LCI Lake Water Quality Summary

General Information

Lake Name: Cliff Lake

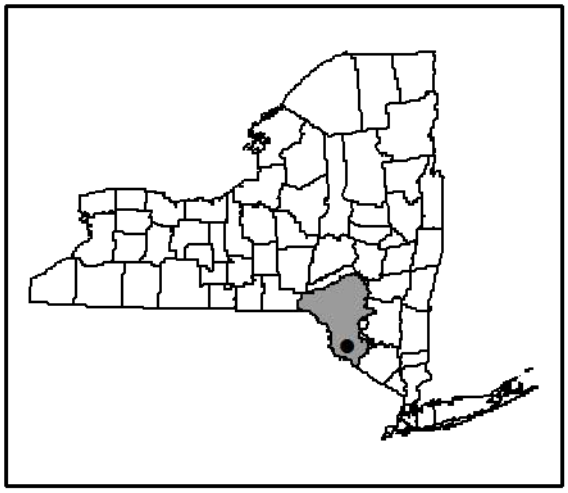
Location: Towns Bethel, Highland and Lumberland, Sullivan County, NY
Basin: Delaware River Basin
Size: 67.4 hectares (166.5 acres)
Lake Origins: man-made/ concrete dam
Major Tributaries: Toronto Reservoir via Black Lake Creek
Lake Tributary to?: Black Lake Creek
Water Quality Classification: B (best intended use: primary contact recreation)

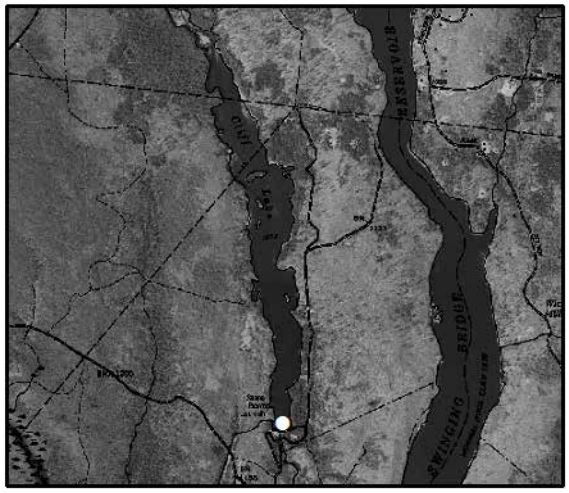
Sounding Depth: 6.0 meters (19.5 feet)
Sampling Coordinates: Latitude: 41.58422, Longitude: -74.79396
Sampling Access Point: private land (Gibson McKean)

Monitoring Program: Lake Classification and Inventory (LCI) Survey
Sampling Date: July 29, 2009
Samplers: David Newman, NYSDEC Division of Water, Albany
Steven Finnemore, NYSDEC Division of Water, Albany

Contact Information: David Newman, NYSDEC Division of Water
djnewman@gw.dec.state.ny.us; 518-402-8201

Lake Map
(sampling location marked with a circle)





Background and Lake Assessment

Cliff Lake is a man made impoundment on Black Lake Creek. The watershed for Cliff Lake is the highly ponded area around Bethel, NY. The Toronto Reservoir is approximately three river-miles upstream on Black Lake Creek. The land around the lake is owned by a single land owner (Gibson McKean). There is a DEC public fishing access point, however it requires a mile walk from the parking area, pretty much precluding public boat access. The dam on the reservoir is owned by a hydro power company who controls the water level on the lake for generation of hydro power on downstream reservoirs. The land around the lake is completely forested with a private dirt road providing access to the dam.

Cliff Lake was screened (single sample) through the NYSDEC Division of Water's Lake Classification and Inventory (LCI) program in the summer of 2009, due to a lack of water quality data in the Division of Water's database. Due to slightly elevated phosphorus and chlorophyll *a* found during the late July sampling, Cliff Lake may be a candidate for more intensive sampling (monthly) during the summer of 2010. This monitoring is contingent upon the availability of state funds to support this monitoring.

Cliff Lake can be characterized as *mesoeutrophic*, or a moderately to highly productive lake. Water clarity readings (TSI = 47, typical of *mesoeutrophic* lakes) were in the expected range given the phosphorus reading (TSI = 47, typical of *mesoeutrophic* lakes) and the chlorophyll *a* reading (TSI = 50, typical of *mesoeutrophic* lakes). These data indicate that an algal bloom was not occurring at the time of the sample, however baseline nutrient levels may support occasional algal blooms. Phosphorus is likely the limiting nutrient, meaning inputs of phosphorus to the lake will fuel primary production in the form of algae.

The lake appeared to be tea colored with a slight yellow/green tint. The yellow/green is due to slightly elevated chlorophyll *a* (algae), while the tea color is due to weak organic acids (tannic acids) from the watershed. This tea or tannic color to the lake is common among the lakes sampled in the region. *Elatine sp.* (waterwort) was the only aquatic plant found in the area near the dam. Reservoirs tend not to support large numbers of aquatic plants due to frequent changes in water level. Waterwort is a native plant species found in other area lakes. No exotic plants species were seen; however, a more extensive search of the lake would need to be done to completely rule out the presence of exotic plants.

Cliff Lake 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 in depth. The thermocline was at about three meters in late July. Dissolved oxygen levels were above the state standard to protect spawning of coldwater fish at three and four meters but dropped below this standard at 5 meters. This finding, coupled with elevated levels of nitrate, iron, and manganese in hypolimnion (bottom waters), may indicate that when summer temperature and nutrient conditions support higher algal production, hypoxic (poorly oxygenated) waters in the hypolimnion may occur. pH readings indicate slightly acidic waters that decrease with depth. Conductivity readings indicate soft water (low ionic strength). Both the pH and conductivity readings were similar to the majority of the lakes sampled in the region, with most lakes having neutral to slightly acid pH readings and soft water.

Cliff Lake appears to be a typical of soft water, weakly colored, slightly acidic lakes. Other lakes with similar water quality characteristics often support warmwater fisheries, although fisheries habitat cannot be fully evaluated through this monitoring program. It is possible that coldwater fisheries may be supported given the oxygen rich cold waters found in the hypolimnion; however, other factors may preclude the reproduction and survival of cold water fish.

Chloride levels are in the moderate range, which is consistent with the levels that were seen in an upstream impoundment. This may indicate that portions of the watershed may run through more urbanized areas that receive moderate road salting in the winters. The levels of other ions were found to be low, which was also consistent with an upstream impoundment.

Evaluation of Lake Condition Impacts to Lake Uses

Potable Water (Drinking Water)

Cliff Lake is not classified for use as a potable water supply. Although the LCI data are not sufficient o evaluate potable water use, these data suggest deep water intakes would require substantial treatment to serve as a potable water supply, due to elevated iron and manganese levels.

Contact Recreation (Swimming)

Cliff Lake is classified for contact recreation- swimming and bathing, but it is not known if people currently swim in the lake. Bacteria data are needed to evaluate the safety of Cliff Lake for swimming- these are not collected through the LCI. The data collected through the LCI do not indicate any stressors to this use. The water clarity reading was well above the minimum DOH guidance value of 1.2 meters to protect the safety of swimmers.

Non-Contact Recreation (Boating and Fishing)

The data collected through the LCI do not indicate any stressors to boating or fishing on the lake. Limited access to the lake limits both of these uses to the general public.

Aquatic Life

The only stressors to aquatic life are reduced pH and dissolved oxygen in the bottom two meters of the lake. Additional biological studies would need to be conducted to evaluate aquatic life impacts from these low levels.

Aesthetics

These data suggest that there are no impacts to the aesthetics of the lake.

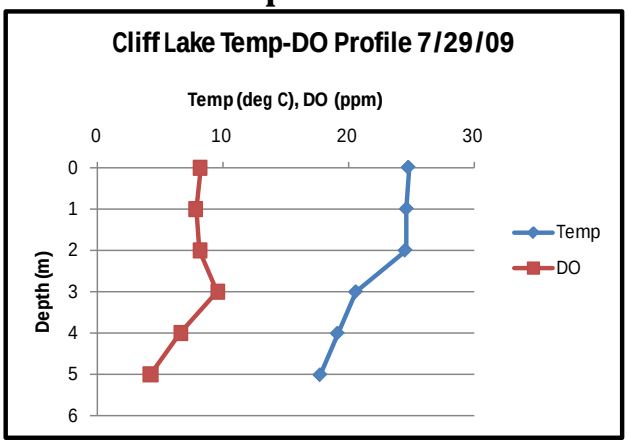
Additional Comments

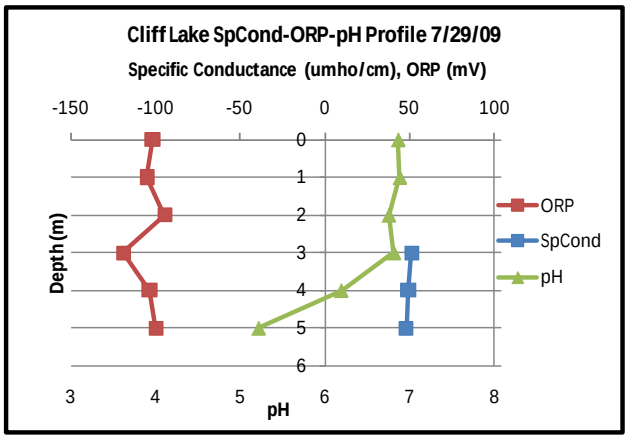
- Periodic surveillance for invasive exotic plant species may help to prevent the establishment and spread of any new invaders, given the escalating problems with exotic aquatic weeds. A single plant of the exotic invasive species water chestnut was found in an upstream impoundment, spread of this species downstream is possible.

Aquatic Plant IDs

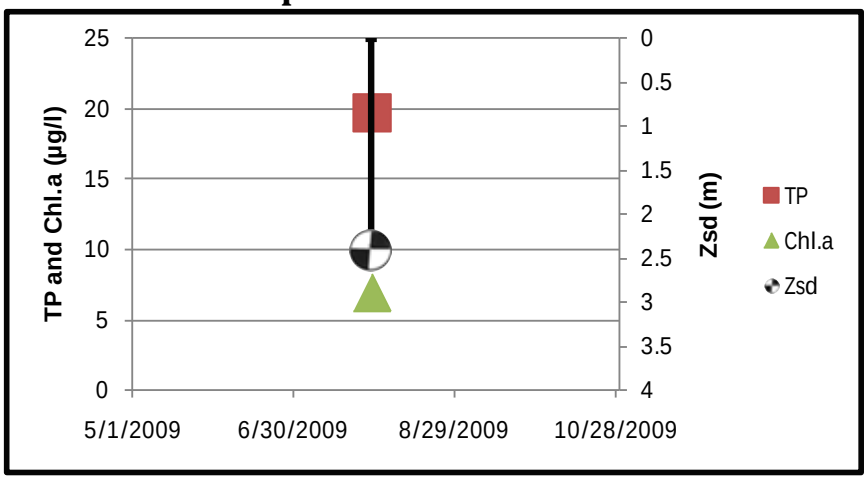
Exotic Plants: None
Native Plants: *Elatine sp.* (waterwort)

Time Series: Depth Profiles





Time Series: Trophic Indicators



WQ Sampling Results

Surface Samples

	UNITS	Reading	Scientific Classification	Regulatory Comments
SECCHI	meters	2.4	Mesotrophic	Readings does not violate DOH guidance value
TSI-Secchi		47.4	Mesotrophic	No pertinent water quality standards
TP	mg/l	0.0197	Mesotrophic	Readings does not violate DEC guidance values
TSI-TP		47.1	Mesotrophic	No pertinent water quality standards
TSP	mg/l	0.0042	Little available phosphorus	No pertinent water quality standards
NOx	mg/l	0.0032	Low nitrate	Reading does not violate guidance
NH4	mg/l	ND	Low ammonia	Reading does not violate guidance
TKN	mg/l	0.24	Low organic nitrogen	No pertinent water quality standards
TN/TP	mg/l	27.16	Nutrient Limitation Unclear	No pertinent water quality standards
CHLA	ug/l	6.9	Mesotrophic	No pertinent water quality standards
TSI-CHLA		49.5	Mesotrophic	No pertinent water quality standards
Alkalinity	mg/l	5.1	Poorly Buffered	No pertinent water quality standards
TCOLOR	ptu	15	Weakly Colored	No pertinent water quality standards
TOC	mg/l	4.3		No pertinent water quality standards
Ca	mg/l	3.79	Does Not Support Zebra Mussels	No pertinent water quality standards
Fe	mg/l	0.104		Reading does not violate water quality standards
Mn	mg/l	0.0329		Reading does not violate water quality standards
Mg	mg/l	0.962		Reading does not violate water quality standards
K	mg/l	0.595		No pertinent water quality standards
Na	mg/l	7.06		Reading does not violate water quality standards
Cl	mg/l	13.5	Moderate road salt runoff	Readings does not violate water quality standards
SO4	mg/l	5.1		Readings does not violate water quality standards

Bottom Samples

	UNITS	Reading	Scientific Classification	Regulatory Comments
TP-bottom	mg/l	0.0331		No pertinent water quality standards
TSP-bottom	mg/l	0.0095	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	0.0235	Evidence of DO depletion	Readings does not violate water quality standards
NH4-bottom	mg/l	0.032		Readings does not violate water quality standards
TKN-bottom	mg/l	0.33		No pertinent water quality standards
Alk-bottom	mg/l	7	Poorly Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	40	Highly Colored	No pertinent water quality standards
TOC-bottom	mg/l	4.9		No pertinent water quality standards
Ca-bottom	mg/l	4.02	Does Not Support Zebra Mussels	No pertinent water quality standards
Fe-bottom	mg/l	0.916	Taste or odor likely	Reading violates water quality standards

Bottom Samples (continued)

	UNITS	Reading	Scientific Classification	Regulatory Comments
Mn-bottom	mg/l	1.05	Taste or odor likely	Reading violates water quality standards
Mg-bottom	mg/l	1.06		Reading does not violate water quality standards
K-bottom	mg/l	0.672		No pertinent water quality standards
Na-bottom	mg/l	6.68		Reading does not violate water quality standards
Cl-bottom	mg/l	10.1		Reading does not violate water quality standards
SO4-bottom	mg/l	4.8		Reading does not violate water quality standards
As-bottom	mg/l	ND	No evidence of potable water threats	Reading does not violate guidance value

Lake Perception

	UNITS	Reading	Scientific Classification	Regulatory Comments
WQ Assessment	1-5, 1 best	1	Crystal Clear	No pertinent water quality standards
Weed Assessment	1-5, 1 best	2	Plants Visible Below Surface	No pertinent water quality standards
Recreational Assessment	1-5, 1 best	2	Excellent for Most Uses	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
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