# LCI Lake Water Quality Summary

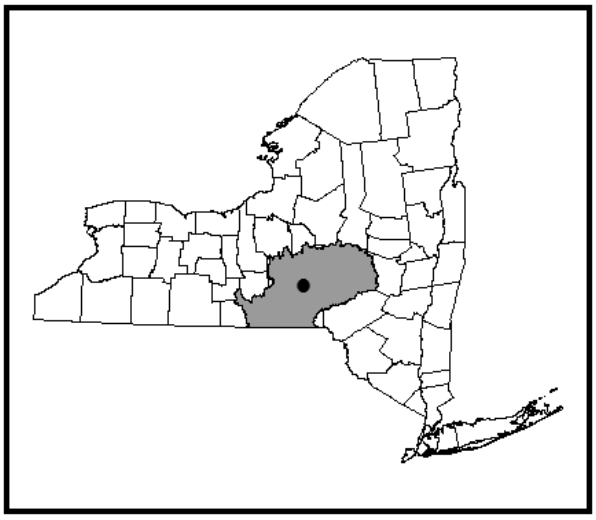
## General Information

## Lake Name: Lake Ludlow

| | |
|---|---|
| **Location:** | Town of McDonough, Chenango County, NY |
| **Basin:** | Susquehanna River Basin |
| **Size:** | 46.6 hectares (= 115 acres) |
| **Lake Origins:** | man-made |
| **Major Tributaries:** | Ludlow Creek |
| **Lake Tributary to?:** | Bowman Creek via Ludlow Creek |
| **Water Quality Classification:** | C (best intended use: secondary contact recreation) |
| **Max Sounding Depth:** | 8.8 meters (= 29 feet) |
| **Sampling Coordinates:** | Latitude: 42.46485, Longitude: -75.70856 |
| **Sampling Access Point:** | Private boat dock (Jim Finch) |
| **Monitoring Program:** | Lake Classification and Inventory (LCI) Survey |
| **Sampling Dates:** | 8/11/2008, 6/9/2009, 7/13/2009, 8/11/2009, 9/8/2009 |
| **Samplers:** | David Newman, NYSDEC Division of Water, Albany<br>Scott Kishbaugh, NYSDEC Division of Water, Albany<br>Steven Finnemore, NYSDEC Division of Water, Albany<br>Lake Ludlow Club Volunteers |
| **Contact Information:** | Scott Kishbaugh, NYSDEC Division of Water<br>sakishba@gw.dec.state.ny.us; 518-402-8282 |

### Lake Map

(sampling location marked with a circle)



## Background and Lake Assessment

Lake Ludlow is a 115 acre impoundment on Ludlow Creek. The lake has been owned and managed by the Lake Ludlow Club, Inc. since the 1920's. Lake Ludlow Club is a hunting and fishing organization that uses the lake and the land surrounding it for these and other recreational purposes. The lake has approximately 50 seasonal use camp/boathouse on the southeastern end of the lake as well as a club house for the Lake Ludlow Club. The majority of the lake's watershed is forested with some agricultural land in upper reaches of the three small streams that form Ludlow Creek. The headwaters of these streams are located in the Genegantslet and McDonough State Forest. Lake access is limited to those with club membership.

The lake was included in the NYSDEC Division of Water's Lake Classification and Inventory (LCI) screening survey LCI of the Susquehanna River basin in the summer of 2008 due to a lack of data from the lake in the Division's database. The results of this survey showed elevated algae, moderate to high nutrient levels, depressed pH and large populations of both submergent and floating leaf macrophytes including the invasive species, *Myriophyllum spicatum* (Eurasian watermilfoil). The preliminary data were summarized in a report to the Lake Ludlow Club, and a letter indicating that aquatic plant control does not appear to be warranted was provided to the Club. To further investigate these findings, the lake was also included in the 2009 intensive (monthly sampling) LCI survey of the basin.

Lake Ludlow can generally be characterized as *mesotrophic*, or moderately productive. The average water clarity reading (TSI = 49, typical of *mesoeutrophic* lakes) was expected, given the average phosphorus (TSI = 47, typical of *mesotrophic* lakes) reading, but are higher than expected given the chlorophyll *a* readings (TSI = 44, typical of *mesotrophic* lakes) in the lake. These data indicate that mid to late summer nutrient levels may support occasional algal blooms. The 2008 water clarity reading was in the range of the 2009 values, while the 2008 chlorophyll *a* and phosphorus readings were slightly higher in 2008 than the range of values recorded in 2009. It is not known if the 2008 or 2009 data are more representative of normal conditions in the lake.

During the August 2008 sampling event the water was noted to have a discernable greenness from the algae in the water column, but this greenness was not noted in any of the 2009 samples. This would be consistent with the 2008 chlorophyll *a* reading being noticeably higher than any of the readings in 2009. The times series chart of trophic indicators (below) shows that chlorophyll levels peaked in early August, coinciding with the lowest water clarity reading.

Numerous aquatic macrophytes were observed at the lake over the two years of sampling (see list below). Of note were the two invasive submergent species that were observed, *Myriophyllum spicatum* (Eurasian watermilfoil) and *Potamogeton crispus* (curly leafed pondweed). Both of these species can be highly invasive, although neither species currently makes up a large part of the plant community of the lake. As noted earlier, despite the presence of exotic plants, aquatic plant management does not appear to be warranted.

Lake Ludlow exhibits thermal stratification, in which depth zones (warm water on top, cold water on the bottom in the summer) are established, as in most NYS lakes greater than six meters in depth. The thermocline in the lake generally occurred between 3 and 5 meters in depth below which oxygen deficits occur throughout the summer. These anoxic conditions (lack of oxygen) trigger elevated bottom water phosphorus, iron and, manganese levels. Contrary to the 2008 data, there were not elevated levels of nitrate in the bottom waters and none of the deep water samples in 2008 or 2009 showed elevated ammonia readings, which sometimes occur in lakes which

experience anoxic conditions. The pH readings indicate slightly acidic conditions for most of the year. The 2008 sample and the June 2009 sample were just above the state's minimum guidance value for pH. Conductivity readings from 2008 and 2009 indicate the lake has soft water (low ionic strength).

Lake Ludlow appears to be typical of softwater, slightly colored, slightly acidic lakes. Other lakes with similar water quality characteristics often support warmwater fisheries. Lake Ludlow Club's website indicates that Walleye are stocked in the lake. Coldwater fisheries may not be supported given the lack of cold water and high oxygen refugia necessary to protect any salmonids or aquatic life susceptible to high summer temperatures. Fisheries habitat cannot be adequately evaluated through the LCI program.

Chloride and other ion levels were low in all of the 2009 samples, although they were elevated in the 2008 sample. Meteorological data show that there was a significant rain event the day before the 2008 sample, which may have contributed to the elevated levels seen in that sample. Elevated ion levels after rain events suggest that the lake may receive runoff from developed areas, although it is more likely that this represents normal variability.

## Evaluation of Lake Condition Impacts to Lake Uses

### Potable Water (Drinking Water)

Lake Ludlow is not classified for use as a potable water supply. Although the LCI data are not sufficient to evaluate potable water use, these data suggest that deepwater intakes quality would be compromised by elevated iron and manganese levels.

### Contact Recreation (Swimming)

Lake Ludlow is not classified for primary contact recreation- swimming and bathing being the best intended use. It is not known whether members of Lake Ludlow Club swim in the lake. The New York State Water Quality Classification of *Class C* states: water quality shall be suitable for primary contact recreation, although other factors may limit the use for this purpose. Bacteria data are needed to evaluate the safety of the Lake for swimming- these however are not collected through the LCI. The data collected through the LCI indicate that for most of the summer the water clarity is above the state minimum to protect the safety of swimmers, although the August water clarity reading was below the 1.2 meter guidance value. Management of nutrient sources may help reduce algae levels and improve the water clarity of the lake. Rooted aquatic vegetation may also make swimming difficult in certain areas of the lake, although the lake presently does not appear to support this use.

### Non-Contact Recreation (Boating and Fishing)

Boating and fishing are currently supported uses of the lake. Although rooted aquatic vegetation in certain areas of the lake may make boating and fishing difficult, open channels within the water shield beds and a defined edge along the weed beds may enhance open water angling. These data indicate that these uses should continue to be supported.

### Aquatic Life

The anoxic conditions may stress aquatic life susceptible to high summer temperatures. Additional biological studies would be needed to evaluate impacts to aquatic life.

## Aesthetics

These data indicate that occasional algal blooms may detract from enjoyment of the lake, although this was not apparent in 2009, the 2008 data may have represented an anomoly.

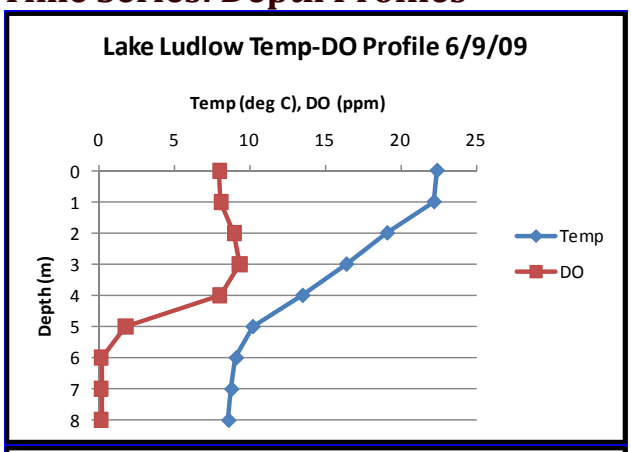
## Additional Comments

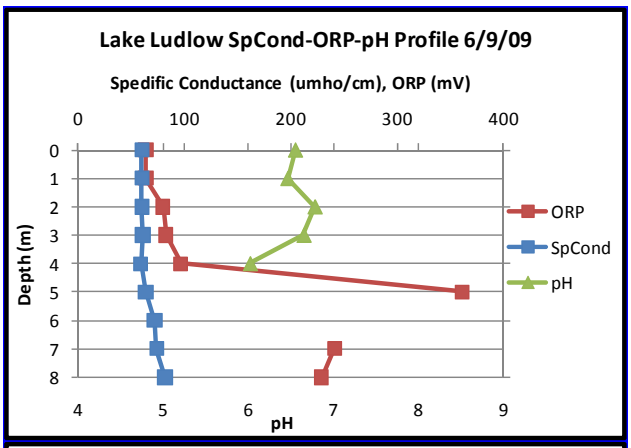
1. Periodic surveillance for invasive exotic plant species may help to prevent the establishment and spread of any new invaders, given the escalating problems with exotic aquatic weeds. Adhering to a policy of prohibiting outside boats on the lake and educating users of the lake about invasive species will help prevent future introduction.
2. Management of water quality conditions in Lake Ludlow should focus on reducing nutrient loading to the lake, through maintaining septic systems, shoreline buffer zones, limited use of lawn fertilizers, minimizing land disturbances in the near-lake watershed, and localized stormwater management.

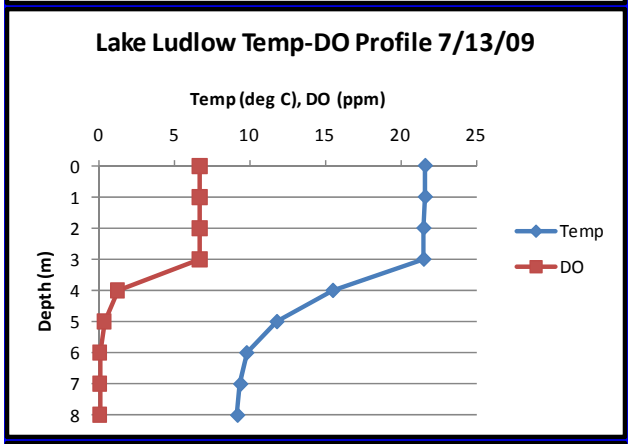
## Aquatic Plant IDs

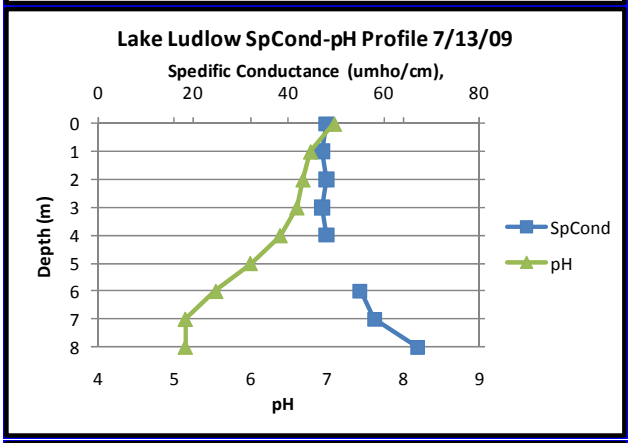
| | |
|---|---|
| Exotic Plants: | *Myriophyllum spicatum* (Eurasian watermilfoil) |
| | *Potamogeton crispus* (curly leafed pondweed) |
| Native Plants: | *Ceratophyllum demersum* (coontail) |
| | *Nymphaea sp.* (white water lily) |
| | *Nuphar sp.* (yellow water lily) |
| | *Brasenia schreberi* (watershield) |
| | *Potamogeton zosteriformis* (flatstem pondweed) |
| | *Potamogeton nodosus* (long-leaf pondweed) |
| | *Potamogeton amplifolius* (large-leaf pondweed |
| | *Potamogeton epihydrus* (ribbonleaf pondweed) |
| | *Stuckenia pectinatus* (Sago pondweed) |
| | *Chara sp.* (stonewort) |
| | *Ranunculus trichophyllus* (water crowfoot) |
| | *Pontederia cordata* (pickerelweed) |
| | *Utricularia vulgaris* (common bladderwort) |
| | *Najas sp.* (unidentified naiad) |

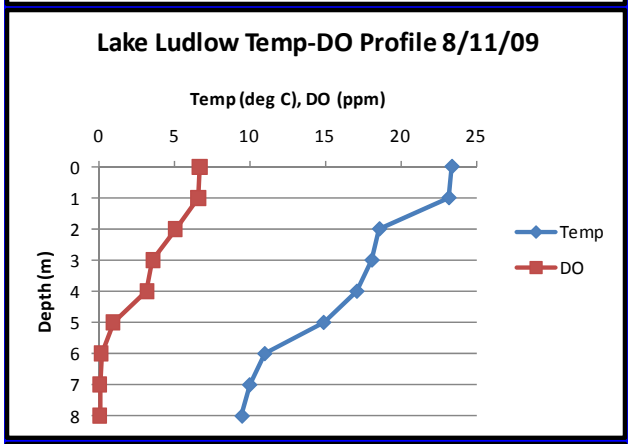
# Time Series: Depth Profiles

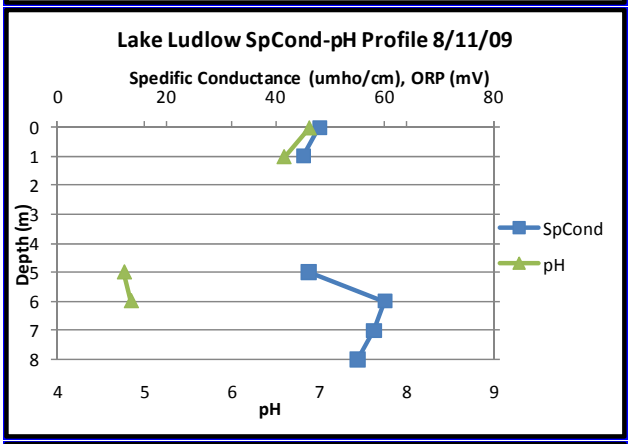


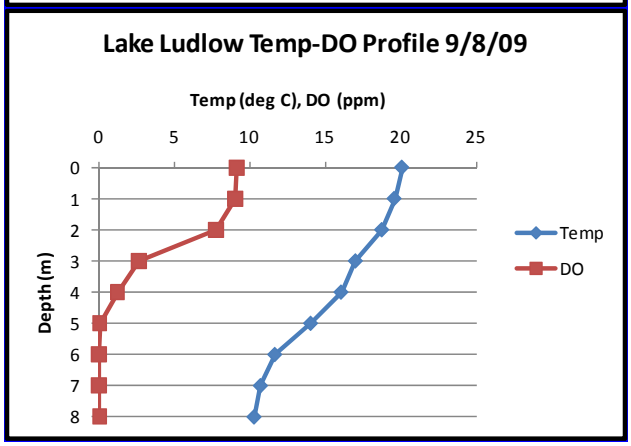



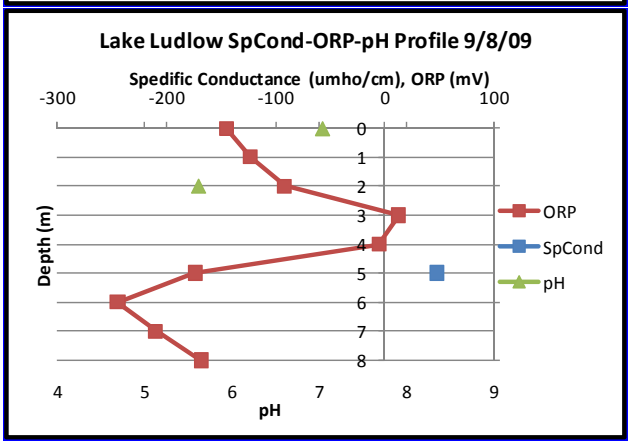



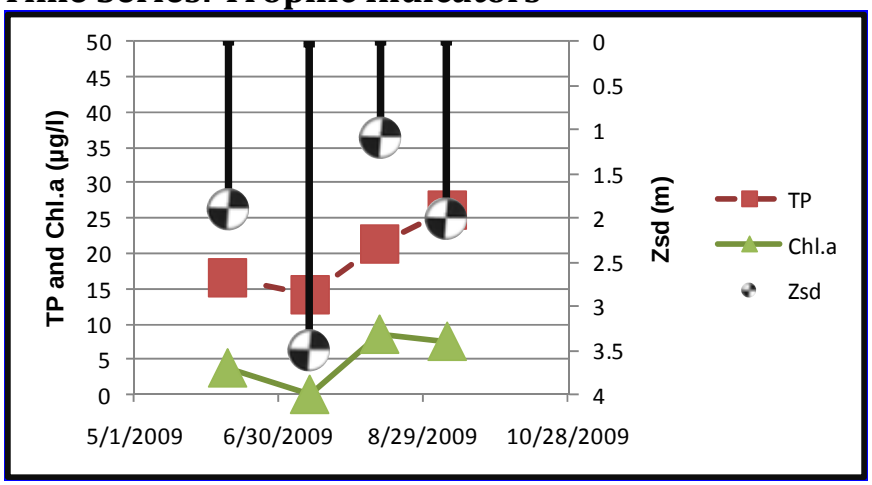



## Time Series: Trophic Indicators




## WQ Sampling Results

### 2009 Surface Samples

| | UNITS | N | MIN | AVG | MAX | Scientific Classification | Regulatory Comments |
|---|---|---|---|---|---|---|---|
| SECCHI | meters | 4 | 1.1 | 2.13 | 3.5 | Mesotrophic | 25% of readings violate DOH guidelines |
| TSI-Secchi | | | 58.6 | 49.1 | 41.9 | Mesotrophic | No pertinent water quality standards |
| TP | mg/l | 4 | 0.0142 | 0.0196 | 0.0262 | Mesotrophic | 50% of readings violate DOH guidelines |
| TSI-TP | | | 42.4 | 47.0 | 51.2 | Mesotrophic | No pertinent water quality standards |
| TSP | mg/l | 4 | 0.0051 | 0.0145 | 0.0271 | High % soluble Phosphorus | No pertinent water quality standards |
| NOx | mg/l | 4 | 0.0027 | 0.03425 | 0.0057 | Low nitrate | No readings violate DOH guidance value |
| NH4 | mg/l | 4 | 0.012 | 0.034 | 0.086 | Low ammonia | No readings violate DOH guidance value |
| TKN | mg/l | 4 | 0.37 | 0.41 | 0.48 | Low organic nitrogen | No pertinent water quality standards |
| TN/TP | mg/l | 4 | 33.84 | 48.31 | 59.76 | Phosphorus Limited | No pertinent water quality standards |
| CHLA | ug/l | 4 | ND | 5.19* | 8.5 | Mesotrophic | No pertinent water quality standards |
| TSI-CHLA | | | ND | 44.1* | 51.6 | Mesotrophic | No pertinent water quality standards |
| Alkalinity | mg/l | 4 | 10 | 11.5 | 12.2 | Poorly Buffered | No pertinent water quality standards |
| TCOLOR | ptu | 4 | 5 | 21.3 | 40 | Weakly Colored | No pertinent water quality standards |
| TOC | mg/l | 4 | 5 | 6.5 | 8.4 | | No pertinent water quality standards |
| Ca | mg/l | 4 | 5.02 | 5.2 | 5.39 | Does Not Support Zebra Mussels | No pertinent water quality standards |
| Fe | mg/l | 4 | 0.131 | 0.296 | 0.479 | May have some taste/odor | 50% of readings violate DOH guidelines |
| Mn | mg/l | 4 | 0.0329 | 0.0425 | 0.0628 | | No readings violate DOH guidance value |
| Mg | mg/l | 4 | 0.82 | 0.89 | 0.947 | | No readings violate DOH guidance value |
| K | mg/l | 4 | 0.397 | 0.56 | 0.738 | | No pertinent water quality standards |
| Na | mg/l | 4 | 3.22 | 3.92 | 4.35 | | No readings violate DOH guidance value |
| Cl | mg/l | 4 | 4.4 | 6.25 | 7.2 | Minor road salt runoff | No readings violate DOH guidance value |
| SO4 | mg/l | 4 | 3.6 | 4.15 | 4.9 | | No readings violate DOH guidance value |

* Non detect values were treated as equal to half the detection limit for computing the average reading

## 2009 Bottom Samples

| | UNITS | N | MIN | AVG | MAX | Scientific Classification | Regulatory Comments |
|---|---|---|---|---|---|---|---|
| TP-bottom | mg/l | 4 | 0.0233 | 0.0548 | 0.0868 | Elevated deepwater phosphorus | No pertinent water quality standards |
| TSP-bottom | mg/l | 4 | 0.0066 | 0.0346 | 0.0745 | High % soluble phosphorus | No pertinent water quality standards |
| NOx-bottom | mg/l | 4 | 0.0028 | 0.0117 | 0.021 | No evidence of DO depletion | No readings violate DOH guidance value |
| NH4-bottom | mg/l | 4 | ND | 0.083* | 0.204 | No evidence of DO depletion | No readings violate DOH guidance value |
| TKN-bottom | mg/l | 4 | 0.28 | 0.45 | 0.62 | | No pertinent water quality standards |
| Alk-bottom | mg/l | 4 | 10.9 | 19 | 25.9 | Poorly Buffered | No pertinent water quality standards |
| TCOLOR-bottom | ptu | 4 | 30 | 43.8 | 50 | Highly Colored | No pertinent water quality standards |
| TOC-bottom | mg/l | 4 | 4.4 | 6.1 | 7.9 | | No pertinent water quality standards |
| Ca-bottom | mg/l | 4 | 5.23 | 6.4 | 7.54 | | Minimally Supports Zebra Mussels |
| Fe-bottom | mg/l | 4 | 0.768 | 4.122 | 6.94 | Taste or odor likely | 100% of readings violate DOH guidelines |
| Mn-bottom | mg/l | 4 | 0.494 | 1.6335 | 2.66 | Taste or odor likely | 100% of readings violate DOH guidelines |
| Mg-bottom | mg/l | 4 | 0.839 | 1 | 1.1 | | No readings violate DOH guidance value |
| K-bottom | mg/l | 4 | 0.588 | 0.7 | 0.791 | | No pertinent water quality standards |
| Na-bottom | mg/l | 4 | 4.36 | 4.8 | 5.31 | | No readings violate DOH guidance value |
| Cl-bottom | mg/l | 4 | 7 | 7.95 | 8.5 | | No readings violate DOH guidance value |
| SO4-bottom | mg/l | 4 | 3.2 | 4.05 | 5.5 | | No readings violate DOH guidance value |
| As-bottom | mg/l | 1 | ND | ND | ND | No evidence of potable water threats | No readings violate guidance values |

* Non detect values were treated as equal to half the detection limit for computing the average reading

## 2009 Lake Perception

| | UNITS | N | MIN | AVG | MAX | Scientific Classification | Regulatory Comments |
|---|---|---|---|---|---|---|---|
| WQ Assessment | 1-5, 1 best | 4 | 2 | 2.5 | 3 | Definite Algal Greenness | No pertinent water quality standards |
| Weed Assessment | 1-5, 1 best | 4 | 3 | 3.5 | 4 | Dense Plant Growth at Lake Surface | No pertinent water quality standards |
| Recreational Assessment | 1-5, 1 best | 4 | 2 | 2.75 | 3 | Slightly Impaired | No pertinent water quality standards |

# Legend Information

## General Legend Information

Surface Samples = integrated sample collected in the first 2 meters of surface water
Bottom Samples = grab sample collected from a depth of approximately 1 meter from the lake bottom
N = number of samples
SECCHI = Secchi disk water transparency or clarity - measured in meters (m)
TSI-SECCHI = Trophic State Index calculated from Secchi, = 60 – 14.41*ln(Secchi)

## Laboratory Parameters

ND = Non-Detect, the level of the analyte in question is at or below the laboratory's detection limit
TP = total phosphorus- milligrams per liter (mg/l)
Detection limit = 0.003 mg/l; NYS Guidance Value = 0.020 mg/l

| | |
|---|---|
| TSI-TP | = Trophic State Index calculated from TP, = 14.42*ln(TP*1000) + 4.15 |
| TSP | = total soluble phosphorus, mg/l<br>Detection limit = 0.003 mg/l; no NYS standard or guidance value |
| NOx | = nitrate + nitrite nitrogen, mg/l<br>Detection limit = 0.01 mg/l; NYS WQ standard = 10 mg/l |
| NH4 | = total ammonia, mg/l<br>Detection limit = 0.01 mg/l; NYS WQ standard = 2 mg/l |
| TKN | = total Kjeldahl nitrogen (= organic nitrogen + ammonia), mg/l<br>Detection limit = 0.01 mg/l; no NYS standard or guidance value |
| TN/TP | = Nitrogen to Phosphorus ratio (molar ratio), = (TKN + NOx)*2.2/TP<br>> 30 suggests phosphorus limitation, < 10 suggests nitrogen limitation |
| CHLA | = chlorophyll *a*, micrograms per liter (µg/l) or parts per billion (ppb)<br>Detection limit = 2 µg/l; no NYS standard or guidance value |
| TSI-CHLA | = Trophic State Index calculated from CHLA, = 9.81*ln(CHLA) + 30.6 |
| ALKALINITY | = total alkalinity in mg/l as calcium carbonate<br>Detection limit = 10 mg/l; no NYS standard or guidance value |
| TCOLOR | = true (filtered or centrifuged) color, platinum color units (ptu)<br>Detection limit = 5 ptu; no NYS standard or guidance value |
| TOC | = total organic carbon, mg/l<br>Detection limit = 1 mg/l; no NYS standard or guidance value |
| Ca | = calcium, mg/l<br>Detection limit = 1 mg/l; no NYS standard or guidance value |
| Fe | = iron, mg/l<br>Detection limit = 0.1 mg/l; NYS standard = 0.3 mg/l |
| Mn | = manganese, mg/l<br>Detection limit = 0.01 mg/l; NYS standard = 0.3 mg/l |
| Mg | = magnesium, mg/l<br>Detection limit = 2 mg/l; NYS standard = 35 mg/l |
| K | = potassium, mg/l<br>Detection limit = 2 mg/l; no NYS standard or guidance value |
| Na | = sodium, mg/l<br>Detection limit = 2 mg/l; NYS standard = 20 mg/l |
| Cl | = chloride, mg/l<br>Detection limit = 2 mg/l; NYS standard = 250 mg/l |
| SO4 | = sulfate, mg/l<br>Detection limit = 2 mg/l; NYS standard = 250 mg/l |
| As | =arsenic, mg/l<br>Detection limit = 3.2 mg/l; NYS standard = 10 mg/l |

## Field Parameters

| | |
|---|---|
| Depth | = water depth, meters |
| Temp | = water temperature, degrees Celsius |
| D.O. | = dissolved oxygen, in milligrams per liter (mg/l) or parts per million (ppm)<br>NYS standard = 4 mg/l; 5 mg/l for salmonids |
| pH | = powers of hydrogen, standard pH units (S.U.)<br>Detection limit = 1 S.U.; NYS standard = 6.5 and 8.5 |
| SpCond | = specific conductance, corrected to 25ºC, micromho per centimeter (µmho/cm)<br>Detection limit = 1 µmho/cm; no NYS standard or guidance value |
| ORP | = Oxygen Reduction Potential, millivolts (MV)<br>Detection limit = -250 mV; no NYS standard or guidance value |

## Lake Assessment

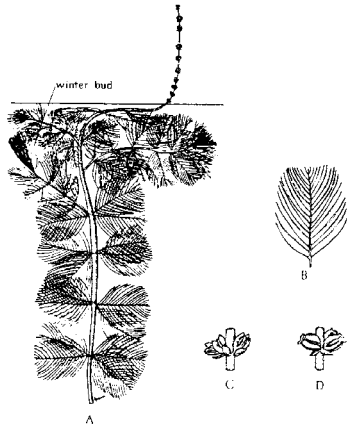
| | |
|---|---|
| WQ Assessment | **= water quality assessment**, 5 point scale, 1= crystal clear, 2 = not quite crystal clear, 3 = definite algae greenness, 4 = high algae levels, 5 = severely high algae levels |
| Weed Assessment | **= weed coverage/density assessment**, 5 point scale, 1 = no plants visible, 2 = plants below surface, 3 = plants at surface, 4 = plants dense at surface, 5 = plants cover surface |
| Recreational Assessment | **= swimming/aesthetic assessment**, 5 point scale; 1 = could not be nicer, 2 = excellent, 3= slightly impaired, 4 = substantially impaired, 5 = lake not usable |

## Exotic Plant Species Profiles

## SPECIES NAME: *Myriophyllum spicatum*

COMMON NAME: Eurasian water milfoil

ECOLOGICAL VALUE: like most submergents, *Myriophyllum* harbors aquatic insects, provides hiding, nurseries, and spawning areas for amphibians and fish, and provides some food for waterfowl. However, *Myriophyllum spicatum* may dominate a water system, restricting boat traffic, recreational activities and water movement. While infestations of milfoil create favorable shelter for small fishes and invertebrates, they also commonly crowds out more desirable waterfowl plants




*Myriophyllum spicatum*: A. habit of submersed form with emergent inflorescence, × ½. B. leaf, × 1. C. flowers, × 2. D. fruits, × 2.

DISTRIBUTION IN UNITED STATES: locally abundant and aggressive from Quebec and New England west to Ontario, Michigan, Wisconsin, and British Columbia, south to Florida, Oklahoma, Texas, Washington, California, and Mexico (the range of this plant continues to increase each year)

DISTRIBUTION IN NEW YORK: found in increasing amounts throughout the State, except in the interior Adirondacks and the Long Island area (although it has recently been discovered in both locations)

DEGREE OF NUISANCE: like most exotics, *M. spicatum* establishes easily, and once established, often becomes the dominant plant in the macrophyte community, growing abundantly to nuisance levels

COMMENTS: while some species of *Myriophyllum* have earned a reputation for aggressive and opportunistic growth, most of the species in this genus are not nearly so robust, and often peacefully coexist with other submergent plants. The individual species within the *Myriophyllum* genus are superficially similar, so complete plants, including flowers (often pink) and fruits, are often needed for positive identification. The leaf structures and patterns of the milfoil closely resemble those of the *Ceratophyllum* (coontail) and *Utricularia* (bladderwort), and as a result, these plants are often confused for each other, particularly when viewed from a slight distance. Peak growth for most species is in mid-summer. *M. spicatum* is distinguished from other milfoils by having smaller flower-leaf structures on the emergent spike, flat-topped ends on the upper most submerged leaves, and red tips during the peak growing season and white to slightly pinkish stems. *Myriophyllum* spreads and reproduces vegetatively. This is one of the most discussed and well-known plants in the state, due to its propensity to form dense canopies that overwhelm the underlying native plant populations. Improved surveillance has greatly expanded the known range of this species within the state, though the range may have concurrently extended due to spread from boat traffic, waterfowl, and water transport from infected to uncontaminated lakes. Appropriate control strategies avoid excessive fragmentation.

Line drawing- Crowe, G.E. and C.B. Hellquist. Aquatic and wetlands plants of northeastern North America. 2000

## SPECIES NAME: *Potamogeton crispus*

COMMON NAME: curlyleaf pondweed

ECOLOGICAL VALUE: While this is not a native plant to New York state, it has become well established in many lakes and does not disrupt the aquatic ecosystem as do other (recently-introduced) exotics, although it still can out-compete native species and dominate a macrophyte community, particularly in late spring and early summer (before the peak growing season for other native and non-native macrophytes).

DISTRIBUTION IN UNITED STATES: In hard or brackish, often polluted waters, naturalized from Europe and common in New England, western Massachusetts, with a range extending from Quebec west to Minnesota, south to Alabama and Texas, and scattered throughout the western states

DISTRIBUTION IN NEW YORK: widespread and often abundant along the Hudson River and Finger Lakes basins, with some occurrences in far western New York

DEGREE OF NUISANCE: *Potamogeton crispus* may establish easily and grow abundantly, reaching nuisance levels, although the extent of coverage and nuisance conditions is limited by the growing season (winter through early-mid summer)

COMMENTS: *Potamogeton* is a highly variable genus within the pondweed family. Species within the genus often are characterized by two leaf types- firm floating leaves and thin emersed leaves. Many mature species have flowers borne in spikes (for wind pollination), conspicuous in early summer. Identification of the individual species can be extremely difficult, particularly among the narrow-leaved pondweeds. The *Potamogeton* are distinguished from the other genus within the pondweed family by having alternate leaves (unlike the *Zanichellia* and *Najas*), and by their presence in fresh or estuarine waters (unlike the *Zostera*). There are nearly 30 species found within New York State, some quite rare and others extremely common. *P. crispus* is one of the four major non-native exotic plant species in New York state, and has served as the impetus for several lake restoration and plant management programs. However, it naturally dies out in many lakes by early to mid summer, often to be replaced by other monocultures. It is characterized by finely-toothed leaf margins and a 'lasagna'-like leaf appearance.

Line drawing- Crowe, G.E. and C.B. Hellquist. Aquatic and wetlands plants of northeastern North America. 2000