3rd Annual
Finger Lakes Research Conference
October 6, 2007

ABSTRACT VOLUME

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601 S. Main Street
Geneva, NY 14456
(315) 781-4390
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...promoting environmental research and education about the Finger Lakes and surrounding environments...
Registration and Continental Breakfast
Library Atrium
8:15 – 9:00 am

Morning Session I
Geneva Room, 2nd Floor
9:00
PHOSPHORUS DISTRIBUTION AT THE SOUTH END OF CAYUGA LAKE
Jose Lozano, City of Ithaca Department of Public Works

9:15
A PRELIMINARY STUDY ON RESPONSES OF EUROPEAN FROGBIT (HYDROCHARIS MORSUS-RANAE) ON INCREASED TEMPERATURE AND NUTRIENT LOADING
Bin Zhu, Finger Lakes Institute at Hobart and William Smith Colleges

9:30
TROPHIC BIOCONTROL OF EURASIAN WATERMILFOIL (MYRIOPHYLLUM SPICATUM) IN LEBANON RESERVOIR, MADISON COUNTY, NY
Paul H. Lord, Cornell University Research Ponds

9:45
HISTORICAL AND INTERDISCIPLINARY LINKAGES: STUDYING THE PAST AND PRESENT AT HANLEY BIOLOGICAL FIELD PRESERVE

10:00
EFFECTS OF THE NUISANCE DIATOM DIDYMOSPHENIA GEMINATA ON INVERTEBRATES IN A ROCKY MOUNTAIN STREAM
Clancy A. Brown, Hobart and William Smith Colleges

Poster Viewing
Library Atrium
10:15-11:00

Morning Session II
Geneva Room, 2nd Floor
11:00
KARST-RELATED FLOODING BETWEEN LEROY AND CALEDONIA
Paul Richards, SUNY Brockport

11:15
HYDROGEOLOGIC APPRAISAL OF SILURIAN AND DEVONIAN CARBONATE BEDROCK IN SOUTHERN CAYUGA COUNTY, NY
David A. Eckhardt, United States Geological Survey

11:30
FIFTEEN YEARS OF WATCHING TRITIUM IN CAYUGA LAKE
Thomas F. Kraemer, United States Geological Survey

11:45
John D. Halfman, Hobart and William Smith Colleges

**Lunch**  
Library Atrium  
12:00-1:00

**Owasco Lake Session**  
Geneva Room, 2nd Floor  
1:00

*STREAM BIOTIC INTEGRITY VARIATION IN THE OWASCO LAKE WATERSHED*  
Susan Cushman, Hobart and William Smith Colleges

1:15

*MACROPHYTE COMMUNITIES OF OWASCO LAKE*  
Bruce Gilman, Finger Lakes Community College

1:30

*CURRENT STATUS OF NATIVE AMPHIPOD DIPOREIA SP. AND ZEBRA MUSSELS IN OWASCO LAKE*  
Mark Leopold, Cornell University

1:45

*ZOOPLANKTON AS INDICATORS OF PRODUCTIVITY AND WATER QUALITY IN OWASCO LAKE*  
Emily Runnells, Hobart and William Smith Colleges

2:00

*THE POTENTIAL LINK BETWEEN LAKE PRODUCTIVITY AND AN INVASIVE ZOOPLANKTON IN OWASCO LAKE*  
Melissa Balk, Hobart and William Smith Colleges

**Tour of the Finger Lakes Institute**  
601 S. Main Street  
2:15-3:00 pm  
Refreshments served

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THANK YOU FOR ATTENDING!
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PHOSPHORUS DISTRIBUTION AT THE SOUTH END OF CAYUGA LAKE

Jose Lozano
Biologist
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Co-author: L. Smith, City of Ithaca DPW

As a result of the Ithaca Area Wastewater Treatment Facility, IAWWTF, upgrading from a secondary to a tertiary treatment facility, the average effluent phosphorus concentration has been significantly reduced. After the tertiary treatment went into operation in April 2006, the effluent phosphorus concentration decreased 44.6 %, from 0.424 milligrams per liter, mg/L, to 0.189 mg/L (Slide #1 & 2)

The IAWWTF effluent load reduction to Cayuga Lake has been 43.9%. During May 2005 through April 2006, before the upgrade, the average load was 23.1 pounds per day, Lb/day. After the upgrade, and during the period from May-2006 to February 2007 the load was 10.1 Lb/day. (Slide # 2)

The phosphorus concentration was significantly lower (95% confidence level) at the Outfall sampling site in Cayuga Lake after May, 2006. The average concentration went from 62 micrograms per liter, ug/L, to 23 ug/L. The comparison was made among sets of samples before and after the start up of the IAWWTF tertiary treatment. The EPA guidance value for total phosphorus is 20 ug/L.

The phosphorus budget for the south end of Cayuga Lake has been estimated at 110.0 Lb/day (IO-RPP 2001\(^1\)). The 2001 IO-RPP also estimated that the contribution of the IAWWTF to the south end Cayuga Lake phosphorus load was 31%, based on data before the IAWWTF improvements. After the tertiary treatment upgrade, the IAWWTF effluent load to Cayuga Lake is now 10.0%, based on the 2001 IO-RPP data. (Slide # 5 & 6)

The phosphorus load from the Inlet and Fall Creek could account for as much as 83% of the phosphorus input to Cayuga Lake.

The results of the testing on the samples that centered on the outfall are shown graphically in Slide 7 and 8. Figure 7 is a composite of the results from 2005, before the tertiary treatment was on line. Figure 8 is from 2006, showing the effect of tertiary treatment. It is important to keep in mind that the data from each day’s sampling is like a snapshot of changing conditions, such as heavy rains and wind. When comparing
Figure 7 with Figure 8, it is evident that the phosphorus plume has shrunk noticeably in the lake since tertiary treatment went online. It appears that the two tributaries, Cayuga Inlet and Fall Creek, have remained the same.

The phosphorus concentration in Cayuga Lake has decreased over the years. This improvement in water quality is also mirrored by other indicators such as chlorophyll alpha.

(1) Cayuga Lake Intermunicipal Organization – Restoration and Protection Plan 2001
A PRELIMINARY STUDY ON RESPONSES OF EUROPEAN FROGBIT (HYDROCHARIS MORSUS-RANAE) ON INCREASED TEMPERATURE AND NUTRIENT LOADING

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Co-authors: Meredith Eppers, Joseph Sullivan, Hobart and William Smith Colleges

The floating invasive plant – European frogbit (Hydrocharis morsus-ranae) originated from Eurasia and was first introduced in an arboretum in Ottawa from Switzerland in 1932. It escaped to the Rideau Canal system in 1939, spreading rapidly by means of water, birds, boats, and human. In 1974, the plant invaded in the St. Lawrence River in New York, USA. By 1994, European frogbit spread up to approximately 644 km from Ottawa to Point Pelee National Park in western Lake Erie (Catling and Porebski, 1995). Since then, this species has invaded to south of Lake Champlain and further south and west of Lake Ontario (Figure 1) and recently has become established in Michigan and Washington State (Catling et al., 2003). Therefore the rapid invasion of European frogbit may be an imminent threat to our lakes and have substantial impacts on these natural ecosystems. A preliminary study conducted this summer revealed that European frogbit reached a local density 512 plantlets/m$^2$ in some bays in Oneida Lake and the dissolved oxygen (DO) concentration was as low as 1.9 mg/L underneath the plants. The high density and low DO concentration will seriously affect organisms in the invaded lakes.

The primary objective of this study was to investigate the growth of European frogbit in response to two occurring environmental changes: increased temperature and nutrient loading. A factorial experiment design (2×2×5) was applied in the study: two levels of temperature (25 and 30 °C), two levels of total phosphorus (TP) concentrations (~ 10 and ~30 µg·L$^{-1}$), and five replicates for each treatment. I used Seneca Lake water as the lower concentration water and dissolved 1.33 mg KH$_2$PO$_4$ into 15 L lake water to simulate a mesotrophic lake water with 30 µg·L$^{-1}$ TP. Twenty individual plants of European frogbit with similar sizes, collected from Oneida Lake, NY, were randomly divided into four groups as the four treatments: A. Temperature 25 °C and TP 10 µg·L$^{-1}$; B. Temperature 25 °C and TP 30 µg·L$^{-1}$; C. Temperature 30 °C and TP 10 µg·L$^{-1}$; and D. Temperature 30 °C and TP 30 µg·L$^{-1}$. The plants were measured in leaf number, leaf area, stem number, stem length, root number, and root length at the beginning of the experiment. After three weeks, they were measured in the same variables as well as stolon number, stolon length, base number, and biomass for all the parts of the plants. Data were analyzed using Analysis of Variance (ANOVA). The analysis showed no significant differences among the four groups at the beginning of the experiments.
(p>0.05). The results also revealed that temperature had significant effects on plant growth at the end of the experiment (ANOVA, DF=1, F=8.04, p=0.005) whereas total phosphorus had no significant effects (DF=1, F=2.54, p=0.113). For example, high temperature increased leaf area (36.8%, DF=3, F= 3.52, p=0.017) and root length (23.6%, DF=3, F=3.35, p=0.020). In contrast, the numbers of leaf, stem, root, and the biomass of all the parts of plants did not differ significantly among the four treatments. However, data suggested trends of better growth at higher temperature. In addition, there was a trend of change in the ratio of above water surface biomass and below water surface biomass, suggesting a change in phenotypic plasticity of European frogbit at higher nutrient level. These should be further investigated due to the limited number of replicates in this study. However, the study clearly showed that European frogbit can invade more rapidly under global warming and can invade both eutrophic/mesotrophic and oligotrophic lakes. This suggests a great potential for European frogbit to invade to our Finger Lakes.

References


Figure 1. European frogbit invasion from Canada to the United States 1942-2002 (Modified from Catling and Porebski 1995 and Catling et al. 2003). Occurrence in the state of Washington by 2002 was not shown and occurrence in Oneida Lake in 2007 was added.
Eurasian watermilfoil (*Myriophyllum spicatum*) is a little noticed part of the aquatic plant community in its native Europe while it disrupts recreational uses of New York lakes and ponds. Augmentation of New York lakes with milfoil herbivores has yet to provide a consistently satisfactory result. Taking note of sunfish (*Lepomis* spp.) predation on milfoil herbivores, we hypothesized an inverse relationship between walleye and sunfish and between sunfish and milfoil herbivores and between milfoil herbivores and Eurasian watermilfoil. To evaluate our hypothesis, we stocked walleye (*Sander vitreus*) in quantities beyond fisheries recommendations to reduce the sunfish population in Lebanon Reservoir (Madison County, NY), a lake with documented Eurasian watermilfoil dominance (99+/% Eurasian watermilfoil biomass at the 3 m depth interval). Sunfish numbers have been dramatically reduced as has Eurasian watermilfoil biomass. A new milfoil herbivore has been identified. We discuss issues associated with this trophic cascade.
HISTORICAL AND INTERDISCIPLINARY LINKAGES: STUDYING THE PAST AND PRESENT AT HANLEY BIOLOGICAL FIELD PRESERVE

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Hobart and William Smith Colleges’ Hanley Biological Field Preserve is located about 15 miles southeast of Geneva, in the town of Fayette, New York. Even though the preserve is less than 110 acres, it contains forest, fields, a stream, wetlands, and numerous man-made ponds. Biological surveys of plants and animals, as well as geological studies, have been conducted since the colleges acquired the property in the 1980s. However, the history of this highly human-manipulated landscape is lacking to properly contextualize research findings. In the summer of 2007, research was conducted over a ten week period at the preserve that focused on detailing the history of the man-made ponds on the property.

The first major pillar of our research was determining the chronology of pond construction on the preserve. After obtaining aerial photographs from Cornell University's Institute for Resource Information Systems (IRIS), we were able to track the property from having no ponds in 1954 to its present complement of over 60 ponds. The first pond was dug in the summer of 1963 (pond number 11) and seven more ponds were present by 1968. Most of the ponds were added to the property during the 1970s, but no new construction was evident after 1980. Over this same time period, the surface area of some ponds reduced and other ponds dried up entirely. An interview with Jim Brown, the caretaker of the Hanley Field Preserve who has worked continuously on the property since the early 1950s, reaffirmed the general order of pond development that had been estimated using the historical images. He was also able to provide information regarding the intent behind many of the ponds. For example, Mr. Henry Hanley, the owner prior to HWS, dug ponds 7 and 11, two of the oldest and deepest ponds, for private recreational fishing. In the years that followed, Mr. Hanley dug shallower ponds for fish bait production. Many of these shallow ponds have become seasonal and in some cases even succeeded to wetlands or meadows.

The second major pillar of our work was to map the bottom of two of the presumed deepest and oldest ponds—pond numbers 11 and 7. Using a Trimble GPS backpack unit and a depth finder, bathymetric information on these ponds was collected in a grid pattern. We used krig interpolation in ArcView 9.2x to generate bathymetric maps. Both ponds have a maximum depth near 4 meters and have gentle even slopes. These maps will provide support to the ongoing biological survey on these two ponds, which have similar abiotic conditions, but exhibit notably different biological communities.
EFFECTS OF THE NUISANCE DIATOM *DIDYMOSPHENIA GEMINATA* ON INVERTEBRATES IN A ROCKY MOUNTAIN STREAM

**Clancy A. Brown**
Undergraduate Student

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Mentor: Brad W. Taylor, Rocky Mountain Biological Laboratory, Crested Butte, CO 81224
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Department of Biological Sciences, Dartmouth College, Hanover, NH 03755

Nuisance blooms of the stalked diatom *Didymosphenia geminata* have become an increasing concern worldwide, yet little is known about their effect on stream food webs. We investigated the effects of *D. geminata* blooms on stream invertebrates of the East River in the western Rocky Mountains. *D. geminata* habitats did not differ in rarefied species richness or total invertebrate density when compared to areas of stream bottom where *D. geminata* was experimentally removed, but patterns were seen in some taxa. Chironomidae larvae and stonefly larvae, such as the perlid *Hesperoperla pacifica*, were 1.3 and 1.1 times more abundant, respectively, in areas containing natural levels of *D. geminata* relative to areas were *D. geminata* was experimentally removed. In contrast, heptageniid mayflies, such as *Epeorus longimanus*, were 1.7 times more abundant in areas were *D. geminata* was removed relative to areas with *D. geminata*. Densities of the numerically abundant and highly mobile mayfly, *Baetis* spp., were similar between areas with *D. geminata* present and areas where *D. geminata* was removed. *D. geminata* did not significantly alter the growth rate of *Baetis* or *Epeorus* mayflies in experimental growth chambers. The thick mats of stalks created by *D. geminata* blooms likely alter stream food webs, particularly due to a dramatic increase in the density of Chironomidae larvae.
Karst-related flooding is occurring between Leroy and Caledonia in an area where water tables exhibit dynamic seasonal variation. This peculiar groundwater environment resulted from the history of deglaciation which has eroded much of the unconsolidated glacial sediments, leaving behind thin immature soils overlying fractured, karsitic, carbonate bedrock. Stream incision and highlands to the south have resulted in high potentiometric gradients and groundwater flowpaths that respond to individual meteorologic events. This peculiar hydrogeologic regime poses a challenge to current watershed management because of the dynamic nature of subsurface flowpaths and their potential to carry pollution. This ongoing study seeks to understand the groundwater system and how it contributes to flooding, much of which occurs along rte 5, the Village of Leroy, Quinlan and Britt Roads (Figs.1-9).

Exposed at the base and northern part of the study area is the Camillus shale, Falkirk FM and the Bertie Limestone. Overlying these units is the Onondaga Formation which consists of the following members: Edgecliff, Clarence, Nedrow and Moorehouse. Beds dip slightly towards the south with the result that the farther south you go the thicker is the Onondaga formation and the deeper it is to the base of the unit. Overlying these rocks are the Oatka Creek shale, Stafford Limestone and Levanna shale. Much of the area south of Rte 5 exposes these shales which have been demonstrated by the DEC to be not very permeable. There is some local structure (minor folds etc) in the area that are believed to be due to subsidence (Fairchild, 1909). The Onondaga limestone in this area is extensively fractured with joint sets that trend north and north east and east south east. Mapping by Fronk (1991) indicates these joint sets change with height and are quite variable. Pump tests suggest the permeability in the Onondaga is low, and dominated by fracture flow. Observations at Buttermilk Falls and numerous quarry exposures show strong evidence of strong fracture flow. Rhinehart (2005) demonstrated through hydrologic modeling that the flooding at one of these sites (Quinlan road) was exasperated by fracture flow coming from outside the watershed. Fracture traces are numerous and well logs in the Village indicate bedrock is between 0 and 12 feet of the ground surface. Aerial photographs and inspection in the field suggest that sinkholes are present, however no large voids (caves) have ever been found. All of the tributaries east of the town of Leroy terminate near Rte 5 with the exception of Mud Creek. These streams probably terminate in sinkholes and contribute surface water into the Onondaga FM. Mud creek flows into a sinkhole just south of Golf Rd. The study area contains broken craggy relief with numerous depressions and hummocky ridges. Information on subsurface flow paths is scant but a TCE plume mapped by the NYS DEC (Dunn Geos.
Eng., 1992) and Fronk (1991) suggests groundwater flows East South East from Leroy and discharges at the springs of Caledonia. This is also supported by water table data. A GPR survey by Dunn Geos. Eng. (1992) suggests that there are large rubble filled depression features at the top of the bedrock below the soil zone. These are NOT expressed in the surface topography and could be zones of enhanced permeability.

Our preliminary interpretation (see arrows in Fig. 1) is that groundwater flows into the area through a series of northeast fracture traces (A). This flow is believed to be shallow and flows on top of the Oatka Creek and Levanna shales, which acts as an aquitard. When the flow reaches the Onondaga FM, the major groundwater flowpath is eastward through fractures toward the Caledonia Springs (B). Some of this water probably seeps northward into Oatka creek at the base of the Onondaga (C). During flood events, a pulse of groundwater causes water tables in the area between Rte 5 and the eastward segment of Oatka Creek to rise. This fills up the abandoned quarries in the region and contributes to the extensive flooding observed at Mud creek south on golf rd. As this groundwater wave progresses towards Caledonia it causes water tables to rise in the vicinity of the sinkholes that capture streams flowing from the south (D). These sites include the golf course sinkhole complex and the other tributaries that terminate inexplicably at Rte 5. With no room left in the aquifer to receive streamflow, these sites flood. Flooding at the beanery, unnamed tributary, Leroy Airport and the Leroy Country Club are caused by a combination of groundwater rise and drainage from surface tributaries. The latter features are also probably impacted by urban runoff from the airfield and Leroy HS. Flooding at Britt rd is probably caused by the water table rising to or above the surface combined with snow melt from the field above it.

The TCE plume from the Golf Rd and water table elevation in wells between Leroy and Caledonia suggest the groundwater is moving east south east. An important question is why does the groundwater not flow northeast along the obvious surface gradient to Oatka Creek? Hydraulic conductivity tests conducted by Dunn Geos. Eng. (1992) indicate that the Onondaga is much less permeable than the rock below it and that much of this permeability is through fractures. Our hypothesis is that the Onondaga dams the groundwater, forcing it to move eastward along open fractures to the Caledonia springs that make up the headwaters of Spring Creek. Flooding is exasperated in the area because the thickness of the unsaturated zone is low and soils are thin. These two characteristics mean that there is little opportunity to store water. We interpret the flooding to be caused by the presence of high elevation recharge areas south of the Onondaga and a pieziometric surface that is close enough to the ground elevation to enable the groundwater table to rise above the surface of the ground during high groundwater discharge events.
Figures 1-9
Map of area showing streams (blue lines), roads (black), RR tracks (red) and locations of flooding events that appear to be karst related. Elevation is shaded in orange with darker shades being higher. Large arrows are groundwater flowpaths that are believed to be contributing to the flooding.

2 Quinlan Rd. sinkhole, note the ice layers caused by warm groundwater rising up and freezing. Water eventually drains away back into the sinkhole, leaving the ice behind. 3 Lerot Country Club sinkhole complex
4 Flashy quarry  5 Beanesy flood site 6 Flooding at terminus of unnamed stream. Water is believed to flow into a sinkhole  7 Flooding at Leroy Airport  8 Sinkhole at Mud Creek 9 Flooding at Britt Rd. There are no streams flowing into or out of the area.

A Groundwater flows from southwest into area along fracture traces as shallow flow overlying the Camillus/Oatka shale which acts as an aquitard. B: Upon reaching the Onondaga FM, groundwater moves east towards the caledonia springs along open conduits and fractures. C: Some of this groundwater probably seeps into Oatka creek (small arrows). D: Tributaries flowing north are intercepted by open conduits in the Onondaga except for Mud creek and Oatka Creek. Flooding at these sites occurs when the aquifer's ability to accept their flow is exceeded.
References Cited


Since 2001, the U.S. Geological Survey (USGS) has provided technical assistance to the U.S. Environmental Protection Agency (USEPA) in the investigation of regional subsurface transport of chlorinated ethene contaminants in a karst region in southern Cayuga County, NY. The objective of the USGS work is to characterize the hydrogeology of the Upper Silurian to Middle Devonian carbonate bedrock. The USEPA has installed 23 multi-level piezometers that are open to hydraulically conductive zones in the carbonate-aquifer system, and the USGS has collected borehole-geophysical logs in more than 70 boreholes to compliment the USEPA data program.

The geophysical data have been used to define the bedrock stratigraphy and delineate fractures penetrated by the boreholes. Measurements of borehole flow under ambient and pumped conditions have yielded estimates of transmissivity of the fracture zones. The borehole data show that the upper and lower aquifer units in the shallow-dipping bedrock are typically separated by confining beds of massive, relatively unfractured limestone and dolostone. Hydraulically conductive zones are commonly present along nearly horizontal bedding planes that are enlarged by solution. Cavernous, highly solutioned gypsum beds also provide a highly transmissive zone in the lower aquifer system. Locally, blind thrust faults and other structures have produced disruptions in hydraulic continuity of the transmissive zones. Water-level data from intervals isolated by the multi-level piezometers show that vertical hydraulic-head differences between the upper and lower aquifer units can exceed 100 feet and show the potential for downward flow. Rapid rises in hydraulic head in the lower aquifer in response to infiltration of rainfall and snowmelt indicate that the lower, confined aquifer system receives transient pulses of recharge through unidentified vertical hydraulic connections. The pieziometric data show that flow in the upper aquifer units is northward to local springs and streams that discharge to the Seneca River, whereas water in the lower aquifer system flows southwestward and discharges to Cayuga Lake.
Tritium in Cayuga Lake and its tributaries has been monitored periodically for the past fifteen years. Tritium in lake water and in the inflowing water have been decreasing over the years as the pulse of thermonuclear-weapons-test-related tritium that was injected into the atmosphere in the 1950s and 1960s has been flushing from the troposphere by rain-out and radioactive decay. The decrease in tritium activity in Cayuga Lake water is consistent with a water retention time of approximately 8 to 12 years, in accord with the findings of others using various techniques. Tritium in the lake is expected to further decrease as the atmosphere and hydrosphere continue to flush tritium through the lake and tritium undergoes radioactive decay. Eventually the tritium in the lake is expected to return to natural equilibrium values controlled by natural production processes in the upper atmosphere. It may then be possible to estimate water retention times for the lake based on equilibrium models instead of transient models. This could result in more precise water retention time estimates for all large lakes.

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The seven central Finger Lakes were sampled over the past three summer seasons (May – October, 2005-07) to investigate the temporal and spatial limnological variability. CTD casts, secchi disk depths, and water samples were collected and analyzed at a minimum of two deepwater sites on a monthly basis. Three lakes were investigated in more detail in 2007 with bi-monthly sampling of Owasco Lake at 11 sites and its major tributaries, bi-monthly sampling of Cayuga Lake at 9 sites, and weekly sampling of Seneca Lake at 4 sites and its major tributaries. SeaBird CTDs (SBE-19 in 05&06, SBE-25 in 07) collected water-column profiles of conductivity (reported as specific conductance), temperature, depth, pH, dissolved oxygen, light transmission (05&06), PAR (07), fluorescence (07), and turbidity (07). Surface and bottom water samples were analyzed for total and dissolved phosphates, nitrates, dissolved silica, chlorophyll-a, total suspended solids, alkalinity, and major ions using standard limnological techniques.

**CTD Profiles:** The temperature profiles were typical for any summer season and similar from one year to the next and reveal the typical development and decay of summer stratification in all but Honeoye Lake. The Honeoye Lake profiles were typically not stratified, reflecting the well mixed, shallow lake.

Specific conductance data in 2007 ranged from 225 µS/cm in Honeoye Lake up to 710 µS/cm in Seneca Lake. Conductivities were 10 to 20 µS/cm smaller in the epilimnion than the hypolimnion of Cayuga, Canandaigua, Owasco, Skaneateles and Seneca Lakes. The largest change was consistently observed in Seneca Lake with conductivities decreasing by 40 µS/cm in the epilimnion and remaining constant in the hypolimnion during each summer, to then decrease through the entire water column by ~10 to 20 µS/cm during overturn. The variability perhaps reflects the input of dilute surface runoff to the epilimnion.
In the deep lakes, dissolved oxygen was nearly saturated in Cayuga, Canandaigua, and Skaneateles Lakes (orthograde profiles). Epilimnetic supersaturation was observed mid-summer in Seneca Lake, and mid-summer hypolimnetic depletion, especially right below the thermocline was observed in Owasco Lake. PAR data revealed exponentially decreasing light levels to 1% $I_0$ at 10 to 20 meters, and the shadow of the field vessel. Fluorescence data revealed algal peaks in the epilimnion (Cayuga, Seneca), metalimnion (Keuka, Owasco) or upper hypolimnion (Canandaigua, Skaneateles), with the largest concentrations mid-summer (Cayuga, Owasco, Seneca), late summer (Canandaigua), or early summer (Skaneateles). Surface water turbid layers were observed in Owasco and Seneca Lakes and to a lesser extent Cayuga Lake. The results suggest that the origin of the epilimnetic turbidity detected by transmissometer in previous years was primarily algal.

Benthic nepheloid layers were observed at least one site in Canandaigua, Cayuga, and Keuka Lakes, but not in Honeoye, Owasco, Seneca and Skaneateles Lakes. The nepheloid layers persisted throughout the survey but their extent varied between lakes and sample dates. The nepheloid layers were best developed in Cayuga and Canandaigua Lakes, and more pronounced in 2007 than 2006 and 2005 with 2007 turbidity values starting to increase from background values of below 1 NTUs just below the thermocline up to 5 NTUs within a few meters above the lake floor. We speculate that the bottom water nepheloid layers are accumulations of resuspended fine-grained sediments and/or allochthonous material that are transported to the lake floor by
density currents, and the denser grid of sites in Cayuga Lake during 2007 revealed larger benthic turbidity closer to major rivers however, more research is required to confirm this hypothesis during years with more runoff.

Secchi Disk, Chlorophyll-a, TSS Data: Average secchi disk depths were deepest in Canandaigua (~7 m) and Skaneateles Lakes (~9 m), and shallowest in Owasco, Cayuga, Honeoye and Seneca Lakes (~3 to 4 m). This trend mimicked variability in chlorophyll-a concentrations (summer surface lake mean concentrations from 0.7 to 34 ug/L) and a lesser extent TSS data.

**Nutrient Data:** Mean nitrate concentrations were again largest in Cayuga, Owasco, Seneca and Skaneateles Lakes (0.5 to 0.9 mg/L), and smallest in Canandaigua, Keuka and Honeoye Lakes (0 to 0.2 mg/L). Bottom water samples had more (up to 1 mg/L) nitrates than surface water, especially in the September samples. It suggests that phosphate is the limiting nutrient in all but Honeoye Lake, or late in the season.

Soluble reactive phosphate (SRP) concentrations were consistently largest in Honeoye Lake. The annual mean phosphate concentrations in the other lakes were below 2.0 µg/L. From year to year, concentrations were larger in 2006 compared to 2005 and 2007, perhaps reflecting greater runoff of phosphates due to more precipitation in 2006. The largest hypolimetic SRP concentrations were detected in Cayuga Lake (8 – 10 µg/L), and its source is probably linked to the source of the nepheloid layer.

Mean total phosphate concentrations ranged from 4 µg/L in Skaneateles Lake to 35 µg/L in Honeoye Lake. The Honeoye mean concentration exceeded results detected in earlier years and is due to a massive bloom (TP > 80 µg/L) on 7/18 perhaps stimulated by anoxic bottom water remobilization of phosphates from the sediments.
Surface water soluble reactive silica (SRSi) concentrations in 2005 were largest in Canandaigua (1100 µg/L), Honeoye (800 µg/L), Owasco (700 µg/L) and Keuka Lakes (600 µg/L), and smallest in Seneca (200 µg/L) and Skaneateles (200 µg/L) Lakes. From 2005 to 2006, silica concentrations increased by 200 to 400 µg/L in Cayuga and Skaneateles Lakes, but then stabilized or declined slightly in 2007. Bottom water silica concentrations were typically larger than the surface waters, with the largest increase with water depth in Owasco Lake (~800 µg/L).

In 2005, Owasco, Seneca and Honeoye Lakes were ranked the most productive lakes, whereas Keuka, Canandaigua and Skaneateles Lakes were ranked the least productive lakes based on annually averaged secchi depths, phosphate, nitrate, chlorophyll-a, total coliform and E. coli bacteria concentrations. In 2006, this order changed slightly as Cayuga was ranked more productive and Seneca Lake less productive but the change probably reflects the lack of bacteria data and inclusion of total phosphate data in 2006.

In 2007, the rank for Owasco Lake decreased below Cayuga and Seneca Lakes. Nutrient loading by streams from agricultural activities, municipal wastewater treatment facilities, residential areas and on-site septic systems are evident in the Seneca and Owasco watershed. The Owasco stream data revealed lower TP and SRP fluxes in 2007 than 2006. It suggests that the 2007 rank reflects the smaller influx of nutrients, perhaps due to less precipitation. We believe that the other lakes were not impacted to the same extent because the residence time is much smaller in Owasco Lake than Cayuga and Seneca Lakes. It also suggests that water quality in Owasco Lake will stay improved if point and non point sources of nutrients are consistently reduced in the future.
Previous studies of water quality in Owasco Lake and its major tributaries have indicated elevated nutrients and suspended solids levels, potentially due to a variety of anthropogenic impacts. The southern region of the watershed contributes significant point sources of pollution via wastewater treatment outfall, localized urbanization, and agriculture, while the northern region of the watershed is experiencing impacts from new construction of residential developments and agricultural activities. To assess these impacts on the biotic integrity of the watershed, benthic macroinvertebrates were surveyed at nine (9) major tributaries, including Veness Creek, Sucker Brook, Dutch Hollow (northern sites), and six (6) sites along the Owasco Lake Inlet (Groton, County Line, Locke, and Moravia, as well as Hemlock and Mill Creeks; southern sites). Macroinvertebrates were collected using a kick sampling method in riffle habitat, and stream channel observations were recorded. Each sample was subsampled and sorted in the laboratory, and macroinvertebrates were identified to family. The richness of macroinvertebrates by order was highest in Sucker Brook and Veness Creek, however family richness was highest at sites draining into and along the inlet (Mill Creek, Groton). EPT richness, a common biotic indicator of stream health, was highest at Hemlock Creek, Locke along the inlet, and Mill Creek, respectively. The biotic integrity was lowest at Dutch Hollow, County Line along the inlet, and Veness Creek. Together with previous nutrient analyses, these data suggest that effluent from the Groton wastewater treatment facility located between Groton and the County Line site along the inlet may impair the biotic integrity locally. However, the macroinvertebrate assemblage further downstream does not exhibit significant impacts. Upstream land use at sites in the northern region of the Owasco Lake watershed shows significantly reduced biotic integrity, particularly at Dutch Hollow. Further assessment of upstream land use and remediation of elevated stream nutrients and suspended solids in the Owasco Lake Inlet and Dutch Hollow will be crucial to improving and maintaining a healthy watershed.
As part of a comprehensive limnological study of Owasco Lake, we studied the macrophyte communities and the growing conditions that influence their occurrence and abundance. The littoral zone was best developed in the shoals at the north and south ends of the lake basin where we established 12 and 15 sites, respectively, and repetitively collected standing crop biomass in June, July and August. An additional 12 sites along the eastern and western shorelines were studied in August. Water depth was measured with a calibrated staff gage or secchi disk sounding line. Substrate samples were collected from every site and analyzed for texture, pH, organic matter content and phosphorus concentration.

All field sampling took place in submerged ½ m$^2$ quadrat frames and was accomplished through SCUBA diving in deep waters and by snorkeling in shallow waters. Quadrat samples were rinsed in situ, transported to campus and immediately refrigerated. Within five days, all samples were sorted by species, placed in paper bags, then air dried in the college greenhouse. Results were recorded as dry weight biomass/m$^2$. Monthly standing crop biomass varied by site with some locations exceeding 1200 g/m$^2$. Annual productivity was estimated as the sum of peak standing crop biomass of a species, whether that occurred in June, July or August, on a site by site basis. Richness within quadrat frames varied from two to eleven species. Correlations between growing conditions and standing crop biomass were examined in an attempt to better understand the patterns and processes in these macrophyte communities.

Eighteen different species were encountered during the course of the study, including 16 vascular plants, one aquatic moss and one macro-algae (Table 1). Two species, curly leaf pondweed and Eurasian milfoil, are considered invasive. They were widely distributed in the lake and often acquired dominance in the stand. Exceptionally dense growth of the native elodea was noted at the south end of the lake. A New York State rare species (ranked S1 by the NYS Heritage Program), spotted pondweed, was sporadic in the north end of the lake.
TABLE 1 – Submersed aquatic plant species found growing in the macrophyte communities of Owasco Lake.

**Vascular Plants**

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coontail</td>
<td><em>Ceratophyllum demersum</em></td>
</tr>
<tr>
<td>Elodea</td>
<td><em>Elodea canadensis</em></td>
</tr>
<tr>
<td>Water stargrass</td>
<td><em>Heteranthera dubia</em></td>
</tr>
<tr>
<td>Eurasian milfoil</td>
<td><em>Myriophyllum spicatum</em></td>
</tr>
<tr>
<td>Slender naiad</td>
<td><em>Najas flexilis</em></td>
</tr>
<tr>
<td>Southern naiad</td>
<td><em>Najas guadalupensis</em></td>
</tr>
<tr>
<td>Large leaf pondweed</td>
<td><em>Potamogeton amplifolius</em></td>
</tr>
<tr>
<td>Curly leaf pondweed</td>
<td><em>Potamogeton crispus</em></td>
</tr>
<tr>
<td>Leafy pondweed</td>
<td><em>Potamogeton foliosus</em></td>
</tr>
<tr>
<td>Grass leaf pondweed</td>
<td><em>Potamogeton gramineus</em></td>
</tr>
<tr>
<td>Spotted pondweed</td>
<td><em>Potamogeton pulcher</em></td>
</tr>
<tr>
<td>Small pondweed</td>
<td><em>Potamogeton pusillus</em></td>
</tr>
<tr>
<td>Flat stem pondweed</td>
<td><em>Potamogeton zosteriformis</em></td>
</tr>
<tr>
<td>Stiff white water buttercup</td>
<td><em>Ranunculus longirostris</em></td>
</tr>
<tr>
<td>Sago pondweed</td>
<td><em>Stuckenia pectinata</em></td>
</tr>
<tr>
<td>Eel grass</td>
<td><em>Vallisneria americana</em></td>
</tr>
</tbody>
</table>

**Non-vascular Plants**

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic moss</td>
<td><em>Fontinalis sp.</em></td>
</tr>
<tr>
<td>Stonewort</td>
<td><em>Chara sp.</em></td>
</tr>
</tbody>
</table>
CURRENT STATUS OF NATIVE AMPHIPOD *DIPOREIA SP.* AND ZEBRA MUSSELS IN OWASCO LAKE

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The native benthic amphipod *Diporeia spp.* plays a key role in the Great Lakes, and Finger Lakes food webs. The recent rapid decline of *Diporeia* in the Great Lakes, thought to be linked to the invasion of quagga mussels (*Dreissena bugensis*), has brought special attention to the populations of *Diporeia* in the Finger Lakes. We updated the status of *Diporeia* and zebra mussels (*Dreissena polymorpha*) in Owasco Lake using a lake-wide benthic survey in June 2007. Triplicate benthic samples were collected along a north-south transect of Owasco Lake at 10m intervals from 10 to 50m using a ponar dredge. *Diporeia* were abundant (up to 2000 *Diporeia* per square meter) at depths of 20-40m at the north and south ends of the lake. *Dreissena polymorpha* densities were up to 29000 per square meter but restricted to sites < 20m. Few *Diporeia* were found in association with *Dreissena*; *Diporeia* were generally found at depths greater than 20 meters, whereas *D. polymorpha* were abundant at depths of less than 20 meters. Results of this study indicate that populations of *Diporeia* are stable in Owasco Lake although this could change if *D. bugensis* populations develop and expand into profundal areas of the lake.

![Abundance of Diporeia (sq. m)](image)

Fig. 1. Site 1 is the 10m depth site at the north end of the lake. Site 6 is the 10m depth site on the south end of the lake. Site depths increase 10m as they converge upon the
middle of the chart. The deepest depth being 50m. Both the north and south ends of the lake have healthy abundances of *Diporeia*.

![Graph showing number of adult Diporeia per site](image)

**Fig. 2.** Site 1 is the 10m depth site at the north end of the lake. Site 6 is the 10m depth site on the south end of the lake. Site depths increase 10m as they converge upon the middle of the chart. The deepest depth being 50m. The south end of the lake has much higher numbers of adult *Diporeia* which may indicate that the populations in the south end may be healthier than those in the north.
ZOOPA LANKTON AS INDICATORS OF PRODUCTIVITY AND WATER QUALITY IN OWASCO LAKE

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In recent years, macrophyte stands and phytoplankton blooms have become more common in Owasco Lake (NYS Finger Lakes). This increase in primary productivity may result from increased nutrient loading through agriculture run-off, waterfowl and human waste, or natural phosphorus inputs. Productivity shifts may also be the result of changes to the lake’s food web, such as increased zooplankton biomass or decreased abundance of fish-eating fishes, which can cascade down to effect the primary producers. Regardless of its cause, increased lake productivity causes concern about the health of the ecosystem and species that occupy the lake, safety of drinking water, and quality of life for lake residents and visitors.

Scientists employ multiple techniques to quantify the primary productivity and trophic status of a lake. These measures are useful for tracking inter- and intra-annual changes within a lake and among groups of lakes. Our study compared some of the traditional methods with a biomonitoring approach. We sampled Owasco Lake every other week from May until August 2007. At two stations (north and middle portions of the lake) vertical profiles of Chlorophyll a and dissolved oxygen concentration were collected. Secchi depth transparency was also determined. These measures, along with other chemical and physical proxies, are routinely used to determine and monitor changes in a lake’s productivity.

Since zooplankton are affected on a short temporal scale by both bottom-up (nutrient additions) and top-down (predation) processes, their status has been used to gauge ecosystem health and primary productivity. Specially, measures of zooplankton community composition can give a accurate portrayal of lake trophic structure and dynamics. We collected zooplankton samples with vertical net tows at the same location and times as the aforementioned limnological samples. In the lab, zooplankton samples were identified to the genus level and the Gannon index (Gannon and Stremberger 1978) was used to assess relative lake productivity. The Gannon index is defined as the density ratio between Calanoid copepods, which are typically dominate during times of low productivity, and the sum of Cladocerans and Cyclopoid copepods, which are more ubiquitous in higher productivity systems. We also calculated size and diversity indices to contextualize the zooplankton community with regard to bottom-up and top-down processes.
In Owasco Lake, Chlorophyll $a$ concentration was relatively high during spring ($\geq 2$ mg/m$^3$), declined in early summer ($\leq 1$ mg/m$^3$), and then increased again in mid-summer. This pattern is typical of north temperate lakes where an early summer decrease in primary production is caused by the onset of herbivorous Cladocerans, which can control the spring phytoplankton bloom. This is mirrored in our data by reciprocal trends in the Gannon index, showing that during periods of high primary production herbivorous Cladocerans are rare in this lake. The out-of-phase relationship between Chlorophyll $a$ and the Gannon index is weak after mid-July, which is likely the result of increased predation influencing the zooplankton assemblage. The patterns for Secchi transparency and zooplankton size and diversity confirm this general pattern. Overall, zooplankton composition data agree well with other data measures of productivity in Owasco Lake.
THE POTENTIAL LINK BETWEEN LAKE PRODUCTIVITY AND AN INVASIVE ZOOPLANKTON IN OWASCO LAKE

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The fishhook waterflea (Cercopagis pengoi) is an invasive carnivorous plankter, which has recently been introduced to North America from Eurasia. Its range expansion has been particularly successful in the Finger Lakes region of New York State. Carnivorous zooplankton can play a critical role in the functioning of aquatic foodwebs. These invertebrate predators, including C. pengoi, directly impact the abundance and diversity of herbivorous zooplankton through consumption of small Cladocera. Indirectly, they may also influence algal growth and lake productivity through trophic cascades (e.g., C. pengoi decreases the abundance of herbivorous, which consequently releases algae from grazing). In the last decade, Owasco Lake (Finger Lakes, NYS) has been invaded by C. pengoi. Over approximately the same time frame, algal productivity has increased and water quality has declined. One hypothesis for the concurrent changes in Owasco’s trophic is the release of algae from herbivory due to the invasion of C. pengoi.

We sampled Owasco Lake biweekly at three locations in the summer of 2007 to estimate carnivorous and herbivorous plankton density, algal productivity (measure by an in-situ fluorometer), and other standard limnological conditions. Our goals were to (1) document summer density dynamics of C. pengoi and native invertebrate predators (2) investigate correlations between C. pengoi and the abiotic environment, and (3) examine the relationships among C. pengoi, herbivorous zooplankton, and algal productivity.

In Owasco Lake, C. pengoi exhibits a single peak in density during mid-summer (~250 ind./m³) when surface temperatures reached 20°C. This abundance far exceeds that of the native invertebrate predator, Leptodora kindti, which had a peak density of 40 ind./m³ only after the decline of C. pengoi in late summer. Our preliminary results show reciprocal correlations between C. pengoi density and herbivorous Cladocera density, and between herbivorous Cladocera density and algal productivity. When C. pengoi densities are high, herbivorous Cladocera density is low, and algal productivity is high. Although these trends are only corollary and not cause-and-effect, they supports the possibility that C. pengoi may be affecting the water quality of Owasco Lake by reducing grazing zooplankton, which in turn control algal density. Certainly other factors must influence the trophic dynamics of Owasco Lake, including nutrient contributions from streams and the surrounding landscape, and stocking and removal of fishes. Continued
investigation of these parameters, as well as investigation of the historical conditions in the lake, will help us better understand and contextualize the relative role of these perturbations to the ecology of Owasco Lake.
WHAT HAPPENED TO OUR LAKE? NUTRIENT LOADING IN OWASCO LAKE AND ITS WATERSHED

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Owasco Lake is one of the 11 Finger Lakes of central New York. It is a source of Class AA drinking water for over 58,000 people, as well as a major recreational resource. After winning Best Tasting Drinking Water in 1997, water quality has declined in the lake. Halfman and Bush (2006) stated that Owasco Lake had the worst water quality of the 7 central Finger Lakes studied as well as poorest water quality protection legislation and/or enforcement. We present the results of a two-year study to track the changes in and nutrient sources to the lake, and outline potential remediation efforts.

Biweekly sampling from May to October in 2006 and 2007, collected lake surface water at 11 sites and bottom water at 2 sites distributed along the long axis of the lake. At each site a CTD profile was collected, secchi disk, temperature, conductivity, pH, dissolved oxygen, and alkalinity were measured, and water collected for subsequent major ion, total suspended solid, total and dissolved phosphate, nitrate, dissolved silica, and chlorophyll analyses back in the laboratory.

The 2006 results indicated that the southern end of the lake was much more productive, thus had worse water quality than the rest of the lake. Biweekly sampling of 7 streams during May-Oct in both years including a 4-site segment analysis of the Owasco Inlet investigated potential nutrient sources to the lake. The Owasco Inlet provides 55% of the surface water to the lake, and enters at the southern end. The remaining water enters from Dutch Hollow Creek (20%), Veness and Sucker Brooks (15%), and other minor tributaries (10%). In 2006, higher concentrations of nutrients were detected in the Owasco Inlet than the other tributaries. The segment analysis revealed nutrient sources from a waste treatment plant, and other agricultural and onsite septic sources. Deeper secchi disk depths, larger salinities, and smaller nutrient concentrations were detected throughout the lake in 2007 than 2006. Nutrient fluxes decreased from 2006 to 2007 in the streams as well. The change may be due to smaller amounts of rain in 2007, which decreased runoff of these nutrients from the watershed. The 2006 to 2007 improvement in water quality suggests that decreasing nutrient sources to the streams will allow for future water quality improvement during normal rain years.
American eel (*Anguilla rostrata*) has historically been a key component of fish communities in the freshwater ecosystem. This catadromous native fish spawns in the Sargasso Sea and uses inland rivers and lakes as rearing habitat, and historically comprised up to 40% of fish biomass in some habitats. As a step in the ongoing development of a series of management recommendations for American eel conservation in New York watersheds, we are compiling and mapping historic and current American eel population data for each basin. In the Finger Lakes region and East through Onondaga and Oneida Lakes, eel were of great importance to First Nations residents through the early 20th century. The Finger Lakes and the Oswego River basin supported a significant commercial eel fishery. There is overwhelming evidence of a widespread decline in eel numbers, with some watersheds (Lake Ontario – Saint Lawrence River basin) containing <1% of historic eel population levels. Identified challenges include dams and other barriers that may restrict eel migration into potentially productive habitat, pollution, and other factors. We present current information on the history and recent status of the eel, and associated eel habitat estimates in the Finger Lakes watershed.
Frequent episodes of benthic anoxia result in the release of deepwater sediment phosphorus into Honeoye Lake. This internal nutrient loading is a significant portion of the lake’s total phosphorus budget and contributes to the lake’s eutrophic status. Alum treatment of deepwater substrates was selected as a nutrient management technique, with the chemical application undertaken during September 2006. To assess possible impacts on benthic organisms, a pre-treatment survey was conducted in July 2005 and a post-treatment survey was conducted in November 2006. Both surveys assessed benthic species richness and total abundance of organisms, and led to the calculation of several biotic community health indices. In both surveys, replicates from three different water depths were collected by standard Ponar dredge. Eighteen samples were taken within the 400 hectare treatment zone and nine were in the immediately adjacent deep edge of the littoral zone.

Pre-treatment survey results: Excluding benthic resting stages, sediment at deep sites (9 m) had the lowest richness (6 taxa) with a density of 960 individuals/m$^2$. Midge fly larvae (*Chironomus* sp.) and annelid worms (*Branchiura sowerbyi*) dominated while phantom midge larvae (*Chaoborus punctipennas*) were frequent. Sediment from moderately deep sites (7 m) had intermediate richness (9 taxa) with a density of 833 individuals/m$^2$. These samples also had abundant midge fly larvae, annelids and finger nail clams (*Pisidium* sp.). Sediment of shallow sites (5 m) had the highest pre-treatment richness (17 taxa) with a density of 1528 individuals/m$^2$. In addition to midge fly larvae and annelids, these sites also contained adult zebra mussels (*Dreissena polymorpha*), banded mystery snails (*Viviparous georgianus*), two other snails (*Valvata tricarinata* and *Physa* sp.), a leech (*Hirudinea*), aquatic sowbugs (*Asellus* sp.), scuds (*Gammarus* sp.), alder fly larvae (*Sialis* sp.) and a roundworm (*Nematoda*). Benthic resting stages were dominated by abundant cladoceran ephippium and statoblasts of the bryozoan, *Pectinatella magnifica*. Incidental capture of pelagic organisms while the dredge was traveling to the bottom sediment revealed a variety of zooplankton and even one fish!

Post-treatment survey results: Excluding benthic resting stages, sediment at deep sites (9 m) contained 14 taxa with a density of 1125 individuals/m$^2$. Midge fly larvae (*Chironomus* sp. and *Procladius* sp.) and phantom midge larvae (*Chaoborus punctipennas*) dominated while annelid worms (*Branchiura sowerbyi*) were frequent.
These replicates also contained finger nail clams (*Pisidium* sp.) and ostracods (c.f. *Darwinula* sp.). Sediment from moderately deep sites (7 m) contained 18 taxa with a density of 1850 individuals/m$^2$. These samples had abundant midge fly larvae, phantom midge larvae, annelids, finger nail clams, adult zebra mussels (*Dreissena polymorpha*) and ostracods. Sediment of shallow sites (5 m) had the highest richness (22 taxa) and greatest density (6690 individuals/m$^2$). These sites were dominated by adult zebra mussels but also contained banded mystery snails (*Viviparous georgianus*), three other snails (*Valvata tricarinata*, *Gyraulus* sp. and *Physa* sp.), a leech (Hirudinea), aquatic sowbugs (*Asellus* sp.), scuds (*Gammarus* sp.) and alder fly larvae (*Sialis* sp.). Benthic resting stages included extremely large numbers of Cladoceran ephippium with abundant statoblasts of the bryozoan, *Pectinatella magnifica*. Incidental capture of pelagic organisms while the dredge was traveling to the bottom sediment again revealed a variety of zooplankton.

Compared to the pre-treatment dredge samples, the post-treatment collections consistently had greater species richness (Figure 1) and higher numbers of organisms (Figure 2) at all water depths. One possible explanation for greater richness involves the difference in the time of the year when sampling occurred. Late season sampling may capture more species because it coincides with dispersal stages in the life cycle of several macro-invertebrates. The random dispersal of typically shallow water species into deep water sites that was detected here, however, does not guarantee long-term survival and persistence in those deep water locations, especially when harsh environmental conditions are known to occur at such depths under the winter ice. The ultimate fate of these colonizers is unknown. One possible explanation for the higher numbers of organisms in the post-treatment samples is that samples were taken at the end of the growing season allowing a longer time for reproduction and the resulting increase in population size for a given species. This seems particularly relevant to the extremely large increases in adult zebra mussels in the 5 m depth zone during November.

Despite these changes in species richness and total abundance, a comparison of the relative dominance of species before and after alum treatment suggests little change in macrobenthos community structure and no apparent negative impact from the chemical treatment of the substrate with alum. Rather, changes detected seem attributable to the differences in the individual life histories of dominant species in the community, revealed here because of the two distinct times of the year when samples were collected. In the future, it would be instructive to repeat sampling at one or both of the time periods used in these surveys, thereby allowing for a more valid comparison.
FIGURE 1 – Richness before and after alum treatment, based on pooled replicates (n = 9) dredged from three water depth zones in Honeoye Lake.

FIGURE 2 – Density before and after alum treatment, based on pooled replicates (n = 9) dredged from three water depth zones in Honeoye Lake. In November 2006, zebra mussel densities (number of individuals/m²) were 4899, 186 and 13 for the 5 meter, 7 meter and 9 meter zone, respectively.
LITTORAL ZONE BOTTOM HABITAT AND THE OCCURRENCE OF EURASIAN WATERMILFOIL IN SKANEATELES LAKE, NY

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The invasive aquatic plant Eurasian Watermilfoil (*Myriophyllum spicatum*) has increased dramatically from 2001 to 2006 in Skaneateles Lake. Eurasian watermilfoil negatively impacts freshwater lakes by 1) aggressively overtaking habitat normally occupied by native plants and species; 2) creating dense vegetation baffles that trap nutrient rich sediment near the shore; 3) clogging the inshore waters of the lake and thus inhibiting recreational activity; 4) obstructing water intake pipes used as a local and municipal water supply; and possibly acting as a nutrient pump by extracting nutrients from the sediment and dispersing them into the water column.

A sediment sampling program is currently underway, and is comprised of 50 shallow water transects at approximately one kilometer spacing around the entire edge of the lake. The transects extend from the shoreline to water depths of ~8 m (26 ft), covering the primary habitat of the watermilfoil. The project objective is to map the bottom type and characterize the sediment grain size distribution around the entire lake margin. The samples are being collected using an Eckman dredge, and an autonomous GPS unit issued to locate the sample sites. A subset of samples is also being collected directly by divers. Further studies will be conducted using a side-scanning sonar unit to map the extent of the watermilfoil growth, and to provide further insight into the habitat of the plant.
Succession of dominant arboreal species in the paleobotanical record has been a key instrument in demonstrating climate and environmental change from the Late Glacial Period to the present in the northeastern United States. Past studies of pollen data found in sediment cores from sites in the Northeast indicate a shift from colder climates supporting spruce-fir-grassland environments to progressively moister, warmer climates of pine-hemlock forests to still warmer, drier oak-birch-beech-hemlock forest environments. While pollen records provide a broad picture of changing vegetation assemblages through time, the analysis of plant macrofossils preserved in lake and bog sediments provides a more detailed, species-specific understanding of prior vegetation. In New York State, the regional coverage of macrofossil studies is poor, and few studies exist for the Finger Lakes Region in particular.

In this ongoing study, we seek to address this imbalance by continuing our analysis of the macrofossil record of Purvis Road Bog, located near Dryden, New York. Purvis Road Bog is one of upstate New York’s so-called “quaking bogs,” formed in glacial kettle ponds that have progressively filled in since the Late Glacial Period with thick mats of sphagnum mosses. The macrofossils being analyzed were sampled from sediment cores taken from areas on the bog in 2006 and a radiocarbon dated core obtained in 2004. These cores were obtained from basal depths and appear to represent the transition from pond to early bog environments. Our study is looking at similarities and differences in terrestrial and aquatic macrofossil species distribution between the cores as well as lithological changes. This data will then be analyzed to reconstruct local successional changes from lake to peat bog, as well as broader regional climatic changes that may have affected the kettle lake-peat bog environment.


Temperate peat land deposits provide a long-term, continuous archive of paleoclimate conditions for much of the Holocene. Here we present a preliminary reconstruction of late Holocene paleohydrology, focusing on a site in upstate New York.

A 12m long sediment core was collected from an ombrotrophic bog in the O.D. Von Engeln Preserve in Dryden. The Preserve is about 35 acres in size, and comprises a variety of wetland habitats, including swamp, mineratrophic fen, and ombrotrophic peat bog. The ombrotrophic bog was formed in a glacial kettle and over time has been isolated from the ground water that flows through the rest of the wetland by the buildup of sediment and organic matter. The surface of the bog receives moisture only from precipitation and is blanketed by a variety of Sphagnum mosses and the protected carnivorous pitcher plant (Sarracenia purpurea), which thrives in the acidic bog conditions.

Fossil testate amoebae assemblages were used to reconstruct past changes in surface hydrology at the site. Testate amoebae are a group of protists (unicellular animals) which form external shells (tests) and live in freshwaters and wet soils. They are sensitive to changes in water level and so are ideal for reconstructing changes in ombrotrophic bog hydrology resulting from natural variability in precipitation. Preliminary analysis of the testate amoebae assemblages in the core indicates distinct trends in moisture variability over the past several thousand years.
HYDROTHERMAL/TRANSPORT MODELS FOR THE THREE EASTERNMOST FINGER LAKES: OWASCO, SKANEATELES, AND OTISCO LAKES

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A two-dimensional (longitudinal and vertical) hydrothermal/transport model, CE-QUAL-W2, was setup and tested for Owasco Lake, Skaneateles Lake, and Otisco Lake (Figure 1). The model assumes lateral uniformity, a common representation for lakes such as these with long, relatively narrow, configurations. The vertical layers were one meter thick. There were 18 longitudinal model segments for Owasco, 24 for Skaneateles and 19 for Otisco. The dimensions of these segmentations were specified according to detailed bathymetric information for each lake. Model inputs included local meteorology, the results of flow budget analyses, stream temperatures and specific conductance, and light extinction coefficient measurements for each lake. The models were calibrated against independently documented thermal stratification regimes of each of the three lakes. The model performed well (Figure 2) in simulating this regime, including the timing of onset and loss of stratification, layer dimensions, and the dynamics of the temperatures of the layers.

The models can presently serve to simulate not only the thermal stratification regimes of the lakes, but also the transport of conservative substances, and the response to “spills” (e.g. Owasco Lake; Figure 3). Moreover, these hydrothermal/transport models can serve as the physical frameworks for future water quality models for these lakes. This capability would be reached by adding appropriate kinetic representations of the various source and sink processes for the constituent(s) of interest.
Figure 1. Model Segmentation for (a) Owasco, (b) Skaneateles, and (c) Otisco, Lakes.

Figure 2. Model observations and predictions for (a) Owasco, (b) Skaneateles, and (c) Otisco, Lakes.
Figure 3. Demonstration of Model ability to simulate a conservative tracer in Owasco Lake for two different environmental conditions, (a) low winds and warm stream for a June runoff event, and (b) high winds cool stream for a September runoff event.
Every lake sits at the bottom of a watershed and is thus influenced by the natural and cultural activities that occur in its surrounding upland landscape. Many Finger Lakes studies focus on lake water quality or tributary stream chemistry (especially following storm events) and attempt to link these through sophisticated computer models that take into account local topography, soils and meteorological data. The usual outcome is a lake nutrient budget that can be utilized by local resource managers for prioritizing decisions about where to implement best management practices. To validate these models, however, also requires knowledge of land use and land cover within each tributary and direct drainage sub-basin of the lake watershed. Real property code classifications are both insufficient and inaccurate for this purpose. Interpretation of aerial imagery alone is prone to error. We combined aerial interpretation with extensive ground surveys to create a “truth image” of the Honeoye Lake watershed. Data files were attributed using the hierarchical classification system of the New York Natural Heritage Program, a widely used and accepted method of ecological community classification in the state. The latest edition is available online at their website, http://www.nynhp.org. Although time-consuming, our research provides superbly detailed and comprehensive watershed information that we believe is critical to the success of holistic management for Honeoye Lake. Our data has already been used to improve the latest nutrient budget model for the lake.

We recognize 10 sub-basins within the larger Honeoye Lake watershed (see the following map). Five sub-basins are drained by perennial streams and collectively account for 76% of the total watershed area. The other five are drained through intermittent streams and/or by direct runoff to the lake, and account for 24% of the total watershed area. Within these 10 sub-basins we mapped and attributed over 3000 polygons representing 32 community cover types belonging to one of four major systems: riverine, lacustrine, palustrine or terrestrial. The cover types ranged from small cultural features like farm ponds to large natural features like extensive tracts of Appalachian oak-hickory forests. Because the New York Natural Heritage Program also ranks each cover type for its rarity, we were able to identify communities such as silver maple-ash swamp and shale talus slope woodland that have statewide significance.
Overall, the mosaic pattern of cover types helps to explain the tremendous biodiversity of the Honeoye Valley.
IDENTIFYING THE ROLE OF PATHOGENS IN THE LOSS OF THE NATIVE BENTHIC AMPHIPOD *DIPOREIA* IN THE GREAT LAKES

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Populations of the native benthic amphipod *Diporeia* sp. have rapidly declined since 1995 in all of the Great Lakes except for Lake Superior. This decline has been associated with the expansion of Eurasian zebra and quagga mussels (*Dreissena* sp.) after their introduction to the Great Lakes via ballast water exchange. *Dreissena* have not been successful in Lake Superior because of low calcium levels and low water temperatures. *Diporeia* populations have also not declined in the New York Finger Lakes despite the presence of abundant *Dreissena*. We collected *Diporeia* and *Dreissena* from each of the Great Lakes aboard the EPA R/V Lake Guardian in August, 2007. *Diporeia* were sampled for estimating abundance, genetic variation, microbial faunal variation and pathogen infection. We also collected live *Diporeia* and *Dreissena* to bring back to Cornell for an experiment exposing *Diporeia* to *Dreissena* from Great Lakes and Finger Lakes starting in Fall, 2007. Our primary hypothesis is that *Dreissena* from the Great Lakes transmit a pathogen to *Diporeia* that are not present within Finger Lakes populations of *Dreissena*. Our experiments coupled with the identification of specific pathogens seeks to pinpoint a causal agent in the decline as well as to evaluate the role of the dreissenids as pathogen vectors.