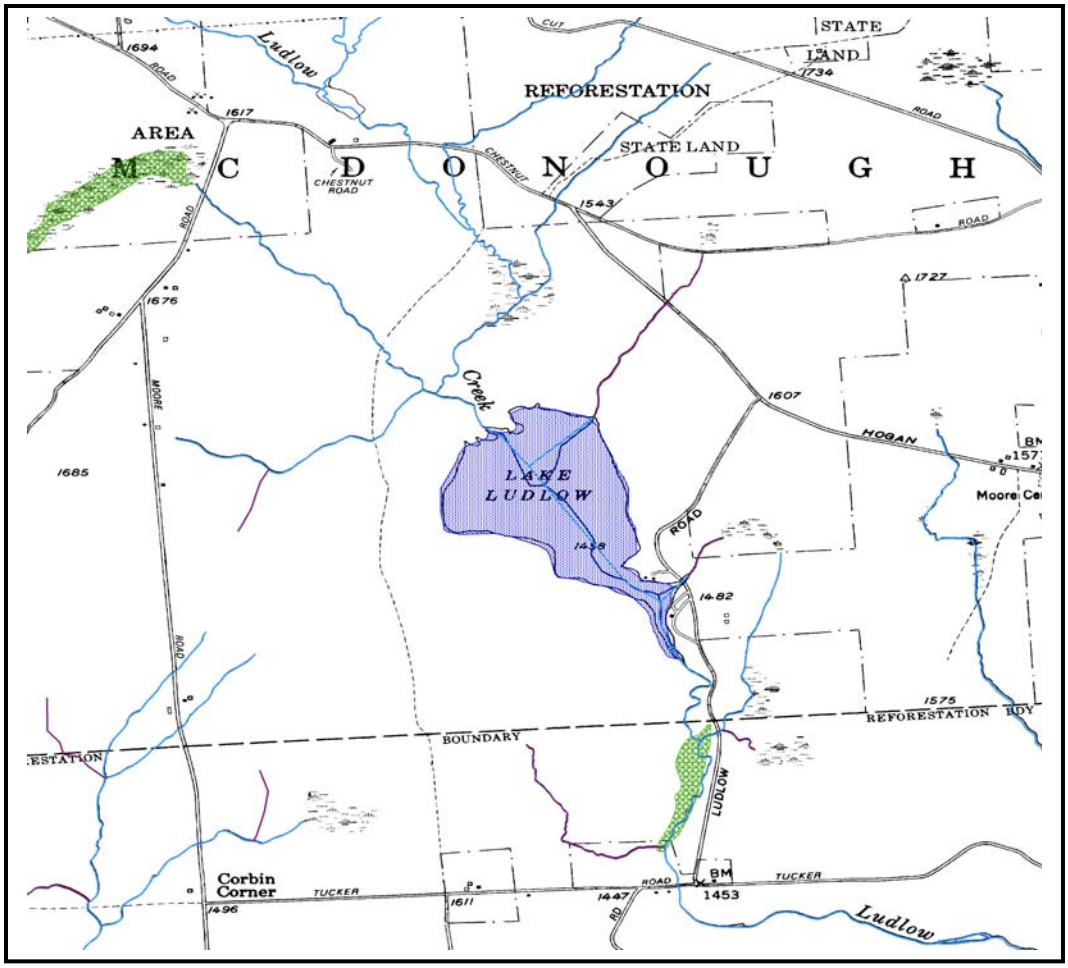
Lake Classification and Inventory (LCI) Program



Evaluation of Lake Ludlow

town of McDonough, Chenango County

NYSDEC Division of Water

March, 2009

Lake Name: Lake Ludlow

Location: town of McDonough, Chenango County
Basin: Susquehanna River basin
Size: 46.6 hectares (= 115 acres)
Water Quality Classification: C (best intended use: non-contact recreation)

Evaluation Criteria Checklist:

1. Regulatory: ***Lake Uses, Water Quality Standards***

Category	Evaluated?	Type of Data
Human Health: Potable Water	Not applicable	Ammonia
Human Health: Fish Consumption	No	
Human Health: Bathing/Contact	No	
Recreation: Swimming	Yes	Trophic data, perception data (professional)
Recreation: Boating/Non-Contact	Yes	Perception data (professional), qualitative plant survey
Recreation: Fishing	No	
Recreation: Aesthetics	Yes	Perception data (professional), qualitative plant survey
Aquatic Life: Fish Habitat	Yes	Depth profiles, trophic data
Aquatic Life: Ecological Health	Yes	Metals, anions, metals, depth profiles

2. Scientific: ***Lake Classification, Ecological Integrity***

Category	Evaluated?	Type of Data
Lake Classification: Trophic status	Yes	Nutrients, water clarity, chlorophyll *a*, color, DO
Lake Classification: Acidity status	Yes	pH, conductivity, alkalinity
Lake Classification: General characterization	Yes	Metals, anions, DOC, ORP
Ecological Integrity: Invasive species	Yes	Aquatic plant ID
Ecological Integrity: Human use stressors	No	
Ecological Integrity: Biological assemblages	No	

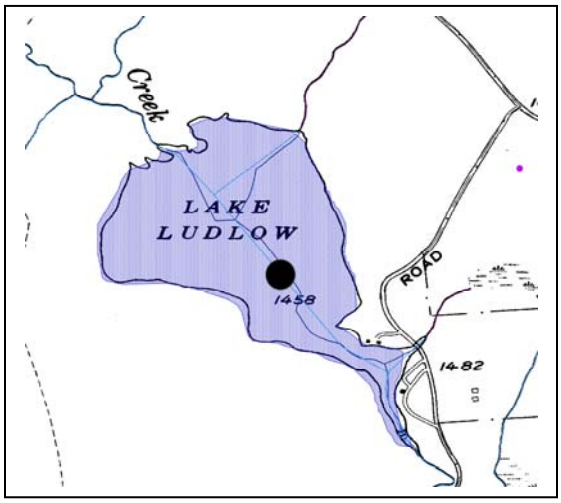
Lake Name: Lake Ludlow

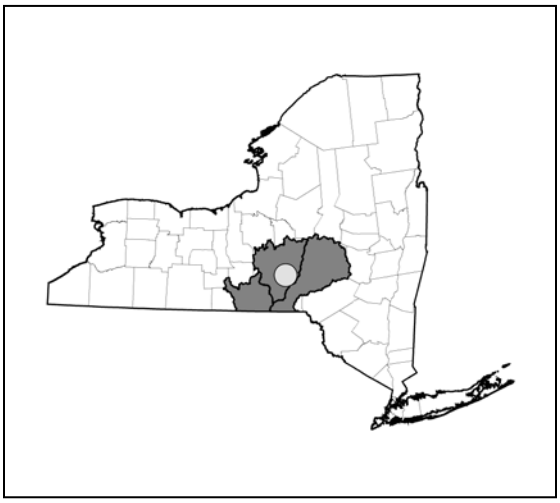
Location: town of McDonough, Chenango County
Basin: Susquehanna River basin
Size: 46.6 hectares (= 115 acres)
Lake Origins: not reported
Major Tributaries: Ludlow Creek
Lake Tributary to?: Bowman Creek via Ludlow Creek
Water Quality Classification: C (best intended use: non-contact recreation)

Sounding Depth: 8.2 meters (= 27 feet)
Sampling Coordinates: Latitude: 42.4646, Longitude: -75.7085
Sampling Access Point: Boat club docks

Monitoring Program: Lake Classification and Inventory (LCI) Survey
Sampling Dates: 8/11/2008
Samplers: Scott Kishbaugh, NYSDEC Division of Water, Albany
Jim Finch, Lake Ludlow
John Carpenter, Lake Ludlow

Lake Map:
(sampling location marked with circle)





Lake Assessment:

Lake Ludlow is a recreational lake used by the patrons of the Lake Ludlow Club Incorporated. It can generally be characterized as a *mesoeutrophic*, or moderately to highly productive lake. Water clarity readings (TSI = 46, typical of *mesotrophic* lakes) are higher than expected given the phosphorus (TSI = 53, typical of *eutrophic* lakes) and chlorophyll *a* (TSI = 55, typical of *eutrophic* lakes) readings in the lake. Algal greenness was visible to the casual observer. Rooted aquatic plants grew to the lake surface throughout the shallow outlet (near the docks) and along the northern shore, although the entire perimetry of the lake was not surveyed to evaluate lakewide rooted plant populations. Aquatic plant populations were evaluated at the request of the Lake Ludlow Club; an assessment of plant communities was previously provided to the Lake Ludlow Club and is attached.

The lake exhibited thermal stratification below a depth of about 5 meters, below which dissolved oxygen deficits occur. Dissolved oxygen readings are below 1 ppm in the bottom 4 meters of the lake, likely indicating anoxic conditions. This triggers elevated bottom phosphorus, nitrate and iron readings, but this does not appear to result in elevated deepwater ammonia readings. Each of the pH readings are near the state water quality standard (= 6.5), although there is no evidence that this has resulted in any ecological impacts. The data from other nearby lakes and the soft water suggest that slightly depressed pH may be a "natural" phenomenon in the region. However, the alkalinity readings indicate that the lake has sufficient buffering capacity to neutralize acidic inputs (via acid rain) to the lake.

Otherwise Lake Ludlow appears to be typical of softwater, slightly colored, slightly acidic lakes. Calcium levels are high enough to support zebra mussels, although these have not been found in the lake. Other lakes with similar water quality characteristics often support warmwater fisheries, although swimming and contact recreation in these lakes can be impacted by excessive algae.

Proposed Assessment and Management Considerations:

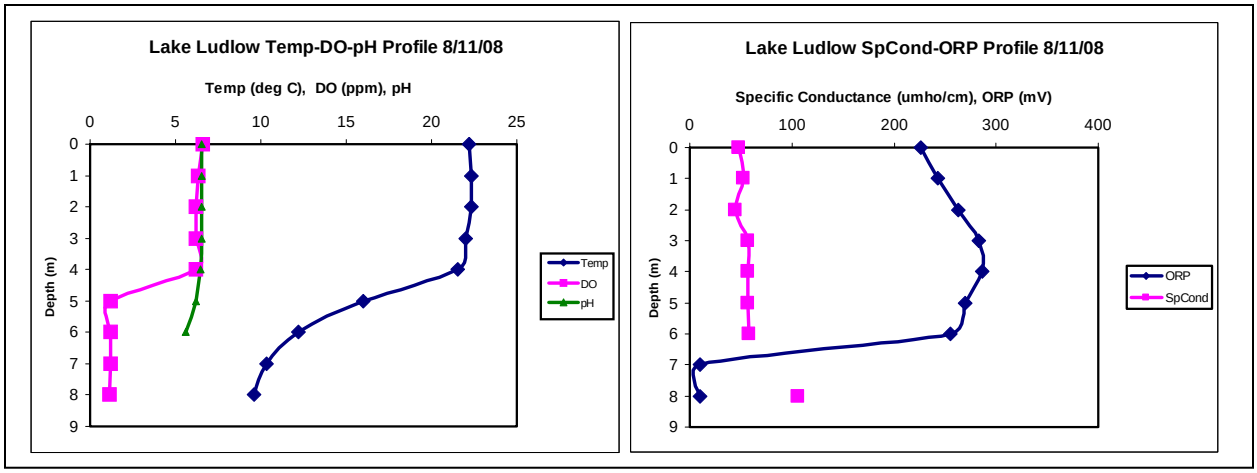
Lake Ludlow is not classified for potable water or contact recreation, and it is not known if the lake is used for either purpose. These data indicate that *recreation* may be *stressed* by excessive algae, and *aquatic life* may be *threatened* by depressed pH and depressed deepwater oxygen. Although exotic macrophytes have been identified in the lake, these plants make up only a small portion of the aquatic plant community and do not appear to affect recreational uses of the lake. Additional (monthly) sampling has been proposed for 2009; this updated information will be used to identify the most appropriate assessment for the lake for the 2010 update to the state Priority Waterbody List/Waterbody Inventory for the Susquehanna River basin.

Elevated surface and deepwater phosphorus readings contribute to the excessive growth of algae, which in turn may contribute to the depressed deepwater oxygen levels in the lake. 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. The lake club is also advised to minimize introductions of exotic plants and animals through the common launch.

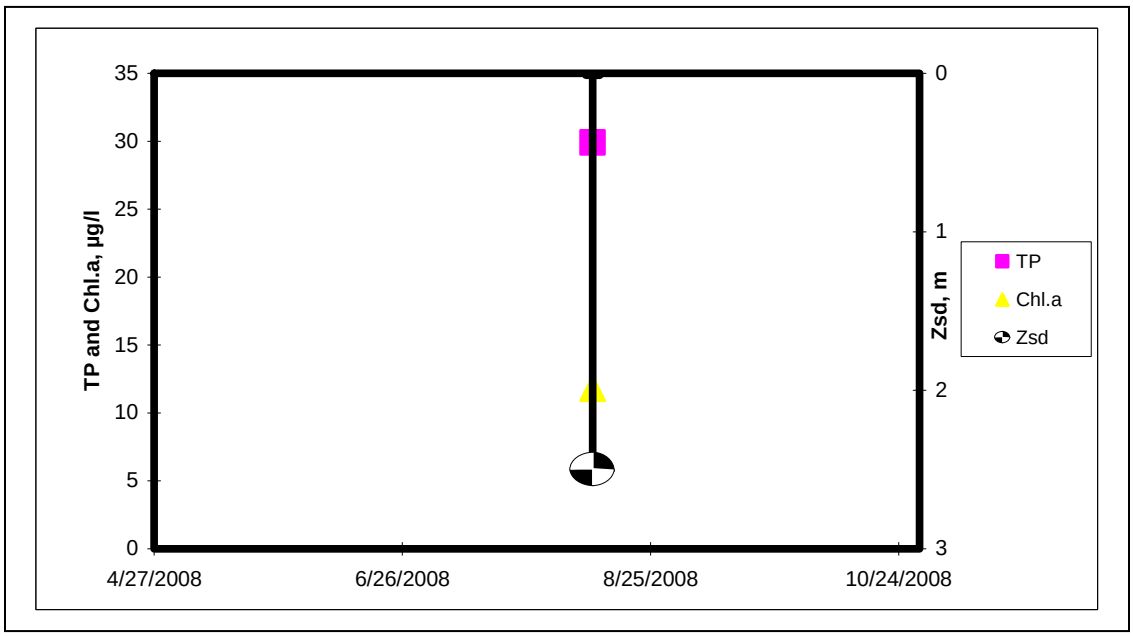
Aquatic Plant IDs:

Exotic Plants:	*Myriophyllum spicatum* (Eurasian watermilfoil)
Native Plants:	*Brasenia schreberi* (watershield)
	Najas sp. (unID naiad)
	Potamogeton amplifolius (large-leaf pondweed)
	Utricularia sp. (bladderwort)

Time Series: Depth Profiles



Time Series: Trophic Indicators



WQ Sampling Results:

Surface Samples:

	UNITS	N	MIN	AVG	MAX	SCIENTIFIC CLASSIFICATION	REGULATORY COMMENTS
SECCHI	meters	1	2.5	2.5	2.5	Mesotrophic	No readings violate guidance value
TSI-Secchi			46	46	46	Mesotrophic	No pertinent water quality standards
TP	mg/l	1	0.030	0.030	0.030	Eutrophic	100% Samples Exceed Guidance Value
TSI-TP			53	53	53	Eutrophic	
TSP	mg/l	1	0.004	0.004	0.004	Little available phosphorus	No pertinent water quality standards
NOx	mg/l	1	0.01	0.01	0.01	Low nitrate	No readings violate guidance
NH4	mg/l	1	0.02	0.02	0.02	Low ammonia	No readings violate guidance
TKN	mg/l	1	0.52	0.52	0.52		No pertinent water quality standards
TN/TP	mg/l	1	38.3	38.3	38.3	Phosphorus Limited	No pertinent water quality standards
CHLA	ug/l	1	11.8	11.8	11.8	Eutrophic	No pertinent water quality standards
TSI-CHLA			55	55	55	Eutrophic	
Alkalinity	mg/l	1	146.0	146.0	146.0	Moderately Buffered	No pertinent water quality standards
TCOLOR	ptu	1	15	15	15	Weakly Colored	No pertinent water quality standards
TOC	mg/l	1	4.2	4.2	4.2		No pertinent water quality standards
Ca	mg/l	1	52	52	52	Strongly Supports Zebra Mussels	No pertinent water quality standards
Fe	mg/l	1	-0.10	-0.10	-0.10		No readings violate water quality standards
Mn	mg/l	1	0.01	0.01	0.01		No readings violate water quality standards
Mg	mg/l	1	9.44	9.44	9.44		No readings violate water quality standards
K	mg/l	1	25.50	25.50	25.50		No pertinent water quality standards
Na	mg/l	1	-2.00	-2.00	-2.00		No readings violate water quality standards
Cl	mg/l	1	67.90	67.90	67.90	Significant road salt runoff	No readings violate water quality standards
SO4	mg/l	1	15.40	15.40	15.40		No readings violate water quality standards

Bottom Samples:

	UNITS	N	MIN	AVG	MAX	SCIENTIFIC CLASSIFICATION	REGULATORY COMMENTS
TP-bottom	mg/l	1	0.155	0.155	0.155	Elevated deepwater phosphorus	No pertinent water quality standards
TSP-bottom	mg/l	1	0.142	0.142	0.142	High % soluble phosphorus	No pertinent water quality standards
NOx-bottom	mg/l	1	0.24	0.24	0.24	Evidence of DO depletion	No readings violate guidance
NH4-bottom	mg/l	1	-0.01	-0.01	-0.01		No readings violate guidance
TKN-bottom	mg/l	1	-0.10	-0.10	-0.10		No pertinent water quality standards
Alk-bottom	mg/l	1	139.0	139.0	139.0	Moderately Buffered	No pertinent water quality standards
TCOLOR-bottom	ptu	1	5	5	5	Uncolored	No pertinent water quality standards
TOC-bottom	mg/l	1	2.2	2.2	2.2		No pertinent water quality standards
Ca-bottom	mg/l	1	46	46	46		Strongly Supports Zebra Mussels
Fe-bottom	mg/l	1	0.41	0.41	0.41	Taste or odor likely	100% readings violate water quality standards
Mn-bottom	mg/l	1	0.12	0.12	0.12		No readings violate water quality standards
Mg-bottom	mg/l	1	12.50	12.50	12.50		No readings violate water quality standards
K-bottom	mg/l	1	35.90	35.90	35.90		
Na-bottom	mg/l	1	2.54	2.54	2.54		No readings violate water quality standards
Cl-bottom	mg/l	1	46.10	46.10	46.10		No readings violate water quality standards
SO4-bottom	mg/l	1	22.30	22.30	22.30	May have rotten egg odor	No readings violate water quality standards

The legend for each of the individual lake summaries is as follows:

Surface Samples = integrated sample collected in the first 2 meters of surface water
Bottom Samples = grab sample collected from a depth of appx 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:

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

Field Parameters:

pH = powers of hydrogen, standard pH units (S.U.)
Detection limit = 1 S.U.; NYS standard = 6.5 and 8.5
COND25 = 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 Perception:

	UNITS	N	MIN	AVG	MAX	MOST TYPICAL ASSESSMENT	REGULATORY COMMENTS
WQ Assessment	1-5, 1 best	1	3	3	3	Definite Algal Greenness	No pertinent water quality standards
Weed Assessment	1-5, 1 best	1	3	3	3	Plants Grow to Lake Surface	No pertinent water quality standards
Recreational Assessment	1-5, 1 best	1	3	3	3	Slightly Impaired	No pertinent water quality standards

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

Recommendations for Future Monitoring (listed in order of importance)

1. Additional water quality data collection will help to determine if conditions measured in the single mid August 2008 represent normal conditions for the lake. Lake Ludlow has been identified as a candidate for intensive sampling through the NYSDEC Lake Classification and Inventory (LCI) survey in 2009.
2. Bacteria monitoring would determine the relative safety of the lake for swimming or other contact recreation. For logistic reasons, this sampling will probably not be conducted through the 2009 LCI, but regular bacteria monitoring could be conducted by the local community at a local certified laboratory.
3. Algae identification would determine if the lake may suffer from HABs (harmful algal blooms) and/or the production of algal toxins. This may be conducted through the LCI in 2009.
4. Deepwater arsenic sampling and continued deepwater ammonia monitoring would identify any significant health impacts associated with any future use of the lake as a potable water supply. This will likely be conducted through the LCI in 2009.
5. Sediment coring may help to determine if the high algal productivity and low dissolved oxygen levels in the lake are contemporary phenomena or have occurred persistently since the creation of the lake. This may be conducted through the LCI in 2009.
6. 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 many nearby lakes