Title: Building Sustainable Solutions to the Issue of Ballast Water Treatment: Testing Relationships between Propagule Pressure and Colonization Success of Invasive Species.

Type of Report: Interim

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Date of Report October 31, 2007

Research funded in part by the Great Lakes Maritime Research Institute.
This study was supported by the U.S. Maritime Administration
Grant # DTMA1-G-06-005

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Executive Summary

This multi-year project addresses the issue of ballast water treatment by examining the efficacy of the standards that will be applied concerning permissible levels of biological pollution. The main objective of this project is to measure relationships between propagule pressure and colonization success of zooplankton in the Duluth-Superior Harbor and St. Louis Estuary through dose-gradient experiments that bracket International Maritime Organization standards.

The objective of this first year of work was to characterize the density and diversity of crustacean zooplankton in the Duluth-Superior Harbor and St. Louis Estuary, a first step in developing the experiments. Twelve locations were selected for sampling. These reflected a random, geographic distribution spanning from the Oliver Bridge to the Duluth Entry. On each of 10 dates between April and October, 2007, the 12 locations were sampled during day time for crustacean zooplankton and a variety of physical and chemical variables. The same set of locations will be sampled again on 10 dates in 2008.

Preliminary data analysis indicates strong gradients in temperature, water clarity and primary productivity across the 12 sampling locations, but little variation in dissolved oxygen concentration. Densities of individual species of zooplankton peak during midsummer which may be explained in part by seasonal variation in water temperature. Zooplankton composition and density show spatial gradients that may be the result of mixing with Lake Superior, but may also reflect variation in the degree of ballast water exchange from ships. Additional data and data analysis will permit us to test this hypothesis. A second year of sampling and analysis will permit us to develop a solid picture of the spatial and temporal characteristics of the zooplankton assemblage in the Duluth-Superior Harbor and St. Louis Estuary. This will provide the context necessary to carryout the other objectives of this project.

Introduction

During the past century the use of ballast water by commercial ships has inadvertently created a highly efficient, global transfer mechanism for non-native species. Foreign ships arriving in U.S. ports discharge in excess of 70 million metric tons of liquid ballast annually, fostering an ongoing transfer of non-native aquatic species into the country (Minton et al. 2005).

In an effort to prevent further biological pollution through ballast water exchange (Grigorovich et al. 2003), the U.S. Congress passed and reauthorized legislation in the 1990s that requires vessels to manage their ballast water in one of two ways. Ships are required either to carryout Ballast Water Exchange (BWE) by flushing ballast tanks in the open ocean or to perform Ballast Water Treatment (BWT) by proactive decontamination. Although BWE has been widely adopted by the shipping industry, it has a number of limitations as a preventative measure. As a result, there is a growing need for research, testing and implementation of BWT technologies.

Effectiveness standards of BWT technologies will be guided by standards agreed upon by the International Maritime Organization (IMO). Recognizing that no BWT technology can be expected to perform with 100% effectiveness all of the time, the IMO standards are meant to reduce the risk of biological pollution. Specifically, IMO standards are a set of permissible, post-treatment concentration limits that vary according to organism body size and taxonomic affiliation. It has been suggested that for organisms of >50 µm body length (e.g., crustacean zooplankton), a density of up to 10 living individuals per cubic meter will be permissible in post-treatment discharge (Global Ballast Water Management Programme, 1997).

There is a significant lack of understanding among ecologists regarding the quantitative relationships between propagule pressure (the size and frequency of founding populations) and colonization success of non-native organisms. The available evidence strongly implicates propagule pressure as a determinant of colonization success in terrestrial plants (Von Holle and Simberloff 2005) but evidence from aquatic ecosystems is limited (Bohonak and Jenkins 2003, Colautti et al. 2006). Examples of recent invasive zooplankton species that have colonized the Great Lakes–St. Lawrence Seaway System through ballast water exchange include zebra mussel larvae (*Dreissena polymorpha*) and the spiny waterflea (*Bythotrephes longimanus*). In neither case was it known how many invasive propagules, or founding events, precipitated the colonization event.

Hence, despite the intended outcomes of the IMO post-treatment standards, there have been no systematic evaluations of the relationships between permissible post-treatment concentration limits (propagule pressure) and the colonization success of aquatic species to which the standards will apply.

This project has three interrelated objectives. 1) Describe the density and diversity of zooplankton in the Duluth-Superior Harbor and St. Louis Estuary. The results will be used to develop the natural communities used to seed mesocosms (see objective 3 below). 2) Couple the results of objective 1 with information on ship traffic and ballast discharge (volume, port of origin) to evaluate the relationship between propagule pressure and colonization success of zooplankton in the Duluth-Superior Harbor and St. Louis Estuary. 3) Measure relationships between the size and frequency of founding populations of zooplankton (propagule pressure) and their colonization success. This interim report addresses data collected under objective 1 which was the focus of the 2007 work plan.

Report body

During the past century the use of ballast water by commercial ships has inadvertently created a highly efficient, global transfer mechanism for non-native species. In an effort to eliminate ballast water as a viable vector, the U.S. Congress passed and reauthorized legislation in the 1990s that requires vessels to manage their ballast water in one of two ways. Ships are required either to carryout Ballast Water Exchange (BWE) by flushing ballast tanks in the open ocean or to perform Ballast Water Treatment (BWT) by proactive decontamination. There has been no systematic evaluation of the relationships between permissible post-treatment concentration limits (propagule pressure) and the colonization success of non-native species. This project will eventually evaluate the quantitative relationship between the size and frequency of founding populations of zooplankton and their colonization success. Those experiments will be conducted in land-based mesocosms. As a first step in this process, surveys of the density and diversity of zooplankton in the Duluth-Superior Harbor are being conducted to help define the natural communities used to seed the experimental mesocosms. Furthermore, by coupling survey results with information on ship traffic and ballast discharge (volume, port of origin) we will test relationships between propagule pressure and colonization success of zooplankton in the Duluth-Superior Harbor.

The three objectives of this project and the basic approach to each are described below. The first year of this study (2007) concentrated on the collection of data under objective 1. This interim report presents the data collected and some preliminary analysis of those data.

1. **Measure the seasonal density and diversity of zooplankton at the species level in the Duluth-Superior Harbor and its connected waters including the St. Louis Estuary and Lake Superior adjacent to the Duluth-Superior Harbor.** Zooplankton collections will be made biweekly from April-October for 2 consecutive years with standard Puget-Sound style zooplankton nets. Associated measurements including temperature, dissolved oxygen, conductivity, pH, fluorescence, photosynthetic active radiation and water clarity will be taken.

2. **Test the hypothesis that seasonal density and diversity of zooplankton in the Duluth-Superior Harbor (a measure of colonization success) as determined under objective 1, is temporally and spatially correlated with seasonal shipping traffic and ballast discharge (volume, port of origin) statistics which is an index of propagule pressure.** Information on seasonal shipping traffic and ballast discharge will be collected. Starting in 2005, Masters were required to report all ballast transfers on the Great Lakes and Seaway. The information is stored at the National Ballast Information Clearing House, Smithsonian Environmental Research Center. Coupled with data about the seasonal density and diversity of zooplankton in the Duluth-Superior Harbor (objective 1), these data will provide a means to test for relationships in-situ between colonization success and propagule pressure.

3. **Measure the relationships between propagule pressure and colonization success of zooplankton in the Duluth-Superior Harbor and St. Louis Estuary through dose-gradient experiments that bracket International Maritime Organization (IMO) standards.** Experiments will be conducted in replicated mesocosms (1 cubic meter volume) in a typical dose-gradient design. Mesocosms will be located at a laboratory on the shores of the Duluth-Superior Harbor and contain native assemblages of bacteria, phytoplankton and zooplankton. Different levels of propagule pressure (inocula concentrations) will be applied that bracket IMO guidelines. Propagule pressure will be manipulated by adjusting independently the density of a 'model' invasive zooplankton species and the number of inoculating events. Candidate 'model' invasive species will include a least one phytoplanktivorous species (e.g., *Daphnia retrocurva*) and one carnivorous species (e.g. *Bythotrephes longimanus*). Quantitative relationships between propagule pressure and colonization success of a species are likely to be context specific and influenced by both biotic and abiotic factors of the recipient system. This will be experimentally tested as resources permit.

The completion of objective 1 required the initial identification of sampling sites within the study grid of the Duluth-Superior Harbor and St. Louis Estuary (Figure 1). Three zones within the grid were defined as follows: 1) Upstream of Spirit Lake, 2) Spirit Lake, and 3) Harbor adjacent to Lake Superior. The selection of our sampling sites within the grid was guided by an electronic-map program developed by the U.S. Environmental Protection Agency. The program was employed to identify 12 random locations within the grid, weighted by the area of each zone. The program identified 1 site in zone 1, 4 sites in zone 2, and 7 sites in zone 3. Sampling sites by name, number and zone are listed in Table 1. General locations of the sampling sites by zone are found in Figure 1.

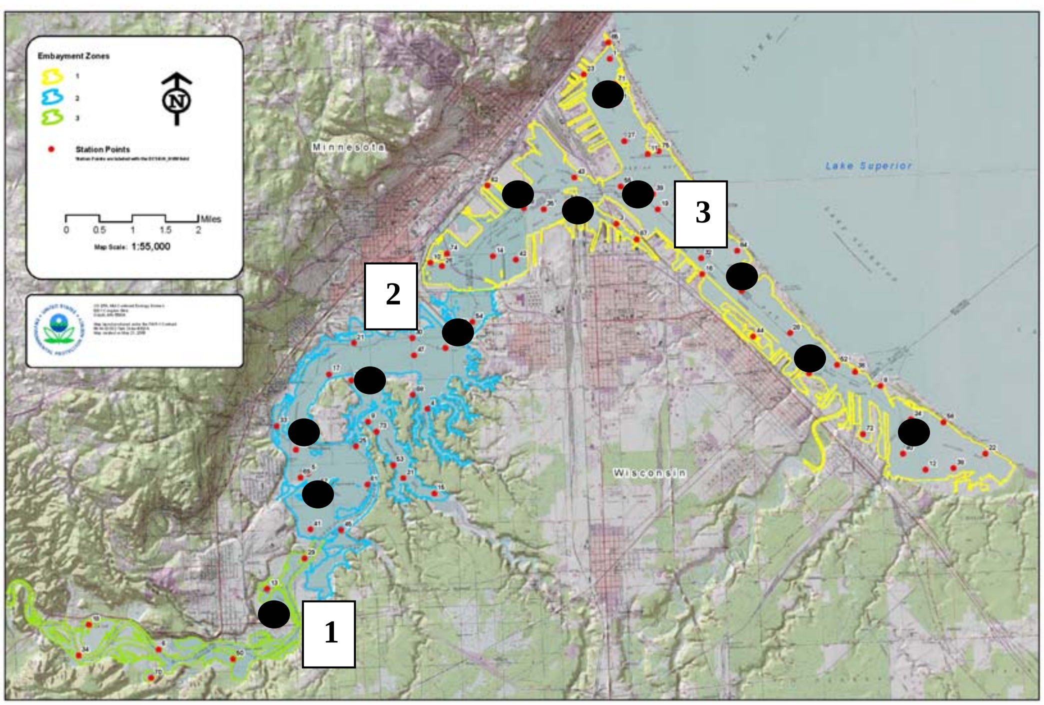

Figure 1. Distribution of the 12 sampling sites (black circles) within the three zones of the Duluth-Superior Harbor and St. Louis Estuary

Samples were collected on 10 dates, approximately biweekly, from 20 April 2007 to 20 October 2007. All 12 stations were sampled on 9 of the 10 dates. On the first sampling date (20 April 2007) 4 of 12 stations were not sampled due to mechanical problems with equipment.
Work was conducted from a 16' Lund boat during daylight hours. At each location on each date the following information was collected.

Table 1. Sampling site name, reference number, and geographic zone of site as given in Figure 1. Rows marked with 'Y' indicate that seasonal data are included in the Appendices of this report.

Site Name	Ref. number	Zone	Phys-Chem	Zooplankton
Riverside Marina	49	2	Y	
Oliver Bridge	50	1	Y	Y
Duluth Entry	51	3	Y	
Hog Island	52	3	Y	
Clough Island	53	2	Y	
Billings Park	54	2	Y	
High Bridge	55	3	Y	
Allouez Bay	56	3	Y	Y
Spirit Lake	57	2	Y	
DMIR	58	3	Y	
Midwest Energy	59	3	Y	Y
Barker's Island	60	3	Y	

Zooplankton were collected with a Puget-Sound style zooplankton net. The net had a mouth opening of 0.5-m diameter, an aspect ratio (opening:length) of 1:3, and nitex mesh of 100 µm aperture. The net was lowered to near the sediment and retrieved to the surface until at least 1,000 L were filtered. This required between 2 to 6 casts per location. Collections were preserved in 75% Ethanol (final volume).

Physical and chemical information was collected at meter intervals through the water column with three different instruments manufactured by YSI Incorporated. The physical and chemical variables included Temperature (ºC), pH, Conductivity (µS), Fluorescence (µg L^{-1}), Dissolved Oxygen (mg L^{-1}), and Turbidity (NTU). In addition, irradiance (foot-candles) at meter intervals was collected with a Protomatic meter. Three Secchi disk measurements were taken per location. Data were entered into an Excel spread sheet.

In the laboratory, zooplankton collections were diluted, split with a Folsom-style plankton splitter, and re-suspended to known volume. Two or more subsamples were scored under a Leica MZ125 dissecting microscope. Summing all dates, the equivalent of at least 100 L of original volume of collection was searched. Zooplankton counts were converted to number m^{-3}. Zooplankton collections on all dates (9 or 10) for 3 of 12 stations were completed by the time of this interim report.

Zooplankton data as well as physical and chemical data were entered into Excel spreadsheets and appear in Appendices 1 and 2, respectively, of this report.

Zooplankton

The crustacean zooplankton assemblage is dominated in number and diversity by copepods (Appendix 1). This pattern of composition strongly reflects the makeup of crustacean zooplankton in Lake Superior. Lake Superior is overwhelmingly dominated by calanoid copepods (e.g., *Diaptomus*) that aggregate in and above the metalimnion during summer (Watson and Wilson 1978, Megard et al. 1997, Zhou et al. 2001, Brown and Branstrator 2004). In Lake Superior, episodic outbreaks of cladoceran zooplankton (e.g., *Daphnia*) occur predominantly nearshore and in offshore surface regions seasonally, but cladocerans are usually present in substantial numbers only in the summer and autumn and are a minor biomass component in comparison to copepods lakewide. As in Lake Superior proper, at the 3 sampling locations analyzed thus far in this study, cladoceran zooplankton express strong seasonality, with highest densities achieved during July and August for most species.

There is a signal in the data that suggests species richness is greater in zone 3 (contiguous with Lake Superior, locations 56 and 59) than zone 1 which is upstream of Spirit Lake (location 50). This may reflect exchange with Lake Superior assemblages of zooplankton through the Duluth and Superior entries but may also reflect variation in the degree of ballast water exchange from ships. This hypothesis will be tested when more data have been analyzed. Aside from one outstanding specimen that will require more taxonomy, there were no individuals at any of the three sites analyzed that would be considered non-native to the region.

Water temperature ranged widely during the sampling campaign. Spring and autumn temperatures were generally in the range of 8-10°C while peak summer temperatures ranged from 23-29°C. The effect of temperature on controlling zooplankton growth in Lake Superior has been studied (Watson and Wilson 1978). Not surprisingly, temperature is an excellent predictor of zooplankton abundance because zooplankton are ectothermic and their growth rate is determined to a large extent by enzyme activity (Vijverberg 1980, Shuter and Ing 1977).

Significant correlations between zooplankton abundance and epilimnetic water temperature have been observed in Lake Superior at the correlation level of 69% (Watson and Wilson 1978) and 54% (Zhou et al. 2001). A correlation of 92% has been reported for several North American large lakes (Patalas 1990). Thus, epilimnetic temperature is certainly an important parameter to consider in variation in zooplankton composition and density. Owing to temperature controls on growth rates, invasive species of crustacean zooplankton may be more likely to establish when water temperatures are warmest. Hence, summer months present a vulnerable period for the Duluth-Superior Harbor and St. Louis Estuary in terms of establishment success of inocula of non-native species.

Physical Chemical

The physical and chemical data (Appendix 2) reveal noteworthy gradients from zone 1 to zone 3 in some variables such as temperature, chlorophyll fluorescence, turbidity and transparency but not in others such as dissolved oxygen.

Dissolved oxygen concentrations were generally uniform from surface to sediment with little indication of gradients in concentration. At no location or time did we detect anoxic or even hypoxic (< 2 mg L^{-1} dissolved oxygen) conditions at the sediment surface. These data indicate that benthic species and the benthic life stages of species will find sufficient oxygen conditions in the Duluth-Superior Harbor and St. Louis Estuary at all depths to complete their life cycles.

Surface temperatures were generally warmer upstream (zone 1) than downstream (zone 3). Gradients in chlorophyll fluorescence and turbidity were in the same direction, while water transparency (Secchi disk) increased from zone 1 to zone 3. Despite this general trend, there was tremendous variation in turbidity and transparency among sites in zone 3 owing to the fact that some sites are quite shallow and strongly influenced by riverine inputs (e.g., Allouez Bay, Location 56) whereas others are flushed more continuously with Lake Superior (e.g., Duluth Entry, Location 51).

In conclusion, there appears to be large gradients in the physical and chemical composition of the pelagic habitats from headwaters to outlets in the Duluth-Superior Harbor and St. Louis Estuary. Our analysis of 3 of 12 crustacean zooplankton samples reveals trends that suggest variation in composition and density from zone to zone, as well as strong seasonality in density. The latter may be governed in part by water temperature. A second year of sampling and analysis will permit us to develop a valuable picture of spatial and temporal variation in the zooplankton assemblage of the Duluth-Superior Harbor and St. Louis Estuary that can be used to complete objectives 2 and 3 of this multi-year project.

Potential Economic Impacts of the Research Results

This project will ultimately provide basic and applied results on relationships between propagule pressure and colonization success of invasive species. Results and reports emanating from this project will include a data-based risk assessment model of invasion success in relation to propagule pressure.

This research will provide a scientific basis for guiding the development of IMO standards as they relate to the effectiveness of BWT technologies. A broad set of professionals should be interested in this research including people in areas of policy, environmental law, research and development of BWT technologies, population biology, invasive species, and limnology.

There is a significant lack of understanding among ecologists regarding the quantitative relationships between propagule pressure and colonization success of dispersing organisms. This in turn presents a serious impediment for identifying specific standards (either concentrations or per-ship discharge) for ballast water management of invasive species. This project fulfills both an important information gap in the discipline of invasion ecology and a specific information gap regarding IMO standards. The Duluth-Superior Harbor has long been recognized as a globally important ecosystem from the perspective of maritime traffic volume and ballast water issues. This research project is basic and applied, as well as timely and geographically significant.

Dissemination of Study Results

This project is providing the basis for the Ph.D. degree sought by Matthew C. TenEyck through the University of Minnesota Water Resources Science Graduate Program. The results of this research will be published in peer-reviewed journals and it is anticipated that this will begin as soon as the completion of the 2008 field season. We anticipate that the first paper will define the spatial and temporal variation in zooplankton community structure within the Duluth-Superior Harbor and St. Louis Estuary and compare and contrast that to physical and chemical gradients as well as gradients and patterns in shipping traffic and ballast discharge.

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APPENDIX 1

Vertical Net Counts

Vertical Net Counts										
Oliver Bridge (location 50)										
#/m3										
Date	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	29-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Bosmina longirostrus	70.9	44.2	67.0	165.8	348.6	1403.1	527.2	7602.0	302.3	81.2
Chydorus sp.	240.9	10.2	63.8	25.5					398.5	81.2
Alona sp.	14.2	20.4	44.6	63.8	8.5			25.5	89.3	162.4
Ceriodaphnia sp				63.8	11.9	95.7	807.8	357.1		
Diaphansoma sp.		23.8		17.0	149.7	561.2	646.3	535.7	34.4	
D. retrocurva						31.9	280.6	1275.5	61.8	
D. g. mendota						6.4	34.0			
D. thomasi male	42.5								6.9	
D. thomasi female	34.0									
A. vernalis male	8.5			4.3						
A. vernalis female	2.8									
E. agilis male				8.5					6.9	
E. agilis female	5.7	10.2		8.5						
T. mexicanus male										
T. mexicanus female	19.8	3.4								
D. sicillodies male	11.3									
D. sicillodies female	2.8									
D. orgenensis male	2.8									
D. orgenensis female										
D. sicilis male		3.4								
D. sicilis female										
Eurytemora male										
Eurytemora female										
Epischura male										
Epischura female										
Harpacticoid male										
Harpacticoid female	2.8	6.8		4.3						
Leptodora				4.3		12.8	110.5			
N auplii	522.0	602.0	172.2	761.1	352.0	548.5	8044.2	6326.5	96.2	121.8
Cyclop copepidids	272.1	224.5	95.7	250.9	35.7		3979.6	2959.2	130.5	609.0
Mesocyclop copepidids	11.3	3.4					8.5			
Tropocyclop copepidids	11.3									
Diaptomus copepidids	5.7	6.8		4.3	98.6		8.5	25.5		
Harpactacoid copepidids	62.4	47.6	3.2							
Eury copepidids						25.5				
Epischura copepidids										

Vertical Net Counts										
Allouez Bay (Location 56)										
#/m3										
Date	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	29-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Bosmina longirostrus		372.2	1820.4	9235.7	995.2	7006.4	5254.8	16162.4	6608.3	410.7
Chydorus sp.										
Alona sp.										
Ceriodaphnia sp				106.2			159.2	636.9	318.5	
Diaphansoma sp.		97.1		3131.6	3861.5	5414.0	4697.5	3901.3	636.9	9.9
D. retrocurva		48.5		2282.4	1950.6	1672.0	1592.4	1433.1	3503.2	19.9
D. thomasi male		841.4	60.7	159.2	159.2	79.6			79.6	3.3
D. thomasi female		258.9		265.4	119.4	79.6			79.6	
A. vernalis male							79.6			
A. vernalis female										
E. agilis male				53.1						
E. agilis female										
T. mexicanus male							159.2		79.6	
T. mexicanus female							79.6			
M. edax male		40.5		1327.0	4657.6	636.9	1751.6	238.9	318.5	
M. edax female		40.5		265.4	3065.3	79.6	557.3	159.2	79.6	
D. sicillodies male										
D. sicillodies female				106.2	79.6					
D. orgenensis male				477.7	318.5	238.9	3343.9	3025.5	2070.1	9.9
D. orgenensis female				530.8	437.9	398.1	2229.3	2547.8	2149.7	16.6
D. sicilis male		16.2							79.6	16.6
D. sicilis female										26.5
Eurytemora male				743.1		238.9				3.3
Eurytemora female				159.2	79.6	79.6				3.3
Epischura male										
Epischura female					39.8					
Harpacticoid male										
Harpacticoid female										
Lepto				796.2	119.4	79.6		79.6		
Holopedium					39.8					
N auplii		1731.4	33798.5	11995.8	19187.9	21178.3	63216.6	47929.9	19426.8	414.0
Cyclop copepidids		2936.9	10012.1	11518.0	3941.1	11305.7	11305.7	14092.4	3025.5	215.3
Mesocyclop copepidids		137.5		3821.7	3423.6	11465.0	14729.3	4140.1	955.4	
Tropocyclop copepidids							159.2	318.5		
Diaptomus copepidids		210.4	182.0	1008.5	2189.5	3742.0	18232.5	6926.8	6210.2	46.4
Harpactacoid copepidids										
Eury copepidids				6316.3	1512.7	2388.5		3105.1	1433.1	79.5
Epischura copepidids				53.1					159.2	
Veligers					10589.2	1273.9				

Vertical Net Counts										
Midwest Energy (Location 59)										
#/m3										
Date	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	29-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Bosmina longirostrus	111.0	336.2	2039.7	4726.1	15095.5	59872.6	12314.2	5573.2	10327.2	273.2
Chydorus sp.	252.1	47.8	28.3							16.6
Alona sp.	16.2	55.7	61.4	51.0	42.5					58.0
Ceriodaphnia sp		15.9		12.7	31.8		1141.2	159.2	243.9	
Diaphansoma sp.		8.0	4.7	12.7	382.2	4670.9	9660.3	3980.9	162.6	
D. retrocurva				51.0	244.2	1114.6	5520.2	4140.1	2032.9	91.1
D. thomasi male	44.0	55.7	37.8	25.5	31.8	53.1	238.9	716.6	243.9	
D. thomasi female	37.0	79.6	80.3		31.8	212.3	132.7	79.6	203.3	
A. vernalis male	4.6									
A. vernalis female	11.6									
E. agilis male	6.9				21.2		159.2	398.1		
E. agilis female	9.3				21.2		159.2	477.7		
T. mexicanus male									40.7	
T. mexicanus female		8.0							81.3	
M. edax male							106.2	636.9		
M. edax female	2.3					53.1		238.9		
D. sicillodies male		31.8		25.5						
D. sicillodies female	2.3	8.0								
D. orgenensis male					21.2	159.2			81.3	
D. orgenensis female					21.2		132.7		203.3	
D. sicilis male	32.4	15.9						79.6		
D. sicilis female	2.3							79.6		
Eurytemora male			14.2	89.2	21.2	159.2	159.2			
Eurytemora female			28.3	165.6	21.2			79.6		
Epischura male				12.7			53.1	79.6		
Epischura female				51.0			79.6	79.6		
Harpacticoid male	4.6									
Harpacticoid female	18.5	15.9						79.6		
Lepto				25.5	31.8	159.2	79.6			
Holopedium							26.5	79.6		
N auplii	1192.7	3837.6	2285.2	3535.0	4203.8	3343.9	4617.8	16879.0	10611.8	49.7
Cyclop copepidids	508.9	4808.9	1383.4	777.1	3620.0	4564.8	5838.6	6767.5	8213.0	256.7
Mesocyclop copepidids	48.6	39.8			42.5	159.2	106.2	79.6		
Tropocyclop copepidids	9.3									
Diaptomus copepidids	6.9	167.2	42.5	51.0	276.0	424.6	1512.7	1751.6	691.2	24.8
Harpactacoid copepidids	101.8	31.8	28.3							
Eury copepidids			75.5	815.3	350.3	265.4	212.3	238.9	203.3	
Epischura copepidids				993.6	658.2	1857.7	1035.0	3025.5	528.6	
Veligers						16135.9	5944.8	5812.1	162.6	

APPENDIX 2

Physical and Chemical Data

Oliver Bridge		Sample Date:									
Site 50	Temp (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	7.7	17.2	19.9	22.2	23.7	29	24.3	21.7	16	10.29
	1	7.6	16.8	19.6	22	23.7	27.8	24.2	21.3	15.5	1.28
	2	7.6	16.5	19.1	22	23.6	26.1	24.1	21.1	15.2	10.28
	3	7.5	16.2	19	21.5	22.8	25.3	24.1	21	15.1	10.28
	4	7.5	14.8	18.8	21	22.5	24.9	24	20.9	15	10.26
	5	7.5	14.7	18.8	20.9	22.3	24	23.8	20.8		10.26
	6				20.8	22.1		23.5			10.26
	7				20						10.27
	DO(mg/L)										
	0	12.6	10.58	9.05	8.32	7.7	8.39	7.9	8.68	10.54	13.12
	1	12.6	10.4	9.08	8.33	7.59	8.43	7.76	8.41	10.23	13.33
	2	12.6	10.49	8.87	8.2	7.58	8.24	7.64	8.26	9.72	13.12
	3	12.5	10.28	8.9	8.15	7.02	7.85	7.5	8.27	9.81	12.76
	4	12.5	10.27	8.85	8.04	7.06	7.35	7.38	8.01	9.85	12.58
	5	12.5	10	8.8	7.95	6.87	6.79	7.18	7.73	9.85	12.5
	6				7.87	6.75		6.85			12.29
	7				7.64						12.56
	pH										
	0	8.49	7.73	7.79	7.6	7.94	8.39	8.05	7.96	7.88	7.68
	1	8.49	7.73	7.76	7.59	7.93	8.35	8.02	7.94	7.87	7.69
	2	8.49	7.73	7.73	7.58	7.91	8.28	8.01	7.93	7.87	7.69
	3	8.49	7.74	7.7	7.59	7.9	8.21	7.99	7.92	7.86	7.7
	4	8.49	7.75	7.68	7.6	7.89	8.13	7.96	7.91	7.84	7.69
	5	8.49	7.75	7.68	7.58	7.88	8.13	7.94	7.92	7.83	7.7
	6				7.59	7.89		7.96			7.7
	7				7.58						7.7
	Specific Cond										
	0	170	189.9	178.7	172.5	184.4	201.3	216.9	219.8	279	120.7
	1	170	190.1	179.7	173.1	184.3	200.3	219.5	221.8	280.4	120.1
	2	170	190.4	177.5	173.8	184.4	199.3	219.3	219.7	283.8	120.9
	3	169	190.3	177.3	173.6	184.1	200.3	219.2	219.9	283.4	120.7
	4	169	189.1	177.1	173.1	184.7	200.1	219.3	219.5	293.2	120.2
	5	169	189.3	177.1	173.1	184.6	200.5	219	220.5	294	120.1
	6				173.6	185.1		219.4			120.1
	7				174.2						
	chl										
	0		11.9	15.4	21.6	12.9	8.3	6.6	8.3	6.5	22.7
	1		14.6	16.2	18.1	14	9.9	6.8	8.3	6.8	23
	2		15.5	15.7	18.4	13.4	10.6	6.3	8.7	7.7	23.1
	3		15.9	15.4	17.8	13.4	11	6.8	7.6	7.6	23
	4		16	15.5	17.5	13.3	10.7	7.2	8.1	7.7	23.8
	5		16.3	16.1	17.9	12.9	11.5	6.8	7.9	7.5	23.4
	6				17.9	13		6.5			23
	7				17.6						24.1
	Turbidity (NTU)										
	0			4.5	5.6	5.1	4	1.6	1.7	3.3	35.4
	1		3.8	4.7	5.6	5.1	4.1	1.8	2	3.1	39
	2		3.9	4.9	6.3	5.2	4.2	1.8	2.3	3.5	40.2
	3		3.9	5.2	6.6	6.1	4.4	1.8	2.4	3.8	40.2
	4		4.2	5.7	6.7	6.2	4.7	1.8	2.4	4.1	43.2
	5		4.5	5.8	7.2	6.4	4.9	1.9	2.6	3.5	40.7
	6				7.5	6.6		2.3			42.1
	7				7.4						43
	Light (ft-candles)										
	0		2400	430	350	650	3200	3000	3200	2400	800
	1		500	32	25	44	700	1000	1000	360	6
	2		23	4	3.5	10	170		200	71	0.03
	3		2.8	0.76	0.44	2.4	34		52	14	0.02
	4		0.9	0.13	0.054	0.35	8		15	3	0.01
	5		0.21	0.001	0.02	0.1	1.8		4.4	0.8	0.01
	6				0	0.05					
	7										
	Secchi										
	1	1.03	1.43	0.74	0.64	0.74	1.41	2	1.68	1.24	
	2	1	1.43	0.77	0.66	0.74	1.39	1.96	1.72	1.25	
	3	1	1.65	0.7	0.67	0.76	1.38	2	1.73	1.23	

Duluth Entry		Sample Date:									
Site 51	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0		13.6	16.3	17.6	17.2	21.5	19.6	18.2	14.7	9.95
	1		12.5	14.9	17.6	17.2	21.2	19.6	18.2	14.3	9.97
	2		10.5	14.3	17.5	17.2	20	19.6	18.2	14.2	9.98
	3		10.1	14	17.1	17.1	19.3	19.6	18.1	14	9.98
	4		9.9	13.4	16.7	16.8	18.9	19.6	18.1	14	9.99
	5		8.9	13.1	16	16.2	18.1	19.4	17.7	14	9.99
	6		8.3	12.6	15.6	16	17.7	19.1	17.6	14	9.99
	7		8.2	12.2	14.9	15.8	17.3	18.9	17.5	13.9	9.99
	8		8	11.2	14	15.6	16.8	18.9	17.4	13.9	9.99
	9				13.3	15.5	14.7	18.8		14	9.99
	DO(mg/L)										
	0		10.49	9.43	8.95	8.99	9.82	9.3	9.39	11.55	13.01
	1		10.43	9.18	8.82	8.97	9.71	9.17	9.34	11.12	12.06
	2		10.93	9.03	8.75	8.92	9.82	9.18	9.33	11.21	11.69
	3		10.82	9	8.7	8.91	9.85	9.1	9.39	11.23	11.7
	4		10.98	9.18	8.79	8.92	10.03	9.03	9.47	11	11.65
	5		11.26	9.46	9.08	9.02	10.24	9.14	9.66	10.65	11.61
	6		11.9	9.68	9.45	9.14	10.17	9.16	9.76	10.79	11.52
	7		12.04	9.87	9.94	9.24	10.19	9.04	9.79	10.72	11.56
	8		12	10.21	10.32	9.39	10.33	9.02	9.78	10.74	11.57
	9				10.64	9.35	10.75	8.8		10.35	11.5
	pH										
	0		8.18	7.69	7.57	8.26	8.26	8.21	7.72	7.71	7.7
	1		8.1	7.66	7.32	8.19	8.23	8.22	7.69	7.75	7.7
	2		8.06	7.71	7.61	8.15	8.26	8.22	7.69	7.82	7.71
	3		8.04	7.6	7.62	8.12	8.25	8.2	7.7	7.79	7.72
	4		8.05	7.44	7.46	8.12	8.27	8.15	7.7	7.75	7.72
	5		8.1	7.68	7.6	8.1	8.12	8.15	7.71	7.78	7.72
	6		8.12	7.71	7.61	8.07	8.24	8.09	7.69	7.77	7.72
	7		8.1	7.76	7.38	8.06	8.27	8.06	7.68	7.83	7.72
	8		8.09	7.83	7.69	8.04	8.27	8.08	7.68	7.64	7.73
	9				7.79	8.03	8.27	8.1		7.54	7.73
	Specific Cond										
	0		217.7	248.8	210.9	171.7	196.7	169.4	164.7	225.1	165
	1		203.6	253.2	210.7	172	194	169.7	164.7	200.1	165
	2		202.2	242.5	210.2	172	153.7	169.3	162.4	168.3	165
	3		200.6	246.9	204.4	170.7	153	169.1	151.3	168.7	164.7
	4		191.9	227.9	198.6	167.2	137.7	169.2	138.8	172	164.8
	5		171	228.1	191.9	159.4	133.4	163.7	128.3	172.4	164.7
	6		169.2	220.5	181.8	156.4	127.6	132.2	126.5	176.6	164.4
	7		165	214	170.3	151.2	125.8	137.8	124.5	170.5	164.5
	8		164.6	186.7	156.4	146.6	120.7	131.6	123.5	240.8	164.7
	9				145.2	143.5	112.8	133.6		420	164.2
	chl										
	0		8.6	5.5	13.6	7.2	8	4	1.6	8.4	19.6
	1		9.1	7.8	13.3	7.3	7.1	4.5	3.3	3.8	19.4
	2		9.5	7.8	12.1	7.3	6.3	4	3.4	2.3	20.4
	3		9.4	8.2	12	7.5	7.8	3.7	3.8	2	20.1
	4		8.8	8	11.3	6.9	5.7	4.5	3.7	1.9	20
	5		7.8	7.2	9.8	6	4.1	3.2	3.5	2.2	20.2
	6		6.8	6.7	8.6	6.1	4	3.4	2.8	2	20.4
	7		6.8	6.4	8.4	5	3.8	3.3	3	2	19.7
	8		6.5	6.5	7	5	3.8	4	2.7	1.5	19.9
	9				5.6	4.3	4.1	4		2	20
	Turbidity (NTU)										
	0		4.7	4.9	6.7	3.4	2	1.7	1.7	3.3	11.8
	1		4.8	5.3	6.6	3.4	1.7	1.8	1.9	2.7	12.1
	2		4.9	5.7	6.4	3.4	1.6	1.8	1.9	2.4	11.9
	3		4.9	6	6.5	3.5	1.4	1.7	2	2.1	11.9
	4		5	5.8	6.4	3.8	1.3	1.5	2	2.5	12
	5		4.8	5.5	5.6	4.5	1	0.9	1.8	1.9	12
	6		4.4	5.3	4.5	4.3	0.7	0.9	1.4	1.8	12.1
	7		4	5	4.1	4.5	0.7	0.8	1.4	1.8	11.8
	8		3.9	4.5	3.6	4.7	0.8	0.9	1.3	1.7	12.1
	9				3	4.4	0.8	1.8		1.9	11.7
	Light (ft-candles)										
	0		200	3100		1400	4800	2000	130	2100	90
	1		18	350		260	1300	1000	61	580	1.4
	2		4.4	55		49	64	330	46	250	0.06
	3		6.5	8.4		10	38	140	23	120	0.01
	4		1.4	1.5		0.7	24	60	12	50	
	5		3	0.35		0.22	14	32	6.6	30	
	6		0.09	0.11		0	7.5	18	4.1	16	
	7		0.04	0.05			4.5	11	2.5	10	
	8		0	0			2.8	6.6	1.6	5.5	
	9						1.8	3.8		3	
	Secchi										
	1		1.08	1.08	0.76	1.32	1.77	2.71	2.26	2.29	0.58
	2		1.12	1.07	0.8	1.3	1.79	2.79	2.22	2.26	0.67
	3		1.06	1.08	0.78	1.29	1.75	2.77	2.26	2.26	0.66

Hog Island		Sample Date:									
Site 52	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0		15.1	16.5	19.5	19.4	23.8	20.5	18.3	15.1	9.95
	1		13.6	16	19.2	19.4	23.8	20.5	18.4	14.9	9.97
	2		12.6	15.3	18.9	19.3	21.9	20.4	18.4	14.8	9.98
	3		11.3	15	18.7	19	18.8	20.4	18.4	14.7	9.99
	4		10.9	14	18	18.7	18	20.3	18.4	14.6	9.99
	5		10.9	13.5	17.3	18.3	17.4	20.3	18.4	14.6	9.99
	6		10.7	13.2	15.8	17.9	16.7	20.2	18	14.5	9.98
	7		10.4	12.7	14.5	17.6	15.5	19.6	17.7	14.5	9.98
	8						15.1				
	DO(mg/L)										
	0		9.8	10.69	8.95	8.79	9.01	8.6	9.02	10.08	12.32
	1		10.15	10.45	8.55	8.63	8.6	8.6	8.98	9.87	11.9
	2		10.23	10.2	8.28	8.55	8.82	8.45	8.91	9.77	11.79
	3		10.14	10	8.12	8.45	8.15	8.44	8.86	9.69	11.62
	4		10.17	9.5	7.9	8.53	8.33	8.4	8.82	9.58	11.56
	5		10.1	9.32	7.78	8.52	8.7	8.3	8.76	9.55	11.66
	6		10.11	9.23	8.08	8.59	8.7	8.4	8.95	9.55	11.71
	7		10.11	9.06	8.12	8.51	9.62	8.4	9.17	9.46	11.56
	8						9.06				11.48
	pH										
	0		7.76	7.81	7.62	7.97	8.39	8.19	7.72	7.74	7.74
	1		7.74	7.77	7.5	7.96	8.29	8.18	7.72	7.74	7.73
	2		7.76	7.76	7.59	7.96	8.14	8.17	7.71	7.72	7.73
	3		7.7	7.76	7.58	7.95	8.1	8.12	7.7	7.7	7.73
	4		7.68	7.72	7.58	7.95	8.01	8.1	7.69	7.69	7.73
	5		7.68	7.74	7.59	7.98	7.99	8.06	7.68	7.67	7.73
	6		7.7	7.75	7.61	7.99	8.08	8.04	7.67	7.68	7.74
	7		7.69	7.78	7.66	7.98	8.14	8.05	7.72	7.67	7.73
	8						8.14				7.73
	Specific Cond										
	0		212.8	239.4	214.2	186.3	176.4	161.4	164	240.5	160.1
	1		209.9	237.5	212.8	185.6	176.6	162.8	166.8	242.5	160.1
	2		204.2	238.5	212.6	185.2	171	162.8	166.9	245	160.2
	3		208.8	238.5	210.9	181.4	173.8	162.8	168.7	244	160
	4		209.4	239.2	213.9	179.2	163.2	161.2	167.3	241.7	160.2
	5		208.5	237.6	204.2	171.4	147	155.4	164.1	234.1	160.1
	6		209.8	237.3	200.2	165.1	140.1	155.8	152.3	218.5	160.3
	7		208.4	231.1	295.6	170.8	123.4	139.7	134.5	219.7	160.5
	8						125.5				161.1
	chl										
	0		12.5	13.7	14.1	10	5.9	3.6	3.3	2.4	17.7
	1		10.5	13.9	13.7	8.8	7.2	3.5	3.9	3.7	20.1
	2		8.6	12.9	12.8	8.9	6	3.2	4.1	3.8	19.5
	3		8.6	10.6	11.5	7.9	5.6	3.6	4.2	3.8	20.8
	4		9.2	9.5	10.3	7.7	5	3.8	4.3	3.2	21
	5		9.5	7.9	11	7.1	4.9	3.8	3.9	3.5	20.3
	6		9	6.6	10	6.5	4.1	3.8	3.3	3.4	20.1
	7		9.5	6.8	8.3	6.7	3.9	3.1	2.8	2.7	21.1
	8						3.9				20.7
	Turbidity (NTU)										
	0			7.3	6.1	5.8	1.4	2.1	2.6	4.6	10.2
	1		6.3	7	6.4	5.9	1.4	2.1	2.7	5	11.2
	2		8.4	6.4	6.4	6	1.6	2.1	2.8	5.1	11.3
	3		7.8	5.9	6.5	6	1.7	2.1	2.8	5.2	11.6
	4		6.5	6	6.8	6.1	1.6	2.2	2.9	5.4	11.5
	5		6	5.9	6.7	6.9	1.8	2.3	2.9	5.6	11.2
	6		6	5.6	6.7	9.2	2.1	2.4	3.2	5.8	11.3
	7		10.4	5.8	7.9	8.2	2.7	2.9	3.7	6.5	11.3
	8						2.7				11.8
	Light (ft-candles)										
	0		3700	3300	2800	2000	3000	2400	1400	380	140
	1		200	300	150	260	1000	1500	370	100	1.1
	2		24	38	15	38	380	450	130	50	0.5
	3		2.8	6.5	1.8	6.3	123	180	50	25	
	4		0.54	1.2	0.26	1.2	47	80	20	8	
	5		0.1	0.28	0.06	0.28	21	32	9	3	
	6		0.048	0.06	0	0.08	9	15	3.7	1	
	7		0	0		0	3.7	6.5	1.8	0.4	
	8						1.5				
	Secchi										
	1		1.4	0.83	0.89	0.98	2	2.42	1.76	1.1	0.47
	2		1.43	0.82	0.91	0.99	2	2.4	1.78	1.14	0.54
	3		1.41	0.81	0.88	0.99	2	2.43	1.76	1.15	0.59

Clough Island		Sample Date:									
Site 53	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	8.4	17.6	19.5	22.3	24.1	27.2	23.5	21.4	16.5	10.29
	1	8.4	17.5	19.3	22	23.2	26.7	23.5	20.8	16.4	10.28
	2	8.3	16.6	18.9	21.4	22.1	26.2	23.5	20.6	16	10.28
	3	8.2	16.2	18.6	21.3	22.9	25.3	23.4	20.5	15.8	10.27
	4	8.1						23.3			10.27
	DO(mg/L)										
	0	12.2	10.24	8.45	8.02	7.94	7.18	7.05	6.77	9.98	12.87
	1	12.2	10.09	8.39	7.9	7.32	7.06	6.92	6.65	9.83	12.66
	2	12.1	9.7	8.53	7.56	6.54	6.74	6.92	6.57	9.66	12.2
	3	12	9.46	8.48	7.44	6.41	6.27	6.76	6.5	9.6	12.69
	4	11.7						6.7			12.15
	pH										
	0	8.31	8.09	7.65	7.64	8.1	8.12	7.97	7.75	7.79	7.64
	1	8.31	7.94	7.67	7.64	8.07	8.08	7.96	7.76	7.79	7.65
	2	8.3	7.85	7.66	7.65	8.07	8.06	7.97	7.76	7.79	7.66
	3	8.3	7.78	7.67	7.68	8.07	8.06	7.95	7.76	7.77	7.66
	4	8.29						7.96			7.67
	Specific Cond										
	0	165	186.6	183.6	172.3	185.8	195.8	204.9	205.2	249.7	125.3
	1	165	185.4	182	172.7	186.3	196	204.9	201.8	256	125.5
	2	165	186.4	181.5	172	186.7	196	202.6	203.3	257.3	125.5
	3	165	185.9	179.7	172.1	187.6	195.6	205.2	205.5	261.3	125.5
	4	165						205.4			125.3
	chl										
	0		16.4	11.8	16.6	10.4	8.9	7.1	7.5	6.3	21.4
	1		12.8	11.8	16.7	10.5	9.3	7	7.6	7.2	21.7
	2		12.3	12.7	15.7	11	9.1	6.8	7.1	7.1	22.6
	3		12.2	13.4	16.1	10.9	8.2	6.8	7.5	7.6	22.5
	4							7.1			22.6
	Turbidity (NTU)										
	0			5.9	4.4	10	4.3	11.9	7.1	5.2	24.9
	1		4.4	6.1	4.4	10.8	4.1	12.2	10.9	4.3	26
	2		3.9	5.1	4.6	10	3.1	12.4	13.5	5.4	27.8
	3		3.9	4.9	4.9	10.8	2.3	12.8	14.6	4.5	29.3
	4							13.2			33.1
	Light (ft-candles)										
	0		3000	500	2500	520	4500	2800	2500	3100	350
	1		250	26	32	17	180	240	520	550	1.2
	2		27	5	3.2	1.6	42	29	51	140	0.04
	3		4	0.9	0.52	0.25	16	2.6	5.1	26	0.01
	4							0.37			
	Secchi										
	1	0.83	1.57	0.8	0.67	0.72	1.21	0.9	1	1.39	0.49
	2	0.87	1.82	0.86	0.67	0.74	1.2	0.86	0.97	1.34	0.42
	3	0.82	1.82	0.83	0.69	0.75	1.23	0.9	0.96	1.36	0.49

Billings Park		Sample Date:									
Site 54	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	8.7	18.7	18.4	21.3	22.1	26.4	23.1	20.9	15.7	10.32
	1	8.7	16.1	18.2	21.2	21.5	25.4	23.14	20.8	15.6	10.07
	2	8.7	15.4	17.8	21	21.4	24.9	23.1	20.8	15.6	10.05
	3	8.6	15.1	17.4	20.7	21.2	24.5	23	20.7	15.1	10.04
	4	8.6	14.8	17	20.6	20.9	24.1	23	20.6	15.1	10.03
	5	8.6	14.1	17	20.5	208	23.6	22.8	20.5	15.1	10.04
	6	8.6	13.7	16.9	20.4	20.4	22.5	22.8	20.5	15.1	10.03
	7	8.6		16.8	20.4	20.1	21.8	22.7	20.4		
	DO(mg/L)										
	0	11.6	10.6	8.23	7.52	7.98	6.65	7.9	7.81	9.27	12.52
	1	11.6	9.56	8.12	7.41	7.6	6.84	7.84	7.77	9.06	12.16
	2	11.4	9.56	7.95	7.31	7.54	6.82	7.78	7.67	8.99	12
	3	11.4	9.51	7.99	7.24	7.51	6.8	7.63	7.57	8.9	12.07
	4	11.3	9.52	8.12	7.22	7.44	6.71	7.41	7.48	8.88	12
	5	11.4	9.38	8.12	7.18	7.39	6.65	7.32	7.33	8.86	12.09
	6	11.6	9.3	8.09	7.14	7.15	6.57	7.27	7.28	8.77	12.03
	7	11.5		8.12	7.04	6.87	6.51	7.19	7.24		
	pH										
	0	7.86	7.62	7.59	7.5	8.03	8.08	8.32	7.82	7.79	7.55
	1	7.88	7.58	7.6	7.5	8.02	8.07	8.32	7.8	7.76	7.59
	2	7.9	7.59	0.59	7.5	8.01	8.07	8.31	7.78	7.81	7.6
	3	7.9	7.59	7.61	7.49	8.01	8.04	8.25	7.75	7.76	7.62
	4	7.9	7.58	7.6	7.49	8	8.01	8.22	7.74	7.74	7.63
	5	7.91	7.57	7.59	7.48	7.99	7.99	8.17	7.73	7.73	7.65
	6	7.91	7.55	7.57	7.48	7.98	7.95	8.19	7.73	7.72	7.65
	7	7.92		7.56	7.48	8	7.97	8.2	7.72		
	Specific Cond										
	0	165	192.9	196.6	173.4	190.6	200.9	193.9	210	243.6	132.1
	1	165	186.7	196.7	174.4	188.5	199.8	198.8	210.6	246.9	131.6
	2	165	182.7	197.7	173.5	189.8	196.5	200.7	210.8	247.7	131.4
	3	165	184	191.8	174.1	188.5	196.4	198.2	211.3	247.3	131.1
	4	165	183.2	188.8	174.4	188.7	196.5	198.5	210.5	247.3	131.2
	5	165	183.6	190.1	174.6	189	197.7	198.7	210.2	249.1	131
	6	165	184.6	191.3	174.5	191.2	204.7	198.6	210.3	248.5	131
	7	165		197	174.4	191	205.6	199.1	210.7		
	chl										
	0		11.8	9.9	15.9	13.4	8	11.8	10.4	6.7	20.1
	1		11.8	11.1	15.8	12.3	8.9	11	11.2	5.6	20.8
	2		11.9	12.5	16.1	12.1	8.9	11.8	10.7	5.7	20.5
	3		12.2	11.9	16.4	12	8.8	13	10.4	5.3	20.6
	4		11.6	12.8	16.4	11.2	8.7	12.6	10.2	5.3	20.3
	5		12.2	12.3	16.3	11.3	8.2	12.1	10.3	5.1	20.4
	6		11.1	12	15.6	11.6	7.8	12.1	9.8	5	20.9
	7			12.2	15.6	11.9	7.4	13.1	9.8		
	Turbidity (NTU)										
	0		51.6	11.7	11.6	6	3.2	8	6.2	7.6	18.7
	1		50.7	12.6	11.4	6.4	3.7	8.5	6.3	8	20.5
	2		242.5	12.2	10.5	6.6	3.8	8.1	6.7	8.3	20.7
	3		243.7	9.7	10.4	6.9	4	7.4	7.2	8.7	20.7
	4		246.4	9.4	10.7	7.5	4.2	6.9	7.3	9.5	21
	5		248.4	9.3	11.1	7.7	4.3	6.8	7.7	10.3	20.7
	6		250.2	9.1	11.2	8.6	5.5	7.4	8.2	13	21.2
	7			9.4	12.4	9.9	7.7	8.8	10.3		
	Light (ft-candles)										
	0		4500	1600	3000	4100	1800	2200	200	2700	400
	1		480	700	600	80	350	150	57	140	4
	2		5.2	40	28	10	100	31	30	32	0.07
	3		0.88	0.5	0.18	2.4	220	7.6	10	7.2	0.03
	4			0.05	0.02	0.41	1.5	1.5	2.6	1.6	0.01
	5			0	0	0.1	0.5	0.41	0.7	0.38	0.01
	6					0.05	0.15	0.1	0.19	0.13	0.01
	7					0.03	0.08	0.05	0.05		
	Secchi										
	1	0.625	1.26	0.6	0.51	0.65	1.16	1.11	0.88	0.87	0.46
	2	0.6	1.26	0.56	0.55	0.68	1.13	1.08	0.86	0.87	0.47
	3	0.62	1.26	0.59	0.54	0.66	1.13	1.08	0.88	0.89	0.44

High Bridge		Sample Date:									
Site 55	Temperature (C)	20-Apr-07	May 9,2007	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	8.4	12.5	15.6	19.4	19	22.4	20.7	18.9	15.2	10.3
	1	8.4	11.6	15.4	19.1	19	21.9	20.7	18.9	15.1	10.29
	2	8.4	11.2	15	18.9	18.9	19.8	20.7	18.9	15.1	10.3
	3	8.3	10.9	14.6	18.8	18.9	19.1	20.7	18.1	15	10.3
	4	8.3	9.8	14.3	18.3	18.7	19	20.7	18.9	15	10.31
	5	7.6	9.6	14.3	17.3	18.4	18.3	20.5	18.8	15	10.31
	6	7.4	9.5	14.1	16.6	18.4	18.1	20.4	18.7	15	10.3
	7	7.2	9.3	13.6	16.1	17.5	17.9	20.1	18.7	15	10.3
	8	7.1	8.6	12.7	15.6	16.7	17.3	19.9	18.5	15	10.26
	9		8.3				17	19.8	18.4	15	10.26
	DO(mg/L)										
	0	12.5	11.16	10.01	7.96	8.98	9.51	8.41	8.99	9.84	11.4
	1	12.5	11.02	9.75	7.93	8.91	9.04	8.41	8.92	9.65	11.3
	2	12.4	11.15	9.59	7.98	8.67	9.61	8.36	8.92	9.45	11.5
	3	12.3	11.3	9.52	8.17	8.58	9.98	8.3	8.85	9.44	11.43
	4	12.3	12.06	9.3	8.33	8.64	9.86	8.34	8.55	9.43	11.39
	5	12.3	11.68	9.33	8.48	8.58	9.75	8.54	8.62	9.3	11.35
	6	12.3	11.64	9.25	8.88	8.4	9.74	8.48	8.66	9.36	11.29
	7	12.2	11.71	9.21	9.05	8.13	10.03	8.49	8.75	9.31	11.42
	8	12.2	11.89	9.34	9.17	8.05	10.04	8.45	8.92	9.31	11.42
	9		11.87				9.42	8.23	8.66	9.42	11.4
	pH										
	0	8.52	7.83	8.64	7.97	7.91	8.23	8.08	7.52	7.57	7.68
	1	8.54	7.86	8.33	7.06	7.91	8.13	8.08	7.5	7.57	7.68
	2	8.53	7.9	8.21	6.82	7.87	8.16	8.06	7.47	7.57	7.68
	3	8.54	7.95	8.07	6.48	7.8	8.19	8.06	7.47	7.55	7.69
	4	8.53	7.94	7.8	6.23	7.78	8.19	8.04	7.46	7.53	7.69
	5	8.51	7.89	7.47	6.08	7.72	8.16	8.02	7.46	7.53	7.69
	6	8.5	7.96	6.8	5.99	7.61	8.01	8.02	7.44	7.52	7.7
	7	8.48	7.93	6.63	5.9	7.8	8.23	7.99	7.44	7.51	7.7
	8	8.48	7.96	6.46	5.68	6.26	8.16	7.99	7.44	7.51	7.69
	9		7.53				6.56	7.64	7.21	6.63	7.7
	Specific Cond										
	0	190	226	207.9	186	223.8	211.7	218.9	206.9	317	144.9
	1	193	225.6	211.4	191.3	223.1	227.6	220.7	207.7	321.4	144.6
	2	191	216.4	216.4	187.4	222.1	179.3	217.3	208.8	320.3	145
	3	195	215.4	217.5	192.6	218	165.4	215.2	206.3	318.9	144.5
	4	195	195.9	218.6	196.5	209.3	164.8	206.8	204.6	317.4	144.6
	5	195	192.1	219.5	194.7	205.9	156.7	201.1	204.8	317.8	144.9
	6	194	188.7	220	198	188	149.9	198	194.1	315.4	144.8
	7	195	186.4	230.2	195.2	192.5	141.2	183.3	189.3	315.2	145.3
	8	195	175.3	219.5	189	176.7	138.8	179.6	181.6	314.8	146
	9		170.3				148.4	179.3	168.5	313.8	145.8
	chl										
	0		11.1	9.8	14.6	7.9	7.9	7.8	3.9	3.9	19.8
	1		10.4	9.5	15	8.9	12.8	7.5	4.2	4.8	16.2
	2		10.1	9.3	14.8	9.1	11	8.8	5.1	4.6	18.4
	3		9.8	8.3	14.6	9.2	8.5	9.1	4.6	4.5	20.1
	4		9	8.4	13.8	8	6.1	7.6	4.2	4.2	19.8
	5		8.8	8.3	12.8	8.9	5.1	7.6	3.4	4.9	19.8
	6		7.9	7.6	11.2	7.6	5.2	7.8	3.8	4.5	20
	7		7.8	7.3	10.3	7.3	5.2	7.9	3.5	4.5	19.6
	8		7.7	6.8	9.1	6.1	5.2	6.7	3.1	4.9	19.2
	9		7.9				5	9.3		4.7	19.2
	Turbidity (NTU)										
	0		5.3	7.4	9.3	5.7	2	15.7	2.4	5.6	36.1
	1		5.5	7.6	9.6	5.8	2.8	5.5	2.5	5.8	36.1
	2		5.6	7.6	9.5	6.2	2.8	4	2.4	5.9	36.5
	3		5.7	6.9	9.4	6.3	2.5	3.7	2.5	5.9	34.6
	4		5.4	7	9.1	6.4	2.1	3.6	2.5	5.9	34.4
	5		5.3	6.7	8	6.1	2.2	3.3	2.6	6.2	34
	6		5.1	6.7	7.3	6.2	2.3	3.2	2.8	6.2	34.8
	7		5	6.1	6.5	7	2	3.1	2.6	6.3	35.5
	8		4.6	6.1	6	7.5	1.9	3.1	2.5	6.3	34.3
	9		6.5				3.8	4.4		8.2	34
	Light (ft-candles)										
	0		200	2900	1000	1000	1200	1200	130	260	50
	1		15	200	25	90	300	200	48	35	0.8
	2		3.5	15	1.2	9	62	45	15	15	0
	3		0.5	2.5	0.12	1.3	19	14	5.6	4.8	
	4		0.14	0.26	0	0.22	7.3	3.7	2.2	1.4	
	5		0.04	0.1		0.05	3	1.4	0.9	0.4	
	6		0	0.05		0.045	1.2	0.54	0.4	0.11	
	7			0		0	0.66	0.2	0.21		
	8						0.35		0.11		
	9						0.2		0.05		
	Secchi										
	1	0.88	1.28	0.9	0.54	0.81	1.27	1.3	1.83	1.13	0.33
	2	0.92	1.26	0.92	0.54	0.84	1.28	1.38	1.79	1.15	0.41
	3	0.89	1.26	0.91	0.59	0.85	1.3	1.35	1.78	1.18	0.44

Allouez Bay		Sample Date:									
Site 56	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0		17.8	17.5	20.6	21.2	25.4	22.2	20.2	14.8	9.95
	1		16.1	14.6	20.6	21.1	24	22.1	20.2	14.6	9.94
	2		14.1		20	20.6	22.7	22	20.2	14.6	9.93
	3				18.5	19	21.6	21.9	20.1	14.5	9.93
	4				18.2	18.1	21.1	21.8		14.5	9.93
	5										
	DO(mg/L)										
	0		12.45	10.37	8.69	8.2	8.25	7.65	8.35	10.29	12.01
	1		11.14	9.13	8.56	8.1	6.84	7.55	8.26	10.05	11.73
	2		10.46		7.64	7.86	5.77	7.41	8.15	9.97	11.47
	3				6.65	6.72	5.59	7.27	8.05	9.84	11.5
	4				6.1	6.3	4.74	7.12		9.81	11.47
	5									9.48	
	pH										
	0		7.87	8.58	7.66	7.95	8.15	7.79	7.68	7.69	7.83
	1		7.83	8.39	7.64	7.92	8.02	7.76	7.66	7.66	7.84
	2		7.86		7.63	7.91	7.95	7.75	7.66	7.67	7.85
	3				7.64	7.91	7.97	7.74	7.66	7.69	7.85
	4				7.67	7.92	8	7.8		7.65	7.86
	5									7.62	
	Specific Cond										
	0		186.2	205.7	213.7	186.2	159	158.8	155.7	152.8	166.5
	1		187.4	201.9	215	185.8	163.6	163.2	155.5	153.7	166.4
	2		186		214.2	185.6	162.7	163	155.4	153.7	166.4
	3				215.1	189.2	163.5	162.9	155.5	154.3	166.4
	4				215.3	189.7	164.6	162.9		154.2	166.6
	5									154.8	
	chl										
	0		16	12.5	10.6	8.9	10.2	6.1	6.8	6	15.1
	1		11.6	12.2	10.3	9.3	7.8	6.6	6.7	5.2	15.1
	2		9.5		10.4	9.7	9.5	6.8	7.1	6.1	15.7
	3				10.7	9.1	7.1	6.3	6.6	6.5	14.3
	4				9.4	9.8	6	6		5.9	15
	5									6.6	
	Turbidity (NTU)										
	0		38.4	27.5	30.1	25.1	12.8	12.3	13.9	24	65.6
	1		37.4	28	30.5	28.2	16.2	12.4	14.3	29.8	73.1
	2		37.6		39.9	29.7	19.9	12.4	15	31.9	76.5
	3				38	33.3	22.9	12.9	17.7	31.6	78.2
	4				37.6	35.4	24.7	13.8		31.5	79.2
	5									35	
	Light (ft-candles)										
	0		3500	3500	3200	2300	2800	2800	1500	280	140
	1		200	100	75	68	250	440	230	12	1
	2		3.6		2.1	2.4	30	63	23	1	0.1
	3				0.05	0.13	2	11	2.9	0.1	
	4				0	0	0.18	1.7		0.01	
	5										
	Secchi										
	1		0.74	0.46	0.32	0.39	0.62	0.71	0.72	0.39	0.23
	2		0.72	0.45	0.38	0.37	0.63	0.74	0.7	0.36	0.23
	3		0.74	0.45	0.35	0.35	0.6	0.73	0.7	0.36	0.23

Spirit Lake		Sample Date:									
Site 57	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	8.2	18	19.8	22.3	23.2	26.8	23.6	21.2	16	1.53
	1	8	17.4	19.7	22	23	26.7	23.6	21.1	15.9	10.5
	2	7.7	16.2	19.5	21.4	22.9	26	23.5	20.9	15.9	10.51
	3	7.4	15.7	19.4	20.9	22.5	25.6	23.5	20.7	15.7	10.5
	4	7.3	15.5	18.5	20.5	22.1	25.5	23.3	20.7	15.6	10.51
	5										10.49
	DO(mg/L)										
	0	11.9	11.05	8.88	7.75	7.39	6.77	8.12	8.01	9.75	12.76
	1	11.8	9.88	8.62	7.56	7.35	6.88	8.02	7.97	9.6	12.13
	2	11.8	9.68	8.46	7.3	7.3	6.72	7.98	7.88	9.55	12.1
	3	11.9	9.47	8.22	7.25	7.29	6.6	7.925	7.76	9.42	12.28
	4	8.6	8.16	6.9	7.29	7.24	6.46	7.82	7.59	9.24	12.28
	5										12.31
	pH										
	0	8.4	8.07	7.5	7.54	8.03	8.17	8.35	7.93	7.83	7.67
	1	8.41	7.89	7.5	7.54	8.03	8.16	8.34	7.92	7.83	7.66
	2	8.4	7.81	7.44	7.54	8.03	8.14	8.32	7.9	7.83	7.66
	3	9.41	7.76	7.42	7.55	8.03	8.12	8.3	7.89	7.8	7.66
	4	8.3	7.57	7.38	7.56	8.03	8.12	8.29	7.89	7.8	7.67
	5										7.67
	Specific Cond										
	0	174	189.2	180.6	172.7	184.3	195.5	204.3	210.1	252.3	127.8
	1	173	188.4	180.6	173	186.4	195.1	203.7	212.3	256	128.1
	2	173	195.5	180.6	172.1	188	194.2	206	212.6	255.6	128.5
	3	173	187.3	182	172.6	188.3	194.7	206.5	213.2	255.8	127.1
	4		187.1	187.1	171.6	188.7	194.7	206.3	213.2	255.3	125.9
	5										125.9
	chl										
	0		13.5	13.9	15.9	10.6	8.5	8.6	7.7	6.8	21.4
	1		12.7	14	16	11.2	8.8	8.2	7.7	6.4	21.3
	2		12.2	13.8	15.9	11.5	9.4	8.8	7.6	5.6	21
	3		12.4	13.6	15.6	11.5	8.9	9.7	7.7	5.4	21.3
	4		14.4		15.9	11.2	8	9.7	7.1	5.7	21.4
	5										22.1
	Turbidity (NTU)										
	0		120.7	4.2	4.3	4.7	1.9	2.6	2.9	3.1	20.6
	1		40	4.2	4.6	4.8	2.1	2.6	2.8	3.2	21.3
	2		39	4.2	5.2	4.8	2.9	2.9	2.9	3.4	20.7
	3		38.5	5.2	5.7	4.9	2.9	2.5	3.1	3.4	21.3
	4		39.4		5.6	6	2.9	2.9	3	3.6	21.5
	5										22.2
	Light (ft-candles)										
	0		3500	1300	2300	3500	1000	2800	2500	3200	650
	1		220	90	150	60	150	100	1000	650	2.2
	2		20	1.4	10	14	35	41	250	150	0.4
	3		2.5	0.4	0.8	3	10	18	64	0.41	0.01
	4		0.9		0.1	0.8	3	10	20	0.11	0.01
	5										
	Secchi										
	1	0.67	1.75	0.86	0.82	0.83	1.39	2.05	1.67	1.52	0.5
	2	0.69	1.75	0.83	0.79	0.81	1.37	2.04	1.69	1.5	0.58
	3	0.7	1.75	0.82	0.81	0.8	1.39	2.01	1.71	1.55	0.53

DMIR		Sample Date:									
Site 58	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	9.7	17.5	17.1	20.9	20.8	24	21.8	20.5	16.5	10.36
	1	9.6	14	17.1	20.6	20.5	23.9	21.5	20	16.4	10.29
	2	9.2	13.2	17.1	20.3	20.3	23.7	21.4	19.9	15.7	10.26
	3	9.2	13	17	20	20	22.4	21.4	19.9	15.4	10.22
	4	9	12.6	16.9	19.8	29.5	21.2	21.4	19.8	15.2	10.23
	5	8.9	12.4	15.8	19.5	19.1	19.9	21.3	19.8	15.2	10.21
	6	8.8	12.1	15.2	19.4	19	19.6	21.3	19.8	15.1	10.2
	7	8.3	11.7	15.1	19	18.8	19.5	21.2	19.8	15.1	10.21
	8										10.21
	DO(mg/L)										
	0	12	9.89	8.88	7.72	7.99	8.2	8.49	7.75	9.37	11.33
	1	12	9.81	8.76	7.52	8	8.24	8.31	7.66	9.25	11.32
	2	11.8	9.99	8.7	7.41	7.97	8.17	8.09	7.6	9	11.3
	3	11.7	9.99	8.64	7.3	7.85	7.85	7.94	7.49	8.83	11.23
	4	11.6	9.92	8.63	7.1	7.79	7.81	7.75	7.35	8.75	11.3
	5	11.7	10	8.5	7.01	7.67	8.02	7.88	7.22	8.7	11.17
	6	11.6	9.87	8.22	6.98	7.67	8.21	7.8	7.22	8.66	11.36
	7	11.7	9.63	7.88	6.95	7.44	8.14	7.83	7.06	8.59	11.31
	8										11.19
	pH										
	0	8.44	7.65	8.6	7.55	7.98	8.26	8.37	7.66	7.72	7.68
	1	8.42	7.65	8.4	7.6	7.97	8.21	8.33	7.65	7.72	7.68
	2	8.33	7.65	8.48	7.59	7.97	8.17	8.29	7.64	7.69	7.68
	3	8.31	7.62	8.19	7.53	7.95	8.11	8.27	7.63	7.69	7.68
	4	8.35	7.55	8.04	7.47	7.94	8.13	8.26	7.62	7.67	7.6
	5	8.33	7.64	7.94	7.48	7.93	8.16	8.26	7.61	7.64	7.69
	6	8.36	7.67	7.71	7.44	7.93	8.18	8.25	7.6	7.64	7.68
	7	8.36	7.66	7.55	7.52	7.94	8.19	8.24	7.6	7.62	7.68
	8										7.68
	Specific Cond										
	0	218	190.6	177.3	185	211.9	218.9	209.9	264.1	256.4	141.6
	1	237	187.9	200.7	179.6	210.7	219.4	214.3	263.9	256.2	142
	2	263	189.6	202.7	177.2	211	218.9	218.7	264.2	255.1	143.6
	3	240	190.7	204.6	197.2	215.3	219.2	217.8	265.4	257.5	142.6
	4	256	195.3	225.1	218.5	219.2	206.4	217.4	265.2	259.5	142.2
	5	260	194.9	242.8	213.9	217.9	186.3	220.1	266.7	259.4	142.3
	6	266	196.5	257.3	230.1	217.7	181.9	219.4	267.1	261.4	142.3
	7	290	197.6	335.4	201.6	215.9	182.5	221.1	267.3	261.8	143.4
	8										144.4
	chl										
	0		8.8	10.6	15.6	9.6	8.4	6.9	18.8	4.9	8.5
	1		12.9	10.9	16.5	9.8	10.5	7.6	18.8	5.4	19.3
	2		11.9	11.2	16.2	9.6	10.5	8.8	17.7	5.8	19.8
	3		11.8	11.3	16	9.5	10.6	9	17.6	5.4	19.9
	4		11.4	10.6	15.7	8.3	8.6	10.6	17	5.2	19.7
	5		11.6	9.6	15.7	9.1	7	12.2	16.5	5	19.9
	6		11.5	8.9	15.1	8.8	7	12.2	17.4	5.1	20.4
	7		10.8		14.9	8.9	6.7	12.9	18.5	5.1	19.8
	8										
	Turbidity (NTU)										
	0		53.2	8.4	8.9	5.8	3.5	3.5	3.7	6.3	27.5
	1		9.2	8.8	9.3	5.8	3.4	3.8	3.7	7	27.4
	2		9.2	8.8	9.9	6	3.5	4.5	3.9	7.2	17.3
	3		9.4	9.1	9.7	6.3	3.6	4.7	4	7.2	26.8
	4		8.9	8.4	8.9	6.5	4.1	4.4	4.3	7.3	27.7
	5		8	8.8	8.6	6.7	5.1	4.5	4.3	7.3	27.7
	6		8.8	10	8.7	6.8	5.3	4.7	4.5	7.6	26.9
	7		9.7		9.3	7.7	5.2	5.4	4.9	7.4	26.3
	8										
	Light (ft-candles)										
	0		3500	1600	2400	3000	3700	4200	2700	3000	700
	1		48	200	100	160	550	150	110	580	4
	2		0.48	19	4.3	22	140	55	37	100	0.05
	3		0.5	1.8	0.29	4.8	30	22	17	20	0.01
	4		0.052	0.24	0.048	1	6.8	7	6.1	4	0.01
	5		0	0.05	0	0.17	1.6	2.5	2	0.9	0.01
	6			0		0.05	0.46	1.1	0.65	0.22	0.03
	7					0.03	0.15	0.3	0.2	0.05	0.01
	8										0.01
	Secchi										
	1	0.77	1.035	0.94	0.58	0.93	1.08	1.96	1.32	1	0.4
	2	0.79	1.03	0.96	0.64	0.95	1.1	1.89	1.39	1.03	0.47
	3	0.78	1.25	0.96	0.62	0.93	1.12	1.62	1.41	1.02	0.45

Midwest Energy		Sample Date:									
Site 59	Temperature (C)	20-Apr-07	9-May-07	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0	8.3	15.6	15.7	20.4	20.7	24.4	22.1	20	16.5	10.3
	1	8.3	14.6	15.6	19.8	20.4	24.1	21.9	19.8	16.2	10.29
	2	8.3	13	15.4	19.4	20.1	22.9	21.6	19.7	16	10.3
	3	8.2	12.7	15.4	19.1	19.9	21.1	21.5	19.6	15.8	10.3
	4	8.2	12.2	15.2	18.9	19.8	20.1	21.4	19.6	15.7	10.29
	5	8.2	11.7	14.9	18.8	19.6	19.3	21.2	19.5	15.6	10.29
	6	8.2	11.2	14.8	18.6	19.3	19	21.2	19.5	15.5	10.29
	7	8.2	10.6	14.7	18.2	19.1	18.6	21.1	19.5	15.4	10.28
	8	8.2	9.8	14.7	17.7	18.7	18.5	21.1	19.5	15.3	10.28
	9	8.2	9.8	14.7	17.4	18.5	18.3	20.8	19.4	15.3	10.28
	10	8.2		14.6		18.4			19.4	15.2	10.28
	DO(mg/L)										
	0	11.8	10.37	8.98	7.6	7.97	8.49	8.66	7.81	9.48	11.72
	1	11.6	9.52	8.94	7.42	7.89	8.44	8.6	7.58	9.26	11.5
	2	11.7	9.87	8.84	7.43	7.89	8.22	8.37	7.42	9.2	11.54
	3	11.7	9.81	8.82	7.39	7.78	8.34	8.31	7.37	9.06	11.55
	4	11.6	9.94	8.76	7.38	7.77	8.43	8.21	7.35	9	11.41
	5	11.6	9.87	8.71	7.37	7.76	8.57	8.05	7.32	8.88	11.39
	6	11.5	9.88	8.72	7.35	7.76	8.37	8.09	7.33	8.73	11.46
	7	11.5	10.29	8.75	7.28	7.67	8.65	7.95	7.17	8.74	11.31
	8	11.6	10.64	8.7	7.39	7.78	8.71	8.02	7.3	8.74	11.23
	9	11.5	9.4	8.72	7.55	7.78	8.69	7.93	7.25	8.62	11.31
	10	11.5		8.69		7.78			7.26	8.62	11.25
	pH										
	0	8.55	8.84	7.8	7.47	7.98	8.19	8.26	7.61	7.67	7.72
	1	8.55	8.45	7.76	7.53	7.94	8.13	8.24	7.6	7.68	7.71
	2	8.55	8.32	7.69	7.39	7.96	8.05	8.22	7.59	7.67	7.71
	3	8.55	8.24	7.73	7.47	7.97	8	8.23	7.59	7.76	7.7
	4	8.53	8.19	7.79	7.51	7.93	8	8.23	7.56	7.65	7.7
	5	8.52	8.17	7.79	7.42	7.92	8.01	8.19	7.58	7.62	7.71
	6	8.52	8.15	7.81	7.48	7.84	8.01	8.17	7.56	7.62	7.7
	7	8.5	8.14	7.81	7.49	7.89	8.02	8.1	7.56	7.62	7.7
	8	8.49	8.15	7.79	7.47	7.87	8.03	8.13	7.33	7.61	7.7
	9	8.47	8.03	7.81	7.49	7.91	8	8.11	7.48	7.54	7.7
	10	8.46		7.82		7.92			7.48	7.53	7.71
	Specific Cond										
	0	224	192.2	214.5	228.5	224.5	201.2	285.6	244	282	132.3
	1	224	195.7	214.9	212.8	229.4	201.6	280.3	254.7	284.2	139.1
	2	224	195.8	217.3	192.5	224.2	199.7	249.4	256.8	286.5	139.4
	3	224	199.3	218.6	190.6	222.6	191.3	237.4	254.9	285.2	139.6
	4	224	204.6	219.6	194.9	225.2	181.6	233.1	253.6	282.7	140
	5	224	203.6	219.2	201.6	230	177.7	230.1	252.7	282.8	140.3
	6	224	201.9	219.2	198.8	233.7	174.6	231.8	252	288.6	140.8
	7	224	198.2	219.9	199.9	232.2	167	234	251.7	295.9	140.3
	8	224	192.5	219.8	199.7	225.7	161.1	225.5	253.8	298.4	140.7
	9	224	187.2	220.6	197.1	215.8	157.1	220	254.2	302.3	140.7
	10	225		219.7		214			255	310.5	140.6
	chl										
	0		9.4	8.8	15.2	9	9.2	5.2	4.8	6	18.8
	1		11.5	10	15.4	9.7	10	7	5.3	5.2	20.6
	2		11.3	9.7	15.3	9.1	10	7	5.7	5.1	20.3
	3		11.3	9.8	15.1	9.2	10.9	6.9	5.1	5.3	20.3
	4		11.4	9.4	15	9.7	11.9	7.4	4.3	5.3	19.6
	5		10.8	9.6	15.7	9.1	9	8.6	4.3	4.9	20
	6		10.6	9.9	15	8.6	7.1	8	4.5	4.4	19.2
	7		11.1	9.2	13.9	8.5	7.1	8.5	4	4.7	19.3
	8		9.3	9.9	12.3	8.2	5.9	8.3	3.3	4.5	19.3
	9			10.3	11.2	7.8	6.3	9.1	4	4.5	20
	10			9.7		7.7			3.3	4.6	
	Turbidity (NTU)										
	0		32	8.9	7	5.4	3.1	3.2	3.1	5.5	33.9
	1		7.4	8.9	7.9	5.6	3.2	3.9	3.3	5.6	33.8
	2		7.5	8.8	8.6	5.8	3.4	4	3.5	5.7	34.4
	3		7.4	10.2	8.9	5.8	3.5	4.2	3.4	5.9	35
	4		7.5	12.2	9	5.8	3.6	4.1	3.3	6.2	34.8
	5		7.4	12.7	8.9	6.2	3.7	4.6	3.3	6.2	35.5
	6		7.1	13	8.9	6.5	4.2	4.7	3.2	6.3	35.1
	7		6.8	13.3	8.6	6.6	4.2	4.6	3.3	6.2	34
	8		6.6	13.3	8	6.5	4.2	4.4	3.5	6.1	33.6
	9			12.7	7.1	6.1	4.7	5.1	3.4	6.1	33.6
	10			12.3		6.1			3.3	7.5	
	Light (ft-candles)										
	0		4200	3100	3500	3800	4500	3500	200	3000	550
	1		80	200	90	200	700	110	60	620	1.2
	2		7.5	25	6	37	150	54	38	120	0.11
	3		1	3.3	0.45	4	35	26	25	25	
	4		0.16	0.3	0.046	1	10	11	10	5	
	5		0.048	0.05	0.02	0.18	2	4.5	3.2	1.5	
	6		0.01	0	0	0.05	0.8	1.4	1.1	0.4	
	7		0			0	0.28	0.37	0.49	0.12	
	8						0.12	0.15	0.15		
	9						0.05		0.05		
	10										
	Secchi										
	1	0.78	1.16	0.88	0.75	0.97	1.24	1.63	1.47	1.21	0.35
	2	0.52	1.17	0.84	0.69	0.96	1.23	1.61	1.46	1.19	0.36
	3	0.56	1.16	0.89	0.73	0.96	1.24	1.58	1.48	1.18	0.37

Barker's Island		Sample Date:									
Site 60	Temperature (C)	20-Apr-07	May 9,2007	1-Jun-07	14-Jun-07	5-Jul-07	25-Jul-07	16-Aug-07	29-Aug-07	23-Sep-07	20-Oct-07
Depth (m)	0		15.1	16	18.8	19.2	23.6	20.4	18.7	15.1	9.98
	1		13.2	15.4	18.7	19	23.4	20.4	18.7	15.1	10.01
	2		12	15	18.5	19	20.5	20.4	18.7	14.9	10.01
	3		11.4	14.6	18.5	18.9	19.1	20.3	18.7	14.9	10
	4		11.1	14.2	17.1	18.7	18.6	20.3	18.7	14.8	10
	5		9.84	13.8	16.3	18.2	17.9	20.2	18.6	14.8	9.97
	6		10.8	13.5	15.9	17.4	17.5	20	18.2	14.7	9.98
	7		10.7	12.7	15	17	16.4	19.1	17.7	14.7	9.97
	8		10.7	12.1	14.2	16.8	15.3	18.9	17.7	14.6	9.96
	DO(mg/L)										
	0		11	9.82	8.01	8.29	9.33	8.65	8.65	9.66	13.87
	1		10.31	9.67	7.9	8.31	9.23	8.57	8.51	9.55	12.25
	2		9.76	9.46	7.71	8.23	8.7	8.5	8.48	9.31	11.71
	3		9.49	9.39	7.66	8.15	8.97	8.35	8.46	9.22	11.71
	4		9.78	9.2	7.61	8.19	8.9	8.3	8.42	9.01	11.62
	5		10.9	9.13	7.84	8.18	8.9	8.3	8.39	9.01	11.4
	6		9.86	9.06	7.95	8.33	8.88	8.24	8.28	8.93	11.51
	7		9.78	8.95	7.99	8.45	8.71	8.22	8.03	8.92	11.43
	8		9.72	8.79	7.84	8.47	8.19	8.25	8.02	8.86	11.39
	pH										
	0		7.65	8.04	7.93	7.89	8.33	8.22	7.63	7.67	7.68
	1		7.7	7.96	7.84	7.88	8.2	8.19	7.63	7.65	7.69
	2		7.71	7.93	7.77	7.87	8.05	8.16	7.61	7.63	7.69
	3		7.71	7.89	7.95	7.86	8.09	8.12	7.59	7.65	7.69
	4		7.71	7.86	7.67	7.84	7.93	8.05	7.58	7.63	7.7
	5		7.71	7.81	7.67	7.88	8	8.02	7.56	7.62	7.7
	6		7.73	7.78	7.66	7.89	8.05	7.95	7.55	7.58	7.7
	7		7.76	7.76	7.65	7.9	8.05	7.96	7.57	7.58	7.7
	8		7.76	7.73	7.64	7.93	8.07	7.97	7.57	7.58	7.71
	Specific Cond										
	0		215.2	235.3	210.5	202.6	186.6	172.4	181.9	347.6	156.8
	1		215.7	234	210.6	202.7	186.4	173.1	182	349.6	156.9
	2		207	236	209.8	201.5	185.6	173.4	182.1	352.6	15.5
	3		207.8	236.4	214.6	201.5	167.4	172.5	181.9	354.2	156
	4		208.5	235.9	208.4	198.8	167.9	172	179.8	354.5	155.9
	5		210.2	239	301	178.1	164.7	171.2	177.1	354.4	155.2
	6		209.4	236.3	197.3	166.9	158.9	167.4	172	352.2	155.6
	7		208.8	234.5	193.3	159.7	159	145	152	349.3	155.4
	8		210.6	227.7	187.9	149.3	151.5	136.3	152.2	342.1	155.5
	chl										
	0		9.2	9	12.5	8.9	6.4	4.3	4.6	4	19.4
	1		9.5	10.2	11.9	8.7	7.1	4.6	4.5	4.3	20
	2		8.9	8.5	11.7	9.2	6.5	5.6	4.4	4.6	20.2
	3		10.3	8.2	10.9	8.5	6.4	4.6	4.2	4.3	20
	4		10.1	7.7	11.6	8.1	6.3	4.9	4.3	3.8	20
	5		10	7.5	10.9	7.8	5.3	4.9	3.5	4	19.1
	6		10.8	7.6	10.5	6.5	5.1	5.2	2.9	4.2	19.6
	7		10.6	7.6	9.3	6.5	5.1	5.6	3	3.6	19.6
	8		11.4	7.6	7.2	5.4	5.8	5.6	2.3	3.9	20
	Turbidity (NTU)										
	0			5.9	6.7	6.1	1.6	2.5	1.8	4.7	238.7
	1			6.1	6.7	6.3	1.6	2.7	2.2	4.8	241.2
	2			6.1	6.4	6.4	1.7	2.8	2.3	5.1	246.3
	3		7.3	6.3	6.4	6.5	2.2	2.9	2.3	5.2	251.2
	4		7.4	6.7	6.8	6.6	1.8	2.7	2.4	5.5	255.2
	5		7.3	6.9	6.6	6.6	1.8	2.8	2.5	5.4	259.4
	6		7.2	6.8	6.2	6.5	1.7	3	3.3	5.7	261.8
	7		7.4	6.9	6.4	6.2	1.7	3.2	3.9	6.8	263.6
	8		17	7.2	7.7	6.2	6.4	3.9	4.6	6.2	266.3
	Light (ft-candles)										
	0		2400	2400	2500	1500	2700	2300	1000	2200	150
	1		160	250	110	160	680	1000	280	430	1.4
	2		22	45	8	19	210	300	100	100	0.3
	3		2.8	7	1	3.4	73	100	35	24	
	4		0.49	1.2	0.13	0.62	25	36	14	6.5	
	5		0.05	0.21	0.02	0.15	10	15	6	1.7	
	6		0.002	0.067	0	0.05	4.3	5.3	2.5	0.5	
	7		0	0			1.7	2.4	1	0.1	
	8						0.68	1	0.49	0.1	
	Secchi										
	1		1.41	0.84	0.86	0.97	1.87	1.96	2.17	1.2	0.51
	2		1.36	0.98	0.88	0.98	1.89	2	2.14	1.2	0.51
	3		1.39	0.97	0.89	0.97	1.91	2.06	2.16	1.21	0.51