December 2006

Onondaga Lake Ambient Monitoring Program 1998—2012

Program Summary

Onondaga County is required by State and Federal regulations to monitor Onondaga Lake and its tributary streams. The January 1998 Amended Consent Judgment required the County's Department of Water Environment Protection (DWEP) to develop and implement a program to measure water quality conditions and assess progress towards compliance with state and federal standards.

This publication describes the ambient monitoring program (AMP) and outlines how results of the program are used to evaluate the effectiveness of improvements to the County's wastewater collection and treatment infrastructure.

Design of the AMP has been guided by a panel of technical experts who serve on the Onondaga Lake Technical Advisory Committee (OLTAC). Members of OLTAC, their affiliation, and areas of expertise are listed below.

Dr. Raymond Canale (EnginComp Software, Inc.): modeling, Seneca River
Dr. Charles Driscoll (Syracuse University): water and sediment chemistry, mercury
Dr. James Hassett (SUNY College of Environmental Science and Forestry): water resources engineering, hydrologic modeling
Dr. Edward Mills (Cornell University): food web, phytoplankton and zooplankton
Dr. Elizabeth Moran (EcoLogic, LLC): monitoring program, limnology
Dr. Lars Rudstam (Cornell University): food web, fish community
Dr. Kenton Stewart (SUNY Buffalo): physical limnology
Dr. William Walker, Jr. (Environmental Engineer): statistical limnology, loading calculations, mass-balance, integrated data management

Many agencies have contributed to the program design and interpretation strategies, including provide oversight and technical assistance to the County, including:

- New York State Department of Environmental Conservation
- United States Environmental Protection Agency
- New York State Attorney General, Environmental Protection Bureau
- United States Army Corps of Engineers
- Onondaga Lake Partnership
- United States Geological Survey
- Atlantic States Legal Foundation

An annual report summarizing the findings of the AMP is available upon request. Please contact the Department of Water Environment Protection at (315) 435-2260 or visit our web site at www.ongov.net

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INTRODUCTION TO THE AMBIENT MONITORING PROGRAM

Onondaga County and its federal and state partners are investing in the future of Onondaga Lake, a natural resource that has been neglected by the community. Improvements to the wastewater collection and treatment system serving six towns, two villages, and the City of Syracuse are currently under construction. These improvements will result in improved water quality conditions in Onondaga Lake and its tributary streams. Projects to reduce the **Combined Sewer Overflows (CSOs)** and provide a higher level of treatment at the **Syracuse Metropolitan Wastewater Treatment Plant (Metro)** began in 1998 with the signing of the **Amended Consent Judgment (ACJ)**. The ACJ outlines a 15-year program with three major elements: CSO abatement projects, Metro treatment improvements, and the **Ambient Monitoring Program (AMP)** to track improvements in water quality.

Sampling along the Onondaga Lake shoreline.

The AMP is designed to provide data and information needed to assess the effectiveness of improvements to the wastewater collection and treatment infrastructure. The monitoring program includes field and laboratory components to identify sources of materials (nutrients, sediment, microorganisms, and chemicals) to the lake, evaluate in-lake water quality conditions, and examine the interactions between Onondaga Lake and the Seneca River. Biological programs encompass much of the food web of the lake and its watershed, including zebra mussels, macroinvertebrates, aquatic plants, phytoplankton, zooplankton, and fish.

Onondaga County's trained technicians collect water quality and biological samples at a number of key locations in the watershed. Streams flowing into Onondaga Lake are monitored to estimate the annual input of water and materials including nutrients, sediment, salts, and bacteria. Samples are collected upstream of the lake to help pinpoint sources of pollution. Accurate estimates of inflows are a critical component of the AMP, since they underlie many of the management decisions facing Onondaga County. Monitoring of Onondaga Lake and the Seneca River is conducted during the ice-free period and, when conditions allow, winter sampling is conducted as well.

INDICATORS AND TRENDS

The AMP generates thousands of observations each year. It is challenging to organize and communicate these data in a way that retains integrity of the scientific information and makes it useful for all stakeholders. To help meet this challenge, a series of indicators are used to summarize water quality and habitat conditions with respect to specific uses. These indicators share several properties: they relate directly to an impairment of the lake or watershed; they relate to a resource of interest; they correspond to a published standard that, in turn, reflects the requirements of public health or the aquatic biota; and they can be measured and interpreted with relative ease. Indicators can help answer basic questions such as: "is the lake getting better?" and "is it safe for my family to swim here?"

Indicators are used to track progress towards lake improvement or compliance with ambient water quality standards. The major indicators are summarized in **Table 1**.

Table 1. Major indicators of water quality for Onondaga Lake.

Desired use	Measured by:
Water contact recreation	Bacteria concentrations
	Nearshore water clarity
Aesthetics	Phosphorus concentrations (narrative standard)
	Algal blooms: intensity, frequency, and duration
	Relative abundance of blue-green algae
	Nearshore macroalgae (algal mats)
Aquatic life protection	Dissolved oxygen concentrations
	Ammonia N concentrations
	Nitrite N concentrations
Recreational angling	Habitat quality: aquatic plant growth
	Nesting success
	Presence of early life stages of target species
	Presence of adult fish sensitive to pollution
	Mercury content of fish

Results help managers assess how conditions during this year met the goals for a swimmable, fishable lake. Throughout the community, there is deep interest in how the lake has changed over time. The County is closely tracking changes in water quality and relating these changes to the improvements in the wastewater collection and treatment system that are underway. As part of the AMP, water quality data collected each year are analyzed for trends. The trend analysis helps gauge how the lake is changing in response to the substantial public investment in improvements to the wastewater collection and treatment system.

The trend analysis examines changes in materials entering the lake (loading from tributaries and Metro), the quality of the lake's upper and lower waters, and materials flowing from the lake at the outflow to the Seneca River. A ten-year window has been identified as the appropriate time scale to track trends in Onondaga Lake's water quality. The lake has a relatively short water residence time and a dynamic history. With a longer period, results could be strongly influenced by historical data that are not representative of current conditions with respect to municipal and industrial wastewater inputs. With shorter time period, trends are more difficult to detect because of the influence of year-to-year variation in rainfall, stream flows, and temperature.

Onondaga Lake and its Watershed

The Onondaga Lake drainage basin encompasses approximately 738 square kilometers (285 square miles) and lies almost entirely in Onondaga County. The drainage basin includes six natural sub-basins: Ninemile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek (**Figure 1**). The outlet of Onondaga Lake flows north to the Seneca River and ultimately into Lake Ontario.

Land use in the watershed is a mixture of agriculture (32%), forests (43%), and urban areas (22%). Urban areas of two towns, two villages, and the City of Syracuse border the lake. Sediment and pollutants from the large watershed make their way to the lake.

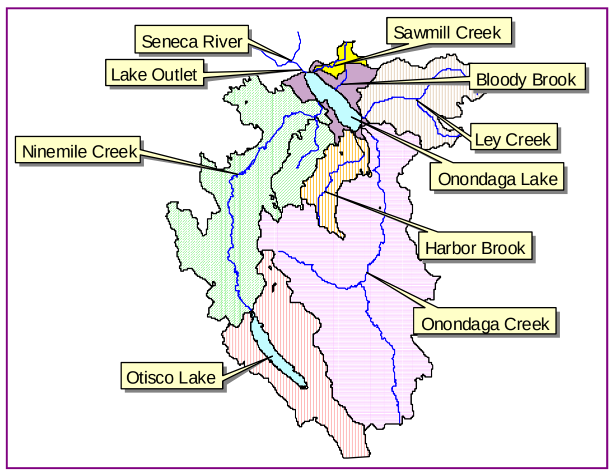

Figure 1. Onondaga Lake watershed.

Onondaga Lake is relatively small, especially compared with the nearby Finger Lakes and Oneida Lake. The shoreline is highly regular, with few bays. Much of the shoreline is owned by Onondaga County and is maintained as part of a popular park and trail system. The lakeside park is used for recreational activities such as jogging, biking, roller-blading, shoreline fishing, and cultural entertainment. The lake is used for secondary water contact recreation such as boating. Fishing derbies attract thousands of anglers.

Fishing was banned in the lake in 1972 because of mercury contamination. The ban was lifted in 1986 and modified into a "catch and release fishery"; that is, recreational fishing was permitted but possession of lake fishes was not. In 1999, the New York State Department of Health (NYSDOH) revised its advisory regarding consumption of gamefish from Onondaga Lake. The current recommendation is to eat no walleye from the lake and restrict consumption of all other fish species to no more than one meal per month. The fish advisory continues to be based on mercury levels in fish flesh. As in all New York waters with health advisories, the Health Department advises that women of childbearing age, infants, and children under the age of 15 eat no fish from these waters.

NYSDEC is responsible for managing water resources throughout the State. Lakes and streams are classified according to their designated best use (for example, water supply, swimming, recreational fishery, and/or aesthetic enjoyment). Monitoring results are evaluated regularly to determine if designated uses are supported. Because water quality and habitat conditions limit their use for swimming and ability to support aquatic life, Onondaga Lake and the Seneca River are among the State's top priorities for water quality improvement.

Metropolitan Syracuse Wastewater Treatment Plant (Metro) on Hiawatha Boulevard.

Metro is a major source of nitrogen, phosphorus, bacteria, and organic (oxygen-demanding) material to Onondaga Lake. In early 2004 Metro was upgraded from an advanced secondary treatment plant operated to enhance conversion of ammonia to nitrate during warm weather (in a process known as nitrification) and removal of phosphorus. The plant now provides year-round nitrification to increase removal of ammonia and oxygen-demanding material. Additional modifications will enhance phosphorus removal as well. An ultra-violet disinfection system is used to kill microorganisms without using chlorine; this system is able to treat up to 126.3 million gallons per day (mgd). Metro provides primary treatment to 240 mgd.

Nonpoint sources (such as runoff from agricultural, suburban, and urban areas) represent significant inputs of pollutants to Onondaga Lake. Nutrients, sediment, bacteria, metals, and pesticides reach surface water and groundwater from these diffuse sources. Industrial residuals continue to enter the lake through surface runoff and infiltrating groundwater. Lake sediments contain elevated concentrations of mercury and organic chemicals.

Monitoring Program Sampling Locations

The AMP is designed to provide data and information to evaluate the effectiveness of improvements to the County's wastewater collection and treatment system. Monitoring stations are located in Onondaga Lake, the lake's tributaries, and along the Seneca River (**Figure 2**).

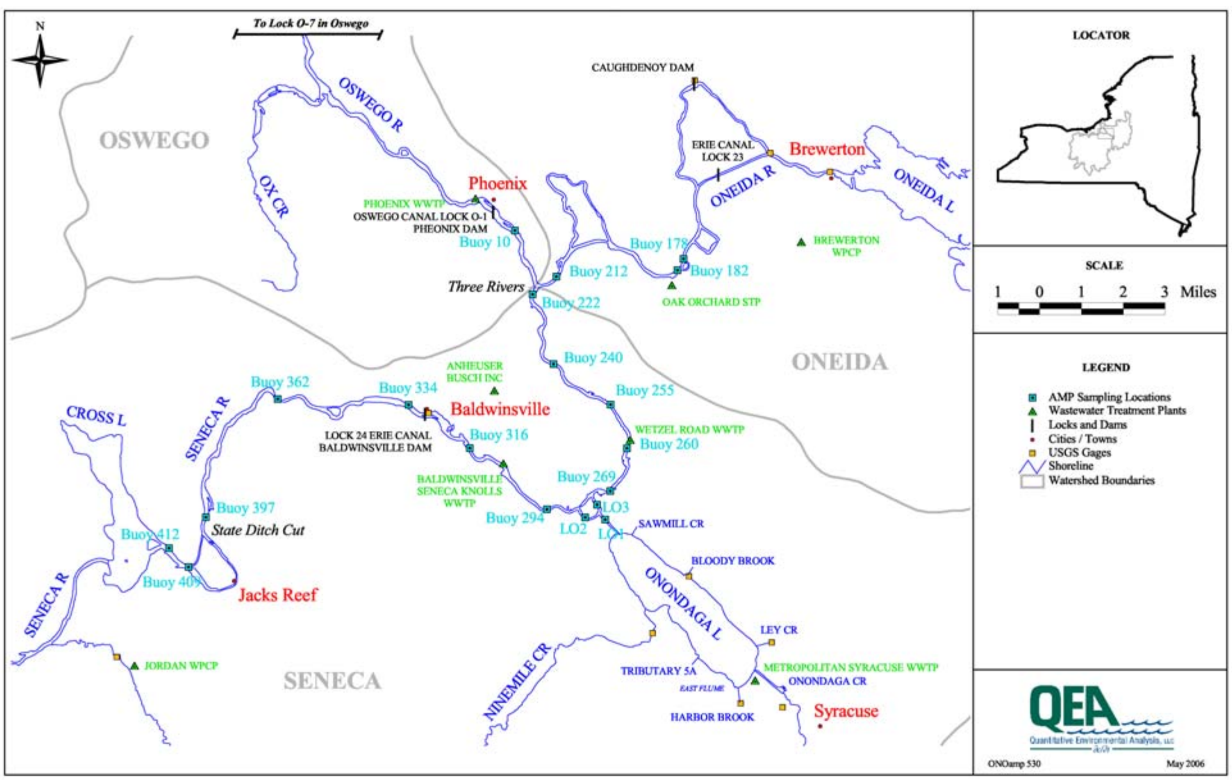

Figure 2. AMP sampling locations.

INFLOWS (TRIBUTARIES AND METRO)

PROGRAM SUMMARY

Stream monitoring provides a basis for estimating the relative importance of sources of sediments, nutrients, bacteria and other potential pollutants. Understanding the contribution of various sources, such as urban stormwater and agriculture, will help managers determine effective strategies for meeting water quality and aesthetic goals for the lake.

Water Balance

Onondaga Lake receives water from two major tributaries (Onondaga and Ninemile Creeks) and several minor ones. The third largest contributor of water to Onondaga Lake is Metro (**Figure 3**). Metro treats wastewater from residential, commercial, and industrial sources within the service area.

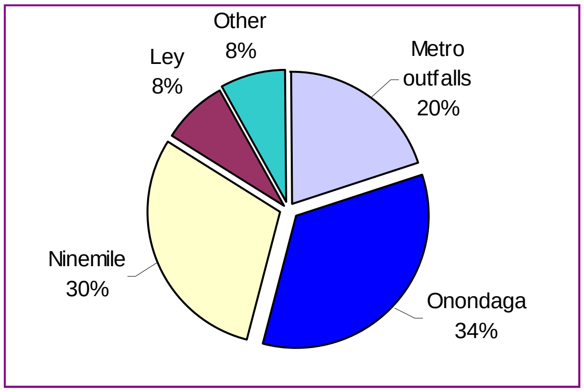

Figure 3. Ten-year average flow contribution to Onondaga Lake (gauged area), 1996-2005 data. Note: "Other" includes measured flow at Harbor Brook, Tributary 5A, and East Flume. Source: USGS.

Materials Balance

Contributions of sediment, nutrients, bacteria, and chemicals vary by tributary. Onondaga Creek stands out as a major source of sediment and chloride. Treated effluent from Metro is a major source of nutrients, bacteria, and oxygen-demanding material.

Integrated Stream Assessments

Because physical features affect the distribution and abundance of life in streams, the AMP examines habitat as well as water quality conditions in the Onondaga Lake watershed. Surveys of physical characteristics of the streams are conducted at regular intervals, along with periodic sampling of the macroinvertebrate community. **Macroinvertebrates** are aquatic insects, worms, clams, snails and other animals visible without the aid of a microscope. These animals spend at least part of their lives associated with the sediments and macrophytes of streams and lakes. Macroinvertebrates are included in the AMP because their numbers and types are closely linked to water quality and habitat conditions.

The macroinvertebrate communities of Onondaga Creek, Ley Creek, and Harbor Brook are affected to various degrees by pollution and habitat degradation. Upstream segments of the tributaries are affected by nonpoint sources, while urban runoff and CSOs influence the community in downstream segments.

Metro Performance: Nitrogen Treatment

Metro was historically the major source of **ammonia nitrogen** to Onondaga Lake. Major improvements to Metro were completed in 2004 and the facility now successfully reduces ammonia concentration in wastewater throughout the year. This upgrade to the treatment process was necessary to bring concentrations in the lake water to levels that meet state and federal standards for protection of aquatic life.

Ammonia is converted to nitrate (a non-toxic form of nitrogen) in a biological process developed by I. Krüger, Inc. using a biological aerated filter (BAF) called Biostyr. At Metro, the BAF process includes eight centrifugal blowers and eighteen individual cells, each with a capacity of about 273,000 gallons. The cells are filled with billions of tiny polystyrene beads. These beads provide a huge surface area on which nitrifying bacteria grow. The bacteria oxidize ammonia to nitrate. The BAF process reduces ammonia concentrations to below 1 mg/L.

In April 2006, OCDWEP published a Plant Guide describing the wastewater treatment process at Metro. The Plant Guide is available on the County web site at http://www.ongov.net/WEP/wepdf/we12a.pdf. OCDWEP provides guided tours of the Metro facility; please call (315) 435-2260 to schedule.

Metro Performance: Phosphorus Treatment

A phased limit for phosphorus discharged from Metro is included in the ACJ. The Stage I limit on phosphorus discharge from Metro became effective as of the signing of the ACJ in 1998; this limit of 400 pounds per day has been consistently met. A Stage II limit of 0.12 mg/l (less than 90 pounds per day) came into effect April 1, 2006. This is a 12-month rolling average limit; compliance with the Stage II limit will be assessed beginning March 31, 2007.

A physical-chemical treatment process known as the High Rate Flocculated Settling (HRFS) or Actiflo is used to meet the Stage II phosphorus limits. Wastewater flows from the BAF system, described above, to the series of tanks comprising the HRFS units. In the first tank, coagulants are injected into the effluent. The coagulant adheres to phosphorus molecules causing them to form larger flocs or clumps of particles. Next, effluent flows through a second tank where micro-sand is added. In the third tank the floc is gently mixed to increase its size. A concentrated sludge is formed in the fourth tank as microsand adheres to the floc and increases its density; the heavier floc is then siphoned off from the clarified effluent. Micro-sand is separated from the phosphorus-rich sludge and recycled; the phosphorus sludge is pumped to Metro's solids handling facilities.

Meeting the proposed Stage III limits of 0.02 mg/l (less than 15 pounds per day) will be challenging. Small-scale tests to determine how much additional phosphorus can be removed are underway to identify appropriate technology and performance limits. NYSDEC will set final Stage III limits using a Total Maximum Daily Load (TMDL) allocation for all sources of phosphorus, including nonpoint source runoff. The U.S. Geologic Survey is developing a watershed model to estimate inputs of materials from the landscape. These loading estimates will be used in the lake water quality model, initiated in 2005. New York State will apply the models as they determine the final TMDL allocation and effluent limits for Metro.

ONONDAGA LAKE

PROGRAM SUMMARY

The County's comprehensive monitoring program of Onondaga Lake is designed to measure the effectiveness of controls on Metro and the CSOs. Samples are collected regularly throughout the ice-free season to characterize water quality conditions in the lake. Data are used to assess compliance with water quality standards and progress toward lake improvement. Experts in statistics have reviewed the program design to ensure that it will support firm conclusions regarding effectiveness of control measures. Monitoring of the **macrophyte** community is conducted periodically, along with assessment of other major components of the lake's food web: **phytoplankton**, **zooplankton**, **macroinvertebrates**, and the **fish community**.

Indicators of Progress: Is the Lake Suitable for Water Contact Recreation?

Bacteria Levels

As water quality conditions improve, the lake will be suitable for water contact recreation. The AMP includes sampling for **fecal coliform bacteria** at a network of nine nearshore stations in addition to South Deep, the primary monitoring site for Onondaga Lake. Fecal coliform bacteria are used to indicate the potential presence of pathogens (disease-causing microorganisms). Weekly sampling during the summer provides information regarding the suitability of the lake for recreational use. The AMP also includes sampling for bacteria in the lake following storms. Results of the wet weather monitoring help OCDWEP and other stakeholders evaluate the effectiveness of the significant remedial projects planned between 1998 and 2012. These remedial projects include major improvements to reduce combined sewer overflows.

Other remedial projects are underway to address nonpoint sources of bacteria including runoff from urban and agricultural areas.

Nearshore Water Clarity

The NYS Department of Health recommends that water clarity in swimming areas be at least 4 ft (1.2 m) to maintain public safety. Onondaga County monitors compliance with this guidance value at nine stations around the lake during the summer recreational period. Nearshore transparency results are affected by wind, waves, precipitation, and algae. Consequently, results can be highly variable from day to day.

Indicators of Progress: Is the Lake Visually Attractive?

The Importance of Phosphorus to the Lake's Aesthetic Quality

Phosphorus is naturally present in all waters and is an essential nutrient for life. In most lakes, phosphorus is the limiting nutrient for algal growth; that is, phosphorus concentration is positively correlated with algal abundance. Excessive algae will make a lake appear turbid or green and diminish its attractiveness for recreational use. Decay of algae reduces the concentration of dissolved oxygen in a lake's deeper waters. Consequently, lake managers focus on controlling phosphorus inputs.

Macroalgae in Onondaga Lake

Algae and Water Clarity

The concentration of **chlorophyll-*a***, the major photosynthetic pigment in plants, is used as an index of algal abundance. Many water resources agencies have developed guidelines on chlorophyll-*a* to protect recreational uses in lakes. Concentrations exceeding 15 µg/l may diminish the lake's attractiveness for recreational use.

Water clarity is measured using a Secchi disk. This measurement is affected primarily by algal abundance, although inorganic sediment particles and dissolved materials can affect the color and clarity of the water.

The AMP team tracks development and extent of algal mats in nearshore areas. This information is used to evaluate the lake's aesthetic qualities in addition to its suitability for contact recreation.

Indicators of Progress: Can Onondaga Lake Water Quality Support a Balanced Community of Plants and Animals?

Ammonia and Nitrite Concentrations

Ammonia and nitrite concentrations are major factors affecting the type and abundance of aquatic life in Onondaga Lake. Reductions in concentration of these harmful forms of nitrogen are required to meet **water quality standards and criteria** and protect a diverse aquatic community.

Dissolved Oxygen

The **dissolved oxygen** (DO) status of Onondaga Lake is closely linked to its annual temperature cycle. During summer, the lake's deeper waters remain isolated from the atmosphere. Light to support photosynthesis by algae or aquatic plants cannot reach the deeper waters; thus no oxygen production occurs. DO in the lower waters is used during decomposition of organic material settling from the sunlit layers above. When DO is depleted, the waters become anoxic and chemicals such as iron, ammonia, hydrogen sulfide, and methane accumulate.

When the lake cools in the fall, temperature differences that kept the water layers isolated begin to break down. Gradually, the deep anoxic waters mix with the upper waters. As the iron, ammonia, hydrogen sulfide, and methane mix into the upper waters, DO is reduced and may fall below levels that support aquatic life. To comply with state and federal standards designed to protect aquatic life, DO should always remain above 4 - 5 mg/l in the upper waters, even during the fall mixing period.

Onondaga County has had a water quality monitoring buoy at South Deep station since 2001. Suspended from the buoy is an array of monitoring and recording instruments. Results are transmitted back to a computer at the OCDWEP offices on Hiawatha Boulevard. The buoy is in operation from early spring to late fall. Data can be viewed through the County's website at ***www.ongov.net***. This near real-time water quality measurement system represents a huge advance in the County's ability to monitor and interpret lake conditions, especially during critical periods such as fall mixing.

Fish Space: Integrated Temperature and Dissolved Oxygen Conditions

As part of the AMP, project scientists have developed a "fish space metric" to measure how dissolved oxygen and temperature jointly affect fish habitat. As displayed in **Figure 4**, there are periods during the year when the lake water is either too warm (yellow) or too low in oxygen (green) to provide habitat suitable for a cold water fish such as the brown trout. The graph uses data from the water quality monitoring buoy and displays the conditions in a slice through the lake's deepest section (the y-axis of the graph is depth) over time (the x-axis of the graph is month).

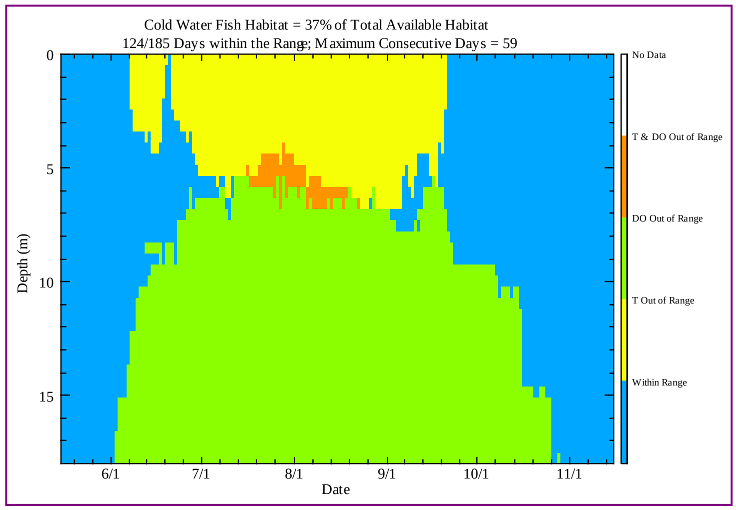

Figure 4. Example of DO and temperature data from 2005 used to calculate fish space.

The fish space metric should not be interpreted as an indicator of whether populations are sustainable. Favorable dissolved oxygen and water temperature conditions are not the only factors required for a fish population to thrive in Onondaga Lake. A sustainable population also needs an adequate forage base and suitable reproductive habitat.

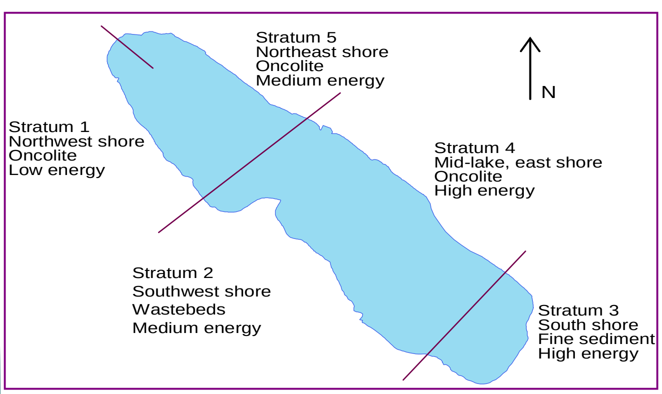

Figure 5. Strata used in Onondaga Lake biological programs.

Elements of a Balanced Biological Community

Monitoring the biological community of Onondaga Lake and its watershed is an important part of the AMP. The nearshore areas of Onondaga Lake are subject to different wave energy that has led to variation in the type and stability of nearshore sediments. To assess the importance of these different habitat conditions, the AMP uses a stratified sampling design. Biological data are collected, analyzed and reported in five distinct nearshore strata (**Figure 5**).

Macroinvertebrates

Macroinvertebrates collected in the lake and its tributaries.

Onondaga Lake's **littoral** (nearshore) macroinvertebrate community is sampled every five years. The macroinvertebrate community in the northern strata is less affected by the pollutant inputs that dominate the southern basin: wastewater, contaminated and/or saline groundwater, and sediment. The combined influences of eutrophication and habitat degradation are the most critical factors determining the makeup of the benthic community in the lake's nearshore area.

Macrophytes

Macrophytes stabilize the lake's bottom sediments, and provide food and shelter for young fish. Detailed surveys are completed every five years and aerial photographs are obtained each year as weather and water clarity allow.

Phytoplankton and Zooplankton

Researchers from the Cornell Biological Field Station evaluate the community of **phytoplankton** and **zooplankton** each year. Abundance and species composition are evaluated from samples collected from early spring through the late fall. Zooplankton size is measured and tracked over the year, as this is affected by the intensity of feeding by the fish community.

Invasive Species

Invasive (non-native) species are an important factor affecting ecosystems throughout the Great Lakes Basin, and Onondaga Lake is no exception. Proliferation of the zebra mussel has caused profound changes in the ecology of lakes and rivers throughout the Finger Lakes and Central New York. A closely-related species, the quagga mussel, is making its way eastward through the Barge Canal from Lake Erie. Macrophytes such as the water chestnut are particularly troubling invasive species, the water chestnut is present in the Seneca River and is making its way into the lake. Recent monitoring has documented the presence of a predatory cladoceran zooplankton *Cercopagis pengoi* that was introduced to the Great Lakes from the Caspian Sea region in Eurasia and is rapidly making its way into adjacent waterways. Shipping from overseas is the most likely source for these organisms to reach Onondaga Lake. The AMP tracks the presence and importance of invasive species each year.

Indicators of Progress: Does the Lake Have a Self-Sustaining Warmwater Fish Community?

This 51-inch lake sturgeon was caught in the lake in 2004 by the AMP field team.

Fish are among the most important elements of the food web of any lake and the AMP includes a major effort to track the types of fish present in the lake and their reproductive success. Onondaga Lake is part of a larger aquatic ecosystem, and it is clear that there is migration between Onondaga Lake, the Seneca River, and Oneida Lake. Therefore, the fish community in Onondaga Lake may be supplemented by migration through the river.

The County uses a combination of classical and innovative techniques to count nests; sample larval, juvenile, and adult fish; and track changes in the fish community. Data are collected each year as improvements to wastewater collection and treatment are phased in. Cooperating anglers are recruited to keep annual diaries of their fishing efforts and successes, and report this information to the County. Standard methods are used so that the fish community of Onondaga Lake can be compared with that of other lakes. Experts in fish ecology oversee program design and implementation. A hydroacoustical survey is conducted in the spring to estimate total fish abundance. The AMP calculates several indicators to evaluate the condition of the lake's total fish community.

SENECA RIVER

The Seneca River connects Onondaga Lake to the greater Oswego River-Great Lakes system (**refer to Figure2 on Page 3)**. Fish and other organisms, including invasive species, can move in and out of the lake through the Seneca River. Water quality of the river is directly affected by the outflow of Onondaga Lake. The capacity of the river to handle additional treated wastewater will affect the final alternatives for discharge of the Metro effluent.

OCDWEP regularly conducts surveys in the river to characterize water quality conditions, assess the impact of zebra mussels on water quality, and support the Three Rivers Water Quality Model (TRWQM).

MODELING

Monitoring data are essential for lake managers to evaluate current conditions, compliance, and trends. However, mathematical water quality models are necessary to make projections of what might happen in the future when reductions in pollution are achieved. Development of a water quality model of Onondaga Lake began in 2005. This model will enable NYSDEC to complete their required Total Maximum Daily Load (TMDL) allocation of phosphorus to the lake. The TMDL accounts for all sources of phosphorus: from Metro and watershed nonpoint sources.

The Onondaga Lake water quality model (OLWQM) will be linked to the existing model of the Three Rivers system. Managers will use the linked model to examine how the level of wastewater treatment and point of discharge affect the lake and river as an integrated system.

The OLWQM will also be linked to a watershed model under development by USGS; the USGS model predicts loss of nutrients and sediment from the landscape. Understanding where the sources of phosphorus and sediment are in the watershed will help managers target specific land uses and locations for control actions.

The network of linked models will provide an effective tool for integrated water quality management throughout the extensive watershed.

Sailing on the lake.

GLOSSARY

Amended Consent Judgment (ACJ). An agreement signed in January 1998 by New York State, Onondaga County, and Atlantic States Legal Foundation committing the County to a 15-year program of improvements to the wastewater collection and treatment system and associated monitoring.

Ambient Monitoring Program (AMP). Annual water quality and biological monitoring program conducted in Onondaga Lake, the lake tributaries, and the Seneca River.

Biological Aerated Filter (BAF). Treatment process to biologically convert (oxidize) ammonia to nitrate; this treatment came on line at Metro in February 2004 and is effective year-round in ammonia removal.

Chlorophyll-a. The primary photosynthetic pigment in algal (phytoplankton) cells, used as an index of algal abundance.

Combined Sewer Overflow (CSO). A relief point in the wastewater collection system that operates when the hydraulic capacity of the pipe is exceeded. CSOs direct a mixture of storm water and untreated sanitary wastewater to nearby water bodies.

Dissolved Oxygen (DO). The quantity of oxygen dissolved in water. DO concentrations vary with depth, season, and time of day in Onondaga Lake in response to photosynthesis and breakdown of organic matter (especially algal cells). DO levels are a major factor affecting the abundance and type of organisms living in the lake.

Eutrophic. A lake characterized by high levels of nutrients and biological productivity.

Fecal coliform. A type of bacteria whose natural habitat is the intestinal tract of mammals. While most fecal coliform bacteria are not harmful, they are used as an indicator of the potential presence of pathogenic (disease-causing) microorganisms associated with recent sewage contamination.

Littoral zone. Shoreline habitat of a lake extending from the water's edge to the limit of light penetration to the sediment surface (often, the greatest depth occupied by rooted plants).

Macroinvertebrate. Aquatic insects, worms, clams, snails and other animals that spend at least part of their life cycle associated with sediments or macrophytes of streams and lakes. Numbers and types of these organisms are used to infer water quality and habitat conditions.

Macrophytes. Aquatic plants large enough to be seen without magnification. While most are rooted, some forms are free-floating. Macrophytes are an important component of the lake's food web.

Metro (Syracuse Metropolitan Wastewater Treatment Plant). Advanced secondary wastewater treatment plant on Hiawatha Boulevard being upgraded for enhanced removal of ammonia and phosphorus, and other improvements.

Nitrification. The biological conversion of ammonia to nitrate.

Nonpoint source pollution. Pollution sources which are diffuse and do not enter receiving waters from a specific outlet. The pollutants (such as sediment, nutrients, microorganisms etc) are generally carried off the land by stormwater runoff.

Phosphorus. An element that is an essential macronutrient for plant growth; the limiting nutrient for phytoplankton growth in Onondaga Lake.

Phytoplankton. Microscopic algae and certain bacteria found in lake water.

Secchi disk transparency. A standard measure of water clarity obtained by lowering a 20-cm disk through the water column and recording the depth at which it is no longer visible.

Water quality criteria. Best scientific judgment of the maximum contaminant level in water that will protect a designated use (such as water supply or swimming).

Water quality standard. An enforceable limit, usually numerical, of the maximum contaminant level in water

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Nicholas J. Pirro
Onondaga County Executive

Dale A. Sweetland
Chair, Onondaga County Legislature

Richard L. Elander, P.E.
Commissioner, Department of Water Environment Protection