LCI Lake Water Quality Summary

General Information

Lake Name: Attica Reservoir #3

Location: Town of Attica, Wyoming County, NY
Basin: Niagara River/Lake Erie Basin
Size: 70 hectares (173 acres)
Lake Origins: Earthen dam built in 1930
Tributaries: Crow Creek, Wards Brook
Watershed Area: 3.6 Square Miles
Lake Tributary to: Crow Creek
Water Quality Classification: A (best intended use: potable water supply)

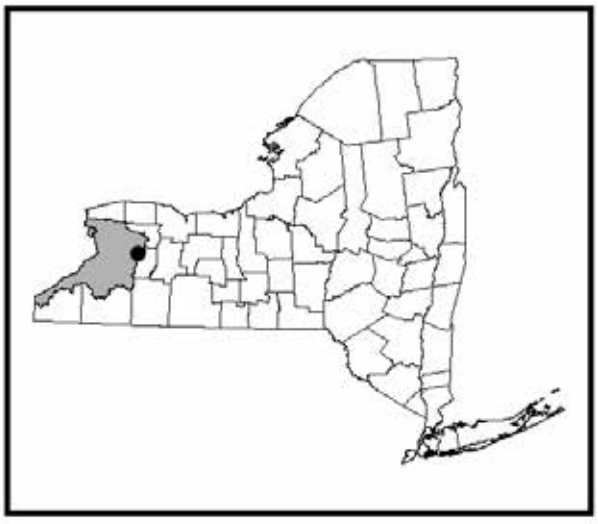
Sounding Depth: 6.5 meters (20 feet)
Sampling Coordinates: 42.78723003, -78.22965899
Sampling Access Point: Village of Attica Right of Way near dam

Monitoring Program: Lake Classification and Inventory (LCI) Survey
Sampling Date: 6/9, 7/5, 8/2, & 9/13/2011
Samplers: David Newman & Scott Kishbaugh, NYSDEC Division of Water, Albany
Bill Murray, Brian Hourigan, & Rick Rink, NYSDEC Division of Water, Buffalo

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

Attica Reservoir #3 is relatively large waterbody at the upstream end of the Village of Attica's water supply network. The outlet of the reservoir forms Crow Creek where water travels ~ 3.5 miles before entering two smaller reservoirs. The reservoir has a drainage area of ~ 3.6 square miles with two minor streams that enter the reservoir, one from the south and the other from the north east. The watershed is predominately a mix of both forested land as well as agricultural land although the near shore area of the reservoir has a treed buffer area around almost the entire shoreline with only a few small maintained grassy areas. The Village of Attica limits access to the reservoir to village and town residents who have acquired a permit from the village.

Attica Reservoir #3 was sampled monthly through the NYSDEC Division of Water's Lake Classification and Inventory (LCI) program in the summer of 2011, due to a *minor impacts* listing in the 2010 Waterbody Inventory and Priority Waterbodies List. This listing was based on elevated nutrient levels related to agricultural activity within the reservoir's watershed. The reservoir had previously been sampled by New York State DEC Division of Water in both 2001 and 2005.

Based on data from the samples collected during the summer of 2011, Attica Reservoir #3 can generally be characterized as a *eutrophic*, or highly productive. The water clarity reading (TSI = 50, typical of *mesoeutrophic* lakes) was expected given the phosphorus reading (TSI = 53, typical of *eutrophic* lakes) and the chlorophyll *a* reading (TSI = 53, typical of *eutrophic* lakes). These data indicate that baseline nutrient levels may support algal blooms in the reservoir.

The water in the reservoir was described as being "not quite crystal clear" in June and having "algal greenness" in July and August and having "high algal greenness" in September. In September high densities of algae were observed throughout the water column. Water clarity in the reservoir was over 2 meters in June and July but fell to 1.6 meters in September. The water clarity was above the state's water quality standard for safe swimming throughout the summer.

Over the course of the summer several native aquatic plant species were observed to be growing in the reservoir. In addition one invasive species, Eurasian watermilfoil was found to be occurring in the reservoir. Eurasian watermilfoil is known to grow to high densities and is able to outcompete many native aquatic plant species. The occurrence of this plant is consistent with a survey conducted by Cornell in 2001. The aquatic plants in reservoir (both native and invasive) were never described as growing at high densities at the surface and they were never listed as being a hindrance to the recreational potential of the reservoir.

Attica Reservoir #3 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 great than six meters in depth. The thermocline in the lake was in the four to five meter depth range from June to August with water temperature and dissolved oxygen levels dropping off below this depth. In September the lake was de-stratifying with water temperatures being fairly consistent between the surface and 5 meters deep. pH levels at the surface of the reservoir indicate alkaline waters. In July and August pH levels were above the state's water quality standard of 8.5. Conductivity readings indicate moderately hardwater.

Attica Reservoir #3 appears to be typical of hardwater, weakly colored, alkaline lakes. Other lakes with similar water quality characteristics often support warmwater fisheries, although

fisheries habitat cannot be fully evaluated through this monitoring program. Coldwater fisheries may be *stressed* due low dissolved oxygen levels in the bottom few meters of the reservoir.

Total phosphorus levels were above the state's guidance value throughout the summer, with a high percent of the total phosphorus being soluble (available for primary production in the form of algae). Iron and manganese levels in the bottom waters were elevated and may cause taste or odor issues with the water. Three bottom water samples were analyzed for arsenic and all came back above the laboratories detection limit, although they were well below the drinking water standard. Elevated iron, manganese and arsenic levels are typically seen in water bodies experiencing oxygen deficits in the bottom waters. All other parameters fell below the state's guidance values.

Most of the data collected in August of 2005 was in the range of values observed in 2011. This includes total phosphorus, nitrate, pH, magnesium, and sodium in both the surface and bottom waters. The 2001 data was also similar to those collected in 2005 and 2011. This indicates that there have not been any large changes to the water quality in the reservoir over the last 10 years. This coincides with an analysis of aerial photographs taken over the last 15 years that shows little change to the land cover within the reservoirs watershed.

Evaluation of Lake Condition Impacts to Lake Uses

Potable Water (Drinking Water)

Attica Reservoir #3 is classified for use as a potable water supply and it is currently used as a water supply reservoir for the Village of Attica. LCI data are not sufficient to evaluate potable water use; however the data collected indicate that iron and manganese levels in the surface water were at a level that may *threaten* the use of the reservoir as a drinking water supply. Direct hypolimnetic withdrawals from the reservoir would be *impaired* by elevated iron and manganese levels. The elevated levels of these two metals are known to cause taste and odor problems with water used for drinking.

Contact Recreation (Swimming)

Attica Reservoir #3 is classified for contact and non-contact recreation. The Village of Attica does allow village and town residence with a permit to access the reservoir for fish and boating, but village regulations prohibit swimming and wading within the reservoir. Bacteria data are needed to evaluate the safety of the reservoir for swimming—these are not collected through the LCI, the Village of Attica may collect these data on the reservoir. The data collected through the LCI indicate that phosphorus levels *threaten* the use of the reservoir for swimming.

Non-Contact Recreation (Boating and Fishing)

The Village of Attica issues permits to village and town residents for fish and boating on the reservoir. Motors both gas and electric and prohibited on the reservoir. The data collected through the LCI indicate that boating and fishing are *threatened* by the occurrence of the aquatic invasive species, Eurasian watermilfoil.

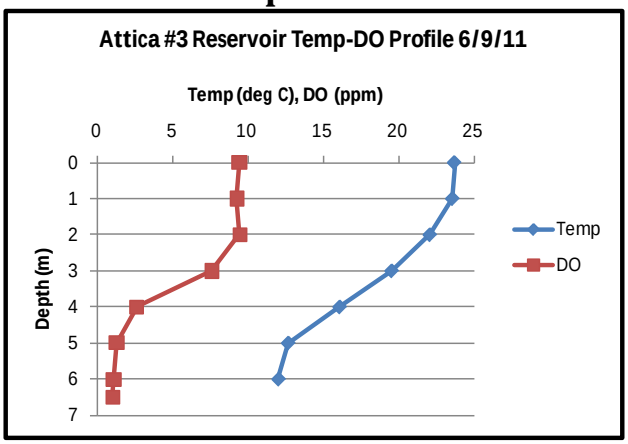
Aquatic Life
The biological community of the reservoir may be *threatened* by the occurrence of Eurasian watermilfoil. Elevated pH levels in the surface waters may also *stress* aquatic life. In addition the low dissolved oxygen levels seen in the hypolimnion during most of the summer may *stress* aquatic life susceptible of high summer water temperatures such as trout.

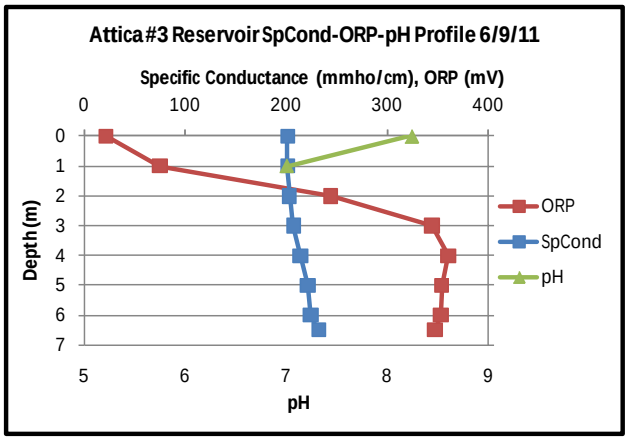
Aesthetics
Field observations did not indicate any impacts to the aesthetics of the reservoir.

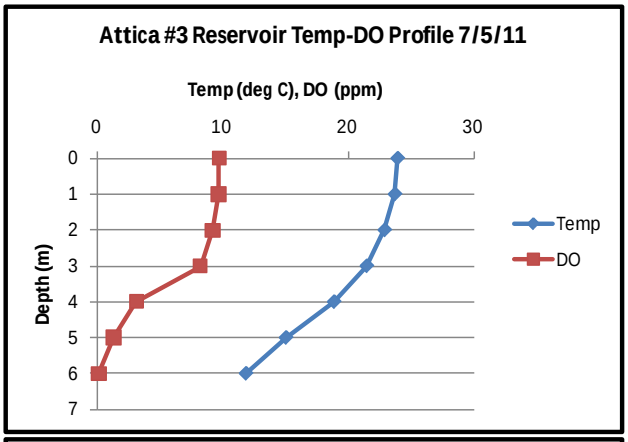
Additional Comments
- Periodic surveillance for invasive exotic plant species may help to prevent the establishment and spread of any new invaders, given the escalating problems with exotic aquatic weeds in New York State.

Aquatic Plant IDs
Exotic Plants: *Myriophyllum spicatum* (Eurasian watermilfoil)

Native Plants: *Najas flexilis* (slender naiad)
Potamogeton richardsonii (Richardson's pondweed)
Potamogeton praelongus (whitestem pondweed)
Ceratophyllum demersum (coontail)
Vallisneria americana (American eelgrass)

Time Series: Depth Profiles


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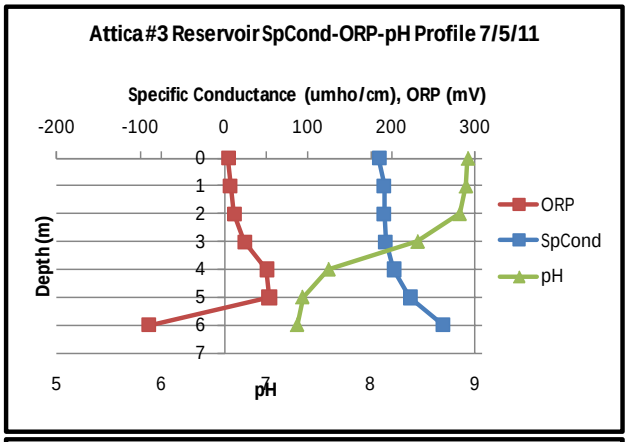
10
20
30
Depth (m)
0
1
2
3
4
5
6
7
Temp
DO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0
100
200
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Depth (m)
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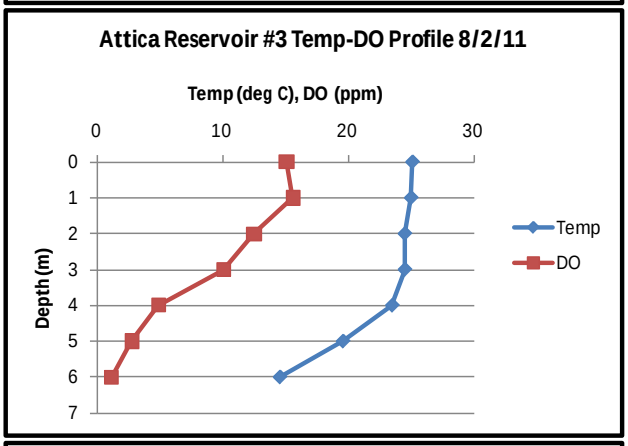
2
3
4
5
6
7
5
6
7
8
9
pH
ORP
SpCond
pH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Temp (deg C), DO (ppm)
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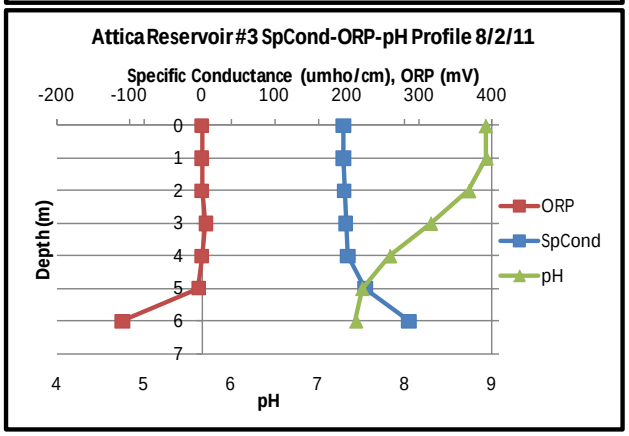
10
20
30
Depth (m)
0
1
2
3
4
5
6
7
Temp
DO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Specific Conductance (umho/cm), ORP (mV)
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0
100
200
300
400
Depth (m)
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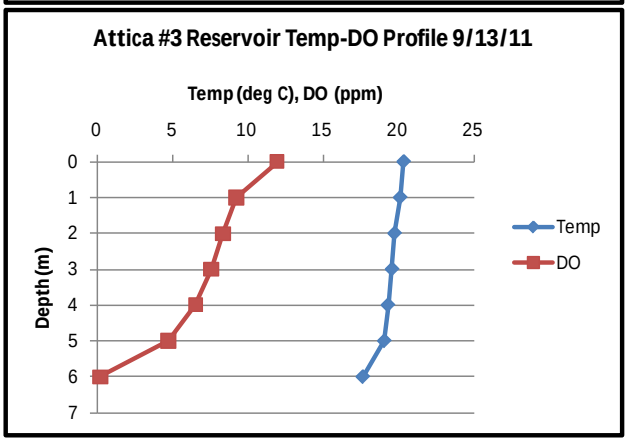
1
2
3
4
5
6
7
4
5
6
7
8
9
pH
ORP
SpCond
pH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10
15
20
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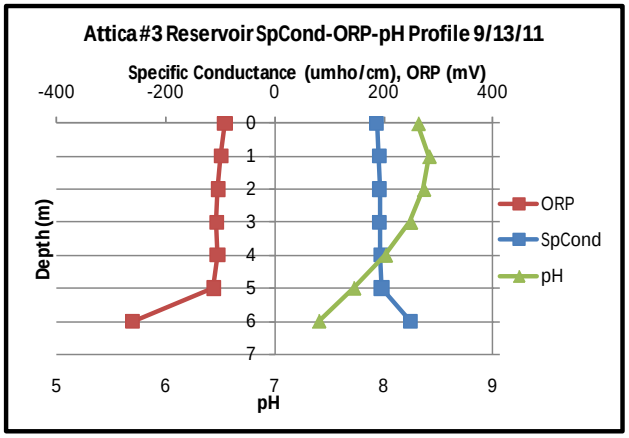
2
3
4
5
6
7
Temp
DO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0
200
400
Depth (m)
0
1
2
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6
7
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6
7
8
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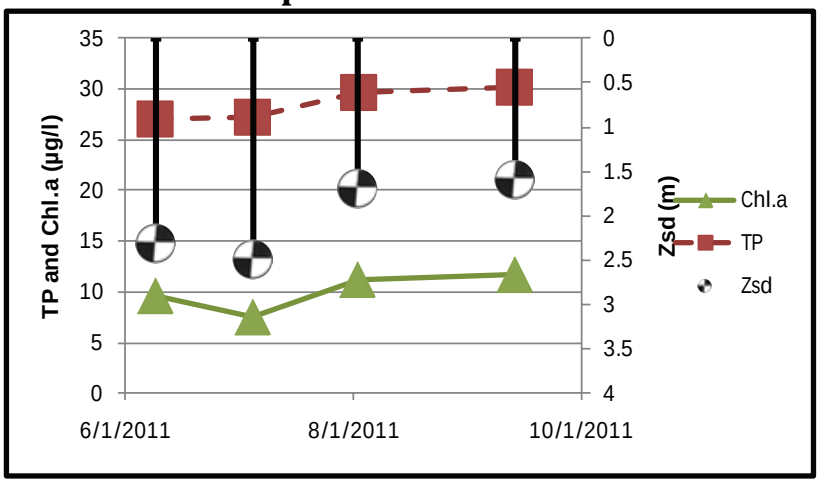
pH
ORP
SpCond
pH

Time Series: Trophic Indicators



WQ Sampling Results

Surface Samples

	UNITS	N	MIN	AVG	MAX	Scientific Classification	Regulatory Comments
SECCHI	meters	4	1.6	2.03	2.5	Mesotrophic	No readings violate DOH guidance value
TSI-Secchi			53.2	49.8	46.8	Mesotrophic	No pertinent water quality standards
TP	mg/l	4	0.027	0.03	0.0302	Eutrophic	100% of readings violate water quality standards
TSI-TP			51.6	53.2	53.3	Eutrophic	No pertinent water quality standards
TSP	mg/l	4	0.0051	0.0081	0.0125	High % soluble Phosphorus	No pertinent water quality standards
NOx	mg/l	4	0.0038	0.02985	0.0656	Low nitrate	No readings violate water quality standards
NH4	mg/l	4	ND	0.017*	0.027	Low ammonia	No readings violate water quality standards
TKN	mg/l	4	0.37	0.54	0.71	Intermediate organic nitrogen	No pertinent water quality standards
TN/TP	mg/l	4	32.98	43.56	52.87	Phosphorus Limited	No pertinent water quality standards
CHLA	ug/l	4	7.5	10	11.7	Eutrophic	No pertinent water quality standards
TSI-CHLA			50.4	53.1	54.7	Eutrophic	No pertinent water quality standards
Alkalinity	mg/l	4	60.3	61.9	65.7	Moderately Buffered	No pertinent water quality standards
TCOLOR	ptu	4	13	18.3	26	Weakly Colored	No pertinent water quality standards
TOC	mg/l	4	5.3	5.5	5.7		No pertinent water quality standards
Ca	mg/l	4	18.9	20	20.6	Minimally Supports Zebra Mussels	No pertinent water quality standards
Fe	mg/l	4	0.105	0.157	0.189		No readings violate water quality standards
Mn	mg/l	4	0.0421	0.0673	0.0772		No readings violate water quality standards
Mg	mg/l	4	4.95	5.29	5.45		No readings violate water quality standards
K	mg/l	4	0.73	0.89	1.13		No pertinent water quality standards
Na	mg/l	4	10.5	11.1	11.6		No readings violate water quality standards
Cl	mg/l	4	16.5	17	17.7	Moderate road salt runoff	No readings violate water quality standards
SO4	mg/l	4	7.6	8.25	9.2		No readings violate water quality standards

* Non-detect (ND) values were set to half the detection limit for calculating the average

Bottom Samples

	UNITS	N	MIN	AVG	MAX	Scientific Classification	Regulatory Comments
TP-bottom	mg/l	4	0.0264	0.0417	0.074		No pertinent water quality standards
TSP-bottom	mg/l	4	0.0084	0.0112	0.0151	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	4	ND	0.0094	0.0203	No evidence of DO depletion	No readings violate water quality standards
NH4-bottom	mg/l	4	ND	0.18575	0.323	Evidence of DO depletion	No readings violate water quality standards
TKN-bottom	mg/l	4	0.56	0.68	0.96		No pertinent water quality standards
Alk-bottom	mg/l	4	63	74.4	95.6	Moderately Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	4	16	26.8	37	Weakly Colored	No pertinent water quality standards
TOC-bottom	mg/l	4	4.7	5.2	5.7		No pertinent water quality standards
Ca-bottom	mg/l	4	19.3	23.5	29.6	Minimally Supports Zebra Mussels	No pertinent water quality standards
Fe-bottom	mg/l	4	0.235	0.5755	1.45	Taste or odor likely	50% of readings violate water quality standards
Mn-bottom	mg/l	4	0.151	1.2363	3.01	Taste or odor likely	75% of readings violate class 'A' water quality standards
Mg-bottom	mg/l	4	5.18	5.6	6.17		No readings violate water quality standards
K-bottom	mg/l	4	ND	0.9395	1.31		No pertinent water quality standards
Na-bottom	mg/l	4	10.4	11.7	12.9		No readings violate water quality standards
Cl-bottom	mg/l	4	16.9	17.63	18.1		No readings violate water quality standards
SO4-bottom	mg/l	4	7.2	7.8	8.9		No readings violate water quality standards
As-bottom	mg/l	3	0.244	0.828	1.3		No readings violate guidance values

Lake Perception

	UNITS	N	MIN	AVG	MAX	Scientific Classification
WQ Assessment	1-5, 1 best	4	2	3	4	Definite Algal Greenness
Weed Assessment	1-5, 1 best	4	2	2.75	3	Plants Grow to Lake Surface
Recreational Assessment	1-5, 1 best	4	2	2.75	3	Slightly Impaired

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 = 0.3 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

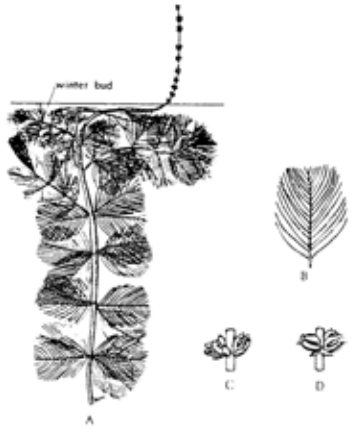
Lake Assessment

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

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