820	-0.8901	26.66653	0.0666
28	22	12.60521	-12.6681	37.87851	0.3267
25	23	11.76471	-2.9261	26.45547	0.1159
135	29	11.03339	-13.9209	35.98763	0.3845
135	27	10.82000	-26.8552	48.49522	0.5720
23	22	9.33389	-17.0088	35.67662	0.4857
25	28	8.49339	-4.1802	21.16694	0.1879
30	22	8.21039	-17.6346	34.05538	0.5319
27	25	5.85474	-24.8259	36.53536	0.7072
29	25	5.64135	-6.3833	17.66604	0.3562
28	30	4.39482	-8.6882	17.47784	0.5086
28	23	3.27132	-10.7694	17.31204	0.6465
23	30	1.12350	-13.9219	16.16894	0.8831
27	29	0.21339	-29.8964	30.32316	0.9889



Analysis 3: East Drain Sites Specific Conductivity

Oneway Analysis of specific conductivity (mS/cm) by DO site number



Missing Rows 20

Comparisons for each pair using Student's t

t	Alpha
1.97038	0.05

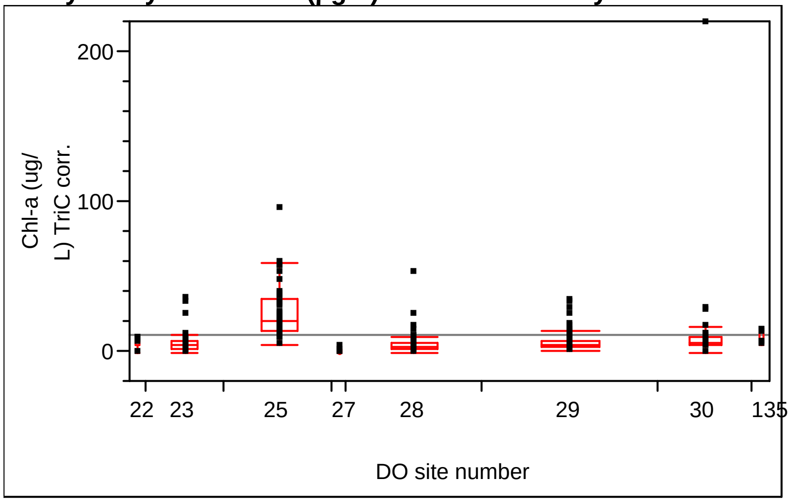
Level			Mean (mS/cm)
29	A		0.69441538
28	A		0.66774000
30	A		0.64119444
25	B		0.33515000
135	B	C	0.25000000
22	B	C	0.17166667
27		C	0.12940000
23		C	0.12434483

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
29	23	0.5700706	0.479838	0.6603029	<.0001	
29	27	0.5650154	0.377490	0.7525412	<.0001	
28	23	0.5433952	0.449080	0.6377107	<.0001	
28	27	0.5383400	0.348816	0.7278644	<.0001	
29	22	0.5227487	0.350343	0.6951540	<.0001	
30	23	0.5168496	0.416026	0.6176728	<.0001	
30	27	0.5117944	0.318949	0.7046399	<.0001	
28	22	0.4960733	0.321496	0.6706504	<.0001	
30	22	0.4695278	0.291351	0.6477047	<.0001	
29	135	0.4444154	0.272010	0.6168207	<.0001	
28	135	0.4177400	0.243163	0.5923171	<.0001	
30	135	0.3911944	0.213017	0.5693714	<.0001	
29	25	0.3592654	0.278064	0.4404665	<.0001	
28	25	0.3325900	0.246874	0.4183056	<.0001	
30	25	0.3060444	0.213216	0.3988725	<.0001	
25	23	0.2108052	0.112257	0.3093535	<.0001	
25	27	0.2057500	0.014084	0.3974160	0.0355	
25	22	0.1634833	-0.013416	0.3403830	0.0699	
135	23	0.1256552	-0.055568	0.3068781	0.1732	
135	27	0.1206000	-0.124075	0.3652750	0.3325	
25	135	0.0851500	-0.091750	0.2620497	0.3439	
135	22	0.0783333	-0.154955	0.3116217	0.5089	
29	30	0.0532209	-0.030726	0.1371682	0.2129	
22	23	0.0473218	-0.133901	0.2285448	0.6074	
22	27	0.0422667	-0.202408	0.2869416	0.7339	
29	28	0.0266754	-0.049333	0.1026837	0.4899	
28	30	0.0265456	-0.061776	0.1148671	0.5543	
27	23	0.0050552	-0.190608	0.2007184	0.9594	

Analysis 4: East Drain Sites Chlorophyll *a*

Oneway Analysis of chl-a (µg/L) TriC corrected by DO site number



Missing Rows 21

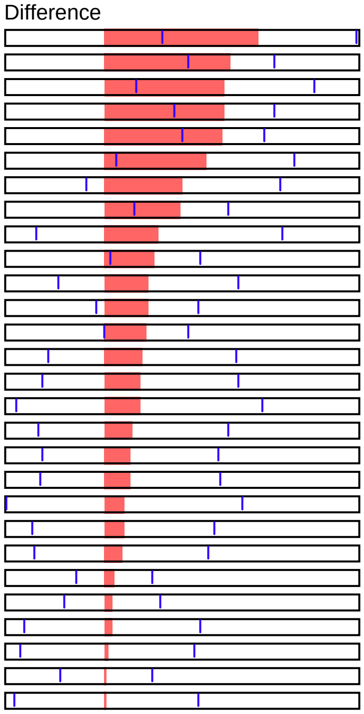
Comparisons for each pair using Student's t

t	Alpha
1.97042	0.05

Level			Mean (µg/L)
25	A		25.640750
30	B		13.112857
135	B	C	9.100000
29	B	C	6.306308
23	B	C	6.089655
22	B	C	5.938333
28		C	4.875400
27	B	C	0.252000

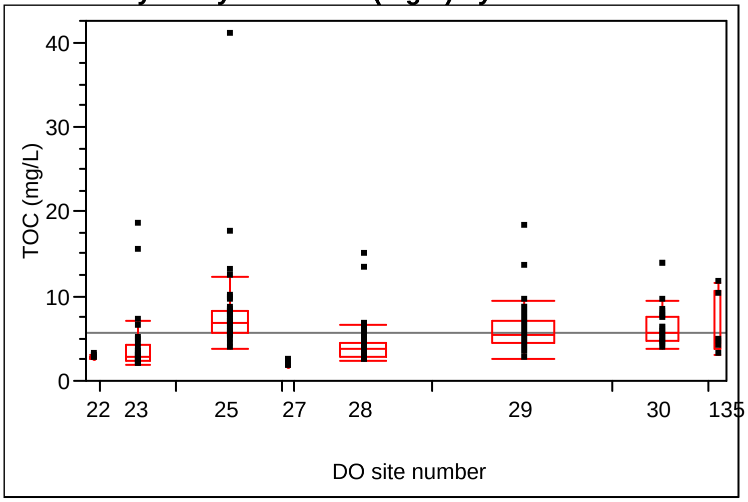
Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
25	27	25.38875	9.4512	41.32626	0.0019
25	28	20.76535	13.6379	27.89282	<.0001
25	22	19.70242	4.9928	34.41207	0.0089
25	23	19.55109	11.3566	27.74564	<.0001
25	29	19.33444	12.5824	26.08651	<.0001
25	135	16.54075	1.8311	31.25040	0.0277
30	27	12.86086	-3.2026	28.92435	0.1161
25	30	12.52789	4.7512	20.30460	0.0017
135	27	8.84800	-11.4973	29.19333	0.3924
30	28	8.23746	0.8326	15.64236	0.0294
30	22	7.17452	-7.6715	22.02059	0.3420
30	23	7.02320	-1.4138	15.46016	0.1023
30	29	6.80655	-0.2378	13.85086	0.0582
29	27	6.05431	-9.5389	21.64755	0.4450
23	27	5.83766	-10.4322	22.10754	0.4803
22	27	5.68633	-14.6590	26.03167	0.5824
28	27	4.62340	-11.1360	20.38283	0.5638
135	28	4.22460	-10.2919	18.74112	0.5669
30	135	4.01286	-10.8332	18.85892	0.5948
135	22	3.16167	-16.2368	22.56018	0.7484
135	23	3.01034	-12.0588	18.07949	0.6942
135	29	2.79369	-11.5422	17.12963	0.7013
29	28	1.43091	-4.8894	7.75119	0.6559
23	28	1.21426	-6.6283	9.05683	0.7606
22	28	1.06293	-13.4536	15.57945	0.8854
29	22	0.36797	-13.9680	14.70391	0.9597
29	23	0.21665	-7.2864	7.71969	0.9547
23	22	0.15132	-14.9178	15.22046	0.9842



Analysis 5: East Drain Sites TOC

Oneway Analysis of TOC (mg/L) by DO site number



Missing Rows 30

Comparisons for each pair using Student's t

t	Alpha
1.97086	0.05

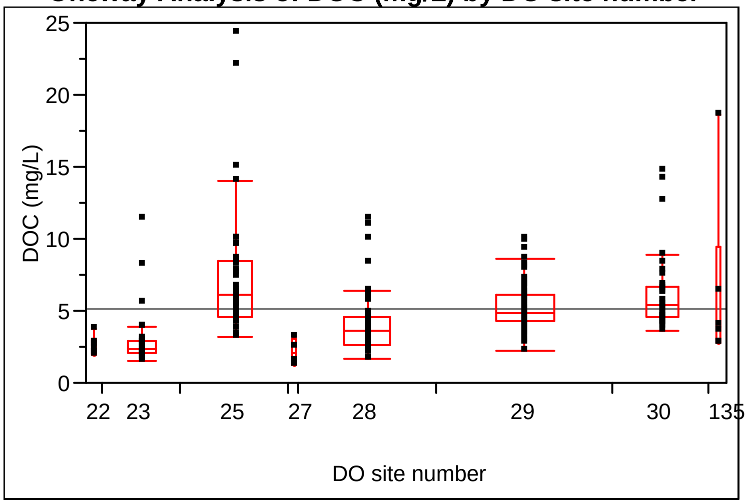
Level					Mean (mg/L)
25	A				8.3775526
135	A	B	C		6.3476667
30		B			6.3123529
29		B			6.0043437
23			C	D	4.1591481
28			C	D	4.1530204
22			C	D	2.7388000
27				D	1.8900000

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
25	27	6.487553	2.92556	10.04955	0.0004	
25	22	5.638753	2.41510	8.86240	0.0007	
135	27	4.457667	0.08361	8.83173	0.0458	
30	27	4.422353	0.84046	8.00425	0.0158	
25	28	4.224532	2.75979	5.68927	<.0001	
25	23	4.218404	2.51282	5.92399	<.0001	
29	27	4.114344	0.62194	7.60675	0.0212	
135	22	3.608867	-0.49437	7.71210	0.0844	
30	22	3.573553	0.32793	6.81918	0.0311	
29	22	3.265544	0.11895	6.41213	0.0420	
25	29	2.373209	0.98547	3.76095	0.0009	
23	27	2.269148	-1.36129	5.89959	0.2193	
28	27	2.263020	-1.26069	5.78673	0.2070	
135	28	2.194646	-0.73623	5.12553	0.1414	
135	23	2.188519	-0.86985	5.24689	0.1599	
30	28	2.159333	0.64684	3.67182	0.0053	
30	23	2.153205	0.40644	3.89997	0.0159	
25	30	2.065200	0.46555	3.66485	0.0116	
25	135	2.029886	-0.94691	5.00668	0.1804	
29	28	1.851323	0.56503	3.13762	0.0050	
29	23	1.845196	0.29016	3.40023	0.0203	
23	22	1.420348	-1.87878	4.71947	0.3971	
28	22	1.414220	-1.76708	4.59552	0.3819	
22	27	0.848800	-3.69686	5.39446	0.7132	
135	29	0.343323	-2.54985	3.23649	0.8153	
30	29	0.308009	-1.13004	1.74606	0.6733	
135	30	0.035314	-2.96527	3.03590	0.9815	
23	28	0.006128	-1.61799	1.63024	0.9941	

Analysis 6: East Drain Sites DOC

Oneway Analysis of DOC (mg/L) by DO site number



Missing Rows 23

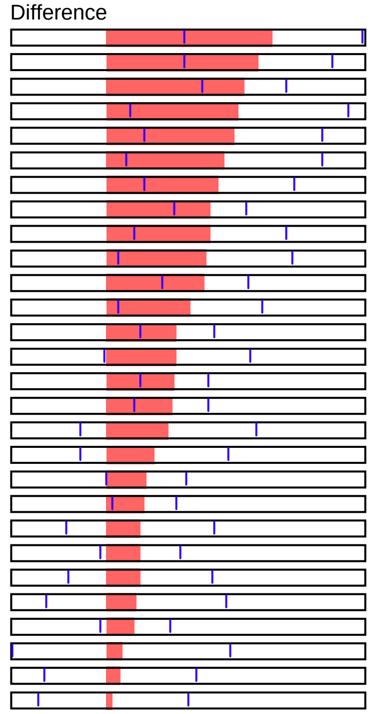
Comparisons for each pair using Student's t

t	Alpha
1.97052	0.05

Level					Mean (mg/L)
25	A				7.4853846
135	A	B	C		6.3895000
30	A	B			6.2096000
29		B			5.3075538
28			C	D	4.1180000
23				D	3.0302414
22				D	2.5888333
27				D	2.1050000

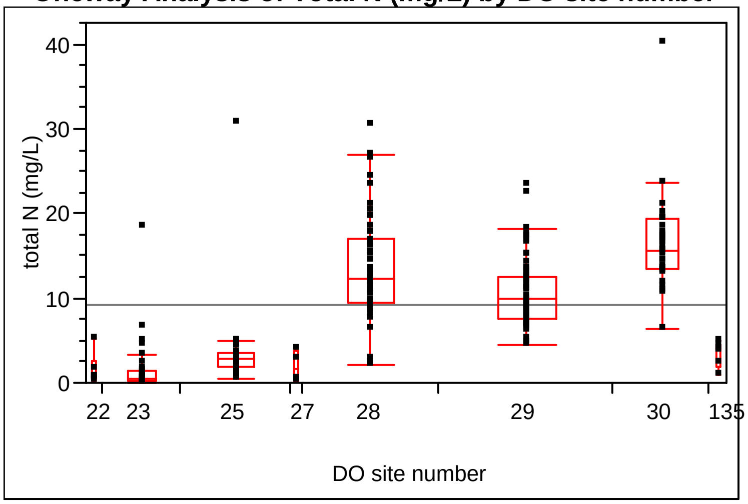
Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
25	27	5.380385	2.50095	8.259818	0.0003
25	22	4.896551	2.49145	7.301653	<.0001
25	23	4.455143	3.11034	5.799945	<.0001
135	27	4.284500	0.74429	7.824714	0.0179
30	27	4.104600	1.20990	6.999299	0.0057
135	22	3.800667	0.63420	6.967131	0.0189
30	22	3.620767	1.19741	6.044124	0.0036
25	28	3.367385	2.19569	4.539075	<.0001
135	23	3.359259	0.89949	5.819029	0.0077
29	27	3.202554	0.37720	6.027909	0.0265
30	23	3.179359	1.80217	4.556543	<.0001
29	22	2.718721	0.37863	5.058808	0.0230
29	23	2.277312	1.05257	3.502051	0.0003
135	28	2.271500	-0.09806	4.641065	0.0602
25	29	2.177831	1.06696	3.288700	0.0001
30	28	2.091600	0.88288	3.300320	0.0008
28	27	2.013000	-0.83682	4.862818	0.1653
28	22	1.529167	-0.84040	3.898731	0.2048
25	30	1.275785	-0.00120	2.552766	0.0502
29	28	1.189554	0.15788	2.221228	0.0240
25	135	1.095885	-1.30922	3.500987	0.3702
28	23	1.087759	-0.19240	2.367920	0.0954
135	29	1.081946	-1.25814	3.422033	0.3632
23	27	0.925241	-2.00001	3.850492	0.5337
30	29	0.902046	-0.24781	2.051905	0.1235
22	27	0.483833	-3.05638	4.024048	0.7879
23	22	0.441408	-2.01836	2.901178	0.7240
135	30	0.179900	-2.24346	2.603257	0.8838



Analysis 7: East Drain Sites Total N

Oneway Analysis of Total N (mg/L) by DO site number



Missing Rows 23

Comparisons for each pair using Student's t

t	Alpha
1.97052	0.05

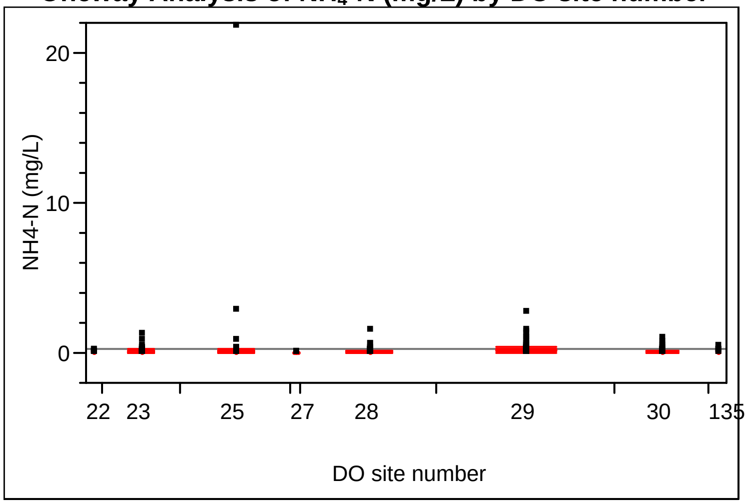
Level					Mean (mg/L)
30	A				16.385400
28		B			13.527800
29			C		10.687281
25				D	3.434100
135				D	3.423667
27				D	1.902000
23				D	1.867414
22				D	1.536833

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
30	22	14.84857	10.7128	18.98432	<.0001	
30	23	14.51799	12.1677	16.86832	<.0001	
30	27	14.48340	9.5432	19.42356	<.0001	
30	135	12.96173	8.8260	17.09749	<.0001	
30	25	12.95130	10.7849	15.11770	<.0001	
28	22	11.99097	7.9470	16.03492	<.0001	
28	23	11.66039	9.4756	13.84514	<.0001	
28	27	11.62580	6.7622	16.48936	<.0001	
28	135	10.10413	6.0602	14.14808	<.0001	
28	25	10.09370	8.1082	12.07924	<.0001	
29	22	9.15045	5.1542	13.14673	<.0001	
29	23	8.81987	6.7247	10.91506	<.0001	
29	27	8.78528	3.9613	13.60928	0.0004	
29	135	7.26361	3.2673	11.25989	0.0004	
29	25	7.25318	5.3666	9.13973	<.0001	
30	29	5.69812	3.7304	7.66585	<.0001	
30	28	2.85760	0.7948	4.92043	0.0068	
28	29	2.84052	1.0739	4.60717	0.0017	
25	22	1.89727	-2.2005	5.99502	0.3626	
135	22	1.88683	-3.5171	7.29079	0.4921	
25	23	1.56669	-0.7161	3.84949	0.1776	
135	23	1.55625	-2.6416	5.75415	0.4658	
25	27	1.53210	-3.3763	6.44049	0.5391	
135	27	1.52167	-4.5201	7.56347	0.6202	
27	22	0.36517	-5.6766	6.40697	0.9053	
23	22	0.33058	-3.8673	4.52848	0.8768	
27	23	0.03459	-4.9577	5.02688	0.9891	
25	135	0.01043	-4.0873	4.10819	0.9960	

Analysis 8: East Drain Sites NH_4-N

Oneway Analysis of NH_4-N (mg/L) by DO site number



Missing Rows 22

Comparisons for each pair using Student's t

t	Alpha
1.97047	0.05

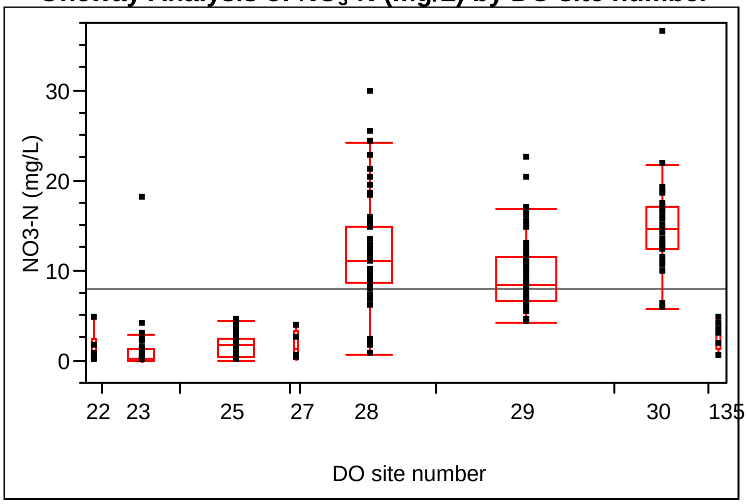
Level		Mean (mg/L)
25	A	0.72072500
29	A	0.27578462
23	A	0.14279310
30	A	0.12828571
135	A	0.12733333
28	A	0.11364000
22	A	0.05500000
27	A	0.01675000

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
25	27	0.7039750	-0.79829	2.206244	0.3568	
25	22	0.6657250	-0.58844	1.919890	0.2967	
25	28	0.6070850	-0.00061	1.214783	0.0502	
25	135	0.5933917	-0.66077	1.847557	0.3522	
25	30	0.5924393	-0.07061	1.255492	0.0796	
25	23	0.5779319	-0.12075	1.276610	0.1045	
25	29	0.4449404	-0.13075	1.020631	0.1292	
29	27	0.2590346	-1.21674	1.734807	0.7298	
29	22	0.2207846	-1.00152	1.443086	0.7222	
29	28	0.1621446	-0.37673	0.701020	0.5538	
29	135	0.1484513	-1.07385	1.370753	0.8111	
29	30	0.1474989	-0.45311	0.748106	0.6289	
29	23	0.1329915	-0.50673	0.772711	0.6825	
23	27	0.1260431	-1.40191	1.653994	0.8710	
30	27	0.1115357	-1.40046	1.623529	0.8846	
135	27	0.1105833	-1.73858	1.959749	0.9063	
28	27	0.0968900	-1.39166	1.585440	0.8981	
23	22	0.0877931	-1.19702	1.372609	0.8930	
30	22	0.0732857	-1.19251	1.339082	0.9093	
135	22	0.0723333	-1.58161	1.726278	0.9314	
28	22	0.0586400	-1.17906	1.296339	0.9257	
22	27	0.0382500	-1.81092	1.887416	0.9675	
23	28	0.0291531	-0.63952	0.697822	0.9316	
23	135	0.0154598	-1.26936	1.300276	0.9811	
30	28	0.0146457	-0.61671	0.645998	0.9636	
23	30	0.0145074	-0.70484	0.733854	0.9683	
135	28	0.0136933	-1.22401	1.251392	0.9826	
30	135	0.0009524	-1.26484	1.266749	0.9988	

Analysis 9: East Drain Sites NO_3-N

Oneway Analysis of NO_3-N (mg/L) by DO site number



Missing Rows 22

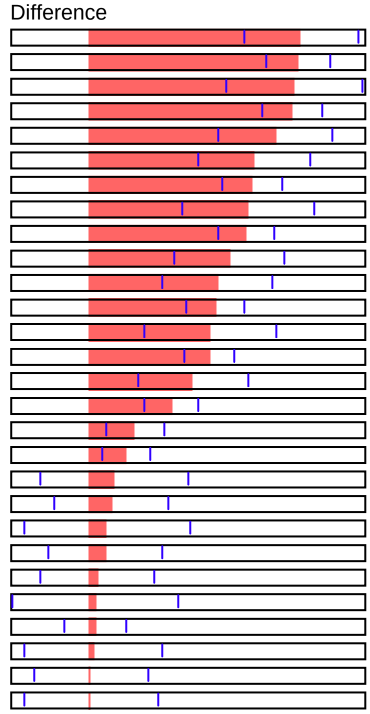
Comparisons for each pair using Student's t

t	Alpha
1.97047	0.05

Level					Mean (mg/L)
30	A				14.952800
28		B			11.951080
29			C		9.558415
135				D	2.797333
25				D	1.731400
27				D	1.615500
23				D	1.318000
22				D	1.189500

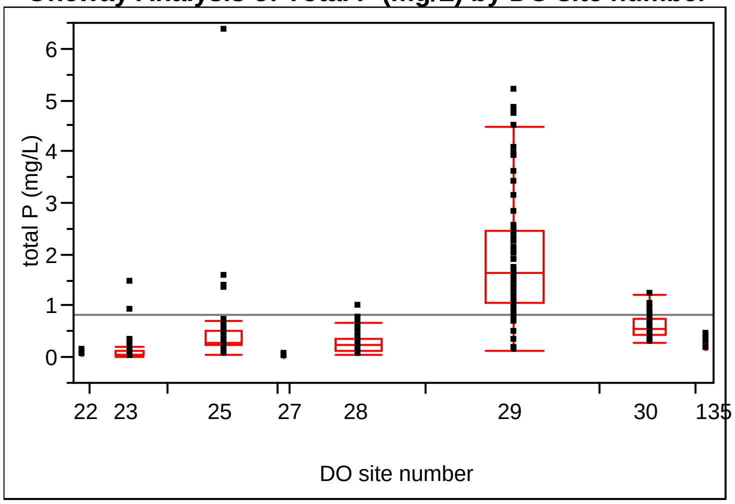
Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
30	22	13.76330	10.0792	17.44741	<.0001
30	23	13.63480	11.5411	15.72847	<.0001
30	27	13.33730	8.9366	17.73797	<.0001
30	25	13.22140	11.2916	15.15122	<.0001
30	135	12.15547	8.4714	15.83958	<.0001
28	22	10.76158	7.1592	14.36392	<.0001
28	23	10.63308	8.6869	12.57925	<.0001
28	27	10.33558	6.0031	14.66802	<.0001
28	25	10.21968	8.4510	11.98839	<.0001
28	135	9.15375	5.5514	12.75608	<.0001
29	22	8.36892	4.8114	11.92644	<.0001
29	23	8.24042	6.3785	10.10233	<.0001
29	27	7.94292	3.6477	12.23817	0.0003
29	25	7.82702	6.1515	9.50257	<.0001
29	135	6.76108	3.2036	10.31860	0.0002
30	29	5.39438	3.6463	7.14246	<.0001
30	28	3.00172	1.1642	4.83928	0.0015
28	29	2.39266	0.8243	3.96107	0.0029
135	22	1.60783	-3.2060	6.42166	0.5111
135	23	1.47933	-2.2601	5.21880	0.4365
135	27	1.18183	-4.2002	6.56385	0.6656
135	25	1.06593	-2.5843	4.71620	0.5656
25	22	0.54190	-3.1084	4.19216	0.7702
27	22	0.42600	-4.9560	5.80802	0.8762
25	23	0.41340	-1.6201	2.44691	0.6891
27	23	0.29750	-4.1496	4.74462	0.8952
23	22	0.12850	-3.6110	3.86797	0.9461
25	27	0.11590	-4.2565	4.48827	0.9584



Analysis 10: East Drain Sites Total P

Oneway Analysis of Total P (mg/L) by DO site number



Missing Rows 23

Comparisons for each pair using Student's t

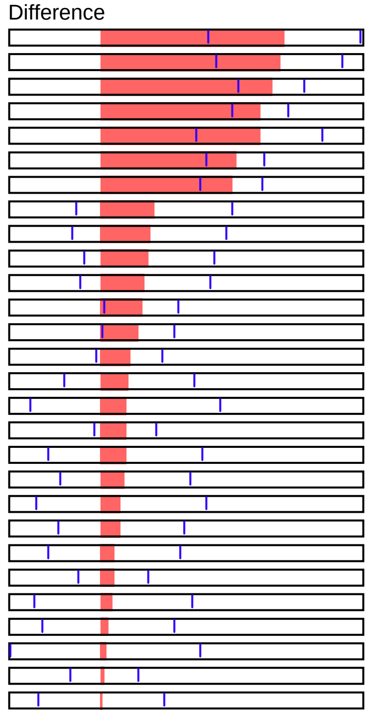
t	Alpha
1.97052	0.05

Level			Mean (mg/L)
29	A		2.0089688
30	B		0.5929429
25	B		0.5487250
135	B	C	0.2888333
28	B	C	0.2853000
23		C	0.1522414
22	B	C	0.0706667
27	B	C	0.0220000

Levels not connected by same letter are significantly different.

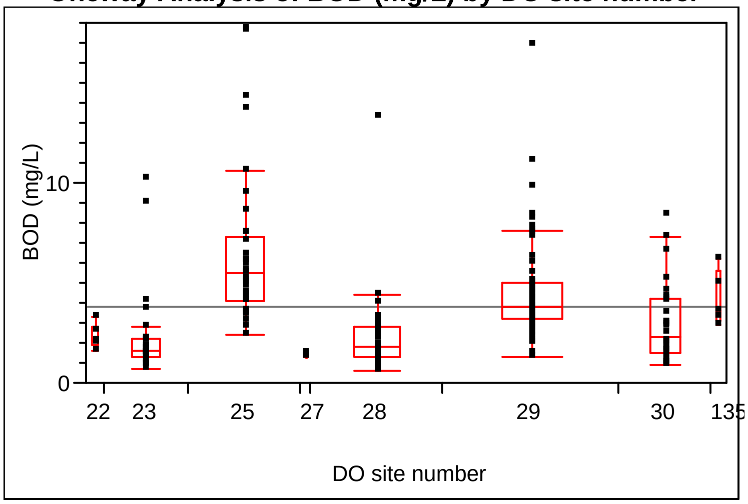
Level	- Level	Difference	Lower CL	Upper CL	p-Value
29	27	1.986969	1.16366	2.810273	<.0001
29	22	1.938302	1.25626	2.620341	<.0001
29	23	1.856727	1.49914	2.214311	<.0001
29	28	1.723669	1.42216	2.025180	<.0001
29	135	1.720135	1.03810	2.402174	<.0001
29	25	1.460244	1.13827	1.782219	<.0001
29	30	1.416026	1.08020	1.751856	<.0001
30	27	0.570943	-0.27219	1.414072	0.1834
25	27	0.526725	-0.31098	1.364432	0.2166
30	22	0.522276	-0.18357	1.228119	0.1462
25	22	0.478058	-0.22130	1.177416	0.1793
30	23	0.440701	0.03957	0.841829	0.0314
25	23	0.396484	0.00688	0.786086	0.0461
30	28	0.307643	-0.04442	0.659702	0.0865
30	135	0.304110	-0.40173	1.009952	0.3968
135	27	0.266833	-0.76431	1.297979	0.6106
25	28	0.263425	-0.07544	0.602294	0.1270
28	27	0.263300	-0.56676	1.093356	0.5326
25	135	0.259892	-0.43947	0.959249	0.4648
135	22	0.218167	-0.70412	1.140452	0.6416
28	22	0.214633	-0.47554	0.904808	0.5406
135	23	0.136592	-0.57986	0.853041	0.7075
28	23	0.133059	-0.23981	0.505927	0.4827
23	27	0.130241	-0.72179	0.982269	0.7635
23	22	0.081575	-0.63487	0.798023	0.8227
22	27	0.048667	-0.98248	1.079813	0.9260
30	25	0.044218	-0.32552	0.413954	0.8139
135	28	0.003533	-0.68664	0.693708	0.9920

Difference



Analysis 11: East Drain Sites BOD

Oneway Analysis of BOD (mg/L) by DO site number



Missing Rows 46

Comparisons for each pair using Student's t

t	Alpha
1.97172	0.05

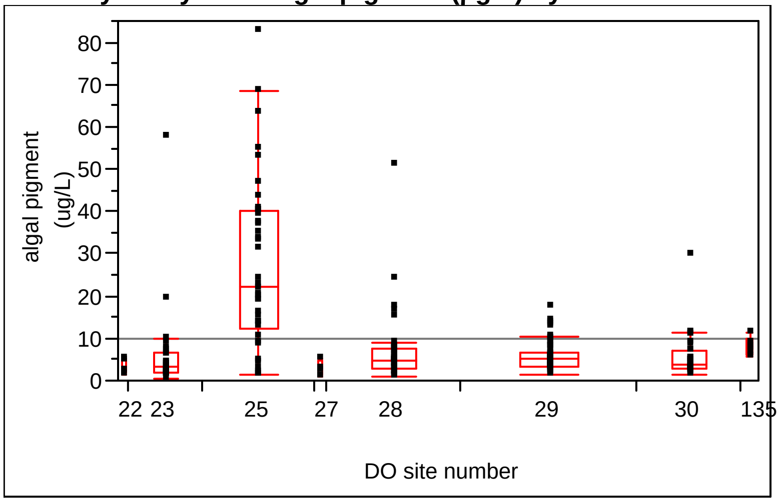
Level				Mean (mg/L)
25	A			6.4651351
29		B		4.6089655
135	A	B	C	4.2100000
30			C	2.9081667
23			C	2.3196429
22			C	2.3000000
28			C	2.2806818
27			C	1.3966667

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
25	27	5.068468	2.04398	8.092960	0.0011	
25	28	4.184453	3.06063	5.308280	<.0001	
25	22	4.165135	1.94775	6.382523	0.0003	
25	23	4.145492	2.88349	5.407496	<.0001	
25	30	3.556968	2.31914	4.794795	<.0001	
29	27	3.212299	0.22916	6.195442	0.0349	
135	27	2.813333	-0.86612	6.492786	0.1332	
29	28	2.328284	1.32102	3.335548	<.0001	
29	22	2.308966	0.14832	4.469614	0.0363	
29	23	2.289323	1.12990	3.448741	0.0001	
25	135	2.255135	-0.14548	4.655751	0.0654	
135	28	1.929318	-0.44846	4.307092	0.1112	
135	22	1.910000	-1.14084	4.960841	0.2185	
135	23	1.890357	-0.55576	4.336472	0.1291	
25	29	1.856170	0.79611	2.916230	0.0007	
29	30	1.700799	0.56774	2.833853	0.0034	
30	27	1.511500	-1.53934	4.562341	0.3298	
135	30	1.301833	-1.13190	3.735562	0.2928	
23	27	0.922976	-2.13775	3.983706	0.5528	
22	27	0.903333	-2.65928	4.465948	0.6177	
28	27	0.884015	-2.12238	3.890409	0.5627	
30	28	0.627485	-0.56544	1.820409	0.3009	
30	22	0.608167	-1.64503	2.861362	0.5952	
30	23	0.588524	-0.73539	1.912433	0.3818	
29	135	0.398966	-1.94934	2.747274	0.7380	
23	28	0.038961	-1.17903	1.256954	0.9498	
23	22	0.019643	-2.24692	2.286210	0.9864	
22	28	0.019318	-2.17332	2.211956	0.9862	

Analysis 12: East Drain Sites Algal Pigment

Oneway Analysis of algal pigment (µg/L) by DO site number



Missing Rows 39

Comparisons for each pair using Student's t

t	Alpha
1.97132	0.05

Level			Mean (µg/L)
25	A		27.416316
135		B	7.995000
28		B	6.860217
23		B	6.583200
29		B	5.802333
30		B	5.610000
22		B	3.425000
27		B	2.922500

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
25	27	24.49382	13.7924	35.19527	<.0001	
25	22	23.99132	13.2899	34.69277	<.0001	
25	30	21.80632	17.0368	26.57585	<.0001	
25	29	21.61398	17.3933	25.83469	<.0001	
25	23	20.83312	15.5905	26.07574	<.0001	
25	28	20.55610	16.0933	25.01891	<.0001	
25	135	19.42132	10.4780	28.36464	<.0001	
135	27	5.07250	-8.0687	18.21368	0.4476	
135	22	4.57000	-8.5712	17.71118	0.4938	
28	27	3.93772	-6.6747	14.55018	0.4653	
23	27	3.66070	-7.3025	14.62394	0.5111	
28	22	3.43522	-7.1772	14.04768	0.5241	
23	22	3.15820	-7.8050	14.12144	0.5707	
29	27	2.87983	-7.6331	13.39278	0.5898	
30	27	2.68750	-8.0575	13.43255	0.6225	
135	30	2.38500	-6.6104	11.38044	0.6018	
29	22	2.37733	-8.1356	12.89028	0.6562	
135	29	2.19267	-6.5242	10.90954	0.6205	
30	22	2.18500	-8.5600	12.93005	0.6889	
135	23	1.41180	-7.8432	10.66678	0.7639	
28	30	1.25022	-3.3161	5.81657	0.5900	
135	28	1.13478	-7.7019	9.97142	0.8004	
28	29	1.05788	-2.9318	5.04757	0.6017	
23	30	0.97320	-4.3578	6.30424	0.7193	
23	29	0.78087	-4.0654	5.62710	0.7511	
22	27	0.50250	-13.8929	14.89795	0.9452	
28	23	0.27702	-4.7815	5.33550	0.9141	
29	30	0.19233	-4.1377	4.52238	0.9303	

Appendix L

Statistical Comparison of Water Quality Indicator Data for River Sites Located East of the San Joaquin River

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Objective

The purpose of this work is to statistically compare the water quality indicator data from various river sites located east of the San Joaquin River (SJR) and determine if significant similarities/differences exist between these sites.

Methods

Data was analyzed using JMP statistical software. Standard unpaired parametric (t-test) analyses comparing data from three river sampling sites located east of the SJR were done (Table 1). The hypothesis tested in these comparisons is:

H_0: There is no significant difference in the water quality data means of these sites.

H_1: There is a significant difference in the water quality data means of these sites.

The results of all analyses are reported in terms of the probability (P) that H_0 is true. For results where $P \geq 0.05$ (where there is a greater than or equal to 5% probability that H_0 is true), data is shown grouped together with a letter designation (A, B, C.), with different letters assigned to means that are statistically different. While the letters A, B, C are used to designate statistically different water quality data means for each analysis, data for each water quality indicator are compared separately, so the same letter designations between different water quality indicator comparisons do not suggest statistically similar means. Two-tailed P values are used, even when one-tailed P values are available, as the two-tailed P is more conservative. The JMP output – including boxplots for each water quality parameter compared – are in the Analyses section of this document.

Results

Data was analyzed for several water quality indicators including total phosphorous (total P), soluble phosphate, total nitrogen (total N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_4-N), chlorophyll *a*, algal pigment, total organic carbon (TOC), dissolved organic carbon (DOC), biochemical oxygen demand (BOD), mineral suspended solids (MSS), and specific conductivity. Similarities in the t-test results between the sites were seen for:

1. total P, soluble phosphate, and algal pigment
2. total N and NO_3-N
3. chlorophyll *a*, TOC, DOC, BOD, and MSS

No similarities between the t-test results for specific conductivity or NH_4-N and any other indicator data were seen. Results from the statistical comparison of water quality indicator data for soluble phosphate, NO_3-N, and chlorophyll *a* indicate that significant differences exist between the sites, and are shown in Figures 1, 2, 3, and 4 and Tables 2, 3, 4, and 5.

Figure 1 shows a boxplot and Table 2 the results of the t-test analysis of the soluble phosphate data means. The analysis indicates that site DO-14 has significantly more soluble phosphate than the other sites analyzed. Site DO-14 also has significantly more total P and algal pigment than the other sites (Analyses 10 and 12).

Figure 2 shows a boxplot and Table 3 the results of the t-test analysis of the NO_3-N data means. The analysis indicates that site DO-16 has significantly more NO_3-N than the other two sites, and site DO-14 has significantly more NO_3-N than site DO-12. A similar result is seen for total N (Analysis 7).

Figure 3 shows a boxplot and Table 4 the results of the t-test analysis of the chlorophyll *a* data means. The analysis indicates that no significant differences exist in the chlorophyll *a* data means of the three sites. The same result is seen for TOC, DOC, BOD, and MSS (Analyses 2, 5, 6, and 11).

Figure 4 shows a boxplot and Table 4 the results of the t-test analysis of the NH_4-N data means. The analysis indicates that there is a significant difference in the NH_4-N data means of sites DO-14 and 16, and that there is no significant difference between the NH_4-N data mean of site DO-12 and the other two sites.

Conclusions

A statistical comparison of water quality indicator data, including total P, soluble phosphate, total N, NO_3-N, NH_4-N, chlorophyll *a*, algal pigment, TOC, DOC, BOD, MSS, and specific conductivity, for river sites located east of the SJR show that significant differences exist between the three sites. Some conclusions that can be made based on the analyses in this report include:

1. A statistical comparison of the sample means for soluble phosphate (Figure 1; Table 2), total P, and algal pigment yields two groupings of east river sites. Site DO-14 (Tuolumne River at Shiloh Bridge) comprises the first group, containing significantly more soluble phosphate, total P, and algal pigment than the second group, which includes the other two east river sites.

2. A statistical comparison of the sample means for NO_3-N (Figure 2; Table 3) and total N yields three groupings of east river sites. The first group is comprised of site DO-16 (Merced River at River Road), and has significantly more NO_3-N and total N than the other sites; the second group is comprised of site DO-14 (Tuolumne River at Shiloh Bridge), and has significantly more NO_3-N and total N than site DO-12; and the third group is comprised of site DO-12 (Stanislaus River at Caswell Park), which has significantly less NO_3-N and total N than the other two sites.

3. A statistical comparison of the sample means for chlorophyll *a* (Figure 3; Table 4), TOC, DOC, BOD, and MSS yields one grouping of east river sites, as there were no significant differences between the three sites.

4. A statistical comparison of the sample means for NH_4-N (Figure 4; Table 5) yields two groupings of east river sites. The first group is comprised of sites DO-16 and 12, and the second group is comprised of sites DO-12 and 14. Site DO-16 (Merced River at River Road) has significantly more NH_4-N than site DO-14

(Tuolumne River at Shiloh Bridge), and site DO-12 (Stanislaus River at Caswell Park) is not significantly different from the other two sites.

Table 1: Sites used for this study

Site Name	DO Site No.	Location
Stanislaus River at Caswell Park	12	
Tuolumne River at Shiloh Bridge	14	
Merced River at River Road	16	

Figure 1: Boxplot of soluble phosphate results.

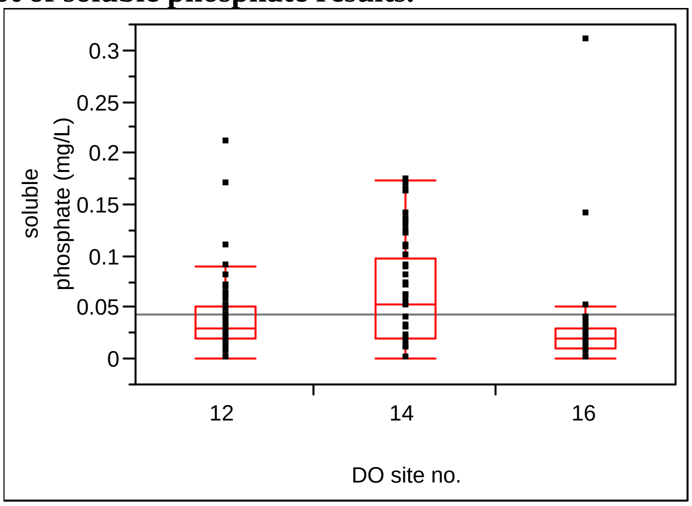


Table 2: Statistical analysis of soluble phosphate data, student's t-test comparison of all pairs of river sites east of the SJR. Statistically similar averages are grouped by letter designation.

Site			Mean (mg/L)
14	A		0.0623
12		B	0.0396
16		B	0.0262

Figure 2: Boxplot of NO_3-N results.

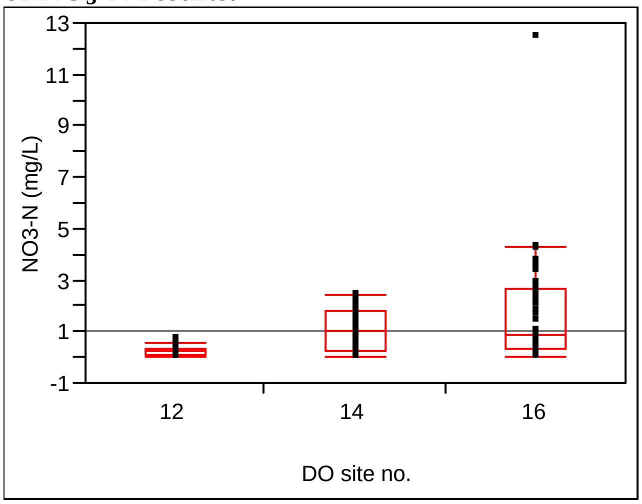


Table 3: Statistical analysis of NO_3-N data, student's t-test comparison of all pairs of river sites east of the SJR. Statistically similar averages are grouped by letter designation.

Site				Mean (mg/L)
16	A			1.65
14		B		1.10
12			C	0.23

Figure 3: Boxplot of chlorophyll *a* results.

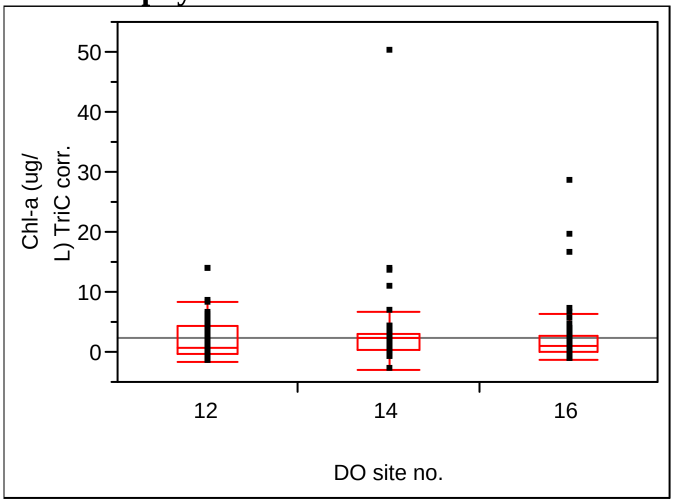


Table 4: Statistical analysis of chlorophyll *a* data, student's t-test comparison of all pairs of river sites east of the SJR. Statistically similar averages are grouped by letter designation.

Site		Mean (µg/L)
14	A	2.89
16	A	2.15
12	A	2.10

Figure 4: Boxplot of NH_4-N results.

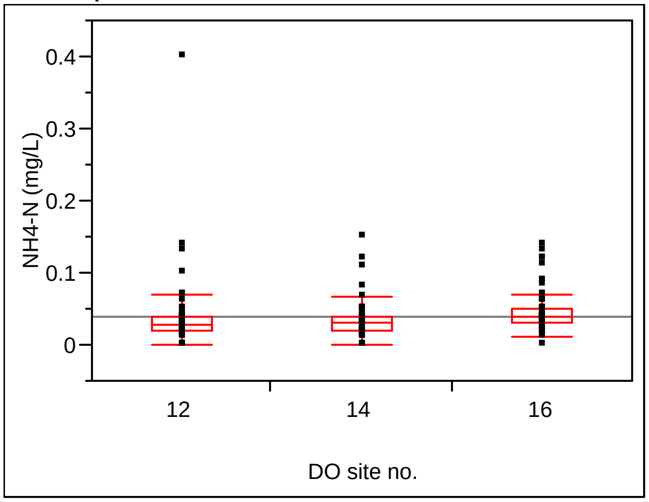


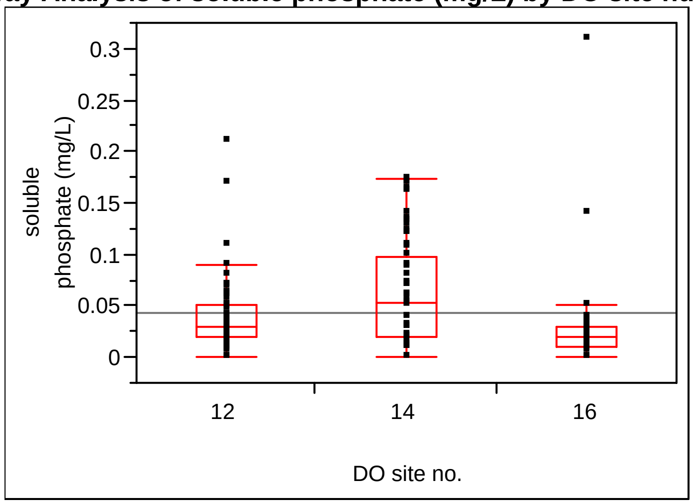
Table 5: Statistical analysis of NH_4-N data, student's t-test comparison of all pairs of river sites east of the SJR. Statistically similar averages are grouped by letter designation.

Site			Mean (mg/L)
16	A		0.0453
12	A	B	0.0369
14		B	0.0324

Analyses 1 - 12: Data from the Statistical Comparison of Water Quality Indicators for Rivers Located East of the SJR

Analysis 1: East River Sites Soluble Phosphate

Oneway Analysis of soluble phosphate (mg/L) by DO site number.



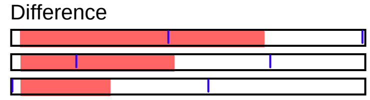
Comparisons for each pair using Student's t

t	Alpha
1.97196	0.05

Positive values show pairs of means that are significantly different.

Level			Mean (mg/L)
14	A		0.06227941
12		B	0.03955224
16		B	0.02622388

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
14	16	0.0360555	0.021806	0.0503053	<.0001	
14	12	0.0227272	0.008477	0.0369770	0.0019	
12	16	0.0133284	-0.000974	0.0276308	0.0676	

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

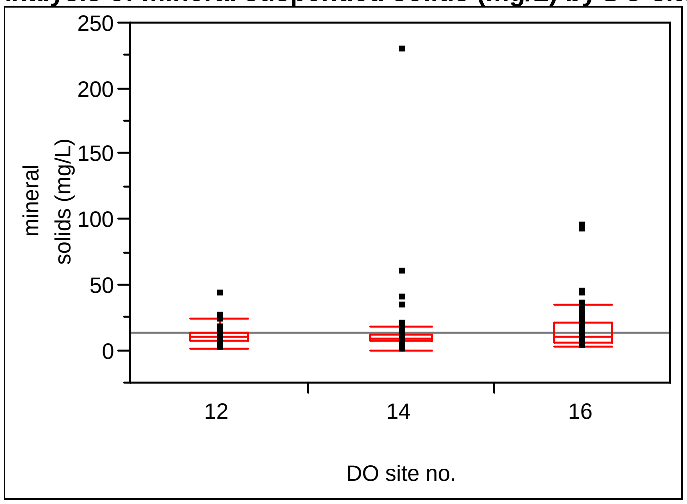
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	3999.50	59.6940	-2.457
14	68	5180.50	76.1838	2.457

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3999.5	-2.45734	0.0140

Analysis 2: East River Sites Mineral Suspended Solids

Oneway Analysis of mineral suspended solids (mg/L) by DO site number.



Missing Rows 8

Comparisons for each pair using Student's t

t	Alpha
1.97246	0.05

Positive values show pairs of means that are significantly different.

Level		Mean (mg/L)
16	A	16.218413
14	A	13.530597
12	A	10.942656

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
16	12	5.275756	-1.57632	12.12784	0.1305	
16	14	2.687816	-4.08774	9.46337	0.4349	
14	12	2.587941	-4.16028	9.33616	0.4503	

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

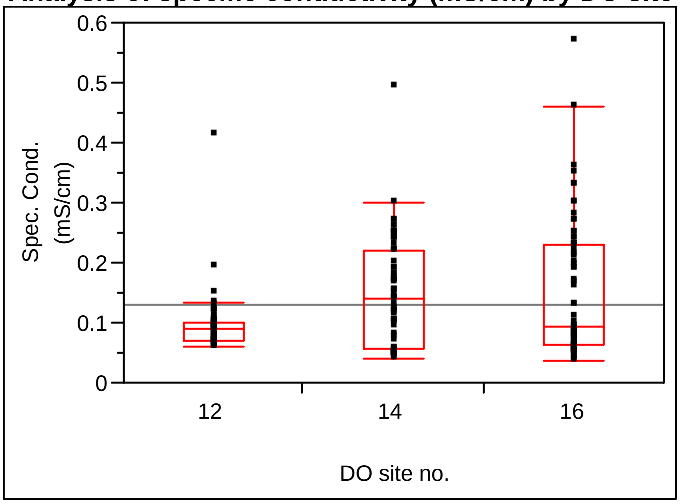
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	64	4534.00	70.8438	1.425
14	67	4112.00	61.3731	-1.425

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
4534	1.42508	0.1541

Analysis 3: East River Sites Specific Conductivity

Oneway Analysis of specific conductivity (mS/cm) by DO site number.



Comparisons for each pair using Student's t

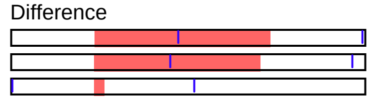
t	Alpha
1.97196	0.05

Positive values show pairs of means that are significantly different.

Level			Mean (mS/cm)
16	A		0.15161194
14	A		0.14857353
12		B	0.09440299

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
16	12	0.0572090	0.027411	0.0870071	0.0002	
14	12	0.0541705	0.024482	0.0838590	0.0004	
16	14	0.0030384	-0.026650	0.0327268	0.8403	



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

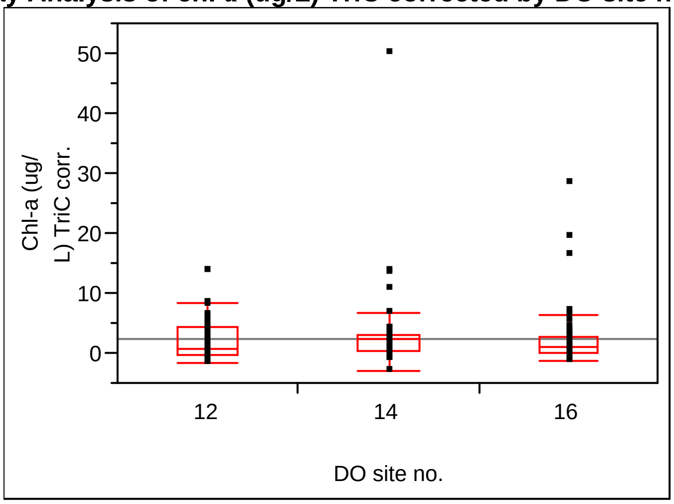
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	3801.00	56.7313	-3.322
14	68	5379.00	79.1029	3.322

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3801	-3.32153	0.0009

Analysis 4: East River Sites Chlorophyll *a*

Oneway Analysis of chl-*a* (ug/L) TriC corrected by DO site number.



Missing Rows 1

Comparisons for each pair using Student's t

t	Alpha
1.97202	0.05

Positive values show pairs of means that are significantly different.

Level		Mean (µg/L)
14	A	2.8913235
16	A	2.1477273
12	A	2.1040299

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
14	12	0.7872937	-0.90977	2.484355	0.3614	
14	16	0.7435963	-0.95993	2.447122	0.3904	
16	12	0.0436974	-1.66608	1.753473	0.9599	

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

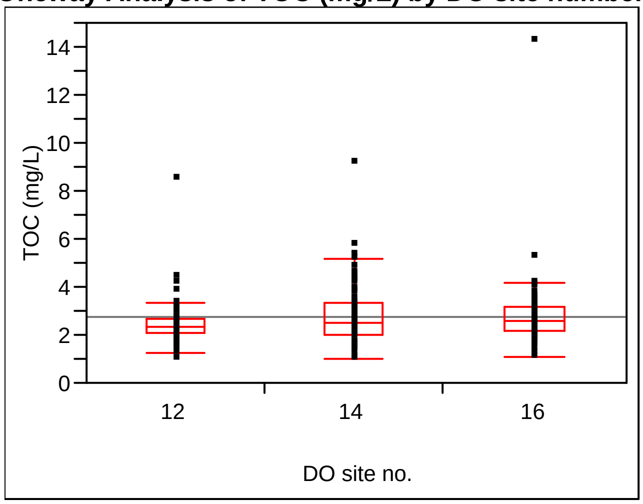
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	4351.50	64.9478	-0.898
14	68	4828.50	71.0074	0.898

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
4351.5	-0.89838	0.3690

Analysis 5: East River Sites TOC

Oneway Analysis of TOC (mg/L) by DO site number.



Missing Rows 5

Comparisons for each pair using Student's t

t	Alpha
1.97227	0.05

Positive values show pairs of means that are significantly different.

Level		Mean (mg/L)
14	A	2.8360154
16	A	2.8278955
12	A	2.4992769

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
14	12	0.3367385	-0.123769	0.7972460	0.1509
16	12	0.3286186	-0.128439	0.7856766	0.1578
14	16	0.0081199	-0.448938	0.4651778	0.9721

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

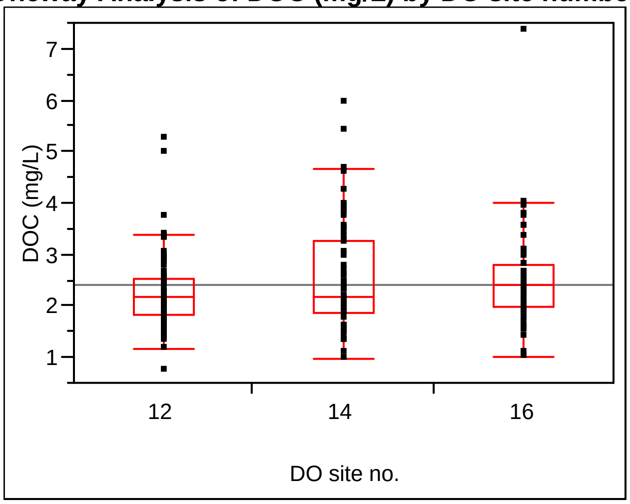
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	65	3995.50	61.4692	-1.218
14	65	4519.50	69.5308	1.218

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
4519.5	1.21765	0.2234

Analysis 6: East River Sites DOC

Oneway Analysis of DOC (mg/L) by DO site number.



Comparisons for each pair using Student's t

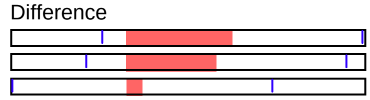
t	Alpha
1.97196	0.05

Positive values show pairs of means that are significantly different.

Level		Mean (mg/L)
14	A	2.5179412
16	A	2.4777761
12	A	2.2605970

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
14	12	0.2573442	-0.054802	0.5694901	0.1056
16	12	0.2171791	-0.096121	0.5304790	0.1732
14	16	0.0401651	-0.271981	0.3523110	0.8000



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

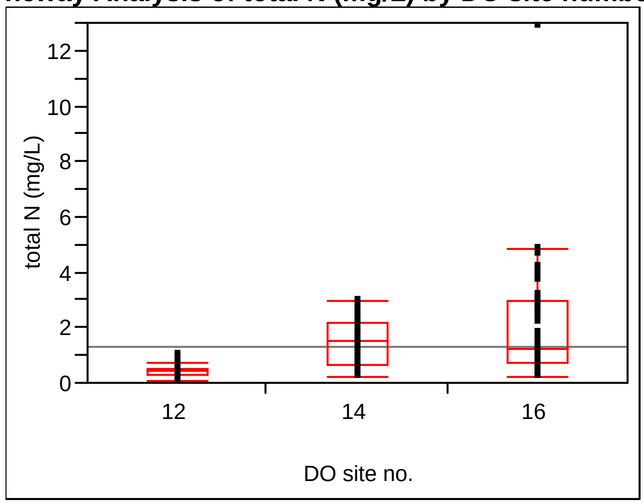
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	4318.00	64.4478	-1.045
14	68	4862.00	71.5000	1.045

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
4318	-1.04523	0.2959

Analysis 7: East River Sites Total N

Oneway Analysis of total N (mg/L) by DO site number.



Missing Rows 6

Comparisons for each pair using Student's t

t	Alpha
1.97233	0.05

Positive values show pairs of means that are significantly different.

Level				Mean (mg/L)
16	A			1.9727846
14		B		1.4107424
12			C	0.4292462

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
16	12	1.543538	1.127406	1.959671	<.0001
14	12	0.981496	0.566943	1.396049	<.0001
16	14	0.562042	0.147489	0.976595	0.0081

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

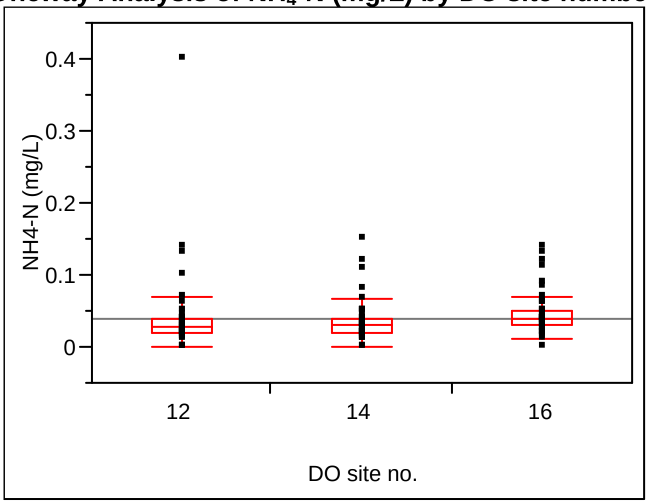
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	65	2835.50	43.6231	-6.694
14	66	5810.50	88.0379	6.694

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
2835.5	-6.69362	<.0001

Analysis 8: East River Sites NH_4-N

Oneway Analysis of NH_4-N (mg/L) by DO site number.



Comparisons for each pair using Student's t

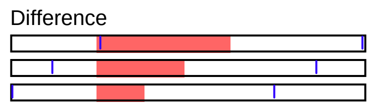
t	Alpha
1.97196	0.05

Positive values show pairs of means that are significantly different.

Level			Mean (mg/L)
16	A		0.04531343
12	A	B	0.03691045
14		B	0.03241176

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
16	14	0.0129017	0.000341	0.0254618	0.0441
16	12	0.0084030	-0.004204	0.0210096	0.1902
12	14	0.0044987	-0.008061	0.0170589	0.4808



Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

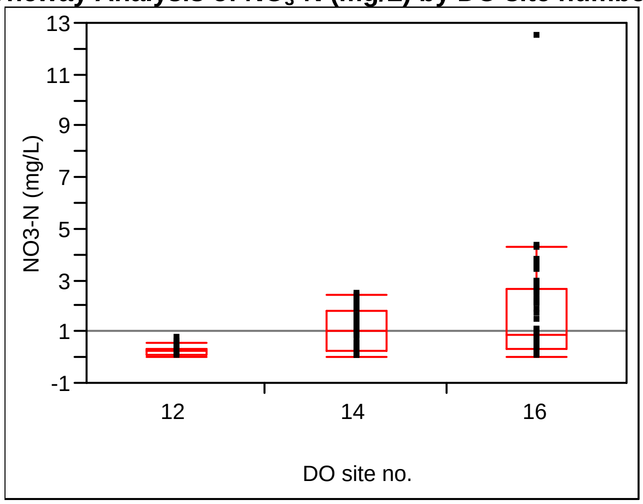
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	4505.50	67.2463	-0.221
14	68	4674.50	68.7426	0.221

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
4505.5	-0.22110	0.8250

Analysis 9: East River Sites NO_3-N

Oneway Analysis of NO_3-N (mg/L) by DO site number.



Comparisons for each pair using Student's t

t	Alpha
1.97196	0.05

Positive values show pairs of means that are significantly different.

Level				Mean (mg/L)
16	A			1.6461791
14		B		1.0983824
12			C	0.2303284

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
16	12	1.415851	1.021025	1.810677	<.0001	
14	12	0.868054	0.474682	1.261426	<.0001	
16	14	0.547797	0.154425	0.941169	0.0066	

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

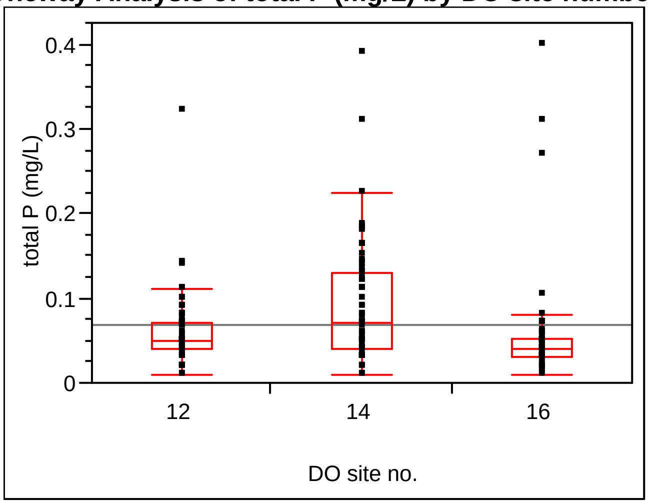
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	67	3215.00	47.9851	-5.900
14	68	5965.00	87.7206	5.900

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3215	-5.90046	<.0001

Analysis 10: East River Sites Total P

Oneway Analysis of total P (mg/L) by DO site number.



Missing Rows 6

Comparisons for each pair using Student's t

t	Alpha
1.97233	0.05

Positive values show pairs of means that are significantly different.

Level			Mean (mg/L)
14	A		0.09157576
12		B	0.06020000
16		B	0.05578462

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
14	16	0.0357911	0.014959	0.0566234	0.0009
14	12	0.0313758	0.010544	0.0522080	0.0034
12	16	0.0044154	-0.016496	0.0253270	0.6775

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

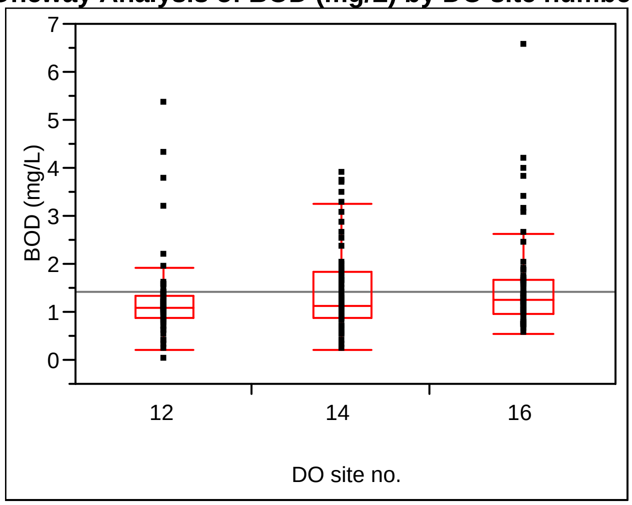
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	65	3748.50	57.6692	-2.496
14	66	4897.50	74.2045	2.496

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3748.5	-2.49574	0.0126

Analysis 11: East River Sites BOD

Oneway Analysis of BOD (mg/L) by DO site number.



Missing Rows 23

Comparisons for each pair using Student's t

t	Alpha
1.97353	0.05

Positive values show pairs of means that are significantly different.

Level		Mean (mg/L)
16	A	1.5563934
14	A	1.4770339
12	A	1.2593220

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value
16	12	0.2970714	-0.052099	0.6462417	0.0949
14	12	0.2177119	-0.134356	0.5697798	0.2239
16	14	0.0793595	-0.269811	0.4285298	0.6543

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

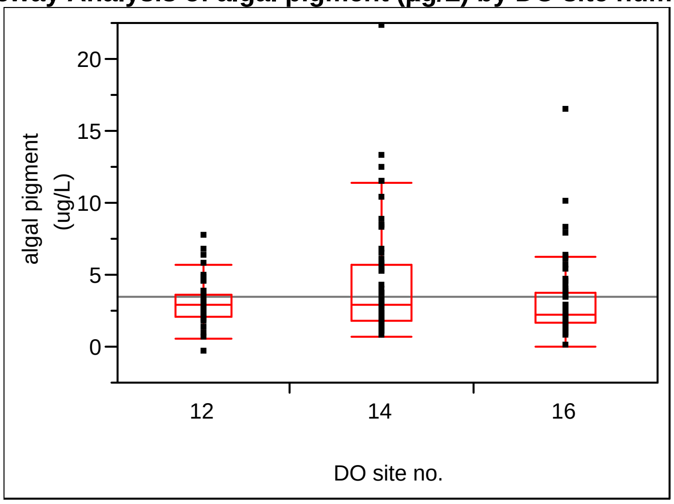
Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	59	3306.50	56.0424	-1.095
14	59	3714.50	62.9576	1.095

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3714.5	1.09543	0.2733

Analysis 12: East River Sites Algal Pigment

Oneway Analysis of algal pigment (µg/L) by DO site number.



Missing Rows 20

Comparisons for each pair using Student's t

t	Alpha
1.97331	0.05

Positive values show pairs of means that are significantly different.

Level			Mean (µg/L)
14	A		4.3662903
16		B	3.0727419
12		B	2.9937931

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL	p-Value	Difference
14	12	1.372497	0.342425	2.402569	0.0093	
14	16	1.293548	0.280790	2.306307	0.0126	
16	12	0.078949	-0.951123	1.109021	0.8800	

Wilcoxon / Kruskal-Wallis Tests (Rank Sums)

Level	Count	Score Sum	Score Mean	(Mean-Mean0)/Std0
12	58	3385.50	58.3707	-0.646
14	62	3874.50	62.4919	0.646

2-Sample Test, Normal Approximation

S	Z	Prob>|Z|
3385.5	-0.64597	0.5183

Appendix M

Development of Water Quality Indexes for Drainage

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February 2008

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Chemosphere 71 (2008) 1895–1908
CHEMOSPHERE
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Ranking tributaries for setting remediation priorities in a TMDL context

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Received 5 September 2007; received in revised form 8 January 2008; accepted 13 January 2008
Available online 6 March 2008

Abstract

The San Joaquin River (SJR) in the Central Valley of California has been designated an impaired waterbody based on its loss of fisheries-related beneficial uses and the river is now subject to regulation under total maximum daily load (TMDL) rules. For impaired waterbodies, numeric standards alone may not be sufficient to establish remediation priorities and priorities must be established by comparing drainages to each other. Data collected as part of regional water quality (WQ) studies in the SJR Valley were not normally distributed, so nonparametric methods based on ranking were used to compare the WQ of individual tributaries and drainages. Normalized rank means (NRMs) were calculated from ranked data and NRMs were mapped to identify priority drainages for WQ improvement activities. NRMs for individual parameters were combined into indexes that are useful for examining the relative importance of different drainages for multiple parameters simultaneously. Indexes were developed for eutrophication and overall WQ. This ranking approach is being proposed as an easily understood, transparent, and scientifically rigorous method to assess the relative WQ impact of individual drainages and set watershed remediation priorities.

Keywords: Eutrophication; TMDL; Chemometric; Water quality index; Wilcoxon–Mann–Whitney; Diffuse pollution

1. Introduction

The San Joaquin River (SJR) in the Central Valley of California was once a vibrant ecosystem that supported forty species of native fish, many unique to California, and spring and fall runs of chinook salmon that were estimated to number hundreds of thousands of fish (Moyle, 2002). The SJR drainage has undergone a series of development actions since the late 1800s that have resulted in the over-utilization of the river and significant impairment of the rivers ability to support native fishes and other wildlife (Brown and Moyle, 1994; Moyle, 2002; Smith, 2004). More recently, the SJR was listed as an impaired waterbody based on its loss of fisheries-related beneficial uses and the river is now subject to regulation under total maximum daily load (TMDL) rules for a number of water quality (WQ) parameters including dissolved oxygen and salt (Central Valley Regional Water Quality Control Board, 1998; Gowdy and Grober, 2003). The implementation of a TMDL requires stakeholders to develop basin-wide management actions to improve WQ.

Implementation of an effective regional TMDL response requires the setting of priorities. Watersheds and drainages (locations) with the most need, and potential for, improvement must be identified. One approach to setting priorities is to establish numeric standards for WQ and determine which sites are better or worse than the numeric standard (Lam et al., 1994; Benner, 2004). There are drawbacks to this approach, including the scientific uncertainty of how to establish numeric goals and the lack of numeric standards for many WQ constituents of concern

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0045-6535/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.chemosphere.2008.01.040

(Lijklema, 1995; Shabman and Smith, 2003; Karr and Yoder, 2004; Jia and Culver, 2006). Additionally, the use of standards developed for one purpose for an unrelated purpose may not provide benefit. For example, optimization of fish habitat is unlikely to be achieved by setting goals based on drinking water standards (Walters and Collie, 1988; Ranta and Lindstrom, 1993; Bauer and Ralph, 2001). There is often lack of agreement among stakeholders and regulators as to what the numeric goals should be and that any actual improvement in environmental conditions may be delayed until final numeric standards are established.

An alternative method for setting remediation or restoration priorities is to compare locations within a watershed to each other. If WQ in the watershed needs improvement, then it follows that taking action toward improvement is rational, even if there is not agreement as to what final level of improvement needs to be reached. By comparing locations in the watershed to each other, priorities for action can be set even in the absence of specific regulatory targets. Comparative methods are obviously useful tools for the TMDL process.

There are numerous ways to compare WQ between locations. Common methods involve comparing the means of locations using parametric statistical techniques, such as ANOVA (Vega et al., 1998). It is widely recognized that WQ data are not normally distributed, so frequently environmental data is transformed to log-values or in other ways before analysis (Sokal and Rohlf, 1995; Vega et al., 1998; Novotny, 2004). Arithmetic or geometric means of individual measurements can be combined into "pollution index" calculations which can be weighed to account for differences in level of activity or toxicity (Khanna, 2000; Jarvie et al., 2002). These types of comparisons are often supplemented with chemometric analysis, which provide additional information, such as the minimum number of measurements required to characterize sites (Vega et al., 1998; Alberto et al., 2001; Kowalkowski et al., 2006; Terrado et al., 2006; Kannel et al., 2007; Terrado et al., 2007).

Parametric statistical techniques have some drawbacks in the context of the TMDL process and setting watershed remediation priorities using monitoring data. Parametric statistical methods assume that data has a normal distribution and the application of parametric analysis to non-normal data can lead to erroneous conclusions (Sokal and Rohlf, 1995; Zar, 1999). Data collected at most locations in the SJR watershed was not normally distributed, even after transformation (Stringfellow et al., 2007). The non-normal distribution of data biases the means, which can be skewed by outlying measurements, particularly in the case where a limited number of values are recorded (Sokal and Rohlf, 1995; Zar, 1999). If zero or non-detect results are ignored when data transformations are applied, biasing will result against locations with only transient poor WQ events. Consequently, analysis based on parametric means are subject to challenge and rejection by the stakeholder community of the SJR and other impaired waterbodies.

In this paper, nonparametric statistical methods are applied as an alternative approach to comparing WQ between locations. In nonparametric analysis, scores (1, 2, 3, ..., n) are substituted for actual numeric data and comparisons are made using sums of score (rankings) rather than the measurements themselves (Sokal and Rohlf, 1995; Lehmann, 2006). Nonparametric methods are less biased by outlying data and are applicable to data that is not normally distributed as well as data that is normally distributed (Sokal and Rohlf, 1995; Lehmann, 2006). Normalized rank means (NRM) are calculated from the rankings and are used to compare WQ between drainages and combined into WQ indexes. This ranking approach, combined with mapping and geographical information system (GIS) analysis, is being proposed as an easily understood, transparent, and scientifically rigorous methods for assessing the relative WQ impact of individual drainages and setting watershed remediation priorities.

2. Methods

2.1. Study area

The project study area is south of Stockton, CA, upstream of the Sacramento San Joaquin Delta, and includes the confluences with the Stanislaus, Tuolumne, and Merced Rivers, as well as a number of smaller tributaries (Fig. 1). Water quality data were collected from all major and most minor tributaries in the SJR upstream of the tidal estuary (Sacramento-San Joaquin River Delta) and below the confluence with Bear Creek (Fig. 2, Table 1). River flow is subject to diversion for agricultural use and in the dry-season the SJR often has no flow for many miles upstream of Bear Creek, therefore the SJR immediately downstream of the confluence with Bear Creek (at Lander Avenue) was chosen as the upstream limit of the study area.

Environmental conditions differ for lands on the western and eastern sides of the San Joaquin River and theses differences influence WQ. On the westside, soils are derived from the Coast Range, which is overlain by Cretaceous marine and continental sediments, and are high in salts and minerals such as selenium and boron (McNeal and Balisteri, 1989; Gronberg et al., 1998). The western side of the watershed is largely occupied by irrigated farmland which receives much of its water from canals that convey pumped water south (up-gradient) from the Sacramento-San Joaquin Delta. Diversions from the SJR are also an important source of water for the westside. The water used for irrigation returns to the SJR and in westside tributaries dry-season flows typically consist entirely of agricultural drainage. High soil concentrations of selenium and other salts on the westside of the San Joaquin Valley have been long recognized as causing agricultural drainage management problems (Johns and Watkins, 1989; McNeal and Balisteri, 1989; San Joaquin Valley Drainage Program, 1990). Major drainages for the westside include Del Puerto Creek, Orestimba Creek, Mud Slough, and Salt Slough (Fig. 1).

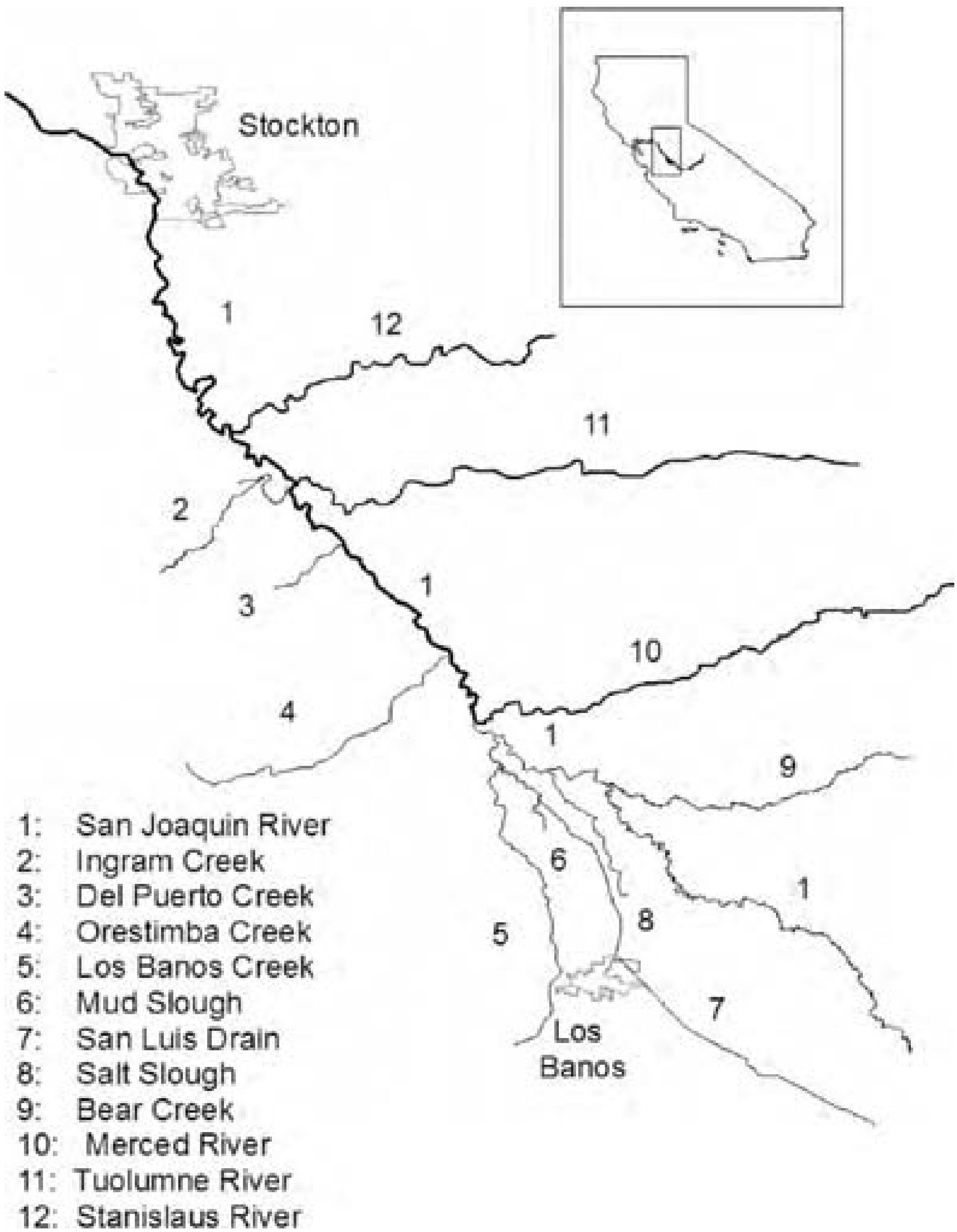

Fig. 1. San Joaquin River study area with major tributaries shown.

On the eastside, soils are derived from the weathered granite of the Sierra Nevada Mountains, which are non-marine in origin. On the eastside, irrigated farmland is mostly supplied by diversions from the Stanislaus, Tuolumne, and Merced Rivers, which convey high quality water from the Sierra Nevada Mountains. Drainage entering the SJR from eastside agricultural activities consists of both agricultural return flows and "spill" or excess unused supply-water discharged as part of water delivery practices. Additionally, both eastside and westside drainages may be impacted by urban activities from communities such as Turlock, Modesto, and Los Banos.

2.2. Sample collection and measurement

Sample collection and measurement of WQ parameters followed procedures described in Stringfellow (2005) and standard methods for the examination of water and wastewater (American Public Health Association, 1998, 2005). Field measurements were made for specific conductance (EC), pH and turbidity (NTU) with handheld sondes and WQ measurement devices, including a YSI 6600 sonde, HACH turbidometer, and Myron combination Ultraprobe. Water samples were collected from mid-channel and depth integrated where possible and kept in the dark

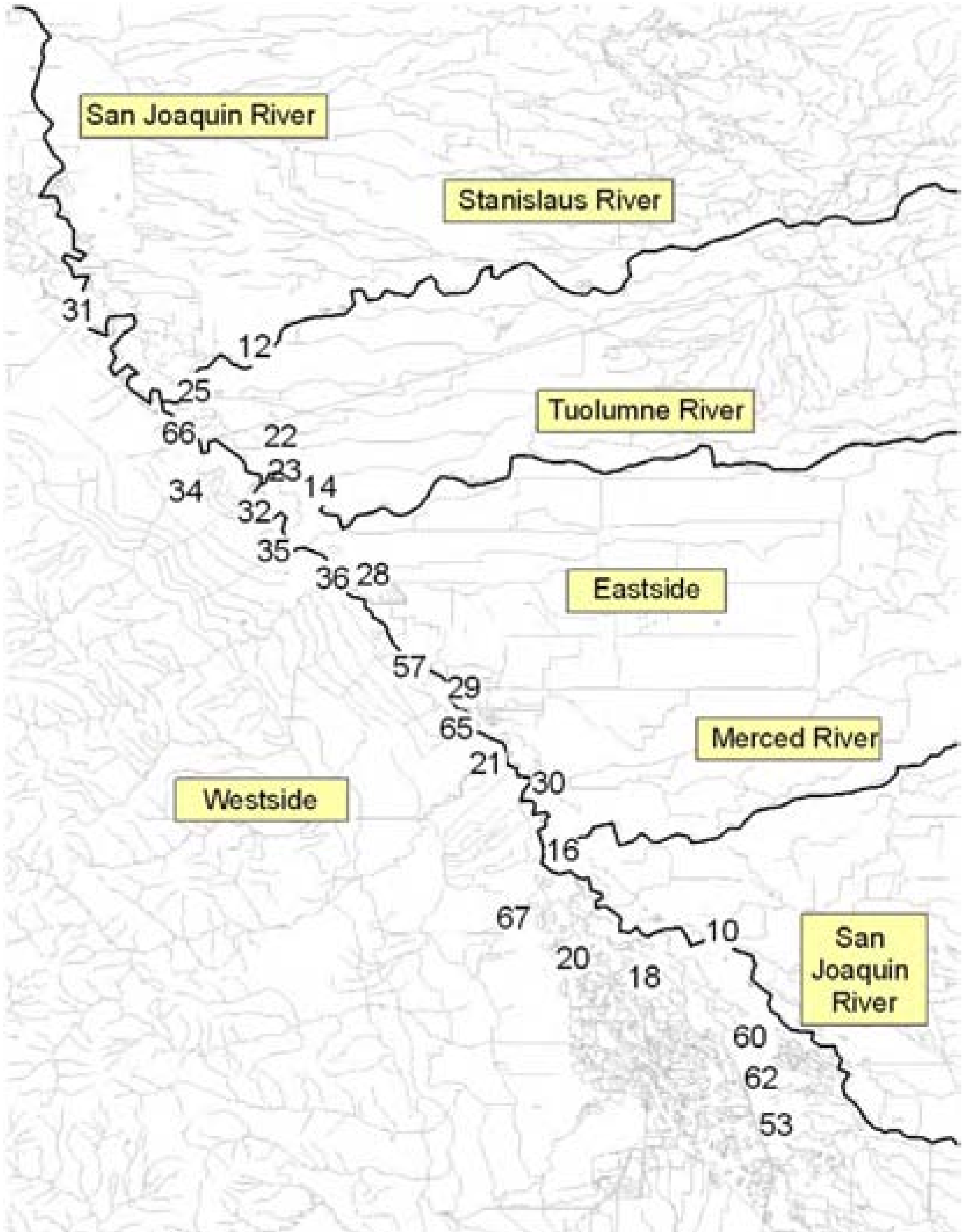

Fig. 2. San Joaquin River study area with water quality sampling locations shown. Site numbers correspond to locations listed in Table 1.

at 4 °C until analyzed or further processed and preserved. All analyses were run within the allowed holding time applicable to the preservation method used (Stringfellow, 2005).

Total organic carbon (TOC) was measured by high temperature combustion according to standard method (SM) 5310 B. Dissolved organic carbon (DOC) was measured after filtration through a GF/F glass-fiber filter by the same method. Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E, respectively. Mineral suspended solids (MSS) was determined by subtracting VSS from TSS. Chlorophyll-*a* (chl-*a*) was extracted and analyzed using spectrophotometric absorption (SM 10200H). *Ortho*-phosphate P (oPO_4-P) was determined on samples filtered through a glass-fiber filter (0.7 µm). Nitrate nitrogen (NO_3-N) was measured by as nitrate and nitrite (NO_3-N + NO_2-N) spectrophotometrically after reaction with a V(III)/Griess reagents to form

Table 1
Tributaries and drainages included in normalized rank mean (NRM) analysis

Site no.	Tributary name	Tributary relation to San Joaquin River	Predominate characteristic[a]
10	Lander Avenue	Upstream limit of study area	Agricultural and Sierra drainage
12	Stanislaus River	Eastside	Sierra drainage
14	Tuolumne River	Eastside	Sierra drainage
16	Merced River	Eastside	Sierra drainage
18	Mud Slough	Westside	Agricultural and wetland drainage
20	Los Banos Creek	Westside	Agricultural and wetland drainage
21	Orestimba Creek	Westside	Agricultural drainage
22	Lateral 4	Eastside	Agricultural drainage
23	Lateral 5	Eastside	Agricultural drainage
25	Miller Lake	Eastside	Agricultural and wetland drainage
28	Westport Drain	Eastside	Agricultural drainage
29	Harding Drain	Eastside	Agricultural and urban drainage
30	Lateral 6 and 7	Eastside	Agricultural drainage
31	New Jerusalem Drain	Westside	Agricultural drainage
32	Grayson Drain	Westside	Agricultural drainage
33	Hospital Creek	Westside	Agricultural drainage
34	Ingram Creek	Westside	Agricultural drainage
35	Westley Wasteway	Westside	Agricultural drainage
36	Del Puerto Creek	Westside	Agricultural drainage
38	Marshall Road Drain	Westside	Agricultural drainage
53	Salt Slough	Westside	Agricultural drainage[b]
57	Ramona drain	Westside	Agricultural drainage
60	Moffit One	Westside	Wetland drainage
61	Deadman's Slough	Westside	Wetland drainage
62	Mallard Slough	Westside	Wetland drainage
64	Moran Drain	Westside	Agricultural drainage
65	Spanish Grant Drain	Westside	Agricultural drainage
66	Maze Drain	Westside	Agricultural drainage
67	Newman Wasteway	Westside	Agricultural drainage

Data from each location are pooled, ranked and compared to prioritize tributaries for TMDL management actions.
[a] Agricultural drainage can include tailwater runoff, tile drainage, and operational spill; urban drainage includes wastewater treatment plant effluent and storm runoff.
[b] Salt Slough can also contain seasonal wetland drainage.

a colored product. Ammonia nitrogen (NH_4-N) was quantified using the Nessler Method. Biochemical oxygen demand (BOD) was analyzed on unfiltered samples by SM 52101 B with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set is consistent with prior studies (Volkmar and Dahlgren, 2006).

2.3. Calculation of NRM indexes

Data from 2005 and 2006 were compiled and analyzed using both parametric and nonparametric statistical methods (Sokal and Rohlf, 1995; Zar, 1999; Lehmann, 2006). Included in this paper are data collected at 29 major and minor tributaries of the SJR in 2005 and 2006. Only locations with complete results from four or more samples were included in this analysis. For normalized rank means (NRM) analysis, the WQ data for all locations to be compared were pooled by parameter and assigned a rank according the method of Wilcoxon (Wilcoxon, 1945; Mann and Whitney, 1947; Lehmann, 2006). For each location, the expected rank under the null hypothesis (that all locations have equal rank) was subtracted from the actual rank sum of that location and the result divided by the standard deviation of pooled data, yielding a NRM expressed in units of standard deviation.

$$\mathrm{NRM} = \frac{(R_j - R_0)}{(\mathrm{SD})}$$

where R_j is the actual rank sum of WQ at location j; R_0 is the expected rank sum for a location under the null hypothesis (that all locations are equal); and SD is the standard deviation for the polled ranks. The NRM is equivalent to the variously called 'C', 'Z' or 'z' Wilcoxon–Mann–Whitney statistic (Sokal and Rohlf, 1995; Zar, 1999; Lehmann, 2006). Statistical calculations were preformed using JMP statistical software (SAS Institute, Research Triangle Park, NC).

For the calculation of an overall WQ index for each location, the average of the NRMs for EC, chl-*a*, TOC, VSS, MSS, NH_4-N, NO_3-N, *o*PO_4-P, and BOD was taken. For an eutrophication index, the average of the NRMs for chl-a, NO_3-N, NH_4-N, and *o*PO_4-P was calculated. The parameters used in the calculation of the eutrophication ranking were previously shown to have a positive correspondence to phytoplankton growth in this system (Herr and Chen, 2006; Stringfellow et al., 2006).

Table 2
Mean concentration of water quality parameters[a] for San Joaquin River tributaries included in normalized rank mean (NRM) analysis

Site no.	Site name	EC (mS/cm)	pH	NTU	Chl-*a* (μg/L)	TOC (mg/L)	DOC (mg/L)	VSS (mg/L)	MSS (mg/L)	NH_4-N (mg/L)	*o*PO_4-P (mg/L)	NO_3-N (mg/L)	BOD (mg/L)
10	Lander Avenue	0.556	8.0	28.9	32.3	6.4	5.2	7.1	33.5	0.28	0.17	1.06	5.3
12	Stanislaus River	0.097	7.5	7.2	3.5	2.7	2.4	2.0	11.3	0.15	0.13	0.21	1.3
14	Tuolumne River	0.103	7.8	6.2	3.7	2.6	2.2	2.1	15.9	0.15	0.10	0.67	1.3
16	Merced River	0.104	7.5	11.4	2.6	3.1	2.6	2.9	20.1	0.17	0.07	0.79	1.7
18	Mud Slough	2.462	8.1	39.5	59.6	11.2	9.3	13.8	58.3	0.37	0.15	4.79	9.0
20	Los Banos Creek	1.263	7.7	78.5	41.5	12.8	11.2	13.8	86.4	0.68	0.42	0.72	9.1
21	Orestimba Creek	0.525	8.0	125.8	12.3	5.5	4.8	14.0	148.4	0.37	0.18	2.58	3.0
22	Lateral 4	0.190	8.7	1.9	7.3	2.7	2.4	1.7	4.2	0.21	0.14	1.32	2.3
23	Lateral 5	0.123	8.3	7.0	6.4	4.2	3.1	2.9	14.3	0.28	0.16	1.39	2.3
25	Miller Lake	0.363	7.6	19.6	25.4	10.0	8.8	9.7	22.8	1.77	0.76	1.12	7.0
28	Westport Drain	0.695	8.0	12.0	7.7	4.8	4.0	2.9	15.0	0.33	0.50	12.81	2.4
29	Harding Drain	0.655	7.8	17.7	8.6	6.0	5.1	5.0	35.9	0.57	1.82	8.78	5.0
30	Lateral 6 & 7	0.694	7.7	10.1	25.8	7.8	7.0	2.4	14.2	0.34	0.62	14.28	3.4
31	New Jerusalem Drain	2.391	7.4	11.7	7.5	2.1	7.3	0.6	5.8	0.14	0.17	13.85	0.4
32	Grayson Drain	0.545	7.9	653.9	32.5	21.6	10.3	58.1	863.7	0.62	0.26	1.29	10.0
33	Hospital Creek	0.455	8.0	524.3	31.4	13.1	6.7	61.8	1007.7	0.56	0.30	1.06	9.3
34	Ingram Creek	0.767	7.9	436.6	28.0	9.5	4.2	31.6	503.1	1.16	0.20	5.33	5.9
35	Westley Wasteway	0.629	8.4	329.9	26.5	12.4	3.6	38.7	676.6	0.41	0.16	1.60	6.8
36	Del Puerto Creek	0.687	8.2	100.8	20.0	7.2	4.7	15.7	142.5	0.69	0.23	3.22	6.4
38	Marshall Road Drain	0.614	7.7	84.0	20.4	5.9	11.8	11.4	68.7	0.38	0.22	2.34	7.2
53	Salt Slough	1.219	7.5	44.5	14.6	7.7	6.3	8.7	64.2	0.36	0.20	0.96	4.0
57	Ramona Drain	1.145	7.9	97.6	81.0	11.0	7.3	19.4	138.5	0.68	0.11	2.36	12.8
60	Moffit One	0.894	7.2	1.8	13.4	11.9	11.4	2.2	1.6	0.46	0.14	0.08	5.4
61	Deadman's Slough	1.075	7.3	14.2	21.4	11.5	10.5	5.7	22.9	0.39	0.21	0.39	5.6
62	Mallard Slough	1.784	7.2	8.5	20.8	11.7	10.9	4.2	9.8	0.50	0.46	0.11	3.9
64	Moran Drain	0.552	7.9	119.2	18.0	7.2	4.4	13.7	155.6	0.81	0.05	0.75	5.8
65	Spanish Grant Drain	0.627	7.9	227.2	20.1	7.7	4.7	23.7	273.0	0.41	0.14	4.45	5.5
66	Maze Drain	0.488	8.5	378.8	21.6	10.5	4.0	27.6	466.2	0.23	0.11	0.74	3.2
67	Newman Wasteway	1.309	7.4	87.6	18.4	7.0	20.7	9.4	76.7	0.67	0.16	3.27	6.4

[a] See Section 2 for analyte abbreviations.

Table 3
Normalized rank means (NRM) results for water quality parameters[a] for San Joaquin River tributaries

Site no.	Site name	EC NRM	pH NRM	NTU NRM	Chl-*a* NRM	TOC NRM	DOC NRM	VSS NRM	MSS NRM	NH_4-N NRM	*o*PO_4-P NRM	NO_3-N NRM	BOD NRM
10	Lander Avenue	−0.76	3.22	1.38	4.41	0.60	1.06	1.99	0.95	−1.96	−1.01	−2.97	2.36
12	Stanislaus River	−7.83	−4.06	−5.51	−6.73	−7.66	−7.72	−6.22	−5.06	−5.60	−3.49	−6.74	−7.51
14	Tuolumne River	−8.25	−0.55	−6.58	−7.56	−8.11	−8.42	−6.87	−5.30	−5.77	−5.01	−3.75	−7.09
16	Merced River	−8.19	−5.26	−4.12	−7.78	−6.80	−6.72	−4.40	−2.91	−4.70	−6.90	−3.32	−5.93
18	Mud Slough	9.80	4.75	3.25	7.84	6.64	6.47	5.75	3.84	0.81	−2.11	5.34	6.62
20	Los Banos Creek	6.36	−2.26	5.52	6.54	7.81	8.25	5.16	4.36	5.97	5.47	−2.75	6.59
21	Orestimba Creek	−0.78	3.03	6.56	0.11	−1.21	−1.42	4.44	6.24	0.14	−0.50	1.98	−2.19
22	Lateral 4	−2.23	3.52	−3.22	−1.00	−2.21	−2.65	−2.31	−3.07	−1.08	−0.82	−1.14	−0.86
23	Lateral 5	−6.58	4.33	−5.46	−4.37	−4.19	−4.86	−3.91	−5.28	−2.82	−3.08	−3.31	−3.48
25	Miller Lake	−2.41	−2.09	−0.91	2.46	2.36	3.25	−0.64	−1.90	1.45	2.57	−1.35	3.01
28	Westport Drain	1.23	3.01	−3.77	−3.50	−2.42	−1.74	−3.48	−4.04	−1.01	4.37	7.44	−3.19
29	Harding Drain	0.95	0.07	−1.59	−3.20	−0.45	0.76	−0.80	−0.95	1.83	9.82	8.26	2.34
30	Lateral 6 & 7	0.78	−0.83	−2.83	−0.66	1.39	2.12	−2.77	−2.79	0.32	4.19	5.75	−0.86
31	New Jerusalem Drain	3.14	−2.06	−0.79	−1.57	−2.99	0.93	−3.35	−2.75	−1.94	−0.72	3.53	−2.81
32	Grayson Drain	−0.18	0.42	2.60	0.60	2.37	1.40	2.29	2.30	1.20	0.87	0.10	1.27
33	Hospital Creek	−1.16	1.63	4.93	2.73	2.73	1.25	3.68	4.63	0.91	0.92	−0.63	2.23
34	Ingram Creek	1.09	1.77	5.18	2.31	1.28	−1.53	3.81	4.82	3.10	0.29	3.53	0.42
35	Westley Wasteway	0.39	3.10	2.60	1.19	0.61	−1.12	1.78	1.83	0.47	−0.98	−0.09	0.57
36	Del Puerto Creek	1.52	5.32	4.24	1.84	−0.42	−1.23	3.05	4.22	2.32	1.04	3.28	2.41
38	Marshall Road Drain	0.18	−0.47	2.11	1.02	−0.04	0.70	1.63	1.61	0.05	0.40	0.91	1.28
53	Salt Slough	4.88	−4.39	2.61	1.16	2.04	2.55	2.84	3.40	1.11	−0.30	−1.25	0.86
57	Ramona Drain	3.69	0.46	4.05	3.71	3.41	2.62	3.43	4.05	2.91	−2.05	1.61	4.47
60	Moffit One	2.31	−5.16	−5.27	0.27	3.93	4.70	−3.50	−5.36	2.43	−1.61	−5.35	1.26
61	Deadman's Slough	3.46	−4.83	−2.56	1.65	3.70	4.29	−0.56	−2.22	1.18	0.33	−4.13	1.31
62	Mallard Slough	4.44	−5.11	−3.22	1.21	3.19	4.41	−1.78	−4.17	1.92	1.36	−4.94	−0.59
64	Moran Drain	−0.11	0.71	2.03	0.98	0.48	−0.39	1.71	2.23	2.01	−2.00	−0.57	0.53
65	Spanish Grant Drain	0.27	0.67	2.35	1.24	0.48	−0.24	2.02	2.38	0.98	−0.65	1.84	0.29
66	Maze Drain	−0.54	2.67	1.31	0.40	0.58	−0.76	−0.16	0.23	−0.76	−1.23	−0.69	−0.43
67	Newman Wasteway	2.27	−2.02	2.20	0.94	0.35	1.98	1.05	1.41	1.89	−0.35	1.54	1.05

[a] See Section 2 for analyte abbreviations.

3. Results and discussion

A key component to the application of NRM analysis is the careful selection of what locations are going to be included in the analysis so that an appropriate comparison can be made. For this paper, it was hypothesized that the watershed would be managed by the stakeholders as a unit and the stakeholders would need to determine what are the locations that deserve priority attention, given a limited remediation budget. It was assumed that, either there were no regulatory targets [as is currently the case for suspended sediments and nutrients], or each drainage was given the same regulatory priority [as is the case with the salt and boron TMDL, where all drainages with a 30 days average

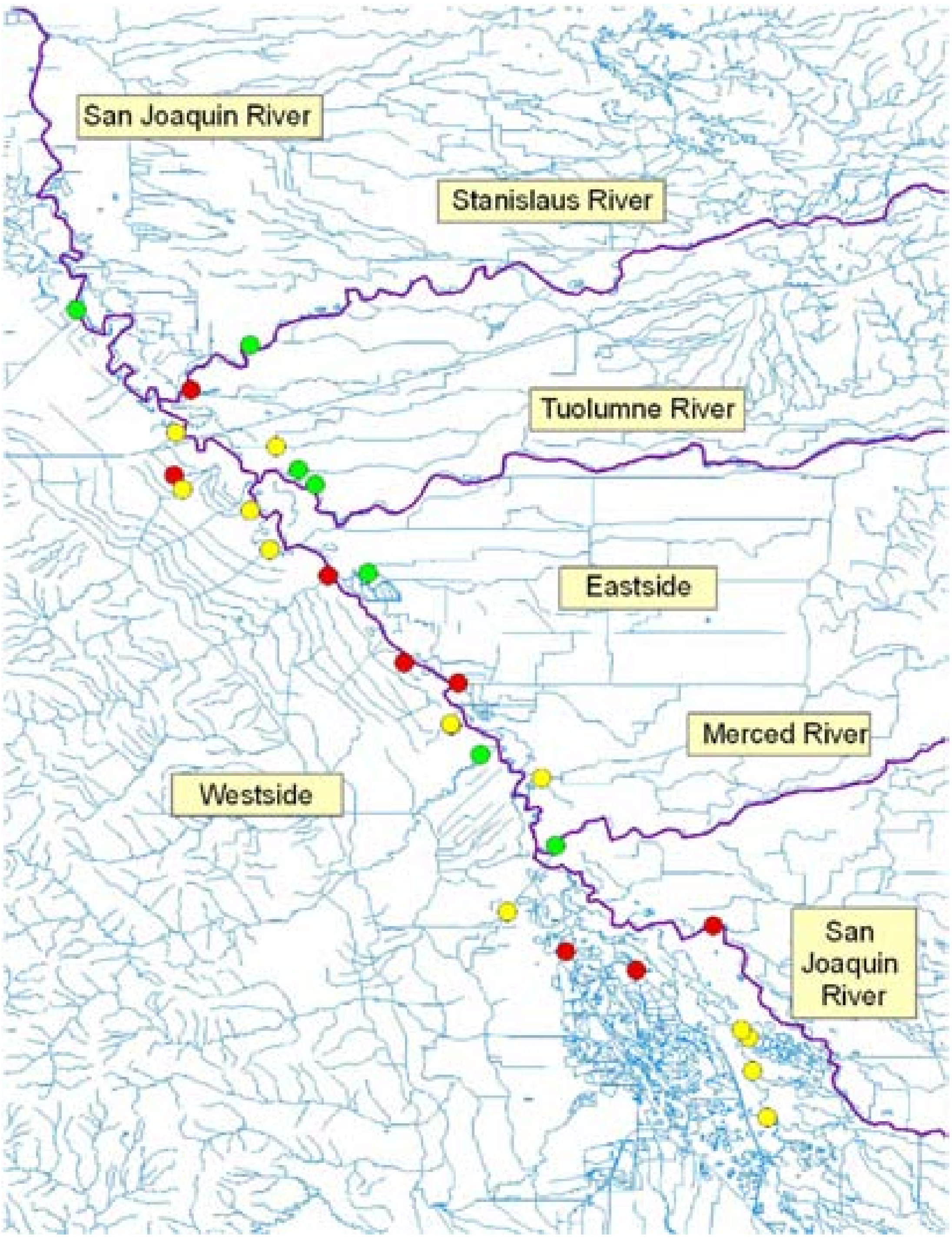

Fig. 3. Geographical analysis of biochemical oxygen demand (BOD) in tributaries of the San Joaquin River using normalized rank mean (NRM) analysis. Sites displayed in red have poorer BOD water quality compared to the other tributaries combined (90% probability). Sites in green are significantly better than the mean for BOD water quality. Yellow locations are not different from the mean.

EC above 0.315 mS/cm are subject to the same regulatory pressure (Central Valley Regional Water Quality Control Board, 2004)]. The locations (Table 1) are all primary tributaries of the SJR, meaning that measurements made at each location represent water that is directly discharging to the SJR without passing another monitoring location (i.e. no drainage is being represented twice). The analysis does not include any river locations, except the upstream limit of the study area (Site 10, Lander Avenue).

The mean values for major WQ parameters of concern for each drainage are presented in Table 2. Eutrophication is a significant issue in the SJR and NH_4-N, oPO_4-P, and NO_3-N influence algal growth rates and yields (e.g. Beardall et al., 2001; Stringfellow and Quinn, 2002; Shostell

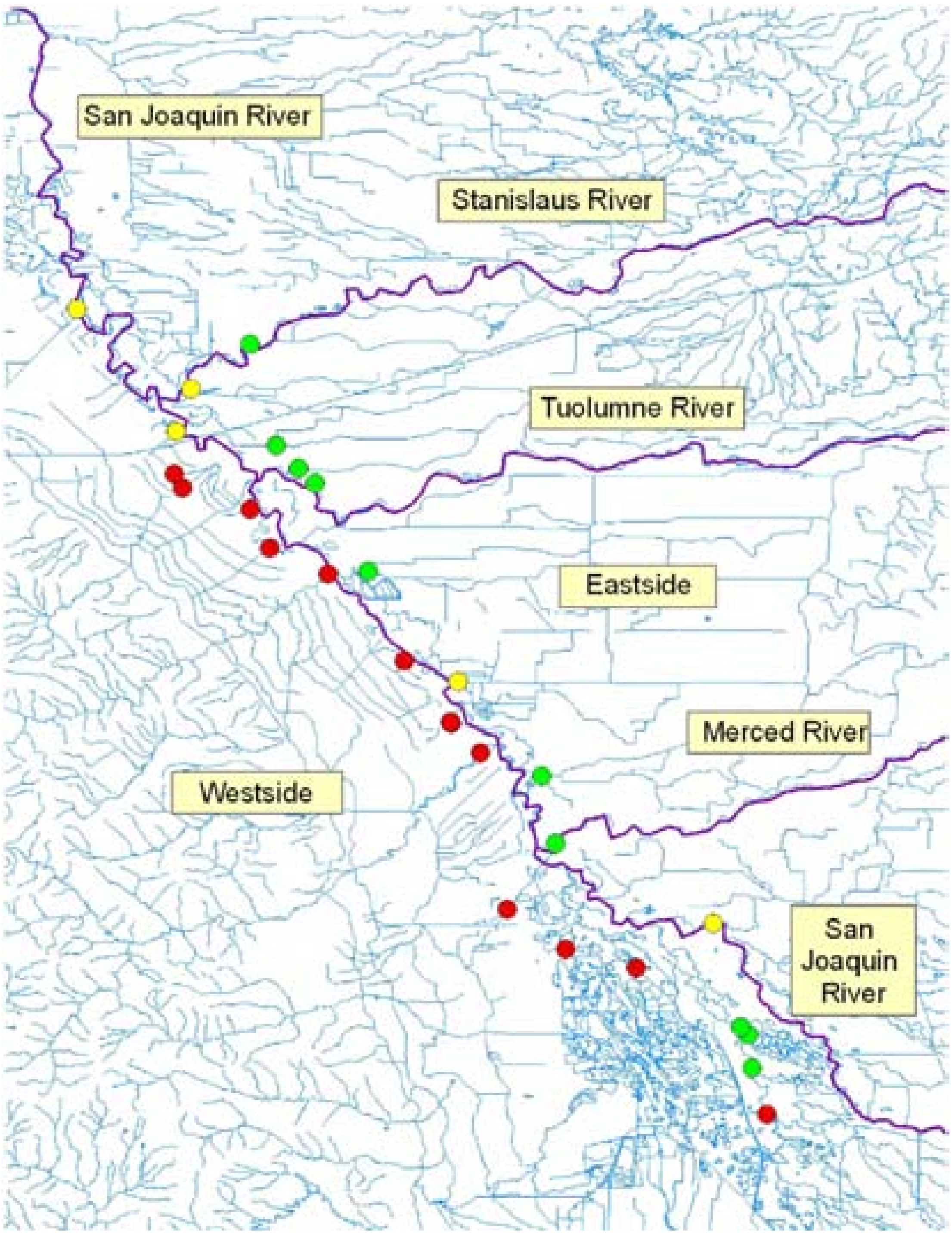

Fig. 4. Geographical analysis of turbidity (NTU) in tributaries of the San Joaquin River using normalized rank mean (NRM) analysis. Sites displayed in red have higher turbidity compared to the other tributaries combined (90% probability). Sites in green are significantly better than the mean for turbidity. Yellow locations are not different from the mean.

and Bukaveckas, 2004; Hilton et al., 2006). Inoculum of planktonic algae (measured as chl-*a*) has been implicated as a potential contributing factor to high yields of biomass in the SJR (Foe et al., 2002). The parameters pH, NTU, MSS, TOC, DOC, VSS, and BOD are important components for a variety of SJR TMDLs under development. Drainage salinity (here reported as EC) is a very important overall WQ parameter for this region (Johns and Watkins, 1989; McNeal and Balisteri, 1989; San Joaquin Valley Drainage Program, 1990) and is used as a calibration parameter for mass balance models of the SJR (Quinn and Karkoski, 1998; California Department of Water Resources, 2006; Herr and Chen, 2006; Stringfellow et al., 2007).

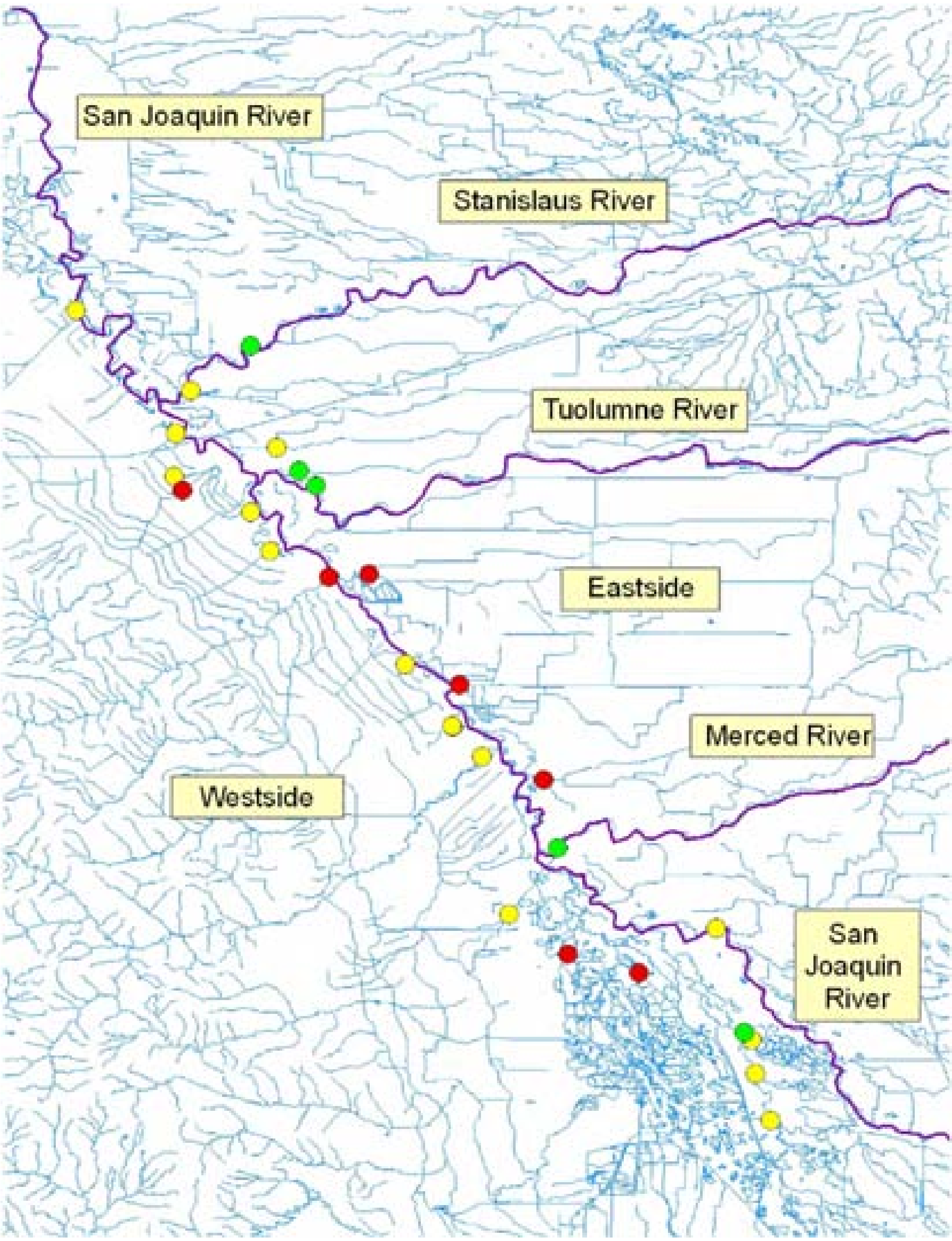

Fig. 5. Geographical analysis of the eutrophication index created using normalized rank mean (NRM) results for nutrients and algal biomass. Sites displayed in red have an index value greater than the group mean (90% probability). Sites in green are significantly better than the mean and yellow locations are not different from the mean.

NRMs (Table 3) were calculated for each location and each WQ parameter shown in Table 2. Negative values indicate that the location has a been ranked as having better WQ than the mean of all the other tributaries included in the analysis, a positive value means the site has poorer WQ than the group. If all locations had an NRM of 0.0, it would indicate that there was no difference between the WQ of any of the drainages. NRMs values follow a normal distribution (Lehmann, 2006), so locations with NRMs greater than 1.65 or less than −1.65 (for example) have a 90% likelihood of being different from the mean of all the tributaries taken as a group. The calculated NRMs have

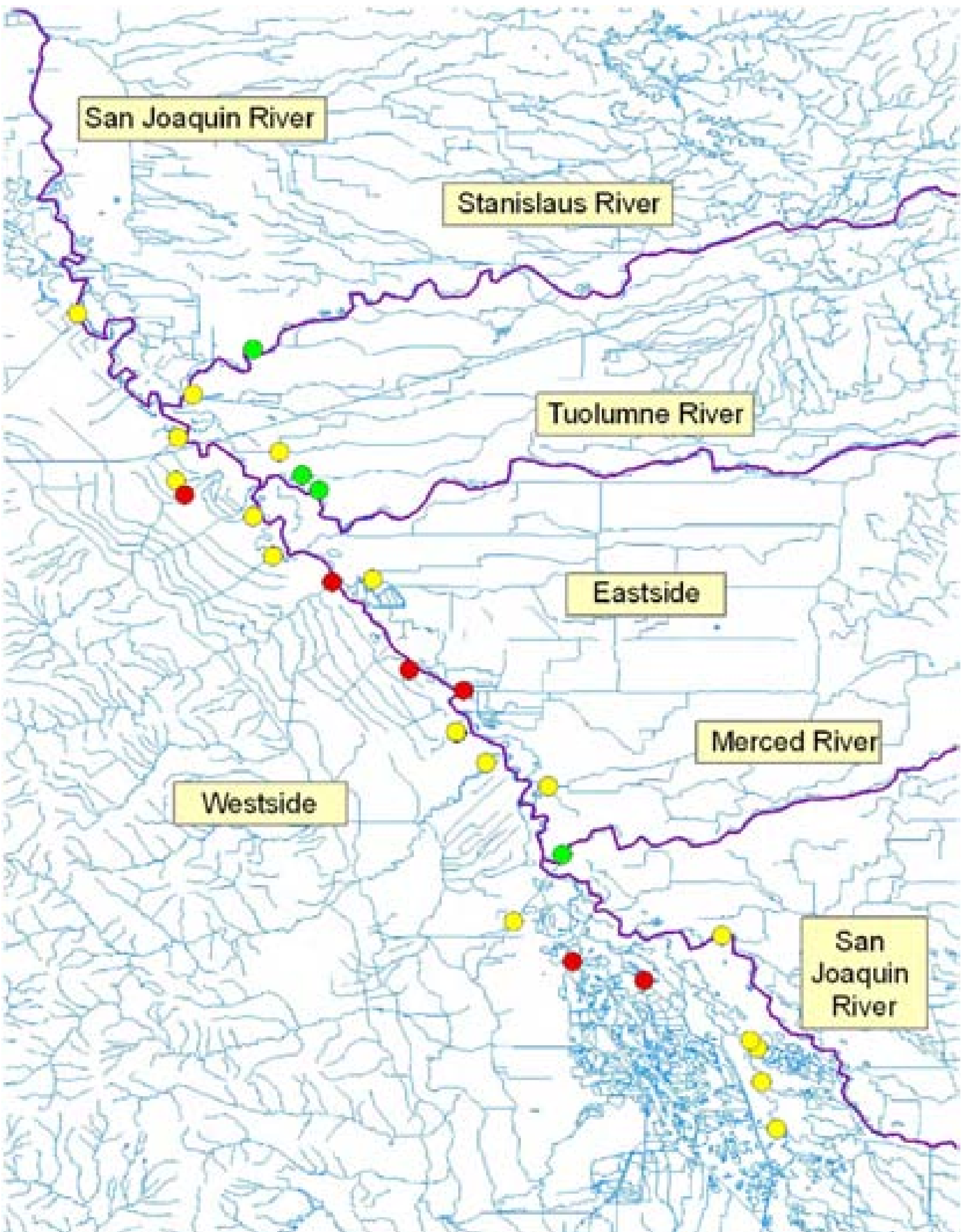

Fig. 6. Geographical analysis of the water quality index created using normalized rank mean (NRM) results for nine water quality parameters as described in the methods. Sites displayed in red have index values greater than the group mean (90% probability). Sites in green are significantly better than the mean and yellow locations are not different from the mean.

several applications and are proposed as a robust method for indexing WQ and a useful tool for setting remediation priorities.

NRMs for individual WQ parameters can be used evaluate watershed WQ and set remediation priorities. For example, the NRMs for BOD (Table 3) are mapped to determine if there are regional patterns for lower BOD WQ (Fig. 3). Locations with a NRM significantly greater (alpha = 0.10) than the mean are marked in red, locations with a BOD NRM similar to the mean are marked in yellow, and those less than the mean are green. Five of the eight highest ranked BOD sites are on the westside, there is significant BOD entering from upstream of the study area, and the eastside has two locations with BOD rankings higher than the mean (Fig. 3, Table 3). Describing the sources of BOD in individual watersheds is beyond the scope of this paper, but westside BOD is often associated with the growth of planktonic algae in agricultural drains. Eastside drains have low turbidity and support benthic algae, not planktonic algae, and have mixed input from urban sources, ranching, dairy, orchards and row crops. The relative importance of each of these sources is under investigation.

This "stoplight" analysis can be applied to any individual WQ parameter. A stoplight analysis of NRM results for suspended sediments (measured in this case at NTU) demonstrates that sediment runoff is predominantly a westside WQ problem (Fig. 4). NRM analysis using MSS yields the same results. This parameter was chosen to illustrate an extreme case, where application of scarce resources to control sediments on the eastside would obviously be a low priority. This result is consistent with the occurrence of highly erodable soils on the westside of the SJR (Gronberg et al., 1998; United States Department of Agriculture, 2006).

A powerful application of NRM analysis is the combining of individual NRMs into WQ indexes. The combination of NRM data into NRM indexes is possible because all NRMs are expressed in common units. Indexes allow the stakeholder to examine multiple parameters simultaneously. As an example, a eutrophication index was calculated using NRMs for phytoplankton biomass, nitrogen compounds, and soluble phosphate (see methods). How the index is calculated can be varied, depending on what the applicable science and modeling determine are controlling factors (Herr and Chen, 2006; Stringfellow et al., 2006), but in this example all variables are weighted equally. Each parameter included in the index will not result in an algal bloom individually, but must be combined (in the presence of light) to result in excess planktonic growth. The resulting eutrophication index, analyzed geographically in Fig. 5, suggests that controlling eutrophication will require stakeholder action on both east and west sides of the SJR and that specific problem areas can be prioritized for action.

The specific NRMs included in a WQ index can be changed depending on any number of priorities or goals. An overall WQ index, created by combining NRMs for chl-*a*, NO_3-N, NH_4-N, *o*PO_4-P, MSS, EC, TOC, and BOD is plotted in Fig. 6. NRM indexes that could be calculated in addition to the eutrophication and WQ indexes include a sediment (VSS, MSS, NTU) and organic carbon (VSS, TOC, DOC, chl-*a*) indexes. Other indexes could including any number of parameters, including pH or temperature, if adjustments are made to account for the non-linearity of those parameters. Which NRMs to include in a specific index and whether to assign weights to individual NRMs would need to be determined based on scientific evidence and program or stakeholder goals.

4. Conclusions

Impaired water bodies are subject to regulation under TMDL programs. Regional stakeholders are expected to develop appropriate, scientifically based WQ management programs to meet TMDL goals. Implementation of an effective regional TMDL response requires the identification of problem areas and setting of priorities for remediation. Stakeholders need rigorous, yet easily understandable, tools for integrating scientific information and setting remediation priorities.

WQ data collected in the SJR of California was not normally distributed, even after transformation. The use of parametric statistical methods on non-normal data can be misleading, so nonparametric methods, based on ranking, were applied to the analysis of WQ monitoring data collected in the San Joaquin Valley.

Ranking results for pooled data were used to calculate NRMs and compare drainages to each other. Mapping NRM results is a scientifically rigorous but easily understood method for setting remediation priorities on a watershed scale.

The application of NRM calculations to WQ data is proposed as a useful method for comparing WQ between locations, even in the absence of specific regulatory goals. NRM results are being combined to create WQ indexes which allow locations to be evaluated for multiple parameters simultaneously.

Acknowledgements

This work was supported by funding from the California Bay Delta Authority (CBDA) and the Regional Water Quality Control Board Central Valley Region (Regional Board). Many people were involved in data collection and analysis for the Upstream DO TMDL effort. Thanks to: Mark Gowdy and Jennifer LaBay of the Regional Board; Barbara Marcotte of the CBDA; Sharon Borglin, Jeremy Hanlon, Justin Graham, Remie Burks, Gary Litton, and many students at the University of the Pacific; Randy Dahlgren at the University of California Davis; Nigel Quinn at Berkeley National Laboratory; Joel Herr and Carl Chen at Systech Inc.; and Russ Brown at Jones and Stokes, Inc. The cooperation and support of the San Joaquin Valley Drainage Authority; the San Joaquin River

Group Authority; and the many individual participants and stakeholders (who prefer to remain anonymous) was and is critical to the success of this effort.

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Appendix N

15 Minute Resolution Water Quality Monitoring with YSI SONDE 6600 Multi-Parameter Instruments During the 2006 and 2007 Summer Seasons

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Stockton, CA 95211

Introduction

In an effort to determine the variance in water quality during the time between discreet grab sampling, several multi-parameter monitoring instruments were placed at key sampling locations along the mainstem (sites DO-5, 6, 7, 8, and 10) of the San Joaquin river and upstream tributaries (sites DO-18, 19 and 44) (Figure 1). YSI Sonde 6600 Multi-parameter instruments were set to record data at 15 minute intervals. Sensor values are time stamped and recorded to memory along with the instrument battery voltage. Instruments were deployed for two week intervals and exchanged with freshly calibrated instruments at the end of each interval. Grab samples were collected during deployment, collection and at least once in between, and brought back to the EERP laboratory for analysis. High temporal resolution data was sought to help calibrate the San Joaquin River WARMF model. With greater temporal resolution, algal growth rates (bio-kinetics) can be accurately determined and the validity of extrapolating data between grab sampling events verified.

Methods

The standard operating procedure (SOP) for deployment of continuously monitoring sonde equipment is described in detail in the EERP Field Protocol Book (Graham and Hanlon, 2008). Calibration, programming, and sensor set up were conducted the day prior to deployment at the EERP lab following the SOP. Dissolved oxygen calibration was performed in the field on the day of deployment using the wet-towel method, a technique where the sonde is placed in a tube with a wet-towel around the sensors and calibrated in a water-saturated air environment. The sensor cleaning wiper was fitted with a longer extended deployment brush to better keep the sensors free of algae and debris over the two week period. Sondes were programmed to run unattended for the length of deployment recording each parameter every 15 minutes. The parameters measured by the Sonde at each site include time, temperature (°C), electrical conductivity (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO) percent, DO concentration (mg/L), DO charge, depth (ft), pH, turbidity (NTU), chlorophyll content (ug/L), chlorophyll-*a* fluorescence, and some instruments were set up to measure oxidation-reduction potential (mV). Flow data was compiled from the California Data Exchange Center on the world wide web. (http://cdec.water.ca.gov/)

At the field sites, the instruments were deployed in custom made PVC housings (Figure 2) for protection against vandalism, theft, etc. In general, the instruments in their housings were secured with cable to existing structures in the river. In 2006, at site DO-05, the instrument was deployed in the existing four inch PVC stilling well on the DWR monitoring platform on the San Joaquin river near Vernalis, but suspended from the platform by cable in its own housing (Figure 3) for part of the 2007 monitoring. Sites DO-06 and 07 were on the San Joaquin river at the pumping platforms for the El Solyo and Patterson Irrigation districts respectively (Figures 4 and 5). Site DO-08 was on the San Joaquin river at the fishing dock of the Turlock Sportsmans club, also the site for other agencies' (DWR) monitoring (Figure 6). The furthest upstream site on the San Joaquin River was DO-10, located under the Lander Ave. bridge. This site required wading into the river and driving a fence post into the river bottom to anchor the instrument and housing (Figure 7). Site DO-18 was on Mud Slough near the town of

Gustine, the same location as the USGS flow monitoring station. Here the instrument was hung from the small bridge over the slough (Figure 8). The DO-19 site was on Salt Slough where Lander Ave crosses, also at a USGS station. The instrument was attached to a fence post attached to the bottom of the slough (Figure 9). Site DO-44 was at the terminous of the San Luis Drain and the instrument was hung from the weir structure at the outlet (Figure 10)

As a check of the deployed Sonde, a second YSI 6600 multi-parameter Sonde connected to a YSI 650 MDS handheld data display was placed in the water next to the in-situ Sonde during both deployment and collection. The non-extended deployment sonde was set out in the sample water and programmed to log a reading for every parameter every four seconds for at least two minutes, providing a statistically significant sample size ($n > 30$). While the second Sonde logged water quality data, water quality grab samples were collected and incident sunlight and water-velocity were measured to document current field conditions.

Upon conclusion of the deployment, Sondes were retrieved and placed into ice chests with a small amount of water to keep them moist until post-calibration could be performed. Post-calibration, also covered in the SOP (Graham and Hanlon, 2008), was completed within twenty-four hours of retrieval. After being post-calibrated, sondes were cleaned up with water and mild soap, the DO membranes and batteries changed, and the extended deploy wipers were cleaned and replaced. Pre and post calibration values for all instruments deployed in 2006 and 2007 are included as Analyses 1 and 2 at the end of this document.

Results

Diurnal variations are seen at all sites in temperature, pH, dissolved oxygen, and chlorophyll fluorescence. San Joaquin river sites show a distinct diurnal cycling for turbidity as well, with low points occurring just before midnight and highpoints just after noon. This is seen particularly with the lower flow of 2007 (Figures 16, 24, 32, 40, and 48). Chlorophyll fluorescence measured simultaneously shows a similar sine wave-like cyclical pattern but at approximately 180 degrees out of phase with the turbidity values (Figures 17, 25, 33, 41, and 49). When chlorophyll fluorescence is at it's highest, turbidity is lowest and vice versa. Dissolved oxygen, temperature, and pH levels cycle on the same time frame as the chlorophyll, reaching a maximum each day around 6pm and minimum values at approximately 6am. Especially large swings in pH at DO-10 from 7.8 to 9.2 in late June 2007 correspond to similar patterns in chlorophyll fluorescence and is indicative of highly productive, or eutrophic systems.

The initial deployment for 2006 was from June 27 to July 13 during which time the San Joaquin river and it's major tributaries had nearly a 60% decrease in flow. For the rest of the 2006 and 2007 monitoring periods, flows were considerably more consistent (Figures 18, 26, 34, 42, 50, and 58). Electrical conductivity at DO-05 during that same period increased from less than 100 milliSemens (mS) to nearly 450 mS as the flow decreased.

Additional statistically correlated data from DWR was included in this report to supplement 2007 monitoring activities at DO-05 SJR at Vernalis (Letain et al., 2008).

These data included temperature and specific conductance from June 21 to July 12 and from August 21 to September 17.

Discussion

Instrument performance and reliability was reasonably good for both years but 2007 in particular yielded the most comprehensive data set. Additional instruments were available for deployment in 2007 which made it possible to simultaneously cover more sites and have calibrated instruments standing by in order to minimize data loss from downtime. The San Joaquin River at Patterson, Site DO-07, had a dissolved oxygen probe failure from July 6, 2007 until the instrument was replaced on July 12, 2007 (Figures 29 and 30). Values from the specific conductance sensor during this period also decline and both failures were attributed to biological activity. Sporadic spikes in turbidity and chlorophyll fluorescence were often caused by interference from the instruments sensor wiping system when it failed to properly park away from the optical sensor. These spikes were easy to identify as they tended to be an order of magnitude greater than measured data and were removed.

Battery failure was an issue when we temporarily switched from Duracell to Energizer batteries mid way through 2007. Several instruments intermittently shut down midway through the two week deployments in August, logging low battery voltages just before and after gaps in data. All of the instruments had recovered from the voltage drop by the time they were picked up and none of the batteries showed unusually low voltages when checked on a voltmeter back at the EERP lab. Fortunately the instruments managed to make at least a few measurements each day despite the low voltages, and after switching back to Duracell batteries the issue did not reoccur.

References

Graham, J., Hanlon, J., 2008. EERP Field Standard Operating Procedures Protocol Book. Environmental Engineering Research Program, Stockton, CA.

Letain, T. E., Hanlon, J. S., Stringfellow, W. T., 2008 Comparison of Continuous Temperature, Specific Conductivity, pH, Dissolved Oxygen, Chlorophyll Fluorescence, and Turbidity Monitoring Data Collected at the San Joaquin River at Vernalis by the University of the Pacific and the Department of Water Resources. Environmental Engineering Research Program, Stockton, CA.

Figure 1: Map of the study area and sampling locations.

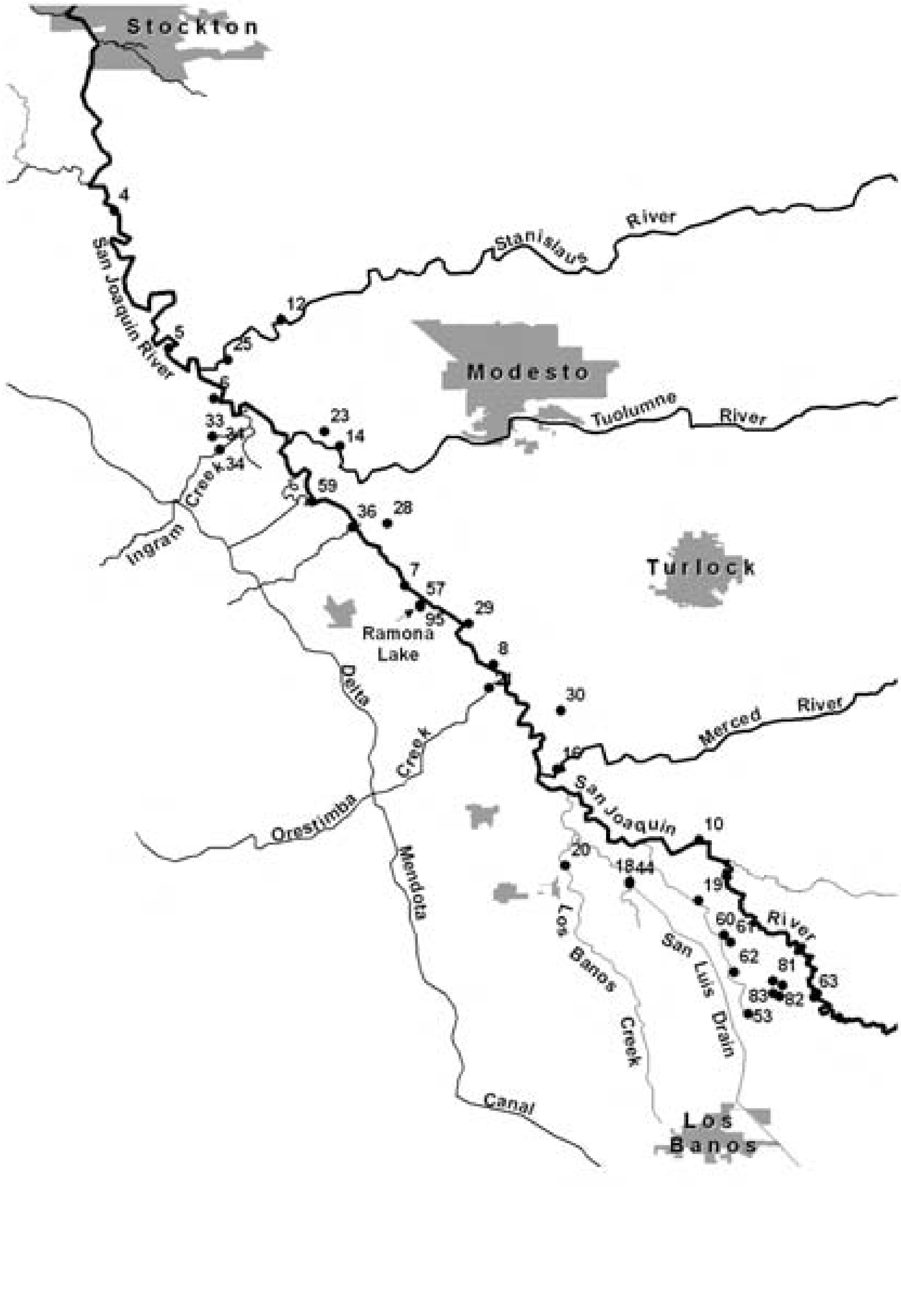


Figure 2: YSI Sonde 6600 with deployment housing.

Figure 3: View from DWR Vernalis platform DO-05 looking down at river and stilling wells.

Figure 4: Elsolyo water district intake structure on San Joaquin river, DO-06.

Figure 5: Patterson irrigation district intake structure on San Joaquin river, DO-07.

Figure 6: Turlock sportsmans club fishing dock, DO-08.

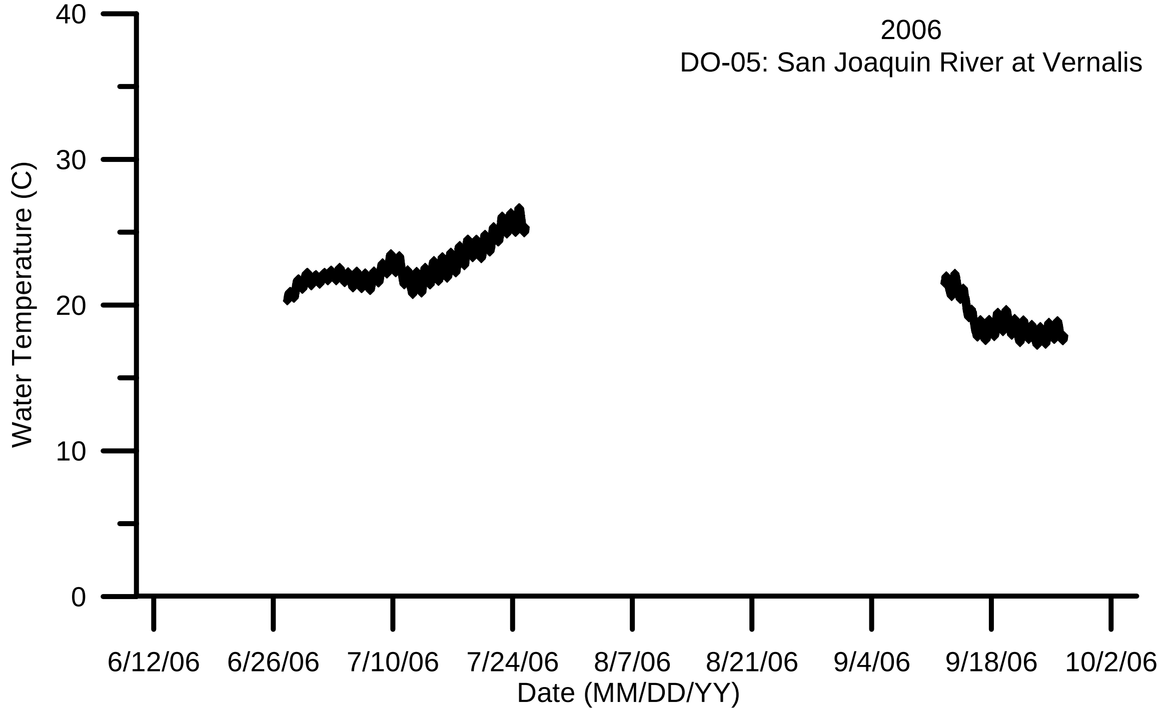
Figure 7: San Joaquin river at Lander Ave., DO-10.

Figure 8: Mudslough near Gustine, DO-18.

Figure 9: Saltslough at Lander Ave., DO-19.

Figure 10: San Luis Drain terminous, DO-44.

Figure 11: Water temperature 15 minute data at DO-05 for 2006 and 2007.



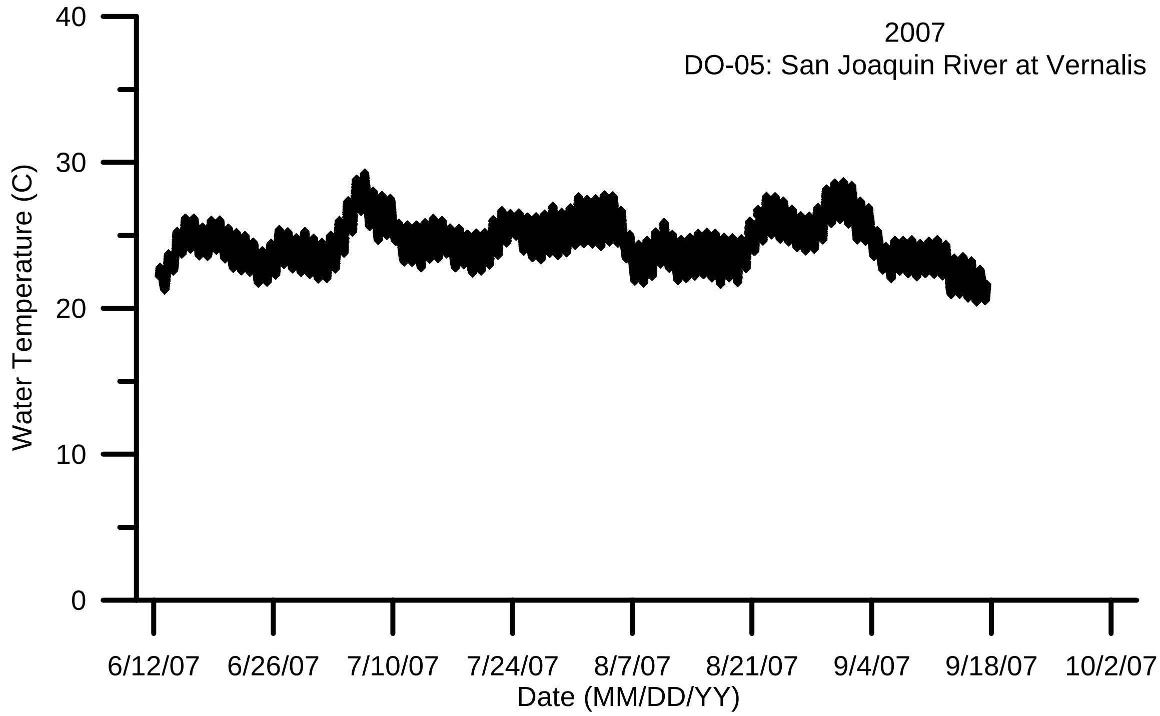
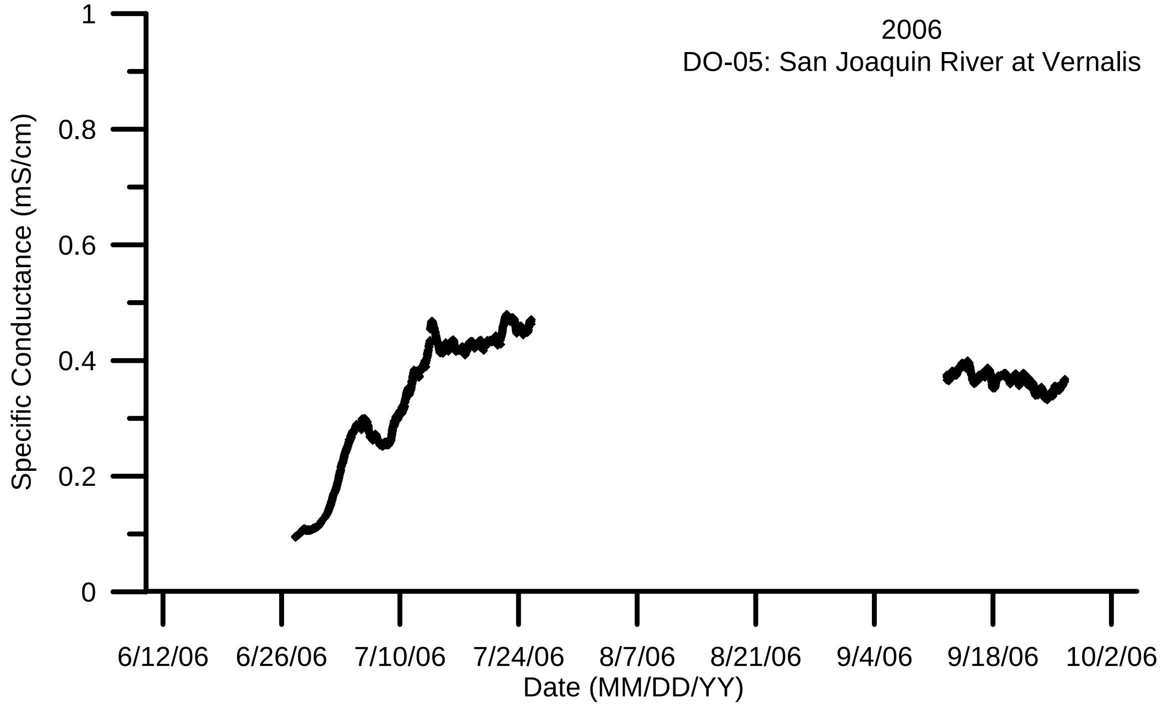


Figure 12: Specific conductance 15 minute data at DO-05 for 2006 and 2007.



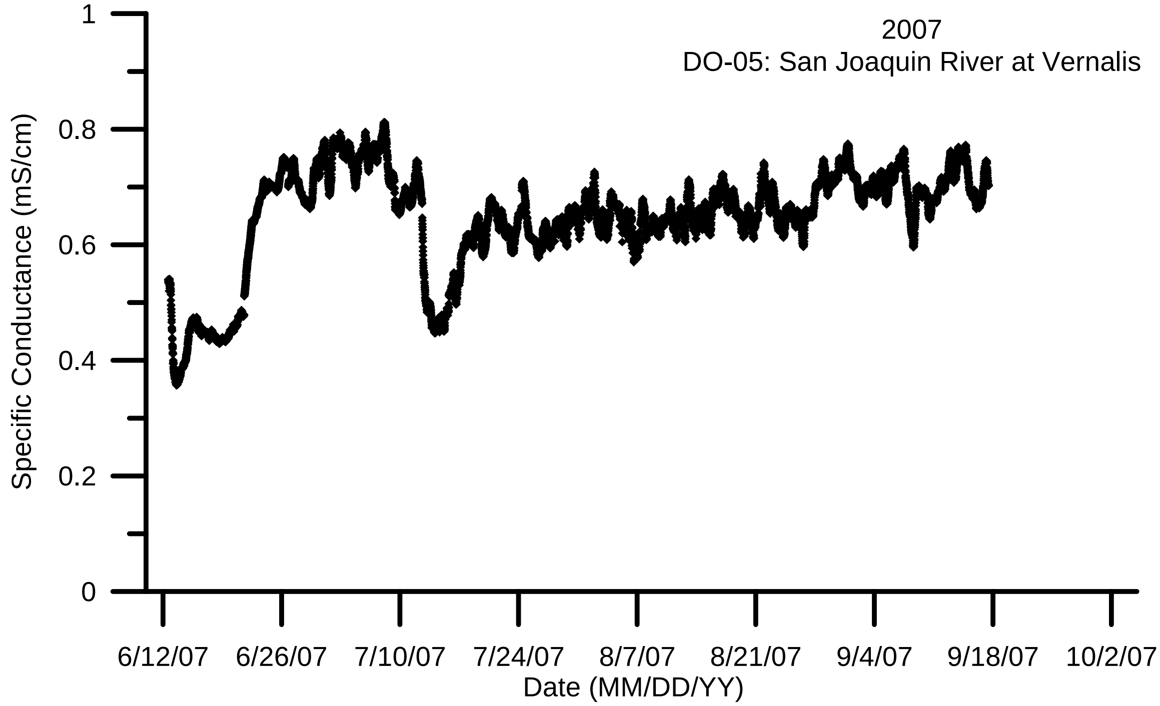
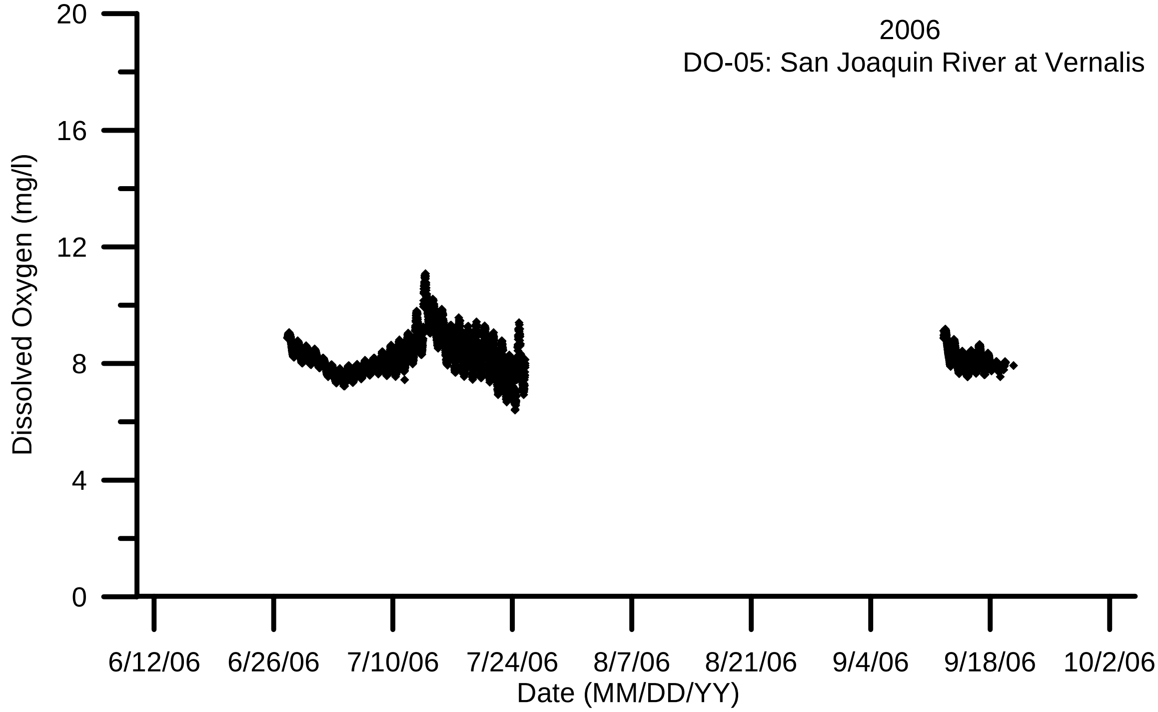


Figure 13: Dissolved oxygen concentration 15 minute data at DO-05 for 2006 and 2007.



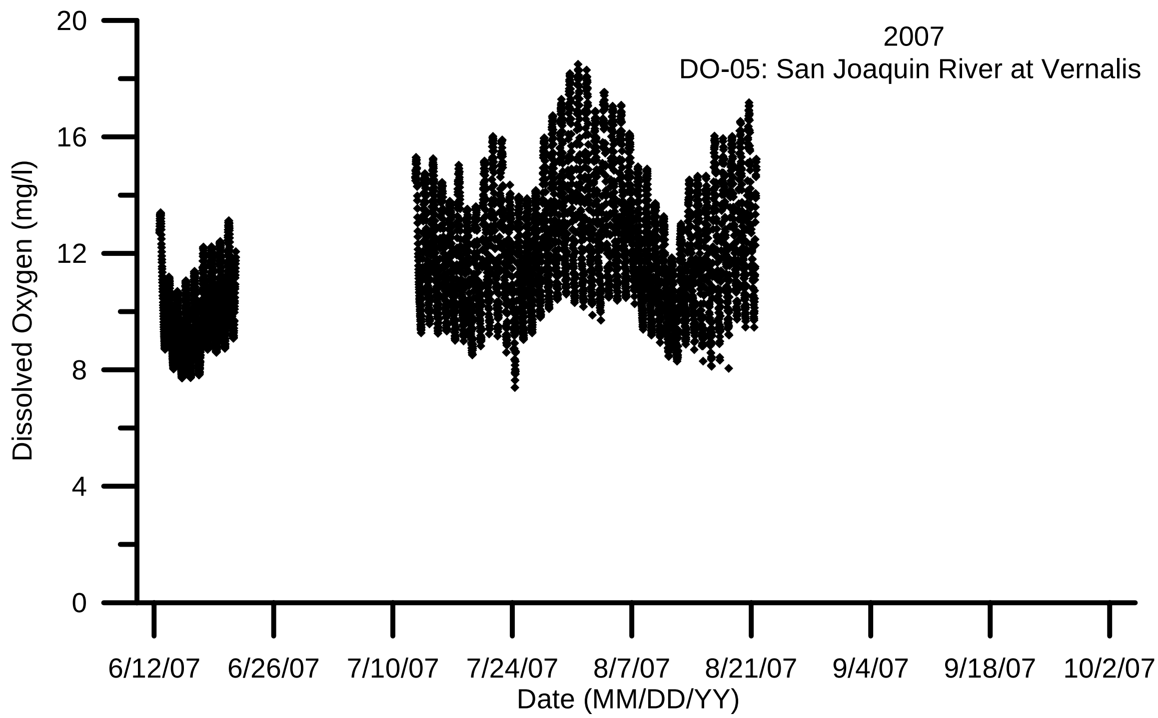
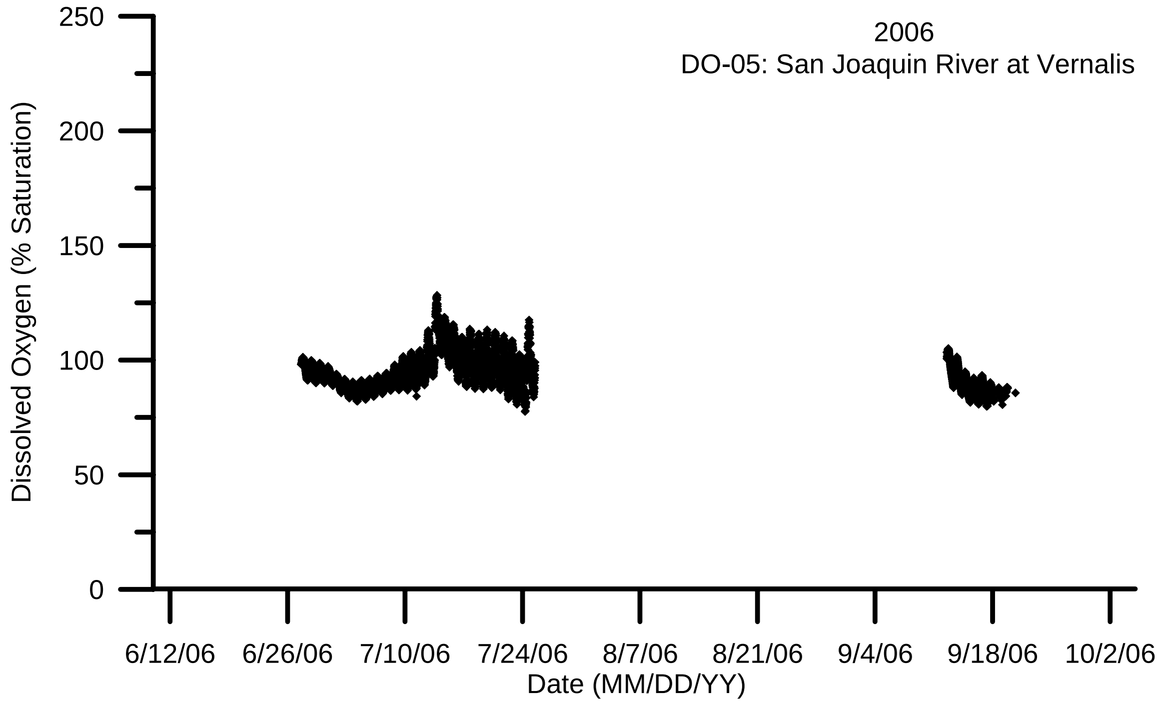


Figure 14: Dissolved oxygen percent of saturation 15 minute data at DO-05 for 2006 and 2007.



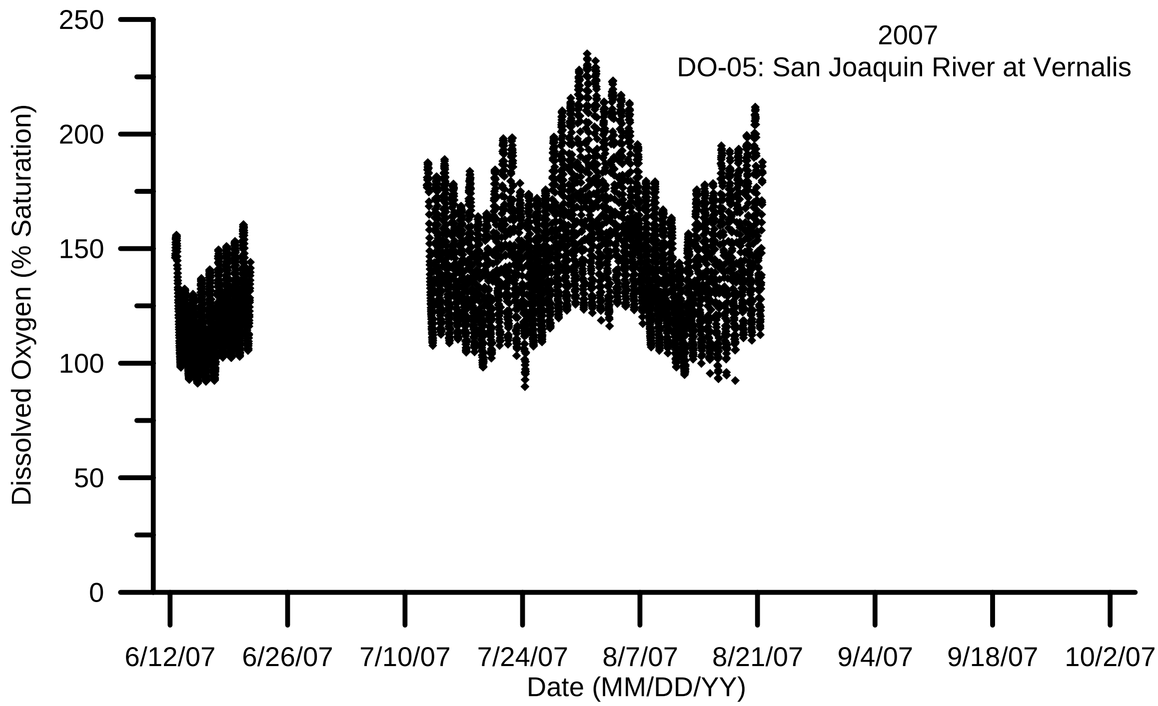
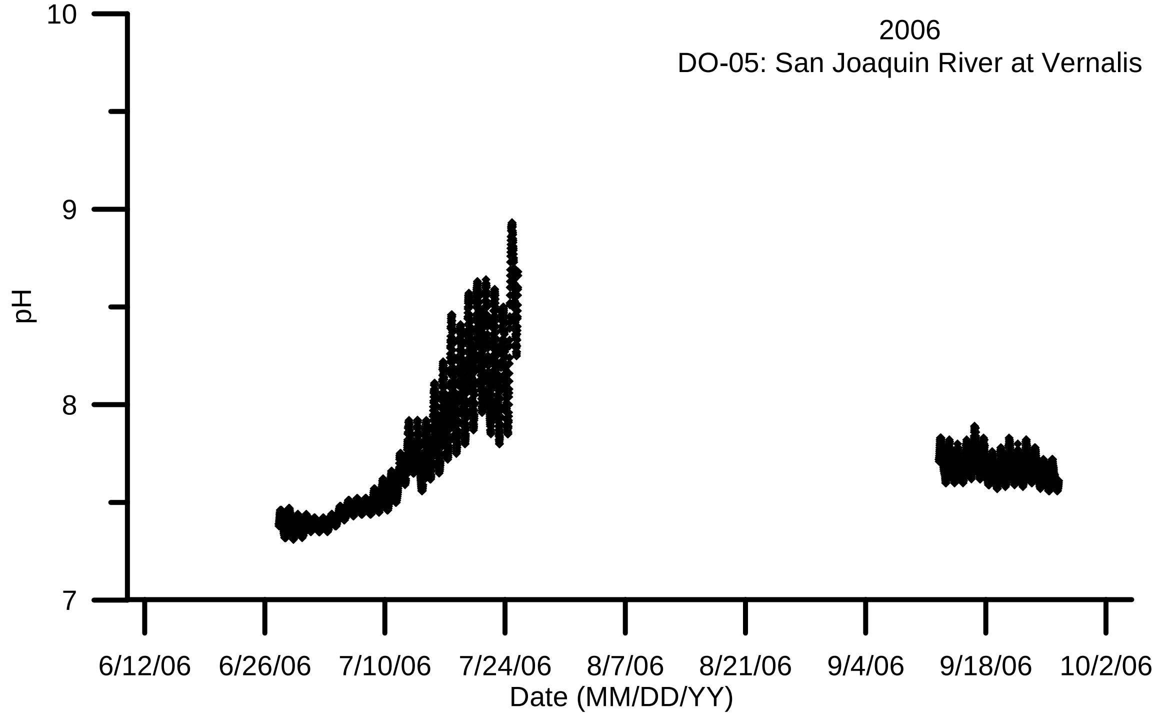


Figure 15: pH 15 minute data at DO-05 for 2006 and 2007.



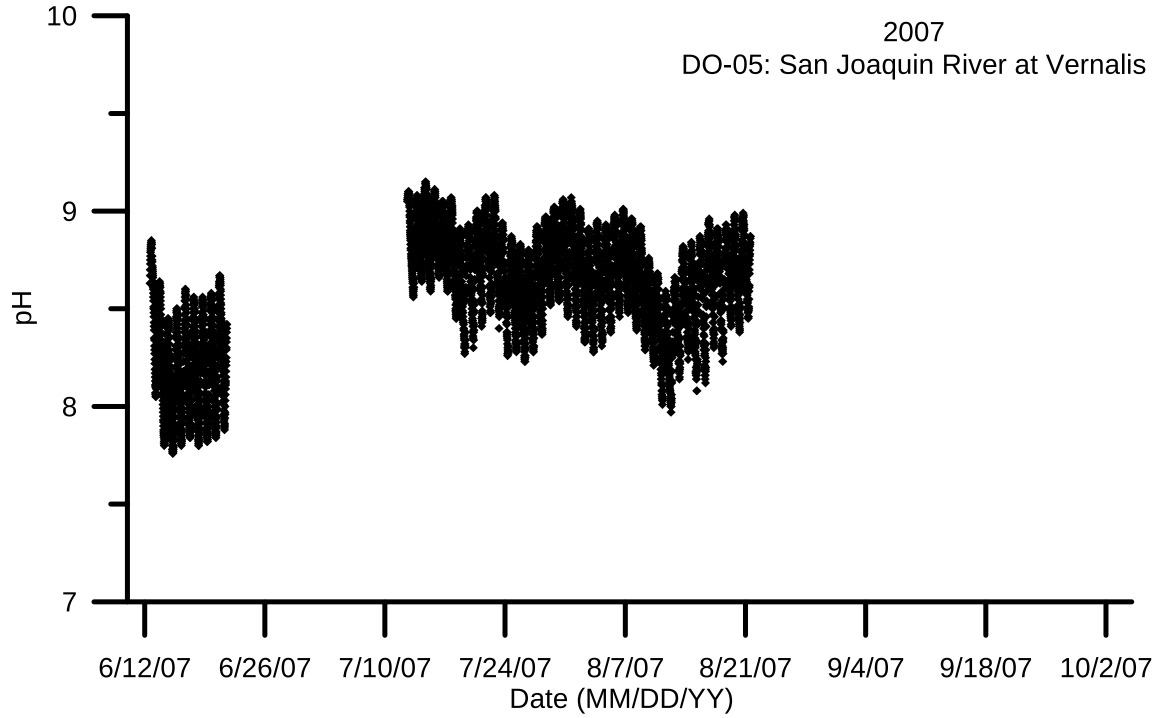
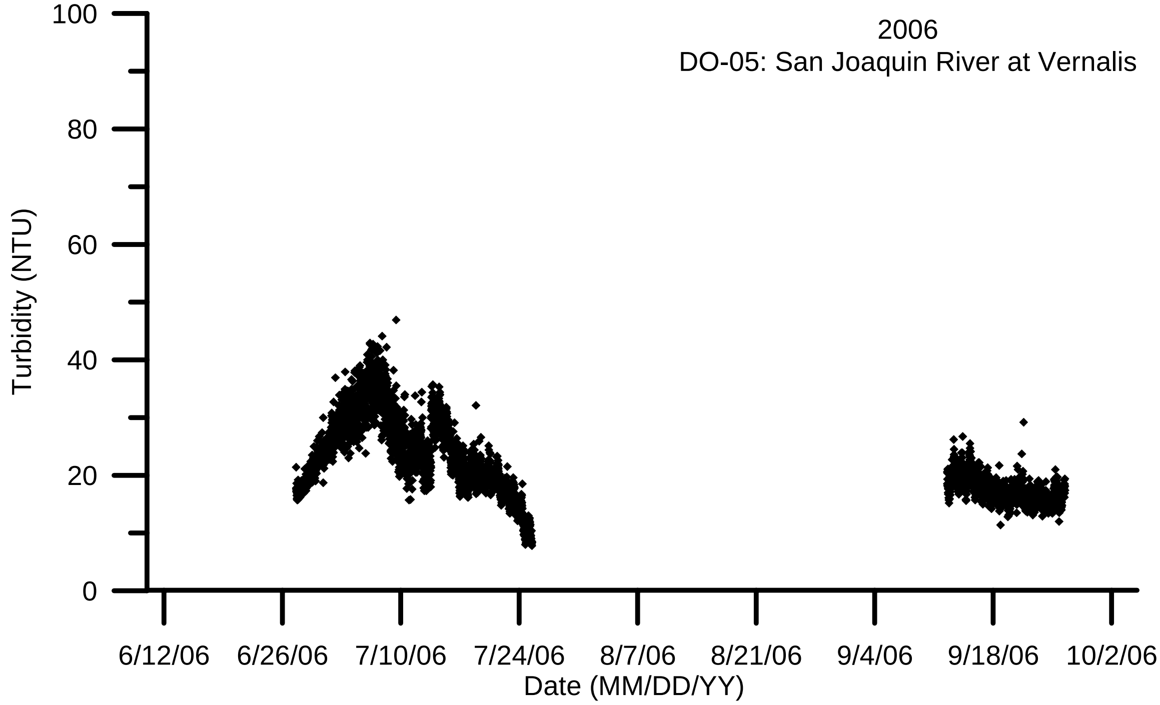


Figure 16: Turbidity 15 minute data at DO-05 for 2006 and 2007.



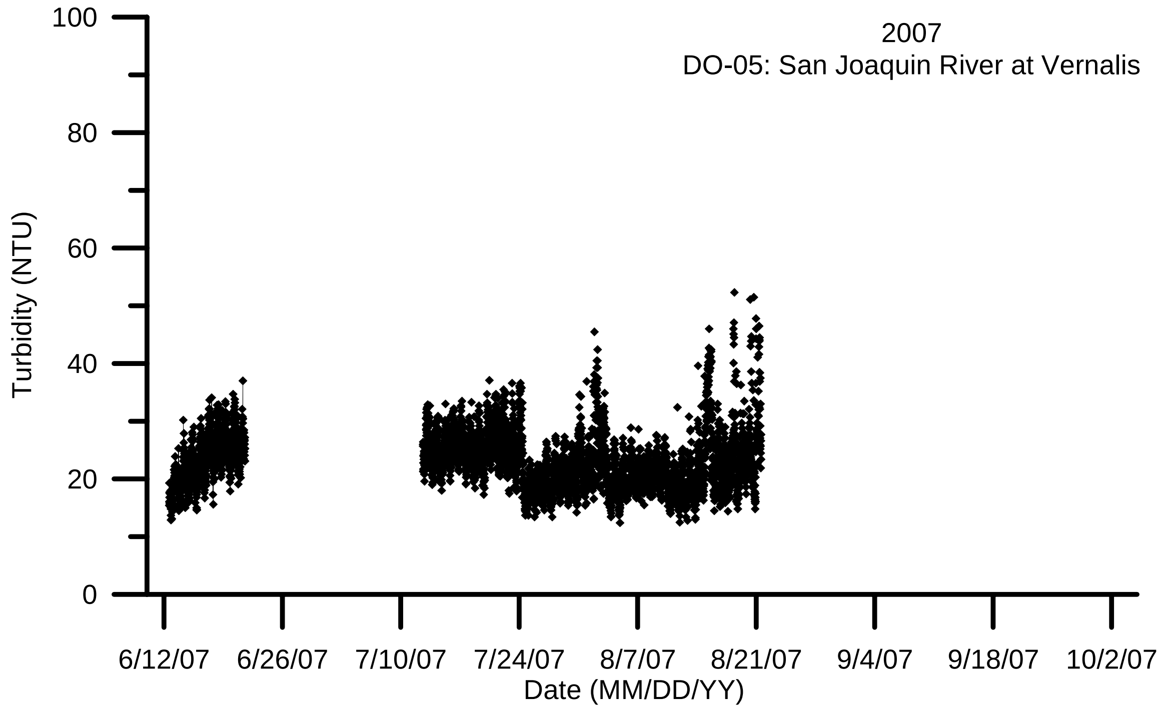
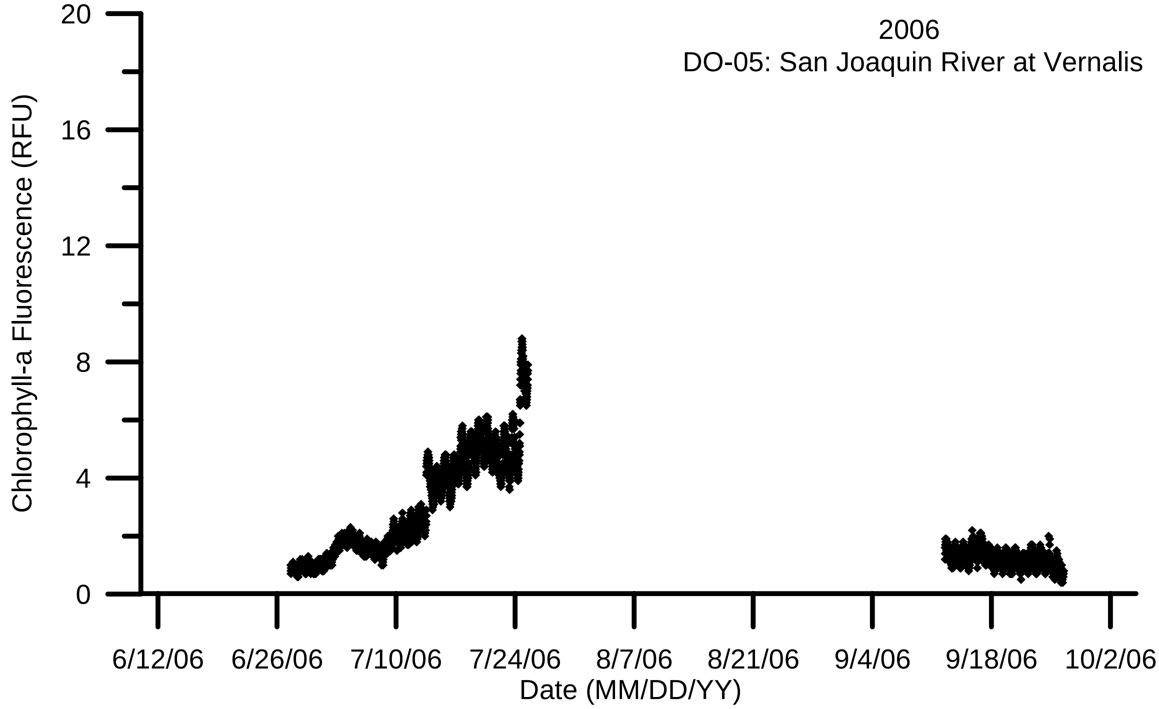


Figure 17: Chlorophyll-*a* fluorescence 15 minute data at DO-05 for 2006 and 2007.



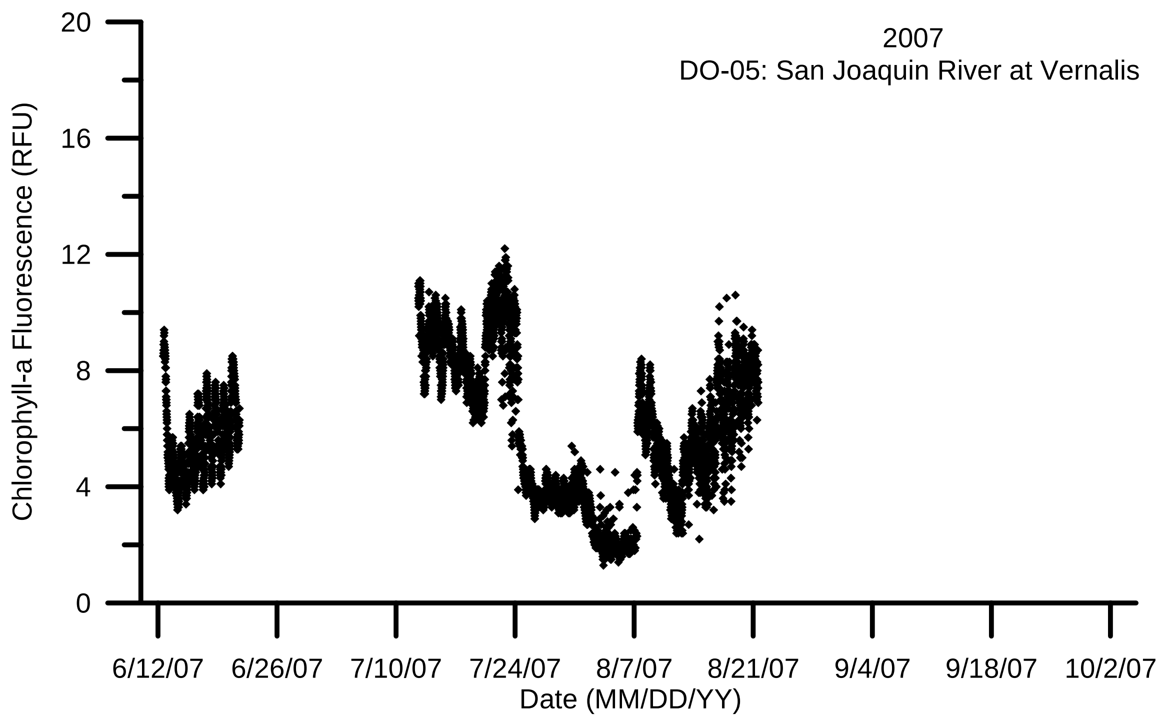
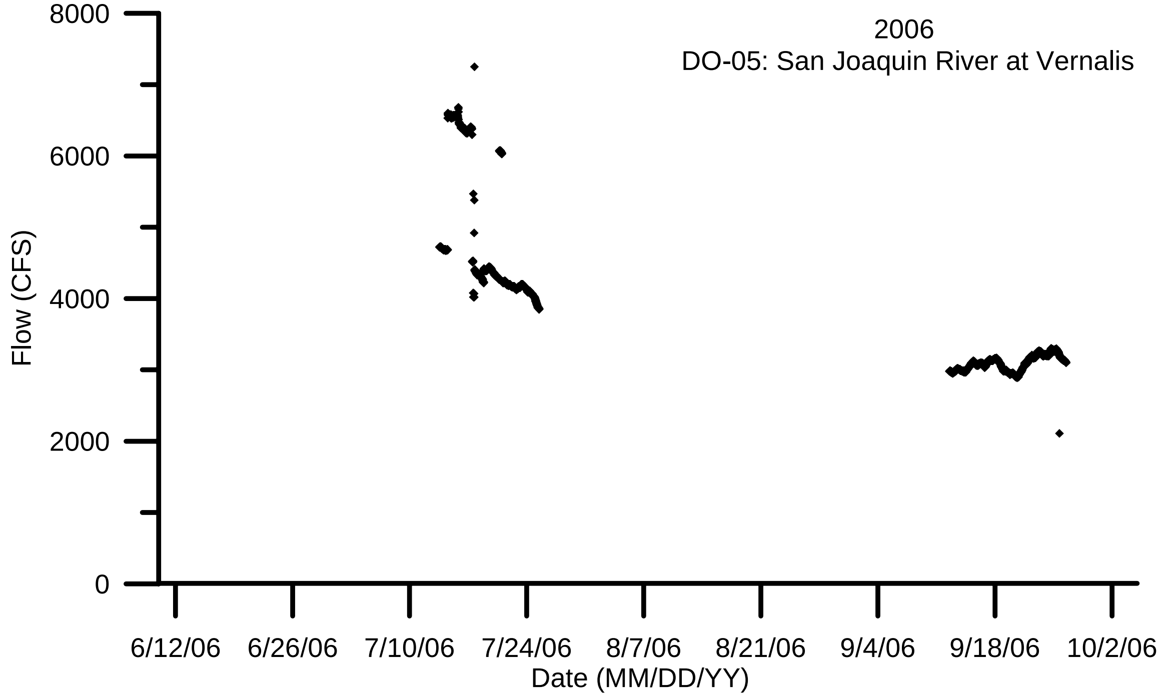


Figure 18: Flow 15 minute data at DO-05 for 2006 and 2007.



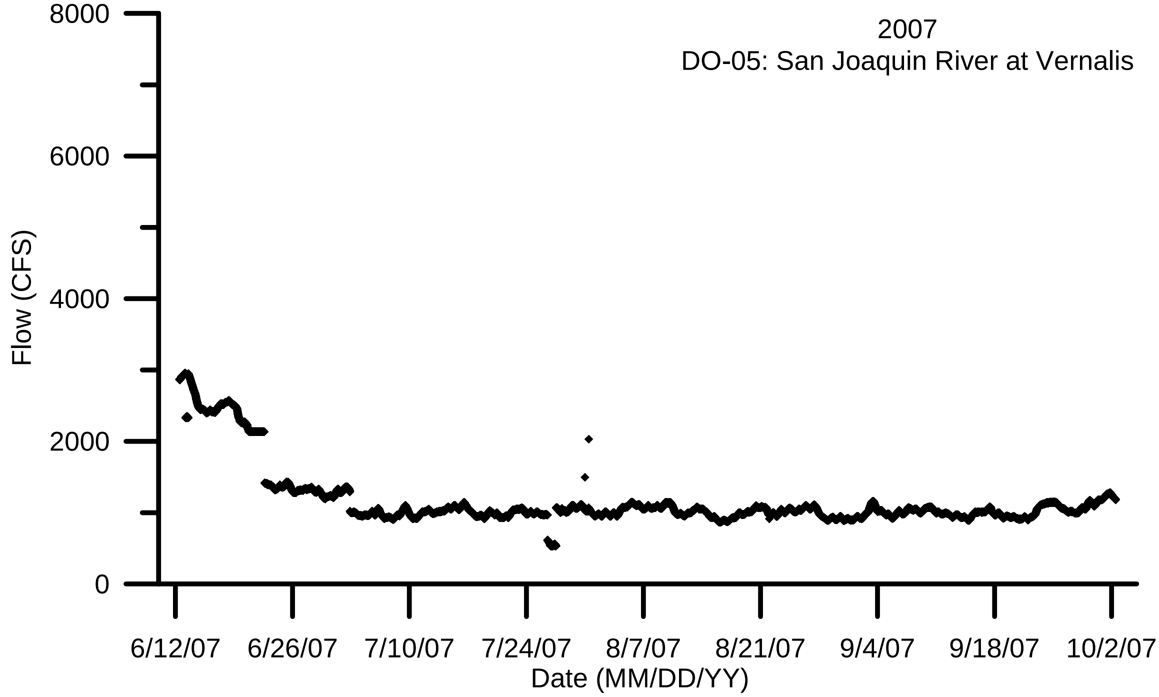
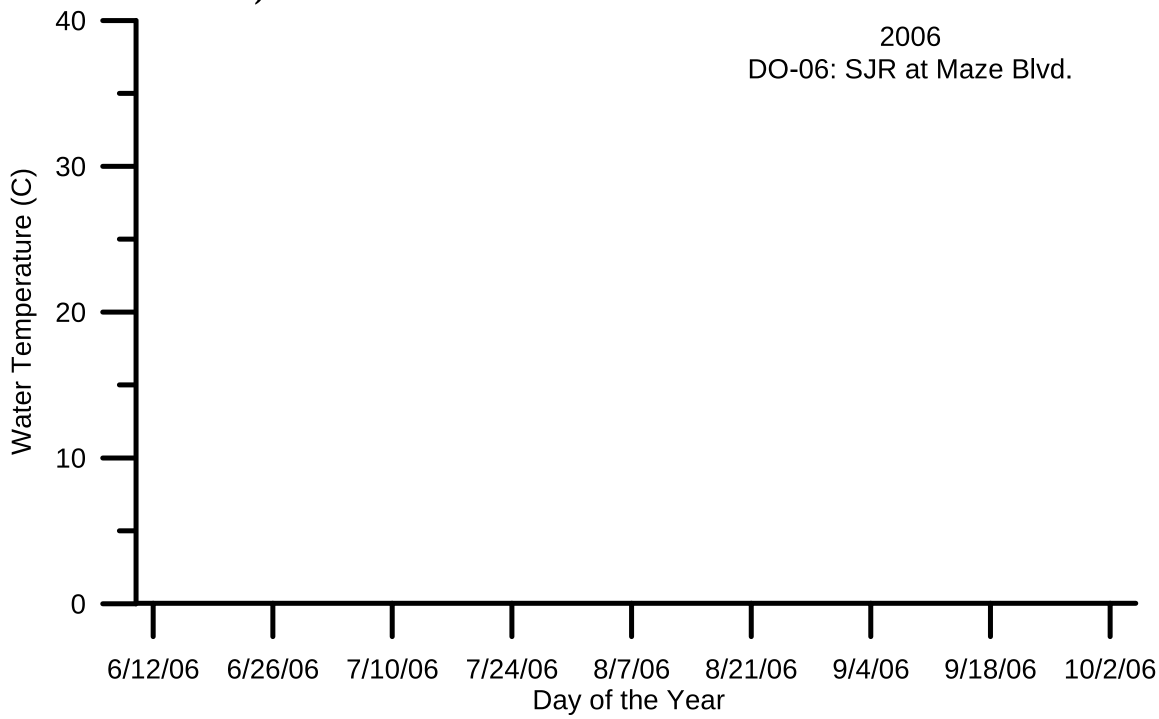


Figure 19: Water temperature 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



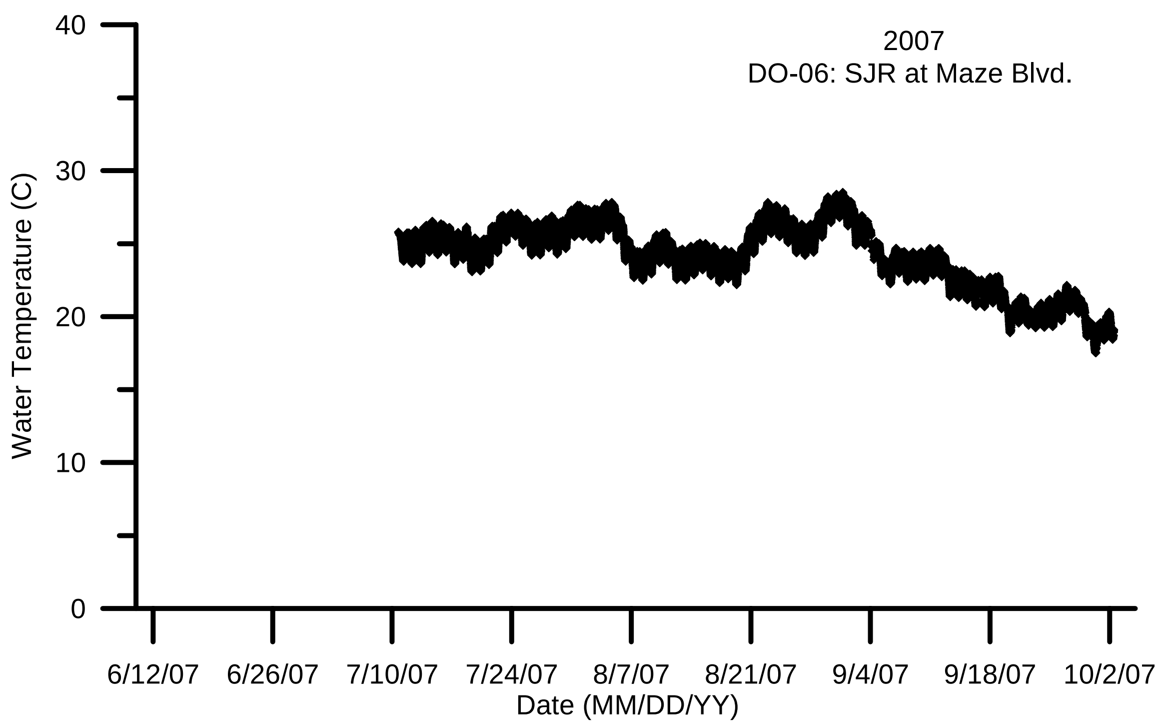
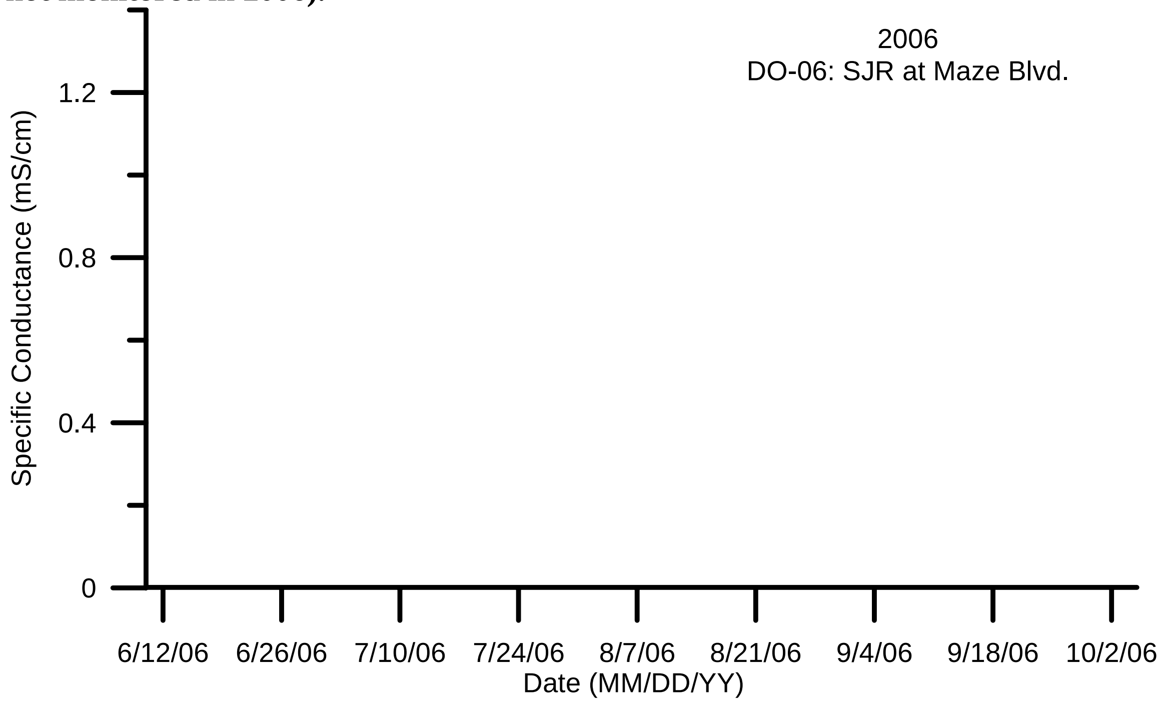


Figure 20: Specific conductance 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



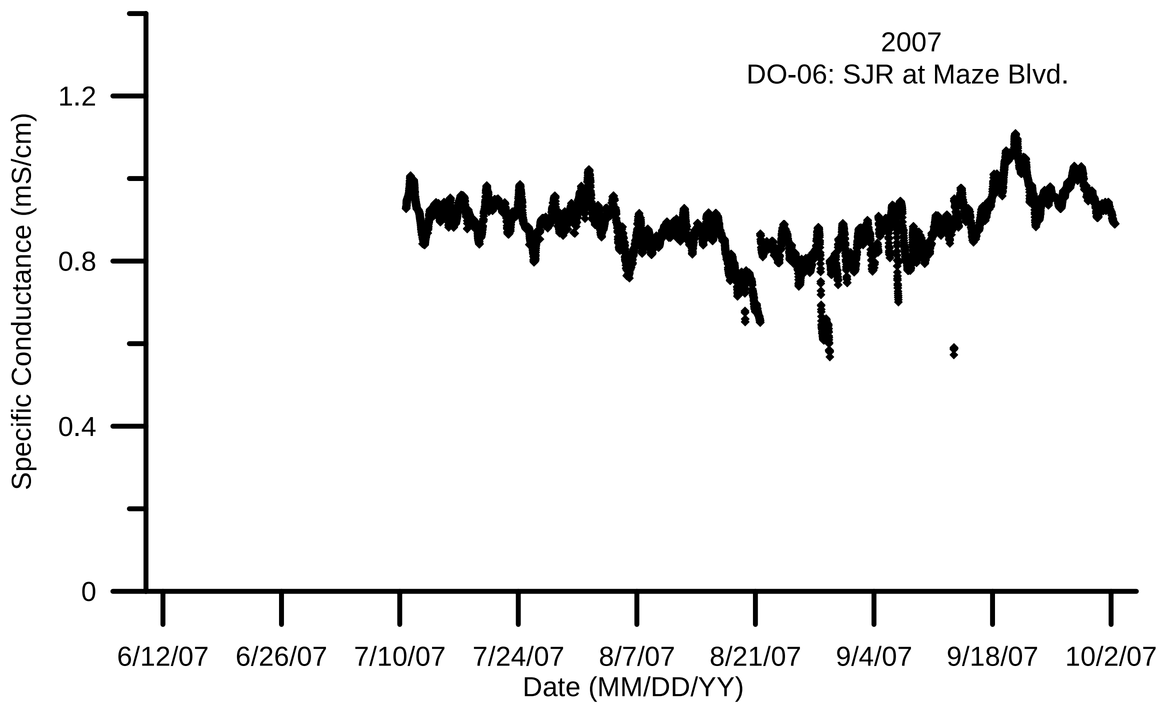
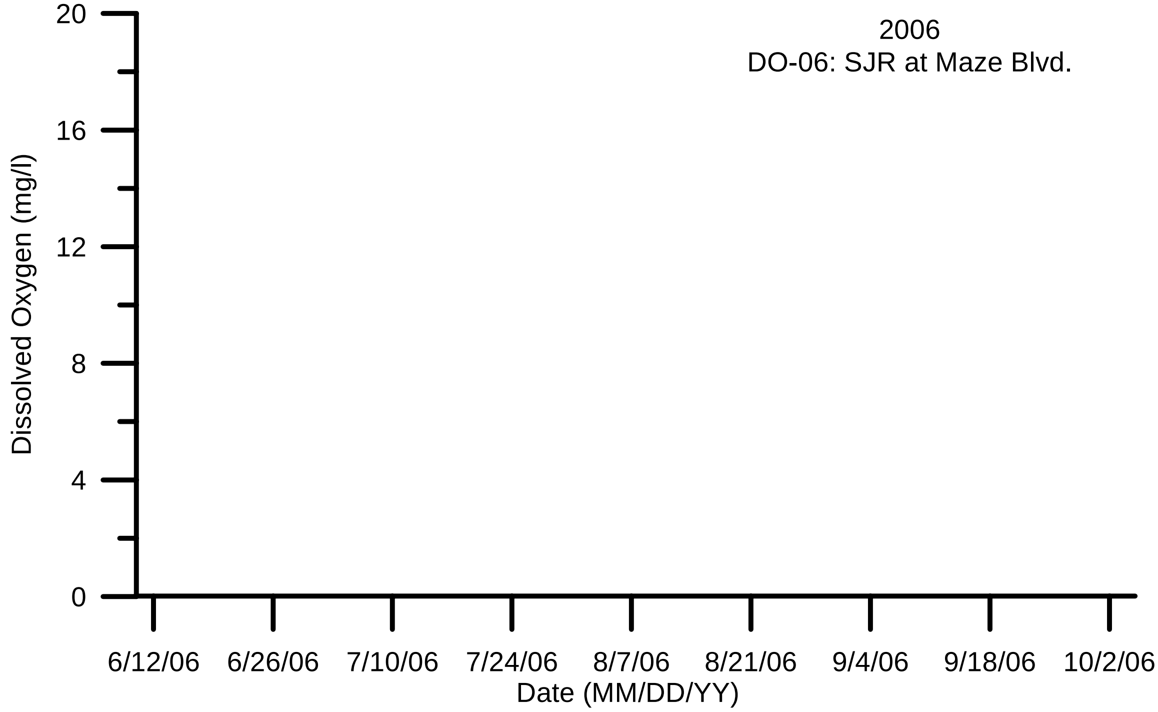


Figure 21: Dissolved oxygen concentration 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



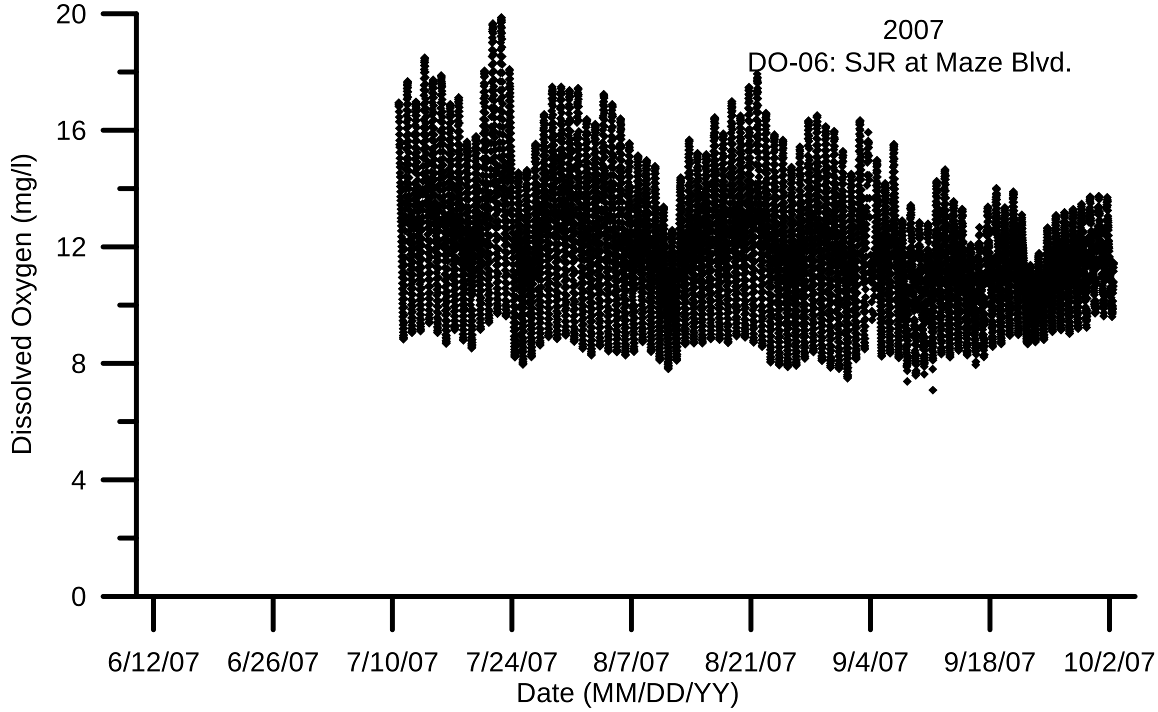
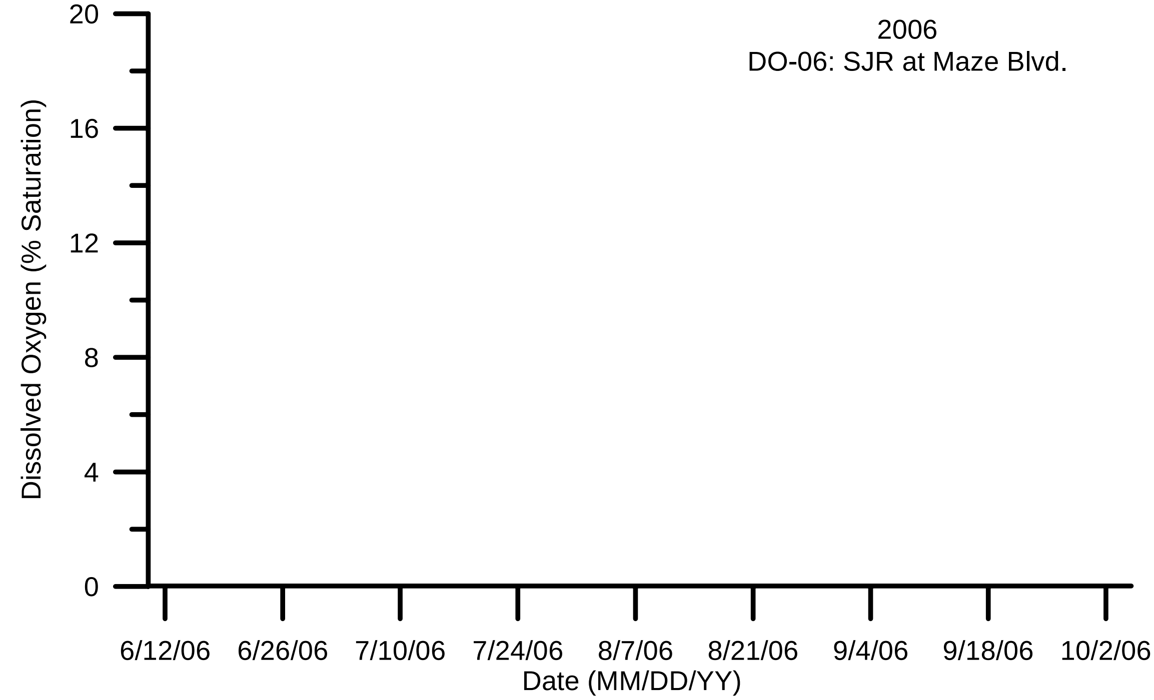


Figure 22: Dissolved oxygen percent of saturation 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



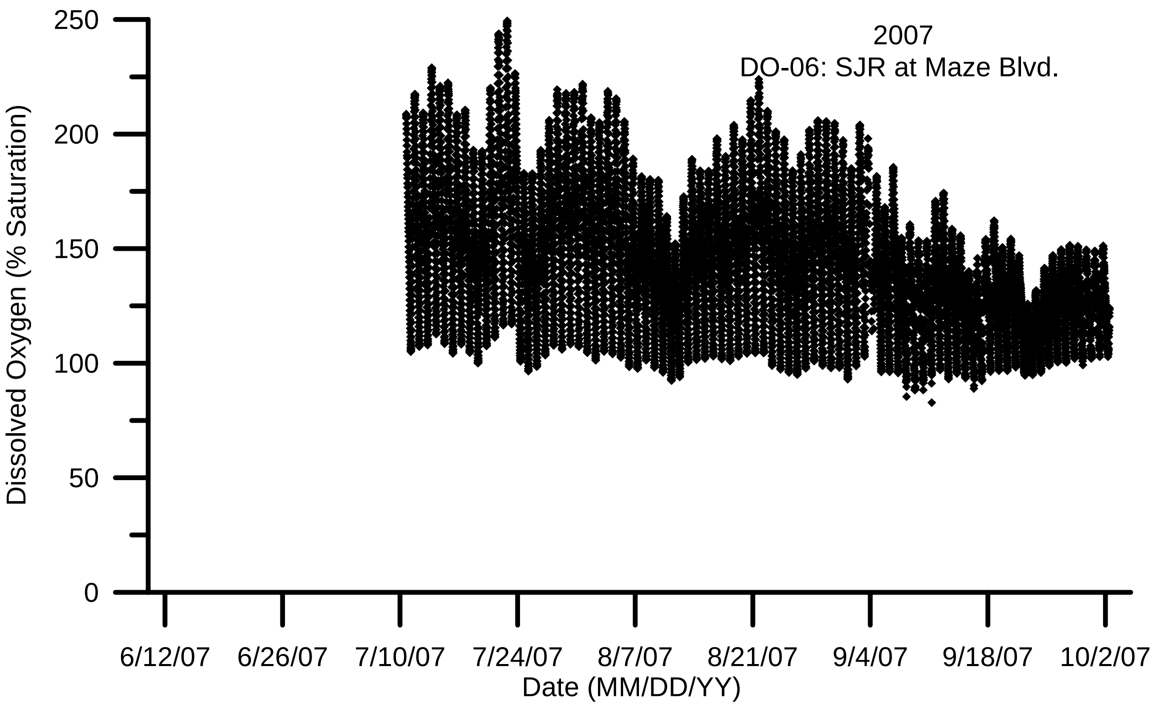
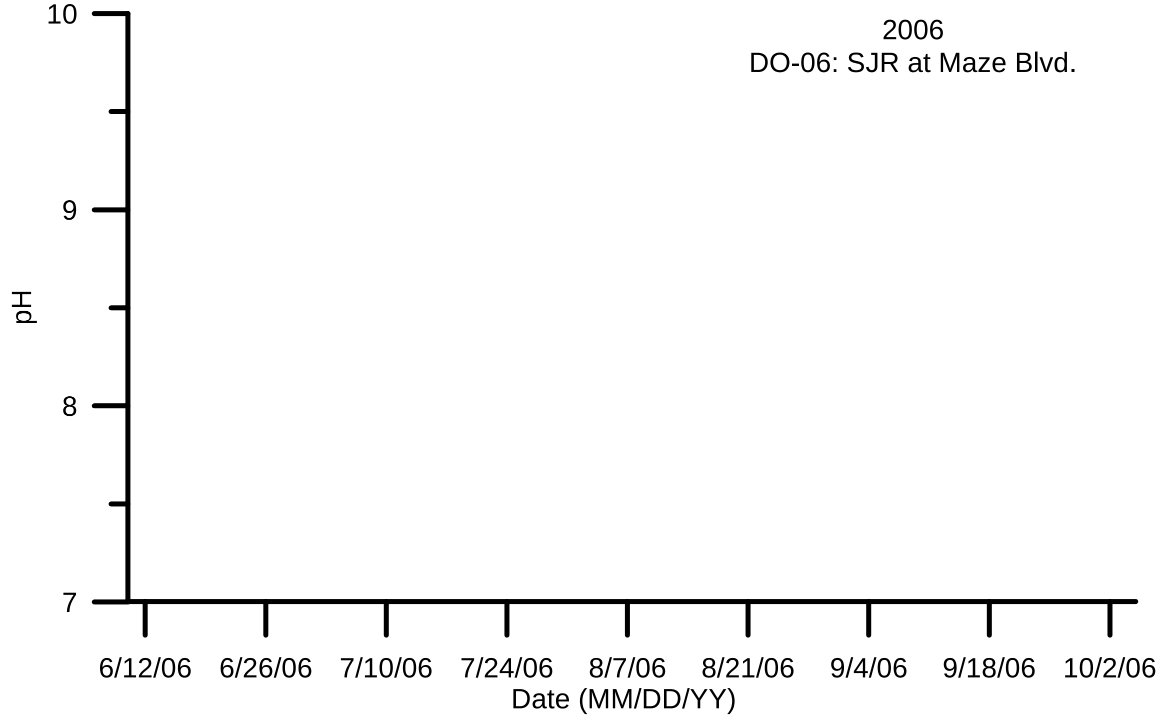


Figure 23: pH 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



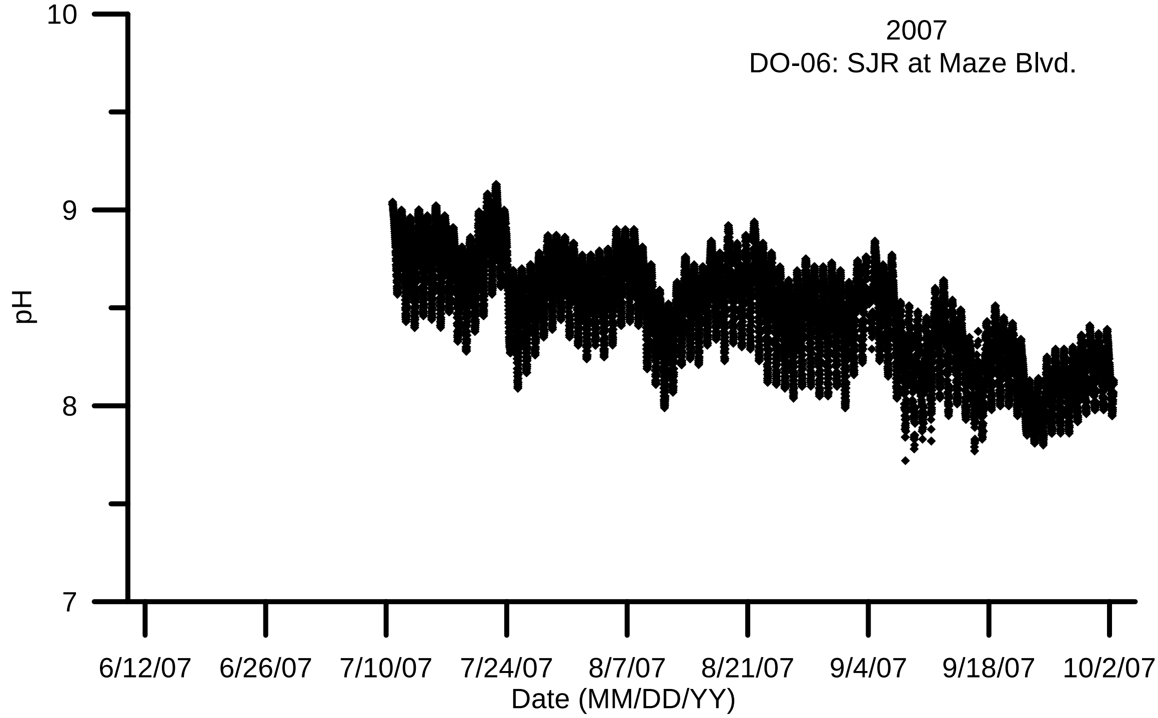
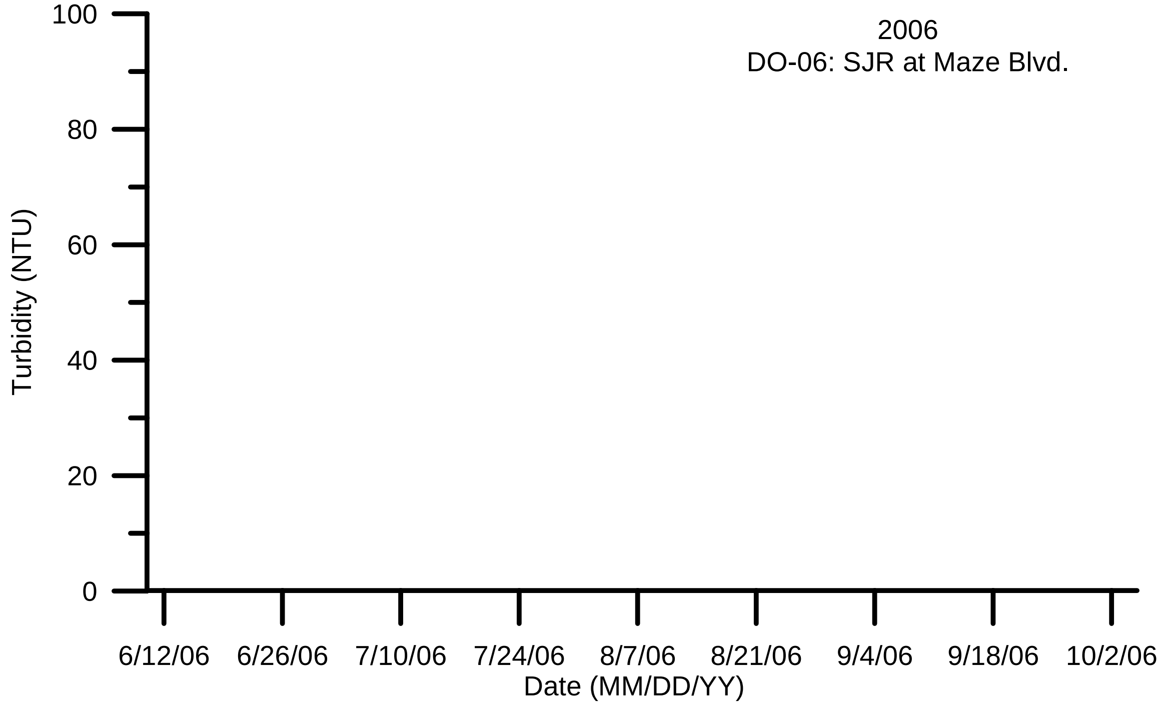


Figure 24: Turbidity 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



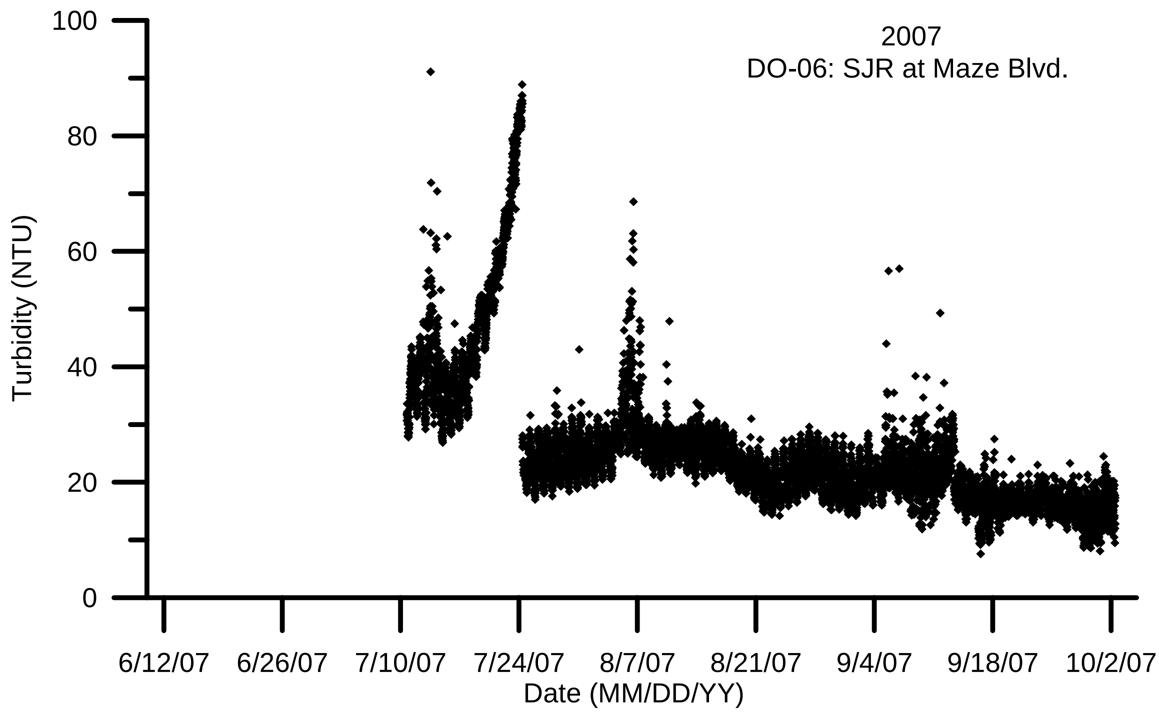
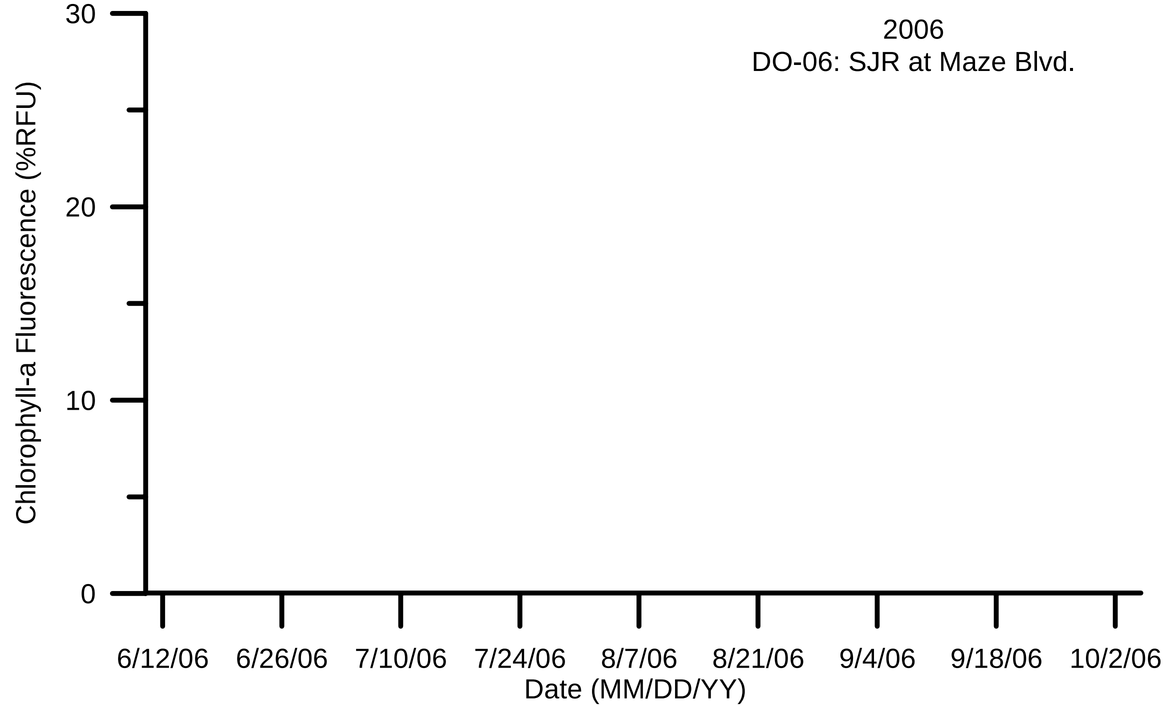


Figure 25: Chlorophyll-*a* fluorescence 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



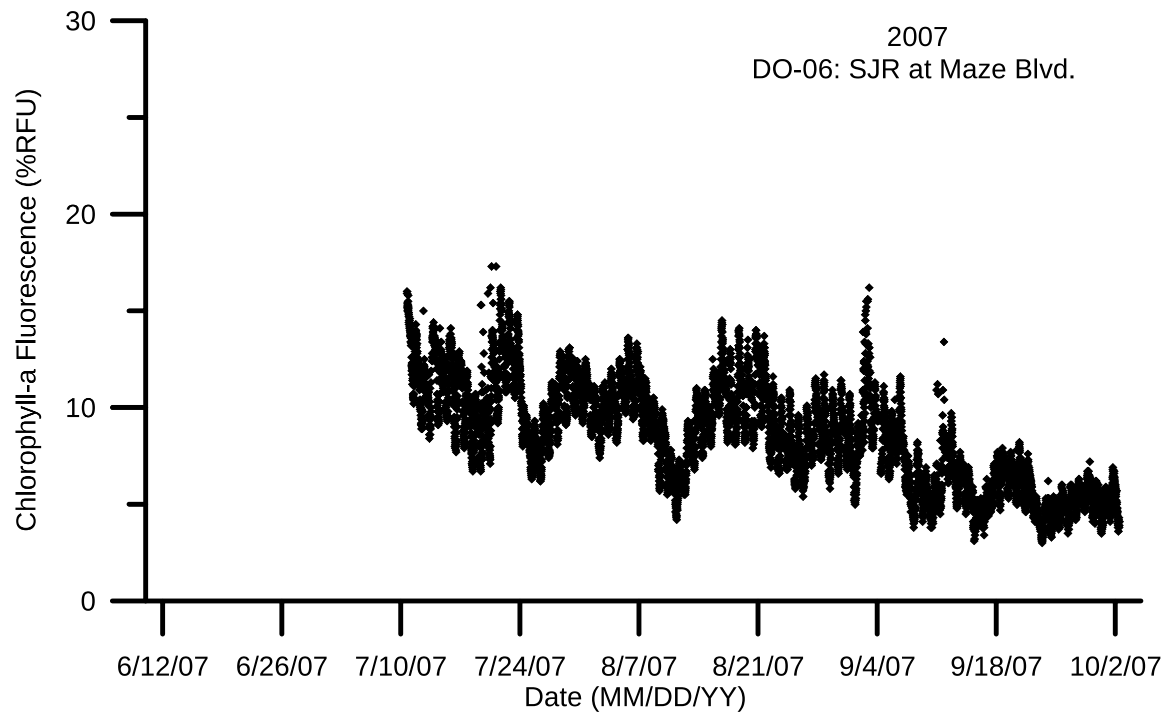
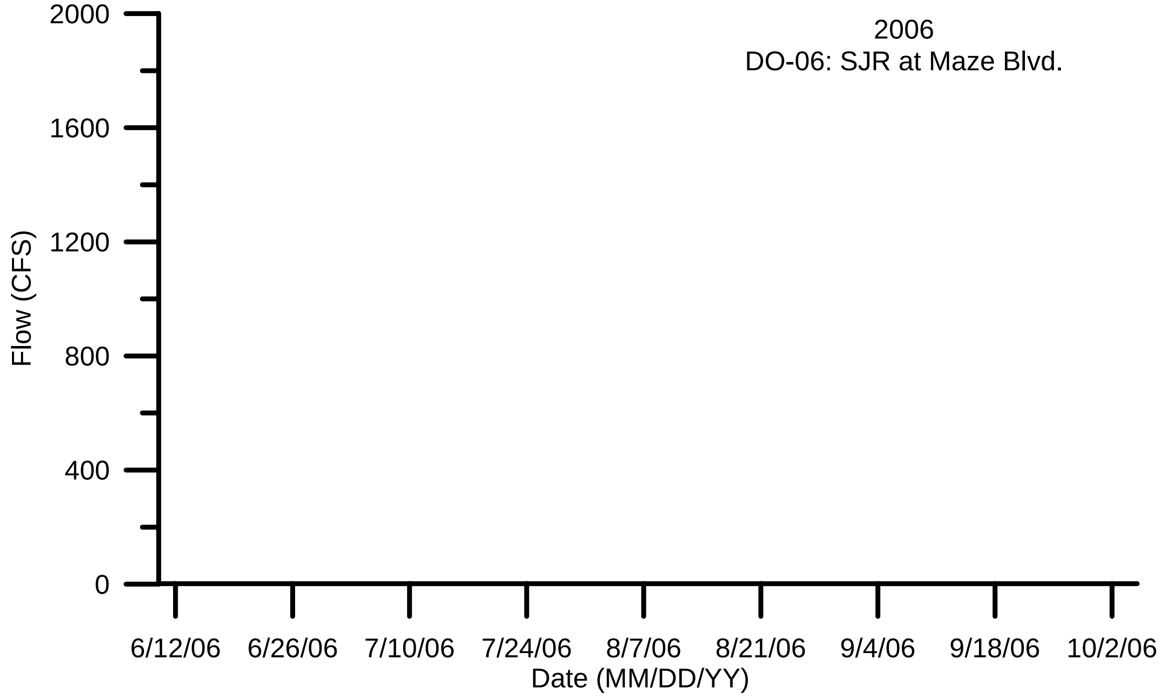


Figure 26: Flow 15 minute data at DO-06 for 2006 and 2007 (site not monitored in 2006).



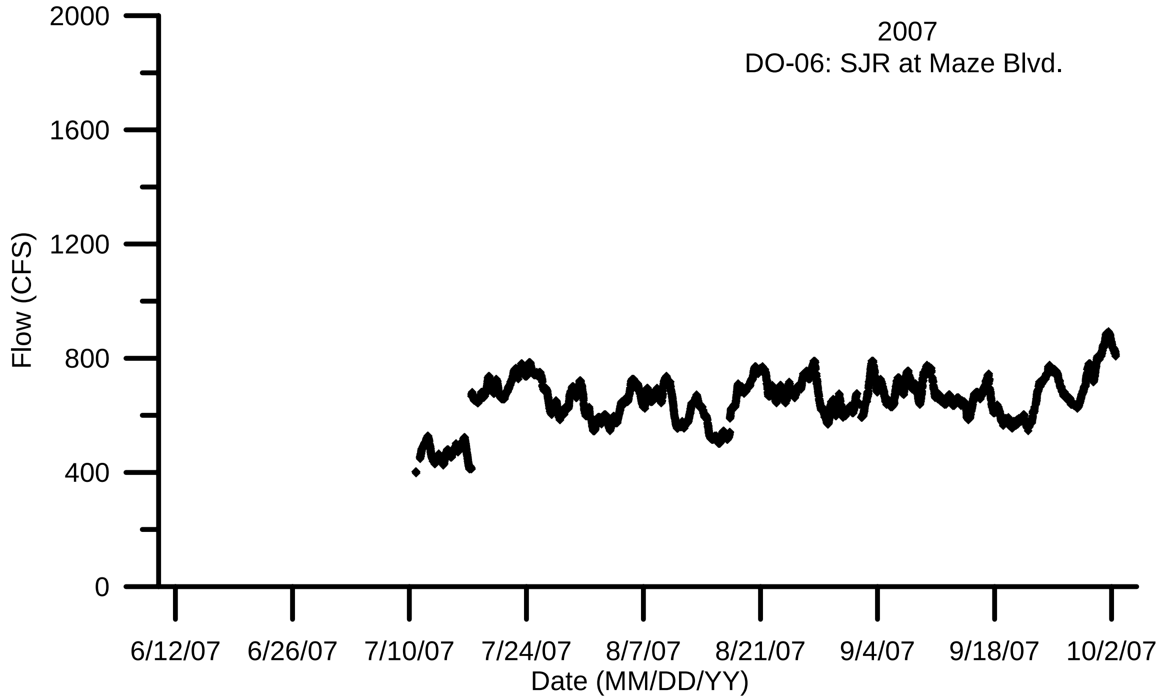
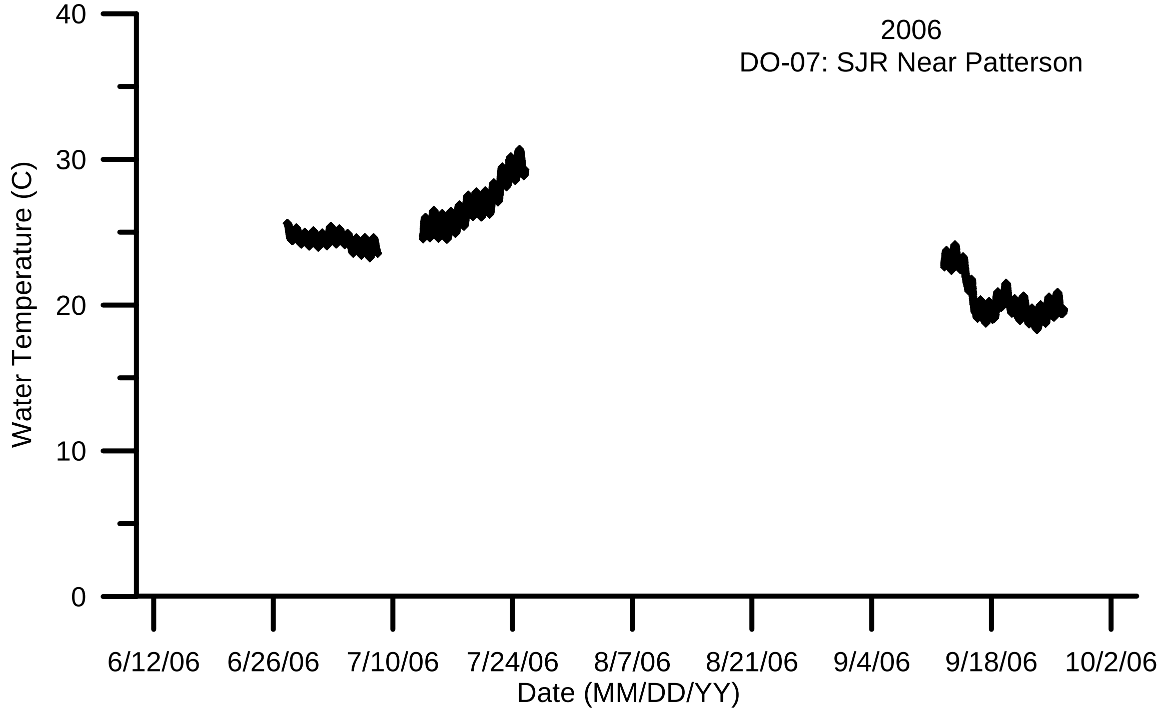


Figure 27: Water temperature 15 minute data at DO-07 for 2006 and 2007.



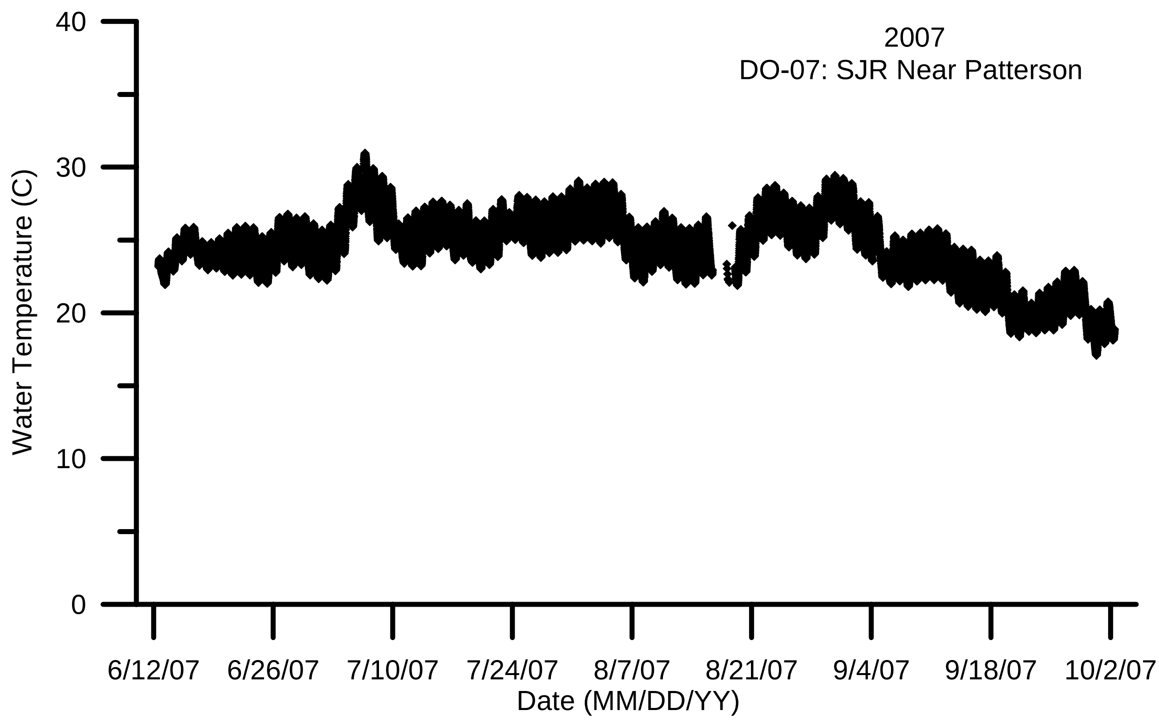
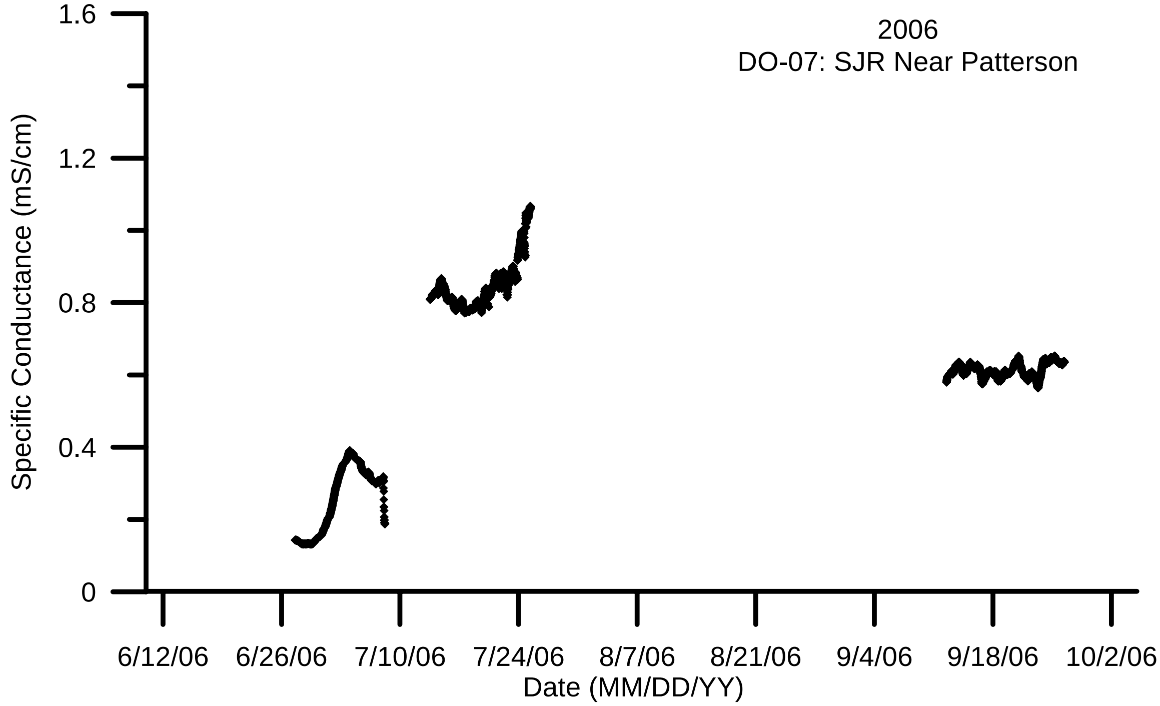


Figure 28: Specific conductance 15 minute data at DO-07 for 2006 and 2007.



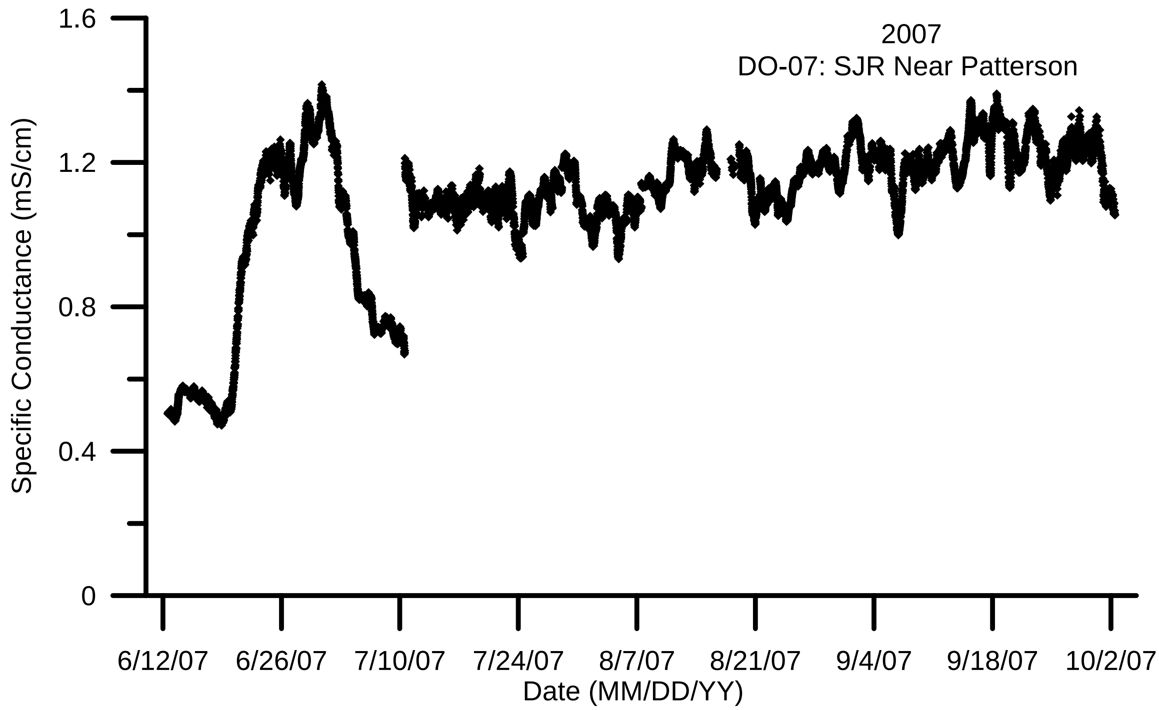
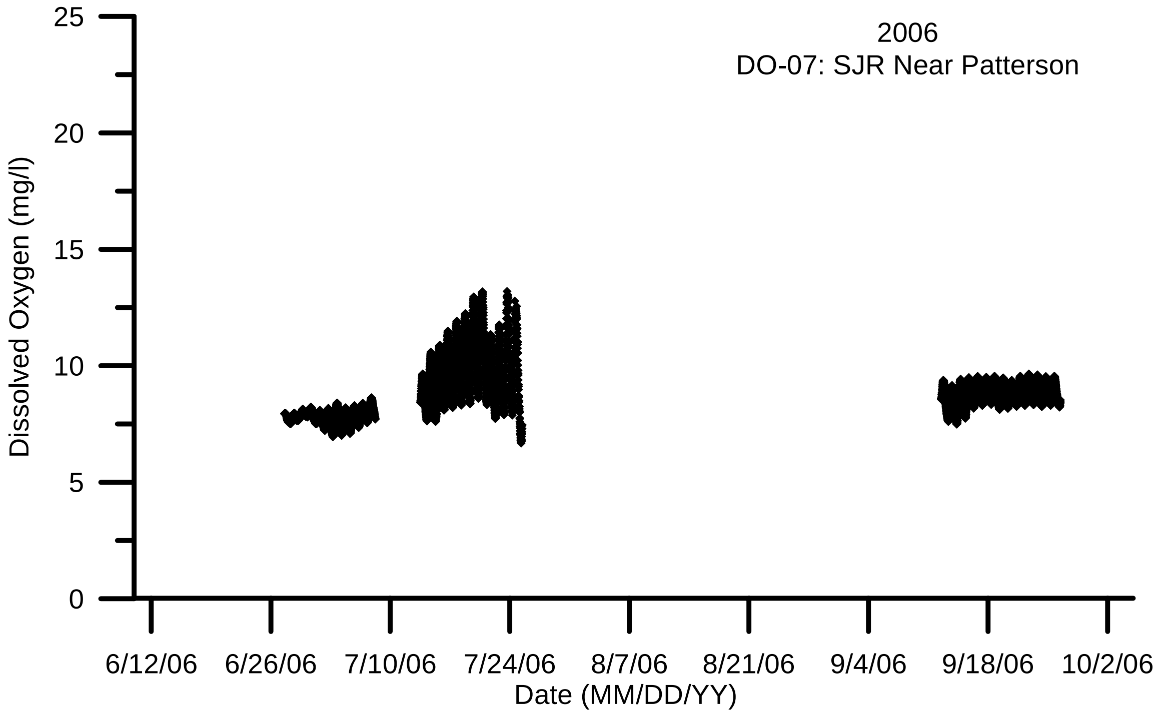


Figure 29: Dissolved oxygen concentration 15 minute data at DO-07 for 2006 and 2007.



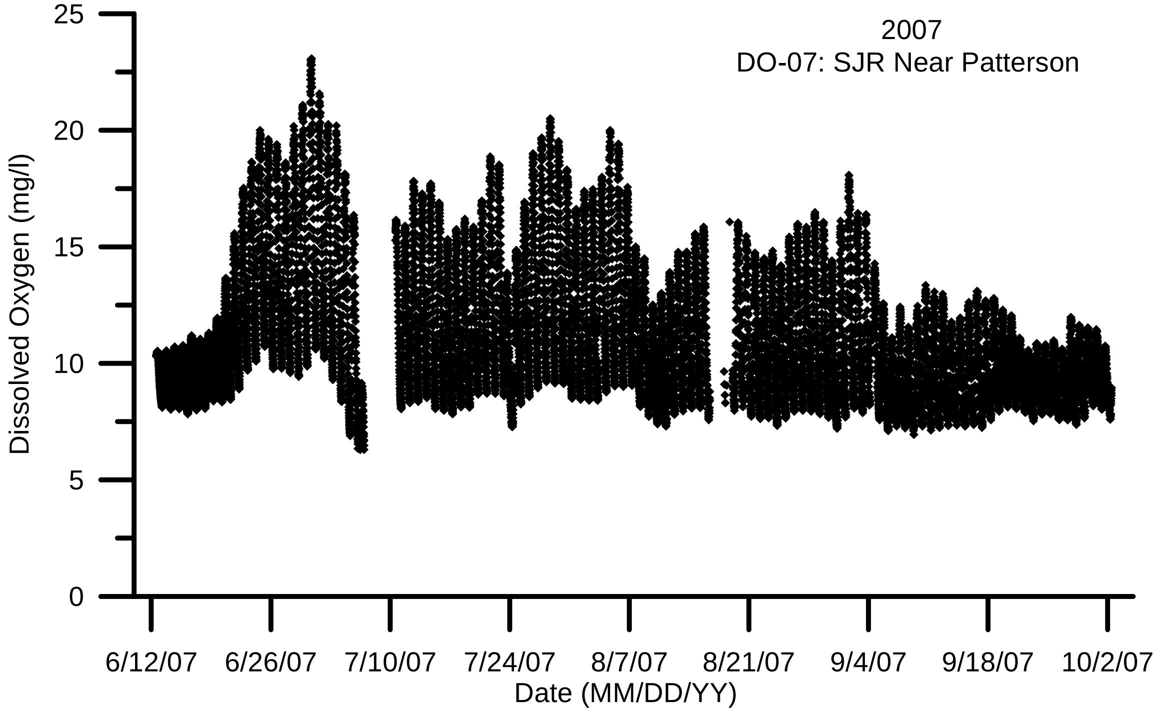
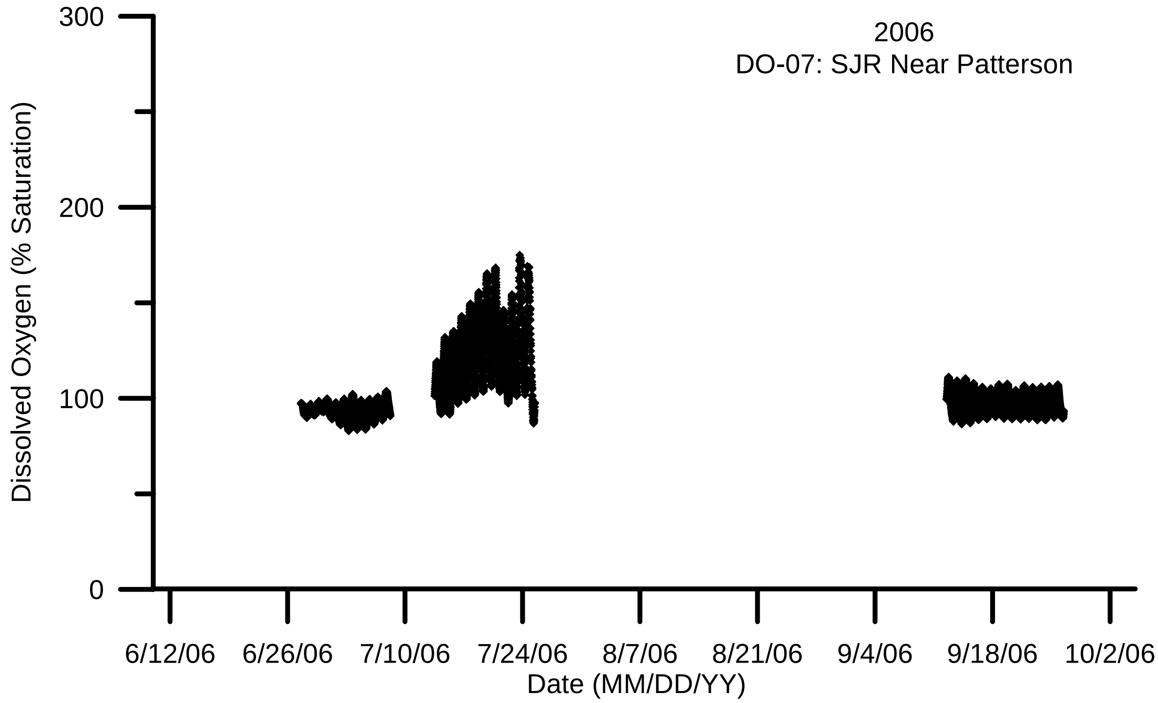


Figure 30: Dissolved oxygen percent of saturation 15 minute data at DO-07 for 2006 and 2007.



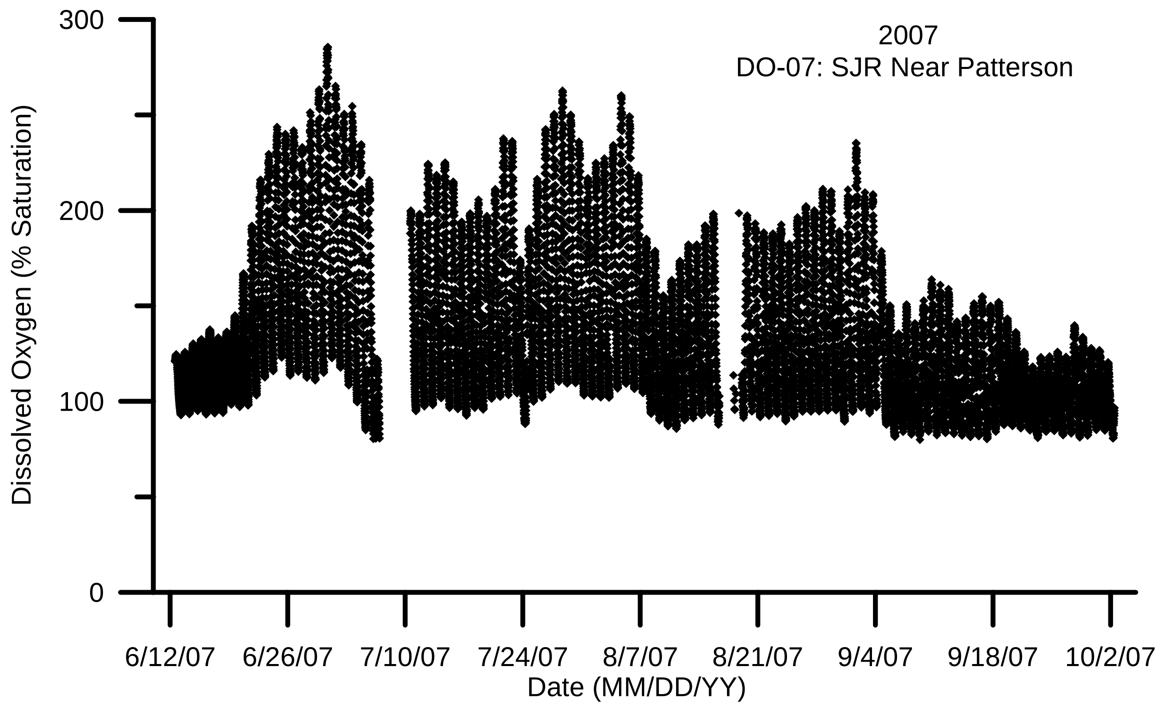
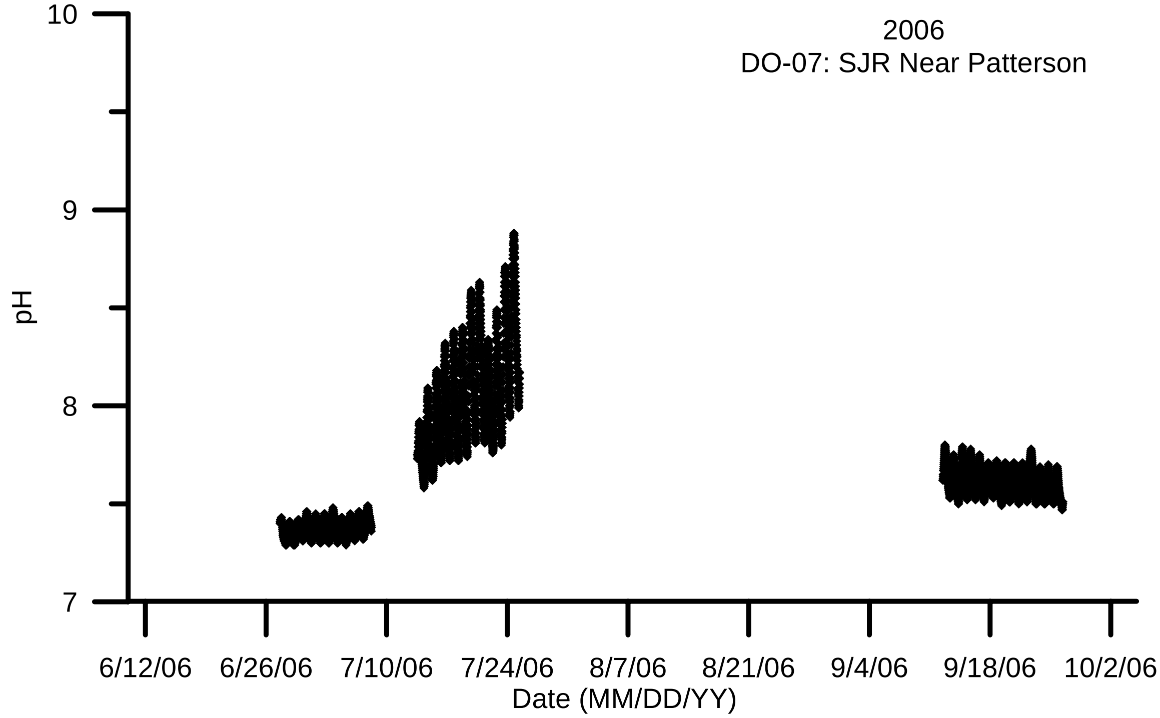


Figure 31: pH 15 minute data at DO-07 for 2006 and 2007.



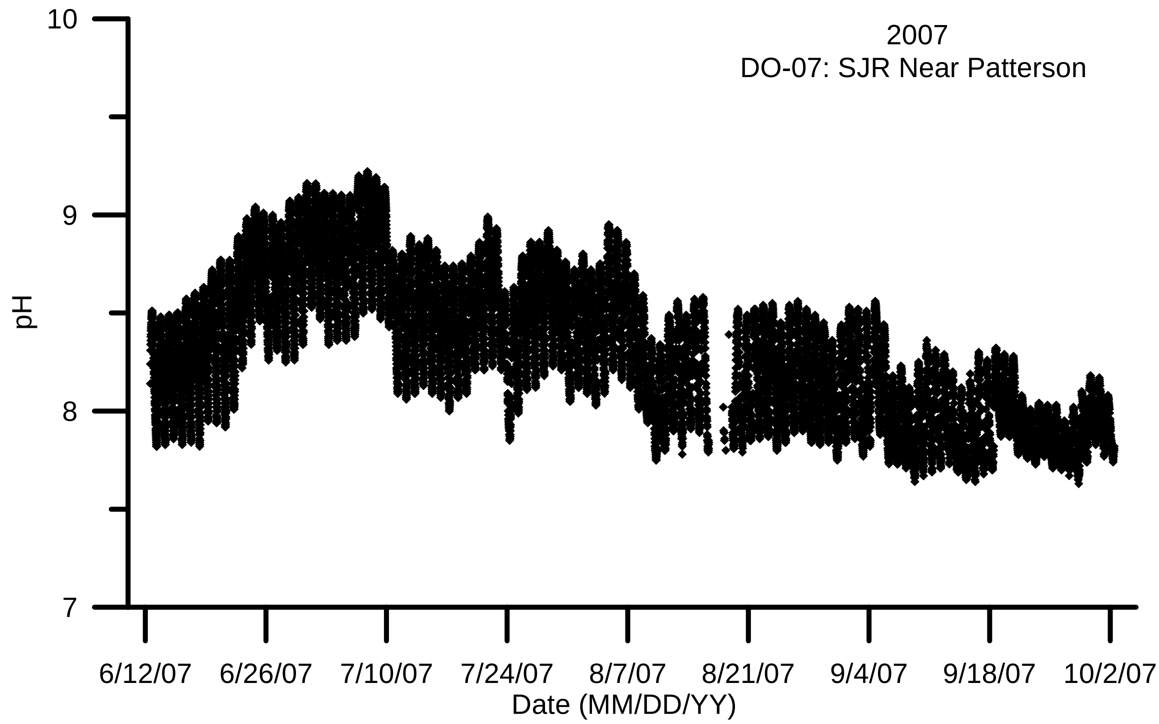
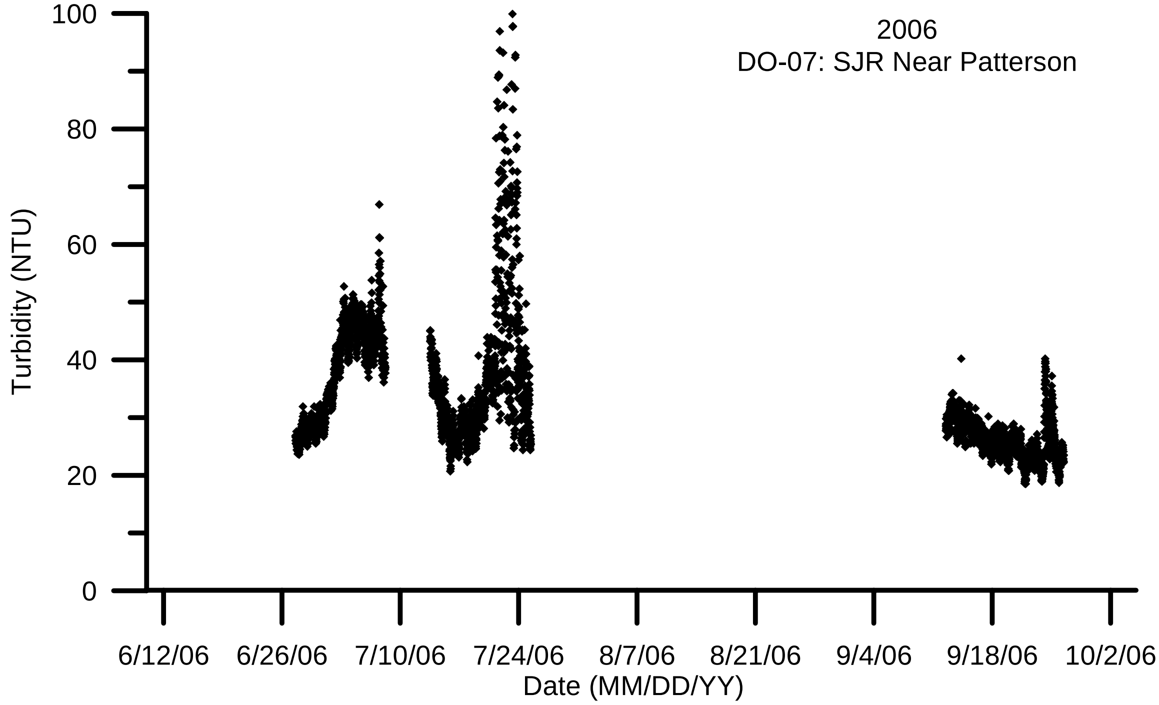


Figure 32: Turbidity 15 minute data at DO-07 for 2006 and 2007.



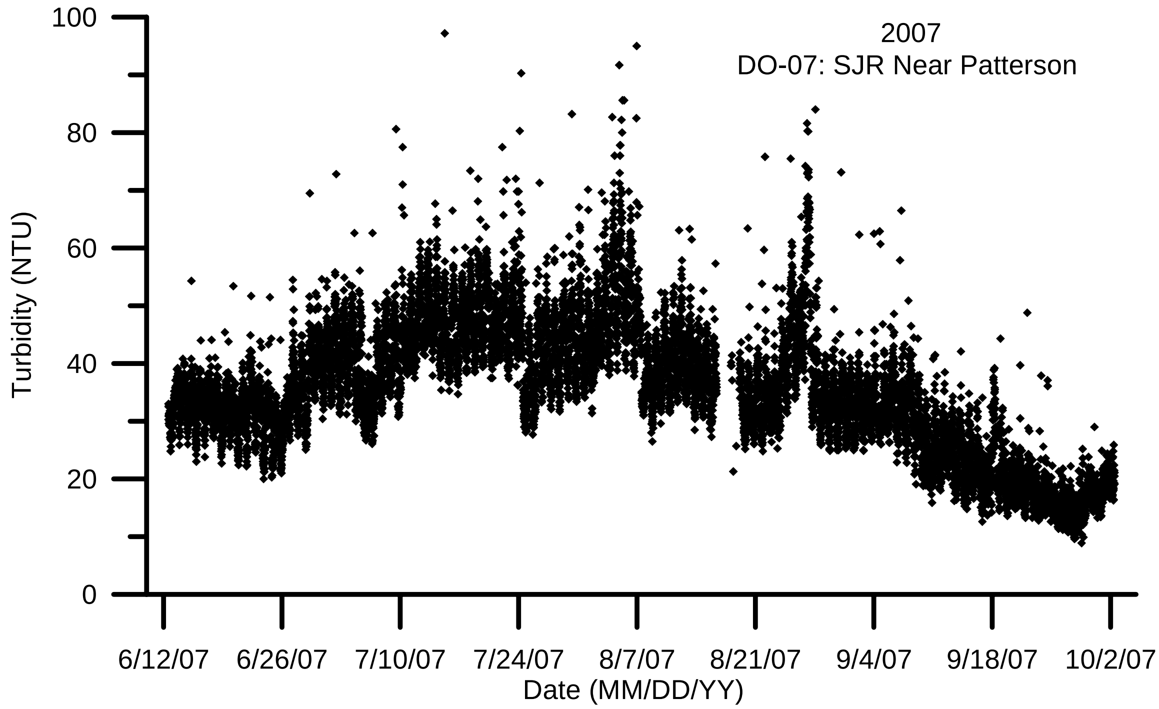
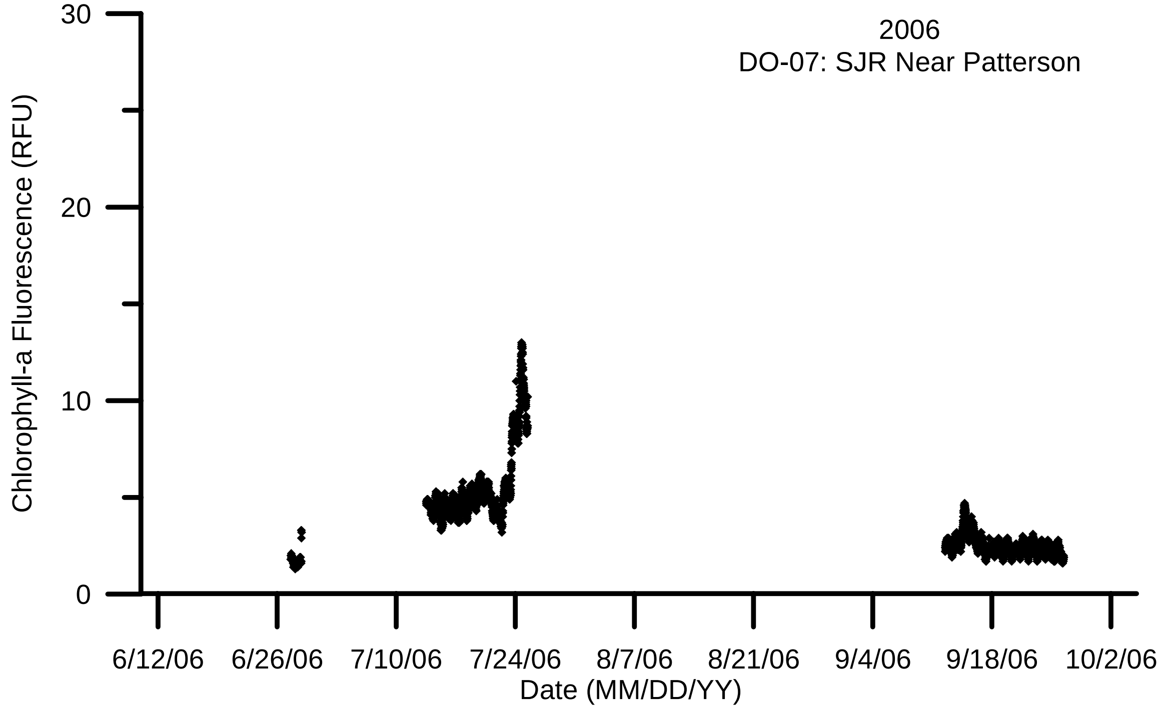


Figure 33: Chlorophyll-*a* fluorescence 15 minute data at DO-07 for 2006 and 2007.



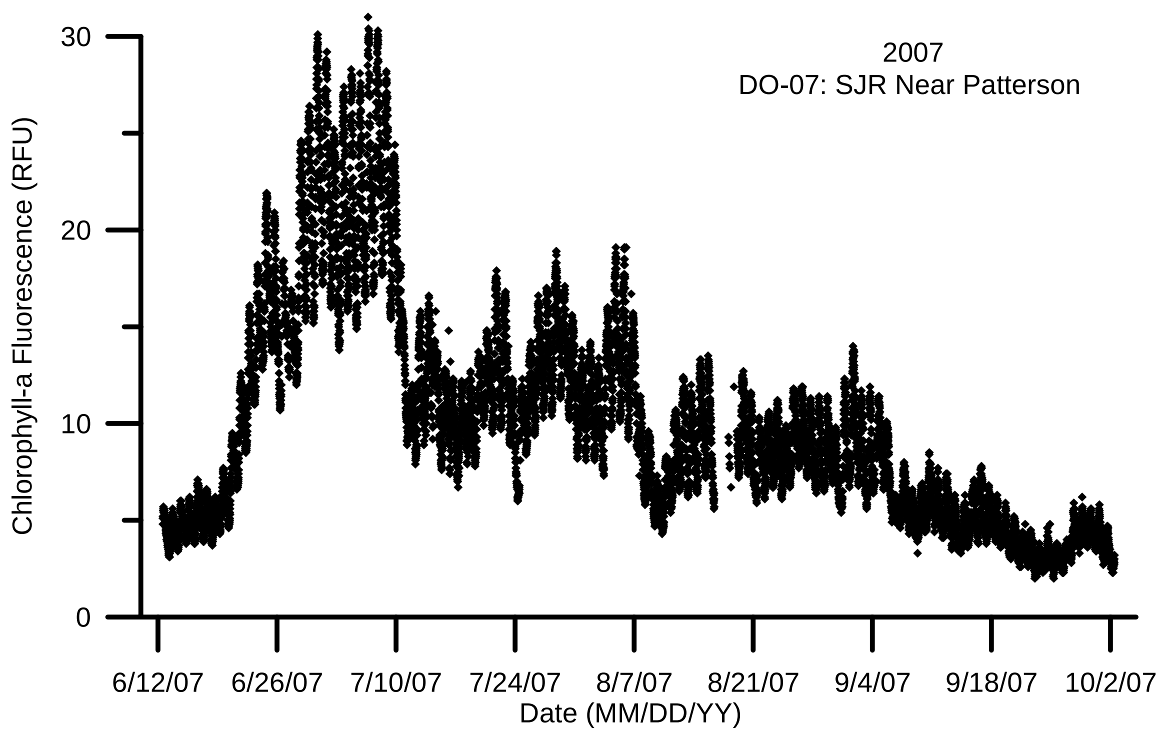
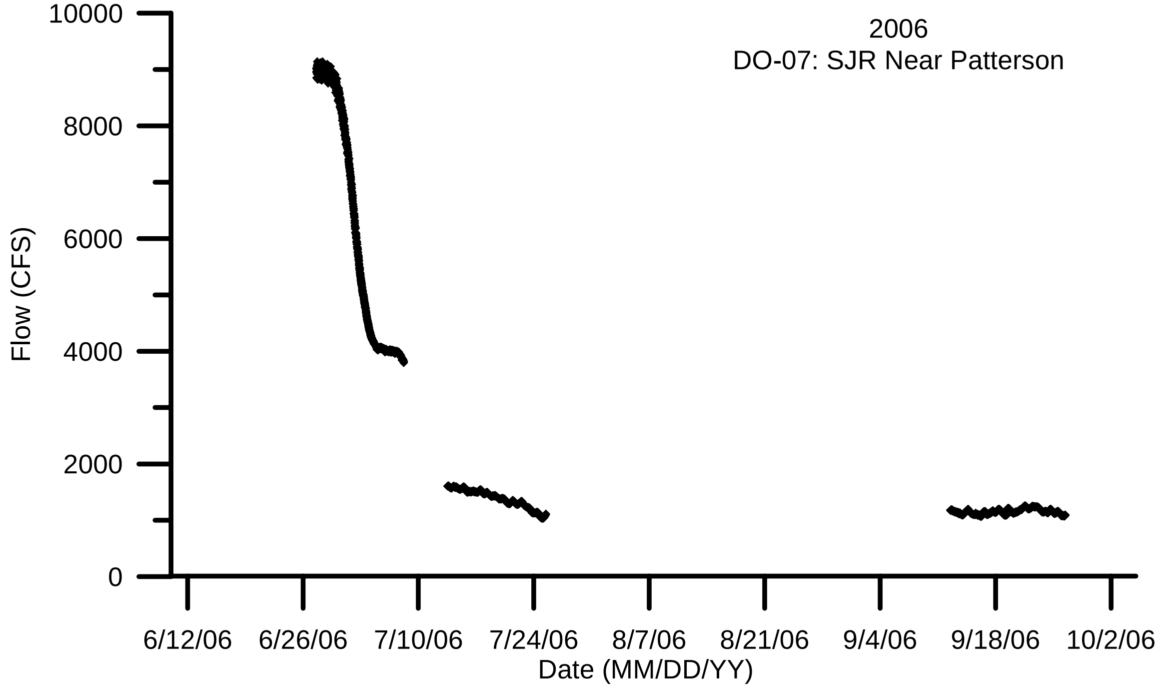


Figure 34: Flow data at DO-07 for 2006 and 2007.



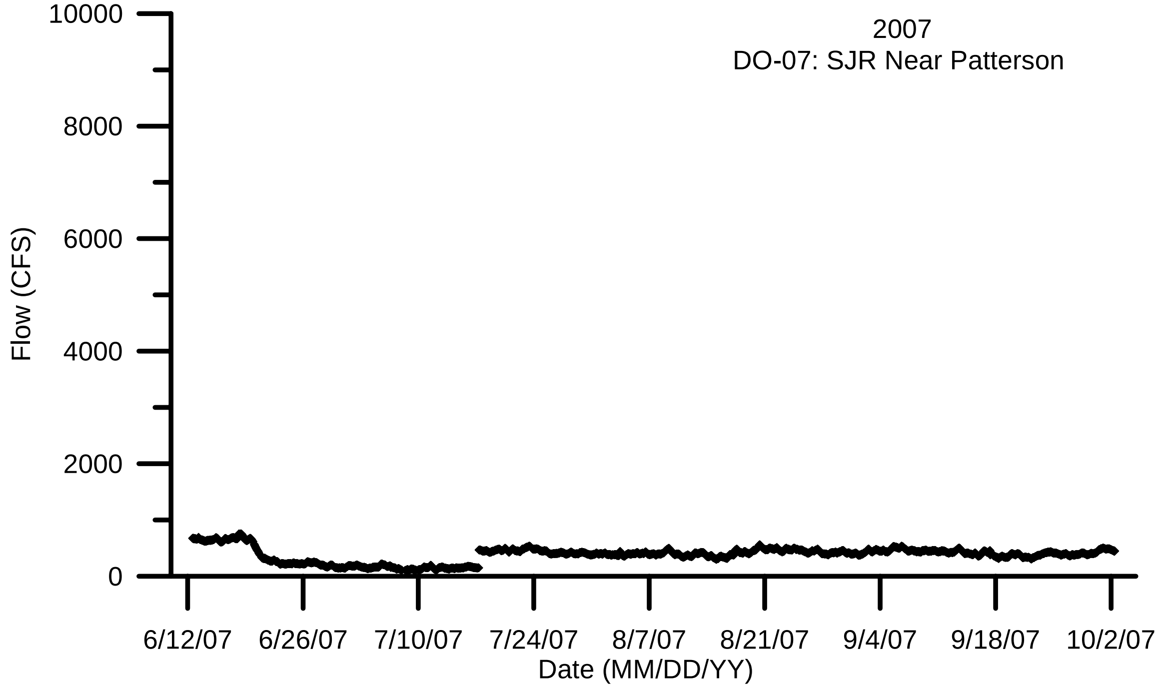
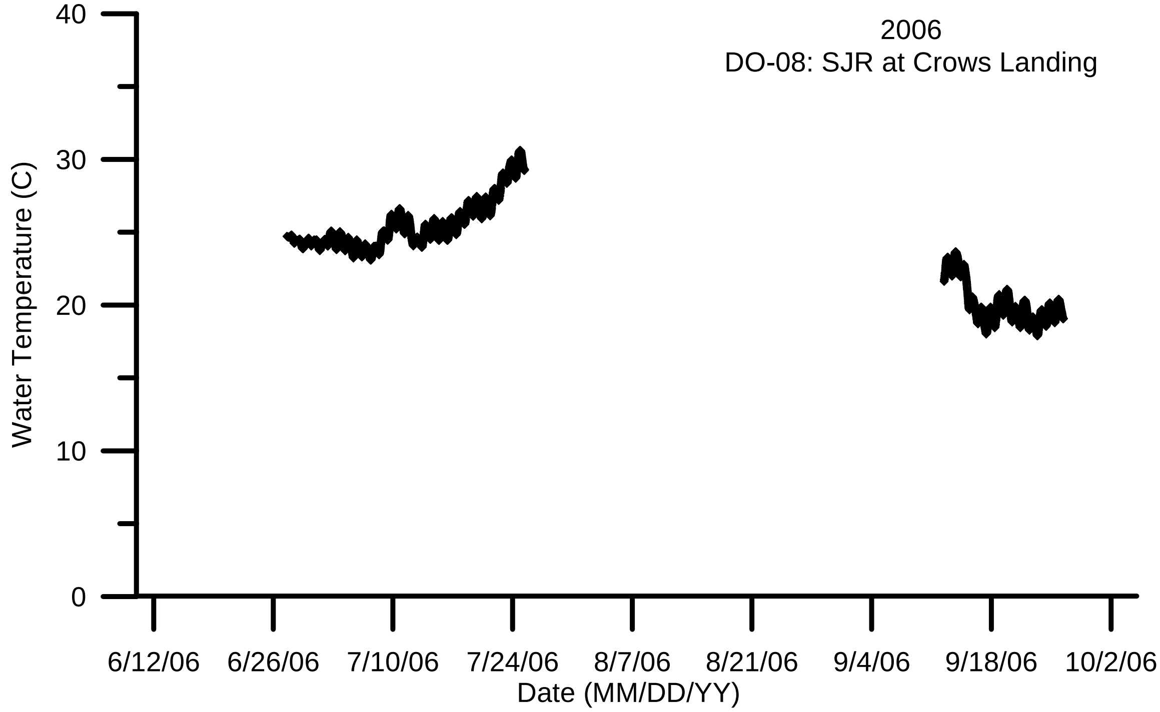


Figure 35: Water temperature 15 minute data at DO-08 for 2006 and 2007.



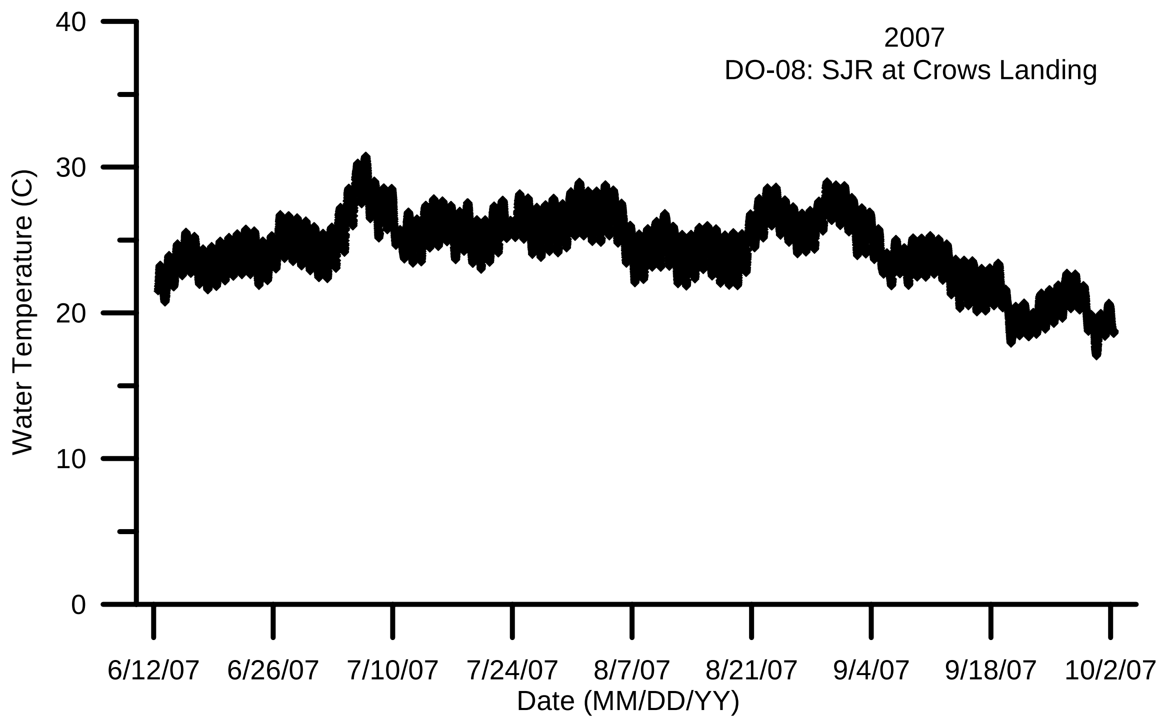
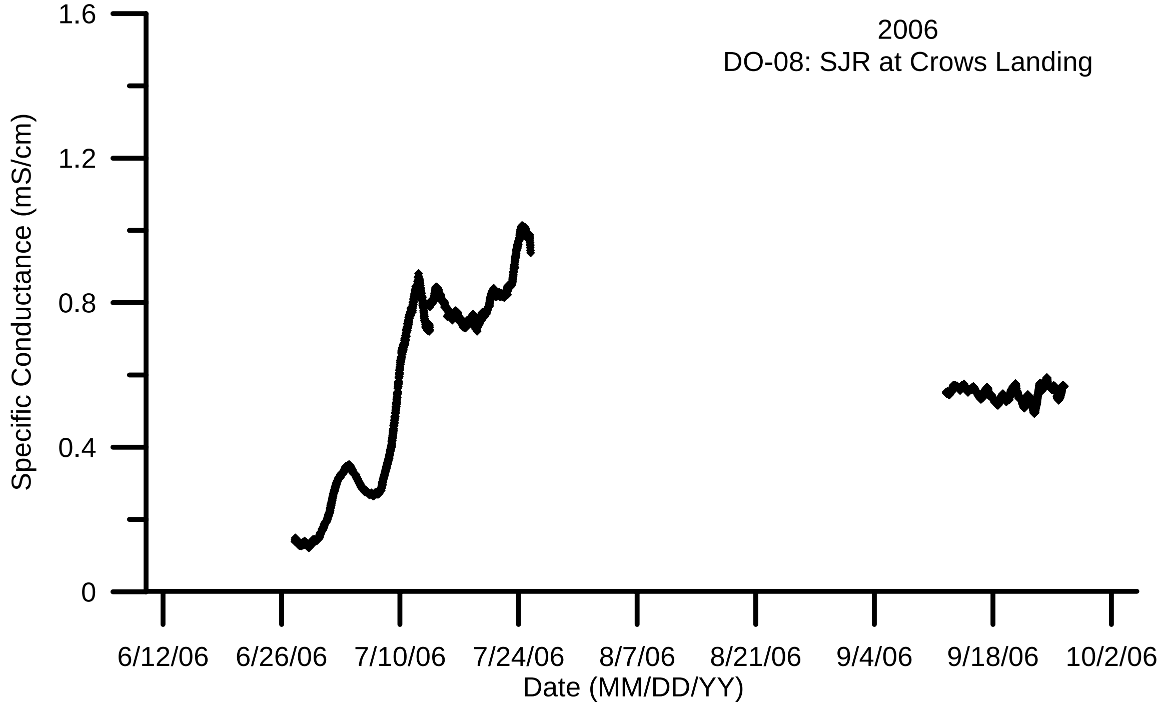


Figure 36: Specific conductance 15 minute data at DO-08 for 2006 and 2007.



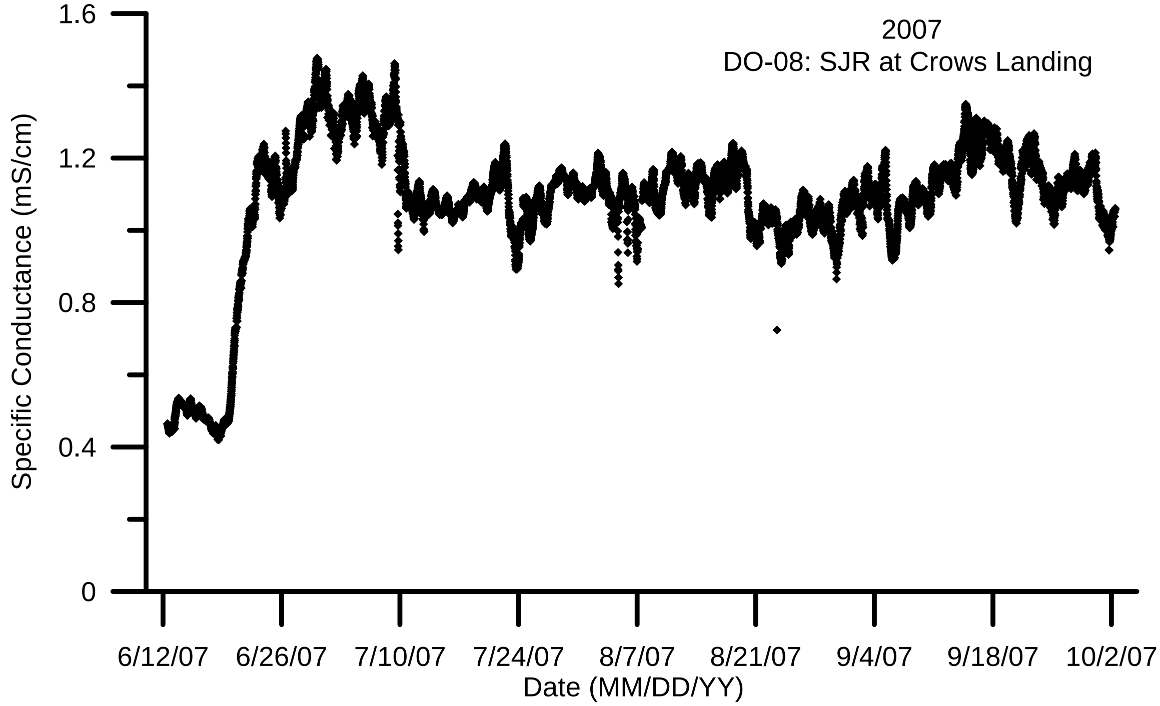
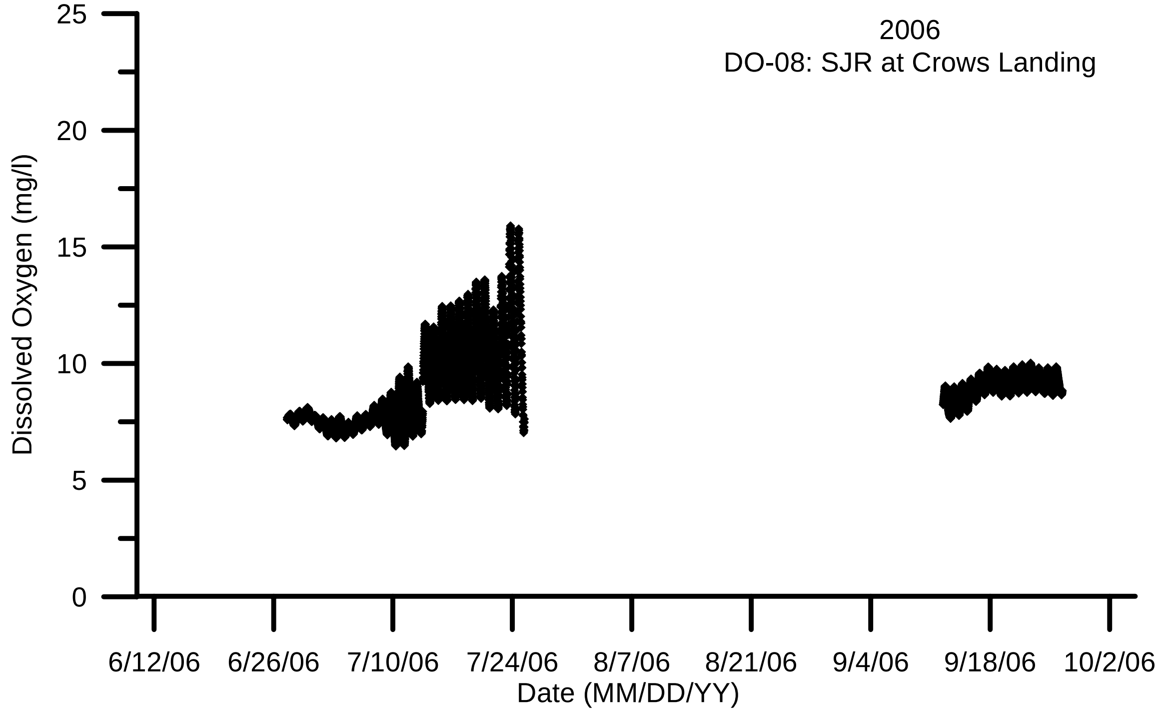


Figure 37: Dissolved oxygen 15 minute data at DO-08 for 2006 and 2007.



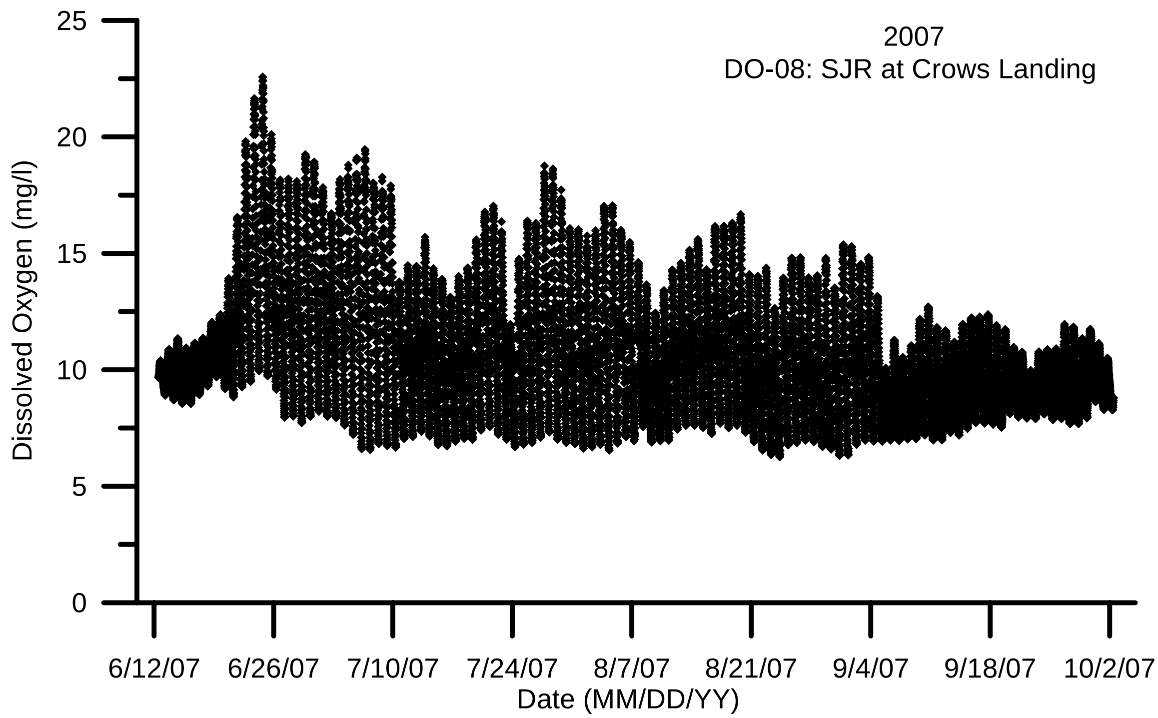
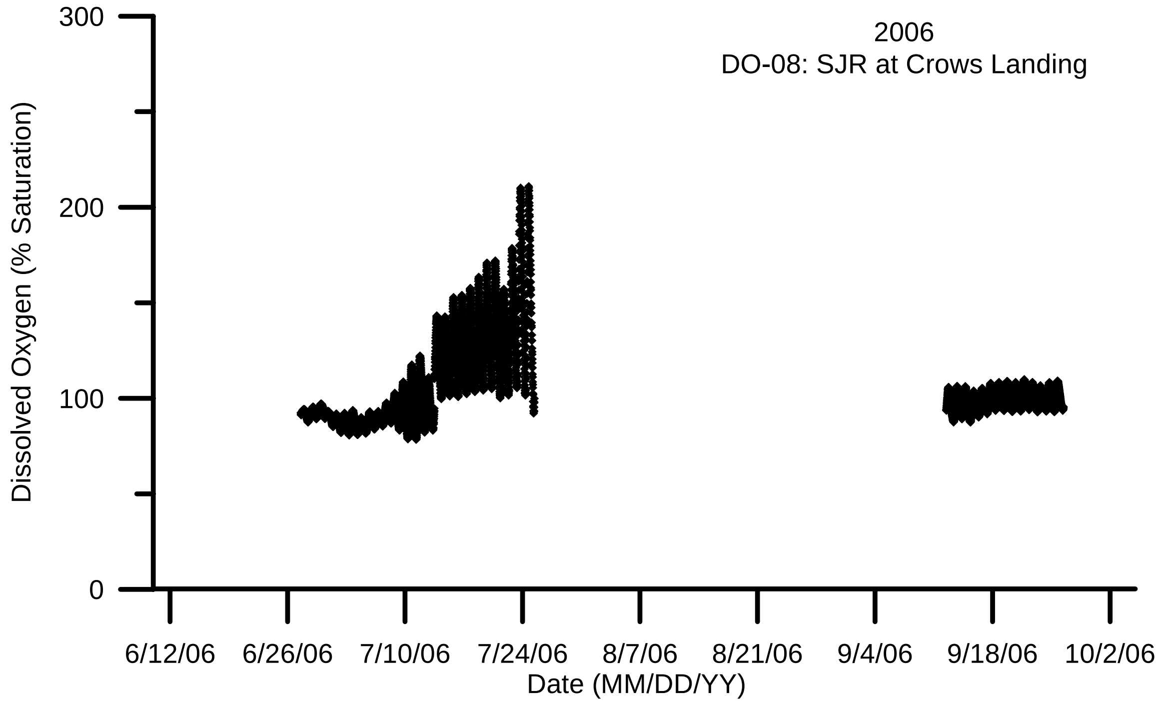


Figure 38: Dissolved oxygen percent of saturation 15 minute data at DO-08 for 2006 and 2007.



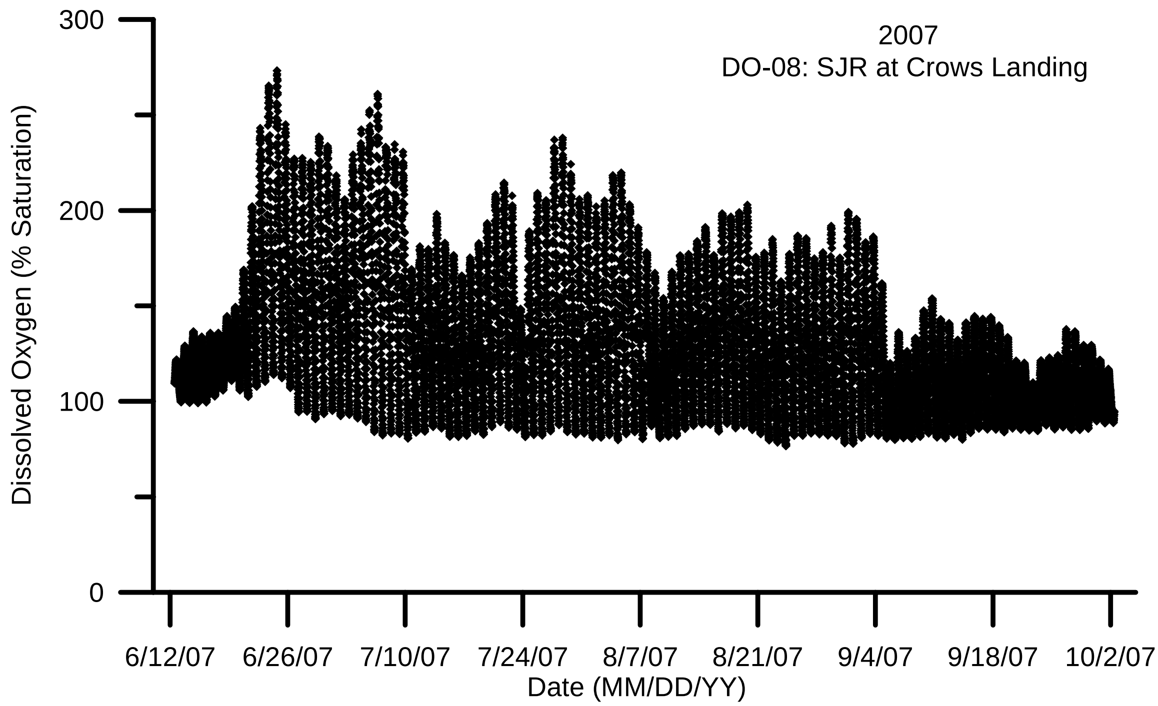
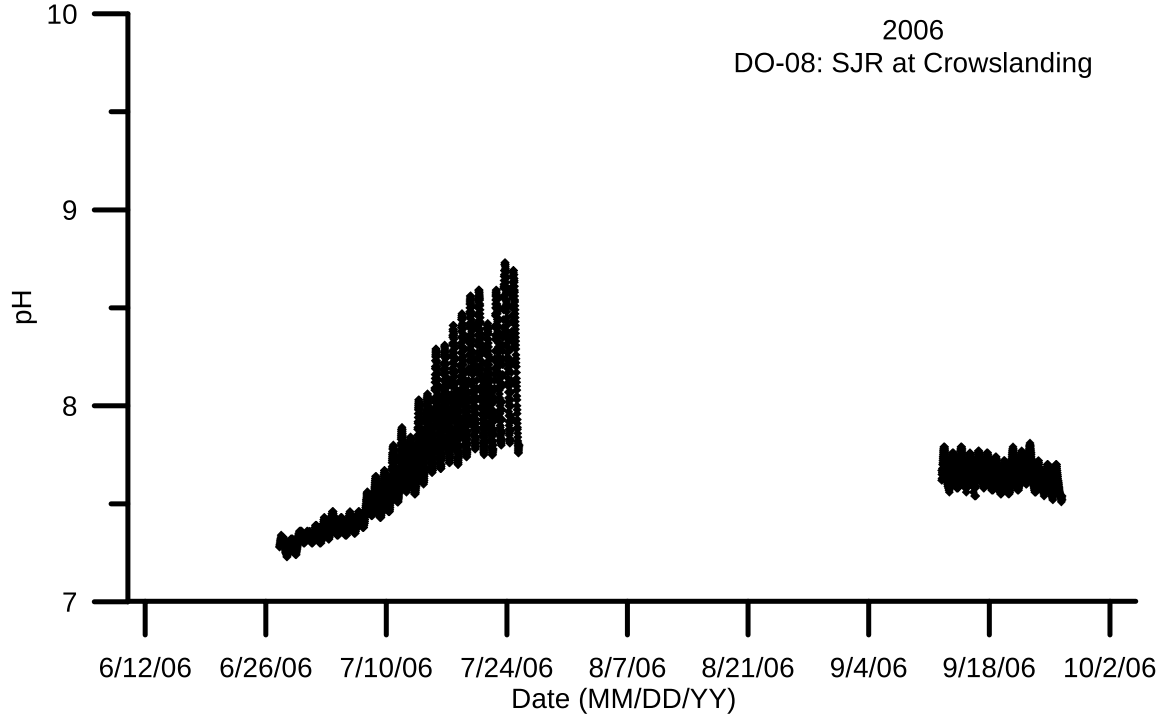


Figure 39: pH 15 minute data at DO-08 for 2006 and 2007.



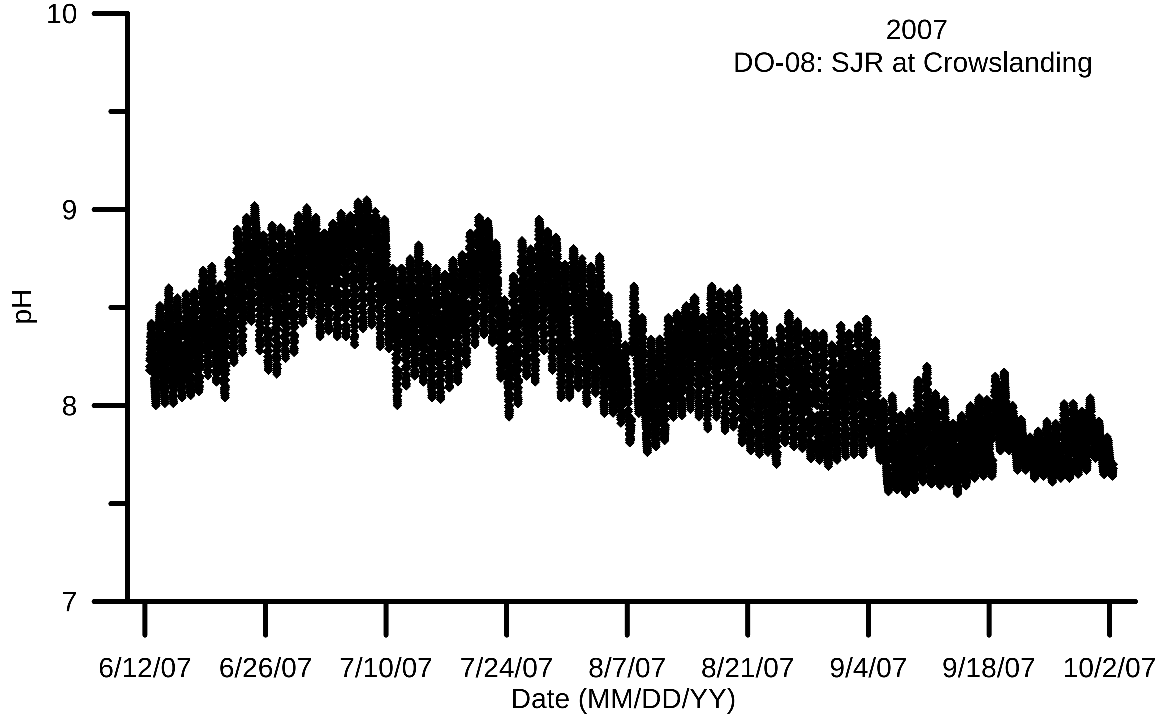
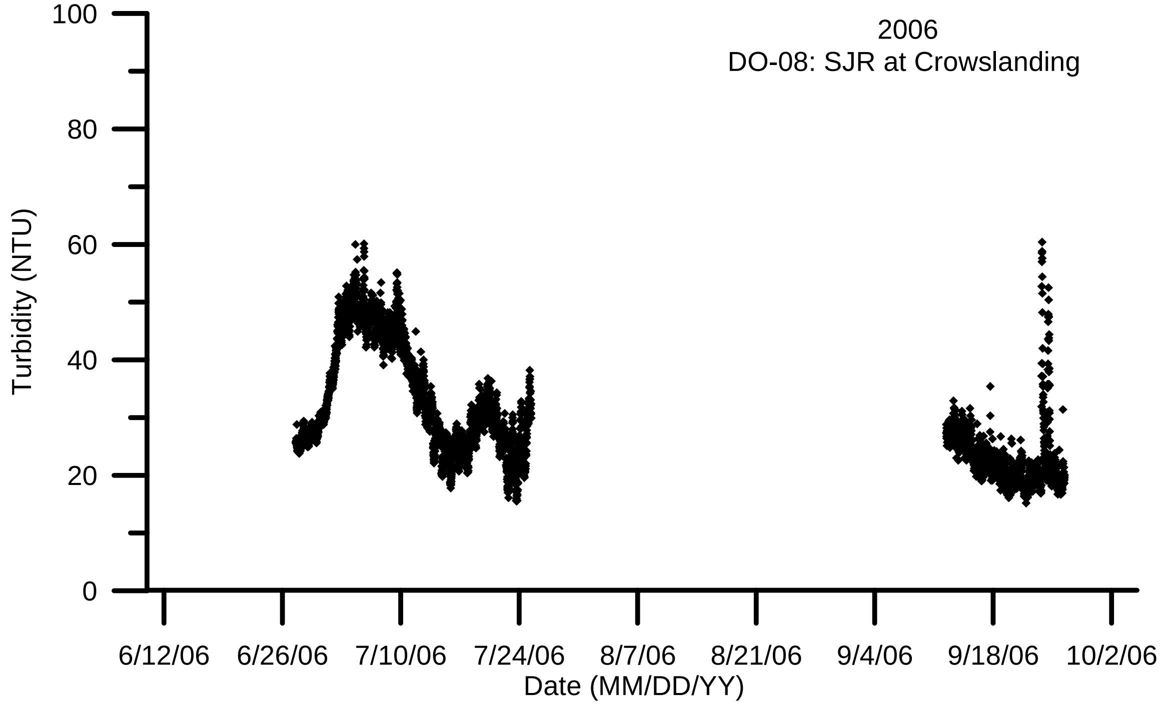


Figure 40: Turbidity 15 minute data at DO-08 for 2006 and 2007.



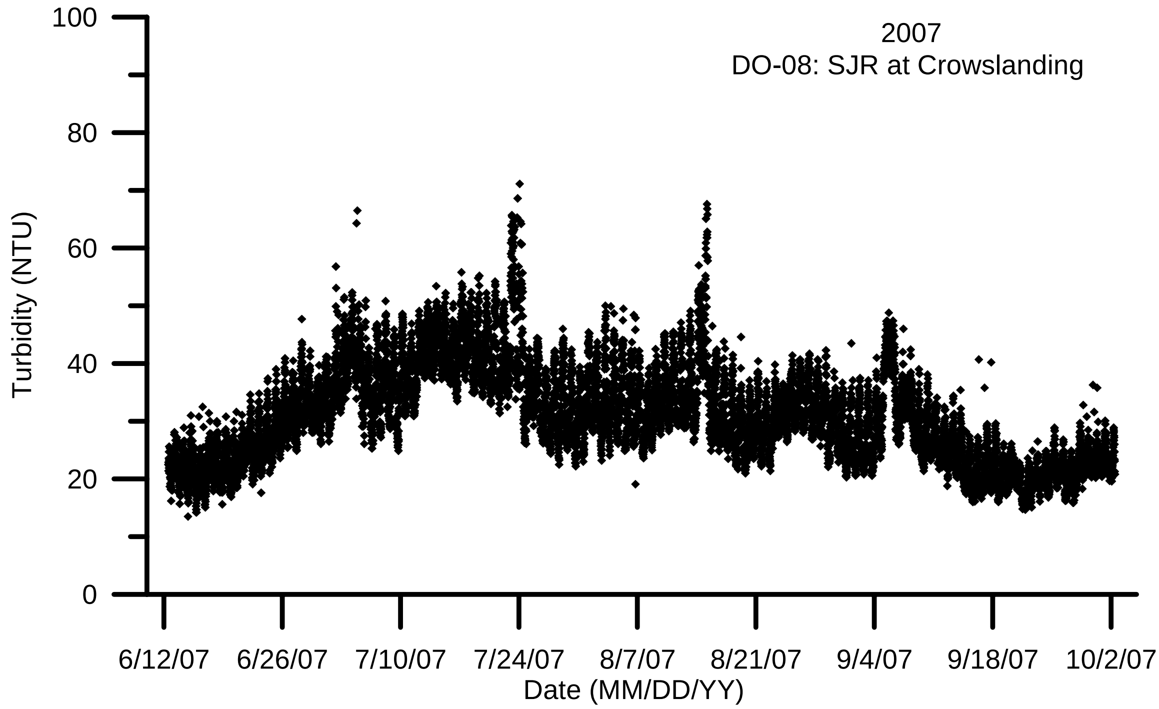
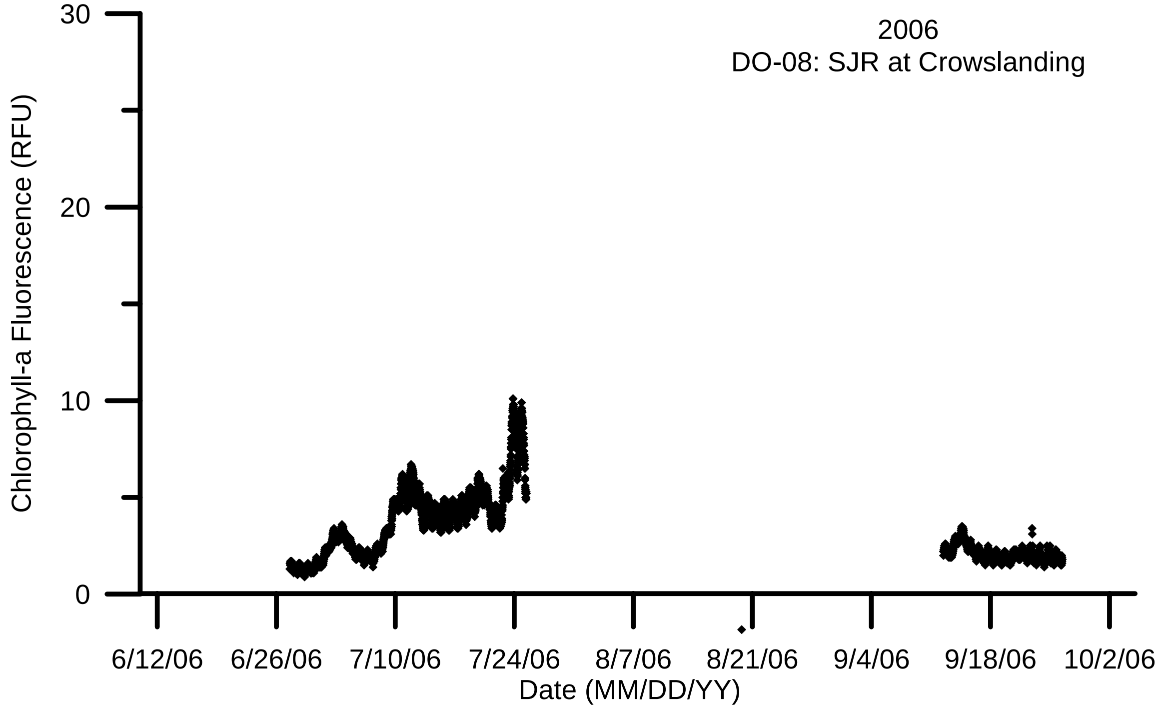


Figure 41: Chlorophyll-*a* fluorescence 15 minute data at DO-08 for 2006 and 2007.



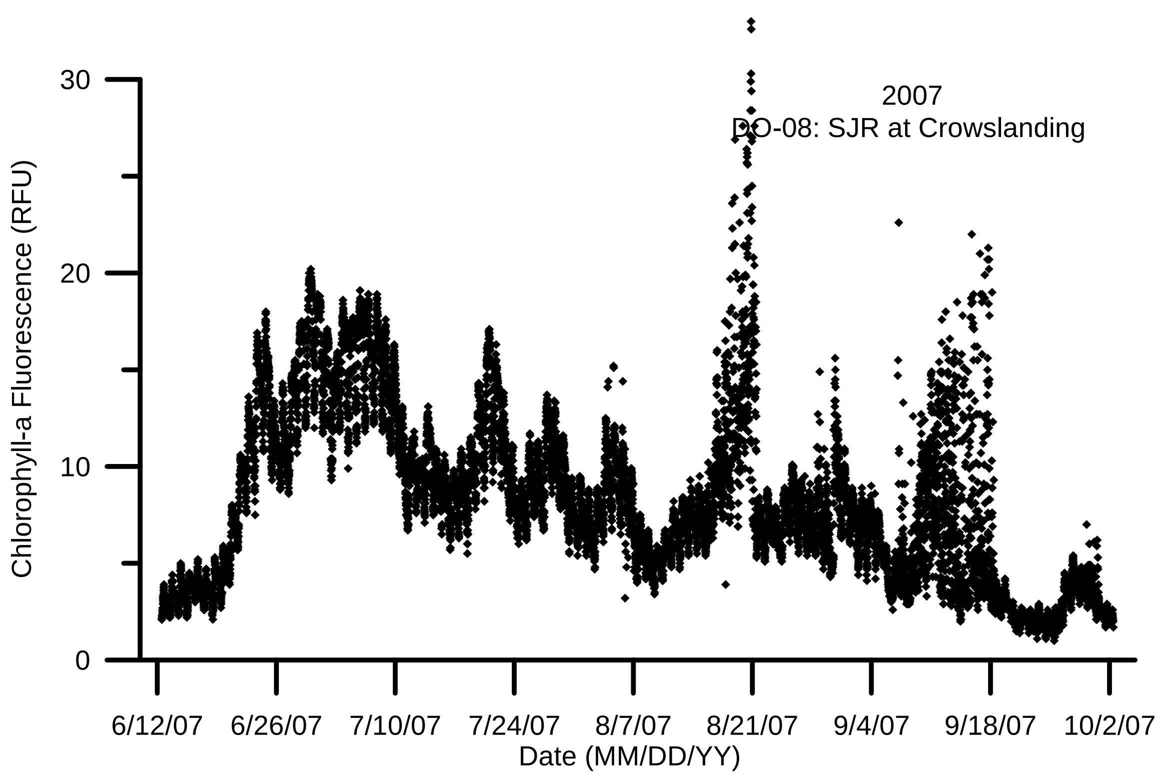
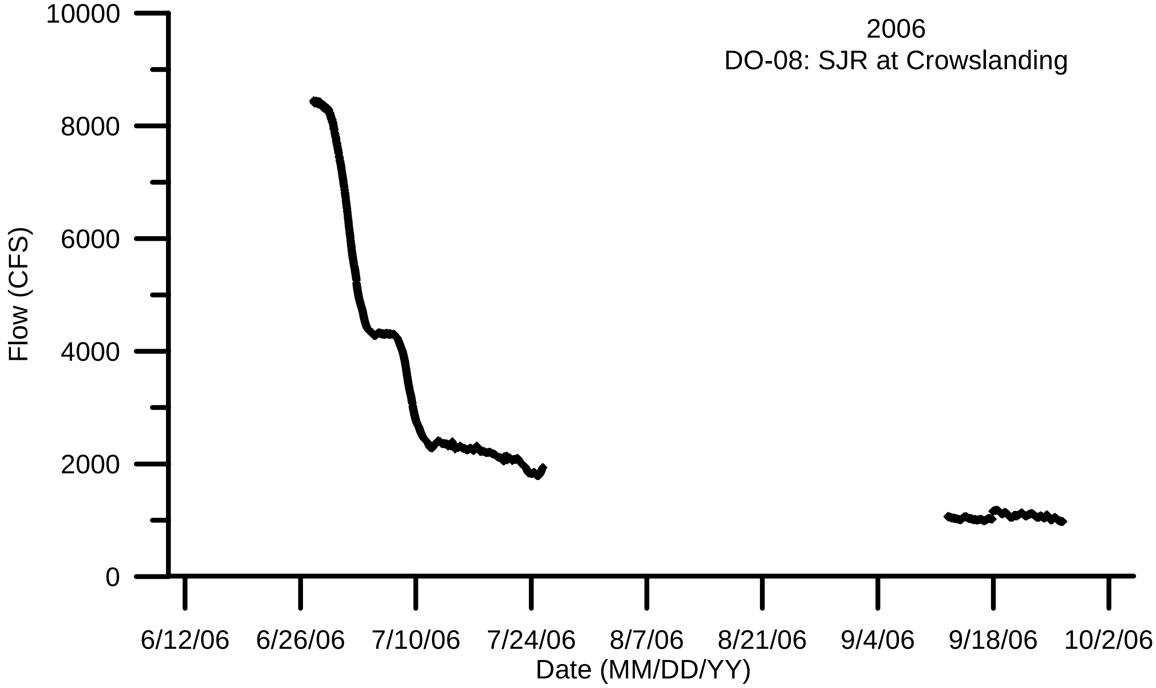


Figure 42: Flow 15 minute data at DO-08 for 2006 and 2007.



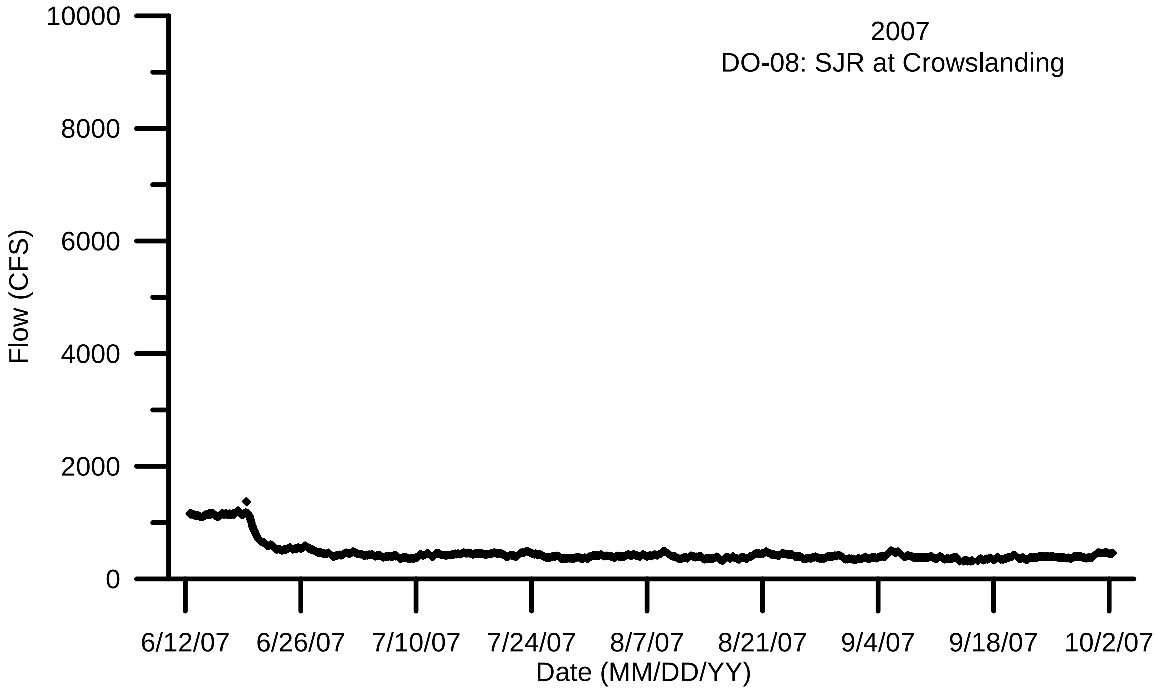
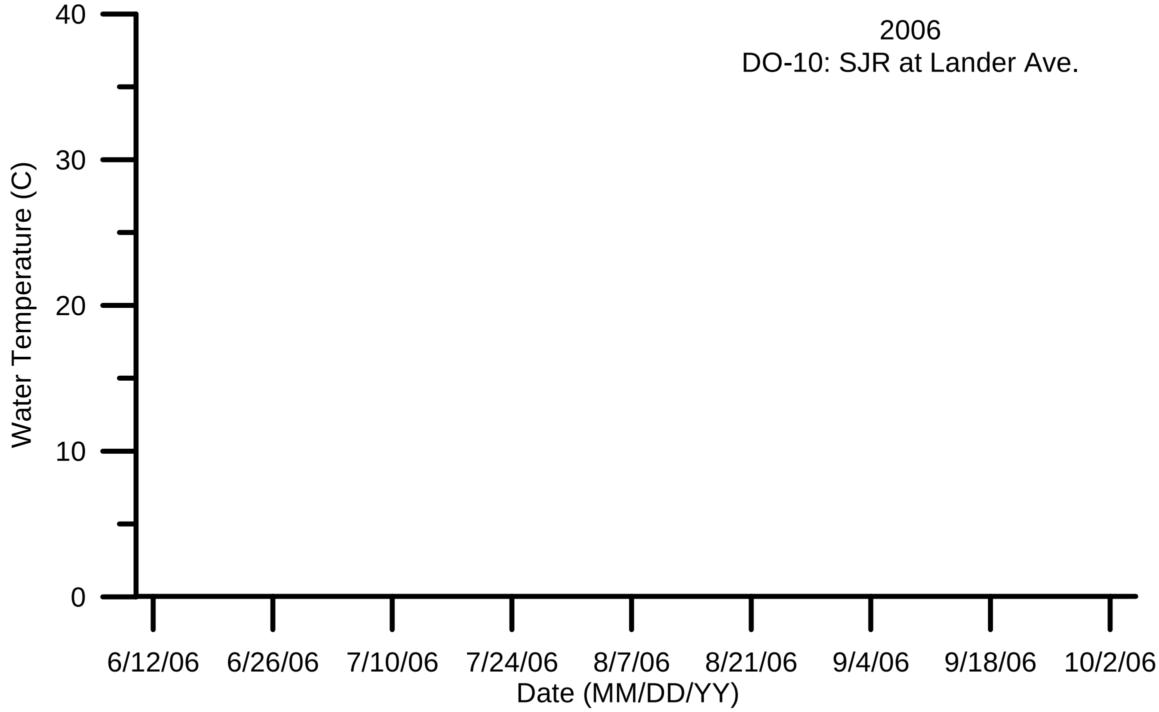


Figure 43: Water temperature 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



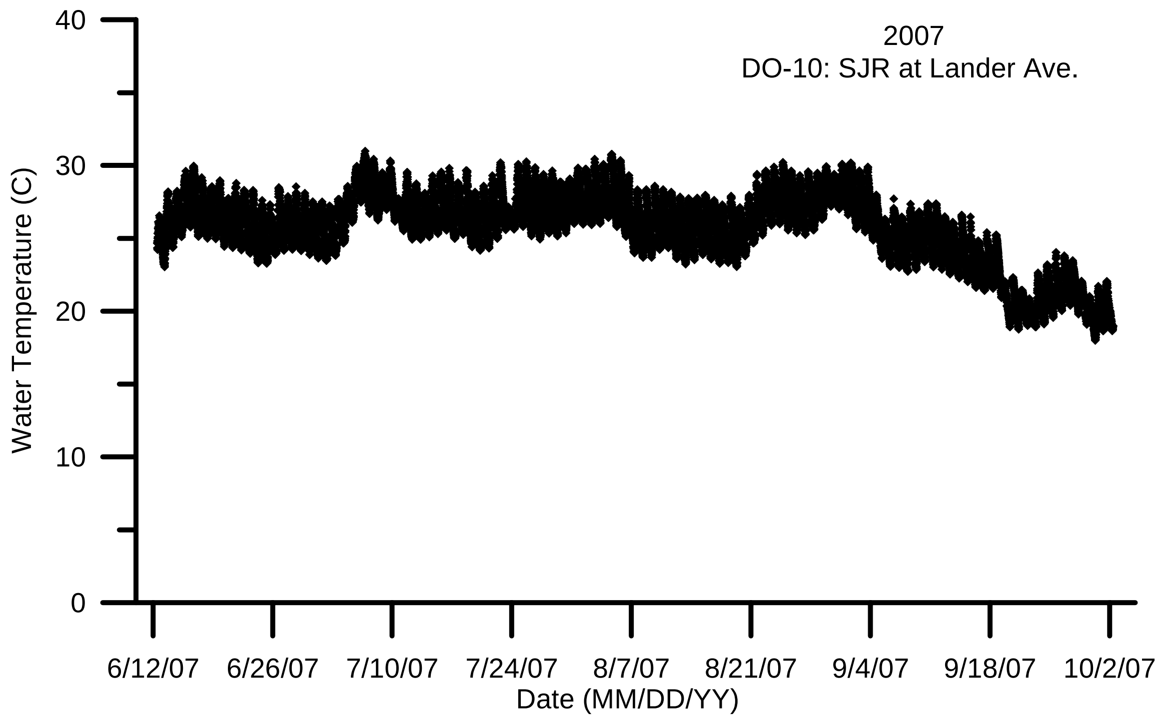
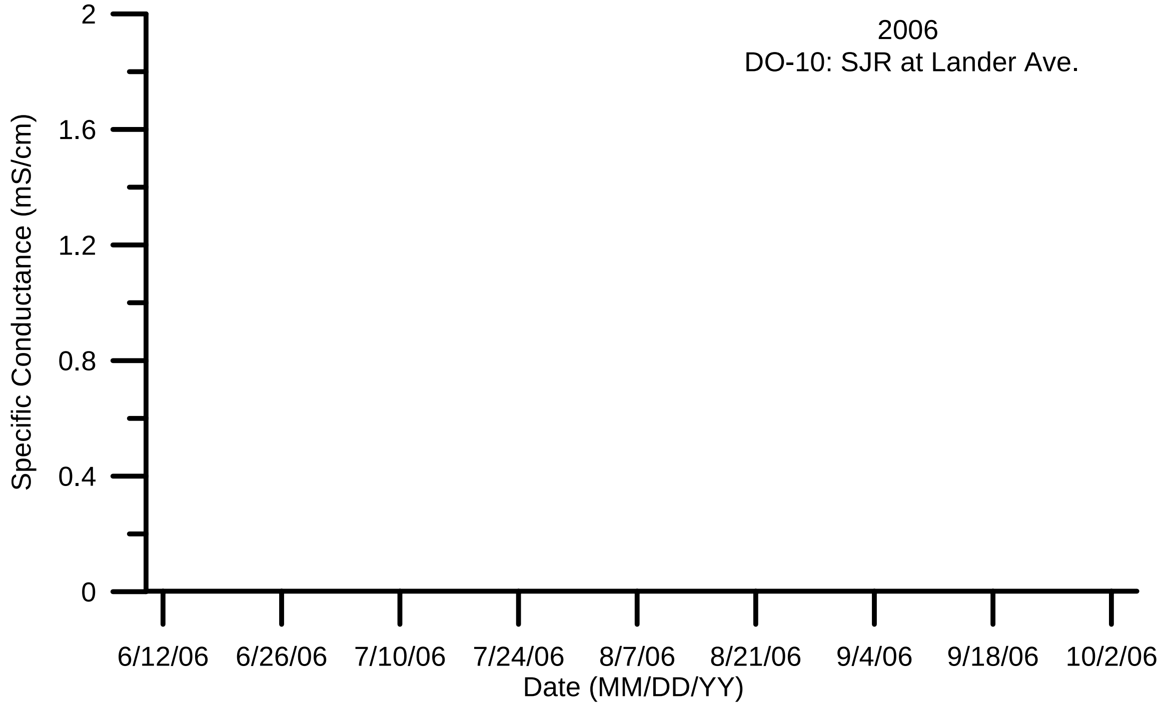


Figure 44: Specific conductance 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



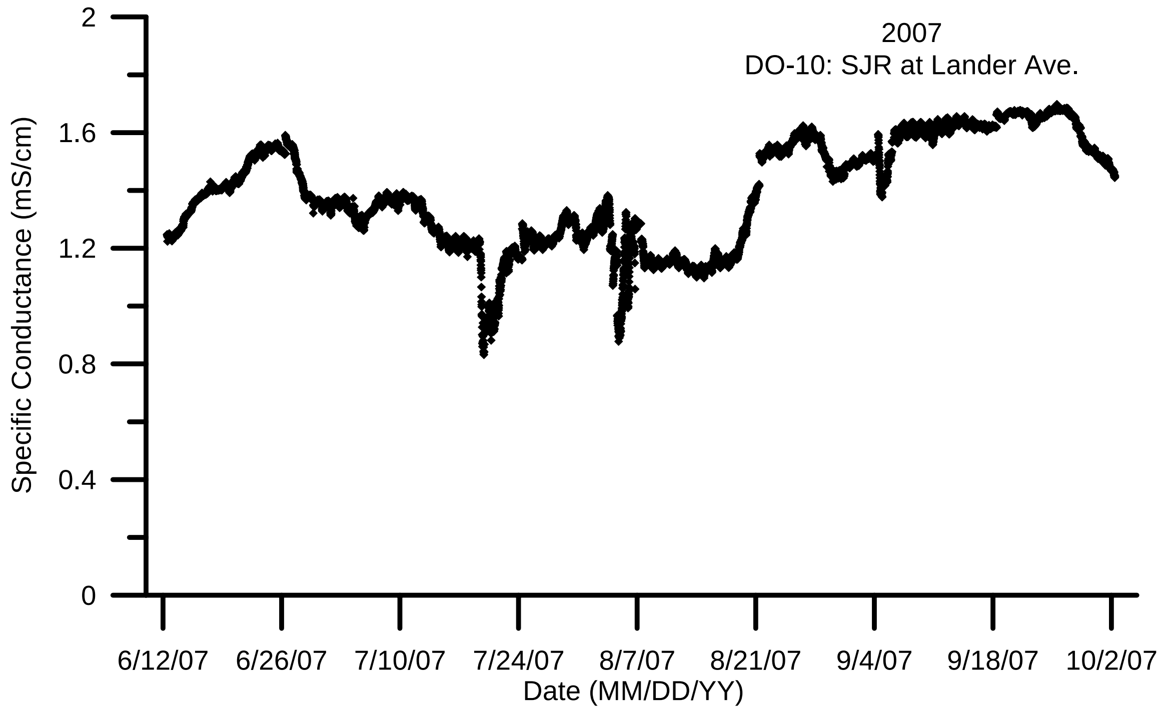
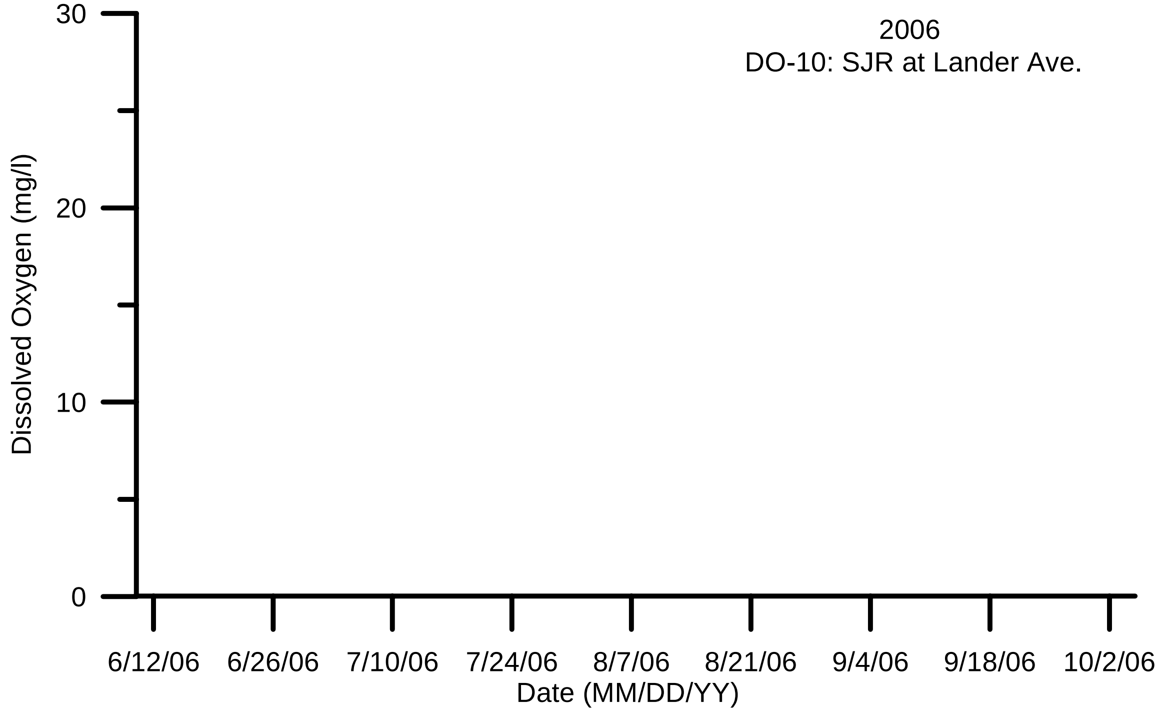


Figure 45: Dissolved oxygen concentration 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



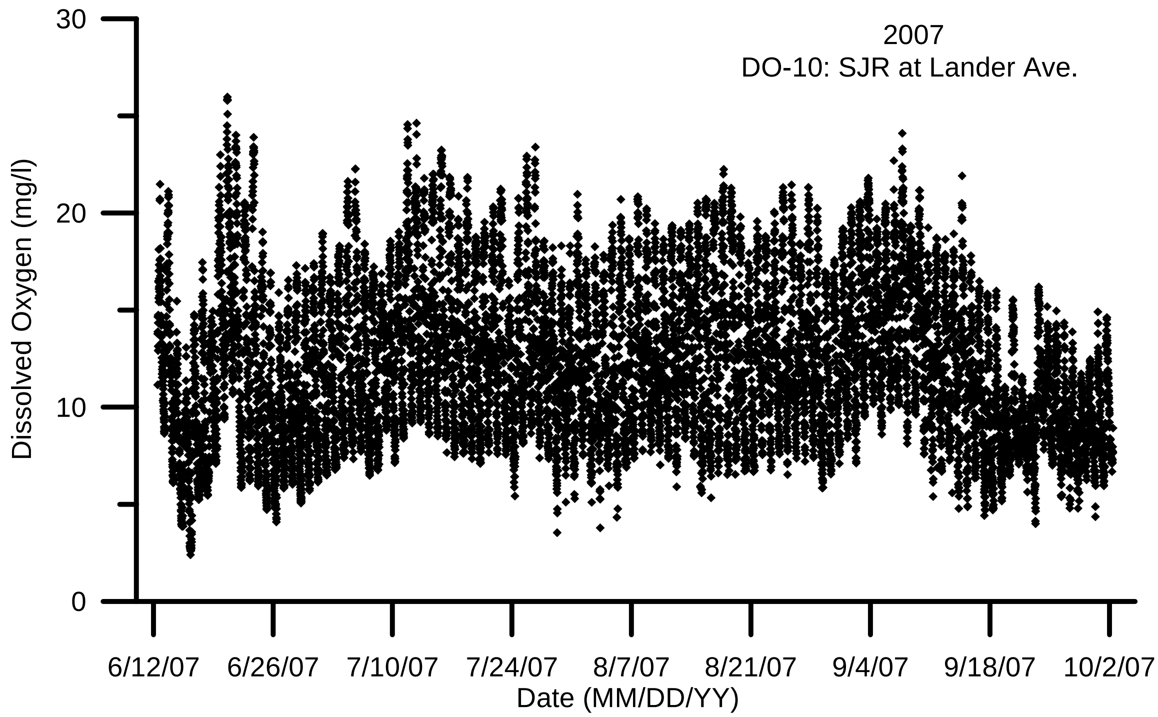
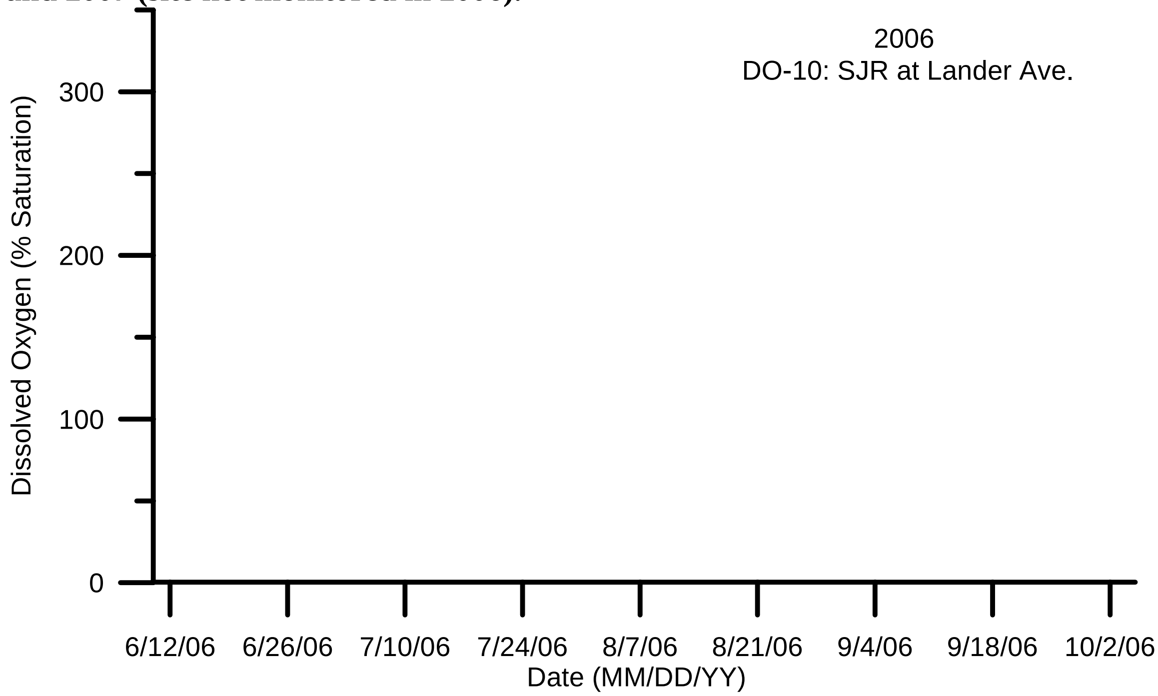


Figure 46: Dissolved oxygen percent of saturation 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



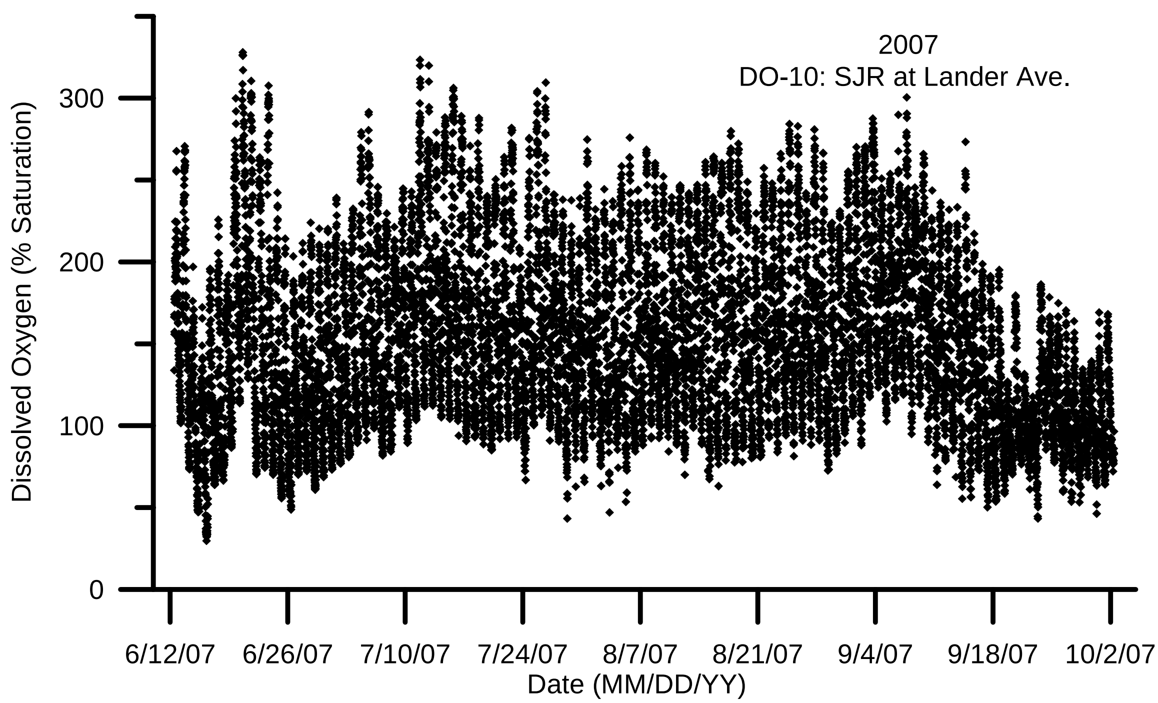
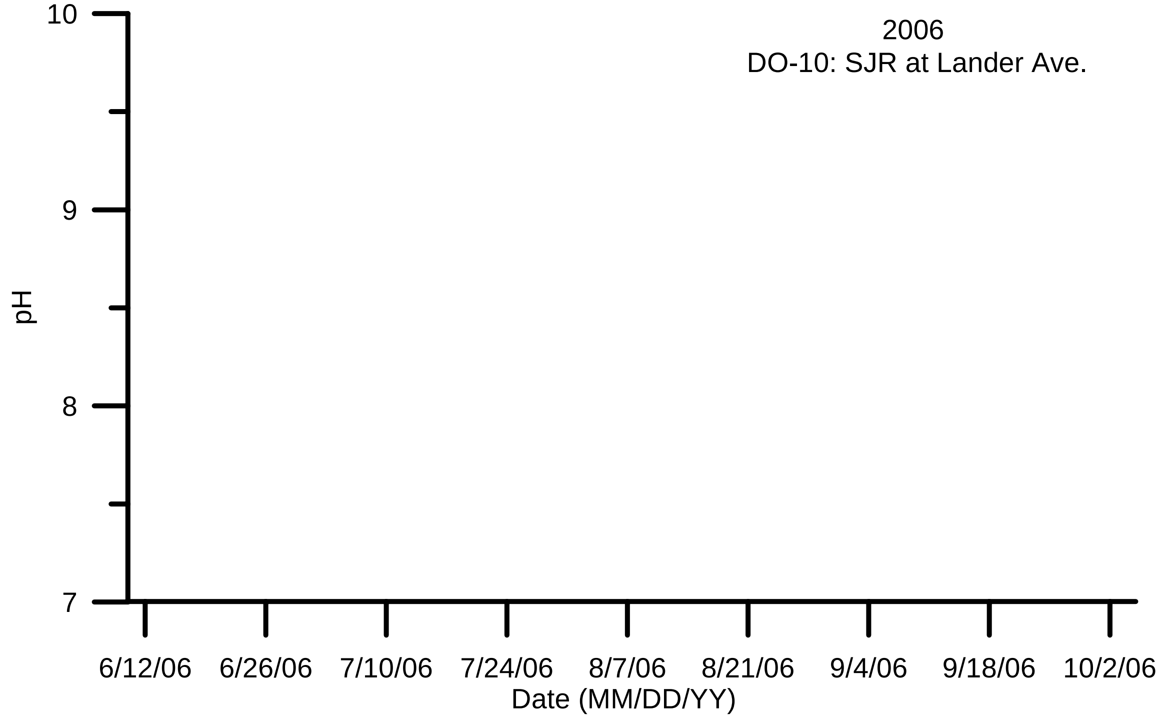


Figure 47: pH 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



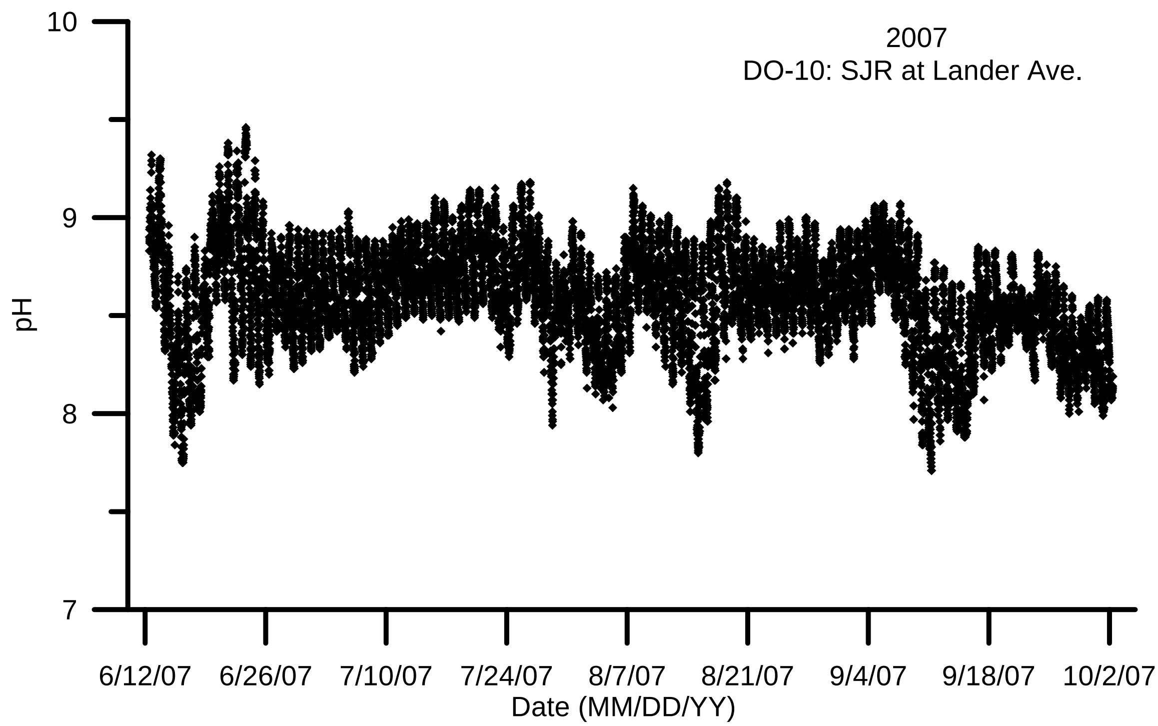
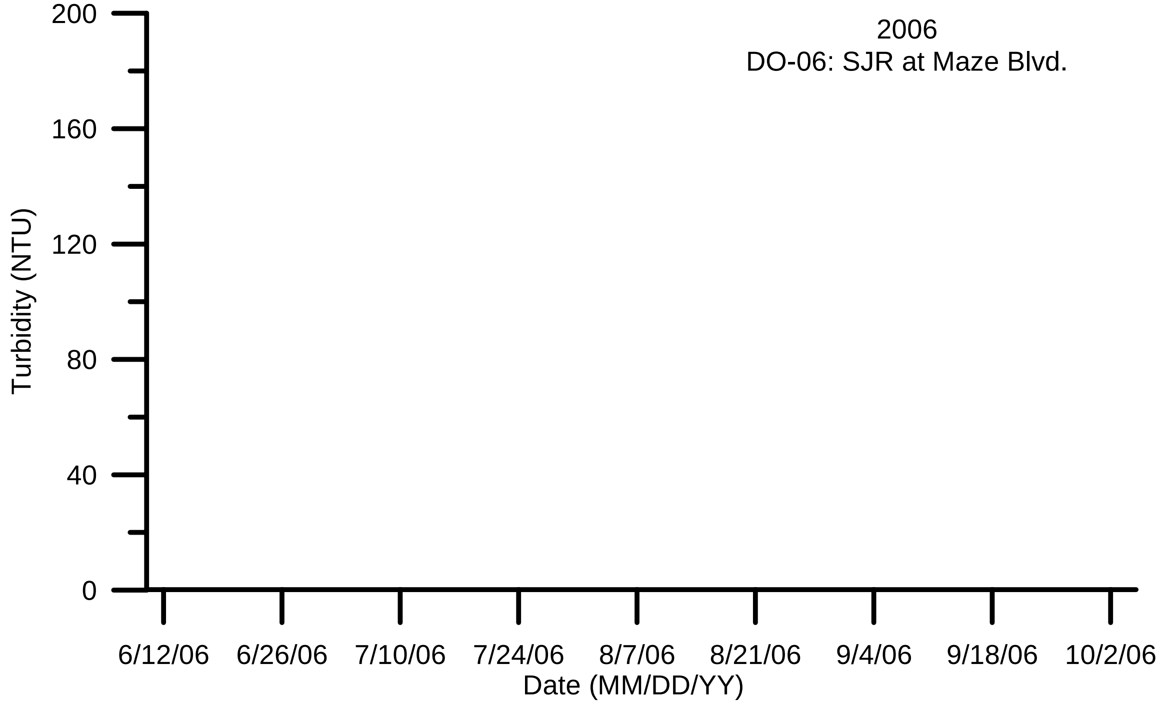


Figure 48: Turbidity 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



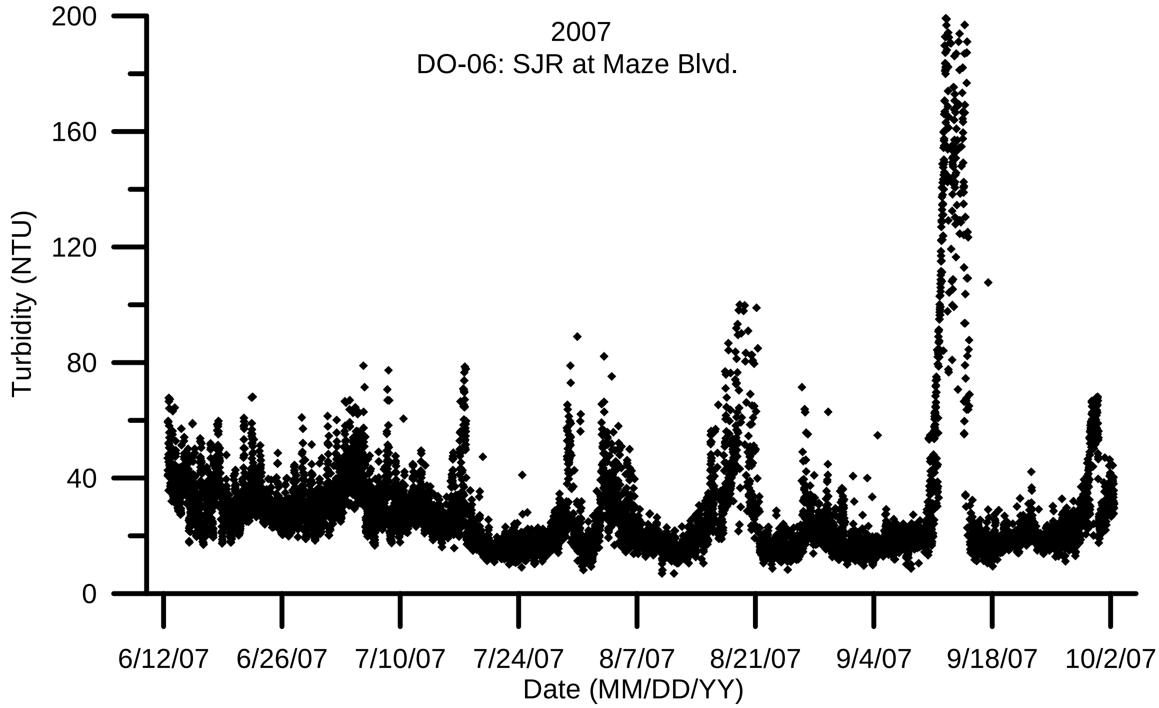
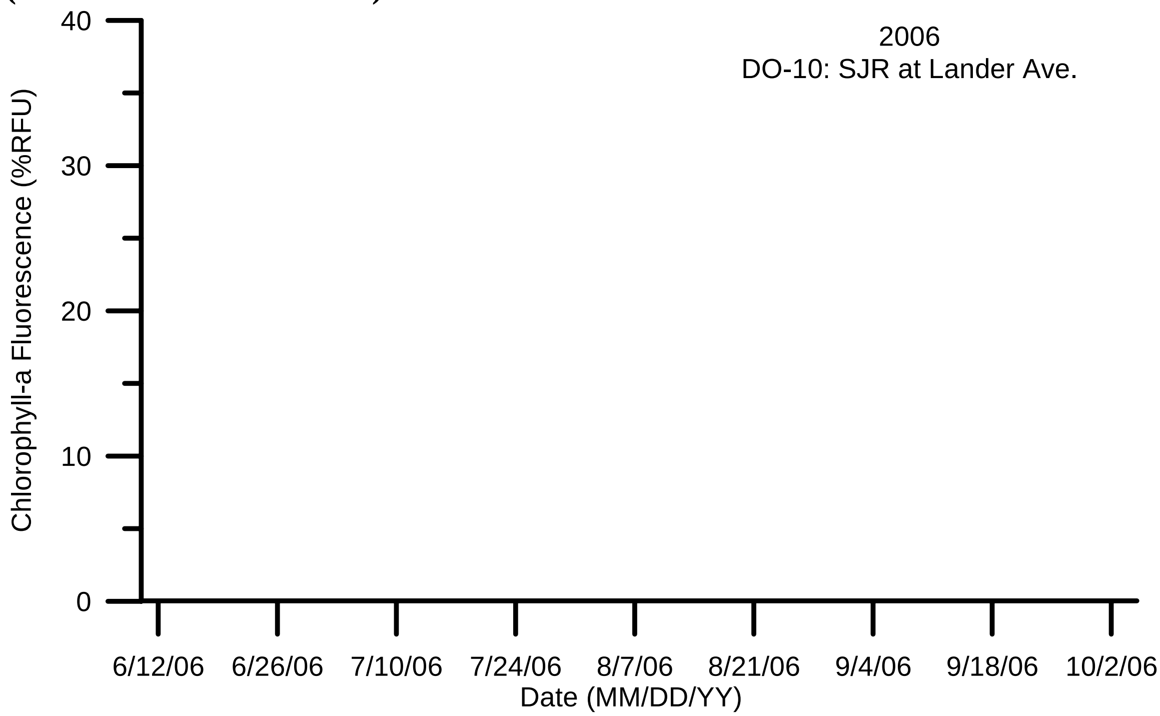


Figure 49: Chlorophyll-*a* fluorescence 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



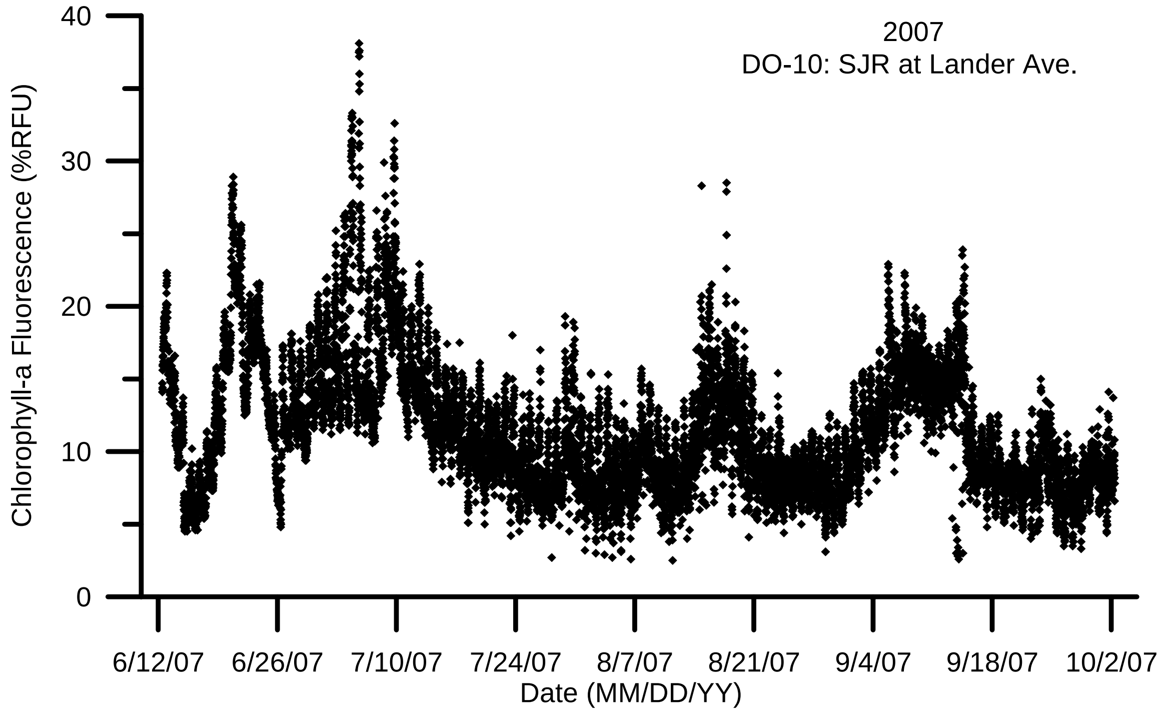
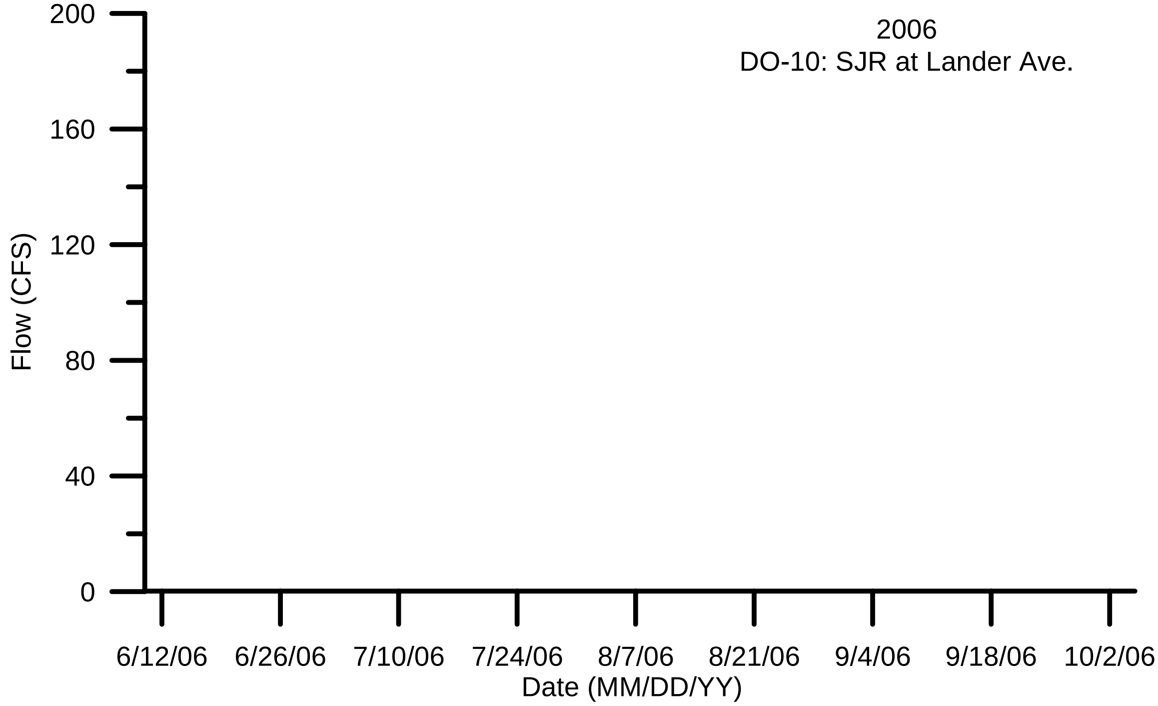


Figure 50: Flow 15 minute data at DO-10 for 2006 and 2007 (site not monitored in 2006).



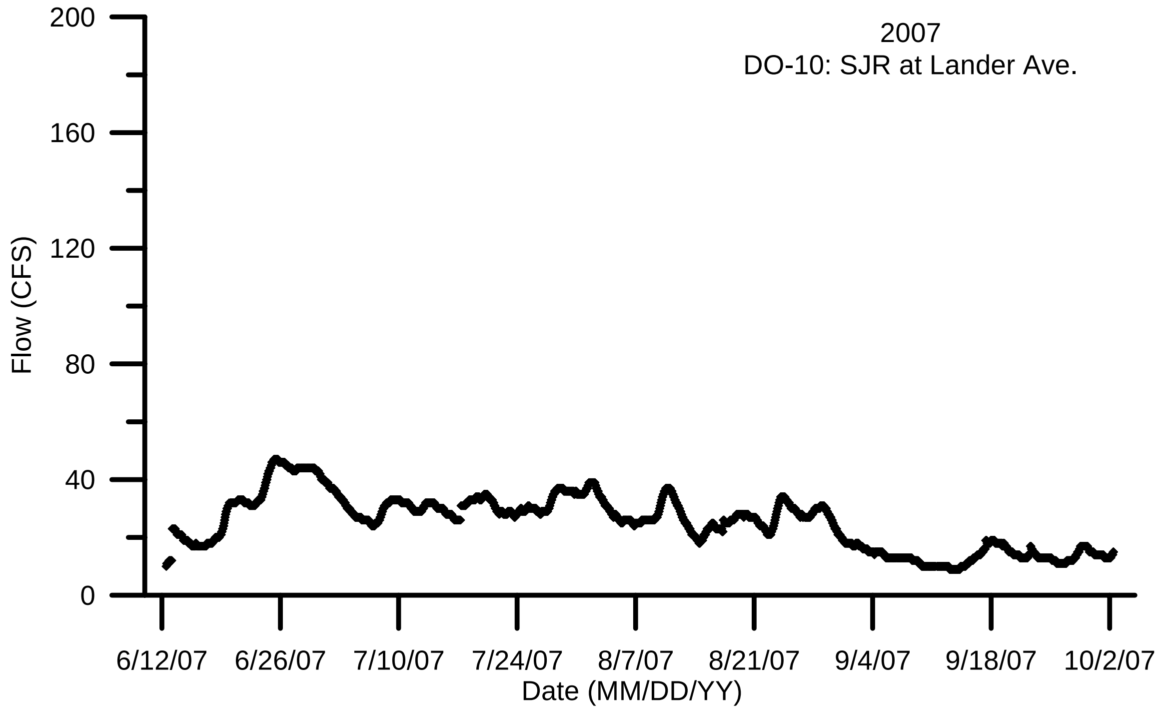
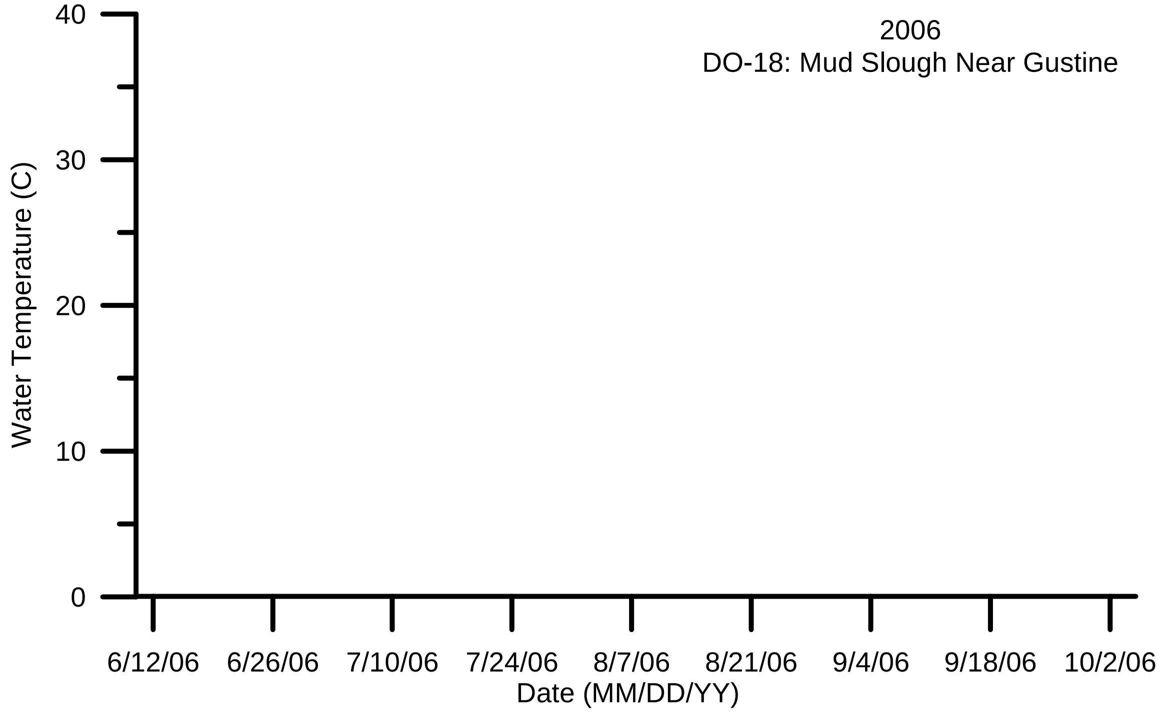


Figure 51: Water temperature 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



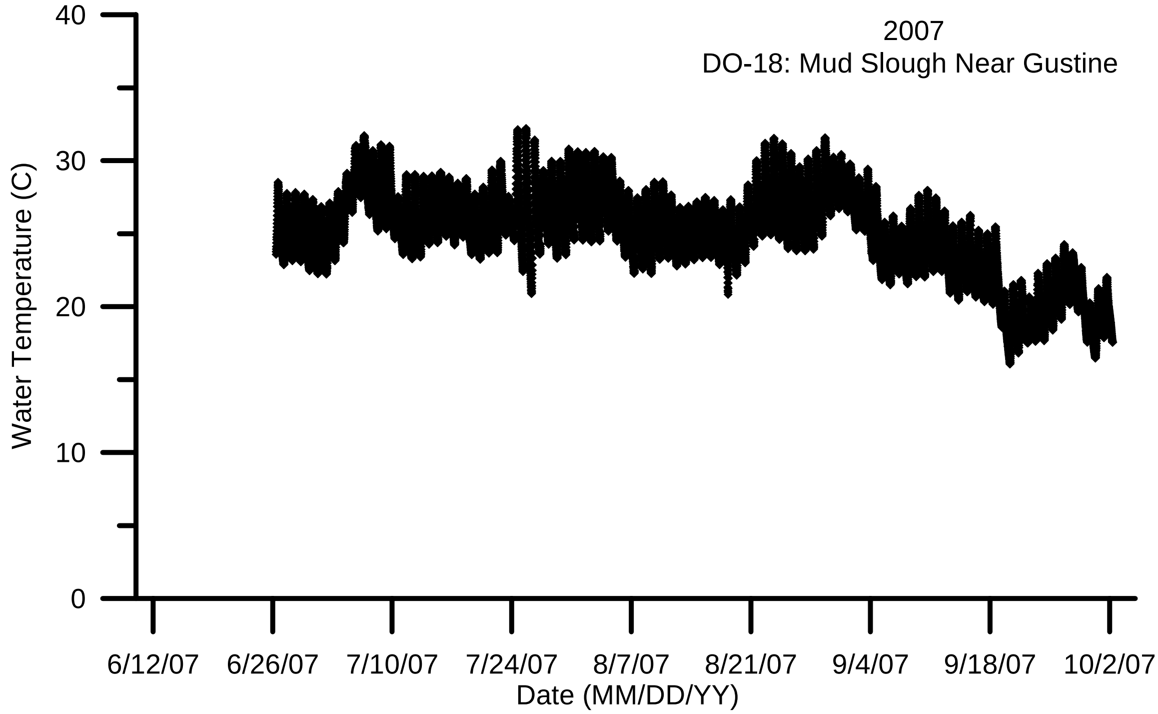
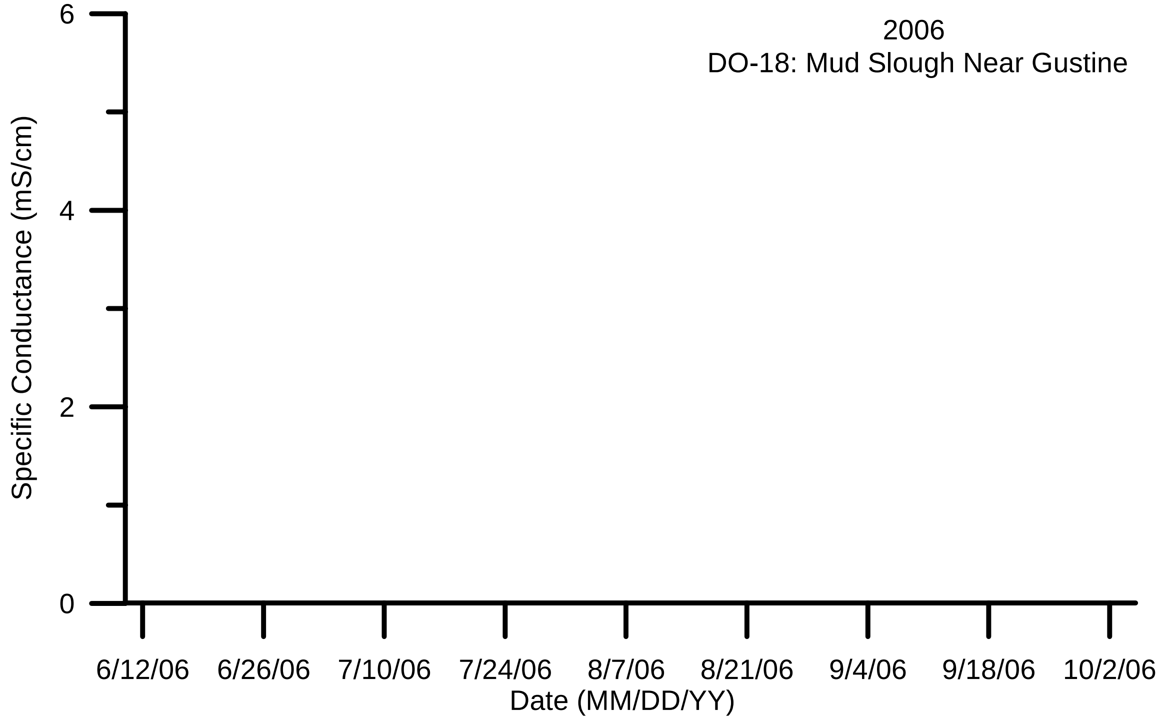


Figure 52: Specific conductance 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



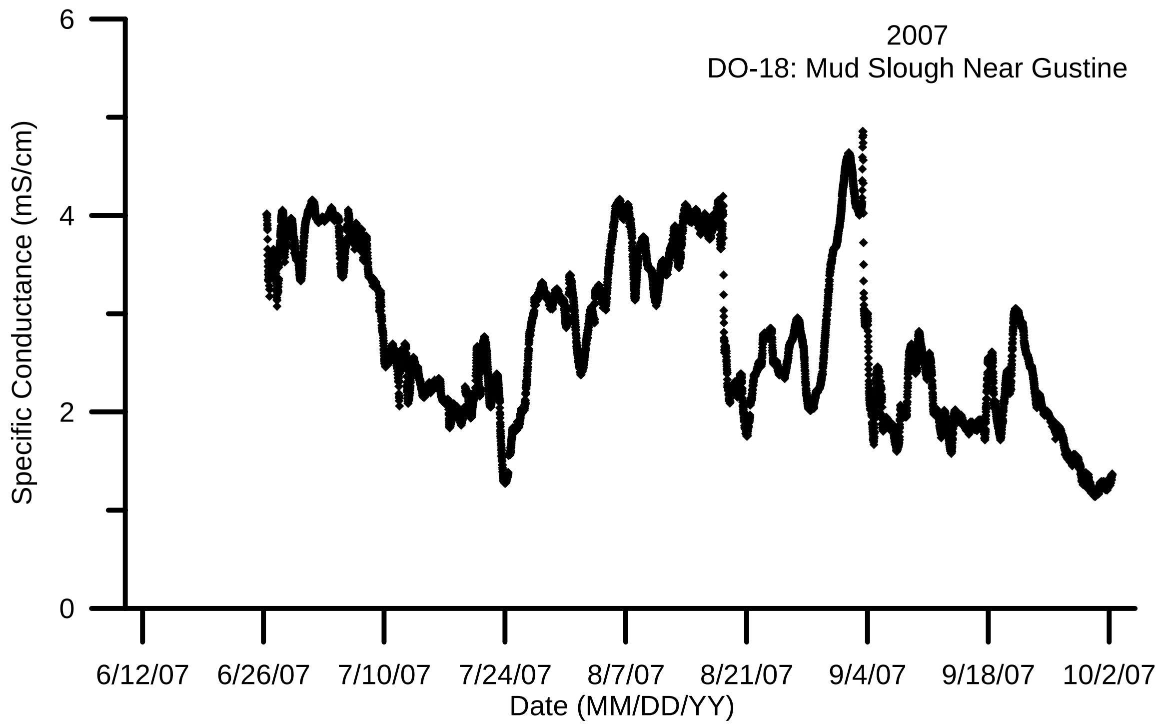
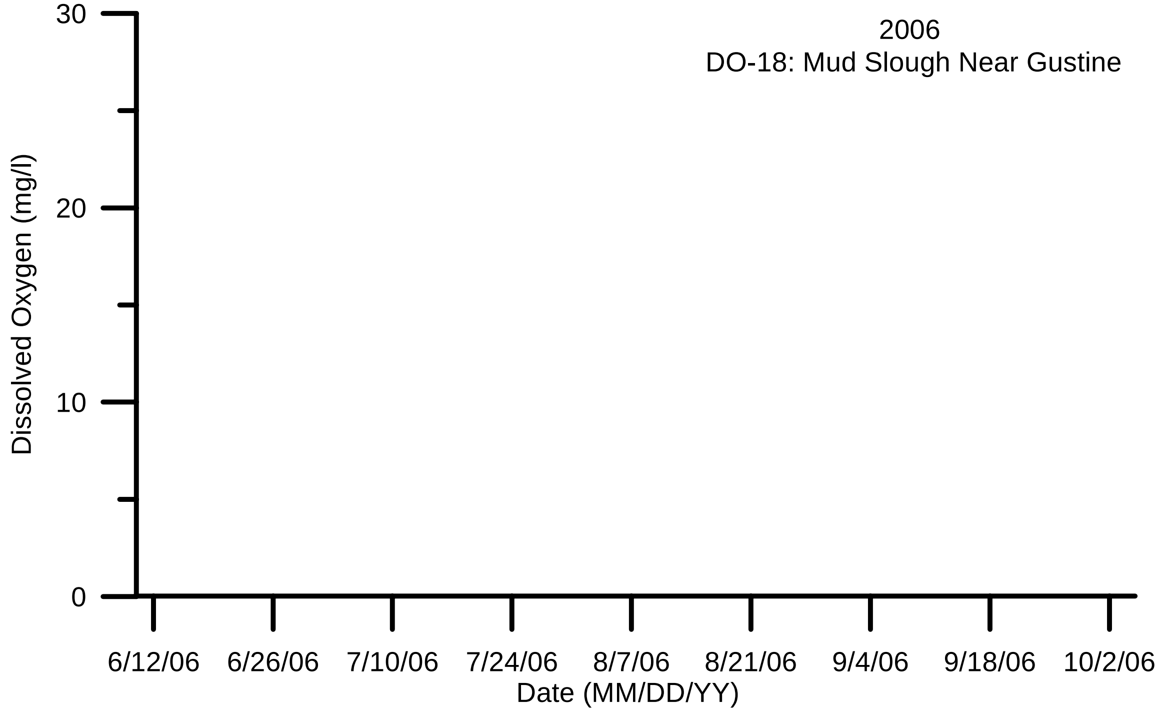


Figure 53: Dissolved oxygen concentration 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



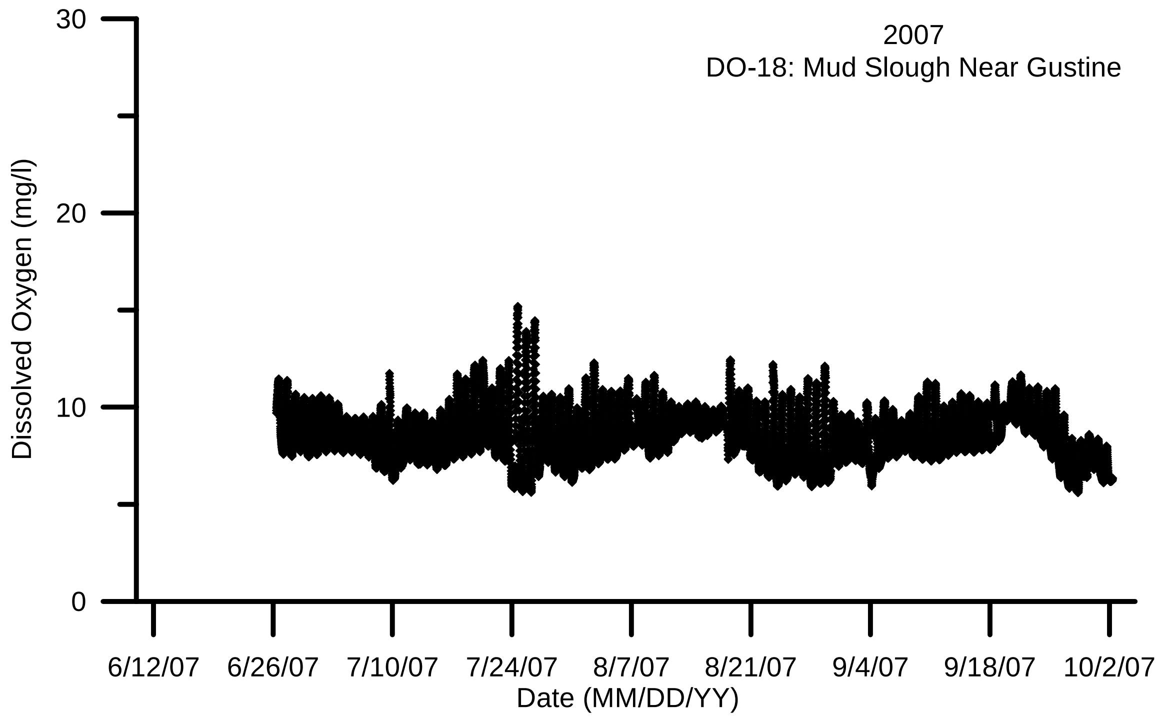
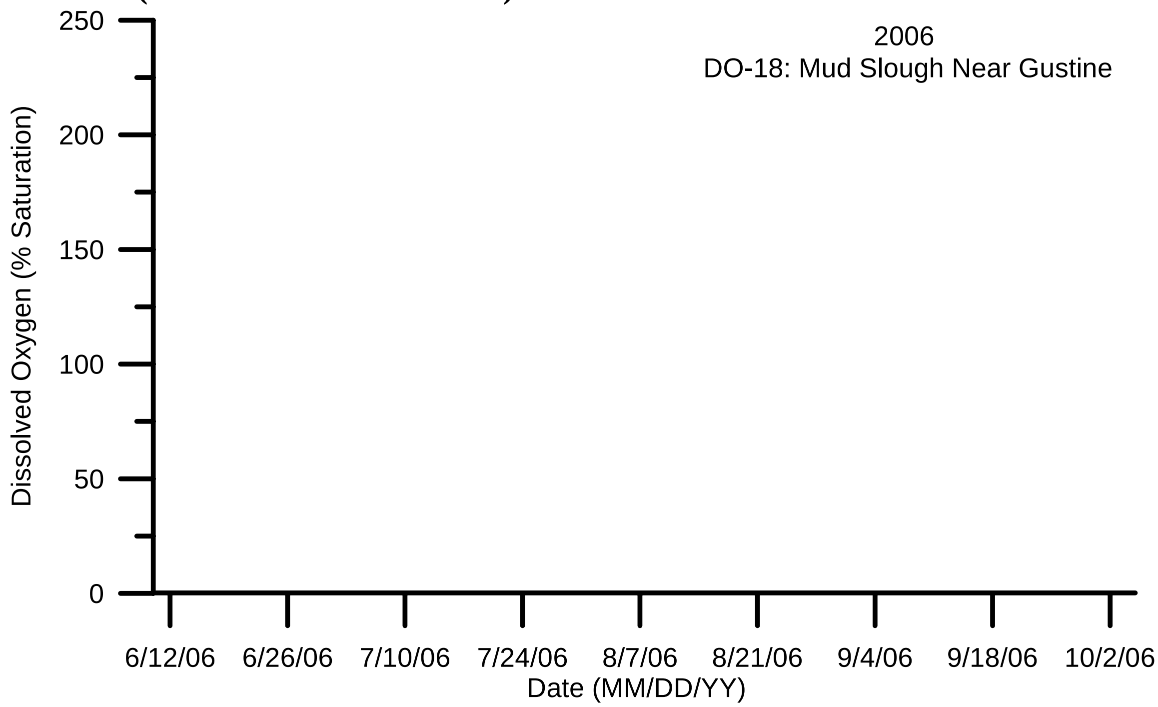


Figure 54: Dissolved oxygen percent of saturation 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



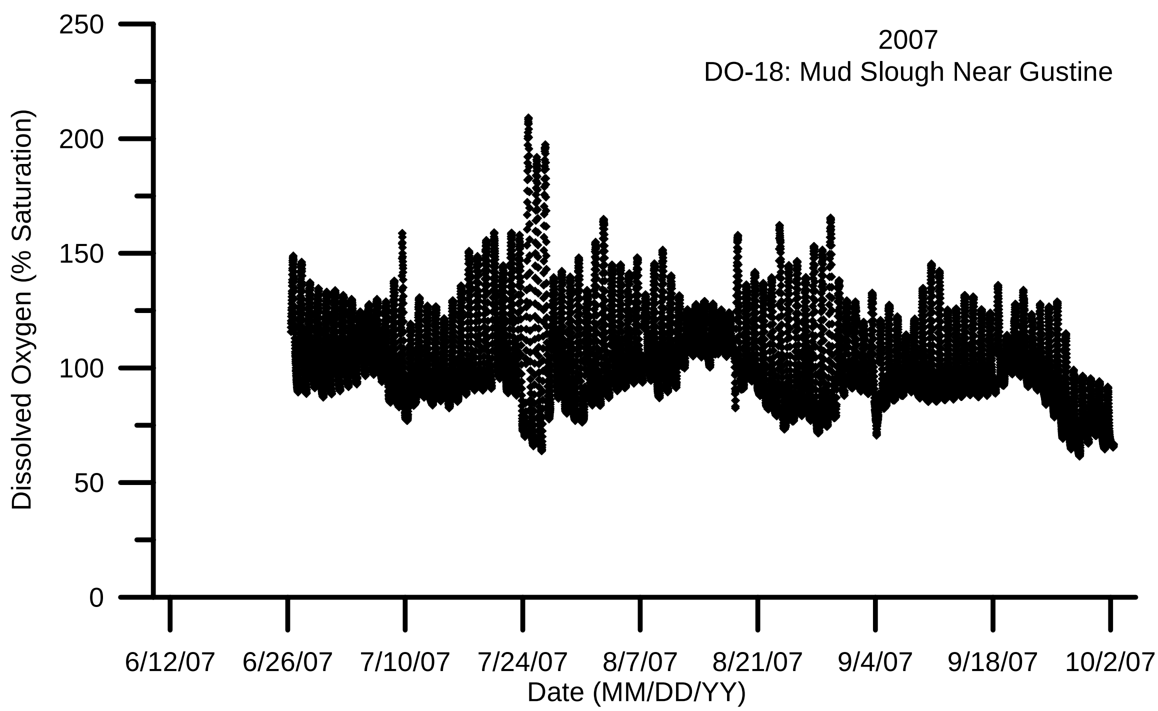
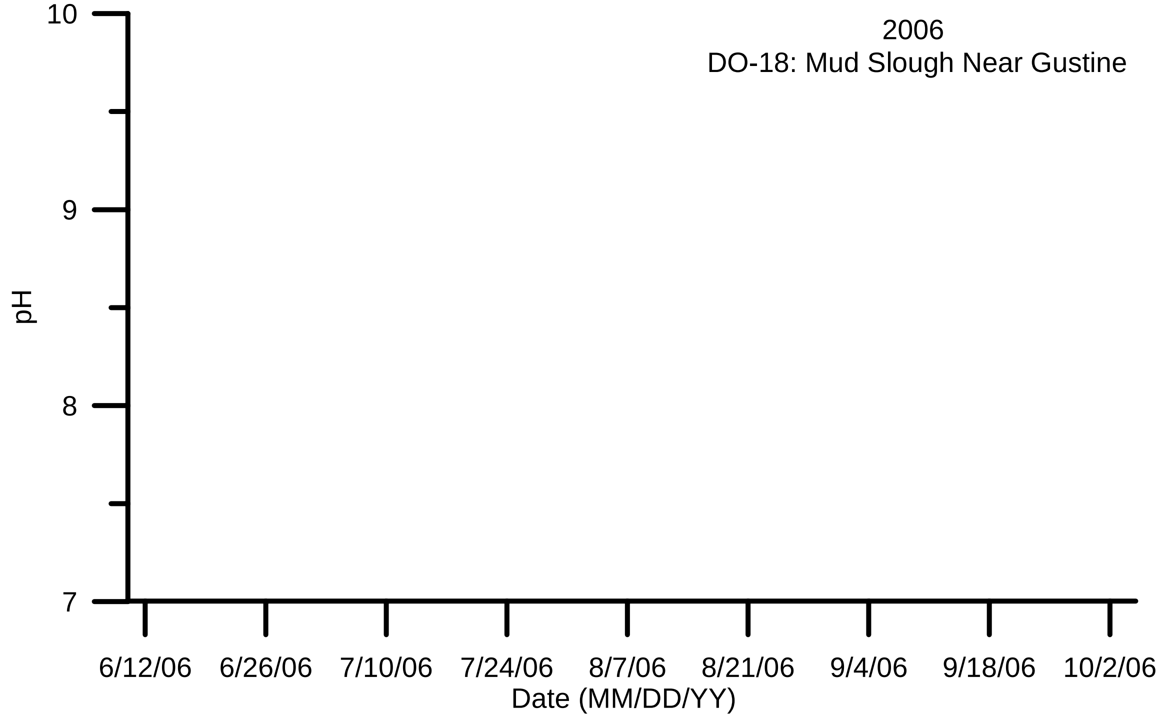


Figure 55: pH 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



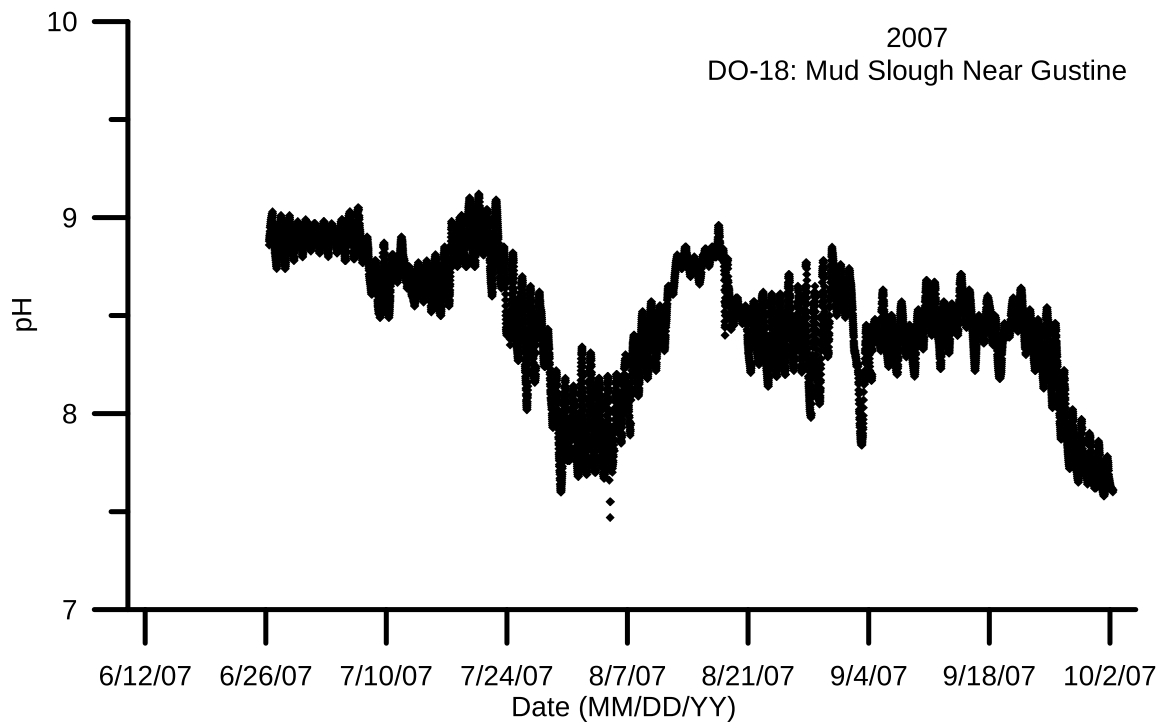
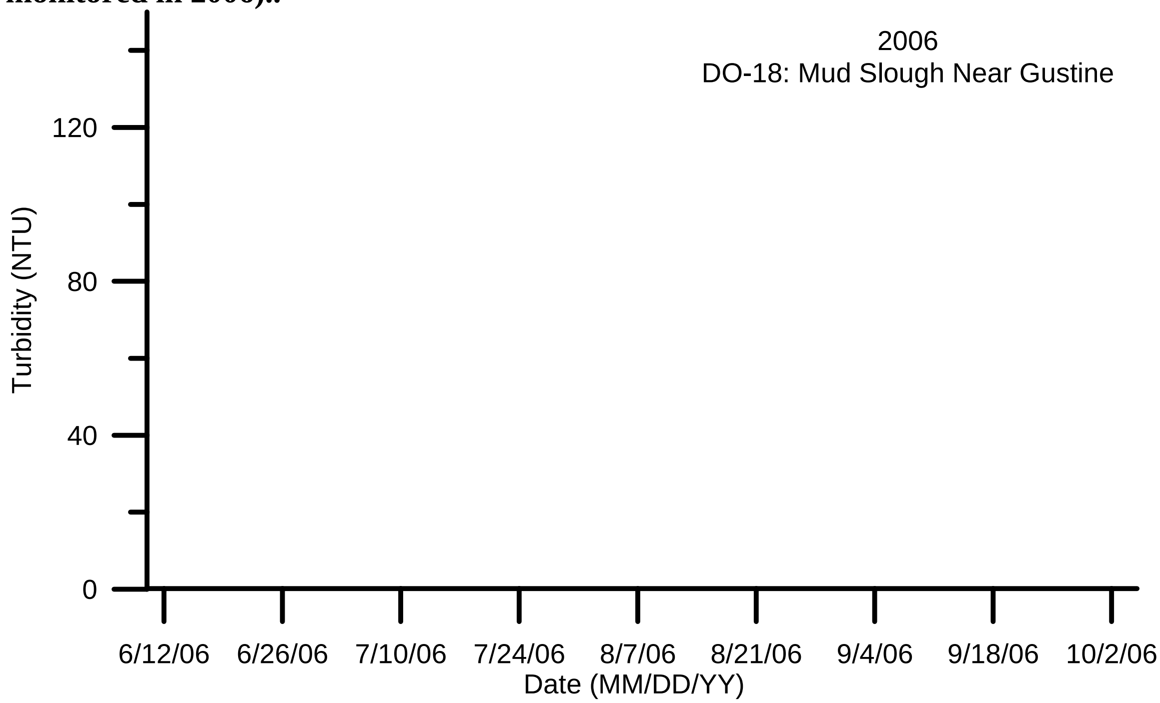


Figure 56: Turbidity 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006)..



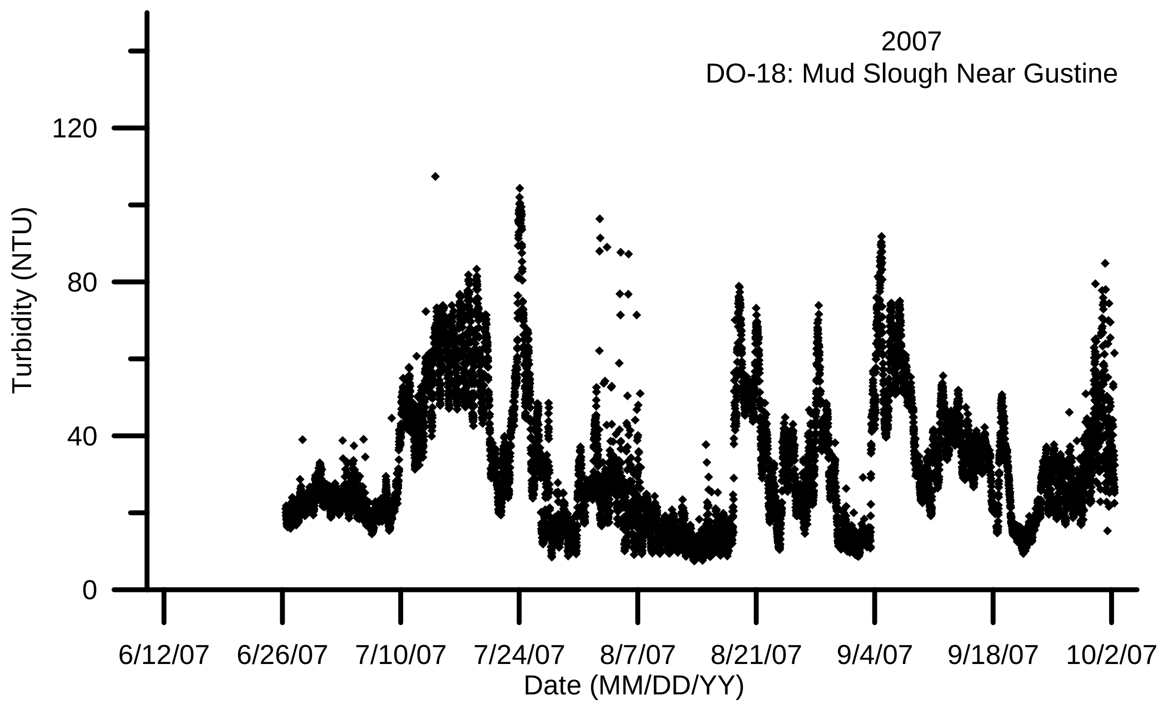


Figure 57: Chlorophyll-*a* fluorescence 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).

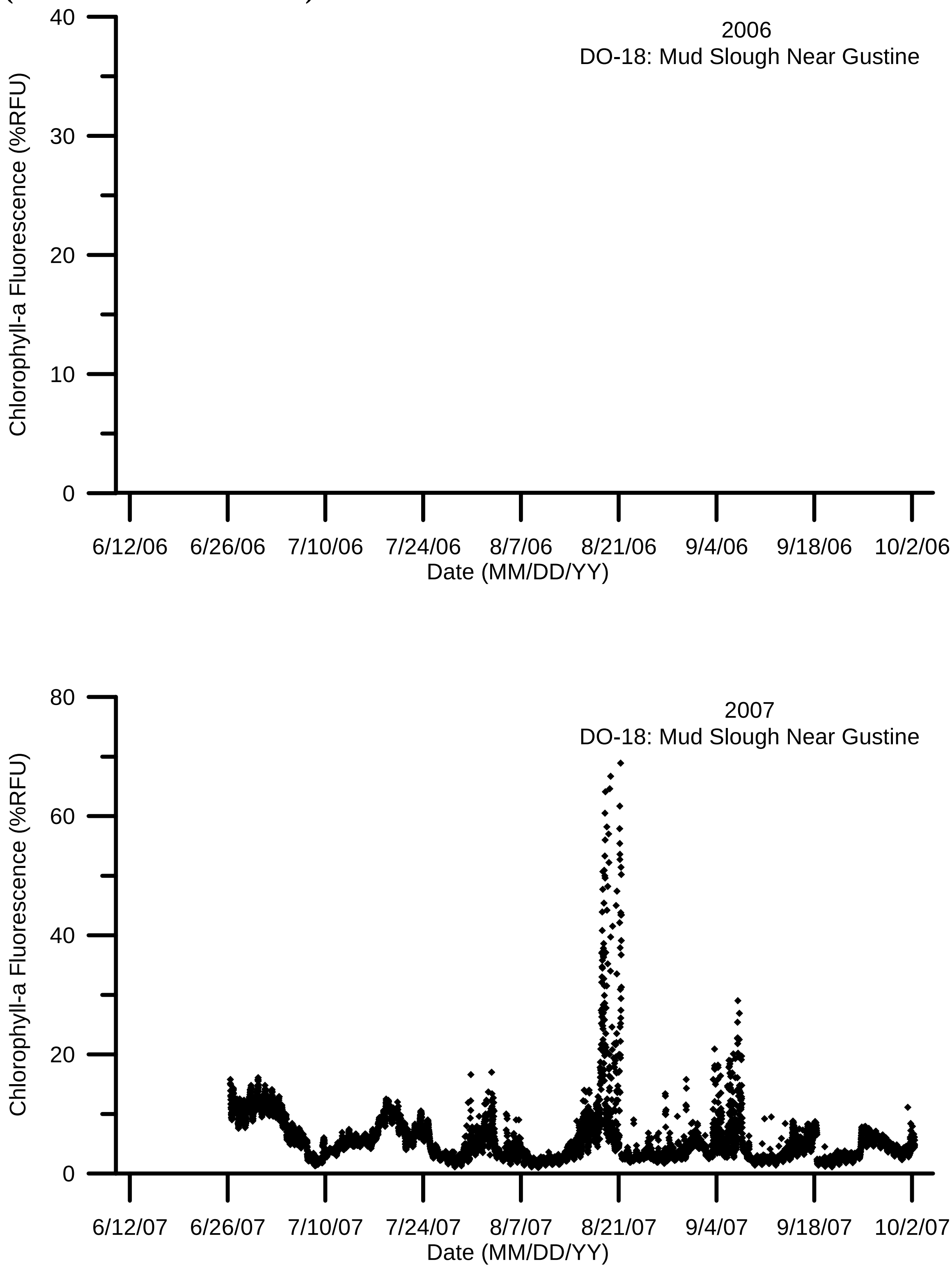
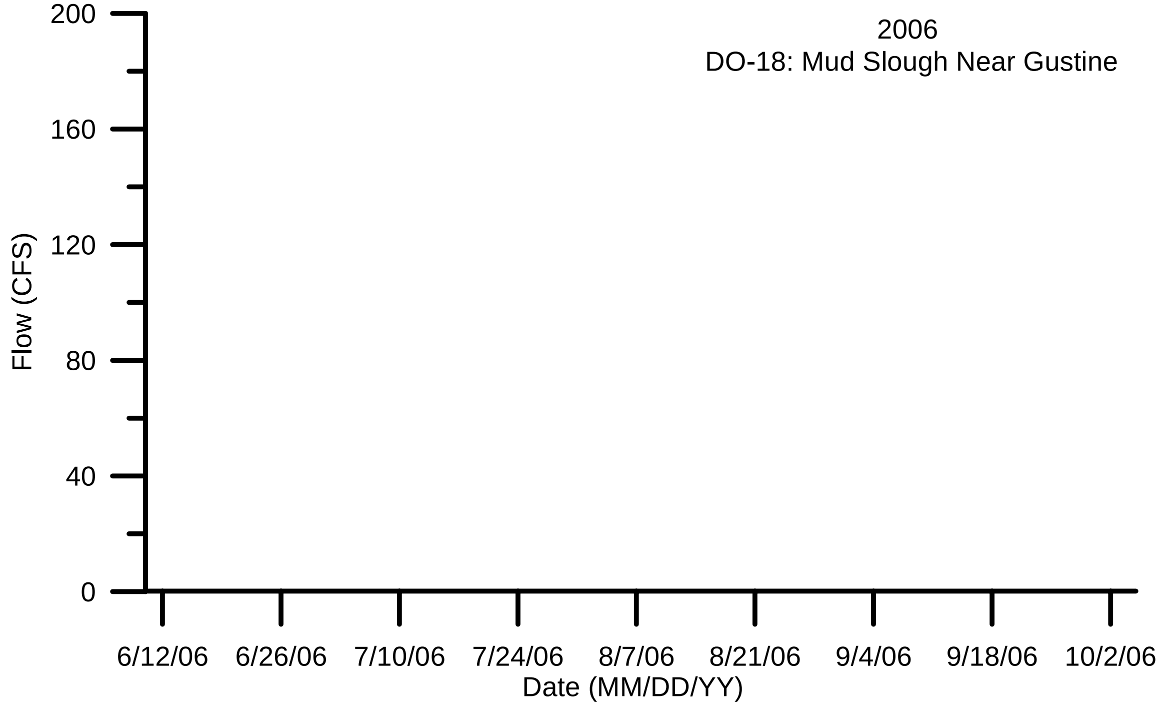


Figure 58: Flow 15 minute data at DO-18 for 2006 and 2007 (site not monitored in 2006).



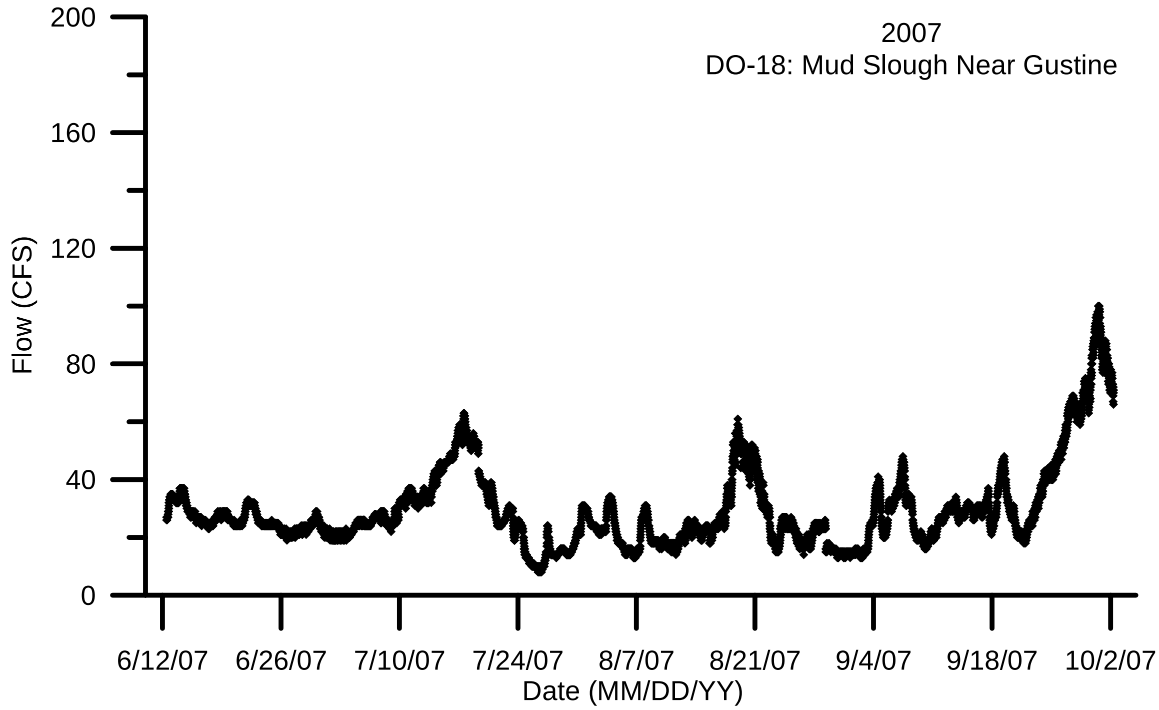
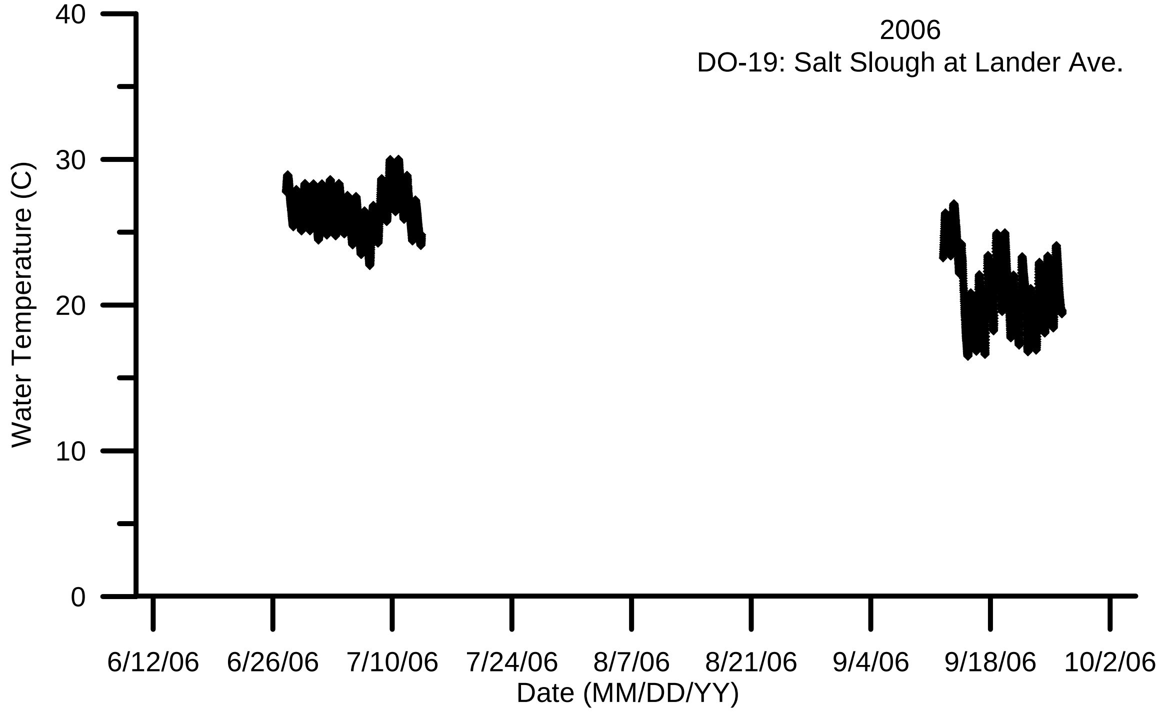


Figure 59: Water temperature 15 minute data at DO-19 for 2006 and 2007.



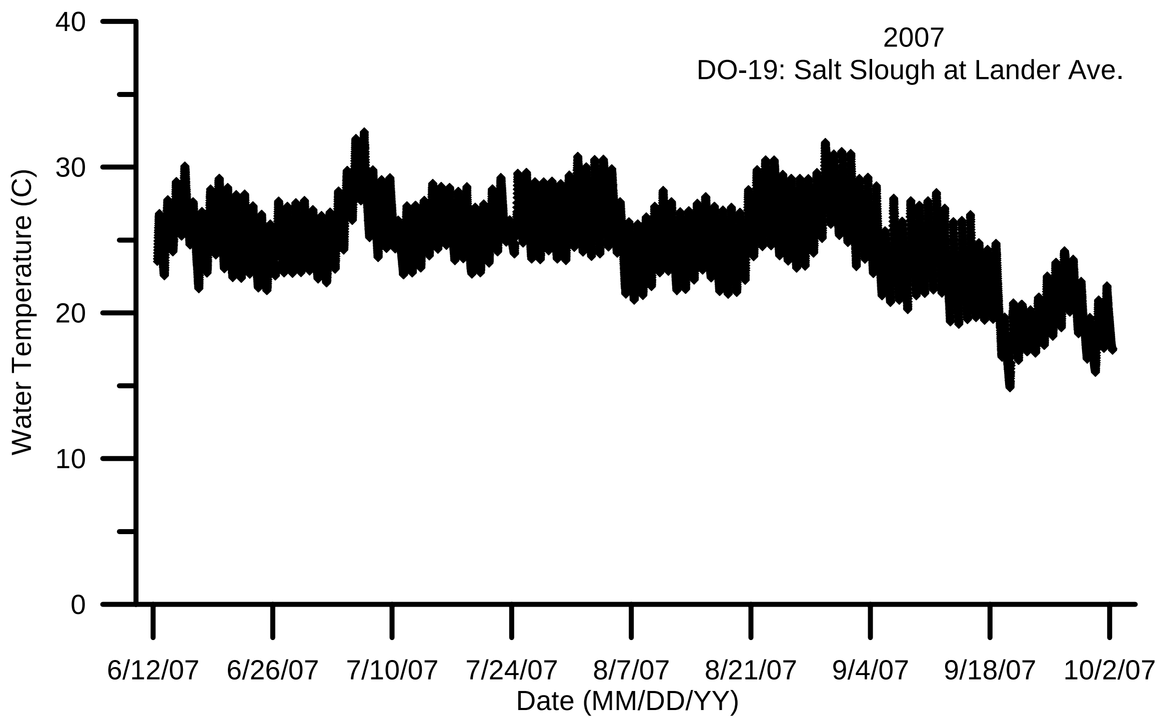
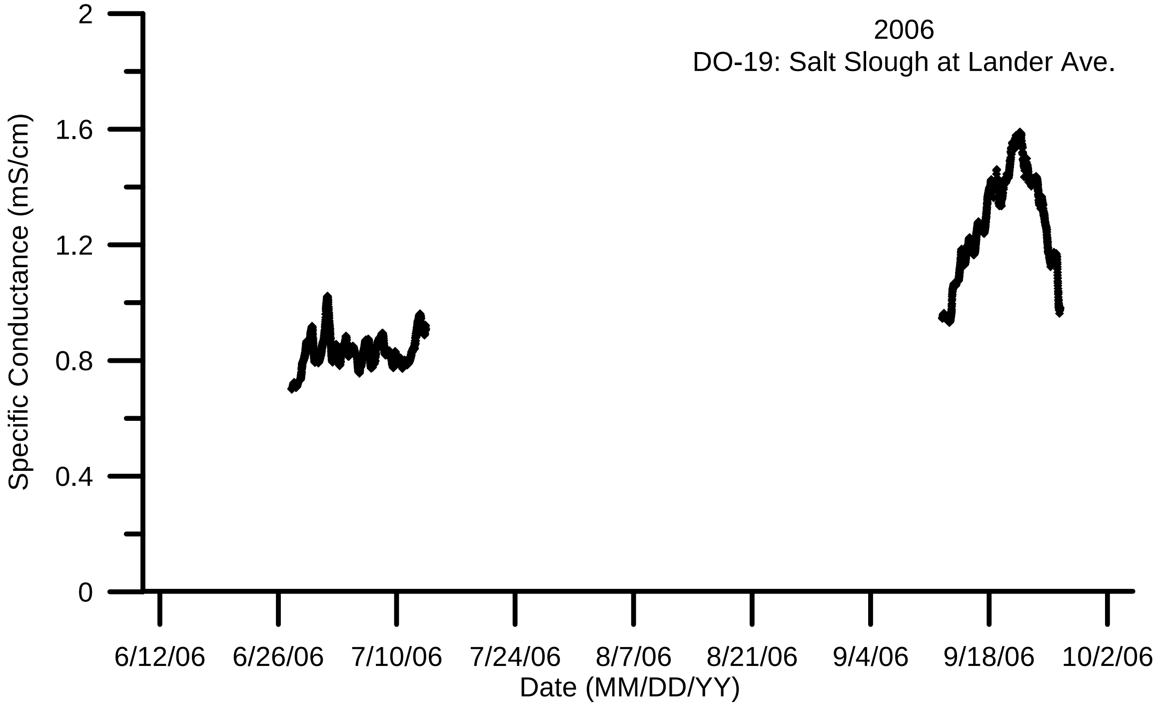


Figure 60: Specific conductance 15 minute data at DO-19 for 2006 and 2007.



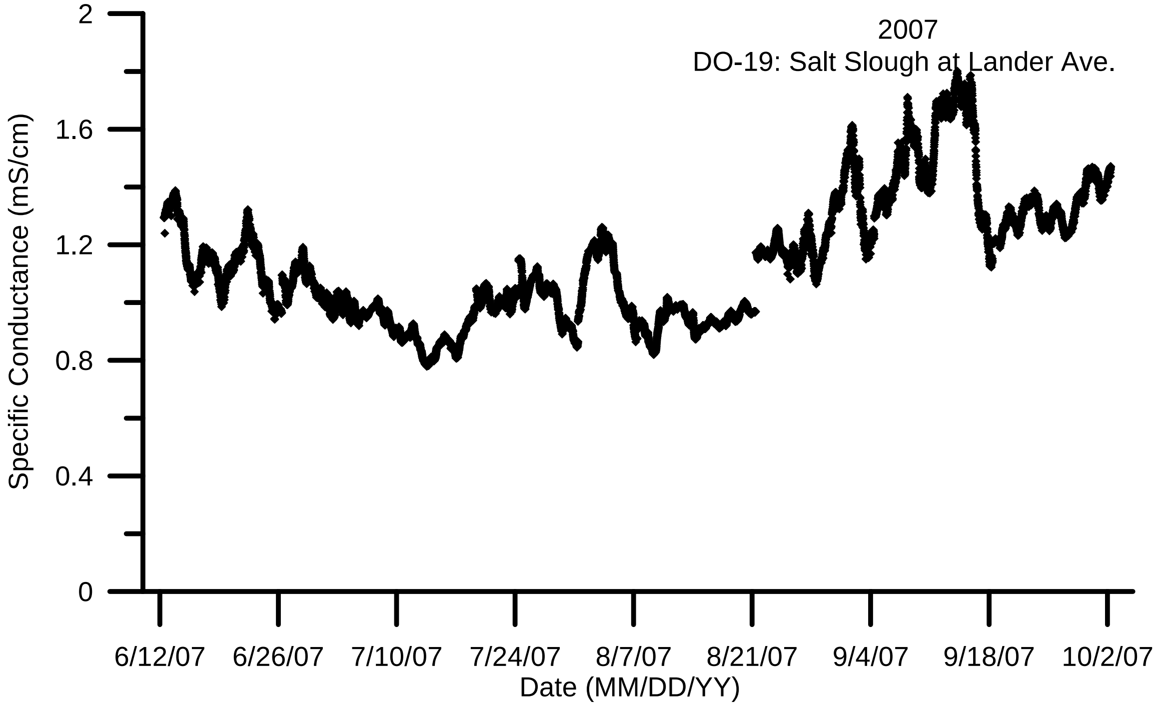
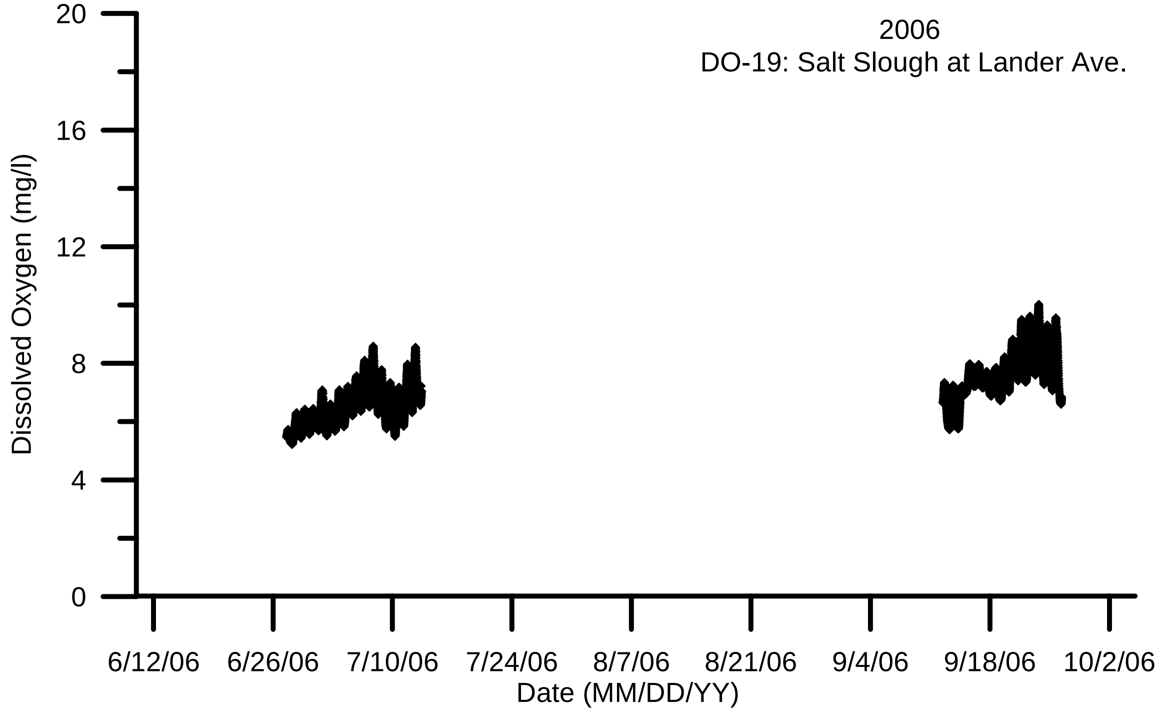


Figure 61: Dissolved oxygen concentration 15 minute data at DO-19 for 2006 and 2007.



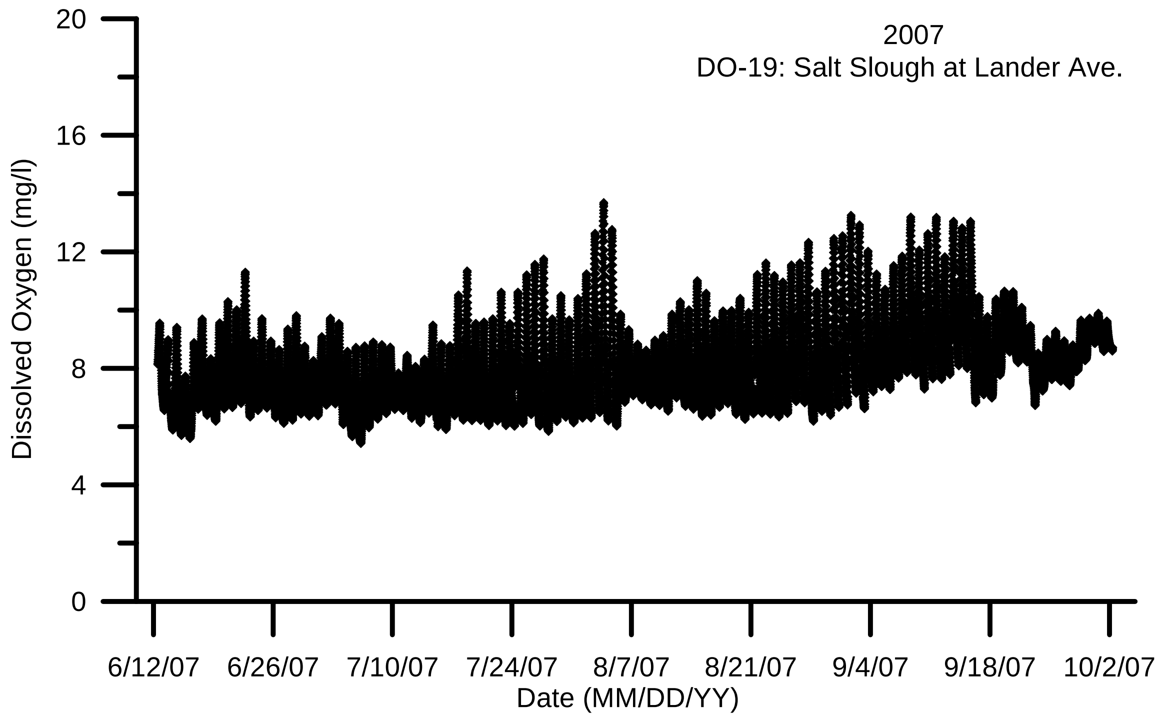
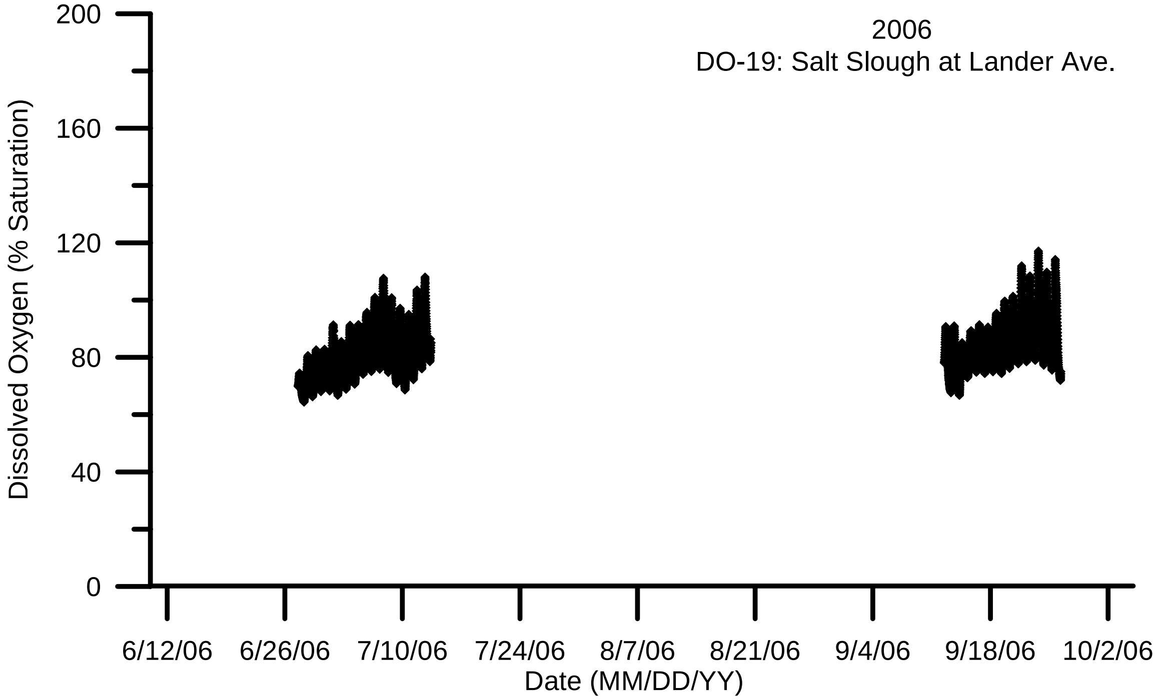


Figure 62: Dissolved oxygen percent of saturation 15 minute data at DO-19 for 2006 and 2007.



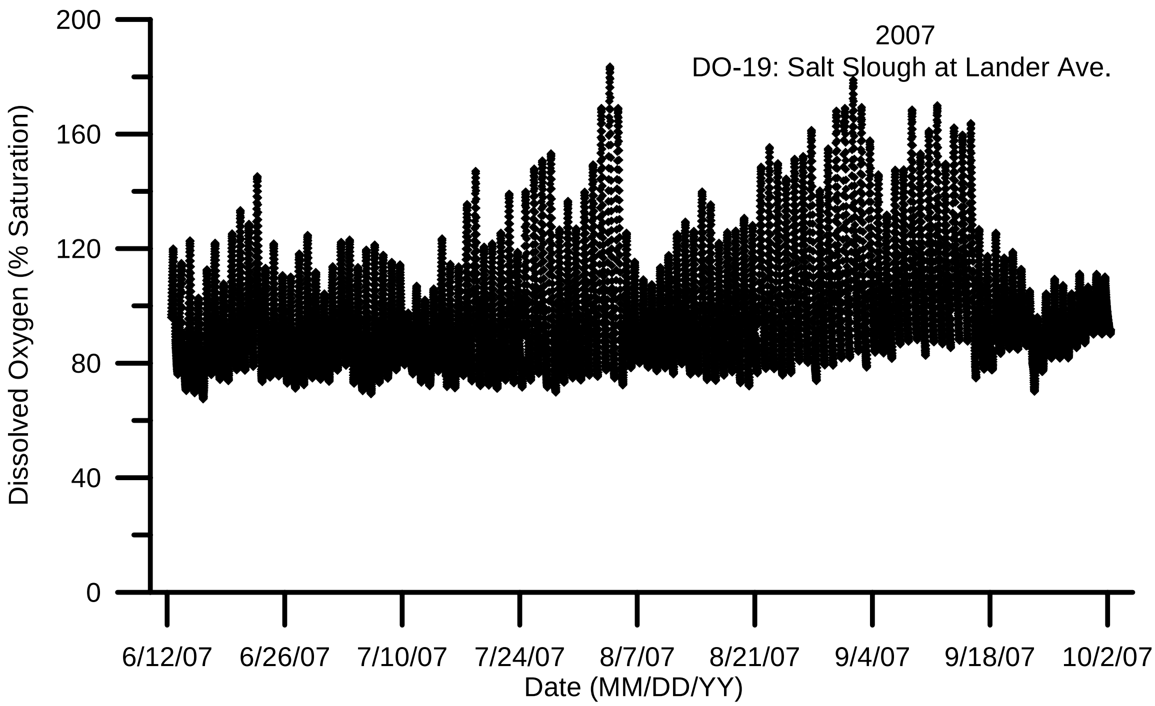
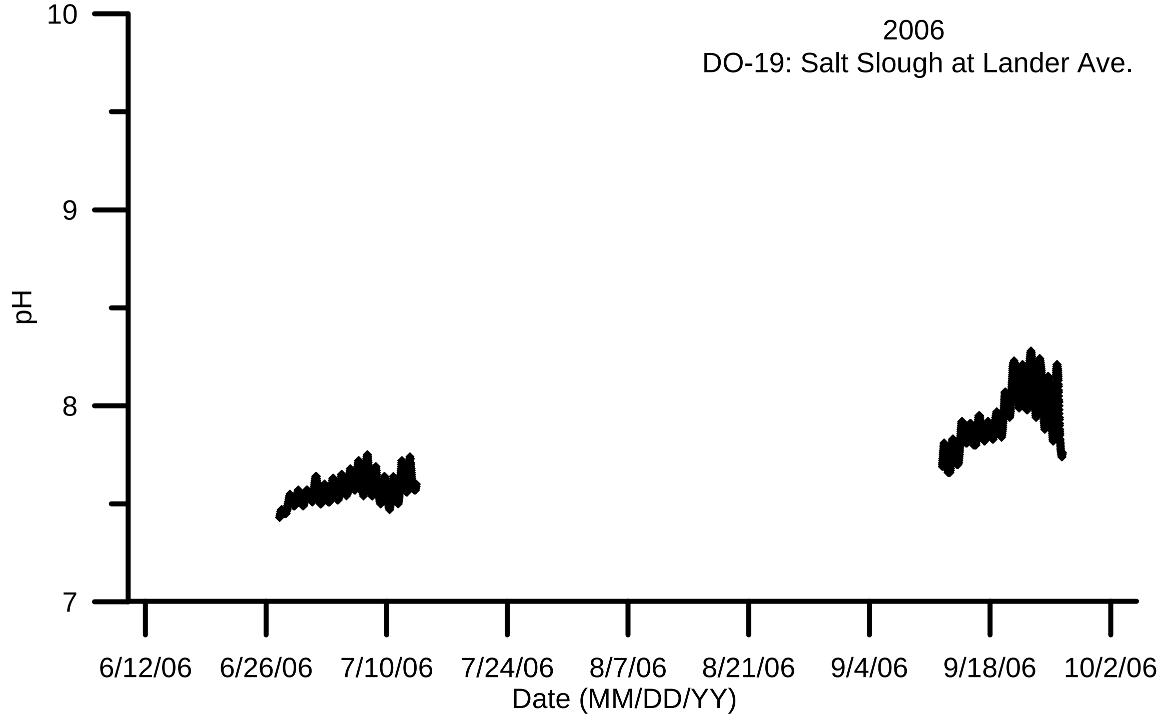


Figure 63: pH 15 minute data at DO-19 for 2006 and 2007.



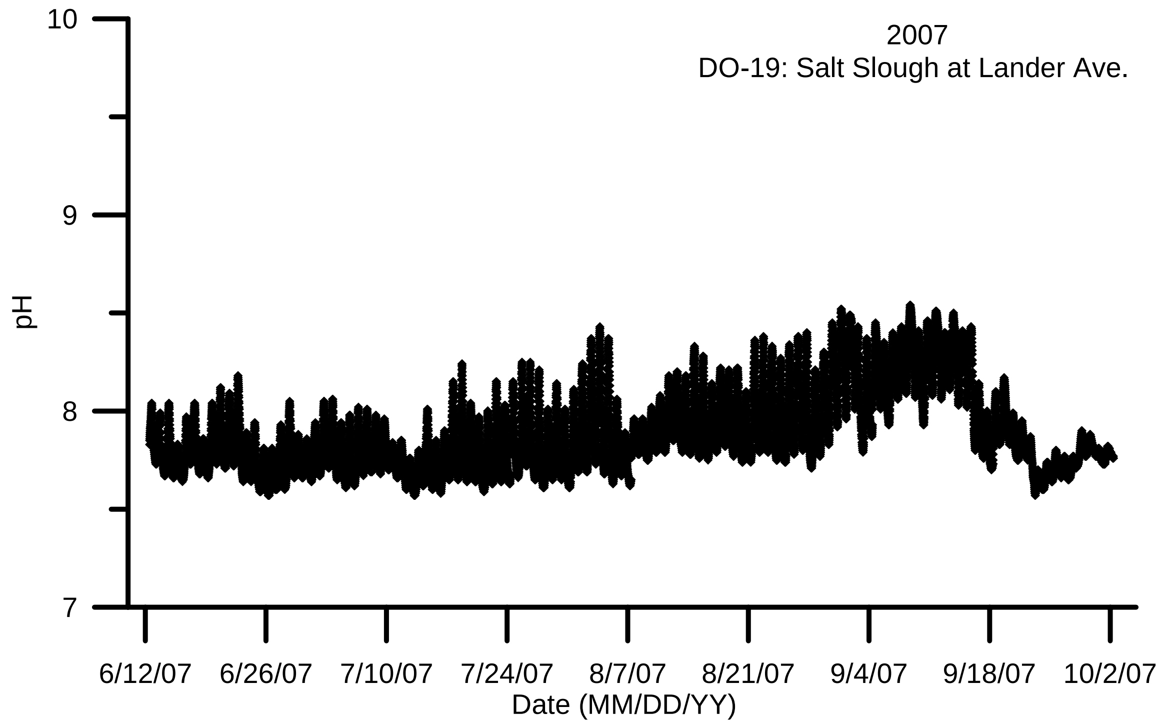
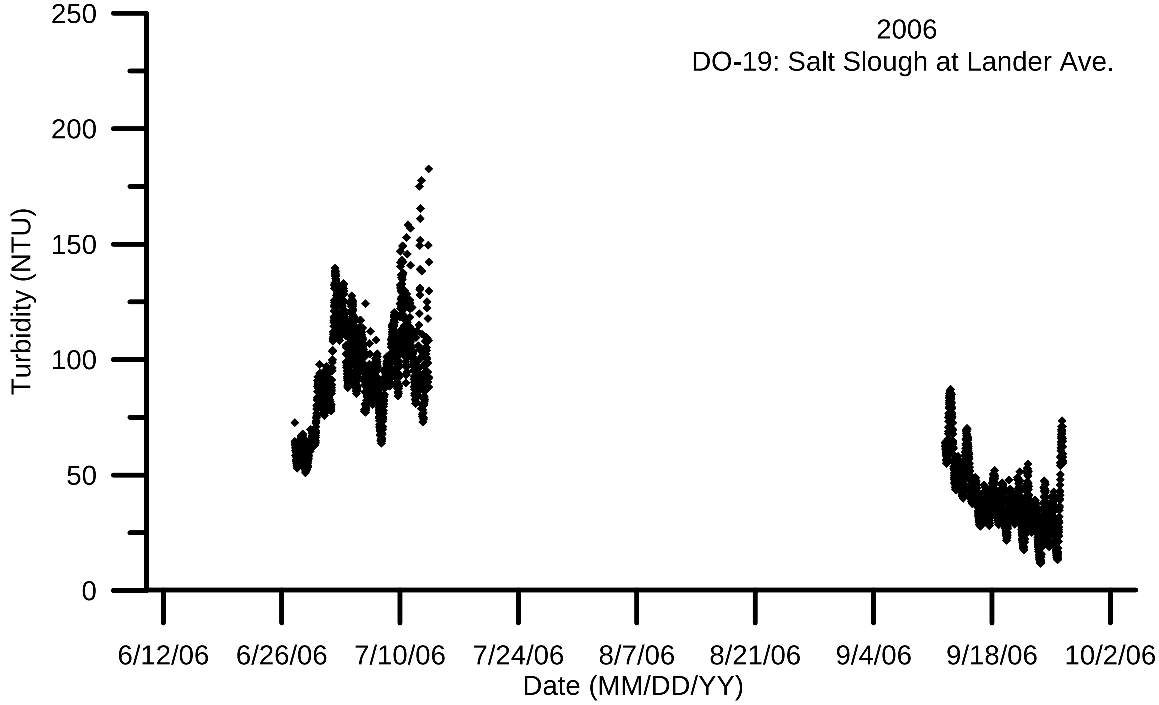


Figure 64: Turbidity 15 minute data at DO-19 for 2006 and 2007.



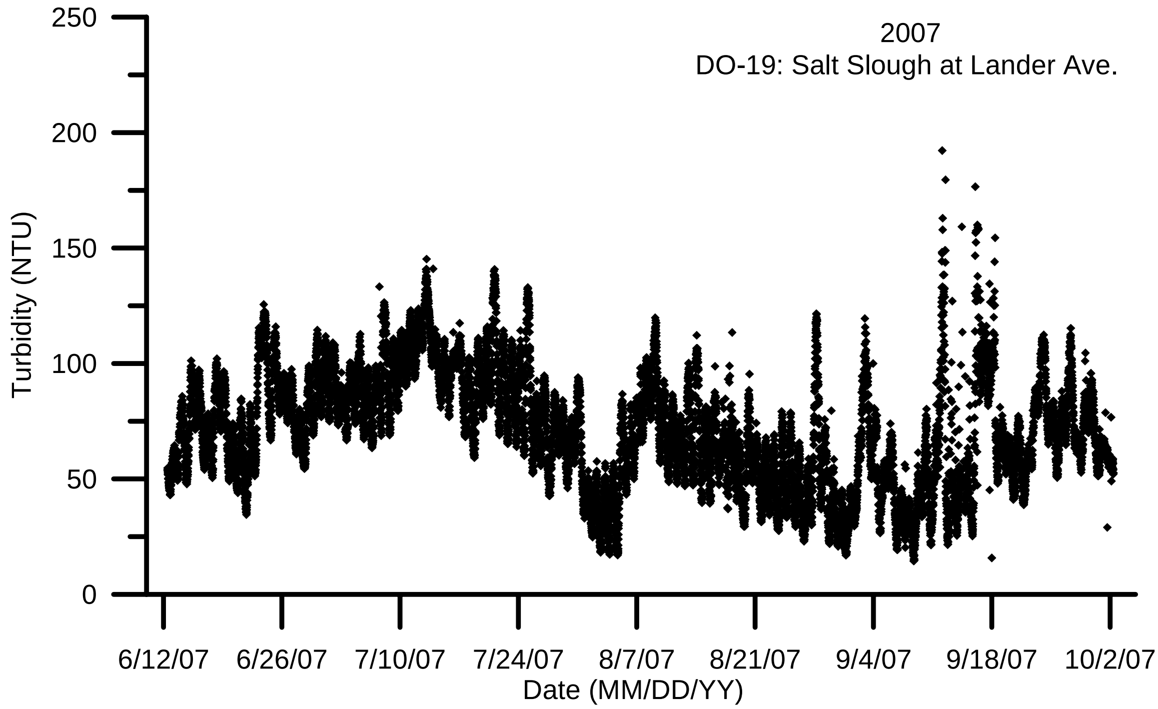
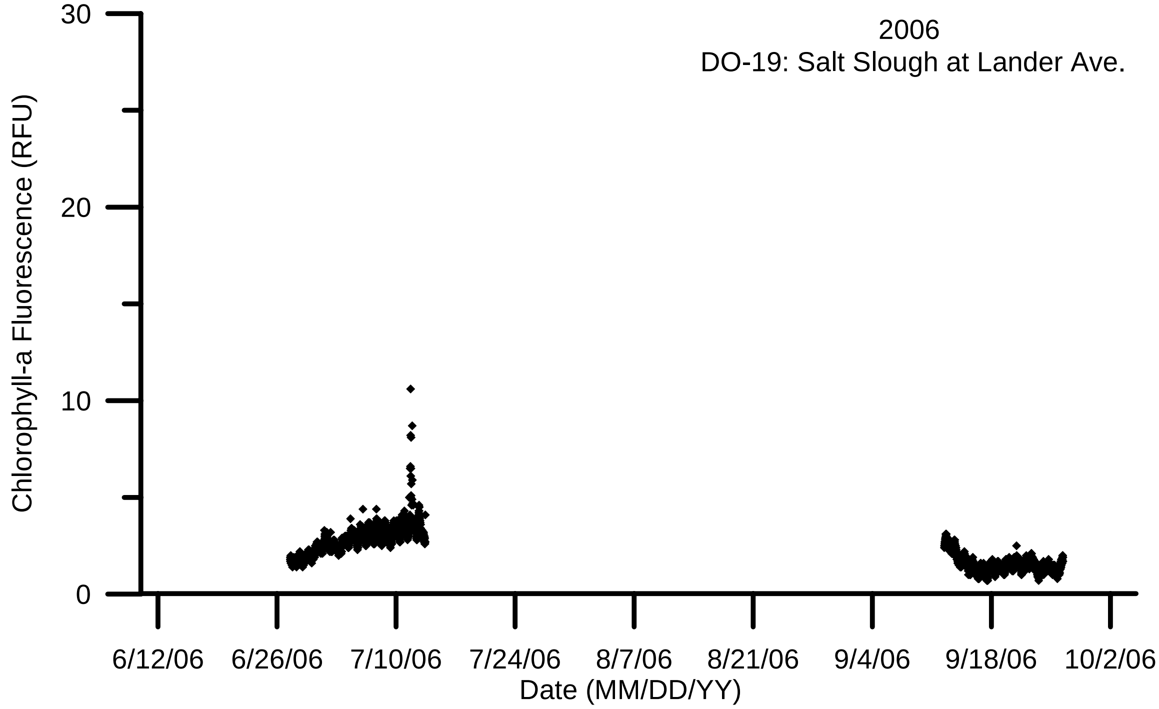


Figure 65: Chlorophyll-*a* fluorescence 15 minute data at DO-19 for 2006 and 2007.



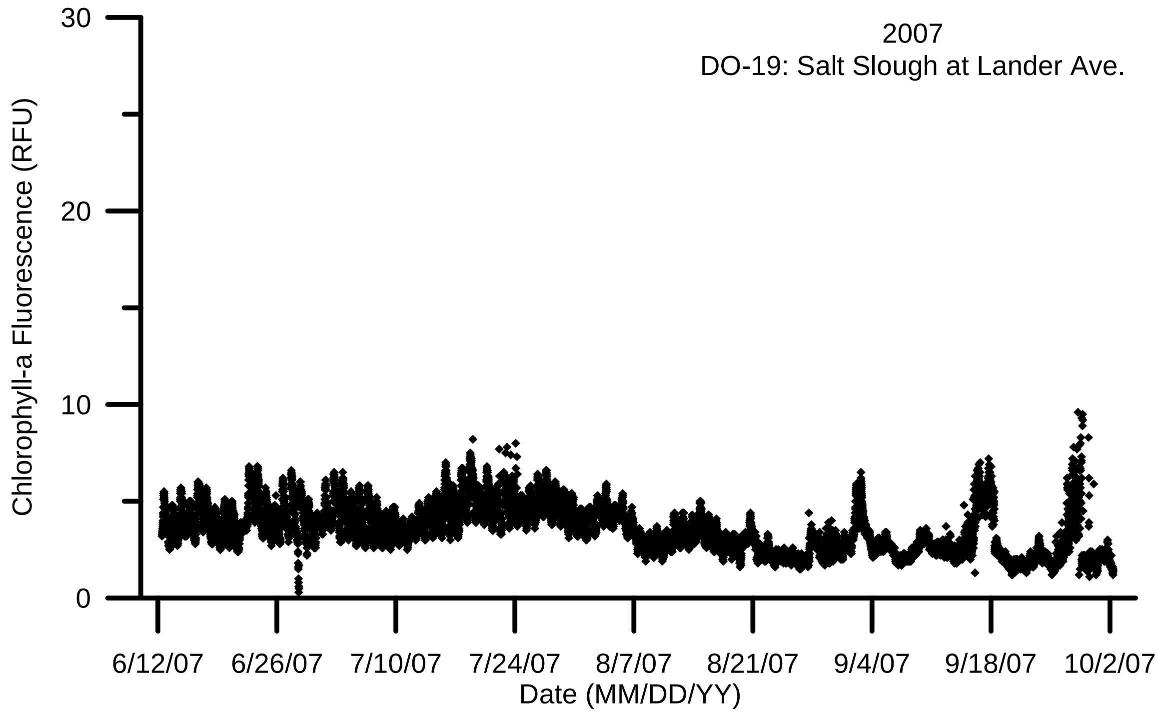
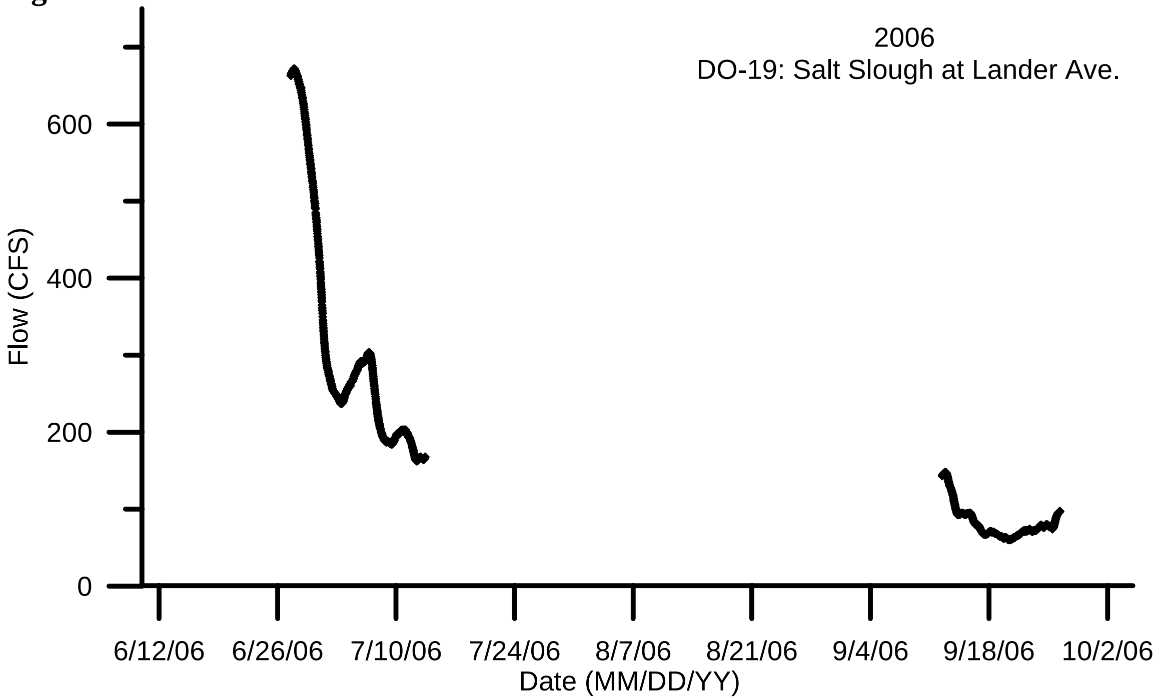


Figure 66: Flow 15 minute data at DO-19 for 2006 and 2007.



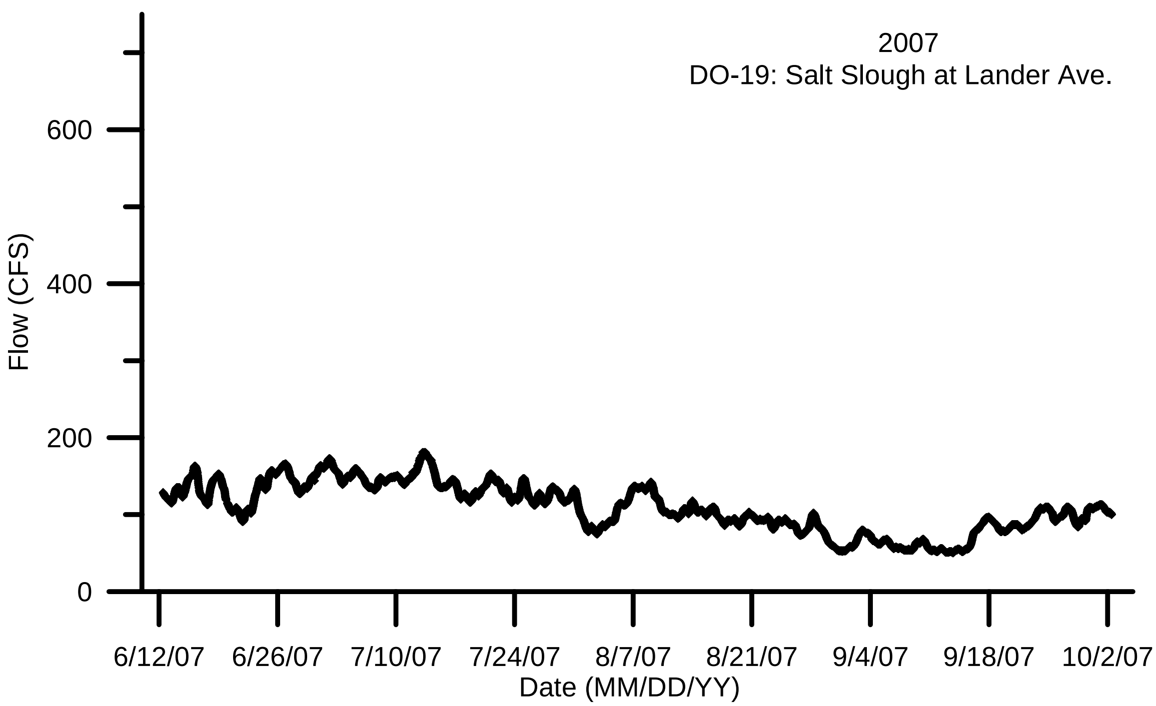
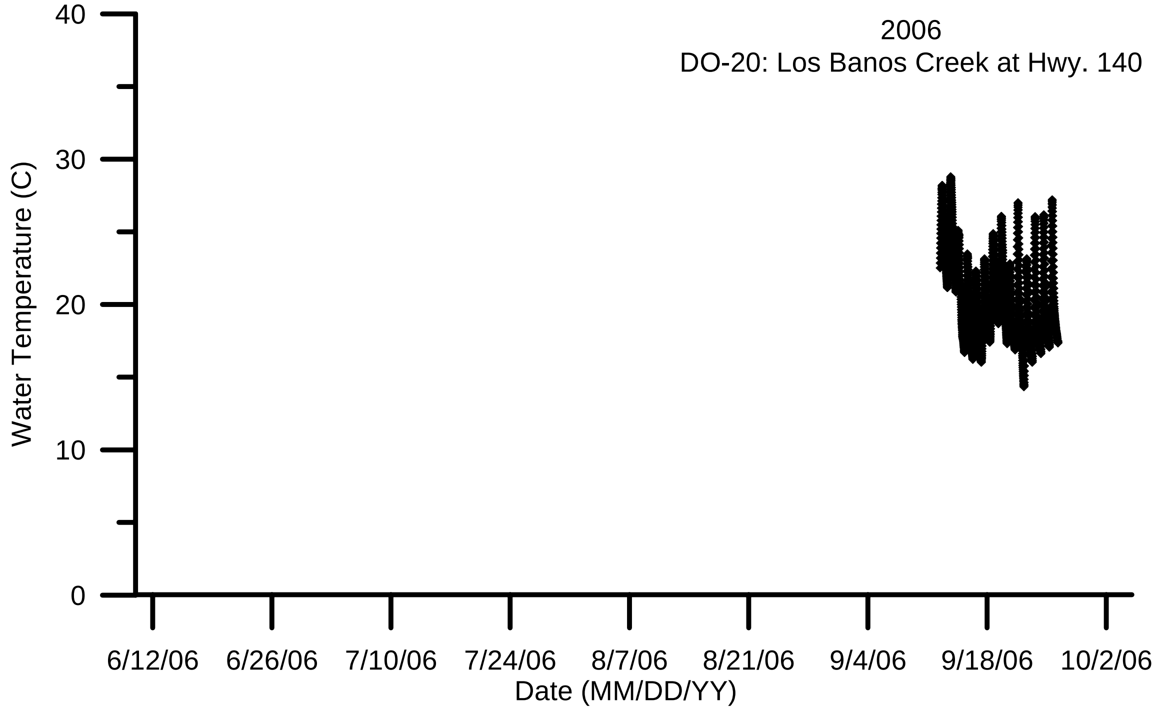


Figure 67: Water temperature 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



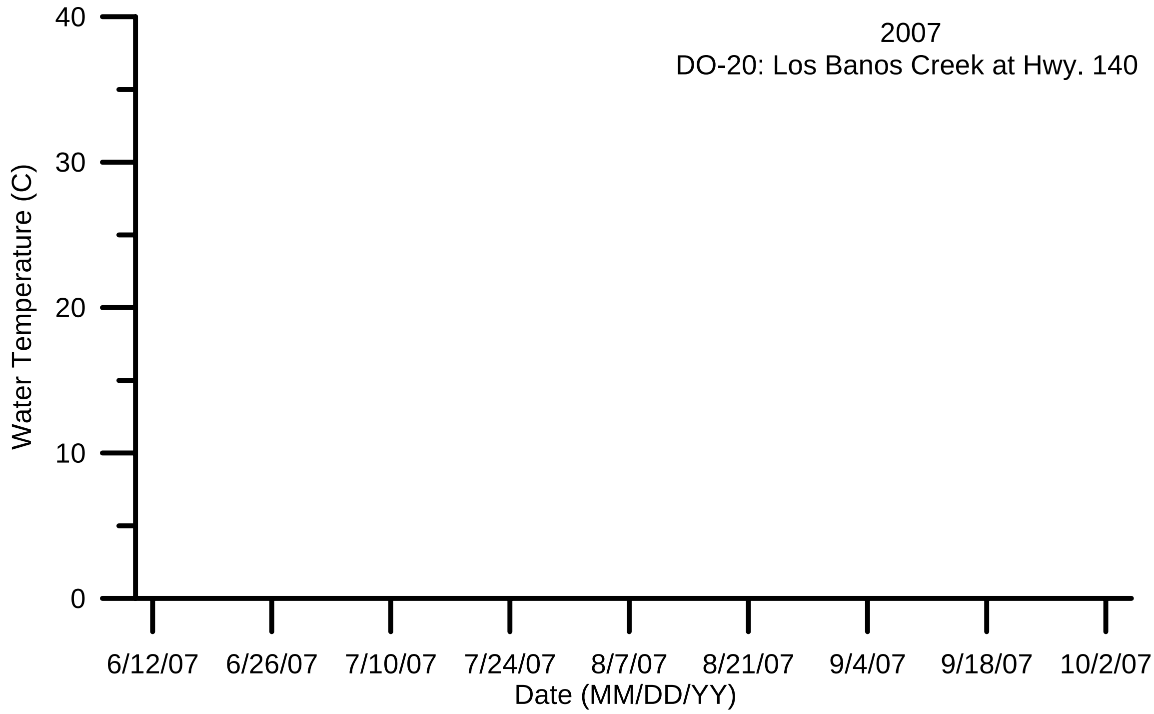
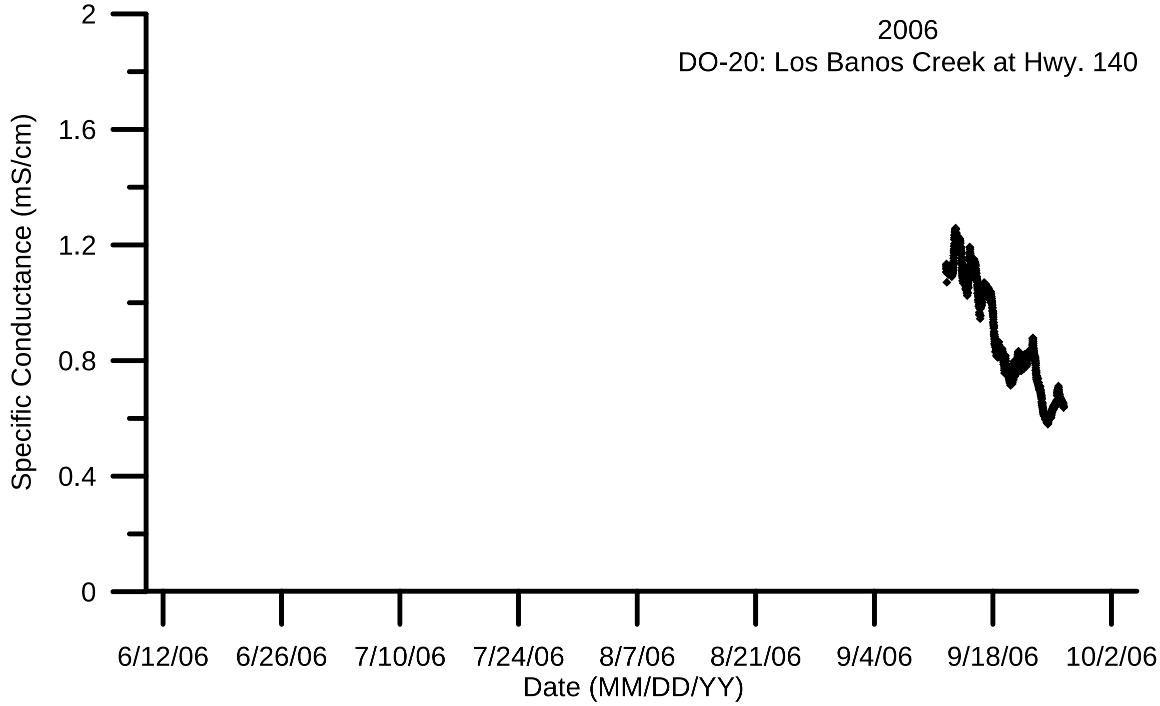


Figure 68: Specific conductance 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



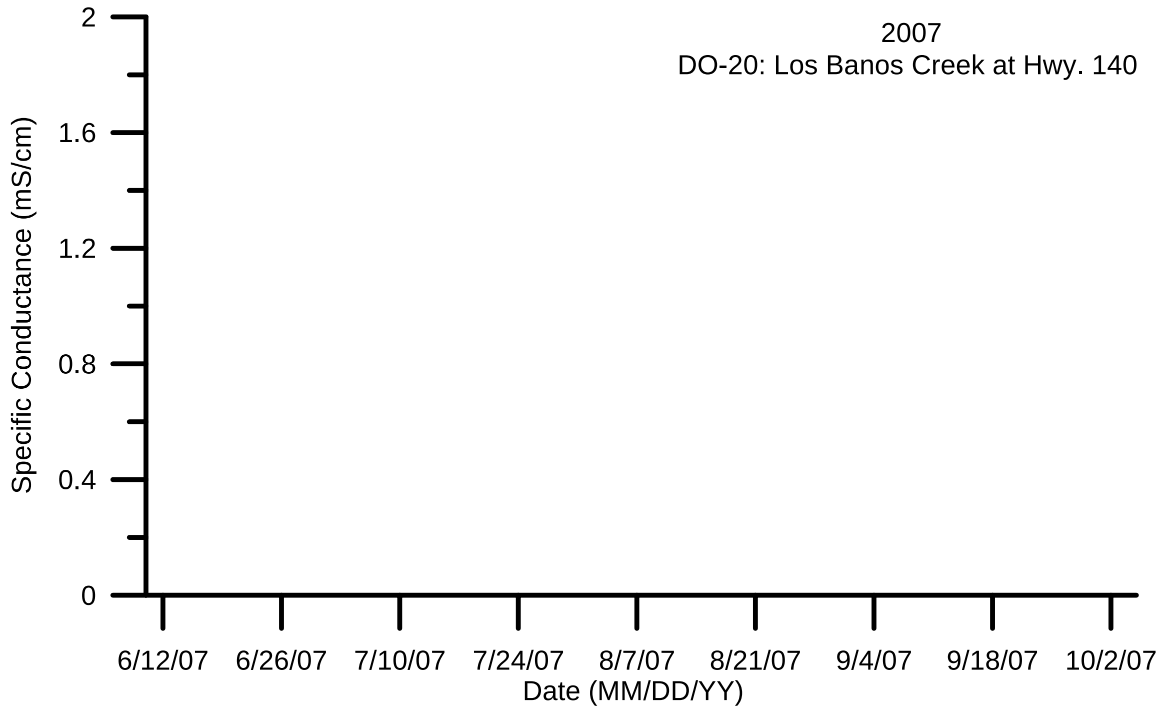
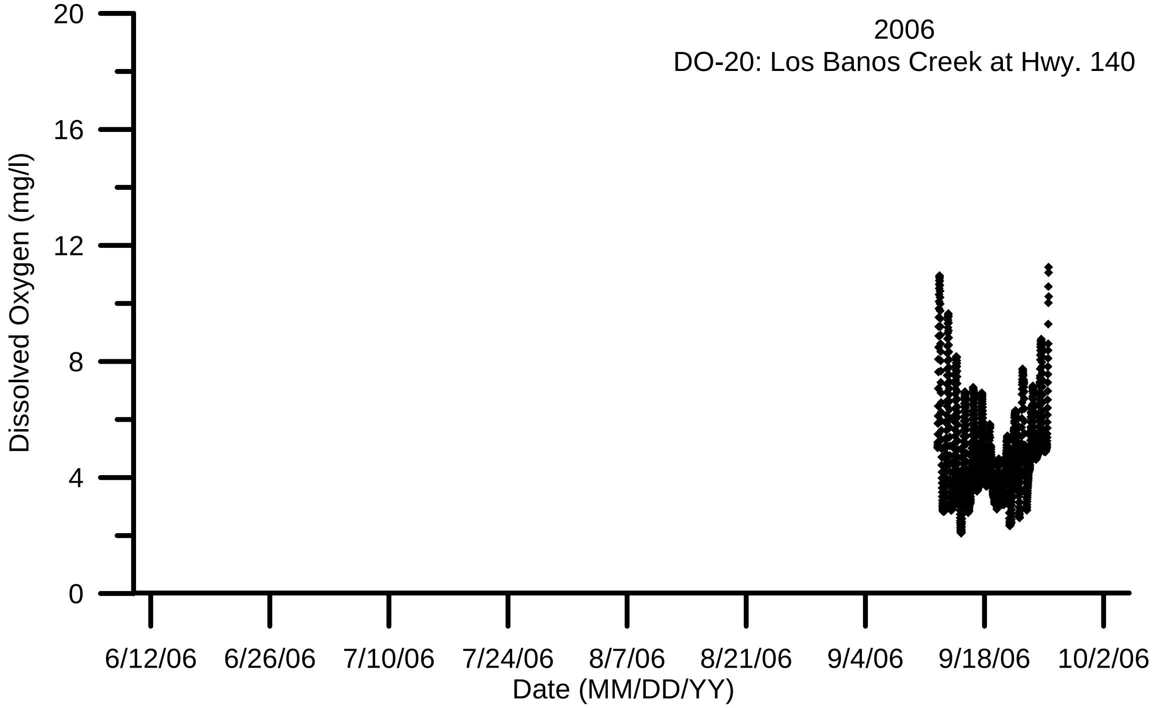


Figure 69: Dissolved oxygen concentration 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



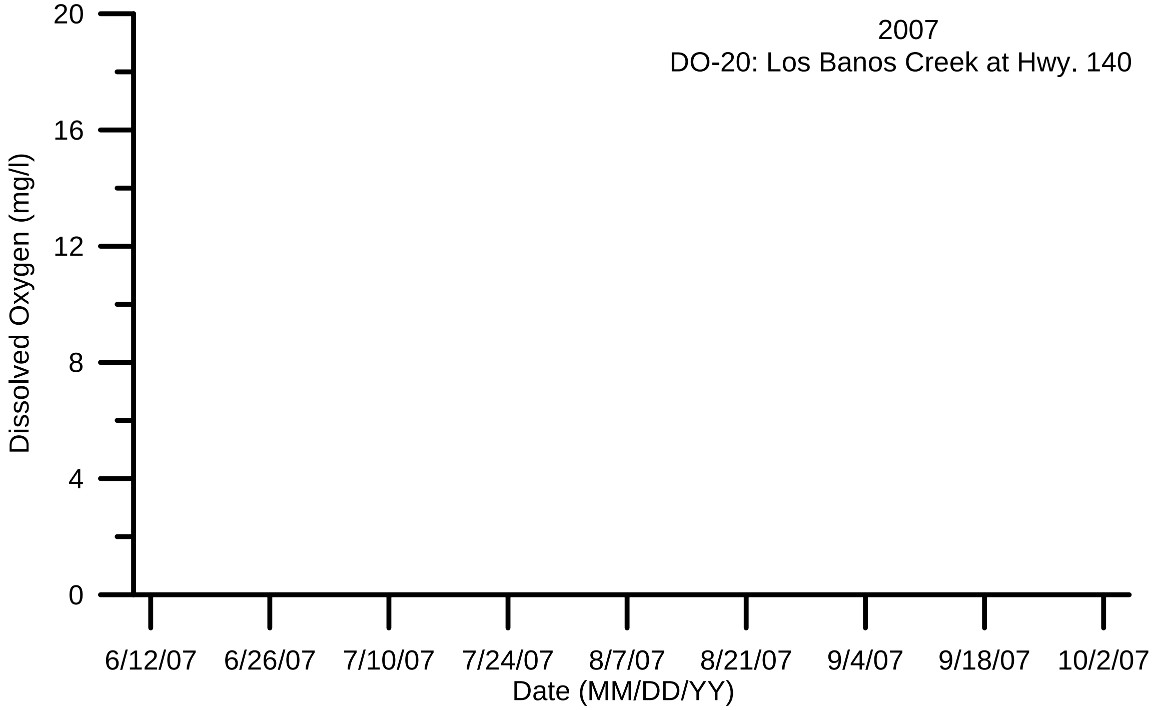
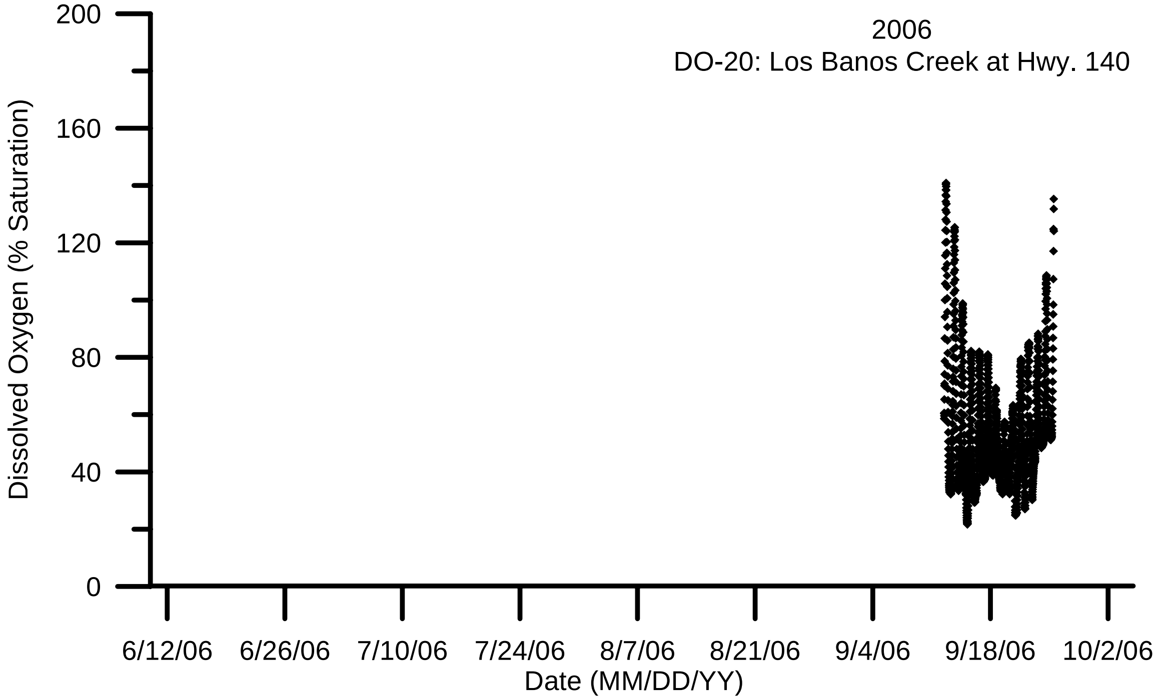


Figure 70: Dissolved oxygen percent of satureation 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



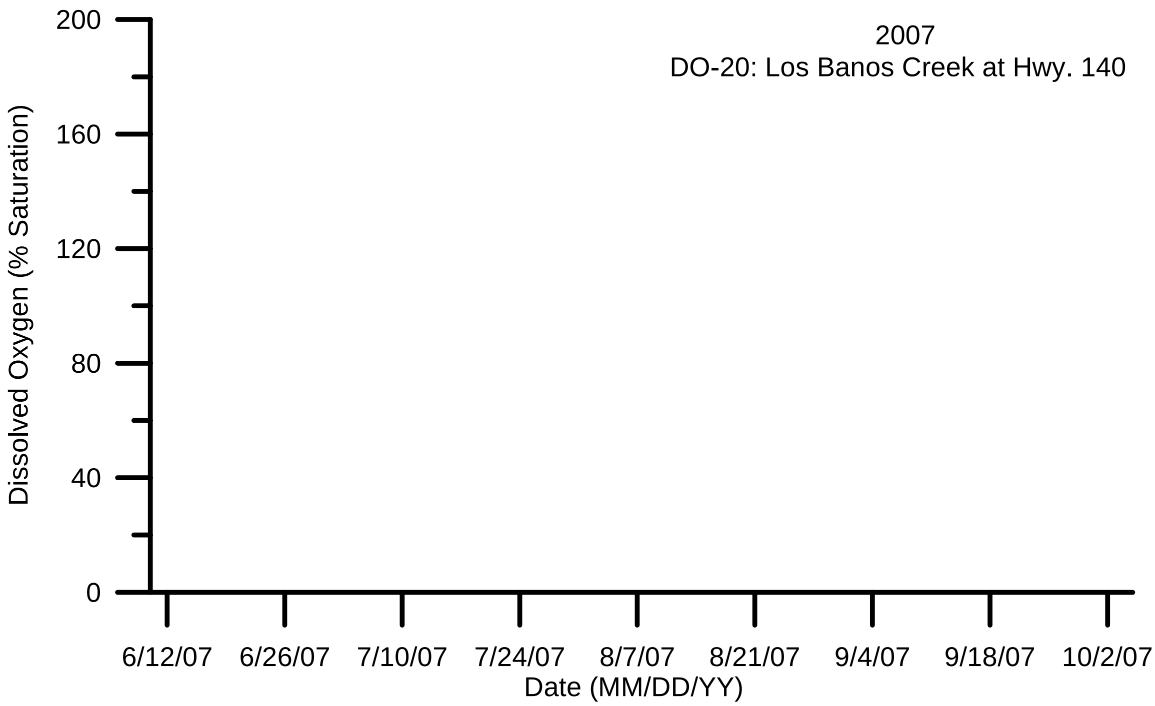
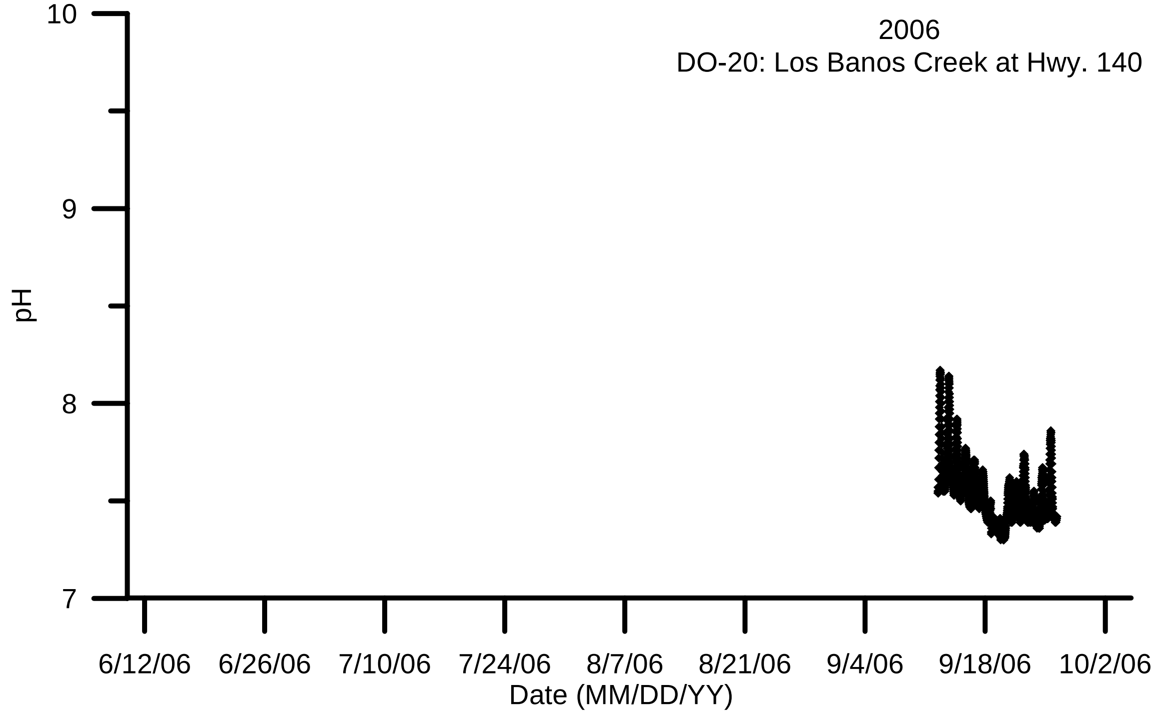


Figure 71: pH 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



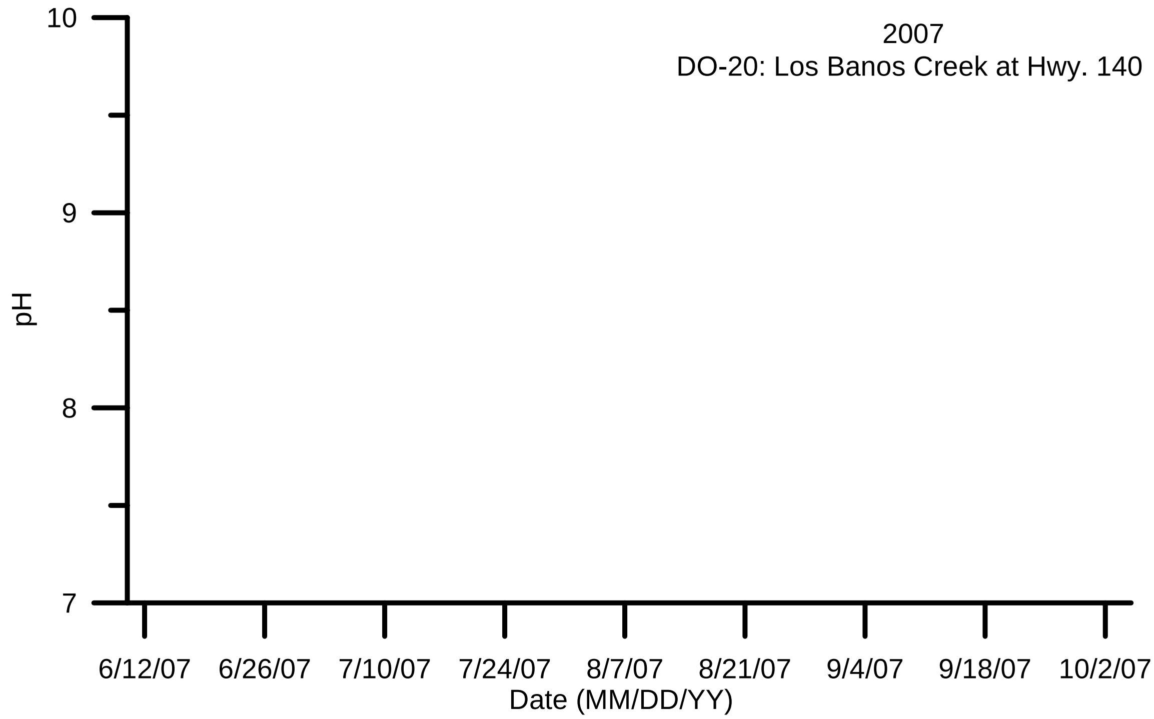
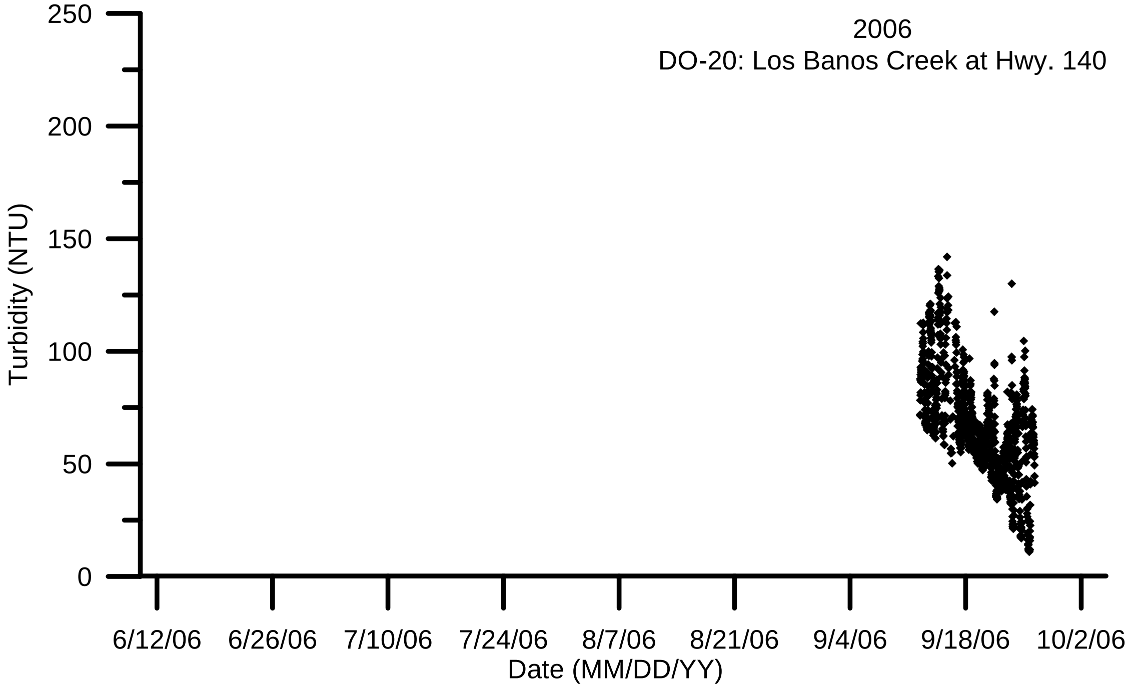


Figure 72: Turbidity 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



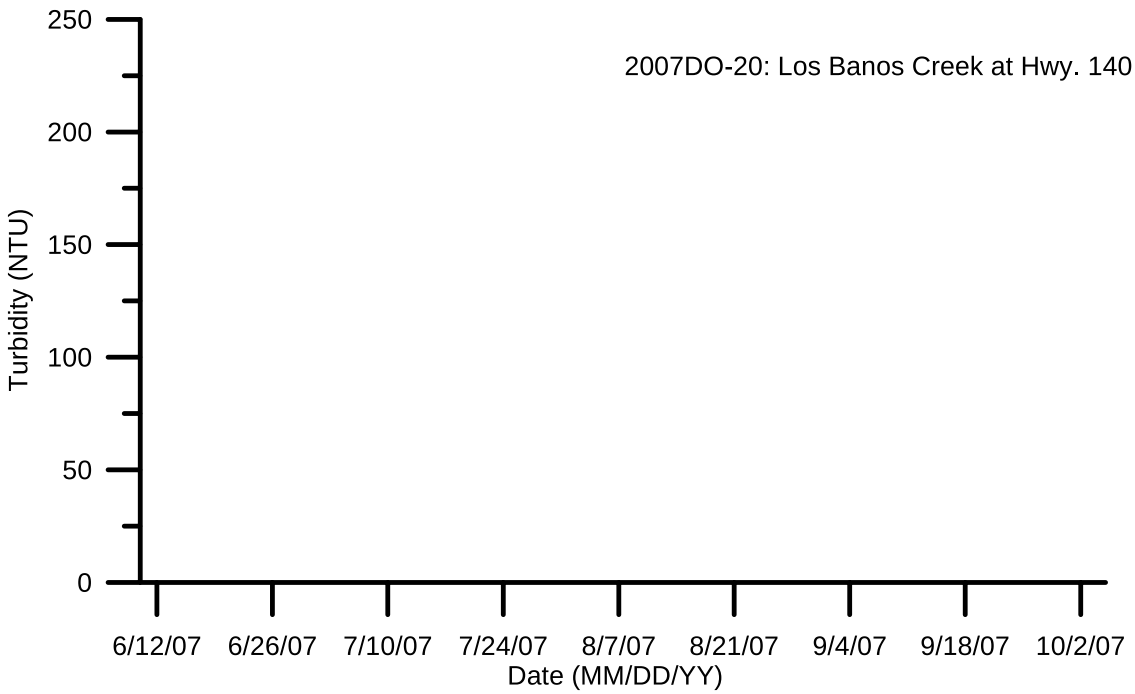
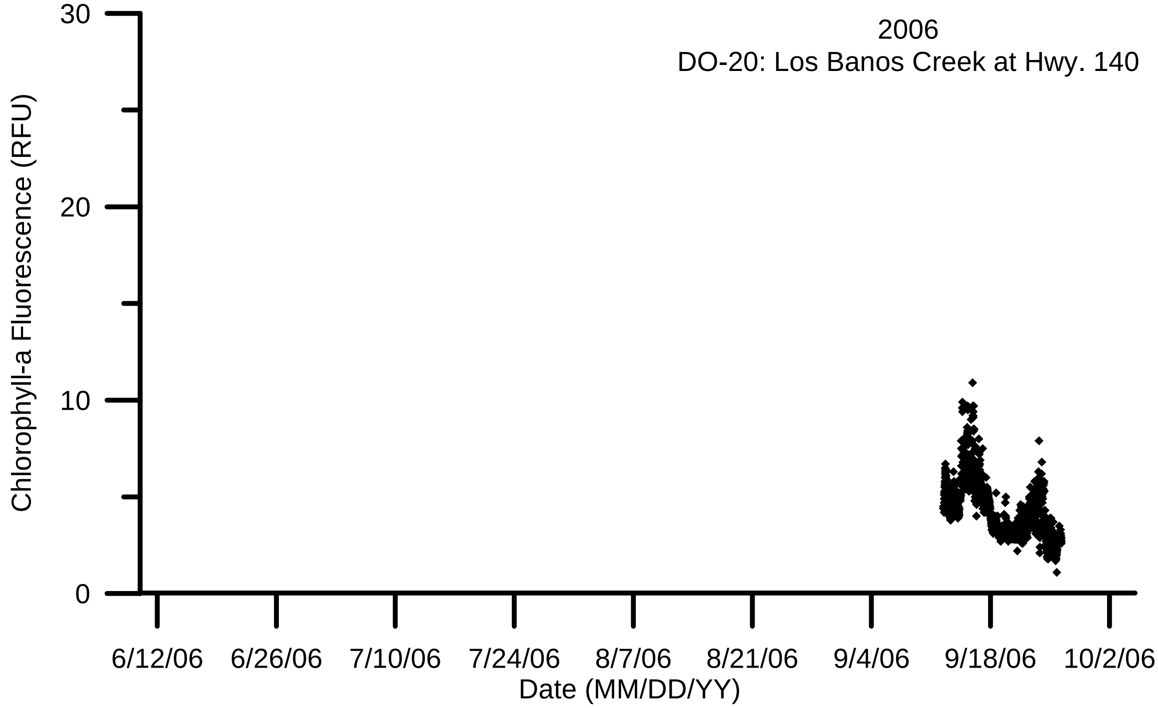


Figure 73: Chlorophyll-*a* fluorescence 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



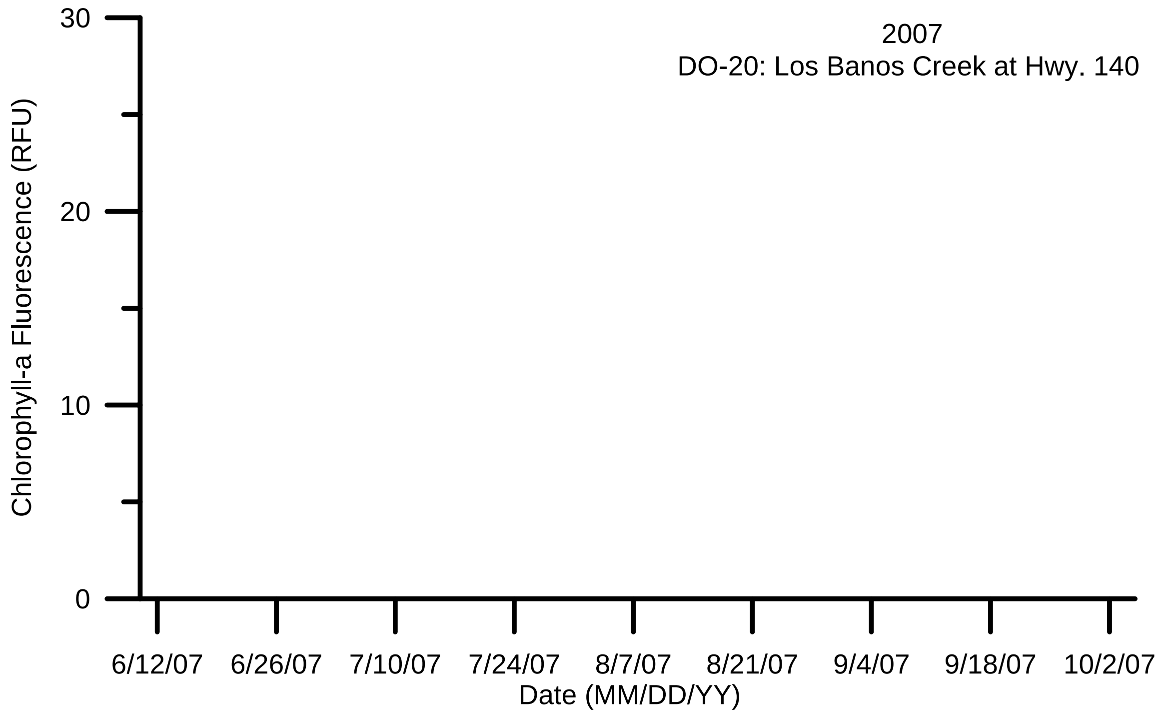
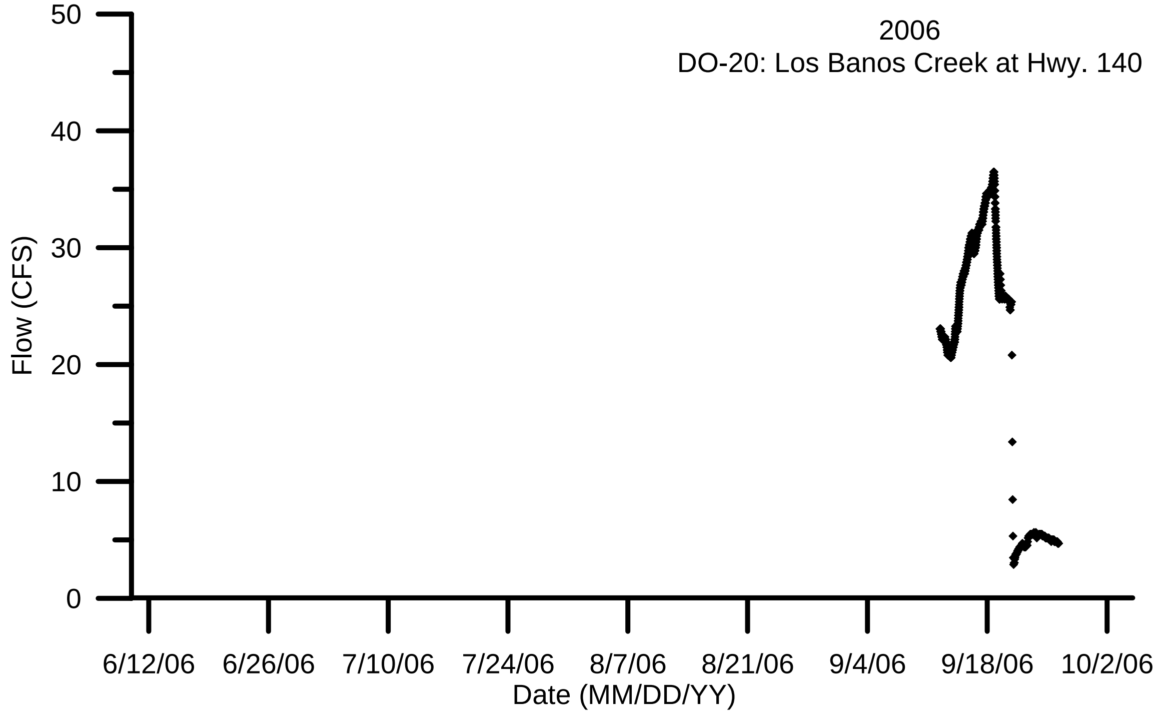


Figure 74: Flow 15 minute data at DO-20 for 2006 and 2007 (site not monitored in 2007).



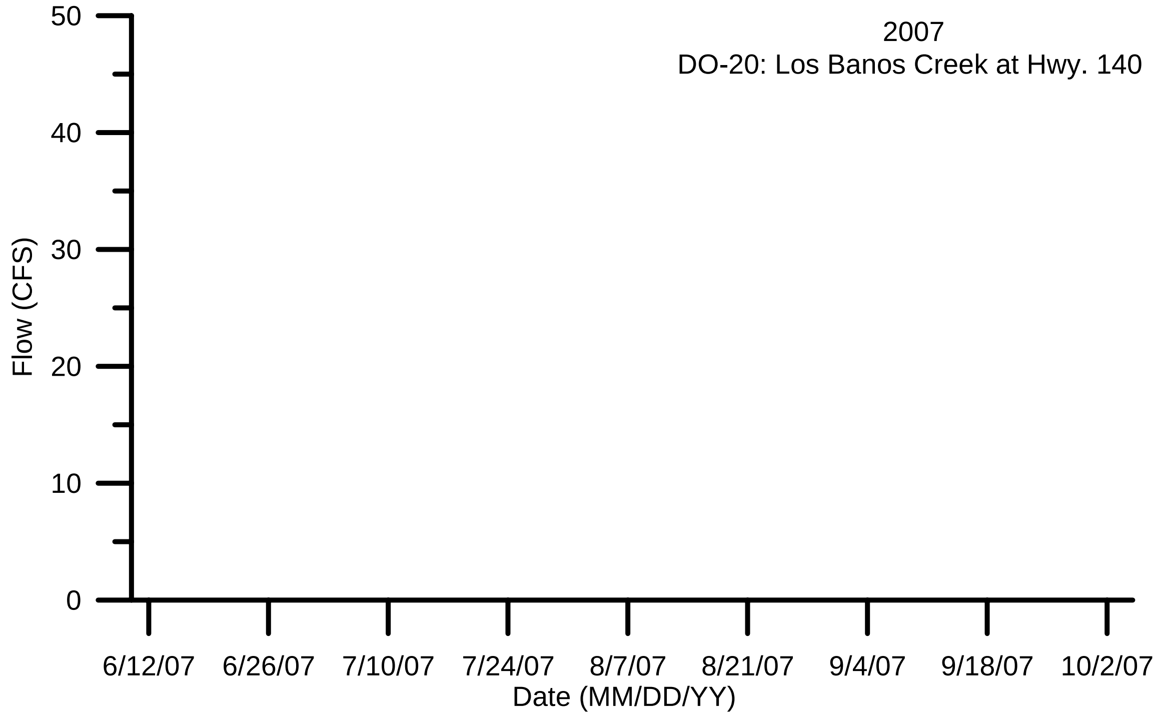
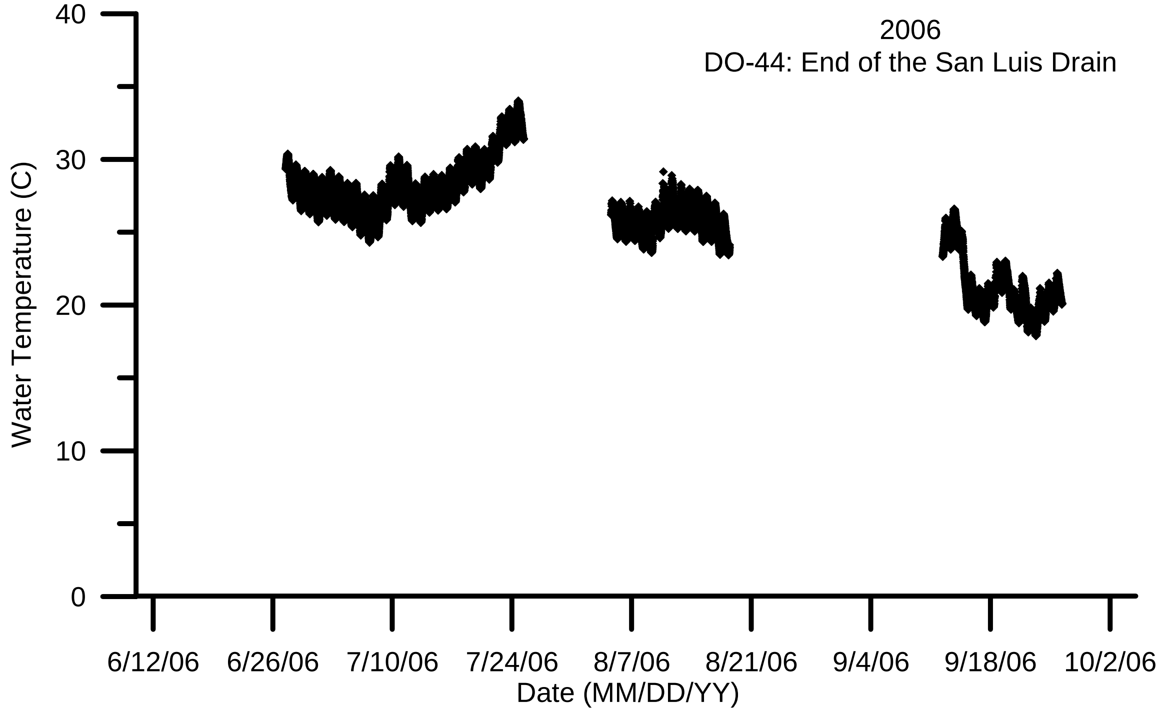


Figure 75: Water temperature 15 minute data at DO-44 for 2006 and 2007.



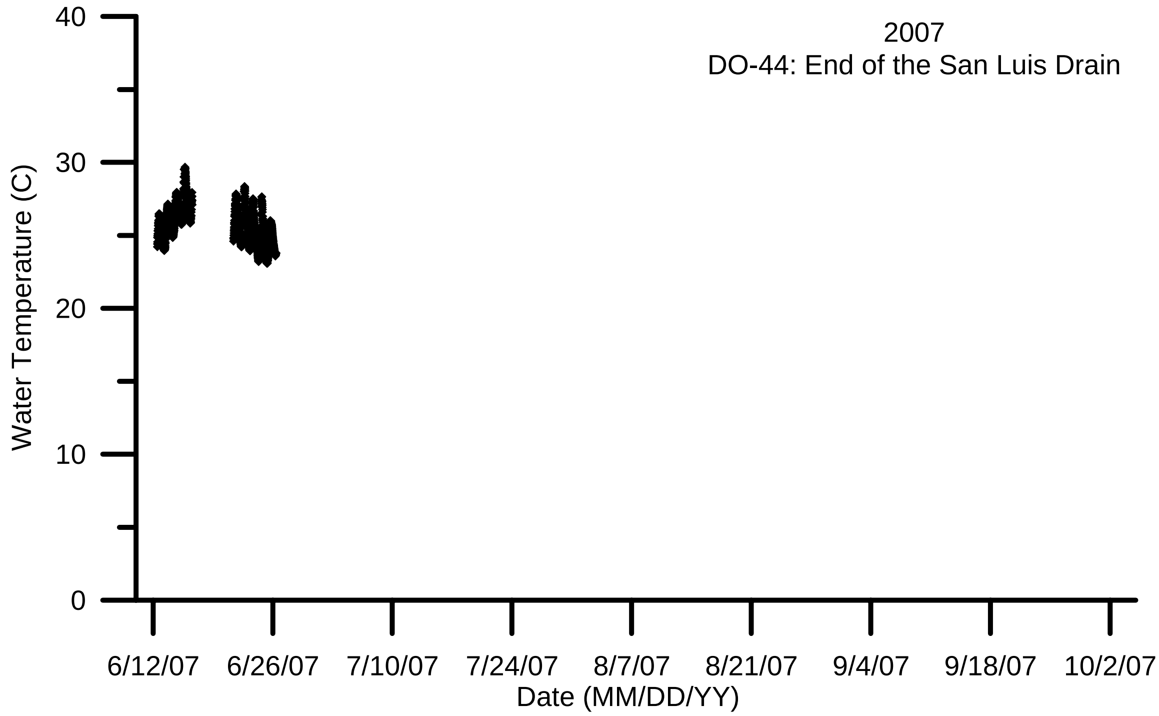
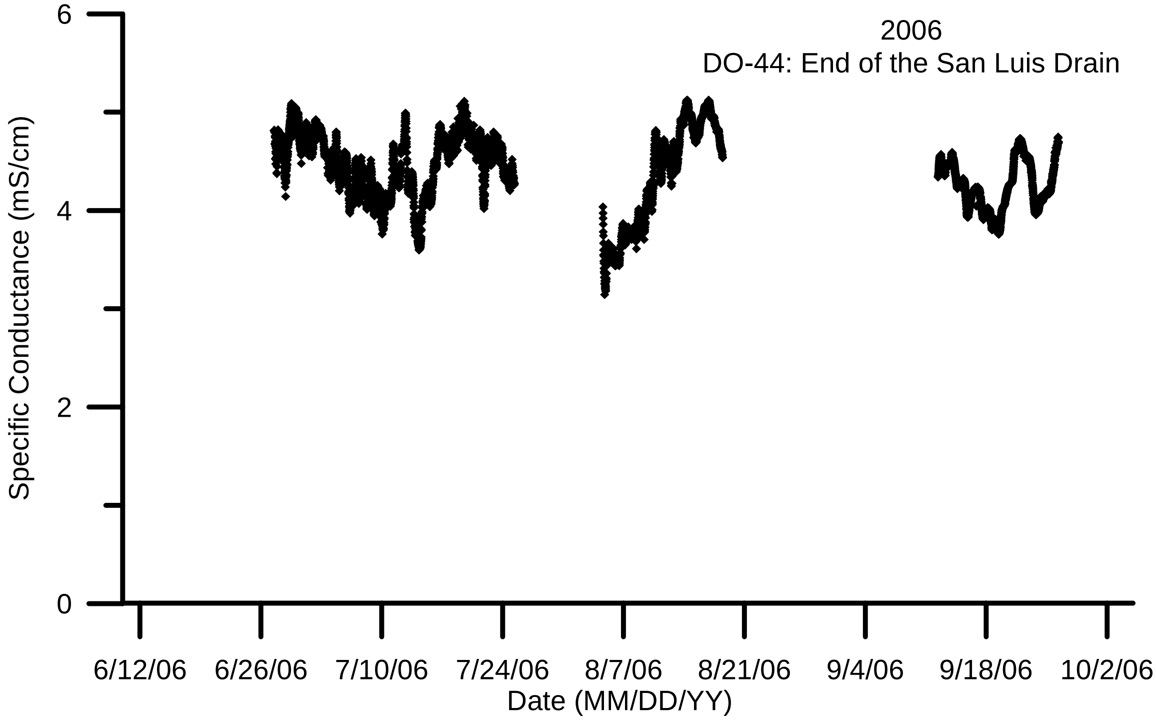


Figure 76: Specific conductance 15 minute data at DO-44 for 2006 and 2007.



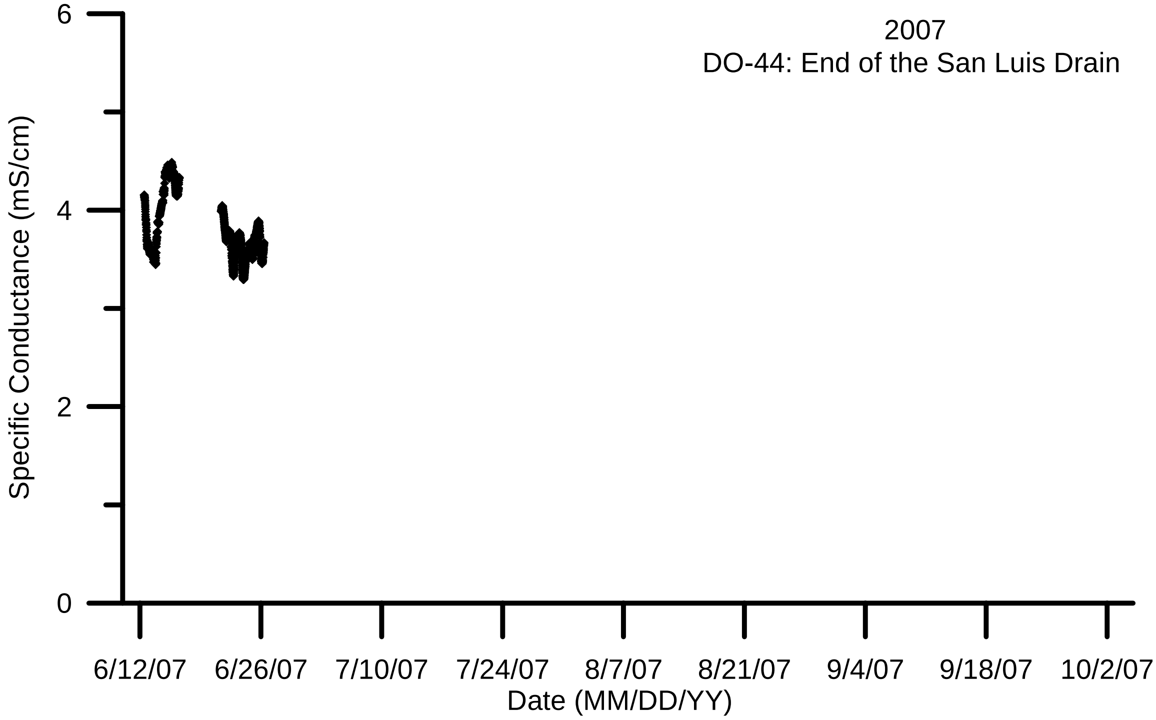
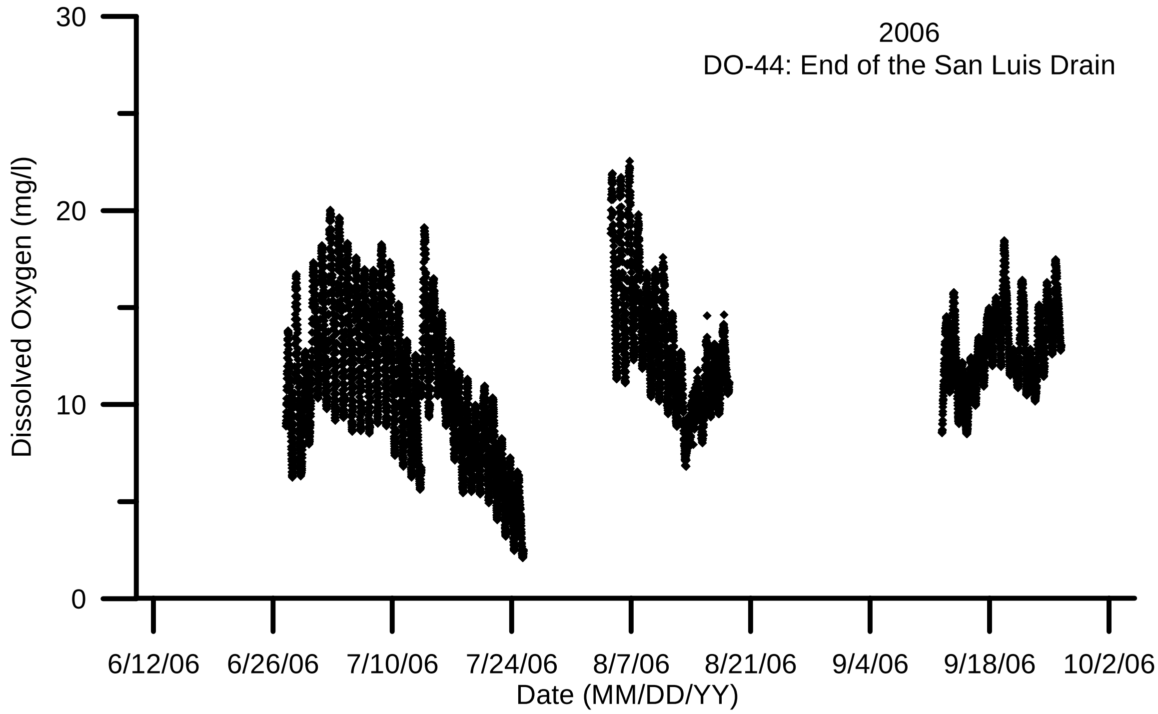


Figure 77: Dissolved oxygen concentration 15 minute data at DO-44 for 2006 and 2007.



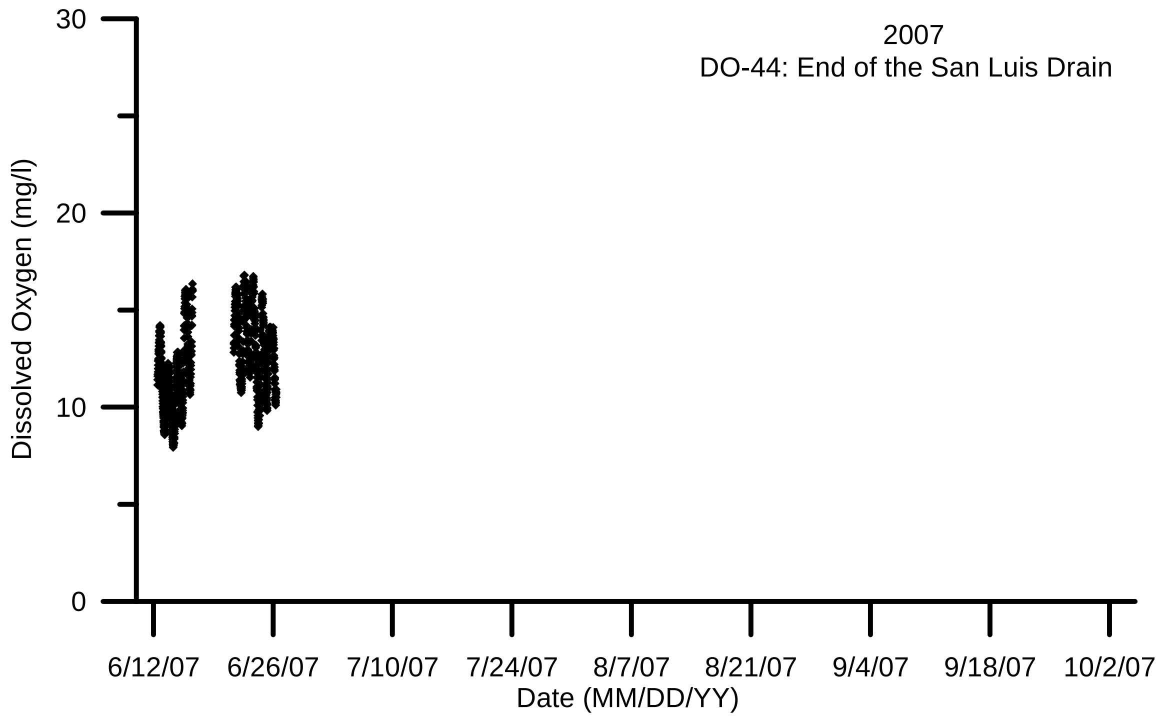
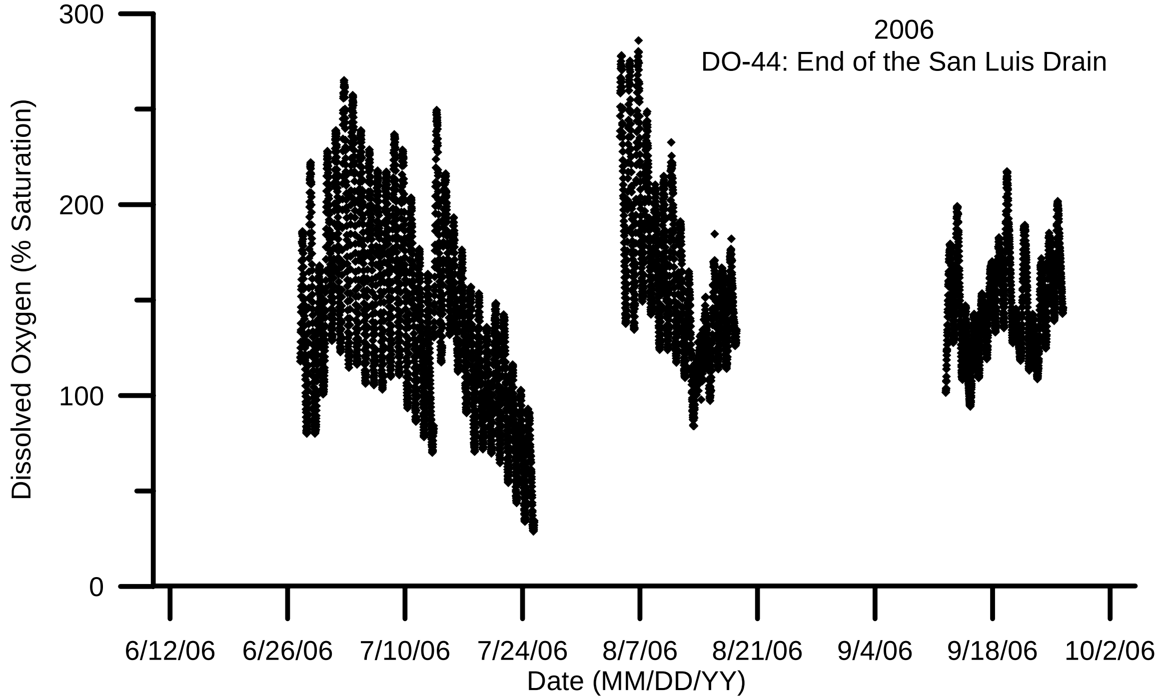


Figure 78: Dissolved oxygen percent of saturation 15 minute data at DO-44 for 2006 and 2007.



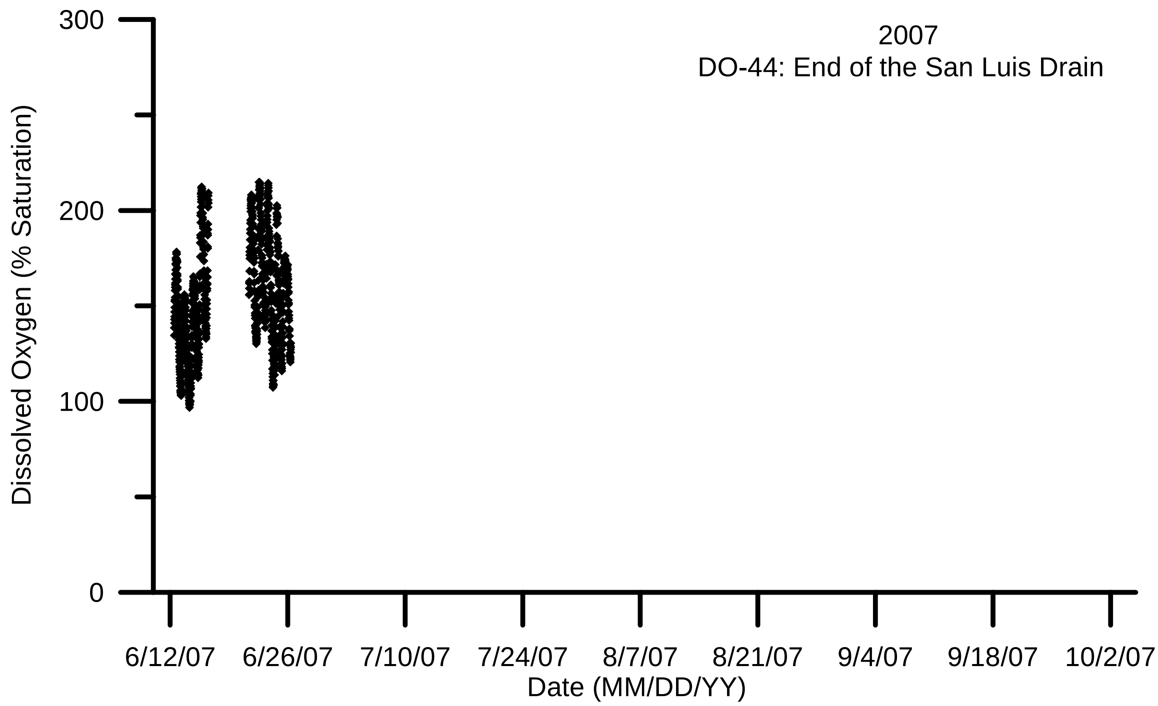
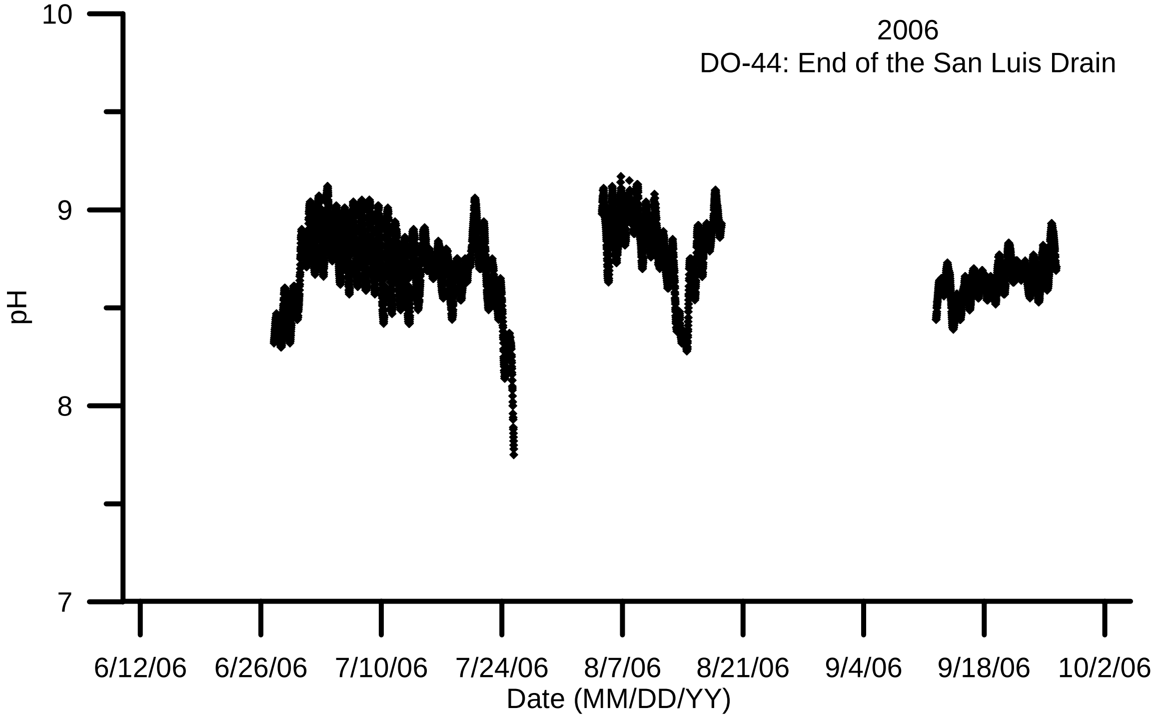


Figure 79: pH 15 minute data at DO-44 for 2006 and 2007.



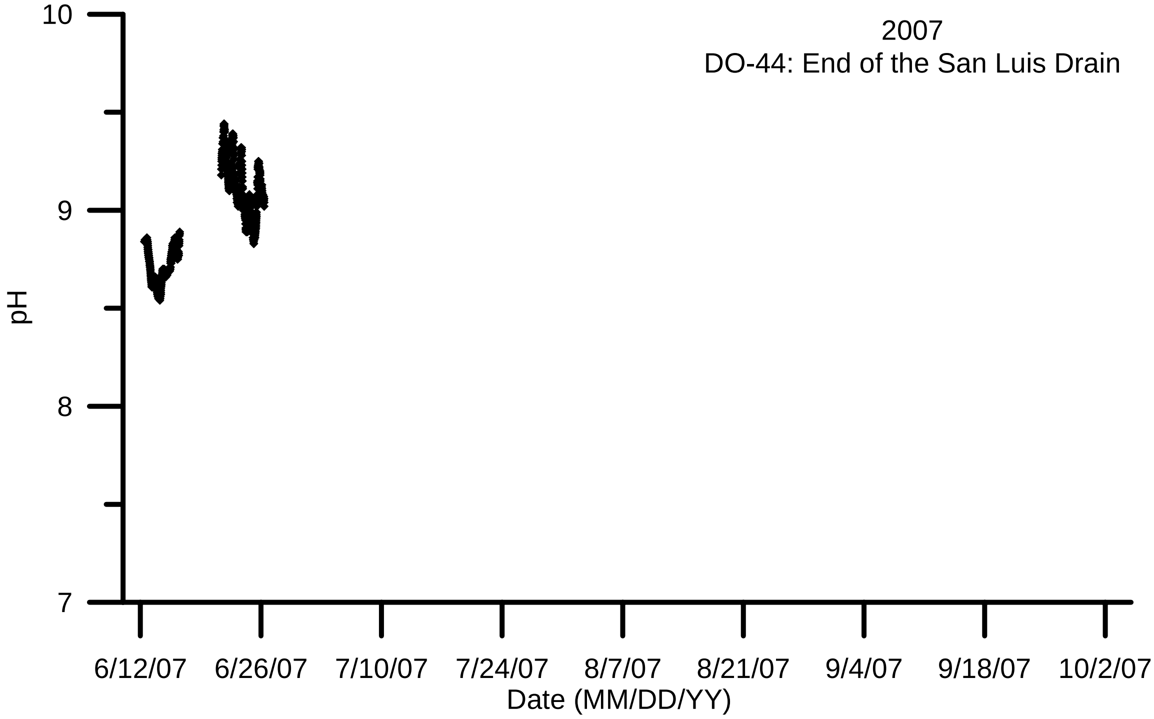
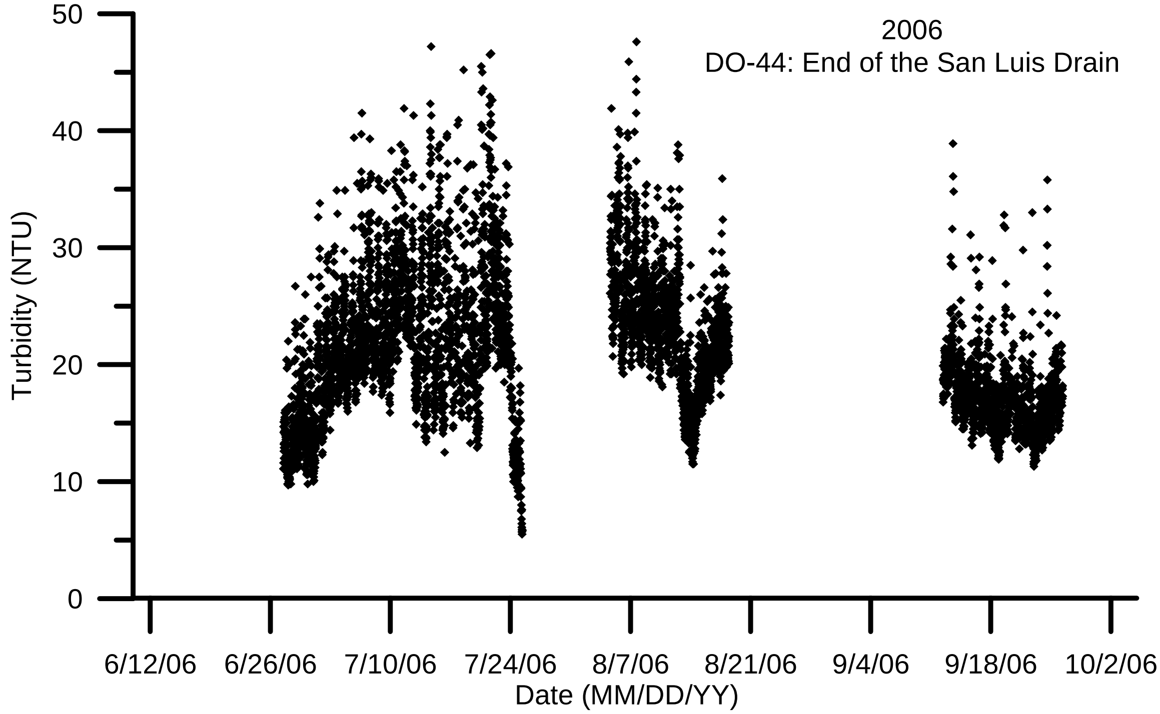


Figure 80: Turbidity 15 minute data at DO-44 for 2006 and 2007.



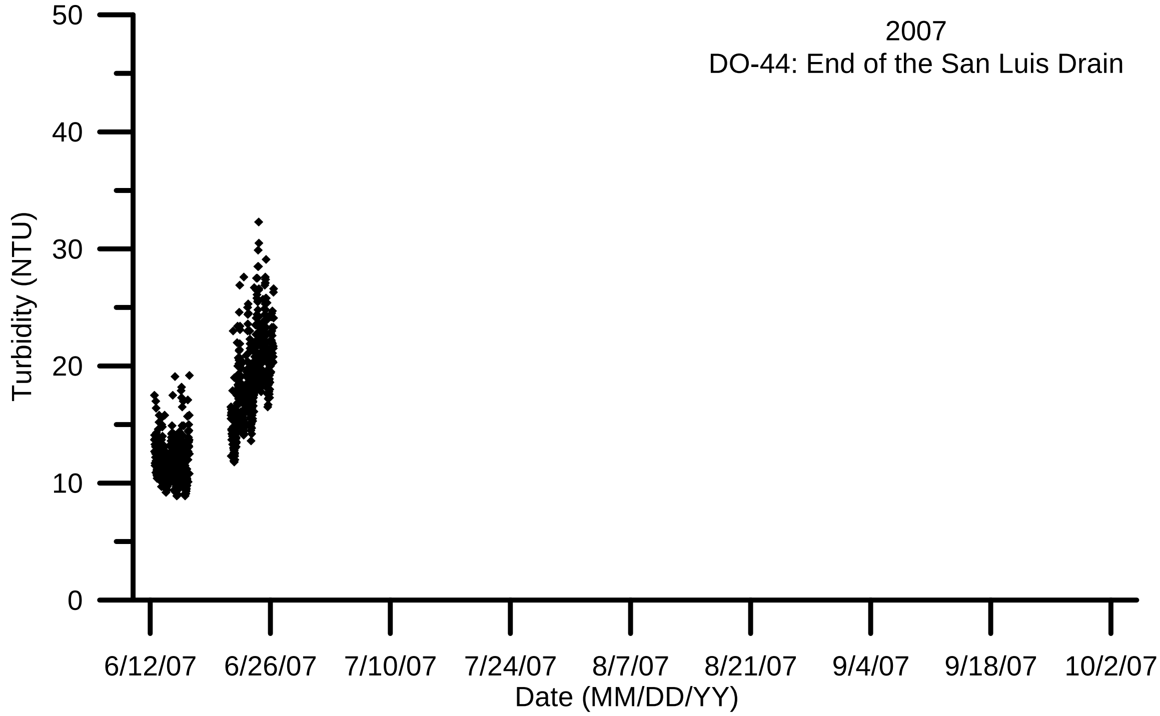
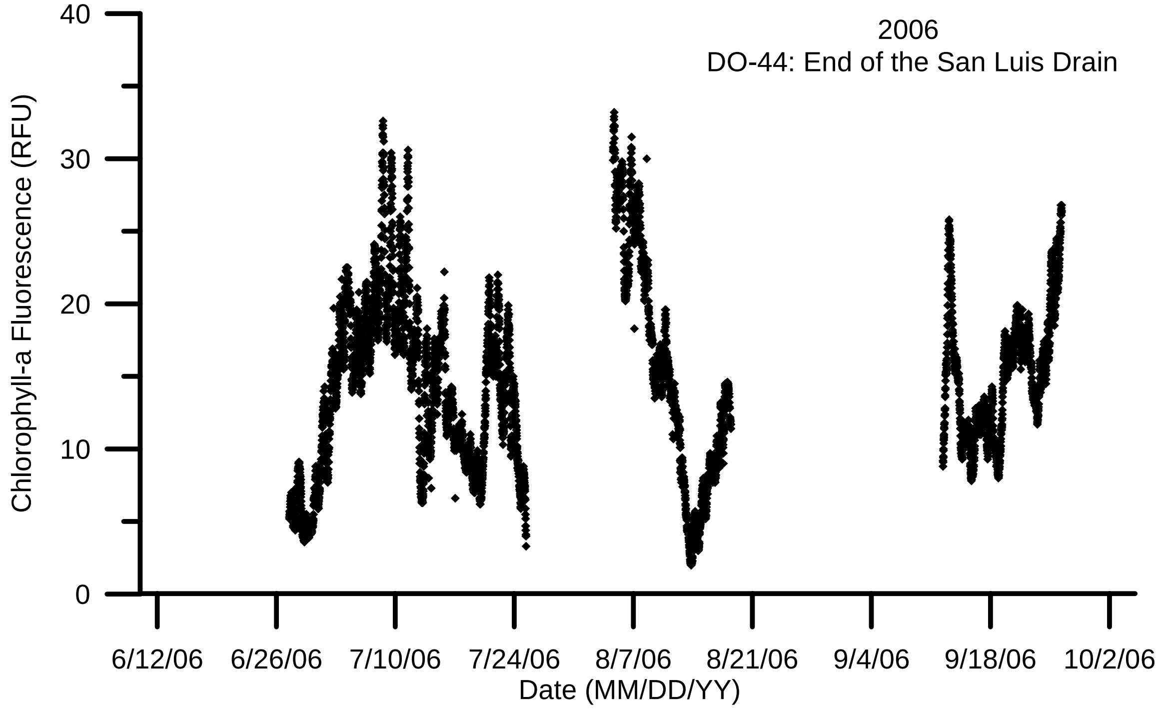


Figure 81: Chlorophyll-*a* fluorescence 15 minute data at DO-44 for 2006 and 2007.



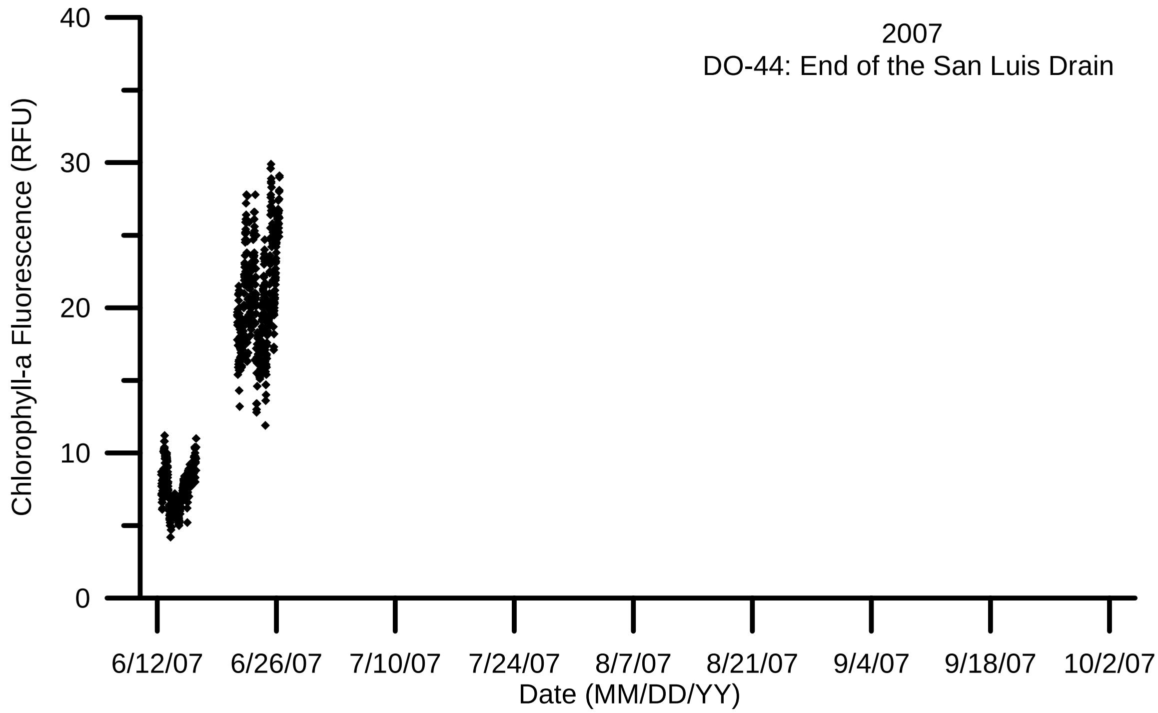
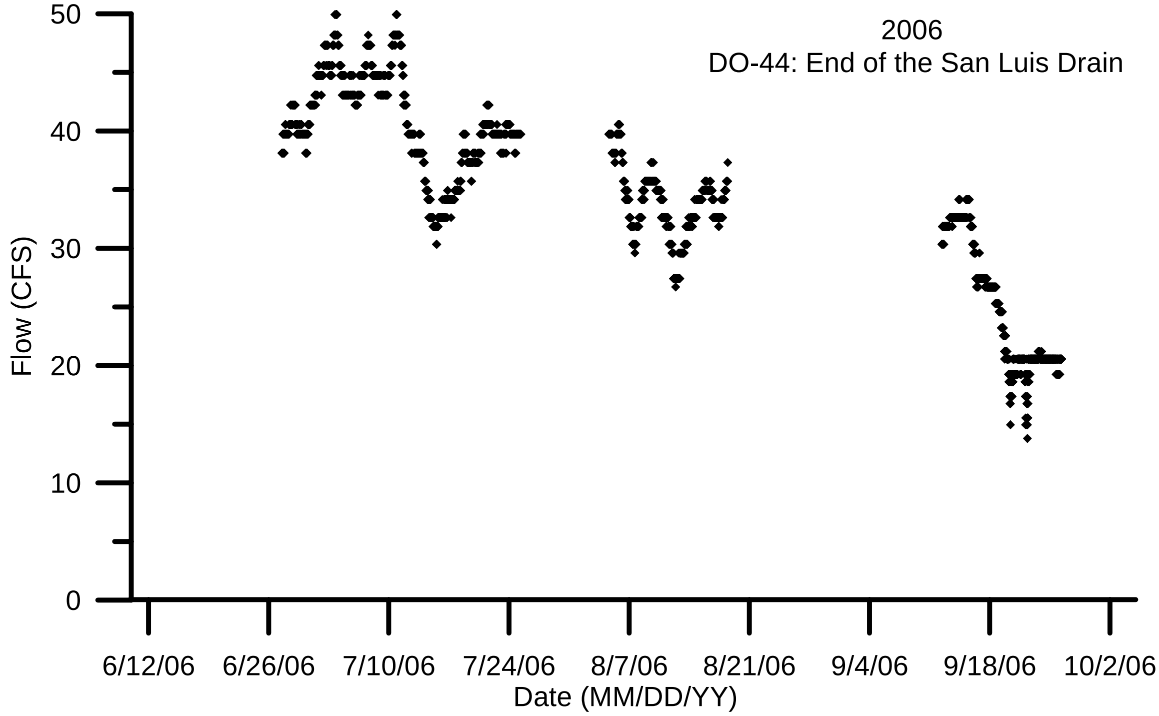
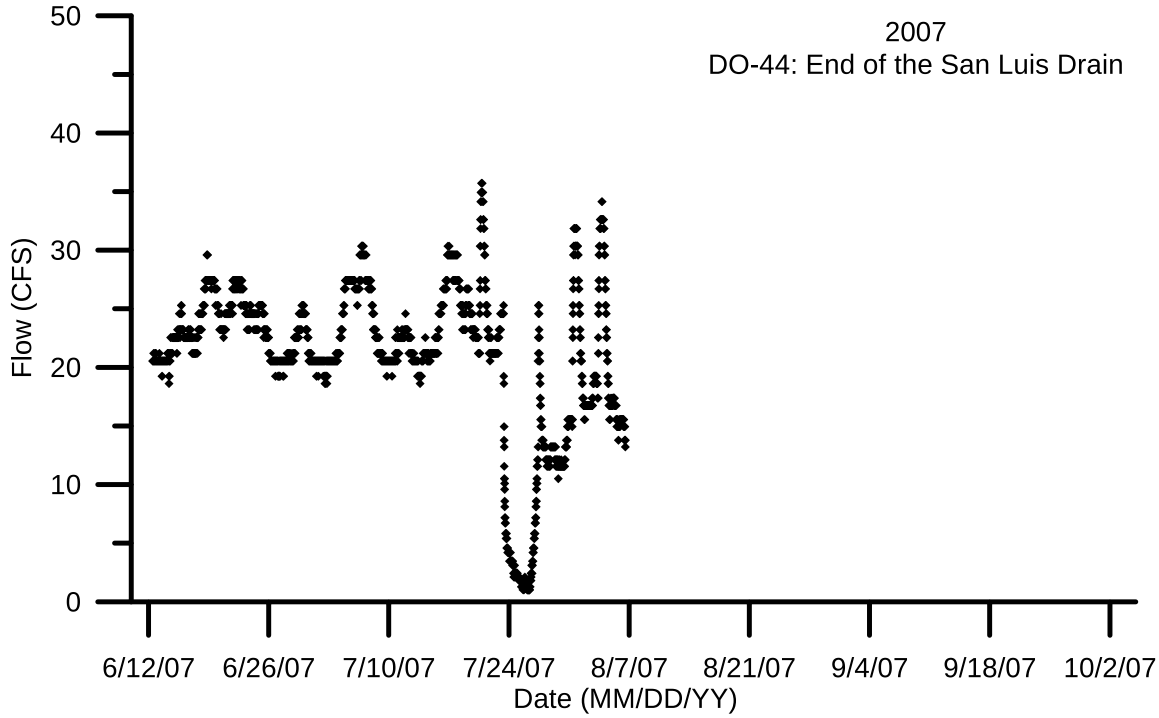


Figure 82: Flow 15 minute data at DO-44 for 2006 and 2007.





Analyses 1 & 2
2006 and 2007 Continuous Monitoring Sonde QA and Deployment Descriptions

Analysis 1: 2006 Continuous Monitoring Sonde QA and Deployment Descriptions

DO-05 SJR at Vernalis

June 27, 2006 to July 13, 2006
Notebook Reference: F10P12-15 F8P112-119 F9P21-29
The instrument was deployed in the existing 4"PVC pipe stilling wells already in place on the monitoring platform. The SONDE was attached to the platform using a 5/8 braided nylon rope and submerged to about 7-8 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged, though barely.

Calibration	**Sonde S/N:**	**06E2316AA YSI#3**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.051	-0.001	Pass	0.084	Pass
Pressure (mmHg)		759.3	759.3	-	761.1	-
DO %	100		99.9	Pass	101.9	Pass
DO (mg/L)	8.445		8.45	Pass		
DO (mg/L)	8.759				8.94	Pass
DO Charge	25-75				45.1	Pass
Temp (degC)	Ambient		23.77	-	21.86	-
EC	1.408	1.397	1.408	Pass	1.382	Pass
pH	4	4	4	Pass	4.17	Pass
	7	7	7	Pass	7.03	Pass
	10	9.98	10	Pass	10.05	Pass
ORP	231	216.9	231	Pass	232.4	Pass
Turbidity (NTU)	0	0.3	0	Pass	1.9	Fail
	40	40.7	40	Pass	35.5	Pass
	200	185	200	Pass		
	180				172.6	Pass
Chla	≤0		-1.9	Pass	-2.2	Pass
Flr	≤0		-0.4	Pass	-0.5	Pass

July 13, 2006 to July 25, 2006

Notebook Reference: F10P12-15, 26-31 F9P17-29

The instrument was deployed in the existing 4"PVC pipe stilling wells already in place on the monitoring platform. The SONDE was attached to the platform using a 5/8 braided nylon rope and submerged to about 3-4 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. Removed values that were below 25 for DO charge.

Calibration	**Sonde S/N:**	**05J2250 AC (YSI#9)**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.059	0	Pass	-0.384	Fail
Pressure (mmHg)		763.1	763.1	-	753.7	-
DO %	100		100.4	Pass	58.5	Fail
DO (mg/L)	8.482		8.53	Pass		
DO (mg/L)	8.578				5.03	Fail
DO Charge	25-75				22.6	Fail
Temp (degC)	Ambient		23.54	-	22.95	-
EC	1.408	1.373	1.408	Pass	1.401	Pass
pH	4	4.09	4	Pass	4.09	Pass
	7	7.04	7	Pass	7.02	Pass
	10	10.01	10	Pass	9.98	Pass
ORP	234	No ORP sensor				
Turbidity (NTU)	0	0.9	0	Pass	-2.3	Fail
	40	39.6	40.1	Pass	40.5	Pass
	180	178.6	180	Pass		
	165				167.3	Pass
Chla	≤0	-0.1	-0.3	Pass	-1.7	Pass
Flr	≤0	0	-0.2	Pass	-0.3	Pass

Sep 12, 2006 to Sep 26, 2006

Notebook Reference: F9P ,90-97

The instrument was deployed in one of our custom 4"PVC pipe housings and attached to the platform using a 5/8 braided nylon rope and submerged to about 3-4 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. Removed values that were below 25 for DO charge.

Calibration	**Sonde S/N:**	**06E2065 AB YSI#5**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.151	0	Pass	0.021	Pass
Pressure (mmHg)		761.7	761.7	-	762.2	-
DO %	100		100.2	Pass	79.6	Fail
DO (mg/L)	8.737		8.77	Pass		
DO (mg/L)	8.692				6.96	Pass
DO Charge	25-75		31.8	Pass	23.7	Fail
Temp (degC)	Ambient		21.99	-	22.26	-
EC	1.408	1.385	1.408	Pass	1.395	Pass
pH	4	4.14	4	Pass	3.97	Pass
	7	6.93	7	Pass	6.95	Pass
	10	10.11	10.02	Pass	10	Pass
ORP	233.6	232.4	233.6	Pass	237.3	Pass
Turbidity (NTU)	0	0.4	0	Pass	-0.1	Pass
	40	37.7	39.9	Pass	42.5	Pass
	200	198.2	199.9	Pass	206.6	Pass
Chla	≤0	-1.7	-1.7	Pass	-2.7	Pass
Flr	≤0	-0.4	-0.3	Pass	-0.6	Pass

DO-07 SJR at Patterson

June 27, 2006 to July 13, 2006
Notebook Reference: F10P12-15 F8P112-119 F9P21-29
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the platform of the pumping station. Upon retrieval of the SONDE, the instrument was found exactly where it was left, but out of the water due to the significant drop in river level SONDE was out of the water for approx. 6 days. *wiper parked over sensor Chla and Flr reading high, removed high values/outliers.

Calibration	**Sonde S/N:**	**06E2064 AA**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	-0.208	0.001	Pass	0.102	Pass
Pressure (mmHg)		759	759.1	-	761.1	-
DO %	100		99.9	Pass	109.4	Pass
DO (mg/L)	8.447		8.45	Pass		
DO (mg/L)	8.662				9.44	Pass
DO Charge	25-75				34.9	Pass
Temp (degC)	Ambient		23.76	-	22.44	-
EC	1.408	1.425	1.408	Pass	1.388	Pass
pH	4	4.06	4	Pass	3.99	Pass
	7	7.03	7	Pass	6.95	Pass
	10	9.99	10	Pass	9.96	Pass
ORP	231	213.5	231	Pass	232.4	Pass
Turbidity (NTU)	0	-0.3	0	Pass	-0.3	Fail
	40	40.7	40	Pass	33.3	Pass
	200	191.4	200	Pass		
	180				160.4	Pass
Chla	≤0		-2.1	Pass	310.1	Fail
Flr	≤0		-0.5	Pass	73.8	Fail

July 13, 2006 to July 25, 2006

Notebook Reference: F10P12-15, 26-31 F9P17-29

The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the ladder on the far end of the pumping station. Upon retrieval of the SONDE, the instrument was found exactly where it was left. All red flagged values for Turbidity on DO-19, DO-7 cannot be discounted as true values. However, they are most likely not valid (high COV, unrealistic compared to other sites upstream/downstream, higher than corresponding independent QC value). Removed values that were below 25 for DO charge.

Calibration	**Sonde S/N:**	**06E2064 AC (YSI #10)**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	1.169	0	Pass	-0.238	Fail
Pressure (mmHg)		762.1	762.1	-	756.6	-
DO %	100		100.3	Pass	56.9	Fail
DO (mg/L)	8.532		8.57	Pass		
DO (mg/L)	8.883				5.07	Fail
DO Charge	25-75		39	Pass	16.5	Fail
Temp (degC)	Ambient		23.23	-	21.14	-
EC	1.408	1.392	1.408	Pass	1.437	Pass
pH	4	4.09	4	Pass	3.98	Pass
	7	6.96	7	Pass	7.01	Pass
	10	9.98	10	Pass	10.07	Pass
ORP	234	213.7	234	Pass	232.9	Pass
Turbidity (NTU)	0	0.8	0	Pass	-1.9	Fail
	40	35.9	40	Pass	41	Pass
	180	176.2	180	Pass		
	165				172.1	Pass
Chla	≤0	0.2	0.2	Pass	-0.4	Pass
Flr	≤0	0.1	0.1	Pass	0	Pass

Sep 12, 2006 to Sep 26, 2006

Notebook Reference: F9P ,90-97

The instrument was deployed in a black PVC housing. The SONDE was attached to the underside of the pump platform near the northeast corner and secured with a cable and padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval, the SONDE was found where it was left and still submerged.

Calibration	**Sonde S/N:**	**06E2064 AA YSI#7**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.136	0	Pass	0.013	Pass
Pressure (mmHg)		762.1	762.1	-	762.4	-
DO %	100		100.3	Pass	102.2	Pass
DO (mg/L)	8.787		8.82	Pass		
DO (mg/L)	8.714				8.92	Pass
DO Charge	25-75		54.3	Pass	40	Pass
Temp (degC)	Ambient		21.7	-	22.13	-
EC	1.408	1.389	1.408	Pass	1.401	Pass
pH	4	4.2	4.02	Pass	3.84	Pass
	7	6.82	7	Pass	6.9	Pass
	10	10.18	10.03	Pass	10.03	Pass
ORP	233.6	236.1	233.6	Pass	233.8	Pass
Turbidity (NTU)	0	0.3	0	Pass	-0.1	Pass
	40	44	39.9	Pass	41.9	Pass
	200	199.2	200	Pass	210.4	Pass
Chla	≤0	-1.5	-1.7	Pass	-3	Pass
Flr	≤0	-0.3	-0.3	Pass	-0.7	Pass

DO-08 SJR at Crows Landing (Turlock Sportsman Club)

June 27, 2006 to July 13, 2006
Notebook Reference: F10P12-15 F8P112-119 F9P21-29
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the dock at the Turlock Sportsman Club. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

Calibration	**Sonde S/N:**	**06E2065 AA**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.044	0	Pass	0.079	Pass
Pressure (mmHg)		759.1	759.1	-	760.6	-
DO %	100		99.9	Pass	103.9	Pass
DO (mg/L)	8.349		8.35	Pass		
DO (mg/L)	8.452				8.78	Pass
DO Charge	25-75				38	Pass
Temp (degC)	Ambient		24.38	-	23.73	-
EC	1.408	1.406	1.408	Pass	1.359	Pass
pH	4	4	4	Pass	4.07	Pass
	7	7	7	Pass	7.02	Pass
	10	9.99	10	Pass	10.04	Pass
ORP	231	217.5	231	Pass	230.5	Pass
Turbidity (NTU)	0	0	0	Pass	0.2	Pass
	40	40.2	40.1	Pass	34.8	Pass
	200	185.1	200.2	Pass		
	180				166.5	Pass
Chla	≤0		-1.8	Pass	-1.1	Pass
Flr	≤0		-0.4	Pass	-0.3	Pass

July 13, 2006 to July 25, 2006
Notebook Reference: F10P12-15, 26-31 F9P17-29
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the dock at the Turlock Sportsman Club. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

Calibration	**Sonde S/N:**	**05J2250 AB (YSI #8)**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.027	0	Pass	-0.255	Fail
Pressure (mmHg)		762.7	762.7	-	756.5	-
DO %	100		99.9	Pass	102.6	Pass
DO (mg/L)	8.530		8.45	Pass		
DO (mg/L)	8.624				8.88	Pass
DO Charge	25-75				26.7	Pass
Temp (degC)	Ambient		23.24	-	22.67	-
EC	1.408	1.384	1.408	Pass	1.404	Pass
pH	4	4.12	4	Pass	4.02	Pass
	7	7.02	7	Pass	7.07	Pass
	10	9.99	10	Pass	10.09	Pass
ORP	234	288.3	237.2	Pass	No ORP sensor	
Turbidity (NTU)	0	-0.9	0	Pass	-0.1	Pass
	40	41.2	40	Pass	41.2	Pass
	180	184	180	Pass		
	165				163.2	Pass
Chla	≤0	0.3	0.4	Fail	0.5	Fail
Flr	≤0	0.1	0.2	Pass	0.1	Pass

Sep 12, 2006 to Sep 26, 2006

Notebook Reference: F9P ,90-97

The instrument was deployed in one of our custom 4"PVC pipe housings. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the dock at the Turlock Sportsman Club. Upon retrieval, the SONDE was found exactly where it was left and still submerged.

Calibration	**Sonde S/N:**	**06E2064 AC YSI#10**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.143	0	Pass	0.033	Pass
Pressure (mmHg)		761.9	761.9	-	762.7	-
DO %	100		100.3	Pass	103.1	Pass
DO (mg/L)	8.787		8.82	Pass		
DO (mg/L)	8.630				8.91	Pass
DO Charge	25-75		35.9	Pass	35.9	Pass
Temp (degC)	Ambient		21.7	-	22.63	-
EC	1.408	1.391	1.408	Pass	1.381	Pass
pH	4	4.17	4	Pass	3.95	Pass
	7	6.93	7	Pass	6.99	Pass
	10	10.06	10.01	Pass	10.03	Pass
ORP	233.6	232	233.6	Pass	233.9	Pass
Turbidity (NTU)	0	0	0	Pass	0.1	Pass
	40	39.5	40	Pass	42.5	Pass
	200	199	200	Pass	211.4	Pass
Chla	≤0	0.4	0.1	Pass	0	Pass
Flr	≤0	0	0	Pass	0.2	Pass

DO-19 Salt slough at Lander Ave.

June 27, 2006 to July 13, 2006
Notebook Reference: F10P12-15 F8P112-119 F9P21-29
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked at arms length under the water surface to stakes which had previously been secured into the stream bed to support the existing USGS monitoring station sensor. Upon retreival of the SONDE, the instrument was found exactly where it was left, but only the bottom 1/2 of the instrument was still in the water because stream levels had receded more than 3 feet. Fortunately the sensors were still submerged and able to take readings.

Calibration	**Sonde S/N:**	**06E2064 AB**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.056	0	Pass	0.03	Pass
Pressure (mmHg)		759.2	759.2	-	760	-
DO %	100		99.9	Pass	109.2	Pass
DO (mg/L)	8.492		8.49	Pass		
DO (mg/L)	8.527				9.32	Pass
DO Charge	25-75				33.9	Pass
Temp (degC)	Ambient		23.48	-	23.26	-
EC	1.408	1.421	1.408	Pass	1.359	Pass
pH	4	4.04	4	Pass	4.14	Pass
	7	7.01	7	Pass	7.02	Pass
	10	9.98	10	Pass	10.01	Pass
ORP	231	214.9	231	Pass	230.2	Pass
Turbidity (NTU)	0	-0.2	0	Pass	0.9	Fail
	40	40.2	40	Pass	37.8	Pass
	200	185.4	200.1	Pass		
	180				156.4	Pass
Chla	≤0		-1.3	Pass	-1.2	Pass
Flr	≤0		-0.4	Pass	-0.3	Pass

Sept. 12, 2006 to Sept. 26, 2006
Notebook Reference: F9P ,90-97
The instrument was deployed in one of our custom 4"PVC pipe housings and attached with a 1/4" vinyl coated cable and padlocked at arms length under the water surface to stakes which had previously been secured into the stream bed to support the existing USGS monitoring station sensor. Upon retrieval, the SONDE was found where it was left and still submerged

Calibration	**Sonde S/N:**	**05K1979 AB YSI#11**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.004	0	Pass	0.067	Pass
Pressure (mmHg)		762.1	762.1	-	762.3	-
DO %	100		100.3	Pass	93.6	Pass
DO (mg/L)	8.817		8.85	Pass		
DO (mg/L)	8.776				8.25	Pass
DO Charge	25-75		49.2	Pass	38	Pass
Temp (degC)	Ambient		21.52	-	21.76	-
EC	1.408	1.391	1.413	Pass	1.404	Pass
pH	4	4.16	4	Pass	4.02	Pass
	7	6.96	7	Pass	7	Pass
	10	10.04	10	Pass	10.03	Pass
ORP	233.6	251.7	232.7	Pass	290	Fail
Turbidity (NTU)	0	-0.2	0.2	Pass	0.1	Pass
	40	45.4	40.1	Pass	41.8	Pass
	200	198.3	199.9	Pass	206.7	Pass
Chla	≤0	-1.7	-2.1	Pass	-1.3	Pass
Flr	≤0	-0.5	-0.5	Pass	-0.3	Pass

DO-20 Los Banos Creek

Sept. 12, 2006 to Sept. 26, 2006
Notebook Reference: F9P ,90-97
The instrument was deployed in one of our custom 4"PVC pipe housings and attached with a 1/4" vinyl coated cable and padlocked to the bridge across the stream. Upon retrieval, the SONDE was found where it was left with sensor end just submerged. Flow is calculated from old rating curve because new one hasn't been established since the bubbler was re-installed new rating curve will likely change flow values so this is preliminary data. Removed values that were below 25 for DO Charge. No ORP sensor.

Calibration	**Sonde S/N:**	**05J2250 AC YSI#9**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.277	0	Pass	0.005	Pass
Pressure (mmHg)		762.2	762.2	-	762.5	-
DO %	100		100.3	Pass	25	Fail
DO (mg/L)	8.763		8.8	Pass		
DO (mg/L)	8.635				2.17	Fail
DO Charge	25-75		53.3	Pass	7.3	Fail
Temp (degC)	Ambient		21.84	-	22.6	-
EC	1.408	1.38	1.409	Pass	1.409	Pass
pH	4	4.13	4	Pass	3.95	Pass
	7	6.86	7	Pass	6.97	Pass
	10	10.14	10.02	Pass	10.04	Pass
ORP	233.6	385	233.6	Pass	295.3	Fail
Turbidity (NTU)	0	0.4	0	Pass	-0.2	Pass
	40	38.9	40	Pass	40.7	Pass
	200	195.7	200	Pass	205.3	Pass
Chla	≤0	-0.6	-0.3	Pass	-0.2	Pass
Flr	≤0	-0.2	-0.1	Pass	-0.1	Pass

DO-44 San Luis Drain End

June 27, 2006 to July 13, 2006

Notebook Reference: F10P12-15 F8P112-119 F9P21-29

The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the side of a USGS monitoring station platform near the San Luis Drain outlet pipe. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

Calibration	**Sonde S/N:**	**06E2065 AB**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.059	0	Pass	0.04	Pass
Pressure (mmHg)		759.3	759.3	-	760.2	-
DO %	100		99.9	Pass	103	Pass
DO (mg/L)	8.384		8.39	Pass		
DO (mg/L)	8.447				8.71	Pass
DO Charge	25-75				41	Pass
Temp (degC)	Ambient		24.16	-	23.76	-
EC	1.408	1.404	1.408	Pass	1.326	Pass
pH	4	4	4	Pass	4.14	Pass
	7	7.03	7	Pass	7.06	Pass
	10	9.99	10	Pass	10.06	Pass
ORP	231	215.2	231	Pass	229.3	Pass
Turbidity (NTU)	0	-0.2	0	Pass	0.9	Fail
	40	41.1	40	Pass	42	Pass
	200	184.9	200	Pass		
	180				175.1	Pass
Chla	≤0		-1.9	Pass	-1.8	Pass
Flr	≤0		-0.4	Pass	-0.5	Pass

July 13, 2006 to July 25, 2006

Notebook Reference: F10P12-15, 26-31 F9P17-29

The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 1/4" vinyl coated cable and padlocked to the side of a USGS monitoring station platform near the San Luis Drain outlet pipe. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

Calibration	**Sonde S/N:**	**05K1978 AB (YSI #11)**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	1.0368	0	Pass	-0.269	Fail
Pressure (mmHg)		762.8	762.8	-	756.6	-
DO %	100		100.4	Pass	97.3	Pass
DO (mg/L)	8.490		8.53	Pass		
DO (mg/L)	8.548				8.31	Pass
DO Charge	25-75		42	Pass	36.9	Pass
Temp (degC)	Ambient		23.49	-	23.13	-
EC	1.408	1.408	1.408	Pass	1.377	Pass
pH	4	4.25	4	Pass	4.06	Pass
	7	6.98	7	Pass	7.05	Pass
	10	9.97	10	Pass	10.1	Pass
ORP		No ORP sensor		Pass		Pass
Turbidity (NTU)	0	6.9	0.1	Pass	-2.1	Fail
	40	36.1	39.7	Pass	41.9	Pass
	180	182	180.1	Pass		
	165				171.1	Pass
Chla	≤0	-1.1	-1.4	Pass	-2.8	Pass
Flr	≤0	-0.2	-0.4	Pass	-0.5	Pass

Aug 04, 2006 to Aug 18, 2006

Notebook Reference: F9P36-39, 46-52, 61-66 F10P69-73

The instrument was deployed in a black PVC housing. The SONDE was attached towards the front of the check station near the edge and secured with a cable and padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

Calibration	**Sonde S/N:**	**06E2065 AA (YSI#4)**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	-0.002	0	Pass	0.096	Pass
Pressure (mmHg)		758.5	758.5	-	760.6	-
DO %	100		99.8	Pass	99.4	Pass
DO (mg/L)	8.584		8.58	Pass		
DO (mg/L)	8.615				8.53	Pass
DO Charge	25-75		35.9	Pass	30.8	Pass
Temp (degC)	Ambient		22.91	-	22.72	-
EC	1.408	1.425	1.408	Pass	1.389	Pass
pH	4	4.02	4	Pass	4.12	Pass
	7	6.99	7	Pass	7.05	Pass
	10	10.02	10	Pass	10.07	Pass
ORP		NO ORP sensor		Pass		Pass
Turbidity (NTU)	0	-0.2	0	Pass	-0.3	Fail
	40	39.3	39.9	Pass	44.3	Pass
	200	190.8	199.7	Pass	228.5	Pass
Chla	≤0	-2	-1.7	Pass	-1	Pass
Flr	≤0	-0.4	-0.4	Pass	-0.3	Pass

Sept. 12, 2006 to Sept. 26, 2006

Notebook Reference: F9P ,90-97

The instrument was deployed in one of our custom 4"PVC pipe housings and attached with a 1/4" vinyl coated cable and padlocked to the side of the platform near the San Luis Drain outlet structure. Upon retrieval, the SONDE was found where it was left and still submerged.

Calibration	**Sonde S/N:**	**06E2064 AB YSI#6**				
Pre-deployment					**Post-deployment**	
	Calibration value	Pre-Calibration	Post-Calibration	pass/fail (+/-20%)	Calibration check	pass/fail (+/-20%)
Depth (ft)	0	0.187	0	Pass	0.014	Pass
Pressure (mmHg)		762	762	-	762.4	-
DO %	100		100.3	Pass	98.6	Pass
DO (mg/L)	8.724		8.76	Pass		
DO (mg/L)	8.724				8.65	Pass
DO Charge	25-75		43.1	Pass	38	Pass
Temp (degC)	Ambient		22.07	-		-
EC	1.408	1.382	1.408	Pass	1.401	Pass
pH	4	4.15	4	Pass	4.07	Pass
	7	6.97	7	Pass	6.96	Pass
	10	10.03	10	Pass	9.99	Pass
ORP	233.6	232.5	233.6	Pass	236	Pass
Turbidity (NTU)	0	-0.2	0	Pass	-0.1	Pass
	40	39.9	40	Pass	40.8	Pass
	200	192.2	199.8	Pass	203.9	Pass
Chla	≤0	-1.7	-1.2	Pass	-0.8	Pass
Flr	≤0	-0.3	-0.3	Pass	-0.2	Pass

Analysis 2: 2007 Continuous Monitoring Sonde QA and Deployment Descriptions

DO-05 SJR at Vernalis

June 12, 2007 to June 21, 2007
15 minute measurements with YSI Sonde 6600: #11
Notebook Reference: F12p105-113,131-140   F13p1-5
The instrument was deployed in a black PVC housing. The SONDE plus housing were attached to the DWR platform with 3/16" steel cable and secured with a padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.178	0	1	0	0.16	1
Pressure (mmHg)	n/a	756.8	756.8	n/a	n/a	759.5	n/a
DO %	100	95.5	99.6	1	100	101.6	1
DO (mg/L)	8.81	8.45	8.82	1	8.81	8.96	1
DO Charge	25-75	47.1	47.1	1	25-75	45.1	1
Wet towel Temp (degC)	Ambient	21.35	21.36	n/a	Ambient	21.56	n/a
EC Temp (degC)	21.6	21.66	21.66	1	23.2	23.05	1
EC	1.408	1.45	1.408	1	1.408	1.432	1
LCS EC	1.412	n/a	1.368	1	1.412	1.354	1
pH 4.0	4	4.04	4	1	4	4.04	1
pH 7.0	7	6.97	7	1	7	7	1
pH 10.0	10	10.06	10.01	1	10	9.98	1
LCS pH 4.01	4.01	n/a	4.05	1	4.01	4.08	1
LCS pH 7.0	7	n/a	6.95	1	7	6.9	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.98	1
ORP	235.42	236.4	235.4	1	233.61	231.1	1
Turbidity 0 NTU	0	-1.8	0.1	1	0	-0.8	1
Turbidity 40 NTU	40	49.1	40.2	1	40	35.8	1
Turbidity 200 NTU	200	207.7	199.8	1	200	169.9	1
Chla	≤0	-1.8	-1.8	1	≤0	-1.7	1
Flr	≤0	-0.5	-0.3	1	≤0	-0.4	1

June 21, 2007 to July 12, 2007
15 minute measurements with YSI SONDE 660: DWR
Data from this time period was provided by Department of Water Resources

July 12 to July 24, 2007
15 minute measurements with YSI Sonde 6600: #14
Notebook reference: F14P32, F13P31
The instrument was deployed in a black PVC housing. The SONDE was suspended from the DWR monitoring platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	34.099	0	1	0	-0.188	1
Pressure (mmHg)	n/a	761.1	761.1	n/a	n/a	756.9	n/a
DO %	100	96.4	100	1	100	103.2	1
DO (mg/L)	8.79	8.46	8.78	1	8.76	9.08	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	21.8	21.82	n/a	Ambient	21.71	n/a
EC Temp (degC)	21.8	22.02	22.02	1	20.8	21.1	1
EC	1.408	1.425	1.408	1	1.408	1.375	1
LCS EC	1.412	n/a	1.367	1	1.412	1.348	1
pH 4.0	4	4.13	4	1	4	4.15	1
pH 7.0	7	6.97	7	1	7	7.06	1
pH 10.0	10	10.07	10.01	1	10	10.14	1
LCS pH 4.01	4.01	n/a	4.07	1	4.01	4.14	1
LCS pH 7.0	7	n/a	6.98	1	7	7.13	1
LCS pH 10.01	10.01	n/a	9.98	1	10.01	10.11	1
ORP	234.96	211.2	235	1	236.16	234.5	1
Turbidity 0 NTU	0	3.2	0	1	0	0.3	1
Turbidity 40 NTU	40	36.6	39.9	1	40	43.6	1
Turbidity 200 NTU	200	239.6	200	1	200	180.4	1
Chla	≤0	-4	-3.5	1	≤0	-3	1
Flr	≤0	-1	-0.8	1	≤0	-0.8	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #5
Notebook reference: F14P64,110
The instrument was deployed in a black PVC housing The SONDE was suspended from the DWR monitoring platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.008	0	1	0	0.1	1
Pressure (mmHg)	n/a	758	758.1	n/a	n/a	759.4	n/a
DO %	100	102	99.7	1	100	108.5	1
DO (mg/L)	8.87	9.07	8.88	1	8.94	9.7	1
DO Charge	25-75	52.3	52.3	1	25-75	35.9	1
Wet towel Temp (degC)	Ambient	20.86	21.09	n/a	Ambient	20.84	n/a
EC Temp (degC)	22.7	22.61	22.65	1	21.4	21.34	1
EC	1.408	1.396	1.408	1	1.408	1.454	1
LCS EC	1.412	n/a	1.372	1	1.412	1.388	1
pH 4.0	4	3.98	4	1	4	4.04	1
pH 7.0	7	6.94	7	1	7	6.99	1
pH 10.0	10	10.15	10.02	1	10	10.01	1
LCS pH 4.01	4.01	n/a	3.95	1	4.01	4.03	1
LCS pH 7.0	7	n/a	7.04	1	7	6.92	1
LCS pH 10.01	10.01	n/a	9.97	1	10.01	10.02	1
ORP	234.14	232.9	234.1	1	235.84	234.7	1
Turbidity 0 NTU	0	0.1	0	1	0	0.2	1
Turbidity 40 NTU	40	48.2	40	1	40	35.4	1
Turbidity 200 NTU	200	183.5	199.9	1	200	192.8	1
Chla	≤0	1.7	0.3	1	≤0	2	0
Flr	≤0	0.3	0.1	1	≤0	0.4	0

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #3
Notebook reference: F14P98
The instrument was deployed in a black PVC housing The SONDE was suspended from the DWR monitoring platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.25	0	1	0	-0.361	1
Pressure (mmHg)	n/a	762.1	762.1	n/a	n/a	754.2	n/a
DO %	100	98.4	100.3	1	100	104.6	1
DO (mg/L)	8.88	8.68	8.88	1	8.78	9.25	1
DO Charge	25-75	45.1	45.1	1	25-75	41	1
Wet towel Temp (degC)	Ambient	22.03	21.36	n/a	Ambient	21.39	n/a
EC Temp (degC)	22.4	21.98	21.99	1	22.5	22.28	1
EC	1.408	1.384	1.408	1	1.408	1.406	1
LCS EC	1.412	n/a	1.378	1	1.412	1.377	1
pH 4.0	4	3.93	4	1	4	4.1	1
pH 7.0	7	7.04	7	1	7	7.02	1
pH 10.0	10	10.04	10.01	1	10	10	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.08	1
LCS pH 7.0	7	n/a	6.98	1	7	7.02	1
LCS pH 10.01	10.01	n/a	9.93	1	10.01	9.94	1
ORP	234.99	231.6	235	1	234.62	236.2	1
Turbidity 0 NTU	0	0.3	0	1	0	0	1
Turbidity 40 NTU	40	45.9	40	1	40	35.1	1
Turbidity 200 NTU	200	191.3	200	1	200	199.6	1
Chla	≤0	-2	-1.9	1	≤0	-1.7	1
Flr	≤0	-0.5	-0.5	1	≤0	-0.4	1

August 21, 2007 to September 17, 2007
15 minute measurements with YSI Sonde 6600: DWR
Data from this time period was provided by Department of Water Resources

San Joaquin River at Maze Blvd DO-06

July 10 to July 24, 2007
15 minute measurements with YSI Sonde 6600: #6
Notebook reference: F14P20,25,73
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.046	0	1	0	0.031	1
Pressure (mmHg)	n/a	758.1	758.1	n/a	n/a	757.2	n/a
DO %	100	122.2	99.8	1	100	107.3	1
DO (mg/L)	8.98	11	8.98	1	8.89	9.5	1
DO Charge	25-75	64.5	63.5	1	25-75	80.8	0
Wet towel Temp (degC)	Ambient	20.51	20.51	n/a	Ambient	20.94	n/a
EC Temp (degC)	20.2	20.55	20.55	1	21.2	21.03	1
EC	1.408	1.366	1.408	1	1.408	1.385	1
LCS EC	1.412	n/a	1.402	1	1.412	1.388	1
pH 4.0	4	4.11	4	1	4	4.04	1
pH 7.0	7	7	7	1	7	7.03	1
pH 10.0	10	10.03	10	1	10	10.01	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.09	1
LCS pH 7.0	7	n/a	6.97	1	7	6.99	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.95	1
ORP	236.87	233	236.9	1	236.25	235.2	1
Turbidity 0 NTU	0	0	0	1	0	0.7	1
Turbidity 40 NTU	40	32.1	40	1	40	44.5	1
Turbidity 200 NTU	200	224.2	200.1	1	200	188.2	1
Chla	≤0	-0.9	-1.2	1	≤0	-1.5	1
Flr	≤0	-0.3	-0.3	1	≤0	-0.3	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #8
Notebook reference: F14P63,111
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.009	0	1	0	0.072	1
Pressure (mmHg)	n/a	758.6	758.7	n/a	n/a	758.6	n/a
DO %	100	111.4	99.8	1	100	106.3	1
DO (mg/L)	8.68	9.2	8.68	1	8.93	9.55	1
DO Charge	25-75	45.1	45.1	1	25-75	43.1	1
Wet towel Temp (degC)	Ambient	22.17	22.28	n/a	Ambient	20.83	n/a
EC Temp (degC)	22.8	22.64	22.65	1	21.5	21.48	1
EC	1.408	1.422	1.408	1	1.408	1.469	1
LCS EC	1.412	n/a	1.377	1	1.412	1.375	1
pH 4.0	4	4	4	1	4	4.1	1
pH 7.0	7	7.06	7	1	7	6.96	1
pH 10.0	10	10.02	10	1	10	10	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.07	1
LCS pH 7.0	7	n/a	6.99	1	7	6.98	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	9.95	1
ORP	234.14	n/a	n/a	n/a	235.66	n/a	n/a
Turbidity 0 NTU	0	0.4	0	1	0	0.2	1
Turbidity 40 NTU	40	41.9	40	1	40	38.4	1
Turbidity 200 NTU	200	188.4	199.9	1	200	192.5	1
Chla	≤0	0.2	0	1	≤0	0.5	1
Flr	≤0	0.1	0	1	≤0	0.1	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #15
Notebook reference: F14P100
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.192	0	1	0	-0.316	1
Pressure (mmHg)	n/a	761.1	761.1	n/a	n/a	754	n/a
DO %	100	99.9	100.1	1	100	98.9	1
DO (mg/L)	8.87	8.85	8.87	1	8.75	8.73	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	21.34	21.35	n/a	Ambient	21.52	n/a
EC Temp (degC)	21.1	21.23	21.23	1	22.4	22.3	1
EC	1.408	1.466	1.408	1	1.408	1.376	1
LCS EC	1.412	n/a	1.343	1	1.412	1.3	1
pH 4.0	4	4.09	4	1	4	4.09	1
pH 7.0	7	6.92	7	1	7	7.03	1
pH 10.0	10	7	10.01	1	10	10.04	1
LCS pH 4.01	4.01	n/a	3.97	1	4.01	4.06	1
LCS pH 7.0	7	n/a	6.94	1	7	7.04	1
LCS pH 10.01	10.01	n/a	10	1	10.01	10.01	1
ORP	235.99	234.8	235.9	1	234.59	233.2	1
Turbidity 0 NTU	0	0.2	0	1	0	0.2	1
Turbidity 40 NTU	40	37.5	40	1	40	41.7	1
Turbidity 200 NTU	200	196.9	200	1	200	203.8	1
Chla	≤0	-2.6	-2.2	1	≤0	-0.4	1
Flr	≤0	-0.4	-0.5	1	≤0	-0.1	1

August 21 to September 4, 2007
15 minute measurements with YSI Sonde 6600: #11
Notebook reference: F14P135,140
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.219	0	1	0	-0.192	1
Pressure (mmHg)	n/a	761.3	761.3	n/a	n/a	754.4	n/a
DO %	100	104.1	100.2	1	100	101.1	1
DO (mg/L)	8.43	8.73	8.43	1	8.91	9.07	1
DO Charge	25-75	63.5	63.5	1	25-75	56.3	1
Wet towel Temp (degC)	Ambient	24.02	24.03	n/a	Ambient	20.66	n/a
EC Temp (degC)	23.76	23.39	23.39	1	20.9	20.84	1
EC	1.408	1.459	1.408	1	1.408	1.352	1
LCS EC	1.412	n/a	1.378	1	1.412	1.333	1
pH 4.0	4	4.03	4	1	4	4.06	1
pH 7.0	7	6.98	7	1	7	7.02	1
pH 10.0	10	9.98	10	1	10	10.02	1
LCS pH 4.01	4.01	n/a	3.99	1	4.01	4.04	1
LCS pH 7.0	7	n/a	6.96	1	7	7.01	1
LCS pH 10.01	10.01	n/a	9.91	1	10.01	10.01	1
ORP	233.17	n/a	n/a	n/a	236.49	236.3	1
Turbidity 0 NTU	0	-1.1	0	1	0	0	1
Turbidity 40 NTU	40	39.1	40	1	40	38.9	1
Turbidity 200 NTU	200	198.1	200	1	200	204.6	1
Chla	≤0	-2	-1.1	1	≤0	-0.4	1
Flr	≤0	-0.5	-0.3	1	≤0	-0.2	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #14
Notebook reference: F15P26,35
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.09	0	1	0	-0.058	1
Pressure (mmHg)	n/a	758.4	758.3	n/a	n/a	757.2	n/a
DO %	100	98.8	99.9	1	100	98.1	1
DO (mg/L)	8.28	8.7	8.7	1	8.79	8.66	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	24.75	24.76	n/a	Ambient	21.51	n/a
EC Temp (degC)	24.9	24.75	24.76	1	22.5	22.94	1
EC	1.408	1.324	1.408	1	1.408	1.372	1
LCS EC	1.412	n/a	1.411	1	1.412	1.373	1
pH 4.0	4	4.07	4	1	4	4	1
pH 7.0	7	6.99	7	1	7	7.02	1
pH 10.0	10	10	10	1	10	10.02	1
LCS pH 4.01	4.01	n/a	4.02	1	4.01	4	1
LCS pH 7.0	7	n/a	7.01	1	7	6.98	1
LCS pH 10.01	10.01	n/a	9.98	1	10.01	10.01	1
ORP	231.39	n/a	n/a	n/a	233.76	232	1
Turbidity 0 NTU	0	-0.2	0	1	0	-0.1	1
Turbidity 40 NTU	40	42.2	39.9	1	40	40.5	1
Turbidity 200 NTU	200	202.7	200	1	200	181.9	1
Chla	≤0	-2.9	-3.4	1	≤0	-3.6	1
Flr	≤0	-0.8	-1	1	≤0	-0.9	1

September 18 to October 2, 2007
15 minute measurements with YSI Sonde 6600: #7
Notebook reference: F15P69, 75
The instrument was deployed in a black PVC housing The SONDE was suspended from the ESWD lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.133	0	1	0	0.084	1
Pressure (mmHg)	n/a	761.4	761.5	n/a	n/a	761.1	n/a
DO %	100	103.4	100.2	1	100	108.5	1
DO (mg/L)	8.66	8.94	8.66	1	8.87	9.61	1
DO Charge	25-75	49.2	49.2	n/a	25-75	43.1	n/a
Wet towel Temp (degC)	Ambient	22.56	22.59	n/a	Ambient	21.32	n/a
EC Temp (degC)	22.8	23	22.98	1	23.1	23.15	1
EC	1.408	1.377	1.408	1	1.408	1.41	1
LCS EC	1.412	n/a	1.415	1	1.412	1.413	1
pH 4.0	4	3.99	4	1	4	4.08	1
pH 7.0	7	7.02	7	1	7	7.05	1
pH 10.0	10	10.02	10	1	10	10.04	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.05	1
LCS pH 7.0	7	n/a	7	1	7	7.02	1
LCS pH 10.01	10.01	n/a	9.97	1	10.01	10.02	1
ORP	233.71	n/a	n/a	n/a	233.48	n/a	n/a
Turbidity 0 NTU	0	-0.1	0	1	0	0.3	1
Turbidity 40 NTU	40	42.1	40	1	40	40.5	1
Turbidity 200 NTU	200	185.5	200	1	200	202.1	1
Chla	≤0	-1.4	-1.7	1	≤0	-1	1
Flr	≤0	-0.3	-0.4	1	≤0	-0.3	1

DO-07 SJR at Patterson

June 12, 2007 to June 26, 2007
15 minute measurements with YSI Sonde 6600: #10
Notebook Reference: F12p105-113, 141-152
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing were attached with 3/16" steel cable and padlocked to the platform of the pumping station Upon retrieval of the SONDE, the instrument was found exactly where it was left , with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.163	0	1	0	0.203	1
Pressure (mmHg)	n/a	756.9	756.9	n/a	n/a	760.8	n/a
DO %	100	94.8	99.6	1	100	96.4	1
DO (mg/L)	8.83	8.4	8.83	1	8.82	8.5	1
DO Charge	25-75	51.2	51.2	1	25-75	54.3	1
Wet towel Temp (degC)	Ambient	21.26	21.27	n/a	Ambient	21.62	n/a
EC Temp (degC)	21.6	21.65	21.65	1	21.8	22.09	1
EC	1.408	1.559	1.408	1	1.408	1.362	1
LCS EC	1.412	n/a	1.342	1	1.412	1.329	1
pH 4.0	4	4.14	4	1	4	3.98	1
pH 7.0	7	6.95	7	1	7	6.91	1
pH 10.0	10	10.05	10.01	1	10	9.97	1
LCS pH 4.01	4.01	n/a	3.92	1	4.01	4	1
LCS pH 7.0	7	n/a	6.93	1	7	6.82	1
LCS pH 10.01	10.01	n/a	10	1	10.01	9.92	1
ORP	235.44	235.4	235.4	1	234.87	232.9	1
Turbidity 0 NTU	0	-1.1	0	1	0	-0.4	1
Turbidity 40 NTU	40	48.1	40	1	40	35.8	1
Turbidity 200 NTU	200	188.5	200.2	1	200	185.4	1
Chla	≤0	-0.3	-0.1	1	≤0	-0.3	1
Flr	≤0	0	0	1	≤0	-0.1	1

June 26 to July 10, 2007
15 minute measurements with YSI Sonde 6600: #7
Notebook reference: F12P143,144
The instrument was deployed in a black PVC housing The SONDE was attached towards the front of the PID lift pump structure in the SJR and secured with a cable and padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.016	-0.001	1	0	0.143	1
Pressure (mmHg)	n/a	760.8	760.7	n/a	n/a	761.5	n/a
DO %	100	94.9	100.1	1	100	33.6	0
DO (mg/L)	8.69	8.23	8.69	1	8.87	2.98	0
DO Charge	25-75	44.1	43.1	1	25-75	15	0
Wet towel Temp (degC)	Ambient	22.38	22.38	n/a	Ambient	21.38	n/a
EC Temp (degC)	22.5	22.68	22.69	1	22.1	21.81	1
EC	1.408	1.361	1.408	1	1.408	1.425	1
LCS EC	1.412	n/a	1.376	1	1.412	1.393	1
pH 4.0	4	4.02	4	1	4	4.1	1
pH 7.0	7	6.98	7	1	7	7.01	1
pH 10.0	10	10.08	10.02	1	10	10.2	1
LCS pH 4.01	4.01	n/a	4.02	1	4.01	4.12	1
LCS pH 7.0	7	n/a	6.86	1	7	7.03	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	10.01	1
ORP	234.08	n/a	n/a	n/a	235.23	n/a	n/a
Turbidity 0 NTU	0	0.3	0	1	0	0.4	1
Turbidity 40 NTU	40	38.3	40	1	40	36.5	1
Turbidity 200 NTU	200	203.8	200.1	1	200	204.9	1
Chla	≤0	-1.4	-1.5	1	≤0	-0.8	1
Flr	≤0	-0.3	-0.4	1	≤0	-0.2	1

July 10 to July 24, 2007
15 minute measurements with YSI Sonde 6600: #3
Notebook reference: F14P21,23, 72
The instrument was deployed in a black PVC housing. The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.025	0	1	0	0.067	1
Pressure (mmHg)	n/a	757.2	757.2	n/a	n/a	757.6	n/a
DO %	100	116.6	99.6	1	100	105.4	1
DO (mg/L)	8.84	10.31	8.85	1	8.93	9.45	1
DO Charge	25-75	49.2	49.2	1	25-75	45.1	1
Wet towel Temp (degC)	Ambient	21.21	21.21	n/a	Ambient	20.75	n/a
EC Temp (degC)	21.1	21.32	21.32	1	20.7	20.69	1
EC	1.408	1.442	1.408	1	1.408	1.374	1
LCS EC	1.412	n/a	1.336	1	1.412	1.351	1
pH 4.0	4	3.99	4	1	4	4.05	1
pH 7.0	7	6.98	7	1	7	6.94	1
pH 10.0	10	10.11	10.02	1	10	9.92	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.03	1
LCS pH 7.0	7	n/a	6.98	1	7	6.94	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.94	1
ORP	235.87	233.6	235.9	1	236.69	234.4	1
Turbidity 0 NTU	0	-0.1	0	1	0	-0.5	1
Turbidity 40 NTU	40	35.4	39.7	1	40	45.2	1
Turbidity 200 NTU	200	214.6	199.9	1	200	199.9	1
Chla	≤0	-1.6	-1.4	1	≤0	-2	1
Flr	≤0	-0.3	-0.3	1	≤0	-0.5	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #7
Notebook reference: F14P63,110
The instrument was deployed in a black PVC housing The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.007	0	1	0	0.081	1
Pressure (mmHg)	n/a	758.4	758.4	n/a	n/a	759.1	n/a
DO %	100	105.5	99.8	1	100	110	1
DO (mg/L)	8.65	9.15	8.65	1	9.01	9.92	1
DO Charge	25-75	54.3	54.3	1	25-75	42	1
Wet towel Temp (degC)	Ambient	22.43	22.45	n/a	Ambient	20.41	n/a
EC Temp (degC)	22.7	22.75	22.77	1	21.5	21.38	1
EC	1.408	1.435	1.408	1	1.408	1.457	1
LCS EC	1.412	n/a	1.372	1	1.412	1.382	1
pH 4.0	4	4.03	4	1	4	4.09	1
pH 7.0	7	6.97	7	1	7	6.97	1
pH 10.0	10	10.05	10.01	1	10	9.98	1
LCS pH 4.01	4.01	n/a	4.01	1	4.01	4.08	1
LCS pH 7.0	7	n/a	7	1	7	6.95	1
LCS pH 10.01	10.01	n/a	9.97	1	10.01	9.97	1
ORP	233.98	n/a	n/a	n/a	235.79	n/a	n/a
Turbidity 0 NTU	0	-0.2	0	1	0	-0.1	1
Turbidity 40 NTU	40	41.9	40	1	40	36.4	1
Turbidity 200 NTU	200	187.2	200	1	200	190.1	1
Chla	≤0	-1.1	-1.1	1	≤0	-1.3	1
Flr	≤0	-0.3	-0.2	1	≤0	-0.3	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #16
Notebook reference: F14P101
The instrument was deployed in a black PVC housing The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. During deployment battery voltage fell below minimum and unit stopped logging for about 2 days battery voltage came back up and unit started logging again. No explanation for battery failure and all sites experienced some drop in battery voltage. Message left with YSI regarding energizer batteries

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.109	0	1	0	-0.208	1
Pressure (mmHg)	n/a	760.7	760.7	n/a	n/a	755.9	n/a
DO %	100	100.8	100.2	1	100	102	1
DO (mg/L)	8.94	9	8.95	1	8.68	8.91	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	20.88	20.9	n/a	Ambient	22.08	n/a
EC Temp (degC)	21.1	21.15	21.15	1	23.2	23.21	1
EC	1.408	1.314	1.408	1	1.408	1.392	1
LCS EC	1.412	n/a	1.362	1	1.412	1.382	1
pH 4.0	4	4.06	4	1	4	4.11	1
pH 7.0	7	7	7	1	7	6.9	1
pH 10.0	10	10.04	10.01	1	10	10.14	1
LCS pH 4.01	4.01	n/a	4.01	1	4.01	3.99	1
LCS pH 7.0	7	n/a	6.96	1	7	7.01	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	10.08	1
ORP	236.09	235.5	236.1	1	233.41	231.4	1
Turbidity 0 NTU	0	-0.1	0	1	0	0.4	1
Turbidity 40 NTU	40	36.8	40	1	40	44.9	1
Turbidity 200 NTU	200	198	199.9	1	200	193.2	1
Chla	≤0	-2.9	-3	1	≤0	-2.7	1
Flr	≤0	-0.7	-0.8	1	≤0	-0.7	1

August 21 to September 4, 2007
15 minute measurements with YSI Sonde 6600: #7
Notebook reference: F14P134,140
The instrument was deployed in a black PVC housing The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. Energizer batteries began to cut out on 9/3

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.196	0	1	0	-0.191	1
Pressure (mmHg)	n/a	761.7	761.7	n/a	n/a	754	n/a
DO %	100	109.8	100.2	1	100	108.3	1
DO (mg/L)	8.44	9.2	8.44	1	9.05	9.89	1
DO Charge	25-75	48.2	48.2	1	25-75	41	1
Wet towel Temp (degC)	Ambient	23.99	24.01	n/a	Ambient	19.81	n/a
EC Temp (degC)	24.3	24.14	24.13	1	20.8	20.68	1
EC	1.408	1.393	1.408	1	1.408	1.372	1
LCS EC	1.412	n/a	1.399	1	1.412	1.363	1
pH 4.0	4	4.11	4	1	4	4.04	1
pH 7.0	7	6.92	7	1	7	7.02	1
pH 10.0	10	10.08	10.01	1	10	10.06	1
LCS pH 4.01	4.01	n/a	3.98	1	4.01	3.99	1
LCS pH 7.0	7	n/a	6.98	1	7	7	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	10.04	1
ORP	232.21	n/a	n/a	n/a	236.70	n/a	n/a
Turbidity 0 NTU	0	-0.2	0	1	0	-0.1	1
Turbidity 40 NTU	40	37.9	40	1	40	38.9	1
Turbidity 200 NTU	200	195.2	200	1	200	204.3	1
Chla	≤0	-1.3	-1.1	1	≤0	-0.3	1
Flr	≤0	-0.3	-0.3	1	≤0	-0.1	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #12
Notebook reference: F15P27,35
The instrument was deployed in a black PVC housing The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. Energizer batteries began to cut out on 9/3

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.072	0	1	0	-0.102	1
Pressure (mmHg)	n/a	758.2	758.2	n/a	n/a	757.1	n/a
DO %	100	101.4	99.9	1	100	98.5	1
DO (mg/L)	8.55	8.71	8.71	1	8.64	8.54	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	23.03	23.03	n/a	Ambient	22.4	n/a
EC Temp (degC)	24.5	24.44	24.42	1	22.4	22.71	1
EC	1.408	1.353	1.408	1	1.408	1.379	1
LCS EC	1.412	n/a	1.42	1	1.412	1.373	1
pH 4.0	4	4.08	4	1	4	4.09	1
pH 7.0	7	7	7	1	7	6.97	1
pH 10.0	10	9.99	10	1	10	9.99	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.07	1
LCS pH 7.0	7	n/a	6.98	1	7	6.98	1
LCS pH 10.01	10.01	n/a	9.99	1	10.01	10	1
ORP	231.83	229.6	231.9	1	234.06	235	1
Turbidity 0 NTU	0	0.3	0	1	0	0.5	1
Turbidity 40 NTU	40	42	40	1	40	43.5	1
Turbidity 200 NTU	200	195.9	200	1	200	194.2	1
Chla	≤0	-1.1	-0.2	1	≤0	-3	1
Flr	≤0	-0.2	0	1	≤0	-0.7	1

September 18 to October 2, 2007
15 minute measurements with YSI Sonde 6600: #17
Notebook reference:F15P71, 75
The instrument was deployed in a black PVC housing The SONDE was suspended from the PID lift platform on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. Energizer batteries began to cut out on 9/3

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.288	0	1	0	0.019	1
Pressure (mmHg)	n/a	759.9	759.9	n/a	n/a	759.2	n/a
DO %	100	102	100	1	100	100.5	1
DO (mg/L)	8.63	8.8	8.63	1	8.84	8.9	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	22.7	22.7	n/a	Ambient	21.35	n/a
EC Temp (degC)	22.5	22.64	22.62	1	22.7	22.65	1
EC	1.408	1.341	1.408	1	1.408	1.436	1
LCS EC	1.412	n/a	1.405	1	1.412	1.418	1
pH 4.0	4	4.08	4	1	4	4.04	1
pH 7.0	7	6.99	7	1	7	6.98	1
pH 10.0	10	10.04	10.01	1	10	10	1
LCS pH 4.01	4.01	n/a	3.98	1	4.01	3.99	1
LCS pH 7.0	7	n/a	7	1	7	6.96	1
LCS pH 10.01	10.01	n/a	10.01	1	10.01	10	1
ORP	234.17	232.5	234.2	1	234.14	233.9	1
Turbidity 0 NTU	0	-0.3	0.1	1	0	0.1	1
Turbidity 40 NTU	40	45.7	40	1	40	39.2	1
Turbidity 200 NTU	200	178.3	199.8	1	200	198.1	1
Chla	≤0	-1.5	-1.4	1	≤0	-2.8	1
Flr	≤0	-0.3	-0.4	1	≤0	-0.7	1

DO-08 SJR at Crows Landing (Turlock Sportsman's Club)

June 12, 2007 to June 26, 2007
15 minute measurements with YSI Sonde 6600: #4
Notebook Reference: F12p105-113, 141-152
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 3/16" steel cable and padlocked to the dock at the Turlock Sportsman's Club Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.179	0	1	0	0.191	1
Pressure (mmHg)	n/a	757.1	757.1	n/a	n/a	761.2	n/a
DO %	100	89.6	99.6	1	100	112.5	0
DO (mg/L)	8.84	7.94	8.84	1	8.96	10.07	0
DO Charge	25-75	41	41	1	25-75	35.9	1
Wet towel Temp (degC)	Ambient	21.25	21.26	n/a	Ambient	20.82	n/a
EC Temp (degC)	21.6	21.65	21.65	1	22.2	21.9	1
EC	1.408	1.456	1.408	1	1.408	1.356	1
LCS EC	1.412	n/a	1.344	1	1.412	1.333	1
pH 4.0	4	4.03	4	1	4	4.03	1
pH 7.0	7	6.97	7	1	7	7	1
pH 10.0	10	10.08	10.02	1	10	10	1
LCS pH 4.01	4.01	n/a	3.96	1	4.01	4.07	1
LCS pH 7.0	7	n/a	6.93	1	7	6.9	1
LCS pH 10.01	10.01	n/a	9.98	1	10.01	9.97	1
ORP	235.44	232.23	235.4	1	235.12	233.3	1
Turbidity 0 NTU	0	-0.7	0	1	0	0	1
Turbidity 40 NTU	40	45.5	40	1	40	37.2	1
Turbidity 200 NTU	200	203	200.8	1	200	184	1
Chla	≤0	-1.2	-1.1	1	≤0	-1.1	1
Flr	≤0	-0.3	-0.3	1	≤0	-0.3	1

June 26 to July 10, 2007
15 minute measurements with YSI Sonde 6600: #8
Notebook reference: F12P143,144
The instrument was deployed in a black PVC housing The SONDE was attached towards the front of the PID lift pump structure in the SJR and secured with a cable and padlock. It was submerged to about 2-3 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.023	0	1	0	0.135	1
Pressure (mmHg)	n/a	760.5	760.5	n/a	n/a	761.5	n/a
DO %	100	96.9	100.1	1	100	102.3	1
DO (mg/L)	8.73	8.45	8.73	1	8.91	9	1
DO Charge	25-75	55.3	54.3	1	25-75	41	1
Wet towel Temp (degC)	Ambient	22.12	22.12	n/a	Ambient	21.16	n/a
EC Temp (degC)	22.3	22.44	22.44	1	22.1	21.95	1
EC	1.408	1.395	1.408	1	1.408	1.37	1
LCS EC	1.412	n/a	1.37	1	1.412	1.412	1
pH 4.0	4	4.02	4	1	4	4.07	1
pH 7.0	7	6.91	7	1	7	7.08	1
pH 10.0	10	10.04	10.01	1	10	10.17	1
LCS pH 4.01	4.01	n/a	4.09	1	4.01	4.1	1
LCS pH 7.0	7	n/a	6.87	1	7	7.09	1
LCS pH 10.01	10.01	n/a	9.9	1	10.01	10.13	1
ORP	234.41	n/a	n/a	n/a	235.05	n/a	n/a
Turbidity 0 NTU	0	-0.4	0	1	0	-0.1	1
Turbidity 40 NTU	40	39	40	1	40	35.5	1
Turbidity 200 NTU	200	205.1	200	1	200	203.5	1
Chla	≤0	0	-0.1	1	≤0	0.1	1
Flr	≤0	0	0	1	≤0	0	1

July 10 to July 24, 2007
15 minute measurements with YSI Sonde 6600: #12
Notebook reference: F14P19,22,73
The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.075	0	1	0	0.021	1
Pressure (mmHg)	n/a	758.2	758.2	n/a	n/a	757.1	n/a
DO %	100	96.2	99.8	1	100	99.7	1
DO (mg/L)	9.12	8.81	9.13	1	8.77	8.78	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	19.68	19.7	n/a	Ambient	21.64	n/a
EC Temp (degC)	20.2	20.23	20.24	1	20.9	21.24	1
EC	1.408	1.358	1.408	1	1.408	1.391	1
LCS EC	1.412	n/a	1.387	1	1.412	1.389	1
pH 4.0	4	4.07	4	1	4	4.15	1
pH 7.0	7	7.01	7	1	7	7.06	1
pH 10.0	10	10	10	1	10	10.07	1
LCS pH 4.01	4.01	n/a	4.06	1	4.01	4.16	1
LCS pH 7.0	7	n/a	6.98	1	7	7.09	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	10.07	1
ORP	237.27	237.1	237.3	1	235.97	233	1
Turbidity 0 NTU	0	-0.1	0	1	0	0.2	1
Turbidity 40 NTU	40	33.1	39.9	1	40	41.8	1
Turbidity 200 NTU	200	211.4	200	1	200	188.9	1
Chla	≤0	-2.4	-2.8	1	≤0	-2.6	1
Flr	≤0	-0.5	-0.7	1	≤0	-0.7	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #17
Notebook reference: F14P61,113
The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	34.092	0	1	0	0.14	1
Pressure (mmHg)	n/a	760.1	760.1	n/a	n/a	758.7	n/a
DO %	100	98.1	99.9	1	100	99.3	1
DO (mg/L)	8.43	8.25	8.42	1	8.88	8.83	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	23.96	23.96	n/a	Ambient	21.13	n/a
EC Temp (degC)	23.8	24.37	24.14	1	21.4	21.55	1
EC	1.408	0.043	1.408	1	1.408	1.464	1
LCS EC	1.412	n/a	1.392	1	1.412	1.402	1
pH 4.0	4	4.07	4	1	4	4.17	1
pH 7.0	7	7	7	1	7	7.01	1
pH 10.0	10	10.05	10.01	1	10	10.03	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.14	1
LCS pH 7.0	7	n/a	7.01	1	7	7.03	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	10.06	1
ORP	232.19	208.9	232.1	1	235.57	233.5	1
Turbidity 0 NTU	0	5.3	0	1	0	0.1	1
Turbidity 40 NTU	40	39.7	40	1	40	40.5	1
Turbidity 200 NTU	200	197.4	200	1	200	186	1
Chla	≤0	-4.9	-4.6	1	≤0	-3.1	1
Flr	≤0	-1.2	-1.1	1	≤0	-0.7	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #6
Notebook reference: F14P99
The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.442	0	1	0	-0.278	1
Pressure (mmHg)	n/a	762.1	762.1	n/a	n/a	753.7	n/a
DO %	100	91.3	100.3	1	100	104.5	1
DO (mg/L)	8.92	8.17	8.92	1	8.74	9.21	1
DO Charge	25-75	60.4	59.4	1	25-75	53.3	1
Wet towel Temp (degC)	Ambient	20.7	21.09	n/a	Ambient	21.6	n/a
EC Temp (degC)	21.9	21.85	21.86	1	22.5	22.31	1
EC	1.408	1.446	1.408	1	1.408	1.394	1
LCS EC	1.412	n/a	1.355	1	1.412	1.363	1
pH 4.0	4	4.04	4	1	4	4.08	1
pH 7.0	7	6.98	7	1	7	6.99	1
pH 10.0	10	10.06	10.01	1	10	9.97	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.08	1
LCS pH 7.0	7	n/a	6.97	1	7	6.99	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.92	1
ORP	235.17	235.3	235.2	1	234.58	234.4	1
Turbidity 0 NTU	0	-0.7	0	1	0	0.1	1
Turbidity 40 NTU	40	44.9	40	1	40	40.8	1
Turbidity 200 NTU	200	187.5	199.9	1	200	206.7	1
Chla	≤0	-0.8	-1.7	1	≤0	-1.7	1
Flr	≤0	-0.3	-0.4	1	≤0	-0.4	1

August 21 to September 4, 2007

15 minute measurements with YSI Sonde 6600: #8

Notebook reference: F14P134,139

The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.001	0	1	0	-0.176	1
Pressure (mmHg)	n/a	761.7	761.8	n/a	n/a	754.3	n/a
DO %	100	102.4	100.2	1	100	109.4	1
DO (mg/L)	8.44	8.63	8.44	1	9.20	10.15	1
DO Charge	25-75	47.1	47.1	1	25-75	40	1
Wet towel Temp (degC)	Ambient	23.97	23.99	n/a	Ambient	19.01	n/a
EC Temp (degC)	24.4	24.14	24.14	1	20.7	20.76	1
EC	1.408	1.437	1.408	1	1.408	1.346	1
LCS EC	1.412	n/a	1.38	1	1.412	1.34	1
pH 4.0	4	4.04	4	1	4	4.05	1
pH 7.0	7	6.96	7	1	7	7.06	1
pH 10.0	10	10	10	1	10	10.08	1
LCS pH 4.01	4.01	n/a	4.03	1	4.01	4.07	1
LCS pH 7.0	7	n/a	7.02	1	7	7.03	1
LCS pH 10.01	10.01	n/a	9.93	1	10.01	10.05	1
ORP	232.19	n/a	n/a	n/a	236.60	n/a	n/a
Turbidity 0 NTU	0	-0.2	0	1	0	0.2	1
Turbidity 40 NTU	40	39	40	1	40	38.8	1
Turbidity 200 NTU	200	197.2	200.1	1	200	199.8	1
Chla	≤0	-0.1	0.5	1	≤0	0.3	1
Flr	≤0	0	0.2	1	≤0	0.1	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #3
Notebook reference: F15P28,34
The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.19	0	1	0	-0.053	1
Pressure (mmHg)	n/a	758	757.9	n/a	n/a	757.4	n/a
DO %	100	102.7	99.7	1	100	100.1	1
DO (mg/L)	8.54	8.77	8.54	1	8.64	8.67	1
DO Charge	25-75	42	42	1	25-75	40	1
Wet towel Temp (degC)	Ambient	23.09	23.09	n/a	Ambient	22.41	n/a
EC Temp (degC)	24.3	24.06	24.05	1	23.1	22.87	1
EC	1.408	1.391	1.408	1	1.408	1.349	1
LCS EC	1.412	n/a	1.405	1	1.412	1.34	1
pH 4.0	4	3.95	4	1	4	3.88	1
pH 7.0	7	7.06	7	1	7	6.82	1
pH 10.0	10	10.19	10	1	10	9.84	1
LCS pH 4.01	4.01	n/a	3.98	1	4.01	3.9	1
LCS pH 7.0	7	n/a	6.92	1	7	6.85	1
LCS pH 10.01	10.01	n/a	9.88	1	10.01	9.82	1
ORP	232.31	232.9	231.9	1	233.84	235	1
Turbidity 0 NTU	0	-0.3	0	1	0	0.5	1
Turbidity 40 NTU	40	38.5	40	1	40	41.4	1
Turbidity 200 NTU	200	205	200	1	200	184.8	1
Chla	≤0	-0.8	-0.8	1	≤0	0.1	1
Flr	≤0	-0.1	-0.1	1	≤0	0	1

September 18 to October 2, 2007
15 minute measurements with YSI Sonde 6600: #8
Notebook reference: F15P69, 74
The instrument was deployed in a black PVC housing The SONDE was suspended from the Turlock Sportsman's Club dock on a 3/16 stainless cable and secured with a padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.128	-0.002	1	0	0.084	1
Pressure (mmHg)	n/a	761.3	761.2	n/a	n/a	761	n/a
DO %	100	107.3	100.2	1	100	104.3	1
DO (mg/L)	8.64	9.2	8.64	1	8.92	9.26	1
DO Charge	25-75	48.2	48.2	1	25-75	41	1
Wet towel Temp (degC)	Ambient	22.71	22.72	n/a	Ambient	21.04	n/a
EC Temp (degC)	22.8	22.82	22.85	1	22.8	22.9	1
EC	1.408	1.342	1.408	1	1.408	1.418	1
LCS EC	1.412	n/a	1.402	1	1.412	1.414	1
pH 4.0	4	4.05	4	1	4	3.96	1
pH 7.0	7	7.01	7	1	7	6.96	1
pH 10.0	10	10.02	10	1	10	9.92	1
LCS pH 4.01	4.01	n/a	4.02	1	4.01	3.94	1
LCS pH 7.0	7	n/a	6.99	1	7	6.9	1
LCS pH 10.01	10.01	n/a	9.97	1	10.01	9.9	1
ORP	233.88	n/a	n/a	n/a	233.81	n/a	n/a
Turbidity 0 NTU	0	-0.7	0	1	0	-0.1	1
Turbidity 40 NTU	40	42.6	40	1	40	39.8	1
Turbidity 200 NTU	200	178.7	199.9	1	200	203.4	1
Chla	≤0	0	-0.1	1	≤0	-4.9	1
Flr	≤0	0	0	1	≤0	-1.4	1

DO-10 SJR at Lander Ave.

June 12, 2007 to June 26, 2007
15 minute measurements with YSI Sonde 6600: #6
Notebook Reference: F12p105-113, 141-152
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached to a stake driven into the river bed. The stake and SONDE plus housing were then padlocked with a 3/16" steel cable to a bracket around the bridge pylon. Upon retrieval of the SONDE, the instrument was found exactly where it was left.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.152	0	1	0	0.171	1
Pressure (mmHg)	n/a	757	757	n/a	n/a	761	n/a
DO %	100	85.5	99.6	1	100	103.6	1
DO (mg/L)	8.93	7.65	8.92	1	8.89	9.2	1
DO Charge	25-75	43.1	43.1	1	25-75	67.6	1
Wet towel Temp (degC)	Ambient	20.72	20.72	n/a	Ambient	21.22	n/a
EC Temp (degC)	21.4	21.6	21.6	1	21.9	22	1
EC	1.408	1.457	1.408	1	1.408	1.357	1
LCS EC	1.412	n/a	1.391	1	1.412	1.356	1
pH 4.0	4	6.16	4	1	4	4.12	1
pH 7.0	7	6.98	7	1	7	7.1	1
pH 10.0	10	10	10	1	10	10.12	1
LCS pH 4.01	4.01	n/a	4.03	1	4.01	4.14	1
LCS pH 7.0	7	n/a	6.94	1	7	6.98	1
LCS pH 10.01	10.01	n/a	10.01	1	10.01	10.07	1
ORP	235.50	244.6	235.5	1	234.98	229.8	1
Turbidity 0 NTU	0	0	0	1	0	0	1
Turbidity 40 NTU	40	46.7	40	1	40	36.7	1
Turbidity 200 NTU	200	192.7	200	1	200	188	1
Chla	≤0	-1.4	-1	1	≤0	-1.1	1
Flr	≤0	-0.3	-0.3	1	≤0	-0.3	1

June 26 to July 10, 2007
15 minute measurements with YSI Sonde 6600: #9
Notebook reference: F12P142,144
The instrument was deployed in a black PVC housing The SONDE was attached to a stake set into the riverbed in the SJR and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.008	0	1	0	0.139	1
Pressure (mmHg)	n/a	761	761	n/a	n/a	761.3	n/a
DO %	100	78.6	100.1	1	100	86.7	1
DO (mg/L)	8.83	6.55	8.83	1	8.99	7.79	1
DO Charge	25-75	51.2	51.2	1	25-75	42	1
Wet towel Temp (degC)	Ambient	22.76	21.59	n/a	Ambient	20.65	n/a
EC Temp (degC)	23.6	23.47	23.54	1	22	22.02	1
EC	1.408	1.41	1.408	1	1.408	1.418	1
LCS EC	1.412	n/a	1.358	1	1.412	1.372	1
pH 4.0	4	4	4	1	4	4.13	1
pH 7.0	7	7.03	7	1	7	7.01	1
pH 10.0	10	10.01	10	1	10	9.99	1
LCS pH 4.01	4.01	n/a	4.05	1	4.01	4.15	1
LCS pH 7.0	7	n/a	6.89	1	7	7.02	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	10.05	1
ORP	232.98	n/a	n/a	n/a	234.96	n/a	n/a
Turbidity 0 NTU	0	0.5	0	1	0	0.1	1
Turbidity 40 NTU	40	39.5	40	1	40	33.9	1
Turbidity 200 NTU	200	203.8	200	1	200	198.8	1
Chla	≤0	-0.1	-0.1	1	≤0	-0.3	1
Flr	≤0			1	≤0	-0.1	1

July 10 to July 19, 2007
15 minute measurements with YSI Sonde 6600: #10 and #16
Notebook reference: F14P19,22,23,52,59,75
The instrument was deployed in a black PVC housing The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.05	0	1	0	0.125	1
Pressure (mmHg)	n/a	758.2	758.1	n/a	n/a	759.3	n/a
DO %	100	111.8	99.8	1	100	102	1
DO (mg/L)	9.04	10.14	9.05	1	8.65	8.83	1
DO Charge	25-75	57.4	56.3	1	25-75	72.7	1
Wet towel Temp (degC)	Ambient	20.11	20.13	n/a	Ambient	22.52	n/a
EC Temp (degC)	19.9	20.35	20.35	1	23.2	23.15	1
EC	1.408	1.414	1.407	1	1.408	1.48	1
LCS EC	1.412	n/a	1.354	1	1.412	1.36	1
pH 4.0	4	3.97	4	1	4	4.03	1
pH 7.0	7	6.98	7	1	7	6.9	1
pH 10.0	10	10.05	10.01	1	10	9.98	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.03	1
LCS pH 7.0	7	n/a	7.01	1	7	6.99	1
LCS pH 10.01	10.01	n/a	9.99	n/a	10.01	9.91	1
ORP	237.13	235.4	237.1	1	233.48	233	1
Turbidity 0 NTU	0	-0.4	0	1	0	0.2	1
Turbidity 40 NTU	40	32	40	1	40	35.8	1
Turbidity 200 NTU	200	224.2	200	1	200	200.9	1
Chla	≤0	-0.2	0	1	≤0	-0.2	1
Flr	≤0	0	0	1	≤0	0	1

July 19 to July 24, 2007

15 minute measurements with YSI Sonde 6600: #10 and #16

Notebook reference: F14P19,22,23,52,59,75

The instrument was deployed in a black PVC housing The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	34.499	0	1	0	-0.064	1
Pressure (mmHg)	n/a	760.5	760.5	n/a	n/a	756.8	n/a
DO %	100	97.1	100	1	100	100.3	1
DO (mg/L)	8.66	8.4	8.65	1	8.73	8.79	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	22.53	22.54	n/a	Ambient	21.88	n/a
EC Temp (degC)	23	23.06	23.03	1	20.9	21.25	1
EC	1.408	4.523	1.408	1	1.408	1.285	1
LCS EC	1.412	n/a	1.291	1	1.412	1.226	1
pH 4.0	4	4.11	4	1	4	4.14	1
pH 7.0	7	6.93	7	1	7	7.02	1
pH 10.0	10	10.15	10.02	1	10	10.03	1
LCS pH 4.01	4.01	n/a	4.06	1	4.01	4.15	1
LCS pH 7.0	7	n/a	6.88	1	7	7.03	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	10.06	1
ORP	233.64	211.1	233.6	1	235.96	233.8	1
Turbidity 0 NTU	0	6	0	1	0	0.2	1
Turbidity 40 NTU	40	46.4	40	1	40	35.9	1
Turbidity 200 NTU	200	194.1	200	1	200	177.5	1
Chla	≤0	-4.1	-3	1	≤0	-3.6	1
Flr	≤0	-1	-1	1	≤0	-0.8	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #13
Notebook reference: F14P61,112
The instrument was deployed in a black PVC housing The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.041	0	1	0	0.132	1
Pressure (mmHg)	n/a	759.9	759.9	n/a	n/a	758.7	n/a
DO %	100	97.7	100	1	100	100.7	1
DO (mg/L)	8.49	8.28	8.49	1	8.93	9.01	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	23.53	23.53	n/a	Ambient	20.82	n/a
EC Temp (degC)	23.6	23.61	23.56	1	21.4	21.52	1
EC	1.408	1.39	1.41	1	1.408	1.442	1
LCS EC	1.412	n/a	1.395	1	1.412	1.395	1
pH 4.0	4	4.01	4	1	4	4.12	1
pH 7.0	7	7.01	7	1	7	7	1
pH 10.0	10	10	10	1	10	9.98	1
LCS pH 4.01	4.01	n/a	4.05	1	4.01	4.07	1
LCS pH 7.0	7	n/a	7.04	1	7	6.97	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	9.94	1
ORP	232.95	230.4	232.9	1	235.61	234.8	1
Turbidity 0 NTU	0	0.8	0	1	0	0.6	1
Turbidity 40 NTU	40	39.3	40	1	40	43.2	1
Turbidity 200 NTU	200	191.4	200.4	1	200	190.8	1
Chla	≤0	-2.4	-3.5	1	≤0	-3.6	1
Flr	≤0	-0.6	-0.8	1	≤0	-0.9	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #14
Notebook reference: F14P100
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.011	0	1	0	-0.322	1
Pressure (mmHg)	n/a	761.4	761.4	n/a	n/a	753.3	n/a
DO %	100	103.9	100.2	1	100	100.6	1
DO (mg/L)	8.89	9.23	8.9	1	8.77	8.9	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	21.23	21.23	n/a	Ambient	21.39	n/a
EC Temp (degC)	20.9	21.27	21.27	1	22.4	22.2	1
EC	1.408	1.456	1.408	1	1.408	1.329	1
LCS EC	1.412	n/a	1.316	1	1.412	1.295	1
pH 4.0	4	4.1	4	1	4	4.14	1
pH 7.0	7	7.01	7	1	7	7.03	1
pH 10.0	10	10.03	10.01	1	10	10.04	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.1	1
LCS pH 7.0	7	n/a	6.98	1	7	7.05	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	10	1
ORP	235.93	233.5	235.9	1	234.72	232	1
Turbidity 0 NTU	0	0.4	0	1	0	1	1
Turbidity 40 NTU	40	44.9	40	1	40	42.5	1
Turbidity 200 NTU	200	191.5	200.1	1	200	202.7	1
Chla	≤0	-4	-3.7	1	≤0	-3.3	1
Flr	≤0	-0.8	-0.8	1	≤0	-0.8	1

August 21 to September 4, 2007
15 minute measurements with YSI Sonde 6600: #10
Notebook reference: F14P135,139
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.356	0	1	0	-0.238	1
Pressure (mmHg)	n/a	761.7	761.7	n/a	n/a	755.7	n/a
DO %	100	105.1	100.2	1	100	109	1
DO (mg/L)	8.47	8.91	8.46	1	9.18	10.04	1
DO Charge	25-75	56.3	56.3	1	25-75	100.2	0
Wet towel Temp (degC)	Ambient	23.79	23.81	n/a	Ambient	19.24	n/a
EC Temp (degC)	24.5	24.3	24.3	1	21	21.39	1
EC	1.408	1.426	1.409	1	1.408	1.355	1
LCS EC	1.412	n/a	1.381	1	1.412	1.365	1
pH 4.0	4	4.01	4	1	4	4.04	1
pH 7.0	7	6.94	7	1	7	7.03	1
pH 10.0	10	10.01	10	1	10	10.01	1
LCS pH 4.01	4.01	n/a	3.99	1	4.01	3.98	1
LCS pH 7.0	7	n/a	6.96	1	7	7.01	1
LCS pH 10.01	10.01	n/a	9.92	1	10.01	9.98	1
ORP	231.98	n/a	n/a	n/a	235.78	237.6	1
Turbidity 0 NTU	0	-0.1	0	1	0	0.8	1
Turbidity 40 NTU	40	38.9	40	1	40	39.3	1
Turbidity 200 NTU	200	199.5	200	1	200	206.8	1
Chla	≤0	1.3	0.3	1	≤0	0	1
Flr	≤0	0.3	0.1	1	≤0	0	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #15
Notebook reference: F15P29,34
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged. There was a fish living in the housing at pickup.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.135	0	1	0	-0.082	1
Pressure (mmHg)	n/a	757.6	757.6	n/a	n/a	756.6	n/a
DO %	100	100.8	99.6	1	100	99.5	1
DO (mg/L)	8.55	8.64	8.56	1	8.73	8.74	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	23	23	n/a	Ambient	21.82	n/a
EC Temp (degC)	24	23.83	23.83	1	22.4	22.5	1
EC	1.408	1.35	1.408	1	1.408	1.362	1
LCS EC	1.412	n/a	1.417	1	1.412	1.382	1
pH 4.0	4	4	4	1	4	4.01	1
pH 7.0	7	7.01	7	1	7	7.03	1
pH 10.0	10	10.02	10	1	10	10.02	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4	1
LCS pH 7.0	7	n/a	7	1	7	6.99	1
LCS pH 10.01	10.01	n/a	10.01	1	10.01	10.01	1
ORP	232.60	230	231.9	1	234.33	231.8	1
Turbidity 0 NTU	0	-0.1	0	1	0	0.3	1
Turbidity 40 NTU	40	43.7	40	1	40	39.9	1
Turbidity 200 NTU	200	196.2	200	1	200	179.3	1
Chla	≤0	-2.5	-2.5	1	≤0	-3.3	1
Flr	≤0	-0.6	-0.6	1	≤0	-0.8	1

September 18 to October 2, 2007

15 minute measurements with YSI Sonde 6600: #16

Notebook reference: F15P70, 74

The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed and 3/16 stainless cable used with a padlock to secure to bridge pillion. It was submerged to about 1-2 feet below the water surface. On July 19 the sonde was swapped out when it was noticed that the DO charge was higher than normal. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.324	0	1	0	0.028	1
Pressure (mmHg)	n/a	760	760	n/a	n/a	759.8	n/a
DO %	100	101.5	100	1	100	99.5	1
DO (mg/L)	8.59	8.72	8.6	1	8.84	8.8	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	22.92	22.92	n/a	Ambient	21.42	n/a
EC Temp (degC)	22.9	22.8	22.81	1	22.5	22.78	1
EC	1.408	1.366	1.408	1	1.408	1.419	1
LCS EC	1.412	n/a	1.404	1	1.412	1.392	1
pH 4.0	4	4.06	4	1	4	4.02	1
pH 7.0	7	6.99	7	1	7	6.98	1
pH 10.0	10	10	10	1	10	10.02	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.02	1
LCS pH 7.0	7	n/a	6.99	1	7	6.97	1
LCS pH 10.01	10.01	n/a	10.01	1	10.01	10.04	1
ORP	233.93	232.8	233.9	1	233.97	232	1
Turbidity 0 NTU	0	-0.1	0	1	0	0	1
Turbidity 40 NTU	40	42.8	40	1	40	39.4	1
Turbidity 200 NTU	200	181.3	200	1	200	198.5	1
Chla	≤0	-0.8	0	1	≤0	-3.3	1
Flr	≤0	-0.2	0	1	≤0	-0.8	1

MudSlough near Gustine DO-18

June 26 to July 12, 2007
15 minute measurements with YSI Sonde 6600: #13
Notebook reference: F12P141,144
The instrument was deployed in a black PVC housing. The SONDE was attached to the bridge over Mud Slough at the USGS monitoring site in SLNWR and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	34.096	0	1	0	0.157	1
Pressure (mmHg)	n/a	761.3	761.3	n/a	n/a	761.8	n/a
DO %	100	97.5	100.2	1	100	99.9	1
DO (mg/L)	8.67	8.44	8.64	1	8.83	8.82	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	22.48	22.55	n/a	Ambient	21.61	n/a
EC Temp (degC)	23.5	23.93	23.9	1	22	22.09	1
EC	1.408	1.415	1.408	1	1.408	1.408	1
LCS EC	1.412	n/a	1.403	1	1.412	1.388	1
pH 4.0	4	4.07	4	1	4	4.05	1
pH 7.0	7	7.04	7	1	7	6.97	1
pH 10.0	10	10.01	10	1	10	9.98	1
LCS pH 4.01	4.01	n/a	4.07	1	4.01	4.03	1
LCS pH 7.0	7	n/a	6.91	1	7	7	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	10	1
ORP	232.51	208.9	232.5	1	234.87	234.4	1
Turbidity 0 NTU	0	5.4	0	1	0	1.2	1
Turbidity 40 NTU	40	44.2	40	1	40	34	1
Turbidity 200 NTU	200	195.2	200	1	200	194.1	1
Chla	≤0	-3	-2.9	1	≤0	-3.6	1
Flr	≤0	-0.6	-0.8	1	≤0	-0.9	1

July 12 to July 24, 2007

15 minute measurements with YSI Sonde 6600: #15

Notebook reference: F14P33-35,74

The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	34.14	0	1	0	-0.194	1
Pressure (mmHg)	n/a	761.2	761.2	n/a	n/a	756.9	n/a
DO %	100	96.3	100.2	1	100	98.1	1
DO (mg/L)	8.75	8.41	8.75	1	8.76	8.63	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	22.07	22.07	n/a	Ambient	21.68	n/a
EC Temp (degC)	21.7	22.06	22.05	1	20.8	21.21	1
EC	1.408	1.445	1.408	1	1.408	1.348	1
LCS EC	1.412	n/a	1.351	1	1.412	1.333	1
pH 4.0	4	4.08	4	1	4	4.15	1
pH 7.0	7	6.95	7	1	7	7.06	1
pH 10.0	10	10.09	10.02	1	10	10.09	1
LCS pH 4.01	4.01	n/a	4.05	1	4.01	4.15	1
LCS pH 7.0	7	n/a	7	1	7	7.12	1
LCS pH 10.01	10.01	n/a	9.99	1	10.01	10.1	1
ORP	234.92	213.4	234.9	1	236.01	233.6	1
Turbidity 0 NTU	0	3.4	0	1	0	-0.1	1
Turbidity 40 NTU	40	35.1	40	1	40	43.1	1
Turbidity 200 NTU	200	288.9	199.9	1	200	179.1	1
Chla	≤0	-3.4	-3.6	1	≤0	-2.6	1
Flr	≤0	-0.8	-0.8	1	≤0	-0.7	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #11
Notebook reference: F14P62,112
The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.051	0	1	0	0.125	1
Pressure (mmHg)	n/a	759.5	759.5	n/a	n/a	758.6	n/a
DO %	100	111	99.9	1	100	101.9	1
DO (mg/L)	8.59	9.56	8.56	1	8.93	9.11	1
DO Charge	25-75	64.5	63.5	1	25-75	61.4	1
Wet towel Temp (degC)	Ambient	22.84	22.89	n/a	Ambient	20.84	n/a
EC Temp (degC)	23.3	23.1	23.03	1	21.5	21.41	1
EC	1.408	1.4	1.408	1	1.408	1.42	1
LCS EC	1.412	n/a	1.405	1	1.412	1.389	1
pH 4.0	4	4.06	4	1	4	4.08	1
pH 7.0	7	6.98	7	1	7	6.96	1
pH 10.0	10	9.98	10	1	10	9.96	1
LCS pH 4.01	4.01	n/a	3.99	1	4.01	4.07	1
LCS pH 7.0	7	n/a	6.96	1	7	6.92	1
LCS pH 10.01	10.01	n/a	9.94	1	10.01	9.94	1
ORP	233.64	233.3	233.6	1	235.75	233.7	1
Turbidity 0 NTU	0	0.2	0	1	0	-0.3	1
Turbidity 40 NTU	40	40.8	40.1	1	40	38.7	1
Turbidity 200 NTU	200	192.2	200	1	200	192.5	1
Chla	≤0	-2.5	-2.9	1	≤0	-2.2	1
Flr	≤0	-0.4	-0.7	1	≤0	-0.5	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #4
Notebook reference: F14P98
The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.25	0	1	0	-0.302	1
Pressure (mmHg)	n/a	762.1	762.1	n/a	n/a	753.7	n/a
DO %	100	95.8	100.3	1	100	107.4	1
DO (mg/L)	8.80	8.38	8.8	1	8.74	9.43	1
DO Charge	25-75	43.1	42	1	25-75	35.9	1
Wet towel Temp (degC)	Ambient	21.81	21.81	n/a	Ambient	21.6	n/a
EC Temp (degC)	21.9	21.98	21.97	1	22.4	22.22	1
EC	1.408	1.38	1.408	1	1.408	1.392	1
LCS EC	1.412	n/a	1.357	1	1.412	1.362	1
pH 4.0	4	3.96	4	1	4	4.09	1
pH 7.0	7	6.97	7	1	7	7.01	1
pH 10.0	10	10.07	10.01	1	10	9.99	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.08	1
LCS pH 7.0	7	n/a	6.97	1	7	7.01	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.93	1
ORP	235.02	233.2	235	1	234.70	232.8	1
Turbidity 0 NTU	0	0.3	0	1	0	0.1	1
Turbidity 40 NTU	40	45.7	40	1	40	39.4	1
Turbidity 200 NTU	200	193.3	199.6	1	200	197.1	1
Chla	≤0	-0.5	-0.8	1	≤0	-1	1
Flr	≤0	-0.1	-0.2	1	≤0	-0.2	1

August 21 to September 4, 2007
15 minute measurements with YSI Sonde 6600: #13
Notebook reference: F14P136,138
The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.22	0	1	0	-0.114	1
Pressure (mmHg)	n/a	760.9	760.9	n/a	n/a	755.9	n/a
DO %	100	98.5	100.1	1	100	100.9	1
DO (mg/L)	8.44	8.29	8.46	1	9.13	9.26	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	23.91	23.91	n/a	Ambient	19.52	n/a
EC Temp (degC)	25	n/a	n/a	n/a	21.5	21.45	1
EC	1.408	1.452	1.408	1	1.408	1.356	1
LCS EC	1.412	n/a	1.377	1	1.412	1.367	1
pH 4.0	4	4.11	4	1	4	4.13	1
pH 7.0	7	6.95	7	1	7	6.97	1
pH 10.0	10	10.02	10	1	10	10.08	1
LCS pH 4.01	4.01	n/a	4	1	4.01	3.97	1
LCS pH 7.0	7	n/a	6.98	1	7	7.02	1
LCS pH 10.01	10.01	n/a	9.94	1	10.01	10.01	1
ORP	n/a	n/a	n/a	n/a	235.70	233.8	1
Turbidity 0 NTU	0	0.7	0	1	0	-0.5	1
Turbidity 40 NTU	40	42.6	40	1	40	38.4	1
Turbidity 200 NTU	200	194.6	200	1	200	206.3	1
Chla	≤0	-2.2	0.1	1	≤0	0.1	1
Flr	≤0	-0.7	0	1	≤0	0	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #4
Notebook reference: F15P30,33
The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.141	0	1	0	-0.072	1
Pressure (mmHg)	n/a	757.2	757.2	n/a	n/a	756.7	n/a
DO %	100	85.5	99.6	1	100	96.5	1
DO (mg/L)	8.62	7.4	8.63	1	8.80	8.55	1
DO Charge	25-75	38	38	1	25-75	38	1
Wet towel Temp (degC)	Ambient	22.51	22.52	n/a	Ambient	21.43	n/a
EC Temp (degC)	23.8	23.69	23.69	1	22.2	22.25	1
EC	1.408	1.38	1.408	1	1.408	1.358	1
LCS EC	1.412	n/a	1.409	1	1.412	1.356	1
pH 4.0	4	4.02	4	1	4	4.07	1
pH 7.0	7	6.95	7	1	7	7	1
pH 10.0	10	10.04	10	1	10	10.02	1
LCS pH 4.01	4.01	n/a	4.03	1	4.01	4.07	1
LCS pH 7.0	7	n/a	7.01	1	7	6.98	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.99	1
ORP	232.78	232.9	231.9	1	234.66	231.6	1
Turbidity 0 NTU	0	-1.3	0	1	0	0.2	1
Turbidity 40 NTU	40	40.9	40	1	40	40.9	1
Turbidity 200 NTU	200	202	200	1	200	180.9	1
Chla	≤0	-0.6	-0.6	1	≤0	-1.8	1
Flr	≤0	-0.1	-0.1	1	≤0	-0.4	1

September 18 to October 2, 2007
15 minute measurements with YSI Sonde 6600: #5
Notebook reference: F15P68, 73
The instrument was deployed in a black PVC housing. The SONDE was suspended from bridge and a 3/16 stainless cable used with a padlock to secure to bridge railing. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.14	-0.001	1	0	0.086	1
Pressure (mmHg)	n/a	761.4	761.4	n/a	n/a	761.2	n/a
DO %	100	106.7	100.2	1	100	102.2	1
DO (mg/L)	8.65	9.21	8.65	1	8.72	8.89	1
DO Charge	25-75	65.5	65.5	1	25-75	51.2	1
Wet towel Temp (degC)	Ambient	22.65	22.65	n/a	Ambient	22.23	n/a
EC Temp (degC)	22.8	22.85	22.85	1	23.5	23.5	1
EC	1.408	1.374	1.408	1	1.408	1.419	1
LCS EC	1.412	n/a	1.414	1	1.412	1.395	1
pH 4.0	4	3.97	4	1	4	4.06	1
pH 7.0	7	7.01	7	1	7	7.01	1
pH 10.0	10	10.04	10.01	1	10	10.03	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4.05	1
LCS pH 7.0	7	n/a	7	1	7	6.99	1
LCS pH 10.01	10.01	n/a	9.99	1	10.01	9.99	1
ORP	233.88	233.8	233.9	1	233.03	232.4	1
Turbidity 0 NTU	0	1.4	0	1	0	-1.5	1
Turbidity 40 NTU	40	39.9	40	1	40	39.6	1
Turbidity 200 NTU	200	189.4	200	1	200	200.8	1
Chla	≤0	-0.3	0	1	≤0	0	1
Flr	≤0	-0.1	0	1	≤0	0	1

DO-19 Salt slough at Lander Ave.

June 12, 2007 to June 26, 2007
Notebook Reference: F12P106,109,112,150
15 minute measurements with YSI Sonde 6600: #3
The instrument was deployed in one of our custom 4"PVC pipe housings for added protection. The SONDE plus housing was attached with a 3/16" steel cable and padlocked at arms length under the water surface to stakes which had previously been secured into the stream bed to support the existing USGS monitoring station sensor. Upon retrieval of the SONDE, the instrument was found exactly where it was left.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	-0.155	0	1	0	0.198	1
Pressure (mmHg)	n/a	757.3	757.2	n/a	n/a	761.7	n/a
DO %	100	87.1	99.6	1	100	105.1	1
DO (mg/L)	8.94	7.79	8.95	1	8.94	9.38	1
DO Charge	25-75	54.3	53.3	1	25-75	43.1	1
Wet towel Temp (degC)	Ambient	20.59	20.64	n/a	Ambient	20.97	n/a
EC Temp (degC)	22	21.75	21.75	1	22.4	22.15	1
EC	1.408	1.442	1.408	1	1.408	1.367	1
LCS EC	1.412	n/a	1.372	1	1.412	1.343	1
pH 4.0	4	4.09	4	1	4	4.05	1
pH 7.0	7	6.96	7	1	7	6.91	1
pH 10.0	10	10.05	10.01	1	10	10	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.05	1
LCS pH 7.0	7	n/a	6.88	1	7	6.85	1
LCS pH 10.01	10.01	n/a	10.04	1	10.01	10.01	1
ORP	235.31	233.9	235.3	1	234.79	229.2	1
Turbidity 0 NTU	0	-0.4	0	1	0	0.4	1
Turbidity 40 NTU	40	41.5	40	1	40	40.2	1
Turbidity 200 NTU	200	207.8	199.6	1	200	193.5	1
Chla	≤0	-1.6	-1.8	1	≤0	-1.4	1
Flr	≤0	-0.3	-0.5	1	≤0	-0.4	1

June 26 to July 10, 2007
15 minute measurements with YSI Sonde 6600: #11
Notebook reference: F12P142,144
The instrument was deployed in a black PVC housing. The SONDE was attached to the stake in the riverbed at the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.222	0	1	0	0.115	1
Pressure (mmHg)	n/a	761	761	n/a	n/a	761.2	n/a
DO %	100	98.6	100.1	1	100	103.3	1
DO (mg/L)	8.68	8.54	8.68	1	8.86	9.13	1
DO Charge	25-75	52.3	51.2	1	25-75	54.3	1
Wet towel Temp (degC)	Ambient	22.41	22.46	n/a	Ambient	21.41	n/a
EC Temp (degC)	22.5	23.02	23.01	1	21.9	22.14	1
EC	1.408	1.377	1.408	1	1.408	1.422	1
LCS EC	1.412	n/a	1.382	1	1.412	1.404	1
pH 4.0	4	3.96	4	1	4	4.11	1
pH 7.0	7	7.01	7	1	7	7.06	1
pH 10.0	10	10.04	10.01	1	10	10.02	1
LCS pH 4.01	4.01	n/a	4.03	1	4.01	4.13	1
LCS pH 7.0	7	n/a	6.87	1	7	7.02	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	9.96	1
ORP	233.67	231	233.7	1	234.80	233.5	1
Turbidity 0 NTU	0	-1	0	1	0	-0.3	1
Turbidity 40 NTU	40	36.8	39.9	1	40	34.9	1
Turbidity 200 NTU	200	203.9	200.2	1	200	203.9	1
Chla	≤0	-1.5	-2.2	1	≤0	-1.3	1
Flr	≤0	-0.3	-0.5	1	≤0	-0.3	1

July 10 to July 24, 2007
15 minute measurements with YSI Sonde 6600: #4
Notebook reference: F14P21-23,72
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.017	0	1	0	0.047	1
Pressure (mmHg)	n/a	757.6	757.6	n/a	n/a	757.4	n/a
DO %	100	112.5	99.7	1	100	99	1
DO (mg/L)	8.87	10.02	8.87	1	8.90	8.84	1
DO Charge	25-75	40	40	1	25-75	38	1
Wet towel Temp (degC)	Ambient	21.07	21.08	n/a	Ambient	20.91	n/a
EC Temp (degC)	21	21.15	21.15	1	20.6	21	1
EC	1.408	1.424	1.408	1	1.408	1.332	1
LCS EC	1.412	n/a	1.31	1	1.412	1.293	1
pH 4.0	4	4.08	4	1	4	3.93	1
pH 7.0	7	6.98	7	1	7	6.89	1
pH 10.0	10	10.02	10	1	10	9.89	1
LCS pH 4.01	4.01	n/a	4.08	1	4.01	3.95	1
LCS pH 7.0	7	n/a	6.98	1	7	6.89	1
LCS pH 10.01	10.01	n/a	9.97	1	10.01	9.85	1
ORP	236.09	234.5	236.1	1	236.29	235.2	1
Turbidity 0 NTU	0	-0.2	0	1	0	-0.6	1
Turbidity 40 NTU	40	32.9	40	1	40	45.6	1
Turbidity 200 NTU	200	218.4	200	1	200	199.5	1
Chla	≤0	-1.8	-1.1	1	≤0	-0.2	1
Flr	≤0	-0.2	-0.2	1	≤0	-0.1	1

July 24 to August 7, 2007
15 minute measurements with YSI Sonde 6600: #10
Notebook reference: F14P62,111
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.102	0	1	0	0.137	1
Pressure (mmHg)	n/a	759.1	759	n/a	n/a	759	n/a
DO %	100	91.8	99.9	1	100	102.2	1
DO (mg/L)	8.78	8.1	8.79	1	9.05	9.26	1
DO Charge	25-75	46.1	46.1	1	25-75	45.1	1
Wet towel Temp (degC)	Ambient	21.55	21.68	n/a	Ambient	20.17	n/a
EC Temp (degC)	22.9	22.79	22.8	1	21.5	21.51	1
EC	1.408	1.386	1.408	1	1.408	1.45	1
LCS EC	1.412	n/a	1.379	1	1.412	1.363	1
pH 4.0	4	3.95	4	1	4	3.99	1
pH 7.0	7	7.02	7	1	7	6.91	1
pH 10.0	10	10.02	10.01	1	10	9.92	1
LCS pH 4.01	4.01	n/a	4	1	4.01	3.97	1
LCS pH 7.0	7	n/a	6.99	1	7	6.85	1
LCS pH 10.01	10.01	n/a	9.94	1	10.01	9.87	1
ORP	233.94	231.6	233.9	1	235.62	236.4	1
Turbidity 0 NTU	0	-0.3	0	1	0	0.5	1
Turbidity 40 NTU	40	46	40	1	40	42.5	1
Turbidity 200 NTU	200	188.6	200	1	200	187.3	1
Chla	≤0	-0.7	-0.6	1	≤0	0	1
Flr	≤0	-0.2	-0.1	1	≤0	0	1

August 7 to August 21, 2007
15 minute measurements with YSI Sonde 6600: #12
Notebook reference: F14P99
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.226	0	1	0	-0.322	1
Pressure (mmHg)	n/a	761.7	761.7	n/a	n/a	753.3	n/a
DO %	100	99.7	100.1	1	100	100	1
DO (mg/L)	8.91	8.86	8.9	1	8.81	8.89	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	21.13	21.13	n/a	Ambient	21.16	n/a
EC Temp (degC)	21.3	21.38	21.38	1	22.4	22.14	1
EC	1.408	1.43	1.408	1	1.408	1.39	1
LCS EC	1.412	n/a	1.368	1	1.412	1.354	1
pH 4.0	4	4.09	4	1	4	4.16	1
pH 7.0	7	7	7	1	7	7.02	1
pH 10.0	10	10	10	1	10	10.01	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.15	1
LCS pH 7.0	7	n/a	6.93	1	7	7.05	1
LCS pH 10.01	10.01	n/a	9.95	1	10.01	9.99	1
ORP	235.79	231.6	235.8	1	234.80	232.1	1
Turbidity 0 NTU	0	0.1	0	1	0	0.5	1
Turbidity 40 NTU	40	46.5	40	1	40	41.3	1
Turbidity 200 NTU	200	189.4	200	1	200	200	1
Chla	≤0	-2.6	-2.9	1	≤0	-2.7	1
Flr	≤0	-0.6	-0.6	1	≤0	-0.7	1

August 21 to September 4, 2007
15 minute measurements with YSI Sonde 6600: #5
Notebook reference: F14P133,138
The instrument was deployed in a black PVC housing. The SONDE was attached to a take in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.192	0	1	0	-0.195	1
Pressure (mmHg)	n/a	761.7	761.7	n/a	n/a	753.7	n/a
DO %	100	106.6	100.2	1	100	105.3	1
DO (mg/L)	8.46	8.98	8.46	1	8.89	n/a	1
DO Charge	25-75	47.1	47.1	1	25-75	n/a	1
Wet towel Temp (degC)	Ambient	23.82	23.85	n/a	Ambient	20.66	n/a
EC Temp (degC)	24.4	24.11	24.45	1	20.7	20.66	1
EC	1.408	1.392	1.408	1	1.408	1.376	1
LCS EC	1.412	n/a	1.4	1	1.412	1.349	1
pH 4.0	4	4.04	4	1	4	3.95	1
pH 7.0	7	6.96	7	1	7	6.96	1
pH 10.0	10	10.04	10.01	1	10	10.03	1
LCS pH 4.01	4.01	n/a	4.01	1	4.01	3.98	1
LCS pH 7.0	7	n/a	6.99	1	7	6.97	1
LCS pH 10.01	10.01	n/a	9.94	1	10.01	10.02	1
ORP	231.79	229.4	231.8	1	236.72	238.1	1
Turbidity 0 NTU	0	0.5	0	1	0	-0.2	1
Turbidity 40 NTU	40	38.1	39.9	1	40	38.1	1
Turbidity 200 NTU	200	169.9	199.9	1	200	196.9	1
Chla	≤0	0.2	-0.5	1	≤0	-0.5	1
Flr	≤0	0	-0.1	1	≤0	0	1

September 4 to September 18, 2007
15 minute measurements with YSI Sonde 6600: #6
Notebook reference: F15P31,33
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.057	0	1	0	-0.277	0
Pressure (mmHg)	n/a	757	757	n/a	n/a	756.5	n/a
DO %	100	100.6	99.6	1	100	99.7	1
DO (mg/L)	8.63	8.72	8.64	1	8.75	8.81	1
DO Charge	25-75	57.4	58.4	1	25-75	72.7	1
Wet towel Temp (degC)	Ambient	22.43	22.44	n/a	Ambient	21.72	n/a
EC Temp (degC)	23.4	24.4	24.4	1	22.5	22.5	1
EC	1.408	1.377	1.408	1	1.408	1.344	1
LCS EC	1.412	n/a	1.409	1	1.412	1.341	1
pH 4.0	4	4.09	4	1	4	4.02	1
pH 7.0	7	6.97	7	1	7	6.93	1
pH 10.0	10	10.04	10	1	10	9.92	1
LCS pH 4.01	4.01	n/a	4	1	4.01	4	1
LCS pH 7.0	7	n/a	7	1	7	6.91	1
LCS pH 10.01	10.01	n/a	10	1	10.01	9.92	1
ORP	231.85	230.5	231.9	1	234.33	232.9	1
Turbidity 0 NTU	0	-0.5	0	1	0	0.4	1
Turbidity 40 NTU	40	40.2	40	1	40	41	1
Turbidity 200 NTU	200	202.8	200	1	200	183	1
Chla	≤0	0	0	1	≤0	-1.3	1
Flr	≤0	0	0	1	≤0	-0.4	1

September 18 to October 2, 2007
15 minute measurements with YSI Sonde 6600: #11
Notebook reference: F15P70, 73
The instrument was deployed in a black PVC housing. The SONDE was attached to a stake in the riverbed near the USGS monitoring site and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. Upon retrieval of the SONDE, the instrument was found exactly where it was left, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	0.095	0	1	0	0	1
Pressure (mmHg)	n/a	760.9	761	n/a	n/a	759.9	n/a
DO %	100	95.1	100.1	1	100	107.3	1
DO (mg/L)	8.63	8.2	8.63	1	8.74	9.37	1
DO Charge	25-75	41	41	1	25-75	33.9	1
Wet towel Temp (degC)	Ambient	22.74	22.75	n/a	Ambient	22	n/a
EC Temp (degC)	22.7	22.75	22.73	1	22.5	22.88	1
EC	1.408	1.335	1.408	1	1.408	1.418	1
LCS EC	1.412	n/a	1.397	1	1.412	1.401	1
pH 4.0	4	4.02	4	1	4	4.02	1
pH 7.0	7	6.99	7	1	7	7	1
pH 10.0	10	10.02	10	1	10	10	1
LCS pH 4.01	4.01	n/a	4.01	1	4.01	4.03	1
LCS pH 7.0	7	n/a	6.96	1	7	6.95	1
LCS pH 10.01	10.01	n/a	9.96	1	10.01	9.97	1
ORP	234.03	233.5	234	1	233.84	232.1	1
Turbidity 0 NTU	0	0.1	0	1	0	0	1
Turbidity 40 NTU	40	41.7	40.1	1	40	41.2	1
Turbidity 200 NTU	200	177.9	200.4	1	200	209.4	1
Chla	≤0	1.1	0	1	≤0	-2.8	1
Flr	≤0	0.2	0	1	≤0	-0.8	1

DO-44 San Luis Drain End

June 12, 2007 to June 26, 2007
15 minute measurements with YSI Sonde 6600: #12
Notebook reference: F12P146,152
The instrument was deployed in a black PVC housing. The SONDE was attached to the platform above the weir structure and the end of the drain and secured with a cable and padlock. It was submerged to about 1-2 feet below the water surface. At 2pm on June 16 the sonde was swept over the weir and dangled in the spill until discovered at 9:30 on June 21. Data during this period is meaningless, data was removed for purpose of graphing and statistics. Upon retrieval of the SONDE, the instrument was found exactly where it was left on the 21st, with the instrument still submerged.

QA/QC	Standard Value Pre Deploy	Pre-Calibration Reading	Post-Calibration Reading	Pass/Fail (+/- 20%) 1=pass 0=fail	Standard Value Post Deploy	Post-Deploy Reading	Pass/Fail (+/- 20%) 1=pass 0=fail
Depth (ft)	0	33.905	0	1	0	0.191	1
Pressure (mmHg)	n/a	756.9	756.7	n/a	n/a	760.8	n/a
DO %	100	92.6	99.5	1	100	95.9	1
DO (mg/L)	8.74	8.15	8.74	1	8.91	8.53	1
DO Charge	25-75	n/a	n/a	n/a	25-75	n/a	n/a
Wet towel Temp (degC)	Ambient	21.68	21.76	n/a	Ambient	21.08	n/a
EC Temp (degC)	22.1	22.08	22.08	1	21.8	22.23	1
EC	1.408	1.464	1.408	1	1.408	1.326	1
LCS EC	1.412	n/a	1.408	1	1.412	1.329	1
pH 4.0	4	3.99	4	1	4	4.17	1
pH 7.0	7	7.07	7	1	7	7.08	1
pH 10.0	10	10.03	10	1	10	10.12	1
LCS pH 4.01	4.01	n/a	4.04	1	4.01	4.17	1
LCS pH 7.0	7	n/a	7	1	7	6.99	1
LCS pH 10.01	10.01	n/a	9.9	1	10.01	10.1	1
ORP	234.88	214	234.8	1	234.68	231.5	1
Turbidity 0 NTU	0	5.8	0	1	0	0.3	1
Turbidity 40 NTU	40	45.8	40	1	40	35.3	1
Turbidity 200 NTU	200	182.7	200	1	200	187.4	1
Chla	≤0	-2.7	-2	1	≤0	-3.9	1
Flr	≤0	-0.6	-0.6	1	≤0	-0.9	1

Appendix O

2007 San Luis Drain Shutoff Study

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March 2008

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Introduction

The Environmental Engineering Research Program (EERP) at the University of the Pacific (UOP) is the lead scientific agency on several water quality and ecosystem restoration projects focused on understanding and improving water quality in the San Joaquin River (SJR). EERP projects include the development of a mass balance on phytoplankton and oxygen demanding materials in the SJR, evaluation of organic carbon sources and fate in the SJR, studies of wetland ecosystems, and studies examining the impact of current agricultural best management practices (BMPs) on water quality. For all of these projects, water quality and water flow must be measured at numerous locations throughout the watershed (Figure 1). One of these locations, San Luis Drain (SLD), was studied during a flow shutoff event to determine the effect of changes in water quality to the SJR.

The San Luis Drain conveys agricultural drainage for about 25 miles from the Grassland Area to Mud Slough (Figure 2). The drainage canal is part of the Grasslands Bypass Project and average summer flows are now about 20 to 25 cubic feet per second (CFS). The primary objective of this experiment was to test the predictive abilities of the San Joaquin River WARMF model to determine what contribution the SLD has to the algae load downstream. Through a coordinated effort by the San Joaquin Valley Drainage Authority, the Grassland Area Farmers, and the Panoche Drainage District, exit flows from the SLD were shutoff by placing boards in each of 16 flow check points and re-circulating upstream farm runoff. The shutoff started on July 23, 2007 and ended on July 26, 2007.

Initial model simulations predicted that a seven day shutoff of the SLD would show a marked decrease in algae loading downstream. If the algae inoculum load from the SLD were removed then an unlimited growth model would predict exponential differences between downstream monitoring points. Such differences were not observed in the data, nor was it obvious that the SLD shut off showed any downstream effect on algae load or concentration.

The EERP collected continuous 15 minute monitoring data from several YSI 6600 sonde multiparameter instruments located at various points above and below the confluence of the SLD with the San Joaquin River. Sondes were deployed from July 10, 2007 to August 21, 2007 for two weeks at a time with instrument exchanges on July 24, 2007 and August 07, 2007. Twice weekly grab samples were taken at 17 sites (Table 1) before, during, and after the shutoff period from July 17, 2007 to August 9, 2007. These samples were taken back to the EERP water lab for further analysis.

Methods

The standard operating procedure (SOP) for deployment of continuously monitoring sonde equipment is described in detail in the EERP Field Protocol Book (Graham and Hanlon, 2008). Calibration, programming and sensor set up were conducted the day prior to deployment at the EERP lab following the SOP. Dissolved oxygen calibration was performed in the field on the day of deployment using the wet-towel method, a technique where the sonde is placed in a tube with a wet-towel around the sensors and calibrated in a water-saturated air environment. The sensor cleaning wiper was fitted with a longer extended deployment brush to better keep the sensors free of algae and debris over the two week period. Sondes were programmed to run unattended for the length of deployment, lasting two weeks, recording each parameter every 15 minutes. The parameters measured by the Sonde at each site include time, temperature (°C), electrical conductivity (mS/cm), total dissolved solids (g/L), dissolved oxygen (DO) percent, DO concentration (mg/L), DO charge, depth of measurement (ft), pH, turbidity (NTU), chlorophyll content (µg/L), chlorophyll-*a* fluorescence, and some instruments were set up to measure oxidation-reduction potential (mV). Upon conclusion of the deployment sondes were retrieved and placed into coolers to keep the membranes moist until post-calibration could be performed. Post-calibration was completed within twenty-four hours of deployment. After being post-calibrated sondes were cleaned with water, the DO membranes and batteries were changed, and the extended deploy wipers were removed (Graham and Hanlon, 2008).

At field sites, instruments were deployed in custom made PVC housings (Figure 3) for protection against vandalism, theft, and other damage. In general, the instruments in their housings were secured with cable to existing structures in the river. The location of our instrument for site DO-05 SJR at Vernalis was the DWR monitoring platform on the SJR near Vernalis, suspended by cable in its own housing (Figure 4). Sites DO-06 SJR at Maze (Figure 5) and DO-07 SJR at Patterson (Figure 6) were on the SJR at the pumping platforms for the El Solyo and Patterson Irrigation districts respectively. Site DO-08 SJR at Crows was on the SJR at the fishing dock of the Turlock Sportsman's club, also the site for other agencies' (DWR) monitoring (Figure 7). The furthest upstream site on the SJR was DO-10 SJR at Lander Ave, located under the Lander Ave. Bridge (Figure 8). This site required wading into the river and driving a fence post into the river bottom to anchor the instrument and housing. Site DO-18 Mud Slough near Gustine was on Mud Slough, the same location as the USGS flow monitoring station and immediately downstream of the confluence with the San Luis Drain (Figure 9). Here the instrument was hung from the middle of the small bridge over the slough. DO-19 Salt Slough at Lander Ave. was on Salt Slough at a USGS station (Figure 10). The instrument was attached to a fence post attached to the bottom of the slough.

Mud Slough receives the effluent from the San Luis Drain and was monitored approximately 1000 ft downstream of their confluence. This water then travels to the San Joaquin River where it enters between DO-08 Crows Landing and DO-10 SJR at Lander Ave. Salt Slough is another major tributary to the San Joaquin River between these monitoring points and so was monitored at DO-19 Salt Slough at Lander Ave. just upstream of its confluence with the SJR. Additional sites were monitored further downstream on the San Joaquin River at DO-07 SJR at Patterson, DO-06 SJR at Maze Blvd., and DO-05 SJR at Vernalis to gauge the effects of the SLD shutoff on the river.

Prior to the shutoff event over a two day period, from July 18 to July 19, 2007, staff from the Panoche Drainage District removed weir boards from several check stations along the drain. Boards were removed from selected checks within the SLD to drop the water level as much as possible, creating storage within the channel for the shutoff event. Weir boards were pulled from downstream to upstream and only in reaches long enough to provide significant storage. The board removal required a crew of four people, as the

10x4 and 8x4 boards were waterlogged and often stuck in place. At the start of the experiment on July 23, 2007, boards were added to all of the checks effectively blocking flow until each reach filled up and began to spill over the boards. The board levels in each check were set to allow approximately 25 CFS of spill before overtopping the channel lining. The boards were gradually returned to their normal settings during the first week of August.

Results and Discussion

A list of sites sampled during the San Luis Drain shutoff study is listed in Table 1. All of the sites were sampled twice a week from July 17, 2007 to August 9, 2007. Samples were collected before the actual drain shutoff to provide background water quality to compare changes along the river. Data was also collected after the flows increased in the drain to catch the water quality changes as they moved downstream. Water quality from other inputs to the San Joaquin River was collected as part of this experiment to provide input for the model.

Discharge from the SLD increased prior to the study on July 21, 2007 when the check boards were removed and storage from each reach was released. The flow reduction of the SLD began the morning of July 23, 2007 when flows dropped from 25 CFS to 10 CFS by noon and down to about 5 CFS by that evening. Flows continued to taper down to about 1 CFS over the next two days. On July 26, 2007 at about noon the SLD had filled to capacity and water began flowing over the last set of weir boards at Check 1, just upstream of the outlet structure. Flow remained steady at about 5 CFS until early July 27, 2007 when the original flow of about 25 CFS was restored. During the first week of August boards were returned to their normal settings by the canal operators. This was done gradually to prevent a large volume of water suddenly being released from the SLD.

Most of the continuous deployment sondes deployed in the field collected reliable data. The sonde at DO-05 SJR at Vernalis did not pass the post-deployment chlorophyll QA on August 7, 2007 due to a faulty chlorophyll probe. DWR had a sonde deployed at this site that was used to replace the low quality data. At DO-10 SJR at Lander Ave. one of the sondes had to be replaced on July 19, 2007 due to a faulty DO membrane and was replaced with a sonde equipped with an optical DO probe. On August 8, 2007 a fish was discovered in the sonde housing at this site. Fish and other organisms living in the housings caused peaks in the turbidity and chlorophyll data. Occasionally the sonde wipers would get fouled and cause wiper parking errors, where the wiper parks over the optical probe resulting in a falsely high reading. These low quality values were removed from the data before analysis.

References

Graham, J., Hanlon, J., 2008. EERP Field Standard Operating Procedures Protocol Book. Environmental Engineering Research Program, Stockton, CA.

Table 1: List of sites sampled during the San Luis Drain Shutoff Study.

Current DO Site Number	Sample Station Name	Latitude	Longitude
4	SJR at Mossdale	37.78710	-121.30757
5	SJR at Vernalis-McCune Station (River Club)	37.67936	-121.26504
6	SJR at Maze	37.64142	-121.22902
7	SJR at Patterson	37.49373	-121.08081
8	SJR at Crows Landing	37.43197	-121.01165
10	SJR at Lander Avenue	37.29424	-120.85125
12	Stanislaus River at Caswell Park	37.70160	-121.17719
14	Tuolumne River at Shiloh Bridge	37.60350	-121.13125
16	Merced River at River Road	37.35043	-120.96196
18	Mud Slough near Gustine	37.26250	-120.90555
19	Salt Slough at Lander Avenue	37.24795	-120.85194
21	Orestimba Creek at River Road	37.41396	-121.01488
28	Turlock ID Westport Drain Flow station	37.54196	-121.09408
29	Turlock ID Harding Drain	37.46427	-121.03093
30	Turlock ID Lateral 6 & 7 at Levee	37.39782	-120.97225
34	Ingram Creek	37.60026	-121.22506
36	Del Puerto Creek Flow Station	37.53947	-121.12206

Figure 1: Map of the study area and sampling locations.

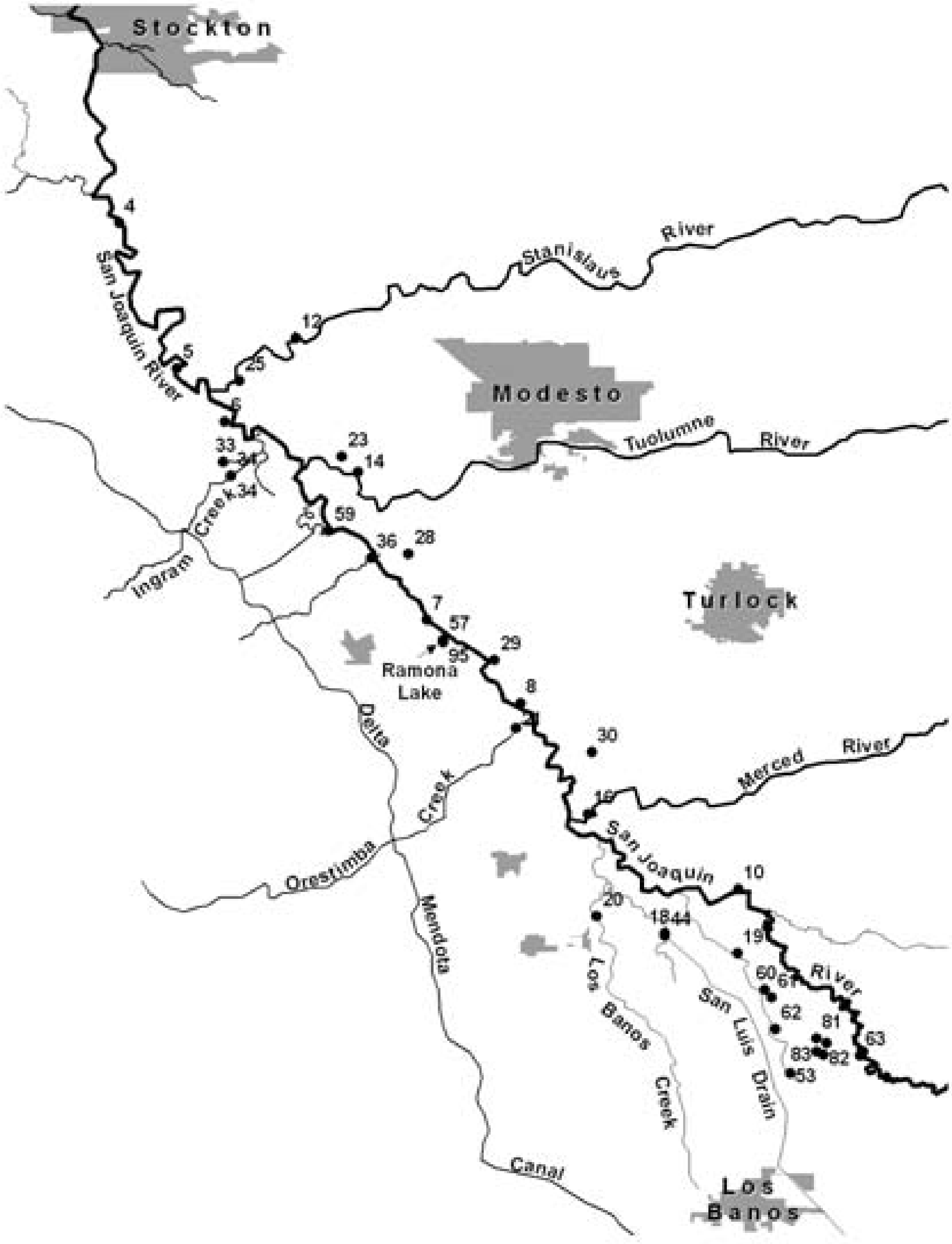


Figure 2: Map of the San Luis Drain located in the San Joaquin Valley of California. The San Luis Drain is a concrete lined channel that conveys agricultural drainage from farms in the south, past sensitive wetland areas, and discharges into the San Joaquin River via Mud Slough.

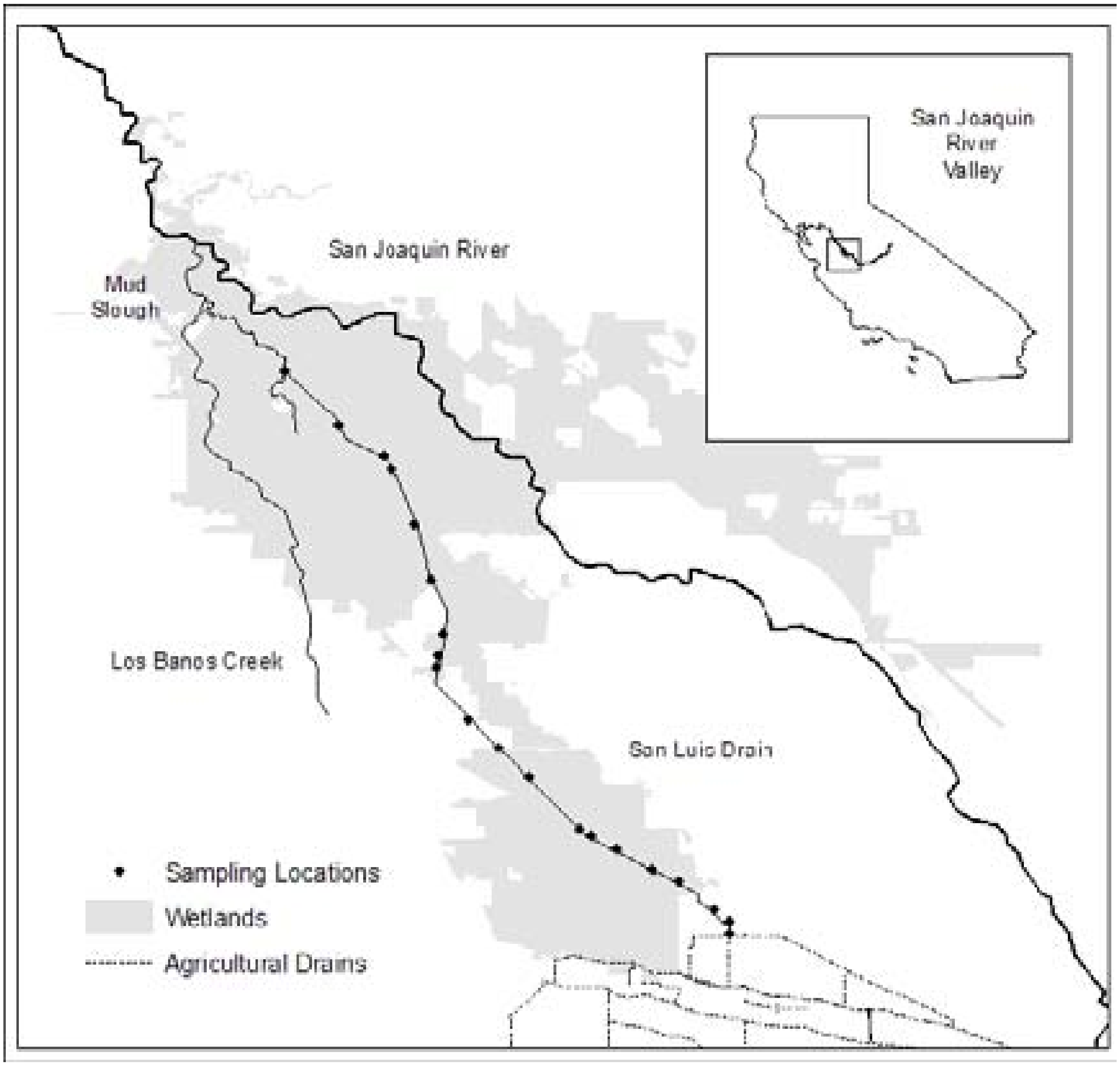


Figure 3: YSI Sonde 6600 with deployment housing.

Figure 4: View from DWR Vernalis platform DO-05 looking down at river and stilling wells.

Figure 5: El Solyo Water District intake structure on San Joaquin river, DO-06.

Figure 6: Patterson Irrigation District intake structure on San Joaquin river, DO-07.

Figure 7: Turlock Sportsmans club fishing dock, DO-08.

Figure 8: San Joaquin River at Lander Ave., DO-10.

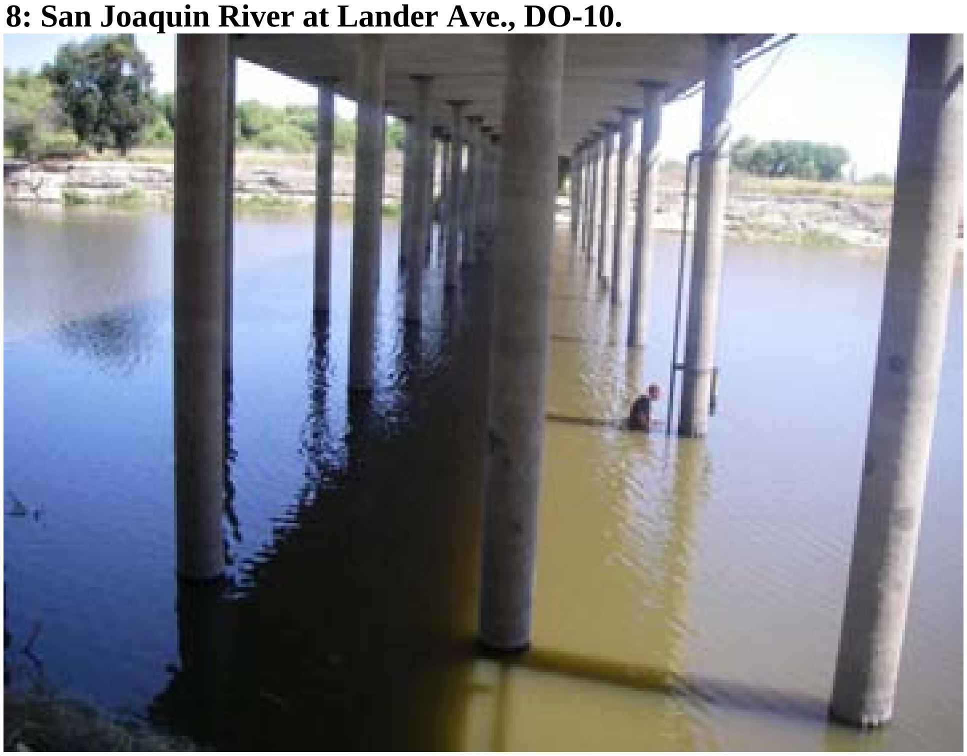


Figure 9: Mud Slough near Gustine, DO-18.

Figure 10: Salt Slough at Lander Ave., DO-19.

Figure 11: San Luis Drain terminus, DO-44.

Figure 12: Bridge across SLD about 200 ft upstream of End of Drain outfall (DO-44) Profile was done in middle of bridge.

Figure 13: Plot of chlorophyll fluorescence by depth for SLD end.

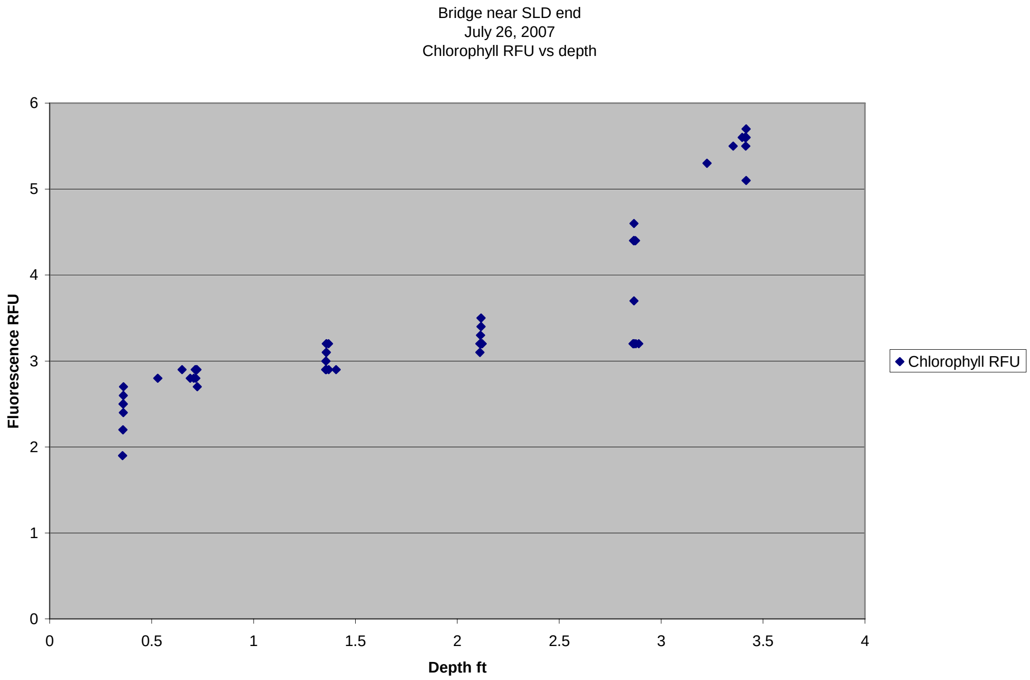


Figure 14: Check Station 1 had leaky boards, sonde profile was performed from wall near boards.

Figure 15: Check Station 1 had leaky boards, sonde profile was performed from wall near boards.

Figure 16: Chlorophyll fluorescence as a function of depth for SLD Check 1.

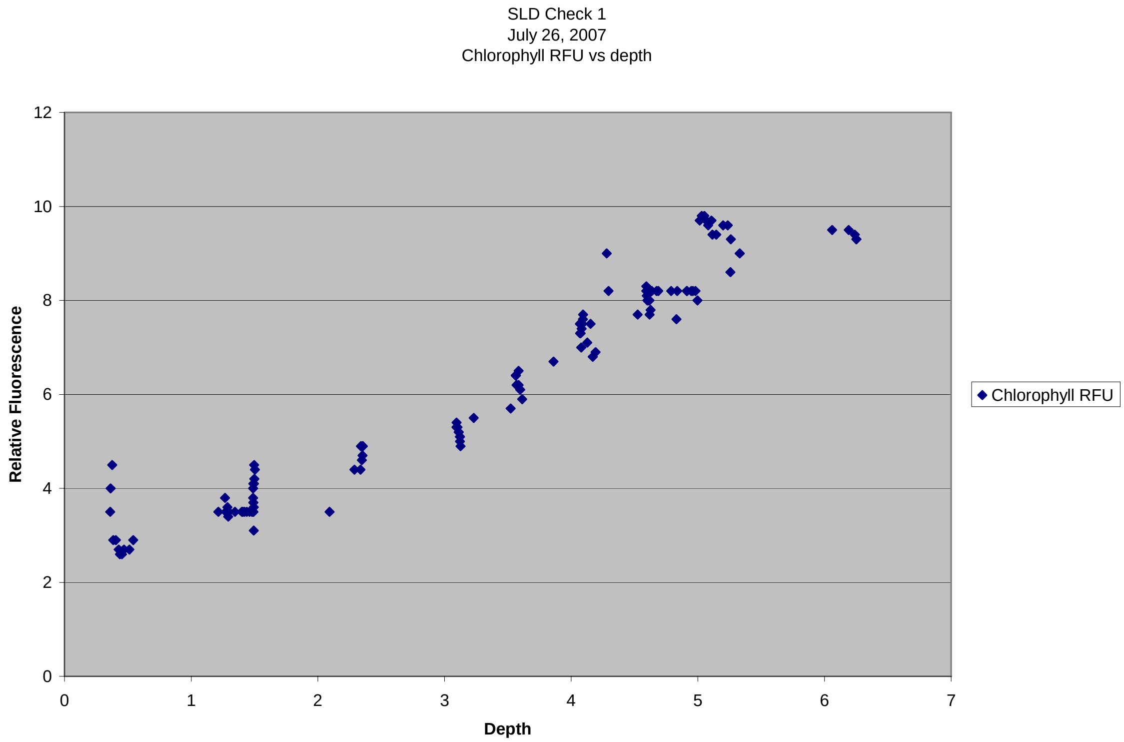


Figure 17: Check Station 2 water had begun to flow over the boards, sonde profile was done from platform where stilling well is located.

Figure 18: Check Station 2 water had begun to flow over the boards, sonde profile was done from platform where stilling well is located.

Figure 19: Plot of chlorophyll fluorescence as a function of depth for SLD Check 2.

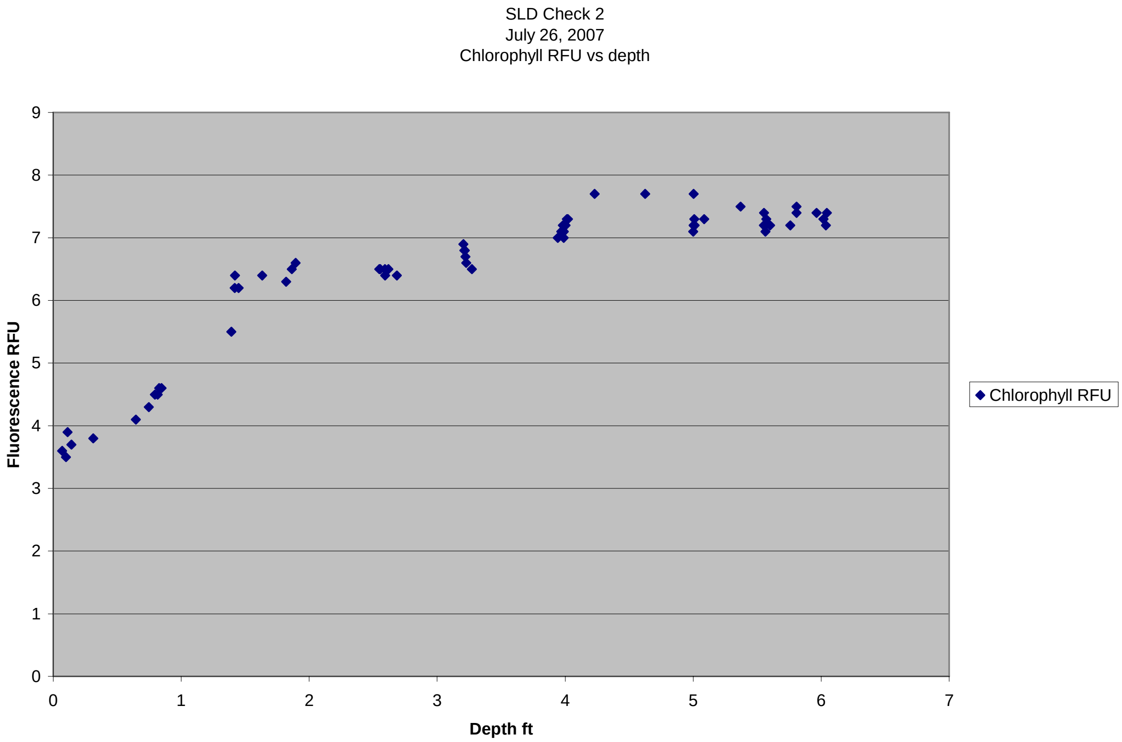


Figure 20: Check Station 3 water was flowing over boards, sonde profile was done from concrete bridge immediately in front of boards.

Figure 21: Check Station 3 water was flowing over boards, sonde profile was done from concrete bridge immediately in front of boards.

Figure 22: Check Station 3 plot of chlorophyll fluorescence as a function of depth.

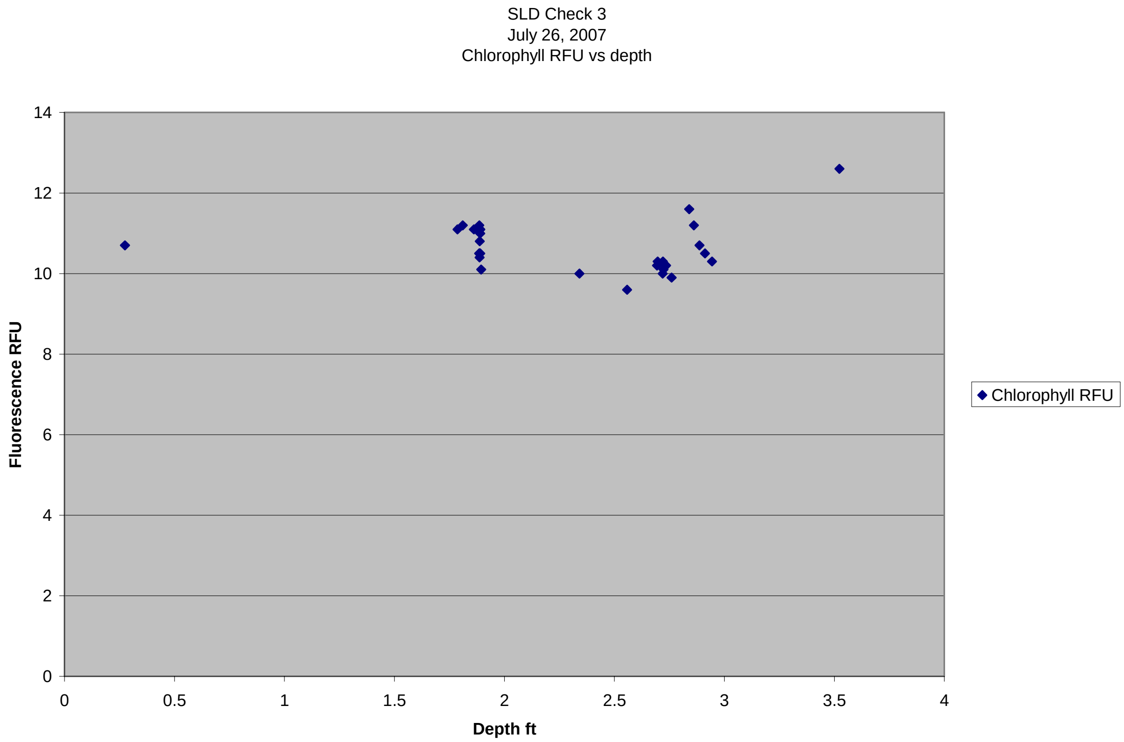


Figure 23: Check Station 4 water flowing over boards, sonde profile was performed from concrete bridge directly in front of weirboards.

Figure 24: Check Station 4 water flowing over boards, strong current made it difficult to keep instrument in place.

Figure 25: Check Station 4 chlorophyll fluorescence as a function of depth.

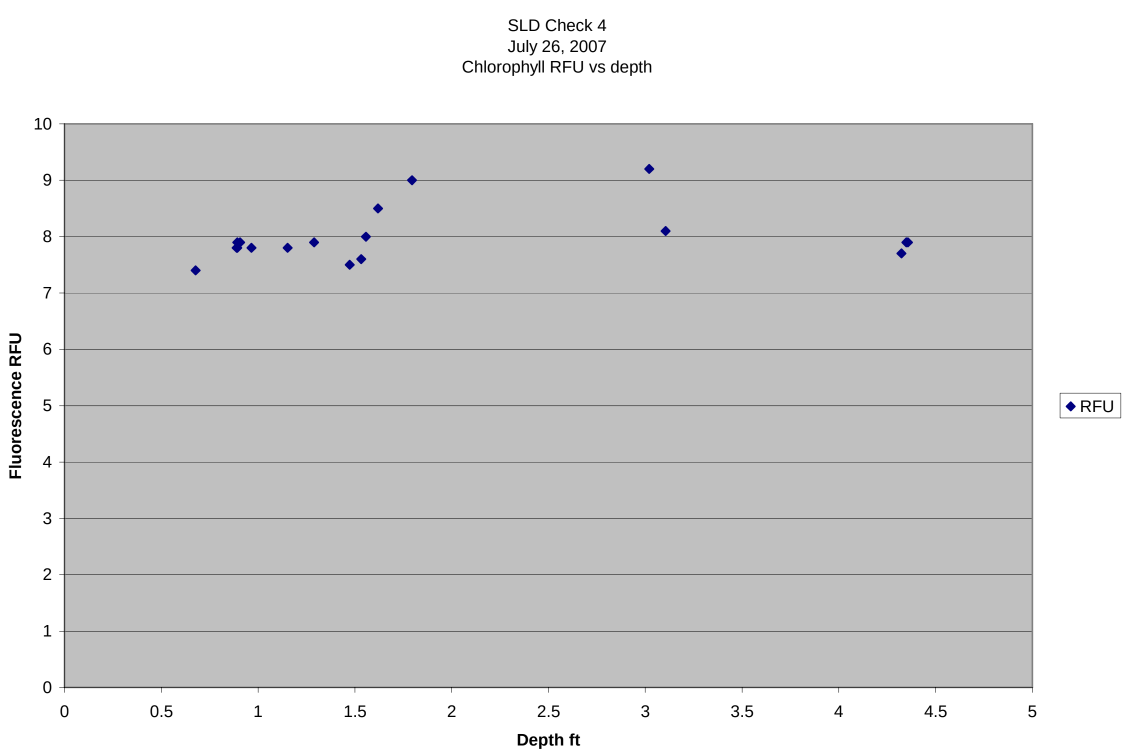


Figure 26: Algae loads from upstream tributaries (DO-10, DO-19) and downstream of San Luis Drain before, during and after the shutoff experiment.

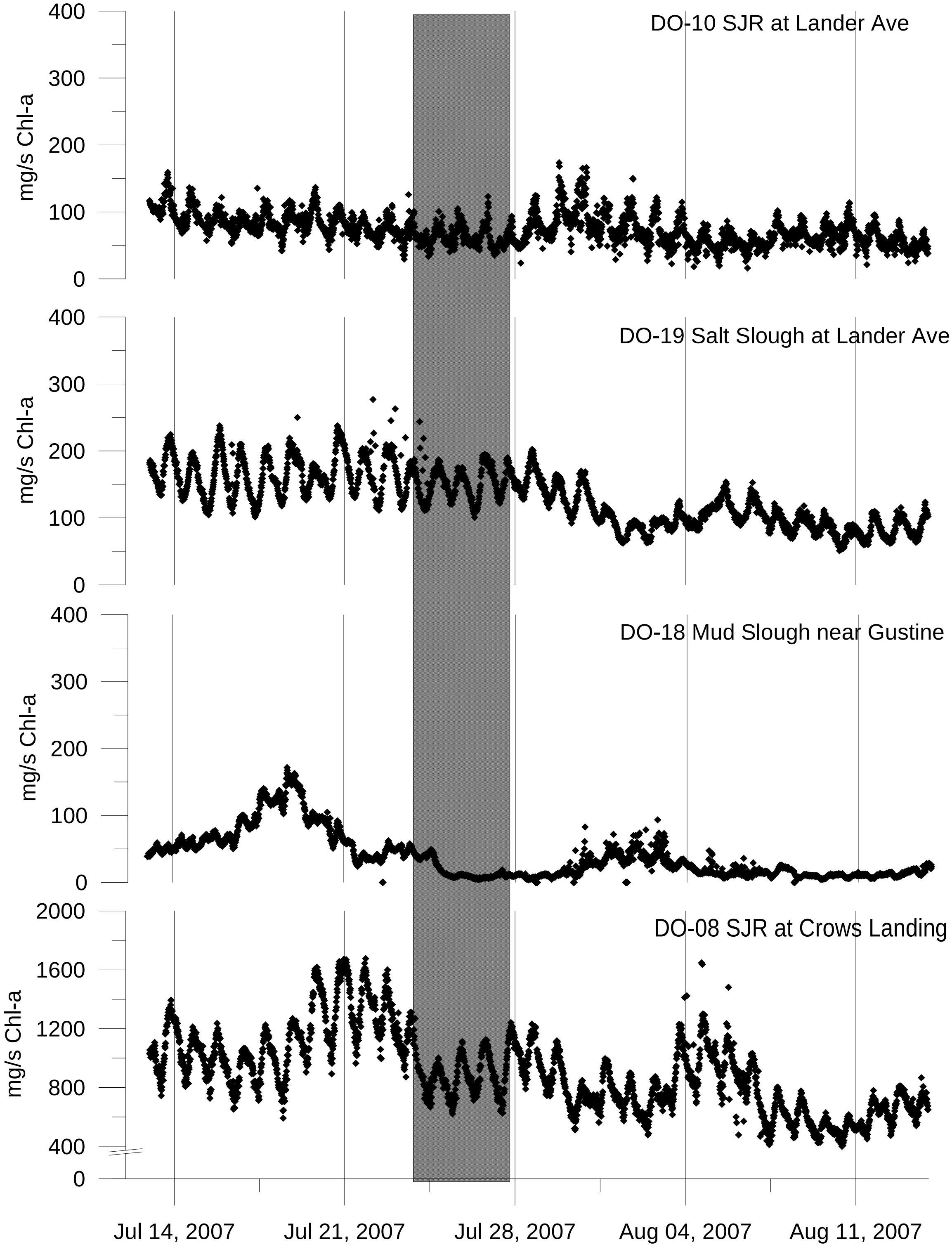


Figure 27: Chlorophyll fluorescence values from other tributaries and downstream of San Luis Drain before, during, and after the shutoff experiment.

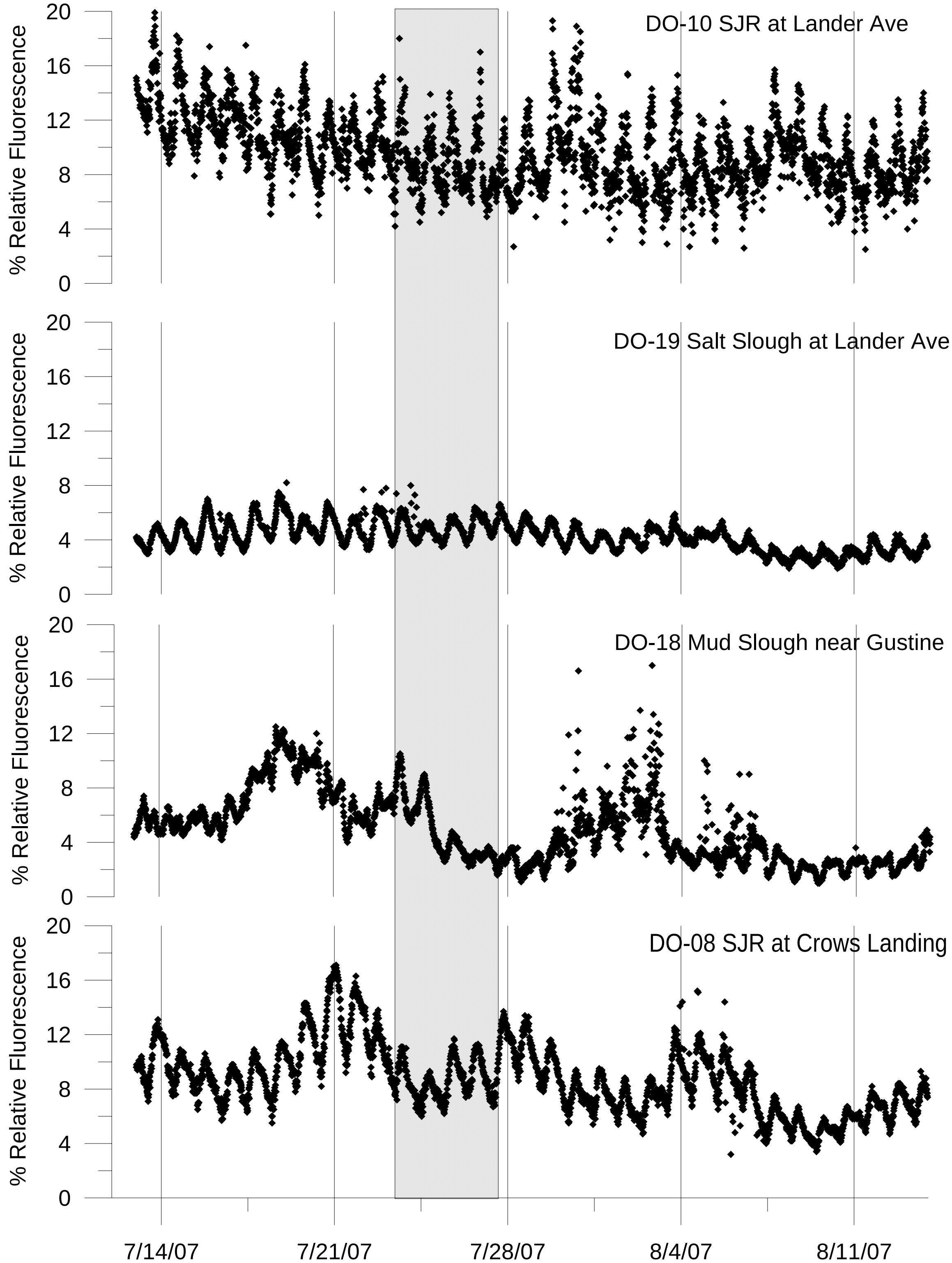


Figure 28: Salt load from other tributaries and downstream of San Luis Drain before, during, and after the shutoff experiment.

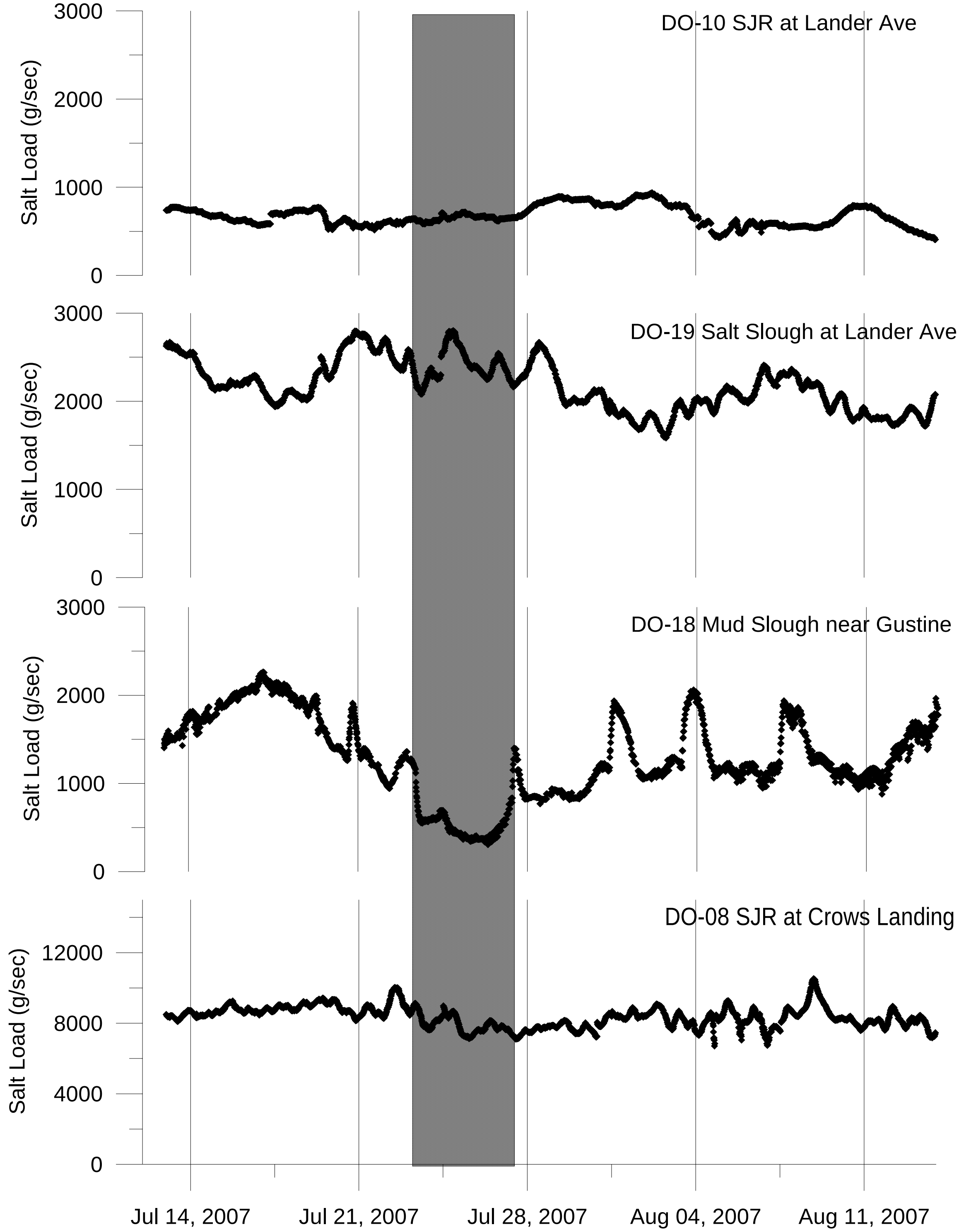
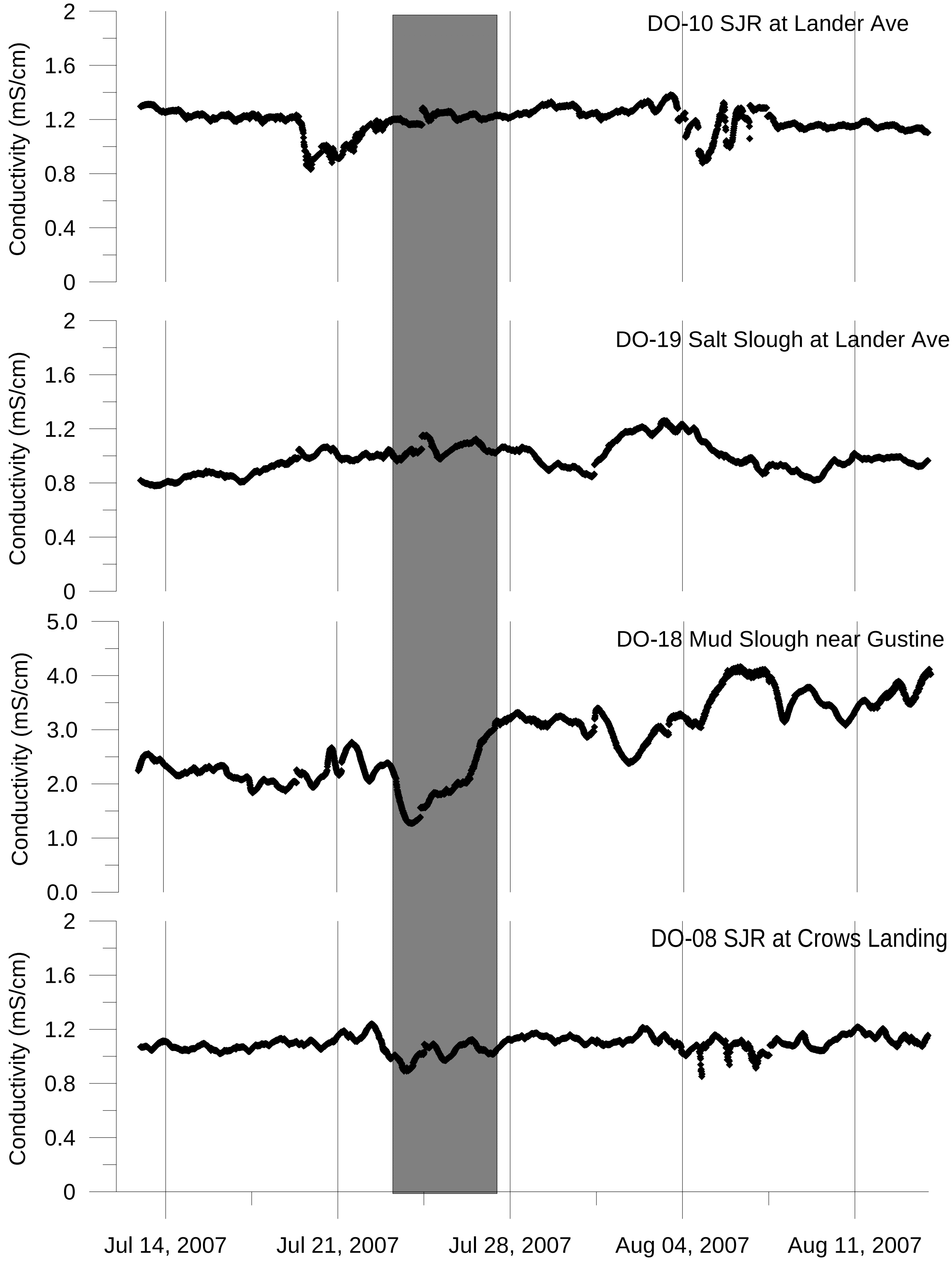


Figure 29: Specific conductance from other tributaries and downstream of San Luis Drain before, during, and after the shutoff experiment.



APPENDIX P

Limiting Factors for Phytoplankton Growth and Yield in the San Luis Drain

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January, 2007

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Abstract

Phytoplankton blooms have been extensively studied and modeled in eutrophic estuaries, lakes, reservoirs, and ponds, but factors regulating phytoplankton growth yield and growth rates (biokinetics) in eutrophic rivers are less well understood. A growing body of evidence suggests that phytoplankton biokinetics in rivers are influenced by factors other than macronutrient concentrations, such as residence time and micronutrient concentrations. In this study, we investigated phytoplankton biokinetics in a nutrient enriched drainage in the Central Valley of California over a three year period. Despite nitrate (13 mg-N L^{-1}) and phosphate (0.2 mg-P L^{-1}) concentrations exceeding up to fifty-times kinetic half-saturation concentrations and saturating sunlight conditions (720 langleys d^{-1}), phytoplankton rarely exhibited maximal growth rates. Only in one instance did the observed growth rate reach the estimated maximum growth rate of 0.06 h^{-1}. Analysis of field observations using a mechanistic model demonstrated that in the presence of excess nitrate and phosphate, phytoplankton growth rates were often limited by carbon dioxide availability and that mineral sediments acted as a reservoir for trace nutrients. Phytoplankton biomass reached a maximum carrying capacity (200 mg-chlorophyll L^{-1}) after approximately 60 hours of residence time. Growth yield was limited by a combination of phosphate depletion and zooplankton grazing.

Keywords

phytoplankton, growth rate, growth yield, nutrient limitation, algae growth model, biokinetics, San Joaquin River, Central Valley

Abbreviations and Notations

SLD	San Luis Drain	μ_{max}	maximum growth rate
N_t	concentration of phytoplankton at time *t*	g_{max}	maximum grazing rate
N_0	concentration of phytoplankton at time *0*	K_{sm}	mineral solids half-saturation constant
K	carrying capacity	K_{sp}	phosphate half-saturation constant
r	observed growth rate	K_{sc}	carbon dioxide half-saturation constant
t	elapsed time	K_{sz}	zooplankton grazing half-saturation constant

Introduction

Eutrophication of surface waters has been a recognized environmental problem for over forty years (Hutchins, 1973; Levin, 1967). Although phytoplankton are the foundation of many aquatic food-webs, the excessive growth of phytoplankton in eutrophic waters can have a significant negative impact on habitat quality and some phytoplankton can be directly toxic to fish and wildlife (Haider et al., 2003; Scavia and Bricker, 2006). Accumulation of phytoplankton biomass and subsequent phytoplankton population crashes can cause anoxic conditions in rivers, lakes and estuaries (Billen et al., 2001; Hagy et al., 2004; Jassby and Nieuwenhuyse, 2005; Jorgensen, 1976; Parr and Mason, 2004; Pers, 2005; Scavia and Bricker, 2006) and high phytoplankton concentrations reduce other beneficial uses by contributing foul tastes, offensive odors and formation of disinfection-by-product precursor compounds (Nikolaou and Lekkas, 2001; Sladeckova, 1998; Wnorowski, 1992).

Phytoplankton blooms, and subsequent negative impacts, have been extensively studied and modeled in estuaries, lakes, reservoirs, and ponds (Billen et al., 2001; Bowie et al., 1984; Cerco and Noel, 2004; Hilton et al., 2006; Jorgensen, 1976; Koelmans et al., 2001; Nyholm, 1978; Pers, 2005). The factors limiting the biomass yield of phytoplankton in confined waterbodies and estuaries are typically attributed to macronutrients: nitrogen and phosphorous , but growth rates can be controlled by any number of factors, including light availability, micronutrient limitation, and zooplankton grazing (Knowlton and Jones, 1995; 1996; Koch et al., 2004; Kuuppo et al., 1998; Robson, 2005; Wu and Chou, 2003). Enclosed systems are well enough understood that robust phytoplankton biokinetic models have been developed for lakes and reservoirs to describe the interactions between algal growth, algal yield, light availability, grazing, and nutrient concentrations (e.g. Bowie et al., 1984; Cugier et al., 2005; Hilton et al., 2006; Pers, 2005; Plus et al., 2006).

Phytoplankton growth in eutrophic rivers is less well understood (Hilton et al., 2006). A growing body of evidence suggests that phytoplankton growth in rivers is strongly influenced by physical factors, such as residence time and mixing rates, and that these and other physical factors may be as important as macronutrient concentrations in regulating phytoplankton growth yield and growth rates (biokinetics).

The objective of this study was to identify fundamental process controlling algal biokinetics in a highly eutrophic river. The limits of phytoplankton biokinetics were examined in a concrete-lined river in the Central Valley of California which conveys nutrient rich agricultural drainage. High nutrient conditions, combined with abundant sunlight and warm temperatures, results in significant summer phytoplankton blooms and presents an opportunity to study factors limiting algal growth in the presence of excess macronutrients. Phytoplankton growth was measured in the river and environmental conditions were related to phytoplankton biokinetics using statistical methods and a mechanist model. The mechanistic model identified limiting factors for growth and yield and suggested that suspended sediments have a stimulatory influence on diatom growth and function as a source of nutrients as dissolved nutrients are depleted.

Methods

Lagrangian studies were conducted in the San Luis Drain (SLD) over a three year period (2003 to 2005). Samples were collected at each of the 18 hydraulic checks along the 43 km study area as well as at the entrance and exit of the channel (Figure 1). Chemical and physiological measurements were made at the up-stream side of each check and grab samples were depth integrated. Flow was measured continuously at the head and exit of the channel. Residence time in the drain as a function of distance was measured by velocity and dye studies and confirmed by hydraulic calculations based on design specifications. The distance along the drain was related to residence time and data was analyzed as a function of residence time. Phytoplankton growth and water quality changes were measured in May 2004 and January 2005 and two times each in June and July 2003 and 2004. Phytoplankton biokinetic pattern in the drain was measured again in June 2005 to confirm that June year to year results were comparable.

Field measurements were made with handheld sondes and water quality measurement devices, including a YSI 6600 sonde, HACH turbidometer, and Myron combination Ultraprobe. For dye studies, Hydrolab combination sondes were used. Handheld probes were calibrated daily before each use. Stream velocity was measured using a Marsh-McBirny velocity probe. Confirmation (QC) of continuous measurements was performed using replicate sampling for laboratory analysis and duplicate calibrated instruments, as required. Measurement of incident photosynthetically active radiation (PAR) and PAR attenuation with depth in the SLD were made using quantum light detectors (LiCor, Lincoln, NE). Photozone was defined as the depth where light penetration was 2% of incident light.

Samples collected in the field were transported to Berkeley National Laboratory for analysis. All analyses were run within the allowed holding time applicable to the preservation method used (American Public Health Association, 1998). Total organic carbon (TOC) was measured by high temperature combustion according to Standard Method (SM) 5310 B (American Public Health Association, 1998). Dissolved organic carbon was measured on split samples after filtration through a GF/F glass fiber filter by the same method. Total suspended solids (TSS) and volatile suspended solids (VSS) were analyzed by SM 2540 D and E, respectively. Mineral solids (MS) was calculated as TSS minus VSS. Chlorophylls (chl-*a*, chl-*b*, chl-*c*), pheophytin-*a* (pha-a), and xanthophyll were extracted and analyzed according to SM 10200H (American Public Health Association, 1998).

Ortho-phosphate was determined on samples filtered through a glass-fiber filter (0.7 micron). Ortho-phosphate and total phosphorous were quantified by the Ascorbic Acid Method (adapted from SM 4500-P-E). Total phosphorus was determined on non-filtered samples following persulfate digestion. Total iron was determined by the Phenanthroline Method (SM 3500-Fe B) (American Public Health Association, 1998).

The algal community was characterized by measurement of phospholipid fatty-acid (PLFA) profile. To extract PLFA from suspended algae and detritus, 500 ml of water sample was filtered through a Whatman GF/F glass fiber filter within 24 hours of collection. The filter was placed in a 25 mm glass tube and stored at -20 ^{o}C until extraction. The total lipids are extracted from the filter with a modified Bligh-Dyer solution which consists of 5 ml of chloroform, 10 ml of methanol, and 4 ml of phosphate buffer. The phospholipids are then separated from total lipids on C18 column (Unisil, Clarkson Chemical, South Williamsport, PA). Isolated phospholipids are methylated and analyzed on an Agilent 6890N Gas Chromatograph (GC) equipped with a Flame Ionization Detector (Guckert et al., 1985). Peak confirmation is accomplished on an Agilent 5972A mass spectrometer and double bond position confirmed with a dimethyl disulfide derivation (Nichols et al., 1986). Peak quantification was accomplished by use of an internal 19:0 phospholipid standard (1,2-Dinonadecanoyl-sn-Glycero-3-phophocholine) (Avanti, Alabaster, AL) which is added immediately prior to extraction, and an external 11:0 carbon fatty acid methyl ester standard (methyl decanoate) (Matreya, Pleasant Gap, PA) which is added immediately before analysis on the GC.

PLFA recovered from water samples can assigned to specific organism classes and biomass estimated for each class using the amount of lipid recovered. Diatom were characterized by 16:3w3 and 20:5 fatty acids; dinoflagellates by the occurrence of 22:6w3; green algae by 18:3w3; bacteria by i15:0 and a15:0; and terrestrial biomass by 25:0 and 26:0 fatty acids (Becker et al., 2004; Galois et al., 1996; Muller-Solger et al., 2002).

Weather data was collected from three stations in the Central Valley. Central Valley temperature and precipitation averages were calculated by averaging daily data for the thirty year record from Stockton, Merced and Los Banos, CA. Weather clarity (number of clear days) was calculated from the 30 year Stockton record only.

Experimental data were fit to the logistic population model using Grapher software (Golden Software, Golden, CO). The Logistic model is used to describe resource limited biokinetic relationships:

$$N_t = \frac{K}{1+\left[\frac{K-N_o}{N_o}\right]e^{-rt}} \qquad \text{Eq. 1}$$

where N_t is the concentration of phytoplankton at time t, N_0 is the initial concentration of phytoplankton, K is the maximum phytoplankton concentration the ecosystem will support, r is the phytoplankton growth rate, and t is the elapsed time.

Mechanistic models were written in Excel software and parameter estimates were generated by minimization of least-square difference between chlorophyll data and model predictions. Statistical analysis were conducted according to Sokol and Rohlf (1995).

Results and Discussion

The San Joaquin River is located in the Central Valley of California, one of the most productive agricultural regions in the world. The San Joaquin Valley has a Mediterranean climate characterized by a dry-season (May through October) and a wet-season (November through April). In June and July, there is typically no measurable precipitation in the Central Valley. Air temperatures are typically mild in the winter (average low temperature of 2.6 ^{o}C in December) and hot in the summer (average high temperature of 35 ^oC in July). In the dry season, most days are clear, there is little fog, and available sunlight is directly related to day-length. Agricultural production is highly dependent on irrigation and the summer months are commonly referred to as the "irrigation season." Irrigation return flows are a significant source of nutrients to the San Joaquin River, which is the major drainage for the region (Figure 1).

The San Luis Drain (SLD) is a major tributary to the San Joaquin River above its confluence with the Merced River (Figure 1). The 43 km SLD drains a watershed of approximately 97,000 acres of irrigated farmland located in seven drainage and irrigation districts. The SLD discharges to Mud Slough, approximately 5 km above its confluence with the San Joaquin River. The soils in the SLD drainage are of marine origin and contain high concentrations of salts and trace elements (Gronberg et al., 1998). There has been an long-term interest in the water-quality of this region, consequently drainage flows in the SLD are accurately measured and several studies have examined the water quality of the SLD (Kratzer and Shelton, 1998; Kratzer et al., 2004; Stringfellow and Quinn, 2002). Previous studies showed that chlorophyll concentrations at the end of the SLD are consistently high in the summer months and that there is significant phytoplankton growth occurring in the SLD between the entrance and exit of the drain (Stringfellow and Quinn, 2002).

The SLD is an open, shallow, concrete lined channel. During the dry season, the flow in the SLD consists entirely of agricultural drainage and inlet and outlet flows approximately balance. Flows between May and September average 1.22 m^3 sec^{-1} and are consistent from year to year. In October, irrigation-return flows decline significantly and flows typically remain low throughout the wet season, except during periods of rainfall. Groundwater can enter the SLD through weep-valves, so during the wet-season exit flows may exceed input flows (data not shown).

The configuration of the SLD makes it an ideal location for meso-scale field experiments examining phytoplankton biokinetics. The SLD has no shading and is therefore fully exposed to sunlight and warm temperatures. The SLD does not support littoral plant or algal communities and all primary production in the drain is planktonic. After the first 2 km, the SLD has a uniform trapezoid shape and a consistent water depth of approximately 2.4 meters. During the summer, the hydraulic residence time of the SLD is approximately four days. The SLD contains a series of check structures at an average interval of 2.2 km. At these check structures, water drops approximately 0.5 meters and is passed through a culvert, which results in a complete mixing of the water at each structure. The uniformity of construction, flows, residence time, and depth, combined with regular mixing and resuspension of materials, allows modeling of the SLD as a complete mix, plug-flow reactor.

Phospholipid analysis shows the phytoplankton community in the SLD is dominated by diatoms (Figure 2) and that algae biomass consistently accounted for approximately 90% of the suspended biomass found at the exit of the channel, with the balance attributable to bacterial and fragments of higher plants. Diatoms were consistently 80% of the algal community, with green algae and dinoflagellates representing 15% and 5% respectively (Figure 2). The community structure was stable as biomass accumulate in the channel (data not shown) and the community structure is stable over time (Figure 2), supporting the conclusion that the SLD can be modeled as a pseudo-steady-state, plug flow reactor.

Measurement of nutrients and other water quality parameters were made at the head of the SLD in May, June, and July of 2003; June and July of 2004; and January of 2005 (Table 1). The water entering the SLD is a nutrient rich media entirely suited for algal growth. Over six years of records of water quality measurements at the terminus of the drain are also available (Kratzer et al., 2004; Stringfellow and Quinn, 2002). In all cases where nitrate was measured at the terminus of the drain during the dry-season months nitrate-N concentrations were above 8 mg L^{-1}, with the exception of one measurement in October where the nitrate-N was 4 mg L^{-1}. These reported NO_3-N concentrations are over 50 times average reported phytoplankton half-saturation constants for nitrogen (Bowie et al., 1984). Available silicon concentrations at the exit of the channel were 20 to 200 times diatom half-saturation constants (Dahlgren, personal communication). Total phosphorous concentrations were also high at the exit of the SLD, consistently being greater than 0.02 mg L^{-1} as P (Kratzer et al., 2004; Stringfellow and Quinn, 2002), but outlet concentrations are significantly lower than measured inlet concentrations (Table 1), suggesting a significant phosphorous demand in the system. Total phosphorous concentrations at the outlet were still greater than or equal to reported half-saturation constants for phosphorous (Bowie et al., 1984). These results suggest that nitrogen and silicon are not limiting in this system, but that phosphate limitation could not be ruled out, despite the high phosphorous concentrations entering the SLD.

During the May and January studies, phytoplankton growth rates appeared exponential for the entire length of the channel and it was not apparent that algae growth ever reached the maximum carrying capacity of the system (data not shown). In contrast, the June and July studies demonstrated a biomass accumulation pattern consistent with limited growth kinetics (Figure 3). The consistency of results between years suggests that in June and July environmental conditions in the channel are sufficiently stable that pseudo-steady state conditions exist. The channel demonstrated a consistent pattern of sediment loss and phytoplankton accumulation as a function of residence time during June and July (Figures 3 and 4). Total phosphorous and soluble ortho-phosphate (oP) also typically demonstrated decline with residence time (Figure 5), but total phosphorous and oP concentrations were not significantly related to sediment concentrations ($r^2 < 0.060$). Agreement between phytoplankton growth patterns between different days and different years confirms that the SLD can be analyzed as a plug-flow reactor.

The logistic population model was fit to the June and July data and it was shown that the model gave an accurate description of the observed algal growth data (Figure 3). Biokinetic parameter estimates generated for individual data sets using the logistic model are shown in Table 2. The June and July data were directly comparable and showed surprising homogeneity year to year. The analysis of this system using the logistic model suggests that algae reach a maximum carrying capacity (K) in this system and that the maximum amount of algae biomass that can be supported on this drain water corresponds to less than 200 $\mu g\ L^{-1}$ of chlorophyll-*a*.

The logistic model describes how a populations may respond to growth limiting conditions, however the model provides no mechanistic explanation as to what factors are limiting growth. As the phytoplankton population was shown to reach a maximum carrying capacity in this system, it was hypothesized that mechanisms controlling phytoplankton biokinetics could be evaluated and further analysis was conducted to determine limiting factors.

The importance of light availability as a limiting factor for phytoplankton growth in the SLD was investigated. Although volatile suspended solids (VSS) concentrations increase as a function of residence time due to algae growth (Figure 3), total suspended solids and mineral solid concentrations decline along the length of the drain, due to settling losses (Figure 4). The removal of mineral solids has a more significant effect on light attenuation than the increase in algal biomass and as a result the depth of the photic zone increases as a function of residence time in the drain (Figure 6). An examination of observed growth rates (μ) demonstrates that the highest growth rates are typically observed in the first 40 hours of residence, in zones of higher turbidity (Figures 3 and 6). Additionally, incident solar radiation averaged 720 ± 64 langleys per day (approximately 138 E/m^2 day) during the study period, which is well above reported saturating light intensities (Bowie et al., 1984; Knowlton and Jones, 1995; 1996; Sellers and Bukaveckas, 2003). Since the depth of the SLD is uniform after the first 2 km, the observation that photic zone is not correlated positively with algal growth rates is direct evidence that self-shading and light limitation are not controlling growth yields of phytoplankton in the SLD.

Analysis was conducted to determine if biomass yield correlated with initial conditions or changes in water chemistry between initial and final conditions. When both summer and winter data sets were included, yield was significantly correlated ($r > 0.900$, alpha = 0.05) with seasonal factors (temperature, day length and day of year). Biomass yield had a significant correlation (alpha = 0.05) with inoculum (initial phytoplankton) concentration ($r = 0.859$), electrical conductivity (-0.740), and changes in soluble o-phosphate (-0.977), turbidity (-0.813), and mineral solids (-0.708), but not initial ortho-phosphate concentration or change in total phosphorous concentration. There was significant correlation among independent variables and many chemical parameters varied with seasonal parameters (data not shown). The correlation between independent parameters in flowing systems limits the ability of statistical methods to identify factors limiting phytoplankton yields and growth rates. To address the limits of the statistical methods, a mechanistic approach to determining limiting factors was applied.

A mechanistic model was used to interpret the field data and evaluate the influence of light, pH, inorganic carbon, nutrient concentration, and mineral availability on algae growth in the SLD. Nitrogen, and silica were not included in the model, since direct measurements demonstrated they were not limiting in this system. Light and temperature were highly correlated and light was not modeled as an independent parameter. The mechanistic model was written using the minimum formulation approach (Bowie et al. 1985):

$$X_2 = X_1 e^{(\mu+g)(t_2-t_1)} \quad \text{Eq. 3}$$

$$\mu = f(T)\, f(L)\, \mu_{\max} \quad \text{Eq. 4}$$

$$g = f(T)\, f(Z)\, g_{\max} \quad \text{Eq. 5}$$

$$f(T) = 2^{(0.138(T-26))} \quad \text{Eq. 6}$$

$$f(L) = \min[\, f(M), f(P), f(C)] \quad \text{Eq. 7}$$

$$f(M) = \frac{M}{M + K_{sm}} \quad \text{Eq. 8}$$

$$f(P) = \frac{P}{P + K_{sp}} \quad \text{Eq. 9}$$

$$f(C) = \frac{C}{C + K_{sc}} \quad \text{Eq. 10}$$

$$C = \left(\frac{[H^+]^2}{[H^+]^2 + [H^+]10^{-6.4} + 10^{-16.7}} \right) 100 \quad \text{Eq. 11}$$

$$f(Z) = \frac{X_1}{X_1 + K_{sz}} \quad \text{Eq. 12}$$

where X_1 equals initial biomass at time 1 (t_1) measured as chlorophyll *a*, X_2 equals biomass at time 2 (t_2) measured as chlorophyll *a*, μ is the algal growth rate, *g* is the rate of algal grazing (negative number describing algal loss due to grazing). The observed growth rate, μ, is a function of the inherent maximum growth rate (μ_{max}), temperature (T), and the most severely limiting factor of either mineral solids concentration (M), carbon dioxide expressed as a percent of total dissolved inorganic carbon (C), or ortho-phosphate (P) concentration. This model uses suspended mineral solids as a bulk measure of un-dissolved nutrients and trace minerals, including silica and iron. The temperature modification factor (*f(T)*) was developed from the Arrhenius equation using observed maximum growth rates calculated by the logistic method as described above. Other factors are based on the Michaelis-Menten relationship (Bowie et al., 1984), where K_{sm}, K_{sp}, K_{sc}, and K_{sz} are the half-saturation constants for minerals, soluble ortho-phosphate (as P), carbon dioxide, and grazing, respectively. The observed grazing rate, *g*, is a function of the inherent maximum zooplankton grazing rate (g_{max}), temperature, and the density of algal biomass (X_1) as measured by chlorophyll *a*.

Data was fit to the model using a least squares approach and the best fit estimates for biokinetic parameters are presented in Table 3. Regression between the predicted and actual values, using the parameters listed in Table 3, yields an r^2 of 0.956 (Figure 7), suggesting the model provides and excellent description of phytoplankton growth in the SLD. The best fit estimate for μ_{max} is consistent with maximum values for *r* estimated using the logistic model (Table 2). These estimates of μ_{max} are consistent with previously reported values for diatoms (Bowie et al., 1984; Litchman et al., 2003).

Phytoplankton growth in the drain can be described as a function of phosphate concentration, mineral solids concentration, carbon dioxide solubility, and grazing pressures (Figure 8). When μ was less than μ_{max}, 61% of the time phytoplankton growth rate was limited by nutrient availability and 39% of the time by carbon dioxide availability. Of the times when nutrients were limiting growth rates, minerals were more limiting that phosphate 59% of the time. The K_{sp} of ortho-phosphate is estimated to be 0.012 mg L^{-1} as P, which is within the range of previously reported values (Bowie et al., 1984).

Carbon dioxide limitation of growth rate occurred at pH values as low as 8.1 during periods of rapid growth. The half-saturation constant for inorganic carbon (K_{sc}), expressed as a percent of total inorganic carbon in Table 3, is equivalent to 0.03 to 0.05 mg L^{-1} of C, assuming at least 50% of the alkalinity is due to carbonate buffering. This is a reasonable estimate for K_{sc} and is comparable to previously reported values (Bowie et al., 1984).

The stimulation of diatom growth by suspended mineral solids has not been demonstrated previously, but previous research supports the concept that suspended sediments can serve as reservoirs for both micro- and macronutrients and support algal growth processes. Sediments control the bioavailability nutrients and trace metals in a wide variety of aquatic systems (Cugier et al., 2005; Ellison and Brett, 2006; Garnier et al., 2005; Simpson et al., 2004; Steveninck et al., 1992; Wu and Chou, 2003). It has been frequently observed that sediment concentrations, nutrient concentrations, and phytoplankton growth yield are often correlated (e. g. Jones and Knowlton, 2005). Results from investigations of phytoplankton blooms in the Rhine and Marne Rivers suggest that during periods of rapid algal growth, soluble nutrients become limiting and the rate of algal growth is dependent on dissolution of nutrients from suspended particles in the water column (Garnier et al., 2005; Steveninck et al., 1992). Our analysis shows a positive relation between suspended mineral solids concentration and phytoplankton growth rate, indicating that suspended mineral solids are positive influence on phytoplankton growth in the SLD. This result is a significant departure from current thinking on the issue, since suspended mineral solids typically are expected to inhibit algal growth (via light attenuation), not act as a stimulant to algal growth.

In this system, mineral solids are believed to be functioning as a reservoir for a number of trace minerals required by algae. There is a correlation between mineral solids concentrations and total iron in river sediments collected in this region ($r^2 = 0.786$) and other trace metals and silica are also associated with sediments in riverine ecosystems (Garnier et al., 2005; Simpson et al., 2004; Steveninck et al., 1992; Wu and Chou, 2003). Suspended mineral solids may be acting as reservoirs for the dissolution of trace nutrients as rapid phytoplankton growth depletes available (soluble) nutrients in the water column. Dissolution limited growth has been observed in bacteria which grown on poorly soluble compounds (Grimberg et al., 1994; Grimberg et al., 1996) and a similar phenomena could explain the dependence of algal growth on suspended mineral particles. The stimulatory effect of sediments on plankton algae, particularly diatoms, also makes sense in that the presence of suspended sediments and associated high turbidity would prevent the growth of benthic plants or algae, benefiting planktonic algal population in the competition for limit ecological resources. The stimulatory effect of sediments on phytoplankton growth is under further investigation.

Biomass yield (carrying capacity) is limited by a combination of phosphate depletion and zooplankton grazing. A density dependent decay component is needed to describe the decline of algae biomass observed at the end of the drain, which typically begins after sixty hours of residence time in the drain (Figure 8). The decline in biomass could not be characterized using a fixed intrinsic decay constant or settling function to describe algal losses (data not shown). The maximum grazing rate estimated by the model is high (Table 3), but the K_{sz} suggested that the process is not particularly efficient, which would suggest that the grazing impact would be from zooplankton rather than benthic bivalves. This is consistent with field observations. The concrete lined channel is inhospitable to benthic organisms, but a fish population is present in the last 16 kilometers of the SLD, suggesting a significant food web is present. Direct measurements of zooplankton were not included in this study, but will be made in future investigations.

Conclusions

The SLD was an ideal system to study factors limiting phytoplankton growth in eutrophic rivers. The hydraulic simplicity of the system allowed the modeling of the system as a plug-flow reactor and excess sunlight allowed phytoplankton to reach their maximum carrying capacity in the study reach, despite very high initial nutrient conditions. The attainment of limited growth conditions in the presence of excess light and nitrogen allowed the direct measurement of other limiting factors in this highly eutrophic system. The use of a mechanistic model provided insight into how statistically correlated factors were influencing phytoplankton biokinetics in a highly eutrophic system. The analysis using the mechanistic model showed that mineral solids were serving as a source of nutrients for the diatom dominated system, that high growth rates occurred in conjunction with high sediment concentrations, and that periods of rapid growth could result in a carbon dioxide limitation. Overall, soluble ortho-phosphate was still was associated with limits to growth yield, but grazing pressures reduced phytoplankton standing crop after maximum yield had been reached. The ability of sediments to stimulate phytoplankton growth has not been previously shown. The applicability of these findings to phytoplankton growth in the San Joaquin River and the role on sediments in the biokinetic stimulation of phytoplankton populations will be further investigated.

Acknowledgements

The cooperation of the San Joaquin Valley Drainage Association with this research was greatly appreciated. This work was funded primarily by the California Bay Delta Authority and the (California) Central Valley Regional Water Quality Control Board. Additional funding was provided by the Department of Energy through The Center for Science and Engineering Education, Berkeley National Laboratory. This work was supported in part by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

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Table 1: Water quality conditions for drainage entering the San Luis Drain during the study period. Data from January, May, June, and July 2003 to 2004 included (n = 6).

Parameter	Mean	Minimum	Maximum
Flow (cfs)	48.4	41.0	55.0
Temp (deg C)	20.9	9.3	26.9
EC (millisemens cm^{-1})	4.842	4.190	6.414
DO (%)	112.8	96.5	152.5
pH	8.06	7.83	8.36
Turbidity (NTU)	77.9	33.4	155.0
Dissolved organic carbon (mg L^{-1})	6.7	5.2	9.4
Total organic carbon (mg L^{-1})	8.1	5.6	11.5
Volatile suspended solids (mg L^{-1})	14.3	3.0	22.0
Total suspended solids (mg L^{-1})	135.1	69.7	199.2

Parameter	Mean	Minimum	Maximum
Mineral suspended solids ($mg\ L^{-1}$)	120.9	59.0	177.2
Nitrate-N ($mg\ L^{-1}$)	12.9	9.4	16.4
Soluble o-phosphate ($mg\ L^{-1}$)	0.208	0.061	0.389
Total phosphorous ($mg\ L^{-1}$)	0.679	0.390	0.942
Chlorophyll-a ($\mu g\ L^{-1}$)	32.4	4.2	49.0
Pheophytin ($\mu g\ L^{-1}$)	9.5	3.1	11.4
Chlorophyll-b ($\mu g\ L^{-1}$)	1.8	1.2	2.8
Xanthophyll ($\mu g\ L^{-1}$)	1.2	0.6	1.8

Table 2: Best fit parameters for the logistic model (eq. 1) to observed algal growth patterns in the SLD.

Date	Day of year	N_0 µg Chl-a L^{-1}	K µg Chl-a L^{-1}	r hr^{-1}	r^2
01/13/05	13	6.71	10.50	0.023	0.971
05/13/04	134	19.02	203.00	0.023	0.936
06/17/03	168	19.90	123.90	0.219	0.745
07/13/04	195	36.60	162.10	0.049	0.922
06/30/03	181	45.70	177.20	0.055	0.942
07/29/03	210	16.60	142.00	0.062	0.931

Table 3: Best fit estimates for parameters included in the mechanistic model for algal growth in the San Luis Drain. See text for explanation. Data from January, May, June, and July 2003 to 2004 included.

Parameter	Best fit estimate	Units
μ_{max}	0.061	hr^{-1}
g_{max}	-0.053	hr^{-1}
K_{sm}	19.3	mg Mineral solids L^{-1}
K_{sp}	0.009	mg PO_4-P L^{-1}
K_{sc}	0.25	% H_2CO_3
K_{sz}	100	µg Chlorophyll-a L^{-1}

Figure 1: Map of study area located in the San Joaquin Valley of California. The San Luis Drain is a concrete lined channel that conveys agricultural drainage from farms in the south, past sensitive wetland areas, and discharges into the San Joaquin River via Mud Slough. Measurements were made at the inlet and outlet and the 18 check structures along the length of the channel.

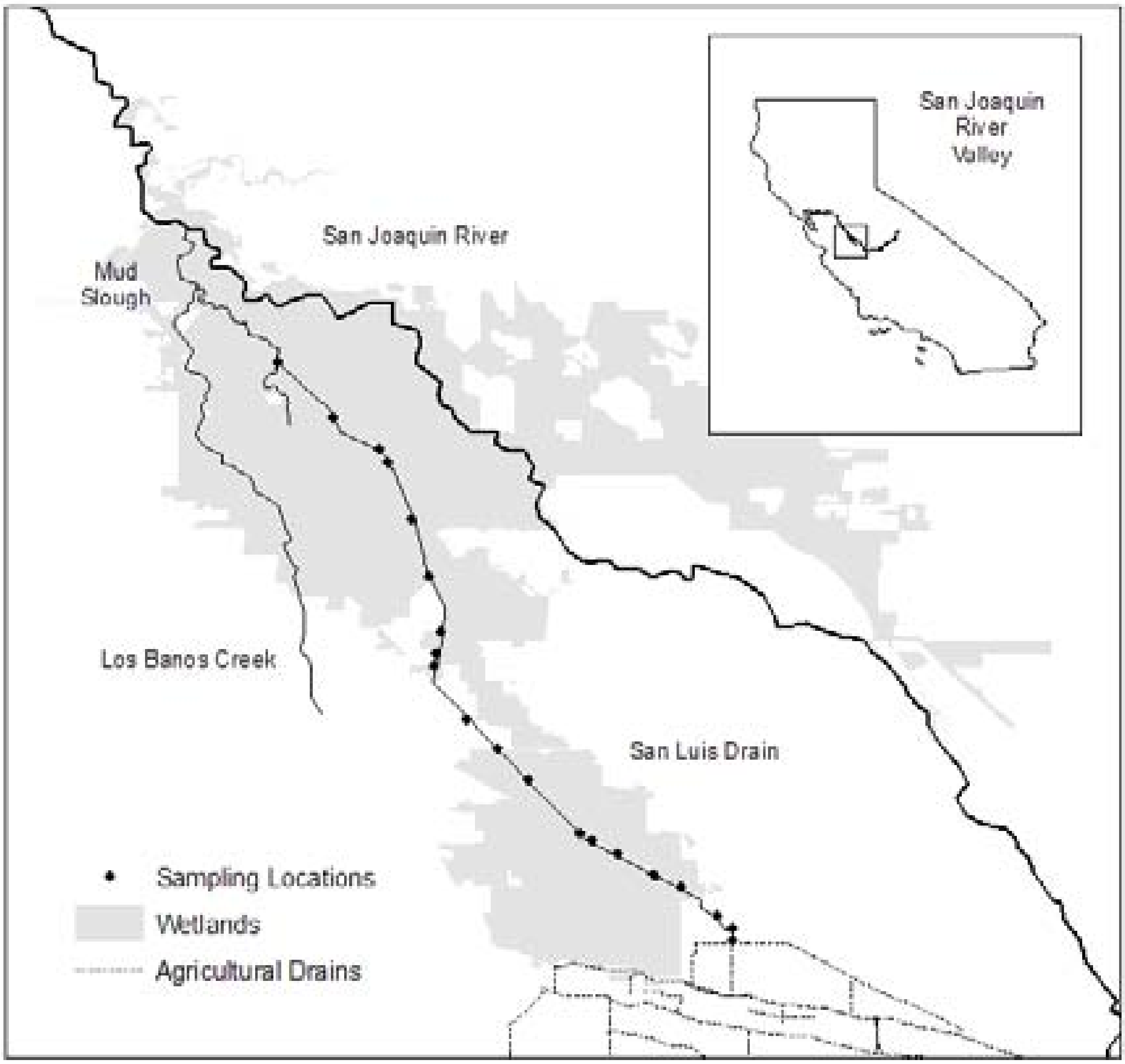


Figure 2: Community structure of biomass in the San Luis Drain as determined by phospholipid fatty acid analysis. The system is dominated by diatoms and exhibits a stable community structure. Data from 2005 shown.

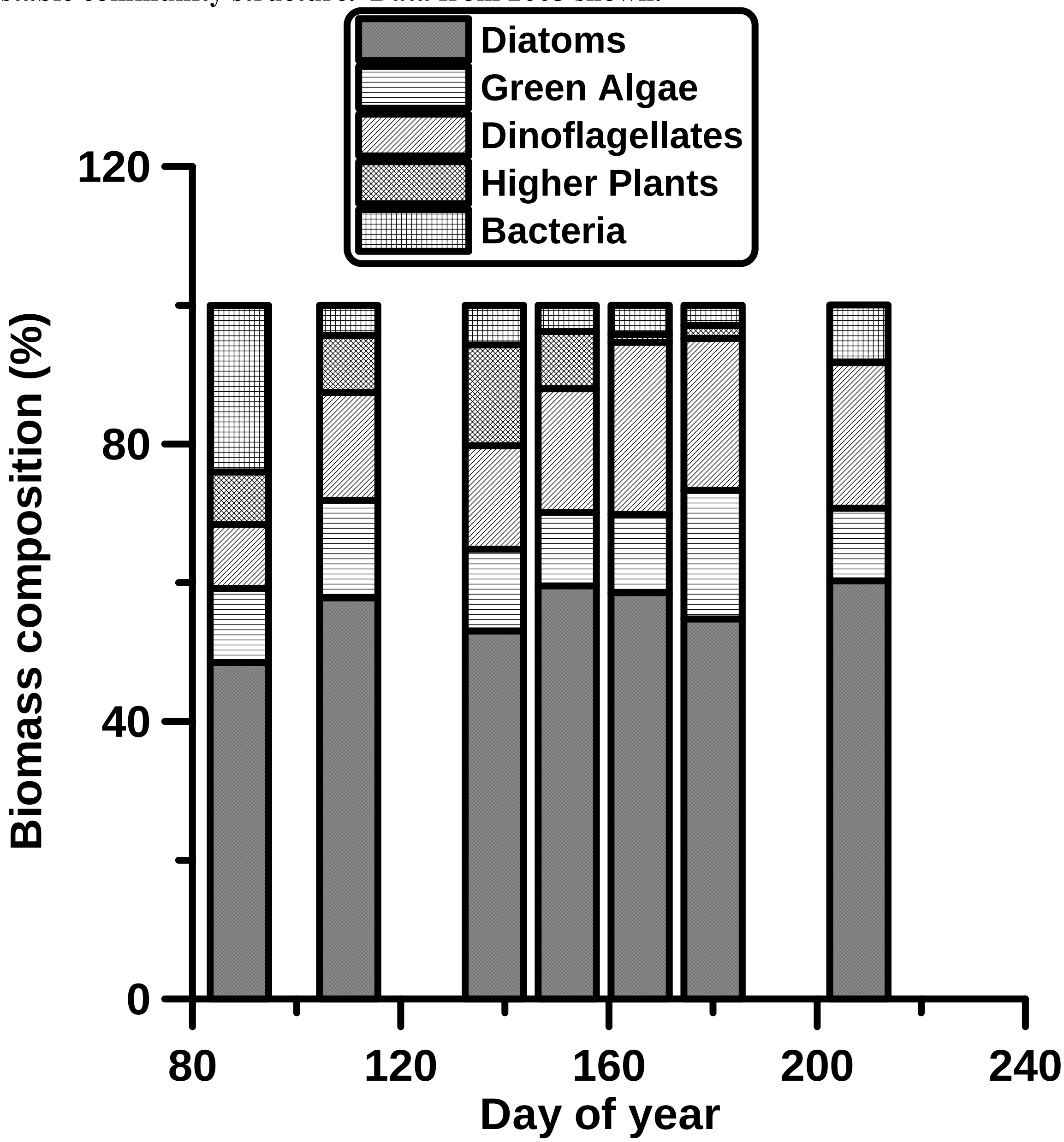


Figure 3: Phytoplankton concentration as a function of hydraulic residence time during June and July for the San Luis Drain. Mean and standard deviation for five surveys conducted between 2003 and 2005 with mean data fit using the logistic equation (eq 1).

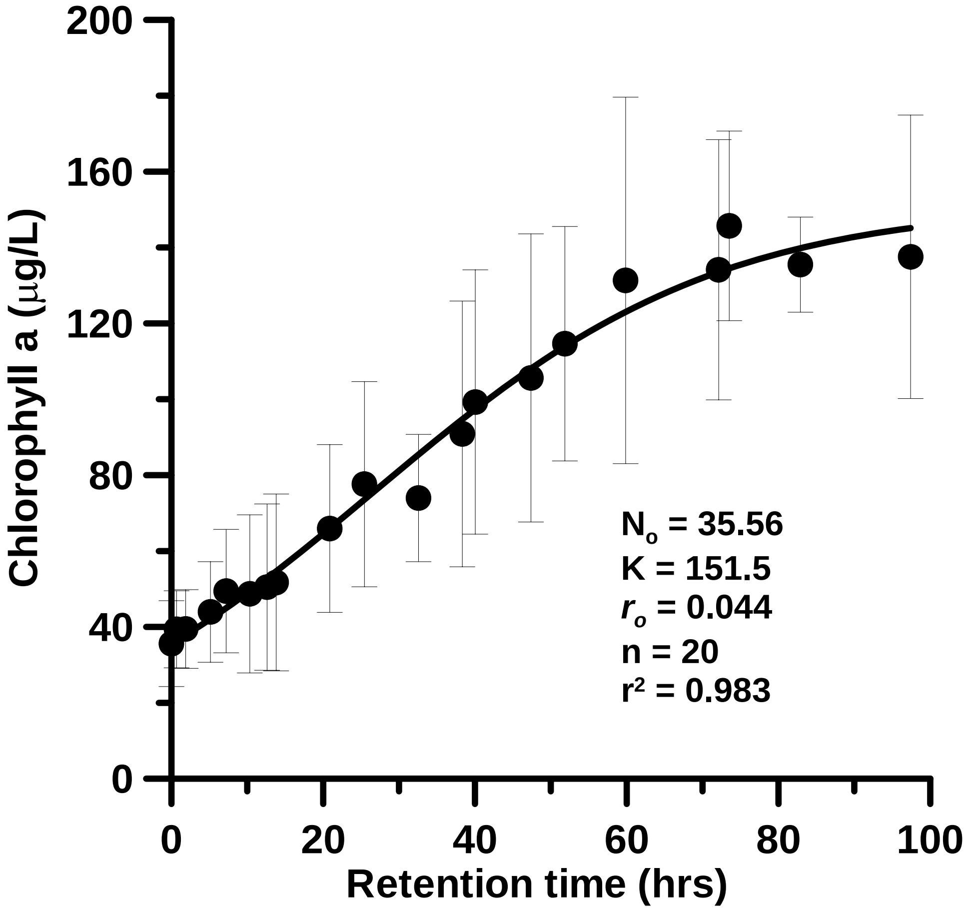


Figure 4: Sediment concentration as a function of hydraulic residence time during June and July for the San Luis Drain. Mean and standard deviation for four surveys conducted in 2003 and 2004.

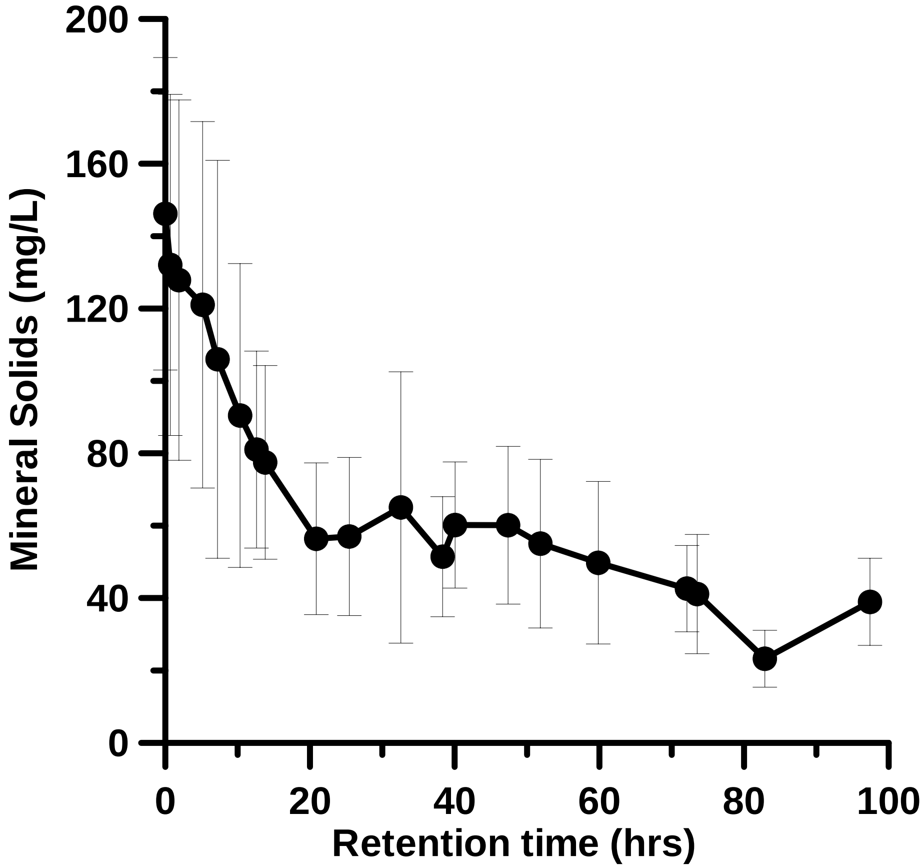


Figure 5: Phosphate concentration as a function of hydraulic residence time during June and July for the San Luis Drain. Mean and standard deviation for four surveys conducted in 2003 and 2004.

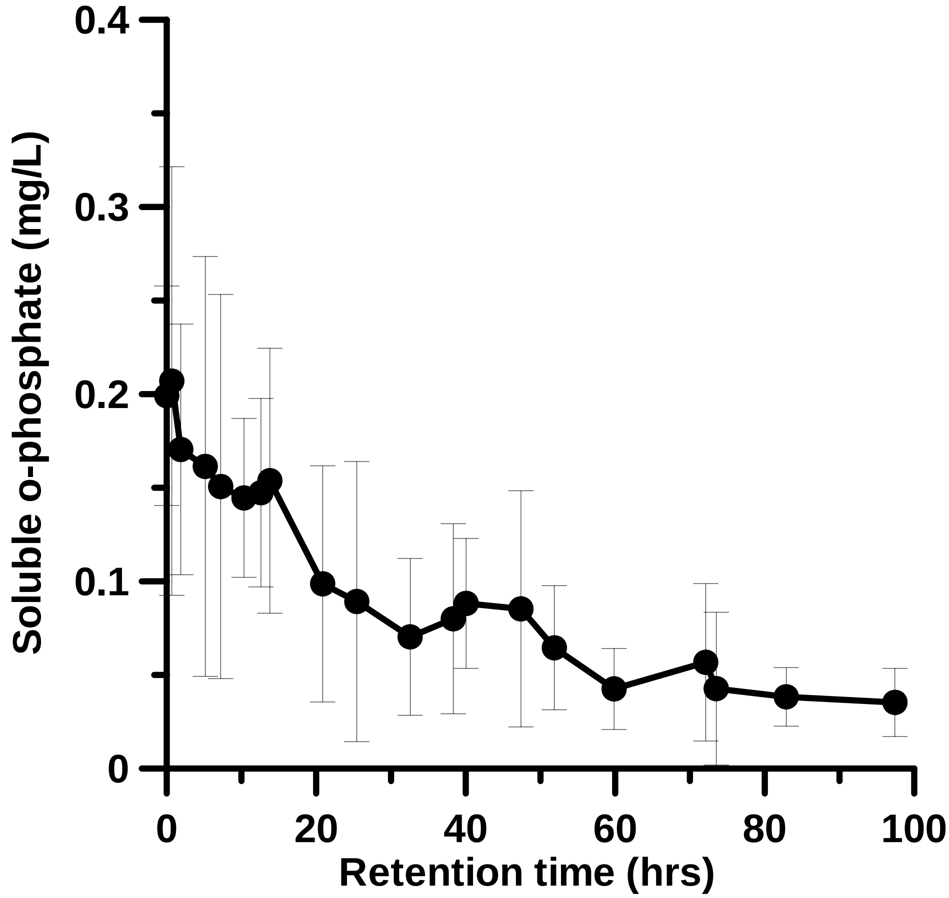


Figure 6: Depth of photic zone and observed phytoplankton growth rate as a function of hydraulic residence time during June and July for the San Luis Drain. Mean and standard deviation for four surveys conducted in 2003 and 2004. Linear least squares fit to all data, mean of all data shown.

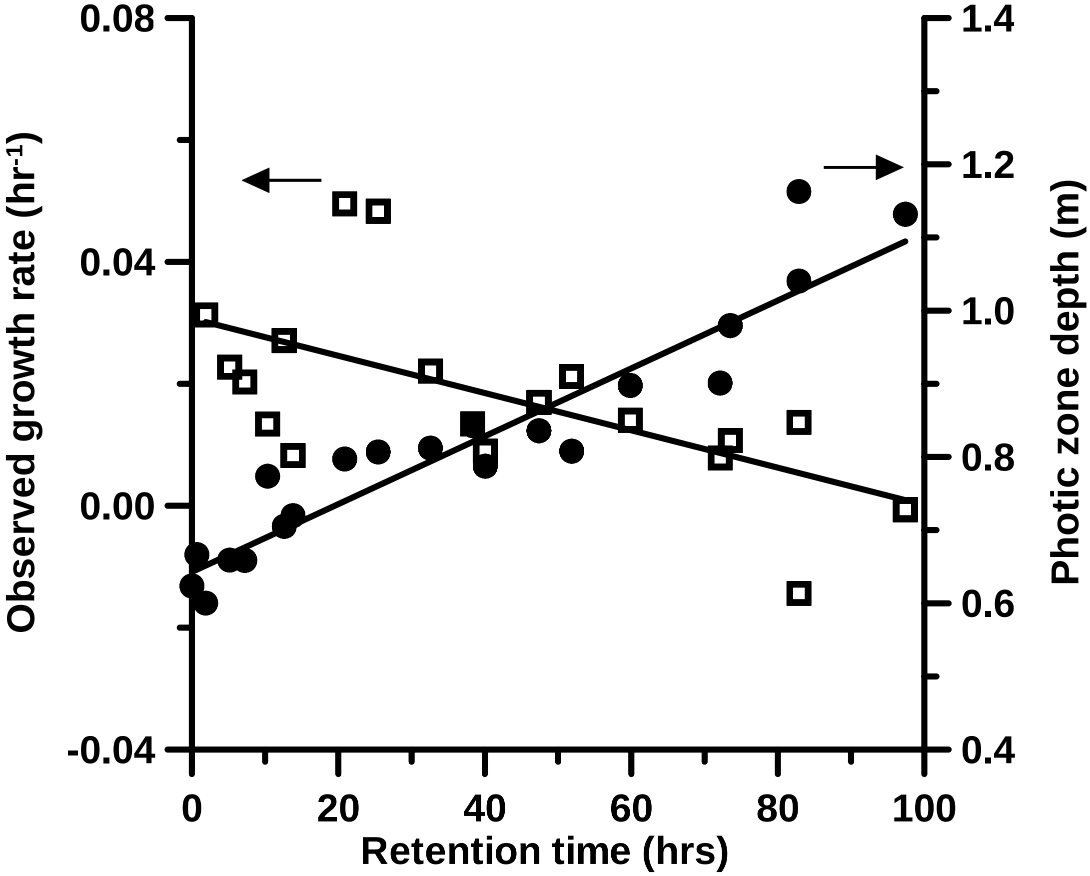


Figure 7: Mechanistic model fit to data using parameters in Table 3. Data for June and July 2003 and 2004.

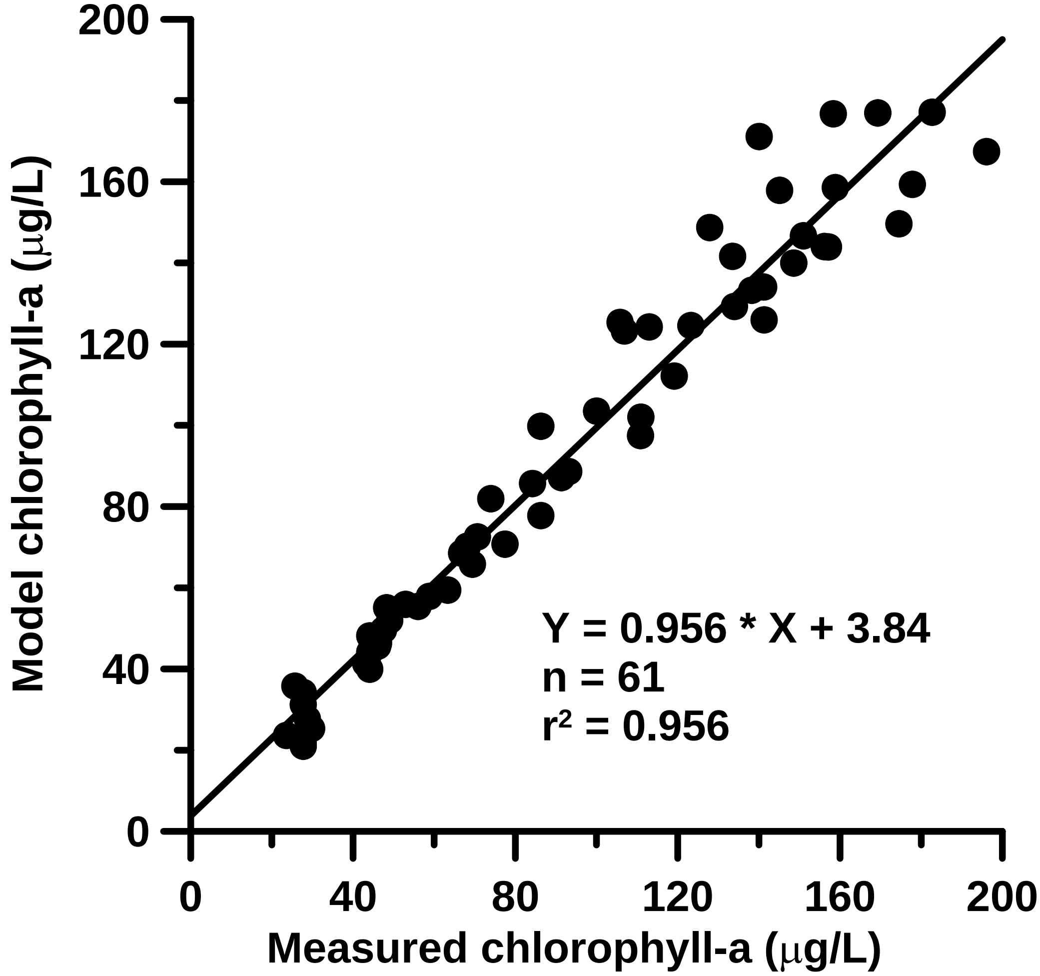
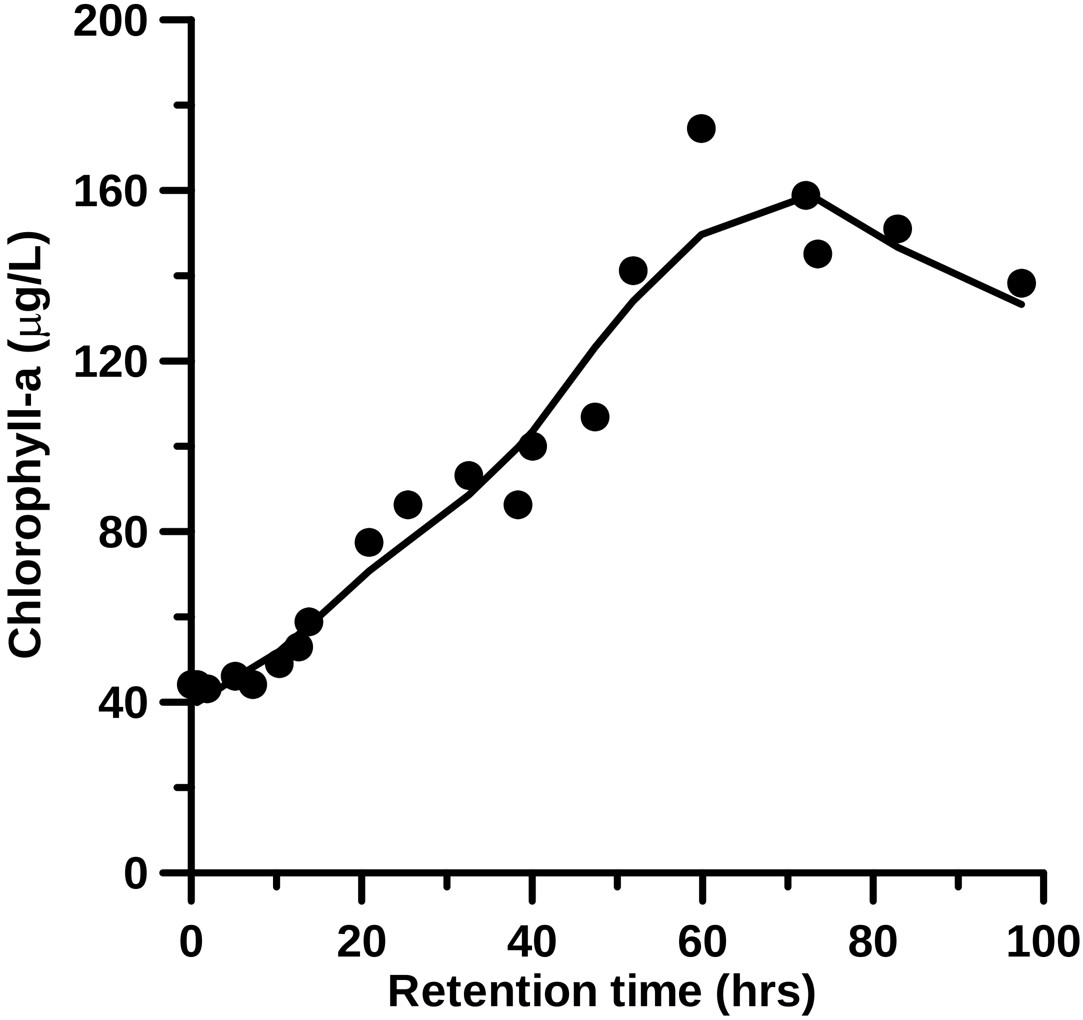


Figure 8: Model fit to data from July 13, 2004, showing decline in phytoplankton chlorophyll a at extended residence times attributed to zooplankton grazing by mechanistic model.



Appendix Q

Preliminary Results for Spatial and Temporal Dynamics of Major Cations and Anions in the San Joaquin River Watershed, 2005-2006

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March, 2007

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Abstract

Preliminary analysis of major cation and anion data is presented for 54 sampling locations within the San Joaquin River watershed for the period March 2005 to December 2007. The major cations and anions are an important water quality constituent as they contribute to the salt load and Br is an important disinfection byproduct precursor in drinking waters. Concentrations of major cations followed the general order: Na > Ca > Mg > K. For the three anions examined, the order followed: Cl > SO_4 >> Br. Major cation/anion concentrations decreased downstream along the mainstem San Joaquin River sites due to dilution from the three east-side tributaries (Merced, Tuolumne, and Stanislaus). Concentrations of Na, Ca, Mg, Cl, and SO_4 in the mainstem sites were highly predictable from electrical conductivity (EC) with r^2 values generally greater than 0.95. Thus, EC can be used as a proxy for major cations and anions in the San Joaquin River and many of its tributaries and drains.

Introduction

Major cation and anion concentrations are of considerable interest in the San Joaquin Valley as part of the Salt TMDL and the role of bromide as a precursor for disinfection byproducts. The salt TMDL has a water quality standard for electrical conductivity at Vernalis of <0.7 dS/m during the irrigation season and <1.0 dS/m during the remainder of the year. In terms of drinking water, bromide is of great concern as it forms disinfection byproducts during chlorination. The CALFED water quality program has set a guideline of <50 ppb for Br concentrations in waters exported from the Delta for drinking water purposes. In addition, major cations and anions maybe useful for determining sources of groundwater and missing agricultural drainage inputs along the San Joaquin River. In particular, the ratios of various ions can be very effective in defining the source of the waters, in particular those originating from east-side versus west-side water sources. This preliminary analysis provides information on major cations (Na, K, Ca, Mg) and anions (Cl, SO_4, Br) for 54 sampling locations within the San Joaquin Valley. Relationships between the major cations/anions and electrical conductivity are developed so that EC can be utilized as a proxy for cation/anion concentrations for selected sampling sites. Future analysis will advance these preliminary analyses.

Methods

Study area

Water samples were taken from 7 locations along the mainstem of the San Joaquin River and 47 locations in tributaries and drains (Analysis 1). Detailed sampling protocols are described in the DO TMDL QAPP (Stringfellow, 2005). Mud Slough, Salt Slough, Los Banos Creek, and San Luis Drain receive discharge from the Grasslands. Mud Slough receives tile drainage from 393 km^2 of the Grasslands Ecological Area, which includes not only wetlands, but also pasture of native vegetation. Drainage canals, such as Harding Drain (east-side), TID Laterals 6/7 (east-side), MID Lateral 5 (east-side), MID Main Drain (east-side), Westport Drain (east-side), Ramona Lake (west-side), Orestimba Creek (west-side), and Hospital Creek (west-side), run through agricultural fields to the San Joaquin River. The west-side drains (Orestimba Creek, Ramona Lake, Ingram

Creek, Del Puerto Creek, and Hospital Creek) receive mainly surface runoff from row crops and orchards, and Hospital Creek contains some tile drainage as well. The east-side Harding Drain receives treated effluent from the City of Turlock wastewater treatment plant in addition to runoff from agricultural areas.

Analytical analyses

Dissolved constituents were determined on a sample filtered through a 0.2 μm polycarbonate membrane (Millipore – formerly Nuclepore). Ion chromatography was utilized for both major anions (Cl^- and SO_4^{2-}, AS18 analytical column), and cations (Na^+, K^+, Ca^{2+}, and Mg^{2+}, CS17 analytical column) using a Dionex ICS-2000 Ion Chromatograph (Dionex Corporation, Sunnyvale, CA). Minimum detection limits were as follows (mg L^{-1}): Cl^- (0.02), Br (0.03), SO_4^{2-} (0.05), Na^+ (0.05), K^+ (0.05), Ca^{2+} (0.08) and Mg^{2+} (0.08). Because of the high ionic strength of many samples, dilutions were necessary for most samples using the following EC criteria:

Conductivity (μS/cm)	Dilution
< 150	1x
150 – 600	5x
600 – 1200	10x
1200 – 2500	20x
> 2500	50x
> 10000	100x

Thus, the actual detection limit for individual samples is the instrument detection limit multiplied by the dilution factor.

Laboratory quality assurance/quality control followed the Surface Water Ambient Monitoring Program protocols (SWAMP) set by the California State Water Resources Control Board (http://www.swrcb.ca.gov/swamp/qapp.html). This includes implementation of standard laboratory procedures including replicates, spikes, reference materials, setting of control limits, criteria for rejection, and data validation methods. Detailed sampling, handling and analytical protocols are described in the DO TMDL QAPP (Stringfellow, 2005).

Results

A summary of the overall major cation and anion concentrations for 7 mainstem sites and 19 tributaries and drains is shown in Tables 1 & 2.

A summary of the regression analyses for major cation and anion concentrations as a function of electrical conductivity are shown in Tables 3a-3f.

Analysis 1 provides summary statistics for all 54 sampling locations.

Table 1: Summary of major cation concentrations for the 7 mainstem sites along the San Joaquin River and the 19 tributaries and drains monitored in this study for the period March 2005 to December 2007. The mean (X), standard deviation (SD), minimum (min), maximum (max), and number of samples (n) are listed for each site.

	River mile	**Na (mg/L)**			**K (mg/L)**			**Mg (mg/L)**			**Ca (mg/L)**		
		X± SD	**Min Max**	**n**	**X± SD**	**Min Max**	**n**	**X± SD**	**Min Max**	**n**	**X± SD**	**Min Max**	**n**
SJR-Mossdale	56.2	57.9 (28.2)	9.2 102.2	65	2.7 (1.0)	1.1 5.2	65	14.0 (6.4)	3.2 24.8	65	29.4 (12.6)	8.2 52.4	65
SJR- Vernalis	72.2	57.8 (27.3)	8.5 100.0	73	2.6 (1.0)	1.0 5.1	73	14.3 (6.5)	3.1 24.5	73	29.1 (12.0)	8.1 48.5	73
SJR – Maze	77.4	81.6 (40.6)	9.5 145.1	70	3.4 (1.5)	1.1 7.5	70	18.8 (9.0)	3.2 33.4	70	37.1 (16.3)	8.4 59.5	70
SJR – Laird Park	91.0	119.5 (157.1)	13.4 801.6	22	3.5 (1.9)	0.6 10.5	22	23.6 (22.0)	2.3 114.8	22	53.1 (65.7)	5.1 338.6	22
SJR – Patterson	99.4	118.5 (54.7)	11.4 216.4	75	4.6 (2.0)	1.2 9.3	75	24.1 (10.5)	3.1 41.5	75	50.2 (20.2)	8.8 84.2	75
SJR – Crows Landing	108.6	121.7 (54.6)	13.7 235.2	80	3.9 (1.6)	1.1 7.9	80	24.8 (10.5)	3.1 45.8	80	49.9 (19.5)	8.6 85.7	80
SJR – Lander Ave.	131.9	130.8 (78.0)	4.0 280.1	83	4.6 (2.2)	0.6 9.9	83	20.3 (10.3)	1.3 38.7	83	52.6 (24.7)	5.4 90.7	83
Stanislaus	74.9	4.7 (1.6)	2.7 11.2	67	1.1 (0.3)	0.7 2.2	67	3.6 (1.3)	2.2 9.7	67	9.1 (1.6)	6.3 15.0	67
Tuolumne	83.8	11.3 (7.1)	2.2 26.4	68	1.6 (1.5)	0.5 11.0	68	4.9 (2.3)	1.9 9.9	68	12.1 (5.7)	4.6 22.9	68
Merced	118.2	13.7 (12.0)	2.0 52.5	67	1.2 (0.6)	0.4 3.3	67	4.5 (2.8)	1.4 13.2	67	13.4 (8.5)	4.7 41.0	67
Salt Slough	129	175.4 (56.1)	91.8 394.7	103	5.9 (1.6)	3.1 14.7	103	33.9 (9.6)	19.3 66.7	103	69.4 (16.5)	43.4 120.5	103
Salt Slough -Wolfsen	-	172.8 (39.6)	110.8 262.5	30	6.0 (1.7)	3.8 10.9	30	40.3 (7.9)	26.9 54.3	30	76.5 (14.4)	41.8 102.8	30
San Luis Drain	-	691.5 (148.9)	55.1 1043.9	73	11.5 (3.9)	3.3 27.8	73	110.8 (102.2)	15.6 957.3	73	294.9 (61.3)	25.9 403.3	73
Mud Slough	122.7	416.6 (174.7)	12.6 762.9	77	8.6 (2.3)	1.2 14.3	77	66.8 (23.2)	4.4 117.7	77	156.7 (61.2)	13.3 292.2	77

Table 1: (continued)	River mile	Na (mg/L)			K (mg/L)			Mg (mg/L)			Ca (mg/L)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
Los Banos	121.0	202.6 (105.1)	53.0 560.6	66	8.3 (2.9)	3.6 17.3	66	49.6 (22.8)	16.8 118.3	66	67.6 (22.2)	30.5 134.7	66
TID Lat. 6/7	110.9	57.5 (22.7)	25.6 125.0	35	5.7 (2.4)	3.1 12.5	35	16.0 (4.5)	9.5 32.9	35	52.7 (14.7)	29.4 112.2	35
Orestimba Crk	109.3	62.5 (25.8)	13.2 160.4	58	3.5 (1.4)	1.6 9.3	58	27.4 (11.3)	5.3 48.9	58	52.8 (21.4)	11.3 94.8	58
Ramona Lake - In	-	190.0 (41.3)	112.0 276.3	16	6.2 (1.5)	4.2 9.5	16	42.3 (9.0)	24.6 58.6	16	87.8 (17.3)	53.4 121.9	16
Ramona Lake - Out	108	172.8 (39.6)	110.8 262.5	29	6.0 (1.7)	3.8 10.9	29	40.3 (7.9)	26.9 54.3	29	76.5 (14.4)	41.8 102.8	29
Harding Drain	101	84.6 (32.8)	16.0 157.8	64	11.8 (6.2)	1.3 29.4	64	12.3 (3.5)	5.1 20.5	64	46.7 (14.9)	18.6 90.6	64
Del Puerto Crk	93.3	101.9 (39.3)	33.3 183.6	58	4.4 (2.0)	1.4 10.0	58	36.2 (14.9)	8.1 75.2	58	48.3 (15.7)	19.8 92.1	58
Westport Drain	93	60.1 (69.5)	12.8 145.8	50	3.6 (4.6)	1.0 33.1	50	14.6 (16.9)	3.9 33.4	50	56.5 (60.1)	13.6 112.8	50
MID Lat. 5 - Tuol.	83	12.2 (16.1)	1.8 66.5	29	1.6 (1.4)	0.4 5.6	29	4.6 (5.2)	1.2 20.2	29	11.7 (10.6)	3.1 46.2	29
Ingram Crk	82.8	116.9 (55.8)	24.0 278.0	44	4.4 (1.9)	1.9 11.1	44	29.2 (13.6)	6.8 66.0	44	62.2 (29.9)	18.0 151.2	44
Hospital Crk	82.8	49.1 (25.3)	14.6 87.2	17	4.1 (1.8)	1.9 7.7	17	13.0 (5.4)	4.1 23.3	17	29.4 (12.3)	10.6 57.8	17
MID Main – Stan.	76.0	30.7 (26.2)	4.3 158.1	41	5.4 (3.4)	0.7 18.0	41	14.4 (7.5)	2.2 37.6	41	32.8 (14.9)	6.2 69.2	41

Table 2: Summary of major anion concentrations for the 7 mainstem sites along the San Joaquin River and the 19 tributaries and drains monitored in this study for the period March 2005 to December 2007. The mean (X), standard deviation (SD), minimum (min), maximum (max), and number of samples (n) are listed for each site.

	River mile	Cl (mg/L)			SO_4 (mg/L)			Br (mg/L)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
SJR-Mossdale	56.2	64.1 (34.3)	7.2 123.3	65	57.7 (26.0)	8.4 99.8	65	0.7 (0.4)	0.1 1.7	65
SJR- Vernalis	72.2	62.9 (31.9)	6.3 112.3	73	57.2 (24.9)	8.0 98.4	73	0.5 (0.3)	0.1 1.5	73
SJR – Maze	77.4	89.7 (47.8)	7.2 160.2	70	82.3 (38.8)	8.7 159.9	70	0.9 (0.6)	0.1 3.5	70
SJR – Laird Park	91.0	113.9 (121.3)	12.6 624.8	22	173.2 (364.6)	15.2 1794.5	22	1.2 (2.1)	0.1 10.5	22
SJR – Patterson	99.4	122.6 (59.0)	8.8 231.6	75	131.4 (59.3)	11.3 251.4	75	1.2 (0.7)	0.1 2.7	75
SJR – Crows Landing	108.6	125.0 (58.2)	11.3 244.9	80	139.4 (64.7)	16.6 294.7	80	1.2 (0.7)	0.1 3.2	80
SJR - Lander	131.9	157.1 (99.1)	2.2 334.1	83	82.0 (48.8)	2.8 192.7	83	1.0 (0.7)	0.1 4.2	83
Stanislaus	74.9	3.2 (1.8)	1.0 9.6	67	3.8 (1.3)	1.9 10.3	67	<0.1 (0.1)	<0.1 0.3	67
Tuolumne	83.8	10.7 (8.0)	0.9 (35.7)	68	6.2 (3.4)	1.8 13.5	68	0.2 (0.2)	<0.1 0.6	68
Merced	118.2	10.9 (10.3)	0.8 44.3	67	9.8 (7.7)	1.7 35.9	67	0.2 (0.2)	<0.1 0.8	67
Salt Slough	129	201.1 (68.2)	89.0 476.2	103	180.6 (66.1)	73.3 430.5	103	1.7 (0.9)	0.3 4.8	103
Salt Slough -Wolfsen	-	198.9 (62.3)	67.6 317.7	30	191.6 (69.9)	60.7 328.2	30	1.6 (0.8)	0.6 3.9	30
San Luis Drain	-	548.0 (105.8)	64.1 832.8	73	1513.6 (304.2)	43.9 2107.6	73	6.1 (3.0)	0.5 13.4	73

Table 2: (continued)	River mile	Cl (mg/L)			SO_4 (mg/L)			Br (mg/L)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
Mud Slough	122.7	350.1 (141.2)	10.6 640.7	77	724.2 (372.3)	10.1 1449.1	77	3.6 (2.0)	0.1 9.0	77
Los Banos	121.0	191.2 (92.3)	56.5 459.1	66	200.7 (112.3)	37.8 498.3	66	2.0 (1.2)	0.3 4.6	66
TID Lat. 6/7	110.9	47.3 (17.6)	20.5 97.8	35	33.3 (13.9)	13.7 81.2	35	0.8 (0.5)	<0.1 2.3	35
Orestimba Crk	109.3	72.3 (32.7)	7.9 165.9	58	99.4 (49.2)	16.3 207.5	58	1.0 (0.6)	0.2 2.8	58
Ramona Lake - In	-	191.4 (42.9)	115.2 267.3	16	279.1 (58.1)	173.3 373.5	16	2.2 (1.3)	0.8 5.4	16
Ramona Lake - Out	108	170.4 (40.9)	114.5 259.8	29	248.7 (56.4)	164.8 372.2	29	1.7 (1.1)	0.3 4.6	29
Harding Drain	101	82.5 (37.4)	8.0 176.7	64	37.2 (13.3)	9.7 70.6	64	0.7 (0.5)	<0.1 1.9	64
Del Puerto Crk	93.3	112.7 (48.4)	15.7 202.5	58	128.8 (57.9)	21.2 281.4	58	1.1 (0.7)	<0.1 3.0	58
Westport Drain	93	45.4 (25.0)	5.7 140.8	50	38.5 (20.6)	8.5 84.2	50	0.9 (0.8)	<0.1 2.5	50
MID Lat. 5 - Tuol.	83	12.1 (18.8)	0.7 80.8	29	7.8 (14.1)	1.2 57.4	29	0.1 (0.2)	<0.1 0.9	29
Ingram Crk	82.8	135.3 (71.0)	22.6 323.3	44	135.5 (73.1)	26.7 357.1	44	1.4 (0.9)	<0.1 3.5	44
Hospital Crk	82.8	53.6 (32.3)	12.2 127.0	17	50.8 (31.5)	15.5 108.8	17	0.4 (0.3)	<0.1 1.2	17
MID Main – Stan.	76.0	20.2 (27.5)	1.5 173.0	41	19.2 (24.7)	2.4 158.3	41	0.4 (0.5)	<0.1 2.1	41

Table 3a: Regression analysis for predicting sodium (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	Na = 125.58 EC – 2.93	0.98
SJR at Vernalis	5	Na = 128.31 EC – 4.12	0.98
SJR at Maze	6	Na = 132.68 EC – 4.82	0.99
SJR at Patterson	7	Na = 139.45 EC – 4.69	0.98
SJR at Crows Landing	8	Na = 143.92 EC – 9.12	0.99
SJR at Lander Avenue	10	Na = 155.75 EC – 12.40	0.97
Stanislaus River at Caswell Park	12	Na = 62.95 EC – 0.90	0.84
Tuolumne River at Shiloh Bridge	14	Na = 91.11 EC – 1.81	0.99
Merced River at River Road	16	Na = 105.83 EC – 2.24	0.95
Mud Slough near Gustine	18	Na = 176.96 EC – 47.33	0.98
Salt Slough at Lander Avenue	19	Na = 160.54 EC – 25.68	0.95
Los Banos Creek at Highway 140	20	Na = 181.24 EC – 50.32	0.97
Orestimba Creek at River Road	21	Na = 69.76 EC + 11.49	0.80
MID Main Drain to Stan. R. via Miller Lake	25	Na = 48.93 EC + 9.00	0.12
Turlock ID Westport Drain Flow Station	28	Na = 123.65 EC – 13.52	0.91
Turlock ID Harding Drain	29	Na = 136.63 EC – 9.36	0.93
Turlock ID Lateral 6 & 7 at Levee	30	Na = 139.24 EC – 27.80	0.87
Ingram Creek Flow Station	34	Na = 133.02 EC – 12.20	0.98
Del Puerto Creek Flow Station	36	Na = 118.91 EC – 1.48	0.87
San Luis Drain End	44	Na = 183.67 EC – 98.90	0.84
Salt Slough at Wolfsen Road	53	Na = 165.63 EC – 34.86	0.97
Ramona Lake Drain at Levee	57	Na = 156.65 EC – 34.19	0.95

Table 3b: Regression analysis for predicting potassium (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	K = 3.77 EC + 0.85	0.66
SJR at Vernalis	5	K = 3.74 EC + 0.78	0.67
SJR at Maze	6	K = 4.22 EC + 0.67	0.72
SJR at Patterson	7	K = 4.28 EC + 0.82	0.69
SJR at Crows Landing	8	K = 3.33 EC + 0.89	0.64
SJR at Lander Avenue	10	K = 3.60 EC + 1.20	0.73
Stanislaus River at Caswell Park	12	K = 10.94 EC + 0.12	0.55
Tuolumne River at Shiloh Bridge	14	K = 11.62 EC - 0.05	0.38
Merced River at River Road	16	K = 3.99 EC + 0.58	0.59
Mud Slough near Gustine	18	K = 0.81 EC + 6.55	0.12
Salt Slough at Lander Avenue	19	K = 2.10 EC + 3.29	0.19
Los Banos Creek at Highway 140	20	K = 3.99 EC + 2.80	0.6
Orestimba Creek at River Road	21	K = 2.66 EC + 1.51	0.35
MID Main Drain to Stan. R. via Miller Lake	25	Not significant	
Turlock ID Westport Drain Flow Station	28	Not significant	
Turlock ID Harding Drain	29	K = 22.69 EC – 3.82	0.69
Turlock ID Lateral 6 & 7 at Levee	30	K = 13.00 EC – 2.24	0.59
Ingram Creek Flow Station	34	K = 126.21 EC + 23.49	0.16
Del Puerto Creek Flow Station	36	K = 2.85 EC + 1.96	0.19
San Luis Drain End	44	Not significant	
Salt Slough at Wolfsen Road	53	K = 2.35 EC + 2.71	0.45
Ramona Lake Drain at Levee	57	K = 3.30 EC + 1.73	0.25

Table 3c: Regression analysis for predicting magnesium (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	Mg = 28.50 EC + 0.19	0.97
SJR at Vernalis	5	Mg = 29.95 EC – 0.19	0.96
SJR at Maze	6	Mg = 28.96 EC – 0.06	0.97
SJR at Patterson	7	Mg = 26.43 EC + 0.63	0.96
SJR at Crows Landing	8	Mg = 26.92 EC + 0.42	0.94
SJR at Lander Avenue	10	Mg = 19.86 EC + 2.29	0.88
Stanislaus River at Caswell Park	12	Mg = 42.55 EC – 0.27	0.65
Tuolumne River at Shiloh Bridge	14	Mg = 29.58 EC + 0.64	0.98
Merced River at River Road	16	Mg = 22.60 EC + 1.07	0.77
Mud Slough near Gustine	18	Mg = 23.03 EC + 6.57	0.96
Salt Slough at Lander Avenue	19	Mg = 27.14 EC – 0.24	0.91
Los Banos Creek at Highway 140	20	Mg = 38.92 EC – 4.56	0.96
Orestimba Creek at River Road	21	Mg = 43.05 EC – 2.59	0.95
MID Main Drain to Stan. R. via Miller Lake	25	Mg = 29.81 EC + 3.71	0.17
Turlock ID Westport Drain Flow Station	28	Mg = 25.30 EC + 0.10	0.86
Turlock ID Harding Drain	29	Mg = 13.91 EC + 2.65	0.82
Turlock ID Lateral 6 & 7 at Levee	30	Mg = 22.15 EC + 2.16	0.79
Ingram Creek Flow Station	34	Mg = 31.84 EC – 1.67	0.95
Del Puerto Creek Flow Station	36	Mg = 42.21 EC – 1.08	0.74
San Luis Drain End	44	Not significant	
Salt Slough at Wolfsen Road	53	Mg = 30.29 EC – 3.87	0.94
Ramona Lake Drain at Levee	57	Mg = 29.40 EC + 1.11	0.86

Table 3d: Regression analysis for predicting calcium (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	Ca = 55.76 EC + 2.48	0.98
SJR at Vernalis	5	Ca = 56.02 EC + 2.12	0.97
SJR at Maze	6	Ca = 52.80 EC + 2.79	0.98
SJR at Patterson	7	Ca = 51.36 EC + 4.90	0.96
SJR at Crows Landing	8	Ca = 50.73 EC + 3.87	0.98
SJR at Lander Avenue	10	Ca = 49.61 EC + 7.46	0.95
Stanislaus River at Caswell Park	12	Ca = 63.69 EC + 3.37	0.84
Tuolumne River at Shiloh Bridge	14	Ca = 72.25 EC + 1.73	0.99
Merced River at River Road	16	Ca = 66.72 EC + 3.26	0.75
Mud Slough near Gustine	18	Ca = 60.93 EC – 3.02	0.95
Salt Slough at Lander Avenue	19	Ca = 44.45 EC + 13.50	0.87
Los Banos Creek at Highway 140	20	Ca = 36.83 EC + 16.25	0.90
Orestimba Creek at River Road	21	Ca = 82.22 EC – 3.49	0.92
MID Main Drain to Stan. R. via Miller Lake	25	Ca = 73.80 EC + 7.84	0.19
Turlock ID Westport Drain Flow Station	28	Ca = 89.82 EC + 0.48	0.90
Turlock ID Harding Drain	29	Ca = 61.77 EC + 3.93	0.87
Turlock ID Lateral 6 & 7 at Levee	30	Ca = 76.24 EC + 5.48	0.85
Ingram Creek Flow Station	34	Ca = 69.26 EC – 5.52	0.91
Del Puerto Creek Flow Station	36	Ca = 44.79 EC + 9.09	0.75
San Luis Drain End	44	Ca = 64.04 EC + 20.23	0.59
Salt Slough at Wolfsen Road	53	Ca = 50.78 EC + 4.87	0.85
Ramona Lake Drain at Levee	57	Ca = 49.51 EC + 9.90	0.73

Table 3e: Regression analysis for predicting chloride (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	Cl = 152.89 EC – 9.96	0.98
SJR at Vernalis	5	Cl = 150.29 EC – 9.65	0.99
SJR at Maze	6	Cl = 156.39 EC – 12.17	0.99
SJR at Patterson	7	Cl = 151.01 EC – 10.70	0.98
SJR at Crows Landing	8	Cl = 153.02 EC – 13.98	0.99
SJR at Lander Avenue	10	Cl = 200.15 EC – 26.16>	0.97
Stanislaus River at Caswell Park	12	Cl = 72.24 EC – 3.29	0.79
Tuolumne River at Shiloh Bridge	14	Cl = 99.61 EC – 3.60	0.94
Merced River at River Road	16	Cl = 92.06 EC – 3.00	0.97
Mud Slough near Gustine	18	Cl = 141.48 EC – 20.61	0.96
Salt Slough at Lander Avenue	19	Cl = 162.44 EC – 1.28	0.65
Los Banos Creek at Highway 140	20	Cl = 158.57 EC – 30.44	0.96
Orestimba Creek at River Road	21	Cl = 108.34 EC – 4.53	0.83
MID Main Drain to Stan. R. via Miller Lake	25	Not significant	
Turlock ID Westport Drain Flow Station	28	Cl = 60.60 EC + 5.15	0.42
Turlock ID Harding Drain	29	Cl = 152.07 EC – 22.07	0.89
Turlock ID Lateral 6 & 7 at Levee	30	Cl = 102.27 EC – 15.10	0.69
Ingram Creek Flow Station	34	Cl = 166.94 EC – 26.11	0.97
Del Puerto Creek Flow Station	36	Cl = 139.68 EC – 8.24	0.82
San Luis Drain End	44	Cl = 134.35 EC – 33.20	0.79
Salt Slough at Wolfsen Road	53	Cl = 189.62 EC – 48.43	0.95
Ramona Lake Drain at Levee	57	Cl = 163.00 EC – 45.48	0.95

Table 3f: Regression analysis for predicting sulfate (mg/L) from electrical conductivity (mS/cm) for sites in the San Joaquin Valley (n>30 for each site).

Site Name	Site ID	Regression Equation	r^2
SJR at Mossdale	4	SO_4 = 113.86 EC + 2.68	0.95
SJR at Vernalis	5	SO_4 = 114.13 EC + 2.06	0.93
SJR at Maze	6	SO_4 = 124.47 EC + 1.26	0.95
SJR at Patterson	7	SO_4 = 148.36 EC + 0.22	0.93
SJR at Crows Landing	8	SO_4 = 161.44 EC – 7.28	0.88
SJR at Lander Avenue	10	SO_4 = 94.18 EC – 3.71	0.87
Stanislaus River at Caswell Park	12	SO_4 = 48.07 EC – 0.53	0.88
Tuolumne River at Shiloh Bridge	14	SO_4 = 43.92 EC – 0.10	0.98
Merced River at River Road	16	SO_4 = 66.36 EC – 0.24	0.92
Mud Slough near Gustine	18	SO_4 = 378.37 EC – 269.79	0.96
Salt Slough at Lander Avenue	19	SO_4 = 162.38 EC – 23.52	0.78
Los Banos Creek at Highway 140	20	SO_4 = 185.48 EC – 58.03	0.89
Orestimba Creek at River Road	21	SO_4 = 180.38 EC – 25.09	0.86
MID Main Drain to Stan. R. via Miller Lake	25	Not significant	
Turlock ID Westport Drain Flow Station	28	SO_4 = 71.36 EC – 9.37	0.89
Turlock ID Harding Drain	29	SO_4 = 54.12 EC – 0.06	0.88
Turlock ID Lateral 6 & 7 at Levee	30	SO_4 = 68.36 EC – 9.54	0.84
Ingram Creek Flow Station	34	SO_4 = 168.96 EC – 27.32	0.95
Del Puerto Creek Flow Station	36	SO_4 = 172.95 EC – 22.19	0.82
San Luis Drain End	44	SO_4 = 410.58 EC – 265.70	0.94
Salt Slough at Wolfsen Road	53	SO_4 = 207.08 EC – 78.01	0.91
Ramona Lake Drain at Levee	57	SO_4 = 223.79 EC – 49.21	0.92

Analysis 1: Summary statistics for all 54 sampling locations.

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
4	SJR at Mossdale	N of cases	65	65	65	65	65	65	65	65
		Minimum	0.042	9.2	1.1	3.2	8.2	7.2	8.4	0.1
		Maximum	0.810	102.2	5.2	24.8	52.4	123.3	99.8	1.7
		Median	0.492	58.8	2.6	14.7	29.3	65.8	58.9	0.5
		Mean	0.478	57.9	2.7	14.0	29.4	64.1	57.7	0.7
		Standard Dev	0.229	28.2	1.0	6.4	12.6	34.3	26.0	0.4
5	SJR at Vernalis	N of cases	74	73	73	73	73	73	73	73
		Minimum	0.094	8.5	1.0	3.1	8.1	6.3	8.0	0.1
		Maximum	0.800	100.0	5.1	24.5	48.5	112.3	98.4	1.5
		Median	0.493	60.4	2.5	14.5	29.7	63.3	62.8	0.4
		Mean	0.478	57.8	2.6	14.3	29.1	62.9	57.2	0.5
		Standard Dev	0.216	27.3	1.0	6.5	12.0	31.9	24.9	0.3
6	SJR at Maze	N of cases	69	70	70	70	70	70	70	70
		Minimum	0.104	9.5	1.1	3.2	8.4	7.2	8.7	0.1
		Maximum	1.080	145.1	7.5	33.4	59.5	160.2	159.9	3.5
		Median	0.656	81.5	3.4	19.4	37.2	88.8	87.9	0.8
		Mean	0.656	81.6	3.4	18.8	37.1	89.7	82.3	0.9
		Standard Dev	0.303	40.6	1.5	9.0	16.3	47.8	38.8	0.6
7	SJR at Patterson	N of cases	76	75	75	75	75	75	75	75
		Minimum	0.117	11.4	1.2	3.1	8.8	8.8	11.3	0.1
		Maximum	1.560	216.4	9.3	41.5	84.2	231.6	251.4	2.7
		Median	0.952	133.6	4.7	26.8	54.8	136.2	145.5	1.0
		Mean	0.868	118.5	4.6	24.1	50.2	122.6	131.1	1.2
		Standard Dev	0.387	54.7	2.0	10.5	20.2	59.0	59.3	0.7
8	SJR at Crows Landing	N of cases	81	80	80	80	80	80	80	80
		Minimum	0.002	13.7	1.1	3.1	8.6	11.3	16.6	0.1
		Maximum	1.660	235.2	7.9	45.8	85.7	244.9	294.7	3.2
		Median	1.005	134.4	4.0	27.1	55.6	140.3	147.3	1.1
		Mean	0.898	121.7	3.9	24.8	49.9	125.0	139.4	1.2
		Standard Dev	0.392	54.6	1.6	10.5	19.5	58.2	64.7	0.7

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
10	SJR at Lander Avenue	N of cases	83	83	83	83	83	83	83	83
		Minimum	0.049	4.0	0.6	1.3	5.4	2.2	2.8	0.1
		Maximum	1.670	280.1	9.9	38.7	90.7	334.1	192.7	4.2
		Median	1.020	152.2	4.6	21.3	56.9	184.5	87.2	1.0
		Mean	0.901	130.8	4.6	20.3	52.6	157.1	82.0	1.0
		Standard Dev	0.485	78.0	2.2	10.3	24.7	99.1	48.8	0.7
11	French Camp Slough	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.099	5.5	1.5	3.2	9.2	3.2	4.5	0.0
		Maximum	0.736	92.2	3.6	18.3	44.7	103.5	97.8	0.8
		Median	0.616	71.8	3.3	16.1	34.1	80.1	73.9	0.5
		Mean	0.477	53.6	3.0	12.8	28.8	58.0	60.5	0.5
		Standard Dev	0.254	35.8	0.8	5.6	13.1	41.1	35.6	0.3
12	Stanislaus River at Caswell Park	N of cases	67	67	67	67	67	67	67	67
		Minimum	0.059	2.7	0.7	2.2	6.3	1.0	1.9	0.0
		Maximum	0.415	11.2	2.2	9.7	15.0	9.6	10.3	0.3
		Median	0.090	4.6	1.0	3.4	8.8	3.2	3.5	0.0
		Mean	0.094	4.7	1.1	3.6	9.1	3.2	3.8	0.0
		Standard Dev	0.046	1.6	0.3	1.3	1.6	1.8	1.3	0.1
14	Tuolumne River at Shiloh Bridge	N of cases	68	68	68	68	68	68	68	68
		Minimum	0.041	2.2	0.5	1.9	4.6	0.9	1.8	0.0
		Maximum	0.494	26.4	11.0	9.9	22.9	35.7	13.5	0.6
		Median	0.140	10.2	1.3	4.7	11.3	9.1	5.8	0.1
		Mean	0.149	11.3	1.6	4.9	12.1	10.7	6.2	0.2
		Standard Dev	0.089	7.1	1.5	2.3	5.7	8.0	3.4	0.2
16	Merced River at River Road	N of cases	67	67	67	67	67	67	67	67
		Minimum	0.036	2.0	0.4	1.4	4.7	0.8	1.7	0.0
		Maximum	0.569	52.5	3.3	13.2	41.0	44.3	35.9	0.8
		Median	0.094	7.4	1.0	3.1	9.3	5.6	5.3	0.1
		Mean	0.152	13.7	1.2	4.5	13.4	10.9	9.8	0.2
		Standard Dev	0.114	12.0	0.6	2.8	8.5	10.3	7.7	0.2

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
18	Mud Slough near Gustine	N of cases	77	77	77	77	77	77	77	77
		Minimum	1.118	12.6	1.2	4.4	13.3	10.6	10.1	0.1
		Maximum	4.710	762.9	14.3	117.7	292.2	640.7	1449.1	9.0
		Median	2.610	410.1	8.5	68.0	157.8	345.1	680.8	3.0
		Mean	2.643	416.6	8.6	66.8	156.7	350.1	724.2	3.6
		Standard Dev	0.943	174.7	2.3	23.2	61.2	141.2	372.3	2.0
19	Salt Slough at Lander Avenue	N of cases	102	103	103	103	103	103	103	103
		Minimum	0.499	91.8	3.1	19.3	43.4	89.0	73.3	0.3
		Maximum	2.379	394.7	14.7	66.7	120.5	476.2	430.5	4.8
		Median	1.183	162.4	5.8	31.8	67.1	188.6	159.6	1.5
		Mean	1.239	175.4	5.9	33.9	69.4	201.1	180.6	1.7
		Standard Dev	0.342	56.1	1.6	9.6	16.5	68.2	66.1	0.9
20	Los Banos Creek at Highway 140	N of cases	66	66	66	66	66	66	66	66
		Minimum	0.499	53.0	3.6	16.8	30.5	56.5	37.8	0.3
		Maximum	3.154	560.6	17.3	118.3	134.7	459.1	498.3	4.6
		Median	1.250	174.8	7.9	45.3	64.8	172.9	180.3	1.6
		Mean	1.386	202.6	8.3	49.6	67.6	191.2	200.7	2.0
		Standard Dev	0.579	105.1	2.9	22.8	22.2	92.3	112.3	1.2
21	Orestimba Creek at River Road	N of cases	58	58	58	58	58	58	58	58
		Minimum	0.090	13.2	1.6	5.3	11.3	7.9	16.3	0.2
		Maximum	1.190	160.4	9.3	48.9	94.8	165.9	207.5	2.8
		Median	0.682	61.7	3.1	26.6	51.1	70.8	90.4	1.0
		Mean	0.676	62.5	3.5	27.4	52.8	72.3	99.4	1.0
		Standard Dev	0.262	25.8	1.4	11.3	21.4	32.7	49.2	0.6
22	Modesto ID Lateral 4 to SJR	N of cases	6	6	6	6	6	6	6	6
		Minimum	0.046	2.3	0.7	1.9	4.9	1.0	1.7	0.1
		Maximum	0.292	21.6	2.9	12.2	28.0	22.7	13.1	1.4
		Median	0.160	12.8	1.2	4.9	12.9	6.0	7.1	0.4
		Mean	0.172	12.4	1.4	6.2	15.5	8.3	7.5	0.5
		Standard Dev	0.114	8.9	0.8	4.4	10.6	8.2	4.9	0.5

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
23	Modesto ID Lateral 5 to Tuolumne	N of cases	29	29	29	29	29	29	29	29
		Minimum	0.030	1.8	0.4	1.2	3.1	0.7	1.2	0.0
		Maximum	0.536	66.5	5.6	20.2	46.2	80.8	57.4	0.9
		Median	0.088	6.3	1.0	2.5	8.3	5.5	2.6	0.0
		Mean	0.124	12.2	1.6	4.6	11.7	12.1	7.8	0.1
		Standard Dev	0.115	16.1	1.4	5.2	10.6	18.8	14.1	0.2
25	MID Main Drain to Stan. R. via Miller Lake	N of cases	40	41	41	41	41	41	41	41
		Minimum	0.065	4.3	0.7	2.2	6.2	1.5	2.4	0.0
		Maximum	0.968	158.1	18.0	37.6	69.2	173.0	158.3	2.1
		Median	0.300	21.2	4.5	12.2	28.9	11.3	12.9	0.2
		Mean	0.335	30.7	5.4	14.4	32.8	20.2	19.2	0.4
		Standard Dev	0.150	26.2	3.4	7.5	14.9	27.5	24.7	0.5
28	Turlock ID Westport Drain Flow Station	N of cases	50	50	50	50	50	50	50	50
		Minimum	0.140	12.8	1.0	3.9	13.6	5.7	8.5	0.0
		Maximum	1.190	145.8	33.1	33.4	112.8	140.8	84.2	2.5
		Median	0.605	60.1	3.6	14.6	56.5	43.2	31.1	0.7
		Mean	0.668	69.5	4.6	16.9	60.1	45.4	38.5	0.9
		Standard Dev	0.260	35.7	4.5	7.2	25.0	25.0	20.6	0.8
29	Turlock ID Harding Drain	N of cases	65	64	64	64	64	64	64	64
		Minimum	0.298	16.0	1.3	5.1	18.6	8.0	9.7	0.0
		Maximum	1.227	157.8	29.4	20.5	90.6	176.7	70.6	1.9
		Median	0.665	81.3	10.4	12.0	45.3	75.1	34.3	0.6
		Mean	0.694	84.6	11.8	12.3	46.7	82.5	37.2	0.7
		Standard Dev	0.224	32.8	6.2	3.5	14.9	37.4	13.3	0.5
30	Turlock ID Lateral 6 & 7 at Levee	N of cases	35	35	35	35	35	35	35	35
		Minimum	0.366	25.6	3.1	9.5	29.4	20.5	13.7	0.0
		Maximum	1.200	125.0	12.5	32.9	112.2	97.8	81.2	2.3
		Median	0.580	51.6	5.0	14.6	49.8	43.5	30.9	0.7
		Mean	0.616	57.5	5.7	16.0	52.7	47.3	33.3	0.8
		Standard Dev	0.168	22.7	2.4	4.5	14.7	17.6	13.9	0.5

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
31	BCID - New Jerusalem Drain	N of cases	8	8	8	8	8	8	8	9
		Minimum	2.156	298.3	0.0	65.3	126.6	312.1	419.8	0.0
		Maximum	2.550	345.7	11.3	82.8	200.9	340.3	524.1	4.3
		Median	2.437	323.3	5.2	72.6	164.1	328.3	459.5	3.0
		Mean	2.423	320.8	4.1	73.3	164.6	326.7	465.3	2.8
		Standard Dev	0.129	17.2	3.9	6.8	26.6	9.6	40.3	1.4
33	Hospital Creek	N of cases	17	17	17	17	17	17	17	17
		Minimum	0.146	14.6	1.9	4.1	10.6	12.2	15.5	0.0
		Maximum	1.241	87.2	7.7	23.3	57.8	127.0	108.8	1.2
		Median	0.420	44.1	3.8	13.5	24.9	50.4	38.3	0.3
		Mean	0.495	49.1	4.1	13.0	29.4	53.6	50.8	0.4
		Standard Dev	0.283	25.3	1.8	5.4	12.3	32.3	31.5	0.3
34	Ingram Creek Flow Station	N of cases	44	44	44	44	44	44	44	44
		Minimum	0.247	24.0	1.9	6.8	18.0	22.6	26.7	0.0
		Maximum	2.030	278.0	11.1	66.0	151.2	323.3	357.1	3.5
		Median	1.035	118.7	4.2	29.0	60.1	142.4	133.8	1.3
		Mean	0.982	116.9	4.4	29.2	62.2	135.3	135.5	1.4
		Standard Dev	0.413	55.8	1.9	13.6	29.9	71.0	73.1	0.9
35	Westley Wasteway Flow Station	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.550	60.7	2.4	14.4	29.3	68.5	52.0	0.4
		Maximum	0.810	100.9	5.0	39.6	43.3	108.9	113.7	1.1
		Median	0.655	71.4	3.2	17.7	32.3	77.2	80.4	0.9
		Mean	0.644	73.0	3.3	21.5	33.6	83.8	80.3	0.8
		Standard Dev	0.092	14.5	0.9	8.8	4.5	13.4	19.0	0.3
36	Del Puerto Creek Flow Station	N of cases	58	58	58	58	58	58	58	58
		Minimum	0.338	33.3	1.4	8.1	19.8	15.7	21.2	0.0
		Maximum	1.441	183.6	10.0	75.2	92.1	202.5	281.4	3.0
		Median	0.837	92.2	3.9	37.2	47.5	100.4	120.4	1.0
		Mean	0.876	101.9	4.4	36.2	48.3	112.7	128.8	1.1
		Standard Dev	0.302	39.3	2.0	14.9	15.7	48.4	57.9	0.7

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
38	Marshall Road Drain	N of cases	7	8	8	8	8	8	8	8
		Minimum	0.449	52.1	2.0	11.6	24.4	52.9	40.5	0.2
		Maximum	1.370	168.2	7.2	41.0	79.4	184.5	274.3	2.0
		Median	0.785	94.2	4.8	21.7	46.4	90.2	124.6	0.6
		Mean	0.848	97.5	4.6	22.5	44.9	100.3	126.2	0.8
		Standard Dev	0.340	44.5	1.6	10.4	20.0	48.4	83.1	0.6
44	San Luis Drain End	N of cases	73	73	73	73	73	73	73	73
		Minimum	3.090	55.1	3.3	15.6	25.9	64.1	43.9	0.5
		Maximum	5.706	1043.9	27.8	957.3	403.3	832.8	2107.6	13.4
		Median	4.409	694.9	10.9	99.6	298.4	555.6	1536.1	5.8
		Mean	4.392	691.5	11.5	110.8	294.9	548.0	1513.6	6.1
		Standard Dev	0.585	148.9	3.9	102.2	61.3	105.8	304.2	3.0
45	Volta Wasteway at Ingomar Grade	N of cases	11	11	11	11	11	11	11	11
		Minimum	0.325	35.0	2.1	10.3	19.3	37.2	23.1	0.3
		Maximum	1.430	218.0	7.8	49.0	81.6	178.1	163.0	3.8
		Median	0.680	88.6	3.4	22.4	42.5	103.7	75.3	0.7
		Mean	0.839	114.9	3.8	26.4	46.4	106.8	85.3	1.2
		Standard Dev	0.420	68.1	1.6	14.4	23.6	52.3	53.6	1.1
46	Mud Slough at Gun Club Road	N of cases	11	11	11	11	11	11	11	11
		Minimum	0.821	102.6	5.7	24.4	45.3	97.9	92.1	0.9
		Maximum	3.490	608.2	22.2	103.7	118.7	539.9	668.3	6.2
		Median	1.560	273.3	7.6	50.4	83.1	251.2	334.6	1.9
		Mean	1.831	311.5	9.4	56.1	81.5	271.3	325.5	2.4
		Standard Dev	0.932	177.0	4.9	27.7	26.9	149.6	193.3	1.7
53	Salt Slough at Wolfsen Road	N of cases	29	30	30	30	30	30	30	30
		Minimum	0.811	104.7	3.9	21.4	49.2	67.6	60.7	0.6
		Maximum	2.033	303.9	8.1	55.3	108.4	317.7	328.2	3.9
		Median	1.215	166.9	5.9	33.1	62.4	185.0	164.4	1.7
		Mean	1.311	181.1	5.8	35.6	70.9	198.9	191.6	1.6
		Standard Dev	0.324	53.8	1.1	10.0	17.8	62.3	69.9	0.8

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
57	Ramona Lake Drain at Levee	N of cases	29	29	29	29	29	29	29	29
		Minimum	0.957	110.8	3.8	26.9	41.8	114.5	164.8	0.3
		Maximum	1.850	262.5	10.9	54.3	102.8	259.8	372.2	4.6
		Median	1.310	166.7	6.2	41.7	77.0	156.7	245.3	1.2
		Mean	1.337	172.8	6.0	40.3	76.5	170.4	248.7	1.7
		Standard Dev	0.241	39.6	1.7	7.9	14.4	40.9	56.4	1.1
59	SJR Laird Park	N of cases	17	22	22	22	22	22	22	22
		Minimum	0.149	13.4	0.6	2.3	5.1	12.6	15.2	0.1
		Maximum	0.958	801.6	10.5	114.8	338.6	624.8	1794.5	10.5
		Median	0.684	86.1	3.5	19.3	42.9	87.8	98.8	0.7
		Mean	0.592	119.5	3.5	23.6	53.1	113.9	173.2	1.2
		Standard Dev	0.274	157.1	1.9	22.0	65.7	121.3	364.6	2.1
60	Moffit 1 South	N of cases	18	19	19	19	19	19	19	19
		Minimum	0.530	63.2	3.4	15.7	34.5	73.8	39.9	0.4
		Maximum	1.640	230.9	8.3	41.9	87.5	255.6	206.8	3.4
		Median	0.916	112.5	5.6	22.9	48.1	133.0	80.7	0.9
		Mean	0.967	127.4	6.0	26.4	56.0	143.9	98.4	0.9
		Standard Dev	0.351	54.9	1.2	8.5	17.3	58.2	52.5	0.7
61	Deadman's Slough	N of cases	24	23	23	23	23	23	23	23
		Minimum	0.566	67.8	3.7	14.7	29.4	75.6	48.1	0.4
		Maximum	2.019	289.8	13.7	50.5	93.5	335.9	299.6	4.1
		Median	0.997	132.9	6.4	27.0	56.3	144.6	137.5	1.2
		Mean	1.140	161.6	6.8	31.5	63.2	181.7	140.0	1.5
		Standard Dev	0.481	78.8	2.6	12.1	20.9	85.0	80.4	0.9
62	Mallard Slough	N of cases	22	22	22	22	22	22	22	22
		Minimum	0.594	97.1	3.7	21.5	48.6	103.8	74.8	0.5
		Maximum	5.984	913.8	54.7	182.1	304.4	787.2	1389.0	5.1
		Median	1.194	170.2	7.2	34.0	76.0	172.2	149.5	1.1
		Mean	1.630	229.3	10.6	45.6	98.8	223.7	246.3	1.6
		Standard Dev	1.177	179.8	11.6	36.7	64.4	154.4	334.5	1.2

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
63	Inlet C Canal	N of cases	26	27	27	27	27	27	27	27
		Minimum	0.357	39.1	2.1	10.6	24.5	40.5	37.4	0.2
		Maximum	1.551	187.7	6.9	41.4	112.4	226.5	201.0	2.5
		Median	0.658	73.0	3.6	18.0	41.0	95.7	73.8	0.8
		Mean	0.729	87.6	3.6	19.6	46.8	106.1	84.3	0.8
		Standard Dev	0.305	40.9	1.2	7.6	21.6	52.0	43.9	0.5
64	Moran Drain	N of cases	6	6	6	6	6	6	6	6
		Minimum	0.434	47.5	2.0	13.6	30.5	49.7	30.7	0.5
		Maximum	0.950	83.0	4.8	36.1	72.5	114.4	120.9	1.8
		Median	0.771	70.9	3.5	25.2	50.0	86.8	85.3	1.1
		Mean	0.740	67.1	3.5	25.1	51.1	84.0	81.0	1.1
		Standard Dev	0.218	15.7	1.0	10.5	21.9	26.2	39.8	0.6
65	Spanish Grant Drain	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.505	80.8	3.1	20.7	41.1	71.6	74.3	0.1
		Maximum	1.330	158.8	5.9	38.8	87.8	144.1	231.0	2.1
		Median	0.719	111.1	4.8	34.3	73.8	109.9	177.9	0.7
		Mean	0.866	112.9	4.5	30.6	65.5	103.9	150.4	0.9
		Standard Dev	0.313	33.5	1.0	8.6	20.5	28.2	62.0	0.8
67	Newman Wasteway at Brazo Road	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.600	83.2	2.7	20.0	27.7	105.4	30.3	0.4
		Maximum	1.740	216.9	9.2	82.7	107.5	173.9	225.4	2.2
		Median	1.057	132.7	5.5	47.7	69.3	125.1	128.6	1.4
		Mean	1.155	141.8	5.3	48.8	72.7	134.7	139.2	1.3
		Standard Dev	0.383	50.3	2.1	21.7	25.4	28.5	62.6	0.6
80	South Marsh 1 Inlet	N of cases	18	17	17	17	17	17	17	17
		Minimum	0.370	39.6	2.1	10.6	25.2	41.8	38.0	0.2
		Maximum	1.392	129.8	6.7	24.9	65.1	160.7	120.1	3.3
		Median	0.680	68.3	3.2	18.8	39.8	82.2	55.4	0.9
		Mean	0.718	80.1	3.5	18.4	43.1	96.4	70.0	1.0
		Standard Dev	0.275	31.0	1.2	5.1	13.6	40.9	29.0	0.8

81	South Marsh 1 Outlet	N of cases	20	19	19	19	19	19	19	19
		Minimum	0.379	43.6	2.9	10.5	24.6	47.7	40.0	0.2
		Maximum	1.346	133.3	7.8	25.5	63.7	168.0	118.6	1.6
		Median	0.682	78.4	4.5	18.1	40.4	89.8	57.1	0.6
		Mean	0.715	80.2	4.8	18.2	42.3	95.1	64.3	0.7
		Standard Dev	0.237	25.4	1.4	4.3	10.5	35.3	24.1	0.4
82	South Marsh 3 Inlet	N of cases	25	23	23	23	23	23	23	23
		Minimum	0.427	45.5	2.6	11.4	27.8	49.6	44.3	0.5
		Maximum	1.729	281.0	12.6	47.0	99.6	315.4	243.0	5.4
		Median	1.090	191.0	6.0	20.5	45.5	213.2	100.0	1.1
		Mean	1.091	178.0	6.5	21.0	47.5	190.5	107.8	1.3
		Standard Dev	0.301	64.7	2.5	7.2	14.9	73.1	48.2	1.0
83	South Marsh 3 Outlet	N of cases	28	26	26	26	26	26	26	26
		Minimum	0.630	104.3	4.2	15.0	34.2	107.5	57.2	0.5
		Maximum	1.839	301.7	10.4	26.6	63.2	347.9	300.9	2.0
		Median	1.085	186.1	6.2	19.7	46.2	206.8	99.6	1.0
		Mean	1.127	181.0	6.4	20.2	46.5	201.8	115.7	1.1
		Standard Dev	0.276	55.0	1.6	4.0	9.1	65.7	57.7	0.5
86	Ramona Drain Apple Ave	N of cases	9	9	9	9	9	9	9	9
		Minimum	0.662	42.6	1.3	15.5	27.4	60.1	70.1	0.3
		Maximum	1.594	179.7	10.8	66.2	143.6	192.5	446.0	2.4
		Median	1.280	166.7	7.7	38.5	67.2	176.5	174.4	1.2
		Mean	1.223	137.2	7.7	37.0	70.7	147.5	188.5	1.3
		Standard Dev	0.268	53.4	2.8	13.6	30.7	52.5	105.1	0.8
88	Ramona Drain Apricot Ave	N of cases	9	9	9	9	9	9	9	9
		Minimum	0.438	43.3	3.1	14.0	31.7	41.8	76.5	0.0
		Maximum	1.730	240.5	10.7	48.6	92.9	268.8	275.2	2.6
		Median	1.360	177.8	9.2	39.7	71.9	189.7	180.7	1.5
		Mean	1.242	150.9	8.0	36.1	69.3	160.2	190.6	1.5
		Standard Dev	0.404	63.9	2.9	11.8	20.3	71.8	64.3	1.0

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
92	Paradise Drain Apricot Ave	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.815	105.9	5.5	24.8	54.9	104.8	142.2	1.2
		Maximum	3.053	505.9	19.0	93.9	199.1	433.8	707.8	3.2
		Median	1.240	167.3	7.6	36.7	68.0	170.9	178.5	2.0
		Mean	1.446	206.1	8.6	43.8	88.9	196.5	267.8	2.1
		Standard Dev	0.746	135.1	4.7	23.6	50.7	110.2	198.4	0.8
94	Paradise Drain Almond Ave	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.773	103.5	5.7	22.8	52.1	102.0	137.8	1.2
		Maximum	2.958	477.9	25.5	102.3	205.0	414.9	713.1	11.4
		Median	1.260	168.5	7.3	37.1	70.3	175.9	179.4	2.4
		Mean	1.466	207.5	9.8	45.8	89.7	205.1	268.7	3.4
		Standard Dev	0.704	123.3	7.0	26.4	53.2	98.4	202.4	3.6
95	Ramona Lake Entrance	N of cases	16	16	16	16	16	16	16	16
		Minimum	0.890	112.0	4.2	24.6	53.4	115.2	173.3	0.8
		Maximum	2.372	276.3	9.5	58.6	121.9	267.3	373.5	5.4
		Median	1.590	187.9	5.9	44.3	87.8	194.4	300.4	1.9
		Mean	1.518	190.0	6.2	42.3	87.8	191.4	279.1	2.2
		Standard Dev	0.387	41.3	1.5	9.0	17.3	42.9	58.1	1.3
120	South Marsh 1 Intermediary	N of cases	11	11	11	11	11	11	11	11
		Minimum	0.378	40.4	2.4	10.6	25.3	44.4	40.3	0.2
		Maximum	0.960	129.7	6.6	24.6	61.5	314.3	263.2	1.5
		Median	0.646	69.1	3.9	18.5	42.3	106.2	73.2	0.5
		Mean	0.648	77.2	3.7	17.3	41.4	115.4	86.5	0.7
		Standard Dev	0.230	33.7	1.3	5.4	13.0	79.4	63.3	0.4
121	South Marsh 1 East	N of cases	10	10	10	10	10	10	10	10
		Minimum	0.388	42.1	2.5	11.0	25.0	45.2	39.3	0.2
		Maximum	0.960	131.6	6.4	24.8	56.7	165.1	102.5	1.6
		Median	0.603	72.6	4.8	17.2	39.2	83.9	46.3	0.6
		Mean	0.656	80.4	4.4	17.7	41.0	96.5	60.9	0.7
		Standard Dev	0.240	36.2	1.4	5.9	13.3	48.1	24.7	0.4

Site No.	Site Name		EC dS/m	Na mg/L	K mg/L	Mg mg/L	Ca mg/L	Cl mg/L	SO4 mg/L	Br mg/L
122	South Marsh 1 West	N of cases	9	9	9	9	9	9	9	9
		Minimum	0.453	48.0	5.2	12.0	31.3	54.3	36.8	0.3
		Maximum	1.190	158.4	10.6	29.0	64.9	200.7	90.6	2.6
		Median	0.740	88.6	7.1	20.4	55.0	110.1	48.8	0.6
		Mean	0.782	96.4	7.4	20.4	52.1	119.2	57.7	1.2
		Standard Dev	0.216	33.9	1.7	5.1	10.5	46.9	19.7	0.9
130	Marshall Rd Reservoir Entrance	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.500	50.7	3.0	13.6	33.5	67.0	57.3	0.2
		Maximum	1.240	157.4	6.2	40.6	75.8	162.3	211.9	4.4
		Median	0.810	90.4	4.0	24.0	51.4	102.6	119.0	1.0
		Mean	0.870	102.0	4.2	25.6	51.0	109.4	136.0	1.4
		Standard Dev	0.257	38.4	1.2	9.9	15.1	37.0	60.7	1.4
131	Marshall Rd Reservoir Exit	N of cases	7	7	7	7	7	7	7	7
		Minimum	0.770	87.2	3.0	22.0	46.4	88.6	130.4	0.7
		Maximum	1.250	151.3	6.1	43.3	77.5	162.2	236.4	6.5
		Median	0.970	118.8	4.7	27.2	51.1	120.4	159.7	1.9
		Mean	0.990	118.9	4.5	30.6	57.9	119.9	178.4	2.2
		Standard Dev	0.167	24.1	1.0	8.5	12.7	25.2	40.2	2.0
135	Modesto ID Main Drain Spill	N of cases	6	6	6	6	6	6	6	6
		Minimum	0.160	9.6	2.0	5.3	13.3	5.3	5.9	0.0
		Maximum	0.340	33.7	4.4	13.7	31.1	18.2	13.3	0.8
		Median	0.265	18.3	3.0	10.5	23.8	9.2	12.0	0.2
		Mean	0.250	18.9	3.1	9.9	22.7	9.9	10.5	0.3
		Standard Dev	0.076	8.5	0.9	3.6	7.4	4.6	3.3	0.4

Appendix R

Spatial and Temporal Nitrogen and Phosphorus Dynamics in the San Joaquin River Watershed, 2005-2007

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April 2008

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Abstract

The San Joaquin River (SJR) is a hypereutrophic river with peak summer mineral nitrogen (NH_4^+ + NO_3^-) concentrations ranging between 2 to 4 mg N L^{-1} and soluble reactive phosphorus ranging between 0.15 and 0.20 mg P L^{-1}. These nutrient levels are non-limiting with respect to algae growth. The nutrient monitoring program associated with the SJR dissolved oxygen TMDL is designed to determine the primary forms and sources of nutrients, namely N and P. This investigation provides a basis for any future nutrient load allocation strategies aimed at reducing nutrient levels in an attempt to reduce algal loads from the upstream watershed. This report evaluates the spatial and temporal patterns in nitrogen and phosphorus for 7 mainstem and 17 tributaries and drains in the SJR watershed for the period March 2005 to December 2007. Nutrient concentrations demonstrate appreciable temporal variability at the seasonal and inter-annual time scales that must be considered in designing monitoring and load reduction strategies. The major sources of nitrogen and phosphorus loads were identified: SJR above Lander, Stanislaus, Tuolumne, Merced, San Luis Drain (N source), Salt Slough, Harding Drain, TID Laterals 6/7, and Westport Drain. The other tributaries and drains accounted for less than 10% of the total load as measured at Vernalis. The measured tributary/drain sources and cumulative longitudinal loads calculated for SJR mainstem sites were within 11% of the expected Vernalis loads for total N and total P indicating that the monitoring program identified the majority of the major nutrient sources contributing to total nutrient loads in the SJR.

Introduction

The San Joaquin River (SJR) is a hypereutrophic river with peak summer chlorophyll-*a* concentrations generally in the range of 75 to 150 μg L^{-1} (Kratzer et al., 2004; Ohte et al., 2007). The phytoplankton community in the SJR during the summer months is dominated by centric diatoms (*e.g., Cycotella meneghiniana*) having a 10 to 15 μm diameter (Leland et al., 2001; Henson, 2006). Centric diatoms in 2004 contributed 76 to 89 percent of the total algal biovolume within the mainstem of the SJR (Henson, 2006). Pennate and filamentous diatoms, as well as blue-green algae, were the next most abundant taxa in 2004, with higher proportions found in the agricultural drains, as well as the Merced and Tuolumne Rivers (Henson, 2006).

The high standing biomass of algae is fueled in part by the high availability of nutrients, including available forms of nitrogen, phosphorus and silicon. Peak summer mineral nitrogen (NH_4^+ + NO_3^- + NO_2^-) concentrations ranged between 2 to 4 mg N L^{-1}, soluble reactive phosphorus ranged between 0.15 and 0.20 mg P L^{-1}, and Si ranged between 5.5 and 9.5 mg Si L^{-1} (Kratzer et al., 2004; Ohte et al., 2007). These values far exceed the nutrient levels suggested to limit algae production: <0.1 mg N L^{-1}, <0.01 mg P L^{-1}, <0.06 mg Si L^{-1} (Lohman et al., 1991; Borchardt, 1996). Given the high concentrations of nutrients relative to algal growth limiting concentrations, the efficacy of nutrient reduction strategies to control eutrophication appear challenging. These nutrients originate from surface and subsurface irrigation return flows, runoff and leaching from livestock operations, nitrogen-rich bedrock in the Coast Ranges, municipal wastewater treatment facilities, and urban runoff (Kratzer et al., 2004).

To assess nutrient dynamics at the watershed scale, water quality must be evaluated at several spatial and temporal scales in order to comprehend the full range of variability within the watershed and the physical, chemical and biological processes that control this variability (Dahlgren et al., 2004). As a first step, a source-search monitoring strategy may be employed to examine spatial patterns in water quality parameters across a representative range of land use/land cover characteristics within a watershed (Ahearn et al., 2005). The synoptic sampling scheme is often employed at a biweekly to monthly time-step throughout the year. While the source-search strategy can often identify the primary pollutant sources, it does not provide an adequate level of detail concerning temporal fluctuations. Various water quality parameters may display diel, storm-event, seasonal and inter-annual variations that could greatly affect the evaluation process (Dahlgren et al., 2004).

Nutrient monitoring in the SJR watershed has been conducted on a wide range of spatial and temporal scales in an attempt to understand specific nutrient sources and their temporal patterns throughout the year. This report presents a summary of nitrogen and phosphorus concentrations and loads for the period March 2005 to December 2007 from 7 mainstem sites and 17 tributaries and drains discharging into the SJR. The major goal of this component of the overall SJR TMDL research is to identify the contribution of nutrients from various sources within the watershed. Once the major sources are identified, nutrient reduction strategies (*i.e.* load allocation) can be evaluated as to their potential for addressing the overall goal of reducing algae biomass exports from the upper watershed to the lower watershed where they contribute to hypoxia in the Stockton Deep Water Ship Channel.

The following report is divided into four sections:

- Forms of nitrogen and phosphorus in waters from the mainstem, tributaries and drains
- Spatial patterns in nutrient concentrations in the mainstem, tributaries and drains
- Evaluation of nutrient loads along the San Joaquin River mainstem and inputs from tributaries and drains, and
- Temporal patterns in nutrient concentrations.

Methods

Study area

Water samples were taken from 7 locations along the mainstem of the San Joaquin River and 17 locations in tributaries and drains (Table 1). All sampling points in tributaries and drains were located near the confluences with the mainstem of the San Joaquin River. Thus, the constituent concentrations and water flow rates measured at these sampling points were used as representative values for each tributary merging into the SJR mainstem. Detailed sampling protocols are described in the DO TMDL QAPP (Stringfellow, 2005). Mud Slough, Salt Slough, Los Banos Creek and San Luis Drain receive discharge from the Grasslands Ecological Area. Mud Slough receives tile drainage from 393 km^2 of the Grasslands Ecological Area (Kratzer et al. 2004), which includes not only wetlands, but also pasture of native vegetation (Quinn et al. 1998).

Drainage canals, such as Harding Drain (east-side), TID Laterals 6/7 (east-side), MID Lateral 5 (east-side), MID Main Drain (east-side), Westport Drain (east-side), Ramona Lake (west-side), Orestimba Creek (west-side), and Hospital Creek (west-side), run through agricultural fields to the San Joaquin River. The west-side drains (Orestimba Creek, Ramona Lake, Ingram Creek, Del Puerto Creek and Hospital Creek) receive mainly surface runoff from row crops and orchards, and Hospital Creek contains some tile drainage as well. The east-side Harding Drain receives treated effluent from the City of Turlock wastewater treatment plant in addition to runoff from agricultural areas (Kratzer et al., 2004).

Analytical analyses

Total nitrogen (TN) and total phosphorus (TP) were determined following oxidization with a 1% potassium persulfate solution (APHA, 1998). TN was determined spectroscopically with a single reagent containing vanadium chloride (VCl_3) (MDL = 0.01 mg N L^{-1}) (Doane and Horwath, 2003). TP was determined spectroscopically with the stannous chloride method (MDL = 0.005 mg P L^{-1}) (APHA, 1998).

Dissolved constituents were determined on a sample filtered through a 0.2 μm polycarbonate membrane (Millipore – formerly Nuclepore). Nitrate plus nitrite were determined using the vanadium chloride method (MDL = 0.01 mg N L^{-1}) (Doane and Horwath, 2003). Since nitrite was always a very small portion (generally <3%) of the nitrate+nitrite concentration, we report this measure as "nitrate" throughout the remainder of this report. Ammonium was determined spectroscopically with the Berthelot reaction, using a salicylate analog of indophenol blue (MDL = 0.01 mg N L^{-1}) (Forster, 1995). Soluble-reactive PO_4 (SRP) was determined spectroscopically with the stannous chloride method (MDL = 0.005 mg P L^{-1}) (APHA, 1998).

Laboratory quality assurance/quality control followed the Surface Water Ambient Monitoring Program protocols (SWAMP) set by the California State Water Resources Control Board (http://www.swrcb.ca.gov/swamp/qapp.html). This includes implementation of standard laboratory procedures including replicates, spikes, reference materials, setting of control limits, criteria for rejection, and data validation methods. Detailed sampling, handling and analytical protocols are described in the DO TMDL QAPP (Stringfellow, 2005).

Results and Discussion

Forms of Nutrients in the SJR mainstem, tributaries and drains

A summary of the overall nutrient concentration data for the seven mainstem and 17 tributaries and drains is shown in Table 1. The sampling period generally represents weekly to biweekly sampling for the time period March 2005 to December 2007 (n=50-101). A few sampling sites, TID Laterals 6/7, Ramona Lake, and Hospital Creek, were added later in the monitoring program and therefore have a lower number of samples (n=17-35).

The primary forms of nitrogen in waters of the SJR watershed are ammonium (NH_4), nitrate (NO_3), and organic (particulate [>0.2 μm] and dissolved [<0.2 μm]) forms. The organic component is defined as total nitrogen minus the NH_4 + NO_3. While NH_4 and

NO_3 are readily available for algae utilization, organic nitrogen must first undergo mineralization to mineral forms (NH_4 and NO_3) prior to algae uptake.

Nitrate was the primary form of nitrogen at six of the seven SJR mainstem sites (Table 2). With the exception of the upper most mainstem site (SJR at Lander), NO_3 represented from 71 to 78% of the total N pool. The upstream SJR site at Lander Avenue had lower median total N concentrations with only 57% in the form of NO_3. Inputs of high NO_3 agricultural drainage waters below Lander Avenue likely contribute to the higher proportion of NO_3 below this site. In addition, the high residence time of water at the Lander Avenue site further allows ample time for conversion of mineral N forms into organic N forms via algae primary production. Ammonium concentrations were less than 2.8% of the total N pool in the SJR mainstem sites. The low proportion of NH_4 is attributable to preferential uptake of NH_4 by algae as a nitrogen source and rapid nitrification of NH_4 to NO_3 in aerobic waters. Organic forms of nitrogen ranged between 20 and 27% at the six SJR downstream sites compared to 41% at the Lander Avenue site.

The three major east-side tributaries (Merced, Tuolumne, Stanislaus) were similarly dominated by NO_3 (54-78%) with organic forms representing 14 to 38%. The creeks and drains had more variable distributions of nitrogen with the San Luis Drain, Harding Drain, TID Laterals 6/7, and Westport Drain having greater than 88% of total N in the form of NO_3. In contrast, Los Banos Creek has a large component of wetland drainage that is reflected in the higher proportion of both organic N (61%) and NH_4 (10.7%) species and a decreased importance of NO_3 (29%).

The primary forms of phosphorus in waters of the SJR are ortho-phosphate and particulate+organic (particulate [>0.2 μm] and dissolved [<0.2 μm]). The particulate+organic component is operationally defined as total P minus SRP. The particulate fraction may include PO_4 adsorbed on inorganic particles and colloidal and dissolved organic P. Since phytoplankton utilize P almost exclusively as orthophosphate, the availability of particulate+organic forms of phosphorus depends on the extent to which it is transformed into bioavailable forms.

SRP (36 to 63%) was generally the dominant form of total P with particulate+organic (37 to 56%) in the mainstem sites, especially below the Harding Drain. The P fractions in the three major east-side tributaries were similarly distributed between SRP (33 to 67%) and particulate+organic (33 to 67%). Among the remaining tributaries and drains, the distribution of SRP (9 to 89%) and particulate+organic (11 to 91%) were highly variable. At the one extreme, the San Luis Drain had generally <10% SRP owing to the origin of these waters largely as subsurface tile drainage. In contrast, the Harding Drain and TID Laterals 6/7 have SRP fractions representing ~89% of total P. In the case of the Harding Drain, the high proportion of SRP results from the contribution of treated wastewater effluent.

The use of total or SRP measurements to predict the effect of agricultural runoff on algal growth is complicated due to the varying bioavailability of the particulate+organic fraction. In agricultural watersheds, particulate+organic has been found to be the dominant fraction of total phosphorus transported in surface runoff (Hart et al., 2004; Sharpley et al., 1992; Uusitalo and Ekholm, 2003). The particulate+organic fraction is associated with soil particles and organic matter eroded from fields during irrigation events. The percentage of particulate+organic P that is bioavailable is generally reported to range between 5 and 30% for agricultural runoff (DePinto et al., 1981; Dorich et al., 1985; Uusitalo et al., 2000).

Spatial nutrient concentrations

The distribution of the various N and P concentrations measured in this study are shown in Figures 1-5 (Table 1 provides data in a tabular format). Along the mainstem of the SJR, median total N concentrations display an increase from Lander Avenue to Patterson, stepped decreases between Patterson and Maze and again between Maze and Vernalis, and similar concentrations between Vernalis and Mossdale (Figure 1). Because Laird Park data were not collected in 2006-07, its median value is not directly comparable to the other mainstem sites. This pattern is due to inputs of nitrogen-rich waters within the upper reaches (above Laird Park) followed by dilution from the Tuolumne and Stanislaus Rivers above Maze and Vernalis, respectively. According to the USGS streamflow data for 1951-1995, 66% of the average streamflow in the San Joaquin River comes from the three major east-side rivers that originate in the Sierra Nevada: Merced River (15%), Tuolumne River (30%), and Stanislaus River (21%) (Kratzer et al., 2004). Thus, the Tuolumne and Stanislaus Rivers can have a large dilution effect as they contribute up to 50% of the summer flows and they have relatively low nutrient concentrations compared to the SJR mainstem. Because there are no major water inputs between Vernalis and Mossdale, total N concentrations display very similar distributions between these sites.

Among the tributaries and drains, the three major east-side tributaries (median values: Merced = 1.24 mg L^{-1}, Tuolumne = 1.51 mg L^{-1} and Stanislaus = 0.42 mg L^{-1}) have the lowest median total N concentrations. In contrast, some of the major drains have very high median total N concentrations (TID Lateral 6/7 = 15.7 mg L^{-1}, San Luis Drain = 13.6 mg L^{-1}, Harding Drain = 9.8 mg L^{-1}, Westport Drain = 12.3 mg L^{-1}). Nearly all of the measured tributaries and drains delivering agricultural tailwaters and tile drainage have total N concentrations higher than the SJR mainstem sites.

Ammonium concentrations in the SJR mainstem sites were generally less than 0.1 mg N L^{-1}, with most median values on the order of 0.02 to 0.03 mg N L^{-1} (Figure 2). Only a few sites (Los Banos, TID Laterals 6/7, Ramona Lake, Harding Drain and Del Puerto Creek) had median NH_4-N concentrations greater than 0.2 mg N L^{-1}. However, there were a few individual samples (*e.g.*, Harding Drain, Del Puerto Creek, Ingram Creek, MID Main) in which NH_4-N concentrations exceed 1 mg N L^{-1}. These isolated high ammonium concentrations could be of short-term, local significance as high ammonia (NH_3) concentrations are toxic to aquatic organisms. The toxicity level of NH_4/NH_3 is dependent on the pH value, which determines the partitioning between NH_4/NH_3 (pKa = 9.25 at 25^o C).

The distribution of NO_3 concentrations follows a pattern very similar to that of total N because the contribution of NO_3 to total nitrogen was relatively similar among most sites (Figure 3). As with total N, median NO_3-N concentrations along the mainstem sites displayed an increase from Lander Avenue to Patterson, with decreased concentrations between Patterson and Maze and again between Maze and Vernalis due to dilution by the Tuolumne and Stanislaus Rivers, respectively. Because Laird Park data were not collected in 2006-07, its median value is not directly comparable to the other mainstem sites. Nitrate concentrations were similar between Vernalis and Mossdale. The highest median concentrations of NO_3-N originated from the San Luis Drain (12.7 mg N L^{-1}), TID Laterals 6/7 (14.3 mg N L^{-1}), Harding Drain (8.8 mg N L^{-1}), and Westport Drain (10.8 mg N L^{-1}). Median, NO_3 concentrations for the three major east-side tributaries (Merced, Tuolumne and Stanislaus) were below 1.2 mg N L^{-1} providing downstream dilution of NO_3 below their confluence with the SJR.

Median TP and soluble-reactive P concentrations along the SJR mainstem display the effects of dilution below the confluences with the Merced (Crows Landing), Tuolumne (Maze) and Stanislaus (Vernalis) Rivers, and a large increase at SJR Patterson due to a large input of soluble-reactive PO_4 from the Harding Drain (Fig. 4 & 5). Median TP concentrations in the Harding Drain were about 1.6 mg L^{-1}, which was nearly 10 times greater than the SJR at its confluence. Higher median TP and SRP values were also found in Los Banos Creek (wetland drainage) and TID Laterals 6/7 (unknown sources). Median TP concentrations in the three east-side tributaries (Merced, Tuolumne and Stanislaus) were very low (0.04 to 0.07 mg P L^{-1}). Because of the low TP concentrations and the relative large river discharges associated with these tributaries, they have a significant dilution capacity below their confluences with the SJR. The San Luis Drain was characterized by having low median TP concentration (0.07 mg P L^{-1}) and SRP concentrations that were generally less than detection limits (<0.005 mg P L^{-1}). The origin of the majority of the water in the San Luis Drain as tile drainage results in sorption of PO_4 by soils during leaching through the vadose zone. The SRP concentrations in the San Luis Drain are generally below concentrations reported to limit algae growth (~0.01 mg P L^{-1}). Of all the sites monitored, the end of the San Luis Drain is possibly the only site where algae standing crop is nutrient limited.

Nutrient Loads along the SJR mainstem and inputs from tributaries and drains

A summary of the overall nutrient loads for the seven mainstem and 17 tributaries and drains is shown in Table 3. The sampling period generally represents weekly to biweekly sampling for the time period March 2005 to December 2007 (n=50-101). A few sampling sites, TID Laterals 6/7, Ramona Lake, and Hospital Creek, were added later in the monitoring program and therefore have a lower number of samples (n=17-35).

The distribution of nutrient loads for the entire study period along with the distribution of longitudinal cumulative loads from measured tributaries and drains are shown in Figures 6-10. The cumulative load lines were drawn by summing the mean daily loads of nitrogen and phosphorus species from the tributaries/drains upstream of the mainstem sites. This analysis provides an assessment of the major nutrient sources and a relative evaluation of potential sources (from mass balance approach) that were not measured for the tributary and drain loads above a given sampling site.

A load assessment based on total N and NO_3-N reveal similar conclusions (Figures 6 and 7). The primary nitrogen sources as a percentage of the total loads measured at Vernalis originate from the SJR above Lander (TN=11.6%, NO_3-N=5.4%), the three east-side tributaries (Merced TN=19.2%, NO_3-N=20.0%; Tuolumne TN=25.1%, NO_3-N=21.4%; Stanislaus TN=7.9%, NO_3-N=5.2%), Salt Slough (TN=9.7%, NO_3-N=10.7%), San Luis Drain (TN=9.2%, NO_3-N=13.7%), Harding Drain (TN=7.1%, NO_3-N=10.5%), Westport Drain (TN=6.3%, NO_3-N=9.0%), and TID Laterals 6/7 (TN=5.4%, NO_3-N=8.0%) (Table

4). The remaining measured sources each generally contributed less than 1% of the TN and NO_3-N loads measured at Vernalis. While the three major east-side tributaries had among the lowest TN and NO_3-N concentrations, the higher flows associated with these tributaries resulted in appreciable TN (52.2% of Vernalis load) and NO_3-N (46.6% of Vernalis load) loads to the SJR. In sum, the measured mean TN and NO_3-N loads from tributaries and drains accounted for about ~111% of the Vernalis nitrogen loads, which suggests that the tributaries and drains measured in this study represent the major nitrogen sources. The cumulative mean values summing to greater than 100% may further suggest that denitrification of nitrate or sedimentation of particulate nitrogen may result in the loss of about 11% of the total nitrogen load during downstream transport.

A similar load assessment for total P and SRP indicates that the primary phosphorus sources as a percentage of the total loads measured at Vernalis originate from the SJR above Lander (TP=8.0%, SRP=5.9%), the three east-side tributaries (Merced TP=17.3%, SRP=17.7%; Tuolumne TP=21.8%, SRP=17.7%; Stanislaus TP=10.1%, SRP=11.5%), Salt Slough (TP=12.3%, SRP=11.0%), and the Harding Drain (TP=9.5%, SRP=16.7%) (Figures 9 and 10; Table 4). The remaining measured sources generally each contributed less than 1% of the TP and SRP loads measured at Vernalis. As with nitrogen, the three major east-side tributaries had very low TP and SRP concentrations, but higher flows that resulted in appreciable TP (42.0% of Vernalis load) and SRP (36.5% of Vernalis load) loads. In sum, the measured loads from tributaries and drains accounted for 89 to 92% of the Vernalis P loads, which leaves 8 to 11% unaccounted for. Because SRP can be transformed by biological (algae uptake) and physical (PO_4 sorption/desorption) processes during downstream transport, it appears best to use TP for cumulative longitudinal load assessments. Given the potential errors in accounting for TP and SRP loads in the complex SJR system, coming within 10% of the mass balance amount measured at Vernalis appears very acceptable.

Temporal patterns in nutrients

Nutrient concentrations in the San Joaquin River demonstrate considerable variability at the diel, seasonal, annual and decade time steps. At the diel scale, nitrate concentrations are inversely related to algae concentrations due to algal uptake of nitrogen during growth. Stoichiometric uptake of N according to the Redfield C:N for algae is on the order of 6.6:1. This can lead to diel fluctuation of NO_3-N on the order of 0.5 mg N L^{-1} associated with peak algae growth rates during the summer months. A strong seasonal pattern in NO_3-N concentrations occurs due to patterns in irrigation, winter storm events, spring snowmelt runoff, and fish augmentation flows. The overall NO_3-N concentration pattern varies from year-to-year, but is generally lowest in the April to early June period associated with snowmelt runoff and spring-fish attracting flow augmentations. Maximum concentrations occur during the late-summer to fall when irrigation return flows are highest and flows from the east-side tributaries are at their annual minimum. Nitrate concentrations were especially low during the very high flows associated with the spring runoff in 2006.

The long-term NO_3-N record for Vernalis consists of data from 1908, 1930, and consistent data since 1950 (Figure 11). Prior to 1950, NO_3-N concentrations ranged from nil to about 0.5 mg N L^{-1}. Concentrations increased progressively from 1950 to about the 1990s when the concentrations appear to level out. The large increase beginning in the

1950s has been largely attributed to the increased use of nitrogen fertilizer and increased numbers of animal husbandry, primarily dairies (Kratzer and Shelton, 1998). While NO_3-N concentrations have not fallen off in recent years, there does appear to be a leveling off in NO_3-N concentrations during the past 20 years.

During the 2005-07 monitoring period, TN and NO_3-N concentrations in the SJR mainstem sites displayed a strong seasonal pattern which grow more prominent at downstream sites (Figures 12-17). The highest concentrations occurred from July to December and concentrations were generally decreased during the winter and spring due to dilution from snowmelt runoff and storm events from the Sierra Nevada. Minimum concentrations were generally associated with fish augmentation flows during the May to early June period. Exceptionally high spring runoff in 2006 resulted in very low concentrations of TN and NO_3-N. TN and NO_3-N concentrations in many of the tributaries and drains demonstrated much greater scatter and weaker seasonal patterns. In particular, the Harding Drain did not show appreciable seasonal patterns; however, there was a wide range of scatter among data.

Seasonal patterns in TP and SRP were evident for the SJR mainstem sites, but they were weaker than for TN and NO_3-N concentrations (Figures 18-23). The timing of maximum and minimum concentrations was comparable between nitrogen and phosphorus concentrations. As with the nitrogen concentrations, seasonal patterns in TP and SRP were less evident and displayed appreciably greater scatter in the temporal record.

Conclusions

- Nutrient concentrations demonstrate appreciable temporal variability at the diel, seasonal and inter-annual time scales. This temporal variability has great ramifications for designing an appropriate monitoring program and for assessing the appropriateness of published data for answering questions concerning nutrient loads.
- The major sources of nitrogen and phosphorus loads were identified: SJR above Lander, Stanislaus, Tuolumne, Merced, San Luis Drain (N source), Salt Slough, Harding Drain, TID Laterals 6/7, and Westport Drain. Contributions from the other tributaries and drains combined accounted for less than 10% of the total load as measured at Vernalis.
- The measured tributary/drain sources and cumulative longitudinal loads calculated for SJR mainstem sites were within 11% of the expected Vernalis loads for total N and total P indicating that the monitoring program identified the majority of the major nutrient sources contributing to total nutrient loads in the SJR.
- Because the three major east-side tributaries (Merced, Tuolumne, Stanislaus) are significant sources of nutrients, a longitudinal assessment along each river reach should be conducted to determine the longitudinal accretion rate of nutrient within these watersheds. Previous studies indicated that nutrient loads from above Highway 99 are minimal and that the primary nutrient accretion occurs in the lower reaches of these tributaries.
- To determine the sensitivity of algae growth to SRP concentrations, P addition experiments should be conducted within the San Luis Drain, the only site within the

SJR watershed that appears to have nutrient-limited (SRP <0.005 mg P L^{-1}) algae growth. Spiking the San Luis Drain with SRP and determining the effect on downstream algae growth could provide evidence for the feasibility of P reductions to limit algae standing biomass in other portions of the SJR watershed.

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Table 1: Summary of nutrient concentrations for the 7 mainstem sites along the San Joaquin River and the 17 tributaries and drains monitored in this study for the period March 2005 to December 2007. The mean (X), standard deviation (SD), minimum (min), maximum (max), and number of samples (n) are listed for each site.

	River mile	Total N (mg/L)			NH_4-N (mg/L)			NO_3-N (mg/L)			Total P (mg/L)			SRP (mg/L)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
SJR-Mossdale	56.2	1.75 (0.66)	0.32 2.76	64	0.03 (0.02)	<0.01 0.10	65	1.24 (0.61)	0.08 2.45	65	0.176 (0.064)	0.060 0.380	64	0.095 (0.041)	0.005 0.194	65
SJR- Vernalis	72.2	1.79 (0.70)	0.31 2.94	70	0.04 (0.03)	0.01 0.14	72	1.32 (0.65)	0.07 2.78	72	0.172 (0.084)	0.060 0.640	70	0.086 (0.034)	0.005 0.200	72
SJR – Maze	77.4	2.52 (1.13)	0.35 4.10	68	0.04 (0.04)	0.01 0.17	69	1.94 (1.00)	0.06 3.72	69	0.211 (0.073)	0.050 0.410	68	0.114 (0.035)	0.050 0.201	69
SJR – Laird Park	91.0	2.74 (1.46)	0.57 8.06	22	0.08 (0.10)	<0.01 0.39	22	2.05 (1.31)	0.16 6.64	22	0.240 (0.071)	0.147 0.377	22	0.125 (0.064)	<0.005 0.260	22
SJR – Patterson	99.4	3.26 (1.49)	0.49 6.02	72	0.05 (0.06)	<0.01 0.45	74	2.55 (1.40)	0.08 5.91	74	0.326 (0.134)	0.090 0.798	72	0.205 (0.091)	0.045 0.450	74
SJR – Crows Landing	108.6	2.94 (1.31)	0.44 6.45	78	0.04 (0.03)	0.01 0.21	80	2.24 (1.25)	0.08 6.11	80	0.192 (0.064)	0.067 0.381	78	0.084 (0.030)	0.032 0.210	80
SJR - Lander	131.9	2.41 (1.84)	0.30 9.58	81	0.05 (0.07)	0.01 0.52	83	1.38 (1.54)	0.01 6.65	83	0.233 (0.089)	0.060 0.502	81	0.084 (0.056)	0.005 0.350	83
Stanislaus	74.9	0.43 (0.17)	0.10 0.98	65	0.04 (0.05)	<0.01 0.40	67	0.23 (0.13)	0.03 0.74	67	0.060 (0.043)	0.010 0.320	65	0.040 (0.035)	0.005 0.210	67
Tuolumne	83.8	1.41 (0.78)	0.19 3.00	66	0.03 (0.03)	<0.01 0.15	68	1.10 (0.75)	0.02 2.42	68	0.092 (0.071)	0.007 0.394	66	0.062 (0.050)	<0.005 0.173	68
Merced	118.2	1.81 (1.34)	0.20 4.83	65	0.05 (0.03)	0.01 0.14	67	1.50 (1.28)	0.04 4.27	67	0.051 (0.054)	0.007 0.401	65	0.023 (0.017)	<0.005 0.142	67
Salt Slough	129	2.03 (1.06)	0.58 5.32	101	0.10 (0.13)	0.01 1.25	103	1.28 (0.96)	0.01 4.31	103	0.348 (0.125)	0.137 0.753	101	0.145 (0.093)	0.020 0.680	103
San Luis Drain	-	13.99 (5.44)	3.76 28.63	72	0.07 (0.11)	<0.01 0.58	73	13.05 (5.85)	2.82 30.29	73	0.075 (0.035)	0.020 0.220	72	0.007 (0.017)	<0.005 0.110	73
Mud Slough	122.7	6.04 (3.30)	1.51 15.96	74	0.11 (0.14)	0.01 1.09	76	4.83 (3.28)	0.14 14.96	76	0.221 (0.114)	0.038 0.563	74	0.073 (0.086)	<0.005 0.320	76

Table 1: (continued)	River mile	Total N (mg/L)			NH_4-N (mg/L)			NO_3-N (mg/L)			Total P (mg/L)			SRP (mg/L)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
Los Banos	121.0	2.17 (1.07)	0.56 5.94	65	0.23 (0.43)	0.01 3.22	66	0.62 (0.53)	0.01 2.09	66	0.623 (0.290)	0.197 1.460	65	0.325 (0.212)	0.071 1.026	66
TID Lat. 6/7	110.9	16.39 (5.39)	6.41 40.06	35	0.13 (0.20)	0.02 0.91	35	14.95 (5.15)	5.66 36.46	35	0.593 (0.2157)	0.290 1.225	35	0.525 (0.184)	0.290 1.173	35
Orestimba Crk	109.3	4.69 (3.20)	0.45 13.01	57	0.21 (0.77)	0.01 5.76	58	3.84 (2.97)	0.05 12.05	58	0.285 (0.158)	0.050 0.760	57	0.110 (0.066)	0.005 0.311	58
Ramona Lake	108	4.10 (0.89)	2.81 5.67	28	0.31 (0.35)	0.01 1.38	28	2.05 (1.03)	0.09 4.02	28	0.418 (0.175)	0.153 0.848	28	0.100 (0.095)	<0.005 0.418	28
Harding Drain	101	10.69 (4.05)	4.56 23.30	64	0.28 (0.44)	0.02 2.67	65	9.56 (3.84)	4.21 22.39	65	2.009 (1.283)	0.120 5.197	64	1.793 (1.208)	0.060 4.740	65
Del Puerto Crk	93.3	5.75 (3.46)	0.22 19.56	57	0.46 (0.85)	<0.01 4.93	58	4.04 (2.15)	0.01 10.71	58	0.342 (0.201)	0.046 0.923	57	0.205 (0.141)	0.020 0.711	58
Westport Drain	93	13.53 (6.15)	2.21 30.53	50	0.11 (0.22)	0.02 1.45	50	11.95 (6.06)	0.62 29.83	50	0.285 (0.201)	0.040 0.980	50	0.231 (0.188)	0.010 0.870	50
MID Lat. 5 - Tuol.	83	1.85 (3.56)	0.08 18.35	29	0.14 (0.25)	<0.01 1.16	29	1.32 (3.36)	<0.01 17.97	29	0.152 (0.299)	0.010 1.431	29	0.100 (0.216)	<0.005 1.053	29
Ingram Crk	82.8	7.36 (4.30)	1.64 16.94	44	0.49 (0.72)	0.02 2.85	44	5.74 (3.57)	0.61 16.53	44	0.399 (0.273)	0.040 1.493	44	0.161 (0.069)	0.020 0.333	44
Hospital Crk	82.8	2.70 (1.51)	0.83 5.65	17	0.15 (0.21)	0.02 0.77	17	1.28 (0.97)	0.35 3.72	17	0.517 (0.360)	0.100 1.441	17	0.264 (0.223)	0.040 0.740	17
MID Main – Stan.	76.0	3.43 (4.61)	0.59 30.79	40	0.72 (3.44)	0.01 21.76	40	1.73 (1.31)	<0.01 3.45	40	0.549 (0.997)	0.040 6.340	40	0.401 (0.852)	0.014 5.310	40

Table 2: **Median concentrations for total N (TN) and total P (TP) concentrations for 7 mainstem sites along the San Joaquin River and 17 tributaries and drains for the monitoring period March 2005 to December 2007. The distribution of the median total N and P is shown for the various nutrient forms.**

	River mile	Median TN mg/L	Organic %	NH_4 %	NO_3 %	Median TP mg/L	Particulate + Organic %	Soluble-reactive P %
SJR-Mossdale	56.2	1.83	27.0	1.9	71.1	0.17	46.0	54.0
SJR- Vernalis	72.2	1.95	24.1	2.0	73.9	0.16	50.0	50.0
SJR – Maze	77.4	2.73	21.4	1.6	77.0	0.22	46.0	54.0
SJR – Laird Park	91.0	2.65	22.4	2.8	74.8	0.23	47.9	52.1
SJR – Patterson	99.4	3.26	20.4	1.4	78.2	0.31	37.1	62.9
SJR – Crows Landing	108.6	2.84	22.5	1.3	76.2	0.18	56.3	43.8
SJR - Lander	131.9	2.02	40.7	2.1	57.2	0.22	52.4	36.1
Stanislaus	74.9	0.42	37.8	8.6	53.6	0.05	67.0	33.0
Tuolumne	83.8	1.51	19.9	2.3	77.8	0.07	32.6	67.4
Merced	118.2	1.24	14.3	2.3	83.4	0.04	53.6	46.4
Salt Slough	129	1.86	32.1	5.1	62.8	0.32	58.3	41.7
San Luis Drain	-	13.63	6.2	0.5	93.3	0.07	90.7	9.3
Mud Slough	122.7	6.04	18.3	1.8	79.9	0.20	67.0	33.0
Los Banos	121.0	1.93	60.5	10.7	28.8	0.57	47.8	52.2
TID Lat. 6/7	110.9	15.65	7.9	0.8	91.3	0.57	11.5	88.5
Orestimba Crk	109.3	4.09	13.6	4.5	81.9	0.25	61.4	38.6
Ramona Lake	108	3.89	42.4	7.5	50.1	0.42	76.1	23.9
Harding Drain	101	9.81	8.0	2.6	89.4	1.63	10.8	89.2
Del Puerto Crk	93.3	5.62	21.8	8.0	70.2	0.29	40.1	59.9
Westport Drain	93	12.27	10.9	0.8	88.3	0.25	18.9	81.1
MID Lat. 5 - Tuol.	83	0.59	21.7	7.7	70.6	0.06	34.2	65.8
Ingram Crk	82.8	6.51	15.4	6.7	77.9	0.36	59.6	40.4
Hospital Crk	82.8	2.88	47.2	5.5	47.3	0.43	48.9	51.1
MID Main – Stan.	76.0	2.87	28.6	21.0	50.4	0.55	27.0	73.0

Table 3: Summary of nutrient loads for the 7 mainstem sites along the San Joaquin River and the 17 tributaries and drains monitored in this study for the period March 2005 to December 2007. The mean (X), standard deviation (SD), minimum (min), maximum (max), and number of samples (n) are listed for each site.

	River mile	Total N (Mg/d)			NH_4-N (Mg/d)			NO_3-N (Mg/d)			Total P (Mg/d)			SRP (Mg/d)		
		X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n	X± SD	Min Max	n
SJR-Mossdale	56.2	13.30 (8.44)	2.88 52.80	64	0.48 (0.74)	<0.01 4.01	64	8.29 (4.25)	1.81 16.57	64	1.77 (2.32)	0.20 15.90	64	1.00 (1.13)	0.01 (5.63)	64
SJR- Vernalis	72.2	13.44 (9.00)	4.25 64.70	70	0.56 (0.99)	0.02 5.66	70	8.30 (3.39)	3.39 16.97	70	1.79 (2.70)	0.32 20.57	70	0.96 (1.33)	0.01 7.43	70
SJR – Maze	77.4	12.19 (9.20)	3.47 67.21	66	0.53 (1.01)	0.01 6.09	66	7.50 (3.15)	2.68 15.37	66	1.63 (2.67)	0.24 18.79	66	0.92 (1.38)	0.09 6.77	66
SJR – Laird Park	91.0	10.57 (4.20)	3.30 18.94	22	0.44 (0.59)	0.01 2.05	22	7.17 (2.59)	1.81 12.60	22	1.18 (0.97)	0.27 4.59	22	0.53 (0.38)	<0.01 1.32	22
SJR – Patterson	99.4	8.64 (6.93)	1.54 41.09	72	0.29 (0.58)	0.01 3.14	72	5.26 (2.39)	1.24 13.64	72	1.17 (1.63)	0.14 10.41	72	0.68 (0.85)	0.11 4.34	72
SJR – Crows Landing	108.6	7.54 (5.35)	2.03 41.45	78	0.19 (0.39)	0.01 2.83	78	4.98 (2.17)	0.09 11.73	78	0.73 (1.29)	0.11 10.79	78	0.32 (0.52)	0.05 3.45	78
SJR - Lander	131.9	1.56 (3.63)	0.01 23.99	79	0.09 (0.27)	<0.01 1.52	79	0.45 (0.81)	<0.01 4.81	79	0.31 (0.90)	<0.01 6.02	79	0.17 (0.51)	<0.01 3.13	79
Stanislaus	74.9	1.06 (1.47)	0.20 10.88	65	0.09 (0.19)	<0.01 1.31	65	0.43 (0.37)	0.12 2.21	65	0.18 (0.50)	0.02 4.05	65	0.11 (0.32)	<0.01 2.58	65
Tuolumne	83.8	3.38 (5.27)	0.94 38.84	66	0.16 (0.33)	<0.01 2.40	66	1.78 (0.96)	0.40 4.53	66	0.39 (1.18)	0.01 7.67	66	0.17 (0.41)	<0.01 3.37	66
Merced	118.2	2.58 (2.63)	0.50 17.46	62	0.15 (0.25)	0.01 1.67	62	1.66 (1.58)	0.26 8.88	62	0.18 (0.61)	0.01 4.81	62	0.07 (0.22)	<0.01 1.70	62
Salt Slough	129	1.31 (1.71)	0.11 11.77	101	0.06 (0.09)	0.01 0.49	101	0.89 (1.36)	<0.01 9.76	101	0.22 (0.29)	0.03 2.03	101	0.11 (0.23)	0.01 1.82	101
San Luis Drain	-	1.23 (0.64)	0.21 3.34	62	<0.01 (0.01)	<0.01 0.03	62	1.14 (0.63)	0.14 3.23	62	0.01 (0.01)	<0.01 0.02	62	<0.01 (<0.01)	<0.01 0.01	62
Mud Slough	122.7	1.55 (1.71)	0.02 11.00	74	0.03 (0.03)	<0.01 0.13	74	1.19 (1.51)	0.01 9.69	74	0.08 (0.10)	<0.01 0.55	74	0.03 (0.05)	<0.01 0.21	74

Table 3: (continued)	**River mile**	**Total N (Mg/d)**			**NH_4-N (Mg/d)**			**NO_3-N (Mg/d)**			**Total P (Mg/d)**			**SRP (Mg/d)**		
		X± SD	**Min Max**	**n**	**X± SD**	**Min Max**	**n**	**X± SD**	**Min Max**	**n**	**X± SD**	**Min Max**	**n**	**X± SD**	**Min Max**	**n**
Los Banos	121.0	0.12 (0.09)	0.01 0.41	56	0.01 (0.01)	<0.01 0.06	56	0.03 (0.03)	<0.01 0.14	56	0.04 (0.03)	<0.01 0.14	56	0.02 (0.02)	<0.01 0.08	56
TID Lat. 6/7	110.9	0.73 (0.54)	0.04 2.32	34	0.01 (0.01)	<0.01 0.06	34	0.66 (0.50)	0.04 2.01	34	0.03 (0.02)	<0.01 0.07	34	0.02 (0.02)	<0.01 0.07	34
Orestimba Crk	109.3	0.14 (0.13)	0.01 0.90	58	0.01 (0.02)	<0.01 0.08	58	0.12 (0.16)	<0.01 1.16	58	0.01 (0.03)	<0.01 0.24	58	<0.01 (0.01)	<0.01 0.06	58
Ramona Lake	108	0.14 (0.09)	0.01 0.28	26	0.01 (0.02)	<0.01 0.05	26	0.07 (0.05)	<0.01 0.18	26	0.01 (<0.01)	0.01 0.03	26	<0.01 (<0.01)	<0.01 0.01	26
Harding Drain	101	0.95 (0.42)	<0.01 1.85	65	0.03 (0.04)	<0.01 0.21	65	0.87 (0.38)	<0.01 1.80	65	0.17 (0.11)	<0.01 0.53	65	0.16 (0.11)	<0.01 0.53	65
Del Puerto Crk	93.3	0.16 (0.13)	<0.01 0.52	42	0.01 (0.03)	<0.01 0.17	42	0.11 (0.08)	<0.01 0.32	42	0.01 (0.01)	<0.01 0.04	42	0.01 (0.01)	<0.01 0.03	42
Westport Drain	93	0.84 (0.44)	0.12 2.24	50	0.01 (0.01)	<0.01 0.07	50	0.75 (0.44)	0.04 2.19	50	0.02 (0.01)	<0.01 0.07	50	0.01 (0.01)	<0.01 0.06	50
MID Lat. 5 - Tuol.	83	0.05 (0.05)	<0.01 0.24	29	0.01 (0.01)	<0.01 0.06	29	0.03 (0.04)	<0.01 0.14	29	<0.01 (0.01)	<0.01 0.04	29	<0.01 (0.01)	<0.01 0.03	29
Ingram Crk	82.8	0.18 (0.19)	0.01 0.68	44	0.02 (0.03)	<0.01 0.11	44	0.13 (0.13)	0.01 0.45	44	0.01 (0.02)	<0.01 0.07	44	<0.01 (<0.01)	<0.01 0.01	44
Hospital Crk	82.8	0.03 (0.03)	<0.01 0.09	17	<0.01 (<0.01)	<0.01 0.01	17	0.02 (0.02)	<0.01 0.06	17	0.01 (0.01)	<0.01 0.02	17	<0.01 (<0.01)	<0.01 0.01	17
MID Main – Stan.	76.0	0.09 (0.16)	<0.01 0.87	36	0.03 (0.11)	<0.01 0.61	36	0.04 (0.05)	<0.01 0.19	36	0.02 (0.04)	<0.01 0.18	36	0.01 (0.03)	<0.01 0.15	36

Table 4: The percentage of nutrient concentrations originating from the various tributaries and drains compared to the mean load measured at the San Joaquin River at Vernalis.

	TN %	NO_3-N %	TP %	SRP %
San Joaquin River – Lander Avenue	11.6	5.4	17.3	17.7
Stanislaus	7.9	5.2	10.1	11.5
Tuolumne	25.1	21.4	21.8	17.7
Merced	19.2	20.0	10.1	7.3
Salt Slough	9.7	10.7	12.3	11.0
San Luis Drain	9.2	13.7	<0.1	<0.1
Mud Slough above San Luis Drain	2.4	0.6	3.9	3.0
Los Banos	0.9	0.4	2.2	2.1
TID Lat. 6/7	5.4	8.0	1.7	2.1
Orestimba Creek	1.0	1.4	<0.1	<0.1
Ramona Lake	1.0	0.8	<0.1	<0.1
Harding Drain	7.1	10.5	9.5	16.7
Del Puerto Creek	1.2	1.3	<0.1	1.0
Westport Drain	6.3	9.0	0.1	1.0
MID Lat. 5 – Tuol.	0.4	0.4	<0.1	<0.1
Ingram Creek	1.3	1.6	<0.1	<0.1
Hospital Creek	0.2	0.2	<0.1	<0.1
MID Main – Stan.	0.7	0.5	0.1	1.0
Sum	**110.6**	**111.1**	**89.1**	**92.1**

Figure 1: Distribution of total nitrogen concentrations for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom). The median (line), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed.

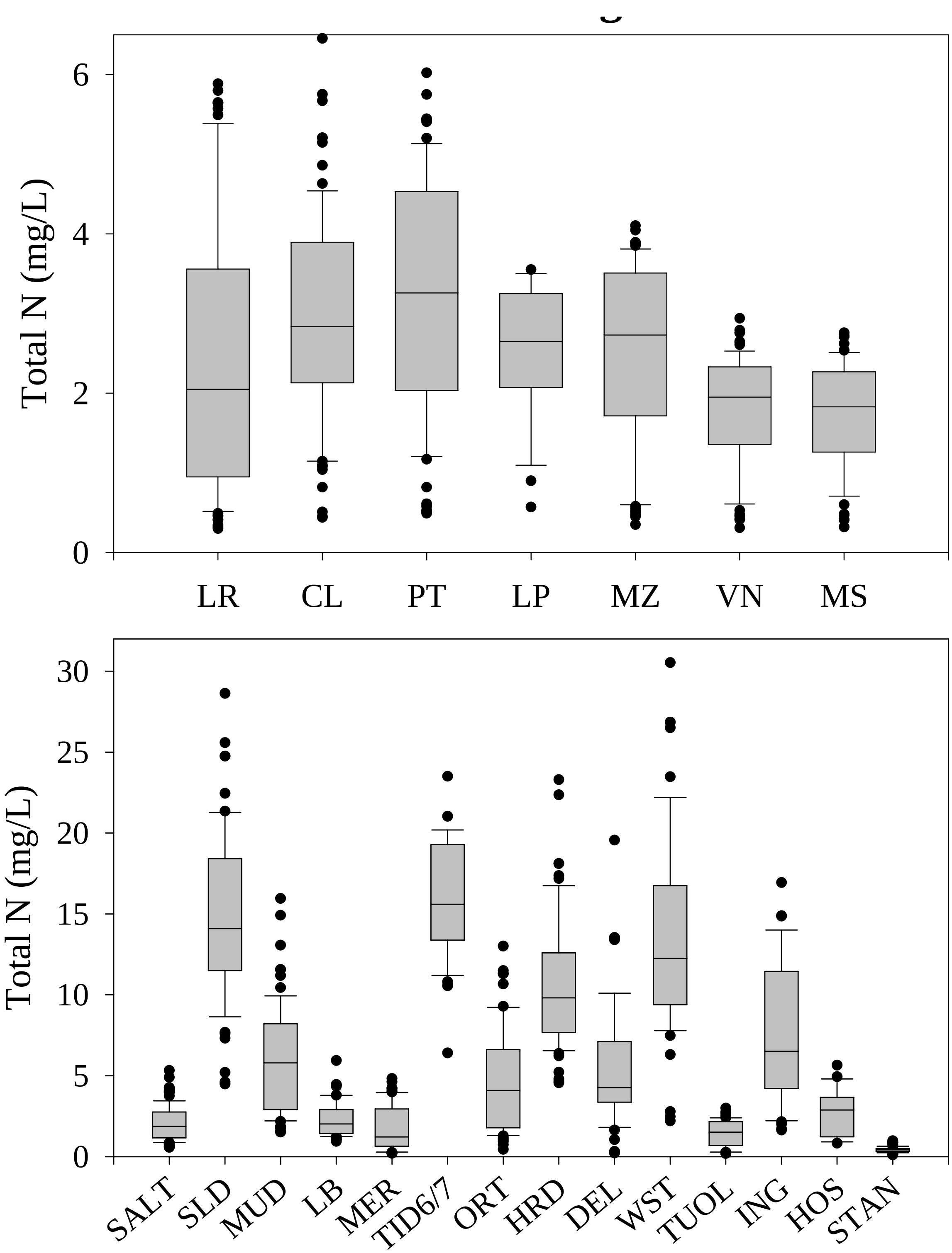


Figure 2: Distribution of ammonium concentrations for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom). The median (line), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed.

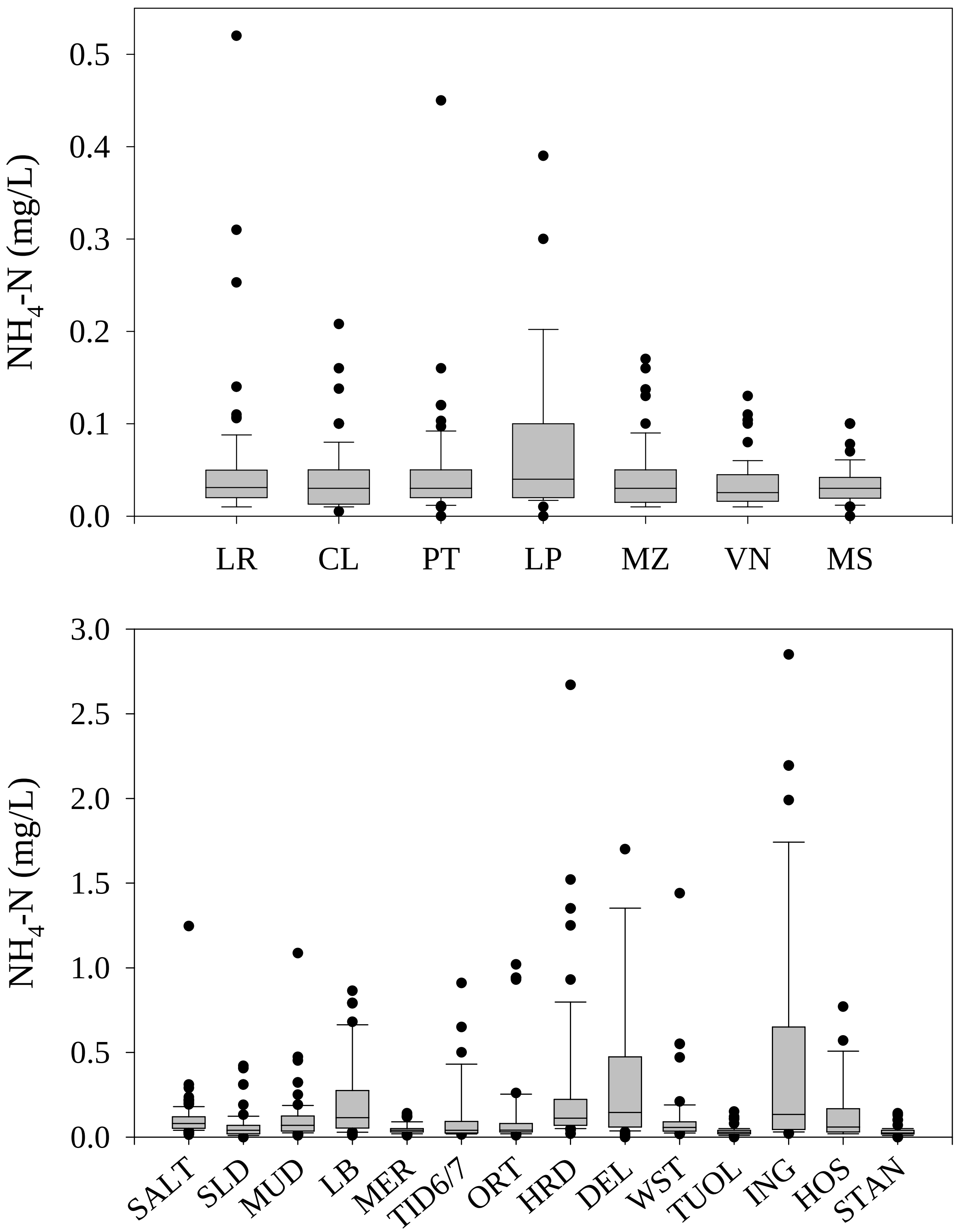
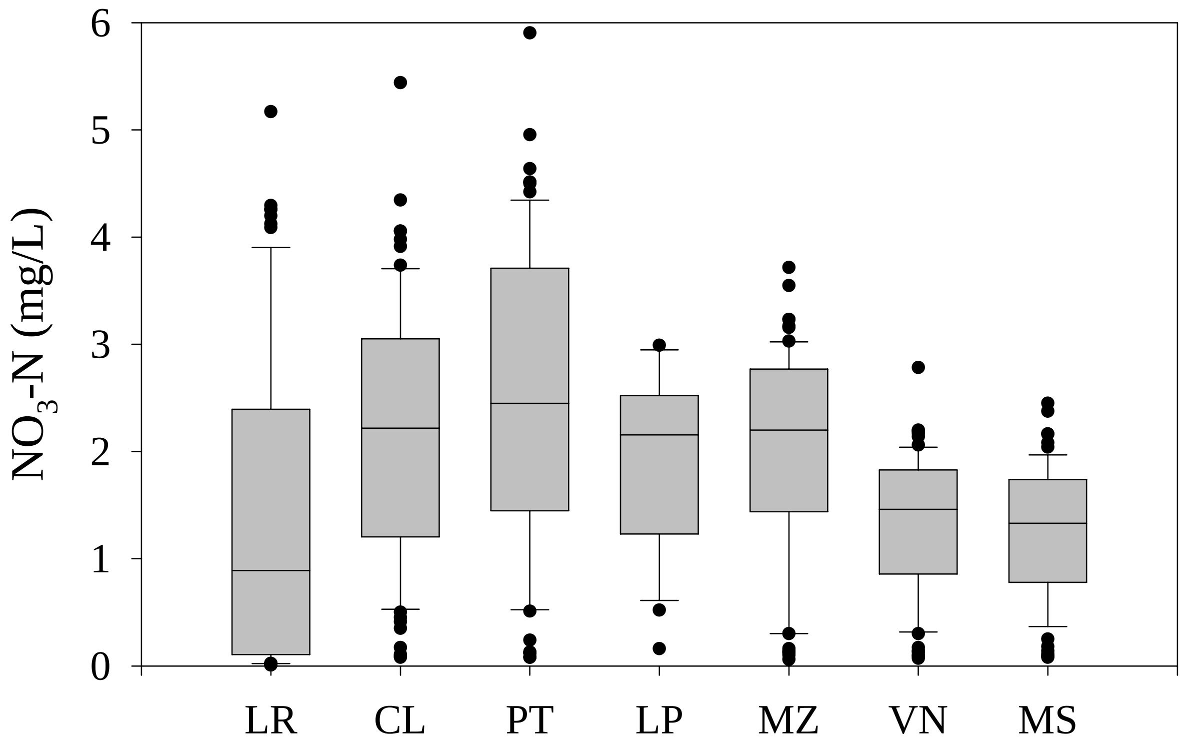


Figure 3: Distribution of nitrate concentrations for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom). The median (line), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed.



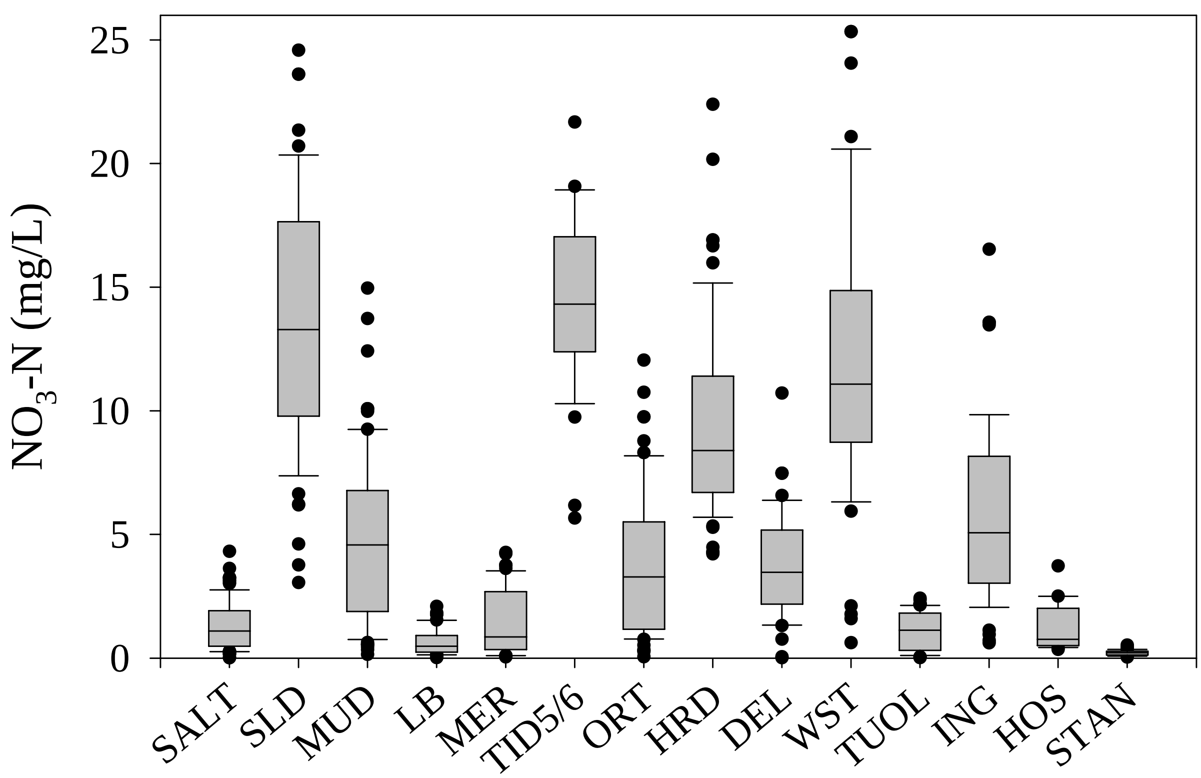
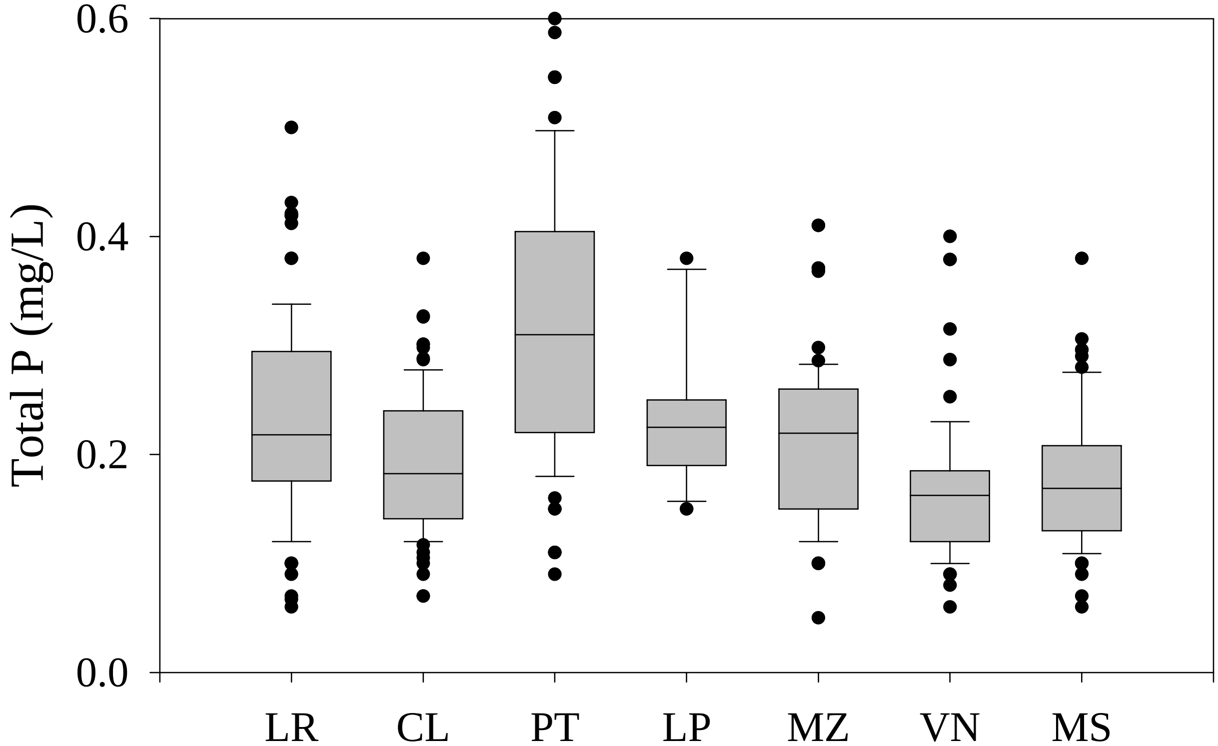


Figure 4: Distribution of total phosphorus concentrations for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom). The median (line), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed.



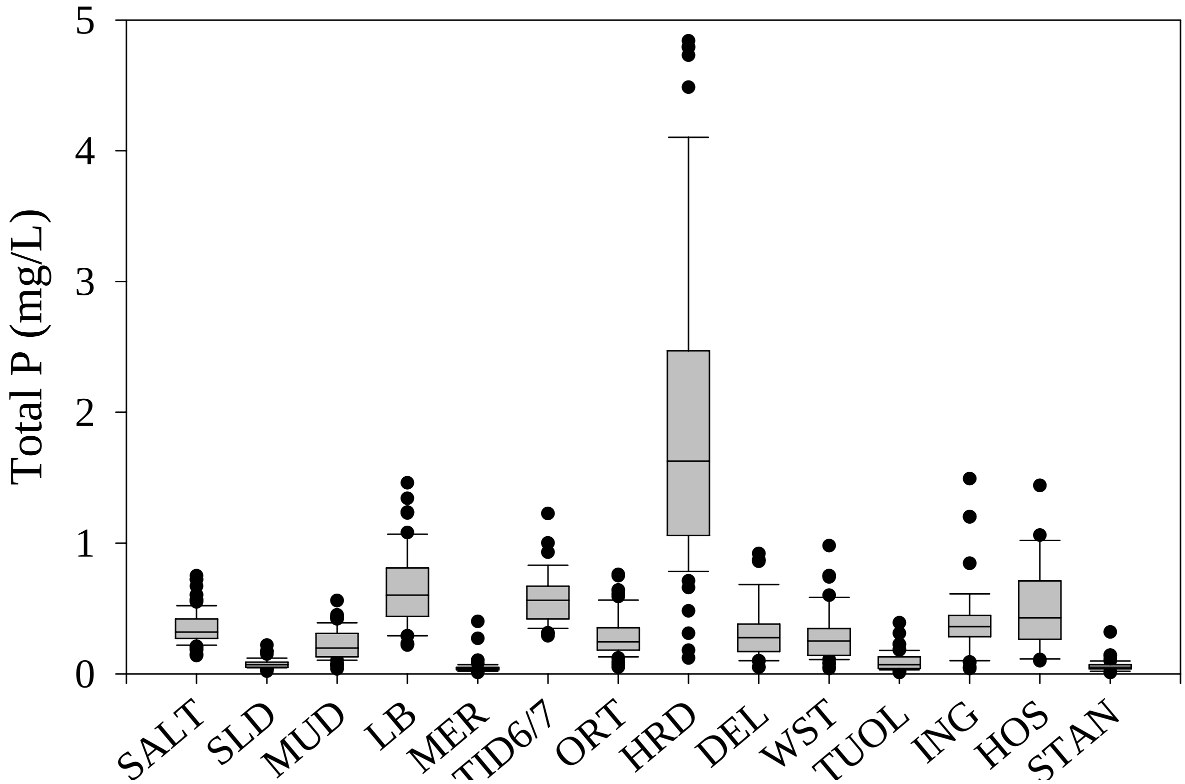


Figure 5: Distribution of soluble-reactive phosphate concentrations for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom). The median (line), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed.

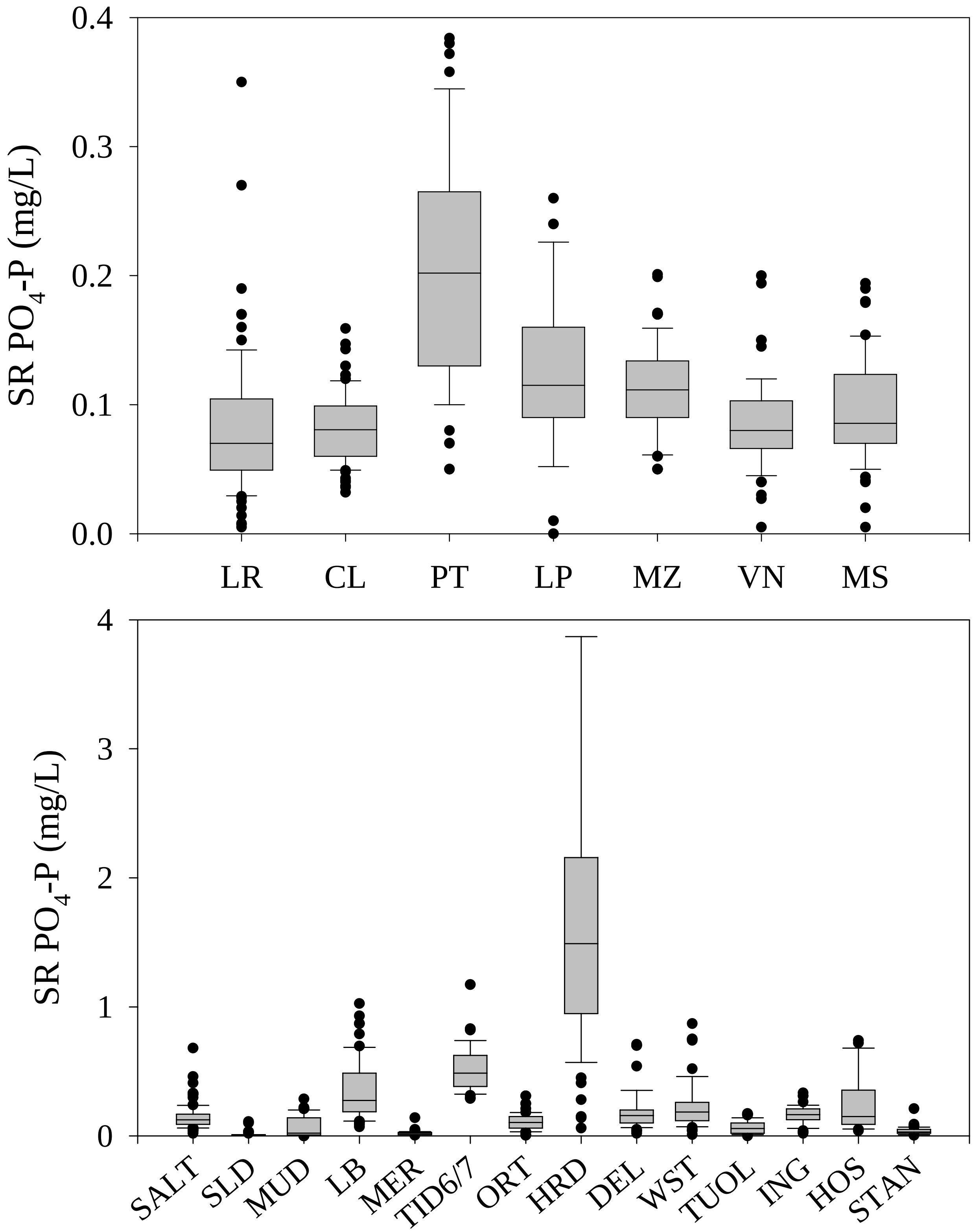
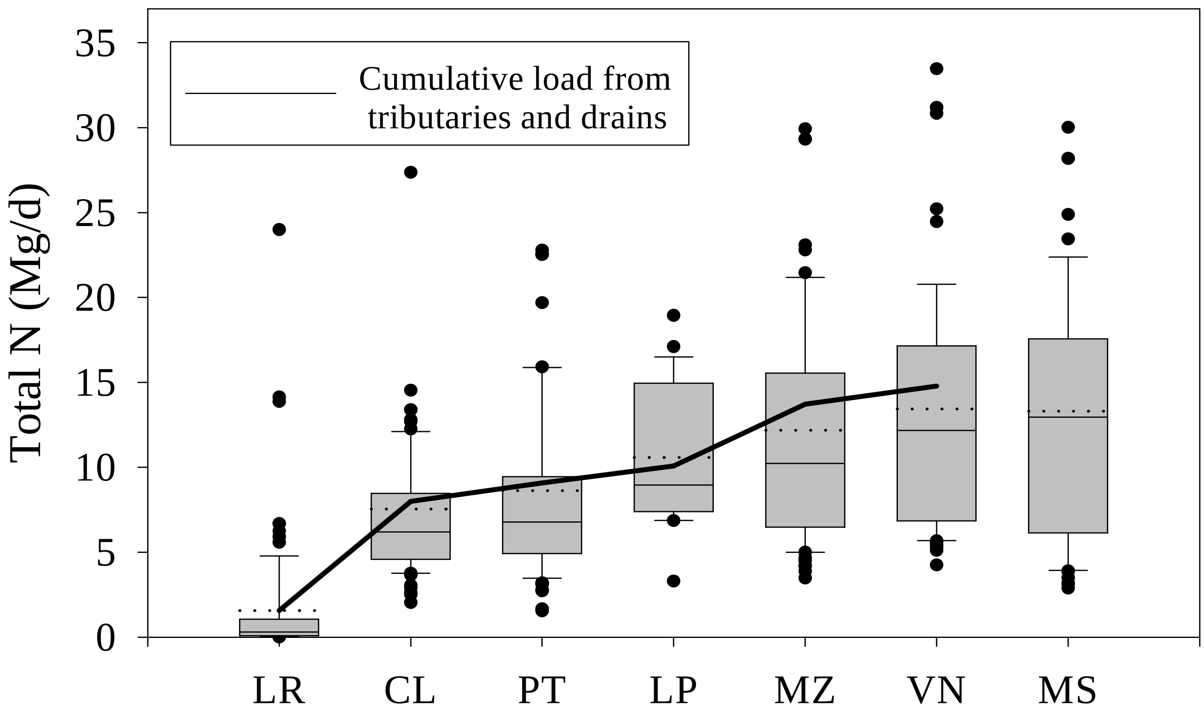


Figure 6: Distribution of total nitrogen loads for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom) for the study period (March 2005 to December 2007). The median (line), mean (dashed), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed. The line represents the cumulative loads based on the mean daily loads from tributaries and drains located above each mainstem site.



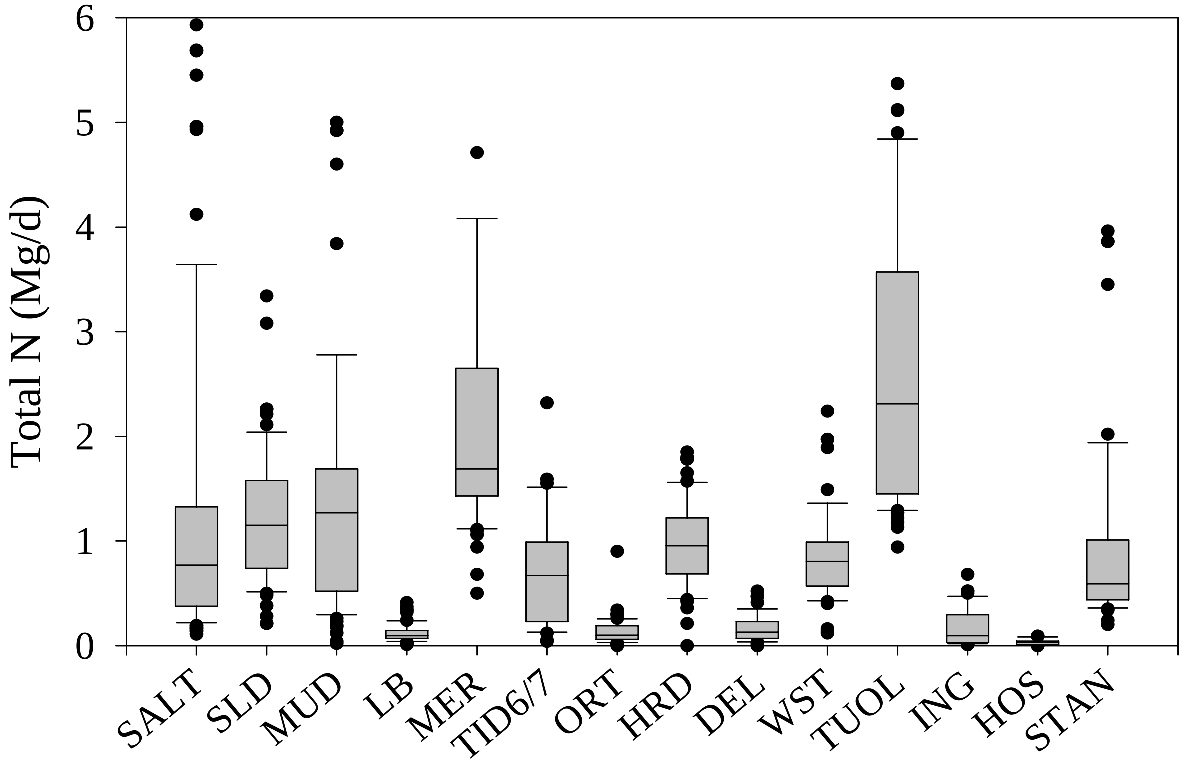


Figure 7: Distribution of nitrate-N loads for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom) for the study period (March 2005 to December 2007). The median (line), mean (dashed), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed. The line represents the cumulative loads based on the mean daily loads from tributaries and drains located above each mainstem site.

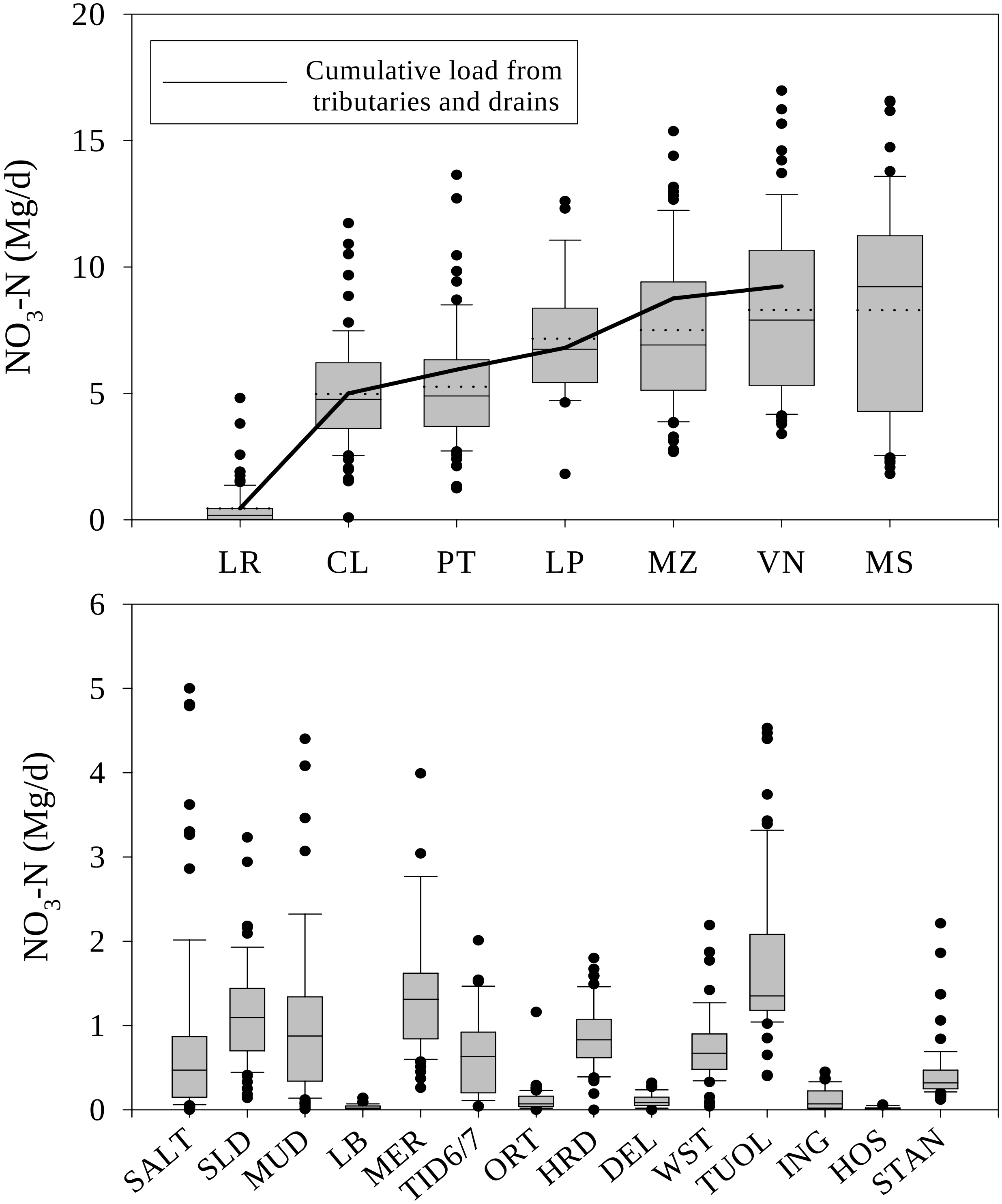


Figure 8: Distribution of ammonium-N loads for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom) for the study period (March 2005 to December 2007). The median (line), mean (dashed), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed. The line represents the cumulative loads based on the mean daily loads from tributaries and drains located above each mainstem site.

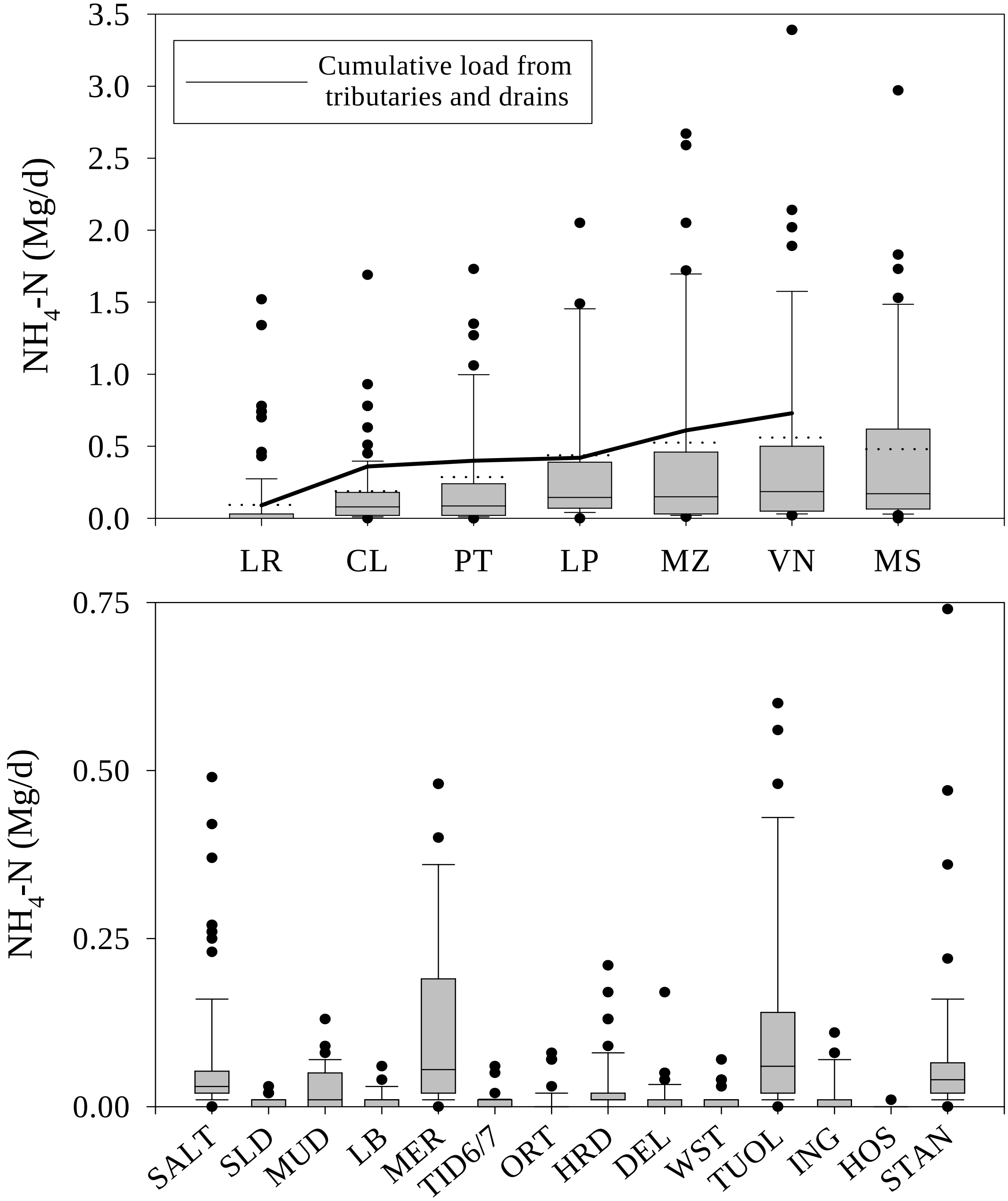


Figure 9: Distribution of total phosphorus loads for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom) for the study period (March 2005 to December 2007). The median (line), mean (dashed), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed. The line represents the cumulative loads based on the mean daily loads from tributaries and drains located above each mainstem site.

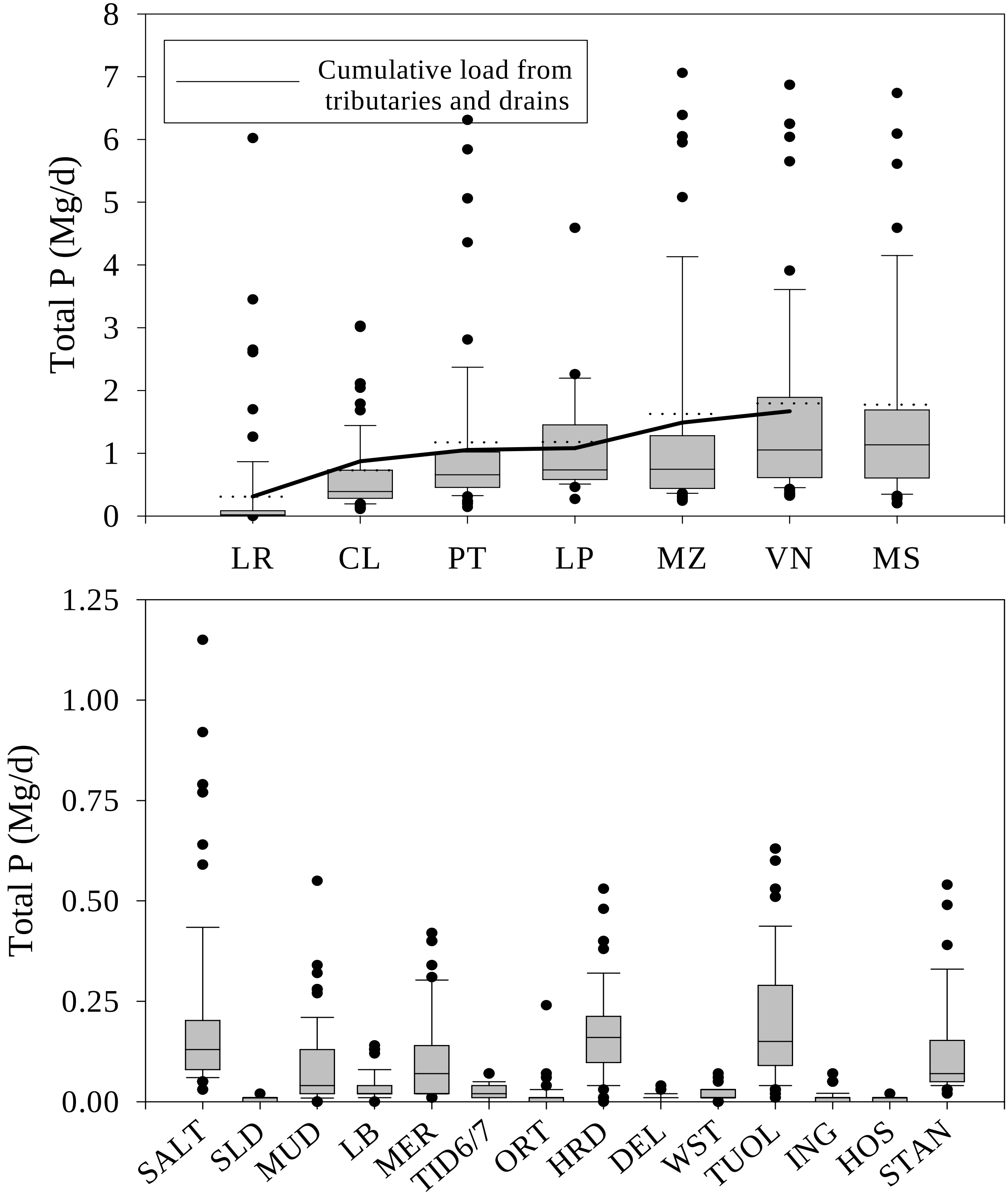


Figure 10: Distribution of soluble-reactive phosphate loads for San Joaquin River mainstem sites (top) and major tributaries and drains (bottom) for the study period (March 2005 to December 2007). The median (line), mean (dashed), 25th and 75th percentile (box), 10th and 90th percentile (whisker), and outlier points (points) are displayed. The line represents the cumulative loads based on the mean daily loads from tributaries and drains located above each mainstem site.

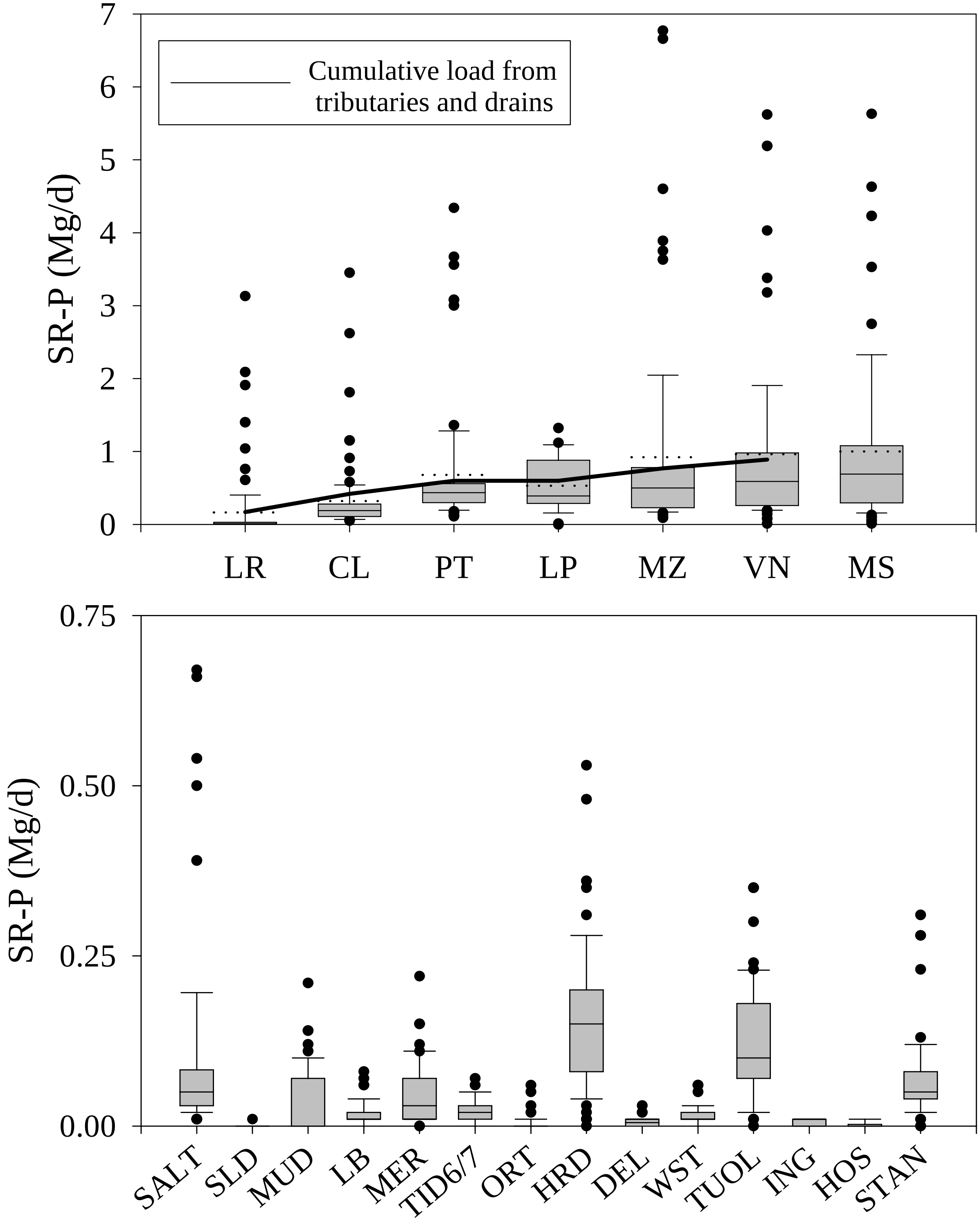


Figure 11: Long-term nitrate-N concentrations for the San Joaquin River at Vernalis.

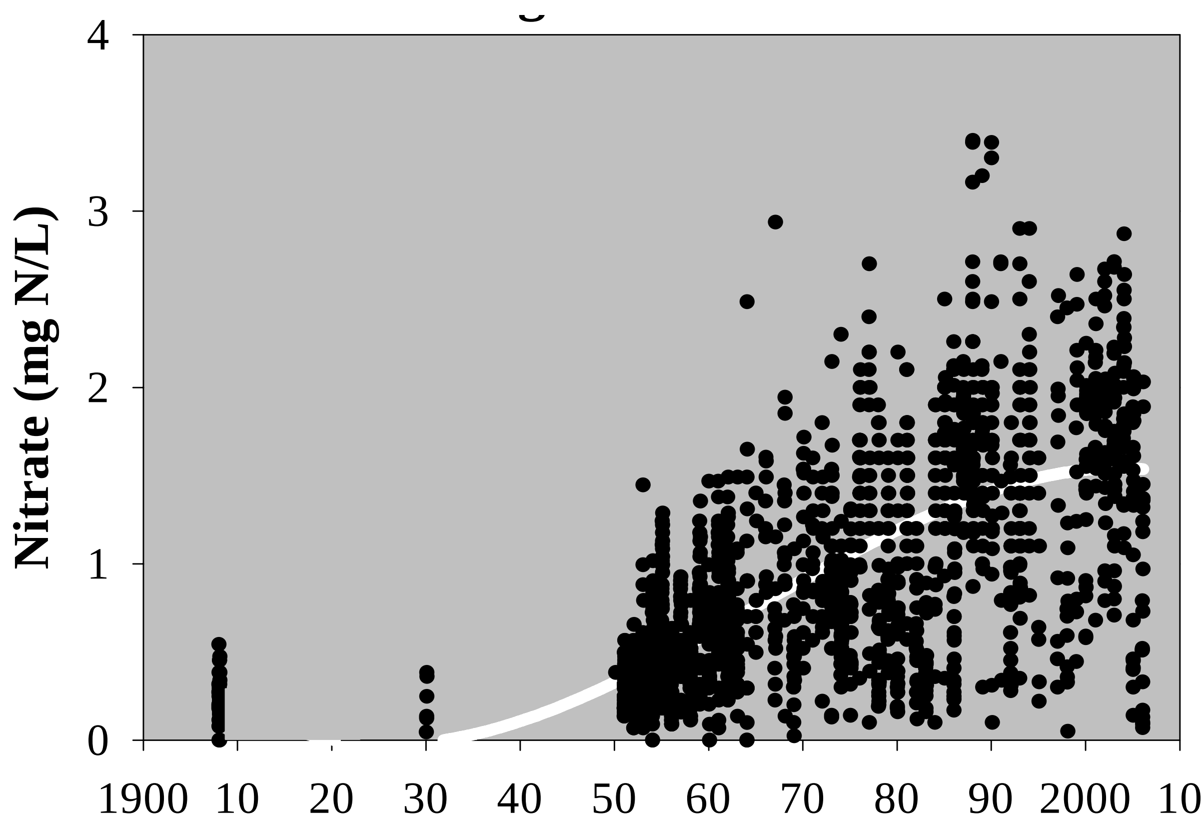


Figure 12: Temporal variability in total N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.

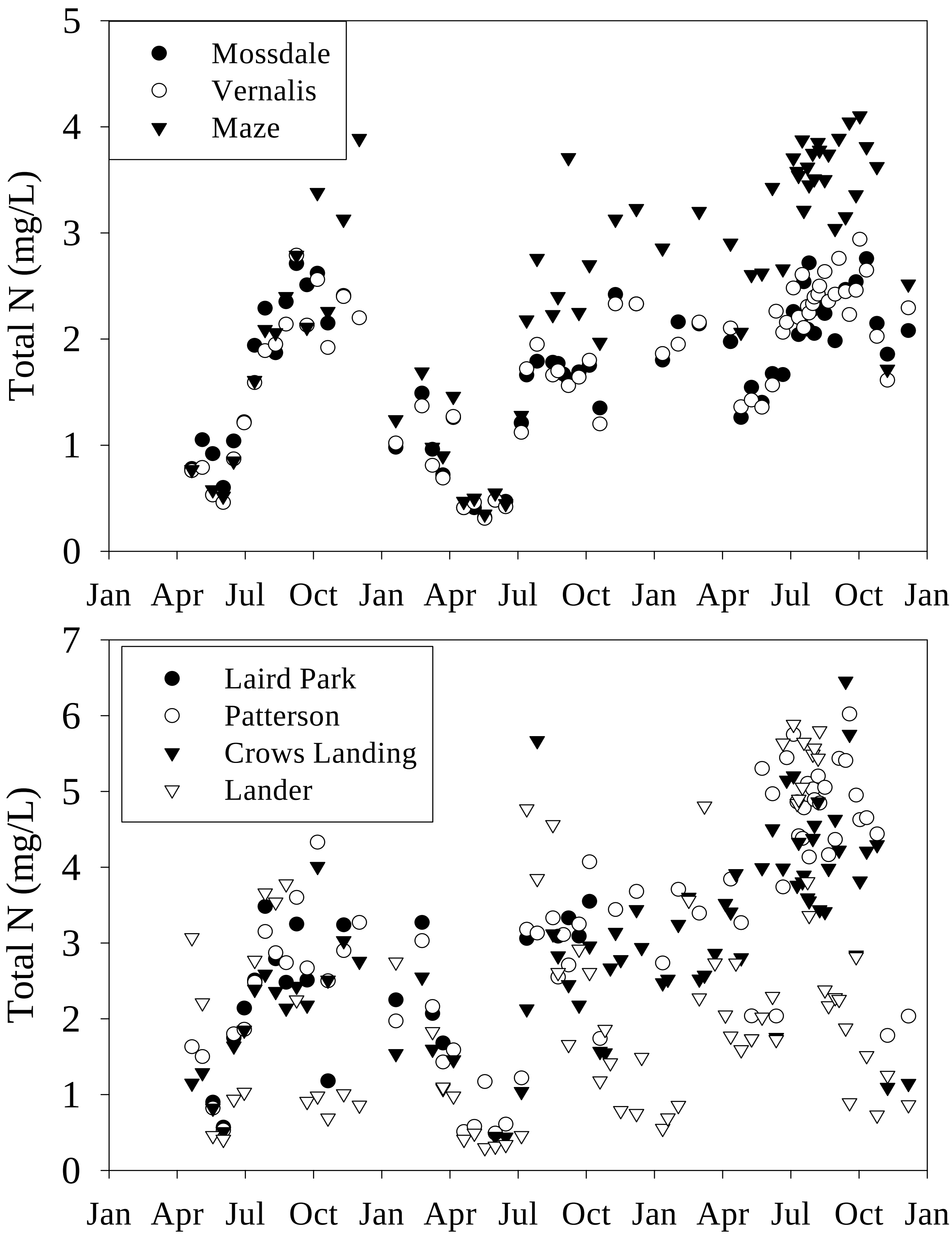
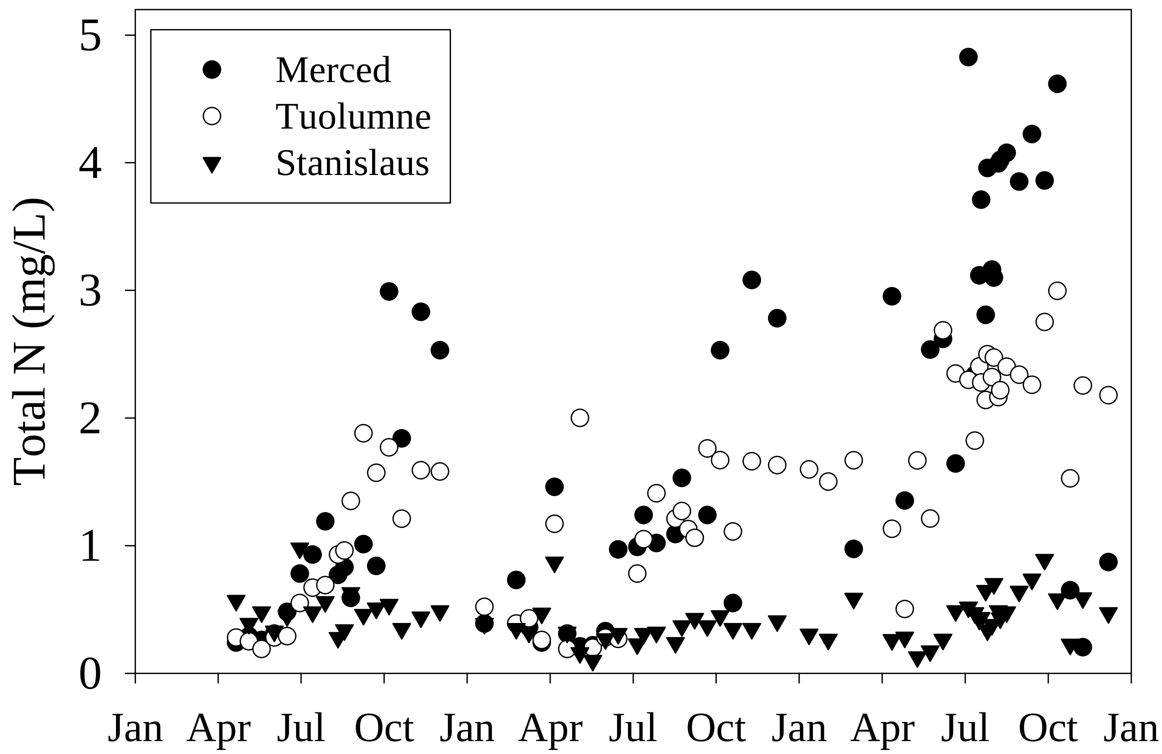


Figure 13: Temporal variability in total N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



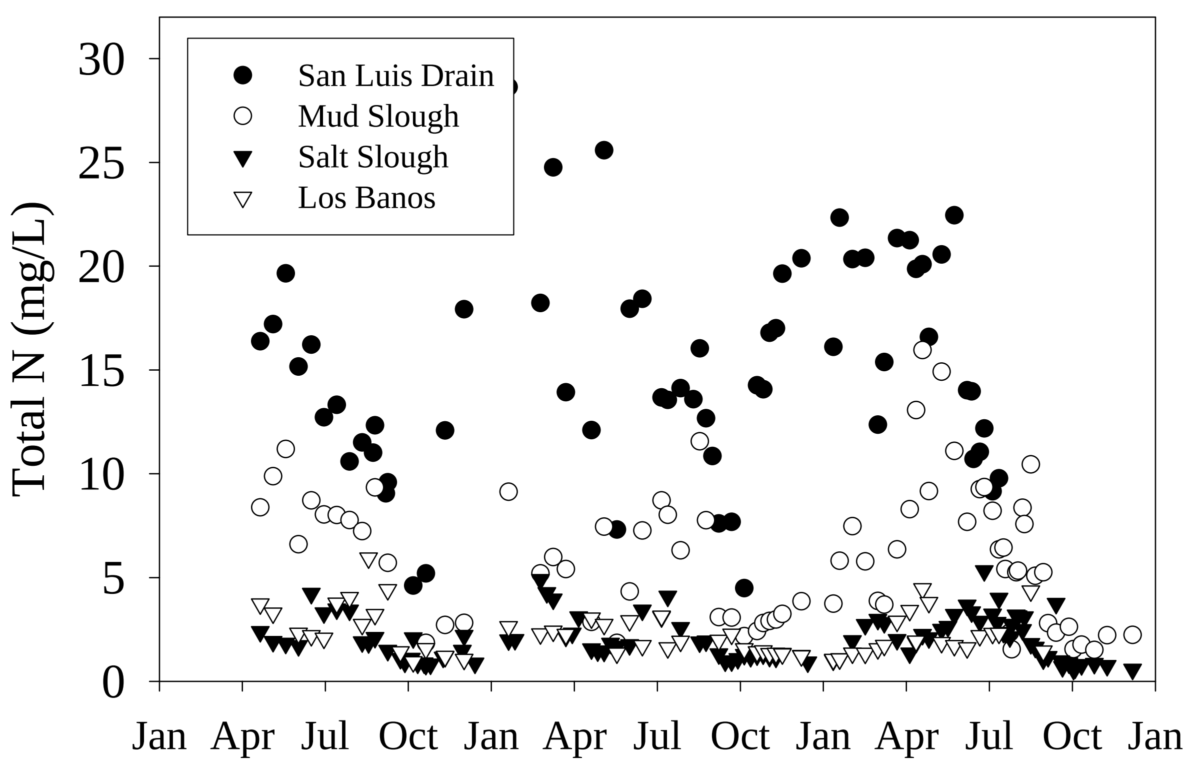
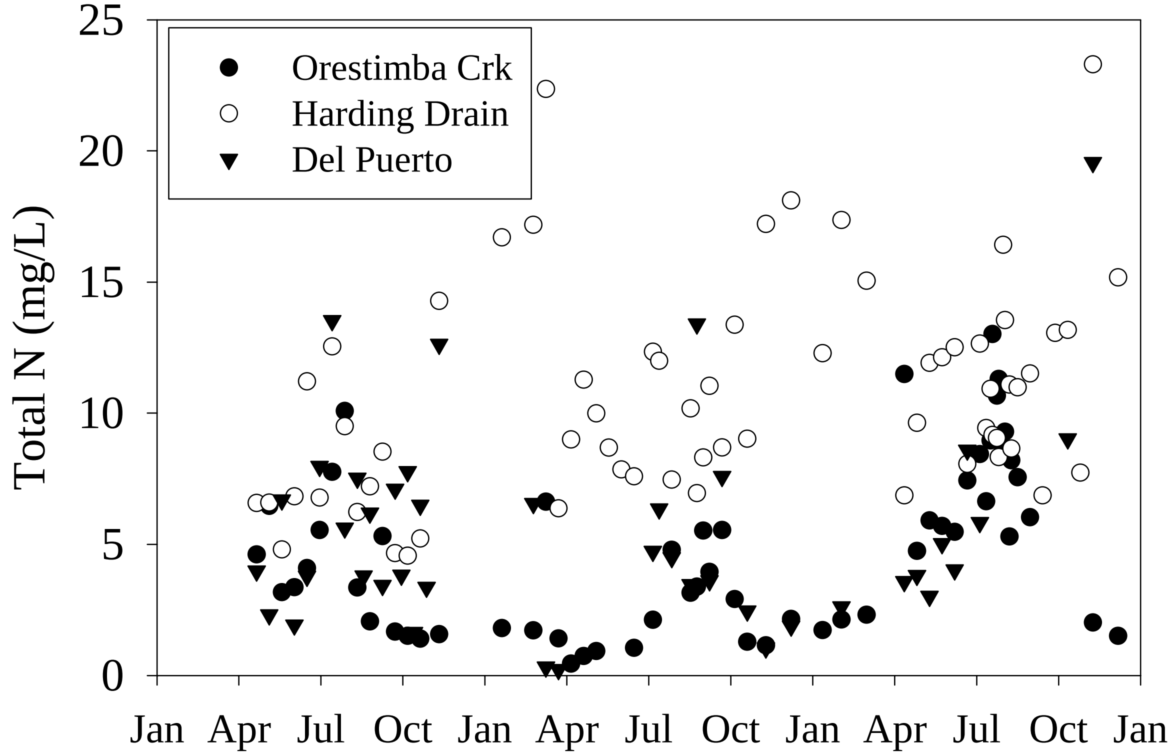


Figure 14: Temporal variability in total N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



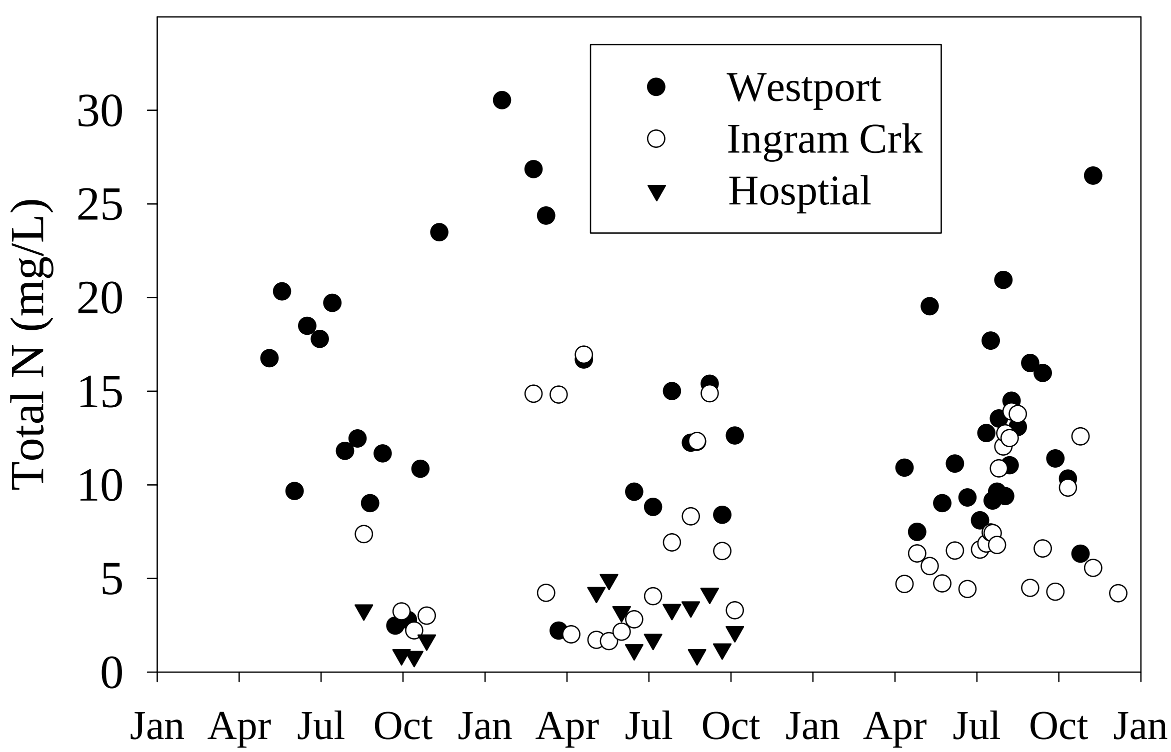
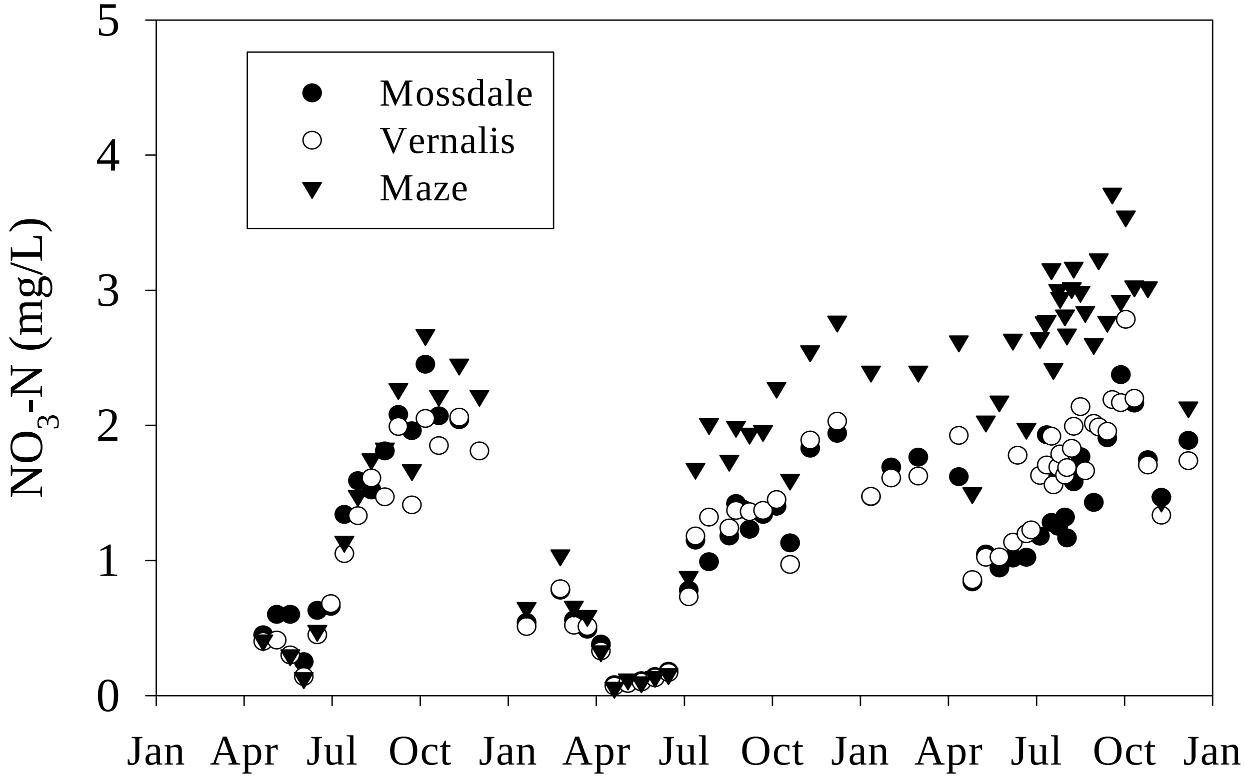


Figure 15: Temporal variability in nitrate-N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



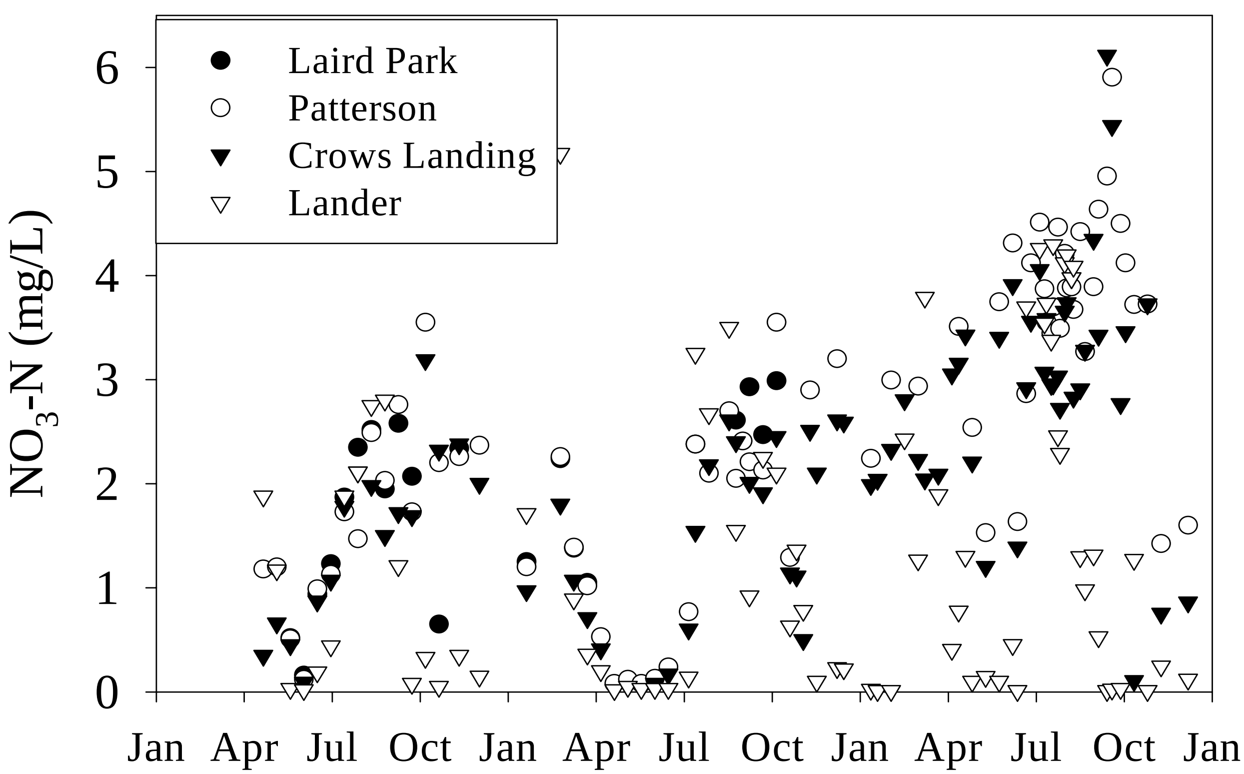


Figure 16: Temporal variability in nitrate-N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.

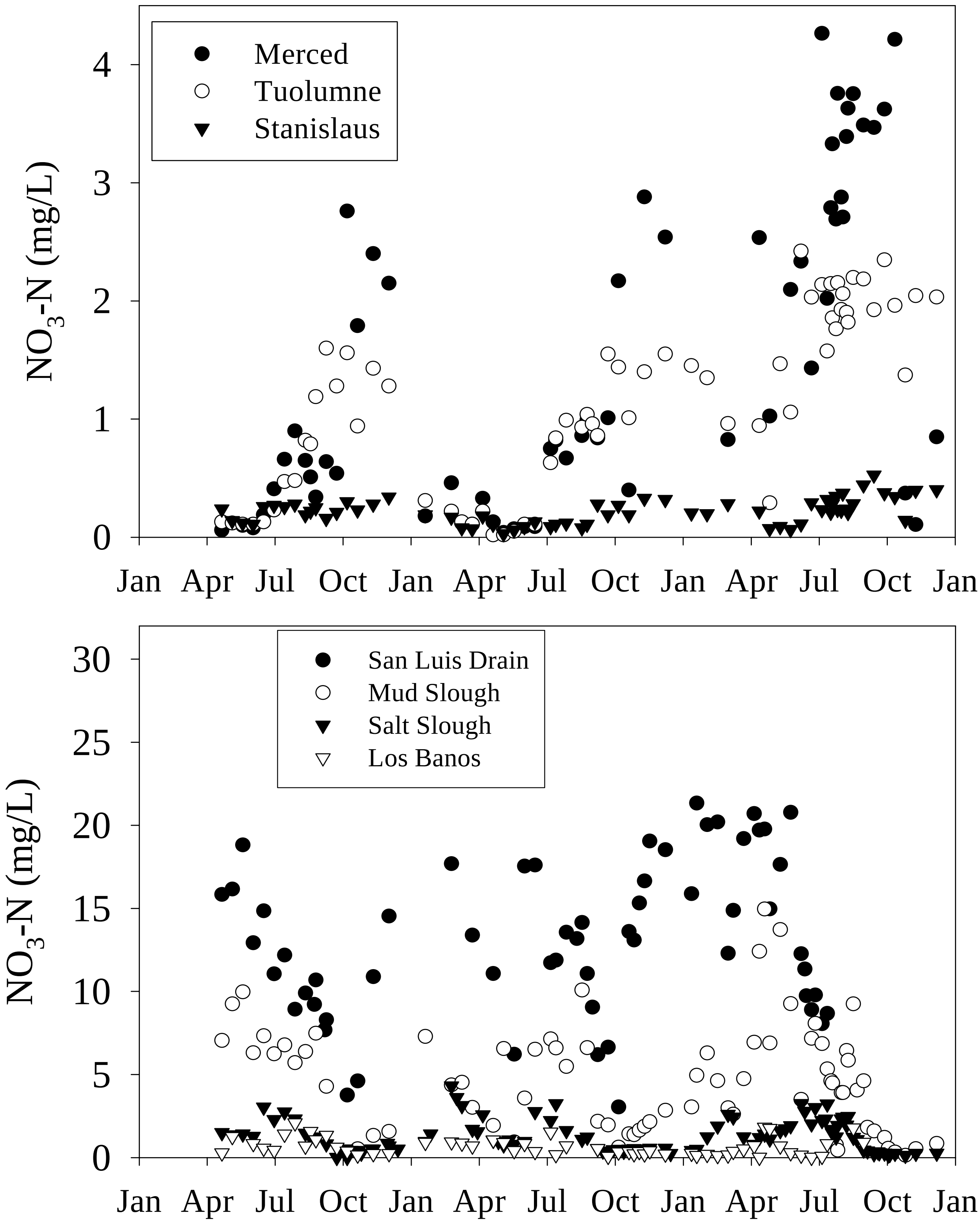
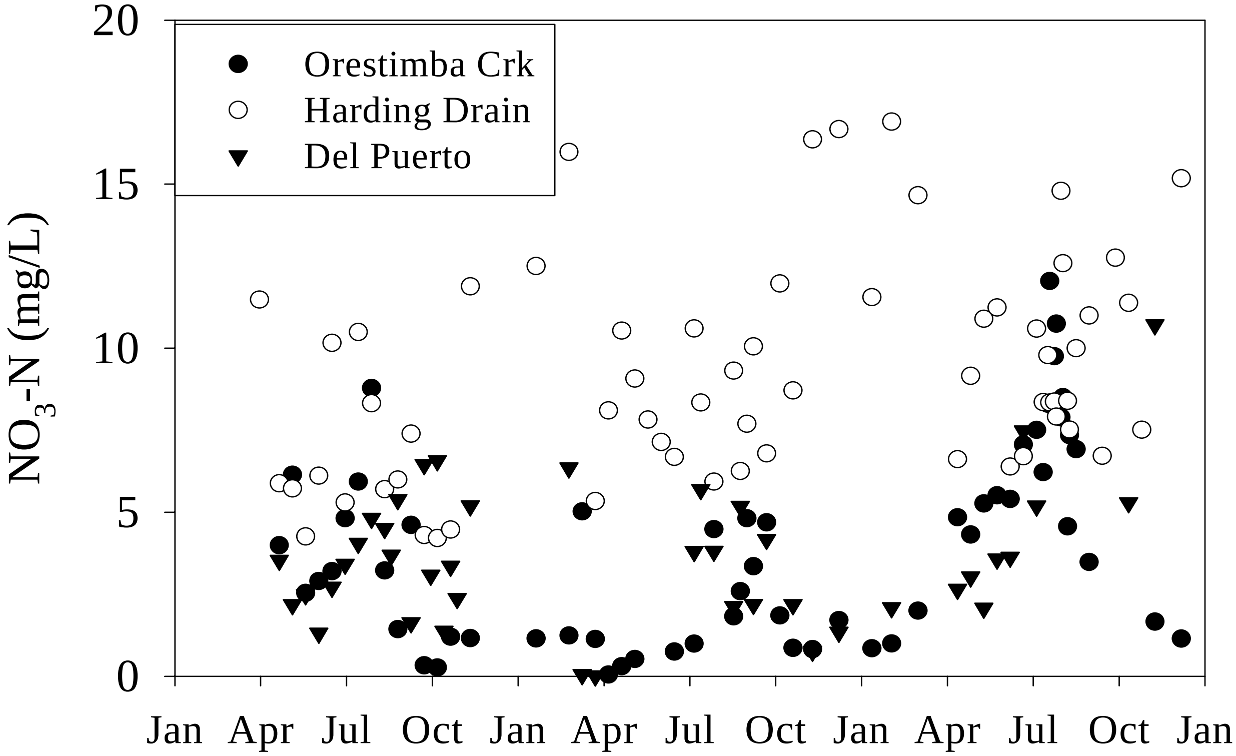


Figure 17: Temporal variability in nitrate-N concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



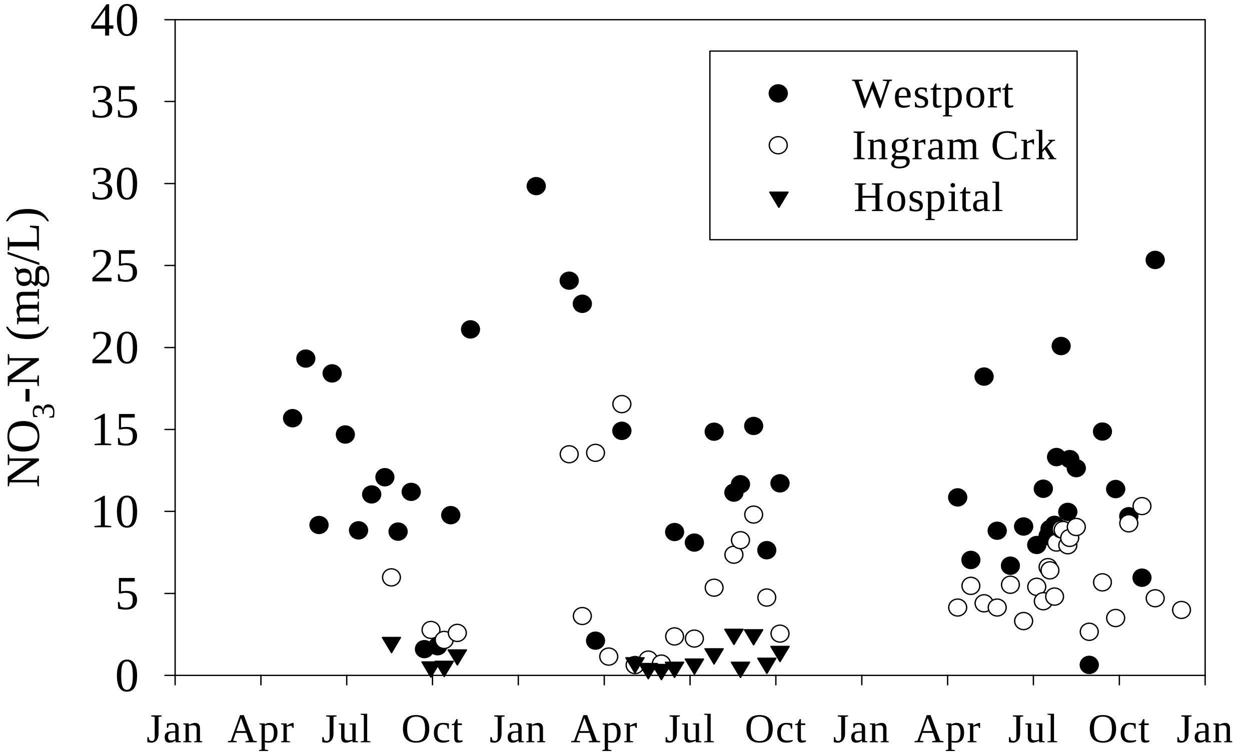
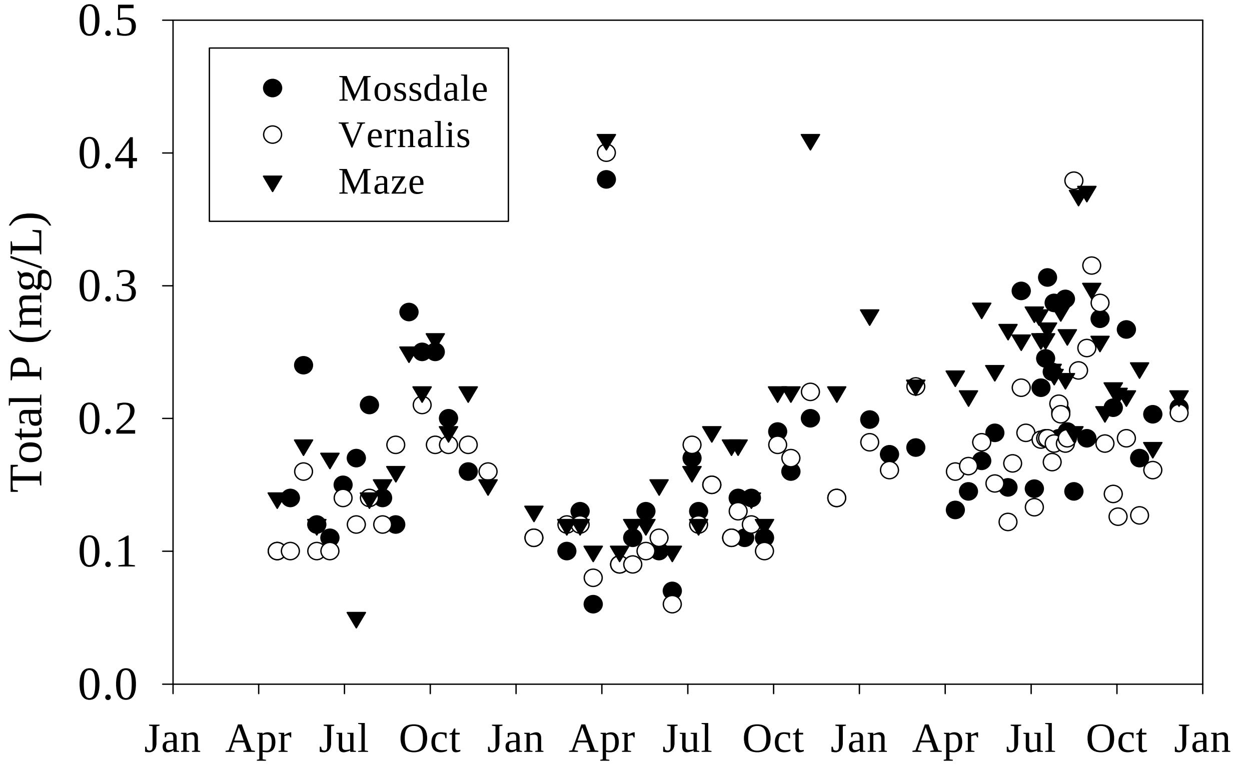


Figure 18: Temporal variability in total phosphorus concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



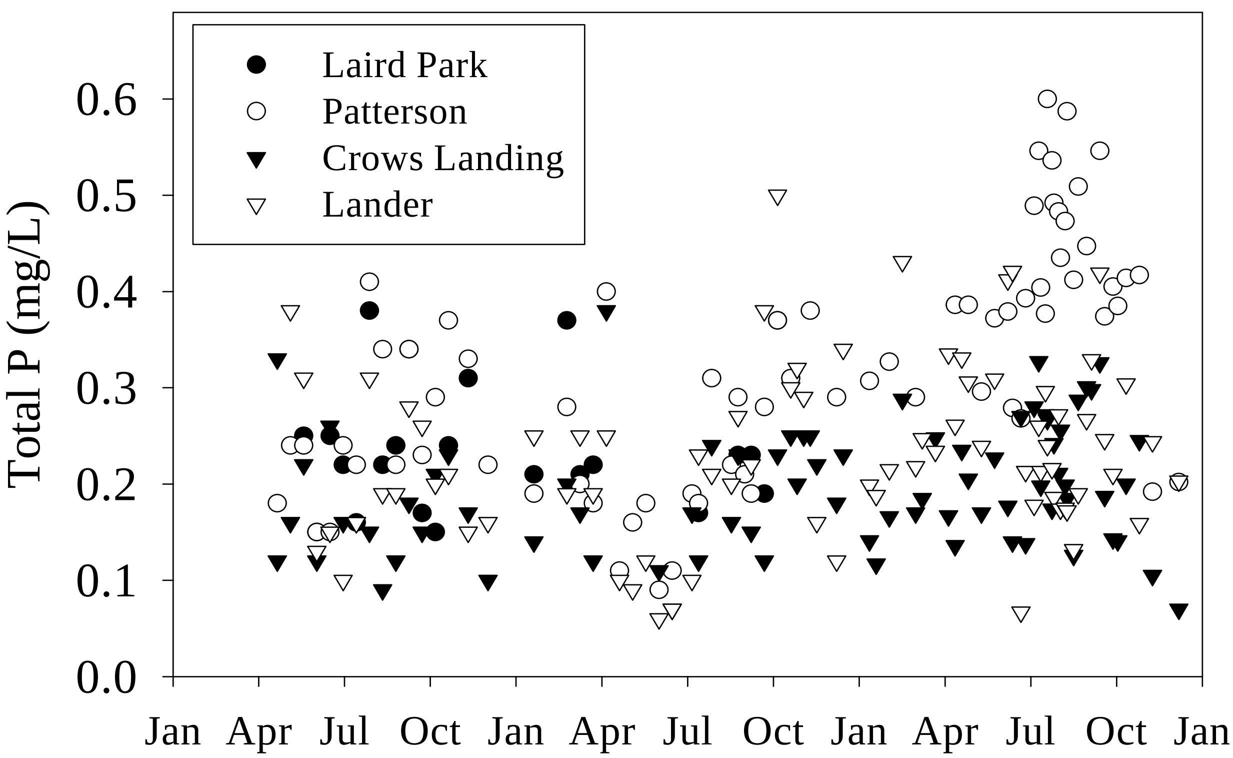


Figure 19: Temporal variability in total phosphorus concentrations for selected sites in the San Joaquin River watershed during 2005-2007.

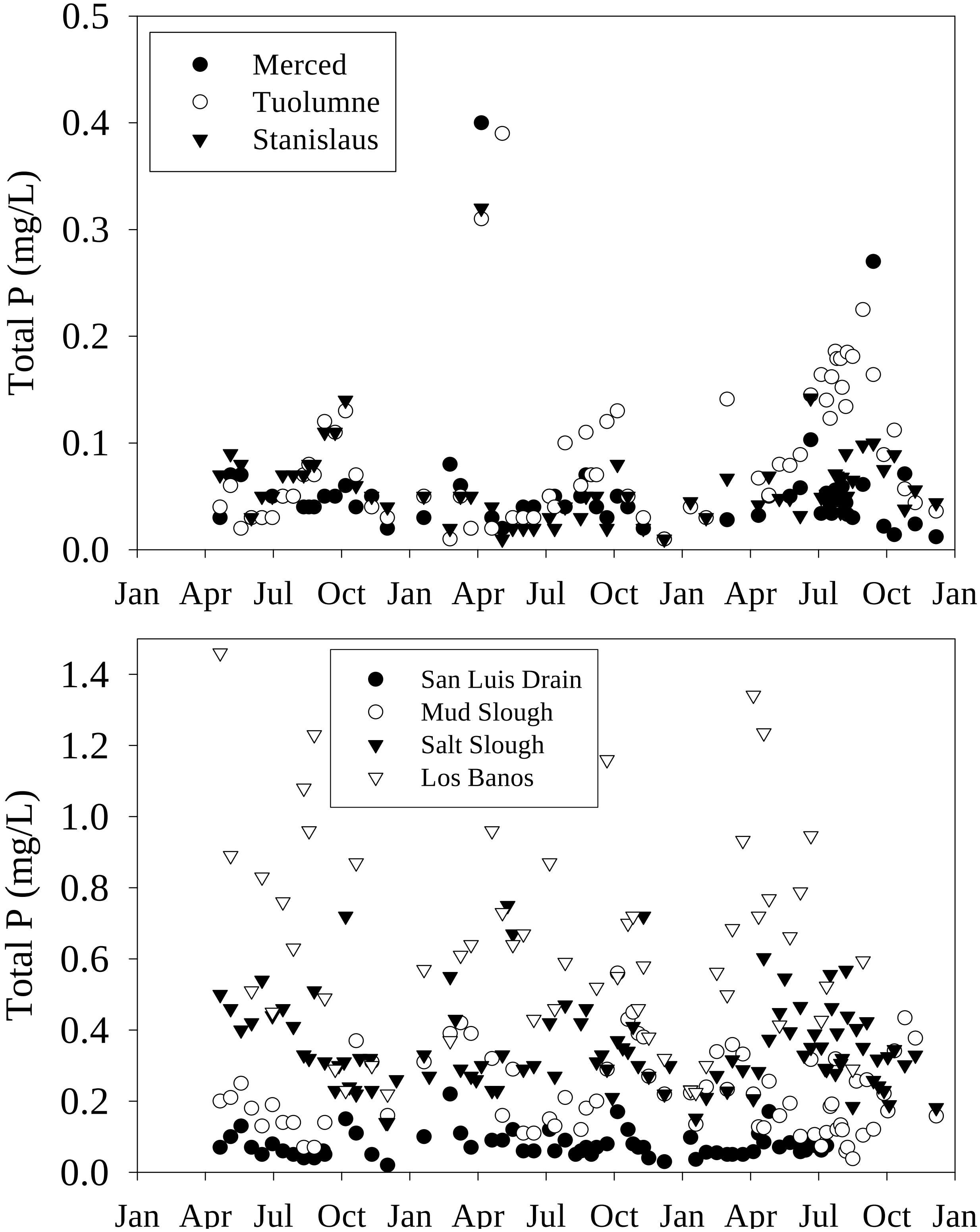
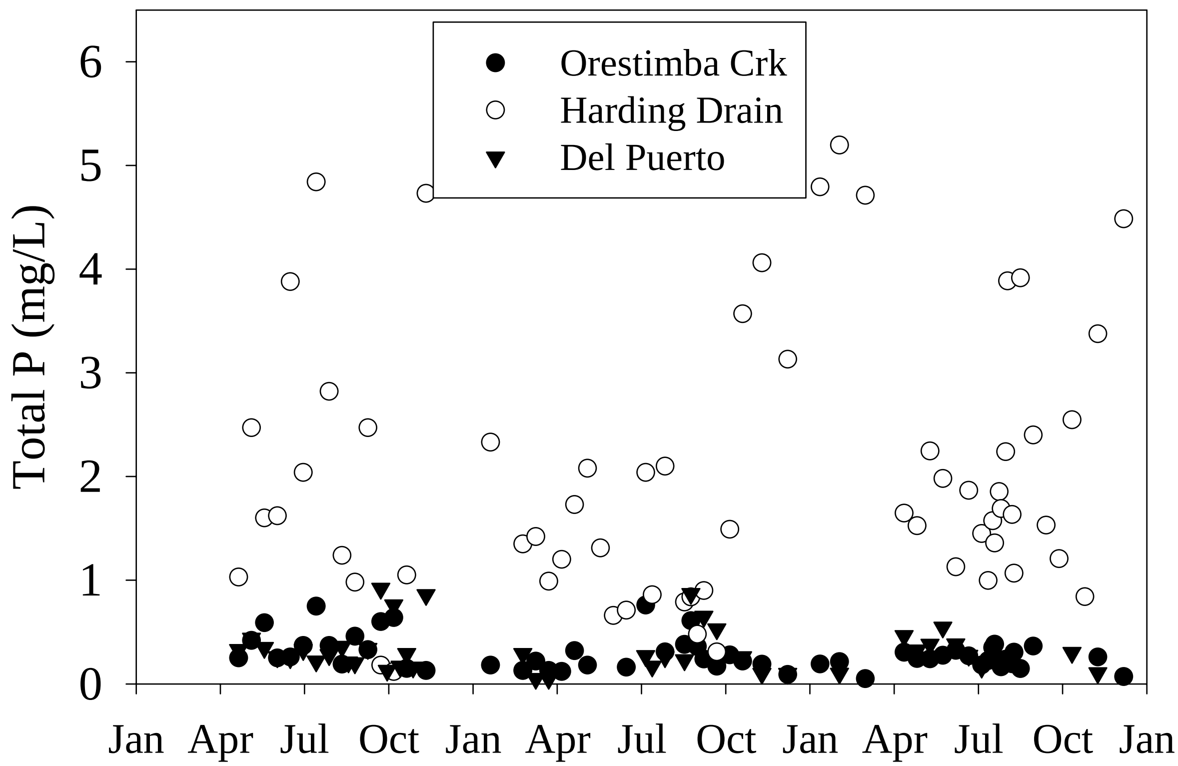


Figure 20: Temporal variability in total phosphorus concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



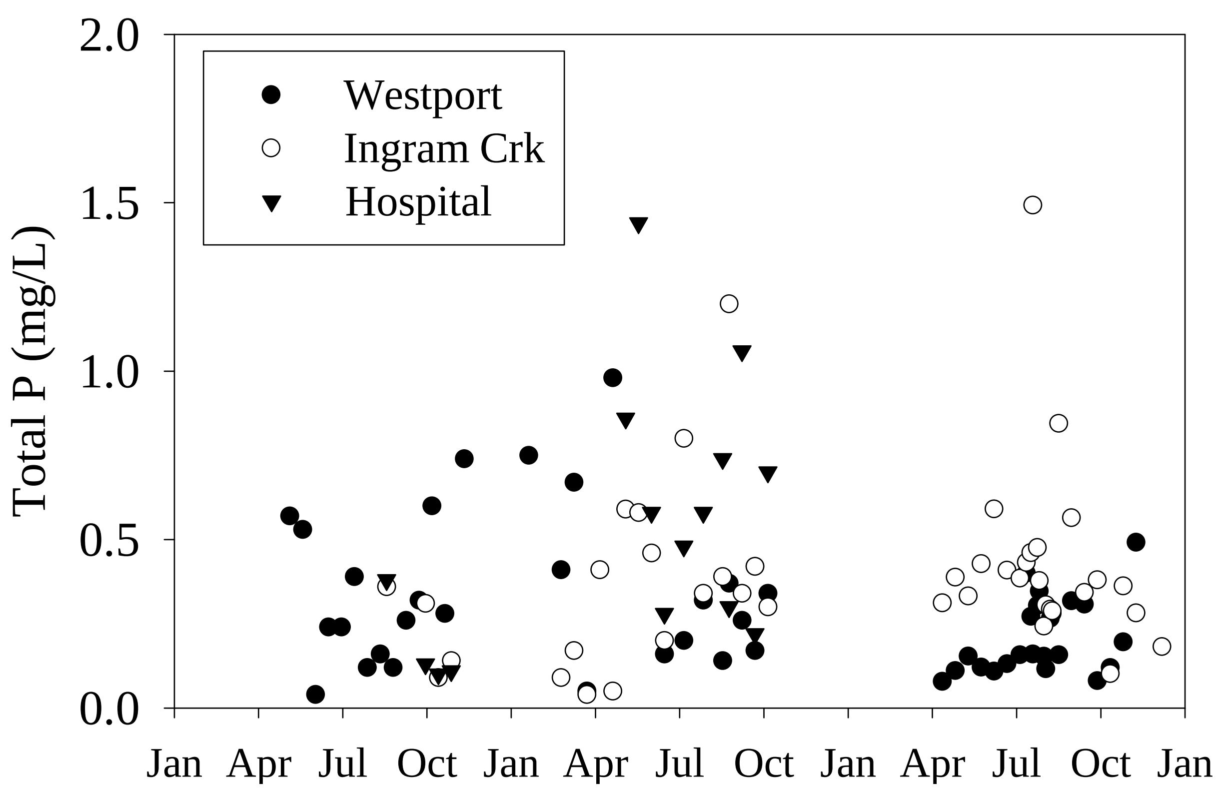
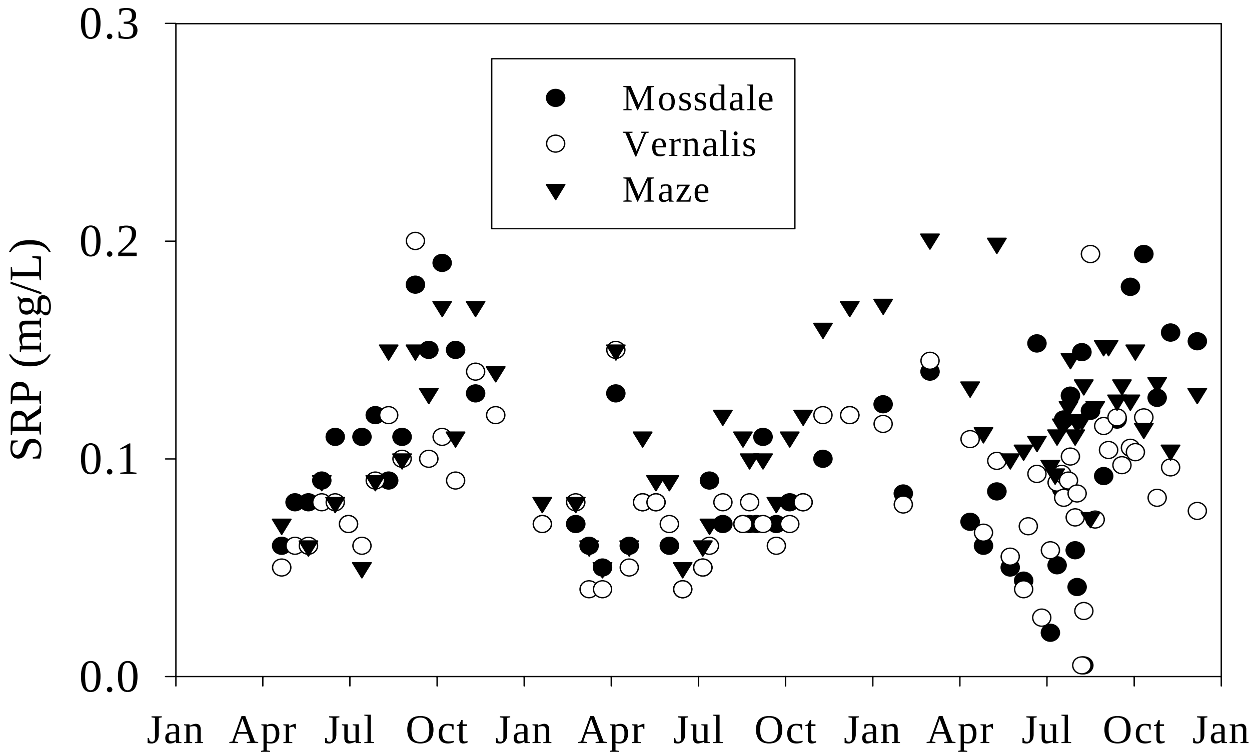


Figure 21: Temporal variability in soluble-reactive phosphate concentrations for selected sites in the San Joaquin River watershed during 2005-2007.



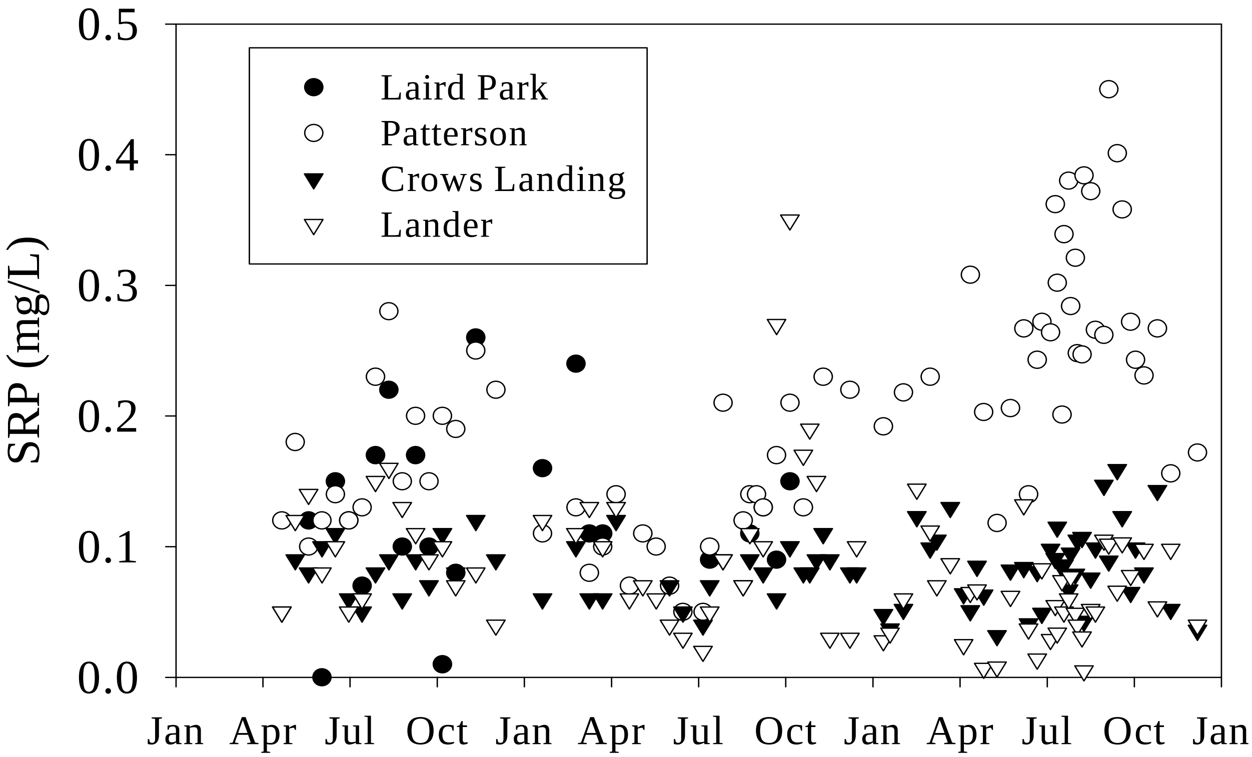


Figure 22: Temporal variability in soluble-reactive phosphate concentrations for selected sites in the San Joaquin River watershed during 2005-2007.

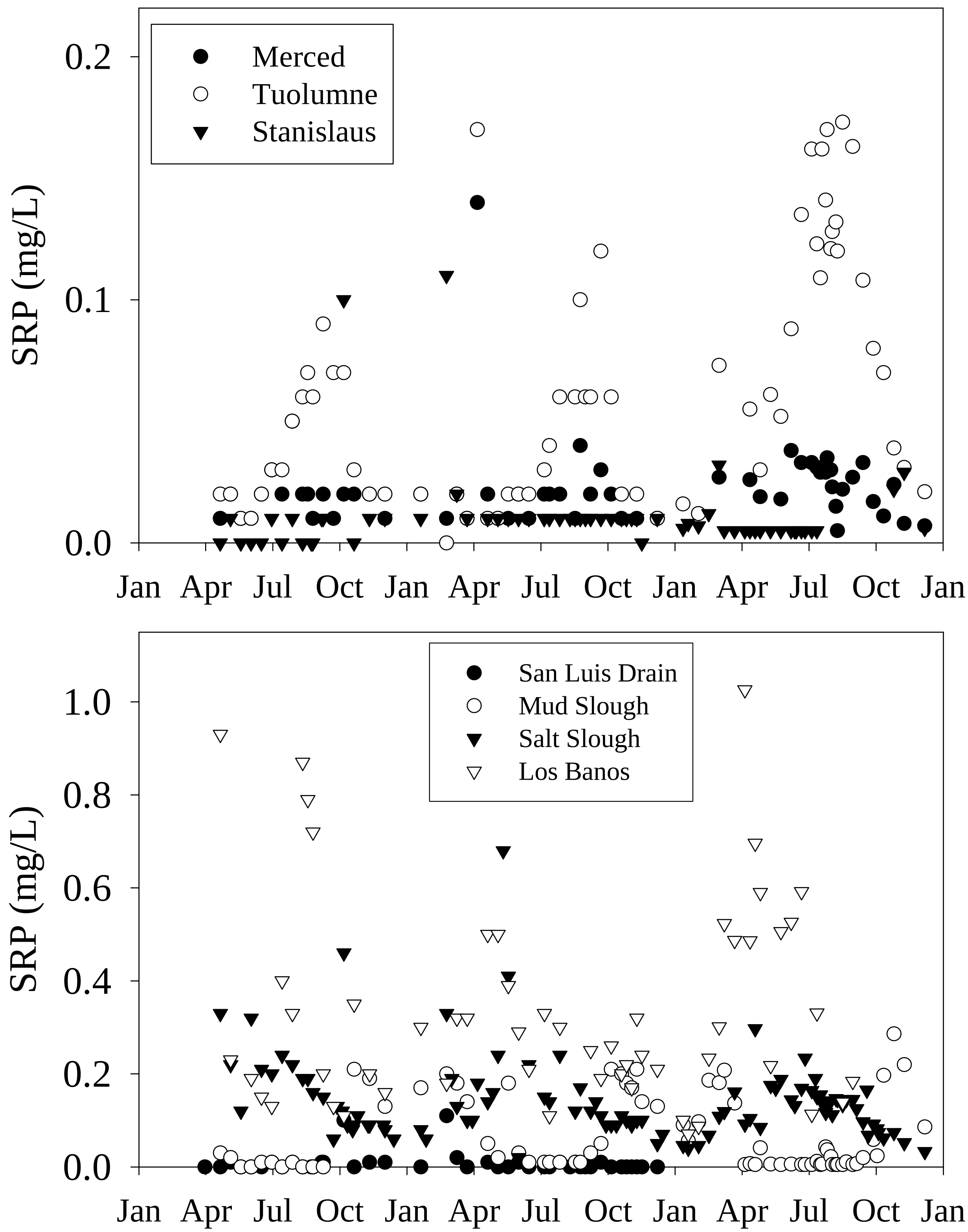
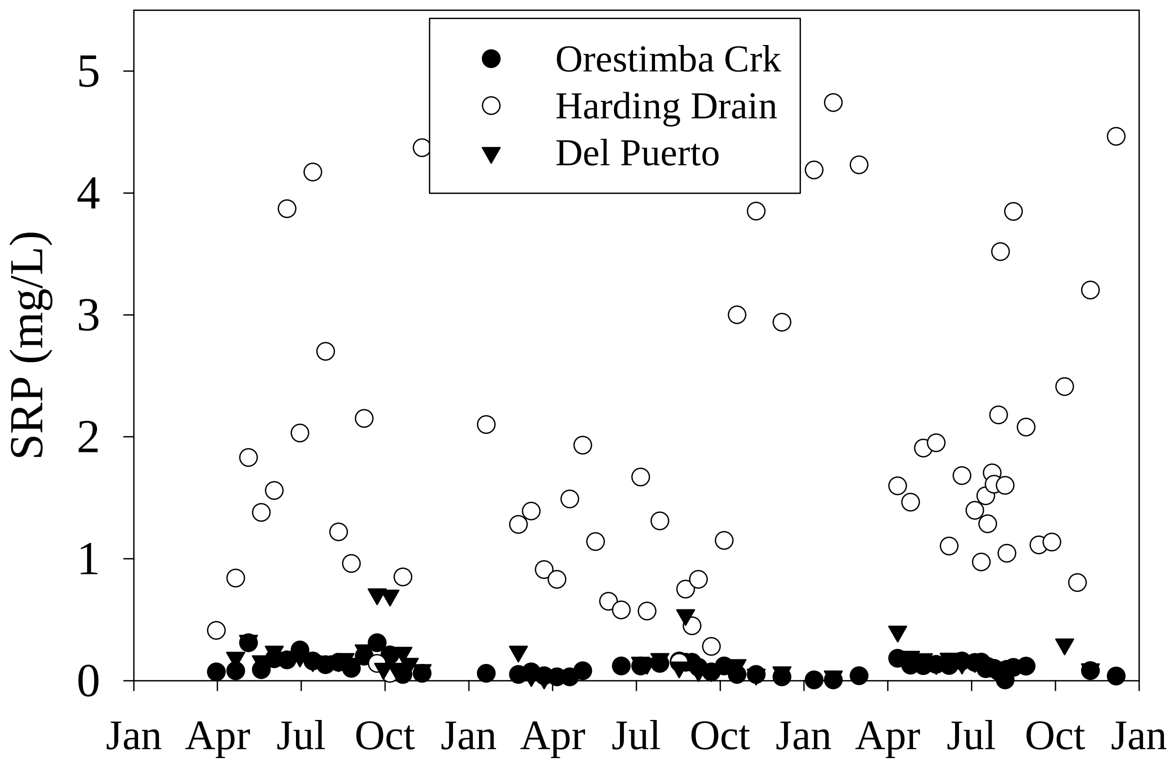
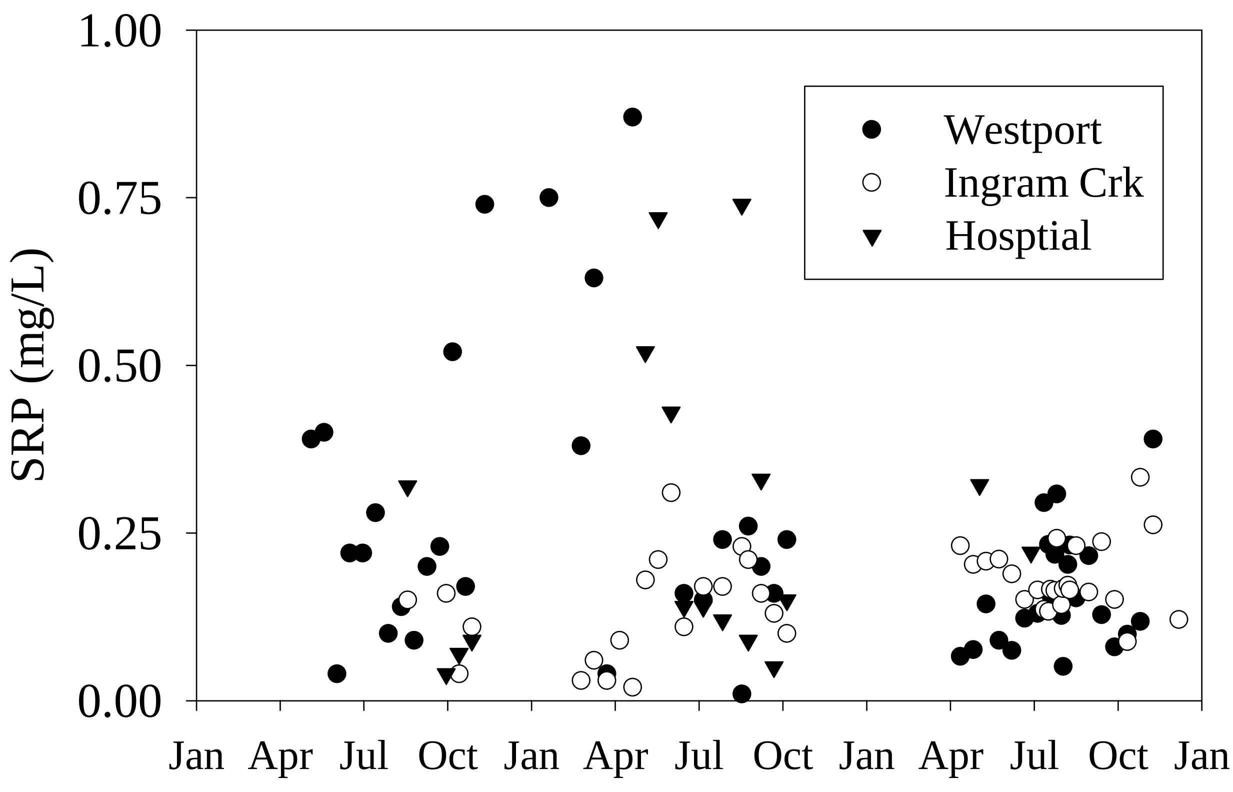


Figure 23: Temporal variability in soluble-reactive phosphate concentrations for selected sites in the San Joaquin River watershed during 2005-2007.





Appendix S

Ranking Methods as an Alternative to Load Analysis for Setting Remediation Priorities on a Watershed Scale

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May 2008

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Ranking Methods as an Alternative to Load Analysis for Setting Remediation Priorities on a Watershed Scale

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Abstract
The establishment of a total maximum daily load (TMDL) is part of management process that results in the institution of watershed-based controls of otherwise unregulated sources of pollution. In California (USA), the implementation of a TMDL is driven forward in a process where watershed stakeholders are expected to cooperate on actions needed to improve ecosystem health. In the TMDL process, methods are needed for synthesizing complex scientific data into actionable management information. Where pollutant load analysis may be misleading or perceived as unfair, non-parametric statistical methods can be applied to flow and water quality data to guide the selection of drainages for remediation. The calculation of normalized rank means (NRMs) for flow and water quality can be used to set priorities for the implementation of TMDL management actions. Drainages can be classified into one of four categories (quadrants) based on the relationship between flow and water quality NRMs. Drainages can be included or excluded from management action based on their quadrant classification. Although there are many possible alternative approaches, this "quadrant analysis" is suggested as a scientifically rigorous methods for identifying priority watersheds in the often contentious, stakeholder driven TMDL implementation process.

Keywords
Diffuse pollution; San Joaquin River; TMDL; dissolved oxygen; water quality index; Central Valley.

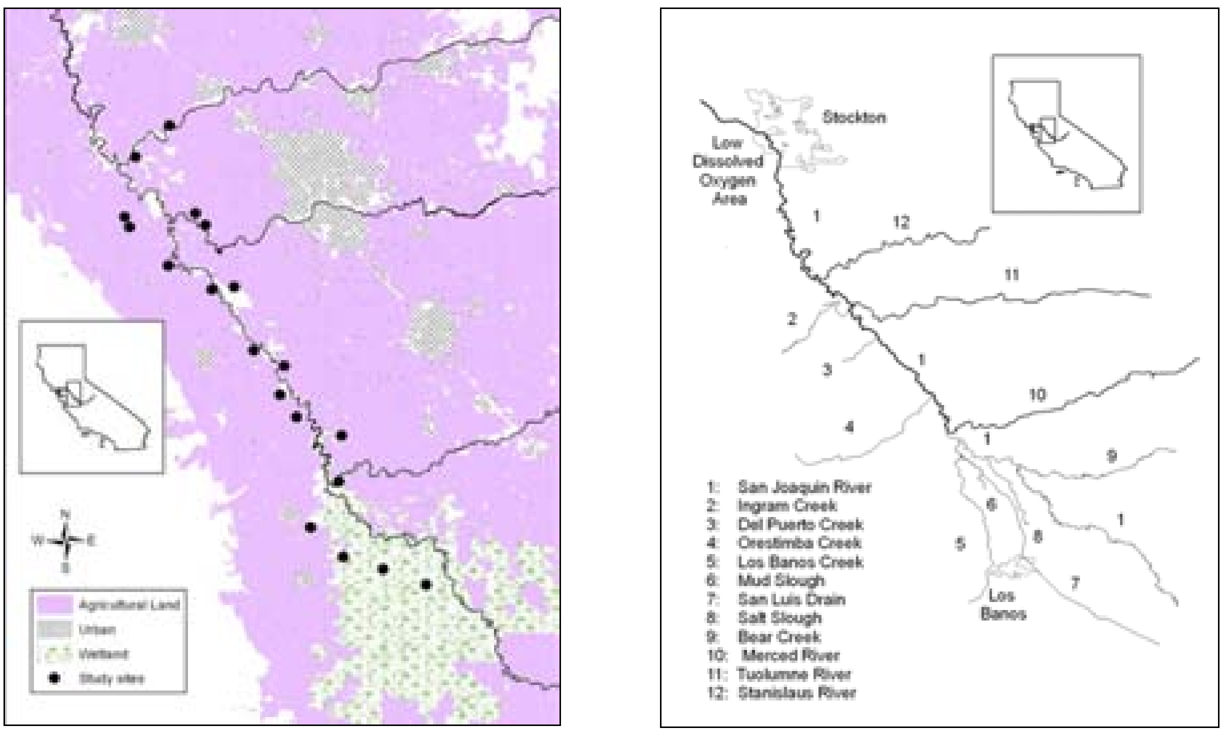
Introduction

In the United States, there has been a new emphasis on establishing and achieving ambient water quality criteria in rivers and other waterbodies that are still impaired even after the implementation of "point of discharge" control programs National Research Council (2001). Waters that are identified as impaired are given a specific ambient water quality objective, called a total maximum daily load (TMDL). In California, the establishment of a TMDL is part of a planning and management process that results in the institution of watershed-based, best management practices (BMPs) for the control of "diffuse" or "non-point" sources of pollution. The implementation of a TMDL is driven forward in an open process where stakeholders (including farmers, ranchers, water suppliers, regulatory agencies, municipalities, federal land managers, and environmental groups) are expected to cooperate on actions needed to achieve improvements in ecosystem health.

In the San Joaquin River Valley, irrigated agricultural is the predominate land-use (Figure 1) and the predominate source of diffuse pollution. Farmers and other stakeholders are under new regulatory and economic pressure to implement water conservation and pollution control practices. Watershed BMPs may include activities as diverse as installing drip-irrigation systems, the construction of regional water recycling facilities, or the installation of riparian wetlands for nutrient and sediment removal. Construction or implementation of BMPs may be funded in part by State and Federal grants, but responses to TMDL requirements are largely paid for by stakeholder groups. There are limited resources available for implementation of BMPs and analytical tools are needed to help set priorities on the watershed scale. In order to maintain stakeholder cooperation, it is important that methods for selecting individual drainages for action not be perceived as arbitrary or unfair.

Figure 1: a. Land use in the San Joaquin River dissolved oxygen TMDL area and location of water quality and flow measurement sites. **b.** The dissolved oxygen TMDL area of the San Joaquin River with major drainages shown. The major eastern tributaries have large flows and hence convey significant loads of nutrients and oxygen demand into the San Joaquin River, despite having low concentrations of pollutants. The San Joaquin River is located in the Central Valley of California, USA.

a. b.



Parts of the San Joaquin River (Figure 1) have had a long-term problem with low DO conditions and portions of the San Joaquin River now have a TMDL for dissolved oxygen concentration Bain et al. (1970, Gowdy and Grober (2003, McCarty (1969). The San Joaquin River is part of a historically important salmon migration route and resolution of the low DO condition of the San Joaquin River is a major focus of ecosystem restoration efforts in California Gowdy and Grober (2003, Jassby and Nieuwenhuyse (2005, Lehman (2001, Stringfellow et al. (2008).

The first hurdle to setting priorities on a watershed scale is the collection of sufficient information on individual drainages to provide an accurate picture of diffuse pollution sources in the watershed. The San Joaquin River has been the subject of intensive monitoring and the watershed is well characterized in relation to constituents of concern for dissolved oxygen Kratzer et al. (2004, Stringfellow et al. (2008, Volkmar and Dahlgren (2006). Significant challenges remain as to how this information will be used to implement BMPs in response to the dissolved oxygen TMDL, particularly in the absence of ambient water quality criteria for nutrients and oxygen demanding materials, typically measured as biochemical oxygen demand (BOD).

It has been shown that large sets of water quality (pollutant concentration) data can be simplified and interpreted using nonparametric statistical methods Stringfellow (2008). Water quality information for individual drainages can be used to calculate normalized rank means (NRMs) and the NRMs can be combined into water quality indices. The water quality NRMs and indices can be used to compare drainages, identify drainages with the poorest water quality, and set priorities for remediation activities Stringfellow (2008).

Setting remediation priorities based on pollutant load is more challenging than setting priorities based on pollutant concentration. High flow drainages can have very good water quality and still be identified as the major sources of pollutant load in a drainage. Setting remediation priorities based on loading, as is suggested under TMDL regulations, would require resources to be directed at removing already low levels of pollutants in high flow systems, an approach that is economically, if not technologically, unfeasible.

In this paper, a method to identify drainages with optimal potential for remediation is proposed. It is shown that water quality NRMs can be used in combination with flow measurements to identify drainages with optimal combinations of flow and water quality for implementation of BMPs.

Methods

Flow and water quality data were collected at major and minor drainages throughout the San Joaquin River Valley between March 2005 and December 2007 Stringfellow et al. (2007). Flow and water quality data was collected in accordance with rigorous QA/QC procedures California Department of Fish and Game (2007, Puckett (2002, Stringfellow (2005).

Unfiltered samples were analyzed for biochemical oxygen demand (BOD) by Standard Method (SM) 5210 B American Public Health Association (2005) with a modification for measurement of oxygen demand at 10 days rather than 5 days. Previous studies in the SJR have used 10-day BOD analysis as a standard procedure and this data set will be consistent with prior studies Kratzer et al. (2004, Stringfellow (2008, Volkmar and Dahlgren (2006). BOD was measured without seed, as in previous studies. Nitrate nitrogen (nitrate) was quantified using a TL-2800 ammonia analyzer (Timberline Instruments, Boulder, CO). Total phosphorus (total-P) was determined on 5.0 mL of unfiltered sample by persulfate digestion and colorimetric determination by the ascorbic acid method, adapted from SM 4500-P B, E American Public Health Association (2005).

Monitoring data were pooled and ranked according to nonparametric methods as described previously Stringfellow (2008). Briefly, for each monitoring location a normalized rank mean (NRM) is calculated for flow or a water quality parameter. NRMs are expressed in units of standard deviation from the mean (e.g. mean of 0 and standard deviation of 1), as

$$\mathrm{NRM} = (R_j - R_o)/(SD)$$

where R_j is the actual rank-sum of water quality at location j; R_o is the expected rank sum for a location under the null hypothesis (that all locations are equal); and SD is the standard deviation for the pooled ranks. The NRM is equivalent to the variously called 'C', 'Z', or 'z' Wilcoxon-Mann-Whitney statistic Lehmann (2006, Sokal and Rohlf (1995, Zar (1999).

Results and Discussion

Flow and water quality data were collected at major and minor drainages that discharged directly to the San Joaquin River (Figure 1). Average loads of nitrate, total-P, and BOD were calculated for 20 drainages. The major loads of these constituents are entering the river from the three major eastside tributaries, the Tuolumne, Stanislaus and Merced Rivers (Figure 1, Table 1). These rivers convey generally high quality water from the Sierra-Nevada Mountains and are characterized by concentrations of nutrients and oxygen demanding materials significantly lower than other drainages entering the San Joaquin River Stringfellow (2008). Although these rivers are the largest sources of load to the river, it is obviously impractical to focus remediation efforts on improvement of systems with already, relative to adjacent drainages, low concentrations of pollutants.

Table 1: Mean flow and loading of nitrate as nitrogen (Nitrate), total phosphate as phosphorous (Total-P), and 10-day biochemical oxygen demand (BOD) for major and minor drainages in the San Joaquin River Valley as measured between 2005 and 2006. The major eastern tributaries contribute the most loading, but are impractical targets the TMDL implementation process.

Drainage	**Flow (m^3 per day) Mean**	**Nitrate load (kg/d) Mean**	**Total-P load (kg/d) Mean**	**BOD load (kg/d) Mean**
Tuolumne River	4,505,437	1,757	399	7,324
Merced River	2,913,088	2,101	193	4,565
Stanislaus River	2,753,013	438	179	3,243
Salt Slough	617,348	907	215	2,020
Mud Slough	337,527	1,284	101	2,569
Harding Drain	96,168	882	177	441
Orestimba Creek	81,936	121	37	160
Westport Drain	63,837	752	23	141
Los Banos Creek	60,622	50	37	552
Ramona Drain	48,937	125	20	628
Lateral 5	48,279	56	20	97
Lateral 6 & 7	41,659	664	34	106
Del Puerto Creek	28,854	127	16	199
Spanish Grant Drain	27,039	143	16	331
Ingram Creek	23,863	139	21	286
Miller Lake Drain	22,847	67	41	201
Newman Wasteway	22,721	58	13	92
Grayson Drain	11,465	54	10	174
Hospital Creek	10,046	30	17	132
Marshall Road Drain	7,557	41	13	132

One approach is to ignore the major drainages and to concentrate remediation efforts on drainages with less flow. It is not clear from loading and flow calculations (Table 1) how selections of priority sites should be made. TMDL implementation requires the cooperation of farmers and other stakeholders and it is important, if not imperative, to successful implementation efforts that individual drainages be characterized fairly and with scientific rigor. Selection of smaller drainages and not larger drainages for priority action should not be arbitrary and will be resisted by stakeholders if perceived as unfair.

One method for evaluation of drainages is to combine flow information with concentration information independently of a load analysis. In Figure 2, the NRM for nitrate is plotted against the NRM for flow for individual drainages and four quadrants are defined by the rank means (0 on the x and y axis). Sites with flows lower than the mean, but concentrations above the mean of the group are found in quadrant 2 (Figure 2). Sites with lower flows, but high concentrations are typically good candidates for implementation of engineered treatment systems, such as constructed wetlands.

Figure 2: Quadrant analysis of San Joaquin River drainages using normalized rank means (NRMs) of flow and nitrate. Quadrant analysis provides an alternative method for setting remediation priorities in systems where load analysis is not leading to practical development of TMDL implementation priorities.

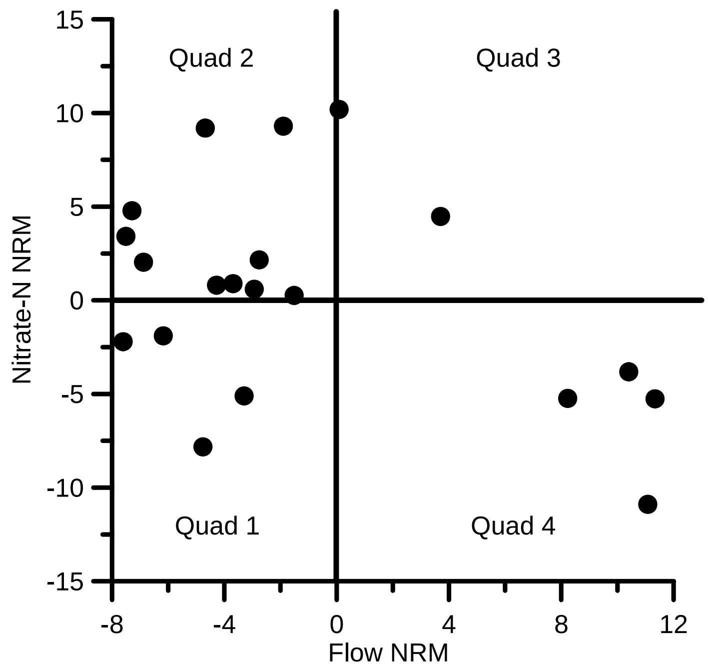


Table 2 lists the NRMs for drainages in the San Joaquin River and their quadrant assignments based on their flow and concentration relationships. In this analysis, it is assumed that the BMP will be a treatment system and maximum engineering efficiency will be achieved at sites with lower flows and higher concentrations. For other BMPs, it may be that sites with high flows and high concentrations (quadrant 3) will be most practical or economical targets for achieving maximum ambient water quality benefits. In all cases, there is a clear rationale and method for defining low-flow, low-concentration drainages (quadrant 1) and high-flow, low-concentration drainages (quadrant 4) that can be excluded as priorities for implementation of TMDL management actions.

Conclusions

Setting watershed management priorities based on pollutant load analysis can be misleading, even in the context of a regional TMDL. High-flow, low-concentration drainages need to be excluded from implementation actions, but the method of exclusion cannot be arbitrary or perceived as unfair by cooperating stakeholders. TMDL implementation is a stakeholder driven process and methods for identifying problem drainages in a regional watershed need to be fair, easily understood, and scientifically rigorous. In the San Joaquin River Valley, sufficient data has been collected on individual drainages to insure that the inputs to the river system are well characterized, but the plethora of information presents challenges for analysis. Methods are needed for synthesizing complex scientific data into actionable management information.

Table 2: Normalized rank mean (NRM) for flow and concentration of nitrate as nitrogen (Nitrate), total phosphate as phosphorous (Total-P), and 10-day biochemical oxygen demand (BOD) for major and minor drainages in the San Joaquin River Valley as measured between 2005 and 2006. The concentration NRMs are plotted against the flow NRM to calculate quadrants. In this analysis, drainages classified as in quadrant 2 are considered the most likely to present practical targets for TMDL implementation activities.

Drainage	Flow NRM	Total-P NRM	Nitrate NRM	BOD NRM	Quad. Total-P	Quad. Nitrate	Quad. BOD
Del Puerto Creek	-7.51	1.52	3.41	3.45	2	2	2
Grayson Drain	-3.69	1.55	0.89	2.39	2	2	2
Hospital Creek	-6.17	2.36	-1.90	2.72	2	1	2
Ingram Creek	-7.29	2.49	4.78	3.43	2	2	2
Los Banos Creek	-4.76	7.90	-7.82	9.09	2	1	2
Marshall Road Drain	-4.28	1.41	0.81	2.27	2	2	2
Merced River	10.40	-10.97	-3.82	-8.17	4	4	4
Miller Lake Drain	-7.60	1.71	-2.21	4.44	2	1	2
Lateral 5	-3.30	-5.40	-5.11	-3.89	1	1	1
Mud Slough	3.70	-2.42	4.48	8.87	4	3	3
Newman Wasteway	-2.93	0.17	0.59	0.81	2	2	2
Orestimba Creek	-6.88	-0.11	2.03	-2.14	1	2	1
Ramona Drain	-1.51	2.06	0.26	4.52	2	2	2
Salt Slough	8.23	3.54	-5.24	0.48	3	4	3
Spanish Grant Drain	-2.76	-0.02	2.16	1.52	1	2	2
Stanislaus River	11.08	-10.34	-10.89	-9.68	4	4	4
Tuolumne River	11.34	-8.76	-5.26	-9.28	4	4	4
Harding Drain	0.09	12.28	10.19	2.78	3	3	3
Lateral 6 & 7	-4.68	6.01	9.19	-1.79	2	2	1
Westport Drain	-1.90	-0.49	9.29	-4.08	1	2	1

It is proposed that application of non-parametric statistical methods, particularly the calculation of NRMs, can be used to set priorities for the implementation of TMDL management actions. NRMs for water quality constituents can be combined with NRMs for flow to classify drainages into four categories (quadrants). Drainages can be included or excluded from management action based on their quadrant classification. Although there are many possible alternative approaches, this "quadrant analysis" is suggested as a scientifically rigorous methods for identifying priority watersheds in the often contentious, stakeholder driven TMDL implementation process.

Acknowledgements

This work was supported by funding from the California Bay Delta Authority (CBDA) and the Regional Water Quality Control Board Central Valley Region (Regional Board). Many people were involved in data collection data collection and analysis for the Upstream DO TMDL effort. Thanks to: Mark Gowdy and Jennifer LaBay of the Regional Board; Barbara Marcotte of the CBDA; Sharon Borglin, Jeremy Hanlon, Justin Graham, Remie Burks, Gary Litton, and many students at the University of the Pacific; Randy Dahlgren at the University of California Davis; Nigel Quinn at Berkeley National Laboratory; Joel Herr and Carl Chen at Systech Inc.; and Russ Brown at Jones and Stokes, Inc. The cooperation and support of the San Joaquin Valley Drainage Authority; the San Joaquin River Group Authority; and the many individual participants and stakeholders (who prefer to remain anonymous) was and is critical to the success of this effort.

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