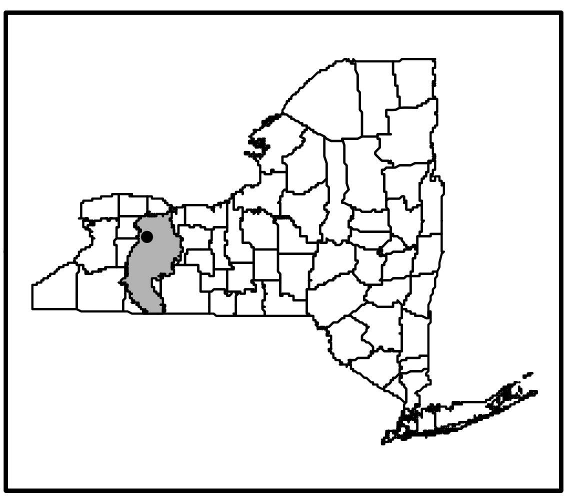
LCI Lake Water Quality Summary

General Information

Lake Name:	**Le Roy Reservoir**
Location:	Town of Pavilion, Genesee County, NY
Basin:	Genesee River Basin
Size:	20.7 hectares (51 acres)
Lake Origins:	man-made/ earthen dam
Major Tributaries:	Mud Creek
Lake Tributary to:	Mud Creek
Water Quality Classification:	A (best intended use: potable water supply)
Maximum Sounding Depth:	7.5 meters (25 feet)
Sampling Coordinates:	Latitude: 42.8941, Longitude: -77.97483
Sampling Access Point:	private land (Noblehurst Farms, Inc.)
Monitoring Program:	Lake Classification and Inventory (LCI) Survey
Sampling Date:	6/2, 7/7, 8/5, & 9/8/2010
Samplers:	David Newman, Scott Kishbaugh, Alene Onion, Erik Posner, & Lorraine Holdridge, NYSDEC Division of Water, Albany
Contact Information:	David Newman, NYSDEC Division of Water djnewman@gw.dec.state.ny.us; 518-402-8201

Lake Maps
(sampling location marked with a circle)



Background and Lake Assessment

Le Roy Reservoir (also spelled LeRoy and referred to as Lake LeRoy Reservoir) is a 50 acre impoundment on Mud Creek in the southeastern corner of Genesee County, New York. Mud Creek was originally impounded in 1915 to provide water to the Village of LeRoy (OCWC 2002). Le Roy Reservoir continued as a source of drinking water for the village through 2004, at which time the town joined the Monroe County Water Authority and sold the land and the water rights to the reservoir. The reservoir is privately owned and used for boating and fishing by the landowner and his guest. There is currently no public access to the reservoir. Mud Creek's watershed is primarily agricultural with a narrow treed buffer along much of the shoreline. The reservoir is also surrounded with a buffer of trees with only a single house being visible from the reservoir.

Le Roy Reservoir was included in the NYSDEC Division of Water's Lake Classification and Inventory (LCI) program in the summer of 2010, due to a *Minor Impacts* listing in the 2001 Genesee River Basin Waterbody Inventory and Priority Waterbodies List (WIPWL). The WIPWL lists known pollutants to the reservoir as "algal/weed growth (algal blooms), nutrients and pesticides. In addition, suspected and possible pollutant sources were listed as silt/sediment and pathogens. The main source of pollutants is the agricultural watershed.

Le Roy Reservoir can be characterized as a *eutrophic*, or highly productive. The average water clarity reading (TSI = 72, typical of *eutrophic* lakes) was in the expected range given the average total phosphorus reading (TSI = 74, typical of *eutrophic* lakes) and the average chlorophyll *a* reading (TSI = 65, typical of *eutrophic* lakes). These data indicate that baseline nutrient levels do support persistent algal blooms in the reservoir. The field crews observed filamentous and planktonic algal blooms in the reservoir during all four sampling events.

The reservoir was observed to have a brownish green coloration throughout the summer of 2010. Algae and silt in the water column limited the water clarity to a half a meter throughout the summer. An examination of the plant community of the lake yielded the following native plant species: *Lemna minor* (lesser duckweed), *Potamogeton richardsonii* (Richardson's pondweed), *Ceratophyllum demersum* (coontail), and *Wolffia sp.* (watermeal). In addition, two exotic invasive species *Potamogeton crispus* (curlyleaf pondweed) and *Myriophyllum spicatum* (Eurasian watermilfoil) were also found to be occurring in the reservoir. Both species are known to out-compete native aquatic plant species and grow to nuisance levels (see plant profiles below). A fisherman indicated that the reservoir was typically clearer with higher densities of aquatic plant life. The fisherman attributed the poor water clarity to the in lake aerators no longer being used. When the village owned and managed the reservoir they used an oxygen injection system and aquatic weed harvester to improve water quality conditions (FLLOWPA 2000).

During the June, July and August sampling events Le Roy Reservoir exhibits thermal stratification, in which depth zones (warm water on top, cold water on the bottom during the summer) are established, as in most NYS lakes greater than 6 meters deep. The thermocline was in the 2-3 meter range throughout the summer with the reservoir coming out of stratification sometime in late August or early September. The hypolimnion (bottom waters) was anoxic (devoid of oxygen) below 2 meters. In September the reservoir was not stratified, but low dissolved oxygen levels were apparent throughout the water column. The surface pH readings indicate alkaline conditions with the June to August readings were above the water quality standards (6.5 to 8.5). Alkaline waters are typical of lakes with high levels of algae. The September pH reading was neutral. Conductivity readings from June to August indicate hard water (high ionic strength), typical of other lakes sampled in the Genesee River Basin. The September conductivity reading was nearly double of that found during the other sampling events, suggesting lake destratification may have brought high conductivity water to the lake surface.

Le Roy Reservoir is a hardwater, highly colored, alkaline lake. Other lakes with similar water quality characteristics often support warmwater fisheries, although fisheries habitat cannot be fully evaluated through this monitoring program. Coldwater fisheries are unlikely to be supported due to the lack of cold oxygen rich water necessary to protect any salmonids or aquatic life susceptible to high summer temperatures. A fisherman indicated that the lake supports mostly panfish.

Nutrient (nitrogen and phosphorus) levels in the surface waters were elevated, with total phosphorus levels well above the state's water quality standards during all four sampling events. 50% of the manganese samples exceeded state water quality standards. Sodium and chloride levels were also elevated, indicating that the reservoir is impacted by road salting and/or runoff through developed areas. In the bottom waters, phosphorus levels were elevated. Three of the four deep water ammonia and manganese samples were above the state water quality standards with all four deep water sodium readings and one of the four sulfate and magnesium readings being above the water quality standards. Arsenic was also detected in the two samples, but these readings fell below the water quality standard. Elevated levels of ammonia, manganese, sulfate and arsenic are typical of waterbodies experiencing persistent oxygen deficits in the bottom waters.

Evaluation of Lake Condition Impacts to Lake Uses

Potable Water (Drinking Water)

Le Roy Reservoir is classified for use as a potable water supply, although is not currently used for this purpose. Although the LCI data are not sufficient to evaluate potable water use, these data indicate the use of the lake for a drinking water supply would be *impaired* by elevated levels of phosphorus, algae, sodium and manganese as well as high turbidity, color and pH. Deep water intakes would be *impaired* by ammonia, manganese, magnesium, sodium, sulfate and arsenic. A study in the late 1990's showed that elevated concentration of some pesticides/herbicides were found in tributaries to Le Roy Reservoir, which may also *threaten* the use of the reservoir for drinking water supply (Philips et al. 2000).

Contact Recreation (Swimming)

Le Roy Reservoir is likely not used for swimming due to the limited access to the lake and poor water quality conditions. Bacteria data are needed to evaluate the safety of Le Roy Reservoir for swimming—these are not collected through the LCI. The data collected through the LCI indicate that swimming is *impaired* by elevated algae and nutrient levels and low water clarity. Water clarity readings throughout the summer failed to reach the NYS Health Departments guidance value of 1.2 meters to protect the safety of swimmers. The recreational assessment of the lake was described as “substantially impaired” due to the low water clarity. Future use of the lake for contact recreation may require management of nutrient and silt/sediment sources to provide safe and aesthetically acceptable swimming conditions.

Non-Contact Recreation (Boating and Fishing)

The private land owner allows a small number of individuals to fish and boat on the reservoir. These data indicated that fishing and boating may be *threatened* by curlyleaf pondweed and Eurasian watermilfoil.

Aquatic Life

Oxygen deficits in the bottom waters of the lake will *stress* aquatic life susceptible to high summer temperatures. The two exotic invasive plant species inhibit the growth of native aquatic plants in the reservoir. In addition, the high pH levels may also *stress* aquatic life in the reservoir. Aquatic life may also be *threatened* by elevated levels of some pesticides (Philips et al. 2000).

Aesthetics

The aesthetics of the lake are *stressed* by algae blooms and low water clarity.

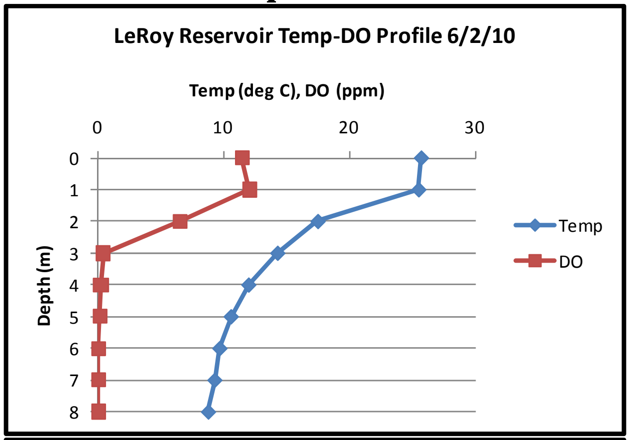
Additional Comments

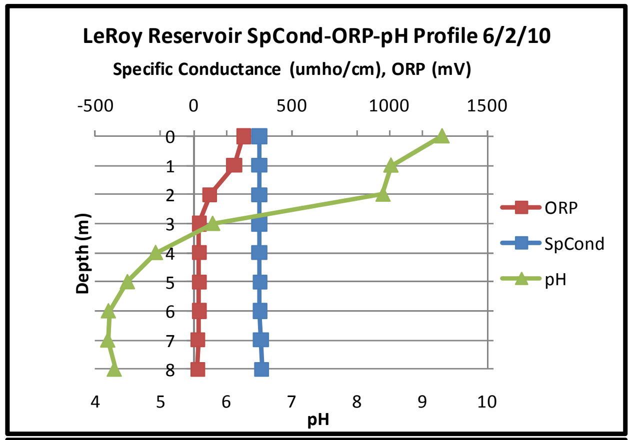
- The agricultural nature of the reservoir’s watershed is known to be the source of much of phosphorus and nitrogen in the reservoir. Continuing to enforce agricultural best management practices and encouraging farmers in the watershed to participate in programs such as Conservation Reserve Enhancement Program (CREP) may help reduce nutrient and sediment inputs to the reservoir. (http://www.nrcs.usda.gov/programs/crp/)
- Using the oxygen injection system may help in preventing the reservoir from stratifying, which may help prevent anoxic conditions that allow nutrients bound in the sediments to be released to the water column.
- Conducting an analysis of sediments in the lake may help to determine if there are high levels of pesticides or other harmful chemicals in the sediments.
- 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.
- Algae identification would determine if the lake may suffer from harmful algal blooms (HABs) and/or the production of algal toxins.

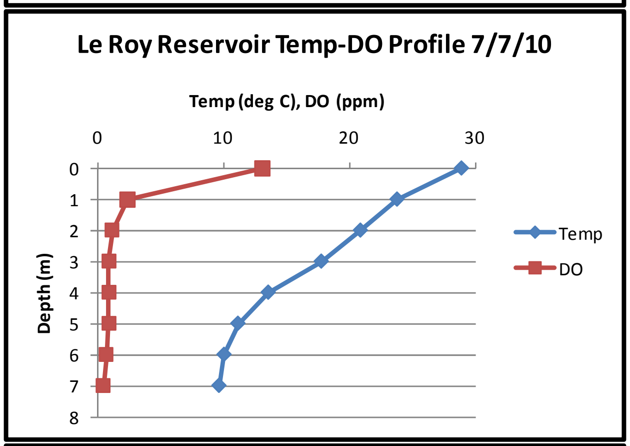
Aquatic Plant IDs

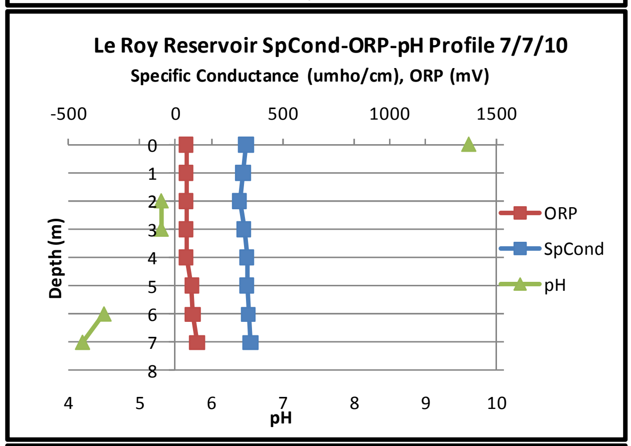
Exotic Plants:	*Potamogeton crispus* (curly leaf pondweed) *Myriophyllum spicatum* (Eurasian watermilfoil)
Native Plants:	*Lemna minor* (lesser duck weed) *Potamogeton richardsonii* (Richardson’s pondweed) *Ceratophyllum demersum* (coontail) *Wolffia sp.* (watermeal)

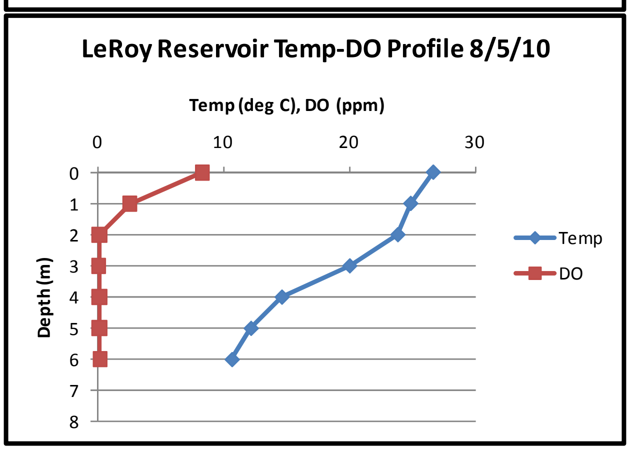
Time Series: Depth Profiles

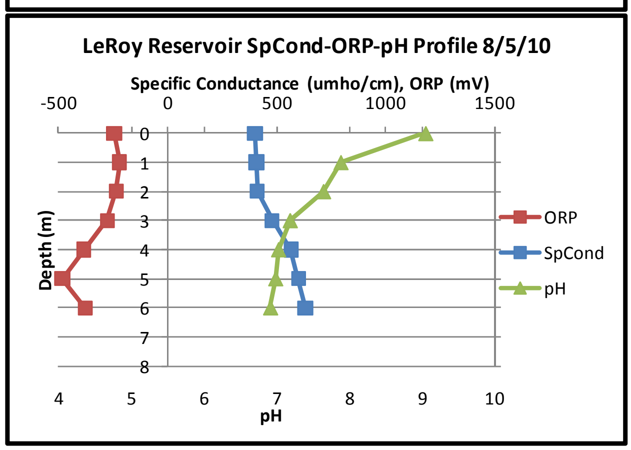


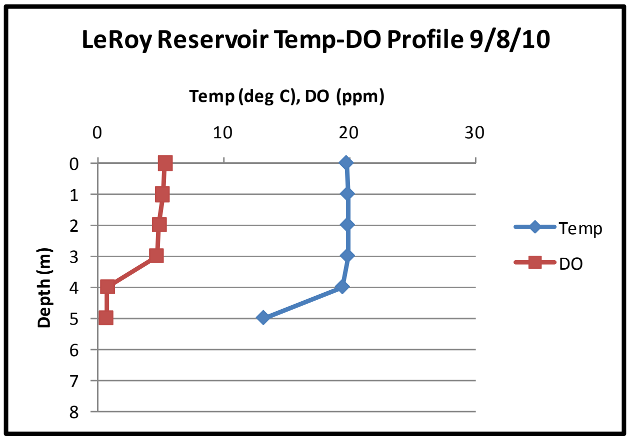


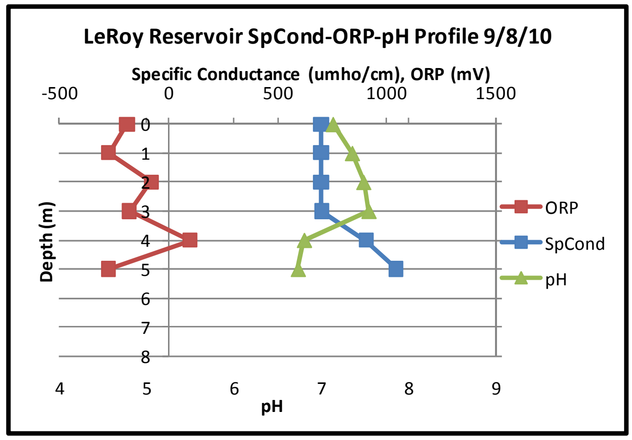




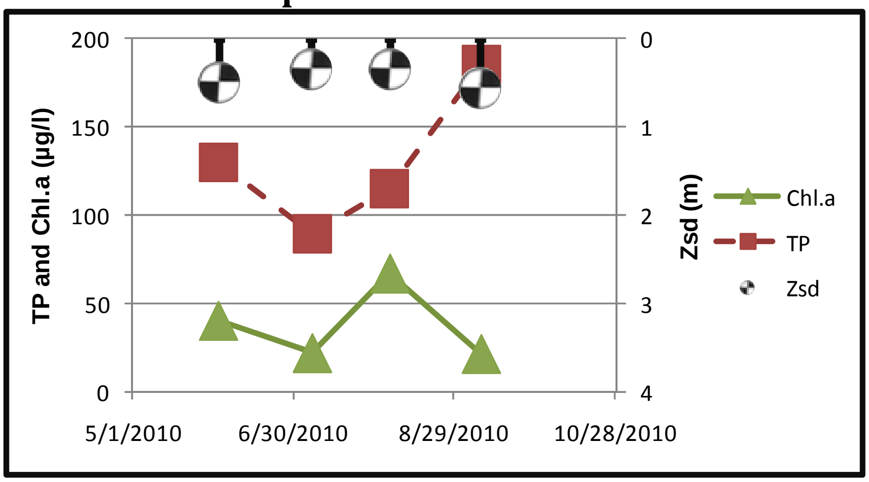








Time Series: Trophic Indicators



WQ Sampling Results

Surface Samples

	UNITS	N	MIN	AVG	MAX	Scientific Classification	Regulatory Comments
SECCHI	meters	4	0.35	0.44	0.55	Eutrophic	100% of readings violate DOH guidelines
TSI-Secchi			75.1	71.8	68.6	Eutrophic	No pertinent water quality standards
TP	mg/l	4	0.0892	0.13	0.185	Eutrophic	100% of readings violate water quality standards
TSI-TP			68.9	74.3	79.4	Eutrophic	No pertinent water quality standards
TSP	mg/l	4	0.0299	0.0472	0.0562	High % soluble Phosphorus	No pertinent water quality standards
NOx	mg/l	4	0.002	0.1995	0.0109	Low nitrate	No readings violate water quality standards
NH4	mg/l	4	0.093	0.2	0.3	Potentially high ammonia	No readings violate water quality standards
TKN	mg/l	4	1.67	2.18	2.66	Elevated organic nitrogen	No pertinent water quality standards
TN/TP	mg/l	4	31.70	38.21	45.76	Phosphorus Limited	No pertinent water quality standards
CHLA	ug/l	4	21.9	37.88	66.8	Eutrophic	No pertinent water quality standards
TSI-CHLA			60.9	65.2	71.8	Eutrophic	No pertinent water quality standards
Alkalinity	mg/l	4	100	103.8	108	Moderately Buffered	No pertinent water quality standards
TCOLOR	ptu	4	30	36.3	45	Highly Colored	No pertinent water quality standards
TOC	mg/l	4	11.8	13.1	14		No pertinent water quality standards
Ca	mg/l	4	24.5	26.8	32	Minimally Supports Zebra Mussels	No pertinent water quality standards
Fe	mg/l	4	0.118	0.131	0.152		No readings violate water quality standards
Mn	mg/l	4	0.193	0.4218	0.607	Taste or odor likely	50% of readings violate water quality standards
Mg	mg/l	4	12.8	13.68	14.5		No readings violate water quality standards
K	mg/l	4	4.64	4.8	4.95		No pertinent water quality standards
Na	mg/l	4	28.4	28.78	29.2		100% of readings violate water quality standards
Cl	mg/l	4	51.9	52.9	53.6	Significant road salt runoff	No readings violate water quality standards
SO4	mg/l	4	9.1	11.35	16.6		No readings violate water quality standards

Bottom Samples

	UNITS	N	MIN	AVG	MAX	Scientific Classification	Regulatory Comments
TP-bottom	mg/l	4	0.0088	1.0372	1.82	Elevated deepwater phosphorus	No pertinent water quality standards
TSP-bottom	mg/l	4	0.0095	1.0674	1.72	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	4	0.0032	0.2231	0.875	No evidence of DO depletion	No readings violate water quality standards
NH4-bottom	mg/l	4	0.01	4.695	8.31	Evidence of DO depletion	75% of readings violate DOH guidelines
TKN-bottom	mg/l	4	0.42	5.25	8.67		No pertinent water quality standards
Alk-bottom	mg/l	4	186	212.8	263	Moderately Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	4	15	23.8	30	Weakly Colored	No pertinent water quality standards
TOC-bottom	mg/l	4	3.8	10.2	12.7		No pertinent water quality standards
Ca-bottom	mg/l	4	50.4	137.2	390		Strongly Supports Zebra Mussels
Fe-bottom	mg/l	4	0.0326	0.1982	0.282		No readings violate water quality standards
Mn-bottom	mg/l	4	0.0231	1.6033	2.49	Taste or odor likely	75% of readings violate water quality standards
Mg-bottom	mg/l	4	13.6	21	41.2		25% of readings violate water quality standards
K-bottom	mg/l	4	2.01	4.16	5.04		No pertinent water quality standards
Na-bottom	mg/l	4	26.8	37.4	67.5		100% of readings violate water quality standards
Cl-bottom	mg/l	4	50.3	67.88	119		No readings violate water quality standards
SO4-bottom	mg/l	4	2.5	215.53	844	May have rotten egg odor	25% of readings violate water quality standards
As-bottom	mg/l	2	0.239	0.513	0.787	Threat to deep potable water intakes	No readings violate guidance values

Lake Perception

	UNITS	N	MIN	AVG	MAX	Scientific Classification	Regulatory Comments
WQ Assessment	1-5, 1 best	4	3	4.25	5	High Algae Levels	No pertinent water quality standards
Weed Assessment	1-5, 1 best	4	2	2.5	3	Plants Grow to Lake Surface	No pertinent water quality standards
Recreational Assessment	1-5, 1 best	4	3	4.25	5	Substantially Impaired	No pertinent water quality standards

References

Finger Lakes-Lake Ontario Watershed Protection Alliance (FLLOWPA). 2000. The State of the New York Lake Ontario Basin: A Report on Water Resources and Local Watershed Management Programs. Available at http://www.fllowpa.org/statebasin.pdf.

The Oatka Creek Watershed Committee (OCWC). 2002. The Oatka Creek Watershed State of the Basin Report. Available at http://www.oatka.org/Reports/StateofBasin.pdf.

Philips, P.J., D.A. Echardt, and L.Rosenmann. 2000. Pesticides and Their Metabolites in Three Small Public Water-Supply Reservoir Systems, Western New York, 1998-99. U.S. Geological Survey Water-Resources Investigations Report 99-4278. Available at http://ny.water.usgs.gov/pubs/wri/wri994278/WRIR99-4278.pdf.

Legend Information

General Legend Information

Surface Samples	= integrated sample collected in the first 2 meters of surface water
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 Detection limit = 0.003 mg/l; no NYS standard or guidance value
NOx	= nitrate + nitrite nitrogen, mg/l Detection limit = 0.01 mg/l; NYS WQ standard = 10 mg/l
NH4	= total ammonia, mg/l Detection limit = 0.01 mg/l; NYS WQ standard = 2 mg/l
TKN	= total Kjeldahl nitrogen (= organic nitrogen + ammonia), mg/l 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 > 30 suggests phosphorus limitation, < 10 suggests nitrogen limitation
CHLA	= chlorophyll *a*, micrograms per liter (µg/l) or parts per billion (ppb) 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 Detection limit = 10 mg/l; no NYS standard or guidance value
TCOLOR	= true (filtered or centrifuged) color, platinum color units (ptu) Detection limit = 5 ptu; no NYS standard or guidance value
TOC	= total organic carbon, mg/l Detection limit = 1 mg/l; no NYS standard or guidance value
Ca	= calcium, mg/l Detection limit = 1 mg/l; no NYS standard or guidance value
Fe	= iron, mg/l

Detection limit = 0.1 mg/l; NYS standard = 1.0 mg/l

Mn = manganese, mg/l
Detection limit = 0.01 mg/l; NYS standard = 0.3 mg/l

Mg = magnesium, mg/l
Detection limit = 2 mg/l; NYS standard = 35 mg/l

K = potassium, mg/l
Detection limit = 2 mg/l; no NYS standard or guidance value

Na = sodium, mg/l
Detection limit = 2 mg/l; NYS standard = 20 mg/l

Cl = chloride, mg/l
Detection limit = 2 mg/l; NYS standard = 250 mg/l

SO4 = sulfate, mg/l
Detection limit = 2 mg/l; NYS standard = 250 mg/l

As =arsenic, mg/l
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)
NYS standard = 4 mg/l; 5 mg/l for salmonids

pH = powers of hydrogen, standard pH units (S.U.)
Detection limit = 1 S.U.; NYS standard = 6.5 and 8.5

SpCond = specific conductance, corrected to 25ºC, micromho per centimeter (μmho/cm)
Detection limit = 1 μmho/cm; no NYS standard or guidance value

ORP = Oxygen Reduction Potential, millivolts (MV)
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

Invasive Aquatic Plant Profiles

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)

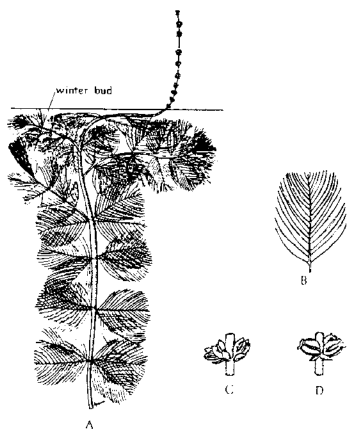
COMMENTS: *Potamogeton* is a highly variable genus within the pondweed family. Species within the genus often are characterized by two leaf types- firm floating leaves and thin emersed leaves. Many mature species have flowers borne in spikes (for wind pollination), conspicuous in early summer. Identification 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

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