# PRAIRIE CROSSING: SANCTUARY POND

# WATER QUALITY REPORT: August 25, 2010


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# SECTION NO. I:  INTRODUCTION

In 2010 ILM performed a water quality monitoring visit at Sanctuary Pond on August 25th.  Sampling has occurred at least once per summer since 1998 with the exception of 2008 when sampling was not performed.  This management report follows the format developed a few years ago which acknowledges the Environmental Management Plan prepared by the Prairie Crossing Homeowners Association. This report addresses the results of the task items that apply only to Sanctuary Pond.  By addressing the efficacy of those task items the Homeowners Association and the Liberty Prairie Foundation can adjust their management plan as appropriate.

Aquatic ecosystems are driven by five major categories of influence: energy sources, biological interactions, water movement, habitat, and water quality.  Historically, these influences have been addressed in our water quality reports.  This year's report is intended to recognize the systems character of lakes and ponds and to comment on discernable influences in the five major categories.

Summaries of results and interpretations are given in the main report.  Methods and data concerning the detail of the monitoring that was carried out are incorporated into the appendix.

Photo 1:  Dense water lilies, but little algae growth observed this year.

# SECTION II:  SUMMARY AND RECOMMENDATIONS

Sanctuary Pond was created in 1995 and became a sanctuary for threatened and endangered fish species in 1998.  This report summarizes a one-time visit on August 25, 2010 for water quality, algal and zooplankton sampling.  Water quality data for the twelve year history from 1998 to the present are reported for purposes of comparison.  Entries are organized to reflect the Environmental Management Plan (EMP) of the Prairie Crossing Homeowners Association (PCHA) and the systems character of pond management.

### A.  EMP Task Items that apply to Sanctuary Pond

1. Sanctuary Pond Monitoring and Management:  Sanctuary Pond was monitored for a suite of water quality parameters and biological data.

2. Eurasian Water Milfoil (EWM) Control:  Very little EWM was observed during this visit.  The dominant vegetation consisted of coontail (*Ceratophyllum demersum*), sago pondweed (*Potamogeton pectinatus*) and water lilies (*Nymphaea tuberosa*).  Approximately five years ago EWM weevils had been introduced

into the system and have been able to control the EWM population, which historically had been quite heavy.

3. Zebra Mussel Monitoring: ILM does assessments of zooplankton populations through Waters Edge Scientific. To date no veligers have been discovered.

4. Goose Control: Dogs are used to chase Canada geese from the site. ILM performs egg oiling to destroy future populations of Canada geese that might imprint to the site. This spring no goose nests had been observed around Sanctuary Pond. The primary goose nesting sites at Prairie Crossing have been at the island in Lake Leopold and more recently at the pond on Prairie Trail and Hedgerow.

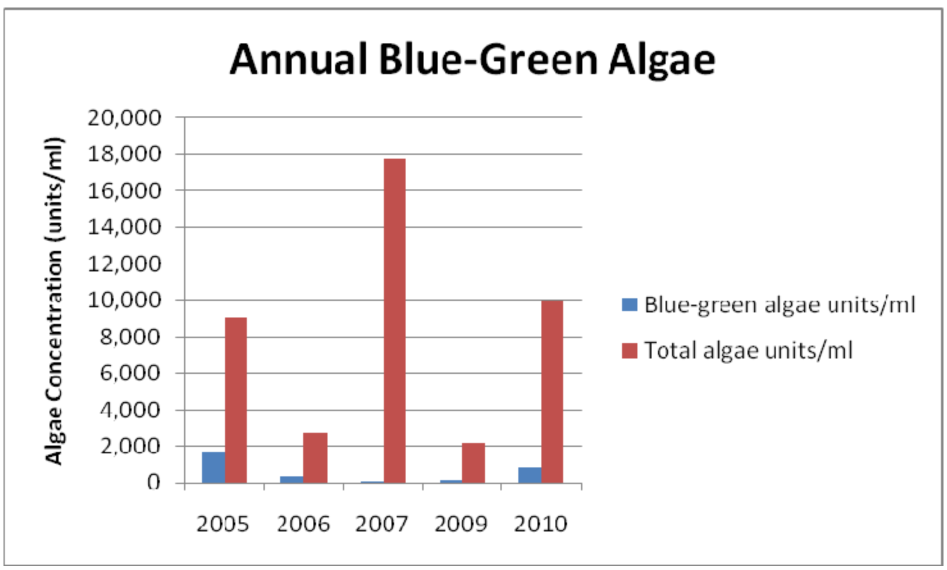
## B. Aquatic Systems Status

### 1. Biological Interactions

Sanctuary Pond was established as a sanctuary for four species of E/T fish in 1998. ILM has confirmed the presence of five E/T species (including the accidental introduction of pugnose shiners). ILM performed fish sampling this fall and the results will be described in a separate report.

Coontail is the dominant aquatic plant species in the pond. Aside from grass carp, there is no biological control to limit the growth of this plant. The only other way to limit these nuisance species would be to apply herbicides in mid summer when other plant species are actively growing. A sediment curtain or an air curtain may be used for partial herbicide treatments.

Blue green algae populations were low during the August 2010 visit, and significantly lower than in previous years, however this data is from only one visit during the 2010 season and previous data is from multiple visits.




### 2. Water Movement

The hydraulic retention time of Sanctuary Pond appears to be about 1 – 1.5 years since it is at the top of the watershed. Both hydrologic and nutrient budgets were calculated in 2007 and the main sources of nutrients to Sanctuary Pond were found to be land runoff and internal regeneration from sediments. Rainfall the last two years has been average to well above average.

**3. Water Quality**

Water quality parameters fell within the range of previous results, and nutrients continue to remain fairly low. The main change that was observed was that the conductivity (salt concentration) has decreased significantly since 2007 – this is probably due primarily to a change in the road deicing formulation used within the Prairie Crossing subdivision.

**4. Habitat**

Rooted aquatic plant populations significantly dominate the ecology of the pond. Habitat within the pond would improve significantly if the aquatic weeds could be removed in several areas to provide more diversity. A sand or gravel base in sections of the pond would improve fish habitat. Also, the pond is heavily dominated by the E/T fish species that were introduced in 1998. No other fish species have been observed in the pond during ILM's fish surveys. The ecology of the pond is unbalanced by design in order to protect the E/T fish. Fish transfers have occurred to Lake Leopold and to several Forest Preserve Lakes to improve the fisheries diversity in those lakes. It has been twelve years since the E/T fish were first introduced into Sanctuary Pond and it seems unlikely that a massive dieback would occur. ILM staff is currently discussing the fishery at Sanctuary Pond with the creators of this sanctuary to determine if the pond should be left as is or allowed to have a more diverse ecology.

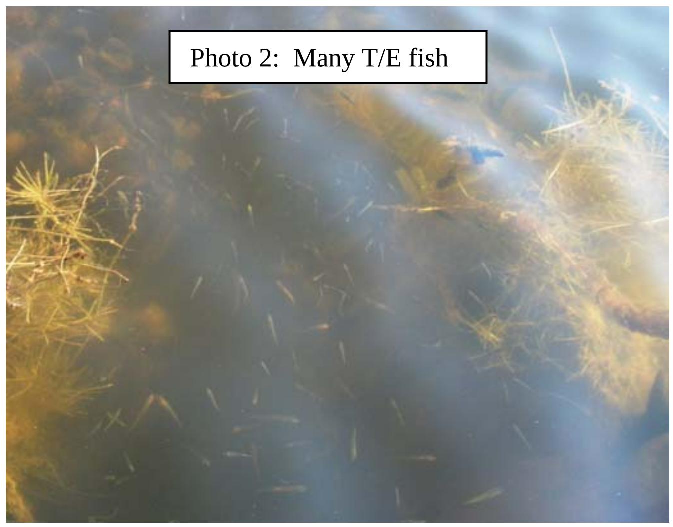


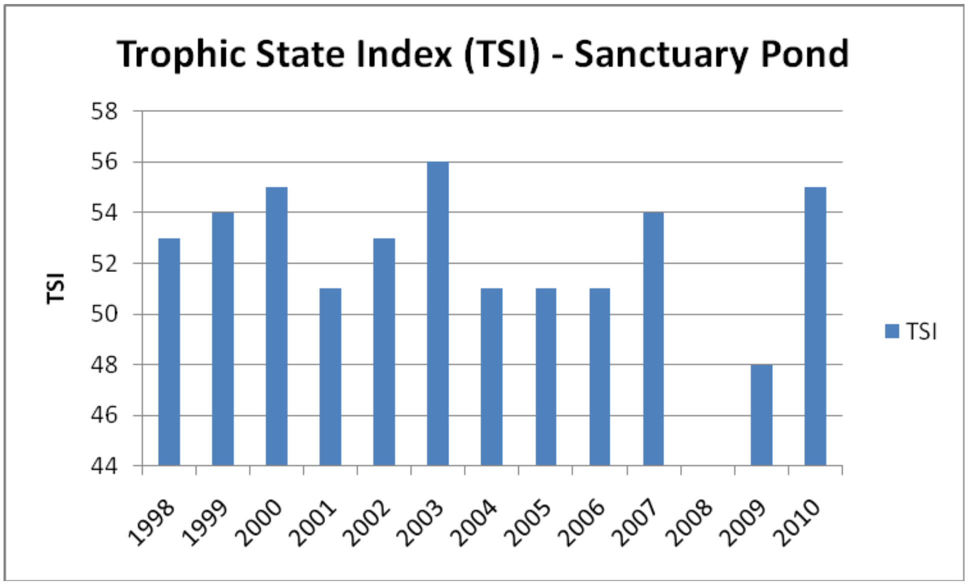
Photo 2: Many T/E fish

A buffer zone of native plants is present around the entire perimeter of the pond, which helps to reduce shoreline erosion and provide habitat for various shoreline species. In the past, several homeowners have been concerned that the cattails were spreading further into the pond. Although they can only spread to a depth of about 3 feet, some spot herbiciding is recommended and would help keep them in check.

**5. Energy Relationships**

Aquatic plants can be classified as; free floating algae (phytoplankton), attached algae (periphyton), submerged aquatic plants, emergent aquatic plants, and floating aquatic plants. Primary productivity refers to the amount of biomass created by photosynthetic organisms across a defined amount of time, generally a year or a growing season. Trophic State Indices (TSIs) are an indirect method of measuring the amount of organic material generated during key stages in the growing season. It should be noted that TSIs only represent the productivity of planktonic algae and do not represent the entire productivity of the pond (i.e. including rooted-aquatic plants and periphyton). Based on the TSI for Sanctuary Pond, the productivity of the pond is borderline mesotrophic / eutrophic and appears to have become a bit more nutrient rich in 2010 (although this only represents one sampling date). The average TSI is 52.6 for the twelve years of monitoring.

TSI = Oligotrophic > 35; Mesotrophic 36 – 53; Eutrophic 54 – 63; Hypereutophic > 64




2009 and 2010 data reflect only one sampling period.

## C. Recommendations

Sanctuary pond is maturing and the natural eutrophication process should be slowed down by:

- Continue to monitor water quality at least once a year at a minimum. Part of the agreement with the IDNR for the E/T fish sanctuary was to perform regular water quality analysis of the pond. . Although major changes are not occurring in the pond, general trends can be determined that would allow for proactive management as opposed to reactive management.

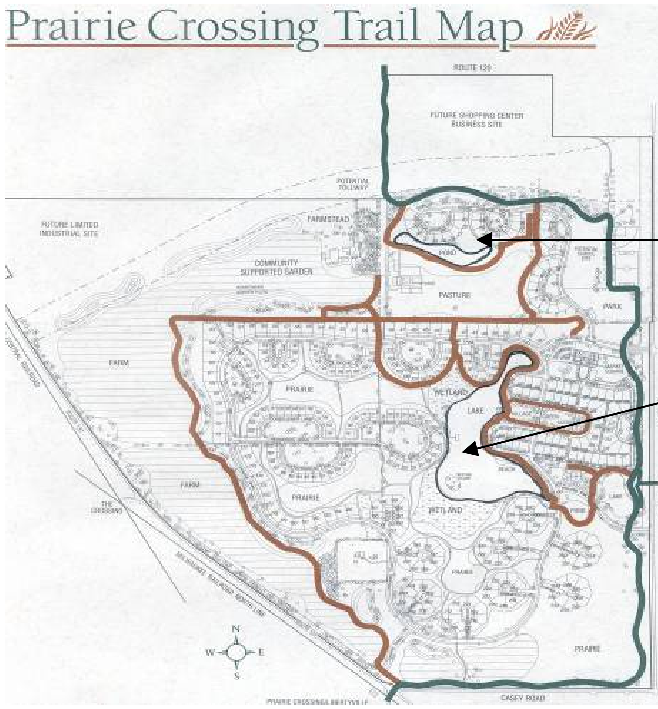
- Diversify the pond bottom with small areas of sand, gravel or rocks Removal of rooted plants and sediment would be needed to prevent the material from sinking into the muck. Diversifying the pond bottom would improve aquatic habitat as well as provide an area for more robust aquatic study and surveys.

- An aquatic plant survey should be conducted annually to notice changes in the plant community and to determine if the weevils used to control milfoil growth are surviving.

- Continue to conduct fish surveys at least once per year to gage the population shifts.

- Maintaining a healthy watershed that drains into the pond should be a priority. This would include herbiciding exotic species and controlling pollutants that could enter the pond.

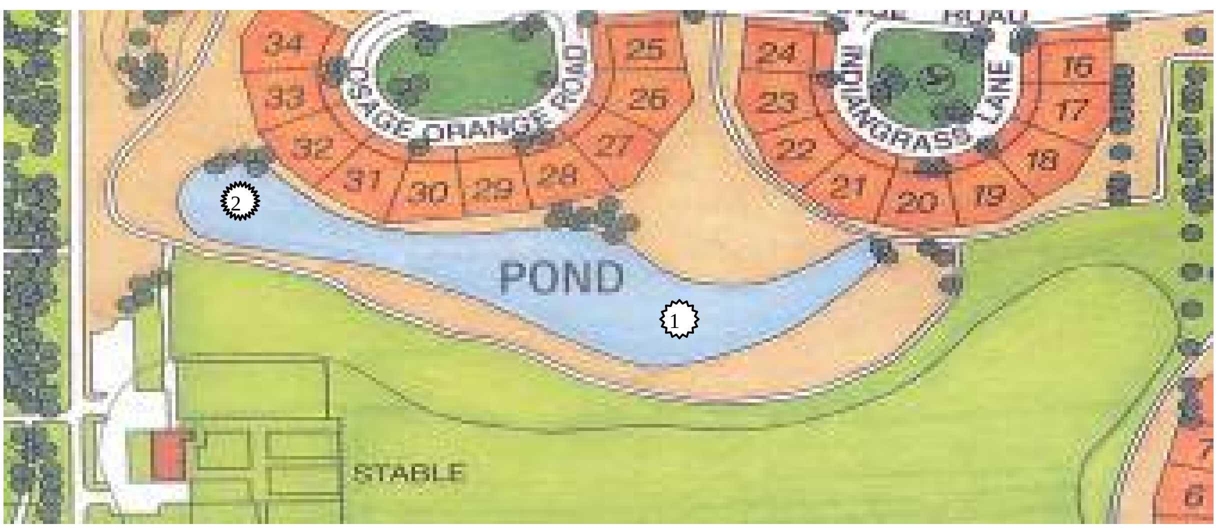
- Rooted aquatic plants, particularly coontail continue to be very extensive. The only practical method to control coontail is with aquatic herbicides, which should be done in lower concentrations or in selected areas with the use of a sediment curtain or an air curtain. Harvesting this plant is an option, but it would not eliminate this plant from the pond.




Sanctuary Pond

Lake Leopold

Monitoring Stations for Sanctuary Pond



# SECTION III: ANALYSIS AND INTERPRETATION

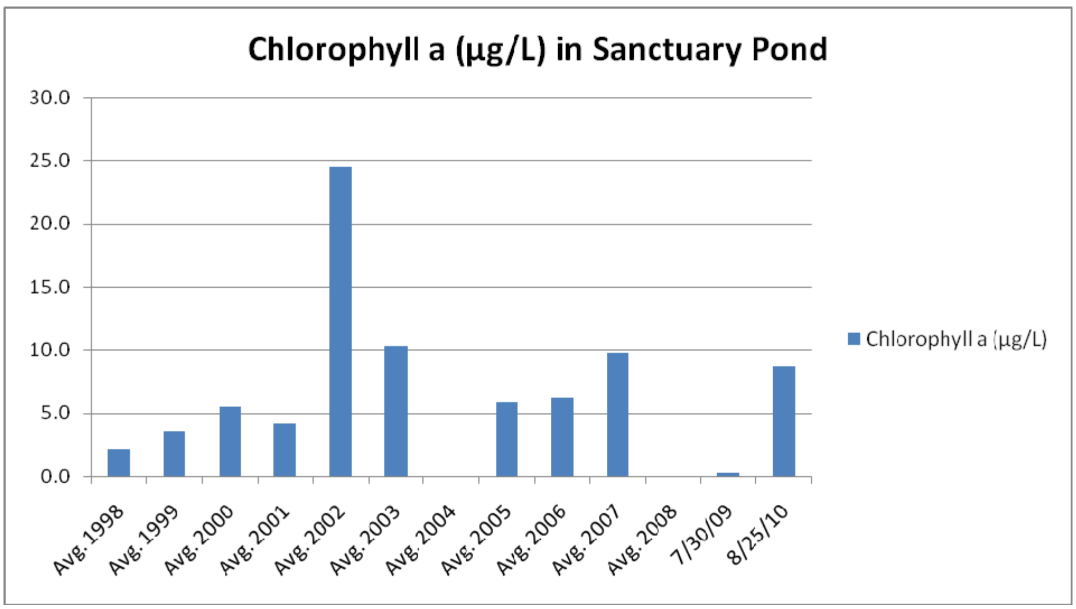
## A. Introduction

This report for Sanctuary Pond includes field observations and biological and chemical testing results for 2010 with a comparison to long term water quality monitoring. Field monitoring and sample collection are undertaken at two stations in Sanctuary Pond, a central station and one on the west side of the pond. Field testing and a traditional suite of chemical diagnostics for lakes were taken. Field testing included: dissolved oxygen and temperature profiles, alkalinity, pH, secchi depth, conductivity, chloride, plankton tows and narrative field observations. Chemical monitoring parameters included nutrients (total & ortho phosphorus and Kjeldahl, nitrate-nitrite, and ammonia nitrogen); suspended solids (total and volatile); algae (chlorophyll *a* and phytoplankton analysis), and chloride. Water samples were also analyzed for relative abundance and biomass of zooplankton.

## B. Water Quality Results

- **Chlorophyll *a*, TSVS, and Seasonal Algae Shifts**

During this visit the chlorophyll *a* value was moderate at 8.7 ųg/l.




**Annual Average Chlorophyll *a* Concentrations**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean (µg/l) | 2.1 | 3.6 | 5.5 | 4.2 | 24.5* | 10.4 | 6.7** | 5.9 | 6.2 | 9.7 | NA | 8.7 |

*This value was skewed by an uncharacteristically high value in August 2002.

** Non-detectable levels of Chlorophyll *a* values were not included in average because method detection limits were higher than in previous years

No sample was collected in 2008.

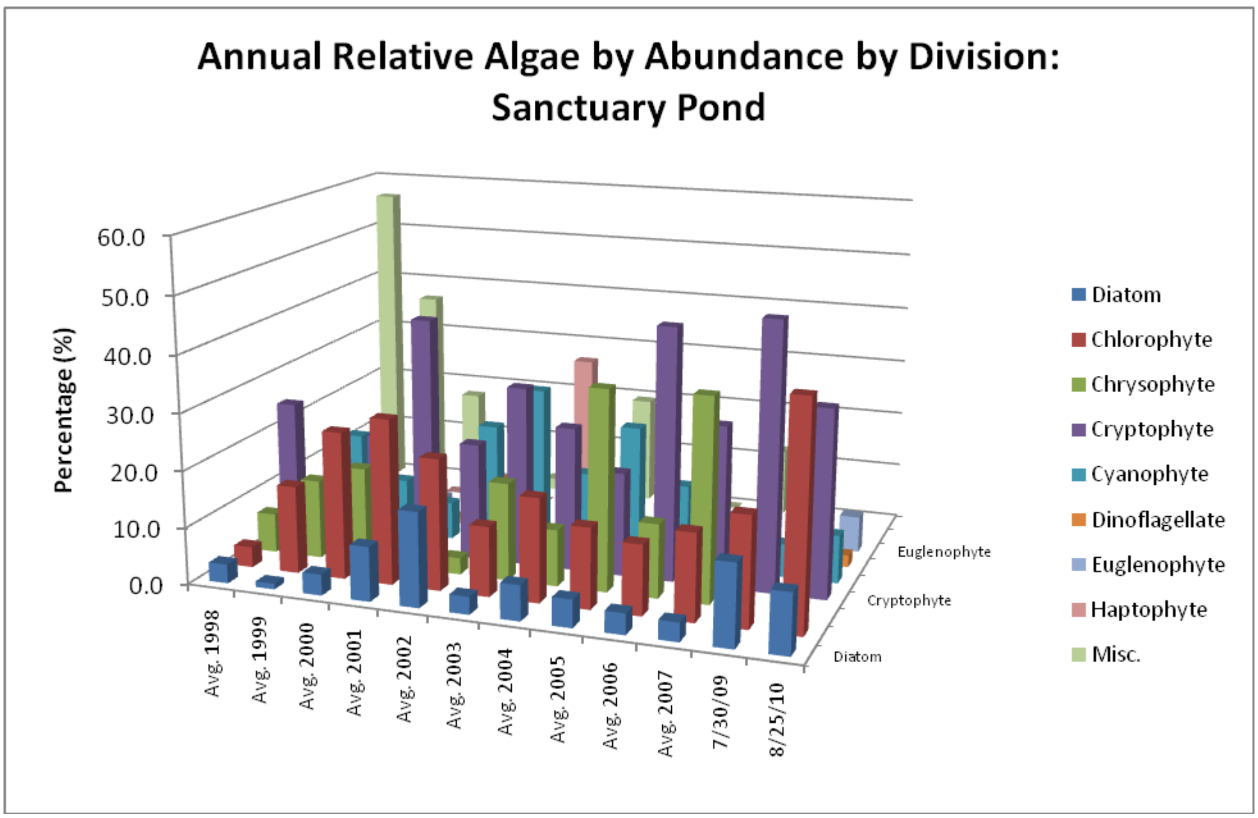
Dominant Algae Present

| Common name | Genus | Relative abundance (%) | Relative biovolume (%) |
|---|---|---|---|
| Euglenoid | *Trachelomonas sp.* | 6.4 | 29.0 |
| Dinoflagellate | *Ceratium sp.* | 1.1 | 20.4 |
| Cryptomonad | *Cryptomonas sp.* | 23.4 | 11.2 |
| Green algae | *Mougeotia sp.* | 2.1 | 10.3 |
| Green algae | *Monoraphidium sp.* | 16.0 | 0.4 |

Blue-green algae were present in very small quantities as shown in a chart on Page 4.

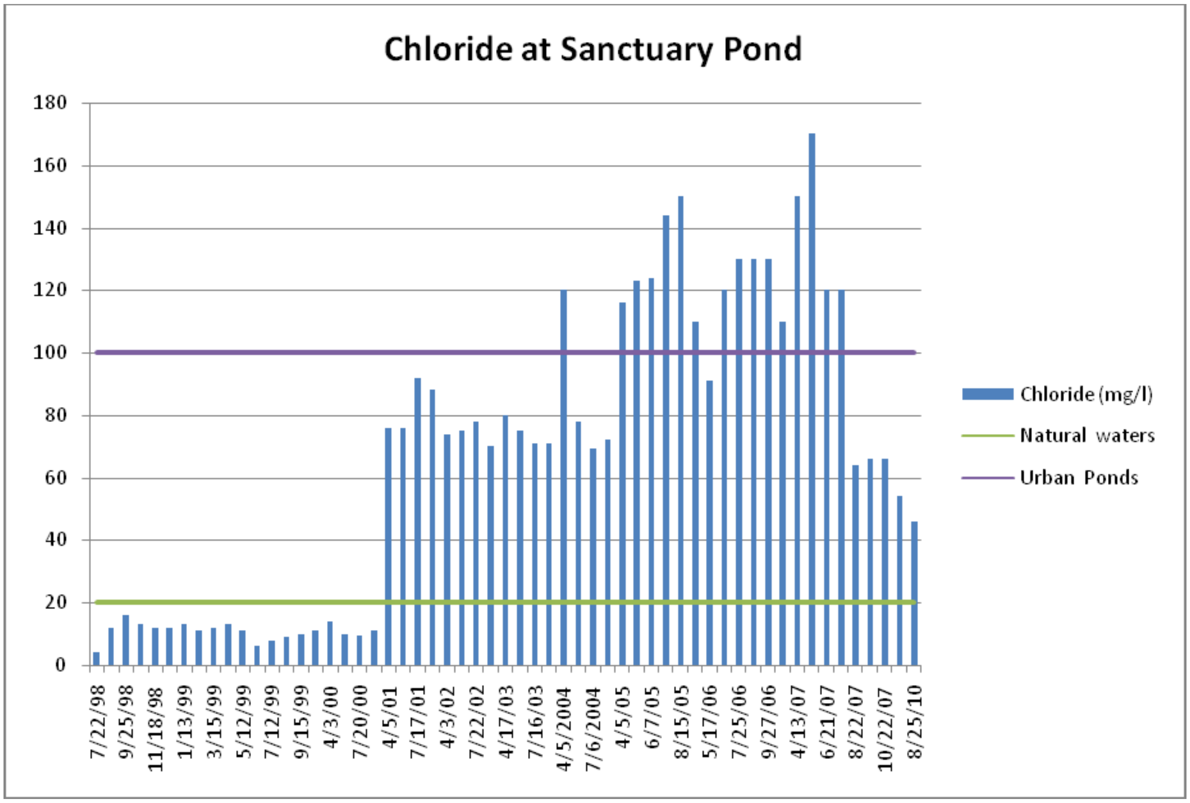
| | Blue-green algae | Total algae | Blue-green algae |
|---|---|---|---|
| | units/ml | units/ml | Percent of total |
| 2005 | 1,669 | 9,041 | 18% |
| 2006 | 363 | 2,738 | 13% |
| 2007 | 119 | 17,737 | 1% |
| 2009 | 131 | 2,223 | 6% |
| 2010 | 852 | 10,007 | 9% |

No sample was collected in 2008.



- **Chloride Concentration**

The average chloride concentration in Sanctuary Pond sharply decreased from 2007 – 2009 due to a change in road deicers used during the winter and also due to dilution caused by above normal precipitation. The pond has a long retention time and chloride entering the pond as road salt slowly becomes diluted from spring and summer rains. High chloride concentrations were observed in 2005 (131.4 mg/l) due to a drought that prevented dilution of the salt in the pond. The main source of chloride is due to road salt that began being applied during the winter of 2000-2001. Studies have suggested that chloride influences on aquatic ecosystems are identifiable when concentrations exceed 250 mg/l.

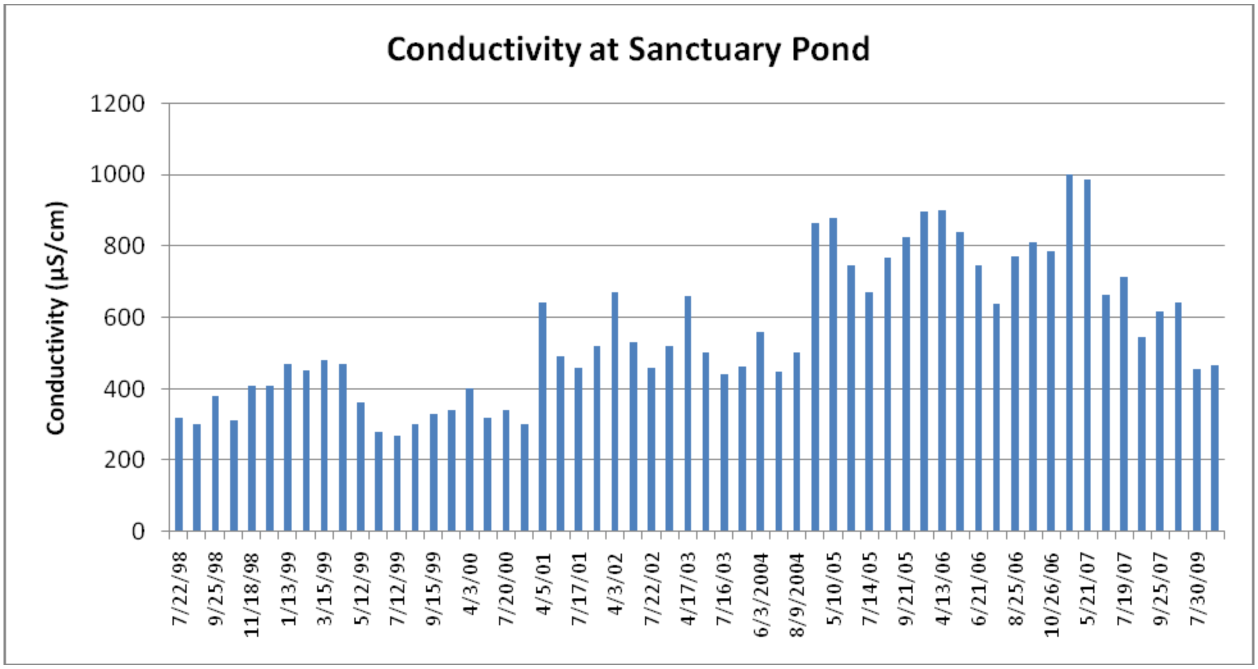



| ` | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean (mg/l) | 11.5 | 10.7 | 11.1 | 83.0 | 74.3 | 74.3 | 84.8 | 131.4 | 117.3 | 108 | 54 | 46 |
| Std. Dev. | 4.0 | 2.2 | 2.0 | 8.2 | 3.3 | 4.3 | 23.7 | 14.7 | 14.7 | 43.5 | NA | NA |

No sample was collected in 2008.

### Conductivity

Conductivity measures the ability of the water to carry an electrical current, which in turn is dependent on the number of soluble ions present. The higher the ion concentration, the higher the conductivity. Chloride is typically the most common ion in water systems, so increases in chloride should cause increases in conductivity. Changes in conductivity that do not involve chlorides imply that other types of chemical loading are taking place. Conductivity values for the 2010 visit correspond to the low chloride concentration discussed above and also observed in 2009.



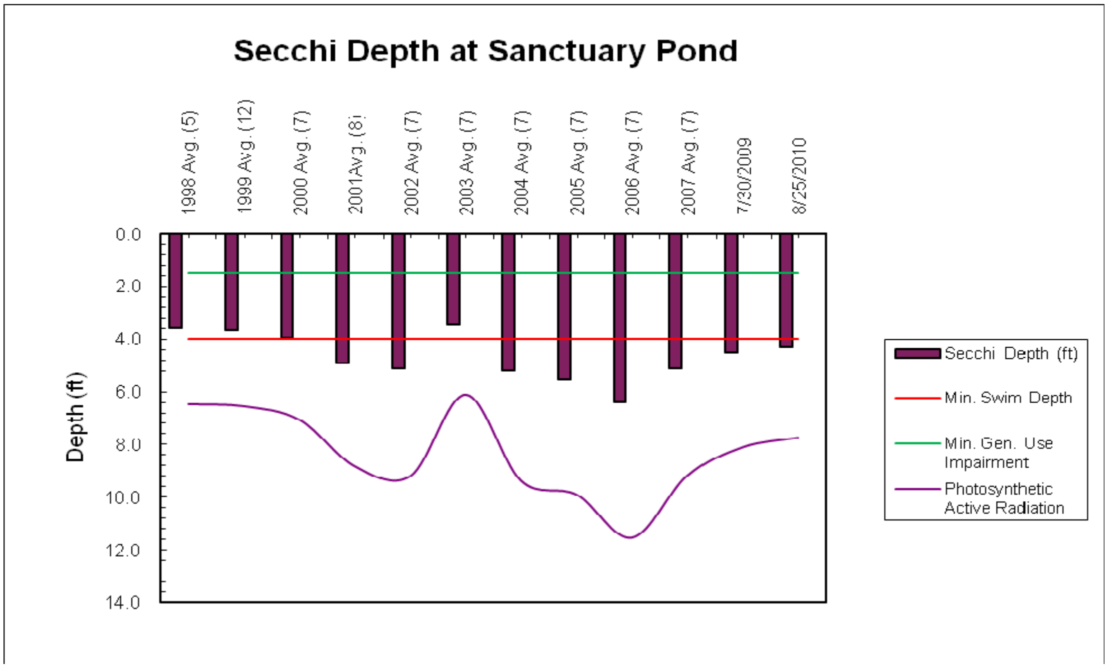

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean (µmhos) | 355 | 378 | 340 | 528 | 545 | 516 | 502 | 806 | 783 | 737 | 455 | 466 |
| Std. Dev. | 50.9 | 84.2 | 43.2 | 78.9 | 88.9 | 99.5 | 56.0 | 82.2 | 81.7 | 180.5 | NA | NA |

No sample was collected in 2008.

## Water Clarity (Secchi Depth), Total Suspended Solids, and Turbidity

Water clarity, as measured with a Secchi disk, is one of the more significant water quality parameters since it can have a direct bearing on aquatic productivity. Clarity can vary dramatically depending on the amount of rooted aquatic plant growth, algae growth, recent wave action and other factors. Water clarity is also related to the depth to which plants or algae can grow (the photic zone). In general the photic zone is approximately twice the secchi depth. For Sanctuary Pond this means that light is sufficient to grow plants or algae across the full depth of the pond. The water clarity at the east end of the pond was 4.3 feet, and 4.4 ft at the west end.

Total suspended solids (TSS) are determined by filtering a water sample under standard conditions and weighing the residue that is left. Organic and inorganic suspended particles contribute to the TSS value and they influence water clarity. TSS can vary dramatically especially during the dormant season when wave action can disturb the lake bottom. Therefore secchi clarity and TSS values are inversely correlated with one another. The total suspended solids (TSS) concentration for this site visit was 2.8 mg/l, which is pretty low, but is typical for midsummer conditons.

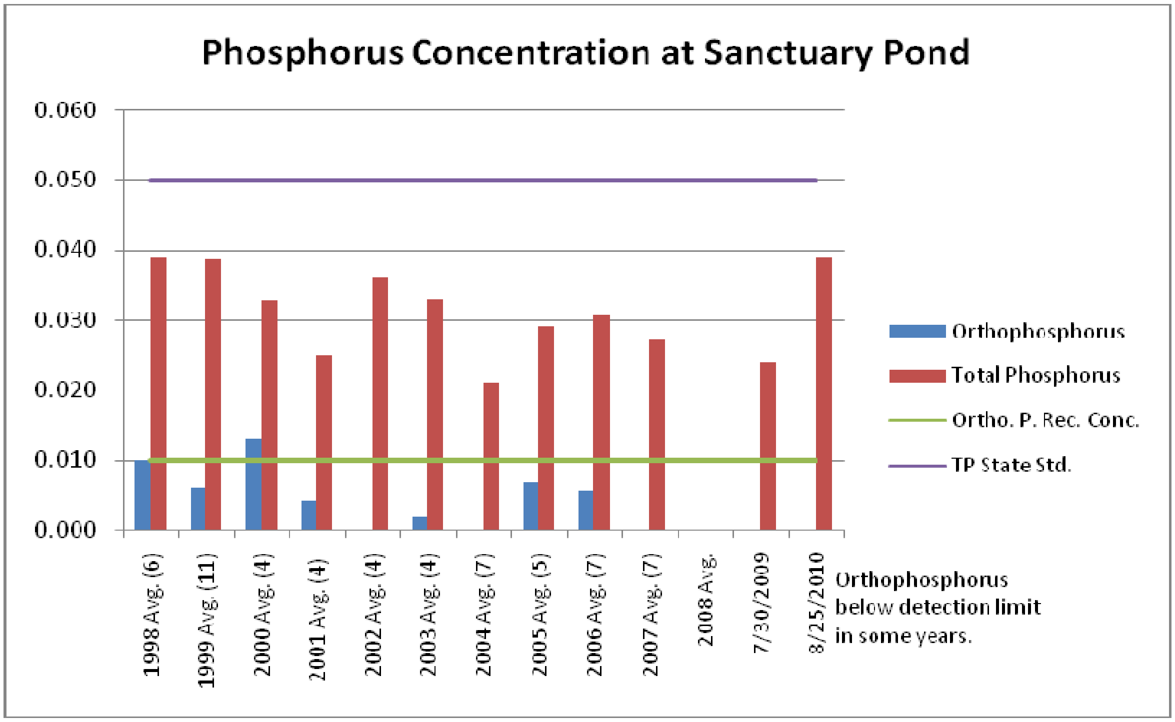



| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Secchi depth (ft) | 3.6 | 3.6 | 3.9 | 4.9 | 5.1 | 3.4 | 5.2 | 5.5 | 6.4 | 5.1 | 4.5 | 4.3 |
| TSS (mg/l) | 9.7 | 9.3 | 6.8 | 1.5 | 4.0 | 5.5 | 2.9 | 3.2 | 1.1 | 2.4 | 2.0 | 2.8 |

No sample was collected in 2008.

## Total Phosphorus and Orthophosphorus

The average total phosphorous concentration was 0.039 mg/l, which is slightly above the long-term annual average of 0.031 mg/l. The phosphorus concentrations have fluctuated between 0.023 and 0.040 mg/l over the twelve year sampling period. Impacts of shading, dilution and nutrient uptake by aquatic plants will be reflected in total phosphorus values. Both total and orthophosphorus were measured during the sampling event.



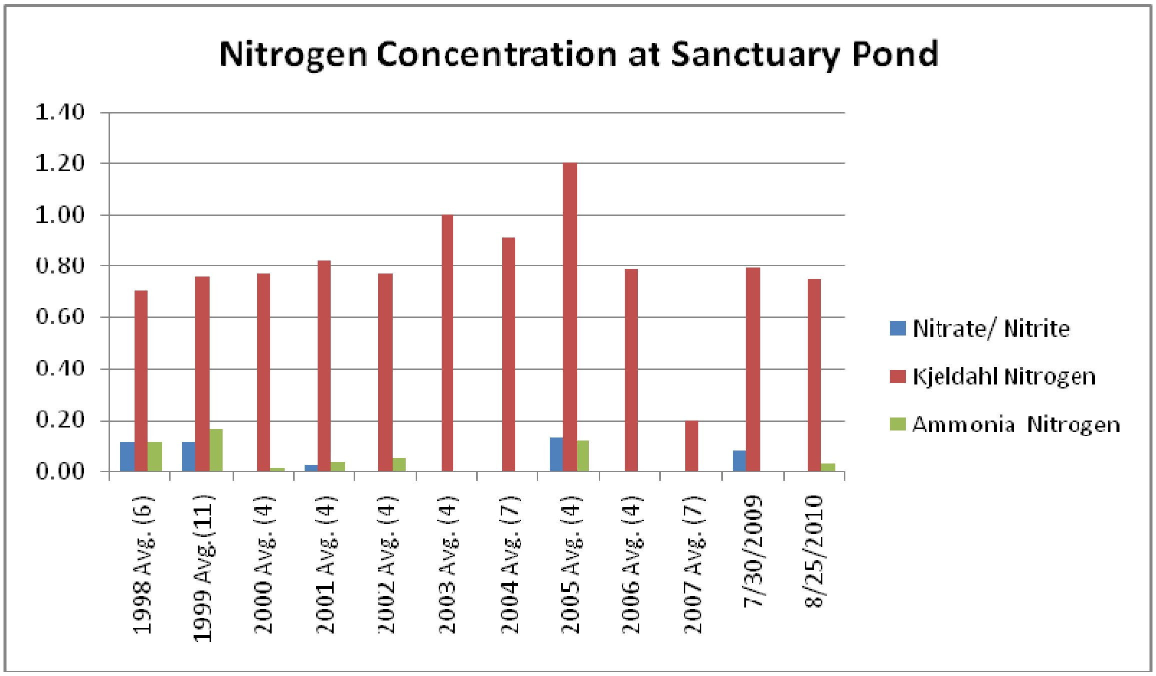

| Annual Phosphorus Concentrations | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
| Total phosphorus (mg/l) | 0.039 | 0.039 | 0.033 | 0.025 | 0.036 | 0.033 | 0.020 | 0.029 | 0.031 | 0.028 | 0.024 | 0.039 |
| Orthophosphorus (mg/l) | 0.010 | 0.006 | 0.013 | 0.004 | ND | 0.002 | <0.010 | 0.010 | 0.006 | ND | ND | ND |

No sample was collected in 2008.

- **Nitrate/Nitrite, Kjeldahl Nitrogen, and Ammonia Nitrogen**

Nitrogen concentrations were predictably very low during this visit. During the growing season nitrogen is actively used by plants and algae and is released into the water when they die in the fall.

Kjeldahl nitrogen (TKN) represents the amount of "organic" nitrogen contained by algae and organic detritus in the water column. The nitrogen to phosphorus (N: P) ratio was 19.2 for 2010 indicating that Sanctuary Pond has phosphorus as the limiting nutrient. Although the N: P ratio has varied from 18 – 47, it has always indicated that the pond is phosphorus limited. Ratios below 10:1 are regarded as nitrogen limited.



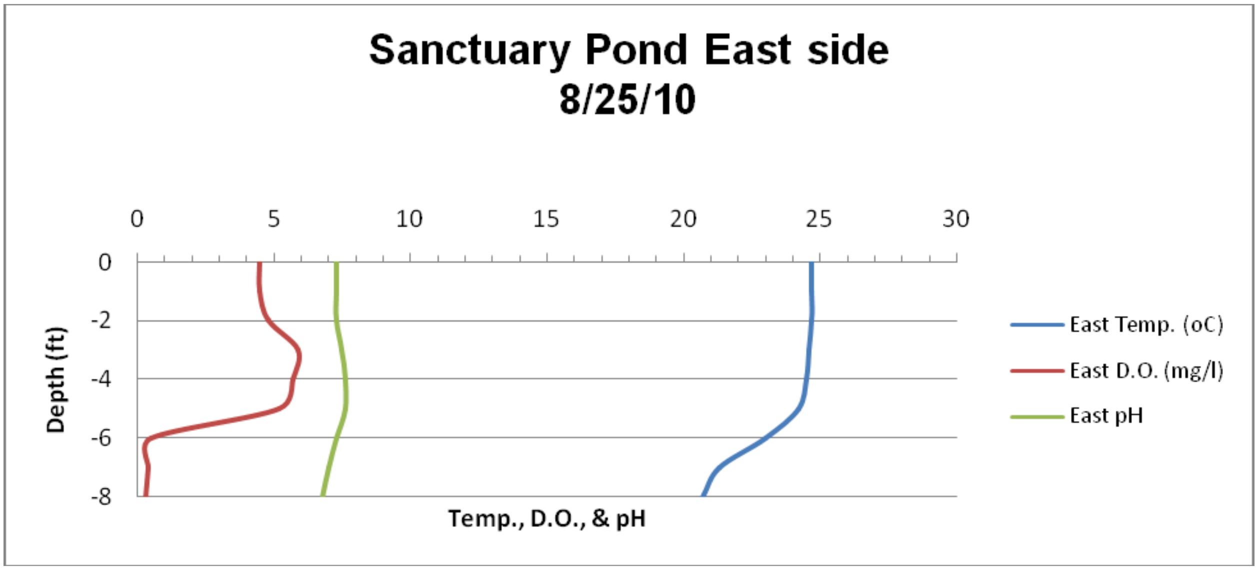

| Average Annual Nutrient Concentrations – Sanctuary Pond | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 8/25/10 |
| Avg. TKN (mg/l) | 0.70 | 0.76 | 0.77 | 0.82 | 0.77 | 0.98 | 0.94 | 1.2 | 0.79 | 0.58 | NA | 0.75 |
| Ammonia nitrogen (mg/l) | 0.11 | 0.16 | 0.01 | 0.03 | 0.04 | ND | ND | 0.10 | ND | ND | NA | 0.025 |
| Nitrate/Nitrate (mg/l) | 0.11 | 0.11 | ND | 0.02 | ND | ND | ND | 0.03 | ND | ND | NA | ND |
| N:P Ratio | 17.95 | 19.49 | 23.33 | 32.80 | 21.39 | 29.69 | 47.00 | 41.38 | 25.5 | 20.7 | NA | 19.2 |

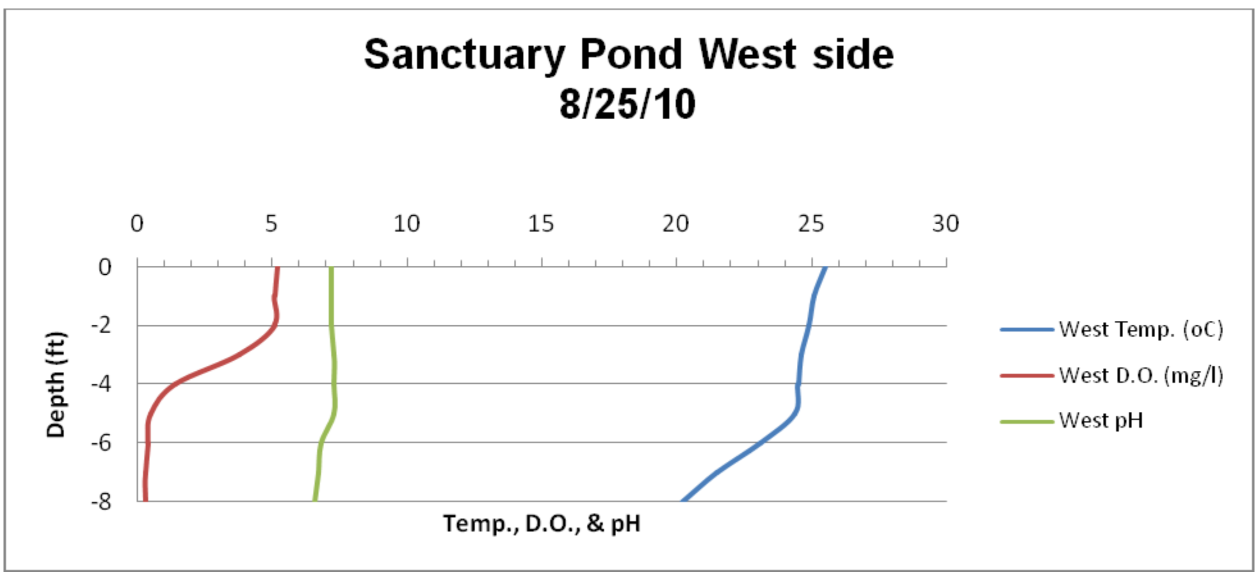
No sample was collected in 2008.

- **Dissolved Oxygen/Temperature Profiles**

Ponds are not considered to be stratified unless there is at least a three degree Centigrade difference between the surface water and the bottom. Temperatures at Sanctuary Pond were stratified during this site visit.

Dissolved oxygen values ranged from 5.2 mg/l at the surface to 0.3 mg/l at the bottom. Values below 2 mg/l at the water-sediment boundary will result in the release of nutrients from bottom sediments. Values above 5.0 mg/l are preferred by most aquatic fauna.



- **Carlson Trophic State Index**

Carlson's Trophic State Index (TSI) is a quick way to determine the health of a pond using water clarity, total phosphorus, and chlorophyll *a* concentrations. The index indirectly measures the relative planktonic algae across the growing season but does not measure the productivity of rooted aquatic plants. The historic average TSI is 52.6 or borderline eutrophic / mesotrophic. During this visit the TSI was a bit higher at 55. The TSI is better if used with an average for the season than just for one visit.

**Carlson Trophic State Index – Sanctuary Pond**

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 7/30/09 | 6/25/10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TSI | 53 | 54 | 55 | 51 | 53 | 56 | 51 | 51 | 51 | 54 | 48 | 55 |
| Class | M | E | E | M | M | E | M | M | M | E | M | E |

M = mesotrophic and E = eutrophic; Values > 53 are considered eutrophic

**8/25/10 TSI**

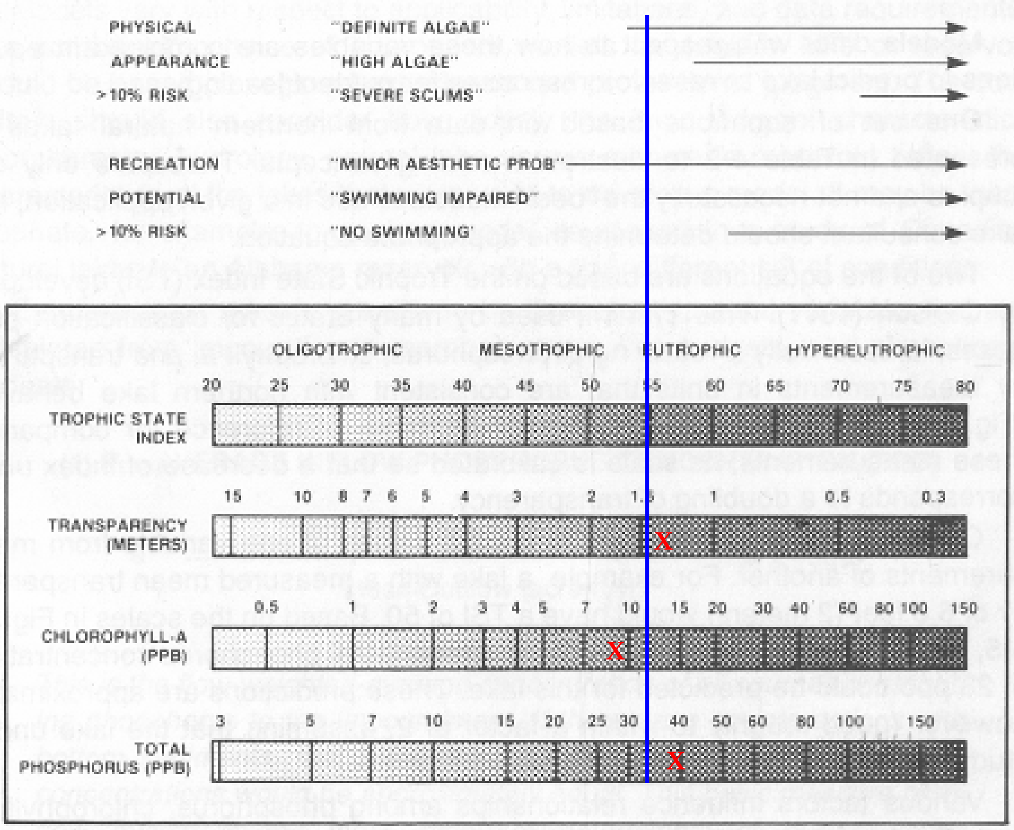



**Figure 4-5.—Carlson's Trophic State Index related to perceived nuisance conditions (Heiskary and Walker, 1987). Length of arrows indicate range over which a greater than 10 percent probability exists that users will perceive a problem.**

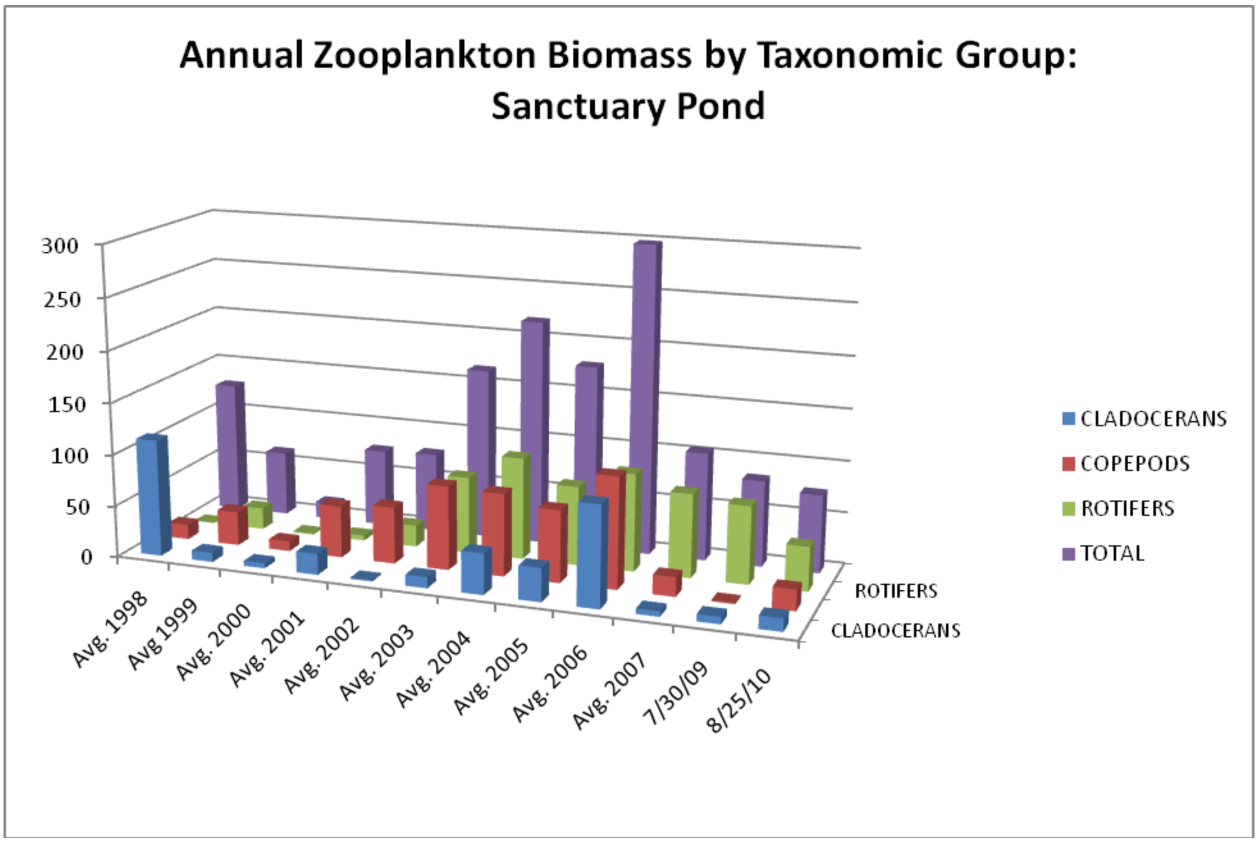
## C.  Zooplankton Populations

Zooplankton sampling indicated that rotifers were the most common species present during this sampling. The average total biomass (µg) of zooplankton observed was lower than it had been the last few years, but since zooplankton populations vary dramatically during the season; this one-time only visit may have been during a low point.

Dominant Zooplankton Present

| Common name | Taxa | Total biomass (µg/) | Relative biomass (%) |
|---|---|---|---|
| Rotifer | *Keratella cochlearis* | 45.6 | 33.3 |
| Copepod | *Nauplius* | 15.2 | 20.2 |
| Rotifer | *Polyarthra vulgaris* | 11.3 | 15.0 |
| Cladoceran | *Chydorus sphaericus* | 7.2 | 9.5 |
| Rotifer | *Lecane sp.* | 6.3 | 8.3 |

No sample was collected in 2008.



# APPENDIX

# DESCRIPTION OF MONITORING PARAMETERS

## Field Monitoring

**Dissolved oxygen** (D.O.) *is needed for aquatic life to survive. A healthy environment for fish has D.O. concentration above 5 mg/L. Below 5 mg/L, fish become stressed. When the D.O. reaches 3 mg/L, fish may begin to die. Dissolved oxygen varies depending day/night cycles, the amount of direct sunlight, and the temperature. D.O. drops at night and is highest on sunny days. D.O. is also much higher in cool water in the spring and fall, than during the summer. The Illinois State standard for D.O. is 5 mg/L at all times, and should not fall below 6 mg/L during at least 16 hours out of any 24 hour period (IEPA Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, State of Illinois Rules and Regulations, 1993).*

**pH** *Some changes in pH occur naturally and are related to the amount of algal growth in the lake. Most lakes in this area have a pH of greater than 7 and often in the 8 range. pH measures the acidity and alkalinity of the water. A pH of 7.0 is neutral, below 7 is acidic and above 7 is alkaline. The pH scale is logarithmic, so a pH change of 1 unit is very significant.*

**Alkalinity** *measures the buffering capacity of the lake. Normal alkalinity for this region is about 90-250 mg/L.*

**Secchi** *indicates the clarity of the lake water. A high secchi depth indicates that the water is quite clear and free of algae and/or suspended sediments*. *A low secchi depth of less than 3 feet indicates that the water is very turbid. Turbidity could be due to either planktonic algae or suspended sediments*.

## Chemical Analysis

**Chloride** *is usually tested in lake waters as an indicator of human activity. Natural waters away from human influence usually have chloride measurements below 20 mg/L. Sources of chloride include agricultural chemicals, human and animal wastes, and road salt.*

**Conductivity** *measures the water's ability to conduct an electrical current, and is influenced by the amount of dissolved ions in the water. Conductivity levels vary dramatically from site to site. Distilled water has essentially no conductivity, while seawater is about 50,000 μmhos/l. Typical streams have a conductivity ranging from 150 to 3000 μmhos/l.*

**Nitrogen** *in a lake usually depends on local land use. High levels of nitrogen are found in runoff from agricultural areas where fertilizer and animal waste occur and from lawns that have been fertilized. Waterfowl waste products also contribute nitrogen to the lake. Nitrogen also enters the water naturally from atmospheric deposition during thunderstorms.*

*Nitrogen has several different forms that are important for lake studies. Ammonium ($NH_4$+) occurs from human and animal waste products and decomposing organic matter. Kjeldahl nitrogen includes organic nitrogen plus ammonium. Organic nitrogen is nitrogen that occurs in living organisms. All inorganic forms of nitrogen, nitrate ($NO_3$-) nitrite ($NO_2$-), and ammonium ($NH_4$+) can be used as food for aquatic plants and algae. Total nitrogen is the sum of nitrate, nitrite, and Kjeldahl nitrogen (Shaw et al.). Although nitrogen may enter the lake in one form, microorganisms in the sediment and water can change nitrogen to a different form. Some of the nitrogen within the lake may eventually leave the lake by entering the atmosphere as nitrogen gas, flowing out the outlet, or becoming part of the sediments (Wetzel, 1983,* Limnology, *2nd ed. Saunders College Publishing: Philadelphia, Pennsylvania).*

*The general use water quality standard for ammonia nitrogen in Illinois is based on the temperature and pH of the water. The maximum allowable ammonia nitrogen concentration is 0.1 mg/L when the water is above 80°F and pH is 9.0 for chronic conditions (IEPA, Title 35: Environmental Protection, Subtitle C:*

*Water Pollution, Chapter 1: Pollution Control Board, State of Illinois Rules and Regulations, 1998). Higher levels of ammonia nitrogen are acceptable when the water has a lower pH and/or when it is cooler. High concentrations of ammonia are potentially toxic to fish life. Lake water concentrations of inorganic nitrogen above 0.3 mg/L can be sufficient to promote algae blooms (Forest Preserve District of DuPage County, 1993, "Phase I Diagnostic - Feasibility study of Herrick Lake, DuPage County, Illinois").*

*Nitrogen levels change throughout the season depending on plant uptake. Typically nitrogen is higher in the spring and fall when plants are not actively taking up nutrients, and the lake is thoroughly mixed. Also, nitrogen re-enters the upper reaches of the water column during the spring and fall turnover, when the nitrogen rich bottom layer of water is mixed with the surface layer.*

*Total nitrogen is the sum of Kjeldahl nitrogen plus nitrate/nitrite. The N: P ratio is helpful to determine if the lake is nitrogen or phosphorus limited. Lakes with a ratio above 10:1 have phosphorus as the limiting nutrient controlling the amount of plant growth. Lakes below the 10:1 ratio have nitrogen as the limiting nutrient.*

*There is the potential for an algal bloom when the inorganic nitrogen (nitrate/nitrite + ammonia) is above 0.3 mg/L (as N).*

**Total phosphorus** (P) *has been the nutrient most often measured in lakes. Phosphorus is the nutrient that stimulates plant growth in most lakes. Total phosphorus represents a sum of all of the different forms of phosphorus in the water column, both dissolved and particulate. Total P includes orthophosphorus, phosphorus contained within organisms and, phosphorus attached to sediments. Orthophosphorus is the dissolved inorganic form of phosphorus that can be used easily by plants. Organisms such as algae contain small amounts of phosphorus that are released when the organism dies. Only very small amounts of phosphorus are needed to stimulate aquatic plant growth.*

*The standard for total P is 0.05 mg/L, which is a guideline for natural waters. Urban and rural lakes usually have a much higher total phosphorus level than 0.05 mg/L. Although the state exceedence standard is 0.05 mg/L for natural water (IEPA Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, State of Illinois Rules and Regulations, 1993), many lakes are well above that level because of nutrient loading in stormwater runoff.*

**Orthophosphorus** *is the dissolved inorganic form of phosphorus that can be immediately used by plants. Levels of ortho P above 0.005 mg/L frequently cause algae blooms. Wastewater, agricultural and urban runoff are major sources of orthophosphorus and particulate phosphorus to lakes and streams. Orthophosphorus is the main form of phosphorus found in domestic wastewater (Garmen, G. D., G. B. Good, and L. M. Hinsman, 1986, Phosphorus: a summary of information regarding lake water quality, IEPA/WPC/86-010, Planning Section Division of Water Pollution Control, Illinois Environmental Protection Agency: Springfield, Illinois.)*

**Total suspended solids (TSS**) *consist of all "filterable" solids present in the water column, and include both inorganic and organic solids. It is determined from the amount of material collected on a filter.*

**Total suspended volatile solids (TSVS)** *includes all the organic material, such as algae and invertebrates, in the water column that can be measured by drying the water sample at high enough temperatures to burn off the sample residue.*

**Chlorophyll *a***, *which is present in plants and algae, is the primary green pigment necessary for photosynthesis to occur. Measuring the amount of chlorophyll a in the water gives a rough indication of the amount of algae present in the lake. The pheophytin a, and trichromomatic chlorophyll a, b, and c represent different pigments that occur in algae. Pheophytin a, in particular, is a degradation product of chlorophyll a that interferes with its analysis. Therefore, corrected chlorophyll a represents the amount of algae present in the lake after adjusting for the presence of pheophytin a.*

## FIELD METHODS FOR WATER QUALITY TESTING

### FIELD MONITORING:

**Water clarity** is measured using a 20-cm secchi disk, a black-and-white painted metal disk attached to a cord which is marked at one-foot intervals. The disk is lowered into the water to the point at which the painted divisions are no longer visible. This depth is recorded as the secchi depth, which is an indicator of the amount of water clarity. At least two readings are taken at every sample site.

**Dissolved oxygen (DO)** is measured using a Hydrolab Quanta Water Quality Monitoring System, a digital multiprobe meter which gives readouts of temperature, dissolved oxygen, pH, and conductivity concentrations. The meter is calibrated at ILM against a solubility table for oxygen in water at various temperatures. The meter is calibrated based on temperature and barometric pressure. Calibrated is typically only needed once per day. To operate the meter, Quanta Transmitter is lowered into the water at one-foot depth intervals and measurements recorded. The Quanta is routinely compared with DO analyses using a HACH kit (model OX-2P). If the differential is greater than 1 mg/l, the readings are regarded as invalid and both the meter and HACH tests are redone.

**Water temperature** is recorded using the Hydrolab Quanta Water Quality Monitoring System, as well as with a backup non-mercury thermometer.

**pH** measurements are taken using the Hydrolab Quanta Water Quality Monitoring System and a back up test is done with a LaMotte model HA analog pH meter. Both meters are standardized before use in the field by inserting the probe into buffer solutions of pH 7.0 and 10.0, and calibrating the meter to the appropriate pH. PH buffers are chosen to be slightly above and below the expected pH encountered in the field. The meter is set to the appropriate water temperature for each site, the probe inserted into the water column, and the pH reading then recorded for each foot of depth.

**Conductivity** measurements are taken in the field using the Hydrolab Quanta Water Quality Monitoring System. The meter uses a two-point calibration, distilled water and 500 umhos/cm. Conductivity is read per foot of water depth.

**Chloride** measures the amount of salt in the water. A Hach Model 8-P, 5-400 mg/l test kit is used for field analysis. Frequently laboratory backup is also employed. Both high range 0 – 400 mg/l and low range 0-100 mg/l can be used. The method utilized involves titrating silver nitrate into the mixing bottle until a color change is noted. The amount of chloride is then calculated from the number of drops added.

**Alkalinity** is measured using a HACH model AL-DT with digital titrator. A sulfuric acid titration cartridge is attached to the titrator body. A 100-ml water sample is collected and placed in a glass flask. Phenolphthalein indicator is added to the sample and swirled to mix. Bromcresol green-methyl red indicator is then added to the sample and mixed. Using the digital titrator, the sample is titrated with the sulfuric acid standard solution to a light pink color, and the concentration of alkalinity recorded from the digital reading. Periodically the kit results are graded against a known standard solution provided by the manufacturer.

A **plankton tow** from Wildlife Supply Company, Wildco 48 C60, is used for specimen collection. The plankton tow is comprised of mesh netting with a weighted chamber and rope attachment. The plankton tow is thrown several feet from the boat and pulled through the water at a depth of one to two feet. The clamp attachment on the outlet hose is released and the water poured from the collection chamber into the specimen bottle, which is then reviewed under a microscope back at ILM. The tow is cleaned between sampling sites with a solution of Chlorox. Chlorox residual is rinsed off with distilled water.

## CHEMICAL TESTING:

Water samples for laboratory analysis are collected using Wildlife Supply Company's Wildco model 1930-G62 beta bottle. The bottle is lowered into the water to the appropriate depth (2 feet for all sites except the deep sample taken at 10 feet). When the weighted metal attachment is dropped along the rope from the surface, the collection chamber's doors are released and the water sample is thus captured and retrieved. To avoid contamination, the beta bottle is periodically cleaned with a solution of liquid Alconox and rinsed with tap water. Prior to specimen collection, the bottle is rinsed with lake water at the site.

All samples are placed on ice in the field immediately after collection. Several tests can be conducted from each sample bottle. Bottles used for collection are clean bottles provided by Northern Lakes Service. A 1-liter unpreserved bottle is collected and tested for chloride, total suspended solids, and conductivity. A 250-ml bottle preserved with sulfuric acid is collected from the lake and tested for the nitrogen series and total phosphorus. A separate 1-liter unpreserved bottle is collected for chlorophyll *a* testing. Following any additional preparation required for each sample, the samples are placed on ice and shipped overnight to Northern Lakes Service in Crandon, Wisconsin for laboratory analysis.

**Ammonia nitrogen** samples are placed in 250-ml plastic containers with sulfuric acid preservative. The samples are maintained at a temperature of approximately 4 ° C upon collection and during shipment.

**Chloride** samples are placed in 250-ml plastic containers with no preservative.

**Chlorophyll *a*** samples are composites taken from 2, 4, and 6-foot depths when the lake is stratified. When the lake is well mixed, chlorophyll *a* samples are collected only at a 2-foot depth. The samples are placed in 1-liter plastic bottles with no preservatives. The samples are maintained at a temperature of approximately 4 ° C upon collection and during shipment.

**Conductivity** samples are placed in plastic containers with no preservative agents. Although this measurement is taken in the field using a conductivity meter, it is standard practice to submit a sample for laboratory analysis as a back up.

**Nitrate and nitrite** samples are placed in 250-ml plastic containers with sulfuric acid preservative and are maintained at a temperature of approximately 4 ° C upon collection and during shipment.

**Total Kjeldahl nitrogen** samples are placed in 250-ml plastic containers with sulfuric acid preservative. The samples are maintained at a temperature of approximately 4° C upon collection and during shipment.

**Orthophosphorus** samples are filtered using Millipore 0.45 um nitrocellulose filters and then placed into 250-ml plastic containers with no preservative agent. The samples are maintained at a temperature of approximately 4 deg. C upon collection and during shipment.

**Total phosphorus** samples are placed into 250-ml plastic containers with sulfuric acid preservative. The samples are maintained at a temperature of approximately 4 deg. C upon collection and during shipment.

**TSS** (total suspended solids) **and TSVS** (total suspended volatile solids) samples are placed in 250-ml plastic containers with no preservatives. The samples are maintained at a temperature of approximately 4 ° C upon collection and during shipment.

**Algae** samples are collected using a 250-ml plastic bottle that contains 1% Lugols iodine. Sample depth is at 2-ft when the lake is well mixed, and is a composite sample a 2, 4, and 6-ft when the lake is stratified. Samples are sent to Water's Edge for analysis.

**Zooplankton** samples are also collected at 2-ft when the lake is mixed and 2, 4, and 6-ft when the lake is stratified. A total of 2 liters of water are collected and sieved through the bottom portion of a plankton tow. The resulting 20 – 40 mls represent a concentrated sample. Samples are preserved in 70% ethyl alcohol and are sent to Water's Edge for analysis.

## Water Quality Results

**2010 Chemical analysis of Sanctuary (Upper) Pond at Prairie Crossing**

**Site 1 Location: Center of pond**

(Samples collected at a 2-foot depth)

Values are mg/l unless otherwise noted

| | BOD 5-Day | C.O.D | Chloride as CL | Conduct. umhos | Ammonia as N Nitrogen | Nitrate/ Nitrite Nitrogen | Kjeldahl Nitrogen | Phos. Dis. as P | Phos. Total | Tot. Susp. Solids | Total Susp. Volatile Solids | Total Solids | Turbidity NTU | Chlorophyll *a* (ug/L) | Fecal Coliform colonies/ 100 ml |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Standard**** | ***5*** | ***30*** | 500 | NA | 15/0.01** | NA | NA | ***0.01*** | 0.05 | ***15**** | NA | NA | NA | ***20*** | 200 |
| Avg. 1998 | ND | 27 | 11.5 | 355 | 0.11 | 0.11 | 0.70 | 0.010 | 0.039 | 9.7 | 1.5 | 320 | NA | 2.1 | NA |
| Avg. 1999 | 0.25 | 24 | 10.7 | 378 | 0.16 | 0.11 | 0.76 | 0.006 | 0.039 | 9.3 | 5.4 | 260 | NA | 3.6 | NA |
| Avg. 2000 | ND | 26 | 11.1 | 340 | 0.01 | ND | 0.77 | 0.013 | 0.033 | 6.8 | 5.5 | 278 | NA | 5.5 | NA |
| Avg. 2001 | 1.75 | 23 | 83.0 | 528 | 0.03 | 0.02 | 0.82 | 0.004 | 0.025 | 1.5 | ND | 377 | NA | 4.2 | NA |
| Avg. 2002 | 0.5 | 30 | 74.3 | 545 | 0.05 | ND | 0.77 | ND | 0.036 | 4.0 | 2 | 383 | 2.6 | 24.5 | 20.5 |
| Avg. 2003 | ND | 28 | 74.3 | 516 | ND | ND | 0.98 | 0.002 | 0.033 | 5.5 | ND | 365 | 2.7 | 10.4 | 6 |
| Avg. 2004 | 6 | 27 | 84.8 | 508 | 0.00 | <0.05/<0.25 | 0.94 | <0.01 | 0.020 | 2.9 | 24 | 433 | 1.87 | 6.7* | NA |
| Avg. 2005 | NA | 31 | 131.4 | NA | 0.10 | < 0.03 | 1.20 | 0.010 | 0.029 | 3.2 | 2.8 | NA | NA | 5.9 | NA |
| Avg. 2006 | NA | NA | 117.3 | NA | NA / ND | NA / ND | 0.79 | 0.006 | 0.031 | 1.1 | ND | NA | NA | 6.2 | NA |
| Avg. 2007 | NA | NA | 108.0 | NA | NA / ND | NA / ND | 0.58 | ND | 0.028 | 2.4 | ND | NA | NA | 9.7 | NA |
| Avg. 2008 | No samples collected this year | | | | | | | | | | | | | | |
| 7/30/09 | NA | NA | 54 | NA | ND | 0.08 | 0.79 | ND | 0.024 | 2.0 | ND | NA | NA | 0.3 | NA |
| 8/25/10 | 2.9 | 28 | 46 | NA | 0.025 | ND | 0.75 | < 0.007 | 0.039 | 2.8 | ND | 260 | NA | 8.7 | NA |

* IL Standards (Title 35, Subtitle C Water Pollution, IEPA 1998) ***or typical limnological recommended concentrations*** (Yellow) = concentrations above State Standards or Recommended Maximum Concentration

** Ammonia nitrogen is dependent on pH and temperature. At pH 9 & temp 80 $^{o}$C, std = 0.1 mg/l. At pH 7 and 65$^{o}$ temp and below std = 15 mg/l

*** Dredging standard for return water

ND = Not detectable values, NA = data not available

* Not detectable values for Chlorophyll a were not included in average because method detection limits were higher than in previous years

**Site 2 Location: West side of pond**

(Samples collected at a 2-foot depth)

Values are mg/l

| | Phos. Dis. as P | Phos. Total | Tot. Susp. Solids |
|---|---|---|---|
| Avg. 1999 | NA | 0.034 | NA |
| Avg. 2000 | 0.010 | 0.032 | 8.3 |
| Avg. 2001 | 0.010 | 0.030 | 1.7 |
| Avg. 2002 | ND | 0.039 | 5.3 |
| Avg. 2003 | 0.008 | 0.033 | 3.5 |
| Avg. 2004 | Samples not collected at this location | | |
| Avg. 2005 | Samples not collected at this location | | |
| | | | |
| Avg. 2006 | Samples not collected at this location | | |
| Avg. 2007 | Samples not collected at this location | | |
| Avg. 2008 | Samples not collected at this location | | |
| 7/30/09 | | | |
| 8/25/10 | Samples not collected at this location | | |

**Site 1 Location: Deep Sample**

(Sample collected 2 feet off bottom)

Values are mg/l

| | Ammonia as N Nitrogen | Nitrate/ Nitrite Nitrogen | Phos. Total | COD |
|---|---|---|---|---|
| Avg. 1999 | 0.05 | ND | 0.249 | 22.5 |
| Avg. 2000 | 0.02 | ND | 0.035 | NA |
| Avg. 2001 | 0.04 | ND | 0.033 | 27.5 |
| Avg. 2002 | 0.04 | ND | 0.128 | 42.3 |
| Avg. 2003 | ND | ND | 0.044 | 29.5 |
| Avg. 2004 | Samples not collected at this location | | | |
| Avg. 2005 | Samples not collected at this location | | | |
| Avg. 2006 | NA | NA | 0.032 | NA |
| Avg. 2008 | No samples collected | | | |
| 7/30/2009 | NA | NA | 0.030 | NA |
| 8/25/2010 | NA | NA | NA | NA |

**Water Level - Gage readings**

| | feet |
|---|---|
| Avg. 2005 | 1.01 |
| Avg. 2006 | 1.37 |
| Avg. 2007 | 1.39 |
| 2008 | No data collected |
| 7/30/2009 | 1.54 |
| 8/25/2010 | 1.6 |

## Field testing of Sanctuary (Upper) Pond at Prairie Crossing

**Site 1 Location: Center of pond**

| | DO Surface (mg/l) | DO Bottom (mg/l) | Depth (ft) | pH | Secchi (ft) | Temp Surface (*C) | Temp Bottom (*C) | Alkalinity (mg/l) | Conduct. Field (umhos) | Chloride (mg/l) | Phosphorus Hach (mg/l) | IEPA Color | Susp. Sed. | Algae | Weeds | Odor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Standard** | 5.0 | 5.0 | NA | 6.5 - 9 | *1.5 / 4* | NA | NA | NA | NA | 500 | | | | | | |
| Avg. 1998 | 9.4 | 6.7 | 8.1 | 8.4 | 3.6 | 15.1 | 13.9 | 144 | 300 | NA | | | | | | |
| Avg. 1999 | 9.5 | 8.3 | 8.4 | 7.8 | 3.6 | 13.0 | 12.2 | 158 | 245 | NA | | | | | | |
| Avg. 2000 | 9.4 | 4.2 | 8.3 | 8.6 | 3.9 | 19.8 | 16.0 | 135 | 278 | NA | | | | | | |
| Avg. 2001 | 10.7 | 7.2 | 8.3 | 8.6 | 4.9 | 15.1 | 14.3 | 111 | 578 | NA | | | | | | |
| Avg. 2002 | 9.7 | 7.9 | 8.1 | 9.0 | 5.1 | 18.2 | 15.2 | 123 | 572 | 95 | | | | | | |
| Avg. 2003 | 9.2 | 4.3 | 8.0 | 8.7 | 3.4 | 18.7 | 15.5 | 136 | 578 | 123 | | | | | | |
| Avg. 2004 | 8.8 | 4.8 | 8.3 | 8.7 | 5.2 | 18.4 | 15.9 | 115 | 616 | 120 | | | | | | |
| Avg. 2005 | 8.2 | 5.4 | 7.9 | 8.5 | 5.5 | 20.6 | 17.6 | 118 | 806 | 154 | | | | | | |
| Avg. 2006 | 9.1 | 4.8 | 8.1 | 8.6 | 6.4 | 18.4 | 16.1 | 110 | 783 | 157 | | | | | | |
| Avg. 2007 | 9.1 | 3.5 | 8.2 | 7.8 | 5.1 | 19.4 | 16.3 | 162 | 737 | 120 | | | | | | |
| Avg. 2008 | No samples collected this year | | | | | | | | | | | | | | | |
| 7/30/2009 | 9.1 | 0.5 | 8.0 | 8.9 | 4.5 | 23.8 | 20.3 | 121 | 455 | 60 | 0.007 | lt. yellow | none | moderate | moderate | none |
| 8/25/2010 | 4.5 | 0.3 | 8.1 | 7.6 | 4.3 | 24.7 | 20.7 | 100 | 466 | 50 | 0.007 | lt. yellow | none | slight | heavy | none |

**Site 2 Location: West side of pond**

| | DO Surface (mg/l) | DO Bottom (mg/l) | Depth (ft) | pH | Secchi (ft) | Temp °C Surface (*C) | Temp °C Bottom (*C) | Alkalinity (mg/l) | Conduct. Field (umhos) | Chloride (mg/l) | Phosphorus Hach (mg/l) | IEPA Color | Susp. Sed. | Algae | Weeds | Odor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Standard** | 5.0 | 5.0 | NA | 6.5 - 9 | *1.5 / 4* | NA | NA | NA | NA | 500 | | | | | | |
| Avg. 1998 | 9.8 | 9.3 | 6.8 | 7.9 | 2.1 | 7.6 | 7.5 | 171 | NA | NA | | | | | | |
| Avg. 1999 | 9.0 | 6.1 | 8.4 | 7.7 | 3.2 | 13.3 | 12.2 | NA | 257.1 | NA | | | | | | |
| Avg. 2000 | 9.8 | 3.3 | 8.4 | 8.5 | 3.8 | 20.4 | 16.2 | NA | 277.2 | NA | | | | | | |
| Avg. 2001 | 10.1 | 7.4 | 8.0 | 8.7 | 5.1 | 15.3 | 13.9 | 174 | 565.9 | NA | | | | | | |
| Avg. 2002 | 10.5 | 6.6 | 8.1 | 9.0 | 5.0 | 18.8 | 14.0 | 175 | 562.0 | 97.5 | | | | | | |
| Avg. 2003 | 9.1 | 1.4 | 7.8 | 8.8 | 3.2 | 19.2 | 14.7 | 121 | 575.8 | 116.7 | | | | | | |
| Avg. 2004 | 9.0 | 5.3 | 8.0 | 9.0 | 5.0 | 20.6 | 16.2 | 98 | 583 | NA | | | | | | |
| Avg. 2005 | 9.0 | 3.7 | 7.3 | 8.8 | 4.7 | 20.9 | 17.0 | 58 | 799 | 160 | | | | | | |
| Avg. 2006 | 9.3 | 4.6 | 8.2 | 8.7 | 6.2 | 18.9 | 15.7 | 68 | 783 | NA | | | | | | |
| Avg. 2007 | 9.1 | 1.9 | 8.3 | 7.7 | 5.1 | 19.3 | 18.3 | 144 | 761 | NA | | | | | | |
| Avg. 2008 | No samples collected this year | | | | | | | | | | | | | | | |
| 7/30/2009 | 9.3 | 1.3 | 6.8 | 8.9 | 5.8 | 23.6 | 19.1 | 115 | 452 | 60 | | | | | | |
| 8/25/2010 | 5.2 | 0.3 | 8.1 | 7.3 | 4.4 | 25.5 | 20.2 | 119 | 478 | 55 | 0.016 | lt. yellow | none | slight | heavy | none |

*IL Standards (Title 35, Subtitle C Water Pollution, IEPA 1998) *or typical limnological recommended concentrations*

* Secchi depth reading limited by bottom plant growth

(Yellow) = concentrations above State Standards or Recommended Maximum Concentration

**NORTHERN LAKE SERVICE, INC.**
**Analytical Laboratory and Environmental Services**
**400 North Lake Avenue - Crandon, WI 54520**
**Ph: (715)-478-2777 Fax: (715)-478-3060**

# ANALYTICAL REPORT

**WDNR Laboratory ID No. 721026460**
**WDATCP Laboratory Certification No. 105-330**
**EPA Laboratory ID No. WI00034**

**Printed: 09/14/10 Code: NNNN-S** 

**NLS Project: 150737**
**NLS Customer: 15036**
**Fax: 847 244 0261 Phone: 847 244 6662**

**Client:** **Integrated Lakes Management Inc**
**Attn: Sandy Kubillus**
**120 Lebaron Street**
**Waukegan, IL 60085**

**Project: Sanctuary Pond**

ILM082510-SP, Comp NLS ID: 578567
COC: 125472 Matrix: SW
Collected: 08/25/10 10:00 Received: 08/26/10

| Parameter | Result | Units | Dilution | LOD | LOQ | Analyzed | Method | Lab |
|---|---|---|---|---|---|---|---|---|
| Chlorophyll, all species | see attached | | | | | 08/31/10 | 10200-H | 721026460 |
| Lab filtration for Chlorophyll | yes | | | | | 08/26/10 | NA | 721026460 |

ILM082510-SP, Grab NLS ID: 578568
COC: 125472 Matrix: SW
Collected: 08/25/10 10:00 Received: 08/26/10

| Parameter | Result | Units | Dilution | LOD | LOQ | Analyzed | Method | Lab |
|---|---|---|---|---|---|---|---|---|
| BOD-5 day | 2.9 | mg/L | 1 | 2.0* | | 08/26/10 | SM 5210-B 19ed | 721026460 |
| C.O.D. (unfiltered) | 28 | mg/L | 1 | 1.8 | 6.0 | 08/31/10 | SM 5220-C 20ed | 721026460 |
| Chloride, as Cl (unfiltered) | 46 | mg/L | 10 | 2.5 | 5.0 | 08/26/10 | EPA 300.0 | 721026460 |
| Nitrogen, ammonia as N (unfiltered) | [0.025] | mg/L | 1 | 0.025 | 0.075 | 08/30/10 | EPA 350.1 | 721026460 |
| Nitrogen, NO2 + NO3 as N (unfiltered) | ND | mg/L | 1 | 0.025 | 0.075 | 08/30/10 | EPA 353.2 | 721026460 |
| Nitrogen, Kjeldahl as N (unfiltered) | 0.75 | mg/L | 1 | 0.12 | 0.35 | 09/01/10 | EPA 351.2 | 721026460 |
| Phosphorus, dis. react. as P | 0.14 | mg/L | 1 | 0.0070* | | 08/27/10 | SM 4500P-E 20ed | 721026460 |
| | Dissolved Reactive Phosphorus was re-analyzed on 9/02/2010 with a result of 0.145 mg/L. An un-filtered portion of the sample was analyzed for Total Reactive Phosphorus on 9/10/2010 resulting in < 0.007 mg/L of Phosphorus. A filter blank was analyzed to verify that the filters were not contaminated with Phosphorus. The filter blank was < 0.007 mg/L Phosphorus. | | | | | | | |
| Phosphorus, tot. as P | 0.039 | mg/L | 1 | 0.0070* | | 08/31/10 | SM 4500P-E 20ed | 721026460 |
| | Sample was reanalyzed on 09/03/2010 and a result of 0.032 mg/L was obtained. On 09/10/2010 the non-preserved sample was analyzed for total phosphorus to verify result conflicts with dissolved ortho phosphorus, yielding a result of 0.031 mg/L. | | | | | | | |
| Solids, susp. volatile (water) | ND | mg/L | 1 | 5.0* | | 08/27/10 | EPA 160.4 | 721026460 |
| Solids, total | 260 | mg/L | 1 | 2.0* | | 08/30/10 | SM 2540-B 20ed | 721026460 |
| Solids, tot. susp. (TSS) | 2.8 | mg/L | 1 | 1.0* | | 08/27/10 | SM 2540-D 20ed | 721026460 |
| | Sample analyzed in duplicate to verify result. | | | | | | | |
| Lab filtration | yes | | | | | 08/27/10 | NA | 721026460 |

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution.

LOD = Limit of Detection LOQ = Limit of Quantitation ND = Not Detected (< LOD) 1000 ug/L = 1 mg/L
DWB = Dry Weight Basis NA = Not Applicable %DWB = (mg/kg DWB) / 10000
MCL = Maximum Contaminant Levels for Drinking Water Samples. Shaded results indicate >MCL.

Reviewed by:

Authorized by:
R. T. Krueger
President

**Northern Lake Service, Inc.**
**Chlorophyll Results**

**Customer:** Integrated Lakes Management Inc
**Project:** 150737
Sanctuary Pond

| Sample | Description | CC a | Pheo a | TC a | TC b | TC c |
|---|---|---|---|---|---|---|
| 578567 | ILM082510-SP, Comp | 8.7 | 0.64 | 9.2 | 2.4 | 0.61 |

CC a = Corrected Chlorophyll a
Pheo a = Pheophytin a
TC a = Trichromatic Chlorophyll a
TC b = Trichromatic Chlorophyll b
TC c = Trichromatic Chlorophyll c
Units = ug/L for Water, ug/$cm^2$ for periphyton samplers

*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.

## Biological Sampling

**Algal Analysis Report** | **Job #:** 202437

| | | | |
|---|---|---|---|
| **Client:** | Integrated Lakes Management | **Sample volume (ml):** | 250 |
| **Project:** | Sanctuary Pond | **Original volume (ml):** | 250 |
| **Station:** | 1 | | |
| **Depth:** | Comp | | |

| | |
|---|---|
| **Date collected:** | 08/25/10 |
| **Date received:** | 08/26/10 |
| **Report date:** | 09/02/10 |

**Method reference**: American Public Health Association (APHA) 1995. Standard Methods for the Examination of Water and Wastewater, 19th Ed. Method 10200F.2.C.1

| TSN[1] | Division | Common name | Genus | Aliases[2] | Concentration[3] (units/mL) | Relative (%) abundance | Biovolume ($\mu m^3$/unit) | Total biovolume ($\mu m^3$/mL) | Relative (%) biovolume |
|---|---|---|---|---|---|---|---|---|---|
| 4795 | Bacillariophyta | Diatom | *Cymbella sp.* | | 425.8 | 4.3 | 3061.5 | 1.3E+06 | 6.9 |
| 2932 | Bacillariophyta | Diatom | *Fragilaria sp.* | | 106.5 | 1.1 | 1406.7 | 1.5E+05 | 0.8 |
| 3649 | Bacillariophyta | Diatom | *Navicula sp.* | | 425.8 | 4.3 | 150.7 | 6.4E+04 | 0.3 |
| 5070 | Bacillariophyta | Diatom | *Nitzschia sp.* | | 106.5 | 1.1 | 2562.2 | 2.7E+05 | 1.5 |
| 5877 | Chlorophycota | Green algae | *Ankistrodesmus sp.* | | 212.9 | 2.1 | 62.8 | 1.3E+04 | 0.1 |
| 6273 | Chlorophycota | Green algae | *Coelastrum sp.* | | 106.5 | 1.1 | 904.3 | 9.6E+04 | 0.5 |
| 7848 | Chlorophycota | Green algae | *Cosmarium sp.* | | 106.5 | 1.1 | 1046.7 | 1.1E+05 | 0.6 |
| 9412 | Chlorophycota | Green algae | *Elakatothrix sp.* | | 106.5 | 1.1 | 67.0 | 7.1E+03 | 0.0 |
| 5990 | Chlorophycota | Green algae | *Monoraphidium sp.* | | 1596.9 | 16.0 | 48.1 | 7.7E+04 | 0.4 |
| 7055 | Chlorophycota | Green algae | *Mougeotia sp.* | | 212.9 | 2.1 | 9043.2 | 1.9E+06 | 10.3 |
| 8959 | Chlorophycota | Green algae | *Oedogonium sp.* | | 106.5 | 1.1 | 1858.9 | 2.0E+05 | 1.1 |
| 6456 | Chlorophycota | Green algae | *Radiofilum sp.* | | 106.5 | 1.1 | 5086.8 | 5.4E+05 | 2.9 |
| 6104 | Chlorophycota | Green algae | *Scenedesmus sp.* | | 851.7 | 8.5 | 37.7 | 3.2E+04 | 0.2 |
| 5661 | Chlorophycota | Green algae | *Tetraëdron sp.* | | 532.3 | 5.3 | 229.7 | 1.2E+05 | 0.7 |
| 10635 | Cryptophycophyta | Cryptomonad | *Cryptomonas sp.* | | 2342.1 | 23.4 | 896.4 | 2.1E+06 | 11.2 |
| 10663 | Cryptophycophyta | Cryptomonad | *Rhodomonas sp.* | | 958.1 | 9.6 | 41.9 | 4.0E+04 | 0.2 |
| 1100 | Cyanophycota | Blue-green algae | *Anabaena sp.* | | 212.9 | 2.1 | 2763.2 | 5.9E+05 | 3.1 |
| 727 | Cyanophycota | Blue-green algae | *Merismopedia sp.* | | 212.9 | 2.1 | 12.6 | 2.7E+03 | 0.0 |
| 747 | Cyanophycota | Blue-green algae | *Microcystis sp.* | *Anacystis, Polycystis* | 212.9 | 2.1 | 78.5 | 1.7E+04 | 0.1 |
| 917 | Cyanophycota | Blue-green algae | *Oscillatoria sp.* | *Planktothrix sp.* | 212.9 | 2.1 | 989.1 | 2.1E+05 | 1.1 |
| 9690 | Euglenophycota | Euglenoid | *Trachelomonas sp.* | | 638.8 | 6.4 | 8508.5 | 5.4E+06 | 29.0 |
| 10397 | Pyrrophycophyta | Dinoflagellate | *Ceratium sp.* | | 106.5 | 1.1 | 35938.0 | 3.8E+06 | 20.4 |
| 10212 | Pyrrophycophyta | Dinoflagellate | *Peridinium sp.* | | 106.5 | 1.1 | 15360.0 | 1.6E+06 | 8.7 |
| | | | | **Totals:** | 10007.1 | 100.0 | | 1.9E+07 | 100.0 |

| Totals by type: | Concentration (units/mL) | Relative (%) abundance | Biovolume | Total biovolume | Relative (%) biovolume |
|---|---|---|---|---|---|
| **Diatoms** | 1064.6 | 10.6 | | 1.8E+06 | 9.5 |
| **Green algae** | 3939.0 | 39.4 | | 3.1E+06 | 16.6 |
| **Cryptomonads** | 3300.2 | 33.0 | | 2.1E+06 | 11.4 |
| **Blue-greens** | 851.7 | 8.5 | | 8.2E+05 | 4.4 |
| **Euglenoids** | 638.8 | 6.4 | | 5.4E+06 | 29.0 |
| **Dinoflagellates** | 212.9 | 2.1 | | 5.5E+06 | 29.1 |
| **Totals:** | 10007.1 | 100.0 | | 1.9E+07 | 100.0 |

**Explanations:**
1. TSN=Taxonomic Serial Number (Integrated Taxonomic Information System).
2. Aliases: Some species have undergone recent taxonomic revisions. Literature may refer to older nomenclature. Both names are provided for convenience.
3. Natural Unit Count; Unit = unicell, colony or filament depending on taxa.

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**Zooplankton Analysis Report** | **Job #:** 202437

**Client:** Integrated Lakes Management
**Project:** Sanctuary Pond
**Station:** 1
**Depth:** Comp
**Sample volume (mL):** 250
**Original volume (mL):** 2000
**Date collected:** 08/25/10
**Date received:** 08/26/10
**Report date:** 09/02/10
**Method reference**: American Public Health Association (APHA) 1995. Standard Methods for the Examination of Water and Wastewater, 19th Ed. Method 10200.G.

| TSN[1] | Common | Order | Taxa | Aliases[2] | Concentration (#/L) | Relative (%) abundance | Individual biomass (µg) | Total biomass (µg/L) | Relative (%) biomass |
|---|---|---|---|---|---|---|---|---|---|
| 84077 | Cladoceran | Cladocera | *Graptoleberis testudinaria* (Fischer) | | 1.0 | 0.2 | 2.3 | 2.3 | 3.1 |
| 83938 | Cladoceran | Cladocera | *Bosmina longirostris* (O.F. Müller) | | 6.0 | 1.1 | 0.3 | 1.7 | 2.3 |
| 83905 | Cladoceran | Cladocera | *Ceriodaphnia sp.* | | 0.5 | 0.1 | 1.7 | 0.8 | 1.1 |
| 83993 | Cladoceran | Cladocera | *Chydorus sphaericus* (O.F. Müller) | | 10.0 | 1.8 | 0.7 | 7.2 | 9.5 |
| 83840 | Cladoceran | Cladocera | *Diaphanosoma birgei* (Korinek) | *D. leuchtenbergianum* | 0.5 | 0.1 | 0.9 | 0.5 | 0.6 |
| 88789 | Copepod | Cyclopoida | *Diacyclops thomasi* (S.A.Forbes) | *Cyclops thomasi, C. bicuspidatus* | 3.0 | 0.5 | 0.9 | 2.8 | 3.7 |
| 88530 | Copepod | Cyclopoida | Immature instar (copepodid) | | 8.0 | 1.5 | 0.3 | 2.2 | 2.9 |
| 85257 | Copepod | n/a | Nauplius (larval instar) | | 18.5 | 3.4 | 0.8 | 15.2 | 20.2 |
| 83983 | Cladoceran | Cladocera | *Alona costata* Sars. | | 0.5 | 0.1 | 0.2 | 0.1 | 0.1 |
| 58360 | Rotifer | Ploima | *Keratella cochlearis* (Gosse) | | 250.00 | 45.6 | 0.1 | 25.0 | 33.3 |
| 58634 | Rotifer | Ploima | *Lecane sp.* | | 62.50 | 11.4 | 0.1 | 6.3 | 8.3 |
| 59277 | Rotifer | Ploima | *Polyarthra vulgaris* Carlin | | 187.50 | 34.2 | 0.1 | 11.3 | 15.0 |
| | | | | **Totals:** | 548.0 | 100.0 | | 75.2 | 100.0 |

**Totals by type:**

| | Concentration (#/L) | Relative (%) abundance | Individual biomass (µg) | Total biomass (µg/L) | Relative (%) biomass |
|---|---|---|---|---|---|
| Cladocerans | 18.0 | 3.3 | | 12.5 | 16.6 |
| Copepods | 30.0 | 5.5 | | 20.2 | 26.9 |
| Rotifers | 500.0 | 91.2 | | 42.5 | 56.5 |
| | 548.0 | 100.0 | | 75.2 | 100.0 |

**Explanations:**

1. TSN=Taxonomic Serial Number (Integrated Taxonomic Information System).
2. Aliases: Some species have undergone recent taxonomic revisions. Literature may refer to older nomenclature. Both names are provided for convenience.

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