Onondaga County Department of
WATER ENVIRONMENT PROTECTION

# Onondaga Lake Ambient Monitoring Program

**2008 Annual Report**
**FINAL**
**March 2010**

Onondaga County, New York
Joanne M. Mahoney, County Executive

**ONONDAGA LAKE AMBIENT MONITORING PROGRAM**

**2008 ANNUAL REPORT**

**ONONDAGA COUNTY, NEW YORK**

**FINAL**
**MARCH 2010**

Prepared for

ONONDAGA COUNTY, NEW YORK

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Onondaga County Department of WATER ENVIRONMENT PROTECTION

## *A MESSAGE FROM THE COUNTY EXECUTIVE*

*Onondaga Lake is on the road to recovery. This report of the 2008 Ambient Monitoring Program carried out by the Onondaga County Department of Water Environment Protection (DWEP) documents significant progress toward attaining the community's vision for a healthy lake. I encourage all residents of Onondaga County to read this report and take pride in the value of our investment in infrastructure improvements.*

*The 2008 AMP report is presented as a concise summary of major findings with links to supporting information. This new format was developed to advance two objectives: first, to reach a broader audience, and second, to reflect the County's commitment to green initiatives. We anticipate that this new format will enable more of our County leaders and citizens to become better informed of the significant progress toward the rehabilitation of Onondaga Lake. Additional program information, including annual reports from previous years, is available at the County web site www.ongov.net.*

Joanne C. Mahoney
Onondaga County Executive

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## *A MESSAGE FROM THE COMMISSIONER OF WATER ENVIRONMENT PROTECTION*

*The Department of Water Environment Protection is responsible for collecting and treating wastewater from homes and businesses throughout the County. As Commissioner, I am proud to lead our dedicated staff under a name that reflects Onondaga County's firm commitment to protecting the water resources we all share.*

*The Department completes an intensive survey of water quality conditions in the Onondaga Lake watershed each year. This publication is a summary of the findings of the 2008 Ambient Monitoring Program (AMP), the 39th consecutive year of Onondaga County monitoring of the lake and adjacent waters. Results of the monitoring program are used to track how Onondaga Lake is responding to pollution abatement activities. Current conditions and trends in water quality and the lake's biological community are highlighted in this document. Comments on this report are encouraged and may be directed to Jeanne C. Powers at 315-435-2260 or email Jeanne.Powers@ongov.net*

Patricia M. Pastella, P.E., BCEE
Commissioner

## *Key Features of this Report*

The 2008 annual report of Onondaga County's Ambient Monitoring Program (AMP) presents an integrated assessment of Onondaga Lake's response to the community's investment in improvements to the wastewater collection and treatment infrastructure. The 2008 annual AMP report differs from those published in previous years. In an effort to improve overall readability, while retaining the level of detail, the report was redesigned for use as both a print document and a web-based electronic document. A CD is included in the print document that includes the report and all the supporting information.

Significant findings of the 2008 AMP, illustrated with summary tables and graphics, are included in the main document. The main document is substantially condensed compared with previous AMP annual reports. This new format greatly reduces the amount of printed material, which helps Onondaga County meet its commitment to green initiatives. All the tables and graphs included in previous reports have been updated with 2008 data, and are in the electronic library distributed on the CD that accompanies the print version of this report. In addition, the complete report and all library documents are on the Onondaga County web site www.ongov.net .

Throughout the document are hyperlinks directing the reader to more detailed data, tables, graphs and related reports. A folder icon at the end of each topic of the summary report links to the section of the electronic library where relevant materials are archived.

Click for More Information

Once in the library of supporting documents, the reader can navigate back to the main report in one of two ways. First, many versions of the Adobe reader have "back buttons" in the toolbar. Second, a link back to the main document has been placed in the library file.

Back to Index

There are more than 500 supporting tables and graphics in the library of supporting materials. While each hyperlink has been checked, it is possible that some features may not be enabled on every computer's operating system. Feedback on the functionality of the electronic features of the document is welcome, please contact info@ecologicllc.com with comments.

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## List of Acronyms

| | |
|---|---|
| AMP | Ambient Monitoring Program |
| ACJ | Amended Consent Judgment |
| ASLF | Atlantic States Legal Foundation |
| AWQS | Ambient Water Quality Standards |
| BAF | Biological Aerated Filter |
| BAP | Biological Assessment Profiles |
| BMP | Best Management Practices |
| BOD | Biochemical Oxygen Demand |
| CBUD | Continuous Backflow Upwelling Dual Filters (Phosphorus Filtration Stage III) |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFU | Colony Forming Units |
| CSO | Combined Sewer Overflows |
| DAIP | Data Analysis and Interpretation Plan |
| DO | Dissolved Oxygen |
| DVT | Data Visualization Tool |
| EPA | Environmental Protection Agency |
| FDA | Food and Drug Administration |
| GIS | Geographic Information System |
| HBI | Hilsenhoff Biotic Index |
| HRFS | High Rate Flocculated Settling |
| ISD | Impact Source Determination |
| METRO | Metropolitan Syracuse Wastewater Treatment Plant |
| MRL | Minimum Reporting Level |
| N | Nitrogen |

| | |
|---|---|
| NYCRR | Official Compilation of the Rules and Regulations of the State of New York |
| NOAA | National Oceanic and Atmospheric Administration |
| NPL | National Priority List |
| NYSDEC | New York State Department of Environmental Conservation |
| OCDWEP | Onondaga County Department of Water Environment Protection |
| OLP | Onondaga Lake Partnership |
| OLTAC | Onondaga Lake Technical Advisory Committee |
| OLWQM | Onondaga Lake Water Quality Model |
| PWL | Priority Waterbodies List |
| RCRA | Resource Conservation and Recovery Act |
| RI/FS | Remedial Investigation/Feasibility Study |
| RSE | Relative Standard Error |
| SPDES | State Pollution Discharge Elimination System |
| SRP | Soluble Reactive Phosphorus |
| SSO | Sanitary Sewer Overflow |
| TKN | Total Kjeldahl Nitrogen |
| TMDL | Total Maximum Daily Load |
| TP | Total Phosphorus |
| TRWQM | Three Rivers Water Quality Model |
| TSS | Total Suspended Solids |
| UFI | Upstate Freshwater Institute |
| USGS | United States Geological Survey |
| WFI | Wetland Fish Index |

# EXECUTIVE SUMMARY

The 2008 Annual Report of Onondaga County's Ambient Monitoring Program (AMP) provides an overview of the results of the extensive monitoring effort underway to characterize Onondaga Lake and its watershed. Conducted annually since completion of a baseline evaluation in 1970, the AMP represents an unparalleled investment in long-term monitoring of the rehabilitation of a complex aquatic ecosystem and its watershed.

The AMP is designed to document the lake's response to pollution control measures. Samples are collected throughout the entire watershed to identify sources of materials (nutrients, sediment, bacteria and chemicals) to the lake. An intensive in-lake monitoring program examines water quality conditions and the interactions between Onondaga Lake and the Seneca River. Data are evaluated for compliance with water quality standards and analyzed for trends. In addition to the water quality monitoring effort, the AMP examines the health of the lake ecosystem by sampling fish, phytoplankton, zooplankton, benthic invertebrates, aquatic plants and dreissenid (zebra and quagga) mussels.

Excessive discharges of municipal and industrial wastewaters, structural modifications, and runoff from urban and rural areas have degraded the quality of some regional waterways, including Onondaga Lake. Contact recreation has historically been precluded by elevated bacteria counts, algal blooms from excessive phosphorus and poor water clarity. Conditions for aquatic life were compromised by high ammonia concentrations, low dissolved oxygen and lack of habitat. Onondaga Lake's degraded water quality resulted from multiple sources of pollution, but more stringent regulations and major investments by the public and private sectors have reduced pollutant inputs, resulting in improved water quality and habitat conditions.

In 1998, an Amended Consent Judgment (ACJ) between Onondaga County, New York State and Atlantic States Legal Foundation was signed to resolve a lawsuit filed against Onondaga County for violations of the Clean Water Act. The lawsuit alleged that discharges from the Metropolitan Syracuse Wastewater Treatment Plant (Metro) exceeded the facility's permitted discharge limits, and that overflows from the combined sewer system (CSOs) were not in compliance with state and federal requirements. The ACJ obligates the County to undertake a phased program of wastewater collection and treatment improvements that will extend though the year 2012, monitor water quality response, and report annually on progress towards compliance. This annual report fulfills the requirement for monitoring and reporting.

In light of the lake's water quality conditions, the primary focus of the improvements to the wastewater treatment system has been to provide a higher level of treatment for ammonia and phosphorus at Metro. Two new treatment systems have been brought on line. The Biological Aerated Filter (BAF) system has resulted in year-round nitrification (conversion of ammonia to nitrate) of the wastewater. This innovative technology, which became fully operational in 2004, has resulted in a 98% decrease in Metro's ammonia output to the lake. As a result, the lake is now in full compliance with ambient water quality standards for ammonia. Phosphorus removal is achieved using a physical-chemical High-Rate Flocculated Settling (HRFS) technology, known as Actiflo. The system came on line in 2005 to meet an interim effluent limit of 0.12 mg/l of total phosphorus. This technology has resulted in an 86% decrease in Metro's total phosphorus output to the lake.

The 2008 results document the significant improvements in Onondaga Lake brought about by these reductions in ammonia and phosphorus load from Metro, in addition to other projects in the watershed to reduce stormwater runoff from urban and rural areas. Water quality has improved dramatically; nutrient levels are reduced and dissolved oxygen has increased. No algal blooms were evident; the lake water was generally clear and aesthetically appealing. Total phosphorus concentrations averaged 15 µg/l over the summer of 2008, the lowest level ever recorded in Onondaga Lake and well within the state's guidance value of 20 µg/l for recreational use.

Clearer water allows light to penetrate deeper into the lake, and fosters the proliferation of macrophytes (rooted aquatic plants and bottom-dwelling algae) in nearshore shallow waters, to a water depth of six meters. The macrophyte community has also become more diverse, as more species of plants have colonized the nearshore waters of the lake. As these macrophyte beds have spread around the perimeter of the lake, they have brought improved habitat conditions. The populations of gamefish such as largemouth and smallmouth bass have increased steadily since 2000. Throughout the summer of 2008, bacteria counts remained within limits set for water contact recreation.

Improvements continue on the wastewater collection infrastructure as well. Four primary approaches were taken to eliminate wet weather discharges from the combined sewer system; these methods include separating sewers, constructing regional treatment facilities, capturing floatable materials and maximizing system storage capacity. During 2008, County officials began evaluating the potential use of "green" infrastructure to help manage urban storm runoff. Green infrastructure encourages infiltration, capture and reuse of storm runoff before it enters the sewer system.

Water quality conditions in the Seneca River during 2008 were comparable to those measured in previous years. The proliferation of dreissenid mussels clearly continues to affect water quality. However, flows in the river system remained relatively high throughout the summer; as a consequence, the duration and extent of low dissolved oxygen conditions were reduced. Ammonia and nitrite concentrations in the monitored segments of the Seneca River were in compliance during 2008.

# SECTION 1: ENVIRONMENTAL SETTING

## Onondaga Lake and its Watershed

The Onondaga Lake watershed encompasses approximately 285 square miles almost entirely within Onondaga County, including six natural sub-basins: Ninemile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek. Tributary 5A and the East Flume direct runoff and industrial discharges into the lake. The outlet of Onondaga Lake flows north to the Seneca River and ultimately into Lake Ontario.

Compared with other lakes in the Seneca-Oneida-Oswego river basin, the watershed of Onondaga Lake is more highly urbanized, as displayed in Figure 1-1, a map of land cover within the watershed. Approximately 28% of the land cover is classified as developed, 51% as forested or scrub/shrub, and 9.5% as cultivated lands or pasture. Urban areas of the City of Syracuse, two towns and two villages border the lake.

Onondaga Lake is relatively small, especially compared with the nearby Finger Lakes and Oneida Lake. The shoreline is highly regular with few embayments. The majority of the shoreline is owned by Onondaga County and is maintained as part of a popular park and trail system. The parklands are used for recreational activities, shoreline fishing and cultural entertainment. The lake is increasingly popular for boating: sailboats, motorboats, kayaks and canoes are familiar sights on summer days. Local and regional fishing tournaments attract anglers to the lake and its shoreline each year.

## History of Pollution

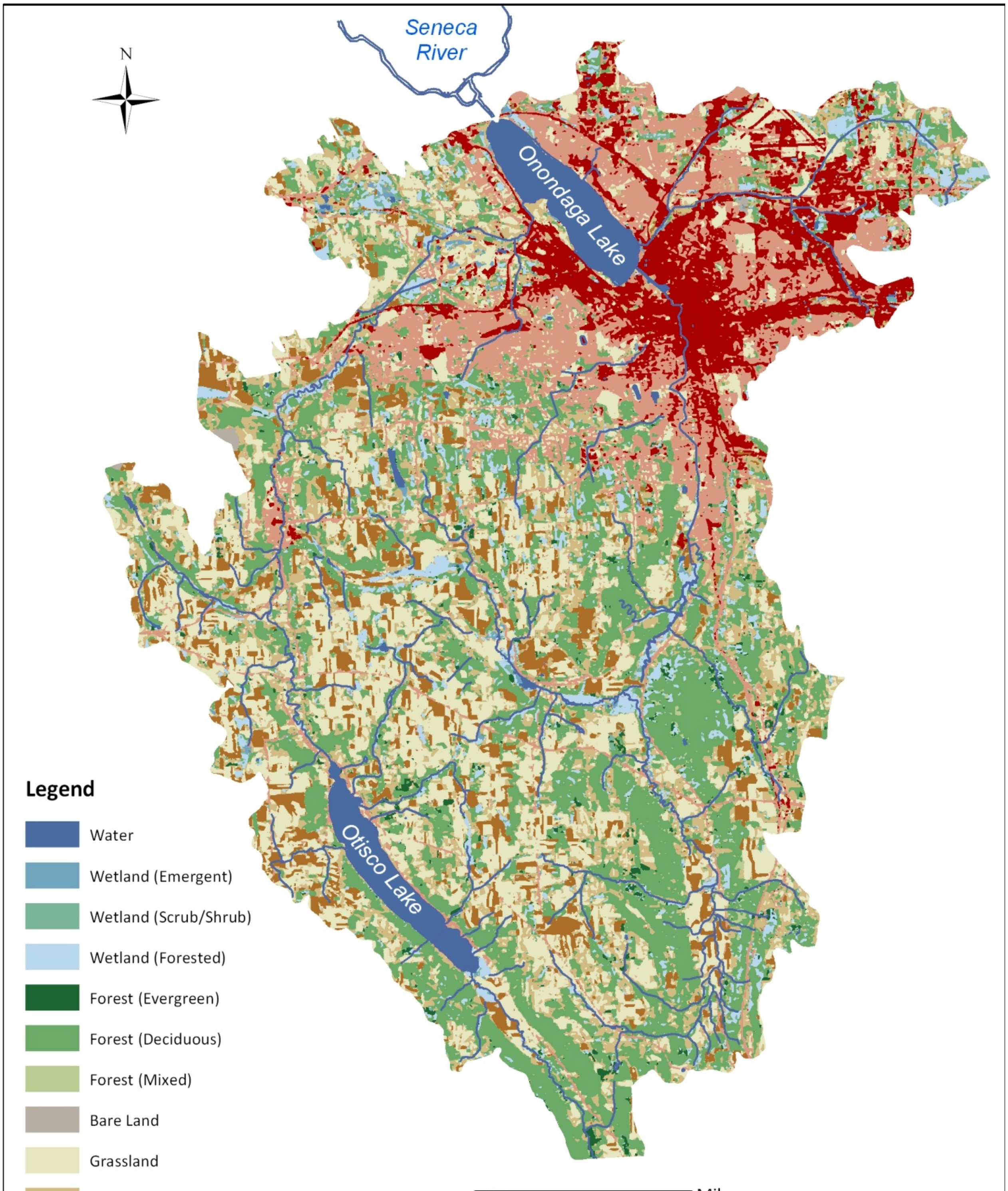
Excessive discharges of municipal and industrial wastewaters and uncontrolled storm water discharges have degraded the quality of some regional waterways, including Onondaga Lake. Swimming has been banned since 1940 due to elevated bacteria counts and poor water clarity. Conditions for aquatic life were compromised by high ammonia concentrations and low dissolved oxygen. The lake's degraded water quality resulted from multiple sources of pollution, but more stringent regulations and significant investments by the public and private sectors have reduced pollutant inputs, resulting in improved water quality and habitat conditions. This annual report documents the significant improvement in Onondaga Lake.

Fishing was banned in Onondaga 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 revised its advisory to warn against consumption of gamefish from Onondaga Lake based on mercury, PCBs and dioxin.

The 2009 – 2010 advisory includes the warning that women of childbearing age, infants, and children under the age of 15 should not consume fish from Onondaga Lake. Everyone else is advised to eat no walleye of any size, nor largemouth or smallmouth bass over 15 inches. For all other species, including carp, white perch, and channel catfish, and for largemouth and smallmouth bass less than 15 inches, the advisory is to eat no more than one meal per month of fish from the lake. Information on these health advisories is available at

http://www.health.state.ny.us/environmental/outdoors/fish/docs/specific_advisory_table.pdf

Figure 1-1. Land Cover Classes, 2001, Onondaga Lake Watershed.




Source: Syracuse Onondaga County Planning Agency.
Land use files obtained from NOAA Coastal Services Center/Coastal Change Analysis Program(C-CAP), published 9/11/2002, NOAA CSC, Charleston, SC (Online_Linkage: http://www.csc.noaa.gov).

# SECTION 1: ENVIRONMENTAL SETTING

The Metropolitan Syracuse Wastewater Treatment Plant (Metro) is located on the lake's southern shoreline, and discharges treated effluent with residual concentrations of nitrogen, phosphorus, bacteria and organic (oxygen-demanding) materials to the lake. Trace concentrations of other materials present in domestic and industrial wastewater also are present in the treated effluent. Recent upgrades to the treatment facility have significantly reduced its discharge of phosphorus, ammonia and organic material.

Some areas of Syracuse are served by combined sewer systems which carry both sewage and storm water in a single pipe. These pipes can overflow during periods of heavy rain and snowmelt, allowing a mixture of stormwater and untreated sewage to flow into creeks and ultimately reach Onondaga Lake. The sewer system was originally designed to overflow to prevent sewage from backing up into streets and basements, thereby protecting public health. The overflows direct bacteria, floating trash, organic material, nutrients and solid materials to the waterways.

Nonpoint sources, such as runoff from agricultural, suburban and urban areas, also contribute pollutants to Onondaga Lake. Nutrients, sediment, bacteria, metals and organic substances such as pesticides reach surface water and groundwater from these diffuse sources. Industrial residuals in the watershed continue to enter the lake through surface runoff and groundwater seepage. Lake sediments contain elevated concentrations of mercury and organic chemicals. Remedial programs are underway to address nonpoint sources throughout the watershed, and to remove or cap lake sediments contaminated by past industrial activities.

## Classification and Best Use

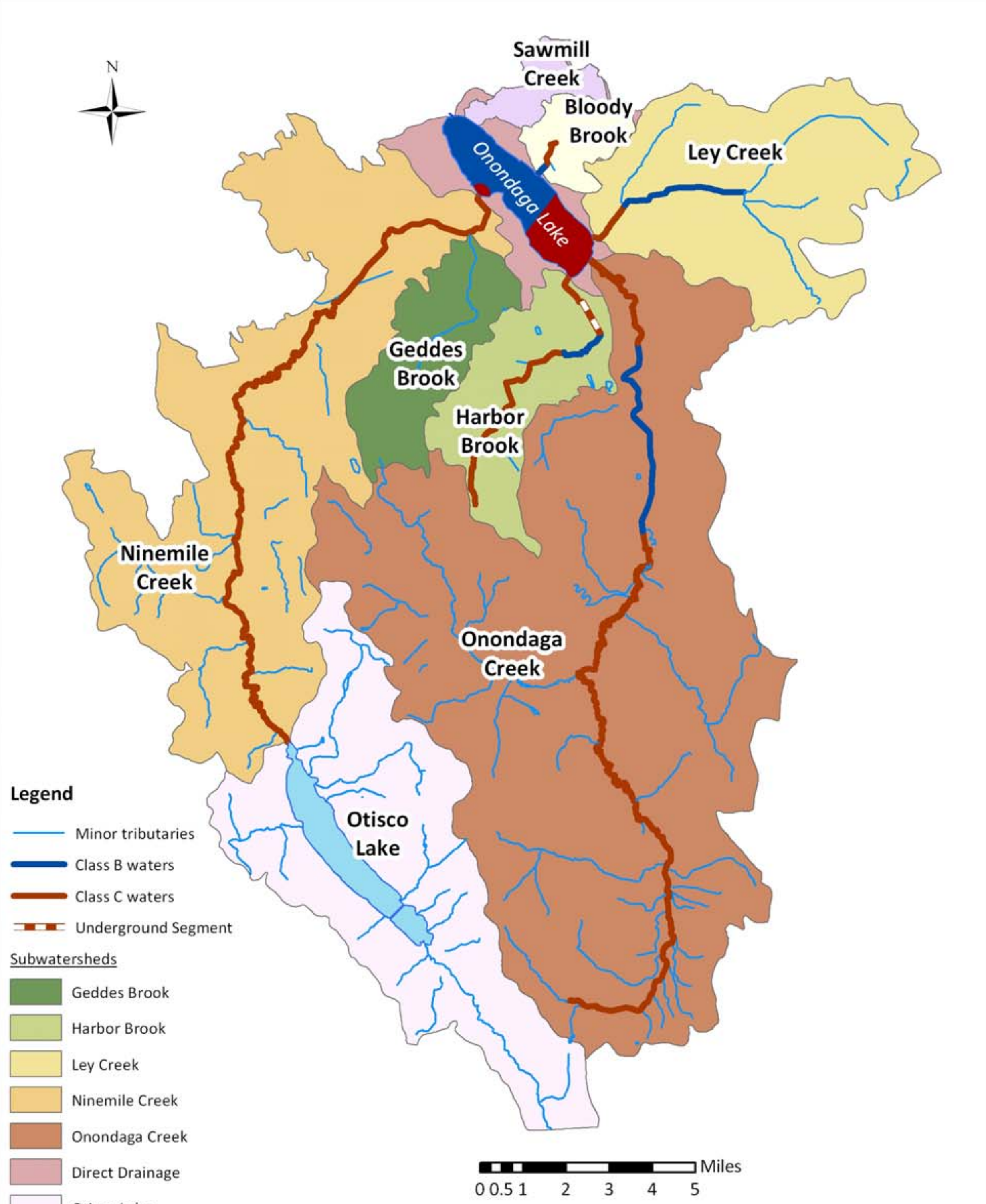
New York State Department of Environmental Conservation (NYSDEC) is responsible for managing water resources throughout the State. As part of this responsibility, NYSDEC classifies surface waters, including lakes, rivers, streams, embayments, estuaries and groundwater with respect to their best use. Monitoring results are evaluated on a regular basis to determine whether designated uses are supported, and if not, the factors precluding use attainment.

Onondaga Lake and its tributaries are currently classified to include Class B and Class C waters, as displayed in Figure 1-2. The best usages of Class B waters are primary and secondary water contact recreation and fishing. Primary water contact recreation includes activities that immerse the body in the water, such as swimming; secondary water contact recreation includes activities without full immersion, such as boating. In addition, Class B waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The best usage of Class C waters is fishing. These waters shall also be suitable for fish, shellfish and wildlife propagation and survival. Class C waters shall be suitable for primary and secondary water contact recreation, although other factors may limit the use for these purposes.

## Nutrients and Trophic State

Onondaga Lake can be characterized by its trophic status, that is, how much sunlight it converts to organic matter through photosynthesis. Highly productive systems are

Figure 1-2. Tributary and Lake Regulatory Classification and Subwatershed Boundaries




Sources: Syracuse Onondaga County Planning Agency. Onondaga County Watersheds (1996) (Online_Linkage: http://www.csc.noaa.gov).
USGS. 2007 Onondaga Lake subbasins (Bloody Brook and Saw Mill)
U.S. Department of Commerce U.S. Census Bureau Geography Division. Census Hydrography, New York State (Shapefile : 2001)

termed **eutrophic**, while systems with low levels of productivity are termed **oligotrophic.** Those in between are called **mesotrophic**. Although some productivity is good for a lake in that it supports the food web, including the fishery, excessive productivity can result in conditions that impair a waterbody for a particular use, such as water supply or recreation.

The productivity of natural waters in the Northeast is typically limited by the availability of nutrients, especially phosphorus. Adding phosphorus induces eutrophication, and such over-productive waters support large populations of algae and cyanobacteria (blue-green algae). Approximately 50 species of cyanobacteria have been shown to produce toxins that are harmful to vertebrates.

When algal biomass settles to the lower, unlighted areas of a productive lake, its decay robs the lower waters of dissolved oxygen, making them uninhabitable by fish or other oxygen-requiring organisms. Under these anaerobic or oxygen-free environments, undesirable compounds such as ammonia and soluble phosphorus may be liberated from the sediments. Monitoring the trophic status of impaired waters like Onondaga Lake involves tracking of a number of key parameters to assess the type and abundance of algae, and the chemistry of the deep waters.

***Total Phosphorus (TP)***

Since the productivity of Onondaga Lake is limited primarily by the availability of phosphorus in the water, total phosphorus concentration (TP) is an important indicator of trophic status. There are no firm demarcations along the trophic continuum from oligotrophic to eutrophic. However, lakes exhibiting TP concentrations in excess of 35 µg/L (a unit of measure equivalent to a part per billion) are generally considered eutrophic. Lakes with TP concentrations less than 10 µg/L are, in contrast, generally considered oligotrophic (Janus and Vollenweider 1981).

***Chlorophyll-a***

One of the undesirable attributes of eutrophic waters is their green-tinged water and turbidity, or cloudiness, which is usually caused by the large populations of algae containing the photosynthetic pigment chlorophyll-*a*. The measurement of chlorophyll-*a* is, therefore, a more or less direct measurement of the turbidity of the water as well as an indicator of its productivity, since the amount of photosynthesis correlates strongly with the amount of chlorophyll-a in the water. Chlorophyll-*a* concentrations above 15 µg/L are associated with green-tinged and turbid waters that are less appealing for recreational use. Nuisance bloom conditions are defined as chlorophyll-a concentrations greater than 30 µg/L.

***Secchi Disk Transparency***

Another—and more direct—indicator of turbidity of the water is the Secchi disk transparency. A Secchi disk is a 25 cm diameter disk with alternating black and white quadrants. It can be lowered into the lake, and the depth at which it can no longer be seen from the surface or from the deck of a boat, is known as the Secchi-disk transparency. Greater depth indicates clearer and less productive waters. Highly productive waters may have Secchi disk readings of less than one meter.

### *Dissolved Oxygen (DO) in Lower Waters*

In the summer, temperate zone lakes, like Onondaga Lake, become stratified with warm, lighter water on top and cool, denser water on the bottom. Typically the temperature of the water drops quickly with depth in a zone called the “thermocline”, such that, during the summer, the top water and the bottom water do not mix. Although there is not enough light in these lower reaches of the lake to support photosynthesis and the oxygen it releases, organic matter continues to respire or decay at these depths, using up whatever oxygen is available.

The extent of summer DO depletion in the lower depths of the lake is another indicator of its trophic status: oligotrophic lakes produce so little organic matter that its descent into the lower depths has no discernable effect on DO concentrations. In contrast, DO may be completely lost from the deeper waters of eutrophic lakes. Decomposition of organic material continues after oxygen is lost, resulting in the accumulation of reduced substances such as hydrogen sulfide. As the waters cool in the fall, stratification breaks down and the surface and bottom waters mix; this process is referred to as the lake “turning over”. The accumulated oxygen debt from reduced substances in a eutrophic lake may depress oxygen concentrations throughout the water column. Thus, measurement of DO in the depths of a lake during the summer is another indicator of a lake’s trophic status.

These indicators of lake trophic status and the 2008 Onondaga Lake conditions are summarized in Table 1-1. Onondaga Lake is now exhibiting characteristics consistent with mesotrophic conditions.

## Status of Impaired Waters

A waterbody is considered impaired when water quality or habitat conditions are not adequate; the most severely impaired waters are placed on the 303(d) list, named for the section of the federal Clean Water Act addressing impaired waters, and reported to the EPA. 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 New York State’s top priorities for water quality improvement. The most recent 303(d) list was finalized in 2008. Notably, the 2008 update cites Onondaga Lake as delisted for ammonia, reflecting that the lake is now in full compliance with this ambient water quality standard.

Several tributaries to Onondaga Lake were included on the most recent 303(d) list. The CSO-affected tributaries (Onondaga Creek, Harbor Brook and Ley Creek), Ninemile Creek and Bloody Brook were cited for pathogens, among other pollutants.

The goal is to return and maintain impaired water bodies to a condition that supports their designated “best use”. Improvements in wastewater treatment at Metro are directed toward that end, as are the myriad efforts to control urban and rural storm water runoff throughout the watershed. The Ambient Monitoring Program’s (AMP) annual reports document these improvements and their concomitant effects on the water quality of Onondaga Lake, the lake tributaries and the Seneca River. In documenting these improvements, the AMP focuses on quantitative indicators that reflect both the quality of the effluent from Metro and the quality of the surface waters.

**Table 1-1**. Trophic State Indicator Parameters Compared with Onondaga Lake 2008 Water Quality Conditions.

| Indicator Parameters | Trophic State Designation | | | Onondaga Lake Measured Conditions, 2008 |
|---|---|---|---|---|
| | Oligotrophic | Mesotrophic | Eutrophic | |
| Summer average total phosphorus, upper waters (µg/l) | <10 | 10-35 | 35 -100 | **15 (June-Sept.)** |
| Summer average chlorophyll-*a*, upper waters (µg/l) | <2.5 | 2.5 – 8 | 8 – 25 | **5.5 (June-Sept.)** |
| Peak chlorophyll-*a* (µg/l) | <8 | 8-25 | 25-75 | **15.5 (May 12)** |
| Average Secchi disk transparency, m | >6 | 6-3 | 3-1.5 | **3.8 (June-Sept.)** |
| Minimum Secchi disk transparency, m | >3 | 3-1.5 | 1.5-0.7 | **1.6 (June 17)** |
| Minimum DO in hypolimnion (% saturation) | 80 – 100 | 10-80 | Less than 10 | **0 (July – Sept.)** |
| *Source:* Janus and Vollenweider 1981[1] | | | | |

Click for More Information

[1] Janus, L.L., and R.A. Vollenweider. 1981. The OECD Cooperative Program on Eutrophication. Summary Report. Canadian Contribution. Canada Center for Inland Waters, Burlington.

# SECTION 2: REGULATORY FRAMEWORK AND AMENDED CONSENT JUDGMENT

In 1998, an Amended Consent Judgment (ACJ) between Onondaga County, New York State Department of Environmental Conservation (NYSDEC) and Atlantic States Legal Foundation was signed to resolve a lawsuit filed against Onondaga County for violations of the Clean Water Act. The lawsuit alleged that discharges from Metro were in violation of the facility's discharge permit, and the combined sewer overflows (CSOs) did not comply with state and federal regulations. The ACJ obligates the County to undertake a phased program of wastewater collection and treatment improvements that will extend though the year 2012. More details about the ACJ are at http://www.ongov.net/wep/we15.html

**The ACJ has three required elements:**

(1) Improvements to the Metropolitan Syracuse Wastewater Treatment Plant to reduce the input of ammonia and phosphorus to Onondaga Lake;

(2) Improvements to the wastewater collection infrastructure to reduce combined sewer overflows (CSOs); and

(3) Monitoring the lake and associated waterways to measure the effectiveness of the improvements to Metro and CSOs.

## ACJ Element 1: Improvements to Metro

In light of the state's basis for designating Onondaga Lake as an impaired waterbody, the primary focus of the improvements to Metro has been to provide a higher level of treatment for ammonia and phosphorus. Onondaga County agreed to upgrade Metro to reduce effluent ammonia and phosphorus levels; these improvements were set forth in the facility's discharge permit (Table 2-1).

Two new treatment systems have been brought on line. The Biological Aerated Filter (BAF) system has resulted in year-round nitrification (conversion of ammonia to nitrate). This innovative technology, which became fully operational in 2004, has resulted in a 98% decrease in Metro's ammonia output to the lake. This improved treatment was operational eight years ahead of schedule. The lake is now in full compliance with ambient water quality standards for ammonia and water quality conditions are protective of the most sensitive forms of aquatic life. In 2008, NYSDEC de-listed Onondaga Lake as impaired by ammonia.

Phosphorus removal is achieved using a physical-chemical High-Rate Flocculated Settling (HRFS) technology, known as Actiflo. The system came on line in 2005 to meet the Stage II effluent limit of 0.12 mg/l. This technology has resulted in an 86% decrease in Metro's phosphorus output to the lake. As a result of this and other efforts to reduce watershed sources of phosphorus, the lake now exhibits summer total P concentrations below the state's guidance value to protect recreational use, set at 20 micrograms per liter (µg/l), a unit of measurement equivalent to parts per billion (Figure 2-1). The 2008 summer (June –

Figure 2-1. Onondaga Lake Summer Average Total P Concentration (0-3m), 1998-2008.

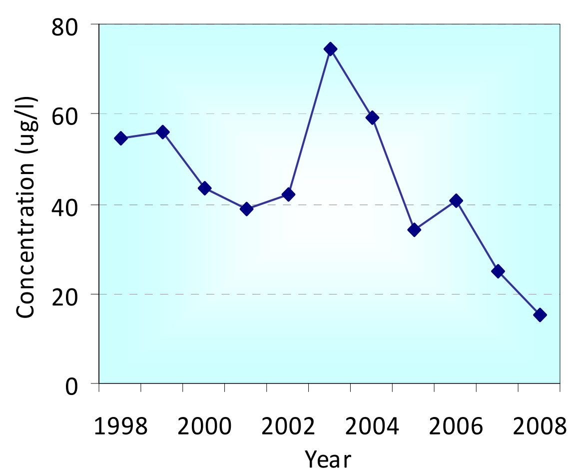


Table 2-1 Metro SPDES Limits for Ammonia and Phosphorus
*(ppd = pounds per day; mg/l = milligrams per liter)*

| Parameter | SPDES Limit | Effective Date | Achieved Date |
|---|---|---|---|
| Ammonia | *Stage I :*<br>8,700 ppd (7/1-9/30)<br>13,100 ppd (10/1-6/30) | January 1998 | January 1998 |
| | *Stage 2:*<br>2 mg/l (6/1-10/31)<br>4 mg/l (11/1-5/31) | May 2004 | February 2004 |
| | *Stage 3:*<br>1.2 mg/l (6/1-10/31)<br>2.4 mg/l (11/1-5/31) | December 2012 | February 2004 |
| Total Phosphorus | *Stage I :*<br>400 ppd<br>(12-month rolling average) | January 1998 | January 1998 |
| | *Stage 2:*<br>0.12 mg/l<br>(12-month rolling average) | April 2006 | April 2006 |
| | *Stage 3:*<br>0.020 mg/l<br>(or as modified by TMDL) | December 2012 (or as modified by TMDL) | Pending |

Sept) average total P level in the lake's upper waters (0-3 m) was 15 µg/l.

### ACJ Element 2: Improvements to the Wastewater Collection Infrastructure

The ACJ calls for a multi-faceted program to address the CSOs, using four principle methods: separating sewers, constructing regional treatment facilities, capturing floatable materials, and maximizing storage capacity. Where possible, storm sewers are separated from sanitary sewers. Eight sewer separation projects have been completed; five more are in the design or construction phase. Regional treatment facilities (RTF) were originally planned to capture overflows in certain areas and provide storage and treatment. The RTF serving the City's north side was completed in 2001; others RTF facilities in various stages of planning and design are being re-evaluated.

At the request of NYSDEC, this re-evaluation of the RTF includes an evaluation of the potential use of "green" infrastructure, such as rain gardens and green roofs, to help manage urban storm runoff. Green infrastructure encourages infiltration, capture, and reuse of storm runoff before it enters the sewer system. With reduced storm water volume, Onondaga County is evaluating opportunities to reduce the size or modify the design of the CSO remedial projects, thereby reducing costs. A "Save the Rain" initiative is underway to educate watershed residents about ways to capture and use rain water.

Floatable control facilities, which include net bags in streams to capture floating material and a skimmer boat at the Inner Harbor, are fully operational. Finally, several projects have been completed to optimize the collection system's capacity and operation. A cooperative program, funded by the Onondaga Lake Partnership and Onondaga County, is also underway to identify and remediate any dry weather sources of bacteria which may include illicit connections or leaks from the City or County infrastructure.

### ACJ Element 3: Monitoring to Measure Effectiveness of Improvements

The Ambient Monitoring Program (AMP) is Onondaga County's comprehensive program to evaluate the quality of the waterways described in Section 1 of this document, and track changes brought about by the improvements to the wastewater collection and treatment infrastructure and reductions in watershed sources of nutrients. The ACJ obligates Onondaga County to conduct this annual monitoring program. Information from the AMP helps answer several important questions.

1. How has water quality changed in response to the improvements at Metro and in the collection system?
2. Are the lake waters suitable for contact recreation?
3. Are water quality conditions adequate to support aquatic life?

These three questions are addressed each year in the annual report. The relationship of Metro performance and lake response is the subject of Section 6. Use attainment, i.e., suitability for recreational use and aquatic life, is discussed in Section 4.

In addition, the AMP is designed to provide managers the data and information needed to address two other important issues:

4. Are additional controls on point or nonpoint source pollution needed?
5. Is a change in the location of the Metro outfall required?

The need for further reductions in nutrient loading or a change in the outfall location will be considered as the monitoring program and water quality modeling projects reach completion in 2012.

The following section outlines the AMP in detail and provides context for the review of 2008 data and long-term trends.

Click for More Information

# SECTION 3: AMBIENT MONITORING PROGRAM DESIGN

The County's lake and watershed monitoring program has expanded since it was initiated almost 40 years ago. Some changes reflect shifts in regulatory priorities; new parameters have been added in response to emerging concerns. Other changes have come about to support mathematical modeling initiatives. As the episodic nature of the tributary loading became clear, monitoring schedules shifted to capture more high flow conditions and storm events. Perhaps the most significant change has been the greatly expanded focus on biological monitoring.

The AMP is designed to identify sources of materials (nutrients, sediment, bacteria and chemicals) to the lake, evaluate in-lake water quality conditions, and examine the interactions between Onondaga Lake and the Seneca River. Data are evaluated with respect to compliance with water quality standards and trends.

In addition to the water quality monitoring effort, the AMP examines the health of the lake ecosystem by sampling fish, phytoplankton, zooplankton, benthic invertebrates, aquatic plants and dreissenid (zebra and quagga) mussels. The health of the watershed is assessed as well, though an integrated program that evaluates watershed nutrient inputs and sources and biological indicators of stream condition. A Data Analysis and Interpretation Plan (DAIP) (Table 3-1) guides program design and is subject to annual review and approval by NYSDEC.

A rigorous Quality Assurance/Quality Control program is in place. The AMP workplan is subject to NYSDEC review and approval each year. Samples are collected by trained technicians and analyzed in a laboratory certified by the NYS Department of Health. Internal and external audits are conducted, blanks and duplicates are evaluated, and the results are presented in the annual AMP report. Experts serving on the Onondaga Lake Technical Advisory Committee review the data and interpretive reports each year and make recommendations.

In addition, Dr. William W. Walker, an expert on statistics and lake water quality, periodically reviews the AMP design for its power to detect trends. That is, what sampling frequency and duration are needed to differentiate a significant change, given the magnitude of natural variation? This analysis, referred to as the Statistical Framework, has been completed for both the water quality and biological parameters.

Technological advances allow the County to monitor water quality on a near real-time basis. A water quality buoy with an array of probes that measure physical and chemical characteristics of the lake water is deployed on the lake at its deepest point. Data from the buoy provide a window into the temporal changes in temperature and water quality. These near real-time data may be viewed at http://www.ongov.net/wep/we1501.html

The U.S. Geological Survey installed Acoustic Doppler devices in the lake outlet to measure water movement and characterize the dynamics of exchange between Onondaga Lake and the Seneca River. These devices were removed in 2008, once QEA completed the Three Rivers Water Quality model. Automated sampling stations or water quality probes are in place on Onondaga Creek at Spencer St and Route 20 in Lafayette, Ley Creek upstream of Park St., and at Buoys 236, 316 and 409 on the Seneca River (see map Figure 6-21). These stations allow the County to collect high frequency water quality measurements during critical periods.

# SECTION 3: AMBIENT MONITORING PROGRAM DESIGN

Each year, OCDWEP tests over 20,000 water samples and examines several thousand biological samples. The County has invested in the creation of custom databases to facilitate analysis and reporting. The 2008 data have been appended to the water quality database, which is a repository of tributary (T), lake (L) and river (R) data collected since 1968. In early 2008, an integrated biological database was completed, making accessible all results of the AMP fisheries, phytoplankton, zooplankton, macroinvertebrate and macrophyte monitoring efforts.

Table 3-1. Data Analysis and Interpretation Plan

| Parameters | Sampling Locations | Compliance | TMDL Analysis | Trend Analysis | Trophic Status | Load Analysis | Model Support | Use Attainment | Effectiveness of CSO control measures | Indicator of Water Clarity | Nutrient Cycling | Habitat Conditions | Lake Ecology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Chemical*** | | | | | | | | | | | | | |
| Alkalinity | L, T | | | ✓ | | | | | | | | | |
| Bacteria | L, T | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | |
| BOD-5 | L, T, R | | | ✓ | | ✓ | ✓ | | | | | | |
| Carbon | L, T, R | | | ✓ | ✓ | ✓ | ✓ | | | | | | |
| Cyanide | T | ✓ | | | | | | | | | | | |
| Mercury | L, T | ✓ | | ✓ | | | | | | | | | |
| Metals/Salts | L, T, R | ✓ | | ✓ | | ✓ | ✓ | | | | | | |
| Nitrogen | L, T, R | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Phosphorus | L, T, R | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ |
| Silica | L | | | | ✓ | | | | | | | | ✓ |
| Solids | L, T, R | ✓ | | ✓ | | | ✓ | | | | | | |
| Sulfides | L | | | | | | ✓ | | | | | | |
| ***Physical*** | | | | | | | | | | | | | |
| Conductivity | L, T, R | ✓ | | ✓ | | | ✓ | ✓ | | | | | |
| Dissolved oxygen | L, T, R | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ |
| LiCor illumination | L, R | | | ✓ | ✓ | | | ✓ | | ✓ | | | ✓ |
| Salinity | L, T, R | ✓ | | ✓ | | | ✓ | ✓ | | | | | |
| Secchi transparency | L, R | ✓ | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ |
| Turbidity | L, T, R | ✓ | | ✓ | | | ✓ | | | ✓ | | | |
| ***Biological*** | | | | | | | | | | | | | |
| Chlorophyll/algae | L, T, R | | | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ |
| Zooplankton | L | | | ✓ | | | | | | | | | ✓ |
| Macrophytes | L | | | ✓ | | | ✓ | | | | | ✓ | ✓ |
| Macroinvertebrates | L, T | | | ✓ | | | | | | | | ✓ | ✓ |
| Fish | L | | | ✓ | | | | | | | | ✓ | ✓ |

*Locations:*
*L = Lake; T = Tributaries; R = Seneca River.*

### Turning Data into Information: Metrics

A series of metrics, defined as quantifiable physical, chemical and/or biological attributes of the ecosystem that respond to human disturbances, are used to help organize the extensive AMP dataset (Table 3-2). For the Onondaga Lake watershed, metrics are used to indicate progress towards compliance and attainment of the designated best use. Four categories address both human uses and ecosystem function:

- water contact recreation;
- aesthetics;
- aquatic life protection;
- sustainable recreational fishery.

As part of the Annual AMP Report, the quality of Onondaga Lake is evaluated with respect to these metrics. Results are reported to the community each year.

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Table 3-2. Summary of metrics used for assessing progress toward improvement

| Metrics | Measured By | Target Levels |
|---|---|---|
| ***Improved Suitability for Water Contact Recreation*** | | |
| Indicator bacteria | Fecal coliform bacteria abundance within the lake's Class B segment | 100% of E. coli and fecal coliform bacteria (monthly geometric means of at least 5 observations) in compliance with water quality standards during the Metro disinfection period (April 1 to October 15) |
| Water clarity | Secchi disk transparency (nearshore, Class B) | 100% of water clarity measurements greater than 4 ft (1.2 m) during summer (June 1 to September 30) |
| ***Improved Aesthetic Appeal*** | | |
| Water clarity | Secchi disk transparency (open waters South Deep) | 100% of water clarity measurements greater than 5 ft (1.5 m) during summer (June 1 to September 30) |
| Algal blooms | Algal abundance low in summer | At least 85% of chlorophyll-*a* measurements less than 15 µg/l during summer (June 1 to September 30) |
| | Lake free of nuisance algal blooms | AT least 90% of chlorophyll-*a* measurements less than 30 µg/l during summer (June 1 to September 30) |
| Algal community structure | Blue-green algal abundance is low | Less than 10% of algal community biomass represented by cyanobacteria (blue-green taxa) |
| ***Improved Aquatic Life Protection*** | | |
| Ammonia | Ammonia N concentrations in lake | 100% of measurements in compliance with standards throughout the year. |
| Nitrite | Nitrite N concentrations in lake | 100% of measurements in compliance with standards throughout the year. |
| Dissolved oxygen (DO) | DO concentrations during fall turnover. | Daily average concentrations greater than 5 mg/l<br>Instantaneous minimum concentration greater than 4 mg/l |
| ***Improving Sustainable Recreational Fishery*** | | |
| Habitat quality | Aerial photograph interpretation of macrophyte cover | At least 40% of the littoral zone supports abundant macrophyte cover, based on optimal habitat for largemouth bass. |
| Fish species successfully reproducing | Nesting surveys, larval sampling, young-of-year sampling (littoral and pelagic) adult surveys | Reproduction occurring of target species in the lake:<br>• largemouth bass, smallmouth bass and sunfish<br>• yellow perch<br>• black crappie<br>• rock bass<br>• walleye and northern pike |
| Community structure | Percent of fish species intolerant or moderately intolerant of pollution | More than 25% of fish species in the lake are intolerant or moderately intolerant of (e.g. sensitive to) pollution. |

# SECTION 4: SUMMARY OF METRICS FOR 2008

As introduced in Section 3, the Department of Water Environment Protection, in consultation with NYSDEC and the Onondaga Lake Technical Advisory Group, has developed a suite of metrics to help organize and report on the extensive AMP data set each year. These metrics relate to the lake's designated "best use" for water contact recreation, fishing and protection of aquatic life. The 2008 results (Table 4-1) document substantial progress toward attaining the designated uses in Onondaga Lake.

Click for More Information

Table 4-1. Summary of Metrics, Onondaga Lake 2008

| Metrics | Measured By | Target | 2008 Results | Significance |
|---|---|---|---|---|
| ***Improved Suitability for Water Contact Recreation*** | | | | |
| Indicator bacteria | *E. Coli* bacteria compliance<br>Fecal colilform bacteria compliance | 100%<br>100% | 100%<br>100% | Progress being made on suitability for water contact recreation |
| Water clarity | Secchi disk transparency (nearshore, Class B) | 100% | 87% | |
| ***Improved Aesthetic Appeal*** | | | | |
| Water clarity | Secchi disk transparency (open waters South Deep) | 100% | 100% | By these metrics, the lake's aesthetic appeal has improved. |
| Algal blooms | Algal abundance low in summer<br>Lake free of nuisance algal blooms | >85%<br>>90% | 100%<br>100% | |
| Algal community structure | Blue-green algal abundance is low | <10% | <1% | |
| ***Improved Aquatic Life Protection*** | | | | |
| Ammonia | In-lake Ammonia N concentrations | 100% | 100% | By these metrics, aquatic life protection in the lake has improved. |
| Nitrite | In-lake Nitrite N concentrations | 100% | 100% | |
| Dissolved oxygen | Daily average during fall turnover<br>Instantaneous minimum | >5 mg/l<br>>4 mg/l | 6.7 mg/l<br>5.8 mg/l | |
| ***Improving Sustainable Recreational Fishery*** | | | | |
| Habitat quality | Aerial photograph interpretation of macrophyte cover | 40% | 40% | Improved habitat quality. |
| Fish reproduction | Reproduction of target species:<br>• Bass and sunfish<br>• yellow perch<br>• black crappie<br>• rock bass<br>• walleye and northern pike | <br>Occurring<br>Occurring<br>Occurring<br>Occurring<br>Occurring | <br>Occurring<br>No evidence<br>No evidence<br>No evidence<br>No evidence | Fish reproduction for several target species has not been observed. |
| Fish recruitment | Percent of fish species intolerant or moderately intolerant of pollution | >25% | 8% | Most fish present are tolerant of pollution |

# SECTION 5: MATHEMATICAL MODELING OF THE LAKE AND WATERSHED

Monitoring data provide a means to evaluate current conditions, compliance and trends. Monitoring data also serve to test hypotheses and elucidate important processes and interactions affecting water quality and aquatic habitat. However, projecting future conditions as loads and environmental conditions change remains a significant challenge. Projecting future conditions requires models; the most robust models are constructed using data from a well-designed monitoring program.

In recognition of the need to project future water quality and habitat conditions, the ACJ requires development, calibration and confirmation of mathematical models using the extensive AMP data. A suite of three integrated mathematical models are near completion; these models are designed to quantify the response of Onondaga Lake and the Seneca River to improvements in wastewater treatment and non-point source pollution control measures within the watershed.

*Mathematical models* are series of equations that represent the response of a water body to variations in water and material inputs. Water quality models generally compute the response of receiving waters as a function of the volume and level of treatment of wastewater effluent. The water body's response varies depending on its physical, chemical and biological attributes. Both *mechanistic* and *empirical* models have been developed to guide management decisions for Onondaga Lake. *Mechanistic models* are based on a theoretical approach, using site-specific data to define physical, chemical and biological variables, while *empirical models* use statistical evaluations of monitoring data to estimate causal relationships between inputs and response.

Three mechanistic models are being developed: a watershed model to simulate the flow of water and materials (nutrients and sediment) to the lake, an Onondaga Lake water quality model focusing on eutrophication, and the Three Rivers water quality model focusing on dissolved oxygen conditions in the Seneca River. The three models are integrated, with output from one providing input to the next, as described in more detail in this section.

### OLWQM and TRWQM

The Onondaga Lake Water Quality Model (OLWQM) is nearing completion. This mechanistic model is being developed by Anchor QEA; a Three Rivers Water Quality Model (TRWQM) simulating water quality conditions in the Seneca River adjacent to the lake outlet has also been completed by this firm. Once calibration of the OLWQM is complete, the two models will be linked to simulate impacts of alternative levels of wastewater treatment and points of discharge on compliance with ambient water quality standards in the lake and river.

The ACJ specifies that the mathematical models for the lake and river must be subject to a rigorous and transparent peer review process. A peer review process has been an important element of the model development.

The coupled Anchor QEA models will be used to evaluate the potential environmental benefits realized by diverting the Metro outfall or achieving the Stage III phosphorus limit. Specifically, the models will provide critical information needed to manage the lake and its watershed, including the following:

- An understanding of the mechanisms underlying observed trends in the water quality of the lake;
- A projection of the benefits of Metro upgrades and CSO abatement measures;
- A more complete assessment of the assimilative capacity of the Seneca River and its ability to accept diverted Metro effluent as well as the impact of such a potential diversion on lake water quality;
- A projection of the benefits of any proposed watershed best management practices (BMPs);
- Development of total maximum daily loads (TMDLs) for phosphorus in the lake and support the development of a TMDL for dissolved oxygen in the Seneca River.

In addition to providing managers with the tools to determine the level of treatment and point of discharge from Metro, the two mechanistic models developed by Anchor QEA are supporting similar evaluations of other Onondaga County wastewater treatment plants discharging to the Seneca River, including the Wetzel Rd. and Baldwinsville-Seneca Knolls facilities.

### Onondaga Lake Basin Model

The OLWQM and TRWQM forecast how Onondaga Lake and the Seneca River respond to inputs of water and materials. Another important tool for understanding and managing the system is the Onondaga Lake Basin Model, developed by the US Geological Survey (USGS) in cooperation with the OLP. This model, which was calibrated using AMP data, supports a quantitative analysis of how land use changes in the lake's watershed affect the water, nutrients, and sediment in runoff to Onondaga Lake. Managers can apply the watershed model to estimate the potential effectiveness of various control strategies such as changing development patterns, or implementing BMPs in particular areas. The USGS watershed model can also be used to evaluate the need for measures such as stormwater retention basins to mitigate peak runoff rates. Projected tributary flows and loads from the Onondaga Lake Basin Model will be used as input to the OLWQM to forecast the lake response to watershed measures, thus providing linkage between the models.

### Mass Balance Framework

Onondaga County also works with Dr. William Walker, an expert on statistical limnology, to support the AMP design and data analysis and interpretation tasks. Dr. Walker developed a mass-balance framework to track the input, output and retention of materials (such as phosphorus) in Onondaga Lake. This framework uses hydrologic and water quality data collected in the lake and its tributaries since 1986. Results provide a basis for three tasks:

1. Estimating the magnitude of loads and precision of load calculations from each source;
2. Assessing long-term trends in load and inflow concentration from each source and source category (point, nonpoint, and total);
3. Evaluating the adequacy of the monitoring program, based upon the precision of loads computed from concentration and flow data.

Reports on these efforts are available at http://www.wwwalker.net/onondaga

# SECTION 5: MATHEMATICAL MODELING OF THE LAKE AND WATERSHED

## Onondaga Lake Empirical Eutrophication Model

Dr. Walker has developed an empirical eutrophication model coupled to the mass-balance framework to predict eutrophication-related water quality conditions. This empirical model uses statistical relationships between inputs of nutrients and water and the resulting conditions in Onondaga Lake. Phosphorus concentrations, chlorophyll-a levels, algal bloom frequency, Secchi disk transparency and hypolimnetic oxygen depletion are predicted. For example, the empirical eutrophication model estimates the risk of algal blooms in response to varying phosphorus concentrations by using site-specific data from Onondaga Lake.

There is some interaction between the mechanistic and empirical modeling tasks. Dr. Walker is also part of the Anchor QEA team, and the mass-balance framework is used as a check on the mechanistic OLWQM. In addition, the empirical relationships between phosphorus concentration and the magnitude, frequency and duration of algal blooms are incorporated in the OLWQM to provide additional site-specific detail to the theoretical formulations.

## 2008 Mass Balance Framework Update

Dr. Walker updated the mass-balance framework to include data through 2008. In this update, recent mass balances for key water quality components were summarized. Long-term (1990-2008) and ten-year (1999-2008) trends were evaluated for each monitored inflow, as well as for site totals such as comparisons of inflow vs. outflow, point vs. nonpoint sources, and urban vs. rural watersheds.

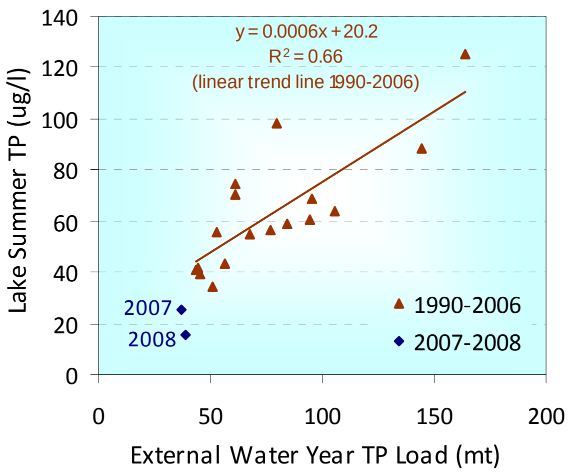
Using the mass balance framework, Dr. Walker reported that total phosphorus concentrations in Onondaga Lake responded dramatically to the decreasing external phosphorus loads over the 1990-2008 period, especially in the past few years (see Section 6). Dr. Walker noted that the sharp decrease in lake total phosphorus in 2008 was unusual in the context of other lake restoration experiences. Decreases in lake concentrations in response to loading reductions typically lag behind due to recycling of phosphorus already stored within the lake and sediments[2].

By comparing the 2008 measured concentrations in the lake with the predicted concentrations from the eutrophication model, Dr. Walker was able to re-evaluate the assumptions of the model. The model assumes a proportional relationship between the amount of phosphorus that enters the lake and the average outflow concentration. This proportion is reflected as a "settling rate" constant that is calibrated into the model. While random year-to-year variations in settling rate are expected due to uncertainty in the load estimates and lake dynamics, the phosphorus settling rate in 2008 was unusually high (Figure 5-1) This may reflect deviations from one or more of the model assumptions. Updating the OLWQM to include data through 2009 would provide a basis for evaluating the potential contributing factors that could affect the phosphorus settling rate, as well as the sensitivity of these factors to changes that occur at the treatment plant and in the watershed. A

[2] Sas, H., Lake Restoration by Reduction of Nutrient Loading: Expectations, Experiences, and Extrapolations. Academia Verlag, ISBN 3-88345-379X, 1989.

better understanding of the contributing factors will guide Dr. Walker in reviewing the assumptions of the model, and modify the calculations to produce a more accurate forecast.

Figure 5-1. Relationship between TP Loading (all sources) and Onondaga Lake TP Concentration, 1990-2008.




The existing calibration of the Onondaga Lake Empirical Eutrophication Model is based upon data through 2007, and it provides a basis for evaluating changes in the overall phosphorus budget dynamics of the lake relative to historical conditions. Calibration of this model has typically been updated every three years. Depending on the results for 2009-2010, another periodic update of the model calibration may be appropriate.

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# SECTION 6: WATER QUALITY CONDITIONS AND LONG TERM TRENDS

## 2008 Climate and Hydrology

The year 2008 was both slightly warmer and slightly wetter than average in the Syracuse region. Total precipitation was 41.9 inches, above the average of 40.1 inches. More of the precipitation fell as rain; snowfall of 109 inches was below the average of 120 inches. The annual temperature of 48.2 °F was above the average 47.4 °F.

## Compliance with Ambient Water Quality Standards

Onondaga Lake was included on the state's inaugural listing of impaired waters in 1998 due to its elevated levels of ammonia, phosphorus, and bacteria and for low dissolved oxygen (DO) during fall mixing. Over the last decade, the lake has shown substantial improvement as remedial projects have been completed (Figure 6-1). For the first time, water quality conditions in 2008 were in full compliance with state standards for these key wastewater-related parameters (Table 6-1). This finding marks the first occasion where phosphorus levels in Onondaga Lake met the state guidance value for recreational use. The lake's total dissolved solids (TDS) were above standards; elevated TDS levels are attributed to natural conditions of saline groundwater.

A similar result was evident for the lake's tributary streams, where conditions at most monitored sites were within ambient water quality standards. A notable exception was the East Flume, where pH, nitrite and ammonia exceeded standards. Elevated levels of these parameters have consistently been detected in the East Flume. In addition, cyanide was detected slightly above standards in one sample at Ley Creek. Copper exceeded the water quality standard in two samples of Tributary 5A, which receives treated industrial wastewater from Crucible Specialty Metals.

Prior to 2008, iron was included on the list of water quality parameters exceeded in Onondaga Lake and its tributary streams. However, NYSDEC has now formally withdrawn its ambient water quality standard for iron based on aquatic life protection. An ambient

Table 6-1. Compliance Summary, Onondaga Lake, 2008

| Parameter | Site | In Compliance | Non-Compliance | Notes |
|---|---|---|---|---|
| Bacteria | Class B segments | ✓ | | During disinfection (Apr. 1 to Oct. 15) |
| Ammonia | Lakewide, all depths | ✓ | | |
| Phosphorus | Upper waters, summer | ✓ | | |
| Total Dissolved Solids | Lakewide | | ✓ | Natural conditions |
| Dissolved oxygen | Upper waters | ✓ | | |
| | Lakewide at fall mixing | ✓ | | |

water quality standard for iron and manganese remains in place for potable waters, based on aesthetics, i.e., the potential for elevated concentrations of these minerals to discolor laundry.

Monitoring of stations in the Seneca River in the vicinity of the lake outlet indicated periodic low DO levels in the deeper waters. Higher streamflow in 2008 led to improved compliance. Respiration of mussels is the primary cause of the depressed oxygen levels; the river's deeper waters undergo transient stratification during low flow conditions. This effect is exacerbated downstream of the lake outlet where the more saline lake water flows in and oxygen consumed by the benthic mussels is not replenished by atmospheric exchange. A "deep hole" in the river bed near Buoy 269 allows groundwater, saline and low in DO, to seep into the Seneca River.

### Phosphorus Sources and Lake Response

Phosphorus, the limiting nutrient for primary production in most inland lakes, reaches Onondaga Lake from both natural and anthropogenic sources. The major anthropogenic source is treated wastewater from Metro.

Nonpoint sources of phosphorus, such as runoff from agricultural fields or urban areas, are generated on the landscape and are transported to the lake from throughout the watershed. A snapshot of external phosphorus inputs to Onondaga Lake (Tables 6-2 and 6-3) compares conditions in 1998 prior to ACJ-required improvements to Metro to conditions in 2008 after the Actiflo facility was fully operational. In 2008, the relative contributions of TP from Metro and the tributaries mirror closely the volume of water entering the lake from each source, indicating that the average TP concentration from Metro is approximately the same as measured in the lake tributaries. Projects to reduce nutrient and sediment loss from the watershed are underway, in accordance with ACJ requirements.

Table 6-2. Tributary and Metro Total Phosphorus (TP) Loading to Onondaga Lake, 1998 and 2008 (mt = metric tons)

| Location | 1998 | | | | 2008 | | | |
|---|---|---|---|---|---|---|---|---|
| | *Flow (%)* | *TP (mt)* | *TP (% Load)* | *TP (mg/l)* | *Flow (%)* | *TP (mt)* | *TP (% Load)* | *TP (mg/l)* |
| Metro: | | | | | | | | |
| fully treated | 22% | 40 | 59% | 0.42 | 18% | 7.5 | 20% | 0.088 |
| bypass | 0.49% | 2.6 | 3.8% | 1.2 | 0.37% | 2.1 | 5.7% | 1.2 |
| Watershed: | | | | | | | | |
| Onondaga Creek | 33% | 11 | 16% | 0.077 | 36% | 13 | 36% | 0.080 |
| Ninemile Creek | 33% | 8.9 | 13% | 0.062 | 34% | 8.6 | 23% | 0.055 |
| Ley Creek | 8.0% | 4.1 | 6.0% | 0.12 | 8.5% | 3.9 | 11% | 0.098 |
| Harbor Brook | 2.1% | 0.74 | 1.1% | 0.080 | 2.5% | 1.1 | 2.9% | 0.094 |
| Tributary 5A | 0.66% | 0.26 | 0.38% | 0.091 | 0.24% | 0.13 | 0.36% | 0.12 |
| East Flume | 0.05% | 0.044 | 0.06% | 0.21 | 0.22% | 0.11 | 0.29% | 0.10 |

Table 6-3. Tributary and Metro Soluble Reactive Phosphorus (SRP) Loading to Onondaga Lake, 1998 and 2008 (mt = metric tons)

| Location | 1998 | | | | 2008 | | | |
|---|---|---|---|---|---|---|---|---|
| | *Flow (%)* | *SRP (mt)* | *SRP (% Load)* | *SRP (mg/l)* | *Flow (%)* | *SRP (mt)* | *SRP (% Load)* | *SRP (mg/l)* |
| Metro: | | | | | | | | |
| fully treated | 22% | 9.7 | 80% | 0.100 | 18% | 0.29 | 6.2% | 0.003 |
| bypass | 0.49% | N/A | N/A | N/A | 0.37% | 0.44 | 9.3% | 0.25 |
| Watershed: | | | | | | | | |
| Onondaga Creek | 33% | 0.76 | 6.3% | 0.005 | 36% | 1.6 | 34% | 0.010 |
| Ninemile Creek | 33% | 0.88 | 7.3% | 0.006 | 34% | 1.3 | 27% | 0.008 |
| Ley Creek | 8.0% | 0.47 | 3.9% | 0.014 | 8.5% | 0.63 | 13% | 0.016 |
| Harbor Brook | 2.1% | 0.16 | 1.3% | 0.017 | 2.5% | 0.44 | 9.3% | 0.038 |
| Tributary 5A | 0.66% | 0.067 | 0.55% | 0.023 | 0.24% | 0.031 | 0.65% | 0.028 |
| East Flume | 0.05% | 0.022 | 0.18% | 0.106 | 0.22% | 0.036 | 0.76% | 0.035 |

Measuring TP concentration at different sites along the tributaries can help identify the effect of changing land use and point source discharges. For example, TP concentrations in the upper reaches of Onondaga Creek (Route 20 and Dorwin Avenue) reflect the contribution from predominantly rural areas. Concentrations at Spencer and Kirkpatrick Streets are influenced by the urban component of the watershed and by CSOs (Table 6-4). As a general rule, TP loading increases with distance downstream because of the larger watershed area contributing water and materials.

Table 6-4. Onondaga Creek TP Loading for Selected Dates in 2008.

| Site on Onondaga Creek (upstream to downstream) | Contributing Area ($km^2$) | 2008 TP Load (mt/d) | | | |
|---|---|---|---|---|---|
| | | *Apr 1* | *Jun 10* | *Sep 16* | *Nov 2* |
| Route 20 (Rural) | 87.8 | 0.077 | 0.0019 | 0.00056 | NA |
| Dorwin Avenue (Rural) | 229 | 0.285 | 0.0040 | 0.0019 | 0.0024 |
| Spencer Street (Urban) | 285 | 0.196 | 0.061 | 0.0034 | 0.0052 |

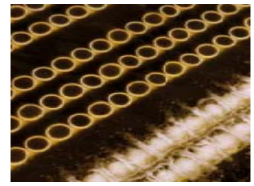
Notes: Instantaneous loading calculated as single TP result for each sample date at each location, times the daily average flow. Daily average flow data for Nov 2 at Route 20 is not yet available from USGS.

# SECTION 6: WATER QUALITY CONDITIONS AND LONG TERM TRENDS

Figure 6-1. Time Line of Onondaga Lake and Watershed Events, 1998-2008

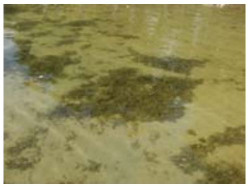
**1998**
- Summer TP 55 ug/l in lake's upper waters.
- Amended Consent Judgment (ACJ) signed.

**1999**
- Metro completes upgrade of aeration system for secondary clarifiers.



*Air bubble diffusers (1999).*

**2000**
- Littoral zone plant coverage in June: 11%.



*Sparse macrophyte cover.*

**2001**

*The reinforcing steel rods that form the BAF cells (2002).*

**2002**

*Juvenile fish seining.*

**2003**
- Compliance with AWQS for DO in lake upper waters during fall.
- Three Rivers Water Quality Model peer review completed.

**2004**
- Compliance with AWQS for fecal coliform bacteria in lake Class B segments during Metro disinfection period.
- Compliance with AWQS for ammonia in lake upper waters.
- Year-round removal of ammonia at Metro; Stage 3 SPDES limit for ammonia met.

*BAF blowers (2004)*

**2005**
- No summer algal blooms. Littoral zone plant coverage in June: 49%
- ACTIFLO system on-line to meet Metro Stage 2 SPDES limit for TP

*Dense macrophyte cover*

*HRFS Microsand Pump Gallery (2005)*

**2006**
- Compliance with AWQS for nitrite in the lake's upper waters.
- ACJ Amendment motion filed by NYS Attorney General's Office.

**2007**
- Compliance with AWQS for ammonia in the lake.
- Summer TP 25 ug/l in lake's upper waters.
- Metro meets Stage 2 SPDES limit for TP on schedule.
- Onondaga Lake Water Quality Model development and calibration review (Phase 2).

**2008**
- Onondaga Lake restored for ammonia.
- Summer TP 15 ug/l in lake's upper waters.

*Timeline Abbreviations:*
*TP = Total Phosphorus*
*DO = Dissolved Oxygen*
*AWQS = New York State Ambient Water Quality Standard*
*SPDES = State Pollutant Discharge Elimination System*

*Timeline Color key:*
*Orange = Regulatory actions*
*Brown = Metro actions*
*Blue = Water quality achievements*
*Green = Biological achievements*

# SECTION 6: WATER QUALITY CONDITIONS AND LONG TERM TRENDS

Historically, point source phosphorus from Metro represented a substantial component of the annual phosphorus input to Onondaga Lake. The percentage contribution of Metro to the lake's phosphorus budget has declined substantially as the Stage II effluent limits have been met (Figures 6-2 and 6-3). The tributary contribution tends to vary each year with the weather: wetter years are associated with higher runoff and more phosphorus input from the watershed.

Figure 6-2. Metro and Tributary Sources of TP to Onondaga Lake, 1998 and 2008.

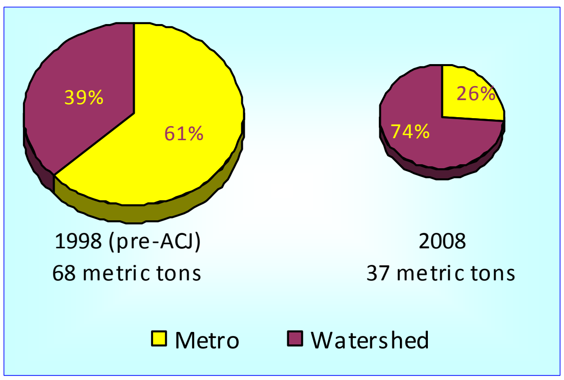
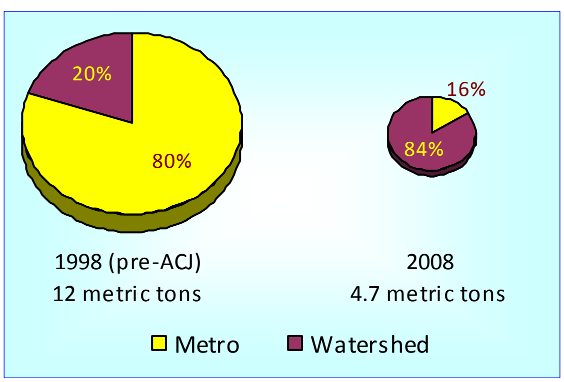


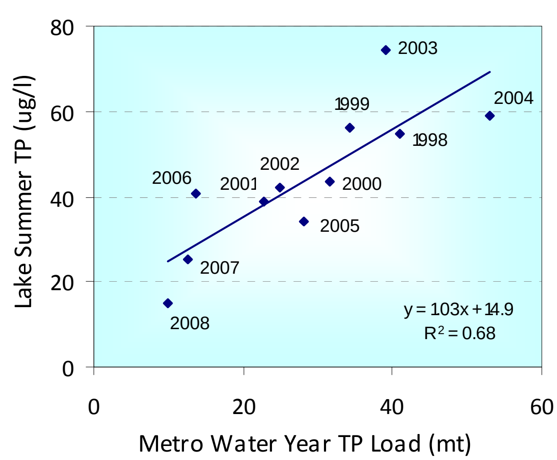

Figure 6-3. Metro and Tributary Sources of SRP to Onondaga Lake, 1998 and 2008.




In 2008, the total annual TP loading to Onondaga Lake measured in the AMP from all monitored sources was 37 metric tons (mt), a unit of measure equivalent to a thousand kg. About 74% of the measured TP load came from the four major tributary streams—Onondaga Creek, Ninemile Creek, Ley Creek and Harbor Brook—and about 26% came from Metro. Soluble reactive phosphorus (SRP) represents chemical forms of phosphorus that are dissolved in the water and are typically readily available as a nutrient for algal growth. Metro contributed approximately 26% of the TP load to the lake in 2008, but contributed only approximately 15% of the SRP. The shift to the watershed as the major source of TP and SRP to Onondaga Lake has important management implications regarding where additional control measures should be focused.

Reduction in point source phosphorus has had a direct beneficial effect on the quality of Onondaga Lake. As illustrated in Figure 6-4, phosphorus loading from Metro has a significant effect on the in-lake concentration.

Figure 6-4. Relationship between Metro TP Water Year Loading (Oct- Sept) and Onondaga Lake Summer TP Concentration (June-Sept), 1998-2008.

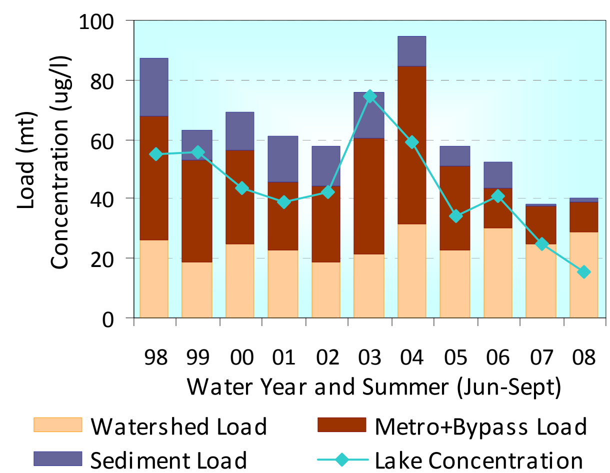


# SECTION 6: WATER QUALITY CONDITIONS AND LONG TERM TRENDS

Not all the phosphorus entering Onondaga Lake each year comes from Metro and the tributaries. The lake sediments can serve as a reservoir for phosphorus that has entered in the past. This phosphorus tends to be bound in insoluble compounds of the metals iron and manganese. As long as dissolved oxygen is present in the lower waters of the lake, bacteria there that break down the organic material, such as algal cells, use oxygen in the process. When the oxygen is depleted, the bacteria next turn to nitrate in their metabolism. Once the nitrate supply diminishes, the bacteria will use the iron and the manganese in the sediments, freeing the phosphorus formerly bound by these metals.

As the productivity of Onondaga Lake has declined in recent years with diminished phosphorus loading, the rate of dissolved oxygen depletion of the lower waters has slowed, and nitrate has persisted far longer into the summer. As a result, the phosphorus loading from the sediments has also decreased. As displayed in Figure 6-5, the loading reduction has resulted in a dramatic decline in TP concentrations in the lake water.

Figure 6-5. Onondaga Lake TP Loading and Concentration, 1998-2008.




## Ammonia Sources and Lake Response

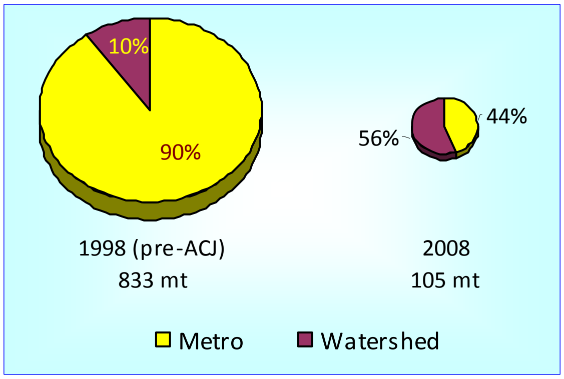
Until recently, Onondaga Lake was considered impaired by elevated concentrations of ammonia; concentrations of this potentially harmful form of nitrogen exceeded the state ambient water quality standard for aquatic life protection (Table 6-5). The lake is now in full compliance with ambient water quality standards for ammonia and was officially de-listed in the state's 2008 report of impaired waterbodies.

Table 6-5. Percent of Ammonia Measurements in Compliance with Ambient Water Quality Standards, Onondaga Lake, 1998-2008.

| Depth (m) | Percent measurements in compliance, NYS standard | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1998* | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* |
| 0 | 64 | 62 | 86 | 95 | 68 | 96 | 100 | 100 | 100 | 100 | 100 |
| 3 | 45 | 67 | 90 | 90 | 68 | 96 | 100 | 100 | 100 | 100 | 100 |
| 6 | 50 | 86 | 90 | 95 | 73 | 100 | 100 | 100 | 100 | 100 | 100 |
| 9 | 41 | 76 | 90 | 95 | 73 | 100 | 100 | 100 | 100 | 100 | 100 |
| 12 | 18 | 52 | 90 | 81 | 50 | 80 | 100 | 100 | 100 | 100 | 100 |
| 15 | 23 | 52 | 57 | 52 | 41 | 56 | 80 | 100 | 100 | 100 | 100 |
| 18 | 23 | 48 | 52 | 38 | 32 | 48 | 75 | 95 | 95 | 100 | 100 |

Prior to completion of the BAF, treated effluent from Metro was the primary source of ammonia to Onondaga Lake (Figure 6-6).

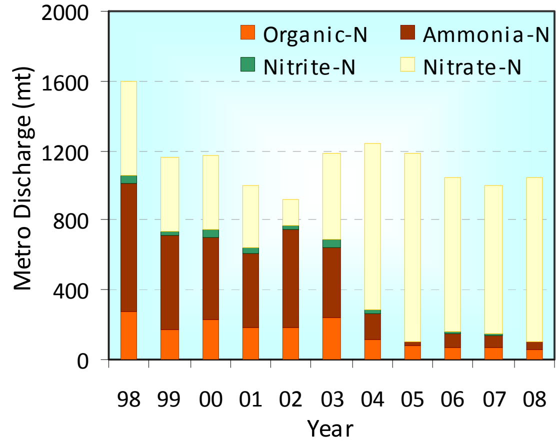
Figure 6-6. Onondaga Lake Ammonia Sources, 1998 and 2008.




Reduced forms of nitrogen are oxidized in the BAF prior to discharge; while the total nitrogen input from Metro has remained relatively unchanged, nitrate is now the dominant form of N in the plant's effluent (Figure 6-7). As described above, the persistence of nitrate in the lake's lower waters during summer has affected phosphorus release from the lake sediments.

In addition to the impact on the lake's phosphorus budget, the reduction in ammonia levels in Onondaga Lake may have resulted in significant changes to the lake's biological community. Overall, improvements to the wastewater treatment system are helping to shift the ecosystem of Onondaga Lake to be increasingly comparable to that of other New York lakes. These ecosystem impacts are discussed in more detail in Section 8.

Figure 6-7. Metro Loading of Ammonia, Nitrite, Nitrate and Organic Nitrogen, 1998-2008

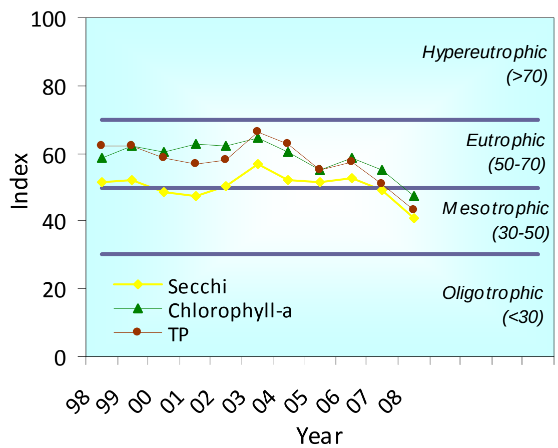



## Overall Nutrient Status and Trophic State Indicators

By all measures, the trophic state of Onondaga Lake has shifted dramatically, as demonstrated by reductions in the lake's trophic state index, or TSI, (Figure 6-8) calculated from summer average total P, chlorophyll-a and Secchi disk transparency (Carlson 1977[3]). The 2008 results demonstrate that Onondaga Lake has become less productive, and all three trophic state indicator parameters are now in the mesotrophic range.

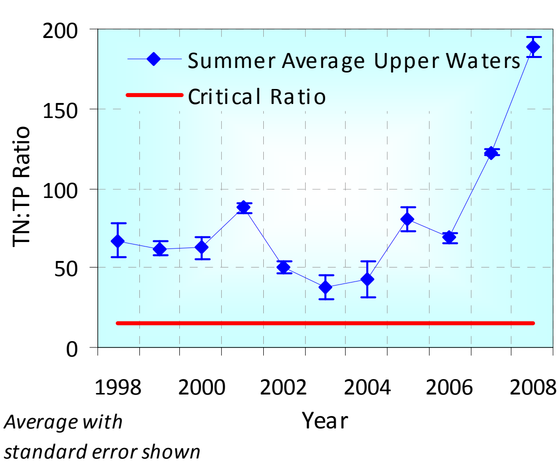
[3] Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22:361-369.

Figure 6-8. Carlson Trophic State Index (TSI) Calculations for Onondaga Lake, June to September, 1998-2008



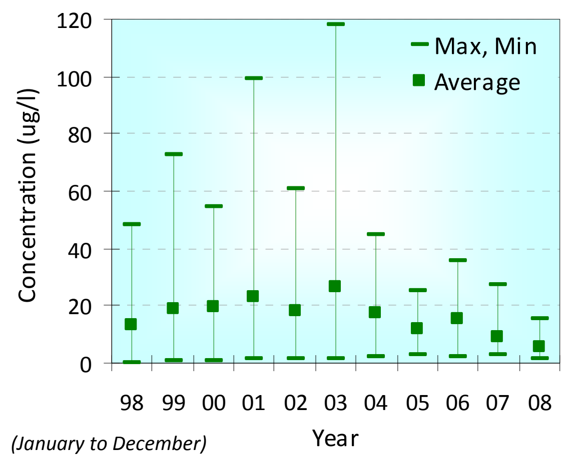

The ratio of concentrations of total nitrogen (TN) to TP have increased sharply since 2006, again, most likely reflecting the dramatic decrease in TP loading from Metro in recent years (Figure 6-9). Projects to reduce watershed sources of nutrients have been completed by the Onondaga Lake Partnership and the Onondaga County Soil and Water Conservation District. The temporal plot of TN:TP ratio confirms that Onondaga Lake is clearly phosphorus limited.

Figure 6-9. Onondaga Lake Nitrogen:Phosphorus Ratio, 1998-2008



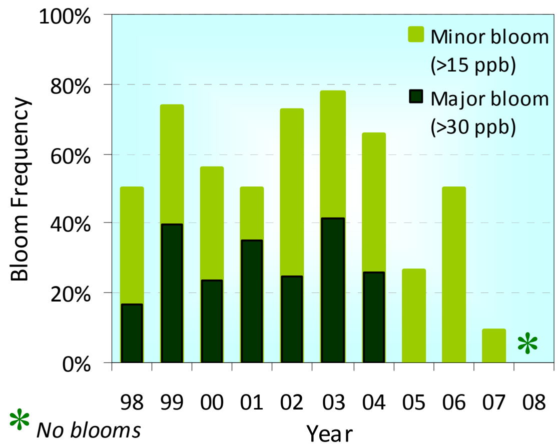

While summer (June 1 – Sept 30) average conditions are generally used to indicate overall trophic state, it is the frequency, intensity and duration of algal blooms that most affect a lake's recreational and aesthetic quality. As shown in Figure 6-10, peaks in chlorophyll-a concentration in Onondaga Lake have declined.

Figure 6-10. Onondaga Lake Chlorophyll-a Concentration, 1998-2008



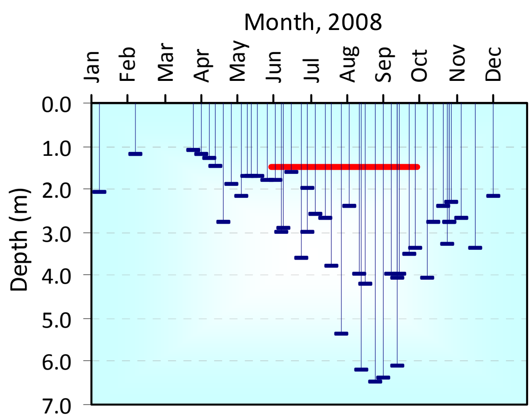

On most summer days from 1998 to 2004, algal abundance in Onondaga Lake exceeded threshold levels for a minor bloom, indexed at 15 µg/L chlorophyll-a. In fact, frequent excursions of the major bloom criterion (30 µg/L chlorophyll-a) were evident over this period (Figure 6-11). Since 2005, however, only minor blooms have occurred, and those have exceeded threshold levels much less frequently. In 2008, algal abundance remained below the minor bloom threshold for the entire year. This overall reduction in frequency and intensity of algal blooms is, at least in part, a direct consequence of the reduced Metro phosphorus loadings as the Stage II effluent limit was met.

Figure 6-11. Onondaga Lake Summer Algal Bloom Frequency, 1998-2008




The unusually high Secchi disk transparency measured during midsummer 2008 is striking (Figure 6-12). This finding likely reflects the complexity of influences from food web dynamics in addition to the nutrient effects. The presence of grazing organisms, both dreissenid mussels and larger zooplankton, and fluctuations in the alewife population all influence water clarity. This is further explored in Section 8.

Figure 6-12. Onondaga Lake Secchi Disk Transparency, January-December, 2008

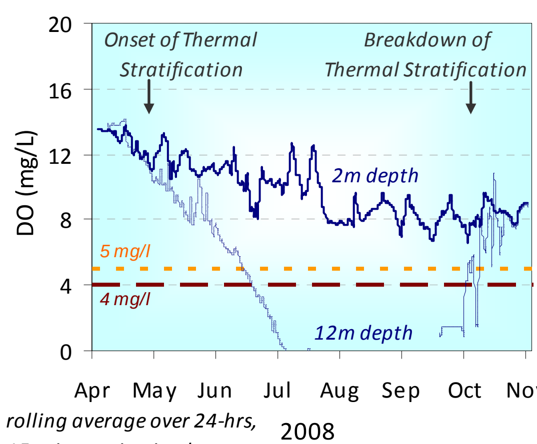



*Aesthetic Guidance Value (red line): 1.5 m Jun 1 to Sep 30*

## Dissolved Oxygen Levels

As described in Section 1, dissolved oxygen (DO) is lost from a lake's hypolimnion, or lower waters, once thermal stratification has set up in late spring, isolating the hypolimnion from oxygen sources. Onondaga Lake demonstrates such a pattern, as displayed in Figure 6-13, graphing daily average DO at 2 m and 12 m depths to indicate DO status of the upper and lower waters. The rate at which DO is lost from the hypolimnion depends primarily on the mass of organic material to be decomposed; this rate is improving in Onondaga Lake. Volume-days of anoxia are calculated each year to quantify the volume of the lake affected by and the duration of oxygen depletion; this index documents improving conditions in Onondaga Lake.

Figure 6-13. Onondaga Lake Dissolved Oxygen (DO) at 2 and 12 Meters, April-November, 2008




*rolling average over 24-hrs, 15-min monitoring buoy*

With fall turnover, which typically occurs in October in Onondaga Lake, the thermocline breaks down, water mixes through all depths of the lake, and the deep waters are recharged with DO. If, however, the extent and duration of oxygen depletion in the hypolimnion are substantial, DO levels can become depressed throughout the entire water column during fall turnover and reach a level that can be harmful to many aquatic organisms. This effect is especially severe in hypereutrophic lakes, and, historically, has been a problem in Onondaga Lake. The extent of DO depletion, however, is tied to the trophic state of the lake, and as the trophic status of Onondaga Lake has improved in recent years, so has deep water DO levels. Since 2005, there has been no significant depression of DO with fall turnover as measured by frequent field profiles during this critical period, continuing a pattern of progressive improvement (Figure 6-14) and addressing a major impairment cited in the ACJ. The percent saturation of the water column with DO in the fall is increasing in response to the reductions in nutrient loading (Figure 6-15).

Figure 6-14. Onondaga Lake Minimum DO in October, 1998-2008

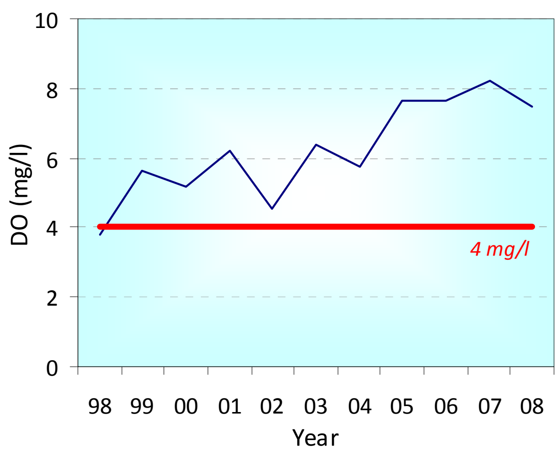
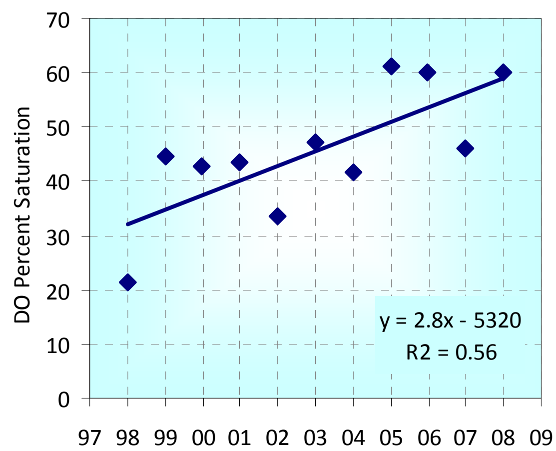



Figure 6-15. Onondaga Lake Minimum DO Percent Saturation, Field Profile Day Average 0-19m, Fall Turnover, 1998-2008.




### Bacteria Levels

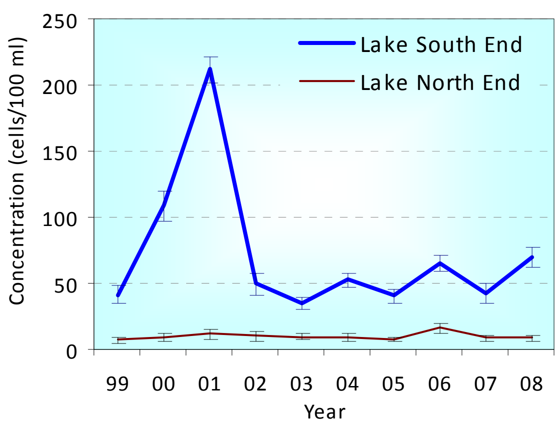
In New York, fecal coliform bacteria are used to indicate the presence of raw or partially treated sewage in water. Although most strains of fecal coliform bacteria are not harmful, this class of bacteria is present in the intestinal tract of all mammals; the presence and abundance of fecal coliform bacteria in water is correlated with the risk of encountering pathogenic microorganisms, including bacteria, viruses and parasites.

The AMP includes assessment of fecal coliform bacteria levels in Onondaga Lake and the inflows, including Metro. Abundance of these indicator bacteria in nearshore Class B areas of Onondaga Lake is used to monitor compliance with ambient water quality standards and the attainment of contact recreational use.

Stream sampling is conducted over a range of flow and precipitation conditions in order to assess impacts of storm runoff and sewage overflows. A cooperative program between Onondaga County Department of Water Environment Protection (OCDWEP) and the

Onondaga Environmental Institute (OEI) is underway to measure bacteria during dry weather, low flow conditions; this program helps pinpoint areas where leaky sewers or illicit connections may be affecting the streams. Bacteriological data often vary by orders of magnitude due to the event-driven nature of the sources. For that reason, summer geometric means are best suited for examining spatial and temporal trends. Looking at the last 10 years of summer data (Figure 6-16), it is clear that bacteria levels are higher in the southern region of Onondaga Lake, close to the major inflows, as compared with the northern region. The positive result is that bacteria levels at the Class B stations and the lake outlet are almost always very low.

Figure 6-16. Onondaga Lake Fecal Coliform Bacteria Abundance, Summer Geometric Mean, 1999-2008

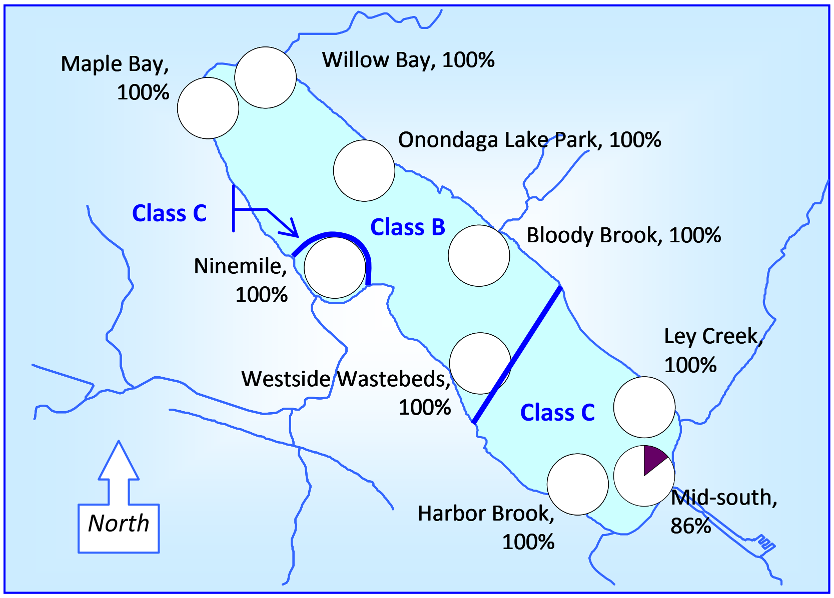



*Geometric mean with standard deviation*

The nearshore fecal coliform bacteria data for 2008 are displayed in Figure 6-17. The fecal coliform bacteria standard of 200 cells per 100 ml of lake water, calculated as a geometric average of at least five samples per month, is used by DEC to evaluate water quality. Bacteria levels in portions of the lake typically increase after significant storm events. These occasional high bacteria levels are among the factors why swimming in the lake is not encouraged and there are no designated bathing beaches; the potential presence of industrial residuals in sediment is another factor.

The periodic spikes in loading and their water quality impacts highlight an important consideration as lake and tributary water quality conditions continue to improve. While average conditions are steadily improving, the periodic high loads may continue to prevent the waters from meeting their designated use.

Figure 6-17. Onondaga Lake Fecal Coliform Bacteria Compliance, April – October 2008




*The percentages represent the percent of months during 2008 that were in compliance for the disinfection period April 1 to October 15. The actual sample results used in this analysis were collected from April 3 to October 13.*

*Compliance is achieved if the monthly geometric averages for the period, based on at least five samples, are less than 200 cells per 100 ml of lake water. In 2008, only September was out of compliance at the Mid-south station (580 cells/100 ml).*

***Storm Event Sampling***

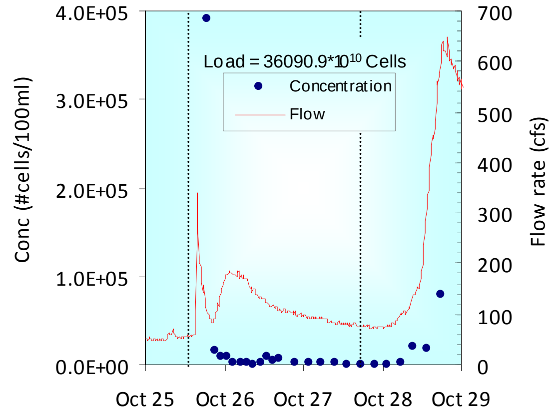
Storm event sampling, which measures conditions during spikes in loading, is an important part of the AMP. In addition to the routine bacteriological monitoring described above, two storm sampling events were completed on Onondaga Creek in 2008. Storm events are conducted as remedial projects are completed; results are compared with baseline (pre-improvement) data.

Storm event samples are collected from streams at frequent intervals over the course of intense rain storms, targeting storms of sufficient intensity to trigger overflow of the sewage collection system (a rainfall intensity of at least 0.35 inches per hour). Loads of fecal coliform bacteria, TP, SRP, total dissolved P (defined as all non-particulate P fractions), total suspended solids, and total Kjeldahl N (defined as organic N and ammonia) are calculated over the course of the storm. These results are added to the cumulative database of storm loads, and compared to tributary-specific baseline (pre-improvement) conditions, as a function of the total volume of storm flow. The hypothesis is that improvements to the collection system will result in reduced loading of fecal coliform bacteria and other wastewater-related parameters.

Water quality monitoring of Onondaga Creek was completed during two intense rainfall events in September and October 2008. The Midland Ave. Regional Treatment Facility, which was designed to capture and treat the mixture of storm water runoff and untreated sewage from three large CSOs, was in start-up mode during the two 2008 storm events. Available information from the real-time supervisory control and data acquisition (SCADA) system indicated that the facility's storage tank completely captured the overflow volume, which was pumped back to Metro for treatment. Ownership of the Midland facility was transferred to Onondaga County in May, 2009; reliability of SCADA system reports prior to this date cannot be verified.

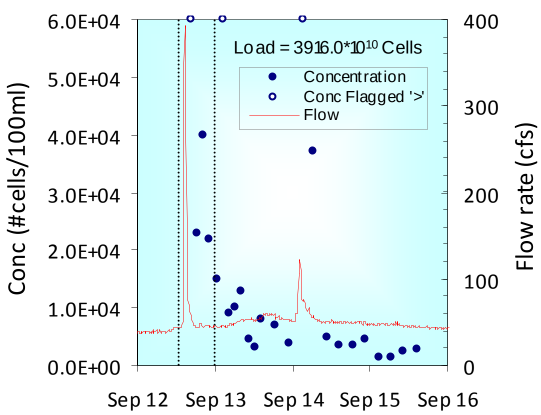
Interestingly, the in-stream concentration of fecal coliform bacteria peaked with the high stream flows (Figures 6-18, September and 6-19, October). As three large CSOs were eliminated by the Midland Ave. facility, urban stormwater runoff and upstream CSOs are the likely source of the elevated concentrations of bacteria. Consistent results were seen for solids and nutrients; peak concentrations occurred during peak stream flows. Resuspension of materials deposited in the stream channel is another potential contributing factor in the measured high concentrations during peak flows.

Figure 6-19. Fecal Coliform Bacteria Abundance, Onondaga Creek at Spencer St., October 2008




*Vertical dashed lines denote start and end time of storm period.*

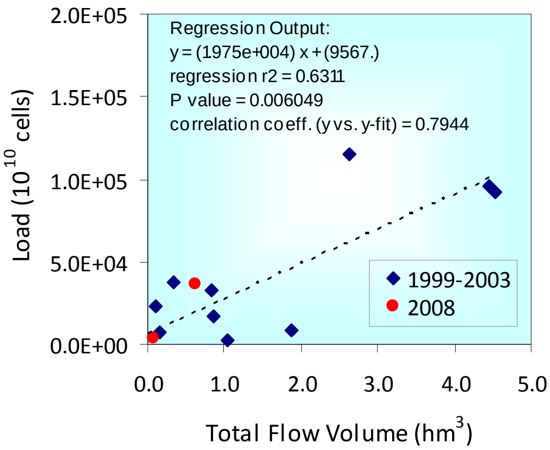
Figure 6-18. Fecal Coliform Bacteria Abundance, Onondaga Creek at Spencer St., September 2008




*Vertical dashed lines denote start and end time of storm period.*

Despite the elevated concentrations of bacteria measured in samples collected during peak flow conditions, the overall loading of fecal coliform bacteria from the two storm events was low (Figure 6-20). Again, data were consistent for nutrients and solids as well. Total flow volume of Onondaga Creek during the two rain storms was low. Because the overflows were held in storage and pumped back to Metro, the flow volume measured in the stream was lower than it would have been prior to completion of the Midland facility. As the SCADA system becomes fully operational, future analysis of storm events will be more definitive. Total flow volume can be modified by adding the volume held in storage to the total flow volume. This adjustment will refine the comparison between baseline conditions and future storm events.

Figure 6-20. Fecal Coliform Bacteria Load and Storm Volume, Onondaga Creek at Spencer St., 2008




The 2008 storm event data are within the range calculated for the baseline conditions. Additional CSO control projects are underway for Onondaga Creek, as discussed in Section 2.

***Dry Weather Sampling***

Results of the 2008 bacteriological monitoring of tributary streams indicate that bacteria levels were rarely elevated from baseline levels in the absence of measurable precipitation. However, the 2008 results do include some exceptions. There was no consistent pattern of location: Nine Mile Creek, Ley Creek, Harbor Brook and Onondaga Creek all exhibited occasional elevated bacteria levels, most often in the fall. The cooperative OEI/DWEP program, which includes more frequent sampling at more sites, has provided additional information regarding the nature and potential significance of these occasional elevated concentrations.

**Seneca River**

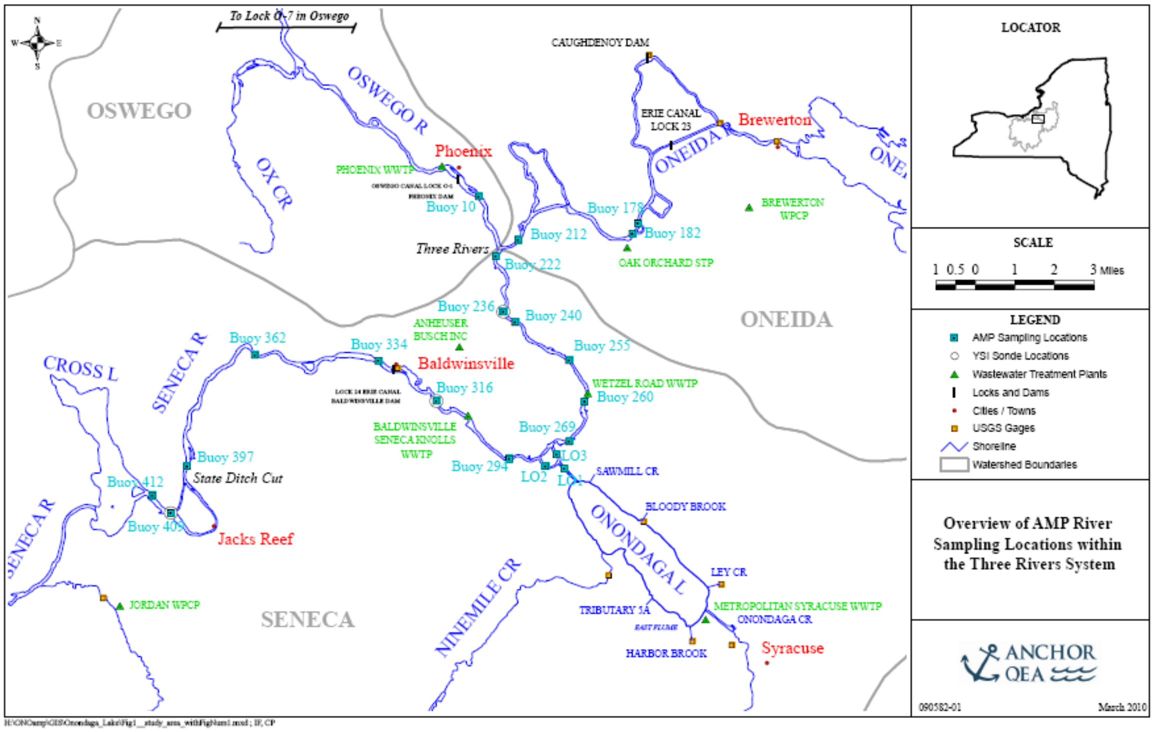
The ACJ requires monitoring and modeling of water quality conditions in the Seneca River as part of a regional approach to wastewater management. The Seneca River is included on the state's compendium of impaired waters, due to low dissolved oxygen concentrations during low flow conditions. The outlet of Onondaga Lake flows into the Seneca River as it makes its way north to Lake Ontario; the chemistry of Onondaga Lake waters clearly affects water quality of the river in the vicinity of the outlet. As part of the annual AMP, water quality conditions are monitored at several locations in the Seneca River during summer low flow conditions (Figure 6-21).

The higher salinity of Onondaga Lake waters compared to the Seneca River affects stratification and mixing of the outflow. Particularly when flow and velocity in the Seneca River are low, the denser water entering from Onondaga Lake forms a discrete lower water layer that is detectable at nearby monitoring locations.

The Onondaga Lake outlet is not the only factor affecting water quality of the Seneca River. In the early 1990s, the invasive dreissenid mussels began to colonize sections of the Seneca River as they migrated eastward from the Great Lakes through the NYS Barge Canal system. Proliferation of zebra and quagga mussels along the river bed has profoundly affected the cycling of nutrients and organic material and consequently the quality of the river water. Respiration of the benthic organisms depletes dissolved oxygen, and the river water has become notably clearer as phytoplankton and other particles are filtered out. Greater light penetration has allowed macrophyte growth to expand into new habitats.

Results of the Seneca River monitoring program support an evaluation of compliance with

Figure 6-21. Three Rivers System Study Area




ambient water quality standards and the development, verification and validation phases of the integrated TRWQM and OLWQM modeling initiatives. Validation of the lake and river models is underway using AMP data from 2004 – 2007.

As is typical, flows in the Seneca River during 2008 were higher and more variable in spring and fall and lower in the summer. The average summer flow rate in 2008 was approximately 1,500 cubic feet per second (cfs), which is close to the long-term summer average of 1,700 cfs. Most significant to water quality and habitat conditions, 2008 streamflow throughout the monitored river segments was sufficient to prevent prolonged periods of low DO.

Between June and October, 2008, water-quality recording devices (YSI sondes) were deployed at Buoys 409, 316 and 236 to measure in-situ dissolved oxygen, pH, salinity and temperature at 15-minute intervals. These locations document ambient water quality conditions upstream of the "state cut", an area of prolific dreissenid mussels (Buoy 409), upstream of the Baldwinsville-Seneca Knolls WWTP outfall and outlet of Onondaga Lake (Buoy 316), and downstream of the lake outlet and Wetzel Rd WWTP outfall (Buoy 236).

In addition to the high-frequency sonde monitoring, three extensive water quality surveys were conducted on July 24th, August 21st and September 11th, 2008. A fourth water quality survey was conducted at Buoy 316 on August 7th. Taken together, these data portray water quality conditions in the Seneca River in response to point source discharges, biological conditions and changes in quality of the outflow of Onondaga Lake. These data will help support the TRWQM, which, in turn, will be a resource for NYSDEC in developing a TMDL for the Seneca River to address low DO conditions.

Overall, results of the 2008 river monitoring effort are consistent with those of previous years. Variations are related to the flow regime. Results of the water quality surveys demonstrate far shorter periods of non-compliance compared with previous (lower flow) years. There was one violation of the NYSDEC instantaneous minimum DO standard (4 mg/l) detected in the bottom water at Buoy 255 during the September event. The ammonia and nitrite standards were never exceeded.

The higher frequency sonde data recorded low DO concentrations; the majority were in the bottom waters of Buoy 409. Dissolved oxygen concentrations below the minimum standard occurred on approximately 30% of days for the instantaneous standard and 40% for the daily average standard (5 mg/l) at Buoy 409. Fewer violations were observed at Buoys 316 (<5% instantaneous and 15% daily average) and 236 (<10% instantaneous and 10% to 15% daily average).

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# SECTION 7: HABITAT CONDITIONS AND LONG TERM TRENDS

## Tributary Streams

As part of the AMP, Onondaga County periodically conducts a habitat survey along the major tributaries to Onondaga Lake. Biologists evaluate the streams' physical, chemical, and biological conditions using a standard protocol developed by the Natural Resources Conservation Service called the Stream Visual Assessment Protocol (SVAP). This effort was completed in 2008; results are displayed in Figure 7-1. Overall, spatial and temporal patterns are consistent with baseline assessments completed in 2000 and 2002. With few exceptions, the downstream areas of Onondaga Creek, Ley Creek, and Harbor Brook, which traverse the urban corridor, continue to be the most altered from natural conditions. The next stream survey is planned for 2012.

A second AMP initiative looks more closely at the type and abundance of insects, worms, and mollusks living in the stream beds (collectively referred to as the benthic macroinvertebrate community) of the three major tributary streams. The tributary benthic macroinvertebrate program, which has been conducted every two years since 2000, was completed in 2008. The structure of the benthic macroinvertebrate community, particularly the presence and abundance of pollution-tolerant and pollution-sensitive species, is used to indicate long-term water quality and habitat conditions. Results of the 2008 program (Figure 7-2) indicate no consistent trends toward improving conditions. Similar to the SVAP results, downstream stations continue to show degraded conditions compared with less urban areas of the watershed.

# SECTION 7: HABITAT CONDITIONS AND LONG TERM TRENDS

Figure 7-1. Stream Visual Assessment Protocol (SVAP) Applied to Onondaga Lake Tributaries, 2008

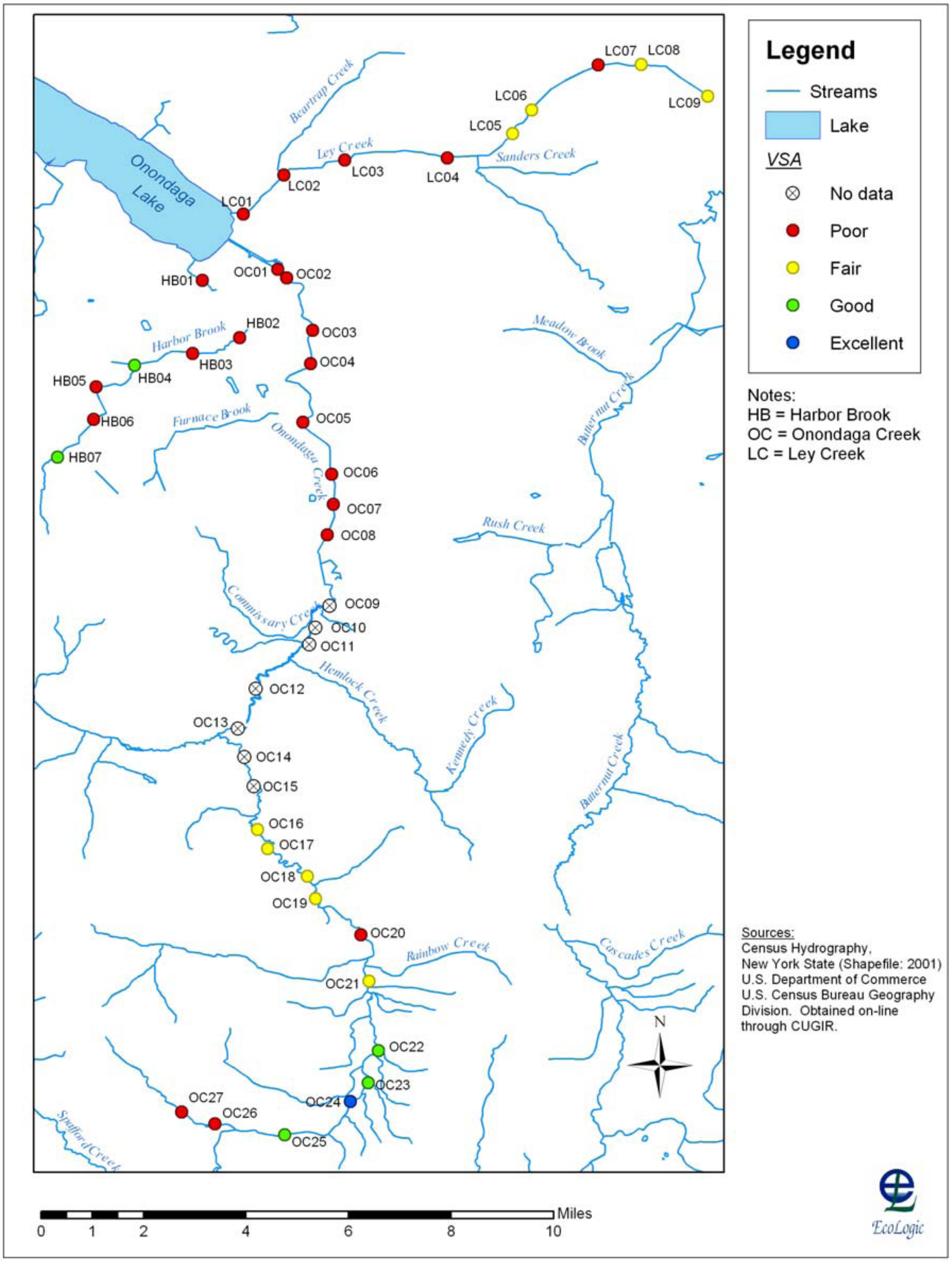
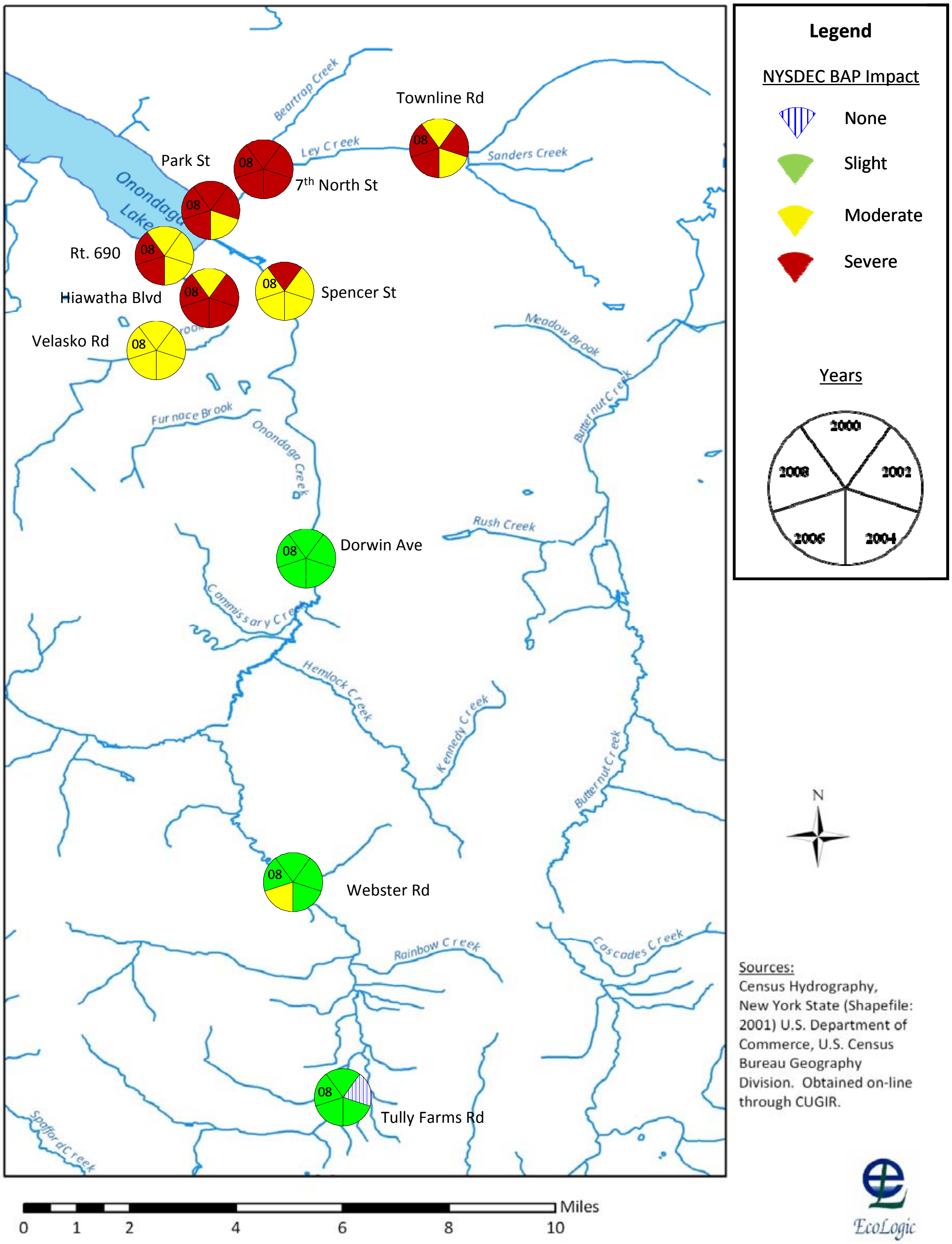


Figure 7-2. NYSDEC Biological Assessment Profile (BAP) Applied to Onondaga Lake Tributaries, 2000-2008



# SECTION 7: HABITAT CONDITIONS AND LONG TERM TRENDS

## Onondaga Lake

As the lake has shifted from eutrophic to mesotrophic conditions, a cascade of desirable consequences has followed. The marked decrease in Metro's contribution to the phosphorus budget of the lake has led to lower ambient concentrations of phosphorus in the lake's water and a decrease in productivity, as indicated by lower chlorophyll-a, fewer and less severe algal blooms, and clearer water. Nitrogen loading has remained stable; the wastewater treatment process oxidizes, but does not remove, N. The resulting high N:P ratio prevents cyanobacteria from becoming an important component of the phytoplankton community.

Clearer water allows light to penetrate deeper into the lake, and fosters the proliferation of rooted macrophytes in shallow nearshore waters, reaching the 6 m depth contour (Figure 7-3). The macrophyte community has also become more diverse, as more species of plants have colonized the near-shore waters of the lake. The productivity, distribution, and species composition of submersed macrophyte communities are affected by a variety of environmental factors such as light, temperature, sediment composition, nutrient status, and wave energy.

As macrophyte beds have spread around the perimeter of the lake, they have brought improved habitat for fish and fish propagation. Aquatic macrophytes are an important component of the lake ecosystem; rooted plants and algae have major effects on productivity and nutrient cycling. Macrophytes produce food for other organisms, provide habitat areas for insects and fish, and help to stabilize sediments. Not surprisingly, as the macrophyte community becomes increasingly established, fish species that rely heavily on macrophyte beds for critical stages of their life history, notably largemouth bass, also increase. The increased catch of adult bass (smallmouth and largemouth) by the electrofishing program is displayed in Figure 7-4.

Figure 7-3. Onondaga Lake Distribution of Macrophytes, 2000 and 2008

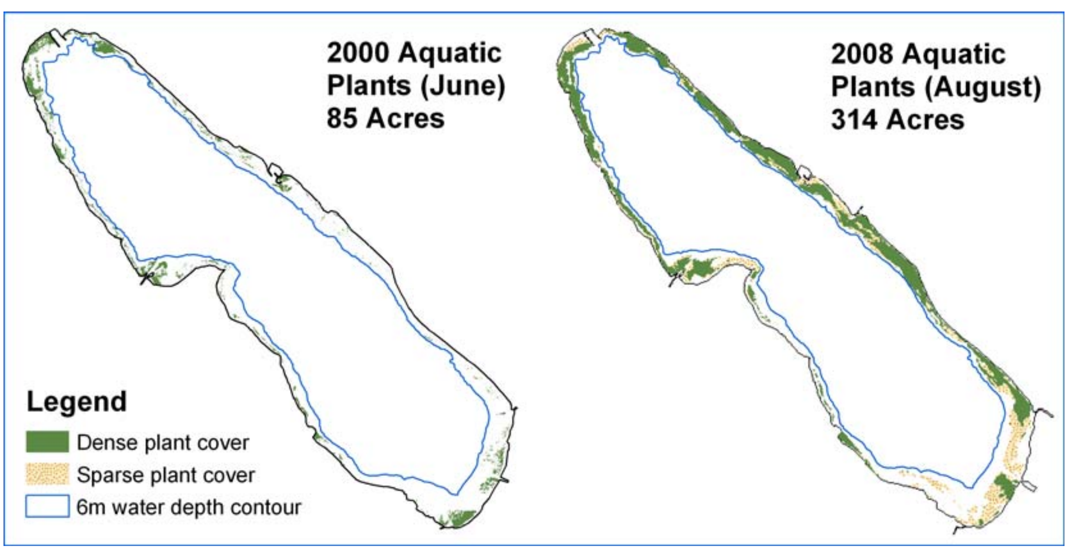
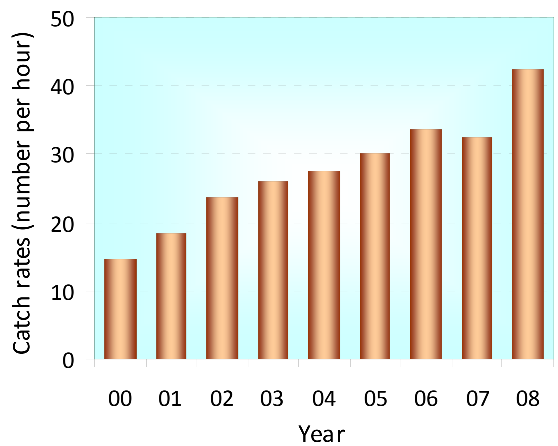


Figure 7-4. Onondaga Lake Electrofishing Capture of Adult Bass, 2000-2008




The Wetland Fish Index (WFI) of biotic integrity (Seilheimer and Chow-Fraser, 2006[4]) reflects the connection between the structure of the fish community and the quality of the water and littoral habitat. Species of fish vary in their tolerance of poor water quality, and a fish community dominated by highly tolerant species is indicative of poor water quality, while a community dominated by intolerant species is indicative of good water quality. The WFI varies between 1, indicating highly impacted conditions, and 5, indicating pristine water quality.

The WFI for Onondaga Lake has improved in the last decade, especially since 2004 (Figure 7-5), indicating an improvement of habitat quality in Onondaga Lake. The improvement in lake-wide WFI, however, does not reflect a trend toward a fish community composed of more species intolerant of pollution, for there is no such trend apparent (Figure 7-6). Rather, this improvement reflects the expansion of the fish community into more sites, especially in the southern end of the lake.

Figure 7-5. Wetland Fish Index (WFI) Applied to Onondaga Lake, 2000-2008

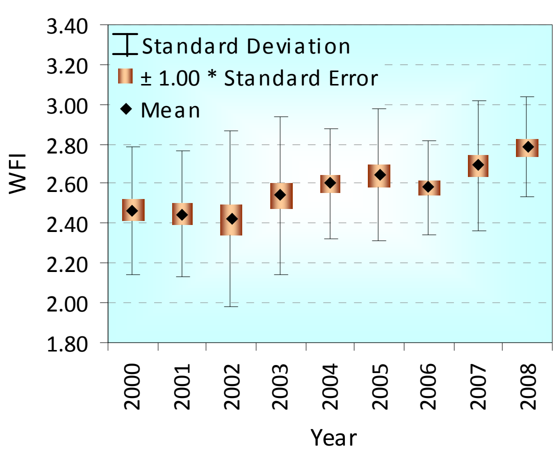
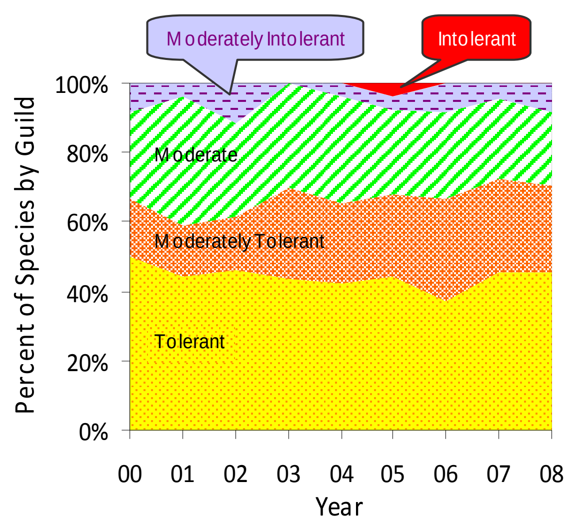



Figure 7-6. Onondaga Lake Fish Community Composition, Pollution Tolerance Guild, 2000-2008

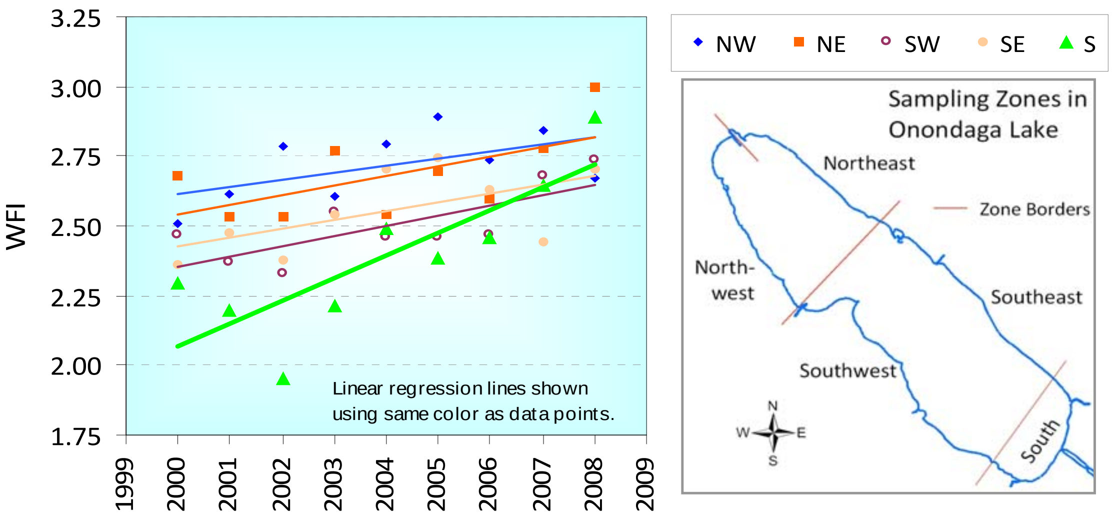



4 Seilheimer, T. and P. Chow-Fraser. 2006. Development and validation of the wetland fish index to assess the quality of coastal wetlands in the Laurentian Great Lakes. *Can. J. Fish. Aquat. Sci* 63:354–366.

# SECTION 7: HABITAT CONDITIONS AND LONG TERM TRENDS

While WFI indices have remained relatively constant in areas near the north shore, the WFI in the southern end of the lake has increased overall, as water quality has improved, with the reduction in ammonia, and as macrophyte beds have expanded in response to clearer water (Figure 7-7).

Figure 7-7. Onondaga Lake WFI by Lake Sampling Zone, 2000-2008

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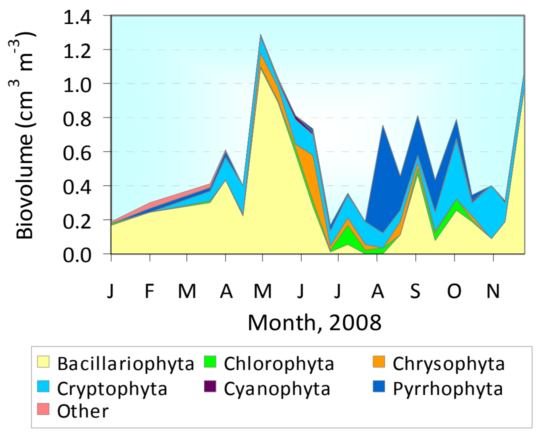
# SECTION 8: BIOLOGICAL CONDITIONS AND LONG TERM TRENDS

## Phytoplankton

The abundance of phytoplankton in Onondaga Lake has decreased with a concomitant increase in water clarity. The nature of the phytoplankton community has also undergone marked change in the last two years. In eutrophic lakes, especially those with low ratios of TN to TP, cyanobacteria or "blue-green algae" tend to dominate the summer phytoplankton community. Low TN:TP reflects high TP concentrations in the water column relative to TN, thereby limiting growth of algae that can only draw N from the water. Cyanobacteria are able to fix atmospheric nitrogen (i.e., convert nitrogen gas ($N_2$) to ammonia and other more readily useable forms of N) and are, consequently, not limited by the availability of N in the water. It is these cyanobacteria that are commonly responsible for nuisance algal blooms in eutrophic lakes.

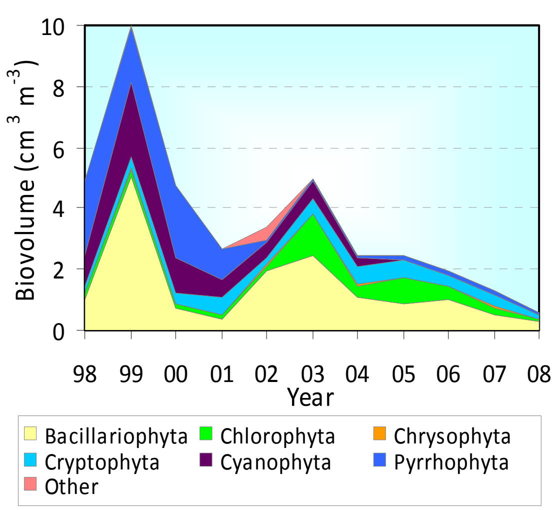
In Onondaga Lake in 2008, cyanobacteria comprised a very small part of the phytoplankton community, never exceeding 5%, and the phytoplankton community was dominated by other algae, notably, diatoms (Bacillariophyta) and dinoflagellates (Pyrrhophyta). Phytoplankton biomass was greatest in May, when diatoms strongly dominated. In late summer and early fall, minor peaks of phytoplankton biomass were dominated by dinoflagellates and diatoms, but never reached the densities of late spring (Figure 8-1). The relationship between biovolume and biomass is based on detailed measurements by PhycoTech Inc., who identify, enumerate and measure the lake's phytoplankton community each year. Each taxon and growth form is assigned a biovolume to biomass conversion.

Figure 8-1. Onondaga Lake Phytoplankton Community Structure and Biovolume, January-December 2008




More significant, perhaps, than the dramatic change in the composition of the phytoplankton community is a marked decrease in algal abundance (Figure 8-2). Average algal biomass in mesotrophic and eutrophic lakes is typically in the range of 3-5 mg/L (Wetzel 2001[5]). The average algal biomass in Onondaga Lake in 2008 was only 0.56 mg/L, which was less than half of the average biomass measured in 2007.

Figure 8-2. Onondaga Lake Phytoplankton Community Structure and Biovolume, 1998-2008




5 Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. Third Edition. Academic Press NY.

Algal biomass did not exceed 1.3 mg/l in 2008, even during peaks in abundance. This trend in decreasing phytoplankton abundance reflects both the decrease in the limiting nutrient phosphorus and significantly more grazing by dreissenid mussels. Furthermore, the biomass of cyanobacteria did not exceed 0.02 mg/l, the lowest value reported since the County began monitoring in 1970. All of these trends reflect a lake recovering from a long period of eutrophic conditions.

## Zooplankton and Dreissenid Mussels

Phytoplankton abundance is not only affected by nutrient concentrations; the presence and abundance of grazing aquatic organisms such as zooplankton and benthic mussels can have dramatic effects as well. The efficiency and size preference of grazers vary by species and life stage. Moreover, the abundance and community composition of zooplankton is, in turn, greatly affected by the nature of the fish community. This section describes the overall impacts of the grazing community on Onondaga Lake's food web. Additional detail may be found in the library.

Onondaga Lake zooplankton biomass declined sharply in 2002 and continued to decline through 2007 (Figure 8-3), linked to high population densities of the planktivorous alewife (*Alosa pseudoharengus)*, a member of the clupeid (herring) family that is a voracious predator of zooplankton. The overall decline in zooplankton biomass has also been associated with a shift in the community structure, from one dominated by the large-bodied cladoceran *Daphnia mendotae* to one dominated by the smaller-bodied *Bosmina longirostris* (Figure 8-3). In 2008, there was an apparent reversal of these trends with a moderate increase in overall zooplankton biomass and an increase in the abundance of *Daphnia* species and copepods, following a decrease in alewife abundance (Figure 8-4).

Figure 8-3. Onondaga Lake Zooplankton Biomass, by Major Taxa, 1999-2008 (April-October)

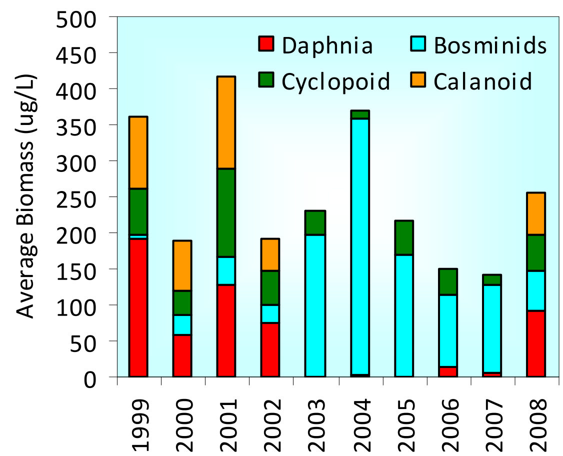
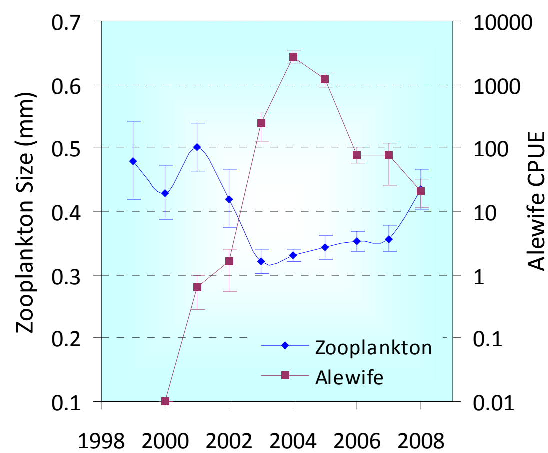



Figure 8-4. Onondaga Lake Zooplankton Average Size and Estimated Alewife Abundance, 1999-2008




In 2008, the increase in zooplankton abundance which typically occurs in late spring (May-June) did not occur until July, when first the small cladoceran *Bosmina longirostris* and then the larger *Daphnia mendotae* increased in abundance. Densities of *Daphnia* were relatively high through the summer compared with previous years, although the lack of a spring peak kept average annual biomass lower than in 1999-2002. The abundance of grazing calanoid copepods also increased in 2008, after being almost absent from the lake from 2003 to 2007. A preview of this major change in the zooplankton community was evident in 2007, with the reappearance of some *Daphnia* and calanoid copepods.

The restructuring of the zooplankton community in Onondaga Lake is almost certainly due to changes in predation by the alewife, which increased in abundance in 2002. *Daphnia* is the favorite prey of the alewife, and the potential for this fish virtually to eliminate larger *Daphnia* species has been well documented in many lakes. However, alewife abundance in Onondaga Lake has now decreased from the high catches observed in 2003-2004; numbers were lower in 2008 than observed since 2003. Although the cause of the alewife decline is unknown, the response of the zooplankton community is a predictable consequence of this decline, as is the increased growth rates observed for alewife in 2008.

When abundant, *Daphnia* can decrease phytoplankton sufficiently to induce a clear water phase in lakes, most often in June. Therefore, the arrival of alewife can result in increased algal abundance and decreased water clarity; this was observed for the spring period in Onondaga Lake in 2003-2007. The converse, the return to a zooplankton community dominated by larger grazers, should add pressure on phytoplankton and further decrease algal abundance. Consistent with these changes, the water clarity in 2008 was exceptional for Onondaga Lake in August and September.

However, the timing of the decrease in phytoplankton and the increase in *Daphnia* suggest other factors are important. Although the phytoplankton decrease coincides with the increase in overall zooplankton biomass, the zooplankton species that increased at that time was a small species (*Bosmina*) that is not known to affect strongly algal abundance. Furthermore, a subsequent, late-summer peak in *Daphnia* abundance in 2008 had no noticeable effect on phytoplankton abundance. Other grazers include zebra mussels (*Dreissenia polymorpha*) that have been present in Onondaga Lake for some time (Figure 8-5), and have increased in recent years. In addition, they have been joined by the quagga mussel (*D. rostriformis bugensis*) and in 2008, quagga mussels comprised 45% of the total dreissenid density (Figure 8-6). These mussels are known to decrease phytoplankton and increase water clarity in many lakes of many sizes, from Lake Erie to nearby Oneida Lake.

Figure 8-5. Onondaga Lake Dreissenid Mussel Average Density and Biomass, 2002-2008

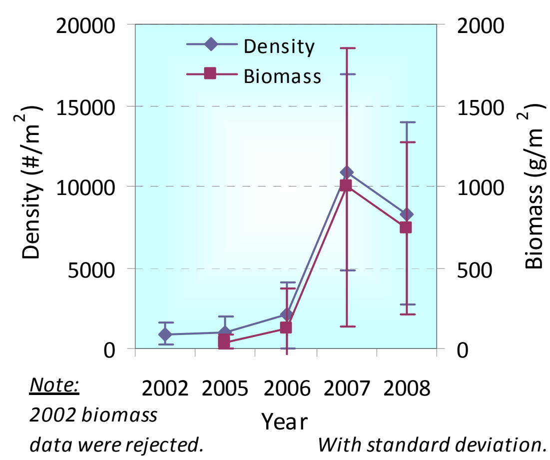


Figure 8-6. Onondaga Lake Relative Abundance of Dreissenid Mussels, 2002-2008

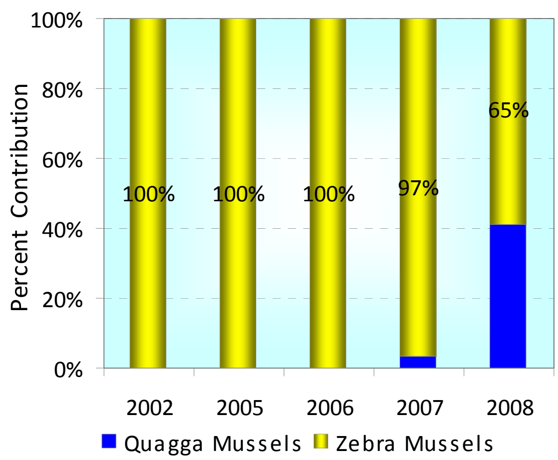
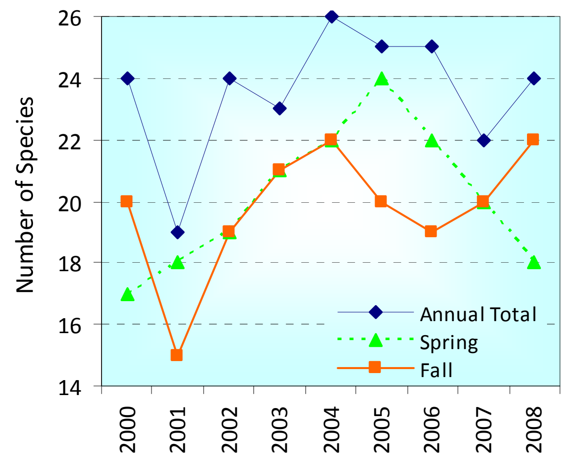



Figure 8-7. Onondaga Lake Fish Species Richness (Electrofishing Data), 2000-2008

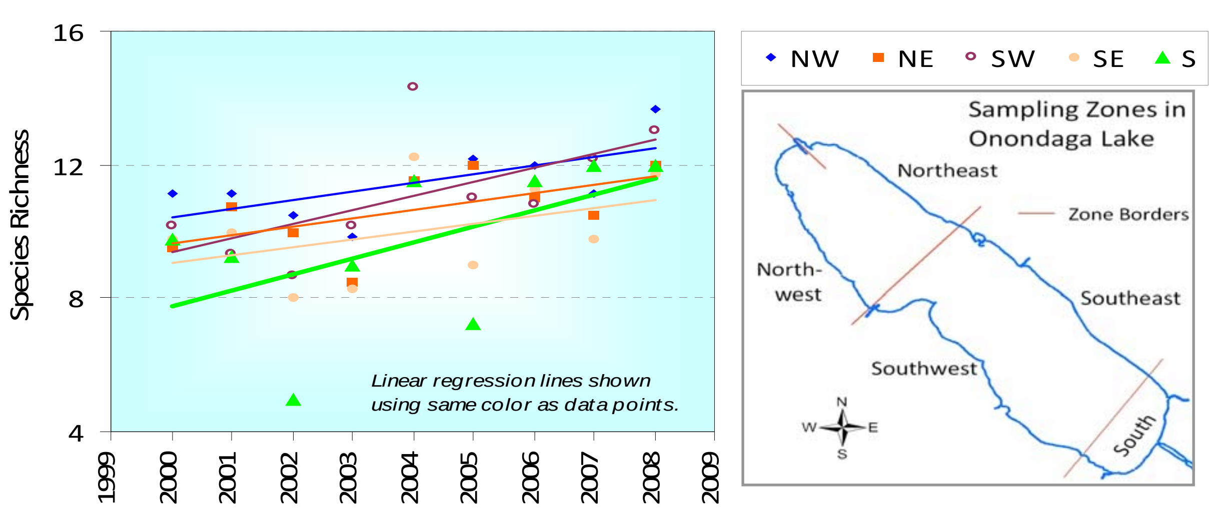



## The Fish Community

As the water quality of Onondaga Lake has improved, so has the fish community. This has occurred not so much through the arrival of fish species not formerly found in the lake, but by the greater distribution of species currently in the lake. The richness of Onondaga Lake's fish community, that is, the number of species found to be present at some time during the year, has varied between 19 and 26 since 2000, with no apparent trend (Figure 8-7).

Many of these species were found in greatest abundance in the northern section of the lake, where water quality conditions are les affected by the major tributary streams and the Metro outfall. The lake's shift to mesotrophic conditions, the decrease in ammonia, and the expansion of macrophyte beds have interacted to expand the habitat available to many fish species. In particular, improvements in fish habitat in the highly impacted areas of the littoral zone (southern and southwestern portions) have resulted in increased species richness (Figure 8-8).

Figure 8-8. Onondaga Lake Fish Species Richness by Lake Sampling Zone (Electrofishing Data), 2000-2008



From 2003 to 2006, Onondaga Lake's fish community was dominated by alewives, which in 2004 made up more than 90% of fish captured by the electrofishing program (Figure 8-9). As discussed above, this planktivorous fish had a pronounced effect on the structure of the zooplankton community. The gizzard shad is another planktivorous clupeid; its population declined as the alewife became dominant. Since 2006, the alewife has declined, contributing to an overall reduction in the lake's estimated fish abundance. Gizzard shad are showing signs of resurgence.

Inshore populations of centrarchid fish (bass and bluegills) remained relatively constant between 2007 and 2008, while the abundance of pumpkinseeds (*Lepomis gibbosus*) increased nearly three-fold (Figure 8-10). Juvenile seine data collected in 2008 indicate low reproductive success of largemouth and smallmouth bass.

Figure 8-9. Onondaga Lake Fish Community Structure, 2000-2008 (Clupeids Included)

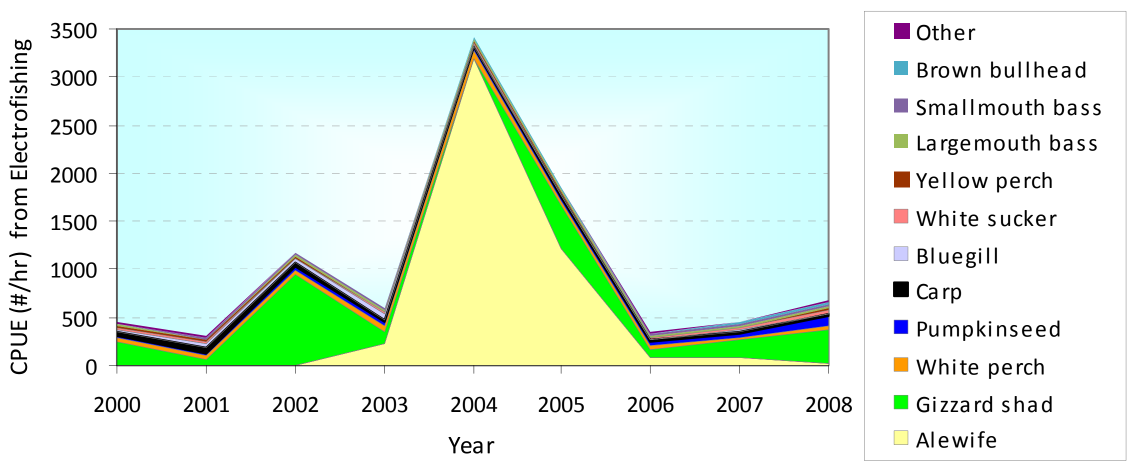
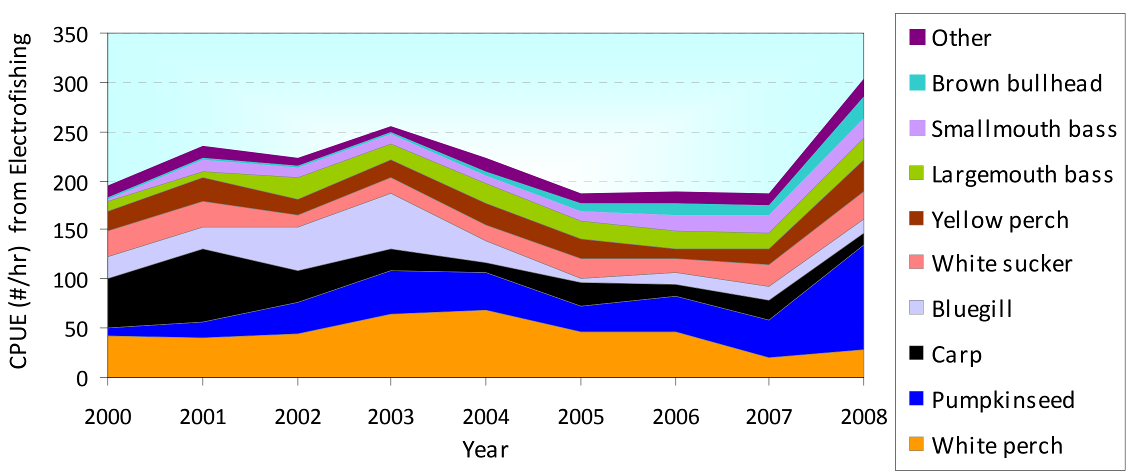



Figure 8-10. Onondaga Lake Fish Community Structure, 2000-2008 (Clupeids Excluded)



# SECTION 8: BIOLOGICAL CONDITIONS AND LONG TERM TRENDS

As part of the AMP, fish collected in Onondaga Lake are examined for tumors and abnormalities using a standardized protocol known as DELT-FM. Data are used for trend analysis and to compare fish collected in this system to those collected in other areas. Fish tumors and abnormalities can result from chemical contamination, biological agents such as bacteria, viruses or fungi, or an interaction among multiple stressors.

The majority of abnormalities in the Onondaga Lake fish community are seen in the brown bullhead (*Ameirus nebulous)*; eroded barbels are the most common. The percent of fish exhibiting abnormalities has increased since 2000; the relative abundance of bullhead in the fish community has also increased over this period. The rate of lesions and tumors in 2008 was the highest measured since monitoring began in 2000.

Researchers from Cornell University's College of Veterinary Medicine identified that a biological agent is currently affecting the lake's brown bullhead population. Bullheads collected in the fall of 2008 appeared to be recovering; lesions were healing. Monitoring will continue to determine whether the rate of abnormalities returns to pre-2008 levels.

**Integrated Assessment of the Food Web**

Phytoplankton abundance and bloom formation cannot be understood without considering both growth rates (limited by nutrient availability, i.e. the "bottom-up" effect) and death rates (primarily through grazing, i.e., the "top-down" effect). A population cannot increase if growth rates are lower than death rates. A fast-growing population can increase even with high grazing rates; conversely, a slow-growing population can decrease even if grazing rates are low. Results of the biological monitoring program indicate that phytoplankton population growth rates declined and zooplankton and mussel grazing rates increased simultaneously in Onondaga Lake in 2008.

Most important among the "bottom-up" effects is the improvement in the nutrient status of the lake associated with the major reduction in phosphorus and ammonia loading from Metro and a striking decrease in ambient levels of phosphorus in the lake. This has contributed to a decreased algal biomass, an overall increase in water clarity and an elimination of the periodic, nuisance algal blooms that formerly plagued the lake.

The increase in the N:P ratio has furthermore led to a shift in the composition of the phytoplankton community with a near complete elimination of cyanobacteria and dominance of diatoms and dinoflagellates.

The top-down effects on phytoplankton and water clarity are associated with the decline of the alewife and feeding by dreissenid mussels. The increasing importance of quagga mussels in the dreissenid community may have accelerated this effect. Reduced numbers of alewife has resulted in increased abundance of larger and more effective zooplankton grazers, further reducing algal abundance. These food web changes in recent years have acted synergistically with improvements at Metro to improve water clarity.

One important lesson is the importance of long-term monitoring to help elucidate these complex interactions. Onondaga Lake continues to fascinate the scientific community as well as inspire optimism among the public as conditions undergo dramatic improvement.

**Recommendations**

- **Continue to share the findings of the AMP with the scientific community, community and agency stakeholders and the interested public.**

*The success of the wastewater treatment plant improvements and progress towards recovery of Onondaga Lake are issues of great community interest. There is a tremendous potential to apply lessons learned, both in the science and policy aspects of the Onondaga Lake story, to other watersheds.*

- **Identify and remediate sources of bacteria within the Onondaga Lake watershed.**

*Data collected during wet weather and dry weather indicate that unknown sources of bacteria are reaching Onondaga Creek and Harbor Brook.*

- **Create a repository of information documenting the effectiveness of controls on nonpoint sources of phosphorus and sediment.**

*Specific project information and any monitoring results are in individual reports agency files. This information could support an analysis of the effectiveness of particular management practices and help set priorities for additional measures.*

- **Support completion and application of the Onondaga Lake Water Quality Model**

*The OLWQM is being developed in an open and collaborative manner, with peer review at each phase. This model will serve the entire community by defining the water quality and aquatic habitat benefits realized by reducing nutrient and sediment inputs from both point and nonpoint sources.*

Click for More Information

# SECTION 9: RELATED INITIATIVES

Onondaga Lake is the focus of several on-going initiatives in addition to the major improvements to the wastewater collection and treatment infrastructure. The Onondaga Lake Partnership (OLP) was created in 1999 to coordinate the environmental revitalization, conservation, and management of Onondaga Lake. Members of the OLP are drawn from six agencies, the U.S. Army Corps of Engineers, Environmental Protection Agency, NYSDEC, the NYS Attorney General's Office, Onondaga County, and the City of Syracuse. Other community groups and volunteers participate through two standing committees. The OLP website www.onlakepartners.org summarizes ongoing efforts.

Honeywell International, Inc. is proceeding with remediation of legacy industrial pollution under regulatory oversight. To date, efforts have focused on identification and removal of sources to prevent additional contamination from reaching the lake. Now, the remedial project effort is addressing contaminated lake sediments. Plans for sediment dredging and capping in certain areas, mostly in the southern littoral zone, are under review. Information on the Honeywell project submittals is available online at www.dec.ny.gov/chemical/37558.html on the NYSDEC website.

The Onondaga Lake Basin Model, described in Section 5, will be used to analyze the effects that proposed BMPs in the tributary subwatersheds are likely to have on the loads of phosphorus and nitrogen entering the lake. These BMPs will include both actions on the landscape (for example, guiding land use changes) and actions to manage hydrology (for example, through detention and storage). The USGS contact person for the watershed model is William Coon wcoon@usgs.gov. The link to reports of the Onondaga Lake Basin Model is http://ny.cf.er.usgs.gov/nyprojectsearch/projects/2457-AF3-1.html

A conceptual design and plan for revitalization of Onondaga Creek has been developed by representatives of the City of Syracuse, Onondaga Environmental Institute, Cornell Cooperative Extension of Onondaga County, Canopy, Atlantic States Legal Foundation, and the SUNY College of Environmental Science and Forestry. Project information is posted at www.esf.edu/onondagacreek/project.htm.

Each year, Onondaga County DWEP updates a bibliography of published information on Onondaga Lake. The engineering improvements to the wastewater collection and treatment infrastructure continue to be the subject of professional and trade publications and presentations. In addition, scientists and academics continue to analyze this unique case study of rehabilitation of a once-degraded lake. The human health impacts and ecological analysis of the contaminant issues are also analyzed by academic and agency scientists, public policy specialists, economists, and engineers. An annual Onondaga Lake Symposium is convened by the Upstate Freshwater Institute in Syracuse each November to discuss recent findings. http://www.upstatefreshwater.org/html/annual_olsf.html

Exploration of green technology solutions to the challenges facing Onondaga Lake is underway from multiple perspectives. In addition to investigating green solutions to urban storm runoff, the OLP is exploring alternative green technologies for mitigating the Tully Valley mudboils, a source of sedimentation to Onondaga Creek.

## SECTION 9: RELATED INITIATIVES

Onondaga County's "Save the Rain" initiative is an effort to educate the watershed community on effective measures to reduce runoff from the urban landscape. Information on porous pavement, tree planting, rain gardens, rain barrels and more are available at http://www.ongov.net/savetherain/index.html.

As efforts continue to reduce point and nonpoint sources of pollution to the lake, other projects are underway to enhance recreational access and opportunities for community involvement with the lake and its shoreline. Planning and design of Phase 1 of the Creekwalk to connect Onondaga Lake to Armory Square are complete and construction is scheduled to begin in spring 2009. Phase 2 of the Creekwalk, connecting Armory Square to Kirk Park, is currently in the design process.

The rehabilitation of Onondaga Lake demonstrates the potential for community-based collaborative efforts to address complex environmental issues. Many factors have contributed to the lake's recovery: the investment of public and private funds, the dedication of state and county officials, the commitment of the County workforce, and the creativity of the engineers and scientists working to find innovative solutions have all played a role. We hope that this 2008 Annual AMP Report will inspire continued actions to keep Onondaga Lake on the road to recovery.