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

Investigators:
Mark Brunell
Sharon Borglin
Gary Litton

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 diveristy 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 12th and October 10th.

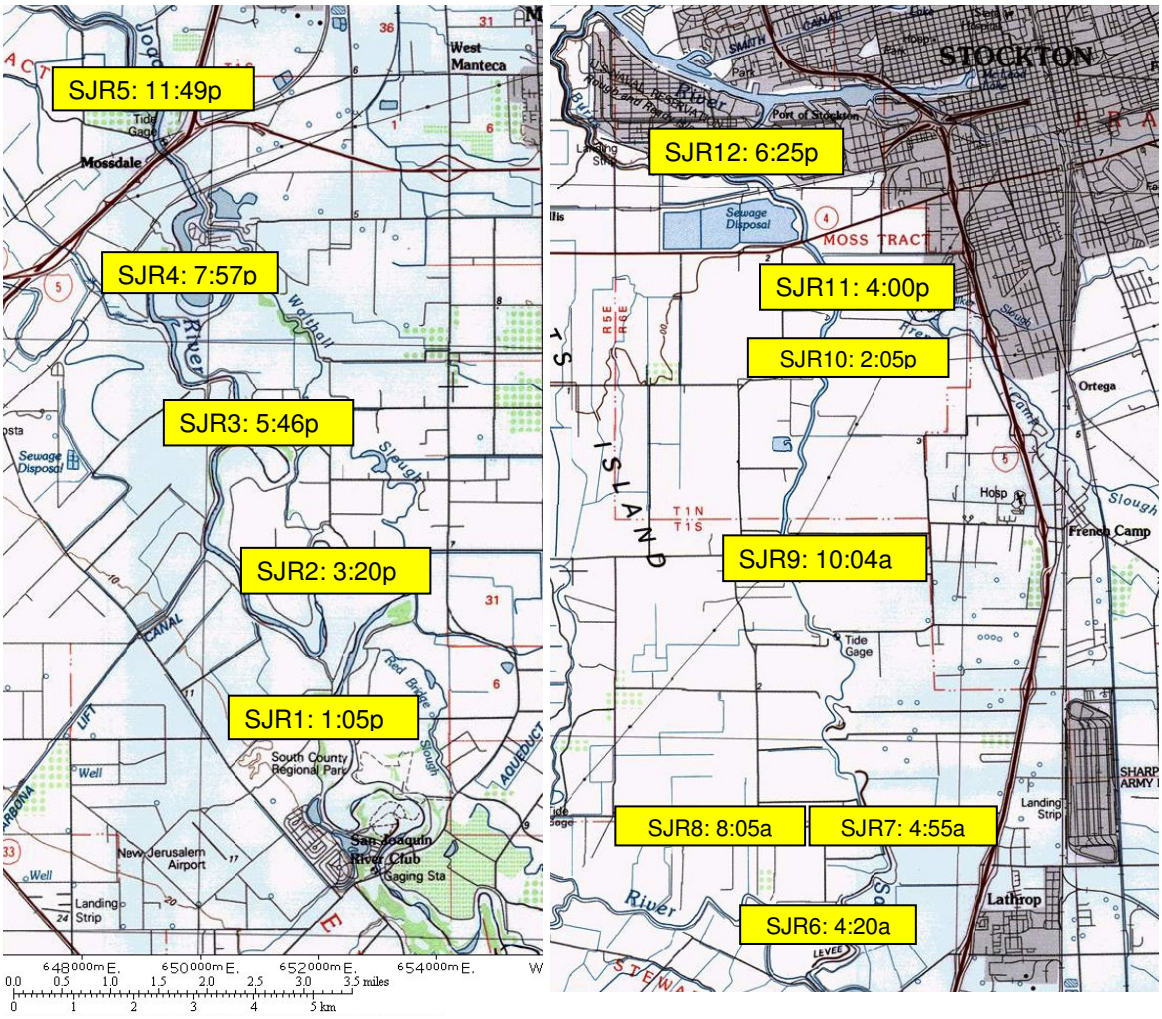


Figure 1. Sample locations for July 13-14, 2005.

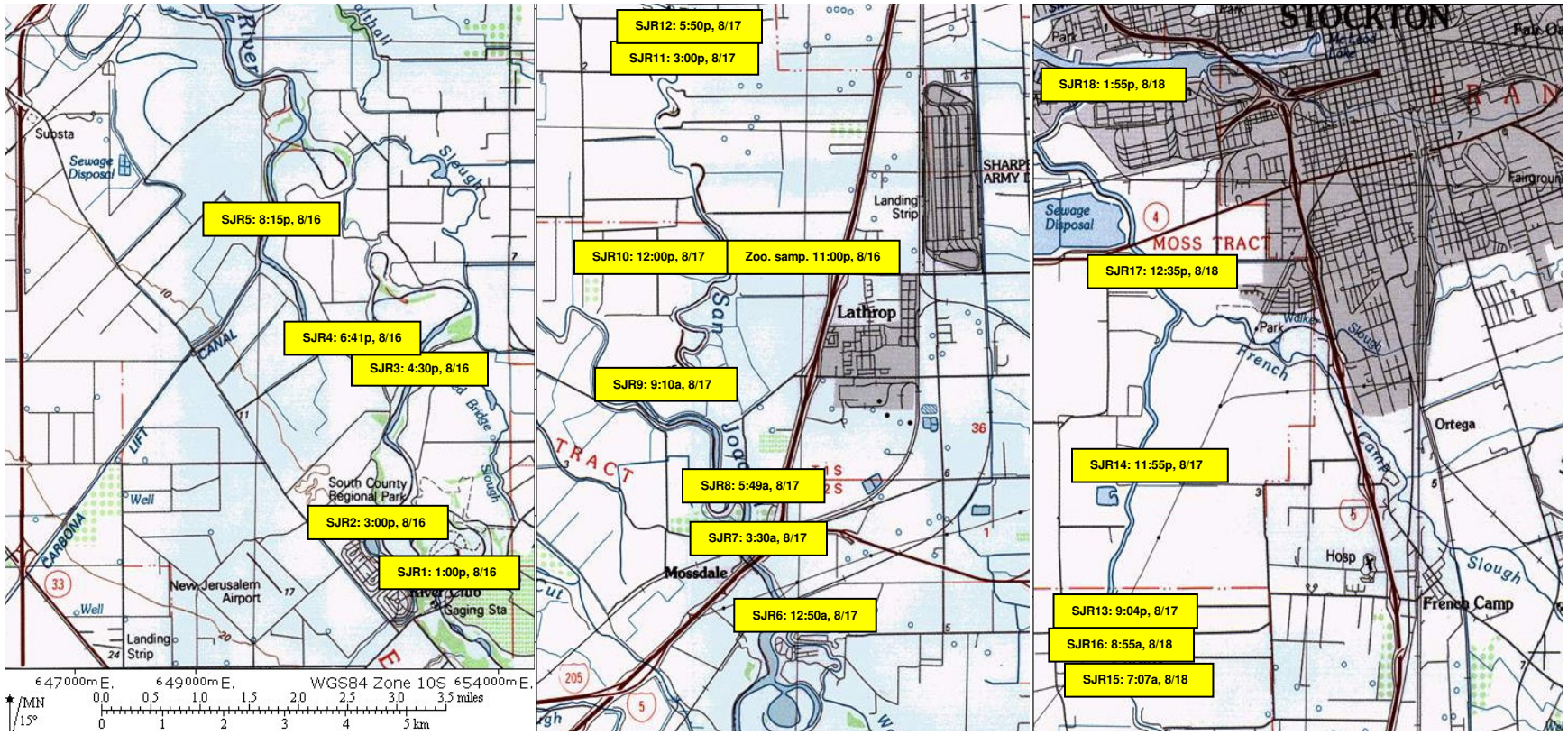


Figure 2. Sample locations for August 16-18, 2005.

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^{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 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-Dinonadecanoyl-sn-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:

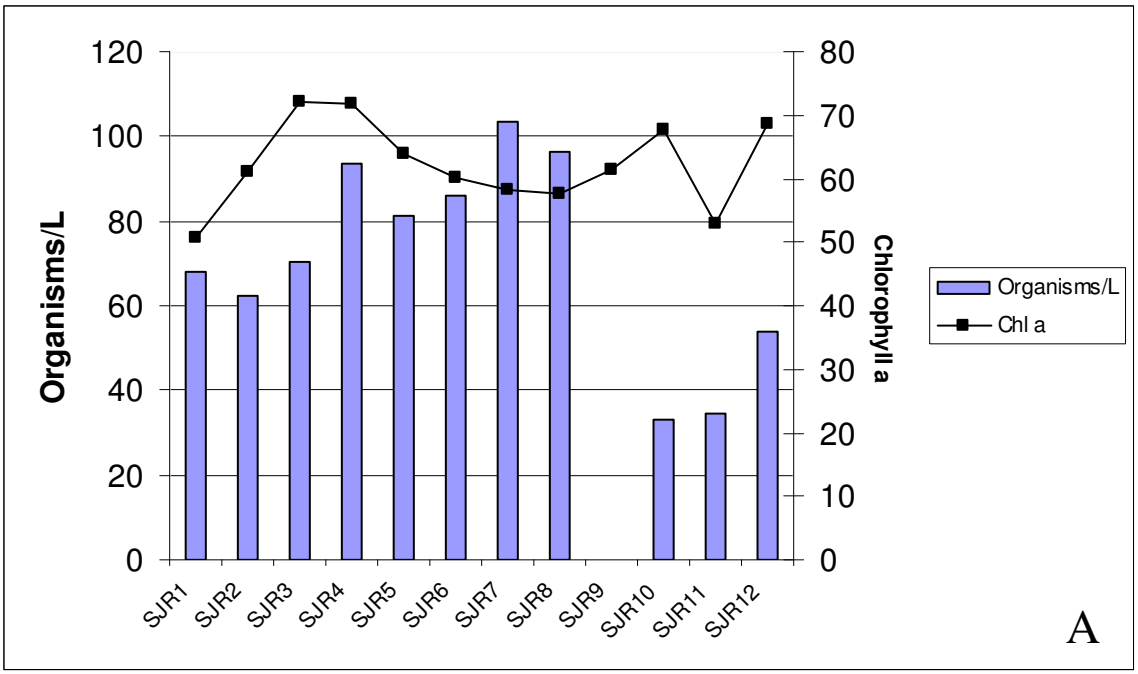
Phytoplankton species present in the samples have been identified and a species list is found in Appendix 2. When this species list is compared to the DWR-IEP Monitoring database entries for samples taken at Vernalis, there are several species that are not listed on the database. These are marked with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



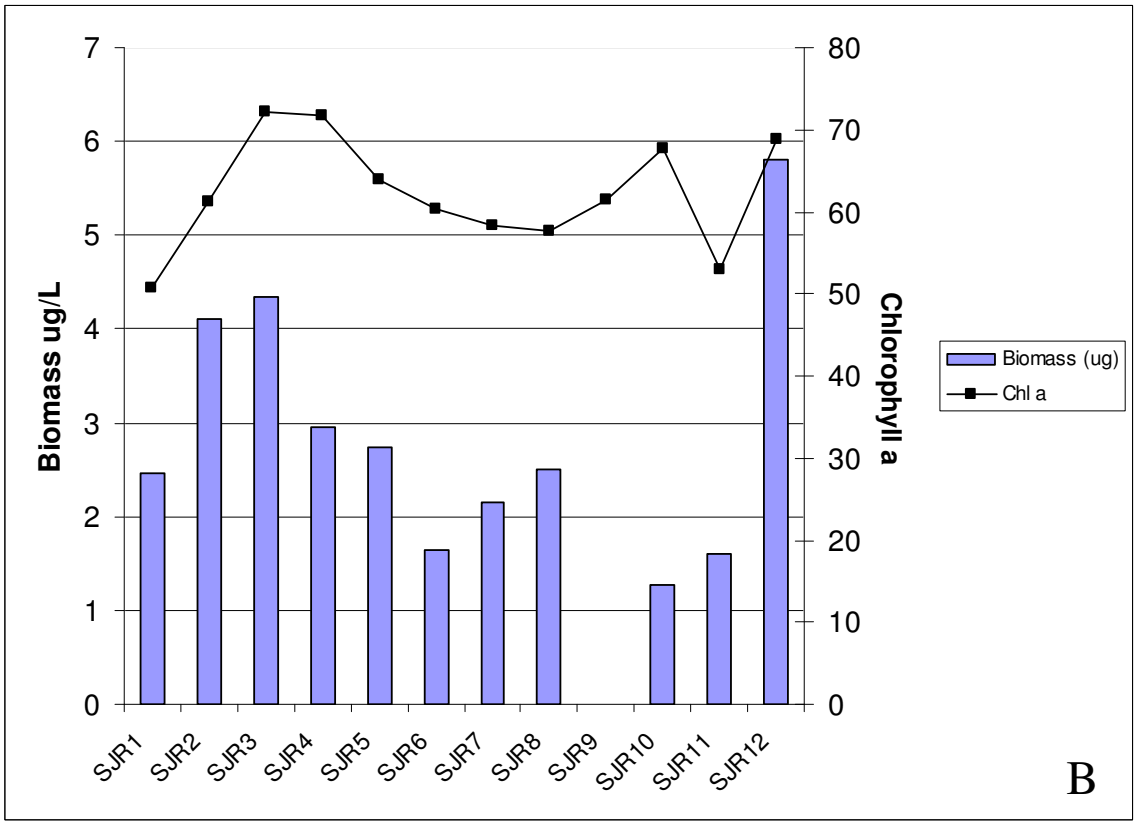


Figure 3. July zooplankton density by site (panel A) and biomass per site (panel B). Chlorophyll a concentrations from Task 8 are superimposed. A correlation coefficient of 0.48 exists between biomass and chlorophyll a.

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.

References:

Balcer, M. D., N. L. Korda, and S. I. Dodson. 1984. Zooplankton of the Great Lakes: a guide to the identification and ecology of the common crustacean species. University of Wisconsin Press, Madison.

Burch, J. B. 1972. Biota of freshwater ecosystems identification manual, No. 3: Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America. U.S. EPA project # 18050 ELD.

Burch, J. B. 1973. Biota of freshwater ecosystems identification manual, No. 11: Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America. U.S. EPA project # 18050 ELD.

Chengalath, R., C. H. Fernando, and M. G. George. 1971. Planktonic Rotifera of Ontario. University of Waterloo Biology Series, Number Two.

Dodd, J. J. 1987. Diatoms. In: Mohlenbrock, R. H. (Ed.), The Illustrated Flora of Illinois, Southern Illinois University Press, Carbondale and Edwardsville.

Kelly, M. 2000. Identification of common diatoms in rivers. Field Studies 9: 583-700.

Nichols, P.D., Guckert, J.D., and White, D.C. 1986. Determination of monounsaturated fatty acid double-bond position and geometry for microbial monocultures and complex consortia by capillary GC-MS of their dimethyl disulfide adducts. Journal of Microbiological Methods 5: 49-55.

Patrick, R., and C. W. Reimer. 1966. The Diatoms of the United States (exclusive of Alaska and Hawaii), Volume 1. Monographs of the Academy of Natural Sciences of Philadelphia, No. 13.

Patrick, R., and C. W. Reimer. 1975. The Diatoms of the United States (exclusive of Alaska and Hawaii), Volume 2, Part 1. Monographs of the Academy of Natural Sciences of Philadelphia, No. 13.

Pennak, R. W. 1989. Fresh-water invertebrates of the United States: Protozoa to Mollusca. 3rd Ed. John Wiley and Sons, Inc.

Pontin, R. M. 1978. A key to the freshwater planktonic and semiplanktonic rotifera of the British Isles. Freshwater Biological Association, Sci. Pub. No. 38.

Prescott, G. W. 1951. Algae of the Western Great Lakes Area. Wm. C. Brown Company Publishers, Dubuque, IA.

Smith, G. M. 1950. The Fresh-water Algae of the United States. McGraw-Hill Book Company, Inc., New York.

U.S. EPA. 2003. Standard Operating Procedure for Zooplankton Analysis, LG403.

U.S. EPA. 2003. Standard Operating Procedure for Phytoplankton Analysis, LG401.

Wallace, R. L., and T. W. Snell. 1991. Rotifera. In: Thorp, J. H., and A. P. Covich (Eds), Ecology and Classification of North American Freshwater Invertebrates, pg. 187 – 248. Academic Press, Inc.

White, C., Bobbie RJ, King JD, Nickels, JS, Amoe P. 1979. Lipid analysis of sediments for microbial biomass and community structure. In: Litchfield CD, Seyfried PL (Eds.), Methodology for biomass determination and microbial activities in sediments. ASTM STO 673. Philadelphia, PA: American Society of Testing and Materials; pg. 87-103.

Wolle, F. 1890. Diatomaceae of North America. The Comenius Press, Bethlehem, PA.

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

SJR 1 7-13-05	Bottle Vol	Aliqot vol			
	370	20			
	count	Per L Density	Ave biomass per ind	SD	Biomass 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			
ug					
Collotheca pelagica	0	0			
ug					
Colurella	1	0.61667			
ug			0.0506		0.0312
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	1	0.61667			
ug			0.0041		0.0025
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	0	0			
ug					
Keratella valga	43	26.5167			
ug			0.0016	0.0006	0.043
Lecane thalera	0	0			
ug					
Polyarthra remata	9	5.55			
ug			0.0275	0.0202	0.1525
Pompholyx sulcata	1	0.61667			
ug			0.0032		0.002
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	6	3.7			
ug			0.0086	0.005	0.0318
Trichocerca similis	0	0			
ug					
Nauplii	6	3.7			
ug			0.4		1.48
	total	67.8333			**2.4672**

SJR 2 7-13-05	Bottle Vol	Aliqot vol			
	340	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	1	1.13333			
ug			0.033		0.0373
Asplancha	0	0			
ug					
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			
ug					
Colurella	1	1.13333			
ug			0.1029		0.1166
Epiphanes senta	0	0			
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			
ug			0.0564	0.0068	0.1279
Polyarthra remata	2	2.26667			
ug			0.0233	0.0147	0.0528
Pompholyx sulcata	0	0			
ug					
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**

SJR 3 7-13-05	Bottle Vol	Aliqot vol			
	390	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	3	3.9			
ug			0.0222	0.0063	0.0866
Asplancha	2	2.6			
ug			0.0482	0.0333	0.1253
Brachionus angularis	7	9.1			
ug			0.0181	0.006	0.1645
Brachionus calyciflorus	12	15.6			
ug			0.0635	0.0329	0.9901
Brachionus havanaensis	2	2.6			
ug			0.0197	0.016	0.0513
Brachionus quadridentatus	0	0			
ug					
Collotheca pelagica	0	0			
ug					
Colurella	0	0			
ug					
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	2	2.6			
ug			0.0052	0.0009	0.0134
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	0	0			
ug					
Keratella valga	16	20.8			
ug			0.0028	0.002	0.058
Lecane thalera		0			
ug					
Polyarthra remata	4	5.2			
ug			0.0467	0.0059	0.2428
Pompholyx sulcata	0	0			
ug					
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	1	1.3			
ug			0.005		0.0065
Trichocerca similis	0	0			
ug					
Nauplii	5	6.5			
ug			0.4		2.6
	total	70.2			**4.3385**

SJR 4 7-13-05	Bottle Vol	Aliqot vol			
	460	20			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	0	0			
ug					
Asplancha	3	2.3			
ug			0.0155	0	0.0357
Brachionus angularis	21	16.1			
ug			0.0147	0.0061	0.237
Brachionus calyciflorus	11	8.43333			
ug			0.0527	0.0518	0.4441
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	2	1.53333			
ug			0.1231	0.0247	0.1887
Collotheca pelagica	0	0			
ug					
Colurella	1	0.76667			
ug			0.015		0.0115
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	3	2.3			
ug			0.0054		0.0124
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	2	1.53333			
ug			0.0012	0.0003	0.0019
Keratella valga	43	32.9667			
ug			0.0017	0.0007	0.056
Lecane thalera	3	2.3			
ug			0.0109	0.0103	0.025
Polyarthra remata	20	15.3333			
ug			0.0225	0.0159	0.3455
Pompholyx sulcata	1	0.76667			
ug			0.0032		0.0025
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	6	4.6			
ug			0.0096		0.044
Trichocerca similis	1	0.76667			
ug			0.0264		0.0203
Nauplii	5	3.83333			
ug			0.4		1.5333
	total	93.5333			**2.9579**

SJR 5 7-14-05	Bottle Vol	Aliqot vol			
	460	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	1	1.53333			
ug			0.0174		0.0266
Asplancha	1	1.53333			
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			
ug			0.0225		0.0345
Colurella	0	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			0.001		0.0016
Keratella valga	20	30.6667			
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					
Trichocerca similis	0	0			
ug					
Nauplii	2	3.06667			
ug			0.4		1.2267
	total	81.2667			**2.7458**

SJR 6 7-14-05	Bottle Vol	Aliqot vol			
	515	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	2	3.43333			
ug			0.0259	0	0.089
Asplancha	0	0			
ug					
Brachionus angularis	9	15.45			
ug			0.0147	0.005	0.2267
Brachionus calyciflorus	4	6.86667			
ug			0.0828	0.0265	0.5686
Brachionus havanaensis	2	3.43333			
ug			0.0132	0	0.0453
Brachionus quadridentatus	0	0			
ug					
Collotheca pelagica	1	1.71667			
ug			0.0922		0.1582
Colurella	1	1.71667			
ug			0.0506		0.0869
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	1	1.71667			
ug			0.0055		0.0094
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	0	0			
ug					
Keratella valga	14	24.0333			
ug			0.0017	0.0004	0.0406
Lecane thalera	5	8.58333			
ug			0.0191	0.0022	0.1642
Polyarthra remata	3	5.15			
ug			0.0273	0.0155	0.1407
Pompholyx sulcata	0	0			
ug					
Synchaeta longipes	2	3.43333			
ug			0.0083	0.0046	0.0287
Trichocerca rousseleti	6	10.3			
ug			0.0077		0.0798
Trichocerca similis	0	0			
ug					
Nauplii	0	0			
ug			0.4		0
	total	85.8333			**1.6381**

SJR 7 7-14-05	Bottle Vol	Aliqot vol			
	420	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	2	2.8			
ug			0.0229	0.0042	0.0642
Asplancha	0	0			
ug					
Brachionus angularis	16	22.4			
ug			0.0118	0.0052	0.264
Brachionus calyciflorus	10	14			
ug			0.0587	0.0248	0.8224
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	0	0			
ug					
Collotheca pelagica	0	0			
ug					
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
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	0	0			
ug					
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					
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	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
	total	103.6			**2.1507**

SJR 8 7-14-05	Bottle Vol	Aliqot vol			
	340	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass 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	8	9.06667			
ug			0.0559	0.0352	0.5073
Brachionus havanaensis	2	2.26667			
ug			0.0404	0.0059	0.0915
Brachionus quadridentatus	0	0			
ug					
Collotheca pelagica	1	1.13333			
ug			0.0299		0.0339
Colurella	0	0			
ug					
Epiphanes senta	1	1.13333			
ug			0.1278		0.1448
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	4	4.53333			
ug			0.0047	0.0017	0.0212
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	2	2.26667			
ug			0.001	0	0.0023
Keratella valga	22	24.9333			
ug			0.002	0.0006	0.0487
Lecane thalera	10	11.3333			
ug			0.0178	0.0025	0.2018
Polyarthra remata	11	12.4667			
ug			0.0123	0.0077	0.1531
Pompholyx sulcata	1	1.13333			
ug			0.0032		0.0037
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	2	2.26667			
ug			0.0071	0.0053	0.0161
Trichocerca similis	1	1.13333			
ug			0.0161		0.0183
Nauplii	2	2.26667			
ug			0.4		0.9067
	total	96.3333			**2.505**

SJR 10 7-14-05	Bottle Vol	Aliqot vol			
	370	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass 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	4	4.93333			
ug			0.0523	0.0197	0.258
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	1	1.23333			
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	0	0			
ug					
Trichocerca rousseleti	5	6.16667			
ug			0.0049	0.002	0.0305
Trichocerca similis	1	1.23333			
ug			0.0161		0.0199
Nauplii	1	1.23333			
ug			0.4		0.4933
	total	33.3			**1.2705**

SJR 11 7-14-05	Bottle Vol	Aliqot vol			
	345	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	0	0			
ug					
Asplancha	1	1.15			
ug			0.0303		0.0348
Brachionus angularis	5	5.75			
ug			0.0227	0.0095	0.1304
Brachionus calyciflorus	4	4.6			
ug			0.0506	0.018	0.2326
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	2	2.3			
ug			0.0446	0	0.1025
Collotheca pelagica	0	0			
ug					
Colurella	1	1.15			
ug			0.0506		0.0582
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	1	1.15			
ug			0.002		0.0023
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	1	1.15			
ug			0.001		0.0012
Keratella valga	3	3.45			
ug			0.0017	0.0004	0.0059
Lecane thalera	3	3.45			
ug			0.0184	0.0046	0.0635
Polyarthra remata	1	1.15			
ug			0.0055		0.0063
Pompholyx sulcata	3	3.45			
ug			0.0072	0.0008	0.0249
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	2	2.3			
ug			0.0046	0.0031	0.0106
Trichocerca similis	1	1.15			
ug			0.0091		0.0105
Nauplii	2	2.3			
ug			0.4		0.92
	total	34.5			**1.6036**

SJR 12 7-14-05	Bottle Vol	Aliqot vol			
	360	10			
	count	Per L Density	Ave biomass per ind	SD	Biomass per L
Anureopsis	0	0			
ug					
Asplancha	0	0			
ug					
Brachionus angularis	13	15.6			
ug			0.0214	0.0057	0.3334
Brachionus calyciflorus	13	15.6			
ug			0.0819	0.0225	1.2774
Brachionus havanaensis	0	0			
ug					
Brachionus quadridentatus	3	3.6			
ug			0.0621	0.0164	0.2237
Collotheca pelagica	0	0			
ug					
Colurella	1	1.2			
ug			0.0506		0.0608
Epiphanes senta	0	0			
ug					
Euchlanis dilatata	0	0			
ug					
Filinia longiseta	0	0			
ug					
Kellicottia longispina	0	0			
ug					
Keratella cochlearis	0	0			
ug					
Keratella valga	0	0			
ug					
Lecane thalera	0	0			
ug					
Polyarthra remata	2	2.4			
ug			0.0055	0	0.0131
Pompholyx sulcata	1	1.2			
ug			0.0019		0.0023
Synchaeta longipes	0	0			
ug					
Trichocerca rousseleti	2	2.4			
ug			0.0068	0	0.0164
Trichocerca similis	2	2.4			
ug			0.0161	0	0.0387
Nauplii	8	9.6			
ug			0.4		3.84
	total	54			**5.8057**

Appendix 2. Phytoplankton species list as of September 2005.

Green algae	**Diatoms**	**Blue-green algae**
Actinastrum hantzschii	*Acanthoceras zachariasii*	*Anabaena circinalis*
Carteria cordiformis	*Achnanthes lanceolata*	*Anabaena laxa*
Ankistrodesmus falcatus	*Amphicampa mirabilis*	*Anacystis nidulans*
Characium sp.	*Amphora sp.*	*Aphanizomenon flos-aquae*
Chlamydomonas sp.	*Asterionella formosa*	*Arthrospira jenneri*
Chlorella sp.	*Aulacoseira granulata*	*Chroococcus sp.*
Closteriopsis longissima	*Aulacoseira italica*	*Gomphosphaeria sp.*
Closterium lunula	*Bacillaria paradoxa*	*Lyngbya limnetica*
Closterium setaceum	*Caloneis lewisii*	*Marssoniella elegans*
Coelastrum microporum	*Cocconeis placentula*	*Merismopedia tenuissima*
Cosmarium sp.	*Coscinodiscus apiculatus*	*Microcystis sp.*
Crucigenia tetrapedia	*Cyclotella meneghiniana*	*Oscillatoria amphibia*
Crucigenia quadrata	*Cymatopleura sp.*	*Oscillatoria limosa*
Crucigenia rectangularis	*Cymbella minuta*	*Oscillatoria nigra*
Dictyosphaerium pulchellum	*Diatoma sp.*	*Oscillatoria tenuis*
Eudorina elegans	*Entomoneis sp.*	*Oscillatoria terebriformis*
Gloeocystis sp.	*Epithemia sp.*	*Romeria sp.*
Hydrodictyon reticulatum	*Fragillaria sp.*	*Spirulina sp.*
Kirchneriella sp.	*Gomphonema subclavatum*	*Synechocystis sp.*
Micractinium pusillum	*Gyrosigma sp.*	
Monoraphidium contortum	*Hydrosera sp.*	**Dinoflagellates**
Oocystis sp.	*Meridion sp.*	*Ceratium hirundinella*
Pandorina sp.	*Navicula protracta*	*Glenodinium pulvisculus*
Pediastrum boryanum	*Nitzschia caledonensis*	
Pediastrum duplex	*Nitzschia closterium*	**Euglenoids**
Pediastrum simplex	*Nitzschia intermedia*	*Euglena sp.*
Scenedesmus abundans	*Nitzschia palea*	*Phacus sp.*
Scenedesmus acuminatus	*Nitzschia reversa*	*Trachelomonas sp.*
Scenedesmus arcuatus	*Pseudostaurosira brevistriata*	
Scenedesmus armatus	*Skeletonema potamos*	
Scenedesmus bijuga	*Staurosirella lapponica*	
Scenedesmus dimorphus	*Staurosirella pinnata*	
Scenedesmus quadricauda	*Surirella linearis*	
Schroederia setigera	*Synedra sp.*	
Selenastrum sp.	*Tabellaria sp.*	
Smithomonas sp.	*Thalassiosira sp.*	
Sphaerellopsis aulata		
Sphaerocystis schroeteri	**Golden Algae**	
Staurastrum	*Dinobryon sertularia*	
Tetraedron gracile	*Synura uvella*	
Tetraedron lunula		
Tetrastrum heterocanthum		
Tetrastrum staurogeniaeforme	**Cryptophyceae**	
Treubaria triappendiculata	*Cryptomonas ovata*	
Westella botryoides		