# Lower Bolton Lake
# Status Report

*Prepared for:*

**Town of Bolton**

Bolton, CT

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# Executive Summary

## Lower Bolton Lake

This report is a summary of 3+ years of lake testing at Lower Bolton Lake by Northeast Aquatic Research (NEAR) between summer of 2011 and November 2015. NEAR was initially retained by the Town of Bolton to check the status of the lake, one visit in July 2011, and then a single visit in July 2012 to investigate prolific spread of southern naiad. Frequent and regular lake monitoring by NEAR started in late August 2012 as the lake experienced a severe algae bloom. NEAR expects to update this report annually as more data is collected.

## Threats to Lower Bolton Lake

1. Proliferation of Southern Naiad

Initial concern at Lower Bolton Lake in 2011 and 2012, was excessive growths of southern naiad. Connecticut Agricultural Experiment Station did not find it in 2005 but re-survey in 2011 found over 80% of the bottom was thickly blanketed by naiad[1] In August 2012 floating rafts densely covered over 12 acres of surface area as in **Photo 1**.

**Photo 1: - Raft of floating naiad (circular dark area) in Lower Bolton Lake August 2012**

[1] http://www.ct.gov/caes/cwp/view.asp?a=2799&q=380464
http://www.ct.gov/caes/cwp/view.asp?a=2799&Q=490410&PM=1

2. **Severe Cyanobacteria Blooms**

In August 2012, Lower Bolton Lake experienced an unprecedented bloom of cyanobacteria. Water clarity declined to less than 1 meter and cyanobacteria cell numbers increased to over 100,000 cells/mL[2] (see **Photo 2**). Lower Bolton Lake became a highly eutrophic lake within 2 months.

**Photo 2: - Lower Bolton Lake during 2012 algae bloom (left) while Middle Bolton Lake (right) was clear.** Photo credit: Friends of Bolton Lakes

3. **Invasive Aquatic Plants**

The invasive non-native aquatic plant variable-leaved milfoil was found growing sporadically on the west shore in 2011 and 2012. Fragments of the invasive non-native aquatic plant fanwort were found in 2011 and 2012. A small bed of fanwort was found in a small cove on the west shore in 2013.

[2] mL = milliliter is a small unit of liquid measure equal to 0.034 ounces

## Threat Update

1. **Southern Naiad**

Southern naiad was controlled in 2013 with a whole lake application of Fluridone, an aquatic plant herbicide. Surveys of Lower Bolton Lake conducted in 2013-2015 have found very little southern naiad. Other native species have been returning including macroalgae, and pondweeds. After three years of very little naiad growth, proliferation of this species is no longer considered a threat. Further discussion on naiad and other native species can be found in the Aquatic Plants Section.

2. **Cyanobacteria**

Cyanobacteria (bluegreen algae) are still a very real threat to Lower Bolton Lake. Although cyanobacteria numbers have not reached levels seen in August and September 2012, pre-bloom conditions occurred in July 2013, and a moderate bloom occurred in September 2015, both prompting treatment with copper sulfate. The 2015 algae bloom persisted into November but shifted to Green algae with scarce cyanobacteria present after the treatment.

Mechanisms that cause the blooms are now partially understood with increases of phosphorus, nitrogen, and iron, implicated as primary drivers. Increased phosphorus is the principal driver of phytoplankton growth in lakes (see **pg. 43**), but higher nitrogen and iron levels combine synergistically to cause very severe cyanobacteria blooms as both are nutrients. Essentially, long-term control of cyanobacteria blooms at Lower Bolton Lake will require limiting the quantity of these three plant nutrients in lake water. Results from the three years of sampling shows:

1. **Phosphorus always at excessive levels,**
    - **With >20ppb in late spring, >30ppb in mid-summer**
2. **Total Nitrogen occasionally at excessive levels,**
    - **>1000ppb during bloom,**
3. **Iron always at greatly excessive levels in the mixed layer,**
    - **>100ppb most of the time, >300ppb in fall**

- **Phosphorus concentrations: Target thresholds are 20ppb in the short-term and 10ppb long-term.**
    - Now that the drainage basin has been mostly sewered, ways to limit phosphorus in the lake include; controlling internal release from bottom sediments, decreasing concentrations in storm-water and other tributary flows, and decreasing the iron concentration in the water.
        - Internal phosphorus release has not been clearly demonstrated to occur but increases of phosphorus in the lake during summer, when there is little to no inflow, points to internal sources. Further investigation into sediment phosphorus levels needs to be done, as well as fractionation of phosphorus types in sediments.
        - Storm-water phosphorus levels of >500ppb have been noted from several sites around the lake. Large changes in lake phosphorus mass could be due to heavy storms causing high amount of loading in a short term. Conveyance of these sub-basins needs to be mapped and investigated. Potential sources of the nutrients need to be identified and corrected.
- **Nitrogen concentrations. Target thresholds are <500ppb in the short-term, and <400ppb long-term.**
    - Investigate the coincidence of spikes in total nitrogen concentration with occurrence of cyanobacteria blooms.
- **Iron levels: target thresholds are <100ppb short-term and <25ppb long-term.**
    - At this time more information is needed to explain why iron remains in the water column at 10x when iron is 100ppb, 30x when iron is 300ppb.
        - Further investigation into the mechanism causing iron to remain in solution is needed. Since Ferric iron forms the insoluble Ferric-hydroxide concentrations of iron in oxygenated water is typically <10ppb. Iron also binds with phosphorus, settling iron from the water column may also settle and hold phosphorus in the bottom sediments.

### 3. Invasive Aquatic Plants

Invasive aquatic plants are treated in detail in the **Aquatic Plant Section (Pg. 18)** that follows.

- Variable-leaved milfoil has not been seen since the Fluridone treatment in 2013.

- Fanwort observed in a small cove on the west shore was treated in September 2013. Fanwort has not been seen in the lake since that treatment.

- Curly-leaf pondweed, a new invasive aquatic plant species, first seen in October 2014, spread quickly around the lake during the summer of 2015. An herbicide treatment was made of known curly-leaf pondweed beds in September 2015 to control the plants spread.
- **Close surveillance of curly-leaf pondweed is needed in 2016.**

## Five actions necessary at this time.

1. Continued close investigation and monitoring.
   a. The lake is still changing, as noted by almost all trends shown for the last three years.
   b. Nutrient levels are still high enough to cause a cyanobacteria bloom.
   c. Invasive aquatic plant species continue to be present in the lake.
   d. The return of native aquatic plants should be closely monitored.
   e. High iron levels in the water may cause unexpected effects.
2. Prepare for a cyanobacteria bloom.
   a. File necessary permit applications so a copper sulfate treatment can be made in 2016 should cyanobacteria numbers increase to threating levels.
   b. Monitor cyanobacteria levels during the summer and treat with copper sulfate if necessary.
3. Prepare for naiad or invasive species treatment.
   a. File necessary permit applications for Diquat / Flumioxazin / Fluridone treatment to control = curly-leaf pondweed, variable-leaved milfoil, fanwort, naiad.
   b. Monitor aquatic plant presence and density and abundance during the spring and early summer.
   c. Treat beds of plants as necessary.
4. Continue drainage basin investigation.
   a. Watershed testing in 2014 & 2015 showed that some flows were very high in nitrogen or phosphorus or both.
   b. More investigation is needed to verify prior high results.
   c. Prioritize importance of possible watershed loads by level of nutrients and water flow.
   d. Refine sampling to systematically find root cause of sources of nutrients.
5. Prepare for an Aluminum Sulfate treatment.
   a. Although not conclusive at this time, internal loading appears to be the principal source of phosphorus in Lower Bolton Lake.
   b. Internal load may be split between anaerobic release from sediments deeper than 14 feet, and ground water seepage.
   **c.** Sulfate will aid in removal of iron suspended in the water column.

# Summary of Monitoring Results

Monitoring conducted at Lower Bolton Lake has goals of; 1) understanding changes in lake-water quality that lead to cyanobacteria blooms, 2) surveying aquatic plant beds searching for invasive species, evaluating the success of treatments, and maintain vigil on recovery of native plants and 3) investigating the drainage basin for nutrient and sediment sources. The following synopsis of the monitoring results presents a summary for each of the primary parameters. Further limnological details can be found in **Appendix 1 Lower Bolton Lake Analysis**, **page 36**.

## 1 In-lake water quality

### Study Design

To track water quality in Lower Bolton Lake, NEAR established Station 1 in July 2011 as the principal location for monitoring in-lake conditions. Station 1, at the site of deepest water of 18-19 feet, allows drawing of three stratified water samples from 1 meter (3 feet), 3 meters (10 feet) and 5 meters (16 feet) depths. Station 2 was established in August 2012 to better represent the more predominant water depths in the lake. Station 2 is located at 10-12 feet of water depth with two water samples collected from 1 meter (3 feet), 3 meters (10 feet). Water quality sampling visits were made between March and November at two to four week intervals with the more frequent visits made during the summer. The overflow from Upper and Middle Bolton Lakes and the discharge from Lower Bolton Lake were measured during each visit made during 2014 and 2015.

Water quality of lakes typically refers to the level of nutrients it contains, specifically phosphorus and to a lesser extent, nitrogen. Principal water quality parameters are phosphorus concentration and water clarity as measured by the Secchi disk. As phosphorus increases, plankton increases which in turn cause the water to get cloudier and the Secchi disk clarity decreases.

### CT DEEP Trophic Categories

Using quantity of phosphorus and resulting plankton and water clarity conditions, CT DEEP grouped lakes into 6 different Lake Trophic Categories (**Table 1).** The Trophic Category,[3] numbered 1-6 in this report, characterize a lake by quantity of phosphorus and resulting plankton growth. At the lowest trophic category 1, phosphorus is almost too low to measure, plankton too low to find easily,

[3] also known as Trophic–Level, Trophic-State, or Trophic–Status

and cyanobacteria are virtually nonexistent. At the highest trophic category 6, plankton is exclusively cyanobacteria forming dense blooms all summer with scums on shore. The difference between 1 and 6 is the addition of about 40ppb of phosphorus. In this report these categories will be used to describe the instantaneous state of the lake.

**Table 1: – CT DEEP lake trophic categories and ranges of indicator parameters**

| Trophic Category | Phosphorus (ppb) | Nitrogen (ppb) | Secchi Depth (meters) | Chlorophyll-*a* (ppb) |
|---|---|---|---|---|
| 1- Oligotrophic | 0 – 10 | 0 – 200 | 6 - 10 | 0 – 2 |
| 2-Oligo-mesotrophic | 10– 15 | 200- 300 | 4– 6 | 2– 5 |
| 3- Mesotrophic | 15 – 25 | 300 - 500 | 3 – 4 | 5 – 10 |
| 4- Meso-eutrophic | 25 – 30 | 500 - 600 | 2 – 3 | 10 – 15 |
| 5- Eutrophic | 30 – 50 | 600 – 1,000 | 1 – 2 | 15 – 30 |
| 6- Highly Eutrophic | 50 + | 1,000 + | 0 – 1 | 30 -50 |

Source = CT DEEP 1982

ppb = parts per billion

## Water Quality of 2012 Bloom

The bloom of 2012, shown in **Photo 2** above, is depicted graphically in the chart below (**Figure 1)** and described numerically in **Table 2.** Data show that in July 2012 Lower Bolton Lake was in Category #2 --Oligo-Mesotrophic, but by early September was in Category #6 --Highly Eutrophic based on clarity readings.

**Figure 1: – Water clarity and cyanobacteria cell numbers in Lower Bolton Lake during 2012**

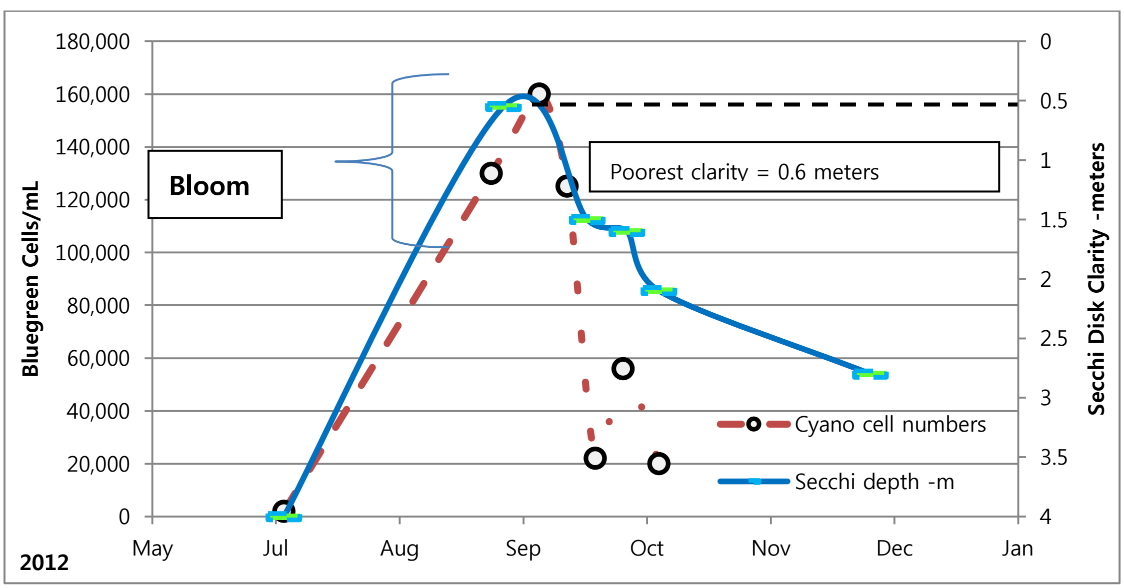


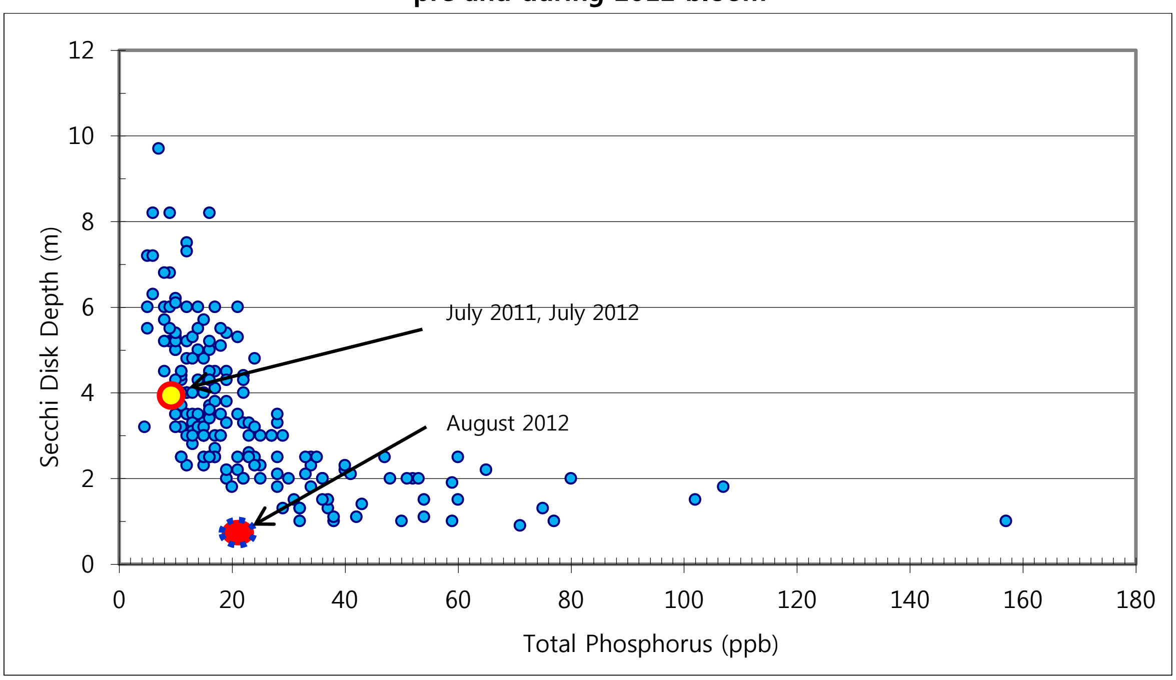
**Table 2: – Changing conditions in Lower Bolton Lake during 2012**

| Category | July 27, 2011 | July 3, 2012 | August 27, 2012 | Sept. 17, 2012 |
|---|---|---|---|---|
| Total Phosphorus (1 and 3m) –-ppb | 9 | 13 | 22 | 13 |
| Total Phosphorus (5m) –-ppb | 52 | 24 | 34 | 10 |
| Total Phosphorus mass (whole lake) –-kg | 21 | 28 | 43 | 26 |
| Total Nitrogen (1 and 3m) –ppb | 307 | 408 | 2,250 | 750 |
| Total Nitrogen (5m) –ppb | 934 | 810 | 2,360 | 1,090 |
| Total Nitrogen mass (whole lake) –-kg | 664 | 832 | 4,434 | 1,541 |
| Secchi Disk clarity –-m | 3.7 | 4.0 | 0.6 | 1.5 |
| Cyanobacteria cell numbers -–cells/mL | | 1,200 | 130,000 | 125,200 |

## Relationship between phosphorus and water clarity

Increasing phosphorus causes declining water clarity in a non-linear way (**Figure 2**[4]). The chart in **Figure 2** shows the position of Lower Bolton Lake (large circles) pre- and during the 2012 bloom with respect to water clarity and phosphorus. Decrease in water clarity was worse than predicted by observed phosphorus. According to the relationship shown in **Figure 2**, predicted phosphorus concentration for 0.6meter clarity is at least 30ppb, not 22ppb as observed, suggesting phosphorus was not the primary driver of the bloom in 2012.

**Figure 2: – Phosphorus/Secchi disk depth relationship in CT lakes showing Lower Bolton Lake pre and during 2012 bloom**




Source = CT Agricultural Experiment Station Bulletin 817, 1984

4 CAES 1984, collection of over 100 lakes in CT in the 1970's

## Water Quality Metrics

Water quality monitoring of lakes involves tracking the following parameters: phosphorus— primary driver of phytoplankton growth, nitrogen-- secondary driver of phytoplankton growth, water clarity— estimates density of phytoplankton, phytoplankton— direct presence and numbers of algae and cyanobacteria, water temperature— determine degree of stratification and mixing depth, and dissolved oxygen— find anoxic water and possible anaerobic respiration. Targets and thresholds used to assess the monitoring data are given here for each parameter.

- **Phosphorus** – Total phosphorus causes increased cyanobacteria growth.
  - Total phosphorus less than 10ppb pre-blooms level.
  - Total phosphorus between 10-20ppb linked to declining water clarity.
  - Total phosphorus over 30ppb is linked to poor clarity and cyanobacteria. Considered Eutrophic by DT DEEP.
- **Nitrogen** – Nitrogen levels have been linked to shifts in algae that favor some types of cyanobacteria.
  - Lakes with total nitrogen of 600ppb considered Eutrophic by CT DEEP.
  - Lakes with total nitrogen of 1,000ppb considered Highly Eutrophic by CT DEEP.
  - Total nitrogen was over 2,000ppb in August 2012.
- **Water Clarity** – The Secchi disk depth is a measure of cyanobacteria density.
  - Clarity of 3 meters and better generally means few cyanobacteria are present.
  - Clarity of <2m considered Eutrophic by CT DEEP.
  - Secchi disk depths <1 meter are severe cyanobacteria bloom conditions.
- **Cyanobacteria Cell Numbers** – Increasing cell numbers caused diminished clarity.
  - Highest cyanobacteria numbers in 2012 bloom was 100,000-230,000 cells/mL.
  - Poor water clarity persisted until cyanobacteria numbers fell below 20,000 cells/mL.
- **Water Temperature**
  - Deeper mixing depths favor non-cyanobacteria types of plankton, while decreased mixing depths favor cyanobacteria.
- **Dissolved Oxygen**
  - Dissolved oxygen should be above 5ppm to avoid hypoxic conditions that stress and threaten organisms.
  - Dissolved oxygen below 1ppm is anoxic and can't support aerobic organisms.
  - Water and sediment with anoxic conditions allow anaerobic respiration.

## Phosphorus

Total phosphorus levels in Lower Bolton Lake between 2012 and 2015 are shown in **Figure 3**. The chart shows the trends of phosphorus concentration at the 1 and 3 meter depths representing the mixed depth. Water deeper than 3 meters is considered stagnant deep water and is treated separately during the stratified summer conditions. **Figure 3** shows the following important aspects:

1 – Very early spring phosphorus has been low with concentrations slightly above 10ppb, suggesting baseline conditions for the lake are near Oligotrophic.

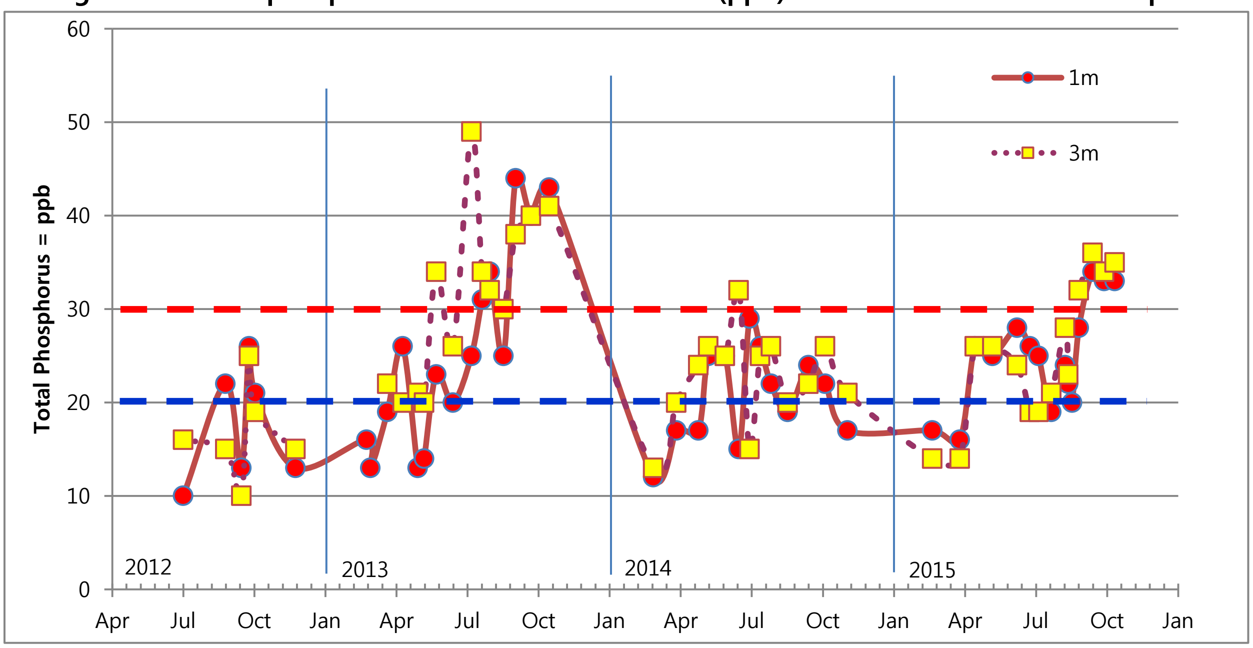
2 – Phosphorus concentration quickly increases to levels >20ppb indicative of a shift in trophic category to Mesotrophic by May each year.

3 - Phosphorus exceeded 30ppb during most of the summer of 2013, approached 30ppb in 2014 and exceeded 30ppb in the fall of 2015. These high values indicate a Eutrophic lake.

4 - Most phosphorus readings in 2013-2015 exceeded the maximum values observed during the 2012 bloom.

5 – Generally phosphorus concentration at the 1 and 3 m depths were identical verifying that these depths represent the mixed layer of the lake.

**Figure 3: - Total phosphorous concentration trends (ppb) at 1 meter and 3 meters depths**




## Total Nitrogen

Total nitrogen trends in the mixed layer of Lower Bolton Lake between 2012 and 2015 are shown in **Figure 4**. The chart in **Figure 4** shows the following important aspects:

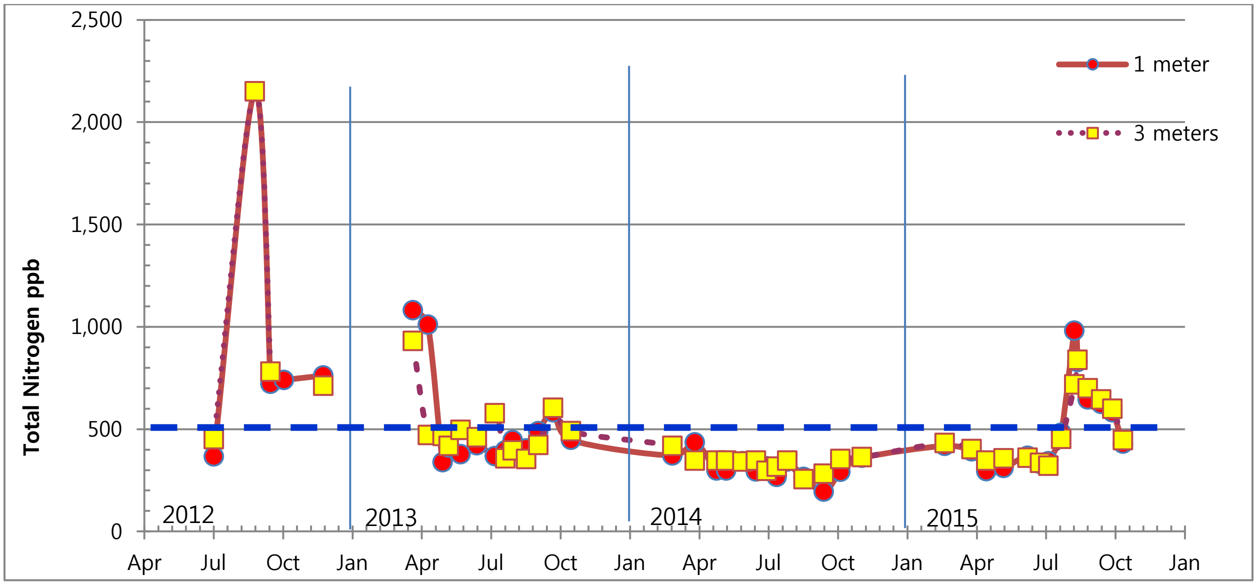
1 - Total nitrogen was exceptionally high during the bloom in 2012, although similar levels have not been seen in the lake since that time.

2 – Two episodes of 1,000ppb concentrations have occurred since 2012, once in early 2013, and next in late August 2015.

3 – With the exception of the two spikes, almost all values have been below the 500ppb--upper threshold for Mesotrophic Lakes.

4 – As with phosphorus, most 1 and 3 meter samples were similar to each other.

**Figure 4: - Total nitrogen concentration trends (ppb) at 1 m and 3 m depths**




## Water clarity:

The water clarity of Lower Bolton Lake between 2012 and 2015 is shown in **Figure 5**. Important aspects of the water clarity trend are:

1 – Poorest clarity measured to-date is still 0.6m from the end of August 2012.

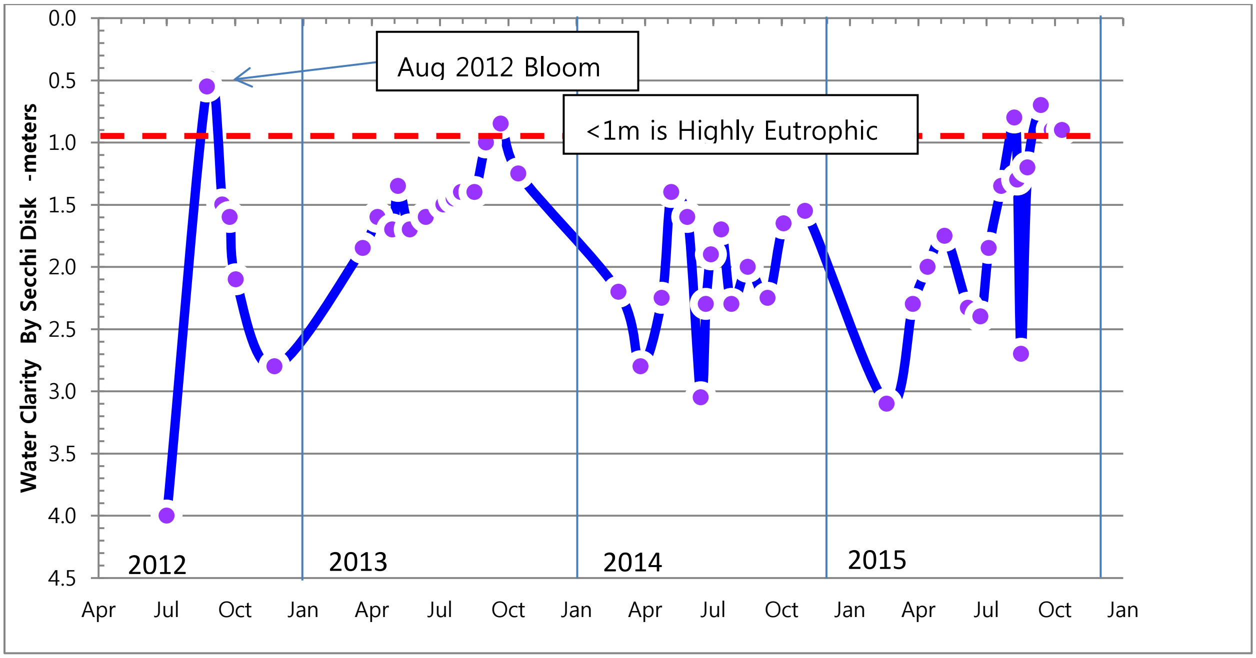
2 – Clarity trends in 2013 and 2015 show that conditions tended to be best at the very beginning of the season followed by gradual decline until falling below 1 meter by end of the season.

3 – Best clarity for the record shown in **Figure 5** remains 4m measured in July 2012, although individual Secchi disk depth measurements of 3m were recorded in 2014 and 2015.

4 – Clarity increased dramatically following the copper treatment in September 2015, jumping from <1m on August 31$^{st}$ to 1.3m on the day of the treatment September 2$^{nd}$, and to 2.7m on September 9$^{th}$ one week later. But the increase in clarity was short lived and within a month of the treatment the clarity was back down below 1m because algae populations shifted in type and rebounded given remaining high nutrient availability.

5 – The decrease in clarity before the copper treatment was caused by increasing cyanobacteria populations, but the decrease in clarity after the copper treatment was caused by increasing Green algae populations (**Figure 6**).

**Figure 5: - Water Clarity (Secchi disk depth) in Lower Bolton Lake during 2012-2015**




## Cyanobacteria

Trends in dominant taxa of phytoplankton in Lower Bolton Lake between 2012 and 2015 are shown in **Figure 6**. The chart in **Figure 6** shows the following important aspects:

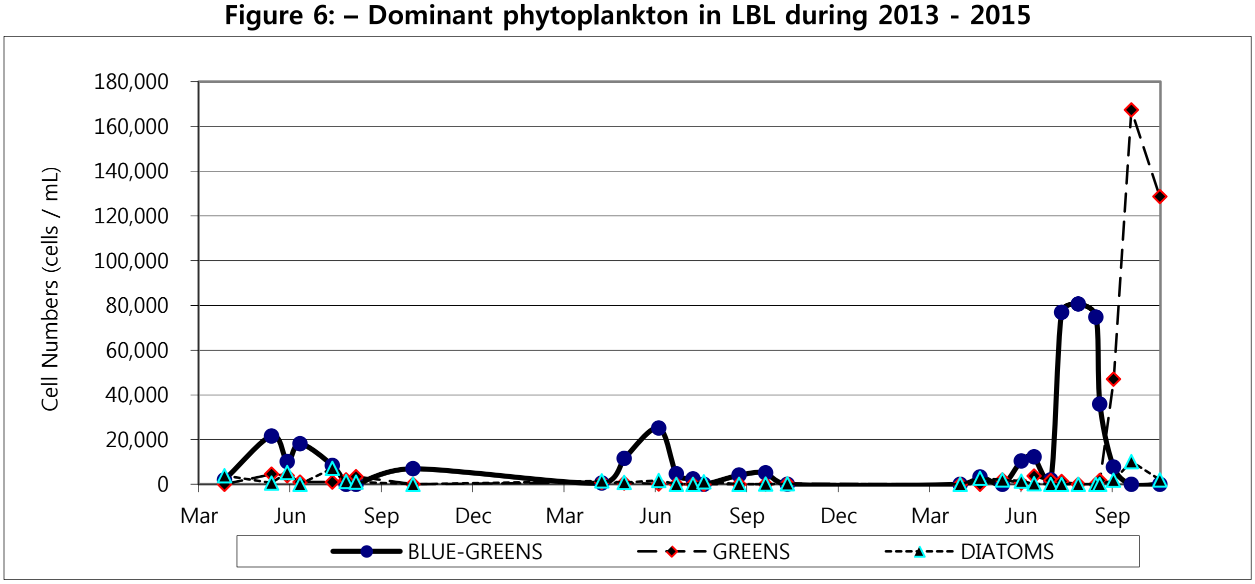
1 – Cyanobacteria remains a threat to Lower Bolton Lake as increases in cell numbers have been seen each year 2013, 2014, and 2015.

2 – Cyanobacteria increases in 2013 and 2015 were arrested from further growth into bloom levels by application of copper sulfate treatments.

3 – Green algae became very numerous after the copper sulfate treatment in 2015.

4 – Diatom populations have remained low throughout the monitoring period.

**Figure 6: – Dominant phytoplankton in LBL during 2013 - 2015**

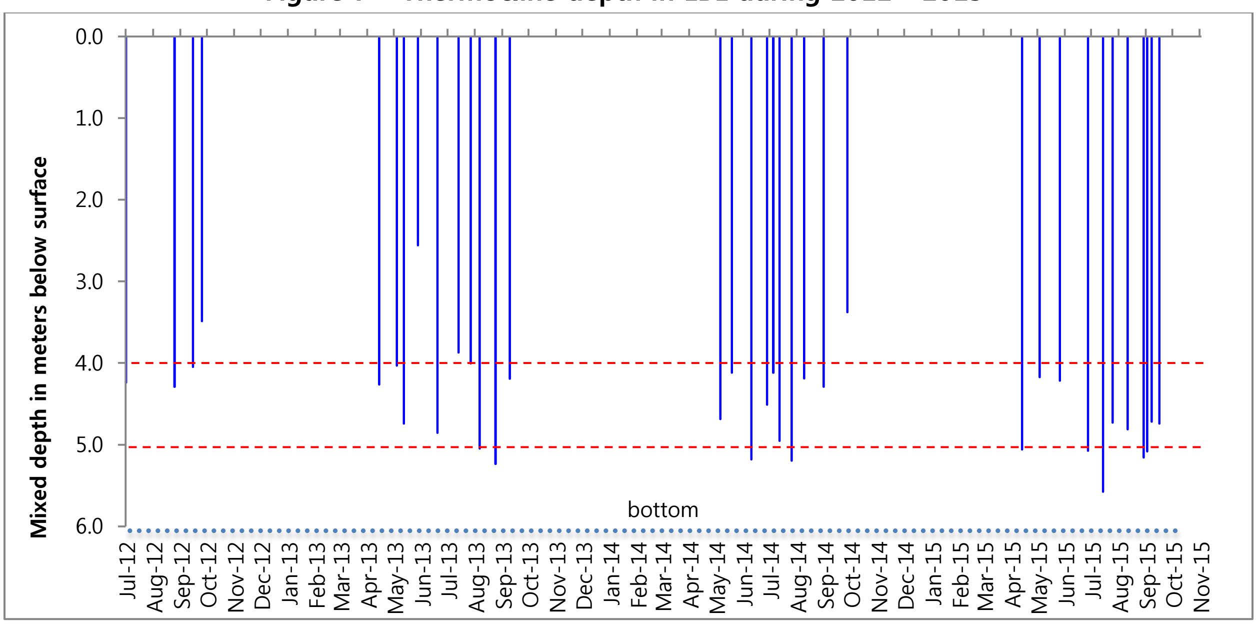


## Water Temperature

Water temperature is the primary factor determining lake structure. In this capacity, structure refers to the stratification of the lake into independent horizontal layers, not the physical aspects of lake basin morphology. Due to temperature-dependent density differences water in each layer will not easily interact with water in other layers (see Lake Layering and Stratification on page 39). Different processes take place in each layer more-or-less separately. The degree of layering, the resulting strength of isolation, and the location (depth) of boundaries between layers governs how the lake functions. The "mixed depth" is the upper layer of water that is in chemical equilibrium with the atmosphere and mixing due to wind (**Figure 7**). Blue lines in **Figure 7** show the depth to the thermocline or lower boundary of the mixed layer in Lower Bolton Lake.

1. Mixed depth generally reaches 4 meters. On a few dates, mixing depth was between 3 and 4 meters, and one date in 2013 had a mixed depth of only 2.6 meters.
2. Mixing depth remains fairly constant during the season with little upward or downward seasonal trends.
3. With mixed depth typically deeper than 3 meters, water chemistry results from 1 and 3 meters should tend to be very similar.
4. Average seasonal mixing depth has deepened during the last three years from 4.3m in 2013 to 4.9m in 2015.
5. Mixing depth to 5 meters leaves a very small volume of lake water remaining as stagnant isolated bottom water.

**Figure 7 – Thermocline depth in LBL during 2012 - 2015**



## Dissolved Oxygen

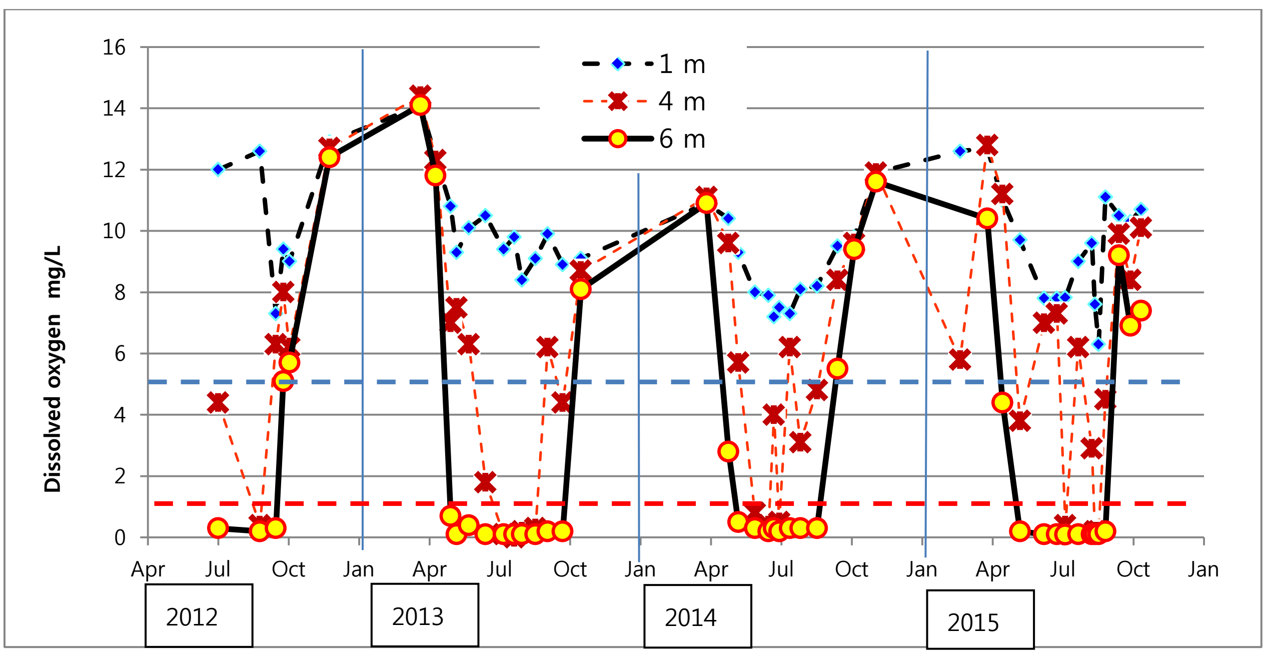
Dissolved oxygen levels in Lower Bolton Lake between August 2012 and the end of 2015 are shown in **Figure 8** at three critical depths. Measurements from 1 meter represent the upper mixed layer. Data from 4 meters is intermediary between the upper mixed layer and deeper waters below, and 6 meters represents stagnant bottom water. Important aspects of the dissolved oxygen trends are:

1 – Water at the bottom of the deep hole (circles and solid line) becomes devoid of dissolved oxygen each year at roughly the same time in the spring (early to late May) and remains devoid of oxygen until about the same time in the fall (late September-early October). The duration of time that bottom water was devoid of dissolved oxygen in 2013 was 148 days, decreasing to 131 days in 2014 and 2015.

2 – Dissolved oxygen at 4 meters (dashed line with x) was <5ppm, between June and late-September **Figure 8** blue dashed line, and completely devoid of dissolved oxygen between early July and mid-September. As demonstrated by shorter periods of anoxia from 2013-2015, dissolved oxygen demands appear to be decreasing.

3 – Dissolved oxygen content at 1 meter (dashed line with diamonds) was good throughout the period shown in the chart, although minor period of depressed levels of dissolved oxygen were noted in the fall.

**Figure 8: - Dissolved oxygen concentrations in Lower Bolton Lake during 2012 - 2015**



# 2 Aquatic Plants

## 2013 Treatments

Between 2005 and 2011, Southern Water-Naiad (*Najas guadalupensis*), a rooted aquatic plant native to Connecticut, experienced explosive growth in Lower Bolton Lake. In 2005, Connecticut Agricultural Experiment Station (CAES) conducted a survey of Lower Bolton Lake and found no southern naiad (**Map 1**). However six years later in 2011, CAES documented southern naiad covering about 97% of the lake area growing to a depth of 15 feet (**Map 2**). That same year--2011, NEAR mapped 12 acres of floating rafts of naiad (**Photo 1**) so dense that mechanical harvesting was considered as a removal option (**Map 3a**). The following year 2012, southern naiad was dense and near the surface over about 90% of the lake area with near topped out growth throughout **(Map 3b)**.

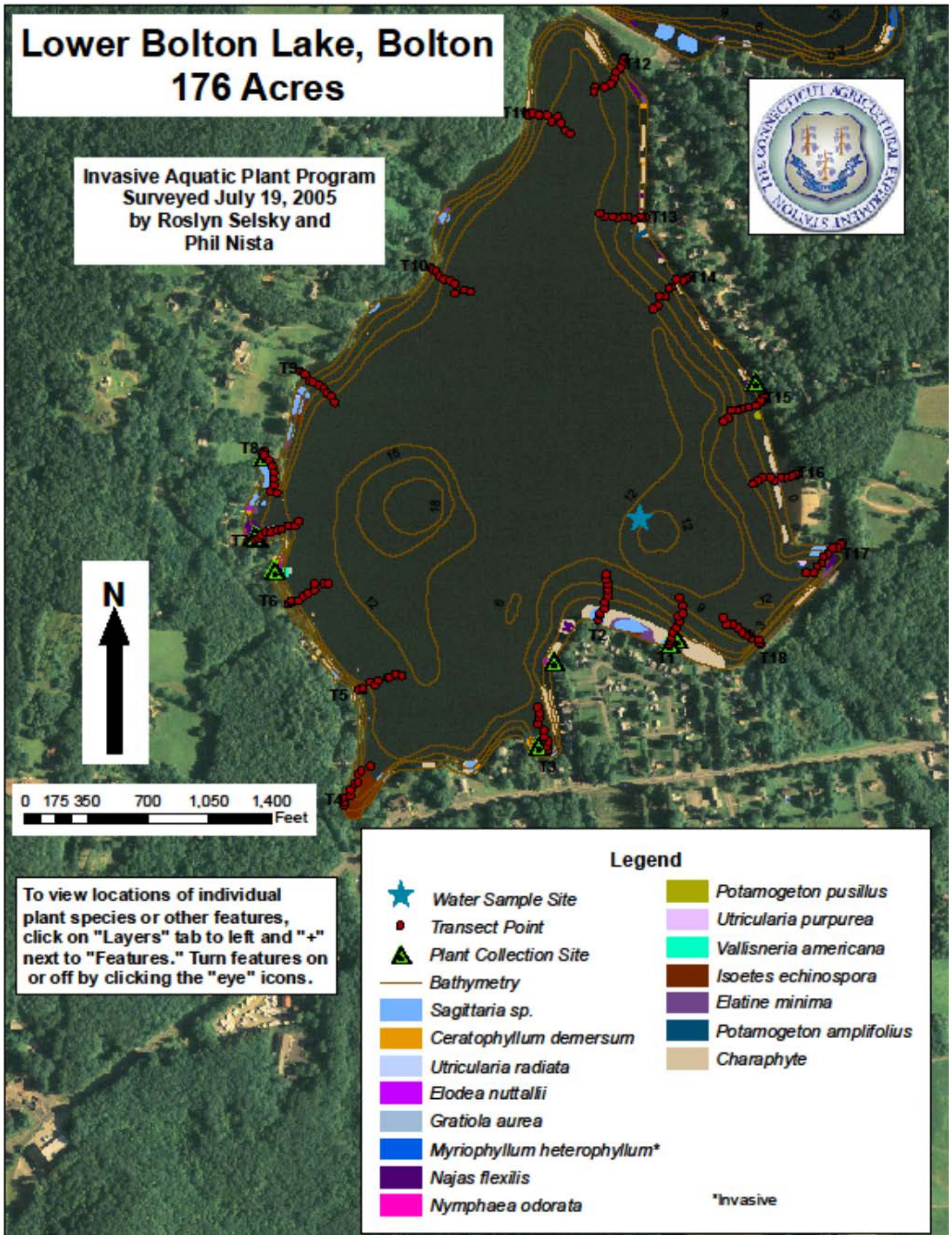
Based on NEAR's recommendation, Aquatic Control Technology (ACT)[5] treated the lake with the herbicide Fluridone in May 2013 with a follow up booster treatment in June 2013 (**Table 3**). NEAR inspections after treatment, July 2013, (also surveys in 2014, 2015 continue to show very little naiad) determined that the cover of Naiad was reduced by >98% (**Map 4**) rendering the naiad control treatment a success.

**Table 3: - Lower Bolton Lake 2013 Treatment Summary**

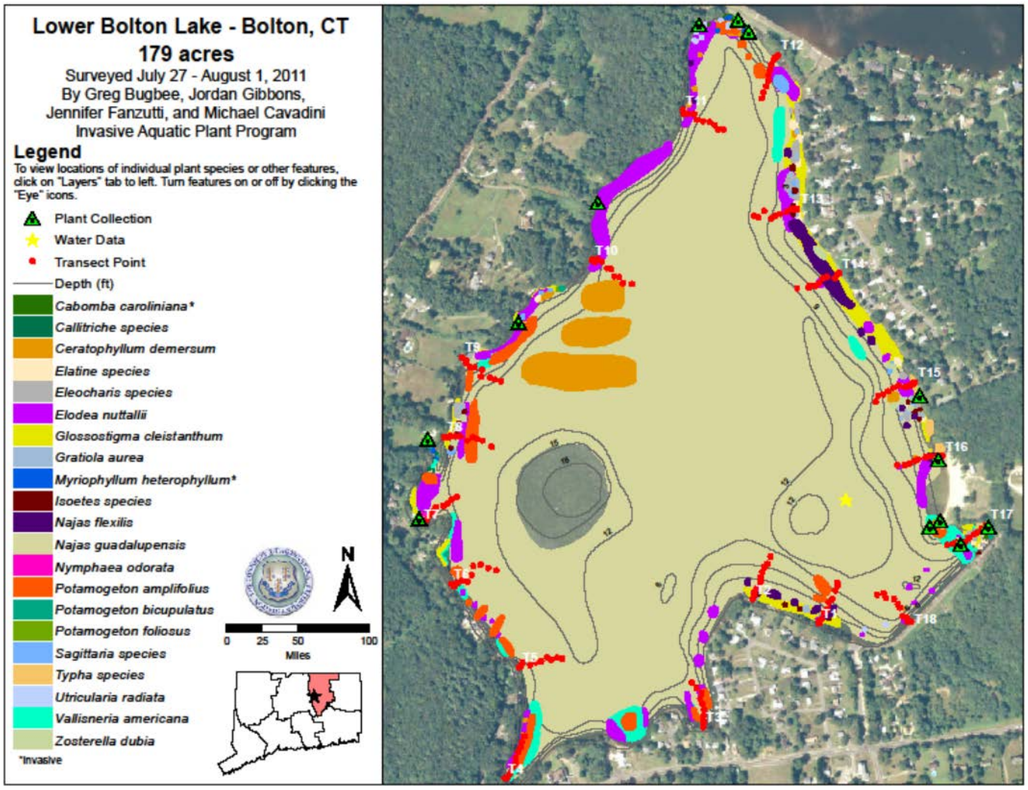
| Date 2013 | Task |
|---|---|
| April 9th | Received CT DEEP Permit |
| April 16th | Pre-Treatment Inspection (ACT) |
| May 20th | Initial Fluridone Herbicide Treatment |
| June 4th | Inspection |
| June 27th | Follow-Up Booster Herbicide Treatment Copper Algaecide Treatment (1/2 lake) |
| August 6th | Inspection |
| September 5th | Inspection Spot Fanwort Treatment |

5 Aquatic Control Technologies is now Solitude Lake Management

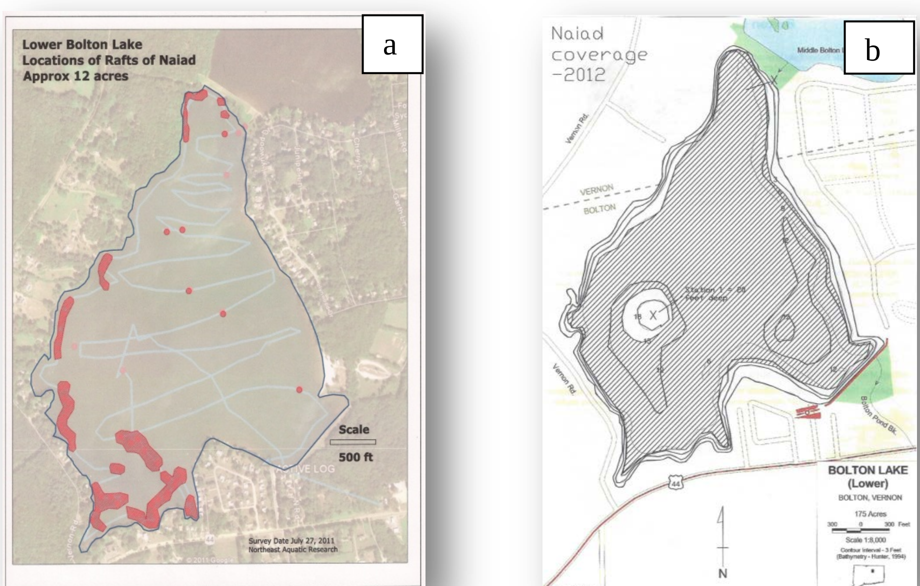
**Map 1: - Map showing no southern naiad (Najas guadalupensis) in Lower Bolton Lake during CAES survey in 2005**



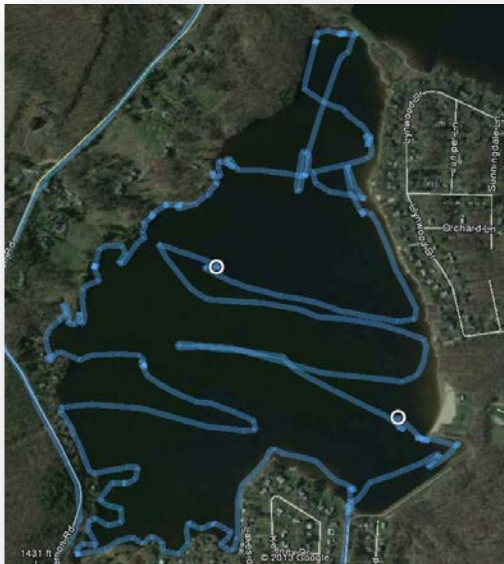
**Map 2: - Map showing extensive coverage of southern Naiad (Najas guadalupensis) in Lower Bolton Lake during CAES survey in 2011**




**Map 3 - a) Map of topped-out (red areas) Southern Naiad (Najas guadalupensis) in 2011, b) bottom covered with Naiad in 2012.**



**Map 4: - Map of aquatic weed survey conducted July 29th, 2013. The white circles indicate the two locations where very small sprigs of southern naiad were found**



In 2012 before Fluridone treatment, there were 16 native aquatic plant species in Lower Bolton Lake and three invasive aquatic plants (red print in **Table 4**). After treatment and during early 2014, 4 native aquatic plant species (1 non-native species) were found. Native species numbers increased to 6 by late 2014, and 8 in early 2015. Invasive fanwort was found in a cove on the west side of the lake (**Map 5)**; and treated with herbicide on September 5, 2013 to control this very small bed of fanwort. The plant has not been seen in the lake since that time and the early detection rapid response treatment is presently viewed as a success.

**Map 5: - Location of fanwort in Lower Bolton Lake during 2013**

**Table 4: - Aquatic plant species list for Lower Bolton Lake before and after Fluridone**

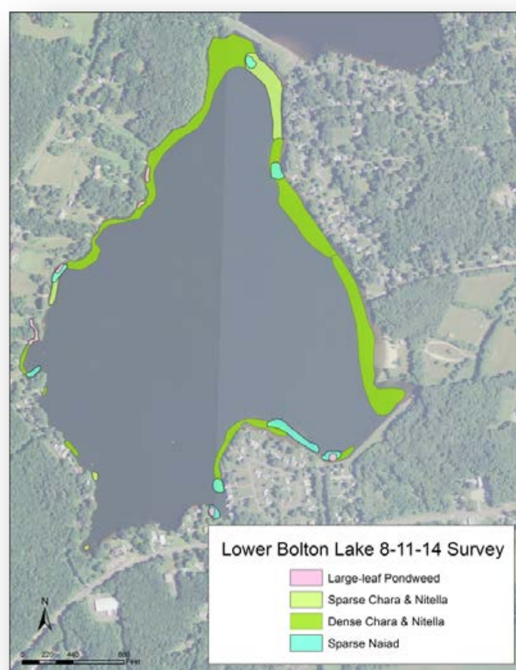
| Species List July 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|
| Large-leaf pondweed *(Potamogeton amplifolius)* | Yes | Yes | Yes |
| Southern naiad *(Najas guadalupensis)* | Yes | Yes | Yes |
| Coontail *(Ceratophyllum demersum)* | Yes | No | No |
| Tape-grass *(Vallisneria americana)* | Yes | No | Yes |
| Snail-seed pondweed *(Potamogeton bicupulatus)* | No | Yes | No |
| Elodea *(Elodea nataliae)* | No | No | No |
| Floating bladderwort *(Utricularia radiata)* | No | No | No |
| Arrowhead *(Sagittaria graminea)* | No | No | Yes |
| Bushy pondweed *(Najas flexilis)* | No | Yes | No |
| **Fanwort *(Cabomba caroliniana)*** | **Yes** | **No** | **No** |
| **Mudmat *(Glossostigma* sp.)** | **No** | **Yes** | **Yes** |
| Quillwort *(Isoetes* sp.) | No | No | No |
| White waterlily *(Nymphaea odorata)* | No | No | No |
| **Variable leaved milfoil *(Myriophyllum heterophyllum)*** | **No** | **No** | **No** |
| Red-leaf pondweed *(Potamogeton epihydrus)* | No | No | No |
| Muskgrass *(Nitellla* sp.) | No | Yes | Yes |
| Stonewort *(Chara* sp.) | No | Yes | Yes |
| *Hedgehyssop* (*Gratiola* sp.) | No | Yes | No |
| **^Curly-leaf pondweed (*Potamogeton crispus*)** | No | No | **Yes** |

RED = Invasive

^ new sighting fall 2014

Native species have been returning to Lower Bolton Lake, with large beds of the macroalgae *Nitella* and *Chara* growing along the east and northwest shores (**Map 6**). There were also a few small beds of large-leaf pondweed along the west shore. Large-leaf pondweed beds expanded somewhat in 2015 with several reappearing close to the boat launch and along the eastern shore. The beds of Naiad also expanded along the southern and eastern shore of the lake. The full extent of plant growth was not mapped in 2015 due to poor water clarity and intensive mapping of curly-leaf pondweed.

**Map 6: - Dominant native aquatic plant beds in Lower Bolton Lake during 2014**



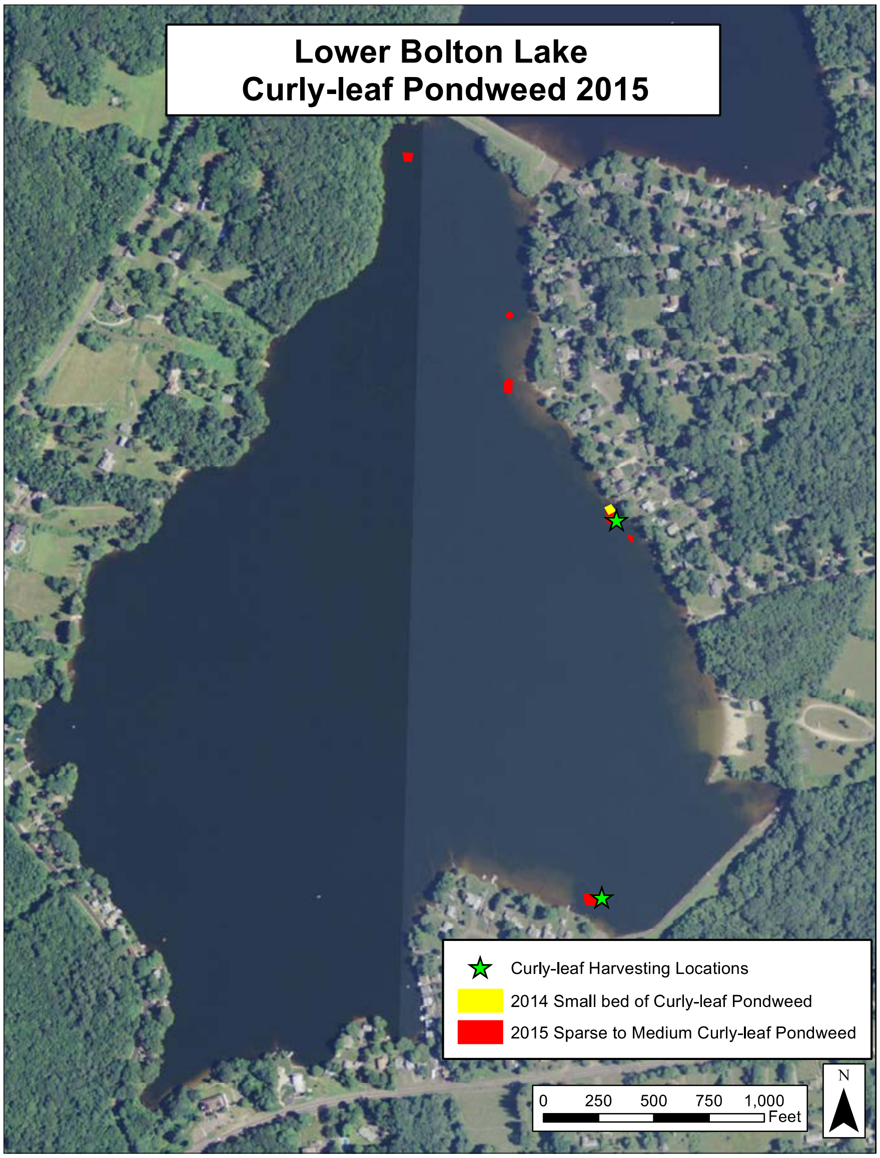
## Curly-leaf Pondweed

**Photo 3: Curly-leaf pondweed in Lower Bolton Lake. Inset shows a turion, one of the ways the plant spreads.**

Curly-leaf pondweed (*Potamogeton crispus*) is an invasive species found in many lakes in Connecticut and the northeast. It is easily recognizable by the characteristic lasagna noodle shape of the leaves (**Photo 3**). This species spreads via root runners and also produces turions, robust buds that can overwinter in the sediment and sprout new plants during subsequent seasons (see inset of **photo 3**). Curly-leaf pondweed was found in one location along the eastern shore of Lower Bolton Lake in 2014 (**Map 5**). In July 2015, NEAR hand-harvested the initial bed located in 2014, and then a secondary bed discovered later near the boat ramp. Aided by reports from local residents, NEAR conducted an intensive search of Lower Bolton Lake for curly-leaf pondweed in August confirming more beds along the northern, eastern and southern shores (**Map 7**). Locating these beds was very difficult due to poor water clarity. Contrary to the plant's behavior in other lakes in Connecticut where it grows to greatest extent in May and early June and then exhibits a die off by July 1, curly-leaf in Bolton was found to be still growing vigorously in August.

Due to minor regrowth observed in the hand-harvested patches of curly-leaf and the difficulty locating all of the patches due to poor water clarity, NEAR recommended that Aquatic Control Technologies (now Solitude) conduct a Diquat herbicide treatment targeting the curly-leaf pondweed. The treatment was completed on September 2, 2015 (**Map 8**). During a post-treatment curly-leaf survey, no plants were found, but due to poor visibility and the ability of curly-leaf plants to grow from turions in the sediment, NEAR will be watching closely for regrowth of this invasive in 2016.

**Map 7: - Curly-leaf pondweed distribution in Lower Bolton Lake 2014 and 2015**



**Map 8: - Curly-leaf pondweed treatment area in Lower Bolton Lake during 2015**

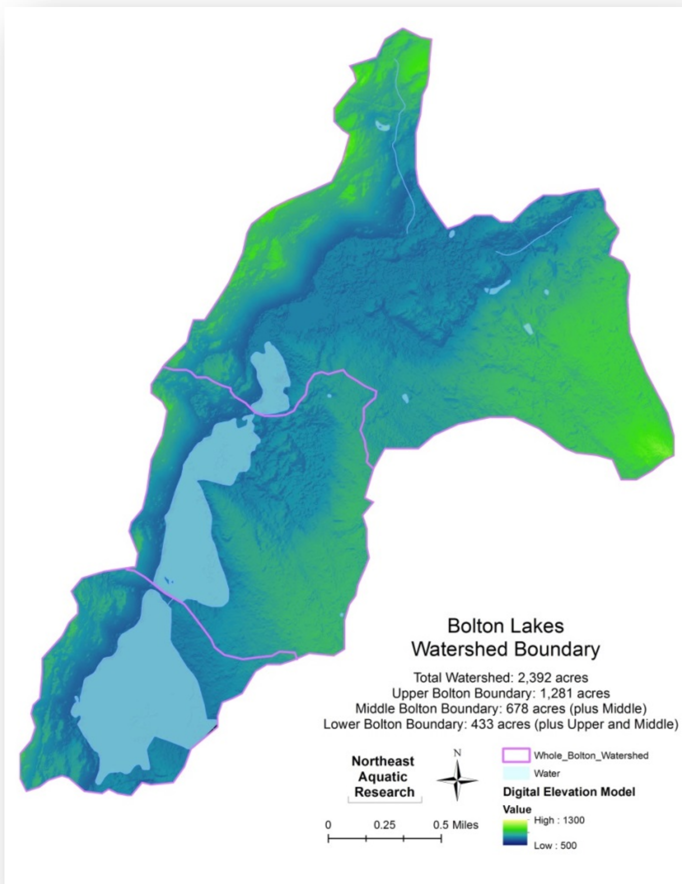

## 2016 Aquatic Plant Management Plan

1. Closely monitor Curly-leaf pondweed populations in the lake starting in the early spring of 2016 and take management action, hand-harvesting or herbicides before the plant has a chance to form more turions.
2. Continue to monitor the regrowth of native plant species in Lower Bolton Lake paying close attention to the spread of Southern naiad and large-leaf pondweed.
3. Maintain vigilance for eradicated variable milfoil and Fanwort plants.
4. File permits for a potential herbicide treatment if deemed necessary to control curly-leaf pondweed in Lower Bolton Lake.

## 3 Drainage Basin and Phosphorus Loading

Lower Bolton Lake is approximately 175 acres in size with a total drainage basin area of 2,379 acres. The watershed boundary, as well as the drainage boundaries for each of the three Bolton Lakes, was found using a 10-foot Digital Elevation Model LIDAR (Light Imaging Detection and Ranging) image, as well as the United States Geological Survey (USGS) topographic contours map. The watershed boundaries of the three lakes are shown on **Map 9**. The watershed of Lower Bolton Lake includes the entire watershed of both Middle and Upper Bolton lakes.

**Map 9 - Map showing the watershed of Lower Bolton Lake, with sub-basin boundaries between Middle and Upper Bolton Lakes**




### Upper Bolton Lake (UBL)

Upper Bolton Lake is small (50ac in size) is a very shallow (3-6 feet), nutrient-enriched lake completely colonized by aquatic plants including a large fraction of the surface area covered by floating-leaved water lilies. The watershed covers 1,293ac the largest of the three lakes, encompasses a large wetland area that includes a protected White Cedar Swamp. Upper Bolton Lake is in transition from open water to wetland. Currently the northeastern-boundary of the lake is indiscernible from the surrounding contiguous wetlands. Upper Bolton Lake flows into Middle Bolton Lake through a culvert (36 inches diameter) that runs underneath Hatch Hill/Vernon Branch Road.

### Middle Bolton Lake (MBL)

Middle Bolton Lake (121ac in size) has about the same maximum water depth as Lower Bolton at 18 feet but has a slightly shallower mean depth[6] of 9.3 feet, and a small total water volume of 1,126 acre-feet. The total drainage basin area of MBL is 1,946 acres, but the lake has only 653 acres of direct drainage area, or the area excluding the Upper Bolton Lake drainage area. Middle Bolton Lake has a flushing rate[7] of 295 days or about 1.2 times a year. Middle Bolton Lake flows into Lower Bolton Lake either by surface discharge over the spillway between March and November, or through the dam during winter drawdown when the controlled valve operation drains water from 9 feet deep in Middle Bolton Lake during November-March. However, during dry periods in summer months no water leaves Middle Bolton Lake by surface flow over the dam.

### Lower Bolton Lake (LBL)

Lower Bolton Lake (175ac in size) is the largest of the three lakes, with the largest total drainage basin area of 2,379 acres. The maximum water depth of LBL is 18 feet, but it has a mean depth of 9.5 feet. The total water volume of the lake is roughly 1,665 acre-feet. The area of direct drainage to LBL is 433ac. The flushing rate for Lower Bolton Lake is about 129 days, or roughly 2.8 times per year. Lower Bolton Lake discharges via the dam at the southeastern end with a 24-foot wide spillway for outflow during the summer and from deep-water release during winter. Outflow goes into Bolton Pond Brook and eventually into the Hop River. However, during dry summer months of 2014 and 2015 no water was observed leaving Lower Bolton Lake over the spillway.

### Lower Bolton Lake direct drainage basin

The direct drainage area to Lower Bolton Lake is 236 acres shown in **Map 9**. Drainage area to the west of the lake is a narrow band that consists of steep hills, to the south and east the land is flatter. Drainage area to the south consists of developed land with vertically no topographic elevation change; to the east of the lake is mostly all developed land with a gentle slope.

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[6] Mean depth is defined as the lake volume divided by its surface area (Wetzel 1975), and reflects how deep the lake would be if it was all one depth, i.e. like a box with a flat bottom and vertical slopes.

[7] Flushing rate is the time it takes to replace the lake volume with new water from the drainage basin.

## Lower Bolton Lake Basin

The bathymetric contours of Lower Bolton Lake are shown in **Map 10** (Jacobs and O'Donnell, 2002). Bathymetric contours show locations of equal water depths around the lake.

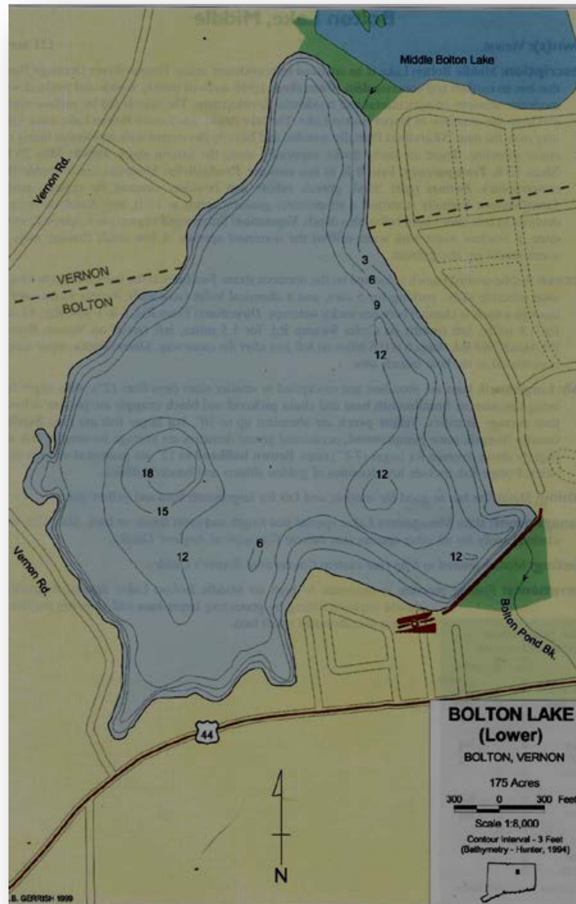
The map depicts a basin that is relatively deep near shore such that water depths reach 6 feet quickly around most of the lake and 9 feet along the west side.

The basin is relatively flat between 9 and 12. Most of the lake (102ac or 58%) has water depths between 9-12 feet.

There is a small area (2ac or 15%) where maximum water depths of 18 feet were found.

A second smaller deep water area—about 12 feet maximum—is located directly in front of the LBL dam and provides deep water release from of lake water through the Lower Bolton Lake dam during winter drawdown.

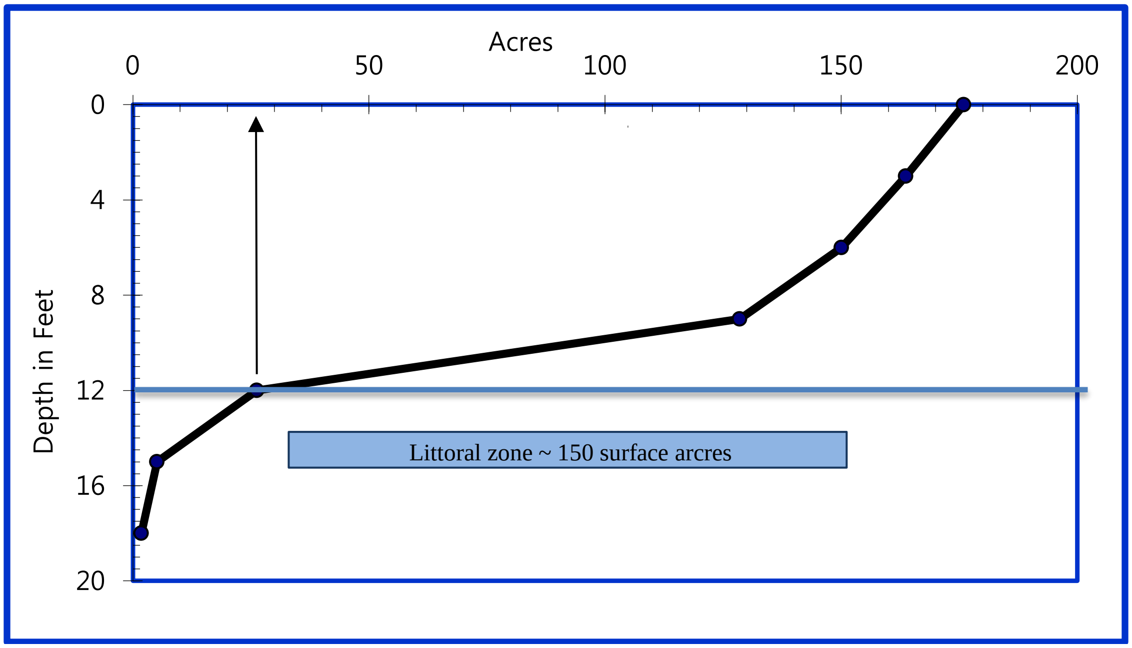
**Map 10: – Bathymetric map of Lower Bolton Lake (CT DEEP)**




The surface areas at depth for Lower Bolton Lake are shown in **Figure 9**. The chart shows three features of the lake basin that are important in understanding functioning of various lake dynamics and details of specific management options.

1. The slope of the basin near shore is steep in that water depth increases quickly with distance from shore until reaching 9 feet of water depth. The area of lake between 0 and 9 feet is approximately 46 acres
2. There is a large flat area of about 105 acres between 9 feet and 12 feet.
3. Plant growth was found to be about 12 feet of water depth indicating that the Littoral Zone, or that region of the lake that supports rooted aquatic plant growth, is most of the lake area at about 150 acres or 85% of the total lake area.
4. There is a very small area 26ac of the lake that is deeper than 12 feet.

**Figure 9: - Hypsographic curve of Lower Bolton Lake; showing acres at depth in feet**




## Water Load

The total watershed of Lower Bolton Lake, 2,379ac, includes the watersheds of both Middle and Upper Bolton Lakes. Estimated water load to Lower Bolton Lake is 5.8 million cubic meters ($m^3$) per year, given a total water volume of 2 million $m^3$ the theoretical flushing rate of the lake is 2.8 times a per year. Approximately 1,946ac, or 82%, of the drainage basin lies above the Middle Bolton Lake dam, and 258ac or 19% of the drainage basin is below Middle Bolton Dam. With such a large percentage of the total water flow into LBL coming from MBL it stands to reason that monitoring the flows and nutrient concentrations at the MBL dam will provide estimates of a large fraction of the total nutrient load to the lake. Detailed measurements of flows at the outlets of Middle and Lower Bolton Lakes began in 2014 (**Figure 10**). MBL discharge values from winter months—November through March—are estimates due to release of water below the LBL surface. There was flow at the outlets of the three dams during winter and spring, but flow drops to zero during summer and fall months. No flow was measureable from Lower Bolton Lake during summer and fall months suggesting that the lake was largely stagnant during those times (**Figure 11**). The contribution of water removal from the drainage basin via the sewer system to the flushing rate of the lake with be investigated in 2016.

**Figure 10: - Daily water flows from Upper, Middle, and Lower Bolton Lakes**

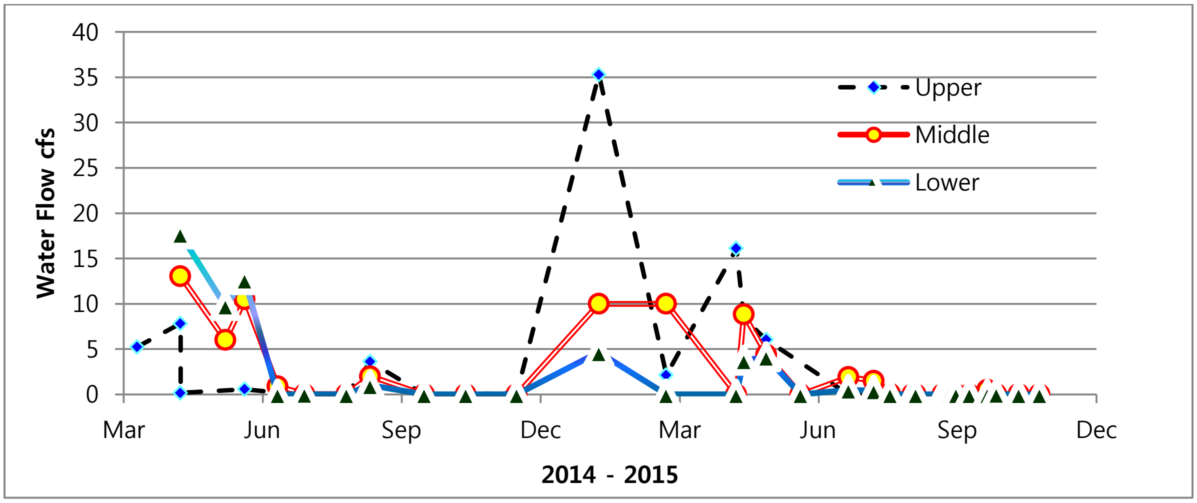
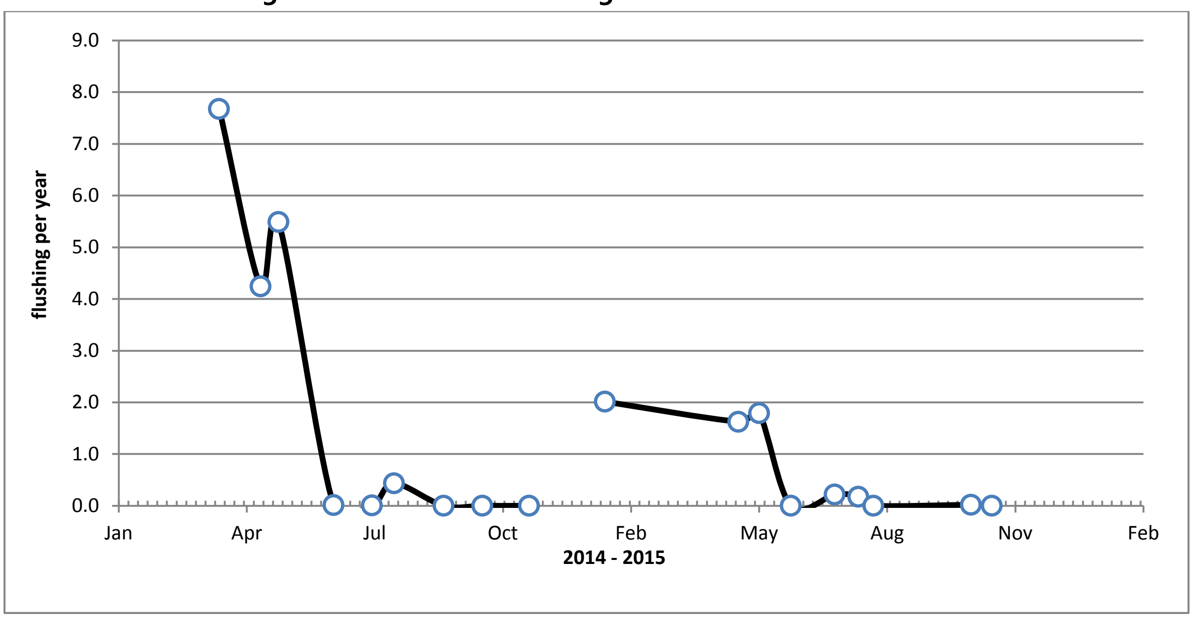



**Figure 11: - Trend in flushing rate of Lower Bolton Lake**




## Phosphorus from Middle Bolton Lake

Total phosphorus concentration of discharge water from the lakes is shown in **Figure 12** (Middle Bolton Lake outflow zeros are when no flow occurred. Winter phosphorus concentrations from Upper and Middle Bolton were moderate during the winter but have been low to very low during other seasons. Mass flow (concentration x water flow) for Middle and Lower Bolton Lakes are shown in **Figure 13**. Middle Bolton Lake may discharge higher mass flows of phosphorus during winter but those values shown in **Figure 13** are estimates due to difficultly measuring the deep water release at Middle Bolton Lake between November and March.

**Figure 12: - Total phosphorous concentration at Upper, Middle, and Lower Bolton Lake outlets**

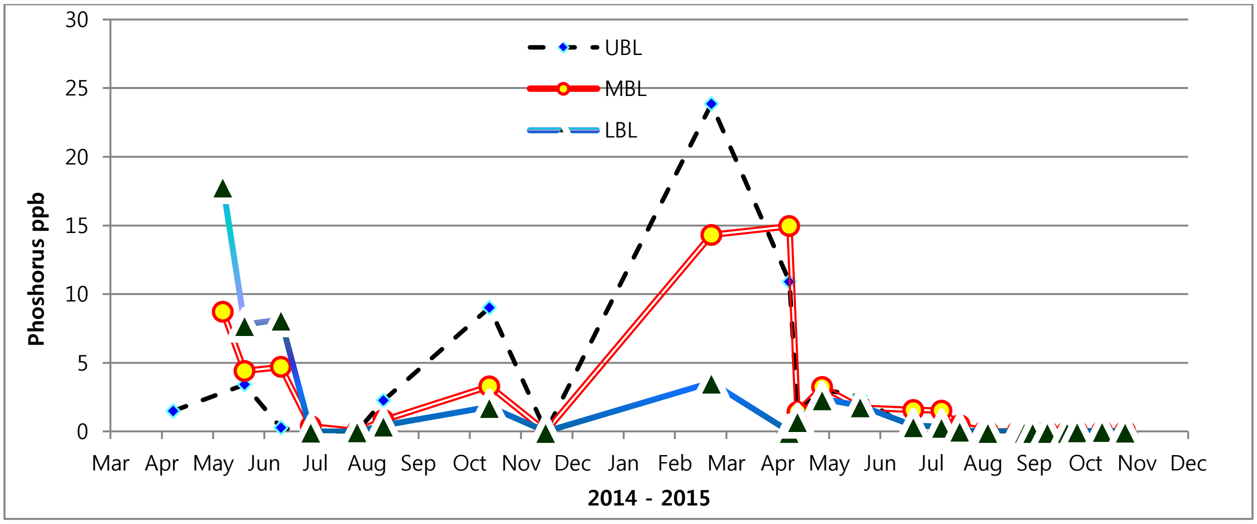
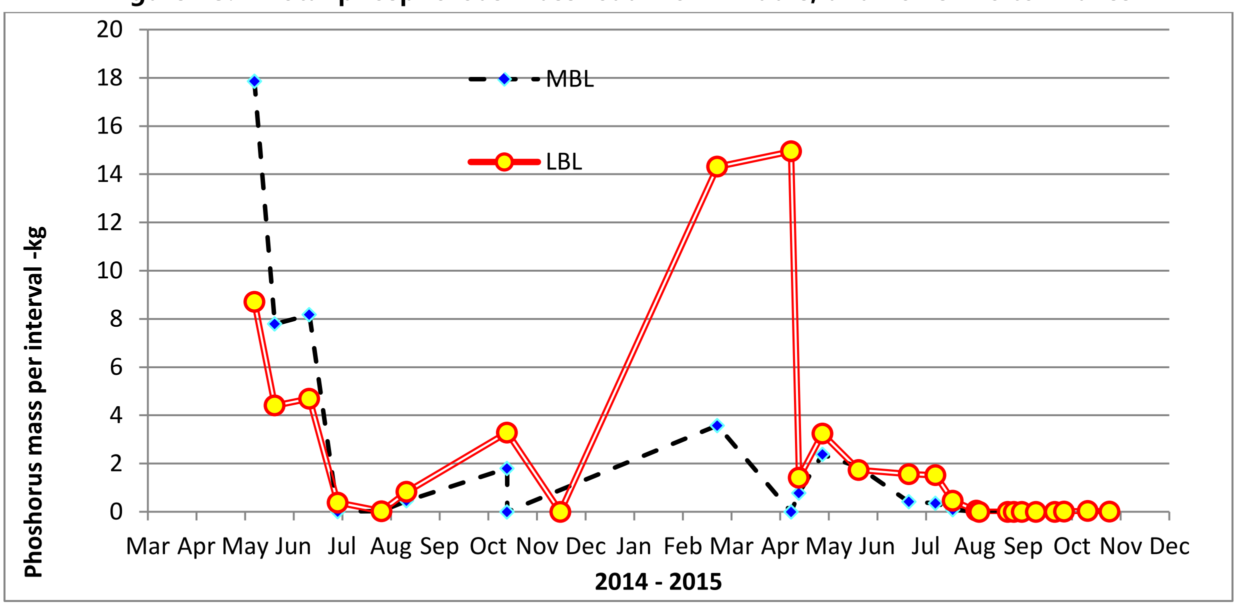



**Figure 13: - Total phosphorous mass load from Middle, and Lower Bolton Lakes**




The change in phosphorus concentration in Lower Bolton Lake is compared to phosphorus concentration of water entering the lake from Middle Bolton Lake in **Figure 14**. The lake data shown is from the 1m sample at the two LBL stations. Concentration changes in the lake cannot be accounted for by inflow concentrations from Middle Bolton Lake. The lake phosphorus concentration was generally higher than MBL discharge water phosphorus concentrations and often considerately higher as shown by the cluster of points above the line equality (black dashed line) in **Figure 15**. Because concentrations of any substance cannot be increased unless supplied substance of higher concentration, the higher phosphorus values in the lake are the result of supply from a source other than MBL.

**Figure 14: - Total phosphorous concentration (ppb) at two surface stations in Lower Bolton Lake and the outlet of Middle Bolton Lake in 2013-2015**

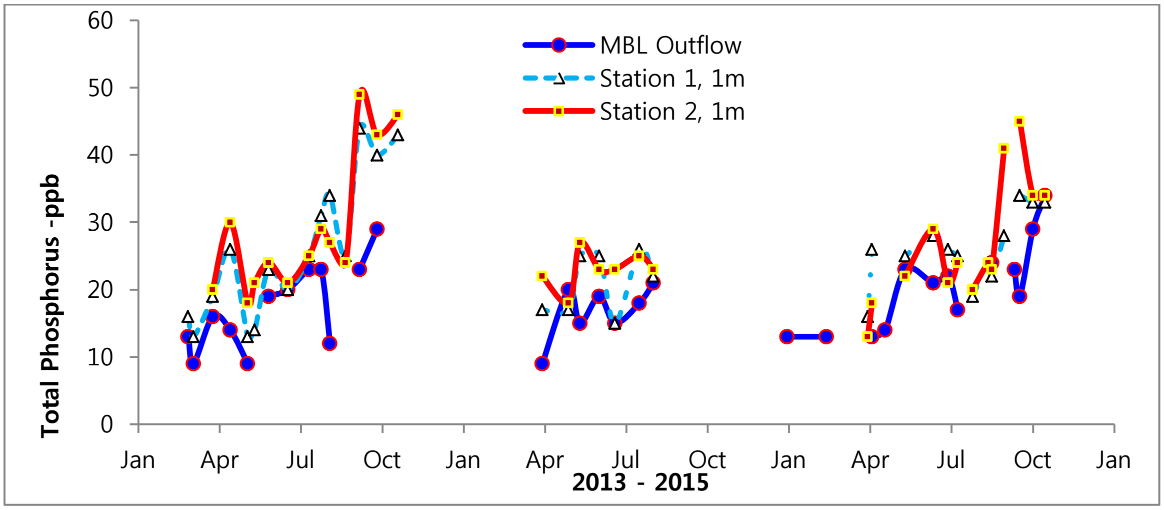
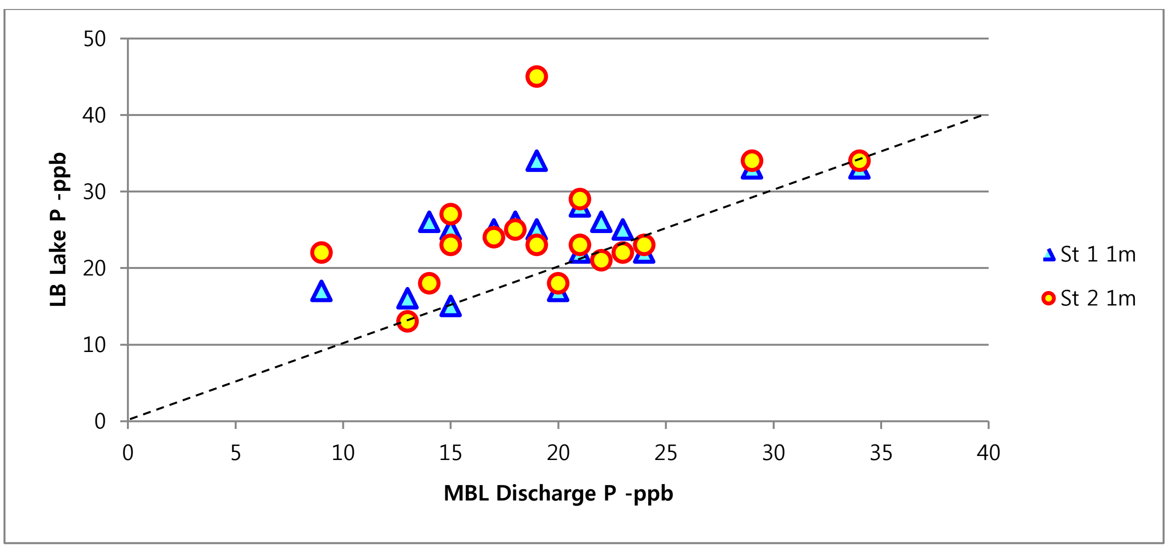


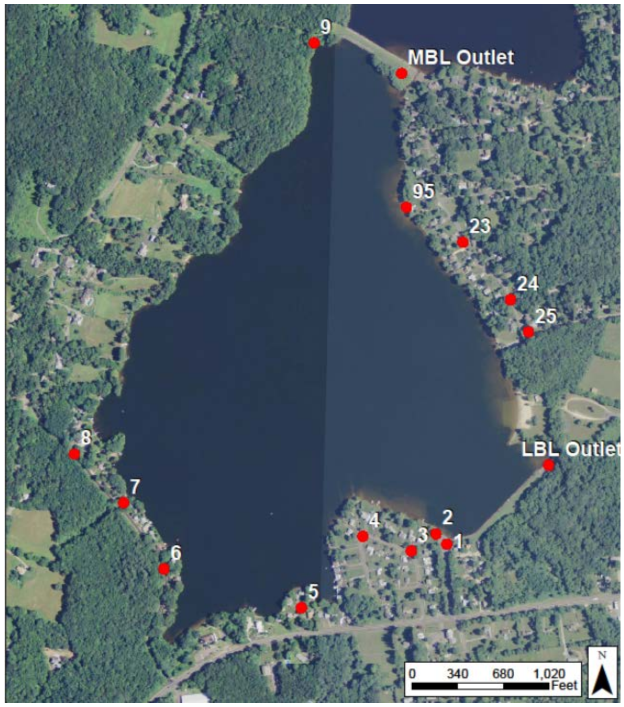

**Figure 15: - Total phosphorous concentration (ppb) at two surface stations in Lower Bolton Lake and the outlet of Middle Bolton Lake in 2013-2015**




## Direct Drainage Basin P load

So far, 15 sites have been identified around Lower Bolton Lake where surface water flows directly into the lake (**Map 11**). Sites #1-5 drain areas south of the lake, #6-9 drain land west of the lake, with the remainder draining lands to east of the lake. Eastern sites are near impossible to sample due to runoff being conveyed via. underground culverts across private property that discharge into the lake below the water surface. We have not yet collected water samples from sites #23-#25 but will be exploring ways to do so in 2016.

**Map 11: - Lower Bolton Lake Inlets 2015**




Results of tributary sampling are given in **Table 5** where the average phosphorus, nitrogen, and suspended solids concentration are given. Several sites have had only 1 or 2 samples collected from them so far. More collections are planned for 2016. Results show that phosphorus and nitrogen are generally very high during storm events.

**Table 5: - Tributary inlets sampled around Lower Bolton Lake**

| Site | # of samples | Phosphorus (ppb) | Nitrogen (ppb) | Solids (mg/L) |
|---|---|---|---|---|
| **1** | 4 | 359 | 1,487 | 105 |
| **1B** | 1 | 530 | 2,488 | 122 |
| **2** | 2 | 219 | 1,550 | 8 |
| **3** | 2 | 256 | 1,431 | 41 |
| **4** | 1 | 128 | 490 | 14 |
| **5E** | 2 | 135 | 1,157 | 43 |
| **5W** | 1 | 137 | 1,108 | 76 |
| **6** | 1 | 228 | 2,889 | 4 |
| **7** | 5 | 31 | 699 | 3 |
| **8** | 7 | 101 | 808 | 62 |
| **9** | 5 | 140 | 978 | 75 |
| **95** | 2 | 304 | 1,862 | 15 |
| **23** | 0 | | | |
| **24** | 0 | | | |
| **25** | 0 | | | |

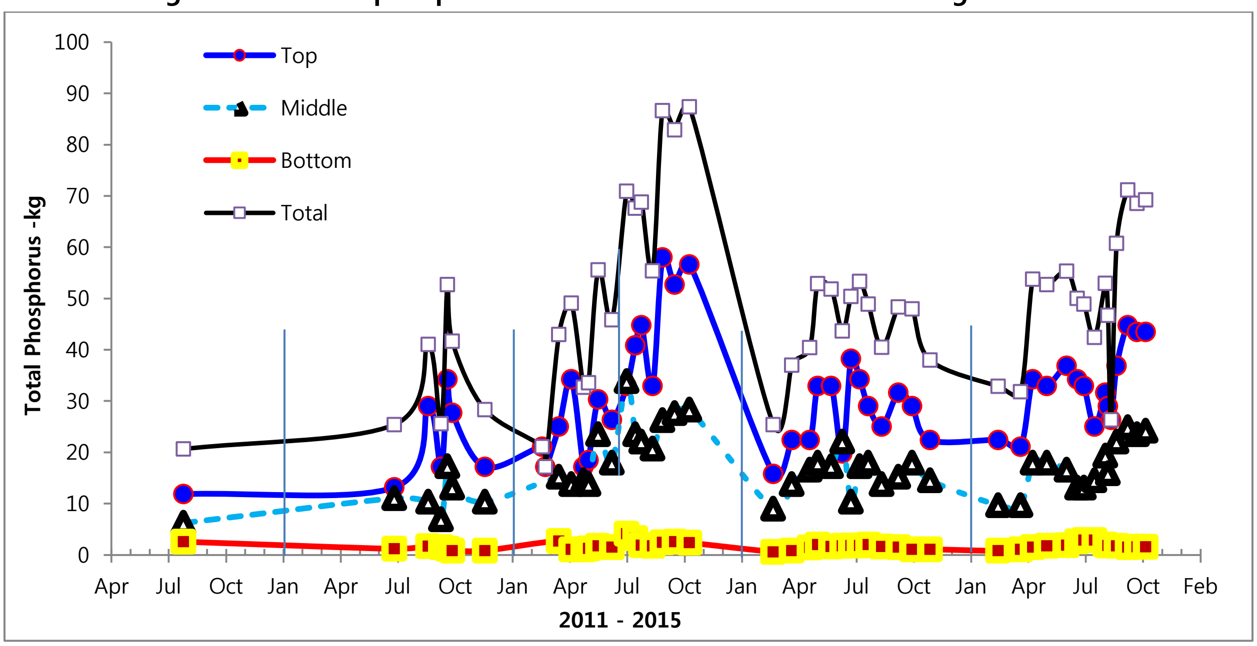
Although concentrations of nutrients in the storm flows are very high the total load expected from the inlets during a daily event are low (**Table 6**) compared to the mass of phosphorus in the lake.

**Table 6: - Total mass of phosphorus load via inlets to Lower Bolton Lake**

| Storm event | TP kg/day |
|---|---|
| **4/8/2014** | 0.04 |
| **8/13/2014** | 3.85 |
| **10/16/2014** | 0.01 |
| **4/20/2015** | 0.27 |
| **5/5/2015** | 0.01 |
| **8/11/2015** | 0.24 |
| **9/30/2015** | 0.13 |

The mass of phosphorus in LBL, during the period of monitoring 2011-2014, is shown in **Figure 16**. There was far more phosphorus in the lake during 2013 than there was in August 2012. Peak mass in 2012 was 64kg while in 2013 phosphorus mass reached 87kg. Phosphorus mass during most of 2014 was above 40kg. Mass is shown to increase between the spring and fall of each year. In 2013, phosphorus mass increased between 20kg and 87kg (+67), in 2014 mass increased between 25kg and 53kg (+28 kg) about a third the increase we saw in 2013.

**Figure 16: - Total phosphorus mass in Lower Bolton Lake during 2011-2015**



# Appendix 1: Lower Bolton Lake Analysis

Lower Bolton Lake is a 175 acre water body located in the towns of Bolton and Vernon, Connecticut, with a 2,379 ac watershed that includes both Middle and Upper Bolton Lakes. The lake is an important recreational feature of the Town of Bolton and State of Connecticut. Town of Bolton Park and Beach provide swimming and water access. CT DEEP boat ramp allows public access for boating. And both the Middle and Lower Bolton Lake dams are accessible by the public for shoreline fishing.

## Introduction

In depth analysis of monitoring data collected at Lower Bolton Lake over the last three and a half seasons is presented in this section. The goal of the analysis is to develop a characterization of Lower Bolton Lake using limnological properties. Establishing the structural aspects of the lake provides knowledge on causes and effect relationships that dictate outward appearance.

The analysis progresses through the following sections:

- Water Temperature
- Basic Stratification
- LBL Stratification
- Dissolved oxygen
- Percent saturation of upper water
- Loss of oxygen and anoxic boundary
- Water clarity
- Phosphorus
- Nitrogen
- Iron
- Plankton
- Zooplankton
- Fisheries

## Water Temperature and Dissolved Oxygen

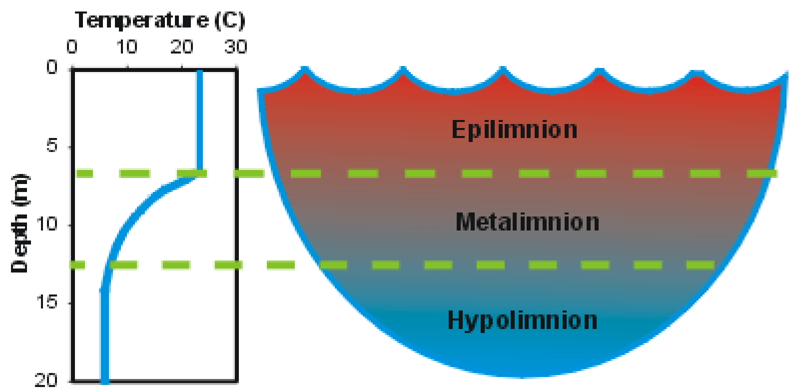
Lakes are warmed by solar radiation. As sun strength increases in March and April, lake water begins to warm. As long as daily air temperatures are warmer than the water (specifically at night) lake water will continue to increase in temperature. Sunlight warms water from the surface downward such that the surface water gets the most heating with gradually less heating occurring in deeper waters. As water warms it becomes less dense and more buoyant. This phenomena causes warmer water to float over the cooler water beneath. The thickness of the layer of warm, floating water is determined by how far the sun penetrates (water clarity). Warming of the upper water layers continues until a maximum surface temperature is reached in early August. Soon after, air temperatures are generally cooler (at night) than the lake water, and lakes begin to lose more heat at night than they gain during the day so begin to cool. Eventually, the whole water column has cooled so that that the lake is the same temperature, an isothermal condition known as turnover. Lakes continue to cool until the whole lake reaches 4 $^{o}$C (40$^{o}$F), after-which the surface begins to cool to the point of freezing and ice forms on the surface.

### Lake Layering and Stratification

Lake stratification (**Figure 17**) involves the unequal heating of a water body. Since sunlight is responsible for lake heating and sunlight can only shine into the top of a lake, heating of lakes occurs from the top down. The result is that lakes develop layers, or stratification, each summer based on sunlight and water clarity. Lake heating occurs only in the lighted depths of the lake as determined by the Secchi disk, so if the Secchi disk depth is 3 meters (~10ft) only the top 3 meters of water will be warmed by sunlight. Water below that depth will be dark and cold.

Wind blowing on the surface of the lake pushes surface water forcing mixing with water of like temperature below. In this way, a mostly stable layer of water is created where water temperature is relatively uniform and warm, sunlight shines throughout and the water is in close equilibrium with the atmosphere. This layer of lake water is referred to as the Epilimnion. The epilimnion can be of varying thickness but is always at the top of the lake with its thickness determined by the light penetration. In this report the epilimnion will also be called the Upper Layer or Upper Waters and refers to the layer of water between surface and about 3-4 meters or 10-12 feet.

**Figure 17: - Stylized image depicting lake stratification**

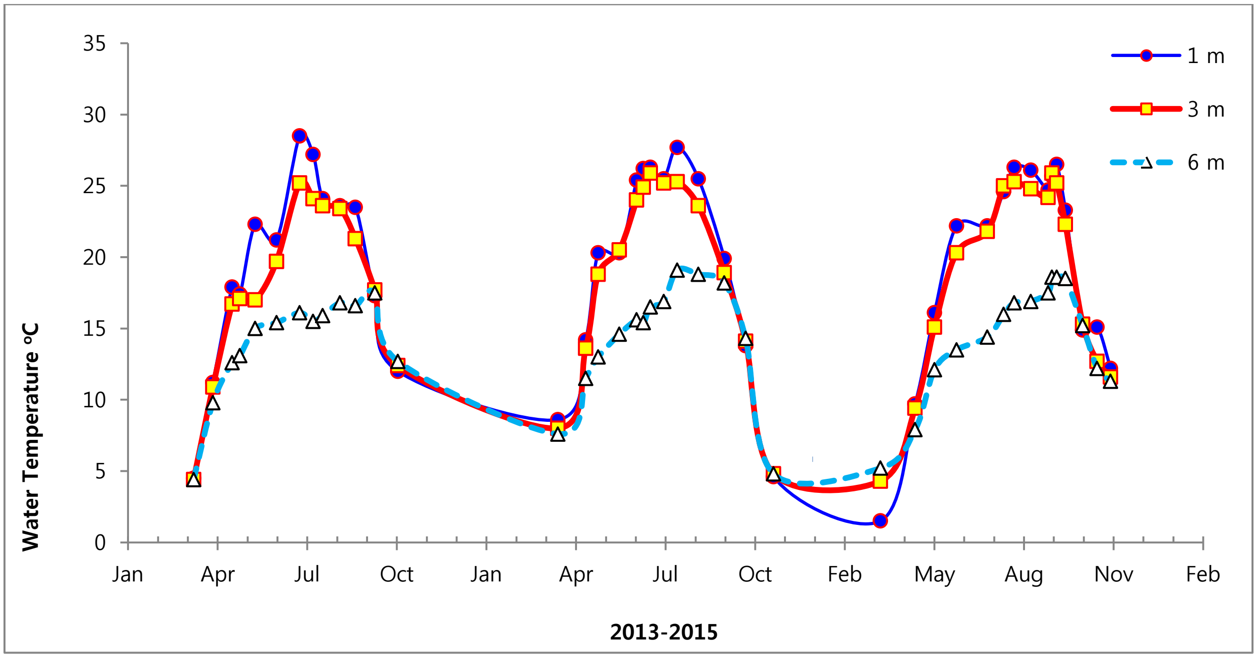



Below the epilimnion, water is not heated by sunlight so temperatures are colder. There is usually a layer of water directly below the epilimnion where water temperature drops quickly with depth. Because cooler water is denser and heavier, this water layer of decreasing temperatures remains isolated from water above it in the epilimnion. The layer of rapid water temperature change is referred to as the Metalimnion, or Thermocline (region of rapid temperature change). Below the thermocline, lake water is dark and cold with no mixing with the upper water layer. This cold, dark, bottom layer is known as the Hypolimnion and remains isolated and stagnant during the stratification period. The three layers provide structure within the lake because many processes are specific to a particular layer. Knowing the positions of boundaries between layers is critical to developing a baseline for the lake, assessing cause and affect relationships, and identifying possible remedial actions.

## Lower Bolton Lake Water Temperature and Stratification

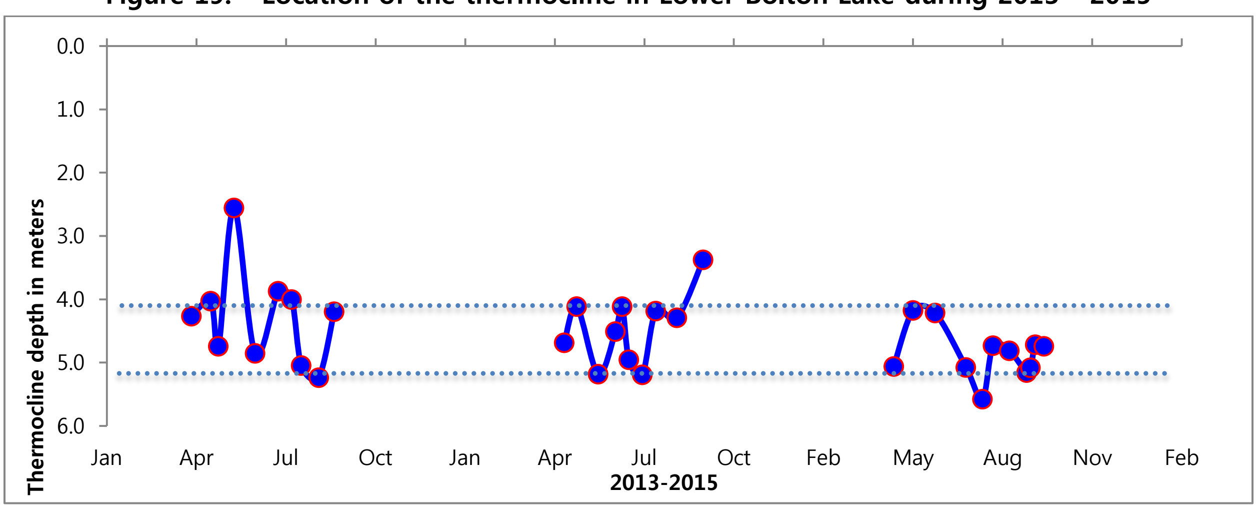
Water temperatures measured at selected depths in Lower Bolton Lake during 2013-2015 are shown in **Figure 18**. Each of the three years shows a similar progression of lake water heating beginning with very low temperature (between 3-5°C) at ice-out in spring, to maximum surface temperatures between 27 and 28°C in mid-July and mid-August. Rapid cooling occurs at LBL in September. The water temperature at 1 and 3 meter depths were nearly identical during the three years of monitoring data. Water at 6 meters warmed very slowly reaching maximum temperatures of 17-19°C, often after the upper layer has begun cooling indicating heating of deep water is by diffusion, not solar radiation.

**Figure 18: - Water temperature trends in Lower Bolton Lake during 2013-2014-2015**




The temperature trends in **Figure 18** show that temperature of water at 1 and 3 meters was similar while bottom water is 5-10 °C colder during the summer. The large difference in water temperature between 3 meters and 6 meters means that Lower Bolton Lake becomes stratified in summer months (May until September) with a Thermocline located between 4 and 5 meters (**Figure 19**). A thermocline marks the depth, or demarcation, between upper warm water and deeper cool water. The location of the thermocline at 4 meters indicates that lake water between the surface and 12 feet is mixing and mostly in equilibrium with the atmosphere based on saturation of dissolved oxygen. Only water deeper than 12 feet becomes isolated from the atmosphere and develops stagnation.

**Figure 19: - Location of the thermocline in Lower Bolton Lake during 2013 - 2015**

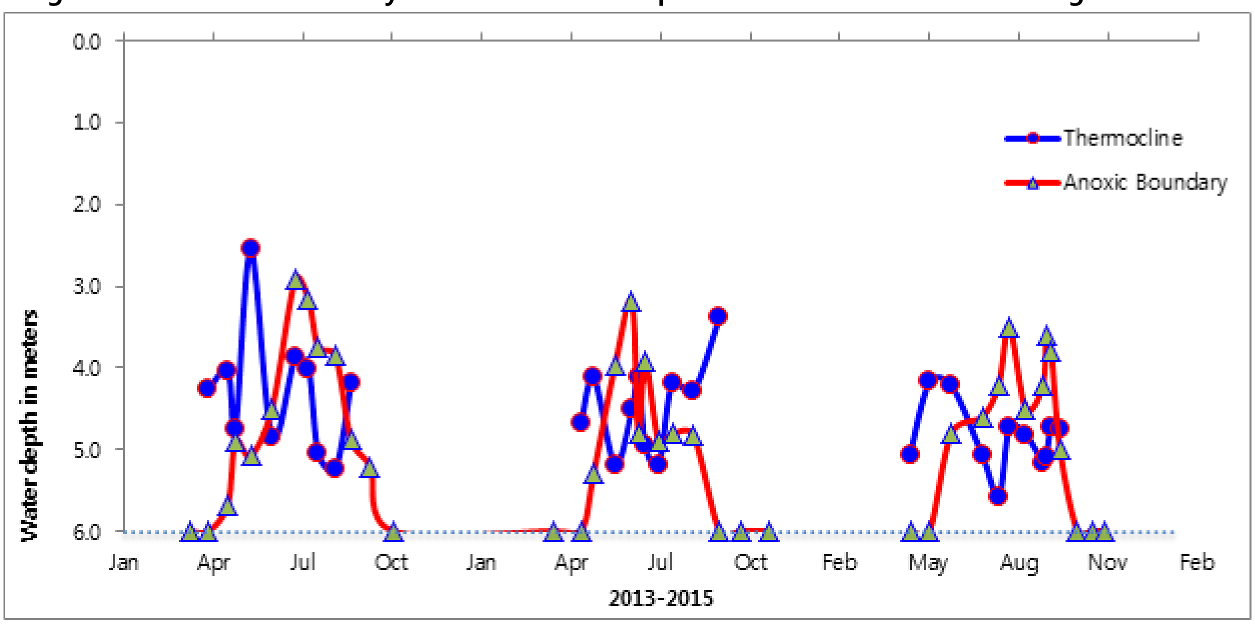


## Oxygen loss and anoxia

Depth to anoxia (red line in **Figure 20**) marks boundary between water with oxygen above, and water devoid of dissolved oxygen below the red line. During the summer of each year, anoxic water migrates above the thermocline as it ascends from the bottom upward. Hence the line rises from the bottom between April and May eventually reaching up to 3meters in 2013 and 3+ meters in 2014 and 2015. Anoxic boundary is measured down from the surface. As the lake begins to cool in the fall oxygen is re-supplied to the lake water so the anoxic boundary migrates downward until the whole water column is re-oxygenated by late September or early October.

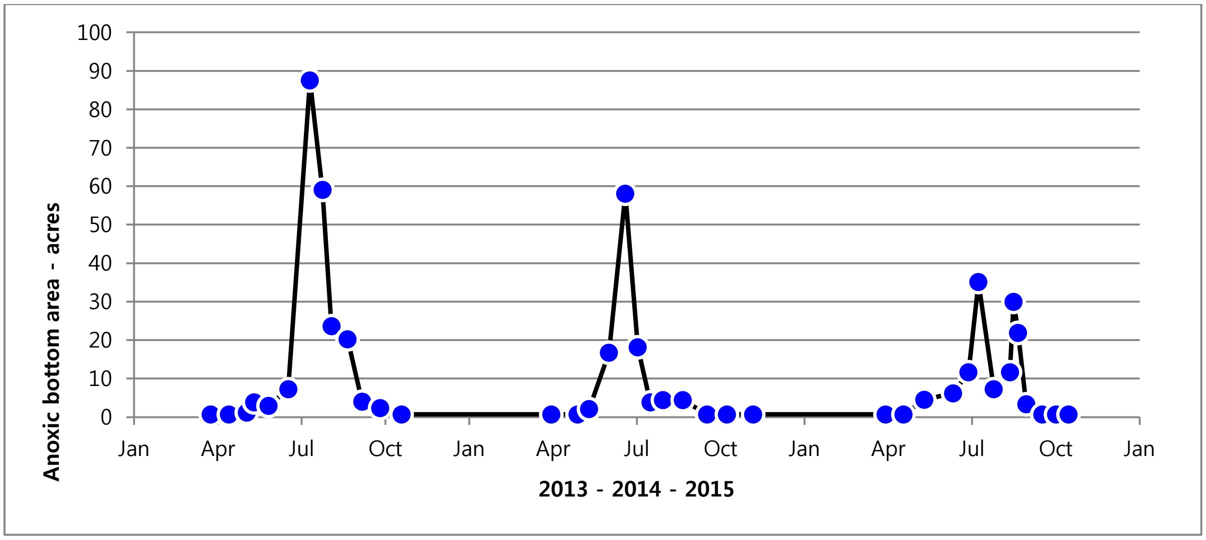
Anoxic water rises above the thermocline each summer as shown by the crossing of the red and blue lines in **Figure 20**. Water above the blue line is mixing and typically where sunlight causes phytoplankton to growth, while water below the red line is devoid of dissolved oxygen and typically has higher concentrations of nitrogen and phosphorus. When the lines cross the likelihood is good that nutrients from the hypolimnion are released into upper waters become available to algae.

**Figure 20: - Anoxic boundary and thermocline depths in Lower Bolton Lake during 2013-2015**



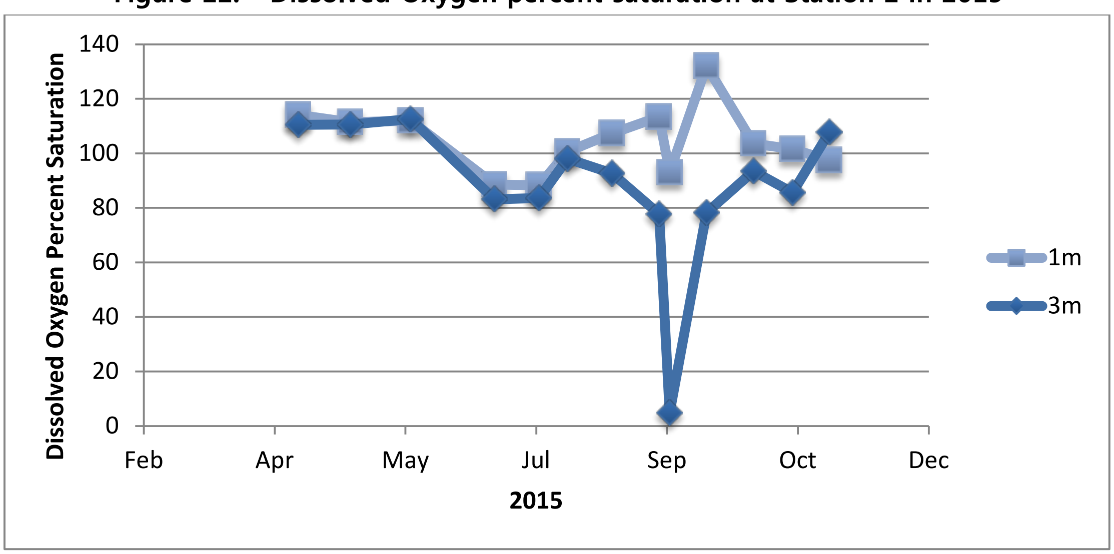

The bottom area affected by anoxia appears to have been greatest at 90 acres in 2013 but has decreased to only 30 acres of bottom sediments overlain by anoxic water in 2015 (**Figure 21**).

**Figure 21: - Bottom area overlain by anoxic water in Lower Bolton Lake during 2013-2015**




However, distribution of anoxic bottom water suggested by the depth of the anoxic boundary shown in **Figure 21** above may have been restricted to the area of deepest water. Dissolved oxygen at the bottom of Station 2, between 11-12 feet, showed generally good dissolved oxygen levels during the summer indicating that the deep water station doesn't exert influence over shallower water conditions (**Figure 22)**. The generally oxygenated conditions at the bottom of Station 2 indicate that internal loading from the broad, flat area between 9 feet and 12 feet deep is probably minor or limited to very short duration events. The loss of oxygen at three meters seen in **Figure 22** occurred two days after the copper and herbicide treatments and likely reflects a loss of oxygen due to increased decomposition of plants and phytoplankton. Internal loading of phosphorus is probably restricted to the small area of the deep hole at Station 1.

**Figure 22: - Dissolved Oxygen percent saturation at Station 2 in 2015**



## Secchi Disk Depth Transparency

Central to modern lake management is the concept that water clarity as measured with a Secchi disk is related to phosphorus concentration and phytoplankton abundance. The Secchi disk is an eight-inch circular black and white disk attached to a measuring tape that is lowered into the water on the shady side of the boat. Secchi measurements are taken in the deepest area of the lake. Using a view scope to shade out light in one's peripheral vision, the disk is lowered into the water until it is no longer visible, and then slowly raised until it is visible again. The average of those two depths is recorded as the Secchi disk depth transparency.

Water clarity of lake water is one of the most fundamental and important aspects of lake condition. Water clarity is also one of the most widely valued aesthetic elements of a lake. The Secchi disk measurement uses light penetration into the water to give estimates of water clarity. Clarity is usually limited by number of phytoplankton algae cells dispersed in the water column, so by inference, water clarity estimates phytoplankton density. Other factors can decrease water clarity; the most common being fine and very fine suspended sediments.

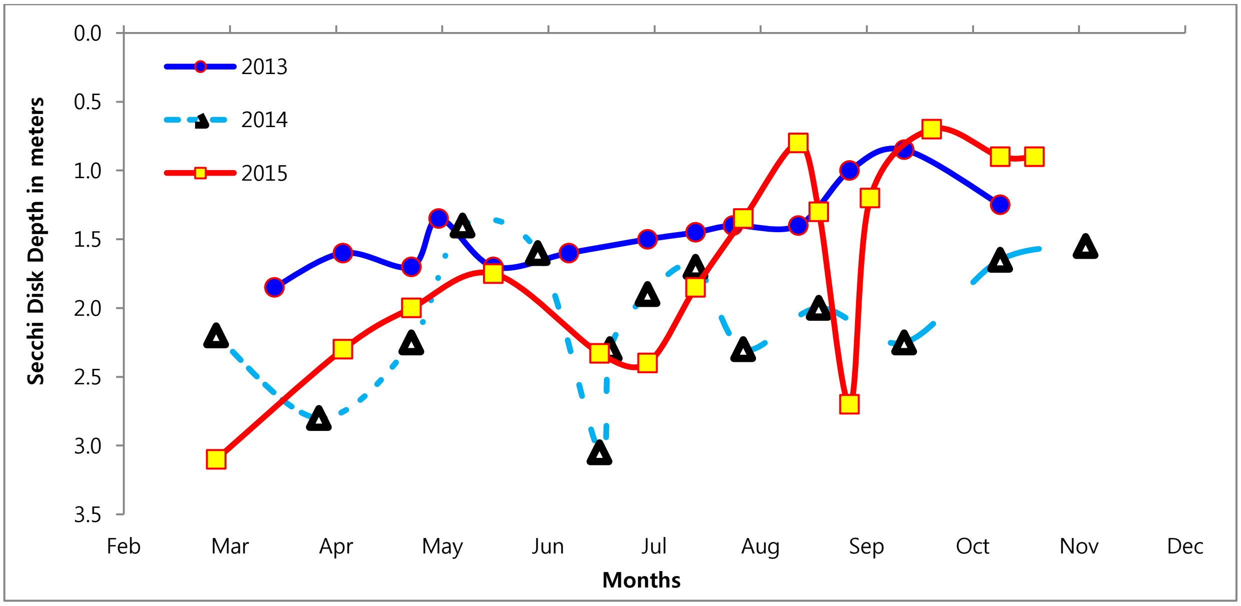
The water clarity readings for Lower Bolton Lake during 2013-2015 are shown below in **Figure 23**. The clarity of LBL tends to degrade during the course of season (March to November), with the best clarity at the beginning of the season and worst at the end of the season.

2013 - Clarity was poor during the entire 2013 season, with best readings occurring early in the season. March under-ice measurement was the best of 2013 at 1.85m, April and May readings of 1.6-1.7m were the best measured clarities during open water 2013 season. Poorest clarity in 2013 occurred in early October when the Secchi disk depth was 0.85m.

2014 - The clarity in 2014 was generally better than 2013, except for a brief period of poorer clarity in late May when clarity was the same as that time in 2013. Best clarity in 2014 was 3.05m occurring in mid-June. Poorest clarity was 1.4m in mid-May.

2015 – Water clarity in 2015 showed a wide range of conditions with both good and bad periods. Most noteworthy was the decline in transparency in August when significant numbers of cyanobacteria prompted a copper sulfate treatment. Clarity improved dramatically following the treatment going from 1.3m the day before to 2.7m a week after application of copper. Improved clarity was short lived however, with plankton numbers rebounding to pre-treatment levels, although cyanobacteria was minor after the treatment.

**Figure 23: - Water Clarity (Secchi disk depth) in Lower Bolton Lake during 2013, 2014, and 2015**




## Nutrients

### Phosphorus

There is a non-linear relationship between increasing phosphorus and declining water clarity shown in **Figure 24.** The data presented are paired measurements of water clarity and total phosphorus from over 100 lakes in CT collected in the 1970's (CAES 1984). Three important aspects of the relationship in **Figure 24** directly affect lake preservation and management.

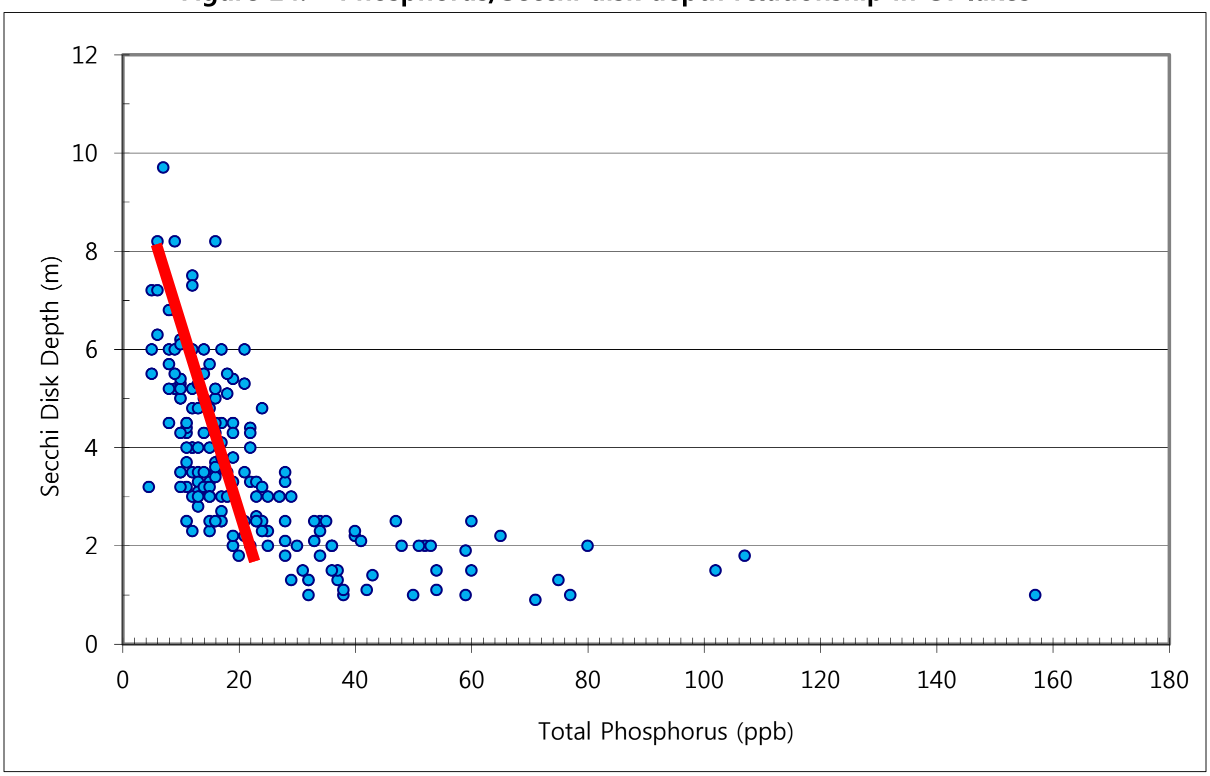
1) Water clarity rapidly declines linearly as phosphorus increases from zero to about 30ppb (red line in **Figure 24**).
   a. At very low phosphorus levels of <5ppb water clarity is usually 10m or better.
   b. With each incremental increase of 5ppb phosphorus, water clarity declines by about a meter until phosphorus concentrations of 20ppb will have water clarity of about 3m. Further increases in phosphorus cause water clarity to decline at a slower rate eventually leveling off at around 1-1.5m clarity when phosphorus is >30ppb.
      1. Water clarity declines quickly between 5ppb and 20ppb. Lake management seeks to maintain lakes near 10ppb.
      ii. However, even at higher phosphorus concentrations >50ppb, the range of expected water clarity is between 0 and 2 meters.

2) When phosphorus is less than 20ppb, water clarity readings can vary considerably with the same phosphorus concentration.
    a. This means that phosphorus caused declines in clarity are often not apparent due to large natural variability in both.

3) Phosphorus concentration can continue to increase past 30ppb with little further decline in clarity.
    a. With phosphorus concentrations >30ppb, water clarity remains between zero and 2m.

        Once phytoplankton reach full bloom growth rates (water clarity of about 0.5 meters) their numbers cause self-shading and general light limitation to the population such that transparency in open water—non-scum—is rarely less than 0.5 meters.

**Figure 24: – Phosphorus/Secchi disk depth relationship in CT lakes**




Source = CT Agricultural Experiment Station Bulletin 817, 1984

### Lower Bolton Lake 2013-2014-2015

Total phosphorus was closely tracked during 2013, 2014, and 2015, results for 1 and 3 meter depths shown in **Figure 25,** and results from 5 meters shown in **Figure 27**. Phosphorus at 3 meters has been slightly higher than concentrations at 1m but generally similar over the course of monitoring indicting mixed conditions (see **Figure 26**—linear relationship shown as solid black line is statistically significant, red dashed line indicates equality).

Phosphorus concentration has been shown to increase each season from lowest values in the spring to highest values in mid-to late-summer or fall. In 2013, phosphorus increased from 20ppb in April, to 40ppb in October. In 2014, phosphorus increased from a low of 18ppb in April, to 30ppb in July, while in 2015 phosphorus increased from 15 ppb in April, to 36ppb in October. Summer phosphorus concentrations during each year 2013, 2014, and 2015 have exceeded the highest concentrations observed in 2012. This slow summer increase suggests internal loading of phosphorus from sediments- either from sediment recycling or from groundwater. Lowest concentrations in the spring suggest that deep release from Middle Bolton Lake during the winter is a minor source of phosphorus load to the lake.

**Figure 25 - Total phosphorous concentration trends (ppb) at 1 m and 3 m depths**

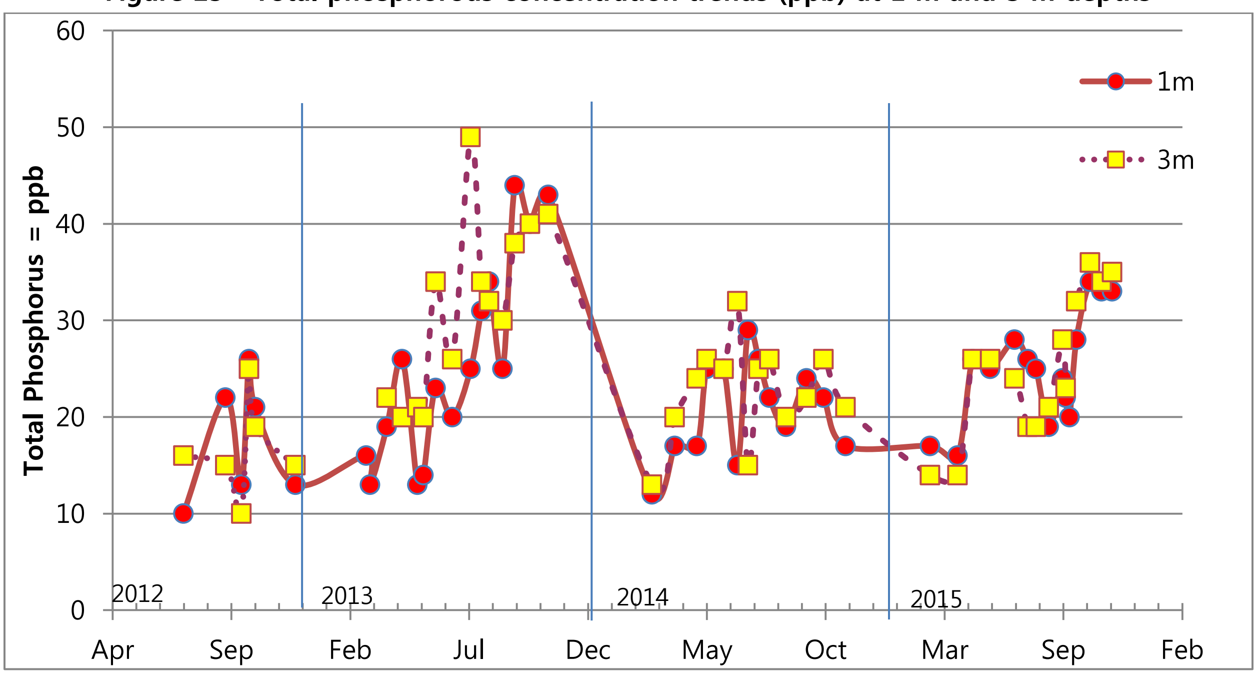
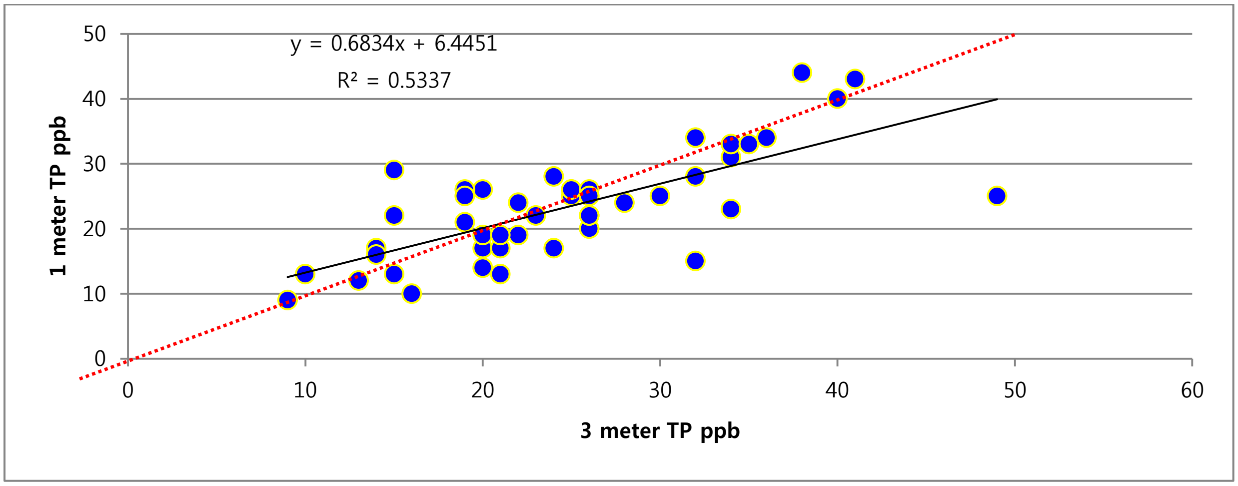


**Figure 26 - Total Phosphorous concentrations at 1 m and 3 m depths**




Bottom phosphorus (5m) has shown the same general trend of increasing during the course of each season following patterns of deep water oxygen loss (**Figure 27**). Due to overlap of anoxic boundary and the thermocline, phosphorus accumulated at the bottom of the deep hole may diffuse into the epilimnion. Water at 5 meters generally had higher concentrations of phosphorus than water at 3 meters and no significant relationship was found between increases at 5 meters and increases at 3 meters (**Figure 28**). Maximum phosphorus concentrations in bottom waters has not been severe, highest value was 83ppb, not significantly different than the maximum concentration observed in 2011 of 52ppb, prior to the bloom of 2012, suggesting that LBL may have routinely had phosphorus accumulate in deepest water during summer months.

**Figure 27: - Total phosphorous concentration trends (ppb) at 5m and anoxic boundary**

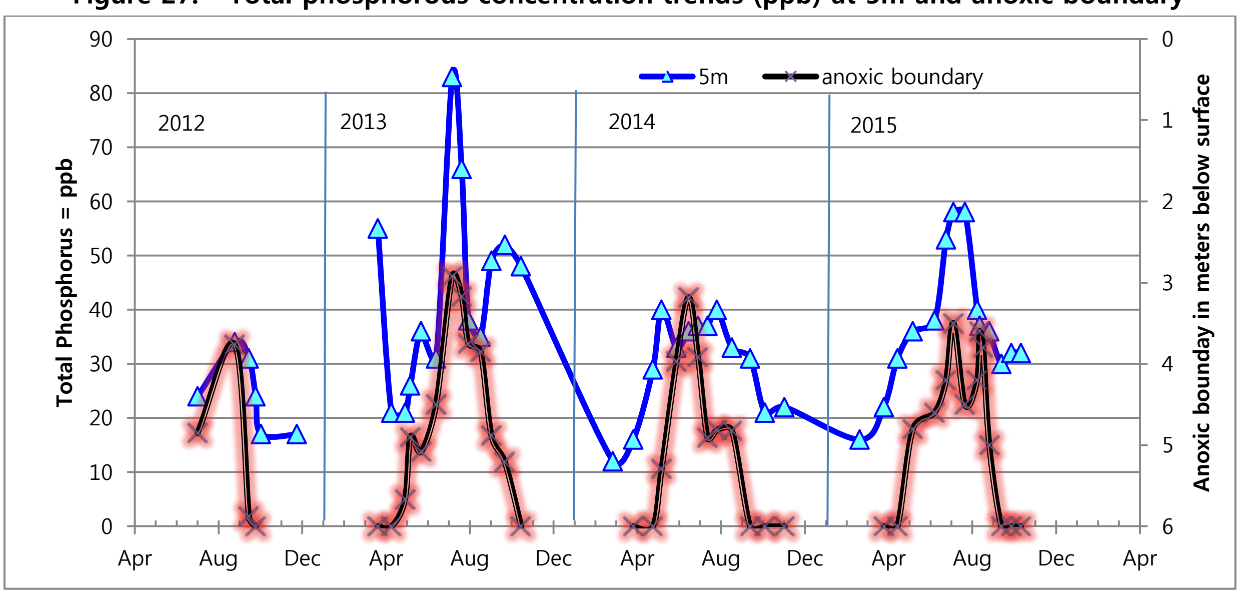
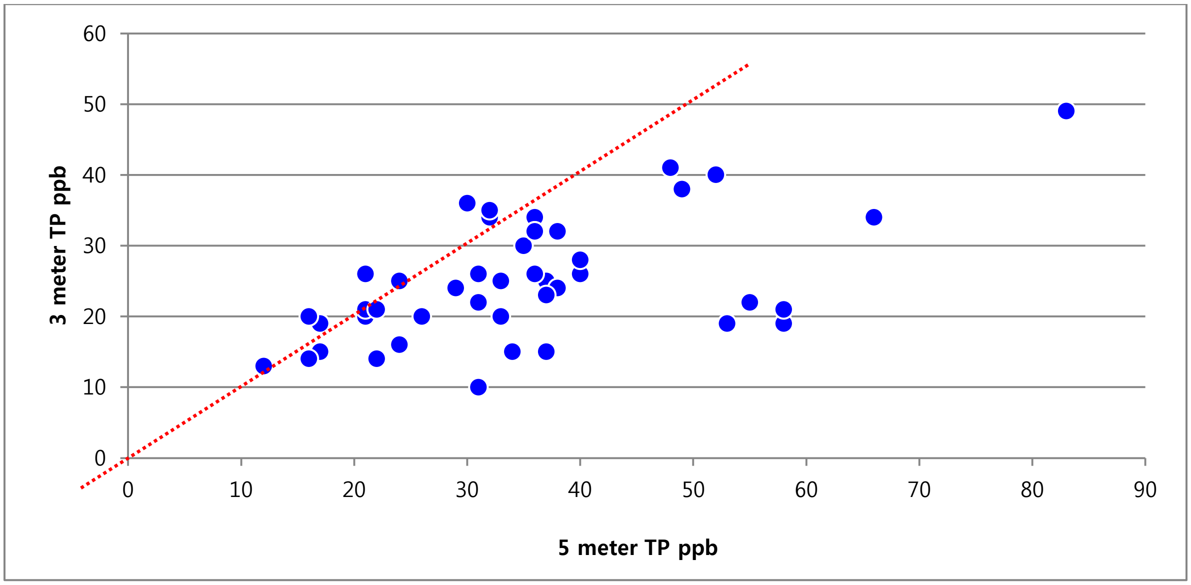


**Figure 28: - Total phosphorous concentration at 3m and 5m depths**




## Nitrogen

Nitrogen is the second important nutrient fueling plant growth in lakes. Although for the most part phosphorus regulates how much phytoplankton can grow, nitrogen factors into which phytoplankton dominate. Nitrogen in lake water can exist in a number of forms depending on background conditions, such as mixing depth, dissolved oxygen content, and the amount of light present.

Typically, nitrogen dissolved in water is either as nitrate (and nitrite, to a lesser extent) when there is plenty of oxygen, and ammonium when oxygen is scarce. Ammonium and nitrate for largely inter-changeable based on assimilation needs of plankton and oxidation/reduction potentials in the water. Organic nitrogen (essentially all the rest of the total nitrogen that is not ammonia or nitrate) is either dissolved or particulate (non-dissolved). In either case, these organic forms of nitrogen are generally not available to phytoplankton. Several components of organic nitrogen are readily decomposed by bacteria causing dissolved oxygen declines, whatever is not decomposed is incorporated into the sediments.

Total nitrogen (sum of all forms of nitrogen) trends between 2011 and 2014 for three depths in Lower Bolton Lake are shown in the following graph **Figure 29**. On August 27$^{th}$, 2012 total nitrogen reached record high levels when concentrations at all three depths simultaneously reached 2,300ppb. Total nitrogen has not reached that level again. In 2013, maximum total nitrogen in bottom water was 1,500ppb between late July and late August. In 2014, highest total nitrogen was 750ppb occurring once in late July. In 2015, total nitrogen reached 1600 ppb in early September, simultaneous with the bloom of cyanobacteria.

The spike in total nitrogen concentration in 2012 was most likely due the prolific southern naiad present in the lake at that time. Many massive colonies—each several tens of feet across that stretched to the bottom, dominated most north, west and southwest areas of the lake. It is possible that large amounts of organic nitrogen were dissolved into lake water due to dying naiad. Graphs of ammonia (**Figure 30**), and nitrate (**Figure 31**) show that the high level of total nitrogen detected on August 27$^{th}$, 2012 consisted of 80% dissolved organic nitrogen with only 20% as ammonium, with no nitrate.

However most total nitrogen at the bottom of the deep hole has occurred as ammonium (**Figure 32**) was found only in bottom water in 2013-2014 with generally little to no ammonium detectable in upper waters. Ammonium peaks occurred during summer months when bottom water was anoxic. Nitrate was rarely detected in Lower Bolton Lake (**Figure 31**), only during winter months at moderately low levels. Highest nitrate occurred in upper water with none detected in bottom water in November 2012 although in March 2014 nitrate was found at all depths, with highest concentration found at the bottom.

**Figure 29: - Total nitrogen concentration in Lower Bolton Lake during 2011-2015**

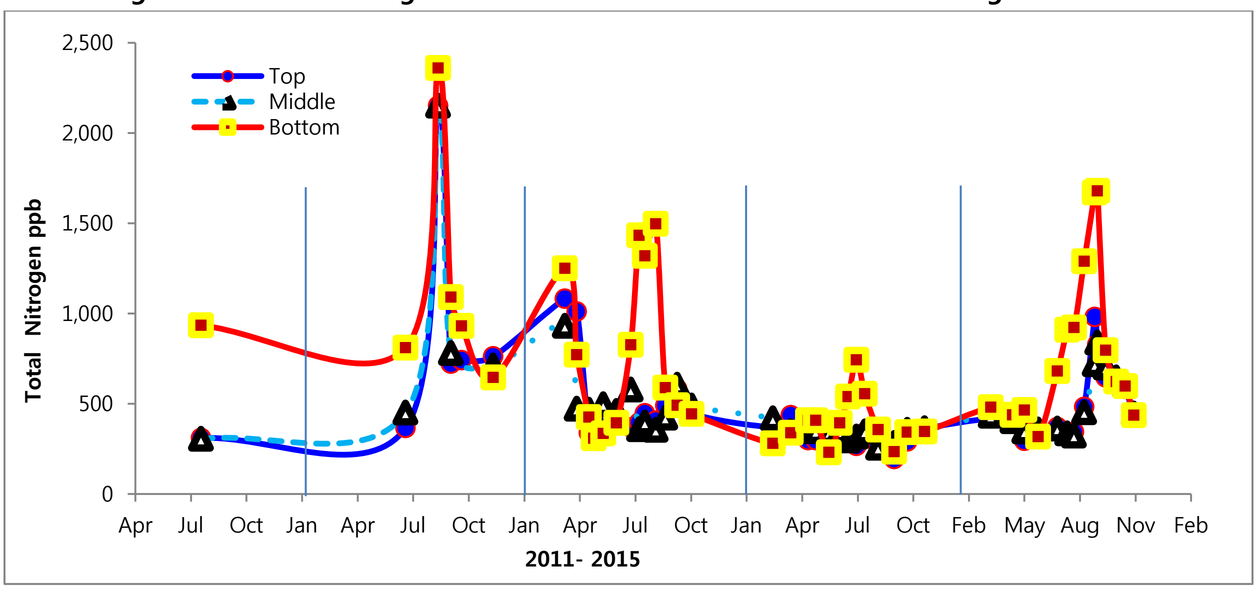


**Figure 30: - Ammonia nitrogen concentration in Lower Bolton Lake during 2011-2015**

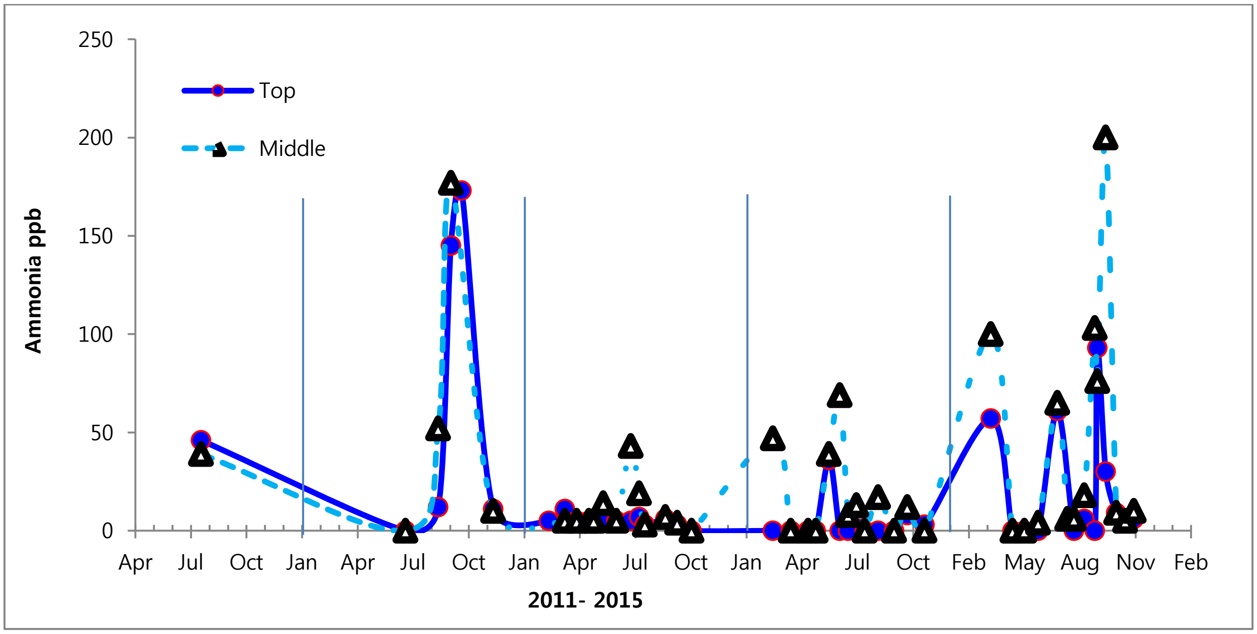



**Figure 31: - Nitrate nitrogen concentration in Lower Bolton Lake, 2011-2014**

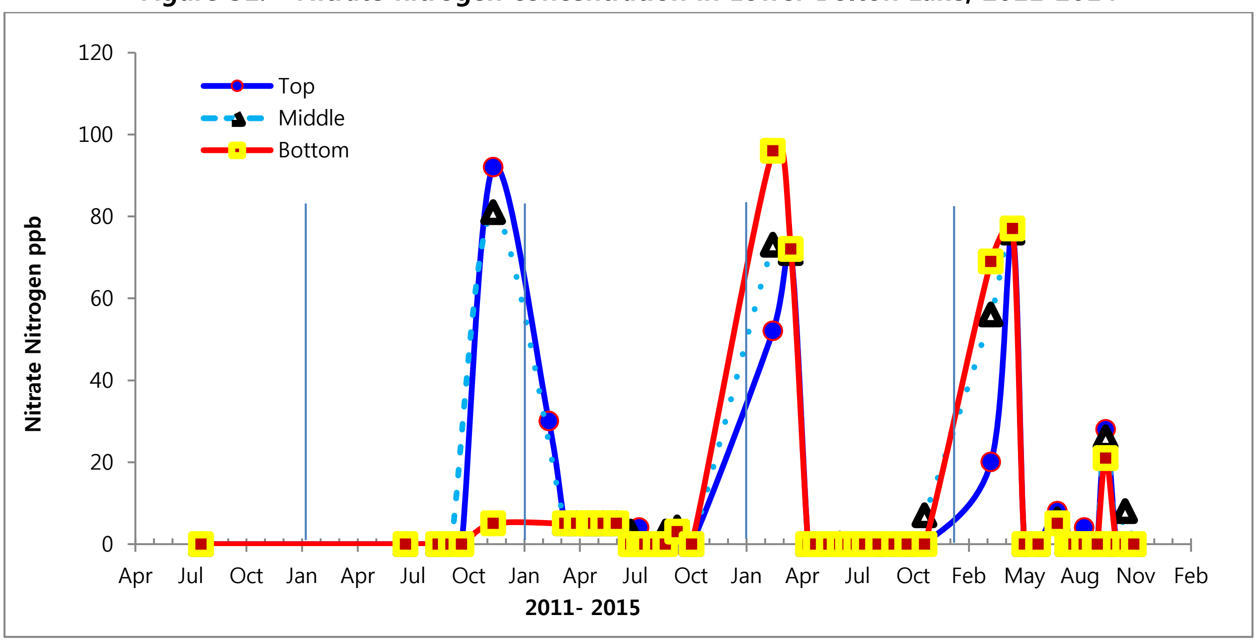
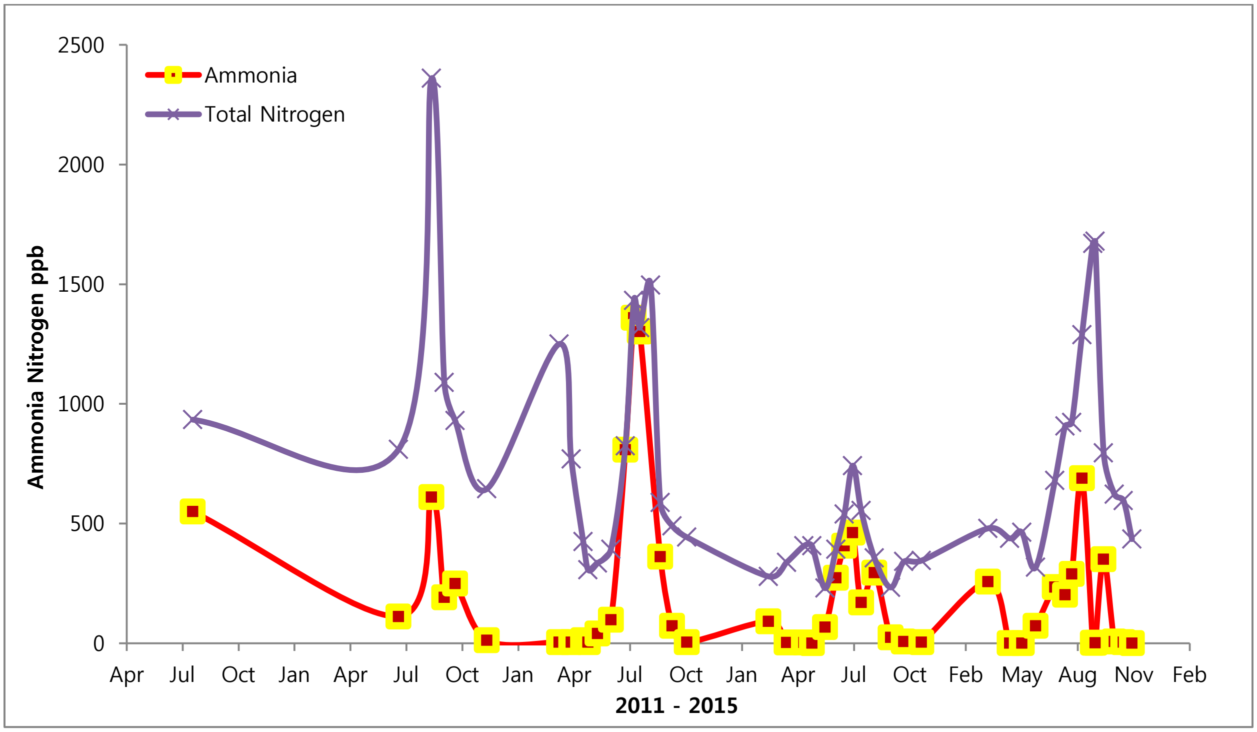


**Figure 32: - Ammonia nitrogen and total nitrogen concentrations at 5 meters in Lower Bolton Lake 2011-2015**




## Iron

Iron is one of the most common elements in the earth's crust. Many areas around New England have high levels of iron in groundwater prompting home water treatment systems. When iron enters lake water in the presence of oxygen it sinks to the bottom and forms a rusty crust over the bottom sediments. Due to this insolubility, iron concentrations in lake water of neutral pH, and oxygen near saturation are <0.01mg/L or 10ppb (Wetzel 1975, Hem and Cropper 1962).

During the summer of 2014 suspicion grew that iron in Lower Bolton Lake water was not sinking but instead remaining dissolved in the water column. Testing in 2014 and 2015 has shown that iron occurred at very high levels in the water column despite saturated oxygen conditions. The data in **Figure 33** shows iron concentrations mostly above 100ppb in the top 10 feet of the water column. Although oxygen was mostly above 80% saturation, levels of iron still exceeded 200ppb in 2015. High levels of soluble iron cause brown coloration of the water that factor strongly in poor clarity. Generally, iron was at similar concentrations at both stations at the 1 meter depth as well as the bottom of Station 2. Iron at middle depth at Station 1 showed some influence from high iron concentrations at 6 meters by almost always exceeding the concentration at 1 meter (**Figure 34**).

At Station 2, bottom iron levels where sometimes higher than the other sites shown in **Figure 33** suggesting dynamic redox potential at the bottom of Station 2, more groundwater in that area, or a total iron source that is closer to Station 2 than to Station 1.

**Figure 33: - Total iron in epilimnion of Lower Bolton Lake 2014 -2015**

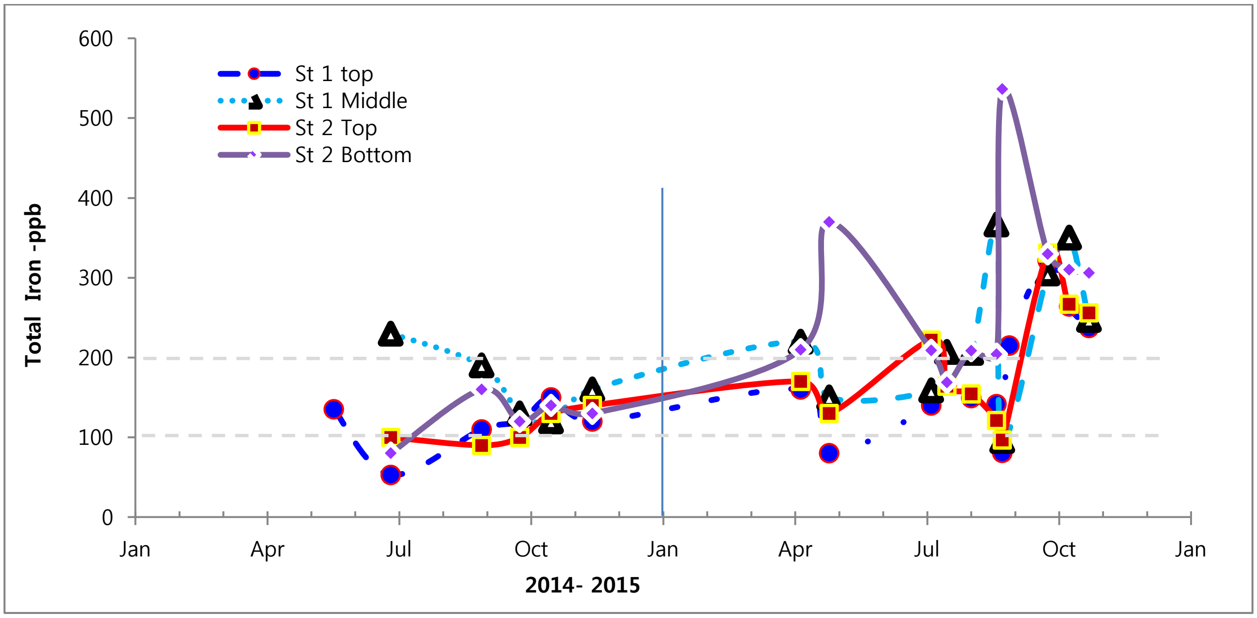
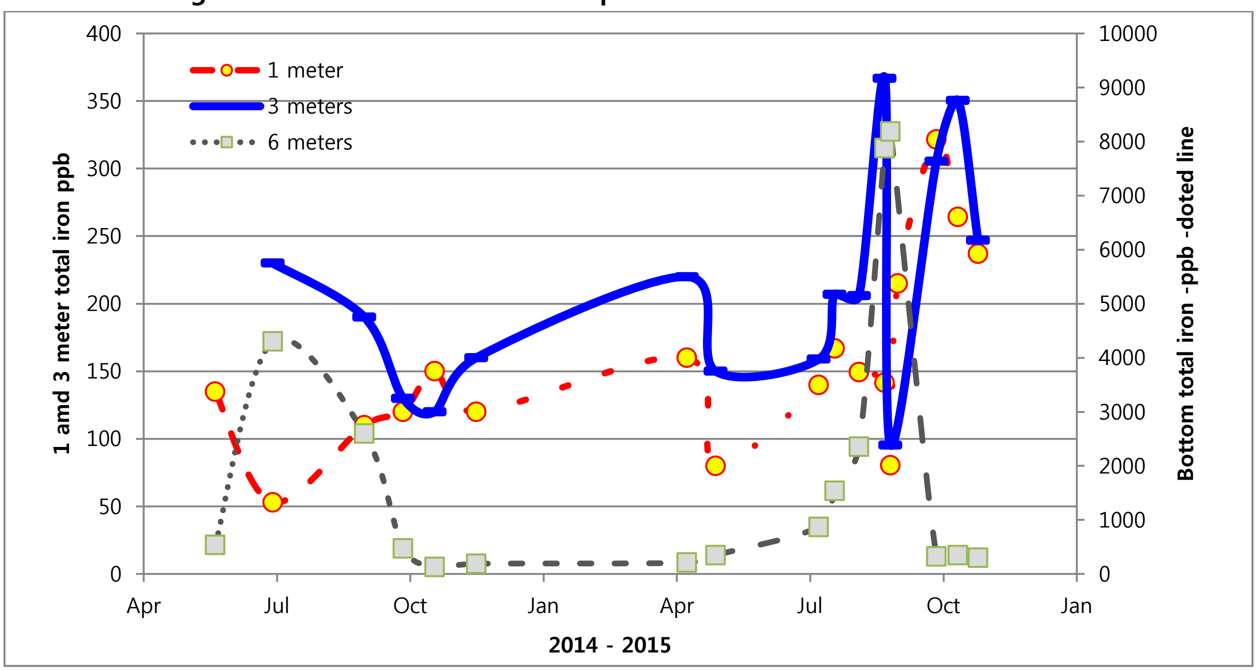
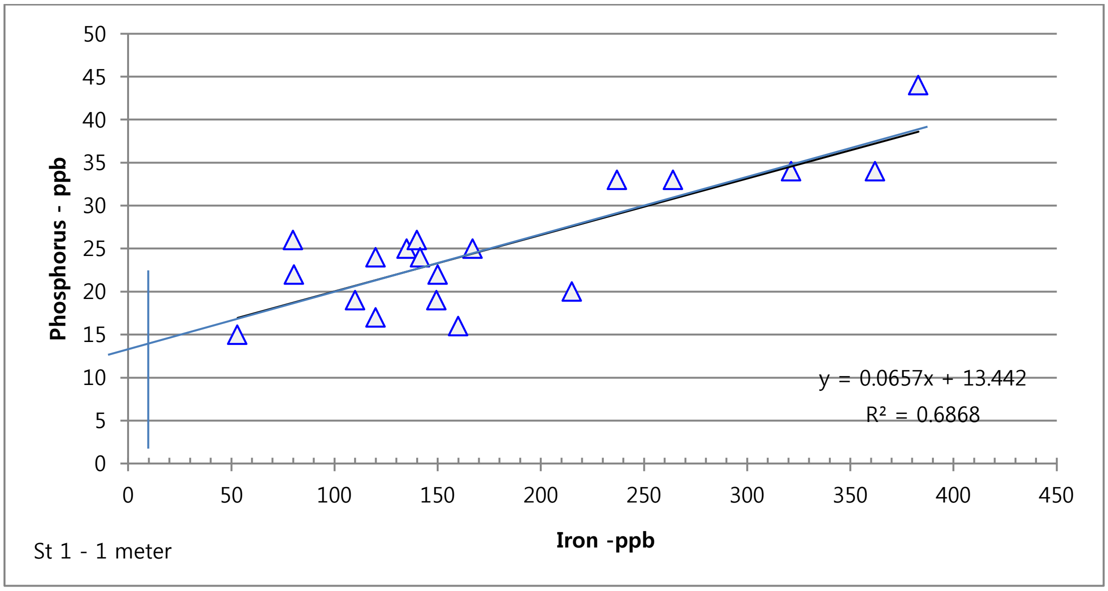



**Figure 34: - Total iron at three depths in Lower Bolton Lake 2014 -2015**




A relationship exists between iron and total phosphorus concentration at 1 meter in Lower Bolton Lake (**Figure 35**). Typically iron is considered the independent variable with respect to phosphorus concentrations in water in that when iron sinks to the bottom it takes phosphorus with it. This indicates that controlling iron concentration will also control phosphorus levels. The data in **Figure 35** suggests that if iron levels were reduced to target 10ppb than phosphorus would decrease to <15ppb.

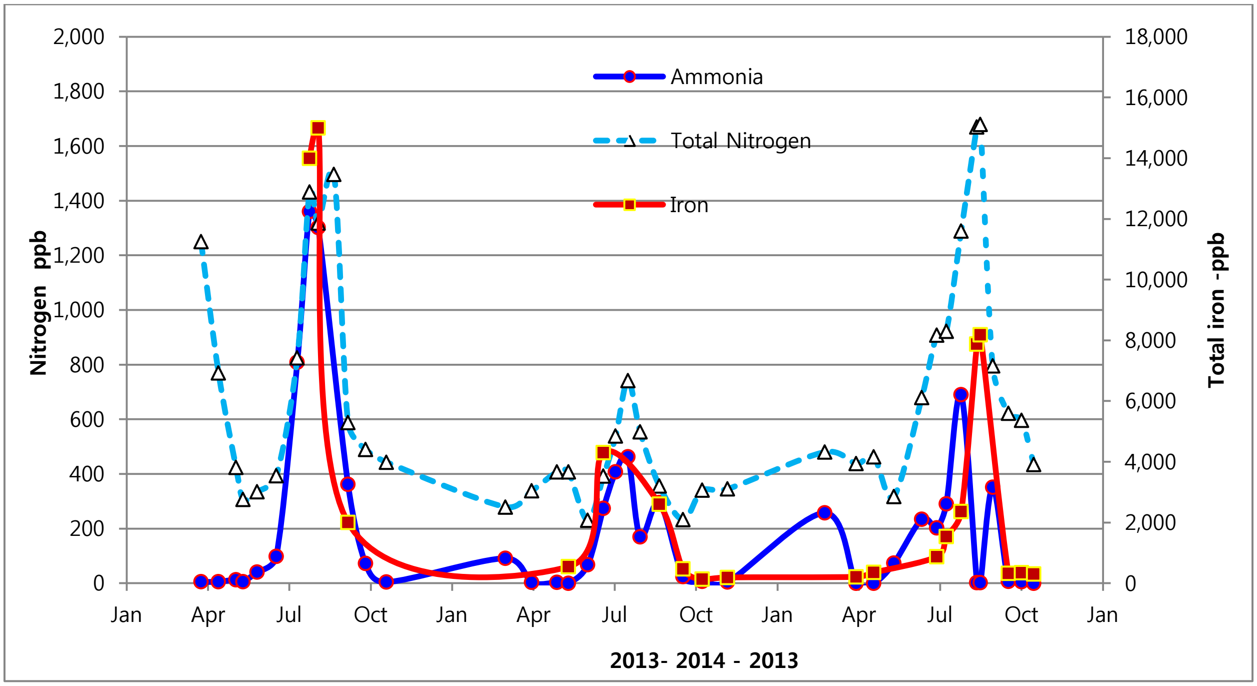
**Figure 35: - Relationship between total iron and total phosphorus in Lower Bolton Lake**




Typically, iron is the principal redox active element in lake water readily shifting between soluble when dissolved oxygen is scarce or depleted, and insoluble when oxygen is present. In 2013, anoxia in Lower Bolton Lake allowed significant amounts--15,000ppb--of iron to accumulate in deepest water (**Figure 36**). Iron has most likely been released from anoxic sediments, a common occurrence in CT lakes with anoxic bottom water but it may also be in runoff water. Iron accumulated in bottom water in both 2014 and 2015 when dissolved oxygen was exhausted. In the oxidized ferric state ($Fe^{+3}$) it can bind with phosphorus; however, reducing iron to its ferrous state ($Fe^{+2}$) relinquishes the bind with phosphorus.

The interaction of iron and nitrogen during the anoxic periods of 2013-2015 is shown in **Figure 36**. The dissolved oxygen at 5 meters is completely exhausted by the first week of May (see **Figure 20**), and remains so until mixing in October. After a lag of about a month, ammonium and iron are released from bottom sediments reaching maximum concentrations in late July/early August. Organic nitrogen continued to increase through August reaching maximum concentration at the end of the month.

**Figure 36: - Concentration trends of nitrogen (separated into ammonia and total nitrogen) and total iron (all in ppb)**




## Plankton Analysis

A cyanobacteria bloom started at the beginning of August 2012. In July, when NEAR visited the lake there were few bluegreens (cyanobacteria) in the water. However, a sample collected on August 8th revealed large numbers of potentially toxic cyanobacteria however the most abundant algae in the sample were the non-toxic Green alga *Staurastrum* sp. (**Photo 3**), the pinnate Diatom *Synedra* sp. (**Photo 4**).

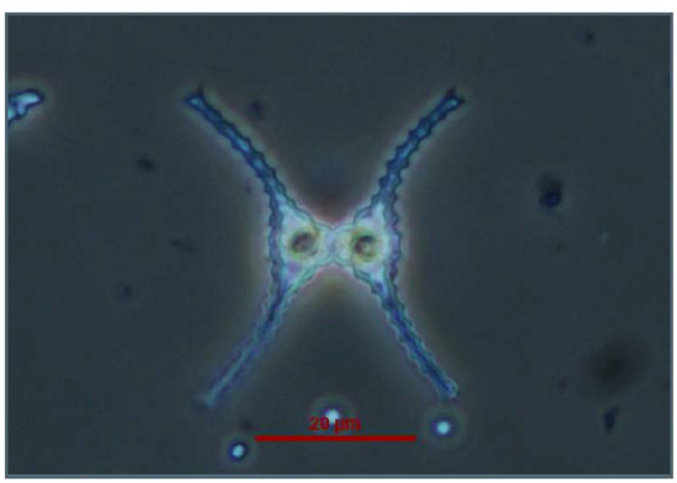


**Photo 3: - Staurastrum sp. 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Labs

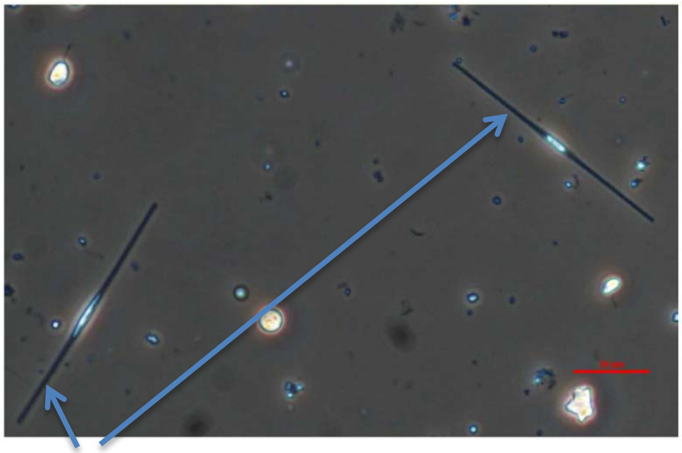


**Photo 4: - <u>Synedra</u> sp. 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Lab

Also present in the sample were the potentially toxigenic colonial cyanobacteria *Woronichinia naegeliana* (**Photo 5**), the filamentous cyanobacteria *Planktothrix agardhii* (**Photo 6**), Anabaena sp. (**Photo 7**), and *Aphanizomenon* sp. (**Photo 8**).

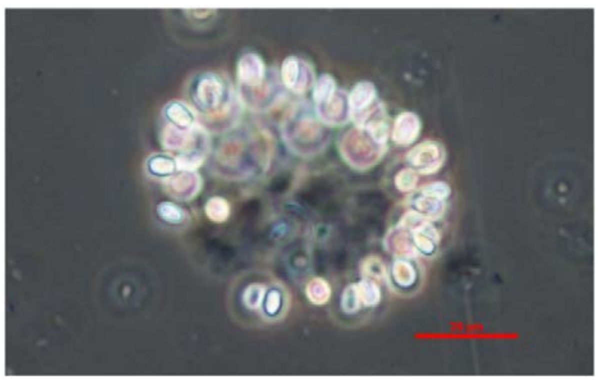


**Photo 5: - <u>Woronichinia naegeliana</u> 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Labs

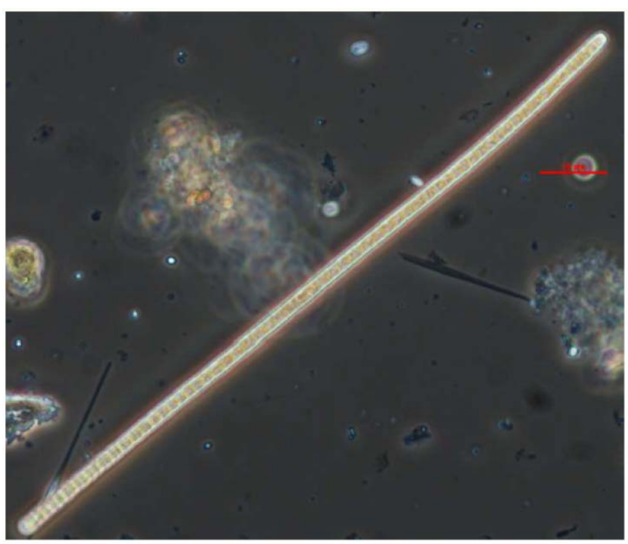


**Photo 6: - <u>Planktothrix agardhii</u> 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Labs

**Photo 7: - Anabaena sp. 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Labs

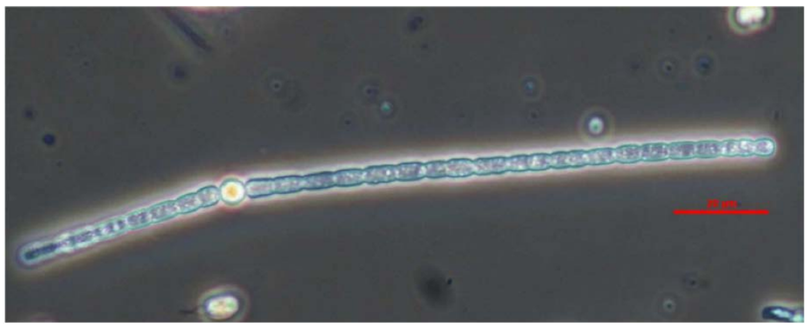
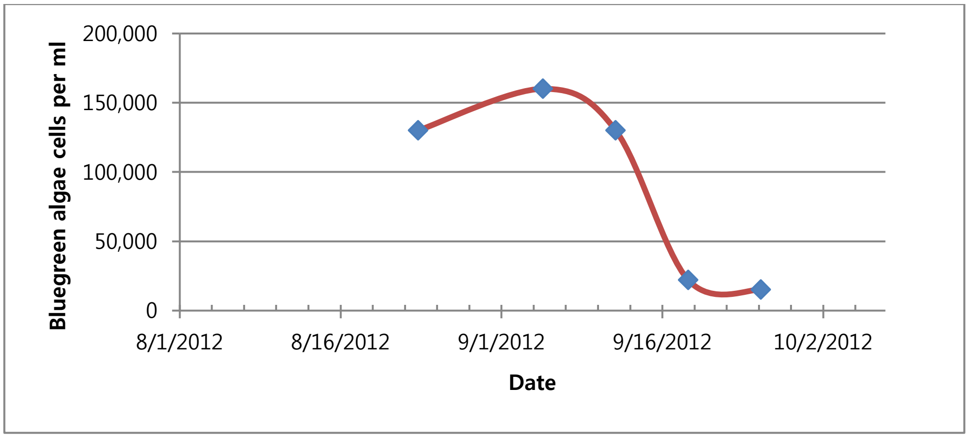


**Photo 8: - Aphanizomenon sp. 400X (Scale bar = 20 µm)** Photo Credit: GreenWater Labs

Other algal groups present included golden-brown algae (Chrysophyceae), cryptophytes (Cryptophyta), haptophytes (Haptophyceae), euglenophytes (Euglenophyta), dinoflagellates (Pyrrhophyta), raphidophytes (Raphidophyceae) and yellowgreen algae (Xanthophyceae).

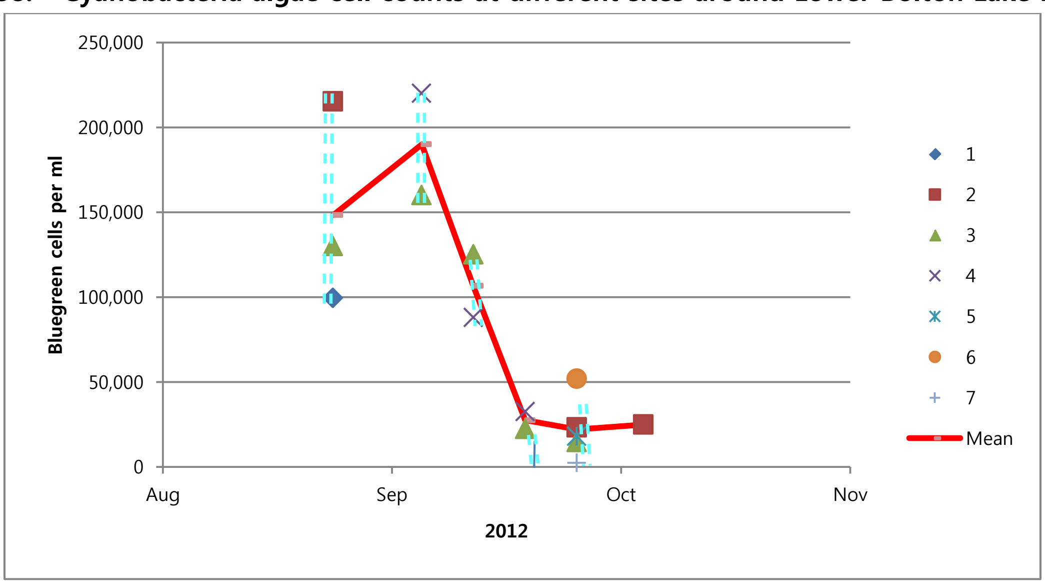
The first 2012 cell count was performed on August 24th and showed more than 100,000 cells per mL of cyanobacteria in the lake. Subsequent counts (shown in **Figure 38** below) reached highest levels in early September at 160,000 cells/mL but receded quickly during September to reach low numbers--below 20,000--by the end of September.

**Figure 37: - Cyanobacteria cell counts at Lower Bolton Lake boat ramp in 2012**




Although cell numbers were high in August, there was apparently no consistency with regard to location on the lake. Data from cell counts made at 7 different sites around the lake are shown in **Figure 39**. Variation in the first round of samples was very high at 100K cells/mL between different sites around the lake. The variation among sites generally declined as bloom waned, although one late summer sample still showed that bloom numbers were different around the shore, indicating that prevailing winds moved the bloom around the lake and concentrated cell numbers along specific shorelines.

**Figure 38: - Cyanobacteria algae cell counts at different sites around Lower Bolton Lake in 2012.**




Despite the presence of potentially toxigenic cyanobacteria in Lower Bolton Lake during 2012, no microcystin was detected (**Table 7**).

**Table 7: - Microcystin results from September 2012**

| Date of Collection | Location | Microcystin (ppb) ^ |
|---|---|---|
| **9/5/12** | Indian Notch Beach | < 1 ppb |
| **9/5/12** | Boat Launch- Lower Bolton Lake | < 1 ppb |
| **9/12/12** | Indian Notch Beach | < 1 ppb |
| **9/12/12** | Boat Launch- Lower Bolton Lake | < 1 ppb |
| **9/19/12** | Indian Notch Beach | < 1 ppb |
| **9/19/12** | Boat Launch- Lower Bolton Lake | < 1 ppb |
| **9/26/12** | 121 Vernon Rd - Bolton | < 1 ppb |
| **9/26/12** | 39 Vernon Rd - Bolton | < 1 ppb |
| **9/26/12** | Boat Launch- Lower Bolton Lake | < 1 ppb |
| **9/26/12** | Rosedale Beach - Lower Bolton Lake | < 1 ppb |
| **9/26/12** | Upper Spillway - Lower Bolton Lake | < 1 ppb |
| **10/5/12** | 17 Lakeside Circle - Bolton | < 1 ppb |
| **10/5/12** | 39 Vernon Rd - Bolton | < 1 ppb |
| **9/18/13** | Lower Bolton Surface Scum | ND* |

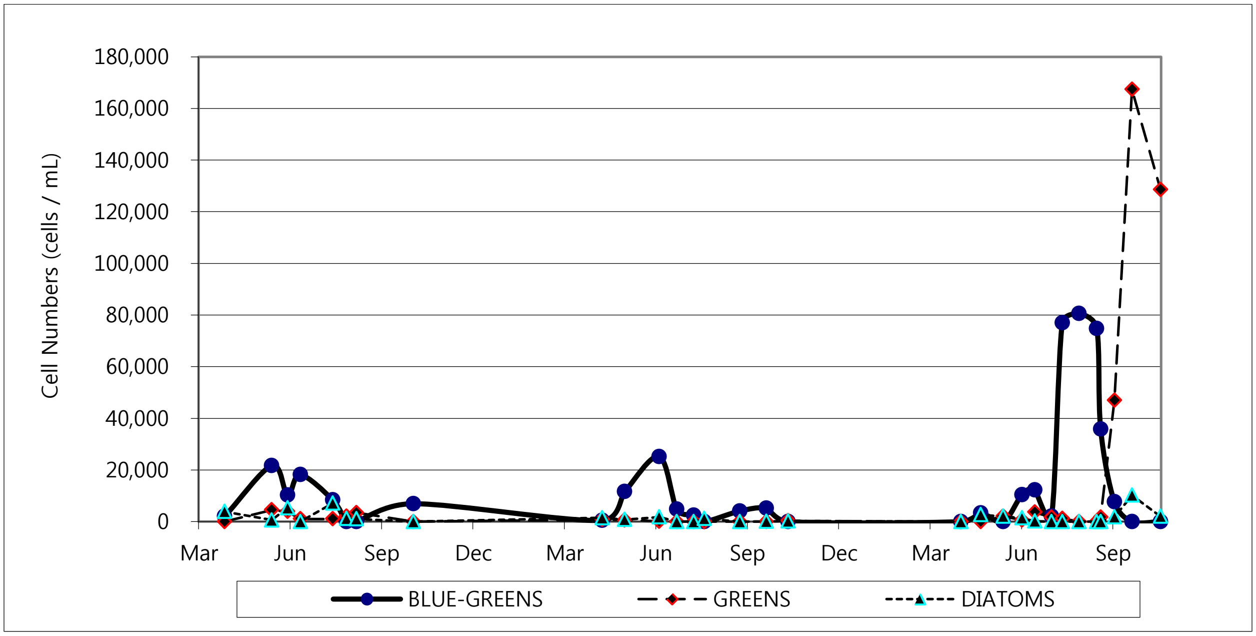
* This sample was tested using the ELISA method by Green Water Labs. ND stands for Not detected.

^Northeast Laboratories Inc. Abraxis 520022 Test Kit

Trends in phytoplankton in Lower Bolton Lake during 2013-2015 are shown in Figure 40. Cyanobacteria (Planktothrix) numbers in 2013 became elevated briefly in July barely exceeding 20,000 cells/L. Greens (Scenedesmus, Pediastrum and Staurastrum) and Diatoms (Fragilaria, Synedra, and Melosira) were important components of the plankton community. Cyanobacteria numbers were found in vertical zooplankton tows[8] in May and June 2013 indicating that bottom water was in pre-bloom stage. Subsequent copper sulfate treatment on June 27, 2013 arrested this bloom such that late July zooplankton tow revealed no cyanobacteria. In 2014, cyanobacteria numbers reached maximum of 25,000 cells/L briefly in June, however greens and Diatoms were scarce that year. In 2015, cyanobacteria bloom of Aphanizomenon and Anabaena occurred beginning in late July. High numbers of cyanobacteria in both upper and deep water in August prompted copper sulfate treatment in early September. Cyanobacteria numbers crashed after that treatment, but population numbers of green algae (Scenedesmus) became prolific into October and November.

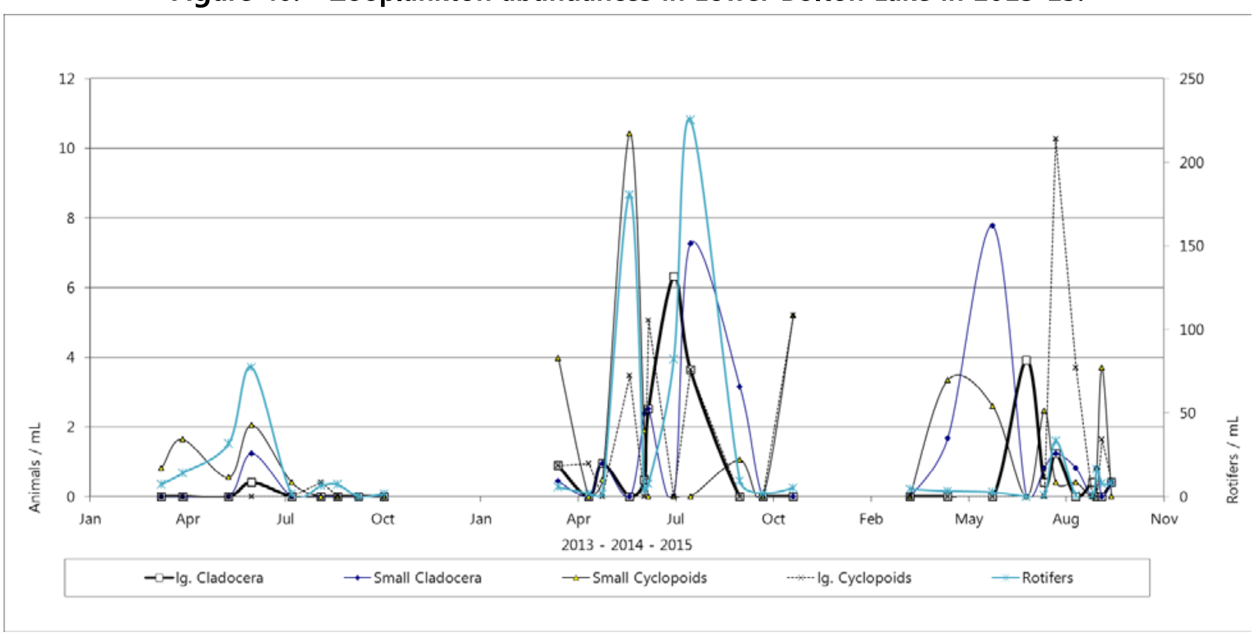
[8] A fine mesh net is hauled from bottom to surface to collect organisms.

**Figure 39: - Dominant algae cell counts from Lower Bolton Lake in 2013-2015**




Zooplankton were scarce to absent in Lower Bolton Lake in 2013 (**Figure 41**) with water column tows in 2014 and 2015 showed that generally the community was composed of tiny Rotifers. In 2015, young Cladocera appeared in the water column in late May reaching maturity in late June indicating that zooplankton are present in LBL and reach healthy population numbers. There did appear to be a crash in zooplankton population numbers coinciding with the copper treatment as we would expect, but recovery of copepod populations is evident by the end of the season.

**Figure 40: - Zooplankton abundances in Lower Bolton Lake in 2013-15.**



## Fisheries

On December 15, 2012 the DEEP released a report on the status of the fisheries resources of the Bolton Lake watershed including Lower Bolton Lake. Fish species in the lake include largemouth and smallmouth bass, chain pickerel, black crappie, yellow perch, channel catfish, and various species of sunfish. In 2008 the DEEP conducted an electroshocking survey of the fish populations in the lake and concluded that Lower Bolton Lake has a higher than average densities of largemouth bass, as well as above average densities of large sunfish (Murphy 2012). Lower Bolton Lake is a Bass Management Lake meaning that there are additional regulations governing large and smallmouth bass fishing in the lake including a daily creel limit of six bass and a limit of two fish over sixteen inches.

Lower Bolton Lake had been stocked with 17,000 channel catfish yearlings by the State of Connecticut during the period from 2007-2012. These fish are non-native to the lake but not exotic, as they are found in all major watersheds in Connecticut (Murphy 2012). DEEP conducted an Environmental Assessment before the commencement of the stocking and found a lack of significant potential stocking impacts. In May 2013 DEEP conducted a "mark recapture" survey to determine the population of channel catfish in Lower Bolton Lake in response to concerns that a large population of these fish might be contributing to the nuisance algal blooms in the lake. They estimated the population of channel catfish to be approximately 430 fish in Lower Bolton Lake, a density that is not excessively large and likely does not contribute significantly to the nutrient loading in the lake (Davis 2013). In fact, through food web dynamics removing the channel catfish from the lake may actually have negative consequences for water quality because adult channel catfish are piscivorous, meaning that they eat smaller fish that forage on zooplankton. These zooplankton, feed on the small phytoplankton which helps keep the water clear. Increased feeding pressure on the small fish releases predation pressure on the zooplankton allowing them to control levels of phytoplankton, lowering the risk of a bloom. For a more in depth discussion on why catfish aren't considered a water-quality concern, please read DEEP's response to Bolton Residents to Questions about Channel Catfish in Lower Bolton Lake compiled by Justin Davis (Davis 2013).

DEEP has not stocked the lake with channel catfish since 2013 due to concern by residents but plan to resume stocking in 2016. NEAR has found no significant evidence of the catfish detrimentally impacting the lake and is of the opinion that catfish do not represent a significant threat to lake health.

# Summary and Recommendations

Lower Bolton Lake experienced a serious and unprecedented bloom of potentially toxic cyanobacteria in August 2012. Although no toxins were detected during the 2012 bloom the level of cyanobacteria cell numbers exceeded 100,000 cells/mL. For several years prior to the bloom of cyanobacteria, southern naiad had overrun the lake, covering 80% of the bottom in a little as 6 years, as no naiad was found in Lower Bolton Lake during a survey in 2005 (CAES) to 2011 when growths were so dense they reached the surface in many areas of the lake from as deep as 12 feet of water.

In 2013, Fluridone, a liquid systemic aquatic plant herbicide, was placed in the lake to control the rampant naiad. During the second application made to maintain herbicide concentration, copper sulfate was applied to parts of the lake to ward off further cyanobacteria growth.

Only tiny sprigs of naiad were found in the lake during surveys in 2013, and 2014. Native plants appear to be returning, with 8 species identified in the lake by May 2015.

The two invasive plants found in the lake prior to Fluridone (fanwort, and variable-leaved milfoil), were not seen in 2014, with no sign during the May 2015 survey. Unfortunately, a new invasive species curly-leaf pondweed (*Potamogeton crispus*) was found in the lake during the intensive fall survey. One non-native species found prior to the treatment, Mudmat (*Glossostigma*) was also found in May 2015. Mudmat is a tiny plant that forms blankets over sediments. The plant does not pose a threat to the lake, and may actually perform a valuable function by buffering sediment and water interface.

Low levels of cyanobacteria occurred in 2013 or 2014, but a moderate bloom occurred in 2015, seemingly arrested by copper sulfate treatment on September 2nd. Water clarity remained poor due to high levels of green algae and dissolved iron in the water column.

At this time it is unclear what caused the cyanobacteria bloom in 2012. Proliferation of naiad progressed to annual generation of massive growths of dense balls of plant material that excluded dissolved oxygen from diffusing into the center. Many of the large islands were so dense that most of the center portions were anoxic. It is possible that extremely high levels of nutrients were tied up in the cycling within the naiad islands, as well as within the vegetated carpet over the bottom, which was generally 1ft thick but was found to be as much as 3ft thick. Higher phosphorus found in the lake in 2013 and 2014 maybe unavailable to phytoplankton due to high iron levels in the lake, a possibility being further investigated.

Five actions are necessary at this time.

1. Continued close investigation and monitoring.
   a. The lake is still changing, as noted by almost all trends shown for the last two years.
   b. Nutrient levels are still high enough to cause a cyanobacteria bloom.
   c. Invasive aquatic plant species continue to be present in the lake.
   d. The return of native aquatic plants should be closely monitored.
   e. High iron levels in the water may cause un-expected effects.
2. Prepare for a cyanobacteria bloom.
   a. File necessary permit application so a copper sulfate treatment can be made should cyanobacteria numbers increase to threating levels.
   b. Monitor cyanobacteria levels during the summer and treat with copper sulfate if necessary.
3. Prepare for naiad or invasive species treatment.
   a. File necessary permit applications for treatment to control variable-leaved milfoil, fanwort, naiad and curly-leaf pondweed.
   b. Monitor aquatic plant presence and density and abundance during the spring and early summer.
   c. Treat beds of plants as necessary.
4. Watershed testing in 2014-2015 showed that some flows could be high in nitrogen and phosphorus.
   a. More investigation is needed to verify prior high results.
   b. Prioritize importance of possible watershed loads by level of nutrients and water flow.
   c. Refine sampling to systematically find root cause.
5. Phosphorus trends at this time point to internal loading as principal source of excess concentrations in the water column.
   a. Phosphorus inactivation and or water column stripping should be considered in 2016.
   b. Fractions of phosphorus in sediment need to be determined for inactivation dosing. Detailed sediment sampling is recommended.
   c. Possible interaction between phosphorus inactivation material (Aluminum sulfate) and iron in the water may cause co-precipitation of phosphorus.

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| | 2011 | 2012 | | | | | |
|---|---|---|---|---|---|---|---|
| **Total Phosphorus (ppb)** | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 9 | 10 | 22 | 13 | 26 | 21 | 13 |
| 3 | 9 | 16 | 15 | 10 | 25 | 19 | 15 |
| 5 | 52 | 24 | 34 | 31 | 24 | 17 | 17 |
| mean = | 23.3 | 16.7 | 23.7 | 18.0 | 25.0 | 19.0 | 15.0 |
| **Ammonia -N (ppb)** | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 46 | 0 | 12 | 145 | | 173 | 11 |
| 3 | 39 | 0 | 52 | 177 | | | 10 |
| 5 | 550 | 112 | 610 | 192 | | 249 | 12 |
| mean = | 212 | 37 | 225 | 171 | | 211 | 11 |
| **Nitrate/Nitrite -N (ppb)** | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 0 | 0 | 0 | 0 | | 0 | 92 |
| 3 | 0 | 0 | 0 | 0 | | | 81 |
| 5 | 0 | 0 | 0 | 0 | | 0 | < 10 |
| mean = | | | | | | | |
| **Organic Nitrogen (ppb)** | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | | 365 | 2150 | 720 | | 740 | 670 |
| 3 | | 450 | | 780 | | | 630 |
| 5 | | 810 | 2,360 | 1,090 | | 930 | 645 |
| mean = | | 542 | 2255 | 863 | | 835 | 648 |
| **Total Nitrogen (ppb)** | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 310 | 365 | 2150 | 720 | | 740 | 762 |
| 3 | 304 | 450 | | 780 | | | 711 |
| 5 | 934 | 810 | 2360 | 1090 | | 930 | 645 |
| mean = | 516 | 542 | 2255 | 863 | | 835 | 706 |
| **Total Iron (ppb)** | | | | | | | |
| Depth m | | | | | 27-Sep | | |

| | |
|---|---|
| 1 | 0 |
| 3 | |
| 5 | 370 |
| mean = | 185 |

| | 2011 | 2012 | | | | | |
|---|---|---|---|---|---|---|---|
| Total Phosphorus(ppb) | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 9 | 10 | 22 | 24 | | 22 | 22 |
| 3 | 10 | 11 | 23 | 110 | | 20 | 20 |
| mean | 10 | 11 | 23 | 67 | | 21 | 21 |
| Ammonia -N (ppb) | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | | | | 150 | | | |
| 3 | | | | 176 | | 242 | 242 |
| Nitrate/Nitrite -N (ppb) | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | | | | | | | |
| 3 | | | | | | | |
| Organic Nitrogen (ppb) | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | | | | | | | |
| 3 | | | | | | 1,080 | 1,080 |
| Total Nitrogen (ppb) | | | | | | | |
| Depth m | 27-Jul | 3-Jul | 27-Aug | 17-Sep | 27-Sep | 5-Oct | 27-Nov |
| 1 | 237 | | | | | | |
| 3 | 256 | | | | | 1,080 | 1,080 |

| Station 1 | 2013 | | | | | | |
|---|---|---|---|---|---|---|---|
| Total Phosphorus (ppb) | | | | | | | |
| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
| 1 | 16 | 13 | 19 | 26 | 13 | 14 | 23 |
| 3 | | | 22 | 20 | 21 | 20 | 34 |
| 5 | | | 55 | 21 | 21 | 26 | 36 |
| mean = | ***16.0*** | ***13.0*** | ***32.0*** | ***22.3*** | ***18.3*** | ***20.0*** | ***31.0*** |
| Ammonia -N (ppb) | | | | | | | |
| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
| 1 | < 10 | | 11 | < 10 | < 10 | < 10 | < 10 |

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 3 | | | < 10 | < 10 | < 10 | < 10 | 14 |
| 5 | | | < 10 | < 10 | 13 | < 10 | 41 |
| mean = | | | *11* | | *13* | | *28* |

**Nitrate/Nitrite –N (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | 30 | | < 10 | < 10 | < 10 | < 10 | < 10 |
| 3 | | | < 10 | < 10 | < 10 | < 10 | < 10 |
| 5 | | | < 10 | < 10 | < 10 | < 10 | < 10 |

**Total Nitrogen (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | | | 1,080 | 1,010 | 337 | 410 | 377 |
| 3 | | | 930 | 470 | 466 | 418 | 495 |
| 5 | | | 1,250 | 770 | 424 | 307 | 335 |
| mean = | | | 1,087 | 750 | 409 | 378 | 402 |

Station 2 — 2013

**Total Phosphorus (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | | | 20 | 30 | 18 | 21 | 24 |
| 3 | | | 18 | 20 | 20 | 23 | 31 |
| mean | | | 19.0 | 25.0 | 19.0 | 22.0 | 27.5 |

**Ammonia –N (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | | | < 10 | < 10 | < 10 | < 10 | < 10 |
| 3 | | | < 10 | < 10 | < 10 | < 10 | < 10 |

**Nitrate/Nitrite –N (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | | | < 10 | < 10 | < 10 | < 10 | < 10 |
| 3 | | | < 10 | < 10 | < 10 | < 10 | < 10 |

**Total Nitrogen (ppb)**

| Depth m | 28-Feb | 5-Mar | 27-Mar | 16-Apr | 6-May | 14-May | 30-May |
|---|---|---|---|---|---|---|---|
| 1 | | | 475 | 560 | 387 | 393 | 360 |
| 3 | | | 555 | 700 | 481 | 412 | 545 |
| | | | 515.0 | 630.0 | 434.0 | 402.5 | 452.5 |

Station 1 — 2013 Continued

**Total Phosphorus (ppb)**

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 25 | 31 | 34 | 25 | 44 | 40 | 43 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | 26 | 49 | 34 | 32 | 30 | 38 | 40 | 41 |
| 5 | 31 | 83 | 66 | 38 | 35 | 49 | 52 | 48 |
| mean = | 25.7 | 52.3 | 43.7 | 34.7 | 30.0 | 43.7 | 44.0 | 44.0 |

Ammonia -N (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | < 10 | 5 | 7 | 3 | | 6 | 3 | 0 |
| 3 | < 10 | 43 | 19 | 3 | | 7 | 4 | 0 |
| 5 | 98 | 808 | 1360 | 1302 | | 362 | 72 | 4 |
| mean = | 98 | 285 | 462 | 436 | | 125 | 26 | 1 |

Nitrate/Nitrite -N (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | < 10 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| 3 | < 10 | 3 | 0 | 0 | 0 | 3 | 4 | 0 |
| 5 | < 10 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| mean = | | | | | | | | |

Total Nitrogen (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | 421 | 368 | 395 | 446 | 405 | 489 | 581 | 447 |
| 3 | 459 | 577 | 357 | 395 | 353 | 422 | 604 | 489 |
| 5 | 393 | 825 | 1,432 | 1,318 | 1,496 | 588 | 490 | 443 |
| mean = | 424 | 590 | 728 | 720 | 751 | 500 | 558 | 460 |

Total Iron (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | 362 | | 383 | | |
| 3 | | | | 446 | | 392 | | |
| 5 | | | 14 | 15 | | 2 | | |
| mean = | | | | | | | | |

Station 2 2013

Total Phosphorus(ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | 21 | 25 | 29 | 27 | 24 | 49 | 43 | 46 |
| 3 | 25 | 47 | 34 | 27 | 27 | 41 | 66 | 52 |
| mean | 23.0 | 36.0 | 31.5 | 27.0 | 25.5 | 45.0 | 54.5 | 49.0 |

Ammonia -N (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | < 10 | 7 | 6 | 3 | 4 | 4 | 5 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | <10 | 3 | 30 | 0 | 9 | 3 | 4 | 0 |

Nitrate/Nitrite –N (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | < 10 | | 4 | 0 | 0 | 0 | 7 | 0 |
| 3 | < 10 | | | 0 | 0 | 0 | 6 | 0 |

Total Nitrogen (ppb)

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | 410 | | 332 | 336 | 269 | 483 | 601 | 431 |
| 3 | 499 | | 379 | 362 | 287 | 440 | 588 | 422 |
| | 454.5 | | 355.5 | 349.0 | 278.0 | 461.5 | 594.5 | 426.5 |

Total Iron ppb

| Depth m | 21-Jun | 15-Jul | 29-Jul | 8-Aug | 26-Aug | 11-Sep | 1-Oct | 25-Oct |
|---|---|---|---|---|---|---|---|---|
| 1 | | | 319 | | | | | |
| 3 | | | 308 | | | | | |

Station 1 2014

Total Phosphorus (ppb)

| Depth m | 10-Mar | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul |
|---|---|---|---|---|---|---|---|
| 1 | 12 | 17 | 17 | 25 | 25 | 15 | 29 |
| 3 | 13 | 20 | 24 | 26 | 25 | 32 | 15 |
| 5 | 12 | 16 | 29 | 40 | 33 | 36 | 37 |
| mean = | 12.3 | 17.7 | 23.3 | 30.3 | 27.7 | 27.7 | 27.0 |

Ammonia –N (ppb)

| Depth m | 10-Mar | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 36 | 0 | 0 |
| 3 | 47 | 0 | 0 | 0 | 39 | 69 | 8 |
| 5 | 91 | 3 | 3 | 0 | 67 | 274 | 407 |
| mean = | 46 | 1 | 1 | 0 | 47 | 114 | 138 |

Nitrate/Nitrite –N (ppb)

| Depth m | 10-Mar | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul |
|---|---|---|---|---|---|---|---|
| 1 | 52 | 71 | 0 | 0 | 0 | 0 | 0 |
| 3 | 73 | 71 | 0 | 0 | 0 | 0.004 | 0 |
| 5 | 96 | 72 | 0 | 0 | 0 | 0 | 0 |
| mean = | | | | | | | |

| Total Nitrogen (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 10-Mar | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul |
| 1 | 371 | 435 | 297 | 297 | 343 | 292 | 317 |
| 3 | 418 | 346 | 346 | 346 | 341 | 345 | 295 |
| 5 | 279 | 338 | 407 | 407 | 230 | 392 | 539 |
| mean = | 356 | 373 | 350 | 350 | 305 | 343 | 384 |

| Total Iron (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 10-Mar | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul |
| 1 | | | | 135 | | 53 | |
| 3 | | | | | | 230 | |
| 5 | | | | 540 | | 4,300 | |

Station 2 2014

| Total Phosphorus(ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul | 28-Jul |
| 1 | 22 | 18 | 27 | 23 | 23 | 20 | 25 |
| 3 | 17 | 23 | 25 | 22 | 22 | 20 | 25 |
| mean | | | | | | | |

| Ammonia -N (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul | 28-Jul |
| 1 | 0 | 0 | 0 | 28 | 10 | 4 | 14 |
| 3 | 4 | 3 | 3 | 40 | 11 | 0 | 19 |

| Nitrate/Nitrite -N (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul | 28-Jul |
| 1 | 73 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 74 | 0 | 0 | 0 | 0 | 0 | 0 |

| Total Nitrogen (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul | 28-Jul |
| 1 | 351 | 304 | 304 | 338 | 356 | 315 | 285 |
| 3 | 332 | 340 | 340 | 320 | 354 | 322 | 308 |

| Total Iron ppb | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 9-Apr | 8-May | 21-May | 12-Jun | 30-Jun | 14-Jul | 28-Jul |
| 1 | | | | | 100 | | |
| 3 | | | | | 80 | | |

Station 1 2014 Continued

| Total Phosphorus (ppb) | | | | | | |
|---|---|---|---|---|---|---|
| Depth m | 28-Jul | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 26 | 22 | 19 | 24 | 22 | 17 |
| 3 | 25 | 26 | 20 | 22 | 26 | 21 |
| 5 | 37 | 40 | 33 | 31 | 21 | 22 |
| mean = | 29.3 | 29.3 | 24.0 | 25.7 | 23.0 | 20.0 |

| Ammonia -N (ppb) | | | | | | |
|---|---|---|---|---|---|---|
| Depth m | 28-Jul | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 10 | 0 | 0 | 0 | 8 | 3 |
| 3 | 13 | 0 | 17 | 0 | 12 | 0 |
| 5 | 462 | 170 | 295 | 24 | 7 | 4 |
| mean = | 162 | 57 | 104 | 8 | 9 | 2 |

| Nitrate/Nitrite -N (ppb) | | | | | | |
|---|---|---|---|---|---|---|
| Depth m | 28-Jul | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 7 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| mean = | | | | | | |

| Total Nitrogen (ppb) | | | | | | |
|---|---|---|---|---|---|---|
| Depth m | 28-Jul | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 266 | 340 | 266 | 193 | 290 | 359 |
| 3 | 316 | 345 | 255 | 281 | 353 | 362 |
| 5 | 742 | 554 | 356 | 233 | 341 | 345 |
| mean = | 441 | 413 | 292 | 236 | 328 | 355 |

| Total Iron (ppb) | | | | | | |
|---|---|---|---|---|---|---|
| Depth m | 28-Jul | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | | | 110 | 120 | 150 | 120 |
| 3 | | | 190 | 130 | 120 | 160 |
| 5 | | | 2,600 | 470 | 130 | 190 |
| mean = | | | | | | |

Station 2 2014

| Total Phosphorus(ppb) | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 23 | 21 | 17 | 23 | 17 |
| 3 | 24 | 21 | 19 | 20 | 18 |
| mean | | | | | |

| Ammonia -N (ppb) | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 0 | 0 | 0 | 5 | 4 |
| 3 | 0 | 9 | 0 | 6 | 4 |

| Nitrate/Nitrite -N (ppb) | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 4 | 0 |

| Organic Nitrogen (ppb) | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | | | | | |
| 3 | | | | | |

| Total Nitrogen (ppb) | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | 318 | 287 | 209 | 337 | 361 |
| 3 | 370 | 295 | 218 | 345 | 357 |

| Total Iron ppb | | | | | |
|---|---|---|---|---|---|
| Depth m | 11-Aug | 2-Sep | 29-Sep | 21-Oct | 19-Nov |
| 1 | | 90 | 100 | 130 | 140 |
| 3 | | 160 | 120 | 140 | 130 |

Station 1 2015

| Total Phosphorus (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 10-Mar | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul |
| 1 | 17 | 16 | 26 | 25 | 28 | 26 | 25 |
| 3 | 14 | 14 | 26 | 26 | 24 | 19 | 19 |
| 5 | 16 | 22 | 31 | 36 | 38 | 53 | 58 |
| mean = | 15.7 | 17.3 | 27.7 | 29.0 | 30.0 | 32.7 | 34.0 |

| Ammonia -N (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 10-Mar | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul |
| 1 | 57 | 0 | 0 | 0 | 61 | | 0 |
| 3 | 100 | 0 | 0 | 4 | 65 | 6 | 6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 257 | 0 | 0 | 73 | 234 | 202 | 290 |
| mean = | 138 | 0 | 0 | 26 | 120 | 104 | 99 |

Nitrate/Nitrite -N (ppb)

| Depth m | 10-Mar | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul |
|---|---|---|---|---|---|---|---|
| 1 | 20 | 76 | 0 | 0 | 8 | | 0 |
| 3 | 56 | 76 | 0 | 0 | 6 | 0 | 0 |
| 5 | 69 | 77 | 0 | 0 | 5 | 0 | 0 |
| mean = | | | | | | | |

Total Nitrogen (ppb)

| Depth m | 10-Mar | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul |
|---|---|---|---|---|---|---|---|
| 1 | 418 | 390 | 294 | 310 | 369 | 330 | 343 |
| 3 | 432 | 401 | 345 | 356 | 360 | 334 | 321 |
| 5 | 480 | 438 | 463 | 317 | 680 | 908 | 922 |
| mean = | 443 | 410 | 367 | 328 | 470 | 524 | 529 |

Total Iron (ppb)

| Depth m | 10-Mar | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul |
|---|---|---|---|---|---|---|---|
| 1 | | 160 | 80 | | | 140 | 167 |
| 3 | | 220 | 150 | | | 159 | 207 |
| 5 | | 210 | 350 | | | 871 | 1538 |
| mean = | | 196.67 | 193.33 | | | 390.00 | 637.33 |

Station 2 2014

Total Phosphorus(ppb)

| Depth m | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul | 13-Aug |
|---|---|---|---|---|---|---|---|
| 1 | 13 | 18 | 22 | 29 | 21 | 24 | 20 |
| 3 | 14 | 19 | 22 | 34 | 21 | 23 | 22 |

Ammonia -N (ppb)

| Depth m | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul | 13-Aug |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 77 | 7 | 0 | 8 |
| 3 | 0 | 0 | 0 | 78 | 12 | 4 | 19 |

Nitrate/Nitrite -N (ppb)

| Depth m | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul | 13-Aug |
|---|---|---|---|---|---|---|---|
| 1 | 76 | 0 | 0 | 7 | 0 | 0 | 0 |
| 3 | 79 | 0 | 0 | 7 | 0 | 0 | 0 |

Total Nitrogen (ppb)

| Depth m | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul | 13-Aug |
|---|---|---|---|---|---|---|---|
| 1 | 402 | 321 | 321 | 393 | 366 | 388 | 486 |

| Depth m | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 393 | 352 | 327 | 379 | 328 | 331 | 462 |

Total Iron ppb

| Depth m | 15-Apr | 5-May | 28-May | 29-Jun | 16-Jul | 27-Jul | 13-Aug |
|---|---|---|---|---|---|---|---|
| 1 | 170 | 130 | | | 222 | 164 | 154.3 |
| 3 | 210 | 370 | | | 209 | 169 | 208.8 |

Station 1 2015

Total Phosphorus (ppb)

| Depth m | 13-Aug | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|
| 1 | 19 | 24 | 22 | 20 | 28 | 34 | 33 | 33 |
| 3 | 21 | 28 | 23 | | 32 | 36 | 34 | 35 |
| 5 | 58 | 40 | 37 | | 36 | 30 | 32 | 32 |
| mean = | 32.7 | 30.7 | 27.3 | 20.0 | 32.0 | 33.3 | 33.0 | 33.3 |

Ammonia -N (ppb)

| Depth m | 13-Aug | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 0 | 93 | | 30 | 9 | 5 | 6 |
| 3 | 18 | 103 | 76 | | 200 | 9 | 5 | 10 |
| 5 | 690 | 1.41 | 1.52 | | 351 | 7 | 5 | 0 |
| mean = | 238 | 35 | 57 | | 194 | 8 | 5 | 5.3 |

Nitrate/Nitrite -N (ppb)

| Depth m | 13-Aug | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 0 | 0.003 | | 28 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | | 26 | 0 | 8 | 0 |
| 5 | 0 | 0 | 0 | | 21 | 0 | 0 | 0 |
| mean = | | | | | | | | ***0.0*** |

Total Nitrogen (ppb)

| Depth m | 13-Aug | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|
| 1 | 481 | 980 | 827 | | 644 | 622 | 581 | 428 |
| 3 | 452 | 718 | 838 | | 699 | 644 | 598 | 445 |
| 5 | 1.289 | 1.67 | 1.679 | | 795 | 622 | 596 | 435 |
| mean = | 311 | 567 | 556 | | 713 | 629 | 592 | ***436.0*** |

Total Iron (ppb)

| Depth m | 13-Aug | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|
| 1 | 149.4 | 141.5 | 80.4 | 215 | | 321.4 | 264.1 | 237 |
| 3 | 205.9 | 366.7 | 95.4 | | | 305.5 | 350.3 | 247 |
| 5 | 2355 | 7876 | 8186 | | | 326.2 | 346.9 | 303 |
| mean = | 903.43 | 2794.73 | 2787.27 | 215.00 | | 317.70 | 320.43 | ***262.3*** |

Station 2 2015 Continued

| Total Phosphorus(ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
| 1 | 24 | 23 | | 41 | 45 | | 34 |
| 3 | 22 | 37 | | 38 | 32 | | 30 |
| mean | | | | | | | |

| Ammonia -N (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
| 1 | 4 | 74 | | 26 | 11 | 5 | 0 |
| 3 | 57 | 338 | | 45 | 9 | 4 | 0 |
| | | | | | | | *0.0* |

| Nitrate/Nitrite -N (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
| 1 | 0 | 0 | | 32 | 0 | 0 | 0 |
| 3 | 0 | 0 | | 28 | 3 | 4 | 0 |
| | | | | | | | *0.0* |

| Total Nitrogen (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
| 1 | 863 | 793 | | 768 | 646 | 636 | 436 |
| 3 | 762 | 753 | | 727 | 641 | 539 | 428 |
| | | | | | | | 432.0 |

| Total Iron ppb | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth m | 31-Aug | 4-Sep | 9-Sep | 18-Sep | 6-Oct | 21-Oct | 4-Nov |
| 1 | 121.1 | 96.53 | | | 331.1 | 266.8 | 256 |
| 3 | 204.2 | 536.4 | | | 330 | 310.1 | 306 |

Water Temperature and Dissolved Oxygen

| | 2011 | 2012 | | | | 2013 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | 8/27/2011 | 7/3/2012 | 8/27/2012 | 9/17/2012 | 9/27/2012 | 3/27/2013 | 4/16/2013 | 5/6/2013 | 5/14/2013 | 5/30/2013 | 6/21/2013 | 7/15/2013 | 7/29/2013 | 8/8/2013 | 8/26/2013 | 9/11/2013 | 10/1/2013 | 10/25/2013 |
| 0 | 25.5 | 27.3 | 26.4 | 22.2 | 20.1 | 4.5 | 11.2 | 17.9 | 17.4 | 22.3 | 21.2 | 28.5 | 27.2 | 24.1 | 23.6 | 23.5 | 17.3 | 12.0 |
| 1 | 25.8 | 26.7 | 25.7 | 21.6 | 20.0 | 4.5 | 11.1 | 17.6 | 17.3 | 20.1 | 22.0 | 27.7 | 25.8 | 24.1 | 23.7 | 22.3 | 17.6 | 12.2 |
| 2 | 25.7 | 26.3 | 25.2 | 21.3 | 19.8 | 4.4 | 11.0 | 17.1 | 17.2 | 18.6 | 21.6 | 27.0 | 24.8 | 24.0 | 23.4 | 21.6 | 17.7 | 12.3 |
| 3 | 25.7 | 25.2 | 24.8 | 21.2 | 19.7 | 4.4 | 10.9 | 16.7 | 17.1 | 17.0 | 19.7 | 25.2 | 24.1 | 23.6 | 23.4 | 21.3 | 17.7 | 12.4 |
| 4 | 22.8 | 23.9 | 24.3 | 21.1 | 19.3 | 4.4 | 10.6 | 15.3 | 16.5 | 16.5 | 18.8 | 21.2 | 22.1 | 22.5 | 22.5 | 21.2 | 17.6 | 12.5 |
| 5 | 18.9 | 20.3 | 23.2 | 21.1 | 19.2 | 4.4 | 10.1 | 13.1 | 13.8 | 15.5 | 16.7 | 17.4 | 18.8 | 19.3 | 20.2 | 19.9 | 17.6 | 12.6 |
| 6 | 16.0 | 18.6 | 20.9 | 19.7 | 19.1 | 4.4 | 9.8 | 12.6 | 13.1 | 15.0 | 15.4 | 16.1 | 15.5 | 15.9 | 16.8 | 16.6 | 17.5 | 12.7 |

| DO | 8/27/2011 | 7/3/2012 | 8/27/2012 | 9/17/2012 | 9/27/2012 | 3/27/2013 | 4/16/2013 | 5/6/2013 | 5/14/2013 | 5/30/2013 | 6/21/2013 | 7/15/2013 | 7/29/2013 | 8/8/2013 | 8/26/2013 | 9/11/2013 | 10/1/2013 | 10/25/2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6.7 | 12.0 | 12.6 | 7.3 | 9.4 | 14.1 | 12.4 | 10.8 | 9.3 | 10.1 | 10.5 | 9.4 | 9.8 | 8.4 | 9.1 | 9.9 | 8.9 | 9.1 |
| 1 | 6.6 | 12.0 | 13.7 | 7.3 | 9.4 | 14.2 | 12.5 | 10.7 | 9.3 | 10.3 | 10.4 | 9.5 | 9.4 | 8.1 | 9.0 | 10.1 | 8.5 | 9.0 |
| 2 | 6.7 | 8.0 | 12.8 | 6.3 | 9.5 | 14.3 | 12.6 | 10.6 | 9.2 | 10.4 | 10.1 | 9.3 | 6.5 | 7.0 | 7.8 | 8.9 | 7.9 | 8.8 |
| 3 | 6.8 | 4.5 | 2.9 | 6.3 | 9.4 | 14.4 | 12.3 | 10.4 | 9.2 | 7.8 | 4.5 | 0.3 | 1.2 | 3.4 | 5.1 | 7.3 | 7.9 | 8.8 |
| 4 | 0.3 | 4.4 | 0.4 | 6.3 | 8.0 | 14.4 | 12.3 | 7.0 | 7.5 | 6.3 | 1.8 | 0.1 | 0.0 | 0.2 | 0.3 | 6.2 | 4.4 | 8.7 |
| 5 | 0.2 | 0.4 | 0.3 | 6.1 | 7.2 | 14.4 | 12.4 | 1.5 | 0.3 | 1.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 | 2.8 | 8.2 |
| 6 | 0.1 | 0.3 | 0.2 | 0.3 | 5.1 | 14.1 | 11.8 | 0.7 | 0.1 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 8.1 |
| Anoxic Bou | 3.89 | 4.85 | 3.76 | 5.88 | 6 | 6 | 6 | 5.67 | 4.9 | 5.08 | 4.5 | 2.92 | 3.17 | 3.75 | 3.85 | 4.88 | 5.21 | 6 |

| O2 Saturati | 8/27/2011 | 7/3/2012 | 8/27/2012 | 9/17/2012 | 9/27/2012 | 3/27/2013 | 4/16/2013 | 5/6/2013 | 5/14/2013 | 5/30/2013 | 6/21/2013 | 7/15/2013 | 7/29/2013 | 8/8/2013 | 8/26/2013 | 9/11/2013 | 10/1/2013 | 10/25/2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 82 | 151 | 156 | 84 | 104 | 109 | 113 | 114 | 97 | 116 | 118 | 121 | 123 | 100 | 107 | 116 | 93 | 84 |
| 1 | 81 | 150 | 168 | 83 | 103 | 110 | 114 | 112 | 97 | 114 | 119 | 121 | 115 | 96 | 106 | 116 | 89 | 84 |
| 2 | 82 | 99 | 155 | 71 | 104 | 110 | 114 | 110 | 96 | 111 | 115 | 117 | 78 | 83 | 92 | 101 | 83 | 82 |
| 3 | 83 | 55 | 35 | 71 | 103 | 111 | 111 | 107 | 95 | 81 | 49 | 4 | 14 | 40 | 60 | 82 | 83 | 82 |
| 4 | 3 | 52 | 5 | 71 | 87 | 111 | 110 | 70 | 77 | 64 | 19 | 1 | 0 | 2 | 3 | 70 | 46 | 82 |
| 5 | 2 | 4 | 4 | 69 | 78 | 111 | 110 | 14 | 3 | 12 | 2 | 1 | 1 | 1 | 2 | 3 | 29 | 77 |
| 6 | 1 | 3 | 2 | 3 | 55 | 109 | 104 | 7 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 76 |

| RTRM | 8/27/2011 | 7/3/2012 | 8/27/2012 | 9/17/2012 | 9/27/2012 | 3/27/2013 | 4/16/2013 | 5/6/2013 | 5/14/2013 | 5/30/2013 | 6/21/2013 | 7/15/2013 | 7/29/2013 | 8/8/2013 | 8/26/2013 | 9/11/2013 | 10/1/2013 | 10/25/2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | | | | |
| 1 | -10 | 20 | 23 | 17 | 3 | 0 | 1 | 7 | 2 | 59 | -22 | 28 | 47 | 0 | -3 | 35 | -7 | -3 |
| 2 | 3 | 13 | 16 | 8 | 5 | 0 | 1 | 11 | 2 | 37 | 11 | 24 | 32 | 3 | 9 | 20 | -2 | -1 |
| 3 | 0 | 36 | 13 | 3 | 2 | 0 | 1 | 8 | 2 | 36 | 50 | 59 | 22 | 12 | 0 | 8 | 0 | -1 |
| 4 | 89 | 41 | 16 | 3 | 10 | 0 | 4 | 28 | 13 | 10 | 22 | 118 | 59 | 32 | 26 | 3 | 2 | -1 |
| 5 | 103 | 101 | 33 | 0 | 2 | 0 | 6 | 38 | 51 | 20 | 47 | 93 | 86 | 85 | 63 | 34 | 0 | -1 |
| 6 | 64 | 42 | 65 | 36 | 2 | 0 | 3 | 8 | 11 | 10 | 26 | 27 | 71 | 76 | 80 | 76 | 2 | -1 |
| Total RTRM | 250 | 253 | 165 | 67 | 25 | 0 | 16 | 100 | 81 | 172 | 134 | 350 | 316 | 208 | 175 | 176 | -4 | -10 |

2014

| 4/9/2014 | 5/8/2014 | 5/21/2014 | 6/12/2014 | 6/30/2014 | 7/7/2014 | 7/14/2014 | 7/28/2014 | 8/11/2014 | 9/2/2014 | 9/29/2014 | 10/21/2014 | 11/19/2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.6 | 14.2 | 20.3 | 20.3 | 25.4 | 26.2 | 26.3 | 25.5 | 27.7 | 25.5 | 19.9 | 13.8 | 4.6 |
| 8.6 | 14.2 | 19.3 | 20.4 | 25.4 | 25.8 | 26.3 | 25.5 | 26.7 | 24.7 | 19.8 | 13.9 | 4.7 |
| 8.0 | 14.0 | 18.9 | 20.5 | 25.0 | 25.4 | 26.0 | 25.3 | 26.1 | 23.9 | 19.3 | 14.0 | 4.8 |
| 8.0 | 13.6 | 18.8 | 20.5 | 24.0 | 24.9 | 25.9 | 25.2 | 25.3 | 23.6 | 18.9 | 14.1 | 4.8 |
| 7.7 | 13.4 | 17.8 | 18.9 | 21.0 | 23.9 | 24.3 | 25.0 | 24.4 | 23.4 | 18.7 | 14.2 | 4.8 |
| 7.7 | 12.5 | 14.4 | 16.5 | 18.5 | 17.8 | 19.8 | 20.2 | 21.8 | 21.4 | 18.4 | 14.2 | 4.8 |
| 7.6 | 11.5 | 13.0 | 14.6 | 15.6 | 15.4 | 16.5 | 16.9 | 19.1 | 18.8 | 18.2 | 14.3 | 4.8 |

| 4/9/2014 | 5/8/2014 | 5/21/2014 | 6/12/2014 | 6/30/2014 | 7/7/2014 | 7/14/2014 | 7/28/2014 | 8/11/2014 | 9/2/2014 | 9/29/2014 | 10/21/2014 | 11/19/2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.9 | 10.4 | 9.3 | 8.0 | 7.9 | 7.2 | 7.5 | 7.3 | 8.1 | 8.2 | 9.5 | 9.8 | 11.9 |
| 11.1 | 10.5 | 9.4 | 8.0 | 7.9 | 7.3 | 7.5 | 7.3 | 8.2 | 8.3 | 9.6 | 9.7 | 11.9 |
| 11.2 | 10.4 | 9.4 | 8.1 | 7.8 | 7.0 | 6.9 | 6.9 | 8.1 | 7.3 | 9.5 | 9.7 | 11.9 |
| 11.2 | 9.5 | 9.2 | 8.1 | 3.5 | 5.9 | 6.9 | 6.5 | 6.7 | 6.2 | 9.0 | 9.6 | 11.9 |
| 11.1 | 9.6 | 5.7 | 0.8 | 0.4 | 4.0 | 0.5 | 6.2 | 3.1 | 4.8 | 8.4 | 9.6 | 11.9 |
| 11.0 | 6.0 | 1.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.4 | 6.2 | 9.6 | 11.8 |
| 10.9 | 2.8 | 0.5 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 5.5 | 9.4 | 11.6 |
| 6 | 6 | 5.29 | 3.97 | 3.18 | 4.81 | 3.92 | 4.91 | 4.81 | 4.82 | 6 | 6 | 6 |

| 4/9/2014 | 5/8/2014 | 5/21/2014 | 6/12/2014 | 6/30/2014 | 7/7/2014 | 7/14/2014 | 7/28/2014 | 8/11/2014 | 9/2/2014 | 9/29/2014 | 10/21/2014 | 11/19/2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 93 | 101 | 103 | 89 | 96 | 103 | 93 | 89 | 103 | 100 | 104 | 95 | 92 |
| 95 | 102 | 102 | 89 | 96 | 102 | 93 | 89 | 102 | 100 | 105 | 94 | 92 |
| 95 | 101 | 101 | 90 | 94 | 101 | 85 | 84 | 100 | 87 | 103 | 94 | 93 |
| 95 | 91 | 99 | 90 | 42 | 99 | 85 | 79 | 82 | 73 | 97 | 93 | 93 |
| 93 | 92 | 60 | 9 | 4 | 60 | 6 | 75 | 37 | 56 | 90 | 94 | 93 |
| 92 | 56 | 12 | 4 | 3 | 12 | 3 | 6 | 6 | 5 | 66 | 94 | 92 |
| 91 | 26 | 5 | 3 | 2 | 5 | 2 | 3 | 3 | 3 | 58 | 92 | 90 |

| 4/9/2014 | 5/8/2014 | 5/21/2014 | 6/12/2014 | 6/30/2014 | 7/7/2014 | 7/14/2014 | 7/28/2014 | 8/11/2014 | 9/2/2014 | 9/29/2014 | 10/21/2014 | 11/19/2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| 0 | 0 | 25 | -3 | 0 | 25 | 0 | 0 | 34 | 25 | 2 | -2 | 0 |
| 5 | 4 | 10 | -3 | 13 | 10 | 10 | 6 | 20 | 25 | 12 | -2 | 0 |
| 0 | 7 | 2 | 0 | 31 | 2 | 3 | 3 | 26 | 9 | 10 | -2 | 0 |
| 2 | 3 | 23 | 40 | 86 | 23 | 51 | 6 | 28 | 6 | 5 | -2 | 0 |
| 0 | 14 | 68 | 54 | 63 | 68 | 126 | 138 | 76 | 57 | 7 | 0 | 0 |
| 1 | 14 | 24 | 37 | 62 | 24 | 76 | 78 | 70 | 67 | 5 | -2 | 0 |
| 8 | 42 | 152 | 125 | 255 | 152 | 266 | 232 | 255 | 189 | 41 | -9 | 0 |

2015

| 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 9.7 | 16.1 | 22.2 | 22.2 | 24.6 | 26.3 | 26.1 | 24.7 | 25.7 | 26.5 | 23.3 | 14.9 | 15.1 | 12.2 |
| 2.2 | 9.6 | 16.1 | 22.0 | 22.1 | 24.8 | 26.1 | 26.0 | 24.7 | 25.9 | 26.5 | 23.1 | 15.3 | 13.6 | 11.9 |
| 3.9 | 9.5 | 15.5 | 21.9 | 21.9 | 25.0 | 25.5 | 25.3 | 24.4 | 25.9 | 25.6 | 22.8 | 15.3 | 13.1 | 11.7 |
| 4.3 | 9.4 | 15.1 | 20.3 | 21.8 | 25.0 | 25.3 | 24.8 | 24.2 | 25.9 | 25.2 | 22.3 | 15.3 | 12.7 | 11.6 |
| 4.6 | 9.4 | 14.0 | 18.2 | 21.6 | 25.1 | 24.3 | 24.6 | 23.9 | 24.1 | 24.2 | 21.8 | 15.3 | 12.4 | 11.5 |
| 5.1 | 9.1 | 13.0 | 14.4 | 17.1 | 19.0 | 19.4 | 20.0 | 20.8 | 21.5 | 21.8 | 20.9 | 15.2 | 12.3 | 11.3 |
|  | 7.9 | 12.1 | 13.5 | 14.4 | 16.0 | 16.8 | 16.9 | 17.5 | 18.6 | 18.6 | 18.5 | 15.2 | 12.2 | 11.3 |

| 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.6 | 12.7 | 11.0 | 9.7 | 7.8 | 7.8 | 7.8 | 9.0 | 9.6 | 7.6 | 6.3 | 11.1 | 10.5 | 10.3 | 10.7 |
| 11.8 | 12.8 | 11.0 | 9.7 | 7.7 | 7.7 | 7.8 | 9.1 | 9.3 | 7.5 | 6.3 | 11.3 | 10.3 | 10.7 | 10.7 |
| 7.8 | 12.8 | 11.2 | 9.7 | 7.6 | 7.5 | 7.6 | 8.7 | 7.5 | 7.5 | 4.1 | 10.9 | 10.1 | 10.4 | 10.4 |
| 7.1 | 12.8 | 11.3 | 8.6 | 7.6 | 7.5 | 6.8 | 7.4 | 4.5 | 7.4 | 2.2 | 5.8 | 10.0 | 9.5 | 10.1 |
| 5.8 | 12.8 | 11.2 | 3.8 | 7.0 | 7.3 | 0.4 | 6.2 | 2.9 | 0.2 | 0.2 | 4.5 | 9.9 | 8.4 | 10.1 |
| 0.3 | 12.4 | 8.4 | 0.3 | 0.3 | 0.1 | 0.1 | 0.2 | 0.3 | 0.2 | 0.1 | 1.0 | 9.4 | 7.7 | 8.4 |
|  | 10.4 | 4.4 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 9.2 | 6.9 | 7.4 |

| 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | 112 | 112 | 111 | 90 | 94 | 97 | 111 | 116 | 93 | 78 | 130 | 104 | 102 | 100 |
| 86 | 112 | 112 | 111 | 88 | 93 | 96 | 112 | 112 | 92 | 78 | 132 | 103 | 103 | 99 |
| 59 | 112 | 112 | 111 | 87 | 91 | 93 | 106 | 90 | 92 | 50 | 127 | 101 | 99 | 96 |
| 55 | 112 | 112 | 95 | 87 | 91 | 83 | 89 | 54 | 91 | 27 | 67 | 100 | 90 | 93 |
| 45 | 112 | 109 | 40 | 79 | 89 | 5 | 74 | 34 | 2 | 2 | 51 | 99 | 79 | 93 |
| 2 | 108 | 80 | 3 | 3 | 1 | 1 | 2 | 3 | 2 | 1 | 11 | 94 | 72 | 77 |
|  | 88 | 41 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 92 | 64 | 68 |

| 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | 1 | 0 | 6 | 3 | -6 | 7 | 3 | 0 | -6 | 0 | 6 | -8 | 26 | 4 |
| 3 | 1 | 12 | 3 | 6 | -6 | 19 | 23 | 9 | 0 | 30 | 9 | 0 | 8 | 3 |
| 0 | 1 | 8 | 43 | 3 | 0 | 6 | 16 | 6 | 0 | 13 | 14 | 0 | 6 | 1 |
| 0 | 0 | 20 | 51 | 5 | 0 | 31 | 6 | 9 | 57 | 31 | 14 | 0 | 4 | 1 |
| -1 | 3 | 16 | 78 | 111 | 48 | 136 | 131 | 88 | 75 | 70 | 25 | 2 | 1 | 3 |
|  | 10 | 13 | 15 | 53 | 66 | 60 | 72 | 80 | 74 | 82 | 60 | 0 | 1 | 0 |
| 5 | 16 | 69 | 196 | 180 | 102 | 260 | 251 | 193 | 200 | 226 | 128 | -6 | 48 | 12 |

| | Station 2 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
| 0 | | 9.6 | 16.6 | 22.7 | 22.4 | 24.8 | 26.6 | 26.0 | 24.7 | 25.5 | | 24.1 | 15.1 | 14.1 | 12.2 |
| 1 | | 9.6 | 16.4 | 22.5 | 22.3 | 25.0 | 26.4 | 25.4 | 24.8 | 25.6 | | 23.6 | 15.2 | 13.4 | 12.0 |
| 2 | | 9.4 | 15.1 | 22.4 | 22.1 | 25.1 | 26.2 | 24.9 | 24.7 | 25.6 | | 22.9 | 15.1 | 12.8 | 11.9 |
| 3 | | 8.6 | 14.8 | 22.2 | 21.8 | 25.1 | 25.7 | 24.7 | 24.4 | 24.3 | | 22.3 | 15.1 | 12.6 | 11.7 |
| 4 | | 8.3 | | | 21.8 | 24.9 | | 24.6 | 24.0 | | | 22.2 | 15.1 | 12.5 | 11.5 |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |

| DO | 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | na | 13.0 | 10.9 | 9.7 | 8.0 | 7.4 | 8.1 | 9.0 | 9.5 | 7.6 | na | 11.3 | 10.6 | 10.5 | 10.7 |
| 1 | na | 13.0 | 10.9 | 9.7 | 7.7 | 7.3 | 8.1 | 8.8 | 9.4 | 7.6 | na | 11.2 | 10.4 | 10.6 | 10.5 |
| 2 | na | 13.0 | 11.0 | 9.8 | 7.7 | 7.3 | 8.1 | 8.1 | 8.0 | 7.6 | na | 10.2 | 9.9 | 9.9 | 10.9 |
| 3 | na | 12.9 | 11.2 | 9.8 | 7.3 | 6.9 | 8.0 | 7.7 | 6.5 | 0.4 | na | 6.8 | 9.4 | 9.1 | 11.7 |
| 4 | na | 13.0 | | | 7.2 | 6.4 | | 6.2 | 3.4 | | na | 4.8 | 8.9 | 7.0 | 11.5 |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| Anoxic Boundary | | | | | | | | | | | | | | | |

| O2 Saturatio | 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | na | 114 | 112 | 112 | 92 | 89 | 101 | 111 | 114 | 93 | na | 134 | 105 | 102 | 100 |
| 1 | na | 114 | 111 | 112 | 89 | 88 | 101 | 107 | 113 | 93 | na | 132 | 104 | 101 | 97 |
| 2 | na | 114 | 109 | 113 | 88 | 89 | 100 | 98 | 96 | 93 | na | 119 | 98 | 94 | 101 |
| 3 | na | 111 | 111 | 113 | 83 | 84 | 98 | 93 | 78 | 5 | na | 78 | 93 | 86 | 108 |
| 4 | na | 111 | | | 82 | 77 | | 74 | 40 | | na | 55 | 88 | 66 | 105 |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |

| RTRM | 3/10/2015 | 4/15/2015 | 5/5/2015 | 5/28/2015 | 6/29/2015 | 7/16/2015 | 7/27/2015 | 8/13/2015 | 8/31/2015 | 9/4/2015 | 9/9/2015 | 9/18/2015 | 10/6/2015 | 10/21/2015 | 11/4/2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | na | | | | | | | | | | na | | | | |
| 1 | na | 0 | 4 | 6 | 3 | -6 | 7 | 19 | -3 | -3 | na | 15 | -2 | 12 | 3 |
| 2 | na | 2 | 26 | 3 | 6 | -3 | 7 | 16 | 3 | 0 | na | 21 | 2 | 10 | 1 |
| 3 | na | 7 | 6 | 6 | 8 | 0 | 16 | 6 | 9 | 41 | na | 17 | 0 | 3 | 3 |
| 4 | na | 2 | | | | 6 | | 3 | 12 | | na | 3 | 0 | 1 | 3 |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| Total RTRM | | 12 | 35 | 14 | 17 | -3 | 30 | 45 | 22 | 38 | 0 | 56 | 0 | 26 | 10 |

## Secchi Disk Depth Measurements

| Station 1 | | (m) | (ft) |
|---|---|---|---|
| 2011 | 27-Jul | 3.7 | 12.1 |
| 2012 | 3-Jul | 4.0 | 13.1 |
| | 27-Aug | 0.6 | 1.8 |
| | 17-Sep | 1.5 | 4.9 |
| | 27-Sep | 1.6 | 5.2 |
| | 5-Oct | 2.1 | 6.9 |
| | 27-Nov | 2.8 | 9.2 |
| 2013 | 27-Mar | 1.9 | 6.1 |
| | 16-Apr | 1.6 | 5.2 |
| | 6-May | 1.7 | 5.6 |
| | 14-May | 1.4 | 4.4 |
| | 30-May | 1.7 | 5.6 |
| | 21-Jun | 1.6 | 5.2 |
| | 15-Jul | 1.5 | 4.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 29-Jul | 1.5 | 4.8 | | | |
| | 8-Aug | 1.4 | 4.6 | | | |
| | 26-Aug | 1.4 | 4.6 | | | |
| | 11-Sep | 1.0 | 3.3 | | | |
| | 1-Oct | 0.9 | 2.8 | Station 2 | | |
| | 25-Oct | 1.3 | 4.1 | | (m) | (ft) |
| 2014 | 10-Mar | 2.2 | 7.2 | 10-Mar | | |
| | 9-Apr | 2.8 | 9.2 | 9-Apr | 2.7 | 8.9 |
| | 8-May | 2.3 | 7.4 | 8-May | 2.3 | 7.5 |
| | 21-May | 1.4 | 4.6 | 21-May | 1.4 | 4.6 |
| | 12-Jun | 1.6 | 5.2 | 12-Jun | 1.7 | 5.6 |
| | 30-Jun | 3.1 | 10.0 | 30-Jun | 3.3 | 10.8 |
| | 7-Jul | 2.3 | 7.5 | 7-Jul | | 0.0 |
| | 14-Jul | 1.9 | 6.2 | 14-Jul | 2.1 | 6.9 |
| | 28-Jul | 1.7 | 5.6 | 28-Jul | 1.7 | 5.6 |
| | 11-Aug | 2.3 | 7.5 | 11-Aug | 2.3 | 7.5 |
| | 2-Sep | 2.0 | 6.6 | 2-Sep | 2.0 | 6.6 |
| | 29-Sep | 2.3 | 7.4 | 29-Sep | 2.2 | 7.2 |
| | 21-Oct | 1.7 | 5.4 | 21-Oct | 1.7 | 5.6 |
| | 19-Nov | 1.6 | 5.1 | 19-Nov | 1.6 | 5.2 |
| 2015 | 10-Mar | 3.1 | 10.2 | 10-Mar | | |
| | 15-Apr | 2.3 | 7.5 | 15-Apr | 2.2 | 7.2 |
| | 5-May | 2.0 | 6.6 | 5-May | 2.1 | 6.9 |
| | 28-May | 1.8 | 5.7 | 28-May | 1.8 | 5.7 |
| | 29-Jun | 2.3 | 7.6 | 29-Jun | | |
| | 16-Jul | 2.4 | 7.9 | 16-Jul | 2.2 | 7.2 |
| | 27-Jul | 1.9 | 6.1 | 27-Jul | 1.8 | 5.9 |
| | 13-Aug | 1.4 | 4.4 | 13-Aug | 1.3 | 4.3 |
| | 31-Aug | 0.8 | 2.6 | 31-Aug | 0.8 | 2.6 |
| | 4-Sep | 1.3 | 4.3 | 4-Sep | 1.4 | 4.4 |
| | 9-Sep | 2.7 | 8.9 | 9-Sep | | |
| | 18-Sep | 1.2 | 3.9 | 18-Sep | 1.1 | 3.6 |
| | 6-Oct | 0.7 | 2.3 | 6-Oct | 0.9 | 2.8 |
| | 21-Oct | 0.9 | 3.0 | 21-Oct | 0.9 | 2.8 |
| | 4-Nov | 0.9 | 3.0 | 4-Nov | 0.9 | 3.0 |

# Inlet Chemistry

| | 4/8/2014 | 8/13/2014 | 10/16/2014 | 4/8/2014 | 8/13/2014 | 10/16/2014 | 8/13/2014 | 10/16/2014 | 10/16/2014 |
|---|---|---|---|---|---|---|---|---|---|
| | TP | TP | TP | TN | TN | TN | TSS | TSS | TURB |
| Stormwater Station * | (ppb) | (ppb) | (ppb) | (ppb) | (ppb) | | (mg/L) | (mg/L) | Units |
| 1 | 332 | 459 | | 1133 | 649 | | 235 | | |
| 1A | | | | | | | | | |
| 2 | 115 | 323 | | 2,008 | 1,091 | | 8 | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 E | | | | | | | | | |
| 5 W | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | 6 | 73 | | 163 | 1,287 | | 10 | | |
| 8 | 15 | 375 | 72 | 414 | 1,712 | 537 | 232 | 53 | 18.3 |
| 9 | 17 | 540 | | 539 | 2,570 | | 222 | | |
| 10b | | | | | | | | | |
| 10 | 4 | 1,510 | | 93 | 1,575 | | 577 | | |
| 11 | 63 | 2,950 | 2,380 | 1,277 | 390 | 469 | 1,388 | 527 | 3350 |
| 12 | | 10,410 | 686 | | | 365 | | 263 | 546 |
| 13 | 6 | | 925 | 23 | 2,300 | 551 | 5,386 | 261 | 562 |
| 14 | | | 750 | | | 547 | | 143 | 316 |
| 15 | | | | | | | | | |
| 16 | 19 | 185 | | 604 | 888 | | 82 | | |
| LVD | | | | | | | | | |
| 17 | | | 256 | | | 547 | | 850 | 2980 |
| 18 | 15 | 165 | | 318 | 1,095 | | 25 | | |
| 19 | 7 | 196 | | 134 | 1,603 | | 40 | | |
| 20 | 31 | 234 | 106 | 453 | 410 | 508 | 98 | 3 | |
| 20B | | | 384 | | | 399 | | 18 | |
| KP House | | | | | | | | | |
| Newhoca Park | | | | | | | | | |
| Rosedale Beach | | | | | | | | | |
| Middle Boat Ramp | | | 750 | | | ND | | 850 | |
| Middle Surface | | | 99 | | | 243 | | 23 | |
| Upper Bolton Dam | 7 | 32 | | 202 | 602 | | 5 | | |
| Middle Bolton Dam | 9 | 21 | | 288 | 285 | | 2 | | |
| | 17 | 23 | | 356 | 334 | | 3 | | |

| | 4/20/2015 | 4/20/2015 | 4/20/2015 | 4/20/2015 | 4/20/2015 | 5/5/2015 | 5/5/2015 | 5/5/2015 |
|---|---|---|---|---|---|---|---|---|
| | TP | TSS | NOx | NH3 | TN | TP | TSS | TN |
| Stormwater Station * | (ppb) | (mg/L) | (ppb) | (ppb) | (ppb) | (ppb) | (mg/L) | (ppb) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 352 | 58 | 544 | 149 | 1718 | | | |
| 1A | | | | | | | | |
| 2 | | | | | | | | |
| 3 | 304 | 63 | 357 | 364 | 1923 | | | |
| 4 | | | | | | | | |
| 5 E | 169 | 69 | 231 | 388 | 1211 | | | |
| 5 W | 179 | 76 | 177 | 377 | 1108 | | | |
| 6 | | | | | | | | |
| 7 | 9 | 0 | 12 | 0 | 154 | 11 | 0 | 112 |
| 8 | 19 | 10 | 148 | 0 | 299 | 9 | 0 | 139 |
| 9 | 82 | 65 | 287 | 0 | 719 | 12 | 3 | 261 |
| 10b | 7 | 2 | 22 | 0 | 116 | 9 | 0 | 61 |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | 17 | 13 | 0 | 0 | 116 | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | 61 | 39 | 164 | 0 | 597 | 10 | 8 | 219 |
| LVD | 493 | 238 | 102 | 80 | 631 | | | |
| 17 | 131 | 42 | 39 | 42 | 131 | | | |
| 18 | 21 | 2 | 0 | 3 | 471 | 21 | 4 | 486 |
| 19 | 4 | 0 | 118 | 0 | 222 | 6 | 0 | 152 |
| 20 | 45 | 5 | 51 | 0 | 493 | 37 | 0 | 423 |
| 20B | | | | | | | | |
| KP House | | | | | | | | |
| Newhoca Park | | | | | | | | |
| Rosedale Beach | | | | | | | | |
| Middle Boat Ramp | 194 | 92 | 235 | 53 | 194 | | | |
| Middle Surface | | | | | | | | |
| Upper Bolton Dam | 9 | 2 | 0 | 0 | 245 | | | |
| Middle Bolton Dam | 13 | 2 | 112 | 0 | 363 | | | |
| | 17 | 9 | 26 | 0 | 429 | | | |

| | 8/11/2015 | 8/11/2015 | 8/11/2015 | 9/30/2015 | 9/30/2015 | 9/30/2015 |
|---|---|---|---|---|---|---|
| | TP | TSS | tn | TP | TSS | tn |
| Stormwater Station * | (ppb) | (mg/L) | (ppb) | (ppb) | (mg/L) | (ppb) |
| 1 | 293 | 21 | 2446 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1A | 530 | 122 | 2488 | | | |
| 2 | | | | | | |
| 3 | 208 | 18 | 939 | | | |
| 4 | 128 | 14 | 490 | | | |
| 5 E | 100 | 17 | 1102 | | | |
| 5 W | | | | | | |
| 6 | 228 | 4 | 2889 | | | |
| 7 | | | | 57 | 2 | 1778 |
| 8 | 143 | 51 | 1556 | 77 | 24 | 1002 |
| 9 | | | | 50 | 8 | 803 |
| 10b | | | | | | |
| 10 | | | | | | |
| 11 | 209 | 41 | 914 | | | |
| 12 | 114 | 32 | 652 | | | |
| 13 | 144 | 14 | 802 | | | |
| 14 | | | | | | |
| 15 | 6630 | 6,758 | 3040 | | | |
| 16 | | | | 46 | 27 | 623 |
| LVD | | | | | | |
| 17 | 219 | 55 | 510 | | | |
| 18 | 958 | 317 | 3450 | | | |
| 19 | | | | | | |
| 20 | 225 | 36 | 911 | 104 | 4 | 1310 |
| 20B | | | | | | |
| KP House | 220 | 18 | 732 | | | |
| Newhoca Park | 612 | 110 | 1514 | | | |
| Rosedale Beach | 447 | 23 | 1380 | 161 | 7 | 2344 |
| Middle Boat Ramp | 950 | 567 | 1156 | | | |
| Middle Surface | | | | | | |
| Upper Bolton Dam | | | | | | |
| Middle Bolton Dam | | | | 23 | 3 | 264 |
| | | | | | | |

## Phytoplankton cell counts in Cells/mL 2014 - 2015

| Taxon | 27-Mar | 14-May | 30-May | 12-Jun | 15-Jul | 29-Jul | 8-Aug | 5-Oct | 8-May | 12-Jun | 30-Jun | 17-Jul | 28-Jul | 2-Sep | 29-Sep | 21-Oct |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anabaena | 2,041 | 6,327 | 0 | 18,163 | 0 | 0 | 0 | 816 | 3,265 | 25,170 | 4,762 | 2,449 | 0 | 4,082 | 5,143 | 0 |
| Aphanizomenon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aphanocapsa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,122 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coelospharium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gleocapsa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gloeothece | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oscillatoria | 0 | 15,306 | 10,204 | 0 | 8,367 | 0 | 0 | 0 | 8,367 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ankistrodesmus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Closterium | 0 | 1,429 | 2,041 | 1,020 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 245 |
| Coelastrum | 0 | 2,449 | 1,837 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dictyosphaerium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pediastrum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Radiococcus | 0 | 612 | 0 | 0 | 0 | 0 | 0 | 0 | 408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenedesmus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Staurastrum | 0 | 0 | 0 | 0 | 1,020 | 2,041 | 3,469 | 0 | 204 | 136 | 0 | 0 | 0 | 0 | 0 | 41 |
| Tribonema | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asterionella | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 408 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diatoma | 0 | 0 | 0 | 0 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fragilaria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204 | 0 | 0 | 0 |
| Melosira | 0 | 0 | 0 | 0 | 0 | 612 | 0 | 0 | 0 | 1,224 | 0 | 0 | 939 | 0 | 0 | 0 |
| Navicula | 0 | 0 | 0 | 0 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stephanodiscus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 82 | 0 |
| Synedra | 3,878 | 612 | 5,306 | 0 | 7,143 | 612 | 612 | 0 | 816 | 136 | 0 | 0 | 0 | 0 | 0 | 245 |
| Ceratium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 |
| Peridinium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Taxon | 15-Apr | 5-May | 28-May | 16-Jun | 29-Jun | 16-Jul | 27-Jul | 13-Aug | 31-Aug | 4-Sep | 18-Sep | 6-Oct | 4-Nov |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anabaena | 0 | 0 | 0 | 1,633 | 0 | 0 | 17,143 | 0 | 6,633 | 2,449 | 0 | 0 | 0 |
| Aphanizomenon | 0 | 3,265 | 0 | 7,755 | 2,653 | 1,837 | 11,429 | 80,544 | 68,163 | 29,082 | 51,837 | 0 | 0 |
| Aphanocapsa | 0 | 0 | 0 | 0 | 9,592 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coelospharium | 0 | 0 | 0 | 204 | 0 | 204 | 11,633 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gleocapsa | 0 | 0 | 0 | 816 | 0 | 0 | 0 | 0 | 0 | 306 | 0 | 0 | 0 |
| Gloeothece | 0 | 0 | 0 | 0 | 0 | 0 | 36,735 | 0 | 0 | 0 | 6,122 | 0 | 0 |
| Oscillatoria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,980 | 0 | 0 | 0 |
| Ankistrodesmus | 0 | 0 | 0 | 408 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 3,061 |
| Closterium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coelastrum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dictyosphaerium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6,939 | 20,918 | 0 |
| Pediastrum | 0 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Radiococcus | 0 | 0 | 2,041 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenedesmus | 0 | 0 | 0 | 0 | 3,469 | 1,429 | 1,224 | 0 | 0 | 1,735 | 30,612 | 144,898 | 122,959 |
| Staurastrum | 0 | 0 | 0 | 0 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tribonema | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,531 | 2,551 |
| Asterionella | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Diatoma | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fragilaria | 0 | 816 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Melosira | 0 | 1,224 | 1,837 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,204 | 2,041 |
| Navicula | 0 | 0 | 0 | 1,429 | 204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stephanodiscus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,429 | 0 | 0 |
| Synedra | 0 | 612 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ceratium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Peridinium | 11,990 | 2,857 | 11,020 | 1,224 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |