While providing an opportunity to meet others interested in environmental science and scholarship, this conference highlights Finger Lakes scientific research particularly as it pertains to issues related to the Finger Lakes of western and central New York State. Funding for this conference is provided by NYS through the advocacy of Senator Michael F. Nozzolio.
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MODELING SEDIMENT LOAD IN ONEIDA CREEK USING DWSM

Maria Josefson, MA’11

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Oneida Lake, located in Central New York, is the largest lake in New York State and a valuable natural resource for the area. While not recognized as one of the Finger Lakes, it is sometimes referred to as the "Thumb of the Finger Lakes." Accelerated erosion and the delivery of sediment and sediment-adsorbed pollutants are issues of concern in the Oneida Lake watershed which encompasses 1,364 square miles. Oneida Creek, one of Oneida Lake’s seven major tributaries, is the primary source of total suspended solids for the lake. This study aims to quantify event-based sediment load and spatial distribution of sediment sources for a major subwatershed of Oneida Creek using a lumped watershed model, Dynamic Watershed Simulation Model (DWSM). The model describes hydrological, soil erosion and sediment transport processes for each hillslope element and its receiving channel reach, delineated from the test subwatershed. Model outputs include water discharge and sediment load for both the test subwatershed and its element components. Using water discharge and sediment load data collected during two rainstorm events in 2009, the DWSM model was calibrated and validated for predicting event-based sediment load. This model may be further used to assess seasonal and annual sediment loads of the test subwatershed.
GIS MODEL TO PREDICT SUBMERGED AQUATIC VEGETATION GROWTH IN ONEIDA LAKE

Nathan Burtch

Submerged aquatic vegetation (SAV) has always been a contentious issue among those who either own lake front property or use the lake recreationally. There are several factors that influence the growth of SAV; important physical and chemical factors include depth, fetch, ice scour, latitude, altitude, nutrient concentrations, shoreline development, slope, substrate type, water clarity, and water levels. The onset of invasive species such as zebra mussels and Eurasian milfoil, have greatly affected factors such as water clarity and nutrient concentrations and increased competition with native SAV species.

This presentation represents a portion of research collaboration on Oneida Lake with the Finger Lakes Institute and Cornell University. A GIS-based model was created to determine the predicted SAV growth areas on Oneida Lake for the past, present, and future, using lake bathymetry, fetch calculations, and water clarity data. The bathymetric surface was created using kriging of acoustic sounding depth data points, while fetch (the effective distance wind travels over water) was calculated using a flow accumulation model. The resulting raster analysis shows where SAV growth changes based on water clarity.
LOCATING KARST FEATURES SENSITIVE TO FERTILIZER APPLICATION IN THE ONONDAGA FORMATION

Paul L. Richards, Jill Libby, Alex Kuhl, Mike Lyzwa and Tim Daniluk

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Assistant Professor

A careful analysis of surface depressions, fracture trace features, gas logs and aerial photography in conjunction with field surveys was used to map areas that are sensitive to groundwater contamination. The study was conducted on the Onondaga FM in Genesee County, an area which has suffered two recent groundwater contamination events that have been attributed to fertilizer contamination on thinly-soiled karst. The methodology consisted of identifying closed sinks in a 10 meter digital elevation model (DEM) and using aerial photography and mapping fracture traces to identify sites of concern. Aerial photography were then analyzed for evidence of hydrologic activity and the sites were superimposed on existing hydrography to identify swallets and isolated streams. Gas logs and available well construction reports were evaluated to determine depth to bedrock. The results suggest many scales of closed depressions exist in the Onondaga FM. These features resulted from a complex history of karst and glacial processes as well as anthropogenic activities such as quarrying and landscape alteration. Fracture traces, particularly those that are parallel to the the major fracture systems (N20-55E and E10-55S), contained systems of sinkholes. Based on previous research and the results of 41 field surveys the features were classified into six types of features (Figure 1). These types include solution sinkholes, pattern ground sinkholes, scoured bedrock zones, glacially enhanced sinkholes, glacial depressions and anthropogenic depressions. Solution sinkholes are steeply-walled collapse features that contain blocks of limestone at the bottom. Pattern ground sinkholes are broad areas of shallow depressions and ridges interpreted to be caused by immature sinkholes and popup ridges. Scoured bedrock zones are areas where fractured bedrock have been exposed by glacial meltwater and other erosion processes. Glacially enhanced sinkholes are depressions that are believed to be the surface expression of sinkholes either buried by glacial sediments or modified by glacial erosion. Close inspection using aerial photography show that many of these features are hydrologically active in the early spring. Transducers in wells within three collapse sinkholes demonstrate these features are subject to dynamic increases in water table rises during the early spring. The DEM approach for identifying depressions provided a reasonable starting point for this analysis, however, it missed many features from aerial photography that are interpreted to be sinkholes. Fracture traces mapped from aerial photography and the 24K USGS quadrangles proved useful in identifying sites of concern, however field surveys were essential in interpretation.
“Pattern ground sinkholes”

“Solution sinkhole”

Suspicious Features on Onondaga Formation

Produced by: Dr. Paul L. Richards and Jill Libby

Legend
- Fracture traces
- Shallow soils
- Onondaga Formation

Sinkholes Type
- Anthropogenic
- Exposed Bedrock
- Glacially Enhanced
- Ground Moraine Depression
- Patterned Sinkhole
- Solution Sinkhole

Description of Sinkhole Types

Anthropogenic: Quarries

Exposed Bedrock: Areas with little to no overlying soil

Glacially Enhanced: Thinly solid areas that align with fracture traces and were further scoured by the glacial advance

Ground Moraine Depressions: Thick deposits of soil with no evidence of bedrock but suspicious flooding events or wetland depressions

Patterned Sinkholes: Hummocky terrain with topographic highs and lows covering large areas

Solution Sinkholes: Steep sided sinkholes with bedrock present and suspicious flooding events

Figure 1
WETLAND MITIGATION BANKING SUITABILITY MODEL FOR MONROE COUNTY

Justin D. Cole, GISP

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With the economic growth of Monroe County a need for wetland mitigation banking was required. The GIS Services Division in conjunction with The Engineering Department came up with different sites and their priority. The sites were prioritized by distance from existing wetland characteristics. The characteristics that were measured are soil water holding capacity, distance from wetlands, from water, and certain elevation characteristics (areas of high slope). These characteristics were analyzed using raster classification and were combined to a four-digit cell, which prioritized the areas. These areas were then compared to land that Monroe County controlled. The lands that were picked as high priority were in Monroe County Park Land due to the fact that part of the project is creating educational and multiuse aspects of the wetland. The overall results allowed for not only location of possible sites to construct a wetland but areas that are wetlands or were wetlands in the past. The model also allowed for the flexibility to adjust the values to work in many different regions worldwide.

Figure 1 The Suitability Model

The Key site that was analyzed for the highest possibility of a wetland mitigation bank was on the south of Black Creek Park. This site was chosen because it had a portion, which was classified in the model as being
suitable. Also, due to its watershed location, it is acceptable for any project at the Airport. When ground truthing the site, we discovered monitoring wells from a previous study. After some discussion, it was discovered, that the site was in fact, the alternate for the wetland mitigation, which occurred in the North region of the park. The site to the North was constructed because of ease of access to facilities. The South site was not chosen because of some existing wetlands and too far from a construction head quarters. Currently, we are investigating the site further, and have been taking weekly ground water measurements.

Figure 2 The result of the model showing the site in Black Creek Park. Also shown on the map are the piezometers, soil groups, parcel and park boundaries, and existing water and wetland data. Blue areas are the best suited then green, yellow and red is not usable areas for creation of a mitigation site.
ENVIRONMENTAL ASSESSMENT OF THE OWASCO INLET

Sam Georgian

Department of Biology, Hobart and William Smith Colleges, Geneva, NY

Owasco Lake provides Class AA drinking water to 44,000 people and plays a fundamental role in the agriculture, tourism, and ecology of the Finger Lakes region. The health of the lake has been threatened in the past by nutrient loading via the Owasco Inlet. Several recent studies highlighted the Groton Wastewater Treatment Plant (WWTP) as a major point-source contributor of pollutants into the inlet. A 2006 Department of Environmental Conservation consent order forced the plant to upgrade their facilities and reduce phosphorous discharges from 16 lbs/day to an interim level of 3 lbs/day. We hypothesize that this reduction will restore normal stream functioning in the Owasco Inlet. Here, we present a comprehensive study of the health of the inlet by evaluating water quality, periphyton growth, and macroinvertebrate community structure.

A total of six sites were sampled twice in the fall of 2009. Two sites bracketed the Groton WWTP, two sites bracketed the Moravia WWTP, and two sites were on tributaries to the inlet. On each date, temperature, dissolved oxygen, pH, and specific conductivity were measured with an YSI probe, and a 1 L water sample was collected for later nutrient analysis. A macroinvertebrate sample was conducted on the first sample date and samples were preserved for later identification. Three replicate periphyton tiles were installed at each site on the first sample date and removed three weeks later. The periphyton was scrubbed off of each tile, filtered onto glass fiber filters, dried, and oxidized in order to measure the ash-free dry mass. Preliminary results indicate that while excess phosphorous was present downstream of the Groton WWTP, it did not lead to increased periphyton growth, indicating that the health of the Owasco Inlet may be improving. Macroinvertebrate samples will be analyzed to family level and compared to data from previous studies.
WATERSHED RESTORATION

Charles N. Greene PE, Benjamin Brazell

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Profession: Licensed Agricultural and Civil Engineer, Certified Professional in Erosion & Sediment Control and Stormwater Quality (C. Greene). Environmental Scientist and Regulatory Specialist (B. Brazell).

Watershed restoration requires multi-disciplinary collaboration. Several of the Finger Lakes retain intact wetlands at their southern (primary inlet) ends. Over the past 1000 years, historical changes in the perceived benefits local residents derive from the Finger Lakes have resulted in variations in use of these wetlands. Recent interest in sustainable development and the transfer of economic resources from local businesses and local governments to multi-national corporations are providing opportunities for innovative watershed restoration. The conceptual design and cost-effectiveness of strategies to restore wetland functions and enhance economic benefits to a typical Finger Lake agrarian community will be discussed in an oral presentation.
A multiyear year (August 2006 to April 2009) project was undertaken to monitor phosphorus and sediment inputs to Cayuga Lake. An important component of this work was incorporation of USGS gages and automated sampling equipment on key streams in the watershed. Traditional monitoring techniques, i.e., mobilizing sampling crews and equipment for storms and sampling at pre-set dates, were used in an earlier project (2004-2005). Streams were well characterized in this way but most storm events were missed. The addition of gages and autosamplers allowed for calculation of loadings. The overall goals of the project were to estimate loading to Cayuga Lake and create a database for use in future management decisions. Data from both monitoring periods is presented along with suggested next steps for long term monitoring and adjustments in management approaches.

Cayuga Lake is located in central New York and is one of eleven Finger Lakes. The Finger Lakes were created by glacial retreat and are so named because they are long and narrow. Cayuga Lake is one of the largest Finger Lakes at 38 miles long, up to 3.5 miles wide and 435 feet deep. Its watershed covers 864 square miles. Most of the inputs to Cayuga Lake are from the southern basin. A few smaller tributaries contribute through the middle and northern portion of the Lake. The Seneca River cuts through the northern end of the lake. Its flow is controlled by locks and hydropower facilities. On the balance, Cayuga Lake flows north though the independent operation of hydropower releases and lockages can result in measurable southward flow from the Seneca River into the Lake.

Cayuga Lake is used for drinking water, fishing and recreation. The Seneca River is listed on New York State’s Priority Waterbody List for pathogens and oxygen demand concerns. The southern end of the lake is listed on the state’s 303(d) list as an impaired water body. The pollutants of concern are phosphorus and sediment and pathogens. This area has also been targeted for development of TMDL regulations. Determinations regarding water quality in New York are based on the State’s water quality criteria.

Very little monitoring of the watershed has included discharge calculations. This has seriously hampered the ability to determine loads to the lake. In this study, discharge was measured at USGS gaging stations on three tributaries representing southern, northern and mid watershed inputs to Cayuga Lake. This is a first step in quantifying pollutant loading throughout the lake. It will also be useful information to New York’s Department of Environmental Conservation in managing water quality.

The project emphasis in the earlier study (2004-2005) was monitoring of tributary flow and analysis of tributary and lake suspended sediment and phosphorus. A suite of other parameters including, *Escherichia coli*, turbidity, Secchi disk (lake only) and datasonde (Hydrolab) parameters (pH, temperature, depth, SPC, ammonium, nitrate, and DO) were also measured to assist in the interpretation of the sediment and phosphorus data. A mid-lake transect was monitored to characterize base line conditions in the lake. The goals remain the same for the more recent monitoring (2006-2009) with the inclusion of more realistic loading data as captured using the gages and autosamplers.

Halfman, John D., Hoering, Katherine A., and Rocchio, Andrea M.

Since 2005, the eight eastern Finger Lakes, Honeoye, Canandaigua, Keuka, Seneca, Cayuga, Owasco, Skaneateles, and Otisco (since 2008) were sampled to investigate and compare 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 during the May – October field-seasons. Seneca Lake was investigated in more detail in 2009 with weekly sampling of 4 sites and its major tributaries. Up to 3 additional sites were surveyed in Cayuga Lake. SeaBird CTDs (SBE-19 in 05&06, SBE-25 since) collected water-column profiles of conductivity (reported as specific conductance), temperature, depth, pH, dissolved oxygen, light transmission (SBE-19), PAR (SBE-25), fluorescence (SBE-25), and turbidity (SBE-25). 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. The 2009 results and comparison to earlier years are highlighted below.

CTD Profiles: The temperature profiles were typical for any summer season, similar from one year to the next and reveal the typical development and decay of summer stratification in all but Honeoye. The 2009 Honeoye profiles were isothermal on all but one survey date (May), reflecting the well mixed, shallow (<= 9 m) lake.

Specific conductance in 2009 ranged from 225 µS/cm in Honeoye up to 705 µS/cm in Seneca Lake. Conductivities were 10 to 30 µS/cm smaller in the epilimnion decreasing through the stratified season than the hypolimnion of Cayuga, Canandaigua, Owasco, Otisco, Skaneateles, and Seneca. The largest change was consistently observed in Seneca with conductivities progressively decreasing by 50 µS/cm in the epilimnion but remaining constant in the hypolimnion through the stratified season. The change is interpreted to reflect the dilution of lake water by surface runoff each year of the survey.

Dissolved oxygen in 2009 was nearly saturated throughout the water column in Skaneateles (orthograde profiles). Mid-summer hypolimnetic depletion, especially right below the thermocline was observed in Cayuga, Owasco, and Seneca. The hypolimnion DO concentrations depleted through the stratified season in Canandaigua and Keuka Lakes. Dissolved oxygen depleted to near anoxic conditions in Otisco and occasionally Honeoye (warm and calm days). DO depletion was larger in 2009 than previous years.

Photosynthetically Active Radiation (PAR) in 2009 revealed exponentially decreasing light levels to 1% I₀ by 10 to 30 meters, the lower depths correlating to lakes with smaller algal concentrations. Fluorescence data in 2009 revealed uniform algal concentration in Honeoye and algal peaks up to 2 to 8 mg/m³ in the mid-epilimnion and upper metalimnion of Cayuga, Keuka, Owasco, Otisco and Seneca, and in the upper hypolimnion of Canandaigua and Skaneateles. The largest 2009 algal concentrations were detected during early summer (Cayuga, Keuka, Otisco), mid-summer (Canandaigua, Honeoye, Seneca, Skaneateles), or persisted all summer (Owasco). This timing shifted from previous years for most lakes.

Benthic nepheloid layers were observed in at least one site from Canandaigua, Cayuga, Keuka and Owasco, but not Honeoye, Otisco, Seneca and Skaneateles. The nepheloid layers, when present, persisted through out the survey but their extent varied between lakes and sample dates. The nepheloid layers were best developed in Cayuga and Canandaigua, and more pronounced in 2009 and 2008 than 2007 or 2006 with 2009 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. In Cayuga Lake, nepheloid layers were better developed after precipitation and/or wind events and are interpreted to reflect the accumulation of both resuspended and runoff materials that are transported to the lake floor by density currents.

**Secchi Disk, Chlorophyll-a, TSS Data:** Average secchi disk depths were deepest in Canandaigua (6.5 m) and Skaneateles (7.6 m), and shallowest in Cayuga, Honeoye, Otisco and Owasco (~2.8 to 3.5 m). This trend mimicked variability in chlorophyll-a concentrations (summer surface lake mean concentrations from 1.1 to 14 µg/L) and a lesser extent TSS data. Chlorophyll-concentrations have steadily increased in Seneca and Cayuga since 2006 but decreased in 2009. Chlorophyll concentrations were much larger in 2009 than earlier years in Otisco, Owasco and Skaneateles.

**Nutrient Data:** Mean 2009 epilimnetic nitrate concentrations were largest in Cayuga, Owasco and Skaneateles (0.5 to 0.9 mg/L), and smallest in Canandaigua, Keuka, Honeoye Seneca and Otisco (0 to 0.3 mg/L). N/P ratios indicate that phosphate is the limiting nutrient in all but Honeoye and to a lesser degree in Keuka.

Soluble reactive phosphate (SRP) concentrations were consistently largest in Honeoye Lake. The annual mean 2009 phosphate concentrations in the epilimnion of the other lakes were below 1.0 µg/L. From year to year, concentrations were larger in 2006 compared to 2005, 2007, 2008 and 2009, perhaps reflecting greater runoff of phosphates in 2006, a rainy year. The largest hypolimnetic SRP concentrations were detected in Cayuga (6 – 10 µg/L), the concentrations have steadily decreased from 2006 through 2009, and its source interpreted as the bacterial decay of resuspended and runoff derived organic matter.

Mean 2009 total phosphate epilimnetic concentrations ranged from 2.7 µg/L in Skaneateles to 19 µg/L in Honeoye and 36 µg/L in Otisco. Epilimnetic concentrations ranged from 5 to 8 µg/L in the other lakes. Surface water soluble reactive silica (SRSi) concentrations in 2009 were largest in Canandaigua (940 µg/L), Honeoye (800 µg/L), and Owasco (740 µg/L), and smallest in Otisco (320 µg/L), Seneca (280 µg/L) and Skaneateles (385 µg/L). Bottom water silica concentrations were typically larger than the surface waters, with the largest difference observed in Keuka, Owasco, and Seneca (~600 µg/L).

**Water Quality Ranking:** A rank was calculated for each lake in each year from annual mean water quality data (Secchi, TP, SRP, Nitrate, Chlorophyll, and TSS data) to assess the relative
water quality between lakes and the year to year variability in each lake. Honeoye and Otisco revealed the worse water quality, whereas Canandaigua, Keuka and Skaneateles revealed the best water quality in 2009. Water quality in Cayuga, Honeoye, Owasco, and Skaneateles declined in 2009, a wet year, compared to the ranking in each lake during the previous two dry years, and suggests that these lakes are susceptible to nutrient loading from the watershed. The water quality rank from year to year remained approximately same in Canandaigua, Keuka and Otisco, and improved in Seneca, over the past three years. The cause for the variability requires additional study but perhaps water quality protection measures are working in Canandaigua and Keuka Lakes, internal loading impacts Otisco and Honeoye, and Seneca is too large to respond as quickly as the other lakes, or different watersheds experienced different amounts of runoff.
Honeoye Lake is the shallowest of the eleven Finger Lakes. The lake produces a significant mass of macrophytes that grow on the lake bottom in waters less than 4.5 meters in depth each summer. In addition, in some years the lake experiences a problematic blue-green algae (cynobacteria) bloom of 1-8+ weeks, which severely affects water clarity and is aesthetically unpleasing. This monitoring program was initiated to better understand the lake dynamics in response to a severe blue-green algae bloom in the summer of 2002, which lasted from mid-July into late-September. In the fall of 2006 and 2007 an alum application was performed to reduce the release of phosphorus from the lake bottom sediment during periods of anoxia, with the hope of reducing the severity of late summer algae blooms.

For each year the monitoring included temperature (T) and dissolved oxygen (DO) profiles from the surface to the bottom and water clarity measured using a Secchi disk. In 2003, 2007, 2008 and 2009 chemical monitoring of phosphorus levels, both total phosphorus (TP) and soluble reactive phosphorus (SRP) at several depths and chlorophyll-a at the surface was also performed.

The eutrophic status of Honeoye Lake is confirmed as shown in Table 1. Although Honeoye does not develop a strong thermocline, as is common in the deeper Finger Lake, it does develop a weak thermocline that promotes low oxygen levels near the lake bottom (Figure 2). The thermocline is easily disrupted by wind, which allows mixing of nutrient rich bottom waters into the water column. The increase in phosphorus released from the bottom sediment during periods of anoxia in late summer can promote an increase in algae growth which causes the poorest water clarity to occur in mid-August. The monitoring data confirms this seasonal variation in water quality.

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<td>Secchi (m)</td>
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Table 2

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An attempt was made to determine if the effect of the alum application is evident in the monitoring data. There appeared to be a reduction in total phosphorus (TP) at the lake bottom in the years following the alum application. However, the change in soluble reactive phosphorus (SRP) did not show a consistent pattern. The biggest problem in trying to determine the effectiveness of the alum application is determining the relative importance of internal versus external phosphorus loading, both of which are dependent on a number of different environmental factors that change with time. As a result, although there is a better understanding of the lake dynamics based on the results of this monitoring program, it is impossible to definitively state that the alum is reducing the internal release of phosphorus.

A report on these results is available at [www.hvaweb.org](http://www.hvaweb.org)
THE ROLE OF FISH IN SHAPING POND COMMUNITIES AT THE HENRY W. HANLEY BIOLOGICAL FIELD PRESERVE

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315 781 3464

Food webs are in-part controlled from the bottom-up, with nutrient concentrations (e.g., nitrogen, phosphorus) controlling the maximum biomass of primary producers that theoretically can be sustained. In aquatic systems that are controlled from the bottom-up, the quantity of phytoplankton in turn controls the abundance of herbivores, which in turn controls the abundance of predators. Food webs are also influenced from the top-down, with predators able to limit the abundance of their prey and cause trophic cascades that alter the base of the food web. The actual biomass—as opposed to the theoretical biomass—of phytoplankton in an aquatic ecosystem can be impacted by the presence of a predator multiple trophic levels above the primary producer. Research on the relative importance of bottom-up and top-down influences have been limited due to the complexity and size of experiments required.

Two ponds at the Henry W. Hanley Biological Field Preserve (Hobart and William Smith Colleges) provided a natural laboratory to study the role of bottom-up and top-down controls on primary production. Pond 7 and 11 are human-made ponds (circa 1960) that are characterized by different levels of phytoplankton primary production. Pond 11 has low phytoplankton concentrations; whereas Pond 7 has high levels of these primary producers. Given the proximity and physical similarities of the two ponds, we hypothesized that the difference between ponds was due to the top of the trophic food webs of each pond. Specifically, we hypothesize that piscivorous fish species are absent in pond 7 but are present in pond 11 creating a different trophic cascade in each pond. The absence of piscivorous fish in pond 7 would lead to the abundance of planktivorous fish, which in turn would consume the largest plankton leaving behind small zooplankton, resulting in higher phytoplankton concentrations in pond 7.

We carried out an ecosystem-level study in Ponds 7 and 11 from 2007 to 2009, which confirmed the importance of vertebrate predators in shaping community structure at the base of the food web. The biotic characteristics of Pond 11 supports that this system is heavily influenced by piscivorous predation. Evidence for this conclusion includes: (1) the presence of Largemouth bass; (2) the limited abundance of Pumpkinseed sunfish; and (3) a zooplankton community composed of mainly larger-bodied taxa. Pond 7 on the other hand lacked a top predator and its food web contrasted with Pond 11 in that (1) Pumpkinseed sun fish were more abundant and (2) it lacked large-bodied zooplankton taxa. Compared to Pond 11, Pond 7 also supported significantly (1) smaller zooplankton of taxa that were common between the two ponds; (2) shallower Secchi depths; and (3) greater concentrations of Chlorophyll a. There was no evidence that the difference in phytoplankton or zooplankton between Ponds 7 and 11 were driven by bottom-up processes. Nutrient concentrations were similar and the rate of primary production was nearly equivalent for the two pond.
LONG-TERM TRENDS IN TOTAL PHOSPHORUS FOR CANANDAIGUA LAKE.

Bruce A. Gilman

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Phosphorus is a critical nutrient for biological growth in freshwater lakes, and most aquatic researchers accept the notion that phosphorus is often the limiting factor for phytoplankton productivity. Increases in phosphorus will increase the amount of algae in a lake, adversely affecting water clarity and degrading water quality. It is understandable that much effort has been directed towards understanding the phosphorus budget of a lake, paying particular attention to contributing watershed conditions. On natural lands, rainwater will infiltrate the soil and then be filtered during its passage through the soil. This filtering removes nutrients, such as phosphorus, retaining them on the soil particles and allowing them to be recycled by plants growing on the land. In contrast, developed lands and their impervious or disturbed surfaces reduce infiltration and move water with higher concentrations of phosphorus to a lake.

Since 1996, the total phosphorus concentrations in Canandaigua Lake have been determined monthly (April through November) from samples collected at six locations and three water depths. The sample sites include two shore locations near stream mouths, two shore locations in direct drainage sub-basins, and two mid-lake stations. Grab samples from a depth of two meters were collected at all sites, with additional samples from depths of 25 meters and 50 meters taken at the mid-lake stations. While sample site diversity contributes to variability in the overall data set, the range in total phosphorus conditions throughout the lake are realistically documented by this design and careful interpretation of data should suggest causative factors for trends in phosphorus concentrations despite the variability.

Mean annual total phosphorus concentration in Canandaigua Lake has increased from 4.74 µg/L in 1996 to 7.21 µg/L in 2008 representing a 52% increase in 12 years (see Figure). The trend line fit to the data depicts a steady increase but the actual data reveals steep increases followed by recovery periods to the trend line. Short-term studies that capture only the recovery periods could reach misleading conclusions about phosphorus dynamics in the lake. Long-term studies with consistent sampling protocols should avoid this error and provide a better estimate of the actual phosphorus dynamics in the lake.

Phosphorus dynamics are analyzed by site, by season, by geographic location, and by water depth. A broader contrast between mid-lake and shoreline sites, as well as between the northern half of the lake where agricultural and residential land uses predominate to the southern half of the watershed where forested land cover is most common are also presented. Stream total phosphorus monitoring, collected in a companion program, corroborates some of the relationship among land use, land cover and external loading of phosphorus from tributaries to the lake. Recent algal blooms (Microcystis and Gleocapsa) may be related to total phosphorus increases although chlorophyll a trends do not mimic total phosphorus trends. The contribution of cyclic, episodic die-offs of zebra mussels (Dreissena polymorpha) to the long-term phosphorus trends is also evaluated.

Bruce is a Professor of Environmental Conservation and Director of the college’s Muller Field Station.
Mean Annual Total Phosphorus in Canandaigua Lake

![Graph showing the mean annual total phosphorus in Canandaigua Lake from 1996 to 2008.](attachment:image.png)
DECREASE OF EURASIAN WATER MILFOIL AT THE NORTH END OF CAYUGA LAKE: POSSIBLE ROLES OF NATIVE PLANTS

Bin Zhu¹,² and Samuel Georgian²

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² - Finger Lakes Institute, Hobart and William Smith Colleges, 601 S. Main Street, Geneva, NY 14456

Presenter Contact Information:
Dr. Bin Zhu, Department of Biology, University of Hartford, 200 Bloomfield Avenue, West Hartford, CT 06117, Phone: 860-768-4367, Email: zhu@hartford.edu.

Decline of Eurasian water milfoil (Myriophyllum spicatum) population at both south and north ends of Cayuga Lake has been observed since 1980s. Past literature suggested that herbivory was responsible for the decline. However, a recent survey in 2008 showed Eurasian milfoil was the most abundant species at the south end followed by native water stargrass (Heteranthera dubia) whereas water stargrass was the only dominant species at the north end with just few Eurasian milfoil. Insect herbivore populations have not been different at the two ends. This suggests there might be other important factors contributing to the decrease in water milfoil at the north end and the possible increase at the south end. Therefore, a series of experiments were conducted to investigate the interactions between Eurasian milfoil and water stargrass. The competition experiment revealed there were 27.0% increase in stem length and 203.2% increase in biomass in native stargrass while there were no significant changes in Eurasian milfoil. Allelopathy experiments showed that extracts from Eurasian milfoil increased stargrass biomass (+19.0%) at lower concentrations and decreased its biomass (-29.1%) at high concentrations. The results also demonstrated extracts from stargrass reduced Eurasian milfoil growth by 45.5% at high concentrations but no effects occurred at low concentrations. Results from these experiments and our findings in the lake were highly correlated. This indicates there are strong interactions among invasive and native plants such as Eurasian water milfoil and water stargrass, thereby affecting plant community in lakes. Aquatic plant management should take these interactions into account.

Biography
Dr. Bin Zhu is an Assistant Professor of Environmental Science at University of Hartford in Connecticut. He was a Research Scientist at the Finger Lakes Institute, NY for about three years. Bin’s research interests focus on biology and management of invasive species and aquatic plants. His current projects include the management of invasive European frogbit and Eurasian water milfoil, and dynamics of aquatic plant communities in the Finger Lakes. Bin has published articles in Aquatic Botany, Ecosystems, Fisheries, Journal of Aquatic Plant Management, and Journal of Great Lakes Research. He is also a reviewer for a number of journals including Aquatic Ecology, American Naturalist, Journal of Aquatic Plant Management, Journal of Ecology, and Journal of Great Lakes Research. He currently serves on the Board of Directors of NEAPMS.
MACROPHYTE COMMUNITY CHANGE VIA HERBICIDES “SONAR” AND “RENOVATE” IN WANETA LAKE, NY 2003-2009

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Waneta Lake is a small eutrophic lake of 320 hectares south of New York’s Finger Lakes with a recent history of management attempts of submersed macrophytes, in particular the non-native Eurasian watermilfoil (*Myriophyllum spicatum*). Historically, plant growth was mechanically harvested on one-fourth of the littoral zone with the remainder of the littoral left for very large indigenous populations of the Eurasian watermilfoil herbivore *Euhrychiopsis lecontei*, a native weevil. In April of 2003, an application of the herbicide fluridone (“Sonar”) resulted in an initial concentration of 12-15 ppb. The herbicide had a very slow rate of decay and remained in the lake at >2ppb through November. In 2004, the year after treatment, the watermilfoil and almost all submersed plant biomass were eliminated except for trace amounts of a few native species. In 2005, the watermilfoil returned but native plant biomass and native plant frequency-of-occurrence continued to decline. Watermilfoil in 2006 and 2007 greatly increased in biomass and frequency-of-occurrence to surpass pretreatment abundance. In 2008, an application of the herbicide triclopyr (“Renovate”) removed watermilfoil from almost 95% of the littoral zone. A second triclopyr treatment in 2009 removed the remaining watermilfoil. However, the total plant biomass increased to amounts previously never recorded in the lake except for the robust watermilfoil in 2007. The species *Najas guadalupensis*, *Elodea sp.* and *Ceratophyllum demersum* now dominate the shoreline out to the 3-meter water depth, impairing recreational use. I will present biomass measures and rake-toss macrophyte abundance of Waneta Lake’s multiyear plant community and littoral zone changes from 2003-2009 (Table 1, Figure 1, Table 2).

**Table 1.** Recorded biomass of aquatic plants (gDW/m²) measured in Waneta Lake from 50 locations sampled first in 2000 and then annually 2003 - 2009. A second grouping of 50 locations, including 28 of the original locations, was sampled.

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Figure 1. Biomass of aquatic plants (gDW/m²) measured in Waneta Lake from 50 locations sampled first in 2000 and then annually 2003-2009. A second grouping of 50 locations, including 28 of the original locations, was sampled from 2003-2009.
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<td>FREQ %</td>
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TERTIARY TREATMENT UPGRADES BEFORE/AFTER IMPACT STUDY: EFFLUENT AND LAKE PHOSPHORUS RESULTS.

Jose Lozano and Lynn Smith, IAWWTF Laboratory

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The results of the wastewater treatment upgrades at the south end of Cayuga Lake are analyzed by geostatistical analysis and Before/After impact studies.

In May 2006, a tertiary treatment process was added to the IAWWTF treatment process. This upgrade has had a significant and positive effect on both the performance of the plant and on the water quality of southern Cayuga Lake. The effluent total phosphorus concentration decreased 58.7% after the upgrade, from an average of 0.424 mg/L to 0.175 mg/L. The effluent phosphorus load also decreased significantly, from 23.8 Lb/day to 9.83 Lb/day after the upgrade. In 2005, the average total phosphorus concentration in the south portion of Cayuga Lake was 40.0 micrograms per liter (µg/L). After the upgrade, the average was 29.0 g/L, a decrease of 40%. The effluent and lake sampling data was statistically robust to detect a 58.7% and 40.0% difference, respectively, at \( \alpha = 0.05 \) and a power goal of 0.95 (Error type II = 0.05).
FISHES OF HONEOYE CREEK

Amy Detwiler, John Foust and Bruce Gilman

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The purpose of this survey was to determine the population structure and diversity of fishes in Honeoye Creek in western New York. A fisheries survey had not been conducted in this stream for nearly twenty-five years. Honeoye Creek originates as the outlet of Honeoye Lake and flows northwestward into the Genesee River. A backpack electro-fisher was used to sample nine sites in Ontario and Monroe County portions of the stream. Two 100 meter reaches were sampled at each site for a total of 18 sampling runs. Fish species, abundances and length (mm) data were recorded at each site. Concurrent water quality measurements included dissolved oxygen (mg/L), temperature (°C) and specific conductance (µs/cm). Thirty-five fish species representing eight families were encountered. Dominant taxa included cutlips minnow (Exoglossum maxillina) from the Cyprinidae Family, and bluegill (Lepomis macrochirus) and pumpkinseed (Lepomis gibbosus) from the Centrarchidae Family. Several fish were collected that had not been recorded previously from Honeoye Creek, including rainbow darter (Etheostoma caeruleum), spottail shiner (Notropis hudsonius), and johnny darter (Etheostoma nigrum). Fish community diversity (H’) was moderate, ranging from 1.73 to 2.53. Sorensen’s index of similarity was used to compare changes in community structure along the length of the creek.

Amy is a graduate of the Fisheries Technology Program at Finger Lakes Community College where John and Bruce teach in the Environmental Conservation and Horticulture Department.
ANALYSIS OF TWO MANAGEMENT TECHNIQUES FOR HYDROCHARIS MORSUS-RANAE L (EUROPEAN FROGBIT) ON ONEIDA LAKE, NEW YORK

Bethany Bashaw, Meghan Brown
Hobart and William Smith Colleges, New York

European frogbit (Hydrocharis morsus-ranae L.) is a free-floating aquatic macrophyte that is invasive in North America. It is a nuisance plant that forms a thick floating mat that depletes oxygen resources, outcompetes native plants, decreases biodiversity, and restricts human activities. Since it has the potential to yield high ecological, economical, and social costs, it is important to devise an effective management strategy for controlling its spread. Studies were conducted in Oneida Lake, which was invaded by European Frogbit in 2004. Here we report on the impact of each control method on native zooplankton abundance and phytoplankton primary productivity (estimated from Chlorophyll a concentration). Crustacean zooplankton and rotifers were identified to genus or family level and analysed for trends among treatments, sample dates, replicate locations. Chlorophyll a concentration showed no significant trends among treatments.
DIET ANALYSIS OF TRANSLOCATED RIVER OTTERS IN HONEOYE LAKE

Elaina Burns, John Van Niel, and Sasha Mackenzie.

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During the mid-1900s, the river otter (Lutra canandensis) was extirpated in much of its original range in New York State. In 1995 to 2000, the Department of Environmental Conservation translocated river otters to Central and Western New York. As part of this effort, seven individuals were released in the study area near Honeoye Lake in 2000 where they have become established. River otters routinely create latrine sites where multiple scats are left. Scat samples were collected from the Honeoye Lake inlet. Diet was analyzed by investigating scat samples for specific prey species in November of 2009. Prey species were identified and quantified by examining the remaining, intact hard parts found in scat samples such as bones, exoskeletons and scales. An inclusive report of prey species, including the major fish taxa, found in scat samples is in order. In addition, the dietary habits of this population will be compared to the results of a similar study of neighboring populations.

Elaina Burns is an undergraduate student at Finger Lakes Community College, John Van Niel is a professor of environmental conservation at Finger Lakes Community College, and Sash Mackenzie is a conservation technician at Finger Lakes Community College.
HISTORICAL RECORD OF LIMNOLOGIC CHANGE IN SENECA LAKE, NY (1970-2008 A.D.)

Tara M. Curtin and David B. Finkelstein

Geoscience Department, Hobart & William Smith Colleges, Geneva, NY 14456 Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996-1410

Understanding the impact of human activities in the watershed such as deforestation, agricultural development, and urbanization on lake ecosystems requires a comparison of the state of the lake before and after those activities began. Because long-term, continuous limnological data are lacking for Seneca Lake, one of the largest Finger Lakes of New York (USA), we used the sediment record preserved in the lake to reconstruct an historical chronology of human activities in the lake and its watershed and infer any changes in the lake’s trophic state since 1770 A.D. Previous work suggested that enhanced chemical weathering since the 1850s rather than cultural eutrophication might explain an increased nutrient loading, biological productivity, and CO2 removal and subsequent calcite precipitation in the Finger Lakes. Here, we re-evaluate the feasibility of the cultural eutrophication hypothesis by analyzing box cores collected from the middle of the lake. Comparing stable isotope data ($\delta^{13}$C (detrended from the modern atmospheric values to adjust for the Suess Effect) and $\delta^{15}$N of bulk organic matter) with additional geochemical proxies for historical trophic state (total phosphorous (TP), C/N ratios) and indicators of cultural disturbance (TP, mean grain size, % sand), changes the trophic classification can be inferred. These indicators first begin to show gradual changes in the late 1800s towards increased primary productivity coincident with the timing of deforestation associated with changes in agricultural practices and European settlement. More rapid changes in these indicators occurred during the early to mid-1900s. The increase in TP, %C, %N, and $\delta^{13}$C points to a rise in primary productivity that continues today and reflects the transition from oligotrophy to mesotrophy.
THE SENECA LAKE INSTRUMENT NETWORK

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http://fli-data.hws.edu/seneca is a new website providing public access to an array of data being collected from
Seneca Lake. The website offers information about the instrument network as well as the ability to retrieve and
download raw data.

Data is being collected by five different types of instruments allocated throughout seven different sites in the northern
end of Seneca Lake. The instruments include sediment traps, temperature probes, a meteorological station, a water
quality sonde, and Doppler profilers. Sediments traps collect sediment which is analyzed for its composition and
chemical makeup. Samples are also analyzed for zooplankton counts and attributes. Each sample covers three days
in the summer and seven days in the winter. Temperature probes record temperature readings every hour. The
meteorological station records hourly and daily minimum/maximum/average wind speed, wind direction, relative
humidity, air temperature, barometric pressure, and light intensity. The water quality sonde records water quality
profiles twice daily. Information recorded includes depth, temperature, conductivity, turbidity, and chlorophyll.
Finally, Doppler profilers record water speed and direction of movement every 30 minutes.

The sites where the instruments are located in the northern end of the lake since
this area of the lake contains both offshore and shallow water regions and is
representative of the whole lake. Sites B, D, H, and FE follow a north-south mid-
lake transect from shallow to deep water locations. Sites G, AC, and FE are
located offshore of Kashong Creek, the largest tributary in the northern section
of Seneca Lake, and provide contrast between the mouth of the creek and open
water conditions. The YSI buoy provides meteorological and water quality data
from a central position in the network (site Y). Site Y has been used for routine
limnological monitoring for more than 30 years. Year-round data is available
from all sites starting in the summer of 2009. Water quality and weather data
from site Y is available for the spring, summer, and fall seasons since 2006.

The website offers public access to the data in two different ways. Data can be
retrieved by either the type of data desired (e.g. water quality or sediment) or
the site of interest. Given the method chosen, the user will presented with a form
for retrieving the data. The form allows the user to select the date range,
specific parameters of interest, and the data format. Data can be viewed in
tabular form or downloaded as a CSV file suitable for importing into Excel or
another data-processing program. If the user chooses to download the data, a
separate file will be generated for each site, instrument, and type of data.

Our future plans involve the expansion of visualization options for the website. Currently work is being done to
provide basic plots to help visualize the data. Short term plans include adding custom-generated plots where users
can directly select the data to be plotted through forms on the website. In the long run, the visualization features
of the website will be expanded further to include interactive data exploration capabilities as well as additional types
of plots.
MONITORING PLAN FOR THE SOUTHERN BASIN OF CAYUGA LAKE

Monitoring Partnership, Roxanna Johnston

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The Partnership, which was formally organized in response to a request by the WRC Chair, Frank Proto, has been meeting regularly since November 2006 to develop a plan for tracking water quality in the southern end of Cayuga Lake. The Partnership was formed, in part, to explore the possibility of redirecting Lake Source Cooling facility monitoring resources to a community based program to better addresses the issues in the lake. The Partnership’s work eventually included evaluating all regular monitoring efforts in the southern basin.

We were surprised to find that existing efforts already include nearly 60 sampling locations in or near the southern basin of the lake. In fact, several independent researchers are monitoring essentially the same points. The Partnership decided the best initial approach was to maintain water quality data at all the existing sampling locations but to re-direct the resources devoted to overlapping monitoring efforts towards new objectives including mapping of circulation patterns and tracking of wind and storm impacts. In this way, the Monitoring Plan uses existing resources to increase our understanding of the southern end of Cayuga Lake.

The Monitoring Plan goes further, however, and recommends additional monitoring efforts. A series of special studies are proposed to develop a better understanding of the ecology of the lake by monitoring the food web, including macrophytes, opossum shrimp, zebra and quagga mussels, Diporeia (a shrimp-like organism), phytoplankton, sediment and fish. Additionally, the only way to really address sediment loading is to monitor the tributary streams that are so efficient at carrying sediment into the lake. These efforts will require new resources, which the Partnership will pursue on behalf of the community.

Title: Member of the Water Resources Council of Tompkins County and Chair of the Monitoring Partnership
LOCAL EFFORTS TO ERADICATE WATER CHESTNUT (Trapa natans L.).

Sarah Meyer¹ and Bruce Gilman²

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² Department of Environmental Conservation and Horticulture, Finger Lakes Community College, 3325 Marvin Sands Drive, Canandaigua, New York 14425-8395. gilmanba@flcc.edu, 585-394-3500 extension 7255.

Water Chestnut (Trapa natans) is native to warm water regions of Eurasia and has become naturalized in North America following its intentional introduction into botanical gardens during the late 1800’s. Beneath its floating rosette of sharply toothed, rhombic-ovate shaped leaves grows a long flexible stem with scattered feathery submersed leaves. Finely branched roots may weakly secure plants to bottom substrates. Inconspicuous white flowers are produced in the center of the leafy rosette, and these give rise to large, sharp spined nut-like fruits. The fruits fall to the lake bottom during autumn, overwinter, and then may germinate the following spring or remain dormant for as long as 12 years.

Water Chestnut has many invasive attributes. It is a habitat generalist growing in shallow, nutrient rich water lakes and streams as well as stranded on wet mucky substrates. The extensive floating leaf rosettes effectively shade out native aquatic species. As the dense water chestnut plants die and decay, dissolved oxygen levels in the water may be lowered by microbial decomposers, leaving little dissolved oxygen for other organisms. Sharps spines on the fruit make it unpalatable, and each surviving fruit can produce as many as 15 rosettes when it germinates. Each leaf rosette can produce as many as 20 fruits thereby demonstrating the high reproductive effort of this invasive plant. Water chestnut was the poster child for “Alive in New York: A Growing Invasion”, a public education exhibit that continues to visit many New York State museums.

Water chestnut was known to grow in the Keuka Lake Outlet marsh during the 1960’s but was thought to have been eradicated. It was rediscovered during the summer of 2009, and the Yates County Soil and Water Conservation District quickly assembled a response team. Participating organizations included the Finger Lakes Institute, Finger Lakes Community College and Keuka College as well as several volunteers from the Keuka Lake Association. Over the course of two days in September, large quantities of water chestnut were hand pulled from the marsh, loaded into college canoes and then transferred to a district pick-up truck. Upstream and downstream sites were searched but no additional infestations were discovered. Plans are underway to repeat these management techniques during the summer of 2010.

Sarah is the Community Outreach Coordinator at the Finger Lakes Institute. Bruce is a Professor of Environmental Conservation at Finger Lakes Community College and Director of the college’s Muller Field Station.
'GROUNDWATER-PROPELLED' VAPOR INTRUSION: A NEW HEALTH HAZARD?

Paul L. Richards

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Vapor intrusion (VI) of chlorinated hydrocarbons is a significant safety concern in areas overlying TCE and petroleum spills. Currently, assessment is carried out by ranking sites for physical factors to determine if VI is present followed by a combination of modeling and sampling in basements. These approaches do not consider seasonal variations in water table. Furthermore, models used to predict VI parameterize it as a mixed advection and diffusion-controlled process from a fixed water table. In New York State, there exist numerous spills of TCE and petroleum in the Onondaga FM. This unit has a history of dynamic water table variations. Underlying one of these dynamic areas, the Leroy RR spill between Leroy and Caledonia, is a TCE plume that is currently being characterized for VI. Well data indicate that water tables may rise between 20 and 50 feet in one day at this site (Figure 1). Transducers in wells at widely separated locations show similar fluctuations, implying these shifts in water tables are regional phenomenon, rather than the result of unique sets of local geological conditions. These shifts commonly occur in the early spring when soils are frozen and when house ventilation is minimized for winter heating. It is hypothesized that water table rises may impact vapor intrusion by acting as a piston, forcing contaminated vapors into basements. This poster discusses the implications of dynamic water behavior in the context of existing VI guidelines and presents evidence that this sort of water table behavior is more common than previously thought. These situations are likely to occur in the Onondaga FM, a lithologic unit that stretches across the entire state and which intersects several Finger Lakes. Modification of existing sampling guidelines is suggested.
Water Table Rises in Spring 2009

- Jan
- Feb
- Mar

WT Fluctuation (ft)

Julian Day

Sinkhole
DC-3
DC-6
DC-11

Water table variation
- 36-56 ft
- 6.6-12 ft
- 12-36 ft
- 2.1-6.5 ft

100 ppb TCE

Figure 1  TCE plume map at the Leroy RR spill site with groundwater table fluctuations observed in select wells last spring. This period corresponds with when soils are commonly frozen. Modified after Dunn et al (1993)
HABITAT PREFERENCES OF NATIVE AND NON-NATIVE TROUT SPECIES IN A RESTORED COLD-WATER STREAM

Elizabeth Zinsser
Department of Biology, Hobart and William Smith Colleges, Geneva, NY

Cold Brook (Hammondsport, NY) underwent restoration efforts to increase the amount of habitat available for rainbow trout *Oncorhynchus mykiss* in 2007. One component of the restoration effort was the creation of large pools and hydraulic jumps using boulders. Native brook trout *Salvelinus fontinalis* compete with stocked rainbow trout for pool habitat in cold-water streams. This study aims to determine the habitat preferences of both species in Cold Brook. It was hypothesized that the rainbow trout prefer the large pools formed by restoration efforts while brook trout will prefer smaller, natural pools. Unbaited traps were set in control (natural) and restored pools at two sites along Cold Brook's length over a period of six weeks. Pool dimensions and distance between pools were also taken. Two rainbow trout and eighteen brook trout were caught in total at both sites. All fish ranged between 60 mm and 180 mm. Preliminary analysis shows that rainbow trout prefer pools with a larger volume and also grow to a larger size. Brook trout and rainbow trout were found in the same pools, showing that they do not entirely exclude each other from their environment. Macroinvertebrates were also collected from Cold Brook because they are an integral part of the trouts' diet. If the restoration effort at Cold Brook were truly successful, the macroinvertebrate community would be healthy. The goal is to analyze macroinvertebrate assemblages upstream and downstream of a restoration site to determine if the restoration had had an impact. We hope to show that the macroinvertebrate community was not adversely affected by the restoration efforts and that the species assemblage is suitable prey for the trout species.
MODELING UNDERWATER LIGHT DYNAMICS AND THEIR ECOLOGICAL RELATIONSHIPS TO DEEP CHLOROPHYLL LAYERS IN THE FINGER LAKES

Tim Sellers

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In many of the Finger Lakes, phytoplankton primarily reside in a distinct layer well below the surface of the lakes. These deep chlorophyll layers (DCL) hold the majority of organic carbon that can drive the rest of the grazing food web. Our underwater light data show that the DCL is very close to the 1% surface light level, the light level where photosynthetic gains are just matched against losses due to respiration. In Keuka Lake (and some other Finger Lakes), the DCL is usually located just below the thermocline meaning the phytoplankton live in a low light and low temperature environment that is very close to a high light and warmer water area. Small changes in environmental conditions can push these phytoplankton communities to very different conditions, and the population and community effects of these changes can cascade through the food web. Environmental changes can cause changes in both light quantity (available photons) and quality (available wavelengths). Reductions in light quantity can occur from surface blooming cyanobacteria (e.g., *Microcystis*), while zebra mussel filtration may result in greater light intensity at depth. DCL depths range between 8 and 20 meters in depth. This means wavelength-specific absorption by water, organics, and phytoplankton make the suite of available wavelengths for photosynthesis very different than in the warmer, surface waters. The presence or absence of accessory pigments (i.e., light harvesting pigments other than chlorophyll a) may drive species composition for DCL phytoplankton. This modeling study describes how environmentally-driven changes in light dynamics (e.g., surface phytoplankton, path length (depth), wavelength-specific and integrated light attenuation coefficients, etc.) can potentially affect food webs and water quality in lakes with prominent DCLs.
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*Note: The above information includes names, roles, institutions, email addresses, and contact details.*
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<tr>
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</table>
THANK YOU FOR ATTENDING!
Please take a few minutes to provide comments and suggestions.

(Please check the number) | Disagree | Neutral | Agree
---|---|---|---
The date/time of event was appropriate. | 1 | 2 | 3 | 4 | 5
The location of the event was good. | 1 | 2 | 3 | 4 | 5
Food/beverages and service were good. | 1 | 2 | 3 | 4 | 5
Facilities were appropriate. | 1 | 2 | 3 | 4 | 5
The event was what I expected. | 1 | 2 | 3 | 4 | 5
The program was good/left me with a good impression of the Finger Lakes Institute and HWS. | 1 | 2 | 3 | 4 | 5

How did you find out about this event? (Please circle all that apply)
- FLI Website
- Regional Listserv/Other Website
- FLI E-Newsletter
- Local Newspaper
- Friend, Alum, Prof.
- Other

What you liked most about the event:

My overall impression of this event was:

- Excellent
- Good
- Average
- Poor

Based on your experience at the event, how likely are you to attend future FLI events?

- Highly Likely
- Somewhat Likely
- Not Likely

Comments/suggestions for future events? What topics are you interested in learning about?

DROP THIS IN THE BOX ON THE REGISTRATION TABLE! THANK YOU!
Like to stay in touch!? Join our Mailing List!

Name:

Address

City:

State:

Zip Code:

Organization:

Email Address:

Work Phone:

Home Phone:

Cell Phone:

Website:

Watershed or Issue of Concern: