

# Limnological investigations of Kayuta Lake, Oneida County, NY

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## INTRODUCTION

Kayuta Lake (N43°24', W75°11') is an impoundment of the Black River in Oneida County, NY (Figure 1). It is fairly shallow, with the maximum depths encountered being 4.9 meters (16.1 ft.) near the dam and at the site routinely sampled for CSLAP monitoring (Kishbaugh and Hohenstein, 2000). The lake a surface area of 192 ha (474 ac) and has a 37,300 ha (92,131 ac) watershed (Kishbaugh and Hohenstein, 2000).

At the request of the Kayuta Lake Association, a team from the Biological Field Station (BFS) visited the lake to collect baseline data on its chemistry and biology to characterize the waterbody as related to management concerns. The primary concern of the Association relates to high sedimentation rates and excessive rooted plant growth. The following were done on-site:

- 1) Temperature, dissolved oxygen, pH, conductivity, total phosphorus, nitrate nitrogen, alkalinity and calcium were profiled at the deepest point of the lake.
- 2) Zooplankton samples were collected for the evaluation of that community, including checks for exotic introduced species (such as zebra mussel larva).
- 3) Qualitative observations of the rooted plant communities were made, noting the presence and dominance by non-native species.

## METHODS

Kayuta Lake was visited on 6 August 01. At the deepest sites encountered, near the dam and at the CSLAP monitoring site (4.9 m; 16.1 ft.), temperature, dissolved oxygen, pH and conductivity were measured at 0.5 m intervals using a Hydrolab Scout 2™ multiprobe digital microprocessor which had been calibrated according to manufacturer's instruction (Hydrolab Corp., 1994) immediately prior to use. Water samples were retrieved from mid depth near the dam and at the mouths of Baker's Brook and Pine Creek for the analyses of total phosphorus, nitrate nitrogen, alkalinity and calcium. A summary of methodologies for chemical analyses employed is given in Table 1.

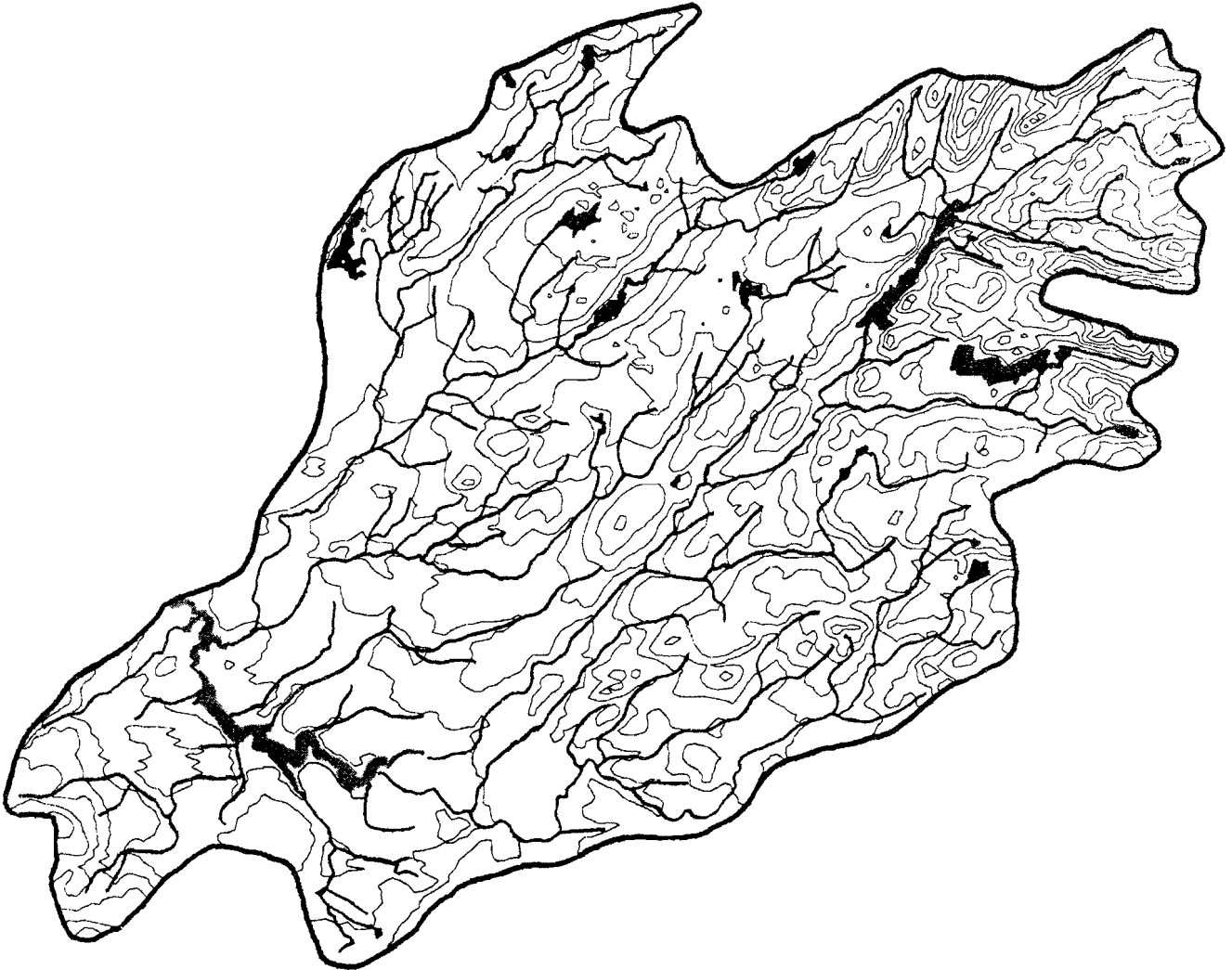


Figure 1. The watershed of Kayuta Lake, Oneida County, NY.

Parameter	Sample volume	Preservation	Method	Reference
Total Phosphorus-P	40 ml	H <sub>2</sub> SO <sub>4</sub> to pH<2	Persulfate digestion followed by single reagent ascorbic acid	EPA, 1983
Nitrite+Nitrate-N	25 ml	Filter and cool to <4° C	Cadmium reduction	APHA, 1989
Calcium	50 ml	None	EDTA titrimetric	EPA, 1983
Alkalinity	100 ml	Cool to <4°C, measure ASAP	Titration to pH=4.6	APHA, 1989

Table 1. Summary of laboratory methodologies employed.

Qualitative zooplankton samples were collected with a .25 m diameter 63  $\mu$ m mesh plankton net. Both horizontal and vertical (bottom to surface) tows were taken. Samples were preserved with 1% Lugol's iodine and were surveyed under a dissecting microscope.

While on the lake, qualitative notes were made on the presence of rooted aquatic plants and the general distributions of species were mapped. Voucher specimens were collected and pressed.

## RESULTS

Profiles of physical parameters at the two sites sampled are given in Table 2. Changes in each parameter from top to bottom were gradual, suggesting occasional mixing. Near-bottom oxygen concentrations were approaching zero at both sites. Specific conductance (an indirect measure of ions in solution) was quite low in the upper layer (~46-48 mmho/cm), but increased sharply toward the bottom (~70-72 mmho/cm). This is likely related to the hypoxic conditions. In the absence of oxygen, many compounds become reduced and are converted from insoluble forms to soluble ones.

The lake's buffering capacity (alkalinity) was 22 mg/l (calcium carbonate equivalent) near the dam. At the mouths of Pine creek and Baker's Brook it was 18 and 95 mg/l respectively. Because alkalinity is primarily a function of local geology, the observed variability suggests heterogeneous bedrock and soil conditions throughout the watershed. This is substantiated by calcium concentrations at the above sites, being 8.8, 9.6 and 38.0 mg/l, respectively. The lower tolerance limit for the exotic zebra mussel is approximately 40 mg/l (D'Itri, 1998). Kayuta Lake is below that and will not be threatened by that pest.

DAM SITE				CSLAP SITE			
Depth (M)	Cond (mmho/cm)	Temp (°C)	DO (mg/l)	Depth (M)	Cond (mmho/cm)	Temp (°C)	DO (mg/l)
0	48.3	27.2	7.5	0	46.1	26.9	7.3
0.5	48.2	26.6	7.3	0.5	47.7	25.2	7.2
1	48.5	25.9	7.14	1	48.3	25	7.25
1.5	48.6	25	7.1	1.5	48.6	24.7	7
2	49.5	24.4	6.7	2	52.6	22.2	6.14
2.5	57.1	21.9	6	2.5	55.2	20.7	5.3
3	56.8	20.4	5.2	3	58.5	20	4.9
3.5	57.4	19.7	4.6	3.5	58.8	19.5	4.4
4	60.3	19.1	3.5	4	60.3	18.5	3.1
4.5	71.4	17.5	2.4	4.5	64.8	17.7	1.8
4.9	72.5	16.7	1.3	4.9	69.1	16.9	1.1

Table 2. Profiles of conductivity, temperature and dissolved oxygen near the dam and at the CSLAP site, Kayuta Lake.

Phosphorus levels were 11, 13 and 14  $\mu\text{g/l}$  at Pine Creek, Baker's Brook and near the dam. Those values are consistent with those of recent years collected through CSLAP (Kishbaugh and Hohenstein, 2000). Those are lower than typically encountered in a eutrophic waterbody. However, given Kayuta's high watershed to surface ratio (194:1) and its short retention time (.02 years), one would expect nutrient levels to be quite variable depending on runoff conditions. Nitrate concentrations at the three sites were 0.14, 0.21 and 0.12  $\text{mg/l}$ . These are also consistent with recent CSLAP data.

There was a paucity of zooplankton collected. The only specimens observed were *Asplanchna* sp., small-bodied rotifers which, themselves, feed upon other zooplankton. Large-bodied crustaceans are generally considered more beneficial, as they are effective algae grazers and are a good food source for fish. We did not encounter these. The fish in your lake are probably dependent upon benthic macroinvertebrates as a food source.

The dominant species of rooted aquatic plants we observed are:

- Myriophyllum spicatum (Eurasian milfoil)
- Vallisneria americana (wild celery)
- Brasenia schreberi (water shield)
- Nymphaea odorata (white water lily)
- Utricularia sp. (bladderwort)
- Potamogeton amplifolius (big-leaved pondweed)
- P. epihydrus (flat-stemmed pondweed)
- P. natans (American pondweed)
- Elodea canadensis (water weed)
- Nitella sp.

The first, Eurasian milfoil, is an aggressive exotic that has the potential of severely impacting recreational activities. When we observed it, it appeared reasonably innocuous. Most of the vegetation we observed was restricted to shallow and silty bays entering (for the most part) the south shoreline of the lake.

## DISCUSSION

### **The role of aquatic plants in freshwater lakes:**

Practically all our northeastern lakes support a diversity of large aquatic plants attached to the bottom (benthic macrophytes) which play an important role in maintaining the potable, recreational and aesthetic characteristics, as well as the ecological functioning, of most waters (Anon., 1990). These plants compete directly with algae in the water column (phytoplankton) for nutrients, thereby maintaining water clarity. They protect shorelines from erosion and stabilize deeper substrates by trapping silts and clays and therefore limiting turbidity by physical disturbance. By preventing the resuspension of sediments which have nutrients adsorbed to them, algal growth is limited (Wetzel, 1983).

Macrophytes provide food and cover and/or supplement oxygen supplies for all of the organisms (i.e., fish, mammals, amphibians, reptiles and invertebrates) that make up shallow water (littoral) aquatic communities. They are the basis of aquatic food webs in these areas, providing indispensable links between the sun's energy and animals that eat plants which are, in turn, eaten by predators (Hutchinson, 1975). In these ways, plants regulate the size and character of game fish and waterfowl populations as well as impact other biotic resources we cherish.

In our region there are a few introduced plant species (e.g., Eurasian milfoil, curly leaved pondweed, water chestnut) that aggressively out-compete our native flora under conditions of excess nutrient loading, destroying biodiversity and causing the loss of some of the abovementioned benefits. The dense beds commonly formed by these plants often reduce the recreational quality of lakes. These introduced exotics are responsible for the great majority of the complaints heard from recreational lake users.

### **Aquatic plant management in the northeast:**

Modern managers recognize the benefits of our native plant communities and therefore, under all but emergency conditions, use techniques to control aggressive introductions while attempting to restore native plant diversity for its inherent values. Techniques can be divided into two types:

1. Those that improve the environment by minimizing nutrient loading, reducing littoral disturbance and preventing further introductions, and:
2. Those that directly impact plant populations.

Even aggressive exotics can become innocuous if cultural pollution (nutrient loading) is minimized. Whole lake and watershed management techniques to control runoff are expensive, often politically charged and must be seen as long-term investments. Nevertheless, they need to be addressed to assure unqualified success over time.

Introductions are most aggressive when native plants or substrates are disturbed. It's harder for exotics to achieve dominance if healthy natives already occupy a lake's bottom. Disturbance of lakeside lands also impacts littoral areas to the benefit of exotics directly by sediment deposition which reduces populations of native plants and indirectly by supplying associated nutrients. All things being equal, the fewer nutrients available for plant growth, the less plants will grow, reducing management problems. However, competitive interactions between planktonic algae and benthic plants may result in situations complicating management. If nutrients are available they will be utilized by algae or rooted macrophytes or some mix of the two. If rooted plants are completely removed, algae will grow unimpeded, clouding the water and preventing further macrophyte growth which results in de-stabilization of substrates and loss of food and cover for higher organisms. Therefore, efforts to manage non-native plants must be selective. The more exotic species present, the more extensive, and costly, are the management strategies required. By far, most introductions to inland lakes have been traced to the activities of recreational navigation. Lakes with public access should have mechanisms in place to minimize the chances of new introductions.

Strategies directly impacting plant populations are normally categorized as: physical (e.g., harvesting, barriers placed on the bottom or water level manipulation), chemical (use of various herbicides) or biological (utilization of other organisms, usually herbivores). Based on the above discussion, it is assumed that management activities normally are directed at selected target species. It is neither feasible nor desirable to remove all plants from a body of water. If necessary, small areas such as channels and spaces around docks can be treated physically for the convenience of individuals. In even more problematic situations mechanical harvesting on a larger scale may be necessary.

Several problems result from harvesting and other means of physical removal of nuisance plants. Since the majority of exotic species are more competitive in disturbed situations, harvesting enhances growth. Because harvesting is non-selective, native plants competing with the target species are also removed allowing exotics to grow even more vigorously. Herbivorous insects which potentially serve as natural biocontrol agents are removed, compounding the problem. Expenses increase since the more an area is harvested, the more it will need harvesting to assure trouble-free utilization of the site.

The use of herbicides has historically been an important tool in macrophyte control. The greatest concerns with herbicides relate to their toxicity. They are poisons. Many can kill non-target plants as well as animals and can cause health problems to lake users. There are also a host of poorly understood, subtle and indirect effects on the biota,

nutrient flow and food web relationships. Herbicides are available today that allow selective targeting of nuisance species. Sonar<sup>®</sup> (1-Methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1H)-pyridinone) is an example of a product that is best used to control Eurasian milfoil while permitting most other plants to recolonize, re-establishing a nearly complete native plant community. This, and similar products, must be carefully handled by permitted, professional applicators with an understanding of aquatic ecosystems. Also, clearly specified targets should be part of plans developed with the involvement of affected stakeholders. There are still many problems to solve regarding maintenance of appropriate herbicide concentrations over time to attain control without killing non-target species. Those problems are particularly difficult to overcome in river-lakes such as Kayuta which rapidly respond to meteorological events with changing discharge rates.

Biological control protocols for aquatic plant management are just now being developed. They have great potential for ecologically friendly plant management. There is still more to learn, as agents become available for utilization. There are at least three native insect herbivores that can help control Eurasian milfoil in our lakes. *Euhrychiopsis lecontei*, the milfoil weevil, is present in most northeastern lakes and is being stocked to augment local populations in an attempt to control milfoil (Sheldon, 1997). *Acentria ephemerella*, the milfoil moth, is being tested for similar use (Johnson, et al., 1998). *Cricotopus myriophylli*, the milfoil midge, is another organism that occurs naturally in our region (Fagnani and Harman, 1987) and attacks Eurasian milfoil in some situations. These organisms, and others, may have a role in the reduction of milfoil allowing for the re-establishment of the native flora in the northern tier of the United States and Canada. Other organisms, such as East Asian grass carp, *Ctenopharyngodon idella*, have been used to good effect in some situations, particularly further south. Permitting issues often preclude their use in New York State.

Introductions of non-native herbivores often requires permits in New York State. It should be recognized that in regulated wetlands, plant management activities of any kind require a permit from the NYS Department of Environmental Conservation and the US Army Corps of Engineers. Plans for introductions to attempt biocontrol should be preceded by intensive monitoring to ascertain native herbivore damage and population densities prior to management decisions. To date, the evidence is tenuous that native herbivore populations, augmented or introduced, control target species successfully.

Efforts to manage aquatic macrophytes should be part of a coherent plan, no matter how informally documented. Involved groups need to precisely articulate goals and coordinate various activities. Physical control, herbicide use and biocontrol procedures are often incompatible and should not be used concurrently except under professional guidance.

## MANAGEMENT RECOMMENDATIONS

In the case of Kayuta Lake, we have concerns because it's probable that homeowners at different locations have differing management priorities. The deposition of silt in headwater areas is economically impossible to control in artificially dammed river-lakes. Dredging is the only solution. It's expensive and not at all environmentally friendly. As implied in the above discussion, luxuriant growth of aquatic plants in upstream bays and stream mouths is nature's way to protect the main basin of the lake from siltation and excess nutrient loading, by trapping the former and using the nutrients in those areas for growth of the latter. Plant beds in those areas are protecting the property values of those with lands on the lake proper.

However, residents with cottages in those smaller bays are understandably not happy with such a situation. The quality of the recreation is diminished. But, if they were to somehow successfully remove the majority of the plants at those sites, water quality over the entire lake would be jeopardized. We would advocate physical removal of offending plants in the immediate vicinity of docks and channels (if stakeholders are severely impacted), leaving the remainder because of their positive attributes.

Along with activities taken to address immediate concerns, actions need to be taken to preclude the introduction of additional exotics. These should include signs at launching facilities and hull washing stations. Long-term nutrient reduction goals need to be spelled out, accompanied by a well thought out educational program so everyone recognizes a series of agreed to problems and their potential resolutions (which may be in part legislative). In other words, as indicated above, a plan is needed that takes into account everyone's concerns and consensually preferred ways to address them. Importantly, someone or some group must be willing to provide the driving force behind such efforts. If we can be of any further assistance please contact us.

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