Contract #: ERP-02D-P63 Interim Task Report #1 Task 9: Grazing Study

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Introduction

The purpose of this task is to investigate the ecological causes for chlorophyll reduction in the San Joaquin River (SJR) between Vernalis and the DWSC, and diel chlorophyll fluctuations. Specifically, the abundance and diversity of zooplankton and benthic macroinvertebrates (bivalves) in the critical reach is quantified in order to estimate algal losses due to grazing. Furthermore, phytoplankton (algae) diversity and abundance is quantified in an effort to understand the biomass and density relationships between zooplankton and algae in the SJR. These data will improve our understanding of the grazing impact on algae in the upper river.

As an independent check of total plankton biomass and degree of plankton diversity, a phospholipid fatty acid analysis (PLFA) will be conducted (White et al. 1979). Once the relationship between plankton species diversity/abundance and PLFA patterns is understood, the latter data could eventually provide a rapid tool for checking plankton population status.

Task 9 will coincide with the dye study of Task 8, providing correlation of biological and water quality data. For example, at each site chlorophyll a data from task 8 will be compared with algal cell counts, which will give a better understanding of how algal diversity contributes to chlorophyll measurements.

Methods

Plankton sampling dates, locations:

13-14 July 2005 sampling: the first data collection event, originally scheduled in June, was delayed until mid-July due to very high flows. For this event, eleven sites were sampled, named SJR1 through SJR12 (Figure 1). Zooplankton sample SJR9 does not exist. All sites except SJR7 and SJR8 were taken in the dyed water mass of task 8. Sampling times are shown in the figure, and span day and night hours.

16-18 August 2005 sampling: for this event, eighteen sites were sampled, named SJR1 through SJR18 (Figure 2). Most of these sites do not match the locations of those sampled in July. All samples were taken in the dyed water mass of task 8, except for an additional zooplankton sample that was taken on 16 August at 11 pm at Dos Reis Park dock (Figure 2).

For 2005, additional sampling events are scheduled for the weeks of September 12^{th} and October 10^{th} .

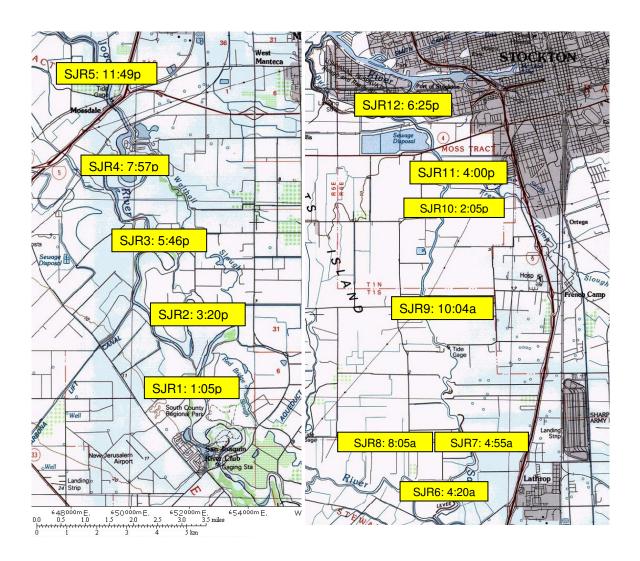


Figure 1. Sample locations for July 13-14, 2005.

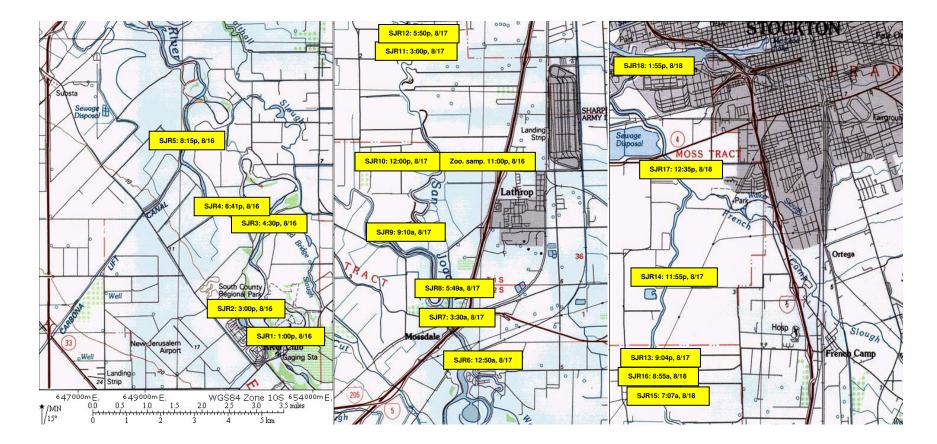


Figure 2. Sample locations for August 16-18, 2005.

Benthic macroinvertebrate sampling dates, locations:

Sampling of benthic organisms occurred in 2005 at the following dates and locations: 24 May, entrance to Burns Cutoff; 27 June, Stockton Brick Company, entrance to French Camp Slough; 1 July, Head of Old River, DWR station; 13 July, many locations from Vernalis to Burns Cutoff; 28 July, between Vernalis and Mossdale; and 17 August, approx. 2 mi N of Dos Reis Park dock.

PFLA Analysis sampling:

Samples were collected for PLFA extraction from all the upstream sites concurrent with the grab sampling program of Task 4. These samples are for testing and preliminary investigation. In the future, sampling will be coordinated with the main sampling for plankton in this task.

Sampling equipment and preservation:

Zooplankton were collected with a 30 L Schindler-Patalas Trap fitted with a 63 um net (Wildlife Supply Company, Buffalo, NY). Using a power winch, the trap was lowered into the water column to approximately one-half depth. The 30L sample is taken at the point in the water column where the trap is pulled upward. The samples were preserved in buffered formalin sucrose (5% final concentration).

Phytoplankton were collected as whole water samples. For non-diatom phytoplankton, 500 mL of whole water from the upper 10 cm of the water column was collected and 1.5 mL Lugol's solution added for preservation. For diatoms, 500 mL whole water from the upper 10 cm of the water column was collected without preservation.

Benthic sampling involved different methods for mid-channel and near-bank locations. A winch-mounted standard Ponar dredge with an 8 L capacity (Wildlife Supply Company, Buffalo, NY) was used to take mid-channel samples. Dredge contents were rinsed into a bucket, mixed with water, and poured into a 500 um mesh sorting frame. A stream of water was used to rinse away all fine sediments. The remaining material was transferred into a 500 mL bottle with buffered formalin sucrose (5% final concentration). For near-bank sampling, hand-digging was performed down to approximately 30 cm depth. Bivalves were placed in 37% buffered formalin for preservation.

Plankton concentration and analysis:

Zooplankton analysis follows U.S. EPA LG403. Briefly, zooplankton samples were thoroughly mixed by inversion and a 10 mL subsample was taken from each using a Stempel pipette. The subsamples were added to a settling apparatus (Standard Utermohl Chamber, Aquatic Research Instruments, Lemhi ID), and settled for 10 hrs. Prior to settling, 100 uL of 1% rose Bengal dye was added to facilitate counting of zooplankton.

Examination of zooplankton took place with a Leica DM-IL inverted microscope fitted with a Canon 350D digital camera. Identification of species followed standard texts (Balcer et al. 1984; Chengalath et al. 1971; Pennak 1989; Pontin 1978; Wallace 1991). All species encountered were photo-vouchered, and all counted samples were stored for future reference.

For zooplankton counts, the entire chamber floor was examined. For biomass estimates, body measurements were taken for several individuals of each species using a calibrated ocular Whipple Grid. Conversion of body measurements into biomass followed U.S. EPA publication LG403.

Phytoplankton samples have not yet been analyzed. Preliminary studies, based on U.S. EPA publication LG401, have established a protocol that will used in the future analysis. In this protocol, 10 mL of the Lugol's preserved non-diatom phytoplankton is settled for 10 hrs in the settling chambers, as in the zooplankton analysis. No rose Bengal dye is added. Using the inverted microscope, either the entire chamber floor will be counted or random 250 um^2 fields will be counted, depending on algal density. At least 250 algal units will be counted per sample. Species identifications will follow standard texts (Prescott 1951; Smith 1950). Estimates of biomass will be derived from cell dimensions following the methods of U.S. EPA publication LG401.

Diatoms will be analyzed following the procedures in U.S. EPA publication LG401. Briefly, 500 mL samples are mixed with nitric acid and boiled, followed by boiling in 30% hydrogen peroxide, washing, and mounting on slides using a permanent mountant. Species identifications, counts, and cell dimensions for biomass estimation will be performed using an Olympus Vanox compound microscope fitted with a digital camera. Species identifications will follow standard texts (Dodd 1987; Kelly 2000; Patrick and Reimer 1966, 1975; Wolle 1890). Counts for specific diatom species are based on multiplying species proportions by total diatom counts taken from the non-diatom analysis, above.

Benthic macroinvertebrate species identifications:

Bivalve mollusks are identified using standard texts (Burch 1972, 1973).

Phospholipid Fatty Acid Analysis:

To extract PLFA from water, approximately 500 ml of water sample is filtered through a Whatman GF/F glass fiber filter within 24 hours of collection. After filtration, the filter is placed in a 25 ml glass tube and stored at -20° 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 extract is used to estimate chlorophyll concentration by measuring absorbance at 435 and 665 nm on a UV/Vis spectrometer. After measuring chlorophyll, phospholipids are separated from total lipids on a C18 silicic acid column (Unisil, Clarkson Chemical, South Williamsport, PA). Isolated phospholipids are methylated and analyzed on an Agilent 6890N Gas Chromatograph (GC) equipped with an Flame Ionization Detector. 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-Dinonadecanoylsn-Glycero-3-phophocholine) (Avanti) which is added immediately prior to extraction, and an external 11:0 carbon fatty acid methyl ester standard (methyl decanoate) (Matreya) which is added immediately before analysis on the GC.

Results

Zooplankton:

At the time of writing, only the July zooplankton samples have been preliminarily analyzed. Appendix 1 lists the known zooplankton species with their densities and biomass. Zooplankton are primarily rotifers and copepod nauplii (larvae). It is notable that adult copepods are scarce (a single specimen of *Acanthocyclops vernalis* found at SJR1), as are copepodites (juvenile copepods (a single specimen found at SJR6), and cladocerans (a single *Bosmina longirostris* found at SJR4). The July samples need additional analysis as the counted numbers should reach a total of 200 organisms per site. Figure 3 shows the results for density and biomass by site. Chlorophyll a concentrations from Task 8 are superimposed over each plot. Biomass and chlorophyll a have a correlation coefficient of 0.48 (Figure 3B).

Phytoplankton:

Phytoplankton species present in the samples have been identified and a species list is found in Appendix 2. When this species list is compared to the DWR-IEP Monitoring database entries for samples taken at Vernalis, there are several species that are not listed on the database. These are marked with an asterisk.

Benthic macroinvertebrates:

Three species of bivalve mollusks have been found. Two native clams, *Anodonta* sp. (California Floater) and *Pisidium* sp. (Pea Mussel), and one introduced clam, *Corbicula fluminea* (Asian Clam), are found discontinuously throughout the river. *Anodonta* and *Corbicula* are in highly clustered positions, largely in shallow water near the banks. *Pisidium* has only been found in the mid-channel position. In general, density of these organisms is extremely low and the exact density and distribution is not known. Future work will improve our understanding of their importance in grazing.

PLFA results:

To date all samples have been extracted and analyzed but at the time of this report data entry and statistical analysis is ongoing. The initial extract has been used to confirm that sample is representative of the algae community by measuring extract absorbance at 435 and 666 nm. This data correlates well to both the Sonde field chlorophyll measurement ($r^2 = 0.949$) and the standard methods chlorophyll extraction ($r^2 = 0.915$). Additionally, one biomass marker lipid (16:0, Hexadecanoic Acid) that is common to all

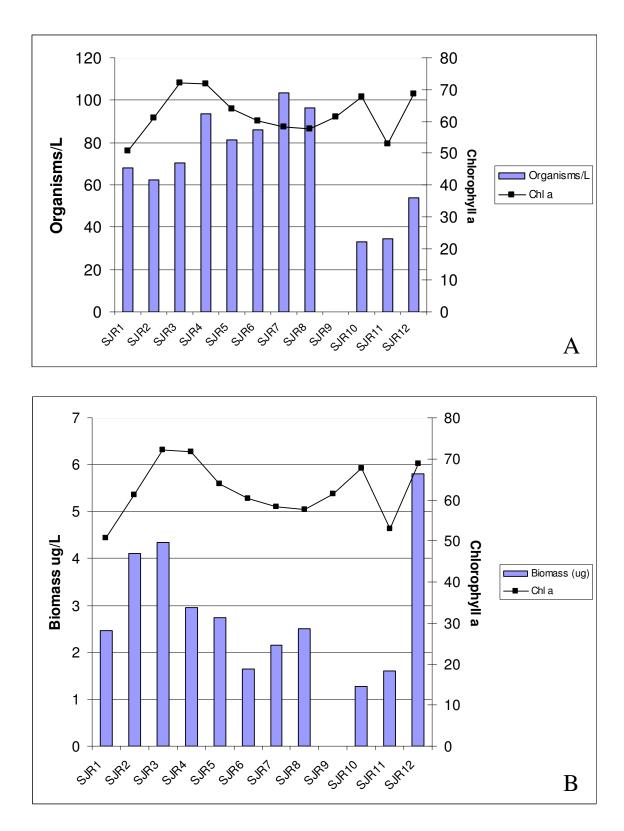


Figure 3. July zooplankton density by site (panel A) and biomass per site (panel B). Chlorophyll a concentrations from Task 8 are superimposed. A correlation coefficient of 0.48 exists between biomass and chlorophyll a.

algae and bacteria that can be used to estimate overall microbial biomass also showed high correlation with the chlorophyll data ($r^2 = 0.861$). The lower level of correlation of the biomass marker lipid could indicate that a portion of the microbial biomass does not contain chlorophyll. Further data analysis will include confirming individual lipid identification including identifying signature biomarkers for algae and zooplankton, and changes in the community structure during flow down the river.

Discussion

Conclusions regarding grazing in the upper SJR are not yet possible because of minimal data collection and analysis. Future data collection and analysis will improve our understanding of the problem. Preliminarily, the zooplankton data show trends that somewhat correlate with chlorophyll changes in the river. It is still too early to know if these findings are repeatable or meaningful. It does seem reasonably clear that bivalves are not in large concentrations in the river, and their grazing impact is likely minimal, although they inhabit relatively still, shallow water and this habitat has not been well studied. It is possible that copepod adults reside in these areas and are cleared away by the bivalves, although no evidence exists for this idea. In the future, we will attempt to analyze the gut contents of bivalves to determine if adult microcrustaceans are present as a food source.

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SJR 1 7-13-05	Bottle Vol	Aliqot vol			
	370	20			
		Per L	Ave bior		Biomass
[count	Density	per ind	SD	per L
Anureopsis	1	0.61667			
ug			0.015		0.0093
Asplancha	1	0.61667			
ug			0.0155		0.0096
Brachionus angularis	23	14.1833			
ug			0.0161	0.0094	0.2287
Brachionus calyciflorus	17	10.4833			
ug	· · ·		0.0441	0.029	0.4626
Brachionus havanaensis	1	0.61667			
Ug			0.0228		0.0141
Brachionus quadridentatus	0	0			
	0	0			
ug Collotheca pelagica	0	0			
		0			
ug Colurella	1	0.61667			
	1	0.01007	0.0506		0.0312
ug Epiphanes senta	0	0	0.0500		0.0312
	0	0			
ug Euchlanis dilatata	0	0			
	0	0			
Ug Filipia langiagta	1	0.61667			
Filinia longiseta	1	0.61667			
			0.0041		0.0005
Ug Kalliaattia langianing	0	0	0.0041		0.0025
Kellicottia longispina	0	0			
Ug Karatalla asablaaria	0	0			
Keratella cochlearis	0	0			
Ug Karatalla valaa	43	00 5107			
Keratella valga	43	26.5167	0.0016	0.0000	0.042
Ug	0	0	0.0016	0.0006	0.043
Lecane thalera	0	0			
Ug Dalvarthra ramata	-				
Polyarthra remata	9	5.55	0.0075	0.0000	0 1505
Ug Domobolius autoata		0.61007	0.0275	0.0202	0.1525
Pompholyx sulcata	1	0.61667	0.0000		0.000
ug Sunskasta lansinas	-		0.0032		0.002
Synchaeta longipes	0	0			
ug Triskssons mensesleti	-				
Trichocerca rousseleti	6	3.7			
			0.0000	0.005	0.0010
ug Taiahaa ay a ainailia	-	-	0.0086	0.005	0.0318
Trichocerca similis	0	0			
Ug	-	<u> </u>			
Nauplii	6	3.7			4 40
ug	1	07.0000	0.4		1.48
	total	67.8333			2.4672

Appendix 1. Zooplankton densities and biomass for July 13-14, 2005.

SJR 2 7-13-05	Bottle Vol	Aliqot vol			
	340	10			
	· · · · · · ·	Per L	Ave bior		Biomass
Anureopsis	count 1	Density 1.13333	per ind	SD	per L
	1	1.13333	0.033		0.0373
ug Asplancha	0	0	0.035		0.0373
Ug	0				
Brachionus angularis	17	19.2667			
ug			0.0174	0.009	0.3346
Brachionus calyciflorus	12	13.6			
ug			0.0486	0.0376	0.6614
Brachionus havanaensis	0	0			
ug					
Brachionus	_	_			
quadridentatus	0	0			
Ug Collotheca pelagica	0	0		<u> </u>	
ug	0	0			
Colurella	1	1.13333			
ug		1.10000	0.1029		0.1166
Epiphanes senta	0	0	0.1020		0.1100
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	0	0			
ug					
Kellicottia longispina	1	1.13333			
ug			0.0103		0.0116
Keratella cochlearis	0	0			
ug					
Keratella valga	11	12.4667			
ug			0.0017	0.0008	0.021
Lecane thalera	2	2.26667	0.0504	0.0000	0 1070
Ug Rolvarthra romata	2	2.26667	0.0564	0.0068	0.1279
Polyarthra remata uq	2	2.2000/	0.0233	0.0147	0.0528
Pompholyx sulcata	0	0	0.0200	0.0147	0.0020
ug	0	0			
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	2	2.26667			
ug			0.0087	0.0026	0.0197
Trichocerca similis	0	0			
ug					
Nauplii	6	6.8			
ug			0.4		2.72
	total	62.3333			4.1029

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ug 0.0028 0.002 0.005 Lecane thalera 0 -			00.0			
Lecane thalera 0			20.8	0.0000	0.000	0.050
ug				0.0028	0.002	0.058
Polyarthra remata 4 5.2			0			
ug 0.0467 0.0059 0.242 Pompholyx sulcata 0 0 - <						
Pompholyx sulcata 0 0 0 ug 0 0 0 0 Synchaeta longipes 0 0 0 0 0 ug 0			5.2			
ug Image: Constraint of the second seco			-	0.0467	0.0059	0.2428
Synchaeta longipes 0 0 0 ug 1 1.3 1 Trichocerca rousseleti 1 1.3 1 ug 0 0.005 0.006 Trichocerca similis 0 0 1 ug 0.005 0.006 1 Nauplii 5 6.5 1 ug 0.4 2.			0			
ug 1 1.3 Trichocerca rousseleti 1 1.3 ug 0.005 0.006 Trichocerca similis 0 0 </td <td></td> <td></td> <td></td> <td> </td> <td> </td> <td></td>						
Trichocerca rousseleti 1 1.3			0			
ug 0.005 0.006 Trichocerca similis 0 0 0 ug 0 0 0 0 ug 0 0 0 0 0 ug 0 <t< td=""><td></td><td></td><td></td><td> </td><td> </td><td></td></t<>						
Trichocerca similis 0 0 ug Nauplii 5 6.5 ug 0.4 2.	Trichocerca rousseleti	1	1.3			
Trichocerca similis 0 0 ug Nauplii 5 6.5 ug 0.4 2.						
ug	ug			0.005		0.0065
Nauplii 5 6.5 2 ug 0.4 2.	Trichocerca similis	0	0			
Nauplii 5 6.5 2 ug 0.4 2.						
ug 0.4 2.	ug					
	Nauplii	5	6.5			
total 70.2 4.338	ug			0.4		2.6
10141 70.2 4.000		total	70.2			4.3385

SJR 4 7-13-05	Bottle Vol	Aliqot vol			
	460	20			
		Per L	Ave bior		Biomass
	count	Density	per ind	SD	per L
Anureopsis	0	0			
U					
Asplancha	3	2.3	0.0455	0	0.0057
U <u>.</u> Dreshianus engularis		10.1	0.0155	0	0.0357
Brachionus angularis	21	16.1	0.0147	0.0001	0.007
U Brachionus calyciflorus	11	8.43333	0.0147	0.0061	0.237
		0.43333	0.0527	0.0518	0.4441
uç Brachionus havanaensis	0	0	0.0327	0.0318	0.4441
		0			
Brachionus	J				
quadridentatus	2	1.53333			
u	9		0.1231	0.0247	0.1887
Collotheca pelagica	0	0			
u	g				
Colurella	1	0.76667			
Ц	g		0.015		0.0115
Epiphanes senta	0	0			
u	g				
Euchlanis dilatata	0	0			
U	g				
Filinia longiseta	3	2.3			
L	g		0.0054		0.0124
Kellicottia longispina	0	0			
L	9				
Keratella cochlearis	2	1.53333			
L	9		0.0012	0.0003	0.0019
Keratella valga	43	32.9667			
LĮ	9		0.0017	0.0007	0.056
Lecane thalera	3	2.3			
uş			0.0109	0.0103	0.025
Polyarthra remata	20	15.3333			
u(, ,		0.0225	0.0159	0.3455
Pompholyx sulcata	1	0.76667	0.0000		0.0007
u(-	0.0032		0.0025
Synchaeta longipes	0	0			
U(
Trichocerca rousseleti	6	4.6			
	_		0.0000		0.044
U(0.70007	0.0096		0.044
Trichocerca similis	1	0.76667			
			0.0004		0.0000
U		0.00000	0.0264		0.0203
Nauplii	5	3.83333			1 5000
U		00 5000	0.4		1.5333
	total	93.5333			2.9579

SJR 5 7-14-05	Bottle Vol	Aliqot vol			
	460	10			
	400	Per L	Ave bior	nass	Biomass
	count	Density	per ind	SD	per L
Anureopsis	1	1.53333	perind		
		1.00000	0.0174		0.0266
Ug Applanaha	1	1.53333	0.0174		0.0200
Asplancha		1.00000	0.0710		0.11
ug		~~~~~	0.0718		0.11
Brachionus angularis	17	26.0667			
ug			0.0193	0.011	0.5021
Brachionus calyciflorus	5	7.66667			
ug			0.0753	0.0239	0.5774
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	0	0			
ug					
Collotheca pelagica	1	1.53333			
		1.00000	0.0225		0.0345
Ug	0	0	0.0225		0.0345
Colurella	_	0			
ug					
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	1	1.53333			
ug			0.0064		0.0098
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	1	1.53333			
ug		1.00000	0.001		0.0016
Keratella valga	20	30.6667	0.001		0.0010
		30.0007	0.0000	0.000	0.0074
ug			0.0028	0.002	0.0874
Lecane thalera	0	0			
Ug		-			
Polyarthra remata	4	6.13333			
ug			0.0277	0.0065	0.1697
Pompholyx sulcata	0	0			
ug					
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	0	0			
ug		1			
Trichocerca similis	0	0			
	0	5			
		<u> </u>			
Ug		0.00007			
Nauplii	2	3.06667			4 0007
UÇ			0.4		1.2267
	total	81.2667			2.7458

SJR 6 7-14-05	Bottle Vol	Aliqot vol			
	515	10			
		Per L	Ave bior	nass	Biomass
	count	Density	per ind	SD	per L
Anureopsis	2	3.43333			
u	g		0.0259	0	0.089
Asplancha	0	0			
u	g				
Brachionus angularis	9	15.45			
u	g		0.0147	0.005	0.2267
Brachionus calyciflorus	4	6.86667			
u	g		0.0828	0.0265	0.5686
Brachionus havanaensis	2	3.43333			
u	g		0.0132	0	0.0453
Brachionus quadridentatus	0	0			
U					
Collotheca pelagica	1	1.71667	1		
U			0.0922		0.1582
Colurella	1	1.71667			0.1002
U		1.7 1007	0.0506		0.0869
Epiphanes senta	0	0	0.0000		0.0000
u u		0			
Euchlanis dilatata	0	0			
		0			
u Filinia longiseta	1	1.71667			
T IIIIIa longiseta	1	1.71007			
	~		0.0055		0.0094
u Kellicottia longispina	0	0	0.0000		0.0004
U	_	0			
Keratella cochlearis	0	0			
	_	0			
u Keratella valga	14	24.0333			
		24.0000	0.0017	0.0004	0.0406
Lecane thalera	5	8.58333	0.0017	0.0004	0.0400
		0.30333	0.0191	0.0022	0.1642
u Polyarthra remata	3	5.15	0.0191	0.0022	0.1042
		0.10	0.0273	0.0155	0.1407
u Pompholyx sulcata	0	0	0.02/3	0.0100	0.1407
		0			
U Synchaota longinos	2	2 40000			
Synchaeta longipes		3.43333	0.0000	0.0046	0.0007
u Trichocerca rousseleti		10.0	0.0083	0.0046	0.0287
THCHOCEICA TOUSSEIELI	6	10.3	<u> </u>		
	~		0.0077		0.0700
U Trichocorco cimilio			0.0077		0.0798
Trichocerca similis	0	0			
	-				
U U		-			
NOUDIU	0	0	1	1	1
Nauplii			0.4		0

42010Per L countPer L DensityAve bio-sc per latSecond per LAnureopsis22.8Anureopsis22.8Anureopsis22.8Asplancha00Brachionus angularis1622.4Brachionus angularis1622.4Ug00.05870.02480.8224Brachionus calycifforus00Ug00.05870.02480.8224Brachionus havanaensis00guadridentatus00Quadridentatus00Quadridentatus00Ug11.4Golotheca pelagica00Ug11.4Ug11.4Epiphanes senta00Ug11.4Euchanis dilatata00Ug11.0Euchanis dilatata00Ug11.0Euchanis dilatata00Ug11.0Ug11.0 <th>SJR 7 7-14-05</th> <th></th> <th>Bottle Vol</th> <th>Aliqot vol</th> <th></th> <th></th> <th></th>	SJR 7 7-14-05		Bottle Vol	Aliqot vol			
countDensityper indSDper LAnureopsis22.8ug00.02290.00420.0642Asplancha00ug00Brachionus angularis1622.4ug00.01180.00220.2644Brachionus calyciflorus1014ug00.05870.02480.8224Brachionus havanaensis00ug00Brachionus00guadridentatus00ug11.4Collotheca pelagica00ug11.4Colurella11.4ug11.4Euchlanis dilatata00ug11.4filinia longispina00ug11Keratella cochlearis00ug10.0180.00250.1085Polyarthra remata45.6filinia longispina00ug10.0140.00550.1085Polyarthra remata45.6 </td <td></td> <td></td> <td>420</td> <td></td> <td></td> <td></td> <td></td>			420				
Anureopsis22.8Image of the second se				-			
ug 0 0.0229 0.0042 0.0642 Asplancha 0 0 0 0 0 Brachionus angularis 16 22.4 0.0118 0.0052 0.264 Brachionus calyciflorus 10 14 0 0.0587 0.0248 0.8224 Brachionus calyciflorus 0 0 0 0 0.0587 0.0248 0.8224 Brachionus havanaensis 0 0 0 0.0587 0.0248 0.8224 Brachionus quadridentatus 0 0 0 0.0259 0.0363 Golurella 1 1.4 0 0.0259 0.0363 Epiphanes senta 0 0 0 0.0363 0.013 0.0267 Keatella longiseta 4 5.6 0 0 0 0.0048 0.0013 0.0267 Keratella cochlearis 0 0 0 0.0013 0.0267 0.0014 0.0025 0.1085 Polyarthra remata 4<	Anuraanaia	T			per ind	SD	per L
Asplancha 0 0 0 Brachionus angularis 16 22.4 0.0118 0.0052 0.264 Brachionus calycifforus 10 14 0.0188 0.0052 0.264 Brachionus calycifforus 10 14 0.0587 0.0248 0.8224 Brachionus havanaensis 0 0 0 0 0 guadridentatus 0 0 0 0 0 Golotheca pelagica 0 0 0.0259 0.0363 Epiphanes senta 0 0 0 0.0259 0.0363 Epiphanes senta 0 0 0 0 0 ug 0 0 0 0.0363 0.0267 Keitalia longiseta 4 5.6 0 0 0 ug 0 0.0048 0.0013 0.0267 0.0013 0.0267 Keratella cochlearis 0 0 0 0 0 0 0 0 <t< td=""><td></td><td></td><td>2</td><td>2.0</td><td>0.0000</td><td>0.0042</td><td>0.0640</td></t<>			2	2.0	0.0000	0.0042	0.0640
ugimageimageimageimageBrachionus angularis1622.4image0.01180.00280.048Brachionus calyciflorus1014imageim		ug	0	0	0.0229	0.0042	0.0042
Brachionus angularis 16 22.4 Image in the image		ua	0	0			
ug0.01180.00520.264Brachionus calyciflorus1014ug0.05870.02480.8224Brachionus havanaensis00ug00Brachionus00guadridentatus00ug00Collotheca pelagica00ug11.4Colurella11.4ug00.02590.0363Epiphanes senta00ug11.4Euchlanis dilatata00ug11.4filinia longiseta45.6ug11.4keratella cochlearis00ug11.4ug11.4filinia longispina00ug11.4ug11.4featella cochlearis00ug10.00180.00130.007Lecane thalera45.6ug001pompholyx sulcata00 <td></td> <td>ug</td> <td>16</td> <td>22.4</td> <td></td> <td></td> <td></td>		ug	16	22.4			
Brachionus calyciflorus1014		ua	10		0.0118	0.0052	0 264
ug 0.0587 0.0248 0.8224 Brachionus havanaensis 0 0 0 0 Brachionus quadridentatus 0 0 0 0 0 Ug 0 <td></td> <td>.g</td> <td>10</td> <td>14</td> <td>010110</td> <td>0.0001</td> <td>0.201</td>		.g	10	14	010110	0.0001	0.201
Brachionus havanaensis 0 0 1 1 ug 0 0 0 0 0 Brachionus 0 0 0 0 0 0 ug 0 0 0 0 0 0 0 Collotheca pelagica 0 <		uq			0.0587	0.0248	0.8224
Brachionus quadridentatus 0 0 0 0 ug 0 0 0 0 Collotheca pelagica 0 0 0 0 ug 1 1.4 0 0 Colurella 1 1.4 0 0.0353 Epiphanes senta 0 0 0 0 ug 0 0 0 0.0363 Epiphanes senta 0 0 0 0.0363 Euchlanis dilatata 0 0 0.0363 0.0363 Filinia longiseta 4 5.6 0 0 0.0363 felicottia longispina 0 0 0 0.0013 0.0267 Keratella cochlearis 0 0 0 0.0267 0.0018 0.0013 0.0267 Keratella cochlearis 0 0 0 0 0.0264 0.0264 0.0267 ug 0.0018 0.00018 0.00025 0.1085 0.017 <td></td> <td>-</td> <td>0</td> <td>0</td> <td></td> <td></td> <td></td>		-	0	0			
quadridentatus0000ug0000Collotheca pelagica0000ug11.400Colurella11.400.02590.0363Epiphanes senta00000ug00000Euchlanis dilatata00000filinia longiseta45.60.00480.00259keratella cochlearis0000ug0000.0267Kellicottia longispina0000ug0000.0267Keratella cochlearis0000ug0000.0267Keratella cochlearis0000ug00000.0267Keratella cochlearis0000ug00000.0267Keratella cochlearis0000ug0000.0267Keratella cochlearis0000ug00000.0267heratella cochlearis000.0180.0068Polyarthra remata45.600ug00000Synchaeta longipes0000		ug					
Collotheca pelagica 0 0 1 ug 1 1.4 - - Colurella 1 1.4 - - ug 0.0259 0.0363 Epiphanes senta 0 0 - - ug - - - - Euchlanis dilatata 0 0 - - ug - - - - - filinia longiseta 4 5.6 - - - ug 0.0048 0.0013 0.0267 - - Keratella longispina 0 0 - - - ug 0.0048 0.0013 0.0267 - - Keratella cochlearis 0 0 - - - ug 0.0018 0.0006 0.07 - - ug 0.01194 0.0025 0.1085 - - ug 0.02			0	0			
ug Image Image Image Image Colurella 1 1.4 Image Image <td></td> <td>ug</td> <td></td> <td></td> <td></td> <td></td> <td></td>		ug					
Colurella 1 1.4 Image Image ug Image 0.0259 0.0363 Epiphanes senta 0 0 Image Image ug Image Image Image Image Image Euchlanis dilatata 0 0 Image	Collotheca pelagica		0	0			
ug 0.0259 0.0363 Epiphanes senta 0 0 - ug 0 0 - - Euchlanis dilatata 0 0 - - ug - - - - - ug - - - - - - ug 0 0 - - - - - ug 0 0 -		ug					
Epiphanes senta 0 0	Colurella		1	1.4			
ugImageImageImageEuchlanis dilatata00ImageugImageImageImageFilinia longiseta45.6ImageugImage0.00480.0013Melicottia longispina00ImageugImageImageImagekeratella cochlearis00ImageugImageImageImagekeratella valga2839.2ImageugImage0.00180.0006ugImage0.001940.0025Nearet halera45.6ImageugImage0.01940.0025Polyarthra remata45.6ImageugImageImageImagepompholyx sulcata0ImageImageugImageImageImageugImage <td></td> <td>ug</td> <td></td> <td></td> <td>0.0259</td> <td></td> <td>0.0363</td>		ug			0.0259		0.0363
Euchlanis dilatata 0 0	Epiphanes senta		0	0			
ug		ug			-		
Filinia longiseta 4 5.6			0	0			
ug 0 0.0048 0.0013 0.0267 Kelicottia longispina 0		ug		5.0			
Kellicottia longispina 0 0	Filinia longiseta		4	5.6			
Kellicottia longispina 0 0					0.0049	0.0012	0.0267
ug		uy	0	0	0.0040	0.0013	0.0207
Keratella cochlearis 0 0 Keratella valga 28 39.2 Keratella valga 28 39.2 Lecane thalera 4 5.6 Lecane thalera 4 5.6 Polyarthra remata 4 5.6 Polyarthra remata 4 5.6 Polyarthra remata 4 5.6 Pompholyx sulcata 0 0 Synchaeta longipes 0 0 Trichocerca rousseleti 2 2.8 Image: Second similis 2 2.8		ua	0	0			
ug		ug	0	0			
Keratella valga 28 39.2 ug 0.0018 0.0006 0.07 Lecane thalera 4 5.6 ug 0.0194 0.0025 0.1085 Polyarthra remata 4 5.6 ug 0.0213 0.0058 0.1193 Pompholyx sulcata 0 0 ug 0 0 Synchaeta longipes 0 0 ug 2.8 Trichocerca rousseleti 2 2.8 ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 ug 0.0204 0.0013 0.057 Nauplii 1<		ua					
ug 0.0018 0.0006 0.077 Lecane thalera 4 5.6			28	39.2			
ug 0.0194 0.0025 0.1085 Polyarthra remata 4 5.6 ug 0.0213 0.0058 0.1193 Pompholyx sulcata 0 0 ug 0 0 Synchaeta longipes 0 0 ug 2 2.8 <td< td=""><td></td><td>ug</td><td></td><td></td><td>0.0018</td><td>0.0006</td><td>0.07</td></td<>		ug			0.0018	0.0006	0.07
Polyarthra remata 4 5.6 ug 0.0213 0.0058 0.1193 Pompholyx sulcata 0 0 ug 0 0 Synchaeta longipes 0 0 ug 2 2.8 </td <td>Lecane thalera</td> <td></td> <td>4</td> <td>5.6</td> <td></td> <td></td> <td></td>	Lecane thalera		4	5.6			
ug 0.0213 0.0058 0.1193 Pompholyx sulcata 0 0 - - ug - - - - - Synchaeta longipes 0 0 - - - ug -		ug			0.0194	0.0025	0.1085
Pompholyx sulcata 0 0 0 ug 0 0 0 Synchaeta longipes 0 0 0 ug 0 0 0 0 Trichocerca rousseleti 2 2.8 0 0 ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 0 0 ug 0.0204 0.0013 0.057 Nauplii 1 1.4 0 0.056	Polyarthra remata		4	5.6			
ug Image Image Image Synchaeta longipes 0 0 Image Image ug Image Image Image Image Trichocerca rousseleti 2 2.8 Image Image ug Image 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 Image Image ug Image Image Image Image ug Image Image Image Image Nauplii 1 1.4 Image Image ug Image Image Image Image		ug			0.0213	0.0058	0.1193
Synchaeta longipes 0 0 0 0 ug 2 2.8	Pompholyx sulcata		0	0		ļ	
ug Image Image Image Trichocerca rousseleti 2 2.8 Image Image ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 Image Image ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 Image Image ug 0.0204 0.0013 0.057 Nauplii 1 1.4 Image ug 0.4 0.56		ug					
Trichocerca rousseleti 2 2.8 ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8 ug 0.0204 0.0013 0.057 Nauplii 1 1.4 ug 0.4 0.56			0	0			
ug 0.0079 0.0025 0.0222 Trichocerca similis 2 2.8		ug					
Trichocerca similis 2 2.8 ug 0.0204 0.0013 0.057 Nauplii 1 1.4 0.056	I richocerca rousseleti		2	2.8			
Trichocerca similis 2 2.8 ug 0.0204 0.0013 0.057 Nauplii 1 1.4 0.056					0.0070	0.0005	0.0000
Image Image <th< td=""><td></td><td>uy</td><td>0</td><td>20</td><td>0.0079</td><td>0.0025</td><td>0.0222</td></th<>		uy	0	20	0.0079	0.0025	0.0222
Nauplii 1 1.4 0.4 0.56			2	2.0			
Nauplii 1 1.4 0.4 0.56		ua			0 0204	0.0013	0.057
ug 0.4 0.56		~9	1	14	0.0204	0.0010	0.007
		ua		11	0.4		0.56
	·	- 3	total	103.6			2.1507

SJR 8 7-14-05		Bottle Vol	Aliqot vol			
		340	10			
			Per L	Ave bior	nass	Biomass
		count	Density	per ind	SD	per L
Anureopsis		1	1.13333			
	ug			0.0087	0.0123	0.0098
Asplancha		4	4.53333			
	ug			0.0211	0.0044	0.0957
Brachionus angularis		13	14.7333			
	ug			0.017	0.0071	0.2501
Brachionus calyciflorus	3	8	9.06667			
	ug			0.0559	0.0352	0.5073
Brachionus havanaens	sis	2	2.26667			
	ug			0.0404	0.0059	0.0915
Brachionus quadridentatus		0	0			
quaunuoniaiuo	110	0	0			
Collotheca pelagica	ug	1	1.13333			
Soliotriola polagica	ug		1.10000	0.0299		0.0339
Colurella	uy	0	0	0.0233		0.0000
Oolurella	uа	0	0			
Epiphanes senta	ug	1	1.13333			-
Epipitaries serita	110	1	1.10000	0.1278		0.1448
Euchlanis dilatata	ug	0	0	0.1270		0.1440
	110	0	0			-
Filinia longiseta	ug	4	4.53333			-
i iliilia lorigisela		4	4.00000			
	110			0.0047	0.0017	0.0212
Kellicottia longispina	ug	0	0	0.0047	0.0017	0.0212
Relicotta longispina	110	0	0			
Keratella cochlearis	ug	2	2.26667			
	ua		2.20007	0.001	0	0.0023
Keratella valga	ug	22	24.9333	0.001	0	0.0020
Roratona valga	ug		21.0000	0.002	0.0006	0.0487
Lecane thalera	ug	10	11.3333	0.002	0.0000	0.0407
	ug	10	11.0000	0.0178	0.0025	0.2018
Polyarthra remata	ug	11	12.4667	0.0170	0.0020	0.2010
. eryanina romata	ua		12.7007	0.0123	0.0077	0.1531
Pompholyx sulcata	~9	1	1.13333	0.0120	0.0077	0.1001
	ug			0.0032		0.0037
Synchaeta longipes	~9	0	0	0.000L		0.0007
Cynonaota longipoo	ug	5	U			
Trichocerca rousseleti	~g	2	2.26667		L	
				L	L	
	ug			0.0071	0.0053	0.0161
Trichocerca similis	-9	1	1.13333			
		· ·				
	ug			0.0161		0.0183
Nauplii	-9	2	2.26667			
	ug			0.4		0.9067
	uy			U		

SJR 10 7-14-05		Bottle Vol	Aliqot vol			
		370	10			
			Per L	Ave bior		Biomass
		count	Density	per ind	SD	per L
Anureopsis		1	1.23333			
	ug			0.0129		0.0159
Asplancha		2	2.46667			
	ug			0.0158	0.0055	0.039
Brachionus angularis		3	3.7			
	ug			0.0228	0	0.0844
Brachionus calyciflorus	3	4	4.93333			
	ug			0.0523	0.0197	0.258
Brachionus havanaens	sis	0	0			
	ug					
Brachionus			4 00000			
quadridentatus		1	1.23333	0.0544		0.0007
0.11.11	ug			0.0541		0.0667
Collotheca pelagica		0	0			
	ug				-	
Colurella		0	0			
	ug					
Epiphanes senta		0	0			
	ug					
Euchlanis dilatata		1	1.23333			
	ug			0.1845		0.2276
Filinia longiseta		0	0			
	ug					
Kellicottia longispina		0	0			
	ug					
Keratella cochlearis		0	0			
	ug					
Keratella valga		5	6.16667			
	ug			0.0029	0.0016	0.0178
Lecane thalera		0	0			
	ug					
Polyarthra remata		2	2.46667			
	ug			0.0055	0	0.0135
Pompholyx sulcata		1	1.23333			
	ug			0.0032		0.004
Synchaeta longipes	Ŭ	0	0			
	ug					
Trichocerca rousseleti	0	5	6.16667			
	ug			0.0049	0.002	0.0305
Trichocerca similis	- 9	1	1.23333			
			0000			
	ug			0.0161		0.0199
Nauplii	μġ	1	1.23333	0.0101		0.0100
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Keratella valga 0 0 0 ug 0 0 0 Lecane thalera 0 0 0 ug 0 0 0 Polyarthra remata 2 2.4 0.0055 0 0.0131 Pompholyx sulcata 1 1.2 0.0019 0.0023 Synchaeta longipes 0 0 0 0.0023 Synchaeta longipes 0 0 0 0.0023 Trichocerca rousseleti 2 2.4 0.0019 0.0023 Ug 0 0 0 0 0.0023 Trichocerca rousseleti 2 2.4 0 0.0023 Ug 0.0068 0 0.0164 0 0.0164 Trichocerca similis 2 2.4 0 0 0.0387 ug 0.0161 0 0.0387 0.0161 0 0.0387 Nauplii 8 9.6 0.4 3.84 0.4 0.	Keratella cochlearis		0	0			
ug		ug					
Lecane thalera 0 0	Keratella valga		0	0			
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Nauplii 8 9.6 ug 0.4 3.84							
Nauplii 8 9.6 ug 0.4 3.84		ua			0.0161	0	0.0387
ug 0.4 3.84	Nauplii	-9	8	9.6			
		μα	Ĵ	0.0	04		3.84
	L	μġ	total	54	0.7	1	5.8057

<u> </u>	Blue-green algae
	Anabaena circinalis
	Anabaena laxa
	Anacystis nidulans
	Aphanizomenon flos-aquae
	Arthrospira jenneri
× · · · · · · · · · · · · · · · · · · ·	Chroococcus sp.
*	Gomphosphaeria sp.
	Lyngbya limnetica
A	Marssoniella elegans
	Merismopedia tenuissima
A	Microcystis sp.
÷	Oscillatoria amphibia
· · · · · · · · · · · · · · · · · · ·	Oscillatoria limosa
	Oscillatoria nigra
	Oscillatoria tenuis
	Oscillatoria terebriformis
â	Romeria sp.
	Spirulina sp.
	Synechocystis sp.
	Syncenoeysus sp.
	Dinoflagellates
· · ·	Ceratium hirundinella
	Glenodinium pulvisculus
<u>^</u>	Greno di num partise unus
	Euglenoids
	Euglena sp.
	Phacus sp.
*	Trachelomonas sp.
<u>^</u>	
*	
Thalassiosira sp.	
Golden Algae	
Dinobryon sertularia	
Synura uvella	
Cryptophyceae	
Cryptomonas ovata	
	Golden Algae Dinobryon sertularia Synura uvella Cryptophyceae

Appendix 2. Phytoplankton species list as of September 2005.