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Summary of regulatory classification of streams within Onondaga Lake watershed.

Stream	Description of Stream Segment	Regulatory Classification	Standards
Onondaga Creek	Enters Onondaga Lake at southeastern end. Mouth to upper end of Barge Canal terminal (0.85 miles)	C	C
	Upper end of Barge Canal terminal to Temple Street (1.7 miles)	C	C
	From Temple Street, Syracuse to Tributary 5B (4.4 miles)	B	B
	From Tributary 5B to Commissary Creek (1.9 miles)	C	C
	From Commissary Creek to source	C	C(T)
Ninemile Creek	Enters Onondaga Lake from south. From mouth to Allied Chemical Corp. water intake located on creek to point mid-way between Airport Rd and Rt. 173 bridge at Amboy (3.4 miles)	C	C
	From point mid-way between Airport Rd and Rt. 173 to outlet of Otisco Lake	C	C(T)
Harbor Brook	Enters Onondaga Lake at the southern most point of the lake and within the City of Syracuse. From mouth to upper end of underground section, at Gifford Street (approx. 1.9 miles)	C	C
	From upper end of underground section to City of Syracuse line (1.3 miles)	B	B
	From City of Syracuse City line to source	C	C(T)
Ley Creek	Enters Onondaga Lake 0.2 mile southeast of point where City of Syracuse line intersects east shore of lake. From mouth to Ley Creek sewage treatment plant outfall sewer	C	C
	From Ley Creek sewage treatment plant outfall sewer to South Branch. Tribs. 3-1A and 3-lB enter from north approximately 3.0 and 3.1 miles above mouth respectively	B	B
Bloody Brook	Enters Onondaga Lake 2.25 miles southeast of outlet. From mouth to trib. 1 of Bloody Brook (approximately 0.37 miles from mouth)	B	B
	From trib. 1 of Bloody Brook to source	C	C

Source:
6 NYCRR Part 895 Onondaga Lake Drainage Basin, on-line at http://www.dec.ny.gov/regs/4539.html

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The Final New York State 2008 Section 303(d)
List of Impaired Waters Requiring a TMDL/Other Strategy (May 26, 2008).

Water body	Type	Class	Cause/Pollutant	Source	Year
Waterbodies for which TMDL Development May be Deferred (Requiring Verification of Cause/Pollutant):					
* Seneca River, Lower, Main Stem (0701-0001)	River	C	D.O./Oxygen Demand	InvSpp, Agric.	1998
Seneca River, Lower, Main Stem (0701-0008)	River	C	**D.O./Oxygen Demand**	InvSpp, Agric.	1998
Multiple Segment/Categorical Impaired Waterbody Segments (fish consumption):					
Onondaga Lake, northern end (0702-0003)	Lake	B	Dioxin Mercury PCBs, other toxics	Contam. Sed. Contam. Sed. Contam. Sed.	1998 1998 1998
Onondaga Lake, southern end (0702-0021)	Lake	C	Dioxin Mercury PCBs, other toxics	Contam. Sed. Contam. Sed. Contam. Sed.	1998 1998 1998
Waterbodies for which TMDL Development May be Deferred (Requiring Verification of Impairment):					
Seneca River (0701-0008)	River	C	Pathogens	On-site WTS	1998
Onondaga Creek, Middle, and tribs (0702-0004)	River	B	**Turbidity**	Streambank Erosion	2008
Waterbodies for which TMDL Development May be Deferred (Pending Implementation/Evaluation of Other Restoration Measures):					
Onondaga Lake Outlet[82] (0702-0020)	River	B	**D.O./Oxygen Demand**	Muni, Urban	2008
Onondaga Lake, southern end[82] (0702-0021)	Lake	C	**Pathogens**	CSOs, Muni, Urban	2008
Minor Tribs to Onondaga Lake[82] (0702-0022)	River	C	**Pathogens** **Nutrients (Phosphorus)** **Ammonia (NH3)** **Cyanide**	CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban	2008 2008 2008 2008
Bloody Brook and tribs[82] (0702-0006)	River	C*	**Pathogens**	Muni, Urban	2008
Ley Creek and tribs[82] (0702-0001)	River	C*	**Pathogens** Nutrients (phosphorus) Ammonia (NH_3) **Cyanide** Unknown Toxicity	Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban Muni, Urban Muni, Urban	2008 1998 1998 2008 2006
Onondaga Creek, lower[82] (0702-0023)	River	C	**Pathogens** Nutrients (phosphorus) Ammonia (NH_3) Unknown Toxicity	CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban	2008 1998 1998 2006
Onondaga Creek, Middle and tribs[82] (0702-0004)	River	B	**Pathogens** **Nutrients (phosphorus)** **Ammonia (NH_3)** **Unknown toxicity**	CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban	2008 2008 2008 2008

Water body	Type	Class	Cause/Pollutant	Source	Year
Harbor Brook, Lower and tribs[82] (0702-0002)	River	B	**Pathogens** Nutrients (phosphorus) Ammonia (NH_3)	CSOs, Muni, Urban CSOs, Muni, Urban CSOs, Muni, Urban	2008 1998 1998
Ninemile Creek, Lower and tribs[82] (0702-0005)	River	C	**Pathogens** Nutrients (phosphorus)	Muni, Urban Muni, Urban	2008 1998
Geddes Brook and tribs[82] (0702-0007)	River	C	Ammonia (NH_3)	Muni, Urban	1998
<u>Other Impaired Waterbody Segments Not Listed Because Development of a TMDL is Not Necessary:</u>					
Onondaga Lake, northern end (0702-0003)	Lake	B	Phosphorus[94]	Muni	4a/1998
Onondaga Lake, southern end (0702-0021)	Lake	C	Phosphorus[94]	Muni	4a/1998
Onondaga Creek, Lower (0702-0023)	River	C	Other/Habitat	Habitat Modification	4c
Onondaga Creek, Middle, and tribs (0702-0004)	RIver	B	Other/Habitat	Habitat Modification	4c
Harbor Brook, Lower, and tribs (0702-0002)	River	B	Other/Habitat	Habitat Modification	4c
<u>2008 Waterbody/Pollutant Delistings (Waters/Pollutants listed in 2006, but that are NOT included in the 2008 Section 303(d) List)</u>					
Onondaga Lake, northern end (0702-0003)	Lake	B	Ammonia	Muni	R[101]
Onondaga Lake, southern end (0702-0021)	Lake	C	Ammonia	Muni	R[101]
These 2 waters/pollutants have been delisted due to recent assessments that show applicable water quality standards for ammonia are being met.					

<u>Notes:</u>

Segments and/or pollutants listed in **Bold Type** are new listings; i.e., they were not included in the previous (2006) Section 303(d) List.

Abbreviations: InvSpp – invasive species; Agric. – Agriculture; Contam. Sed. – Contaminated Sediment; Muni – municipal source; Urban – Urban runoff; CSOs – Combined Sewer Overflows; On-site WTS – On-site wastewater treatment system.

* Denotes High Priority Waters, scheduled for TMDL/restoration strategy development and submission for approval to USEPA within the next two years.

4a - indicates Category 4a - TMDL development is not necessary because a TMDL has already been established for the segment/pollutant.

4c - indicates Category 4c - TMDL is not appropriate because the sole impairment is the result of pollution, rather than a pollutant that can be allocated through a TMDL.

[82] - Impairments to these waters are being addressed through the efforts of the Onondaga Lake Partnership. Onondaga Lake and some of its tribs (Ley Creek, Onondaga Creek, Harbor Brook) have or will also benefit from actions related to the Onondaga Lake Amended Consent Judgement.

[94] - Onondaga Lake previously appeared on the list of Other Impaired Waterbody Segments Not Listed Because Development of a TMDL is Not Necessary due to impairments from, and development of a TMDL for, ammonia and phosphorus. Subsequently the lake has been found to be meeting water quality standards for ammonia, so Onondaga Lake is considered to have been restored for this pollutant.

R[101] - Reassessment - These waterbodies were previously included as impaired but not requiring TMDL development in the 2006 Section 303(d) List because a TMDL for ammonia in Onondaga Lake was completed in 1998.

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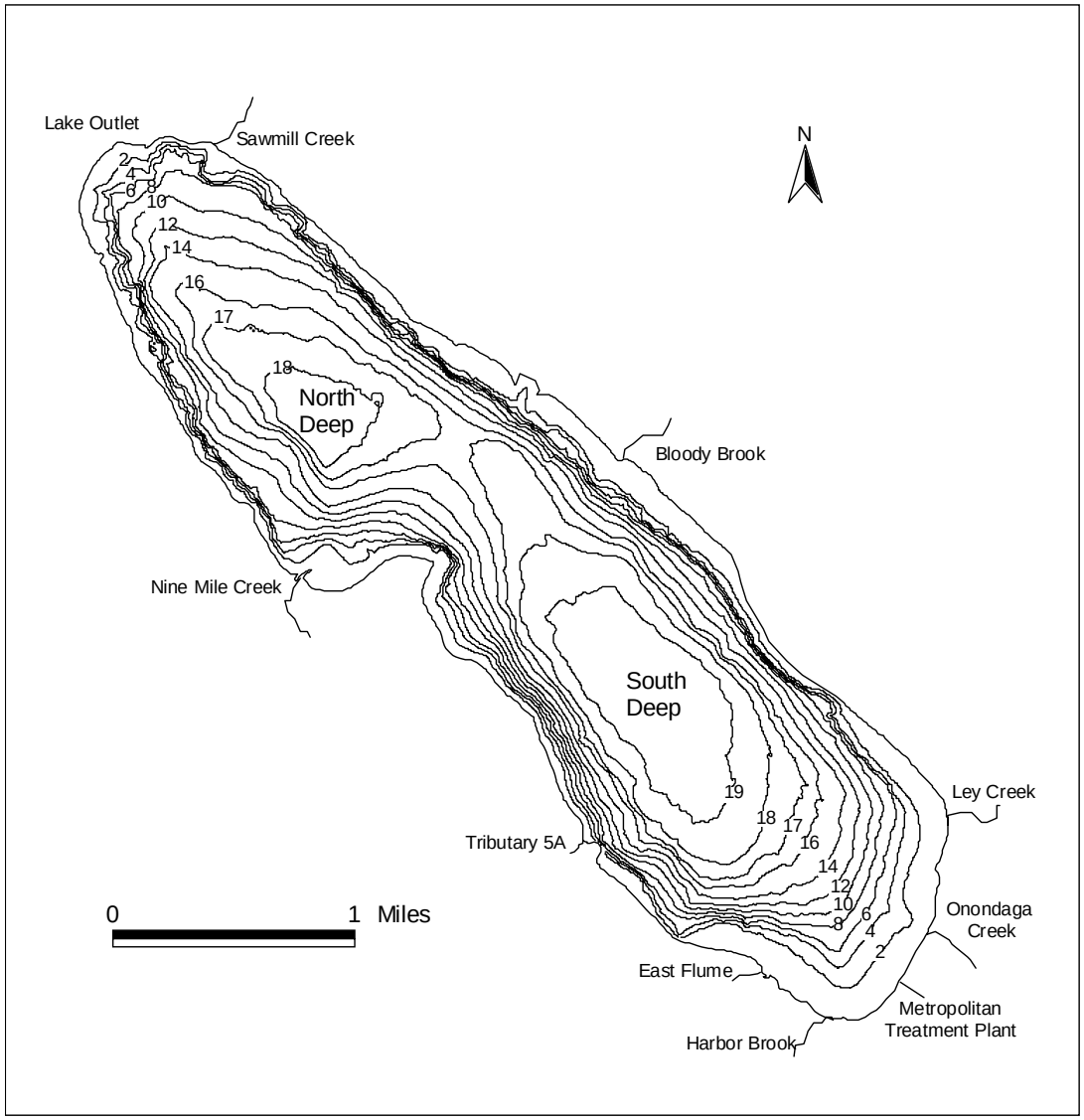
NYSDEC fish stocking in waters connected to Onondaga Lake, 2008.

Stream Segment	Species Stocked	Number Stocked
Ninemile Creek	Rainbow Trout	300
	Brown Trout	20,914
	Brook Trout	2,747
Geddes Brook	Brown Trout	725
	Rainbow Trout	355
Furnace Brook	Brook Trout	400
Harbor Brook	Brown Trout	200
Onondaga Creek	Brown Trout	1,649
West Branch Onondaga Creek	Brown Trout	970
Otisco Lake	Brown Trout	2,500
	Tiger muskellunge	7,815
	Walleye	45,000

Source: NYSDEC - Fish Stocking Lists 2008 Lists by County
http://www.dec.ny.gov/outdoor/30467.html



Bathymetric map of Onondaga Lake. (Note: Contour lines are in meters.)

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Climate Statistics

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Climate statistics for Onondaga Lake basin.

	Normals for Syracuse, NY	2008
Maximum monthly average temperature	70.9 ºF (July)	81.2 ºF (July)
Minimum monthly average temperature	22.7 ºF (January)	18.8 ºF (February)
Annual average temperature	47.4 ºF	48.2 ºF
Annual precipitation	40.05 inches	41.91 in (+1.86 in)
Snowfall	121.1 inches	109.1 in (-12 in)

Sources:

Normals for Syracuse NY (1971-2000): National Weather Service Binghamton Weather Forecast Office obtained 03/23/2009 (on-line linkage: http://www.erh.noaa.gov/bgm/climate/syr/syr_normals.shtml)

2008: NOWData - NOAA Online Weather Data obtained 03/23/2009 (on-line linkage: http://www.nws.noaa.gov/climate/xmacis.php?wfo=bgm).

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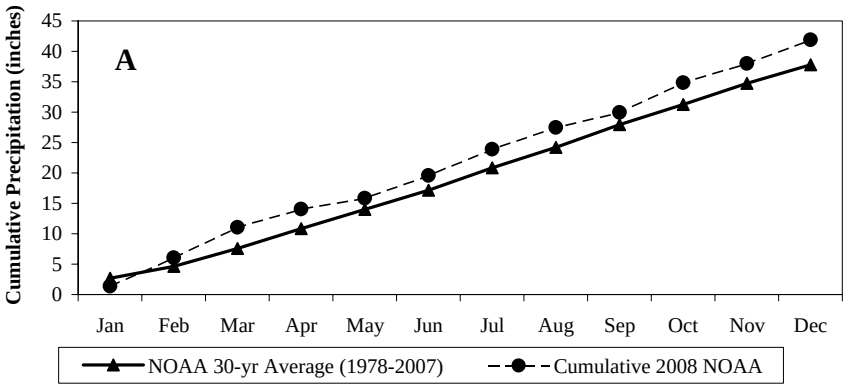
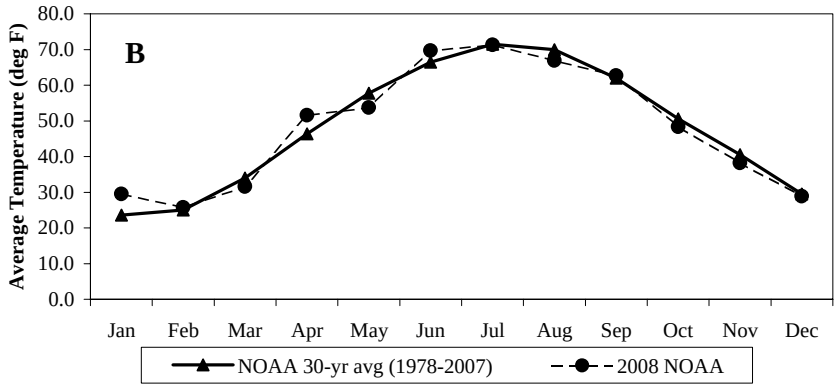
NOAA Syracuse Hancock Airport precipitation and temperature data.

Measure	2008 (NOAA*)	30-year Average (1978-2007)	Notes
Precipitation (inches)			
Annual	41.91	37.96	3.95 above
Monthly Avg Low	1.36 (January)	2.70 (January)	1.34 below
Monthly Avg High	5.00 (March)	2.88 (March)	2.12 above
Temperature (°F)			
Annual	48.2	48.1	0.11 above
Monthly Avg Low	25.7 (February)	25.0 (February)	0.14 below
Monthly Avg High	71.3 (July)	71.4 (July)	0.70 above

*Obtained from **NOWData - NOAA Online Weather Data** (http://www.nws.noaa.gov/climate/xmacis.php?wfo=bgm) on March 24, 2009

Library Reference 1.5.3





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In 2008, annual precipitation (A) measured at Syracuse Hancock Airport was above the NOAA 30-year historical average. Monthly total precipitation overall was close to the 30-year average except for the periods January through March and September through October. During the summer months precipitation was close to normal. Monthly air temperatures (B) were close to the 30-year average, though January, April and June were slightly warmer than normal.

Library Reference 1.5.4

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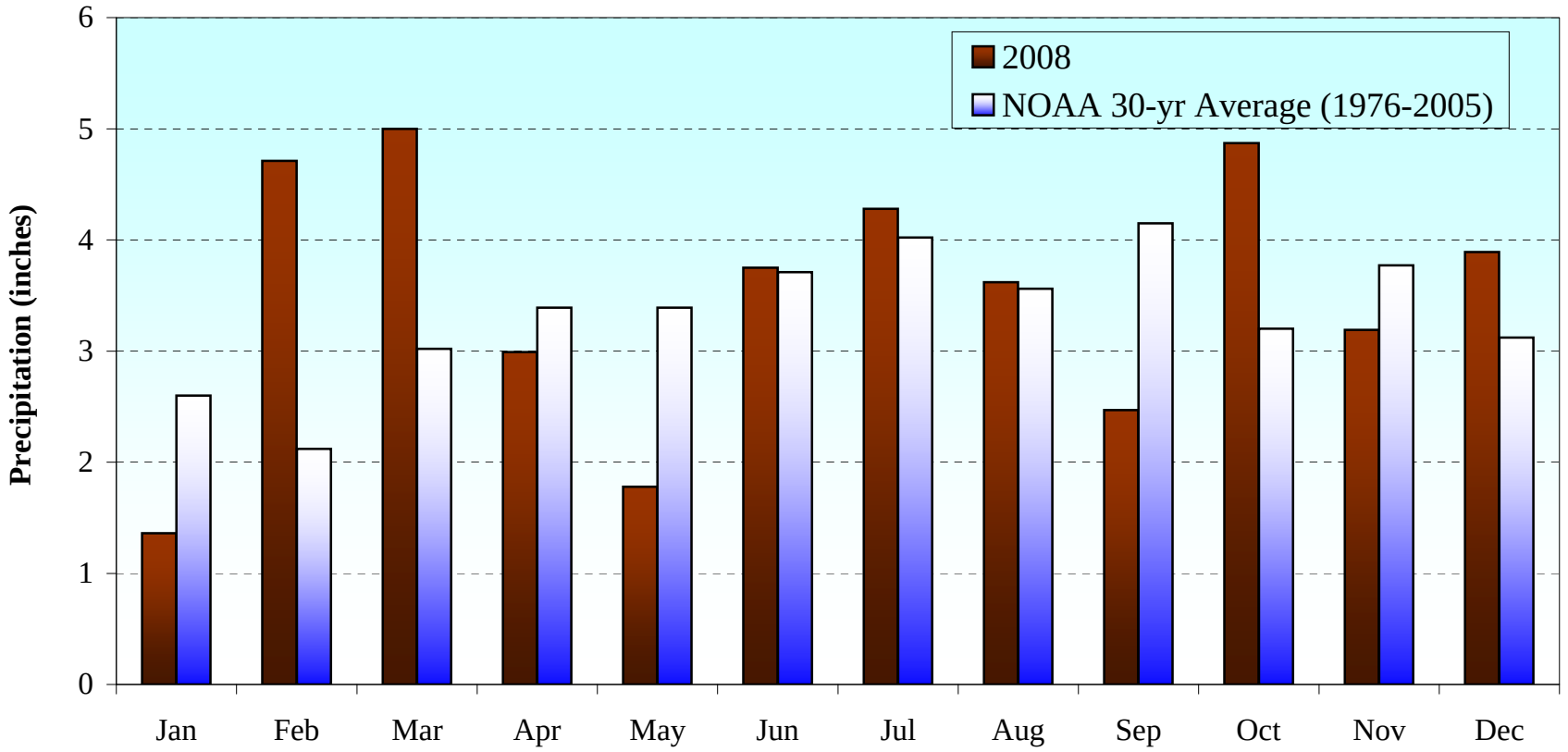

Comparison of monthly precipitation for 2008 with long-term (30-year) monthly averages. Data obtained from the NOAA web site http://www.nws.noaa.gov/climate/xmacis.php?wfo=bgm.

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Land Cover Summary Statistics

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Land cover percent change by subwatershed, Onondaga Lake Watershed, 1992 and 2001. *Source: SOCPA*

	Land Cover Designation			
Tributary	**Urban/Developed**	**Forest**	**Agriculture**	**Wetlands**
Onondaga Lake (Nearshore)	+18%	-2%	-16%	--
Onondaga Cr	+7%	+12%	-22%	+3%
Ninemile Cr	+13%	+14%	-29%	+2%
Ley Cr	+17%	+1%	-16%	-3%
Harbor Brook	+14%	+8%	-25%	+3%
Otisco Lake	+3%	+24%	-29%	+1%
Range:	**+3% to +18%**	**-2% to 24%**	**-29% to -16%**	**-3% to +3%**

Note: "+" indicates percent increase from 1992 to 2001; "-" indicates percent decrease.

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LIBRARY-SECTION 02
AMBIENT MONITORING PROGRAM
BACKGROUND

Summary of management questions and decision analysis.

Management Question	Decision Analysis Components and Regulatory References	Spatial and Temporal Scale of Assessment	Tools for Assessment
Can ambient water quality standards be achieved with continued Metro discharge to Onondaga Lake? **Decision date: February 1, 2009**	Dissolved Oxygen: 6 NYCRR Sec. 703.3 Ammonia: 6 NYCRR Sec. 703.5 Turbidity: 6 NYCRR Sec. 703.2 Floatables: 6 NYCRR Sec. 703.2 Phosphorus: 6 NYCRR Sec. 703.2 TOGS 1.1.1 Water Quality Standards & Guidelines Nitrogen: 6 NYCRR Sec. 703.2 Bacteria: 6 NYCRR Sec. 703.4	Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia and Nitrite: Upper waters; South Deep, year-round Bacteria: Class B portions of lake	Monitoring: AMP data Modeling CSOs: use SWMM to confirm: system-wide annual average capture of at least 85% of combined sewage volume. Modeling Lake: Onondaga Lake model (development began in 2005 and continues)
Must Metro effluent meet the Stage III phosphorus and ammonia limits for discharge to Onondaga Lake or the Seneca River in order for the receiving water to achieve compliance with ambient water quality standards? **Decision date: February 1, 2009**	Phosphorus: 6 NYCRR Sec. 703.2 (*possibly modified by site-specific guidance value)* Trophic state indicators: frequency, intensity and duration of algal blooms Ammonia: TOGS 1.1.1 Water Quality Standards & Guidelines (*latest revision to NYS standards*) NYSDEC revised TMDL for phosphorus and ammonia: **January 1, 2009**	Phosphorus and other trophic state parameters: Summer average, upper waters, South Deep (per NYSDEC guidance). Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia: Upper waters, South Deep, year-round	*For lake discharge:* • AMP data: Ammonia: effects of Stage III limits, met in 2004 TP: effects of Stage II limits, met in 2006 • Use lake model to project compliance under critical conditions *For Seneca River discharge*: TRWQM (in development)
Are additional measures needed to ensure compliance with dissolved oxygen standards during fall mixing? **Decision date: December 1, 2012**	Feasibility analysis of hypolimnetic oxygenation (ENSR 2004). *Status: on hold*	Focus of compliance for dissolved oxygen: fall mixing, upper waters	• AMP data: profiles and buoy • Mass-balance model • Onondaga Lake model (in development)

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Summary of metrics: measuring progress towards improvement in Onondaga Lake

Desired Use	Metrics	Measured By
Water contact recreation	Indicator bacteria	Fecal coliform bacteria abundance within the lake's Class B segment
	Water clarity	Secchi disk transparency (nearshore)
Aesthetics	Water clarity	Secchi disk transparency (open waters)
	Bloom frequency, magnitude and duration	Percent of chlorophyll-*a* measurements greater than 15 µg/l
		Percent of chlorophyll-*a* measurements greater than 30 µg/l
	Algal community structure	Percent of algal community represented by cyanobacteria (blue-green taxa)
	Macroalgae proliferation	Percent cover of littoral zone, measured at nearshore stations
Aquatic life protection	Ammonia N	Percent of measurements in compliance with standards.
	Nitrite N	Percent of measurements in compliance with standards.
	Dissolved oxygen	DO at fall mixing.
		Duration of DO concentrations < 4 mg/l
	Integrated metrics	"Fish space" metrics, volume-days with suitable conditions of DO and temperature for cold water and cool water fish communities
	Species assemblage	Percent intolerant or moderately intolerant of pollution
Sustainable recreational fishery	Fish species successfully reproducing	Nesting surveys, larval sampling, young-of-year sampling (littoral and pelagic) adult surveys
	Habitat quality	Percent cover of macrophytes

2008 Results from Onondaga Lake Water Quality and Habitat Metrics.

Issue: Water Contact Recreation		
Metrics (Summer June 1 – September 30)	**Target**	**2008**
Percent of water clarity measurements > 4 ft (1.2 m); nearshore Class B stations	100%	87%
Percent of *E. coli* bacteria monthly geometric means* in compliance; Class B stations	100%	100%
Percent of fecal coliform bacteria monthly geometric means** in compliance; Class B stations	100%	100%
Metrics (Disinfection Period April 1 through October 15)		
Percent of *E. coli* bacteria monthly geometric means* in compliance; Class B stations	100%	100%
Percent of fecal coliform bacteria monthly geometric means** in compliance; Class B stations	100%	100%
Issue: Aesthetics		
Metrics (Summer June 1 – September 30)	**Target**	**2008**
Water clarity > 5 ft (1.5 m) at mid-lake station (South Deep)	100 %	100%
Algal abundance low in summer (chlorophyll-*a* < 15 µg/l in 85% of measurements)	>85%	100%
Lake is free of nuisance algal blooms 90% of time (nuisance algal bloom = chlorophyll-*a* > 30 µg/l)	>90 %	100%
Cyanobacterial abundance is low (< 10% of community biomass)	<10%	<1%
Issue: Aquatic Life Protection		
Metrics	**Target**	**2008**
Dissolved oxygen > 5 mg/l during turnover Oct 1-Dec 1 (daily average); > 4 mg/l (instantaneous minimum)	>5 mg/l >4 mg/l	5.8 mg/l *** 5.6 mg/l ***
NH_3-N meets standards in 100% of measurements throughout the year	100%	100%
Nitrite meets standards in 100% of measurements throughout the year	100%	100%
Issue: Fish Reproduction		
Metrics	**Target**	**2008**
Reproduction of target species in the lake:		
• largemouth bass, smallmouth bass, and sunfish	• Occurring	• Occurring
• yellow perch	• Occurring	• Occurring
• black crappie	• Occurring	• No evidence
• rock bass	• Occurring	• Occurring
• walleye and northern pike	• Occurring	• No evidence
Percent intolerant or moderately intolerant species in Lake	>25%	8%
Percent macrophyte cover of littoral zone, based on optimal habitat for largemouth bass {percent based on aerial photograph interpretation}	40%	40%

Notes:

** The EPA criterion for E. coli for bathing beaches (126 cfu/100ml) is based on the geometric mean of a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period). Results from the Class B stations were compiled to calculate the monthly geometric means.*

*** §703.4 Water quality standards for coliforms - The monthly geometric mean, from a minimum of five examinations, shall not exceed 200 cfu/100ml during disinfection period Apr 1 to Oct 15. Results from the Class B stations were compiled to calculate the monthly geometric means.*

**** During fall turnover in 2008, the 2m buoy sonde was malfunctioning; the field profile DO measurements during the fall turnover period indicated that the 6m buoy measurements were comparable to the upper waters (e.g. 0m and 3m) field profile measurements. The values shown here were obtained from the 6m buoy sonde.*

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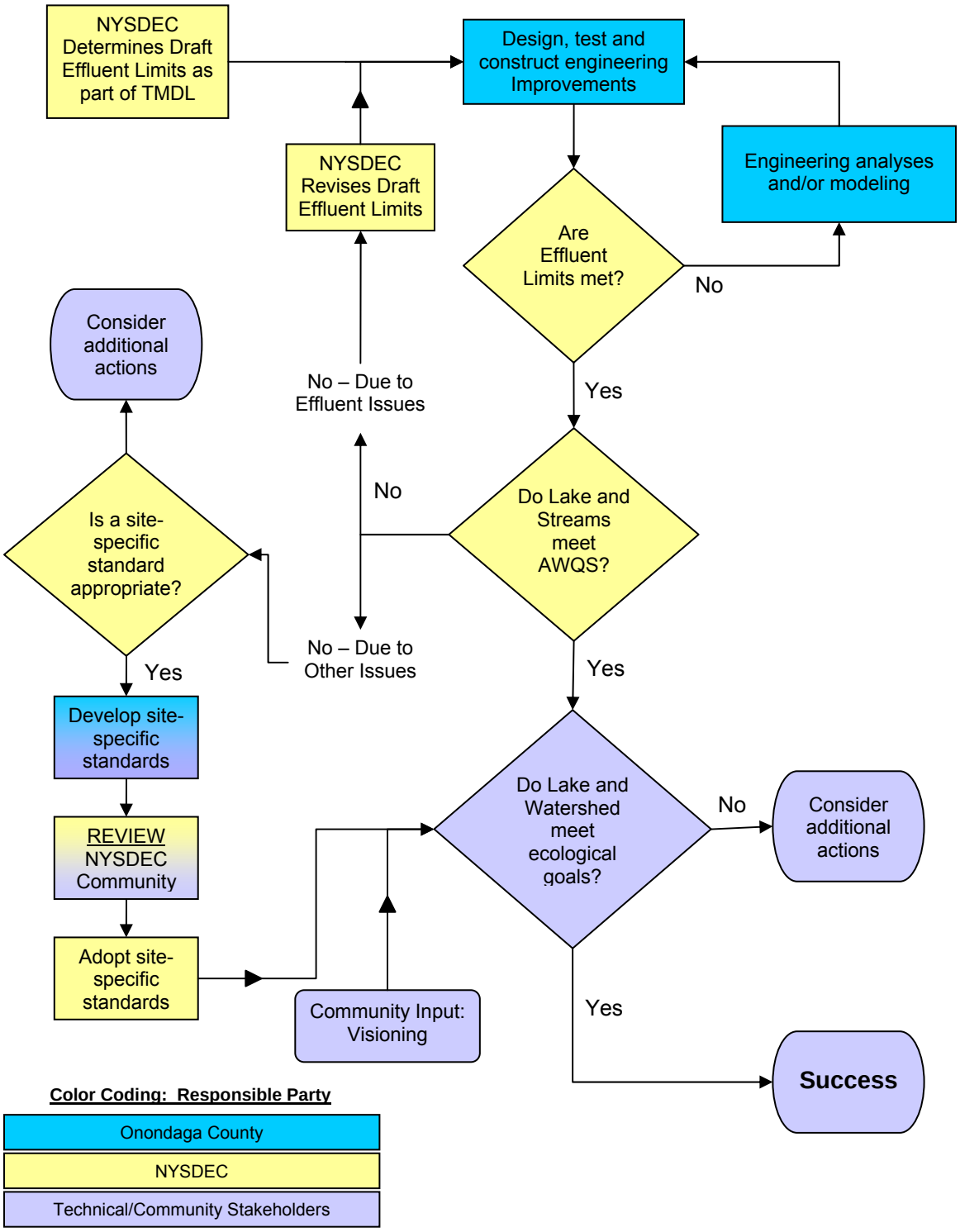
The Annual Monitoring Program (AMP) is the primary source of data to support engineering and regulatory evaluations of water quality conditions in Onondaga Lake. This flow chart shows the linkage of decision-makers and responsibilities for this program.



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Summary of management questions and decision analysis.

Management Question	Decision Analysis Components and Regulatory References	Spatial and Temporal Scale of Assessment	Tools for Assessment
Can ambient water quality standards be achieved with continued Metro discharge to Onondaga Lake?	Dissolved Oxygen: 6 NYCRR Sec. 703.3 Ammonia: 6 NYCRR Sec. 703.5 Turbidity: 6 NYCRR Sec. 703.2 Floatables: 6 NYCRR Sec. 703.2 Phosphorus: 6 NYCRR Sec. 703.2 TOGS 1.1.1 Water Quality Standards & Guidelines Nitrogen: 6 NYCRR Sec. 703.2 Bacteria: 6 NYCRR Sec. 703.4	Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia and Nitrite: Upper waters; South Deep, year-round Bacteria: Class B portions of lake	Monitoring: AMP data Modeling CSOs: use SWMM to confirm: system-wide annual average capture of at least 85% of combined sewage volume. Modeling Lake: OLWQM to project: • Summer average TP • DO at fall mixing • Ammonia and NO_2-N compared to standards • Algal bloom frequency
Must Metro effluent meet the Stage III phosphorus and ammonia limits for discharge to Onondaga Lake or the Seneca River in order for the receiving water to achieve compliance with ambient water quality standards?	Phosphorus: 6 NYCRR Sec. 703.2 (*possibly modified by site-specific guidance value)* Trophic state indicators: frequency, intensity and duration of algal blooms Ammonia: TOGS 1.1.1 Water Quality Standards & Guidelines (*latest revision to NYS standards*) NYSDEC revised TMDL for phosphorus: **December 31, 2011**	Phosphorus and other trophic state parameters: Summer average, upper waters, South Deep (per NYSDEC guidance). Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia: Upper waters, South Deep, year-round	*For lake discharge:* • AMP data: Ammonia: effects of Stage III limits, met in 2004 TP: effects of Stage II limits, met in 2006 • Use lake model to project compliance under critical conditions *For Seneca River discharge*: TRWQM to project: DO and NH_3-N in Seneca River under low flow conditions
Are additional measures needed to ensure compliance with dissolved oxygen standards during fall mixing?	Feasibility analysis of hypolimnetic oxygenation (ENSR 2004). *Status: removed from ACJ per stipulation*	Focus of compliance for dissolved oxygen: fall mixing, upper waters	• AMP data: profiles and buoy • Mass-balance model • OLWQM

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Elements of the 2008 AMP in relation to ACJ-required monitoring objectives.

ACJ Statement of Required Program Objective:	**2008 Program Elements**	**Data Used To**
Quantify external loading of phosphorus, nitrogen, suspended solids, indicator bacteria, and salts. Assess the reduction in loading achieved by the CSO improvements. Design program to evaluate the relative contribution of point and nonpoint sources of pollution to the lake.	(Annual program) Tributary monitoring: biweekly, and high flows – Includes locations upstream and downstream of CSOs, urban and rural segments of subwatersheds.	Estimate annual external loading to Onondaga Lake
Assess the tributaries' physical habitat and macroinvertebrate community.	(Periodically) • Stream mapping using NRCS Visual Stream Assessment Protocol in CSO-subwatersheds: Onondaga Creek, Ley Creek and Harbor Brook (Every 2 years, even years) • Macroinvertebrate surveys of CSO-affected subwatersheds	Quantify baseline conditions and provide basis to measure change. Quantify baseline conditions and provide basis to measure change
Gather data on an adequate temporal and spatial scale to assess compliance with ambient water quality standards.	(Annual programs) • Lake monitoring program: South Deep Station and nine nearshore stations • Tributary monitoring program • Seneca River monitoring program	Assess compliance with numerical and narrative standards Calibrate and verify models

Elements of the 2008 AMP in relation to ACJ-required monitoring objectives (continued).

ACJ Statement of Required Program Objective:	**2008 Program Elements**	**Data Used To**
Evaluate changes in the water quality and trophic state of Onondaga Lake in response to reductions in external loading achieved by the improvements to Metro and the CSOs.	(Annual programs) • Lake monitoring • Tributary monitoring • River monitoring	Assess conditions in relation to inputs and trends Calibrate USGS watershed model of land use and nutrient export (using AMP tributary data) Construct conceptual model and mass-balance model Calculate "fish space metrics" to track changes in available habitat for cold water, cool water and warm water fish Develop and calibrate Onondaga Lake model
Expand the chemical monitoring program to include other indices of ecological integrity: biological data, contaminant burden, and physical habitat.	(Annual biological program unless noted otherwise) • Fish: nesting, larvae, juveniles, and adult communities • Lower trophic levels: phytoplankton and zooplankton • macrophytes: annual aerial surveys with ground-truthing; full field surveys in 2000, 2005 and 2010 • macroalgae: visual surveys in nearshore areas • littoral macroinvertebrates: surveys in 2000, 2005 and 2010 Fish flesh contaminant levels, monitored and reported by NYSDEC	Assess current trophic state, abundance and diversity of species, importance of exotic species, reproductive success Test for trends or shifts in data Compare Onondaga Lake with Oneida Lake (zooplankton community) and other regional lakes (fish community)

Elements of the 2008 AMP in relation to ACJ-required monitoring objectives (continued).

ACJ Statement of Required Program Objective:	**2008 Program Elements**	**Data Used To**
Through interaction with NYSDEC and appropriate peer reviewers, coordinate data collection and analysis to provide data at an adequate spatial and temporal scale to use in existing or revised lake models.	Annual program and supplemental investigations, NYSDEC review and approvals Meetings with OLTAC and work groups	Support conceptual and empirical (mass-balance) model; AMP data will be used to calibrate and verify new lake model (begun in 2005)
Define ambient water quality conditions in the Seneca River between Cross Lake and the Three Rivers junction.	(Annual program) Surveys at Seneca River Buoy 316 (target low flow conditions)	Assess current conditions, data set for model validation Assess compliance with ambient water quality standards
Evaluate and quantify the assimilative capacity of the Seneca River and quantify effects of zebra mussels. Quantitative Environmental Analysis, LLC. Final Phase 2 Report Three Rivers Water Quality Model. Prepared for: Onondaga County Department of Water Environment Protection Syracuse, NY, Onondaga Lake Cleanup Corp., Syracuse, NY. Job Number: ONOsen: 227. August 2005.	River modeling work group and peer review (Annual program) Surveys during low flow conditions in the fall (depends on hydrologic conditions) Periodic zebra mussel assessment	Assess current conditions, data set for model verification Assess current conditions, compile data for model verification

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Data Analysis and Interpretation Plan
Onondaga Lake and Watershed
Ambient Monitoring Program

Onondaga County Department of Water Environment Protection
650 Hiawatha Boulevard West
Syracuse, New York 13204-1194

Version 2.5
April 2009

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Figure 3 Conceptual model of phosphorus dynamics in Onondaga Lake under present conditions

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Figure 5 Conceptual model of dissolved oxygen dynamics in Onondaga Lake under present conditions

Data Analysis and Interpretation Plan (DAIP)

1. OBJECTIVE OF THE DAIP

Each year Onondaga County Department of Water Environment Protection (OCDWEP) collects and analyzes more than 20,000 water quality samples and hundreds of biological samples collected from Onondaga Lake and its watershed. Results are used to evaluate water quality conditions and assess whether the waters are in compliance with applicable standards, criteria, and guidance values. The biological samples are used to evaluate the nature of the biological community and assess change.

This Data Analysis and Interpretation Plan (DAIP) was prepared to guide program managers and advisors regarding how these thousands of measurements will be analyzed and interpreted. It is a roadmap of how data become information (refer to **Figure 1-1** in the 2007 Annual AMP report: flow chart of decisions and responsibilities). This document will be revised and updated as new information becomes available, new issues emerge, or new tools are developed to help with data analysis and interpretation.

2. REGULATORY BACKGROUND – AMENDED CONSENT JUDGMENT

In January 1998, Onondaga County signed an Amended Consent Judgment (ACJ) committing to a phased program of upgrades and improvements to the County's wastewater collection and treatment system. The ACJ includes three major elements:

1. Improvements to the wastewater and stormwater collection systems to abate Combined Sewer Overflows (CSOs).

2. Improvements to the Metropolitan Syracuse Wastewater Treatment Plant (Metro) to reduce the concentration of ammonia N, phosphorus, BOD, solids, and bacteria in treated effluent prior to discharge.

3. Monitoring Onondaga Lake, the lake tributaries, and the Seneca River to track their response to the pollution abatement actions.

Improvements to Metro and the CSOs are phased over a 15-year period. One of the factors considered in developing the phasing plan was uncertainty regarding how Onondaga Lake would respond to reductions in the loading of wastewater-related contaminants. Onondaga County was required to design, fund, and implement a monitoring program that would provide the data and information needed to support key decisions regarding adequacy of the pollution abatement measures and the need for additional actions. These key decisions relate to the level of treatment and the location of the Metro discharge; results will provide the foundation for the Metro SPDES permit, which will include the CSOs.

2.1. Required Actions by Onondaga County and NYSDEC

Specific compliance requirements for Onondaga Lake and its watershed are referenced in the ACJ. The following summary was prepared by John Ferrante of Central New York Regional Planning and Development Board; Dr. Ferrante is working under contract to NYSDEC on Onondaga Lake issues.

****

COMPLIANCE REQUIREMENTS FOR THE AMENDED CONSENT JUDGMENT

The following list contains the primary legal and programmatic actions that are required in the Amended Consent Judgment. This list is not meant to be comprehensive of all ACJ requirements but identifies only those of a technical nature. The Party responsible for implementing each action and bringing it to an acceptable conclusion is identified after each requirement. The source document is the Amended Consent Judgment signed and entered into the Court on January 20, 1998.

SOURCE **REQUIREMENT**

Page 4-5: Insure that Onondaga Lake and its tributaries achieve best usage designated for Class B and C water pursuant to 6 New York Code of Rules and Regulations (NYCRR) Parts 701 and 703. Applicable NY State Water Quality Standards and Guidelines:

1. Dissolved Oxygen: 6NYCRR Sec. 703.3
2. Ammonia: 6 NYCRR Sec. 703.5
3. Turbidity: 6 NYCRR Sec. 703.2
4. Floatable Solids: 6 NYCRR Sec. 703.2
5. Phosphorus: 6 NYCRR Sec. 703.2
6. Technical & Operational Guidance Series (TOGS) 1.1.1 Water Quality Standards and Guidelines
7. Nitrogen: 6 NYCRR Sec. 703.2
8. Bacteria: 6 NYCRR Sec. 703.4

Responsible Party: New York State Department of Environmental Conservation

Page 5: The State is required "…to determine, as soon as sufficient data and other information are available, whether water quality standards and guidelines for Onondaga Lake can be achieved with the continued discharge of Metro's effluent into the Lake;…"

Responsible Party: New York State Department of Environmental Conservation

Paragraph 9: Onondaga County is responsible for complying with the following Stage III effluent discharge limits from the Metro wastewater treatment plant (*or as amended based on revised Total Maximum Daily Load (TMDL))*

1. Ammonia: 1.2 mg/l (June 1 – October 31 [30 day average])
   2.4 mg/l (November 1 – May 31 [30 day average])
2. Phosphorus: 0.02 mg/l [12 month rolling average]

Responsible Party: Onondaga County

Paragraph 10: Report on the ability of the County (based on demonstrated information) to achieve compliance with effluent limitations specified in ACJ, paragraph 9, or as amended based on a revised TMDL allocation.

Responsible Party: Onondaga County

Paragraph 11: Failure to demonstrate ability (per paragraph 10) by February 1, 2009, cease causing or contributing to the violation of water quality standards in Onondaga Lake by diverting

Metro's effluent to the Seneca River or by implementing another engineering alternative which fully complies with the water quality standards no later than December 1, 2012.

Responsible Party: Onondaga County

Paragraph 12: Reassess Total Maximum Daily Load (TMDL) allocation for Onondaga Lake "on or about" January 1, 2009 and modify Stage III effluent limits as needed to reflect revised TMDL.

Responsible Party: New York State Department of Environmental Conservation

Paragraph 13: Metro construction compliance requirements and schedule per paragraphs 5 – 11, Appendix A

Responsible Party: Onondaga County

Paragraph 14: Design, construct, and maintain and modify and/or supplement, as necessary, a CSO control and upgrade program in accordance with DEC CSO guidance, as set forth in TOGS 1.6.3 (CSO Control Strategy).

Responsible Party: Onondaga County

Paragraph 15: Develop and implement an oxygenation demonstration project in Onondaga Lake.

Responsible Party: Onondaga County *{note: this requirement has been suspended pending stipulation that it be withdrawn from the ACJ based on current water quality conditions}*.

Paragraph 16: Monitor conditions in the Lake and its tributaries, and evaluate the effect that alterations in Metro and CSO operations are having on the water quality.

Responsible Party: Onondaga County

Paragraph 24: Enter into an agreement with CNYRPDB and provide funding for an Environmental Benefits Project (as set forth in Paragraph 25.C)

Responsible Party: Onondaga County

****

2.2. Water Quality Classification and Designated Use

Lakes and streams are classified according to their designated best use (for example, water supply, swimming, fish propagation, aesthetic enjoyment, and fish survival). Onondaga Lake is classified as B and C waters (**Figure 1** and **Table 1**) The Class B segment encompasses the northern basin; the Class C segments include much of the southern basin and a small area around the mouth of Ninemile Creek. Both B and C waters must exhibit water quality conditions suitable for fish survival and propagation. Class B waters are to be suitable for primary water contact recreation (e.g. swimming) and secondary water contact recreation (e.g. boating). Class C waters shall be suitable for primary and secondary water contact recreation, although other factors may limit the use for these purposes.

The main stems of the lake tributaries are primarily classified as C waters (suitable for fish propagation and secondary water contact recreation) but several small segments are Class B. The Seneca River segment in the vicinity of the Onondaga Lake outflow and downstream is Class B. As summarized in **Table 1**, several Class C stream segments within the subwatersheds are required to comply with Class C(T) water quality standards, meaning that dissolved oxygen and ammonia levels shall be suitable for salmonids.

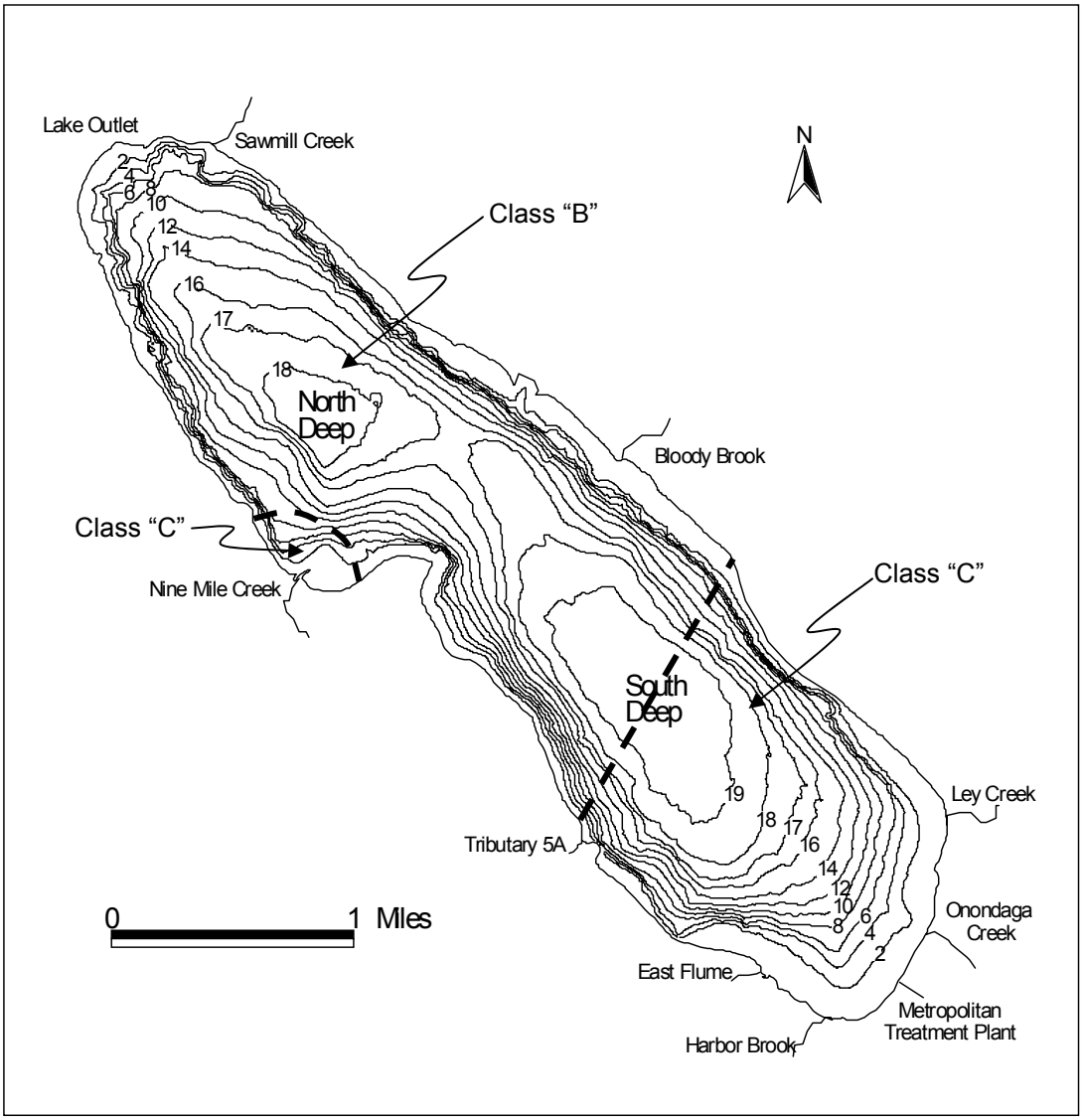


Figure 1. Regulatory Classifications and Bathymetry of Onondaga Lake..
(Note: Contour lines are in meters.)

Table 1. Summary of Regulatory Classification of Onondaga Lake and Tributary Streams.

Water body	Description of Segment	Regulatory Classification	Standards
Onondaga Creek	Enters Onondaga Lake at southeastern end. Mouth to upper end of Barge Canal terminal (0.85 miles)	C	C
	Upper end of Barge Canal terminal to Temple Street (1.7 miles)	C	C
	From Temple Street, Syracuse to Tributary 5B (4.4 miles)	B	B
	From Tributary 5B to Commissary Creek (1.9 miles)	C	C
	From Commissary Creek to source	C	C(T)
Ninemile Creek	Enters Onondaga Lake from south. From mouth to Allied Chemical Corp. water intake located on creek to point mid-way between Airport Rd and Rt. 173 bridge at Amboy (3.4 miles).	C	C
	From point mid-way between Airport Rd and Rt. 173 to outlet of Otisco Lake	C	C(T)
Harbor Brook	Enters Onondaga Lake at the southern most point of the lake and within the City of Syracuse. From mouth to upper end of underground section, at Gifford Street (approx. 1.9 miles)	C	C
	From upper end of underground section to City of Syracuse line (1.3 miles)	B	B
	From City of Syracuse City line to source	C	C(T)
Ley Creek	Enters Onondaga Lake 0.2 mile southeast of point where City of Syracuse line intersects east shore of lake. From mouth to Ley Creek sewage treatment plant outfall sewer.	C	C
	From Ley Creek sewage treatment plant outfall sewer to South Branch. Tribs. 3-1A and 3-lB enter from north approximately 3.0 and 3.1 miles above mouth respectively.	B	B
Bloody Brook	Enters Onondaga Lake 2.25 miles southeast of outlet. From mouth to trib. 1 of Bloody Brook (approximately 0.37 miles from mouth)	B	B
	From trib. 1 of Bloody Brook to source.	C	C
Onondaga Lake (1)	Northwest of a line extending from a point located on the west shore 0.25 miles northwest of the mouth of trib. 5A to a point on the east shore located at a point 0.6 miles southeast of the mouth of Bloody Brook, except portions of the lake designated as items no. 2 and 3.	B	B
Onondaga Lake (2)	Southeast of a line extending from a point located on the west shore 0.25 miles northwest of the mouth of trib. 5A to a point on the east shore located at a point 0.6 miles southeast of the mouth of Bloody Brook, except portions of the lake designated as items numbered 1 and 3.	C	C
Onondaga Lake (3)	Area within 0.25 mile radius of the mouth of Ninemile Creek, except portions designated as items numbered 1 and 2.	C	C

Source: NYSDEC (classifications as of July 2004); on-line linkage http://www.dec.ny.gov/regs/4539.html#17588

2.3. Compliance Assessment

The regulatory goal of the ACJ is to bring Onondaga Lake and its tributaries into compliance with best usage designated for Class B and C waters pursuant to 6 NYCRR Parts 701 and 703. Applicable NY State Water Quality Standards and Guidance that will be used to assess the extent to which these actions are successful include the following:

1. Dissolved Oxygen: 6NYCRR Sec. 703.3
2. Ammonia: 6 NYCRR Sec. 703.5
3. Turbidity: 6 NYCRR Sec. 703.2
4. Floatable Solids in CSO Discharges: 6 NYCRR Sec. 703.2
5. Phosphorus: 6 NYCRR Sec. 703.2
6. Water Quality Standards & Guidelines (NYSDEC Technical & Operational Guidance Series TOGS 1.1.1)
7. Nitrogen: 6 NYCRR Sec. 703.2
8. Bacteria: 6 NYCRR Sec. 703.4

3. Summary of the Onondaga County Ambient Monitoring Program (AMP)

Onondaga County is required by the ACJ to design and implement an annual monitoring program of the lake, the lake tributaries, and portions of the Seneca River adjacent to the Onondaga Lake Outlet. The objective of the Ambient Monitoring Program (AMP) is to provide the data and information needed to assess the effectiveness of the controls at Metro and the CSOs and determine if additional remedial measures are required to bring the waters into compliance with applicable state standards and guidelines and federal criteria.

Onondaga County and its partners rely on an integrated program of monitoring and modeling to determine whether the planned improvements to the Onondaga County wastewater collection and treatment infrastructure are effective in bringing the surface

water system into compliance with state and federal requirements. Monitoring is used to measure conditions over the 15-year period of phased improvements to the wastewater collection and treatment system. Modeling is used to describe the interrelationships between physical, chemical, and biological characteristics of the lake and watershed. Models are also valuable tools for interpreting data and understanding underlying mechanisms. Once verified, models can be used to predict future conditions under a range of management scenarios and environmental conditions.

The interrelationship between the management questions, monitoring and modeling, and the spatial and temporal designation of compliance is summarized in **Table 2**.

Table 2. Summary of management questions and decision analysis.

Management Question:	Decision Analysis Components and Regulatory References	Spatial and Temporal Scale of Assessment	Tools for Assessment
Can ambient water quality standards be achieved with continued Metro discharge to Onondaga Lake? **Decision date: February 1, 2009**	Dissolved Oxygen: 6NYCRR Sec. 703.3 Ammonia: 6 NYCRR Sec. 703.5 Turbidity: 6 NYCRR Sec. 703.2 Floatables: 6 NYCRR Sec. 703.2 Phosphorus: 6 NYCRR Sec. 703.2 TOG 1.1.1 Water Quality Standards & Guidelines Nitrogen: 6 NYCRR Sec. 703.2 Bacteria: 6 NYCRR Sec. 703.4	Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia and nitrite: Upper waters; South Deep, year-round Bacteria: Class B portions of lake	Monitoring: AMP data Modeling CSOs: Use SWMM to confirm: system-wide annual average capture of 85% of combined sewage volume. Modeling Lake: Onondaga Lake model (development began in 2005)
Must Metro effluent meet the Stage III phosphorus and ammonia limits for discharge to Onondaga Lake or the Seneca River in order for the receiving water to achieve compliance with ambient water quality standards? **Decision date: February 1, 2009**	Phosphorus: 6 NYCRR Sec. 703.2 (*possibly modified by site-specific guidance value)* Trophic state indicators: frequency, intensity and duration of algal blooms Ammonia: TOG 1.1.1 Water Quality Standards & Guidelines (*latest revision to NYS standards*) NYSDEC revised TMDL for phosphorus and ammonia: **January 1, 2009**	Phosphorus and other trophic state parameters: Summer average, upper waters, South Deep (per NYSDEC guidance). Dissolved Oxygen: Upper waters, fall mixing, South Deep Ammonia: Upper waters; South Deep, year-round	For lake discharge: • AMP data: Ammonia: effects of Stage 3 limits, met in 2004 TP: effects of Stage 2 limits, met in 2006 • Use lake model to project compliance under critical conditions For Seneca River discharge: TRWQM
Are additional measures needed to ensure compliance with dissolved oxygen standards during fall mixing? **Decision date: December 1, 2012**	Feasibility analysis of hypolimnetic oxygenation (ENSR 2004). *Status: on hold*	Focus of compliance for dissolved oxygen: fall mixing, upper waters	• AMP data: profiles and buoy • Mass-balance model • Onondaga Lake model

3.1. History of Onondaga County Monitoring Efforts

The AMP is not Onondaga County's first monitoring effort. Following completion of a baseline State of the Lake Report in 1970, Onondaga County conducted an annual program from 1970–1997 to monitor tributaries, quantify external loading, and track lake water quality conditions and trends in response to pollution abatement efforts. When the ACJ was signed in 1998, Onondaga County modified its historical monitoring program to ensure that the data collected would be adequate to evaluate the response of the lake, streams, and river to the planned improvements to the CSOs and Metro. This process of evaluation and modification was a collaborative effort of Onondaga County, Onondaga Lake Technical Advisory Committee (OLTAC), U.S. Geological Survey (USGS), New York State Department of Environmental Conservation (NYSDEC), Environmental Protection Agency (EPA) and Atlantic States Legal Foundation (ASLF). The AMP began in August 1998 and is scheduled to continue through 2012.

The AMP differs from the historical program in several important ways:

- Storm Event Monitoring: The AMP incorporated a storm event program on the CSO-affected tributaries (Onondaga Creek, Harbor Brook, Ley Creek), plus Ninemile Creek. Storm event data are used to evaluate the effectiveness of the CSO remedial measures.

- Stream Mapping: A stream mapping component was added to the AMP to document habitat quality along the CSO-affected tributaries; this program will support evaluation of the effectiveness of CSO controls and has provided additional information regarding nonpoint sources of pollution (particularly sediment).

- Recreational Indices: The AMP was expanded to include monitoring for indices of recreational quality (bacteria and water transparency) at a network of eight nearshore stations (a ninth station was added in 2006).

- In-Situ Buoy: A monitoring buoy has been placed at the South Deep station to provide high-frequency measurements of water temperature, dissolved oxygen and related parameters.

- Precipitation Stations: Onondaga County has expanded its network of precipitation gauging stations.

- Biological Monitoring: The most significant change, however, has been the addition of an extensive biological monitoring program.

3.2. Design of the AMP: Required Elements

The AMP was designed to provide data and information needed to guide management decisions regarding the level of treatment of municipal wastewater (including CSOs) and the location of the Metro discharge.

The AMP includes Onondaga Lake, the lake's tributaries, and the Seneca River in the region of the Onondaga Lake outlet. The program includes measures to evaluate physical and habitat conditions, chemical water quality, and the nature of the biota as summarized in the language from the ACJ listing the required elements of the AMP.

These required elements from Appendix D of the ACJ include measures to:

- Assess compliance with ambient water quality standards in the lake and tributary streams
- Estimate loading of materials to the lake, including the volume and loading of materials from the combined sewer overflows
- Evaluate physical habitat conditions in the lake and tributaries
- Evaluate the lake's trophic state (level of productivity)
- Model the assimilative capacity of the Seneca River in the region of the Onondaga Lake outlet to support a decision regarding diversion of Metro effluent
- Characterize the lake's biological community.

In addition to these specific measures, Appendix D of the ACJ includes requirements to document data integrity (for example, preparation of a detailed Quality Assurance Project Plan). Onondaga County is required to consult with technical experts to ensure that the AMP is designed and implemented in a defensible manner. Data interpretation and reporting is to be open and subject to rigorous technical review. Finally, Appendix D includes specific requirements to ensure that Onondaga County's monitoring program collects data related to habitat quality. The addition of attributes to measure habitat quality highlights the expansion of the program from a traditional water quality monitoring program to one that aims at a more holistic assessment of ecological integrity. Appendix D of the ACJ is abstracted below.

OCDWEP also has an expanded monitoring program on the Seneca River that is not part of the AMP; this program extends into the Oneida River and is used to evaluate performance of other Onondaga County wastewater treatment plants.

An overview of how the AMP is designed to meet ACJ requirements is provided in **Table 3**. While the AMP is designed to assure compliance with the specific requirements in the ACJ, Onondaga County collects and analyzes additional data to meet related program objectives. In many cases, additional data are collected that enable a more integrated analysis of water quality conditions and the response of the biota. Details of how data collected through the AMP are used and interpreted is included in **Table 4**, which is subdivided into these sections:

A. Onondaga Lake Chemical/Water Quality Monitoring Program
B. Onondaga Lake Physical Parameters
C. Onondaga Lake Chlorophyll-a, Phaeophytin-a, Phytoplankton, Zooplankton, Macrophytes and Littoral Macroinvertebrates.
D. Onondaga Lake Fisheries Program
E. Tributary Program Summary
F. Seneca River Program Summary

AMBIENT MONITORING PROGRAM REQUIREMENTS
(Appendix D of the ACJ)

Abstracted from the Amended Consent Judgment, January 1998

I. Tributaries and Lake Water Quality Monitoring Program

1. Assess compliance with ambient water quality standards and progress toward use attainment.
2. Assess physical habitat for stream and lake biota, and indicators of the biotic response.
3. Incorporate flexibility to assess additional chemicals or potential sources as needed
4. Concentrate data collection during critical ecological periods (e.g. spring spawning of dominant lake fishes, onset of thermal stratification, fall mixing).
5. Define monitoring as a priority at the Department and commit adequate resources
6. Increase participation of outside technical experts, e.g., Onondaga Lake Technical Advisory Committee in design and implementation of AMP and interpretation of results.
7. Incorporate appropriate QA/QC.
8. Maintain data in an electronic format that facilitates summarizing data, reporting results, and depicting results (including graphical depiction)

II. Tributary Monitoring Program

1. Quantify external loadings of phosphorus, nitrogen, suspended solids, indicator bacteria, heavy metals, and salts. Utilize FLUX. Events-based schedule.
2. High flow monitoring to partition point and nonpoint sources of phosphorus to the Lake (minimum of 5 days).
3. Collect storm event data upstream and downstream of CSO discharges to Onondaga Creek, Harbor Brook and Ley Creek.
4. Assess compliance with water quality standards in Onondaga Cr, Harbor Br, and Ley Cr.
5. Measure attributes of the physical environment in tributaries: (a) velocity; (b) cross-sectional area to map erosional and depositional sections; (c) survey for presence and character of sludge deposits in depositional areas and map; (d) map physical characteristics of the stream bed that could affect spawning habitat from mouth to first barrier; (e) sample macroinvertebrate communities and calculate NYSDEC rapid field biotic index throughout tributaries' length.
6. Continue cooperative arrangements with USGS to gauge discharge of the major tributaries.
7. Continue data collection, analysis and reporting consistent with historical database (1970 to 1997) to enable statistical trend analysis.

III. Onondaga Lake Monitoring Program

1. Assess compliance with ambient water quality standards including bacterial concentrations in nearshore areas.
2. Assess trophic status of the Lake.
3. Continue data collection, analysis, and reporting consistent with the long-term lake database (1970 – 1997) to enable statistical trend analysis.
4. Complement chemical program with a biological monitoring effort to assess the densities and species composition of phytoplankton, zooplankton, macrophytes, macroinvertebrate, and fish.
5. Evaluate success of walleye, bass, and sunfish propagation (quantitative lake-wide nest surveys, recruitment estimates, and juvenile community structure). Coordinate with NYSDEC fisheries management activities on the lake.
6. Establish sharing protocols with NYSDEC for County to track contaminants in fish flesh.
7. Acquire and track data by others regarding nature of littoral (shallow area) sediments in Onondaga Lake.

IV. Seneca River Program

1. Evaluate current water quality of the Seneca River and compliance with water quality standards upstream and downstream of the Onondaga Lake outlet.
2. Evaluate and quantify the assimilative capacity of the Seneca River and quantify effects of zebra mussels.
3. Monitor critical conditions of warm weather and low flows.
4. Test temporal and spatial variability (e.g., diurnal variations in river water quality, and the extent of chemical stratification).

Table 3. Elements of the AMP in relation to ACJ-Required Monitoring Objectives.

ACJ Statement of Required Program Objective	Ambient Monitoring Program Elements	Data Used To
Quantify external loading of phosphorus, nitrogen, suspended solids, indicator bacteria, and salts. Assess the reduction in loading achieved by the CSO improvements. Design program to evaluate the relative contribution of point and nonpoint sources of pollution to the lake.	Tributary monitoring (Annual Program): biweekly and high flow events – includes locations upstream and downstream of CSOs, urban and rural segments of subwatersheds. Storm event program (Periodic): higher frequency sampling on CSO-affected streams during storms.	Estimate annual external loading to Onondaga Lake Calculate loading from CSO-affected tributaries and compare pre-and post-remedial load of phosphorus, suspended sediment, and bacteria
Assess the tributaries' physical habitat and macroinvertebrate community	Stream mapping using NRCS Visual Stream Assessment Protocol in CSO-subwatersheds (Periodic): Onondaga, Ley and Harbor Brook. Baseline, 2000 and 2002; post-improvements scheduled for 2008 and 2012; note: may be modified based on CSO construction schedule or major hydrologic event Macroinvertebrate surveys (Periodic): CSO-affected subwatersheds every 2 years, even years.	Quantify baseline conditions and provide basis to measure change. Calculate standard indices (using NYSDEC protocols) that use numbers and types of benthic macroinvertebrates to indicate status of water quality and habitat conditions. Test for improvement over time.
Gather data on an adequate temporal and spatial scale to assess compliance with ambient water quality standards	Lake monitoring program (Annual): South Deep Station and nine nearshore stations Tributary monitoring program (Annual) Seneca River monitoring program (Annual)	Assess compliance with numerical and narrative standards for substances listed in TOGS 1.1.1 Calibrate and verify models

Table 3. Elements of the AMP in relation to ACJ-Required Monitoring Objectives. (continued)

ACJ Statement of Required Program Objective	Ambient Monitoring Program Elements	Data Used To
Evaluate changes in the water quality and trophic state of Onondaga Lake in response to reductions in external loading achieved by the improvements to Metro and the CSOs.	Lake monitoring program (Annual): phosphorus, chlorophyll-a, water clarity, DO status of lower waters Tributary and Metro effluent monitoring (Annual): loads (esp. nutrients) Seneca River monitoring (Annual)	Assess conditions in relation to inputs and trends Calibrate USGS watershed model of land use and nutrient export (using AMP tributary data) Construct conceptual model and mass-balance model Calculate "fish space metrics" to track changes in available habitat for cold water, cool water and warm water fish Develop and calibrate Onondaga Lake model
Through interaction with NYSDEC and appropriate peer reviewers, coordinate data collection and analysis to provide data at an adequate spatial and temporal scale to use in existing or revised lake models	Annual program and supplemental investigations, NYSDEC review and approvals Meetings with OLTAC and work groups	Support conceptual and empirical (mass-balance) model; AMP data will be used to calibrate and verify new lake model (begun in 2005)
Define ambient water quality conditions in the Seneca River between Cross Lake and the Three Rivers junction.	Annual surveys during low flow conditions at Seneca River Buoy 316.	Assess current conditions, provide data for model verification Assess compliance with ambient water quality standards
Evaluate and quantify the assimilative capacity of the Seneca River and quantify effects of zebra mussels. Quantitative Environmental Analysis, LLC. *Final Phase 2 Report Three Rivers Water Quality Model.* Prepared for: Onondaga County Department of Water Environment Protection Syracuse, NY, Onondaga Lake Cleanup Corp., Syracuse, NY. Job Number: ONOsen: 227. August 2005.	River modeling work group and peer review (Annual program) Surveys during low flow conditions in the fall (depends on hydrologic conditions)	Assess current conditions, data set for model verification
	Periodic zebra mussel assessment (surveys completed in spring and summer 2007)	Support TRWQM model of assimilative capacity of River, including zebra mussel activity. Domain is Cross Lake to Phoenix Dam. Assess current conditions, compile data for model verification

Table 4. Detailed Reporting of AMP Program, Data Analysis and Interpretation Strategy.

A. Onondaga Lake Chemical/Water Quality Monitoring Program

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Alkalinity, Total	Concentration	• Charge Balance • Trends • Compute Hardness	South Deep North Deep	UML1 composite LWL composite	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Wildco Beta horizontal sampler/ Churn
Bacteria Fecal Coliform, E. Coli	• Abundance of indicator organisms • Percent of measurements meeting swimming standards	• Potential presence of pathogens • Compliance with standards • Use attainment. • Trend analysis • Effectiveness of CSO control measures. • Model support	South Deep North Deep Nearshore sites	0m	South Deep: Biweekly (Oct-Apr) and weekly (May-Sept) North Deep: Quarterly Weekly (Feb-Mar) ("winter lake") Nearshore: Weekly (May-Sept)	Grab sample into sterile bottle

1 UML and LWL composite samples are based on the thermocline depth determined through the field profile (temperature, pH, dissolved oxygen, and specific conductance). Two periods are defined as default conditions that vary depending on the lake's annual stratification and mixing: October 1 – May 31, (not strongly stratified) and June 1 – Sept 30 (strongly stratified). During the October 1 – May 31 period, default UML includes the 0, 3 and 6 m depths; default LWL includes the 9, 12, 15 and 18 m depths. During the June 1 – September 30 period, default UML includes 0 and 3 m depths (always); 6 m may be excluded based on field conditions. The LWL during the summer period typically includes 12, 15, and 18 m; 9m is excluded as it is consistently in the metalimnion. Occasionally, the thermal structure during summer leads the field team to exclude the 12 m depth as well.

Table 4. Detailed Reporting of AMP Program. (continued)
A. Onondaga Lake Chemical/Water Quality Monitoring Program (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
BOD-5	Concentration	• Indicator of oxygen-demanding material • Model support • Trends	South Deep North Deep	UML composite LWL composite	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Wildco Beta horizontal sampler/ Churn
Carbon: TOC, TOC-F, TIC	Concentration	• Trends • Trophic Status. • Indicator of oxygen demanding material. • Support models	South Deep North Deep	Discrete depths (0m, 6m, 12m, 18m)	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Submersible Pump
Mercury: Total and Methyl Mercury (low-level)	Concentration	• Compliance • Trends	South Deep North Deep	3m & 18m	April, June, August, October	Teflon Dunker Modified USEPA Method 1669
Metals: Cd, Cr, Cu, Ni, Pb, Se, Zn, As, K	Concentration	• Compliance • Charge balance computations (K)	South Deep North Deep	UML composite LWL composite	Quarterly	Wildco Beta horizontal sampler/ Churn

Table 4. Detailed Reporting of AMP Program. (continued)
A. Onondaga Lake Chemical/Water Quality Monitoring Program (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Metals/Salts: Ca, Na, Mg, Mn, Fe, Cl, SO_4	Concentration	• Charge Balance (data quality) • Trends • Geochemical Analysis • Electrochemical (redox) • Density stratification • Phytoplankton community structure	South Deep North Deep	UML composite LWL composite	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Wildco Beta horizontal sampler/ Churn
Nitrogen: NO_3, NO_2	• Concentration • Compliance with NYS standard (100 ug/l Nitrite in upper waters for warmwater fishery)	• Compliance with AWQS[2]. • Measure in-lake nitrification and nitrogen cycling • Use attainment (warm water fishery)	South Deep North Deep	UML composite LWL composite	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Wildco Beta horizontal sampler/ Churn

[2] AWQS – Ambient Water Quality Standard

Table 4. Detailed Reporting of AMP Program. (continued)
A. Onondaga Lake Chemical/Water Quality Monitoring Program (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Nitrogen: TKN, NH3-N, Org-N, TKN-Filtered	Concentration	• Compliance with standards • Measure in-lake nitrification, nitrogen cycling • Compute N:P ratios • Habitat for biota • Trend analysis • TMDL. Analysis • Model support	South Deep North Deep	Discrete Depths (0m, 3m, 6m, 9m, 12m, 15m, 18m)	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Submersible Pump
Phosphorus: TP, SRP, TDP	Concentration	• Trophic status • Trends • Compliance with NYS guidance value of 20 µg/l summer average, upper waters guidance value (support for site-specific analysis) • TMDL analysis • Model support • Bioavailability	South Deep North Deep	Discrete Depths (0m, 3m, 6m, 9m, 12m, 15m, 18m) plus 1m, biweekly, June 1 – Sept 30 (NYS guidance value)	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Submersible Pump

Table 4 Detailed Reporting of AMP Program. (continued)
A. Onondaga Lake Chemical/Water Quality Monitoring Program (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Silica	Concentration	Trophic levels interaction (potential for silica to limit diatom production)	South Deep North Deep	Discrete depths (0m, 6m, 12m, 18m)	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Submersible Pump
Solids: TS, TSS, VSS, TVS, TDS	Concentration	• Compliance • Trend analysis • Chemical stratification • Correlation with turbidity (water clarity)	South Deep North Deep	Discrete depths (0m, 6m, 12m, 18m)	South Deep: Biweekly (Apr-Dec) North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Submersible Pump
Sulfides	Concentration	• Anoxia • Model support (diagenesis)	South Deep North Deep	Discrete depths (12m, 15m, 18m)	Only when anoxic conditions are present South Deep: Biweekly North Deep: Quarterly	Wildo Beta horizontal sampler

Table 4 Detailed Reporting of AMP Program. (continued)
B. Onondaga Lake Physical Parameters

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Turbidity	Light scattering (NTU)	• Trend analysis • Correlation with other indices affecting water clarity	South Deep	Discrete depths (2m, 6m)	Daily at 15 minute intervals (Apr-Dec)	YSI Buoy
			South Deep North Deep	South Deep: UML composite Discrete depth (0m) North Deep: UML composite	South Deep UML: Biweekly (Apr-Dec) and monthly in winter, as conditions allow South Deep 0m: Weekly May-Sept North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	Wildco Beta horizontal sampler/ Churn

Table 4. Detailed Reporting of AMP Program. (continued)
B. Onondaga Lake Physical Parameters (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Field data: pH, Temperature, Salinity, Conductivity, Dissolved Oxygen, ORP	• Volume-days of Anoxia • Rate of depletion from LWL • DO during fall mixing • Volume-days of hypoxia • Fish-space metrics	• Compliance • Stratification (thermal and chemical) • Model support • Trend analysis • Ammonia toxicity. • Use attainment.(habitat) • Concentration of reduced substances and oxidation status of lake (ORP data) • pH indicator of CO2 production and decomposition.	South Deep North Deep	0.5 m intervals through water column	South Deep: Biweekly (Apr-Dec) and monthly in winter, as conditions allow North Deep: Quarterly Weekly (Feb-Mar) ("winter lake")	YSI (In-situ)
		• Compliance with DO and pH standards. • Evidence of mixing processes (seiche)	South Deep	Discrete depths (2m, 6m, 12m, 15m)	Daily at 15 minute intervals (Apr-Dec)	YSI Buoy

Table 4. Detailed Reporting of AMP Program. (continued)
B. Onondaga Lake Physical Parameters (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Secchi Disk Transparency	• Average Secchi, percent of measurements meeting 1.2 m (nearshore), 1.5 m (South Deep)	• Secchi disk transparency: Compliance with NYSDOH[3] guidance value for bathing beaches (1.2 m or 4 ft). • Trends • Trophic Status • Indicator of water clarity • Aesthetics (1.5 m or 5 ft) • Use attainment	South Deep North Deep Nearshore sites	Depth at which the disk is no longer visible from the surface	South Deep: Weekly (May-Sep) Biweekly (Apr, Oct-Dec) North Deep: Quarterly Weekly (Feb-Mar) ("winter lake") Nearshore: Weekly (May–Sep)	Secchi Disk
LiCor Underwater Illumination Profile	• Extinction coefficient	• Trends • Trophic Status • Indicator of water clarity • Aesthetics (1.5 m or 5 ft) • Use attainment	South Deep North Deep	From lake surface to depth at which light is 1% of surface illumination	Biweekly (Apr-Dec)	LiCor Datalogger

[3] NYSDOH – New York State Department of Health

Table 4. Detailed Reporting of AMP Program. (continued)

C. Onondaga Lake chlorophyll-a, phaeophytin-a, phytoplankton, zooplankton, macrophytes, and littoral macroinvertebrates

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Chlorophyll-*a* & Phaeophytin-*a*	• Concentration • Magnitude and frequency of bloom conditions	• Use attainment. • Aesthetic quality • Site-specific guidance • Assess trophic status and algal productivity. • Trends • Compare to phytoplankton and zooplankton. • Evaluate variability. • Lake model calibration and validation	South Deep North Deep	UML composite and Photic Zone[4]	South Deep: In duplicate weekly (May-Sept) and biweekly (April; Oct – Dec) North Deep: Quarterly	¾" Tygon tube sampler (Depth-integrated tube samples)
Phytoplankton	• Biovolume • Abundance • Species composition • Annual succession • Percent blue green	• Assess community structure, importance of cyanobacteria • Trends in abundance and biomass • Aesthetic quality • Correlation with chlorophyll • Relationship to light penetration	South Deep North Deep	UML composite	South Deep: Biweekly (Apr–Nov) and monthly in winter, as conditions allow North Deep: Quarterly	¾" Tygon tube sampler (Depth-integrated tube samples)

4 The Photic Zone is defined as two times the Secchi disk transparency depth measured the day of sampling.

Table 4. Detailed Reporting of AMP Program. (continued)
C. Onondaga Lake chlorophyll-a, phaeophytin-a, plankton, macrophytes, and littoral macroinvertebrates (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Zooplankton	• Count • Dry weight biomass • Identification • Abundance • Species composition • Annual succession • Size	• Trends in abundance and biomass • Assess community structure • Size structure • Correlate data with other regional lakes (Oneida Lake) • Test relationship to fish community • Infer food web impacts	South Deep North Deep	UML composite and 15 m tow	South Deep: Biweekly (Apr–Nov) and monthly in winter, as conditions allow North Deep: Quarterly	Vertical Haul 0.5 m diameter net, 80 μm mesh
Macrophytes	Plant distribution	Used to track percent cover during years without field surveys	Entire Lake	-	Annual	Digitize beds from aerial photographs using GIS software
	Lakewide and by strata: • Species richness • Biomass • Percent cover	• Percent cover compared with optimal levels for warmwater fish community (bass) nursery and cover • Biomass to support lake model • Richness compared with regional lakes • Trends	Transects in littoral strata	From shoreline to depth where plant growth stops (6 m contour standard)	2000, 2005, 2010 (August surveys)	Field surveys

Table 4. Detailed Reporting of AMP Program. (continued)
C. Onondaga Lake chlorophyll-a, phaeophytin-a, plankton, macrophytes, and littoral macroinvertebrates (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Littoral macroinverte-brates	Lakewide and by strata: • NYSDEC indices • Percent oligochaetes and chironomids • Species richness	Change from baseline conditions, lakewide and by strata	18 samples, in 5 strata (90 total)	From shoreline to 1.5 m depth	2000, 2005, 2010 (June surveys)	Field surveys

Table 4. Detailed Reporting of AMP Program. (continued)
D. Onondaga Lake Fisheries Program

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Nesting survey	Count Where possible, identify species	Change over time: lakewide and at five strata used for biological programs	Entire Lake divided into 24 sections	1 m	June	Visual Count around entire littoral zone (along depth contour)
Pelagic Larvae	• Species identification • Length frequency	• Community Structure • Growth rate, compared to regional lakes and to historical Onondaga Lake data • Condition factor • Species Richness • Pollution tolerance	South basin North basin	5.5 meter double oblique tow	Biweekly (April-August)	Miller Trawl

Table 4. Detailed Reporting of AMP Program. (continued)
D. Onondaga Lake Fisheries Program (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Littoral Juvenile	• Number and species of juveniles captured • Catch per unit effort	• Community Structure • Size/length distribution • Species Richness • Evidence of recruitment • Pollution tolerance	15 sites lakewide	~ 1m	Every three weeks (July-October)	¼" mesh bag seine sweep
Littoral Adults	• Number and species captured • Catch per unit effort	• Community Structure • Size/length distribution • Species Richness • Evidence of recruitment • Pollution tolerance • Index of Biological Integrity	24 sections	< 1m	May, September, October	Night Electrofishing Angler diary program
Pelagic Adults	• Number and species captured • Catch per unit effort	• Community Structure • Size/length distribution • Species Richness • Evidence of recruitment • Pollution tolerance	5 sites (1 per station)	4-5 m water (2 hour set)	May, October	Littoral - Profundal Gill Nets Experimental: hydroacoustics Angler diary program
Deformities, Erosions, Lesions, Tumors, Fungal and Multiple Anomalies (DELT-FM)	Number and types of anomalies	Change over time (trend)	Lakewide	All (most are adults captured by electrofishing)	Screening on all captured fish	Visual analysis by trained field teams

Table 4. Detailed Reporting of AMP Program. (continued)
E. Tributary Program Summary

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Frequency Sampling Interval	Method
Alkalinity	Concentration	• Calculate bicarbonate (charge balance) • Trends	Routine[5]: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Spencer; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Bacteria: Fecal Coliform	Abundance	• Potential presence of pathogens • Trends • Effectiveness of CSO control measures	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet (2ft) High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
BOD-5	Concentration	• Load • Indicator of oxygen-demanding material	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Wildco Beta horizontal sampler/churn

5 Ninemile – Ninemile Creek at Route 48
Hiawatha, Velasko – Harbor Brook
Kirkpatrick, Dorwin, Spencer, Adams – Onondaga Creek
Ley – Ley Creek at Park
Sawmill – Sawmill Creek
Bloody – Bloody Brook;
Trib5A – Tributary 5A at State Fair Boulevard
Metro - Outfalls 001 and 002
EF – Allied East Flume
Outlet - Onondaga Lake outlet at 2 ft and 12 ft depths

Table 4. Detailed Reporting of AMP Program. (continued)
E. Tributary Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Frequency Sampling Interval	Method
Carbon: TOC, TOC-F, TIC	Concentration	• Trends • Trophic status • Oxygen demand • Load	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Chlorophyll-a	Concentration	Boundary condition for river model	Outlet	Biweekly (January-December)	Discrete samples at 2 ft and 12 ft
Cyanide	Concentration	Compliance	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Quarterly High flow events as occur	Depth Integrated Sampling Techniques
Metals: Cd, Cr, Cu, Ni, Pb, Hg, Zn, As, K	Concentration	• Compliance (if AWQS) • Load • Data quality (K used in charge balance)	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody Spencer location monitored for K only	Quarterly High flow events as occur	Depth Integrated Sampling Techniques

Table 4. Detailed Reporting of AMP Program. (continued)
E. Tributary Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Frequency Sampling Interval	Method
Metals/Salts: Ca, Na, Mg, Mn, Fe, Cl, SO4, SiO2	Concentration	• Compliance (if AWQS) • Load • Data quality (major ions used in charge balance) • Geochemical analysis	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody Spencer location monitored for Ca, Na, Mg, Cl and SO_4 only	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Nitrogen: TKN, NH_3-N, Org-N, TKN-Filtered	Concentration	• Trends • Support TMDL • Load	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Spencer; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Nitrogen: NO_3, NO_2	Concentration	• Compliance with AWQS • Load • Trends	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Phosphorus: TP, SRP, TDP	Concentration	• Trends • Support TMDL • Load • Bioavailability	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques

Table 4. Detailed Reporting of AMP Program. (continued)
E. Tributary Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Frequency Sampling Interval	Method
Solids: TSS, TDS	Concentration	Compliance with AWQS	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Turbidity	Concentration	Transport dynamics	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	Depth Integrated Sampling Techniques
Field data: pH, Temperature, Salinity, Specific conductance, Redox potential, dissolved oxygen	• Fish-space metrics	• Compliance • Model support • Trend analysis. • Use attainment.(habitat) • pH indicator of CO2 production and decomposition.	Routine: Ninemile; Hiawatha; Velasko; Kirkpatrick; Dorwin; Spencer; Adams; Ley; Trib5A; Metro; EF; Outlet High flow: Routine plus Sawmill and Bloody	Biweekly (January-December) High flow events as occur	
Stream benthic Macroinvertebrates (BMI) & Stream Characteristics	• NYSDEC water quality Index • NRCS Visual Stream Assessment Protocol	Change from baseline conditions	4 sites in Onondaga Creek 3 sites in Ley Creek 3 sites in Harbor Brook	BMI: every other year, from 1998 – 2012 Stream mapping: baseline assessment in 2000 and 2002, to be repeated in 2008 and 2012	Various methods, most BMI collected using kick screens

Table 4. Detailed Reporting of AMP Program. (continued)
F. Seneca River Program Summary

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
BOD-5	Concentration	• Indicator of oxygen-demanding material • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
Carbon: TOC, TDC	Concentration	• Trends • Trophic status • Indicator of oxygen-demanding material • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
Chlorophyll-*a*	Concentration	• Trophic status • Trends • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	Through the water column. Tube composite through the photic zone and a grab at 1-meter above the river sediments.	Monthly (July – September)	Tube sampler "Depth Integrated Tube samples"
			Buoy 316 (Seneca River)	Upper waters: 0.86m Lower waters: 3.80 m	Daily at 15 minute intervals (April- Nov)	YSI Buoy

Table 4. Detailed Reporting of AMP Program. (continued)
F. Seneca River Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Metals/Salts: Cl	Concentration	• Trends • Geochemical analysis • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
Nitrogen: TKN, NH3-N, TKN-Filtered, NO3, NO2	Concentration	• Compliance • N dynamics • N:P ratios • Trends • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
Phosphorus: TP, SRP, TDP	Concentration	• Trophic status and algal productivity • Trends • Model support	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
Solids: TSS, VSS	Concentration	• Trends • Model support • Indicator of water clarity	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July –September)	Wildco Beta horizontal sampler

Table 4. Detailed Reporting of AMP Program. (continued)
F. Seneca River Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
Turbidity	Light scattering (NTU)	• Trends • Model support • Indicator of water clarity	16 sites (Seneca, Oneida & Oswego Rivers)	1 meter below water surface 1 meter above the river sediments	Monthly (July – September)	Wildco Beta horizontal sampler
			Buoy 316 (Seneca River)	Upper waters: 0.86m Lower waters: 3.80 m	Daily at 15 minute intervals (April- Nov)	YSI Buoy
Field data: pH, Temperature, Salinity, Conductivity, Dissolved Oxygen, ORP	Concentration	• Compliance • Stratification regime. • Trends • Ammonia toxicity. • Redox status • pH indicator of CO2 production/decomposition. • DO indicator of suitability of aquatic biota/zebra mussel activity. • Support river model and evaluate assimilative capacity	16 sites (Seneca, Oneida & Oswego Rivers)	0.5 m increments	Monthly (July – September)	YSI (in-situ)
			Buoy 316 (Seneca River)	Upper waters: 0.86m Lower waters: 3.80 m	Daily at 15 minute intervals (April- Nov)	YSI Buoy
Secchi Disk Transparency		• Model support • Indicator of water clarity • Use attainment	16 sites (Seneca, Oneida & Oswego Rivers)	Depth at which the disk is no longer visible from the surface		Secchi Disk

Table 4. Detailed Reporting of AMP Program. (continued)
F. Seneca River Program Summary (continued)

Parameter	Data Analysis and Reporting	Data Interpretation Strategy	Sites	Depths	Frequency Sampling Interval	Method
LiCor Underwater Illumination Profile		• Trends • Model support • Indicator of water clarity	16 sites (Seneca, Oneida & Oswego Rivers)	Licor data – 20 cm intervals from river surface to depth at which light is 1% of surface illumination	Monthly (July – September) & with diurnal cycles	LiCor Datalogger

3.3. Design of the AMP: Underlying Assumptions

Design of the AMP builds on decades of monitoring within the lake and its watershed. Several important assumptions underlie the monitoring program; these assumptions are based on analysis of the historical data and mass-balance calculations. Among the assumptions are:

- South Deep is representative of lake-wide conditions.

  This assumption has been evaluated by comparing data collected at North Deep on a quarterly frequency with the South Deep data. A t-test of paired samples was used to compare data from 1999-2007. There is no systematic difference in trophic status indicator parameters (chlorophyll-a, phytoplankton biomass, and Secchi disk transparency) measured at North and South Deep. Of the other parameters, the N species and Fe are higher at South Deep, which is likely due to the Metro discharge. Fecal coliform bacteria are higher at South Deep; this is attributed to the proximity of major sources (storm water and CSO discharges). Specific conductance and pH were higher at North Deep, likely reflecting the influence of Ninemile Creek. (Appendix 10, 2007 AMP report)

- External loading to the lake is assessed by monitoring discharge and concentration of six tributaries plus Metro effluent. In total, approximately 95% of the water flow into the lake is gauged and sampled. It is assumed that this monitoring is sufficient to provide a robust estimate of external loading.

  This assumption was tested in 2003, when storm event samples were obtained from two small streams draining the nearshore (ungauged) portion of the watershed. The concentrations of monitored parameters in the two streams, Bloody Brook and Sawmill Creek, were less than or comparable to concentrations measured in the gauged streams. With the very low flow contribution, it was determined that the loading from the

nearshore (ungauged) portion of the lake watershed was minimal. That is, the ungauged areas do not contribute a disproportionate load given their drainage area.

- Deposition onto the lake surface (including precipitation and dry fall) accounts for a small fraction of the total external nutrient load and can be adequately characterized from regional data.

  The mass balance framework developed by Dr. William Walker provides a basis for evaluating the magnitude and importance of precipitation within the lake's phosphorus budget. The lake surface area comprises a very small fraction of the overall drainage basin, and precipitation onto the lake surface represents about 2% of the total water inflow. The concentration of phosphorus in rainwater is variable, but typically well below the concentrations measured in the tributary streams, and an order of magnitude less than the concentration in the Metro effluent. Again looking to Dr. Walker's mass balance framework, precipitation represents < 1% of the total P loading to the lake assuming the regional average TP concentration in precipitation of 30 µg/l. Doubling this estimated concentration still represents less than 1% of the current total annual TOP load; for this reason site-specific sampling has not been recommended. The magnitude and importance of atmospheric loading of mercury has not been quantified as part of the AMP.

- Groundwater does not represent a significant component of the lake's hydrologic budget.

  This assumption can be examined by evaluating the extent to which water and chloride models show reasonable agreement between inputs, outputs, and retention in the lake. Onondaga Creek is influenced by groundwater seepage into the downstream reaches just above the Inner Harbor. Likewise, groundwater flux into Ninemile Creek has been documented. A chloride model of the lake, assuming no groundwater contribution, was

constructed (Doerr et al. 1994) and predicted measured concentrations within about 5%. This implies that groundwater input to the lake is likely a minor component (<5%) of the hydrologic budget.

- Water quality of the lake may be adequately characterized by examining the lake as a two-layer system during the period of thermal stratification, which typically extends from late May through late October. Furthermore, the photic zone does not extend into the lower water layer.

  This assumption will be examined through the Onondaga Lake modeling project, which began in 2005.

3.4. Design of the AMP: Hypothesis Testing and Statistical Power

The elements of the monitoring program were distilled into a series of testable hypotheses. This work product was used as a basis for evaluating the AMP design, allowing the project team and the advisors to determine whether the correct parameters were being measured. A summary of the hypotheses for elements of the monitoring program is presented in **Table 5**. There are three types of hypotheses to be tested using data generated by the AMP:

- Is Onondaga County in compliance with the effluent limits required by the State Pollution Discharge Elimination System (SPDES) permit?
- Have ambient water quality standards or guidance values in the receiving water been met?
- Is there a trend or shift in the monitoring data, in both water quality and biological programs?

It is evident from the list of hypotheses that a major focus of the AMP is to differentiate actual trends from natural variability. OLTAC member Dr. William W. Walker Jr. examined the historical monitoring data to characterize the variability of the parameters

used to assess progress (for example, concentrations of ammonia-N, bacteria, chlorophyll-a at the lake's South Deep station). The AMP design was then evaluated to determine what magnitude of "true" change in concentration could be detected at a given level of statistical certainty. The AMP was modified to increase the monitoring frequency for certain parameters that are highly variable (e.g. chlorophyll-a). For the majority of lake water quality parameters the biweekly sampling program was found to be adequate. Dr. Walker summarized his analysis of the power of the water quality monitoring program in the Phase 1 Statistical Framework (January 1999) and an updated Phase 1 Statistical Framework (January 2002). His report evaluating the design of the biological programs and their power to detect change was issued as the Phase 2 Statistical Framework (February 2000) and an update to the Phase 2 Statistical Framework (August 2002).

Dr. Walker has updated the statistical framework for both the water quality and biological programs using recent data. The update was structured to reference these specific hypotheses.

Table 5. Summary of Hypotheses Underlying the AMP.

Monitoring Parameter	Hypothesis	Type of Hypothesis			Data Used for Assessment
		Compliance with SPDES permit	Compliance with AWQS or guidance value	Significant Trend or Shift in Monitoring Data	
Ammonia-N	Improvements at Metro enable the County to meet Stage III effluent limits for ammonia N	*			Outfall 001 effluent concentrations, calculated for summer and winter (seasonal limits apply)
	Reduced ammonia load results in compliance with ambient water quality standards and federal criteria for ammonia in Onondaga Lake		*	*	South Deep station, biweekly monitoring, discrete samples collected at 3-m intervals, with temperature and pH
Nitrite-N	Achievement of Stage III effluent limits for ammonia results in compliance with the NYS ambient water quality standard for nitrite (warm water fish community)		*	*	UML, LWL composite samples, biweekly at South Deep
Phosphorus	Improvements at Metro enable the County to meet final SPDES effluent limits (as set forth in a revised TMDL on or before Jan 1 2009)	*			Outfall 001 effluent concentrations
	Reduced phosphorus load from Metro reduces concentration of phosphorus in Onondaga Lake		*	*	South Deep station Biweekly monitoring TP, SRP and TDP, discrete samples collected at 3-m intervals
	Reduced phosphorus load from Metro brings the lake into compliance with guidance value (or site-specific guidance value)		*	*	TP at South Deep, 1-m depth (biweekly measurements, June – Sept)

Table 5. Summary of Hypotheses Underlying the AMP. (continued)

Monitoring Parameter	Hypothesis	Type of Hypothesis			Data Used for Assessment
		Compliance with SPDES permit	Compliance with AWQS or guidance value	Significant Trend or Shift in Monitoring Data	
Dissolved Oxygen	Improvements at Metro enable the County to meet interim effluent limits for BOD	*			Outfall 001 effluent concentrations
	Improvements at Metro and related nonpoint source phosphorus load reductions bring the lake into compliance with NYS AWQS for DO during fall mixing.		*	*	Weekly or biweekly measurements through water column and high-frequency measurements at buoy at South Deep station
	Improvements at Metro and related nonpoint source phosphorus load reductions reduce the volume-days of anoxia and hypoxia.			*	Weekly or biweekly measurements through water column and high-frequency measurements at buoy at South Deep station
	Improvements at Metro and related nonpoint source phosphorus load reductions reduce the areal hypolimnetic oxygen depletion rate.			*	Weekly or biweekly measurements through water column and high-frequency measurements at buoy at South Deep station
Indicator bacteria	CSO remedial measures and improved stormwater management reduce the loading of fecal coliform bacteria entering the lake from tributaries during high flow conditions.	*		*	Storm event data: baseline and post-improvement rating curves for fecal coliform bacteria (load as a function of total precipitation, and total storm flow)
	Implementation of Stage I and II improvements to the wastewater collection and treatment system (including CSO projects) and progress with stormwater management will reduce concentration of indicator organisms in Onondaga Lake	*	*	*	Indicator bacteria abundance at nearshore stations during summer and following storms. Annual average concentration at South Deep, 0m depth

Table 5. Summary of Hypotheses Underlying the AMP. (continued)

Monitoring Parameter	Hypothesis	Type of Hypothesis			Data Used for Assessment
		Compliance with SPDES permit	Compliance with AWQS or guidance value	Significant Trend or Shift in Monitoring Data	
Chlorophyll-*a*	Metro improvements and watershed phosphorus load reductions result in lower chlorophyll-a concentrations in the lake.			*	Weekly or biweekly measurements at South Deep, photic zone and UML
Secchi disk transparency	Metro improvements and related nutrient load reductions result in improved water clarity (as measured by Secchi disk transparency) in Onondaga Lake			*	Weekly or Biweekly measurements at South Deep and nearshore stations.
Phytoplankton community	Metro improvements and watershed phosphorus load reductions result in lower biomass of phytoplankton in Onondaga Lake			*	Biweekly samples of UML phytoplankton community, numbers, size and identifications (PhycoTech)
	Metro improvements and watershed phosphorus load reductions result in reduced relative abundance of cyanobacteria to the lake's phytoplankton community (measured by percent of total biomass)			*	Biweekly composite samples of UML phytoplankton abundance, biomass, and ID (PhycoTech)
Zooplankton community	Metro improvements and watershed phosphorus load reductions reduce the biomass of zooplankton in Onondaga Lake by reducing the algal food supply			*	Biweekly composite samples of UML and tow (0-15 m), zooplankton abundance, size, biomass, ID (Cornell)
Macroalgae	Metro improvements and watershed phosphorus load reductions result in reduced areal coverage of macroalgae in nearshore areas of Onondaga Lake			*	Weekly surveys during recreational period (June –Sept) at nine nearshore stations.

Table 5. Summary of Hypotheses Underlying the AMP. (continued)

Monitoring Parameter	Hypothesis	Type of Hypothesis			Data Used for Assessment
		Compliance with SPDES permit	Compliance with AWSQ or guidance value	Significant Trend or Shift in Monitoring Data	
Macrophytes	Metro improvements and watershed phosphorus load reductions indirectly result in increased areal coverage of macrophytes in the littoral zone of Onondaga Lake			*	Percent cover, biomass, and maximum depth of growth. Surveys: 2000, 2005, 2010 plus annual aerial photo evaluation (% cover)
	Metro improvements and watershed phosphorus load reductions indirectly result in increased number of macrophyte species in Onondaga Lake			*	Macrophyte species richness Detailed surveys: 2000, 2005, 2010
Littoral macroinvertebrates *Note: effects may be in strata 2, 3, and 4*	Implementation of load reductions at Metro and CSO remediation will increase species richness of littoral benthic macroinvertebrates			*	Littoral macroinvertebrate species richness. Detailed surveys: 2000, 2005, 2010
	Implementation of load reductions at Metro and CSO remediation will decrease the relative abundance of oligochaetes			*	Littoral macroinvertebrate dominance, percent oligochaetes. Detailed surveys: 2000, 2005, 2010
	Implementation of load reductions at Metro and CSO remediation will improve the NYSDEC Biological Assessment Profile as compared to baseline conditions.			*	NYSDEC calculated index Detailed surveys: 2000, 2005, 2010
	Implementation of load reductions at Metro and CSO remediation will improve the littoral macroinvertebrate HBI as compared to baseline conditions, indicating increased importance of pollution-sensitive organisms in the community			*	Hilsenhoff Biotic Index (HBI) Detailed surveys: 2000, 2005, 2010

Table 5. Summary of Hypotheses Underlying the AMP. (continued)

Monitoring Parameter	Hypothesis	Type of Hypothesis			Data Used for Assessment
		Compliance with SPDES permit	Compliance with AWQS or guidance value	Significant Trend or Shift in Monitoring Data	
Fish community	Implementation of nutrient load reductions at Metro and nonpoint sources, including CSO remediation, will indirectly increase the number of fish species present in Onondaga Lake			*	Annual monitoring program: Species richness, electrofishing, gill nets, seines
	Implementation of point and nonpoint nutrient load reductions will indirectly increase the number of fish species that are sensitive to pollution in Onondaga Lake			*	Annual monitoring program: Electrofishing, pollution tolerance index (Whittier and Hughes 1998)
	Implementation of point and nonpoint nutrient load reductions will increase the reproductive success of fish in Onondaga Lake			*	Annual monitoring program: Nesting survey, larval tows, larval light traps, littoral seines
	Implementation of point and nonpoint nutrient load reductions will improve the lake's IBI. Note effects may be more evident in Strata 2,3, and 4.			*	Annual monitoring program: Electrofishing
	Implementation of point and nonpoint nutrient load reductions will increase the habitat available for the coolwater fish community			*	Fish space metrics: dissolved oxygen and temperature profiles at South Deep station

3.5. Design of the AMP: Data Management

The AMP produces an extensive dataset; more than 20,000 water quality measurements are obtained each year in Onondaga Lake, its tributary streams, and the Seneca River. Dr. Walker has developed an integrated database to manage the data. This effort has resulted in a powerful tool for the County and other stakeholders to evaluate specific results by parameter, depth, and date. The database is also used to screen for outliers and test for trends; it generates plots for data exploration and reporting.

3.6. Design of the AMP: Metrics to Measure and Report Progress

Analytical and field data are submitted on a quarterly basis to the NYSDEC. Screened and validated data are provided annually and are included in the OCDWEP Annual AMP Report. The process of turning data into information occurs continually through the year and is formalized in the Annual AMP report. Results and findings of the complete monitoring effort are documented in this report is reviewed by OLTAC members and NYSDEC. The County is required to submit an approvable annual AMP report to NYSDEC by December 1 each year.

A series of metrics have been developed to organize and report the extensive AMP dataset. As defined by EPA, metrics are attributes of the physical, chemical and/or biological ecosystem that respond to human disturbance. For the Onondaga Lake watershed, metrics are designed to indicate progress towards compliance with applicable standards and guidelines, and progress towards attaining a desired use.

Selected metrics may relate directly to an impairment of the lake or watershed; relate to a resource of interest; or correspond to a published standard that, in turn, reflects the requirements of public health or the aquatic biota. Candidate metrics can be measured and interpreted with relative ease to answer basic questions such as: “is the lake getting better?” and “is it safe for my family to swim here?”

Metrics selected to interpret and report on the AMP data are listed in **Table 6**. Note that the metrics are grouped into categories that address human uses and ecosystem function:

(1) water contact recreation;

(2) aesthetics;

(3) aquatic life protection; and

(4) sustainable recreational fishery

Metrics for water contact recreation are straightforward: New York State Department of Health and EPA have standards and guidance values for indicator bacteria and water clarity that are designed to be protective of human health and safety. Selecting metrics for aesthetics is slightly more judgmental, as they relate to perceived attributes such as water color and clarity, odors, and the visible extent of weed and algal growth. Water quality conditions needed to support aquatic life are fairly well defined in federal criteria and state standards. Onondaga County AMP metrics are designed to track water quality and habitat conditions during critical periods for reproduction and survival of young animals.

Table 6. Summary of Metrics.

Desired Use	Metrics	Measured By
Water contact recreation	Indicator Bacteria	Fecal coliform bacteria abundance measured at stations within the Class B segment of Onondaga Lake (includes nearshore and North Deep station)
	Water Clarity	Secchi disk transparency at nearshore stations.
Aesthetics	Water Clarity	Secchi disk transparency at South Deep.
	Bloom frequency and magnitude	Percent of chlorophyll-*a* measurements greater than 15 µg/l (USEPA threshold for public perception as impaired for recreational use)
		Percent of chlorophyll-*a* measurements greater than 30 µg/l (threshold for public perception of nuisance bloom).
	Algal community structure	Percent of algal community represented by cyanobacteria (blue-green taxa)
	Macroalgae proliferation	Percent cover of littoral zone, measured at nine nearshore stations June 1 – August 31 annually
Aquatic Life Protection	Ammonia N	Percent of measurements in compliance with standards.
	Nitrite N	Percent of measurements in compliance with standards.
	Dissolved Oxygen	DO at fall mixing.
		Duration of DO concentrations < 4 mg/l (data source: measurements at 15-minute intervals from probe on buoy)
	Integrated metrics	"Fish space" metrics, volume-days with suitable conditions of DO and temperature for cold water and cool water fish communities *(Note: this metric does not account for other requirements such as habitat and forage base)*
	Species assemblage	Percent intolerant or moderately intolerant of pollution
Fish Reproduction	Number of species with documented reproduction and recruitment[6]	Nesting surveys, larval sampling (Miller tows), young-of-year sampling (littoral and pelagic) adult survey (electrofishing, gill netting), hydroacoustical survey.
	Habitat quality	Percent cover of macrophytes: scaled to optimal level for largemouth bass (40 - 60% cover is target).

[6] Sampling captures young-of-the-year (YOY) fish in the lake. It is assumed that the majority of these small fish originated in the lake, given their size and limited mobility of the early life stages. However, the presence of YOY fish that originated in the Seneca River or tributaries to Onondaga Lake cannot be ruled out.

4. Data interpretation for the biological programs

Analysis and interpretation of the biological components of the AMP is challenging. There are no equivalent promulgated standards as cited for the water quality parameters. The plan for analysis and interpretation of the biological data is primarily focused on changes over time. There are also limited comparisons with reference systems such as Oneida Lake, and comparisons to benchmark conditions considered desirable for various functions and values of the aquatic ecosystem.

One way to interpret the fish data is to compare the current community to the fish community present in Onondaga Lake at two critical periods: (1) during the early years of European settlement, and (2) during the early 1960s. The nature of the early fish community can provide insight into the natural condition, while the community during the 1960s likely represents the worst conditions of water quality and habitat degradation.

However, the biological data, including fish, must be evaluated with respect to the rest of the ecosystem. For example, the reproductive success of some fish species is influenced by macrophyte coverage, planktivorous fish can alter zooplankton community assemblages, and zebra mussels can alter trophic interactions. In order to fully understand and interpret changes to one aspect of the biological community it is necessary to describe the biological components that interact and influence the community in question. This important effort will continue as the AMP progresses through 2012.

4.1. Sampling design

Biological sampling in Onondaga Lake occurs both nearshore (fish, macroinvertebrates, macrophytes) and offshore (larval fish, zooplankton, phytoplankton). Because of the variability of the lake's nearshore habitat conditions, the littoral habitat was divided into five strata based on a combination of substrate type and wave energy, both of which influence aquatic macrophytes and macroinvertebrates and, in turn, fish distribution. These five strata are displayed in **Figure 2**:

Stratum 1. Oncolite substrate with low wave energy (NW portion of the lake).

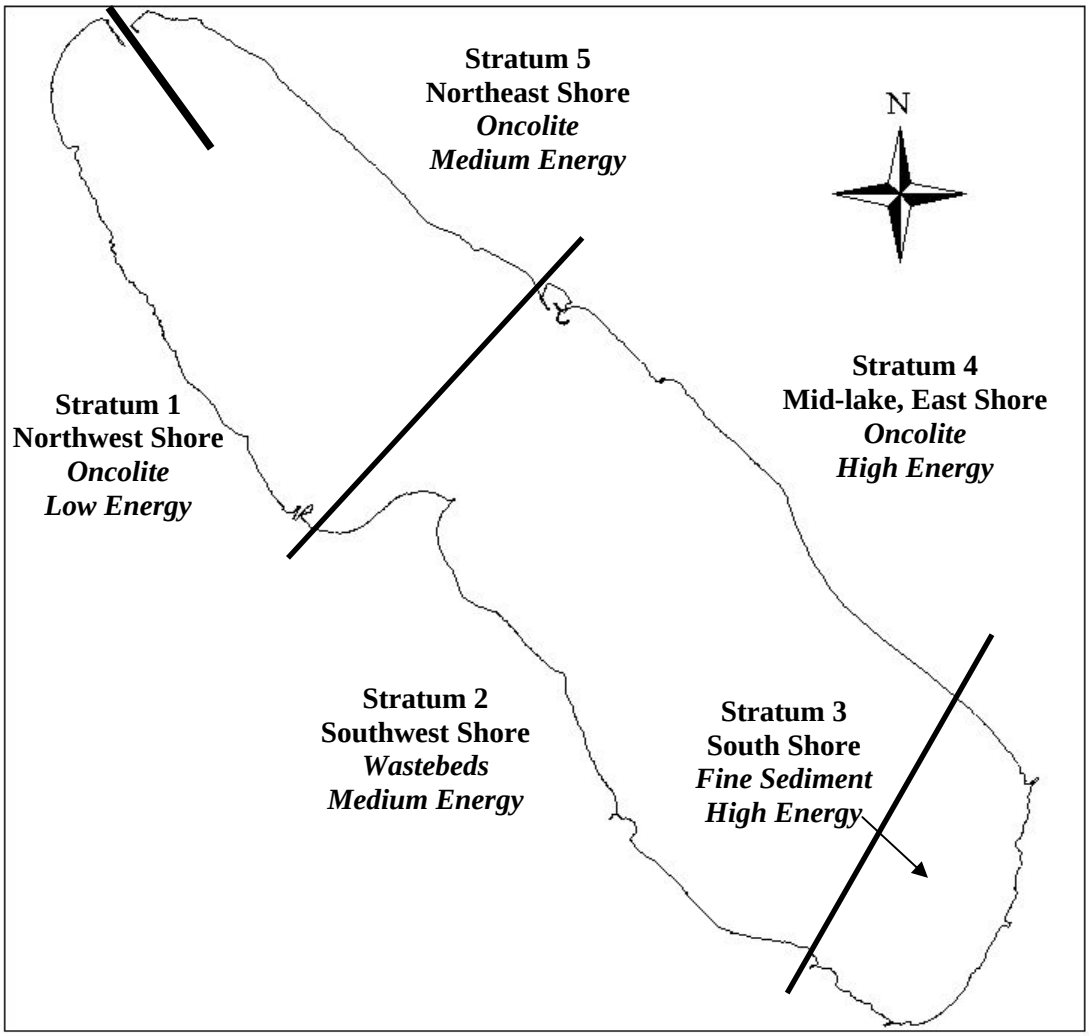
Stratum 2. Wastebed substrate with moderate wave energy (SW shore)

Stratum 3. Soft substrate with high wave energy (South end)

Stratum 4. Oncolite substrate with high wave energy (SE shore)

Stratum 5. Oncolite substrate with medium wave energy (NE shore)

The current schedule for biological monitoring through the 15-year AMP program is summarized in **Table 7**. This schedule may change as completion dates for CSO projects become firm or new issues arise. This table will be updated with subsequent revisions of the DAIP.



Strata Boundaries	**Figure 2**. Map of Onondaga Lake showing boundaries of five sampling strata based on a combination of sediment texture and wave energy.

Table 7. Summary of Schedule and Methodologies Used for the Biological Monitoring Program *(Subject to annual NYSDEC review and approval; last updated March 2005)*

Program	Component	Methods	Schedule	Comments
Fish	Adult	Littoral Electrofishing	Annual	Entire lake shoreline, transects alternate between collecting all fish encountered and gamefish only, 2 surveys; May, Sept.
		Littoral-profundal Gill Nets	Annual	One net each stratum, set on bottom at 5m depth, 2 events; May, Sept.
		Angler Diaries	Annual	Dependant on number of diaries returned
	Young-of-the-Year	Littoral Seines	Annual	15 sites, three sites per stratum, every 3 weeks, May-Oct, 8 events total
	Larvae	Pelagic Miller High Speed Trawls	Annual	Daytime samples, 4 transects N/S, oblique tows, ~surface to 5m depth, bi-weekly, May-Aug., 8 events total
	Nests	Visual Observation	Annual	Entire Shoreline, June
Macroinvertebrates	Lake Littoral Zone	Petite Ponar	2000 2005 2010	Five sites, one in each stratum, June, 18 replicates, identified to species level
	Tributary	Kick Net and Jab Net	Bi-annual	Four sites in Onondaga Creek, three sites in Ley Creek and Harbor Brook, July samples, 4 replicates, identified to species level
	As part of Tributary Mapping	Kick Net	2000 2008 2012	One site per mile of stream, 26 sites in Onondaga Creek, 9 in Ley Creek, 7 in Harbor Brook, one sample per site, identified to family level in the field
Macrophytes	Field Survey	Quadrats along Line Transects	2000 2005 2010	20 line transects, four per stratum, $1/2m^2$, quadrats spaced every other m along the transect, from shore to 6m depth, species presence, percent coverage and biomass, August
	Lakewide Survey of Cover	Aerial Survey	Annual (if water clarity permits)	Low altitude aerial photographs of entire lake, color film, digital images. Includes ground-truthing. Images are imported to GIS and areas of macrophyte growth delineated.

Table 7. Summary of Schedule and Methodologies Used for the Biological Monitoring Program. (continued)

Program	Component	Methods	Schedule	Comments
Zooplankton	Lake	Vertical Net Haul	Annual	Bi-weekly at South Deep, April to Nov., Quarterly at North Deep, UML sample plus 15m vertical net haul. Winter sampling if possible.
Phytoplankton	Lake	Tygon tube	Annual	Bi-weekly at South Deep, April to Nov., Quarterly at North Deep, UML sample. Monthly in winter, as conditions allow

4.2. Species Data

Species data collected during the biological monitoring programs are used to evaluate pollution tolerance of the biological community, the presence of exotic or invasive species, nuisance species that affect best usage of the lake, and evaluate the status of those species highlighted in the ACJ.

- Pollution tolerance. Organisms have varying degrees of sensitivity to disturbances in their environment. Those most sensitive to disturbance are the first to be extirpated and the last to re-colonize. Dominance and distribution of pollution-tolerant or pollution-sensitive organisms can indicate relative degree of impact between locations. Changes in the distribution of these communities can be tracked over time. The AMP utilizes several ways of examining pollution tolerance, including metrics specifically derived to quantify this property of the community (**Table 8**).

- Exotic/invasive species. Onondaga Lake is directly connected to the Barge Canal system, therefore it is highly susceptible to invasion by exotic species. Invasive species often take advantage of disturbance to establish populations. Once established they can dramatically alter habitat, water quality, and trophic structure. The AMP has detected the early stages of invasion of several important species. For example, the exotic zooplankton Cercopagis pengoi was first detected in Onondaga Lake during routine sampling in 2000. Once exotic species are

detected, the program can be tailored to track their progress and effects on the ecosystem.

- Associated with nuisance conditions. Some species can be considered to be a nuisance to humans. Some of these are directly perceptible, such as blue-green algal blooms, others become apparent to lake users through indirect effects in the food web. For example, the recent dramatic increase in the fish species alewife (Alosa pseudoharengus) has reduced the population of large-sized zooplankton (their preferred food source) in the lake; this reduction in large-sized zooplankton decreased the effective grazing pressure on algae. As a result, water clarity has declined.

- Included in management/rehabilitation plan. Some species have special meaning within the context of the ACJ and/or future management plans. This is most common with the fish program. For example, the ACJ states the County should "evaluate the success of walleye, bass and sunfish propagation (quantitative lakewide nest surveys, survival and recruitment estimates, and juvenile community structure) in the lake" (ACJ Appendix D, IV.5). These species are given special consideration within the biological monitoring program.

Table 8. Summary of Pollution Tolerance Metrics Used for the Biological Monitoring Program.

Program	Component	Pollution Tolerance Metric	Comments
Fish	Adult	Pollution Tolerance Index	Based on the Index published by Whittier and Hughes (1998). These investigators compiled data from 169 lakes to develop an overall rating based on tolerance to eutrophication, turbidity, human activity in the watershed and species introductions. Their tolerance categories include: intolerant, moderately intolerant, moderate, moderately tolerant, and tolerant.
		Indicator Species	Indicator species are those that can be used to assess environmental condition. Presence of organisms known to be tolerant or sensitive to environmental degradation offer important information. Adult fish as indicator species are most useful if populations exist and are less useful if only a few individuals are encountered.
	Young-of-the-Year	Indicator Species	Young-of-the-year organisms are excellent indicators of environmental change, as the early life history stages are usually most susceptible to disturbance and pollution.
Macroinvertebrates	Lake Littoral Zone & Tributary	NYSDEC Biological Assessment Profiles	NYSDEC Biological Assessment Profiles are an Index of Biotic Integrity developed specifically for macroinvertebrates in New York State. An overall assessment of water quality for each site is calculated by averaging results of four individual metrics obtained through a scaled ranking of the index values. After all index values for a site are converted to a common scale value, they are averaged to obtain a score denoting overall assessment of water quality. The score results in a designation of one of four categories: non-impacted, slightly impacted, moderately impacted, or severely impacted.
		HBI	The Hilsenhoff Biotic Index (HBI) is considered by many investigators to be the most reliable index of composition of the macroinvertebrate community and water quality status (Novak and Bode 1992). HBI indicates the effects of organic pollution and is based on species-specific tolerance levels.
		Percent Oligochaetes	As oligochaetes are often found in high relative proportions in areas impaired by organic enrichment, their percent contribution to the community can be a good measure of the relative amount of organic enrichment at different locations. More importantly, the change in the percent contribution of oligochaetes over time, will be a good measure of the change in organic enrichment at the study sites.

Table 8. Summary of Pollution Tolerance Metrics Used for the Biological Monitoring Program. (continued)

Program	Component	Pollution Tolerance Metric	Comments
Macroinvertebrates (continued)	As part of Tributary Mapping	FBI	The Family Level Index (FBI) is based upon the tolerance values and theories the HBI but is conducted in the field with family level identifications.
Macrophytes	Field Survey	Indicator Species	Determination of environmental impact based on macrophytes is difficult. However some species have known tolerances to water quality variables. For example *Potamogeton pectinatus* (a species that has been common in Onondaga Lake since at least the early 1990's) is more tolerant of salinity than many other macrophytes. Knowledge of these types of tolerances can help in understanding the current lake community as well as the changes that occur.

4.3. Population Data

Population data collected during the biological monitoring programs are used to evaluate individual size, abundance and reproductive success in Onondaga Lake and the tributaries.

- Average size of individuals. Size of individuals is monitored for fish and zooplankton in the AMP. The size that animals attain is a function of both the genetics of the organism as well as the environmental conditions the organism has been subjected to throughout its life. Changes in the ecosystem are often reflected by changes in growth, thus making analysis of size of certain organisms a potential valuable monitoring tool. For example, growth may be density dependant, so populations with poor recruitment may be characterized by fast-growing individuals. In addition, the size structure of some organisms can have dramatic cascading effects throughout the trophic structure of the lake. Average size of some organisms can also be compared to other regional lakes.

- Abundance. Abundance measures are difficult to quantify in biological populations due to their inherent spatial and temporal variability. However,

changes in abundance can provide useful information in the AMP because change in population size is the mechanism underlying changes in many community metrics. Expected changes in abundance due to improving water quality or habitat may not always be positive. Some species exploit disturbed conditions and their abundance can be expected to decrease with improving conditions. As the dynamics of the lake community change, the lake will become more hospitable to some species and less to others, gradually abundance of species will change to reflect the new lake condition.

- Reproductive success. Monitoring reproduction and recruitment of the fish community is particularly useful because the early life history stages are often very sensitive to disturbance. Reproductive success is affected by both biotic and abiotic factors. For example, reduction in ammonia concentration in the water column during the spring is likely to increase survival of sensitive early life stages (abiotic factor). Any effects of improved water quality on the fish community will likely first be reflected in the early life history stages. However, the food web effects must also be considered. Predation by fish such as alewife will reduce survival of larval fishes (biotic factor). The AMP monitors nesting of fish, larval fish, and juveniles.

4.4. Community Data

Community data collected during the biological monitoring programs are used to evaluate richness, diversity, and relative abundance of indicator species in Onondaga Lake and the tributaries.

- Richness. Richness, the number of different taxa (usually species) found in a community, is calculated for all components of the biological monitoring program. Richness may not be correlated with water or habitat quality. In fact, richness can increase with disturbance; for example, invasive species may become established without eliminating native species. Richness measurements can be used to detect substantial changes in community structure, if the sampling effort is

held relatively constant. If changes in richness are detected, the underlying mechanism will be investigated to analyze the potential significance.

- Diversity. The distribution and abundance of different organisms, and how these attributes vary both spatially and temporally, play a major role in determining how an ecosystem functions to process energy and materials (Hooper et al. 2005). The numbers and types of organisms present (sometimes referred to as biodiversity) act together with the effects of climate, resource availability, and disturbance regimes to influence ecosystem properties (Hooper et al. 2005). Species composition, richness, evenness, and interactions respond to and influence ecosystem properties (Hooper et al. 2005). A high biodiversity can be interpreted as indicating functional stability (Karr 1968, Margalef 1968, Odum 1969). Biodiversity can be expressed in terms of numbers of entities (how many genotypes, species, or ecosystems), the evenness of their distribution, the differences in their functional traits, and their interactions (Hooper et al. 2005).

  The Onondaga Lake biological monitoring program utilizes the Shannon-Weiner diversity index as a measure of biodiversity. Shannon-Weiner diversity is a function of both the number of species present (richness) and the equitability of distribution of individuals within these species (evenness) (Washington 1984). Shannon-Weiner diversity is greatest when large numbers of taxa are represented in equal proportions. Shannon-Weiner diversity can help determine if disparity occurs between different sites within the same waterbody or over time. However, care should be taken to not compare Shannon-Weiner diversity values between waterbodies as this metric is expected to differ depending on size and connectedness of the waterbody. Shannon-Weiner diversity is usually utilized with other more descriptive indices that, taken together, can yield a more complete view of the community. This group of metrics is used to document change at the community level. If changes are observed, species-level information is examined to determine the source of those changes and whether they might be attributed to changes in habitat or water quality.

- Presence and relative abundance of indicator organisms. One important characteristic of macroinvertebrates is their differential tolerance to various types of pollution; these different tolerances can influence the species composition and relative abundance of organisms in stream segments affected by various types of pollution. Several indices have been developed to examine the macroinvertebrate community and infer water quality and habitat conditions. Benthic macroinvertebrates are good indicators of localized conditions due to their limited migration patterns and sessile mode of life.

  The tolerance of benthic macroinvertebrates to various types of pollution has been investigated, including organic (oxygen-demanding) waste, nutrients, sediment, salts, metals, and temperature. Both point sources and nonpoint sources (runoff) can cause these types of pollution to reach streams and rivers.

  The AMP includes two macroinvertebrate sampling efforts to evaluate if the stream biota changes as CSO improvements are brought on line. The first is the biennial tributary macroinvertebrate program; macroinvertebrates are collected and identified to the lowest possible taxon (ideally, the species level) at three or four sites on the CSO-affected streams (Onondaga Creek, Ley Creek, and Harbor Brook). The second effort is associated with the periodic stream mapping program; macroinvertebrates are collected and identified to family at one site per stream mile on the three CSO-affected streams. Results are used to calculate standard indices that assess whether a stream segment is impaired, and what type of pollution is most likely responsible.

5. MODELING

An integrated program of monitoring and modeling will provide the information needed to determine whether the improvements to Metro and the CSOs are sufficient to bring the surface waters (Onondaga Lake, the tributary streams, and a segment of the Seneca River) into compliance with state and federal requirements. Data from the AMP are used to construct and verify models. There are conceptual models of the lake and its watershed that describe how energy and materials cycle. Mathematical models, which are

quantitative formulations of mechanisms and interactions that affect water quality, are under development.

5.1. Conceptual Model

A conceptual model describes the interrelationships between physical, chemical, and biological characteristics of the lake and watershed; it provides a tool for interpreting data and understanding underlying mechanisms. The conceptual model also provides a valuable tool to evaluate the adequacy of the monitoring program itself and determine whether the appropriate questions are being asked of the ecosystem and the data set. Finally, the conceptual model provides the foundation for development of a predictive mathematical model.

A conceptual model of the phosphorus, nitrogen, and dissolved oxygen dynamics in Onondaga Lake was drafted by QEA, LLC and first presented in the Onondaga County 2001 Annual AMP report. Figures from the 2001 AMP Annual Report are included below:

- **Figure 3** is the phosphorus cycle
- **Figure 4** is the nitrogen cycle
- **Figure 5** is the dissolved oxygen (DO) cycle.

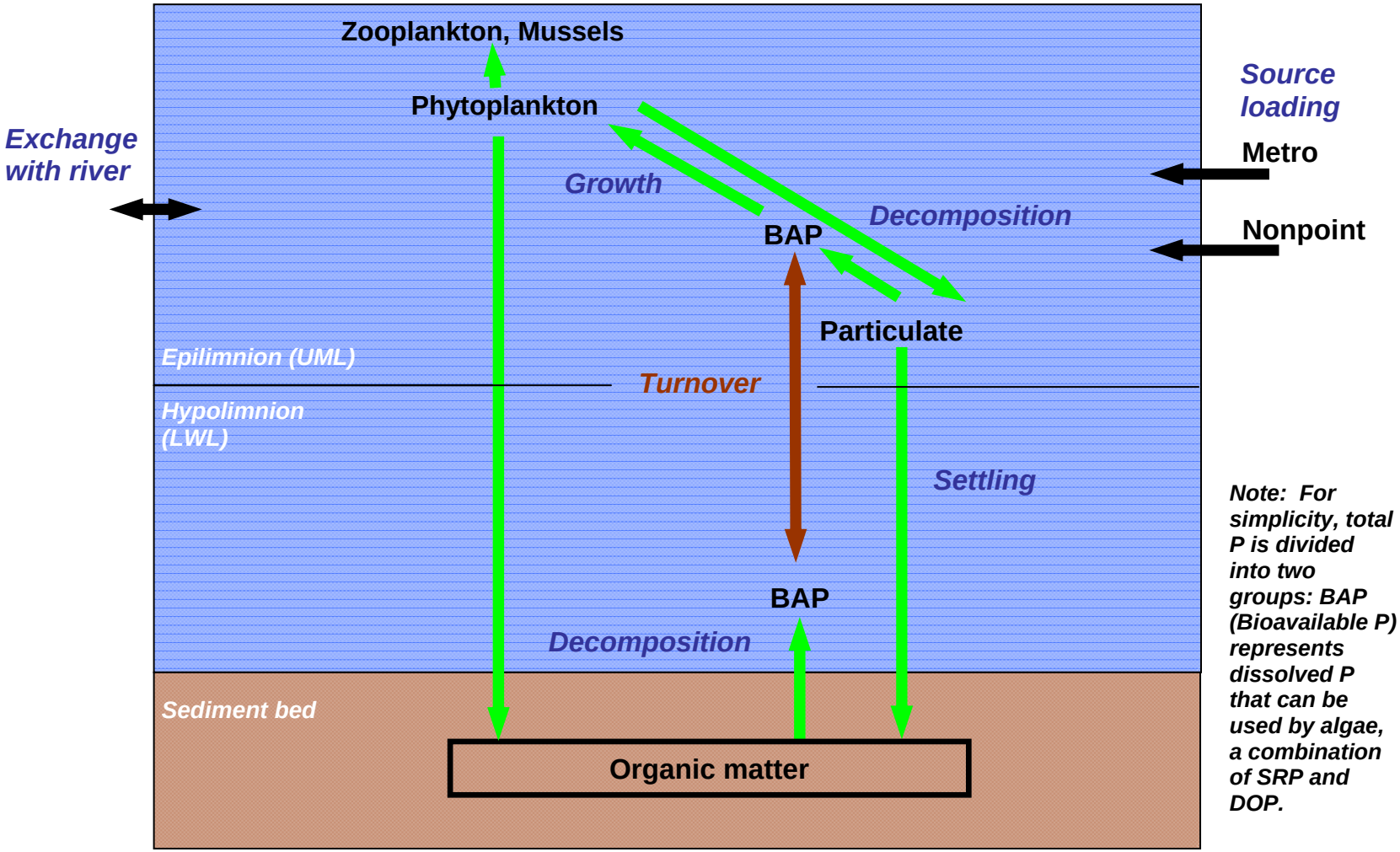


Figure 3. Conceptual model of phosphorus dynamics in Onondaga Lake under present conditions. Seasonal importance of primary pathways indicated by colors: Summer, Fall.

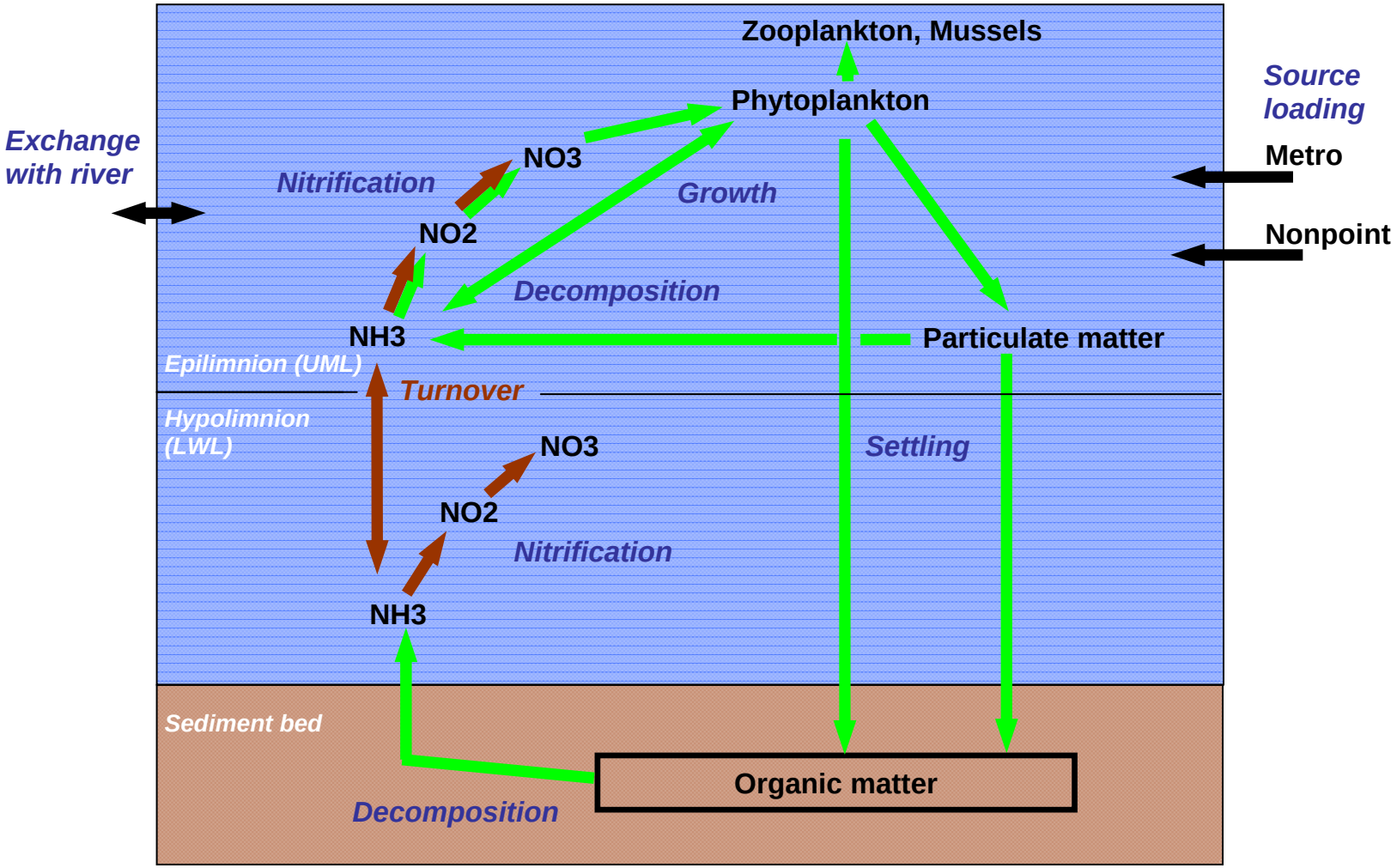


Figure 4. Conceptual model of nitrogen dynamics in Onondaga Lake under present conditions. Seasonal importance of primary pathways indicated by colors: Summer, Fall.

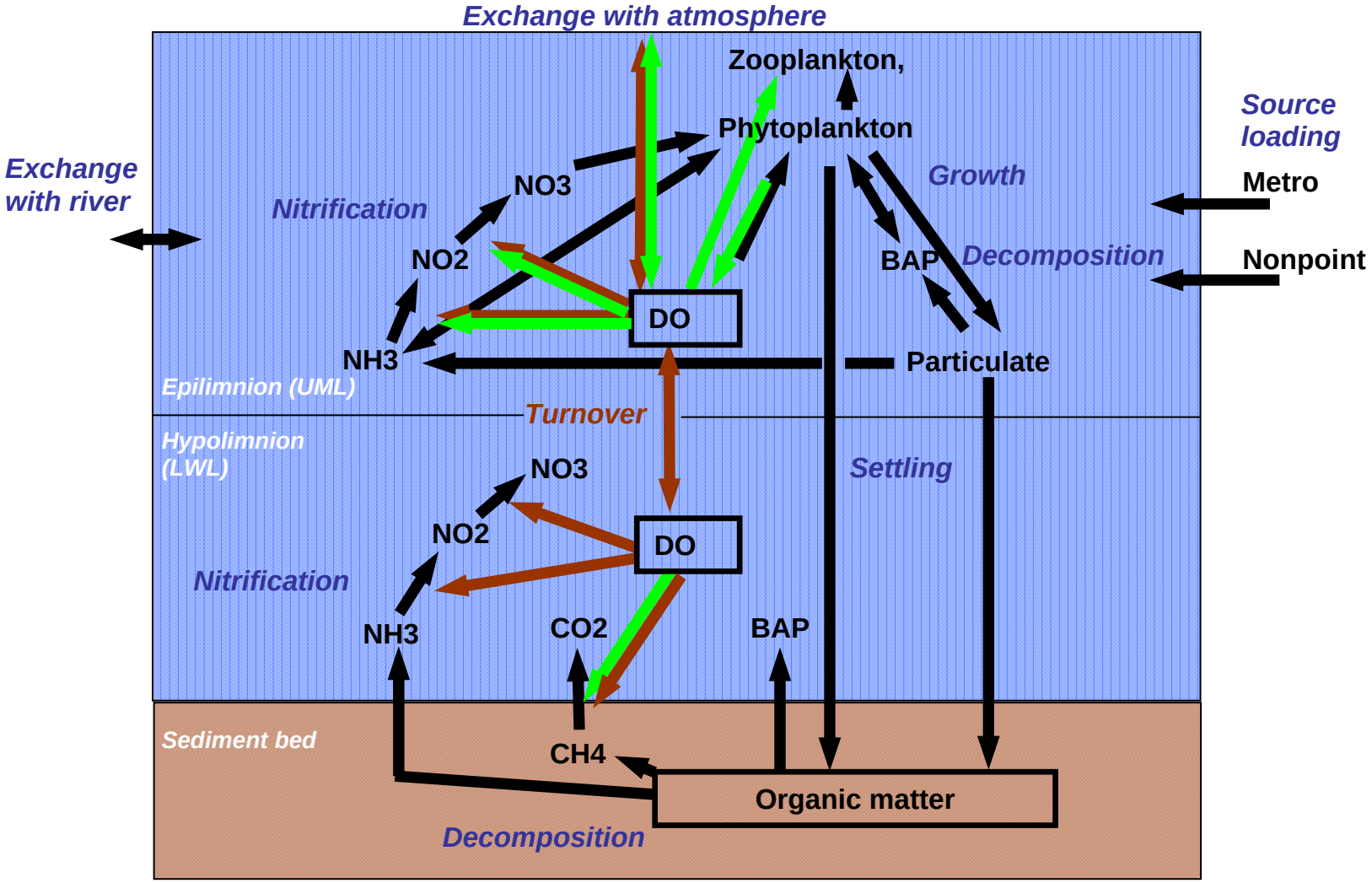


Figure 5. Conceptual model of dissolved oxygen dynamics in Onondaga Lake under present conditions. Seasonal importance of primary pathways indicated by colors: Summer, Fall.

5.2. Mass-balance Model

The development and structure of a mass-balance modeling framework for Onondaga Lake is described in the Onondaga County AMP Annual Reports. The framework facilitates computation and analysis of mass balances for nutrients and other water quality components using hydrologic and water quality data collected in the Lake and its tributaries since 1986. Lake water and mass balances are formulated on yearly and seasonal (May-September) time scales. Results provide a basis for:

1. Estimating the magnitude and precision of loads from each source;
2. Assessing long-term trends in load and inflow concentration from each source and source category (point, nonpoint, total);
3. Evaluating the adequacy of the monitoring program, based on the precision of loads computed from concentration and flow data;
4. Developing and updating an empirical nutrient loading model that predicts eutrophication-related water quality conditions (as measured by nutrient concentrations, chlorophyll-a, algal bloom frequency, transparency, and hypolimnetic oxygen depletion) as a function of yearly nutrient loads, inflows, and lake morphometry;
5. Developing simple input/output models for other constituents; and
6. Developing data summaries to support integration and interpretation of monitoring results in the County's annual AMP reports.

5.3. NYSDEC Total Maximum Daily Load (TMDL) Allocation

The ACJ requires that NYSDEC issue a revised Total Maximum Daily Load (TMDL) allocation for ammonia and phosphorus inputs to Onondaga Lake on or about January 1, 2009. The TMDL will define the total loading of ammonia and phosphorus that can be assimilated by the lake while maintaining compliance with water quality standards. The total required reductions in point and nonpoint source loading will be defined. To complete this task, NYSDEC requires a reliable model of how the lake responds to loading, plus an accurate allocation of the sources of ammonia and phosphorus.

5.4. USGS Onondaga Lake Watershed Model

One of the projects funded by the Onondaga Lake Partnership is a watershed model of the lake. USGS is developing this model which will be used to estimate nonpoint source loads of materials to Onondaga Lake under various hydrologic conditions and land use practices. The tributary loading estimates developed through the AMP are the basis for model calibration.

5.5. Three Rivers Water Quality Model (TRWQM)

A water quality model of the Three Rivers system was developed by QEA, LLC to assess the waste load assimilative capacity of the Seneca River. The model quantifies the River's assimilative capacity and accommodates respiration of zebra mussels, as set forth in the AMP Requirements (ACJ Appendix D, item IV.2). The model will serve as the basis for a TMDL allocation for oxygen-demanding materials and will be used to determine if diversion of Metro effluent to the Seneca River is a viable alternative.

Onondaga County funded development of the TRWQM. The model domain extends from Cross Lake to the Phoenix Dam. A peer review of the TRWQM has been completed.

The model simulates water quality conditions in the river in response to various environmental conditions, including upstream water quality conditions, point source discharges, water temperature, and zebra mussel growth.

5.6. Onondaga Lake Model

Onondaga County has completed a Request for Proposals and selection process for development of a water quality/eutrophication model of Onondaga Lake. QEA, LLC will complete the lake model that will be used for the NYSDEC TMDL allocation and final effluent limits. This water quality model will link the watershed model and the TRWQM. The model will be developed using data from the AMP and will be the primary means of determining the level of treatment and location of the Metro discharge. Model development will be a collaborative effort that includes Onondaga Lake Partnership as well as expert peer reviewers. While the primary focus is on water quality, the model will incorporate biological influences on the lake ecosystem. The overall goal will be to

develop a tool that can help assess water quality improvements from both the bottom-up effects (i.e. reduced loading of nutrients and organic material) and the top-down effects (i.e. food web interactions).

6. LITERATURE CITED

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Library Reference 2.8

Progress towards improvement tables

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Progress towards water quality improvement: Total Phosphorus. AMP 2008 Annual Report. (Guidance Value)

AMENDED CONSENT JUDGMENT GOAL

Achieve compliance with the applicable ambient water quality standard in the upper waters considering all watershed sources of phosphorus. Achieve phosphorus reduction sufficient to reduce the frequency and duration of nuisance algal blooms and eliminate turbidity as impairment to desired uses of the lake for water contact recreation, aesthetics, aquatic life protection and fish reproduction.

Hypotheses to be tested:	**Status:**
Improvements at Metro will enable the County to meet final effluent limits (as set forth in a revised TMDL on or before Jan 1, 2009)	• TMDL is under development.
Reduced phosphorus load from Metro reduces concentration of phosphorus in Onondaga Lake	• Phosphorus loading has been reduced from about 58 metric tons on average annually in the 1990's to 9.6 metric tons in 2008. • Phosphorus concentration in the lake's upper waters has been reduced from about 79 µg/L in the 1990's to 15 µg/l in 2008.
Reduced phosphorus load from Metro and the nonpoint sources brings the lake into compliance with the numerical TP guidance value 20 ug/l summer average, (or alternative, such as a site-specific guidance value or EPA ecoregional criteria, appropriate for this urban lake).	• The lake met the numerical TP guidance value of 20 µg/l summer average in 2008, with an upper waters summer average of 15 µg/l.

Current Conditions with Historical Comparison

Major Sources – Percent Contribution
(Annual Average (standard deviation); 1998 – Stage I Limit caps loading; 2005 – HRFS on-line in February)

Time Period	Metro and Bypass Effluent	Tributaries
1990-1997:	64% (13%)	36% (13%)
1998-2004:	59% (5.7%)	41% (5.7%)
2005-2007:	35% (7.4%)	65% (7.4%)
2008:	26%	74%

Upper Waters Concentration
(Annual Average (standard deviation))

Time Period	South Deep, 0-3 meters, Jun 1 – Sept 30 (µg/L)
1990-1997:	79 (23)
1998-2004:	53 (12)
2005-2007:	33 (7.9)
2008:	15

Compliance with NYS AWQS in Upper Waters

- *Narrative Standard: None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages*
- *Guidance Value: 20 µg/l summer average in upper waters*

Narrative standard met throughout 2008, as there were no nuisance algal blooms (chlorophyll-α >30 µg/l) measured in 2008.

Guidance value was met in 2008.

Factors Affecting Compliance: Hydrology, Metro performance, land use in watershed, CSO performance.

Progress towards water quality improvement: Total Phosphorus. AMP 2008 Annual Report. (Guidance Value) (continued).

Planned Load Reductions (1998 – 2012)	
Metro SPDES Permit Requirement	Stage I Limit: Cap on Loading • effective Jan. 1998 – April 2006 (completed) Stage II: effective April 2006 – Dec. 2012 • Metro effluent TP 0.12 mg/l (12-month rolling average) Stage III: effective Dec. 2012 • Metro effluent TP at 0.020 mg/l • Watershed nonpoint source reduction of approximately 50% (includes CSO) Or as modified based on revised TMDL (anticipated in 2009)
Monitoring and Assessment Program	
Loading Estimates *Annual County monitoring program*	• Biweekly tributary monitoring, supplemented with samples collected during high flow conditions • Storm event monitoring in tributaries • Daily measurements of Metro effluent
Lake Monitoring *Annual County monitoring program*	• Biweekly profiles in Lake of P fractions (TP, SRP, TDP), April – Nov, 3-meter intervals • Chlorophyll-α, Secchi disk transparency and LiCor measurements • Winter sampling as weather allows
Related Biological Monitoring	• Annual phytoplankton and zooplankton monitoring • Macrophyte survey every five years (began in 2000)
Tools for Decision Making	
Models	• USGS watershed model for Onondaga Lake Partnership • Onondaga Lake Water Quality Model (under development by QEA,LLC) • Mass balance TP framework and linked empirical eutrophication model (William Walker)
TMDL Allocations	NYSDEC Phase I TMDL 8/27/97; Phase II TMDL by January 2009
NYS AWQS and Guidance Value; Federal Criteria	Narrative standard Guidance value of 20 µg/l summer average upper waters Possible site-specific guidance value for TP EPA ecoregional criteria

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Progress towards water quality improvement: Chlorophyll-a. AMP 2008 Annual Report. (Narrative Standard, Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Reduction in average and peak algal biomass, and frequency and duration of bloom conditions as a result of reduced phosphorus loading from Metro, to achieve desired uses of the lake for water contact recreation, aesthetics and aquatic life protection.

Hypotheses to be tested:	**Status:**
Metro improvements and watershed phosphorus load reductions result in lower chlorophyll-a concentrations in the lake.	• 2005 – HRFS phosphorus treatment came on-line; reduced percent contribution of phosphorus to lake from 49% to 26%. • Chlorophyll-a concentrations have been below the nuisance bloom threshold (30 µg/l) during the summers since 2005.

Current Conditions with Historical Comparison

Major Sources	Internal algal production based on nutrients (phosphorus is limiting as of late 1990s), light, and temperature.

Upper Waters and Photic Zone Concentrations

(Summer= June 1 – September 30, Annual = January 1 – December 31; includes samples designated as "South", "Photic", "Epi", "UML", or "Tube", at depths ranging from 0 to 8 meters)

Time Period	Summer Average (µg/l) with Standard Deviation	Annual Maximum (µg/l) with Date Observed
1990-1997:	23.4 (14.6)	716.4 (07/11/1990)
1998-2004:	24.3 (4.66)	129.2 (04/30/2001)
2005-2007:	13.1 (3.85)	35.8 (03/28/2006)
2008:	5.55	15.5 (05/12/2008)

Compliance with NYS AWQS and Guidance Value

(No NY State standard or guidance value for chlorophyll-a. Narrative P standard references algal abundance at nuisance levels. Federal guidance based on ecoregion and reference lakes)

Time Period	Percent exceeding 15 µg/l (Perceived impairment)	Percent exceeding 30 µg/l (Nuisance bloom)
1990-1997:	49%	26%
1998-2004:	65%	31%
2005-2007:	29%	0%
2008:	0%	0%

Factors Affecting Compliance	Nutrients, light, temperature, grazing pressure, species composition

Planned Load Reductions (1998 – 2012)

Metro SPDES Permit Requirement	• No SPDES requirement for chlorophyll-a • Staged reduction in total phosphorus load from Metro • Staged implementation of CSO and watershed projects to reduce phosphorus loading from nonpoint sources

Monitoring and Assessment Program

Lake Monitoring *(Annual County monitoring program)*	• Weekly measurements at South Deep Station, May–September *Collected as depth-integrated tube samples through the UML of the water column and as photic zone (2x Secchi depth,) composites. The photic zone composites were discontinued in 2008. The UML depth is determined by the temperature profile; should no distinct thermocline be present, 0, 3, 6 meters in depth is the UML default.*
Related Biological Monitoring	• Phytoplankton community measurements biweekly April-November • Zooplankton community measurements biweekly April-November • Alewife monitoring by hydroacoustics

Tools for Decision Making

Model	• Onondaga Lake Water Quality Model (under development by QEA,LLC) • Mass balance TP framework and linked empirical eutrophication model (William Walker)
TMDL Allocations	Phosphorus - NYSDEC Phase I TMDL 8/27/97; Phase II TMDL by January 2009

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Progress towards water quality improvement: Secchi Disk Transparency. AMP 2008 Annual Report. (Guidance Value)

AMENDED CONSENT JUDGMENT GOAL

Eliminate turbidity as an impairment to use of the lake for water contact recreation. Improve water clarity to meet aesthetic quality and public bathing beach safety objectives.

Hypotheses to be tested:	**Status:**
Metro improvements and related nutrient load reductions result in improved water clarity (as measured by Secchi disk transparency) in Onondaga Lake	• Since the 1990's, there has been an increase in the percent of summer Secchi disk measurements that exceed 1.5 m at the South Deep station • Over the past ten years of monitoring at the nearshore stations, there has been an increase in the percent of summer Secchi disk measurements that exceed the NYS DOH 1.2 m safety guidance value for bathing beaches.

Current Conditions with Historical Comparison

Secchi Disk Transparency
(Jun 1 to Sep 30 average (standard deviation))

Time Period	South Deep Station (m)	Nearshore Stations (Class B & C) (m)
1990-1997:	2.1 (0.47)	*No data 1990 - 1998*
1998-2004:	1.9 (0.37)	1.5 (0.17) *(starting 1999)*
2005-2007:	1.9 (0.23)	1.7 (0.36)
2008:	3.79	1.51

Compliance with NYS AWQS and Guidance Value
(Jun 1 to Sep 30 average (standard deviation); No NY State standard or guidance value for Secchi disk transparency. NYS DOH bathing beach swimming safety guidance value of 1.2m)

Time Period	South Deep measurements % greater than 1.5 m	Nearshore (Class B & C) % greater than 1.2 m
1990-1997:	54% (25%)	*No data 1990 - 1998*
1998-2004:	62% (20%)	70% (15%) *(starting 1999)*
2005-2007:	67% (5%)	81% (12%)
2008:	100%	96%

2008 - Nearshore Stations Class B % measurements greater than 1.2 m	2008 - Nearshore Stations Class C % measurements greater than 1.2 m
Bloody Brook: 96%	Ninemile Creek: 100%
Eastside: 96%	Harbor Brook: 96%
Maple Bay: 96%	Ley Creek: 91%
Wastebeds: 96%	Mid-south: 96%
Willow Bay: 96%	

Factors Affecting Water Clarity: Algal abundance (depends on light, temperature, nutrients and grazing pressure), external loading of suspended solids, re-suspension of bottom sediments, precipitation of calcite, suspension of sediment from tributary high flow

Planned Load Reductions (1998 – 2012)

Metro SPDES Permit Requirement
- No SPDES requirement for Secchi disk transparency
- Staged reduction in total phosphorus load from Metro
- Staged implementation of CSO and watershed projects to reduce phosphorus loading from nonpoint sources

Monitoring and Assessment Program

Lake Monitoring
(Annual County monitoring program)
- Biweekly measurements of Secchi disk at South Deep (weekly between 5/1 and 9/30)
- Nearshore Secchi disk measurements: weekly (summer). and following storm events

Related Biological Monitoring
- Phytoplankton and zooplankton abundance and community composition
- Alewife hydroacoustic surveys

Progress towards water quality improvement: Secchi Disk Transparency. AMP 2008 Annual Report. (Guidance Value) – *continued*

Tools for Decision Making	
Models	• Mass balance TP framework and linked empirical eutrophication model (William Walker) • Onondaga Lake Water Quality Model (under development by QEA,LLC)
TMDL Allocations	Phosphorus - NYSDEC Phase I TMDL 8/27/97; Phase II TMDL by January 2009

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Progress towards water quality improvement: Macrophytes. AMP 2008 Annual Report. (Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Expansion of the areal coverage and increase in diversity of macrophyte community, where number of species and biomass in the littoral zone (6m water depth) are comparable to other regional lakes. Increase percent cover of littoral zone to optimal levels (40% – 60%) for largemouth bass habitat, to achieve desired use of the lake for warmwater fish reproduction.

Hypotheses to be tested:	**Status:**
Metro improvements and watershed phosphorus load reductions indirectly result in increased areal coverage of macrophytes in littoral zone of Onondaga Lake.	• Metro improvements to reduce nutrient loading were implemented in 2004 (BAF) and 2005 (HRFS) • Areal coverage in the littoral zone has increased between 2000 and 2005
Metro improvements and watershed phosphorus load reductions indirectly result in increased number of macrophyte species in Onondaga Lake.	• The number of macrophyte species has increased from 5 in 1991 to 17 in 2005; the next survey will be conducted in 2010.

Current Conditions with Historical Comparison

Community Composition *(Lakewide)*

Year	Number of species present	Dominant species by relative % cover
1991:	5	*no data*
2000:	10	Sago pondweed (52%) Common waterweed (26%)
2005:	17	Common waterweed (62%) Coontail (19%)

1991 data from John Madsen, Army Corps of Engineers, 1996

Biomass *(Lakewide average)*

1991: *no data*
2000: 16 g/m^2 dry weight
2005: 51 g/m^2 dry weight

Species Richness *(Transect average)*

1991: 1.3 species per transect (Madsen et al 1996)
2000: 3.6 species per transect
2005: 6.0 species per transect

Percent of Subplots with Macrophytes

1991: 13% (Madsen et al 1996)
2000: 28%
2005: 62%

Percent Cover in littoral zone *(Lakewide average)*

1991: *no data*
2000: 18%
2005: 26%

Aerial Photographs

2000: 85 acres (11%)
2001: 134 acres (17%)
2002: 142 acres (18%)
2003: 267 acres (34%)
2004: No data
2005: 378 acres (49%)
2006: 183 acres (24%)*
2007: 210 acres (27%)*
2008: 314 acres (40%)*

Percent indicates percent coverage of littoral zone. Aerial photographs were obtained in June except for 2006, 2007, and 2008 when the photographs were taken in August.

Factors affecting macrophyte community

- Sediment texture (oncolites are nutrient-poor and unstable), light penetration, salinity, zebra mussels

Progress towards water quality improvement: Macrophytes. AMP 2008 Annual Report. (Assessment Measure) *(continued).*

Monitoring and Assessment Program	
Lake Monitoring	• Survey species composition, percent cover, and biomass every 5 years, from 2000 to 2010. • Annual aerial photographs of littoral zone to estimate acres of macrophytes. *Metrics to track over time* • Number of species (richness) • Percent cover • Biomass
Tools for Decision Making	
Qualitative and Quantitative Analysis	Compare to baseline survey in 2000

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Progress towards water quality improvement: Dissolved Oxygen. AMP 2008 Annual Report. (Water Quality Standard)

AMENDED CONSENT JUDGMENT GOAL

Achieve compliance with the applicable ambient water quality standard in the upper waters, and removal of oxygen depletion as impairment to designated best use for survival and propagation of a coolwater fish community such as walleye. Eliminate dissolved oxygen as impairment to desired uses of the lake for aquatic life protection and fish reproduction.

Hypotheses to be tested:	**Status:**
Improvements at Metro enable the County to meet interim effluent limits for BOD	• Since 2004, interim effluent limits for BOD have been met.
Improvements at Metro and nonpoint sources reduce the volume-days of anoxia and hypoxia.	• Volume days of anoxia and hypoxia have decreased since the 2004-2005 improvements at Metro to treat ammonia and phosphorus were implemented (BAF and HRFS, respectively).
Improvements at Metro and related nonpoint source phosphorus load reductions bring the lake into compliance with NYS AWQS for DO during fall mixing.	• Since 2003, NYS AWQS (daily average DO >5 mg/l) has been met in upper waters (0-3m) during fall turnover, based on field profiles data.
Improvements at Metro and nonpoint sources reduce the areal hypolimnetic oxygen depletion rate.	• The average oxygen depletion rate for the period 2001-2005 was 998 mg/m^2-day, and was 987 mg/m^2-day for the period 2003-2007. *The rate reflects oxygen consumption below the thermocline between the first sampling date with thermal stratification and the last date prior to development of anoxic conditions (hypolimnetic mean < 2 ppm). The areal rate is computed as the product of the mean hypolimnetic depth and the decrease in volume-averaged concentration divided by the number of days between sampling events.*

Current Conditions with Historical Comparison

Major Sources

Oxygen depletion in the LWL is primarily due to decomposing algal biomass (excess algae is caused by phosphorus load). Other sources include ultimate oxygen demand from organic material in watershed and reduced nitrogen species (including ammonia from Metro)

Upper Waters Concentration during fall mixing
(Annual Average of minimum daily averages (standard deviation))

Time Period	South Deep, 0-3 meters (mg/l)
1994-2003:	4.9 (1.5)
2004-2007:	7.3 (1.1)
2008:	7.5

(Source: calculated from field profile data collected 1 week before and 1 week after measured DO minimum for each year)

Volume-days of anoxia
(Annual Average (standard deviation))

Time Period	Anoxia (<0.5 mg/l)	Hypoxia (< 2 mg/l)
1994-2003:	4958 (1342)	5834 (1209)
2004-2007:	2786 (1061)	4672 (616)
2008:	3053	4189

(Source: calculated from field profile data)

Compliance with NYS AWQS in Upper Waters
("For nontrout waters, the minimum daily average shall not be less than 5.0 mg/L, and at no time shall the DO concentration be less than 4.0 mg/L")

In Onondaga Lake upper waters in 2008, the minimum daily average was 6.71 mg/l (09/16), and the minimum instantaneous reading was 5.76 mg/l (09/16 at 9:34 a.m.). *(Source: 2-meter depth in-situ buoy. Note that faulty probe measurements at 2m depth, verified by comparison to 6m depth and field profiles, were not included in evaluation of the minimums).*

Factors Affecting Compliance

Algal abundance (related to phosphorus load), ammonia N concentration and dynamics, meteorology

Progress towards water quality improvement: Dissolved Oxygen. AMP 2008 Annual Report. (Water Quality Standard) – (continued).

Planned Load Reductions (1998 – 2012)	
Metro SPDES Permit Requirement	See staged effluent limits for total phosphorus Interim BOD limit: 21 mg/l (30-day average)
Monitoring and Assessment Program	
Loading Estimates *Annual County monitoring program*	• Biweekly tributary monitoring, supplemented with samples collected during high flow conditions to estimate TP, N and BOD inputs, which influence DO concentrations in the lake. • Storm event monitoring in tributaries • Daily measurements of Metro effluent
Lake Monitoring *Annual County monitoring program*	• Biweekly DO profiles in Lake, Apr to Nov, 0.5-meter intervals • Intensive sampling during fall, including tributary mouths • Monitoring buoy installed at South Deep for near-continuous measurements and transmittal of water quality data including DO • Winter sampling as weather allows
Related Biological Monitoring	• Annual phytoplankton monitoring • Annual zooplankton monitoring • Macroinvertebrate monitoring • Assessment of fish community
Tools for Decision Making	
Models	• Onondaga Lake Water Quality Model (under development by QEA,LLC) • Mass balance TP framework and linked empirical eutrophication model (developed by William Walker)
TMDL Allocations	• NYSDEC Phase I TMDL for phosphorus 8/27/97 • Phase II TMDL for phosphorus by January 2009

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Progress towards water quality improvement: Ammonia-N. AMP 2008 Annual Report. (Water Quality Standard)

AMENDED CONSENT JUDGMENT GOAL

Achieve compliance with the applicable ambient water quality standard in the upper waters, and removal of ammonia toxicity as impairment to designated best use for survival and propagation of a warmwater fish community. Achieve desired use of aquatic life protection.

Hypotheses to be tested:	**Status:**
Improvements at Metro enables the County to meet Stage III effluent limits for ammonia N	• Stage III effluent limits have been met for ammonia-N since 2004, after the BAF upgrade was implemented for year-round ammonia treatment.
Reduced ammonia load results in compliance with ambient water quality standards and federal criteria for ammonia in Onondaga Lake	• Since 2004, Onondaga Lake has been in full compliance with NYS AWQS in upper waters.

Current Conditions with Historical Comparison

Major Sources – Percent Contribution
(Annual Average (standard deviation))

Time Period	Metro Effluent and Bypass	Tributaries
1985-2003:	89% (6%)	11% (6%)
2004-2007:	54% (15%)	46% (15%)
2008:	44%	56%

Upper Waters Concentration
(Annual Average (standard deviation))

Time Period	South Deep, 0-6 meters, Jan-Dec (mg/l)
1985-2003:	1.56 (0.63)
2004-2007:	0.20 (0.09)
2008:	0.20

Compliance with NYS AWQS in Upper Waters: Full compliance in 2008
Full compliance in upper waters since 2004.

Factors Affecting Compliance: Metro performance, hydrology, pH, and water temperature

Planned Load Reductions (1998 – 2012)

Metro SPDES Permit Requirement

(Stage III Limit has been met since 2004, eight years ahead of schedule)

Stage I Limit: Cap on Loading
- effective Jan 1998 - April 30, 2004 (completed)

Stage II Limit: effective May 1, 2004 – Dec. 2012
- June 1 – Oct. 31: 2.0 mg/l (as NH_3)
- Nov. 1 – May 31: 4.0 mg/l (as NH_3)

Stage III Limit: effective Dec. 2012
- June 1 – Oct. 31: 1.2 mg/l (as NH_3)
- Nov. 1 – May 31: 2.4 mg/l (as NH_3)

Monitoring and Assessment Program

Loading Estimates
Annual County monitoring program
- Biweekly tributary monitoring, supplemented with samples collected during high flow conditions
- Daily measurements of Metro effluent

Lake Monitoring
Annual County monitoring program
- Biweekly profiles in Lake, April –Nov, 3-meter intervals
- Winter sampling as weather allows

Related Biological Monitoring
- Assessment of fish community began in 2000
- Annual zooplankton monitoring

Tools for Decision Making

Model	Onondaga Lake Water Quality Model (under development by QEA, LLC)
TMDL Allocations	NYSDEC Phase I TMDL 8/27/97

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Progress towards water quality improvement: Nitrite-N. AMP 2008 Annual Report. (Water Quality Standard)

AMENDED CONSENT JUDGMENT GOAL

Achieve compliance with the applicable ambient water quality standard in the upper waters to meet designated best use for survival and propagation of a warmwater fish community. Achieve desired use of aquatic life protection.

Hypotheses to be tested:	**Status:**
Achievement of Stage III effluent limits for ammonia results in compliance with the NYS ambient water quality standard for nitrite (warmwater fish community)	• Stage III effluent limits have been met for ammonia-N since 2004, after the BAF upgrade was implemented for year-round ammonia treatment. • Since 2006, Onondaga Lake has been in full compliance with NYS AWQS for nitrite-N in upper waters.

Current Conditions with Historical Comparison

Major Sources – Percent Contribution
(Annual Average (standard deviation))

Time Period	Metro Effluent Outfall 001	Tributaries
1985-2003:	75% (14%)	25% (14%)
2004-2007:	45% (18%)	55% (18%)
2008:	28%	72%

Upper Waters Concentration
(Annual Average (standard deviation))

Time Period	South Deep, 0-6 meters, Jan-Dec (µg/L)
1985-2003:	166 (76)
2004-2007:	56 (18)
2008:	35

Compliance with NYS AWQS in Upper Waters

Percent of observations exceeding standard (100 µg/l):
1985-2003: 55%
2004-2007: 10%
2008: 0% Full compliance in 2008

Factors Affecting Compliance: Metro performance, Hydrology

Planned Load Reductions (1998 – 2012)

Metro SPDES Permit Requirement: No numerical limit for nitrite in SPDES permit; Monitor only (one sample per week)

Monitoring and Assessment Program

Loading Estimates
Annual County monitoring program
- Biweekly tributary monitoring, supplemented with samples collected during high flow conditions
- Daily measurements of Metro effluent

Lake Monitoring
Annual County monitoring program
- Biweekly profiles in Lake, April –Nov, UML and LWL
- Additional sampling during fall mixing
- Winter sampling as weather allows

Related Biological Monitoring
- Assessment of fish community began in 2000
- Annual zooplankton monitoring

Tools for Decision Making

Model	Onondaga Lake Water Quality Model (under development by QEA, LLC)
NYS AWQS	100 µg/l

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Progress towards water quality improvement: Bacteria. AMP 2008 Annual Report. (Water Quality Standard)

AMENDED CONSENT JUDGMENT GOAL

Achieve compliance with the applicable ambient water quality standard for fecal coliform bacteria, Class B segment, applicable during the period of Metro disinfection (April 1- October 15). Include bacteria concentrations in nearshore areas following storm events. Reduce fecal coliform bacteria levels in the lake to achieve desired use for water contact recreation.

Hypotheses to be tested:	**Status:**
CSO remedial measures and improved stormwater management reduce the loading of fecal coliform bacteria entering the lake	• The annual load of fecal coliform bacteria in 2008 was 1,476,249 10^{10} CFU, a 43% decrease from the 1990-2007 annual average of 2,570,984 10^{10} CFU
Implementation of Stage I and II improvements to the wastewater collection and treatment system (including CSO projects) and progress with stormwater management will reduce concentration of indicator organisms in Onondaga Lake	• In 2008, bacteria levels were generally low throughout the lake during the summer, coincident with normal to slightly above average summer precipitation.

Current Conditions with Historical Comparison	
Major Sources	Combined sewer overflows (major); sanitary sewer overflows (rare) Stormwater from urban and agricultural land use Metro effluent (disinfection period April 1– Oct 15) and by-pass Other sources (wildlife, birds, etc.)
Compliance with NYS AWQS in Class B Segment	<u>Percent in compliance Class B</u> 1999-2003: 99% 2004-2007: 100% 2008: 100% <u>Class B Locations</u>: Bloody Brook Willow Bay Maple Bay Wastebeds Onondaga Lake Park North Basin
Factors Affecting Compliance	Metro disinfection, extent of CSO and Sanitary Sewer Overflow (SSO) Meteorological conditions (rainfall, temperature, sunlight, winds) Lake water quality (turbidity); Abundance of waterfowl

Planned Load Reductions (1998 – 2012)	
Metro SPDES Permit Requirement	Seasonal disinfection (4/1 – 10/15) of Metro effluent required
Staged CSO Remediation	CSO phased plan to capture combined sewage and stormwater: • Stage I captures 62% of volume through best management practices • Stage II eliminates and/or captures 85% of volume and provides equivalent of primary treatment.

Monitoring and Assessment Program	
Loading Estimates *(Annual County monitoring program)*	• Biweekly tributary monitoring for fecal coliform bacteria supplemented with samples collected during high flow conditions. • Daily measurements of Metro (001 and 002 if active) for fecal coliform bacteria • Storm event monitoring in tributaries for fecal coliform bacteria
Lake Monitoring *(Annual County monitoring program)*	• Weekly monitoring for Fecal coliform and E. coli bacteria at South Deep, Class C segment (May – Sept) • Quarterly monitoring for Fecal coliform and E. coli bacteria at North Deep, Class B segment (Apr – Nov) • Nine nearshore stations weekly (summer) and following storms, both Class B and Class C segments, for Fecal coliform and E. coli bacteria

Progress towards water quality improvement: Bacteria. AMP 2008 Annual Report. (Water Quality Standard) – *(continued)*.

Tools for Decision Making	
Model	Storm Water Management Model (simulates bacteria loads in tributaries from collection system given rainfall conditions)
TMDL Allocations	Based on presumptive approach for CSO control: percent capture of combined storm and wastewater. Must account for urban stormwater.
NYS AWQS	The monthly geometric mean of fecal coliforms, from a minimum of five examinations, shall not exceed 200 cfu/100ml during disinfection period Apr 1 to Oct 15.
Federal Criteria	NYS indicator bacteria standards include total and fecal coliform. EPA criteria now use *E. coli* (freshwater) and *Enterococcus* (marine water) as indicators; states are encouraged to adopt *E. coli*.

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Progress towards water quality improvement: Phytoplankton. AMP 2008 Annual Report. (Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Reduce the frequency, magnitude and duration of elevated chlorophyll-a- concentrations in Onondaga Lake during the recreational period. Reduce the abundance of cyanobacteria (blue-green algae) in phytoplankton biomass

Hypotheses to be tested:	**Status:**
Metro improvements and watershed phosphorus load reductions result in lower biomass of phytoplankton in Onondaga Lake.	• Since Metro improvements have reduced phosphorus loading to the lake, the biomass of phytoplankton in the lake has also declined.
Metro improvements and watershed phosphorus load reductions, reflected in a higher N:P ratio, result in reduced importance of cyanobacteria to the lake's phytoplankton biomass.	• Since Metro improvements have reduced phosphorus loading to the lake, the proportion of cyanobacteria in the phytoplankton community has also declined.

Current Conditions with Historical Comparison	
Biomass *(Annual average (standard deviation))*	1998-2004: 4.7 mg/L (2.5 mg/L) 2005-2007: 1.9 mg/L (0.6 mg/L) 2008: 0.6 mg/L
Community Composition *(Annual average biomass (standard deviation))*	<u>Cyanobacteria</u> 1998-2004: 19% (5%) 2005-2007: 1.5% (0.6%) 2008: 0.6%
Factors affecting algal community	Nutrients, light, temperature, grazing pressure from *Daphnia*

Monitoring and Assessment Program	
Lake Monitoring *(Annual County monitoring program)*	Biweekly sampling events: • Phytoplankton abundance (number per liter) • Biomass (mg/l) • Composition of the algal community (7 major groups) • Cell size divisions (nannoplankton and netplankton) Metrics to track over time: • Percent of major taxa • Cyanobacteria relative importance • Shifts in N:P ratio of lake water • Biomass trend

Tools for Decision Making	
Model	Onondaga Lake Water Quality Model (under development by QEA,LLC)
TMDL Allocations	Phosphorus - NYSDEC Phase I TMDL 8/27/97; Phase II TMDL by January 2009

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Progress towards water quality improvement: Metaphyton. AMP 2008 Annual Report. (Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Reduction of the areal coverage of metaphyton (filamentous algae) to improve aesthetic quality of the lake for recreational use, and improve conditions for growth of aquatic plants.

Hypotheses to be tested:	**Status:**
Metro improvements and watershed phosphorus load reductions result in reduced areal coverage of metaphyton in nearshore areas of Onondaga Lake	• Metaphyton coverage was high compared to past years.
Current Conditions with Historical Comparison	
Estimated Areal Coverage *(Annual average (standard deviation))*	2004: 5 (8) square meters (eight stations) 2005: 13 (17) square meters (eight stations) 2006: 2 (5) square meters (nine stations) 2007: 6 (9) square meters (nine stations) 2008: 15 (23) square meters (nine stations)
Factors affecting abundance of macroalgae	Phosphorus, water clarity, zebra mussels, lake water level, water temperature, wind, emerged macrophyte growth.
Monitoring and Assessment Program	
Lake Monitoring *(Annual County monitoring program)*	• Weekly surveys during recreational period (June –Sept) at nine nearshore stations (Wastebeds station added in 2006) (see Figure 1 Appendix 1) • Semi-quantitative method employed using visual observation and measurements

Progress towards water quality improvement: Zooplankton. AMP 2008 Annual Report. (Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Achieve abundance and species composition of a zooplankton community comparable to productive lakes in the geologic and climatic setting of Onondaga Lake.

Hypotheses to be tested:	**Status:**
Metro improvements and watershed phosphorus load reductions reduce the biomass of zooplankton by reducing the algal food supply in Onondaga Lake.	• Data suggest that the biomass of zooplankton in Onondaga Lake is influenced more by alewife predation than by fluctuations in the algal food supply. In the aquatic environment, larger zooplankton are the most effective grazers of phytoplankton and exert a major control on the standing crop (Mills et al. 1987). Alewives graze on larger zooplankton; years with abundant alewives consistently exhibit the smallest zooplankton and lower water clarity than would be expected from phosphorus concentrations alone.
Current Conditions with Historical Comparison	
Community Biomass *(Annual average April-Oct (standard deviation))*	1999-2002: 297 ug/L (111 ug/L) 2003-2007: 228 ug/L (67 ug/L) 2008: 245 ug/L
Daphnia Biomass *(Annual average (standard deviation))*	1998-2002 (before alewife abundant): 114 ug/L (59 ug/L) 2003-2007 (while alewife abundant): 4 ug/L (5 ug/L) 2008: 92 ug/L
Forcing Functions	Food supply (algal abundance), species composition, grazing pressure (alewives), water quality (ammonia, chlorides)
Monitoring and Assessment Program	
Lake Monitoring *(Annual County monitoring program)*	Biweekly monitoring for density (organisms per ml) and biomass (µg/l), March – November/December Metrics to track over time: • Average size in spring (June 1 – 15) and fall (Sept. 1 – 15) • Relative biomass of major cladoceran types • Relative biomass of major copepod types Number of crustacean taxa (1995 to present)
Tools for Decision Making	
Model	None developed. Zooplankton grazing rate will be specified in the Onondaga Lake Water Quality Model (under development by QEA,LLC)

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Progress towards water quality improvement: Fish Community. AMP 2008 Annual Report. (Assessment Measure)

AMENDED CONSENT JUDGMENT GOAL

Expand habitat for fish community and promote water quality conditions that support diverse warmwater fish community. Achieve conditions to support a self-sustaining sport fishery, and achieve desired use of the lake for recreation.

Hypotheses to be tested:	**Status:**
Implementation of point and nonpoint nutrient load reductions will indirectly increase the number of fish species that are sensitive to pollution present in Onondaga Lake	• Fish Index of Biotic Integrity, based on tolerance values, shows improvement since 2003. Most improvement documented in south end of the lake.
Implementation of nutrient load reductions at Metro and nonpoint sources including CSO remediation will indirectly increase the number of fish species present in Onondaga Lake	• Number of species captured in the lake as a whole is currently stable, but more species are being captured per year in the south end of the lake. This is likely due to improving habitat conditions there.
Implementation of point and nonpoint nutrient load reductions will increase the reproductive success of fish in Onondaga Lake	• Catch of YOY has decline for most species. Possible causes include; predation on larvae by alewives, more dispersed population due to increased habitat, and decreased sampling efficiency due to increased plant growth.
Implementation of point and nonpoint nutrient load reductions will increase the habitat available for the coolwater fish community	• Habitat available to coolwater fish appears to have shown some improvement, but is highly variable. Controlled by summer temperature and intrusion of hypoxia into metalimnion.

Current Conditions with Historical Comparison	
Number of fish species (from electrofishing) *(Average Annual Total & Standard Deviation)*	2000-2003: 22.5 (2.4) 2004-2007: 24.5 (1.7) 2008: 24
Number of fish species reproducing in the lake	2001-2003: 16-20 2004-2007: 13-17 2008: 23
Index of Biotic Integrity *(Annual Average & Standard Deviation of WFI P/A)*	2000-2003: 2.47 (0.05) 2004-2007: 2.63 (0.05) 2008: 2.78
Cool water habitat *(Annual Average Percent of Habitat Available and Standard Deviation)*	2000-2003: 74% (3.6%) 2004-2007: 81% (4.2%) 2008: 88%
Forcing Functions	Extent of aerobic habitat, water temperature, abundance of preferred food sources, habitat for spawning and juveniles, predation of larvae by alewives, abundance of macrophytes

Progress towards water quality improvement: Fish Community. AMP 2008 Annual Report. (Assessment Measure) (continued).

Monitoring and Assessment Program	
Lake Monitoring *(Annual County monitoring program)*	Annual monitoring, beginning in 2000 to assess reproductive success and community structure • Number and distribution of littoral nests • ID and enumerate larval fishes • ID and enumerate juvenile and YOY stages • ID and estimate (CPUE) of adult community using electrofishing, gillnets, and angler diaries Assess and record DELT-FM anomalies
Tools for Decision Making	
Quantitative and Qualitative Analyses	Data collection techniques and data analysis comparable to standard procedures used throughout New York.

LIBRARY-SECTION 03
METHODOLOGY FOR 2008 PROGRAM

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Summary of monitoring locations: tributaries and inflows, 2008.

Tributary/ Inflow Gauged and Monitored	**Drainage Area (km^2)**	**Gauge Site(s)**	**Percent of Lake Water Budget**
Ninemile Creek	298	Lakeland (Rt. 48)	32%
Onondaga Creek	285	• Rt. 20, Lafayette • Dorwin • Spencer	34 %
Metro: *Outfalls 001 and 002*	Syracuse service area	Post treatment, at outfall to Lake	18%
Ley Creek	66.1	Park St.	8.1%
Harbor Brook	31.4	• Velasko Rd. • Hiawatha Blvd.	2.3%
East Flume *(includes Honeywell International complex)*	<3	At weir	0.21%
Tributary 5A (*includes Crucible Specialty Metals*)	<8	Downstream of facility outfall	0.23%
Direct precipitation and ungauged drainage area *(including Bloody Brook and Sawmill Creek)*	Lake surface area: 11.7 Direct drainage < 30	None	Approx. 5.2%
Total	**727 km^2**	**--**	**100%**

Library Reference 3.2

Onondaga County Department of
WATER ENVIRONMENT PROTECTION

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April 1, 2008

HAND DELIVERY

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James E. Burke, P.E.
Environmental Engineer 3
Regional Water Manager
NYSDEC – Division of Water, Region 7
615 Erie Boulevard West
Syracuse, New York 13204-2400

Re: Year 2008 Ambient Monitoring Program (Final - April 2008)

Mr. Burke:

A meeting was held on March 27, 2008 with Dr. John G. Ferrante (NYSDEC/CNYRPDB) and OCDWEP staff to discuss NYSDEC's review comments on OCDWEP's Proposed Year 2008 Ambient Monitoring Program (draft version dated February, 2008). Attached is a copy of OCDWEP's response to the review comments received from Dr. Ferrante (via e-mail dated March 17, 2008), and for your approval a copy of the revised 2008 Ambient Monitoring Program (final version dated April 2008), which reflects the modifications.

I want to take this opportunity to thank you for the NYSDEC's review and constructive comments. Should you have any questions, please contact me or Joseph J. Mastriano.

Sincerely,

RANDY R. OTT, P.E.
Commissioner

JS/ncs
cc ltr only: Sandra Allen, NYSDEC
Scott Crisifulli, NYSDEC
Jimmy F. Ng, NYSEFC
Norman Spiegel, Office of Attorney General, EPB
Luis Mendez, Onondaga County Dept. of Law
David Coburn, Onondaga County Office of Environment

Richard Lippes, Lippes & Associates
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Jean Smiley, Onondaga County, Administrator/Physical Services
Susan A. Miller, Onondaga County Lake Improvement Office

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File - AMP Correspondence

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Onondaga Lake Ambient Monitoring Program (Draft – February 2008)

Proposed 2008 field sampling program review comments w/responses
(Dr. John Ferrante comments dated 3/18/08)

General Comments

Comment 1. The proposed AMP sampling program for the 2008 field season is substantially the same as that conducted in 2007. Frequent interactions between OCDWEP and DEC since the initial program was designed have resulted in a scientifically and technically strong program and the 2008 program is no exception. Special attention is paid to the microbial sampling program for Onondaga Lake and Lake tributaries and discussed more fully in the Specific Comments section.

Response 1: No response required.

Comment 2. At this time DEC has not received a copy of the workplan for the Supplemental Three Rivers Monitoring Program, therefore no comments are provided on said document in this submittal. It is my understanding that this workplan covers the full river surveys from Cross Lake to the Three Rivers Junction. DEC will conduct a review and submit any comments once the workplan is received (see SUPPLEMENTAL PROGRAMS, page 2 of 3 on cover letter).

Response 2: The goal for conducting additional water quality sampling in 2008 is to gain additional data to support further calibration and validation efforts of the Three Rivers Water Quality Model. The plan will be drafted and a copy will be forwarded to you at a later date.
It should be noted that the Supplemental Three Rivers Water Quality Monitoring Program is not included with the Year 2008 AMP submittal, as it is not part of the approvable program.

Specific Comments

Comment 1. Appendix A, page 3: Please describe the "Quarterly Extended" event for tributaries in a foot note to the table.

Response 1: The "Quarterly Extended" is used to designate the quarterly tributary sampling events which include the Extended parameters (including the quarterly metals and Cyanide). Also described in Footnote 1, Appendix C, Page 9.

Comment 2. Appendix D: Parameter Fecal Coliform, E. coli, Frequency: Using a bi-weekly frequency of sampling will not consistently provide a minimum of five samples per month per sampling station throughout the April to November sampling period. Section 703.4, Water Quality Standards for Coliforms, Part (b) Fecal Coliforms of the NYSDEC Water Quality Regulations states the following for Class B & C water: "The monthly geometric mean, from a minimum of five examinations, shall not exceed 200". The volume for the standards in this section is per 100 ml. This needs to be discussed more fully.

Response 2: The proposed monitoring program is based on samples being collected from the Lake during the period when the Metro Effluent is disinfected; therefore weekly sampling is now scheduled from April 1 through October 15. The North Deep station (Class B) site has also been added to the weekly sampling program, in order to increase the number of samples collected per month.

The County is asking for guidance from the DEC with regard to the monitoring program design in order to ensure that sufficient number of samples are collected to assess compliance with the regulatory water quality standard of 200 colonies per 100ml, based on 5^{+} samples geometrically averaged over one month. Clarification is needed as to whether compliance is to be calculated for each site or within the Class B and Class C segments. The County is willing to re-evaluate the sample frequency based on the results of these responses.

The Data Analysis Interpretation Plan (DAIP), which is updated annually and included in the annual AMP Report, will provide a context for interpreting the data summaries and assessing compliance.

The County is also interested in how bacteriological compliance is assessed by the DEC for other regional lakes.

Comment 3. Appendix H: This is to acknowledge that the Buoy 316 sampling program is contained in this document and is acceptable. This also acknowledges the "workplan" referenced in General comment #2 as that for the full river sampling program.

Response 3: No response required.

Comment 4. Appendix H: (1) Footnote #4 what is these single samples at Buoys 316, 260, and 182 used for. (2) Why is the County analyzing for Bis(2-Ethylhexyl) Phthalate and Di-N-Octyl Phthalate? (see footnote #4) If this is part of a continuing historic sampling effort please state. If not justify these analyses.

Response 4: These samples are special samples collected pertaining to the data needs for the Technical Evaluation of Local Limits Project Study and are not part of the approvable AMP submittal. Please note that Footnote 4 has been deleted.

Comment 5. Appendix I: Storm-Event Sampling - Sampling stations # 1 (Ninemile Creek), 2 (Harbor Brook), 4 Ley Creek, & 8 (Bloody Brook) are located in Onondaga Lake while four tributary sampling locations are in Onondaga Creek. There are no corresponding tributary sampling stations for Ninemile Creek, Harbor Brook and Ley Creek and no corresponding Lake sampling location for Onondaga Creek identified in this table. Are there any sampling stations in the respective tributaries that are used for storm events? This is especially true for a sampling location in the Lake offshore from the confluence of

Onondaga Creek which is under increasingly hard scrutiny for bacterial contamination and resulting Lake contamination as it relates to water quality. This needs to be addressed.

Response 5 Lake Nearshore Site 3 (Metro) is the sampling location used to represent the South end of the lake. The 2008 program includes a storm event monitoring program for Onondaga Creek only, following the completion of the Midland Avenue Regional Treatment Facility and therefore four (4) Onondaga Creek tributary sampling locations are included.

Sampling locations in the respective tributaries (Ninemile Creek, Harbor Brook and Ley Creek) are included only in conjunction with those years when storm event monitoring is scheduled. Prior year storm event monitoring program tributary monitoring sites are as follows:

- Ninemile Creek: @Route 48 (2001, 2002, 2006)
- Harbor Brook: Velasko Road & Hiawatha Boulevard (1999, 2000, 2001, 2003)
- Ley Creek: Park Street, 7th North Street, Dorwin Avenue & Route 11 (1999, 2000, 2001, 2003)

Comment 6. Appendix J: This appendix identifies the modifications incorporated in the 2008 sampling program. (1) Appendix D discusses a modification to the sampling of Chlorophyll-*a* and the elimination of the second tube composite sample. While appreciating the justification given here, what implications are there to eliminating this sample when the depth of the photic zone may change significantly as Chl *a* concentration are reduced and light penetration increases?

Response 6: Standardizing the depth of the chlorophyll-*a* sampling will simplify the field program without reducing information used for management decisions. These data are used for trend analysis; the statistical evaluation of the paired samples indicates that the 0-3 m sample will be adequate for this purpose. In addition, data are used to indicate use attainment in terms of perceived recreational quality of the waters. The algal density in the top three meters is a reasonable indicator of water clarity and color. For example, the CSLAP program, which NYSDEC used to develop its phosphorus guidance value, samples chlorophyll-*a* at a single depth of 1.5 m. The AMP includes other metrics (Secchi disk transparency, LiCor measurements) to directly evaluate water clarity.

Comment 7. (2) Item Appendix F, bullet #1 refers to microbial sampling program frequency. This is an open issue (described in comment #2 above that will need to be addressed).

Response 7: See response to Comment 2.

Comment 8. Please cross-reference the separate workplan for the full river system sampling identified on page 2 and discussed in General Comment #2 above.

Response 8: Agreed. Change will be made.

Comment 9. ATTACHMENT 1, Section B: Please include the day April 1 and November 15 in the sampling period, line 1.

Response 9: Agreed. Change will be made.

Comment 10. ATTACHMENT 1, D: I believe it is important to identify both river sampling programs when discussing each. That is, identify that Buoy 316 is only one part of the river sampling program and that a separate workplan has been developed for the river from Cross Lake to Three Rivers and cross reference.

Response 10: Agreed. Change will be made.

Comment 11. ATTACHMENT 1, Table 1: Analyte #1: Is that Fecal Coliforms or Fecal Coliforms and E. coli or both?

Response 11: Table 1 includes the sample collection and preservation requirements for both the Fecal Coliforms and E. Coli.

Comment 12. Page 23, description of thermocline: Redundant.

Response 12: No change.

Comment 13. Page 24, 1st #3: Clarify what is meant by a "water-sediment" sample.

Response 13: In the depth-integrated sampling operation, the "water-sediment" sample is used to describe the sample collected using this technique, where the intake nozzle of the sampling device is orientated into the current and held in a horizontal position while the sample is lowered at a uniform rate from the water surface to the bottom of the stream, instantly reversed, and then raised again to the water surface at a uniform rate. This sampling method is designed to collect a representative sample of water and suspended sediment.

Comment 14. Page 43, Method Blank: Spell out MRL.

Response 14: MRL (Minimum Reportable Limit) will be written out.

Comment 15. ATTACHMENT 2, Quality Assurance Program Plan, Onondaga Lake Fish Sampling Program (2008): I have no comments on Attachment 2.

Response 15: No response needed.

Comment 16. ATTACHMENT 3: I have no comments on Attachment 3.

Response 16: No response needed.

Comment 17. ATTACHMENT 4: I have no comments on Attachment 4.

Response 17: No response needed.

YEAR 2008

ONONDAGA LAKE

AMBIENT MONITORING PROGRAM

Onondaga County
Department of Water Environment Protection
Syracuse, New York

April 2008

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FIGURE

Figure 1- Onondaga Lake Near Shore Sampling Locations 15

ATTACHMENTS

ATTACHMENT 1: Quality Assurance Program Plan (Water Quality Monitoring Program 2008)

ATTACHMENT 2: Quality Assurance Program Plan (Onondaga Lake Fish Sampling Program 2008)

ATTACHMENT 3: Quality Assurance Program Plan (Onondaga Lake Macrophyte Assessment Program 2008)

ATTACHMENT 4: Quality Assurance Program Plan (Onondaga Lake and Tributary Macroinvertebrate Assessment Program 2008)

APPENDIX A

2008 Non-Event Water Quality & Biological

Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
April 2008			
April 1/Tuesday	Tributary	Quarterly Extended	C
April 2/Wedesday	Onondaga Lake	Lake Special Weekly	F
April 8/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
April 14/Monday	Onondaga Lake	Lake Special Weekly	F
April 15/Tuesday	Tributary	Biweekly	C
April 22/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
April 28/Monday	Onondaga Lake	Lake Special Weekly	F
April 29/Tuesday	Tributary	Biweekly	C
May 2008			
May 6/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
May 12/Monday	Onondaga Lake	Lake Special Weekly	F
May 13/Tuesday	Tributary	Biweekly	C
May 20/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D &F
May 27/Tuesday	Onondaga Lake	Lake Special Weekly	F
May 28/Wednesday	Tributary	Biweekly	C
June 2008			
June 3/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
June 9/Monday	Onondaga Lake	Lake Special Weekly	F
June 10/Tuesday	Tributary	Quarterly Extended	C
June 17/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
June 23/Monday	Onondaga Lake	Lake Special Weekly	F
June 24/Tuesday	Tributary	Biweekly	C
July 2008			
July 1/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
July 7/Monday	Onondaga Lake	Lake Special Weekly	F
July 8/Tuesday	Tributary	Biweekly	C
July 10/Thursday	River*	Monthly	H
July 15/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
July 21/Monday	Onondaga Lake	Lake Special Weekly	F
July 22/Tuesday	Tributary	Biweekly	C
July 29/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
August 2008			
August 4/Monday	Onondaga Lake	Lake Special Weekly	F
August 5/Tuesday	Tributary	Biweekly	C
August 7/Thursday	River*	Monthly	H
August 12/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F

APPENDIX A

2008 Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009) (Cont.)

DATE /DAY	PROGRAM	EVENT	APPENDIX
August 18/Monday	Onondaga Lake	Lake Special Weekly	F
August 19/Tuesday	Tributary	Biweekly	C

2008 Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
August 26/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
September 2008			
September 2/Tuesday	Onondaga Lake	Lake Special Weekly	F
September 3/Wednesday	Tributary	Biweekly	C
September 9/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
September 11/Thursday	River*	Monthly	H
September 15/Monday	Onondaga Lake	Lake Special Weekly	F
September 16/Tuesday	Tributary	Quarterly Extended	C
September 23/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
September 29/Monday	Onondaga Lake	Lake Special Weekly	F
September 30/Tuesday	Tributary	Biweekly	C
October 2008			
October 7/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
October 13/Monday	Onondaga Lake	Lake Special Weekly	F
October 14/Tuesday	Tributary	Biweekly	C
October 21/Tuesday	Onondaga Lake	Lake South Deep	D
October 28/Tuesday	Tributary	Biweekly	C
November 2008			
November 5/Wednesday	Onondaga Lake	Lake South Deep	E
November 12/Wednesday	Tributary	Quarterly Extended	C
November 18/Tuesday	Onondaga Lake	Double Lake (South & North Deep)	D
November 25/Tuesday	Tributary	Biweekly	C
December 2008			
December 2/Tuesday	Onondaga Lake	Lake South Deep	D
December 9/Tuesday	Tributary	Biweekly	C
December 23/Tuesday	Tributary	Biweekly	C
January 2009			
January 6/Tuesday	Tributary	Biweekly	C
January 7/Wednesday	Onondaga Lake	Winter**	E
January 20/Tuesday	Tributary	Biweekly	C
February 2009			
February 3/Tuesday	Tributary	Biweekly	C
February 10/Tuesday	Onondaga Lake	Winter**	E
February 17/Wednesday	Tributary	Biweekly	C
March 2009			
March 3/Tuesday	Tributary	Biweekly	C
March 10/Tuesday	Onondaga Lake	Winter**	E
March 17/Tuesday	Tributary	Biweekly	C

*** River sampling events to target low flows (at or less than 500 cfs at Baldwinsville). Sampling event dates may be altered.**

**** Lake Winter dates are tentative and will depend on weather conditions/extent of ice cover on lake.**

Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
April 2008			
Week of April 21st [1]	Fish Community	Pelagic Larval	K
May 2008			
Week of May 5th	Fish Community	Pelagic Larval	K
Week of May 19th	Fish Community	Pelagic Larval	K
Week of May 19th [2]	Fish Community	Electrofishing	K
Week of May 26th [3]	Fish Community	Adult Fish Profundal Zone (Gill Nets)	K
June 2008			
Month of June [4]	Macrophyte	Aerial Flight	L
Month of June [4]	Macrophyte	Field Species Verification	L
Week of June 2nd	Fish Community	Pelagic Larval	K
Week of June 2nd [5]	Fish Community	Nesting Survey	K
Week of June 16th	Fish Community	Pelagic Larval	K
Week of June 23rd	Fish Community	Juvenile Seines	K
Week of June 30th	Fish Community	Pelagic Larval	K
July 2008			
Month of July	Tributary Macroinv.	Macroinvertebrates	M
Month of July	Tributary Habitat	Macroinvertebrates	M
Week of July 14th	Fish Community	Juvenile Seines	K
Week of July 14th	Fish Community	Pelagic Larval	K
Week of July 28th	Fish Community	Pelagic Larval	K
August 2008			
Month of August	Tributary Mapping	Macroinvertebrates	M
Week of August 4th	Fish Community	Juvenile Seines	K
Week of August 25th	Fish Community	Juvenile Seines	K
September 2008			
Week of September 8th	Fish Community	Juvenile Seines	K
Week of September 15th [2]	Fish Community	Electrofishing	K
Week of September 22nd [3]	Fish Community	Adult Fish-Profundal Zone (Gill Nets)	K
Week of September 29th	Fish Community	Juvenile Seines	K

[1]Pelagic Larval sampling events will begin in April when the water temperatures are 7-8°C; all events are weather dependent.

[2]Electrofishing events are night events; dependent on weather conditions and water temperatures of 15-20°C; (Tentative back-up sampling set for Week of May 26th/Sept. 22nd)

[3]Gill Nets are done during the day within one week of littoral electrofishing; (Tentative back-up events week of June 2nd/Sept. 29th).

[4]Field Species Verification will take place within one week of Aerial Photography; Aerial photography is dependent upon water clarity (approximately >2.5 meters Secchi disk transparency) and weather (wind and cloud cover/rain).

[5]Nesting Survey event occurs once in June depending on water temperatures of 15-20°C, clarity, and peak spawning of select gamefish.

NOTE - Macroalgae Are Surveyed Each Time Lake Weekly Is Scheduled (Appendix F).

APPENDIX B

2008 Event-Based Water Quality Sampling Schedule

Ambient Monitoring Program
Onondaga County, New York

PROGRAM/EVENT(S)	FREQUENCY	PARAMETERS	LOCATIONS
I. ONONDAGA LAKE TRIBUTARIES 1. High-Flow	Minimum 5 times/year.	APPENDIX C	All Tributary Monitoring Sites.
II. ONONDAGA LAKE 1. Winter	Once per month January, February, March (Weather Permitting).	APPENDIX E	North or South Deep (sampling station depends on extent of ice cover).
2. Fall Monitoring	Weekly sampling and field data more frequently.	APPENDIX G	Onondaga Lake
III. RIVER MONITORING 1. Annual River Monitoring Program	Three times per year. Once per month July-September. (Target Low-flows).	APPENDIX H	1 River Monitoring Station.
IV. STORM-EVENT MONITORING	Onondaga Creek – Three times. Onondaga Lake – Three times.	APPENDIX I	Onondaga Creek Onondaga Lake

APPENDIX C
2008 Tributary Sampling Program

Ambient Monitoring Program
Onondaga County, New York

Sampling site numbers correspond to the following sites:

1 Nine Mile Creek at Lakeland (Route 48)
2a Harbor Brook at Hiawatha Blvd.
2b Harbor Brook at Velasko Road
3a Onondaga Creek at Kirkpatrick Street
3b Onondaga Creek at Dorwin Avenue
3c Onondaga Creek at Spencer Street
4 Ley Creek at Park Street
5 Tributary 5A at State Fair Boulevard[1]
6 Metro Effluent[2]
7 Allied East Flume
8a Onondaga Lake Outlet at Long Branch Road - 2 feet (0.61 meters)
8b Onondaga Lake Outlet at Long Branch Road - 12 feet (3.66 meters)
9 Bloody Brook at Onondaga Lake Parkway[5]
10 Sawmill Creek at Onondaga Lake Recreational Trail[6]
11 Onondaga Creek Salt Spring (Spence-patrick Spring wellpoint)[7]

PARAMETER/ FREQUENCY	SAMPLING SITES														
	1	**2a**	**2b**	**3a**	**3b**	**3c**	**4**	**5**	**6**	**7**	**8a**	**8b**	**9**	**10**	**11**
Cd, Cr, Cu, Ni, Pb, Hg, Zn, As, K/ Quarterly	X	X	X	X	X	X[4]	X	X	X	X	X	X	X	X	X[7]
CN/ Quarterly	X	X	X	X	X		X	X	X	X	X	X	X	X	
Ca, Na, Mg, Mn, Fe/ Biweekly	X	X	X	X	X	X[4]	X	X	X	X	X	X	X	X	X[7]
TP, SRP, TDP/ Biweekly	X	X	X	X	X		X	X	X	X	X	X	X	X	
BOD_5, TSS, TDS, Cl, SiO_2, SO_4, TOC, TOC-F, TIC, Turbidity/ Biweekly	X	X	X	X	X	X[4]	X	X	X	X	X	X	X	X	X[7]
TKN, NH_3-N, NO_3, NO_2, Org-N/ Biweekly	X	X	X	X	X		X	X	X	X	X	X	X	X	
ALK-T/ Biweekly	X	X	X	X	X	X[4]	X	X	X	X	X	X	X	X	X[7]
Fecal Coliform/ Biweekly	X	X	X	X	X		X	X	X	X	[3]		X	X	

APPENDIX C (Continued)

2008 Tributary Sampling Program

PARAMETER/ FREQUENCY	1	2a	2b	3a	3b	3c	4	5	6	7	8a	8b	9	10	11
Chlorophyll-*a*											X	X			
In-situ: pH, Temperature, Salinity, Conductivity, Redox Potential, Dissolved Oxygen/ Biweekly	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X[7]
Equipment Blank 1 – Dunker-Churn (Churn A) BOD5, TSS, TOC, TDS, TOC-F, TIC, SO_4, NO_3, NO_2, TP, Cl, SiO_2, NH_3-N, TKN, Org-N, Na, Ca, Mg, Mn, Fe, SRP, TDP, ALK-T, Turbidity/ Biweekly															
Equipment Blank 1 – Dunker-Churn (Churn A) BOD5, TSS, TOC, TDS, TOC-F, TIC, SO_4, NO_3, NO_2, TP, Cl, SiO_2, NH_3-N, TKN, Org-N, Na, Ca, Mg, Mn, Fe, As, Cd, Cr, Cu, Hg, K, Ni, Pb, Zn, SRP, TDP, CN, ALK-T, Turbidity/ Quarterly															
Equipment Blank 2 – Churn (Churn B) BOD_5, TSS, TOC, TDS, TOC-F, TIC, SO_4, NO_3, NO_2, TP, Cl, SiO_2, NH_3-N, TKN, Org-N, Na, Ca, Mg, Mn, Fe, SRP, TDP, ALK-T, Turbidity/ Biweekly															
Equipment Blank 2 – Churn (Churn B) BOD_5, TSS, TOC, TDS, TOC-F, TIC, SO_4, NO_3, NO_2, TP, Cl, SiO_2, NH_3-N, TKN, Org-N, Na, Ca, Mg, Mn, Fe, As, Cd, Cr, Cu, Hg, K, Ni, Pb, Zn, SRP, TDP, CN, ALK-T, Turbidity/ Quarterly															

APPENDIX C (Continued)
2008 Tributary Sampling Program

[1]Tributary 5A flow will also be monitored quarterly (during the Quarterly Extended Tributary sampling events, which includes the quarterly and biweekly parameters).
[2] Metro Effluent sampled biweekly for all parameters. If any flow is bypassed on tributary sampling date, this water is sampled for the same parameters as all other tributaries.
[3] The Fecal Coliform sample will be collected at the surface (0m) for the Lake Outlet sampling site.
[4] Includes only the parameters K, Ca, Na, Mg, Cl, SO_4.
[5] Bloody Brook at Onondaga Lake Parkway will be sampled biweekly from June 1 – September 30 during the Tributary sampling events.
[6] Sawmill Creek at Onondaga Lake Recreational Trail will be sampled biweekly from June 1 – September 30 during the Tributary sampling events.
[7] Includes the parameters Cl, Ca, Na, Mg, K, SO_4, Fe, Mn, Alk-T, pH, Temperature, D.O., Redox, Salinity, Conductivity. Sampling to be conducted on a quarterly basis.
Note: A minimum of 5 tributary sampling events will be conducted for predetermined high flow conditions [defined as one standard deviation above the long-term monthly mean flow value based on the USGS gage height at Onondaga Creek (Spencer Street site)].

APPENDIX D

2008 Onondaga Lake Sampling Program

Ambient Monitoring Program

Onondaga County, New York

	METERS							
PARAMETER	**0**	**3**	**6**	**9**	**12**	**15**	**18**	**FREQUENCY[1]**
	UML[2]			LWL[2]				
Cd, Cr, Cu, Ni, Pb, Se, Zn, As, K	Composite			Composite				Quarterly
Hg[3]		X					X	April, August, October (post-turnover)
Ca, Na, Mg, Mn, Fe	Composite			Composite				Biweekly
Cl, SO_4	Composite			Composite				Biweekly
TS, TSS, VSS, TVS, TDS, SiO_2, TOC, TOC-F, TIC	X		X		X		X	Biweekly
Turbidity	Composite							Biweekly
BOD_5	Composite			Composite				Biweekly
TP[4], SRP, TDP	X	X	X	X	X	X	X	Biweekly
NO_3, NO_2	Composite			Composite				Biweekly
TKN, NH_3-N, Org-N, F-TKN	X	X	X	X	X	X	X	Biweekly
ALK-T	Composite			Composite				Biweekly
Fecal Coliform, E. Coli	X							Biweekly
CHLOR-A[5], PHAEO-A	Composite							Biweekly
Sulfide[6]					X	X	X	Biweekly
Temperature, pH, Salinity, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	Measured every half-meter from 0- to 18-meter depth							Biweekly
Underwater Illumination profile, Secchi Disk Transparency	Recorded at each site							Biweekly
Phytoplankton[7]	Composite							Biweekly
Zooplankton[8]	Composite			X				
Equipment Blank 1 – Pump TS, TSS, VSS, TVS, TDS, SiO_2, TOC, TOC-F, TIC, TP, SRP, TDP, TKN, NH_3-N, Org-N, F-TKN								Biweekly

APPENDIX D (Continued)
2008 Onondaga Lake Sampling Program

Equipment Blank 2 – Dunker-Churn (Churn Blank) Ca, Na, Mg, Mn, Fe, Cl, SO_4, NO_3, BOD_5, NO_2, ALK-T, Turbidity		Biweekly
Equipment Blank 2 – Dunker-Churn (Churn Blank) Cd, Cr, Cu, Ni, Pb, Se, Zn, As, K, Ca, Na, Mg, Mn, Fe, Cl, SO_4, NO_3, NO_2, ALK-T		Quarterly

[1] Samples are taken at the South Deep Station, which is representative of the lake conditions.
Additional quarterly sampling is conducted at the North Deep Station (during Double Lake sampling events).
[2] Please note that "UML" (Upper Mixed Layer) and "LWL" (Lower Water Layer) composite samples collected during the sampling events will be made by mixing samples from each depth according to the following field protocol:

(a) Late fall, winter, and early spring (October 1 – May 31) when the lake waters are not strongly stratified.
   i. The default UML during this period of the year is 0, 3, 6m.
   ii. The default LWL during this period of the year is defined as 9, 12, 15 and 18m.

(b) Summer stratification period (June 1 – September 30)
   i. The UML composite shall always include samples collected at 0 and 3 m depths. Inclusion of water collected at 6 m in the composite shall be evaluated based on the temperature profiles measured during the sampling event.
   ii. The composite sample of the LWL will typically include water collected at depths of 12, 15 and 18 m during this period. The inclusion of the 12 m depth in the composite of the lower waters should be reviewed during each sampling event. Because the 9m depth is consistently in the metalimnion during this period, water from this depth will not be included in either composite sample.

[3] Hg - Special low-level Hg (total and methyl Hg analysis by Contract Laboratory) at the Lake South and North Deep stations. A duplicate sample will be collected at the 18m depth at the South and North Deep station during each sampling event. Also, a separate equipment rinseate blank will be collected for special low-level Hg analysis.
[4] A "Special" TP 500 ml sample to be collected during the South Deep biweekly sampling events at 1m depth between June 1 - September 30, 2008.
[5] The Chlorophyll-*a* tube composite sample has been standardized to a depth of 0-3m year round.
[6] Sampling of sulfides only if anoxic conditions are determined through the YSI profile (to be completed prior to sampling).
[7] Phytoplankton tube composite sample has been standardized to a depth of 0-3m year round.
Frequency of Phytoplankton samples will be:
South Deep station: biweekly from April - November and monthly January, February, March, December.
[8] Zooplankton will be collected as follows:
i) a net tow through the UML during the thermally stratified period; and
ii) a 15 meter vertical net haul during the unstratified period.
Frequency of Zooplankton samples will be:
South Deep station: biweekly from April - November and monthly January, February, March, December.
North Deep station: quarterly (during the Double lake sampling events).

APPENDIX E

2008 Onondaga Lake Winter Sampling Program

Ambient Monitoring Program
Onondaga County, New York

	METERS							
PARAMETER	**0**	**3**	**6**	**9**	**12**	**15**	**18**	**FREQUENCY[1]**
Ca, Na, Mg, Mn, Fe, Hardness	Composite[2]			Composite[2]				
Cl, SO_4	Composite			Composite				
TS, TSS, VSS, TVS, TDS, SiO_2, TOC, TOC-F, TIC	X		X		X		X	
Turbidity	Composite							
BOD_5	Composite			Composite				
TP, SRP, TDP	X	X	X	X	X	X	X	
TKN, NH_3-N, Org-N, F-TKN	X	X	X	X	X	X	X	
NO_3, NO_2	Composite			Composite				
ALK-T	Composite			Composite				
CHLOR-A, PHAEO-A	Composite							
Fecal Coliform, E. Coli	X							
Sulfide[3]					X	X	X	
Temperature, pH, Salinity, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	Measured every half-meter from 0-to 18-meter depth							
Underwater Illumination profile, Secchi Disk Transparency	Recorded at site							
Phytoplankton [4]	Composite							
Zooplankton [5]	Composite			X				
Equipment Blank 1 – Pump TS, TSS, VSS, TVS, TDS, SiO2, TOC, TOC-F, TIC, TP, SRP, TDP, TKN, NH3-N, F-TKN								
Equipment Blank 2 – Dunker-Churn (Churn Blank) Ca, Na, Mg, Mn, Fe, Cl, SO_4, BOD5, NO_3, NO_2, ALK-T, Turbidity								

2008 Onondaga Lake Winter Sampling Program

[1] Samples are taken at the South Deep Station, which is representative of the lake conditions. Sampling will be conducted at North Deep Station if sampling during ice cover.
Frequency is once per month during January, February, and March (as weather allows).

[2] As the lake waters are not strongly stratified in the winter:

i) The default UML during this period of the year is 0, 3, 6 m.

ii) The default LWL during this period of the year is defined as 9, 12, 15 and 18 m.

Composites are made by mixing samples from each depth.

[3] Sampling of sulfides only if anoxic conditions are determined through the YSI profile (to be completed prior to sampling).

[4] Phytoplankton tube composite sample has been standardized to a depth of 0-3m year round.

[5] Zooplankton will be collected as a 15 meter vertical net haul when lake is ice free. When sampling over ice for a qualitative assessment, a special zooplankton sample will be collected using an 8 inch diameter net (with 80 um mesh through the UML and poured into a 1-liter container and preserved according to the Field Preservation Guide).

APPENDIX F

2008 Onondaga Lake Special Weekly Sampling Program

Ambient Monitoring Program
Onondaga County, New York

PARAMETERS	FREQUENCY	LOCATIONS
Fecal Coliform E. Coli Turbidity Secchi Disk Transparency[2] Temperature	Weekly sampling April 1 – October 15	Onondaga Lake (Near shore sites)[1] (See Figure 1) GPS Coordinates: Site 1 – 43° 05.477' N 76° 13.650' W Site 2 – 43° 03.877' N 76° 11.043' W Site 3 – 43° 03.937' N 76° 10.931' W Site 4 – 43° 04.407' N 76° 10.768' W Site 5 – 43° 06.529' N 76° 13.598' W Site 6 – 43° 06.873' N 76° 14.156' W Site 7 – 43° 06.732' N 76° 14.713' W Site 8 – 43° 05.720' N 76° 12.225' W Site 9 – 43° 04.880' N 76° 12.620'W
Chlorophyll-*a*[2] Fecal Coliforms E. Coli Turbidity Secchi Disk Transparency In-situ field data (measured every half-meter from 0- to 18-meter depth) : pH, Temperature, Salinity, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	Weekly sampling April 1 – October 15	Onondaga Lake South Deep station – Site 10 43° 04.670' N 76° 11.880' W
Fecal Coliforms E. Coli Turbidity Secchi Disk Transparency In-situ field data (measured every half-meter from 0- to 18-meter depth) : pH, Temperature, Salinity, Conductivity, Dissolved Oxygen, Oxidation-Reduction Potential	Weekly sampling April 1 – October 15	Onondaga Lake North Deep station – Site 11 43° 05.930' N 76° 13.730' W

[1] The nearshore sampling stations are standardized to water depths of 4-5 feet of water. Samples will be collected from the water surface (<1m).

[2] Chlorophyll-*a* composite samples will be collected at the South Deep station weekly from May – September only, to a standardized depth of 0-3m year round.

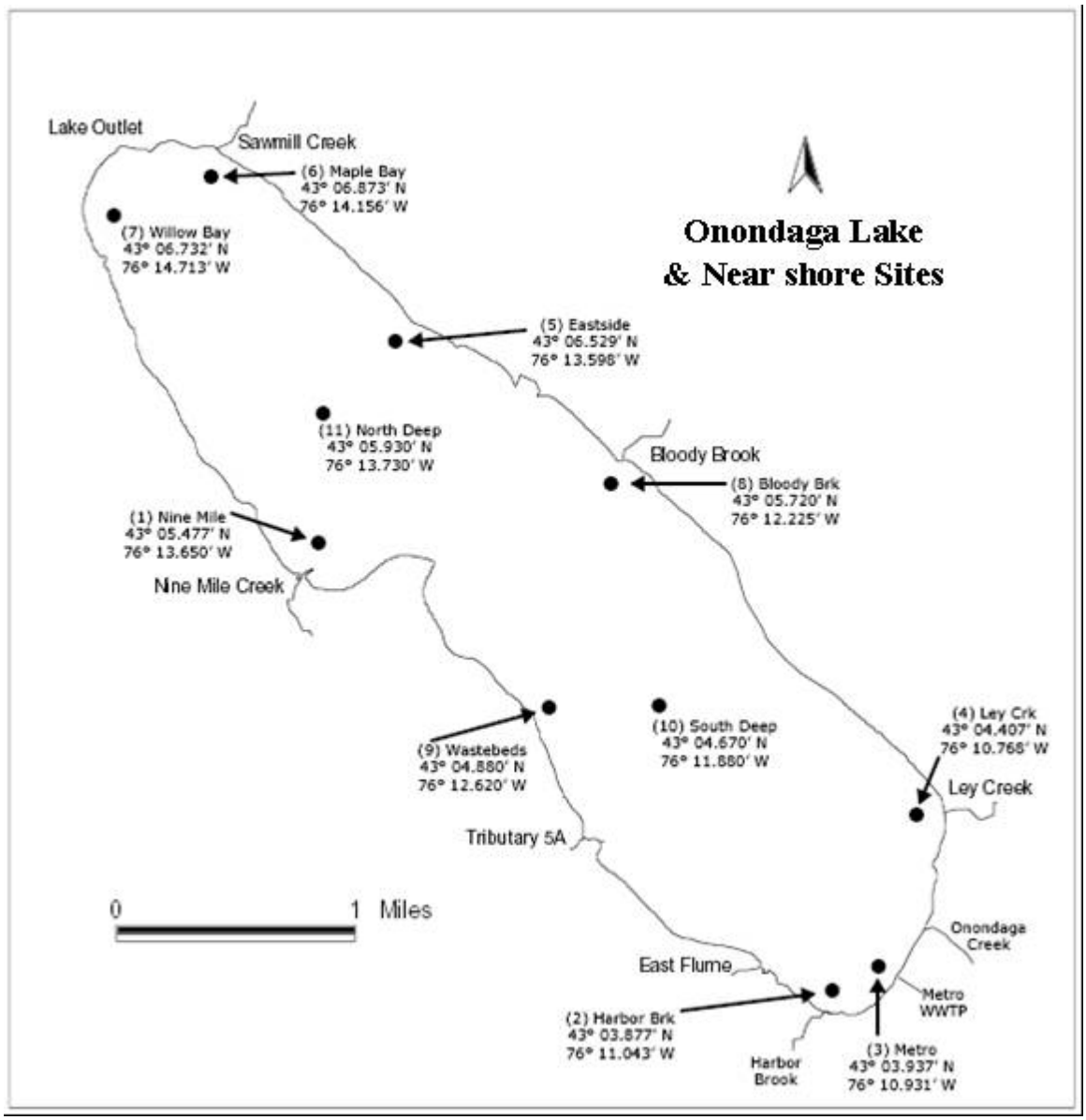


Figure 1 Onondaga Lake Near Shore Sampling Locations

APPENDIX G

2008 Onondaga Lake Fall Turnover Sampling Program

Ambient Monitoring Program
Onondaga County, New York

PARAMETER	METERS							FREQUENCY
	0	**3**	**6**	**9**	**12**	**15**	**18**	
Cl, NO_3*, NO_2*	Composite			Composite				Weekly[1] (During Fall Turnover)
TDS, SiO_2	X		X		X		X	
TP, SRP, TDP	Composite			Composite				
NH_3-N*, TKN*, F-TKN				Composite				
ALK-T	X		X		X		X	
CHLOR-A[2]	Composite							
Temperature, pH, Dissolved Oxygen, Specific Conductance, Salinity, Redox Potential	Measured every half-meter from 0- to 18-meter depth							More frequently[3]. Every effort made to collect daily profiles during the first three days of fall mixing.
Secchi Disk Transparency								During each event.
Equipment Blank 1 - Pump TDS, SiO_2, ALK-T								Weekly (during Fall Turnover)
Equipment Blank 2 - Dunker-Churn (Churn Blank) - Cl, NO_3, NO_2, TP, SRP, TDP, NH_3-N, TKN, F-TKN								Weekly (during Fall Turnover)

[1] Samples are taken at the South Deep Station, which is representative of the lake conditions.
[2] The Chlorophyll-*a* tube composite sample has been standardized to a depth of 0-6m year round.
[3] In addition, YSI field data will also be collected at the mouth of Onondaga Lake Tributaries (including Sawmill, Bloody Brook, East Flume, Tributary 5A, Ley Creek, Onondaga Creek, Harbor Brook, Ninemile Creek, Metro Outfall), North Deep station and Onondaga Lake Outlet once during turnover.

APPENDIX H

2008 River Sampling Program

Ambient Monitoring Program
Onondaga County, New York

Buoy Location: Seneca River: Buoy # 316 (43° 07.249' N Latitude, 76° 14.938' W Longitude)
Frequency: Monthly sampling event from July – September 2008

The following table summarizes the field data to be collected typically at 15-minute intervals over a 24-hour period at Buoy 316 by installing two (2) YSI data-loggers (one in the upper and one in the lower waters) during the monthly sampling events from July through September 2008.

FIELD DATA*	FREQUENCY/TIMING
pH, S.U.	Monthly (July – September) Target low stream flows.
Specific Conductance, mS/cm	
Temperature, Deg C	
Dissolved Oxygen, mg/l	
Salinity, ppt	
Oxidation-Reduction Potential, mV (ORP)	
Underwater Illumination Profile ($\mu mol\ s^{-1}\ m^{-2}$)	
Secchi Disk Transparency (m)	

APPENDIX H (Continued)

2008 River Sampling Program

The following table summarizes the parameters for analysis. One set of samples will be collected at 2 depths for Buoy 316 (1-meter below the water surface and 1-meter above the river sediments) during the 24-hour period, during each of the monthly sampling events from July – September 2008.

Analytical parameters		
PARAMETER	**NO. OF SAMPLES PER EVENT (2 SAMPLES)[3]**	**FREQUENCY/TIMING**
TOC	2	Monthly (July – September) Target low stream flows.
TDC	2	
TKN	2	
NO_2	2	
NH_3	2	
F-TKN	2	
NO_3	2	
Chlorophyll-*a*[1]	2	
SRP	2	
TDP	2	
TP	2	
TSS	2	
Cl	2	
BOD_5 [2]	2	
Turbidity	2	
Equipment Blank 1 – Dunker-Churn TOC, TDC, TKN, NO_2, NH_3, F-TKN, NO_3, SRP, TDP, TP, TSS, Cl, BOD_5, Turbidity		Monthly

[1] Chlorophyll-*a* will be collected at Buoy 316 from the 2 depths (1-meter below the water surface and 1-meter above the river sediments) during each of the sampling events.
[2] BOD_5 will be field composited from the 2 depths for the buoy location (1-meter below the water surface and 1-meter above the river sediments for one composite sample for analysis) during each of the sampling events.
[3] Field duplicates will be collected at Buoy 316 (1-meter below the water surface and 1-meter above the river sediments) during each of the monthly sampling events for each parameter.

APPENDIX I
Year 2008 Storm-Event Sampling Program

Ambient Monitoring Program
Onondaga County, New York

Tributary	Locations	Parameters	Frequency/Type of sample
Onondaga Creek	• Rte. 20 • Dorwin Avenue • Spencer St. • Hiawatha Blvd. Bridge[3]	TP, SRP, TDP, TKN, Cl, TSS, Fecal Coliform, Turbidity, Temperature	3 times in Year 2008. Sampling will be initiated within 2 hours of a storm event.[1] Sample[2] every 2 hours for 1st day (24 hours); every 4 hrs for 2 consecutive days (48 hours) thereafter.
Onondaga Lake	• Onondaga Lake Sites 1-11[4] (See Figure 1) Site 1 – Ninemile Creek 43° 05. 477'N 76° 13. 650'W Site 2 – Harbor Brook 43° 03. 877'N 76° 11. 043'W Site 3 – Metro 43° 03. 937'N 76° 10. 931'W Site 4 – Ley Creek 43° 04. 407'N 76° 10. 768'W Site 5 – Eastside 43° 06. 529'N 76° 13. 598'W Site 6 – Maple Bay 43° 06. 873'N 76° 14. 156'W Site 7 – Willow Bay 43° 06. 732'N 76° 14. 713'W Site 8 – Bloody Brook 43° 05. 720'N 76° 12. 225'W Site 9 – Wastebeds 43° 04.880' N 76° 12.620'W Site 10 – South Deep 43° 04.670' N 76° 11.880'W Site 11 – North Deep 43° 05.930' N 76° 13.730'W	Fecal Coliform, E. Coli, Turbidity Secchi Disk, Temperature	3 times in Year 2008. Once per day for 3 consecutive days per storm event.
Equipment Blank 1 - SS Pail TP, SRP, TDP, TKN, Cl, TSS, Turbidity			Once per sampling event.

[1] To target storms with rainfall intensities of 0.35"rain per hour.

[2] Sample from stream.
[3] Duplicate samples will be collected at the Onondaga Creek Hiawatha Blvd. location (during every other cycle).
[4] Onondaga Lake samples collected from the surface (to be collected within 24 hours of storm-event initiation).

APPENDIX J
2008 Water Quality Monitoring Programs
Summary of Modifications

Appendix A: Year 2008 Non-Event Sampling Schedule (April 2008 - March 2009)
As required by Appendix D of the Amended Consent Judgment, included is an annual sampling schedule for the 2008 non-event related sampling, specifying dates, locations, and parameters.

Appendix B: Year 2008 Event-Based Sampling Schedule
The monitoring program for event related sampling specifies the number of annual activities. In the event of a need to alter the schedule due to unforeseeable circumstances, NYSDEC and ASLF shall be notified *via fax only* as soon as practicable prior to the event.

Appendix C: Year 2008 Tributary Sampling Program
Modification:

- Footnotes 5 and 6:
  Changed Bloody Brook (at Onondaga Lake Park) and Sawmill Creek at (Onondaga Lake Recreational Trail) sampling from high flow events (four times a year) for all extended parameters to biweekly sampling from June 1 through September 30, 2008. Based on previous years sampling results, the contribution of these two tributaries to loading in Onondaga Lake is proportionally much less than that from other tributaries. These two tributaries contributed approximately 3.6% of the flow during the 2006 sampling events. Sampling in 2008 will focus on the period of dry weather and will be tied to the summer recreational period (June – September).

Appendix D: Year 2008 Onondaga Lake Sampling Program
Modification:
Chlorophyll-*a* & Phytoplankton Samples:

(1) Standardize the depth of the tube composite for Chlorophyll-*a* to 0-3 m, year round, and eliminate the second tube composite sample for Chlorophyll-*a* identified as the "photic zone" sample.

This recommendation will result in dropping the photic zone tube composite (defined as twice the depth of the Secchi disk transparency) from the biweekly monitoring program. To evaluate the potential implications of dropping the photic zone composite sample, we reviewed results of paired measurements using the two depths (UML and photic) over the time period when both were measured.

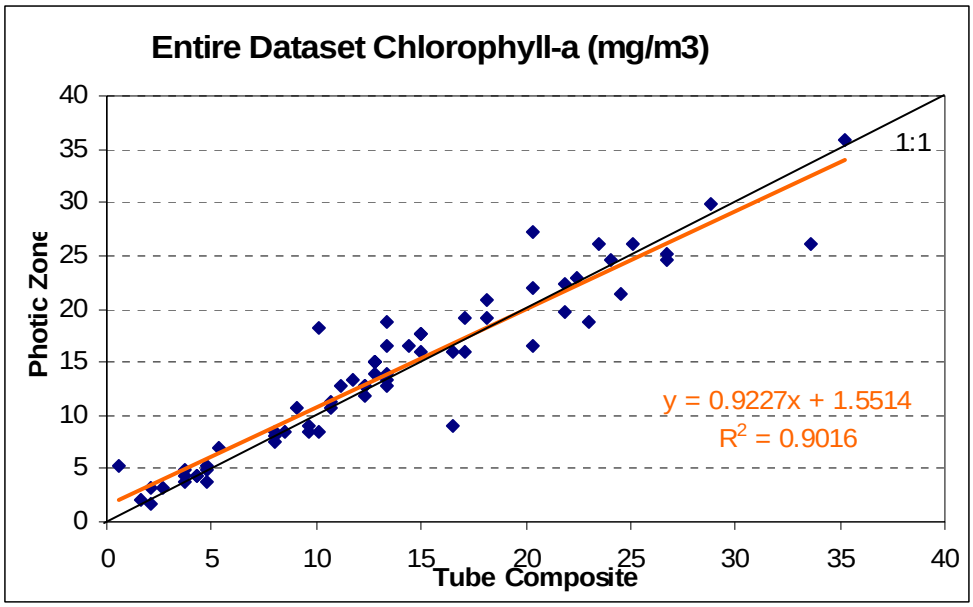
The AMP included collecting the two tube composites beginning in May 2005; the data we used for the statistical evaluation extended through December 2006. There were 65 paired samples total in the two years, including both North and South basins, from winter, spring, summer and fall seasons. Chlorophyll-*a* concentrations as measured on samples collected from tube composites extending to the two depths are not statistically different.

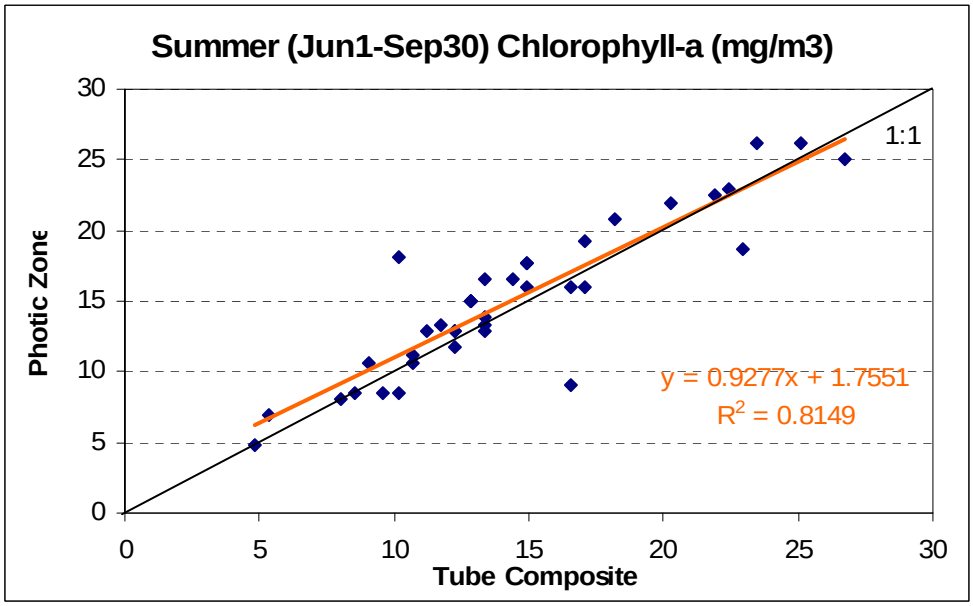
a) T-test on the 65 paired sample results indicates no statistically significant difference ($p = 0.12$) at alpha=0.05. The difference in the means was 0.49 mg/m^3.

b) T-test on summer subset of 38 paired samples (Jun 1 – Sept 30) indicates no statistically significant difference ($p = 0.069$) at alpha=0.05. The difference in the means was 0.72 mg/m^3.

Plots of the paired data are included, demonstrating the strong correlation between the paired samples.

Phytoplankton analyses will be collected as tube composites also from 0-3m. Standardizing the Chlorophyll-*a* and Phytoplankton sampling depth to 3 m year-round will benefit in simplifying the program.





Zooplankton Samples:

(2) Modify the sample depth collection for zooplankton; sample from 0-15 m during the unstratified period, and UML during the stratified period.

We conferred with Dr. Ed Mills on this recommendation. Historically, zooplankton samples have been collected using two tows: one through the UML and the second from 0-15 m. These samples have been averaged in the reporting.

The standardization of depth will improve the comparability of the biological and water quality data sets.

Appendix E: Year 2008 Onondaga Lake Winter Sampling Program

Modification:

- Deleted Chlorophyll-*a* Photic Zone sample and standardized to a consistent depth of 3m year round.
- Zooplankton will be collected as a 15 meter vertical net haul when lake is ice free.
- Phytoplankton analyses will be collected as tube composites also from 0-3m.

Appendix F: Year 2008 Onondaga Lake Special Weekly Sampling Program

Modification:

- Changed the frequency of the weekly sampling from May 1 – September 30 to April 1 – October 15 in order to evaluate compliance with the NYS water quality Fecal Coliform monthly geometric mean from a minimum of five samples, standard of 200 colonies per 100 mL to be met during all periods when disinfection is practiced (to coincide with the Metro Effluent disinfection period).
- Added North Deep station (Class B site) to the weekly sampling program.
- Chlorophyll-*a* will be collected at a standardized depth of 3m year round.

Appendix G: Year 2008 Onondaga Lake Fall Turnover Sampling Schedule

Modification:

- Deleted Weekly sampling for the parameters NO_3, NO_2, NH_3-N, TKN, F-TKN weekly during October 15 – November 15, as the Lake is already in compliance with the Ammonia standards.
- Deleted Chlorophyll-*a* Photic Zone sample and standardized to a consistent depth of 3m year round.

Appendix H: Year 2008 River Monitoring Program

Modification:

- No change.

Appendix I: Year 2008 Storm-Event Monitoring Program

Added. The 2008 AMP includes storm event monitoring for Onondaga Creek following completion of the Midland Avenue Regional Treatment Facility.

APPENDIX K

Onondaga Lake Fish Community Sampling Plan 2008

Ambient Monitoring Program
Onondaga County, New York

Component	Methodology/Gear	Sampling Objectives	Location and Number of Samples	Timing	Changes
Pelagic Larvae	Modified double oblique Miller high-speed trawl, with flow meter attached, collected during the day in the pelagic zone.	Determine species richness.	- 4 double oblique tows in each basin (North and South) per event. -Tows will sample water depths from the surface to 5.5 meters. -Total No. of events =8 -Total No. of samples =64	-Daytime -Bi-weekly. -April (when water temps. are 7-8 ºC) through end of July.	-No Change from previous year.
Juvenile Fish	50’ x 4’ x 1/4” bag seine swept into shore in the littoral zone.	Determine community structure and species richness.	-5 strata with 3 sites in each strata and 1 sweep at each site. -No. of Sites = 15 -Total No. of events = 6 -Total No. of samples = 90	-Daytime -Every 3 weeks. -July - October.	-No Change from previous year.
Nesting Fish	Lake wide nest survey.	Document spatial distribution and species composition	-Entire perimeter of lake divided into 24 equal length sections. -Total No. of events = 1 -Total No. of samples = 24	-Once in June when water temperature is between 15° and 20 °C.	-No Change from previous year.
Adult Fish-Littoral Zone	Boat mounted electrofisher in the littoral zone at night.	Determine community structure, species richness, CPUE, and relative abundance.	-Entire perimeter of lake shocked in 24 contiguous transects. -Alternating all-fish/gamefish transects. -Total No. of events = 2 -Total No. of samples = 48	-Night-time. -Twice per year; Spring and Fall. -Spring and Fall. -Water temp. between 15º and 21 ºC.	-No Change from previous year.
Adult Fish-Profundal Zone	Experimental gill nets of standard NYSDEC dimensions.	Determine community structure, and species richness.	-One net per strata. -Nets set on bottom, parallel to shore at a water depth of 4-5m for two hours. -Total No. of events = 2 -Total No. of samples = 10	-During the day. -Twice per year, within one week of littoral electrofishing.	-No Change from previous year.
Angler Census	Angler diary program and bass tournament surveys.	Determine catch rates, species composition. Attitudes and opinions over the AMP.	-Recruit diary participants at fish & game clubs and fishing organizations. - Fish from tournaments will be tagged at time of weigh-in.	-Issued annually and collected at end of fishing season (fall). -Tournament schedule TBA	-No Change from previous year.

APPENDIX L

Onondaga Lake Macrophyte Assessment Program 2008

Ambient Monitoring Program
Onondaga County, New York

Component	Methodology/Gear	Sampling Objectives	Location and Number of Samples	Timing	Change
Onondaga Lake Aerial Photography	Program utilizes plane with belly mounted 9x9 camera. 60% forward overlap, 30% side overlap.	Determine annual percent of littoral zone with macrophytes.	-Three (3) flight lines full lake coverage.	-June or July when water clarity is approximately 3-meters on the secchi disk. -Early morning or early evening with low sun angle.	-No change from previous year.
Field Species Verification of Aerial Photography	Visual identification.	Determine species.	-Two (2) sites in each of the five (5) strata for a total of ten (10) sites.	-Within 1 week of the aerial photos.	-No change from previous year.
Macroalgae	At nine (9) near shore locations using a laser range finder to estimate distance from shore and visual percent cover estimate.	Document percent cover and annual proliferation of littoral zone macroalgae.	-Survey once per week at nine (9) near shore buoy locations.	-May through September.	- No change from previous year.

APPENDIX M

Onondaga Lake and Tributary Macroinvertebrate Assessment Program 2008

Ambient Monitoring Program
Onondaga County, New York

Component*	Methodology/ Gear	Sampling Objectives	Location and Number of Samples	Timing	Change
Tributary Macroinvertebrate Sampling	Kick Screen Sampling Jab Net Sampling	NYSDEC Water Quality Assessment Protocol HBI – Hilsenhoff Biotic Index % Oligocheates	- Four (4) Sites on Onondaga Creek - Three (3) Sites on Ley Creek - Three (3) Sites on Harbor Brook	July during low flow conditions.	No Change from 2006.
Habitat Assessment	USEPA Rapid Bioassessment Protocol	Habitat Characterization	- Four (4) Sites on Onondaga Creek - Three (3) Sites on Ley Creek - Three (3) Sites on Harbor Brook	July during low flow conditions.	No Change from 2006.
Tributary Mapping	Stream Visual Assessment Protocol (SVAP) developed by the NRCS	Physical Assessment of ten (10) elements. FBI – Family Level Biotic Index.	- Twenty-seven (27) sites on Onondaga Creek. - Nine (9) sites on Ley Creek. - Seven (7) sites on Harbor Brook.	August during low flow conditions.	No Change from 2002.

* No Lake Macroinvertebrate Monitoring Scheduled in 2008. Next event scheduled for 2010.

ATTACHMENT 1

QUALITY ASSURANCE PROGRAM PLAN
FOR THE 2008 WATER QUALITY MONITORING PROGRAM

AMBIENT MONITORING PROGRAM

Prepared for the NYSDEC

by:

Onondaga County
Department of Water Environment Protection

July 1998 (Original)
February 2003 (Revision)
June 2003 (Revision)
March 2004 (Revision)
March 2005 (Revision)
April 2006 (Revision)
April 2008 (Revision)

QUALITY ASSURANCE PROGRAM PLAN

YEAR 2008 WATER QUALITY MONITORING PROGRAM
(AMBIENT MONITORING PROGRAM)
Onondaga County
Syracuse, New York
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I. PROGRAM DESCRIPTION

Onondaga Lake is an urban lake located in Onondaga County, New York. The lake has several natural tributaries and receives overflow from combined sewers in the City of Syracuse, treated effluent from the Metropolitan Syracuse Wastewater Treatment Plant (Metro) as well as non-point runoff from a mix of urban, residential, and agricultural areas.

Onondaga Lake is located immediately northwest of the City of Syracuse in Onondaga County, New York, USA (43° 06' 54" N, 76° 14' 34" W). The outlet of Onondaga Lake flows into the Seneca River, which joins with the Oswego River which eventually flows into Lake Ontario. The Onondaga Lake drainage basin encompasses approximately 700 km^2 and with exception of 2 km^2 in Cortland County lies almost entirely in Onondaga County. The tributary drainage basins include six natural sub-basins: Ninemile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek. Although much of the lake watershed is agricultural, the lake itself is surrounded by urban and suburban development.

Since 1968, the water quality of Onondaga Lake and its tributaries have been monitored to meet the objectives of assessing: trophic status, compliance with New York State ambient water quality standards and guidance values, external loading of pollutants to Onondaga Lake through its tributaries, and trends in water quality in response to major pollutant abatement activities at Metro and the CSOs.

The annual lake monitoring program was originally implemented to comply with a special federal grant condition for the major upgrade of the Metro facility completed in the early 1970s. The scope of the annual monitoring program has expanded over the years in response to the enhanced understanding of the complex interactions between pollutant inputs and lake response. In 1998, the monitoring program was modified to provide specific data and information needed to assess the effectiveness of another round of improvements to the wastewater collection and treatment system. The Year 2008 Onondaga Lake Ambient Monitoring Program (AMP) is designed to determine whether planned controls on point and nonpoint source pollution loading will be sufficient to bring the lake, the lake tributaries, and a segment of the Seneca River into compliance with state and federal standards.

Trophic status of the lake will be assessed by monitoring Secchi disk transparency, major nutrient concentrations, chlorophyll-*a*, phytoplankton abundance and species composition, zooplankton species composition and abundance, the fish community, hypolimnetic dissolved oxygen, and accumulation of reduced species.

Compliance of the lake and tributary waters with the New York State ambient water quality standards will be evaluated. The lake is Class B and Class C; tributaries are Classes B, C, or C (T). Numerical standards exist for dissolved oxygen, ammonia, nitrite, and nitrate nitrogen, bacteria, pH, dissolved solids, and a large number of other organic and inorganic parameters. Narrative standards are in effect for several water quality parameters of Class B and C waters (including Onondaga Lake and its tributaries)."

As detailed in Section 703.2 of the New York State Environmental Conservation Law, parameters regulated by a narrative standard include:

Taste-, color-, and toxic and other deleterious substances	AA, A, B, C, D, SA, SB, SC, I, SD, A-Special, GA, GSA, GSB	None in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages.
Turbidity	AA, A, B, C, D, SA, SB, SC, I, SD	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal and settleable solids	AA, A, B, C, D, SA, SB, SC, I, SD, A-Special	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating substances	AA, A, B, C, D, SA, SB, SC, I, SD, A-Special	No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
Phosphorus and nitrogen	AA, A, B, C, D, SA, SB, SC, I, SD, A-Special	None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.
Thermal discharges	AA, A, B, C, D, SA, SB, SC, I, SD, A-Special	See Part 704 of the NYS ECL

External annual loadings (concentration and flow) to Onondaga Lake through its tributary streams of oxygen demanding materials, sediments, bacteria, metals, dissolved salts, plant nutrients are monitored. Monitoring is conducted throughout the year and the program is designed to capture high flow and storm events along with baseline conditions. These data are also used for general surveillance to evaluate compliance with the County's pretreatment program. The trends in Onondaga Lake and Tributary water quality over time and in response to major reductions in point source loadings will be assessed through statistical evaluations of the long-term data set developed for this system. An annual report summarizing the results of the current year's data acquisition program and the statistical analyses of trends in external loading and lake response is prepared each year. Data are archived in a database.

The annual Onondaga Lake Monitoring program was expanded in 1994 to include water quality sampling at key locations in the Seneca/Oneida/Oswego river system. The purpose of the County's river monitoring program is to define ambient water quality conditions in the River system, between Cross Lake and Three Rivers, determine compliance with the water quality standards, evaluate the assimilative capacity of the Seneca River, and identify the impacts of the Baldwinsville Seneca-Knolls WWTP, Wetzel Road WWTP, Oak Orchard WWTP and the Onondaga Lake Outlet on River water quality.

In January 1998, Onondaga County signed an Amended Consent Judgment (ACJ) committing to a phased 15-year program of upgrades and improvements to the County's wastewater collection and treatment system. The County's long-term monitoring program was evaluated and modified to ensure that the data collected would be adequate to evaluate the response of the lake, streams, and river to the planned improvements to the Combined Sewer Overflows (CSOs) and Metro. This process of evaluation and modification was a collaborative effort of Onondaga County, its technical advisors, New York State Department of Environmental Conservation (NYSDEC), the Environmental Protection Agency (EPA), and Atlantic States Legal Foundation (ASLF). Modifications were made to focus the monitoring program on a series of hypotheses related to the effectiveness of the County's improvements to the wastewater collection and treatment system. A revised monitoring program, known as the Ambient Monitoring Program (AMP) was initiated in August 1998.

The effectiveness of the improvements to the County's wastewater system can be measured in terms of (1) compliance with water quality standards and guidance values, and (2) restoration of a balanced ecological community of plants and animals. A significant change in the annual monitoring program was the greatly expanded focus on the biology of the aquatic system including the status of the fish community, macroinvertebrates, rooted aquatic plants, algae, and zooplankton, in addition to tracking the physical and chemical variables.

II. TECHNICAL DESIGN

The monitoring program described above discusses the full matrix of water quality issues and parameters of concern to Onondaga County.

A. INTRODUCTION

The Onondaga County Department of Water Environment Protection (OCDWEP) has monitored the water quality of Onondaga Lake and its tributaries since 1970.

Refer to Appendix A Year 2008 Water Quality Program-Ambient Monitoring Program (non-event sampling schedule).

Water samples for analysis will be collected and analyzed according to EPA requirements for Water Planning and Management (40 CFR 136, 1991 or latest version) and EPA 600/4-82-029. Sampling and analysis will be consistent with New York State's Environmental Laboratory Approval Program (ELAP). The OCDWEP Environmental Laboratory is certified by New York State (ELAP #10191) and the National Environmental Laboratory Accreditation Conference (NELAC).

B. ONONDAGA LAKE

Onondaga Lake will be sampled from April 1 through December 2, 2008, according to the calendar included in Appendix A Year 2008 Ambient Monitoring Program (non-event sampling schedule). The parameters to be sampled and their schedules are also detailed.

Samples will be collected from the locations identified as "South Deep" and "North Deep" stations. The exact sampling location will be at the mooring buoys deployed at the South and North Deep stations as listed below.

The coordinates of the monitoring stations are as follows:

South Deep:	43° 04.670' N	Latitude
	76° 11.880' W	Longitude
North Deep:	43° 05.930' N	Latitude
	76° 13.730' W	Longitude

Studies have shown that sampling from these basins will reflect the condition of the remainder of the lake.

In-situ data for pH, Dissolved Oxygen (DO), Temperature, Specific Conductance, and Oxidation-

Reduction Potential (ORP) will be collected at half-meter intervals throughout the water column using either a YSI 600 or a YSI 6600 in-situ monitoring sonde. Calibration and instrument calibration drift checks will be conducted before and after each sampling event.

Samples will be collected using a submersible pump and a Wildco Beta sampler, depending on the sample parameter. However, samples of bacteria will be collected in sterile containers. When pumping, sufficient time will be allowed in order to evacuate the pump lines of all previous samples. In addition, all sample containers will be rinsed with sample water, unless they are pre-preserved. Composite samples will be collected on a volumetric basis (i.e., the proportions of samples collected at the series of depths are composited equally using a Wildco Beta sampler). Compositing will be accomplished using a sample-splitting churn. Samples will be thoroughly mixed and poured-off from the churn. All sampling equipment used on Onondaga Lake is dedicated for this purpose only.

Other field data to be collected include Secchi disk transparency and light availability. Light availability data are collected at 20-cm intervals from the water surface to a depth at which light is 1% of surface illumination, as noted during the sampling event, using a LiCor datalogger.

In addition to the above, OCDWEP partially funds the gauging stations on Onondaga Lake and its tributaries in conjunction with the United States Geological Survey. Flow data are used to calculate loading rates.

C. TRIBUTARIES

Onondaga Lake tributaries are sampled throughout the year, according to the calendar included as Appendix A Year 2008 Ambient Monitoring Program (non-event sampling schedule). The parameters to be sampled and their schedules are detailed in Appendix C Year 2008 Ambient Monitoring Program (Tributary Sampling Program).

In-situ data for pH, Dissolved Oxygen, Temperature, Specific Conductance, and Oxidation-Reduction Potential will be collected using a YSI sonde. Calibration and calibration drift checks will be conducted before and after each sampling event.

Tributary samples will be collected using the depth-integrated sampling technique from each location, except for at the Allied East Flume, Sawmill Creek, Onondaga Lake Outlet, Harbor Brook at Hiawatha Boulevard, and Ley Creek monitoring sites. The Allied East Flume, Bloody Brook and Sawmill Creek samples are taken as described in Attachment A, sections 9, 13, and 14, respectively. A vertical Kemmerer Bottle sampler will be used at the Onondaga Lake Outlet, Harbor Brook at Hiawatha Boulevard, and Ley Creek monitoring sites. Samplers and sample containers are rinsed prior to dispensing sample water for analysis into the sample containers. Bacteria samples will be collected in sterile containers. All sampling equipment used on the tributaries is dedicated for this purpose. Stage gauge measurements will be taken to record the water surface elevation during each sampling event.

D. RIVER

River samples will be collected using grab techniques from Buoy 316 as part of the AMP. A separate A Three Rivers Water Quality Monitoring Program at select sites between Cross Lake and the Three Rivers Junction will be conducted in 2008 to gain additional data to support further calibration and validation efforts of the Three Rivers Water Quality Model. The Supplemental Workplan is not

included with the Year 2008 AMP submittal, as it is not part of the approvable program.

A Beta sampler will be utilized for sample collection. Samplers and sample containers are rinsed prior to dispensing sample water for analysis into the sample containers.

The station will be sampled for analytical parameters at 1-meter below the water surface and 1-meter above the channel bottom in order to evaluate density stratification effects on water quality.

Measurements taken during the sampling events will also include vertical profiles of the field parameters to define possible stratification. In-situ data for pH, Dissolved Oxygen, Temperature, Specific Conductance, and Oxidation-Reduction Potential will be collected at half-meter intervals throughout the water column using a YSI sonde. Calibration and calibration drift checks will be conducted before and after each sampling event. Samples will be collected for laboratory analysis in accordance with Appendix H of the Year 2008 Ambient Monitoring Program.

III. PROGRAM ORGANIZATION AND RESPONSIBILITY

The responsibilities and qualifications of the key Program Team members are discussed below. Members of this Team have the experience and capabilities to conduct all aspects of the program and to effectively interact and communicate with NYSDEC staff.

A. RESPONSIBILITIES AND QUALIFICATIONS

Mr. Joseph J. Mastriano, Program Manager

Joseph J. Mastriano will serve as Program Manager and will be responsible for the management of program activities. Mr. Mastriano will be responsible for monitoring program budgetary control, coordinating field activities and lab analysis, coordinating and overseeing the work of program sub-contractors including report preparation.

Mr. Mastriano has over 28 years experience in the field of water and wastewater resources and has been intimately involved in several projects related to Onondaga Lake. Specifically, Mr. Mastriano has:

- Conducted field monitoring of Onondaga Lake and its tributaries from May 1978 until Spring 1985.
- Served as the Department's primary contact responsible for coordinating departmental efforts associated with Dr. William Walker's compilation and validation of the 24-year database.
- Designed and administered special studies to determine the effects of atypical conditions on receiving water. Examples of these efforts include: monitoring conducted in response to failures in the collection/treatment system infrastructure, and monitoring the effect of wet weather conditions on the lake and its tributaries.

Other examples of Mr. Mastriano's work experience include:

- Administration of the County's industrial pretreatment and other source control programs including: review and approval of treatment system design, permitting, monitoring, enforcement, and cost recovery activities.
- Serves as the County's primary on-call contact for directing the response to uncontrolled discharge of materials to the sanitary sewer system and those sections of lake tributaries maintained by the County.
- Administration of special studies conducted by the County including projects such as tracer/dye studies of lake tributaries, the collection system, and treatment plant unit processes; and studies to evaluate the source, effect and fate of materials entering the wastewater treatment system.

Mr. Jeff Noce, Laboratory Director

Mr. Noce will be responsible for the general administration of the analytical elements of the program. He will assist other members of the team on analytical issues and ensure compliance with proper analytical protocol. He will also ensure dissemination of analytical results in a timely and efficient manner to facilitate completion of schedule work tasks.

Mr. Noce has 28 years of experience in analytical chemistry with OCDWEP. For 22 of those years as a supervisor in charge of nutrient, organic and solids analysis with the Department. Since 2003, Mr. Noce has been involved in the administrative aspects of the lab, first as Senior Chemist and then as Laboratory Director.

Representative examples of Mr. Noce's work experience include:

- Environmental Laboratory supervisor responsible for nutrient, organic and solid waste analysis for 22 years.
- Responsibility for the collection and analyses of surface water, wastewaters, and solid/hazardous wastes utilized in a variety of programs by the Department of Water Environment Protection.
- Laboratory Director for Water Environment Protection responsible for administration of analytical service and compliance mandated by the National Environmental Laboratory Accreditation Program. Responsibilities include operation of lab facility and general supervision of 19 analysts.'

Ms. Jeanne C. Powers, Sanitary Engineer III

Ms. Powers has worked as a Sanitary Engineer for the County since 1987. She has supervised field technician and engineering staff in several process control engineering related projects. Ms. Powers will be responsible for overall monitoring program supervision, budgetary control, coordinating and overseeing the work of program sub-contractors. In addition, she has administered day-to-day activities of the County's annual Onondaga Lake monitoring program from 1995 to the present, including contract administration.

Ms. Janaki Suryadevara, Sanitary Engineer II

Ms. Suryadevara has worked as a Sanitary Engineer for the County since 1993. Ms. Suryadevara coordinates the County's water quality programs and will be responsible for scheduling the Onondaga Lake, tributary and river sampling events and developing QA/QC procedures for sample collection. Ms. Suryadevara will be responsible for coordinating the review and preparation of the Annual Lake Ambient Monitoring Program Report, oversight and design of the field program, coordinating field and laboratory efforts, and for supervision of the technician staff performing field sampling.

Mr. David Snyder, P.E., Sanitary Engineer II

Mr. Snyder coordinates the County's biological monitoring programs, which include monitoring of the fishery, macroinvertebrates, macrophytes, and zebra mussels on Onondaga Lake, its tributary streams and the Three Rivers system. He is also responsible for biological program design and implementation.

Mr. Antonio D. Deskins, Sanitary Engineer I

Mr. Deskins will be responsible for the initial data review, compilation and maintenance of the database. Mr. Deskins also participates in Lake/Tributary/River sampling events and performs field audits as necessary. Mr. Deskins' computer skills are utilized in evaluating and presenting AMP field/analytical data and in generation of the Annual Lake Ambient Monitoring Program Report. Mr. Deskins will also utilize his data-processing experience in order to maintain the AMP databases and produce the tabular and graphical summaries, which are necessary to analyze trends and tributary loading computations.

Onondaga Lake Technical Advisory Committee (OLTAC):

In addition to the team referenced above, the County will utilize a Technical Advisory Group composed of experts in several disciplines to discuss results and implications of the annual program. Current members, their areas of technical expertise, affiliation, and addresses are as follows:

1. Dr. Charles T. Driscoll - Aquatic Chemistry
   Department of Civil and Environmental Engineering
   220 Hinds Hall
   Syracuse University
   Syracuse, NY 13244

2. Dr. James Hassett - Engineering Hydrology; Water Pollution Engineering; Water Quality Modeling
   SUNY College of Environmental Science and Forestry (ESF)
   122 Bray Hall
   Syracuse, NY 13210

3. Dr. Edward L. Mills - Aquatic Food Web; Zebra Mussel Dynamics
   Cornell University Biological Field Station
   900 Shackelton Point Road
   Bridgeport, N.Y. 13030-9747

4. Dr. Elizabeth Moran - Limnology
   EcoLogic, LLC.
   Atwell Mill Annex, Suite S-2
   132 ½ Albany Street
   Cazenovia, N.Y. 13035

5. Dr. Lars Rudstam - Fisheries
   Cornell University Biological Field Station
   900 Shackelton Point Road
   Bridgeport, N.Y. 13030-9747

6. Dr. Kenton Stewart - Physical Limnology
   University of Buffalo
   199 Crown Royal Drive
   Williamsville, N.Y. 14221

7. Dr. William Walker, Jr. - Limnological and Statistical Modeling
   1127 Lowell Road
   Concord, MA 01742

B. SAMPLING SCHEDULE

2008 Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
April 2008			
April 1/Tuesday	Tributary	Quarterly Extended	C
April 2/Wedesday	Onondaga Lake	Lake Special Weekly	F
April 8/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
April 14/Monday	Onondaga Lake	Lake Special Weekly	F
April 15/Tuesday	Tributary	Biweekly	C
April 22/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
April 28/Monday	Onondaga Lake	Lake Special Weekly	F
April 29/Tuesday	Tributary	Biweekly	C
May 2008			
May 6/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
May 12/Monday	Onondaga Lake	Lake Special Weekly	F
May 13/Tuesday	Tributary	Biweekly	C
May 20/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D &F
May 27/Tuesday	Onondaga Lake	Lake Special Weekly	F
May 28/Wednesday	Tributary	Biweekly	C
June 2008			
June 3/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
June 9/Monday	Onondaga Lake	Lake Special Weekly	F
June 10/Tuesday	Tributary	Quarterly Extended	C
June 17/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
June 23/Monday	Onondaga Lake	Lake Special Weekly	F
June 24/Tuesday	Tributary	Biweekly	C
July 2008			
July 1/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
July 7/Monday	Onondaga Lake	Lake Special Weekly	F
July 8/Tuesday	Tributary	Biweekly	C
July 10/Thursday	River*	Monthly	H
July 15/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
July 21/Monday	Onondaga Lake	Lake Special Weekly	F
July 22/Tuesday	Tributary	Biweekly	C
July 29/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
August 2008			
August 4/Monday	Onondaga Lake	Lake Special Weekly	F
August 5/Tuesday	Tributary	Biweekly	C

2008 Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
August 7/Thursday	River*	Monthly	H
August 12/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
August 18/Monday	Onondaga Lake	Lake Special Weekly	F
August 19/Tuesday	Tributary	Biweekly	C
August 26/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
September 2008			
September 2/Tuesday	Onondaga Lake	Lake Special Weekly	F
September 3/Wednesday	Tributary	Biweekly	C
September 9/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
September 11/Thursday	River*	Monthly	H
September 15/Monday	Onondaga Lake	Lake Special Weekly	F
September 16/Tuesday	Tributary	Quarterly Extended	C
September 23/Tuesday	Onondaga Lake	Double Lake (South & North Deep) (w/Lake Special Weekly)	D & F
September 29/Monday	Onondaga Lake	Lake Special Weekly	F
September 30/Tuesday	Tributary	Biweekly	C
October 2008			
October 7/Tuesday	Onondaga Lake	Lake South Deep (w/Lake Special Weekly)	D & F
October 13/Monday	Onondaga Lake	Lake Special Weekly	F
October 14/Tuesday	Tributary	Biweekly	C
October 21/Tuesday	Onondaga Lake	Lake South Deep	D
October 28/Tuesday	Tributary	Biweekly	C
November 2008			
November 5/Wednesday	Onondaga Lake	Lake South Deep	E
November 12/Wednesday	Tributary	Quarterly Extended	C
November 18/Tuesday	Onondaga Lake	Double Lake (South & North Deep)	D
November 25/Tuesday	Tributary	Biweekly	C
December 2008			
December 2/Tuesday	Onondaga Lake	Lake South Deep	D
December 9/Tuesday	Tributary	Biweekly	C
December 23/Tuesday	Tributary	Biweekly	C
January 2009			
January 6/Tuesday	Tributary	Biweekly	C
January 7/Wednesday	Onondaga Lake	Winter**	E
January 20/Tuesday	Tributary	Biweekly	C
February 2009			
February 3/Tuesday	Tributary	Biweekly	C
February 10/Tuesday	Onondaga Lake	Winter**	E
February 17/Wednesday	Tributary	Biweekly	C
March 2009			
March 3/Tuesday	Tributary	Biweekly	C
March 10/Tuesday	Onondaga Lake	Winter**	E

2008 Non-Event Water Quality & Biological Sampling Schedule (April 2008 - March 2009)

DATE /DAY	PROGRAM	EVENT	APPENDIX
March 17/Tuesday	Tributary	Biweekly	C

*** River sampling events to target low flows (at or less than 500 cfs at Baldwinsville). Sampling event dates may be altered.**
**** Lake Winter dates are tentative and will depend on weather conditions/extent of ice cover on lake.**

C. DATA VALIDATION

1. Results of laboratory analyses are submitted to the program team members Janaki Suryadevara and Antonio Deskins within four weeks of collection.

2. Interim product: monthly data summaries (paper and diskette) will be compiled with codes flagging any limitations to data usability identified during the data validation process. Data validation will occur within four weeks of receipt of laboratory data.

D. DATA SUMMARIES

Data summaries: within three months of receipt of a complete set of validated data, a data summary will be compiled.

1. Calculate means, medians and averages of lake data.

2. Compare measured lake concentration to ambient water quality standards.

3. Calculate means, medians of concentrations of tributary water quality data.

4. Compare measured tributary concentration to compliance with ambient water quality standards.

E. ANNUAL REPORT PREPARATION

The "draft" report will be compiled within five months of receipt of complete set of validated data.

Annual Results -

1. Tables of Year 2008 results (concentrations and loads in lake and tributaries).

2. Statistical comparisons of Year 2008 results to the long-term data set.

Trend Analysis -

3. The trend analysis for the tributary and lake data, which is an important step in tracking progress towards lake restoration, using the most recent ten years of data, will be completed. The standard methodology developed by Dr. William Walker, Jr. will be used to apply the seasonal Kendall test to the lake datasets.

Compliance -

4. The report will include a section on the water quality conditions and compliance with the ambient water quality standards for the water body segment measured in the tributaries, Onondaga Lake, and the Seneca River. The report will include a summary analysis of the Metro discharge with the SPDES permit.

Loading -

5. External loading of materials to the lake will be calculated once USGS discharge records are received. In mid-2004, Dr. William Walker, Jr. refined his program used to estimate loading to Onondaga Lake. The improved estimation technique, called "Method 5", was developed in conjunction with the compilation of the OCDWEP long-term integrated water quality database and supporting software. The new technique was developed to support estimation of daily loads, to support development of monthly and seasonal lake mass balances, and to improve the accuracy and precision of the annual load estimates. Method 5 differs from AUTOFLUX Method 2 in several ways. Data are stratified by flow regime (similar to AUTOFLUX Method 2) and are also stratified by season using a multiple regression technique. Conditions during the unmonitored period are projected using a residual interpolation method that includes a flow derivative term.

Lower Trophic Levels -

6. Phytoplankton identification and enumeration will be completed and key findings of the lower trophic levels analysis will be evaluated and included as part of the integrated assessment of water quality conditions and ecosystem response.

7. Zooplankton density, species composition, size, and biomass will be determined and evaluated.

IV. FIELD SAMPLE COLLECTION & PRESERVATION

A. Field sampling techniques are consistent with those described in the following U.S. Government publications:

1. EPA 600/4-82-029 (September 1982)

2. 40 CFR 136 (March 1991)

3. EPA 821-R-95-034 (Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels).

B. Field QC consists of replicates and equipment rinsate blanks as specified in ELAP protocol.

C. Sample preservation requirements:

Due to the variety of possible sample types, only generalizations can be made. Preservatives are added in compliance with the analytical protocols (reference Table 2, Attachment C – Analytical Methodologies). Analysis begins as soon as possible. A complete chain-of-custody record is maintained on each sample to provide a history of sample handling from collection to analysis.

Table 1 indicates the criteria for sample collection and preservation. All samples are aqueous.

TABLE 1 - SAMPLE COLLECTION AND PRESERVATION				
ANALYTE	**VOLUME**	**CONTAINER**	**PRESERVATION**	**MAXIMUM HOLDING TIME**
Biological				
Coli, Fecal	125ml	P	Cool 4° C	6 Hrs.
E. Coli	125ml	P	Cool 4 ° C	6 Hrs.
Chlorophyll a	2000ml	P	Cool 4 ° C	
Phaeophytin a	2000ml	P	Cool 4 ° C	
Phytoplankton	500ml	P	Lugol's solution, Cool 4 ° C	
Zooplankton	1000ml	P	Ethanol (70% by Volume), Cool 4 ° C	
Inorganic Tests				
Biochemical Oxygen Demand	1/2 Gallon	P	Cool 4 ° C	48 Hrs.
Cyanide, Total	1000ml	P	Cool 4 ° C, NaOH to pH > 12, 0.6g ascorbic acid	14 Days
Kjeldahl and Organic Nitrogen	1000ml	P	Cool 4 ° C, H_2SO_4 to pH < 2	28 Days
Total Phosphorus	1000ml	P	Cool 4 ° C, H_2SO_4 to pH < 2	28 Days
Soluble Reactive Phosphorus	125ml	P	Cool 4 ° C	24 Hrs.
Total Dissolved Phosphorus	125ml	P	Cool 4 ° C, H_2SO_4 to pH < 2	24 Hrs.
All Metals				
Arsenic	1000ml	P	HNO_3 to pH<2	6 Months
Cadmium	1000ml	P	HNO_3 to pH<2	6 Months
Calcium	1000ml	P	HNO_3 to pH<2	6 Months
Chromium (GFA)	1000ml	P	HNO_3 to pH<2	6 Months
Copper	1000ml	P	HNO_3 to pH<2	6 Months
Iron	1000ml	P	HNO_3 to pH<2	6 Months
Lead (GFA)	1000ml	P	HNO_3 to pH<2	6 Months
Magnesium	1000ml	P	HNO_3 to pH<2	6 Months
Manganese	1000ml	P	HNO_3 to pH<2	6 Months
Nickel	1000ml	P	HNO_3 to pH<2	6 Months
Potassium	1000ml	P	HNO_3 to pH<2	6 Months
Sodium	1000ml	P	HNO_3 to pH<2	6 Months
Selenium	1000ml	P	HNO_3 to pH<2	6 Months

TABLE 1 - SAMPLE COLLECTION AND PRESERVATION				
ANALYTE	**VOLUME**	**CONTAINER**	**PRESERVATION**	**MAXIMUM HOLDING TIME**
Zinc	1000ml	P	HNO_3 to pH<2	6 Months
Mercury	1000ml	P	HNO_3 to pH<2	28 Days
Organic Carbon, Total	1/2 Gallon	P	Analyze within 24 hours or Cool 4 ^oC H_3PO_4 to pH < 2	28 Days
Organic Carbon, Filtered Total	1/2 Gallon	P	Analyze within 24 hours or Cool 4 ^{o} C H_3PO_4 to pH < 2	28 Days
Inorganic Carbon, Total	1/2 Gallon	P	Cool 4 ^oC	48 Hours
Phenols	1000ml	G	Cool 4 ^oC, H_2SO_4 to pH < 2	28 Days
Solids, Total	1/2 Gallon	P	Cool 4 ^oC	7 Days
Solids, Total Suspended	1/2 Gallon	P	Cool 4 ^oC	7 Days
Solids, Total Volatile	1/2 Gallon	P	Cool 4 ^oC	7 Days
Solids, Total Suspended	1/2 Gallon	P	Cool 4 ^oC	7 Days
Volatile	1/2 Gallon	P	Cool 4 ^oC	7 Days
Solids, Total Dissolved	1/2 Gallon	P	Cool 4 ^oC	7 Days
Silica	1/2 Gallon	P	Cool 4 ^oC	28 Days
Sulfate	1/2 Gallon	P	Cool 4 ^oC	28 Days
Sulfide	300ml	G	Cool 4 ^oC, add zinc acetate plus sodium hydroxide to pH > 9	7 Days
Specials				
T-Alkalinity	500ml	P	Cool 4 ^oC (no air bubbles present)	14 Days

All samples are aqueous.
Containers: P = Plastic; G = Glass

V. FIELD SAMPLING PROCEDURES

A. ONONDAGA LAKE

1. Metals

i. Samples are collected as grabs and composited volumetrically.

ii. The Wildco Beta sampler is used for sample collection. The sampler is rinsed in lake water prior to use in order to ensure cleanliness. Samples are mixed in a churn, which has also been rinsed in lake water. The sample bottle is rinsed with the composite sample prior to pouring-off from the churn into the one-liter plastic bottle, and filled to the shoulder.

iii. Parameters to be analyzed biweekly include:

Ca, Na, Mg, Mn, Fe

iv. Parameters to be analyzed quarterly include:

Cd, Cr, Cu, Ni, Pb, Se, Zn, As, K

v. Quarterly metals samples will be collected using modified trace metals sampling techniques for sample collection. This sampling methodology is described in EPA Method 1669 (Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria). The sample crew incorporates as much of this procedure as possible given the field conditions during the sampling event.

vi. All samples are preserved by adding Nitric Acid to pH < 2, and cooling to 4°C.

2. Mercury

i. Special samples for Total and Methyl Mercury will be collected at 3m and 18m depths in 500-ml Teflon bottles using the "clean hands-dirty hands" technique for sample collection. The Teflon® Dunker used shall be pre-cleaned and stored in accordance with the procedures contained in the OCDWEP SOP titled "Onondaga Lake Sampling Preparation", document number 00077. Use of the Teflon® Dunker will be in accordance with the procedures contained in the OCDWEP SOP titled "Onondaga Lake Sampling Methodology", document number 00085. The dirty hands sampling technician will be responsible for handling the Teflon® Dunker and pouring the sample. The clean hands sampling technician shall only touch the sample container and cap.

ii. A separate equipment rinseate blank for the Teflon Kemmerer Water Sampler will be collected for special low-level mercury analysis.

iii. A field blank will also be collected at the sampling site, prior to sample collection. This will consist of reagent water, supplied by the contract laboratory,

processed through the sampling device.

iv. The analysis of samples for the determination of Total Mercury will be achieved by Cold Vapor Atomic Fluorescence (CVAFS) Spectrometry. The methodology is described by Fitzgerald and Gill (1979), Bloom and Crecelius (1983), Gill and Fitzgerald (1985); Bloom and Fitzgerald (1988), Method 1631 (USEPA, 1995).

3. Conventionals

i. "Conventional" discrete samples are collected at 0m, 6m, 12m, and 18m depths using a submersible pump.

ii. The pump is allowed to flow freely for a minimum of two minutes prior to filling sample bottles in order to evacuate the hoses of all previous samples. Sample bottles are also rinsed with lake water collected from the appropriate depth prior to filling.

iii. One gallon plastic or gallon sample bottles are filled to the shoulder and then cooled to 4°C (no further preservation is required).

iv. "Conventional" parameters include:

TS, TSS, TDS, VSS, TVS, SiO_2, TOC, TOC-F, TIC

v. A second "conventional" composite sample for both the upper mixed layer (UML) and the lower water layer (LWL) is collected as grabs and composited volumetrically. (See Page 23 - **Composite Sample collection**).

vi. The Wildco Beta sampler is used for sample collection. The sampler is rinsed in lake water prior to use in order to ensure cleanliness. Samples are mixed in a churn, which has also been rinsed in lake water. The sample bottle is rinsed with the composite sample prior to pouring-off from the churn into the half-gallon plastic sample bottles filled to the shoulder and then cooled to 4°C (no further preservation is required).

vii. Composite Parameters include:

BOD_5, NO_2, NO_3, Cl, SO_4, Turbidity (UML only).

4. Soluble Reactive Phosphorus (SRP)

i. SRP samples are collected at 0m, 3m, 6m, 9m, 12m, 15m, 18m depths using a submersible pump.

ii. The pump is allowed to flow freely for a minimum of two minutes prior to filling sample bottles in order to evacuate the hoses of all previous samples. Sample bottles are also rinsed with lake water at the appropriate depth prior to filling.

iii. The sample will be filtered on site.

iv. Collect sample in a new disposable container.

v. Place a previously washed 0.45-micron filter into filter apparatus.

vi. Filter sample into the SRP container (250-ml plastic disposable) leaving a small airspace.

vii. Discard filter and rinse apparatus.

NOTE: When sample turbidity prevents using one filter to fill container; remove clogged filter, replace with another washed filter and continue filtration. Under extreme conditions of algal density (i.e., when filter clogs yielding less than 20 ml filtrate) sample may be pre-filtered using a washed glass-microfiber filter, and filtered into a clean container before final filtration with a 0.45 micron filter.

viii. The 250-ml plastic disposable sample bottles are then cooled to 4°C (no further preservation is required).

5. Total Dissolved Phosphorus (TDP)

i. TDP samples are collected at 0m, 3m, 6m, 9m, 12m, 15m, 18m depths using a submersible pump.

ii. The pump is allowed to flow freely for a minimum of two minutes prior to filling sample bottles in order to evacuate the hoses of all previous samples. Sample bottles are also rinsed with lake water at the appropriate depth prior to filling.

iii. The sample will be filtered on site.

iv. Collect sample in new disposable container.

v. Place a previously washed 0.45-micron filter into filter apparatus.

vi. Filter sample into the TDP container (250-ml plastic disposable) leaving a small airspace.

vii. Discard filter and rinse apparatus.

NOTE: When sample turbidity prevents using one filter to fill container; remove clogged filter, replace with another washed filter and continue filtration. Under extreme conditions of algal density (i.e., when filter clogs yielding less than 20 ml filtrate), sample may be pre-filtered using a washed glass-microfiber filter, and filtered into a clean container before final filtration with a 0.45 micron filter.

viii. Preservation: Adjust pH < 2 with H_2SO_4.

ix. The 250-ml plastic disposable sample bottles are then cooled to 4°C.

6. Chlorophyll-*a*

i. Chlorophyll-*a* samples are collected as depth-integrated tube samples through the standard depth of 0-3m of the water column year round. A 3/4" tygon tubing is used as the sample collection device.

ii. Samples are analyzed for chlorophyll-*a* and phaeophytin-*a* content.

Equipment Requirements: 3/4" Tygon Tube compositing apparatus
Chlorophyll Bottle
YSI Unit
Secchi disc

Bottle Requirements: (1) 2 liter Amber Bottle

iii. Lower the tube sampler to the 3m depth (Step 1). Place a stopper in the end of the tube (Step 2). Rinse the sample bottle with the sample water and pour out (Step 3). Repeat Steps 1 and 2 pull the tube from the water and pour the entire tube contents into the dedicated carboy. Repeat tube composites until sufficient volume is collected. Use only a full tube composite. Thoroughly mix sample prior to pouring off into container.

7. Net Haul

i. A net haul sample is obtained for zooplankton analysis.

Equipment Requirements: 0.5 Meter Wildco Beta Plankton Net with 80 um mesh 80 um sieve and Mechanical flowmeter (RIGO Type 5571-A)

Bottle Requirements: (1) 1000-ml bottle
(2) 500 ml containers of 95% Ethanol/Alka-Seltzer

Collect samples as follows: 0-15 Meters (during unstratified periods)
UML (during the thermally stratified period)

ii. Record the flowmeter dials, and place the net into the water to allow the sample bucket to fill with water. Allow the net to sink to a depth of 15 meters. Draw the net to the surface at a rate of 0.5 meter per second or less and record the final flowmeter dials. Carefully wash all the residual sample clinging to the net into the quick disconnect bucket. Filter as much water as possible. Pour the entire sample into the 80 um sieve and filter further until you have a slurry of sample. Pour the entire sample into the 1000-ml plastic jar and rinse any residual into the jar with wash bottle. Place a quarter tablet of Alka-Seltzer into the jar and wait for zooplankton movement to stop. Add 70% by volume of 95% reagent grade non-denatured ethanol. (More ethanol is better.) Example: 150-ml sample requires 350-ml ethanol. The same procedure should be followed for the sample to be collected at the UML depth. Record the UML depth and flowmeter reading on the chain of custody form.

An "efficiency" reading will be recorded two times per year. This will entail performing a vertical tow with a netless ring and flowmeter at a known depth (Note: a netless ring will be kept in the boat at all times). This will also ensure that the depth being sampled is accurately being

sampled by the net tow. Extreme caution should be used for samples collected during conditions of strong winds and high current, to minimize the error in the flowmeter readings and to prevent the net from floating to the surface.

Refer to the flowmeter Standard Operating Procedure (SOP) for flowmeter operation and calibration checks.

Note: The UML composite depth shall be determined by the temperature profile.

8. Phytoplankton

i. Phytoplankton samples are obtained by OCDWEP for analysis.

Equipment Requirements:	(1) 500 ml Bottle Dedicated Carboy 3/4" Tygon Tube Secchi Disk YSI Unit
Sampling Requirements:	0-3 meter Composite

ii. Record a Secchi Disk Reading. The composite sample is collected using the tube composite sampler from 0-3 meters in the water column.

iii. Preserve the samples with enough Lugols Solution to turn the sample iodine color (maroon in Color), approximately 5 to 7 mls. per 100-mls of sample.
Note: The UML composite depth shall be determined by the temperature profile. Should no distinct thermocline profile be present, use 0-6 meters in depth as the UML default.

9. Sulfide

i. Samples for analysis of sulfide ion content are collected from 12m, 15m, 18m depths only when anoxic conditions are present at these depths. The Wildco Beta sampler is used in order to ensure minimum mixing and air entrainment into the sample.

ii. Samples are poured from the Wildco Beta sampler into a rinsed Boston round clear glass jar (8-oz capacity) with a conical insert screw closure and low-density polyethylene poly-seal liner. Samples are poured down the side of the bottle to minimize turbulence. The bottle is filled to the top and then stopped, being careful not to enclose any air bubbles.

iii. Preservation: 2 ml of Zn acetate is added to the bottle prior to the addition of sample. After sample addition, pH is adjusted to >9 with NaOH, container is topped off with sample to exclude air from the container, then cooled to 4°C.

10. TKN, NH_3-N & TP

i. Samples are collected in one liter disposable plastic bottles from 0m, 3m, 6m,

9m, 12m, 15m, and 18m depths. Samples are collected via the submersible pump, in a manner consistent with that described above for "conventionals."

ii. Determine Cl_2 residual with a LaMotte Test Kit. If Cl_2 residual is measured, add 30% Sodium Thiosulfate drop-wise; 1 drop/1 ppm Cl_2, then add 1 drop excess.

iii. Preservation: Adjust pH < 2 with H_2SO_4, cool to 4°C.

Example: Cl_2 measures 2.5 ppm - add 4 drops Sodium Thiosulfate - then H_2SO_4 to pH 1.5 - 2.0.

iv. Org-N results are calculated by subtracting the results of analyses of samples for Total Kjeldahl Nitrogen (TKN) and Ammonia Nitrogen (NH_3-N).

v. This sample will also be analyzed for Total Phosphorus (TP).

11. T-Alk

i. T-Alk samples are to be analyzed for Total Alkalinity as $CaCO_3$.

ii. T-Alk samples are collected as UML and LWL composites as described above for metals samples.

iii. T-Alk samples are poured-off from the churn into a rinsed 500-ml plastic bottle. The bottle is carefully stopped in order to exclude air and then cooled to 4°C.

12. Fecal Coliform

i. A Fecal Coliform sample is collected at 0m. Two sterile 125-ml plastic containers will be used.

The first container will be filled from the source (at 0m). The second container (disposable), pre-preserved with Sodium Thiosulfate crystals will be filled from the first container leaving a small airspace to enable the sample to be shaken, and then cooled to 4°C. This is the sample to be delivered to the laboratory for analysis. Samples will be checked for residual chlorine using a LaMotte "DPD Chlorine Test Kit."
***Sample volumes for this parameter are crucial. Fill the bottle to just above the shoulder of the bottle leaving a small (approximately 2.5 cm) airspace to enable sample to be shaken. Do no allow the water to rise above the threads of the bottle. Samples will be analyzed for E. Coli and Fecal Coliform.

Composite Sample collection:

The "UML" (Upper Mixed Layer) and "LWL" (Lower Water Layer) composite samples collected during the sampling events will be made by mixing samples from discrete depths according to the following field protocol:

(a) Late fall, winter, and early spring (October 1 - May 31) when the lake waters are not strongly stratified.

i. The default UML during this period of the year is 0, 3, 6-m.

ii. The default LWL during this period of the year is defined as 9, 12, 15, and 18-m.

(b) Summer stratification period (June 1 - September 30)

i. The UML composite shall always include samples collected at 0 and 3-m depths. Inclusion of water collected at 6 m in the composite shall be evaluated based on the temperature profiles measured during the sampling event.

ii. The composite sample of the LWL will typically include water collected at depths of 12, 15, and 18-m during this period. The inclusion of the 12-m depth in the composite of the lower waters should be reviewed during each sampling event. Because the 9-m depth is consistently in the metalimnion (or "transition zone") during this period, water from this depth will not be included in either composite sample.

- The Thermocline is the area at which the temperature gradient is steepest during the summer; usually this gradient must be at least 1°C per meter. A rule of thumb is that the Thermocline exhibits a temperature change of approximately 1°C per meter.

- Record the field YSI profile to define depths of UML, Transition zone, and LWL prior to composite sample collection.

- Once the Thermocline depth is determined, samples are collected as grabs from the discrete sample depths, 0m, 3m, 6m, 9m, 12m, 15m, and 18m depths using a Wildco Beta sampling device. The Thermocline depth should not be included with either composite sample (UML or LWL). The Wildco Beta sampler is rinsed in lake water prior to use in order to ensure cleanliness. Samples are mixed in a churn, which has also been rinsed in lake water. The sample bottle is rinsed with the composite sampler prior to pouring-off from the churn into the sample bottle.

B. ONONDAGA LAKE TRIBUTARIES

The procedures used for the collection of samples from Onondaga Lake Tributaries are as follows:

1. All tributaries are sampled using the depth-integrated sampling technique, except the

   Allied East Flume, Sawmill Creek and Bloody Brook monitoring stations. For streams with low velocity and depositional conditions, the vertical kemmerer water

sampler is used (Ley Creek @ Park Street and Harbor Brook @ Hiawatha Boulevard sampling sites) – Refer to Attachment A - Tributary Field Sampling Procedures.

2. The Onondaga Lake Outlet is sampled at depths of 2 feet and 12 feet using the Kemmerer tube-sampling device from mid-channel. The sample for Fecal Coliform will be collected from mid-channel at the surface.

3. All sample bottles are rinsed in sample water prior to filling, and preserved according to the instructions detailed above.

   Depending on the depth of water at each station, a suspended (deep water) or hand-held sampler (wadeable) may be used. The depth-integrated sampling device is designed to accumulate a water-sediment sample from a stream vertical at such a rate that the velocity in the nozzle is nearly identical with the stream velocity. Judgment will be used to select the number and location of transects. The sampling procedures for this monitoring program will follow the protocol outlined in the New York State DEC Division of Water Bureau of Watershed Assessment & Research Program Plan for Rotating Intensive Basin Studies Water Quality Section (1997-1998). Procedures by sampling site are outlined in Attachment A.

   NOTE: A dedicated dunker with only silicone end seals will be utilized for the trace metals quarterly sampling events.

C. STORM-EVENT

1. The storm-event monitoring program is summarized in Appendix I of the Year 2008 Ambient Monitoring Program.

2. Tributary sampling will be initiated within 2 hours of a storm event. Samples will be collected as grabs from mid-stream of Onondaga Creek, every two hours for the first day and every four hours for 2 days thereafter. Tributary storm-event sampling will include the parameters TP, SRP, TDP, TKN, Cl, TSS, Turbidity and Fecal Coliform.

3. Bacteria samples from the ten (10) Onondaga Lake stations will be collected from the surface, within twenty-four hours, once per day for 3 consecutive days. Analysis will include F. Coliform, E. Coli, Secchi Disk, Turbidity and Temperature. GPS coordinates will be recorded for the sampling sites during each sampling event.

4. Rainfall data will be collected at the Metro WWTP.

D. RIVER

1. The River samples are collected using a rinsed Wildco Beta sampler at 1 meter below the water surface and 1 meter above the sediment at each of the buoy stations.

2. All sample bottles are rinsed in sample water prior to filling, and preserved according to the instructions detailed above.

VI. QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

A. FIELD DUPLICATES

1. One field duplicate will be collected by using a separate sample collected for each parameter analyzed for Onondaga Lake, its tributaries, and the Seneca River. These are collected as separate samples taken from the same site at the same time. These provide a check on sampling equipment and precision techniques.

2. For Onondaga Lake, all field duplicates will be collected at the 6m sampling depth except for F. Coli (0m), and Sulfide (15m).

3. For the Onondaga Lake Tributaries, the sampling site for field duplicate sample collection is rotated for the different sampling events.

4. For the Seneca River, two field duplicates will be collected at Buoy 316 during each sampling event (at the 1-meter below the water surface and 1-meter above the river sediment depths).

5. Some field duplicates are identified only as quality control “blind” duplicate samples, which are unknown to laboratory personnel. These “blind” duplicate samples will be collected four times a year for the Onondaga Lake and Tributary sampling events.

B. EQUIPMENT RINSEATE BLANKS

1. Equipment rinseate blanks will be collected for the submersible pump and churn used on Onondaga Lake. Blank samples will be collected prior to collecting water quality samples from Onondaga Lake and analyzed for all parameters. This schedule complies with the minimum frequency of one field blank per 20 samples.

2. Equipment rinseate blanks will be collected for the churn and dunker used for the Onondaga Lake Tributaries and analyzed for all parameters. Blank samples will be collected prior to the collection of water quality samples from any of the tributaries. This schedule also complies with the minimum frequency of one field blank per 20 samples.

3. Equipment rinseate blanks will be collected for the stainless-steel pail used for the storm event monitoring program and analyzed for all parameters. Blank samples will be collected prior to the collection of water quality samples from any of the sample sites.

C. SAMPLE CONTAINERS:

1. The containers currently used for metals are certified as Class 3000 bottles washed under EPA protocol "C". In addition to receiving a Certificate of Analysis for each bottle lot, all pre-cleaned sample containers will be checked by our laboratory by lot to insure that they are clean. This will be performed by delivering a minimum of (1) one, but as many as five (5), randomly selected containers from each lot received by

the OCDWEP Lab. These containers will be empty with an appropriate label, Chain -Of-Custody form and copy of the sample container lot Certificate-Of-Analysis. The laboratory will fill the container with deionized water, preserve the sample with nitric acid and analyze it immediately for total cadmium, chromium, copper, nickel, lead, zinc, arsenic, mercury, manganese, and iron. All results must be less than or equal to the Minimum Reportable Limit (MRL). If the results meet this criteria, the sample containers in the lot will be released for use in AMP sampling events. If results do not meet this criteria, an additional sample container will be checked for each container that failed. If these results meet the criteria, the sample containers in the lot will be released for use in AMP sampling events. If there is a second failure, the sample containers in the lot will not be used for AMP sampling events.

2. Each sampling event (Lake or Tributary), will use containers from one specific lot (i.e., sample containers from different lots will not be mixed during each sampling event). The sample lot # will be recorded on the C-O-C forms for the respective samples to insure this.

VII. SAMPLE CUSTODY

A. FIELD SAMPLE CUSTODY

When samples are delivered to the OCDWEP Laboratory for analysis following sample collection, the original C-O-C forms are submitted to the Laboratory.

For samples sent to a contract laboratory for analysis, three copies of an Engineering and Laboratory Services (ELS) Contract Laboratory C-O-C form will be used. The original C-O-C form will be maintained by the OCDWEP Laboratory, two copies will be shipped to the contract laboratory with the samples, for analysis. The contract laboratory will retain one copy and return a signed copy to the OCDWEP laboratory.

Attachment B is a typical example of a C-O-C form. The "Remarks" area is used to record specific considerations associated with sample acquisition such as sample type, container type, sample preservation methods, and analyses to be performed. The original copy of this record follows the samples to the laboratory. The laboratory maintains the completed original and also scans the record into a computer.

B. LABORATORY SAMPLE CUSTODY

The field team leader notifies the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be delivered as well as the anticipated date and time of arrival.

The laboratory sample program meets the following criteria:

1. The laboratory has designated a sample custodian who is responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody.

2. Upon receipt of the samples, the custodian will check the original chain-of-custody documents and compare them with the labeled contents of each sample container for correctness and traceability. The pH of preserved samples is checked at the time of sample receipt. The sample custodian signs the chain-of-custody record and records the date and time received.

3. Care is exercised to annotate any labeling or descriptive errors. In the event of discrepant documentation, the laboratory will immediately contact the field team leader as part of the corrective action process. A qualitative assessment of each sample container is performed to note any anomalies, such as broken or leaking bottles. This assessment is recorded as part of the incoming chain-of-custody procedure.

4. The samples are stored in a secured area at a temperature of approximately 4°C until analyses are to commence.

5. A laboratory chain-of-custody record accompanies the sample or sample fraction through

final analysis for control. These forms are scanned by the lab into the computer (Adobe PDF format) and placed in a centrally located directory.

6. A copy of the chain-of-custody form will accompany the laboratory report and will become a permanent part of the program records.

C. FINAL EVIDENCE FILES

Final evidence files include all originals of laboratory reports and are maintained under documented control in a secure area.

A sample or an evidence file is under custody if:

- it is in your possession;
- it is in your view, after being in your possession;
- it was in your possession and you placed it in a secure area; and
- It is in a designated secure area.

VIII. FIELD EQUIPMENT CALIBRATION PROCEDURES/MAINTENANCE

A. YSI SONDES

1. Calibration procedures for the YSI 600 & 6600, which are used to monitor water quality parameters in Onondaga Lake, are included as Attachments D through I. Calibration data including the date of calibration, the results of calibration, the technician's initials, and the results of the post-use instrument calibration for drift checks are maintained in a bound notebook.

2. The YSI units (sondes) are calibrated no more than 24-hours prior to each day of use. If the DO membrane is replaced, the unit is allowed to stabilize overnight. Calibration is typically performed in the morning before use. A calibration check is performed after use to ensure that calibration drift is acceptable.

3. Temperature calibration is set by the factory and, reportedly, does not require frequent recalibration.

4. Depth is calibrated in air, just above the water surface, as 0 meters.

5. Preventative Maintenance:

   i. Dissolved oxygen membranes are checked and replaced as needed after each use.

   ii. The pH reference probe and the temperature probes are cleaned with 1:1 HCl and a cotton swab after each use.

   iii. The pH probe calibration solution is replaced once per day.

   iv. For long term storage, the sondes are stored clean and dry in a case in order to prevent physical damage. For short term storage, the sondes are stored in a calibration cup with tap water.

   v. Watertight connectors are lubricated when necessary in order to ensure a waterproof connection, which will prevent faulty readings.

B. SECCHI DISK

1. Taped depth markings for the Secchi disk are calibrated annually.

C. UNDERWATER ILLUMINATION

1. Data on Light attenuation are collected at 20-cm intervals from water surface to the depth at which light is 1% of surface illumination, as noted during the sampling event, using a LiCor datalogger, to provide sufficient detail.

D. WILDCO BETA SAMPLE TUBES

1. The Wildco Beta sample tubes are cleaned in DI water after each use. Prior to use, the tubes are rinsed in Onondaga Lake water.

2. Depth markings are calibrated annually.

E. SUBMERSIBLE PUMP

1. The submersible pump is cleaned using DI water after each use. Prior to use, the pump and hoses are rinsed in Onondaga Lake water.

2. Hoses for the submersible pumps are replaced annually or as needed.

3. Depth markings are calibrated annually.

IX. ANALYTICAL PROCEDURES

A. INTRODUCTION

Appropriate use of analytical data generated under the great range of analytical conditions encountered in environmental analyses requires reliance on the quality control practices incorporated in the methods and procedures used by the Onondaga County Department of Water Environment Protection Environmental Laboratory (OCDWEP). Attachment C lists the methodologies utilized for the analysis of water quality samples from the Onondaga Lake Monitoring Program. As a participating member of the New York State Department of Health Environmental Laboratory Approval Program (ELAP), this laboratory uses only those methods and equipment certified by NYS to generate data. Inaccuracies can result from many causes, including unanticipated matrix effects, equipment malfunctions, and operator error. Therefore, the QA/QC aspects of this laboratory are indispensable. The data acquired from QA/QC procedures is used to estimate and evaluate the information content of analytical data and to determine the necessity of corrective action procedures. The means used to estimate information content are also an important part of the ELAP program to which we adhere.

This section defines the QA/QC procedures and components that are mandatory in the performance of analysis performed by the OCDWEP laboratory, and indicates the QA/QC information which must be generated with the analytical data.

B. CHEMICALS AND REAGENTS

1. Reagent grade water

1. Reagent grade water in the OCDWEP environmental laboratory consists of DI water purified by means of mixed bed deionization. The processed water is required to attain a minimum resistivity of 10 mSiemen. A final pass through another mixed bed deionization filter at point of use maintains the highest quality possible (18 mS output). Actual Conductivity is determined daily. The date, conductivity @ 25°C, and analyst's initials are recorded in a tabular format in a bound notebook.

2. To monitor the quality of reagent grade water for bacteriological use, the following tests are performed:

TABLE III - REAGENT GRADE WATER TESTS

Parameter	Frequency	Acceptable
Free Residual Chlorine	Monthly	None acceptable
Standard Plate Count	Monthly	<500 colonies/ml
Heavy Metals (Pb,Cd,Cu,Cr,Ni,Zn)	Yearly	<0.05 mg/l per metal <0.1 mg/l total
Suitability Test	Yearly	Ratio between 0.8-3.0

2. Reagents

Only American Chemical Society (ACS) grade or better chemicals are used. Chemicals are discarded within manufacturer's expiration date or 3 years, whichever comes first. Date of receipt is recorded on each container.

3. Standard Solutions/Titrants

Anhydrous reagent chemicals are oven dried @ 100-105°C for at least 2 hours. Standard solutions or titrants not prepared from a primary standard are standardized against a primary standard at the frequency specified by the method or every 6 months if no frequency is specified. Standard solutions or titrants are not kept longer than 1 year. The date prepared and the expiration date appear on the container, along with title of standard or titrant, concentration, and preparer's initials. In a bound notebook, the preparation date, title of solution, concentration, manufacturer and lot number of reagent grade chemical(s) used, quantity prepared, expiration date, preparer's signature and, if appropriate, drying times & temperatures, tare and net weight, citation of preparation of primary standard, standardization titers and calculations are recorded.

4. Bench or Shelf Reagents

These are non-standardized solutions prepared by laboratory personnel. All of the pertinent information listed for standard solutions is recorded on both bottle label and in a bound notebook.

C. MICROBIOLOGY: CHEMICALS AND REAGENTS

1. Bacteriological Media

Dehydrated media is discarded within six months when opened and stored in a dessicator, or within manufacturer's expiration date, if unopened. If opened, each new lot is compared to an existing lot that has been found acceptable. The date, name of media, lot #'s of control and test media, results of comparison, and analyst's initials are recorded in a tabular format in a bound notebook. On each bottle of media, dates of receipt and opening and discard date are recorded. Media is prepared according to method instructions. Sterilized glassware is used in the

preparation of media. Date, name of medium, gross, tare, and net weights, volumes used, quantity prepared, pH of finished medium, and preparer's initials are recorded.

2. Autoclaving

The appropriate sterilization times @ 121°C and a pressure of 15-pounds per square inch for various materials are determined as follows:

Membrane filters and pads	10 min.
Carbohydrate containing media (Lauryl tryptose, BGB broth, etc.)	15 min.
Contaminated material, discarded cultures	45 min.
Membrane filter assemblies (wrapped to include all glass/plastic ware used to filter samples)	45 min.
Dilution water in screw-cap bottles	30 min.
Rinse water (200-1000-ml)	≥ 30 min.

3. Bacti Glassware

Every batch of glassware is checked after washing for detergent with 4-5 drops of bromthymol blue indicator, added to 4-ml of final rinse water from randomly chosen items of glassware; a neutral indication allows glassware use. The date, description of glassware, indicator reaction and analyst's initials are recorded in a tabular format in a bound notebook.

Each batch of sterilized bacti sample bottles is checked for sterility by aseptically adding 25-ml of tryptic soy broth into a randomly chosen sample bottle. After 24 hrs. of incubation @ 35°C +/- .5°C, the sample is checked for growth. The date, batch identifier, turbidity check, disposition of the batch, and analyst's initials are recorded in tabular form in a bound notebook.

4. Prepared Media Shelf Life

The following table indicates the holding times for bacteriological media prepared in advance:

TABLE IV - HOLDING TIMES BACTERIOLOGICAL MEDIA

Medium	Holding Time
MF Agar in screw-caps flasks	@ 4°C 96 Hrs.
Broth in capped tubes	@ Room Temperature for 3-months
Poured agar plates with tight-fitting Covers in sealed plastic bags	2 Weeks @ 4°C

5. Membrane Filter Sterility Blanks

a. The sterility of each lot number of membranes is verified by checking for growth after 1 membrane is placed in 50-ml of tryptic soy broth for 24 hrs. @ 35°C+/- 0.5°C incubation. The date, lot number, check for turbidity, and analysts initials are recorded.

b. At the beginning and end of each membrane filter series, a sterility check is performed. The date, # of samples analyzed during run, counts for blanks and analyst's initials are recorded in a tabular format in a bound notebook.

6. Negative and Positive Controls

a. Prior to the first use of a medium, each prepared, ready-to-use lot of medium and each batch of medium prepared in the laboratory shall be tested. Tests will consist of using at least one pure culture of a known positive reaction and at least one negative culture control, as appropriate to the method.

D. CALCULATIONS AND CHARTS

1. Reference Sample

A chart is constructed as follows:

a. The measured values and dates of analysis of the reference sample are tabulated;

b. When at least 20 reference samples have been tabulated, compute the mean: x;

c. Using the mean, compute the standard deviation (SD), as in the following example using the formula:

$$SD = \sqrt{\frac{\Sigma (x - \overline{x})^2}{N-1}}$$

Where: x = the measured value of an individual reference sample

$\overline{x}$ = the mean of the measured values

N = the number of data points

$(x - \overline{x})^2$ = the sum of the squares of all the differences of the mean and measured values.

Example:

	Date	X	$(X - \overline{X})$		$(X - \overline{X})^2$	
1.	4-25-96	207	(207 - 207 = 0)	0	(0 x 0 = 0)	0
2.	5-03-96	214	(214 - 207 = +7)	+7	(7 x 7 = 49)	49
3.	5-10-96	200	(200 - 207 = -7)	-7	(7 x 7 = 49)	49
4.	5-17-96	210	(210 - 207 = +3)	+3	(3 x 3 = 9)	9
5.	6-10-96	219	(219 - 207 = +12)	+12	(12 x 12 = 144)	144
6.	6-10-96	190	(190 - 207 = -17)	-17	(17 x 17 = 289)	289
7.	6-18-96	203	etc.	-4	etc.	16
8.	6-27-96	210	"	+3	"	9
9.	7-03-96	204	"	-3	"	9
10.	7-11-96	207	"	0	“	0
11.	7-19-96	207	"	0	"	0
12.	8-01-96	201	“	-6	“	36
13.	8-10-96	204	“	-3	“	9
14.	8-17-96	200	“	-7	“	49
15.	8-27-96	221	“	+14	"	196
16.	9-03-96	205	"	-2	"	4
17.	9-11-96	210	"	+3	"	9
18.	9-20-96	201	“	-6	“	36
19.	9-30-96	217	"	+10	“	100
20.	10-10-96	210	“	+3	“	9

N=20 Total X = 4140 = 1022

Example

N = 20

$\sum (X - \overline{X})^2 = 1022$

$SD = \sqrt{(X - \overline{X})^2 / N-1}$

$SD = \sqrt{1022 / 19}$

SD= 7.33

2. Determine the warning limits

Determine the warning limits (WL), and the control limits (CL) as in the following example using the formulas:

$WL = \overline{X} \pm 2SD$

$CL = \overline{X} \pm 3SD$

Where $\overline{X}$ = the previously computed mean

SD = the standard deviation

WL = 207± (2 x 7.33)

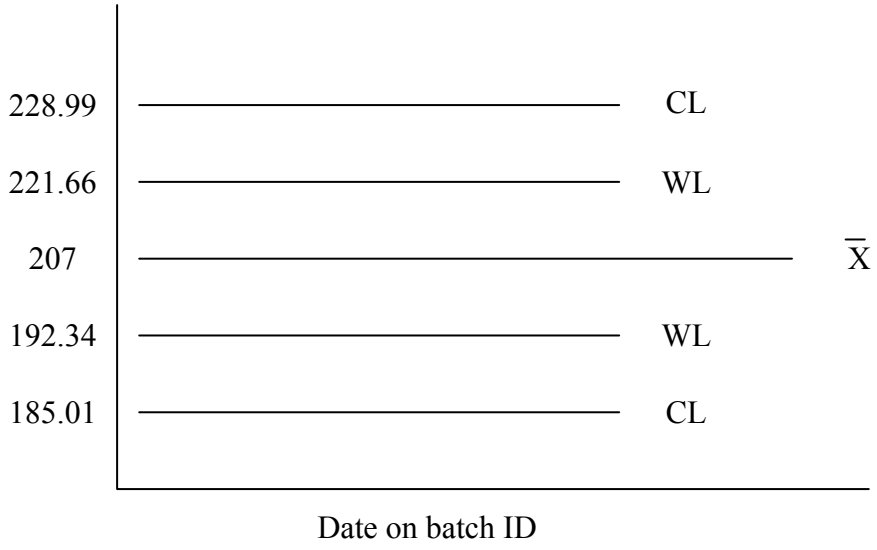
The warning limits (WL) in the example, are 221.66 for the upper warning limit and 192.34 for the lower warning limit.

CL = 207± (3 x 7.33)

The control limits (CL) in the example are 228.99 for the upper control limit and 185.01 for the lower control limit.

3. Construct a control chart

Construct a control chart as done below for the example. The measured values of the reference samples are then plotted in the chart.



4. Percent Recovery

The percent recovery, P is calculated as follows:

$P = 100 (M - B)/T$

Where: T = the target value, i.e. the known concentration of analyte spiked into the sample aliquot.

M = the measured concentration of analyte in the spiked sample aliquot.

B = the background concentration of the unspiked sample aliquot.

The percent recovery data are used to construct a control chart with control limits with acceptance limits as follows:

a. The percent recoveries and analysis dates of the spiked samples are tabulated.

b. When a minimum of five percent recoveries have been tabulated, compute P (the mean percent recovery).

c. Compute SD, the standard deviation (see section on reference standard for example).

5. Surrogate Standard

The percent recovery, P, is calculated as follows:

$$P = 100 (M/T)$$

Where: M = the measured value

T = the target value, (i.e. the known value of surrogate spiked into the sample)

A tabulation of percent recoveries is maintained for each surrogate. The tabulation includes the analysis date, the percent recovery and the control limits for P. Control limits, using a minimum of 5 data points for each surrogate standard are calculated as follows:

$$CL = X \pm 3SD$$

Where: CL = the control limits

X = the mean percent recovery

SD = the standard deviation (see section on reference standard for example)

Compute WL, the warning limits, and CL, the control limits as follows:

$$WL = X \pm 2SD$$

$$CL = X \pm 3SD$$

The computed limits are recorded on the tabulation or control chart.

6. Duplicate Analysis

The difference (i.e. range) between duplicate analyses is determined as follows:

R = the difference (or range)

X_1 = the greater of the measured values

X_2 = the lower of the measured values

A tabulation of duplicates is maintained for each analyte listing dates of analysis, X_1, X_2, R, and the acceptance limit for R. The acceptance limit is established using the following equation:

$$UCL = 3.27 R$$

Where: UCL = the acceptance limit

R = the average range for a minimum of 5 sets of duplicates in a specified concentration range.

X. LABORATORY CALIBRATION/EQUIPMENT MAINTENANCE PROCEDURES

A. LABORATORY EQUIPMENT

1. Analytical Balance

a. Analytical balances are serviced and calibrated internally by a qualified service organization 1/year and a dated certification sticker is provided.

b. Analytical balances are checked daily in two ranges with Class S weights. The ranges selected reflect the routine use of the balance. For example, the analytical balance used principally for evaporating dishes and aluminum dishes would need Class S weights having target values of bracketing the expected weights of the dishes. The date, target reading, actual reading, and analyst's initials are recorded in a bound notebook.

2. pH meter

pH meters are calibrated daily using standard buffers and a two point calibration. This consists of creating a slope using standard pH buffers of pH 4.0 and 10.0. The slope is then checked using a standard buffer of pH 7.0, with an acceptable reading of + /- 0.05 pH units. The date, pH buffer target values, set points, actual readings, and analyst's initials are recorded in a tabular format in a bound notebook.

3. Conductivity meter and cell

a. The conductivity cell constant is determined annually using a 0.01-M potassium chloride solution. The date, resistance readings, average resistance, temperature, calculations, and analyst's initials are recorded in a bound notebook.

b. The conductivity meter and cell is calibrated daily with a 0.001 M potassium chloride solution. An acceptable reading is +/- 20% of target value. The date, target value, actual reading, temperature, and analyst's initials are recorded in a tabular format in a bound notebook.

4. Dissolved Oxygen Meter

The dissolved oxygen meter and probe is calibrated daily using air calibration. The calibration is checked against the Winkler method. This consists of filling two bottles with aerated distilled water; checking the DO value of each bottle using the calibrated DO meter, and then determining the DO value of each bottle using the Winkler method. The DO values of the two methods are then compared. The dates, titers, DO values, average DO, and analyst's initials are recorded in a tabular format in a bound notebook.

5. Turbidimeters

The turbidimeter is calibrated per manufacturer's recommendation using a certified secondary gelex standard with each use. The date, target and observed values, and the analyst's initials are

recorded in a tabular format in a bound notebook.

6. Thermometers

a. The OCDWEP environmental laboratory possesses an NIST (National Institute of Standardized Temperature) traceable, factory-certified thermometer, which is checked at the various temperatures required by a variety of analytical requirements. Correction factors and adjustments to correction factors, new correction factors and analysts initials are recorded in a tabular format in a bound notebook.

b. Each working thermometer has a dedicated use, and is calibrated annually at the temperature of interest using the NBS thermometer. The date, thermometer designation, calibration temperature, correction factor, and the analyst's initials are recorded in a bound notebook.

7. Refrigerators

Laboratory refrigerators maintain a temperature of 1° to 5°C. These temperatures are checked once daily. An NIST certified thermometer with 1°C graduations is used. The date, times, temperature readings and analyst's initials are recorded in tabular format in a bound notebook.

8. BOD Incubator

The BOD Incubator maintains a temperature of 20°, +/- 1°C. Temperature readings are taken twice a day. This thermometer has graduations of 0.2°C. The same data is recorded as for refrigerators.

9. Bacteriological Incubators

a. The air bath incubators maintain a temperature of 35°+/- 0.5°C. A thermometer with graduations of 0.1°C is used. Temperatures are taken twice a day and the same data is recorded.

b. The water bath incubator maintains a temperature of 44.5°+/- 0.2°C. A thermometer with graduations of 0.1°C is used. The same temperature reading schedule and data recording is used as for the air bath incubator.

10. Ovens

Ovens are maintained at the target temperature of interest during use. Temperatures are checked at the beginning and end of each use. A dedicated thermometer with graduations of 1°C is used. The date, target temperature, time and temperature at the start and end of each cycle, oven use, and analysts initials are recorded in a tabular format in a bound format.

11. Autoclave

Autoclave maintains sterilization temperature and pressure during the sterilization cycle and completes the entire cycle within 45 minutes when a 10-12 min. sterilization period is used. A separate calibrated thermometer is used in combination with a sterilization indicator. The date,

time material is placed in autoclave, time of sterilization period, time material was removed, description of sterilized material and analyst's initials are recorded.

12. Automated Ion Analyzer

For instruments at this level of sophistication, the procedures for ensuring correct analytical results are too lengthy for this manual, and the USEPA/ELAP instructions should be followed for specific information. Good general laboratory procedures (GLP) are followed in the daily operation of this instrument; including, but not limited to:

a. Daily calibration for each analyte of interest.

b. Instrument blank for each analyte.

c. Method blank, duplicates, spikes, reference, and check standards are utilized daily for each analyte.

13. Atomic Absorption Spectrophotometer

For instruments at this level of sophistication, the procedures for ensuring correct analytical results are too lengthy for this manual, and the USEPA/ELAP instructions should be followed for specific information. Good general laboratory procedures (GLP) are followed in the daily operation of this instrument; including, but not limited to:

a. Daily calibration for each analyte of interest.

b. Instrument blank for each analyte.

c. Method blank, duplicates, spikes, reference, and check standards are utilized daily for each analyte.

14. Inductively Coupled Plasma (ICP) Spectrophotometer

For instruments at this level of sophistication, the procedures for ensuring correct analytical results are too lengthy for this manual, and the USEPA/ELAP instructions should be followed for specific information. Good general laboratory procedures (GLP) are followed in the daily operation of this instrument; including, but not limited to:

a. Daily calibration for each analyte of interest.

b. Instrument blank for each analyte.

c. Method blank, duplicates, spikes, reference, and check standards are utilized daily for each analyte.

15. TOC Analyzer

For instruments at this level of sophistication, the procedures for ensuring correct analytical results are too lengthy for this manual, and the USEPA/ELAP instructions should be followed for specific information. Good general laboratory procedures (GLP) are followed in the daily

operation of this instrument; including, but not limited to:

a. Daily calibration for each analyte of interest.

b. Instrument blank for each analyte.

c. Method blank, duplicates, spikes, reference, and check standards are utilized daily for each analyte.

B. LABORATORY QUALITY CONTROL DOCUMENTATION REQUIREMENTS

1. Standard Curves

Standard curves are prepared as specified in QA/QC manuals. All standard curves are dated and labeled with method, analyte, standard concentrations, and instrument responses.

A best-fit, straight line is drawn on graphed curves: the axis is labeled. The correlation coefficient is calculated. An acceptable correlation coefficient is 0.995 or greater.

Instrument response for samples is less than the highest standard. The lowest standard is near the detection limit.

If a specific method does not provide guidance in the preparation of a standard curve, the following guidelines are followed. For manual colorimetric methods, a blank and five standards that lie on the linear portion of the curve are used. A new curve is prepared each time an analysis is run. At each use, the curve is checked with a blank and a high standard. The high standard selected is greater than the expected sample concentrations. For automated colorimetric methods, a blank and a minimum of five standards are used. A new curve is prepared for each run. Instrument response is checked with a QC reference sample after each 10 samples. Low level standards are freshly prepared for each run.

2. Method Blank

A method blank consists of laboratory-pure water, which is processed and analyzed as if it were a sample. A method blank is run daily or with each batch of samples. Samples are related to the method blank by means of a date or batch identifier. Where applicable, the blank is calculated as a sample and a tabulation of blank results for each analyte with the date run and its appropriate acceptance criteria is maintained. Acceptance criteria for a method blank is a result less than the Minimum Reportable Limit (MRL) only.

3. Instrument Blank

An instrument blank consists of laboratory water, which is analyzed without adding reagents, filtering, etc. It is used for instrument set-up and no readings are recorded.

4. Trip Blank - Special

Trip blanks are required when analyzing volatile compounds in water. A trip blank is a sample of laboratory-pure water contained in a sample bottle appropriate to the analyte to be determined.

Trip blanks are present but unopened at the sampling site and shipped to the laboratory with the environmental samples taken. A trip blank is included with samples collected at each sampling site. The trip blank is analyzed only when samples from a specific sampling site are positive for the analyte of interest. If reportable levels of the analyses of interest are demonstrated to have contaminated the field blank, resampling is required.

5. Reference Sample

A reference sample is prepared by spiking a known amount of analyte into an appropriate solvent. The concentrate or quality control sample is preferably obtained from an external source. When necessary, a sample prepared in-house is prepared independently of the calibration standard. A reference sample is analyzed with every tenth sample or monthly samples if fewer than ten samples per month are analyzed. Environmental samples are tied to the reference standard by means of a date or batch identifier.

Data generated by the analysis of reference standard are used to construct a control chart and control limits established. Instructions for constructing a control chart and computing limits are to be found later in this section.

Should a result fall outside the control limits, the analysis is out of control and immediate action is taken to determine the cause of the outlying result. Data generated on the same day as the outlying result are regarded as unreliable and the analyses repeated after corrective action has been taken and the procedure is back in control.

A new control chart with freshly computed control limits is generated annually. The last 20 reference standard data points for the previous year are used to compute the new control limits.

6. Spiked Recovery

Spiked recovery for an environmental sample is determined by dividing the sample into two aliquots. The first aliquot is analyzed as usual. The second aliquot is spiked with a known concentration of the analyte of interest. The spike should be approximately 10 times the method's standard deviation (at the level of interest). A spiked environmental sample is analyzed when appropriate at a frequency of 1 spiked sample for every 20 samples or 1 spiked sample per month if fewer than 20 samples per month are analyzed. Samples are related to the spiked recovery date by means of a date or batch identifier.

Data generated by the analysis of spiked samples are used to calculate the percent recovery. The percent recovery data is used to construct a control chart and tabulation and limits established. Instructions for constructing a chart or tabulation and computing limits are to be found later in this section.

A new control chart of tabulation, the analysis is regarded as out of control and immediate action is taken to determine the cause of the outlying result. Data generated on the same day as the outlying result are regarded as unreliable and the analysis repeated after corrective action has been taken and the procedure is back in control. A new control chart or tabulation with freshly computed limits is generated annually. The last 20 data points for the previous year are used to compute the new limits.

7. Duplicate Analysis

A duplicate analysis is required only when a sample yields a positive result. A minimum of 10 percent of all positive samples for a given analyte is analyzed in duplicate. The range between the duplicates is tabulated and acceptance limits established. Instructions for the tabulation and the computation of limits are to be found later in this section.

A new tabulation with a freshly computed acceptance limit is generated annually. The last 20 data points for the previous year are used to compute the acceptable control limits.

8. External QA/QC

In as much as the OCDWEP laboratory is a NYSDOH-ELAP certified laboratory, it is also National Environmental Laboratory Accreditation Conference (NELAC) certified, and is obligated to follow all of the criteria for maintaining this certification under the auspices of the ELAP program. Part of this program consists of a biannual inspection by a NYS Laboratory Inspector, who spends one or more days at each facility checking all aspects of the operation. In addition, performance evaluations are conducted twice per year. This consists of unknown samples sent to the laboratory to be analyzed and the results reported back to ELAP. The laboratory is required to submit results for each parameter that we are certified for, including bacteriology, metals, nutrients, etc.

The USEPA also uses the results from this program to satisfy the requirements of the SPDES permit program that regulates the various wastewater treatment plants in the OCDWEP system.

9. Internal QA/QC

In addition to the above, the OCDWEP laboratory conducts an internal QA/QC program consisting of unknowns that are generated periodically by the OCDWEP staff and given to technicians as “typical” samples, occurring without the analysts' knowledge. The object of this is to ensure that “typical” samples are analyzed using the same care as the “official” samples.

C. LABORATORY QUALITY CONTROL REQUIRED - BY PARAMETER

Inorganic Analytes		
Sub-Category or Analytical Group	**QC Measure Record Acquired**	**Frequency**
Demand/Residue		
BOD	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
COD and TOC	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 20th sample or monthly if less than 20 samples per month are analyzed.
	Duplicates Tabulation* Of all positive samples	On positive samples only, a minimum of 10% of all samples.
Mineral		
Alkalinity and Hardness	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
All other analyses except pH	Reference Sample Chart*	Every 10^{th} sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 20^{th} sample or monthly if less than 20 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.

Sub-Category or Analytical Group	QC Measure Record Acquired	Frequency
Nutrient		
All nutrient analyses	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 20th sample or monthly if less than 20 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.
Wastewater Metals		
ICP (same as Flame)	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.
Flame or Colorimetric Method	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.
Furnace Method	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Post only if Dupes are ±15%.
	Duplicates Tabulation*	Double matrix spiked every 10th sample.
Mercury (FIMS)	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Post only if Dupes are ±15%.
	Duplicates Tabulation*	Double matrix spiked every 10th sample.

Sub-Category or Analytical Group	QC Measure Record Acquired	Frequency
Miscellaneous Analytes		
Oil & Grease	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
Cyanide, Phenols, and Silica	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 20th sample or monthly if less than 20 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.
Organic Analytes		
Organic Purgeables		
Priority Pollutants by GC	Laboratory Blank Tabulation*	Daily or with each batch run.
	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Surrogate Standard Tabulation*	All samples.
Organic Extractables		
Priority Pollutants and Pesticides by GC	Laboratory Blank Tabulation*	Daily or with each batch run.
	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.

Sub-Category or Analytical Group	QC Measure Record Acquired	Frequency
	Spiked Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Surrogate Standard Tabulation*	All samples.
Solid Waste Metals		
All Methods	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.
All Other Analytes		
Inorganic	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Spiked Sample Chart*	Every 20th sample or monthly if less than 20 samples per month are analyzed.
	Duplicates Tabulation*	On positive samples only, a minimum of 10% of all samples.

Sub-Category or Analytical Group	QC Measure Record Acquired	Frequency
All Other Analytes		
Organic	Laboratory Blank Tabulation*	Daily or with each batch run.
	Duplicates Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Reference Sample Chart*	Every 10th sample or monthly if less than 10 samples per month are analyzed.
	Matrix Check	Daily or with each batch run.

XI. PROGRAM ASSESSMENTS

OCDWEP has designed several means of assessing whether the goals of the data acquisition program are being met. Both the field and laboratory components of the Ambient Monitoring Program will be assessed on an ongoing basis, with formal checkpoints each month.

The program team reviews the workplan with key field and laboratory personnel. An annual calendar is put together, noting field sampling days. Weekly coordination meetings are held with field and laboratory personnel in attendance. Any significant activities or problems identified in either the field or laboratory component of the program are discussed. A formal list of action items is kept from these weekly meetings.

Data are received from the laboratory on a monthly basis and are reviewed. Charge balances (summing the milliequivalent of the major anions and cations) of the inorganic data are performed to screen for data quality. Relative percent difference between field replicates is calculated.

A field audit will be conducted during the Year 2008 monitoring season. Members of the project team will accompany the field sampling team and observe sample collection and field data acquisition. A formal report of the field assessment will be maintained in the OCDWEP lake files. A laboratory audit will also be scheduled. The procedures for sample handling and analysis will be evaluated whether the criteria defined in the workplan are being consistently implemented.

XII. DATA QUALITY ASSESSMENT

Choices made in design of the sampling program (spatial and temporal), field sampling procedures, laboratory procedures, and data evaluation and interpretation can greatly influence the ability to draw conclusions. In this section, we describe the quantitative and qualitative decisions made to ensure that the data quality is adequate to meet the needs of this program. Data quality will be assessed using EPA's 40 CFR 30.503 standard criteria; precision, accuracy, representativeness, completeness, and comparability. In addition, a field audit will be performed to assess field procedures and sample handling. QA/QC methods for field and analytical procedures are those mandated by the New York State Department of Health Environmental Laboratory Approval Program (ELAP).

A. PRECISION

The plan to monitor and control the precision and accuracy of analytical measurements is described in the section on analytical procedures. Precision of field samples will be assessed through a program of field replicate analyses: one replicate per sample delivery group, or twenty samples. For routine lake and tributary monitoring, one sampling depth (lake) and station (tributary) will be sampled in duplicate for the complete suite of parameters.

B. ACCURACY

Accuracy, or how close the reported concentrations of concern are to “true” values, can be difficult to assess. The laboratory analytical program describes how this data quality indicator is monitored through a program of audit samples. A second approach Onondaga County has implemented is a validation program, using an outside expert in limnology and statistics to audit the results. The data validation program cannot be a final arbiter of what values in a data set are true, but it can help test for outliers and systematic differences between researchers that warrant further investigation. In addition, ELAP Laboratories require proficiency samples.

C. REPRESENTATIVENESS

Representativeness refers to the degree to which the samples acquired reflect the nature of the underlying population. Any monitoring program relies on the results of a limited number of samples drawn from a much larger underlying population to provide information regarding the nature of that larger population. The sampling program described in this document has been designed to accommodate the known temporal and spatial variability of the lake and its tributaries. Onondaga Lakes undergoes thermal stratification.

This requires both temporal and spatial adjustments to the annual monitoring program. Water quality analyses and data manipulation reflects the nature of the lake's stratification. Samples are taken at 3m intervals that span the thermal regime. Upper Mixed Layer (UML) results are separated from the Lower Water Layer (LWL) results in the calculations of annual and growing season (5/15 - 9/15) means and medians. Trends in concentrations during both the mixed and stratified periods are calculated. The primary sampling station in the Year 2008 Monitoring Program is a point in the southern lake basin (South deep). This station has been sampled throughout the 36 years of lake monitoring. Four times each year, Onondaga County monitors a second station (designated North Deep) to determine whether water quality results differ. Tributary monitoring is on a bi-weekly basis. Judgment will be used to select the number and location of transects to collect water samples in the

tributaries. Samples of the Lake Outlet are obtained at 2-feet and 12-feet depths to accommodate the density stratification that has been documented to occur in the Seneca River under low-flow conditions.

D. COMPARABILITY

Documentation of procedures and results of the monitoring program have been maintained by OCDWEP since 1968. Our goal is for data generated during the Year 2008 program to be comparable to the historical data. To meet this goal, we are committed to fully documenting the sampling and analytical procedures used, including any special modifications necessary to maximize precision, accuracy, or sensitivity in the lake water matrix.

E. COMPLETENESS

We are fortunate to have an extensive database of Onondaga Lake water quality to provide guidance regarding optimal sampling design with respect to variability of the measured parameters. An analysis of the reduction on the coefficient of variation achieved by different sampling strategies for the lake indicates that a monthly sampling program is adequate for most parameters (Walker 1992). Other parameters associated with short-term fluctuations in algal populations such as Chlorophyll-*a* require more frequent (weekly) monitoring from May through September.

Non-parametric statistics has been selected to indicate trends in water quality over time. The seasonal Kendall test allows us to differentiate seasonal variations within years from changes between years. The non-parametric statistics will maintain their power even with occasional missing values. Our goal for Year 2008 is to complete and validate 100% of the planned samples.

F. FIELD AUDIT

A technical advisor, to assess the field procedures and sample handling will perform an annual field audit. The audit findings and recommendations will be forwarded to the NYSDEC and also included in the annual monitoring report.

G. EQUIPMENT RINSATE BLANKS

Wildco Beta Dunker, Churn, and Pump QA/QC equipment rinsate blanks will be collected for each of the AMP sampling events, as appropriate.

XIII. DATA REVIEW AND VALIDATION

Data will be screened for both technical defensibility (were procedures followed, were the laboratory control limits for precision and accuracy observed and usability, are the sample results sufficient to allow inferences regarding the nature of the underlying population?). Both of these criteria are important to meet the objectives of the lake-monitoring program.

Technical defensibility includes evaluation of the following:

a. Internal laboratory quality control: blanks, spikes, replicates, and standard curves;

b. Chain-of-custody complete; and

c. Holding times for all parameters met in accordance with analytical method.

Data usability includes evaluation of the following:

a. Charge balance of major anions and cations;

b. Results of field replicates; and

c. Statistical evaluation of outliers.

XIV. DOCUMENTATION

A. FIELD AND LABORATORY DATA

Field and laboratory data are stored both on the Laboratory Information Management System (LIMS) and on paper copy to be filed at OCDWEP. Data may be retrieved at any time from either of these sources.

B. LABORATORY REPORTS

Samples are delivered to the laboratory along with chain of custody forms on the date of sampling. YSI sondes' field data are delivered to the laboratory by the next day. Laboratory reports are finalized and delivered to the program manager and field supervisor within 30 days of the sample date.

C. PRELIMINARY DATA VALIDATION

Preliminary data validation is performed within 30 days of receipt of final laboratory data.

D. TREND ANALYSIS

Statistical trend analysis of the data will be performed. The non-parametric seasonal Kendall test will be performed on the lake and tributary data to test for long-term trends and changes in lake water quality in response to the major reductions in external loading.

E. ANNUAL TRIBUTARY LOADS

The flow-weighted concentrations of the constituents will be summarized. Dr. Walker's refined program used to estimate loading to Onondaga Lake will be used. The improved estimation technique, called "Method 5", was developed in conjunction with the compilation of the OCDWEP long-term integrated water quality data base and supporting software. The new technique was developed to support estimation of daily loads, to support development of monthly and seasonal lake mass balances, and to improve the accuracy and precision of the annual load estimates. Method 5 differs from AUTOFLUX Method 2 in several ways. Data are stratified by flow regime (similar to AUTOFLUX Method 2) and are also stratified by season using a multiple regression technique. Conditions during the unmonitored period are projected using a residual interpolation method that includes a flow derivative term.

F. ANNUAL REPORT

At the end of the monitoring year, data are compiled and manipulated into a report of analyses computation and evaluation of the ambient monitoring program.

XV. QAPP – SUMMARY OF REVISIONS

1. Page 6: Jeff Noce, new Laboratory Director, OCDWEP Environmental Laboratory.
2. Page 9 & 10: Update of Appendix A (Year April 2008-March 2009 Non-Event Based Water Quality Sampling Schedule).
3. Page 19: Standardized Chlorophyll-a sample depth to 3m of the water column year round. Deleted Photic Zone sample.
4. Page 20: Net Haul Zooplankton sample: 0-15 m (during unstratified period) and UML (during thermally stratified period).
5. Page 21: Phytoplankton sample changed from UML to 0-3 meter standard depth tube composite sample.
6. Page 24: Added storm-event program in 2008.
7. Page 25: Quality Assurance/Quality Control Samples (Field Duplicates): Added quality control "blind" duplicate samples which are unknown to lab personnel (to be collected 4 times per year) for Onondaga Lake and Tributary sampling events.
8. Page 28: The Wildco Beta Sample Tubes and Submersible Pump are cleaned with DI water after each use.
9. Page 29: Section VIII. Field Equipment Calibration Procedure/Maintenance – YSI sondes: Minor revisions to Calibration/Maintenance Procedures.
10. Page 58: Attachment A (Tributary Field Sampling Procedures) – Added instructions for churning rate for the sample compositing churn for tributary sites using the churn.
11. Page 76: Attachment C (Analytical Methodologies List) - Updated to reflect 2007 Minimum Reporting Limit (MRL), accuracy, and precision values.
12. Page 80: YSI 600 & 6600 Calibration: Post-Calibration checks are conducted after use, on the same day (to the extent possible or the following day).

Attachments

Attachment A: Tributary Field Sampling Procedures – by sampling site

Attachment B: Chain-Of-Custody Form (Example)

Attachment C: Analytical Methodologies

Attachment D: YSI 600/6600 Calibration Procedures

Attachment E: YSI 600/6600 Maintenance Procedures

Attachment F: YSI 600/6600 Operation Procedures

ATTACHMENT A:

Tributary Field Sampling Procedures

1. Ninemile Creek Rt. 48 Bridge Sampling Procedures

Equipment Requirements: Bridge Crane and Bomb Sampler
Sample Compositing Churn
Coli Sampler
In-situ parameters - See YSI Standard Operating Procedure (SOP).

Bottle Requirements:
(1) 1-L plastic pre-cleaned (metals)
(1) ½-gallon plastic (t-Cn)
(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
(1) ½-gallon plastic (conv)
(1) 500-ml boston round plastic (t-alk)
(2) 125-ml sterile plastic (coli)
(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 5 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and allow the sampler to orient to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 5 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information and USGS stage gage reading on the Chain-of-Custody and record all field observations on the field sheets. Should the gage house not be accessible, provisional readings may be taken from the USGS Internet site.

2. Onondaga Creek at Dorwin Avenue Sampling Procedures

Equipment Requirements:	Bridge Crane and Bomb Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 5 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and allow the sampler to orient to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 5 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information and USGS stage gage readings on the Chain-of-Custody and record field observations on the field sheets. Should the gage house not be accessible, provisional readings may be taken from the USGS Internet site.

3. Onondaga Creek at Spencer Street Sampling Procedures

Equipment Requirements:	Bridge Crane and Bomb Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)

Step 1: Divide the stream into 5 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and allow the sampler to orient to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 5 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information and USGS stage gage reading on the Chain-of-Custody and record field observations on the field sheets. Should the gage house not be accessible, provisional readings may be taken from the USGS Internet site.

4. Onondaga Creek at Kirkpatrick Street Sampling Procedures

Equipment Requirements:	Bridge Crane and Bomb Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 5 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and allow the sampler to orient to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 5 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information and USGS stage gage readings on the Chain-of-Custody and record field observations on the field sheets.

5. Harbor Brook at Velasko Road Sampling Procedures

Equipment Requirements:	Hand Held Depth Integrated Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 3 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and orient the nozzle to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 3 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information and USGS stage gage reading on the Chain-of-Custody and record field observations on the field sheets.

6. Harbor Brook at Hiawatha Boulevard Sampling Procedure

Equipment Requirements:	Vertical Kemmerer Bottle Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 3 equal transects.

Step 2: Set the sampler and lower the sampler into the water until fully submerged.

Step 3: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with water samples.

Step 4: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 5: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 6: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 7: Place samples on ice.

Step 8: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 9: Record sample information and USGS stage gage reading on the Chain-of-Custody and record field observations on the field sheets. Should the gage house not be accessible, provisional readings may be taken from the USGS Internet site.

7. Ley Creek at Park Street Sampling Procedure

Equipment Requirements:	Vertical Kemmerer Bottle Sampler
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 3 equal transects.

Step 2: Set the sampler and lower the sampler into the water until fully submerged.

Step 3: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with water samples.

Step 4: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 5: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 6: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 7: Place samples on ice.

Step 8: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 9: Record sample information and USGS stage gage reading on the Chain-of-Custody and record field observations on the field sheets. Should the gage house not be accessible, provisional readings may be taken from the USGS Internet site.

8. Tributary 5A Sampling Procedures

Equipment Requirements:	Hand Held Depth Integrated Sampler Sample Compositing Churn Coli Sampler In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals) (1) ½-gallon plastic (t-Cn) (1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP) (1) ½-gallon plastic (conv) (1) 500-ml boston round plastic (t-alk) (2) 125-ml sterile plastic (coli) (2) 250-ml round plastic (srp/tdp)

Step 1: Divide the stream into 3 equal transects.

Step 2: Locate the area in the stream with the highest velocity.

Step 3: Lower the sampler to the water surface and allow the sampler to orient to the stream flow direction. Lower and raise the sampler at a rate of 1 foot per second. Record the number of repetitions (Dips) to fill 75% of the sample bottle. Be careful not to disturb the stream bottom.

Step 4: Pour the water sample into the churn and rinse out the churn thoroughly.

Step 5: Perform the same number of trips and dips at all 3 transect locations. Record the number of trips that will be needed to collect sufficient sample volume and the amount of water needed to keep the churn wet.

Step 6: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 7: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 8: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 9: Place samples on ice.

Step 10: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 11: Record sample information on the Chain-of-Custody and record field observations on the field sheets.

9. East Flume Sampling Procedure

Equipment Requirements:	1-Quart glass jar
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Use a 1-Qt. glass jar at the V-notch weir, collect samples off the downside of the weir.

Step 2: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with 12 (1-qt) grab samples.

Step 3: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 4: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 5: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 6: Place samples on ice.

Step 7: Collect field data with the YSI. Place sonde just behind v-notch weir.

Step 8: Record sample information on the Chain-of-Custody and record field observations on the field sheets.

10. Metro Effluent Sampling Procedure

Equipment Requirements:	1-Quart glass grab jar
	Sample Compositing Churn
	Coli Sampler
	Bucket (for sonde use)
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Use a 1-Qt. glass jar in a grab polyethylene sampling apparatus on a rope. Collect sample from the Final Effluent (IC#789) Grab location.

Step 2: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with 12 (1-qt.) grab samples.

Step 3: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 4: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 5: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 6: Place samples on ice.

Step 7: Collect field data with the YSI. Place sonde in a sample bucket/sample compositing churn.

Step 8: Record sample information on the Chain-of-Custody and record field observations on the field sheets.

11. Lake Outlet Sampling Procedure

Equipment Requirements: Vertical Kemmerer Bottle Sampler (Dunker)
Coli Sampler
Sample Compositing Churn
In-situ parameters - See - YSI SOP

Bottle Requirements:

Lake Outlet 2-ft.	**Lake Outlet 12-ft.**
(1) 1-L plastic pre-cleaned (metals)	(1) 1-L plastic pre-cleaned (metals)
(1) 500-ml boston round plastic (t-alk)	(1) 500-ml boston rnd. plastic (t-alk)
(1) 125-ml plastic (coli)	(1) ½-gallon plastic (t-Cn)
(2) 250-ml round plastic (srp/tdp)	(2) 250-ml round plastic (srp/tdp)
(1) ½-gallon plastic (t-Cn)	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)	
(1) 2 liter amber bottle (Chlorophyll-*a*)	(1) 2 liter amber bottle (Chlorophyll-*a*)

Step 1: Locate the sampling location at mid-channel.

Step 2: Collect one sample from the required sampling depth to rinse the churn.

Step 3: Collect three samples at a depth of 2 feet and deposit the samples in the Churn.

Step 4: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn.

Step 5: Repeat steps 2, 3 and 4 for the 12-foot sample. If a field duplicate is required at either location, collect that sample using the same protocol. Rinse the Churn with water from the corresponding depth prior to sampling.

Step 6: Preserve the samples as per Section IV (Table 1-Sample Collection and Preservation).

Step 7: Place the samples on ice.

Step 8: Collect field data with the YSI. The sonde should be placed at mid-channel. In-situ data will be recorded at .5 meter increments and at .6 m and 3.7 m.

Step 9: Record sample information on Section IV (Table 1-Sample Collection and Preservation) and record all field observations on the field sheets.

NOTE: The sampling site has been moved to the downstream site of the one-lane pedestrian bridge.

12. Metro Bypass Sampling Procedure

Equipment Requirements:
- 1-Quart glass grab jar
- Sample Compositing Churn
- Coli Sampler

Bottle Requirements:
- (1) 1-L plastic pre-cleaned (metals)
- (1) ½-gallon plastic (t-Cn)
- (1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
- (1) ½-gallon plastic (conv)
- (1) 500-ml boston round plastic (t-alk)
- (2) 125-ml sterile plastic (coli)
- (2) 250-ml round plastic (srp/tdp)

Step 1: Use a 1-Qt. glass jar in a grab can on a rope. Collect samples from the Metro Bypass sampling location and pour into a dedicated carboy.

Step 2: Ensure sample is completely mixed prior to pouring sample from the carboy into the sample containers.

Step 3: The Field Sheet will specify what bottles need to be filled for that event.

Step 4: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 5: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 6: Place samples on ice.

Step 7: Collect field data with the YSI. Place sonde in a sample bucket.

Step 8: Record sample information on the Chain-of-Custody and record field observations on the field sheets.

13. Bloody Brook at Onondaga Lake Parkway Sampling Procedure

Equipment Requirements:	1-Quart glass jar
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Use a 1 Qt. glass jar in a grab can on a rope. Collect sample from the Blood Brook Creek bridge grab location.

Step 2: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with 12-15 (1qt.) grab samples.

Step 3: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the churn. The Chain-of-Custody form will specify what bottles need to be filled for that event.

Step 4: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 5: Preserve samples as per Chain-of-Custody and check samples for the appropriate pH.

Step 6: Place samples on ice.

Step 7: Collect field data with the YSI.

Step 8: Record sample information on the Chain-of-Custody and record field observations on the field sheet. Record the USGS Staff Gage Reading.

14. Sawmill Creek at Onondaga Lake Recreational Path Sampling Procedure

Equipment Requirements:	1-Quart glass jar
	Sample Compositing Churn
	Coli Sampler
	In-situ parameters - See YSI SOP
Bottle Requirements:	(1) 1-L plastic pre-cleaned (metals)
	(1) ½-gallon plastic (t-Cn)
	(1) 1-L white plastic pre-cleaned (TKN, NH_3-N, TP)
	(1) ½-gallon plastic (conv)
	(1) 500-ml boston round plastic (t-alk)
	(2) 125-ml sterile plastic (coli)
	(2) 250-ml round plastic (srp/tdp)

Step 1: Use a 1-Qt. glass jar at the downstream side of the Path, dip jar into stream flow as near to center of stream as possible, to collect samples.

Step 2: Pour the water sample into the churn and rinse out the churn thoroughly. Fill the churn with 12 (1-qt) grab samples.

Step 3: When churning, the disk should touch the bottom on every stroke, and the stroke should be as long as possible without breaking the water surface. The churning rate should be about 9 inches per second (faster rates could introduce air into the sample). Churn for about 10 strokes before subsampling. The first subsample should be the one that requires the largest volume. Fill the required bottles from the Churn. The Field Sheet will specify what bottles need to be filled for that event.

Step 4: Collect a Coliform sample as per the Coliform Sampling Procedure.

Step 5: Preserve samples as per Section IV (Table 1-Sample Collection and Preservation) and check samples for the appropriate pH.

Step 6: Place samples on ice.

Step 7: Collect field data with the YSI. Place sonde at mid-channel and mid-depth.

Step 8: Record sample information and USGS stage gage reading on the Chain-of-Custody and record field observations on the field sheets.

15. Onondaga Creek Salt Spring (Spence-Patrick Spring Well Point) Sampling Procedure

Location: East Side of Onondaga Creek between Spencer and Kirkpatrick Streets

Equipment Requirements:
Gallon jug deionized water
Sample Compositing Carboy
Portable Pump with NiCd Battery
In-situ parameters - See YSI 600 SOP

Bottle Requirements:
(1) 1 L plastic pre-cleaned (metals)
(1) gallon plastic (conv)
(1) 500ml boston round plastic (t-alk)

Step 1: Unhook the sampling tube attached to the tree located at the sampling site. The sampling site is along the bank between Spencer St. and Kirkpatrick St. (that is, the right bank of Onondaga Creek if facing in the direction of Onondaga Lake). Place the sampling tube in the one gallon jug of deionized water.

Step 2: Turn the pump to reverse. Pump the deionized water into the sampling line and discard the rinse water.

Step 3: Turn the dial to pump "forward". Pump the sample water into a carboy to composite.

Step 4: Be sure to pump up enough volume to fill the sample containers and to get an in-situ YSI reading. The YSI probes need to be covered completely to get an accurate reading.

Step 5: Swirl the carboy and pour off the sample containers.

Step 6: Preserve samples as per Section IV (Table 2 – Sample Collection and Preservation and check the samples for the appropriate pH.

Step 7: Place samples on ice.

Step 8: Collect field data with the YSI 600. The YSI can be placed in the sampling carboy provided all the sample containers have been filled.

Step 9: Record sample information on the Chain of Custody and record field observations on the field sheet.

ATTACHMENT B:

Chain-Of-Custody Form (Example)

ATTACHMENT C:

Analytical Methodologies

ANALYTICAL PROCEDURES FOR WATER QUALITY ANALYSES
2007 AMBIENT MONITORING PROGRAM

Parameter	Code	Methods *	Minimum Reportable Limit (mg/L)	Accuracy (%)	Precision (%)
Bio Oxy Demand 5-day	BOD5	2:(5210)	2.0	100.5	6.1
Carbon. Bio Oxy Demand 5-day	CBOD5	2:(5210 B)	2.0	95.9	5.7
Total Alk as CaCO3	ALK-T	1:(310.1)	1.0	97.9	1.9
Total Organic Carbon	TOC	1:(415.1)	0.5	98.4	8.7
Total Organic Carbon - Filtered	TOC-F	1:(415.1)	0.5		
Total Inorganic Carbon	TIC	1:(415.1)	0.5	101.1	1.9
Total Kjeldahl Nitrogen as N	TKN	3:(10-107-06-2-D)	0.15	89.2	5.4
Ammonia Nitrogen as N	NH3-N	3:(10-107-06-1-B)	0.03	93.6	6.3
Organic Nitrogen as N	ORG-N	3:(10-107-06-2-D)	0.05		
Nitrate as N	NO3	3:(10-107-04-1-B)	0.01	99.1	3.0
Nitrite as N	NO2	3:(10-107-04-1-B)	0.01	99.6	1.4
Total Phosphorus (Manual)**	TP	1:(365.2)	0.003	98.6	3.4
Total Phosphorus	TP	3:(10-115-01-1-E)	0.01	94.7	6.2
Total Dissolved Phosphorus	TDP	1:(365.2)	0.003	98.6	3.4
Soluble Reactive Phosphorus	SRP (OP)	1:(365.2)	0.001	99.1	2.5
Silica	SiO2	1:(370.1)	0.2	100	6.2
Sulfates	SO4	1:(375.4)	10.0	101.3	4.3
Total Sulfides	S=	1:(376.1)	0.2		
Total Solids	TS	1:(160.3)	1.0		
Total Volatile Solids	TVS	1:(160.4)	1.0		
Total Suspended Solids	TSS	1:(160.2)	1.0		
Total Volatile Suspended Solids	VSS	1:(160.4)	1.0		
Total Dissolved Solids	TDS	1:(160.1)	1.0	100.4	19.0
Arsenic - furnace	As - GFA	4:(200.9)	0.002	98	4.3
Total Cadmium	Cd - GFA	4:(200.9)	0.0008	104.5	3
Total Calcium	Ca	1:(215.1)	1.0	99	1.8
Total Chromium	Cr	4:(200.7)	0.010(0.0025)*	100.9	3.0
Chloride	Cl	3:(10-117-07-1-B)	1.0	100.6	1.9
Residual Chlorine	CL2 RES	1:(330.4)	0.1		
Total Copper	Cu	4:(200.7)	0.0125(0.0031)*	101.4	2.6
Chlorinated Cyanide	CN-CL2	3:(10-204-00-1-A)	0.005		
Total Cyanide	CN-T	3:(10-201-00-1-A)	0.003	105.8	8.8

ANALYTICAL PROCEDURES FOR WATER QUALITY ANALYSES
2007 AMBIENT MONITORING PROGRAM
(CONTINUED)

Parameter	Code	Methods *	Minimum Reportable Limit (mg/L)	Accuracy (%)	Precision (%)
Total Iron	Fe	4:(200.7)	0.05	101.0	3.4
Total Lead - furnace	Pb - GFA	4:(200.9)	0.002	100.8	2.9
Total Magnesium	Mg	1:(242.1)	0.1	98.8	1.4
Total Manganese	Mn	4:(200.7)	0.025	100.7	3.0
Total Mercury (Cold Vapor)	Hg	1:(245.2)	0.00002	101	4.1
Selenium - furnace	Se - GFA	4:(200.9)	0.002	101.8	3.9
Total Sodium	Na	1:(273.1)	3.0	100.4	1.2
Total Nickel	Ni	4:(200.7)	0.015(0.00375)*	100.6	3.2
Potassium	K	1:(258.1)	0.020	99.4	2.2
Total Silver	Ag	4:(200.7)	0.0125	100.8	2.6
Total Zinc	Zn	4:(200.7)	0.025(0.00625)*	100.8	3.2
Turbidity			0.1	92.1	5.5
Conductivity	COND	2:(2510B)	-		
Dissolved Oxygen - Field	DO - Field	1:(360.1)	0.1		
Dissolved Oxygen - Lab	DO - Lab	1:(360.1)	-		
Dissolved Oxygen - Winkler	DO - Winkler	1:(360.2)	-		
pH	pH	1:(150.1)	-		
Temperature	TEMP	1:(170.1)	-		
Phenol	PHENOL	3:(10-210-00-1-B)	0.1	117.7	12.3
Phaeophytin *a*	PHEO-A	2:(10200 H.2)	0.0002		
Chlorophyll *a*	CHLOR-A	2:(10200 H.2)	0.0002		
Enterococci	ECOCCI-Enterolert	6:(1040)	1.0 (cells/100mls) MPN		
E. Coliform	ECOLI-Colilert	2:(9223 B)	1.0 (cells/100mls) MPN		
Fecal Coliform	FCOLI-MF	2:(9222 D)	2.0 (cells/100 ml)		

Methods listed are applicable for all matrices of water, wastewater, and surface waters.

* Indicates method has a lower level of detection due to sample concentration

**Started in August 2000 for all AMP samples.

1: Indicates USEPA Methods for Chemical Analysis of Water and Waste 1979

2: Indicates Standard Methods (18th Edition)

3: Indicates Lachat Instruments QuickChem Methods: Approved for use by USEPA - NYSDOH - ELAP

4: Indicates USEPA "Methods for the Determination of Metals in Environmental Samples" Supplement 1, May 1994

5: USEPA Microbiological Methods Manual 1996

6: Approved for use by ELAP

ATTACHMENT D:

YSI 600/6600 Calibration Procedures

YSI 600 & 6600 Calibration

The YSI 600 & 6600 sonde units are calibrated in the OCDWEP Laboratory located at the Henry Clay Boulevard Facility (HCBF). All calibration solutions e.g. (20^0C DI water; pH buffers 7,10; Conductivity KCl buffers 0.01N & 0.02N) are purchased and supplied with a certificate of analysis and stored in the laboratory. The YSI 600 & 6600 are calibrated no more than 24 hours prior to use on the day that it is used in the field. Post-calibration checks are conducted after use, on the same day (to the extent possible or the following day), on all calibrated parameters. All calibration records are maintained in a bound book.

Dissolved Oxygen (DO) Calibration

1. Bring the DI water bucket, which can be found in the 20^0C walk-in incubator room, to the ELS Field Staging Room. Place the sonde unit (with attached weighted probe guard) into the 20° C DI water bucket. Allow the unit to stabilize in the bucket for 10 minutes.

2. Record the current barometric pressure (from the MDS 650). Record the mm of Hg value in the bound calibration notebook.

3. The DI water in the bucket should be well stirred, and the YSI 600 or 6600 should be temperature stabilized before proceeding with DO calibration.

4. Once stable, record in the calibration log book the DO and temperature value on the display unit. Collect two Winkler bottle DO samples from the DI water bucket, and turn these samples over to the laboratory technician responsible for DO analysis.

5. The DO concentration is determined in each of the two bottles using the Winkler method. Record each result and the average value of the two DO concentrations in the calibration logbook.

6. If the concentration results of the two bottles, using the Winkler method, are greater than 0.2 ppm different, the DO concentrations should be determined again.

7. If the "average Winkler DO" value is not within five-hundredths (0.05) of the value on the display unit, then it is necessary to calibrate the YSI 600 or 6600, using the "average Winkler DO" value.

8. Select **"Sonde Menu,"** then **"Calibrate,"** then **"DO %"** on the display unit. Enter the calculated barometric pressure **"mm/Hg."** The display will then return to the data display screen, with the option **"calibrate"** highlighted. Record the displayed DO value as the initial reading. Then select "enter"; the calibration will stabilize and be completed. Record the new displayed value in the logbook as the calibrated value. Select the highlighted option **"continue"** by pressing "enter". For calibration to a DO Winkler value, select **"DO mg/L"**, enter the average Winkler DO value. The display will then return to the data display screen, with the option **"calibrate"** highlighted. Record the displayed DO value as the initial reading. Then select "enter"; the calibration will stabilize and be completed. Record the new displayed value in the logbook as the calibrated value. Select the highlighted option **"continue"** by pressing "enter". The DO is now calibrated.

9. <u>After use in the field</u>, conduct the post-calibration procedure repeating steps 1 through 5 as listed above. The difference between the displayed DO value recorded in the log book and the "average Winkler DO" is the drift, which should be recorded in the log book.

pH Calibration

1. Remove the weighted probe guard from the sonde unit and screw on the calibration cup. Rinse the cup with DI water. Thoroughly mix the container of pH 6 buffer, making sure the solution is dated, and fresh. Rinse the probes in the calibration cup with pH 6 buffer, then fill the cup with the buffer until all probes are submerged. Allow the readings to stabilize for approximately 90 seconds.

2. Select **"Sonde Menu,"** then **"Calibrate,"** then **"pH,"** then **"2 point cal"** on the display unit. Enter the first pH buffer for calibration (pH 6.00). The display will then return to the data display screen, with the option **"calibrate"** highlighted. Record the displayed pH value as the initial reading. Then select "enter", the calibration will stabilize and be completed. Record the new displayed value in the logbook as the calibrated value. Select the highlighted option **"continue"** by pressing "enter".

3. Rinse the cup with DI water. Thoroughly mix the container of pH 10 buffer, making sure the solution is dated, and fresh. Rinse the probes in the calibration cup with pH 10 buffer, then fill the cup with the buffer until all probes are submerged. Allow the readings to stabilize for approximately 90 seconds.

4. Next, enter the second pH buffer for calibration (pH 10.00). The display will then return to the data display screen, with the option "**calibrate**" highlighted. Record the displayed pH value as the initial reading. Then select "enter", the calibration will stabilize and be completed. Record the new displayed value as the calibrated pH in the logbook. The display will show "**continue**" highlighted, select "enter" to continue with options.

5. Next, put the display unit in run mode. Rinse the cup with DI water. Thoroughly mix the container of pH 7.00 buffer, making sure the solution is dated, and fresh. Rinse the probes in the calibration cup with pH 7.00 buffer, then fill the cup with the buffer. All probes should be submerged. Allow the readings to stabilize for approximately 90 seconds. Record the value on the display unit. This value should be recorded in the logbook as the check value. (Target value +/- 0.05 Standard Units)

6. <u>After use in the field</u>, conduct the post-calibration procedure by repeating steps 1 and 3. The displayed value should be recorded as the "after use" value. The difference between the "after use" value and the "calibrated" value is the drift. Record this value in the logbook.

Conductivity Calibration

1. Rinse the calibration cup twice with DI water, then once with the 0.02N KCl solution. Fill the calibration cup with the 0.02N KCl solution such that the conductivity block is fully submerged. Tap the sonde unit to dislodge any possible air bubbles.

2. Select **"Sonde Menu,"** then **"Calibrate,"** then **"conductivity,"** then **"sp. cond."** Enter the value 2.76 mS/cm for calibration of (0.02N KCl). The display will then return to the data display screen, with the option **"calibrate"** highlighted. Record the displayed sp.cond. value as the initial reading. Then select "enter", the calibration will stabilize and be completed. Record the new displayed value in the logbook as the calibrated value. Select the highlighted option **"continue"** by pressing "enter". The display will then continue with options. Advance to **"sonde run."**

3. Rinse the calibration cup twice with DI water, then once with the 0.01N KCl solution. Fill the calibration cup with the 0.01N KCl solution such that the entire conductivity block is fully submerged. Tap the sonde unit to dislodge any possible air bubbles.

4. Record the displayed conductivity value in the logbook as the "initial reading".

5. After use in the field, conduct the post-calibration procedure by repeating steps 1 and 3. The displayed value for each solution should be recorded as the "after use" value. The difference between the "after use" value and the "calibrated value" (for 0.02N KCl) and "initial value" (for 0.01N KCl) should be recorded as the drift.

Depth Calibration

1. Calibration of depth should occur in the field, immediately prior to use. Suspend the sonde unit by holding the cable, such that the probes are just above the water surface. Select **"Sonde Menu,"** then **"Calibrate"**, then **"Pressure-ABS"** on the display unit. Enter the calibrated value (0.0 meters). The display will then return to the data display screen, with the option **"calibrate"** highlighted. Select "enter", the calibration will stabilize and be completed. Select the highlighted option **"continue"** by pressing "enter". The display will then continue with options. Advance to **"sonde run."**

Battery Voltage Evaluation

1. Internal battery voltage is shown on the display unit. Batteries are replaced when the battery voltage indicator is down to 1/4 charge. Replace with four C cell batteries.

Temperature Calibration

1. The temperature sensor is factory calibrated.

2. Quarterly calibration checks are performed by the OCDWEP Lab.

ORP Calibration

The ORP sensor is factory calibrated. However, it is possible to calibrate or check the sensor using a standard Zobel's solution. This calibration will be done quarterly.

2. Rinse the calibration cup twice with DI water, then once with the Zobel's solution. Fill the calibration cup with the Zobel's solution such that the ORP probe is fully submerged.

3. Select **"Sonde Menu,"** then **"Calibrate,"** then **"ORP"**. Record the temperature of the unit and enter the correct value for Zobel's solution which corresponds to the temperature value (See instrument manual for table). The display will then return to the data display screen, with the option **"calibrate"** highlighted. Record the displayed ORP value as the initial reading. Then select "enter", the calibration will stabilize and be completed. Record the new displayed value in the logbook as the calibrated value. Select the highlighted option **"continue"** by pressing "enter". The display will then continue with options. Advance to **"sonde run."**

Turbidity Calibration (6600 Sondes Only)

1. The Turbidity sensor is calibrated as needed for each use. A three- point calibration is performed at the office or in the field.

2. Rinse the calibration cup twice with DI water. (Note: Presence of air can cause erroneous readings. DI water should be allowed to stand prior to calibration.)

3. Carefully fill the calibration cup with DI water by pouring the DI water gently onto the side of the

calibration chamber to reduce air bubbles. Place the calibration cup/chamber with a black cover on the countertop. Approximately two to three inches of water will be sufficient.

4. Carefully place the sonde on top of the calibration cup. Loosely screw the cap on. Be sure that the sonde is stable and not going to fall over.

5. Select **"Sonde Menu"**, then **"Calibrate".** Scroll down to select **"Optic T-Turbidity".** Press Enter. Scroll to" **3- point calibration**". Press the "enter" key.

6. At this point, press the ESC and Enter key simultaneously. The screen will then ask if you want to **Uncal**. Select yes. The display will return to the calibration value screen.

7. The display will then ask for a calibration value, enter 0.0. Press the "enter" key. The unit will stabilize and display "Calibrate" and "Clean Optics". Scroll to "**clean optics**". When complete, scroll to "**calibrate**". When the display is stable, press the enter key. Unit will display "**Continue**" and press the enter key.

8. Rinse the calibration cup with 10 NTU standard. Check the expiration date on the standard prior to use. (**NOTE:** If you are limited on standard volume, the probes must be clean and dry prior to immersing in the standard.) Fill calibration cup with 10 NTU standard. Pour the standard gently onto the side of the calibration cup to prevent air bubbles. Be sure to use the black chamber cover. The standard should not be shaken or agitated. Again the sonde is placed on top of the chamber loosely. Follow the keypad instructions. The black turbidity probes are 6136 probes. The 10 NTU standard is adjusted to a value of 11.2 NTU . If the turbidity probe is gray in color the NTU standard value would be 10.0. Enter the second point **11.2** value. Press the "enter "key.

9. Rinse the calibration cup with 100 NTU standard. Check the expiration date on the standard prior to use.

10. Fill calibration cup with 100 NTU standard. Follow the keypad instructions. Again if the turbidity probe is black, it is a 6136 probe and the 100 NTU standard value is adjusted to 123 NTU. Enter third point **123** value. Press the "Enter" key.

10. Calibration is complete. Press **ESC** to go back to main screen.

Chlorophyll (Total) Calibration (6600 Sondes Only)

1. The Chlorophyll sensor is calibrated as needed for each use. A single point calibration is done at the office or in the field. Allow distilled water to stand to due air bubbles prior to calibration.

3. Rinse the calibration cup twice with DI water. Fill the calibration cup by pouring slowly onto the side of the calibration cup to reduce air bubbles. Be sure to use the black colored cap. Set the cup on the bench top and the sonde on top of the chamber loosely. Be careful that the sonde is secure enough not to fall over.

4. Select **"Sonde Menu"**, then scroll to **"Calibrate"**. Select "**Optic-C Chlorophyll**" and press the enter key. Select "**Fluor zero**" and press the "enter" key**.**

5. The display will then prompt you to enter a calibration value, type in **0.0** and press the "enter" key.

5. Unit will stabilize. Display will highlight "**Calibrate**" or "Clean Optics". Select "**Calibrate**". When stable, press the "enter "key on the keypad. The calibration is complete. Press "**Esc"** key to go back to the main menu.

ATTACHMENT E:

YSI 600/6600 Maintenance Procedures

YSI 600 & 6600 Maintenance

General Maintenance

1. After use, the YSI 600 / YSI 6600 units are stored clean and dry in the Field Support Staging room at the HCBF. Batteries are replaced on the 650 MDS when the battery voltage indicator is down to 1/4 charge. Replace with four C cell batteries.

2. The cable is cleaned and recoiled, clean and lubricate the rubber connectors. Store the sonde unit with ~ 1 inch of tap water in storage cup.

3. Check the Dissolved Oxygen (DO) membrane after each use and replace as needed. Avoid over stretching the membrane, invert sonde unit several times, check for trapped air bubbles under the membrane.

4. Rinse pH bulb with tap water to remove any film or debris. If good readings are not established, soak the probe in a dishwashing liquid solution for 10-15 minutes. A cotton swab can be used gently to clean the bulb, if needed.

Quarterly Maintenance

1. If the sonde does not have a good response time, soak the pH electrode in a 1:1 HCl solution for 30 - 60 minutes. Remove and rinse the electrode with water. If biological contamination is present soak the probe in a 1 to 1 dilution of chlorine bleach. Then rinse the probe in clean tap water for one hour, swirl occasionally.

2. Clean the Conductivity block and electrodes with a dishwashing liquid solution.

3. Maintain the ORP sensor in the same manner as the pH probe.

4. The depth sensor port should be inspected for blockages or build-ups of mineral or biological matter. A syringe can be used to flush out the ports with tap water.

5. The temperature sensor is factory set and requires no calibration, however, it should be checked against a certified laboratory thermometer quarterly. Wipe down the temperature sensor with a clean cloth.

6. The function of the Redox (ORP) sensor can be checked quarterly against a standard Zobel's solution.

Special Maintenance on the 6600 Sonde Units

1. The Chlorophyll optical sensor should be cleaned, as needed, using the attached wiper mechanism. The wiper should be changed as needed.

2. The Turbidity optical sensor should be cleaned, as needed, using the attached wiper mechanism. The wiper should be changed as needed.

ATTACHMENT F:

YSI 600/6600 Operation Procedures

YSI 600 & 6600 Operation

Tributary Field Sampling

1. Transport the YSI 600 or 6600 sonde unit along with the 650 MDS in the carry case, with the storage cap secured. Be sure to keep the cable coiled neatly and secure the unit such that it does not slide in the cab of the vehicle. When using the unit in the field, set the case on a plastic crate, keeping it off the ground and clean.

2. Before lowering the sonde unit, attach the weighted probe guard. Throughout the day, and in between sampling sites, the probe guard may be removed and the storage cup is replaced.

3. Lower the sonde unit into the stream at mid-stream & mid-depth. This method should be used at all sampling locations except for the following sites. At the **Lake Outlet** sampling site collect a mid-channel profile along the bridge, obtain readings at half-meter increments and at 0.6 meters and 3.7 meters (corresponding to the sample depths of 2' and 12'). At **East Flume** sampling site, lay the sonde unit in front of the v-notch weir.

4. When securing the sonde unit cable to a railing be sure not to overly bend it, as that could damage the coaxial **cable**.

5. Log the data after approximately 2 minutes or when the readings appear stable. Record data by: selecting **"sonde run"** from the 650 Main Menu, then **select "log one sample"** from the 650 column, selecting **"enter"**. Choose a file name and select **"ok."** The display will tell you that the sample is logged. Note that the sonde unit will take longer to stabilize in cold weather.

Lake Sampling

1. Transport the YSI 600 or 6600 sonde unit along with the 650 MDS in the carry case, with the storage cap secured to the sonde unit. Be sure to keep the cable coiled neatly and secure the unit such that it does not slide in the cab of the vehicle.

2. Before lowering the sonde unit, attach the weighted probe guard. Throughout the day, and in between sampling sites, the probe guard may be removed and the storage cup is replaced.

3. Record data at every 0.5 meter increment, starting at the surface to the bottom. Log the data after approximately 2 minutes or when **the** readings appear stable. To record data for the event select **"sonde run"** from the 650 Main Menu, then **select "log one sample"** from the 650 column, selecting **"enter"**. Choose a file name and select **"ok."** The display will tell you that the sample is logged. Note that the sonde unit will take longer to stabilize in cold weather.

River Sampling

1. Transport the YSI 600/6600 sonde unit along with the 650 MDS in the carry case, with the storage cap secured to the sonde unit. Be sure to keep the cable coiled neatly and secure the unit such that it does not slide in the cab of the vehicle. When using the unit in the field, set the case on a plastic crate if possible, keeping it off the deck of the boat.

2. Before lowering the sonde unit, attach the weighted probe guard. Throughout the day it is advisable to keep the sonde unit in a tub of river water. This allows for quicker usage and reduces the need for frequent removal of the probe guard.

3. Record data at every 0.5 meter increment, starting at the surface to the bottom. Be sure to log a data reading at 1 meter below the surface and 1 meter above the bottom, to correspond to water sample collection depths. Record the data after approximately 2 minutes or when the readings appear stable. Record data as described above.

Data Download

1. Connect the YSI 650 display unit to the interface cable on the designated computer. Turn the YSI 650-display unit on.

2. On the computer; access **EcoWatch** from the Windows menu, by selecting the icon.

3. On the YSI 650 select **"file"** from the main menu, then select **"upload to PC,"** then choose the file you wish to transfer.

4. On the computer select the **"sonde icon on the tool bar,"** the file transfer status will be displayed on the computer. After the file has been transferred select **"file"**, then **"open"** from the main tool bar and choose the file you wish to open. The new file will be opened in the EcoWatch software and can now be exported as a text file. In the file menu system on the computer, select **"export"**, then **"CDF/WMF."** Now give the file to be exported a text file name, such as: 05-22-02, in the Q:\AMP\2008\Tribs\Biweekly\ directory. Select **"export"** on the computer. The transfer will be completed.

5. Open *Excel* from the Windows menu, open Q:\AMP\2008\Tribs\Biweekly\ then choose the file type as **"All Files,"** then selected text file e.g. 05-22-02. In order to import this file into *Excel* two options must be **selected**. The first drop down box selection should be **"delimited"**, then choose **"Next"**, the second drop down box selection should be **"comma"**, be sure to click off **"tab"**, then choose **"finish"**.

6. Save the file in *Excel*. Select **"Save as"**. For a lake file save as: Q:\AMP\2008\Lake\Biweekly\05-22-02SD. Be sure to select the **"File Type"** as **"Microsoft Excel Workbook."** Open *Excel* from the Windows menu and open the desired file. Manipulate the data to fit the data format.

ATTACHMENT 2

QUALITY ASSURANCE PROGRAM PLAN

ONONDAGA LAKE FISH SAMPLING PROGRAM (2008)

AMBIENT MONITORING PROGRAM

Prepared for the NYSDEC

Prepared by:

Onondaga County
Department Of Water Environment Protection

April 2008

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1.0 INTRODUCTION/PURPOSE

As part of the Onondaga Lake Ambient Monitoring Program the Onondaga County Department of Water Environment Protection has prepared a Quality Assurance Program Plan (QAPP) for the Onondaga Lake Fish Sampling Program for 2008. This document provides written documentation of the QAPP associated with a baseline fisheries investigation that was initiated in 2000, and subsequent revision or modifications to the program.

The County's long-term monitoring program includes assessment of physical, chemical, and biological attributes of the aquatic resource. The baseline Onondaga Lake Fisheries Monitoring Program and on going studies are expected to address the goal of the *Ambient Monitoring Program* to assess progress towards "swimmable and fishable" conditions in Onondaga Lake by monitoring fish reproductive success and changes in the structure of the fish community.

Background

The Onondaga Lake Fish Program was developed in consultation with expert technical advisors in limnology, engineering, statistics, and fisheries. In addition, Ichthyological Associates, Inc assisted with the development of the original document, and Ecologic, LLC assisted with the development of the original document and subsequent revisions. The 2008 lake fisheries program is summarized in Table 1.

Development of the QAPP

OCDWEP (formerly OCDDS), Ichthyological Associates, Inc. (IA), and EcoLogic, LLC (EcoLogic) staff met on August 15, 2000 to review the schedule and services to be provided for the AMP. Following those discussions, IA/EcoLogic began a series of meetings with OCDWEP technical staff to document procedures used for the Onondaga Lake 2000 Fisheries AMP. The meetings included interviews of OCDWEP staff involved in each aspect of the program. Following initial interviews IA/EcoLogic staff observed field collections of ongoing program and reviewed data entry requirements for each program. Following the initial interviews and review of the *Onondaga County Ambient Monitoring Program: Year 2000 Onondaga Lake Fish Sampling Program* (EcoLogic 2000), IA/EcoLogic prepared the initial draft of the QAPP for review and comment by the OCDWEP. The April 2008 revision of the QAPP was completed by OCDWEP.

The purpose of the QAPP is to mesh field collection procedures and data requirements into a comprehensive document that provides a template for field, laboratory, and data management methods. The QAPP is meant to supplement in-house training of OCDWEP technicians and provide a framework from which trained staff can conduct consistent field surveys. The QAPP is considered to be a living document. That is, as changes are made in the Onondaga Lake Fisheries AMP, revisions will be made to the QAPP to reflect those changes.

Changes or revisions to the QAPP may include:

- intensity of the sampling program;
- incorporation of new elements to the program, or deletion of specific;
- revisions and improvements to methodologies; and
- incorporation of new methodologies into the program.

Thus the QAPP will serve multiple purposes. It will provide annual documentation of Standard Operating Procedures (SOPs), although more formal and detailed SOPs have developed for in-house training and documentation purposes. It will provide a framework of data forms designed to ensure collection and entry of data, and provide a framework for training of OCDWEP's staff via consistent mentoring by more senior, experienced staff through the structure of the QAPP.

The QAPP has been divided into chapters, with each chapter represents a major field component of the AMP. Each chapter provides a purpose and description of the component, the procedures for sampling that component, appropriate data sheets, maps, and descriptions of stations and station codes. Only minor clarifications were made to the QAPP, and no major program modifications were incorporated in to the 2008 monitoring season.

Table 1. Summary of Year 2008 Onondaga Lake Fish Community AMP Sampling Plan.

Component	Methodology/Gear	Sampling Objectives	Location and Number of Samples	Timing	Changes
Pelagic Larvae	Modified double oblique Miller high-speed trawl, with flow meter attached, collected during the day in the pelagic zone.	Determine species richness.	- 4 double oblique tows in each basin (North and South) per event. -Tows will sample water depths from the surface to 5.5 meters. -Total No. of events =8 -Total No. of samples =64	-Daytime -Bi-weekly. -April (when water temps. are 7-8 ºC) through end of July.	-No Change from previous year.
Juvenile Fish	50' x 4' x 1/4" bag seine swept into shore in the littoral zone.	Determine community structure and species richness.	-5 strata with 3 sites in each strata and 1 sweep at each site. -No. of Sites = 15 -Total No. of events = 6 -Total No. of samples = 90	-Daytime -Every 3 weeks. -July - October.	-No Change from previous year.
Nesting Fish	Lake wide nest survey.	Document spatial distribution and species composition	-Entire perimeter of lake divided into 24 equal length sections. -Total No. of events = 1 -Total No. of samples = 24	-Once in June when water temperature is between 15° and 20 °C.	-No Change from previous year.
Adult Fish-Littoral Zone	Boat mounted electrofisher in the littoral zone at night.	Determine community structure, species richness, CPUE, and relative abundance.	-Entire perimeter of lake shocked in 24 contiguous transects. -Alternating all-fish/gamefish transects. -Total No. of events = 2 -Total No. of samples = 48	-Night-time. -Twice per year; Spring and Fall. -Spring and Fall. -Water temp. between 15º and 21 ºC.	-No Change from previous year.
Adult Fish-Profundal Zone	Experimental gill nets of standard NYSDEC dimensions.	Determine community structure, and species richness.	-One net per strata. -Nets set on bottom, parallel to shore at a water depth of 4-5m for two hours. -Total No. of events = 2 -Total No. of samples = 10	-During the day. -Twice per year, within one week of littoral electrofishing.	-No Change from previous year.
Angler Census	Angler diary program and bass tournament tagging.	Determine catch rates, species composition. Attitudes and opinions over the AMP.	-Recruit diary participants at fish & game clubs and fishing organizations. -Fish from tournaments will be tagged at time of weigh-in.	-Issued annually and collected at end of fishing season (fall). -Tournament schedule TBA	-No Change from previous year.

2.0 STAFF TRAINING

The OCDWEP has approached the AMP under the self-monitoring element that is central to the Federal Clean Water Act. OCDWEP has acquired a staff with a wide range of academic education supplemented by experience gained by working for state fisheries agencies, universities, and environmental consulting and research firms. This staff of scientists and technicians are supported by maintenance and operation personnel that provide the skills to build, construct, maintain, and modify gear needed to conduct the fisheries surveys. This expertise allows the OCDWEP to successfully train and mentor qualified individuals to provide a high level of quality to the data of the fisheries program. As with any long-term monitoring program, individuals will advance in their careers, retire, or move to new locations. This matriculation will require periodic in-house training of new individuals. The QAPP is integral to this training. Its use and understanding will provide each individual with an easy to understand document to ensure day-to-day and year-to-year consistency of the Onondaga Lake Fish Sampling Program.

In addition to the QAPP and SOPs, the County's Consultant, Ecologic LLC, conducts annual audits for each biological monitoring component. The audits are intended to ensure that the field technicians conducted their work in a professional manner and comply with the procedures outlined in the QAPP and SOPs. In addition, the audits determine if any observation would jeopardize the quality of the data (technique, field logs, training, etc.). The biological monitoring components to be audited annually includes the pelagic larvae, juvenile seining, adult electrofishing, and adult gill nets.

Thus the use of the QAPP in conjunction with the formal Standard Operating Procedures (SOPs) and external audits for the biological monitoring program activities, the *Onondaga County Ambient Monitoring Program: Onondaga Lake Fish Sampling Program (2008)*, and subsequent programs will provide OCDWEP with a successful fisheries assessment program.

3.0 PELAGIC LARVAE – Miller High Speed/Modified Double Oblique Tow

3.1 Procedures

Pelagic larvae will be collected using the Miller High Speed/Modified Double Oblique Tow during eight (8) sampling events occurring biweekly from April (water temperature between 7 and 8°C) through the end of July. One (1) sample will be collected from each of eight (8) transects (four (4) in the north basin and four (4) in the south basin) in Onondaga Lake during each sampling event.

3.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: field data sheet packet, and equipment.

Step 3. Examine equipment for needed repairs.

Step 4. Print labels and pre-label sample jars.

Step 5. Check calibration of water quality (WQ) meter.

Step 6. Review weather reports for sampling feasibility.

3.1.2 Field:

Step 1. Proceed to (north basin or south basin) predetermined locations using the Global Positioning System (GPS). These locations were determined and set at the beginning of the 2002 sampling season. Collect water quality data from 0 to 6 meters, in 0.5 meter intervals, using a pre-calibrated water quality meter. Log the depth and water quality data on the meter (all data will be downloaded at the end of the day). Standard water quality parameters include temperature, Dissolved Oxygen (percent saturation and concentration), salinity, conductivity, pH, and ORP.

Step 2. Proceed to the first transect (refer to Appendix A1) and record transect number, date, time, and actual GPS coordinates on the field data sheets.

Step 3. Attach one (1) sampling rig to the crane and record starting flow meter reading. Thoroughly inspect the net, collection chamber mesh, cable, connections and all hardware prior to deployment at each location. Any repairs or replacements must be completed prior to deployment.

Step 4. Place the boat in forward gear and accelerate to 3 miles per hour. Pay out sufficient cable to achieve the correct depth of 5.5 meters (this is the last meter mark on cable). The direction of the travel shall be in a straight line heading in a northwest to southeasterly direction (or southeast to northeasterly direction depending on the transect or influence of the sun glare on visual contact with the cable marks).

Step 5. When the correct depth is achieved, accelerate the boat to approximately 5 or 6 miles per hour. Pay out additional cable to maintain a proper depth of approximately 5-5.5 meters. Confirm the actual depth via the following method:

Measure the angle of the cable from vertical (the optimal angle range should be between 55°- 60°) using the WildCo clinometer, and record the angle measurement on the field data sheet. Using the "Angle of Cable Measured" (between 55°- 60°) and the "Length of Cable" let out (typically 10 meters as measured from the water surface), verify on the following chart that the "Proper Vertical Depth" of the sampler has been achieved (optimum depth of approximately 5.0 to 5.5 meters):

Angle of Cable Measured from the Vertical (Degree)		**Proper Vertical Depth (Meters)**		
		5.0	**5.5**	
	53	8.3	9.1	Length of cable measured from the water surface to the sampler (meters)
	54	8.5	9.4	
Optimal Range	**55**	**8.7**	**9.6**	
	56	**8.9**	**9.8**	
	57	**9.1**	**10.1**	
	58	**9.4**	**10.4**	
	59	**9.7**	**10.7**	
	60	**10.0**	**11**	
	61	10.3	11.3	
	62	10.7	11.7	

Step 6. Once a depth of 5-5.5 meters is obtained tow the sampler at a consistent speed (approximately 5 or 6 miles per hour) for 25 seconds heading northeast to southwest or vice versa.

Step 7. After 25 seconds has elapsed, begin retrieving the sampler until the next meter mark is visible and continue towing at that depth for 25 seconds. Repeat this procedure at each individual meter depth on the cable until the 1 meter mark is visible, at which time reduce boat speed to idle and retrieve the sampler. After retrieval, thoroughly inspect the net and collection chamber mesh for any tears that may have compromised the sample. If the sample has been compromised, the location will need to be resampled/repeated.

Step 8. Record ending flow meter reading on the field data sheet, and rinse the inside of the sampler and the net into the sampling bucket with the wash down pump or pump sprayer. Decant as much water as possible. Remove the sampling bucket and pour the contents into the pre-labeled sample jar. Rinse the remaining sample into the jar using tap water from a squirt bottle. Preserve the sample with 10% buffered formalin, filling the jar below the shoulder (wear Nitrile gloves and goggles during this operation).

Step 9. Fill out chain of custody form, and place the sample and Chain of Custody in a clip board box (or equivalent) for safekeeping.

Step 10. Repeat the above process four (4) times in each basin.

3.1.3 End of Sample Day

Step 1. Review field notes for completeness and QAPP sign offs.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

Step 4. Download water quality data.

3.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

3.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet.
- Facility code/station description.
- List of fish species codes/names (identification will be completed in the HCBF Biology laboratory location).
- Sample labels.
- Chain-of-custody forms (as appropriate).

Appendix A1 contains examples of the station data sheet, map of sampling stations, list of facility codes/station description, and list of species codes/names appropriate for use in pelagic larvae sampling.

4.0 LITTORAL YOUNG-OF-YEAR (YOY)/JUVENILE FISH – BAG SEINE

4.1 Procedures

Littoral YOY/juvenile fish will be collected using a bag seine (seine dimension - 50' x 4' x 1/4") approximately every three (3) weeks from July to October, resulting in a total of six (6) sampling events. Three (3) randomly selected sites within each of five (5) strata encompassing the littoral zone of the lake were selected in 2000 and are revisited for each sampling event. These sites are physically marked on the shoreline and their coordinates documented with a GPS unit. One (1) sample will be collected at each sampling site for a total of fifteen (15) samples collected from Onondaga Lake during each sampling event.

4.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: field data sheet packet and equipment.

Step 3. Examine equipment for needed repairs.

Step 4. Check calibration of water quality (WQ) meter.

Step 5. Review weather reports for sampling feasibility.

4.1.2 Field:

Step 1. Proceed to appropriate station and record WQ meter number, facility code/location, date, time, and WQ data at the near surface. Standard water quality parameters include temperature, Dissolved Oxygen (percent saturation and concentration), salinity, conductivity, pH, and ORP.

Step 2. Stretch the seine out on shore and remove any material lodged in the mesh. Check for holes and repair if necessary.

Step 3. Bring net to the marked site location. (Note: Sites have been previously selected and marked by OCDWEP staff).

Step 4. Walk one end of the seine off shore until full length of net is deployed perpendicular to the shoreline.

Step 5. Check the bag section of the seine to make sure it is fully deployed and not tangled.

Step 6. With one person holding the in-shore brail stationary, a second person sweeps the offshore brail to shore. A third person walks behind the bag end of the seine to dislodge the seine if it becomes stuck. A sample will be rejected if the leadline of the seine must be lifted or the seine must be fully stopped in order to dislodge the snag.

In this case, the site will be returned to later during the sampling event to collect the sample.

Step 7. As the offshore brail approaches shore, the two brails will be worked together, and the seine will be beached while being careful to maintain the integrity of the bag section of the seine and keeping the leadline on bottom.

Step 8. Immediately upon retrieval of the seine all fish will be picked and placed in holding tanks. Care shall be taken to sort through captured debris (algae mats and macrophytes) in order to retrieve all fish. In the event adult fish are captured, they should be identified to species, counted, released back into the lake, and noted as such on the data forms. Representative adult bass and other selected game fish should be tagged with a numbered floy tag, measured and sampled for scales (scales are only collected in the fall) prior to release. The tag number, scale envelope number, and other related information should be recorded on the appropriate data form.

Step 9. Stretch the seine out on shore and remove any material lodged in the mesh. Check for holes and repair if necessary.

Step 10. Stretch out seine to dry while processing samples.

Step 11. A minimum of 30 random individuals in each life stage (YOY and juvenile) and species should be measured (total length in mm). Remaining fish should be mass-counted based on life stage (YOY, juvenile, adult). YOY sunfish should be grouped as "*Lepomis* sp." All other individuals should be identified to species. All fish should be returned to the lake after completing measurements.

Unknown species should be noted as such on the data forms by number (for example *Unknown Species No.1* and *Unknown Species No. 2*) and placed in a formalin-filled, labeled jar and identified later in the laboratory.

Step 12. Review data sheets for completeness before proceeding to next station.

4.1.3 End of Sample Day

Step 1. Review field notes for completeness and QAPP sign offs.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

4.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

4.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet.
- Bulk fish data sheet.
- Individual fish data sheet.
- Map showing location of sampling stations.
- Facility code/station description.
- List of fish species codes/names.
- Sample labels.
- Scale envelopes.

Appendix A2 contains examples of the station data sheet, individual fish data sheet, bulk fish data sheet, map of sampling stations, list of facility codes/station description, and list of species codes/names appropriate for use in sampling littoral YOY and juvenile fish.

5.0 NESTING SURVEY

5.1 Procedures

Nesting survey transects were determined in 2000 by dividing the lake's littoral zone into twenty-four (24) approximately equal length transects that encompass the entire perimeter of the lake. These transects are utilized for each annual event, and these are the same transects used for the adult fish boat electrofishing events. The beginning and ends of each transect are designated by GPS coordinates. Fish nests will be identified when possible and counted along these transects that are parallel to the shoreline. Date of the survey will be determined based on the time of year (June), water temperature (between 15 and 20ºC), water clarity (ability to see bottom in 2 m of water), weather conditions (sunny and calm), and observations of peak spawning activities of select gamefish.

5.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of program.

Step 2. Determine if bluegill, pumpkinseed and largemouth bass appear to be near peak spawn (typically observed during other lake sampling events).

Step 3. Determine if water visibility is at least 2 m (based on secchi disc readings).

Step 4. Assemble: field data sheet packet and equipment.

Step 5. Examine equipment for needed repairs.

Step 6. Check calibration of water quality (WQ) meter.

Step 7. Review weather reports for sampling feasibility.

5.1.2 Field:

Step 1. Proceed to appropriate transect and position boat at its start in 1 m of water. Record WQ meter number, facility code/location, date, time, and WQ data at the near surface. Standard water quality parameters include temperature, Dissolved Oxygen (percent saturation and concentration), salinity, conductivity, pH, and ORP.

Step 2. Post one technician on the bow of the boat with polarized glasses. This technician will serve as nest spotter. Position a second technician in the center of the boat. This technician will serve as the data recorder. A third technician serves as the boat driver.

Step 3. Start boat and proceed parallel to shore keeping the boat in 1 m of water at all times. Speed of travel will be dependent on the nest spotters and nest density.

Step 4. The technician on the bow will count and report to the data recorder all nests observed, and when possible identify species on the nest. The observer shall report nest counts to the recorder every five (5) to ten (10) fish nest observed. An alternative method is to utilize a mechanical handheld counter.

Step 5. The driver will stop the boat at the end of the transect.

Step 6. Review data sheets for completeness before proceeding to next transect.

Step 7. Bring the boat to the beginning of the next transect and repeat steps 1 through 6.

5.1.3 End of Sample Day

Step 1. Review field notes for completeness and QAPP sign offs.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

5.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

5.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet.
- Map showing location of sampling stations.
- Facility code/station description.
- List of fish species codes/names.

Appendix A3 contains examples of the station data sheet, map of sampling stations, list of facility codes/station description, and list of species codes/names (located on station data sheet) appropriate for use in conducting a nest survey.

6.0 ADULT FISH – BOAT ELECTROFISHING

6.1 Procedures

Boat electrofishing stations were determined in 2000 by dividing the lake's littoral zone into twenty-four (24) approximately equal length transects that encompass the entire perimeter of the lake. These transects are utilized for each sampling event. The beginning and ends of each transect are designated by GPS coordinates. Transects are divided into alternating all-fish/gamefish samples (odd number transects are always all fish and even numbered transects are always game fish only). In "all-fish" transects all species are netted, while in "gamefish only" transects only those species designated as gamefish by the County are netted (see attached list). Time spent electrofishing at each transect will be recorded during each sampling event to allow for standardization of catch per unit effort.

Boat electrofishing is conducted for two (2) sampling events, in the Spring and in the Fall based on surface water temperatures between 15 and 21° C. During each sampling event, fish will be collected during the night along the twenty-four (24) transects distributed around the perimeter of the lake, resulting in collection of a total of forty-eight (48) boat electrofishing samples/transects for the year (24 all-fish and 24 gamefish).

6.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: field data sheet packet and equipment.

Step 3. Examine equipment for needed repairs.

Step 4. Check calibration of water quality (WQ) meter.

Step 5. Review weather reports for sampling feasibility.

Step 6. Notify Onondaga County Sheriff's Office and the OCDWEP Metro Board operator of proposed night sampling event.

6.1.2 Field:

Step 1. Proceed to predetermined transect location and record facility code/location, date, time, and WQ data taken at near surface depth. Standard water quality parameters include temperature, Dissolved Oxygen (percent saturation and concentration), salinity, conductivity, pH, and ORP.

This event will require four technicians, two (2) will collect fish with nets at the front of the electrofishing boat, one (1) will be the data recorder, and one (1) will drive and operate the generator/pulsator.

Step 2. Determine if transect is for all fish or game fish (odd number transects are all fish and even numbered transects are game fish).

Step 3. Record start of sample data: time of day, starting seconds on pulsator, and actual GPS coordinates.

Step 4. Place boat into forward gear at idle speed. Start the generator, activate electrofisher and begin collection of fish. The two netting technicians will maintain the foot pedal, that activates the electrofisher, in the "on" position for the entire transect. For gamefish transects any fish that resembles one of the gamefish species should be boated. If the fish is identified as being a non-gamefish species while still in the net it may be immediately released.

For all-fish transects, an attempt should be made to collect all fish encountered, with the exception of common carp, or gizzard shad and alewives occurring in large schools or quantities incapable of boarding. The quantity of common carp within netting distance shall be counted (or estimated if in large numbers) and noted as a count (or estimate) in the bulk fish section of the field sheet.

Gizzard shad and alewives occurring in large schools or un-boardable quantities may be estimated without actually collecting each fish (this will minimize catch mortality and will prevent under estimating significant quantities of "missed/non-boarded" fish. However, these "missed/non-boarded" fish shall be noted in the bulk fish section of the field sheet as an "estimate". Gizzard shad and alewives that are boarded, but are in excess of the 30 individuals initially counted and measured, shall be individually counted (not measured) and noted in the bulk fish section of the field sheets as a "count". Because of the difficulty in differentiating small shad and alewives from one another, if a school of small clupeids (shad/alewives) is encountered, a sample of the school should be netted, brought on board and identified. After positive identification the number of fish in the school can be estimated.

For all other species, missed fish shall be estimated, and recorded in the bulk fish section of the field sheets as an "estimate". Since the two netting technicians will be maintaining a mental tally of "missed/non-boarded" fish, this data should be recorded immediate following the completion of each transect to minimize loss of semi-quantifiable data.

Step 5. Record electrofisher data: voltage, amps, and pulse width. Monitor settings and displays throughout the transect.

Step 6. Maintain the boat electrofisher on course approximately parallel with the shore in one meter of water at approximately idle speed (the motor tilt will need to be adjusted to maintain appropriate speed). The boat may be slowed down in order to try and capture a rare fish that is initially missed by the netters. However, all attempts should be made to keep the boat moving slowly forward in approximately one meter of water for the majority of the transect.

Note: All attempts are made to maintain the monitoring depth of one (1) meter. However, the natural variation of the depth contours or abrupt drop offs (natural or man-made) may result in short periods of shallower or deeper monitoring.

Step 7. When the end of the transect is reached, turn off electrofisher unit, and return boat to neutral.

Step 8. Record time, GPS coordinates, and miscellaneous collection notes (missed/non-boarded fish, estimates, counts, etc.)

Step 9. Proceed to approximately the mid-transect location to work up collected fish.

Step 10. Fish whose numbers were estimated should be entered in the bulk fish section of the field form first to prevent omissions.

Then, collected fish should be identified to species, measured for length (nearest mm), and, for the fall samples only, measured for weight (nearest gram).

Note: Individual fish weighing less than 100 grams will be weighed on the small scale.

If the small scale will not stabilize, multiple fish of the same species and size range may be bulk weighed and divided by the total number of fish to establish a relative weight (e.g. weigh all alewife between 140 mm and 160 mm – divide total weight of all alewife weighed by total number of alewife to establish a relative weight for each of the individual alewife). These weights shall be noted in the comment section of the individual fish data sheet as a "bulk weight".

For samples in which small to moderate numbers of fish are collected (less than 30), all fish should be measured. In samples in which high numbers (greater than 30) of one or more species are collected, random sub-samples of the abundant species will be measured, and the remaining individuals of those species need only be counted and listed in the bulk fish data sheet. This will result in some samples having both individual fish data and bulk fish data. Fish not measured individually should be mass-counted based on life stage (YOY, juvenile, adult). Unknown species should be noted as such on the data forms by number (for example unknown species 1 and unknown species 2) and placed in a formalin-filled, labeled jar and identified later.

Step 11. Representative adult bass and other selected game fish should be tagged with a numbered floy tag and sampled for scales (fall only) prior to release. In addition, during the fall, select species (bluegill, pumkinseed, white perch, yellow perch, and gizzard shad) shall also be randomly sampled for scales prior to release.

On spiny-rayed species, including but not limited to largemouth bass, smallmouth bass, bluegill, pumpkinseed, white perch, walleye, yellow perch and black crappie,

scales will be removed from left side of the body below the lateral line, near the tip of the depressed left pectoral fin. On soft-rayed species, including trout and salmon, scales will be removed from the middle region of the body above the lateral line, beneath the posterior end of the dorsal fin on the left side.

Fish that are tagged should appear to be in good health and not overly stressed from the capture experience. The tag number, scale envelope number, and other related information should be recorded on the appropriate data form. Any recaptured fish shall be recorded on the individual field sheet data form, and evaluated to determine the need for a replacement tag.

Step 12. Review data sheets for completeness before proceeding to next station.

6.1.3 End of Sample Day

Step 1. Notify Metro Board of safe return from field.

Step 2. Review field notes for completeness and QAPP sign offs.

Step 3. Submit original data sheets and field notes for duplication.

Step 4. Write down needed equipment repairs and report to supervisor.

6.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

6.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet.
- Bulk fish data sheet.
- Individual fish data sheet.
- Map showing location of sampling stations.
- Facility code/station description.
- List of fish species codes/names.
- Sample labels.
- Scale envelopes.

Appendix A4 contains examples of the station data sheet, individual fish data sheet, bulk fish data sheet, map of sampling stations, list of facility codes/station description, and list of species codes/names appropriate for use in sampling littoral adult fish.

7.0 ADULT FISH – Littoral-Profundal (Fixed Deep Water) Gill Net Sampling

7.1 Procedures

Gill net sampling will be conducted during two (2) sampling events, in Spring and Fall within one (1) week of the electrofishing events. During day-time hours, one (1) net will be randomly set in each of the five (5) strata (refer to Appendix A5). The nets will be set for two (2) hours on the lake bottom in 4 to 5 meters of water, resulting in collection of a total of ten (10) samples/sets during the year.

7.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: field data sheet packet and equipment.

Step 3. Examine equipment for needed repairs.

Step 4. Check calibration of water quality (WQ) meter.

Step 5. Review weather reports for sampling feasibility.

7.1.2 Field (Gill Net Setting):

Step 1. Proceed to a random monitoring location within one (1) of the five (5) stratums.

Step 2. Upon arrival locate 5 meters depth of water with depth finder and collect water quality data from 0 to 5 meters in 0.5 meter intervals. Log the depth and water quality data on the meter (all data will be downloaded at the end of the day). Standard water quality parameters include temperature, Dissolved Oxygen (percent saturation and concentration), salinity, conductivity, pH, and ORP. Record the GPS coordinates on the field data sheet.

Step 3. Rig gill net with appropriate anchors and buoys.

Step 4. Bring the boat parallel to shore in 5 meters of water (turn the boat into the prevailing wind if possible).

Step 5. With one technician on the bow of the boat lower the leading anchor to the bottom and pay out the net as the boat is slowly reversed. Pay out the net by handling the float-line and shaking out or spreading the mesh as the boat reverses to assure net deploys.

Step 6. After the full length if the gill net is set out, stretch the net as taut as possible, and drop the trailing anchor.

Step 7. Allow for two hours to elapse before retrieval.

7.1.3 Field (Gill Net Retrieval):

Step 1. Pull in the downwind buoy and anchor, and remove them from the net. Grasping the lead and floatlines together, slowly bring in the net.

Step 2. As fish are encountered remove them as fast as possible and place in a live well. Under ideal conditions and a light catch, the fish may be removed from the net as it is being retrieved. When large catches are encountered, remove only gamefish, all other fish can be removed after net is retrieved at a location secluded from public viewing.

Step 3. Record data on catch using the appropriate field forms, recording the following information:

- Species identification.
- Length (mm) total length.
- Weight (gram - fall sample only).
- Scale samples (only in fall samples on all bass).
- Condition of fish (dead or alive).
- Tag all game fish if healthy and record tag number.

Step 4. Repeat all steps (7.1.2 and 7.1.3) for the other four (4) locations.

7.1.4 End of Sample Day

Step 1. Review field notes for completeness and QAPP sign offs.

Step 2 Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

Step 4. Download water quality data.

7.1.5 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

7.1.6 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet
- Bulk fish
- Individual fish
- Map showing location of sampling stations
- Facility code/station description
- List of fish species codes/names
- Sample labels
- Scale envelopes

Appendix A5 contains examples of the station data sheet, individual fish data sheet, bulk fish data sheet, map of sampling stations, list of facility codes/station description, and list of species codes/names appropriate for use in sampling pelagic adult fish.

8.0 DEFORMITIES, EROSIONS, LESIONS, TUMORS, FUNGAL INFECTIONS, AND MALIGNANCIES (DELTFM) MONITORING

Tracking of DELTFM parameters will be conducted in conjunction with all fisheries sampling activities with the exception of larval fish sampling and the adult fish nesting survey. DELTFM parameters will be recorded for only individual juvenile fish (not the bulk counts). All captured fish will be screened for any visible abnormalities. The abnormalities will be recorded on the corresponding data sheet. The technicians will be required to record the following abnormalities on the data sheets:

Deformities – Any distorted form of the fishes anatomy.
Erosions – Wear marks, scares, or scrapes.
Lesions – Visible sores, or wounds.
Tumors – A localized swelling of tissue on or in the body that has no physical function.
Fungal Infections – Any visible fungal growth on the fish.
Malignancies – A growth that could be cancerous. (use field judgement).

9.0 RECREATIONAL FISHERY – ANGLER DIARY

Angler diaries will continue to be used to assess the recreational fishery of Onondaga Lake. Angler catch rate and species composition of the catch, as well as angler attitude and opinions will be assessed. Potential anglers for participation in the angler diary program will be solicited at various fishing tournaments and through local sportsman organizations. The OCDWEP angler diary program uses record keeping forms similar to those used by the New York State Department of Environmental Conservation in their angler diary program.

10.0 CHRONOLOGY OF QAPP

The QAPP for the Onondaga Lake Fish Sampling Program is a living document in that it will be periodically updated to reflect changes in the monitoring program that are instituted to improve the efficiency of data collection, focus on a particular aspect of the fish community, or narrow or expand the scope of investigation. The periodic updating of the QAPP will provide a written record of sampling procedures over the entire life of the Onondaga Lake Fish Sampling Program. This April 2008 version of the QAPP is the seventh version/issue of the document.

The first version (Initial Draft) was submitted to OCDWEP on October 18, 2000 for review and comment by OCDWEP staff. Following review of the Initial Draft by OCDWEP, a meeting was held between IA and OCDWEP in which comments on the Initial Draft were provided. These comments, along with information gathered during data analysis and report preparation for the 2000 fish sampling program were incorporated into a second version of the document submitted to OCDWEP in July 2001. Annual revisions to the QAPP have incorporated various changes made to the fisheries assessment program.

The original QAPP, and subsequent revisions, have been reviewed by the NYSDEC, revised by OCDWEP as requested, and approved by the NYSDEC prior to implementation.

11.0 LITERATURE CITED

EcoLogic, LLC. *Onondaga County Ambient Monitoring Program: Year 2000 Onondaga Lake Fish Sampling Program. Prepared for Onondaga County Department of Drainage and Sanitation, Syracuse, NY. EcoLogic, LLC., Cazenovia, NY.*

OCDWEP *SOP For Fish Scale Age and Growth Determination (DOC No. BIO-001)*

OCDWEP *SOP For Larval Fish Identification (DOC No. BIO-002)*

OCDWEP *SOP For Fish Tagging (DOC No. BIO-003)*

OCDWEP *SOP For Littoral-Profundal Zone Fixed Deep Water Gill Net Sampling (DOC No. BIO-006)*

OCDWEP *SOP For Littoral Zone Electrofishing (DOC No. BIO-007)*

OCDWEP *SOP For Littoral Zone Young-Of-Year and Juvenile Fish Bag Seine (DOC No. BIO-008)*

OCDWEP *SOP For Fish Nesting Survey (DOC No. BIO-009)*

OCDWEP *SOP For Pelagic Larvae Sampling – Miller High Speed/Modified Double Oblique Tow (DOC No. BIO-010)*

APPENDIX A1:

Field Data Packet For Pelagic Larvae Sampling

Facility Code and Station Description

Facility Code	Site Abbreviation	Site Description
2700	NBMHT1	North Basin Miller High Speed Trawl 1
2701	NBMHT2	North Basin Miller High Speed Trawl 2
2702	NBMHT3	North Basin Miller High Speed Trawl 3
2703	NBMHT4	North Basin Miller High Speed Trawl 4
2704	SBMHT1	South Basin Miller High Speed Trawl 1
2705	SBMHT2	South Basin Miller High Speed Trawl 2
2706	SBMHT3	South Basin Miller High Speed Trawl 3
2707	SBMHT4	South Basin Miller High Speed Trawl 4

Onondaga County Department of Water Environment Protection
Onondaga Lake Fish Monitoring Program

PELAGIC LARVAE -- MILLER TRAWL
Modified Double Oblique Tow

Date: _____ **Basin:** _____

Crew: _____ **Site Abbreviation:** _____

Time Start: _____ *(trawl)* **End:** _____ *(trawl)* **Bottle No:** _____

GPS: North: 43° _____ *(Start)* West: 76° _____ **Fac. Code:** _____ **Preserv.Y/N** _____

North: 43° _____ *(End)* West: 76° _____ **# of Bottles:** _____ **Compass Brg:** _____

Flow Meter Start: _____ **Flow End:** _____ **Cable Angle:** _____ **At** _____ **Meters**

Total Trawl Time: _____ *(min:sec)* **Avg Speed:** _____ *(mph)*

Field Observations - Only Enter One (1) Option

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Waves: *Calm / Swells / Whitecaps*

Water Clarity: *Poor / Moderate / Good*

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,SE,SSE, etc.*

Significant Rainfall in the Last 48 Hours? *Yes / No*

Water Quality Profile Taken? *Yes / No*

Comments: *(Gear Condition, Unusual Weather or Conditions, Equipment or Sampling Problems, etc.)*

Meters	Cable Angle	Meters	Cable Angle
10		5	
9		4	
8		3	
7		2	
6		1	

Measure/Check at 1 or 2 locations.

Data Validity Classification: *Good / Conditional / Invalid*

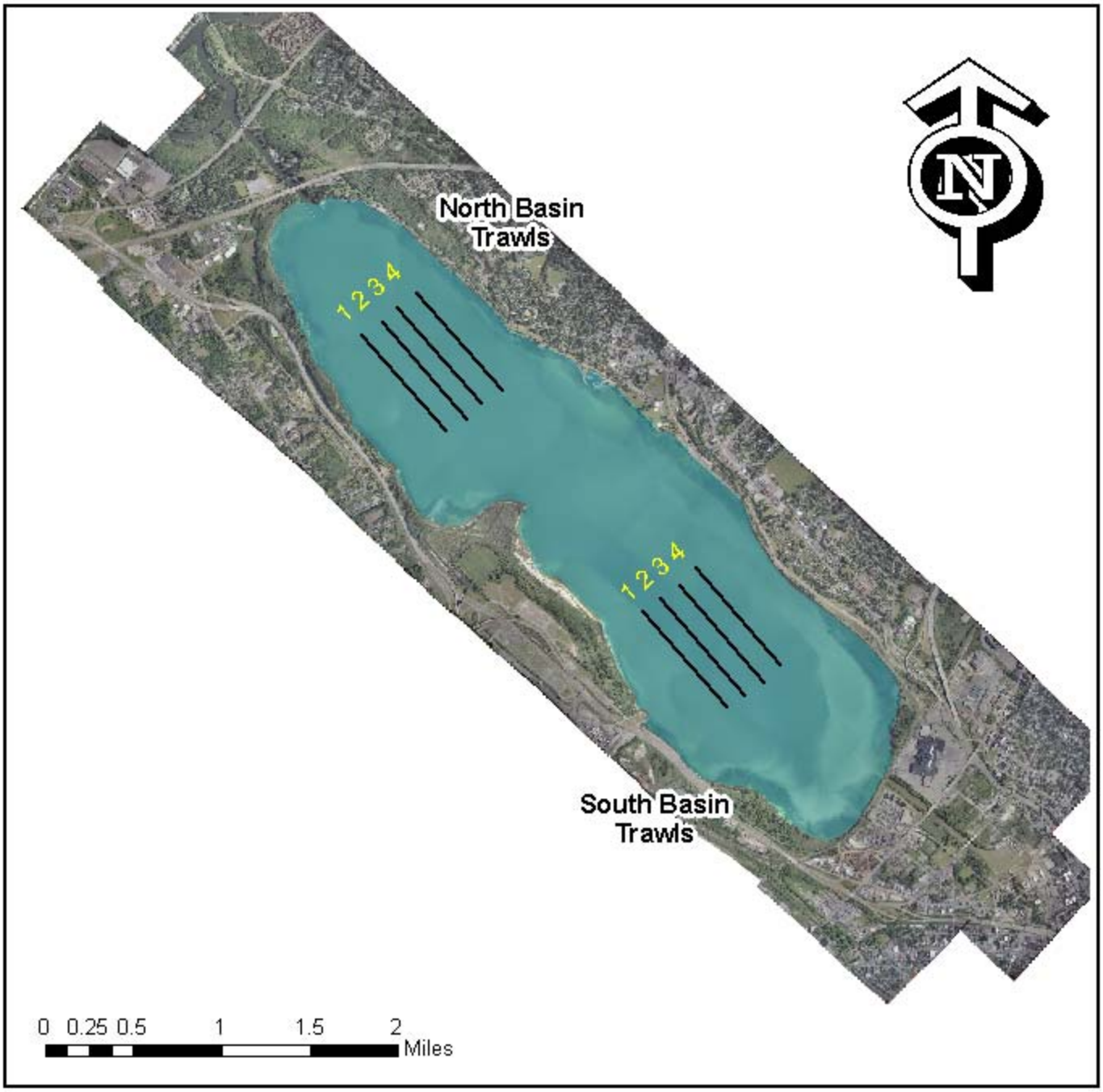
# of Attached Data Sheets: Bulk Fish _____ Larval Fish _____ (During Biology Lab ID)
C of C _____

Date Sorted: _____ **QA/QC Date:** _____
Initials: _____ **Initials:** _____

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____

Species Codes and Common Names

Species Code	Common Name	Species Code	Common Name	Species Code	Common Name
0	No Catch	390	Spottail shiner	576	White bass
207	Sea lamprey	394	Spotfin Shiner	576.1	Temperate Basses
268	Longnose gar	396	Redfin shiner	591	Rock bass
271	Bowfin	397.1	Notropis sp.	595	Green sunfish
276	American eel	400	Bluntnose minnow	596	Pumpkinseed
285	Blueback Herring	401	Fathead minnow	598	Bluegill
289	Alewife	401.1	Pimephalus sp.	599.1	Lepomis sp.
290.1	Blueback and/or Alewife	403	Longnose dace	600	Smallmouth bass
294	Gizzard shad	406	Creek chub	601	Largemouth bass
297.1	Herring Family (Cluepeidae)	407	Fallfish	601.1	Black Bass (SM or LM)
326	Rainbow trout	408.1	Semotilus sp.	602	White crappie
327	Atlantic salmon	409.1	Minnow Family (Cyprinadae)	603	Black crappie
328	Brown trout	419	White sucker	603.1	Crappie (White or Black)
329	Brook trout	423	Northern hog sucker	603.2	Sunfish Family (Centrarchidae)
329.1	Tiger Trout (hybrid)	432	Shorthead redhorse	613	Johnny darter
332	Splake	433.1	Suckers (Catostomidae)	614	Tesselated darter
332.1	Trout Family (Salmonidae)	443	Yellow bullhead	616.1	Ethostoma sp.
335	Rainbow smelt	444	Brown bullhead	617	Yellow perch
340	Central mudminnow	444.1	Bullhead (species unknown)	618	Logperch
347	Northern pike	445	Channel catfish	624.1	Darter (not YPerch)
349	Chain pickerel	450.1	Freshwater Catfish	626	Walleye
350	Tiger muskellunge	461	Trout perch	628.1	Perch Family (Percidae)
350.1	Pike Family (Esocidae)	493	Burbot	700	Freshwater drum
365	Carp	531	Banded killifish	970	NS (Bullhead sunfish, etc)
377	Golden shiner	545	Brook Silverside	999	SPECIES UNKNOWN
381	Emerald shiner	561	Brook stickleback		
385	Common shiner	575	White perch		



Trawl Tow Sites

LOCATION OF PELAGIC LARVAL TRAWL SITES ON ONONDAGA LAKE

APPENDIX A2:

Field Data Packet For Littoral YOY/Juvenile Fish Sampling

Facility Code and Station Description

Facility Code	Site Abbreviation	Site Description
2581	ST1JS1R1	Stratum 1 Juvenile Seine Site 1
2584	ST1JS2R1	Stratum 1 Juvenile Seine Site 2
2587	ST1JS3R1	Stratum 1 Juvenile Seine Site 3
2590	ST2JS1R1	Stratum 2 Juvenile Seine Site 1
2593	ST2JS2R1	Stratum 2 Juvenile Seine Site 2
2596	ST2JS3R1	Stratum 2 Juvenile Seine Site 3
2599	ST3JS1R1	Stratum 3 Juvenile Seine Site 1
2602	ST3JS2R1	Stratum 3 Juvenile Seine Site 2
2605	ST3JS3R1	Stratum 3 Juvenile Seine Site 3
2608	ST4JS1R1	Stratum 4 Juvenile Seine Site 1
2611	ST4JS2R1	Stratum 4 Juvenile Seine Site 2
2614	ST4JS3R1	Stratum 4 Juvenile Seine Site 3
2617	ST5JS1R1	Stratum 5 Juvenile Seine Site 1
2620	ST5JS2R1	Stratum 5 Juvenile Seine Site 2
2623	ST5JS3R1	Stratum 5 Juvenile Seine Site 3

Onondaga County Department of Water Envrironment Protection
Onondaga Lake Fish Monitoring Program

LITTORAL JUVENILES -- BAG SEINE

Date: _____ **Stratum:** _____

Crew: _____ **Site:** _____

Time Start: _____ (Start Seining) **Time End:** _____ (Processing Fish) **Facility Code:** _____

GPS North: 43° _____ West: 76° _____ *(decimal minutes)*

Field Observations - Only Enter One (1) Option

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Waves: *Calm / Swells / Whitecaps*

Water Clarity: *Poor / Moderate / Good*

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,SE,SSE, etc.*

Significant Rainfall in the Last 48 Hours?
Yes / No

Habitat and Substrate Observations - Include Only The Actual Physical Area Seined.

Habitat: Vegetation _____ Pct cover _____ Structure _____ Pct _____
Emergent Submerged Algae Debris None *overhead Veg. Rocks Logs Dropoff Manmade*
Pct Cover Codes: N=none 0=1-5% 1=6-25% 2=26-50% 3=51-90% 4=>90%

Substrate: *VeGetated Plant Debris MuD Sllt SAnd* Type _____ Pct _____
GRavel CObble BOulder BedRock CLay Type _____ Pct _____
ONcolites WasteBed ConcreTe MarL UNknown Type _____ Pct _____
Pct Cover Codes: N=none 0=1-5% 1=6-25% 2=26-50% 3=51-90% 4=>90%

Water Quality:	*Depth(m)*	*Temp('C)*	*DO(mg/l)*	*DO(%Sat)*	*Cond*	*pH*	*Redox*

Average Depth (m): _____ **Shoreline Length (m)** _____

Comments: *(Gear Condition, Unusual Weather or Conditions, Equipment or Sampling Problems, etc.)*

_____

_____

_____

_____

_____

Data Validity Classification: *Good / Conditional / Invalid*

# of Attached Data Sheets: Bulk Fish _____ Indiv. Fish _____

QAPP Signoffs (Inititial and Date):

Field: _____ Office: _____ Data Entry: _____

_____ _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

INDIVIDUAL FISH DATA SHEET

Date: _____ **Program/GearType:** _____
Facility Code: _____ **Location/Site:** _____
(Include Facility Codes for all samples on data sheet)

Facility Code	Species Code	Common Name	Stage *(A,J,Y)*	Length *(mm)*	Weight *(grams)*	Scale #	Tag #	*Is fish Dead?*	DELTFM *Codes*	Comments

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____
_____ _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

BULK CATCH DATA SHEET

(Record Individual Fish > Initial 30 Count, and Non-Boarded Estimates and/or Counts)

Date: _____ **Program/GearType:** _____

Facility Code: _____ **Location/Site:** _____

(Include Facility Codes for all samples on data sheet) _____

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

QAPP Signoffs (Initital and Date):

Field: _____ Office: _____ Data _____

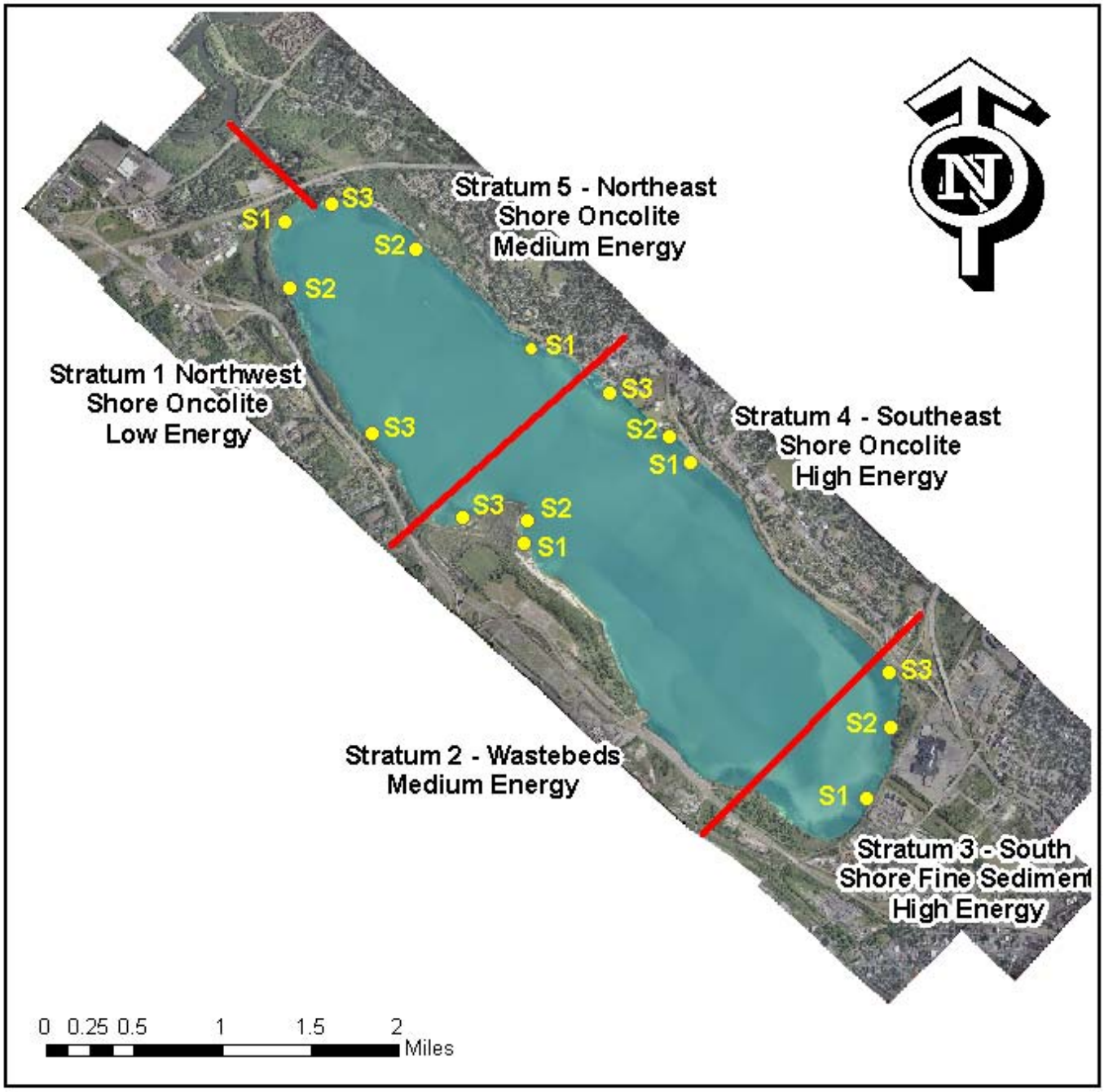
_____ _____ Entry: _____

*** All fish with obvious DELTFM parameters must be listed on the individual fish data form.**

Revised by OCDWEP 2/2006

Species Codes and Common Names

Species Code	Common Name	Species Code	Common Name	Species Code	Common Name
0	No Catch	390	Spottail shiner	576	White bass
207	Sea lamprey	394	Spotfin Shiner	576.1	Temperate Basses
268	Longnose gar	396	Redfin shiner	591	Rock bass
271	Bowfin	397.1	Notropis sp.	595	Green sunfish
276	American eel	400	Bluntnose minnow	596	Pumpkinseed
285	Blueback Herring	401	Fathead minnow	598	Bluegill
289	Alewife	401.1	Pimephalus sp.	599.1	Lepomis sp.
290.1	Blueback and/or Alewife	403	Longnose dace	600	Smallmouth bass
294	Gizzard shad	406	Creek chub	601	Largemouth bass
297.1	Herring Family (Cluepeidae)	407	Fallfish	601.1	Black Bass (SM or LM)
326	Rainbow trout	408.1	Semotilus sp.	602	White crappie
327	Atlantic salmon	409.1	Minnow Family (Cyprinadae)	603	Black crappie
328	Brown trout	419	White sucker	603.1	Crappie (White or Black)
329	Brook trout	423	Northern hog sucker	603.2	Sunfish Family (Centrarchidae)
329.1	Tiger Trout (hybrid)	432	Shorthead redhorse	613	Johnny darter
332	Splake	433.1	Suckers (Catostomidae)	614	Tesselated darter
332.1	Trout Family (Salmonidae)	443	Yellow bullhead	616.1	Ethostoma sp.
335	Rainbow smelt	444	Brown bullhead	617	Yellow perch
340	Central mudminnow	444.1	Bullhead (species unknown)	618	Logperch
347	Northern pike	445	Channel catfish	624.1	Darter (not YPerch)
349	Chain pickerel	450.1	Freshwater Catfish	626	Walleye
350	Tiger muskellunge	461	Trout perch	628.1	Perch Family (Percidae)
350.1	Pike Family (Esocidae)	493	Burbot	700	Freshwater drum
365	Carp	531	Banded killifish	970	NS (Bullhead sunfish, etc)
377	Golden shiner	545	Brook Silverside	999	SPECIES UNKNOWN
381	Emerald shiner	561	Brook stickleback		
385	Common shiner	575	White perch		



Seine Sites

Stratum Border

LOCATION OF YOY-JUVENILE SEINE SITES ON ONONDAGA LAKE

APPENDIX A3:

Field Data Packet For Nesting Surveys

Facility Code and Station Description

Facility Code	Site Abbreviation	Site Description
2626	NS1	Nesting Survey Transect 1
2627	NS2	Nesting Survey Transect 2
2628	NS3	Nesting Survey Transect 3
2629	NS4	Nesting Survey Transect 4
2630	NS5	Nesting Survey Transect 5
2631	NS6	Nesting Survey Transect 6
2632	NS7	Nesting Survey Transect 7
2633	NS8	Nesting Survey Transect 8
2634	NS9	Nesting Survey Transect 9
2635	NS10	Nesting Survey Transect 10
2636	NS11	Nesting Survey Transect 11
2637	NS12	Nesting Survey Transect 12
2638	NS13	Nesting Survey Transect 13
2639	NS14	Nesting Survey Transect 14
2640	NS15	Nesting Survey Transect 15
2641	NS16	Nesting Survey Transect 16
2642	NS17	Nesting Survey Transect 17
2643	NS18	Nesting Survey Transect 18
2644	NS19	Nesting Survey Transect 19
2645	NS20	Nesting Survey Transect 20
2646	NS21	Nesting Survey Transect 21
2647	NS22	Nesting Survey Transect 22
2648	NS23	Nesting Survey Transect 23
2649	NS24	Nesting Survey Transect 24

Onondaga County Department of Water Environment Protection
Onondaga Lake Fish Monitoring Program

NEST SURVEY COVER SHEET

Date: _____ **Transect:** _____
Crew: _____ **Facility Code:** _____
Time Start: _____ **End:** _____ **Observer:** _____

Field Observations - Only Enter One (1) Option

GPS: *Starting Coordinates* North: 43° _____ West: 76° _____ *(decimal minutes)*
Ending Coordinates North: 43° _____ West: 76° _____ *(decimal minutes)*

Weather: _____ **Waves:** *Calm / Swells / Whitecaps*
OVercast PartlyCloudy HaZy CLear RAining **Water Clarity:** *Poor / Moderate / Good*

Wind: _____ **from:** _____ **Significant Rainfall in the Last 48 Hours?**
0-5mph 5-10 10-15 >15 *N,SE,SSE, etc.* *Yes / No*

Habitat: Vegetation _____ Pct cover _____ Structure _____ Pct _____
Emergent Submerged Algae Debris *overhead Veg. Rocks Logs Dropoff Manmade*
Pct Cover Codes: N=none 0=1-5% 1=6-25% 2=26-50% 3=51-90% 4=>90%

Substrate: *VeGetated Plant Debris MuD Sllt SAnd* Type _____ Pct _____
GRavel CObble BOulder BedRock CLay Type _____ Pct _____
ONcolites WasteBed ConcreTe MarL UNknown Type _____ Pct _____
Pct Cover Codes: N=none 0=1-5% 1=6-25% 2=26-50% 3=51-90% 4=>90%

Water Quality:	*Depth(m)*	*Temp('C)*	*DO(mg/l)*	*DO(%Sat)*	*Cond*	*pH*	*Redox*

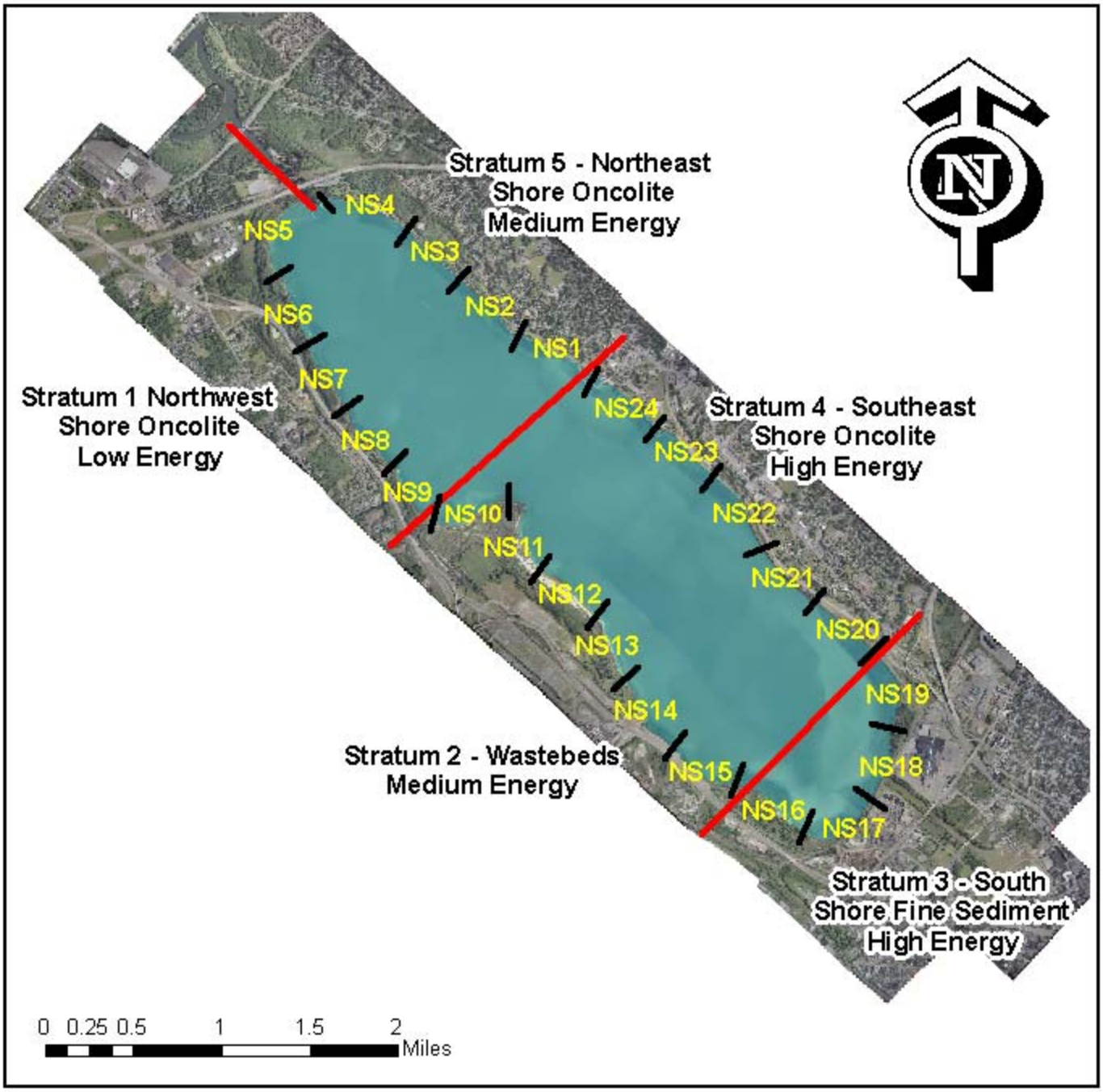
Comments: *(Gear Condition, Unusual Weather or Conditions, Equipment or Sampling Problems, etc.)*

NUMBER OF NESTS OBSERVED

SppCode	Common Name	Field Marks	#Nests
999	UNKNOWN		
596	Pumpkinseed		
598	Bluegill		
599.1	Lepomis. sp.		
600	Smallmouth Bass		
601	Largemouth Bass		
601.1	Black Bass		
444.1	Bullhead		
		Total No. of Nests Observed:	

Average Water Depth (Meters) _____ **Data Validity Class:** *Good / Conditional / Invalid*

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____



Transect Border

Stratum Border

LOCATION OF NESTING SURVEY TRANSECTS IN ONONDAGA LAKE

APPENDIX A4:

Field Data Packet For Littoral Adult Fish Sampling (Electrofishing)

Facility Code and Station Description

Facility Code	Site Abbreviation	Site Description
2676	EF1	Electrofishing Transect 1
2677	EF2	Electrofishing Transect 2
2678	EF3	Electrofishing Transect 3
2679	EF4	Electrofishing Transect 4
2680	EF5	Electrofishing Transect 5
2681	EF6	Electrofishing Transect 6
2682	EF7	Electrofishing Transect 7
2683	EF8	Electrofishing Transect 8
2684	EF9	Electrofishing Transect 9
2685	EF10	Electrofishing Transect 10
2686	EF11	Electrofishing Transect 11
2687	EF12	Electrofishing Transect 12
2688	EF13	Electrofishing Transect 13
2689	EF14	Electrofishing Transect 14
2690	EF15	Electrofishing Transect 15
2691	EF16	Electrofishing Transect 16
2692	EF17	Electrofishing Transect 17
2693	EF18	Electrofishing Transect 18
2694	EF19	Electrofishing Transect 19
2695	EF20	Electrofishing Transect 20
2696	EF21	Electrofishing Transect 21
2697	EF22	Electrofishing Transect 22
2698	EF23	Electrofishing Transect 23
2699	EF24	Electrofishing Transect 24

Onondaga County Department of Water Environment Protection
Onondaga Lake Fish Monitoring Program

LITTORAL ADULTS -- BOAT ELECTROFISHER

Date: _____ **Transect:** _____
Crew: _____ **Facility Code:** _____
Start Time : _____ **End Time:** _____
GPS: North: 43° _____ West: 76° _____ **GPS:** North: 43° _____ West: 76° _____

Field Observations - Only Enter One (1) Option

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Waves: *Calm / Swells / Whitecaps*

Water Clarity: *Poor / Moderate / Good*

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,S,E,W,SE,SW,NE,NW.*

Significant Rainfall in the Last 48 Hours? *Yes / No*

Water Quality:	*Depth(m)*	*Temp('C)*	*DO(mg/l)*	*DO(%Sat)*	*Cond*	*pH*	*Redox*

Comments: *(Gear Condition, Unusual Weather or Conditions, Equipment or Sampling Problems, etc.)*

_____
_____

BULK CATCH DATA -- Include Individual fish > initial 30 count, & non-boarded estimates and/or counts)

Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
		Total Catch:				

EF Settings:

Sec. Start:		**Sec End:**		**Total # Seconds:**	**(UnitEffort)**
Pct Range:		**Amps:**		**Avg. Speed:**	
Frequency:		**Volts:**		**Avg. Depth:**	

Data Validity Classification: *Good / Conditional / Invalid*

# of Attached Data Sheets: Bulk Fish _____ Indiv. Fish _____

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____
_____ _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

INDIVIDUAL FISH DATA SHEET

Date: _____ **Program/GearType:** _____
Facility Code: _____ **Location/Site:** _____
(Include Facility Codes for all samples on data sheet)

Facility Code	Species Code	Common Name	Stage *(A,J,Y)*	Length *(mm)*	Weight *(grams)*	Scale #	Tag #	*Is fish Dead?*	DELTFM *Codes*	Comments

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____
_____ _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

BULK CATCH DATA SHEET

(Record Individual Fish > Initial 30 Count, and Non-Boarded Estimates and/or Counts)

Date: _____ **Program/GearType:** _____

Facility Code: _____ **Location/Site:** _____

(Include Facility Codes for all samples on data sheet) _____

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

QAPP Signoffs (Initital and Date):

Field: _____ Office: _____ Data _____

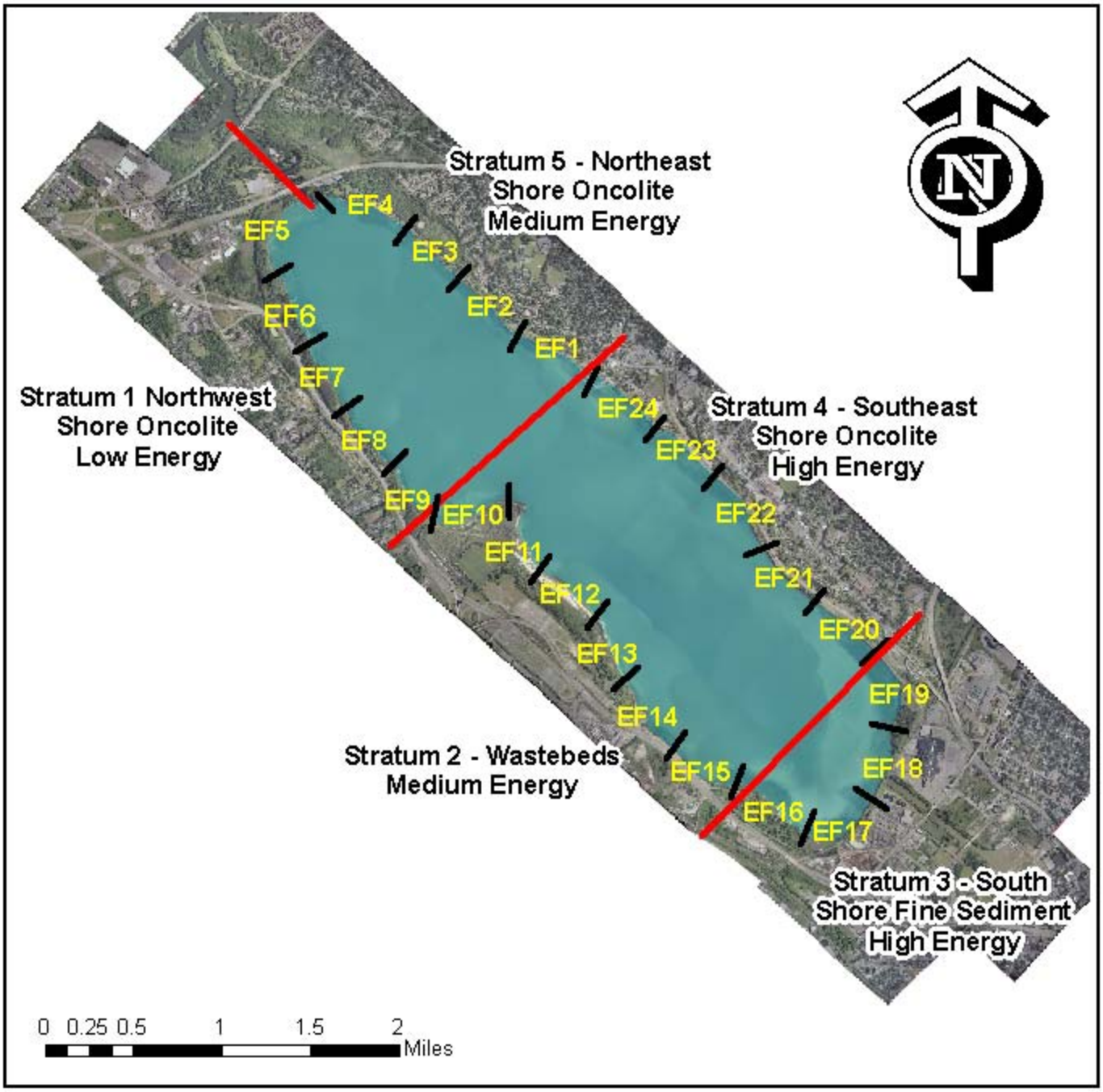
_____ _____ Entry: _____

*** All fish with obvious DELTFM parameters must be listed on the individual fish data form.**

Revised by OCDWEP 2/2006

Species Codes and Common Names

Species Code	Common Name	Species Code	Common Name	Species Code	Common Name
0	No Catch	390	Spottail shiner	576	White bass
207	Sea lamprey	394	Spotfin Shiner	576.1	Temperate Basses
268	Longnose gar	396	Redfin shiner	591	Rock bass
271	Bowfin	397.1	Notropis sp.	595	Green sunfish
276	American eel	400	Bluntnose minnow	596	Pumpkinseed
285	Blueback Herring	401	Fathead minnow	598	Bluegill
289	Alewife	401.1	Pimephalus sp.	599.1	Lepomis sp.
290.1	Blueback and/or Alewife	403	Longnose dace	600	Smallmouth bass
294	Gizzard shad	406	Creek chub	601	Largemouth bass
297.1	Herring Family (Cluepeidae)	407	Fallfish	601.1	Black Bass (SM or LM)
326	Rainbow trout	408.1	Semotilus sp.	602	White crappie
327	Atlantic salmon	409.1	Minnow Family (Cyprinadae)	603	Black crappie
328	Brown trout	419	White sucker	603.1	Crappie (White or Black)
329	Brook trout	423	Northern hog sucker	603.2	Sunfish Family (Centrarchidae)
329.1	Tiger Trout (hybrid)	432	Shorthead redhorse	613	Johnny darter
332	Splake	433.1	Suckers (Catostomidae)	614	Tesselated darter
332.1	Trout Family (Salmonidae)	443	Yellow bullhead	616.1	Ethostoma sp.
335	Rainbow smelt	444	Brown bullhead	617	Yellow perch
340	Central mudminnow	444.1	Bullhead (species unknown)	618	Logperch
347	Northern pike	445	Channel catfish	624.1	Darter (not YPerch)
349	Chain pickerel	450.1	Freshwater Catfish	626	Walleye
350	Tiger muskellunge	461	Trout perch	628.1	Perch Family (Percidae)
350.1	Pike Family (Esocidae)	493	Burbot	700	Freshwater drum
365	Carp	531	Banded killifish	970	NS (Bullhead sunfish, etc)
377	Golden shiner	545	Brook Silverside	999	SPECIES UNKNOWN
381	Emerald shiner	561	Brook stickleback		
385	Common shiner	575	White perch		



Transect Border

Stratum Border

LOCATION OF ADULT ELECTROFISHING TRANSECTS IN ONONDAGA LAKE

APPENDIX A5:

Field Data Packet For Pelagic Adult Fish Sampling (Gill Nets)

Facility Code and Station Description

Facility Code	Site Description
2750	Stratum 1 – Northwest Shore
2756	Stratum 2 – Wastebeds
2762	Stratum 3 – South Shore
2768	Stratum 4 – Southeast Shore
2774	Stratum 5 – Northeast Shore

Onondaga County Department of Water Environment Protection
Onondaga Lake Fish Monitoring Program

PELAGIC ADULTS -- GILL NET

Haul Date: _____ **Basin:** _____ **Facility Code:** _____

Net Set	**Net Hauled**
Date: _____	**Date:** _____
Crew: _____	**Crew:** _____
Time: _____	**Time:** _____
GPS North: 43° _____ *(decimal minutes)*	**GPS** North: 43° _____ *(decimal minutes)*
Position: West: 76° _____	**Position:** West: 76° _____
Water Depth _____ *(meters)*	
Weather: _____	**Weather:** _____
OVercast PartlyCloudy HaZy CLear RAining SNowing	*OVercast PartlyCloudy HaZy CLear RAining SNowing*
Wind: _____ **from:** _____	**Wind:** _____ **from:** _____
0-5mph 5-10 10-15 >15 N,SE,SSE, etc.	*0-5mph 5-10 10-15 >15 N,SE,SSE, etc.*
For the Following Data, Circle the Appropriate Response	*For the Following Data, Circle the Appropriate Response*
Waves: *Calm / Swells / Whitecaps*	**Waves:** *Calm / Swells / Whitecaps*
Water Clarity: *Poor / Moderate / Good*	**Water Clarity:** *Poor / Moderate / Good*
Significant Rainfall in the Last 48 Hours? *Yes / No*	**Significant Rainfall in the Last 48 Hours?** *Yes / No*
Water Quality Profile Taken? *Yes / No*	**Water Quality Profile Taken?** *Yes / No*

Comments: *(Gear Condition, Unusual Weather, Predator Damage, Equipment or Sampling Problems, etc.)*

_____

_____

_____

_____

_____

Is Net Intact Upon Recovery? *Yes / No*

Total # of Hours Fished (Unit Effort): _____

Data Validity Classification: *Good / Conditional / Invalid*

# of Attached Data Sheets: BulkFish _____ Indiv. Fish _____

QAPP Signoffs (Initital and Date):

Field: _____ Office: _____ Data _____

_____ _____ Entry: _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

INDIVIDUAL FISH DATA SHEET

Date: _____ **Program/GearType:** _____
Facility Code: _____ **Location/Site:** _____
(Include Facility Codes for all samples on data sheet)

Facility Code	Species Code	Common Name	Stage *(A,J,Y)*	Length *(mm)*	Weight *(grams)*	Scale #	Tag #	*Is fish Dead?*	DELTFM *Codes*	Comments

QAPP Signoffs (Initital and Date):
Field: _____ Office: _____ Data Entry: _____
_____ _____

Onondaga County Department of Water Environment Protection
Onondaga Lake Fisheries Assessment Program

Page _____ **of** _____

BULK CATCH DATA SHEET

(Record Individual Fish > Initial 30 Count, and Non-Boarded Estimates and/or Counts)

Date: _____ **Program/GearType:** _____

Facility Code: _____ **Location/Site:** _____

(Include Facility Codes for all samples on data sheet) _____

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

Facility Code	Species Code	Common Name	Stage *(A/J/Y)*	Total #Fish	Total Wt (g)	#Fish Dead	Count or Est?
Total Fish:							

QAPP Signoffs (Initital and Date):

Field: _____ Office: _____ Data _____

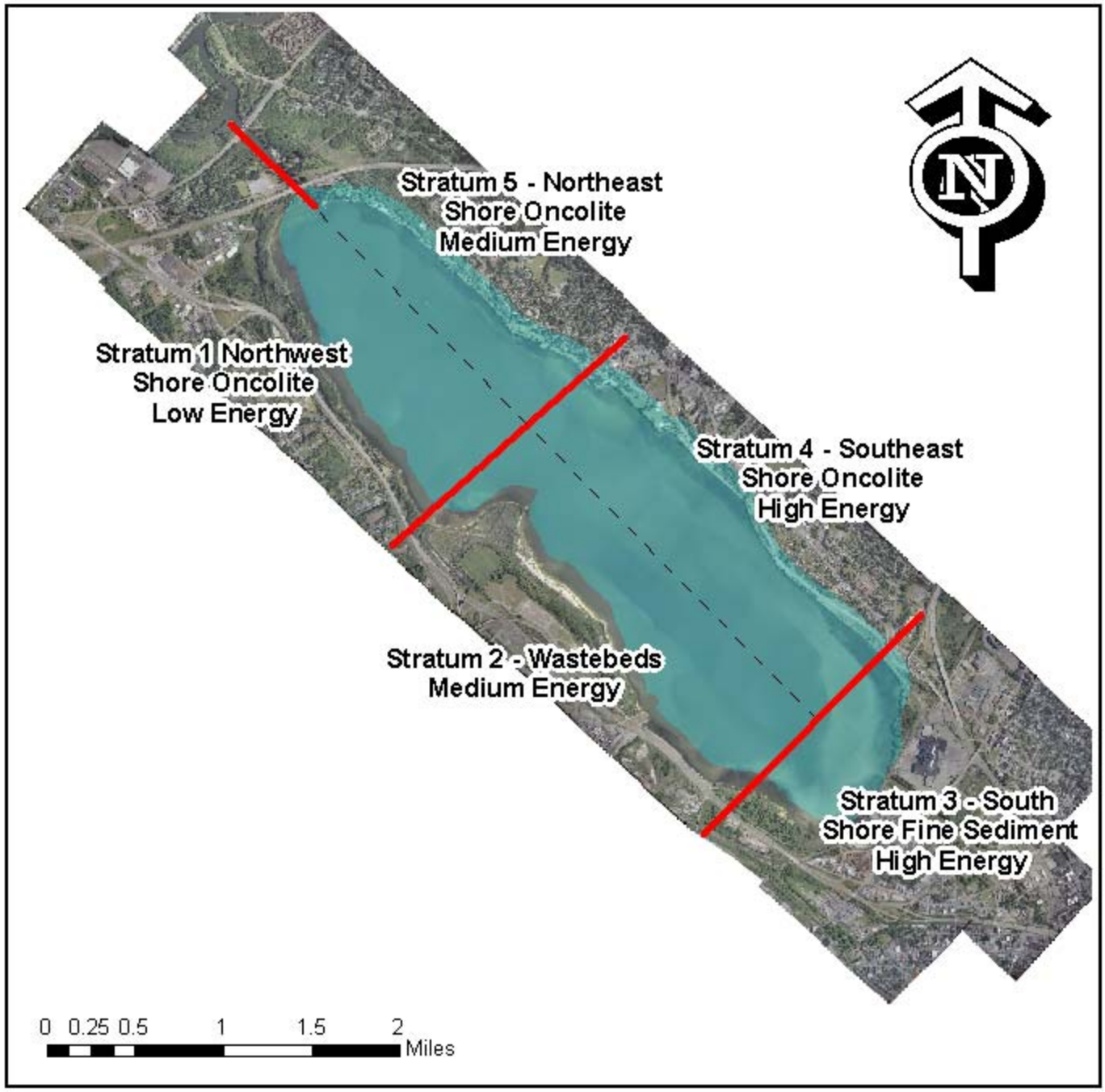
_____ _____ Entry: _____

*** All fish with obvious DELTFM parameters must be listed on the individual fish data form.**

Revised by OCDWEP 2/2006

Species Codes and Common Names

Species Code	Common Name	Species Code	Common Name	Species Code	Common Name
0	No Catch	390	Spottail shiner	576	White bass
207	Sea lamprey	394	Spotfin Shiner	576.1	Temperate Basses
268	Longnose gar	396	Redfin shiner	591	Rock bass
271	Bowfin	397.1	Notropis sp.	595	Green sunfish
276	American eel	400	Bluntnose minnow	596	Pumpkinseed
285	Blueback Herring	401	Fathead minnow	598	Bluegill
289	Alewife	401.1	Pimephalus sp.	599.1	Lepomis sp.
290.1	Blueback and/or Alewife	403	Longnose dace	600	Smallmouth bass
294	Gizzard shad	406	Creek chub	601	Largemouth bass
297.1	Herring Family (Cluepeidae)	407	Fallfish	601.1	Black Bass (SM or LM)
326	Rainbow trout	408.1	Semotilus sp.	602	White crappie
327	Atlantic salmon	409.1	Minnow Family (Cyprinadae)	603	Black crappie
328	Brown trout	419	White sucker	603.1	Crappie (White or Black)
329	Brook trout	423	Northern hog sucker	603.2	Sunfish Family (Centrarchidae)
329.1	Tiger Trout (hybrid)	432	Shorthead redhorse	613	Johnny darter
332	Splake	433.1	Suckers (Catostomidae)	614	Tesselated darter
332.1	Trout Family (Salmonidae)	443	Yellow bullhead	616.1	Ethostoma sp.
335	Rainbow smelt	444	Brown bullhead	617	Yellow perch
340	Central mudminnow	444.1	Bullhead (species unknown)	618	Logperch
347	Northern pike	445	Channel catfish	624.1	Darter (not YPerch)
349	Chain pickerel	450.1	Freshwater Catfish	626	Walleye
350	Tiger muskellunge	461	Trout perch	628.1	Perch Family (Percidae)
350.1	Pike Family (Esocidae)	493	Burbot	700	Freshwater drum
365	Carp	531	Banded killifish	970	NS (Bullhead sunfish, etc)
377	Golden shiner	545	Brook Silverside	999	SPECIES UNKNOWN
381	Emerald shiner	561	Brook stickleback		
385	Common shiner	575	White perch		



Stratum Border

Note: One gill net is randomly placed in each of the five (5) strata at a depth of 4 to 5 Meters.

LOCATION OF LITTORAL-PROFUNDAL GILL NET SETS IN ONONDAGA LAKE

APPENDIX A6:

Game Fish List

Onondaga Lake Fisheries Assessment
Game Fish List

Largemouth bass
Walleye
White Crappie
Yellow Bullhead
Bluegill
Pumpkinseed
Yellow Perch
Smallmouth bass
Black Crappie
Brown Bullhead
Channel catfish
All esocids (pike family)
All salmonids (trout)
Rock bass

ATTACHMENT 3

QUALITY ASSURANCE PROGRAM PLAN

ONONDAGA LAKE MACROPHYTE ASSESSMENT PROGRAM
(2008)

AMBIENT MONITORING PROGRAM

Prepared for the NYSDEC

Prepared by:

Onondaga County
Department Of Water Environment Protection

April 2008

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1.0 INTRODUCTION/PURPOSE

As part of the Onondaga Lake Ambient Monitoring Program the Onondaga County Department of Water Environment Protection has prepared a Quality Assurance Program Plan (QAPP) for the Onondaga Lake Macrophyte Assessment Program, 2008.

The County's long-term monitoring program includes assessment of physical, chemical, and biological attributes of the aquatic resource. The baseline Onondaga Lake Macrophyte Assessment Program and on going studies are expected to address the goal of the *Ambient Monitoring Program*.

Background

The Macrophyte Assessment Program was developed in consultation with expert technical advisors in limnology. The 2008 lake macrophyte program is summarized in Table 1.

Development of the QAPP

The purpose of the QAPP is to mesh field collection procedures and data requirements into a comprehensive document that provides a template for field, laboratory, and data management methods. The QAPP is meant to supplement in-house training of OCDWEP technicians and provide a framework from which trained staff can conduct consistent field surveys. The QAPP is considered to be a living document. That is, as changes are made in the Onondaga Lake Macrophyte Assessment Program, revisions will be made to the QAPP to reflect those changes. These may include changes to the:

- intensity of the sampling program;
- incorporation of new elements to the program, or deletion of specific;
- revisions and improvements to methodologies; and
- incorporation of new methodologies into the program.

Thus the QAPP will serve multiple purposes. It will provide documentation of standardized operations and procedures (SOPs), although more formal SOPs have been developed for in-house training and documentation purposes. It will provide a framework of data forms designed to ensure collection and entry of data, and provide a framework for training of OCDWEP's staff via consistent mentoring by more senior, experienced staff through the structure of the QAPP.

The QAPP has been divided into chapters. Each chapter represents a major field component of the AMP. Each chapter provides a purpose and description of the component, the procedures for sampling that component, appropriate data sheets, maps, and descriptions of stations and station codes. Only minor clarifications were made to the QAPP, and no major program modifications were incorporated in to the 2008 monitoring season.

Table 1. Summary of year 2008 Onondaga Lake Macrophyte Assessment Program.

Component	Methodology/Gear	Sampling Objectives	Location and Number of Samples	Timing	Change
Onondaga Lake Aerial Photography	Program utilizes plane with belly mounted 9x9 camera. 60% forward overlap, 30% side overlap.	Determine annual percent of littoral zone with macrophytes.	-Three (3) flight lines full lake coverage.	-June or July when water clarity is approximately 3-meters on the secchi disk. -Early morning or early evening with low sun angle.	-No change from previous year.
Field Species Verification of Aerial Photography	Visual identification.	Determine species.	-Two (2) sites in each of the five (5) strata for a total of ten (10) sites.	-Within 1 week of the aerial photos.	-No change from previous year.
Macroalgae	At nine (9) near shore locations using a laser range finder to estimate distance from shore and visual percent cover estimate.	Document percent cover and annual proliferation of littoral zone macroalgae.	-Survey once per week at nine (9) near shore buoy locations.	-May through September.	- No change from previous year.

2.0 STAFF TRAINING

The OCDWEP has approached the AMP under the self-monitoring element that is central to the federal Clean Water Act. OCDWEP has acquired a staff with a wide range of academic education supplemented by experience gained by working for state agencies, universities, and environmental consulting and research firms. This staff of scientists and technicians are supported by maintenance and operation personnel that provide the skills to build, construct, maintain, and modify gear needed to conduct the surveys. This expertise allows the OCDWEP to successfully train and mentor qualified individuals to provide a high level of quality to the data of the macrophyte assessment program. As with any long-term monitoring program, individuals will advance in their careers, retire, or move to new locations. This matriculation will require periodic in-house training of new individuals. The QAPP is integral to this training. Its use and understanding will provide each individual with an easy to understand document to ensure day-to-day and year-to-year consistency of the Onondaga Lake Macrophyte Assessment Program.

In addition to the QAPP and SOPs, the County's Consultant, Ecologic LLC, conducts annual audits for macrophyte field verification component. The audit is intended to ensure that the field technicians conducted their work in a professional manner and comply with the procedures outlined in the QAPP and SOPs. In addition, the audits determine if any observation would jeopardize the quality of the data (technique, field logs, training, etc.).

Thus the use of the QAPP in conjunction with the formal Standard Operating Procedures (SOPs) and external audits for the biological monitoring program activities, the *Onondaga County Ambient Monitoring Program: Onondaga Lake Macrophyte Assessment Program (2008)* and subsequent programs will provide OCDWEP with a successful monitoring program.

3.0 AERIAL PHOTOGRAPHY

3.1 Procedures

Aerial photographs will be taken of Onondaga Lake on an annual basis utilizing a qualified contracted aerial photography firm. The aerial photographs must meet the following specifications:

- 1"=445' +/- scale.
- 3 flight lines (Must duplicate previous flight lines).
- 63 total exposures.
- 60% forward lap.
- 30% side lap.
- Formal titling of 63 exposure (*Onondaga Lake Macrophyte Survey – Date, Time, Scale, Flight Line and Exposure).*
- 2 sets of color contact prints.
- 1 set of black and white prints.

3.1.1 Lake Macrophyte Growth Conditions

Step 1. Visually survey the macrophyte growth in the littoral zone from a boat during other lake sampling events (optimal time is usually Early July). Timing is critical; the aerial flight needs to be scheduled when macrophytes are approaching their peak, but before the lake macroalgae peaks (Usually late June to mid July).

Note: Prior to the aerial flight, large buoys (nearly 3ft diameter) will be positioned at the field verification locations for visual identification in the photos.

Step 2. Contact flight contractor to determine flight feasibility.

Note: These indicators are not always achieved due to turbidity, wind and other environmental factors. These are guidelines to determine the best possible conditions for aerial photographs.

3.1.2 Pre-flight Planning and Coordination

Step 1. Review weekly secchi disc readings.

Step 2. Review weather report for the past week. No significant rainfall should be recorded for at least 48 hours prior to the flight.

Step 3. Review detailed weather report for the next few days. A clear day with low humidity and no haze needs to be targeted for the flight.

Step 4. Contact flight contractor as early as possible in the morning to confirm the flight. Usually this is done at 700 hours to allow the contractor travel time to shoot the photos during the period of low sun angle which is the period of 600 –1030 hours and 1630 – 2000 hours during this time of year.

3.2 Macrophyte Digitizing from Aerial Photos

Step 1. Geo referenced color Tiff images of the littoral zone are imported into an ArcView job file.

Step 2. The Tiff images are overlaid at a scale of 1:1,856 on a bathymetric map of Onondaga Lake. Digitizing should be carried out on the computer screen and areas perceived as macrophyte growth, based on color and texture, should be delineated.

Step 3. The perimeter of each macrophyte bed in the lake is outlined using the polygon feature of ArcView.

Step 4. In addition to macrophyte beds, nearshore areas that appear to have been dredged, piers, and other structures should be delineated and categorized separately from the macrophyte beds.

Step 5. ArcView will calculate the area of polygons in the file; this will be comparable to the area of the lake where macrophytes are present.

4.0 FIELD SPECIES VERIFICATION OF AERIAL PHOTOGRAPHY

4.1 Procedures

Field verification of macrophyte species present in Onondaga Lake will be conducted within one (1) week of the aerial flight. Two (2) samples will be collected from each of the five (5) strata for a total of ten (10) samples.

4.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: map and field sheets, equipment, and species key.

Step 3. Review weather reports for sampling feasibility.

4.1.2 Field:

Step 1. Proceed to the first monitoring site. The following table summarizes the site description and coordinates for each sampling location.

Site Description	Coordinates/Position
Onondaga Lake Site 1	43° 06.653' N, 76° 13.746' W
Onondaga Lake Site 2	43° 05.966' N, 76° 12.525' W
Onondaga Lake Site 3	43° 05.468' N, 76° 11.773' W
Onondaga Lake Site 4	43° 04.489' N, 76° 10.667' W
Onondaga Lake Site 5	43° 03.853' N, 76° 11.057' W
Onondaga Lake Site 6	43° 04.324' N, 76° 12.202' W
Onondaga Lake Site 7	43° 05.388' N, 76° 12.565' W
Onondaga Lake Site 8	43° 06.813' N, 76° 14.702' W
Onondaga Lake Site 9	43° 05.589' N, 76° 13.937' W
Onondaga Lake Site 10	43° 06.909' N, 76° 14.390' W

Step 2. Upon arrival at site position the boat in approximately 1 to 1.5 meters of water, Then anchor the boat to secure the position.

Step 3. Confirm and record GPS location (the actual final position) and site number, then begin filling out the macrophyte field verification sheet (Figure 2).

Step 4. With rope or pole attached, position the meter-squared frame in the water and lower to bottom If dense beds of macrophytes are present use the rake to firmly ground the frame.

Step 5. Using the metal rake remove all macrophytes from the square meter area. If there are emergent or floating leafed macrophytes in the sample area, it may be necessary to

pull them by hand in order to get them loose from the bottom. If large amounts of macroalgae are present the algae should be carefully pushed aside prior to collecting the sample, note presence of macroalgae and relative abundance on the datasheet in the comment section.

Step 6. As macrophytes are removed from the sample area place them in a tub filled with water.

Step 7. After removing all the macrophytes in the sample area, visually separate them into similar groups, placing each group into a separate 5-gallon bucket.

Step 8. Once all macrophytes are separated into groups, remove individual specimens from the 5-gallon buckets for identification. Spread the specimen out on a flat surface (top of a cooler) and identify it using a key. Record the identified species on the macrophyte field verification sheet. Continue to identify all remaining species of plants in this manner.

Step 9. Estimate percent cover of macrophytes from the area around the sample site in approximately a 5-meter radius around the boat. In addition, estimate the relative abundance for each species within the 5-meter radius.

Note: Determine and record if the species in the 5-meter radius represent the species around the boat (growth may be patchy). For example, the 1-square meter area may be primarily curly pondweed, but may have an elodea nearby within the 5-meter radius. These types of comments should be noted on the field data sheet.

Note: If a successful identification cannot be completed in the field, place the specimen in a plastic quart jar and fill with 10% buffered formalin for preservation. Use a separate generic name on the data sheet (such as Species a, b and so on) for each unidentified species, and estimate relative abundance for that species as you would for species identified in the field. The jar should be clearly marked with the following information:

- Date and time.
- Generic species name.
- Location.
- Field crew.
- Comments.

Step 10. Once all of the plants have been identified or preserved for further identification, and the field data sheet entries are complete, remove group of buoys. Then proceed to next station, and repeat Step 1 through 9.

4.1.3 End of Sample Day

Step 1. Review field notes for completeness.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs.

Step 4. Log any samples into the biological laboratory

4.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

4.1.5 Field Data Sheet Packet

Appendix B1 contains examples of the field verification data sheet and map of sampling stations.

5.0 MACROALGAE

5.1 Procedures

Annual macroalgae proliferation will be estimated on Onondaga Lake to determine the season percent cover within the littoral zone. This task will be coupled with the weekly lake near shore sampling. A total of nine (9) measurements will be collected weekly. Stakes with reflective discs will be placed on shore at the beginning of the field season. These stakes will be the bench mark to estimate the distance that the algae extends from shore.

5.1.1 Pre-field:

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble field data sheets, laser range finder, and digital camera.

Step 3. Check batteries in laser range finder.

5.1.2 Field:

Step 1. Proceed to site number, and position boat at its start at the outer edge of the algae mat, or in approximately 1 m of water if the algae mat does not extended beyond the 1 meter depth. The following table summarizes the coordinates of transects used in the macroalgae monitoring program in Onondaga Lake.

Site #	Location	Buoy Coordinates	Shore Benchmark
Site 1	Lake Nearshore (Nine Mile Creek)	43° 05.477'N 76° 13.650'W	Point adjacent to Trib Mouth.
Site 2	Lake Nearshore (Harbor Brook)	43° 03.877'N 76° 11.043'W	43° 03.77'N 76° 11.06'W
Site 3	Lake Nearshore (Metro/Outfall)	43° 03.923'N 76° 10.805'W	43° 03.90'N 76° 10.85'W
Site 4	Lake Nearshore (Ley Creek)	43° 04.516'N 76° 10.592'W	43° 04.52'N 76° 10.61'W
Site 5	Lake Nearshore (Eastside)	43° 06.529'N 76° 13.598'W	43° 06.55'N 76° 13.58'W
Site 6	Lake Nearshore (Willow Bay)	43° 06.907'N 76° 14.167'W	43° 06.90'N 76° 14.17'W
Site 7	Lake Nearshore (Maple Bay)	43° 06.732'N 76° 14.713'W	43° 06.70'N 76° 14.83'W
Site 8	Lake Nearshore (Bloody Brook)	43° 05.720'N 76° 12.225'W	43° 05.76'N 76° 12.11'W
Site 9	Lake Nearshore (Wastebeds)	43° 04.880'N 76° 12.620'W	NA

Step 2. Using the laser range finder, aim at the shoreline stake with the reflective disc and record the distance on the field sheet. Record the approximate depth of water (in meters), and document each location with a digital picture.

Step 3. Estimate the percentage of the algae mat surface coverage along a straight visual line, approximately 2 meters wide, from the boat to the shoreline. If the algae mat is not large, or to distinguish between algae mats and emergent macrophytes, the boat may be moved towards shore to establish an accurate estimate. The laser range finder may be used to measure the inner and outer edge of any large algae mats to develop the estimate.

Step 4. The field data sheet should include a sketch of the algae mat formation from the boat to the shoreline, and include a description of the algae mats (e.g. some formation on emergent macrophytes, no mats present, primarily *Cladophora,* some blue-green algae present, etc.).

Step 5. Proceed to next station, and repeat steps 1 through 4.

5.1.3 End of Sample Day

Step 1. Review field notes for completeness.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

Step 4. Download digital pictures.

5.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

5.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet
- Map showing location of sampling stations
- Facility code/station description and coordinates

Appendix B2 contains examples of the station data sheet and map of sampling stations.

6.0 CHRONOLOGY OF QAPP

The QAPP for the Onondaga Macrophyte Assessment Program is a living document in that it will be periodically updated to reflect changes in the monitoring program that are instituted to improve the efficiency of data collection, focus on a particular aspect of the aquatic macrophytes. The periodic updating of the QAPP will provide a written record of sampling procedures over the entire life of the Onondaga Macrophyte Assessment Program. Annual revisions to the QAPP have incorporated various changes made to the macrophyte assessment program.

The original QAPP, and subsequent revisions, have been reviewed by the NYSDEC, revised by OCDWEP as requested, and approved by the NYSDEC prior to implementation.

7.0 LITERATURE CITED

OCDWEP *SOP For Macroalgae Survey (DOC No. BIO-011)*

OCDWEP *SOP For Macrophyte Field Verification of Aerial Photography (DOC No. BIO-012)*

APPENDIX B1

Field Data Packet for Macrophyte Species Verification of Aerial Photography

Onondaga County Department of WATER ENVIRONMENT PROTECTION

MACROPHYTE FIELD VERIFICATION SHEET

Date: _____

Crew: _____

Site Number: _____

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,S,E,W,SE,SW,NE,NW.*

Date of Aerial Photography: _____

Depth of Water (Meters): _____

Substrate Type: _____
Rock, logs, sand, silt, oncolites,solvay waste, etc.

Do the Species in the 1-meter^2 Represent the Species Found in the 5-meter Radius (Y/N)? ___

COMMENTS:

GPS Coordinates: N: 43° _____
W: 76° _____

MACROPHYTE SPECIES IDENTIFICATION		
Common Name	**Scientific Name**	**Est. Percent Coverage (5-meter Radius)**

Samples Collected For Laboratory Identification*
* Preserve samples in 10% Buffered Formalin.

Date: _____

Crew: _____

Site Number: _____

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,S,E,W,SE,SW,NE,NW.*

Date of Aerial Photography: _____

Depth of Water (Meters): _____

Substrate Type: _____
Rock, logs, sand, silt, oncolites,solvay waste, etc.

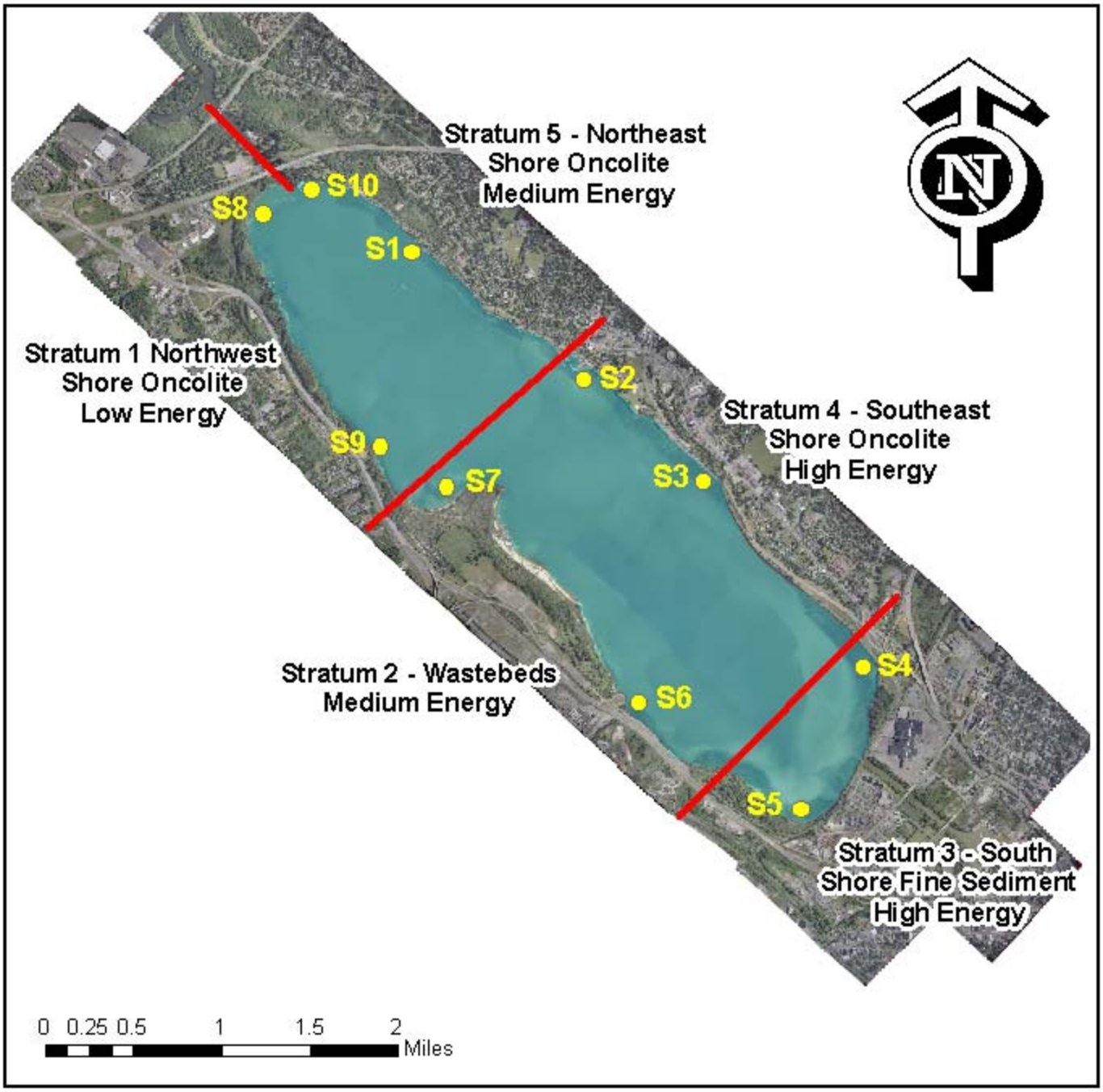
Do the Species in the 1-meter^2 Represent the Species Found in the 5-meter Radius (Y/N)? ___

COMMENTS:

GPS Coordinates: N: 43° _____
W: 76° _____

MACROPHYTE SPECIES IDENTIFICATION		
Common Name	**Scientific Name**	**Est. Percent Coverage (5-meter Radius)**

Samples Collected For Laboratory Identification*
* Preserve samples in 10% Buffered Formalin.



Verification Sites

Stratum Border

SITES FOR FIELD SPECIES VERIFICATION OF AERIAL PHOTOGRAPHY ON ONONDAGA LAKE

APPENDIX B2

Field Data Packet for Macroalgae

Onondaga County Department of WATER ENVIRONMENT PROTECTION

MACROALGAE FIELD SHEET

Date: _____

Crew: _____

Near Shore Location: _____

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,S,E,W,SE,SW,NE,NW.*

Are Shoreline Bench Marks Intact (Y/N)? ____

Check if Any Algae Samples Were Collected: ____

Depth of Water at Edge of Algal Mat (or Formation) in (Meters):

(Left side)	(Middle)	(Right Side)

Distance From Edge of Algal Mat (or Formation) To Shoreline Benchmark/Target (Meters):

(Left side)	(Middle)	(Right Side)

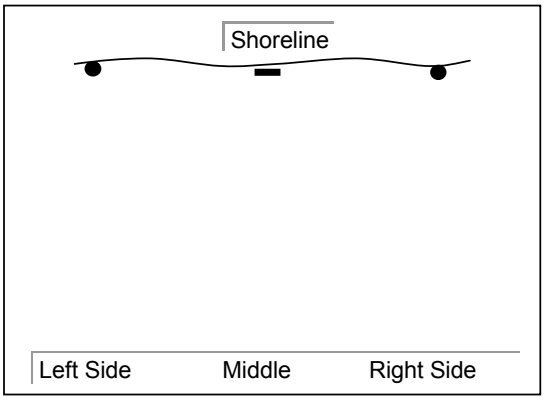
Estimated Percent Cover (Range):

(Left side)	(Middle)	(Right Side)

Percent Cover Ranges:
0%, 1-20%, 21-40%, 41-60%, 61-80%, 81-100%

COMMENTS:

Algal Mat Sketch



Date: _____

Crew: _____

Near Shore Location: _____

Weather: _____
OVercast PartlyCloudy HaZy CLear RAining SNowing

Wind: _____ **from:** _____
0-5mph 5-10 10-15 >15 *N,S,E,W,SE,SW,NE,NW.*

Are Shoreline Bench Marks Intact (Y/N)? ____

Check if Any Algae Samples Were Collected: ____

Depth of Water at Edge of Algal Mat (or Formation) in (Meters):

(Left side)	(Middle)	(Right Side)

Distance From Edge of Algal Mat (or Formation) To Shoreline Benchmark/Target (Meters):

(Left side)	(Middle)	(Right Side)

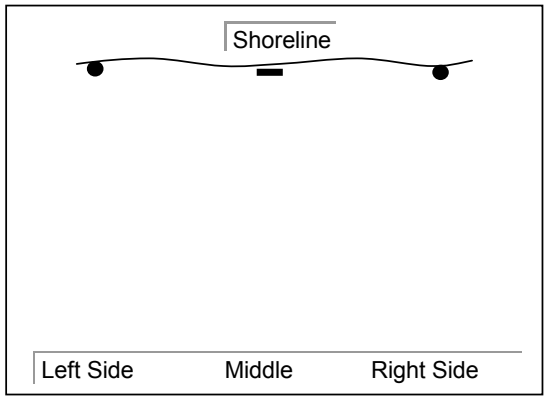
Estimated Percent Cover (Range):

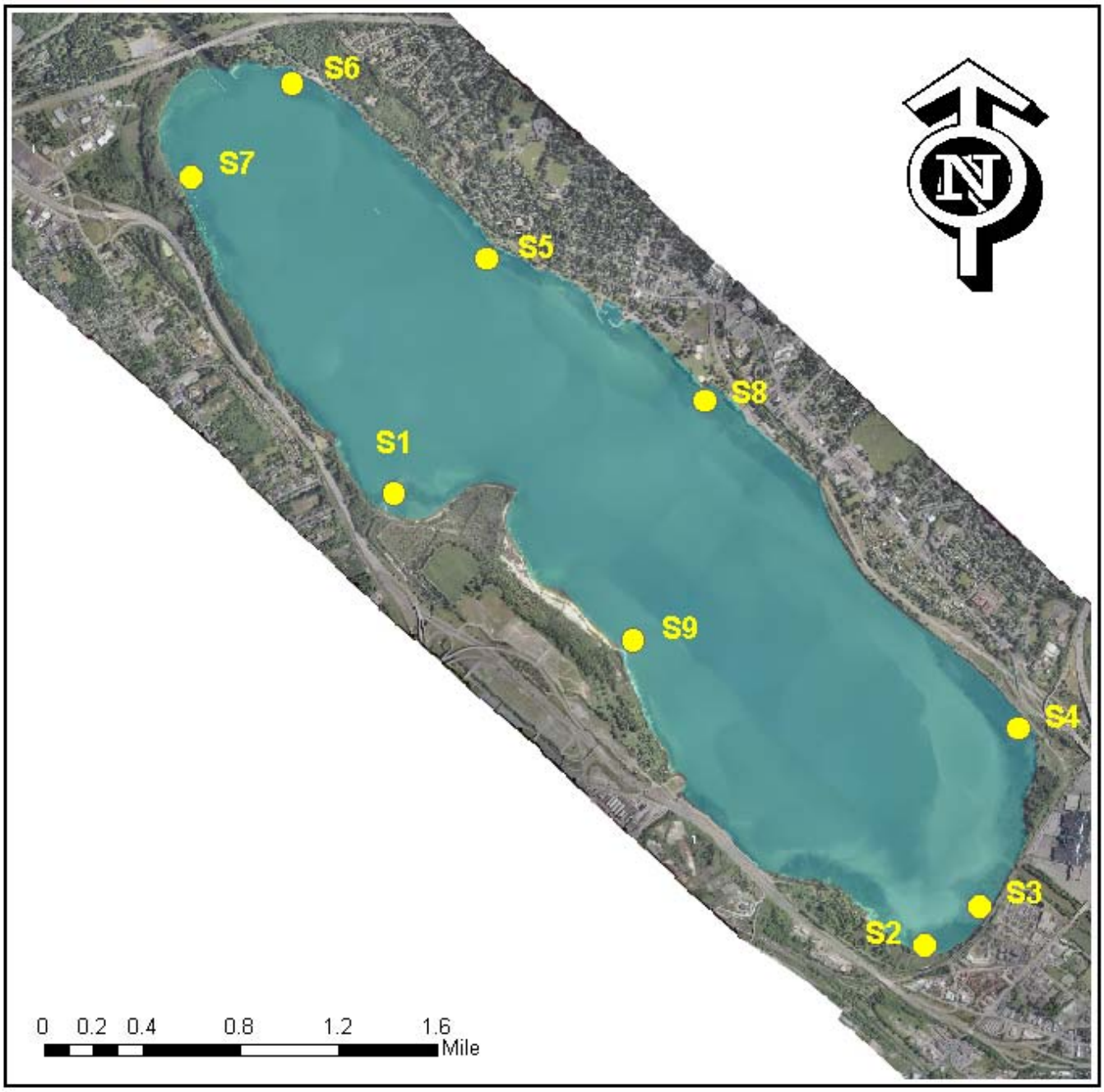
(Left side)	(Middle)	(Right Side)

Percent Cover Ranges:
0%, 1-20%, 21-40%, 41-60%, 61-80%, 81-100%

COMMENTS:

Algal Mat Sketch





Verification Sites

SITES FOR MACROALGAE MONITORING ON ONONDAGA LAKE

ATTACHMENT 4

QUALITY ASSURANCE PROGRAM PLAN

ONONDAGA LAKE AND TRIBUTARY
MACROINVERTEBRATE ASSESSMENT PROGRAM (2008)

AMBIENT MONITORING PROGRAM

Prepared for the NYSDEC

Prepared and Revised by:

Onondaga County
Department Of Water Environment Protection

April 2008

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1.0 INTRODUCTION/PURPOSE

As part of the Onondaga Lake Ambient Monitoring Program the Onondaga County Department of Water Environment Protection has prepared a Quality Assurance Program Plan (QAPP) for the Macroinvertebrate Assessment Program, 2008.

The County's long-term monitoring program includes assessment of physical, chemical, and biological attributes of the aquatic resource. The baseline Onondaga Lake and Tributary Stream Macroinvertebrate Assessment Program and on going studies are expected to address the goals of the *Ambient Monitoring Program*.

Background

The year 2008 Macroinvertebrate Assessment Program was developed in consultation with expert technical advisors in limnology. The 2008 program is summarized in Table 1.

Development of the QAPP

The purpose of the QAPP is to mesh field collection procedures and data requirements into a comprehensive document that provides a template for field, laboratory, and data management methods. The QAPP is meant to supplement in-house training of OCDWEP technicians and provide a framework from which trained staff can conduct consistent field surveys. The QAPP is considered to be a living document. That is, as changes are made in the Onondaga Lake and Tributary Stream Macroinvertebrate Assessment Program, revisions will be made to the QAPP to reflect those changes. These may include changes to the:

- intensity of the sampling program;
- incorporation of new elements of the program;
- deletion of specific elements of the program;
- revisions and improvements to methodologies; and
- incorporation of new methodologies into the program.

Thus the QAPP will serve multiple purposes. It will provide documentation of standardized operations and procedures (SOPs), although more formal SOPs have been developed for in-house training and documentation purposes. It will provide a framework of data forms designed to ensure collection and entry of data, and provide a framework for training of OCDWEP's staff via consistent mentoring by more senior, experienced staff through the structure of the QAPP.

The QAPP has been divided into chapters. Each chapter represents a major field component of the AMP. Each chapter provides a purpose and description of the component, the procedures for sampling that component, appropriate data sheets, maps, and descriptions of stations and station codes. This QAPP was revised for the 2008 sampling season.

Table 1. Summary of year 2008 Onondaga Lake and Tributary Macroinvertebrate Assessment Program.

Component	Methodology/Gear	Sampling Objectives	Location and Number of Samples	Timing	Change from previous year
Tributary Macroinvertebrate Sampling	Kick Screen Sampling. Jab Net Sampling.	NYSDEC Water Quality Assessment Protocol. HBI – Hilsenhoff Biotic Index. % Oligocheates.	- Four (4) Sites on Onondaga Creek. - Three (3) Sites on Ley Creek. - Three (3) Sites on Harbor Brook.	July during low flow conditions.	No Change from 2006.
Habitat Assessment	USEPA Rapid Bioassessment Protocol	Habitat Characterization	- Four (4) Sites on Onondaga Creek. - Three (3) Sites on Ley Creek. - Three (3) Sites on Harbor Brook.	July during low flow conditions.	No Change from 2006.
Tributary Mapping	Stream Visual Assessment Protocol (SVAP) developed by the NRCS	Physical Assessment of ten (10) elements. FBI – Family Level Biotic Index.	- Twenty-seven (27) sites on Onondaga Creek. - Nine (9) sites on Ley Creek. - Seven (7) sites on Harbor Brook.	August during low flow conditions.	No Change from 2002.

2.0 STAFF TRAINING

The OCDWEP has approached the AMP under the self-monitoring element that is central to the federal Clean Water Act. OCDWEP has acquired a staff with a wide range of academic education supplemented by experience gained by working for state agencies, universities, and environmental consulting and research firms. This staff of scientists and technicians are supported by maintenance and operation personnel that provide the skills to build, construct, maintain, and modify gear needed to conduct the surveys. This expertise allows the OCDWEP to successfully train and mentor qualified individuals to provide a high level of quality to the data of the macroinvertebrate assessment program.

As with any long-term monitoring program, individuals will advance in their careers, retire, or move to new locations. This matriculation will require periodic in-house training of new individuals. The QAPP is integral to this training. Its use and understanding will provide each individual with an easy to understand document to ensure day-to-day and year-to-year consistency of the Macroinvertebrate Assessment Program. Thus the use of the QAPP in conjunction with the formal Standard Operating Procedures (SOPs) for the biological monitoring program activities, the *Onondaga County Ambient Monitoring Program: Macroinvertebrate Assessment Program (2008)* and subsequent programs documentation will provide OCDWEP with a successful program.

3.0 ONONDAGA LAKE TRIBUTARY MACROINVERTEBRATE SAMPLING AND HABITAT ASSESSMENT

3.1 Procedures

Tributary macroinvertebrate sampling is conducted at ten (10) locations in the Onondaga Lake watershed during low flow periods in July (refer to Appendix C.1 for a map of the locations). Tributary macroinvertebrate sampling will be completed in conjunction with the tributary Habitat Assessment activities at the following locations:

Site Name	Site Location	Site Abbreviation	Sample Type	Reference Coordinates
Onondaga Creek Site 1	Tully Farms Road	OCS1	Kick Screen	N 42° 49.49', W 76° 08.20'
Onondaga Creek Site 2	Webster Road	OCS2	Kick Screen	N 42° 52.95', W 76° 09.24'
Onondaga Creek Site 3	Dorwin Ave. Bridge	OCS3	Kick Screen	N 42° 59.137', W 76° 08.961'
Onondaga Creek Site 4	Spencer Street	OCS4	Kick Screen	N 43° 03.349', W 76° 09.670'
Harbor Brook Site 1	Velasko Road	HBS1	Kick Screen	N 43° 02.156', W 76° 11.467'
Harbor Brook Site 2	Hiawatha Boulevard	HBS2	Kick Screen	N 43° 03.393', W 76° 11.132'
Harbor Brook Site 3	Route 690	HBS3	Jab Net	N 43° 03.722', W 76° 11.277'
Ley Creek Site 1	Townline Road Bridge	LCS1	Kick Screen	N 43° 05.453', W 76° 06.987'
Ley Creek Site 2	7th North Street	LCS2	Jab Net	N 43° 05.242', W 76° 09.706'
Ley Creek Site 3	Park Street	LCS3	Jab Net	N 43° 04.496', W 76° 10.359'

Protocols for data collection shall be consistent with the New York State Department of Environmental Conservation, Divisions of Water's, *Quality Assurance Work Plan for Biological Stream Monitoring in New York State,* dated June 2002.

3.1.1 Pre-Field

Step 1. Review QAPP to determine overall needs of programs.

Step 2. Assemble: field data sheet packet, Chain of Custody forms, and equipment.

Step 3. Examine equipment for needed repairs.

Step 4. Print labels and pre-label sample jars.

Step 5. Check calibration of water quality (WQ) meter.

Step 6. Review weather reports for sampling feasibility.

3.1.2 Field

3.1.2.1 Kick Screen Sampling Locations

Step 1: Four (4) full stream cross-section replicate samples will be collected at each site. Start by identifying the four (4) replicate sample locations, leaving roughly 5-meters between each replicate.

Step 2: Starting with the replicate furthest down stream in order to minimize disturbance of the subsequent sampling sites. Enter the water with a kick screen and move in a perpendicular direction towards the far shore/stream bank.

Step 3: Position the kick screen in the water approximately 0.5-meters downstream of the samplers feet. The field data recorder will note the starting time.

Step 4: With the kick screen remaining in the water and resting upon the bottom substrate, the stream bottom is disturbed by foot (shuffle back and forth), so that dislodged organisms are carried into the net. If possible, roll over larger cobbles to dislodge organisms from their refuge. Sampling will continue for 5-minutes, with the objective of sampling the entire stream cross-section in a diagonal transect while heading upstream toward the near shore. The speed in which the kick screen is moved across the stream channel will be dependent upon the stream width, however, the speed shall be adjusted to ensure consistent sampling disturbance across the stream width.

Step 5: As acknowledged by the field data recorder, after the 5-minutes of sampling is completed, lift the net out of the water being careful that material in the net is not lost.

Step 6: Empty the contents of the net into the wash bucket, being sure to thoroughly rinse the net with the garden sprayer. Large rocks and sticks may only be removed from the sample after vigorous rinsing.

Step 7: Carefully pour the contents of the wash bucket into a 500 μm sieve, making sure wash bucket is thoroughly rinsed into the sieve.

Step 8: Once the contents are drained and rinsed, transfer the material on the sieve to the pre-labeled sample container, filling no more than 50% of the container volume. If more than one sample container is required, label the container with the same information as the first, and include the jar number (i.e. container 1 of 2, etc.). If any organisms are removed from the kick-screen, but not placed into the sampling container (i.e. cray-fish, minnow species, etc.), they must be listed on the Chain of Custody.

Step 9: The sample jar shall be topped off just below the shoulder with fixative (70% ethyl-alcohol), capped tightly, and gently inverted several times to distribute the fixative solution. Double check the label(s), making sure all required information is recorded.

Step 10: Fill out the appropriate chain for the sample and sign your name.

Step 11: Complete the remaining replicate samples following the steps contained in Section 3.1.2.1 Kick Screen Sampling Locations. Continue with the next furthest downstream site, and be certain not to overlap sample sites.

3.1.2.2 Jab Net Sampling Locations

Step 1: Attach a rope to each side of the shoreline. Use the zodiac to cross the stream and attach the rope to the far shore. The rope should be taut for this activity. Divide the stream width into four (4) equal sections starting from the near shore, and mark the rope at these locations.

Step 2: Using the rope for stability, position the boat at the first far shore mark. Lower the kick screen net, through the water column, until the bottom substrate is reached.

Step 3: Using a jabbing motion, push the net into the sediment and rake across the bottom substrate until the net is filled.

Step 4: Slowly bring the net to the surface to avoid loss of material, and transport the sample to shore.

Step 5: Empty the contents of the net into the wash bucket, being sure to thoroughly rinse the net with the garden sprayer. Large rocks and sticks may only be removed from the sample after vigorous rinsing.

Step 6: Carefully pour the contents of the wash bucket into a 500 μm sieve, making sure wash bucket is thoroughly rinsed into the sieve.

Step 7: Once the contents are drained and rinsed, transfer the material on the sieve to the pre-labeled sample container, filling no more than 50% of the container volume. If more than one sample container is required, label the container with the same information as the first, and include the jar number (i.e. container 1 of 2, etc.). If any organisms are removed from the kick-screen, but not placed into the sampling container (i.e. cray-fish, minnow species, etc.), they must be listed on the Chain of Custody.

Step 8: The sample jar shall be topped off just below the shoulder with fixative (70% ethyl-alcohol), capped tightly, and gently inverted several times to distribute

the fixative solution. Double check the label(s), making sure all required information is recorded.

Step 9: Fill out the appropriate chain for the sample and sign your name.

Step 10: Complete the remaining replicate samples following the steps contained in Section 3.1.2.2. Jab Net Sampling Locations. Continue with remaining replicates, and be certain not to overlap sample sites.

3.1.2.3 Habitat Assessment and Physicochemical Characterization Forms

Physical Characterization/Water Quality and Habitat Assessment Field Data Sheet forms will be completed in conjunction with tributary macroinvertebrate sampling at the following locations:

Site Name	Site Location	Site Abbreviation	Reference Coordinates
Onondaga Creek Site 1	Tully Farms Road	OCS1	N 42° 49.49', W 76° 08.20'
Onondaga Creek Site 2	Webster Road	OCS2	N 42° 52.95', W 76° 09.24'
Onondaga Creek Site 3	Dorwin Ave. Bridge	OCS3	N 42° 59.137', W 76° 08.961'
Onondaga Creek Site 4	Spencer Street	OCS4	N 43° 03.349', W 76° 09.670'
Harbor Brook Site 1	Velasko Road	HBS1	N 43° 02.156', W 76° 11.467'
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Harbor Brook Site 3	Route 690	HBS3	N 43° 03.722', W 76° 11.277'
Ley Creek Site 1	Townline Road Bridge	LCS1	N 43° 05.453', W 76° 06.987'
Ley Creek Site 2	7th North Street	LCS2	N 43° 05.242', W 76° 09.706'
Ley Creek Site 3	Park Street	LCS3	N 43° 04.496', W 76° 10.359'

The procedures contained herein shall be considered general procedures to ensure completeness of the forms. All personnel who complete the Physical Characterization/Water Quality Field Data Sheets shall review, and reference for characterization accuracy, the USEPA Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers (Barbour et al 1997), specifically Chapter 5, Habitat Assessment and Physicochemical Parameters, pages 5-1 to 5-5. In addition, all personnel who complete the Habitat Assessment Field Data Sheets shall review and reference for habitat parameter accuracy, the USEPA Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers (Barbour et al 1997), specifically Chapter 5, Habitat Assessment and Physicochemical Parameters, pages 5-11 to 5-31.

3.1.2.4 General Procedures – Physical Characterization/Water Quality Field Data Sheet

Step 1: Complete the Physical Characterization/Water Quality Field Data Sheet form for each site (front and back). This form includes basic information such as location, date, time, personnel, methods, and sketch of characterization area.

Header Information – Complete all requested information, except River Mile, Stream Class, and STORET#. Latitude and longitude must be included.

Weather Conditions – Complete all requested information.

Site Location Map – A hand-drawn map is necessary to illustrate major landmarks or features of the channel morphology or orientation, vegetative zones, buildings, etc. that might be used to aid in data interpretation. Also indicate areas where macroinvertebrate samples were collected. Use the recent historical Physical Characterization/Water Quality Field Data Sheets to identify new or modified features or stream improvements (i.e. culverts, bank stabilization, dredging, etc.).

Stream Characterization – Complete all requested information, except catchment area.

Watershed Features – Complete all requested information.

Riparian Vegetation – Complete all requested information.

Instream Features – Complete all requested information. Section 4.3, In-stream Flow Measurements, will supplement this section.

Large Woody Debris (LWD) – Complete all requested information.

Aquatic Vegetation – Complete all requested information.

Water Quality – Complete all requested information and record in-situ water quality data in this section.
Sediment Substrate – Complete all requested information.

Inorganic and Organic Substrate Components - Complete all requested information.

Step 2: Take photographs at each location, and record photo numbers on the Physical Characterization/Water Quality Field Data Sheet, with a brief description of each photo.

3.1.2.5. General Procedures – Habitat Assessment Field Data Sheet (Low Gradient Streams)

Step 1: Complete the Habitat Assessment Field Data Sheet form for each site (front and back). All sampling locations are currently classified as low gradient. However, the field team shall verify if stream is high or low gradient prior to completing the corresponding forms. The forms should be completed by two (2) experienced personnel in order to reach consensus on the condition category score.

High-gradient or riffle/run prevalent streams are those in moderate to high gradient landscapes. Natural high-gradient streams have substrates primarily composed of coarse sediment particles (i.e., gravel or larger) or frequent coarse particulate aggregations along stream reaches. Low gradient or glide/pool prevalent streams are those in low to moderate gradient landscapes. Natural low-gradient streams have substrates of fine sediment or infrequent aggregations of more coarse (gravel or larger) sediment particles along stream reaches.

Header Information – Complete all requested information, except River Mile, Stream Class, and STORET#. Latitude and longitude must be included.

The following Habitat Parameters shall be completed for the entire stream width to complete the Condition Category within the designated range of Optimal, Suboptimal, Marginal, and Poor:

1. Epifaunal Substrate/Available Cover.
2. Pool Substrate Characterization.
3. Pool Variability.
4. Sediment Deposition.
5. Channel Flow Status.
6. Channel Alteration.
7. Channel Sinnosity.

Note: Write the Condition Category score in the corresponding Habitat Parameter column.

The following Habitat Parameters shall be completed for the Left Bank (LB) and Right Bank (RB) to complete the Condition Category within the designated range of Optimal, Suboptimal, Marginal, and Poor:

8. Bank Stability.
9. Vegetative Protection.
10. Riparian Vegetative Zone Width.

Note: Write the Condition Category score for each bank in the corresponding Habitat Parameter column.

Step 2: Complete the Total Score by adding all the individual Habitat Parameter Scores (including the individual scores for the Right Bank and Left Bank).

3.1.2.6 FLOW MEASUREMENTS

In-stream flow measurements will be completed for each site location.

Step 1: Complete the header information of the Discharge Calculation Field form.

Step 2: Measure the stream width and record on Discharge Calculation Field form.

Step 3: Divide the stream width into 2-foot increments (these will be the flow meter reading stations). During the collection of velocities, keep tape measure stretched across the stream either by attaching to a tree or utilization of another sampling technician.

Step 4: Using the Sontek Flow Tracker flow meter, connect flow meter to wading staff. Turn flow meter on and set to ft/sec.

Step 5: Wade into water, down stream of the flow meter, and proceed to first 2-foot mark. Using the wading staff, determine depth of water, and record on the field sheet.

Step 6: If the water depth is less than 2-feet, only one (1) velocity reading will be required at 0.60 depth (as measured from the top). To set the sensor at 0.60 depth, line up the foot scale on the sliding rod with the tenth scale at the top of the depth gauge rod. If, for example, the total depth is 1.7-feet, then line up the one (1) on the foot scale with the seven (7) on the tenth scale. This will set the sensor to 0.60 depth.

If the water depth is greater than 2-feet, two (2) velocity readings will be required at 0.20 and 0.80 depths. To set the sensor at 0.20 depth, multiply the total depth by two (2) and repeat the above procedure. To set the sensor to 0.80 depth divide the total depth by two and repeat the above procedure.

Record the velocity (or velocities) on the discharge sheet and continue to the next 2-foot increments. Using the same procedures listed above, continue until the opposite bank is reached.

Note: For streams that are to deep to wade, the inflatable Zodiac boat will be used to obtain flow readings. Use rope attached to each shore to stabilize the boat so that flow measurements may be obtained.

Step 7: Using the formulas included on the Discharge Calculation Field form, calculate the average velocity, cross-sectional area, and discharge volume for each flow meter reading station. Upon completion of the calculations for the

individual stations, sum the individual values to determine the total width, cross-sectional area, and discharge. The total average velocity is equal to the total discharge volume (CFS) divided by the total cross sectional area (ft^2).

3.1.3 End of Sample Day

Step 1. Review field notes and Chain of Custody for completeness.

Step 2. Submit original data sheets and field notes for duplication.

Step 3. Write down needed equipment repairs and report to supervisor.

3.1.4 End of Sample Event

Step 1. Log original data sheets/notes into OCDWEP Hardcopy File System.

Step 2. Submit duplicate copy of data sheets/notes for data entry.

3.1.5 Field Data Sheet Packet

The following items should be included in the field data sheet packet for this sampling activity.

- Station data sheet.
- Facility code/station description.
- Sample labels.
- Chain-of-custody forms (as appropriate).

Appendix C1 contains examples of the station data sheets and map of sampling stations.

4.0 ONONDAGA LAKE TRIBUTARY MAPPING

4.1 Procedures

Tributary mapping is conducted at forty-three (43) locations in the Onondaga Lake watershed; consisting of twenty-seven (27) sites on Onondaga Creek, nine (9) sites on Ley Creek, and seven (7) sites on Harbor Brook (refer to Appendix C.2 for a summary and map of the locations). The procedures utilize the Stream Visual Assessment Protocol (SVAP) conducted during low flow periods in August. The SVAP methodology was developed by the Natural Resource Conservation Service (NRCS) as a tool for evaluating stream condition. The protocol provides a basic level of stream evaluation, and is based primarily on the physical conditions within the assessment areas (stream segment extending approximately twelve (12) times the active stream width). The overall scoring system for the SVAP is as follows:

Condition	Overall Score
Poor	<6.0
Fair	6.1-7.4
Good	7.5-8.9
Excellent	>9.0

The NRCS protocol includes the visual physical assessment of ten (10) elements which are assigned a numerical score in the field, with the overall score comprising the sum of each individual element. The ten (10) elements include Channel Condition, Hydraulic Alteration, Riparian Zone, Bank Stability, Water Appearance, Nutrient Enrichment, Barrier to Fish Movement, In-stream Fish Cover, Pools, and Invertebrate Habitat. The SVAP form also includes a site diagram for historical comparison and future reference, and a observation of the suspected problems.

In addition, a rapid field assessment of the stream arthropods will be assessed at each of the forty-three (43) locations using the Family Level Biotic Index (FBI) provided the sites meet the habitat requirements for sampling (primarily flow). The FBI will be used to determine the relative degrees of impact from organic pollution. FBI's are based on the well known Hilsenhoff Biotic Index (HBI) but only identify organisms to the family level instead of to genus or species. The overall scoring system for the FBI evaluation is as follows:

FBI Score	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic Pollution Unlikely
3.76-4.25	Very Good	Possible Slight Organic Pollution
4.26-5.00	Good	Some Organic Pollution Probable
5.01-5.75	Fair	Fairly Substantial Pollution Likely
5.76-6.50	Fairly Poor	Substantial Pollution Likely
6.51-7.25	Poor	Very Substantial Pollution Likely
7.26-10.00	Very Poor	Severe Organic Pollution Likely

The procedures contained herein shall be considered general procedures. All of the field work for this effort will be completed by our consultant, Ecologic, LLC who completed the same effort in

August 2002. All SVAP evaluations will be performed in accordance with the procedures detailed in the *United States Department of Agriculture Natural Resources Conservation Service, National Water and Climate Center Technical Note 99–1, Stream Visual Assessment Protocol, issued December 1998*, and FBI evaluations in accordance with W. L. Hilsenhoff's *Rapid Field Assessment Of Organic Pollution With A Family-Level Biotic Index.*

5.0 CHRONOLOGY OF QAPP

The QAPP for the Macroinvertebrate Assessment Program is a living document in that it will be periodically updated to reflect changes in the monitoring program that are instituted to improve the efficiency of data collection, focus on a particular aspect of Macroinvertebrates. The periodic updating of the QAPP will provide a written record of sampling procedures over the entire life of the Macroinvertebrate Assessment Program. This April 2008 version of the QAPP is the fourth version of the document.

6.0 LITERATURE CITED

USDA NRCS *National Water and Climate Center Technical Note 99–1, Stream Visual Assessment Protocol, issued December 1998*.

USEPA *Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition (EPA 841-B-99-002), Barbour et al 1997.*

NYSDEC DOW *Quality Assurance Work Plan for Biological Stream Monitoring in New York State, June 2002.*

HILSENHOFF *Rapid Field Assessment Of Organic Pollution With A Family-Level Biotic Index. J. N. Am. Benthol So., 7, 65-68, 1998.*

OCDWEP *SOP for Macroinvertebrates - Lake and Tributaries (Doc. # BIO–004).*

OCDWEP *SOP for Tributary Habitat Assessment (Doc. # BIO–005).*

APPENDIX C1:

Field Data Packet For Onondaga Lake Tributary Macroinvertebrate Sampling and Habitat Assessment

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

WEATHER CONDITIONS	**Now**		**Past 24 hours**	**Has there been a heavy rain in the last 7 days?** ❑ Yes ❑ No
	❑	storm (heavy rain)	❑	
	❑	rain (steady rain)	❑	**Air Temperature**_____ ^{0} C
	❑	showers (intermittent)	❑	
	____%❑	%cloud cover	❑____%	**Other**_____
	❑	clear/sunny	❑	
SITE LOCATION/MAP	**Draw a map of the site and indicate the areas sampled (or attach a photograph)**			
STREAM CHARACTERIZATION	**Stream Subsystem** ❑ Perennial ❑ Intermittent ❑ Tidal			**Stream Type** ❑ Coldwater ❑ Warmwater
	Stream Origin ❑ Glacial ❑ Non-glacial montane ❑ Swamp and bog	❑ Spring-fed ❑ Mixture of origins ❑ Other_____		**Catchment Area**_____km^2

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES	**Predominant Surrounding Landuse** ❑ Forest ❑ Commercial ❑ Field/Pasture ❑ Industrial ❑ Agricultural ❑ Other _____ ❑ Residential **Local Watershed NPS Pollution** ❑ No evidence ❑ Some potential sources ❑ Obvious sources **Local Watershed Erosion** ❑ None ❑ Moderate ❑ Heavy
RIPARIAN VEGETATION (18 meter buffer)	**Indicate the dominant type and record the dominant species present** ❑ Trees ❑ Shrubs ❑ Grasses ❑ Herbaceous **dominant species present** _____
INSTREAM FEATURES	**Estimated Reach Length** _____m **Estimated Stream Width** _____m **Sampling Reach Area** _____m^2 **Area in km^2 (m^2x1000)** _____km^2 **Estimated Stream Depth** _____m **Surface Velocity (at thalweg)** _____m/sec **Canopy Cover** ❑ Partly open ❑ Partly shaded ❑ Shaded **High Water Mark** _____m **Proportion of Reach Represented by Stream Morphology Types** ❑ Riffle_____% ❑ Run_____% ❑ Pool_____% **Channelized** ❑ Yes ❑ No **Dam Present** ❑ Yes ❑ No
LARGE WOODY DEBRIS	**LWD** _____m^2 **Density of LWD** _____m^2/km^2 **(LWD/ reach area)**
AQUATIC VEGETATION	**Indicate the dominant type and record the dominant species present** ❑ Rooted emergent ❑ Rooted submergent ❑ Rooted floating ❑ Free floating ❑ Floating Algae ❑ Attached Algae **dominant species present** _____ **Portion of the reach with aquatic vegetation** _____%
WATER QUALITY	**Temperature**_____^{0} C **Specific Conductance**_____ **Dissolved Oxygen** _____ **pH** _____ **Turbidity** _____ **WQ Instrument Used** _____ **Water Odors** ❑ Normal/None ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Fishy ❑ Other_____ **Water Surface Oils** ❑ Slick ❑ Sheen ❑ Globs ❑ Flecks ❑ None ❑ Other_____ **Turbidity (if not measured)** ❑ Clear ❑ Slightly turbid ❑ Turbid ❑ Opaque ❑ Stained ❑ Other_____
SEDIMENT/ SUBSTRATE	**Odors** ❑ Normal ❑ Sewage ❑ Petroleum ❑ Chemical ❑ Anaerobic ❑ None ❑ Other_____ **Oils** ❑ Absent ❑ Slight ❑ Moderate ❑ Profuse **Deposits** ❑ Sludge ❑ Sawdust ❑ Paper fiber ❑ Sand ❑ Relict shells ❑ Other_____ **Looking at stones which are not deeply embedded, are the undersides black in color?** ❑ Yes ❑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			**ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)**		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVERMILE_____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
	6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
	10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

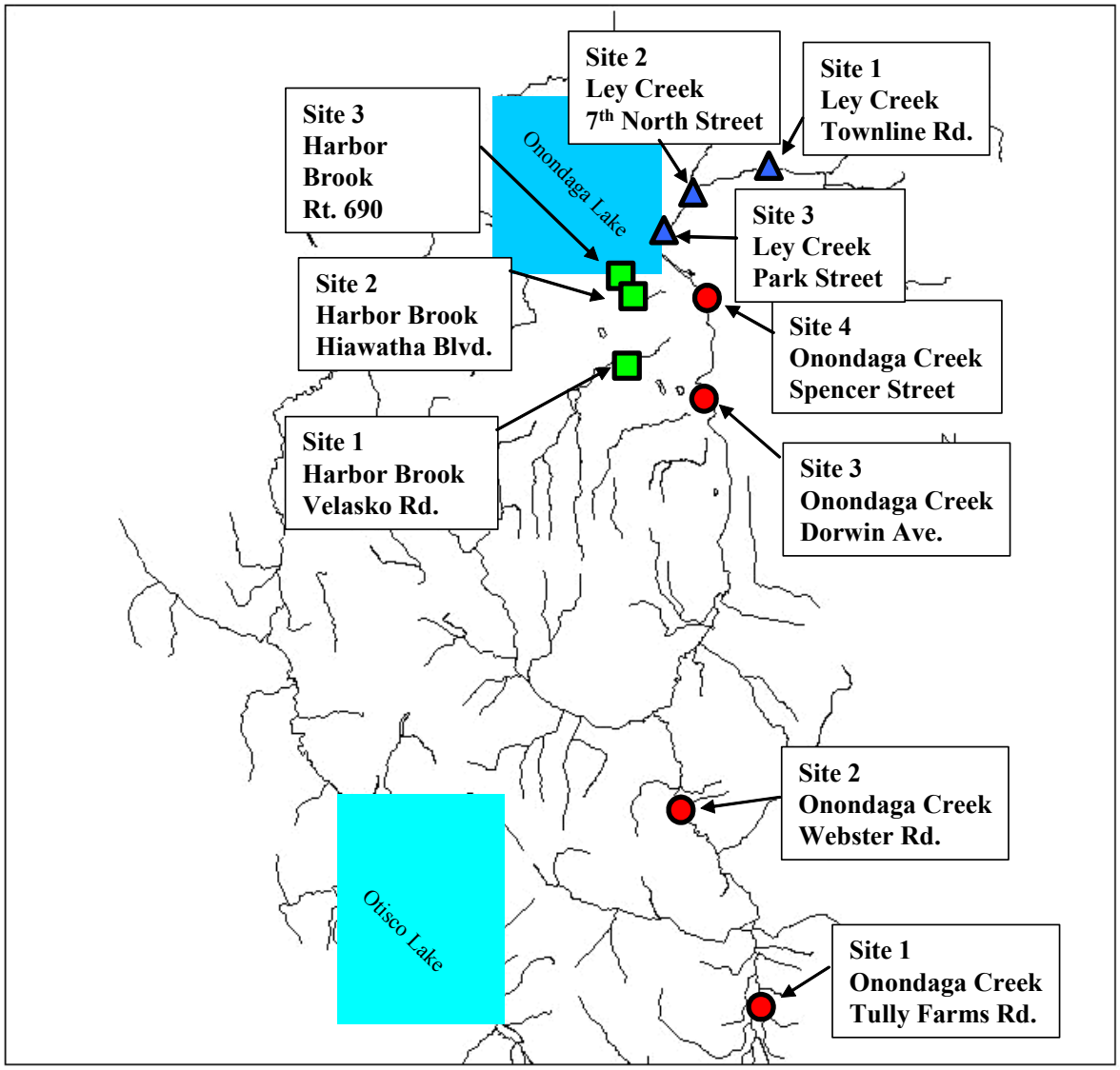
Sample Type (Circle One): Petite Ponar Kick Screen Jab Net

Facility Code:		Location and Site #	
Transect #		Replicate #	
Date Collected:		Sampler Initials:	
Date Sorted:		Sorter Initials:	
Date QA/QC:		QA/QC Initials:	

Chironomid	1st	2nd	
		Total	
Oligochete	1st	2nd	
		Total	
Amphipoda	1st	2nd	
		Total	
Coleoptera	1st	2nd	
		Total	
Isopoda	1st	2nd	
		Total	
Others	1st	2nd	
		Total	

Total Organisms Sorted Note: Tally Zebra Mussels Seperately.		
	By Sorter	**By QA/QC**

Zebra Mussels	1st	Remainder of Sample (or Quarter)
		Total



Legend

- Onondaga Creek sites
- Harbor Brook sites
- Ley Creek sites

Onondaga Lake Tributary Macroinvertebrate Monitoring Locations.

APPENDIX C2:

Field Data Packet For Onondaga Lake Tributary Mapping

Monitoring Locations and Coordinates

Site Designation	Location	Northing	Easting
Onondaga Creek			
OC1	Between Kirkpatrick and Spencer Streets	43 03 34.1	07 60 95.0
OC2	1st pedestrian walkway above Spencer Street	43 03 25.8	26 09 41.3
OC3	E. Adams Street	42 02 32.5	76 09 15.1
OC4	Midland Ave.	43 01 58.6	76 09 17.3
OC5	Newell St.	43 01 00.2	76 09 26.2
OC6	Rt. 173	43 00 06.5	76 08 55.2
OC7	Rosemont Drive	42 59 35.7	76 08 52.4
OC8	Dorwin Ave.	42 59 04.9	76 09 00.3
OC9	Onondaga Nation	42 57 53.2	76 08 57.9
OC10	Onondaga Nation	42 57 31.1	76 09 12.1
OC11	Onondaga Nation	42 57 14.4	76 09 19.2
OC12	Gibson Rd.	42 56 29.1	76 10 14.3
OC13	Above flood control dam	42 55 48.8	76 10 31.0
OC14	Onondaga Nation	42 55 19.9	76 10 25.0
OC15	Indian Rd.	42 54 50.0	76 10 15.0
OC16	Rt. 20	42 54 06.0	76 10 11.3
OC17	Turner Rd.	42 53 46.4	76 10 01.3
OC18	Bear Mt. Road	42 53 17.9	76 09 21.5
OC19	Webster Rd.	42 52 55.9	76 09 13.3
OC20	Nichols Rd.	42 52 19.2	76 08 27.7
OC21	Otisco Rd.	42 51 32.1	76 08 18.6
OC22	Parking area off Rt. 11A	42 50 21.7	76 08 07.8
OC23	Dirt Rd Crossing off Rt. 11A	42 49 50.3	76 08 18.0
OC24	Tully Farms Rd.	42 49 29.5	76 08 35.0
OC25	Fellows Falls	42 48 56.2	76 09 43.5
OC26	Impoundment at Rt. 80	42 49 07.5	76 10 54.3
OC27	Dirt Rd Crossing off Rt. 80	42 49 19.4	76 11 28.4
Harbor Brook			
HB1	Hiawatha Blvd.	43 03 23.1	76 11 07.4
HB2	Amy St.	43 02 25.1	76 10 29.4
HB3	Velasko Rd.	43 02 08.7	76 11 17.2
HB4	Grand Ave. Pump Station	43 01 56.9	76 12 15.5
HB5	Onondaga Blvd. @ Bellevue Manor	43 01 35.4	76 12 55.2
HB6	Rt. 173 @ St. George Church	43 01 02.2	76 12 57.6
HB7	Harris St.	43 00 23.9	76 13 34.5
Ley Creek			
LC1	Below Rt.81	43 04 28.7	76 10 25.6
LC2	7th North Street	43 05 10.1	76 09 44.5
LC3	LeMoyne Ave.	43 05 23.8	76 08 42.2
LC4	Townline Rd.	43 05 27.1	76 06 58.3
LC5	E. Molloy Rd.	43 05 52.1	76 05 51.9
LC6	Thompson Rd. @ OCM BOCES	43 05 52.1	76 05 51.9
LC7	Schuyler Rd.	43 07 01.6	76 04 24.9
LC8	Fly Rd.	43 07 02.2	76 03 41.1
LC9	Rt. 298	43 06 29.9	76 02 33.6

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name_____ Date _____

Stream name _____ Waterbody ID number _____

Reach location _____

_____

Ecoregion _____ Drainage area _____ Gradient_____

Applicable reference site _____

Land use within drainage (%): row crop _____ hayland _____ grazing/pasture _____ forest _____ residential _____

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today _____ Past 2-5 days _____

Active channel width _____ Dominant substrate: boulder _____ gravel _____ sand _____ silt _____ mud _____

Site Diagram

Assessment Scores

Channel condition ☐

Hydrologic alteration ☐

Riparian zone ☐

Bank stability ☐

Water appearance ☐

Nutrient enrichment ☐

Barriers to fish movement ☐

Instream fish cover ☐

Pools ☐

Invertebrate habitat ☐

Score only if applicable

Canopy cover ☐

Manure presence ☐

Salinity ☐

Riffle embeddedness ☐

Marcroinvertebrates Observed (optional) ☐

Overall score		<6.0	**Poor**
(Total divided by number scored)		6.1-7.4	**Fair**
	_____	7.5-8.9	**Good**
		>9.0	**Excellent**

Suspected causes of observed problems_____

_____

_____

_____

Recommendations_____

_____

_____

_____

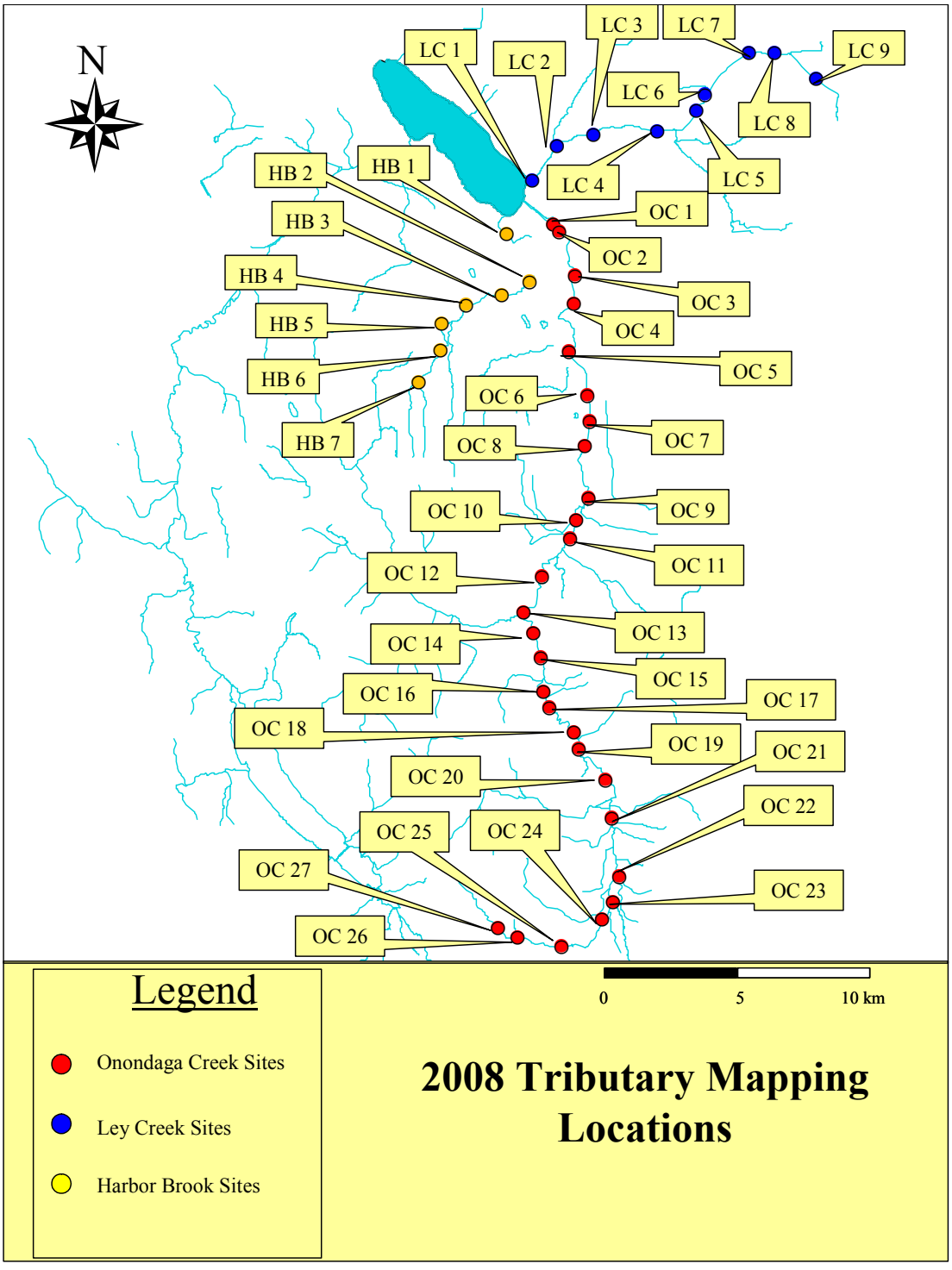
_____

_____

_____

_____

_____


N
LC 1
LC 2
LC 3
LC 7
LC 9
LC 6
LC 8
LC 4
LC 5
HB 2
HB 1
HB 3
OC 1
OC 2
HB 4
OC 3
HB 5
OC 4
OC 5
HB 6
OC 6
HB 7
OC 8
OC 7
OC 10
OC 9
OC 11
OC 12
OC 13
OC 14
OC 15
OC 16
OC 17
OC 18
OC 19
OC 21
OC 20
OC 22
OC 25
OC 24
OC 27
OC 23
OC 26
Legend
Onondaga Creek Sites
Ley Creek Sites
Harbor Brook Sites
0
5
10 km
2008 Tributary Mapping Locations

Back to Index

EcoLogic Memorandum

TO: Onondaga County Department of Water Environment Protection
FROM: Liz Moran and Kerry Thurston
RE: Data quality review, 2008 AMP Data
REVISION DATE: August 18, 2009

The following analytical data quality review was completed on the 2008 data in the Onondaga database (Onondaga.mdb) obtained from the County on March 26, 2009. The review consisted of these elements:

1. Rinsate and field blanks

   No issues noted except for detectable concentrations of alkalinity and TDS; water supply is implicated.

2. Field duplicates

   Fifty-six field duplicate RPD exceeded 20% and the absolute difference between the sample and duplicate results exceeded 2x the MRL. These were submitted for re-evaluation to the laboratory; the laboratory verified all results.

3. Charge Balance summary

   The laboratory re-evaluated the major cations and anions for seven samples where charge balance exceeded 20%; high solids were cited as the source of interference in the balance calculation for most of the samples.

4. Database non-detects check

   The laboratory reviewed sample results (326 for metals, 720 for solids and 429 for other parameters) for possible data entry errors in reporting results less than the MRL. The laboratory reported "All 'Less Than' reported values are correct. Most differences are due to sample dilutions or are results from the contract laboratory (CES)".

5. Verify parameters for limnological reasonableness

   The laboratory verified four samples where total dissolved phosphorus results were greater than the soluble reactive phosphorus results. The laboratory attributed cloudy or unfiltered sample conditions for the biased high results for two of these four samples. There was no commentary provided to explain the other two samples.

6. Review for outliers

   No data were rejected as outliers.

7. Low-level mercury results

   Data are acceptable.

This memorandum concludes with a Summary of Recommended Data Actions, and Data Qualification in the AMP database.

1. Rinsate and field blanks

The AMP calls for preparing rinsate blanks of the cleaned sampling equipment prior to its use. Results of these samples are used to infer whether any field samples are potentially compromised by the presence of contaminants in the sampling equipment.

Screen for analytes of interest

The blanks in the database were screened for detectable concentrations. Twelve parameters were detected in the blanks:

alkalinity (ALK-T)	ammonia-N (NH_3-N)
biochemical oxygen demand (BOD_5)	chloride
nitrate (NO_3)	total dissolved solids (TDS)
soluble reactive phosphorus (SRP)	total organic carbon (TOC)
total Kjeldahl nitrogen (TKN)	total solids (TS)
total organic carbon filtered (TOC-F)	total volatile solids (TVS)

There were blank detections for low-level mercury as well, and these are discussed in the low-level mercury section of this memorandum.

Compare results of rinsate blanks to MRL by parameter

Measured concentrations were compared to the MRL as listed in **Attachment 1**. Nine of the 12 parameters were measured in rinsate blanks at concentrations less than or equal to twice the MRL; these parameters were considered present at "trace" concentrations. ***No further action is recommended.***

Parameters present in rinsate blank samples at concentrations <2x MRL:

Parameter	Minimum Reportable Limit		Range and Total Number of Blank Detections <2x MRL
	MRL	2x MRL	min – max (count)
BOD_5 (mg/l)	2	4	4 (1)
Chloride (mg/l)	1	2	2 (3); verified by lab
NH3-N	0.01	0.02	0.011 (1)
SRP (mg/l)	0.001	0.002	0.001 (2) 0.002 (1)
TKN (mg/l)	0.15	0.30	0.15 (1)
TOC (mg/l)	0.5	1	0.87 (1)
TOC-F (mg/l)	0.5	1	0.84 (1)
TS (mg/l)	1	2	2 (1)
TVS (mg/l)	1	2	2 (1)

The rinsate blank results were also screened against a criterion of 5x the MRL. Two parameters had blank concentrations above this value, as summarized below.

Parameters with blank concentrations >5x MRL:

Parameter	Minimum Reportable Limit		Range and Total Number of Blank Detections >5x MRL
	MRL	5x MRL	min – max (count)
ALK-T (mg/l)	1	5	6 – 8 (3)
TDS (mg/l)	10*	50	10 – 74 (6)

*The MRL for TDS is 1 mg/l if 1000 ml of sample is used. All AMP blanks were 100 ml, so the MRL for these blanks is 10 mg/l.

Detectable concentrations of total alkalinity in the rinsate blanks were first identified in 2005; the laboratory switched from dishwasher to hand-rinsing of the sample bottles to address the issue. In addition, in an effort to eliminate any potential of residual contamination from the sample containers, the total alkalinity sample containers are soaked with deionized water for 24 hours during sampling event preparation by a WW Technician prior to each use. New sampling bottles are now purchased annually or on an as-needed basis. An upgrade in the laboratory water treatment system to reverse osmosis is planned for 2009.

In 2008, 2% of rinsate blanks had alkalinity results greater than five times the MRL. This result implicates the laboratory water as a source of alkalinity. Similarly, the water supply is considered the cause of the occasional elevated concentrations of dissolved solids in rinsate blanks. The detected levels of alkalinity and TDS in the blanks do not affect data usability because ambient concentrations in the Onondaga watershed are substantially higher. The efficacy of the reverse osmosis treatment system in reducing the concentrations of total alkalinity and dissolved solids should continue to be examined.

No further action is recommended

2. Field duplicates

As outlined in the Standard Operating Procedure for the completing the data quality review, field blanks are screened using a two step process.

(1) identify all with RPD>20%

(2) Calculate: is the absolute value of the difference greater than 2x the MRL? If so, investigate. If not, no further action.

Field duplicates were evaluated using relative percent difference (RPD) of the results and the absolute difference of the sample and duplicate results. RPD greater than 20% are considered

outside of quality control limits. In some cases, the RPD are greater than 20% because concentrations are at or near the detection level for some parameters; therefore, field duplicates with RPD greater than 20% were also evaluated for absolute difference greater than 2x the MRL. Where the absolute difference was less than 2x the MRL, no further action was required; where the absolute difference was greater than 2x the MRL, additional investigation was warranted.

For 2008, 149 duplicate results had RPDs greater than 20%; of those, 56 also had absolute difference values greater than 2x MRL. Duplicate results with RPDs exceeding 20% were re-evaluated by the laboratory. The laboratory confirmed all sample results. A list of the field duplicate RPDs exceeding 20% where the absolute difference was also greater than 2x the MRL is included as **Attachment 2**.

This issue should be further evaluated with the sampling team.

3. Charge Balance Summary

The charge balance results were evaluated against an upper limit of 20% for field samples and duplicates from the lake and the tributaries.

	Tributaries	**Lake**
Average	4.62%	2.52%
Median	3.29%	2.33%
N Exceeds 20%	7	0

The laboratory confirmed the major cations and anions results for seven samples where charge balance exceeded 20% (listed below),. The laboratory also noted that several samples had unusually high solids which will interfere with the analytical measurements. The tributary samples were collected on February 5, during high flow and turbidity conditions. ***No further action is recommended.***

Sample No.	Source	Date	Charge Balance (%)	TSS (mg/l)
2801315	Crk-Harbor Brook @ Hiawatha	2/5/2008	30.9	276
2801329	Crk-Harbor Brook @ Hiawatha - Duplicate	2/5/2008	21.6	293
2801317	Crk-Ley Creek @ Park Street	2/5/2008	21.5	258
2801327	Crk-Onondaga Creek @ Adams Street	2/5/2008	20.8	446
2801324	Crk-Onondaga Creek @ Dorwin Ave.	2/5/2008	30.0	450
2801316	Crk-Onondaga Creek @ Kirkpatrick	2/5/2008	23.8	240
2803824	Crk-Spencepatrick Spring Wellpoint	4/2/2008	21.0	na

na – indicates TSS was not analyzed for this sample.

4. Database non-detects check

Non-detect data in the database are reported as less than the MRL. As a QC check to identify possible typographic errors, the "less than MRL" values were compared against the published MRL list for the 2008 AMP. The result of this evaluation is reported with respect to three categories: metals, solids, and other parameters.

□ ***Metals*** – These metals were reported at levels less than the MRL, but the MRL does not match the DWEP laboratory's official values. The MRLs for metals varies depending on whether concentration procedures were used. When there are relatively few samples for which the MRL does not match the reported value, this may be an indicator of a data entry error. The laboratory verified that the reported sample results were accurate.

No further action is recommended.

Parameter (units)	Reported Result	N Samples	Published MRL	Laboratory response
Ag (mg/l)	<0.001	4	0.0125	All "Less Than" reported values are correct. Most differences are due to sample dilutions or are results from the contract laboratory (CES).
Ca (mg/l)	<1.25	148	1	
Cd (mg/l)	<0.001	1	0.0008	
	<0.002	3	0.0008	
	<0.005	7	0.0008	
Cr (mg/l)	<0.002	3	0.01	
Hg (mg/l)	<0.0002	4	0.00002	
Mg (mg/l)	<0.125	148	0.1	
Pb (mg/l)	<0.03	7	0.002	
Se (mg/l)	<0.005	1	0.002	

Ag = silver; Ca = calcium; Cd = cadmium; Cr = chromium; Hg = mercury; Mg = magnesium; Pb = lead; Se = selenium

□ ***Solids*** – The MRL for solids (TS, TVS, TSS, VSS and TDS) is 1 mg/l. Numerous results were reported ranging from <2 to <10. Given the high number of sample results with elevated detection levels, it is likely these are not data entry errors. However, for completeness, the laboratory verified that the sample results were reported correctly.

No further action is recommended.

Parameter (units)	Reported Result	N Samples	Published MRL	Laboratory response
*TS (mg/l)	<10	22	1	All "Less Than" reported values are correct. Most differences are due to sample dilutions or are results from the contract laboratory (CES).
*TVS (mg/l)	<10	20	1	
TSS (mg/l)	<2	65	1	
	<4	336	1	
	<5	1	1	
VSS (mg/l)	<2	101	1	
	<4	25	1	
*TDS (mg/l)	<10	150	1	

TS = total solids; TVS = total volatile solids; TSS = total suspended solids; VSS = volatile suspended solids; TDS = total dissolved solids

*Note that all MRL's are based upon a sample volume of 1000 mL. Most blanks and samples are run at a smaller sample volume and therefore the MRL would be higher than the stated value.

□ ***Other parameters*** – Five other parameters were reported in the database with "less than MRL" values that did not match the published MRLS. The number of these samples was generally low, raising the possibility of data entry error. The laboratory verified that the sample results were reported correctly.

No further action is recommended.

Parameter (units)	Reported Result	N Samples	Published MRL	Laboratory response
CN-A (mg/l)	<0.003	24	0.005	All "Less Than" reported values are correct. Most differences are due to sample dilutions or are results from the contract laboratory (CES)
CN-Cl2 (mg/l)	<0.003	22	0.005	
CN-T (mg/l)	<0.005	4	0.003	
	<0.03	1	0.003	
ECOLI (count/100ml)	<2	1	1	
FCOLI-MF (count/100ml)	<4	3	Jan-May = 2; May-Dec = 1	
	<5	117		
	<10	45		
	<20	9		
	<100	1		
K (mg/l)	<0.025	20	0.02	
Na (mg/l)	<4	148	3	
TP (mg/l)	<0.05	5	0.003	

CN-A = amendable cyanide; CN-Cl2 = chlorinated cyanide ; CN-T = total cyanide ; ECOLI = E. Coliform; FCOLI-MF = fecal coliforms; K = potassium; Na = sodium; TP = total phosphorus

5. Verify parameters for limnological reasonableness

Several parameters were evaluated for limnological reasonableness for each sample, using the data from tributaries and the lakes. These evaluations were:

- Soluble reactive phosphorus (SRP) should be less than or equal to total phosphorus (TP)
- Total dissolved phosphorus (TDP) should be greater than or equal to SRP
- TDP should be less than or equal to TP
- Ammonia as nitrogen (NH_3-N) should be less than or equal to total Kjeldahl nitrogen (TKN)
- NH3-N should be less than or equal to filtered TKN
- Biochemical oxygen demand (BOD_5) should be greater than or equal to carbonaceous biochemical oxygen demand ($CBOD_5$)
- Plot TP versus TSS
- Plot TP versus chlorophyll-α (lake only)

Overall, the comparisons were reasonable, with the following exceptions:

□ *Comparison of TPD and SRP results*: Four samples exhibited TDP results less than the SRP results. The laboratory confirmed that there was no reporting error.

Sample No	Source	Date 2008	TDP (mg/l)	SRP (mg/l)	Laboratory Response
2802453	Crk-Onondaga Creek @ Water Street	03/04	0.019	0.078	SRP & TDP samples are cloudy and have sediment in sample. *ECOLOGIC RECOMMENDATION: REJECT*
2803671	Trib-Onon Creek @ Hiawatha-Duplicate	09/13	0.094	0.101	SRP (non-certified container) appears to be unfiltered, causing a biased high result. *ECOLOGIC RECOMMENDATION: REJECT*
2810463	River Lake Outlet #1 Top	09/11	0.027	0.031	No response. *ECOLOGIC RECOMMENDATION: REPORT BOTH AS 0.03 MG/L.*
2811062	Trib-Onon Creek @ Rt20	10/28	0.02	0.028	No Response. *ECOLOGIC RECOMMENDATION: REJECT*

□ *Comparison of TP and TSS results*: Several samples exhibited high TSS and/or TP, relative to the other sample results obtained in 2008 from the same locations. This comparison is relevant to the tributary samples and the lake's upper waters.

- In the tributaries, samples from Onondaga Creek, Harbor Brook and Ley Creek collected on 2/5/08 exhibited unusually high values of both TSS and TP. Provisional discharge measured at the Onondaga Creek Spencer St. location was 570 cfs daily average, up from 230 cfs daily average the day before, and well above the 37-year average for the date. These high TSS and TP values are considered to be a result of high flows, storm water runoff, and potential CSO influence.

  No action recommended.

Sample Date 2/5/2008:

Site	Sample No.	TSS (mg/l)	TP (mg/l)
Crk-Onondaga Creek @ Dorwin Ave.	2801324	450	0.176
Crk-Harbor Brook @ Hiawatha	2801315	276	0.284
Crk-Harbor Brook @ Hiawatha - Duplicate	2801329	293	0.255
Crk-Harbor Brook @ Velasko Road	2801323	566	0.265
Crk-Ley Creek @ Park Street	2801317	258	0.506

- Samples collected on 9/14/08 at the Onondaga Creek @ Hiawatha sampling station had unusually high TP concentrations relative to the TSS concentrations. The provisional discharge measured at the Onondaga Creek Spencer St. location (56 cfs daily average) was comparable to the 37-year average for this date.

  Recommendation: examine data to see if wastewater indicator parameters are high for this site and date.

Sample Date 9/14/2008:

Site	Sample No.	TSS (mg/l)	TP (mg/l)
Trib-Onon Creek @ Hiawatha	2803706	27	0.485
Trib-Onon Creek @ Hiawatha-Duplicate	2803707	24	0.50
Comparison Statistics for Onondaga Creek @ Hiawatha (samples selected with TSS concentrations between 20 and 30 mg/l).	*N Samples*	22	22
	Average	23.6	0.10
	Range	21-29	0.05-0.22

- Samples collected on 10/28 from Onondaga Creek @ Dorwin sample station showed relatively high values for both TP and TSS. The provisional discharge at the Onondaga Creek Spencer St. location was 303 cfs daily average on 10/28, which was a sharp increase from 81 cfs the day before.

  No action recommended.

Sample Date 10/28/2008:

Site	Sample No.	TSS (mg/l)	TP (mg/l)
Trib-Onon Creek @ Dorwin	2811063	480	0.417

6. Review for Outliers

The 2008 AMP data were reviewed for outliers in the tributaries and in the lake. Due to the nature of the data set, this review for outliers was conducted using different methods for tributaries and the lake:

Tributaries: The tributary data are influenced in large part by stream flow. Therefore, the 2008 concentration data for the monitored parameters were compared to the 10-year average (1998-2007) plus two standard deviations. Measurements outside the two standard deviation range were considered outliers. Data from the following sample locations were evaluated:

Tributary	Station
Onondaga Creek	Dorwin and Kirkpatrick
Harbor Brook	Velasko and Hiawatha
Ley Creek	Park St.
Ninemile Creek	Rt. 48
Tributary 5A	
East Flume	

Other tributary sampling locations in 2008, which were not compared to 10-year averages due to shorter periods of record, were:

Tributary	Station	Period of record
Onondaga Creek*	Adams St.	2006-2008
	Dickerson St.	2008
	Elmhurst Ave.	2008
	Gibson	2008
	Hitchings Rd. (West Branch)	2008
	Plum St.	2008
	Rt. 20	2006-2008
	Spencer St.	2000-2008
	Tallman Ave.	2008
	Tully Farms Rd. (South)	2008
	Walton St.	2008
	Water St.	2007-2008
	West Genesee St.	2008
	West Kirkpatrick St.	2008
	West Onondaga St.	2008
Harbor Brook	Bellevue Ave.	2008
	Delaware St.	2008
	Fowler H.S.	2008
	Onondaga Rd.	2008
Sawmill Creek	Onondaga Lake Park	2003-2008
Bloody Brook	Onondaga Lake Park	2003-2008

*These Onondaga Creek stations were sampled in 2008 as part of the Dry Weather Project, and as such were not included in the long-term comparison.

Onondaga Lake: Histograms and temporal plots were constructed for analytical parameters of greatest interest – dissolved oxygen (DO), chlorophyll-α, Phaeophytin-α, Secchi depth, fecal coliforms (FCOLI), E. coli (ECOLI), phosphorus (TP, SRP and TDP), nitrogen (NH3-N, nitrate NO_3 and nitrite NO2). These parameters were evaluated separately for depths 0-3 meters, 6 meters, and 9-18 meters at both North and South Deep. Outliers were identified by visual assessment of the plots.

The results of the outlier reviews are discussed below.

a. Tributaries

Several parameters were identified with results greater than the defined screening values (10-year average plus two standard deviations). Many of these were found to occur on sample dates with high or low flow (based on preliminary USGS flow data):

- **February 5** was a high flow date for Onondaga Creek, Ninemile Creek, Ley Creek and Harbor Brook and Tributary 5A. Parameters that exceeded the screening values on this date are listed below. Not all parameters exceeded the screening values for all tributaries. ***No action is recommended.***

Parameter concentrations exceeding 10-year average plus two standard deviations on February 5, 2008.

Parameter	KIRKPAT*	DORWIN*	VELASKO	HIAWATHA*	RT48	PARK*	TRIB5A
BOD5 (mg/l)		5	4		5		
Fe (mg/l)		12.5	7.15	7.35		7.03	5.58
Mn (mg/l)	0.378	0.358	0.15	0.147		0.238	0.22
NO2 (mg/l)	0.13	0.12	0.08	0.09		0.08	0.12
ORG-N (mg/l)		0.98		1.21		1.32	
TKN (mg/l)		1.06		1.38		1.59	
TP (mg/l)	0.346		0.265	0.284		0.506	
TSS (mg/l)	240	450	566	276		258	156

*Charge balance for these locations exceeded 20% and was attributed to unusually high TSS.

The 2008 data were also screened against the winter (December, January and February) 10-year average plus two standard deviations to refine evaluation of parameters found in road de-icing materials.

- At the Onondaga Creek Dorwin monitoring location, conductivity and salinity exceeded the winter screening values on February 5. The charge balance for this date was 30%. The high charge balance was verified by the laboratory, and attributed to unusually high solids in the sample.

  No action recommended.

- At the Tributary 5A monitoring location, chloride and TDS exceeded the winter screening values on January 9 (charge balance = 3.59%), while conductivity and salinity exceeded winter screening values on February 5 (charge balance = 5.04%). The charge balance verifies that these results are not the result of laboratory analytical issues.

  No action recommended.

b. *Onondaga Lake North and South basins*

No action recommended.

7. Low-level mercury results

The County subcontracts low-level mercury and methyl mercury analyses. In 2008, samples were collected on three dates – April 9, August 12 and October 22 - and analyzed by Frontier Geosciences, Inc.

There was a missing field blank result for August 12 in the ONONDAGA.MDB database. According to the Chain of Custody, seven samples were submitted for analysis, including one equipment blank and a field blank; six sample results were reported to the ONONDAGA.MDB database. The missing blank is likely "Lake Field Blk (Teflon Dunker)" and was identified on the Chain of Custody as "97395-01, 02-1". The laboratory was contacted and provided the missing results.

The data packages for low-level mercury were reviewed, and the results presented below.

- Sample receipt Notes:
    - April 09, 2008: cooler temperature 2.4°C; broken bottle caps were noted. Lake 18m South (2804125) sample bottle for total Hg had a broken cap so the sample volume could not be used; therefore, the smaller bottle volume designated for methyl analysis was used for both total and methyl Hg analyses.

      Sample 2804126 was crossed off the Chain of Custody; however, the hand-written note adjacent to the mark was not legible.

      The laboratory also noted on the Chain of Custody that no duplicate was collected due to the broken bottle caps; however, laboratory duplicate results for RPDs were reported.

    - August 12, 2008: cooler temp 6.7°C; no other notations. These samples were received outside the temperature of 4°C required to be maintained for the Methyl Mercury samples, therefore the County laboratory flagged these samples with an "N" flag ("Variance from quality control or quality assurance criteria, however result is considered acceptable under established NELAC guidelines") in the LIMS database. The total mercury samples are not temperature-sensitive.

- October 22, 2008: cooler temp 4.8°C; one of two containers submitted for Lake 18m South Duplicate (sample A-872-016) arrived broken, so a split was taken from the remaining container (sample A-872-015). These samples were received outside the temperature of 4°C required to be maintained for the Methyl Mercury samples, therefore the County laboratory flagged these samples with an "N" flag ("Variance from quality control or quality assurance criteria, however result is considered acceptable under established NELAC guidelines") in the LIMS database. The total mercury samples are not temperature-sensitive.

- Holding times were met.
- Calibration verification was within QC limits.
- Matrix Spike and Matrix spike duplicates were within QC limits
- Method, Prep and Calibration Blanks were within QC limit, although the following items were noted:

Sample Date, 2008	Analyte	Blank Type	Comments
April 9	Total Hg	Prep	Prep blanks were reported "U", with two additional notes: • QB-04: "The blank was preserved to 2% BrCl rather than 1%. The control limit for blanks preserved to greater than 1% BrCl is the preservation percentage multiplied by the MRL." • QB-05: "The blank was preserved to 2% BrCl rather than 1%. The control limit for blanks preserved to greater than 1% BrCl is the preservation percentage multiplied by the MRL.
		Initial/ Continuing	For initial and continuing calibration blanks, there were three results found, ranging from 0.02 to 0.03 ng/l, that were less than the MRL (0.50 ng/l) and were not flagged "U". The laboratory did not provide additional commentary.
	Methyl Hg	Initial/ Continuing	Two of four results were flagged "U", two results were not so flagged (0.001 and 0.003 ng/l) reported below the MRL (0.045 ng/l). The laboratory did not provide additional commentary

Sample Date, 2008	Analyte	Blank Type	Comments
August 12	Total Hg:	Initial/ Continuing	Three of five initial and calibration blanks were reported "U". The remaining two were reported at 0.02 ng/l (MRL = 0.50 ng/l). The laboratory did not provide additional commentary.
	Methyl Hg	Initial/ Continuing	Two of five initial and continuing calibration blanks were reported "U". Reported concentrations in the other three ranged from 0.0003 to 0.002 ng/l (MRL = 0.045 ng/l). The laboratory did not provide additional commentary.
October 22	Total Hg	Prep	Prep blanks were reported "U", with additional notes: • QB-04: "The blank was preserved to 2% BrCl rather than 1%. The control limit for blanks preserved to greater than 1% BrCl is the preservation percentage multiplied by the MRL." • QB-05: "The blank was preserved to 3% BrCl rather than 1%. The control limit for blanks preserved to greater than 1% BrCl is the preservation percentage multiplied by the MRL." • QB-06: "The blank was preserved to 5% BrCl rather than 1%. The control limit for blanks preserved to greater than 1% BrCl is the preservation percentage multiplied by the MRL." The reported value was 1.04 ng/l (MRL = 0.52 ng/l).
		Initial/ Continuing	Four of six initial and continuing calibration blanks were reported "U", the remaining two were reported at 0.03 and 0.04 ng/l (MRL = 0.50 ng/L). The laboratory did not provide additional commentary.
	Methyl Hg	Initial/ Continuing	Two of five initial and continuing calibration blanks were reported "U", the remaining three ranged from 0.0007 to 0.002 ng/l (MRL = 0.045 ng/l). The laboratory did not provide additional commentary.

- Laboratory spike blanks were within QC limits except:

    - August 12, 2008 – One RPD (26.7%) for methyl Hg exceeded the QC limit (25%), and was flagged by the laboratory as follows:

        "The RPD value for the LCS/LCSD was outside of acceptance limits. Batch QC acceptable based on matrix duplicate and MS/MSD RPD values within control limits".

- Laboratory duplicates were within QC limits except:
    - August 12 – Methyl Hg "Dup1" RPD (26.4%) exceeded the RPD limit (25%) and was flagged by the laboratory as follows:

      "RPD and/or RSD value exceeded control limit. Sample concentrations less than 10 times the reporting limit and the difference between the QC values were less than 2 times the reporting limit."

- MRLs – The laboratory identified the following MRLs for the 2008 data, noting where sample-specific MRLs were used:

Date	Parameter	MRL	Sample-specific MRL
4/09/08	Total mercury	0.50	Lake 3m North - 1.10 (dilution 2)
	Methyl mercury	0.050	none; dilution noted as 1.25
8/12/08	Total mercury	0.50	none; dilution noted as 1.0
	Methyl mercury	0.050	none; dilution noted as 1.25
10/22/08	Total mercury	0.50	none; flagged FB-1631 – see below for blanks evaluation
	Methyl mercury	0.050	none; dilution noted as 1.25

- Rinsate and Field Blanks were non-detect except for:
    - October 22 – For blank "Lake Field Blk (Teflon Dunker)", the total Hg concentration reported was 0.65 ng/l (MRL = 0.50 ng/l). The laboratory flagged all the sample results as follows:

      "Required equipment/field/filter blank not submitted by the client. The sample has been analyzed according to 1631E, but does not meet 1631E criteria."

      Review of the Chain of Custody submitted to the laboratory revealed that the blanks were in fact identified as blanks in the "Matrix" column on the Chain. In a communication between Onondaga County DWEP and Frontier Geosciences, the laboratory indicated that the flag was incorrectly entered and has submitted a "revised" report on April 7, 2009 for these samples.

Conclusion: low level mercury data are usable.

8. Summary of Recommended Data Actions

Based on the results of this evaluation, EcoLogic recommends that the following sample results be rejected or modified because the SRP result exceeded the TDP result:

- **REJECTED**: SRP and TDP analytical results for sample 2802453 (Crk-Onondaga Creek @ Water Street) collected on March 4, 2008.
- **REJECTED**: SRP and TDP analytical results for sample 2803671 (Trib-Onon Creek @ Hiawatha-Duplicate) collected on September 13, 2008.
- **MODIFIED**: Report the SRP and TDP analytical results for sample 2810463 (River Lake Outlet #1 Top) collected on September 11, 2008, rounded to 0.03 mg/l.
- **REJECTED**: SRP and TDP analytical results for sample 2811062 (Trib-Onon Creek @ Rt20) collected on October 28, 2008

9. Data Qualification

The laboratory began annotating AMP analytical results with standard data qualifiers (flags) as defined by NELAC, as of January 1, 2004 (**Attachment 3**). In addition, the laboratory provided QC comments for samples.

"P" qualified data - Laboratory data qualified with "P" do not meet all internal laboratory QC requirements, and are therefore considered unacceptable for quality assurance criteria. No data were flagged "P" in the water quality database.

"V" qualified data - The laboratory data qualified with "V" are reported as estimates due to variance from quality assurance or control criteria. All the results with a "V" were removed from the database as per the discussions at the April 2, 2009, QA/QC review of 2008 AMP Data Meeting. These records are presented in **Attachment 4**.

"N" qualified data - The laboratory data qualified with "N" varied from quality control or assurance criteria, however the result is considered acceptable under established NELAC guidelines. These records are presented in **Attachment 5**.

"J" qualified data - The laboratory data qualified with "J" indicates that the reported value is greater than the MRL but below the PQL, result is considered estimated. No data were flagged "J" in the water quality database.

"U" qualified data - The laboratory data qualified with "U" indicates that the measured value is below the MRL, and it is possible that MRL/PQL elevation is dependent upon analyzed mass, volume, and/or dilutions. Value reported is the <MRL. These records are presented in **Attachment 6**.

Attachments

Attachment 1 – Ambient Monitoring Program 2008 - Parameter Minimum Reportable Limits Summary

Attachment 2 – List of 2008 samples and field duplicates with Relative Percent Difference (RPD) exceeding 20% and absolute difference is greater than 2x the MRL

Attachment 3 – Summary of NELAC Data Qualifiers, Implementation Date: January 1, 2004

Attachment 4 – Sample results qualified "V" - Reported value is considered estimate due to variance from quality assurance or control criteria.

Attachment 5 – Sample results qualified "N" - Variance from quality control or assurance criteria, however result is considered acceptable under established NELAC guidelines.

Attachment 6 – Sample results qualified "U" - Indicates that the measured value is below the MRL.

Attachment 1. Ambient Monitoring Program 2008 - Parameter Minimum Reportable Limits Summary

	Database parameters - 2008			Analytical Procedures for Water Quality Analyses			
				2007 (Jan-May)		2008 (May-Dec)	
Parameter	**Code**	**Units**	**Method**	**Method**	**MRL**	**Method**	**MRL**
Bio Oxy Demand 5-day	BOD5	mg/L	3	2:(5210)	2	2:(5210)	2
Carbon. Bio Oxy Demand 5-day	CBOD5	mg/L	48	2:(5210 B)	2	2:(5210 B)	2
Total Alk as CaCO3	ALK-T	mg/L	37	1:(310.1)	1	1:(310.1)	1
Total Organic Carbon	TOC	mg/L	140; 146	1:(415.1)	0.5	1:(415.1)	0.5
Total Organic Carbon - Filtered	TOC-F	mg/L	141; 146	1:(415.1)	0.5	1:(415.1)	0.5
Total Inorganic Carbon	TIC	mg/L	146	1:(415.1)	0.5	1:(415.1)	0.5
Total Kjeldahl Nitrogen as N	TKN	mg/L	138	3:(10-107-06-2-D)	0.15	3:(10-107-06-2-D)	0.15
Total Kjeldahl Nitrogen as N, filtered	TKN-F	mg/L	139	3:(10-107-06-2-D)	0.15	3:(10-107-06-2-D)	0.15
Ammonia Nitrogen as N	NH3-N	mg/L	125; 506	3:(10-107-06-1-B)	0.03	2:(4500-NH3-N)	0.01
Organic Nitrogen as N	ORG-N	mg/L	447	3:(10-107-06-2-D)	0.05	3:(10-107-06-2-D)	0.01
Nitrate as N	NO3	mg/L	118	3:(10-107-04-1-B)	0.01	3:(10-107-04-1-C)	0.01
Nitrite as N	NO2	mg/L	118	3:(10-107-04-1-B)	0.01	3:(10-107-04-1-C)	0.01
Total Phosphorus -Manual	TP	mg/L	5; 354; 617	1:(365.2)	0.003	1:(365.2)	0.003
Total Dissolved Phosphorus	TDP	mg/L	134	1:(365.2)	0.003	1:(365.2)	0.003
Soluble Reactive Phosphorus	SRP	mg/L	308	1:(365.2)	0.001	2:(4500-P E)	0.001
Silica	SiO2	mg/L	129	1:(370.1)	0.2	1:(370.1)	0.2
Sulfates	SO4	mg/L	130	1:(375.4)	10	1:(375.4)	10
Sulfide	Sulfide	mg/L	127	1:(376.1)	0.2	1:(376.1)	0.2
Total Solids***	TS	mg/L	143	1:(160.3)	10	1:(160.3)	10
Total Volatile Solids	TVS	mg/L	144	1:(160.4)	1	1:(160.4)	1
Total Suspended Solids	TSS	mg/L	4	1:(160.2)	1	1:(160.2)	1
Total Volatile Suspended Solids	VSS	mg/L	38	1:(160.4)	1	1:(160.4)	1
Total Dissolved Solids***	TDS	mg/L	142	1:(160.1)	10	1:(160.1)	10

Attachment 1. Ambient Monitoring Program 2008 - Parameter Minimum Reportable Limits Summary

	Database parameters - 2008			Analytical Procedures for Water Quality Analyses			
				2007 (Jan-May)		2008 (May-Dec)	
Parameter	**Code**	**Units**	**Method**	**Method**	**MRL**	**Method**	**MRL**
Arsenic - furnace	As	mg/L	470; 509	4:(200.9)	0.002	4:(200.9)	0.002
Beryllium	Be	mg/L	509	Contract Lab		Contract Lab	
Total Cadmium	Cd	mg/L	161; 500; 509	4:(200.9)	0.0008	4:(200.9)	0.0008
Total Calcium	Ca	mg/L	35	1:(215.1)	1	1:(215.1)	1
Total Chromium	Cr	mg/L	161; 356; 509	4:(200.7)	0.010(0.0025)*	4:(200.7)	0.010(0.0025)*
Hexavalent Chromium	Cr-Hex	mg/L	69	2:(3500CrD)	0.005	2:(3500CrD)	0.005
Chloride	Chloride	mg/L	68	3:(10-117-07-1-B)	2	3:(10-117-07-1-B)	1
Residual Chlorine	CL2-Res-field	mg/L	206	1:(330.4)	0.1	1:(330.4)	0.1
Total Copper	Cu	mg/L	161; 356; 509	4:(200.7)	0.0125(0.0031)*	4:(200.7)	0.0125(0.0031)*
Ammendable Cyanide	CN-A	mg/L	73	3:(10-204-00-1-A)	0.005	3:(10-204-00-1-A)	0.005
Chlorinated Cyanide	CN-Cl2	mg/L	73	3:(10-204-00-1-A)	0.005	3:(10-204-00-1-A)	0.005
Total Cyanide	CN-T	mg/L	73; 75; 399	3:(10-201-00-1-A)	0.003	3:(10-204-00-1-A)	0.003
Total Iron	Fe	mg/L	85; 537	4:(200.7)	0.05	4:(200.7)	0.05
Total Lead - furnace	Pb	mg/L	95; 161; 509	4:(200.9)	0.002	4:(200.9)	0.002
Total Magnesium	Mg	mg/L	88	1:(242.1)	0.1	1:(242.1)	0.1
Total Manganese	Mn	mg/L	89	4:(200.7)	0.025	4:(200.7)	0.025
Total Molybdenum	Mo	mg/L	311	Contract Lab		Contract Lab	
Total Mercury (Cold Vapor)	Hg	mg/L	86; 389; 509	1:(245.2)	0.00002	1:(245.2)	0.00002
Total Mercury (low-level)**	Hg	ng/l	393	EPA Method 1631	0.5	EPA Method 1631	0.5
Methyl Mercury (low-level)**	Hg-methyl	ng/l	295	EPA Method 1630	0.05	EPA Method 1630	0.05
Antimony	Sb	mg/L	509	Contract Lab		Contract Lab	
Selenium - furnace	Se	mg/L	472; 509	4:(200.9)	0.002	4:(200.9)	0.002
Total Sodium	Na	mg/L	92	1:(273.1)	3	1:(273.1)	3
Total Nickel	Ni	mg/L	161; 356; 509	4:(200.7)	0.015(0.00375)*	4:(200.7)	0.015(0.00375)*
Potassium	K	mg/L	87	1:(258.1)	0.02	1:(258.1)	0.02
Thallium	Tl	mg/L	509	Contract Lab		Contract Lab	
Total Silver	Ag	mg/L	17; 509	4:(200.7)	0.0125	4:(200.7)	0.0125
Total Zinc	Zn	mg/L	161; 356; 509	4:(200.7)	0.025(0.00625)*	4:(200.7)	0.025(0.00625)*
Turbidity	Turbidity	NTU	145	2:(2130B)	0.1	2:(2130B)	0.1

Attachment 1. Ambient Monitoring Program 2008 - Parameter Minimum Reportable Limits Summary

	Database parameters - 2008			Analytical Procedures for Water Quality Analyses			
				2007 (Jan-May)		2008 (May-Dec)	
Parameter	**Code**	**Units**	**Method**	**Method**	**MRL**	**Method**	**MRL**
Hardness	Hardness	mg/L	238	4:(215.1 & 424.1)	3	4:(215.1 & 424.1)	3
Conductivity - field	COND-field	umHos/cm	286	2:(2510B)	-	2:(2510B)	-
Dissolved Oxygen - field	DO-field	mg/L	286	1:(360.1)	0.1	1:(360.1)	0.1
pH - field	pH-field	Std Units	286	1:(150.1)	-	1:(150.1)	-
Temperature - field	Temp-field	°C	133; 286	1:(170.1)	-	1:(170.1)	-
Phenol	Phenol	mg/L	126; 433	3:(10-210-00-1-B)	0.015	3:(10-210-00-1-A)	0.010
Phaeophytin a	Phaeophytin-a	mg/m3	155	2:(10200 H.2)	0.2	2:(10200 H.2)	0.2
Chlorophyll a	Chlorophyll-a	mg/m3	155	2:(10200 H.2)	0.2	2:(10200 H.2)	0.2
Enterococci	ECOCCI	cells/100ml	565	6:(1040)	1.0 MPN	6:(1040)	1.0 MPN
E. Coliform	ECOLI	cells/100ml	525	2:(9223 B)	1.0 MPN	2:(9223 B)	1.0 MPN
Fecal Coliform	FCOLI-MF	cells/100ml	80	2:(9222 D)	2	2:(9222 D)	2
Total Coliform	TCOLI	cells/100ml	616	2:(9222 B)	1	2:(9222 B)	1

Notes:

Methods listed are applicable for all matrices of water, wastewater, and surface waters.

* Indicates method has a lower level of detection due to sample concentration.

**Started in August 2000 for all AMP samples.

1: Indicates USEPA Methods for Chemical Analysis of Water and Waste 1979
2: Indicates Standard Methods (18th Edition)
3: Indicates Lachat Instruments QuickChem Methods: Approved for use by USEPA - NYSDOH – ELAP
4: Indicates USEPA "Methods for the Determination of Metals in Environmental Samples" Supplement 1, May 1994
5: USEPA Microbiological Methods Manual 1996
6: Approved for use by ELAP

*** All MRL's are based upon a sample volume of 1000 mL. Most blanks and samples are run at a smaller sample volume and therefore the MRL would be higher than the stated value. For example, the MRL for TS and TDS at 1000 mL is 1 mg/l, but for sample volume of 100 mL the MRL is 10 mg/l.

Contract Lab - indicates the analyses were conducted by a contract laboratory (in 2008, Frontier Geosciences for low-level mercury, and Certified Environmental Services for other analytes) using unidentified method and/or reporting limits.

N/A - Not applicable; MPN – Most Probable Number

Attachment 2. List of 2008 samples and field duplicates with Relative Percent Difference (RPD) exceeding 20% and absolute difference is greater than 2x the MRL.

Source	Date (2008)	Sample No.	Duplicate No.	Parameter	Units	Sample Conc	Dup Conc	RPD	Abs Diff	2x MRL
Effluent										
Metro Final Effluent	1/9	2800253	2800372	TKN	mg/L	1.72	1.38	21.9	0.34	0.3
Metro Final Effluent	2/21	2802031	2802193	TSS	mg/L	8	4	66.7	4	4
Metro Final Effluent	11/5	2813327	2813342	TKN	mg/L	2.23	1.72	25.8	0.51	0.3
Lake-North										
Lake 6m North	4/9	2804105	2804106	ORG-N	mg/L	0.29	0.39	29.4	0.1	0.1
Lake 6m North	6/17	2806757	2806762	TVS	mg/L	228	298	26.6	70	2
Lake 6m North	11/18	2813953	2813958	ORG-N	mg/L	0.31	0.39	22.9	0.08	0.02
Lake Tube Composite (North)	11/18	2813947	2813948	Phaeophytin-a	mg/m3	0.43	0.96	76.3	0.53	0.4
Lake-South										
Lake Tube Composite (South)	3/27	2803437	2803438	Chlorophyll-a	mg/m3	3.74	4.81	25.0	1.07	0.4
Lake Tube Composite (South)	3/27	2803437	2803438	Phaeophytin-a	mg/m3	1.87	0.8	80.1	1.07	0.4
Lake Tube Composite (South)	4/9	2804116	2804117	Phaeophytin-a	mg/m3	1.17	<0.2	**141.6**	0.97	0.4
Lake Tube Composite (South)	4/22	2804602	2804603	Phaeophytin-a	mg/m3	0.75	<0.2	**115.8**	0.55	0.4
Lake Tube Composite (South)	6/3	2806164	2806165	Phaeophytin-a	mg/m3	<0.2	0.75	**115.8**	0.55	0.4
Lake Tube Composite (South)	6/17	2806750	2806751	Phaeophytin-a	mg/m3	<0.2	0.8	**120.0**	0.6	0.4
Lake Tube Composite (South)	9/9	2810277	2810278	Chlorophyll-a	mg/m3	3.2	4.27	28.6	1.07	0.4
Lake Tube Composite (South)	9/9	2810277	2810278	Phaeophytin-a	mg/m3	0.91	<0.2	**127.9**	0.71	0.4
Lake Tube Composite (South)	9/23	2810922	2810923	Phaeophytin-a	mg/m3	1.28	2.24	54.5	0.96	0.4
Lake Tube Composite (South)	10/9	2811705	2811706	Phaeophytin-a	mg/m3	1.17	1.98	51.4	0.81	0.4
Lake Tube Composite (South)	10/22	2812611	2812612	Chlorophyll-a	mg/m3	3.2	4.27	28.6	1.07	0.4
Lake Tube Composite (South)	10/22	2812611	2812612	Phaeophytin-a	mg/m3	1.66	0.96	53.4	0.7	0.4
Lake 18m South	10/22	2812838	2812839	Hg	ng/l	12	8.49	34.3	3.51	1
Lake 6m South	11/6	2813273	2813278	ORG-N	mg/L	0.44	0.54	20.4	0.1	0.02
Lake 6m South	12/3	2814458	2814459	ORG-N	mg/L	0.42	0.64	41.5	0.22	0.02
Lake Upper Mixed Layer South	12/3	2814464	2814465	Turbidity	NTU	1.42	1.15	21.0	0.27	0.2
River										
River Buoy #316 Top	7/24	2808185	2808187	Phaeophytin-a	mg/m3	3.95	2.83	33.0	1.12	0.4
River Buoy #316 Bottom	7/24	2808186	2808188	Chlorophyll-a	mg/m3	3.2	4.27	28.6	1.07	0.4
River Buoy #316 Top	8/7	2808962	2808964	Chlorophyll-a	mg/m3	5.34	4.27	22.3	1.07	0.4

Source	Date (2008)	Sample No.	Duplicate No.	Parameter	Units	Sample Conc	Dup Conc	RPD	Abs Diff	2x MRL
River Buoy #316 Top	8/7	2808962	2808964	ORG-N	mg/L	0.56	0.45	21.8	0.11	0.02
River Buoy #316 Bottom	8/7	2808963	2808965	Chlorophyll-a	mg/m3	2.67	1.6	50.1	1.07	0.4
River Buoy #316 Bottom	8/7	2808963	2808965	Phaeophytin-a	mg/m3	1.07	2.14	66.7	1.07	0.4
River Buoy #316 Top	8/21	2809482	2809484	Phaeophytin-a	mg/m3	4.17	5.23	22.6	1.06	0.4
River Buoy #316 Bottom	8/21	2809483	2809485	Chlorophyll-a	mg/m3	8.54	6.41	28.5	2.13	0.4
River Buoy #316 Bottom	8/21	2809483	2809485	Phaeophytin-a	mg/m3	4.17	5.55	28.4	1.38	0.4
River Buoy #316 Top	9/11	2810436	2810438	Phaeophytin-a	mg/m3	3.63	2.88	23.0	0.75	0.4
River Buoy #316 Bottom	9/11	2810437	2810439	Chlorophyll-a	mg/m3	8.54	4.27	66.7	4.27	0.4
River Buoy #316 Bottom	9/11	2810437	2810439	Phaeophytin-a	mg/m3	7.9	5.45	36.7	2.45	0.4
Harbor Brook										
Crk-Harbour Brook @ Hiawatha	7/22	2808151	2808165	ORG-N	mg/L	0.29	0.16	57.8	0.13	0.02
Crk-Harbor Brook @ Hiawatha	9/30	2811332	2811346	TSS	mg/L	5	9	57.1	4	2
Crk-Harbor Brook @ Hiawatha	12/10	2814719	2814733	ORG-N	mg/L	0.5	0.34	38.1	0.16	0.02
Crk-Harbor Brook @ Hiawatha	12/10	2814719	2814733	TSS	mg/L	52	40	26.1	12	2
Crk-Harbor Brook @ Velasko Road	5/27	2805893	2805899	ORG-N	mg/L	0.26	0.33	23.7	0.07	0.02
Crk-Harbor Brook @ Velasko Road	10/30	2812935	2812941	ORG-N	mg/L	0.18	0.23	24.4	0.05	0.02
Ley Creek										
Crk-Ley Creek @ Park Street	8/19	2809440	2809452	ORG-N	mg/L	0.5	0.32	43.9	0.18	0.02
Crk-Ley Creek @ Park Street	8/19	2809440	2809452	TSS	mg/L	25	20	22.2	5	2
Metro Effluent										
Crk-Metro Effluent	2/19	2801865	2801869	ORG-N	mg/L	0.28	0.06	**129.4**	0.22	0.1
Onondaga Creek										
Crk-Onondaga Creek @ Tully Farms Road (South)	11/5	2813290	2813444	ECOLI	count/100	2520	1545	48.0	975	2
Crk-Onondaga Creek @ Tully Farms Road (South)	11/5	2813290	2813444	FCOLI-MF	count/100	1500	1200	22.2	300	2
Crk-Onondaga Creek @ Tully Farms Road (South)	11/5	2813290	2813444	TSS	mg/L	13	18	32.3	5	2
Crk-Onondaga Creek @ West Genesee Street	10/7	2811732	2811740	FCOLI-MF	count/100	1300	2800	73.2	1500	2
Crk-Onondaga Creek @ West Onondaga Street	10/24	2812719	2812720	FCOLI-MF	count/100	40	64	46.2	24	2
Trib-Onon Creek @ Hiawatha	9/13	2803688	2803689	TSS	mg/L	11	8	31.6	3	2
Trib-Onon Creek @ Hiawatha	9/13	2803670	2803671	SRP	mg/L	0.061	0.101	49.4	0.04	0.002
Trib-Onon Creek @ Hiawatha	10/26	2810997	2810998	SRP	mg/L	0.012	0.009	28.6	0.003	0.002
Trib-Onon Creek @ Hiawatha	10/28	2811051	2811052	TKN	mg/L	0.21	0.56	90.9	0.35	0.3

Source	Date (2008)	Sample No.	Duplicate No.	Parameter	Units	Sample Conc	Dup Conc	RPD	Abs Diff	2x MRL
Tributary 5a										
Crk-Tributary 5a @ State Fair Blvd	4/15	2804377	2804385	TSS	mg/L	6	9	40.0	3	2
Crk-Tributary 5a @ State Fair Blvd	8/5	2808793	2808794	TSS	mg/L	31	24	25.5	7	2
Outlet										
Crk-Onondaga Lake Outlet 2 ft.	6/10	2806496	2806507	Phaeophytin-a	mg/m3	<0.2	0.69	**110.1**	0.49	0.4

Attachment 3. Summary of NELAC Data Qualifiers, Implementation Date: January 1, 2004

Qualifier	NELAC Designation
N	Variance from quality control or assurance criteria, however result is considered acceptable under established NELAC guidelines
V	Reported value is considered estimate due to variance from quality assurance or control criteria
J	Indicates that the reported value is greater than the MRL but below the PQL, result is considered estimated
U	Indicates that the measured value is below the MRL. Possible MRL/PQL elevation dependent upon analyzed mass, volume, and/or dilutions. Value reported is the <MRL
P	Unacceptable for quality assurance criteria

Attachment 4. Sample results qualified "V" - Reported value is considered estimate due to variance from quality assurance or control criteria.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	Remarks
Tributary Samples						
Crk Metro Effluent						
2805895	789	Crk-Metro Effluent	05/27/08	BOD5 (mg/L)	2	Two consecutive sets of QC standards failed the acceptance criteria.
2808805	789	Crk-Metro Effluent	08/05/08	BOD5 (mg/L)	3	Two consecutive sets of QC standards failed the acceptance criteria.
Bloody Brook						
2808787	794	Crk-Bloody Brk @ Onondaga Lake Parkway	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Sawmill Crk						
2801371	796	Crk-Sawmill Crk @ Onondaga Lake Rec. Trail	02/05/08	CN-T (mg/L)	<0.003	Sample acceptance criteria not met.
2808788	796	Crk-Sawmill Crk @ Onondaga Lake Rec. Trail	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Onondaga Creek						
2800794	882	Crk-Onondaga Creek @ Kirkpatrick	01/22/08	Fe (mg/L)	0.377	Sample acceptance criteria not met.
2800794	882	Crk-Onondaga Creek @ Kirkpatrick	01/22/08	Mn (mg/L)	0.0362	Sample acceptance criteria not met.
2800794	882	Crk-Onondaga Creek @ Kirkpatrick	01/22/08	Mg (mg/L)	30.1	Sample acceptance criteria not met.
2800794	882	Crk-Onondaga Creek @ Kirkpatrick	01/22/08	Na (mg/L)	502	Sample acceptance criteria not met.
2800794	882	Crk-Onondaga Creek @ Kirkpatrick	01/22/08	Ca (mg/L)	148	Sample acceptance criteria not met.
2802441	882	Crk-Onondaga Creek @ Kirkpatrick	03/04/08	TKN (mg/L)	0.80	Sample acceptance criteria not met.
2802441	882	Crk-Onondaga Creek @ Kirkpatrick	03/04/08	TP (mg/L)	0.160	Sample acceptance criteria not met.
2802441	882	Crk-Onondaga Creek @ Kirkpatrick	03/04/08	NH3-N (mg/L)	0.110	Sample acceptance criteria not met.
2805886	882	Crk-Onondaga Creek @ Kirkpatrick	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808789	882	Crk-Onondaga Creek @ Kirkpatrick	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2802449	910	Crk-Onondaga Creek @ Dorwin Ave.	03/04/08	TKN (mg/L)	0.63	Sample acceptance criteria not met.
2802449	910	Crk-Onondaga Creek @ Dorwin Ave.	03/04/08	TP (mg/L)	0.144	Sample acceptance criteria not met.
2802449	910	Crk-Onondaga Creek @ Dorwin Ave.	03/04/08	NH3-N (mg/L)	0.105	Sample acceptance criteria not met.
2804541	910	Crk-Onondaga Creek @ Dorwin Ave.	04/21/08	TDS (mg/L)	462	Equipment Blank had > MRL result for TDS.
2805894	910	Crk-Onondaga Creek @ Dorwin Ave.	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808798	910	Crk-Onondaga Creek @ Dorwin Ave.	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2814360	910	Crk-Onondaga Creek @ Dorwin Ave.	12/01/08	TIC (mg/L)	55.4	Analysis past hold time - instrument out of service.
2802452	1939	Crk-Onondaga Creek @ Adams Street	03/04/08	TKN (mg/L)	0.53	Sample acceptance criteria not met.
2802452	1939	Crk-Onondaga Creek @ Adams Street	03/04/08	TP (mg/L)	0.130	Sample acceptance criteria not met.
2802452	1939	Crk-Onondaga Creek @ Adams Street	03/04/08	NH3-N (mg/L)	0.070	Sample acceptance criteria not met.
2805897	1939	Crk-Onondaga Creek @ Adams Street	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808802	1939	Crk-Onondaga Creek @ Adams Street	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2802453	1940	Crk-Onondaga Creek @ Water Street	03/04/08	TKN (mg/L)	0.58	Sample acceptance criteria not met.
2802453	1940	Crk-Onondaga Creek @ Water Street	03/04/08	TP (mg/L)	0.140	Sample acceptance criteria not met.
2802453	1940	Crk-Onondaga Creek @ Water Street	03/04/08	NH3-N (mg/L)	0.090	Sample acceptance criteria not met.
2805898	1940	Crk-Onondaga Creek @ Water Street	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808803	1940	Crk-Onondaga Creek @ Water Street	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2814362	1940	Crk-Onondaga Creek @ Water Street	12/01/08	TIC (mg/L)	56.8	Analysis past hold time - instrument out of service.
Harbor Brook						
2813173	902	Crk-Harbor Brook @ Hiawatha	11/07/08	ECOLI (#/100)	100	Samples read past 24 hour incubation time limit.
2813173	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	50	Samples read past 24 hour incubation time limit.
2813173	902	Crk-Harbor Brook @ Hiawatha	11/07/08	TCOLI (#/100)	4800	Samples read past 24 hour incubation time limit.

Attachment 4. Sample results qualified "V" - Reported value is considered estimate due to variance from quality assurance or control criteria.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	Remarks
2813173	902	Crk-Harbor Brook @ Hiawatha	11/07/08	ECOCCI (#/100)	12	Samples read past 24 hour incubation time limit.
2813176	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	100	Samples read past 24 hour incubation time limit.
2813179	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	100	Samples read past 24 hour incubation time limit.
2813184	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	45	Samples read past 24 hour incubation time limit.
2813187	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	100	Samples read past 24 hour incubation time limit.
2813190	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	182	Samples read past 24 hour incubation time limit.
2813193	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	145	Samples read past 24 hour incubation time limit.
2813196	902	Crk-Harbor Brook @ Hiawatha	11/07/08	FCOLI-MF (#/100)	150	Samples read past 24 hour incubation time limit.
2805885	902	Crk-Harbour Brook @ Hiawatha	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808791	902	Crk-Harbour Brook @ Hiawatha	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2805893	911	Crk-Harbor Brook @ Velasko Road	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808799	911	Crk-Harbor Brook @ Velasko Road	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2813171	911	Crk-Harbor Brook @ Velasko Road	11/07/08	ECOLI (#/100)	370	Samples read past 24 hour incubation time limit.
2813171	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	1000	Samples read past 24 hour incubation time limit.
2813171	911	Crk-Harbor Brook @ Velasko Road	11/07/08	TCOLI (#/100)	3840	Samples read past 24 hour incubation time limit.
2813171	911	Crk-Harbor Brook @ Velasko Road	11/07/08	ECOCCI (#/100)	101	Samples read past 24 hour incubation time limit.
2813174	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	230	Samples read past 24 hour incubation time limit.
2813177	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	1540	Samples read past 24 hour incubation time limit.
2813182	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	450	Samples read past 24 hour incubation time limit.
2813185	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	350	Samples read past 24 hour incubation time limit.
2813188	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	260	Samples read past 24 hour incubation time limit.
2813191	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	210	Samples read past 24 hour incubation time limit.
2813194	911	Crk-Harbor Brook @ Velasko Road	11/07/08	FCOLI-MF (#/100)	230	Samples read past 24 hour incubation time limit.
2813172	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	ECOLI (#/100)	50	Samples read past 24 hour incubation time limit.
2813172	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	191	Samples read past 24 hour incubation time limit.
2813172	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	TCOLI (#/100)	4960	Samples read past 24 hour incubation time limit.
2813172	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	ECOCCI (#/100)	48	Samples read past 24 hour incubation time limit.
2813175	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	189	Samples read past 24 hour incubation time limit.
2813178	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	189	Samples read past 24 hour incubation time limit.
2813183	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	280	Samples read past 24 hour incubation time limit.
2813186	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	270	Samples read past 24 hour incubation time limit.
2813189	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	153	Samples read past 24 hour incubation time limit.
2813192	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	182	Samples read past 24 hour incubation time limit.
2813195	1958	Crk-Harbor Brook @ Fowler High School	11/07/08	FCOLI-MF (#/100)	191	Samples read past 24 hour incubation time limit.
East Flume						
2805892	903	Crk-Allied East Flume-Over Weir	05/27/08	BOD5 (mg/L)	4	Two consecutive sets of QC standards failed the acceptance criteria.
2808792	903	Crk-Allied East Flume-Over Weir	08/05/08	BOD5 (mg/L)	3	Two consecutive sets of QC standards failed the acceptance criteria.
Tributary 5A						
2804377	904	Crk-Tributary 5a @ State Fair Blvd	04/15/08	BOD5 (mg/L)	16	Past hold time.
2804864	904	Crk-Tributary 5a @ State Fair Blvd	04/29/08	TKN (mg/L)	0.53	TKN reprepped 5/12/2008 from the conventional container.
2805891	904	Crk-Tributary 5a @ State Fair Blvd	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808793	904	Crk-Tributary 5a @ State Fair Blvd	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Ninemile Creek						
2805890	905	Crk-Nine Mile Creek @ Lakeland Rt 48	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.

Attachment 4. Sample results qualified "V" - Reported value is considered estimate due to variance from quality assurance or control criteria.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	Remarks
2808795	905	Crk-Nine Mile Creek @ Lakeland Rt 48	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Ley Creek						
2805887	908	Crk-Ley Creek @ Park Street	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808796	908	Crk-Ley Creek @ Park Street	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Lake Samples						
2804092	918	Lake 0m South	04/09/08	pH-field (Std Units)	7.86	Probe appears not to have been submerged.
2804092	918	Lake 0m South	04/09/08	DO-field (mg/L)	12.06	Probe appears not to have been submerged.
2804092	918	Lake 0m South	04/09/08	Temp-field (°C)	5.10	Probe appears not to have been submerged.
2804092	918	Lake 0m South	04/09/08	COND-field (umHos/cm)	98	Probe appears not to have been submerged.
2804092	918	Lake 0m South	04/09/08	Salinity-field (ppt)	0.05	Probe appears not to have been submerged.
2805641	918	Lake 0m South	05/20/08	COND-field (umHos/cm)	41	Probe appears not to have been submerged.
2805641	918	Lake 0m South	05/20/08	Salinity-field (ppt)	0.02	Probe appears not to have been submerged.
2808515	918	Lake 0m South	07/29/08	TIC (mg/L)	32.6	Analysis past hold time - instrument out of service.
2808521	924	Lake 18m South	07/29/08	TIC (mg/L)	49.9	Analysis past hold time - instrument out of service.
2810266	918	Lake 0m South	09/09/08	Temp-field (°C)	22.36	Probe appears not to have been submerged.
2810266	918	Lake 0m South	09/09/08	COND-field (umHos/cm)	21	Probe appears not to have been submerged.
Lake Outlet Samples						
2803027	1906	Crk-Onondaga Lake Outlet 2 ft.	03/18/08	TP (mg/L)	0.033	Sample acceptance criteria not met.
2803027	1906	Crk-Onondaga Lake Outlet 2 ft.	03/18/08	TKN (mg/L)	0.53	Sample acceptance criteria not met.
2803027	1906	Crk-Onondaga Lake Outlet 2 ft.	03/18/08	ORG-N (mg/L)	0.34	Sample acceptance criteria not met.
2803027	1906	Crk-Onondaga Lake Outlet 2 ft.	03/18/08	NH3-N (mg/L)	0.192	Sample acceptance criteria not met.
2805888	1906	Crk-Onondaga Lake Outlet 2 ft.	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808800	1906	Crk-Onondaga Lake Outlet 2 ft.	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2805889	1907	Crk-Onondaga Lake Outlet 12 ft.	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808801	1907	Crk-Onondaga Lake Outlet 12 ft.	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
Quality Control Samples						
2804385	904	Crk-Tributary 5a @ State Fair Blvd - Duplicate	04/15/08	BOD5 (mg/L)	16	Past hold time.
2804539	990	Crk-Blank Churn (Crew A)	04/21/08	NO2 (mg/L)	<0.01	
2805899	911	Crk-Harbor Brook @ Velasko Road - Duplicate	05/27/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808514	917	Lake Equip. Blk (Pump)	07/29/08	TIC (mg/L)	<0.5	Analysis past hold time - instrument out of service.
2808522	920	Lake 6m South - Duplicate	07/29/08	TIC (mg/L)	32.9	Analysis past hold time - instrument out of service.
2808784	990	Crk-Blank Churn (Crew A)	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808785	888	Crk-Blank Dunker Churn (Crew B)	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808786	901	Crk-Blank SS Pail (Crew A)	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2808794	904	Crk-Tributary 5a @ State Fair Blvd-Duplicate	08/05/08	BOD5 (mg/L)	<2	Two consecutive sets of QC standards failed the acceptance criteria.
2810863	990	Crk-Blank Churn (Crew A)	09/22/08	NO2 (mg/L)	<0.01	
2810864	901	Crk-Blank SS Pail (Crew A)	09/22/08	NO2 (mg/L)	<0.01	
2813180	999	Crk-Harbor Brook Duplicate 5	11/07/08	FCOLI-MF (#/100)	210	Samples read past 24 hour incubation time limit.
2813181	999	Crk-Harbor Brook Duplicate 6	11/07/08	FCOLI-MF (#/100)	173	Samples read past 24 hour incubation time limit.
2813984	990	Crk-Blank Churn (Crew A)	11/17/08	NO2 (mg/L)	<0.01	Past hold time.
2813985	901	Crk-Blank SS Pail (Crew A)	11/17/08	NO2 (mg/L)	<0.01	Past hold time.
2814358	990	Crk-Blank Churn (Crew A)	12/01/08	TIC (mg/L)	<0.5	Analysis past hold time - instrument out of service.
2814359	901	Crk-Blank SS Pail (Crew A)	12/01/08	TIC (mg/L)	<0.5	Analysis past hold time - instrument out of service.

Attachment 5. Sample results qualified "N" - Variance from quality control or assurance criteria, however result is considered acceptable under established NELAC guidelines.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	REMARKS
Tributary Samples						
Crk Metro Effluent						
2801400	630	Crk-Metro By Pass	02/05/08	BOD5 (mg/L)	56	
2801325	789	Crk-Metro Effluent	02/05/08	SO4 (mg/L)	105	
2801325	789	Crk-Metro Effluent	02/05/08	BOD5 (mg/L)	3	
Bloody Brook						
2801370	794	Crk-Bloody Brk @ Onondaga Lake Parkway	02/05/08	BOD5 (mg/L)	5	
2802533	794	Crk-Bloody Brk @ Onondaga Lake Parkway	03/04/08	Cd (mg/L)	0.0029	Concentration procedure used for some metals.
Sawmill Crk						
2800390	796	Crk-Sawmill Crk @ Onondaga Lake Rec. Trail	01/09/08	As (mg/L)	<0.002	Concentration procedure used for some metals.
2801371	796	Crk-Sawmill Crk @ Onondaga Lake Rec. Trail	02/05/08	BOD5 (mg/L)	3	
Onondaga Creek						
2801316	882	Crk-Onondaga Creek @ Kirkpatrick	02/05/08	BOD5 (mg/L)	5	
2806494	882	Crk-Onondaga Creek @ Kirkpatrick	06/10/08	NH3-N (mg/L)	0.414	
2810680	909	Crk-Onondaga Creek @ Spencer St	09/16/08	K (mg/L)	2.71	
2810680	909	Crk-Onondaga Creek @ Spencer St	09/16/08	Na (mg/L)	211	
2801324	910	Crk-Onondaga Creek @ Dorwin Ave.	02/05/08	BOD5 (mg/L)	5	
2810201	910	Crk-Onondaga Creek @ Dorwin Ave.	09/08/08	Na (mg/L)	192	
2813986	910	Crk-Onondaga Creek @ Dorwin Ave.	11/17/08	TIC (mg/L)	59.3	
2814360	910	Crk-Onondaga Creek @ Dorwin Ave.	12/01/08	NH3-N (mg/L)	0.017	
2801327	1939	Crk-Onondaga Creek @ Adams Street	02/05/08	BOD5 (mg/L)	6	
2801328	1940	Crk-Onondaga Creek @ Water Street	02/05/08	BOD5 (mg/L)	4	
2807564	1940	Crk-Onondaga Creek @ Water Street	07/15/08	Na (mg/L)	1550	
2815245	1940	Crk-Onondaga Creek @ Water Street	12/29/08	TP (mg/L)	0.008	TP<TDP due to matrix interference. Duplicate out of control.
Harbor Brook						
2801315	902	Crk-Harbour Brook @ Hiawatha	02/05/08	BOD5 (mg/L)	6	
2813525	902	Crk-Harbor Brook @ Hiawatha	11/12/08	Cd (mg/L)	<0.0008	Concentration procedure used for some metals.
2801323	911	Crk-Harbor Brook @ Velasko Road	02/05/08	BOD5 (mg/L)	4	
2807623	911	Crk-Harbor Brook @ Velasko Road	07/08/08	Ca (mg/L)	327	
2807623	911	Crk-Harbor Brook @ Velasko Road	07/08/08	Na (mg/L)	190	
East Flume						
2801322	903	Crk-Allied East Flume-Over Weir	02/05/08	BOD5 (mg/L)	5	
Tributary 5A						
2801321	904	Crk-Tributary 5a @ State Fair Blvd	02/05/08	BOD5 (mg/L)	5	

Attachment 5. Sample results qualified "N" - Variance from quality control or assurance criteria, however result is considered acceptable under established NELAC guidelines.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	REMARKS
Ninemile Creek						
2801320	905	Crk-Nine Mile Creek @ Lakeland Rt 48	02/05/08	BOD5 (mg/L)	5	
2805361	905	Crk-Nine Mile Creek @ Lakeland Rt 48	05/13/08	Mg (mg/L)	34.6	
2805361	905	Crk-Nine Mile Creek @ Lakeland Rt 48	05/13/08	Ca (mg/L)	288	
2805890	905	Crk-Nine Mile Creek @ Lakeland Rt 48	05/27/08	TIC (mg/L)	46.7	
Ley Creek						
2801317	908	Crk-Ley Creek @ Park Street	02/05/08	BOD5 (mg/L)	7	
Lake Samples						
2804599	925	Lake Upper Mixed Layer South	04/22/08	Na (mg/L)	253	
2807346	925	Lake Upper Mixed Layer South	07/01/08	Na (mg/L)	263	
2808523	925	Lake Upper Mixed Layer South	07/29/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.
2812951	925	Lake Upper Mixed Layer South	10/27/08	NH3-N (mg/L)	0.398	
2813279	925	Lake Upper Mixed Layer South	11/06/08	Na (mg/L)	315	
2806747	926	Lake Lower Water Layer South	06/17/08	Se (mg/L)	<0.002	Concentration procedure used for some metals.
2808524	926	Lake Lower Water Layer South	07/29/08	BOD5 (mg/L)	2	QC standards failed the acceptance criteria.
Lake Outlet Samples						
2801318	1906	Crk-Onondaga Lake Outlet 2 ft.	02/05/08	BOD5 (mg/L)	<2	
2801319	1907	Crk-Onondaga Lake Outlet 12 ft.	02/05/08	BOD5 (mg/L)	<2	
River Monitoring Samples						
2808966	1025	River Buoy #316 BOD Composite	08/07/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.
2808216	1066	River Lake Outlet #3 Top	07/24/08	NH3-N (mg/L)	0.156	
Quality Control Samples						
2801312	888	Crk-Blank Dunker Churn (Crew B)	02/05/08	BOD5 (mg/L)	<2	
2801329	902	Crk-Harbour Brook @ Hiawatha - Duplicate	02/05/08	BOD5 (mg/L)	6	
2808513	916	Lake Equip. Blk (Dunker Churn)	07/29/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.
2808525	925	Lake Upper Mixed Layer South - Duplicate	07/29/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.
2810920	925	Lake Upper Mixed Layer South - Duplicate	09/23/08	Se (mg/L)	<0.002	Concentration procedure used for some metals.
2808961	940	River Equipment Blank Dunker Crew A	08/07/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.
2801311	990	Crk-Blank Churn (Crew A)	02/05/08	BOD5 (mg/L)	<2	
2808967	1025	River Buoy #316 BOD Composite - Duplicate	08/07/08	BOD5 (mg/L)	<2	QC standards failed the acceptance criteria.

Attachment 6. Sample results qualified "U" - Indicates that the measured value is below the MRL.

Sample No.	IND_ CODE	Source	Sample Date	Parameter (units)	Result	REMARKS
Quality Control Samples						
2804121	1943	Lake Equip. Blank (Teflon Dunker)	04/09/08	Hg (ng/l)	<0.50	
2804121	1943	Lake Equip. Blank (Teflon Dunker)	04/09/08	Hg-methyl (ng/l)	<0.05	
2804122	780	Lake Field Blank (Teflon Dunker)	04/09/08	Hg (ng/l)	<0.50	
2804122	780	Lake Field Blank (Teflon Dunker)	04/09/08	Hg-methyl (ng/l)	<0.05	

Library Reference 3.4

Onondaga County Department of Water Environment Protection
Lake Audit Checklist

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Completed on: May 6,2008
Completed by: Liz Moran, EcoLogic

Quality Assurance Project Plan Requirement (April 2008 Revision)	Comment
Sondes calibrated per written procedure and logged in bound notebook	Acceptable
Bottles pre-labeled and match planned field effort	Acceptable
Chain-of-custody accurate and complete	Acceptable
Wash blanks prepared on cleaned equipment and submitted to lab check-in	Acceptable
Field crews verify that all equipment is loaded into vehicle prior to departure	Needs improvement. Recommend a checklist of equipment for review prior to departure from Henry Clay.
Schedule and sequence of sites are reviewed prior to departure	Acceptable (S. Deep., N. Deep, plus nearshore)
Field team verifies correct location prior to initiating sampling	Acceptable. Buoys are used at South and North Deep sites. Targets on shore for nearshore samples, and depth finder. I noted less reliance on GPS coordinates to verify location, way points are programmed in. Crew had questions about acceptable depths for collecting the nearshore bacteria samples, standardize at 5 ft water depth.
Samples collected per QAPP	Acceptable. Need to include the SOP and instruction manual for the LiCor on board.
Duplicate sample collected	Acceptable, Lab suggests quarterly blind field duplicate, I support this idea.
Equipment markings maintained and legible	Acceptable
Submersible pump allowed to run for sufficient time to purge system of previous sample	Acceptable. Noted that Tygon tubing has some accumulation of deposits, which is unlikely to affect chlor samples, but consider a dilute acid rinse after sampling and keeping tube in the dark.
Tube composites sampled properly	Acceptable
Depth composites determined in field using proper reasoning and reference to SOP	DWEP to include reference profiles to assist field crews with determination of composites. Need to be able to plot profiles on board (investigate hardware/software for this).
Water mixed in churn at proper rate	Acceptable
Flow meter for zooplankton net tow calculations	Acceptable, field crew verified and discussed.
Bottles rinsed with sample prior to filling	Acceptable. Recommending increased volume for pre-rinsing filtered sample bottles (currently use only a few ml).

Field filtration SRP, TDP samples	Acceptable
Field crew discusses and reaches correct decision regarding collection of sulfide samples	Not observed (DO remained at 70% saturation at 18 m).
Preservation in accordance with QAPP	Acceptable
Proper equipment used for each sampling location	Acceptable
Field crews observe ambient conditions and make notes as needed	Acceptable. When nearshore Secchi is on bottom, record as >depth (e.g., >1.3 m).
Field crews properly trained and understand assignments	Acceptable. Will plan for another training session, Dan Walpole to suggest specific topics.

Summary: Janaki Suryadevara and I accompanied the AMP technicians on their lake sampling event. There has been a lot of turnover in staff and several of the technicians are just now beginning their field season on Onondaga Lake AMP. Overall, the field team is committed to following protocols and collecting representative samples. As they gain experience on the lake, they will be better able to interpret field measurements with respect to an expected range of values.

Comments for follow-up:

(1) Plotting temperature profiles in the field will be beneficial.
(2) The second full depth profile at North Deep is very time-consuming and does not add value to the weekly events (this was added with the fecal coliform bacteria sample collection). I recommend collecting only temperature and pH data associated with the surface bacteria sample.
(3) The protocol for bacteria includes a field test for chlorine residual. Janaki thought that there had been at least one instance over the years of monitoring where there was detectable chlorine at the nearshore Metro effluent site following a bypass event. My question is how the lab interprets these data; are the bacteria data flagged as “possibly biased low” if chlorine is detected? How is this handled in the database?

Library Reference 3.5

Onondaga County Department of Water Environment Protection
Tributary Audit Checklist

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Completed on: April 29, 2008
Completed by: Liz Moran, EcoLogic

Quality Assurance Project Plan Requirement (April 2008 Revision)	Comment
Sondes calibrated per written procedure and logged in bound notebook	Acceptable
Bottles pre-labeled and match planned field effort	Acceptable
Chain-of-custody accurate and complete	Acceptable. New notebooks very well organized for field effort.
Wash blanks prepared on cleaned equipment and submitted to lab check-in prior to departure.	Acceptable
Field crews verify that all equipment is loaded into vehicles prior to departure	Acceptable
Schedule and sequence of sites are reviewed prior to departure	Acceptable. We modified usual routine, efficient communication using radios.
Safety precautions observed	Acceptable. Cones are now used consistently. Safety vests on most staff.
Field team verifies correct location prior to initiating sampling	Acceptable. Marks on bridges are wearing off.
Samples collected per QAPP	Acceptable
Duplicate sample collected	Acceptable
Water mixed in churn	Field crews have modified churning, goes to bottom, faster rate.
Bottles rinsed with sample water prior to filling	Acceptable
Field filtration SRP, TDP samples	Acceptable
Preservation in accordance with QAPP	Acceptable, verified with dip strips.
Proper equipment used for each sampling location	Acceptable
Field crews observe ambient conditions and make notes as needed	Acceptable
Field crews properly trained and understand assignments	Acceptable

Summary: Janaki Suryadevara and I accompanied the AMP technicians and had the opportunity to observe both crews (A and B). Began at Dorwin Ave, then Water St in City of Syracuse (first time at that site), Tributary 5A, East Flume, Lake Outlet. Overall, well-organized effort, follows protocol. Field teams very committed and focused.

Comments for follow-up:
(1) Verify with QEA the use of the chlor sample at the Lake Outlet. Is this to establish boundary conditions for model interface?

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EcoLogic Memorandum

TO: Joseph Mastriano, Jeanne Powers, and Janaki Suryadevara
FROM: Liz Moran
RE: Ammonia Audit
DATE: August 19, 2008

Onondaga County Department of Water Environment Protection (DWEP) is continuing its evaluation of precision and accuracy of measurements of ammonia in water at ambient Onondaga Lake and lake tributary concentrations. The Department's objective was to document performance of the revised ammonia-N analytical protocol at the County laboratory, using SPEX-CertiPrep proficiency samples. EcoLogic managed this effort on behalf of DWEP.

SPEX CertiPrep prepared proficiency samples within the range of 0.020 – 0.080 mg/l NH3-N. The proficiency samples were shipped in vials, stable for six months. According to the audit's design, these vials are to be diluted 10x with laboratory water to create analytical samples with ammonia concentrations in the target range.

The vials from SPEXCertiPrep were delivered to the County laboratory on May 21, 2008. Analytical samples were created by diluting the content of the vials 10:1 with laboratory water, and the samples were analyzed 5/23/08 using the low-level procedures currently in place.

May 23 sample data package evaluation

Samples were analyzed on 5/23/08; there were no holding time issues. Quality control samples were within acceptable limits:

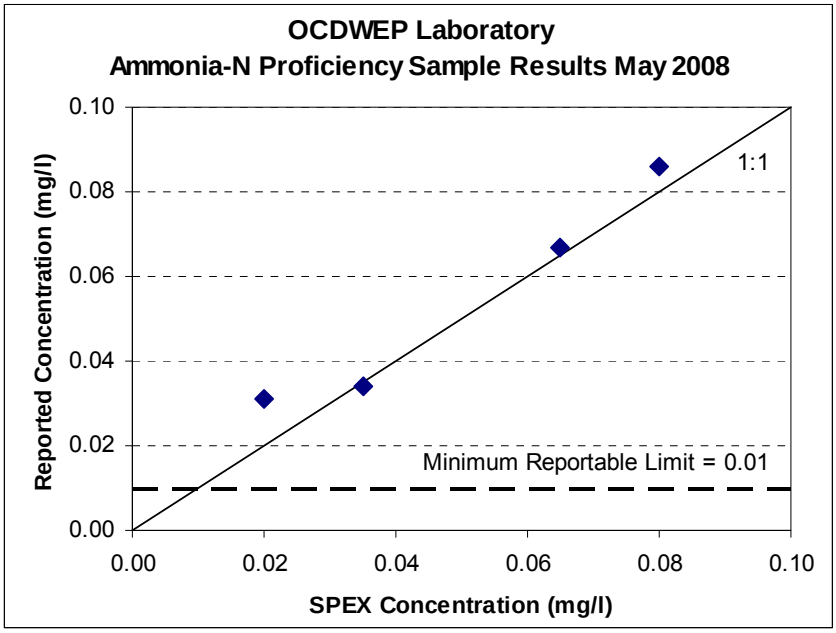
	QC Limits	Reported
LRB	0.01	0.0083 - 0.0097
LFB*	83.8% - 108.3%	97.4% - 97.5%
ICV**	85% - 115%	101.2% - 103.2%
LOQ	60% - 140%	97.0% - 125.0%
CCV** - Hi	85% - 115%	100.2% - 101.3%
CCV** - Lo	85% - 115%	105.6% - 107.2%
LFS* (spike recovery)	82.8% - 116.9%	93.6% - 98.7%
Duplicate Difference	0.029	0.0001 – 0.0133

** fortified standard solutions*
*** initial and continuing calibration verification standards*

Analytical results – SPEX Proficiency Samples

Sample ID	Reported	SPEX	RPD	Diff
QELNY-14-90	0.031	0.020	43%	0.011
QELNY-10-90	0.034	0.035	3%	0.001
QELNY-15.90	0.067	0.065	3%	0.002
QELNY-7-90	0.086	0.080	7%	0.006

The following graphic displays the reported results from the laboratory plotted against the SPEX proficiency sample target concentrations; the 1:1 line is included.



Results indicate that the revised ammonia-N analytical protocol performed well for three of the four SPEX samples. The accuracy for the reported results was lowest for the sample with the lowest concentration (0.020 mg/l NH_3-N).

The laboratory was asked to review their internal documentation and comment on the deviation of the reported value from the true value. The laboratory investigation did not reveal any discrepancies or abnormalities during the analytical process. DWEP was the only laboratory participating in this proficiency evaluation; consequently, there is no means to calculate a standard deviation and define acceptable limits for the results.

Sample# 2805812 and Laboratory Duplicate

	NH3- N, mg/l				
Sample	Results	Target Value	MRL	RPD (%)	% Recovery
Original	0.0313	0.02	0.01	43%	--
Lab Duplicate	0.0285	0.02	0.01	35%	--
Lab Spike	0.2195	0.22	--	--	94%

*Note: Laboratory duplicate and spike was prepared and determined at the same time as the original. The spike concentration was 0.20 mg/L.

Conclusion

The laboratory will document their MRL. Another audit is recommended in 2009.

LIBRARY-SECTION 04
DEPARTMENT OF WATER ENVIRONMENT PROTECTION ACTIONS: 2008

Library Reference 4.1

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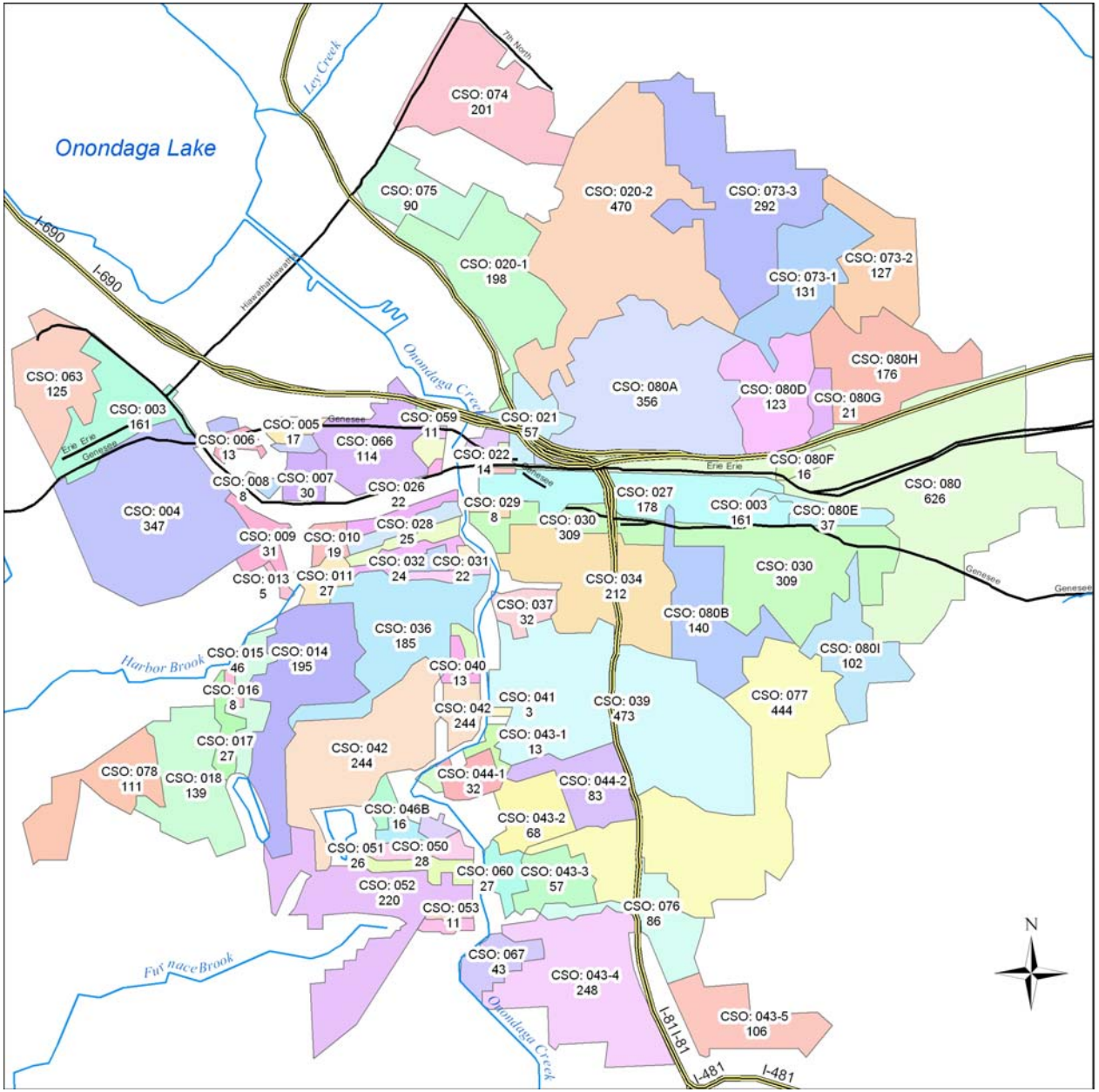

Onondaga Lake Combined Sewer Overlow Areas

Legend

- Surface Water

Roads

- Major road
- Highway

Source: Brown and Caldwell, based on report "Onondaga Lake Nonpoint Source Environmental Benefit Project" November 2002. Submitted to Central New York Regional Planning and Development Board, Syracuse NY, by Moffa and Associates A Unit of Brown and Caldwell, East Syracuse NY.

Note: Values shown indicate acres.

Miles
0 0.5 1

This document was developed in color. Reproduction in B/W may not represent the data as intended. This figure is available on the OCDWEP web site.

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General information:

The plant is designed to treat an average influent of 84.2 million gallons a day (mgd) of wastewater. Metro provides full secondary and tertiary treatment to flows up to 126 mgd; treated wastewater is discharged to the surface of Onondaga Lake through Metro Outfall 001. Flows greater than 126 mgd receive primary treatment and disinfection and are discharged to the lake through Bypass Outfall 002. On rare occasions of high rainfall and/or snowmelt, flows in the service area exceed Metro's hydraulic capacity of 240 mgd and bypass the plant with a direct discharge to Onondaga Lake.[1]

Information for 2008:

Metro provided full treatment to an average flow of 61.1 mgd in 2008, which was discharged to the lake through Outfall 001. On an annual basis, this discharge summed to more than 22.3 billion gallons. An additional 387 million gallons were discharged through Bypass Outfall 002.[2]

[1] Onondaga County Department of Water Environment Protection web site: http://ongov.net/WEP/we1901.html

[2] "2008 Metropolitan Syracuse WWTP Bypass Data". Onondaga County Department of Water Environment Protection inter-office memorandum from Cary Bustin to Janaki Suryadevara dated June 11, 2009.

Library Reference 4.3

Metro Performance Details for 2008

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Metro SPDES limit exceedances 2008*.

SPDES Permit Parameter (Outfall 001)	SPDES Limit	Number of Exceedances
Flow (12-month rolling average)	80 MGD	0
$CBOD_5$ (30-day average concentration)	21 mg/l	0
$CBOD_5$ (30-day average load)	14,011 lbs/day	0
$CBOD_5$ (7-day average concentration)	31.5 mg/l	0
$CBOD_5$ (7-day average load)	21,017 lbs/day	0
$CBOD_5$ Percent Removal	85%	0
Suspended Solids (30-day average concentration)	30 mg/l	0
Suspended Solids (30-day average load)	20,016 lbs/day	0
Suspended Solids (7-day average concentration)	45 mg/l	0
Suspended Solids (7-day average load)	30,024 lbs/day	0
Suspended Solids Percent Removal	85%	0
Fecal coliform bacteria (30-day average)	200 cfu/100 ml	1
Fecal coliform bacteria (7-day average)	400 cfu/100 ml	1
pH	6.0-9.0 SU	0
Settleable Solids	0.3 ml/l	0
Ammonia-N (as NH_3) (30-day average concentration)	1.2 mg/l; 2.4 mg/l	0
Total Phosphorus (12-month rolling average)	0.12 mg/l	0
Cyanide	40.0 lbs/day	0
Bypass (Outfall 002) total residual chlorine	0.1 mg/l	0
Bypass (Outfall 002) settleable solids	0.8 mg/l	3
Cadmium	4.0 lbs/day	0
	Action Levels	
Lead	5.0 lbs/day	0
Zinc	40.0 lbs/day	0
	Total	**5**

Notes:
* Exceedances based on effluent limits. As in previous years, the exceedance column does not reflect data reported as greater than (“>”) values on the Discharge Monitoring Reports. The County does not consider values required to be reported with a greater than symbol (“<”) as exceedances.

Metro effluent concentrations for Ammonia-N, 2008, with SPDES limits.

SPDES Limit	**Effective Date**	**2008 Results (average)**
Stage I : 8,700 ppd (7/1-9/30) 13,100 ppd (10/1-6/30)	January 1998	0.54 mg/l (6/1/08-10/31/08)
Stage 2: 2 mg/l (6/1-10/31) 4 mg/l (11/1-5/31)	May 2004	0.44 mg/l (11/1/07 –5/31/08)
Stage 3: 1.2 mg/l (6/1-10/31) 2.4 mg/l (11/1-5/31)	Dec. 2012 (Met Feb. 2004)	

Library Reference 4.3.3

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Metro effluent concentrations for Total Phosphorus, 2008, with SPDES limits.

SPDES Limit	**Effective Date**	**2008 Results (range)**
Stage I : 400 pounds per day (12-month rolling average)	January 1998 – April 2006	0.091 mg/l – 0.117 mg/l (12-month rolling averages)
Stage 2: 0.12 mg/l (12-month rolling average)	April 2006 – December 2012	
Stage 3: 0.020 mg/l	December 2012	

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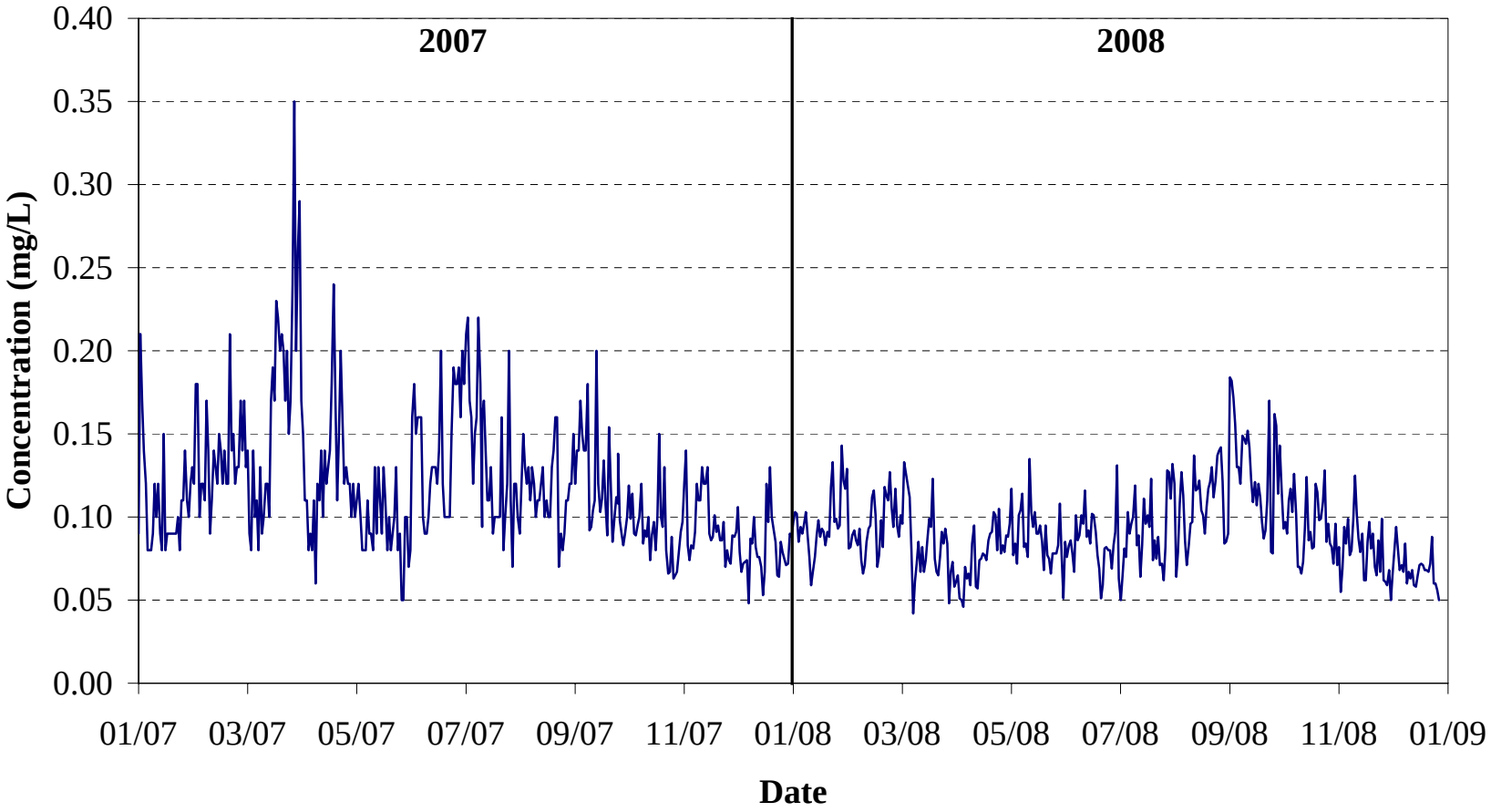

Onondaga County has been upgrading the Metro plant to remove phosphorus from the effluent discharged to the lake. This graphic shows the total phosphorus daily concentrations in Metro effluent during 2007 and 2008.

Library Reference 4.3.5

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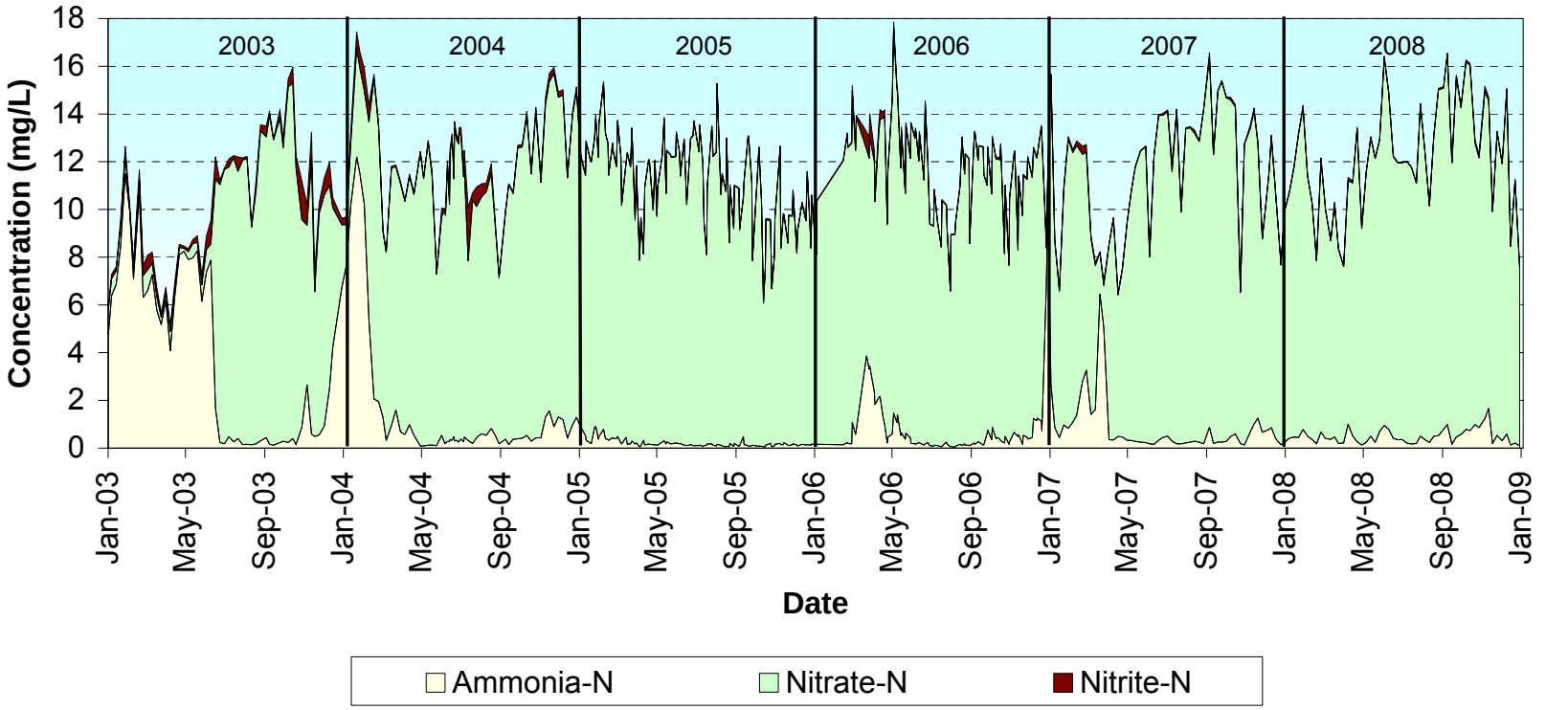

Inorganic nitrogen species concentration in Metro effluent over time. Ammonia-N and nitrite-N loading from the Metro plant has decreased as a direct result of the improvements in ammonia treatment, including the nitrification provided by operation of the BAF which went on-line in January 2004. Concurrent with the decrease in ammonia-N and nitrite-N, loading of nitrate-N has increased, since nitrate-N is the by-product of the nitrification process that the BAF operation provides.

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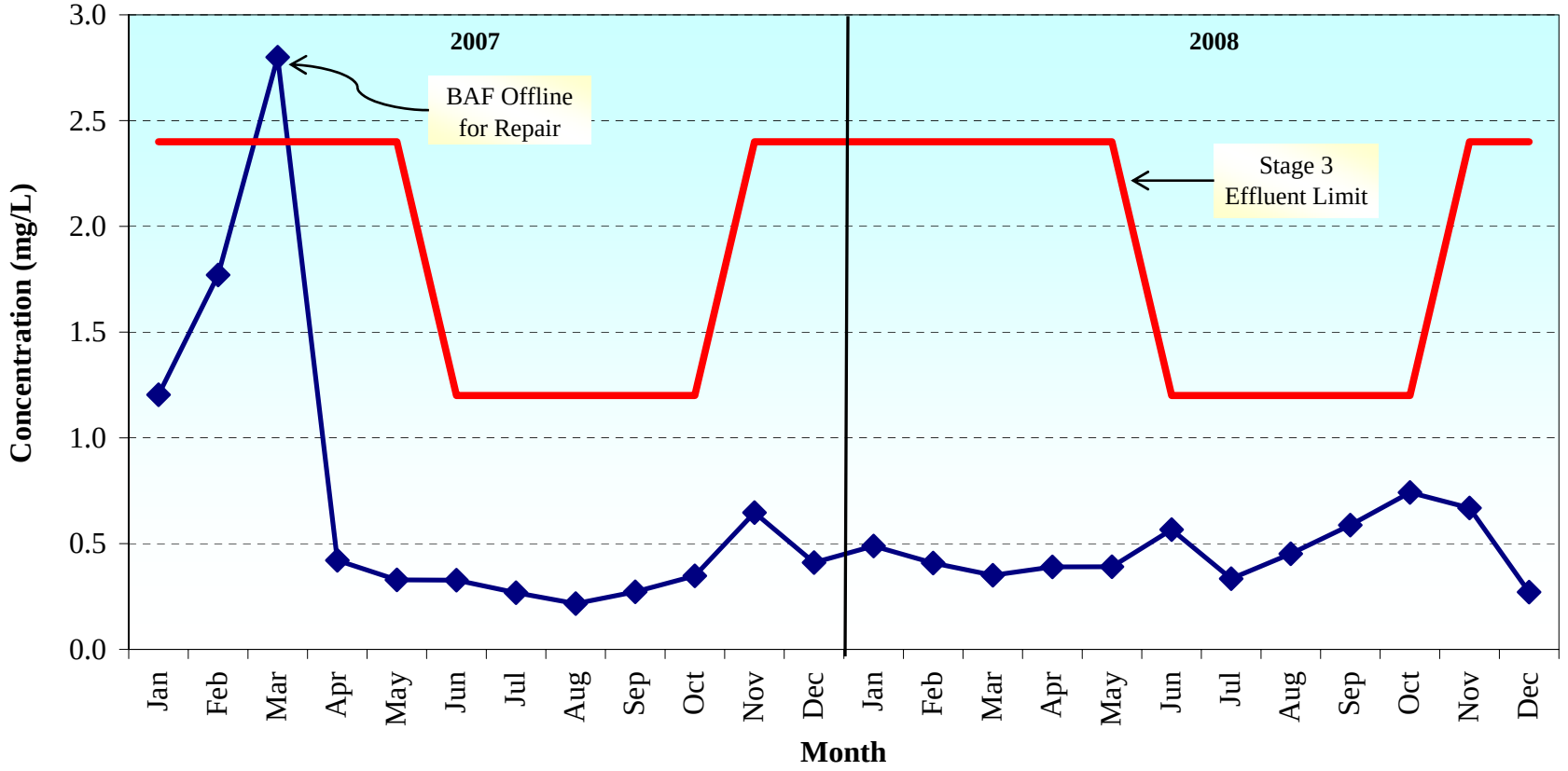

Monthly average ammonia concentration in Metro effluent, compared with seasonal effluent limit (red line)

Library Reference 4.3.7

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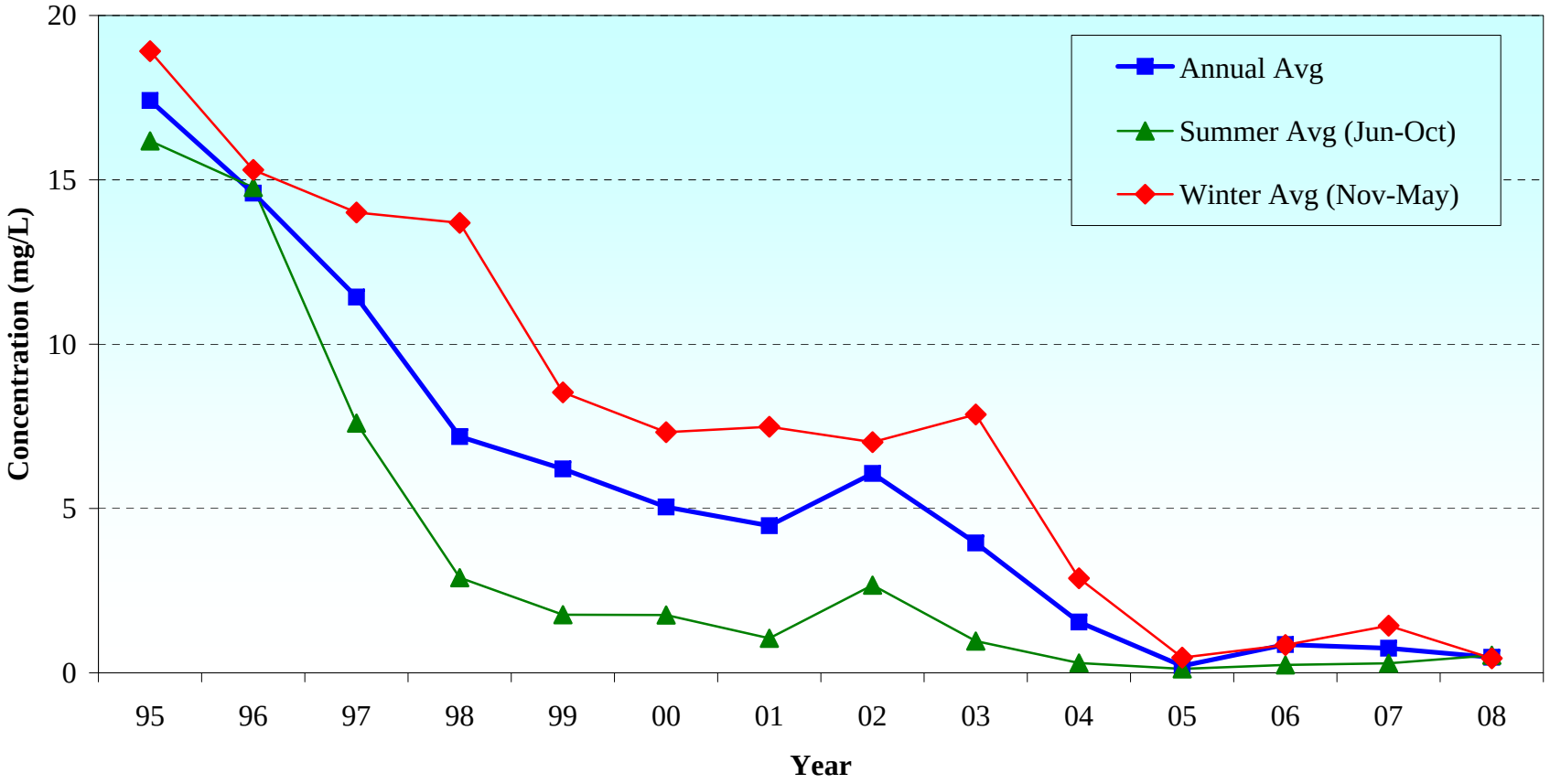

Seasonal average ammonia-N concentration in Metro Outfall 001 effluent over time.

Library Reference 4.3.8

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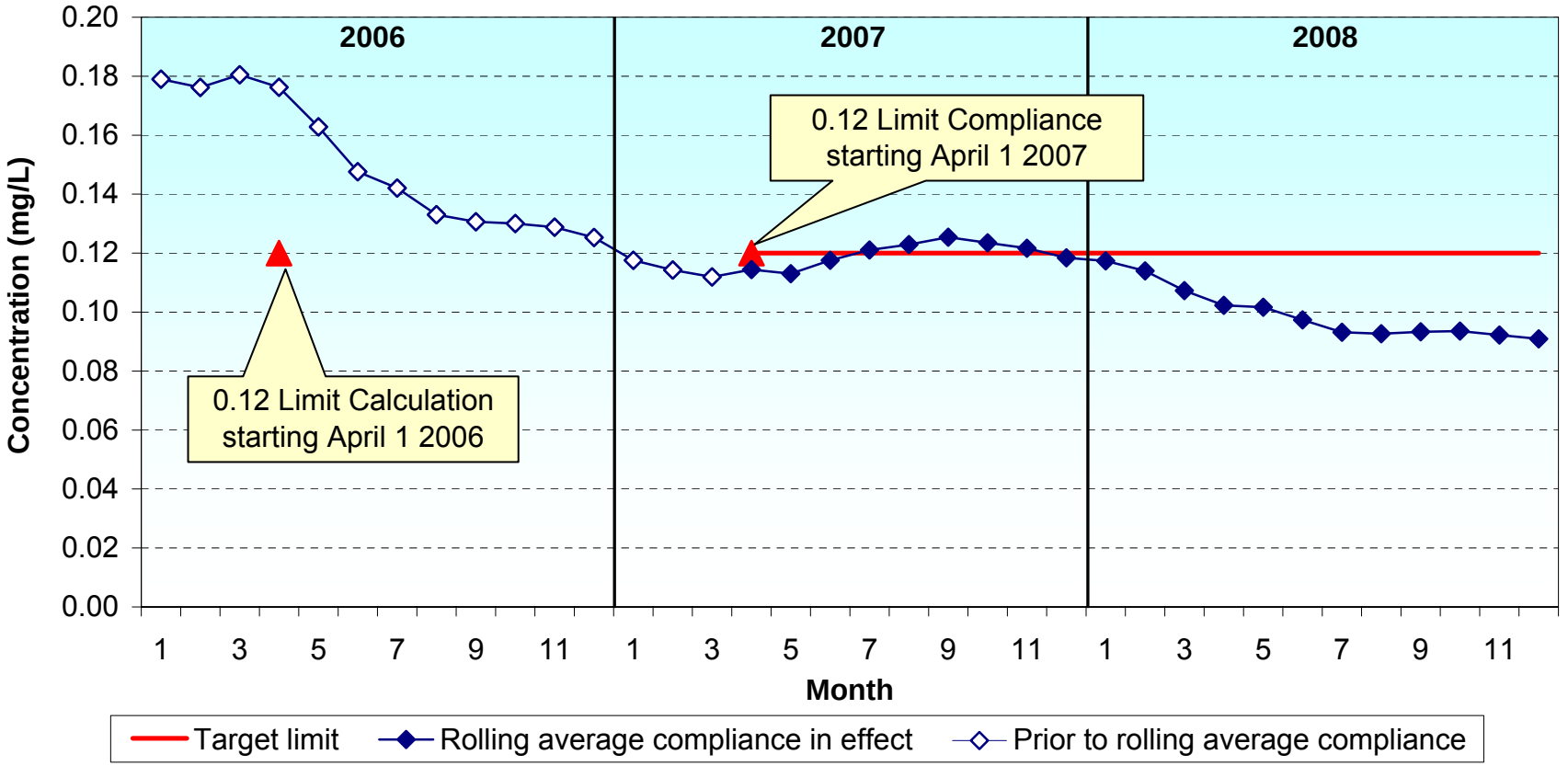

As of April 1, 2007, Metro effluent compliance for total phosphorus concentration is calculated as a rolling average of the previous 12 months. The first data point of compliance (April 1, 2007) represents the 12-month average from April 1, 2006 through March 31, 2007. Blue markers below the red target line are in compliance with the 12-month rolling average limit of 0.12 mg/L.

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Secondary Bypass Volumes (Outfall 002), 2008

Start Date	Duration (hours)	Million Gallons
1/11/08	5.32	2.23
2/1/08	14.83	14.25
2/5/08	17.03	22.05
2/6/08	23.92	43.43
2/7/08	9.40	4.48
2/17/08	9.73	3.80
3/3/08	5.38	1.75
3/4/08	23.45	30.31
3/5/08	0.72	0.07
3/7/08	16.40	25.62
3/8/08	22.05	14.93
3/19/08	15.78	10.56
3/31/08	15.07	14.51
4/1/08	5.12	2.97
4/11/08	4.03	2.87
4/26/08	6.48	10.10
4/28/08	5.68	2.07
6/10/08	0.95	0.46
6/15/08	0.20	0.02
6/21/08	1.82	1.93
6/29/08	1.42	1.58
7/13/08	3.28	5.22
7/20/08	2.07	1.44
7/22/08	0.53	0.06
7/24/08	4.32	1.60
8/16/08	0.98	0.50
8/30/08	1.12	0.71
9/2/08	0.95	0.06
9/12/08	1.98	1.29
9/14/08	0.42	0.08
9/27/08	2.45	0.76
10/2/08	2.42	0.91
10/16/08	9.85	9.85
10/25/08	3.92	4.64
10/28/08	18.35	26.66
11/8/08	1.78	0.61
11/15/08	10.95	10.66
11/25/08	12.05	7.67
11/30/08	7.75	4.19
12/15/08	1.65	0.31
12/24/08	11.87	14.66
12/27/08	23.53	54.90
12/28/08	19.65	28.02
12/29/08	3.08	2.24
TOTAL	**349.73**	**387.03**

Library Reference 4.3.10

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Headworks Bypasses (Outfall 001), 2008.

Start Date	Duration (hours)	Million Gallons
3/5/08	1.02	0.12
7/13/08	1.93	5.13
Total	***2.95***	***5.25***

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2008 record of sanitary sewer overflows (SSO), Onondaga Basin.

Date	Estimated Volume (gallons)	Receiving Water
01/02/2008	500	Harbor Brook
01/16/2008	10,000	Seneca River (storm drain to)
02/06/2008	275,000	Seneca River (storm drain to)
02/25/2008	40	Limestone Creek (storm sewer to)
02/29/2008	1,000	Butternut Creek (storm sewer to)
03/08/2008	150,000	Ley Creek – Onondaga Lake
03/10/2008	500	Mud Creek (drainage swale to)
03/14/2008	720	Harbor Brook
04/16/2008	3,500	Limestone Creek
07/18/2008	300	Bloody Brook (storm sewer to)

Total SSO releases in 2008 (gal)	**441,560**
Bloody Brook (storm sewer to)	300
Butternut Creek (storm sewer to)	1,000
Harbor Brook	1,220
Ley Creek – Onondaga Lake	150,000
Limestone Creek	3,500
Limestone Creek (storm sewer to)	40
Mud Creek (drainage swale to)	500
Seneca River (storm drain to)	285,000

Source: Onondaga County Department of Water Environment Protection Sanitary Sewer Overflow Reports for 2008.

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Summary of combined sewer overflow (CSO) Facility Reports, 2008.

Facility | **Comments from reports**

Newell St. Regional Treatment Facility (RTF)

Designed for 90% storm event (23 cfs). Presently in service as a vortex separator for CSO #067; will be taken out of service when Midland is complete. 18-inch underdrain to creek is monitored for flow.

2008 Discharges to Onondaga Creek:

Quarter	# Overflows	Average Volume (gal)	Notes
01/01 – 03/31	3	46,215	none
04/01 – 06/30	2	25,670	cleaned a plugged pump
07/01 – 09/30	8	13,097	pump problems
10/01 – 12/31	3	31,593	pump problems

Third quarter pump problems: On 7/21 the pump was pulled from the pit prior to being returned to service. On 7/29 the pump was momentarily out of service until an alarm was reset (returning the pump to service).

Fourth quarter pump problems: On 10/27/08 the underflow pump shut down due to plugging; the pump was pulled, repaired, and returned to service on 10/31/2008.

Burnet floatables control facility (FCF)

Uses bags to capture solids. Operators change bags at approximately 30%-40% capacity or as needed. Considered effective in reducing solids load during wet-weather flows.

2008 Discharges to Onondaga Creek (total captured = 8.95 tons):

Quarter	# Events	Average Volume (mgal)	Captured (tons)	Notes
01/01 – 03/31	26	2.64	2.08	none
04/01 – 06/30	10	2.25	2.19	flow meter problems
07/01 – 09/30	4	0.583	1.97	flow meter problems
10/01 – 12/31	22	1.55	2.71	none

Flow meter problems occurred starting in May 2008; replaced in August 2008.

Teall Brook FCF

No permanent flow monitoring device installed at the facility; operational information is an hour meter reading which indicates the number of hours the bar screens have operated. The Copa bar screen is fully automatic, activating the raking mechanism when water levels rise. Considered effective in reducing solids load during wet-weather flows.

2008 Report Results

Quarter	# Events	Hours of Operation	Station Cleaning	Notes
01/01 – 03/31	9	23	2 times	none
04/01 – 06/30	13	20	2 times	none
07/01 – 09/30	15	21.5	3 times	none
10/01 – 12/31	13	16	2 times	none

Butternut FCF

Uses bags to capture solids. Operators change bags at approximately 30%-40% capacity or as needed. Considered effective in reducing solids load during wet-weather flows.

2008 Discharges to Onondaga Creek (total captured = 11.18 tons):

Quarter	# Events	Average Volume (mgal)	Captured (tons)	Notes
01/01 – 03/31	21	3.59	2.78	none
04/01 – 06/30	22	0.633	2.92	none
07/01 – 09/30	27	0.839	2.62	none
10/01 – 12/31	27	2.45	2.86	none

On June 10, high differential head conditions occurred since the gate actuator remained in the closed position when called to open. This failure of the gate actuator seemed to be intermittent and operated as designed for the remainder of the monitoring period.

Summary of combined sewer overflow (CSO) Facility Reports, 2008 (continued).

Facility | **Comments from reports**

Maltbie St. FCF

Uses bags to capture floating solids. Operators change bags at approximately 30%-40% capacity or as needed. Considered effective in reducing solids load during wet-weather flows.

2008 Discharges to Onondaga Creek (total captured = 3.963 tons):

Quarter	# Events	Average Volume (gal)	Captured (tons)	Notes
01/01 – 03/31	13	273,438	0.399	flow meter malfunction
04/01 – 06/30	17	211,204	NA	none
07/01 – 09/30	24	180,592	0.984	none
10/01 – 12/31	22	223,867	2.58	none

Flow meter data collected in January and February appeared to be inaccurate; possible causes could be cold temperatures or debris on the area velocity sensor. The March data appeared reasonable based on precipitation amounts during the month.

Harbor Brook FCF

Uses bags to capture floating solids. Operators change bags at approximately 40%-50% capacity or as needed. Considered effective in reducing solids load during wet-weather flows.

2008 Discharges to Harbor Brook (total captured = 5.344 tons):

Quarter	# Changeouts	Captured (tons)	Notes
01/01 – 03/31	2	1.04	none
04/01 – 06/30	2	1.10	none
07/01 – 09/30	2	0.984	none
10/01 – 12/31	3	2.22	none

The facility was damaged in the June 19, 2007 storm event (greater than 5-year return frequency storm); work toward repairing the damage and protecting the facility from "flash flooding" type events is proceeding.

Proposals for engineering design services were received on July 28, 2008. A contract for evaluating remedial alternatives with recommendations for a revised facility design was awarded on Dec 26, 2008. The engineering services contract is scheduled to be completed by the end of 2009.

The facility was removed from service on Dec 18, 2008 for work consisting of removal of the pontoon structure and attached bag frames. This work was necessary due to bank erosion.

Erie Blvd Storage System (EBSS)

This system has a capacity of 5.5 mg; designed to retain discharge for a 90th percentile storm from 9 CSOs, and bleed back to Metro. In the event the maximum capacity of the EBSS and Main Intercepting Sewer was reached, further incoming CSO flows were discharged to Onondaga Creek to prevent flooding.

2008 Discharges to Onondaga Creek:

Quarter	Date	Overflow (mgal)	%CSO ; %SW	Notes
01/01 – 03/31	--	--	--	no releases
04/01 – 06/30	06/23	0.0006	N/A	one release
07/01 – 09/30	--	--	--	no releases
10/01 – 12/31	--	--	--	no releases

% CSO ; %SW – estimated percent contribution of volume originating from Combined Sewer Overflows and urban stormwater. During periods of no releases, CSO contribution is less than 20%.

On Jun 23, 0.39 inches of rainfall was recorded at Metro; the only discharge to the EBSS was from an overflow sewer. This flow did not initiate the system storage mode and an overflow to the creek occurred. The flow meter must detect continuous flow for a minimum of 60 seconds in order to initiate storage mode; if there is flow for less than 60 seconds, the timer will stop and re-start timing from zero when flow is detected. The system functioned as designed.

Summary of combined sewer overflow (CSO) Facility Reports, 2008 (continued).

Facility	Comments from reports
Hiawatha RTF	Facility consists of Swirl Concentrator (SC), Storage Tank (ST) and Disinfection Tank (DT) process units, which are activated during rain events. Overflows discharged to Ley Creek Outfall.

2008 Discharges to Ley Creek:

Quarter	# Overflows	Volume (gal)	Time (hours)	Units Activated
01/01 – 03/31	0	--	--	SC, ST
04/01 – 06/30	0	--	--	SC, ST, DT
07/01 – 09/30	0	--	--	SC, ST
10/01 – 12/31	0	--	--	SC

Routine inspection of the Hiawatha Facility showed no equipment problems except for the automated chemical feed system, which is out of service because the carrier pipes have settled and separated. Due to the location of this piping system, the capital expenditure to repair/replace the existing piping system is prohibitive. It would be difficult to justify this expenditure based on the infrequency of events at the facility that necessitate use of the automated chemical feed system. A back-up chemical feed system is used for disinfection, if needed.

Library Reference 4.3.13

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CSO remedial projects presently underway.

Tributary	Project	Facility Type	Status
Onondaga Creek	Midland CSO Abatement Facility	RTF	Under construction
	Clinton CSO Abatement Facility	RTF	Planning, design, and approvals are completed. Projected date of construction completion: 2012. Project is on-hold awaiting review of green and grey infrastructure alternatives.
	Onondaga Creek	FCF	Complete (skimmer boat, interim measure)
	Parkway-Rockland CSO Basin (050)	SS	Underway
Harbor Brook	Harbor Brook CSO Abatement Facility	RTF	Planning, design, and approvals are completed. Projected date of construction completion: 2012 Project is on-hold awaiting review of green and grey infrastructure alternatives.
	Harbor Brook	FCF	Complete (interim measures)

Facility Types:
FCF = Floatables Control Facility
RTF = Regional storage and treatment facility
SS = Sewer Separation

LIBRARY-SECTION 05
TRIBUTARY MONITORING RESULTS

Library Reference 5.1

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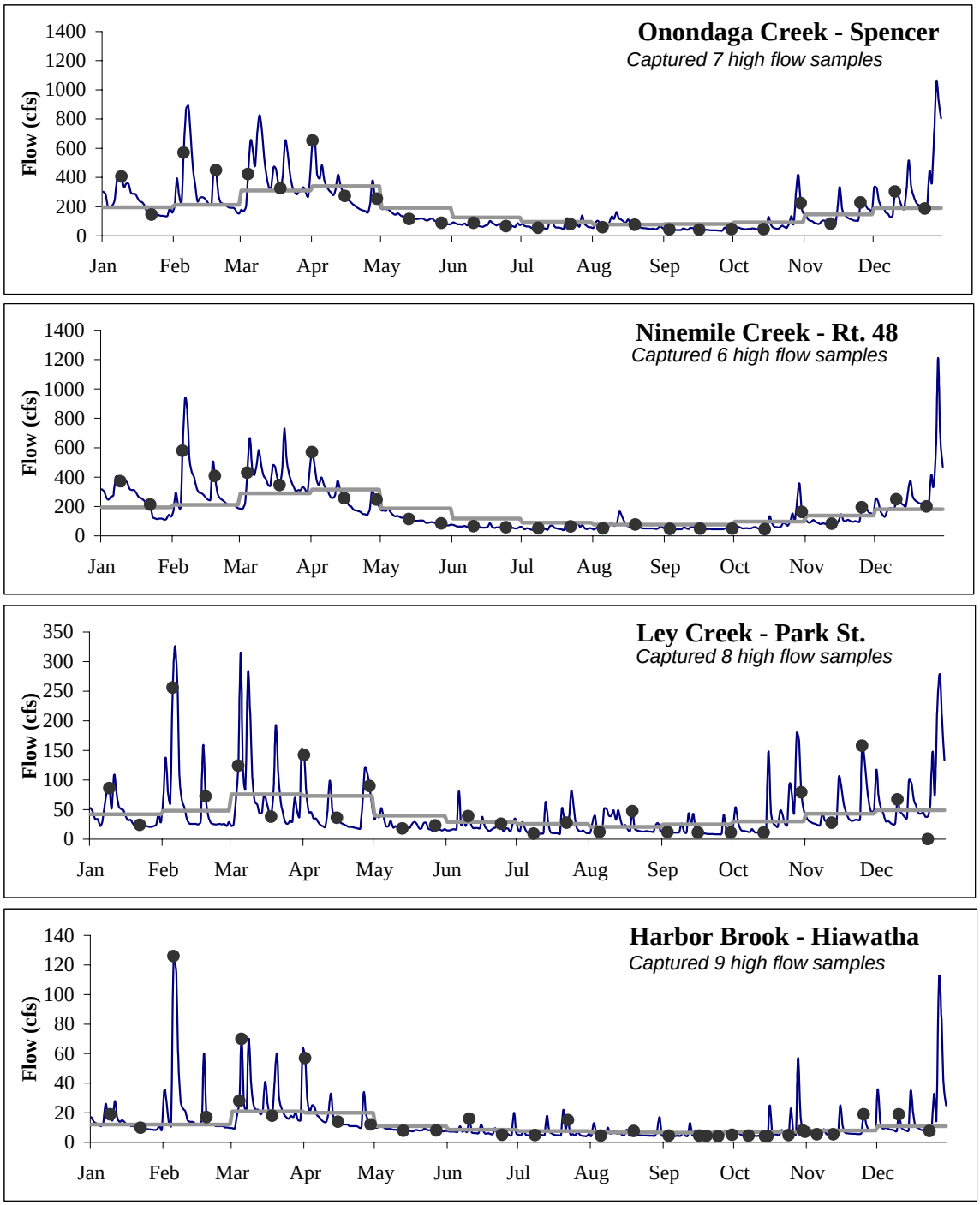

Hydrographs of the major tributaries to Onondaga Lake, showing observed tributary flows in 2008 compared with the long-term (1978-2007) USGS average flow record and Onondaga County sampling events. The goal is to sample the tributaries over a range of representative flow conditions, targeting a minimum of five samples collected during high flow (one standard deviation above the long-term monthly average flow).

Library Reference 5.2

Concentration data: flow-weighted and annual averages

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Flow-weighted average of limnological parameters, 2008, in Onondaga Lake tributaries with standard error of estimate.

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Parameter	Units	Nine Mile Creek		Harbor Brook		Onondaga Creek @		Ley Creek	
		Concentration	*RSE*	Concentration	*RSE*	Concentration	*RSE*	Concentration	*RSE*
5-day BOD	mg/l	2.4	*13.5%*	2.6	*32.5%*	2.2	*16.6%*	3.9	*22.7%*
Total Alkalinity	mg/l	189	*2.2%*	222	*4.9%*	211	*2.6%*	180	*4.3%*
Total Organic Carbon	mg/l	2.7	*19.6%*	2.0	*27.7%*	2.3	*23.9%*	6.5	*7.9%*
TOC-filtered	mg/l	2.6	*14.9%*	1.9	*29.5%*	2.2	*25.6%*	6.1	*7.7%*
Total Inorganic Carbon	mg/l	46.7	*2.0%*	54.7	*5.1%*	52.7	*3.0%*	45.4	*5.7%*
Total Kjeldahl Nitrogen as N	mg/l	0.56	*10.5%*	0.44	*21.1%*	0.48	*13.3%*	0.76	*13.0%*
Organic Nitrogen as N	mg/l	0.35	*14.1%*	0.37	*24.9%*	0.41	*18.7%*	0.48	*15.0%*
Ammonia as N	mg/l	0.22	*8.6%*	0.08	*21.0%*	0.07	*13.3%*	0.27	*14.4%*
Nitrate as N	mg/l	0.85	*7.5%*	1.36	*5.7%*	1.00	*7.1%*	0.37	*16.6%*
Nitrite as N	mg/l	0.02	*13.2%*	0.02	*22.9%*	0.03	*50.3%*	0.02	*22.6%*
Arsenic	ug/l	2.1	*3.6%*	2.0	*2.3%*	2.0	*14.2%*	2.1	*3.4%*
Total Phosphorus	ug/l	55.1	*21.2%*	93.9	*25.0%*	80.0	*30.5%*	98.2	*28.6%*
Soluble Reactive Phosphorus	ug/l	8.0	*26.7%*	38.0	*16.8%*	9.5	*30.3%*	16.0	*16.5%*
Silica	mg/l	3.9	*5.3%*	4.5	*5.5%*	4.9	*7.3%*	5.7	*5.8%*
Calcium	mg/l	181.1	*2.3%*	192.0	*4.9%*	111.2	*2.2%*	103.9	*5.4%*
Sodium	mg/l	102.5	*5.0%*	155.8	*13.4%*	327.5	*7.1%*	226.6	*19.8%*
Sulfate	mg/l	206.0	*5.0%*	327.6	*6.6%*	116.8	*4.0%*	112.5	*7.1%*
Chloride	mg/l	288.2	*3.8%*	272.0	*10.9%*	524.5	*7.5%*	373.4	*20.1%*
Total Suspended Solids	mg/l	21	*31.8%*	38	*57.2%*	57	*49.6%*	27	*53.0%*
Total Dissolved Solids	mg/l	985	*3.0%*	1167	*5.7%*	1234	*5.1%*	973	*11.6%*
Zinc	ug/l	48.0	*31.8%*	11.6	*27.6%*	23.5	*31.1%*	14.8	*20.2%*
Copper	ug/l	3.9	*12.3%*	4.1	*30.6%*	11.8	*39.3%*	5.1	*22.5%*
Chromium	ug/l	2.6	*23.3%*	2.5	*36.2%*	5.4	*38.6%*	2.5	*26.7%*
Cadmium	ug/l	0.8	*11.8%*	0.8	*12.6%*	0.8	*14.0%*	0.8	*8.8%*
Lead	ug/l	4.4	*15.6%*	2.0	*20.4%*	5.1	*30.3%*	2.0	*31.0%*
Iron	mg/l	0.74	*20.4%*	1.03	*53.0%*	2.2	*74.3%*	1.2	*39.0%*
Magnesium	mg/l	25.9	*1.8%*	35.0	*4.6%*	23.7	*2.2%*	20.1	*5.6%*
Manganese	ug/l	55.3	*11.4%*	36.9	*17.4%*	81.6	*35.8%*	116.2	*11.6%*
Nickel	ug/l	3.8	*14.0%*	3.8	*20.0%*	8.7	*32.7%*	3.8	*10.7%*
Fecal Coliforms	cells/100ml	206	*148.7%*	2,406	*124.1%*	1,144	*76.1%*	2,228	*68.3%*

RSE = relative standard error of the concentration estimate. ** METRO BOD5, NH3-N, TP, TSS based on observations made daily, Calculated using a multiple regression algorithm relating concentration to flow, season, and trend with residual interpolation.

METRO TKN based on observations made 5 times each 2 week period. Other values are based on data collected bi-weekly; heavy metals sampled quarterly. Calculations use the laboratory reported minimal reportable limit (MRL) when observations were below the MRL.

Flow-weighted average of limnological parameters, 2008, in Onondaga Lake tributaries with standard error of estimate (continued).

		Trib. 5A		METRO Effluent **		METRO By-Pass		East Flume	
Parameter	**Units**	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***
5-day BOD	mg/l	3.0	*14.2%*	3.9	*3.6%*	58.8	*6.5%*	3.5	*13.0%*
Total Alkalinity	mg/l	157	*2.6%*	142	*3.0%*	142	*15.2%*	152	*5.0%*
Total Organic Carbon	mg/l	3.8	*6.1%*	7.1	*5.6%*	13.5	*25.0%*	3.8	*7.4%*
TOC-filtered	mg/l	3.6	*5.8%*	6.7	*4.7%*	10.8	*25.8%*	3.5	*7.4%*
Total Inorganic Carbon	mg/l	38.7	*3.6%*	38.3	*3.2%*	35.9	*17.8%*	34.8	*5.3%*
Total Kjeldahl Nitrogen as N	mg/l	0.46	*35.2%*	1.4	*3.4%*	9.6	*7.9%*	0.9	*9.9%*
Organic Nitrogen as N	mg/l	0.33	*15.9%*	0.7	*16.5%*	4.8	*30.8%*	0.48	*13.7%*
Ammonia as N	mg/l	0.13	*85.8%*	0.4	*5.3%*	5.6	*11.9%*	0.39	*13.1%*
Nitrate as N	mg/l	0.77	*14.3%*	11.2	*6.3%*	1.1	*43.2%*	3.0	*7.5%*
Nitrite as N	mg/l	0.03	*20.2%*	0.05	*14.9%*	0.13	*83.3%*	0.71	*19.5%*
Arsenic	ug/l	2.5	*11.3%*	2.0	*6.4%*	2.0	*5.9%*	2.8	*16.8%*
Total Phosphorus	ug/l	119.1	*8.2%*	88.3	*3.3%*	1219.0	*7.4%*	104.2	*16.5%*
Soluble Reactive Phosphorus	ug/l	27.8	*13.4%*	3.4	*36.0%*	253.9	*98.4%*	35.1	*18.8%*
Silica	mg/l	7.5	*5.9%*	5.5	*3.6%*	3.8	*22.2%*	9.8	*7.2%*
Calcium	mg/l	128.2	*3.7%*	140.5	*6.5%*	89.4	*38.0%*	109.5	*7.5%*
Sodium	mg/l	163.5	*5.3%*	391.0	*14.5%*	217.2	*43.0%*	405.1	*8.8%*
Sulfate	mg/l	92.6	*12.0%*	192.3	*4.3%*	83.7	*21.2%*	325.3	*9.6%*
Chloride	mg/l	328.5	*5.4%*	631.6	*6.7%*	370.9	*49.0%*	507.3	*9.7%*
Total Suspended Solids	mg/l	30	*68.1%*	6.0	*5.0%*	69	*10.1%*	14	*39.3%*
Total Dissolved Solids	mg/l	941	*4.6%*	1561	*4.4%*	872	*33.5%*	1486	*7.7%*
Zinc	ug/l	25.2	*45.3%*	24.2	*7.0%*	45.0	*14.4%*	17.9	*53.7%*
Copper	ug/l	42.8	*36.0%*	12.1	*6.4%*	19.9	*13.1%*	4.1	*64.3%*
Chromium	ug/l	80.2	*39.5%*	9.0	*6.5%*	10.0	*16.3%*	2.5	*45.5%*
Cadmium	ug/l	0.80	*25.0%*	0.8	*10.5%*	5.0	*7.8%*	0.80	*46.3%*
Lead	ug/l	4.9	*30.0%*	2.0	*6.4%*	30.0	*11.7%*	2.2	*67.9%*
Iron	mg/l	1.6	*48.6%*	1.54	*7.2%*	2.7	*15.7%*	0.31	*39.7%*
Magnesium	mg/l	15.4	*2.7%*	24.8	*3.2%*	13.2	*21.4%*	19.2	*7.4%*
Manganese	ug/l	81.4	*26.3%*	38.0	*7.4%*	61.3	*20.4%*	25.6	*17.8%*
Nickel	ug/l	125.9	*19.3%*	14.3	*5.4%*	15.0	*16.0%*	3.8	*23.0%*
Fecal Coliforms	cells/100ml	76	*503.1%*	923	*61.8%*	611,269	*52.9%*	249	*98.7%*

RSE = relative standard error of the concentration estimate. ** METRO BOD5, NH3-N, TP, TSS based on observations made daily, Calculated using a multiple regression algorithm relating concentration to flow, season, and trend with residual interpolation.

METRO TKN based on observations made 5 times each 2 week period. Other values are based on data collected bi-weekly; heavy metals sampled quarterly. Calculations use the laboratory reported minimal reportable limit (MRL) when observations were below the MRL.

Ten Year Trends in Concentration (1999-2008) - Summary

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Symbol	Description
I	increasing trend (p < 0.1)
D	decreasing trend (p > 0.1)
blank	no trend indicated (p = 0.1)
p2	significance level, two-tailed, seasonal kendall test accounting for serial correlation.
--	parameter not measured at this location

	Onondaga Lake						Metro		Onondaga Creek		Harbor Brook		Ley Creek	Ninemile Creek		
VARIABLE	SOUTH_U	SOUTH_L	NORTH_U	NORTH_L	OUTLET12	OUTLET2	METRO	BYPASS	DORWIN	KIRKPAT	VELASKO	HIAWATHA	PARK	RT48	TRIB5A	EFLUME
ALK											I				I	
BOD5*							D									
CA			I				I							D		
CHLA	D						--	--	--	--	--	--	--	--	--	--
CL					D	D	I		D		I	I	I	D	D	
COND						D	I		D					D	D	I
DO_F		I			I					I		I		I		I
FCOLI									I						I	
HARD							I							D		
MG							I					D		D		
NA							I		D		I	I	I	D	D	I
NH3N	D	D	D	D	D	D	D		D	D	D	D	D	D		D
NO2N	D	D	D		D	D	D						D			D
NO3N	I	I	I	I	I	I	I									
ORGN	D	D	D	D	D	D	D				I		D		I	D
PH_F									D	I	D				I	
PHAEO					D		--	--	--	--	--	--	--	--	--	--
SECCHI					--	--	--	--	--	--	--	--	--	--	--	--
SIO2	I		I		I	I									I	
SO4	D	D			D			D	D			D			D	
SRP	D	D		D	D	D	D	I	I			I	D		D	D
TDS					D		I		D					D	D	
TEMP											D					
TIC											I				I	
TKN	D	D	D	D	D	D	D						D	D		D
TOC	D	D	D	D	D	D	D		D							D
TOC_F	D	D	D	D	D	D	D		D							D
TP	D	D	D	D	D	D	D	I	I			I	D		D	D
TS					--	--	--	--	--	--	--	--	--	--	--	--
TSS						I	D		I	I	I	I			I	
VSS					--	--			--	--	--	--	--	--	--	--

**BOD5 test reliable only for METRO & BYPASS because of variations in detection limits.*

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Mercury results in tributaries, 2008.

Tributary	Number of Samples	Results (ug/l)
Metro:		
Metro Outfall 001	48	<0.02
	4	<0.2
Metro Outfall 002	1	<0.02
	1	0.021
	1	0.025
	1	0.026
	1	0.028
	1	0.029
	1	0.039
Natural Tributaries:		
Bloody Brook	7	<0.020
Harbor Brook	6	<0.020
	1	0.020
	1	0.025
Ley Creek	3	<0.020
	1	0.046
Ninemile Creek	4	<0.020
Onondaga Creek	6	<0.020
	1	0.021
	1	0.056
Sawmill Creek	5	<0.020
	1	0.020
Industrial Tributaries:		
Trib 5A	1	<0.020
	2	0.024
	1	0.025
East Flume	1	0.041
	1	0.058
	1	0.083
	1	0.114

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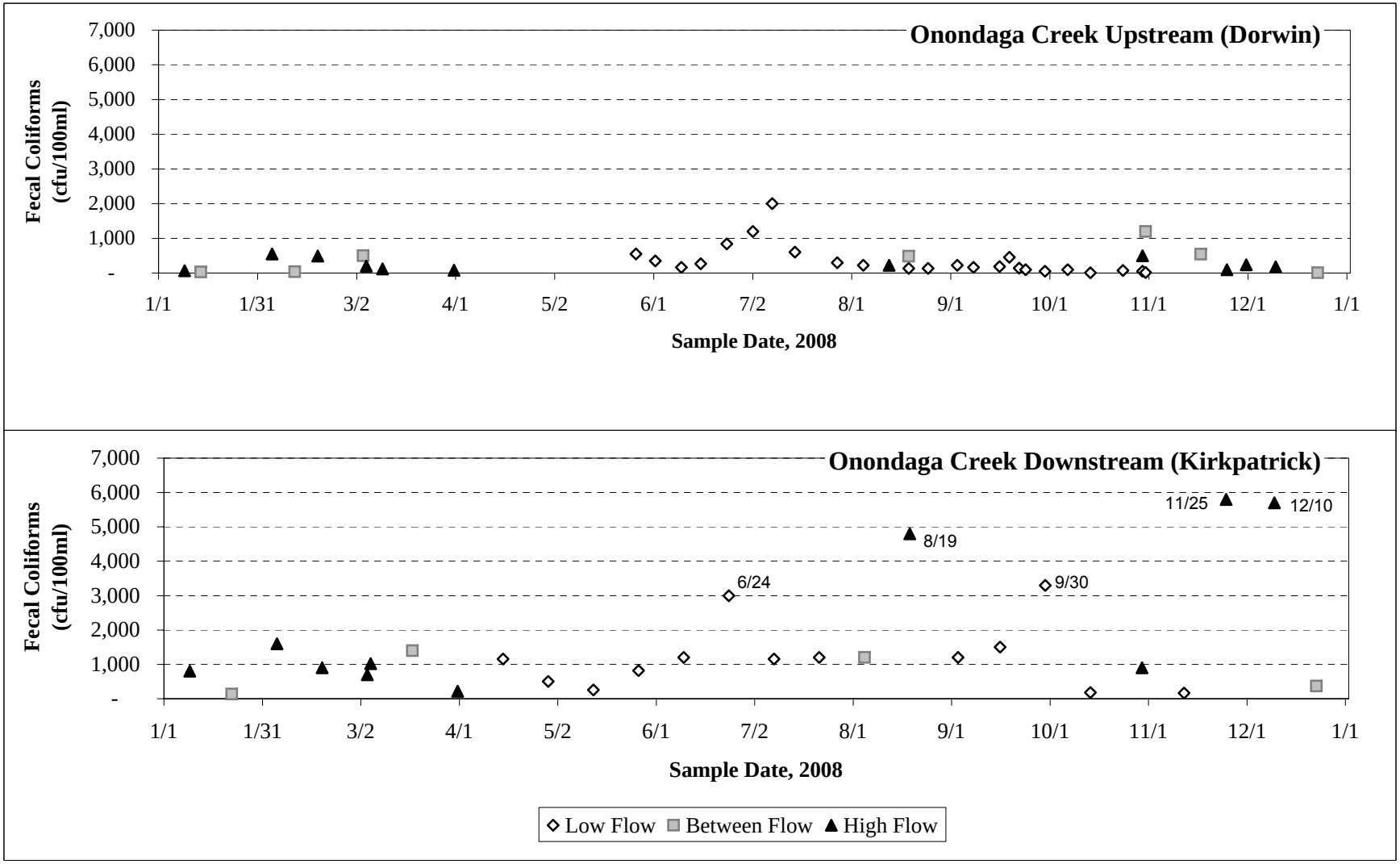

Measured concentrations of fecal coliform bacteria in Onondaga Creek during 2008.

Notes: Low flow is defined as flows less than or equal to the long-term monthly average flow for the period of record. High flow is defined as flows greater than one standard deviation above the long-term monthly average flow. “Between” indicates flows that occur between low and high flows.

Library Reference 5.2.5

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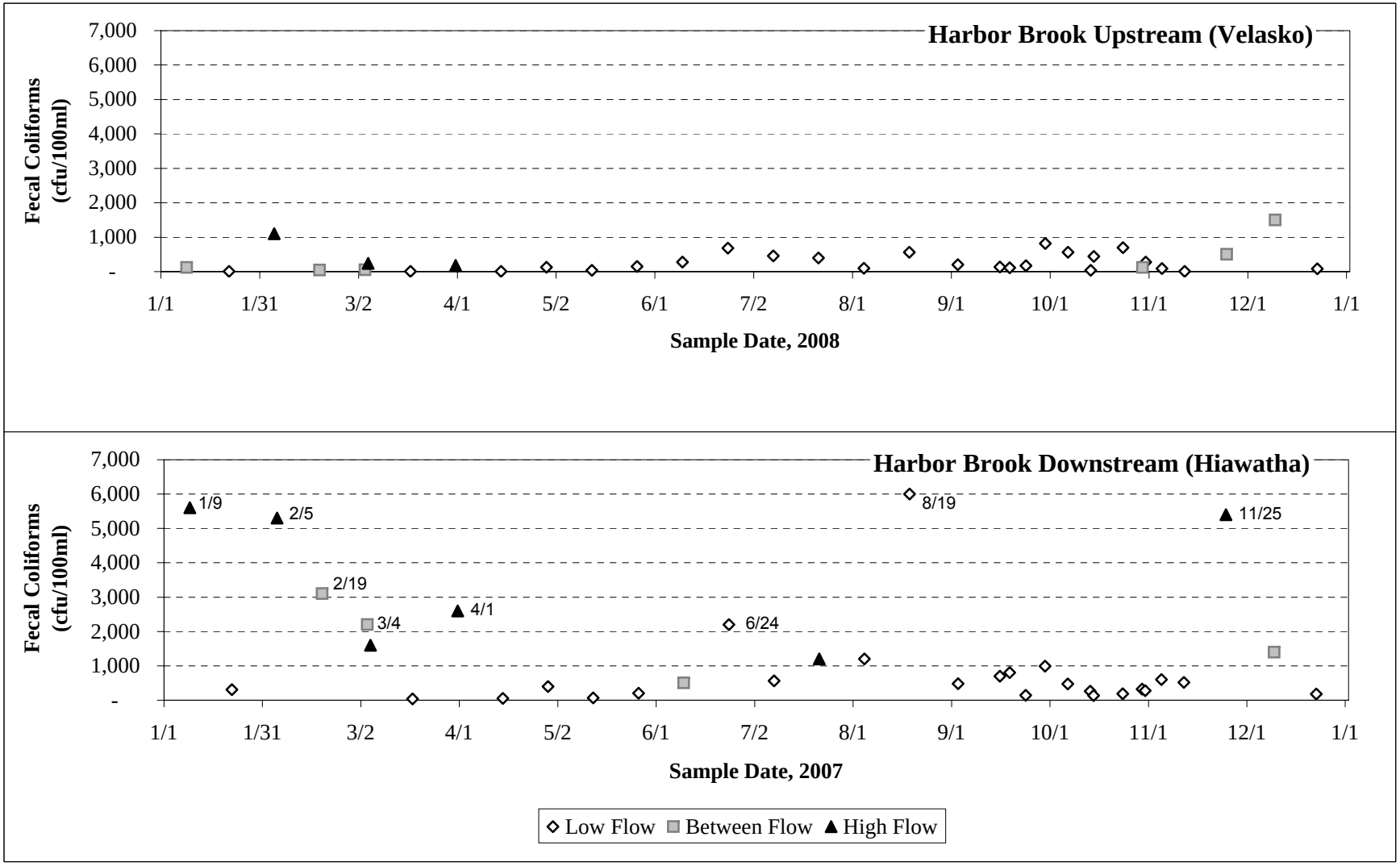

Measured concentrations of fecal coliform bacteria in Harbor Brook during 2008.

Notes: Low flow is defined as flows less than or equal to the long-term monthly average flow for the period of record. High flow is defined as flows greater than one standard deviation above the long-term monthly average flow. “Between” indicates flows that occur between low and high flows.

Library Reference 5.2.6

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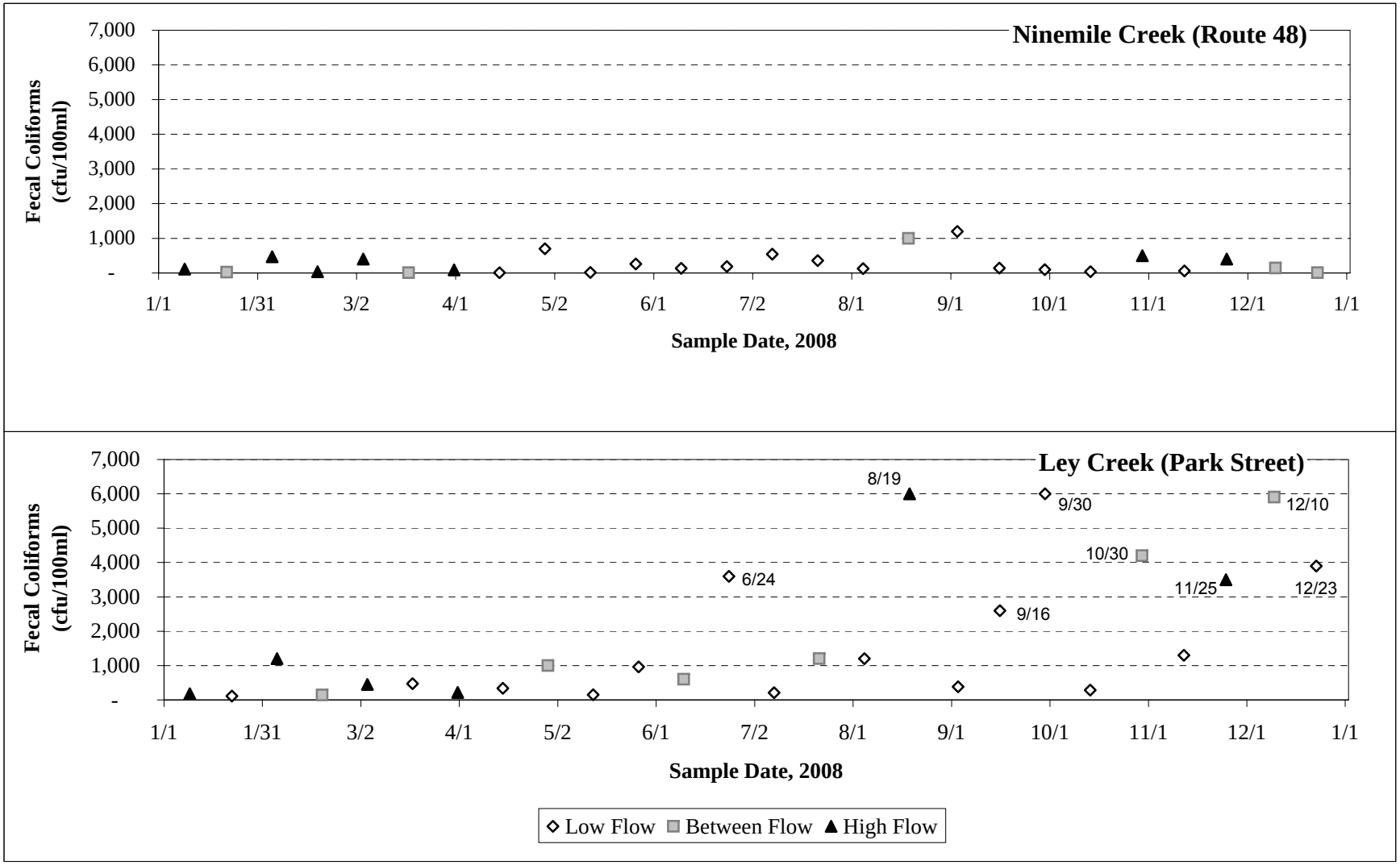

Measured concentrations of fecal coliform bacteria in Ninemile and Ley Creeks during 2008.

Notes: Low flow is defined as flows less than or equal to the long-term monthly average flow for the period of record. High flow is defined as flows greater than one standard deviation above the long-term monthly average flow. “Between” indicates flows that occur between low and high flows.

Loading data

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Library Reference 5.3.1

Loading of major water quality parameters to Onondaga Lake, January to December 2008.

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Parameter	Units	Onondaga Crk at Kirkpatrick[3,4]	Ninemile Creek at Rt. 48[3,4]	Metro[1] Outfall 001	Bypass[2] Outfall 002	Ley Creek at Park[3,4]	Harbor Brook at Hiawatha[3,4]	East Flume[3]	Tributary 5A[3]	Total Monitored
Water	hm^3	168	157	84.7	1.73	39.4	11.5	1.01	1.11	464
Total P	mt	13	8.6	7.5	2.1	3.9	1.08	0.11	0.13	37
SRP	mt	1.6	1.3	0.29	0.44	0.63	0.44	0.04	0.03	5
TKN	mt	81	89	119	17	30	5.1	0.90	0.51	342
Nitrate-N	mt	169	133	946	2.0	15	16	3.0	0.86	1,284
Nitrite-N	mt	5.4	3.3	3.8	0.22	0.85	0.22	0.72	0.03	15
Ammonia-N	mt	12	34	36	9.7	10.8	0.87	0.40	0.15	105
Organic-N	mt	70	56	62	8.4	19.0	4.3	0.48	0.36	219
Ca	mt	18,684	28,414	11,896	155	4,099	2,209	111	142	65,710
Cl	mt	88,162	45,223	53,490	642	14,729	3,130	514	365	206,254
Na	mt	55,049	16,082	33,114	376	8,936	1,792	411	182	115,942
TSS	mt	9,532	3,281	509	119	1,062	435	15	33	14,986
Fecal Coli (annual)	10^{10} cfu	192,356	32,335	78,173	1,057,498	87,865	27,684	253	85	1,476,249
Fecal Coli (May-Sept)	10^{10} cfu	54,730	9,082	7,079	198,073	20,373	5,656	55	65	295,113
BOD -5 day	mt	378	377	334	102	154	30	4	3	1,382
T-Alk	mt	35,500	29,625	11,999	245	7,082	2,549	154	174	87,329
TOC	mt	389	431	603	23	257	23	4	4	1,735
TIC	mt	8,854	7,334	3,244	62	1,790	629	35	43	21,990

NOTES

Notes: mt = metric tons; hm3 = million cubic meters; cfu = colony forming units

(1) Metro Outfall 001 calculated loads of BOD5, NH3-N, TP, TSS are based on daily measurements; METRO TKN based on 5 measurements/2 wks

(2) Metro Bypass Outfall 002 estimates based on periodic grab samples when outfall is active (high flow events)

(3) Natural tributaries, East Flume and Tributary 5A calculations based on biweekly program, plus high flow events and storms

(4) Tributary BOD samples include a large percentage of observations reported as less than the minimal reportable limit; for these observations, the minimal reportable limit was used in loading calculations.

Library Reference 5.3.2

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Annual (January to December) tributary loadings to Onondaga Lake 1990-2008, and comparison of 2008 to long-term average conditions.

Parameter	Units	Annual Load 1990	Annual Load 1991	Annual Load 1992	Annual Load 1993	Annual Load 1994	Annual Load 1995	Annual Load 1996	Annual Load 1997	Annual Load 1998	Annual Load 1999
5-day BOD	mt	2,835	2,109	4,059	4,226	2,928	2,433	3,300	2,134	2,220	1,745
Total Alkalinity	mt	127,204	86,082	104,777	107,504	92,308	64,728	101,576	75,112	83,374	59,355
Total Organic Carbon	mt	5,836	4,531	3,324	4,344	2,558	2,369	3,867	2,269	2,072	1,682
Total Inorganic Carbon	mt	32,160	21,471	26,846	26,429	23,876	16,533	26,113	18,466	22,172	15,203
Total Kjeldahl N	mt	1,907	1,745	1,880	2,003	1,927	1,883	2,081	1,494	1,274	907
Ammonia-N	mt	1,364	1,265	1,287	1,321	1,408	1,541	1,498	1,118	833	614
Nitrate-N	mt	779	488	485	515	476	295	534	465	869	625
Nitrite-N	mt	84	88	61	53	49	46	44	62	46	41
Organic-N	mt	551	436	584	666	514	324	580	376	413	276
Total Phosphorus	mt	149	83	126	140	83	65	112	50	68	54
Soluble Reactive P	mt	29	24	22	30	20	19	24	12	12	9.3
Calcium	mt	98,242	72,741	77,957	76,011	67,176	50,443	72,581	57,271	61,175	49,142
Sodium	mt	88,765	75,504	76,862	91,093	82,787	58,656	77,378	65,721	76,469	76,776
Chloride	mt	220,065	182,969	180,697	196,525	164,121	119,322	156,452	138,290	156,969	144,908
Total Suspended Solids	mt	24,975	13,120	22,603	15,568	11,670	5,694	19,230	5,404	10,397	11,342
Fecal Coliform	10^{10} cfu	1,120,878	1,099,838	3,040,649	5,519,621	1,103,861	9,182,161	3,254,615	1,833,174	2,849,618	3,957,407

Annual (January to December) tributary loadings to Onondaga Lake 1990-2008, and comparison of 2008 to long-term average conditions (continued).

Parameter	Units	Annual Load 2000	Annual Load 2001	Annual Load 2002	Annual Load 2003	Annual Load 2004	Annual Load 2005	Annual Load 2006	Annual Load 2007	Annual Load 2008	Average Load 1990-2007	% Change 2008 from Average
5-day BOD	mt	1,981	1,734	2,325	2,696	2,054	1,495	1,495	1,447	1,382	2,401	-42%
Total Alkalinity	mt	90,576	75,898	85,765	102,123	110,499	104,601	109,320	97,150	87,329	93,220	-6%
Total Organic Carbon	mt	2,224	1,895	1,975	2,896	3,121	2,196	2,073	1,827	1,735	2,837	-39%
Total Inorganic Carbon	mt	23,876	19,667	22,533	26,978	29,222	27,387	27,469	25,433	21,990	23,991	-8%
Total Kjeldahl N	mt	982	824	1,018	932	580	363	405	402	342	1,256	-73%
Ammonia-N	mt	571	499	643	503	240	94	150	142	105	838	-88%
Nitrate-N	mt	772	667	463	977	1,379	1,541	1,261	1,243	1,284	769	67%
Nitrite-N	mt	52	38	31	47	31	13	20	17	15	46	-68%
Organic-N	mt	403	319	332	440	318	255	241	230	219	403	-46%
Total Phosphorus	mt	53	46	48	68	83	49	42	37	37	75	-51%
Soluble Reactive P	mt	7.4	7.5	6.7	15	31	7.3	4.6	5.1	4.7	16	-70%
Calcium	mt	64,406	55,498	60,308	68,945	73,697	77,168	75,710	70,602	65,710	68,282	-4%
Sodium	mt	90,648	85,662	88,817	102,078	96,368	109,127	106,490	110,621	115,942	86,657	34%
Chloride	mt	171,897	167,643	168,405	193,596	186,907	199,532	187,570	205,855	206,254	174,540	18%
Total Suspended Solids	mt	14,034	9,567	9,109	10,368	16,157	14,209	17,923	15,958	14,986	13,740	9%
Fecal Coliform	10^{10} cfu	1,629,608	1,957,691	2,635,930	1,196,515	2,044,624	830,885	1,329,586	1,691,052	1,476,249	2,570,984	-43%

Library Reference 5.3.3

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Percent contribution by gauged inflow, January to December 2008.

Parameter	Onondaga Crk at Kirkpatrick	Ninemile Creek at Rt. 48	Metro Outfall 001	Bypass Outfall 002	Ley Creek at Park	Harbor Brook at Hiawatha	East Flume	Tributary 5A
Water	36%	34%	18%	0.37%	8.5%	2.5%	0.22%	0.24%
Total P	36%	23%	20%	5.7%	10.5%	2.9%	0.29%	0.36%
SRP	34%	27%	6.2%	9.3%	13.4%	9%	0.76%	0.65%
TKN	24%	26%	35%	4.9%	8.8%	1.5%	0.26%	0.150%
Nitrate-N	13%	10%	74%	0.15%	1.1%	1.2%	0.24%	0.067%
Nitrite-N	37%	23%	26%	1.52%	5.8%	1.5%	5.0%	0.23%
Ammonia-N	11.7%	33%	35%	9.2%	10.4%	0.83%	0.38%	0.139%
Organic-N	32%	25%	28%	3.8%	8.7%	1.9%	0.22%	0.166%
Ca	28%	43%	18%	0.24%	6.2%	3.4%	0.17%	0.22%
Cl	43%	22%	26%	0.31%	7.1%	1.5%	0.25%	0.177%
Na	47%	14%	29%	0.32%	7.7%	1.5%	0.35%	0.157%
TSS	64%	22%	3.4%	0.79%	7.1%	2.9%	0.097%	0.222%
Fecal Coli (annual)	13%	2.2%	5%	72%	6.0%	1.9%	0.0171%	0.0057%
Fecal Coli (May-Sept)	19%	3%	2.4%	67%	6.9%	1.9%	0.0186%	0.022%
BOD -5 day	27%	27%	24%	7.4%	11.1%	2.2%	0.26%	0.24%
T-Alk	41%	34%	14%	0.28%	8.1%	2.9%	0.18%	0.20%
TOC	22%	25%	35%	1.3%	15%	1.4%	0.22%	0.24%
TIC	40%	33%	15%	0.28%	8.1%	2.9%	0.16%	0.20%

Note: Approximately 93.5% of flow to Onondaga lake is from gauged sources. The remainder of flow is attributed to non-point ungauged sources and precipitation.

Library Reference 5.3.4

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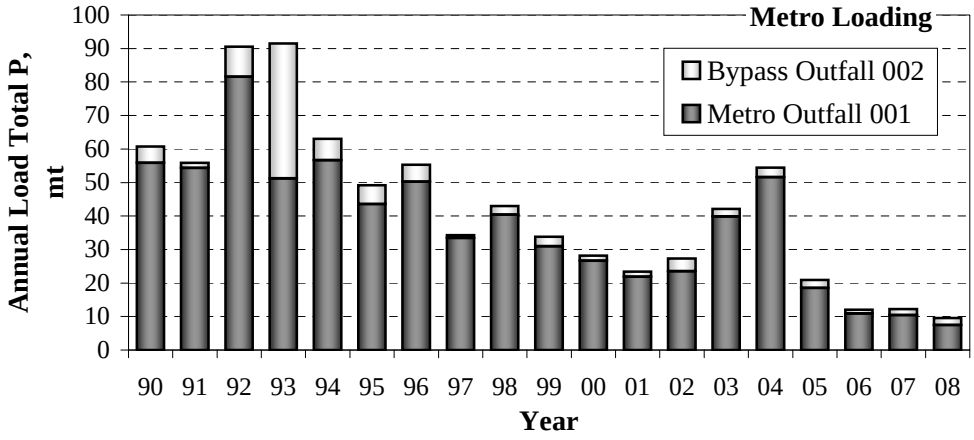

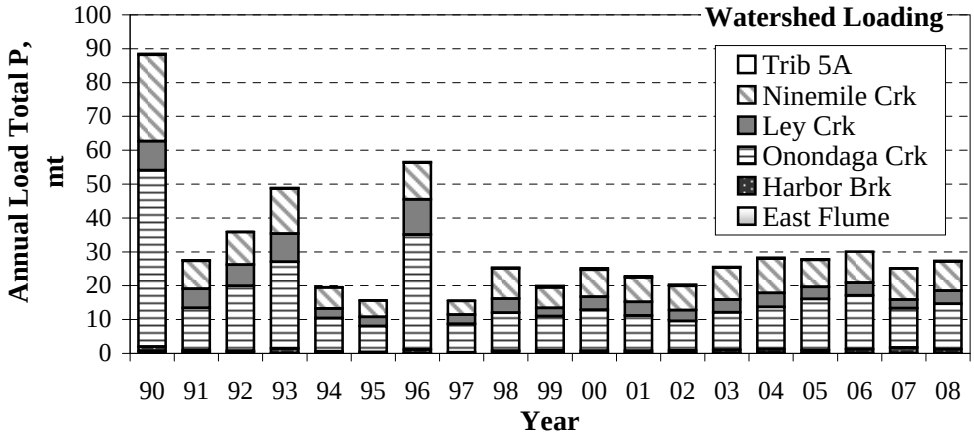

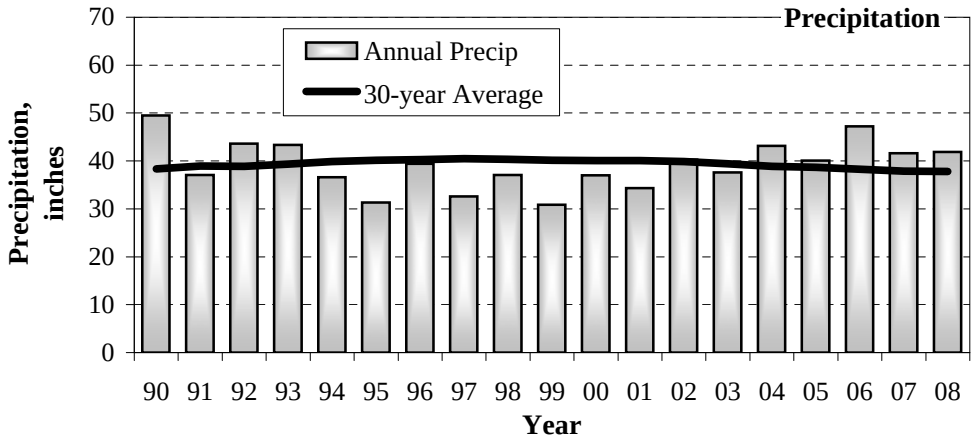

Total phosphorus loading over time from Metro and the watershed. The 30-year average precipitation represents the 30-year period preceding each year; for example, the 30-year average precipitation for 1990 represents the period 1960-1989.

Library Reference 5.3.5

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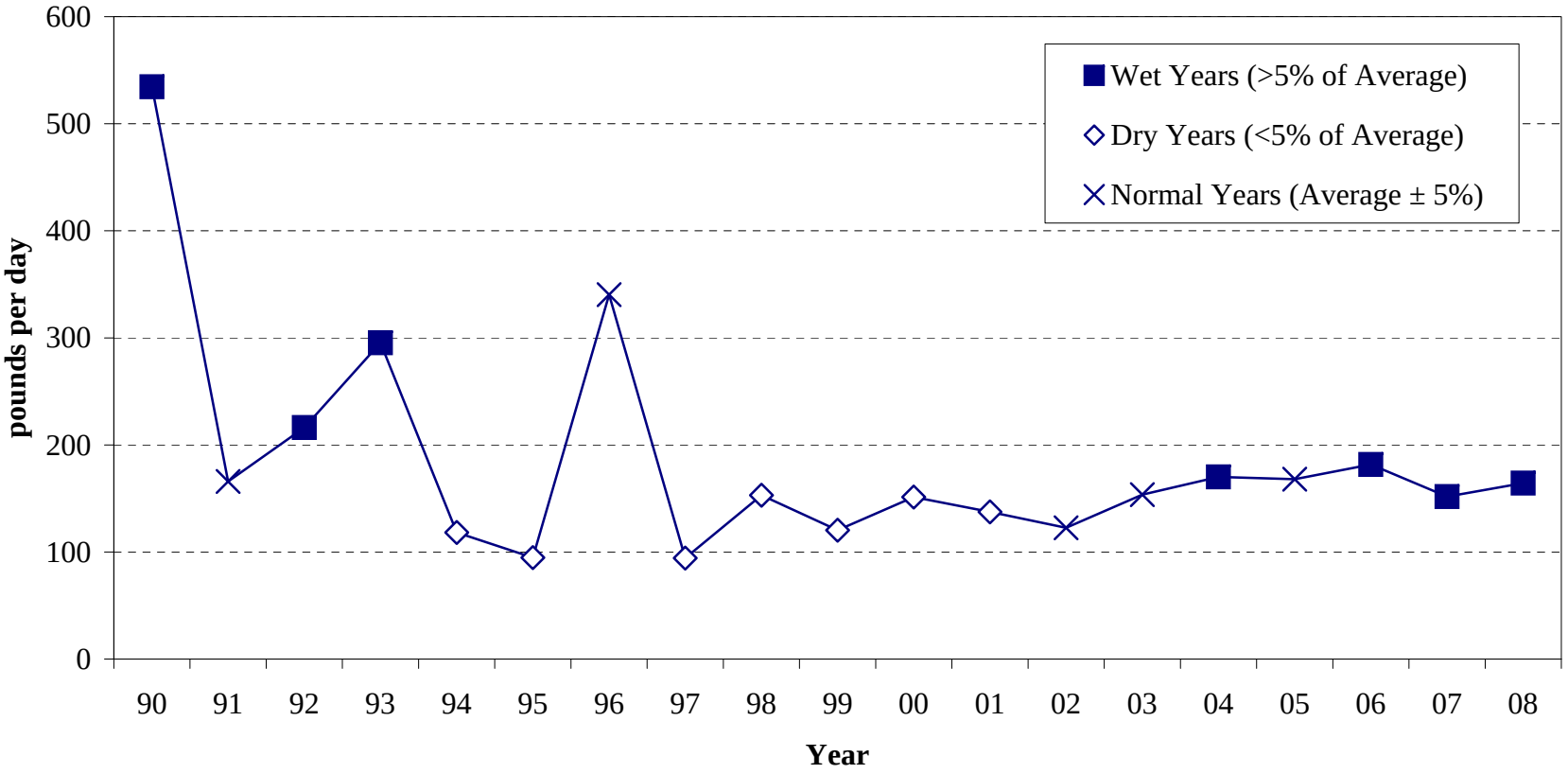

Pounds of phosphorus discharged to Onondaga Lake from non-Metro watershed sources. To evaluate wet and dry years, the 30-year rolling average precipitation was used. Therefore, 2006 is represented as a wet year, with precipitation greater than 5% of the 30-year average 1976-2005; and 2005 was a normal year relative to the 30-year average from 1975-2004.

Library Reference 5.3.6

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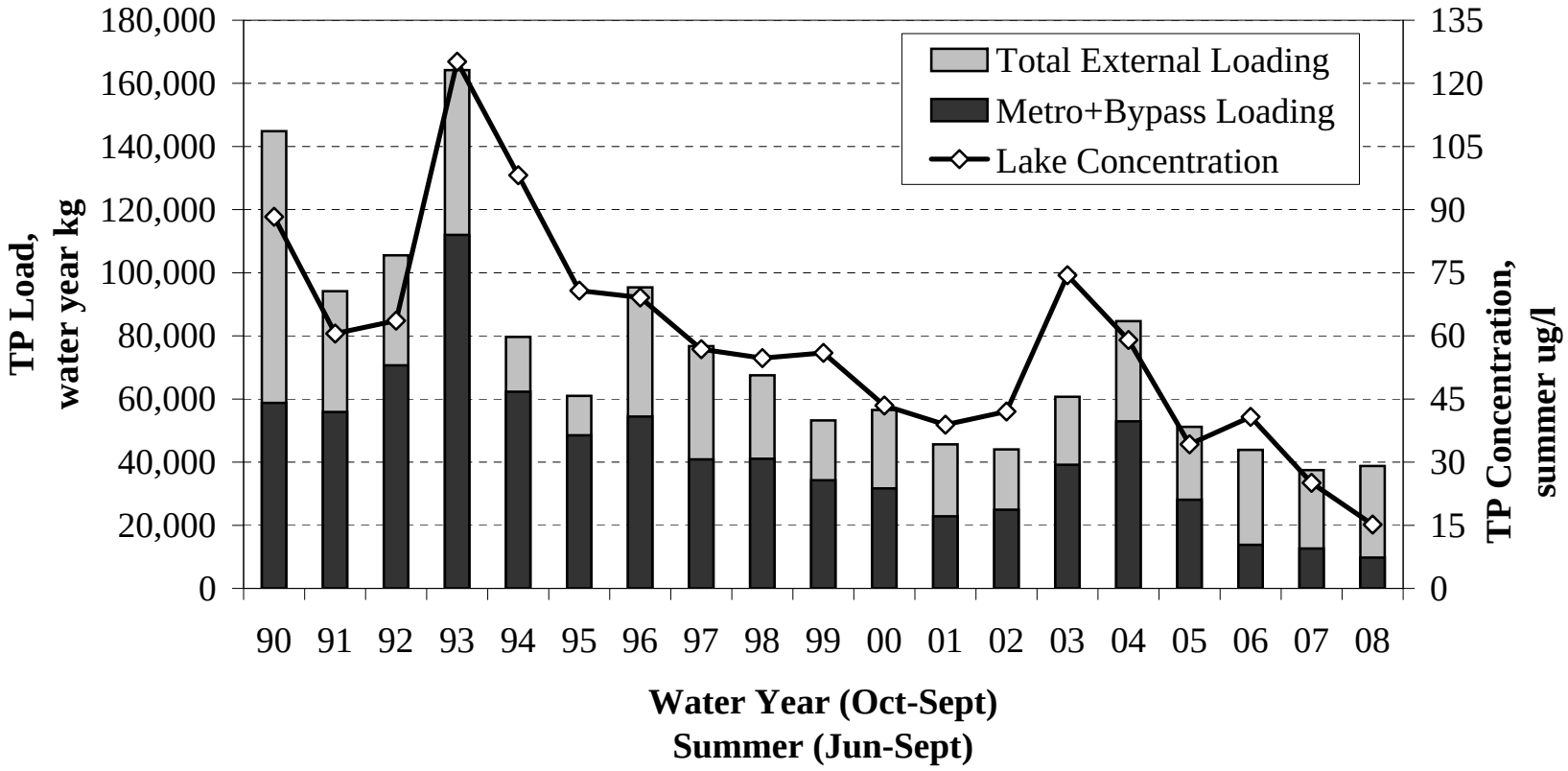

Total phosphorus external loading to Onondaga Lake by Water Year (October to September), also showing the Metro and Bypass portion, compared with South Deep summer (June-September) daily average concentrations for upper waters (0 to 3 meters). The lake concentrations mirror the Metro and Bypass portions of the total loading.

Library Reference 5.4

Onondaga Creek-Route 20 and Spencer Street data

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Precipitation events corresponding to sampling events for laboratory analyses.

Analytical Sample Date	Precipitation (inches)						
	Spencer Gauge	Route 20 Gauge	Hancock Airport	3-day Period	Spencer Gauge	Route 20 Gauge	Hancock Airport
04/01/08	0.012	0.05	0.01	03/30-04/01	0.59	0.31	0.88
06/10/08	0.036	na	0.30	06/08-06/10	0.16	0.09	0.34
09/16/08	0	0	0	09/14-09/16	0.27	0.09	0.41
11/12/08	0	0	trace	11/10-11/12	0.06	0.08	0.15

Note: Precipitation is shown for the date of sampling, and for the three-day period prior to and including the date of sampling. The three-day period was selected to provide a perspective on the moisture conditions occurring prior to the sampling event. “na” indicates data were not available for this date.

Comparison of 2008 data from upstream and downstream locations on Onondaga Creek.

Parameter	Sample Date	Onondaga Creek	
		Route 20 Upstream	Spencer Downstream
Solids:			
Total suspended solids	04/01/08	80	144
	06/10/08	14	121
	09/16/08	13	<4.0
	11/12/08	3.0	5.0
Phosphorus:			
Total phosphorus	04/01/08	0.113	0.123
	06/10/08	0.043	0.278
	09/16/08	0.032	0.034
	11/12/08	0.022	0.026
Soluble reactive phosphorus	04/01/08	0.010	0.015
	06/10/08	0.002	0.004
	09/16/08	<0.001	0.009
	11/12/08	0.001	0.008
Total dissolved phosphorus	04/01/08	0.024	0.016
	06/10/08	0.006	0.007
	09/16/08	0.007	0.017
	11/12/08	0.011	0.017
Nitrogen:			
Ammonia-N	04/01/08	0.050	0.058
	06/10/08	0.075	0.178
	09/16/08	0.057	0.030
	11/12/08	0.028	0.021
Total Kjeldahl Nitrogen	04/01/08	0.580	0.600
	06/10/08	0.390	2.110
	09/16/08	0.370	0.320
	11/12/08	0.210	0.240

Library Reference 5.4.3

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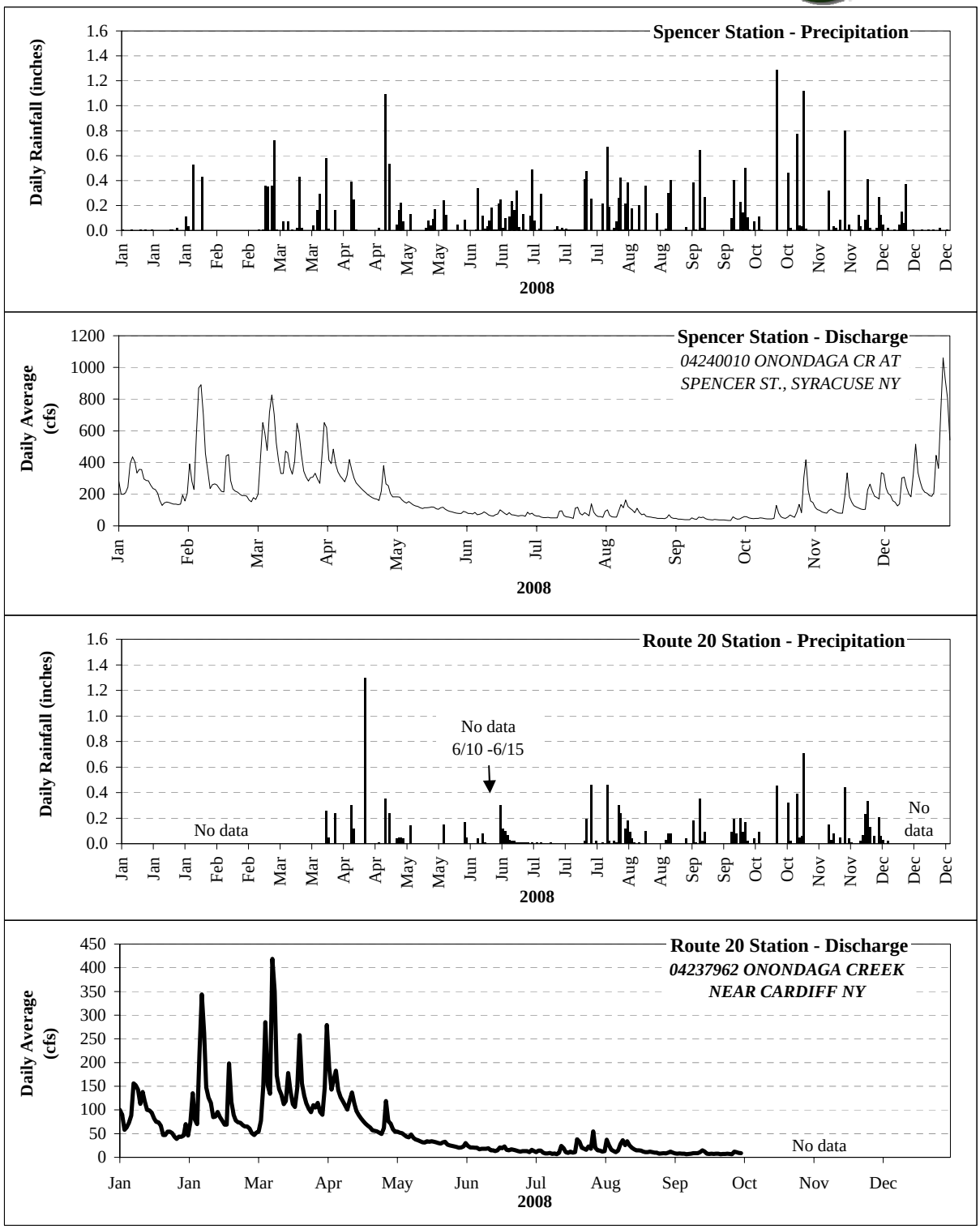

Daily total precipitation and daily average flow in 2008 at Spencer Street (downstream) and Route 20 (upstream) stations on Onondaga Creek.

Library Reference 5.4.4

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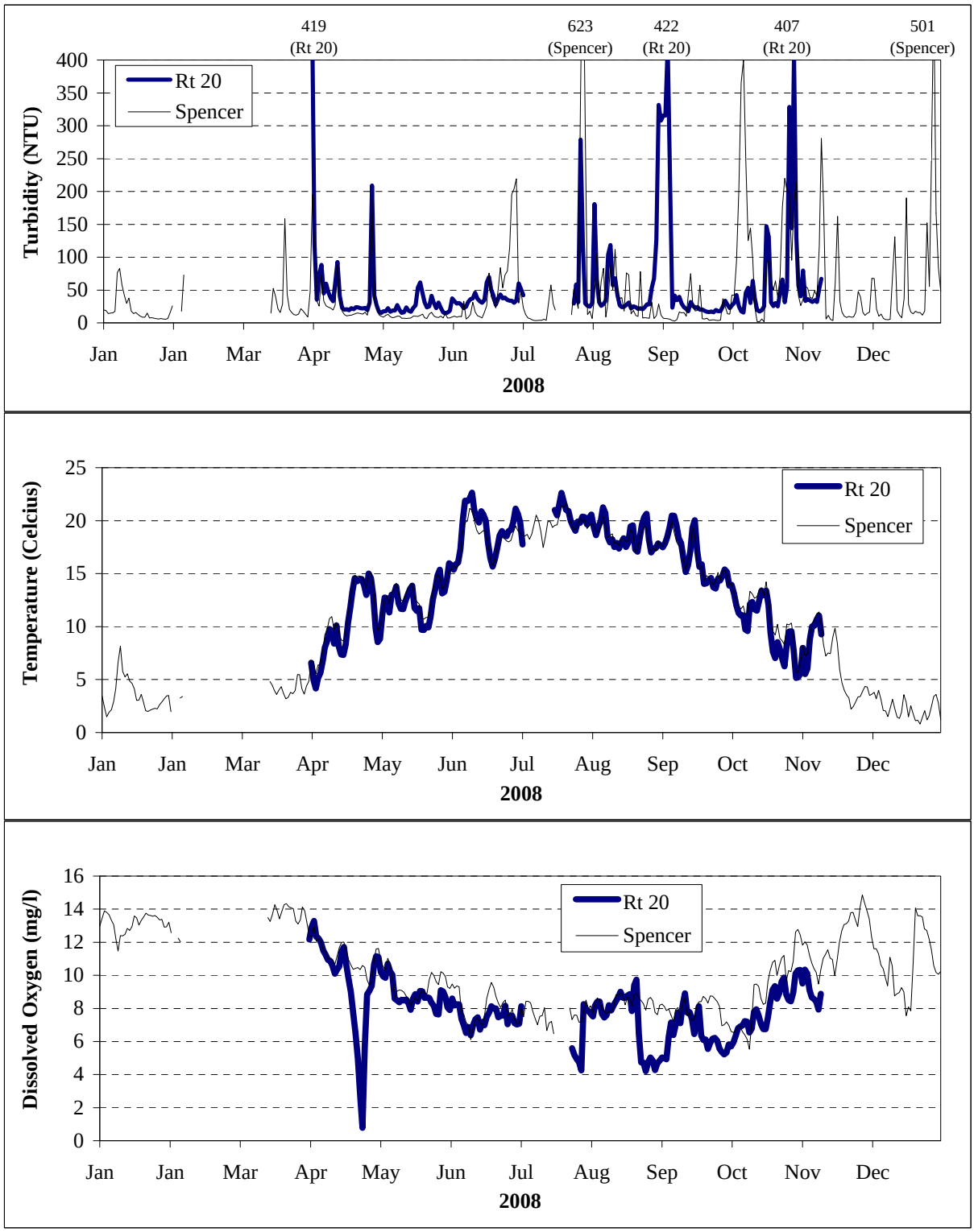

Daily average in-situ sonde results in 2008 for turbidity, temperature and dissolved oxygen at Spencer Street (downstream) and Route 20 (upstream) stations on Onondaga Creek. Daily averages calculated from 15-minute interval data.

Library Reference 5.4.5

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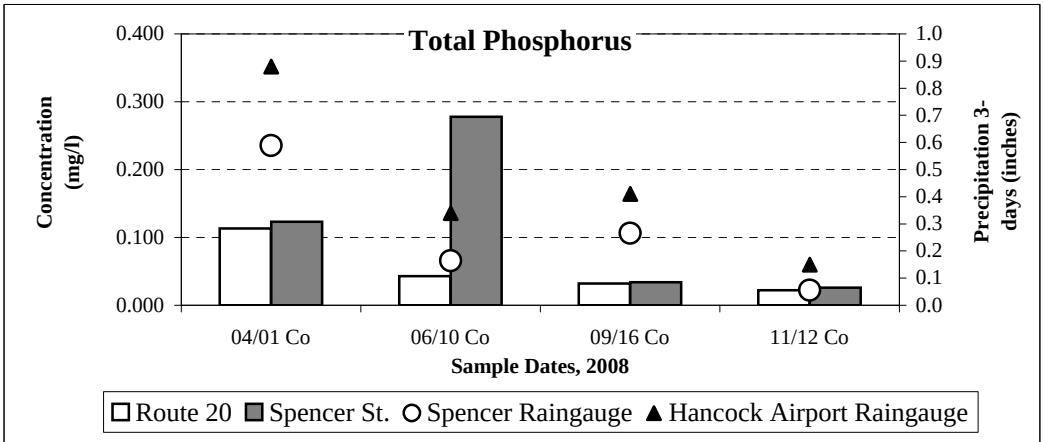
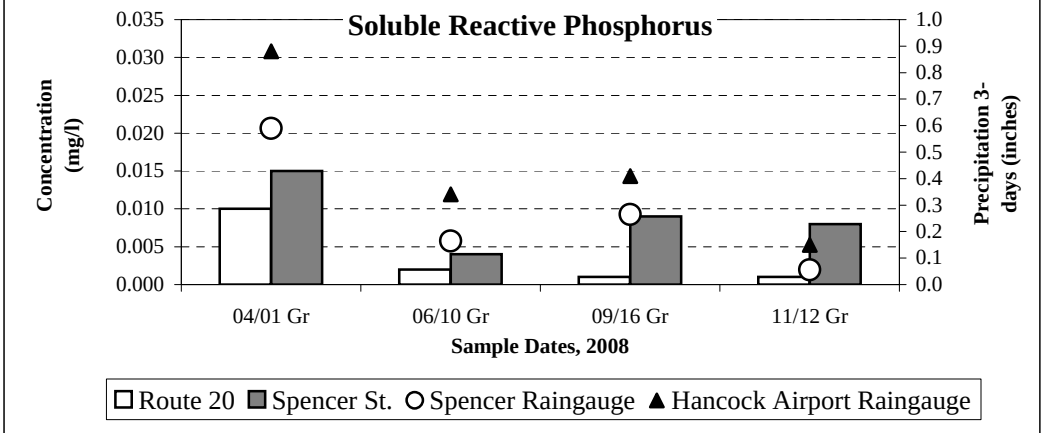
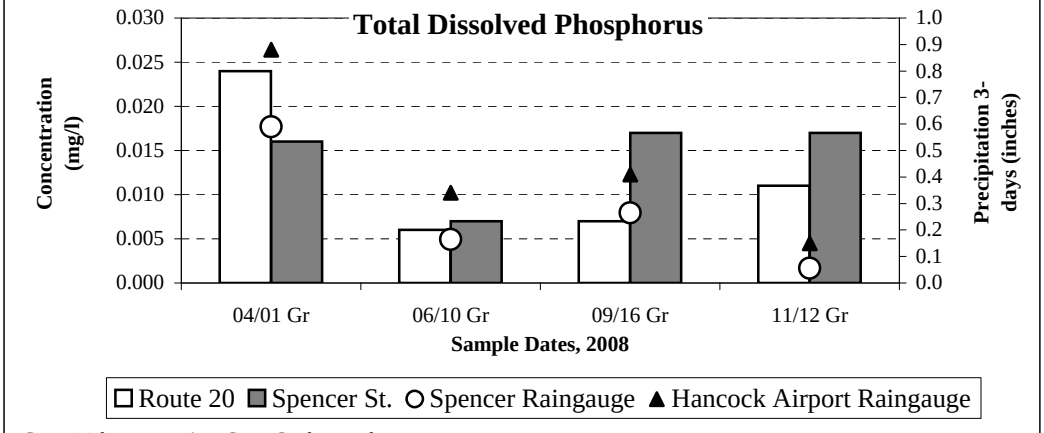


Co = 24-hr composite; Gr = Grab sample



Co = 24-hr composite; Gr = Grab sample



Co = 24-hr composite; Gr = Grab sample

Analytical results for phosphorus, with the sum of precipitation over three-days up to and including the sample date.

Library Reference 5.4.6

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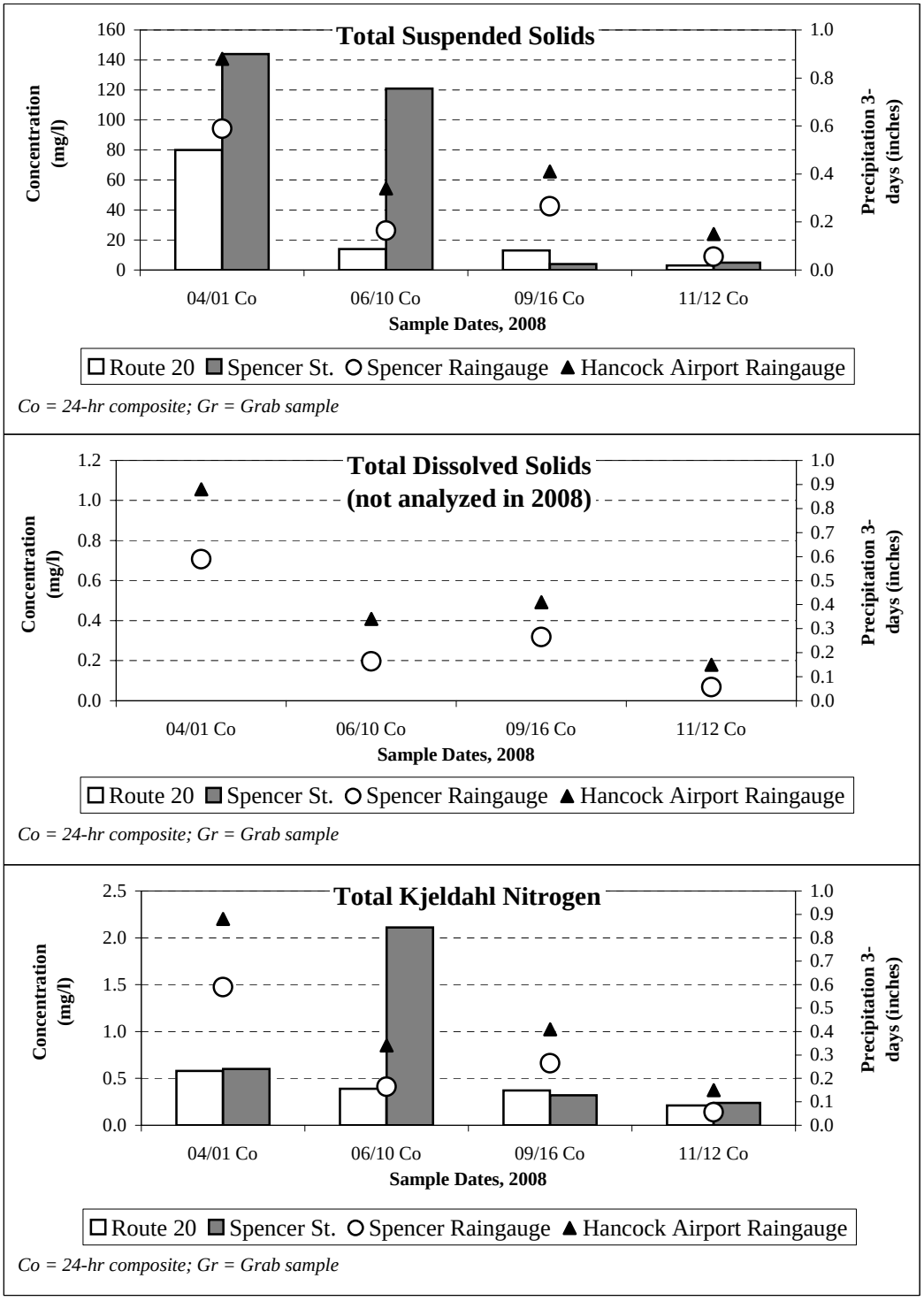

Analytical results for solids and Total Kjeldahl Nitrogen, with the sum of precipitation over three-days up to and including the sample date.

Library Reference 5.4.7

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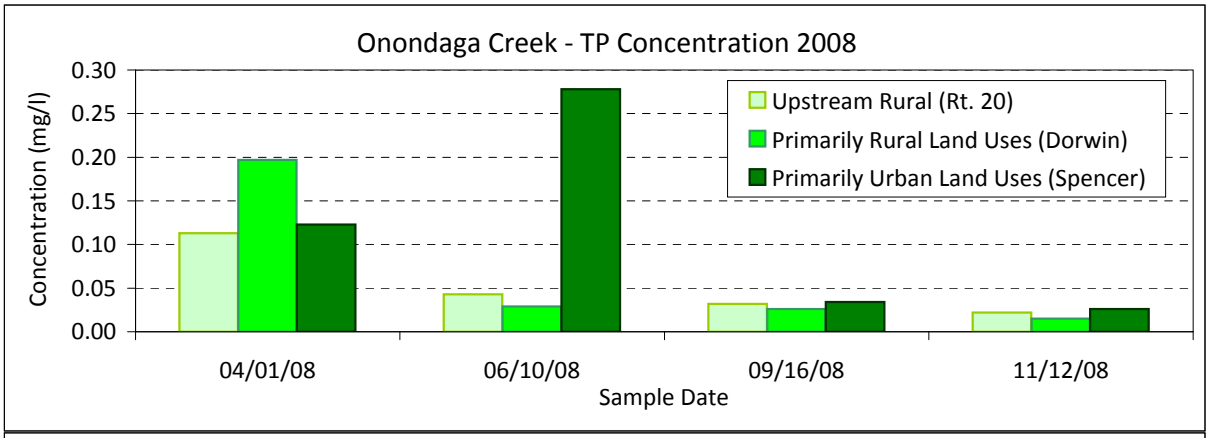

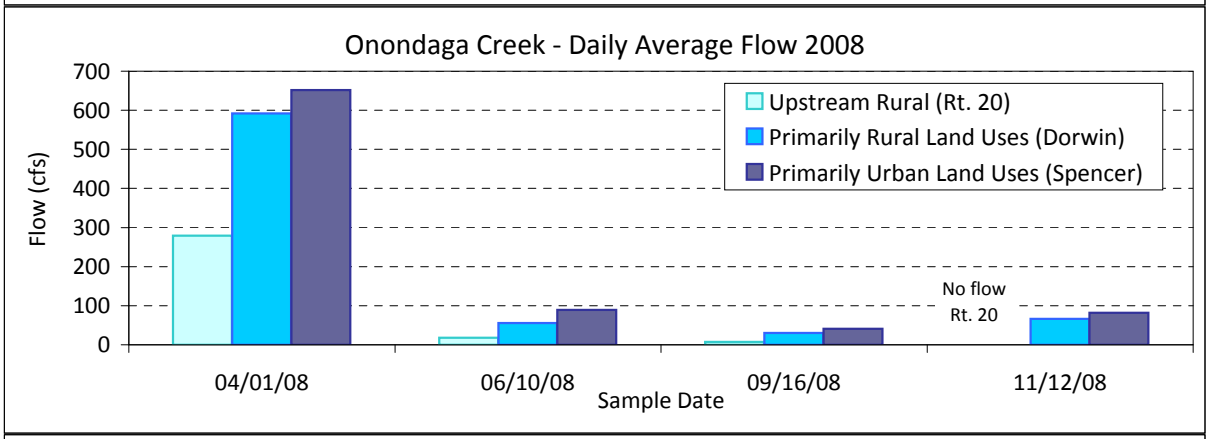

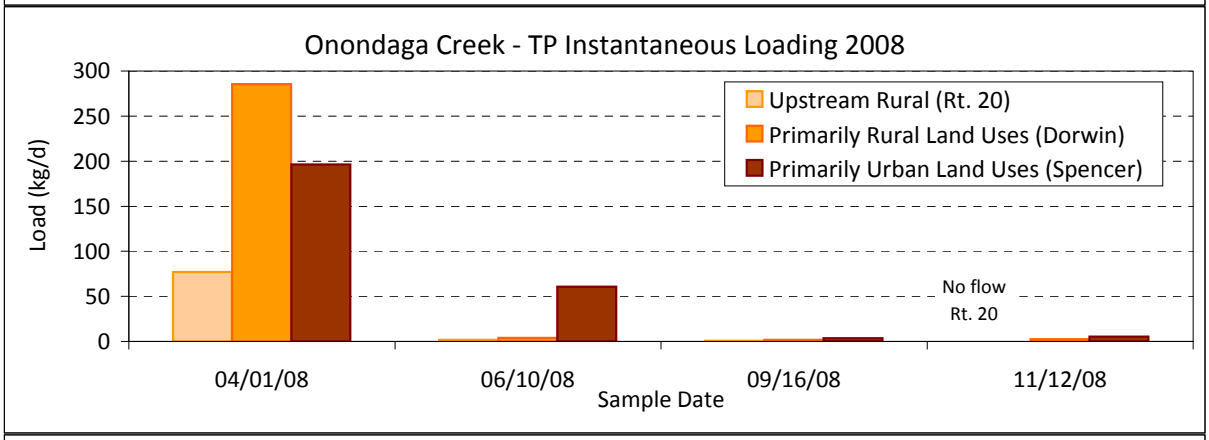

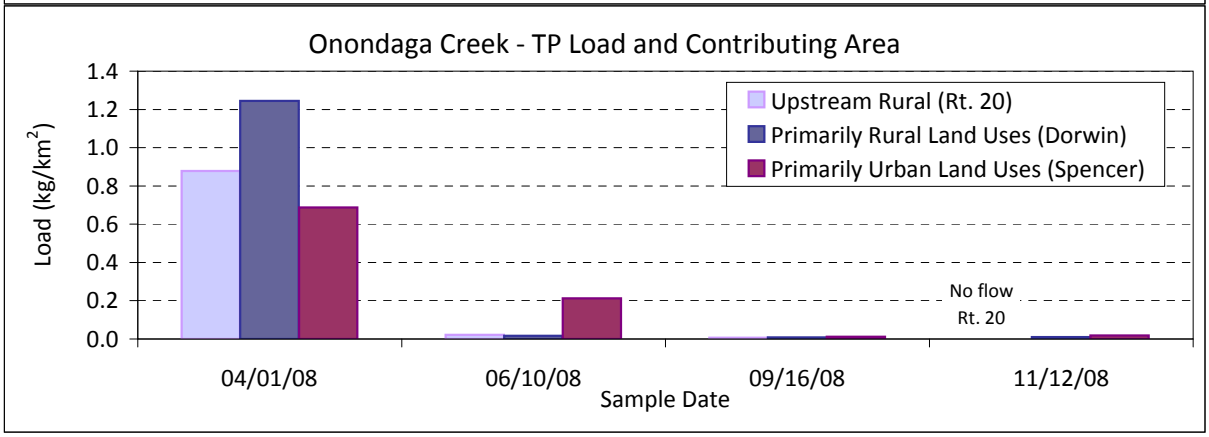

Library Reference 5.5

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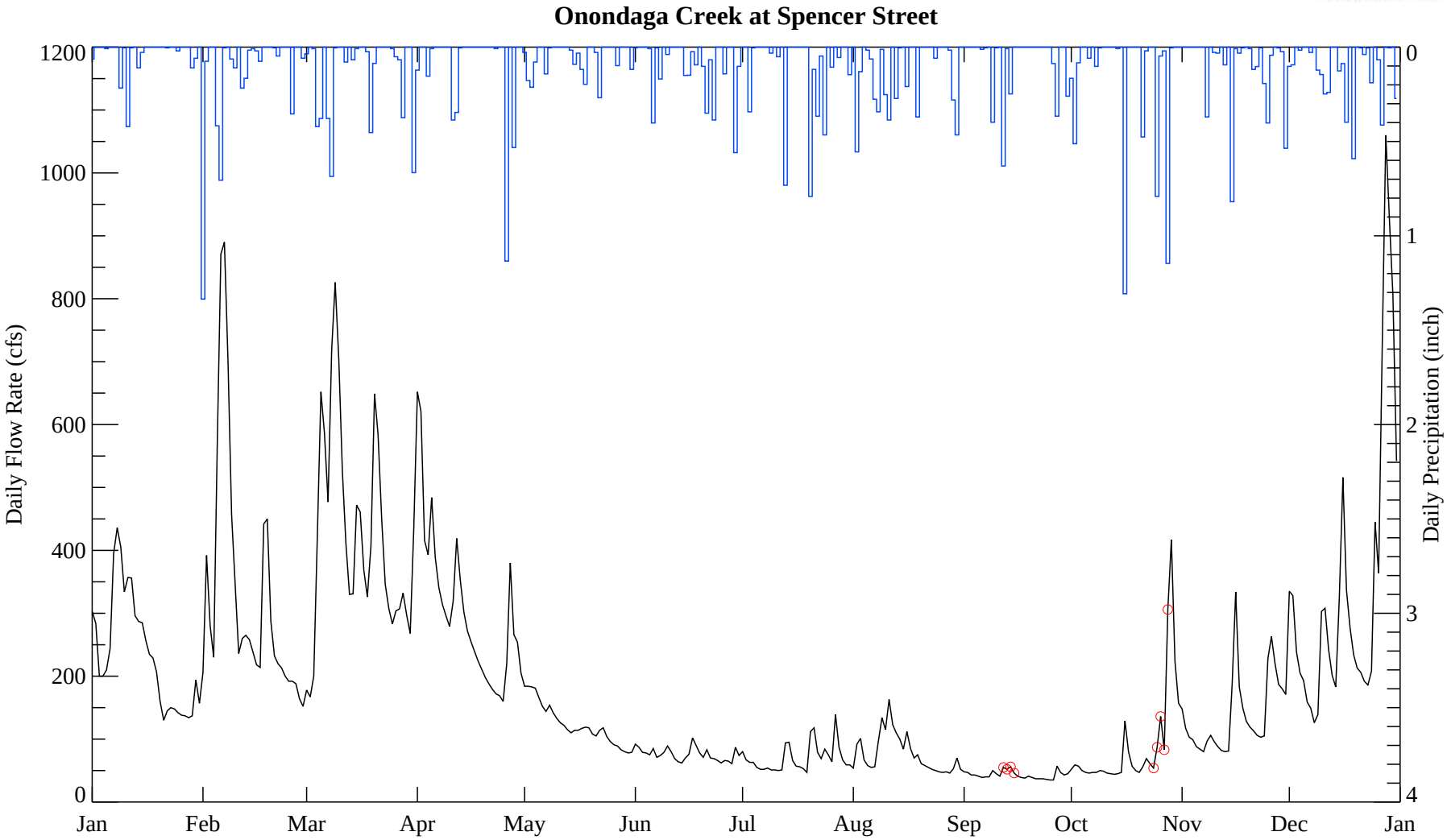

Temporal plot of USGS daily flow in Onondaga Creek at Spencer Street, precipitation at Metro station and days that storm surveys were conducted in 2008.

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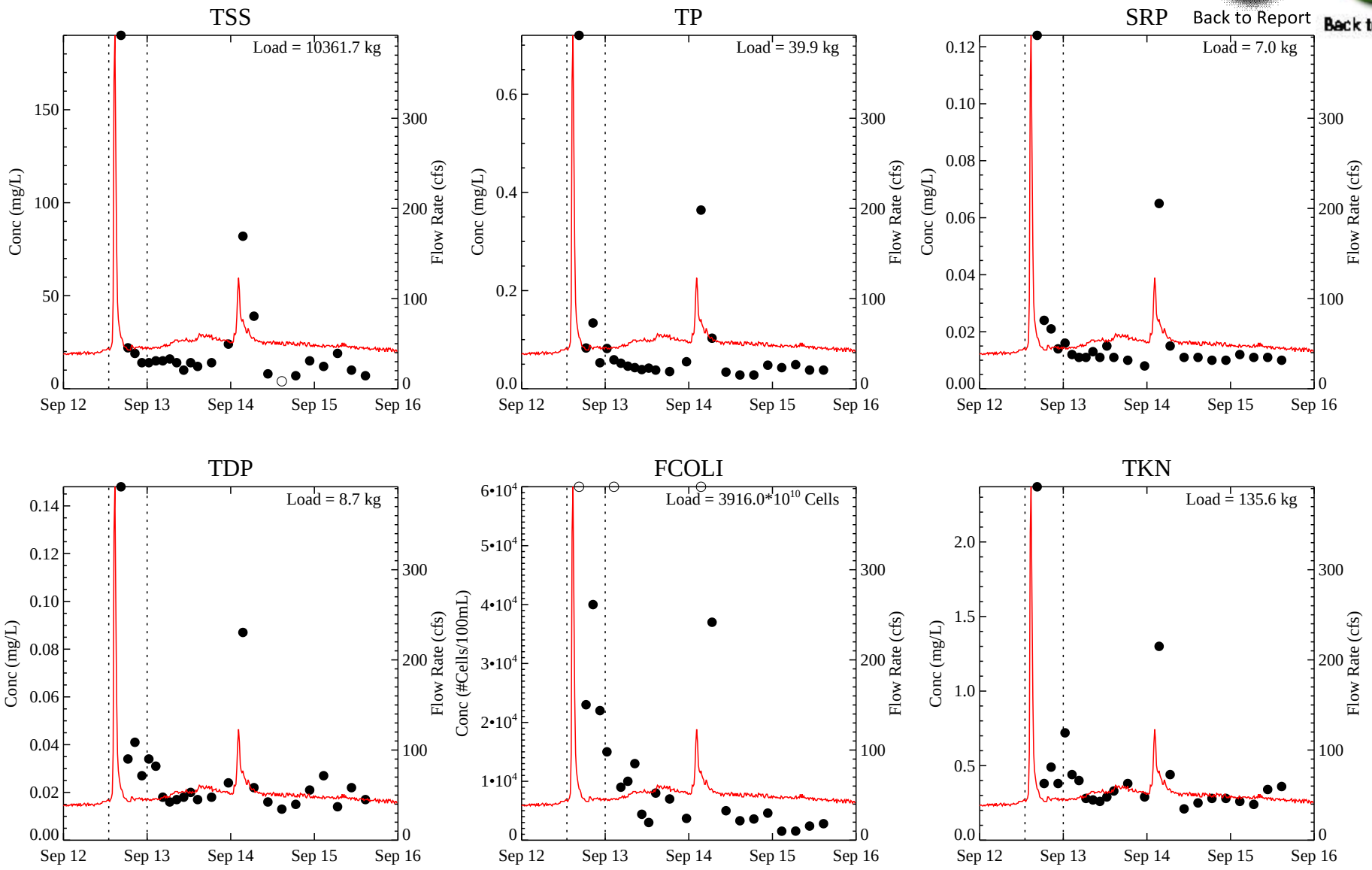
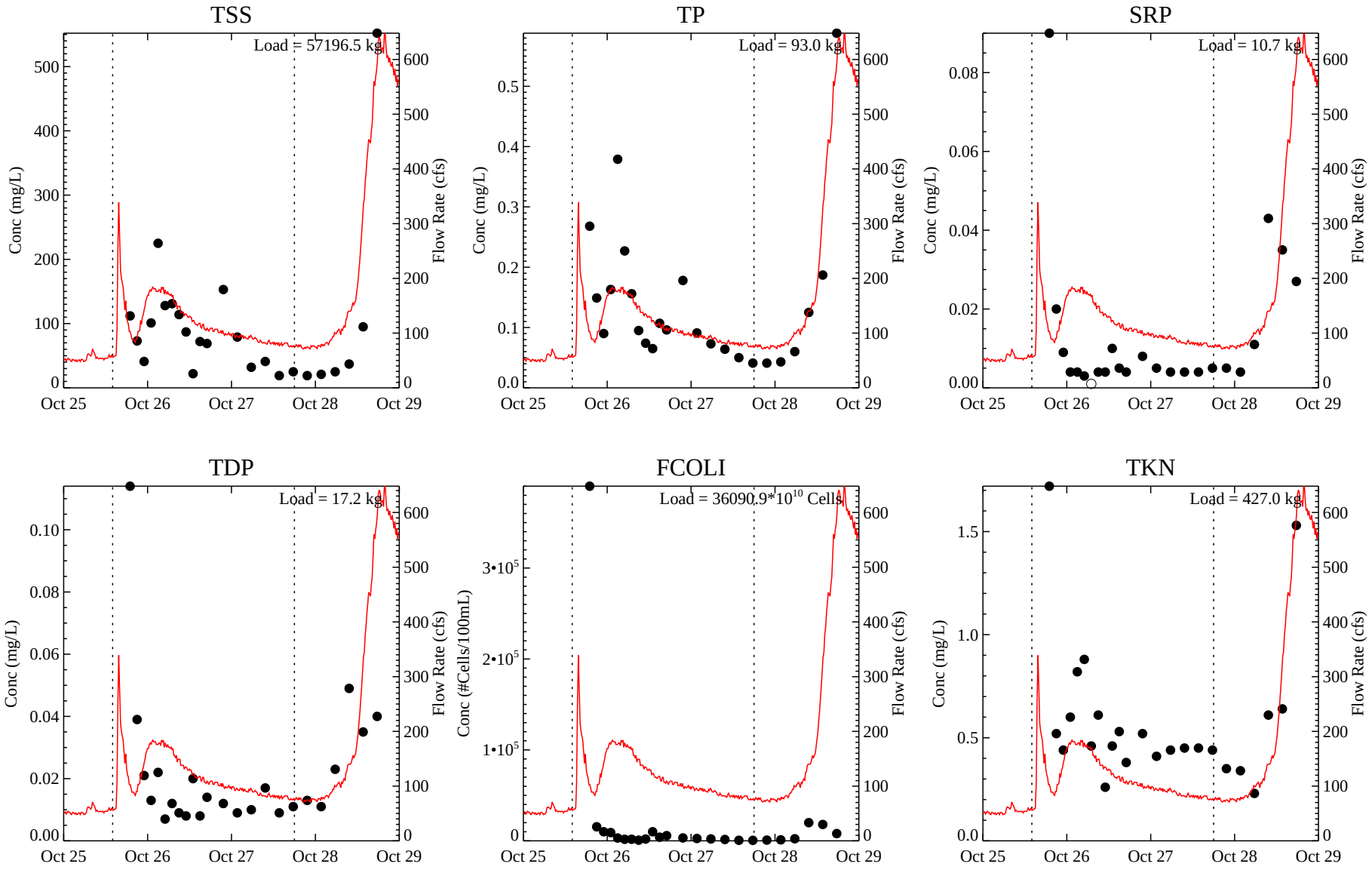
Thu Jun 11 14:10:29 2009



Temporal plot of storm survery data collected by OCDWEP and 15-minute flows recorded by USGS in Onondaga Creek at Spencer St in September 2008.

Note: Triangle symbols denote samples that reached maximum detection limit; Vertical dashed lines denote start and end time of storm period.

- Concentration
- Conc Flagged as < or >
- Flow



Temporal plot of storm survery data collected by OCDWEP and 15-minute flows recorded by USGS in Onondaga Creek at Spencer St in October 2008.

Note: Triangle symbols denote samples that reached maximum detection limit; Vertical dashed lines denote start and end time of storm period.

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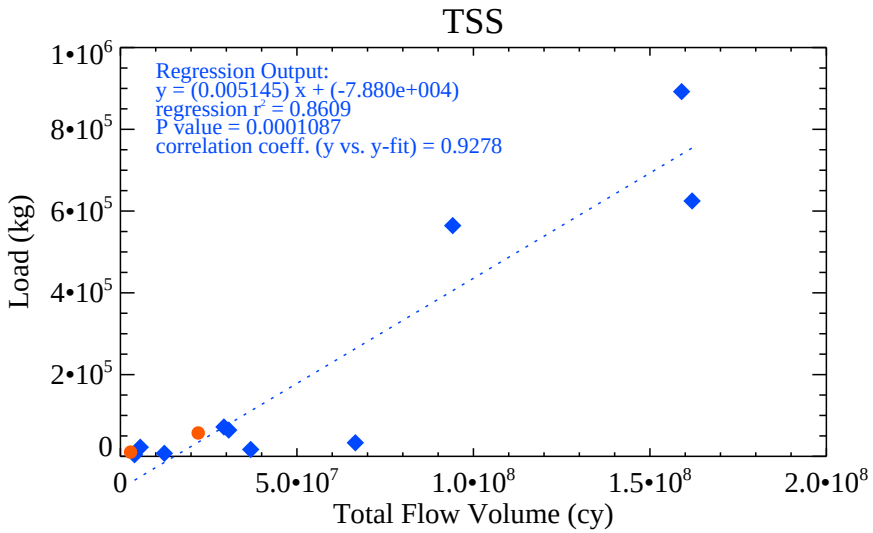

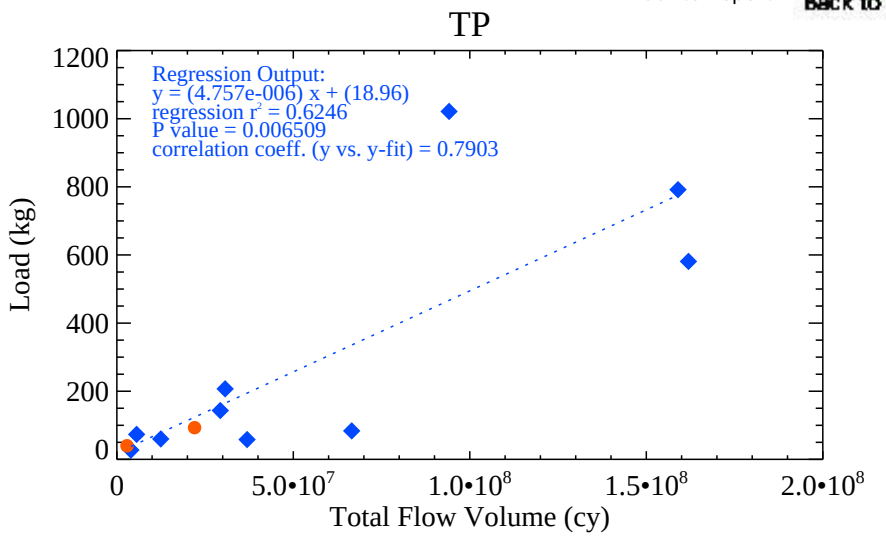

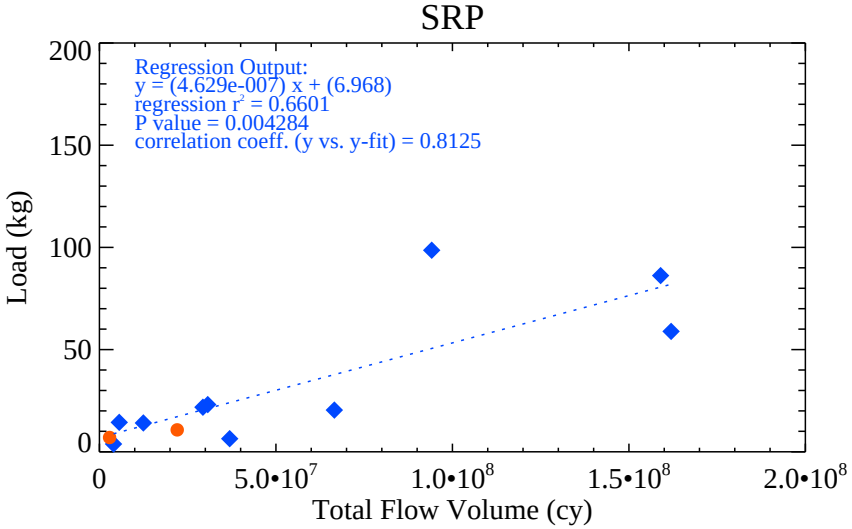

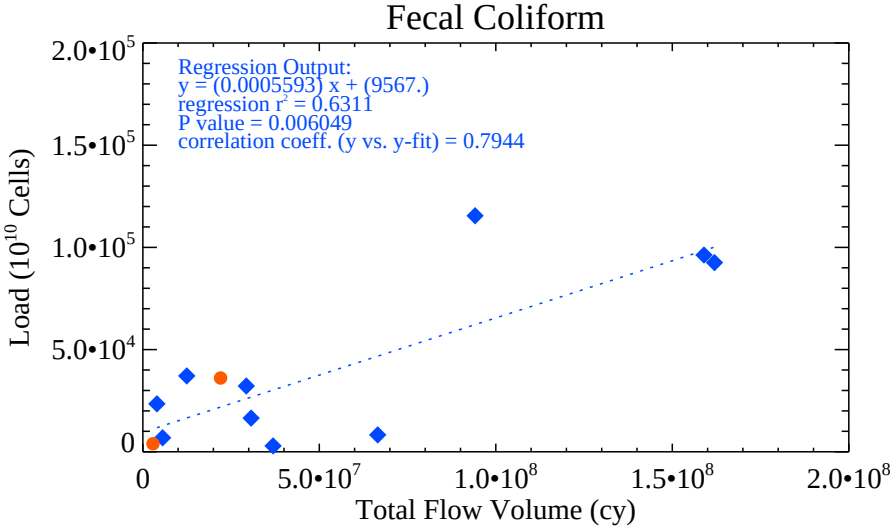

Plot of total load and total storm flow volume for all available storm events in Onondaga Creek at Spencer Street.

Note: Regression based on 1999-2003 data.

1999-2003
2008

Library Reference 5.8

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Dry and wet weather tributary bacteria analyses

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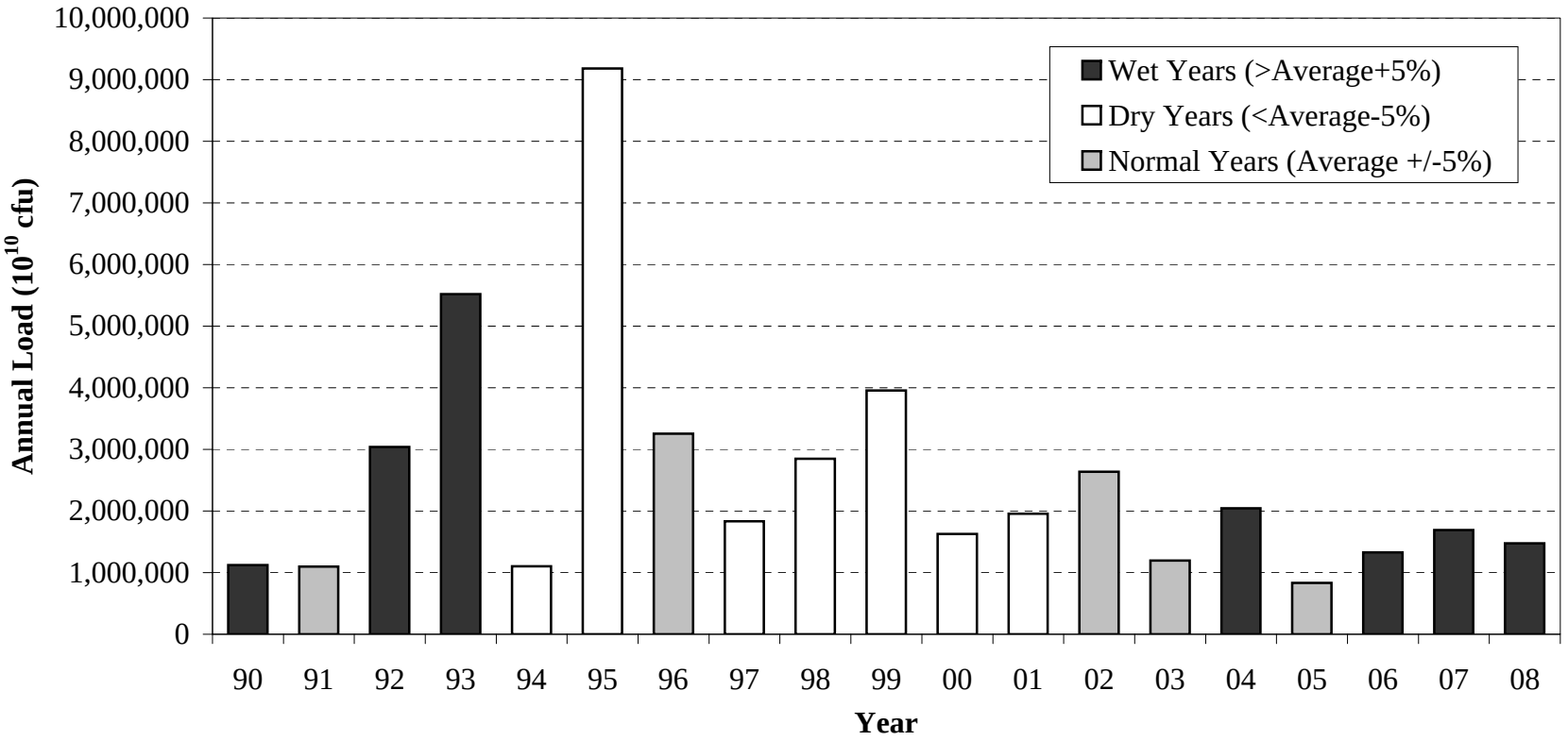

Annual total loading of fecal coliforms over time, coded for wet, dry and normal precipitation years. Wet years were defined as precipitation 5% greater than the preceding 30-year average; dry years were defined as precipitation 5% less than the preceding 30-year average; normal years were defined as precipitation equal to the preceding 30-year average ± 5%.

Library Reference 5.8.2

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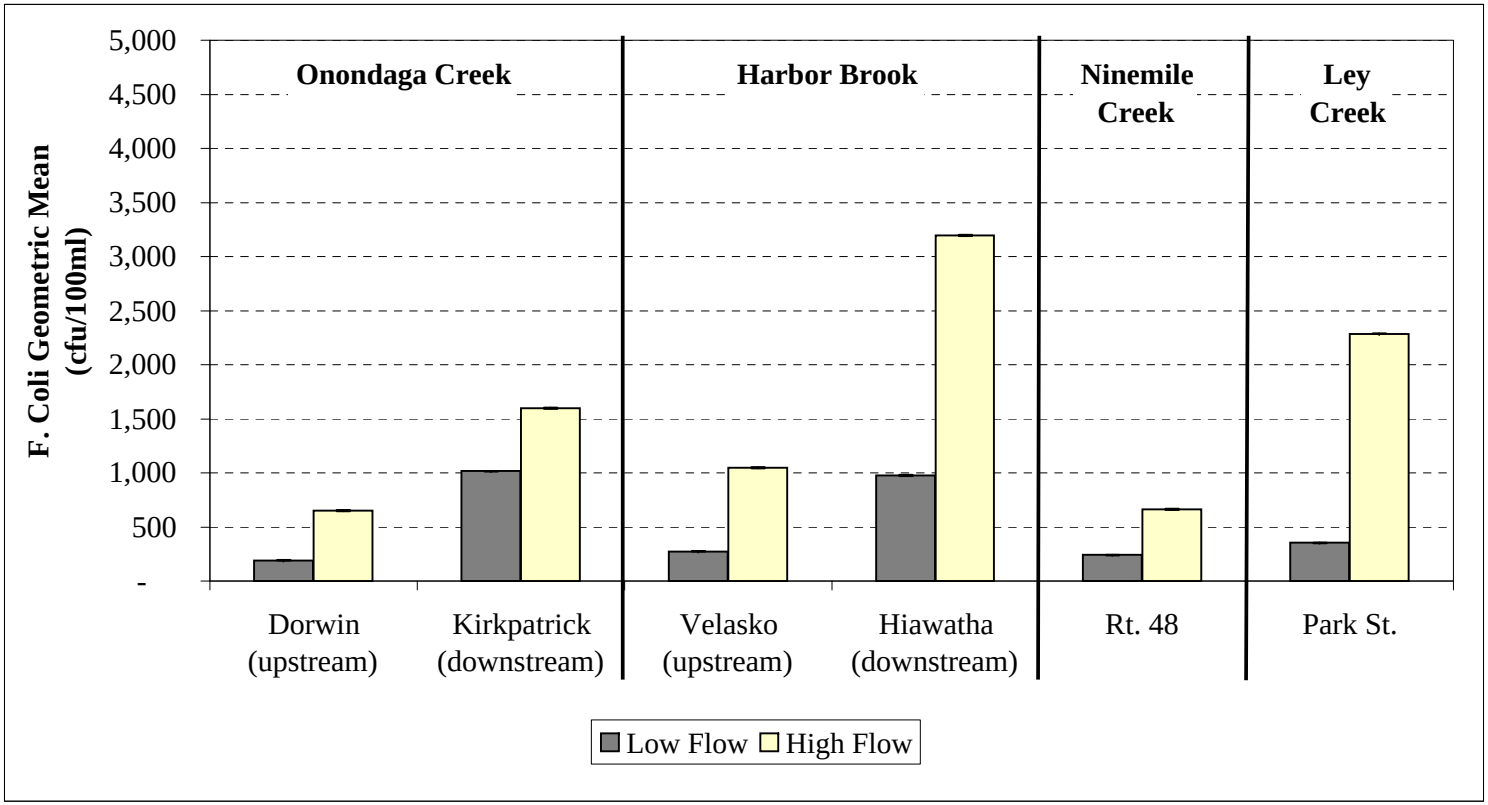

Fecal coliform bacteria (geometric mean and standard deviation) for the summer period June to September (1999-2008), showing low flow and high flow statistics by monitoring site. Low flow represents samples collected when daily average flow was less than or equal to the long-term monthly average flow. High flow represents samples collected when daily average flow was greater than one standard deviation above the monthly average flow. (As there were no samples collected when daily flows met the low flow definition at Onondaga Creek/Kirkpatrick site in 2000 and 2006, samples with flow less than 100 cfs were used.)

Library Reference 5.8.3

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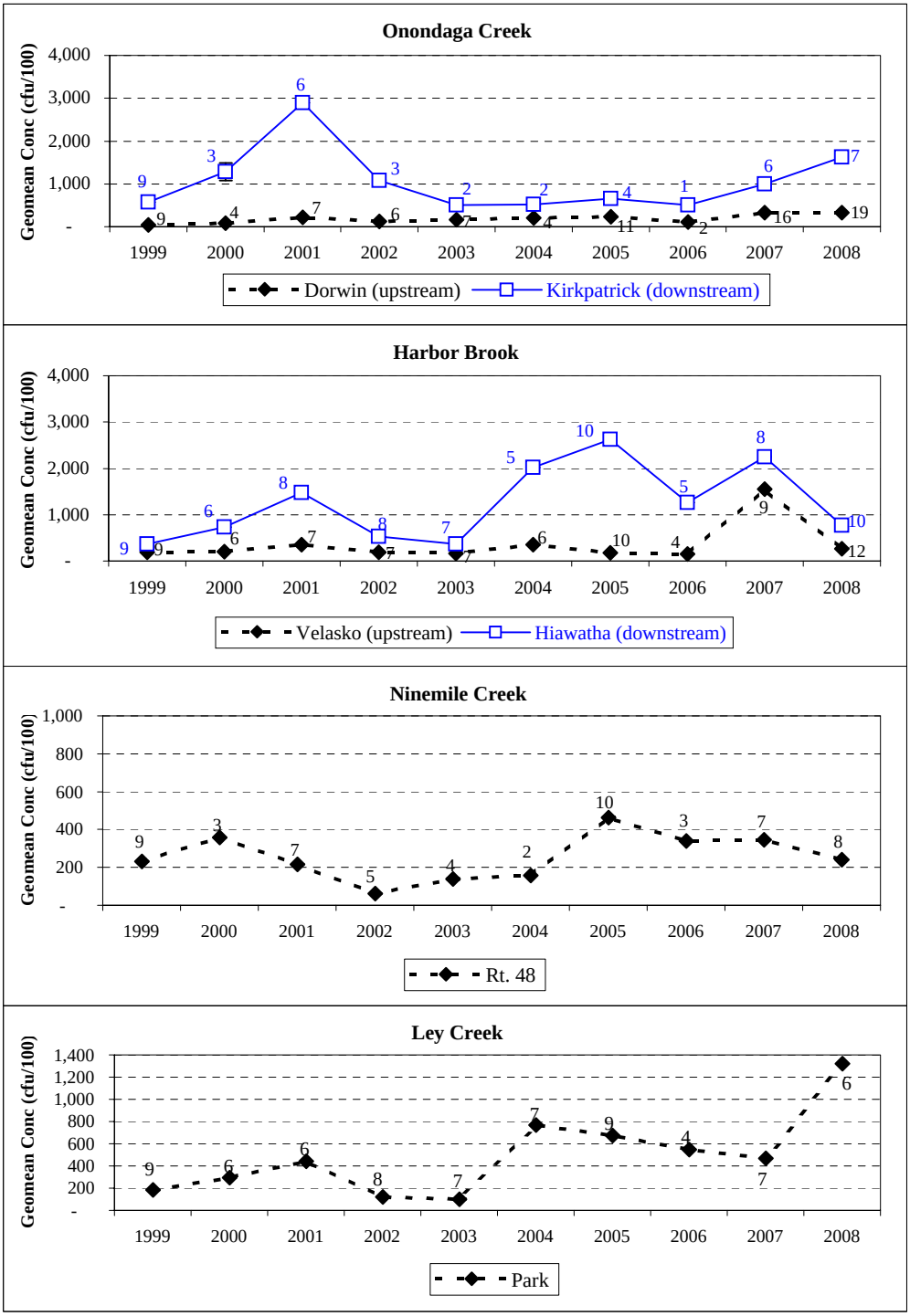

Geometric mean concentration, with standard deviation, of fecal coliform bacteria at base flow during summer (June to September) in Onondaga Lake tributaries. Number of samples per summer is shown. Base flow is defined as daily flow (cfs) at or less than the monthly average. (As there were no daily flows that met the base flow definition at Onondaga Creek Kirkpatrick site in 2000 and 2006, samples with flows less than 100 cfs were used.)

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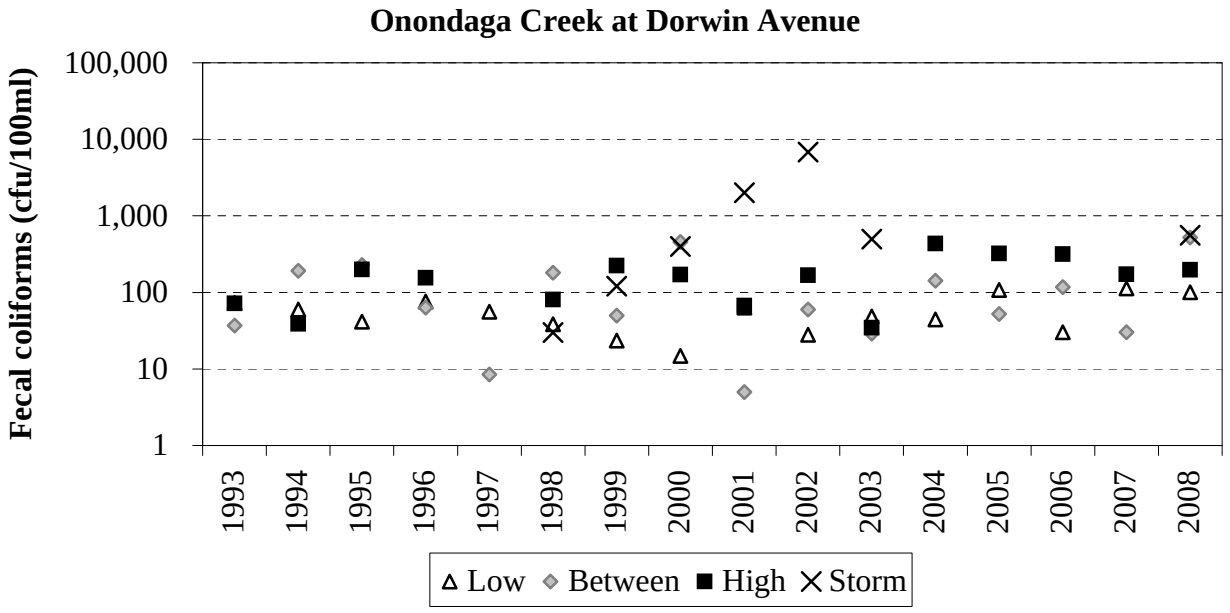

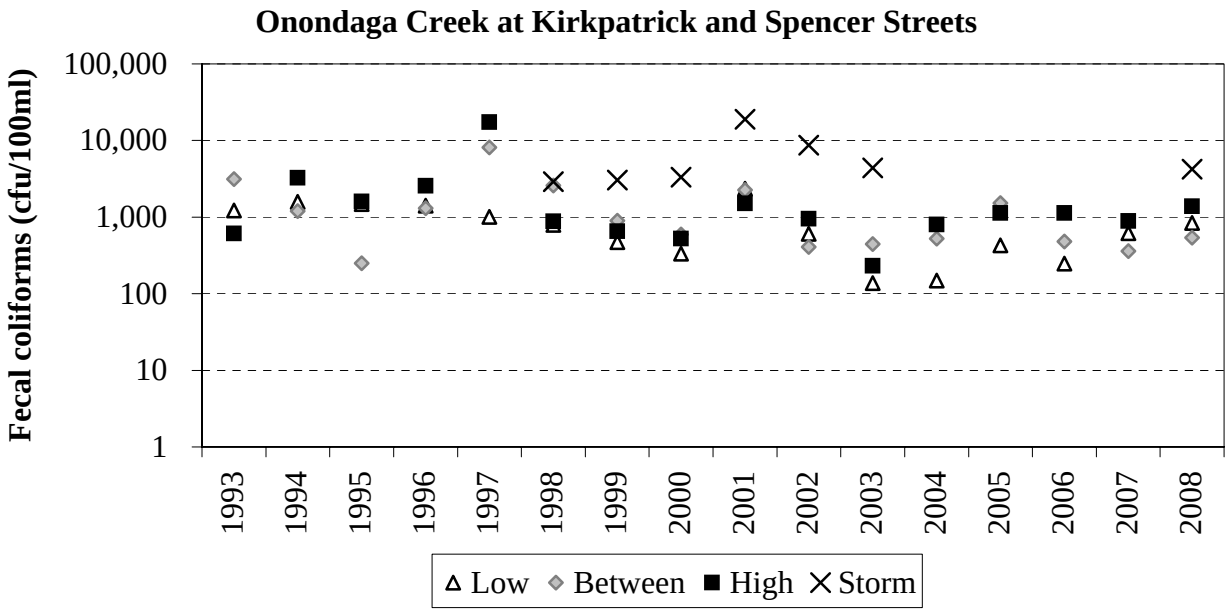

Annual geometric means of fecal coliform concentrations at two monitoring stations on Onondaga Creek. "Low" represents stream flow conditions less than or equal to the monthly average flow. "High" represents stream flow conditions greater than one standard deviation above the monthly average flow. "Between" represents stream flow conditions in the range between low and high flows. "Storm" represents samples collected for storm events.

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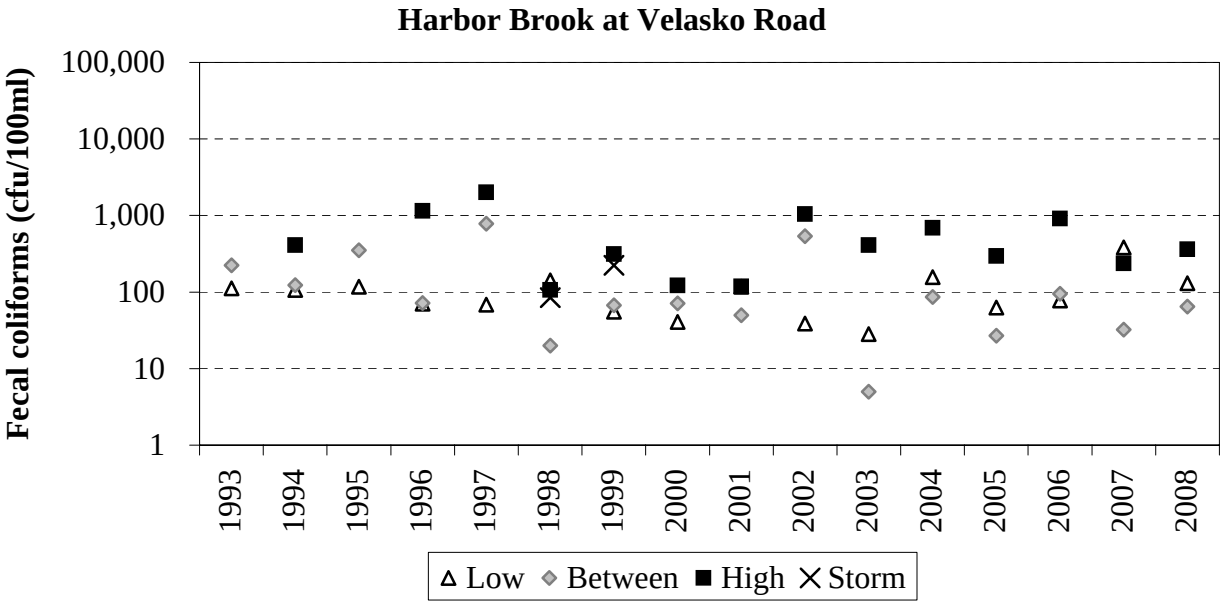

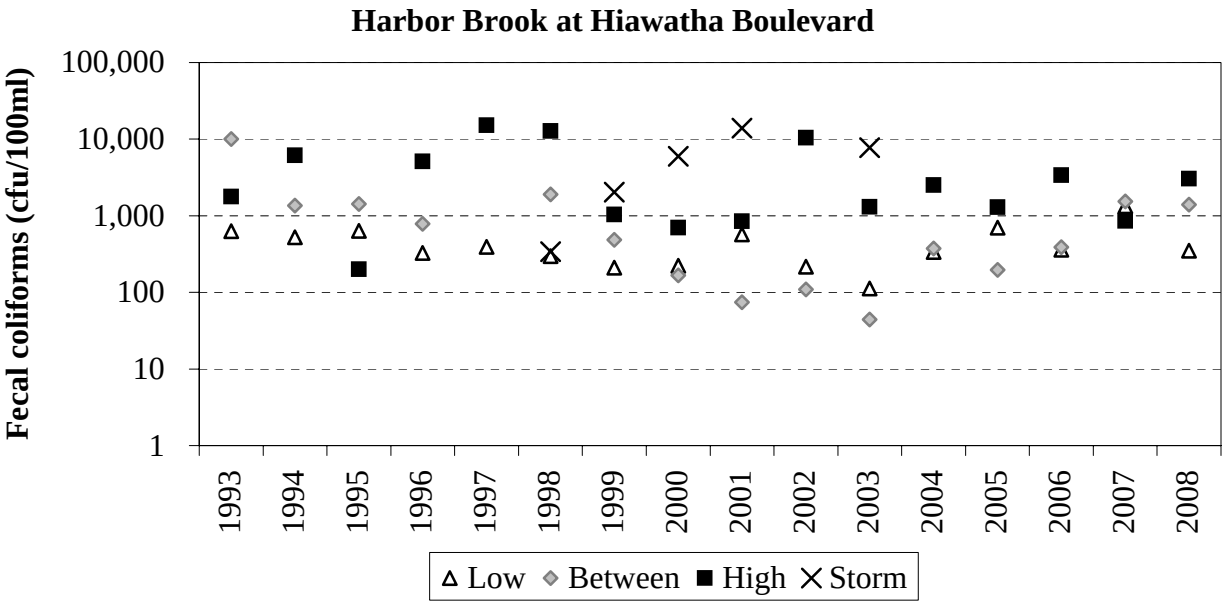

Annual geometric means of fecal coliform concentrations at two monitoring stations on Harbor Brook. "Low" represents stream flow conditions less than or equal to the monthly average flow. "High" represents stream flow conditions greater than one standard deviation above the monthly average flow. "Between" represents stream flow conditions in the range between low and high flows. "Storm" represents samples collected for storm events.

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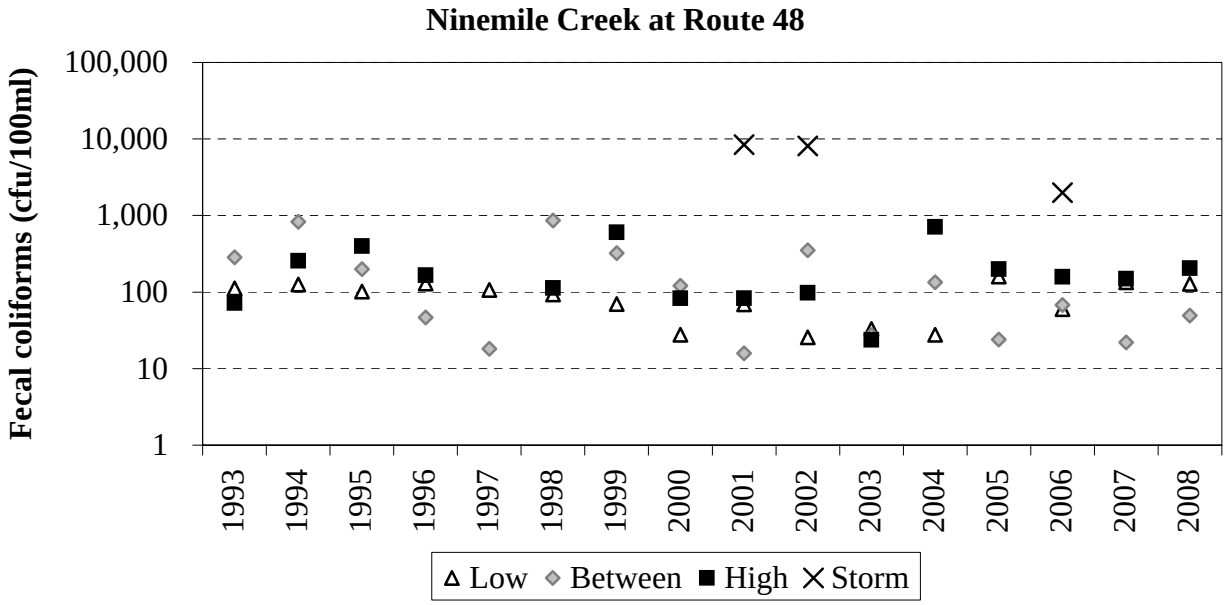

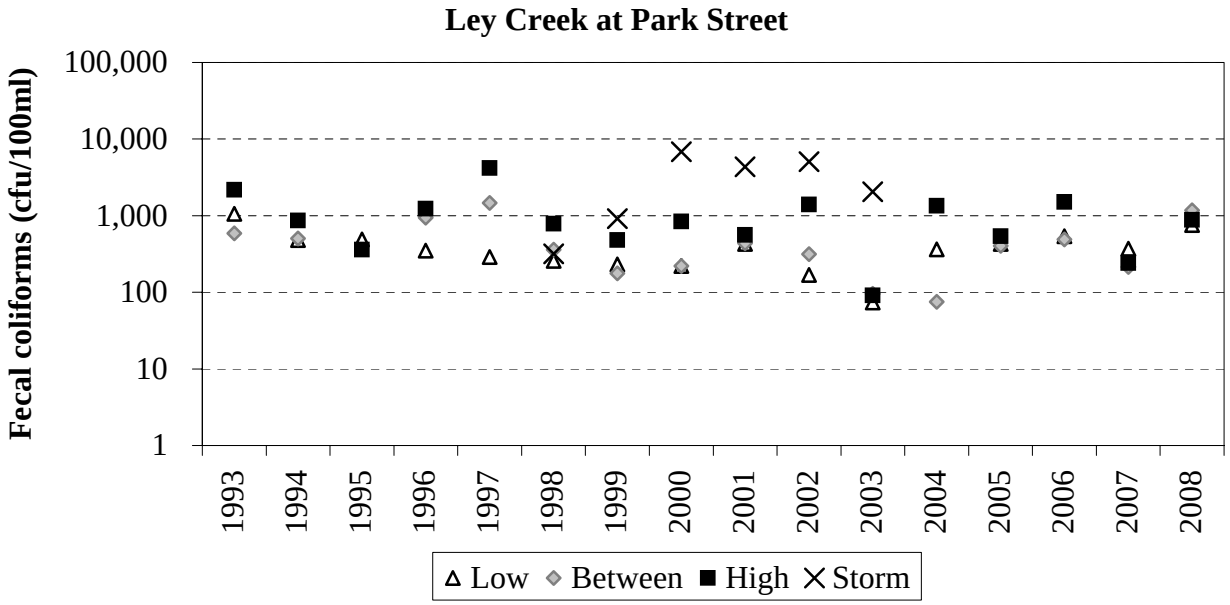

Annual geometric means of fecal coliform concentrations at stations on Ninemile Creek and Ley Creek. "Low" represents stream flow conditions less than or equal to the monthly average flow. "High" represents stream flow conditions greater than one standard deviation above the monthly average flow. "Between" represents stream flow conditions in the range between low and high flows. "Storm" represents samples collected for storm events.

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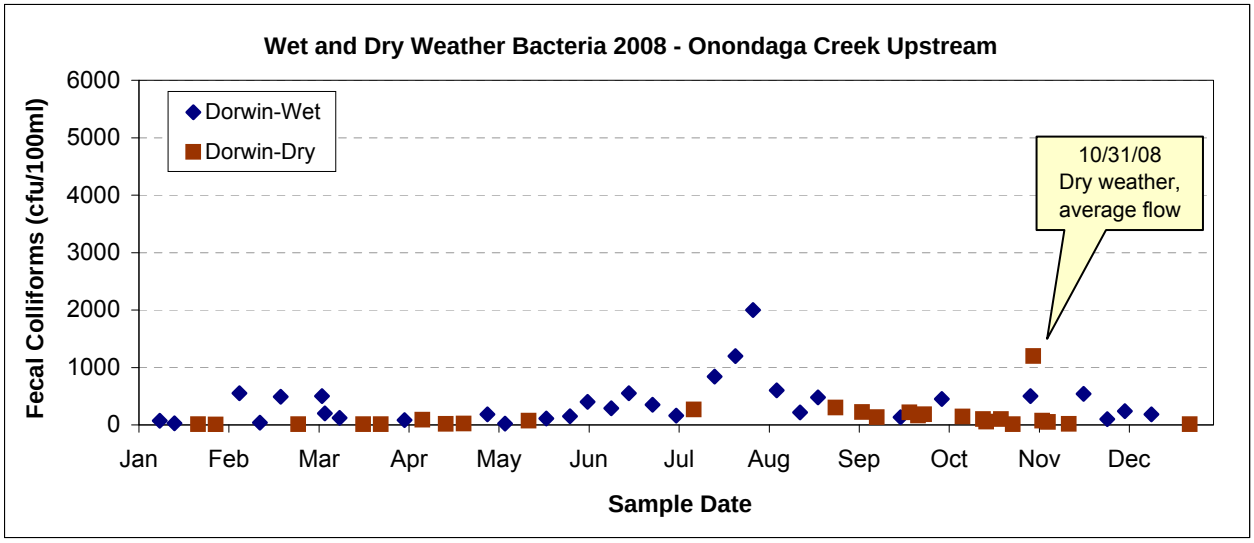
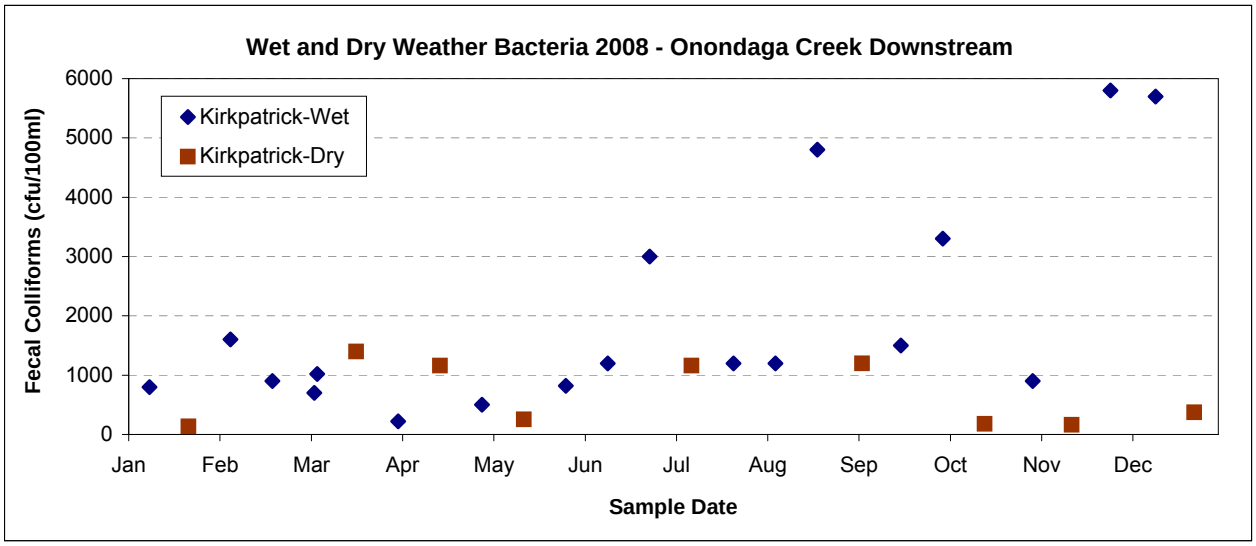
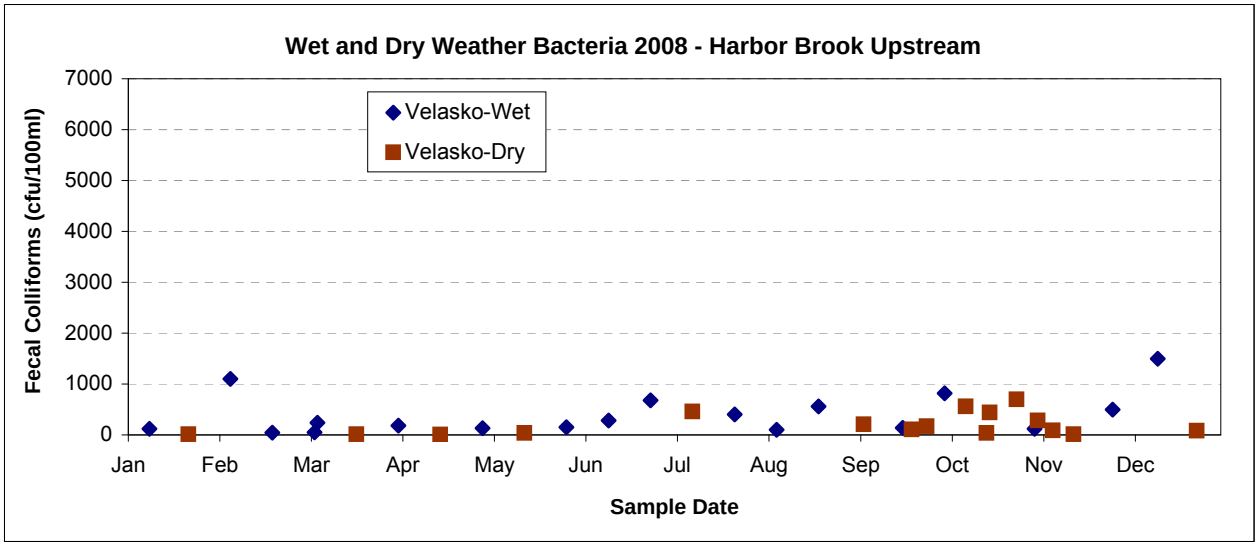
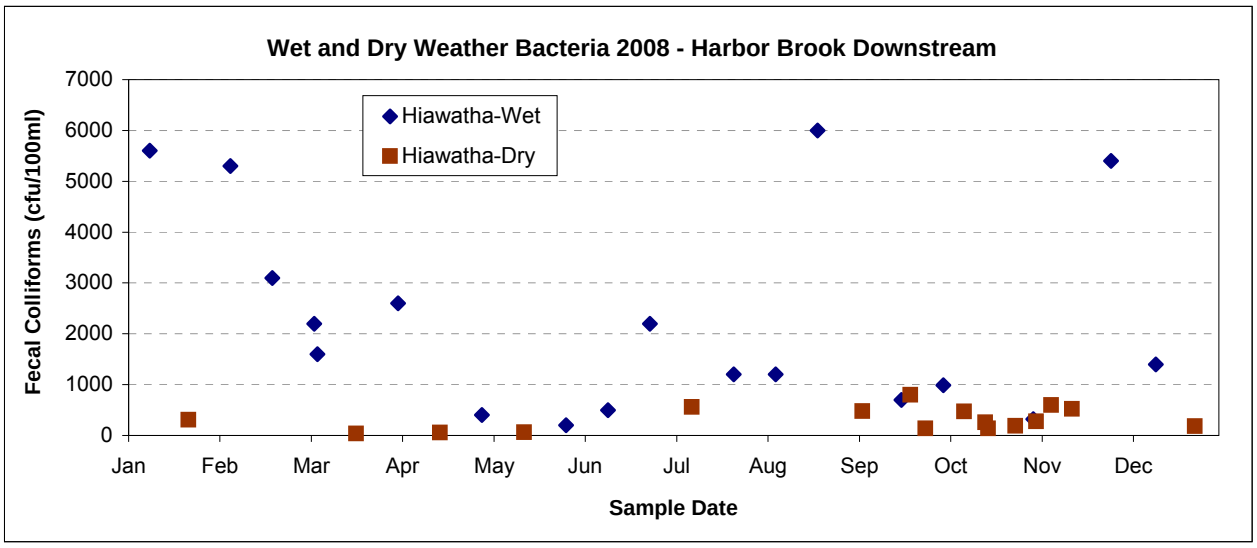




Based on the rainfall totals for the 2008 tributary (Biweekly and Weekly) sampling event dates, "dry" indicates the total inches of rain on the preceding 48 hours and up to 12:00 pm on the day of the sampling event that meet the dry weather criteria of <0.08 inches of rain for the event. Rainfall data is from the Metro Weather station.





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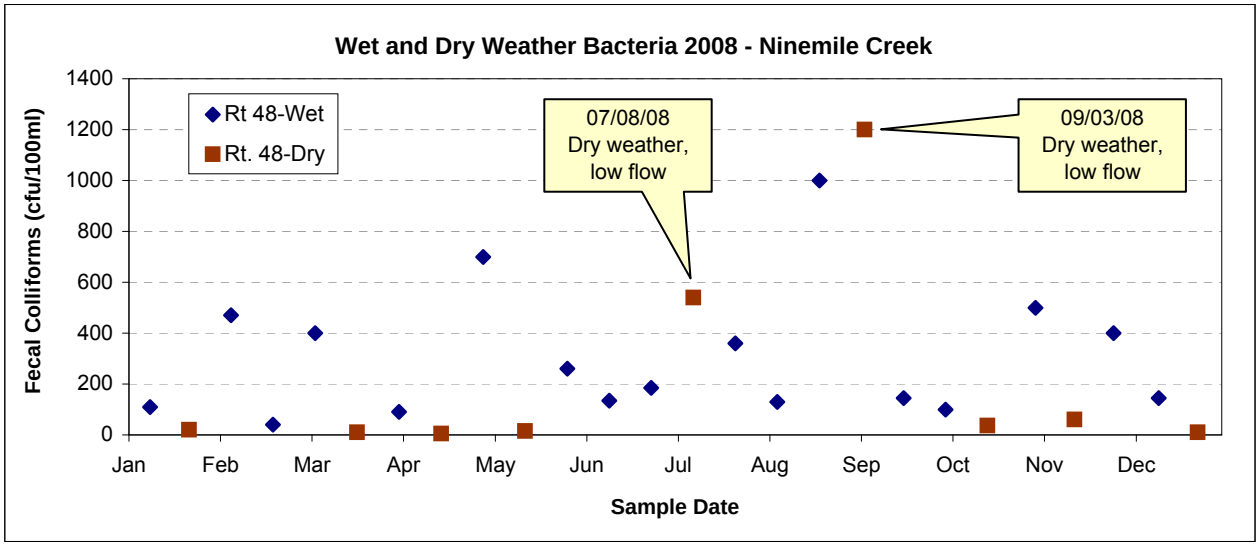

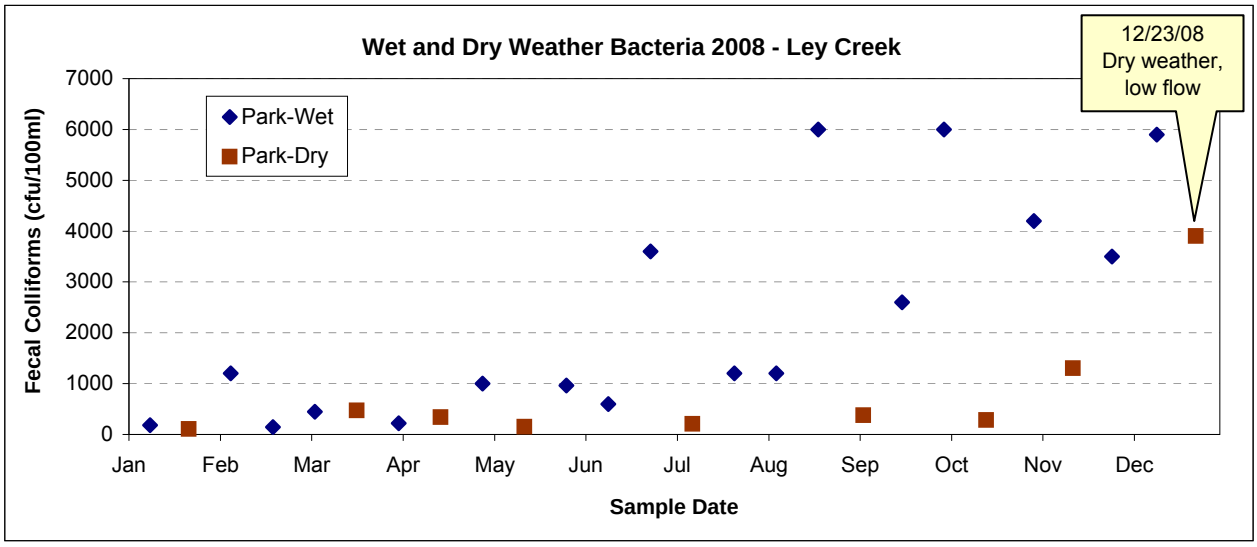

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Onondaga County Department of
WATER ENVIRONMENT PROTECTION

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ONONDAGA LAKE TRIBUTARY MAPPING

2008 Final Report
January 2009

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

EcoLogic

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1.0 Introduction

The 2008 stream mapping project was completed on behalf of the Onondaga County Department of Water Environment Protection (OCDWEP) and represents the third survey of this type undertaken by OCDWEP as part of their Ambient Monitoring Program (AMP). The timing of stream mapping surveys has been designed to coincide with major combined sewer overflow (CSO) improvement milestones, the next survey is scheduled for 2012. Onondaga County has monitored the major tributaries flowing into Onondaga Lake for almost 30 years to track concentration of pollutants and estimate annual loads. With implementation of the AMP in 1998, the scope of the County's investigations of these tributaries was expanded into the stream mapping project presented here.

This report presents results of stream mapping of three tributaries to Onondaga Lake: Harbor Brook, Onondaga Creek, and Ley Creek. The most recent field data, collected in August 2008, are compared to two previous surveys completed in 2000 and 2002. These surveys were conducted to assess the physical and biological conditions of these tributaries.

Stream conditions were assessed using a standard stream characterization and assessment protocol published by the Natural Resources Conservation Service (NRCS 1999). This standard protocol, called the Stream Visual Assessment Protocol (SVAP) provided the assessment of stream conditions in both qualitative and quantitative manner. In addition, a rapid field assessment of benthic arthropods utilizing the Family Level Biotic index (FBI) was carried out at each sampling station.

2.0 Technical Approach

The AMP stipulates that sampling shall occur along 500 ft. stream segments located in each stream mile. Therefore, Onondaga Creek (27.5 miles) required 27 sampling locations, Ley Creek (9.5 miles) 9 sample locations, and Harbor Brook (7.5 miles) 7 sampling locations. In total, 44 sampling locations were required (Table 1, Figure 1). Sampling locations were set during the baseline survey in 2000 and re-visited in 2002 and 2008 except for these sites:

- Ley Creek Site 6 was moved about 100 yards downstream in 2002 because permission to access the Air National Guard property was difficult to obtain after the events of September 11, 2001.

- Onondaga Creek Site 16 was moved approximately 200 yards upstream in 2008 because access to the original site had become severely overgrown and inundated with water, presumably from beaver dams.

- Sites 9 to 15 in Onondaga Creek pass through the Onondaga Nation Territory. Permission to access Nation lands was not granted in either 2002 or 2008 so no data are available for these sites in those years.

Table 1. Location of Stream Mapping sites within the Onondaga Lake watershed.

Site Designation	Location	Northing	Easting
Onondaga Creek			
OC1	Kirkpatrick Street	43 03 34.1	76 09 50.0
OC2	1st pedestrian walkway above Spencer Street	43 03 25.8	76 09 41.3
OC3	E. Adams Street	42 02 32.5	76 09 15.1
OC4	Midland Ave.	43 01 58.6	76 09 17.3
OC5	Newell St.	43 01 00.2	76 09 26.2
OC6	Rt. 173	43 00 06.5	76 08 55.2
OC7	Rosemont Drive	42 59 35.7	76 08 52.4
OC8	Dorwin Ave.	42 59 04.9	76 09 00.3
OC9	Onondaga Nation	42 57 53.2	76 08 57.9
OC10	Onondaga Nation	42 57 31.1	76 09 12.1
OC11	Onondaga Nation	42 57 14.4	76 09 19.2
OC12	Gibson Rd.	42 56 29.1	76 10 14.3
OC13	Above flood control dam	42 55 48.8	76 10 31.0
OC14	Onondaga Nation	42 55 19.9	76 10 25.0
OC15	Indian Rd.	42 54 50.0	76 10 15.0
OC16	Rt. 20	42 54 06.0	76 10 11.3
OC17	Turner Rd.	42 53 46.4	76 10 01.3
OC18	Bear Mt. Road	42 53 17.9	76 09 21.5
OC19	Webster Rd.	42 52 55.9	76 09 13.3
OC20	Nichols Rd.	42 52 19.2	76 08 27.7
OC21	Otisco Rd.	42 51 32.1	76 08 18.6
OC22	Parking area off Rt. 11A	42 50 21.7	76 08 07.8
OC23	Dirt Rd Crossing off Rt. 11A	42 49 50.3	76 08 18.0
OC24	Tully Farms Rd.	42 49 29.5	76 08 35.0
OC25	Fellows Falls	42 48 56.2	76 09 43.5
OC26	Impoundment at Rt. 80	42 49 07.5	76 10 54.3
OC27	Dirt Rd Crossing off Rt. 80	42 49 19.4	76 11 28.4
Harbor Brook			
HB1	Hiawatha Blvd.	43 03 23.1	76 11 07.4
HB2	Amy St.	43 02 25.1	76 10 29.4
HB3	Velasko Rd.	43 02 08.7	76 11 17.2
HB4	Grand Ave. Pump Station	43 01 56.9	76 12 15.5
HB5	Onondaga Blvd. @ Bellevue Manor	43 01 35.4	76 12 55.2
HB6	Rt. 173 @ St. George Church	43 01 02.2	76 12 57.6
HB7	Harris St.	43 00 23.9	76 13 34.5
Ley Creek			
LC1	Below Rt.81	43 04 28.7	76 10 25.6
LC2	7th North Street	43 05 10.1	76 09 44.5
LC3	LeMoyne Ave.	43 05 23.8	76 08 42.2
LC4	Townline Rd.	43 05 27.1	76 06 58.3
LC5	E. Molloy Rd.	43 05 52.1	76 05 51.9
LC6	Thompson Rd. @ OCM BOCES	43 06 16.1	76 05 32.2
LC7	Schuyler Rd.	43 07 01.6	76 04 24.9
LC8	Fly Rd.	43 07 02.2	76 03 41.1
LC9	Rt. 298	43 06 29.9	76 02 33.6

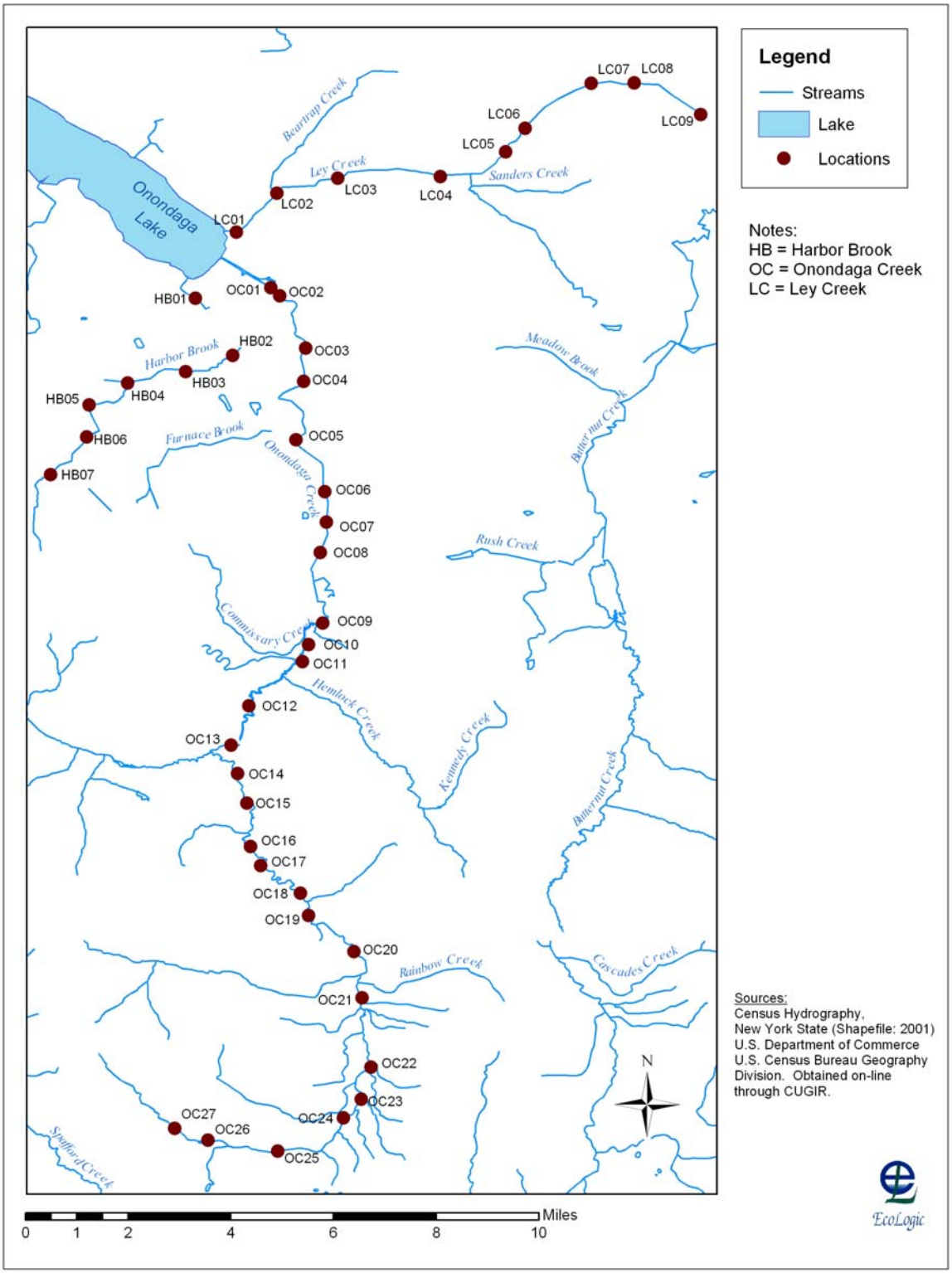


Figure 1. Location of Stream Mapping sample sites within the Onondaga Lake watershed.

2.1 Stream Visual Assessment Protocol (SVAP)

The SVAP is a methodology for the evaluation of stream condition developed by the Natural Resource Conservation Service (NRCS). The assessment protocol provides a basic level of stream evaluation. The SVAP is intended to be a simple, comprehensive assessment of stream condition that maximizes ease of use. The SVAP is based primarily on physical conditions within the assessment areas, standardized as a stream segment extending about 12 times the active stream width. The system may not detect some resource problems caused by factors beyond the assessment area. The overall scoring system is depicted in Table 2.

Table 2. Visual Assessment Scores

Condition	Overall Score
Poor	<6.0
Fair	6.1-7.4
Good	7.5-8.9
Excellent	>9.0

The NRCS protocol includes ten elements that were assessed in the field and assigned a numerical score to each element in the field. The elements are:

- Channel condition
- Hydrologic alteration
- Riparian zone
- Bank stability
- Water appearance
- Nutrient enrichment
- Barriers to fish movement
- Instream fish cover
- Pools
- Invertebrate habitat

This assessment protocol is summarized in Appendix 1.

2.2 Family-Level Biotic Index (FBI)

The FBI is a rapid field assessment of stream arthropods used to determine relative degrees of impact from organic pollution. FBI's are based on the established Hilsenhoff Biotic Index (HBI) but only identify organisms to the family level instead of genus or species level. Use of the FBI is advantageous for quickly evaluating the general status of the organic pollution in streams (Hilsenhoff 1988). However, FBI's are less accurate and can more frequently lead to erroneous conclusions about water quality than a standard HBI's. FBI's tend to indicate greater pollution than

an HBI in unpolluted or slightly polluted streams and less pollution in polluted streams. FBI's were calculated at most sites of the Stream Mapping Program. FBI calculations were not performed for sites which did not meet habitat requirements for sampling.

The FBI uses a scaled ranking from 0 to 10 where lower numbers indicate more pristine conditions. This is opposite of the SVAP ranking where higher numbers indicate more pristine conditions. To avoid confusion we report the inverse FBI values to bring the results in line with SVAP rankings (Table 3). This protocol is summarized in Appendix 2.

Table 3. Evaluation of water quality using the inverse family-level biotic index.

Inverse FBI	Water Quality	Degree of Organic Pollution
10.00-6.25	Excellent	Organic pollution unlikely
6.24-5.75	Very Good	Possible slight organic pollution
5.74-5.0	Good	Some organic pollution probable
4.99-4.25	Fair	Fairly substantial pollution likely
4.24-3.50	Fairly Poor	Substantial pollution likely
3.49-2.75	Poor	Very substantial pollution likely
2.74-0	Very Poor	Severe organic pollution likely

3.0 Results

The results of the three Stream Mapping events (2000, 2002, and 2008) are similar within each of the three sampled tributaries, although there are some key differences at individual sites. In this section the spatial and temporal patterns observed in the data are presented and substantial changes at individual sites in 2008 relative to the other two years are noted.

3.1 Stream Visual Assessment Protocol Results

Overall the SVAP graphically depicts the extent to which the three tributaries to Onondaga Lake have been modified over the years. Figure 2 shows the watershed wide view of SVAP results. Most sites are categorized as "Fair" or "Poor". The following sections present the results of the 2008 SVAP for each sampled stream. The raw data are presented in Appendix 3.

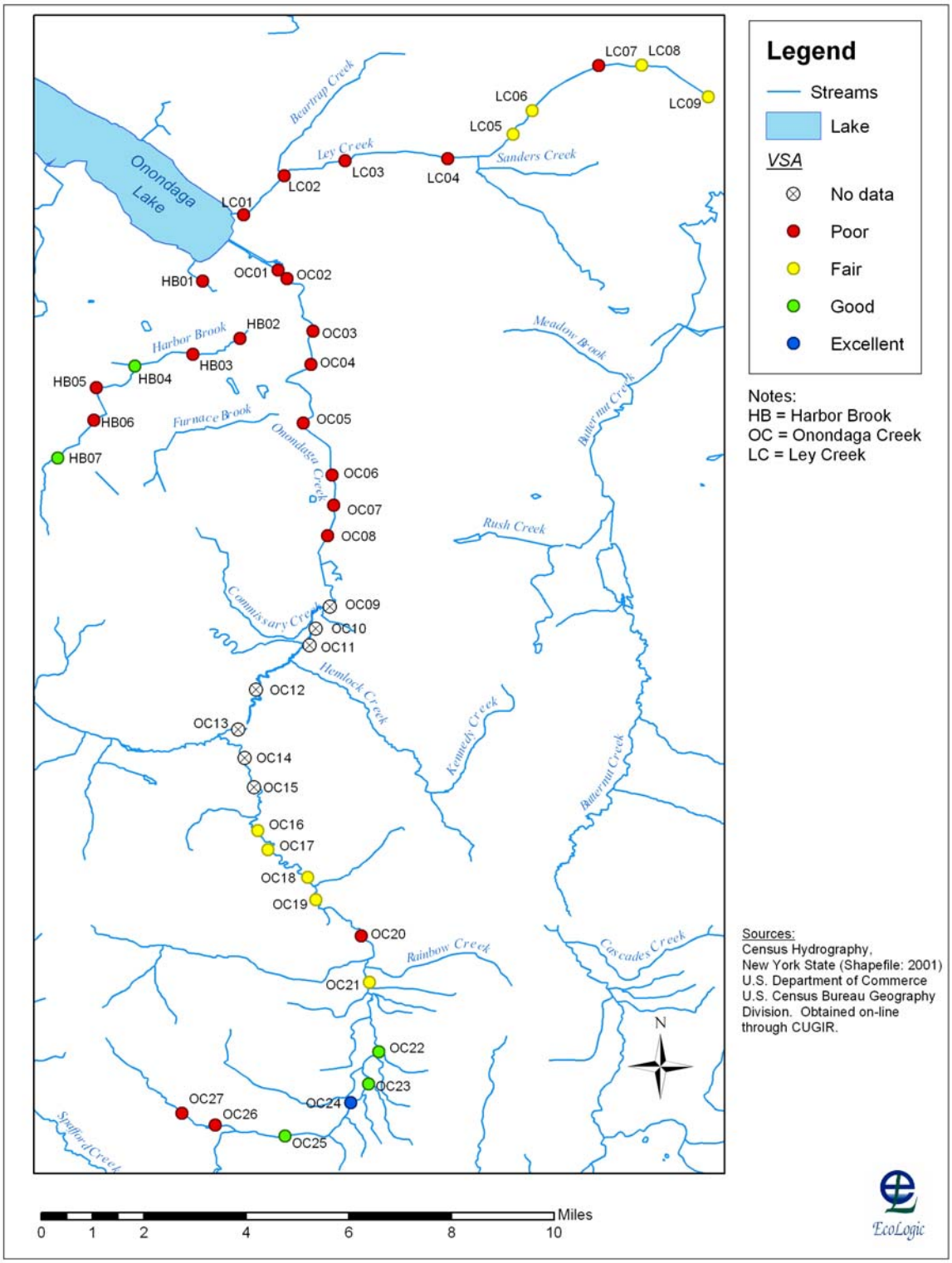


Figure 2. SVAP designations for each sampled site from the 2008 survey.

3.1.1 Onondaga Creek

The SVA scores in Onondaga Creek exhibited the same general spatial pattern throughout the three surveys (Figure 3). The scores were very low in the headwaters where the stream runs through dredged agricultural land with little riparian buffer. SVA's then improved greatly at the sites just downstream of the agricultural land as the stream increases in gradient, flows through mostly forested lands, and goes over two large waterfalls. The highest SVA's in the study streams were documented at four sites downstream of Fellows Falls (Sites 22, 23, 24, and 25). In all three surveys SVA scores indicated that these stream segments were in "Good" to "Excellent" condition. Assessment scores steadily declined for the next three downstream sites and stabilized in the "Poor" to "Fair" range until the stream reaches the last site before the Onondaga Nation (Site 16; Rt. 20). The 2008 data for Sites 16 through 19, which encompasses the area between Rt. 20 and Webster Road in the Tully Valley, suggested a subtle improvement compared to years 2000 and 2002. This improvement corresponded somewhat with increased FBI in this region of the watershed (discussed in the following section), which may indicate that the improved stream condition is having cascading impacts on the biological community here.

Permission to access Onondaga Nation lands was not granted in either 2002 or 2008 so there are no data from this area of the watershed for those years. The next downstream site is located at Dorwin Ave. (Site 8) and represents the point where the watershed becomes mostly urban. SVA's in all three surveys were substantially lower than most sites in the upstream Tully Valley and were mostly within the "Poor" range of the SVA (lowest possible ranking). SVA scores remained "Poor" from this point downstream to the last site before the creek enters the Inner Harbor at Kirkpatrick Street. Extensive dredging, straightening, urbanization, and bottom modification (concrete channel) were the primary causes of the low SVA score in these areas.

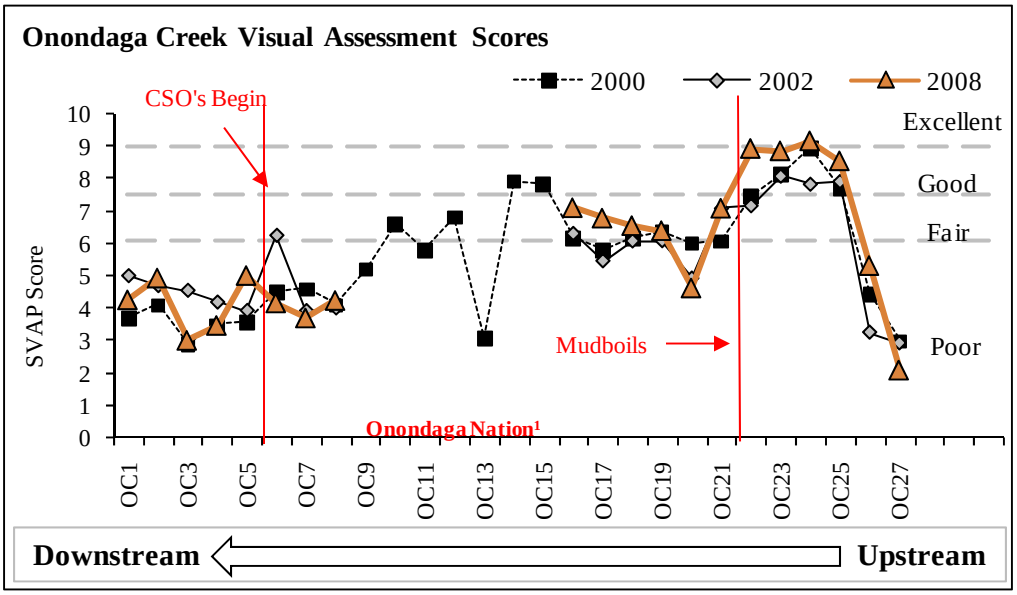


Figure 3. SVAP scores for each site on Onondaga Creek during each of the three surveys. [1] No samples collected on Onondaga Nation Territory in 2002 or 2008.

3.1.2 Ley Creek

Ley Creek sites are divided between the main branch and north branch; the south branch is not sampled as part of this program. The main branch of the creek progresses from Site 1 (Park St.) to Site 4 (Townline Rd), the north branch is from Site 5 (E. Molloy Rd.) to Site 9 (Rt. 298). In all three surveys the SVA scores showed a steady downstream decline from "Fair" condition in the upper most reaches to "Poor" condition downstream (Figure 4). Much of this stream has been dredged and straightened in the past so the low ratings are not unexpected. The 2008 results indicated slightly improved conditions at most north branch sites compared past years. These changes were particularly evident at Sites 5, 6, and 8. The primary measurement that caused the SVAP increase at Site 5 was improved canopy cover. At Site 6 a combination of improvements in water appearance, nutrient enrichment, and macroinvertebrates was responsible. At Site 8 the riparian zone and bank stability scores showed the greatest improvement. The improvements at sites 5 and 8 seem to be generally related to maturation of the riparian zone.

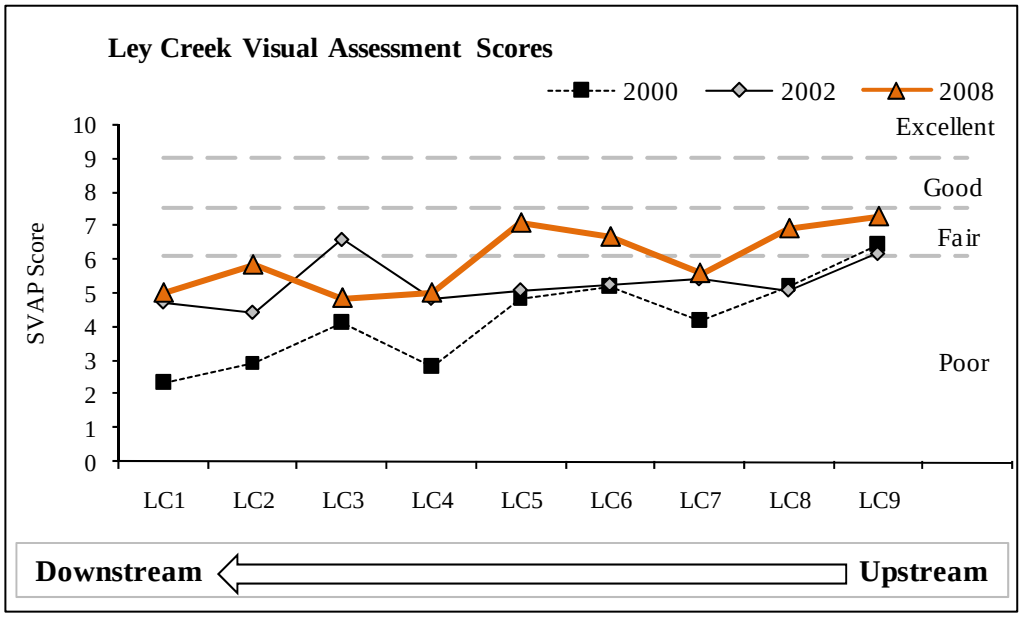


Figure 4. SVAP scores for each site on Ley Creek during each of the three surveys.

3.1.3 Harbor Brook

Like Ley Creek, much of Harbor Brook has been straightened over the years; this negatively affects the SVA scores at most sites. Harbor Brook VSA ratings were consistently "Poor" across the three study years with the exception of Site 4 (Grand Ave.) that has been borderline "Fair" to "Good" (Figure 5). Site 4 is the only SVA site on Harbor Brook that does not appear to have been highly modified. The stream in this location flows through a wooded residential area and is characterized by shallow depth and swift flow over clean gravel, pebble, and cobble. With the exception of Sites 5, 6, and 7, most sites had similar SVA ratings between the three surveys. Sites 5 and 6 in 2008 and 2002 were similar to each other but much lower than in 2000 (although all three years were still categorized as being "Poor"). This decline from 2000 was a result of the stream being dry or nearly dry in 2002 and 2008. This dryness was reflected in low scores or no score for a number of water-related variables (for example "water appearance"), therefore the other variables contributed a greater amount to the overall site score. In general, the non-water related scores, such as riparian habitat, were similar at these sites for all three study years.

Site 7 (Harris Rd) showed dramatic improvement from the 2000 and 2002 surveys. This improvement is obvious when comparing photos from the three surveys (Figure 6). In 2000 it appears that this stretch of stream had been recently dredged; the channel is wide and straight with little vegetation. In 2002 the channel is still straight and wide but some vegetation has begun to re-colonize the bank. By the 2008 survey, the stream channel had narrowed considerably and regained a natural meander; streambank vegetation was also much denser.

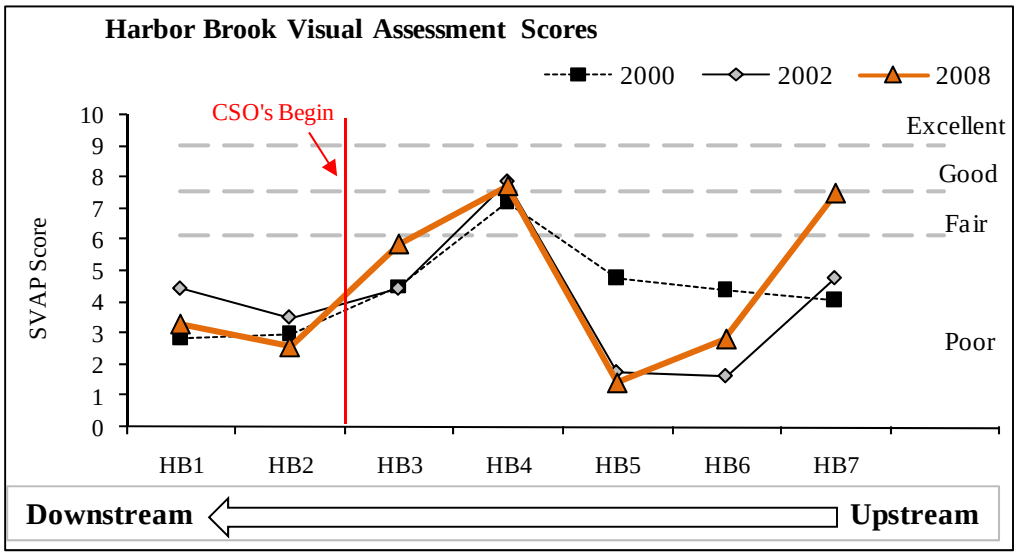


Figure 5. SVAP scores for each site on Harbor Brook during each of the three surveys.

Figure 6. Photos of Site 7 Harris Rd on Harbor Brook during each of the three surveys; 2000, 2002, and 2008.

3.2 Family Level Biotic Index Results

Overall the FBI results for 2008 indicated that impact from oxygen demanding wastes was prevalent in most segments of the study streams (Figure 7). Ley Creek exhibited the greatest overall impact, but two sites on Onondaga Creek showed the greatest individual impact.

The raw data are presented in Appendix 4.

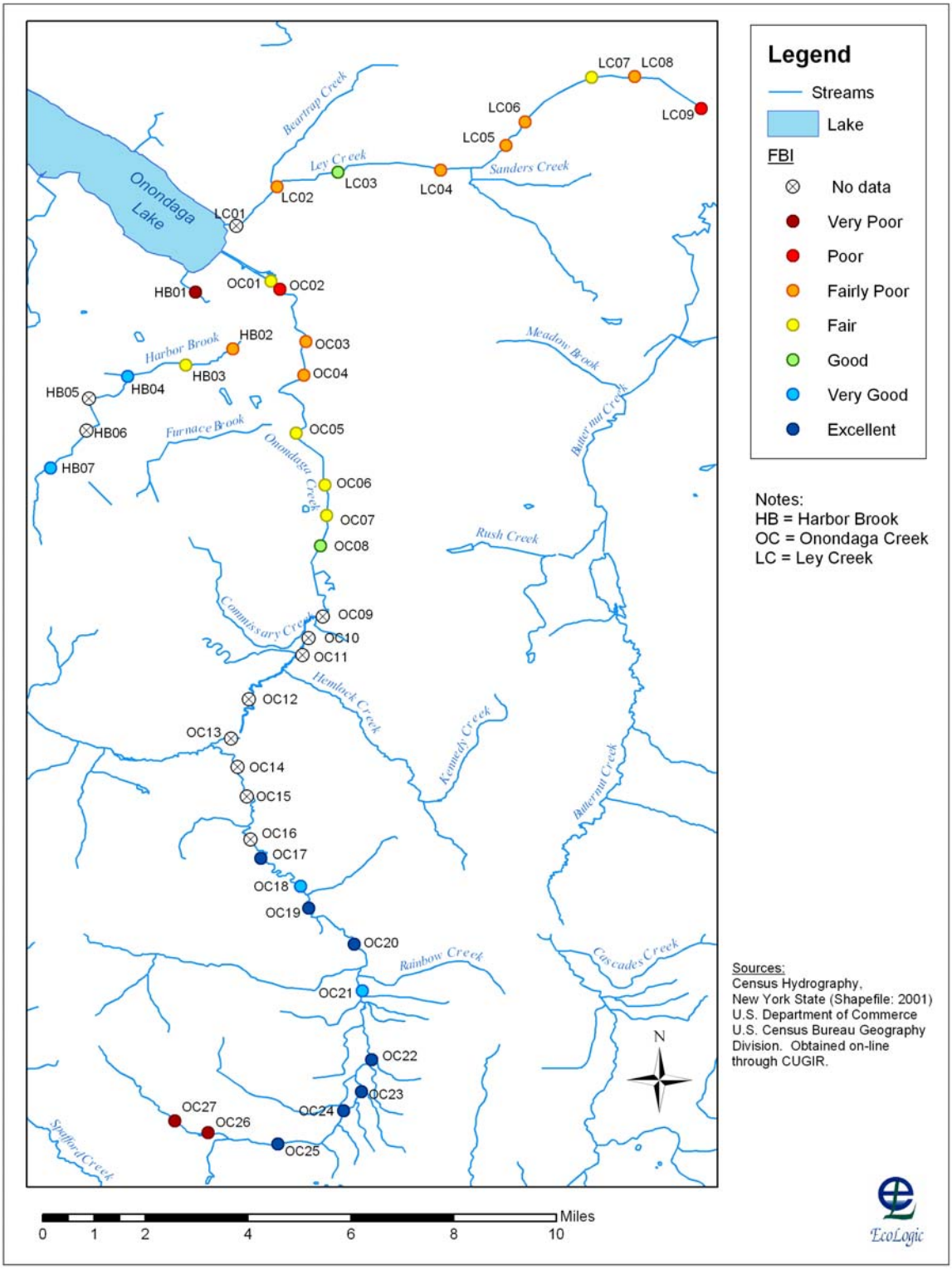


Figure 7. Impact assessment from FBIs at each sampled site from the 2008 survey.

3.2.1 Onondaga Creek

The spatial pattern for the FBI in each of the streams was very similar to that of the SVAP in each of the three sample years (Figure 8). FBI's were generally poor in the headwaters indicating extensive pollution from oxygen-demanding wastes, probably from agriculture. There was a rapid improvement in the macroinvertebrate community once Onondaga Creek goes over Fellows Falls (Site 25). In 2008, FBI scores increased from 1.2 ("Very Poor") at Site 26 (downstream of the impoundment at Rt. 80) to 8.0 ("Excellent") at Site 25 (Fellows Falls). This was the largest increase observed between two adjacent sites. Similar increases were noted during the previous surveys.

In the 2000 and 2002 surveys there was a general downward trend downstream from the falls to the Rt. 20 sampling location at Site 16. This is indicative of gradually increasing organic enrichment through this stream reach, likely attributable to the dairy and row crop farms common in this portion of the watershed. However, the 2008 results in this section of Creek showed improvement from the previous surveys. Like past years there was a decline in FBI score downstream of the Fellows Falls site, however instead of continuing to decline downstream the FBI stabilized between scores of 6 and 7, thus remaining in the "Excellent" to "Very Good" range. There was evidence of stream restoration work having been conducted since the 2002 survey in this portion of the watershed. These efforts may have beneficial affects to the macroinvertebrate community.

The section of stream from Site 22 (Nichols Road) to Site 16 (Rt. 20) encompasses the portion of the creek most impacted by mud boils. In 2000 and 2008 there was a slight decline in FBI at the first site downstream of the mudboils (Site 22); however, in 2002 there was an increase. The FBI is not known to be highly correlated with turbidity or sedimentation. If the mudboils caused an increase in oxygen demand, then there could be a direct link between the mudboils and the drop in FBI in 2000 and 2008. If not, then the changes in FBI downstream of the mudboils were likely due to random variation in the community or controlled by another unknown source.

Downstream of Rt. 20 is a stretch of creek that flows through the Onondaga Nation (Sites 9 -15). Access to sample these sites was not obtained in either 2002 or 2008. In 2000 the FBIs only declined slightly through the Nation territory indicating that the Nation territory was likely not a significant source of oxygen-demanding waste to the creek at that time.

The first site downstream of the Onondaga Nation is at Site 8 (Dorwin Ave) which constitutes the start of the channelized urban section of Onondaga Creek. The FBI results from Site 8 (Dorwin Ave) to the most downstream site at Kirkpatrick Street (Site 1) showed a slight downward trend in 2000 and 2008, but an abrupt decline in 2002. The difference between the 2000/2008 and 2002 results at Sites 1 through 6 are the most significant of the monitored sites in the survey streams. The reason for the dramatic decline in FBI at these sites in 2002 is not understood, but the underlying cause appears to have been transient.

Sites 1 (Kirkpatrick St.) through 5 (Newell St.) are downstream of the Combined Sewer Overflows (CSO's). At the initiation of the surveys in the year 2000, it was expected that significant declines in FBI would be observed here. This has not been the case. FBI's in 2000 and 2008 generally showed only a slight decline through this stretch. In 2002 there was a dramatic decline but the affects appeared to begin at Site 6 (Rt. 173), upstream of the CSO's. The cumulative effects of upstream nutrient sources, severe habitat modification, urbanization, and CSO's are the likely major structuring elements for the macroinvertebrate community in the lower reaches of Onondaga Creek.

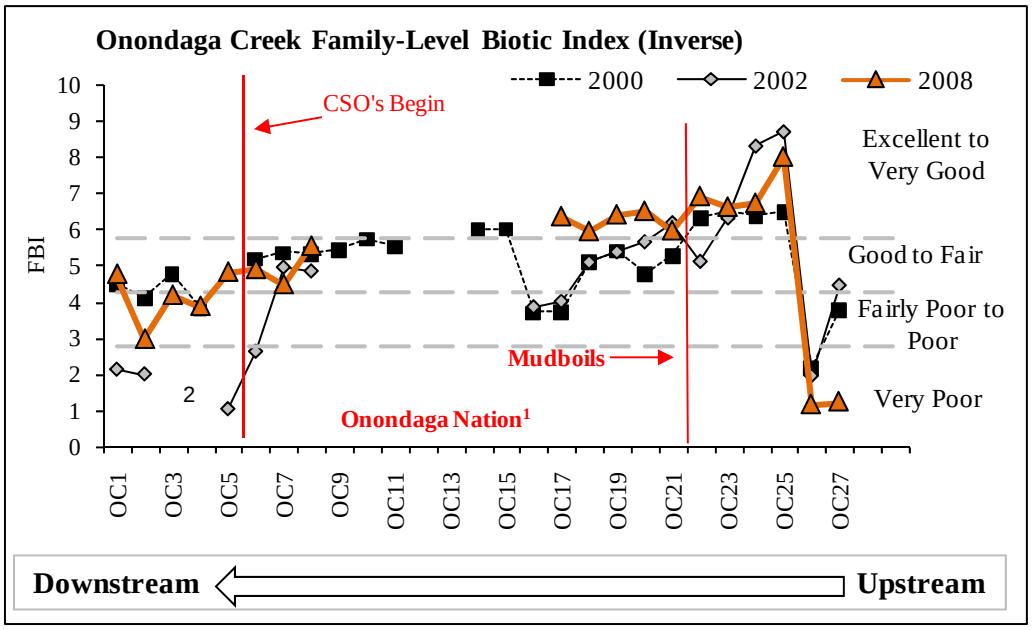


Figure 8. FBI scores for each site on Onondaga Creek during each of the three surveys. [1] No samples collected on Onondaga Nation Territory in 2002 or 2008. [2] Sites 3 and 4 were not accessible for FBI assessment in 2002.

3.2.2 Ley Creek

The FBI results in Ley Creek indicate that most sites were either "Fairly Poor" to "Poor" in most years (Figure 9). This indicates a general level of impairment due to oxygen-demanding wastes throughout the stream. In 2008 several sites appeared to have improved compared to previous surveys. This was particularly evident at Sites 2 (7th North St.) and Site 3 (LeMoyne Ave). In fact Site 3 was designated as "Good" in 2008, the only Ley Creek site in the three surveys to achieve this high a score.

The improvements observed at both Sites 2 and 3 suggest there was a decrease in oxygen-demanding wastes somewhere between Sites 3 and 4 after 2002. This area includes a section along the banks of Ley Creek where PCB-contaminated dredge spoils from Ley Creek had been placed historically.

Remedial construction at this location began in 1999 with most of the restoration work completed by late 2000. The restoration did not involve significant in-stream modification. It is questionable whether a project of this type, largely focused on removal of PCB-contaminated sediment, would have resulted in a decrease in oxygen-demanding waste to Ley Creek and thus an increase in the FBI. Another, albeit speculative, possibility is that the remedial activities themselves had a negative impact on the macroinvertebrates population which resulted in depressed FBI scores during and immediately after restoration activities, and that the community has now recovered. Unfortunately the physical characteristic of the stream at Site 1 (Park St.) precluded sample collection in all three of the surveys, so it is not known if the improvements observed at Sites 2 and 3 have also occurred there. Site 1 is sampled biennially as part of the AMP macroinvertebrate monitoring program. Once analysis of those data is completed (to be reported in the 2008 AMP annual report) it will be clearer whether or not changes have occurred.

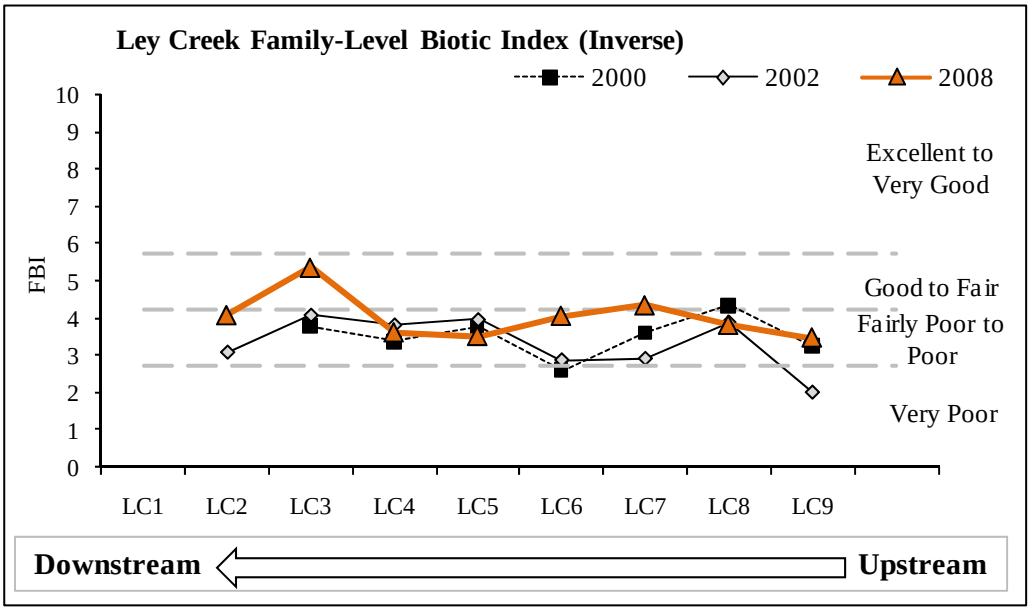


Figure 9. FBI scores for each site on Ley Creek during each of the three surveys.
Note: Ley Creek Site 1 does not have suitable habitat for FBI sampling.

3.2.3 Harbor Brook

FBIs in Harbor Brook are complicated by the fact that two of the seven sites (Sites 5 and 6) are located in an area of stream that has intermittent flows and are often dry in summer. These sites were dry or mostly dry (only small stagnated pools present) in both 2002 and 2008 so no FBI samples were collected in those years.

Although there is some variability between surveys, the FBI results in the lower portions of Harbor Brook have remained mostly unchanged over the nine year survey period (Figure 10). However, there was a decline in FBI at Site 1 (Hiawatha Blvd) in 2008. There is some indication that nutrients and bacteria have increased during periods of low flow in this downstream stretch of the stream in recent years (OCDWEP 2007). The source(s) of these dry weather loads is not clear. If these dry weather loads are still occurring, the increased inputs of oxygen-demanding wastes would account for the lower FBI at this site in 2008.

Another obvious change in FBI was the dramatic improvement at the most upstream site, Site 7 (Harris Rd.), in 2008. This improvement was almost directly proportional to the improvement observed in SVAP score over the same time period at this location (Figure 5). The improvement in SVAP was directly related to natural reestablishment of riparian vegetation and stream meander after extensive dredging. It is reasonable to assume the improvement in FBI was also related to the re-establishment of higher quality habitat at this location.

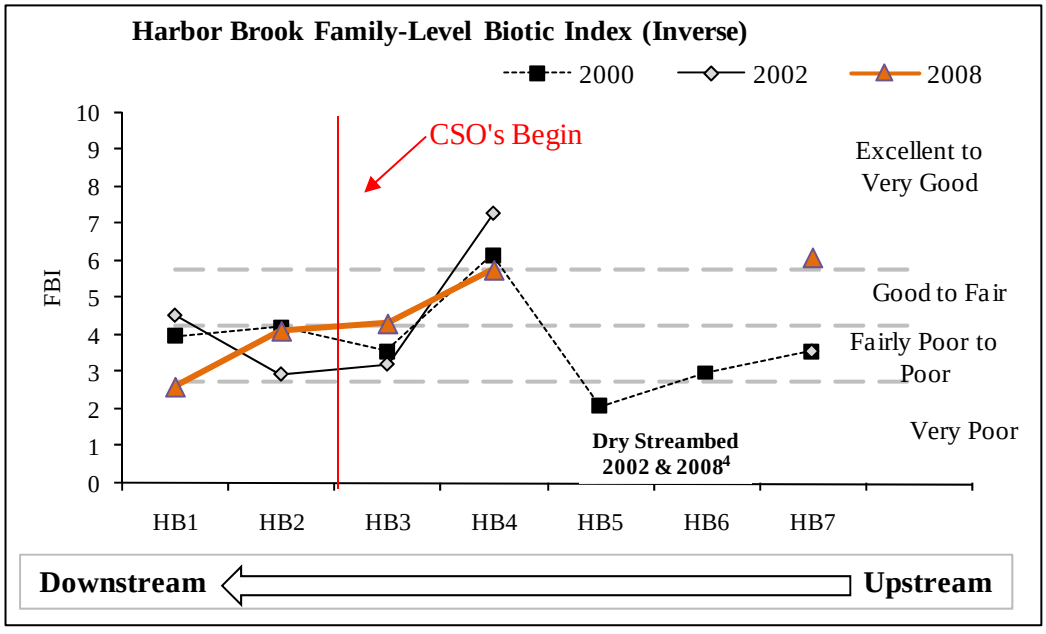


Figure 10. FBI scores for each site on Harbor Brook during each of the three surveys.
Note: Harbor Brook Sites 5 and 6 were dry in 2002 and 2008.

3.3 Water Quality

Field measurements of water temperature, dissolved oxygen concentration, dissolved oxygen percent saturation, specific conductance, and pH were measured at each site. The complete spatial and temporal results are presented in Figures 11 to 16. The following section provides the narrative of significant results for each stream.

3.3.1 Onondaga Creek

Water temperature in Onondaga Creek varies somewhat by year, as would be expected (Figure 11). What is interesting is that the water temperature decreased between Sites 6 (Rt. 173) and 5 (Newel St.) and remained cooler until the creek joins the Inner Harbor. Streams tend to warm as they progress downstream, particularly if they flow through urbanized areas. The decrease in water temperature through this area is likely an indication of cold groundwater springs entering the creek in this stretch. With few exceptions, dissolved oxygen (DO) is near saturation in the creek's upper reaches (Figure 12). By the time the creek enters the urbanized portion of the watershed DO was super-saturated, likely due to increased photosynthesis from algae in the slower moving dredged flood control section upstream of Site 8. There was a steady decline in DO at sites downstream such that the most downstream site at Kirkpatrick Street was below complete saturation in each of the three surveys. The decline in DO began upstream of the CSOs, particularly in 2008. Although DO was somewhat depressed in the lower segments, the levels measured are capable of supporting a wide range of aquatic life.

Specific conductance in Onondaga Creek was very similar at most sites during the 2000 and 2008 surveys but was elevated in 2002 downstream of the mudboils (Figure 11). This is likely due to the creek having higher flows during the 2000 and 2008 surveys that tended to dilute the saltier groundwater contribution.

The 2000 and 2002 survey documented large increases (Figure 11) in specific conductance at Site 1 (Kirkpatrick St.). This is due to what is commonly referred to as the SpencePatrick Salt Spring which discharges saline water (about 45% saturation) to the creek between Sites 1 (Kirkpatrick Street) and Site 2 (Spencer Street) (Yager et al, 2007). In 2008, specific conductance at this location was only slightly higher than upstream locations. De-watering activities at a nearby construction site tapped into the saline groundwater, which was withdrawn and diverted to the nearby METRO wastewater treatment facility. Apparently, this diversion dramatically decreased the volume of saline discharge from the spring reaching the creek. The decline in specific conductance was supported by Spencepatrick well data collected by DWEP. This accounts for the lower specific conductance noted in the creek in 2008. The de-watering was a temporary activity associated with subsurface construction and has since ceased. Presumably specific conductance in this portion of the creek will return to the levels previously observed.

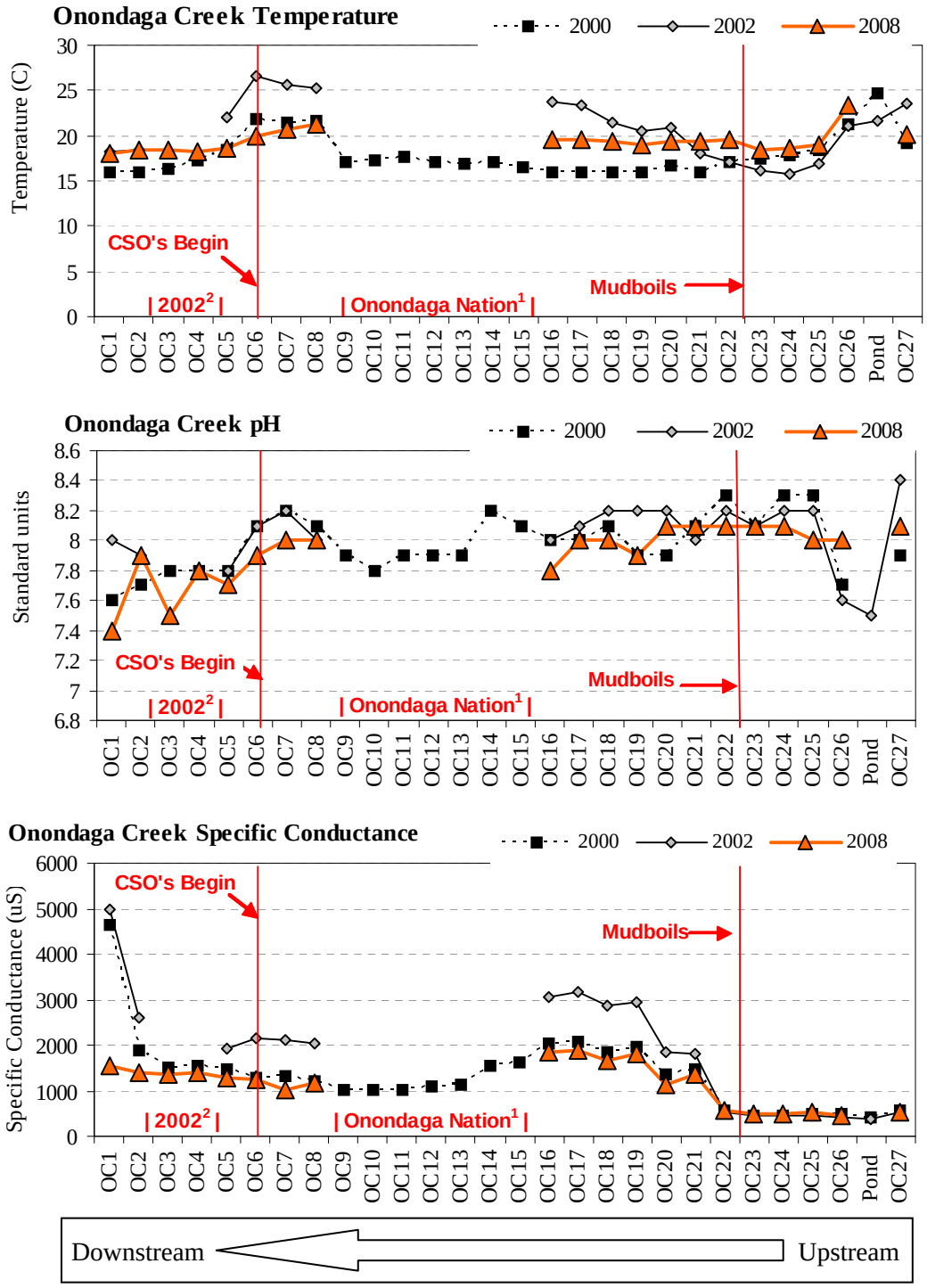


Figure 11. Onondaga Creek water quality results for temperature, pH and specific conductivity. Data collected with a calibrated YSI 85 water quality meter.

[1] No samples collected on Onondaga Nation Territory in 2002 or 2008

[2] Onondaga Creek Sites 3 and 4 were not accessible in 2002 for water quality measurements

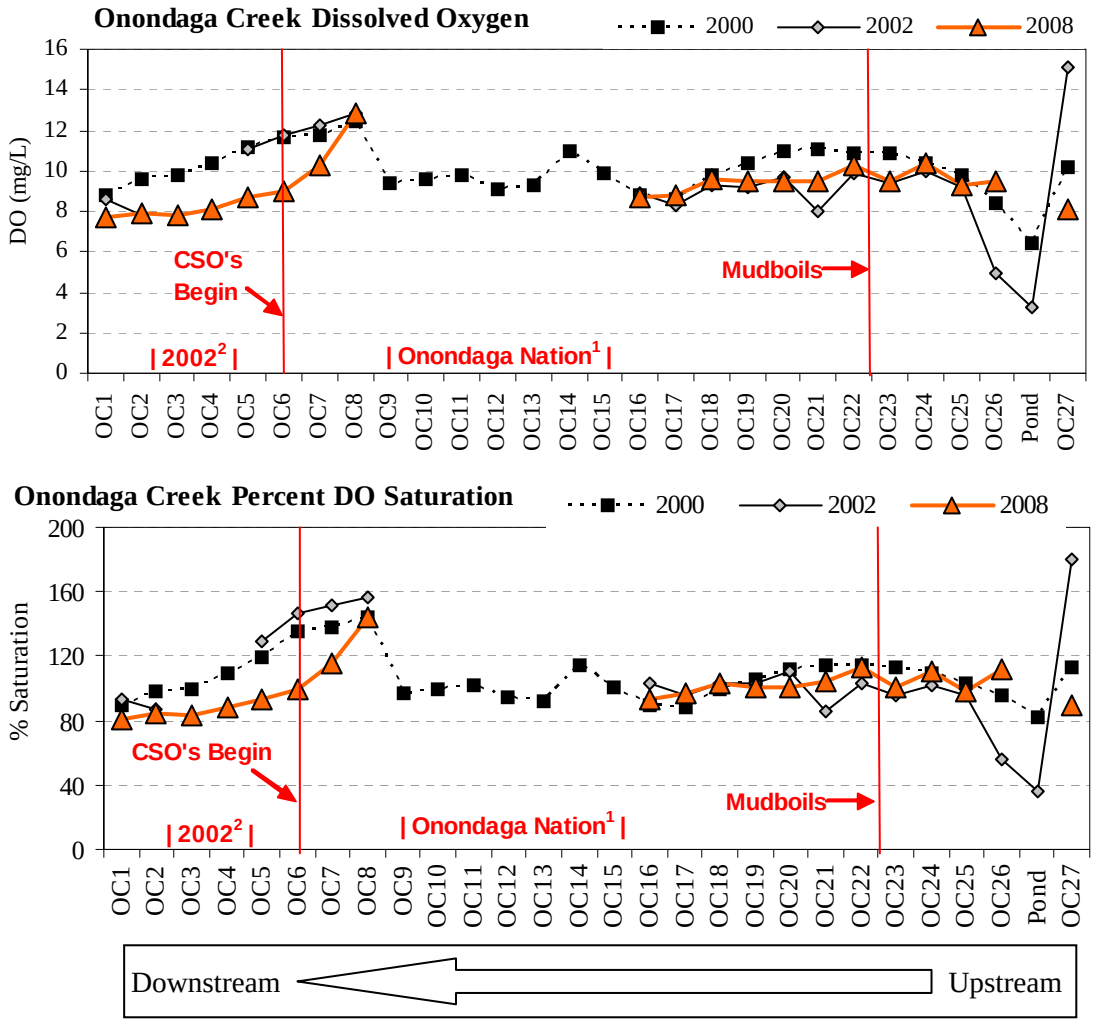


Figure 12. Onondaga Creek water quality results for dissolved oxygen. Data collected with a calibrated YSI 85 water quality meter.

[1] No samples collected on Onondaga Nation Territory in 2002 or 2008

[2] Onondaga Creek Sites 3 and 4 were not accessible in 2002 for water quality measurements

3.3.2 Ley Creek

Water quality variables in Ley Creek are within the range expected for a low gradient stream (Figures 13 and 14). Temperatures tend to be warm and dissolved oxygen varies widely in some years, likely a function of photosynthesis from the abundant algal and macrophyte community. A decline in specific conductance between upstream Site 8 and 7, followed by a gradual increase at downstream sites, was noted in 2008. This is similar to the pattern documented in 2002. This may be related to changes in groundwater contributions along the stream.

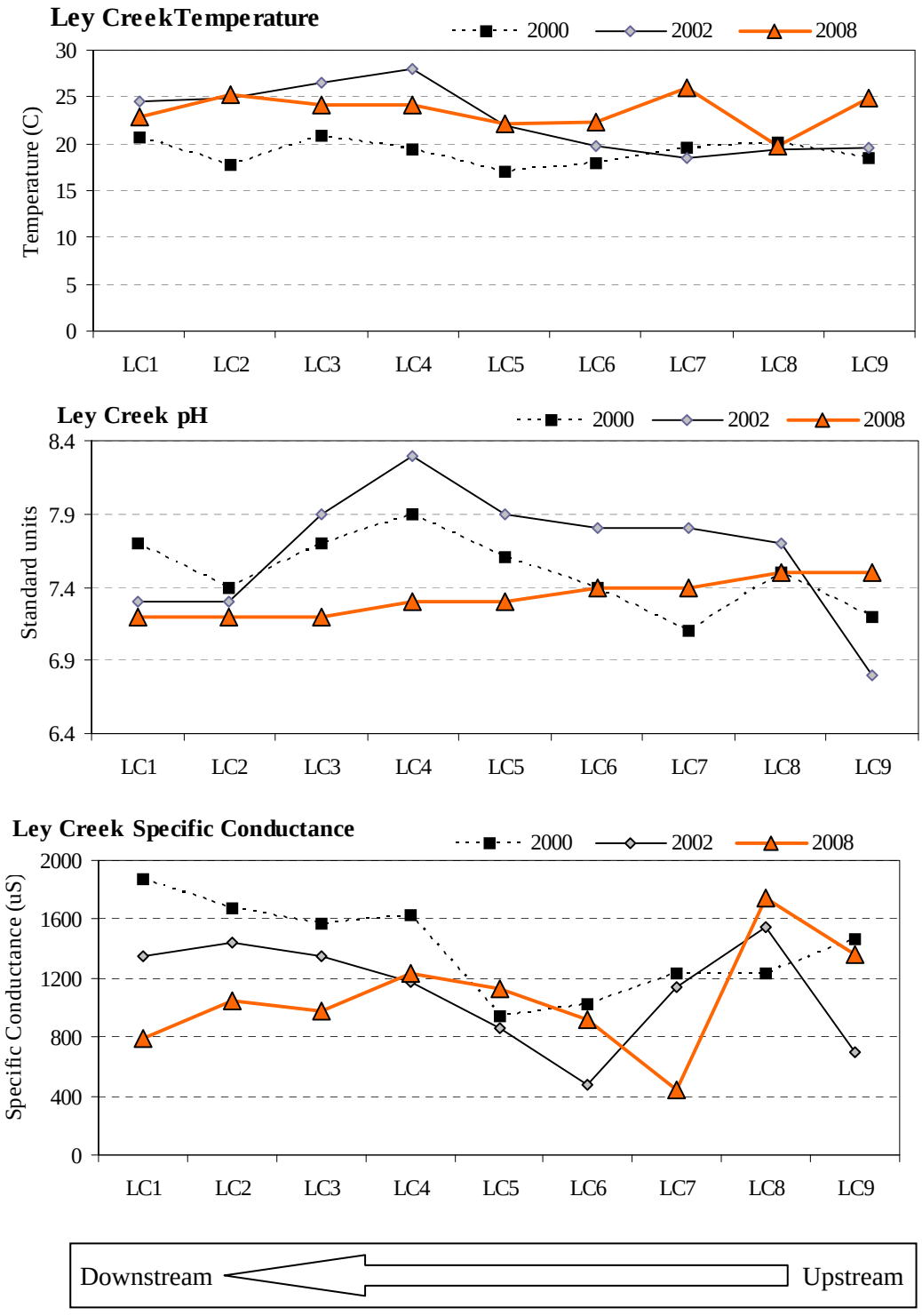


Figure 13. Ley Creek water quality results for temperature, pH and specific conductivity. Data collected with a calibrated YSI 85 water quality meter.

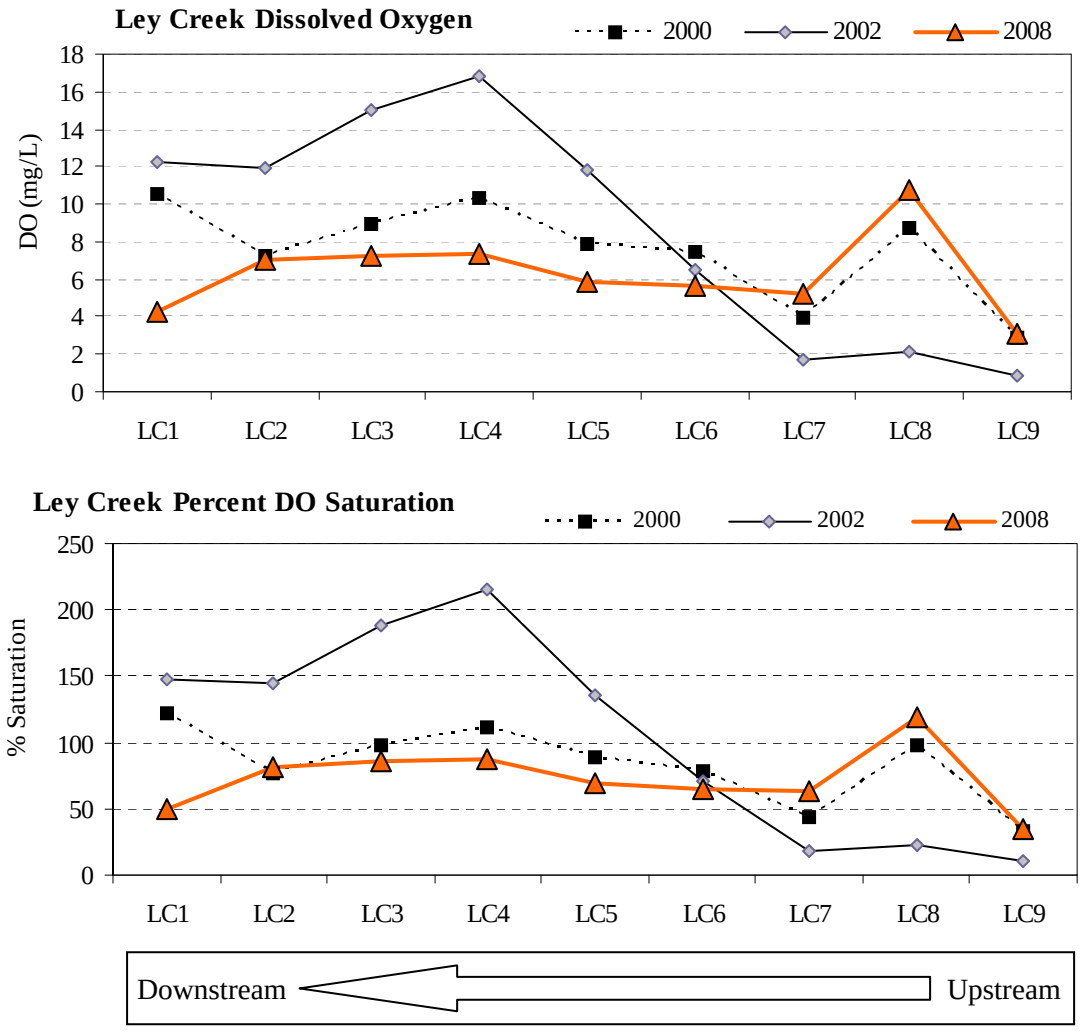


Figure 14. Ley Creek water quality results for dissolved oxygen. Data collected with a calibrated YSI 85 water quality meter.

3.3.3 Harbor Brook

Water temperatures in Harbor Brook's headwaters were warmer than in the lower reaches (Figure 15). The intermittent nature of the mid-section of the creek suggests that there is a level of hydrologic disconnect between the upper and lower watershed. Cooler groundwater discharging to the downstream portion may explain the lower water temperatures there.

In each of the three surveys DO declined considerably (Figure 16) between Site 2 (Amy St.) and Site 1 (Hiawatha Blvd). The area between these sites is mostly underground and encompasses the area where most of the CSO discharges enter the stream. The lack of photosynthesis in the darkened underground section combined with an increased oxygen demand likely accounts for the decline in stream DO.

Specific conductance at the most downstream sites (Sites 1 through 4) was elevated above background levels documented upstream (Figure 15). The levels documented at these sites were consistently higher than most other sites in the other survey streams. The increase above background likely indicates that this section of stream is more influenced by groundwater than upstream sections.

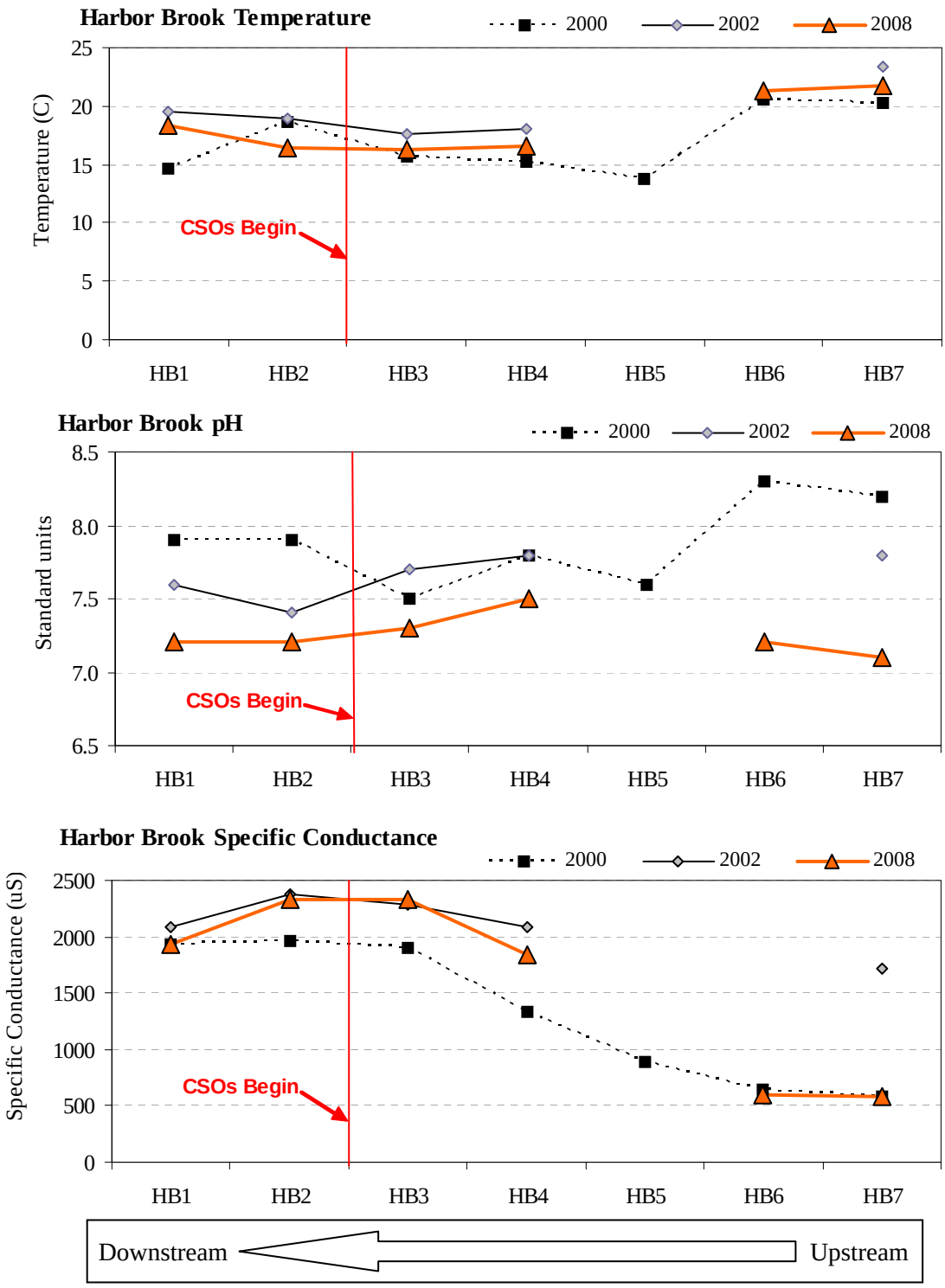


Figure 15. Harbor Brook water quality results for temperature, pH and specific conductivity. Data collected with a calibrated YSI 85 water quality meter.
Note: The streambed was dry at Site 5 in 2002 and 2008, and at Site 6 in 2002.

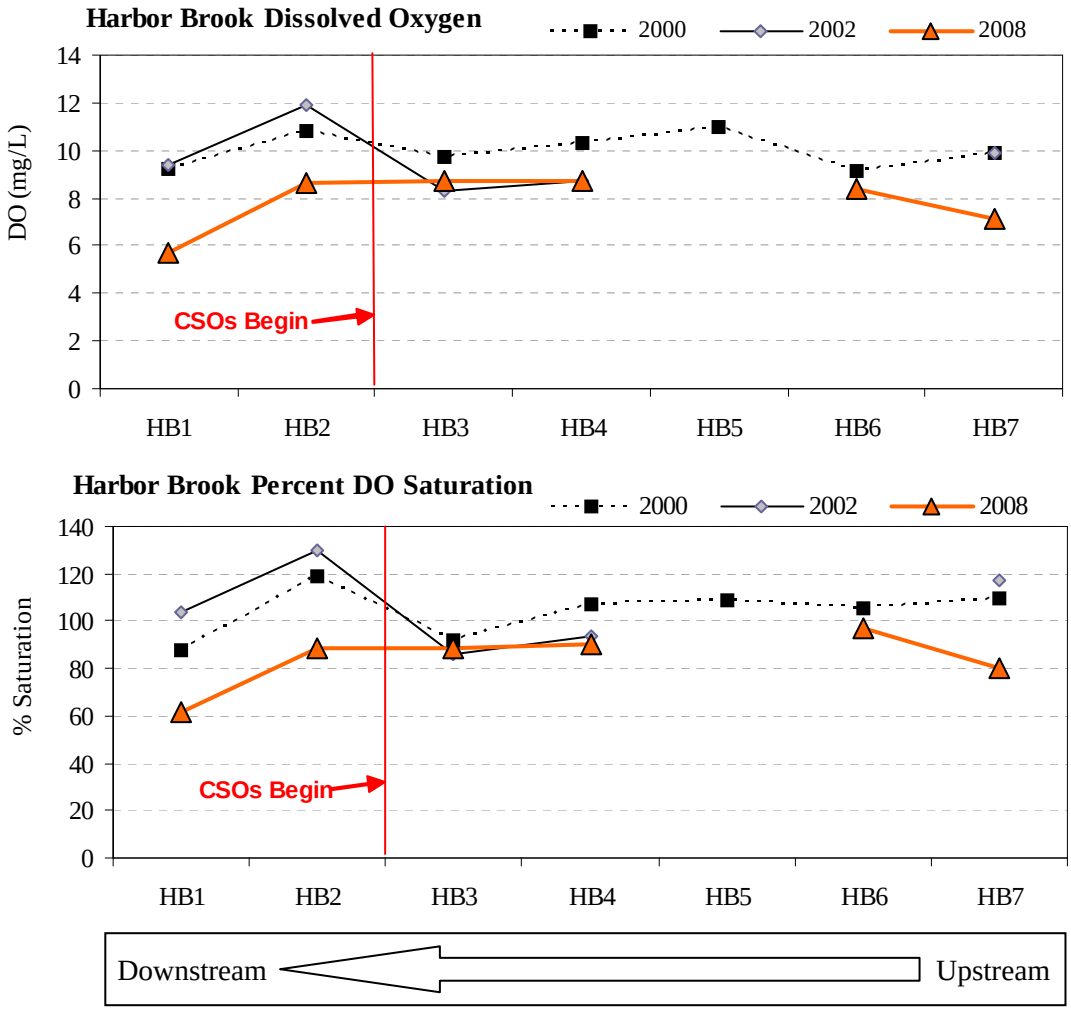


Figure 16. Harbor Brook water quality results for dissolved oxygen. Data collected with a calibrated YSI 85 water quality meter.
Note: The streambed was dry at Site 5 in 2002 and 2008, and at Site 6 in 2002.

4.0 Discussion

Three Stream Mapping surveys have been completed that encompass a nine year period (2000-2008). The SVAP results indicate that most stream segments were highly modified in the past. Overall, spatial and temporal patterns have been remarkably consistent between surveys. This stability demonstrates that there has been no recent watershed-wide modification to the streams that would influence the result of other components of the AMP.

With some exceptions, the downstream areas of Onondaga Creek, Ley Creek, and Harbor Brook exhibited the greatest impact. This is not surprising as these are the sections that traverse the urbanized portions of the watersheds.

The FBI results generally parallel those of the SVAP indicating a relatively high degree of impact from oxygen-demanding wastes in each stream. Downstream sites tended to show the greatest impacts in Onondaga Creek and Harbor Brook, but in Ley Creek the relative degree of impact was similar for most sites.

There was no clear indication of significant impact to SVAP or FBI scores downstream of CSOs. Instead, there was a general downward trend in scores within the urban corridor indicating that the cumulative impacts of habitat degradation and non-point sources are likely the major structuring elements in these streams.

5.0 References

Hilsenhoff, W.L. 1988. Rapid Field Assessment of Organic Pollution with a Family-Level Biotic Index.

NRCS. 1998. Stream Visual Assessment Protocol. USDA Natural Resource Conservation Service, National Water and Climate Center. Technical Note 99-1. December 1998.

Yager, R.M., W.M. Kappel, and L.N. Plummer. 2007. Halite brine in the Onondaga Trough near Syracuse, New York: characterization and simulation of variable-density flow. U.S. Geological Survey Scientific Investigations Report 2007–5058, 40 p.

Appendix 1. Stream Visual Assessment Protocol

Appendix 1. Visual Assessment Protocol

Task 1 – Select Locations for Stream and Reach Description

The first task was to compile existing data and maps to define the stream corridors and identify sampling points within the stream reaches. This was completed prior to the baseline survey in 2000. As a first step EcoLogic staff identified drainage patterns and stream locations using topographic maps and aerial photos. Field reconnaissance was used to add information on point source pollution. EcoLogic staff noted CSO locations, mudboils location, major culverts and other drainage alterations in the developed areas. Based on this information sampling locations for carrying out the assessment protocol were selected. The sampling locations used for the County's macroinvertebrate assessment program were also included.

Sampling was conducted within each one mile segment of each stream. Therefore, Onondaga Creek (27.5 miles) required 27 sampling locations, Ley Creek (9.5 miles) 9 sample locations, and Harbor Brook (7.5 miles) 7 sampling locations. In total, 44 sampling locations were required.

Task 2. - Perform Stream Visual Assessment

Task 2.1 Reach Description. EcoLogic staff made a visual estimate of the active channel width at bankfull discharge. *Bankfull discharge* is the approximate flow rate at which the stream begins to move from the stream channel into the flood plain if the stream has an active flood plain. As part of the reach description the stream channel shape was described. *Stream channel shape* refers to the geometry of the stream's cross-section, a feature important in characterizing the type of habitat provided by the stream. The condition of the bank, the gradients of the stream channel, the streambed substrate, and the discharge of the stream determine the shape of the stream channel. Visual estimates were obtained for the stream channel width and mean depth.

Task 2.2 Streambank Condition. EcoLogic staff identified the characteristics of the stream banks and noted alterations in the riparian zone within the sampling locations. Reference points such as fence posts or large trees were recorded. Changes in the edge of stream can provide a quick indication of bank stability and migration.

EcoLogic staff recorded the score that best fit the field observations. Unless otherwise directed, the lowest score that applies was assigned.

Score:	Narrative Descriptions
10	Natural channel; no structures, dikes. No evidence of downcutting.
7	Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate flood plain.
3	Altered channel; <50% of the reach with riprap and /or channelization; braided channel. Dike or levees restrict flood plain width.
1	Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the floodplain.

Task 2.3 Hydrologic alteration. The river channel and flood plain exist in a dynamic equilibrium. This task evaluated the degree of hydrological alteration that has occurred.

Score:	Narrative Descriptions
10	Flooding every 1.5 to 2 years. No dams, no water withdrawals, no dikes or structures limiting the streams access to the floodplain. Channel is not incised.
7	Flooding occurs only every 3 to 5 years; limited channel incision.
3	Flooding occurs only once every 6 to 10 years; channel deeply incised.
1	No flooding; channel deeply incised or structures prevent access to floodplain or dam operations prevent flood flows.

Task 2.4 Riparian Zone. Riparian vegetation plays a very important role in stream systems, particularly with respect to controlling erosion and providing habitat for both aquatic and terrestrial species. EcoLogic staff noted removal or destruction of riparian vegetation, and collected additional site-specific vegetation data.

Score:	Narrative Descriptions
10	Natural vegetation extends at least two active channel widths on each side.
7	Natural vegetation extends one active channel width on each side.
3	Natural vegetation extends half of the active channel width on each side.
1	Natural vegetation extends less than a third of the active channel width on each side.

Task 2.5 Bank Stability. Both bank and channel erosion were examined by EcoLogic staff, to assess the potential for erosion to occur. Vegetative cover was recorded, as the amount and type of riparian vegetation affects stream temperatures, flood storage capacity, and soil erodability. The presence of native species and valuable assemblages was also noted and integrated into the habitat evaluation.

Score:	Narrative Descriptions
10	Banks are stable; banks are low (at elevation of active flood plain); 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.
7	Moderately stable; banks are low (at elevation of active flood plain); less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the baseflow elevation.
3	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently); outside bends are actively eroding.
1	Unstable; bank may be lost, but typically are high; some straight reaches and inside edges of bends actively eroding as well as outside bends.

Task 2.6 Water appearance. EcoLogic staff compared turbidity, color, and other visual characteristics with a healthy or reference stream to assess the water's appearance.

Score:	Narrative Descriptions
10	Very clear or clear but tea-colored; objects visible to depth 3 to 6 ft.
7	Occasionally cloudy, especially after a storm event but clears rapidly; objects visible at depth 1.5 to 3 ft; may have a slight green color; no oil sheen on the surface.
3	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft.
1	Very turbid or muddy appearance most of the time; objects visible to depth <0.5 ft.

Task 2.7 Nutrient enrichment. Using a portable YSI Model #85D meter EcoLogic staff measured pH, salinity, and temperature in addition to observing indicators of nutrient status such as aquatic vegetation, overabundance of algae, and floating and rooted macrophytes. The presence of these indicators helps to determine the degree of nutrient enrichment along each reach.

Score:	Narrative Descriptions
10	Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.
7	Fairly clear or slightly greenish water along the entire reach; moderate algal growth on stream substrates.
3	Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.
1	Pea green, gray, or brown water along entire reach; dense stands of macrophytes clog streams; severe algal blooms create thick algal mats in stream.

Task 2.8 Barriers to fish movement. EcoLogic staff examined the stream three miles upstream and downstream of each sampling reach for barriers to fish movement. Barriers included natural barriers such as waterfalls and boulder dams, as well as man-made obstructions such as dams.

Score:	Narrative Descriptions
10	No barriers
7	Seasonal water withdrawals inhibit movement within each reach.
3	Drop structures, culverts, dams, or diversions (<1 foot drop) within 3 miles of the reach
1	Drop structures culverts, dams, or diversions (> 1 foot drop) with the reach

Streams create and maintain habitats for a large variety of fish and other aquatic organisms, within the water as well as on or below the channel bed. Physical components of in-stream habitat include pools, riffles, cover provided by substrate, aquatic vegetation, woody debris, undercut banks, overhanging vegetation, temperature, dissolved oxygen and volume of water (discharge).

These characteristics were used to examine fisheries habitat for Tasks 2.9 through 2.12. Fisheries

habitats could be classified as:

- Refuge habitats (high quality, undisturbed, native, highly productive areas)
- Adjunct habitats (adjacent to refuge, but degraded)
- Source areas (headwater, often low aquatic diversity, but stable systems)
- Degraded habitats (heavily impacted and disturbed areas)

Task 2.9 Instream Fish cover. Under this task, the availability of physical habitat for fish was assessed. EcoLogic staff evaluated the number of different habitat and cover types within a representative subsection of the assessment reach equivalent in length to five times the active channel width. Cover types included: logs/large woody debris; deep pools; overhanging vegetation; boulders and cobbles; undercut banks; thick root mats; dense macrophyte beds; riffles; and isolated or backwater pools.

Score:	**Narrative Descriptions**
10	> 7 cover types available.
8	6 to 7 cover types available.
5	4 to 5 cover types available.
3	2 to 3 cover types available.
1	None to 1 cover type available

Task 2.10 Pools EcoLogic staff walked the stream and probed from the streambank with a stick or length of rebar to determine the size, diversity, and abundance of pools.

Score:	**Narrative Descriptions**
10	Deep and shallow pools abundant; greater than 30% of the pool bottom obscured due to depth, or the pools are at least 5 feet deep.
7	Pools present, but not abundant; from 10 to 30% of the pool bottom is obscured due to depth, or the pools are at least 3 feet deep.
3	Pools present, but shallow; from 5 to 10% of the pool bottom is obscured due to depth, or the pools are less than 3 feet deep.
1	Pools absent, or the entire bottom is discernible.

Task 2.11 Insect/invertebrate habitat. EcoLogic staff recorded the number of different types of habitat and cover within representative subsections of the assessment reach equivalent in length to five times the active channel width. Only those habitat cover types present in appreciable amounts were included in the scores. Cover types included: fine woody debris; submerged logs, leaf packs, undercut banks; cobble, boulders and coarse gravel

Score:	Narrative Descriptions
10	At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen).
7	3 to 4 types of habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream.
3	1 to 2 types of habitat. The substrate is often disturbed, covered or removed by high stream velocities and scour or by sediment deposition.
1	None to 1 type of habitat.

The following tasks were recorded only if applicable:

Task 2.12 Canopy Cover (if applicable) EcoLogic staff estimated the portion of the water surface area for the whole reach that was shaded by estimating areas with no shade, poor shade, and shade. This was estimated assuming the sun was directly overhead and the vegetation was in full leaf-out condition. By walking the stream, EcoLogic staff also estimated the shading conditions 2 to 3 miles upstream.

Score:	Narrative Descriptions
10	25 to 90% of water surface shaded; mixture of conditions.
7	> 90% shaded; full canopy; same shading condition throughout the reach.
1	< 25% water surface shaded in reach.

Task 2.13 Manure present (if applicable). This task represents a visual assessment of the presence of agricultural residuals that could enter the streams.

Task 2.14 Salinity (if applicable). EcoLogic staff evaluated aquatic plants for indicators of salinity. In addition, a portable YSI meter was used to measure conductivity.

Score:	Narrative Descriptions
5	Minimal wilting, bleaching, leaf burn, or stunting of aquatic vegetation; some salt tolerant streamside vegetation.
7	Aquatic vegetation may show significant wilting, bleaching, leaf burn, or stunting; dominance of salt-tolerant streamside vegetation.
1	Severe wilting, bleaching, leaf burn, or stunting; presence of only salt tolerant aquatic vegetation; most streamside vegetation salt tolerant.

Task 2.15 Riffle embeddedness (if applicable). EcoLogic staff examined the substrate in riffle areas where present. *Substrate* refers to the composition of the material underlying the stream channel and bank. A stream's substrate is the result of the underlying rock type and lithology, and the overlying soil. Channel particle analysis (e.g. pebble count) provides an easy and rapid measurement of the stream's substrate characteristics. *Embeddedness* measures the degree to which gravel and cobble substrates are surrounded by fine sediments. The characteristics of the stream substrate provide valuable information on the stream's suitability for spawning, insect production, and in-stream cover.

Score:	**Narrative Descriptions**
10	Gravel or cobble particles are < 20% embedded.
8	Gravel or cobble particles are 20 to 30% embedded.
5	Gravel or cobble particles are 30 to 40% embedded.
3	Gravel or cobble particles are > 40% embedded.
1	Riffle is completely embedded.

Task 2.16 Macroinvertebrates observed. Detailed macroinvertebrate data from the kick sampling was used where habitat was present. If such habitat was not present, kick sampling was not conducted. The macroinvertebrate community reflects the ability of the stream to support aquatic invertebrate animals. Scoring value for this element ranges from –3 to 15.

Score:	**Narrative Descriptions**
15	Community dominated by Group 1 or intolerant species with good species diversity. Examples include caddisflies, mayflies, stoneflies, and hellgrammites.
6	Community dominated by Group II or facultative species, such as damselflies, dragonflies, aquatic sowbugs, blackflies, and crayfish.
3	Community dominated by Group III or tolerant species, such as midges, craneflies, horseflies, leeches, aquatic earthworms, and tubificid worms.
-3	Very reduced number of species or near absence of all macroinvertebrates.

Appendix 2. Family Level Biotic Index Protocol

Appendix 2. Family Level Biotic Index protocol

Procedure for evaluating streams with the family-level biotic index. Based on Hilsenhoff (1988).

1. Using an aquatic net, samples are collected from a riffle area or a shallow run where the current is greater than 0.30 m/s (1.0 ft/s) and the substrate is composed of gravel, pebbles, and/or small rocks. Collection of arthropods is best accomplished by placing the net against the stream bottom and disturbing the substrate immediately upstream from the net. Snags of debris may be sampled if no riffle or run is present.

2. Sampling continues until somewhat in excess of 100 arthropods are collected, but no more than 200 because large numbers may bias picking of the sample.

3. The contents of the net are placed in a shallow white pan with a small amount of water.

4. About eight small white dishes containing 70% ethanol are arranged to receive arthropods picked from the pan, each dish holding an order or common family.

5. Arthropods clinging to the net are placed in the appropriate dish. No more than 20 arthropods should be removed from the net to avoid bias in the sample.

6. About one hundred arthropods are removed from the pan and net, excluding Hemiptera and Coleoptera (except Dryopoidea) and individuals that are too small to be identified to family.

7. The number of arthropods in each family is recorded, using a hand lens for identification if needed.

8. An FBI is calculated by multiplying the number in each family by the tolerance value for that family, summing the products and dividing by the total number in the sample.

Table A2-1. Evaluation of water quality using the family-level biotic index.

FBI	Water Quality	Degree of Organic Pollution
0.00 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very Good	Possible slight organic pollution
4.26 - 5.00	Good	Some organic pollution probable
5.01 - 5.75	Fair	Fairly substantial pollution likely
5.76 - 6.50	Fairly Poor	Substantial pollution likely
6.51 - 7.25	Poor	Very substantial pollution likely
7.26 - 10.00	Very Poor	Severe organic pollution likely

Appendix 3. Raw SVAP Data for 2008

Appendix 3. Raw SVAP data for the 2008 survey.

Onondaga Creek

SVAP category	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21	OC22	OC23	OC24
channel condition	3	5	1	5	1	1	1	1								8	8	4	5	3	5	10	10	10
hydrologic alteration	7	7	1	1	1	1	1	1								7	8	7	5	3	5	10	10	10
riparian zone	4	3	3	0	2	0	0	0								10	10	1	10	1	6	10	10	7
bank stability	5	7	5	7	10	10	8	10								7	5	6	3	1	7	4	10	10
water appearance	7	7	5	7	7	7	7	7								3	3	4	3	5	7	10	10	7
nutrient enrichment	6	6	5	7	7	7	7	7								7	5	7	5	7	7	10	10	9
barriers, fish movement	3	1	3	3	10	3	3	1								10	10	10	10	10	10	10	10	10
instream fish cover	5	5	2	5	3	4	6	6								6	7	9	9	6	6	10	7	9
pools	3	3	1	1	3	5	3	3								8	8	9	8	6	5	8	2	7
invertebrate habitat	7	7	2	6	3	5	3	7								7	10	10	10	8	10	10	10	10
canopy cover	1	8	8	0	7	0	0	0								5	4	4	1	1	8	8	9	10
riffle embeddedness		5		3	10	6	6	4									2	5	5	3	8	6	7	8
Manure																								
Macroinverts	0	0	0	0	1	5	3	8									8	9	9	6	8	10	10	12
VSA	**4.25**	**4.92**	**3.00**	**3.46**	**5.00**	**4.15**	**3.69**	**4.23**								**7.09**	**6.77**	**6.54**	**6.38**	**4.62**	**7.08**	**8.92**	**8.85**	**9.15**
Score	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**								**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Fair**	**Excellent**	**Good**	**Excellent**

Onondaga Nation Territory, permission was not granted to access sites in 2008

Ley Creek

SVAP category	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9
channel condition	4	8	3	3	6	5	5	5	7
hydrologic alteration	5	7	1	5	3	7	8	10	10
riparian zone	4	8	3	7	8	8	5	10	10
bank stability	8	7	7	6	3	1	7	10	10
water appearance	1	1	5	3	8	7	3	10	3
nutrient enrichment	1	1	3	2	8	7	0	3	3
barriers, fish movement	10	10	10	10	10	10	10	10	10
instream fish cover	6	6	6	6	8	9	8	8	6
pools	10	10	7	7	7	8	7	4	8
invertebrate habitat	6	8	10	7	8	9	7	8	6
canopy cover	0	0	1	1	10	3	1	1	7
riffle embeddedness			3						
Manure									
Macroinverts	5	4	4	3	6	6	6	4	
VSA	**5.00**	**5.83**	**4.85**	**5.00**	**7.08**	**6.67**	**5.58**	**6.92**	**7.27**
Score	**Poor**	**Poor**	**Poor**	**Poor**	**Fair**	**Fair**	**Poor**	**Fair**	**Fair**

Harbor Brook

SVAP category	HB1	HB2	HB3	HB4	HB5	HB6	HB7
channel condition	2	2	7	8	1	3	10
hydrologic alteration	2	2	5	7	1	1	10
riparian zone	1	0	5	4	1	1	10
bank stability	5	5	10	8	6	5	10
water appearance	5	5	7	3		1	5
nutrient enrichment	5	5	7	9		5	5
barriers, fish movement	5	3	10	10	0	0	7
instream fish cover	4	2	8	10	3	4	8
pools	5	1	5	6		1	6
invertebrate habitat	3	1	8	10	0	5	7
canopy cover	5	4	1	6	1	3	5
riffle embeddedness	1		1	10		5	6
Manure							
Macroinverts	0	1	2	9	0		8
VSA	**3.31**	**2.58**	**5.85**	**7.69**	**1.44**	**2.83**	**7.46**
Score	**Poor**	**Poor**	**Poor**	**Good**	**Poor**	**Poor**	**Good**

Appendix 4. Raw FBI Data for 2008

APPENDIX 4. 2008 FBI raw data.

Onondaga Creek

Taxa	TI	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21	OC22	OC23	OC24	OC25	OC26	OC27
OLIGOCHAETA	**10**		5	4		1		4																				
Hurudinea	**7**	3	2	3																							2	
ASELLIDAE	**8**	2	21	18	20	6	10	5	1																		18	2
GAMMARIDAE	**4**	58	14	48	46	64	26	54	24																			
BAETIDAE	**4**								4									8	1	6		6	7	6		3		
HEPTAGENIIDAE	**4**								1											1			4	9				
Tricorythidae	**4**																											
Caenidae	**7**				41	11	22		6									3	1	4		4	5			4		
Ephemerellidae	**1**																			2		1	4	7		6		
Chloroperlidae	**1**																						5		1	2		
Perlidae	**1**																	4	5	10	11	2	14	9	24	39		
Pteronar	**0**																									3		
Perlodidae	**2**																						1	1		1		
Leuctridae	**0**																							4				
PHILOPOTAMIDAE	**3**						2													4	3	1	6	8				
HYDROPSYCHIDAE	**4**					6	48	6	46									31	42	48	76	60	43	64	41	20		
Helicopsychidae	**3**																											
Hydroptilidae	**4**								2											2	4		2	7				
Rhyacophilidae	**0**								4											4	1	2	8	4		14		
Polycentropidae	**6**						1		8																			
Limnophillidae	**4**																											
Leptoceridae	**4**																			4					3	12		
Glossosomatidae	**0**																				1					6		
Brachycentridae	**1**																									4		
Odontoceridae	**0**																									8		
Corydalidae	**0**						4												6	1		1	1	1	1			
Sialidae	**4**																		1	4		2	2					
Psephenus	**4**																									2		
Elmidae	**4**								15												3	4	3					
Dryopidae	**5**																	8			1	6			4			
Ceratapogonidae	**6**																	2			1	3						
TIPULIDAE	**3**								2									12	5	7	3	8	6	3	8	6		
Tabanidae	**6**																	1	1			1						
Empidae	**6**																	2	1									
Athericidae	**2**																	31	4	7	9	9	4		3	6		
Dolichopdidae	**4**																	4	1				1					
Simulidae	**6**			6	22	8		9	3									2	3			2						
Muscidae	**6**																	3										
Psychidae	**10**																										8	4
Syrphidae	**10**																										7	3
Chiro-blood	**8**	21	12	12	15	8	7	20	6										4			1					12	12
Chiro-other	**6**	4	4	2	8	12	14	12	4									4	6	8	2	6	2	4	6			
SPHAERIIDAE	**6**																											
Zygo-Coenagrionidae	**9**																											9
Anisop-Libelludae	**9**																										1	
Anisop-Aeshnidae	**3**																							2				
Anisop-Gomphidae	**1**																							2				
Notonectidae	**6**																											
Belostomatidae	**10**																										10	
Decapoda	**6**			1		2	2	3											8	3		3		6	4	3		
Total		88	58	94	152	118	136	113	126	0	0	0	0	0	0	0	0	115	89	115	115	122	118	137	95	139	58	30

Site	OC1	OC2	OC3	OC4	OC5	OC6	OC7	OC8	OC9	OC10	OC11	OC12	OC13	OC14	OC15	OC16	OC17	OC18	OC19	OC20	OC21	OC22	OC23	OC24	OC25	OC26	OC27
FBI	5.2	7.0	5.8	6.1	5.2	5.1	5.5	4.5									3.6	4.1	3.6	3.5	4.0	3.1	3.4	3.3	2.0	8.8	8.8
Score	Fair	Poor	Fairly Poor	Fairly Poor	Fair	Fair	Fair	Good									Excellent	Very Good	Excellent	Excellent	Very Good	Excellent	Excellent	Excellent	Excellent	Very Poor	Very Poor

APPENDIX 4 cont'd. 2008 FBI raw data.

Ley Creek

Taxa	TI	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9
OLIGOCHAETA	**10**		8		2			2		
Hurudinea	**7**		2		1					
ASELLIDAE	**8**		10	5	8	35			6	6
GAMMARIDAE	**4**		38	70	25	16			7	
BAETIDAE	**4**							6		
HEPTAGENIIDAE	**4**									
Tricorythidae	**4**									
Caenidae	**7**									
Ephemerellidae	**1**									
Libelludae	**9**		7					2		
cordulegastridae	**3**							1		
Corduliidae	**5**							3		
Macromiidae	**3**							3		
Coenagrionidae	**9**							6		2
Calopterygidae	**5**							1		
Chloroperlidae	**1**									
Perlidae	**1**									
Pteronar	**0**									
Perlodidae	**2**									
PHILOPOTAMIDAE	**3**									
HYDROPSYCHIDAE	**4**			5						
Helicopsych	**3**									
Hydroptil	**4**									
Rhyacophil	**0**									
Polycentrop	**6**									
Limnophillidae	**4**									
Corydalidae	**0**									
Sialidae	**4**						4			
Psephenus	**4**									
Elmidae	**4**									
Dytiscidae	**5**									
Dryopidae	**5**								7	
Ceratap	**6**							1		
TIPULIDAE	**3**									
Tabanidae	**6**									
Empidae	**6**									
Athericidae	**2**									
Simulidae	**6**									
Chiro-blood	**8**		6		36	3	1		21	8
Chiro-other	**6**		4		42	15	8	4	11	7
SPHAERIIDAE	**6**						4			
Physidae	**8**						16			
Notonectidae	**6**		7			4	4	2	23	7
Corixidae	**5**		20			6	31	24	12	12
Decapoda	**6**		7	22	9		8	2	31	
Total			109	102	123	79	76	57	118	42

Site	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9
FBI		5.9	4.6	6.4	6.5	5.9	5.6	6.2	6.5
Score		Fairly	Good	Fairly	Fairly	Fairly	Fair	Fairly	Poor

APPENDIX 4 cont'd. 2008 FBI raw data.

Harbor Brook

Taxa	TI	HB1	HB2	HB3	HB4	HB5	HB6	HB7
OLIGOCHAETA	**10**	3		3				1
Hurudinea	**7**	12	1	2				
ASELLIDAE	**8**	29	22	15				
GAMMARIDAE	**4**	9	45	60	58			
BAETIDAE	**4**							
HEPTAGENIIDAE	**4**							
Tricorythidae	**4**							
Caenidae	**7**							
Ephemerellidae	**1**							
Chloroperlidae	**1**							
Perlidae	**1**							
Pteronar	**0**							
Perlodidae	**2**							
Leuctridae	**0**				8			
PHILOPOTAMIDAE	**3**							4
HYDROPSYCHIDAE	**4**				10			60
Helicopsych	**3**							
Hydroptil	**4**							
Rhyacophil	**0**							1
Polycentrop	**6**							
Limnophillidae	**4**							
Leptoceridae	**4**							4
Corydalidae	**0**							
Sialidae	**4**							5
Psephenus	**4**							
Elmidae	**4**							
Dytiscidae	**5**							
Ceratap	**6**			2				
TIPULIDAE	**3**				23			22
Tabanidae	**6**							
Empidae	**6**							
Athericidae	**2**							
Psychodidae	**10**			1				
Simulidae	**6**				26			4
Muscidae								1
Chiro-blood	**8**	57	16	15	8			
Chiro-other	**6**	19	22	32	6			8
SPHAERIIDAE	**6**							
Physidae	**8**							
Zygo-Coen	**9**							
Anisop-Aeshnidae	**3**							
Anisop-Gomphidae	**1**							
Notonectidae	**6**							
Corixidae	**5**							4
Decapoda	**6**				2			3
Total		129	106	130	141			117

Site	HB1	HB2	HB3	HB4	HB5	HB6	HB7
FBI	7.4	5.9	5.7	4.2			3.9
Score	Very Poor	Fairly Poor	Fair	Very Good			Very Good

Appendix 5. Photo Atlas 2008

Appendix 5
2008 Onondaga Lake Tributary Mapping Photo Atlas

Prepared for the Onondaga County Department of Water Environment Protection

by *EcoLogic* LLC

Onondaga Creek: Site 1, Kirkpatrick Street

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 2, Above Spencer Street

Looking upstream

Surface sheen on shore

Looking downstream

Onondaga Creek: Site 2, Above Spencer Street, cont'd

Looking across stream

Onondaga Creek: Site 3, E. Adams Street

Looking upstream

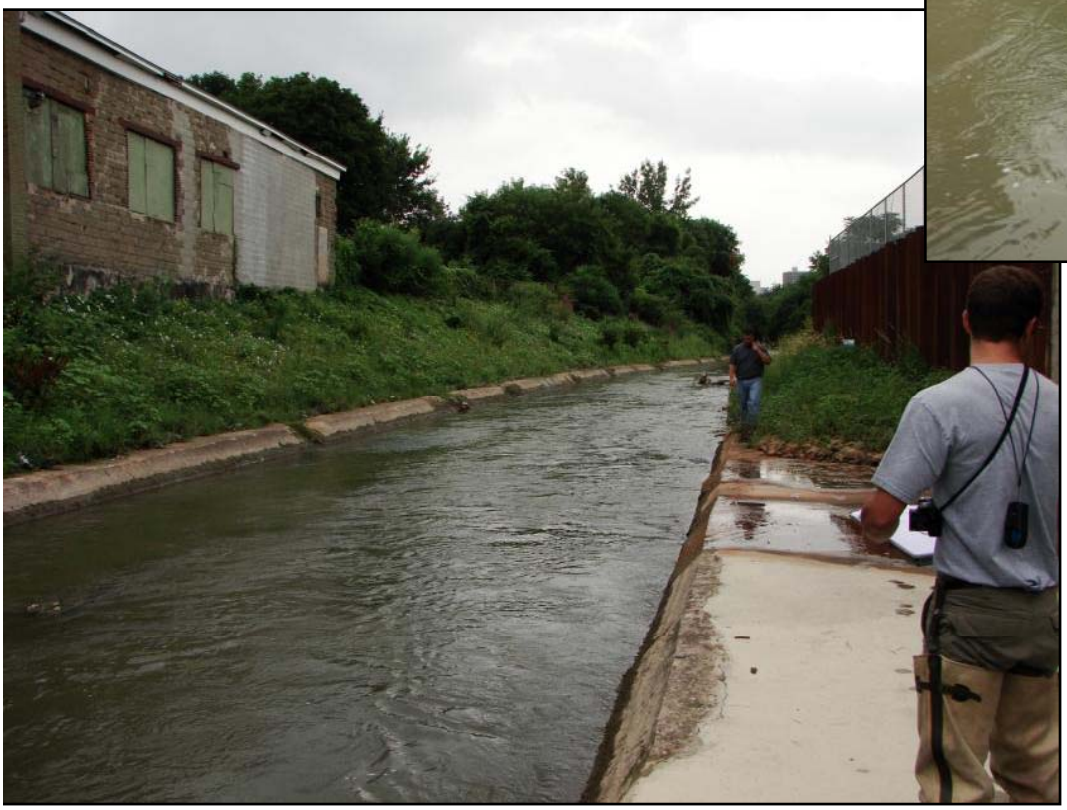
Looking across stream

Looking downstream

Onondaga Creek: Site 4, Midland Ave.

Looking upstream

Looking across stream



Looking downstream

Onondaga Creek: Site 5, Newell Street

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 6, Rt. 173

Looking upstream

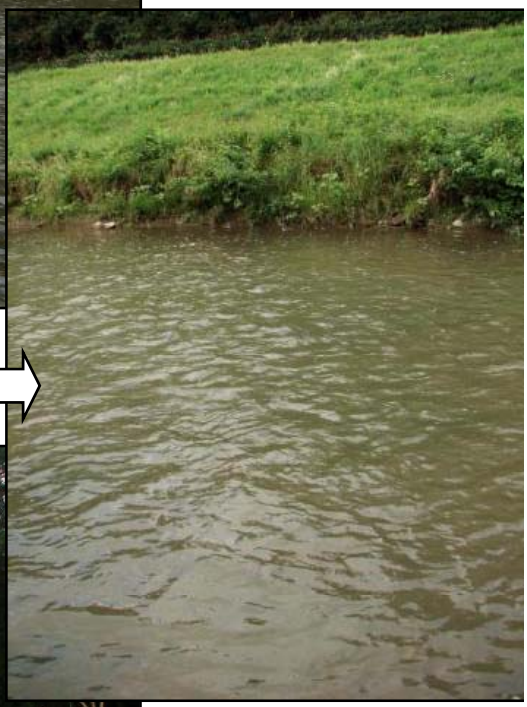
Looking across stream

Looking downstream

Onondaga Creek: Site 7, Rosemont Drive

Looking upstream

Looking across stream



Looking downstream

Onondaga Creek: Site 8, Dorwin Ave.

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Sites 9-15, Onondaga Nation

Not completed in 2008

Onondaga Creek: Site 16, Rt. 20

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 17, Turner Road

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 18, Bear Mt. Road

Looking upstream at Tully Farms Rd. Bridge

Looking across stream

Looking downstream

Onondaga Creek: Site 19, Webster Rd.

Looking upstream

Looking across stream

Looking downstream

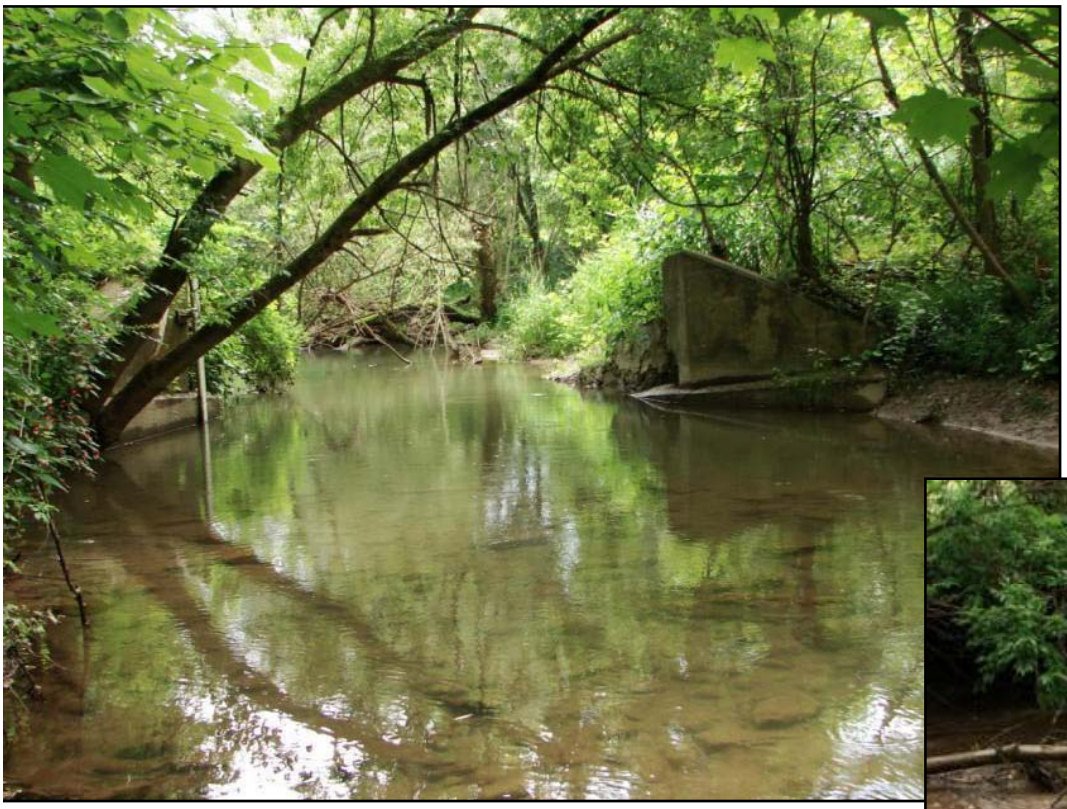
Onondaga Creek: Site 20, Nichols Rd.

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 21, Otisco Rd.



Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 22, Off 11A

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 23, Off 11A

Looking upstream

Dirt road the crosses stream

Looking downstream

Onondaga Creek: Site 24, Tully Farms Road

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 25, Fellows Falls

Looking upstream

Looking across stream

Looking downstream

Onondaga Creek: Site 26, Rt.80

Looking upstream @ impounded section

Looking downstream

Onondaga Creek: Site 27, Rt.80

Looking upstream

Looking downstream

Ley Creek: Site 1, Below Rt.81

Looking upstream

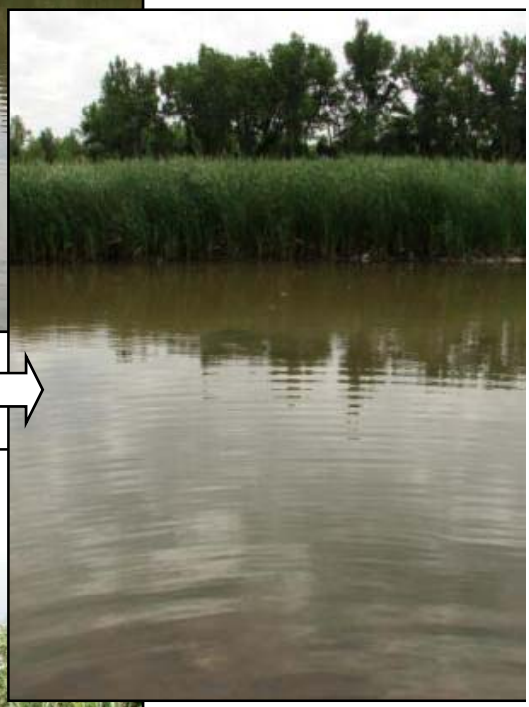
Looking across stream

Looking downstream

Ley Creek: Site 2, 7th North Street

Looking upstream

Looking across stream

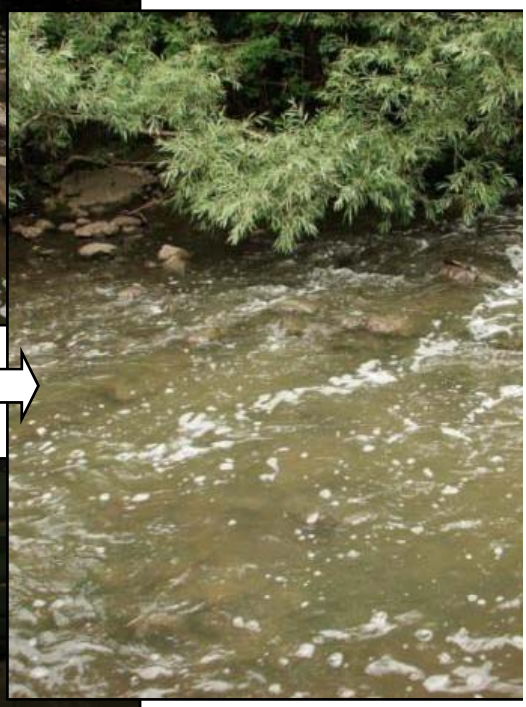


Looking downstream

Ley Creek: Site 3, LeMoyne Ave.

Looking upstream

Looking across stream



Looking downstream

Ley Creek: Site 4, Townline Rd.

Looking upstream

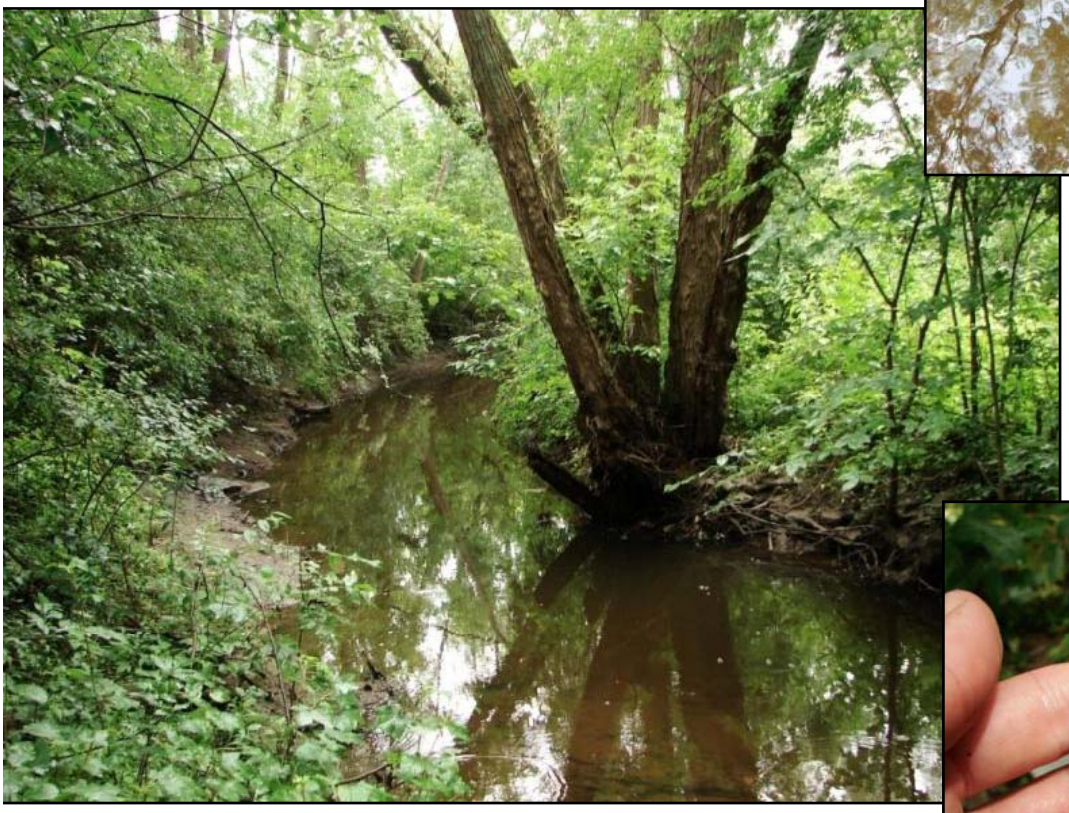
Culverts installed in 2002

Looking downstream

Ley Creek: Site 5, Below E. Molloy Rd.

Looking upstream

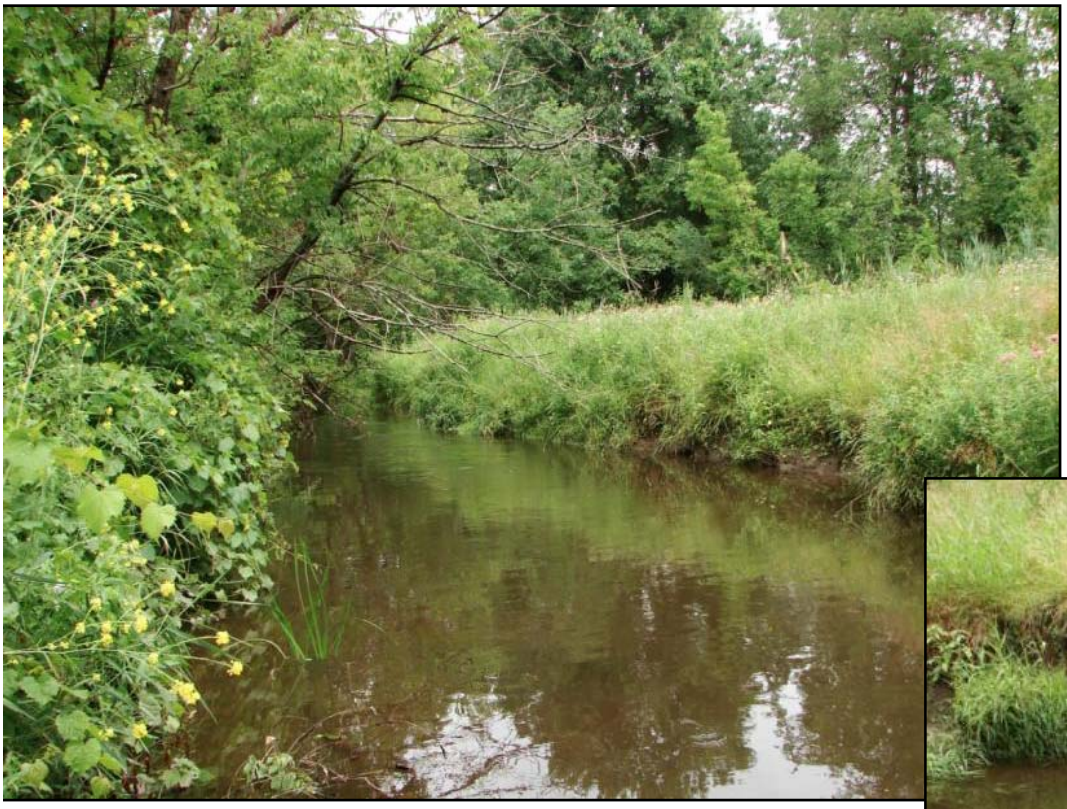
Looking across stream



Looking downstream

Freshwater mussel *Pyganodon cataracta* found at site

Ley Creek: Site 6, Thompson Rd. @OCM BOCES



Looking upstream

Looking across stream

Looking downstream

Ley Creek: Site 7, Schuyler Rd.

Looking upstream

Looking across stream

Looking downstream

Ley Creek: Site 8, Fly Rd.

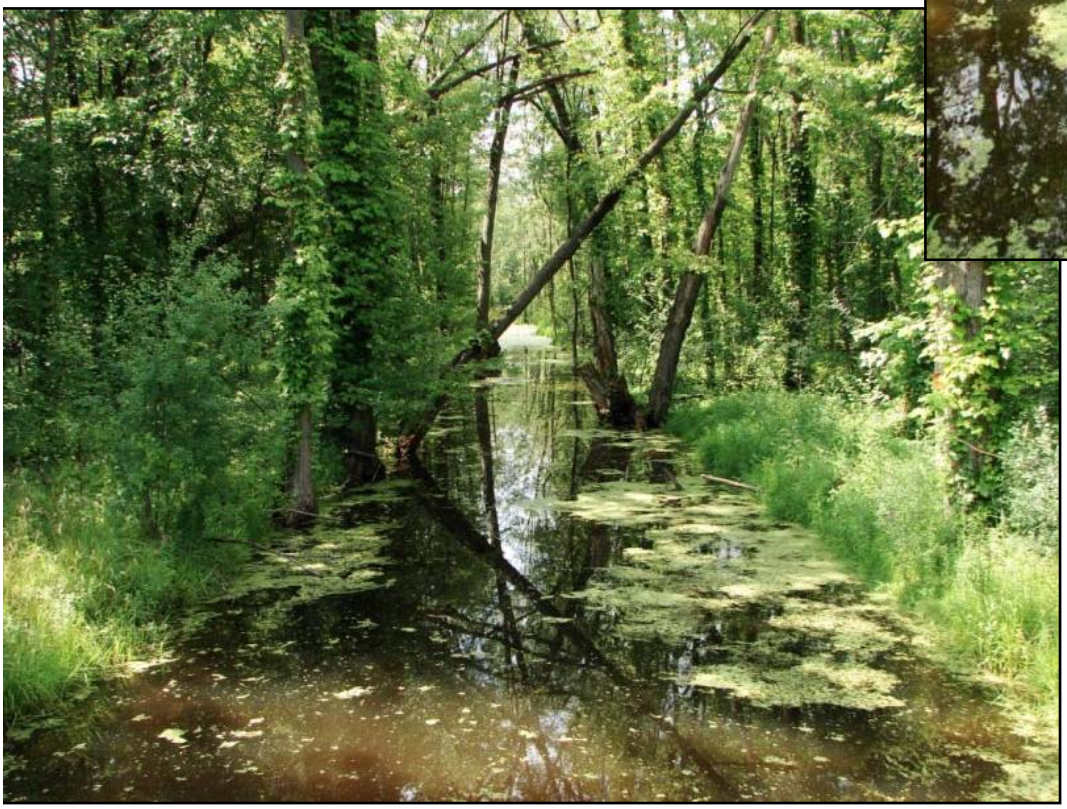
Looking upstream

Looking downstream

Ley Creek: Site 9, Rt. 298

Looking upstream

Looking across stream

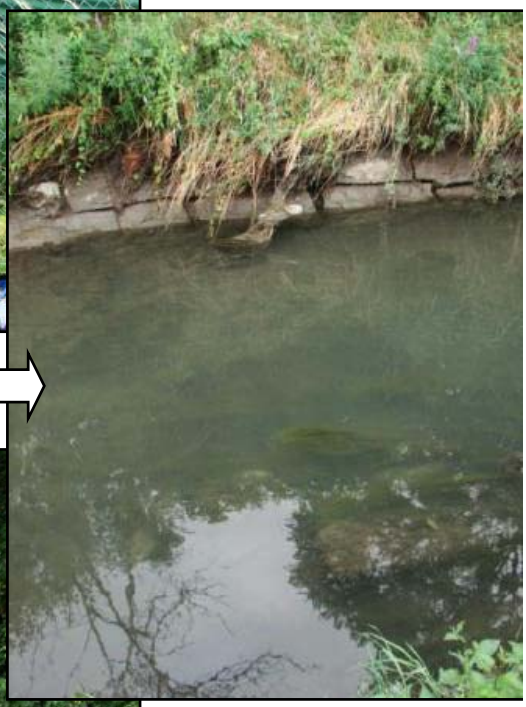


Looking downstream

Harbor Brook: Site 1, Hiawatha Blvd.

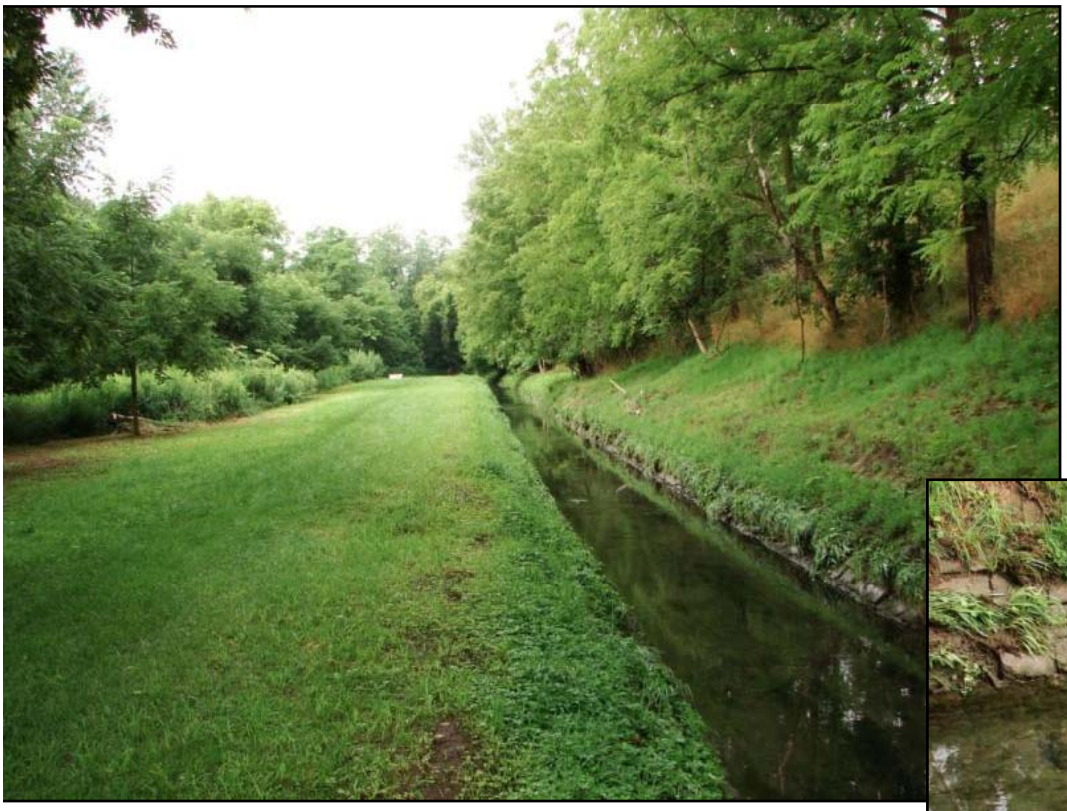
Looking upstream

Looking across stream



Looking downstream

Harbor Brook: Site 2, Amy St.



Looking upstream

Looking across stream

Looking downstream at entrance to underground section

Harbor Brook: Site 3, Velasko Road

Looking upstream

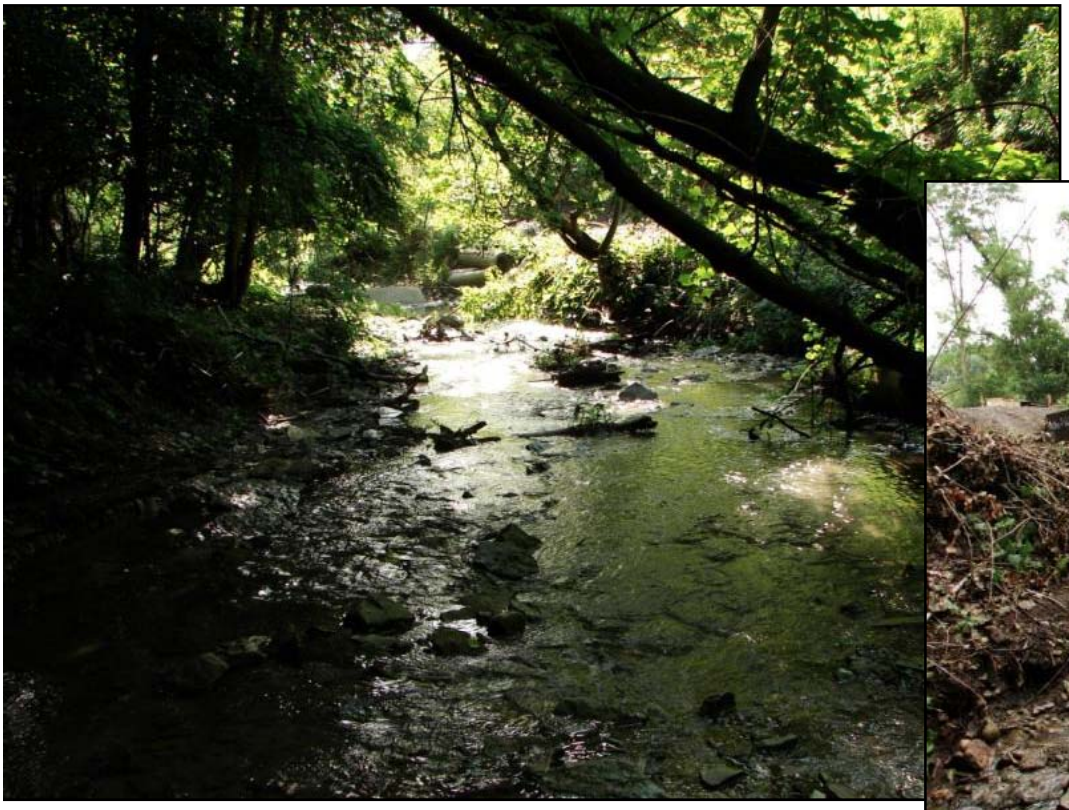
Looking across stream

Looking downstream

Harbor Brook: Site 4, Grand Ave. Pump Station

Looking upstream

Looking across stream

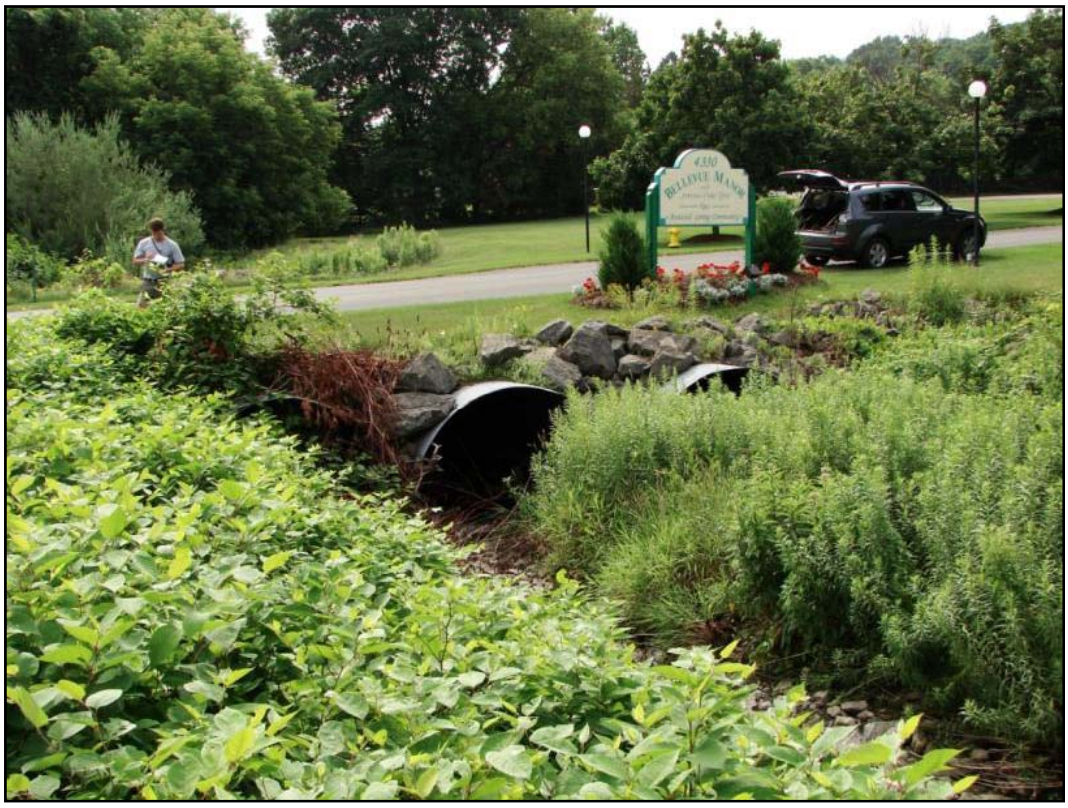


Looking downstream

Construction Near Stream

Harbor Brook: Site 5, Onondaga Blvd. @ Bellevue Manor

Looking upstream



Looking downstream

Harbor Brook: Site 6, Rt. 173 @ St. George Church

Looking upstream

Looking across stream

Looking downstream

Harbor Brook: Site 7, Harris Rd.

Looking upstream

Looking across stream

Looking downstream

Library Reference 5.10

2008 ONONDAGA LAKE TRIBUTARIES MACROINVERTEBRATE MONITORING

Significant Findings and Data Summaries

PREPARED FOR:

ONONDAGA COUNTY
DEPARTMENT OF WATER ENVIRONMENT PROTECTION

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1.0 INTRODUCTION

This document presents the significant findings and data summaries of the 2008 Onondaga Lake Tributary macroinvertebrate monitoring program. Macroinvertebrates are an important component of the aquatic food web. Because they have limited migration patterns or a sessile mode of life, they are well suited for assessing site-specific impacts of point and nonpoint discharges. Many state agencies, including NYSDEC, use macroinvertebrates as indicators of stream quality.

Macroinvertebrate sampling is among the requirements of the Amended Consent Judgment signed in January 1998. Onondaga County is required to assess the macroinvertebrate communities of selected Onondaga Lake tributaries (Appendix D, III. 5 ".... Sample the stream's macroinvertebrate communities and calculate the NYSDEC rapid Field Biotic Index throughout the tributaries' length....") and the Lake (Appendix D, IV 4 "Complement the chemical monitoring program with a biological monitoring effort to assess the densities and species composition of phytoplankton, zooplankton, macrophytes, macrobenthos, and fish").

Sampling in the tributaries is conducted every two years and sampling in the lake's littoral zone is conducted every five years throughout the Ambient Monitoring program (AMP). Macroinvertebrates were sampled in Onondaga Lake tributaries in 2000, 2002, 2004, 2006, and 2008. The objectives of monitoring this element of the aquatic ecosystem are to characterize the existence and severity of use impairment, and evaluate the effectiveness of improvements to the County’s wastewater collection and treatment infrastructure.

2.0 METHODS

A total of ten sampling sites are located along the three CSO-affected tributaries: Onondaga Creek, Harbor Brook and Ley Creek. The macroinvertebrate community present at these sites is assessed every two years. Samples from the stream bottom are collected using either kick samples or jab samples. Data are analyzed using NYSDEC Biological Assessment Profiles (BAP); an index of overall impact to the macroinvertebrate community, and the Hilsenhoff Biotic Index (HBI), and the percent oligochaete; both indicators of organic, oxygen demanding, wastes, such as sewage and animal waste. In addition, the NYSDEC Impact Source Determination (ISD) is calculated at kick sample sites to determine the primary factor(s) influencing the macroinvertebrate community. A more detailed description of the methods is provided in the 2008 Onondaga County Department of Water Environment Protections (OCDWEP) Annual Program Submittal, a copy of which can be found in the 2008 Onondaga Lake AMP Report Methodologies Library.

3.0 SIGNIFICANT FINDINGS

The combination of habitat degradation, non-point source pollution, and CSO discharges influence the community structure of the respective tributary macroinvertebrate communities. In 2008, like past years, the macroinvertebrate communities of Onondaga Creek, Ley Creek, and Harbor Brook showed varying levels of impact. Sites in Ley Creek tended to be the most severely impacted, followed closely by Harbor Brook. Sites in Onondaga Creek tended to be the least impacted.

3.1 Onondaga Creek

Sites on Onondaga Creek showed a wide range of conditions in 2008 with a trend towards increasing impacts downstream (Figure 1). This downstream trend has been evident since 2000, and is likely related to downstream increases in loading due first to changes from forested to agricultural land use in the upper waters followed by changes to urban land use downstream. Impacts to the macroinvertebrate community are evident both upstream (Site 1, 2 and 3) and downstream (Site 4) of urban areas and CSO's.

Site 1 Tully Farms Road

This most upstream site has shown little change since 2000 with BAP scores generally close to the impact demarcation for "None" and "Slight" impact (Figure 1). An unexplained decline in BAP observed in 2004 has since recovered. High HBI scores and low percentage of oligochaetes in samples since 2000 indicate that nutrient enrichment is likely not a major concern at this site.

Immediately after the 2006 samples were collected a streambank stabilization project took place at a bridge immediately upstream of this site. The results of the 2008 analysis indicate that the stabilization work does not appear to have affected the macroinvertebrate community.

Site 2 Webster Road

The site at Webster Road has shown consistently lower BAP scores than the Site 1 Tully Farms Road, located four mile upstream, since monitoring began in 2000. The increased levels of impact at Webster Road appear to be mostly related to increases in oxygen demanding wastes as indicated by lower HBI scores and increased percent contribution of oligochaetes at this location. Modifications in agricultural land use and dairy farming, resulting in increased stream loadings between these two locations, may be playing a role here.

There was a small declining trend in BAP scores at this site from 2000 to 2006. In 2008 the values appear to have rebounded somewhat to levels consistent with the 2004 and 2006 results. The 2008 results indicate that the site is once again considered "slightly impacted" as opposed to the "Moderately" impacted condition during the last survey in 2006 (Figure 2).

Site 3 Dorwin Avenue

Dorwin Avenue is located at the southern edge of the city of Syracuse where urban runoff is expected to begin impacting the stream. This location is also upstream of all CSO's. The level of impact at Dorwin Avenue has not changed substantially since monitoring began in 2000 (Figure

3). This location has consistently been measured as “slightly impacted” based on NYSDEC BAP scores. HBI and percent oligochaete results indicate that the level of organic, oxygen demanding, wastes has not increased during the monitoring period at this location.

The steadily decreasing BAP scores evident at Webster Road are not apparent downstream at Dorwin Ave. In fact BAP scores at Dorwin Ave. in recent years are higher than the upstream Webster Road site, indicating that some level of recovery occurs during the approximately eight miles that separate the two sites.

Site 4 Spencer Street

The most downstream site on Onondaga Creek is located at Spencer Street, which is approximately 6 miles downstream from Site 2, 14 miles from Site 3, and 18 miles from Site 4. The Spencer Street site is downstream of most CSOs and is also impacted by urban runoff from most of the city of Syracuse. As in past years, this site shows the greatest level of impact of the four Onondaga Creek sites. Like recent years the 2008 BAP impact designation was “moderately impacted” (Figure 3).

Although still the most impacted site on Onondaga Creek this location has shown signs of improvement since 2004. NYSDEC BAP scores have improved from borderline “severely/moderately impacted” in 2000 and 2002 to about the mid-range of “moderately impacted” in 2004, 2006, and 2008. In contrast the HBI scores suggest that impacts form organic, oxygen demanding, wastes increased in 2006 and 2008 compared to previous years.

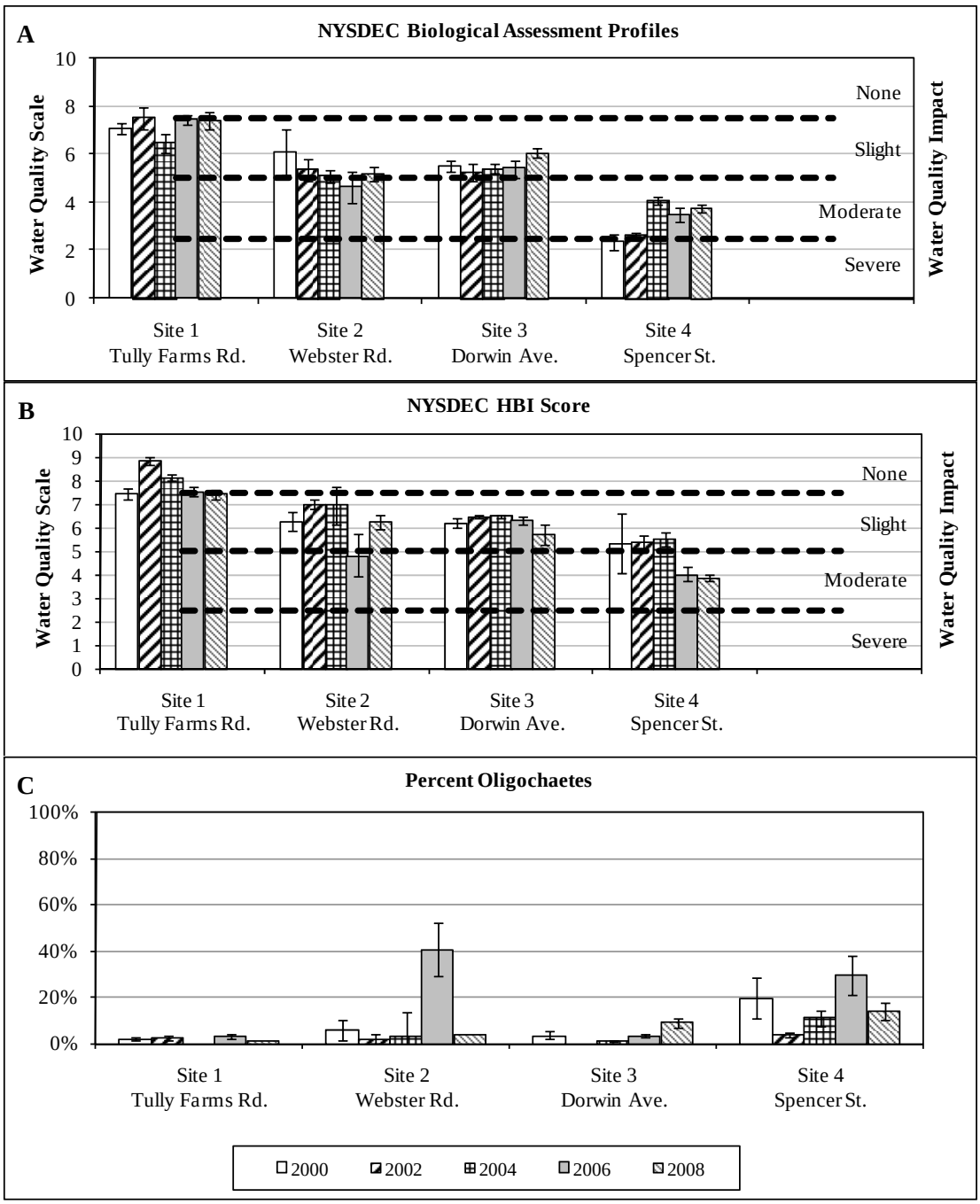


Figure1. NYSDEC Biological Assessment Profile (BAP) scores (A), NYSDEC Hilsenhoff Biotic Index (HBI) scores (B), and percent oligochaetes (C) at sites in Onondaga Creek collected every two years since 2000. The NYSDEC BAP utilizes four individual metrics scaled from 0-10 and averaged; this metric indicates overall level of impact. The NYSDEC HBI is scales result of the traditional HBI metrics; this indicates the level of impact from oxygen demanding waste. The percent oligochaetes shows the average relative abundant of oligochaetes; because oligochaetes can tolerate lower dissolved oxygen levels than most macroinvertebrates they tend to have greater relative abundances in areas associated with oxygen demanding wastes. Error bars are standard error.

3.2 Ley Creek

Of the three Onondaga Lake tributaries monitored for macroinvertebrates, Ley Creek tends to show the greatest degree of overall impacted. Sites are consistently measured as "severely impacted" by the NYSDEC BAP, HBI scores also indicates severe to moderate impact.

In 2008 the percent oligochaetes in samples was notably lower at all three sites than in past years. Two of the three sites had corresponding increases in the HBI, indicating impact from oxygen demanding wastes has likely declined at these sites. These improvements correspond to similar macroinvertebrate improvements observed during the OCDWEP Stream Mapping survey also conducted in 2008 at locations near to or at these sites.

Since the summer of 2001, coinciding with the Hiawatha RTF completion, Ley Creek is the least impacted by CSO discharges of the three monitoring streams. Currently there are only two active CSO's (both immediately upstream of Site 3) that very rarely contribute water to the stream, therefore the source(s) of the overall impact and subsequent improvements in HBI and percent oligochaetes in 2008 in this stream must be from sources other than CSO's.

Site 1 Townline Road

This most upstream site in Ley Creek showed very similar levels of impact from 2000 to 2004, and 2008 with BAP scores close to the impact demarcation for "Severe" and "Moderate" impact (Figure 3). In 2008 the percent oligochaetes in the samples was notably less than in the past.

The results for the last survey, in 2006, indicted a drop in BAP score at this location signifying probable increased impact. The lack of comparable change in HBI scores or percent oligochaetes at that time indicates that the cause of the measured change was likely not due to increases in organic, oxygen demanding wastes. In 2008 the site appears to have recovered to levels near those documented in 2000 – 2004.

Site 2 7th North Street

The 7th North Street sampling location is approximately two and a half miles downstream of the Townline Road site. This location had consistently been the most severely impacted of any of the ten sites in the monitoring program. Levels of impact as measured by the BAP have been mostly on the low end of "severely impacted" prior to 2008 (Figure 3). Analysis in 2008 indicates that although the site is still considered "severely impacted" there has been improvement. This improvement appears related to a decrease in oxygen demanding wastes as determined from increases in the HBI and dramatic decline in percent oligochaetes.

Site 3 Park Street

The Park Street sampling location is approximately one mile downstream of the 7th North Street site, and is the only site in Ley Creek downstream of CSO's. The overall level of impact at this location appears to have remained largely unchanged since the monitoring program began in 2000, and remains "severe". However, in 2008 there was a dramatic decline in the percent oligochaetes in the samples and a subsequent increase in HBI score. Both of these are indicative of decreased levels of oxygen demanding wastes. There were no major upgrades to the

wastewater collection system since 2006 that would be expected to have impacted this site in this way. It is likely that the improvements is die to sources other than CSOs.

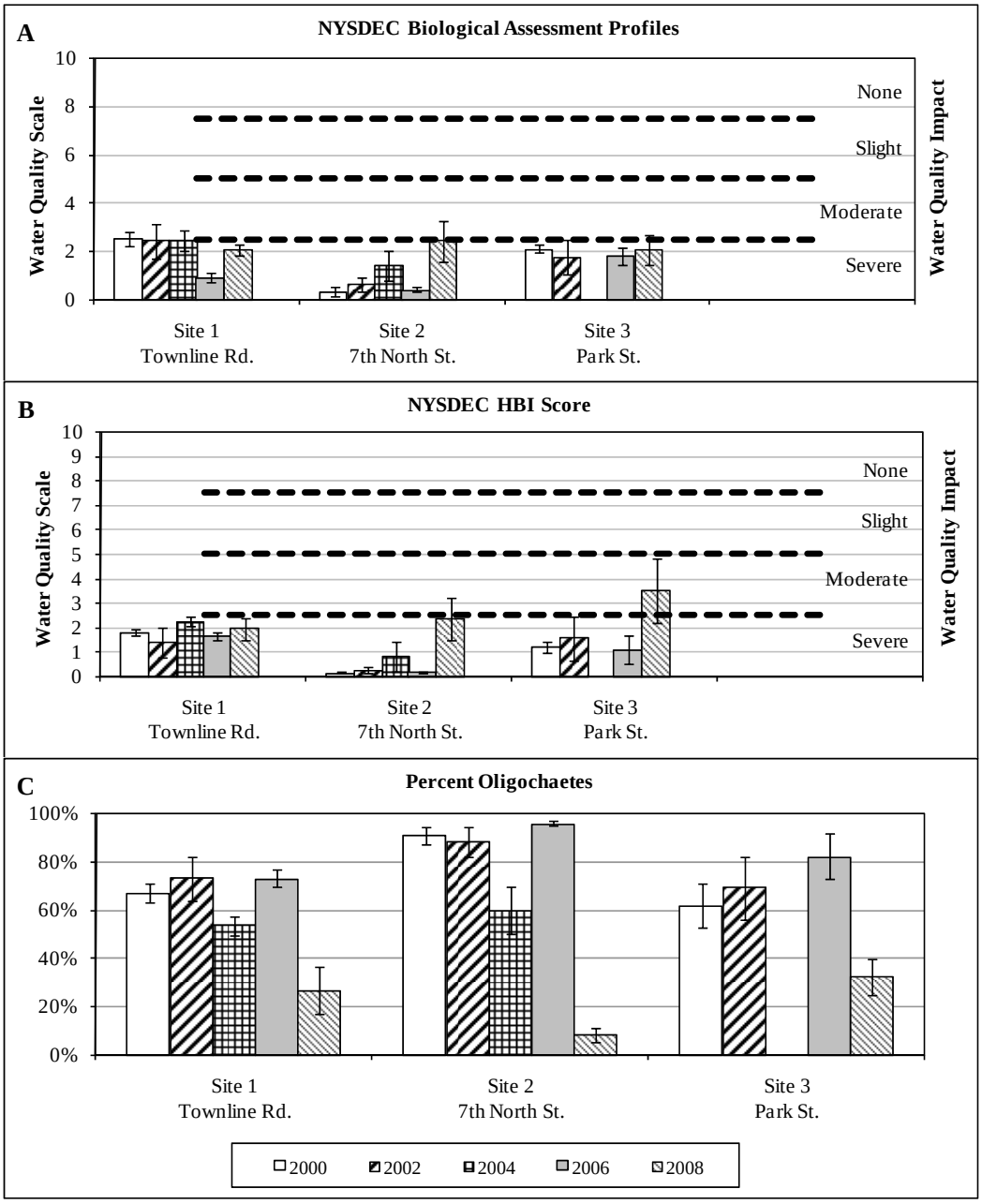


Figure 2. NYSDEC Biological Assessment Profile (BAP) scores (A), NYSDEC Hilsenhoff Biotic Index (HBI) scores (B), and percent oligochaetes (C) at sites in Ley Creek collected every two years since 2000. The NYSDEC BAP utilizes four individual metrics scaled from 0-10 and averaged; this metric indicates overall level of impact. The NYSDEC HBI is scales result of the traditional HBI metrics; this indicates the level of impact from oxygen demanding waste. The percent oligochaetes shows the average relative abundant of oligochaetes; because oligochaetes can tolerate lower dissolved oxygen levels than most macroinvertebrates they tend to have greater relative abundances in areas associated with oxygen demanding wastes. Error bars are standard error. Error bars are standard error.

Note: In 2004 all four replicates at Site 3 had to be combined into a single sample to compensate for low organism numbers. With the addition of the 2006 and 2008 results it appears that the 2004 results are outliers and likely do not accurately reflect the condition of this site in 2004. Therefore the 2004 results for Site 3 have been removed.

3.3 Harbor Brook

Sites on Harbor Brook range from moderately to severely impacted based on BAP scores. The two sites downstream of the most urbanized areas, and all CSO's, show greater degree of impact than the upstream reference site.

Site 1 Velasko Road

This most upstream site in Harbor Brook has had BAP scores consistently in the "Moderately" impact range for all years sampled (Figure 3). Results for the HBI scores for this time period are disproportionably better then the BAP results, particularly for the 2002 to 2008 time period, indicating that the primary sources of impact were likely not associated with organic, oxygen demanding wastes. This suggests some other unknown cause of the measured disturbance at this site.

Site 2 Hiawatha Blvd.

The Hiawatha Blvd. sampling location is approximately two miles downstream of the Velasko Road site of which about one mile is composed of an underground culvert. This location had shown a steady decline in BAP scores from 2000 through 2006 (Figure 3). These declining BAP scores correspond to decreasing HBI scores and increasing percent oligochaetes, both of which are indicative of increased impact from organic, oxygen demanding wastes through this time period. In 2008 there is evidence of recovery; BAP scores are higher than 2006, HBI scores have increased to levels only slightly lower than the 2000 and 2002 results, and the percent oligochaetes were at their lowest levels recorded during the monitoring program. These results seem to indicate that an increase in oxygen demanding wastes occurred from 2000 through 2006 then declined between 2006 and 2008.

Site 3 Rt. 690

The Rt. 690 sampling location is approximately a half miles downstream of the Hiawatha Blvd. site (Figure 3). The level of impact at this location has remained relatively stable over the course of the monitoring program remaining near the demarcation of "Severe" and "Moderate" impact.

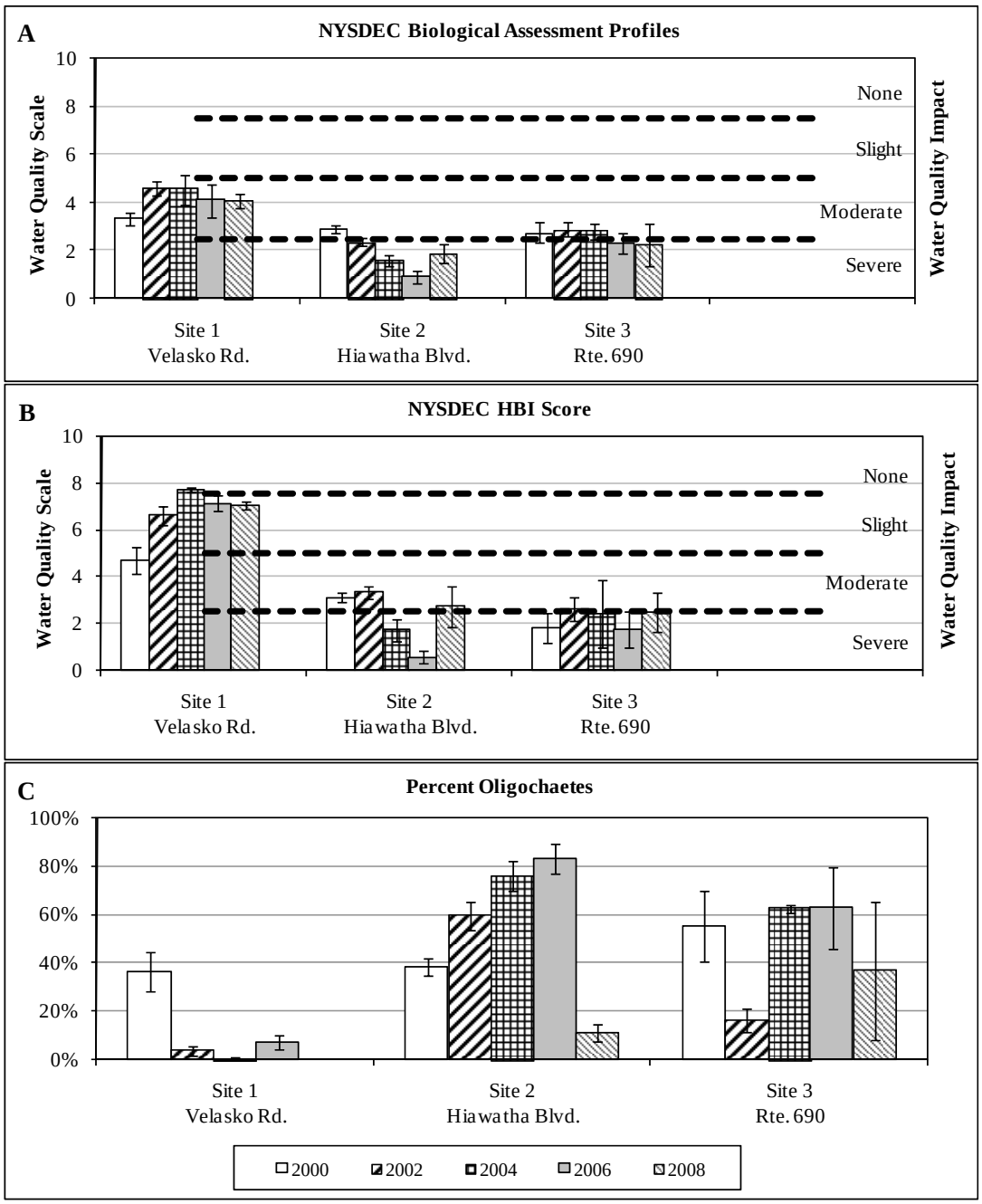
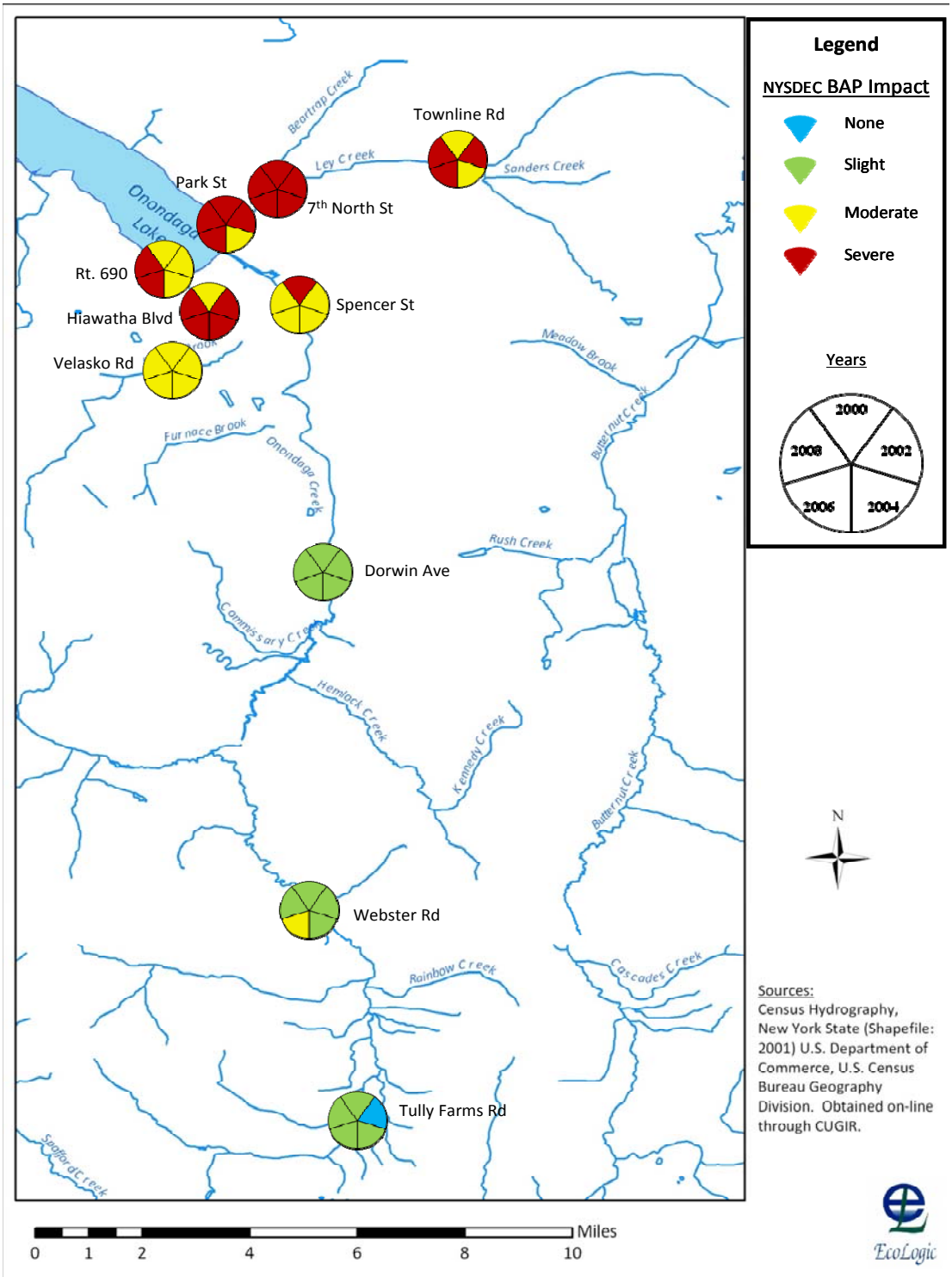


Figure 3. NYSDEC Biological Assessment Profile (BAP) scores (A), NYSDEC Hilsenhoff Biotic Index (HBI) scores (B), and percent oligochaetes (C) at sites in Harbor Brook collected every two years since 2000. The NYSDEC BAP utilizes four individual metrics scaled from 0-10 and averaged; this metric indicates overall level of impact. The NYSDEC HBI is scales result of the traditional HBI metrics; this indicates the level of impact from oxygen demanding waste. The percent oligochaetes shows the average relative abundant of oligochaetes; because oligochaetes can tolerate lower dissolved oxygen levels than most macroinvertebrates they tend to have greater relative abundances in areas associated with oxygen demanding wastes. Error bars are standard error.

4.0 SUMMARY

Results of the nine year macroinvertebrate monitoring program indicate no consistent trends toward improving conditions in the monitored portions of the watershed (Figure 4). Some individual sites have shown varying levels of change, both positive and negative, with no apparent correlation to combined sewer overflows.

Figure 4. Results over time of NYSDEC Biological Assessment Profile Impact.



APPENDIX 1, AMP MACROINVERTEBRATE TAXA LIST

TAXONOMIC LIST OF VOUCHER COLLECTION SPECIMENS FROM ONONDAGA LAKE AND ADJACENT STREAMS, NEW YORK, 1999 - 2008

Platyhelminthes	
Turbellaria	
Tricladida	
Planariidae	
Cura foremanii	J3
Dugesia polychroa	J2
Dugesia tigrina	J1
Cnidaria	
Hydrozoa	
Hydroida	
Hydridae	
Hydra	Y1
Annelida	
Oligochaeta	
Enchytraeida	
Enchytraeidae	L10
Enchytraeus	L39*
Lumbricillus	L38*
Lumbriculida	
Lumbriculidae	L40*
Tubificida	
Naididae	
Amphichaeta leydigi	L29
Chaetogaster diaphanus	L26
Chaetogaster diastrophus	L31
Dero digitata	L7
Dero lodeni	L33
Dero nivea	L25
Dero trifida	L22
Nais barbata	L19
Nais bretscheri	L43[3]
Nais communis	L34
Nais elinguis	L24
Nais variabilis	L18
Ophidonais serpentina	L8
Paranais frici	L42*
Paranais litoralis	L21
Pristina aequiseta	L30
Pristina leidyi	L35
Pristinella jenkinae	L23
Pristinella osborni	L27
Specaria josinae	L44[3]
Stylaria lacustris	L9
Vejdovskyella intermedia	L16
Tubificidae	
Aulodrilus limnobius	L28
Aulodrilus pigueti	L13
Ilyodrilus templetoni	L17
Limnodrilus cervix	L5
Limnodrilus claparedeianus	L12
Limnodrilus hoffmeisteri	L3
Limnodrilus profundicola	L4
Limnodrilus udekemianus	L2
Quistadrilus multisetosus	L41*
Potamothrix bavaricus	L11
Potamothrix bedoti	L20
Potamothrix moldaviensis	L14
Tubifex tubifex	L6
Lumbricida	
Lumbricidae	
Eiseniella tetraedra	L36*
Allolobophora chlorotica	L37*
Hirudinea	
Rhynchobdellida	
Glossiphoniidae	
Helobdella	H1
Helobdella stagnalis	H3*
Helobdella triserialis	H2
Piscicolidae	
Piscicola	H6 [1]
Arynchobdellida	
Erpobdellidae	
Mooreobdella fervida	H5*
Mooreobdella microstoma	H4*
Arthropoda	
Arachnida	
Hydrachnida	
Hygrobatidae	
Hygrobates	W7
Limnesiidae	
Limnesia	W3
Pionidae	
Piona	W2
Sperchontidae	
Sperchon	W8[5]
Torrenticolidae	
Torrenticola	W1
Unionicolidae	
Neumania	W5
Koenikea	W6
Unionicola	W4
Malacostraca	
Amphipoda	
Crangonyctidae	
Crangonyx pseudogracilis	A4*
Gammaridae	
Gammarus fasciatus	A1
Gammarus pseudogracilis	A4*
Gammarus pseudolimnaeus	A2
Hyalellidae	

TAXONOMIC LIST OF VOUCHER COLLECTION SPECIMENS FROM ONONDAGA LAKE AND ADJACENT STREAMS, NEW YORK, 1999 - 2008

Hyalella azteca	A3
Isopoda	
Asellidae	
Caecidotea racovitzai	I2
Caecidotea	I1
Entognatha	
Collembola	
Entomobryidae	
Orchesella	S2
Isotomidae	
Isotomus cf. *sensibilis*	S1
Isotomurus	S3
Insecta	
Ephemeroptera	
Baetidae	
Baetis	E1
Procloeon	E5*
Caenidae	
Caenis	E4
Ephemerellidae	
Attenella	E11[5]
Timpanoga (Dannella)	E3, E9 [1]
Heptageniidae	
Epeorus	E8*
Heptagenia	E6*
Leucrocuta	E10 [2]
Leptophlebiidae	
Paraleptophlebia	E7*
Tricorythidae	
Tricorythodes	E2
Odonata	
Aeshnidae	
Boyeria	N5*
Calopterygidae	
Calopteryx maculata	N1
Coenagrionidae	
Coenagrion/Enallagma	N3
Ischnura	N2
Cordulegasturidae	
Cordulegaster obliqua	N6 [4]
Gomphidae	
Lanthus parvulus	N4*
Plecoptera	
Chloroperlidae	
Alloperla	P6 [1]
Sweltsa	P5*
Leuctridae	
Leuctra	P1
Perlidae	
Acroneuria	P3
Agnetina	P2
Pteronarcyidae	
Pteronarcys	P4*
Hemiptera	
Corixidae	
Hesperocorixa	U4 [1]
Trichocorixa	U3 [1]
Notonectidae	
Notonecta	U5[5]
Saldidae	U2
Veliidae	
Rhagovelia	U1
Megaloptera	
Corydalidae	
Nigronia serricornis	M1
Sialidae	
Sialis	M2
Trichoptera	
Glossosomatidae	
Glossosoma	T14*
Helicopsychidae	
Helicopsyche borealis	T15 [1]
Hydropsychidae	
Cheumatopsyche	T4
Hydropsyche betteni	T8
Hydropsyche bronta	T6
Hydropsyche slossonae	T2
Hydropsyche sparna	T3
Hydropsyche cf. *scalaris*	T17 [4]
Hydroptilidae	
Hydroptila	T1
Leptoceridae	
Nectopsyche	T12
Oecetis (Pseudosetodes) avara grp.	T9
Limnephilidae	
Pycnopsyche	T16 [2]
Philopotamidae	
Chimarra	T7
Dolophilodes	T13*
Polycentropodidae	
Nyctiophylax	T11
Polycentropus	T10
Rhyacophilidae	
Rhyacophila	T5
Lepidoptera	
Pyralidae	
Acentria	LE1
Coleoptera	
Dytiscidae	
Agabus	C2
Elmidae	

TAXONOMIC LIST OF VOUCHER COLLECTION SPECIMENS FROM ONONDAGA LAKE AND ADJACENT STREAMS, NEW YORK, 1999 - 2008

- *Ancyronyx* C9
- *Dubiraphia* C7
- *Macronychus* C5
- *Optioservus* C1
- *Promoresia* C6
- *Stenelmis* C4
- Gyrinidae
  - *Dineutus* C12 [1]
- Haliplidae
  - *Haliplus* C11
- Hydrophilidae
  - *Berosus* C10
  - *Hydrobius* C3
  - *Tropisternus* C13 [1]
- Lampyridae C8
- Psephenidae
  - *Ectopria* C14[5]

Diptera

- Athericidae
  - *Atherix* Z6*
- Ceratopogonidae
  - *Bezzia/Palpomyia* R1
  - *Ceratopogon* R4[5]
  - *Monohelea* R2
  - *Mallochohelea* R3
  - *Sphaeromais* R5[5]
- Chironomidae
  - *Ablabesmyia mallochi* 34
  - *Alotanypus* 75
  - *Brillia flavifrons* 22
  - *Chironomus* 81*
  - *Cladopelma* 67
  - *Cladotanytarsus* 20
  - *Corynoneura* 41
  - *Cricotopus bicinctus* 7
  - *Cricotopus* cf. *intersectus* 83*
  - *Cricotopus sylvestris* grp. 44
  - *Cricotopus* cf. *triannulatus* 43
  - *Cricotopus trifascia* 3
  - *Cricotopus* cf. *vierriensis* 39
  - *Cricotopus/Orthocladius* 19
  - *Cryptochironomus* 27
  - *Cryptotendipes* 63
  - *Demicryptochironomus* 89 [2]
  - *Diamesa* 25
  - *Dicrotendipes fumidus* 38
  - *Dicrotendipes simpsoni* 48
  - *Dicrotendipes modestus* 36
  - *Dicrotendipes neomodestus* 37
  - *Dicrotendipes nervosus* 30
  - *Doncricotopus* cf. *bicaudatus* 54
  - *Endochironomus* 35
  - *Eukiefferiella brehmi* grp. 64
  - *Eukiefferiella claripennis* grp. 76
  - *Eukiefferiella coerulescens* grp. 90 [2]
  - *Eukiefferiella devonica* grp. 13
  - *Glyptotendipes* (*Glyptotendipes*) 46
  - *Heleniella* 84 [1]
  - *Heterotrissocladius marcidus* grp. 29
  - *Labrundinia neopilosella* 51
  - *Labrundinia pilosella* 47
  - *Larsia* 79*
  - *Micropsectra* 17
  - *Microtendipes pedellus* grp. 4
  - *Nanocladius alternantherae* 94[3]
  - *Nanocladius* cf. *minimus* 16
  - *Nanocladius* cf. *rectinervis* 70
  - *Natarsia* 80*
  - *Nilotanypus fimbriatus* 66
  - *Nilothauma* 91 [2]
  - *Orthocladius* (*Euorthocladius*) 73
  - *Pagastia* sp. A of Oliver 12
  - *Parachironomus* cf. *carinatus* 52
  - *Parachironomus* cf. *frequens* 49
  - *Parachironomus* cf. *monochromus* 53
  - *Paracladopelma* 88 [1]
  - *Parakiefferiella* cf. sp. A of Epler 50
  - *Parakiefferiella* cf. sp. B of Epler 69
  - *Paralauterborniella* 61
  - *Parametriocnemus* 31
  - *Paratanytarsus* 8
  - *Paratendipes* 55
  - *Phaenopsectra obediens* grp. 15
  - *Phaenopsecra punctipes* 32
  - *Polypedilum aviceps* 77*
  - *Polypedilum convictum* grp. 5
  - *Polypedilum fallax* 42
  - *Polypedilum flavum* 92 [2]
  - *Polypedilum halterale* grp. 71
  - *Polypedilum illinoense* grp. 28
  - *Polypedilum laetum* 14
  - *Polypedilum scalaenum* grp. 56
  - *Polypedilum tritum* 93 [2]
  - *Potthastia gaedii* grp. 68
  - *Procladius* (*Holotanypus*) 33
  - *Prodiamesa* 11
  - *Psectrocladius* 82*
  - *Psectrotanypus* 87 [1]
  - *Pseudochironomus* 95 [5]
  - *Pseudosmittia* 60
  - *Rheocricotopus* 45
  - *Rheotanytarsus* 23
  - *Stempellinella* 78*
  - *Stenochironomus* 65

TAXONOMIC LIST OF VOUCHER COLLECTION SPECIMENS FROM ONONDAGA LAKE AND ADJACENT STREAMS, NEW YORK, 1999 - 2008

Stictochironomus	74
Sublettea	85 [1]
Tanypus	86 [1]
Tanytarsus cf. sp. A of Epler	9
Tanytarsus cf. sp. C of Epler	10
Tanytarsus cf. sp. E of Epler	72
Tanytarsus cf. sp. G of Epler	40
Tanytarsus cf. sp. L of Epler	62
Tanytarsus cf. sp. P of Epler	26
Tanytarsus cf. sp. T of Epler	58
Tanytarsus cf. sp. W of Epler	18
Thienemanniella cf. *xena*	24
Thienemanniella cf. sp. A of Epler	57
Thienemannimyia grp.	1, 2
Tribelos	96 [5]
Tvetenia bavarica grp.	21
Tvetenia discoloripes grp.	6
Zavrelimyia	59
Empididae	
Chelifera	Q2
Clinocera	Q1
Hemerodromia	Q3
Muscidae	Z1
Psychodidae	
Pericoma	Z3*
Psychoda	Z4*
Simuliidae	
Simulium	Z2
Stratiomyiidae	
Caloparyphus	Z9 [1]
Euparyphus	Z11 [2]
Stratiomys	Z10 [1]
Tabanidae	
Chrysops	Z5*
Tipulidae	
Antocha	V3
Dicranota	V2
Gonomyia	V5 [1]
Hexatoma	V1
Pseudolimnophila	V6 [2]
Tipula	V4*
Mollusca	
Bivalvia	
Veneroida	
Dreissenidae	
Dreissena polymorpha	B3
Sphaeriidae	
Musculium	B5*
Pisidium casertanum	B6*
Pisidium compressum	B2
Pisidium punctatum	B4
Pisidium dubium	B1
Sphaerium	B7 [1]
Gastropoda	
Limnophila	
Ancylidae	
Ferrissia rivularis	G6
Lymnaeidae	
Fossaria	G5
Fossaria rustica	G7
Pseudosuccinea columella	G8
Physidae	
Physa cf. *heterostropha*	G1, G4
Planorbidae	
Gyraulus circumstriatus	G2
Micromenetus dilatatus	G3
Valvatidae	
Valvata piscinalis	G9
Mesogastropoda	
Bithyniidae	
Bithynia tentaculata	G11 [5]
Hydrobiidae	
Amnicola (Lyogyrus)	G10[3]

* Taxa added from the samples collected in 2000.
[1] Taxa added from the samples collected in 2002.
[2] Taxa added from the samples collected in 2004.
[3] Taxa added from the samples collected in 2005.
[4] Taxa added from the samples collected in 2006.
[5] Taxa added from the samples collected in 2008.

Alphanumeric/numeric designation following taxon pertains to the code found in the vial/on the vial lid or on the microscope slide.

APPENDIX 2, METRIC RESULTS AND BAP DESIGNATIONS

Mean index value and corresponding mean NYSDEC Biological Assessment Profiles (BAP) Score and Designations from monitoring sites in Onondaga Creek in all sampled years.

			Species Richness		EPT Richness		HBI		PMA		NYSDEC	
Year	Site	Description	*Index Mean*	*NYSDEC BAP Mean*	*Index Mean*	*NYSDEC BAP Mean*	*Index Mean*	*NYSDEC BAP Mean*	*Index Mean*	*NYSDEC BAP Mean*	**Mean BAP Score**	**BAP Impact Designation**
2000	1	Tully Farms Rd.	20.0	5.6	9.0	6.9	4.5	7.4	74%	8.5	**7.1**	**Slight**
	2	Webster Rd.	24.5	7.0	5.5	4.7	5.5	6.3	60%	6.5	**6.1**	**Slight**
	3	Dorwin Ave.	19.5	5.4	5.3	4.9	5.5	6.2	52%	5.4	**5.5**	**Slight**
	4	Spencer Street	7.3	1.0	0.3	0.3	6.2	5.3	35%	2.7	**2.3**	**Severe**
2002	1	Tully Farms Rd.	21.5	6.0	10.8	7.8	3.2	8.8	66%	7.5	**7.5**	**None/Slight**
	2	Webster Rd.	21.5	6.0	3.8	3.8	4.9	7.0	47%	4.7	**5.4**	**Slight**
	3	Dorwin Ave.	18.0	5.0	5.0	4.8	5.3	6.4	48%	4.8	**5.3**	**Slight**
	4	Spencer Street	12.0	3.0	0.0	0.0	6.2	5.4	33%	2.2	**2.6**	**Moderate**
2004	1	Tully Farms Rd.	21.3	6.0	6.8	5.7	3.9	8.1	58%	6.2	**6.5**	**Slight**
	2	Webster Rd.	18.3	5.0	3.5	3.9	4.9	6.9	47%	4.6	**5.1**	**Slight**
	3	Dorwin Ave.	18.0	4.9	4.5	4.5	5.3	6.5	54%	5.8	**5.4**	**Slight**
	4	Spencer Street	19.0	5.2	1.8	2.6	6.1	5.5	38%	3.1	**4.1**	**Moderate**
2006	1	Tully Farms Rd.	23.0	6.5	9.0	6.9	4.5	7.5	78%	8.8	**7.4**	**Slight**
	2	Webster Rd.	19.8	5.5	3.8	4.0	6.6	4.8	44%	4.2	**4.6**	**Moderate**
	3	Dorwin Ave.	18.0	5.0	6.3	5.6	5.5	6.3	48%	4.7	**5.4**	**Slight**
	4	Spencer Street	21.8	6.1	0.8	1.1	7.3	4.0	36%	2.7	**3.5**	**Moderate**
2008	1	Tully Farms Rd.	24.5	6.8	9.5	7.2	4.6	7.4	73%	8.4	**7.4**	**Slight**
	2	Webster Rd.	21.5	6.0	4.5	4.5	5.5	6.3	44%	4.1	**5.2**	**Slight**
	3	Dorwin Ave.	27.0	7.7	5.5	5.1	6.0	5.7	54%	5.8	**6.1**	**Slight**
	4	Spencer Street	18.0	5.0	1.8	2.6	7.4	3.9	40%	3.5	**3.7**	**Moderate**

Mean index value and corresponding mean NYSDEC Biological Assessment Profiles (BAP) Score and Designations from monitoring sites in Ley Creek in all sampled years.

			Species Richness		EPT Richness		HBI		PMA		NCO		NYSDEC	
			Index	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	**Mean**	**BAP Impact**
Year	**Site**	**Description**	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	**BAP Score**	**Designation**
2000	1	Townline Road	14.8	4.1	0.3	0.4	8.9	1.8	--	--	3.3	3.8	**2.5**	**Moderate/Severe**
	2	7th North Street	8.8	0.9	0.0	0.0	9.9	0.2	--	--	0.3	0.3	**0.3**	**Severe**
	3	Park Street	14.0	3.8	0.0	0.0	9.3	1.2	--	--	2.8	3.5	**2.1**	**Severe**
2002	1	Townline Road	15.3	4.4	0.0	0.0	9.1	1.4	--	--	4.5	3.8	**2.4**	**Severe**
	2	7th North Street	7.8	0.4	0.0	0.0	9.9	0.2	--	--	1.3	1.8	**0.6**	**Severe**
	3	Park Street	11.3	2.2	0.3	0.4	9.1	1.5	--	--	2.8	2.9	**1.7**	**Severe**
2004	1	Townline Road	16.3	4.4	0.5	0.8	8.7	2.2	34%	2.4	--	--	**2.5**	**Moderate/Severe**
	2	7th North Street	11.3	1.9	0.0	0.0	9.4	0.8	--	--	1.3	1.4	**1.4**	**Severe**
	3	Park Street	18.0	5.9	1.0	1.5	7.6	4.0	--	--	6.0	5.5	**4.2**	**Moderate**
2006	1	Townline Road	9.5	1.9	0.0	0.0	9.0	1.6	16%	0.0	0.0	0.0	**0.9**	**Severe**
	2	7th North Street	8.5	0.8	0.0	0.0	9.9	0.2	0.0	0.0	0.5	0.6	**0.4**	**Severe**
	3	Park Street	11.0	2.3	0.0	0.0	9.3	1.1	0.0	0.0	3.3	3.8	**1.8**	**Severe**
2008	1	Townline Road	13.3	3.4	0.3	0.3	8.8	1.9	35%	2.6	0.0	0.0	**1.4**	**Severe**
	2	7th North Street	14.5	4.2	0.0	0.0	8.6	2.3	0.0	0.0	3.0	3.1	**2.4**	**Severe**
	3	Park Street	9.8	2.1	0.0	0.0	7.9	3.5	0.0	0.0	2.3	2.7	**2.1**	**Severe**

Note: Due to habitat changes, samples at Site 1 were collected with kick samples in 2004, 2006, and 2008, and jab samples in 2000 and 2002.

According to NYSDEC guidance PMA is calculated for kick sample sites and NCO for jab sites.

Site 3, Park Street, in 2004 had fewer organisms in all four replicates (22, 19, 30 and 12) than is needed to calculate NYSDEC metrics (100).

As a result replicates were combined into a single sample of 83 organisms to approach the 100 organisms needed.

A single replicate at Site 2, 7th North Street, in 2004 and Site 3 Park Street in 2006 also had few organism, these replicates were not used in the analysis.

Mean index value and corresponding mean NYSDEC Biological Assessment Profiles (BAP) Score and Designations from monitoring sites in Harbor Brook in all sampled years.

			Species Richness		EPT Richness		HBI		PMA		NCO		NYSDEC	
			Index	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	*Index*	*NYSDEC*	**Mean**	**BAP Impact**
Year	**Site**	**Description**	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	*Mean*	*BAP Mean*	**BAP Score**	**Designation**
2000	1	Velasko Road	16.0	4.3	1.5	2.2	6.7	4.7	32%	2.1	--	--	**3.3**	**Moderate**
	2	Hiawatha Blvd.	20.0	5.6	0.3	0.3	8.1	3.1	35%	2.6	--	--	**2.9**	**Moderate**
	3	Rt. 690	15.0	4.3	0.3	0.4	9.0	1.8	--	--	4.0	4.2	**2.7**	**Moderate**
2002	1	Velasko Road	18.8	5.2	2.3	2.9	5.2	6.6	42%	3.8	--	--	**4.6**	**Moderate**
	2	Hiawatha Blvd.	15.3	4.0	0.3	0.3	7.9	3.3	30%	1.8	--	--	**2.4**	**Severe**
	3	Rt. 690	16.8	5.3	--	--	8.4	2.6	--	--	3.0	3.6	**3.8**	**Moderate**
2004	1	Velasko Road	11.8	2.8	2.8	3.5	4.3	7.7	46%	4.5	--	--	**4.6**	**Moderate**
	2	Hiawatha Blvd.	15.5	4.1			9.0	1.7	23%	0.7	--	--	**2.1**	**Severe**
	3	Rt. 690	15.0	4.4	0.5	0.8	8.6	2.4	--	--	3.5	3.9	**2.9**	**Moderate**
2006	1	Velasko Road	13.8	3.5	2.3	2.9	4.8	7.1	37%	2.9	--	--	**4.1**	**Moderate**
	2	Hiawatha Blvd.	12.5	3.0	--	--	9.7	0.6	17%	0.1	--	--	**1.2**	**Severe**
	3	Rt. 690	13.3	3.4	--	--	9.0	1.7	--	--	4.0	4.2	**3.1**	**Severe**
2008	1	Velasko Road	14.3	3.8	2.5	3.0	4.9	7.0	35%	2.5	--	--	**4.1**	**Moderate**
	2	Hiawatha Blvd.	11.0	2.5	0.3	0.3	8.2	2.7	32%	2.1	--	--	**1.9**	**Severe**
	3	Rt. 690	10.5	2.1	0.5	0.8	8.5	2.5	--	--	4.0	3.7	**2.3**	**Severe**

Note: Site 1 and 2 use kick samples and Site 3 utilizes jab samples. According to NYSDEC guidance PMA is calculated for kick sample sites and NCO for jab sites.

APPENDIX 3, IMPACT SOURCE DETERMINATIONS

Impact Source Determination (ISD), Onondaga Creek for years sampled. The NYSDEC Impact Source Determination (ISD) ascertains the primary factor influencing the macroinvertebrate community in stream riffle habitats based on similarity to impacted community models (Bode et al. 2002). The model community that exhibits the highest similarity to the test data indicates the likely impact source type for that site. If data from a site do not match any of the modeled communities (based on a standard of 50% affinity) the determination is "inconclusive".

	Site 1 - Tully Farms Road				
ISD Model Group	*2000*	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	**62**	**64**	**45**	**55**	**56**
Nonpoint: nutrients, pesticides	35	41	39	53	45
Toxic	27	33	44	39	32
Organic: sewage, animal waste	28	27	31	42	33
Municipal/Industrial	23	26	35	31	30
Siltation	31	36	33	39	36
Impoundment	25	26	30	31	27

	Site 2 - Webster Road				
ISD Model Group	*2000*	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	51	**53**	53	46	48
Nonpoint: nutrients, pesticides	57	49	51	52	**57**
Toxic	56	44	42	48	45
Organic: sewage, animal waste	**60**	41	42	**56**	53
Municipal/Industrial	42	39	42	44	53
Siltation	54	51	46	50	55
Impoundment	51	42	**57**	**56**	54

	Site 3 - Dorwin Avenue				
ISD Model Group	*2000*	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	42	42	39	38	43
Nonpoint: nutrients, pesticides	63	58	61	65	**60**
Toxic	53	58	**62**	59	56
Organic: sewage, animal waste	47	59	47	**73**	55
Municipal/Industrial	56	60	58	**73**	52
Siltation	**64**	**63**	61	59	56
Impoundment	62	62	**62**	68	51

	Site 4 - Spencer Street				
ISD Model Group	*2000*	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	13	19	24	20	22
Nonpoint: nutrients, pesticides	21	35	29	25	32
Toxic	21	**44**	46	51	41
Organic: sewage, animal waste	41	29	48	**59**	**46**
Municipal/Industrial	42	33	**49**	**59**	46
Siltation	24	30	33	40	37
Impoundment	**46**	43	46	52	45

Note: Numbers represent maximum similarity to macroinvertebrate community type models for each impact category. The highest similarities (within 5 percentage points of the highest) at each station are highlighted. Highest similarity represents probable type of impact and is bolded. Similarities less than 50% are less conclusive.

Impact Source Determination (ISD), Ley Creek, Site 1 for years sampled.

	Site 1 - Townline Road				
ISD Model Group	*2000*	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	-	-	13	6	17
Nonpoint: nutrients, pesticides	-	-	28	16	48
Toxic	-	-	35	23	40
Organic: sewage, animal waste	-	-	**68**	48	**66**
Municipal/Industrial	-	-	58	**73**	40
Siltation	-	-	33	21	32
Impoundment	-	-	52	53	47

Note: ISD can only be calculated for sites sampled with kick sampling therefore only Site 1 in 2004, 2006, and 2008 that were sampled with kick samples have results. Numbers represent maximum similarity to macroinvertebrate community type models for each impact category. The highest similarities (within 5 percentage points of the highest) at each station are highlighted. Highest similarity represents probable type of impact and is bolded. Similarities less than 50% are less conclusive.

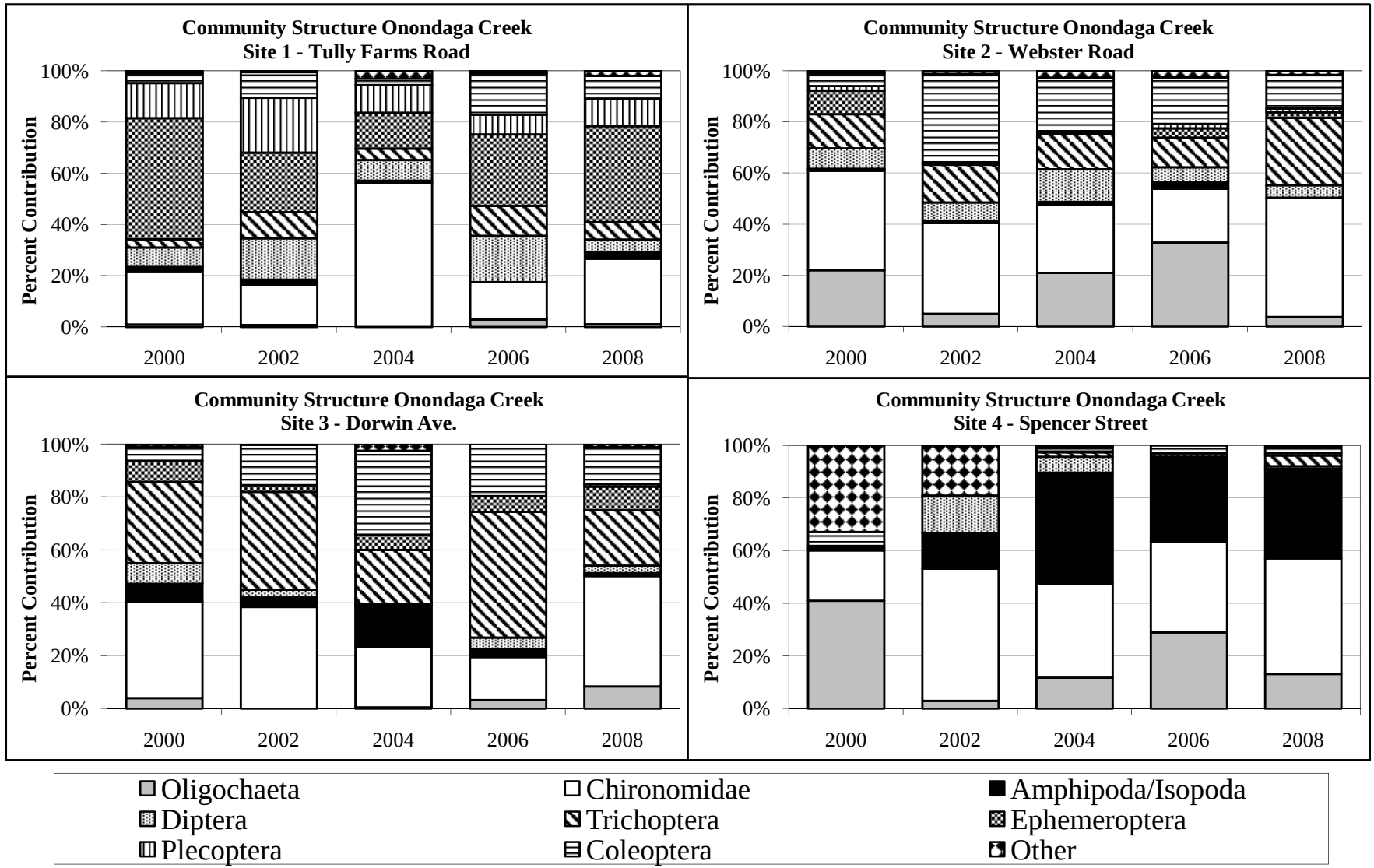
Impact Source Determination (ISD), Harbor Brook for years sampled.

ISD Model Group	Site 1 - Velasko Road				
	2000	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	13	28	28	24	17
Nonpoint: nutrients, pesticides	22	24	26	22	18
Toxic	27	33	27	22	27
Organic: sewage, animal waste	46	25	19	25	24
Municipal/Industrial	**65**	**51**	53	57	47
Siltation	25	36	23	25	18
Impoundment	54	45	**57**	**58**	**51**

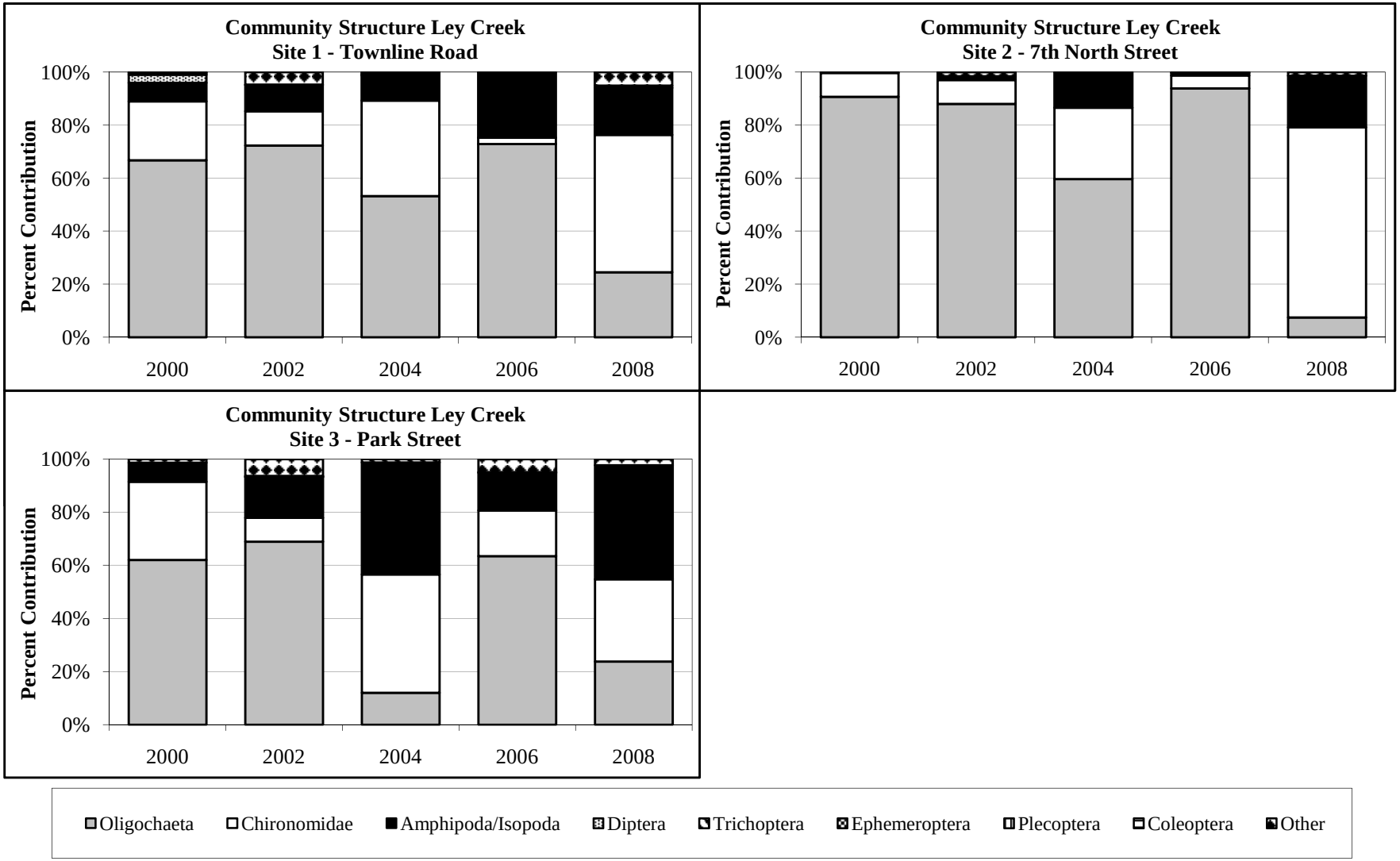
ISD Model Group	Site 2 - Hiawatha Boulevard				
	2000	*2002*	*2004*	*2006*	*2008*
Natural: minimal human impact	9	25	7	6	6
Nonpoint: nutrients, pesticides	24	35	18	22	31
Toxic	35	37	25	25	26
Organic: sewage, animal waste	**62**	61	49	53	**54**
Municipal/Industrial	53	**75**	**74**	**78**	39
Siltation	24	42	22	21	21
Impoundment	60	57	54	49	31

Note: ISD can only be calculated for sites sampled with kick sampling therefore Site 3 (Jab samples) has no results. Numbers represent maximum similarity to macroinvertebrate community type models for each impact category. The highest similarities (within 5 percentage points of the highest) at each station are highlighted. Highest similarity represents probable type of impact and is bolded. Similarities less than 50% are less conclusive.

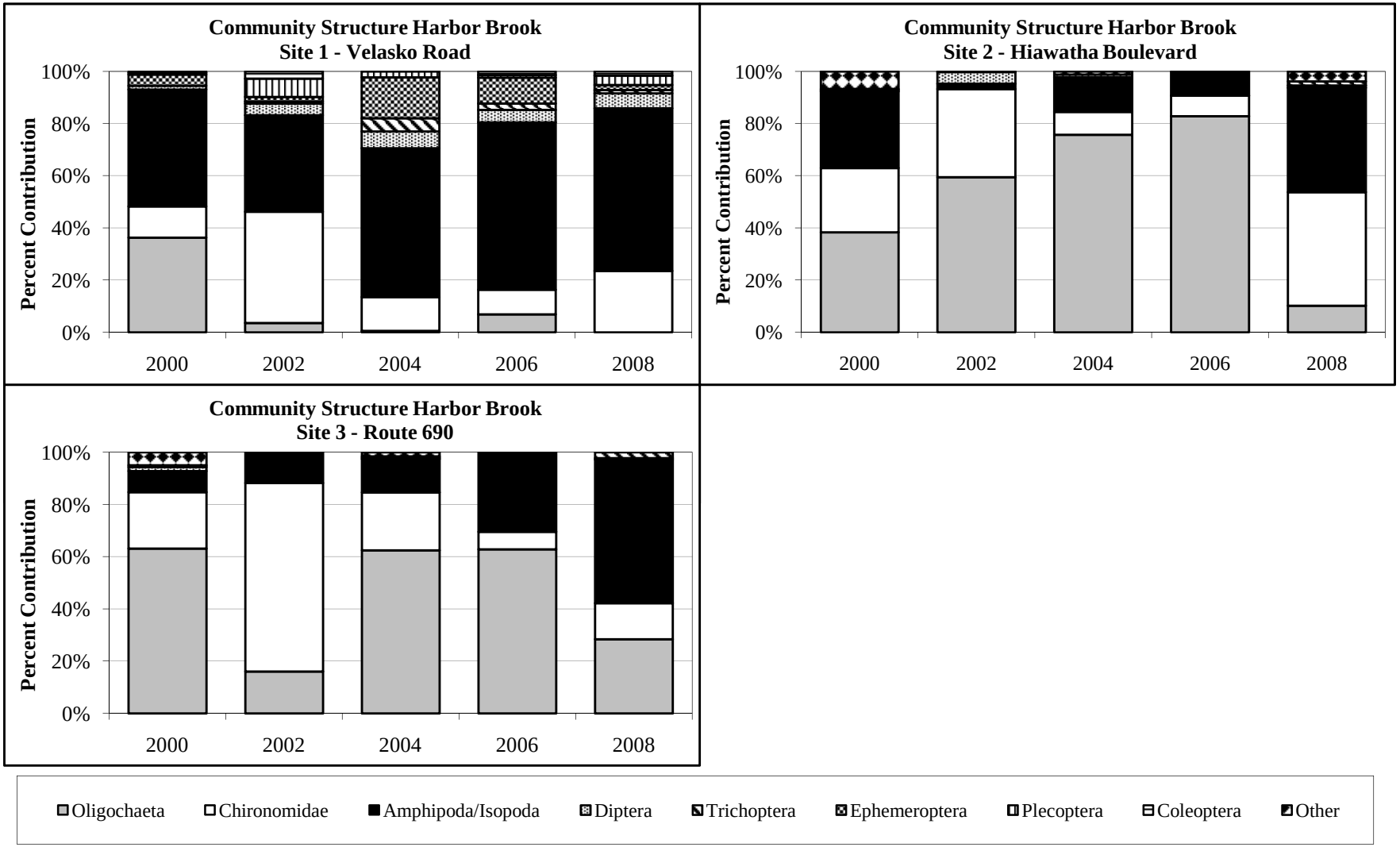
APPENDIX 4, COMMUNITY STRUCTURE



Community structure of macroinvertebrate communities at Onondaga Creek sites surveyed every two years since 2000.



Community structure of the macroinvertebrate communities at Ley Creek sites surveyed every two years since 2000.



Community structure of the macroinvertebrate communities at Harbor Brook sites surveyed every two years since 2000.

LIBRARY-SECTION 06
ONONDAGA LAKE RESULTS: PHYSICAL PARAMETERS AND HABITAT CONDITIONS

Library Reference 6.1

Water clarity: LiCor and Secchi disk transparency analyses

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Library Reference 6.1.1

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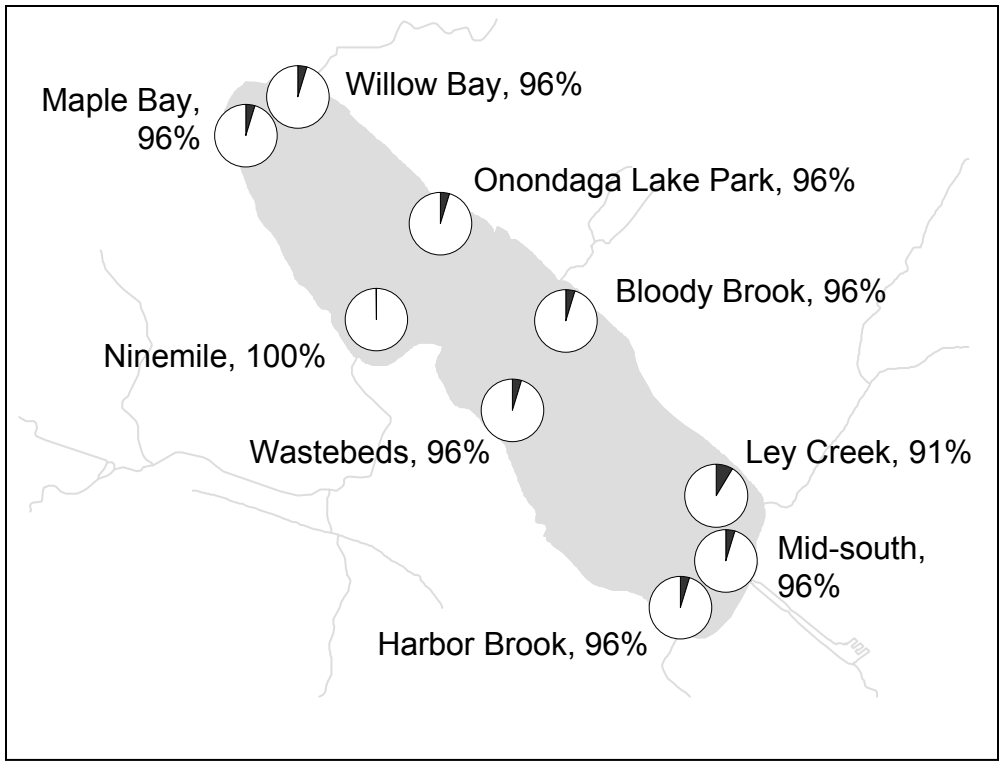

Nearshore water clarity conditions measured as Secchi disk transparency during 2008. The percent shown in figure indicates compliance with swimming safety guidance value (1.2 m), and the shaded area of pie charts indicates percent of samples where Secchi depth was below guidance value for the period June 1 through September 30.
Note that many readings in 2008 were reported as “greater than” the water depth at the monitoring station (e.g. “Secchi disk reading on the bottom.”). These values ranged from 0.9 m to 3 m. These results were flagged as “in compliance” with the 1.2 m guidance value where the water depth was less than 1.2 m.

Library Reference 6.1.2

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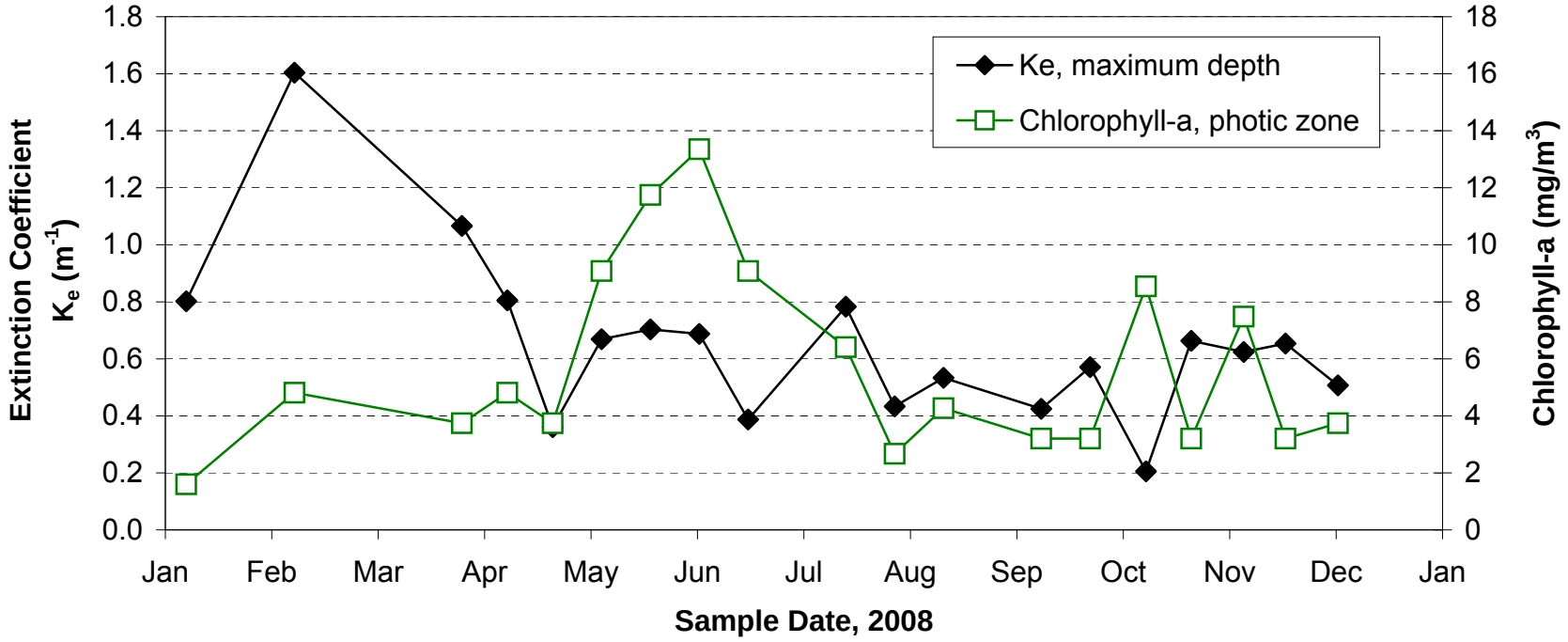

Temporal distribution of light extinction coefficient (K_e) paired with chlorophyll-a data (photic zone), in Onondaga Lake South Deep during 2008. The *photic zone* represents water depth of two times the measured Secchi disk transparency, and therefore varies from day to day. K_e (extinction coefficient) is based on Licor data reading at the maximum depth for each sample date. Light attenuation is measured at 20 cm intervals from water surface to a maximum depth (defined as the depth at which light is 1% of surface illumination, as noted during the sampling event), using a LiCor datalogger. K_e represents the slope of the line formed when the natural log of the ratio of light penetration at the surface to light penetration at depth is plotted against depth. The greater the K_e, the greater the turbidity in the water column.

Library Reference 6.1.3

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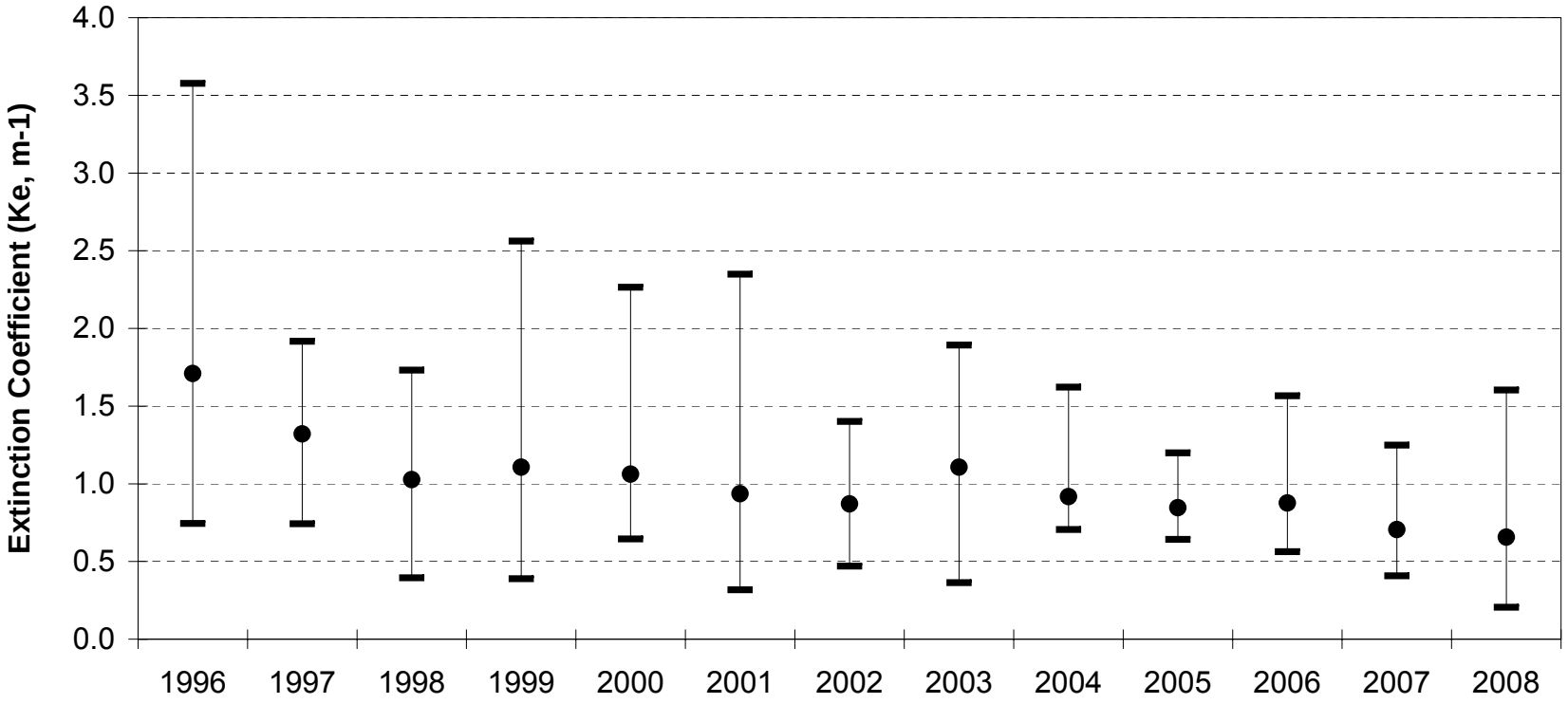

Yearly maximum, minimum, and average of light extinction coefficient (Ke) data measured in Onondaga Lake at South Deep station. Ke represents the slope of the line formed when the natural log of the ratio of light penetration at the surface to light penetration at depth is plotted against depth. The greater the Ke, the steeper the slope of the line, therefore the more rapidly light is extinguished with depth, indicating greater turbidity in the water column. Annual statistics for Ke are based on the maximum depth of light extinction measured for each sample date.

Library Reference 6.1.4

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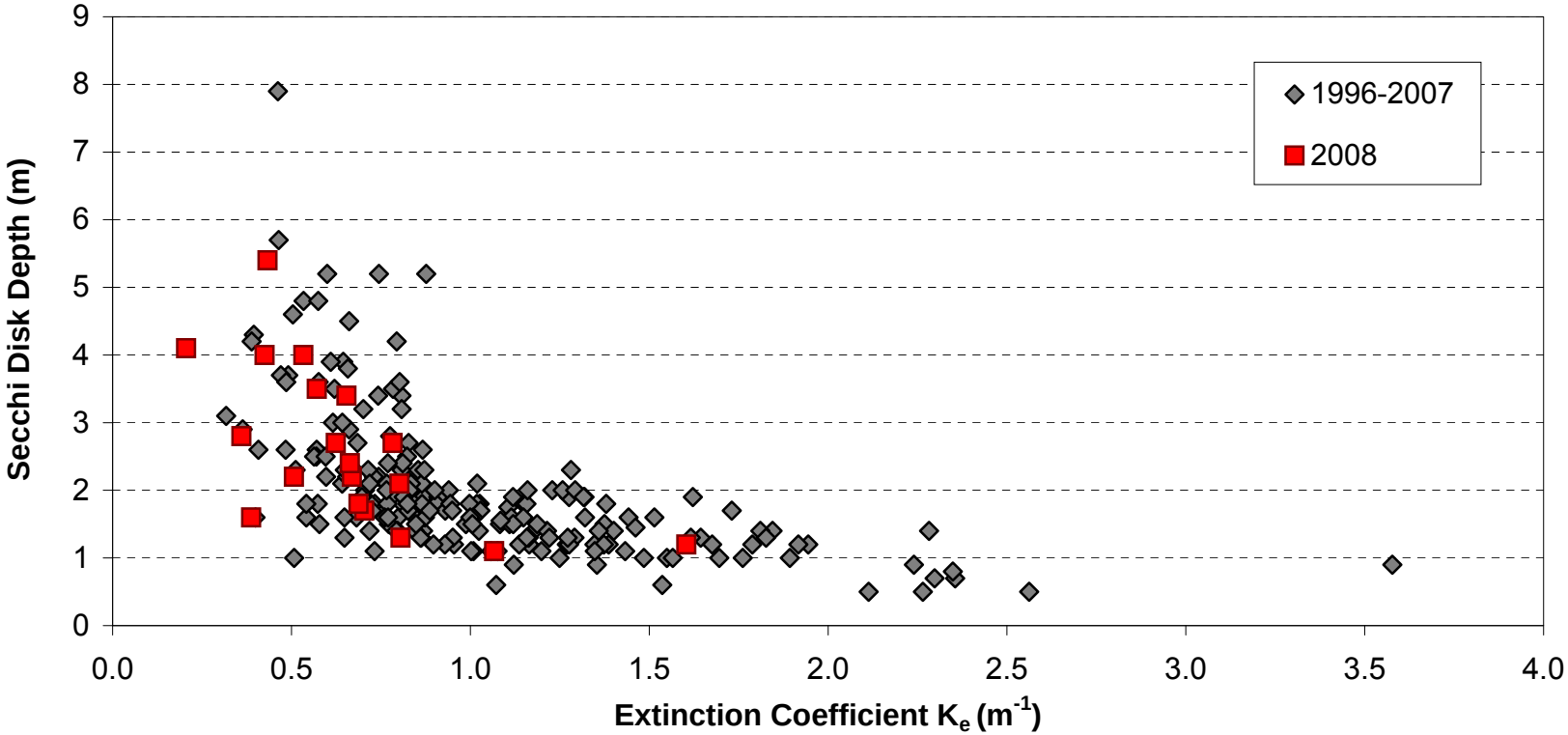

Correlation of light extinction (K_e) data with Secchi depth at Onondaga Lake South Deep over time (1996-2008). K_e represents the slope of the line formed when the natural log of the ratio of light penetration at the surface to light penetration at depth is plotted against depth. The greater the K_e, the steeper the slope of the line, therefore the more rapidly light is extinguished with depth, indicating greater turbidity in the water column. Based on the Licor data reading at maximum depth for each sample date. Light attenuation measurements are collected at 20 cm intervals from water surface to a maximum depth (defined as the depth at which light is 1% of surface illumination, as noted during the sampling event).

Library Reference 6.1.5

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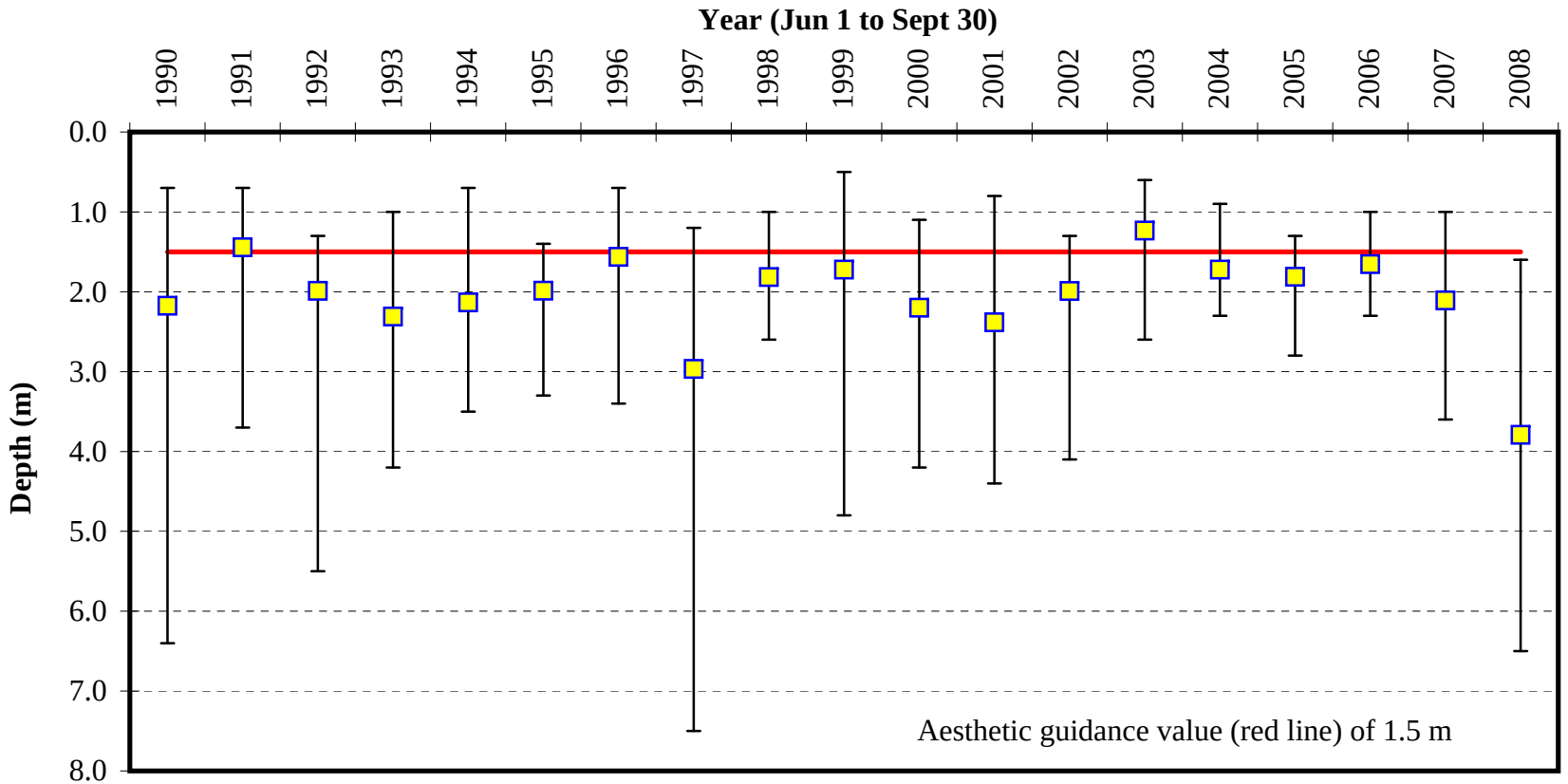

Secchi disk transparency (summer average with minimum and maximum) over time at South Deep station in Onondaga Lake. The aesthetic guidance value is used to indicate suitability for recreational use and aesthetic quality (USEPA Clean Lakes Program Guidance 2000).

Library Reference 6.2

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Temperature records

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Library Reference 6.2.1

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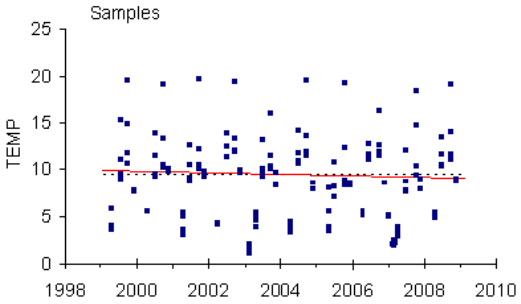
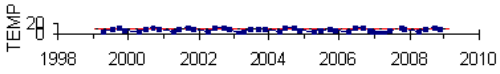
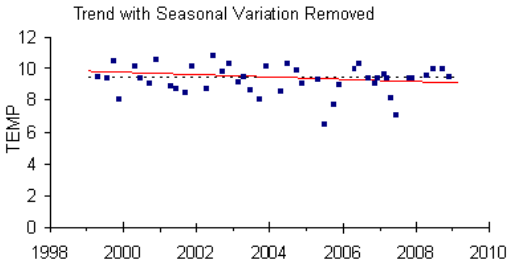
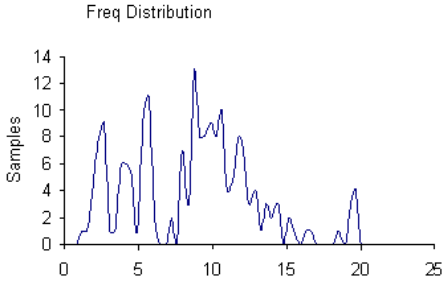
Site	NORTH_L	Lake North - Lower Layer
Variable	TEMP	water temperature (deg C)
Samples	187	Outliers 0
Date Range	4/6/1999	11/18/2008
Median	8.96	deg C linear
Trend / Year	-0.8%	p = 0.46

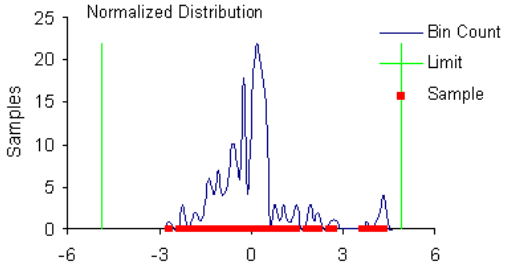


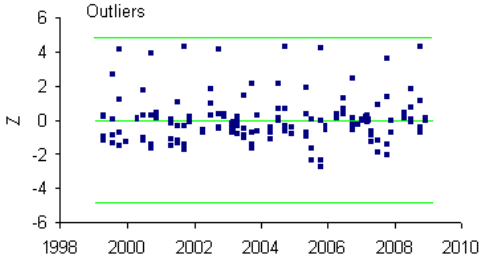
Trend-Season Medians

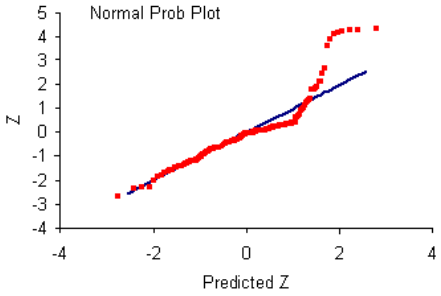












Library Reference 6.2.2

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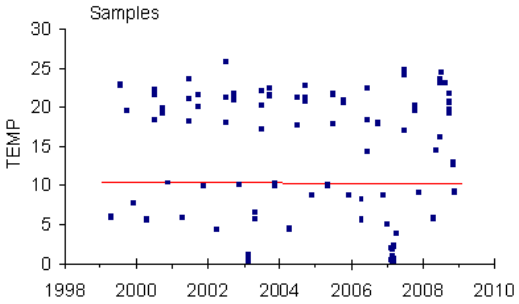
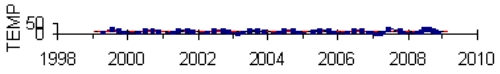
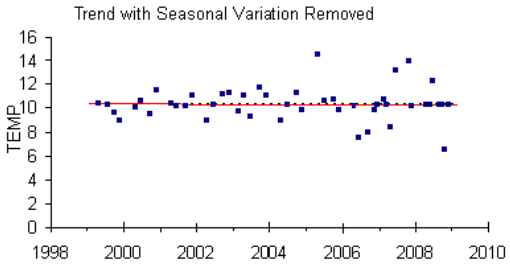
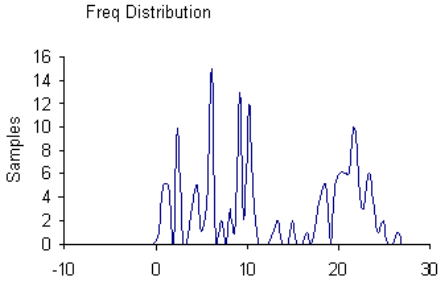
Site	NORTH_U	Lake North - Upper Layer
Variable	TEMP	water temperature (deg C)
Samples	155	Outliers 0
Date Range	4/6/1999	11/18/2008
Median	10.03	deg C linear
Trend / Year	-0.1%	p = 0.96

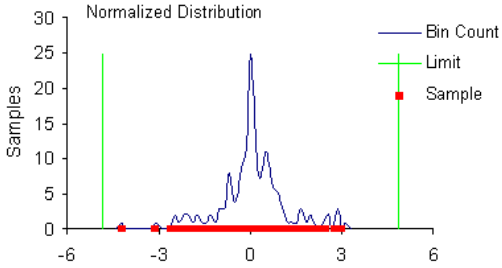


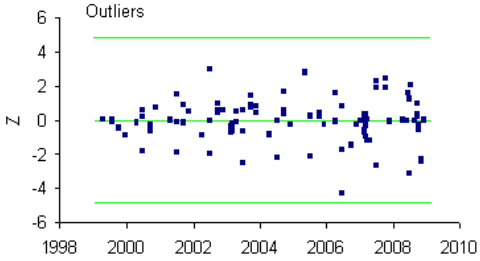


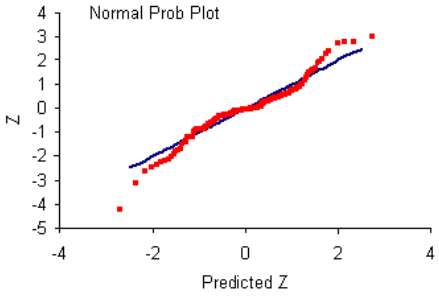
Trend-Season Medians











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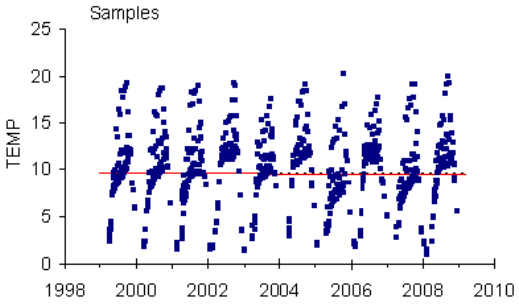
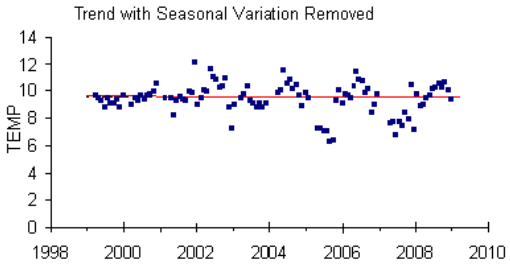
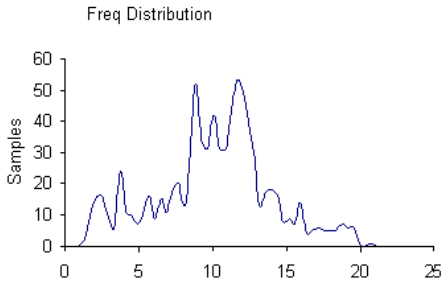
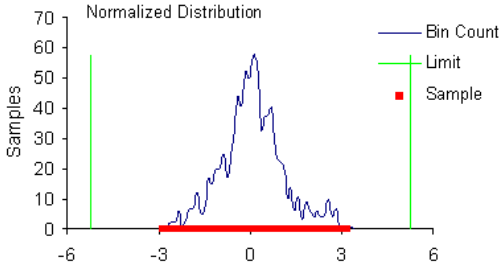
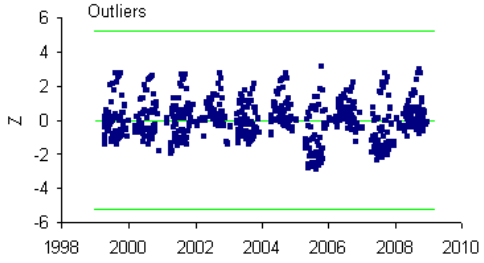
Site	SOUTH_L	Lake South - Lower Layer
Variable	TEMP	water temperature (deg C)
Samples	843	Outliers 0
Date Range	3/29/1999	12/3/2008
Median	10.16	deg C linear
Trend / Year	-0.1%	p = 0.93

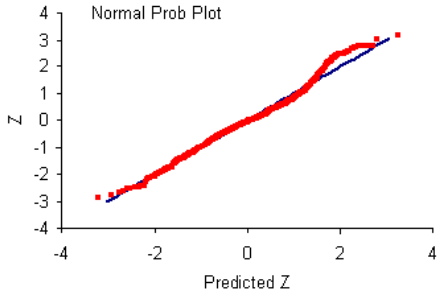












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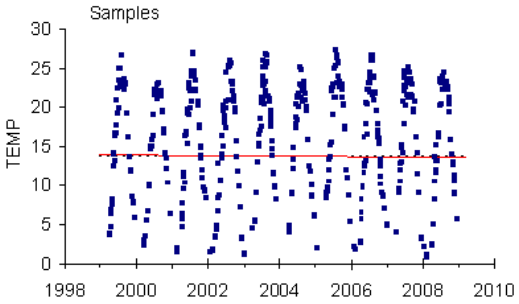
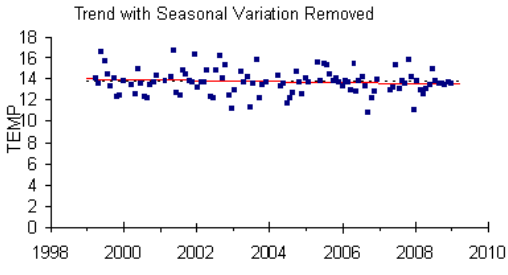
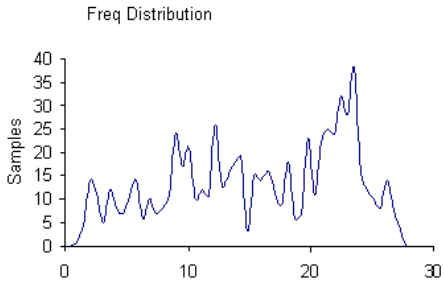
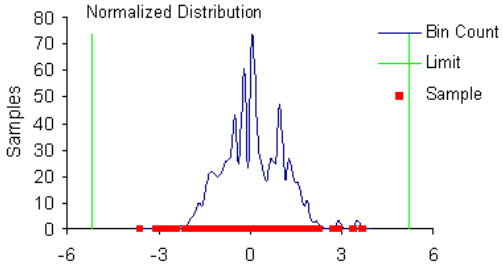
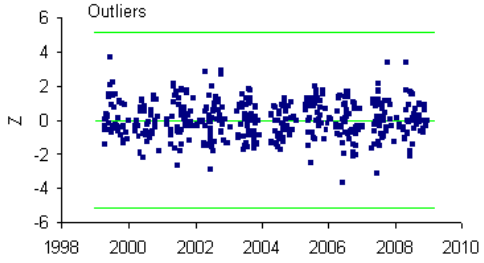
Site	SOUTH_U	Lake South - Upper Layer
Variable	TEMP	water temperature (deg C)
Samples	690	Outliers 0
Date Range	3/29/1999	12/3/2008
Median	15.91	deg C linear
Trend / Year	-0.3%	p = 0.60

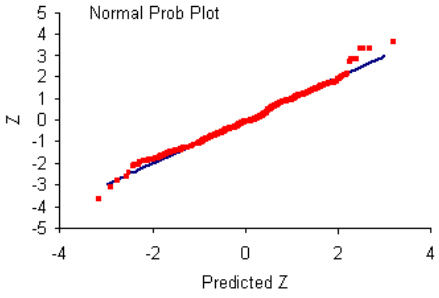












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Onondaga Lake ice cover, 1987-2008.

Winter	Date Ice First Reported	Date Ice Last Reported	Approximate Days of Ice Cover, North Basin	Approximate Days of Ice Cover, Lakewide *(diary notes >90%)*
87-88	12/31/1987	03/28/1988	70 days	20 days
88-89	12/14/1988	03/22/1989	75 days	9 days
89-90	12/06/1989	03/14/1990	90 days	30 days
90-91	12/27/1990	03/04/1991	54 days	6 days
91-92	12/19/1991	03/25/1992	59 days	19 days
92-93	12/14/1992	04/09/1993	76 days	13 days
93-94	12/23/1993	04/04/1994	78 days	18 days
94-95	12/12/1994	03/16/1995	53 days	5 days
95-96	12/13/1995	03/06/1996	32 days	11 days
96-97	01/09/1997	02/27/1997	47 days	19 days
97-98	12/31/1997	02/11/1998	15 days	0 days
98-99	12/23/1998	03/29/1999	62 days	12 days
99-00	01/17/2000	NA	42 days	28 days
00-01	12/26/2000	04/06/2001	66+ days	54 days
01-02	01/08/2002	02/20/2002	2 days	2 days
02-03	01/04/2003	03/26/2003	42 days	40 days
03-04	01/09/2004	03/26/2004	61 days	73 days
04-05	01/20/2005	04/01/2005	73 days	72 days
05-06	12/14/2005	03/13/2006	23 days	14 days
06-07	01/22/2007	03/30/2007	69 days	64 days
07-08	12/19/2007	03/25/2008	37 days	35 days
08-09	12/08/2008	03/17/2009	70 days	67 days

LIBRARY-SECTION 07
ONONDAGA LAKE RESULTS: CHEMICAL PARAMETERS

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Dissolved Oxygen-includes buoy data

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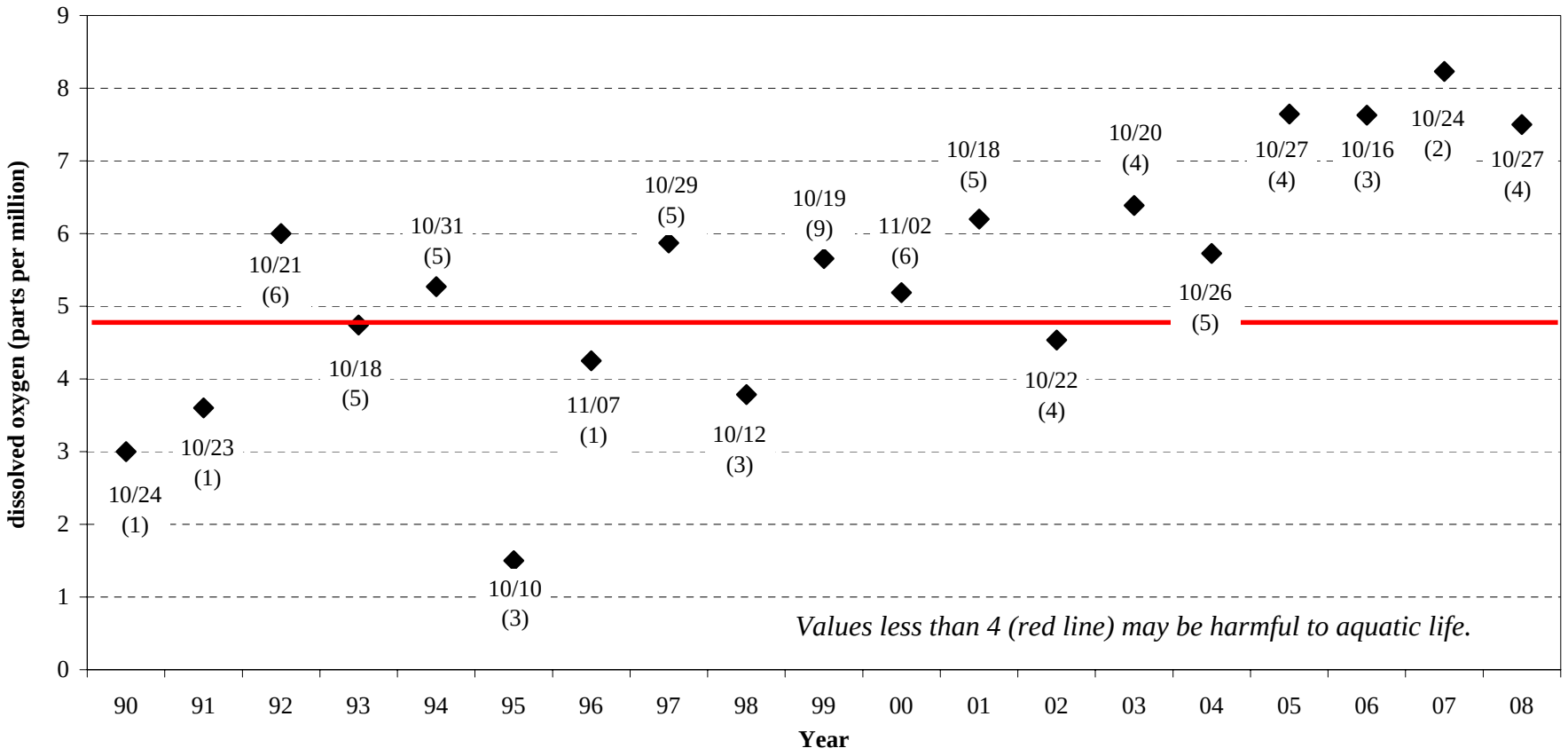
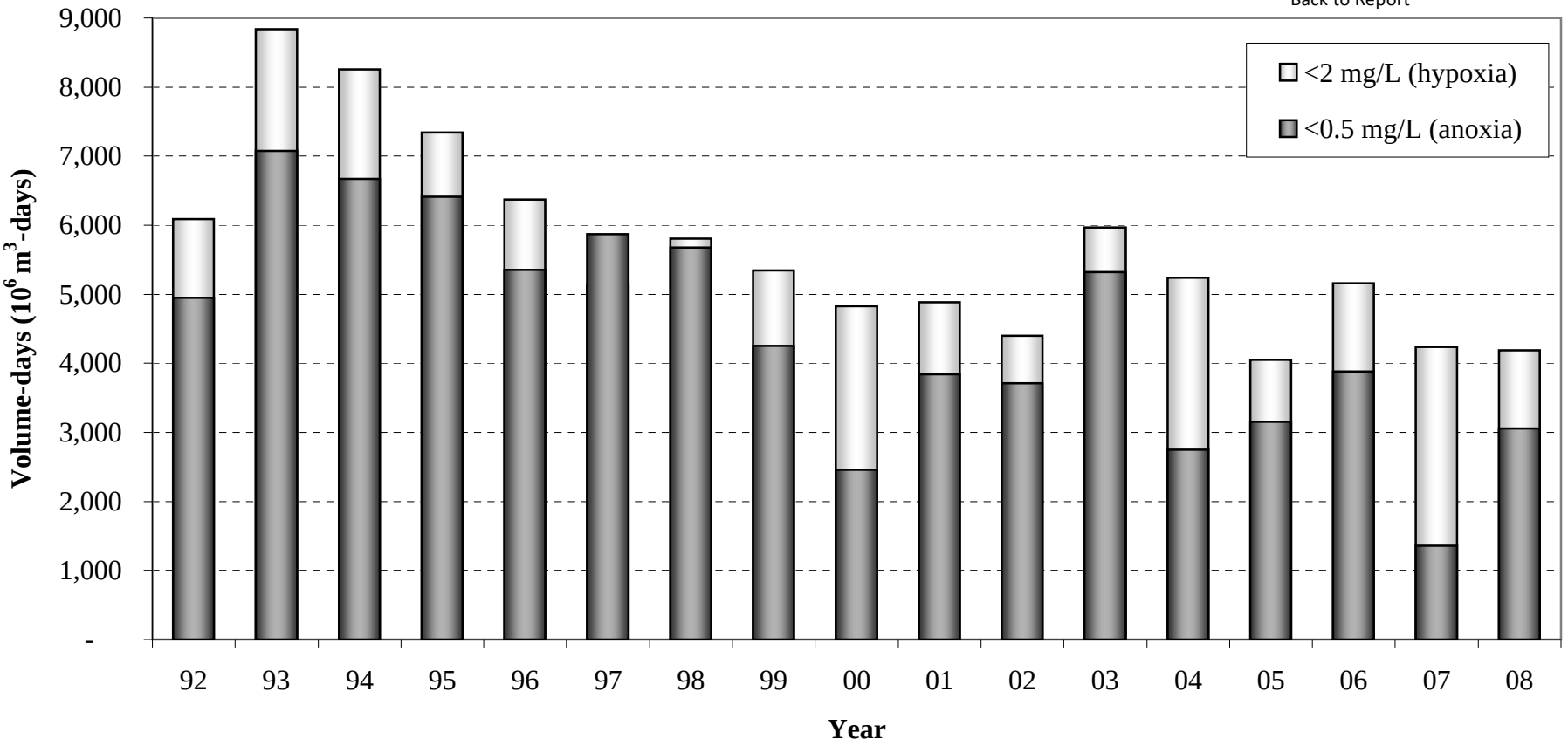


Minimum daily average dissolved oxygen in the upper waters (0-3m) of Onondaga Lake during fall turnover (based on South Deep field profiles). The time period selected is based on one week plus and minus the date (shown) of the minimum daily average for October and November each year. The minimum daily average during this period is assumed to represent fall turnover, the timing of which varies from year to year. The number of profiles collected during the selected time period is shown in parentheses.

Library Reference 7.1.2



Volume-days of anoxia (dissolved oxygen less than 0.5 mg/l) and hypoxia (dissolved oxygen less than 2 mg/l) in Onondaga Lake at South Deep Station over time (1992-2008) from available data collected from January to December each year. One measure of the lake's dissolved oxygen status is in terms of "volume-days", in which both the affected volume of water and the duration (days) of anoxia and hypoxia are calculated in a single measurement that can be tracked from year to year. The calculation is based on field profile dissolved oxygen readings taken at half-meter intervals down to about 20 meters depth.

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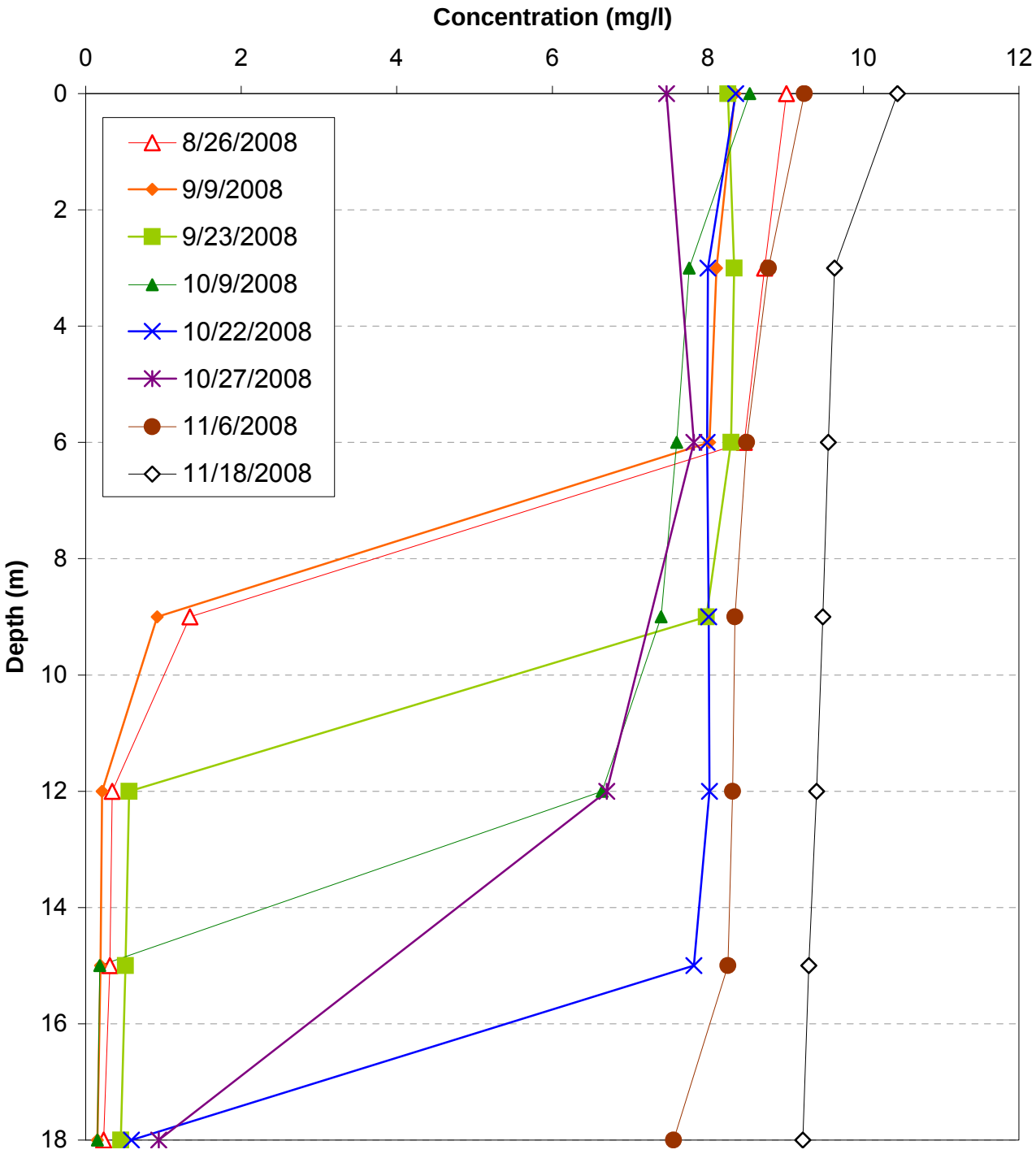
Field Profiles, South Deep Dissolved Oxygen



Field profiles are collected biweekly at Onondaga Lake South Deep Station. In 2008 the lake was stratified until early October, when DO concentrations in the lower waters began to increase. The lake was fully mixed by November 6, based on these profiles.

Library Reference 7.1.4

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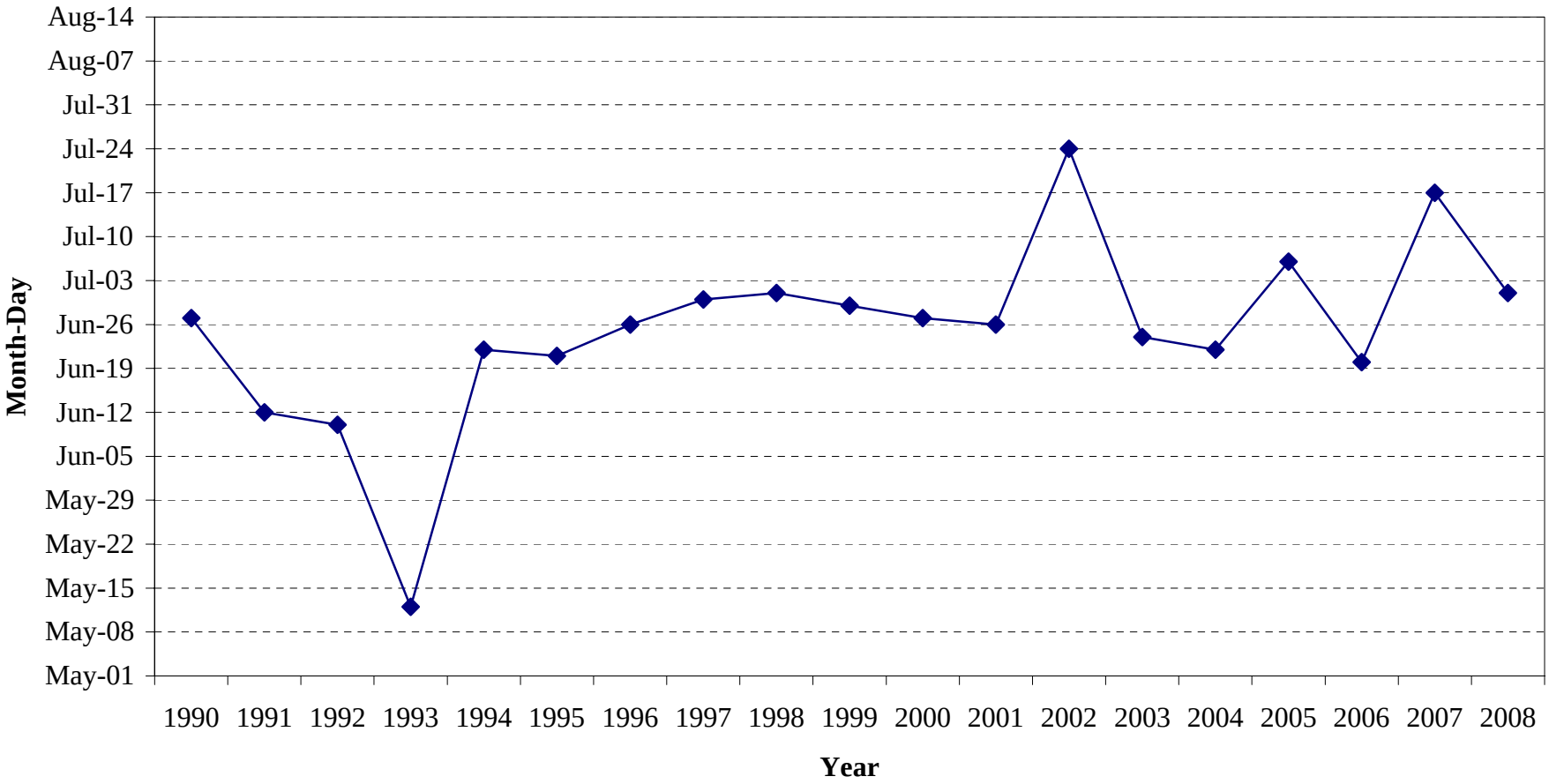

Measurements of dissolved oxygen (DO) at 15m depth, reflecting the earliest date each year at which the DO concentration in lower waters was effectively zero (considered to be 0.5 mg/l, or the limit of detection of the meter/method in place for that year). In the early 1990's, the earliest dates occurred between May 12 and July 1. Since 2000, the earliest dates have occurred from June 20 to July 24.

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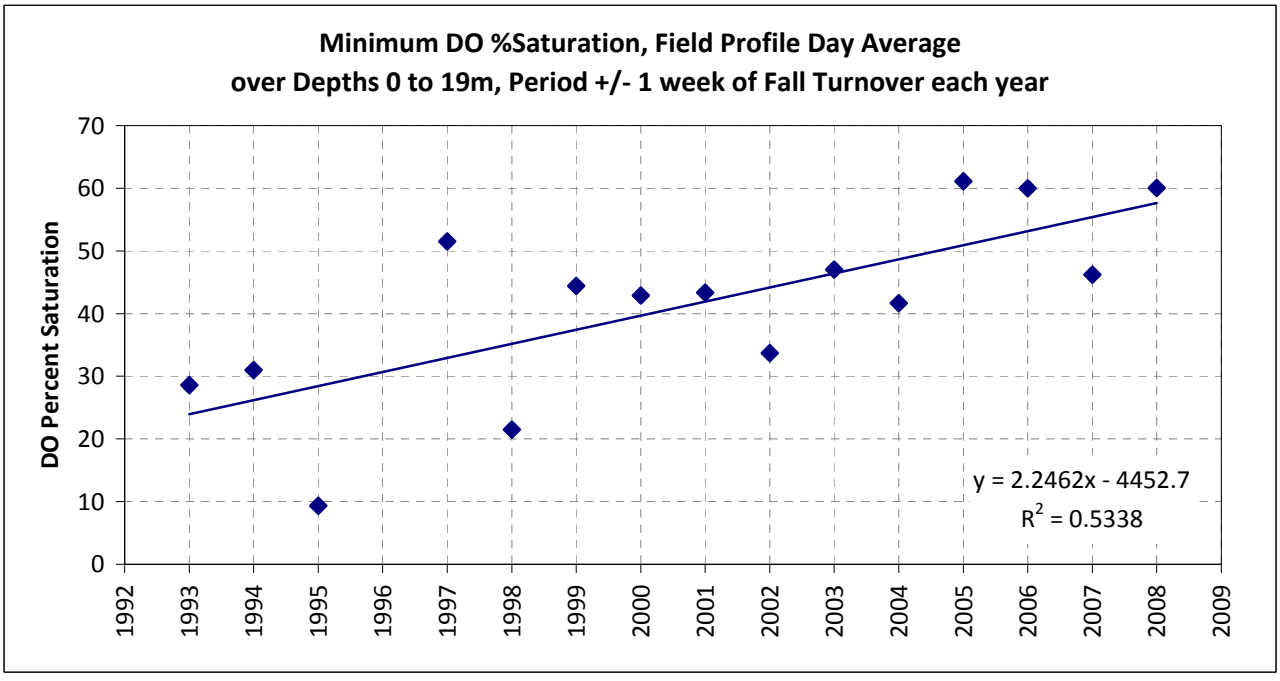
Onondaga Lake Ambient Monitoring Program
Field Profile Dissolved Oxygen Percent Saturation
Through the Water Column, South Deep, During Fall Turnover

Year	MinOfAvgOf DO_SAT_%	MinOfAvg Profile Date	Depth (m) Min	Depth (m) Max	Sampling Period Min	Sampling Period Max	N Profiles CountOfDATE
1993	28.6	10/16/1993	0	18.5	10/16/1993	10/22/1993	4
1994	31.0	10/31/1994	0	19.3	10/24/1994	11/03/1994	5
1995	9.4	10/11/1995	0	19.5	10/10/1995	10/13/1995	3
1997	51.5	10/29/1997	0	19.2	10/23/1997	10/31/1997	4
1998	21.5	10/06/1998	0	19.26	10/06/1998	10/12/1998	3
1999	44.4	10/19/1999	0	19.5	10/13/1999	10/26/1999	9
2000	42.9	11/13/2000	0	19.14	11/06/2000	11/20/2000	6
2001	43.4	10/16/2001	0.09	19.45	10/11/2001	10/24/2001	5
2002	33.7	10/15/2002	0.209	19.322	10/15/2002	10/29/2002	4
2003	47.0	10/14/2003	0.071	19.209	10/14/2003	10/20/2003	4
2004	41.6	10/29/2004	0.026	19.005	10/20/2004	11/01/2004	5
2005	61.1	10/24/2005	0.2	19	10/24/2005	10/31/2005	4
2006	60.0	10/16/2006	0.1	19	10/10/2006	10/22/2006	3
2007	46.2	10/24/2007	-0.073	19.296	10/24/2007	10/31/2007	2
2008	60.0	10/27/2008	0.002	18.502	10/22/2008	10/27/2008	4



Notes:

Queried Percent Saturation from Field Data table, using time period of minimum upper waters DO +/- 1 week each year to represent fall turnover. Then calculated average for each field profile date during the period across depths, and selected minimum day average for each year during the period. Assigned the minimum average to the date on which it occurred, with minimum and maximum sample depths, minimum and maximum profile dates for the period, and number of field profiles collected during the period.

Library Reference 7.2

Nitrogen

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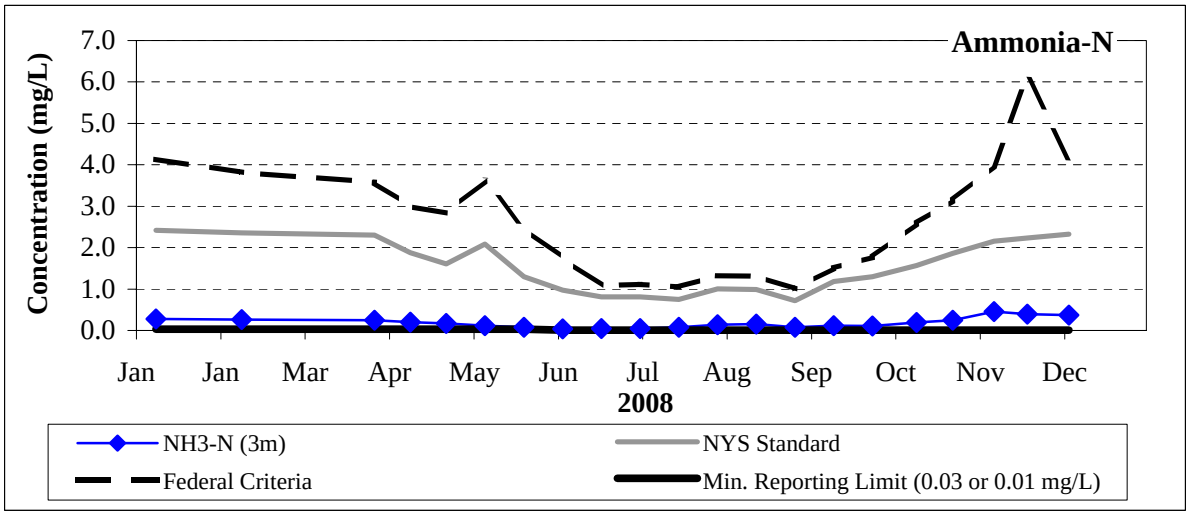

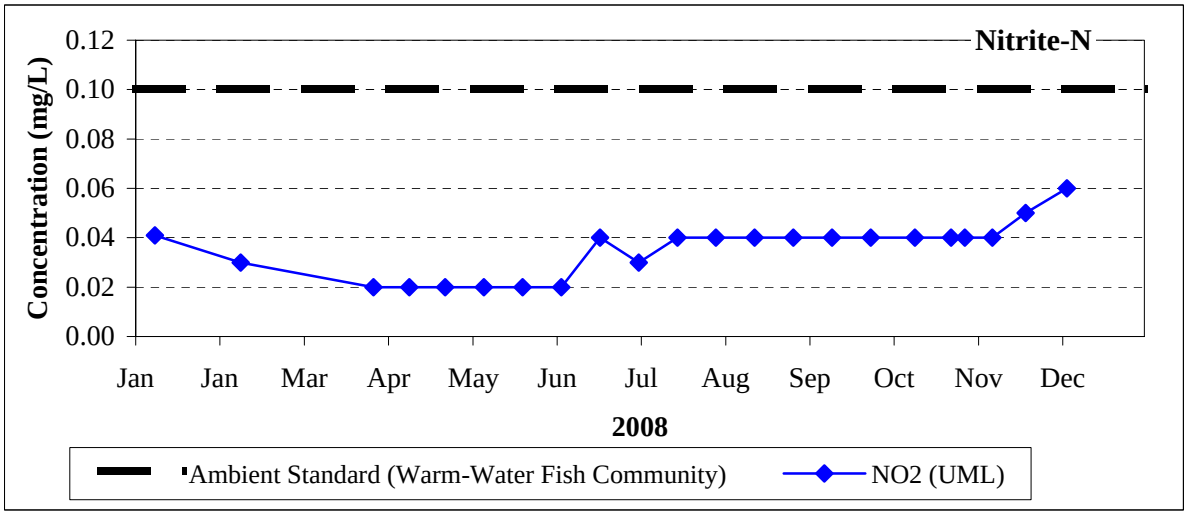

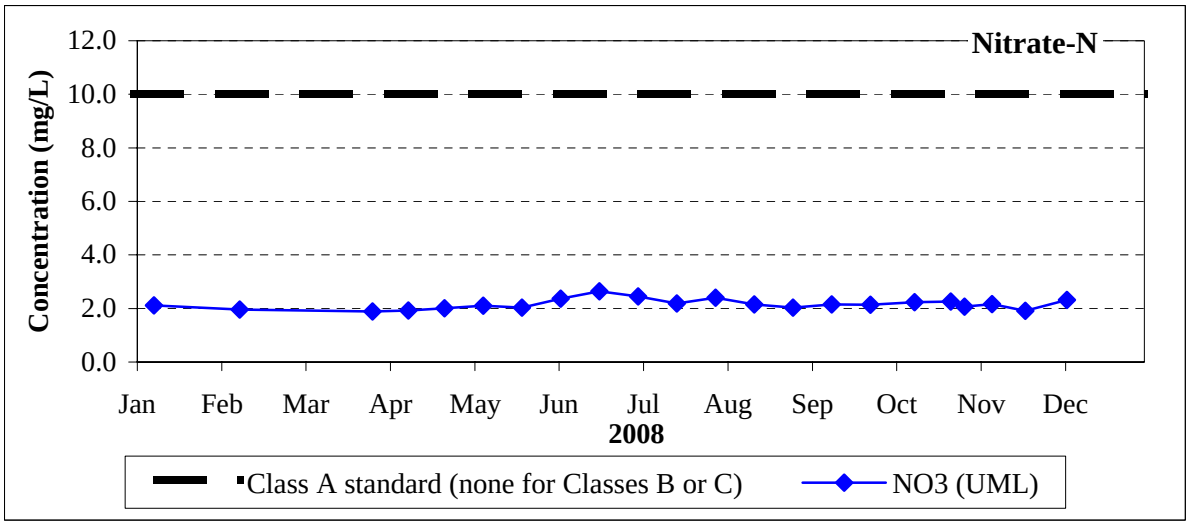

2008 concentrations of ammonia-N (3-meter depth), nitrite-N (UML) and nitrate-N (UML) at the Onondaga Lake South Deep Station, compared with applicable federal and/or state water quality standards and/or criteria.

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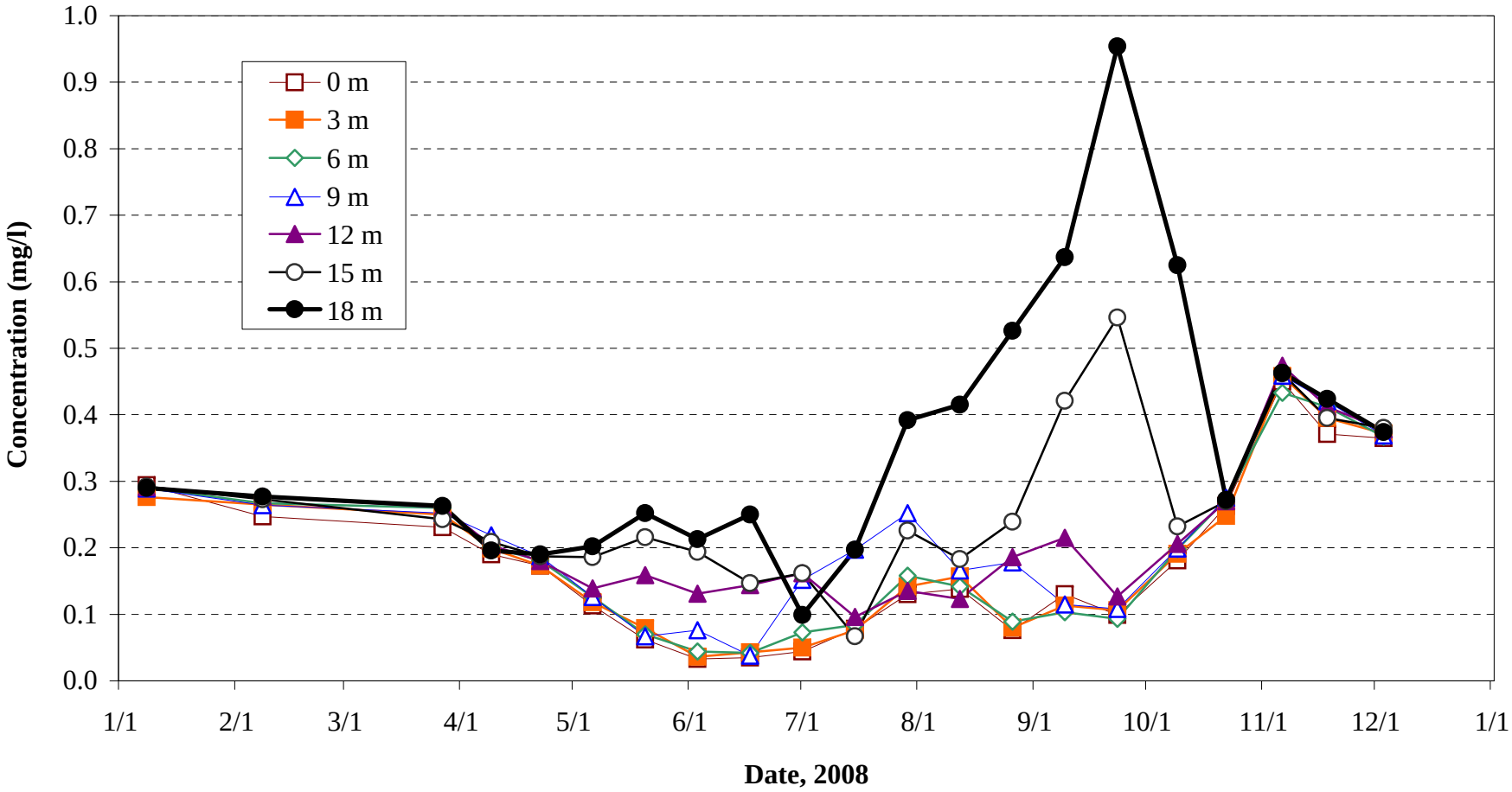

2008 concentrations of ammonia-N at South Deep by depths. The lower waters of the lake exhibit an increase in ammonia-N during the stratified period, reflecting decay of settled organic matter (primarily phytoplankton) and release of ammonia from the sediments. At fall turnover, the ammonia that had accumulated in the lower waters mixed throughout the water column, coming into contact with oxygen and becoming nitrified.

Library Reference 7.3

Phosphorus

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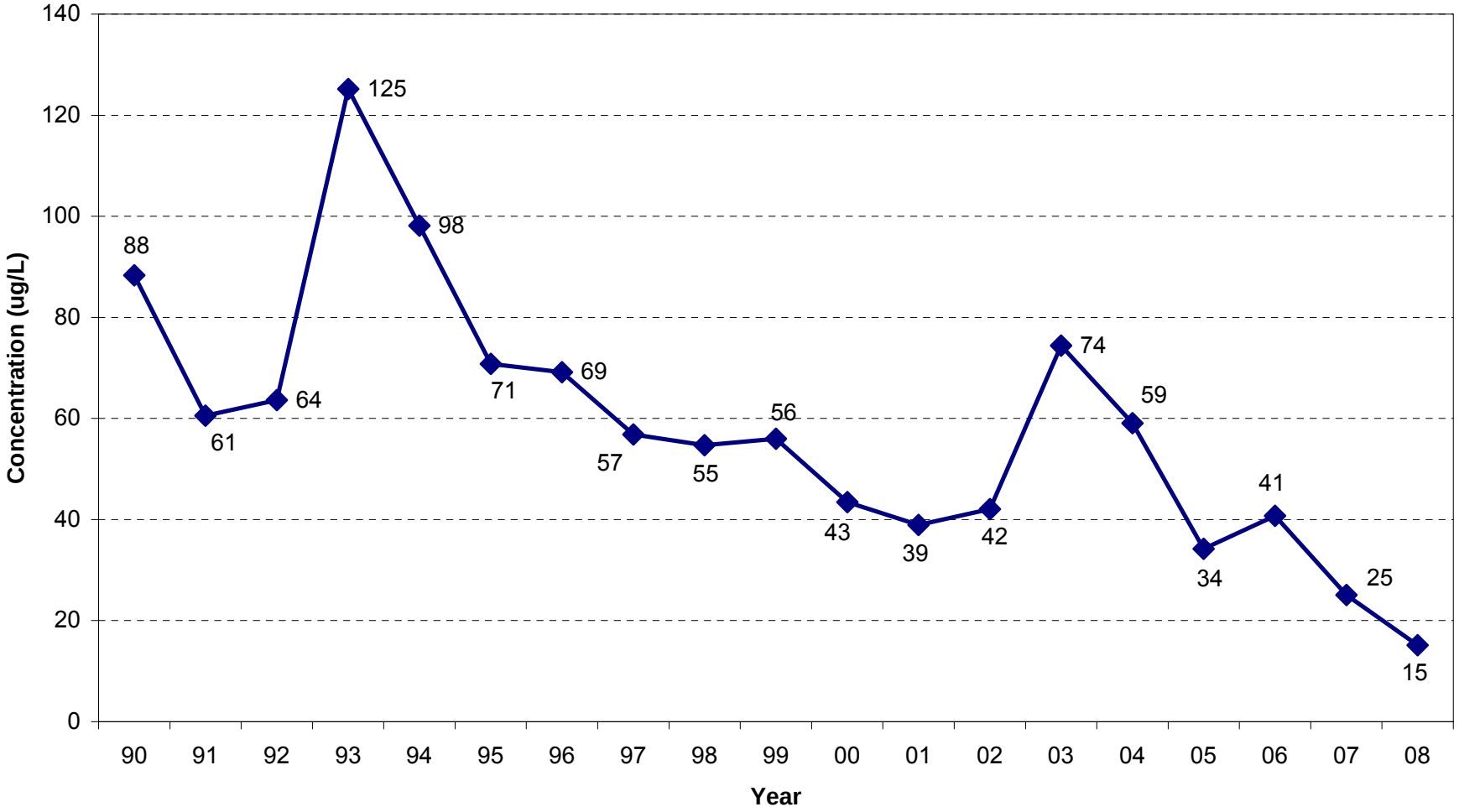

Average total phosphorus concentrations measured in Onondaga Lake at the South Deep station upper waters (0-3m) for the summer period June through September.

Flow-weighted average of limnological parameters, 2008, in Onondaga Lake tributaries with standard error of estimate.

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		Nine Mile Creek		Harbor Brook		Onondaga Creek @		Ley Creek	
Parameter	**Units**	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***
5-day BOD	mg/l	2.4	*13.5%*	2.6	*32.5%*	2.2	*16.6%*	3.9	*22.7%*
Total Alkalinity	mg/l	189	*2.2%*	222	*4.9%*	211	*2.6%*	180	*4.3%*
Total Organic Carbon	mg/l	2.7	*19.6%*	2.0	*27.7%*	2.3	*23.9%*	6.5	*7.9%*
TOC-filtered	mg/l	2.6	*14.9%*	1.9	*29.5%*	2.2	*25.6%*	6.1	*7.7%*
Total Inorganic Carbon	mg/l	46.7	*2.0%*	54.7	*5.1%*	52.7	*3.0%*	45.4	*5.7%*
Total Kjeldahl Nitrogen as N	mg/l	0.56	*10.5%*	0.44	*21.1%*	0.48	*13.3%*	0.76	*13.0%*
Organic Nitrogen as N	mg/l	0.35	*14.1%*	0.37	*24.9%*	0.41	*18.7%*	0.48	*15.0%*
Ammonia as N	mg/l	0.22	*8.6%*	0.08	*21.0%*	0.07	*13.3%*	0.27	*14.4%*
Nitrate as N	mg/l	0.85	*7.5%*	1.36	*5.7%*	1.00	*7.1%*	0.37	*16.6%*
Nitrite as N	mg/l	0.02	*13.2%*	0.02	*22.9%*	0.03	*50.3%*	0.02	*22.6%*
Arsenic	ug/l	2.1	*3.6%*	2.0	*2.3%*	2.0	*14.2%*	2.1	*3.4%*
Total Phosphorus	ug/l	55.1	*21.2%*	93.9	*25.0%*	80.0	*30.5%*	98.2	*28.6%*
Soluble Reactive Phosphorus	ug/l	8.0	*26.7%*	38.0	*16.8%*	9.5	*30.3%*	16.0	*16.5%*
Silica	mg/l	3.9	*5.3%*	4.5	*5.5%*	4.9	*7.3%*	5.7	*5.8%*
Calcium	mg/l	181.1	*2.3%*	192.0	*4.9%*	111.2	*2.2%*	103.9	*5.4%*
Sodium	mg/l	102.5	*5.0%*	155.8	*13.4%*	327.5	*7.1%*	226.6	*19.8%*
Sulfate	mg/l	206.0	*5.0%*	327.6	*6.6%*	116.8	*4.0%*	112.5	*7.1%*
Chloride	mg/l	288.2	*3.8%*	272.0	*10.9%*	524.5	*7.5%*	373.4	*20.1%*
Total Suspended Solids	mg/l	21	*31.8%*	38	*57.2%*	57	*49.6%*	27	*53.0%*
Total Dissolved Solids	mg/l	985	*3.0%*	1167	*5.7%*	1234	*5.1%*	973	*11.6%*
Zinc	ug/l	48.0	*31.8%*	11.6	*27.6%*	23.5	*31.1%*	14.8	*20.2%*
Copper	ug/l	3.9	*12.3%*	4.1	*30.6%*	11.8	*39.3%*	5.1	*22.5%*
Chromium	ug/l	2.6	*23.3%*	2.5	*36.2%*	5.4	*38.6%*	2.5	*26.7%*
Cadmium	ug/l	0.8	*11.8%*	0.8	*12.6%*	0.8	*14.0%*	0.8	*8.8%*
Lead	ug/l	4.4	*15.6%*	2.0	*20.4%*	5.1	*30.3%*	2.0	*31.0%*
Iron	mg/l	0.74	*20.4%*	1.03	*53.0%*	2.2	*74.3%*	1.2	*39.0%*
Magnesium	mg/l	25.9	*1.8%*	35.0	*4.6%*	23.7	*2.2%*	20.1	*5.6%*
Manganese	ug/l	55.3	*11.4%*	36.9	*17.4%*	81.6	*35.8%*	116.2	*11.6%*
Nickel	ug/l	3.8	*14.0%*	3.8	*20.0%*	8.7	*32.7%*	3.8	*10.7%*
Fecal Coliforms	cells/100ml	206	*148.7%*	2,406	*124.1%*	1,144	*76.1%*	2,228	*68.3%*

RSE = relative standard error of the concentration estimate. ** METRO BOD5, NH3-N, TP, TSS based on observations made daily, Calculated using a multiple regression algorithm relating concentration to flow, season, and trend with residual interpolation.

METRO TKN based on observations made 5 times each 2 week period. Other values are based on data collected bi-weekly; heavy metals sampled quarterly. Calculations use the laboratory reported minimal reportable limit (MRL) when observations were below the MRL.

Flow-weighted average of limnological parameters, 2008, in Onondaga Lake tributaries with standard error of estimate (continued).

		Trib. 5A		METRO Effluent **		METRO By-Pass		East Flume	
Parameter	**Units**	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***	Concentration	***RSE***
5-day BOD	mg/l	3.0	*14.2%*	3.9	*3.6%*	58.8	*6.5%*	3.5	*13.0%*
Total Alkalinity	mg/l	157	*2.6%*	142	*3.0%*	142	*15.2%*	152	*5.0%*
Total Organic Carbon	mg/l	3.8	*6.1%*	7.1	*5.6%*	13.5	*25.0%*	3.8	*7.4%*
TOC-filtered	mg/l	3.6	*5.8%*	6.7	*4.7%*	10.8	*25.8%*	3.5	*7.4%*
Total Inorganic Carbon	mg/l	38.7	*3.6%*	38.3	*3.2%*	35.9	*17.8%*	34.8	*5.3%*
Total Kjeldahl Nitrogen as N	mg/l	0.46	*35.2%*	1.4	*3.4%*	9.6	*7.9%*	0.9	*9.9%*
Organic Nitrogen as N	mg/l	0.33	*15.9%*	0.7	*16.5%*	4.8	*30.8%*	0.48	*13.7%*
Ammonia as N	mg/l	0.13	*85.8%*	0.4	*5.3%*	5.6	*11.9%*	0.39	*13.1%*
Nitrate as N	mg/l	0.77	*14.3%*	11.2	*6.3%*	1.1	*43.2%*	3.0	*7.5%*
Nitrite as N	mg/l	0.03	*20.2%*	0.05	*14.9%*	0.13	*83.3%*	0.71	*19.5%*
Arsenic	ug/l	2.5	*11.3%*	2.0	*6.4%*	2.0	*5.9%*	2.8	*16.8%*
Total Phosphorus	ug/l	119.1	*8.2%*	88.3	*3.3%*	1219.0	*7.4%*	104.2	*16.5%*
Soluble Reactive Phosphorus	ug/l	27.8	*13.4%*	3.4	*36.0%*	253.9	*98.4%*	35.1	*18.8%*
Silica	mg/l	7.5	*5.9%*	5.5	*3.6%*	3.8	*22.2%*	9.8	*7.2%*
Calcium	mg/l	128.2	*3.7%*	140.5	*6.5%*	89.4	*38.0%*	109.5	*7.5%*
Sodium	mg/l	163.5	*5.3%*	391.0	*14.5%*	217.2	*43.0%*	405.1	*8.8%*
Sulfate	mg/l	92.6	*12.0%*	192.3	*4.3%*	83.7	*21.2%*	325.3	*9.6%*
Chloride	mg/l	328.5	*5.4%*	631.6	*6.7%*	370.9	*49.0%*	507.3	*9.7%*
Total Suspended Solids	mg/l	30	*68.1%*	6.0	*5.0%*	69	*10.1%*	14	*39.3%*
Total Dissolved Solids	mg/l	941	*4.6%*	1561	*4.4%*	872	*33.5%*	1486	*7.7%*
Zinc	ug/l	25.2	*45.3%*	24.2	*7.0%*	45.0	*14.4%*	17.9	*53.7%*
Copper	ug/l	42.8	*36.0%*	12.1	*6.4%*	19.9	*13.1%*	4.1	*64.3%*
Chromium	ug/l	80.2	*39.5%*	9.0	*6.5%*	10.0	*16.3%*	2.5	*45.5%*
Cadmium	ug/l	0.80	*25.0%*	0.8	*10.5%*	5.0	*7.8%*	0.80	*46.3%*
Lead	ug/l	4.9	*30.0%*	2.0	*6.4%*	30.0	*11.7%*	2.2	*67.9%*
Iron	mg/l	1.6	*48.6%*	1.54	*7.2%*	2.7	*15.7%*	0.31	*39.7%*
Magnesium	mg/l	15.4	*2.7%*	24.8	*3.2%*	13.2	*21.4%*	19.2	*7.4%*
Manganese	ug/l	81.4	*26.3%*	38.0	*7.4%*	61.3	*20.4%*	25.6	*17.8%*
Nickel	ug/l	125.9	*19.3%*	14.3	*5.4%*	15.0	*16.0%*	3.8	*23.0%*
Fecal Coliforms	cells/100ml	76	*503.1%*	923	*61.8%*	611,269	*52.9%*	249	*98.7%*

RSE = relative standard error of the concentration estimate. ** METRO BOD5, NH3-N, TP, TSS based on observations made daily, Calculated using a multiple regression algorithm relating concentration to flow, season, and trend with residual interpolation.

METRO TKN based on observations made 5 times each 2 week period. Other values are based on data collected bi-weekly; heavy metals sampled quarterly. Calculations use the laboratory reported minimal reportable limit (MRL) when observations were below the MRL.

Library Reference 7.5

Low-level mercury (Hg) results

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Mercury is one of the industrial contaminants of concern for Onondaga Lake. The County has been monitoring mercury concentrations in the lake since 1998.

In Onondaga Lake, samples are collected from upper and lower waters and analyzed for ultra low-level mercury and methyl mercury both when the lake is thermally stratified and when the lake is fully mixed.

In the lower waters during the period of stratification, anoxic conditions allow bacteria to convert mercury into methyl mercury, a more toxic form that is readily bioaccumulated by aquatic organisms. This process of biomethylation allows mercury from the sediments to migrate into the water column. Historically, there has been a pattern of peak mercury levels in late summer and early fall, typical of data collected since 1999, which is consistent with the conceptual model of mercury cycling in productive lakes (see, for example, Driscoll et al. 1995[1]).

Ultra low-level mercury sampling, Onondaga Lake 2008.

Sampling Event	Location and Depth	Total Hg (ng/l)	Methyl Hg (ng/l)	Detection Limits (ng/l)	
				Total Hg	Methyl Hg
April 9, 2008	South Deep 3 m	1.93	0.145	0.50	0.050
Lake fully mixed	South Deep 18 m*	1.89	0.05		
	North Deep 3 m	2.65	0.063		
	North Deep 18 m	1.77	0.085		
August 12, 2008	South Deep 3 m	1.86	0.113	0.5	0.050
Stratified	South Deep 18 m	3.9	0.214		
	South Deep 18 m Dup	3.74	0.287		
	North Deep 3 m	1.23	0.19		
	North Deep 18 m	2.03	0.38		
October 22, 2008	South Deep 3 m	7.88	0.148	0.5	0.050
Stratified	South Deep 18 m	12	0.2		
	South Deep 18 m Dup	8.49	0.158		
	North Deep 3 m	1.86	0.129		
	North Deep 18 m	4.38	1.51		

Notes:
* No duplicate analyzed due to broken bottle caps
Ultra low-level mercury analyses (EPA Method 1631) were performed by Frontier Geosciences, Inc.
Detection limit is shown as minimum reportable limit (MRL).
Duplicate RPDs - the target for field duplicate RPDs is not to exceed 20%:
4/09/2008 - no field duplicate analyzed due to broken bottle caps
08/12/2008 - Hg = 4.2%, MHg = 29%
10/22/2008 - Hg = 34%, MHg = 24%

[1] Driscoll, C. T., V. Blette, C. Yan, C.L. Schofield, R. Munson and J. Holsapple. 1995. The role of dissolved organic carbon in the chemistry and bioavailability of mercury in remote Adirondack lakes. *Water, Air & Soil Poll.* 80(1-4), p. 499-508.

Library Reference 7.5.2

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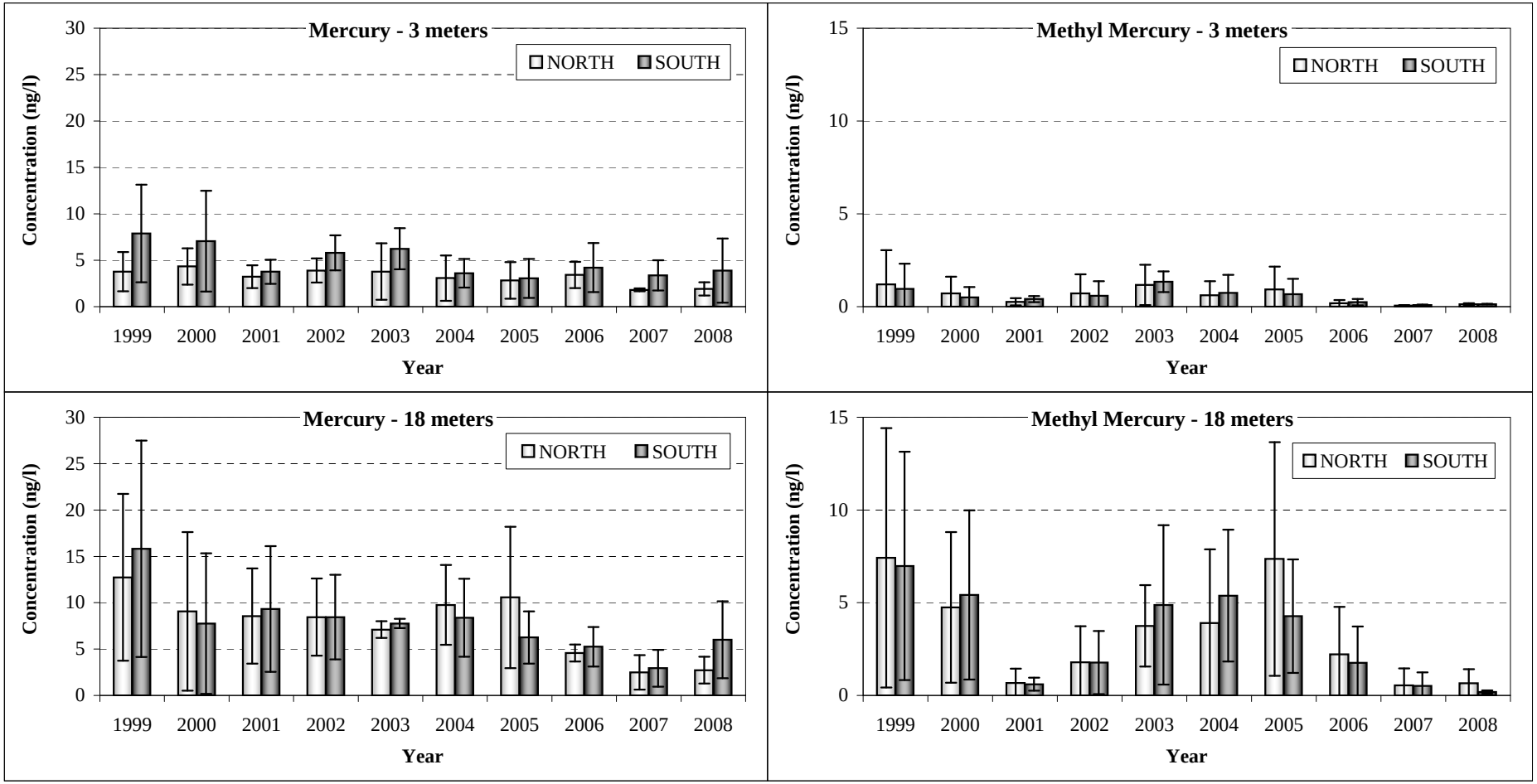

Average mercury and methyl-mercury concentrations, with standard deviations, in Onondaga Lake North and South Basins. Samples were collected at 3-meter and 18-meter depths.

Library Reference 7.6

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North and South Deep stations paired sample comparison

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North Deep and South Deep Comparison

There are two basins in Onondaga Lake, identified as North Deep and South Deep. Overall, the analysis of the lake's water quality presented in the AMP annual report is based on the higher-frequency data collected at South Deep rather than quarterly data collected at North Deep. The rationale for this approach is that conditions in both basins are very similar. Paired sample analysis of both basins is conducted each year as part of the AMP in order to verify that water quality in both basins is similar.

Paired sampling was conducted on these dates in 2008, for the parameters shown below. The sample dates were grouped into four events.

Paired sample dates for 2008 AMP.

Event	Sample Date	Low resolution mercury	List of 48 parameters*
1	April 9	X	X
2	June 17	--	X
3	September 23	--	X
4	November 18	--	X

**List of 48 parameters*:
ALK-T, As, BOD5, Ca, Cd, Chloride, Chlorophyll-a, COND-field, Cr, Cu, DO-field, ECOLI-MF, FCOLI-MF, Fe, Hardness, K, Mg, Mn, Na, NH3-N, Ni, NO2, NO3, ORG-N, Pb, Phaeophytin-a, pH-field, Salinity-field, Se, Secchi Disk, SiO2, SO4, SRP, TDP, TDS, Temp-field, TIC, TKN, TKN-F, TOC, TOC-F, TP, TS, TSS, Turbidity, TVS, VSS, Zn

Based on 2008 paired sampling results from the North Deep and South Deep stations, the lake is laterally well-mixed. With minor exceptions, there does not appear to be a strong gradient in water quality conditions from the south, where most of the inflows enter the lake, to the north.

As part of the update of the statistical framework, Dr. Walker examined whether the trophic state indicator parameters used to track algal abundance (an important restoration goal for Onondaga Lake) differed between North Deep and South Deep. Three parameters: phytoplankton biomass, chlorophyll-a concentrations, and Secchi disk transparency were evaluated using a paired t-test of log-transformed values. No statistically significant differences were evident between the two stations.

Dr. Walker also examined whether the calculated precision and trends of nutrient concentrations in the upper mixed layer at South Deep station were consistent with the calculated precision and trends of nutrient concentrations measured in the lake outlet (12-ft depth). Dr. Walker's finding of comparable results for the two sites supports the conclusion that there are no large differences in water quality conditions along the north-south axis of Onondaga Lake.

The statistical analysis indicates that, for most parameters, measured water quality conditions at North Deep and South Deep are comparable. However, there are several slight, but statistically significant, differences in average concentrations of certain parameters. Most of the differences can be attributed to the effect of the location of inflows of Metro and the major tributaries.

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Comparison of South and North data, April 9, 2008.

		Upper Mixed Layer		Lower Water Layer	
Parameter	**Units**	**South**	**North**	**South**	**North**
Secchi Disc Depth	meters	1.3	1.7		
pH	Std Units	*7.863	*7.963	*7.87	*7.873
Temperature	°C	*5.05	*5.79	*4.95	*4.977
Specific conductance	umHos/cm	*1285.333	*1826	*1881.667	*1882
Dissolved oxygen	mg/L	*11.85	*11.833	*11.627	*11.573
5-day BOD	mg/L	<2	3.0	<2	<2
Total Alkalinity	mg/L	182	180	178	176
Total Organic Carbon	mg/L	*2.615	*2.615	*2.595	*2.61
TOC Filtered	mg/L	*2.52	*2.41	*2.455	*2.455
Total Inorganic Carbon	mg/L	*42.65	*42.5	*42.8	*42.65
Total Kjeldahl Nitrogen	mg/L	*0.51	*0.53	*0.523	*0.533
TKN Filtered	mg/L	*0.443	*0.443	*0.397	*0.44
Organic Nitrogen	mg/L	*0.313	*0.343	*0.32	*0.333
Ammonia-N	mg/L	*0.197	*0.189	*0.203	*0.201
Nitrite-N	mg/L	0.02	0.02	0.02	0.02
Nitrate-N	mg/L	1.93	1.78	1.93	1.88
Total Phosphorus	mg/L	*0.02	*0.021	*0.018	*0.019
Soluble Reactive Phosphorus	mg/L	*0.001	*0.005	*0.001	*0.004
Silica	mg/L	*4.23	*3.96	*3.54	*4.14
Calcium	mg/L	119	129	118	123
Sodium	mg/L	223	227	243	238
Potassium	mg/L	3.56	3.66	3.71	3.67
Sulfate	mg/L	136	141	137	140
Chloride	mg/L	413	398	416	413
Total Solids	mg/L	*1130	*1113	*1143	*1149
Total Volatile Solids	mg/L	*145	*157	*153	*155
Total Suspended Solids	mg/L	*3.5	*3	*3	*2.5
Volatile Suspended Solids	mg/L	*2	*2	*2.5	*2
Total Dissolved Solids	mg/L	*1077	*1082	*1103	*1095
Turbidity	NTU	*5.885	*6.05		
Arsenic	mg/L	<0.002	<0.002	<0.002	<0.002
Iron	mg/L	0.142	0.127	0.138	0.123
Copper	mg/L	<0.0031	<0.0031	<0.0031	<0.0031
Chromium	mg/L	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	mg/L	<0.0008	<0.0008	<0.0008	<0.0008
Mercury	ng/l	1.93	2.65	1.89	1.77
Methyl mercury	ng/l	0.145	0.063	0.05	0.085
Lead	mg/L	<0.002	<0.002	<0.002	<0.002
Magnesium	mg/L	20.3	22	21.5	21.6
Manganese	mg/L	<0.0250	<0.0250	<0.0250	<0.0250
Nickel	mg/L	<0.0038	<0.0038	0.0039	<0.0038
Selenium	mg/L	<0.002	<0.002	<0.002	<0.002
Zinc	mg/L	0.0115	0.008	0.0625	0.0076
Phaeophytin-a	mg/m3	1.17	0.32		
Chlorophyll-a	mg/m3	4.81	6.41		
Fecal Coliforms	count/100	10	<5		
E. Coli	count/100	10	4		

Notes: * indicates the data were averaged over several depths: UML = 0m, 3m and 6m; LWL = 12m, 15m, 18m

The averages are based on concentration data, and are not volume-averages. Phaeophytin-a and Chlorophyll-a were collected as Tube Composites. Averages were calculated using the laboratory reported limit of detection when an observation was reported at or below that limit. NA: Not Analyzed.

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Comparison of South and North data, June 17, 2008.

Parameter	Units	Upper Mixed Layer		Lower Water Layer	
		South	North	South	North
Secchi Disc Depth	meters	1.6	1.8		
pH	Std Units	*8.083	*8.15	*7.483	*7.437
Temperature	°C	*22.337	*20.87	*11.373	*10.923
Specific conductance	umHos/cm	*2068	*2017.667	*2236.667	*2212.333
Dissolved oxygen	mg/L	*10.223	*11.007	*3.547	*2.427
5-day BOD	mg/L	3	3.0	<2	<2
Total Alkalinity	mg/L	156	154	178	188
Total Organic Carbon	mg/L	*3.415	*3.345	*2.615	*2.47
TOC Filtered	mg/L	*3.275	*3.04	*2.51	*2.405
Total Inorganic Carbon	mg/L	*37.6	*38.9	*45.7	*46.9
Total Kjeldahl Nitrogen	mg/L	*0.563	*0.547	*0.567	*0.64
TKN Filtered	mg/L	*0.38	*0.38	*0.423	*0.513
Organic Nitrogen	mg/L	*0.527	*0.51	*0.387	*0.373
Ammonia-N	mg/L	*0.04	*0.036	*0.18	*0.271
Nitrite-N	mg/L	0.04	0.03	0.03	0.04
Nitrate-N	mg/L	2.64	2.27	2.06	1.62
Total Phosphorus	mg/L	*0.012	*0.013	*0.01	*0.012
Soluble Reactive Phosphorus	mg/L	*0.001	*0.002	*0.002	*0.002
Silica	mg/L	*1.61	*1.64	*3.27	*3.86
Calcium	mg/L	133	136	142	135
Sodium	mg/L	237	234	263	269
Potassium	mg/L	4.4	4.22	4.08	3.95
Sulfate	mg/L	157	160	154	156
Chloride	mg/L	445	436	467	485
Total Solids	mg/L	*1284	*1307	*1388	*1370
Total Volatile Solids	mg/L	*256	*261	*275	*238
Total Suspended Solids	mg/L	*2	*2.5	*2	*2
Volatile Suspended Solids	mg/L	*2	*2	*2	*2
Total Dissolved Solids	mg/L	*1229	*1252	*1304	*1310
Turbidity	NTU	*2.96	*2.66		
Arsenic	mg/L	<0.002	<0.002	<0.002	<0.002
Iron	mg/L	<0.0500	<0.0500	0.0642	<0.0500
Copper	mg/L	<0.0031	<0.0031	0.0037	<0.0031
Chromium	mg/L	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	mg/L	<0.0008	<0.0008	<0.0008	<0.0008
Lead	mg/L	<0.002	<0.002	<0.002	<0.002
Magnesium	mg/L	24.1	24.4	24.9	23.9
Manganese	mg/L	<0.0250	<0.0250	<0.0250	0.287
Nickel	mg/L	<0.0038	<0.0038	<0.0038	<0.0038
Selenium	mg/L	<0.002	<0.002	<0.002	<0.002
Zinc	mg/L	<0.0063	<0.0063	<0.0063	<0.0063
Phaeophytin-a	mg/m3	<0.2	<0.2		
Chlorophyll-a	mg/m3	9.08	8.54		
Fecal Coliforms	count/100	<10	<10		
E. Coli	count/100	3	1		

Notes: * indicates the data were averaged over several depths: UML = 0m, 3m and 6m; LWL = 12m, 15m, 18m
The averages are based on concentration data, and are not volume-averages. Phaeophytin-a and Chlorophyll-a were collected as Tube Composites. Averages were calculated using the laboratory reported limit of detection when an observation was reported at below that limit. NA: Not Analyzed.

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Comparison of South and North data, September 23, 2008.

Parameter	Units	Upper Mixed Layer		Lower Water Layer	
		South	North	South	North
Secchi Disc Depth	meters	3.5	4.6		
pH	Std Units	*8	*7.933	*7.333	*7.3
Temperature	°C	*19.433	*19.54	*11.873	*12.307
Specific conductance	umHos/cm	*2346.333	*2340	*2380.333	*2391.333
Dissolved oxygen	mg/L	*8.3	*7.697	*0.507	*0.46
5-day BOD	mg/L	<2	<2	<2	2.0
Total Alkalinity	mg/L	154	158	156	206
Total Organic Carbon	mg/L	*3.27	*3.22	*2.98	*2.845
TOC Filtered	mg/L	*3.01	*2.93	*2.815	*2.655
Total Inorganic Carbon	mg/L	*38.45	*38.65	*45.95	*47
Total Kjeldahl Nitrogen	mg/L	*0.553	*0.533	*0.873	*0.907
TKN Filtered	mg/L	*0.423	*0.413	*0.757	*0.79
Organic Nitrogen	mg/L	*0.453	*0.413	*0.33	*0.327
Ammonia-N	mg/L	*0.099	*0.122	*0.542	*0.582
Nitrite-N	mg/L	0.04	0.04	0.04	<0.01
Nitrate-N	mg/L	2.14	2.06	2.19	0.56
Total Phosphorus	mg/L	*0.02	*0.017	*0.081	*0.077
Soluble Reactive Phosphorus	mg/L	*0.001	*0.001	*0.054	*0.048
Silica	mg/L	*2.27	*2.3	*4.17	*4.03
Calcium	mg/L	148	150	141	146
Sodium	mg/L	321	321	318	344
Potassium	mg/L	5.18	5.01	5.05	4.5
Sulfate	mg/L	205	206	203	176
Chloride	mg/L	605	607	606	602
Total Solids	mg/L	*1556	*1575	*1585	*1553
Total Volatile Solids	mg/L	*250	*253	*258	*210
Total Suspended Solids	mg/L	*2.5	*2	*2	*2
Volatile Suspended Solids	mg/L	*2	*2	*2	*2
Total Dissolved Solids	mg/L	*1474	*1511	*1502	*1510
Turbidity	NTU	*1.7	*1.625		
Arsenic	mg/L	<0.002	<0.002	<0.002	<0.002
Iron	mg/L	0.0908	<0.0500	<0.0500	0.197
Copper	mg/L	<0.0031	<0.0031	<0.0031	<0.0031
Chromium	mg/L	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	mg/L	<0.0008	<0.0008	<0.0008	<0.0008
Lead	mg/L	<0.002	<0.002	<0.002	<0.002
Magnesium	mg/L	25.7	25.9	25.2	25
Manganese	mg/L	<0.0250	<0.0250	<0.0250	1.08
Nickel	mg/L	<0.0038	<0.0038	<0.0038	<0.0038
Selenium	mg/L	<0.002	<0.002	<0.002	<0.002
Zinc	mg/L	<0.0063	<0.0063	<0.0063	<0.0063
Phaeophytin-a	mg/m3	1.28	2.62		
Chlorophyll-a	mg/m3	3.2	7.48		
Fecal Coliforms	count/100	<5	<5		
E. Coli	count/100	2	1		

Notes: * indicates the data were averaged over several depths: UML = 0m, 3m and 6m; LWL = 12m, 15m, 18m
The averages are based on concentration data, and are not volume-averages. Phaeophytin-a and Chlorophyll-a were collected as Tube Composites. Averages were calculated using the laboratory reported limit of detection when an observation was reported at below that limit. NA: Not Analyzed.

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Comparison of South and North data, November 18, 2008.

Parameter	Units	Upper Mixed Layer		Lower Water Layer	
		South	North	South	North
Secchi Disc Depth	meters	3.4	4.2		
pH	Std Units	*6.857	*6.977	*7.037	*7.15
Temperature	°C	*8.953	*9.103	*9.133	*9.06
Specific conductance	umHos/cm	*1811.667	*2286	*2253	*2282.667
Dissolved oxygen	mg/L	*9.873	*10.083	*9.307	*9.01
5-day BOD	mg/L	<2	<2	<2	<2
Total Alkalinity	mg/L	172	172	172	170
Total Organic Carbon	mg/L	*3.35	*3.29	*3.41	*3.145
TOC Filtered	mg/L	*3.34	*3.235	*3.26	*3.065
Total Inorganic Carbon	mg/L	*44.65	*45.1	*45	*45.1
Total Kjeldahl Nitrogen	mg/L	*0.84	*0.777	*0.78	*0.773
TKN Filtered	mg/L	*0.64	*0.633	*0.66	*0.627
Organic Nitrogen	mg/L	*0.45	*0.367	*0.373	*0.357
Ammonia-N	mg/L	*0.393	*0.413	*0.41	*0.42
Nitrite-N	mg/L	0.05	0.05	0.06	0.05
Nitrate-N	mg/L	1.91	1.85	1.92	1.88
Total Phosphorus	mg/L	*0.063	*0.059	*0.062	*0.063
Soluble Reactive Phosphorus	mg/L	*0.032	*0.035	*0.033	*0.036
Silica	mg/L	*4.04	*4.04	*4.07	*4.01
Calcium	mg/L	127	146	144	147
Sodium	mg/L	287	302	299	304
Potassium	mg/L	5.23	4.99	5.01	5.02
Sulfate	mg/L	164	184	160	182
Chloride	mg/L	518	538	523	544
Total Solids	mg/L	*1353	*1403	*1367	*1416
Total Volatile Solids	mg/L	*170	*192	*184	*194
Total Suspended Solids	mg/L	*3.5	*2	*2	*2
Volatile Suspended Solids	mg/L	*2	*2	*2	*2
Total Dissolved Solids	mg/L	*1305	*1331	*1323	*1339
Turbidity	NTU	*4.87	*1.77		
Arsenic	mg/L	<0.002	<0.002	<0.002	<0.002
Iron	mg/L	0.0956	<0.0500	0.0932	0.0926
Copper	mg/L	<0.0031	<0.0031	<0.0031	<0.0031
Chromium	mg/L	<0.0025	<0.0025	<0.0025	<0.0025
Cadmium	mg/L	<0.0008	<0.0008	<0.0008	<0.0008
Lead	mg/L	<0.002	<0.002	<0.002	<0.002
Magnesium	mg/L	24.8	25.6	25.3	25.9
Manganese	mg/L	<0.0250	<0.0250	<0.0250	<0.0250
Nickel	mg/L	<0.0038	0.0039	<0.0038	<0.0038
Selenium	mg/L	<0.002	<0.002	<0.002	<0.002
Zinc	mg/L	<0.0063	<0.0063	<0.0063	0.0067
Phaeophytin-a	mg/m3	1.66	0.43		
Chlorophyll-a	mg/m3	3.2	4.81		
Fecal Coliforms	count/100	340	20		
E. Coli	count/100	236	25		

Notes: * indicates the data were averaged over several depths: UML = 0m, 3m and 6m; LWL = 12m, 15m, 18m
The averages are based on concentration data, and are not volume-averages. Phaeophytin-a and Chlorophyll-a were collected as Tube Composites. Averages were calculated using the laboratory reported limit of detection when an observation was reported at below that limit. NA: Not Analyzed.

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Statistical comparison of mean results between South and North deep stations from 1999 to 2008 combined.
Statistically significant results (P<0.05) are shaded. NA= No data available.

		Upper Mixed Layer				Lower Water Layer			
Parameter	**Units**	**N**	**South**	**North**	**P**	**N**	**South**	**North**	**P**
Secchi Disc Depth	meters	39	2.00	2.15	0.020	0	NA	NA	NA
pH	Std Units	40	7.85	7.89	0.019	40	7.51	7.52	0.293
Temperature	°C	40	14.2	14.1	0.275	40	8.82	8.79	0.787
Specific conductance	umHos/cm	40	1,910	1,951	0.033	40	1,996	2,022	0.043
Dissolved oxygen	mg/L	40	10.2	10.2	0.809	40	5.42	5.14	0.018
5-day BOD	mg/L	40	2.68	2.84	0.160	40	3.38	3.52	0.335
Total Alkalinity	mg/L	40	165	166	0.916	40	190	192	0.263
Total Organic Carbon	mg/L	40	4.10	4.16	0.463	40	3.80	3.89	0.581
TOC Filtered	mg/L	40	3.71	3.75	0.543	40	3.44	3.58	0.441
Total Inorganic Carbon	mg/L	40	42	43	0.158	40	51	51	0.595
Total Kjeldahl Nitrogen	mg/L	40	1.06	1.02	0.0035	40	1.66	1.64	0.682
TKN Filtered	mg/L	40	0.88	0.84	0.082	40	1.50	1.48	0.678
Organic Nitrogen	mg/L	40	0.56	0.52	0.013	40	0.39	0.38	0.705
Ammonia-N	mg/L	40	0.50	0.50	0.988	40	1.27	1.26	0.710
Nitrite-N	mg/L	40	0.081	0.077	0.001	40	0.076	0.077	0.938
Nitrate-N	mg/L	40	1.59	1.50	0.00000001	40	1.19	1.09	0.049
Total Phosphorus	mg/L	40	0.07	0.07	0.133	40	0.19	0.19	0.469
Soluble Reactive Phosphorus	mg/L	40	0.03	0.03	0.095	40	0.15	0.15	0.572
Silica	mg/L	40	2.44	2.47	0.487	40	3.86	3.94	0.282
Calcium	mg/L	40	131	134	0.021	40	134	137	0.044
Sodium	mg/L	40	227	229	0.199	40	236	237	0.594
Potassium	mg/L	40	4.60	4.54	0.046	40	4.39	4.36	0.265
Sulfate	mg/L	40	164	165	0.559	40	156	156	0.886
Chloride	mg/L	40	434	438	0.114	40	445	448	0.346
Total Solids	mg/L	40	1,249	1,263	0.046	40	1,278	1,286	0.313
Total Volatile Solids	mg/L	40	212	221	0.153	40	209	209	1.000
Total Suspended Solids	mg/L	40	3.48	3.18	0.092	40	2.79	2.60	0.330
Volatile Suspended Solids	mg/L	40	2.44	2.39	0.691	40	2.04	1.96	0.361
Total Dissolved Solids	mg/L	40	1,171	1,194	0.016	40	1,201	1,214	0.092
Turbidity	NTU	28	4.00	3.57	0.085	0	NA	NA	NA
Arsenic	mg/L	40	0.002	0.002	P-1	40	0.002	0.002	0.141
Iron	mg/L	40	0.089	0.069	0.002	40	0.10	0.09	0.268
Copper	mg/L	40	0.0021	0.0021	0.746	40	0.0019	0.0018	0.139
Chromium	mg/L	40	0.0013	0.0013	0.283	40	0.0014	0.0013	0.149
Cadmium	mg/L	40	0.00071	0.00058	0.251	40	0.00068	0.00069	0.323
Mercury	ng/L	9	3.13	2.24	0.053	9	2.94	2.79	0.622
Methyl mercury	ng/L	9	0.12	0.08	0.048	9	0.45	0.54	0.277
Lead	mg/L	39	0.0036	0.0028	0.189	39	0.00	0.00	0.358
Magnesium	mg/L	40	23.86	24.16	0.004	40	23.66	24.08	0.030
Manganese	mg/L	40	0.031	0.049	0.330	40	0.03	0.05	0.547
Nickel	mg/L	40	0.0042	0.0046	0.309	40	0.0039	0.0039	0.709
Selenium	mg/L	40	0.0020	0.0020	P-1	40	0.0020	0.0020	P-1
Zinc	mg/L	40	0.0077	0.0063	0.141	40	0.0082	0.0066	0.263
Phaeophytin-a	meters	40	1.41	1.50	0.560	0	NA	NA	NA
Chlorophyll-a; Log Transformed	mg/m3	40	1.00	1.02	0.574	0	NA	NA	NA
Fecal Coliforms; Log Transformed	count/100	40	1.39	1.21	0.0065	0	NA	NA	NA
E. coli; Log Transformed	count/100	31	1.29	1.11	0.033	0	NA	NA	NA

Notes: UML = 0m, 3m and 6m; LWL = 12m, 15m, 18m

The averages are based on concentration data, and are not volume-averages. Phaeophytin-a and Chlorophyll-a were collected in the Photic Zone through 2007; in 2008, only Tube Composite samples were collected.

Averages were calculated using the laboratory reported limit of detection when an observation was reported at below that limit. NA: Not Analyzed.

P-1 indicates the Pearson correlation was 1, and the values between North and South were identical.

Summary of parameters with statistically significant differences (P<0.05), 1999-2008

Parameters	Observations		Interpretation
	Upper Waters (UML)	***Lower Waters (LWL)***	
Nitrogen (Total Kjeldahl Nitrogen, Organic Nitrogen, Nitrite-N, and Nitrate-N)	Higher at South	Nitrate Higher at South	Higher concentrations of nitrogen species at South Deep are likely due to the Metro discharge.
Specific conductance	Higher at North	Higher at North	The higher specific conductance may be related to the proximity of Ninemile Creek, which is a higher salinity inflow as compared with Metro and the southern tributaries.
pH	Higher at North	Not different	
Solids (Total and Dissolved)	Higher at North	Not different	
Dissolved oxygen	Not different	Higher at South	
Iron	Higher at South	Not different	Higher concentrations of iron at South Deep are likely due to the Metro discharge.
Mercury (methyl)	Higher at South	Not different	Higher mercury concentrations at South Deep may be related to proximity to historic industrial discharge of mercury.
Magnesium	Higher at North	Higher at North	The reason for the elevated Mg concentration at North Deep is unknown.
Fecal coliforms	Higher at South	Not sampled	The higher fecal coliform bacteria concentrations at South Deep are likely due to the proximity of the larger tributaries (CSOs and urban storm water) and the requirement for seasonal disinfection of the Metro effluent.

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ONONDAGA LAKE RESULTS: BIOLOGY

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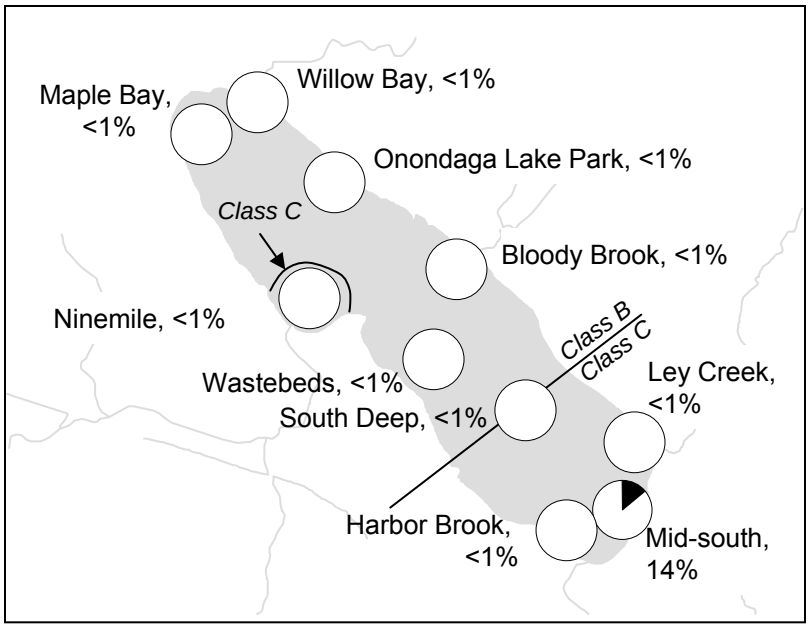
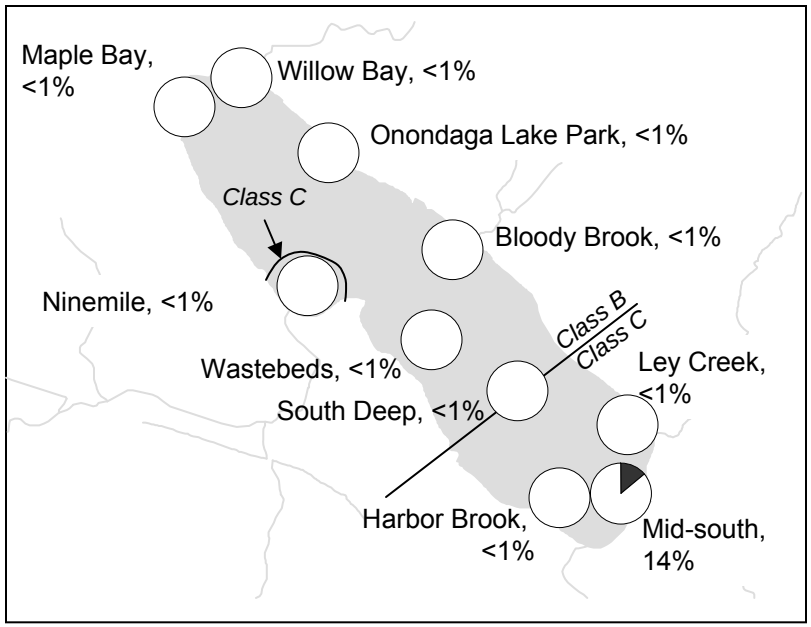
Fecal Coliforms



Nearshore and South Deep fecal coliform bacteria results in 2008. Shaded area of pie charts indicates percent of monthly geometric means that exceeded 200 cells per 100 ml for the disinfection period April 1 through October 15.

E. Coli



Nearshore and South Deep E coli results in 2008. Shaded area of pie charts indicates percent of monthly geometric means that exceeded 126 cells per 100 ml for the disinfection period April 1 through October 15.

Library Reference 8.2

Chlorophyll-a

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Library Reference 8.2.1

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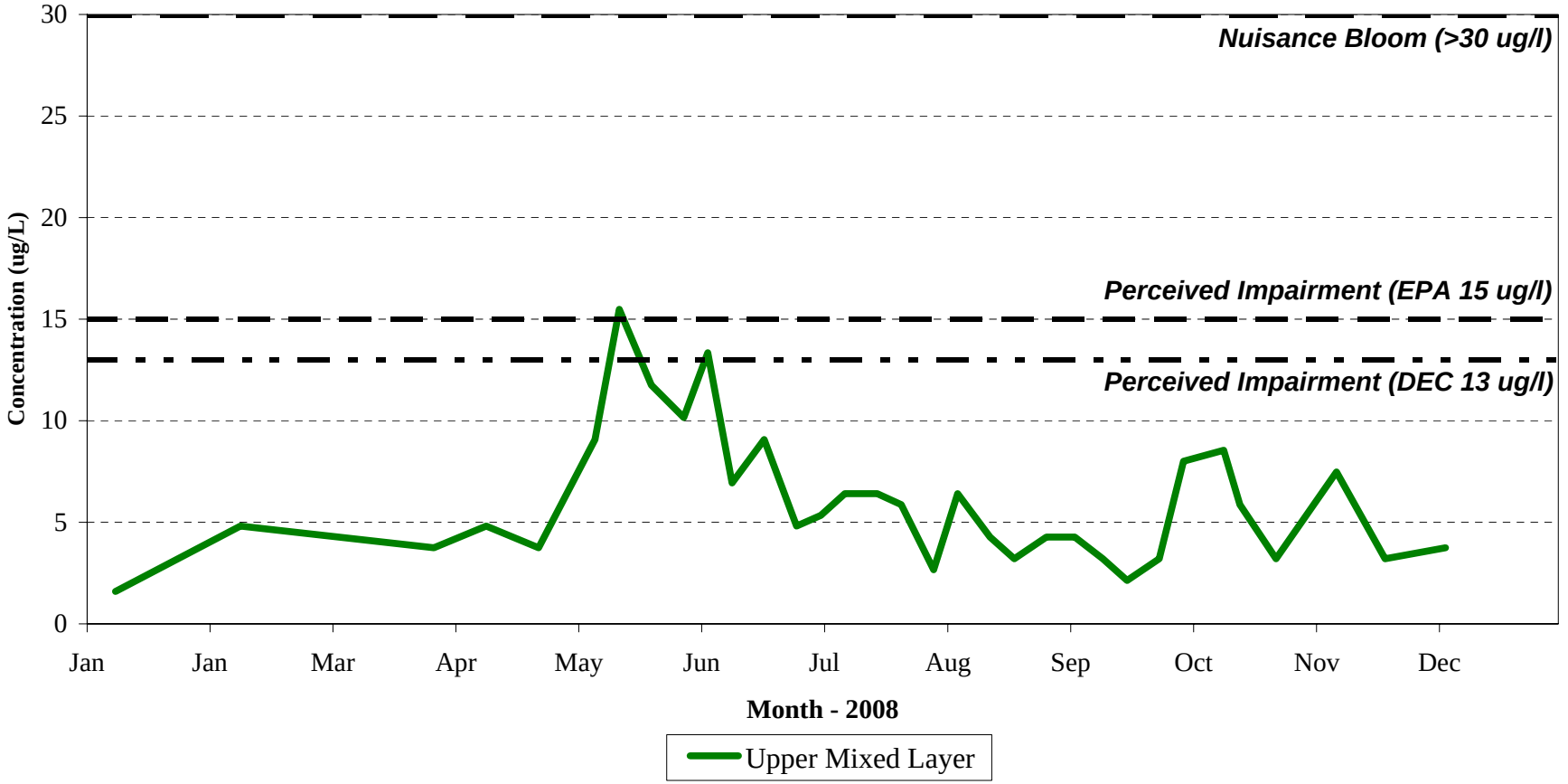

Chlorophyll-a concentration at South Deep, upper mixed layer (tube) sampling, during 2008; photic zone sampling discontinued March 2008. Upper mixed layer samples are composited from the 0- and 3-meter depths always; and may also include the 6-meter depth during the summer stratified period (depending on the field temperature profile). Perceived impairment and nuisance bloom guidance values based on surveys on the public by NYSDEC.

Library Reference 8.2.2

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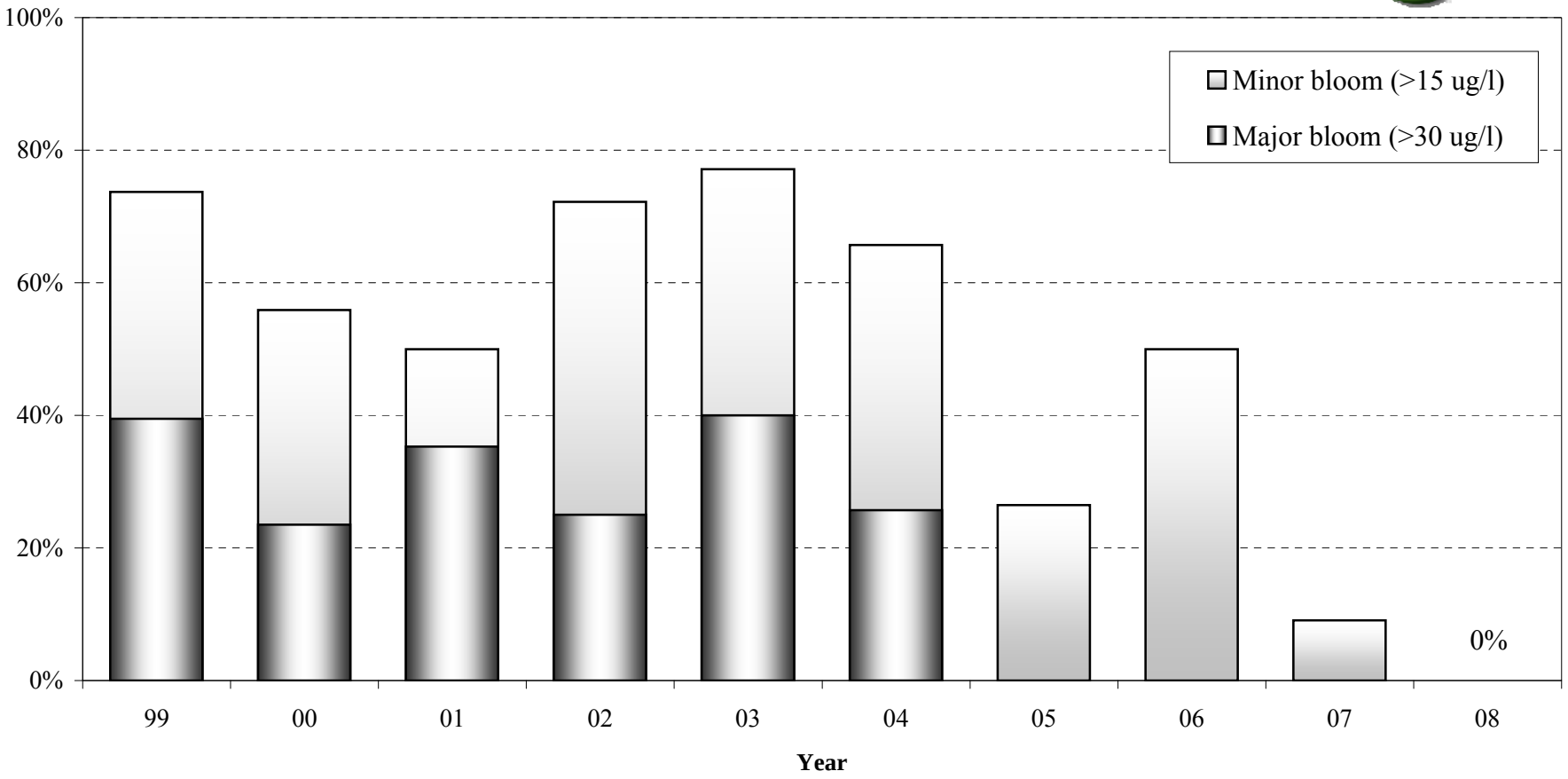

The percent of summer (June 1 to Sept 30) chlorophyll-a measurements that exceed algal bloom thresholds in Onondaga Lake are shown for the years 1999 to 2008. Nuisance bloom conditions are defined as chlorophyll-a concentrations greater than 30 µg/L. The concentration 15 µg/L is considered to represent a threshold where the public may perceive impairment for recreational use of a lake.

Library Reference 8.2.3

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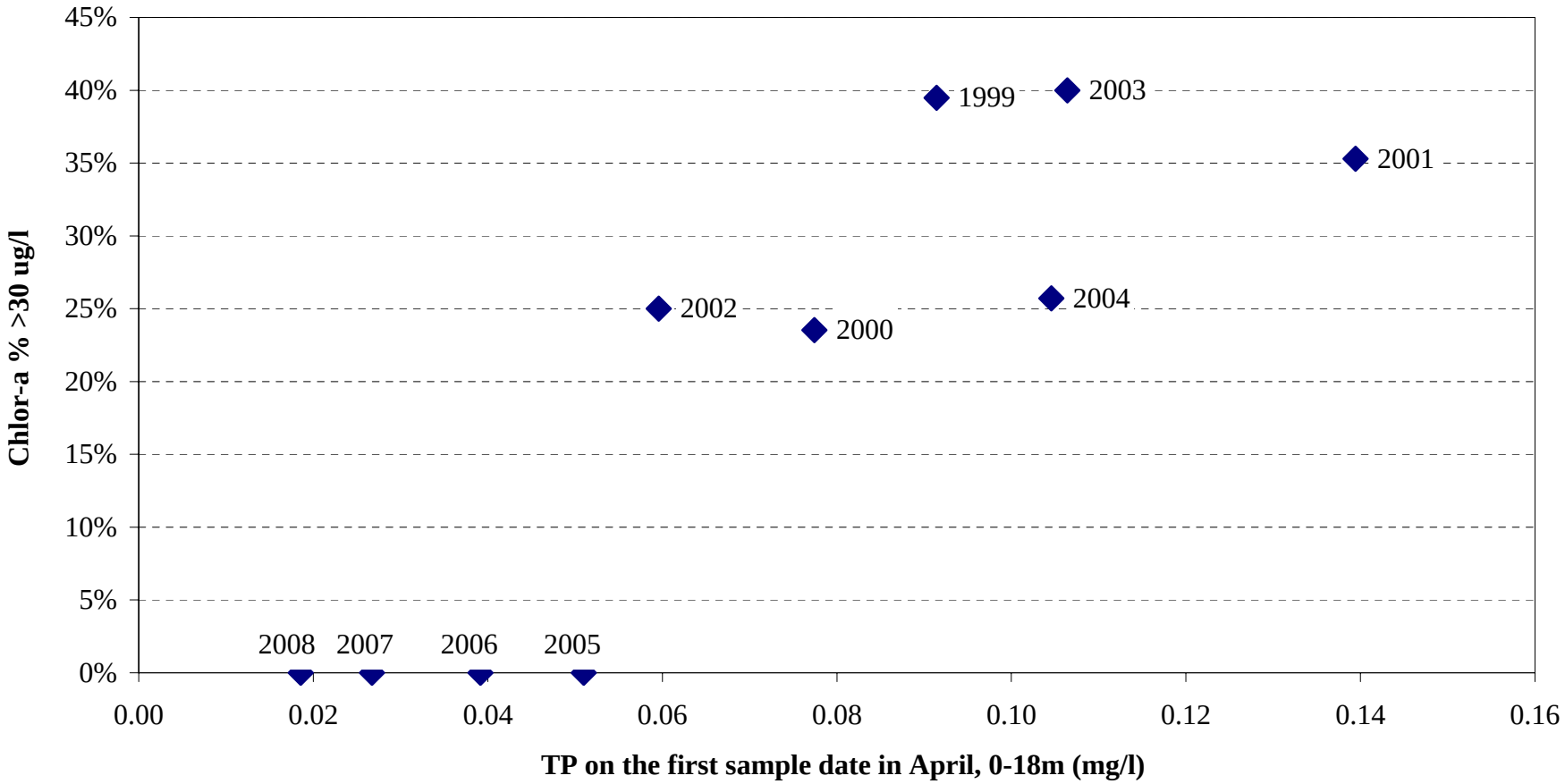

Relationship over ten years between spring total phosphorus (TP) concentration (averaged across sample depths from 0 to 18 meters) and the frequency of summertime nuisance algal blooms at South Deep station in Onondaga Lake. Summertime nuisance algal blooms are defined as concentrations of chlorophyll-a exceeding 30 ug/l for the period from June through September.

Library Reference 8.2.4

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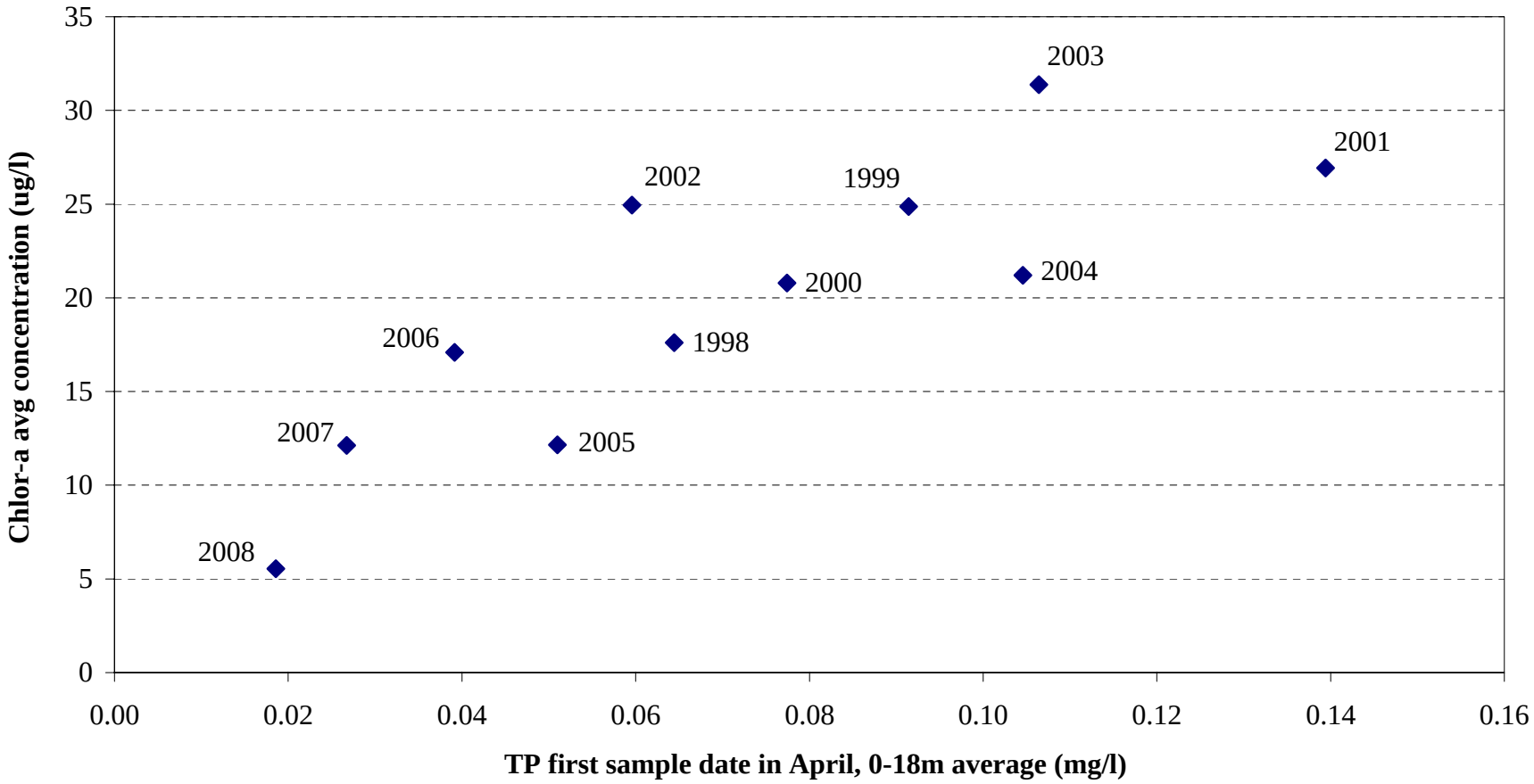

Relationship over ten years between spring total phosphorus (TP) concentration (averaged across sample depths from 0 to 18 meters) and summertime chlorophyll-a concentrations at South Deep station in Onondaga Lake. Summertime is defined as the period from June 1 through September 30.

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Assessing Community Structure of Lower Trophic Levels In Onondaga Lake, New York in 2008

2008 Annual Report

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Introduction

This report summarizes the information collected by Onondaga County and processed by Cornell Biological Field Station. The raw data have been sent to the Onondaga County through Ecologic and have been incorporated in the Onondaga County Bio Database.

The report consists of a method section and a series of tables and figures with our interpretations of the observed patterns.

Methods

Phytoplankton samples were collected approximately biweekly January through December in 2008 and preserved in Lugol's Iodine solution. The phytoplankton sample for each date and sampling site is an integrated sample of the upper mixed layer (UML) of the water column. The UML depth is the same depth as the epilimnion depth when a thermocline is present or is a default of six meters when there is no thermocline. All integrated water samples for phytoplankton analysis were collected using a 2 cm i.d. Tygon tube.

Phytoplankton samples were processed by Ann St. Amand at PhycoTech, Inc. (620 Broad St., Ste. 100, St. Joseph, MI 49085). Raw water samples were run through filtration towers, and the filters from these towers were then made into slides. The method used in counting the phytoplankton depended on the relative importance of soft algae and diatoms in the samples as well as algal size. Phytoplankton were identified to species when possible and cells were measured to determine species-specific greatest axial length dimension (GALD) and individual biovolume. Species with GALD>50µm were classified as netplankton and species with GALD<50µm were classified as nannoplankton. Total biovolume for each species was calculated by multiplying cell concentration by individual biovolume. PhycoTech reported total biovolume in $\mu m^3/mL$, which we converted to cm^3/m^3 (a unit more commonly used in the literature) by dividing by 1,000,000. We also converted total biovolume to algal biomass, assuming density of algal cells was equal to that of water (1 g/cm^3). Converting among units of biovolume and biomass can be cumbersome and different literature sources uses different units. To convert among units use:

1 cm^3/m^3 = 1 mm^3/L = 1 mg/L = 1 µg/mL = 1000 µg/L = 1,000,000 $\mu m^3/mL$
1 g/m^3 = 1 mg/L = 1 µg/mL = 1000 µg/L

Calculations of zooplankton density, species composition, size structure, and biomass were based on vertical hauls using a 0.50 m diameter net with 80 micron nylon mesh. Vertical tows were taken from the UML from a depth of three, six or nine meters when the lake was thermally stratified and from 15 meters when no thermocline was present. In addition, from January through March two samples were collected with a vertical tow to a depth of 6 and 15 meters. Zooplankton samples were collected at the South Deep site throughout the year and at the North Deep site on several dates. Samples were

preserved in 190-proof ethyl alcohol, this preservative comprising at least 70% of each final sample volume. Flowmeter readings were taken on the zooplankton net tows to determine the volume of water strained in each haul.

A compound microscope (40X-200X magnification) was used to identify zooplankton to species when possible. For each sample, one to three 1-mL subsamples were withdrawn with a Henson-Stemple pipette from a known volume of sample, until at least 100 individual zooplankton were counted. Zooplankton length was measured using a compound scope equipped with a drawing tube and a digitizing pad interfaced with a computer. Dry mass was estimated for each measured animal from standard species-specific length-weight regressions used in the Lake Ontario Biomonitoring program (Holeck et al. 2008).

Results and Discussion

List of Tables and Figures:

Tables for 2008 data:

- Table 1. Zooplankton abundance, average size and biomass calculated for winter, spring, summer and fall as well as annual.
- Table 2. Phytoplankton abundance and biovolume for the major divisions for the same time periods.
- Table 3. Major genera of phytoplankton.

Figures for 2008 data:

- Fig 1 Biovolume and proportional composition of phytoplankton of 7 algal division.
- Fig 2 Biovolume of phytoplankton divided in net and nannoplankton..
- Fig 3. Composition by genera of cyanophytes (bluegreens).
- Fig 4. Biomass and density of crustacean zooplankton.
- Fig 5. Zooplankton biomass divided in copepods and cladocerans.
- Fig 6 Proportional composition by biomass for the cladoceran and the copepod assemblages.
- Fig.7 Biomass of predatory zooplankton (*Cercopagis, Leptodora, Mesocyclops* and *Acanthocyclops*).
- Fig 8. Average length of crustacean zooplankton in Onondaga and Oneida Lakes.
- Fig 9. Seasonal development of phytoplankton and zooplankton biomass in Onondaga Lake.

Figures for time trends:

Fig. 10. Time trend in annual phytoplankton biomass in Onondaga Lake, 1998 – 2008.
Fig. 11. Temporal trend of average annual phytoplankton biomass divided in 7 divisions, 1998-2008.
Fig. 12. Temporal trend of average composition of the phytoplankton assemblage in Onondaga Lake, 1998-2008.
Fig. 13. Average crustacean zooplankton biomass 1999-2008 and time trends for selected major groups (*Daphnia mendotae*, *Bosmina longirostris*, *Diacypclos thomasi*, diaptomids, and nauplii/copepodites). other small cladocerans, other cladocerans if sufficiently abundant)
Fig 14. Time trend off the biomass of different Daphnia species in Onondaga Lake, 1998-2008.
Fig 15 Time trend of average length of crustacean zooplankton in Onondaga Lake, 1999-2008.
Fig 16. Comparison of time trends in zooplankton and phytoplankton biomass.

Onondaga Lake in 2008

Table 1. Density (animals/L), average size (mm), and biomass (μg/L, dwt) of the total zooplankton community, cladocerans, copepods, and individual taxa collected from Onondaga Lake, NY, 01/08/08-12/03/08. Data are grouped by season into Winter (n = 2), Spring (n=7), Summer (n=6), and Fall (n=6). Yearly averages (n=21) are also listed. An asterisk ("*") indicates that the sample is an average of "North" and "South" site collections. Averages are generated from epilimnion and 15m tows for 1/8, 2/8, and 3/27. Data are mean and standard errors (SE). Total Community = Cladocerans + Copepods. Cladocerans = Individually listed species + Other Cladocerans. Copepods = Individually listed species + nauplii + cyclopoid copepods + calanoid copepods. Cyclopoid and calanoid copepods are mostly small copepodites that were not identified to species.

Seasonally, total zooplankton density and biomass were highest during summer 2008 (Table 1). Zooplankton density and biomass were lowest in early December (16.2/L and 21.8 μg/L, respectively). Zooplankton density and biomass peaked in early July (755.7/L and 619.9 μg/L, respectively). While zooplankton density and biomass were generally high from early May to early October (>80.8/L and >137.6 μg/L, respectively), during the rest of the season they remained relatively low ranging from 16.2/L to 37.2/L and 21.6 μg/L to 66.3 μg/L, respectively (Figure 5).

		Winter (n = 2) 1/8, 2/8			Spring (n =7) 3/27, 4/9*, 4/22, 5/6, 5/20, 6/3, 6/17*			Summer (n = 6) 7/1, 7/15, 7/29, 8/12,8/26, 9/9		
		Density (animals/L)	Ave. Size (mm)	Biomass (µg/L)	Density (animals/L)	Ave. Size (mm)	Biomass (µg/L)	Density (animals/L)	Ave. Size (mm)	Biomass (µg/L)
Total Community	mean	18.96	0.51	37.15	105.66	0.38	102.64	390.02	0.42	523.03
	SE	1.30	0.05	7.24	29.69	0.04	24.90	79.70	0.04	39.72
Cladocerans	mean	1.98		2.83	26.77		20.34	214.58		322.17
	SE	1.59		2.11	18.87		13.78	105.51		83.42
Copepods	mean	16.98		34.32	78.89		82.30	175.44		200.86
	SE	2.89		9.35	19.99		20.57	41.65		67.37
Bosmina longirostris	mean	1.91	0.37	2.69	26.47	0.28	20.21	154.40	0.30	132.44
	SE	1.53	0.03	2.02	18.78	0.03	13.70	115.47	0.01	93.39
Diacyclops thomasi	mean	9.82	0.79	33.86	41.34	0.62	79.97	27.26	0.53	36.56
	SE	3.13	0.01	9.45	12.28	0.06	20.15	6.90	0.04	10.59
Daphnia mendotae	mean	0.07	0.75	0.14	0.08	0.44	0.03	37.98	0.80	124.53
	SE	0.06	0.10	0.09	0.08		0.03	13.23	0.03	46.58
Daphnia retrocurva	mean	0.00		0.00	0.13	0.53	0.09	7.38	0.78	24.70
	SE	0.00		0.00	0.13		0.09	4.10	0.10	15.19
Daphnia ambigua	mean	0.00		0.00	0.00		0.00	2.71	0.59	3.54
	SE	0.00		0.00	0.00		0.00	1.57	0.06	2.43
Daphnia sp.	mean	0.00		0.00	0.08	0.33	0.01	11.47	0.69	24.35
	SE	0.00		0.00	0.08		0.01	6.07	0.02	14.52
Nauplii	mean	7.14	0.17	0.45	37.55	0.17	2.33	86.00	0.18	6.62
	SE	0.23	0.01	0.09	8.15	0.01	0.58	19.46	0.01	1.87
Acanthocyclops vernalis	mean	0.00		0.00	0.00		0.00	1.76	1.01	9.70
	SE	0.00		0.00	0.00		0.00	0.95	0.09	5.60
Mesocyclops edax	mean	0.00		0.00	0.00		0.00	2.68	0.79	8.89
	SE	0.00		0.00	0.00		0.00	1.86	0.05	6.68
Diaptomus minutus	mean	0.00		0.00	0.00		0.00	9.29	0.82	33.03
	SE	0.00		0.00	0.00		0.00	4.43	0.05	15.92
D. oregonensis	mean	0.00		0.00	0.00		0.00	3.71	0.97	19.39
	SE	0.00		0.00	0.00		0.00	1.92	0.04	9.67
Diaptomus siciloides	mean	0.00		0.00	0.00		0.00	8.90	1.06	55.79
	SE	0.00		0.00	0.00		0.00	5.43	0.04	33.56
Cercopagis pengoi	mean	0.00		0.00	0.00		0.00	0.13	1.36	1.55
	SE	0.00		0.00	0.00		0.00	0.09	0.05	1.11
Other Cladocerans	mean	0.00		0.00	0.01		0.00	0.52		11.05
	SE	0.00		0.00	0.01		0.00	0.33		10.66
Cyclopoid Copepods	mean	0.02	0.41	0.01	0.00		0.00	16.08	0.36	7.18
	SE	0.01	0.02	0.01	0.00		0.00	8.52	0.00	3.72
Calanoid Copepods	mean	0.00		0.00	0.00		0.00	19.75	0.52	23.71
	SE	0.00		0.00	0.00		0.00	9.77	0.10	11.71

		Fall (n = 6) 9/23*, 10/9, 10/22, 11/6,11/18*, 12/3			Year (n = 21)		
		Density (animals/L)	Ave. Size (mm)	Biomass (µg/L)	Density (animals/L)	Ave. Size (mm)	Biomass (µg/L)
Total Community	mean	47.78	0.57	109.78	162.11	0.42	218.56
	SE	14.20	0.04	48.37	40.44	0.03	47.08
Cladocerans	mean	18.17		54.00	75.61		114.53
	SE	8.88		36.67	35.00		38.57
Copepods	mean	29.62		55.78	86.50		104.03
	SE	8.40		17.35	18.77		24.22
Bosmina longirostris	mean	3.65	0.35	4.56	54.16	0.29	46.14
	SE	0.64	0.02	0.91	34.55	0.01	28.16
Diacyclops thomasi	mean	2.43	0.66	5.46	23.20	0.60	41.89
	SE	0.81	0.05	1.89	5.60	0.03	9.65
Daphnia mendotae	mean	13.44	0.83	47.06	14.72	0.81	49.05
	SE	8.98	0.04	36.54	5.53	0.03	19.58
Daphnia retrocurva	mean	0.06	1.07	0.38	2.17	0.78	7.20
	SE	0.06		0.38	1.32	0.10	4.76
Daphnia ambigua	mean	0.00		0.00	0.78	0.59	1.01
	SE	0.00		0.00	0.50	0.06	0.74
Daphnia sp.	mean	0.61	0.61	0.86	3.48	0.68	7.21
	SE	0.35	0.05	0.53	1.98	0.04	4.58
Nauplii	mean	15.64	0.19	1.21	42.24	0.18	3.06
	SE	4.87	0.01	0.38	8.89	0.00	0.75
Acanthocyclops vernalis	mean	0.00		0.00	0.50	1.01	2.77
	SE	0.00		0.00	0.31	0.09	1.79
Mesocyclops edax	mean	0.22	0.92	1.49	0.83	0.80	2.96
	SE	0.22		1.49	0.57	0.06	2.02
Diaptomus minutus	mean	0.06	0.72	0.16	2.67	0.82	9.48
	SE	0.06		0.16	1.51	0.04	5.40
Diaptomus oregonensis	mean	0.65	1.04	4.04	1.25	0.98	6.69
	SE	0.16	0.02	1.05	0.62	0.02	3.18
Diaptomus siciloides	mean	7.02	1.00	39.32	4.55	1.03	27.17
	SE	2.47	0.03	14.37	1.83	0.03	11.17
Cercopagis pengoi	mean	0.01	1.47	0.17	0.04	1.37	0.49
	SE	0.01	0.17	0.09	0.03	0.12	0.33
Other Cladocerans	mean	0.39		0.97	0.26		3.44
	SE	0.14		0.50	0.11		3.05
Cyclopoid Copepods	mean	0.57	0.41	0.34	4.76	0.36	2.15
	SE	0.16	0.01	0.12	2.79	0.01	1.22
Calanoid Copepods	mean	3.02	0.53	3.77	6.50	0.52	7.85
	SE	1.22	0.04	1.62	3.24	0.05	3.89

Table 2. Abundance (#/mL) and biomass (µg/L) of phytoplankton in Onondaga Lake in 2008. The phytoplankton community of Onondaga Lake typically consists of Bacillariophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Pyrrhophyta, Euglenophyta, and “miscellaneous microflagellates”, but Euglenophyta were absent from the samples in 2008. Data are presented for each sampling date at both north ("N") and south ("S") stations, when taken. Samples taken were integrated upper mixed layer samples.

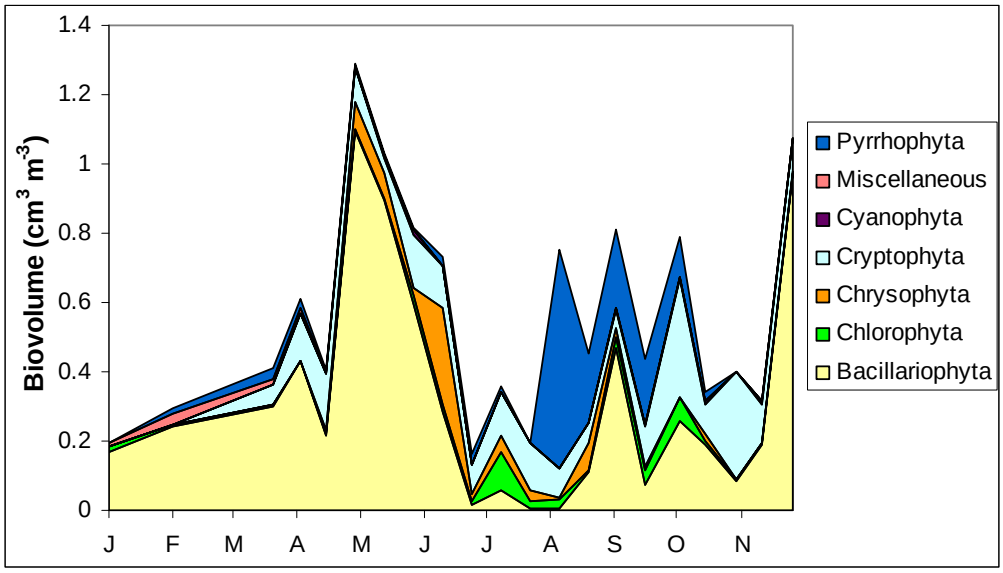
Date	Depth	Station	Variable	Bacillario	Chloro	Chryso	Crypto
1/8	UML	South	Abundance	81.79	213.14	6.06	218.10
			Biomass	167.19	15.01	0.29	18.73
2/8	UML	South	Abundance	587.25	27.26	0	1226.84
			Biomass	239.87	5.76	0	151.13
3/27	UML	South	Abundance	1054.03	37.87	0	433.56
			Biomass	300.16	6.89	0	55.90
4/9	UML	North	Abundance	958.42	39.76	0	650.34
			Biomass	429.07	4.41	0	155.22
4/9	UML	South	Abundance	1186.89	45.44	22.72	744.06
			Biomass	429.06	4.27	0.69	117.43
4/22	UML	South	Abundance	221.32	45.44	11.36	3555.56
			Biomass	216.88	3.16	12.85	164.07
5/6	UML	South	Abundance	1736.40	54.09	183.92	1233.33
			Biomass	1094.35	5.43	83.73	100.78
6/3	UML	South	Abundance	1468.29	83.46	1670.74	760.40
			Biomass	893.30	5.49	77.24	40.85
6/17	UML	North	Abundance	1261.24	367.84	7097.06	649.12
			Biomass	211.91	27.43	215.38	214.50
6/17	UML	South	Abundance	2986.11	298.37	9351.67	1698.53
			Biomass	946.56	48.53	379.06	182.41
7/1	UML	South	Abundance	52.02	68.16	772.45	904.23
			Biomass	13.24	11.45	23.24	82.31
7/15	UML	South	Abundance	503.07	4822.86	470.61	194.74
			Biomass	56.58	109.96	52.31	128.48
7/29	UML	South	Abundance	9.09	129.42	122.68	1290.45
			Biomass	3.63	21.17	37.53	134.96
8/12	UML	South	Abundance	11.28	58.91	47.71	567.98
			Biomass	5.14	24.29	7.79	85.95
8/26	UML	South	Abundance	86.33	54.53	458.93	1240.47
			Biomass	111.95	3.93	82.10	61.90
9/9	UML	South	Abundance	239.92	119.28	863.33	715.66
			Biomass	467.66	34.71	27.46	52.67
9/23	UML	North	Abundance	794.98	171.77	193.11	1317.72
			Biomass	114.51	41.09	12.91	112.00
9/23	UML	South	Abundance	551.75	129.82	108.23	1923.02
			Biomass	33.62	47.59	11.34	118.72
10/9	UML	South	Abundance	779.51	45.44	17.04	1638.63
			Biomass	256.42	69.70	1.24	342.71
10/22	UML	South	Abundance	127.23	21.47	45.44	502.85
			Biomass	189.89	12.25	19.50	81.19
11/6	UML	South	Abundance	51.50	13.21	28.36	1032.97
			Biomass	75.36	3.80	1.97	307.13
11/18	UML	North	Abundance	70.77	18.18	64.71	1378.30
			Biomass	147.58	4.45	2.11	135.20
11/18	UML	South	Abundance	113.18	0	39.38	825.47
			Biomass	177.60	0	0.61	86.59
12/3	UML	South	Abundance	157.52	4.13	127.23	836.33
			Biomass	964.10	1.31	1.80	95.57

Date	Depth	Station	Variable	Eugleno	Cyano	Misc. Micro	Pyrrho
1/8	UML	South	Abundance	0	0	708.84	3.03
			Biomass	0	0	9.89	0.61
2/8	UML	South	Abundance	0	0	436.21	19.27
			Biomass	0	0	34.16	15.60
3/27	UML	South	Abundance	0	3.79	340.79	22.72
			Biomass	0	0.01	16.22	31.05
4/9	UML	North	Abundance	0	0	110.76	17.04
			Biomass	0	0	11.95	8.15
4/9	UML	South	Abundance	0	0	0.00	34.08
			Biomass	0	0	0.00	46.58
4/22	UML	South	Abundance	0	0	511.18	11.36
			Biomass	0	0	3.21	3.57
5/6	UML	South	Abundance	0	5.41	113.60	21.64
			Biomass	0	0.01	3.44	5.10
6/3	UML	South	Abundance	0	12.41	83.46	46.37
			Biomass	0	3.19	5.99	8.39
6/17	UML	North	Abundance	0	324.56	0	6.27
			Biomass	0	0.54	0	22.31
6/17	UML	South	Abundance	0	1231.17	0	41.11
			Biomass	0	20.30	0	30.61
7/1	UML	South	Abundance	0	22.72	0	18.18
			Biomass	0	3.96	0	29.87
7/15	UML	South	Abundance	0	697.81	0	3.14
			Biomass	0	0.81	0	13.24
7/29	UML	South	Abundance	0	9.09	0	0
			Biomass	0	0.02	0	0
8/12	UML	South	Abundance	0	31.81	0	15.90
			Biomass	0	0.04	0	628.94
8/26	UML	South	Abundance	0	599.79	0	4.54
			Biomass	0	0.84	0	197.59
9/9	UML	South	Abundance	0	397.59	0	5.68
			Biomass	0	0.82	0	227.68
9/23	UML	North	Abundance	0	3879.31	0	4.11
			Biomass	0	5.36	0	128.09
9/23	UML	South	Abundance	0	1706.69	0	8.11
			Biomass	0	4.31	0	250.18
10/9	UML	South	Abundance	0	18.41	0	5.68
			Biomass	0	2.55	0	116.98
10/22	UML	South	Abundance	0	451.36	0	3.03
			Biomass	0	12.86	0	28.55
11/6	UML	South	Abundance	0	2.19	0	0
			Biomass	0	4.65	0	0
11/18	UML	North	Abundance	0	12.12	0	0
			Biomass	0	3.06	0	0
11/18	UML	South	Abundance	0	124.20	0	0
			Biomass	0	18.47	0	0
12/3	UML	South	Abundance	0	281.72	0	6.06
			Biomass	0	0.43	0	0.46

Table 3. The major algal genera in Onondaga Lake in 2008. The most frequently occurring algal genus was *Crypotomona*, a cryptophyte. Other genera contributing more than 1% of the total biomass in 2008 include several diatom genera, (*Synedra, Stephanodiscus, Fragilaria, Asterionella, Diatoma, Cyclostephanos, Cyclotella* and *Entomoneis*), two dinoflagellates (*Ceratium, Peridinium*), one more cryptophyte (*Rhodomonas*) and two chrysophytes (*Dinobryon, Erkenia*). It is notable that no cyanobacteria genus made up more than 1 % of the biomass in 2008.
In: 2008 phyto genera.xls

Genus	Division	Mean biomass (ug/L)	Relative biomass (% of total)
Cryptomonas	Cryptophyta	84.5	14.80
Synedra	Bacillariophyta	84.5	14.79
Stephanodiscus	Bacillariophyta	66.7	11.67
Ceratium	Pyrrhophyta	64.8	11.34
Fragilaria	Bacillariophyta	60.1	10.52
Asterionella	Bacillariophyta	27.6	4.83
Rhodomonas	Cryptophyta	23.8	4.16
Diatoma	Bacillariophyta	23.0	4.02
Cyclostephanos	Bacillariophyta	18.1	3.16
Dinobryon	Chrysophtya	18.0	3.15
Erkenia	Chrysophyta	17.4	3.04
Cyclotella	Bacillariophyta	17.2	3.01
Entomoneis	Bacillariophyta	12.0	2.09
Peridinium	Pyrrhophyta	7.4	1.30

Figure 1. (A) Temporal trend in biovolume (panel A) and proporitional biovolume (panel B) of phytoplankton divisions in Onondaga Lake in 2008. Phytoplankton biomass peaked in May during the diatom-dominated spring bloom (Bacillariophyta), and decreased in early summer, coinciding with increasing zooplankton biomass (Fig. 9). Several small phytoplankton peaks occurred during late summer and early fall. The first was dominated by dinoflagellates (Pyrrhophyta) and the latter two by a combination of dinoflagellates, diatoms, and cryptophytes. A larger bloom, dominated by diatoms, developed in December. Dinoflagellates (Pyrrhophyta) dominated during late summer and early fall, but were rare the rest of the year. Cryptophytes were moderately abundant for much of the year and occasionally represented more than 50% of the total biovolume. Cyanobacteria (Cyanophyta) never made up more than 5% of total biovolume



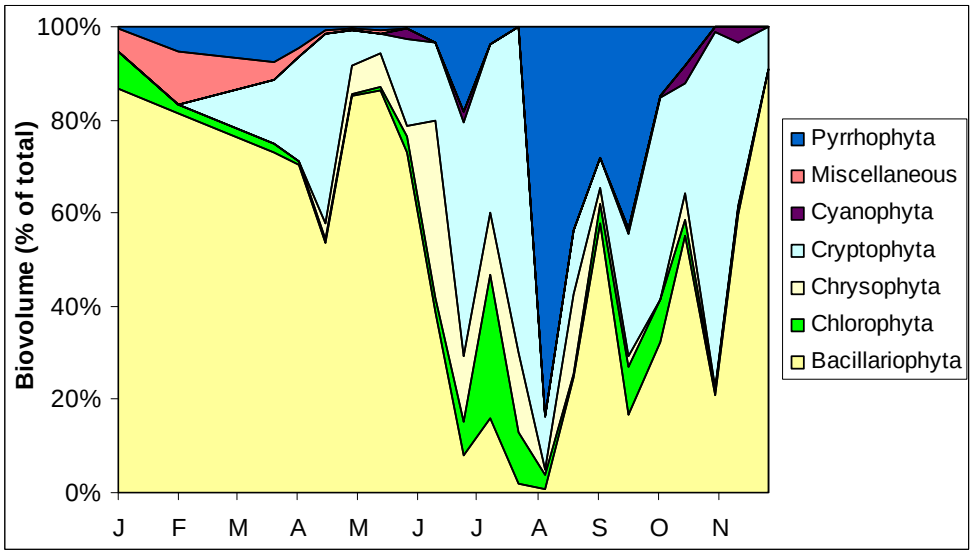


Figure 2. Temporal tends in phytoplankton in Onondaga Lake in 2008 divided in netplankton (GALD>50um) and nanoplankton (GALD<50um). Small phytoplankton dominate most of the year, but the May diatom bloom and the peaks in August – October consisted of larger taxa

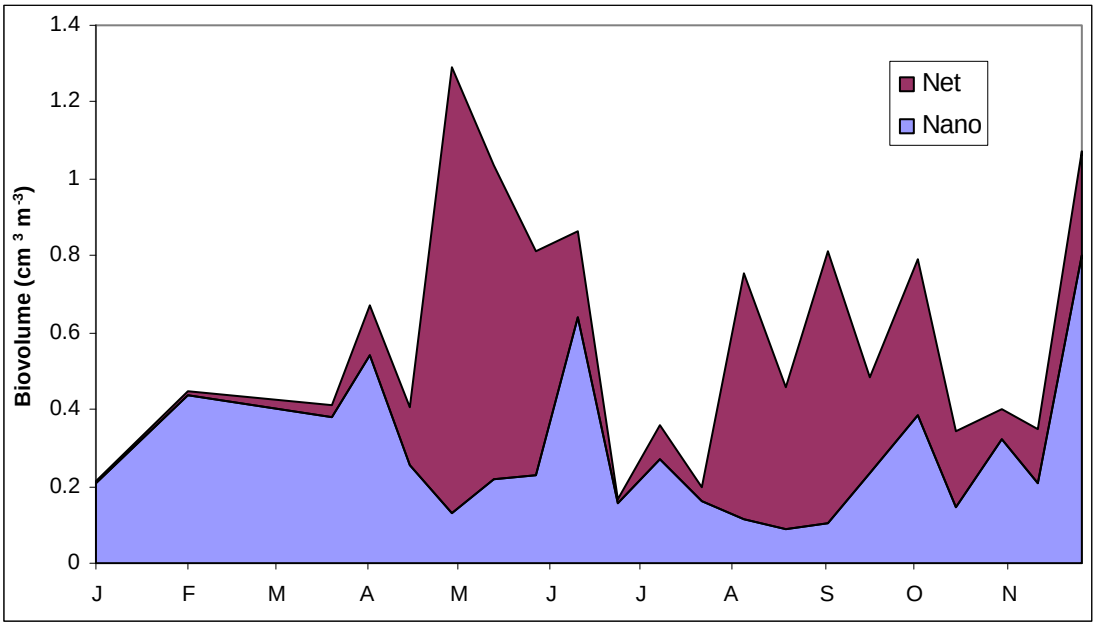


Figure 3. Temporal trend of biovolume of cyanobacteria genera in Onondaga Lake in 2008. Cyanobacteria biovolume was generally low throughout the year. The largest peaks occurred in June and November, dominated by *Aphanocapsa* and *Aphanizomenon*, respectively. The other group includes the genera *Merismopedia*, *Myxobaktron*, *Pseudanabaena* and *Synechococcus*.

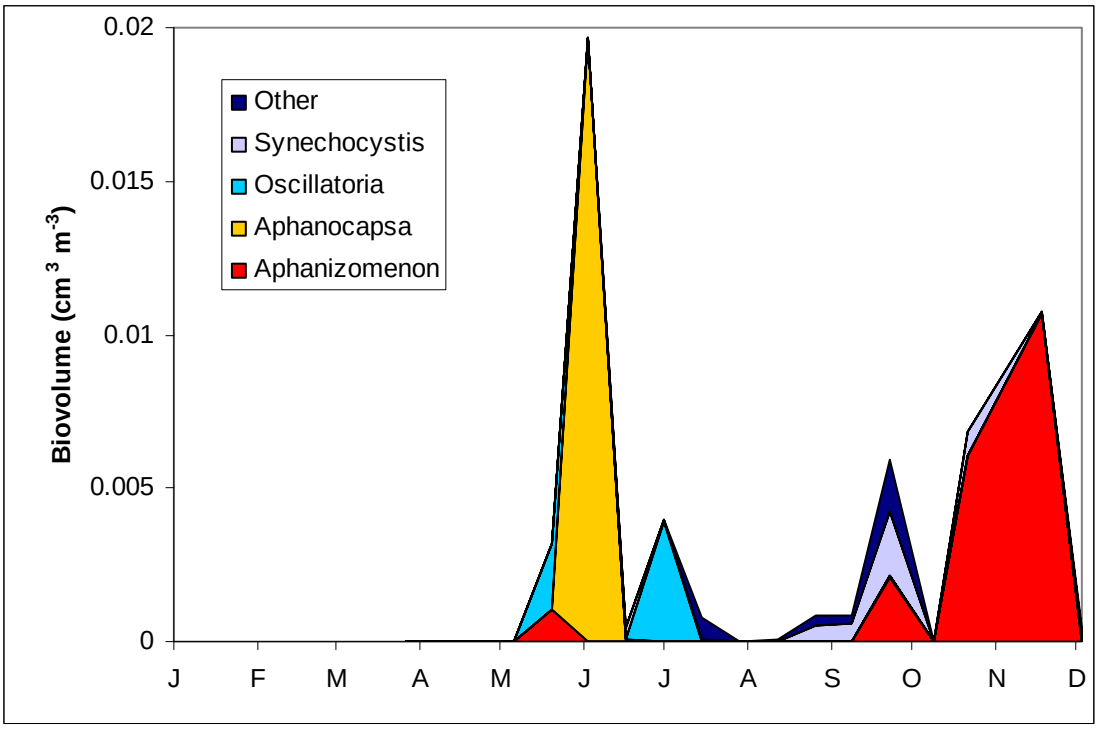


Figure 4. Total density (A) and biomass (B) of crustacean zooplankton in Onondaga Lake in 2008. Density and biomass increased in the late June and remained relatively high through September. The late June increase is due to cladocerans, first an increase in *Bosmina*, than an increase in *Daphnia mendotae*. The later summer peak also includes copepods, primarily in the genus *Diaptomus*.

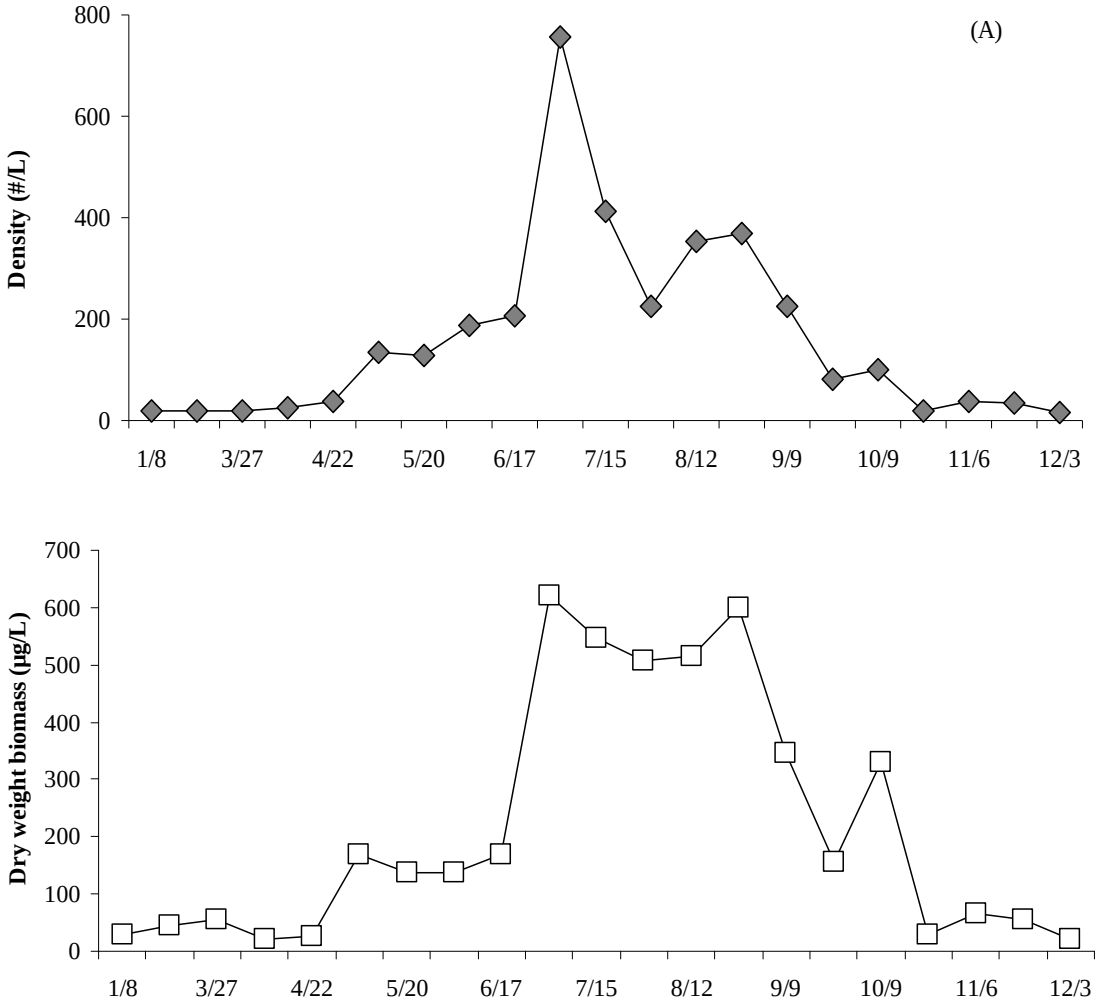


Figure 5. Composition of copepod and cladocerans as total biomass (A) and as proportion of biomass (B) in Onondaga Lake in 2008.

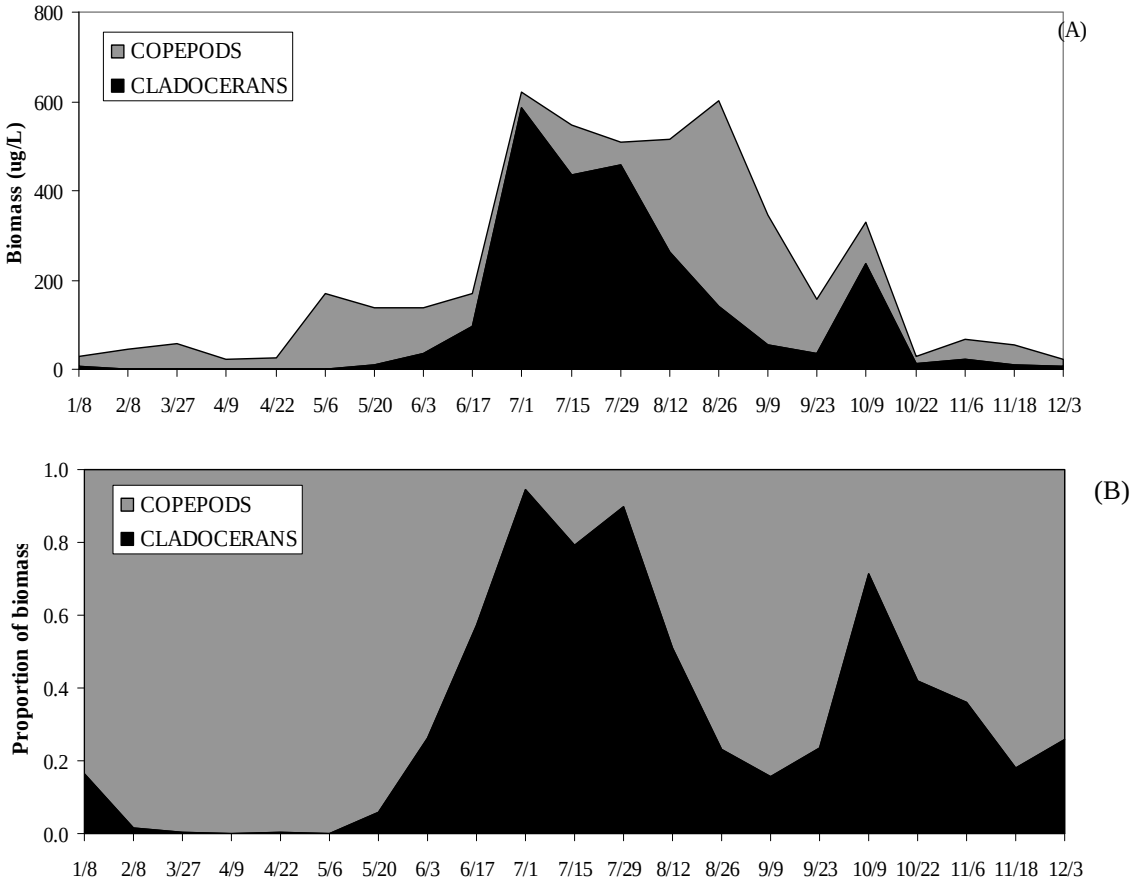


Figure 6. Composition of the cladoceran (A) and copepod (B) community in Onondaga Lake in 2008. A total of 15 species, as well as nauplii and copepodites, were identified in Onondaga Lake in 2008. The dominant cladocerans were *Bosmina longirostris* and *Daphnia mendotae*. Other cladocerans present included *Diaphanosoma birgei*, *Eubosmina coregoni*, *Chydorus sphaericus*, *Daphnia retrocurva*, *Daphnia ambigua*, *Daphnia sp.*, *Leptodora kindtii*, and *Cercopagis pengoi*. The dominant copepods during the year were *Diacyclops thomasi, Diaptomus siciloides,* and nauplii. *Diaptomus minutus*, *Diaptomus oregonensis, Acanthocyclops vernalis*, and *Mesocyclops edax* were also observed. We analyzed the zooplankton community by assessing the relative proportion in density and biomass by taxa and by species. Cladoceran proportional abundance was high from mid-June through mid-August and again in late September, with copepods dominating in January through early June, from late August until mid-September and in mid-October through December. The cladoceran zooplankton community was dominated by *Bosmina longirostris* (spring until 7/15, and October/November) and *Daphnia mendotae (*summer-early fall*). Cercopagis pengoi* was not a significant contributor to cladoceran biomass with a peak contribution of only 1.7% in late October. The prevalence of *Bosmina longirostris* was consistent with our observations from 1996 through 2007. The copepod community was largely dominated by *D. thomasi* until late July after which *Diaptomus siciloides* dominated the rest of the year. *Bosmina longirostris, Diacyclops. thomasi, Daphnia mendotae* and *Diaptomus siciloides* were the dominant species in the zooplankton community throughout 2008.

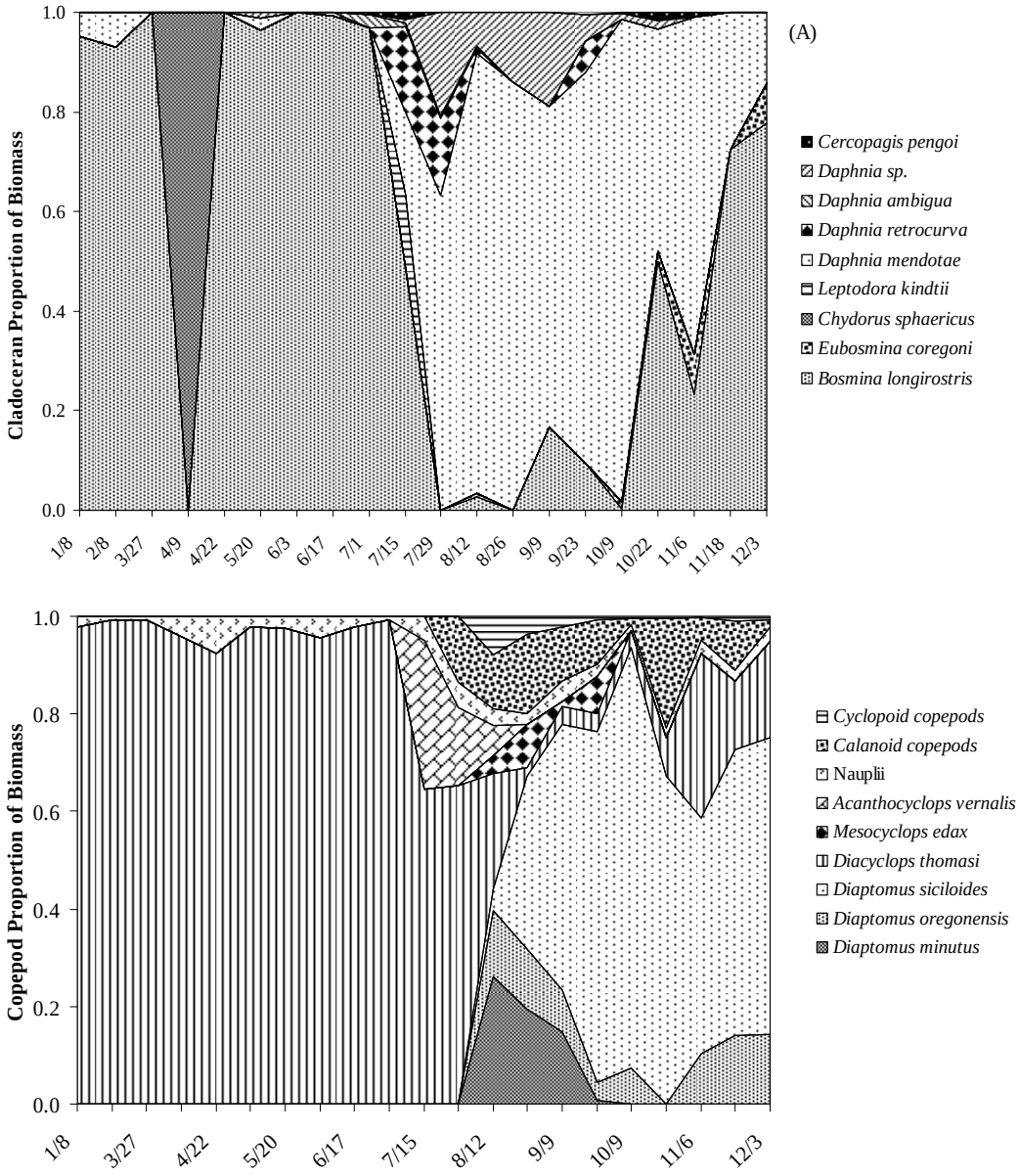

(A)
Cladoceran Proportion of Biomass
1.0
0.8
0.6
0.4
0.2
0.0
1/8
2/8
3/27
4/9
4/22
5/20
6/3
6/17
7/1
7/15
7/29
8/12
8/26
9/9
9/23
10/9
10/22
11/6
11/18
12/3
Cercopagis pengoi
Daphnia sp.
Daphnia ambigua
Daphnia retrocurva
Daphnia mendotae
Leptodora kindtii
Chydorus sphaericus
Eubosmina coregoni
Bosmina longirostris
Copepod Proportion of Biomass
1.0
0.8
0.6
0.4
0.2
0.0
1/8
3/27
4/22
5/20
6/17
7/15
8/12
9/9
10/9
11/6
12/3
Cyclopoid copepods
Calanoid copepods
Nauplii
Acanthocyclops vernalis
Mesocyclops edax
Diacyclops thomasi
Diaptomus siciloides
Diaptomus oregonensis
Diaptomus minutus

Figure 7. Biomass of predatory zooplankton in Onondaga Lake in 2008. The peak in *Leptodora* density in June is due to finding one large specimen in the subsample count and is therefore uncertain. Predatory cyclopoid copepod (*Acanthocyclops* and *Mesocyclops*) were more abundant than predatory cladocerans in 2008. The exotic zooplanktor *Cercopagis pengoi* was observed in 2008 as it has been in 2000 and 2002-2007. It was found in samples collected on 8 dates (7/1, 7/15, 9/9, 9/23, 10/9, 10/22, 11/6 and 11/18), in early summer and then from late summer to mid-fall. The biomass of the species was relatively small throughout most of the season (maximum value of 6.6 µg/L), only reaching a proportion of 0.7% of the total biomass in mid-October of 2008. Although *Cercopagis* can have an impact on smaller zooplankton such as *Bosmina* and nauplii (Benoit et al. 2002, Warner et al. 2006), this is unlikely in 2008.

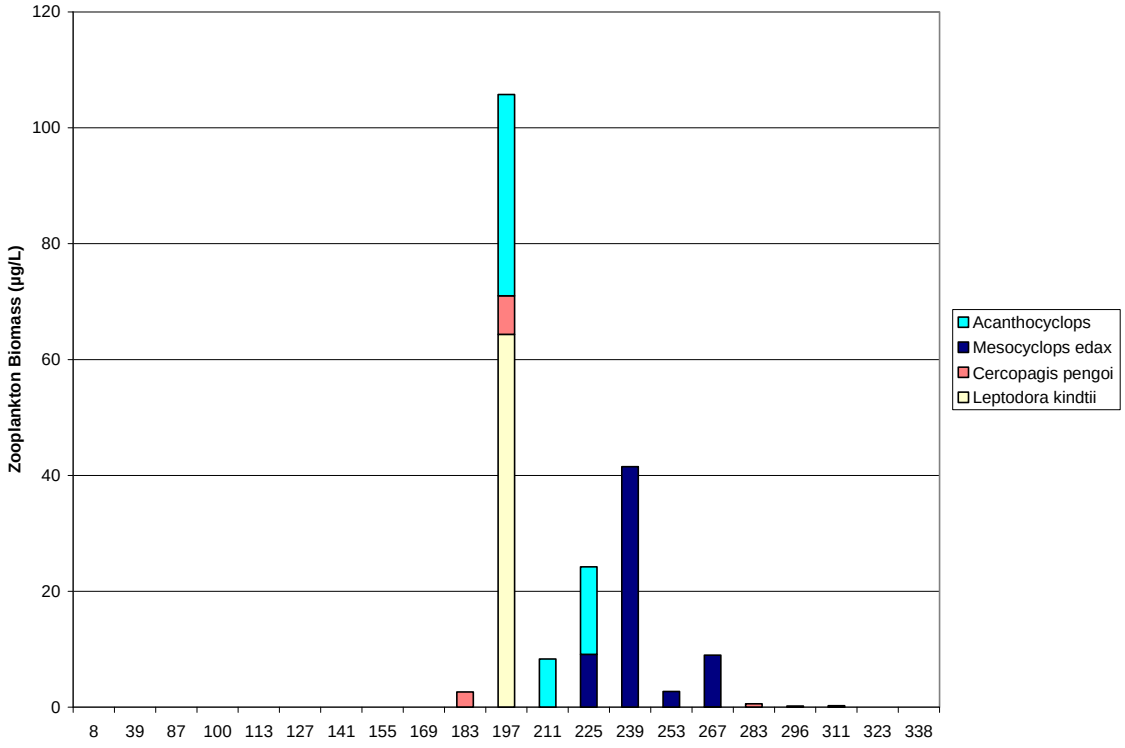


Figure 8. Average crustacean zooplankton lengths (mm) in Oneida and Onondaga Lakes. The largest mean size of zooplankton (0.73 mm) was observed in early October in Onondaga Lake, while average body lengths ranged from 0.28 to 0.62 mm for the remainder of 2008. We compared mean zooplankton size found at the Shackelton Point site of Oneida Lake with data from Onondaga Lake. Because mesh size differ between the two lakes (80-um mesh net in Onondaga, 153 um mesh net in Oneida), the average size of Onondaga Lake zooplankton is smaller than in Oneida simply because smaller nauplii are retained. More importantly is the seasonal patterns which were inverted between the two lakes. Average zooplankton size in Oneida were larger from mid-May to mid-July, and then again from late October to the end of the season. Average zooplankton size in Onondaga was larger from late July to mid-October. As average size is a good indicator of fish planktivory (Mills et al. 1987), this indicates different seasonal patterns in fish planktivory in the two lakes. In Oneida Lake, young-of-year fish dominate and their impact is larger in late summer and fall. In Onondaga Lake, adult alewives are more important, and their abundance appears to have declined after the spring of 2008.

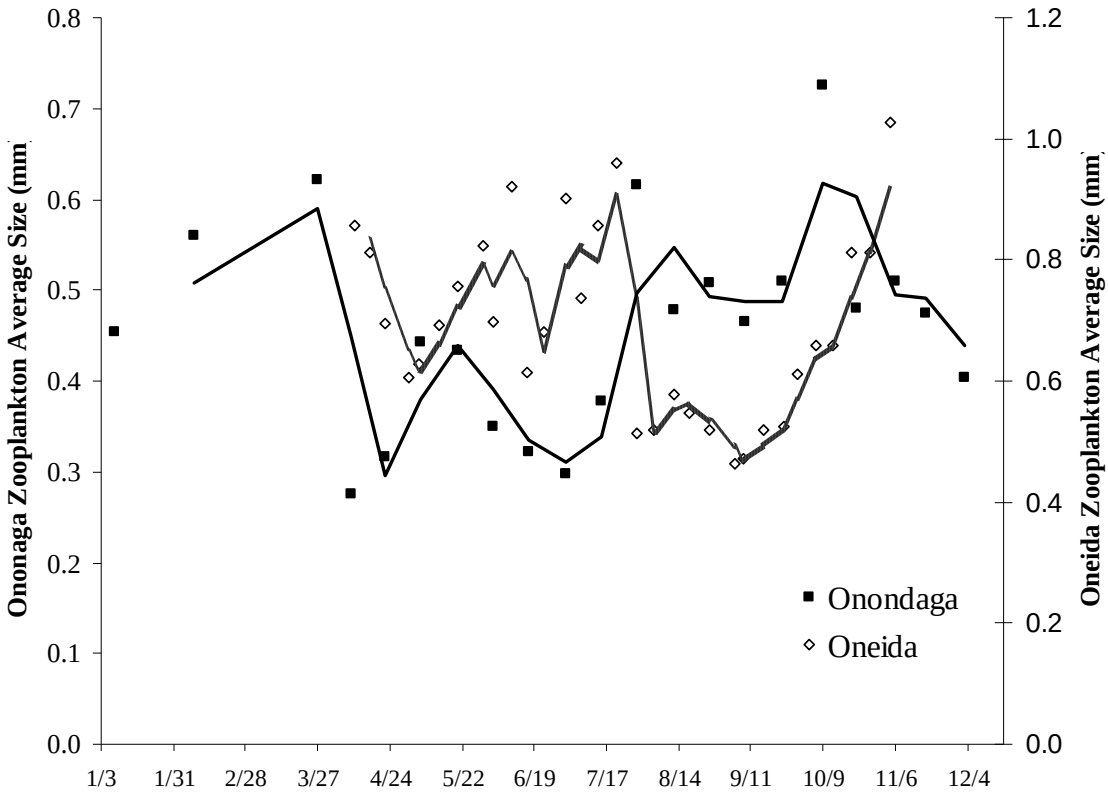
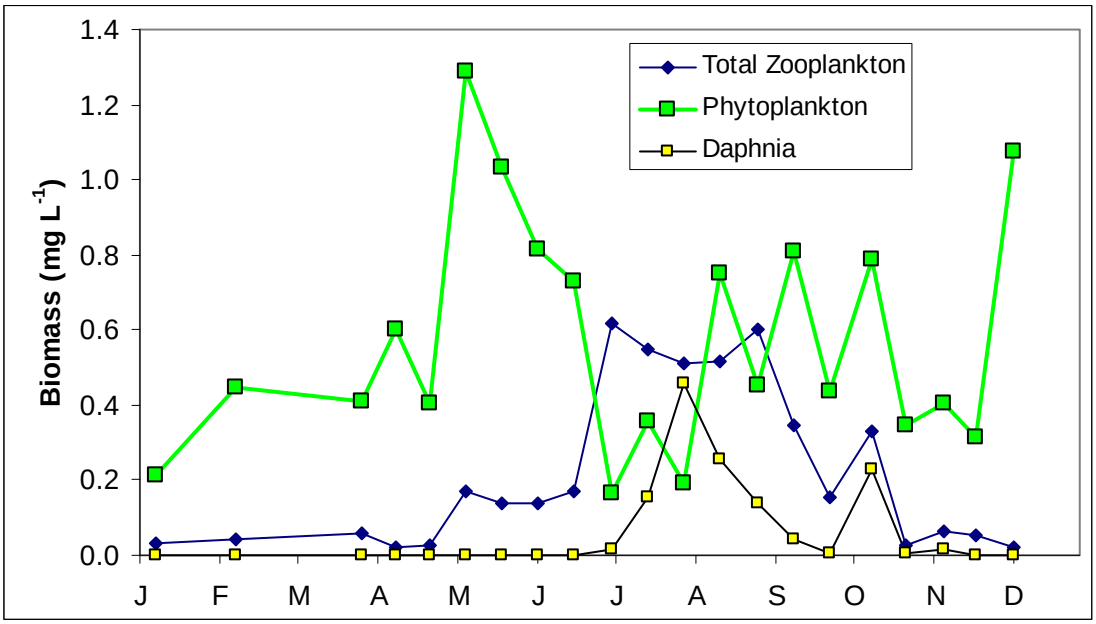


Figure 9. Temporal trend of zooplankton and phytoplankton biomass in Onondaga Lake in 2008. The decline in phytoplankton biomass in the middle of June follows a decline in diatoms a few weeks earlier. Zooplankton biomass increased at that time, but the increase was primarily in *Bosmina longirostris* at the time of the phytoplankton decline. *Bosmina* is not considered an efficient grazer capable of decreasing algal abundance in lakes. The decline could be due to silica depletion as the decline was mainly in diatoms, or to increased grazing by zebra mussels.



Time series 1998 – 2008 for Onondaga Lake

Figure 10. Temporal trend of average annual phytoplankton biovolume in Onondaga Lake from 1998-2008. Mean annual biovolume of the phytoplankton community decreased significantly during this period (linear regression, p=0.004).

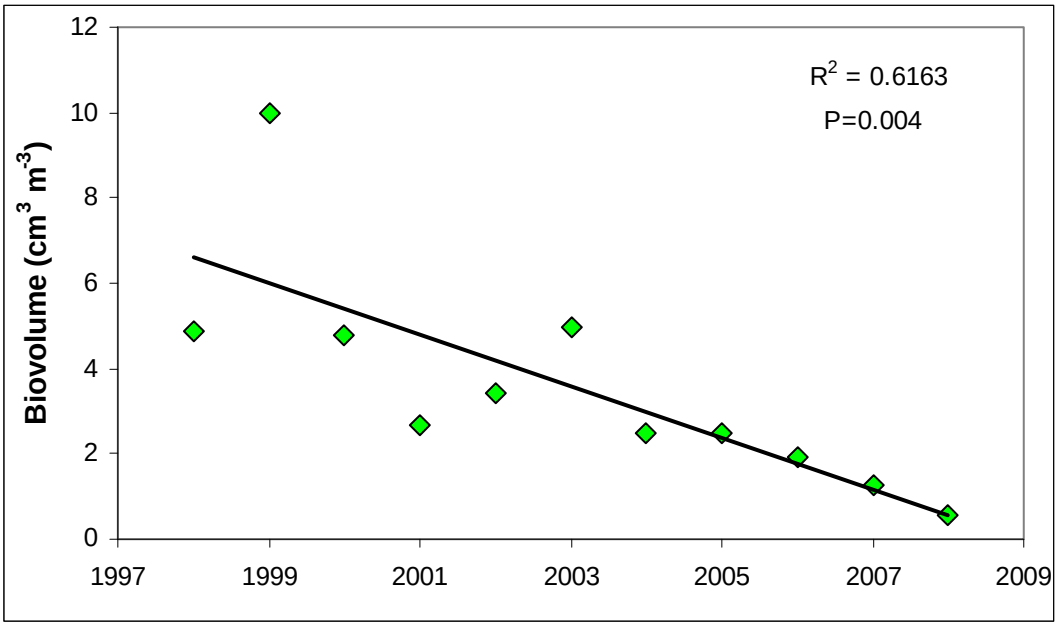


Figure 11. Temporal trend of average annual biovolume of phytoplankton divisions in Onondaga Lake from 1998-2008. The phytoplankton community of Onondaga Lake consists of Bacillariophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Pyrrhophyta, Euglenophyta, and "miscellaneous microflagellates". Euglenophyta and Xanthophyta were present briefly in June 2002 but Xanthophyta has not been seen since 2002, and Euglenophyta was absent in 2003 and 2004 but present briefly in the spring of 2005, 2006 and 2007. Cyanobacteria (Cyanophyta) and dinoflagellates (Pyrrhophyta) decreased significantly during this period (linear regressions, both $p<0.003$). No division had an increasing trend in total biovolume. Figure 11B has the time trend for cyanobacteria by major genera.

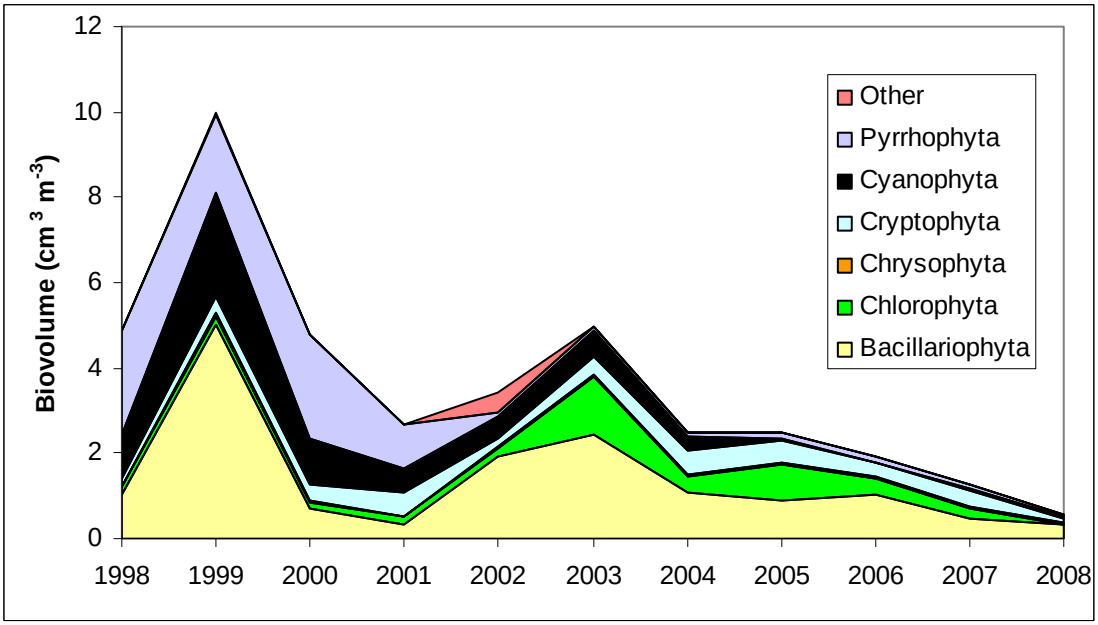


Figure 11B. Time trend of mean annual biovolume of cyanobacteria genera in Onondaga Lake from 1998 to 2008.

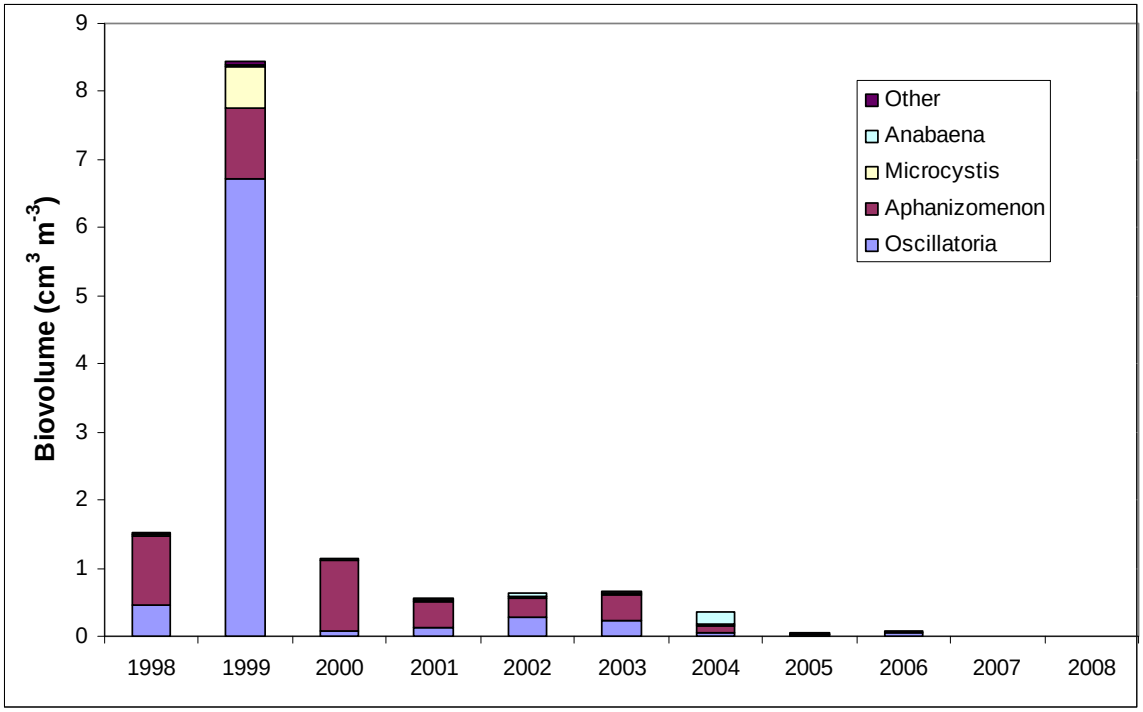


Figure 12. Temporal trend of average annual proportional biovolume of phytoplankton divisions in Onondaga Lake from 1998-2008. Chrysophytes and cryptophytes increased in proportional biovolume over this period, while cyanobacteria (Cyanophyta) and dinoflagellates (Pyrrhophyta) decreased (linear regressions, all $p<0.005$). Proportional biovolume of diatoms (Bacillariophyta) and green algae (Chlorophyta) did not display significant trends.

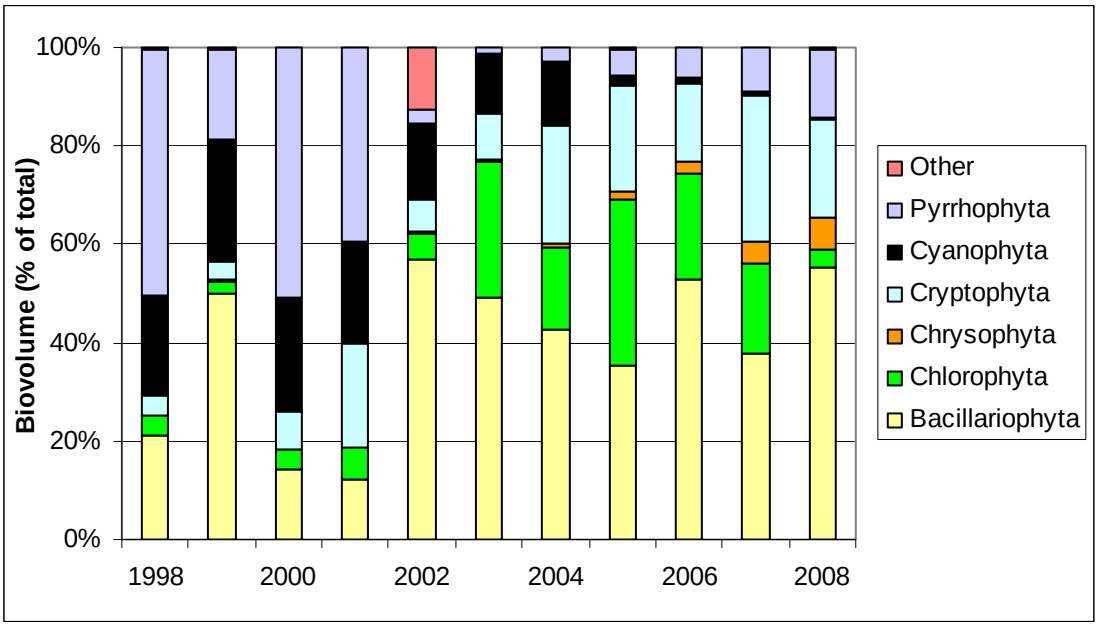
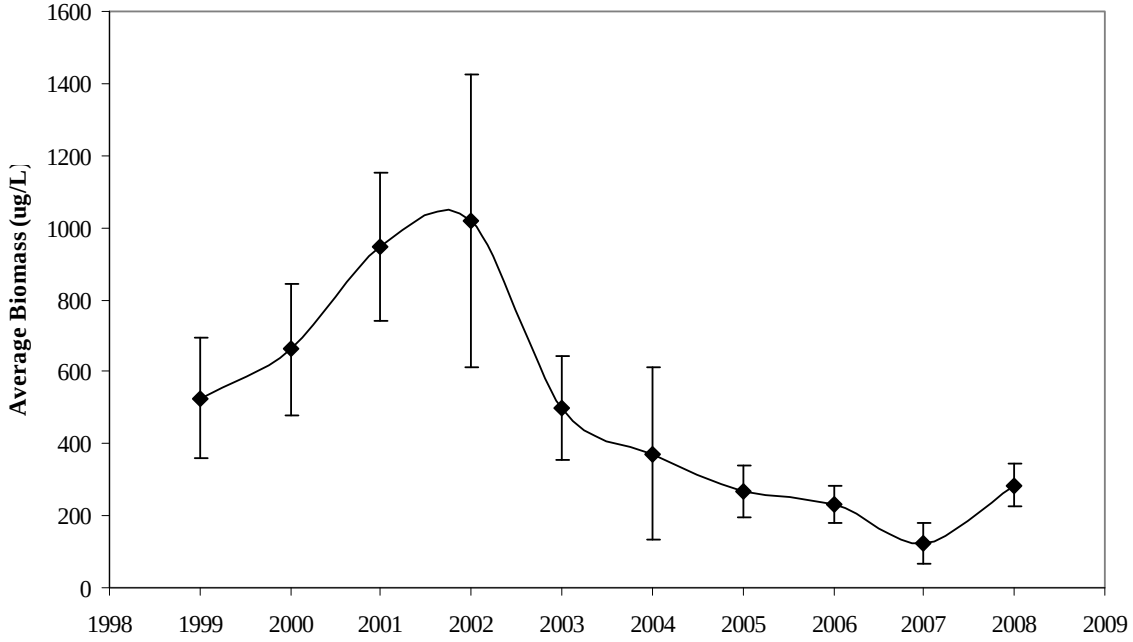


Figure 13. Average biomass of zooplankton (all taxa combined) and major taxa in Onondaga Lake from April through October in 1999-2008. Error bars in Figure A are standard error. Note that the trend of decreasing zooplankton biomass since 2002 has ended as the 2008 biomass is higher than the biomass in 2007. This is due to an increase in the biomass of the larger zooplankton *Daphnia mendotae* and diaptomid copepods.

A. Average Zooplankton Biomass of All Taxa



B. Average Zooplankton Biomass of Major Taxa

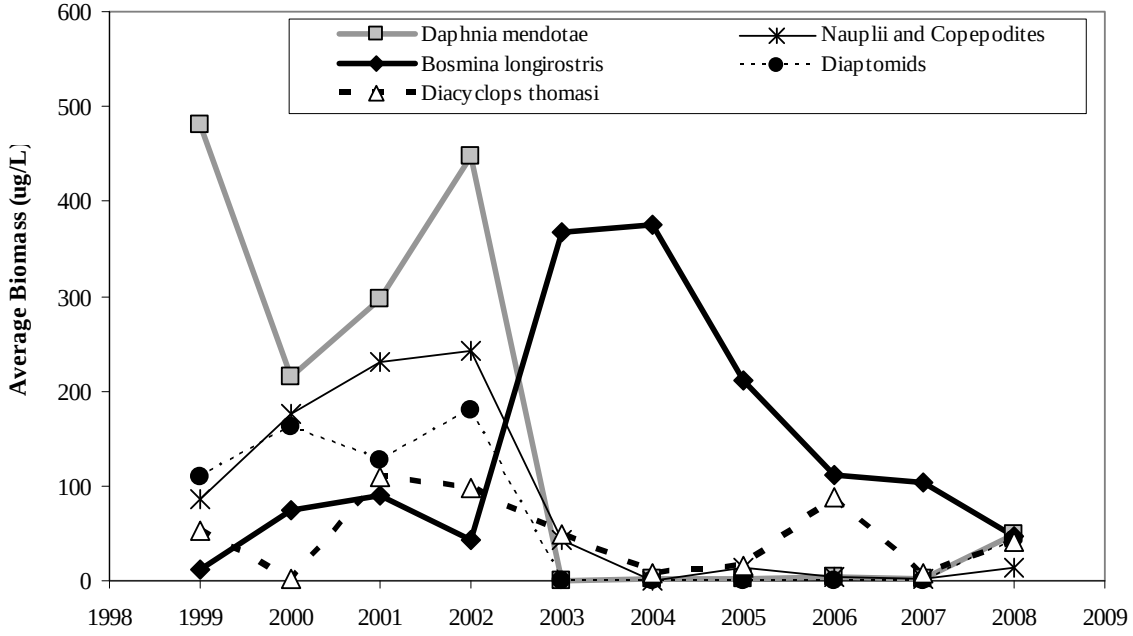


Fig 14. Time trend of different Daphnia species in Onondaga Lake. Daphnia species composition is a sensitive indicator of fish zooplanktivory rate. Data are average of samples collected during each year extracted from the Onondaga Bio Database using the upper mixed layer sample from the South Deep station only. In 2006 and 2008, *D. mendotae* was a significant contributor to cladoceran biomass; however, in 2007 it was a minor contributor to cladoceran biomass. *D. mendotae* was only detected in mid to late September 2007, but was observed from mid-July to early December in 2008. *D. retrocurva* was a significant contributor to cladoceran biomass from mid-July to late October in 2006 and 2007, but to a lesser extent from mid-July to late July in 2008.

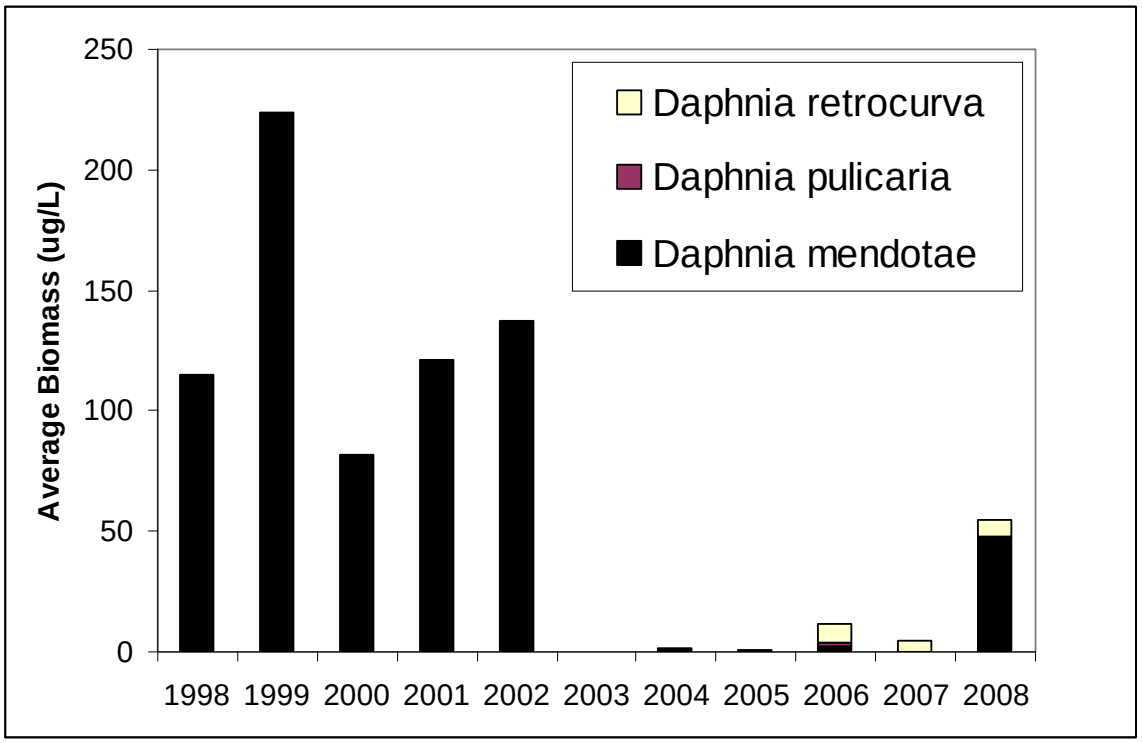


Figure 15. Time trends in average size of all crustaceans from 1999 to 2008 in Onondaga Lake. Data is extracted from the Onondaga Lake Bio Database. Error bars are one SE. Note the increasing trend in average size since 2003 and the return to the average size observed in 2002 in the year 2008. These lengths include nauplii.

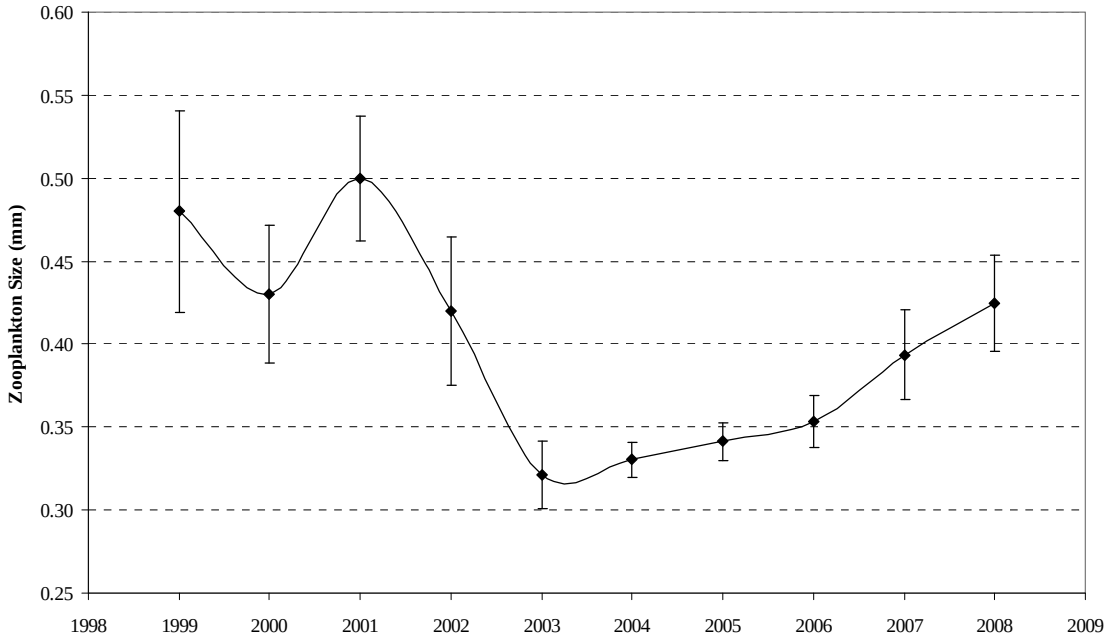
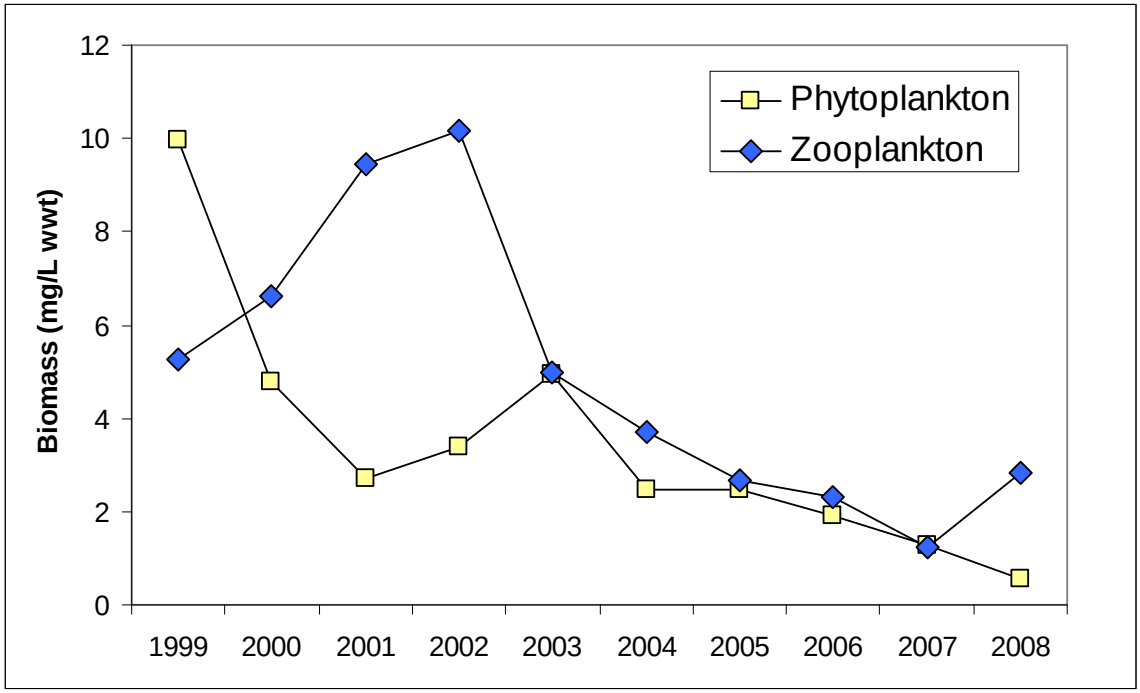


Figure 16 Time trend of zooplankton and phytoplankton biomass in Onondaga Lake 1999 to 2008. Zooplankton biomass was converted to wet weight assuming a dry to weight ratio of 10%. For zooplankton biomass in dry weight, see Figure 13



Significant Findings

The average and peak algal biomass in Onondaga Lake are declining. In 2008, the average algal biovolume is at values lower than expected from meso-eutrophic systems (3-5 mg/L, Wetzel 2001). Peak algal biomass did not exceed 1.3 mg/L. This is a dramatic change in the lake, as average biomass (0.56 mg/L) is less than half the average of 2007 (1.15 mg/L), the previous low year. The time trend shows a continuous decline in algal biomass since 2003 that is highly significant. The decline is in line with the declining phosphorus levels in the lake shown elsewhere, and also in line with increasing grazing by zebra mussels since 2002.

Bluegreens (cyanobacteria) were probably at lower levels in 2008 than anytime since the 1950s when many lakes suffered from eutrophication due to increases in phosphorus loading. The duration of the cyanobacteria blooms in Onondaga Lake declined from 1996-2000, increased in 2002-2003, and declined again through 2008. The main species in the past was *Aphanizomenon flos-aquae*. This species historically occurred July through October (1996) but blooms decreased in duration to July – August in 1997-2000. In 2008, *Aphanizomenon* (*A. gracile* and *A. flos-aquae*) was only found in significant numbers in October- November. Peak cyanobacteria abundance was only 0.02 mg/L in 2008.

Average total zooplankton biomass (dry wt) in nearby Oneida Lake (Cornell Biological Field Station unpublished data) was 162 μg/L for a single deep site (April - November 2008), while it averaged 274 μg/L in Onondaga Lake for the same time period. In 2008, as had been the case from 1997-2003, average total zooplankton biomass was greater in Onondaga Lake than Oneida Lake. During 1996, and 2004-2007 small zooplankton dominated Onondaga Lake while larger species, especially *Daphnia pulicaria* and *Daphnia mendotae*, led to high average total zooplankton biomass in Oneida Lake. In 2008, Onondaga Lake zooplankton biomass peaked at a lower value (619.9 μg/L) than Oneida Lake biomass (768.2 μg/L), but Onondaga Lake biomass had a larger proportion of values greater than 250 μg/L. Temporal patterns in the average zooplankton size between the two lakes were similar in April and then inverted for the remainder of the year (Figure 8). The average size of the total zooplankton community in Onondaga Lake throughout the year in 2008 (0.42 mm) is larger than values observed in 2003-2007 (0.29 mm) and the size and species composition is returning to the one present in 2000-2002. This change in size structure is due to the dominance of the small cladoceran *B. longirostris*, and the decline in larger daphnids and calanoid copepods in 2003 to 2007 compared to 1999-2002 and 2008 (Figure 13B).

The temporal changes in the zooplankton community is linked to changes in predation by the dominant fish planktivore in the lake, the alewife (*Alosa pseudoharengus*) (Wang et al. submitted). Catches and acoustic densities were lower in the spring of 2008 than in the previous 3 years (2005-2007). Catches in the spring of 2009 were even lower. Acoustic analysis for the spring of 2009 data is not yet completed. The data from Onondaga Lake support the strong structuring effect fish planktivory, especially alewife, on the species composition and size structure of zooplankton (Brooks and Dodson 1965,

Post et al. 2008). *Cercopagis pengoi* again appeared in the lake in the 2008 season. However, the density of *Cercopagis* was too low to suggest a decreased dominance by *Bosmina longirostris* as result of *Cercopagis* predation (see Warner et al. 2006).

Populations of *Daphnia* have a capability to exert strong influence on the phytoplankton community (Sommer et al. 1986, Mills and Forney 1988). It is therefore reasonable to assume that the decline in phytoplankton biomass in the summer of 2008 was due to grazing by *Daphnia mendotae*. Although this is likely part of the explanation for low summer phytoplankton abundance in the lake, *D. mendotae* increased after the early summer phytoplankton bloom had declined. The main zooplankton species that increased at the time of the decline was *Bosmina longirostris*, a species that is not know for strong grazing effects on phytoplankton. Other explanations for the decline in the early summer bloom include silica depletion and zebra mussel grazing. Mussels are known to maintain phytoplankton biomass at a lower level than expected from the decreased nutrient loading alone (Idrisi et al. 2001, Zhu et al. 2006).

The late peak in *Daphnia* in Onondaga Lake in 2008 suggest continued planktivory by alewife into the early summer of 2008 followed by a decline in alewife abundance at that time. This late peak (7/29) is unusual for temperate lakes. A typical seasonal succession includes a midsummer decline in *Daphnia* associated with the increase in predation from young-of-year fish, possibly from invertebrates, and depletion of the spring bloom by *Daphnia* in the spring bloom (Sommers et al. 1986, DeStasio et al 1995). This seasonal pattern is typically found in the nearby Oneida Lake when young-of-year abundance of yellow perch and gizzard shad is high (Mills and Forney 1988, Roseman et al. 1996).

Further analysis of temporal trends and seasonal successions need to include water chemistry and information on fish and zebra mussels in the lake.

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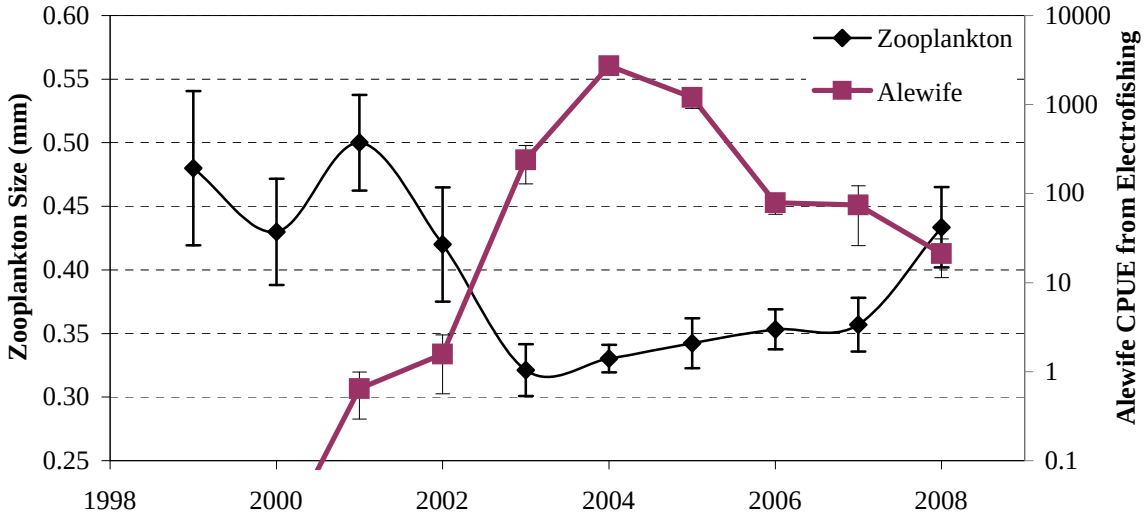
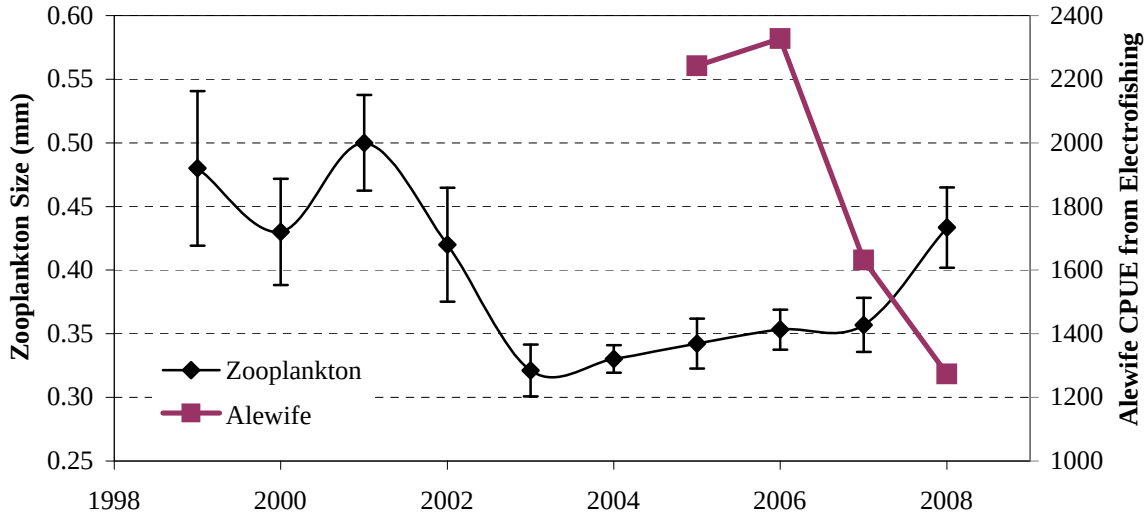


Average size of zooplankton (all taxa combined) in Onondaga Lake from April until October in 1999 to 2008 compared to annual alewife catch rates from electrofishing from 2000-2008.
Note: error bars are standard error.



Average size of zooplankton (all taxa combined) in Onondaga Lake from April until October in 1999 to 2008 compared to annual alewife abundance estimates from hydracoustic surveys conducted in June from 2005-2008.
Note: error bars are standard error. Hydroacoustics report indicates that 2008 alewife abundance is likely overestimated due to interference from bubbles.

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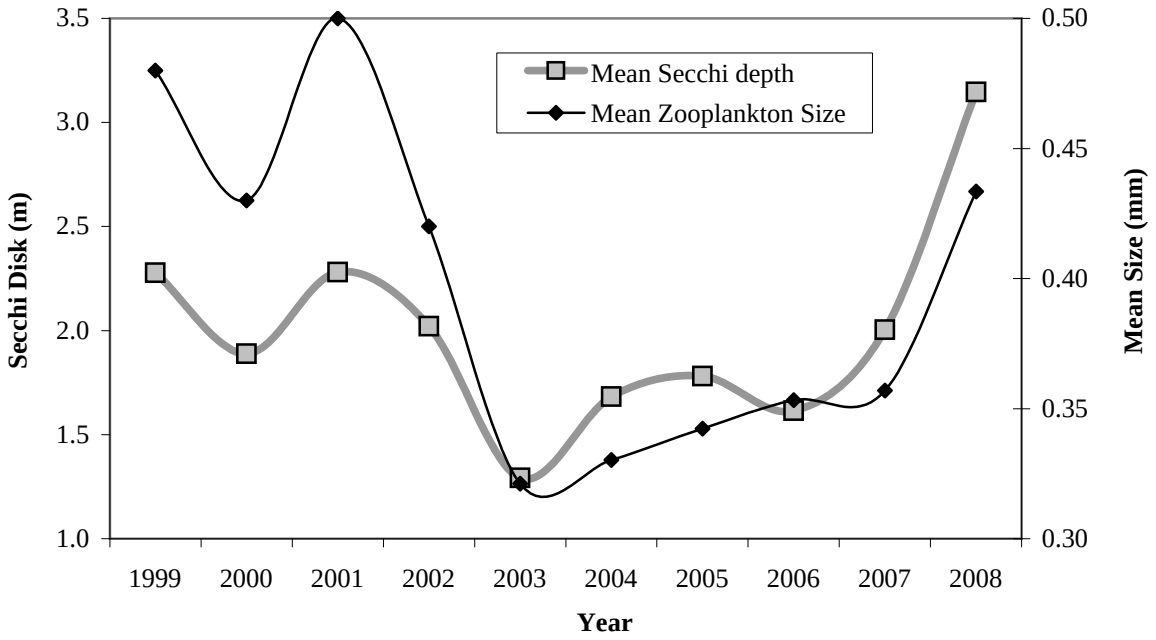
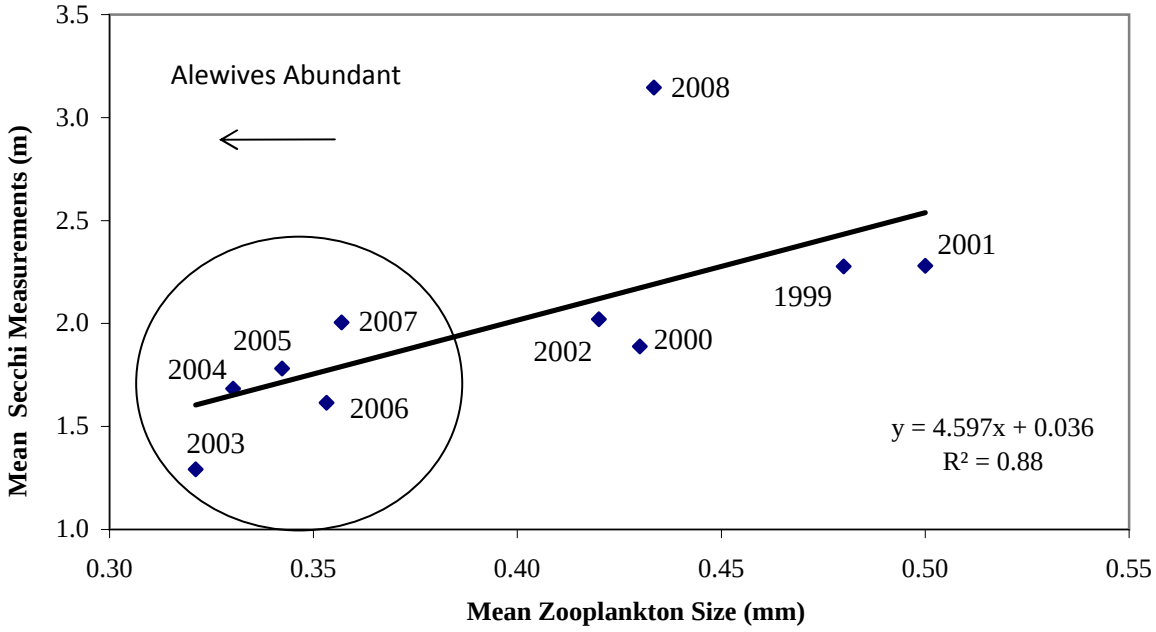
A. Secchi Depth and Mean Zooplankton Size



B. Secchi vs. Mean Zooplankton Size



A) Mean Secchi disk measurements and mean zooplankton size from April through October in Onondaga Lake, 1999 to 2008. B) Regression of mean Secchi disk measurements and mean zooplankton size from April through October in Onondaga Lake 1999 to 2008, labels are the year.

Library Reference 8.4

Macroalgae

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Library Reference 8.4.1

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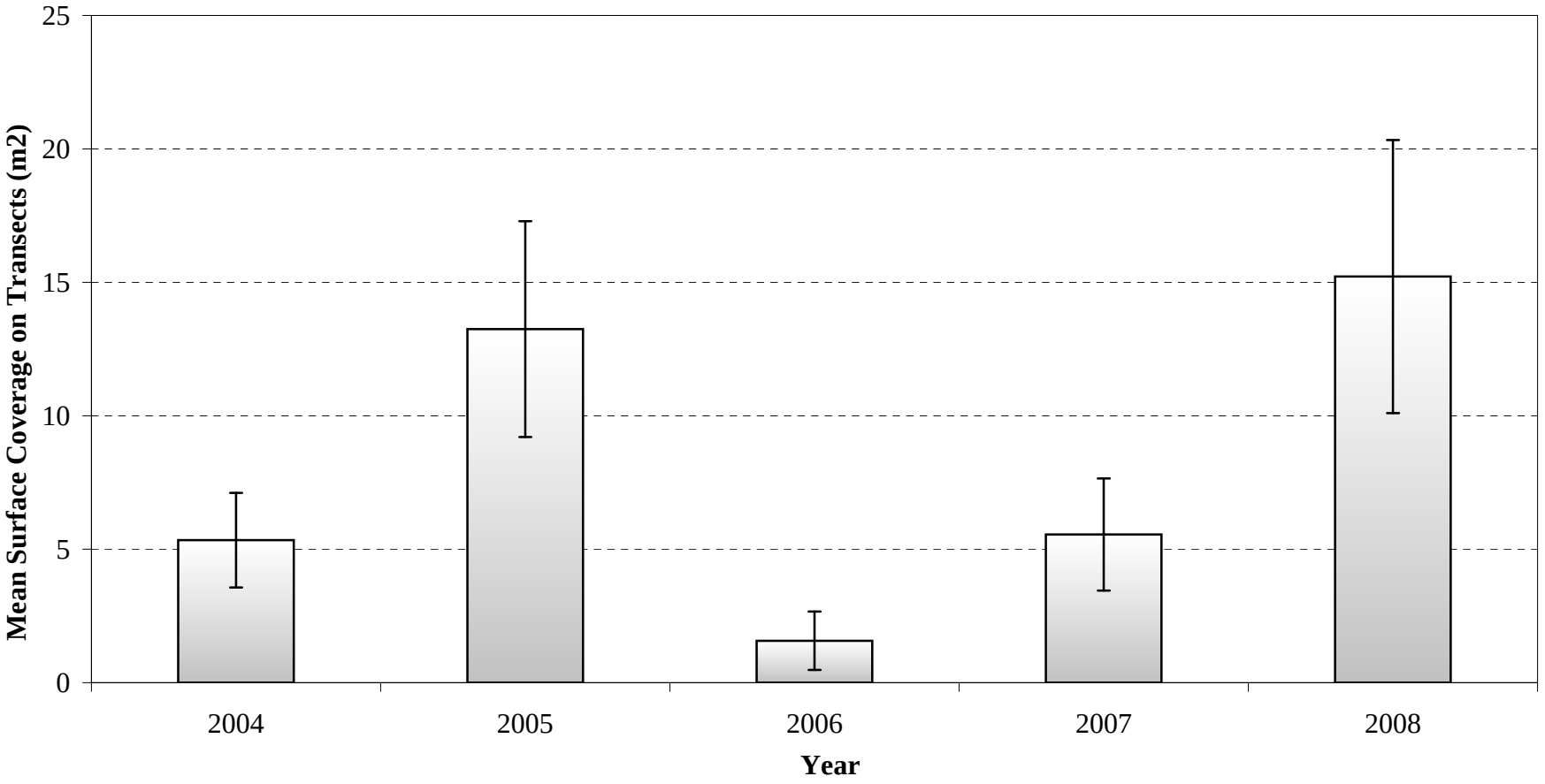

Mean macroalgae abundance, with standard error, at nine nearshore sample locations in Onondaga Lake from 2004 to 2008.

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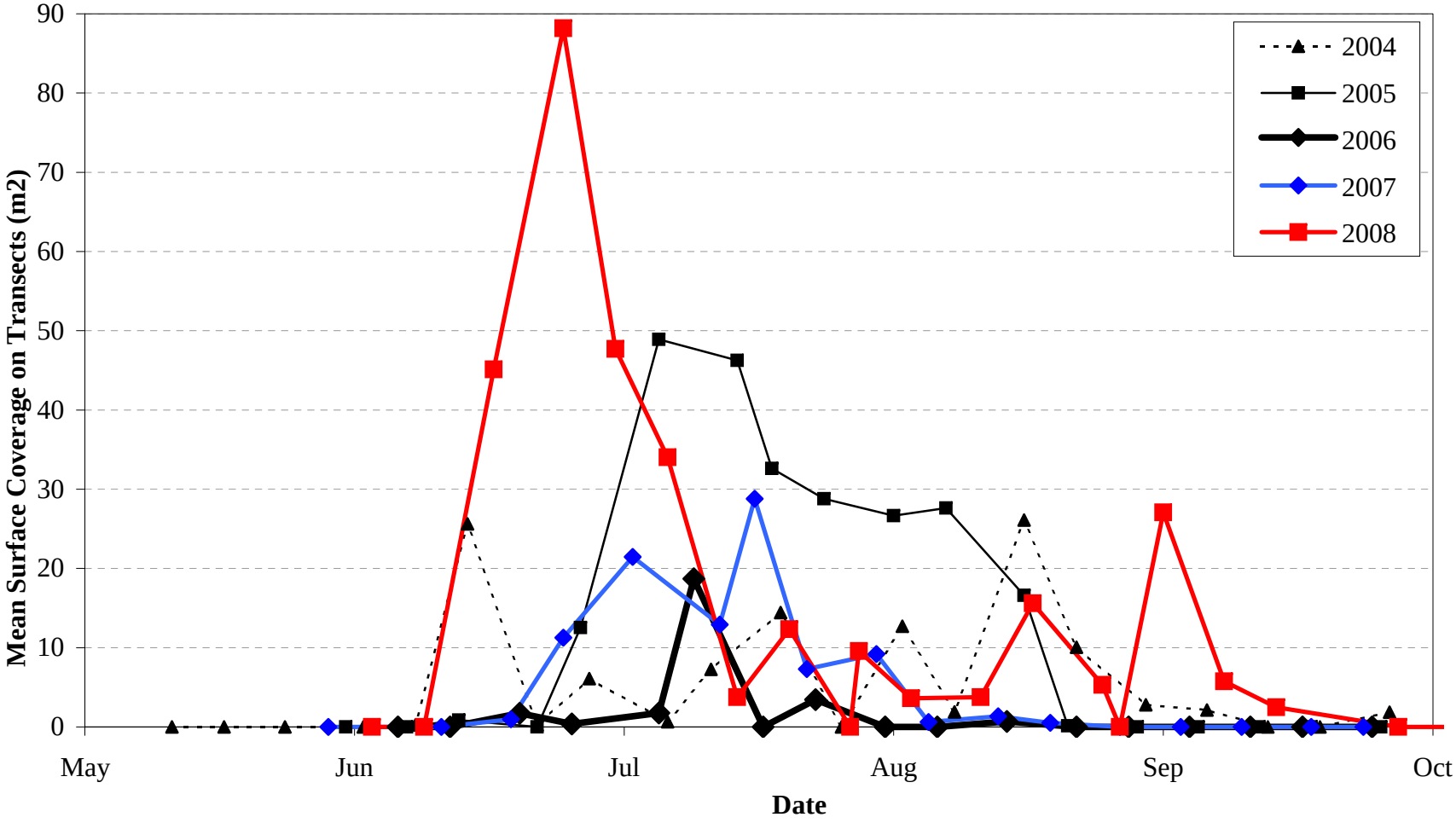
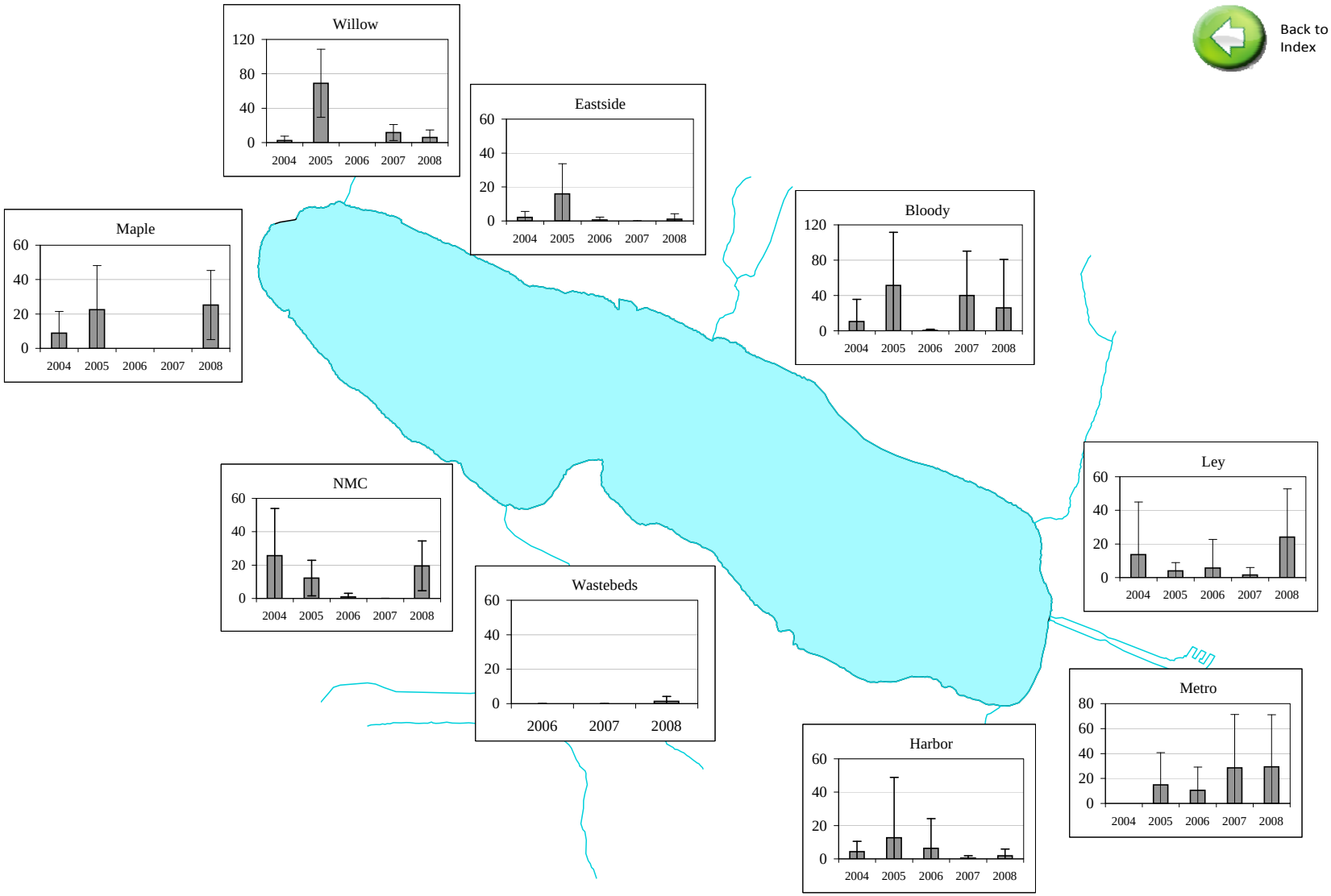


Temporal pattern of mean macroalgae abundance from nine nearshore sample locations in Onondaga Lake from 2004 to 2008 .



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Spatial pattern (mean square meters with standard deviation, July and August) of macroalgae at nine nearshore sampling locations in Onondaga Lake from 2004 to 2008 note that the wastebed site was added in 2006 so no data are available for 2004 or 2005.

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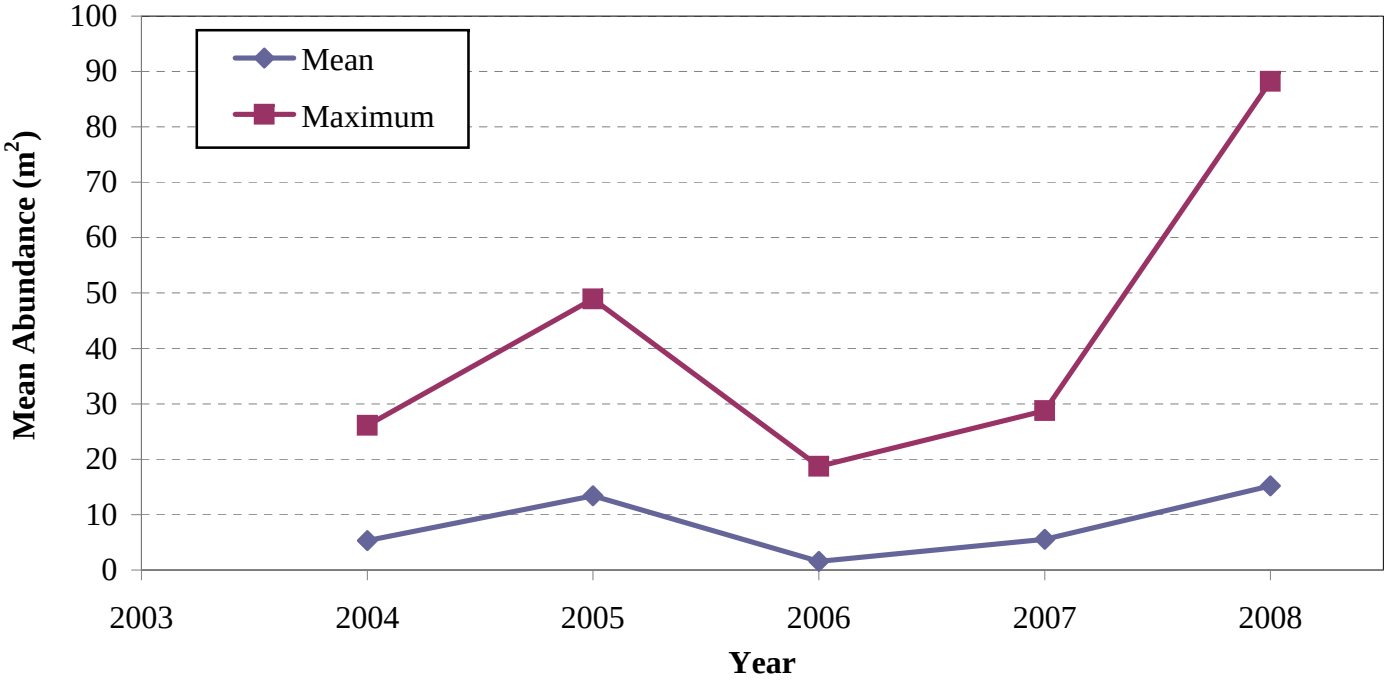

Macroalgae is monitored along transects at nine nearshore stations bi-weekly from May through September. This chart shows the annual mean and maximum abundance of macroalgae (based on days sampled) in Onondaga Lake since sampling began in 2004.

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Macrophytes

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EcoLogic Memorandum

Back to Report

TO: Dave Snyder
FROM: Mark Arrigo
RE: Onondaga Lake 2008 Macrophyte Monitoring Results
DATE: 11/4/08

This memorandum is a summary of the 2008 Onondaga Lake macrophyte monitoring results. The annual macrophyte monitoring program consists of a combination of aerial photographs and ground truthing. Aerial photographs were taken in August 2008 by Airphotographics Inc. Ten ground truthing sites were marked with large buoys, intending to be visible in the photographs, prior to the flight. The photographs were transferred to digital format, georeferenced and copied to a DVD that was sent to EcoLogic. The digitized photographs were imported into Arcview and the margins of beds delineated.

Within one week of shooting the aerial photographs, a ground truth sampling effort occurred. Onondaga County Department of Water Environment Protection (OCDWEP) staff visited each of the ten ground truthing sites (Map 1) and collected data on species composition and relative abundance. These data were used to verify that objects delineated in the air photographs were macrophyte beds.

In 2008, dense beds were evident along the northwest and entire east shores (Maps 2 – 6). Macrophyte growth appeared to be poorest along the south and southwest shores. There has been an apparent decline in the amount of macrophytes in the south end of the lake. In the past dense beds occurred off the mouth of Harbor Brook and between Harbor Brook and Metro. These beds appear much less dense than in the past. A review of past years delineations indicates that this area has had variable growth since 2000 with a gradual decline in density.

A total of 314 acres of macrophytes were delineated in the 2008 air photographs (Figure 1; Maps 2 through 6). The overall coverage of macrophytes in 2008 was the second highest delineated value since air photographs began in 2000. The greatest density of macrophytes was delineated in 2005 (378 acres), the least in 2000 (85 acres). Improved water clarity compared to past years may have played some role in the increased amount of macrophytes in the lake in 2008.

Increased density was particularly apparent along the southeast shore compared to recent years. This section of the lake has had highly variable growth since delineations first began in 2000.

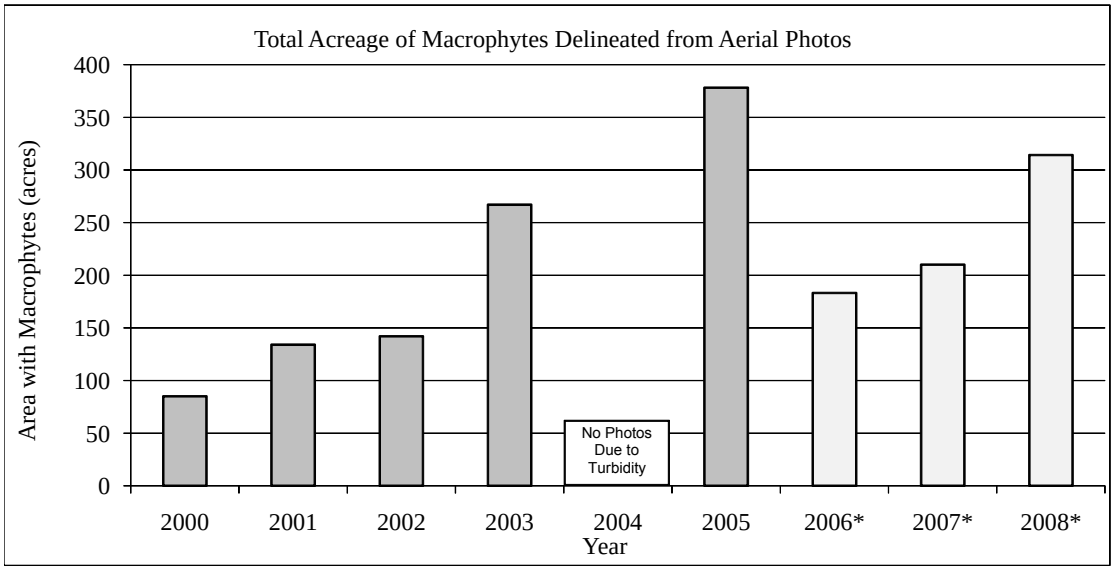


FIGURE 1. Total acreage of macrophytes in Onondaga Lake from 2000 to 2008 based on areas delineated as macrophytes from digitized aerial photographs. * Note 2006 - 2008 photographs were taken in August, all others were taken in June or early July; this adds an unknown level of variability to the analysis so those three years are depicted seperatly.

The ground truthing effort identified ten taxa at ten sites (Table 1). Eurasian watermilfoil, coontail and elodea were the most widely distributed species being found at almost all sites. The only other taxon found in 50% or more of the sites was southern naiad. Coontail had the highest overall relative abundance (25%), five other taxa were present in nearly equivalent amounts: Eurasian watermilfoil, elodea, southern naiad, sago pondweed, and water stargrass (range 10% - 19%).

Table 1. 2008 ground truthing results.

Species	**Percent of Sites**	**Relative Abundance When Present**	**Overall Relative Abundance**
Eurasian water milfoil	100%	14%	15%
Coontail	90%	26%	25%
Elodea	90%	14%	18%
Southern naiad	50%	35%	19%
Curly leaf pondweed	40%	1%	1%
Sago pondweed	30%	40%	13%
Water star grass	30%	33%	10%
Eel grass	20%	1%	0.2%
Leafy pondweed	20%	1%	0.2%
Muskgrass	10%	1%	0.1%

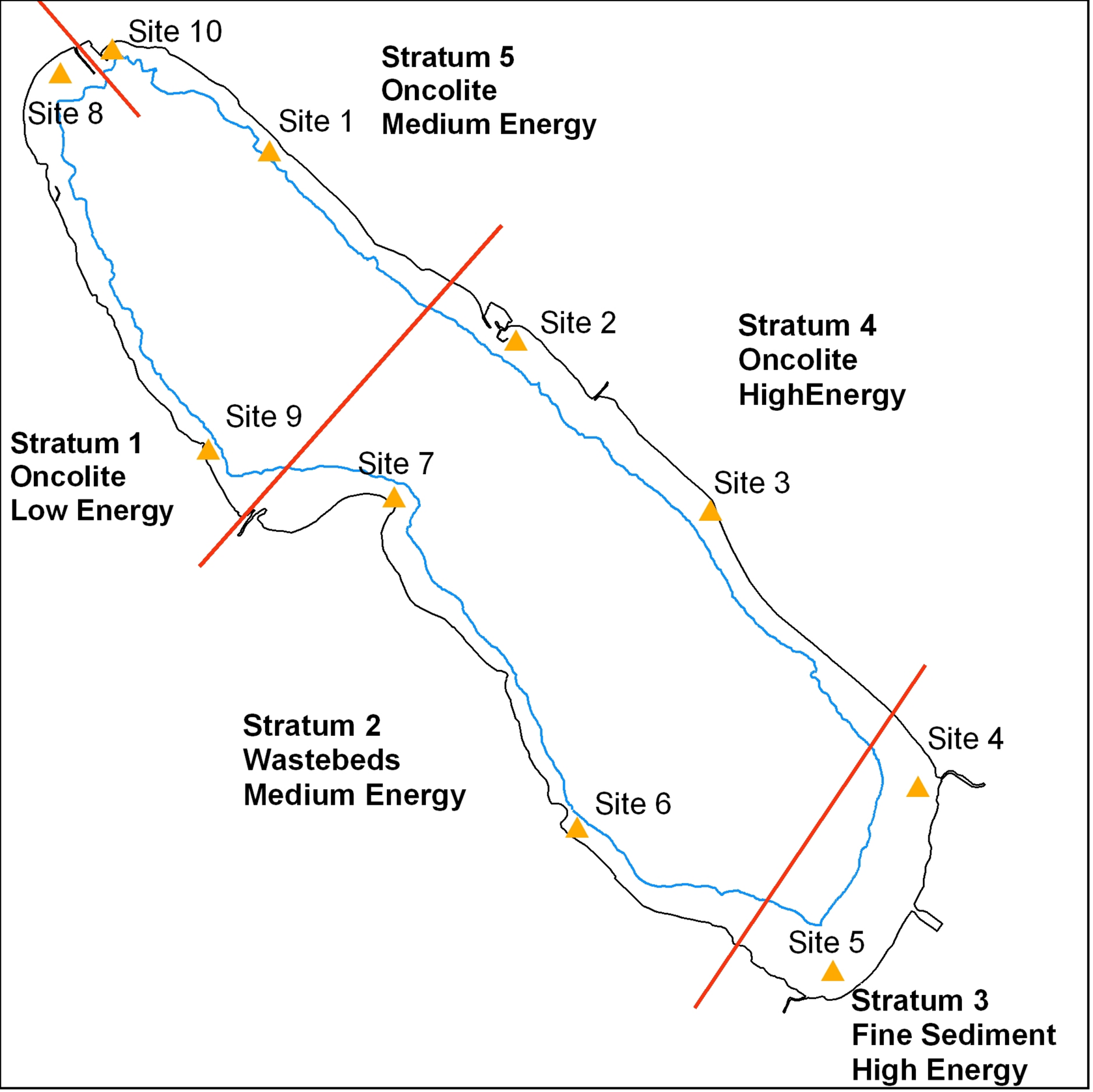
A small amount of muskgrass (*Chara* sp.) was identified at Site 9, near Ninemile Creek. This species had been documented in the lake historically but this is the first record of this taxa in the AMP program. This brings the total number of species identified in the AMP program since 2000 to 19.

Results of the ground truthing were compared to the digitized macrophytes (Maps 7 through 16). There was good agreement between what was identified as macrophytes on the photographs and what was observed on the ground. It appears that some areas of metaphyton growing on bottom adjacent to macrophytes beds can be difficult to distinguish from the beds resulting in those areas being delineated with the macrophytes. It does not appear that these types of areas are a significant part of the delineations.

Overall, the ground truthing seems to verify that the photo delineations are a reasonable interpretation of lake macrophyte distribution.

Map 1

Location of Ground Truth Buoys
Onondaga Lake, August 2008



N

Legend

- Strata borders
- 6-meter depth
- Buoys

Source: Shoreline and buoys digitized from aerial photographs provided by Airphotographics.

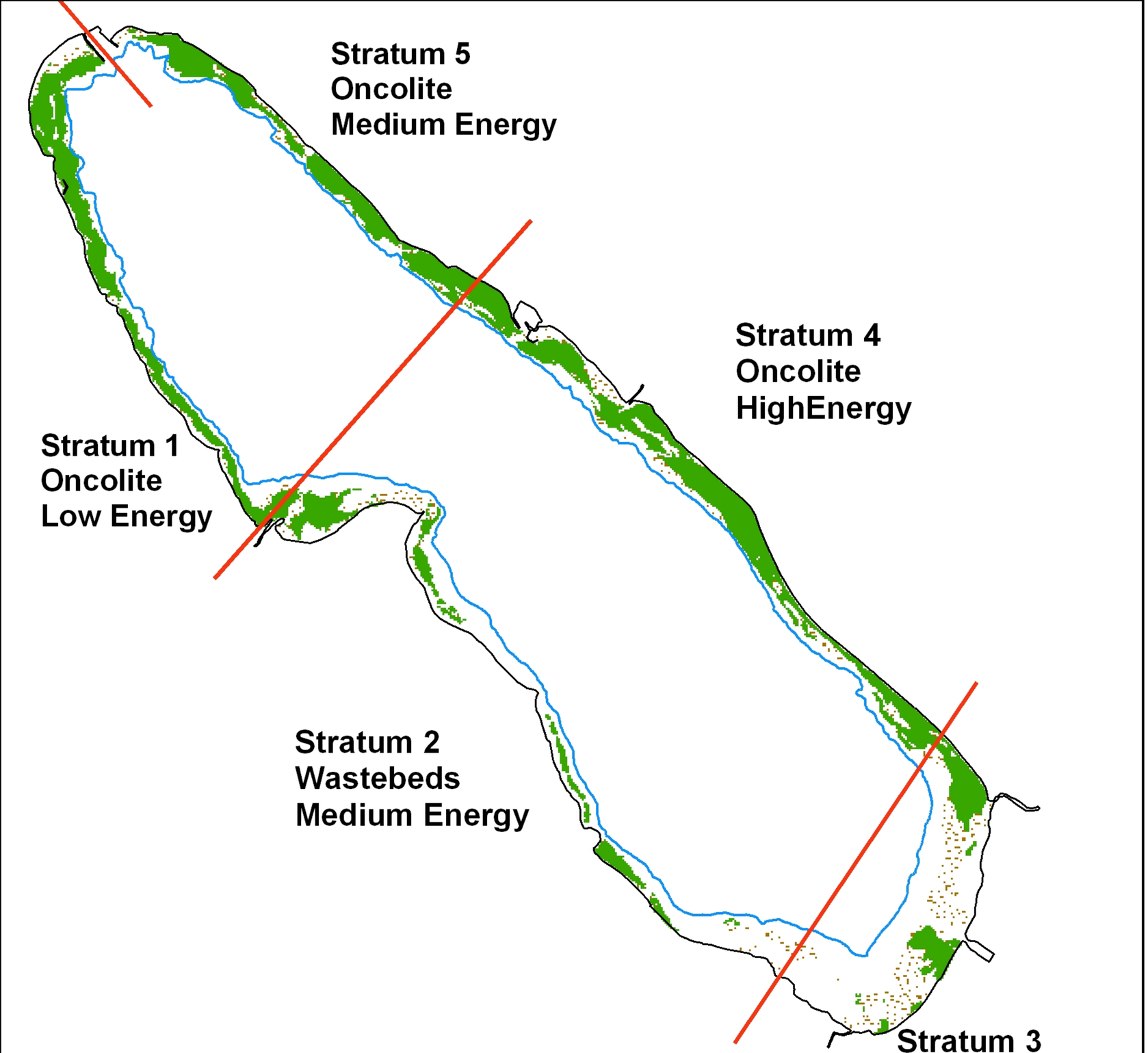
0 500 1,000 2,000 3,000 4,000 Meters

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 2

Lakewide Macrophyte Distribution Onondaga Lake, August 2008



N

Legend

- Strata borders
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Estimated macrophyte area: 314 acres

Source: Shoreline, macrophyte beds and sparse growth digitized from aerial photographs provided by Airphotographics.

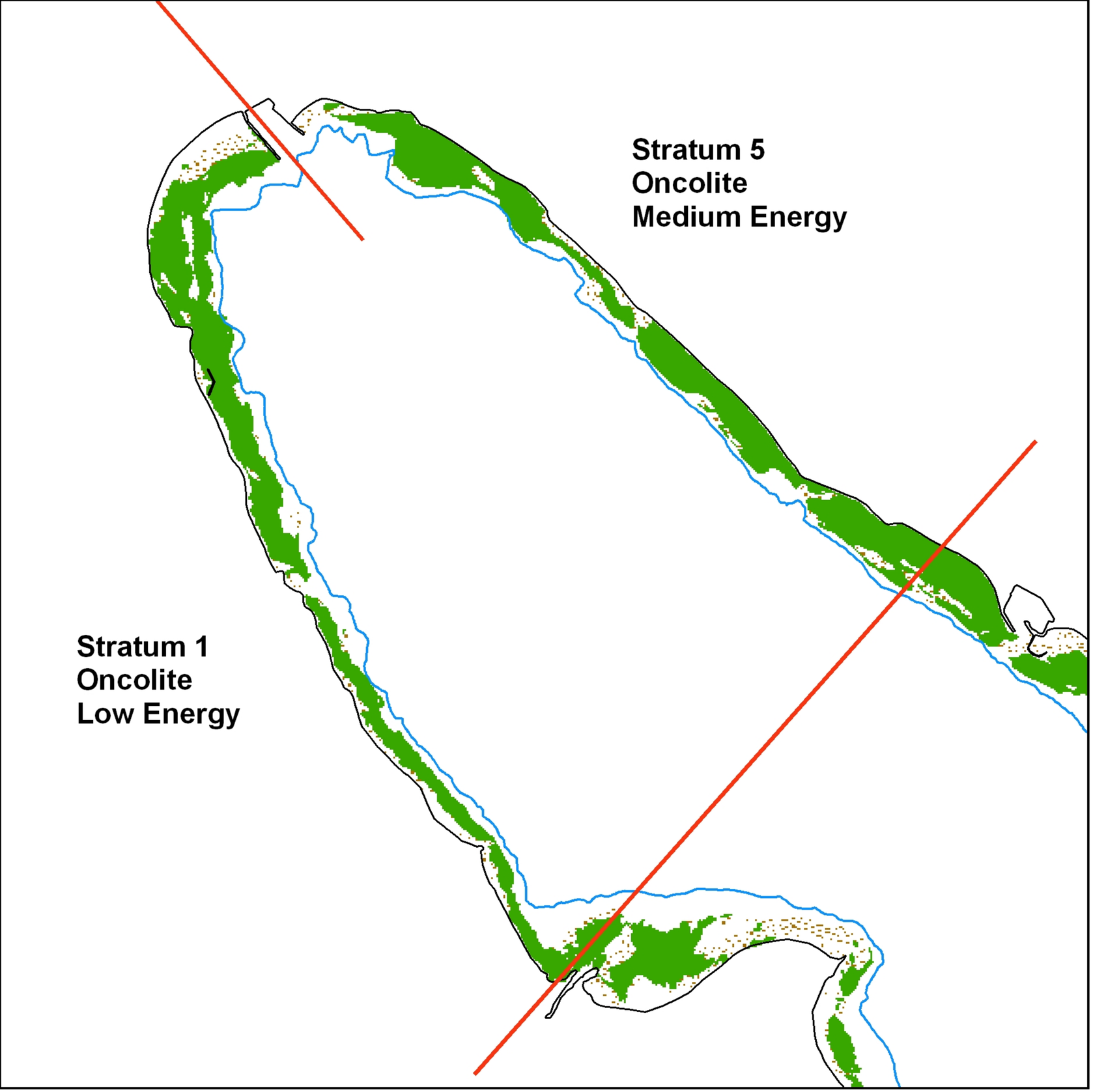
Meters
0 500 1,000 2,000 3,000 4,000

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 3

Strata 1 and 5
Macrophyte Distribution
Onondaga Lake, August 2008



N

Legend

- Strata borders
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Shoreline, macrophyte beds and sparse growth digitized from aerial photographs provided by Airphotographics.

0 200 400 800 1,200 1,600 Meters

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 4

Stratum 2
Macrophyte Distribution
Onondaga Lake, August 2008

N

Stratum 2
Wastebeds
Medium Energy

Legend

- Strata borders
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Shoreline, macrophyte beds and sparse growth digitized from aerial photographs provided by Airphotographics.

Meters
0 200 400 800 1,200 1,600

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 5

Stratum 3
Macrophyte Distribution
Onondaga Lake, August 2008

N

Legend

- Strata borders
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Stratum 3
Fine Sediment
High Energy

Source: Shoreline, macrophyte beds and sparse growth digitized from aerial photographs provided by Airphotographics.

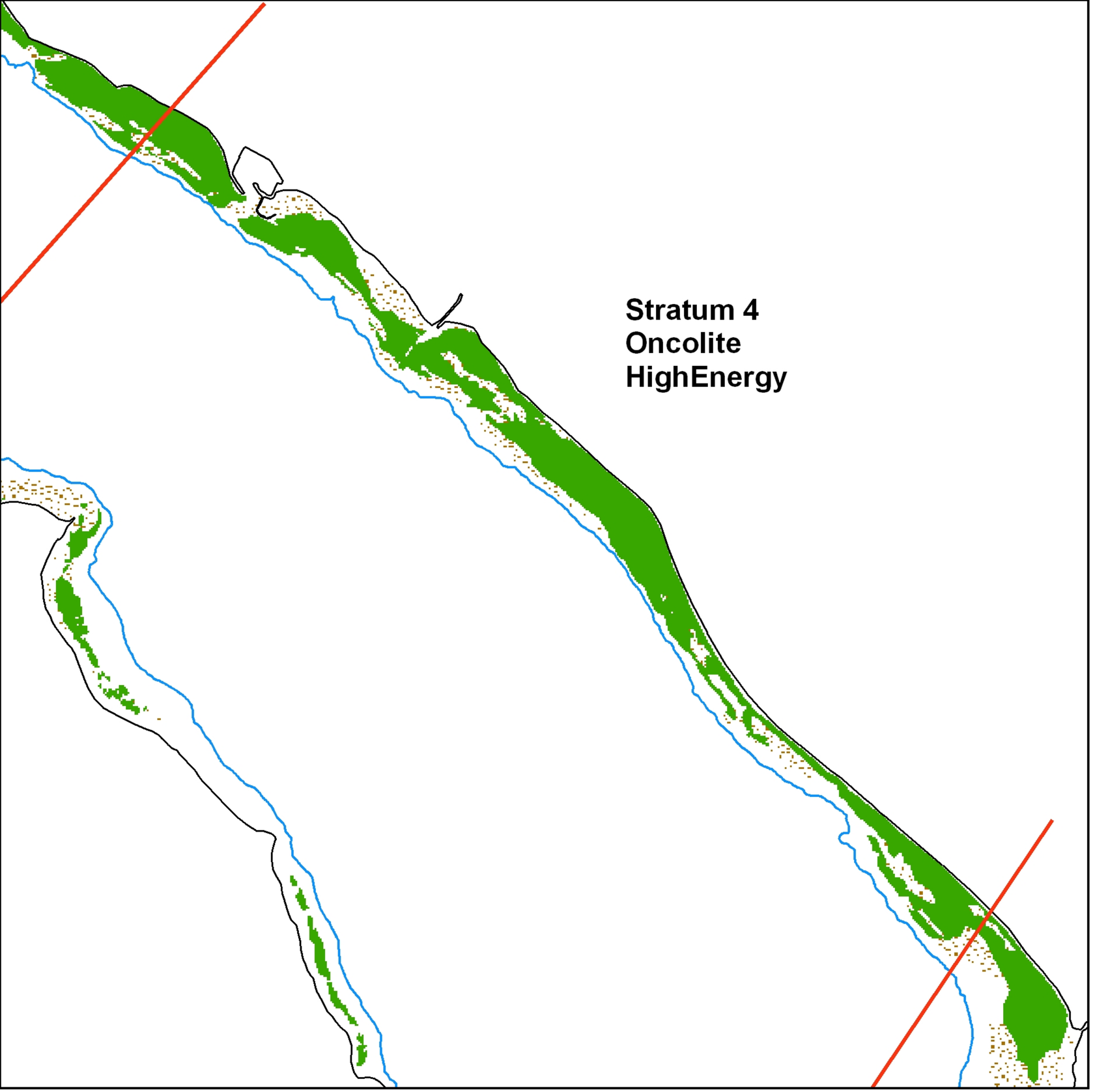
Meters
0 200 400 800 1,200 1,600

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 6

Stratum 4
Macrophyte Distribution
Onondaga Lake, August 2008



N

Legend

- Strata borders
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

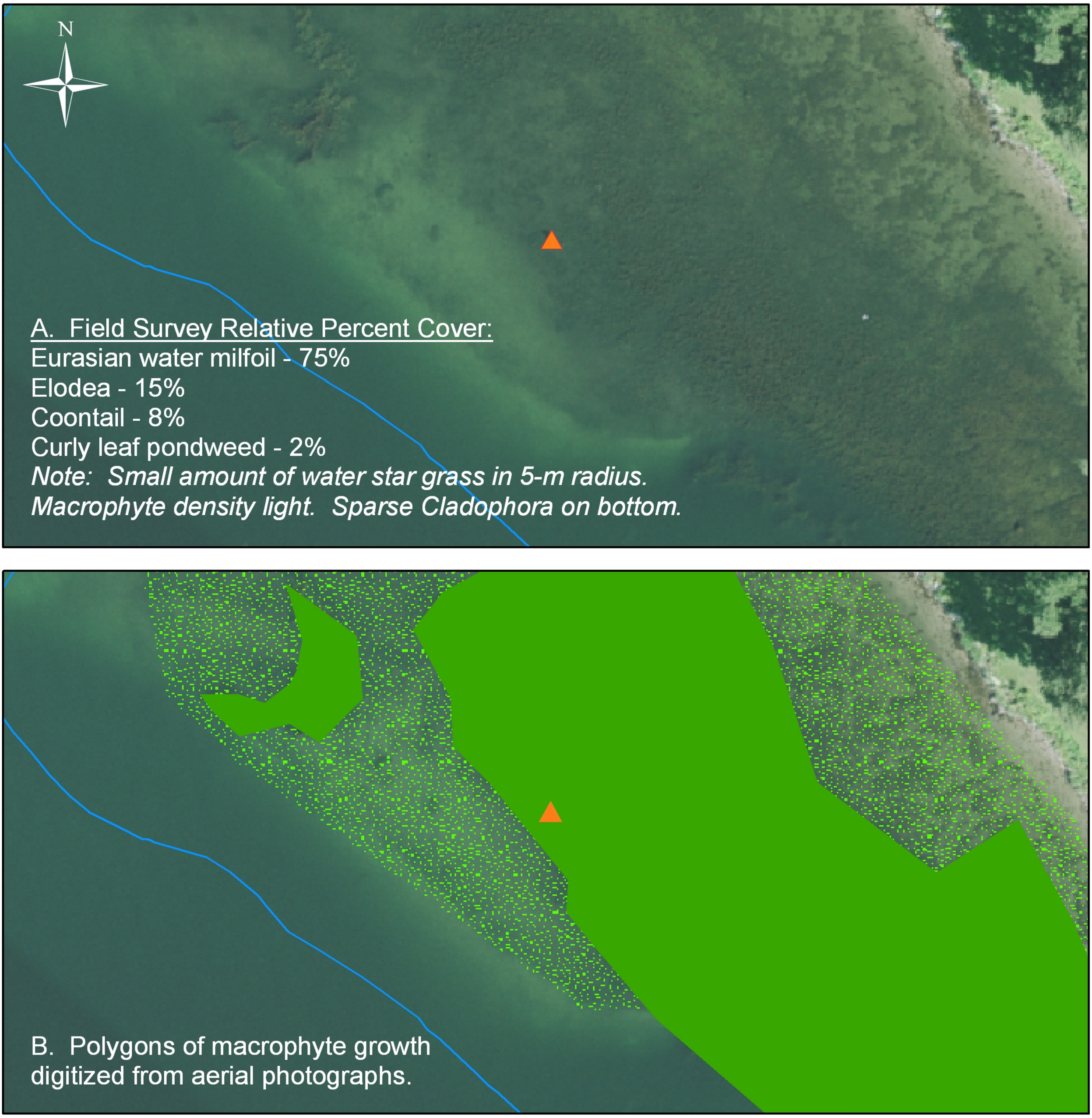
Source: Shoreline, macrophyte beds and sparse growth digitized from aerial photographs provided by Airphotographics.

Meters
0 200 400 800 1,200 1,600

Onondaga County Department Water Environment Protection
2008 Onondaga Lake Aquatic Macrophyte Survey

EcoLogic

Map 7
Ground Truth Buoy Site 1
August 2008, Onondaga Lake



Legend

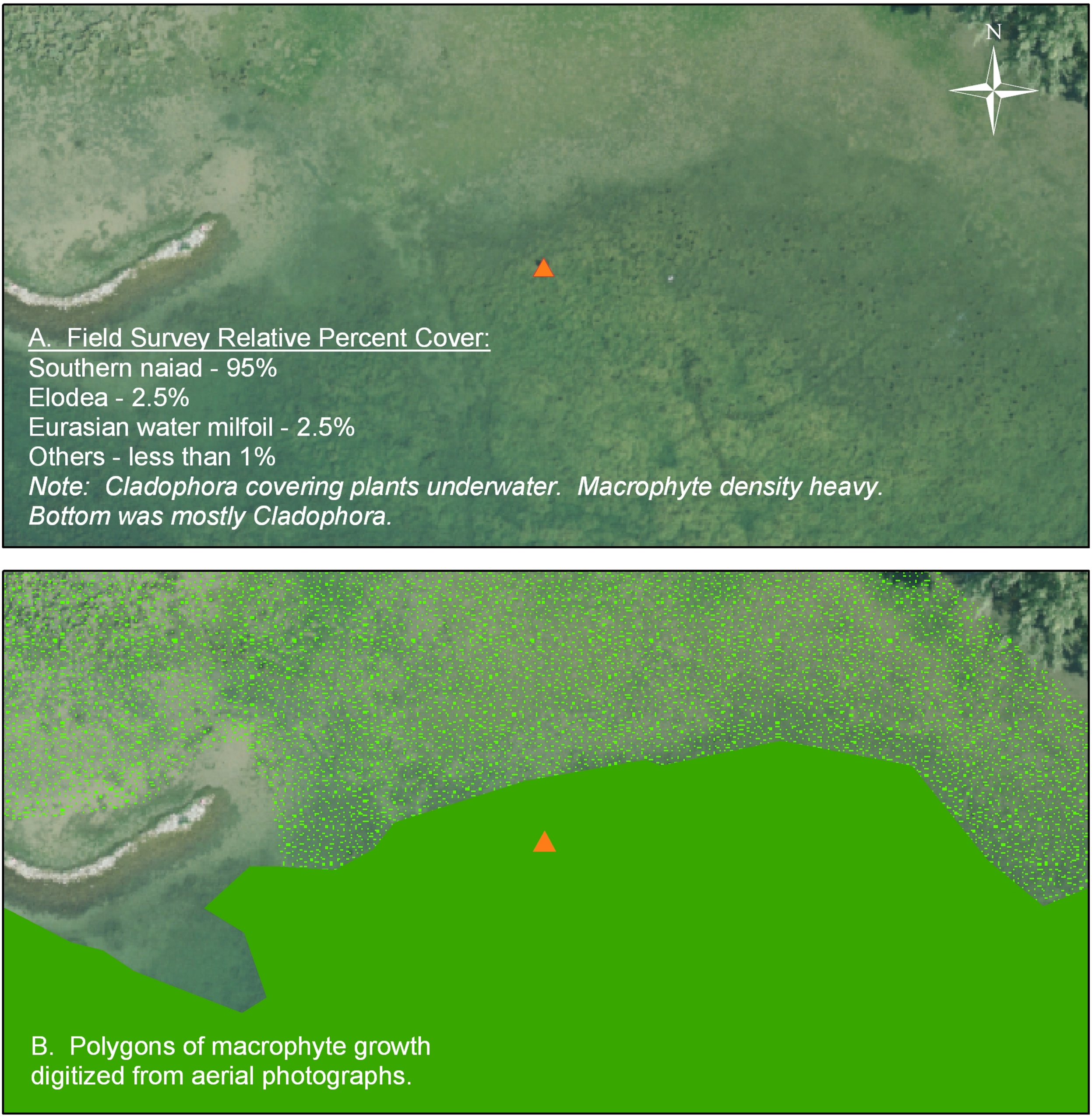
- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

0 10 20 40 60 Meters

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 8
Ground Truth Buoy Site 2
August 2008, Onondaga Lake



Meters
0 10 20 40 60

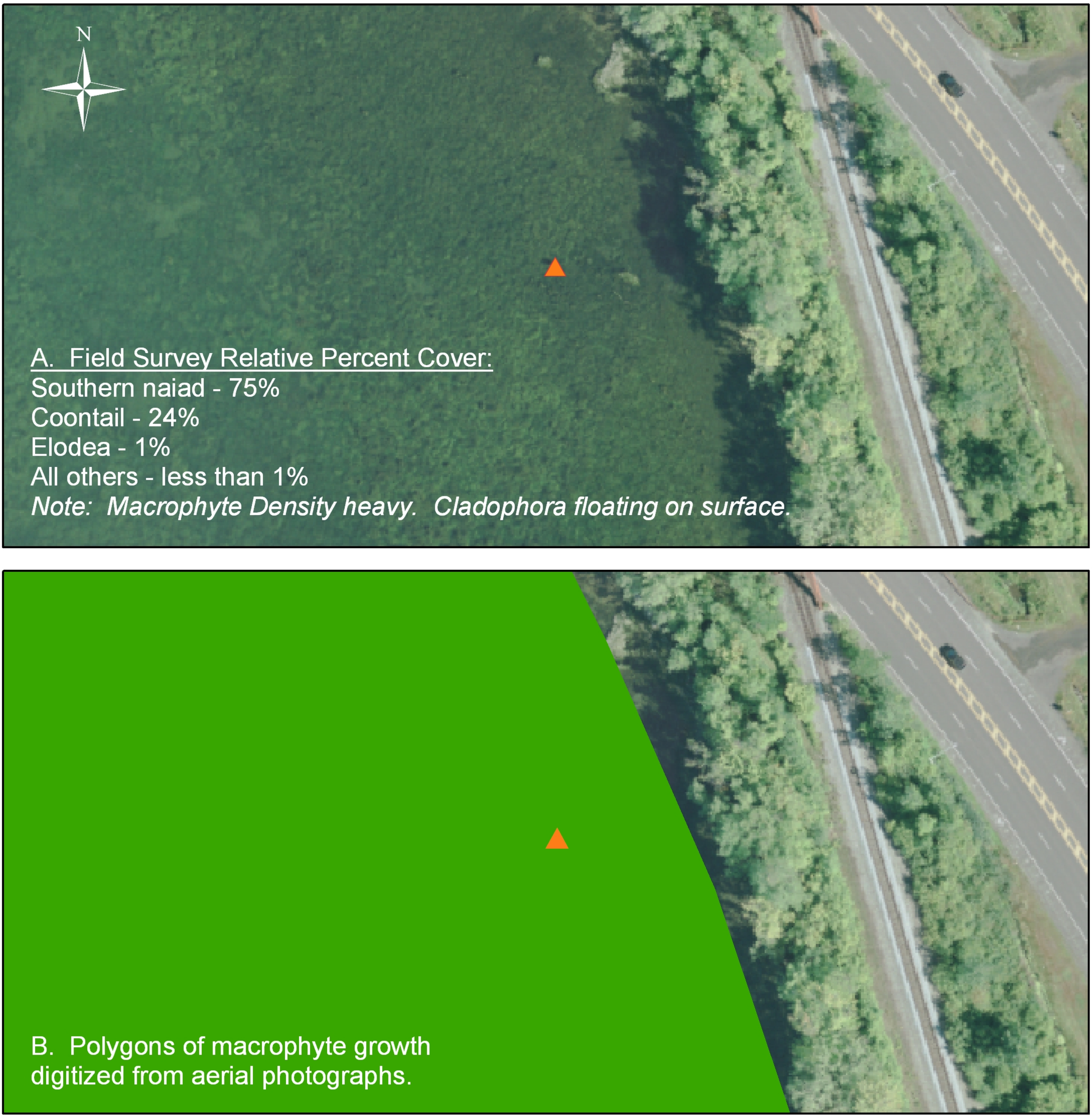
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

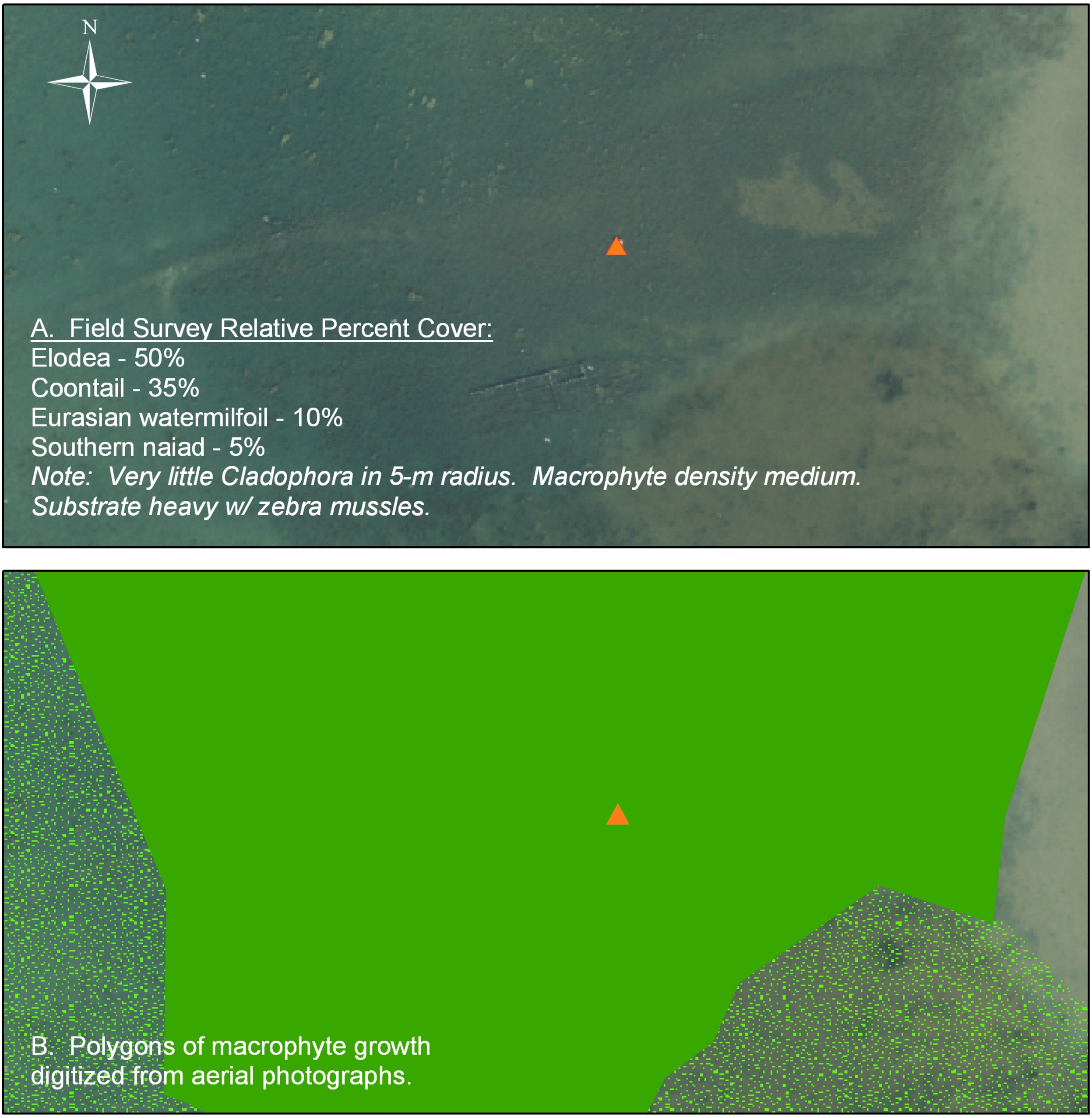
Map 9
Ground Truth Buoy Site 3
August 2008, Onondaga Lake



Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 10
Ground Truth Buoy Site 4
August 2008, Onondaga Lake



Meters
0 10 20 40 60

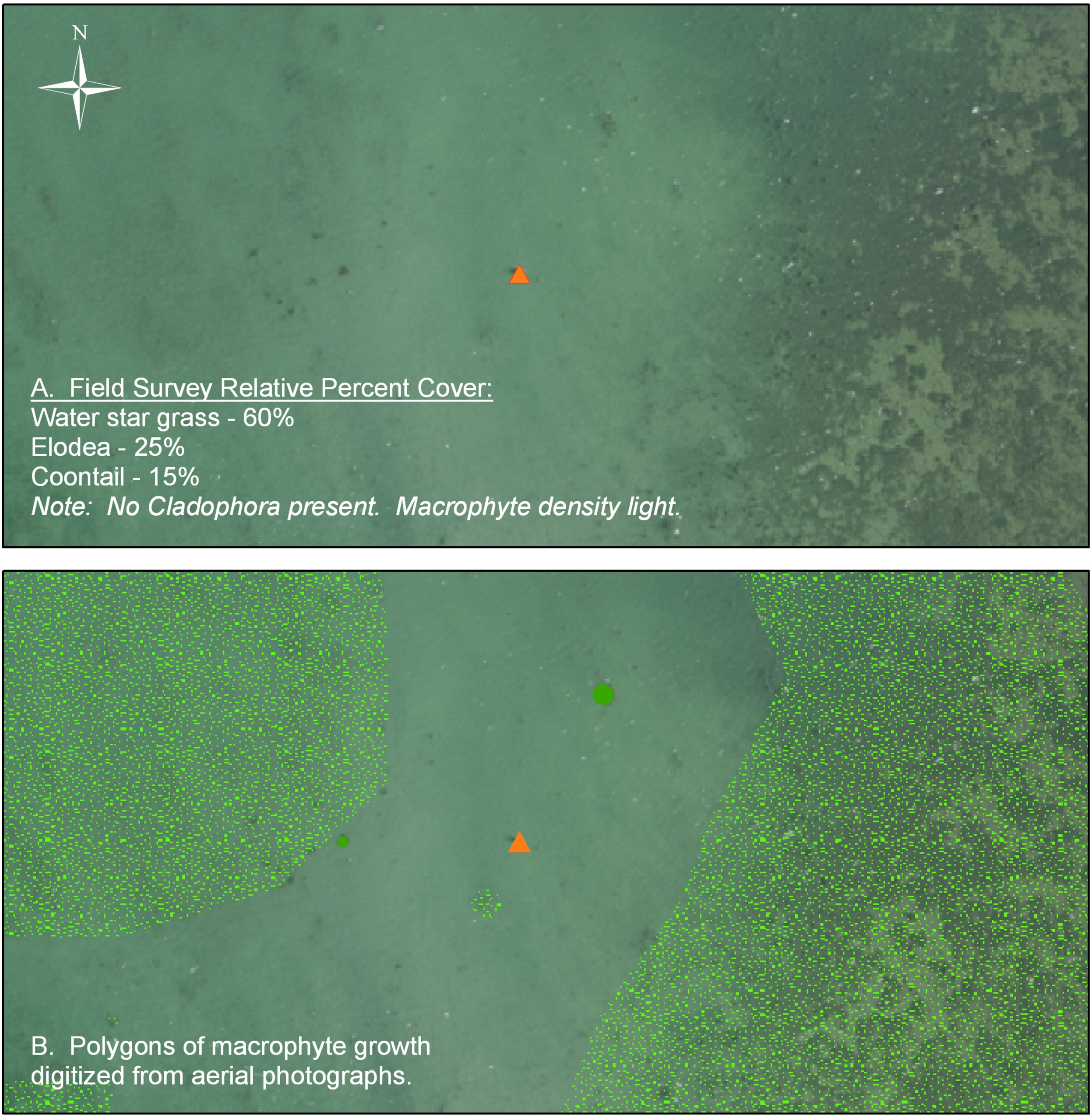
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 11
Ground Truth Buoy Site 5
August 2008, Onondaga Lake



Meters
0 10 20 40 60

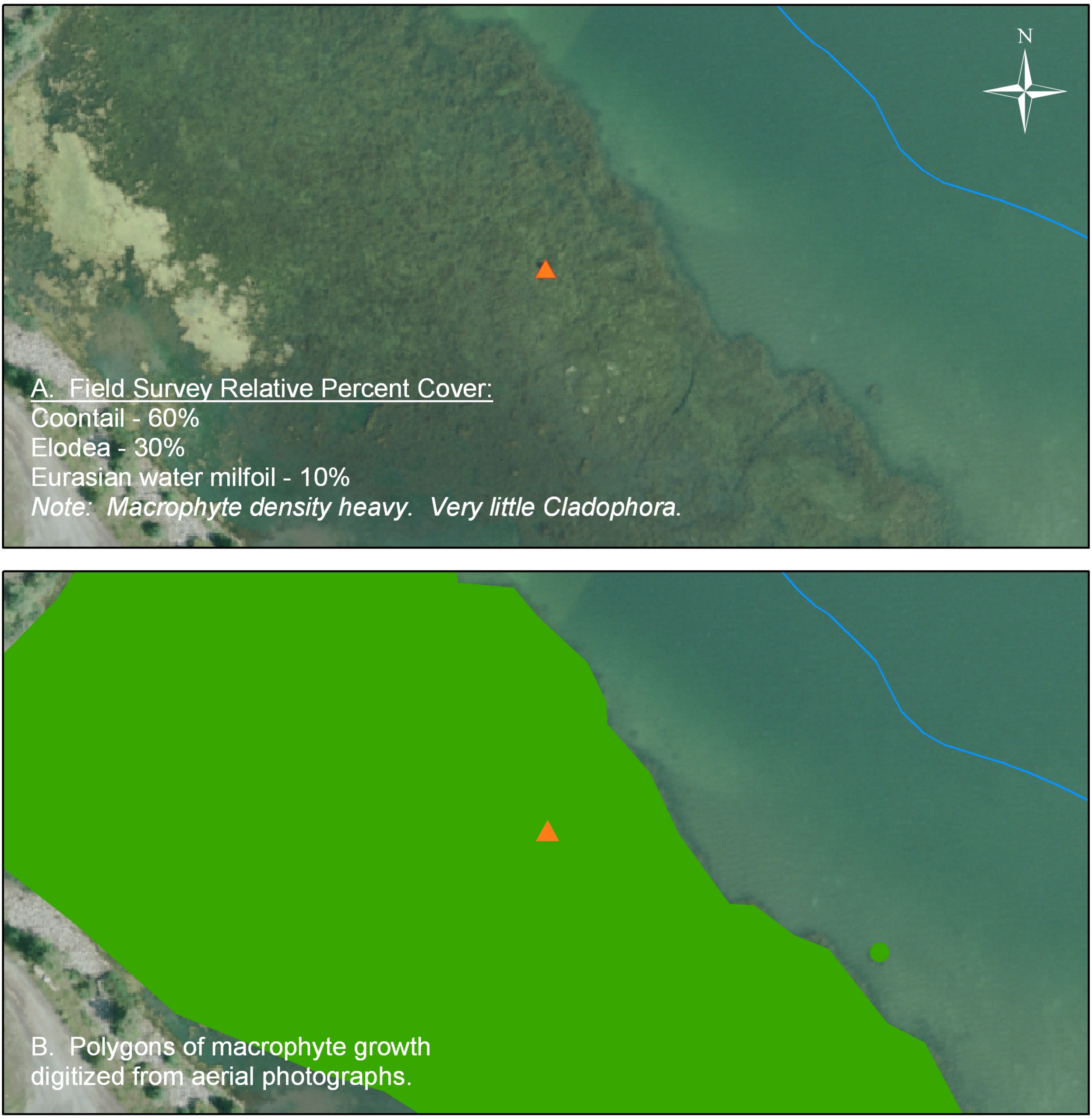
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

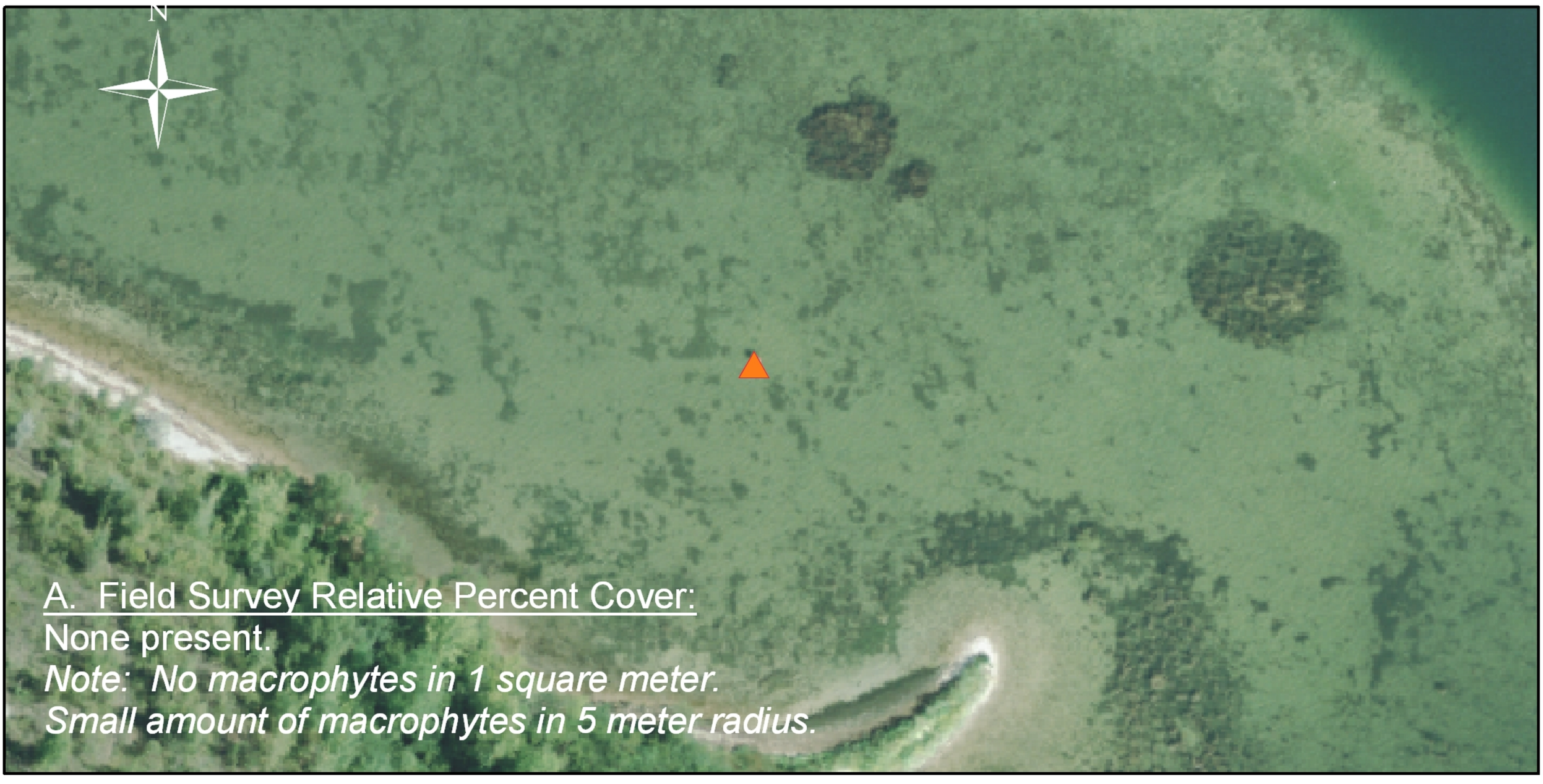
Map 12
Ground Truth Buoy Site 6
August 2008, Onondaga Lake

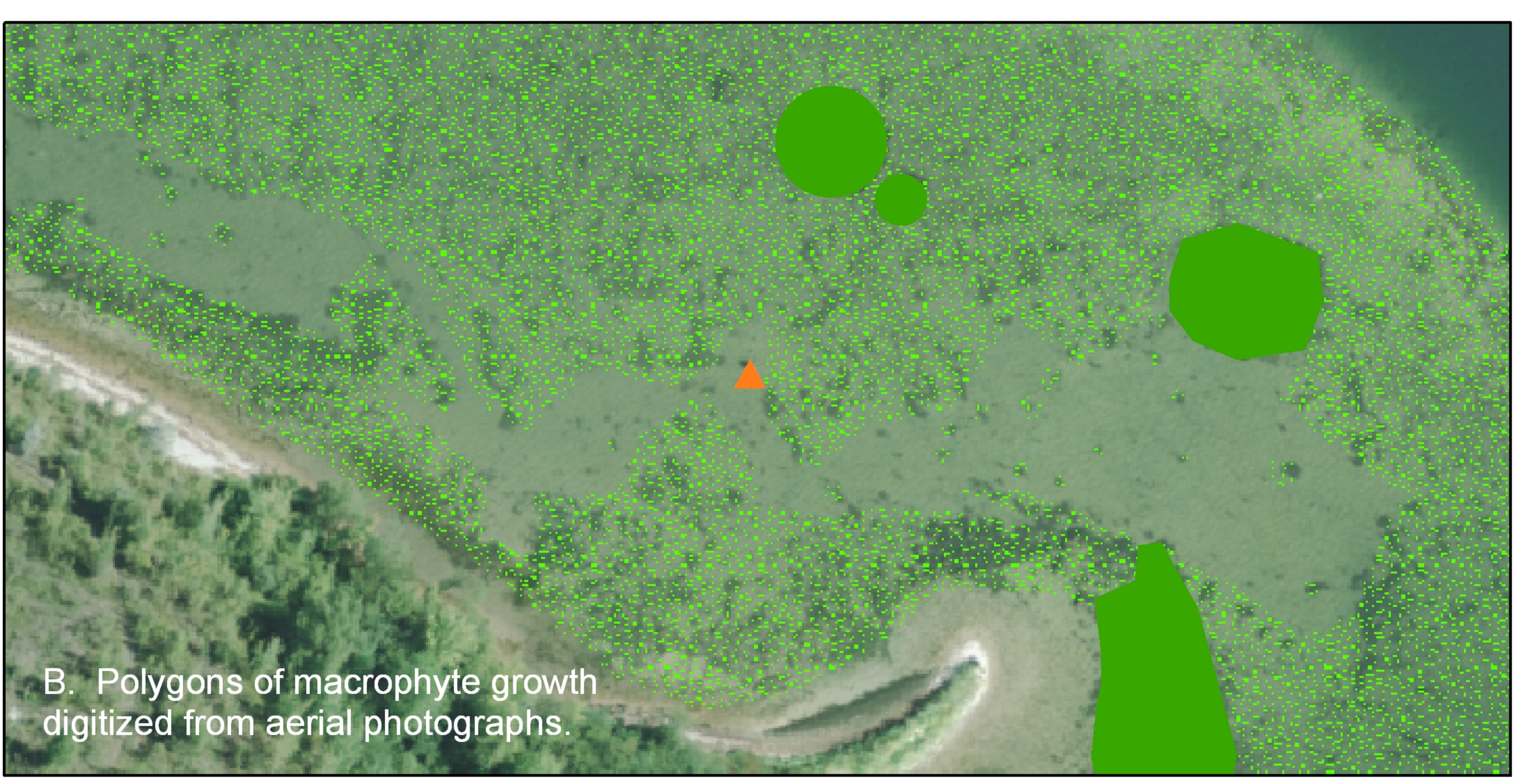


Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 13
Ground Truth Buoy Site 7
August 2008, Onondaga Lake





Meters
0 10 20 40 60

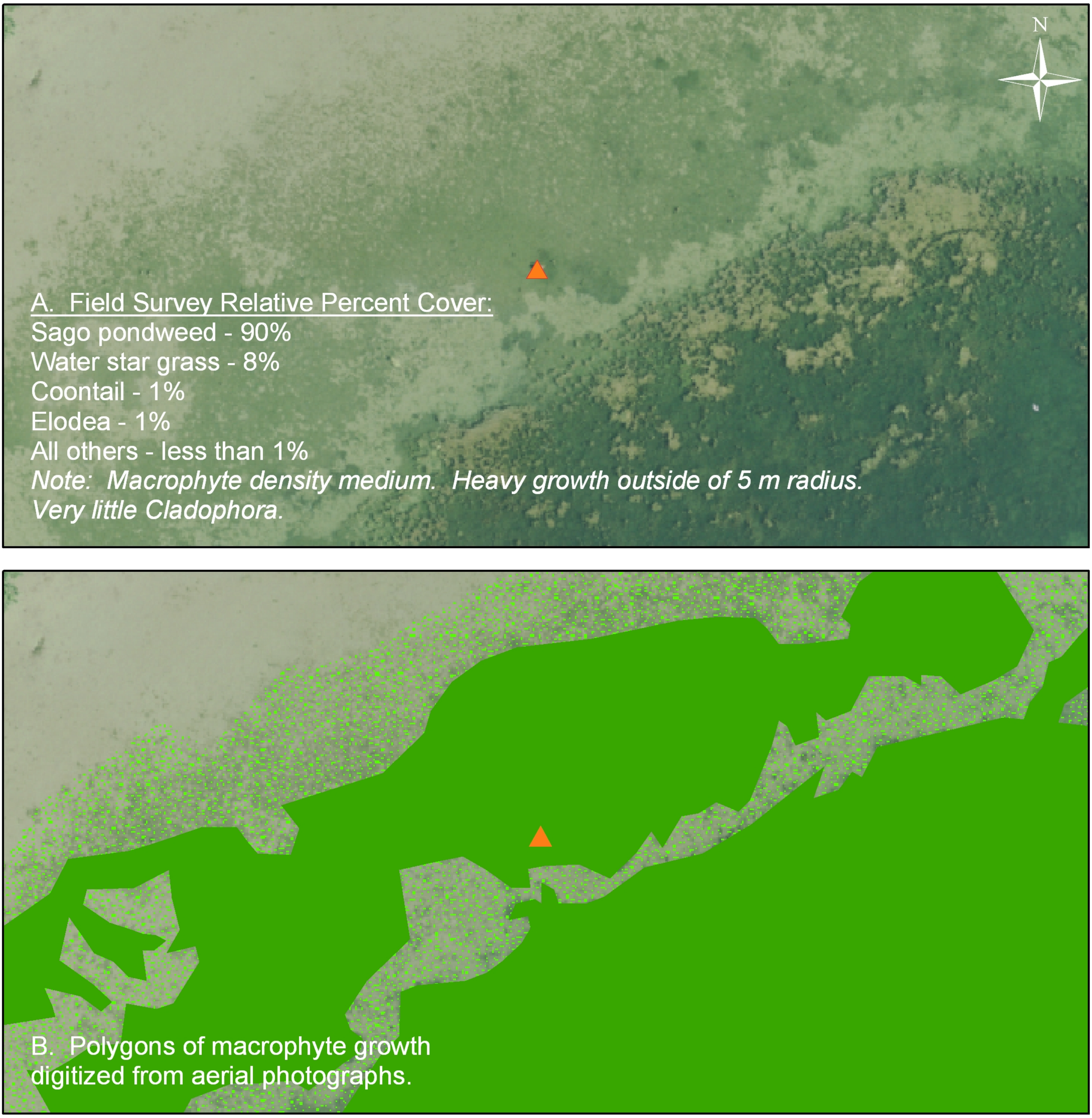
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 14
Ground Truth Buoy Site 8
August 2008, Onondaga Lake



Meters
0 10 20 40 60

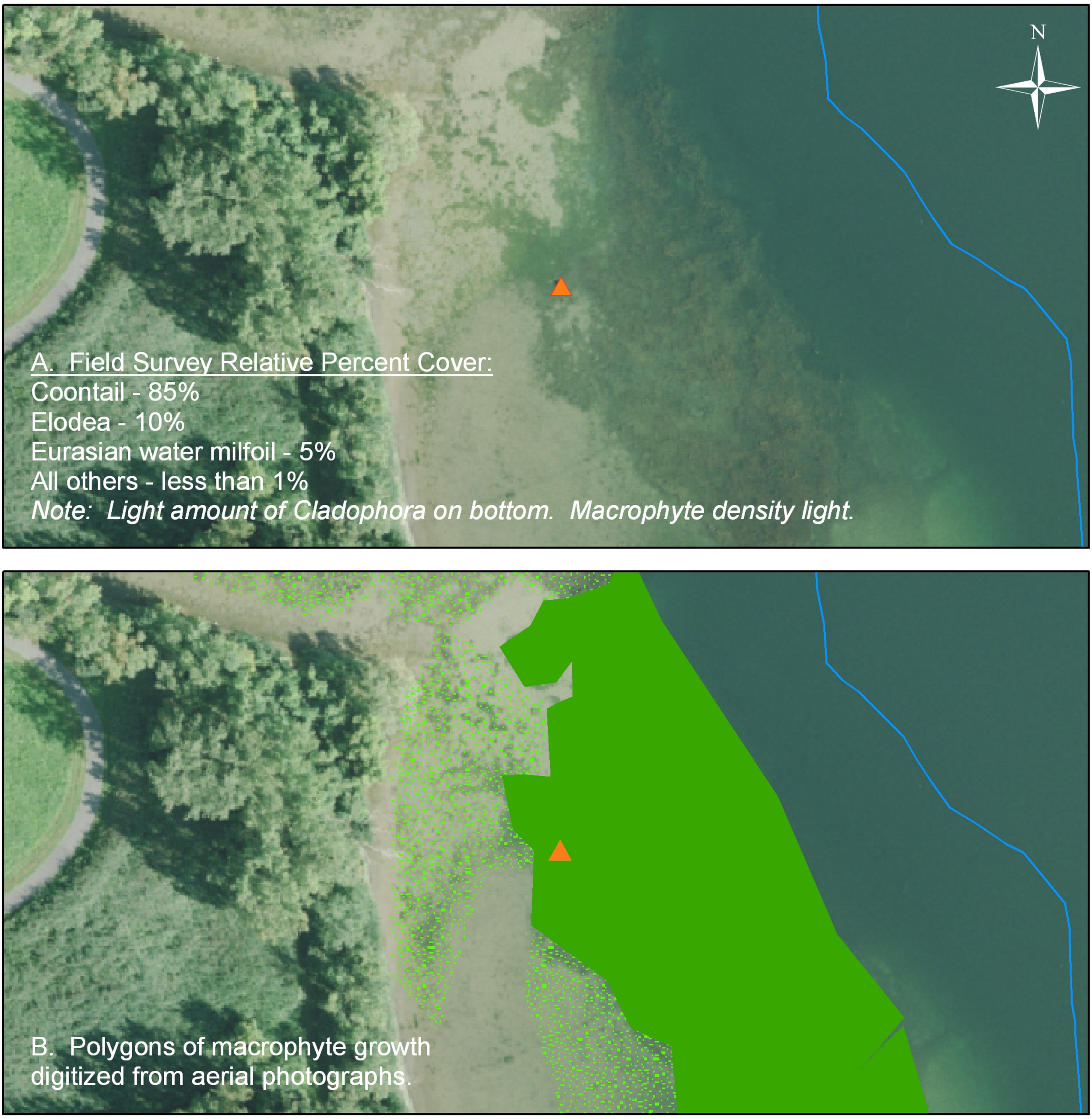
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 15
Ground Truth Buoy Site 9
August 2008, Onondaga Lake



Meters
0 10 20 40 60

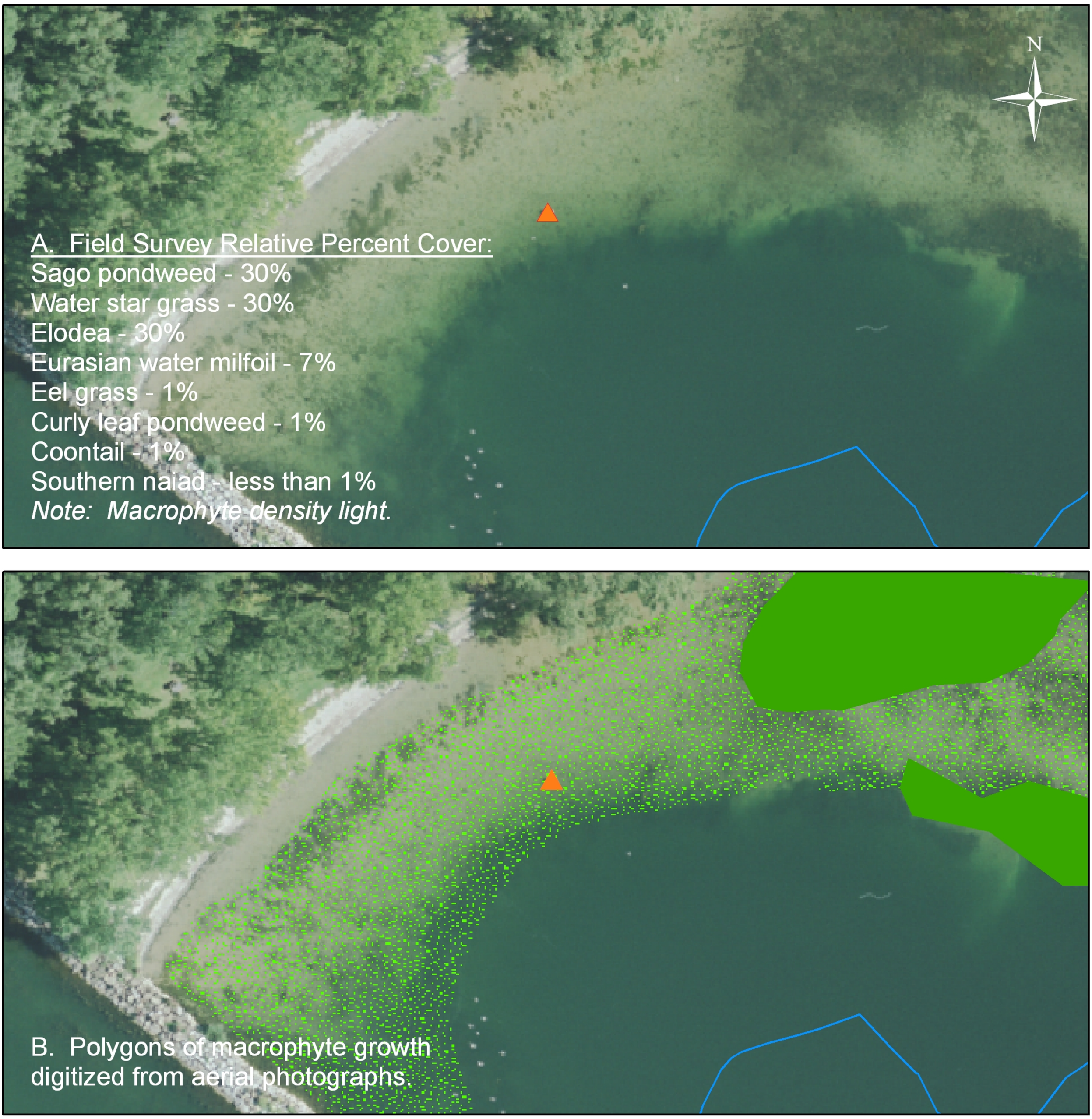
Legend

- Buoys
- 6-meter depth
- Dense macrophyte growth
- Sparse macrophyte growth

Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

Map 16
Ground Truth Buoy Site 10
August 2008, Onondaga Lake



Source: Buoy locations and macrophyte polygons digitized from aerial photographs provided by Airphotographics.

EcoLogic

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Species list of aquatic macrophytes observed in Onondaga Lake.

Scientific Name	Common Name	2000-2008[a]	2005[b]	2000[c]	1993[d]	1992[c,e]	1991[f]	Historical
Ceratophyllum demersum	Coontail	X	X	X	X	X	X	X[g]
Potamogeton crispus	Curly-leaf pondweed	X	X	X	X	X	X	X[h]
Stuckenia pectinata	Sago pondweed	X	X	X	X	X	X	X[g,h,i]
Zosterella dubia	Water stargrass	X	X	X	X	X	X	X[g,h,i,j]
Myriophyllum spicatum	Eurasian Water Milfoil	X	X	X	X	X	X	--
Elodea canadensis	Common waterweed	X	X	X	X	X	--	--
Potamogeton pusillus	Small pondweed	X	X	X	--	--	--	--
Sagittaria latifolia	Arrowhead	X	X	X	--	--	--	--
Vallisneria americana	Wild celery	X	X	X	--	--	--	--
Lemna minor	Small duckweed	X	X	--	X[1]	--	--	--
Lemna trisulca	Forked duckweed	X	X	--	--	--	--	--
Najas flexilis	Slender naiad	X	X	--	--	--	--	X[g,h,j]
Najas quadalupensis[2]	Southern naiad	X	X	--	--	--	--	--
Potamogeton strictifolius[3]	Straight-leaf pondweed	X	X	--	--	--	--	--
Spirodela polyrhiza	Greater duckweed	X	X	--	--	--	--	--
Trapa natans	Water chestnut	X	X	--	--	--	--	--
Ruppia maritima	Widgeon grass	X	X	--	--	--	--	--
Ranunculus sp.	Water crowfoot	X	--	X	--	--	--	--
Chara sp.	Muskgrass	X	--	--	--	--	--	X[i]
Potamogeton nodosus	Long-leaf pondweed	X	--	--	--	--	--	--
Zannichellia palustris	Horned pondweed	--	--	--	X[1]	--	--	X[7]
Potamogeton diversilfolius[3]	Variable-leaf pondweed	--	--	--	X[1]	--	--	--
Sparganium sp.	Bur-reed	--	--	--	X[1]	--	--	--
Najas marina[3]	Spiny naiad	--	--	--	--	--	--	X[g,h,j]
Nitella sp.	Stonewort	--	--	--	--	--	--	X[k]
Polygonum amphibium	Water smartweed	--	--	--	--	--	--	X[i]
Total Number		**20**	**17**	**10**	**10**	**6**	**5**	**10**

a) OCDWEP AMP; includes both 2000 and 2005 field surveys and 2000-2008 ground truthing of air photos
b) OCDWEP 2006
c) OCDWEP 2001
d) Madsen et al. 1996b
e) Exponent 1998
f) Madsen et al. 1991
g) Paine 1865
h) Bye and Oettinger 1969
i) NYS Museum voucher specimen (Madsen et al. 1996a)
j) Goodrich 1912
k) Dean and Eggleston 1984

1. Only a few plants found behind experimental wave breaks (Madsen et al. 1996b)
2. There are four recognized varieties of *Najas quadalupensis.* Of these, var. *quadalupensis* is the most widespread and ranges over much of the United States. The other three varieties have more restricted distributions. Variety *muenscheri* is restricted to the Hudson River system of New York, and var. *olivacea* occurs from central New York west to Minnesota and Iowa, both these varieties are listed as "Endangered" in New York State. It is not know which variety(s) is present in Onondaga Lake. Seeds are required for positive identification.
3. Listed as "Endangered" in New York State

Library Reference 8.6

Dreissenid (zebra and quagga) mussels

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Library Reference 8.6.1

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Dreissenid mussel biomass and density estimates in Onondaga Lake.

Zone	Mean Weight (g/m^2)					Mean Estimated Number / m^2				
	2002	**2005**	**2006**	**2007**	**2008**	**2002**	**2005**	**2006**	**2007[a]**	**2008[a]**
A	2008	42	717	1150	298	1834	1187	5465	14559 (229)	2721 (1328)
B	0	6	47	338	650	0	133	4803	12148	2522 (4558)
C	256	58	74	1748	856	514	1040	1991	12396 (2522)	5627 (2980)
D	542	45	70	1261	472	1356	907	774	18791 (281)	1460 (1092)
E	1458	17	27	348	1435	1460	752	1549	7806	5782 (12448)
F	1688	133	7	2586	1620	1141	3319	59	13211	7965 (6785)
G	0	0	0	65	325	0	15	0	2383	2522 (501)
H	1201	23	94	457	272	1102	789	1667	2463	8120 (244)
Lake Average	***894***	***40***	***130***	***994***	***741***	***926***	***1018***	***2038***	***10470 (379)***	***3937(3742)***

[a]The 2007 and 2008 results are expressed as “N zebra mussels (N quagga mussels)” when quagga mussels are present.

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2008 Seneca River and Onondaga Lake Dreissenid Mussel Survey

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Seneca River and Onondaga Lake Dreissenid Mussel Survey

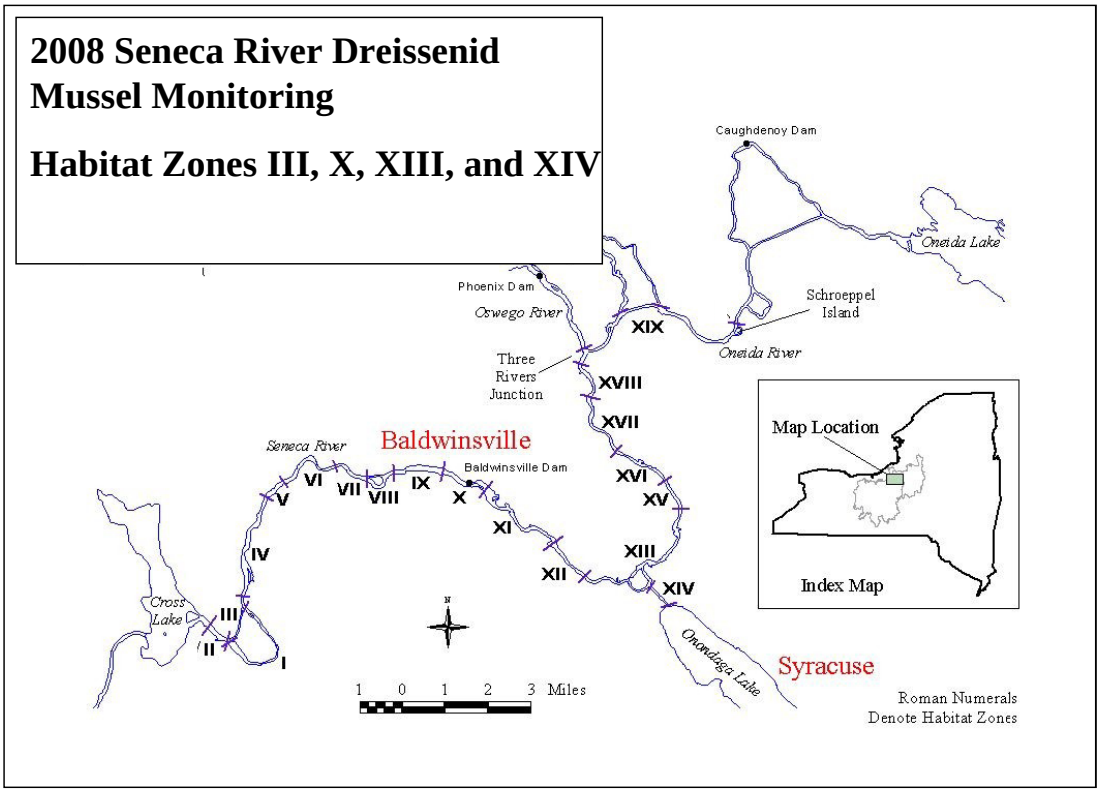
During the fall of 2008, OCDWEP staff completed a Seneca River and Onondaga Lake dreissenid mussel survey in support of the model and/or validation needs for the Three Rivers Water Quality Model (TRWQM) and Onondaga Lake Water Quality Model (OLWQM). The Dreissenid mussels include both zebra and quagga mussels.

1 Seneca River

The October 3, 2008, monitoring event included the collection and estimation of dreissenid mussels at key locations recommended by Anchor QEA to provide a measure of length frequency distribution and density (#/m^2 and grams/m^2). The monitoring locations include the following four (4) habitat zones:

- Zone III – State Ditch Cut – 3 Transects, 3 samples per transect.
- Zone X – Near Buoy Marker 334– 3 Transects, 3 samples per transect.
- Zone XIII – Near Buoy Marker 260 – 5 Transects, 3 samples per transect.
- Zone XIV – Onondaga Lake Outlet– 2 Transects, 3 samples per transect.

Map of General Seneca River Dreissenid Mussel Transect Locations



Three (3) samples were collected along each transect. One (1) at approximately mid-channel (Middle), and one (1) between the channel marker buoy and shoreline on each side of the river (Red and Green). The boat was anchored to provide a fixed position, and the technicians record the date, time, water depth (ft), composition of the field crew, general weather conditions, and GPS coordinates. The Green and Red locations are designated by the channel marker buoys.

A single grab sample was collected at each depth interval with a petit ponar dredge, which has a sample area of 35 in^2 (226 cm^2). The impact with the bottom activates the closing mechanism, and the dredge is then slowly brought to the surface.

Once at the surface, all substrate within the sampler is carefully placed into the wash bucket with the mesh screen. Lake water is used to rinse any remaining material into the wash bucket. Fine sediments were rinsed through the wash bucket, and all remaining material was placed in a labeled zip-lock bag. Following field sample collection, all samples were placed in a cooler with ice until transported to a refrigerator at the HCBF laboratory. Label information included date and location (i.e. Zone III, Transect A, Location G).

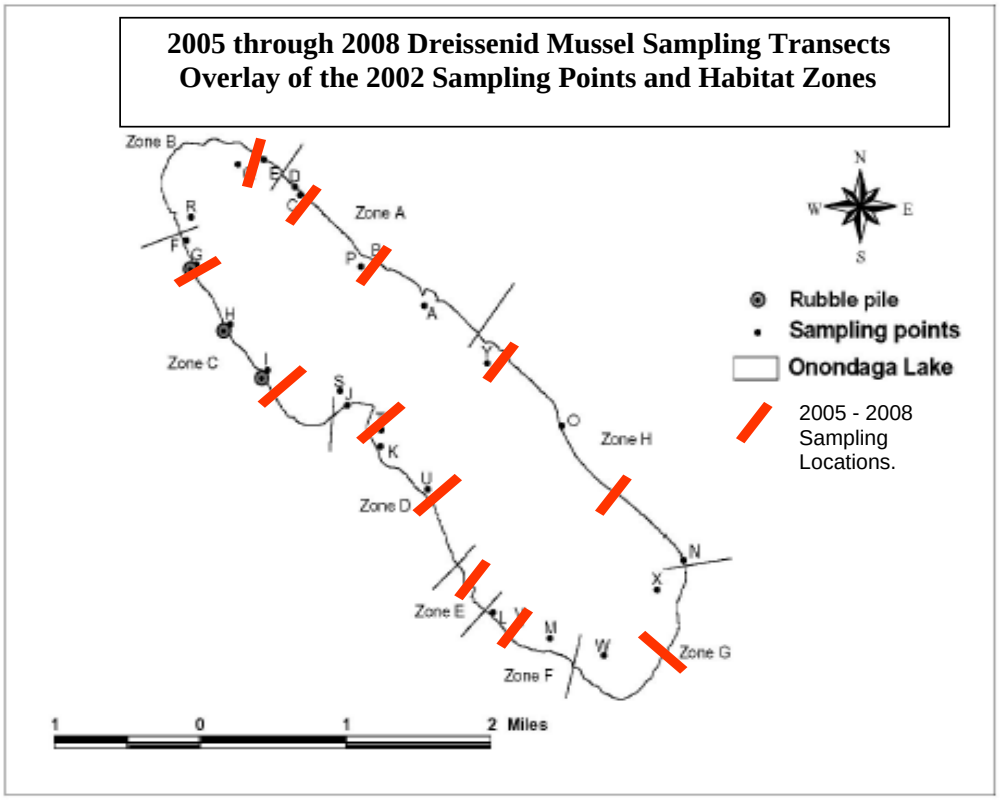
Thirty-nine (39) samples were collected from the Seneca River during the 2008 field effort.

2 Onondaga Lake

The October 10, 2008, monitoring event on Onondaga Lake included the collection and estimation of dreissenid mussels within habitat zones identified by Stantec during the 2002 Onondaga Lake Zebra Mussel Assessment Program, and transects and water depth intervals recommended by QEA in 2005. The recent efforts provide a limited measure of length frequency distribution and density (#/m^2 and grams/m^2) in Onondaga Lake. The monitoring locations include the following eight (8) habitat zones:

- Zone A – 2 Transects, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone B – 1 Transect, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone C – 2 Transects, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone D – 2 Transects, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone E – 1 Transect, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone F – 1 Transect, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone G – 1 Transect, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.
- Zone H – 2 Transects, 3 samples per transect, at 0-1.5 m, 1.5 – 3 m, and 3 – 4.5 m.

Map of General Onondaga Dreissenid Mussel Transect Locations



Three (3) samples were collected along each transect. The first at a water depth of approximately 0 to 1.5 meters, the second at a water depth of approximately 1.5 to 3.0 meters, and the third at a water depth of approximately 3.0 to 4.5 meters. The boat was anchored to provide a fixed position, and technicians recorded the date, time, actual water depth (ft), field crew, general weather conditions, and GPS coordinates.

A single grab sample was collected at each depth interval with a petit ponar dredge, which has a sample area of 35 in^2 (226 cm^2). The impact with the bottom activates the closing mechanism, and the dredge is then slowly brought to the surface.

Once at the surface, all substrate within the sampler is carefully placed into the wash bucket with the mesh screen. Lake water is used to rinse any remaining material into the wash bucket. Fine sediments were rinsed through the wash bucket, and all remaining material was placed in a labeled zip-lock bag. Following field sample collection, all samples were placed in a cooler with ice until transported to refrigerator at the HCBF laboratory.

The sample was rejected if the dredge was only partially filled with substrate sediment. Possible causes of less than a full sample included non-vertical deployment, premature triggering of the closing mechanism, an object stuck in the jaws of the ponar, or hard sediments that are impenetrable by the petite ponar. If the sampling team observed bottom material draining from the dredge as it is brought out of the water, the sample was rejected. If a sample was rejected, the procedure was repeated.

Thirty-six (36) samples were collected in Onondaga Lake during the 2008 field effort.

3 River and Lake Biological Laboratory Processing

At the HCBF biological laboratory, all mussels in the sample were carefully removed from the substrate material. Laboratory measurements of the collected samples were completed within two (2) weeks of sample collection. The entire sample was sorted to remove the live mussels. Care was taken to distinguish between zebra and quagga mussels that are similar in appearance for young-of-year mussels. The mussels were then blotted dry with paper towels.

Note: The data tables provide weight, and weight based density (g/m^2), for combined dreissenid mussels (quagga and zebra mussels) unless otherwise noted.

3.1 Length Frequency

Using the blotted samples, technicians randomly select 100 mussels from the sample for length measurement. Using the digital caliper, the technicians recorded the length of each mussel (nearest 1 mm) on the Log Sheet for Mussel Length. If a sample results in less than 150 mussels for any given transect (because of the lack of mussels in some individual samples), additional randomly selected mussels were then measured in those samples within the transect with more than 100 mussels (if such were available), with the goal of at least 150 measurements per transect.

3.2 Weight and Density Determination (Estimate)

Upon completion of the length measurements for the sample, technicians used the 100 randomly selected mussels (or using all the mussels samples that were measured for those sample locations that did not contain 100 mussels) for a batch weigh per sub-sample. Technicians recorded the number of mussels in the sub-sample and the weight of the sub-sample on the Log Sheet for Weight and Density Determination (weight was recorded to the nearest 0.1 grams). The technicians then combined the sub-sample mussels with the remaining mussels in the sample for a total weight for the entire sample. The calculation for the estimated total number of mussels per sample as follows:

$$\text{Total \# of Mussels per Sample} = \frac{(\text{\# mussels per sub-sample} * \text{weight per entire sample})}{\text{weight per sub-sample}}$$

4 Seneca River Data

On October 3, 2008, OCDWEP technicians collected the dreissenid mussel samples at the designated locations. Samples were collected and measured in accordance with the standard procedures unless otherwise noted. In general, all locations sampled contained a significant quantity of dreissenid mussel shell fragments requiring considerable laboratory effort to distinguish between the dead and live mussels.

During 2008, the survey identified two (2) locations that contained quagga mussels. Quagga mussels were identified near Kline Island (XIIIA and XIIIB), and both of the Lake outlet locations (XIVA and XIVB). The quagga mussels represented less than 1% of the Seneca River dreissenid mussels sampled, and nearly 54% of the Lake Outlet dreissenid mussels sampled.

The Seneca River and Onondaga Lake outlet locations have continued to identify fluctuating dreissenid mussel densities (Table 2). Noteworthy during 2008, is the decline (g/m^2 and $\#/m^2$) in the Onondaga Lake outlet (XIVA and XIVB) and the increase through the State Ditch Cut (IIIA, IIIB, and IIIC located down stream from the Cross Lake outlet).

The fluctuation in dreissenid mussel density may be a function of annual variability in the mussel populations (mortality vs. distribution of year classes), a change in water quality conditions (increased clarity), a function of comparing results from different sampling methodologies (SCUBA diver collected vs. petit ponar dredge), or a combination of each.

Note: The 2004 data utilized scuba divers for sample collection, and the 2005 through 2008 data utilized the petit ponar dredge for sample collection.

5 Onondaga Lake Data

On October 10, 2008, OCDWEP technicians collected the dreissenid mussel samples at the designated locations. Samples were collected and measured in accordance with the procedures unless otherwise noted. In general, most locations sampled contained a significant quantity of dreissenid mussel shell fragments requiring considerable laboratory effort to distinguish between the dead and live mussels.

During 2008, the survey identified that all zones contained quagga mussels, suggesting they are well distributed with in the lake (in 2007, only three (3) zone contained quagga mussels). Quagga mussels were identified in 34 of the 36 samples collected, with water depths ranging from 0 to 4.5 meters; although the greatest densities were in the 3.0 to 4.5 meter depth range. The quagga mussels represented 45% of the Onondaga Lake dreissenid mussel sampled.

Particularly noteworthy is the 23% decrease in the mean estimated number of mussels per m^2, and a 22% decrease in the mean weight (g/m^2). The decrease was primarily attributed to the 0 to 3.0 m depths, while the 3.0 to 4.5 m range increased in density. With the exception of Zone E which had a 59% increase in dreissenid mussel density, all other zones decreased in density from 49% to 94% compared with 2007.

The fluctuation in dreissenid mussel density may be a function of annual variability in mussel populations (mortality vs. distribution of year classes), a change in water quality conditions (increased clarity), a function of comparing results from different sampling methodologies (SCUBA diver collected vs. petit ponar dredge), or a combination of each.

Note: The 2002 data utilized scuba divers for sample collection, and the 2005 through 2008 data utilized the petit ponar dredge for sample collection.

Table 1. Seneca River Dreissenid Mussel Survey Fall 2008 - Length and Weight Data Summary

Zone	Transect	Transect Coordinates	Channel Location	Water Depth (m)	Number of Mussels Per Sub-Sample	Weight Per Sub-Sample (g)	Weight Per Entire Sample (g)	Total Weight (g/m^2)	Mean Weight (g/m^2) per Transect	Median Mussel Length (mm)	Mean Mussel Length (mm)	Total Number of Mussels Per Sample	Estimated Total Number of Mussels per m^2	Mean Estimated Number of Mussels per m^2 by Transect
III	A	N 43 06.448, W 76 26.460	Green	2.6	100	3.3	7.1	314.2	435.1	5	5.5	215.2	9520.0	11001
			Middle	4.4	100	4.6	21.1	933.6		6	6.1	458.7	20296.3	
			Red	1.7	72	1.3	1.3	57.5		3	4.0	72.0	3185.8	
III	B	N 43 06.602, W 76 26.426	Green	1.6	100	2.1	2.5	110.6	179.9	5	4.8	119.0	5267.6	5663
			Middle	4.2	100	5.6	8.3	367.3		6	6.6	148.2	6558.2	
			Red	1.8	100	1.2	1.4	61.9		3	3.6	116.7	5162.2	
III	C	N 43 06.746, W 76 26.380	Green	2.4	63	0.9	0.9	39.8	131.3	3	3.6	63.0	2787.6	4017
			Middle	4.2	100	3.8	5.6	247.8		5	5.7	147.4	6520.7	
			Red	2.2	62	2.4	2.4	106.2		4	4.9	62.0	2743.4	
X	A	N 43 09.638, W 76 20.582	Green	2.0	4	0.2	0.2	8.8	5.9	6	6.5	4.0	177.0	74
			Middle	4.1	1	0.2	0.2	8.8		12	11.8	1.0	44.2	
			Red	2.4	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
X	B	N 43 09.538, W 76 20.389	Green	1.5	0	0.0	0.0	0.0	22.1	0	0.0	0.0	0.0	88
			Middle	4.0	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	2.1	6	1.5	1.5	66.4		11	11.4	6.0	265.5	
X	C	N 43 09.377, W 76 19.721	Green	2.6	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0
			Middle	4.1	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	2.9	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
XIII	A	N 43 09.473, W 76 16.739	Green	2.8	12	1.9	1.9	84.1	29.0 (0.3)	8	9.0	12.0	531.0	221 (15)
			Middle	7.0	3 (1)	1.6 (0.4)	1.6 (0.4)	3 (1)		17 (16)	16.6 (15.5)	3 (1)	132.7 (44.2)	
			Red	2.4	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
XIII	B	N 43 07.458, W 76 16.125	Green	2.0	0	0.0	0.0	0.0	10.3 (41.3)	0	0.0	0.0	0.0	89 (74)
			Middle	5.8	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	4.7	6 (5)	0.7 (2.8)	0.7 (2.8)	31.0 (123.9)		6 (17)	8.6 (15.2)	6 (5)	265.5 (221.2)	
XIII	C	N 43 07.567, W 76 15.494	Green	2.0	0	0.0	0.0	0.0	4.4	0	0.0	0.0	0.0	0
			Middle	5.0	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	1.5	13	0.3	0.3	13.3		6	5.5	0.0	0.0	
XIII	D	N 43 07.270, W 76 15.535	Green	1.8	2	0.001	0.001	0.0	5.9	1	1.5	0.0	0.0	310
			Middle	5.0	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	2.0	21	0.4	0.4	17.7		5	4.9	21.0	929.2	
XIII	E	N 43 07.477, W 76 15.100	Green	2.6	131	46.5	86.3	3818.6	1274.3	14	14.1	243.1	10757.7	3586
			Middle	4.6	0	0.0	0.0	0.0		0	0.0	0.0	0.0	
			Red	1.5	19	0.1	0.1	4.4		3	3.2	0.0	0.0	
XIV	A	N 43 07.236, W 76 14.955	Green	1.7	0	0.0	0.0	0.0	67.8 (23.6)	0	0.0	0.0	0.0	2168 (177)
			Middle	4.7	43 (12)	4.0 (1.6)	4.0 (1.6)	177.0 (70.8)		6 (10)	7.3 (10.2)	43 (12)	1902.7 (531.0)	
			Red	1.3	104	0.6	0.6	26.5		3	3.6	104.0	4601.8	
XIV	B	N 43 07.047, W 76 14.708	Green	1.0	NA (NA)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	9 (9)	9.4 (9.2)	18 (340)	796.5 (15044.3)	4199 (7242)
			Middle	4.4	100	7.5	16.4	725.7		8	8.7	218.7	9675.5	
			Red	1.8	NA (NA)	NA (NA)	NA (NA)	NA (NA)		8 (11)	8.4 (11.4)	48 (151)	2123.9 (6681.4)	

Note: Petit Ponar Dredge Sample Area is 226 cm2.
Results expressed as Zebra mussel (Quagga mussel) when Quagga mussels are present.
XIVB Samples were preserved before a recount for quagga mussels.
XIVBR and XIVBG Number of Mussels per sample are actual counts.

Samples were collected on October 3, 2008.

Table 2. Seneca River Dreissenid Mussel Survey - Fall 2004 through Fall 2008 Comparison of Mean Weight (g/m^2) and Mean Density ($\#/m^2$)

Zone	Transect	Mean Weight (g/m^2) per Transect					Mean Estimated Number of Mussels per m^2 by Transect				
		2004	2005	2006	2007	2008	2004	2005	2006	2007[1)]	2008[1)]
III	A	4025.8	140.7	808.0	8.8	435.1	11987	15433	5760	1608	11001
III	B	2569.0	327.1	789.1	61.9	179.9	9691	5525	6638	4241 (74)	5663
III	C	1392.2	66.2	413.0	10.3	131.3	17860	12133	6449	1740	4017
X	A	549.0	284.4	236.0	1.5	5.9	1500	1796	546	15	74
X	B	444.9	176.5	311.2	8.8	22.1	1692	546	619	88.5 (15)	88
X	C	0.0	1.8	0.0	0	0	0	88	0	0	0
XIII	A	477.2	0.0	19.2	308.3	29.0 (0.3)	1909	0	44	959 (251)	221 (15)
XIII	B	563.3	151.9	272.9	1.5	10.3 (41.3)	2012	826	560	29	89 (74)
XIII	C	0.0	14.4	35.4	19.2	4.4	0	162	2581	118	0
XIII	D	308.6	0.3	2.9	1.5	5.9	1815	59	162	29	310
XIII	E	958.0	1272.8	986.7	427.7	1274.3	5042	3290	4869	2271 (413)	3586
XIV	A	1532.1	0.0	23.6	2166.7	67.8 (23.6)	8157	0	3053	21211 (811)	2168 (177)
XIV	B	3042.7	146.2	1991.2	4246.3	NA (NA)	15445	796	10041	24676 (929)	4199 (7242)

[1)] The 2007 and 2008 results are expressed as Zebra mussel (Quagga mussel) when Quagga mussels are present.

Note: The 2004 data utilized scuba divers for sample collection, and the 2005 through 2008 data utilized the petit ponar dredge for sample collection.

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
Median Length	**5**	**6**	**3**	**5**	**6**	**3**	**3**	**5**	**4**	**6**	**12**	**0**	**0**	**0**	**11**	**0**	**0**	**0**	**8**	**17**	**0**
Mean Length	**5.5**	**6.1**	**4.0**	**4.8**	**6.6**	**3.6**	**3.6**	**5.7**	**4.9**	**6.5**	**11.8**	**0.0**	**0.0**	**0.0**	**11.4**	**0.0**	**0.0**	**0.0**	**9.0**	**16.6**	**0.0**
1	4.8	9.0	10.8	4.6	11.9	11.9	2.6	5.4	11.7	5.2	11.8	0.0	0.0	0.0	19.3	0.0	0.0	0.0	18.9	19.0	0.0
2	4.0	7.5	9.5	2.7	8.2	6.8	4.2	4.0	11.6	5.9					14.2				12.9	17.1	
3	3.6	9.1	9.6	2.5	6.1	2.6	3.2	3.7	19.3	8.6					7.6				7.7	13.8	
4	5.3	7.1	9.9	5.2	8.3	2.0	2.8	3.8	5.8	6.4					9.2				12.5		
5	4.9	10.3	8.1	2.6	13.9	5.9	1.5	9.5	4.8						6.0				5.8		
6	4.5	7.0	10.1	3.7	3.0	6.2	3.7	6.8	4.4						12.3				9.5		
7	4.1	6.8	7.3	5.5	3.7	6.9	3.3	4.2	5.5										4.2		
8	4.8	5.3	6.7	4.8	5.0	5.1	2.3	7.8	3.5										10.6		
9	4.7	3.9	6.8	4.1	6.4	5.1	1.7	8.8	4.1										5.2		
10	4.3	1.8	6.6	4.3	2.8	2.8	1.7	5.2	5.8										8.4		
11	6.0	3.5	6.6	3.9	8.4	2.7	2.4	2.7	6.7										6.7		
12	5.0	8.1	5.9	5.7	5.6	3.4	3.3	8.9	2.2										5.2		
13	4.2	7.0	5.2	3.7	6.9	3.3	1.6	5.9	3.0												
14	4.6	8.2	5.4	4.3	6.7	2.6	1.7	3.3	4.2												
15	4.9	5.2	5.3	6.1	8.5	5.0	1.3	3.9	7.7												
16	4.0	4.5	5.0	5.2	5.1	4.1	2.1	2.7	5.5												
17	5.5	4.1	5.2	6.5	5.3	3.4	2.3	5.1	4.9												
18	1.9	7.4	4.9	5.6	6.6	2.9	1.6	4.4	11.1												
19	5.7	5.1	4.3	4.3	4.8	3.4	1.6	6.3	3.1												
20	4.0	4.2	4.6	5.7	4.7	5.6	1.7	6.5	2.2												
21	3.1	6.2	4.7	2.9	5.6	7.9	1.2	5.7	5.1												
22	4.8	2.2	4.3	2.6	5.1	3.5	1.3	5.0	5.0												
23	6.0	5.6	4.8	4.3	4.8	11.1	9.5	9.6	4.6												
24	4.4	6.5	4.6	5.1	7.1	1.6	8.0	4.5	4.8												
25	3.2	2.8	4.8	5.0	7.1	1.6	6.3	4.3	6.0												
26	3.7	6.7	5.4	4.3	5.6	1.8	3.1	9.1	4.7												
27	6.8	6.4	4.6	9.7	9.9	2.0	3.0	6.1	3.5												
28	5.3	5.7	4.3	6.2	2.4	2.2	1.8	6.1	2.9												
29	4.5	4.9	4.2	1.8	16.8	4.8	4.7	4.1	5.3												
30	6.2	4.7	3.8	4.7	11.8	6.4	2.4	3.6	2.2												
31	2.8	4.0	3.9	4.0	10.2	3.8	3.9	10.5	2.6												
32	2.6	2.6	3.9	9.6	2.5	2.8	3.6	4.0	2.7												
33	2.1	10.3	3.2	4.7	5.8	4.7	2.7	4.1	3.5												
34	3.4	9.3	4.1	6.9	4.6	3.1	3.7	4.3	2.4												
35	3.7	7.5	3.5	5.7	4.5	3.3	5.1	6.7	3.6												
36	7.1	7.9	3.5	3.3	4.7	1.3	3.8	4.5	2.7												
37	5.4	9.6	3.2	4.2	5.2	3.1	4.9	4.0	1.8												
38	6.0	7.6	2.7	5.8	6.1	2.1	5.2	4.6	2.3												
39	3.2	5.9	3.2	6.1	4.6	2.0	1.5	12.1	4.9												
40	2.7	12.1	2.9	7.0	10.2	3.0	3.5	7.6	3.5												
41	2.2	2.4	2.6	1.4	3.3	2.2	4.0	8.0	3.0												
42	3.4	6.3	3.1	3.8	11.4	2.6	5.4	3.8	3.7												
43	6.3	1.4	3.3	4.2	10.6	2.3	9.2	8.1	0.9												
44	2.7	8.8	3.2	9.8	7.3	2.1	4.3	5.3	3.2												

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
45	3.5	9.3	3.1	5.5	10.1	3.4	3.7	4.2	6.6												
46	4.5	5.6	3.0	5.9	8.7	3.1	2.0	5.2	1.9												
47	4.3	9.8	2.5	6.9	3.7	1.6	2.6	3.7	2.1												
48	2.9	3.1	2.4	4.3	4.6	6.4	2.1	4.3	8.5												
49	4.5	3.1	2.9	5.6	4.9	2.4	5.8	8.2	8.2												
50	11.2	2.6	2.7	1.7	7.7	0.7	6.1	2.6	4.4												
51	3.3	3.3	2.6	5.3	3.5	2.7	3.9	4.0	1.7												
52	5.3	3.8	2.7	3.6	7.0	1.4	4.0	12.5	3.0												
53	1.7	6.9	2.3	7.1	5.5	1.5	4.3	3.6	2.6												
54	5.4	7.5	2.2	6.3	6.4	1.9	8.8	8.1	5.3												
55	3.3	3.9	2.6	7.1	3.9	3.0	4.6	8.6	10.1												
56	5.8	10.9	2.3	4.2	10.7	3.8	3.8	4.2	7.1												
57	5.0	6.6	2.2	3.5	4.0	1.8	3.2	4.1	2.0												
58	2.7	9.5	1.9	6.1	5.8	1.5	3.5	8.4	3.5												
59	4.1	4.7	2.0	1.9	8.0	3.4	7.2	3.8	8.0												
60	6.7	6.3	2.4	6.6	3.1	1.8	2.3	3.3	3.5												
61	5.2	8.6	2.1	6.5	9.0	4.0	3.1	7.1	6.0												
62	6.7	6.0	1.8	7.1	8.1	3.9	2.7	6.9	4.9												
63	2.4	7.9	1.8	7.3	4.2	1.1	3.6	9.9													
64	4.0	7.0	2.0	2.7	4.5	3.4		6.7													
65	6.6	4.8	2.4	5.0	6.4	2.9		6.5													
66	5.3	1.5	1.8	1.1	5.0	3.1		7.4													
67	2.8	3.5	1.3	1.9	5.1	4.0		6.3													
68	8.4	3.8	1.4	5.0	12.8	2.4		3.7													
69	8.3	4.6	1.3	4.1	7.0	1.0		6.1													
70	9.7	6.3	0.9	3.9	5.2	1.2		2.7													
71	9.5	5.8	1.4	4.3	6.9	3.9		4.0													
72	11.6	4.7	1.3	3.2	5.7	2.1		3.1													
73	7.8	3.4		5.7	3.3	3.8		4.2													
74	6.2	5.6		2.9	4.3	4.1		3.8													
75	8.5	7.8		4.7	4.6	1.9		3.5													
76	4.1	8.1		7.4	3.5	4.5		5.4													
77	3.2	7.5		6.0	5.5	3.6		4.2													
78	8.9	4.2		2.8	7.1	2.6		4.5													
79	5.7	5.7		5.0	5.2	3.6		5.1													
80	7.8	2.6		3.4	6.2	2.8		7.2													
81	4.2	1.5		2.6	7.0	3.3		6.2													
82	6.5	7.6		6.4	5.9	3.5		9.2													
83	6.8	6.5		8.1	3.4	2.8		11.4													
84	7.4	11.5		2.8	15.0	3.6		4.8													
85	4.6	2.4		3.4	5.8	8.3		6.3													
86	9.3	9.4		5.2	4.9	5.1		3.9													
87	8.6	8.2		3.8	7.3	2.7		4.2													
88	7.2	5.4		2.8	8.4	1.4		6.0													
89	8.8	7.1		2.5	5.4	1.6		3.2													
90	9.4	4.5		2.9	8.3	5.2		4.2													

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
91	8.0	7.1		3.3	9.8	2.8		4.6													
92	9.5	9.0		8.3	7.5	8.1		5.5													
93	6.5	7.9		3.9	4.5	7.2		5.2													
94	7.0	4.1		1.6	8.8	6.1		6.0													
95	4.0	7.6		4.6	6.7	6.8		5.2													
96	4.8	2.9		4.7	8.7	3.5		8.6													
97	9.6	3.6		5.5	6.2	1.3		2.9													
98	9.5	9.3		9.2	5.2	4.4		10.1													
99	8.5	6.3		8.7	6.7	2.5		4.7													
100	9.1	7.6		8.6	4.8	5.7		6.3													
101																					
102																					
103																					
104																					
105																					
106																					
107																					
108																					
109																					
110																					
111																					
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125																					
126																					
127																					
128																					
129																					
130																					
131																					

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
Median Length	**0**	**0**	**6**	**0**	**0**	**6**	**1**	**0**	**5**	**14**	**0**	**3**	**0**	**6**	**3**	**9**	**8**	**8**
Mean Length	**0.0**	**0.0**	**8.6**	**0.0**	**0.0**	**5.5**	**1.5**	**0.0**	**4.9**	**14.1**	**0.0**	**3.2**	**0.0**	**7.3**	**3.6**	**9.4**	**8.7**	**8.4**
1	0.0	0.0	5.8	0.0	0.0	8.3	1.2	0.0	7.6	16.2	0.0	6.2	0.0	7.0	3.8	10.7	8.2	4.6
2			5.9			6.2	1.7		4.8	12.7		4.0		9.9	2.6	8.4	8.1	13.3
3			12.6			7.9			9.1	11.6		2.3		7.4	2.3	12.9	20.0	11.2
4			6.0			7.0			7.1	15.4		4.2		7.1	2.7	9.5	11.4	9.0
5			16.0			3.6			7.6	14.6		5.2		4.8	4.1	8.7	9.8	12.5
6			5.3			8.0			3.9	13.1		2.3		5.0	6.7	14.8	8.4	11.4
7						5.1			5.8	13.5		4.6		5.2	3.2	9.2	6.8	9.8
8						4.6			4.5	13.2		2.5		4.5	3.4	7.6	6.5	7.2
9						6.6			4.2	11.2		3.6		7.8	3.7	9.0	12.1	4.2
10						5.6			3.6	13.3		2.6		7.7	2.5	7.6	9.5	10.8
11						3.1			3.8	18.1		2.7		5.8	3.1	10.4	6.1	10.3
12						3.5			7.1	15.5		3.4		6.0	4.8	7.9	11.9	8.2
13						2.6			6.0	17.1		3.4		6.9	4.4	9.7	5.2	17.3
14									1.9	26.0		2.8		9.2	3.8	12.4	11.3	9.3
15									5.7	18.7		2.5		8.5	3.5	8.9	7.6	10.2
16									3.4	16.9		1.9		5.9	5.3	7.4	8.1	9.7
17									4.7	16.1		1.8		6.0	2.5	5.1	10.1	12.0
18									3.1	16.6		2.6		4.7	2.6	9.2	13.8	5.5
19									2.8	14.3		2.6		3.3	7.0		9.8	5.1
20									4.0	17.5				4.1	5.9		7.8	8.6
21									2.9	10.7				5.9	3.6		7.7	6.1
22										17.0				3.1	2.3		8.3	9.0
23										15.9				18.0	4.1		9.0	12.2
24										16.0				21.1	4.1		8.3	12.6
25										13.9				13.1	5.2		6.1	5.1
26										16.3				13.9	5.0		7.7	10.0
27										16.7				11.5	5.1		9.2	10.9
28										14.4				10.5	3.7		13.6	8.9
29										19.5				12.1	4.5		5.2	6.3
30										16.1				12.9	3.2		9.6	5.3
31										16.7				8.8	4.1		11.6	6.4
32										13.9				5.7	5.9		10.8	7.8
33										16.0				10.9	3.0		5.7	5.4
34										12.3				4.8	2.7		11.6	10.0
35										14.9				4.8	3.2		10.4	6.0
36										13.3				3.8	4.6		6.7	7.0
37										13.8				5.3	2.4		6.4	7.5
38										13.4				4.2	4.4		7.4	8.5
39										16.2				4.1	3.6		9.1	7.4
40										13.4				4.2	3.4		10.4	6.9
41										12.6				3.2	3.2		8.4	5.0
42										12.6				5.0	4.1		7.8	9.7
43										11.3				2.1	4.0		11.1	6.6
44										11.4					4.1		12.0	4.8

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
45										15.4					4.1		10.0	11.0
46										13.7					3.2		7.9	7.4
47										14.0					3.1		8.0	5.1
48										13.0					3.2		7.8	4.5
49										13.9					3.4		9.7	
50										12.9					4.1		8.1	
51										11.7					4.5		8.4	
52										15.7					5.6		6.5	
53										12.2					3.2		11.9	
54										11.3					3.3		12.4	
55										14.1					3.5		4.3	
56										12.0					2.6		10.0	
57										13.5					5.4		10.4	
58										14.6					3.5		8.8	
59										12.5					4.6		15.8	
60										14.4					6.0		7.9	
61										13.5					4.5		8.4	
62										13.1					3.2		6.9	
63										9.7					3.7		8.5	
64										12.7					3.5		9.8	
65										10.9					1.8		9.9	
66										11.6					4.6		9.3	
67										14.9					2.1		5.4	
68										12.8					3.2		8.5	
69										12.6					5.0		7.0	
70										13.4					2.0		10.2	
71										14.1					2.1		7.4	
72										15.0					2.4		10.1	
73										11.5					2.1		5.0	
74										12.7					3.7		9.5	
75										13.2					6.8		7.5	
76										11.7					2.2		7.5	
77										12.7					1.8		8.2	
78										13.5					3.2		7.9	
79										12.3					1.7		8.3	
80										10.9					2.2		11.0	
81										12.6					2.0		6.3	
82										12.8					2.1		8.6	
83										13.7					6.3		8.8	
84										14.1					4.8		7.4	
85										10.3					3.3		5.5	
86										10.0					2.2		4.3	
87										12.5					2.6		6.1	
88										11.7					3.3		6.5	
89										11.1					1.5		7.8	
90										12.5					3.0		8.5	

Table 3a. Seneca River Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
91										17.0					2.6		7.9	
92										14.6					2.4		7.9	
93										16.1					3.0		8.1	
94										15.0					4.1		8.7	
95										16.0					2.8		9.5	
96										22.6					3.3		9.3	
97										16.4					3.7		7.1	
98										17.9					3.1		10.8	
99										12.5					2.3		5.4	
100										16.3					3.3		5.2	
101										11.7					3.1			
102										15.0					3.3			
103										13.0					3.4			
104										13.4					4.6			
105										16.2								
106										10.8								
107										13.4								
108										14.6								
109										13.2								
110										14.3								
111										14.1								
112										13.7								
113										14.5								
114										13.9								
115										11.7								
116										13.7								
117										14.6								
118										14.7								
119										13.1								
120										12.9								
121										13.6								
122										16.3								
123										12.0								
124										15.5								
125										13.9								
126										12.0								
127										14.9								
128										13.0								
129										16.5								
130										13.6								
131										14.3								

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
Median Length	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**16**	**0**
Mean Length	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**15.5**	**0.0**
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.5	0.0
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
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16																					
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36																					
37																					
38																					
39																					
40																					
41																					
42																					
43																					

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
44																					
45																					
46																					
47																					
48																					
49																					
50																					
51																					
52																					
53																					
54																					
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56																					
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59																					
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61																					
62																					
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64																					
65																					
66																					
67																					
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80																					
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83																					
84																					
85																					
86																					
87																					
88																					

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone III			Zone III			Zone III			Zone X			Zone X			Zone X			Zone XIII		
Transect	Transect A			Transect B			Transect C			Transect A			Transect B			Transect C			Transect A		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
89																					
90																					
91																					
92																					
93																					
94																					
95																					
96																					
97																					
98																					
99																					
100																					

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
Median Length	**0**	**0**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**9**	**0**	**11**
Mean Length	**0.0**	**0.0**	**15.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**10.2**	**0.0**	**9.2**	**0.0**	**11.4**
1	0.0	0.0	16.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	0.0	7.9	0.0	25.0
2			20.6											13.9		9.2		17.8
3			16.8											12.8		7.0		17.3
4			12.9											7.6		6.2		17.9
5			8.9											11.1		6.5		17.8
6														9.8		7.7		12.4
7														9.3		13.2		11.7
8														9.6		6.1		13.5
9														9.5		7.0		11.8
10														9.1		8.0		14.9
11														8.8		11.4		14.9
12														6.8		8.2		14.1
13																12.6		10.5
14																11.6		8.6
15																12.0		11.0
16																5.6		9.4
17																8.3		11.1
18																8.1		14.4
19																7.4		19.3
20																9.5		15.0
21																4.9		13.0
22																8.6		12.6
23																7.3		11.7
24																10.7		12.3
25																12.3		11.1
26																12.1		11.1
27																6.6		10.1
28																8.8		15.6
29																9.6		10.7
30																7.3		11.1
31																10.7		10.4
32																11.8		9.9
33																7.6		9.9
34																7.8		10.1
35																10.0		19.0
36																8.7		17.5
37																9.8		12.1
38																13.2		13.1
39																8.6		13.1
40																9.0		12.6
41																12.2		11.9
42																12.6		7.3
43																9.0		11.1

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
44																12.5		6.6
45																8.9		7.2
46																8.5		6.7
47																14.2		9.0
48																13.2		16.0
49																7.5		9.9
50																6.8		8.6
51																10.0		8.5
52																13.6		12.1
53																12.4		9.6
54																7.6		12.8
55																9.8		12.4
56																7.8		14.5
57																9.5		13.1
58																9.6		11.8
59																8.5		8.1
60																12.7		21.4
61																9.2		12.1
62																6.7		11.2
63																8.9		13.3
64																7.0		8.6
65																7.7		9.3
66																7.5		10.3
67																11.4		12.6
68																8.9		9.0
69																10.5		6.9
70																10.0		16.7
71																8.9		18.3
72																7.7		5.0
73																12.6		6.6
74																8.0		7.0
75																9.9		6.3
76																10.8		5.9
77																6.5		7.9
78																5.2		10.3
79																9.5		8.5
80																9.0		9.3
81																8.7		12.9
82																10.2		11.5
83																9.8		15.1
84																10.8		14.5
85																13.9		12.8
86																10.0		13.4
87																8.7		9.0
88																8.2		7.3

Table 3b. Seneca River Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data

Zone	Zone XIII			Zone XIII			Zone XIII			Zone XIII			Zone XIV			Zone XIV		
Transect	Transect B			Transect C			Transect D			Transect E			Transect A			Transect B		
Location	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red	Green	Middle	Red
89																7.1		6.0
90																6.0		8.9
91																7.0		7.7
92																7.1		11.8
93																5.0		5.7
94																12.3		11.8
95																11.2		5.4
96																9.5		9.3
97																8.5		9.0
98																7.1		5.5
99																8.1		9.7
100																9.3		5.8

Table 4. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Length and Weight Data Summary

Zone	Transect	Transect Coordinates	Water Depth at Sample Collection (m)	Water Depth Section/Range (m)	Number of Mussels Per Sub-Sample	Weight Per Sub-Sample (g)	Weight Per Entire Sample (g)	Total Weight (g/m^2)	Mean Weight (g/m^2) per Transect	Mean Weight (g/m^2) per Zone	Median Mussel Length (mm)	Mean Mussel Length (mm)	Total Number of Mussels Per Sample	Estimated Total Number of Mussels per m^2	Mean Estimated Number of Mussels per m^2 by Transect	Mean Estimated Number of Mussels per m^2 by Zone
A	1	N 43 06.238, W 76 13.192	0.8	0-1.5	1	0.1	0.1	4.4	16.2	297.9	8	8.4	1.0	44.2	2492 (15)	2721 (1328)
			1.8	1.5-3.0	0	0.0	0.0	0.0			0	0.0	0.0	0.0		
			3.7	3.0-4.5	150	0.9	1.0	44.2			4 (9)	3.9 (8.5)	168 (1)	7433.6 (44.2)		
A	2	N 43 06.615, W 76 13.760	1.0	0-1.5	21	3.2	3.2	141.6	579.6		7	8.1	21.0	929.2	2950 (2640)	
			2.0	1.5-3.0	100	12.8	24.6	1088.5			9 (8)	9.6 (8.2)	129 (116)	5707.9 (5132.7)		
			3.6	3.0-4.5	50 (63)	5.2 (6.3)	11.5	508.8			7 (10)	8.1 (9.6)	50 (63)	2212.4 (2787.6)		
B	1	N 43 06.894, W 76 14.309	0.9	0-1.5	95 (5)	5.6 (0.3)	7.3	323.0	650.4	650.4	8 (7)	7.8 (7.3)	114 (13)	5044.2 (575.2)	2522 (4558)	2522 (4558)
			1.5	1.5-3.0	30 (70)	2.4 (8.0)	19.3	854.0			7 (10)	8 (10.1)	29 (155)	1283.2 (6858.4)		
			3.7	3.0-4.5	32 (68)	1.8 (7.6)	17.5	774.3			7 (10)	7.4 (9.9)	28 (141)	1238.9 (6238.9)		
C	1	N 43 06.348, W 76 14.547	1.0	0-1.5	7	0.3	0.3	13.3	1097.3	855.5	7	6.9	7.0	309.7	5487 (3643)	5627 (2980)
			2.2	1.5-3.0	96 (4)	9.3 (1.9)	12.5	553.1			9 (5)	8.6 (5.1)	124 (2)	5486.7 (88.5)		
			3.3	3.0-4.5	44 (56)	6.3 (16.2)	61.6	2725.7			9 (6)	8.9 (7.3)	241 (245)	10663.7 (10840.7)		
C	2	N 43 05.551, W 76 13.907	1.2	0-1.5	79 (21)	4.5 (1.3)	12.3	544.2	613.6		7 (6)	7.6 (7.3)	198 (23)	8761.1 (1017.7)	5767 (2316)	
			2.7	1.5-3.0	54 (46)	5.5 (8.4)	25.8	1141.6			8 (9)	8.5 (9.7)	175 (114)	7743.4 (5044.2)		
			3.4	3.0-4.5	18 (20)	1.4 (2.1)	3.5	154.9			8 (10)	8.3 (10.2)	18 (20)	796.5 (885.0)		
D	1	N 43 05.253, W 76 13.026	0.9	0-1.5	50 (50)	25.5 (12.2)	45.9	2031.0	775.8	472.7	11 (8)	11.1 (9.7)	132 (92)	5840.7 (4070.8)	2581 (2183)	1460 (1092)
			1.7	1.5-3.0	41 (40)	2.3 (1.5)	3.8	168.1			8 (8)	7.5 (7.5)	41 (40)	1814.2 (1769.9)		
			4.0	3.0-4.5	2 (16)	0.3 (2.6)	2.9	128.3			11 (11)	11.3 (11.7)	2 (16)	88.5 (708.0)		
D	2	N 43 04.877, W 76 12.594	1.0	0-1.5	0	0.0	0.0	0.0	169.6		0	0.0	0.0	0.0	339	
			2.9	1.5-3.0	18	11.4	11.4	504.4			16	14.2	18.0	796.5		
			3.5	3.0-4.5	5	0.1	0.1	4.4			4	3.5	5.0	221.2		
E	1	N 43 04.318, W 76 12.172	1.2	0-1.5	50 (50)	7.1 (6.5)	31.3	1385.0	1435.1	1435.1	8 (10)	8.8 (10.0)	163 (177)	7212.4 (7831.9)	5782 (12448)	5782 (12448)
			2.1	1.5-3.0	50 (50)	6.7 (7.1)	24.8	1097.3			7 (9)	7.8 (9.5)	101 (178)	4469.0 (7876.1)		
			4.4	3.0-4.5	50 (50)	3.1 (11.0)	41.2	1823.0			7 (9)	7.0 (9.5)	128 (489)	5663.7 (21637.2)		
F	1	N 43 04.095, W 76 11.583	1.1	0-1.5	92 (8)	11.0 (2.7)	19.3	854.0	1619.5	1619.5	8 (11)	8.9 (12.4)	185 (10)	8185.8 (442.5)	7965 (6785)	7965 (6785)
			2.4	1.5-3.0	50 (50)	12.3 (2.4)	24.5	1084.1			10 (5)	10.2 (5.0)	113 (66)	5000.0 (2920.4)		
			4.0	3.0-4.5	50 (50)	8.0 (7.6)	66.0	2920.4			10 (6)	9.7 (6.1)	242 (384)	10708.0 (16991.2)		
G	1	N 43 04.037, W 76 11.431	1.4	0-1.5	68 (5)	11.5 (2.7)	14.2	628.3	324.5	324.5	9 (20)	9.8 (14.0)	68 (5)	3008.8 (221.2)	2522 (501)	2522 (501)
			2.6	1.5-3.0	78	3.9	3.9	172.6			7	7.4	78.0	3451.3		
			3.7	3.0-4.5	25 (29)	1.9 (2.0)	3.9	172.6			7 (8)	7.2 (8.6)	25 (29)	1106.2 (1283.2)		
H	1	N 43 03.951, W 76 11.065	0.8	0-1.5	6	0.4	0.4	17.7	7.4	272.1	7	6.8	6.0	265.5	103	8120 (244)
			2.2	1.5-3.0	0	0.0	0.0	0.0			0	0.0	0.0	0.0		
			3.6	3.0-4.5	1	0.1	0.1	4.4			3	2.6	1.0	44.2		
H	2	N 43 05.623, W 76 12.113	0.5	0-1.5	15 (1)	2.3 (0.2)	2.5	110.6	536.9		9 (12)	9.3 (11.7)	15 (1)	663.7 (44.2)	16136 (487)	
			2.7	1.5-3.0	82 (18)	6.1 (1.3)	23.8	1053.1			5 (7)	5.5 (7.4)	777 (19)	34380.5 (840.7)		
			3.6	3.0-4.5	87 (13)	3.6 (0.6)	10.1	446.9			8 (6)	7.9 (7.4)	302 (13)	13362.8 (575.2)		

Note: Petit Ponar Dredge Sample Area is 226 cm2.
Results expressed as Zebra mussel (Quagga mussel) when Quagga mussels are present.
Weights represent the combined Dreissenid, Zebra and Quagga mussel, weight unless otherwise noted.

Note: Samples were collected on October 10, 2008.

Table 5. Onondaga Lake Dreissenid Mussel Survey - Fall 2002, and Fall 2005 through Fall 2008 Comparison of Density (#/m^2)

Zone	Water Depth Section/Range (m)	Mean Estimated Total Number of Mussels per m^2 by Depth					Mean Estimated Number of Mussels per m^2 by Zone				
		2002	2005	2006	2007	2008	2002 (0-4.5 M)	2005 (0-4.5 M)	2006 (0-4.5 M)	2007 (0-4.5 M)	2008 (0-4.5 M)
A	0 -1.5	2036.2	66.4	774.4	17704.0 (199.1)	486.7	1834	1187	5465	14559 (229)	2721 (1328)
	1.5 - 3.0	3465.5	3385.0	6216.4	21084.2 (398.3)	2854.0 (2566.4)					
	3.0 - 4.5	0.0	110.6	9403.5	4889.4 (88.5)	4823.0 (1415.9)					
B	0 -1.5	0.0	0.0	13877.7	14896.8	5044.2 (575.2)	0	133	4803	12148	2522 (4558)
	1.5 - 3.0	0.0	221.2	531.0	21238.9	1283.2 (6858.4)					
	3.0 - 4.5	0.0	177.0	0.0	309.7	1238.9 (6238.9)					
C	0 -1.5	754.7	44.8	3340.7	4002.3	4535.4 (508.9)	514	1040	1991	12396 (2522)	5627 (2980)
	1.5 - 3.0	788.6	2013.3	2522.2	16017.7 (1305.3)	6615.1 (2566.4)					
	3.0 - 4.5	0.0	951.3	110.6	17455.8 (2477.9)	5730.1 (5862.9)					
D	0 -1.5	3941.9	1017.7	199.1	4911.5 (132.8)	2920.4 (2035.4)	1356	907	774	18791 (281)	1460 (1092)
	1.5 - 3.0	124.8	774.4	221.2	4292.1 (132.8)	1305.4 (885.0)					
	3.0 - 4.5	0.0	929.2	1902.7	47168.2 (575.2)	154.9 (354.0)					
E	0 -1.5	225.0	575.2	2522.1	20452.3	7212.4 (7831.9)	1460	752	1549	7806	5782 (12448)
	1.5 - 3.0	4154.5	442.5	619.5	619.5	4469.0 (7876.1)					
	3.0 - 4.5	0.0	1238.9	1504.4	2345.1	5663.7 (21637.2)					
F	0 -1.5	3069.8	929.2	88.5	6761.5	8185.8 (442.5)	1141	3319	59	13211	7965 (6785)
	1.5 - 3.0	351.7	8274.3	88.5	26737	5000.0 (2920.4)					
	3.0 - 4.5	0.0	752.2	0.0	6134.4	10708.0 (16991.2)					
G	0 -1.5	0.0	0.0	0.0	354	3008.8 (221.2)	0	15	0	2383	2522 (501)
	1.5 - 3.0	0.0	44.2	0.0	6795.2	3451.3					
	3.0 - 4.5	0.0	0.0	0.0	0	1106.2 (1283.2)					
H	0 -1.5	2650.6	22.1	2500.0	3473.5	464.6 (22.1)	1102	789	1667	2463	8120 (244)
	1.5 - 3.0	655.9	2256.7	1371.7	1283.2	17190.3 (420.4)					
	3.0 - 4.5	0.0	88.5	1128.3	2632.7	6703.5 (287.6)					
Total 0-1.5 M		12678	2655	23302	72556 (332)	31858 (11637)					
Total 1.5 to 3.0 M		9541	17411	11570	98068 (1836)	42168 (24093)					
Total 3.0 to 4.5 M		0	4248	14049	80935 (3142)	36128 (54071)					
Total 0 to 3.0 M		22219	20067	34873	170624 (2168)	74027 (35730)	**Mean**	926	1018	2038	10470 (379)	4590 (3742)
Total 0 to 4.5 M		22219	24314	48922	251559 (5310)	110155 (89801)	**Sum**	7406	8142	16307	83757 (3032)	36719 (29936)

Note: Results expressed as Zebra mussel (Quagga mussel) when Quagga mussels are present.
The 2002 data utilized scuba divers for sample collection, and the 2005 through 2008 data utilized the petit ponar dredge for sample collection.

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
Median Length	**8**	**0**	**4**	**7**	**9**	**7**	**8**	**7**	**7**	**7**	**9**	**9**	**7**	**8**	**8**	**11**	**8**	**11**	**0**	**16**	**4**
Mean Length	**8.4**	**0.0**	**3.9**	**8.1**	**9.6**	**8.1**	**7.8**	**8.0**	**7.4**	**6.9**	**8.6**	**8.9**	**7.6**	**8.5**	**8.3**	**11.1**	**7.5**	**11.3**	**0.0**	**14.2**	**3.5**
1	8.4	0.0	3.9	13.4	10.7	12.5	8.7	15.3	10.6	9.4	11.7	9.2	13.3	10.2	13.3	19.8	12.8	11.2	0.0	21.5	4.3
2			4.5	20.3	12.6	4.6	10.0	11.8	7.3	6.8	10.0	10.9	14.5	9.2	9.8	16.1	10.1	11.3		24.9	4.1
3			8.2	11.0	5.8	16.9	9.4	11.8	9.8	5.9	11.1	9.1	4.5	13.5	6.6	16.5	12.6			11.8	3.8
4			9.1	9.9	8.2	14.7	10.8	11.3	6.5	6.7	12.0	11.2	6.0	14.6	9.6	15.0	8.5			25.1	2.7
5			7.3	5.2	6.0	15.0	11.4	10.3	9.0	4.8	10.6	11.5	7.2	12.0	10.7	13.9	9.3			26.3	2.4
6			6.3	6.9	18.6	7.7	9.6	10.4	6.7	5.6	12.8	8.3	8.2	8.7	8.6	18.0	11.3			18.2	
7			7.7	5.9	4.6	14.2	9.8	9.7	5.9	8.9	13.8	11.7	10.5	12.4	10.4	16.2	9.9			15.6	
8			3.9	6.9	8.4	18.5	11.6	9.6	7.5		11.8	10.5	6.0	6.3	8.5	8.5	7.7			19.3	
9			4.3	5.1	11.2	3.9	10.9	9.5	10.6		7.3	7.4	5.3	13.6	6.0	12.5	10.3			19.0	
10			6.6	6.0	5.3	4.5	11.0	8.7	9.2		11.5	10.4	6.2	12.2	8.4	15.3	9.9			16.0	
11			6.0	8.8	10.0	13.9	10.8	7.7	9.8		11.1	12.7	8.3	11.2	8.5	7.4	10.7			3.7	
12			6.2	7.0	7.5	14.3	8.4	8.3	8.3		7.1	9.2	5.1	9.3	8.3	13.7	10.8			3.2	
13			4.8	9.3	13.4	9.4	8.0	8.4	9.7		9.4	8.2	5.7	7.7	8.3	9.8	6.8			18.6	
14			5.6	6.6	14.6	8.0	8.7	6.8	4.3		8.5	9.2	10.1	3.4	6.1	15.0	8.0			7.9	
15			3.9	9.4	8.2	6.2	11.1	7.8	8.4		9.1	4.5	5.9	7.8	5.7	13.7	6.0			9.7	
16			2.5	8.6	12.2	12.0	9.2	7.4	7.3		9.4	9.2	9.6	8.0	5.3	8.9	9.1			9.0	
17			2.7	3.3	13.1	10.9	9.7	6.9	7.8		13.1	10.4	5.8	9.9	7.3	18.5	9.2			2.3	
18			2.8	7.9	6.3	2.3	10.4	6.4	8.4		15.2	11.6	5.1	7.8	8.1	5.3	9.5			2.6	
19			2.9	5.8	22.7	6.6	10.1	6.7	5.9		9.0	7.5	7.3	7.0		9.6	9.0				
20			2.1	9.0	7.1	4.5	10.3	6.5	8.8		10.5	7.8	8.7	8.9		12.8	11.2				
21			2.8	4.0	24.0	3.3	10.0	6.3	4.7		8.7	8.4	3.8	14.8		11.4	8.0				
22			1.9		13.7	6.2	10.2	5.1	8.2		12.9	9.0	8.2	13.0		16.6	6.6				
23			1.4		5.5	11.1	9.4	7.0	6.0		9.4	9.2	5.8	5.8		13.5	6.9				
24			3.3		8.6	11.3	10.0	5.3	4.3		10.8	11.1	5.4	9.5		8.7	9.1				
25			4.0		15.3	6.3	10.0	7.1	6.2		9.7	9.8	9.7	11.4		9.4	5.6				
26			1.6		10.0	5.0	10.3	6.3	7.0		8.7	8.1	8.8	7.9		6.9	4.4				
27			2.7		8.0	3.9	9.0	5.3	6.6		11.8	8.2	13.6	6.8		9.7	6.9				
28			3.3		5.2	6.8	10.3	5.7	3.7		12.8	9.3	4.6	8.7		10.0	6.4				
29			2.1		7.1	7.0	8.9	2.7			7.7	8.2	4.1	11.7		10.8	5.6				
30			2.3		7.4	4.0	9.2				9.7	9.0	10.1	10.2		10.5	4.1				
31			2.1		7.2	5.5	8.6				7.9	9.4	8.9	5.6		10.1	7.8				
32			1.6		7.4	6.4	8.4				10.6	11.1	6.6	12.7		7.2	4.8				
33			4.5		7.2	7.4	8.3				10.3	9.3	10.3	7.4		7.1	4.1				
34			2.6		6.5	10.2	9.5				9.7	11.0	7.2	10.3		7.6	3.2				
35			4.9		12.8	8.0	8.6				10.1	8.7	4.6	7.2		8.4	5.3				
36			3.2		10.4	8.4	8.9				11.3	8.4	6.8	9.2		6.4	5.0				
37			3.7		11.8	8.2	8.1				6.0	7.6	5.2	8.8		6.4	5.3				
38			4.2		8.4	6.9	8.4				9.3	8.8	4.8	9.2		5.1	4.3				
39			4.7		9.1	7.9	8.7				9.8	7.6	10.4	6.0		4.2	3.4				
40			4.9		14.2	4.3	8.2				7.2	8.7	6.3	6.8		20.9	3.3				
41			5.4		9.1	8.2	7.8				10.0	8.1	5.3	10.0		14.6	2.8				
42			2.5		9.9	6.1	8.2				9.4	6.7	5.4	10.4		13.5					

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
43			2.6		6.5	4.8	7.8				6.9	6.8	6.5	5.2		11.8					
44			2.9		10.1	10.2	6.7				8.8	6.6	5.6	7.0		15.0					
45			3.4		7.3	4.7	8.2				9.4	8.7	5.0	5.6		13.5					
46			3.0		12.3	7.1	7.9				8.6	7.5	9.5	13.5		8.8					
47			3.0		14.5	5.0	7.8				9.6	7.2	5.7	11.7		13.6					
48			3.1		8.0	5.2	9.1				5.1	8.1	6.7	11.5		7.2					
49			4.2		16.1	6.6	7.1				5.8	7.2	7.1	7.7		8.3					
50			3.7		8.2	7.1	8.2				5.2	8.1	9.5	7.7		17.7					
51			2.6		10.4		8.7				6.3	6.6	8.4	9.3		11.3					
52			3.4		7.3		7.9				7.6	6.7	8.1	5.0		12.9					
53			2.3		6.9		8.3				9.1	4.4	8.4	7.8		11.1					
54			3.9		10.7		7.4				7.3	4.0	6.6	8.9		10.1					
55			2.1		10.9		8.9				8.4	4.3	10.1	7.5		12.6					
56			3.4		7.0		9.0				9.6	5.3	6.5	6.0		11.1					
57			3.2		11.4		7.9				7.6	4.3	9.3	6.2		6.5					
58			6.1		9.0		7.3				7.3	3.3	5.4	3.8		5.6					
59			4.2		7.3		7.7				8.5	3.2	8.7	7.4		5.6					
60			3.8		9.9		7.6				9.1	4.2	8.1	13.6		7.6					
61			2.9		8.6		7.2				6.5	19.7	4.2	11.9		4.2					
62			4.8		7.8		7.8				5.1	13.7	12.1	9.5		21.8					
63			3.4		6.7		6.8				7.4	10.6	9.0	7.7		3.9					
64			3.7		11.6		6.9				6.7	11.6	4.8	6.6		13.0					
65			2.8		6.6		7.5				4.8	12.5	9.2	5.6		4.2					
66			1.9		10.3		7.7				5.8	8.8	10.5	10.3		15.9					
67			4.3		9.1		7.2				3.4	9.5	7.3	7.9		15.6					
68			4.0		8.8		7.6				8.5	8.4	9.4	7.2		12.9					
69			4.9		10.8		7.0				4.9	10.2	8.3	9.6		16.3					
70			3.8		10.6		7.1				5.7	8.8	8.2	10.0		19.2					
71			5.2		11.6		7.5				6.5	11.6	9.6	10.5		14.8					
72			5.4		6.4		6.9				7.6	9.4	3.2	7.5		12.2					
73			4.7		10.7		6.9				8.7	8.9	11.3	6.1		19.1					
74			4.5		11.0		6.8				7.3	8.7	12.0	6.3		8.3					
75			3.8		7.7		7.1				6.3	6.9	11.0	6.5		7.8					
76			5.1		6.5		6.8				8.4	8.0	11.3	7.9		7.2					
77			4.0		9.9		6.4				4.4	7.3	6.3	6.3		13.7					
78			4.2		10.5		6.2				3.6	8.9	9.2	11.0		12.0					
79			3.7		11.0		6.4				5.1	7.2	6.1	8.1		7.6					
80			4.4		6.6		6.5				6.9	8.0	6.7	7.9		0.5					
81			4.4		4.6		6.0				7.5	7.5	4.3	9.8		12.5					
82			5.2		5.2		5.8				6.5	10.2	6.7	7.0		9.6					
83			5.9		7.3		6.0				11.8	12.9	6.7	7.6		12.3					
84			3.0		8.4		5.6				10.7	10.4	4.6	8.2		5.7					
85			2.7		7.8		5.1				6.4	9.7	9.0	7.5		12.8					
86			2.6		11.0		4.8				8.4	13.2	8.8	7.4		4.8					

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
87			2.3		13.1		5.2				4.6	12.8	7.1	5.9		8.1					
88			3.8		10.8		2.7				9.6	10.1	6.8	6.2		8.8					
89			4.1		12.9		2.3				7.9	10.9	6.8	6.6		6.2					
90			3.7		9.3		3.9				9.1	9.8	6.3	7.8		9.1					
91			3.6		7.1		6.4				8.5	12.4	10.2	6.1		14.2					
92			4.0		8.0		5.3				9.1	10.4	10.4	5.2		13.5					
93			4.1		8.1		5.2				9.0	8.8	12.6	7.1		11.3					
94			3.2		8.3		3.2				7.5	11.2	8.7	7.8		10.7					
95			3.4		8.5		4.3				6.6	6.0	4.3	5.6		4.1					
96			3.5		10.0		4.7				9.3	8.0	7.1	4.5		4.4					
97			3.0		9.9		5.8				9.3	8.7	4.8	4.0		18.9					
98			3.8		6.9		3.5				7.6	8.7	7.1	7.0		17.3					
99			2.9		8.9		5.1				7.6	7.9	13.0	7.6		9.0					
100			3.1		7.9		5.5				6.8	8.1	5.0	10.4		10.5					

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
Median Length	**8**	**7**	**7**	**8**	**10**	**10**	**9**	**7**	**7**	**7**	**0**	**3**	**9**	**5**	**8**
Mean Length	**8.8**	**7.8**	**7.0**	**8.9**	**10.2**	**9.7**	**9.8**	**7.4**	**7.2**	**6.8**	**0.0**	**2.6**	**9.3**	**5.5**	**7.9**
1	18.1	15.3	12.3	9.7	13.7	13.9	20.4	9.0	7.0	10.0	0.0	2.6	13.4	9.0	4.8
2	13.7	16.7	12.0	12.2	20.8	12.4	18.4	7.4	6.7	9.3			17.7	5.0	7.1
3	11.0	14.2	11.6	15.6	21.2	10.6	21.1	10.0	7.1	4.9			8.5	4.0	6.2
4	6.9	8.8	13.3	16.1	19.7	12.8	15.1	4.0	7.5	7.7			10.0	4.9	6.3
5	7.3	13.9	11.9	15.7	19.9	11.8	15.5	11.5	13.7	7.0			7.5	4.4	6.4
6	12.2	6.2	9.7	18.7	14.1	13.9	16.9	8.1	11.3	2.1			11.2	4.1	5.9
7	8.2	8.6	9.9	14.3	16.5	5.5	14.3	9.4	9.1				8.4	4.2	7.8
8	6.0	11.3	9.7	13.5	17.1	14.1	14.1	10.3	9.4				5.2	2.7	6.9
9	7.1	5.7	9.3	12.5	14.2	11.4	13.8	12.9	10.1				11.7	2.5	8.7
10	8.2	8.8	11.7	15.9	15.8	13.2	15.2	9.3	5.4				8.0	2.5	9.0
11	11.5	5.7	9.3	13.5	16.6	5.5	13.5	5.7	10.3				11.0	2.7	7.5
12	9.3	4.6	10.0	11.5	15.7	12.6	12.7	5.4	6.7				9.3	4.5	7.0
13	5.7	12.7	9.1	11.9	15.0	12.2	13.1	8.4	8.1				6.9	3.8	10.3
14	3.1	12.7	7.8	12.1	16.8	11.1	12.9	7.1	5.3				5.2	4.0	9.6
15	5.9	5.6	8.7	9.2	19.7	10.9	12.2	4.5	9.4				5.0	4.0	4.6
16	6.9	16.3	8.1	11.6	15.2	11.4	11.8	4.1	6.5					3.3	6.8
17	17.1	10.4	6.8	11.1	15.6	7.8	12.1	4.4	6.9					2.8	12.3
18	10.6	5.5	7.5	11.3	15.5	6.4	12.1	4.4	8.3					3.0	11.4
19	8.2	6.1	7.4	2.5	17.0	12.6	11.8	9.1	7.2					3.1	6.8
20	8.0	6.5	7.9	5.2	14.9	13.9	12.1	10.8	5.5					4.6	8.0
21	10.7	5.5	8.0	6.9	14.5	11.1	10.9	8.4	4.8					2.6	10.0
22	10.4	11.2	8.2	6.8	13.7	11.2	11.0	8.4	6.5					5.4	11.6
23	5.9	12.7	8.0	11.0	11.5	7.4	9.9	8.8	6.4					5.3	8.2
24	10.6	5.6	10.1	12.3	13.9	6.2	10.5	10.9	5.3					5.7	6.1
25	14.4	7.8	9.0	7.3	13.7	14.8	9.5	9.9	5.1					5.2	8.3
26	7.9	15.5	10.1	12.1	11.8	9.9	9.3	6.3	4.7					4.1	7.0
27	9.3	6.2	8.1	12.8	12.2	8.7	9.7	8.9	4.3					8.6	11.2
28	6.5	12.3	8.4	9.4	12.9	8.9	10.3	8.3	5.8					6.6	9.0
29	7.3	7.0	8.6	9.8	12.3	8.0	9.7	6.6	5.3					3.1	8.1
30	8.5	7.4	7.4	8.8	11.7	6.9	9.9	8.3						4.0	11.9
31	11.9	5.5	7.5	9.8	12.1	6.3	9.0	8.3						4.8	10.9
32	6.9	4.7	8.4	12.4	10.6	5.4	10.0	5.9						9.0	8.6
33	10.9	5.9	8.1	7.4	10.6	8.4	9.2	6.9						9.7	8.4
34	3.3	5.4	7.6	7.6	14.8	5.4	9.7	6.2						7.3	9.5
35	8.2	4.4	8.3	5.6	11.2	7.3	8.8	6.0						3.2	9.1
36	9.6	11.3	7.4	5.8	9.4	5.5	8.7	6.6						4.1	10.2.
37	8.7	4.2	7.7	7.4	10.3	9.9	9.6	6.6						4.0	9.4
38	7.4	11.3	7.9	7.8	12.4	10.6	8.2	4.2						3.2	8.8
39	8.0	16.1	8.6	10.3	9.6	8.7	9.0	5.2						4.7	8.7
40	7.5	4.6	7.9	9.6	11.8	4.8	8.2	7.6						2.9	6.4
41	6.5	7.1	7.9	10.9	12.2	4.5	8.3	6.7						3.5	10.3
42	6.1	3.8	7.1	3.8	3.3	7.1	8.7	8.2						3.3	8.5

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
43	7.9	9.6	7.9	7.7	8.6	13.2	8.2	10.6						3.7	9.6
44	10.1	5.5	7.4	8.2	12.8	10.1	7.3	12.6						3.3	10.3
45	6.4	14.2	6.0	9.2	7.7	9.8	8.7	8.4						5.8	2.6
46	5.5	10.0	7.6	7.1	11.8	9.6	8.6	9.3						8.5	4.7
47	5.0	7.4	4.5	6.8	13.1	4.9	6.9	7.3						8.8	8.0
48	4.6	9.0	6.6	8.0	8.6	6.3	8.9	6.6						9.1	9.9
49	14.4	12.7	2.8	7.3	8.0	4.8	7.9	8.7						7.4	8.8
50	5.9	4.3	6.8	5.8	10.8	10.5	7.6	6.9						6.6	12.8
51	8.0	12.5	3.9	6.9	7.9	4.5	7.6	7.9						5.8	7.3
52	7.5	4.7	2.6	9.2	8.8	5.7	8.1	4.0						3.5	10.5
53	13.1	4.8	3.3	7.0	8.6	6.9	7.0	7.1						3.3	5.4
54	7.4	13.7	3.6	7.4	4.6	8.3	7.8	8.5						6.5	6.8
55	6.6	7.6	7.3	9.3	6.7	4.0	7.3	6.3						8.0	9.9
56	9.5	11.0	6.4	11.3	8.9	5.4	6.7	7.6						5.8	8.4
57	13.5	8.0	7.3	6.9	4.9	7.8	6.2	4.7						4.4	5.8
58	9.6	9.2	6.9	6.5	8.2	5.1	6.5	3.8						6.3	6.4
59	8.2	3.0	5.4	5.4	9.7	5.8	6.2	7.9						5.5	9.9
60	9.5	4.8	5.3	8.8	7.4	8.0	7.2	7.1						6.5	7.3
61	5.9	6.2	6.8	6.3	7.3	10.2	6.6	7.8						11.2	2.3
62	6.8	8.4	6.9	7.7	7.9	9.1	5.8	7.6						10.0	3.6
63	10.5	8.8	6.0	9.3	7.3	10.3	5.9	4.9						5.1	10.9
64	9.0	5.9	3.3	6.3	8.2	8.1	2.6	4.2						5.9	10.0
65	7.0	6.8	3.6	9.3	3.9	12.2	4.0	8.9						3.5	10.1
66	10.3	9.1	4.7	9.1	3.5	7.3	4.0	5.0						3.4	6.5
67	8.3	9.5	6.7	8.1	3.6	4.8	3.3	6.8						8.7	5.1
68	14.1	8.6	6.0	6.3	9.9	11.3	3.9	5.9						9.8	7.9
69	6.6	5.1	6.7	6.2	8.5	13.5		8.4						7.5	9.3
70	7.9	11.2	6.9	8.4	5.5	12.2		6.6						8.0	3.9
71	4.7	7.0	7.1	9.2	7.5	6.1		7.8						5.8	7.0
72	14.8	13.4	7.5	9.6	2.7	8.3		4.6						5.9	9.8
73	7.9	4.4	7.4	6.5	7.7	12.4		5.0						14.7	5.2
74	7.8	8.4	5.9	6.9	7.3	12.0								6.2	8.8
75	8.5	5.6	6.3	7.0	7.1	16.1								7.7	10.0
76	7.5	4.8	7.2	8.0	8.1	12.7								3.4	7.0
77	10.5	7.9	7.1	5.7	8.3	8.0								4.2	9.6
78	12.7	6.5	7.2	6.7	10.2	7.4								8.9	7.2
79	9.1	5.1	6.6	7.9	10.7	15.9								3.4	7.2
80	7.9	9.8	6.3	8.1	10.4	10.2								7.2	4.4
81	6.4	5.0	5.9	8.1	6.9	12.3								4.9	6.7
82	7.3	7.9	3.4	10.2	11.0	17.0								3.8	5.7
83	9.4	7.9	2.5	9.3	5.9	9.1								2.9	12.6
84	4.7	6.1	5.9	6.1	4.6	12.7								8.0	9.5
85	9.4	6.4	3.3	6.2	3.1	9.7								3.8	9.6
86	13.2	5.3	5.1	7.2	4.8	14.8								8.3	7.1

Table 6a. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Zebra Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
87	8.3	3.6	6.5	7.3	8.8	8.6								5.8	5.3
88	11.7	5.3	6.0	7.9	5.5	6.2								5.3	4.7
89	9.2	8.2	5.5	8.5	7.3	10.3								5.6	5.3
90	6.1	5.1	3.7	7.6	4.0	8.4								5.6	3.8
91	6.9	5.2	4.3	8.6	7.5	5.3								3.0	7.9
92	11.1	6.2	6.4	10.9	7.0	10.1								3.2	8.4
93	6.7	5.0	4.3	7.9	9.8	11.9								2.1	7.5
94	12.5	3.3	3.5	6.4	7.6	19.3								6.6	6.8
95	5.9	4.7	2.6	8.8	6.7	20.3								11.9	7.1
96	6.4	3.8	5.5	6.5	7.9	6.3								3.4	10.4
97	6.9	5.7	4.5	6.2	2.9	11.2								7.5	6.5
98	15.7	4.9	5.3	6.5	6.4	13.1								6.0	8.1
99	7.9	3.4	5.6	7.7	7.4	8.3								5.7	7.6
100	9.8	3.1	5.8	6.8	4.3	14.3								5.5	4.3

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
Median Length	**0**	**0**	**9**	**0**	**8**	**10**	**7**	**10**	**10**	**0**	**5**	**6**	**6**	**9**	**10**	**8**	**8**	**11**	**0**	**0**	**0**
Mean Length	**0.0**	**0.0**	**8.5**	**0.0**	**8.2**	**9.6**	**7.3**	**10.1**	**9.9**	**0.0**	**5.1**	**7.3**	**7.3**	**9.7**	**10.2**	**9.7**	**7.5**	**11.7**	**0.0**	**0.0**	**0.0**
1	0.0	0.0	8.5	0.0	19.2	14.6	8.4	12.4	6.7	0.0	5.5	11.8	12.1	18.2	10.2	20.6	12.6	14.2	0.0	0.0	0.0
2					8.5	10.9	7.2	8.7	15.4		4.7	7.0	15.9	15.9	9.6	22.5	7.4	9.7			
3					9.8	9.5	11.8	16.2	12.5			19.8	13.5	13.6	9.2	13.2	11.5	10.4			
4					8.7	6.6	6.6	10.8	10.4			4.6	9.3	15.0	8.9	11.3	9.1	14.4			
5					7.8	14.6	8.0	12.5	7.5			7.6	9.6	13.7	10.2	12.7	7.6	12.8			
6					16.9	12.5	8.4	12.6	11.3			18.1	4.4	8.2	12.2	6.4	7.2	10.6			
7					18.8	7.8	8.3	12.7	12.4			15.6	5.1	4.1	11.8	6.0	9.8	14.1			
8					13.2	15.2	7.6	6.1	7.7			17.6	9.1	10.3	12.2	10.9	11.4	13.9			
9					6.9	15.2	6.8	7.2	6.0			12.0	5.4	14.3	11.1	5.3	9.5	12.9			
10					7.3	11.8	7.3	9.9	6.1			9.3	5.5	14.8	10.2	9.3	8.3	11.6			
11					20.0	9.0	5.4	13.3	11.0			7.4	5.3	15.8	10.0	6.2	6.7	10.2			
12					5.1	8.5	5.6	12.1	12.0			12.0	6.6	12.9	11.3	4.8	10.3	10.7			
13					9.3	8.6	3.4	12.8	10.4			10.8	5.3	12.5	9.2	9.0	9.8	10.8			
14					7.1	7.5		16.0	15.0			13.5	6.5	16.4	9.6	10.9	6.0	9.8			
15					4.7	7.1		13.5	11.3			10.9	6.3	13.9	10.7	8.6	9.0	11.4			
16					6.8	10.6		12.7	8.0			8.1	7.0	14.2	11.4	5.4	10.5	10.3			
17					9.5	12.3		7.1	16.8			9.7	7.7	10.7	9.8	8.0	8.1				
18					8.8	10.6		10.7	7.7			6.8	4.2	9.5	8.7	14.7	7.6				
19					7.6	11.2		11.4	6.0			8.3	6.9	10.7	9.9	6.5	9.8				
20					8.4	11.8		11.7	13.1			8.6	5.7	12.5	8.4	14.2	7.1				
21					7.9	11.7		11.0	8.4			10.4	6.3	13.6		11.6	8.6				
22					5.4	11.3		12.4	9.3			9.5	6.4	13.5		6.0	5.3				
23					9.8	9.5		12.4	6.9			8.3	3.8	12.1		14.7	7.2				
24					6.6	10.5		9.2	9.2			6.0		10.7		9.5	8.5				
25					12.0	12.6		10.6	10.4			6.3		10.6		5.9	6.5				
26					7.9	7.7		11.2	5.5			5.3		10.9		6.7	8.1				
27					7.8	11.3		11.8	10.0			4.1		12.6		7.8	6.4				
28					4.4	8.0		10.3	10.3			3.3		7.5		7.2	7.6				
29					9.8	15.9		10.1	12.0			8.0		8.9		8.4	7.7				
30					10.2	13.1		8.1	13.1			7.3		13.6		6.9	6.9				
31					6.6	2.2		6.2	10.7			7.7		14.4		4.3	8.0				
32					11.0	10.5		3.7	8.5			7.2		9.5		6.2	7.4				
33					5.3	9.3		8.6	9.8			7.7		7.4		6.4	6.8				
34					5.4	6.1		8.5	7.1			6.4		10.7		7.8	5.9				
35					9.5	7.7		8.6	12.5			7.1		12.0		4.7	4.7				
36					5.3	8.2		8.8	10.5			5.4		12.7		4.7	4.1				
37					6.6	6.1		8.5	13.0			5.2		11.5		22.3	3.1				
38					2.6	5.8		7.6	12.3			4.3		8.0		7.3	3.1				
39					10.4	11.6		10.0	6.1			3.7		10.2		3.6	2.1				
40					8.7	6.1		8.8	6.8			6.3		6.0		12.0	2.0				

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
41					5.3	12.2		7.3	7.5			6.3		7.9		5.5					
42					5.0	9.6		7.8	10.9			3.6		12.7		6.8					
43					5.3	9.9		8.4	10.0			4.8		11.0		19.6					
44					9.2	7.2		7.9	8.7			6.9		8.9		23.3					
45					12.4	6.6		6.7	11.9			7.9		12.4		11.9					
46					9.8	8.2		8.2	12.3			9.0		11.5		12.9					
47					10.9	4.9		9.4	9.6			6.0		10.3		11.3					
48					6.9	3.7		7.2	9.4			7.6		8.2		12.3					
49					8.1	5.3		6.7	11.0			6.9		7.8		8.9					
50					8.9	10.0		8.1	10.7			6.7		14.3		11.9					
51					9.7	7.1		8.0	8.6			9.2		6.8		4.9					
52					8.0	12.3		17.2	13.3			7.4		8.3		5.7					
53					10.1	8.5		14.9	6.3			6.7		8.3		9.0					
54					9.9	6.4		14.8	12.2			6.9		9.4		6.2					
55					11.6	12.1		8.3	12.2			6.3		10.6		13.5					
56					7.3	12.1		10.9	8.9			6.2		9.6		7.4					
57					7.4	7.7		11.2	6.4			6.9		9.2		10.7					
58					9.0	10.5		14.7	13.7			7.4		9.9		7.2					
59					10.1	8.3		10.9	9.8			4.9		8.1		5.7					
60					9.5	6.1		12.3	3.8			6.5		8.9		10.9					
61					9.9	12.2		10.2	6.8			5.9		8.9		8.9					
62					6.2	12.9		8.2	9.6			5.9		9.1		9.1					
63					8.9	12.6		8.9	11.5			4.9		7.4		3.6					
64					6.4			9.2	12.0			6.6		7.1		5.4					
65					11.3			6.2	5.6			6.8		9.1		6.0					
66					6.8			8.3	9.2			6.4		9.7		22.0					
67					5.6			5.7	12.5			4.6		7.7		12.0					
68					7.1			10.9	11.7			4.4		9.1		22.6					
69					9.0			8.7	10.5			3.1		8.0		12.7					
70					11.3			7.7	6.7			5.2		7.8		11.3					
71					8.0			11.9	8.8			5.4		9.9		6.6					
72					6.0			12.0	7.9			7.0		7.9		7.0					
73					5.8			12.4	8.3			5.0		7.2		5.1					
74					5.2			13.7	13.0			5.9		6.6		6.2					
75					5.2			12.9	9.3			5.8		8.6		5.9					
76					5.3			12.1	7.7			2.8		5.1		22.9					
77					6.9			14.9	15.9			6.3		7.5		7.1					
78					6.6			13.1	9.8			6.3		8.3		12.5					
79					8.5			12.6	9.0			5.5		7.2		7.4					
80					8.0			10.6	6.6			5.7		7.6		19.9					
81					10.5			11.7	12.6			6.6		7.3		5.8					
82					3.5			10.0	8.3			6.5		6.0		11.0					

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone A			Zone A			Zone B			Zone C			Zone C			Zone D			Zone D		
Transect	Transect 1			Transect 2			Transect 1			Transect 1			Transect 2			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
83					12.0			11.5	10.8			6.1		7.2		12.4					
84					8.0			12.3	10.3			5.9		6.0		5.0					
85					8.6			11.2	9.0			5.8		6.1		11.9					
86					6.9			13.0	8.9			4.4		6.3		4.8					
87					10.2			14.1	12.7			6.5		8.3		7.3					
88					6.3			9.2	16.0			6.1		7.8		4.6					
89					4.0			9.4	10.9			5.0		7.7		7.4					
90					12.1			8.6	10.4			4.7		7.1		7.0					
91					9.0			8.1	6.1			4.7		7.9		8.0					
92					8.4			5.4	8.1			4.4		7.1		12.7					
93					5.2			8.6	11.9			21.3		6.6							
94					6.5			8.9	15.0			20.5		7.0							
95					5.8			5.4	9.4			11.2		8.1							
96					5.8			6.5	8.1			4.9		7.7							
97					4.1			7.5	7.4			4.3		6.4							
98					5.6			6.6	9.3			1.7		5.1							
99					4.2			7.6	7.5			3.8		6.3							
100					5.7			7.3	10.4			3.0		5.6							

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
Median Length	**10**	**9**	**9**	**11**	**5**	**6**	**20**	**0**	**8**	**0**	**0**	**0**	**12**	**7**	**6**
Mean Length	**10.0**	**9.5**	**9.5**	**12.4**	**5.0**	**6.1**	**14.0**	**0.0**	**8.6**	**0.0**	**0.0**	**0.0**	**11.7**	**7.4**	**7.4**
1	11.3	12.7	14.3	14.1	21.7	7.9	20.1	0.0	12.8	0.0	0.0	0.0	11.7	14.1	10.2
2	16.3	6.5	15.1	9.2	17.7	7.5	19.6		13.0					14.8	11.3
3	11.4	7.8	10.8	17.2	7.4	5.8	19.5		10.1					13.3	6.0
4	9.6	11.8	4.6	16.2	6.1	7.9	5.0		10.0					8.6	9.4
5	14.8	10.2	13.8	12.1	6.3	5.6	5.9		8.4					8.1	9.2
6	7.4	9.4	12.8	8.1	6.1	4.1			8.2					6.6	5.6
7	9.4	7.8	3.3	10.7	4.7	9.2			9.2					6.7	5.4
8	11.4	8.3	6.1	7.2	4.6	3.9			10.4					6.8	9.2
9	8.9	9.2	17.4	8.2	5.1	5.0			9.7					9.1	6.9
10	7.2	9.4	15.9	20.9	4.2	3.7			4.1					9.3	6.2
11	11.4	4.7	2.7		5.6	3.8			8.1					5.7	5.6
12	12.4	8.7	5.2		4.0	18.1			10.9					4.9	6.3
13	6.8	8.0	10.2		5.3	3.5			9.1					4.0	5.4
14	13.5	5.4	11.4		5.5	7.8			9.4					6.2	
15	9.1	8.3	8.7		6.8	6.1			7.1					3.9	
16	6.8	6.5	8.4		4.7	3.4			8.0					4.5	
17	7.7	7.5	14.0		5.1	5.3			6.6					6.9	
18	8.2	9.7	4.2		6.1	4.9			4.6					3.8	
19	9.1	6.4	11.5		5.4	6.6			11.2					4.0	
20	11.0	10.8	9.1		5.1	6.8			6.8						
21	11.9	8.7	14.9		6.4	4.3			7.3						
22	9.6	8.6	16.9		4.8	6.1			6.7						
23	9.8	14.4	4.6		4.5	5.5			8.1						
24	9.7	5.8	5.9		4.9	6.4			7.5						
25	14.6	11.2	14.9		4.3	4.8			7.1						
26	9.9	9.7	17.0		3.2	7.7									
27	9.7	9.0	8.1		5.2	4.6									
28	11.8	9.6	7.3		5.2	5.3									
29	11.7	9.9	10.0		4.8	7.3									
30	10.4	8.7	6.3		5.0	4.4									
31	8.6	8.0	6.2		4.0	6.9									
32	14.0	9.6	7.6		3.9	3.7									
33	8.7	5.1	13.9		4.4	9.2									
34	10.2	12.6	13.3		4.3	9.0									
35	8.6	10.8	5.8		3.7	5.4									
36	6.8	8.7	5.0		6.3	6.0									
37	10.6	8.3	14.6		5.8	5.5									
38	10.5	11.6	14.9		2.9	4.8									
39	8.7	8.4	6.7		4.4	3.1									
40	6.9	5.5	5.6		2.0	7.2									

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
41	9.3	4.7	13.6		4.3	10.0									
42	12.2	6.8	12.5		5.1	2.4									
43	7.1	8.1	9.1		5.0	6.6									
44	7.5	5.3	12.6		5.2	3.2									
45	8.5	11.6	5.3		5.6	4.9									
46	8.2	10.0	8.0		3.4	5.8									
47	10.5	9.4	5.6		2.4	9.1									
48	8.9	13.0	5.7		5.1	5.6									
49	10.2	10.2	13.5		3.3	5.2									
50	7.7	8.8	11.0		3.3	4.5									
51	11.2	16.7	8.8		3.7	4.8									
52	7.2	8.5	3.6		3.4	6.4									
53	7.9	15.8	12.3		4.5	5.4									
54	7.8	15.8	14.2		4.7	6.6									
55	11.4	11.3	8.3		4.2	7.2									
56	9.8	6.2	5.0		3.4	6.3									
57	9.9	16.0	8.8		3.4	4.4									
58	9.9	9.8	7.3		4.7	5.7									
59	6.7	7.3	14.2		4.6	6.8									
60	8.5	6.9	5.0		5.0	5.2									
61	9.0	7.2	16.3		3.9	7.3									
62	9.8	7.1	14.8		2.4	3.9									
63	10.8	12.2	11.6		3.8	4.5									
64	8.6	9.9	5.4		3.3	7.2									
65	9.1	5.6	6.5		3.9	6.4									
66	10.6	11.1	5.7		3.7	6.7									
67	11.3	13.3	17.2			8.0									
68	9.3	11.5	3.5			6.0									
69	5.9	12.9	8.3			4.6									
70	12.3	9.0	10.8			4.4									
71	14.7	7.8	6.1			7.5									
72	10.2	5.4	6.0			4.5									
73	13.4	10.6	6.2			4.2									
74	11.9	11.8	4.5			3.5									
75	13.2	11.3	5.4			3.7									
76	7.1	6.9	5.6			5.1									
77	8.6	8.2	7.5			3.7									
78	7.2	10.2	7.3			7.7									
79	13.0	14.4	10.6			6.6									
80	8.6	10.7	16.9			5.1									
81	13.1	13.9	10.0			6.7									
82	10.3	14.9	4.5			19.8									

Table 6b. Onondaga Lake Dreissenid Mussel Survey Fall 2008 - Quagga Mussel Raw Length (mm) Data.

Zone	Zone E			Zone F			Zone G			Zone H			Zone H		
Transect	Transect 1			Transect 1			Transect 1			Transect 1			Transect 2		
Water Depth	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5	0 - 1.5	1.5 - 3	3 - 4.5
83	8.1	9.1	13.1			3.9									
84	9.1	8.5	9.0			6.9									
85	12.4	13.1	18.0			7.0									
86	12.7	6.8	16.1			6.8									
87	10.3	8.3	6.2			6.8									
88	10.5	8.3	7.4			7.7									
89	8.6	9.1	5.8			6.5									
90	8.5	7.5	5.9			6.9									
91	7.0	15.6	2.3			6.6									
92	11.6	14.4	16.3			9.9									
93	11.0	13.3	13.5			5.4									
94	13.4	9.1	11.7			5.6									
95	14.6	8.9	8.4			8.0									
96	7.5	6.9	12.9			6.0									
97	9.4	6.5	11.7			6.2									
98	12.6	5.4	9.1			4.3									
99	8.6	4.9	8.3			5.1									
100	8.6	12.8	3.5			5.8									

Figure A6.1 - Seneca River Dreissenid Mussel Survey – Length Frequency Distribution by Transect (04'-08')

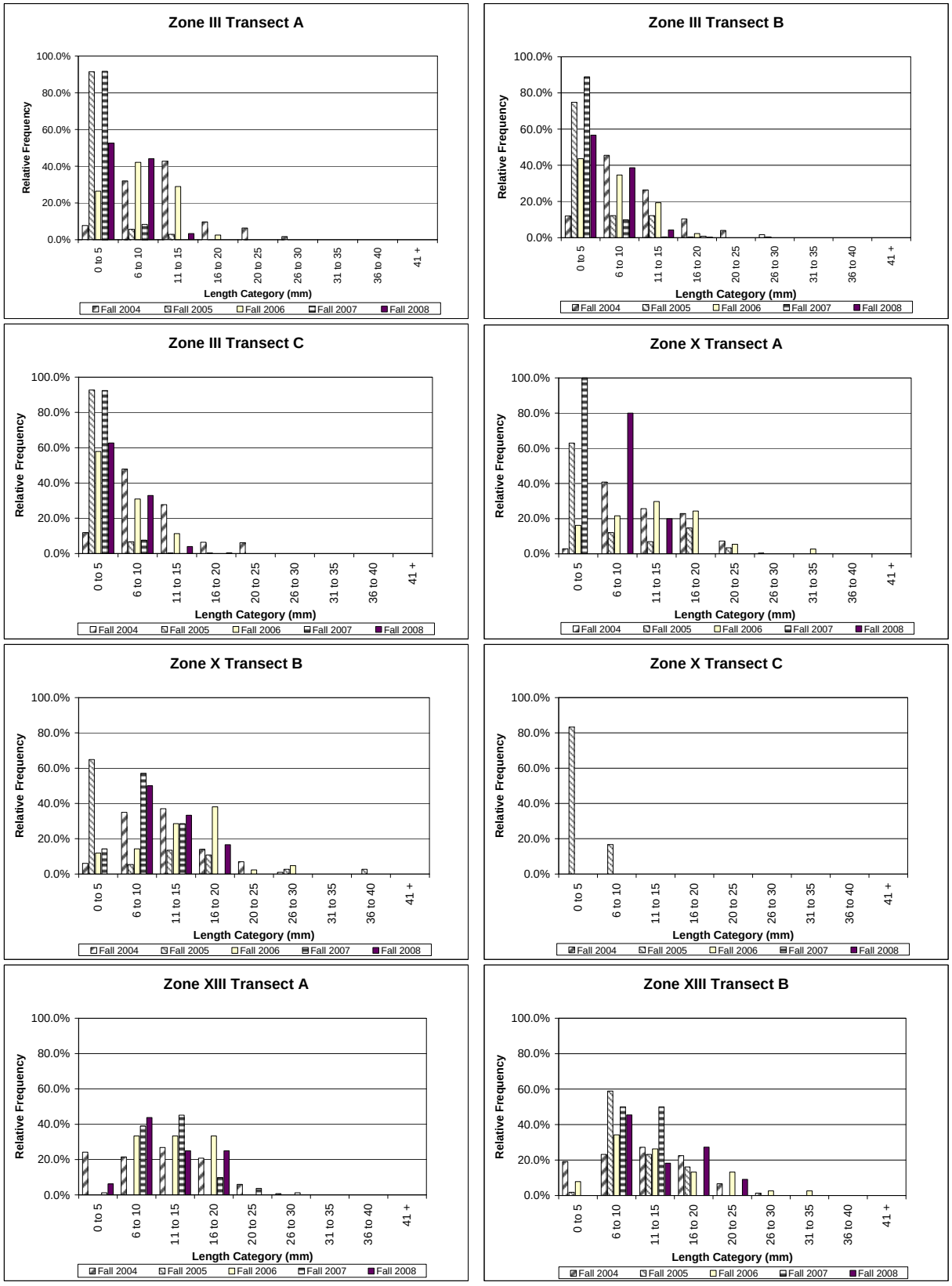
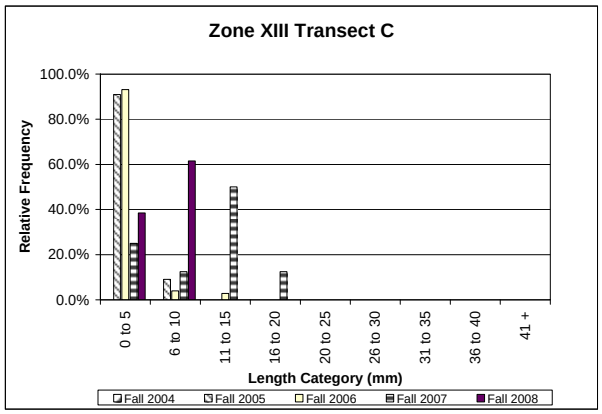
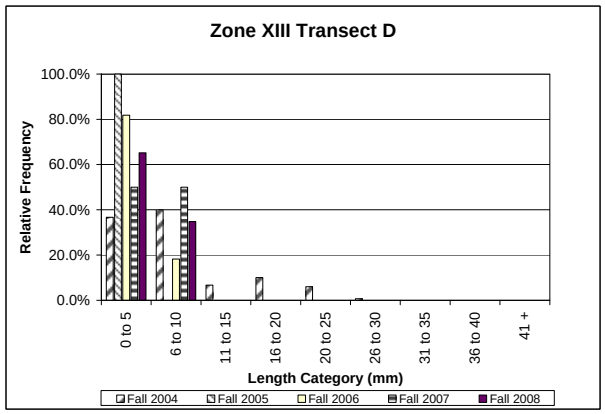
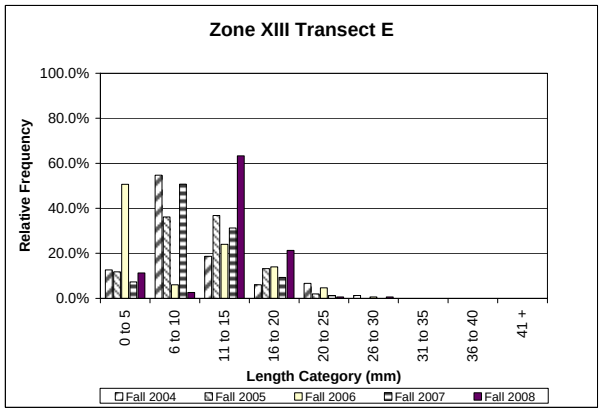
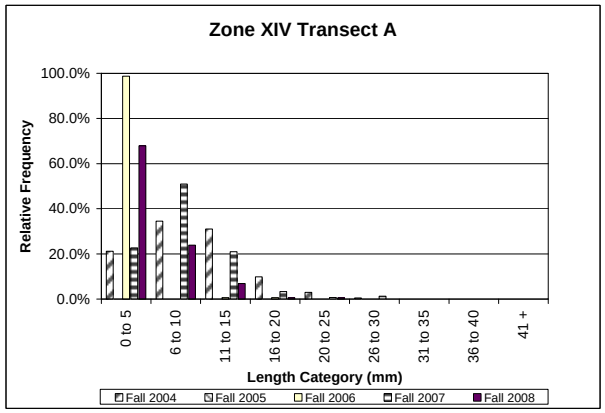


Figure A6.1 - Seneca River Dreissenid Mussel Survey – Length Frequency Distribution by Transect (04'-08') (continued)









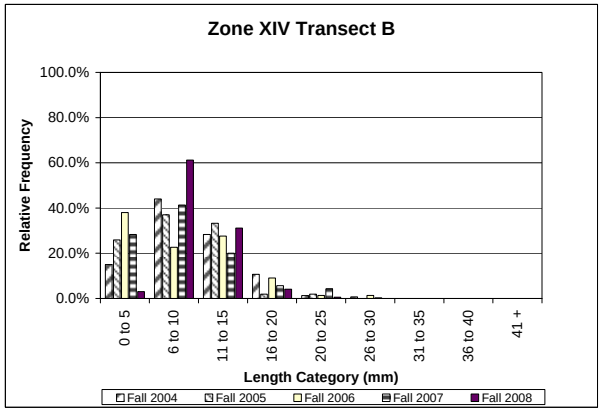
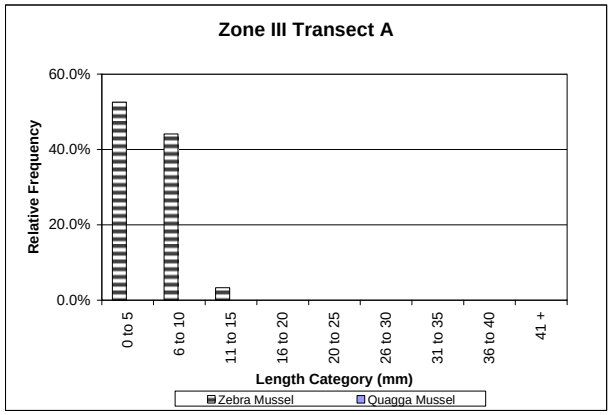
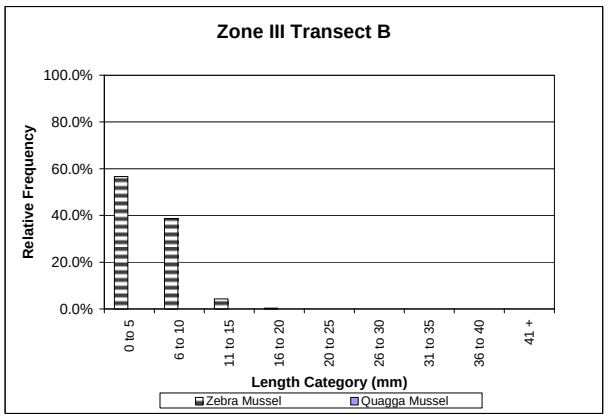
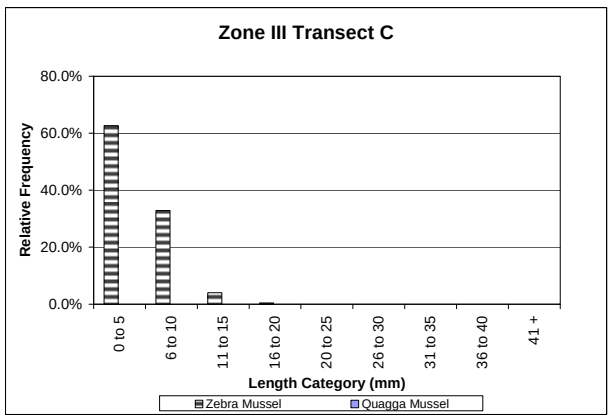
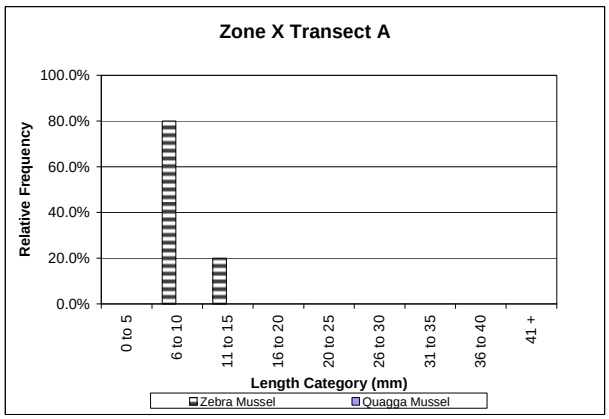


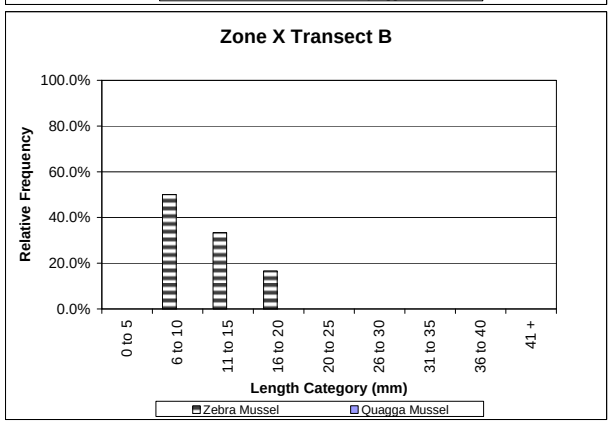
Figure A6.2 – Seneca River Dreissenid Mussel Survey Fall 2008 – Length Frequency Distribution by Transect for Zebra and Quagga Mussels

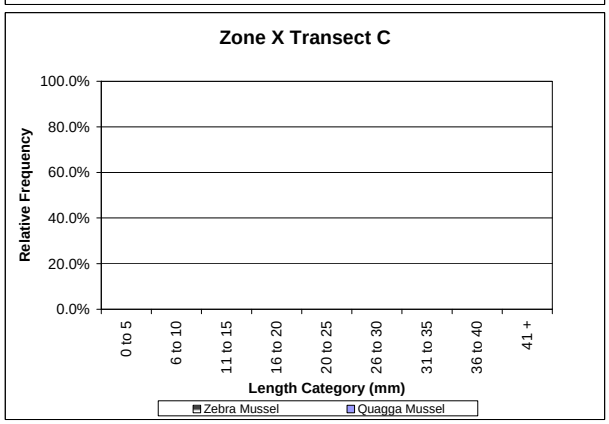


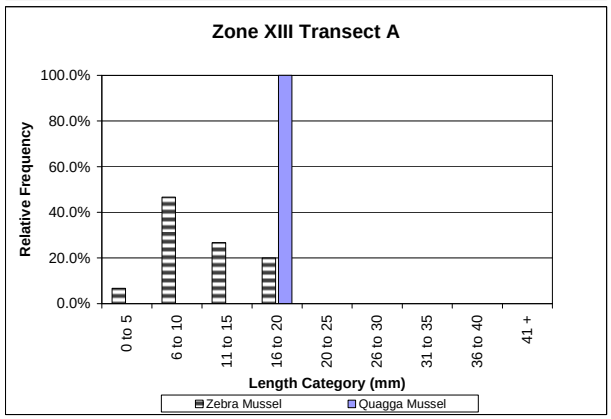












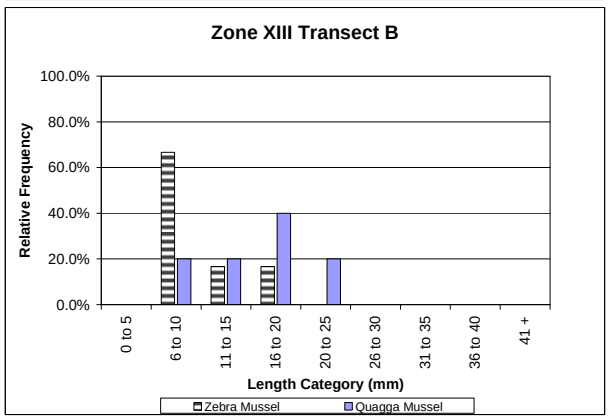
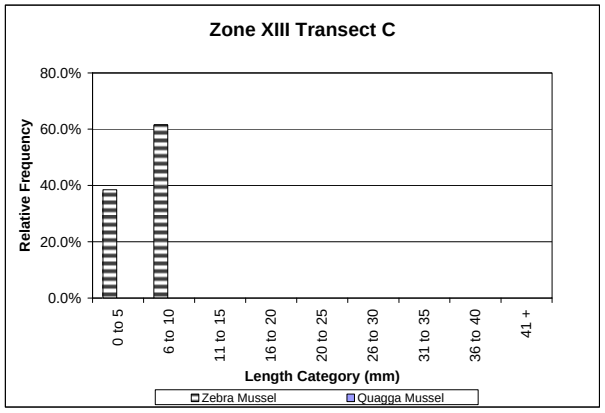
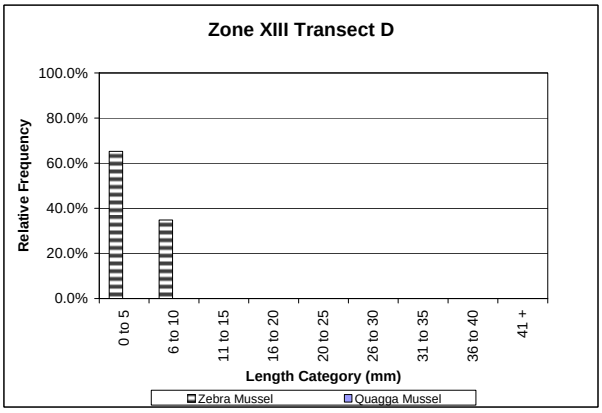
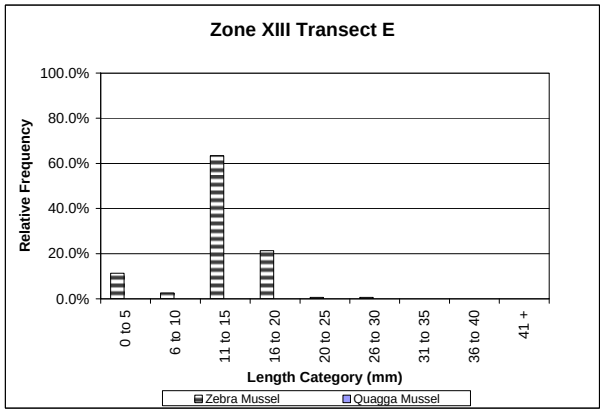
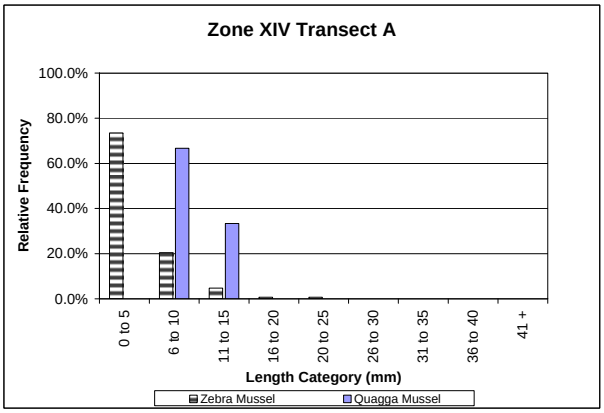


Figure A6.2 – Seneca River Dreissenid Mussel Survey Fall 2008 – Length Frequency Distribution by Transect for Zebra and Quagga Mussels (continued)









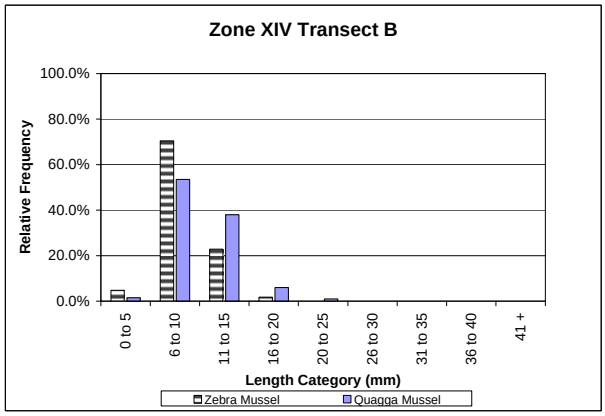


Figure A6.3 – Onondaga Lake Dreissenid Mussel Survey Fall 2008 – Length Frequency Distribution by Zone (All Transects) and Depth Range/Category (All Depths) for Zebra and Quagga Mussel

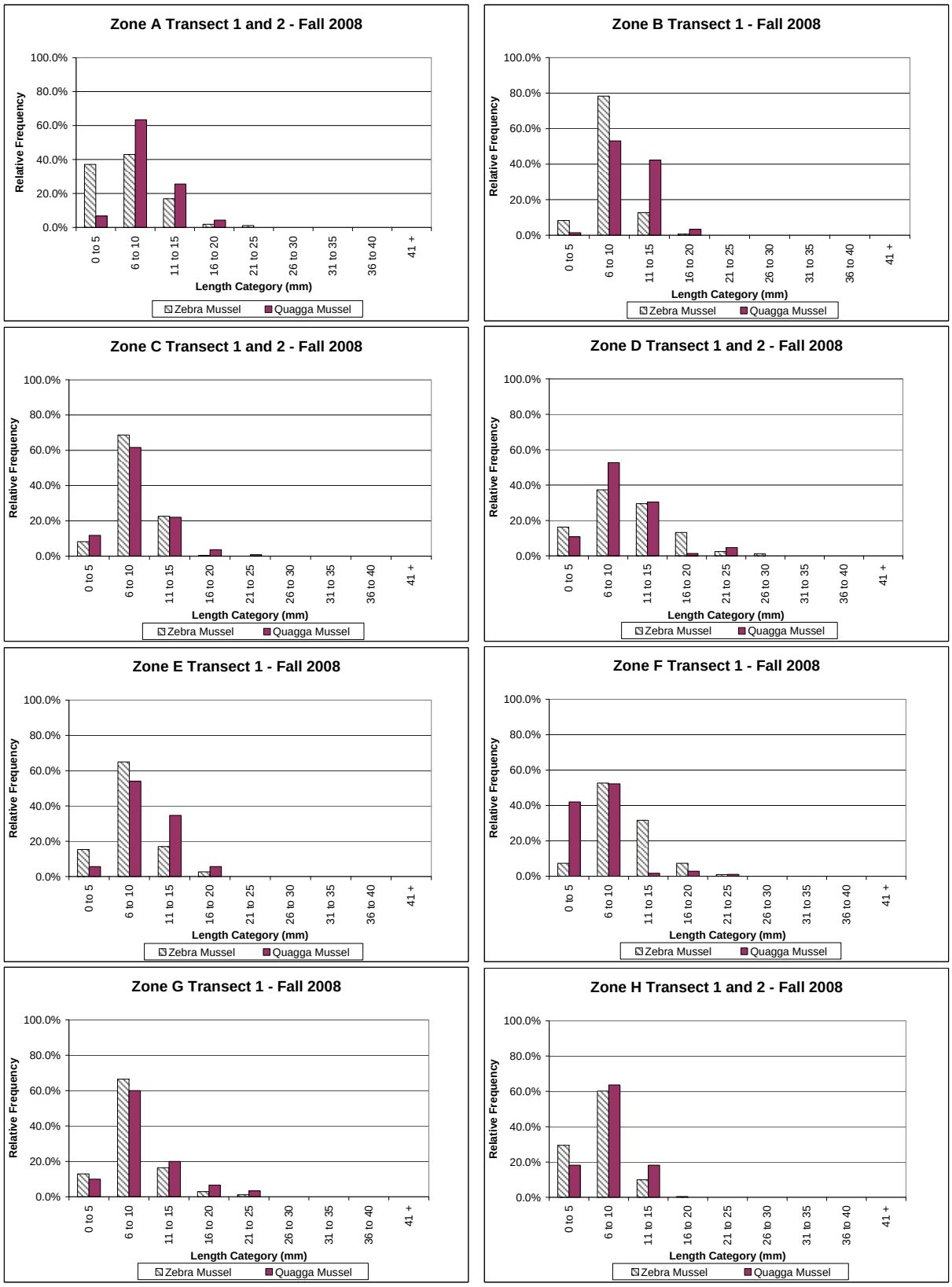
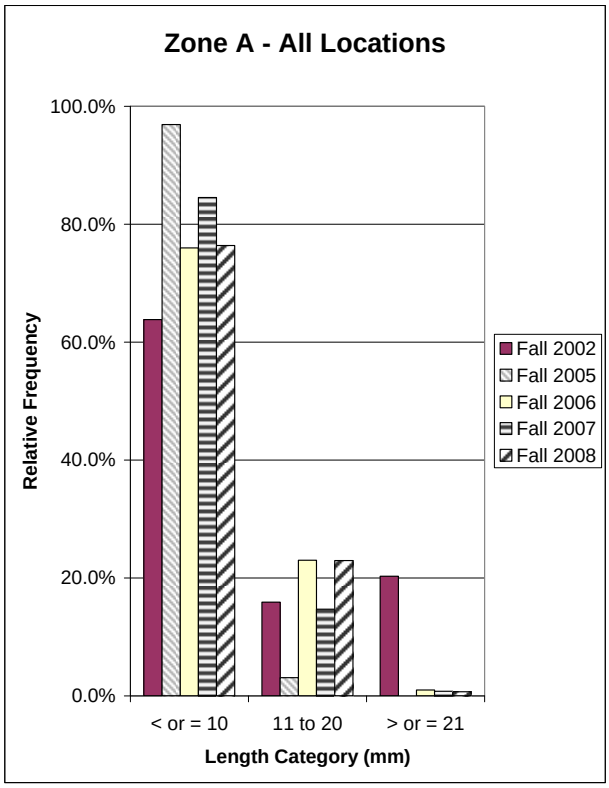
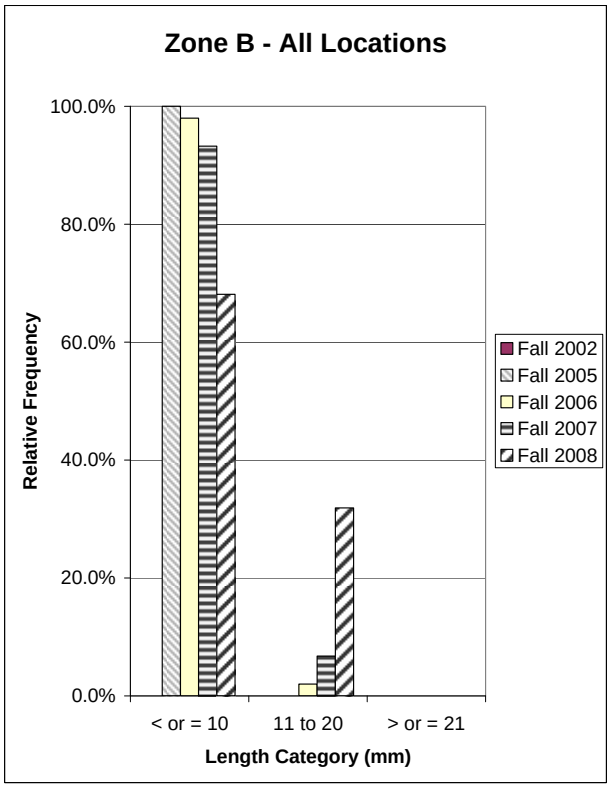
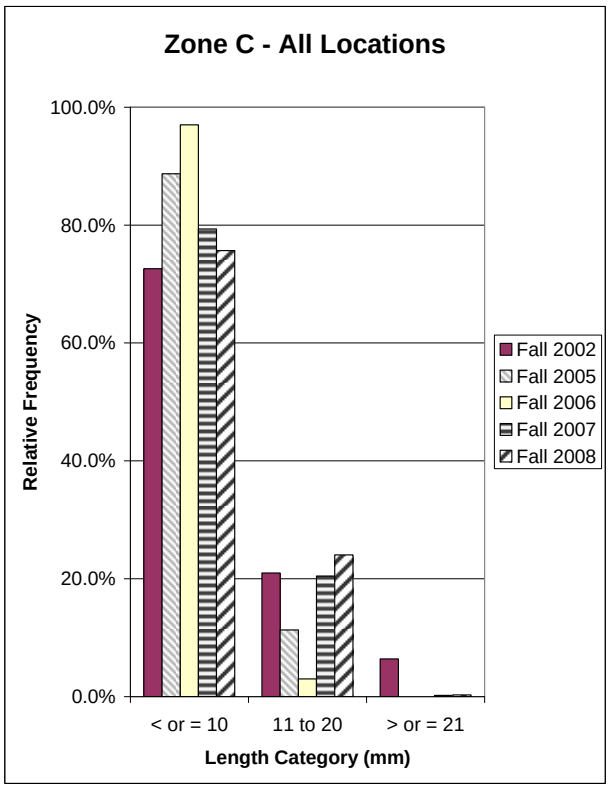


Figure A6.4 – Onondaga Lake Dreissenid Mussel Survey – Fall 2002, and 2005 through 2008 Comparison of Length Frequency Distribution by Zone (All Transects) and Depth Range/Category (All Depths)







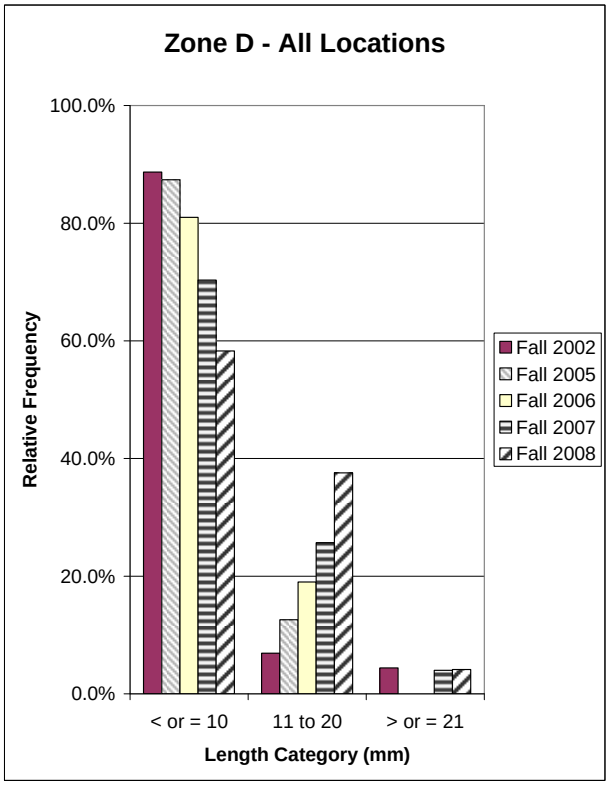
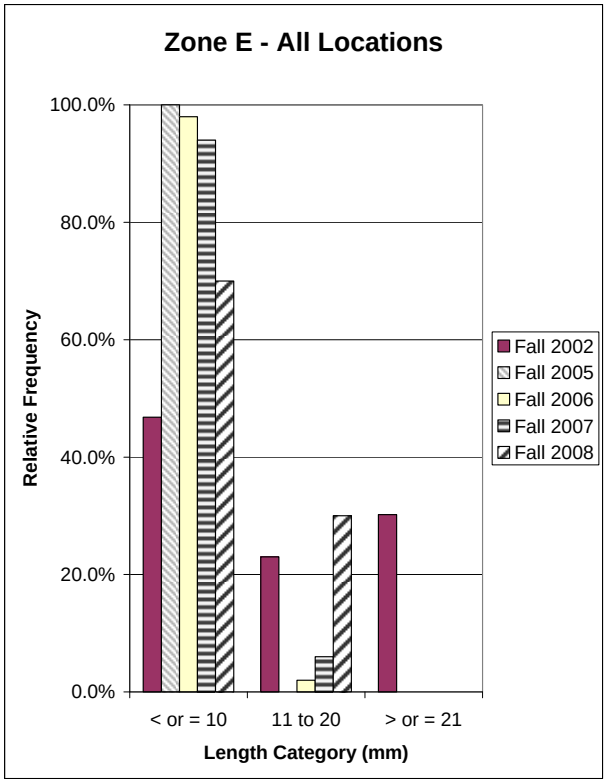
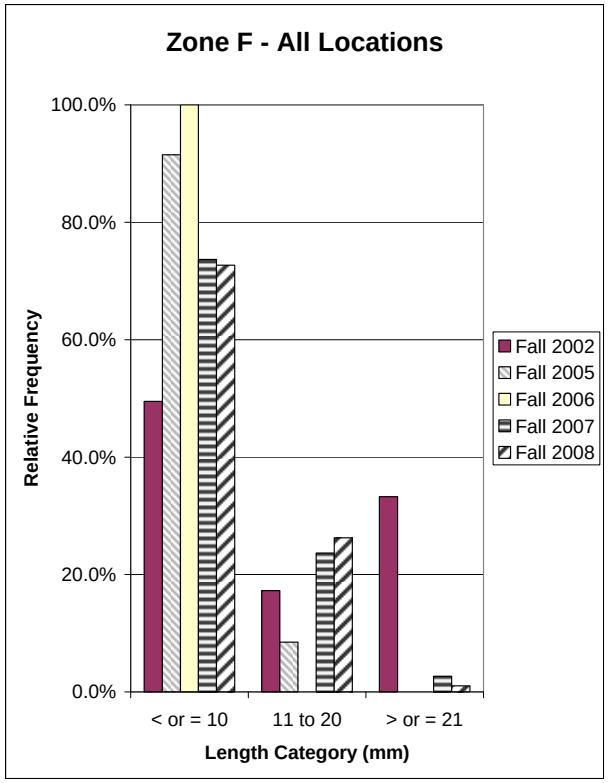
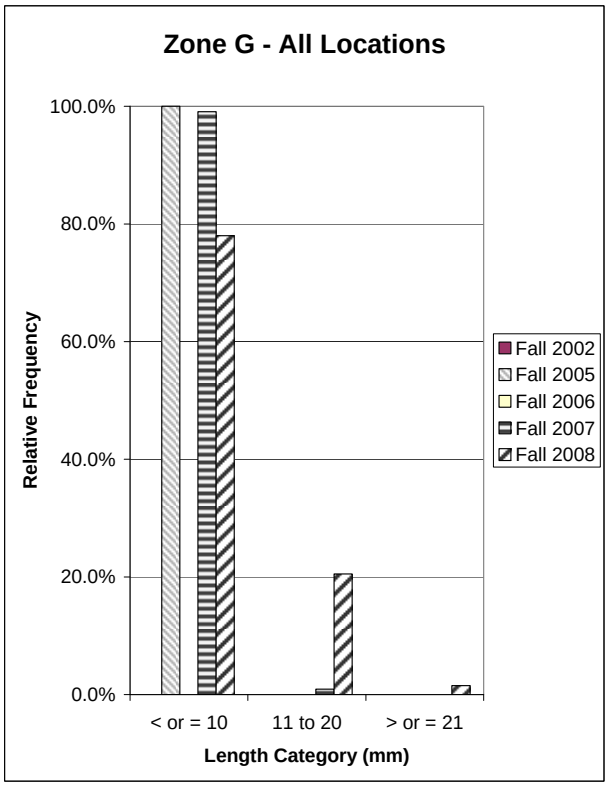


Figure A6.4 – Onondaga Lake Dreissenid Mussel Survey – Fall 2002, and 2005 through 2008 Comparison of Length Frequency Distribution by Zone (All Transects) and Depth Range/Category (All Depths) (continued)







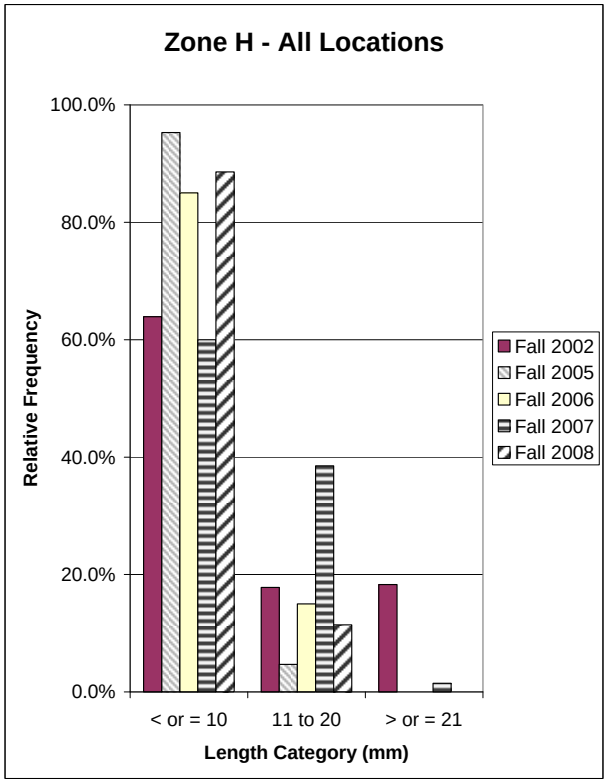


Figure A6.5 – Onondaga Lake Dreissenid Mussel Survey – Fall 2002, and 2005 through 2008 Comparison of Length Frequency Distribution by Zone (All Transects) and Depth Range/Category

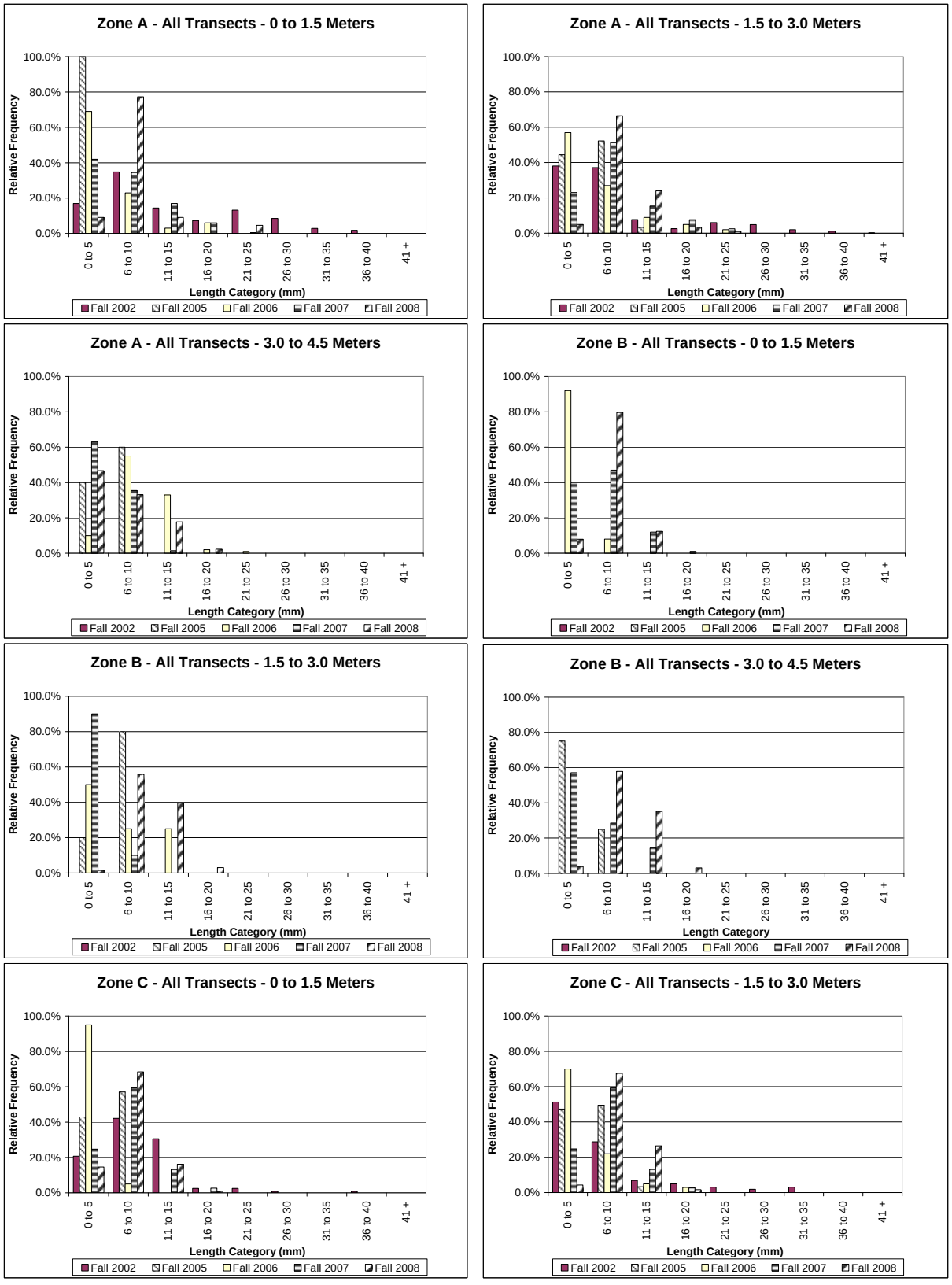


Figure A6.5 – Onondaga Lake Dreissenid Mussel Survey – Fall 2002, and 2005 through 2008 Comparison of Length Frequency Distribution by Zone (All Transects) and Depth Range/Category (continued)

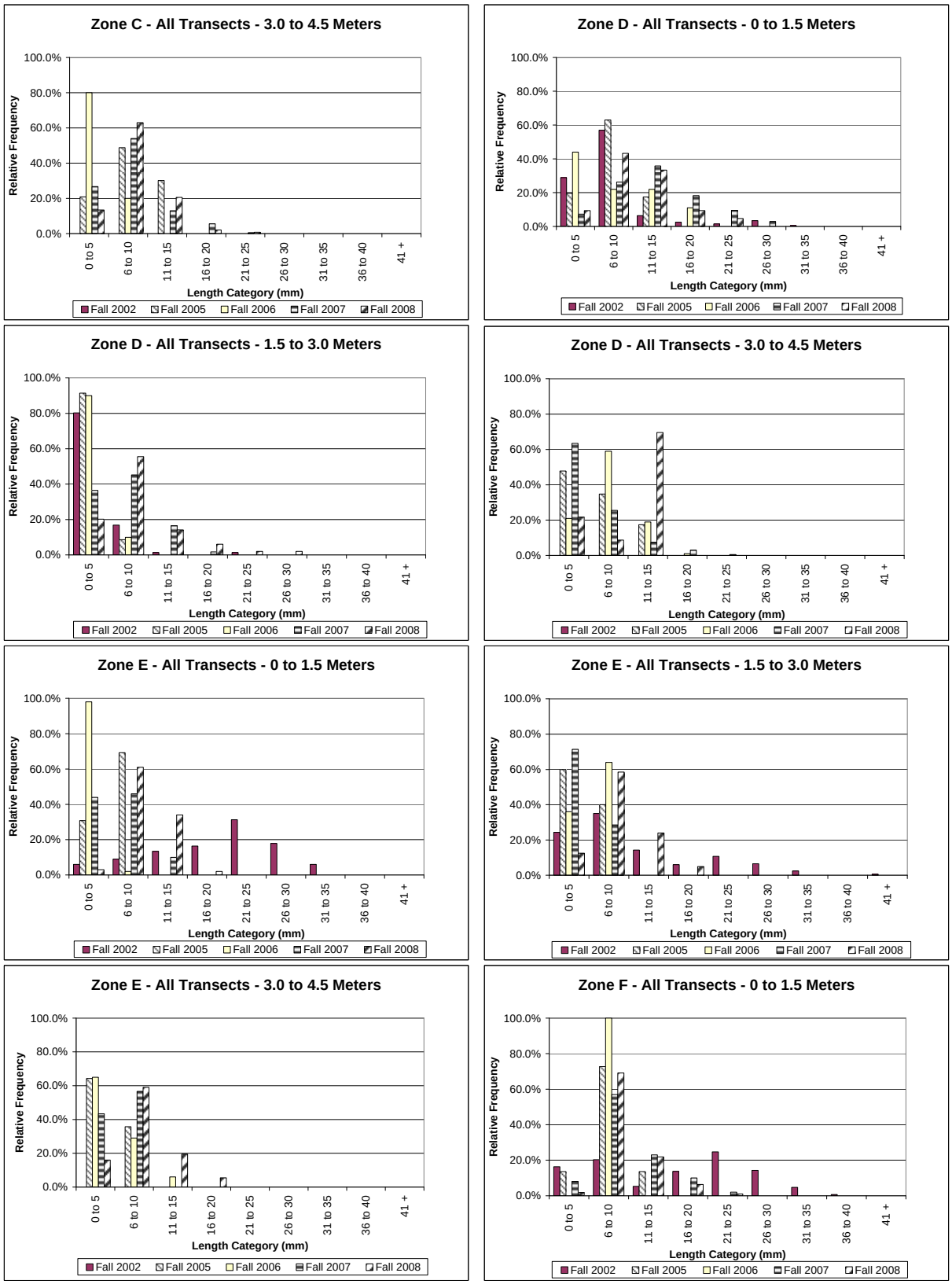
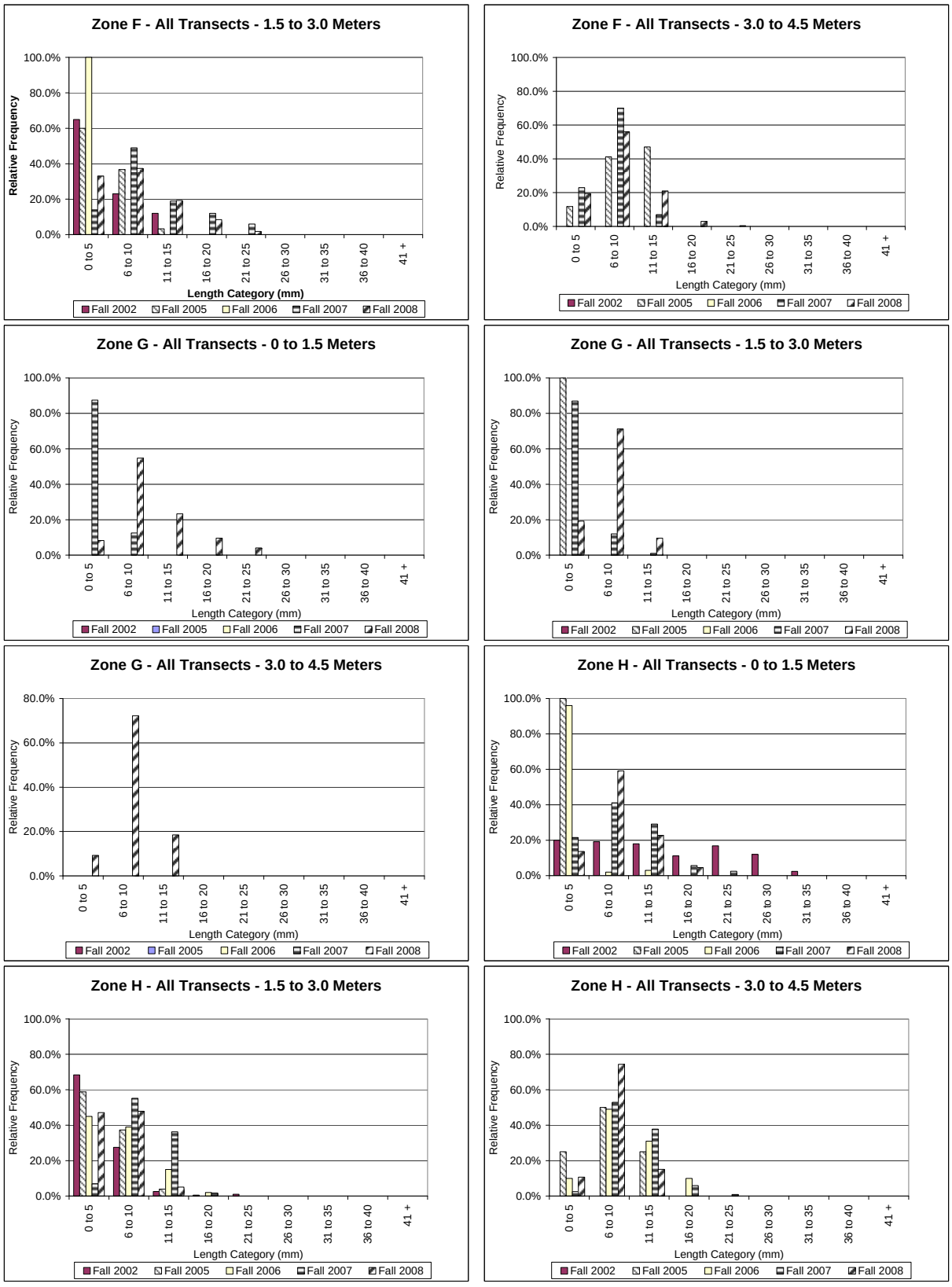


Figure A6.5 – Onondaga Lake Dreissenid Mussel Survey – Fall 2002, and 2005 through 2008 Comparison of Length Frequency Distribution by Zone (All Transects) and Depth Range/Category (continued)



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Fish Community

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Library Reference 8.7.1

Alewife Hydroacoustics Survey

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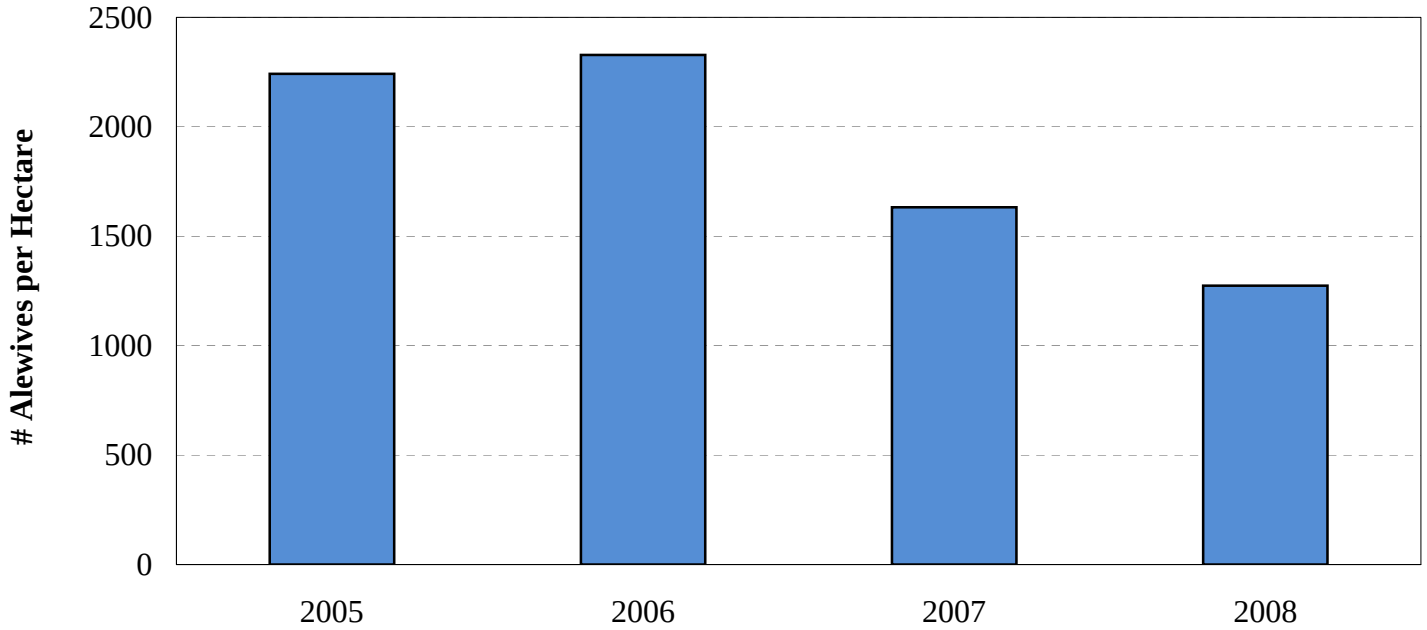

Estimated alewife density in Onondaga Lake 2005 – 2008, using hydroacoustical sampling conducted in June of each year.

Notes: Density is calculated from areal back scattering using the average target strength of alewife found during the survey. Refer to 2008 hydroacoustics report for further details.

Alewife (*Alosa pseudoharengus*) abundance in Onondaga Lake, 2008.
A report to Onondaga County.

November 24, 2008

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Abstract: The alewife (*Alosa pseudoharengus)* population in Onondaga Lake was surveyed June 4, 2008 using small mesh pelagic gill nets and hydroacoustics (123 kHz split beam). Catches in the vertical gill nets were 22 to 94 fish /hr, with 97 % of the catch being alewife. Other species caught included white perch, walleye, yellow perch, brown trout, smallmouth bass and emerald shiner. Average length and weight of alewife was 145 mm (115-176mm) and 28.8 g. Average length of eleven white perch was 185 mm (range 100-215 mm). Alewives were in two length groups; 41% of the fish in the 115-140 mm size group and 59% in the larger, 140-176 mm size group. This size distribution is similar to previous years. Size distributions and age structure in 2004-2008 indicate reproduction in all years since 2002. Because 97% of the fish caught were alewife we assumed all targets were alewife. Density in June 2008 for targets > -60dB was estimated to 1390 per ha for the whole water column. The corresponding fish biomass is 40 kg/ha. Alewife were distributed across the lake and densities among transects ranged from 520 to 2160 fish/ha, resulting in coefficient of variation (SE/mean) of 16%. Conditions were not ideal in 2008 due both to weather and equipment problems associated with transducer mounting, and the interpretation of the target strength distribution is more uncertain than in previous years. Mean TS was 10 dB smaller (-52dB) then expected from net catches (-42dB). We discuss possible reasons for the smaller in situ TS in 2008 and implications for alewife abundance estimates. It is likely that our estimates are biased high due to inclusion of smaller targets that are not alewife (larval fish or bubbles).

Introduction.

Alewife, *Alosa pseudoharengus*, increased dramatically in Onondaga County's electrofishing samples in 2003 and remained high in 2004 to 2007 (OCDWEP 2008). This increase was due to a strong 2002 year class, and the increase in biomass of that year class was correlated with the disappearance of large *Daphnia* from the lake in the fall of 2002. Wang et al. (submitted) showed that additional year classes of alewife were produced in 2004 – 2006 and that the abundance of alewife remained high through the spring of 2007 (over 1600 fish/ha). Large *Daphnia* and the associated spring clear water phase have been absent from the lake between 2003 and 2007, although the smaller *Daphnia retrocurva* was present in 2007. Decreased water clarity is counter to the expected improvement of Onondaga Lake associated with upgrades to Onondaga County's Metro sewage treatment plant. It is likely that these changes in lower trophic levels were caused by increased alewife planktivory (Brooks and Dodson 1965, Harman et al. 2002, Wang et al. submitted). Therefore, it is important to maintain a monitoring program for alewife in the lake as part of the ambient monitoring program of Onondaga County. This report presents the results of the 2008 spring survey of alewife and compares the densities and size structure obtained during that survey with previous year's surveys in 2005 to 2007.

Materials and methods

Acoustics.

Onondaga Lake was surveyed using a 123 kHz split beam echo sounder (Biosonics DtX, full half-power beam angle 7.5^{o}, 0.3 ms pulse length, pulse rate 3 ping/sec) along six roughly parallel SW to NE transects (total survey length 9.1 km). The survey was conducted on the night of June 4, 2008 between 21:51 and 00:13.

Acoustic data were recorded directly to a laptop computer in the field and analyzed with the EchoView software (version 4.5, Myriax). The unit was calibrated by the manufacturer in April 2008 and with a standard -39.5 dB 38.1 mm tungsten carbide sphere in July 2008. Separate gains were applied to the echo integration (measured as area backscattering coefficient, ABC) and target strength (TS) data based on this calibration. All data were visually inspected for consistent bottom detection and corrected when needed, as well as for interference from surface bubbles and aquatic vegetation. Surface interference was more prominent than in previous years due to some wind induced bubbles in the surface layer. Those areas were removed from the analysis. Noise levels were -112dB (Sv domain), corresponding to -138 dB in the TS domain. This is low enough to register fish with a TS of -60 dB at 45 m depth without bias and thus sufficient for alewife surveys at all depths in Onondaga Lake (maximum depth 19.5 m). Analysis was done for each transect for depth layers 2-6m and 6 m to the bottom and lake wide averages calculated using the average density from each transect. The near-field of this transducer is approximately 1.5m (Parker-Stetter et al.

2009) and the transducer was mounted on a rigid pole 0.5 m below the surface. Therefore, the acoustic analysis is restricted to depth below 2 m from the surface.

Fish density from June 2008 was calculated from the average measured in situ TS and ABC as follows. In situ TS distributions were obtained with EchoView using targets within the half power beam angle and settings for single fish determination following the Standard Operating Procedure for Great Lakes Acoustics (Parker-Stetter et al. 2009). Alewives were assumed to be targets larger than -60dB based on the shape of the TS distribution (Fig. 1), although the identity of the smaller targets is questionable (see discussion). Fish density was calculated based on in situ target strengths larger than -60dB and the echo integration values. In addition to the top 2 m of the water column, some areas down to 4 m depth were excluded due to wave induced bubbles. Fish densities in those depths were assumed to be the same as in water from 2 to 6 m that were not contaminated by surface bubbles. Appropriate depth varying thresholds were applied to the Sv data following Parker-Stetter et al. (2009).

Spatial location of the data was measured with a GPS that recorded latitude and longitude directly to the acoustic data stream. Total fish density was obtained from the ABC values and the in situ TS in two ways, both with the average in situ TS obtained in each transect and with the overall average TS obtained for all transects. All averages and calculations are made in the linear domain and back transformed to dB unit when appropriate. More details on acoustic methods are in Simmonds and MacLennan (2005), Sullivan and Rudstam (www.acousticsunpacked.org) or Parker-Stetter et al. (2009).

Fish were sampled using vertical gill nets set at four locations (Table 1). The 6 m deep and 21 m long nets consisted of 7 panels, each with a different mesh size (6.25, 8, 10, 12.5, 15, 18.75, 25mm bar mesh). This set of mesh sizes will catch alewife between 50 and 240mm (Warner et al. 2002). The nets were set from the surface to 6 m depth for approximately 2 hrs in water with bottom depth between 6 and 8 m (Table 1). Fish were identified to species and depth of catch recorded in 2 m intervals. A random subsample of 30 alewives or all individual (other species) were measured (total length in mm, weight in g).

Results and Discussion.

Net sampling

A total of 552 fish were caught in the gill nets (Table 1, 22 to 94 fish/hr, average 66.7 fish/hr). Other fish species caught include emerald shiner (*Notropis atherinoides*), white perch (*Morone americana*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*) and brown trout (*Salmo trutta*). Alewife represented 97 % of the catch (93% -100%, Table 1). Interestingly, no gizzard shad were caught. This may be due to a large die-off of 340-380 mm shad in April of 2008 (Snyder, pers. obs.) but also indicate that there were little over-winter survival of young shad in 2007-2008 which should be smaller than 200 mm in June 2008. Similar numbers of fish were caught in the three depth layers 0-2m (37%), 2-4m (46%) and 4-6m (17%) (Table 1). The average percent catch in each depth layer is based

on total catch/hr of all alewife in the four nets. These catches suggest a relatively even distribution of alewife in the top 6 m of water.

The alewife size distribution had two distinct modes: fish larger and smaller than 140mm (Fig. 1). The smaller length mode is most likely age-1 fish, and represented 41% of the catch. Average length of alewife was 145 mm (N=120, range 115-176 mm), similar to other years (Table 2). Average length of the smaller age group was 129 mm. Alewives typically reach lengths of 60 to 90mm by September of their first year of life in New York inland lakes (Rudstam and Brooking 2005), but can get larger, up to 140mm, in productive lakes with large zooplankton (e.g. Oneida Lake and Canadarago Lake, Rudstam unpubl. data). Similar size fish caught in June 2007 were aged as mostly age 1 but included some age 2 fish (Wang et al. submitted).

Acoustic data

Average TS of alewife in Onondaga Lake calculated from 1657 single fish targets larger than –60 dB was –52.0dB for an average fish length of 145 mm (Fig 2). This is not consistent with the average TS obtained in 2005-2007 (-44.2 to -43.3 dB), from measurements in net cages of similar size fish (Brooking and Rudstam in press, expected TS of a 145 mm fish –41.6 dB) or existing TS-L regressions for alewife (Warner et al. 2002, expected TS of a 145 mm fish -40.4 dB). We return to this issue below. Average TS for different transects varied between –54.2 and –51.5 dB (Table 3).

Fish density calculated from either the in situ TS data obtained at each transect or from the overall average TS was 1390 fish/ha and 1274 fish/ha, respectively (Table 3). These densities are from the surface to the bottom and calculated as the sum of densities in 0-6 m and 6 m to the bottom. The surface area (0-2m) and variable amount of water down to 4 m depth were excluded to avoid surface bubbles. The densities obtained for the 0-6 m water depth assumes that the densities at the depth measured were the same as in the excluded depths. Because almost exactly 1/3 (37%) of the fish caught in our 0-6 m nets were indeed caught in 0-2 m water, this appear to be a reasonable assumption in Onondaga Lake. This pattern has held for the other surveys in 2005, 2006 and 2007 (Table 2) indicating similar density distribution in the top 6 m in May-June in Onondaga Lake. Assuming all of these fish were alewife and an average weight of alewife of 28.8g (Table 1), the alewife biomass was calculated to 40 kg/ha (Table 3).

Transect densities ranged from 520 to 2160 fish/ha (SE 221 N=6, CV (SE/mean) 16%, Fig. 3). This is similar to previous years. The fewest fish were found along transect 3 and there were no obvious north-south gradient in fish density in 2008. In other years, fish were concentrated in the north or south part of the lake (Wang et al. submitted).

Discussion

Densities obtained from the 2008 survey were lower than in 2005 – 2007 (1632 to 2328 alewife/ha, Wang et al. submitted) but are consistent with a small decline in net catches in 2008 compared to 2007 (Fig. 3, Table 2). Electrofishing catch rates

in the spring (42 alewife/hr) were also lower than in 2006 (153 fish/hr) and 2007 (55 fish/hr) but not dramatically so. The acoustic densities are still high relative to observed abundance of age 1 and older alewife across the Finger Lakes (Fitzsimons et al. 2005). Interestingly, electrofishing catches in 2006-2008 were all substantially lower than in 2005 when alewife abundance was estimated visually to 1823 fish/hr due to high catch rates.

However, the in situ TS measured in 2008 are too low given the catch in the gill nets, which raises concerns about the identity of the observed targets. Brooking and Rudstam (in press) found only 26% of the targets from a 100 mm alewife to be smaller than -50dB when insonified in a large net cage. The TS distribution from June 2008 indicate a larger proportion of small targets with 86% of the targets smaller than -50dB. There are four possible explanations for this:

1) equipment malfunction or improper calibration

2) the transducer was towed at an angle relative to the fish resulting in smaller TS due to tilted orientation of the fish relative the transducer beam

3) presence of fish smaller than 50 mm that were not caught in the vertical gill nets, and

4) inclusions of bubbles in the estimate.

The interpretation of the results is very much dependent on which of these reasons caused the low in situ TS. Equipment malfunction and calibration errors are always possible, but not likely since the unit was calibrated by the manufacturer in April 2008, and checked against standard targets (2 different targets) in July, August and November of 2008 (observed values were within 0.2 and 2dB of factory settings, much smaller deviation than the 10dB difference between expected and observed TS in Onondaga Lake).

The second explanation is more likely to at least contribute to the low TS values. Observations on the data when stationary at the end of the survey indicate that the transducer was at an angle relative the vertical. Large changes in tilt angle can cause TS to decrease two orders of magnitude (20dB, Horne and Jech 2005), but it is uncertain if the tilt angle was sufficient to cause a change of 10dB. If this is the problem, the reported densities are acceptable because changes in TS due to tilt angle are accounted for when using in situ TS to scale echo integration data.

The alternative that the small targets are either other, small fish or bubbles is more problematic. If that is the case, the densities reported here may be substantially higher than the actual alewife densities in the lake (maybe as low as 20% of reported densities). Evidence against this possibility is that there were few fish caught in the smallest mesh size and that most yearling fish in the spring should be larger than 50 mm. Larval fish should have TS between -76 and -58dB (Rudstam et al. 2002). Finally, bubbles were present due to wave action, especially in the surface water, However, small targets were present throughout the water column, not just in the surface water, and oxygen levels in the bottom waters were relatively high (4 ppm), which should prevent methane ebullition from the sediments. However, small targets cannot be excluded as a possible

explanation. We find it most likely that TS was distorted due to tilt angles as well as some of the smaller targets between -55 to -60 dB originate from other fish or bubbles and are not alewife. Unfortunately, we do not have samples with small enough mesh sizes to test this suggestion. Thus, the densities reported here are likely biased high.

Acknowledgment

We thank Onondaga County (Chris Gandino) and Roland Wang for help during field sampling and Ecologic (Liz Moran and Mark Arrigo) for logistic support. This study was supported by the Onondaga County Ambient Lake Monitoring Program.

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Table 1. Summary of fish catches in the four vertical gill nets with variable mesh size set in Onondaga Lake on June 4, 2008. Nets were set after dark and retrieved 2 hours later. Proportion by depth layer is based on alewife only. Average proportion by depth is based on all fish caught. Other species includes 2 walleye, 2 smallmouth bass and 1 yellow perch.

	Net 1	Net 2	Net 3	Net 4	Averages
Latitude N	43.0999	43.1045	43.0864	43.917	
Longitude W	76.2378	76.2220	76.2151	76.1997	
Soak time (h)	2.04	2.04	2.00	2.00	
# fish caught	192	140	44	176	138
Water depth (m)	6.5	8	7.5	6	
Catch / hour	94.1	68.6	22.0	88.0	68.2
Proportion 0-2m	0.42	0.29	0.35	0.39	0.37
2-4m	0.42	0.46	0.42	0.50	0.46
4-6m	0.16	0.26	0.23	0.11	0.17
Alewife					
Catch / hour	87.3	68.6	21.5	86.5	66.0
Mean Length (mm)	145.0	150.4	138.8	146.7	145.2
Range of lengths (mm)	122-176	122-175	115-168	118-171	115-176
Mean Weight (g)	28.9	30.6	24.3	28.3	28.8
White perch					
Catch / hour	5.0	0	0	0.5	1.4
Mean Length (mm)	182.9			208	185.2
Range of lengths (mm)	100-215				100-215
Emerald shiner					
Catch / hour	0.5	0	0	0	0.1
Mean Length (mm)	88				88
Brown trout					
Catch / hour	0	0	0.5	0	0.1
Mean Length (mm)			261		261
Other species					
Catch / hour	1.5	0	0	1.0	0.7
Mean Length (mm)	356.3			490	410
Range of lengths (mm)	205-444			419-561	205-561

Table 2.–Average fish catches in the vertical gill nets with variable mesh size set in Onondaga Lake in 2004-08. Four nets were set in each survey, with the exception on July 18, 2007 were only two nets were set. Details on the sets for 2008 are in Table 1.

Date	**10/7/2004**	**5/17/2005**	**6/4/2006**	**6/6/2007**	**7/18/2007**	**6/4/2008**
Soak time (h)	3.42	2.45	5.61	2.34	1.08	2.02
Proportion (0-2m)	0.35	0.38	0.43	0.42	0.28	0.37
(2-4m)	0.37	0.41	0.24	0.31	0.40	0.46
(4-6m)	0.28	0.21	0.32	0.27	0.32	0.17
Alewife (#/h)						
Catch/hour	58.51	75.4	56.4	94.9	143.5	66.0
Mean length (mm) (range)	148 (132-165)	149 (108-164)	132 (110-169)	153 (104-195)	150 (110-173)	145 (115-176)
Mean weight (g)	29.8	33.7	24.9	28.4	26.8	28.0
Other species (#/h)						
Gizzard shad	3.1	0	6.7	1.0	0	0
White perch	0.1	0.1	0.1	0.4	0	1.4
Yellow perch	0	0	0	0.5	0.5	0.1
Walleye	0	0	0	0	0	0.2
Emerald shiner	0	0	1.4	0	0	0.1
Golden shiner	0.1	0	0	0	0	0
Smallmouth bass	0	0	0	0.2	0	0.2
Pumpkin seed	0	0	0	0	0.5	0
Brown trout	0	0.1	0.02	0	0	0.1
Channel catfish	0.1	0	0	0	0.5	0

Table 3. Results from acoustics estimate of alewife in Onondaga Lake June 4, 2008, using a 123 kHz split beam unit. Density includes the whole water column assuming the density in surface waters is the same as in 2 -6 m. ABC is the area back scattering coefficient. Density is calculated from ABC/σ_{bs}, where σ_{bs} is target strength in the linear domain (back scattering cross section: $\sigma_{bs} = 10^{(TS/10)}$). Fish density is calculated based on transect specific *in situ* TS (superscript 1) and based on an overall average TS from whole lake (-52.0 dB, superscript 2, Fig. 3). Biomass is the density multiplied with the average weight of alewife caught in gill nets.

Transect #	Transect Length (m)	Average TS (dB)	ABC (m^2/ha)	Density[1] (fish/ha)	Density[2] (fish/ha)
1	1147	-54.18	0.0052	1396	819
2	1630	-51.53	0.0110	1908	1744
3	1723	-51.03	0.0081	520	1286
4	1491	-52.50	0.0046	1200	736
5	1598	-52.22	0.0070	1153	1106
6	1528	-51.71	0.0123	2160	1952
Mean	1519	-52.0	0.0080	1390	1274
Biomass (kg/ha)				40.0	36.7

Figure 1. Length distribution of alewife in vertical gill nets in 2005 to 2008.

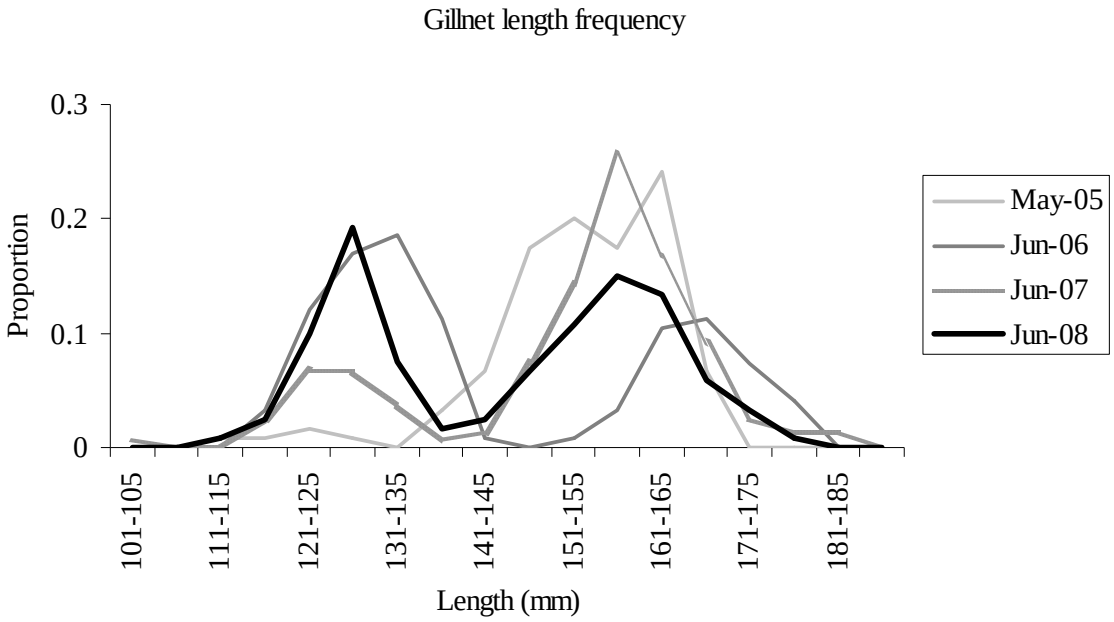


Figure 2. Target strength distribution from the June 4, 2008 survey in Onondaga Lake from the whole survey. The left graph shows TS as a function of depth in the lake, the right graph is a frequency distribution of targets. Both graphs include all targets passing the single echo detection algorithm of EchoView 4.5. Alewife are assumed to be targets larger then -60 dB, but the smaller peak around -64 to -55dB could be other fish larvae or echoes from bubbles. Most bubbles echoes are around -70 dB and smaller and concentrated in the surface water (left graph).

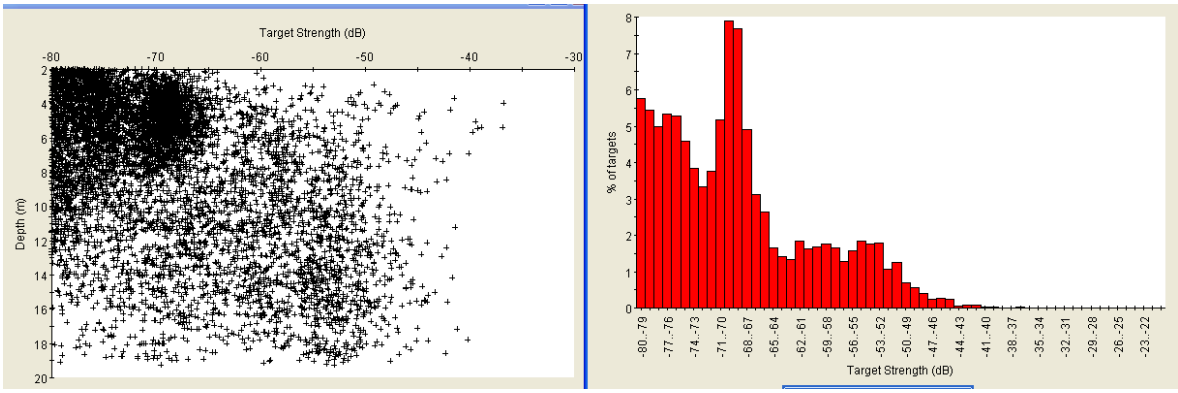
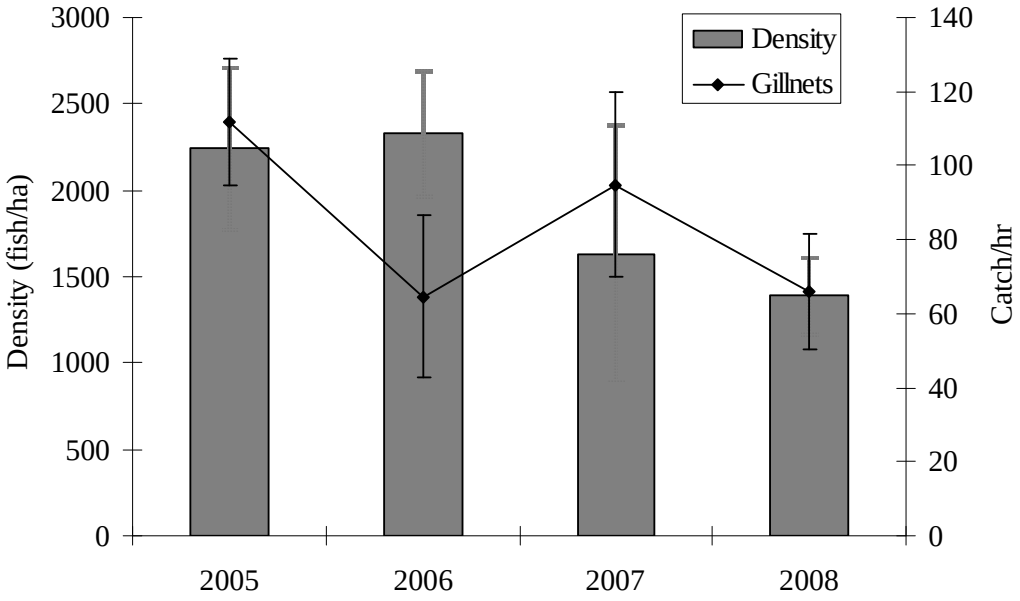


Figure 3. Alewife densities obtained with hydroacoustics (Density) and the gill net catch per hour from 2005 to 2008.



Angler Catch

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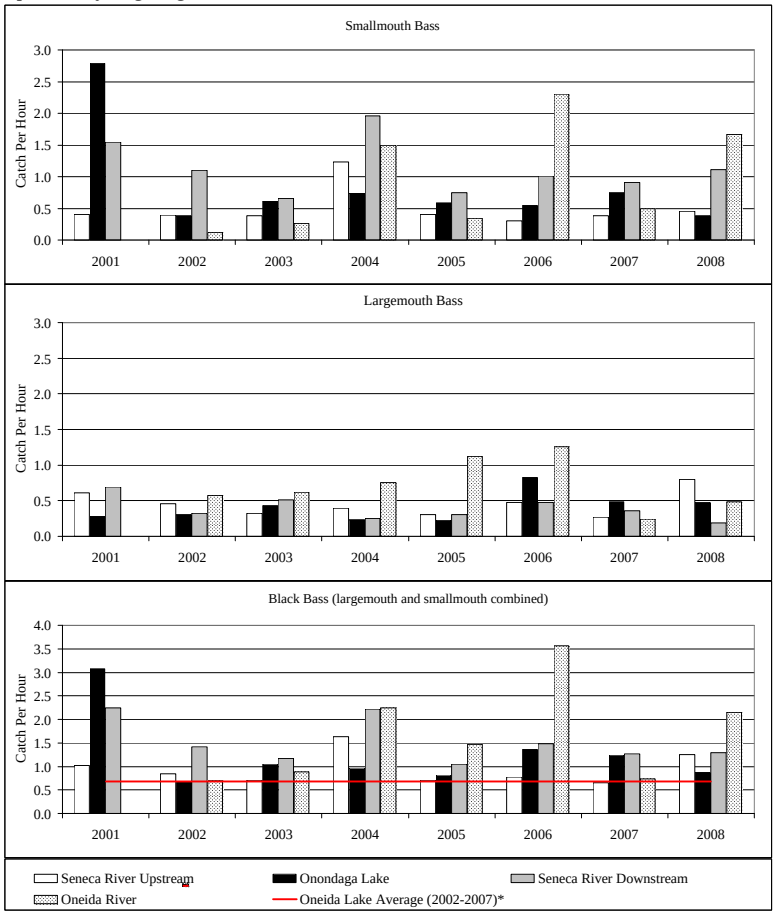
2001-2008 angler catch rates of bass, from diaries, in Onondaga Lake, Seneca River, and Oneida River. Combined bass catch rates are compared to average catch rates for trips specifically targeting bass in Oneida Lake from 2002 to 2007.



Graph Data

Smallmouth Bass

Year	Onondaga Lake	Seneca River Upstream	Seneca River Downstream	Oneida River
2001	2.8	0.4	1.5	
2002	0.4	0.4	1.1	0.1
2003	0.6	0.4	0.7	0.3
2004	0.7	1.2	2.0	1.5
2005	0.6	0.4	0.7	0.3
2006	0.5	0.3	1.0	2.3
2007	0.7	0.4	0.9	0.5
2008	0.4	0.5	1.1	1.7

Largemouth Bass

Year	Onondaga Lake	Seneca River	Seneca River Downstream	Oneida River
2001	0.28	0.61	0.69	
2002	0.31	0.46	0.32	0.57
2003	0.43	0.33	0.51	0.62
2004	0.23	0.40	0.25	0.76
2005	0.23	0.31	0.30	1.13
2006	0.83	0.47	0.47	1.26
2007	0.48	0.27	0.36	0.25
2008	0.48	0.80	0.19	0.48

Black Bass

Year	Onondaga Lake	Seneca River Upstream	Seneca River Downstream	Oneida River	Oneida Lake Average (2002-2007)*
2001	3.1	1.0	2.2		0.685
2002	0.7	0.8	1.4	0.7	0.685
2003	1.0	0.7	1.2	0.9	0.685
2004	1.0	1.6	2.2	2.2	0.685
2005	0.8	0.7	1.0	1.5	0.685
2006	1.4	0.8	1.5	3.6	0.685
2007	1.2	0.7	1.3	0.7	0.685
2008	0.9	1.3	1.3	2.2	0.685

** The Oneida Lake Creel Survey, 2002-2007. January 2009. Scott D. Krueger, James R. Jackson, Anthony J. VanDeValk, and Lars G. Rudstam. New York Federal Aid in Sport Fish Restoration; Study 2, Job 1 Grant F-56-R: Warmwater Fisheries . Cornell University Biological Field Station, 900 Shackelton Point Rd, Bridgeport, NY, 13030*

Library Reference 8.7.2.2

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2008 Angler Diary Summary for all species caught by diary participants in Onondaga Lake, Seneca River, and Oneida River.

a) Number of hours fished by section in 2008.

Zone	Location	Total hours
1	Onondaga Lake	842.5
2	Seneca River Upstream	52.5
3	Seneca River Downstream	221.5
4	Oneida River	101.8
	Total	1218.3

b) Catch-per-unit-effort of fish species by zone in 2008.

Zone*	Species	Total	CPUE
1, Onondaga Lake	All Fish	790	0.938
	Channel Catfish	2	0.002
	Largemouth Bass	403	0.478
	Other	24	0.028
	Pumpkinseed/Bluegill	18	0.021
	Smallmouth Bass	326	0.387
	Walleye	3	0.004
	Yellow Perch	14	0.017
2, Seneca River Upstream	All Fish	73	1.390
	Largemouth Bass	42	0.800
	Other	7	0.133
	Smallmouth Bass	24	0.457
3, Seneca River Downstream	All Fish	380	1.716
	Channel Catfish	2	0.009
	Largemouth Bass	41	0.185
	Other	83	0.375
	Pumpkinseed/Bluegill	2	0.009
	Smallmouth Bass	245	1.106
	Walleye	2	0.009
	Yellow Perch	5	0.023
4, Oneida River	All Fish	328	3.221
	Channel Catfish	1	0.010
	Largemouth Bass	49	0.481
	Other	101	0.992
	Pumpkinseed/Bluegill	5	0.049
	Smallmouth Bass	170	1.669
	Walleye	1	0.010
	Yellow Perch	1	0.010

Community Structure

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Catch rates

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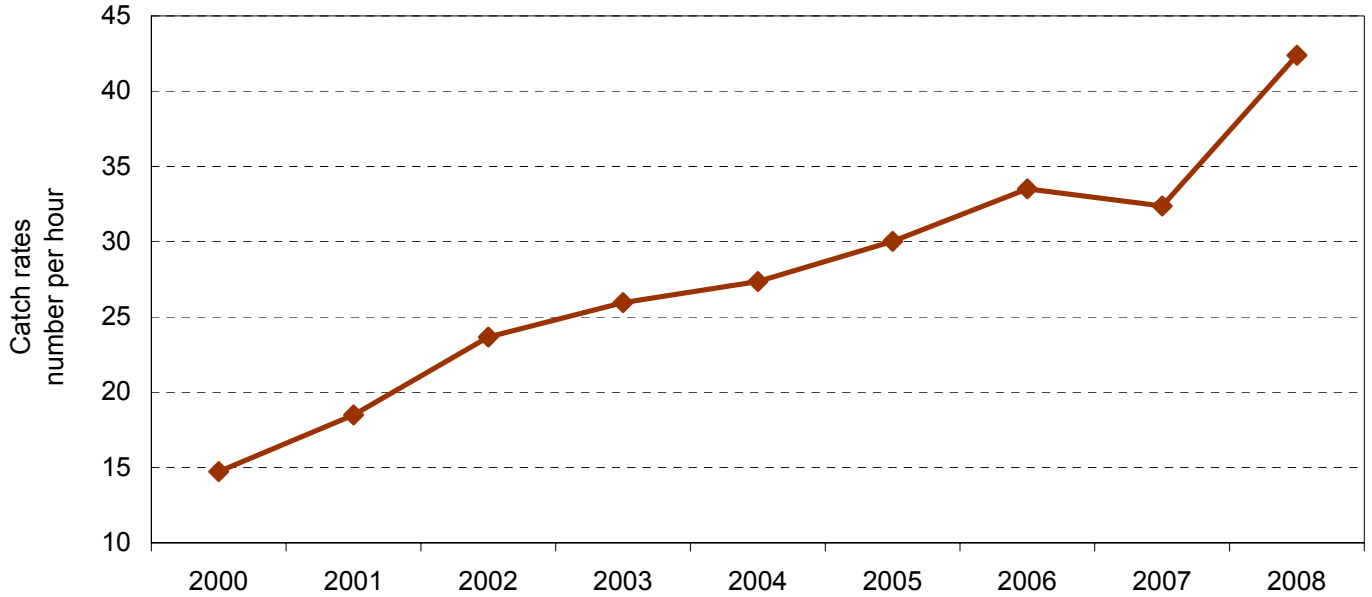

Trend in annual average catch rates (#/hr) from two electrofishing events (spring and fall) of largemouth and smallmouth bass combined in Onondaga Lake from 2000 to 2008)

Whole lake electrofishing relative abundance in 2008.

Notes: Clupeids (shad and alewives) are often captured in high numbers because they are abundant and have a tendency to school. Therefore the charts are presented with clupeids included and not included so that the relative proportion of non-clupeids can be discerned. CPUE (catch per hour) for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from a combination of fish that are boated and estimates of the number of fish missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water.

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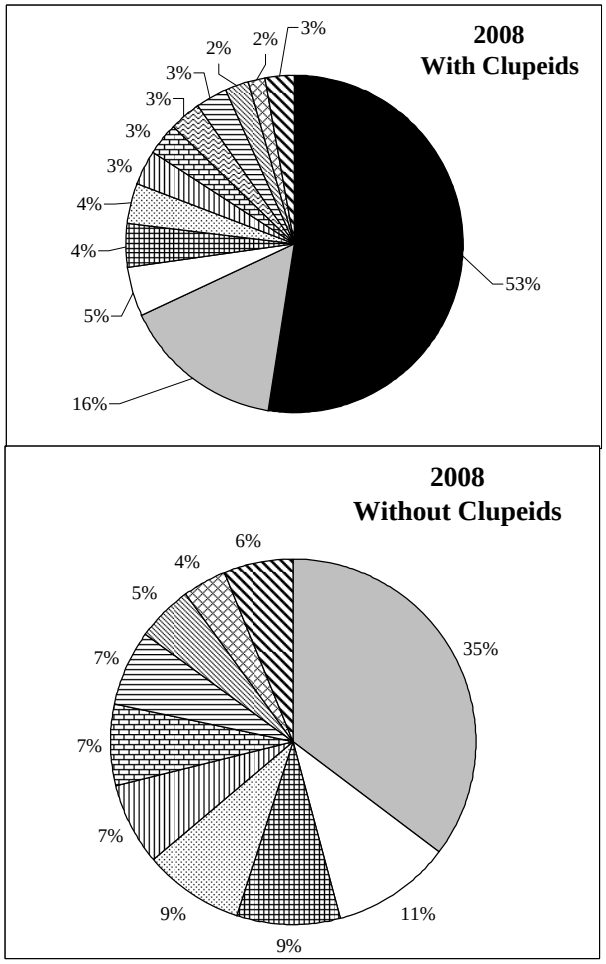

graph data with clupeids

Species	Mean CPUE	SE	Number	Relative Abundance with Clupeids	Relative Abundance without Clupeids
Gizzard shad	359.3	223.7	1817	52.5%	-
Pumpkinseed	107.1	16.8	1108	15.7%	35.3%
Yellow perch	32.3	4.7	324	4.7%	10.6%
White perch	27.9	7.5	142	4.1%	9.2%
White sucker	26.9	4.6	141	3.9%	8.9%
Largemouth bass	22.0	2.8	228	3.2%	7.3%
Brown bullhead	21.4	1.8	223	3.1%	7.1%
Alewife	21.2	9.8	100	3.1%	-
Smallmouth bass	20.4	2.4	212	3.0%	6.7%
Bluegill	15.6	2.6	159	2.3%	5.1%
Carp	11.2	3.9	57	1.6%	3.7%
Other	18.8	6.3	149	3%	6%

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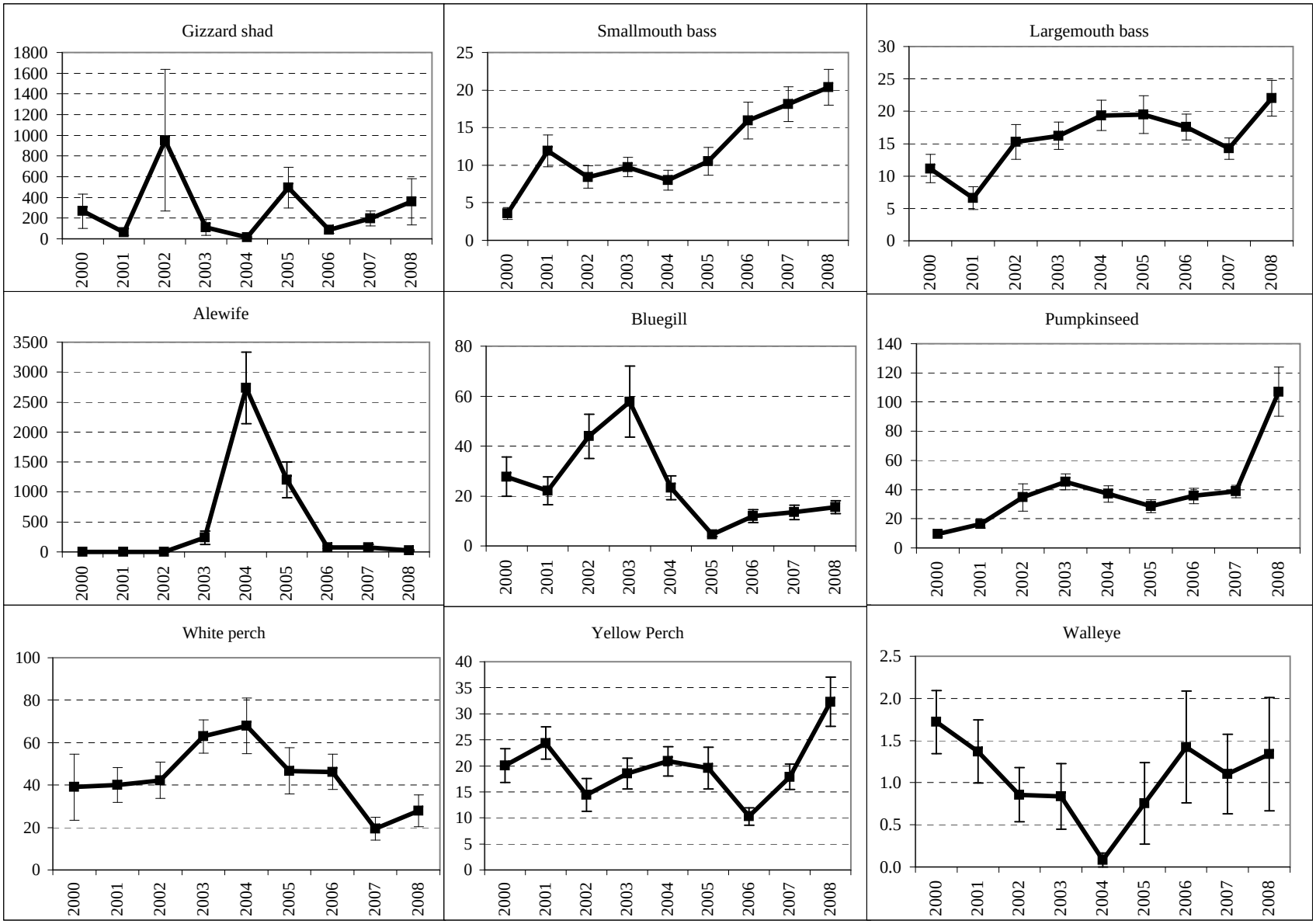
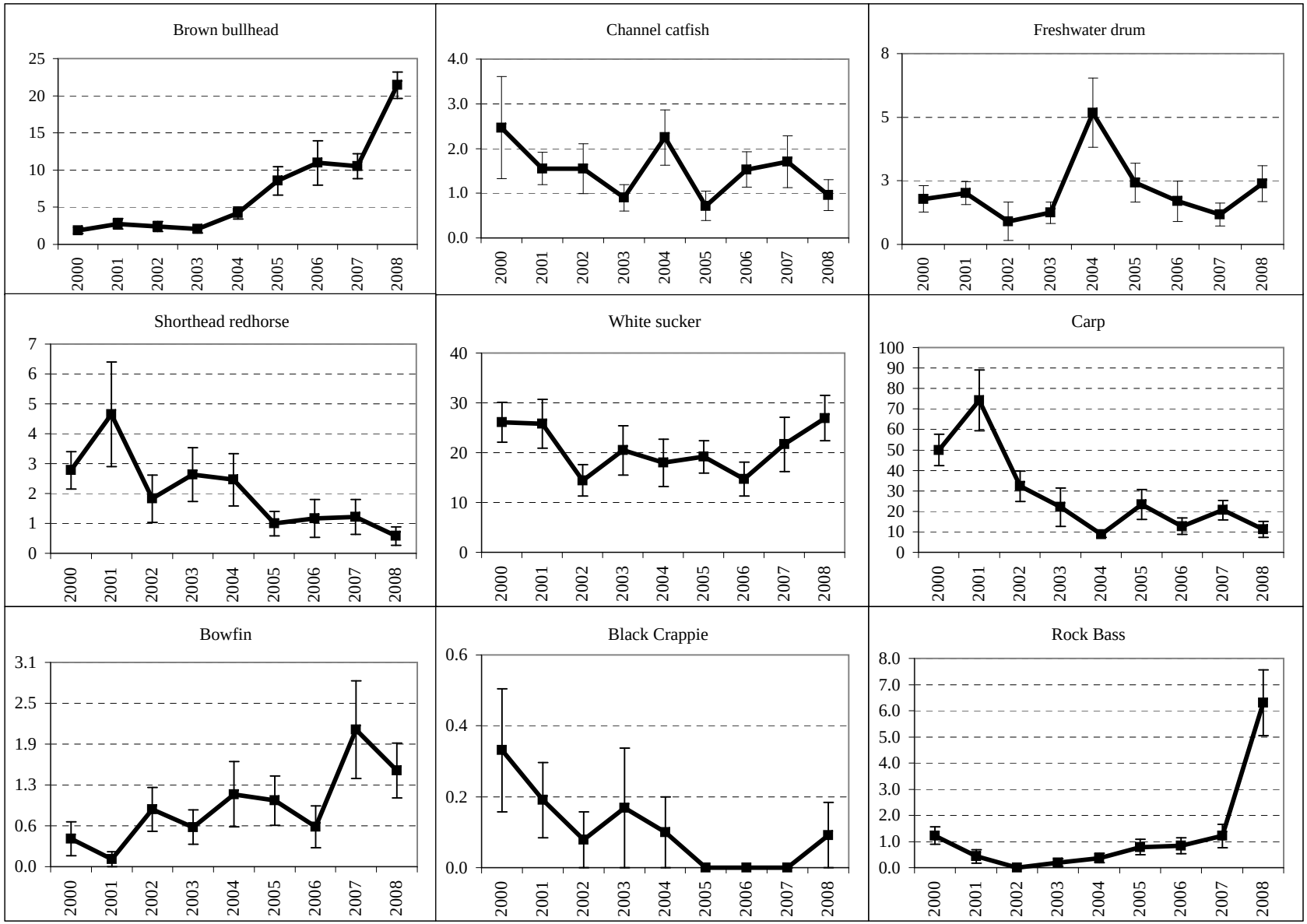
Trends in annual mean CPUE (catch per hour) of select species caught by electrofishing from 2000-2008.

Note: CPUE for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from a combination of fish that are boated and estimates of the number of fish missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water. Note: Y-axis (catch per hour) differs for each species.



Trends in annual mean CPUE (catch per hour) of select species caught by electrofishing from 2000-2008 (continued).

Note: CPUE for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from a combination of fish that are boated and estimates of the number of fish missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water. Note: Y-axis (catch per hour) differs for each species.



Trends in CPUE (catch per hour) of select species caught by electrofishing from 2000-2008. (continued)

CPUE

Common name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Gizzard shad	266.7	63.1	952.2	110.2	12.2	495.3	84.3	194.6	359.3
Bluegill	27.7	22.1	43.9	57.8	23.3	4.6	12.0	13.5	15.6
Pumpkinseed	9.5	16.2	34.7	45.3	37.0	28.6	35.6	38.7	107.1
White perch	39.1	40.1	42.3	62.9	67.9	46.7	46.2	19.4	27.9
Carp	49.9	74.1	32.3	22.0	8.8	23.4	12.8	20.6	11.2
Largemouth bass	11.2	6.6	15.3	16.2	19.4	19.5	17.6	14.2	22.0
Yellow perch	20.0	24.4	14.4	18.5	20.9	19.6	10.3	17.9	32.3
Smallmouth bass	3.6	11.9	8.4	9.7	8.0	10.5	15.9	18.1	20.4
White sucker	26.1	25.8	14.4	20.5	18.0	19.2	14.7	21.7	26.9
Brown bullhead	1.9	2.8	2.4	2.1	4.2	8.6	11.0	10.5	21.4
Channel catfish	2.5	1.6	1.5	0.9	2.2	0.7	1.5	1.7	1.0
Walleye	1.7	1.4	0.9	0.8	0.1	0.8	1.4	1.1	1.3
Shorthead redhorse	2.8	4.7	1.8	2.6	2.5	1.0	1.2	1.2	0.6
Bowfin	0.4	0.1	0.9	0.6	1.1	1.0	0.6	2.1	1.5
Alewife	0.0	0.6	1.6	238.4	#####	#####	78.7	74.4	21.2
Rock bass	1.2	0.4	0.0	0.2	0.4	0.8	0.8	1.2	6.3
Freshwater drum	1.9	2.1	1.0	1.3	5.4	2.5	1.8	1.2	2.5
Longnose gar	0.5	0.1	0.7	0.0	0.6	1.2	0.3	2.3	0.2
Northern pike	0.2	0.1	0.2	0.2	0.1	0.2	0.3	0.2	0.5
Rainbow trout	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Northern hog sucker	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.4	0.4
Logperch	0.2	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Black crappie	0.3	0.2	0.1	0.2	0.1	0.0	0.0	0.0	0.1
Tiger muskellunge	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.0	0.0
Golden shiner	0.5	0.0	0.0	0.7	1.1	1.1	4.1	0.6	4.3
Banded killifish	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Black bullhead	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Quillback	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Brown trout	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1
Emerald shiner	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0

Standard Error of CPUE

Common name	2000	2001	2002	2003	2004	2005	2006	2007	2008
Gizzard shad	167.5	31.4	683.1	76.5	6.2	196.3	31.4	72.1	223.7
Bluegill	7.9	5.6	8.9	14.3	4.8	0.8	2.6	2.9	2.6
Pumpkinseed	2.1	2.5	9.4	5.5	5.6	4.5	5.3	4.3	16.8
White perch	15.6	8.2	8.5	7.8	13.1	10.9	8.3	5.4	7.5
Carp	7.7	14.8	7.4	9.3	1.6	7.3	4.0	4.8	3.9
Largemouth bass	2.2	1.7	2.7	2.1	2.4	2.9	2.0	1.7	2.8
Yellow perch	3.3	3.1	3.1	3.0	2.8	4.0	1.7	2.4	4.7
Smallmouth bass	0.8	2.1	1.5	1.3	1.3	1.9	2.4	2.3	2.4
White sucker	4.0	4.9	3.1	4.9	4.7	3.2	3.4	5.4	4.6
Brown bullhead	0.4	0.7	0.7	0.5	0.8	1.9	3.0	1.7	1.8
Channel catfish	1.1	0.4	0.6	0.3	0.6	0.3	0.4	0.6	0.3
Walleye	0.4	0.4	0.3	0.4	0.1	0.5	0.7	0.5	0.7
Shorthead redhorse	0.6	1.8	0.8	0.9	0.9	0.4	0.6	0.6	0.3
Bowfin	0.3	0.1	0.3	0.3	0.5	0.4	0.3	0.7	0.4
Alewife	0.0	0.4	1.0	110.0	594.6	297.9	20.2	48.3	9.8
Rock bass	0.3	0.3	0.0	0.1	0.2	0.3	0.3	0.4	1.3
Freshwater drum	0.5	0.5	0.8	0.4	1.4	0.8	0.8	0.5	0.7
Longnose gar	0.4	0.1	0.6	0.0	0.3	0.5	0.3	1.4	0.2
Northern pike	0.1	0.1	0.1	0.2	0.0	0.2	0.2	0.2	0.2
Rainbow trout	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Northern hog sucker	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.3	0.3
Logperch	0.2	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Black crappie	0.2	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.1
Tiger muskellunge	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Golden shiner	0.3	0.0	0.0	0.5	0.5	0.6	1.7	0.3	1.6
Banded killifish	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Black bullhead	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Quillback	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Rudd	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0
Yellow bullhead	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1

Library Reference 8.7.3.1.4

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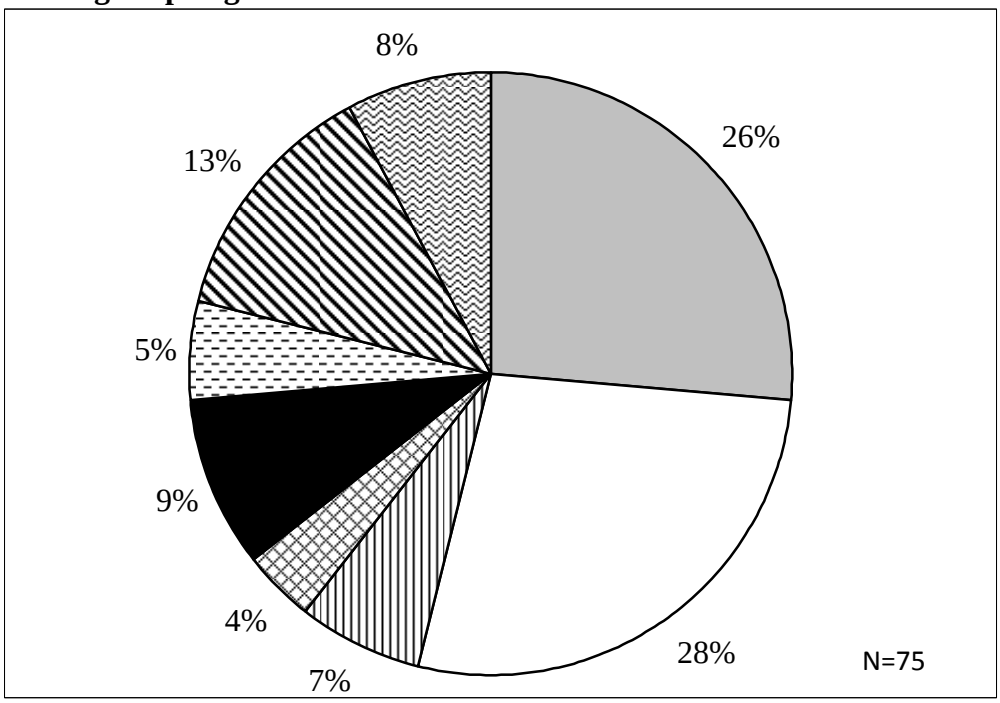
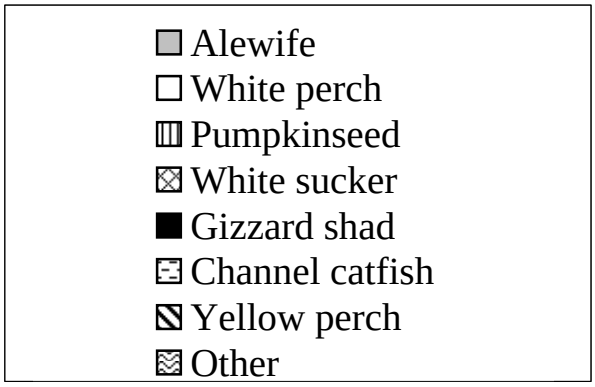
Relative abundance of fish species caught in gill nets in 2008. A single net was set in each of the lakes five strata, on bottom, in 4 to 5 m of water, within one week of electrofishing in spring and fall.



Graph Data

Species	Mean CPUE	Relative Abundance
Alewife	1.000	26.3%
White perch	1.048	27.6%
Pumpkinseed	0.250	6.6%
White sucker	0.150	3.9%
Gizzard shad	0.350	9.2%
Channel catfish	0.200	5.3%
Yellow perch	0.500	13.2%
Other	0.30	7.9%



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Whole Lake Electrofishing CPUE, total catch, and relative abundance in 2008 for each sampling event (spring and fall) - 2008 entire year.

Note: CPUE for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from the combination of the number of fish netted and estimates of the number missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water.

2008 Entire year

Species	Mean CPUE	SE	Total fish	Relative abundance with clupeids	Relative abundance without clupeids
Gizzard shad	359.3	223.7	1817	52.5%	-
Pumpkinseed	107.1	16.8	1108	15.7%	35.3%
Yellow perch	32.3	4.7	324	4.7%	10.6%
White perch	27.9	7.5	142	4.1%	9.2%
White sucker	26.9	4.6	141	3.9%	8.9%
Largemouth bass	22.0	2.8	228	3.2%	7.3%
Brown bullhead	21.4	1.8	223	3.1%	7.1%
Alewife	21.2	9.8	100	3.1%	-
Smallmouth bass	20.4	2.4	212	3.0%	6.7%
Bluegill	15.6	2.6	159	2.3%	5.1%
Carp	11.2	3.9	57	1.6%	3.7%
Rock bass	6.3	1.3	67	0.9%	2.1%
Golden shiner	4.3	1.6	23	0.6%	1.4%
Freshwater drum	2.5	0.7	14	0.4%	0.8%
Bowfin	1.5	0.4	8	0.2%	0.5%
Walleye	1.3	0.7	14	0.2%	0.4%
Channel catfish	1.0	0.3	9	0.1%	0.3%
Shorthead redhorse	0.6	0.3	3	0.1%	0.2%
Northern pike	0.5	0.2	5	0.1%	0.2%
Northern hog sucker	0.4	0.3	2	0.1%	0.1%
Longnose gar	0.2	0.2	1	0.03%	0.1%
Brown trout	0.1	0.1	1	0.01%	0.03%
Yellow bullhead	0.1	0.1	1	0.01%	0.03%
Black crappie	0.1	0.1	1	0.01%	0.03%

Whole Lake Electrofishing CPUE, total catch, and relative abundance in 2008 for each sampling event (spring and fall). (continued) - 2008 Spring

Note: CPUE for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from the combination of the number of fish netted and estimates of the number missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water.

2008 Spring

Species	Mean CPUE	SE	Total fish	Relative abundance with clupeids	Relative abundance without clupeids
Pumpkinseed	127.3	19.3	651	34.0%	39.1%
Alewife	42.3	18.7	100	11.3%	-
Yellow perch	34.6	6.0	168	9.3%	10.6%
White sucker	33.9	8.4	90	9.1%	10.4%
Smallmouth bass	25.0	3.5	127	6.7%	7.7%
White perch	24.9	4.3	64	6.7%	7.6%
Brown bullhead	22.8	3.1	117	6.1%	7.0%
Bluegill	18.1	3.7	89	4.9%	5.6%
Largemouth bass	17.9	2.9	88	4.8%	5.5%
Carp	9.9	4.5	25	2.7%	3.0%
Gizzard shad	5.6	2.6	16	1.5%	-
Golden shiner	4.4	1.9	12	1.2%	1.4%
Rock bass	4.0	1.3	21	1.1%	1.2%
Walleye	2.5	1.6	12	0.7%	0.8%
Shorthead redhorse	0.4	0.4	1	0.1%	0.1%
Brown trout	0.2	0.2	1	0.1%	0.1%

Whole Lake Electrofishing CPUE, total catch, and relative abundance in 2008 for each sampling event (spring and fall). (continued) - 2008 Fall.

Note: CPUE for gamefish (bolded) is calculated from all 24 transects. CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect). Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from the combination of the number of fish netted and estimates of the number missed. Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water.

2008 Fall

Species	Mean CPUE	SE	Total fish	Relative abundance with clupeids	Relative abundance without clupeids
Gizzard shad	696.3	433.4	1801	71.3%	-
Pumpkinseed	86.2	17.9	457	8.8%	30.7%
White perch	32.0	14.5	78	3.3%	11.4%
Yellow perch	29.9	5.1	156	3.1%	10.7%
Largemouth bass	26.1	3.8	140	2.7%	9.3%
Brown bullhead	20.2	2.9	106	2.1%	7.2%
White sucker	19.1	4.4	51	2.0%	6.8%
Smallmouth bass	15.8	2.1	85	1.6%	5.6%
Bluegill	13.1	2.5	70	1.3%	4.7%
Carp	12.5	3.5	32	1.3%	4.4%
Rock bass	8.5	1.7	46	0.9%	3.0%
Freshwater drum	5.0	1.5	14	0.5%	1.8%
Golden shiner	4.1	1.9	11	0.4%	1.5%
Bowfin	2.9	0.8	8	0.3%	1.0%
Channel catfish	1.9	0.7	9	0.2%	0.7%
Northern pike	0.9	0.5	5	0.1%	0.3%
Shorthead redhorse	0.7	0.5	2	0.1%	0.3%
Northern hog sucker	0.7	0.5	2	0.1%	0.3%
Walleye	0.4	0.3	2	0.04%	0.2%
Longnose gar	0.3	0.3	1	0.03%	0.1%
Black crappie	0.2	0.2	1	0.02%	0.1%
Yellow bullhead	0.2	0.2	1	0.02%	0.1%

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Whole Lake Electrofishing number netted and number missed in 2008 for each sampling event (spring and fall) - 2008 entire year.

Note: Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water therefore no carp within netting distance are ever "missed". Lepomis sp. include bluegill and pumpkinseed because these species cannot be distinguished while still in the water, at night when missed. Although most fish in the genus Micropterus sp. (black bass) are large enough to be readily distinguishable when missed, some are not, these are counted under the designation "Micropterus sp.". Bullhead that are missed are assumed to be brown bullhead. The "number netted" for shad and alewives (clupeids) differs from the "total number" depicted in Tables A8-3(a-c) because the totals in those tables include both the netted and missed fish (see note under Table A8-3(a-c) title). For the clupeids in Tables A8-3(d-f) the sum of the "Number Missed" and "Number Netted" will equal the total number for those species in Table A8-3(a-c).

2008 Entire year

Species	Number Netted	Number Missed
Pumpkinseed	1108	0
Yellow perch	324	301
Largemouth bass	228	5
Brown bullhead	223	170
Gizzard shad	215	1602
Smallmouth bass	212	7
Bluegill	159	0
White perch	143	155
White sucker	141	37
Rock bass	67	5
Carp	57	0
Alewife	30	70
Golden shiner	23	0
Bowfin	17	4
Freshwater drum	14	11
Walleye	14	1
Channel catfish	9	8
Northern pike	5	0
Longnose gar	4	1
Shorthead redhorse	3	0
Northern hog sucker	2	0
Black crappie	1	0
Yellow bullhead	1	0
Brown trout	1	0
Lepomis sp.	0	2742
Micropterus sp.	0	106
Pike Family (Esocidae)	0	1
No Catch	0	0

Whole Lake Electrofishing number netted and number missed in 2008 for each sampling event (spring and fall) (continued) - 2008 Spring.

Note: Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water therefore no carp within netting distance are ever "missed". Lepomis sp. include bluegill and pumpkinseed because these species cannot be distinguished while still in the water, at night when missed. Although most fish in the genus Micropterus sp. (black bass) are large enough to be readily distinguishable when missed, some are not, these are counted under the designation "Micropterus sp.". Bullhead that are missed are assumed to be brown bullhead. The "number netted" for shad and alewives (clupeids) differs from the "total number" depicted in Tables A8-3(a-c) because the totals in those tables include both the netted and missed fish (see note under Table A8-3(a-c) title). For the clupeids in Tables A8-3(d-f) the sum of the "Number Missed" and "Number Netted" will equal the total number for those species in Table A8-3(a-c).

2008 Spring

Species	Number Netted	Number Missed
Pumpkinseed	651	0
Yellow perch	168	71
Smallmouth bass	127	7
Brown bullhead	117	16
White sucker	90	28
Bluegill	89	0
Largemouth bass	88	5
White perch	65	20
Alewife	30	70
Carp	25	0
Rock bass	21	0
Gizzard shad	14	2
Walleye	12	1
Golden shiner	12	0
Bowfin	6	1
Brown trout	1	0
Longnose gar	1	0
Shorthead redhorse	1	0
Lepomis sp.	0	547
No Catch	0	0

Whole Lake Electrofishing number netted and number missed in 2008 for each sampling event (spring and fall) (continued) - 2008 Fall.

Note: Because of their large size carp are not boated, instead carp within netting distance are counted while still in the water therefore no carp within netting distance are ever "missed". Lepomis sp. include bluegill and pumpkinseed because these species cannot be distinguished while still in the water, at night when missed. Although most fish in the genus Micropterus sp. (black bass) are large enough to be readily distinguishable when missed, some are not, these are counted under the designation "Micropterus sp.". Bullhead that are missed are assumed to be brown bullhead. The "number netted" for shad and alewives (clupeids) differs from the "total number" depicted in Tables A8-3(a-c) because the totals in those tables include both the netted and missed fish (see note under Table A8-3(a-c) title). For the clupeids in Tables A8-3(d-f) the sum of the "Number Missed" and "Number Netted" will equal the total number for those species in Table A8-3(a-c).

2008 Fall

Species	Number Netted	Number Missed
Pumpkinseed	457	0
Gizzard shad	201	1600
Yellow perch	156	230
Largemouth bass	140	0
Brown bullhead	106	154
Smallmouth bass	85	0
White perch	78	135
Bluegill	70	0
White sucker	51	9
Rock bass	46	5
Carp	32	0
Freshwater drum	14	11
Bowfin	11	3
Golden shiner	11	0
Channel catfish	9	8
Northern pike	5	0
Longnose gar	3	1
Northern hog sucker	2	0
Shorthead redhorse	2	0
Walleye	2	0
Black crappie	1	0
Yellow bullhead	1	0
Lepomis sp.	0	2195
Micropterus sp.	0	106
Pike Family (Esocidae)	0	1

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A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata.

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

a.) Entire year 2008	Stratum 1 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	4.33	3.43	0.7%	-
	Bluegill	23.33	5.90	4.0%	5.9%
	Bowfin	2.10	1.29	0.4%	0.5%
	Brown bullhead	24.51	3.97	4.2%	6.2%
	Carp	0.62	0.62	0.1%	0.2%
	Channel catfish	0.44	0.44	0.1%	0.1%
	Freshwater drum	5.60	0.94	1.0%	1.4%
	Gizzard shad	185.41	149.13	31.5%	-
	Golden shiner	5.29	2.96	0.9%	1.3%
	Largemouth bass	29.64	5.07	5.0%	7.4%
	Northern pike	0.86	0.86	0.2%	0.2%
	Pumpkinseed	193.82	35.64	33.0%	48.7%
	Rock bass	14.79	3.10	2.5%	3.7%
	Shorthead redhorse	0.62	0.62	0.1%	0.2%
	Smallmouth bass	20.24	5.14	3.4%	5.1%
	Walleye	0.37	0.37	0.1%	0.1%
	White perch	18.48	3.64	3.1%	4.6%
	White sucker	21.02	2.94	3.6%	5.3%
	Yellow perch	36.62	9.60	6.2%	9.2%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

b.) Spring 2008	Stratum 1				
	Species	**Mean CPUE**	**SE**	**Relative abundance with clupeids**	**Relative abundance without clupeids**
	Alewife	8.93	7.15	1.9%	0.0%
	Bluegill	25.08	6.03	5.3%	5.5%
	Brown bullhead	29.10	5.96	6.1%	6.4%
	Gizzard shad	16.50	6.15	3.5%	0.0%
	Golden shiner	7.87	5.55	1.7%	1.7%
	Largemouth bass	17.63	5.88	3.7%	3.9%
	Pumpkinseed	255.77	26.96	53.5%	56.5%
	Rock bass	8.89	5.64	1.9%	2.0%
	Smallmouth bass	25.79	6.53	5.4%	5.7%
	Walleye	0.74	0.74	0.2%	0.2%
	White perch	21.41	9.49	4.5%	4.7%
	White sucker	22.59	7.11	4.7%	5.0%
	Yellow perch	37.56	9.39	7.9%	8.3%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

c.) Fall 2008	Stratum 1 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	21.67	7.54	3.1%	6.3%
	Bowfin	4.11	2.48	0.6%	1.2%
	Brown bullhead	20.25	6.00	2.9%	5.9%
	Carp	1.25	1.25	0.2%	0.4%
	Channel catfish	0.86	0.86	0.1%	0.3%
	Freshwater drum	11.05	2.01	1.6%	3.2%
	Gizzard shad	354.57	295.05	50.6%	0.0%
	Golden shiner	2.68	1.35	0.4%	0.8%
	Largemouth bass	41.16	7.03	5.9%	11.9%
	Northern pike	1.66	1.66	0.2%	0.5%
	Pumpkinseed	134.00	44.87	19.1%	38.7%
	Rock bass	20.70	3.30	3.0%	6.0%
	Shorthead redhorse	1.25	1.25	0.2%	0.4%
	Smallmouth bass	15.01	5.07	2.1%	4.3%
	White perch	15.52	9.41	2.2%	4.5%
	White sucker	19.06	12.60	2.7%	5.5%
	Yellow perch	35.75	14.14	5.1%	10.3%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

d.) Entire year 2008	Stratum 2 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	8.12	3.97	1.5%	0.0%
	Bluegill	6.45	2.32	1.2%	2.8%
	Bowfin	1.39	0.71	0.3%	0.6%
	Brown bullhead	24.12	2.79	4.4%	10.6%
	Brown trout	0.40	0.40	0.1%	0.2%
	Carp	21.78	9.09	4.0%	9.6%
	Freshwater drum	2.26	1.27	0.4%	1.0%
	Gizzard shad	307.86	131.72	56.7%	0.0%
	Golden shiner	2.21	2.21	0.4%	1.0%
	Largemouth bass	16.10	4.43	3.0%	7.1%
	Pumpkinseed	43.60	9.80	8.0%	19.2%
	Rock bass	4.05	1.48	0.8%	1.8%
	Shorthead redhorse	0.79	0.79	0.2%	0.4%
	Smallmouth bass	15.56	4.19	2.9%	6.9%
	Walleye	1.23	0.80	0.2%	0.5%
	White perch	21.15	7.42	3.9%	9.3%
	White sucker	45.00	10.04	8.3%	19.9%
	Yellow perch	20.58	6.67	3.8%	9.1%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

e.) Spring 2008	Stratum 2 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	16.09	8.10	4.9%	0.0%
	Bluegill	7.18	2.44	2.2%	2.4%
	Brown bullhead	31.69	5.50	9.7%	10.4%
	Brown trout	0.72	0.72	0.2%	0.2%
	Carp	22.07	11.15	6.8%	7.2%
	Gizzard shad	5.82	3.81	1.8%	0.0%
	Golden shiner	4.49	4.49	1.4%	1.5%
	Largemouth bass	15.06	5.12	4.6%	4.9%
	Pumpkinseed	70.18	17.15	21.5%	23.0%
	Rock bass	4.43	1.68	1.4%	1.5%
	Shorthead redhorse	1.44	1.44	0.4%	0.5%
	Smallmouth bass	21.34	5.30	6.5%	7.0%
	Walleye	1.50	1.50	0.5%	0.5%
	White perch	29.27	2.84	9.0%	9.6%
	White sucker	69.21	21.22	21.2%	22.7%
	Yellow perch	26.38	7.75	8.1%	8.7%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

f.) Fall 2008	Stratum 2 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	5.59	3.57	0.8%	3.8%
	Bowfin	2.87	1.54	0.4%	2.0%
	Brown bullhead	17.01	5.33	2.3%	11.7%
	Carp	21.42	7.53	2.9%	14.7%
	Freshwater drum	4.64	2.52	0.6%	3.2%
	Gizzard shad	601.90	241.15	80.5%	0.0%
	Largemouth bass	17.14	4.77	2.3%	11.7%
	Pumpkinseed	16.78	3.53	2.2%	11.5%
	Rock bass	3.68	1.36	0.5%	2.5%
	Smallmouth bass	9.61	4.80	1.3%	6.6%
	Walleye	0.89	0.89	0.1%	0.6%
	White perch	12.30	12.30	1.6%	8.4%
	White sucker	18.85	5.36	2.5%	12.9%
	Yellow perch	15.20	6.12	2.0%	10.4%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

g.) Entire year 2008	Stratum 3 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	32.86	10.23	2.1%	0.0%
	Bluegill	4.22	1.10	0.3%	2.6%
	Bowfin	2.37	0.32	0.2%	1.5%
	Brown bullhead	24.17	4.97	1.5%	15.1%
	Carp	5.14	5.14	0.3%	3.2%
	Channel catfish	2.54	1.11	0.2%	1.6%
	Freshwater drum	2.06	2.06	0.1%	1.3%
	Gizzard shad	1394.50	1349.24	87.8%	0.0%
	Golden shiner	4.75	0.64	0.3%	3.0%
	Largemouth bass	8.35	3.51	0.5%	5.2%
	Longnose gar	1.03	1.03	0.1%	0.6%
	Northern pike	0.67	0.67	0.0%	0.4%
	Pumpkinseed	36.44	11.60	2.3%	22.7%
	Rock bass	2.43	1.12	0.2%	1.5%
	Shorthead redhorse	1.35	1.35	0.1%	0.8%
	Smallmouth bass	11.03	3.83	0.7%	6.9%
	Walleye	4.59	3.74	0.3%	2.9%
	White perch	15.67	4.90	1.0%	9.8%
	White sucker	22.64	12.36	1.4%	14.1%
	Yellow perch	10.83	1.06	0.7%	6.8%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

h.) Spring 2008	Stratum 3 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	69.30	19.73	45.8%	0.0%
	Bluegill	2.43	1.41	1.6%	3.0%
	Brown bullhead	8.94	3.28	5.9%	10.9%
	Golden shiner	2.25	2.25	1.5%	2.7%
	Largemouth bass	5.12	2.14	3.4%	6.2%
	Pumpkinseed	11.96	7.02	7.9%	14.6%
	Rock bass	1.13	1.13	0.7%	1.4%
	Smallmouth bass	5.12	2.14	3.4%	6.2%
	Walleye	10.48	8.74	6.9%	12.8%
	White perch	6.76	6.76	4.5%	8.2%
	White sucker	23.98	14.97	15.8%	29.2%
	Yellow perch	3.98	2.51	2.6%	4.8%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

i.) Fall 2008	Stratum 3 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	5.91	2.23	0.2%	2.6%
	Bowfin	4.50	0.72	0.2%	2.0%
	Brown bullhead	37.40	6.11	1.3%	16.3%
	Carp	9.46	9.46	0.3%	4.1%
	Channel catfish	4.90	2.16	0.2%	2.1%
	Freshwater drum	3.79	3.79	0.1%	1.7%
	Gizzard shad	2699.85	2616.57	92.2%	0.0%
	Golden shiner	7.11	3.32	0.2%	3.1%
	Largemouth bass	10.94	4.93	0.4%	4.8%
	Longnose gar	1.89	1.89	0.1%	0.8%
	Northern pike	1.30	1.30	0.0%	0.6%
	Pumpkinseed	57.46	19.48	2.0%	25.1%
	Rock bass	3.67	2.54	0.1%	1.6%
	Shorthead redhorse	2.61	2.61	0.1%	1.1%
	Smallmouth bass	15.98	5.13	0.6%	7.0%
	White perch	23.68	2.81	0.8%	10.4%
	White sucker	21.33	9.97	0.7%	9.3%
	Yellow perch	16.96	1.32	0.6%	7.4%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

j.) Entire year 2008	Stratum 4 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	75.67	44.33	15.2%	0.0%
	Black crappie	0.44	0.44	0.1%	0.1%
	Bluegill	30.28	1.80	6.1%	7.3%
	Brown bullhead	15.84	4.72	3.2%	3.8%
	Carp	25.18	8.30	5.1%	6.1%
	Channel catfish	1.63	1.11	0.3%	0.4%
	Gizzard shad	11.04	8.25	2.2%	0.0%
	Largemouth bass	26.97	6.42	5.4%	6.5%
	Northern hog sucker	1.21	1.21	0.2%	0.3%
	Northern pike	0.91	0.56	0.2%	0.2%
	Pumpkinseed	152.71	38.10	30.6%	37.0%
	Rock bass	3.71	1.49	0.7%	0.9%
	Smallmouth bass	29.67	4.46	5.9%	7.2%
	Walleye	0.44	0.44	0.1%	0.1%
	White perch	66.10	37.16	13.2%	16.0%
	White sucker	16.18	8.94	3.2%	3.9%
	Yellow bullhead	0.44	0.44	0.1%	0.1%
	Yellow perch	40.73	10.07	8.2%	9.9%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

k.) Spring 2008	Stratum 4 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Alewife	147.09	78.56	25.6%	0.0%
	Bluegill	44.74	5.18	7.8%	10.5%
	Brown bullhead	17.01	4.82	3.0%	4.0%
	Carp	26.27	10.46	4.6%	6.2%
	Largemouth bass	28.06	6.26	4.9%	6.6%
	Pumpkinseed	142.08	25.84	24.8%	33.3%
	Rock bass	2.04	1.25	0.4%	0.5%
	Smallmouth bass	38.18	7.47	6.7%	8.9%
	Walleye	0.98	0.98	0.2%	0.2%
	White perch	44.72	7.99	7.8%	10.5%
	White sucker	28.90	13.08	5.0%	6.8%
	Yellow perch	53.98	18.17	9.4%	12.6%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

l.) Fall 2008	Stratum 4 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Black crappie	0.80	0.80	0.2%	0.2%
	Bluegill	16.36	3.16	3.9%	4.1%
	Brown bullhead	14.57	6.35	3.5%	3.6%
	Carp	23.79	6.01	5.6%	5.9%
	Channel catfish	3.41	2.35	0.8%	0.9%
	Gizzard shad	20.76	14.80	4.9%	0.0%
	Largemouth bass	25.92	6.77	6.1%	6.5%
	Northern hog sucker	2.22	2.22	0.5%	0.6%
	Northern pike	1.72	1.06	0.4%	0.4%
	Pumpkinseed	160.82	51.14	38.1%	40.1%
	Rock bass	5.24	1.92	1.2%	1.3%
	Smallmouth bass	22.09	4.68	5.2%	5.5%
	White perch	93.85	84.96	22.2%	23.4%
	White sucker	2.98	2.98	0.7%	0.7%
	Yellow bullhead	0.80	0.80	0.2%	0.2%
	Yellow perch	26.74	8.73	6.3%	6.7%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

m.) Entire year 2008	Stratum 5 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	12.44	5.91	3.7%	3.9%
	Bowfin	1.27	1.27	0.4%	0.4%
	Brown bullhead	17.76	3.30	5.3%	5.5%
	Carp	3.50	3.50	1.1%	1.1%
	Channel catfish	0.60	0.60	0.2%	0.2%
	Freshwater drum	1.17	1.17	0.4%	0.4%
	Gizzard shad	10.49	10.49	3.2%	0.0%
	Golden shiner	10.03	7.70	3.0%	3.1%
	Largemouth bass	28.84	7.37	8.7%	9.0%
	Northern hog sucker	1.27	1.27	0.4%	0.4%
	Pumpkinseed	107.65	17.90	32.4%	33.4%
	Rock bass	6.17	2.44	1.9%	1.9%
	Smallmouth bass	25.51	6.02	7.7%	7.9%
	Walleye	0.58	0.58	0.2%	0.2%
	White perch	25.94	18.34	7.8%	8.1%
	White sucker	23.81	11.14	7.2%	7.4%
	Yellow perch	55.40	12.37	16.7%	17.2%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

n.) Spring 2008	Stratum 5 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	8.38	5.52	2.6%	2.6%
	Brown bullhead	22.78	11.00	6.9%	6.9%
	Golden shiner	5.82	5.82	1.8%	1.8%
	Largemouth bass	22.50	9.20	6.9%	6.9%
	Pumpkinseed	149.03	29.67	45.3%	45.3%
	Rock bass	2.55	1.50	0.8%	0.8%
	Smallmouth bass	33.16	8.99	10.1%	10.1%
	White perch	21.83	4.38	6.6%	6.6%
	White sucker	13.11	13.11	4.0%	4.0%
	Yellow perch	49.53	14.51	15.1%	15.1%

A through O. Electrofishing CPUE (#/hr) and relative abundance in 2008 from each of five lake strata. (continued)

Note: CPUE for gamefish (bolded) is calculated from all transects within the Stratum. CPUE for non-gamefish are calculated from only the transects where all fish are collected. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from estimates of the number of fish.

o.) Fall 2008	Stratum 5 Species	Mean CPUE	SE	Relative abundance with clupeids	Relative abundance without clupeids
	Bluegill	16.51	7.32	4.8%	5.2%
	Bowfin	2.24	2.24	0.7%	0.7%
	Brown bullhead	14.56	4.65	4.3%	4.6%
	Carp	7.49	7.49	2.2%	2.4%
	Channel catfish	1.22	1.22	0.4%	0.4%
	Freshwater drum	2.50	2.50	0.7%	0.8%
	Gizzard shad	22.47	22.47	6.6%	0.0%
	Golden shiner	13.72	8.73	4.0%	4.3%
	Largemouth bass	36.04	13.03	10.6%	11.3%
	Northern hog sucker	2.24	2.24	0.7%	0.7%
	Pumpkinseed	65.77	23.83	19.3%	20.7%
	Rock bass	9.35	4.18	2.7%	2.9%
	Smallmouth bass	17.92	3.00	5.3%	5.6%
	Walleye	1.25	1.25	0.4%	0.4%
	White perch	32.45	32.45	9.5%	10.2%
	White sucker	33.69	11.25	9.9%	10.6%
	Yellow perch	61.54	11.11	18.1%	19.3%

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A through D. Electrofishing CPUE (#/hr) for each species in each of 24 transects in 2008.

Note: CPUE for non-gamefish are calculated from only the one-half of the transects where all fish are collected (every other transect, shaded). Cells with no data indicate a non-gamefish species in a gamefish only transect. Because of the difficulty in netting clupeids (shad and alewives), the CPUE for these species is calculated from a combination of the number of fish netted and estimates of the number missed.

a.) 2008 entire year mean CPUE

Transect	Alewife	Black crappie	Bluegill	Bowfin	Brown bullhead	Brown trout	Carp	Channel catfish	Freshwater drum	Gizzard shad	Golden shiner	Largemouth bass	Longnose gar	Northern hog sucker	Northern pike	Pumpkinseed	Rock bass	Shorthead redhorse	Smallmouth bass	Walleye	White perch	White sucker	Yellow bullhead	Yellow perch
EF 1	0.00	0.00	4.99	0.00	16.85	0.00	7.49	0.00	2.50	22.47	2.50	9.36	0.00	0.00	0.00	129.51	2.18	0.00	34.02	2.50	45.56	35.58	0.00	25.90
EF 2	0.00	0.00	21.92	0.00	20.32	0.00	0.00	0.00	0.00	0.00	0.00	44.32	0.00	0.00	0.00	81.45	2.40	0.00	35.04	0.00	0.00	0.00	0.00	69.29
EF 3	0.00	0.00	22.85	2.24	27.75	0.00	0.00	0.00	0.00	0.00	17.04	29.33	0.00	2.24	0.00	144.27	11.89	0.00	23.52	0.00	8.72	11.22	0.00	81.11
EF 4	0.00	0.00	0.00	0.00	9.76	0.00	0.00	2.44	0.00	0.00	0.00	34.06	0.00	0.00	0.00	74.37	7.32	0.00	9.59	0.00	0.00	0.00	0.00	45.84
EF 5	1.86	0.00	9.37	1.88	29.82	0.00	1.88	0.00	7.51	484.13	11.17	30.00	0.00	0.00	0.00	126.74	11.24	1.88	37.35	1.86	11.19	16.74	0.00	3.72
EF 6	0.00	0.00	38.33	0.00	25.92	0.00	0.00	0.00	0.00	0.00	0.00	14.64	0.00	0.00	4.14	297.22	25.92	0.00	24.16	0.00	0.00	0.00	0.00	55.04
EF 7	0.00	0.00	34.38	0.00	9.79	0.00	0.00	0.00	4.78	9.67	2.51	46.20	0.00	0.00	0.00	175.72	7.28	0.00	19.70	0.00	22.44	19.70	0.00	34.14
EF 8	0.00	0.00	23.26	0.00	32.96	0.00	0.00	0.00	0.00	0.00	0.00	25.66	0.00	0.00	0.00	256.08	16.66	0.00	14.03	0.00	0.00	0.00	0.00	56.10
EF 9	11.54	0.00	11.54	4.29	24.89	0.00	0.00	2.14	4.29	62.80	2.14	30.50	0.00	0.00	0.00	118.68	12.86	0.00	6.76	0.00	21.76	26.04	0.00	34.29
EF 10	0.00	0.00	0.00	0.00	14.57	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00	0.00	0.00	2.67	0.00	0.00	9.85	2.67	0.00	0.00	0.00	11.90
EF 11	1.94	0.00	11.11	1.68	19.13	0.00	3.36	0.00	0.00	516.68	0.00	12.53	0.00	0.00	0.00	44.09	3.62	0.00	23.64	0.00	35.91	27.00	0.00	9.44
EF 12	0.00	0.00	13.79	0.00	23.94	0.00	0.00	0.00	0.00	0.00	0.00	7.33	0.00	0.00	0.00	36.64	0.00	0.00	21.12	0.00	0.00	0.00	0.00	9.87
EF 13	6.49	0.00	2.16	2.63	33.07	2.16	30.91	0.00	2.63	292.91	0.00	17.00	0.00	0.00	0.00	62.43	4.79	2.16	26.89	0.00	12.98	58.11	0.00	19.17
EF 14	0.00	0.00	2.35	0.00	28.44	0.00	0.00	0.00	0.00	0.00	0.00	30.76	0.00	0.00	0.00	68.37	7.09	0.00	2.35	0.00	0.00	0.00	0.00	52.07
EF 15	15.71	0.00	8.90	0.00	26.93	0.00	30.97	0.00	4.34	102.00	6.73	26.33	0.00	0.00	0.00	46.68	8.83	0.00	8.98	4.49	13.47	46.98	0.00	22.29
EF 16	0.00	0.00	6.52	0.00	31.33	0.00	0.00	0.00	0.00	0.00	0.00	15.01	0.00	0.00	0.00	61.39	1.96	0.00	20.89	18.21	0.00	0.00	0.00	13.05
EF 17	44.51	0.00	5.22	2.61	29.04	0.00	0.00	5.22	0.00	2658.22	5.22	5.39	0.00	0.00	2.61	39.13	0.00	2.61	8.00	0.00	10.44	35.13	0.00	10.44
EF 18	0.00	0.00	2.69	0.00	10.76	0.00	0.00	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.45	5.38	0.00	5.38	2.76	0.00	0.00	0.00	10.83
EF 19	24.78	0.00	2.25	1.89	21.54	0.00	9.46	1.89	3.79	41.64	4.15	11.72	1.89	0.00	0.00	24.87	2.25	0.00	7.93	0.00	20.01	10.18	0.00	7.57
EF 20	0.00	0.00	31.30	0.00	18.12	0.00	0.00	2.57	0.00	0.00	0.00	41.47	0.00	0.00	0.00	225.34	2.57	0.00	12.98	0.00	0.00	0.00	0.00	70.40
EF 21	112.83	0.00	24.33	0.00	10.50	0.00	33.27	5.96	0.00	2.98	0.00	11.21	0.00	0.00	0.00	68.45	0.00	0.00	33.62	0.00	#####	23.97	0.00	31.84
EF 22	0.00	0.00	30.52	0.00	25.61	0.00	0.00	0.00	0.00	0.00	0.00	32.74	0.00	0.00	2.31	67.79	2.31	0.00	39.86	0.00	0.00	0.00	0.00	11.70
EF 23	34.26	0.00	37.88	0.00	0.00	0.00	16.80	0.00	0.00	17.78	0.00	12.35	0.00	2.22	0.00	245.16	4.86	0.00	33.02	0.00	30.80	7.91	0.00	56.07
EF 24	0.00	2.00	28.72	0.00	24.72	0.00	0.00	0.00	0.00	0.00	0.00	37.17	0.00	0.00	2.00	150.50	8.45	0.00	31.17	2.46	0.00	0.00	2.00	31.80

A through D. Electrofishing CPUE (#/hr) for each species in each of 24 transects in 2008. (continued)

b.) Entire year SE of the mean for table a.

Transect	Alewife	Black crappie	Bluegill	Bowfin	Brown bullhead	Brown trout	Carp	Channel catfish	Freshwater drum	Gizzard shad	Golden shiner	Largemouth bass	Longnose gar	Northern hog sucker	Northern pike	Pumpkinseed	Rock bass	Shorthead redhorse	Smallmouth bass	Walleye	White perch	White sucker	Yellow bullhead	Yellow perch	
EF 2	0.00	0.00	11.68	0.00	15.52	0.00	0.00	0.00	0.00	0.00	0.00	8.48	0.00	0.00	0.00	67.05	2.40	0.00	11.04	0.00	0.00	0.00	0.00	2.72	0.00
EF 3	0.00	0.00	0.41	2.24	18.78	0.00	0.00	0.00	0.00	0.00	5.41	11.38	0.00	2.24	0.00	18.58	6.07	0.00	5.56	0.00	8.72	11.22	0.00	0.31	0.00
EF 4	0.00	0.00	0.00	0.00	9.76	0.00	0.00	2.44	0.00	0.00	0.00	29.35	0.00	0.00	0.00	3.68	7.32	0.00	0.17	0.00	0.00	0.00	0.00	17.57	0.00
EF 5	1.86	0.00	5.65	1.88	14.81	0.00	1.88	0.00	7.51	458.10	7.42	22.56	0.00	0.00	0.00	62.93	7.53	1.88	3.56	1.86	3.68	16.74	0.00	3.72	0.00
EF 6	0.00	0.00	7.18	0.00	5.23	0.00	0.00	0.00	0.00	0.00	0.00	10.19	0.00	0.00	4.14	36.53	5.23	0.00	15.89	0.00	0.00	0.00	0.00	19.44	0.00
EF 7	0.00	0.00	5.73	0.00	0.24	0.00	0.00	0.00	4.78	4.66	2.51	11.10	0.00	0.00	0.00	85.01	2.27	0.00	5.37	0.00	17.67	5.37	0.00	4.06	0.00
EF 8	0.00	0.00	4.08	0.00	10.18	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.00	0.00	0.00	35.57	12.10	0.00	0.36	0.00	0.00	0.00	0.00	1.42	0.00
EF 9	11.54	0.00	11.54	4.29	12.03	0.00	0.00	2.14	4.29	44.34	2.14	16.65	0.00	0.00	0.00	84.39	12.86	0.00	2.47	0.00	12.53	16.81	0.00	25.71	0.00
EF 10	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00	0.00	0.00	2.67	0.00	0.00	9.85	2.67	0.00	0.00	0.00	1.24	0.00
EF 11	1.94	0.00	4.40	1.68	15.78	0.00	3.36	0.00	0.00	516.68	0.00	0.89	0.00	0.00	0.00	37.38	0.26	0.00	3.51	0.00	1.00	0.16	0.00	6.08	0.00
EF 12	0.00	0.00	8.71	0.00	1.44	0.00	0.00	0.00	0.00	0.00	0.00	2.83	0.00	0.00	0.00	14.14	0.00	0.00	5.88	0.00	0.00	0.00	0.00	5.37	0.00
EF 13	6.49	0.00	2.16	2.63	1.54	2.16	0.62	0.00	2.63	279.93	0.00	4.02	0.00	0.00	0.00	41.41	0.46	2.16	16.38	0.00	12.98	37.09	0.00	1.86	0.00
EF 14	0.00	0.00	2.35	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	6.89	0.00	0.00	0.00	49.27	2.32	0.00	2.35	0.00	0.00	0.00	0.00	9.10	0.00
EF 15	15.71	0.00	4.56	0.00	26.93	0.00	4.94	0.00	4.34	97.51	6.73	8.37	0.00	0.00	0.00	20.65	0.15	0.00	8.98	4.49	13.47	38.31	0.00	13.62	0.00
EF 16	0.00	0.00	1.32	0.00	15.73	0.00	0.00	0.00	0.00	0.00	0.00	4.60	0.00	0.00	0.00	40.58	1.96	0.00	10.48	18.21	0.00	0.00	0.00	2.64	0.00
EF 17	44.51	0.00	5.22	2.61	17.91	0.00	0.00	5.22	0.00	2658.22	5.22	0.17	0.00	0.00	2.61	39.13	0.00	2.61	2.44	0.00	10.44	3.82	0.00	10.44	0.00
EF 18	0.00	0.00	2.69	0.00	10.76	0.00	0.00	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.45	5.38	0.00	5.38	2.76	0.00	0.00	0.00	5.32	0.00
EF 19	24.78	0.00	2.25	1.89	12.53	0.00	9.46	1.89	3.79	41.64	0.36	7.21	1.89	0.00	0.00	2.16	2.25	0.00	3.43	0.00	6.49	1.17	0.00	7.57	0.00
EF 20	0.00	0.00	21.03	0.00	2.42	0.00	0.00	2.57	0.00	0.00	0.00	0.39	0.00	0.00	0.00	16.03	2.57	0.00	2.71	0.00	0.00	0.00	0.00	44.72	0.00
EF 21	112.83	0.00	12.41	0.00	10.50	0.00	3.47	5.96	0.00	2.98	0.00	0.71	0.00	0.00	0.00	20.77	0.00	0.00	2.14	0.00	71.04	18.01	0.00	25.88	0.00
EF 22	0.00	0.00	16.66	0.00	6.74	0.00	0.00	0.00	0.00	0.00	0.00	5.01	0.00	0.00	2.31	7.71	2.31	0.00	16.76	0.00	0.00	0.00	0.00	2.46	0.00
EF 23	34.26	0.00	20.10	0.00	0.00	0.00	0.98	0.00	0.00	17.78	0.00	3.46	0.00	2.22	0.00	65.95	0.41	0.00	19.69	0.00	21.91	7.91	0.00	7.18	0.00
EF 24	0.00	2.00	0.75	0.00	4.75	0.00	0.00	0.00	0.00	0.00	0.00	2.79	0.00	0.00	2.00	6.66	3.54	0.00	3.21	2.46	0.00	0.00	2.00	12.15	0.00

A through D. Electrofishing CPUE (#/hr) for each species in each of 24 transects in 2008. (continued)

c.) 2008 spring CPUE

Transect	Alewife	Black crappie	Bluegill	Bowfin	Brown bullhead	Brown trout	Carp	Channel catfish	Freshwater drum	Gizzard shad	Golden shiner	Largemouth bass	Longnose gar	Northern hog sucker	Northern pike	Pumpkinseed	Rock bass	Shorthead redhorse	Smallmouth bass	Walleye	White perch	White sucker	Yellow bullhead	Yellow perch	
EF 1	0.00	0.00	0.00	0.00	8.74	0.00	0.00	0.00	0.00	0.00	0.00	8.74	0.00	0.00	0.00	214.08	4.37	0.00	48.06	0.00	26.21	26.21	0.00	21.85	0.00
EF 2	0.00	0.00	10.24	0.00	35.85	0.00	0.00	0.00	0.00	0.00	0.00	35.85	0.00	0.00	0.00	148.51	0.00	0.00	46.09	0.00	0.00	0.00	0.00	66.57	0.00
EF 3	0.00	0.00	23.26	0.00	46.53	0.00	0.00	0.00	0.00	0.00	11.63	40.71	0.00	0.00	0.00	162.85	5.82	0.00	29.08	0.00	17.45	0.00	0.00	81.42	0.00
EF 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71	0.00	0.00	0.00	70.68	0.00	0.00	9.42	0.00	0.00	0.00	0.00	28.27	0.00
EF 5	3.72	0.00	3.72	0.00	44.63	0.00	0.00	0.00	0.00	26.03	18.60	7.44	0.00	0.00	0.00	189.67	3.72	0.00	40.91	3.72	14.88	33.47	0.00	7.44	0.00
EF 6	0.00	0.00	31.15	0.00	31.15	0.00	0.00	0.00	0.00	0.00	0.00	4.45	0.00	0.00	0.00	333.75	31.15	0.00	40.05	0.00	0.00	0.00	0.00	35.60	0.00
EF 7	0.00	0.00	40.11	0.00	10.03	0.00	0.00	0.00	0.00	5.01	5.01	35.10	0.00	0.00	0.00	260.73	5.01	0.00	25.07	0.00	40.11	25.07	0.00	30.08	0.00
EF 8	0.00	0.00	27.34	0.00	22.79	0.00	0.00	0.00	0.00	0.00	0.00	27.34	0.00	0.00	0.00	291.65	4.56	0.00	13.67	0.00	0.00	0.00	0.00	54.69	0.00
EF 9	23.08	0.00	23.08	0.00	36.92	0.00	0.00	0.00	0.00	18.46	0.00	13.85	0.00	0.00	0.00	203.07	0.00	0.00	9.23	0.00	9.23	9.23	0.00	60.00	0.00
EF 10	0.00	0.00	0.00	0.00	13.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.71	0.00	0.00	0.00	0.00	13.14	0.00
EF 11	3.88	0.00	15.52	0.00	34.91	0.00	0.00	0.00	0.00	0.00	0.00	11.64	0.00	0.00	0.00	81.47	3.88	0.00	27.16	0.00	34.91	27.16	0.00	15.52	0.00
EF 12	0.00	0.00	5.08	0.00	25.39	0.00	0.00	0.00	0.00	0.00	0.00	10.16	0.00	0.00	0.00	50.78	0.00	0.00	15.23	0.00	0.00	0.00	0.00	15.23	0.00
EF 13	12.98	0.00	4.33	0.00	34.62	4.33	30.29	0.00	0.00	12.98	0.00	12.98	0.00	0.00	0.00	103.85	4.33	4.33	43.27	0.00	25.96	95.19	0.00	17.31	0.00
EF 14	0.00	0.00	4.71	0.00	28.24	0.00	0.00	0.00	0.00	0.00	0.00	37.65	0.00	0.00	0.00	117.65	9.41	0.00	4.71	0.00	0.00	0.00	0.00	61.18	0.00
EF 15	31.42	0.00	13.47	0.00	53.87	0.00	35.91	0.00	0.00	4.49	13.47	17.96	0.00	0.00	0.00	67.33	8.98	0.00	17.96	8.98	26.93	85.29	0.00	35.91	0.00
EF 16	0.00	0.00	5.20	0.00	15.61	0.00	0.00	0.00	0.00	0.00	0.00	10.41	0.00	0.00	0.00	20.81	0.00	0.00	10.41	36.42	0.00	0.00	0.00	10.41	0.00
EF 17	89.03	0.00	0.00	0.00	11.13	0.00	0.00	0.00	0.00	0.00	0.00	5.56	0.00	0.00	0.00	0.00	0.00	0.00	5.56	0.00	0.00	38.95	0.00	0.00	0.00
EF 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.51	0.00	0.00	0.00	5.51	0.00
EF 19	49.56	0.00	4.51	0.00	9.01	0.00	0.00	0.00	0.00	0.00	4.51	4.51	0.00	0.00	0.00	27.03	4.51	0.00	4.51	0.00	13.52	9.01	0.00	0.00	0.00
EF 20	0.00	0.00	52.33	0.00	15.70	0.00	0.00	0.00	0.00	0.00	0.00	41.86	0.00	0.00	0.00	209.30	0.00	0.00	15.70	0.00	0.00	0.00	0.00	#####	0.00
EF 21	225.65	0.00	36.73	0.00	20.99	0.00	36.73	0.00	0.00	0.00	0.00	10.50	0.00	0.00	0.00	89.21	0.00	0.00	31.49	0.00	36.73	41.98	0.00	57.73	0.00
EF 22	0.00	0.00	47.18	0.00	18.87	0.00	0.00	0.00	0.00	0.00	0.00	37.75	0.00	0.00	0.00	75.49	0.00	0.00	56.62	0.00	0.00	0.00	0.00	14.16	0.00
EF 23	68.52	0.00	57.98	0.00	0.00	0.00	15.81	0.00	0.00	0.00	0.00	15.81	0.00	0.00	0.00	179.21	5.27	0.00	52.71	0.00	52.71	15.81	0.00	63.25	0.00
EF 24	0.00	0.00	29.47	0.00	29.47	0.00	0.00	0.00	0.00	0.00	0.00	34.38	0.00	0.00	0.00	157.16	4.91	0.00	34.38	4.91	0.00	0.00	0.00	19.65	0.00

A through D. Electrofishing CPUE (#/hr) for each species in each of 24 transects in 2008. (continued)

d.) 2008 fall CPUE

Transect	Alewife	Black crappie	Bluegill	Bowfin	Brown bullhead	Brown trout	Carp	Channel catfish	Freshwater drum	Gizzard shad	Golden shiner	Largemouth bass	Longnose gar	Northern hog sucker	Northern pike	Pumpkinseed	Rock bass	Shorthead redhorse	Smallmouth bass	Walleye	White perch	White sucker	Yellow bullhead	Yellow perch	
EF 1	0.00	0.00	9.99	0.00	24.97	0.00	14.98	0.00	4.99	44.94	4.99	9.99	0.00	0.00	0.00	44.94	0.00	0.00	19.97	4.99	64.91	44.94	0.00	29.96	0.00
EF 2	0.00	0.00	33.60	0.00	4.80	0.00	0.00	0.00	0.00	0.00	0.00	52.80	0.00	0.00	0.00	14.40	4.80	0.00	24.00	0.00	0.00	0.00	0.00	72.00	0.00
EF 3	0.00	0.00	22.44	4.49	8.98	0.00	0.00	0.00	0.00	0.00	22.44	17.96	0.00	4.49	0.00	125.69	17.96	0.00	17.96	0.00	0.00	22.44	0.00	80.80	0.00
EF 4	0.00	0.00	0.00	0.00	19.51	0.00	0.00	4.88	0.00	0.00	0.00	63.42	0.00	0.00	0.00	78.05	14.63	0.00	9.76	0.00	0.00	0.00	0.00	63.42	0.00
EF 5	0.00	0.00	15.02	3.75	15.02	0.00	3.75	0.00	####	942.23	3.75	52.56	0.00	0.00	0.00	63.82	18.77	3.75	33.79	0.00	7.51	0.00	0.00	0.00	0.00
EF 6	0.00	0.00	45.52	0.00	20.69	0.00	0.00	0.00	0.00	0.00	0.00	24.83	0.00	0.00	8.28	260.69	20.69	0.00	8.28	0.00	0.00	0.00	0.00	74.48	0.00
EF 7	0.00	0.00	28.65	0.00	9.55	0.00	0.00	0.00	9.55	14.32	0.00	57.30	0.00	0.00	0.00	90.72	9.55	0.00	14.32	0.00	4.78	14.32	0.00	38.20	0.00
EF 8	0.00	0.00	19.18	0.00	43.14	0.00	0.00	0.00	0.00	0.00	0.00	23.97	0.00	0.00	0.00	220.51	28.76	0.00	14.38	0.00	0.00	0.00	0.00	57.52	0.00
EF 9	0.00	0.00	0.00	8.57	12.86	0.00	0.00	4.29	8.57	107.14	4.29	47.14	0.00	0.00	0.00	34.29	25.72	0.00	4.29	0.00	34.29	42.86	0.00	8.57	0.00
EF 10	0.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	5.33	0.00	0.00	0.00	5.33	0.00	0.00	0.00	5.33	0.00	0.00	0.00	10.67	0.00
EF 11	0.00	0.00	6.71	3.36	3.36	0.00	6.71	0.00	0.00	1033.35	0.00	13.42	0.00	0.00	0.00	6.71	3.36	0.00	20.13	0.00	36.91	26.84	0.00	3.36	0.00
EF 12	0.00	0.00	22.50	0.00	22.50	0.00	0.00	0.00	0.00	0.00	0.00	4.50	0.00	0.00	0.00	22.50	0.00	0.00	27.00	0.00	0.00	0.00	0.00	4.50	0.00
EF 13	0.00	0.00	0.00	5.26	31.53	0.00	31.53	0.00	5.26	572.84	0.00	21.02	0.00	0.00	0.00	21.02	5.26	0.00	10.51	0.00	0.00	21.02	0.00	21.02	0.00
EF 14	0.00	0.00	0.00	0.00	28.65	0.00	0.00	0.00	0.00	0.00	0.00	23.87	0.00	0.00	0.00	19.10	4.78	0.00	0.00	0.00	0.00	0.00	0.00	42.97	0.00
EF 15	0.00	0.00	4.34	0.00	0.00	0.00	26.02	0.00	8.68	199.51	0.00	34.70	0.00	0.00	0.00	26.02	8.68	0.00	0.00	0.00	0.00	8.68	0.00	8.68	0.00
EF 16	0.00	0.00	7.84	0.00	47.06	0.00	0.00	0.00	0.00	0.00	0.00	19.61	0.00	0.00	0.00	101.96	3.92	0.00	31.37	0.00	0.00	0.00	0.00	15.69	0.00
EF 17	0.00	0.00	10.44	5.22	46.96	0.00	0.00	10.44	0.00	5316.43	10.44	5.22	0.00	0.00	5.22	78.26	0.00	5.22	10.44	0.00	20.87	31.30	0.00	20.87	0.00
EF 18	0.00	0.00	5.38	0.00	21.53	0.00	0.00	5.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.91	10.76	0.00	10.76	0.00	0.00	0.00	0.00	16.14	0.00
EF 19	0.00	0.00	0.00	3.79	34.07	0.00	18.93	3.79	7.57	83.28	3.79	18.93	3.79	0.00	0.00	22.71	0.00	0.00	11.36	0.00	26.50	11.36	0.00	15.14	0.00
EF 20	0.00	0.00	10.27	0.00	20.54	0.00	0.00	5.14	0.00	0.00	0.00	41.09	0.00	0.00	0.00	241.37	5.14	0.00	10.27	0.00	0.00	0.00	0.00	25.68	0.00
EF 21	0.00	0.00	11.92	0.00	0.00	0.00	29.80	11.92	0.00	5.96	0.00	11.92	0.00	0.00	0.00	47.68	0.00	0.00	35.76	0.00	#####	5.96	0.00	5.96	0.00
EF 22	0.00	0.00	13.86	0.00	32.35	0.00	0.00	0.00	0.00	0.00	0.00	27.73	0.00	0.00	4.62	60.08	4.62	0.00	23.11	0.00	0.00	0.00	0.00	9.24	0.00
EF 23	0.00	0.00	17.78	0.00	0.00	0.00	17.78	0.00	0.00	35.56	0.00	8.89	0.00	4.44	0.00	311.11	4.44	0.00	13.33	0.00	8.89	0.00	0.00	48.89	0.00
EF 24	0.00	4.00	27.97	0.00	19.98	0.00	0.00	0.00	0.00	0.00	0.00	39.96	0.00	0.00	4.00	143.84	11.99	0.00	27.97	0.00	0.00	0.00	4.00	43.95	0.00

Library Reference 8.7.3.1.9

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A and B. Largemouth and smallmouth bass fingerling and yearling catch rates from electrofishing in 2008.

a) Largemouth bass

Season	CPUE	Category*
Spring	0.20	yearling
	1.81	yearling to 10 inch
	15.68	> 10 inch
	10.26	> 12 inch
Fall	6.81	fingerling
	6.24	fingerling to 10 inch
	13.43	> 10 inch
	10.60	> 12 inch

b) Smallmouth bass

Season	CPUE	Category*
Spring	3.02	yearling
	13.47	yearling to 10 inch
	9.05	> 10 inch
	4.83	> 12 inch
Fall	1.51	fingerling
	10.98	fingerling to 10 inch
	3.60	> 10 inch
	0.00	#VALUE!

* Note: Yearlings are less than or equal to 200 mm total length. Fingerlings are less than or equal to 150 mm total length. These sizes are based on length frequency data from the OCDWEP database.

A through D. Gill net CPUE (#/hr) by location, time period, and species in 2008. A single net was set in each of the lakes five strata, on bottom, in 4 to 5 m of water, within one week of electrofishing in spring and fall.

a) Gill net CPUE by location, time period, and species.

Year	Location	Season	Species	Mean CPUE
2008	Stratum 1	Spring	Longnose gar	0.500
2008	Stratum 1	Spring	White perch	0.500
2008	Stratum 1	Spring	Yellow perch	1.500
2008	Stratum 2	Spring	Alewife	10.000
2008	Stratum 2	Spring	White perch	0.500
2008	Stratum 3	Spring	Golden shiner	0.500
2008	Stratum 3	Spring	Smallmouth bass	0.500
2008	Stratum 3	Spring	White perch	7.000
2008	Stratum 3	Spring	White sucker	0.500
2008	Stratum 3	Spring	Yellow perch	1.000
2008	Stratum 4	Spring	White perch	2.000
2008	Stratum 4	Spring	Yellow perch	0.500
2008	Stratum 5	Spring	Brown bullhead	0.500
2008	Stratum 5	Spring	White perch	0.500
2008	Stratum 2	Fall	Yellow perch	0.500
2008	Stratum 3	Fall	Channel catfish	2.000
2008	Stratum 3	Fall	Gizzard shad	3.500
2008	Stratum 3	Fall	Smallmouth bass	0.500
2008	Stratum 3	Fall	White sucker	1.000
2008	Stratum 4	Fall	Largemouth bass	0.500
2008	Stratum 4	Fall	Pumpkinseed	2.500
2008	Stratum 4	Fall	Yellow perch	1.500

A through D. Gill net CPUE (#/hr) by location, time period, and species in 2008. A single net was set in each of the lakes five strata, on bottom, in 4 to 5 m of water, within one week of electrofishing in spring and fall. (continued)

b) Whole year gill net CPUE by location and species.

Year	Location	Species	Mean CPUE
2008	Stratum 1	Longnose gar	0.250
2008	Stratum 1	White perch	0.250
2008	Stratum 1	Yellow perch	0.750
2008	Stratum 2	Alewife	5.000
2008	Stratum 2	White perch	0.250
2008	Stratum 2	Yellow perch	0.250
2008	Stratum 3	Channel catfish	1.000
2008	Stratum 3	Gizzard shad	1.750
2008	Stratum 3	Golden shiner	0.250
2008	Stratum 3	Smallmouth bass	0.500
2008	Stratum 3	White perch	3.500
2008	Stratum 3	White sucker	0.750
2008	Stratum 3	Yellow perch	0.500
2008	Stratum 4	Largemouth bass	0.250
2008	Stratum 4	Pumpkinseed	1.250
2008	Stratum 4	White perch	1.000
2008	Stratum 4	Yellow perch	1.000
2008	Stratum 5	Brown bullhead	0.240
2008	Stratum 5	White perch	0.240

A through D. Gill net CPUE (#/hr) by location, time period, and species in 2008. A single net was set in each of the lakes five strata, on bottom, in 4 to 5 m of water, within one week of electrofishing in spring and fall. (continued)

c) Gillnet CPUE by time period and species.

Year	Season	Species	Mean CPUE	Relative Abundance
2008	Spring	Alewife	2.000	38.5%
2008	Spring	Brown bullhead	0.100	1.9%
2008	Spring	Golden shiner	0.100	1.9%
2008	Spring	Longnose gar	0.100	1.9%
2008	Spring	Smallmouth bass	0.100	1.9%
2008	Spring	White perch	2.100	40.4%
2008	Spring	White sucker	0.100	1.9%
2008	Spring	Yellow perch	0.600	11.5%
2008	Fall	Channel catfish	0.400	16.7%
2008	Fall	Gizzard shad	0.700	29.2%
2008	Fall	Largemouth bass	0.100	4.2%
2008	Fall	Pumpkinseed	0.500	20.8%
2008	Fall	Smallmouth bass	0.100	4.2%
2008	Fall	White sucker	0.200	8.3%
2008	Fall	Yellow perch	0.400	16.7%

A through D. Gill net CPUE (#/hr) by location, time period, and species in 2008. A single net was set in each of the lakes five strata, on bottom, in 4 to 5 m of water, within one week of electrofishing in spring and fall. (continued)

d) Gillnet CPUE for 2008 for entire year

Year	Species	Mean CPUE	Relative Abundance
2008	Alewife	1.000	26.3%
2008	Brown bullhead	0.048	1.3%
2008	Channel catfish	0.200	5.3%
2008	Gizzard shad	0.350	9.2%
2008	Golden shiner	0.050	1.3%
2008	Largemouth bass	0.050	1.3%
2008	Longnose gar	0.050	1.3%
2008	Pumpkinseed	0.250	6.6%
2008	Smallmouth bass	0.100	2.6%
2008	White perch	1.048	27.6%
2008	White sucker	0.150	3.9%
2008	Yellow perch	0.500	13.2%

Nine-year trend analysis (percent change per year) and level of significance of square root-normalized catch per hour from electrofishing results of commonly captured species in Onondaga Lake.

Species	Annual Mean CPUE	2008 Mean CPUE	Trophic Guild	Pollution Tolerance	Thermal Guild	Trend	Level of Significance
Golden shiner	1.4	4.3	Planktivore/ Invertivore	Tolerant	Cool	21%	0.09
Alewife	489	21	Planktivore	Moderate	Cool	19%	0.37
Brown bullhead	7.2	21	Invertivore/ Piscivore	Tolerant	Warm	14%	0.002
Bowfin	0.9	1.5	Piscivore	Tolerant	Warm	11%	0.03
Smallmouth bass	12	20	Piscivore	Moderate	Cool	8%	0.01
Longnose gar	0.7	0.2	Invertivore/ Piscivore	Tolerant	Warm	8%	**0**.41
Rock bass	1.3	6	Invertivore/ Piscivore	Moderate	Warm	7%	0.44
Pumpkinseed	39	107	Invertivore	Tolerant	Warm	7%	0.05
Largemouth bass	16	22	Piscivore	Tolerant	Warm	4%	0.11
Gizzard shad	279	359	Detritivore	Moderately Tolerant	Warm	4%	0.73
Northern pike	0.2	0.5	Piscivore	Moderate	Cool	2%	0.41
Freshwater drum	2.2	3	Invertivore/ Piscivore	Moderate	Warm	1%	0.92
White perch	43	28	Invertivore/ Piscivore	Tolerant	Warm	-2%	0.59
White sucker	20	27	Benthic Invertivore	Moderately Tolerant	Cool	-2%	0.27
Yellow perch	20	32	Invertivore/ Piscivore	Moderately Tolerant	Cool	-2%	0.28
Channel catfish	1.5	1	Invertivore/ Piscivore	Moderately Tolerant	Warm	-2%	0.49
Walleye	1.0	1	Piscivore	Moderately Tolerant	Cool	-3%	0.60
Bluegill	24	16	Invertivore	Tolerant	Warm	-8%	0.16
Shorthead redhorse	2.0	0.6	Benthic Invertivore	Moderately Tolerant	Cool	-9%	0.02
Carp	28	11	Benthic Invertivore	Tolerant	Warm	-11%	0.03
Black crappie	0.1	0.1	Invertivore/Piscivore	Tolerant	Warm	-34%	0.001

Notes: Table is sorted first by trend, then by significance level. Trends that are statistically significant at the alpha< 0.10 level are shaded.

Guilds

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Guild and Tolerance Designations for Species Collected from Surveys in Onondaga Lake, 2000-2008.

Common name	Trophic Guild	Pollution Tolerance	Thermal Guild	Reproductive Guild
Alewife	Planktivore	Moderate	Cool	Nonguarder, open substrate spawner, phyto-lithophil
Banded killifish	Planktivore/invertivore	Moderate	Warm	Nonguarder, open substrate spawner, phytophil
Black crappie	Invertivore/Piscivore	Tolerant	Warm	Guarder, nest spawner, phytophil
Black Bullhead	Invertivore/Piscivore	Moderately Tolerant	Warm	Guarder, nest spawner, phytophil
Bluegill	Invertivore	Tolerant	Warm	Guarder, nest spawner, lithophil
Bluntnose minnow	Detritivore	Moderate	-	Guarder, nest spawner, speleophil
Bowfin	Piscivore	Tolerant	Warm	Guarder, nest spawner, phytophil
Brook silverside	Planktivore/invertivore	-	Warm	Nonguarder, open substrate spawner, phyto-lithophil
Brook stickleback	Planktivore/invertivore	-	Cool	Guarder, nest spawner, ariadnophil
Brown bullhead	Invertivore/Piscivore	Tolerant	Warm	Guarder, nest spawner, speleophil
Brown trout	Invertivore/Piscivore	Moderately Intolerant	Cold	Nonguarder, brood hider, lithophil
Carp	Benthic Invertivore	Tolerant	Warm	Nonguarder, open substrate spawner, phytophil
Channel catfish	Invertivore/Piscivore	Moderately Tolerant	Warm	Guarder, nest spawner, speleophil
Emerald shiner	Planktivore	-	Warm	Nonguarder, open substrate spawner, pelagophil
Fathead minnow	Invertivore	Intolerant	Warm	Guarder, nest spawner, speleophil
Freshwater drum	Invertivore/Piscivore	Moderate	Warm	Nonguarder, open substrate spawner, pelagophil
Gizzard shad	Detritivore	Moderately Tolerant	Warm	Nonguarder, open substrate spawner, litho-pelagophil
Golden shiner	Planktivore/invertivore	Tolerant	Cool	Nonguarder, open substrate spawner, phytophil
Greater Redhorse	Benthic Invertivore	Intolerant	Cool	Nonguarder, open substrate spawner, lithophil
Green sunfish	Invertivore/Piscivore	Tolerant	Warm	Guarder, nest spawner, lithophil
Johnny darter	Invertivore	Moderate	Cool	Guarder, nest spawner, speleophil
Lake Sturgeon	Benthic Invertivore	Moderate	Cold/Cool	Nonguarder, open substrate spawner, lithophil
Largemouth bass	Piscivore	Tolerant	Warm	Guarder, nest spawner, phytophil
Logperch	Invertivore	Moderate	Cool/Warm	Nonguarder, open substrate spawner, psammophil
Longnose dace	Planktivore/invertivore	Moderately Intolerant	Cool	Nonguarder, brood hider, lithophil
Longnose gar	Invertivore/Piscivore	Tolerant	Warm	Nonguarder, open substrate spawner, phytophil
Northern hog sucker	Benthic Invertivore	Moderately Intolerant	Cool	Nonguarder, open substrate spawner, lithophil
Northern pike	Piscivore	Moderate	Cool	Nonguarder, open substrate spawner, phytophil

Guild and Tolerance Designations for Species Collected from Surveys in Onondaga Lake, 2000-2008. (continued)

Common name	Trophic Guild	Pollution Tolerance	Thermal Guild	Reproductive Guild
Pumpkinseed	Invertivore	Tolerant	Warm	Guarder, nest spawner, lithophil
Quillback	Benthic Invertivore	Moderate	Warm	Nonguarder, open substrate spawner, litho-pelagophil
Rainbow trout	Invertivore/Piscivore	Moderately Intolerant	Cold	Nonguarder, brood hider, lithophil
Rock bass	Invertivore/Piscivore	Moderate	Warm	Guarder, nest spawner, lithophil
Rudd	Invertivore	Tolerant	Warm	Nonguarder, open substrate spawner, phytophil
Shorthead redhorse	Benthic Invertivore	Moderately Tolerant	Cool	Nonguarder, open substrate spawner, lithophil
Smallmouth bass	Piscivore	Moderate	Cool	Guarder, nest spawner, lithophil
Tessellated darter	Invertivore	Moderate	Cool	Guarder, nest spawner, speleophil
Tiger muskellunge	Piscivore	Moderate1	Cool	Sterile hybrid
Trout perch	Invertivore/Piscivore	-	Cold	Nonguarder, open substrate spawner, lithophil
Walleye	Piscivore	Moderately Tolerant	Cool	Nonguarder, open substrate spawner, lithophil
White perch	Invertivore/Piscivore	Tolerant	Warm	Nonguarder, open substrate spawner, phyto-lithophil
White sucker	Benthic Invertivore	Moderately Tolerant	Cool	Nonguarder, open substrate spawner, lithophil
Yellow Bullhead	Invertivore/Piscivore	Tolerant	Warm	Guarder, nest spawner, speleophil
Yellow perch	Invertivore/Piscivore	Moderately Tolerant	Cool	Nonguarder, open substrate spawner, phyto-lithophil

* Notes: brown and rainbow trout trophic guilds are for lakes. Not all species were able to be grouped into tolerance categories or thermal guilds.

Reproductive guild substrate types: lithophils (sediment), phytophils (plant material, live or dead), speleophils (holes, crevices), pelagophils (openwater), psammophils (sand) and ariadnophils (specialised nest building that include some level of parent

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Library Reference 8.7.3.2.2

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Trophic Guild CPUE and Relative Abundance from electrofishing data in 2008. Results are presented for each of five strata and the whole lake, for each sampling event (spring and fall) and for both sampling events combined. Clupeids (shad and alewives) are often captured in high numbers. Therefore the tables are presented with clupeids included (A) and not included (B) so that the relative proportion of non-clupeids can be discerned. For a list of species within each guild click here.

A) Clupeids Included

Area	Time	Planktivore		Benthic Invertivore		Invertivore/ Piscivore		Piscivore		Invertivore		Planktivore/ Invertivore		Detritivore	
		CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance
Whole Lake	Spring	42	11%	44	12%	86	23%	45	12%	145	39%	4	1%	6	1%
	Fall	0	0%	33	3%	98	10%	46	5%	99	10%	4	0%	696	71%
	Whole Year	21	3%	39	6%	92	13%	46	7%	123	18%	4	1%	359	53%
Stratum 1	Spring	9	2%	23	5%	97	20%	44	9%	281	59%	8	2%	17	3%
	Fall	0	0%	22	3%	104	15%	62	9%	156	22%	3	0%	355	51%
	Whole Year	4	1%	22	4%	100	17%	53	9%	217	37%	5	1%	185	32%
Stratum 2	Spring	16	5%	93	28%	92	28%	38	12%	77	24%	4	1%	6	2%
	Fall	0	0%	40	5%	53	7%	31	4%	22	3%	0	0%	602	80%
	Whole Year	8	1%	68	12%	73	13%	34	6%	50	9%	2	0%	308	57%
Stratum 3	Spring	69	46%	24	16%	21	14%	21	14%	14	10%	2	1%	0	0%
	Fall	0	0%	33	1%	92	3%	33	1%	63	2%	7	0%	2700	92%
	Whole Year	33	2%	29	2%	59	4%	27	2%	41	3%	5	0%	1395	88%
Stratum 4	Spring	147	26%	55	10%	118	21%	67	12%	187	33%	0	0%	0	0%
	Fall	0	0%	29	7%	145	34%	50	12%	177	42%	0	0%	21	5%
	Whole Year	76	15%	43	9%	129	26%	58	12%	183	37%	0	0%	11	2%
Stratum 5	Spring	0	0%	13	4%	97	29%	56	17%	157	48%	6	2%	0	0%
	Fall	0	0%	43	13%	122	36%	57	17%	82	24%	14	4%	22	7%
	Whole Year	0	0%	29	9%	107	32%	56	17%	120	36%	10	3%	10	3%

Trophic Guild CPUE and Relative Abundance from electrofishing data in 2008. Results are presented for each of five strata and the whole lake, for each sampling event (spring and fall) and for both sampling events combined. Clupeids (shad and alewives) are often captured in high numbers. Therefore the tables are presented with clupeids included (A) and not included (B) so that the relative proportion of non-clupeids can be discerned. (continued)

B) Clupeids Excluded

Area	Time	Planktivore		Benthic Invertivore		Invertivore/ Piscivore		Piscivore		Invertivore		Planktivore/ Invertivore		Detritivore	
		CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance
Whole Lake	Spring	0	0%	44	14%	86	27%	45	14%	145	45%	4	1%	0	0%
	Fall	0	0%	33	12%	98	35%	46	16%	99	35%	4	1%	0	0%
	Whole Year	0	0%	39	13%	92	30%	46	15%	123	40%	4	1%	0	0%
Stratum 1	Spring	0	0%	23	5%	97	21%	44	10%	281	62%	8	2%	0	0%
	Fall	0	0%	22	6%	104	30%	62	18%	156	45%	3	1%	0	0%
	Whole Year	0	0%	22	6%	100	25%	53	13%	217	55%	5	1%	0	0%
Stratum 2	Spring	0	0%	93	30%	92	30%	38	12%	77	25%	4	1%	0	0%
	Fall	0	0%	40	28%	53	36%	31	21%	22	15%	0	0%	0	0%
	Whole Year	0	0%	68	30%	73	32%	34	15%	50	22%	2	1%	0	0%
Stratum 3	Spring	0	0%	24	29%	21	25%	21	25%	14	18%	2	3%	0	0%
	Fall	0	0%	33	15%	92	40%	33	14%	63	28%	7	3%	0	0%
	Whole Year	0	0%	29	18%	59	37%	27	17%	41	25%	5	3%	0	0%
Stratum 4	Spring	0	0%	55	13%	118	28%	67	16%	187	44%	0	0%	0	0%
	Fall	0	0%	29	7%	145	36%	50	12%	177	44%	0	0%	0	0%
	Whole Year	0	0%	43	10%	129	31%	58	14%	183	44%	0	0%	0	0%
Stratum 5	Spring	0	0%	13	4%	97	29%	56	17%	157	48%	6	2%	0	0%
	Fall	0	0%	43	14%	122	38%	57	18%	82	26%	14	4%	0	0%
	Whole Year	0	0%	29	9%	107	33%	56	17%	120	37%	10	3%	0	0%

Library Reference 8.7.3.2.3

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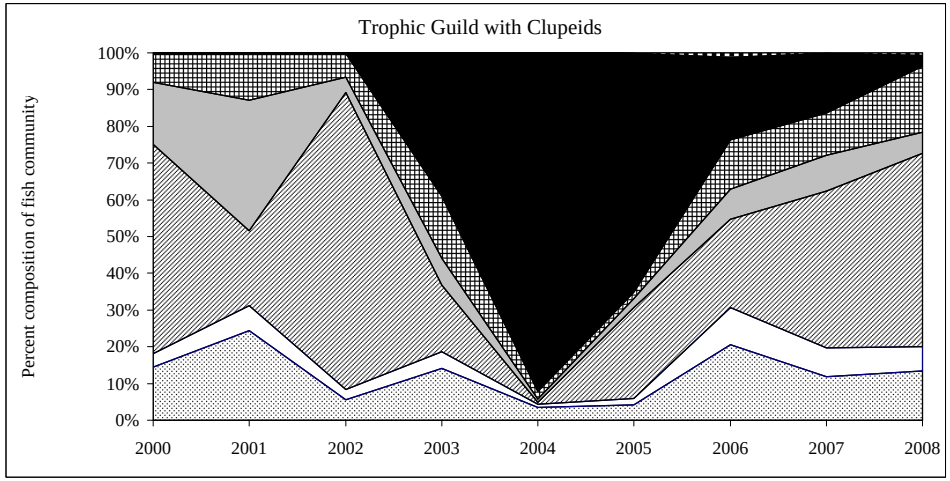
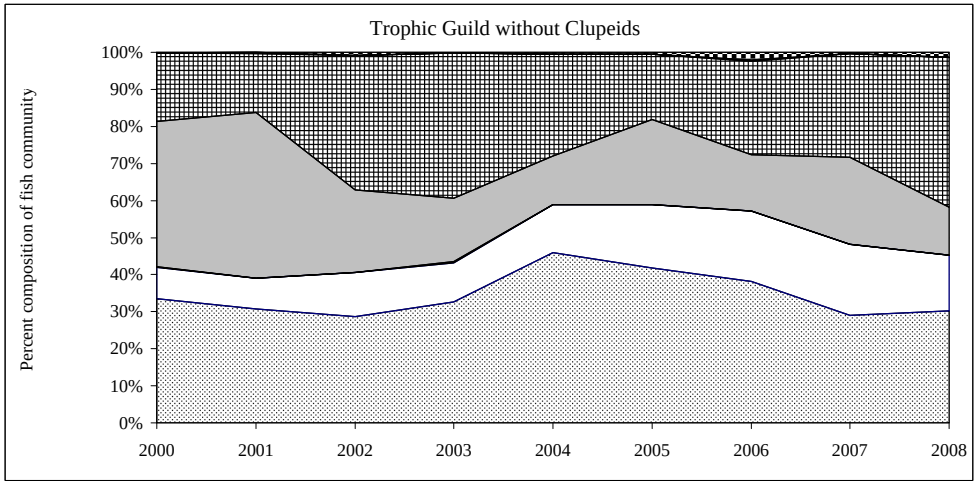
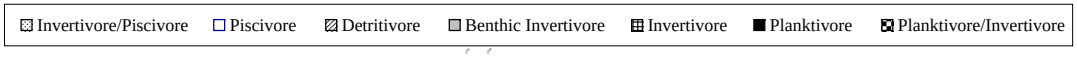
Trophic guild trends from electrofishing data in 2000-2008. Clupeids (shad (detritivore) and alewives (planktivore)) are often captured in high numbers because they are abundant and have a tendency to school. Therefore the charts are presented with clupeids included and not included so that the relative proportion of non-clupeids can be discerned. For a list of species within each guild click here.







Graph Data

Trophic Guilds with Clupeids

Trophic Guild	2000	2001	2002	2003	2004	2005	2006	2007	2008
Benthic Invertivore	17%	36%	4%	7%	1%	2%	8%	10%	6%
Piscivore	4%	7%	3%	5%	1%	2%	10%	8%	7%
Detritivore	57%	20%	81%	18%	0%	25%	24%	43%	53%
Invertivore	8%	13%	6%	17%	2%	2%	14%	11%	18%
Invertivore/Piscivore	14%	24%	6%	14%	3%	4%	21%	12%	13%
Planktivore	0%	0%	0%	39%	92%	65%	22%	16%	3%
Planktivore/Invertivore	0%	0%	0%	0%	0%	0%	1%	0%	1%

Graph Data

Trophic Guilds without Clupeids

Trophic Guild	2000	2001	2002	2003	2004	2005	2006	2007	2008
Benthic Invertivore	39%	45%	22%	17%	13%	23%	15%	23%	13%
Piscivore	8%	8%	12%	10%	13%	17%	19%	19%	15%
Detritivore	0%	0%	0%	0%	0%	0%	0%	0%	0%
Invertivore	19%	16%	36%	39%	27%	18%	25%	28%	40%
Invertivore/Piscivore	33%	31%	29%	33%	46%	42%	38%	29%	30%
Planktivore	0%	0%	0%	0%	0%	0%	0%	0%	0%
Planktivore/Invertivore	0%	0%	1%	0%	1%	1%	2%	0%	1%

Library Reference 8.7.3.2.4

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Thermal Guild CPUE and relative abundance from electrofishing sampling events in 2008. Results are presented for each of five strata and the whole lake, for each sampling event (spring and fall) and for both sampling events combined. Clupeids (shad and alewives) are often captured in high numbers. Therefore the tables are presented with clupeids included (A) and not included (B) so that the relative proportion of non-clupeids can be discerned. For a list of species within each guild click here.

a) Clupeids Included

Area	Time	Warm		Cool		Cold	
		CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance
Whole Lake	Spring	230	62%	143	38%	0.18	0.05%
	Fall	905	93%	72	7%	0	0%
	Whole Year	576	84%	108	16%	0.10	0.01%
Stratum 1	Spring	374	78%	103	22%	0	0%
	Fall	625	89%	75	11%	0	0%
	Whole Year	499	85%	89	15%	0	0%
Stratum 2	Spring	186	57%	140	43%	0.72	0.22%
	Fall	703	94%	45	6%	0	0%
	Whole Year	449	83%	93	17%	0.40	0.07%
Stratum 3	Spring	36	24%	115	76%	0	0%
	Fall	2863	98%	65	2%	0	0%
	Whole Year	1499	94%	89	6%	0	0%
Stratum 4	Spring	305	53%	269	47%	0	0%
	Fall	366	87%	56	13%	0	0%
	Whole Year	334	67%	165	33%	0	0%
Stratum 5	Spring	227	69%	102	31%	0	0%
	Fall	211	62%	130	38%	0	0%
	Whole Year	216	65%	117	35%	0	0%

Thermal Guild CPUE and Relative Abundance from electrofishing data in 2008 with and without Clupeids. Results are presented for each stratum and the whole lake during each sampling even (spring and fall) and for both events combined. (continued)

b) Clupeids Excluded

Area	Time	Warm		Cool		Cold	
		CPUE	Relative Abundance	CPUE	Relative Abundance	CPUE	Relative Abundance
Whole Lake	Spring	225	69%	101	31%	0.18	0.06%
	Fall	209	74%	72	26%	0	0%
	Whole Year	217	71%	87	29%	0.10	0.03%
Stratum 1	Spring	358	79%	95	21%	0	0%
	Fall	271	78%	75	22%	0	0%
	Whole Year	313	79%	85	21%	0	0%
Stratum 2	Spring	180	59%	124	41%	0.72	0.24%
	Fall	101	69%	45	31%	0	0%
	Whole Year	141	62%	85	38%	0.40	0.17%
Stratum 3	Spring	36	44%	46	56%	0	0%
	Fall	164	71%	65	29%	0	0%
	Whole Year	104	65%	56	35%	0	0%
Stratum 4	Spring	305	71%	122	29%	0	0%
	Fall	346	86%	56	14%	0	0%
	Whole Year	323	78%	89	22%	0	0%
Stratum 5	Spring	227	69%	102	31%	0	0%
	Fall	188	59%	130	41%	0	0%
	Whole Year	205	64%	117	36%	0	0%

Library Reference 8.7.3.2.5

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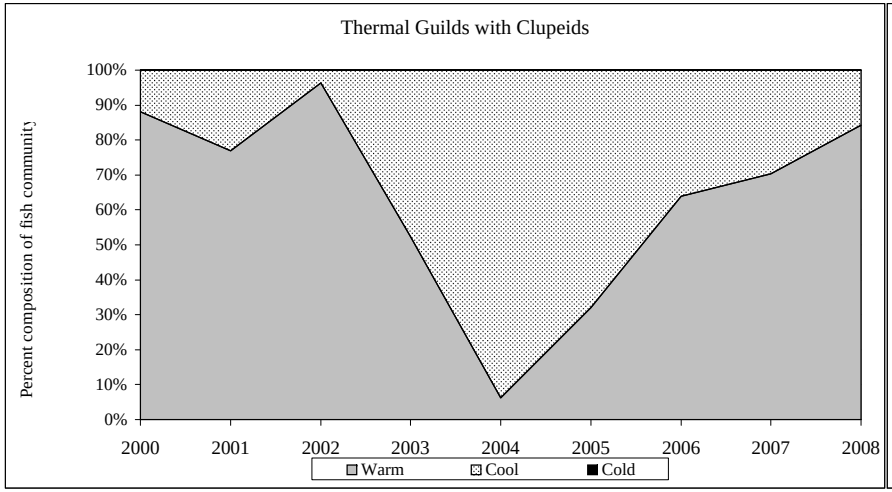
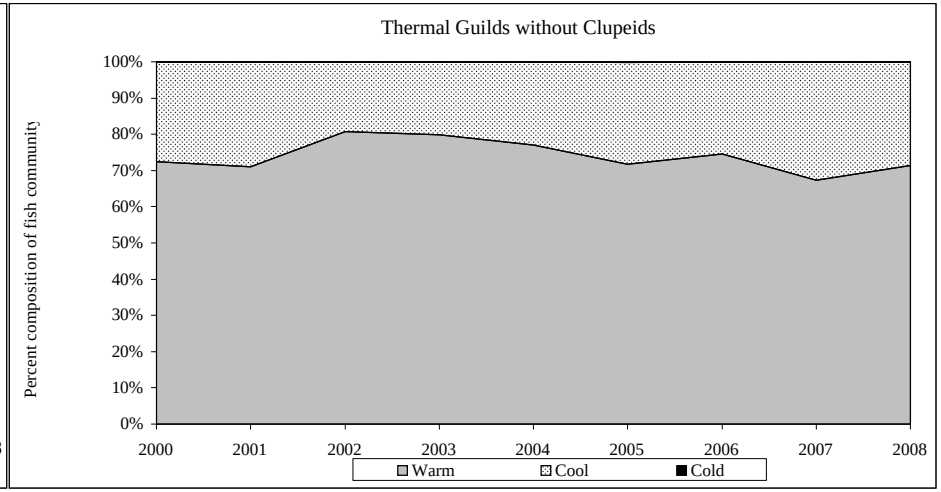
Thermal guild trends from electrofishing data in 2000-2008. Clupeids (shad and alewives) are often captured in high numbers because they are abundant and have a tendency to school. Therefore the charts are presented with clupeids included and not included so that the relative proportion of non-clupeids can be discerned. For a list of species within each guild click here.





Graph Data

Relative abundance of thermal guilds with Clupeids

Thermal Guild	2000	2001	2002	2003	2004	2005	2006	2007	2008
Cold	0.04%	0.00%	0.01%	0.00%	0.003%	0.01%	0.03%	0.00%	0.01%
Cool	11.81%	23.13%	3.63%	47.66%	94%	68%	36%	30%	16%
Warm	88.15%	76.87%	96.34%	52.30%	6%	32%	64%	70%	84%

Relative abundance of thermal guilds without Clupeids

Thermal Guild	2000	2001	2002	2003	2004	2005	2006	2007	2008
Cold	0.08%	0.00%	0.05%	0.00%	0.04%	0.1%	0.06%	0.00%	0.03%
Cool	27.55%	29.06%	19.29%	20.19%	23%	28%	25%	33%	29%
Warm	72.37%	70.94%	80.66%	79.70%	77%	72%	75%	67%	71%

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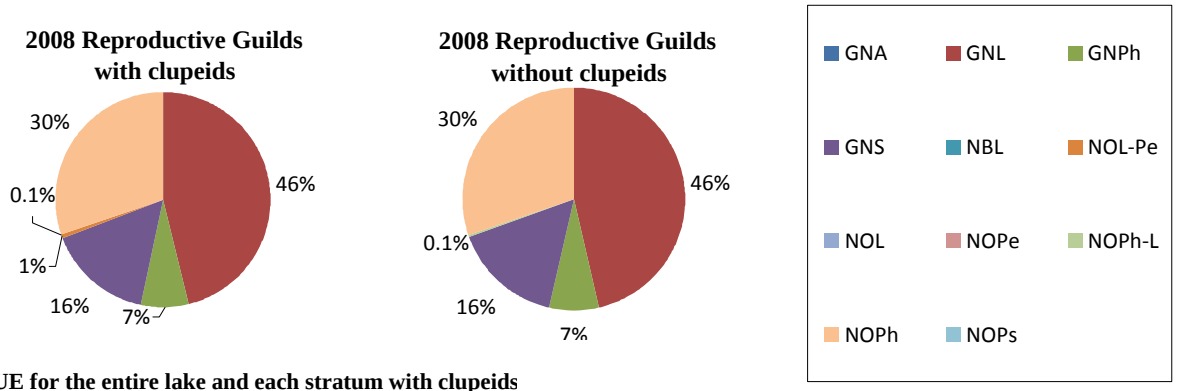
Reproductive guild relative abundance derived from juvenile seine data in 2008, with and without clupeids. Clupeids (shad and alewives) are often captured in high numbers because they are abundant and have a tendency to school. Therefore the charts for the AMP program are presented with clupeids included and not included so that the relative proportion of non-clupeids can be discerned in years when they are abundant. For a list of species within each guild click **here**.



CPUE for the entire lake and each stratum with clupeids

Legend Key	Reproductive Guild	Entire Lake	Stratum 1	2	3	4	5
GNA	Guarder, nest spawner, ariadnophi	0	0	0	0	0	0
GNL	Guarder, nest spawner, lithophi	7.8	3.8	0.44	24	4.0	6.9
GNPh	Guarder, nest spawner, phytophi	1.2	2.2	0.56	0.56	1.6	1.2
GNS	Guarder, nest spawner, speleophi	2.7	12	0.11	0.06	1.1	0.06
NBL	Nonguarder, brood hider, lithophi	0	0	0	0	0	0
NOL-Pe	Nonguarder, open substrate spawner, litho-pelagophi	0.10	0	0	0.28	0.22	0.00
NOL	Nonguarder, open substrate spawner, lithophi	0	0	0	0	0	0
NOPe	Nonguarder, open substrate spawner, pelagophi	0	0	0	0	0	0
NOPh-L	Nonguarder, open substrate spawner, phyto-lithophi	0.02	0	0	0.06	0	0.06
NOPh	Nonguarder, open substrate spawner, phytophi	5.09	0.28	0.11	4.2	19	2.4
NOPs	Nonguarder, open substrate spawner, psammophi	0	0	0	0	0	0
	Total	**17**	**18**	**1.22**	**29**	**25**	**11**

Reproductive guild relative abundance for the entire lake and each stratum in 2008 with clupeid

Legend Key	Reproductive Guild	Entire Lake	Stratum 1	2	3	4	5
GNA	Guarder, nest spawner, ariadnophi	0%	0%	0%	0%	0%	0%
GNL	Guarder, nest spawner, lithophi	46%	21%	36%	82%	16%	65%
GNPh	Guarder, nest spawner, phytophi	7.2%	12%	45%	1.9%	6.3%	11%
GNS	Guarder, nest spawner, speleophi	16%	66%	9.1%	0.19%	4.2%	0.53%
NBL	Nonguarder, brood hider, lithophi	0%	0%	0%	0%	0%	0%
NOL-Pe	Nonguarder, open substrate spawner, litho-pelagophi	0.59%	0%	0%	0.96%	0.88%	0%
NOL	Nonguarder, open substrate spawner, lithophi	0%	0%	0%	0%	0%	0%
NOPe	Nonguarder, open substrate spawner, pelagophi	0%	0%	0%	0%	0%	0%
NOPh-L	Nonguarder, open substrate spawner, phyto-lithophi	0.13%	0%	0%	0.19%	0%	0.53%
NOPh	Nonguarder, open substrate spawner, phytophi	30%	1.5%	9.1%	14%	73%	23%
NOPs	Nonguarder, open substrate spawner, psammophi	0%	0%	0%	0%	0%	0%

Reproductive guild relative abundance for the entire lake and each stratum in 2008 without clupeid

Legend Key	Reproductive Guild	Entire Lake	Stratum 1	2	3	4	5
GNA	Guarder, nest spawner, ariadnophi	0%	0%	0%	0%	0%	0%
GNL	Guarder, nest spawner, lithophi	46%	21%	36%	83%	16%	65%
GNPh	Guarder, nest spawner, phytophi	7.2%	12%	45%	1.9%	6.4%	11%
GNS	Guarder, nest spawner, speleophi	16%	66%	9.1%	0.19%	4.2%	0.53%
NBL	Nonguarder, brood hider, lithophi	0%	0%	0%	0%	0%	0%
NOL-Pe	Nonguarder, open substrate spawner, litho-pelagophi	0%	0%	0%	0%	0%	0%
NOL	Nonguarder, open substrate spawner, lithophi	0%	0%	0%	0%	0%	0%
NOPe	Nonguarder, open substrate spawner, pelagophi	0%	0%	0%	0%	0%	0%
NOPh-L	Nonguarder, open substrate spawner, phyto-lithophi	0.13%	0%	0%	0.19%	0%	0.53%
NOPh	Nonguarder, open substrate spawner, phytophi	30%	1.5%	9.1%	15%	74%	23%
NOPs	Nonguarder, open substrate spawner, psammophi	0%	0%	0%	0%	0%	0%

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Relative contribution of each Pollution Tolerance category in 2008 for each electrofishing event (spring and fall) and both events combined. For a list of species within each guild click here.

Area	Time	Tolerant	Moderately Tolerant	Moderate	Moderately Intolerant	Intolerant
Whole Lake	Spring	44%	31%	19%	6%	0%
	Fall	50%	27%	18%	5%	0%
	Whole Year	46%	25%	21%	8%	0%
Stratum 1	Spring	46%	31%	23%	0%	0%
	Fall	47%	29%	24%	0%	0%
	Whole Year	42%	32%	26%	0%	0%
Stratum 2	Spring	44%	31%	19%	6%	0%
	Fall	50%	29%	21%	0%	0%
	Whole Year	44%	28%	22%	6%	0%
Stratum 3	Spring	50%	25%	25%	0%	0%
	Fall	50%	28%	22%	0%	0%
	Whole Year	45%	30%	25%	0%	0%
Stratum 4	Spring	50%	25%	25%	0%	0%
	Fall	50%	25%	19%	6%	0%
	Whole Year	44%	28%	22%	6%	0%
Stratum 5	Spring	60%	20%	20%	0%	0%
	Fall	47%	29%	18%	6%	0%
	Whole Year	47%	29%	18%	6%	0%

Percent of species in each tolerance category, based on presence of species.
Tolerance designations based on Whittier and Hughes (1998)

Nine-year trend analysis (percent change per year) and level of significance of trophic guilds based on square root-normalized catch per hour from electrofishing. For a list of species within each guild click here

Trophic Guild	Trend	Significance
Planktivore/Invertivore	20%	0.03
Planktivore	9%	0.61
Piscivore	5%	0.00
Invertivore	3.2%	0.34
Detritivore	-0.03%	0.97
Invertivore/Piscivore	0.6%	0.67
Benthic Invertivore	-6%	0.03

Notes: Table is sorted first by trend, then by significance level. Trends that are statistically significant at the alpha< 0.10 level are shaded.

Library Reference 8.7.4

Size and growth

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Library Reference 8.7.4.1

Adults

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Mean total lengths of largemouth and smallmouth bass in each stratum and the whole lake for each sampling event and the whole year from electrofishing, and mean lengths of all species in each event and the whole year.

a) Smallmouth bass.

Season	Stratum	Mean Total Length (mm)	Standard Error	N
Whole Year	Stratum 1	235.77	11.69	48
	Stratum 2	235.86	7.08	42
	Stratum 3	237.26	5.77	19
	Stratum 4	245.03	7.27	61
	Stratum 5	250.02	13.74	42
	Whole Lake	241.41	4.56	212
Spring	Stratum 1	260.63	14.17	30
	Stratum 2	239.89	10.13	28
	Stratum 3	214.00	7.20	4
	Stratum 4	257.71	9.75	38
	Stratum 5	289.78	16.69	27
	Whole Lake	259.91	6.26	127
Fall	Stratum 1	194.33	16.59	18
	Stratum 2	227.79	6.34	14
	Stratum 3	243.47	6.18	15
	Stratum 4	224.09	9.28	23
	Stratum 5	178.47	6.98	15
	Whole Lake	213.76	5.26	85

b) Largemouth bass.

Season	Stratum	Mean Total Length (mm)	Standard Error	N
Whole Year	Stratum 1	297.54	14.68	67
	Stratum 2	273.95	16.35	43
	Stratum 3	238.80	29.82	15
	Stratum 4	306.86	11.84	56
	Stratum 5	287.66	13.10	47
	Whole Lake	289.48	6.94	228
Spring	Stratum 1	362.53	16.58	19
	Stratum 2	297.65	11.20	20
	Stratum 3	345.25	30.36	4
	Stratum 4	334.46	12.99	28
	Stratum 5	317.06	15.76	17
	Whole Lake	329.28	7.17	88
Fall	Stratum 1	271.81	18.20	48
	Stratum 2	253.35	28.61	23
	Stratum 3	200.09	32.17	11
	Stratum 4	279.25	18.59	28
	Stratum 5	271.00	17.95	30
	Whole Lake	264.46	9.82	140

Mean total lengths of largemouth and smallmouth bass in each stratum and the whole lake for each sampling event and the whole year from electrofishing, and mean lengths of all other species in each event and the whole year. (continued).

c) 2008 all other species.

	2008			Spring			Fall		
Species	Mean Total Length (mm)	Standard Error	N	Mean Total Length (mm)	Standard Error	N	Mean Total Length (mm)	Standard Error	N
Alewife	154.67	1.70	30	154.67	1.70	30			
Black crappie	196.00		1				196.00		1
Bluegill	167.49	2.23	159	173.81	2.12	89	159.46	4.12	70
Bowfin	516.41	27.15	17	502.50	58.75	6	524.00	29.41	11
Brown bullhead	295.29	2.17	223	296.34	2.80	117	294.12	3.39	106
Brown trout	391.00		1	391.00		1			
Channel catfish	513.00	16.77	9				513.00	16.77	9
Freshwater drum	424.21	33.27	14				424.21	33.27	14
Gizzard shad	296.80	8.33	166	321.07	11.86	14	294.56	9.02	152
Golden shiner	152.30	8.20	23	151.67	14.01	12	153.00	8.57	11
Largemouth bass	289.48	6.94	228	329.28	7.17	88	264.46	9.82	140
Longnose gar	650.00	44.41	4	710.00		1	630.00	56.07	3
Northern hog sucker	276.50	85.50	2				276.50	85.50	2
Northern pike	510.00	112.98	5				510.00	112.98	5
Pumpkinseed	155.56	1.10	858	171.81	0.82	512	131.51	1.76	346
Rock bass	165.09	3.28	67	158.52	5.99	21	168.09	3.88	46
Shorthead redhorse	496.67	9.28	3	490.00		1	500.00	15.00	2
Smallmouth bass	241.41	4.56	212	259.91	6.26	127	213.76	5.26	85
Walleye	574.07	26.21	14	571.00	30.59	12	592.50	18.50	2
White perch	186.10	2.69	143	198.62	2.22	65	175.68	4.23	78
White sucker	458.59	4.91	141	452.30	5.43	90	469.69	9.51	51
Yellow bullhead	224.00		1				224.00		1
Yellow perch	214.65	1.84	324	215.50	2.17	168	213.72	3.02	156

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Length frequency in Fall 2008 electrofishing and gill netting combined for species where n > 20.

Total Length (mm)	Bluegill	Brown_bullhead	Gizzard_shad	Largemouth_bass	Pumpkinseed	Rock_bass	Smallmouth_bass	White_perch	White_sucker	Yellow_perch	
0 - 59				1	1						
60 - 79	3		3		1		1				
80 - 99			10	4	24		2	2			
100 - 119	7		11	16	147	2				5	
120 - 139	12		9	14	77	3	2	11			
140 - 159	2		3	1	16	13	9	20		7	
160 - 179	22	1	3	1	24	14	9	5	1	24	
180 - 199	23	2		5	54	7	4	17	1	15	
200 - 219	1	2		10	6	6	15	11		19	
220 - 239		2	1	14			16	11		47	
240 - 259		5		4		1	11	1		34	
260 - 279		15	1	4			9			7	
280 - 299		23	1	7	1		7			2	
300 - 319		37	3	6							
320 - 339		14	21	16							
340 - 359		3	48	8							
360 - 379		1	31	3							
380 - 399		1	7	5							
400 - 419			1	3					1		
420 - 439				7					5		
440 - 459			1	8			1		10		
460 - 479			5	3					9		
480 - 499				1					9		
500 - 519									11		
> 519									6		
Total	**70**	**106**	**159**	**141**	**351**	**46**	**86**	**78**	**53**	**160**	**0**

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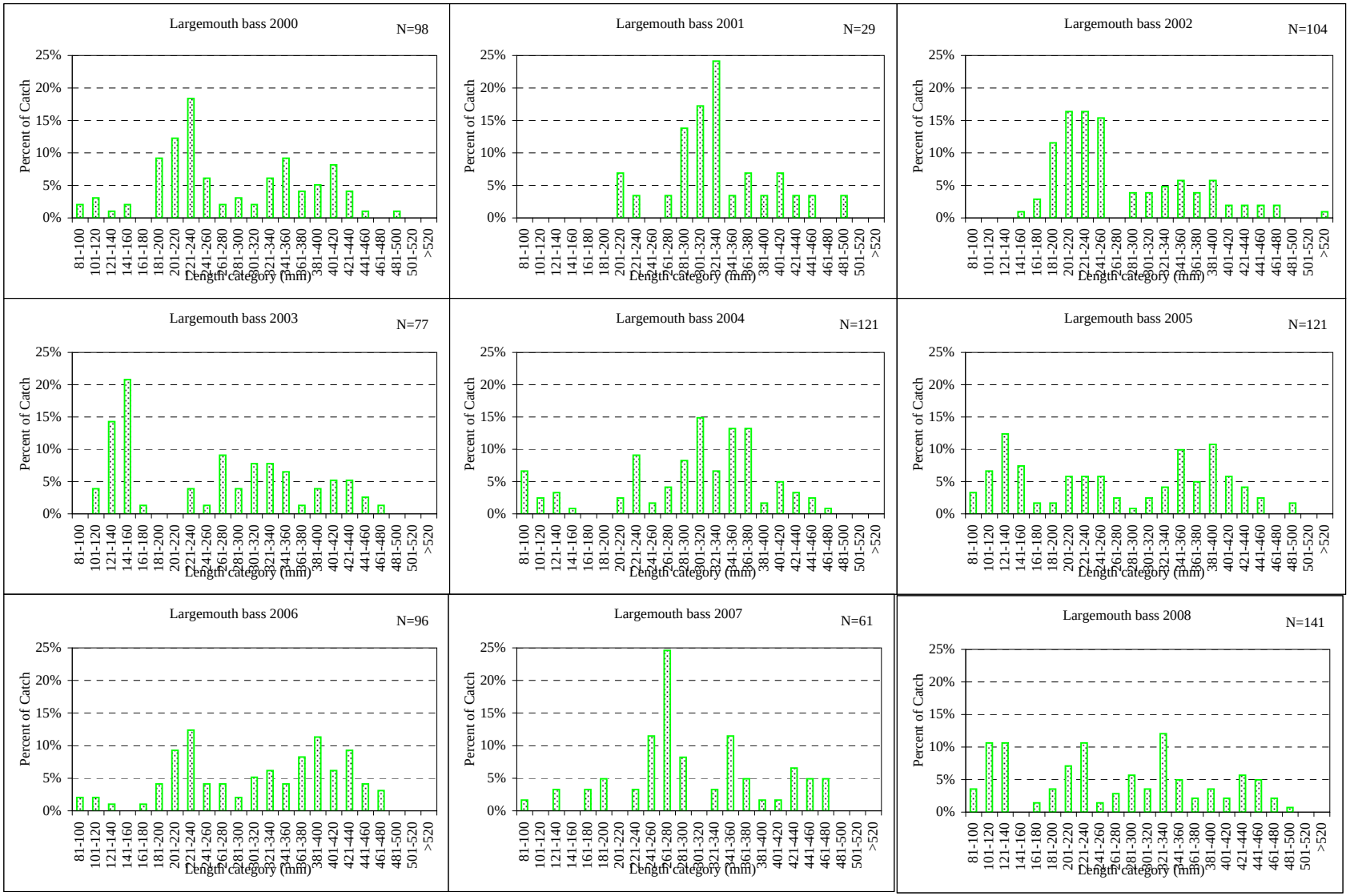
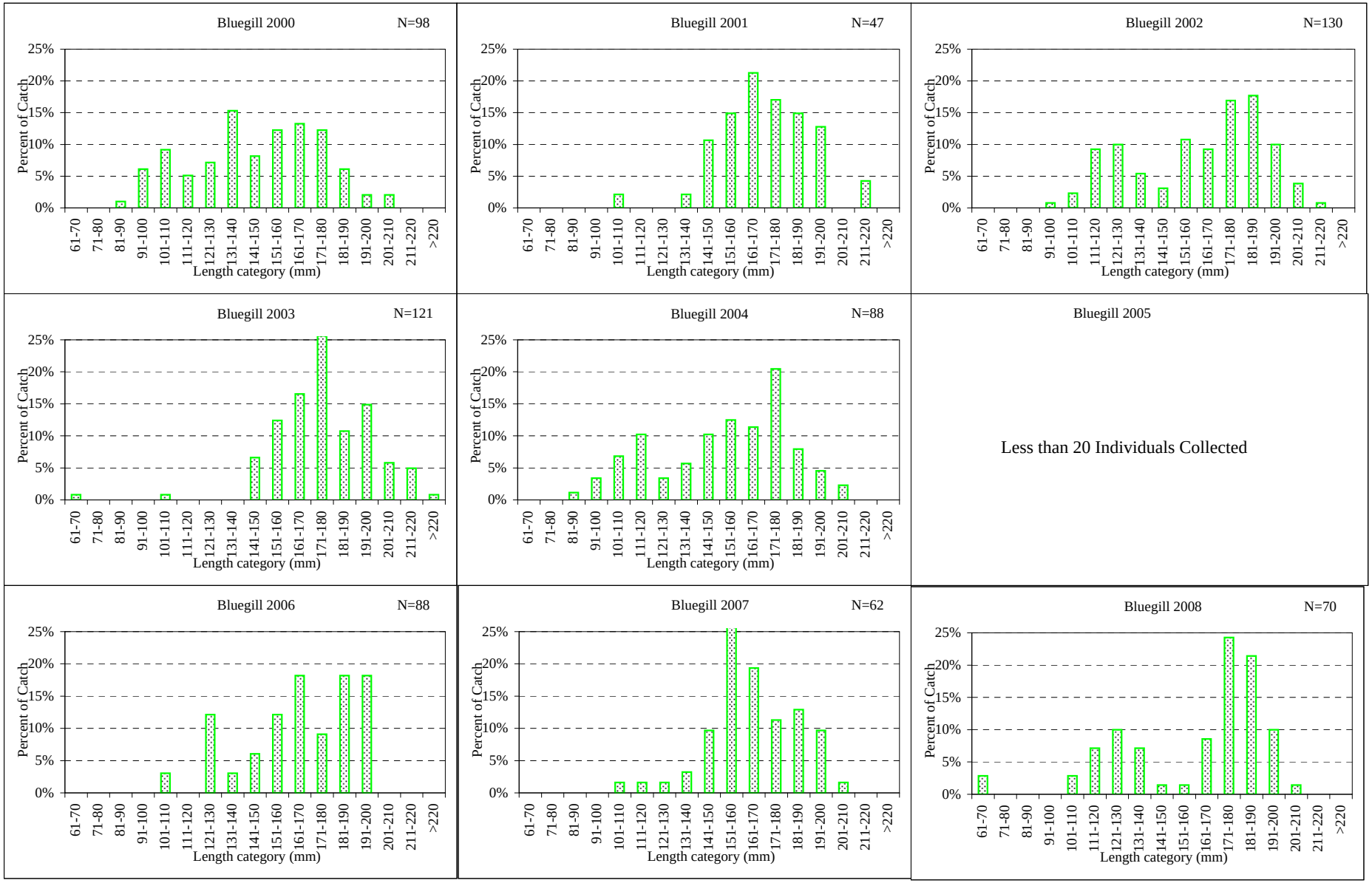


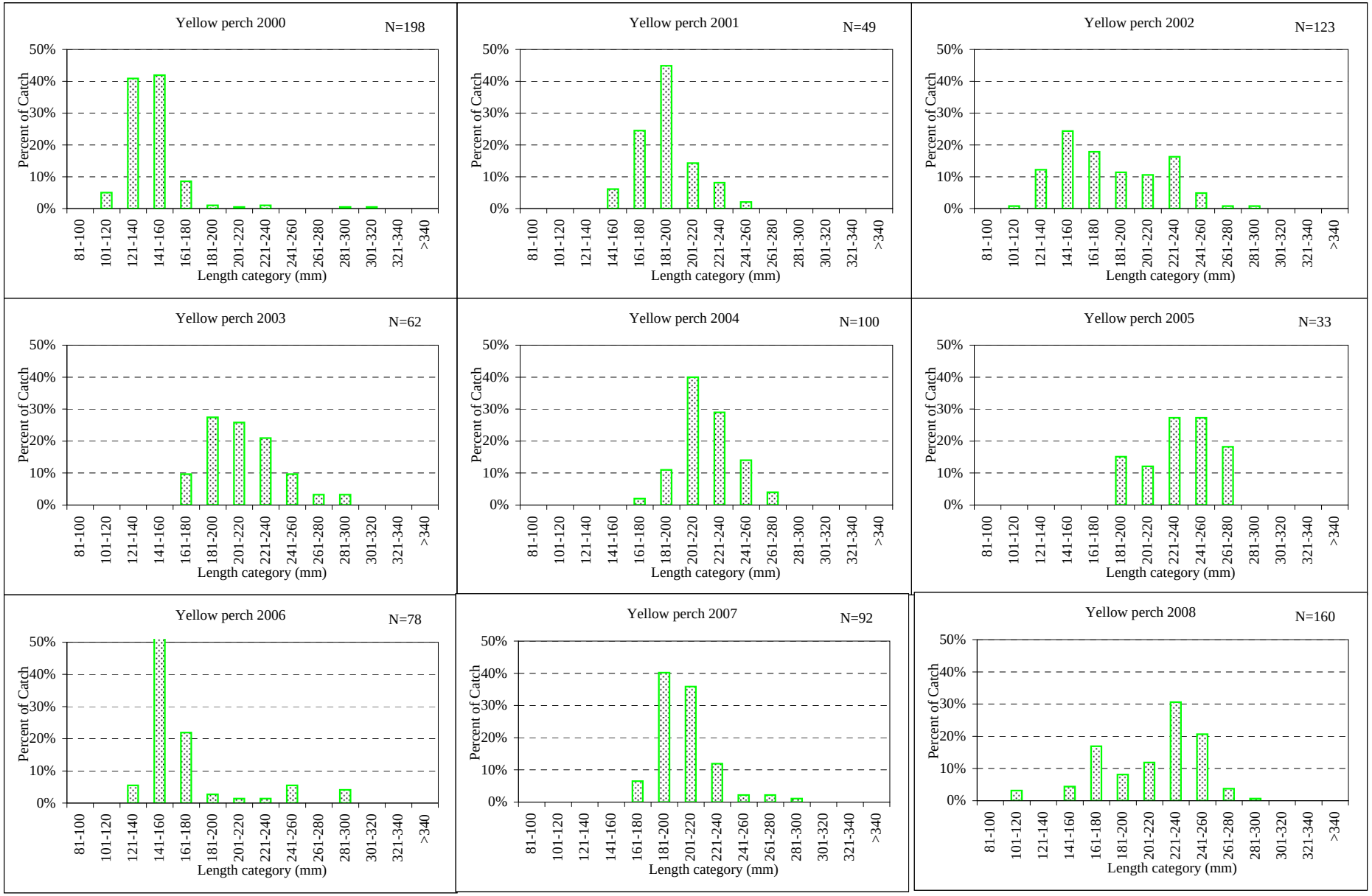
A. Largemouth bass length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

B. Smallmouth bass length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

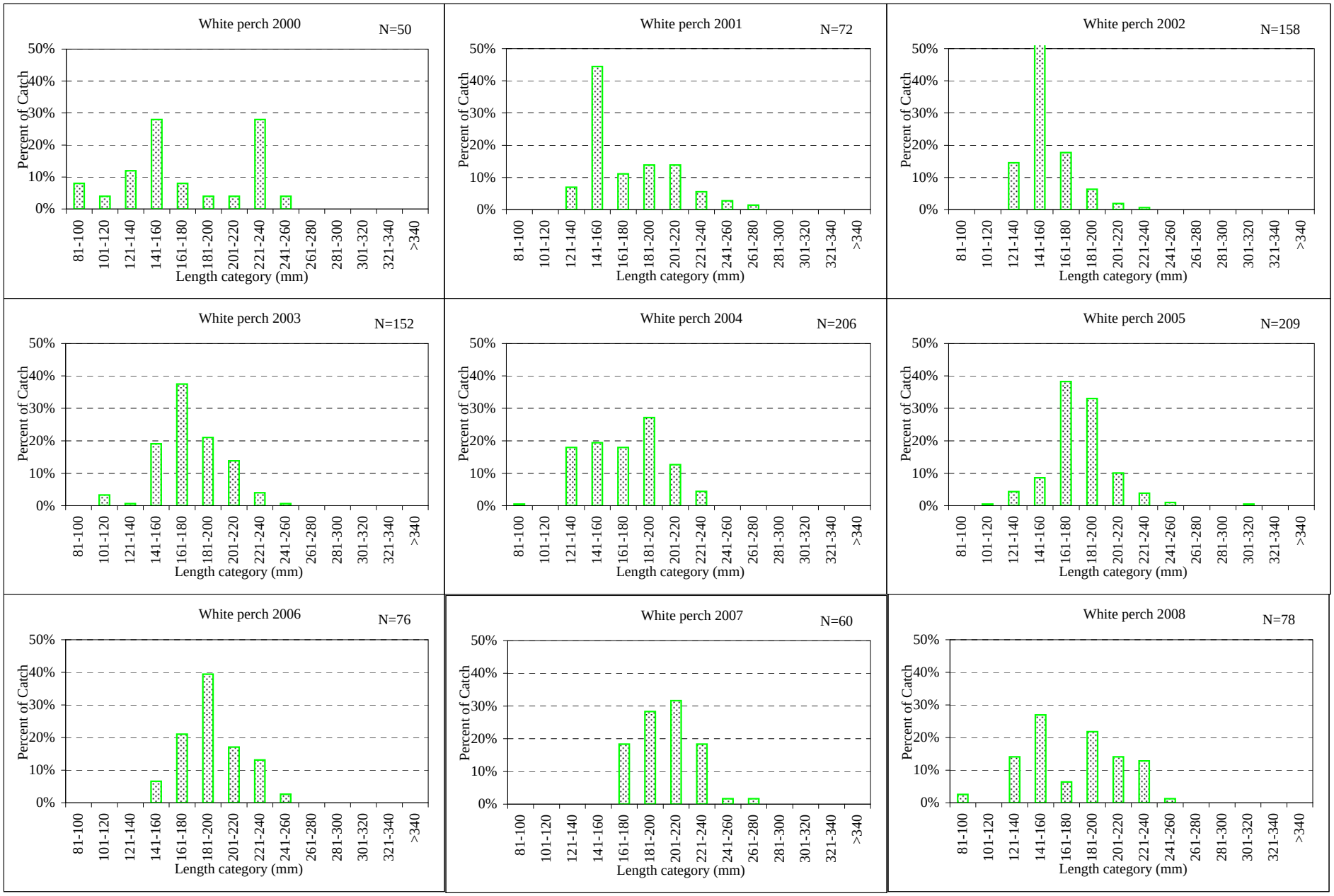


C. Bluegill length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

D. Pumpkinseed length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

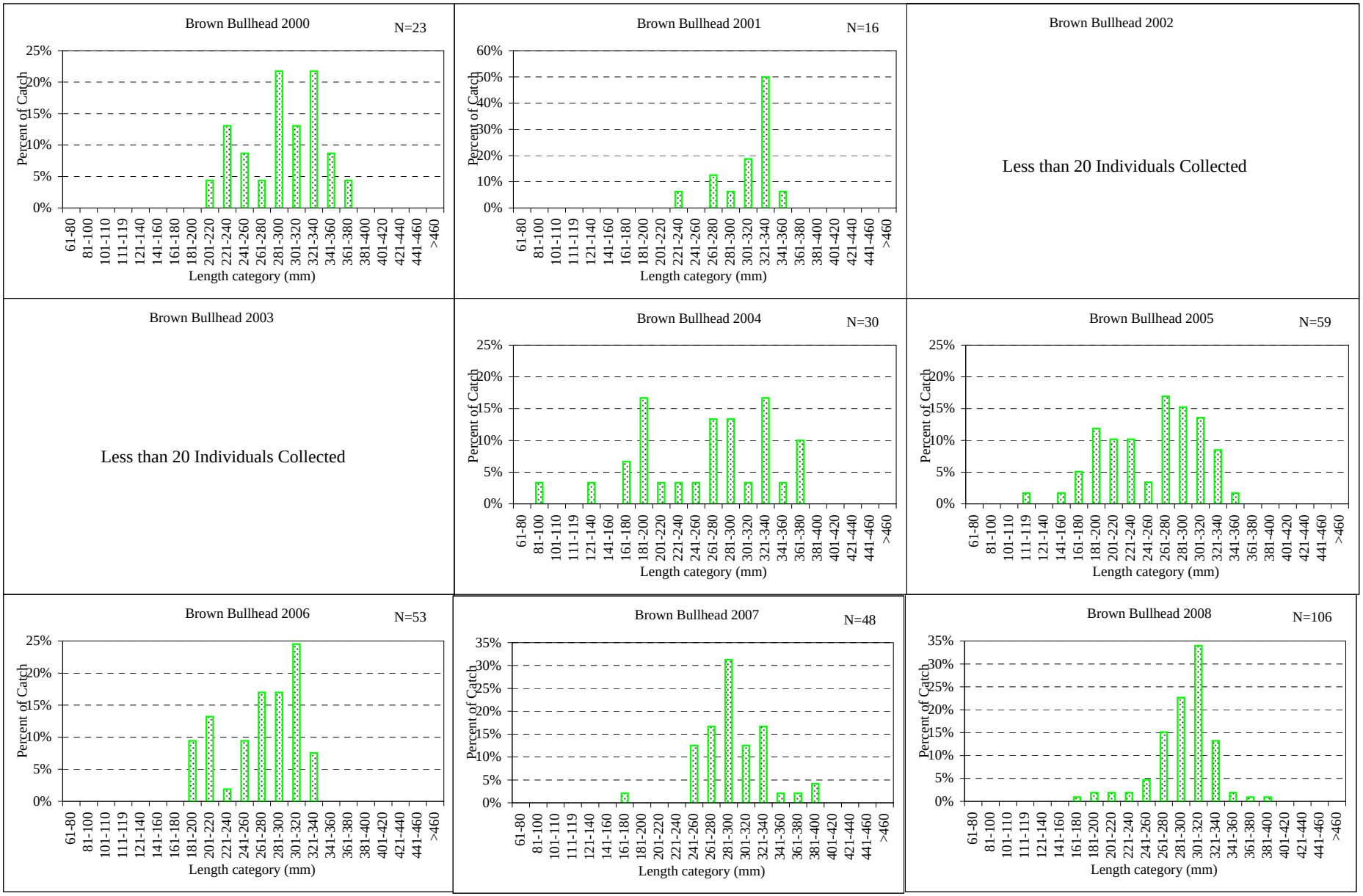


E. Yellow perch length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

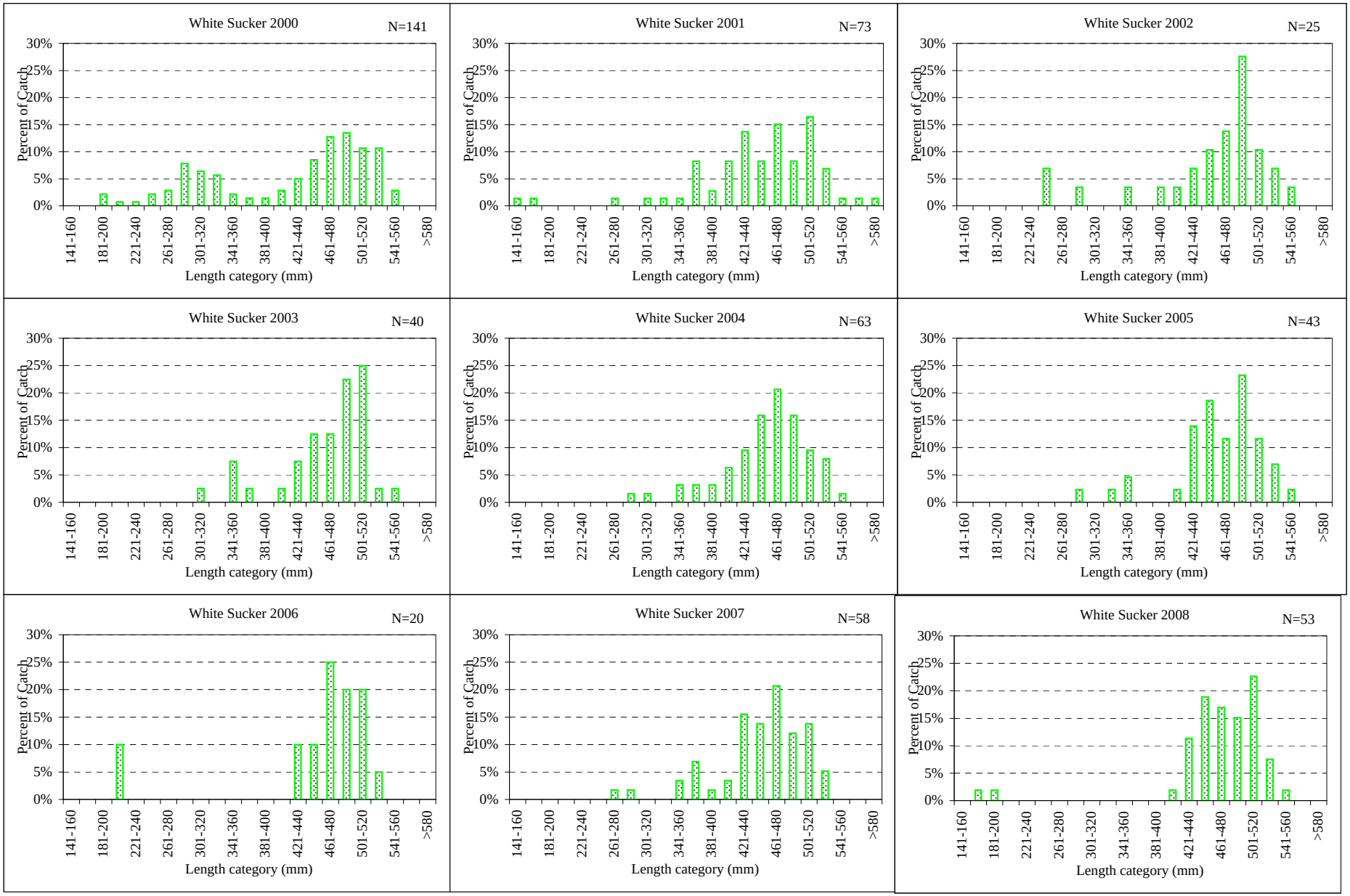


F. White perch length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

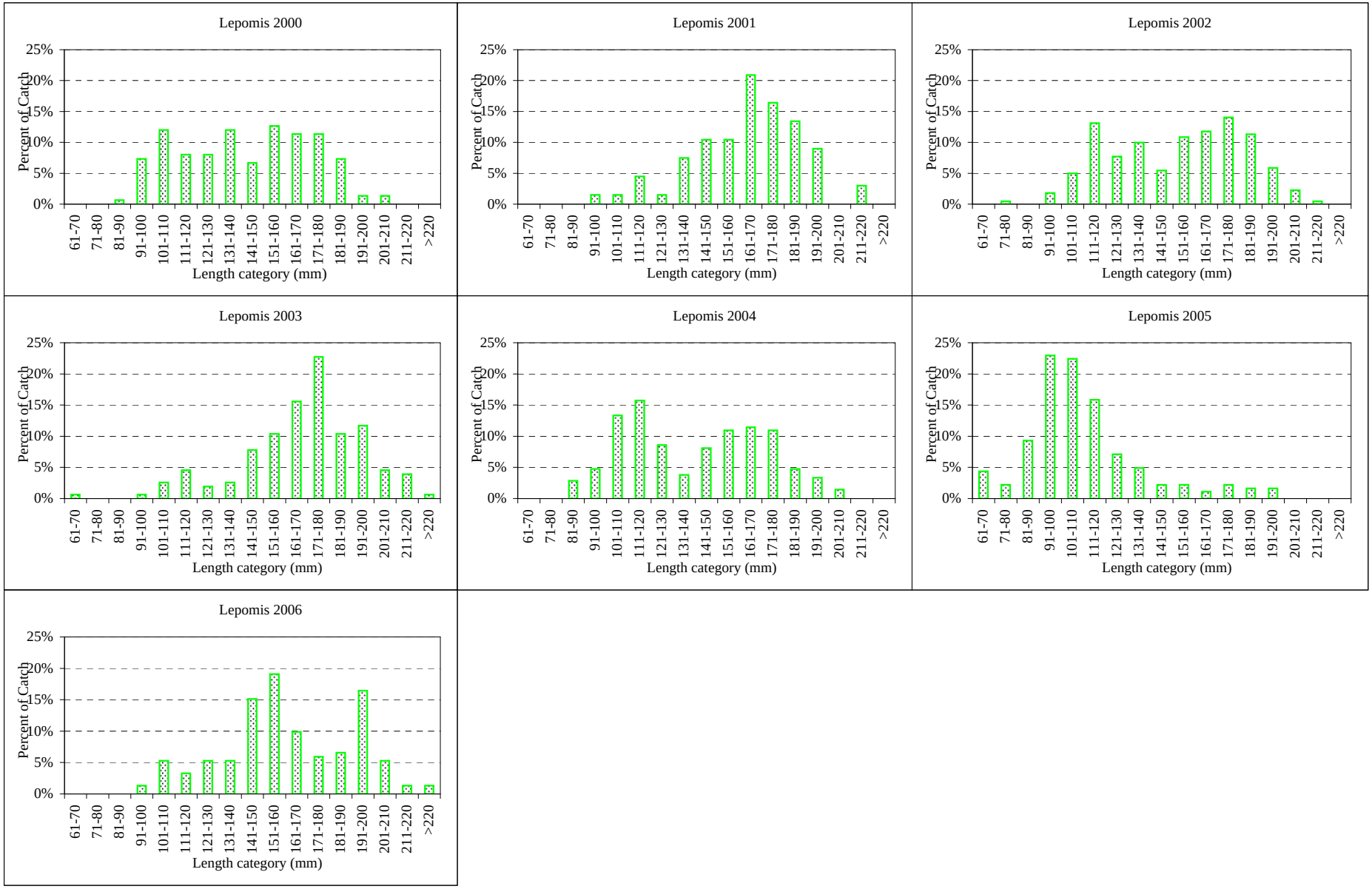
G. Gizzard shad length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.



H. Brown bullhead length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.



I. White sucker length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.



J. Lepomis length frequency in Fall electrofishing and gill netting combined from 2000 to 2008.

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Proportional Stock Density (PSD) & Relative Stock Density (RSD) of select species captured during Fall 2008 electrofishing. PSD and RSD are numerical descriptors of length-frequency data. Number after "RSD" designates fish size in inches. For example RSD8 is the RSD of fish 8 inches and larger. PSD is the percentage of fish of quality length compared to the number of fish of stock length. Quality and stock lengths are standardized from the literature.

Species	PSD or RSD	Value
Bluegill	PSD	70.15
	RSD8	1
Gizzard shad	PSD	98
Largemouth bass	PSD	57
	RSD15	28
	RSD18	4
Lepomis sp.	PSD	32
	RSD8	1
Pumpkinseed	PSD	24
	RSD8	1
Smallmouth bass	PSD	11
	RSD12	0
	RSD14	0
	RSD18	0

* Number after "PSD" or "RSD" designates fish size in inches. For example RSD8 is the RSD of fish 8 inches and larger.

Library Reference 8.7.4.1.5

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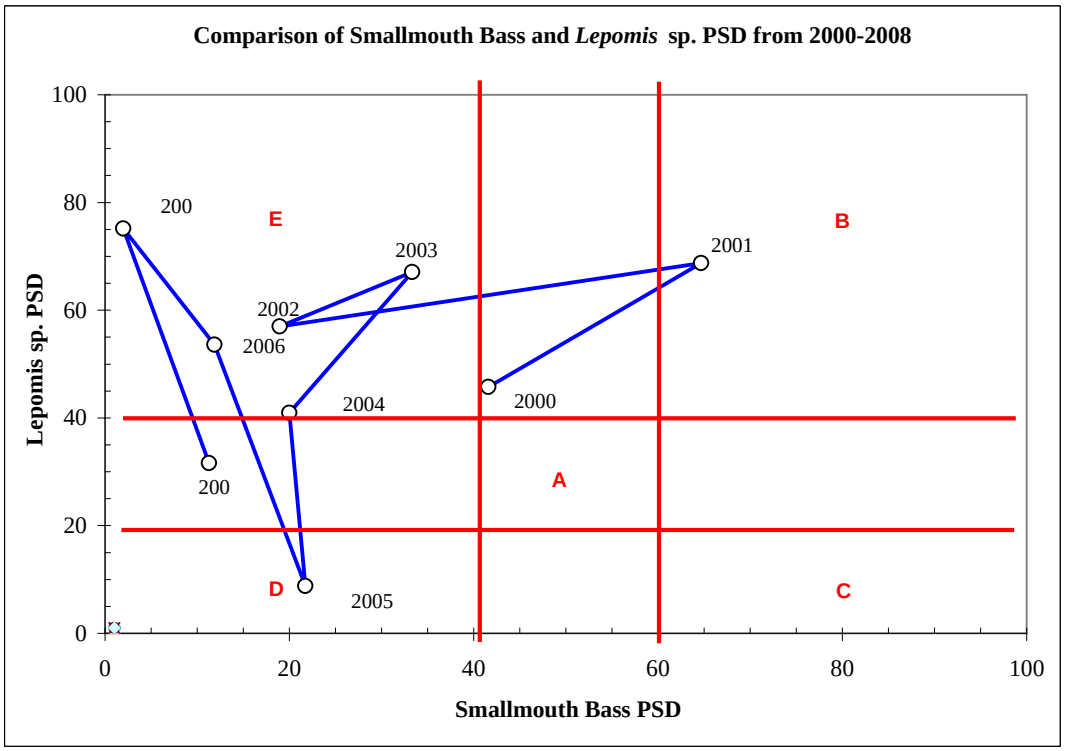
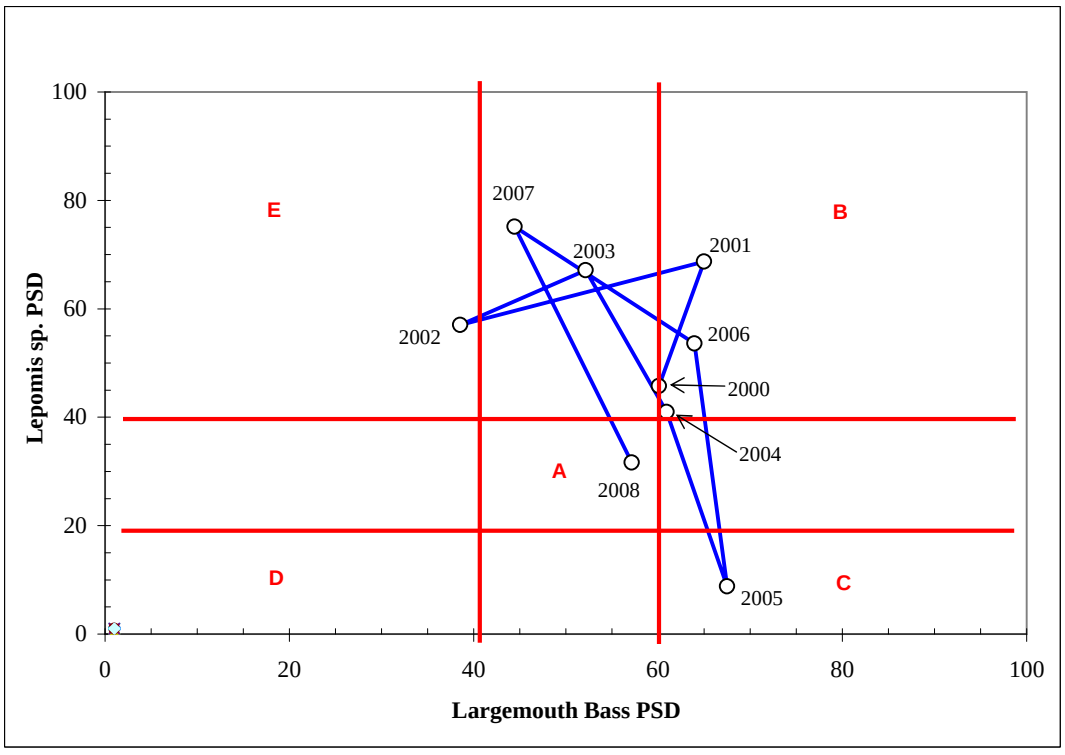
Comparison of largemouth and smallmouth bass Proportional Stock Density (PSD) vs. Lepomis PSD from electrofishing data in 2000-2008. Potential interpretations for the different combinations are : A = mutual balance for satisfactory fishing; B = community comprised of large, old specimens, indicative of an unfished population; C = large predators excessively cropping large prey; D = overfishing of predators and stunting of prey; and E = high population of small predators excessively cropping young





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Relative weights (A) and condition factor (B) of select species captured during electrofishing in the fall of 2008. Relative weight (Wr) is the ratio of the actual weight of a fish to what an average healthy fish of the same length should weigh (called standard weight which is based on published values). Fish with high Wr (>100) are fatter than the standard weight of a fish of the same length, while those with low Wr (<100) are thinner. Condition Factor is the relative robustness, or degree of well-being, of a fish. Variations in a fish's coefficient of condition primarily reflect state of sexual maturity and degree of nourishment. Condition values may also vary with fish age, and in some species, with sex.

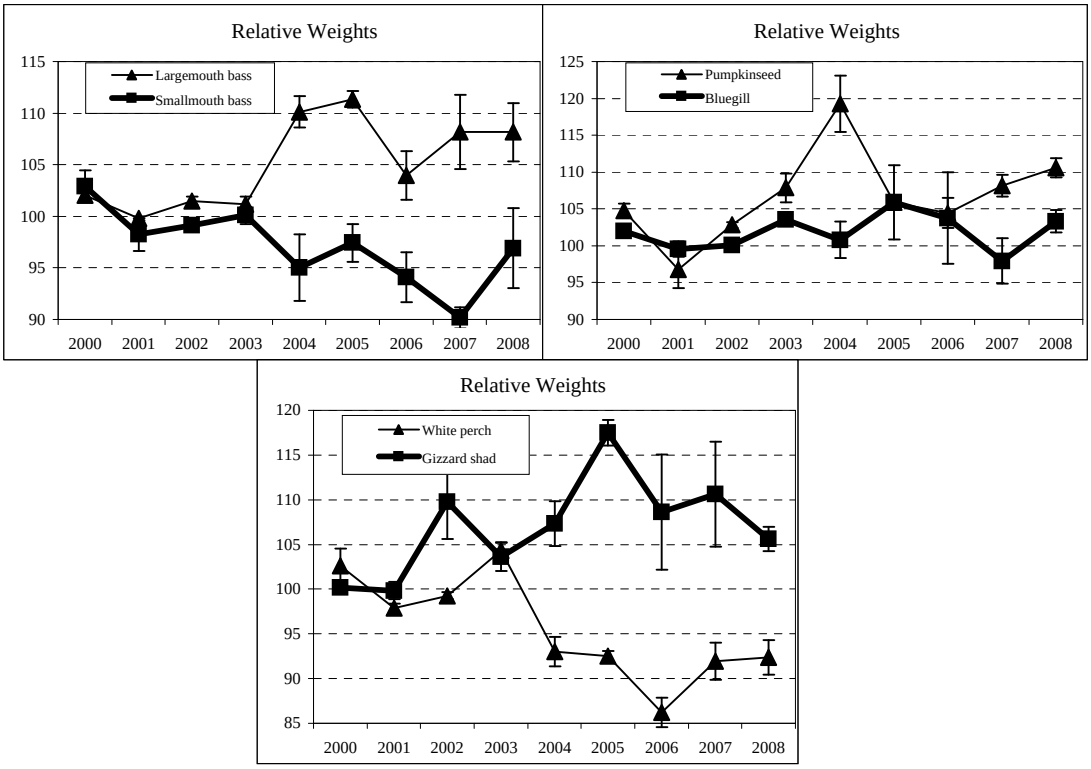
a) 2008 Relative Weights

Species	Mean Relative Weight	SE	N
Bluegill	103.32	1.52	69
Gizzard shad	105.62	1.36	152
Largemouth bass	108.15	2.81	140
Pumpkinseed	110.60	1.33	346
Smallmouth bass	96.90	3.87	84
White perch	92.39	1.93	78
Yellow perch	94.62	4.56	156

b) 2008 Condition Factors

Species	Condition Factor
Bluegill	2.22
Gizzard shad	1.14
Largemouth bass	1.54
Pumpkinseed	2.34
Smallmouth bass	1.25
White perch	1.37
Yellow perch	1.25

Relative weights trends of select species from 2000-2008. Relative weight (Wr) is the ratio of the actual weight of a fish to what an average healthy fish of the same length should weigh (called standard weight which is based on published values). Fish with high Wr (>100) are fatter than the standard weight of a fish of the same length, while those with low Wr (<100) are thinner.



Graph Data

Relative weights of select species captured during electrofishing in the fall of 2000-2008.

Bluegill	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rel. Wt	101.97	99.56	100.11	103.57	100.81	105.91	103.74	97.95	103.32
SE	0.42	1.04	0.37	0.61	2.46	5.03	6.23	3.11	1.52
Count	174	51	60	31	71	20	33	61	69
Gizzard shad	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rel. Wt	100.17	99.83	109.75	103.62	107.32	117.47	108.6	110.6	105.6
SE	0.48	0.96	4.10	1.56	2.50	1.43	6.4	5.9	1.4
Count	191	15	66	30	20	172	98	105	152
Largemouth bass	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rel. Wt	102.02	99.82	101.50	101.15	110.12	111.36	103.96	108.19	108.15
SE	0.34	0.17	0.39	0.77	1.51	0.80	2.38	3.61	2.81
Count	127	21	181	54	108	122	94	61	140
Pumpkinseed	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rel. Wt	104.76	96.79	102.82	107.86	119.25	105.91	104.46	108.19	110.60
SE	0.92	2.55	0.41	1.93	3.80	0.82	2.02	1.47	1.33
Count	50	3	67	31	108	164	90	104	346
Smallmouth bass	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rel. Wt	102.93	98.23	99.14	100.10	95.03	97.41	94.09	90.18	96.90
SE	1.53	1.56	0.41	0.83	3.23	1.82	2.45	1.03	3.87
Count	31	9	58	11	36	72	96	115	84
White perch	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Rel. Wt	102.59	97.86	99.27	104.31	93.02	92.53	86.21	91.94	92.39
SE	1.98	0.55	0.38	0.97	1.65	0.56	1.67	2.05	1.93
Count	51	42	92	31	158	139	62	43	78

Library Reference 8.7.4.2

Young of Year (YOY)

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Mean total length of YOY fish for each stratum and whole lake by sample period in 2008.

a) By stratum and sampling period

Sample period	Stratum	Species	Mean total length (mm)	SE	N
late June	Stratum 1	No Catch	0.00	0.00	0
	Stratum 2	No Catch	0.00	0.00	0
	Stratum 3	No Catch	0.00	0.00	0
	Stratum 4	Longnose gar	32.00		1
	Stratum 5	No Catch	0.00	0.00	0
July	Stratum 1	Brown bullhead	39.62	0.51	29
		Carp	40.00		1
		Golden shiner	20.00		1
		Largemouth bass	53.31	3.11	16
		Lepomis sp.	23.00	3.00	2
		Smallmouth bass	46.00		1
	Stratum 2	Brown bullhead	36.00	4.00	2
		Carp	44.00	0.00	2
		Largemouth bass	51.50	5.36	4
		Lepomis sp.	27.00		1
	Stratum 3	Carp	36.75	1.25	4
		Golden shiner	36.50	0.50	2
		Largemouth bass	60.43	2.52	7
		Lepomis sp.	28.75	0.59	32
		Yellow perch	49.00		1
	Stratum 4	Brown bullhead	40.69	0.96	16
		Carp	25.00		1
		Golden shiner	29.71	0.90	31
		Largemouth bass	58.30	2.02	10
		Lepomis sp.	23.00	1.43	7
		Rock bass	24.00		1
	Stratum 5	Golden shiner	30.23	1.03	31
		Largemouth bass	58.80	3.64	10
		Lepomis sp.	27.00		1
		Rock bass	31.00		1
		Smallmouth bass	46.88	2.38	8
		Tesselated darter	29.00		1
early August	Stratum 1	Golden shiner	31.67	0.88	3
		Largemouth bass	70.77	1.74	13
		Lepomis sp.	31.00	5.69	3
	Stratum 2	Largemouth bass	59.00	2.30	5
		Lepomis sp.	36.33	0.76	6
	Stratum 3	Brown bullhead	34.00		1
		Carp	29.00	2.08	6

a) By stratum and sampling period

Sample period	Stratum	Species	Mean total length (mm)	SE	N
early August	Stratum 3	Gizzard shad	44.50	2.40	4
(continued)	(continued)	Golden shiner	32.44	1.82	16
		Largemouth bass	73.00	3.06	3
		Lepomis sp.	36.00	0.45	17
	Stratum 4	Brown bullhead	43.00		1
		Largemouth bass	69.73	2.14	15
		Lepomis sp.	32.71	0.99	31
		Rock bass	38.00	1.00	2
		Smallmouth bass	64.50	2.90	6
	Stratum 5	Largemouth bass	68.00	2.44	10
		Lepomis sp.	32.67	1.00	24
		Rock bass	27.00		1
		Smallmouth bass	62.00	9.00	2
		White perch	47.00		1
late August	Stratum 1	Largemouth bass	62.89	2.41	9
		Lepomis sp.	34.13	1.38	8
		Smallmouth bass	70.00		1
	Stratum 2	Largemouth bass	78.00		1
		Smallmouth bass	70.00		1
	Stratum 3	Carp	46.00		1
		Lepomis sp.	35.27	0.63	30
	Stratum 4	Largemouth bass	77.00	0.58	3
		Lepomis sp.	37.82	0.30	17
		Smallmouth bass	76.00		1
	Stratum 5	Brown bullhead	30.00		1
		Golden shiner	45.00		1
		Lepomis sp.	30.30	2.20	10
		Rock bass	47.00		1

Mean total length of YOY fish for each stratum and whole lake by sample period in 2008 (continued).

a) By stratum and sampling period (continued)

Sample period	Stratum	Species	Mean total length (mm)	SE	N
mid September	Stratum 1	Largemouth bass	64.00		1
		Lepomis sp.	39.41	1.16	44
		Pumpkinseed	52.50	6.50	2
		Smallmouth bass	92.00		1
	Stratum 2	No Catch	0.00	0.00	0
	Stratum 3	Golden shiner	47.00	2.31	3
		Lepomis sp.	42.97	0.91	59
	Stratum 4	Brown bullhead	68.00		1
		Gizzard shad	90.25	4.46	4
		Golden shiner	60.68	1.06	31
		Largemouth bass	115.00		1
		Lepomis sp.	39.00	2.00	2
		Smallmouth bass	83.20	7.09	5
	Stratum 5	Largemouth bass	83.00		1
		Lepomis sp.	41.91	0.86	44
		Rock bass	46.67	2.40	3
		Smallmouth bass	77.50	6.50	2
early October	Stratum 1	Lepomis sp.	38.83	5.72	6
	Stratum 2	No Catch	0.00	0.00	0
	Stratum 3	Bluegill	43.67	0.33	3
		Gizzard shad	65.00		1
		Golden shiner	61.79	1.81	34
		Lepomis sp.	40.50	2.63	4
	Stratum 4	Brown bullhead	63.00		1
		Golden shiner	73.00		1
	Stratum 5	No Catch	0.00	0.00	0

Mean total length of YOY fish for each stratum and whole lake by sample period in 2008 (continued).

b) Whole lake by sampling period

Sample period	Species	Mean total length (mm)	SE	N
late June	Longnose gar	32.0		1
July	Brown bullhead	39.8	0.5	47
	Carp	37.5	2.2	8
	Golden shiner	30.0	0.7	65
	Largemouth bass	56.4	1.5	47
	Lepomis sp.	27.5	0.6	43
	Rock bass	27.5	3.5	2
	Smallmouth bass	46.8	2.1	9
	Tesselated darter	29.0		1
	Yellow perch	49.0		1
early August	Brown bullhead	38.5	4.5	2
	Carp	29.0	2.1	6
	Gizzard shad	44.5	2.4	4
	Golden shiner	32.3	1.5	19
	Largemouth bass	68.7	1.1	46
	Lepomis sp.	33.6	0.5	81
	Rock bass	34.3	3.7	3
	Smallmouth bass	63.9	2.7	8
	White perch	47.0		1
late August	Brown bullhead	30.0		1
	Carp	46.0		1
	Golden shiner	45.0		1
	Largemouth bass	67.3	2.5	13
	Lepomis sp.	35.0	0.6	65
	Rock bass	47.0		1
	Smallmouth bass	72.0	2.0	3
5 - mid September	Brown bullhead	68.0		1
	Gizzard shad	90.3	4.5	4
	Golden shiner	59.5	1.2	34
	Largemouth bass	87.3	14.9	3
	Lepomis sp.	41.6	0.6	149
	Pumpkinseed	52.5	6.5	2
	Rock bass	46.7	2.4	3
	Smallmouth bass	82.9	4.7	8
6 - early October	Bluegill	43.7	0.3	3
	Brown bullhead	63.0		1
	Gizzard shad	65.0		1
	Golden shiner	62.1	1.8	35
	Lepomis sp.	39.5	3.5	10

Mean total length of YOY fish for each stratum and whole lake by sample period in 2008 (continued).

c) Whole lake, whole year

Species	Mean length (mm)	SE	N
Bluegill	43.7	0.3	3
Brown bullhead	40.6	0.9	52
Carp	34.7	1.9	15
Gizzard shad	67.1	7.9	9
Golden shiner	44.2	1.4	154
Largemouth bass	63.8	1.1	109
Lepomis sp.	36.7	0.41	348
Longnose gar	32.0		1
Pumpkinseed	52.5	6.5	2
Rock bass	38.3	3.1	9
Smallmouth bass	64.7	3.2	28
Tesselated darter	29.0		1
White perch	47.0		1
Yellow perch	49.0		1

Mean total length of YOY fish for each stratum and whole lake by sample period in 2008 (continued).

d) Whole year by stratum

Stratum	Species	Mean total length (mm)	SE	N
Stratum 1	Brown bullhead	39.62	0.51	29
	Carp	40.00		1
	Golden shiner	28.75	2.98	4
	Largemouth bass	61.62	1.91	39
	Lepomis sp.	37.76	1.09	63
	Pumpkinseed	52.50	6.50	2
	Smallmouth bass	69.33	13.28	3
Stratum 2	Brown bullhead	36.00	4.00	2
	Carp	44.00	0.00	2
	Largemouth bass	57.90	3.37	10
	Lepomis sp.	35.00	1.48	7
	Smallmouth bass	70.00		1
Stratum 3	Bluegill	43.67	0.33	3
	Brown bullhead	34.00		1
	Carp	33.36	2.06	11
	Gizzard shad	48.60	4.50	5
	Golden shiner	51.53	2.20	55
	Largemouth bass	64.20	2.70	10
	Lepomis sp.	37.23	0.64	142
	Yellow perch	49		1
Stratum 4	Brown bullhead	43.42	1.97	19
	Carp	25.00		1
	Gizzard shad	90.25	4.46	4
	Golden shiner	45.63	2.11	63
	Largemouth bass	68.10	2.42	29
	Lepomis sp.	33.26	0.83	57
	Longnose gar	32.00		1
	Rock bass	33.33	4.70	3
	Smallmouth bass	73.25	4.10	12
Stratum 5	Brown bullhead	30.00		1
	Golden shiner	30.69	1.10	32
	Largemouth bass	64.33	2.45	21
	Lepomis sp.	37.44	0.85	79
	Rock bass	40.83	3.93	6
	Smallmouth bass	54.50	4.08	12
	Tesselated darter	29.00		1
	White perch	47.00		1

Library Reference 8.7.4.2.2

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YOY mean total length in August in each stratum and the entire lake in 2008.

Species	Stratum	Mean total length (mm)	SE	N
Golden shiner	Stratum 1	31.67	0.88	3
Largemouth bass	Stratum 1	67.55	1.62	22
Lepomis sp.	Stratum 1	33.27	1.71	11
Smallmouth bass	Stratum 1	70.00		1
Largemouth bass	Stratum 2	62.17	3.68	6
Lepomis sp.	Stratum 2	36.33	0.76	6
Smallmouth bass	Stratum 2	70.00		1
Brown bullhead	Stratum 3	34.00		1
Carp	Stratum 3	31.43	3.00	7
Gizzard shad	Stratum 3	44.50	2.40	4
Golden shiner	Stratum 3	32.44	1.82	16
Largemouth bass	Stratum 3	73.00	3.06	3
Lepomis sp.	Stratum 3	35.53	0.44	47
Brown bullhead	Stratum 4	43.00		1
Largemouth bass	Stratum 4	70.94	1.90	18
Lepomis sp.	Stratum 4	34.52	0.74	48
Rock bass	Stratum 4	38.00	1.00	2
Smallmouth bass	Stratum 4	66.14	2.95	7
Brown bullhead	Stratum 5	30.00		1
Golden shiner	Stratum 5	45.00		1
Largemouth bass	Stratum 5	68.00	2.44	10
Lepomis sp.	Stratum 5	31.97	0.95	34
Rock bass	Stratum 5	37.00	10.00	2
Smallmouth bass	Stratum 5	62.00	9.00	2
White perch	Stratum 5	47.00		1
Brown bullhead	Whole Lake	35.67	3.84	3
Carp	Whole Lake	31.43	3.00	7
Gizzard shad	Whole Lake	44.50	2.40	4
Golden shiner	Whole Lake	32.95	1.59	20
Largemouth bass	Whole Lake	68.39	1.05	59
Lepomis sp.	Whole Lake	34.23	0.39	146
Rock bass	Whole Lake	37.50	4.11	4
Smallmouth bass	Whole Lake	66.09	2.32	11
White perch	Whole Lake	47.00		1

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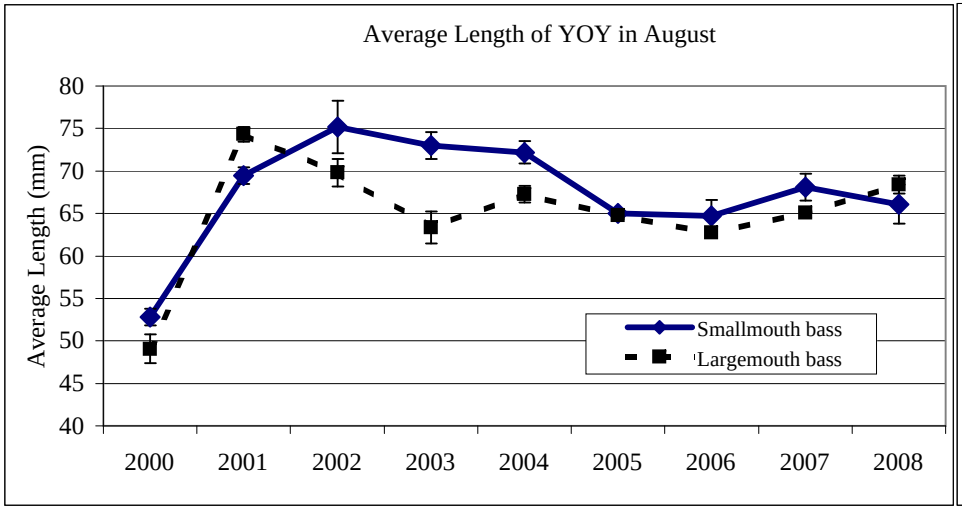
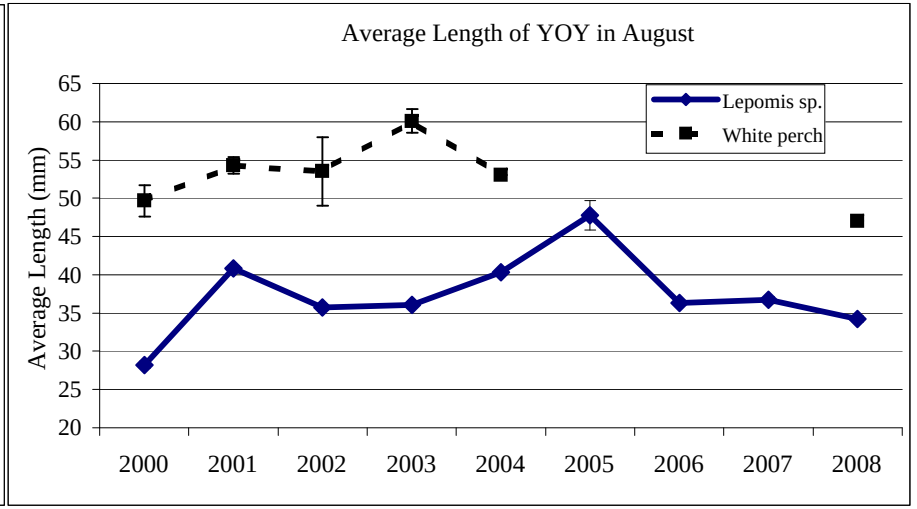
Mean length of select YOY species in August from 2000-2008.





Graph Data

YOY mean length in August in the entire lake from 2000-2008

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Lepomis sp.	28.2	40.9	35.7	36.09	40.30	47.75	36.29	36.69	34.23
White perch	49.7	54.3	53.5	60.10	53.00				47
Largemouth bass	49.1	74.3	69.8	63.33	67.29	64.75	62.77	65.06	68.39
Smallmouth bass	52.8	69.5	75.2	73.00	72.18	65.00	64.72	68.09	66.09
Gizzard shad	55.2	58.7		52.83					44.5
Yellow perch		68.6	79.0						

Standard error of mean length in August in the entire lake from 2000-2008

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Lepomis sp.	0.476	0.264	0.355	0.26	0.37	1.93	0.32	0.43	0.39
White perch	2.053	1.111	4.500	1.53	0.000				0
Largemouth bass	1.715	0.891	1.593	1.90	0.99	0.40	0.45	0.52	1.05
Smallmouth bass	0.989	1.006	3.071	1.56	1.31	0.54	1.84	1.59	2.32
Gizzard shad	0.497	1.402		1.45					2.40
Yellow perch		0.534	7.000						

Growth of YOY between sampling periods in 2008.

Time period	Species	Stratum	Growth over period (g) (ln(Wt/Wo))	N
July to early August	Largemouth bass	Stratum 1	0.846	28
		Stratum 2	-0.031	8
		Stratum 3	0.514	10
		Stratum 4	0.441	25
		Stratum 5	0.441	20
		Whole Lake	0.526	91
	Smallmouth bass	Stratum 1	0	0
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0	0
		Stratum 5	0.733	10
		Whole Lake	0.862	17
July to late August	Largemouth bass	Stratum 1	0.468	24
		Stratum 2	0.967	4
		Stratum 3	0	0
		Stratum 4	0.692	13
		Stratum 5	0	0
		Whole Lake	0.478	58
	Smallmouth bass	Stratum 1	1.365	2
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0	0
		Stratum 5	0	0
		Whole Lake	1.262	12
July to mid September	Largemouth bass	Stratum 1	0.488	16
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	1.904	11
		Stratum 5	0.963	11
		Whole Lake	1.362	48
	Smallmouth bass	Stratum 1	2.179	2
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0	0
		Stratum 5	1.302	10
		Whole Lake	1.663	17
early August to late August	Largemouth bass	Stratum 1	-0.377	22
		Stratum 2	0.998	6
		Stratum 3	0	0
		Stratum 4	0.251	18
		Stratum 5	0	0
		Whole Lake	-0.048	59
	Smallmouth bass	Stratum 1	0.000	0
		Stratum 2	0.000	0
		Stratum 3	0.000	0
		Stratum 4	0.647	7
		Stratum 5	0.000	0
		Whole Lake	0.401	11

Note: *Wo* is the weight at the beginning of the period, and *Wt* is the weight at the end of the period.

Growth of YOY between sampling periods in 2008 (continued).

Time period	Species	Stratum	Growth over period (g) (ln(Wt/Wo))	N
early August to mid September	Largemouth bass	Stratum 1	-0.358	14
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	1.463	16
		Stratum 5	0.523	11
		Whole Lake	0.836	49
	Smallmouth bass	Stratum 1	0	0
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0.815	11
		Stratum 5	0.569	4
		Whole Lake	0.802	16
late August to mid September	Largemouth bass	Stratum 1	0.020	10
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	1.212	4
		Stratum 5	0	0
		Whole Lake	0.884	16
	Smallmouth bass	Stratum 1	0.813	2
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0.168	6
		Stratum 5	0	0
		Whole Lake	0.401	11
early August to mid September	Largemouth bass	Stratum 1	-0.358	14
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	1.463	16
		Stratum 5	0.523	11
		Whole Lake	0.836	49
	Smallmouth bass	Stratum 1	0	0
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0.815	11
		Stratum 5	0.569	4
		Whole Lake	0.802	16
late August to mid September	Largemouth bass	Stratum 1	0.020	10
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	1.212	4
		Stratum 5	0	0
		Whole Lake	0.884	16
	Smallmouth bass	Stratum 1	0.813	2
		Stratum 2	0	0
		Stratum 3	0	0
		Stratum 4	0.168	6
		Stratum 5	0	0
		Whole Lake	0.401	11

Note: *Wo* is the weight at the beginning of the period, and *Wt* is the weight at the end of the period.

Growth of YOY between sampling periods in 2008 (continued).

Time period: Note that Wo is the weight at the beginning of the period, and Wt is the weight at the end	Species	Stratum	Growth over period (ln(Wt/Wo))	N
early August to mid September	Largemouth bass	Stratum 1	-0.358	14
		Stratum 2	0.000	0
		Stratum 3	0.000	0
		Stratum 4	1.463	16
		Stratum 5	0.523	11
		Whole Lake	0.836	49
	Smallmouth bass	Stratum 1	0.000	0
		Stratum 2	0.000	0
		Stratum 3	0.000	0
		Stratum 4	0.815	11
		Stratum 5	0.569	4
		Whole Lake	0.802	16
late August to mid September	Largemouth bass	Stratum 1	0.020	10
		Stratum 2	0.000	0
		Stratum 3	0.000	0
		Stratum 4	1.212	4
		Stratum 5	0.000	0
		Whole Lake	0.884	16
	Smallmouth bass	Stratum 1	0.813	2
		Stratum 2	0.000	0
		Stratum 3	0.000	0
		Stratum 4	0.168	6
		Stratum 5	0.000	0
		Whole Lake	0.401	11

2008 YOY relative weight. Relative weight (Wr) is the ratio of the actual weight of a fish to what an average healthy fish of the same length should weigh (called standard weight which is based on published values). Fish with high Wr (>100) are fatter than the standard weight of a fish of the same length, while those with low Wr (<100) are thinner.

a. Sorted by sample period and stratum.

Sample period	Stratum	Species	Relative weight	SE	N
July	Stratum 1	Largemouth bass	114.42	7.92	15
		Smallmouth bass	122.28		1
	Stratum 2	Largemouth bass	129.36	11.27	3
	Stratum 3	Largemouth bass	123.59	3.34	7
	Stratum 4	Largemouth bass	137.13	9.13	10
	Stratum 5	Largemouth bass	120.08	6.62	10
		Smallmouth bass	140.36	5.62	8
early August	Stratum 1	Largemouth bass	124.19	2.48	13
	Stratum 2	Largemouth bass	104.29	7.65	5
	Stratum 3	Largemouth bass	117.45	10.51	3
	Stratum 4	Largemouth bass	117.66	2.54	15
		Smallmouth bass	124.64	4.51	6
	Stratum 5	Largemouth bass	122.80	5.40	10
		Smallmouth bass	122.63	13.37	2
late August	Stratum 1	Largemouth bass	120.08	1.90	9
		Smallmouth bass	124.96		1
	Stratum 2	Largemouth bass	121.48		1
		Smallmouth bass	111.67		1
	Stratum 4	Largemouth bass	115.33	1.68	3
		Smallmouth bass	143.05		1
mid September	Stratum 1	Largemouth bass	121.33		1
		Smallmouth bass	117.54		1
	Stratum 4	Largemouth bass	107.79		1
		Smallmouth bass	115.70	6.27	5
	Stratum 5	Largemouth bass	110.53		1
		Smallmouth bass	109.20	12.76	2

2008 YOY relative weight. (continued)

b. Sorted by sample period for whole lake

Sample period	Species	Relative weight	SE	N
July	Largemouth bass	123.15	3.84	45
	Smallmouth bass	138.35	5.35	9
early August	Largemouth bass	119.15	2.01	46
	Smallmouth bass	124.14	4.17	8
late August	Largemouth bass	119.09	1.46	13
	Smallmouth bass	126.56	9.09	3
mid September	Largemouth bass	113.22	4.13	3
	Smallmouth bass	114.31	4.60	8

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Deformities, Erosions, Lesions, Tumors, Fungus, and/or Malignancies (DELTFM)

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A through C. Summary of DELTFM (Deformities, Erosions, Lesions, Tumors, Fungus, and/or Malignancies) results from Onondaga Lake in 2008.

a) Adult Fish DELTFM Summary

Stratum	Number
Stratum 1	35
Stratum 2	42
Stratum 3	12
Stratum 4	18
Stratum 5	21
Whole Lake	128

* Note: Juvenile DELTFM are not included in the count by stratum above.

b) Whole lake DELTFM abnormalities by type and species for juveniles.

Species	DELTFM	Number
Largemouth bass	Erosions - Tail Fin	1

A through C. Summary of DELTFM (Deformities, Erosions, Lesions, Tumors, Fungus, and/or Malignancies) results from Onondaga Lake in 2008. (continued).

c) Whole lake DELTFM abnormalities by type and species for adults.

Species	DELTFM	Number
Bowfin	Deformities - No Eye	1
Brown bullhead	Deformities - Chin barbels missing	1
	Deformities - Lip (upper)	1
	Deformities - Missing barbels	1
	Deformities - Missing chin barbel	1
	Deformities - Missing chin barbels	1
	Deformities - Mouth	1
	Deformities - Pectoral fin	1
	Erosions - Burnt Barbels	1
	Erosions - Burnt barbels	3
	Erosions - burnt chin barbels	1
	Erosions - Dorsal fin	1
	Erosions - Left pelvic side	1
	Erosions - Lower jaw	1
	Fungal Infections - upper lip	1
	Lesions -	15
	Lesions - Caudal fin	1
	Lesions - Erosions - Burnt Barbels	2
	Lesions - Head	1
	Lesions - in Mouth	1
	Lesions - L. Jaw	1
	Lesions - Lower jaw	2
	Lesions - Lower mandible	1
	Lesions - Mouth and Head	1
	Lesions - Multiple	15
	Lesions - Multiple Lesions	1
	Lesions - On Head	1
	Lesions - Pectoral spine	1
	Malignancies -	12
	Malignancies - E - Burnt Barbels	1
	Malignancies - Erosions - Burnt Barbels	1
	Malignancies - Erosions, Lesions - Burnt Barbels	1
	Malignancies - Tumors - Mouth	1
	Tumors -	1
Channel catfish	Lesions - Chin lesions	1
Gizzard shad	Lesions -	1
Golden shiner	Tumors - Caudal fin	1
Largemouth bass	Deformities - 1 inch gash	1
	Deformities - Broken Jaw	1
	Deformities - Dorsal Fin	1
	Deformities □Blind in right eye	1
	Deformities - Missing upper caudal fin	1
	Deformities - Pop-eye	1
	Deformities - Recap. Exposed operculum missing 1/2	1
	Erosions - Caudal fin	1

Library Reference 8.7.4.3.2

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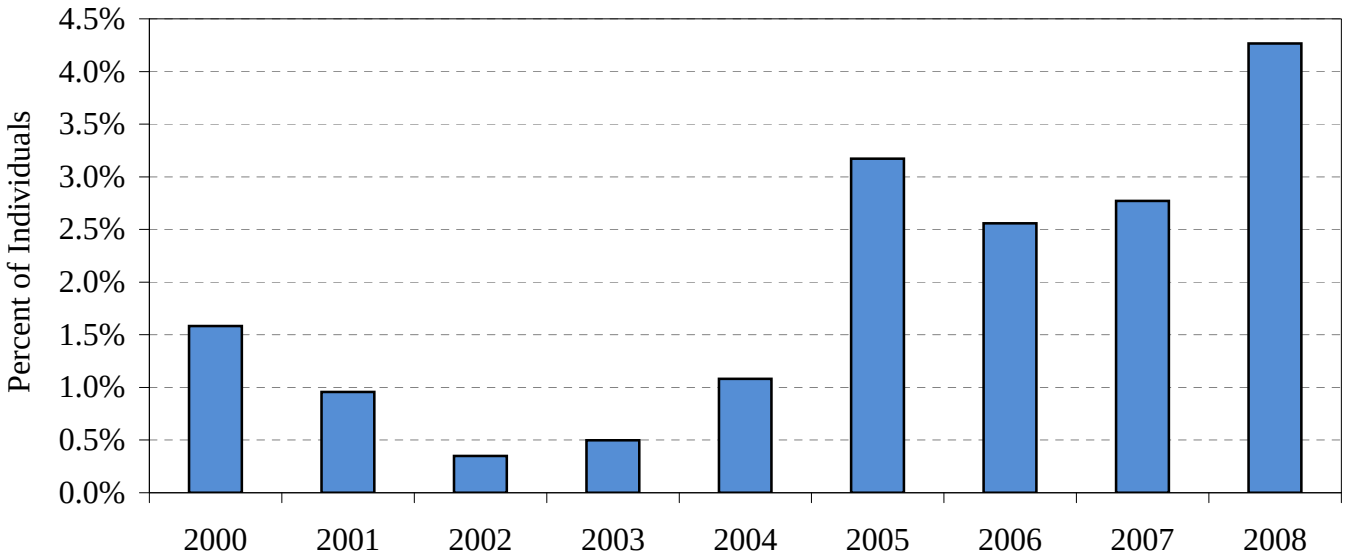

Percent of adult fish captured during AMP sampling with DELTFM abnormalities. DELTFM are defined as Deformities, Erosions, Lesions, Tumors, Fungus, and/or Malignancies. The increase in recent years is mostly due to an increase in the brown bullhead catch and a higher proportion of those brown bullhead having skin lesions. Analysis, by Cornell University, of Onondaga Lake bullhead in 2008 found a variety of pathogens including; *Trichodina, Saprolegnia, Digenean infestations, Micrococcus luteus,* and *Aeromonas sobria* .

Library Reference 8.7.4.3.3

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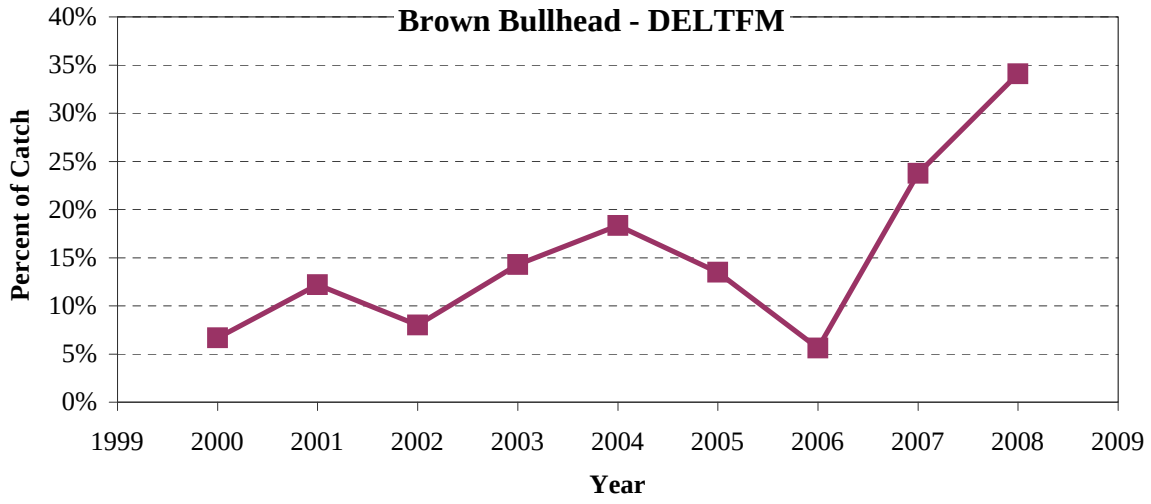
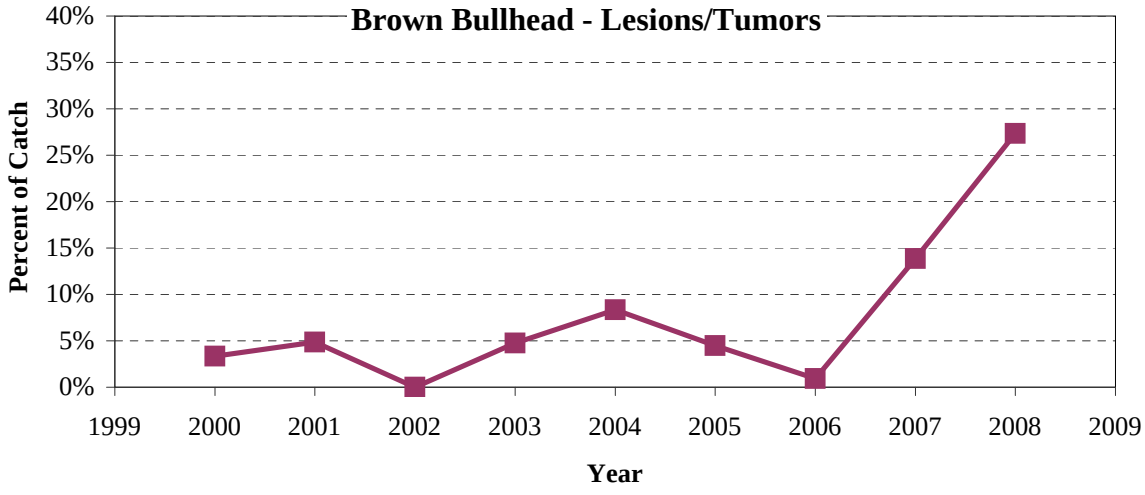
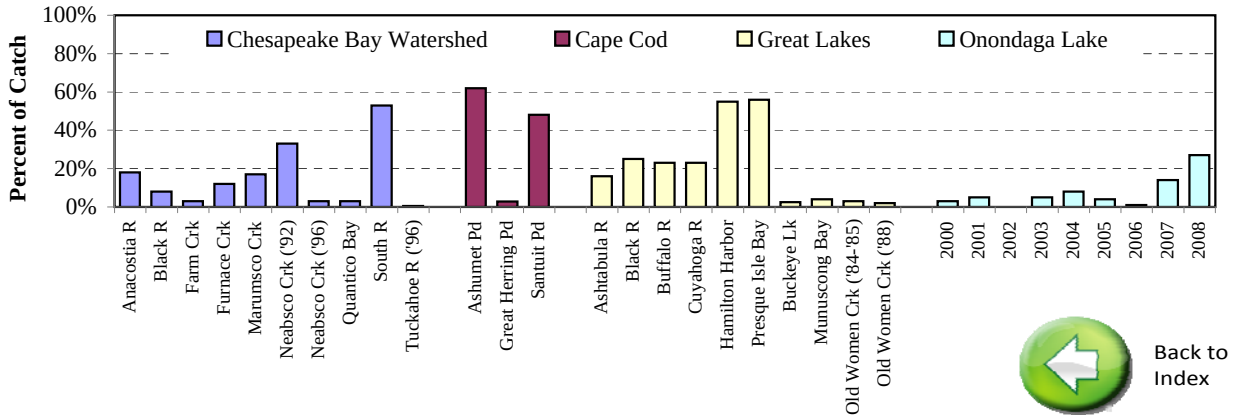


Percent of adult brown bullhead captured during AMP sampling with DELTFM abnormalities. DELTFM are defined as Deformities, Erosions, Lesions, Tumors, Fungus, and/or Malignancies. Analysis of Onondaga Lake bullhead in 2008 found a variety of pathogens including; *Trichodina, Saprolegnia, Digenean infestations, Micrococcus luteus,* and *Aeromonas sobria* (Cornell University).



Percent of adult brown bullhead captured during AMP sampling with lesions and/or tumors (a subset of DELTFM). Analysis of Onondaga Lake bullhead in 2008 found a variety of pathogens including; *Trichodina, Saprolegnia, Digenean infestations, Micrococcus luteus,* and *Aeromonas sobria* (Cornell University).

Occurrence of Lesions and Tumors in Brown Bullhead from Onondaga Lake and other Regional Waters



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Area	Waterbody	Location	Site type	% Skin Lesion	Source
Chesapeake Bay Watershed					
	Anacostia River	Washington, D.C.	--	18%	1
	Black River	Maryland	--	8.0%	2
	Farm Creek	--	--	3.0%	3
	Furnace Creek	Maryland	--	12%	2
	Marumsco Creek	--	--	17%	3
	Neabsco Creek ('92)	--	--	33%	3
	Neabsco Creek ('96)	--	--	3.0%	3
	Quantico Bay	--	--	3.0%	3
	South River	--	--	53%	3
	Tuckahoe River ('96)	Maryland	--	0.50%	1
Cape Cod					
	Ashumet Pond	Cape Cod MA	Contaminated	62%	1
	Great Herring Pond	Cape Cod MA	Reference	2.8%	1
	Santuit Pond	Cape Cod MA	Reference	48%	1
Great Lakes					
	Ashtabula River	Ohio	Contaminated	16%	1
	Black River	Ohio	Contaminated	25%	1
	Buffalo River	New York	Contaminated	23%	1
	Cuyahoga River	Ohio	Contaminated	23%	1
	Hamilton Harbor	Ontario, Canada	Contaminated	55%	1
	Presque Isle Bay	Pennsylvania	Contaminated	56%	1
	Buckeye Lake	Ohio	Reference	2.5%	1
	Munuscong Bay	Michigan	Reference	4.0%	1
	Old Women Creek ('84-'85)	Ohio	Reference	3.0%	1
	Old Women Creek ('88)	Ohio	Reference	2.0%	1
Onondaga Lake					
	2000	--	--	3.0%	AMP
	2001	--	--	5.0%	AMP
	2002	--	--	0%	AMP
	2003	--	--	5.0%	AMP
	2004	--	--	8.0%	AMP
	2005	--	--	4.0%	AMP
	2006	--	--	1.0%	AMP
	2007	--	--	14%	AMP
	2008	--	--	27%	AMP

Sources:

1. Baumann, P.C., LeBlanc, D.R., Blazer, V.S., Meier, J.R., Hurley, S.T., and Kiryu, Yasu, 2008, Prevalence of tumors in brown bullhead from three lakes in southeastern Massachusetts, 2002: U.S. Geological Survey Scientific Investigations
2. Report 2008–5198, 43 p., available online at http://pubs.usgs.gov/sir/2008/5198.
3. Pinkney, A E (AE); Harshbarger, J C (JC); May, E B (EB); Melancon, M J (MJ); Tumor prevalence and biomarkers of exposure in brown bullhead (Ameiurus nebulosus) from Back River, Furnace Creek, and Tuckahoe River, Maryland. Archives of environmental contamination and toxicology (Arch Environ Contam Toxicol), published in United States. 004-May; vol 46 (issue 4) : pp 492-501

Library Reference 8.7.4.4

Wetland Fish Index of Biotic Integrity

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Library Reference 8.7.4.4.1

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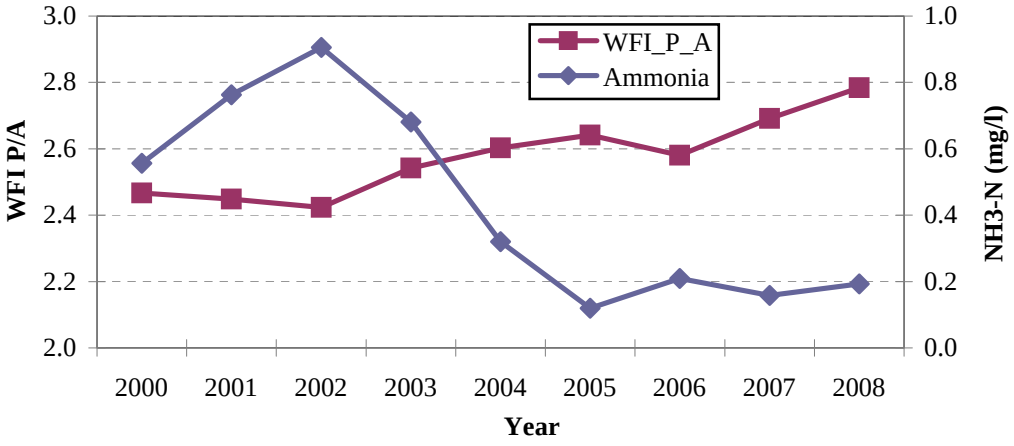

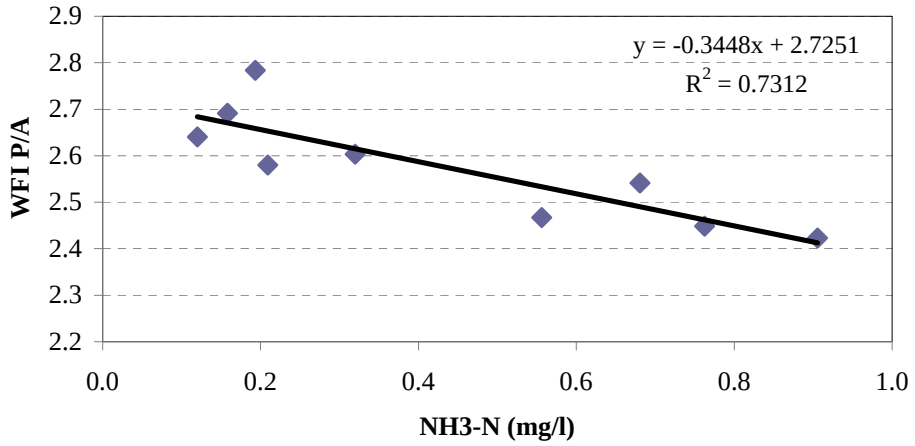

Relationship between annual average ammonia concentration and annual average Wetland Fish Index using Presence/Absence formula (WFI P/A) in Onondaga Lake from 2000-2008. The decline in lake ammonia concentrations after 2002 is due to upgrades at Metro. The second version of the WFI calculation that uses abundance data shows a similiar relationship with an R^2 of 0.45; an average of the two indices results in an R^2 of 0.61.

Library Reference 8.7.4.4,2

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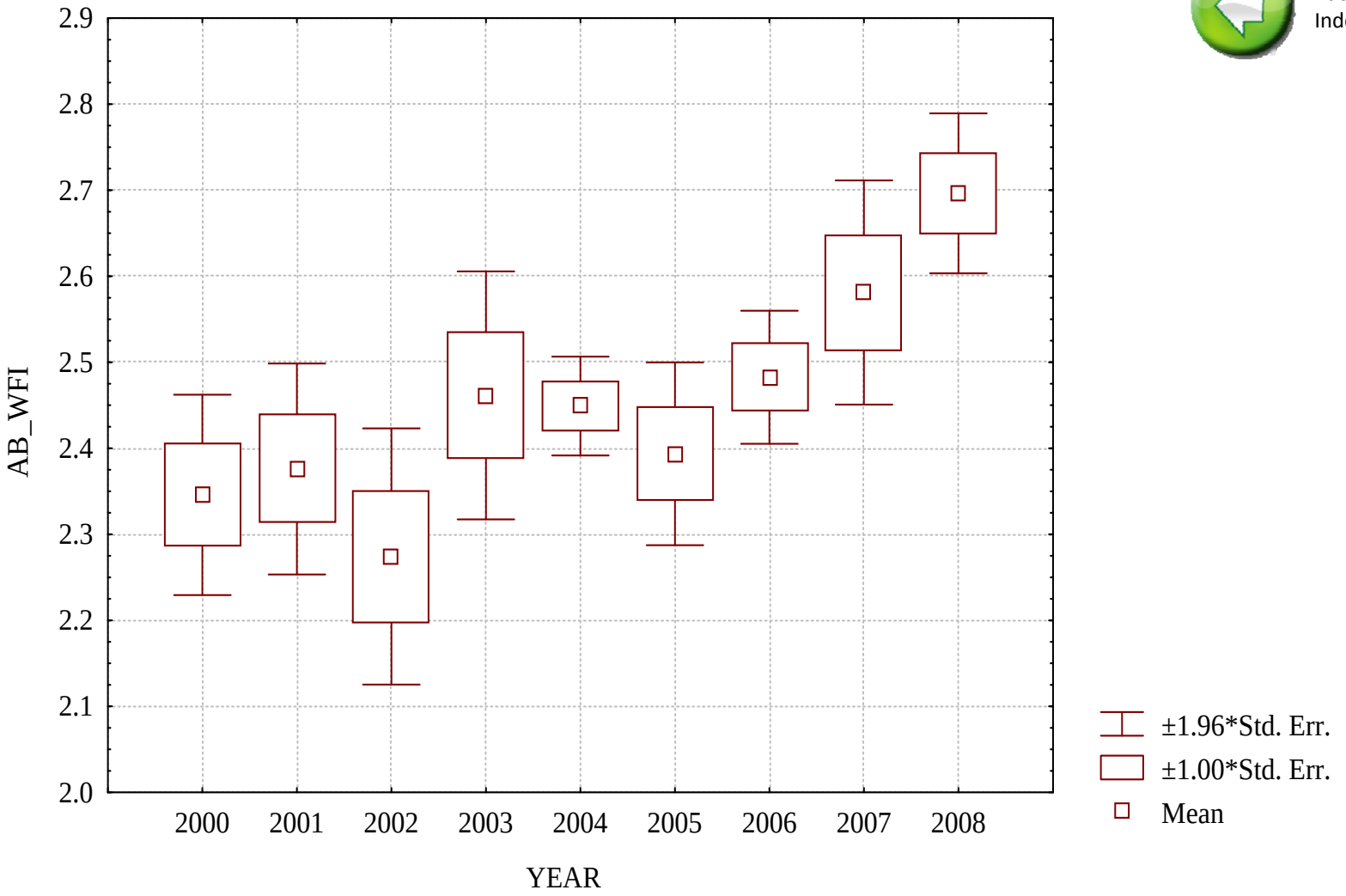

Temporal trend in the Abundance version of the Wetland Fish Index of Biotic Integrity (WFI AB) in Onondaga Lake from 2000 to 2008. Ambient Monitoring Program littoral zone electrofishing “all fish transects” data used for calculations. Data queried from OCDWEP Integrated Biological Database.

WFI Reference:
Seilheimer, T. S. and P. Chow-Fraser. 2006. Development and use of the Wetland Fish Index to assess the quality of coastal wetlands in the Laurentian Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 63:354-366.

Library Reference 8.7.4.5

Species Richness and Diversity

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Library Reference 8.7.4.5.1

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Shannon Diversity Index from gill nets for each stratum in Onondaga Lake in 2008.

Season	Stratum	With Clupeids
Whole Year	Whole Lake	0.859
	Stratum 1	0.413
	Stratum 2	0.160
	Stratum 3	0.700
	Stratum 4	0.552
	Stratum 5	0.301
Spring	Whole Lake	0.592
	Stratum 1	0.413
	Stratum 2	0.083
	Stratum 3	0.403
	Stratum 4	0.217
	Stratum 5	0.301
Fall	Whole Lake	0.762
	Stratum 1	0.000
	Stratum 2	0.000
	Stratum 3	0.509
	Stratum 4	0.407
	Stratum 5	0.000

Library Reference 8.7.4.5.2

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Electrofishing Shannon Diversity Index in 2008 from each stratum and the entire lake for each sampling event. Clupeids (shad and alewives) are often captured in high numbers that can dramatically alter the diversity results, therefore the table is presented with clupeids included and not included so that the diversity of the remaining community can be discerned.

Season	Stratum	With Clupeids	Without Clupeids
Whole Year	Whole Lake	0.856	0.891
	Stratum 1	0.836	0.777
	Stratum 2	0.814	0.974
	Stratum 3	0.420	1.008
	Stratum 4	0.900	0.830
	Stratum 5	0.874	0.850
Spring	Whole Lake	0.896	0.830
	Stratum 1	0.724	0.671
	Stratum 2	0.975	0.926
	Stratum 3	0.902	0.947
	Stratum 4	0.902	0.843
	Stratum 5	0.709	0.709
Fall	Whole Lake	0.686	0.940
	Stratum 1	0.795	0.870
	Stratum 2	0.503	1.016
	Stratum 3	0.319	0.974
	Stratum 4	0.812	0.781
	Stratum 5	0.980	0.946

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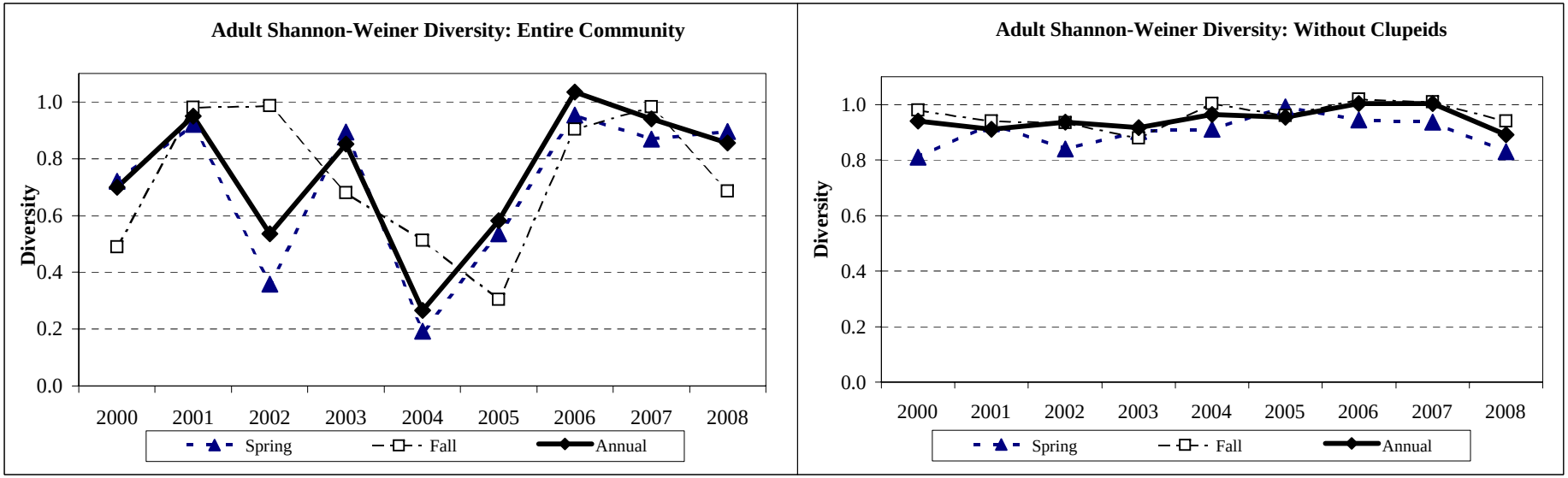
Electrofishing diversity in Onondaga Lake from 2000-2008. Data collected from AMP littoral zone electrofishing efforts. Clupeids (shad and alewives) are often captured in high numbers which can dramatically alter the diversity results, therefore the charts are presented with clupeids included and not included so that the trends in diversity of the remaining community can be discerned.



2000-2008 Trends

Diversity with Clupeid

Sample Period	2000	2001	2002	2003	2004	2005	2006	2007	2008
Spring	0.72	0.92	0.36	0.89	0.19	0.54	0.95	0.87	0.90
Fall	0.49	0.98	0.99	0.68	0.51	0.30	0.90	0.98	0.69
Annual	0.7	0.95	0.53	0.85	0.27	0.58	1.04	0.94	0.86

Diversity without Clupeid

Sample Period	2000	2001	2002	2003	2004	2005	2006	2007	2008
Spring	0.81	0.93	0.84	0.90	0.91	0.99	0.94	0.94	0.83
Fall	0.98	0.94	0.94	0.88	1.00	0.96	1.02	1.01	0.94
Annual	0.94	0.91	0.94	0.92	0.96	0.95	1.00	1.00	0.89

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Total species richness in each stratum of Onondaga Lake in 2008 for each sampling event. Data collected from AMP littoral zone electrofishing efforts.

SEASON	Whole Lake	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Year	24	20	18	20	20	17
Spring	18	14	16	12	14	10
Fall	22	18	14	18	17	17

Note: Richness is calculated as the number of species observed during each sampling event. Richness does not include the fish identified in the field as "*Lepomis sp*" as these are likely either bluegill or pumpkinseed which are already included in the richness calculation.

Library Reference 8.7.4.5.5

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Total species richness in each stratum of Onondaga Lake in 2008 for each gill net sampling event.

Season	Whole Lake	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Year	13	4	3	7	4	2
Spring	8	3	2	5	2	2
Fall	8	1	1	4	3	0

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Habitat Conditions: Data Visualization Tool (DVT) and Fish Space

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Habitat Conditions: Data Visualization Tool (DVT) and Fish Space

The fish space metric is useful for tracking changes in habitat based on DO and temperature, two variables that are necessary, but not sufficient to maintain a population. Available habitat for the cold water fish community is calculated as a percent of the theoretical total, using volume-days as the measurement. For example; if half the lake's water volume had suitable DO and temperature conditions for half of the selected time period, the metric is 25% for a given year. The six month period from May 15 through November 15 (185 days) is used because it encompasses the summer season when the upper waters of the lake can reach temperatures that are potentially stressful to the coldwater fish community. Moreover, the County monitoring probes are deployed over this period and high frequency data are available. Two metrics illustrate this approach: (1) coldwater fish habitat (Table A, Figure A), and (2) coolwater fish habitat (Table B, Figure B).

Table A. Habitat availability for coldwater fishes in Onondaga Lake from 2000 to 2008 based on default DVT criteria[1].

Year	Coldwater Habitat		
	% Available Habitat[2]	Total # Days In Range[3] (max 185 days)	# Consecutive Days In Range[3] (max 185 days)
2000	40	161	72
2001	39	140	72
2002	35	112	50
2003	34	129	51
2004	40	175	71
2005	37	124	59
2006	42	132	80
2007	41	150	67
2008	43	131	67

1 default DVT criteria: temperature ≤ 22ºC and dissolved oxygen > 5 mg/L between May 15 and November 15.
2 Assumes entire volume of the lake from May 15 to November 15 is available.
3 Number of days where temperature and DO are within range in at least a one meter vertical section of the lake.

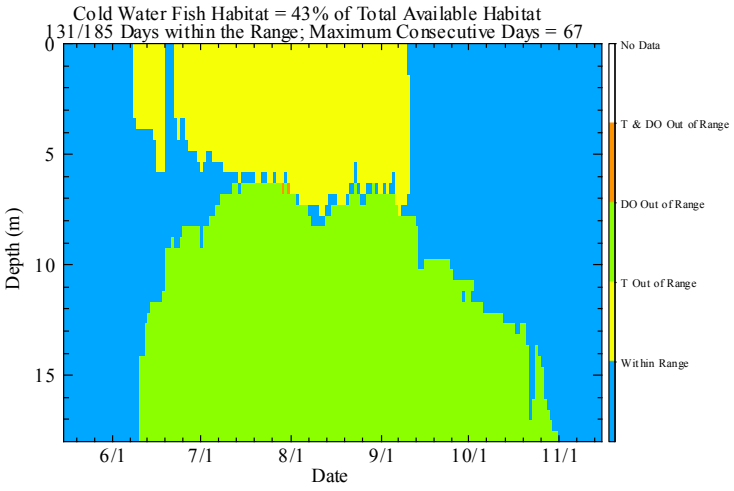

Figure A. Coldwater Fish Habitat in Onondaga Lake in 2008.
Note: Water temperature < 22°C and dissolved oxygen >5.0 mg/L between May 15 and Nov 15.

Table B. Habitat availability for cool water fishes in Onondaga Lake from 2000 to 2008 based on default DVT criteria[1].

Year	Coolwater Habitat		
	% Available Habitat	Total # Days In Range[2] (max 185 days)	# Consecutive Days In Range[2] (max 185 days)
2000	77	114	109
2001	76	117	114
2002	75	101	47
2003	69	102	61
2004	80	134	124
2005	77	115	52
2006	80	116	50
2007	87	141	141
2008	88	118	118

1 Default values: temperature between 18º - 25ºC and dissolved oxygen > 6 mg/L between May 15 and November 15.

2 Number of days where temperature and DO are within range in at least a one meter vertical section of the lake.

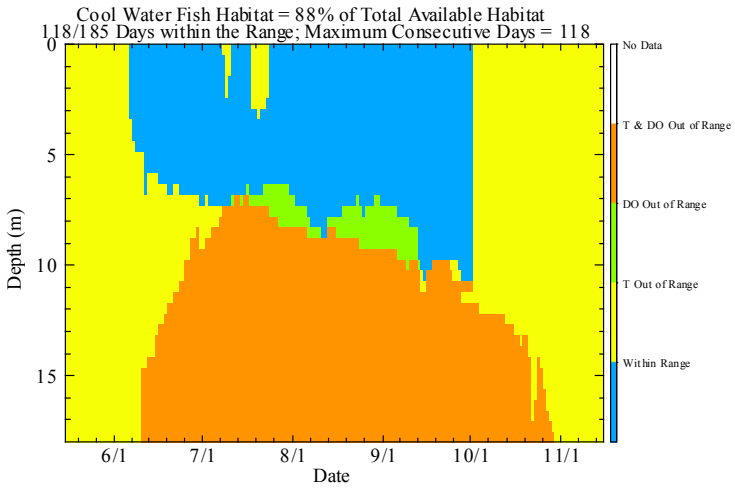

Figure B. Coolwater Fish Habitat in Onondaga Lake in 2008.

Note: Water temperature between 18-25°C and dissolved oxygen >=4.0 mg/L between May 15 and Nov 15.

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Mercury in Fish Flesh

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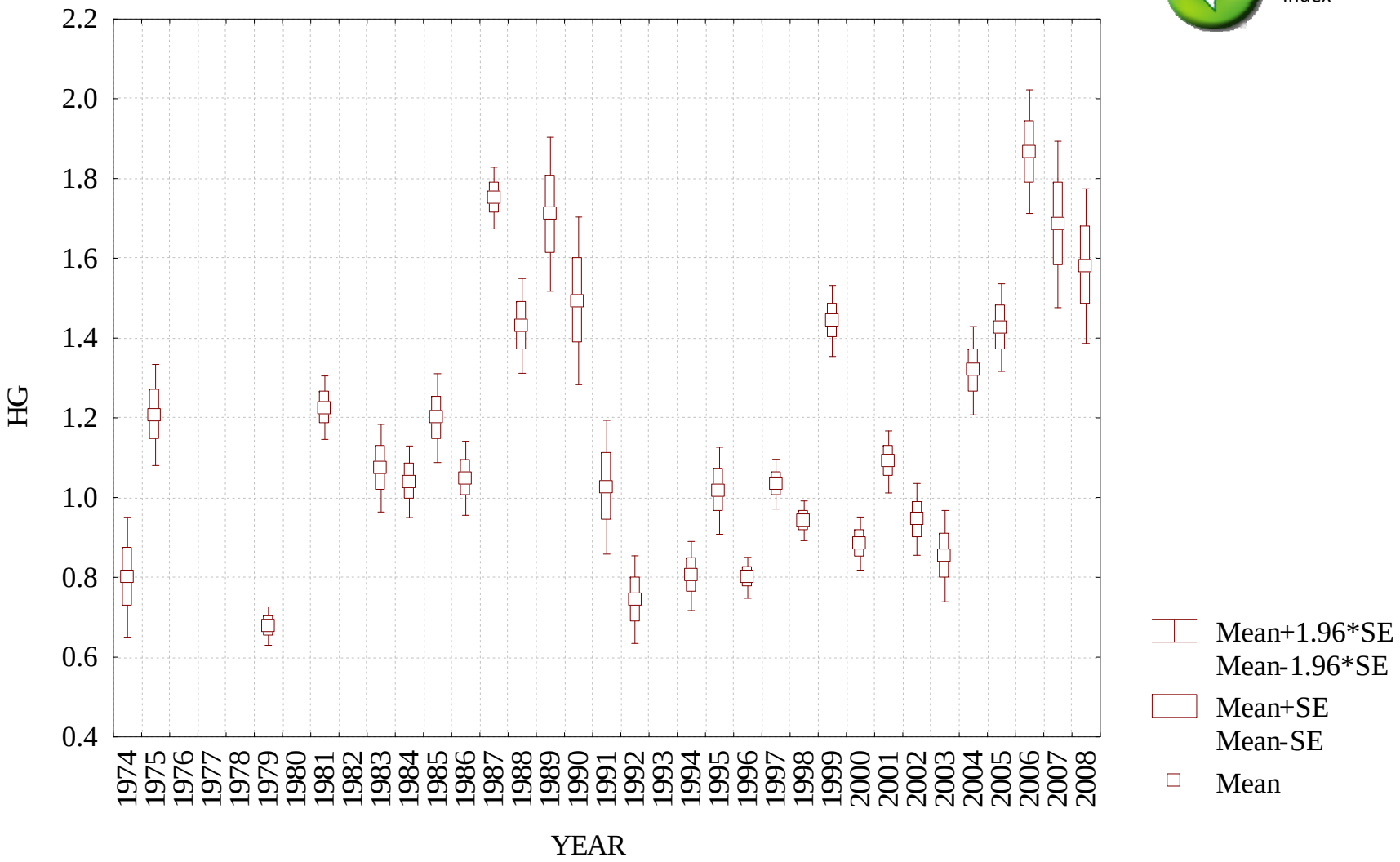

Total mercury body burden (mg/kg) of bass in Onondaga Lake since 1974. From 1974 to 1996 smallmouth bass were used, from 1996 to 2006 both smallmouth bass and largemouth bass were used, since 2006 only largemouth bass were sampled. The switch from smallmouth bass to largemouth bass by NYSDEC was done because largemouth bass are more easily sampled and the ten years of side by side data indicated similar body burden between the two species. Data obtained from NYSDEC Hudson River Contaminant Database, received May 2009.

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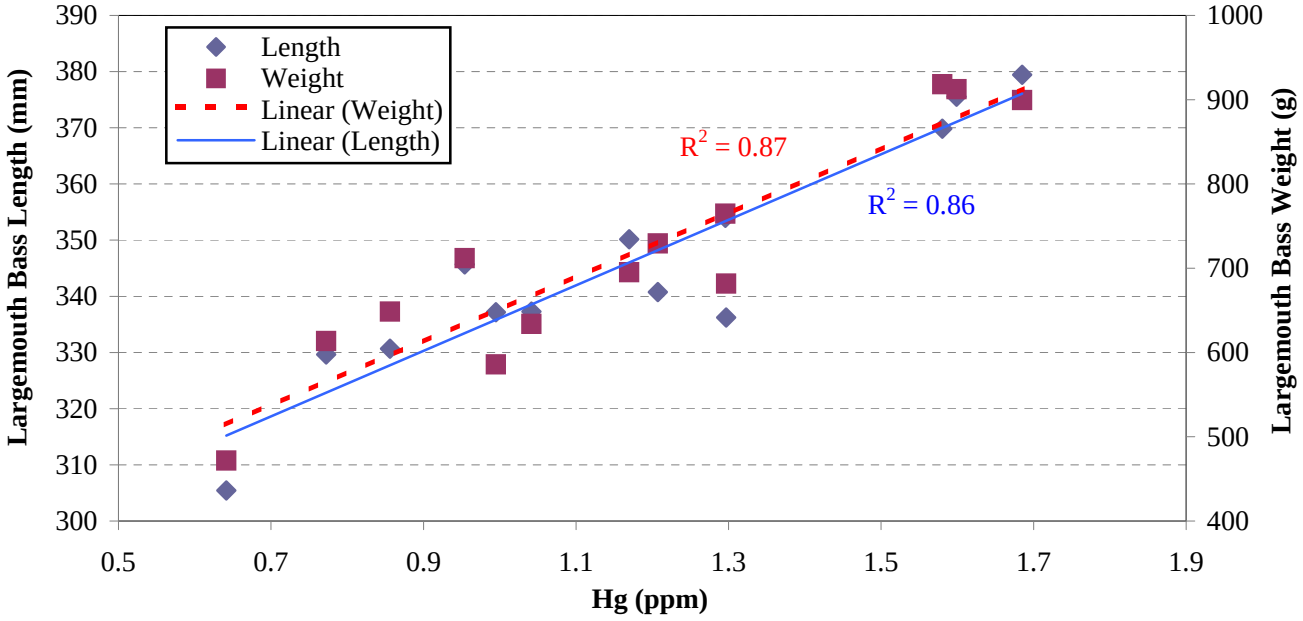

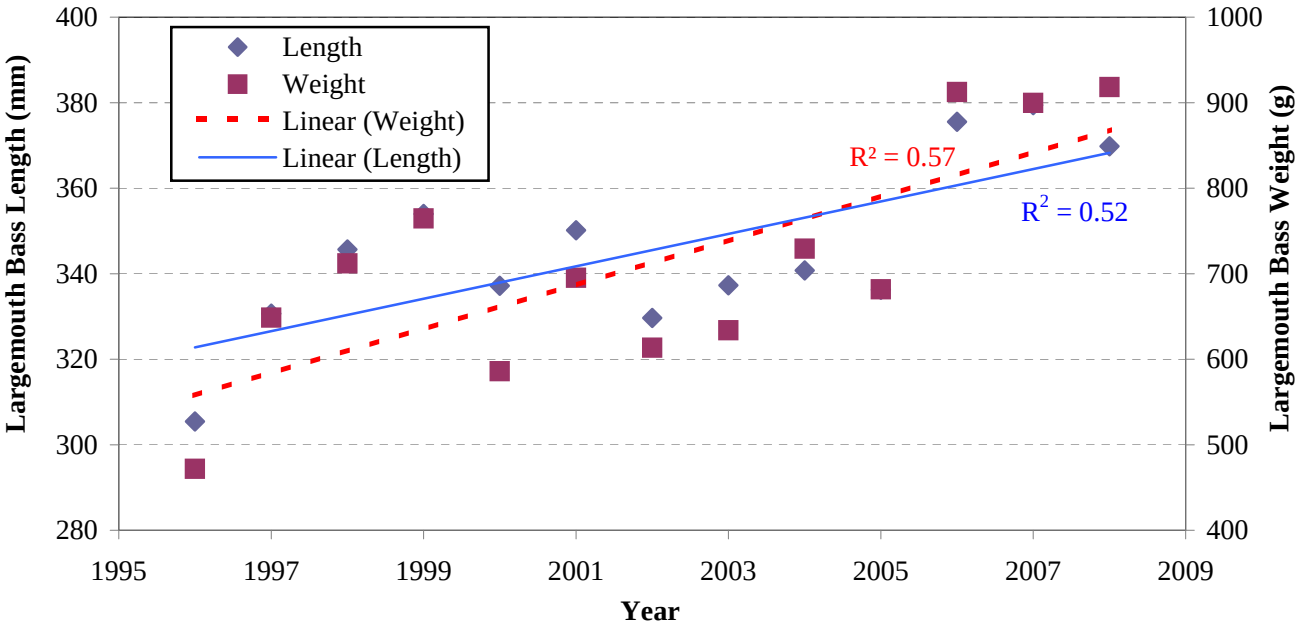

Top chart shows the relationship between annual mean largemouth bass size (length and weight) and the annual mean mercury body burden since 2006 (year largemouth bass began to be routinely sampled); the larger the fish the greater the burden. Bottom chart shows the trend in the size of largemouth bass (length and weight) collected for mercury sampling; bass being collected for mercury sampling are getting larger.

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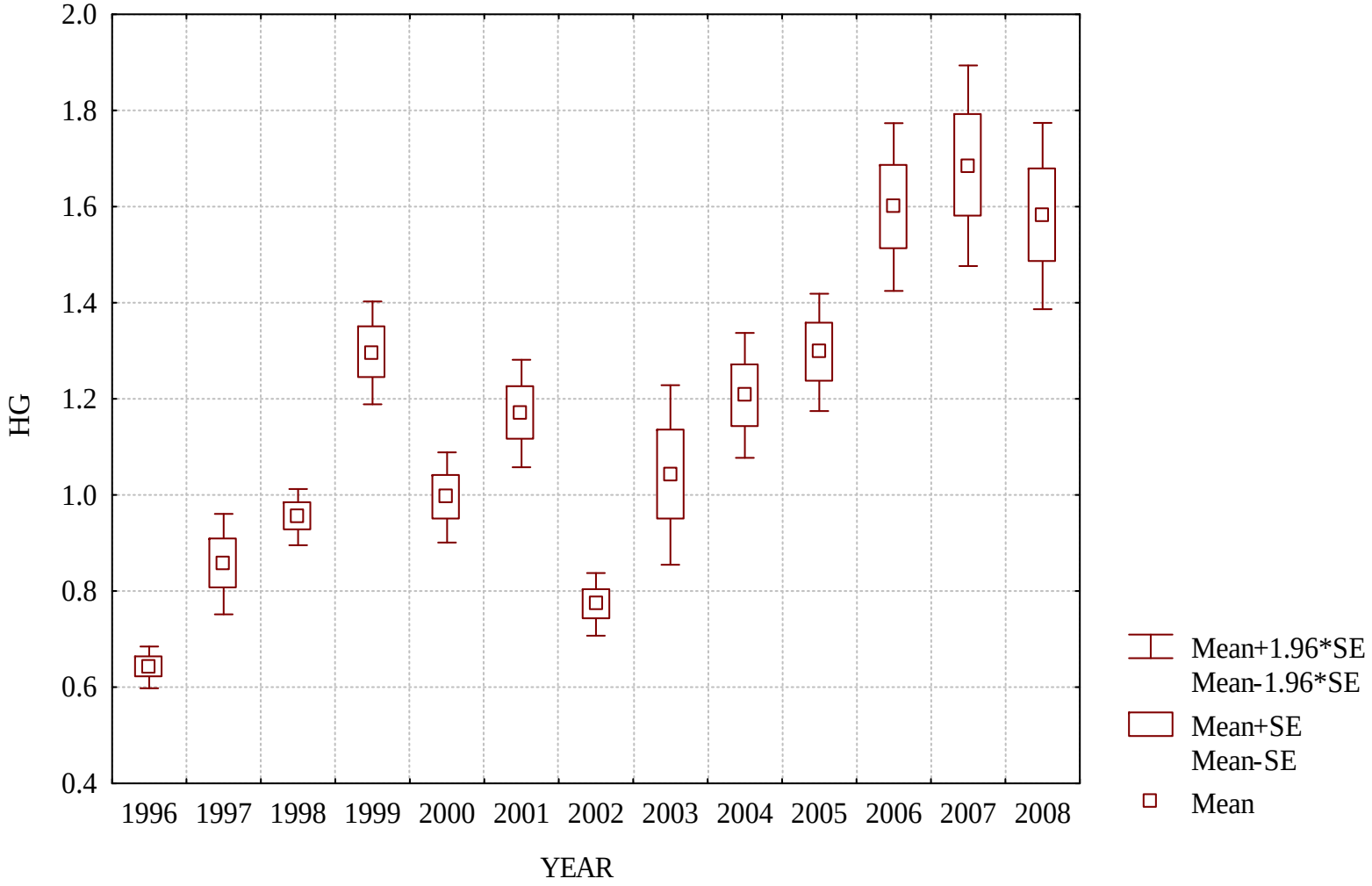

Total mercury body burden (mg/kg) of largemouth bass in Onondaga Lake since 1996. Data obtained from NYSDEC Hudson River Contaminant Database, received May 2009.

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Reproduction

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Larvae

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Pelagic larvae catch summary for 2008.

a) Whole year CPUE by species

Species	Basin	Mean (#/m3)	SE
Alewife	North Basin	0.0055	0.0111
	South Basin	0.0418	0.0422
	Whole Lake	0.0237	0.0244
Bluegill	North Basin	0.0168	0.0215
	South Basin	0.0431	0.0587
	Whole Lake	0.0299	0.0306
Freshwater drum	North Basin	0.0055	0.0110
	South Basin	0.0000	0.0000
	Whole Lake	0.0028	0.0055
Gizzard shad	North Basin	0.0168	0.0112
	South Basin	0.0491	0.0410
	Whole Lake	0.0330	0.0232
Pumpkinseed	North Basin	0.0167	0.0112
	South Basin	0.0272	0.0108
	Whole Lake	0.0220	0.0082

Pelagic larvae catch summary for 2008. (continued)

b) Sampling Event CPUE by species and location

* Note: two other sample periods had no fish captured.

Sample Period	Species	Basin	Mean (#/m3)	SE
late May	Bluegill	North Basin	0.0522	0.1043
		South Basin	0	0
		Whole Lake	0.0261	0.0522
mid June	Alewife	North Basin	0	0
		South Basin	0.1201	0.0804
		Whole Lake	0.0600	0.0587
	Bluegill	North Basin	0	0
		South Basin	0.0000	0.0000
		Whole Lake	0.0209	0.0418
	Gizzard shad	North Basin	0.08223	0.09498
		South Basin	0.0434	0.0867
		Whole Lake	0.0628	0.0613
late June	Alewife	North Basin	0.03721	0.07442
		South Basin	0.0623	0.1246
		Whole Lake	0.0498	0.0679
	Bluegill	North Basin	0.0000	0.0000
		South Basin	0	0
		Whole Lake	0.0104	0.0208
	Gizzard shad	North Basin	0	0
		South Basin	0.0807	0.1614
		Whole Lake	0.0403	0.0807
	Pumpkinseed	North Basin	0	0
		South Basin	0.0431	0.0863
		Whole Lake	0.0216	0.0431
mid July	Alewife	North Basin	0	0
		South Basin	0.0856	0.0989
		Whole Lake	0.0428	0.0561
	Bluegill	North Basin	0.0000	0.0000
		South Basin	0.2939	0.4816
		Whole Lake	0.1470	0.2491
	Gizzard shad	North Basin	0.0422	0.0845
		South Basin	0.2561	0.2888
		Whole Lake	0.1492	0.1610
	Pumpkinseed	North Basin	0.0439	0.0878
		South Basin	0.0839	0.1677
		Whole Lake	0.0639	0.0889
late July	Bluegill	North Basin	0.0415	0.0831
		South Basin	0.0000	0.0000
		Whole Lake	0.0208	0.0415
	Freshwater drum	North Basin	0.0418	0.0836
		South Basin	0.0000	0.0000
		Whole Lake	0.0209	0.0418
	Pumpkinseed	North Basin	0.0835	0.0964
		South Basin	0.0823	0.0950
		Whole Lake	0.0829	0.0627

Pelagic larvae catch summary for 2008. (continued)

c) Species richness in 2008.

Location	Number of Species
North Basin	5
South Basin	4
Whole Lake	5

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Young of the Year (YOY)

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2008 YOY mean CPUE (#/haul) for each species for the whole year from each stratum and the entire lake.

Species	Entire Lake		Stratum 1		Stratum 2		Stratum 3		Stratum 4		Stratum 5	
	Mean CPUE	*SE*	*Mean CPUE*	*SE*	*Mean CPUE*	*SE*	*Mean CPUE*	*SE*	*Mean CPUE*	*SE*	*Mean CPUE*	*SE*
Bluegill	0.03	0.02	0.00	0.00	0.00	0.00	0.17	0.12	0.00	0.00	0.00	0.00
Brown bullhead	2.67	2.41	12.06	12.06	0.11	0.08	0.06	0.06	1.06	0.77	0.06	0.06
Carp	0.17	0.08	0.06	0.06	0.11	0.11	0.61	0.39	0.06	0.06	0.00	0.00
Gizzard shad	0.10	0.06	0.00	0.00	0.00	0.00	0.28	0.23	0.22	0.22	0.00	0.00
Golden shiner	4.91	2.75	0.22	0.17	0.00	0.00	3.56	2.16	18.39	13.20	2.39	2.27
Largemouth bass	1.21	0.25	2.17	0.76	0.56	0.18	0.56	0.35	1.61	0.77	1.17	0.51
Longnose gar	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00
Pumpkinseed	0.02	0.02	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rock bass	0.10	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.12	0.33	0.18
Smallmouth bass	0.31	0.09	0.17	0.09	0.06	0.06	0.00	0.00	0.67	0.28	0.67	0.32
Tesselated darter	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06
White perch	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06
Yellow perch	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00
Total	**9.53**	**5.77**	**14.78**	**13.24**	**0.83**	**0.43**	**5.11**	**3.23**	**22.22**	**15.48**	**4.72**	**3.46**

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YOY mean CPUE (#/seine haul) for each species from each site for 2008.

Stratum	Site	Species	Mean CPUE	SE
Stratum 1	Site 1	Brown bullhead	36.17	36.17
		Carp	0.17	0.17
		Golden shiner	0.17	0.17
		Largemouth bass	4.17	1.80
		Lepomis sp.	5.83	3.43
		Smallmouth bass	0.33	0.21
	Site 2	Golden shiner	0.50	0.50
		Largemouth bass	1.83	1.05
		Lepomis sp.	4.67	3.53
	Site 3	Largemouth bass	0.50	0.34
		Pumpkinseed	0.33	0.33
		Smallmouth bass	0.17	0.17
Stratum 2	Site 1	Carp	0.33	0.33
		Largemouth bass	0.67	0.33
		Lepomis sp.	0.33	0.33
		Smallmouth bass	0.17	0.17
	Site 2	Brown bullhead	0.17	0.17
		Largemouth bass	0.50	0.34
		Lepomis sp.	0.50	0.50
	Site 3	Brown bullhead	0.17	0.17
		Largemouth bass	0.50	0.34
		Lepomis sp.	0.33	0.21
Stratum 3	Site 1	Bluegill	0.17	0.17
		Carp	1.83	1.05
		Gizzard shad	0.17	0.17
		Golden shiner	7.50	6.32
		Largemouth bass	0.17	0.17
		Lepomis sp.	53.83	29.36
		Yellow perch	0.17	0.17
	Site 2	Bluegill	0.33	0.33
		Brown bullhead	0.17	0.17
		Gizzard shad	0.67	0.67
		Golden shiner	2.00	1.37
		Largemouth bass	0.17	0.17
		Lepomis sp.	0.67	0.33
	Site 3	Golden shiner	1.17	0.98
		Largemouth bass	1.33	0.99
		Lepomis sp.	16.33	12.81
Stratum 4	Site 1	Brown bullhead	0.33	0.33
		Golden shiner	0.17	0.17
		Lepomis sp.	0.17	0.17
		Smallmouth bass	0.50	0.50
	Site 2	Golden shiner	0.33	0.21
		Largemouth bass	2.50	1.77
		Lepomis sp.	5.83	3.71
		Rock bass	0.33	0.33
		Smallmouth bass	0.50	0.50

YOY mean CPUE (#/seine haul) for each species from each site for 2008.

Stratum	Site	Species	Mean CPUE	SE
Stratum 4	Site 3	Brown bullhead	2.83	2.24
(continued)		Carp	0.17	0.17
		Gizzard shad	0.67	0.67
		Golden shiner	54.67	37.18
		Largemouth bass	2.33	1.48
		Lepomis sp.	3.50	2.03
		Longnose gar	0.17	0.17
		Rock bass	0.17	0.17
		Smallmouth bass	1.00	0.52
Stratum 5	Site 1	Golden shiner	0.17	0.17
		Lepomis sp.	5.17	4.20
		Smallmouth bass	0.50	0.34
	Site 2	Golden shiner	0.17	0.17
		Largemouth bass	2.17	1.22
		Lepomis sp.	8.83	5.44
		Rock bass	0.83	0.48
		Smallmouth bass	0.50	0.50
	Site 3	Brown bullhead	0.17	0.17
		Golden shiner	6.83	6.83
		Largemouth bass	1.33	0.84
		Lepomis sp.	3.67	2.91
		Rock bass	0.17	0.17
		Smallmouth bass	1.00	0.82
		Tesselated darter	0.17	0.17
		White perch	0.17	0.17

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YOY CPUE (#/seine haul) in each stratum during each sampling event for each species, 2008.

Sample period	Stratum	Species	CPUE	SE
late June	Stratum 1	No Catch	0.00	0.00
	Stratum 2	No Catch	0.00	0.00
	Stratum 3	No Catch	0.00	0.00
	Stratum 4	Longnose gar	0.33	0.33
	Stratum 5	No Catch	0.00	0.00
July	Stratum 1	Brown bullhead	72.33	72.33
		Carp	0.33	0.33
		Golden shiner	0.33	0.33
		Largemouth bass	5.33	2.40
		Lepomis sp.	0.67	0.67
		Smallmouth bass	0.33	0.33
	Stratum 2	Brown bullhead	0.67	0.33
		Carp	0.67	0.67
		Largemouth bass	1.33	0.33
		Lepomis sp.	0.33	0.33
	Stratum 3	Carp	1.33	1.33
		Golden shiner	0.67	0.33
		Largemouth bass	2.33	1.86
		Lepomis sp.	44.67	43.67
		Yellow perch	0.33	0.33
	Stratum 4	Brown bullhead	5.33	4.37
		Carp	0.33	0.33
		Golden shiner	37.33	36.83
		Largemouth bass	3.33	2.85
		Lepomis sp.	2.33	2.33
		Rock bass	0.33	0.33
	Stratum 5	Golden shiner	14.00	13.50
		Largemouth bass	3.33	1.76
		Lepomis sp.	0.33	0.33
		Rock bass	0.33	0.33
		Smallmouth bass	2.67	1.45
		Tesselated darter	0.33	0.33
early August	Stratum 1	Golden shiner	1.00	1.00
		Largemouth bass	4.33	1.67
		Lepomis sp.	1.00	0.58
	Stratum 2	Largemouth bass	1.67	0.33
		Lepomis sp.	2.00	0.58
	Stratum 3	Brown bullhead	0.33	0.33
		Carp	2.00	2.00
		Gizzard shad	1.33	1.33
		Golden shiner	5.33	1.76
		Largemouth bass	1.00	0.58
		Lepomis sp.	5.67	3.48

YOY CPUE (#/seine haul) in each stratum during each sampling event for each species, 2008.

Sample period	Stratum	Species	CPUE	SE
early August	Stratum 4	Brown bullhead	0.33	0.33
(continued)		Largemouth bass	5.00	3.21
		Lepomis sp.	10.33	5.55
		Rock bass	0.67	0.67
		Smallmouth bass	2.00	1.00
	Stratum 5	Largemouth bass	3.33	1.76
		Lepomis sp.	8.00	5.00
		Rock bass	0.33	0.33
		Smallmouth bass	0.67	0.33
		White perch	0.33	0.33
4 - late August	Stratum 1	Largemouth bass	3.00	2.52
		Lepomis sp.	2.67	2.67
		Smallmouth bass	0.33	0.33
	Stratum 2	Largemouth bass	0.33	0.33
		Smallmouth bass	0.33	0.33
	Stratum 3	Carp	0.33	0.33
		Lepomis sp.	10.00	5.51
	Stratum 4	Largemouth bass	1.00	1.00
		Lepomis sp.	5.67	5.17
		Smallmouth bass	0.33	0.33
	Stratum 5	Brown bullhead	0.33	0.33
		Golden shiner	0.33	0.33
		Lepomis sp.	12.33	9.84
		Rock bass	0.33	0.33

YOY CPUE (#/seine haul) in each stratum during each sampling event for each species, 2008 (continued).

Sample period	Stratum	Species	CPUE	SE
mid September	Stratum 1	Largemouth bass	0.33	0.33
		Lepomis sp.	14.67	7.33
		Pumpkinseed	0.67	0.67
		Smallmouth bass	0.33	0.33
	Stratum 2	No Catch	0.00	0.00
	Stratum 3	Golden shiner	1.00	1.00
		Lepomis sp.	80.00	45.61
	Stratum 4	Brown bullhead	0.33	0.33
		Gizzard shad	1.33	1.33
		Golden shiner	72.67	72.17
		Largemouth bass	0.33	0.33
		Lepomis sp.	0.67	0.67
		Smallmouth bass	1.67	0.88
	Stratum 5	Largemouth bass	0.33	0.33
		Lepomis sp.	14.67	7.69
		Rock bass	1.00	1.00
		Smallmouth bass	0.67	0.67
early October	Stratum 1	Lepomis sp.	2.00	1.15
	Stratum 2	No Catch	0.00	0.00
	Stratum 3	Bluegill	1.00	0.58
		Gizzard shad	0.33	0.33
		Golden shiner	14.33	12.39
		Lepomis sp.	1.33	1.33
	Stratum 4	Brown bullhead	0.33	0.33
		Golden shiner	0.33	0.33
	Stratum 5	No Catch	0.00	0.00

Library Reference 8.7.7.2.4

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Mean CPUE (#/seine haul) of incidental catch of non-YOY species for entire lake in 2008.

Species	Mean CPUE	SE
Banded killifish	26.60	5.76
Bluegill	0.21	0.12
Bluntnose minnow	0.09	0.06
Brook Silverside	2.20	0.81
Brook stickleback	0.01	0.01
Brown bullhead	0.03	0.02
Carp	0.41	0.20
Emerald shiner	0.06	0.04
Gizzard shad	0.18	0.18
Golden shiner	0.52	0.31
Green sunfish	0.01	0.01
Largemouth bass	0.81	0.26
Lepomis sp.	0.99	0.36
Longnose gar	0.01	0.01
Northern hog sucker	0.01	0.01
Pumpkinseed	1.20	0.37
Rock bass	0.08	0.04
Smallmouth bass	0.09	0.05
Tesselated darter	0.30	0.11
White perch	0.01	0.01
White sucker	0.07	0.05
Yellow perch	0.02	0.02

Library Reference 8.7.7.2.5

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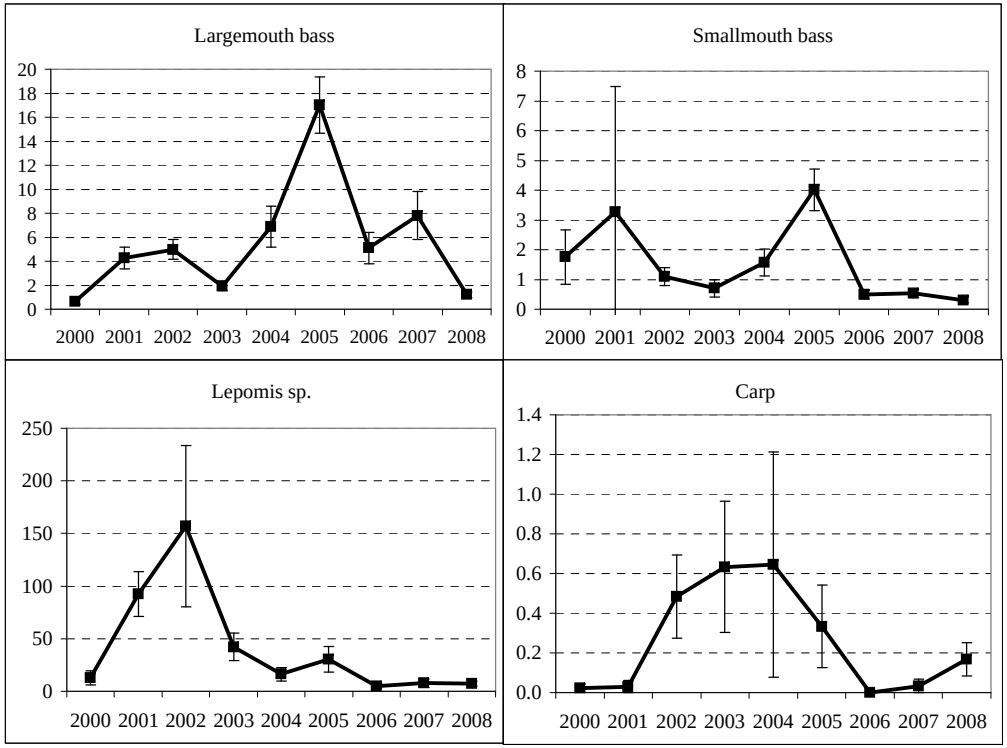
YOY CPUE (#/haul) trends for select species from 2000-2008. Note; bluegill and pumpkinseed YOY are difficult to distinguish in the field therefore they are combined and designated "Lepomis sp".



Graph Data

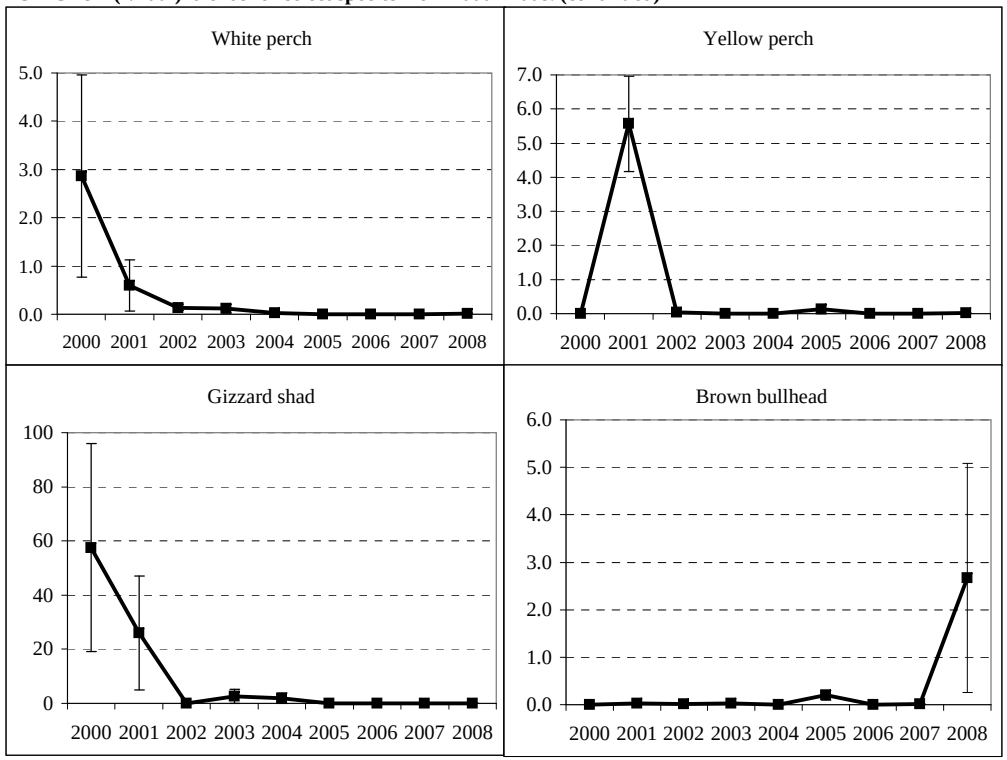
YOY Annual CPUE from 2000-2008

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Lepomis sp.	12.96	92.48	156.93	42.13	16.12	30.17	4.64	7.66	7.31
Largemouth bass	0.64	4.27	4.98	1.94	6.87	16.99	5.10	7.81	1.21
Smallmouth bass	1.76	3.27	1.10	0.70	1.57	4.01	0.50	0.53	0.31
Carp	0.02	0.03	0.48	0.63	0.64	0.33	0.00	0.03	0.17
White perch	2.87	0.6	0.13	0.12	0.02	0.00	0.00	0.00	0.01
Yellow perch	0.00	5.57	0.03	0.00	0.00	0.13	0.00	0.00	0.01
Brown bullhead	0.00	0.03	0.02	0.03	0.00	0.20	0.00	0.01	2.67
Gizzard shad	57.56	26.05	0.03	2.68	1.98	0.02	0.00	0.00	0.10

Standard Errors

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Lepomis sp.	6.73	21.56	76.80	13.04	6.30	12.14	2.41	3.94	2.48
Largemouth bass	0.23	0.91	0.80	0.42	1.71	2.35	1.33	1.98	0.25
Smallmouth bass	0.91	4.20	0.31	0.29	0.45	0.69	0.15	0.14	0.09
Carp	0.02	0.03	0.21	0.33	0.57	0.21	0.00	0.03	0.08
White perch	2.10	0.53	0.06	0.09	0.02	0.00	0.00	0.00	0.01
Yellow perch	0.00	1.4	0.03	0.00	0	0.13	0.00	0.00	0.01
Brown bullhead	0.00	0	0.00	0.03	0	0.10	0.00	0.01	2.41
Gizzard shad	38.32	21.05	0.03	2.62	1.91	0.02	0.00	0.00	0.06

YOY CPUE (#/haul) trends for select species from 2000 - 2008. (continued)



Library Reference 8.7.7.2.6

	Lepomis sp.	Largemouth	Smallmouth	Gizzard sh	Other
2000	12.96	0.64	1.76	57.56	2.89
2001	92.48	4.27	3.27	26.05	6.23
2002	156.93	4.98	1.10	0.03	0.66
2003	42.13	1.94	0.70	2.68	0.78
2004	16.12	6.87	1.57	1.98	0.66
2005	30.17	16.99	4.01	0.02	0.66
2006	4.64	5.10	0.50	0	0.00
2007	7.66	7.81	0.53	0	0.04
2008	7.31	1.21	0.31	0.1	2.86

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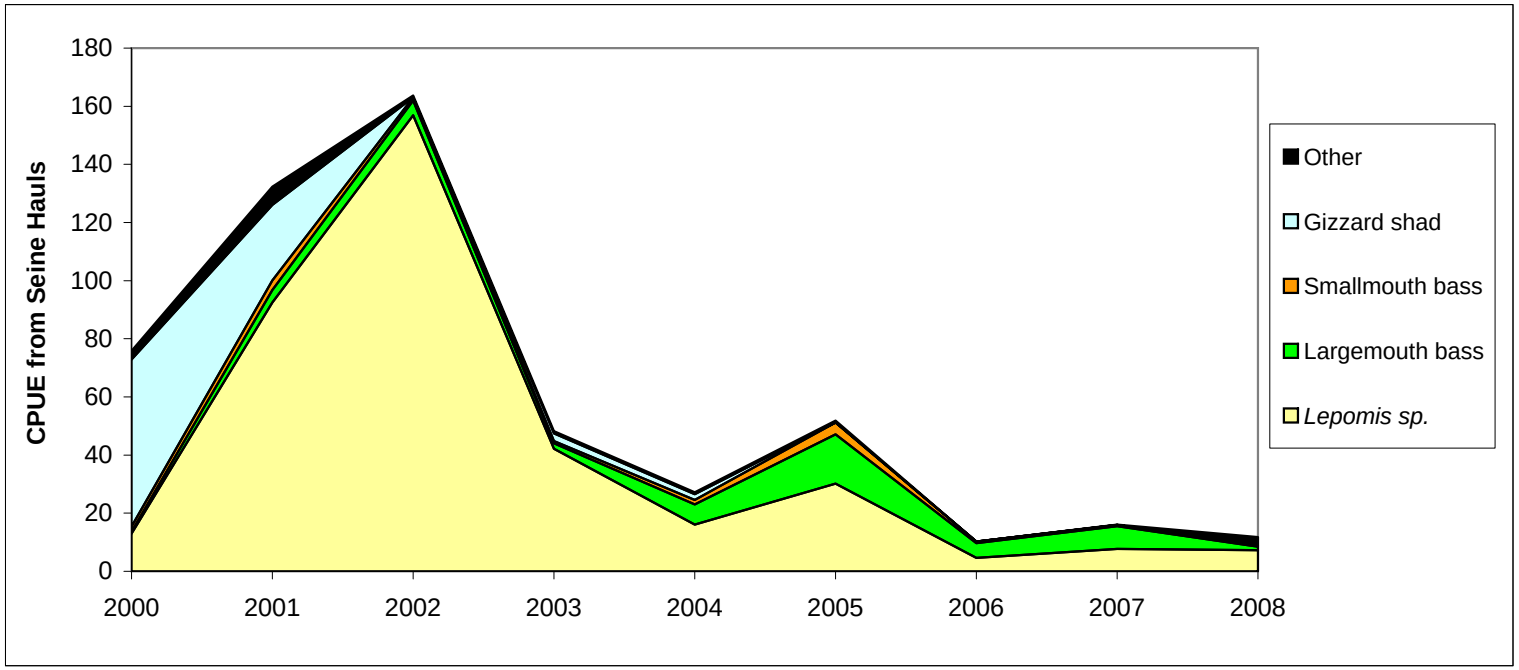

Community structure of young-of-the-year captured in seine haul s in Onondaga Lake since 2000. Overall catch rates have declined markedly, mostly due to a decline in *Lepomis* sp. (mostly bluegill and pumpkinseed). The decline may be due to several reasons including; predation of larvae by alewives, increases macrophyte growth allowing for greater dispersion of young, and decreased sampling efficiency due to increased macrophyte density.

Library Reference 8.7.7.2.7

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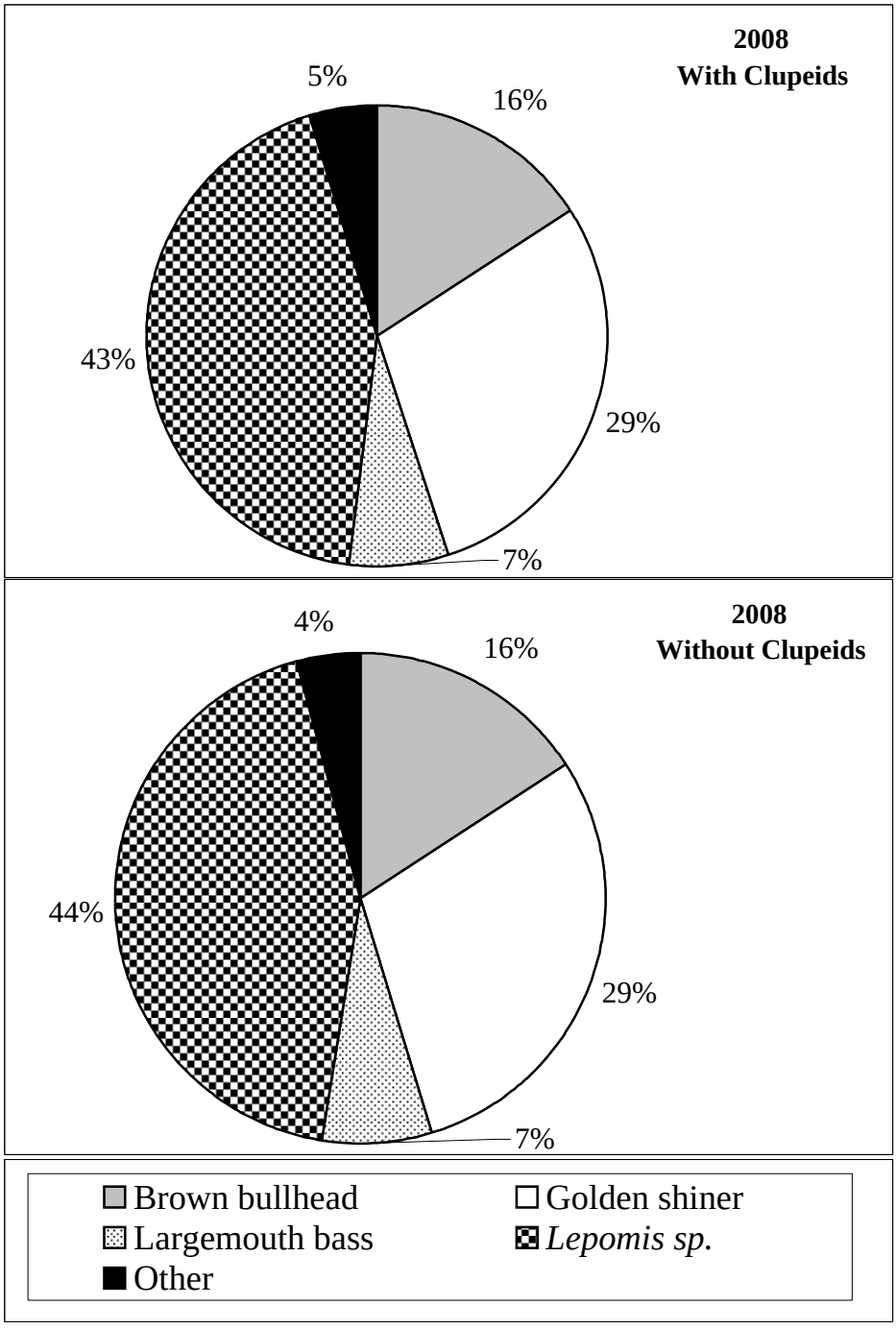
2008 YOY Relative abundance. In some years clupeid species (gizzard shad and alewives) can produce very large years classes that dominate the catch. Therefore the AMP program looks at relative abundances two ways; with and without clupeids. Note; bluegill and pumpkinseed YOY are difficult to distinguish in the field therefore they are combined and designated *"Lepomis* sp".



Graph Data

Relative Abundance W/Clupeids

Species	Entire Lake
Brown bullhead	15.80%
Golden shiner	29.10%
Largemouth bass	7.18%
Lepomis sp.	43.32%
Other	4.6%

Relative Abundance W/O Clupeids

Species	Entire Lake
Brown bullhead	15.89%
Golden shiner	29.27%
Largemouth bass	7.22%
Lepomis sp.	43.58%
Other	4.0%

Library Reference 8.7.7.2.8

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YOY Relative abundance for each species for 2008 from each stratum and the entire lake. In some years clupeid species (gizzard shad and alewives) can produce very large years classes that dominate the catch. Therefore the AMP program looks at relative abundances two ways; with (A) and without (B) clupeids.

a) With Clupeids

Species	Entire Lake	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Bluegill	0.20%	0%	0%	0.58%	0.00%	0%
Brown bullhead	15.80%	65.96%	9%	0.19%	4.16%	1%
Carp	0.99%	0.30%	9%	2.12%	0.22%	0%
Gizzard shad	0.59%	0.00%	0%	0.96%	0.88%	0%
Golden shiner	29.10%	1.22%	0%	12%	72%	23%
Largemouth bass	7.18%	11.85%	45%	2%	6%	11%
Lepomis sp.	43%	19%	32%	82%	12%	56%
Longnose gar	0%	0%	0%	0%	0.2%	0%
Pumpkinseed	0.1%	0.6%	0.00%	0.0%	0%	0%
Rock bass	0.59%	0.00%	0%	0%	1%	3%
Smallmouth bass	1.8%	0.9%	4.6%	0.0%	2.6%	6%
Tesselated darter	0.07%	0%	0%	0%	0.00%	1%
White perch	0.07%	0%	0%	0%	0.00%	1%
Yellow perch	0.07%	0.00%	0.00%	0.19%	0.00%	0.00%

b) Without Clupeids

Species	Entire Lake	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Bluegill	0.20%	0%	0%	0.58%	0.0%	0%
Brown bullhead	15.89%	65.96%	9%	0.19%	4.19%	1%
Carp	0.99%	0.30%	9%	2.14%	0.2%	0%
Golden shiner	29.27%	1.22%	0%	12.43%	73.07%	23%
Largemouth bass	7%	12%	45%	2%	6%	11%
Lepomis sp.	43.58%	19.15%	32%	83%	13%	56%
Longnose gar	0%	0%	0%	0%	0%	0%
Pumpkinseed	0%	1%	0%	0%	0.0%	0%
Rock bass	0.6%	0.0%	0.00%	0.0%	1%	3%
Smallmouth bass	1.85%	0.91%	5%	0%	3%	6%
Tesselated darter	0.1%	0.0%	0.0%	0.0%	0.0%	1%
White perch	0.07%	0%	0%	0%	0.00%	1%
Yellow perch	0.07%	0%	0%	0%	0.0%	0%

Library Reference 8.7.7.2.9

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Shannon Diversity Index for YOY fish collected in seine hauls in 2008. In some years clupeid species (gizzard shad and alewives) can produce very large years classes that dominate the catch. Therefore the AMP program looks at relative abundances two ways; with and without clupeids.

Stratum	With Clupeids	Without Clupeids
Stratum 1	0.43	0.43
Stratum 2	0.56	0.56
Stratum 3	0.29	0.27
Stratum 4	0.43	0.41
Stratum 5	0.55	0.55
Whole Lake	0.62	0.61

Library Reference 8.7.7.2.10

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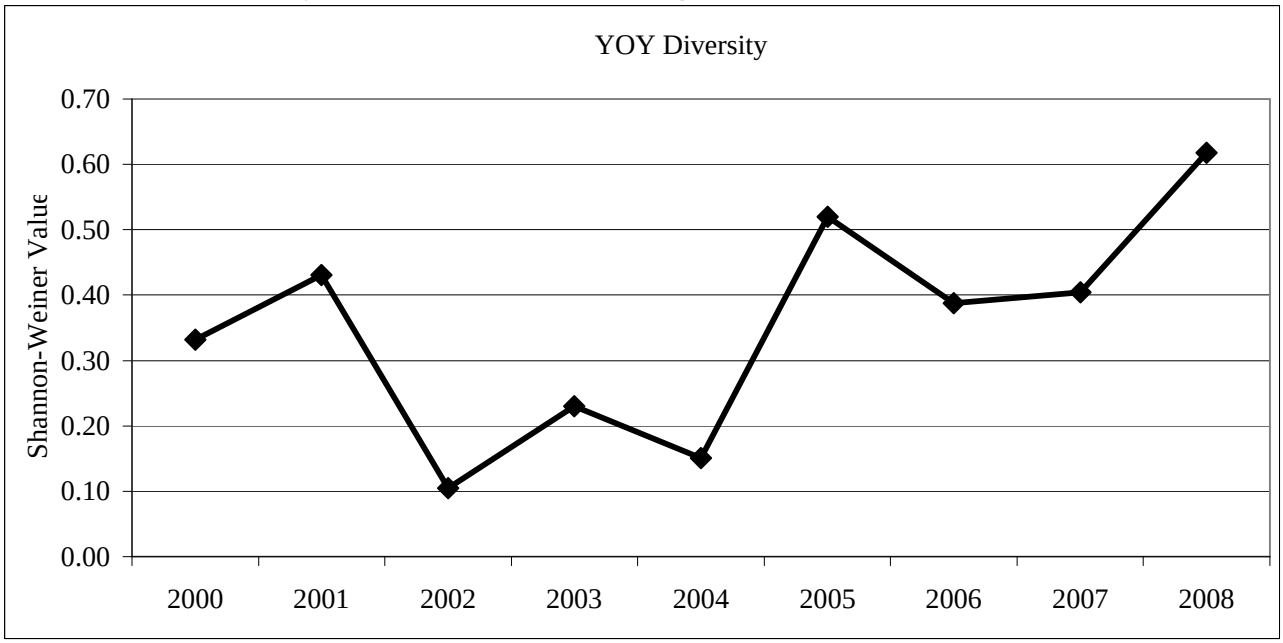
YOY whole lake diversity from 2000 to 2008 in Onondaga Lake. Data from littoral zone seine hauls.



Graph Data

Seine diversity indices from 2000-2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Shannon-Weiner value	0.33	0.43	0.10	0.23	0.15	0.52	0.39	0.40	0.62

Library Reference 8.7.7.2.11

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Presence/Absence of Early Life History Stages and Adults in 2008. In 2008 71% of the species captured during AMP sampling showed some indication of successful reproduction.

Life Stages Present	Species	Count of Species
L/Y/A	Bluegill	3
	Gizzard shad	
	Pumpkinseed	
L/A	Alewife	2
	Freshwater drum	
Y/A	Brown bullhead	17
	Carp	
	Golden shiner	
	Largemouth bass	
	Longnose gar	
	Rock bass	
	Smallmouth bass	
	Tessellated darter	
	Walleye	
	White perch	
	White sucker	
	Yellow perch	
	Banded killifish	
	Bluntnose minnow	
	Brook Silverside	
	Brook stickleback	
	Emerald shiner	
A	Black crappie	9
	Bowfin	
	Brown trout	
	Channel catfish	
	Green sunfish	
	Northern hog sucker	
	Northern pike	
	Shorthead redhorse	
	Yellow bullhead	

A= Adult stage present

L= Larvae present (captured during larvae sampling)

Y= YOY present (captured during YOY seining)

* Indicates species whose adult sizes are small and difficult to differentiate from YOY; presence of adults of these species likely indicates a reproducing population.

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Presence/absence and CPUE of larval and YOY fishes in samples collected from Onondaga Lake from 2000-current year (continued).

a) Larvae Trawls (#/ m3). Note: trawls in 2000 were done at night. Trawls since 2001 have been completed during the day.

Species	Notes	2000	2001	2002	2003	2004	2005	2006	2007	2008
Alewife						0.0041	0.0522	0.0004	0.0205	0.0237
Bluegill									0.0080	0.0299
Brook silverside						0.0020				
Carp				0.0050			0.0030			
Freshwater drum		0.31	0.01	0.0310						0.0028
Gizzard shad	*3*	2.472	0.49	0.8500	0.0590	0.0271		0.0147		0.0330
Lepomis	*1*	0.382	0.01	0.3440	0.0950	0.0019	0.0028	0.0047		
Logperch		<0.01								
Pumpkinseed									0.0025	0.0220
White perch		0.027	0.04	0.0480						
White sucker			0.07							
Yellow perch			0.14	0.019			0.0031			
Richness	**2**	**5**	**6**	**6**	**2**	**4**	**4**	**3**	**3**	**5**

Notes:

1 - Lepomis are likely a combination of both bluegill and pumpkinseed.

2 - Richness assumes Lepomis is composed both bluegill and pumpkinseed

3 - Gizzard shad cpue in 2000 trawls is a combination of gizzard shad (0.017) and herring family (2.46).

Presence/absence and CPUE of larval and YOY fishes in samples collected from Onondaga Lake from 2000-current year (continued).

b) Young-of-the-Year (# per seine haul)

Species	Notes	2000	2001	2002	2003	2004	2005	2006	2007	2008
Banded killifish*						0.07	0.54		0.26	
Bluntnose minnow*								0.01		
Brook silverside*										
Brook stickleback*										
Brown bullhead			0.03	0.02	0.03		0.20		0.01	2.67
Carp		0.02	0.03	0.48	0.63	0.64	0.33		0.03	0.17
Channel catfish				0.02						
Emerald shiner*										
Fathead minnow*										
Gizzard shad		70.30	26.10	0.03	2.70	1.98	0.02			0.10
Golden shiner*							0.02		0.01	4.91
Johnny darter*										
Largemouth bass		1.50	4.30	5.00	1.90	6.87	16.99	5.10	7.81	1.21
Lepomis	*1*	25.20	92.40	157.00	42.20	16.12	33.36	4.64	7.66	7.31
Logperch*										
Longnose gar		0.02				0.01				
Northern hogsucker		0.02								
Pumpkinseed								0.01		0.02
Rock bass							0.07	0.04	0.06	0.10
Smallmouth bass		2.70	3.30	1.10	0.70	1.57	4.01	0.50	0.53	0.31
Tessellated darter*							0.02			
White perch		2.60	0.60	0.13	0.12	0.02				0.01
White sucker		0.06	0.15	0.02						
Yellow perch			5.60	0.03			0.13			0.01
Richness	*2*	**14**	**18**	**17**	**15**	**14**	**14**	**11**	**10**	**17**

Notes:

1 - Lepomis are likely a combination of both bluegill and pumpkinseed.

2 - Richness assumes Lepomis is composed both bluegill and pumpkinseed

* denotes species that are difficult to distinguish in the YOY stage due to their small size as adults. These species are assumed to be present as YOY if captured in littoral seines, but a CPUE is not included because the catch may include both YOY and adults.

Library Reference 8.7.7.3

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Nesting Survey

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Library Reference 8.7.7.3.1

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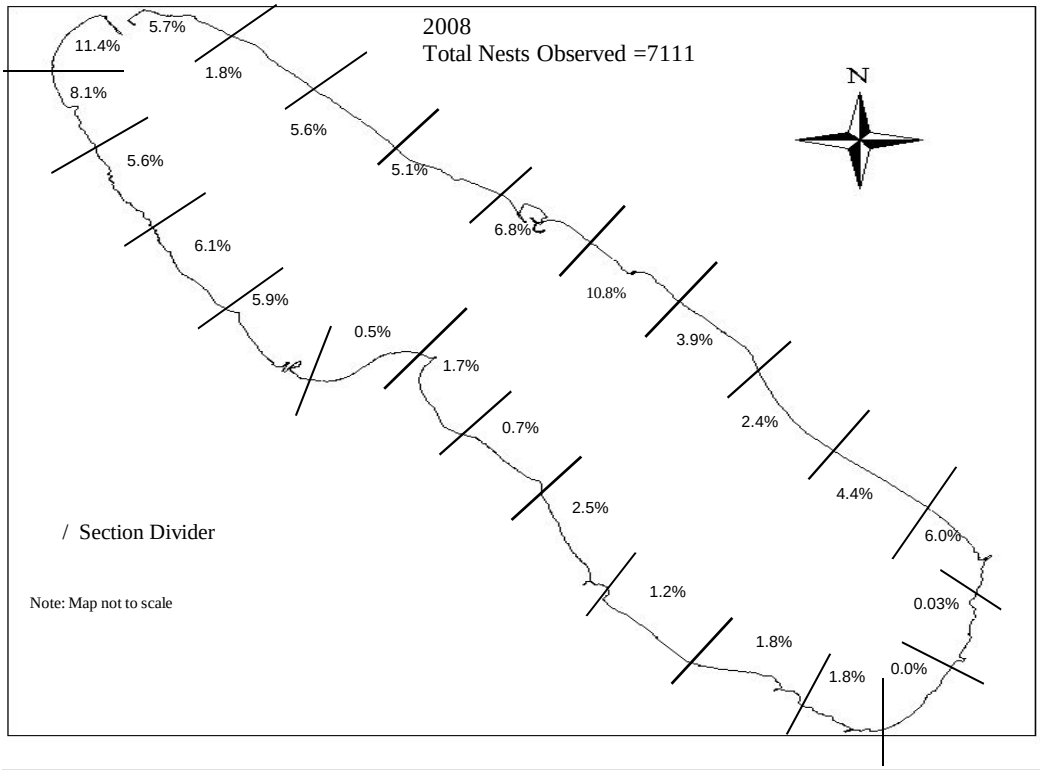
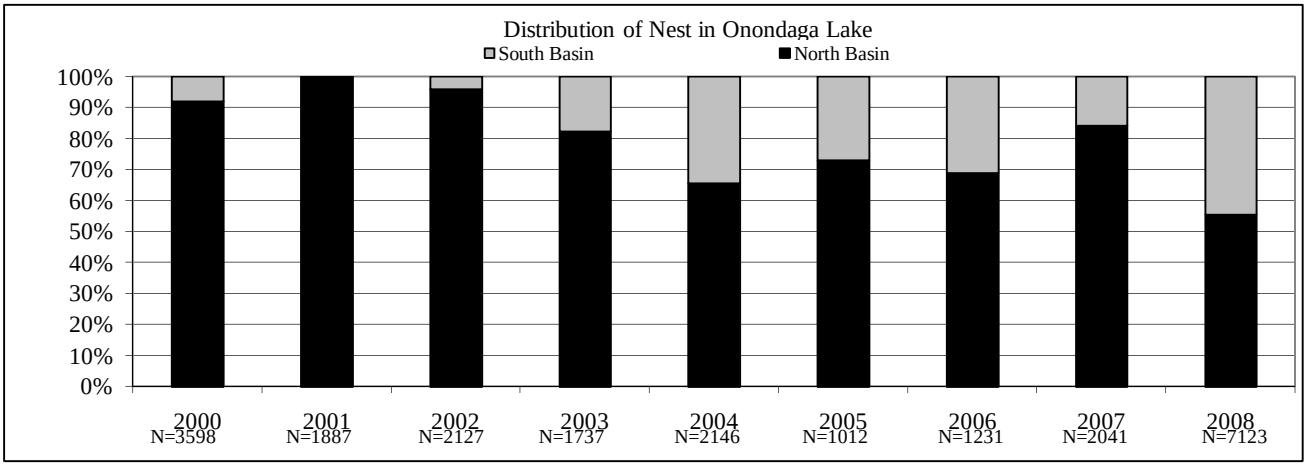
2008 Nesting survey map and comparison of north vs. south nests from 2000-2008.





	2000	2001	2002	2003	2004	2005	2006	2007	2008
North Basin	92%	100%	96%	82%	66%	73%	68.9%	84.1%	55.4%
South Basin	8%	0%	4%	18%	34%	27%	31.1%	15.9%	44.6%
Entire Lake	3598	1887	2127	1737	2146	1012	1231	2041	7123
Stratum 1	1254	1070	1130	777	1310	341	697	778	2642
Stratum 2	11	4	10	99	341	68	98	67	598
Stratum 3	0	0	29	55	12	10	82	9	559
Stratum 4	416	0	79	298	384	195	203	248	2018
Stratum 5	1917	813	879	508	99	398	151	939	1306

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2008 Nesting survey results by species and transect, with comparison of north vs. south.

a) 2008 Nesting survey results by species and transect (1-12).

Transect	Species	Number of Nests
Transect 1	Other	30
	Pumpkinseed	329
	Smallmouth bass	2
	Largemouth bass	2
Transect 2	Largemouth bass	8
	Other	76
	Pumpkinseed	317
Transect 3	Bullhead (species unknown)	1
	Pumpkinseed	66
	Other	49
	Largemouth bass	7
	Bluegill	1
	Lepomis sp.	3
Transect 4	Pumpkinseed	242
	Smallmouth bass	1
	Bluegill	3
	Largemouth bass	4
	Lepomis sp.	28
	Other	137
Transect 5	Smallmouth bass	2
	Other	19
	Lepomis sp.	2
	Largemouth bass	13
	Bullhead (species unknown)	2
	Bluegill	1
	Pumpkinseed	770
Transect 6	Smallmouth bass	1
	Pumpkinseed	521
	Other	10
	Lepomis sp.	25
	Bluegill	3
	Largemouth bass	17
Transect 7	Largemouth bass	15
	Other	30
	Bluegill	1
	Pumpkinseed	354
Transect 8	Bluegill	1
	Largemouth bass	4
	Other	25
	Pumpkinseed	405
Transect 9		390
	Other	20
	Largemouth bass	11
Transect 10	Pumpkinseed	30
	Lepomis sp.	5

2008 Nesting survey results by species and transect, with comparison of north vs. south (continued)

b) 2008 Nesting survey results by species and transect (13-24).

Transect	Species	Number of Nests
Transect 13	Pumpkinseed	172
	Largemouth bass	7
Transect 14	Bullhead (species unknown)	1
	Largemouth bass	3
	Pumpkinseed	81
Transect 15	Largemouth bass	2
	Pumpkinseed	125
Transect 16	Largemouth bass	1
	Pumpkinseed	128
	Smallmouth bass	1
Transect 17	No Catch	0
Transect 18	Other	2
Transect 19	Largemouth bass	6
	Bluegill	421
Transect 20	Pumpkinseed	310
	Smallmouth bass	1
	Largemouth bass	7
Transect 21	Largemouth bass	6
	Pumpkinseed	167
Transect 22	Bluegill	34
	Largemouth bass	5
	Pumpkinseed	238
Transect 23	Brown bullhead	1
	Largemouth bass	1
	Other	110
	Pumpkinseed	658
Transect 24	Pumpkinseed	479
	Largemouth bass	1

2008 Nesting survey results by species and transect, with comparison of north vs. south (continued)

c) 2008 total number of nests in each transect and relative abundance.

Transect	Total Number of Nests	Percent of Total
Transect 1	363	5.1%
Transect 2	401	5.6%
Transect 3	127	1.8%
Transect 4	415	5.8%
Transect 5	809	11.4%
Transect 6	577	8.1%
Transect 7	400	5.6%
Transect 8	435	6.1%
Transect 9	421	5.9%
Transect 10	35	0.5%
Transect 11	119	1.7%
Transect 12	53	0.7%
Transect 13	179	2.5%
Transect 14	85	1.2%
Transect 15	127	1.8%
Transect 16	130	1.8%
Transect 17	0	0.0%
Transect 18	2	0.0%
Transect 19	427	6.0%
Transect 20	318	4.5%
Transect 21	173	2.4%
Transect 22	277	3.9%
Transect 23	770	10.8%
Transect 24	480	6.7%

d) 2008 nest distribution.

Basin	Total Number of Nests	Percent of Total
North Basin	3948	55.4%
South Basin	3175	44.6%

e) 2008 species contribution.

Species	Total Number of Nests	Percent of Total
Bluegill	465	6.5%
Brown bullhead	1	0.0%
Bullhead (species unknown)	4	0.1%
Largemouth bass	123	1.7%
Lepomis sp.	113	1.6%
Other	508	7%
Pumpkinseed	5901	82.8%
Smallmouth bass	8	0.1%

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SENECA RIVER CONDITIONS

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Three Rivers System – Summary of 2008 Data

Overview Map and Sample Summary Table

- Three full water quality surveys were conducted on July 24th, August 21st and September 11th, 2008. An additional survey was conducted at Buoy 316 on August 7th. Furthermore, from June to October, 2008 YSI data sondes were deployed at Buoys 409, 316, and 236 to measure in-situ water quality parameters (e.g., dissolved oxygen, pH, salinity, and temperature) at 15-minute intervals.

Hydrograph Figure and Flow Summary Table

- Flow conditions of the Seneca River in 2008 exhibited a pattern consisting of higher and more variable flows in spring and fall and lower flow conditions with occasional increases during the summer. The average summer flow rate in 2008 was approximately 1,500 cfs, which is comparable with the long-term summer average of 1,700 cfs, but higher than what might be considered a summer low flow condition (e.g., the summer average flow rate in 2007 was 800 cfs, and the 7Q10 flow is estimated at 350 cfs).

Spatial Plots of Water Quality Parameters

- The Seneca River water column appeared to be vertically well-mixed during the 7/24 survey (3,510 cfs), but exhibited some stratification in water quality parameters during the 8/21 (1,120 cfs) and 9/11 surveys (773 cfs), especially in the vicinity and downstream of the Onondaga Lake outlet.
- Generally the spatial trends of the water quality parameters in 2008 were similar to those measured in previous years. However, they were generally less pronounced than those observed in lower flow years (e.g., 2007), especially for the July event due to its higher flow. A general description of the trends in 2008 water quality is as follows:
    - Between Cross Lake and the Onondaga Lake outlet:
        - Soluble reactive phosphorus (SRP) concentrations increased and chlorophyll-a concentrations decreased due to zebra mussel activities.

- Dissolved oxygen (DO) concentrations in the August and September surveys decreased, by 3 to 4 mg/L, as a result of zebra mussel respiration and sediment oxygen demand.
- Ammonia-N (NH3-N) and nitrate (NO3-N) concentrations exhibited little change, with only a slight increase in some events, due to zebra mussel activities.

o Between the Onondaga Lake outlet and Three Rivers Junction:

- SRP concentrations remained relatively constant in the surface waters as a result of the balancing of algal production with filtration of the remaining algae by zebra mussels, as well as mixing with deeper waters and Onondaga Lake inflows. Similar to previous years, but to a greater extent, SRP concentrations in the bottom waters decreased and remained low at several successive sampling stations downstream of the Lake Outlet, due to the lower SRP concentrations entering from the lake and relatively slow vertical mixing in the "Deep Hole" area.
- Stratification downstream of the outlet was observed for salinity, and to a much lesser extent for DO and temperature, which likely reflects the influx of Onondaga Lake water, limited vertical mixing, and potential inflow of groundwater (as observed in past years) in the area of the "Deep Hole".
- NH3-N concentrations exhibited little change, with the exception of a single elevated sample point in the September event (Buoy 255).
- NO3-N concentrations exhibited a strong vertical stratification just downstream of the outlet, due to the relatively high concentration waters that enter from the lake and experience limited vertical mixing in the area of the "Deep Hole". The concentrations increased toward the Three Rivers Junction due to vertical mixing.

<u>YSI Sonde Figure</u>

- Temporal trends in the high frequency DO data recorded by the YSI sondes exhibited a generally high level of stratification at Buoy 409, with several periods of low concentrations in the bottom waters and larger diurnal variations. At Buoy 316, DO data showed little stratification and generally higher concentrations during summer, and less day-to-day variation. Similar patterns were observed for Buoy 236.

Seneca River Compliance and Sonde Compliance Tables

- From the routine water quality surveys, the data showed just one violation of the NYSDEC instantaneous minimum DO standard (4 mg/L) for the bottom water at Buoy 255 during the September event. There were no observed violations of the NH3 or NO2 standards.
- In 2008, DO standard violations were observed in the 15-minute sonde data. Similarly to previous years, most of the violations were observed at the bottom waters of Buoy 409 (violations occurred on approximately 30% of days in which the sonde was in operation for the instantaneous standard and 40% for the daily average standard), with fewer violations being observed at Buoys 316 (<5% instantaneous and 15% daily average) and 236 (<10% instantaneous and 10% to 15% daily average). In comparison to previous lower flow years, these data represent an improvement in water quality conditions (e.g., the frequency of violations was much higher in 2007).

Three Rivers System – 2008 Major Findings

- The water quality data collected in 2008 during the three full river surveys were generally similar to data collected in previous years. The data measured during the individual surveys were reflective of the predominant processes occurring in the river at that time of the year, such as zebra mussel activities and inflow from Onondaga Lake and subsequent mixing.
- The average summer flow rate in 2008 was comparable with the long-term summer average, but higher than what might be considered a summer low flow condition. As a result, the spatial trends of water quality parameters were slightly less pronounced than those typically observed under the lower flow conditions.
- Due to the somewhat higher flows, the water quality conditions in 2008 exhibited an improvement in terms of regulatory compliance when compared with previous lower flows years (e.g., 2007).

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TABLES

Summary of Seneca River flow conditions between 2001 and 2008. past years.

This indicates that the summer flow conditions in year 2008 were moderate, compared to past years.

Year	Summer flow rates (cfs)	Days below 7Q10 criteria
2001	800	0
2002	842	7
2003	2,028	0
2004	4,518	0
2005	1,052	8
2006	4,607	3
2007	774	4
2008	1,497	0

Summary of AMP river sampling locations and total numbers of samples collected in 2008.

Buoy	Buoy 412	Buoy 409	Buoy 397	Buoy 362	Buoy 334	Buoy 316	Buoy 294	Buoy 269	Buoy 260	Buoy 255	Buoy 240	Buoy 222	Buoy 178	Buoy 182	Buoy 212	Buoy 10	LO1	LO2	LO3
River	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Seneca	Oneida	Oneida	Oneida	Oswego	Lake Outlet	Lake Outlet	Lake Outlet
Kilometer[1]	-36.5	-35.4	-33.3	-26.9	-21.6	-18.4	-14.1	-10.1	-8.3	-6.4	-3.5	-0.4	-7.3	-6.7	-0.9	2.4	-11.7	-12.4	-11.4
DO-field	6	6	6	6	6	8	6	9	6	6	6	6	6	6	6	6	6	6	6
Chlorophyll-a	6	6	6	6	6	16	6	6	6	6	6	6	6	6	6	6	6	6	6
Pheophytin-a	6	6	6	6	6	16	6	6	6	6	6	6	6	6	6	6	6	6	6
TOC	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
TOC-F	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
NH3-N	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
NO2	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
NO3	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
ORG-N	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
TKN	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
TKN-F	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
TP	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
SRP	6	6	6	6	6	16	6	9	5	6	6	6	6	6	6	6	6	6	6
TDP	6	6	6	6	6	16	6	9	5	6	6	6	6	6	6	6	6	6	6
Chloride	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
COND-field	6	6	6	6	6	8	6	9	6	6	6	6	6	6	6	6	6	6	6
Salinity-field	6	6	6	6	6	8	6	9	6	6	6	6	6	6	6	6	6	6	6
Temp-field	6	6	6	6	6	8	6	9	6	6	6	6	6	6	6	6	6	6	6
pH-field	6	6	6	6	6	8	6	9	6	6	6	6	6	6	6	6	6	6	6
Turbidity	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6
TSS	6	6	6	6	6	16	6	9	6	6	6	6	6	6	6	6	6	6	6

Note:

[1] *River kilometers measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego.*

Summary of non-compliances dissolved oxygen, Nitrite and total ammonia in the Seneca River during 2008 river sur

Parameter	Sampling Date	Location	Depth	Values below criteria (mg/L)
Dissolved Oxygen (Compliance criteria = 4 mg/L)	9/11/2008	BUOY-225	BOTTOM	3.77
Parameter	**Sampling Date**	**Location**	**Depth**	**Values above criteria (mgN/L)**
Nitrite (Compliance criteria = 0.1 mgN/L)	None	None	None	---
Total NH3 (NYSDEC criteria calculated from pH and Temperature)	None	None	None	---

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Summary of 15-minute dissolved oxygen (DO) data collected by the YSI sondes in 2008.

Sonde Location	Deployment Dates [1]		Operation (days) [2]	DO ≤ 5 mg/L	DO ≤ 4 mg/L
	Start	End		(days) [3]	(days) [4]
Buoy 409 (Top)	6/4/2008	10/31/2008	149	4	1
Buoy 409 (Bottom)			149	61	43
Buoy 316 (Top)	5/30/2008	11/3/2008	156	23	6
Buoy 316 (Bottom)			156	27	5
Buoy 236 (Top)	6/20/2008	10/31/2008	133	19	12
Buoy 236 (Bottom)			134	15	0

[1] *Not all parameters may have been measured during the deployment dates.*

[2] *DO measured at least half of the time within one day*

[3] *NYSDEC minimum daily average DO standard*

[4] *NYSDEC instantaneous minimum DO standard*

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FIGURES

N

To Lock O-7 in Oswego

OSWEGO

OSWEGO R

OX CR

Phoenix

PHOENIX WWTP

OSWEGO CANAL LOCK O-1

PHEONIX DAM

Buoy 10

Three Rivers

Buoy 212

Buoy 222

CAUGHDENOY DAM

ERIE CANAL
LOCK 23

Brewerton

ONEIDA R

ONEIDA L

Buoy 178

Buoy 182

BREWERTON
WPCP

OAK ORCHARD STP

Buoy 240

ONEIDA

ANHEUSER
BUSCH INC

Buoy 362

Buoy 334

Baldwinsville

Buoy 255

WETZEL ROAD WWTP

Buoy 260

LOCK 24 ERIE CANAL
BALDWINSVILLE DAM

Buoy 316

Buoy 269

BALDWINSVILLE
SENECA KNOLLS
WWTP

Buoy 294

LO3

LO2

LO1

SAWMILL CR

CROSS L

SENECA R

Buoy 397

State Ditch Cut

Buoy 412

Buoy 409

Jacks Reef

BLOODY BROOK

ONONDAGA L

LEY CR

NINEMILE CR

TRIBUTARY 5A

METROPOLITAN SYRACUSE WWTP

ONONDAGA CR

EAST FLUME

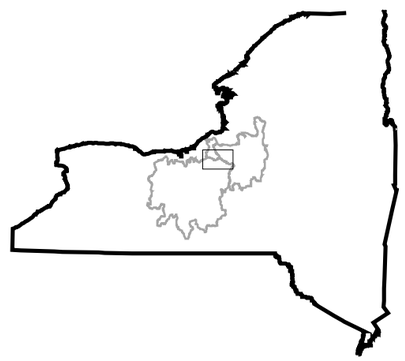
HARBOR BROOK

Syracuse

JORDAN WPCP

SENECA

LOCATOR



SCALE

1 0 1 2 3 Miles

LEGEND

- AMP Sampling Locations
- Wastewater Treatment Plants
- Locks and Dams
- Cities / Towns
- USGS Gages
- Shoreline
- Watershed Boundaries

Overview of AMP River Sampling Locations within the Three Rivers System.

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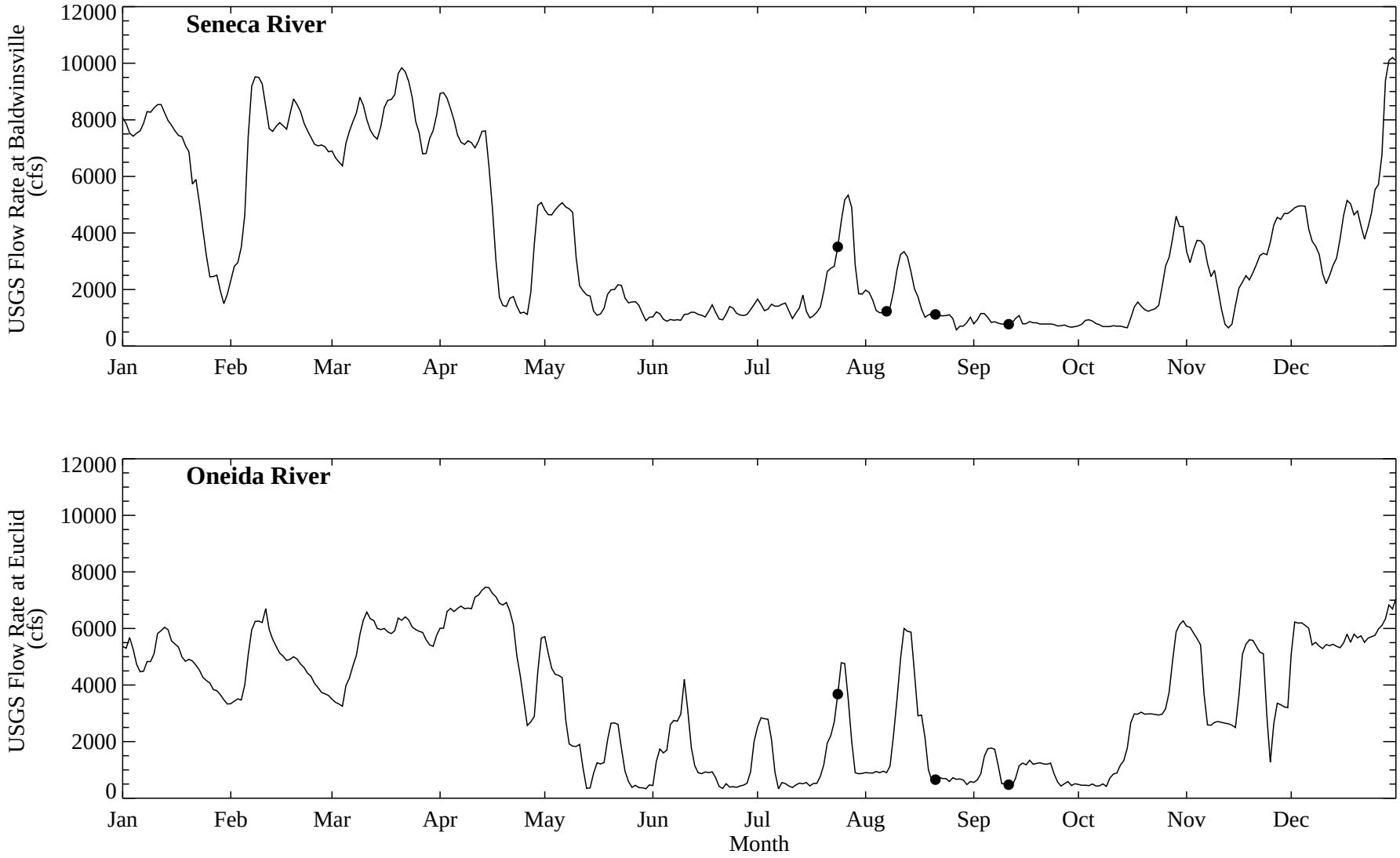
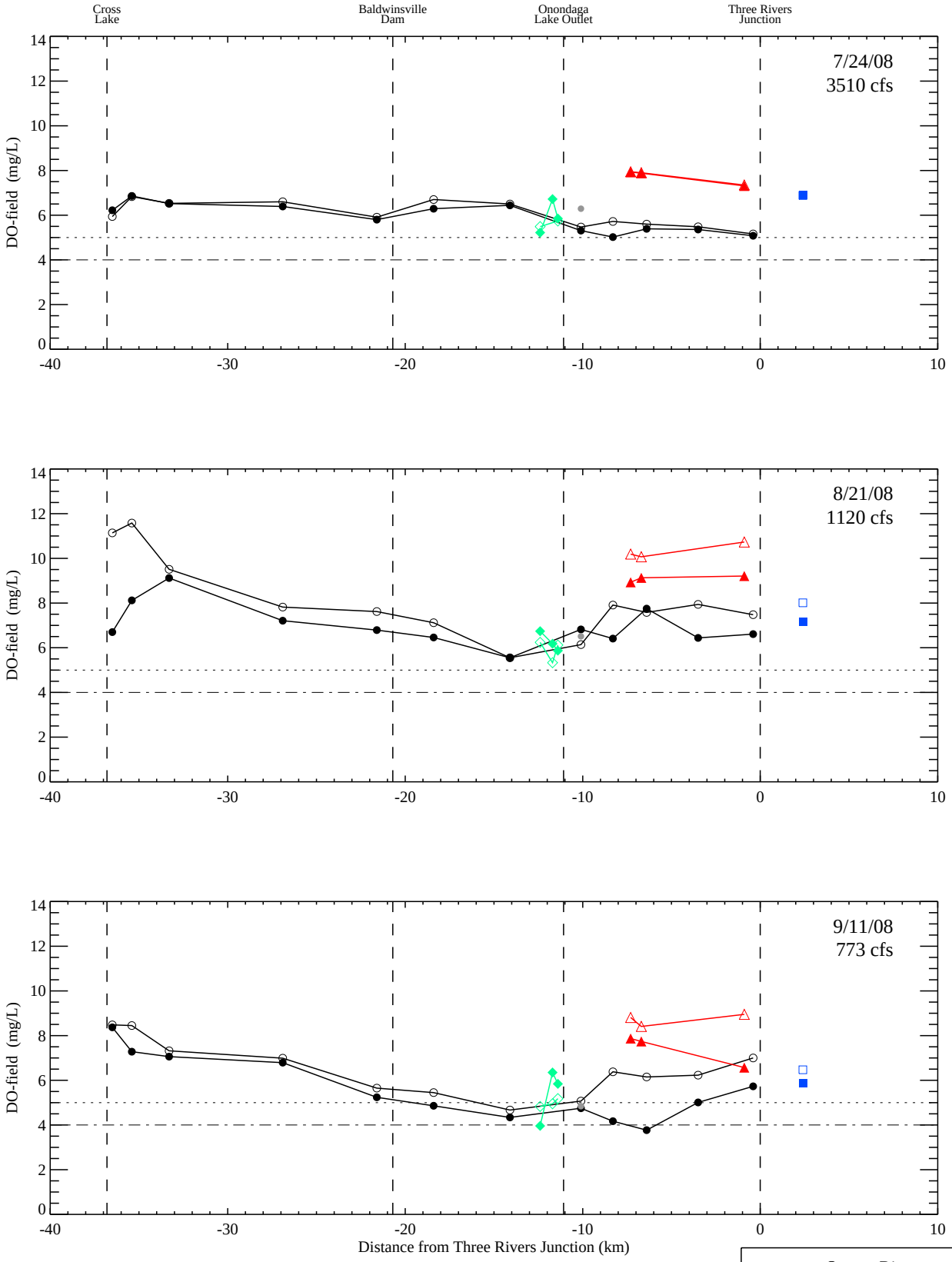


USGS flow rate and OCDWEP AMP sampling dates of surface water quality surveys conducted during 2008.

Note: Points represent OCDWEP water quality sampling dates.

DO-field



Spatial profiles of dissolved oxygen collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel. (4)One DO-field surface sample (75.7 mg/L) collected from LO1 on 7/24/08 was eliminated from analysis.

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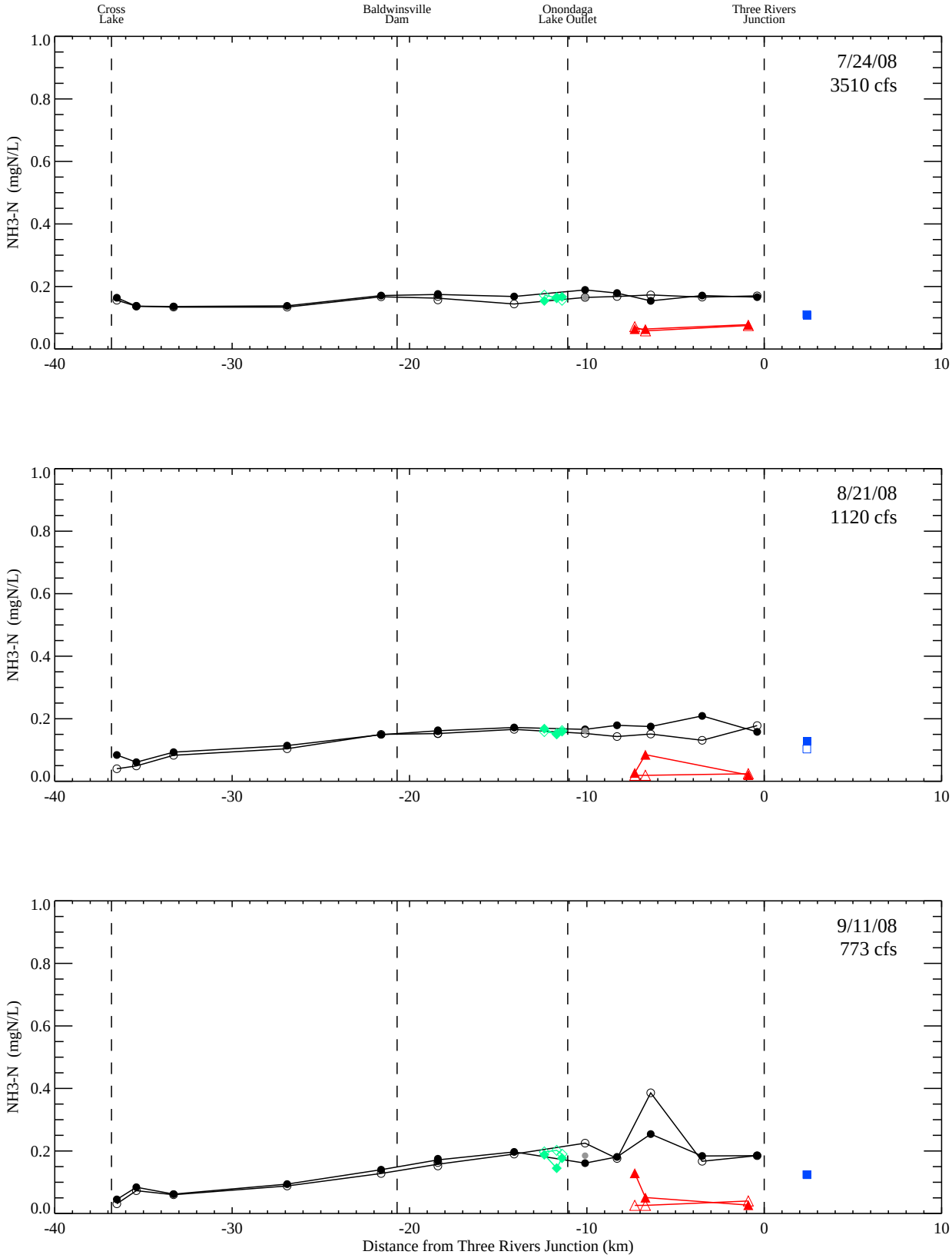
NH3-N



Spatial profiles of ammonia collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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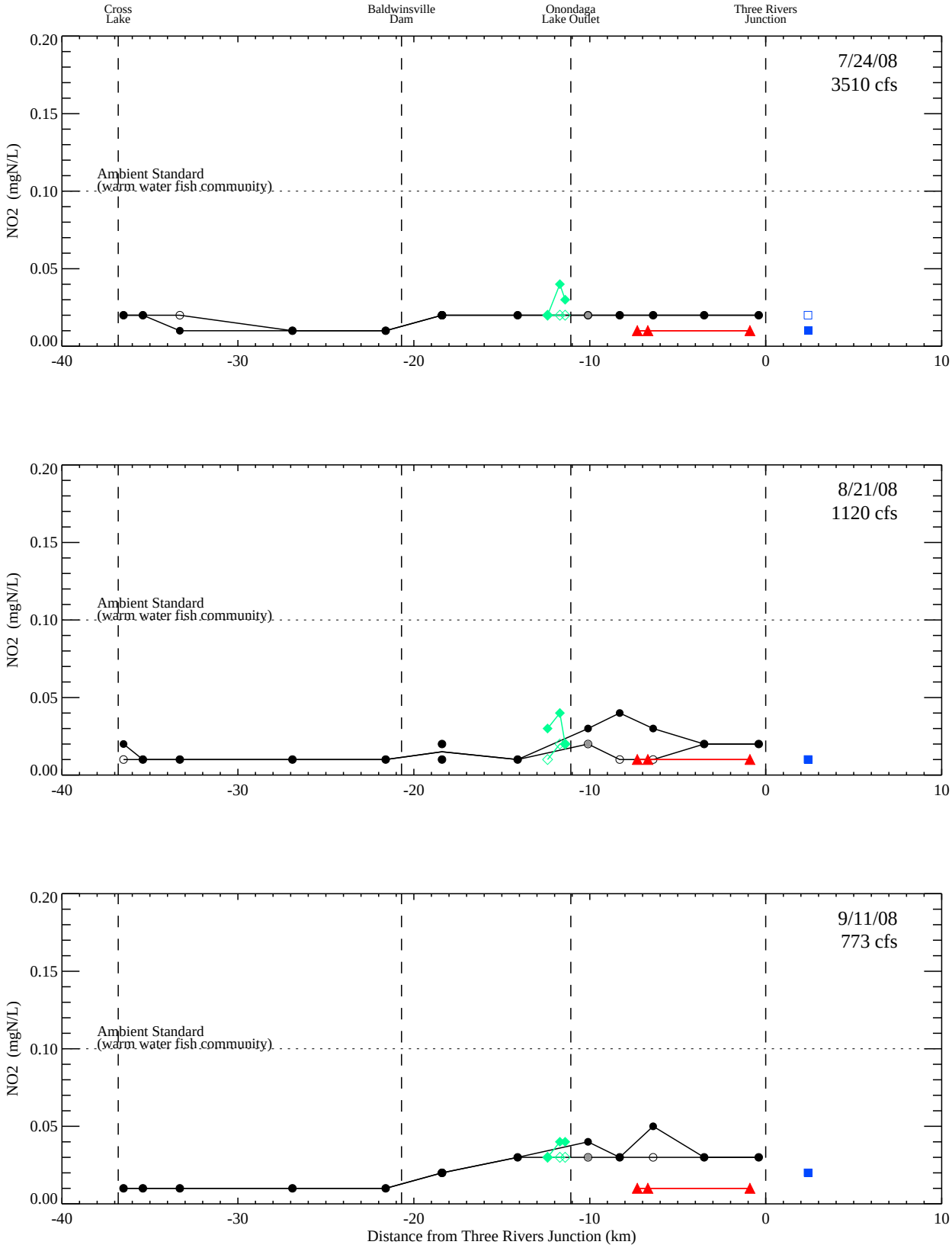

Spatial profiles of nitrite collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

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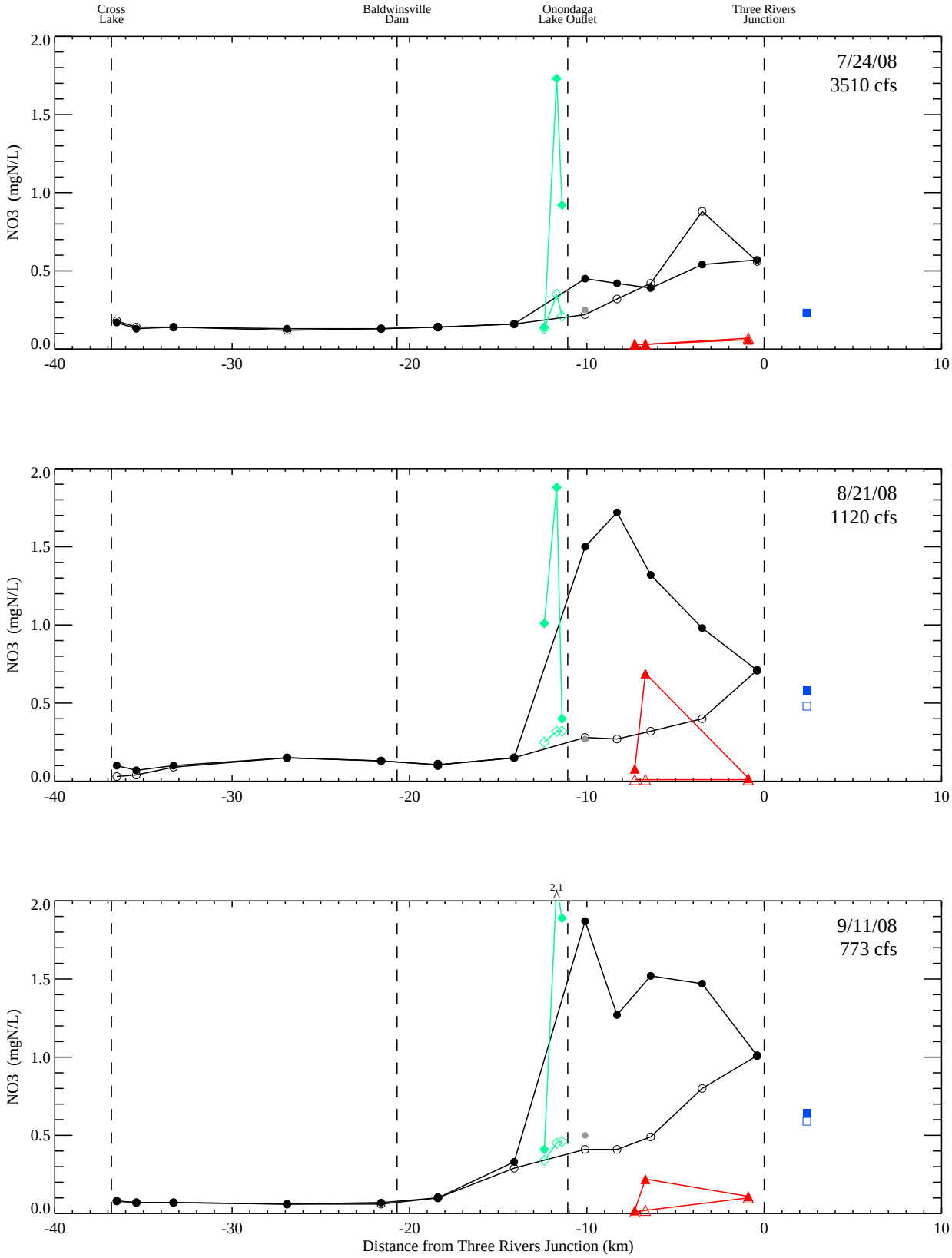

Spatial profiles of nitrate collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

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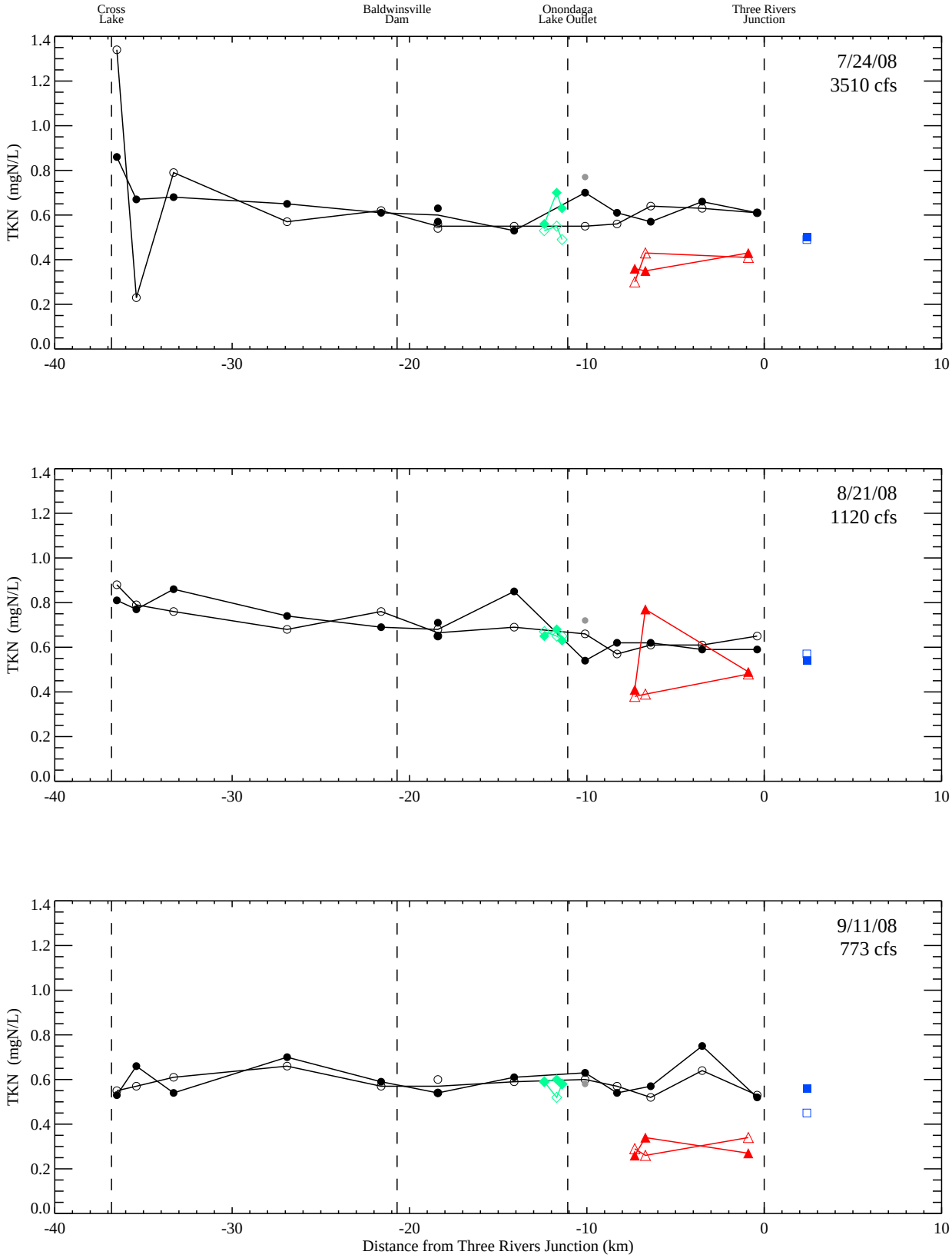
TKN

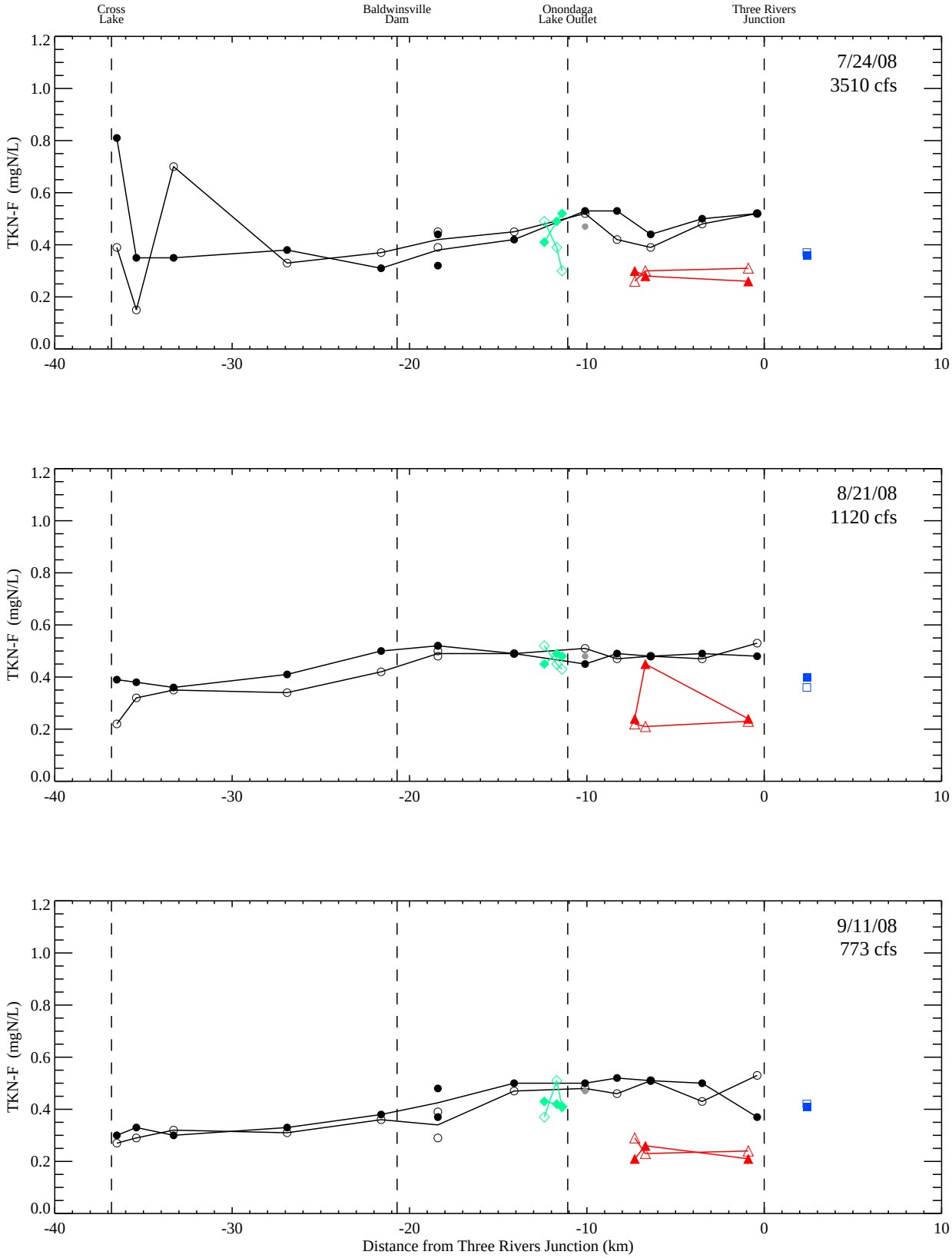


Spatial profiles of TKN collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

IF - Z:\ONOamp\DOCUMENTS\Reports\2008_AMP_chapter\Figures\River_Appendix\FigA1_2_11__spatial_by_parameter.pro
Fri Jun 12 21:00:01 2009

TKN-F

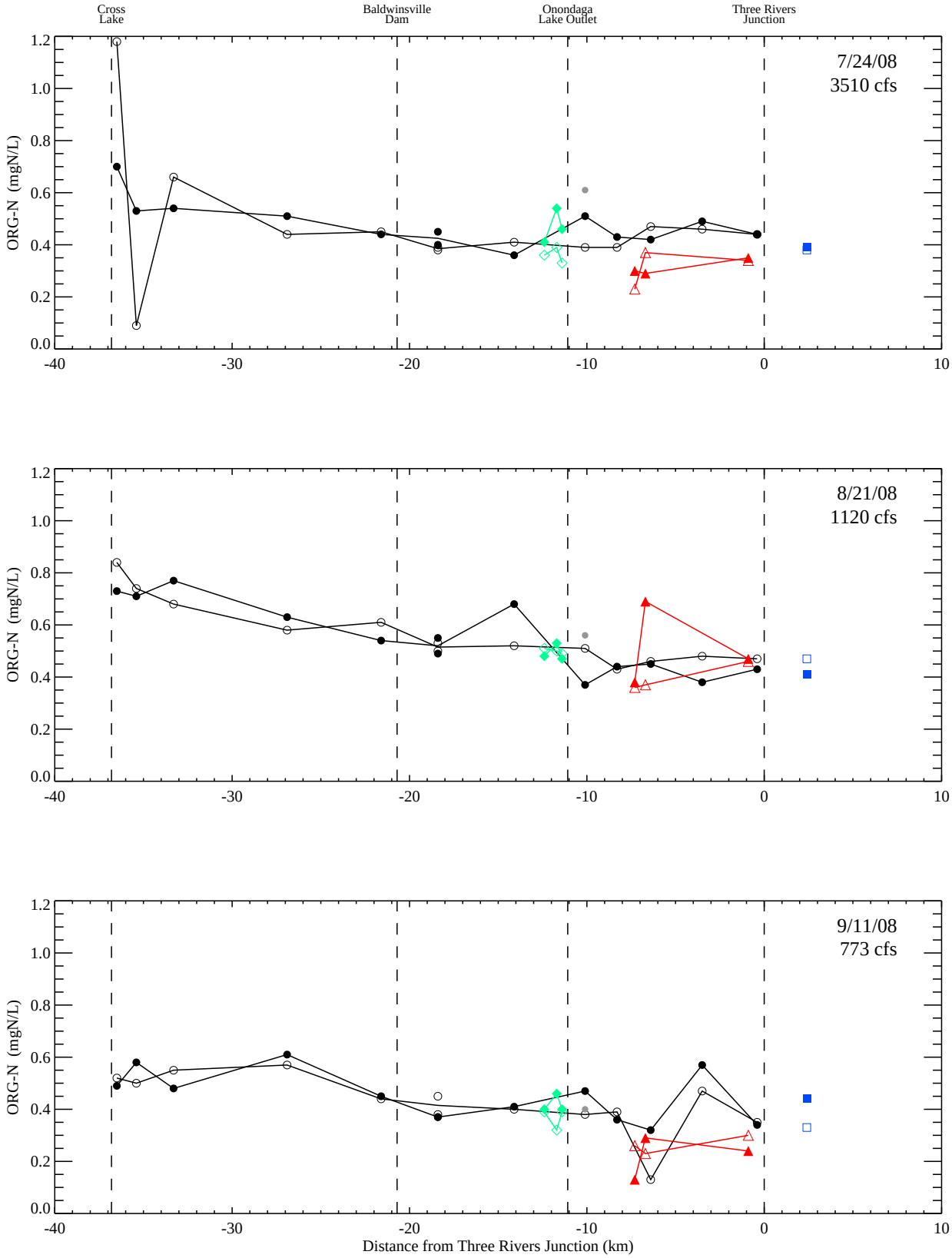


Spatial profiles of TKN (filtered) collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

IF - Z:\ONOamp\DOCUMENTS\Reports\2008_AMP_chapter\Figures\River_Appendix\FigA1_2_11__spatial_by_parameter.pro
Fri Jun 12 21:00:01 2009

ORG-N



Spatial profiles of organic N collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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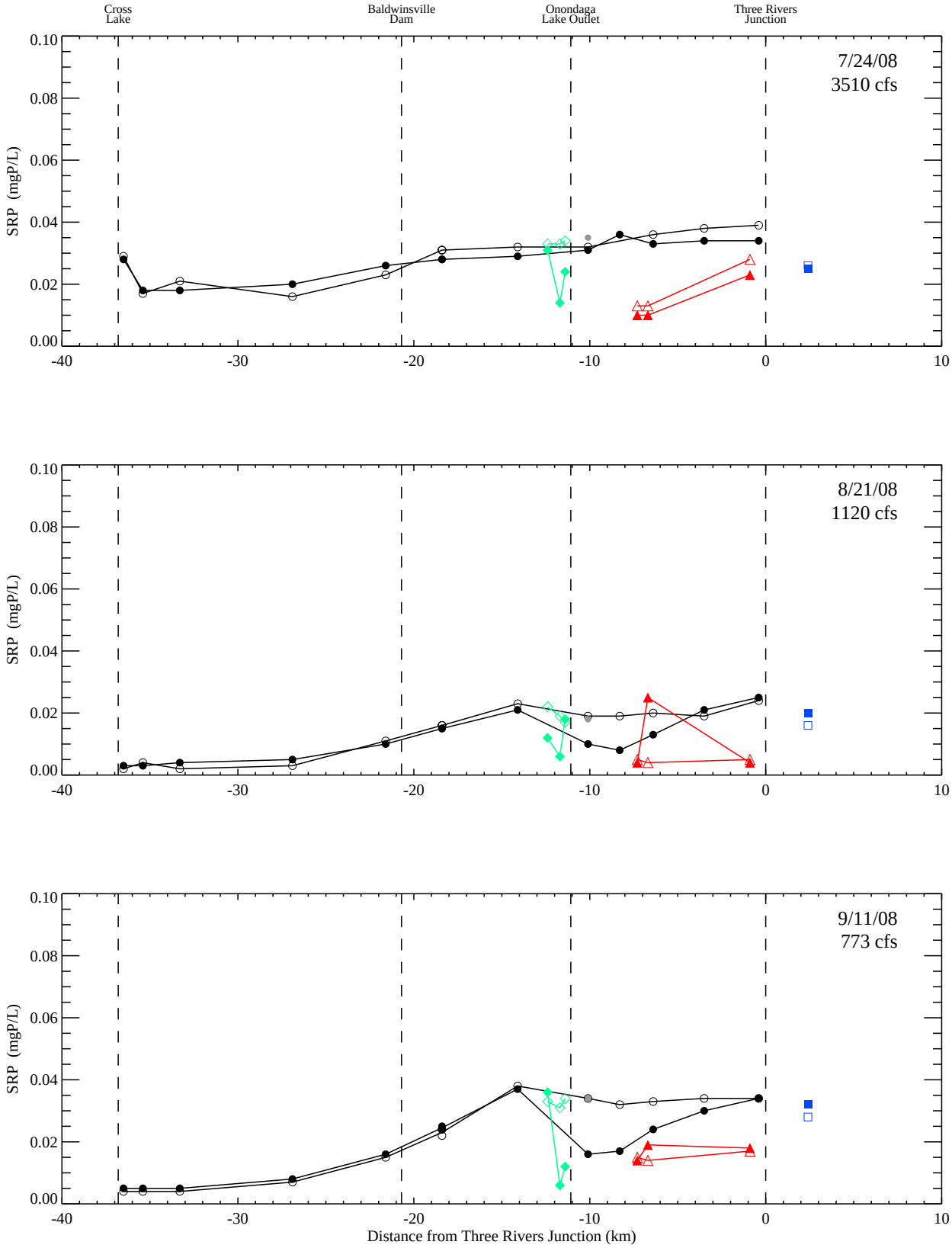
Fri Jun 12 21:00:01 2009

SRP



Spatial profiles of SRP collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

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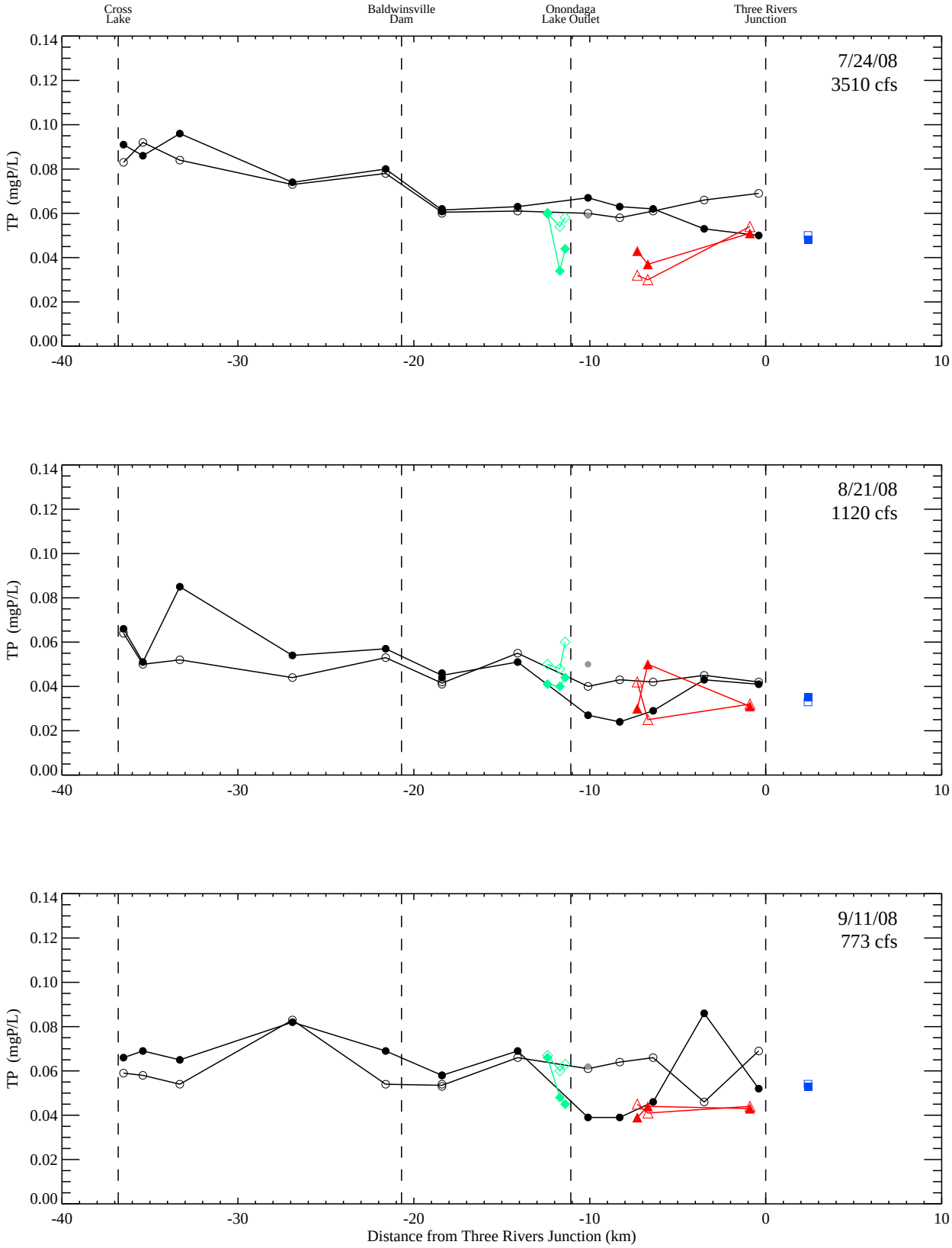
TP



Spatial profiles of total P collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

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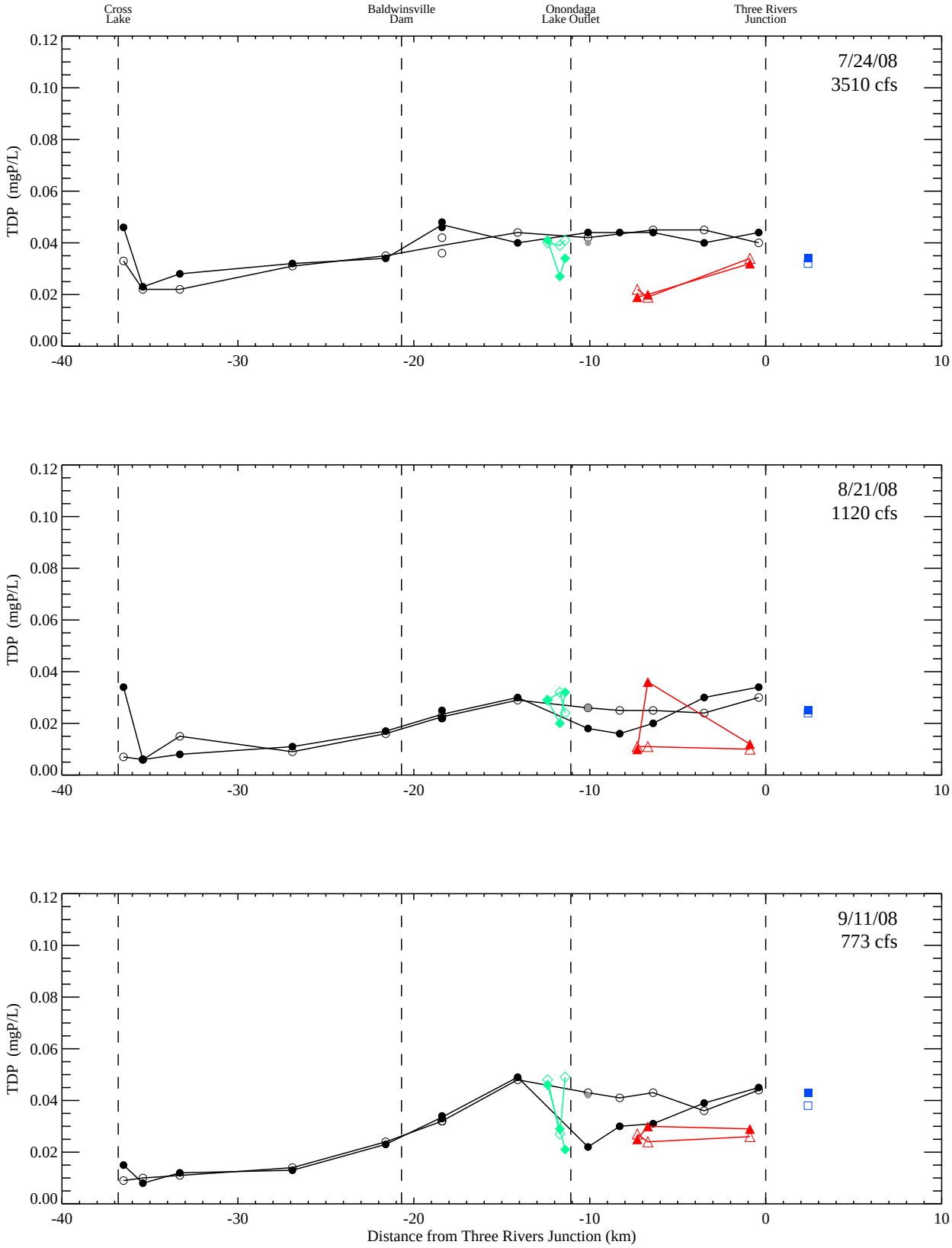
Fri Jun 12 21:00:01 2009

TDP



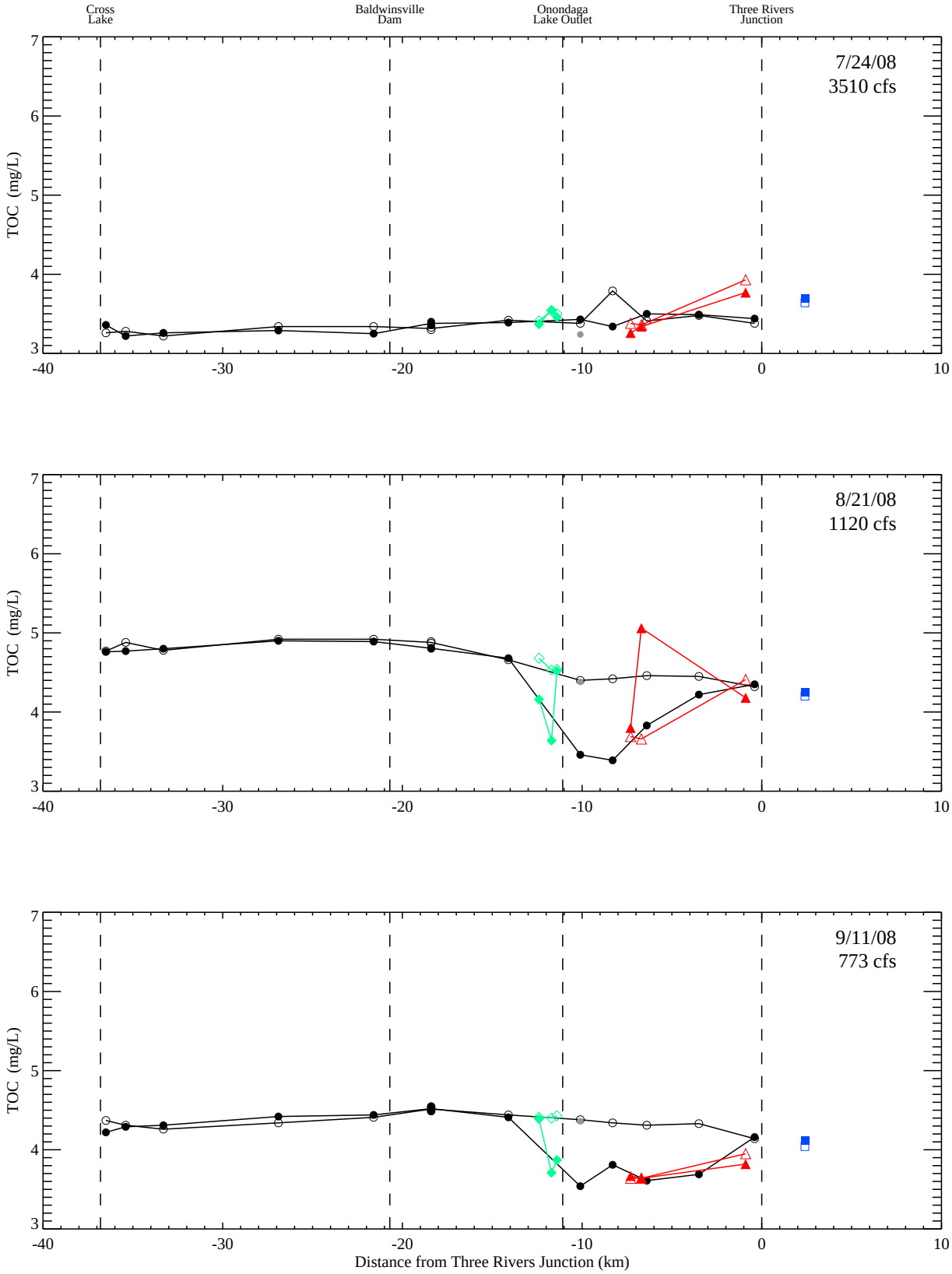
Spatial profiles of total dissolved P collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

IF - Z:\ONOamp\DOCUMENTS\Reports\2008_AMP_chapter\Figures\River_Appendix\FigA1_2_11__spatial_by_parameter.pro
Fri Jun 12 21:00:01 2009

TOC



Spatial profiles of TOC collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

- Seneca River
- Oneida River
- Oswego River
- Onondaga Lake Outlet

IF - Z:\ONOamp\DOCUMENTS\Reports\2008_AMP_chapter\Figures\River_Appendix\FigA1_2_11__spatial_by_parameter.pro
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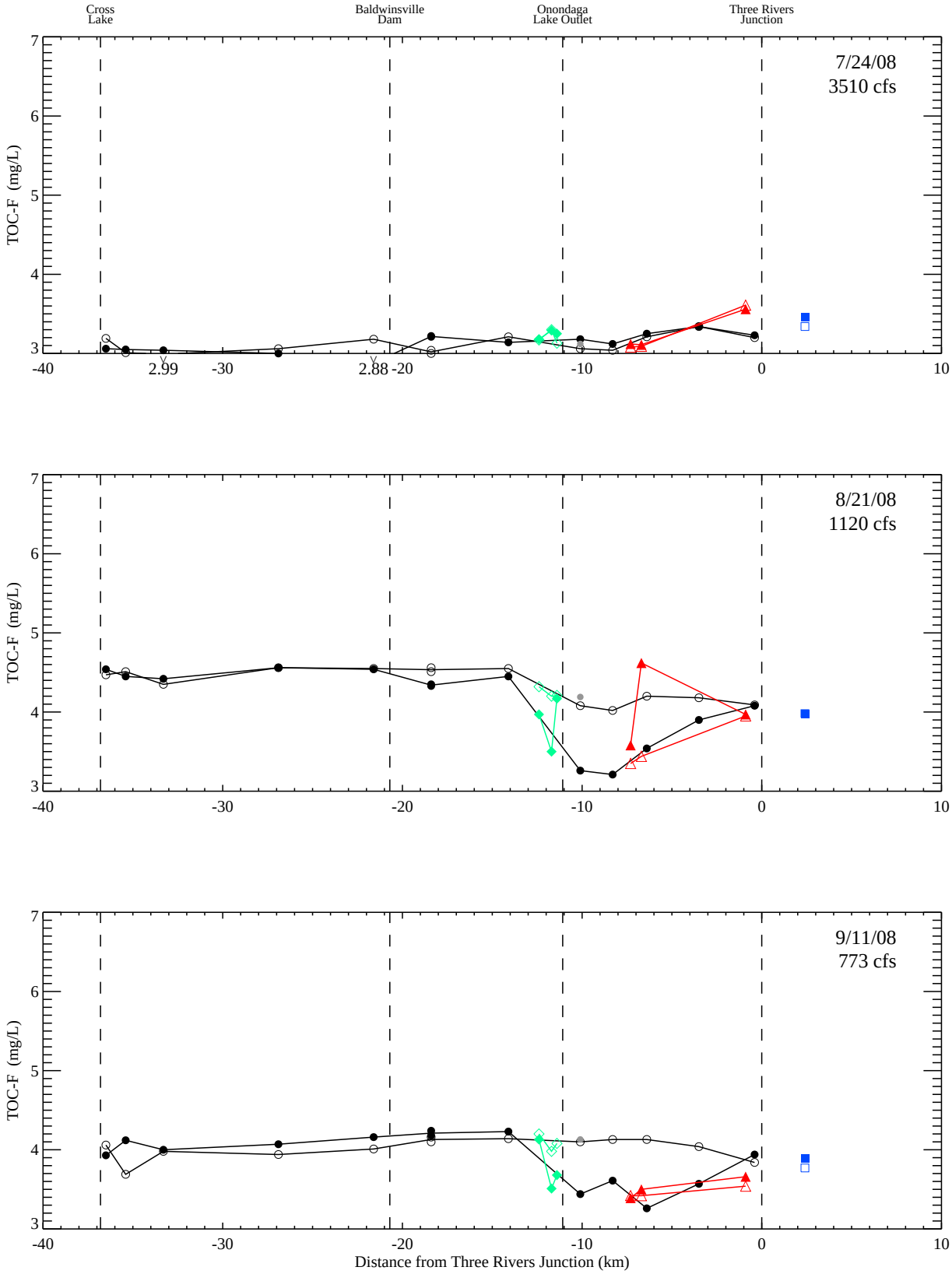
TOC-F



Spatial profiles of TOC (filtered) collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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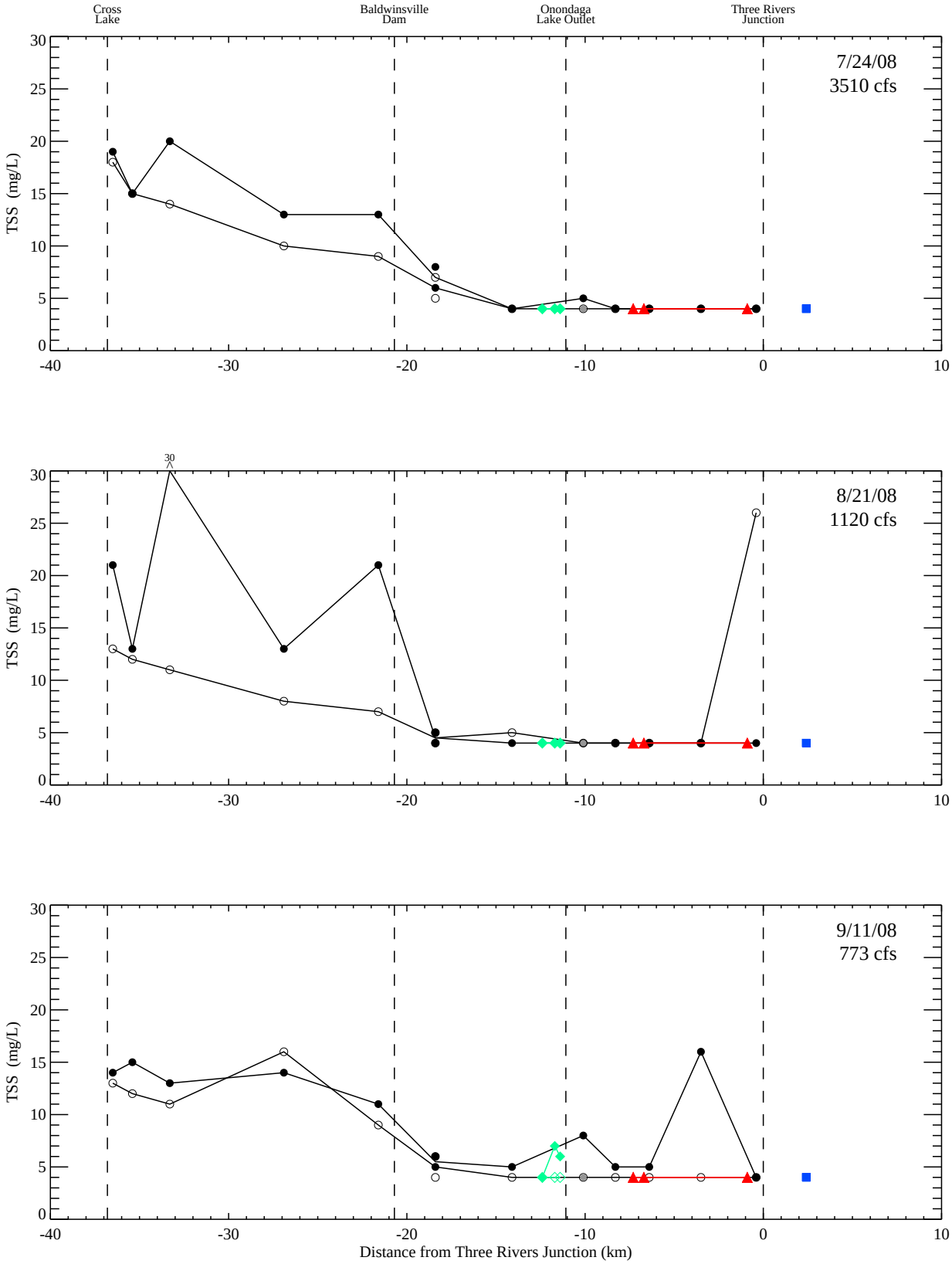
Fri Jun 12 21:00:01 2009

TSS



Spatial profiles of TSS collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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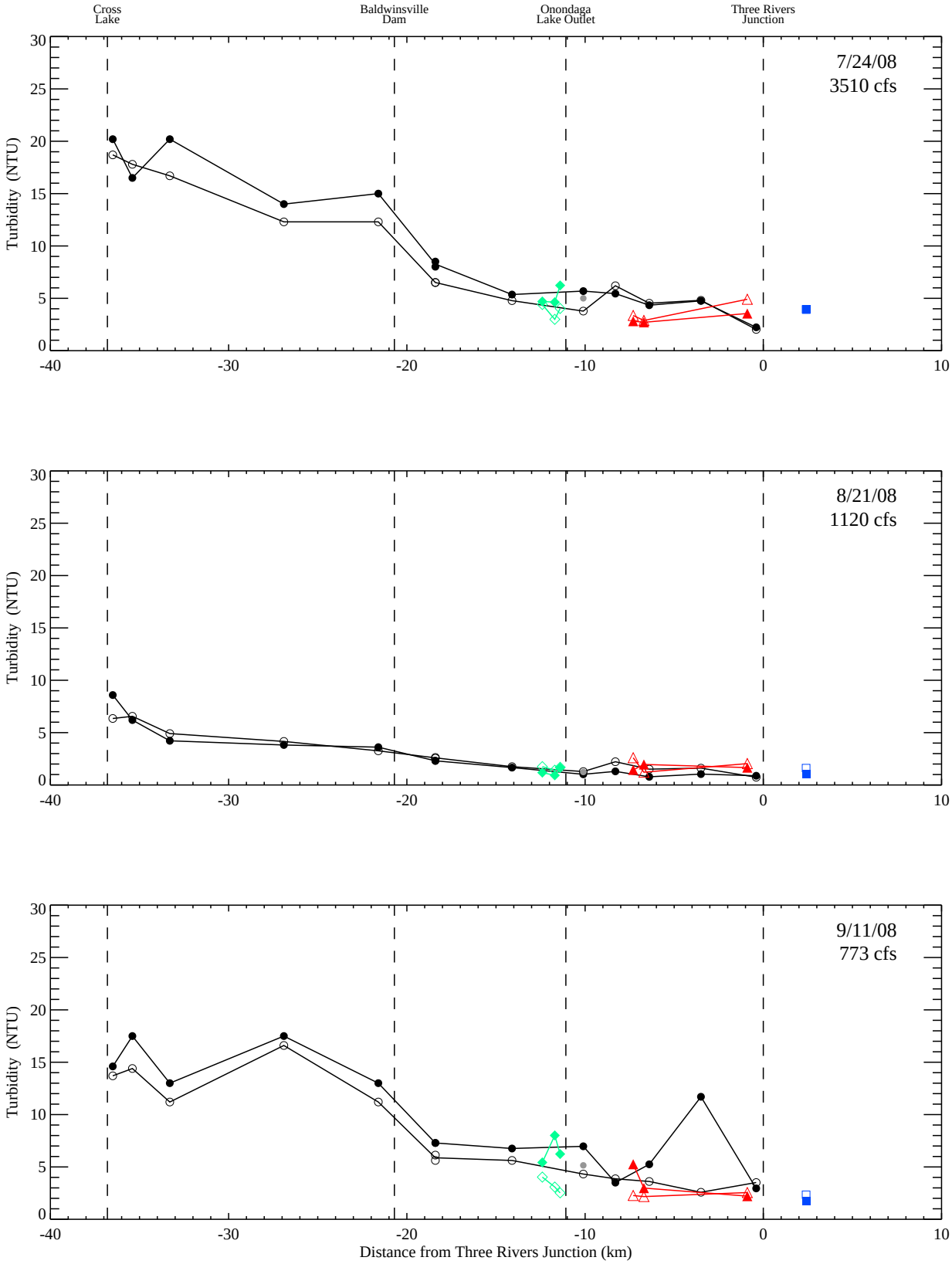
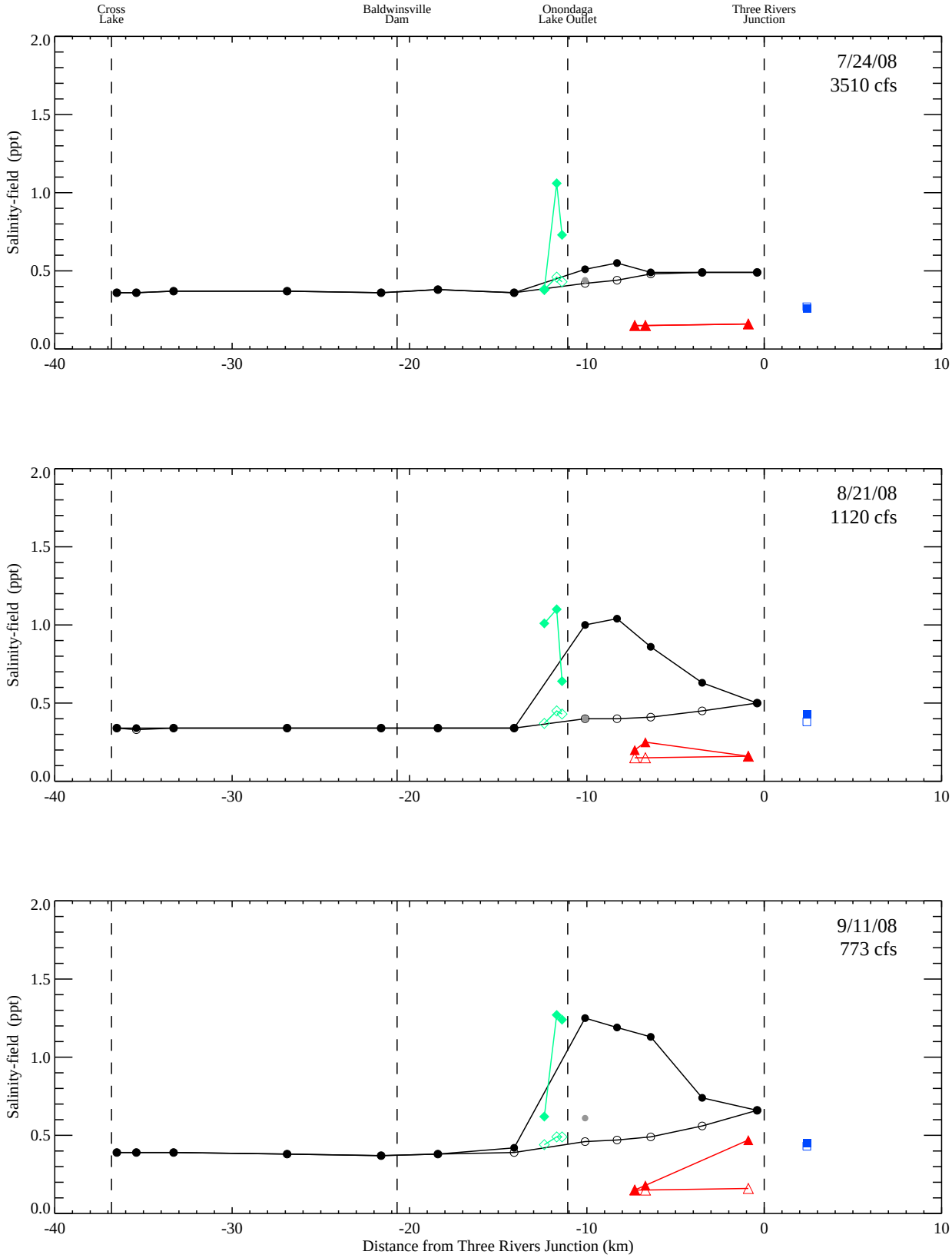
Turbidity



Spatial profiles of turbidity collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

Salinity-field



Spatial profiles of salinity collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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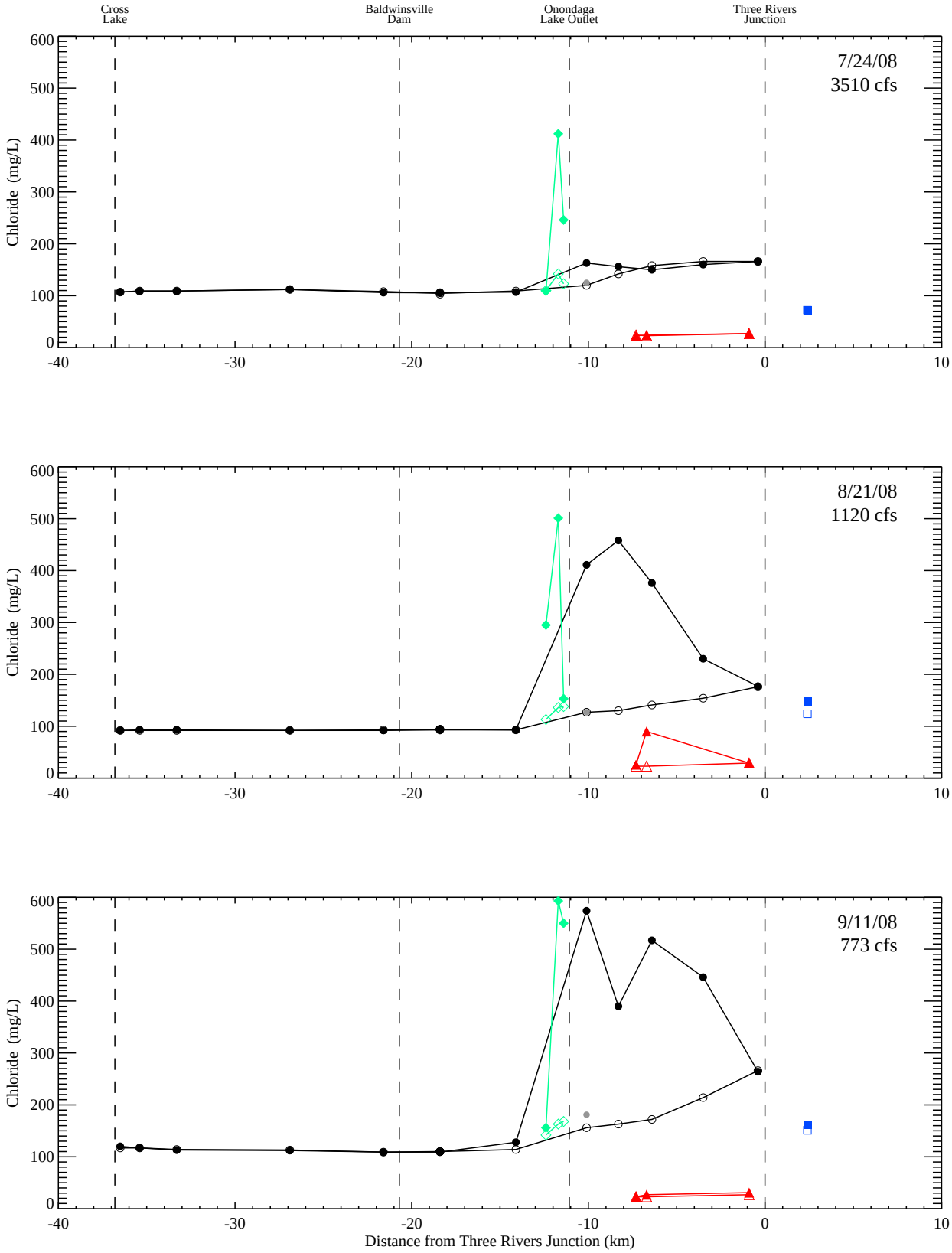
Chloride



Spatial profiles of chloride collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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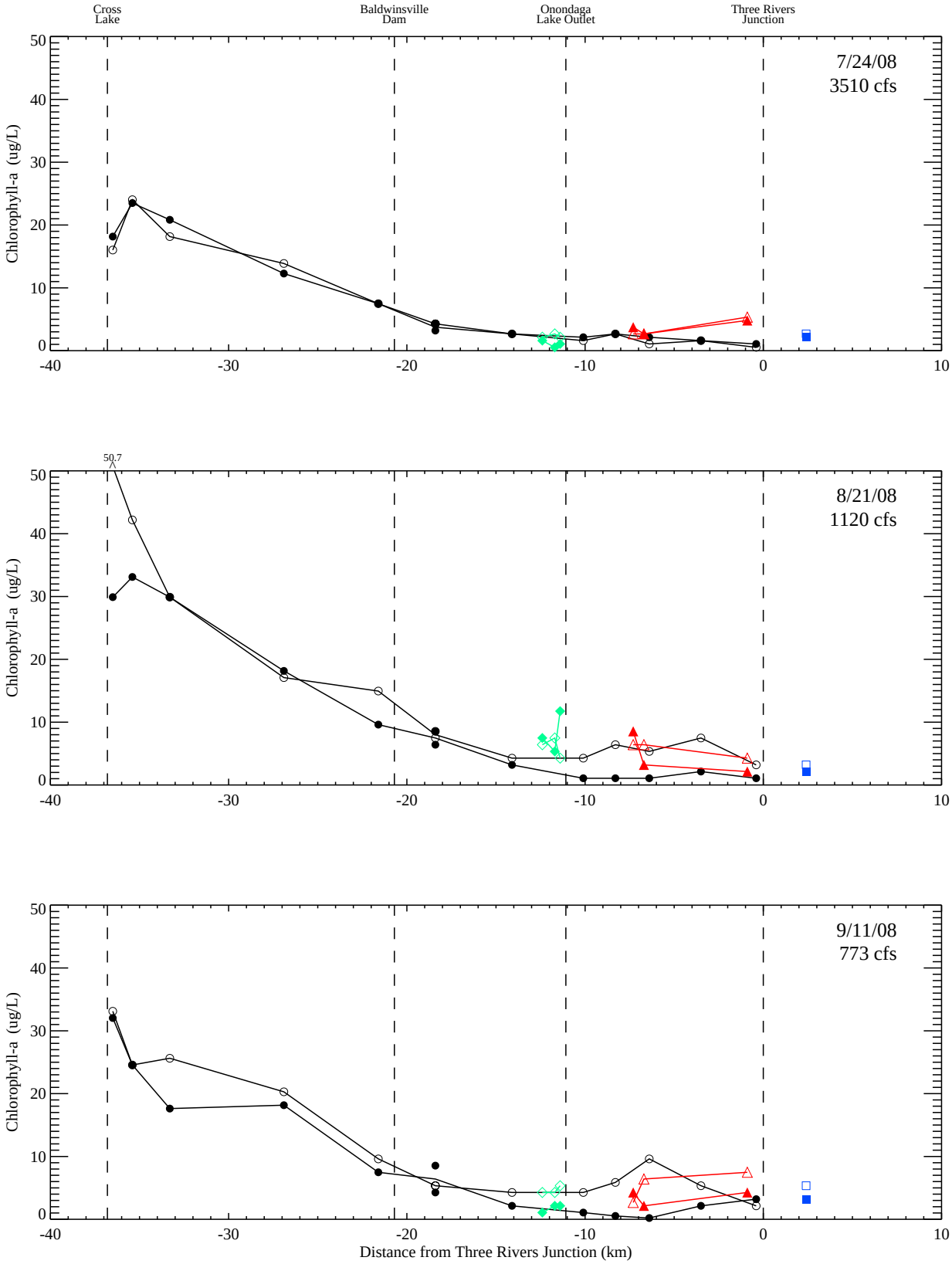
Chlorophyll-a



Spatial profiles of chlorophyll-a collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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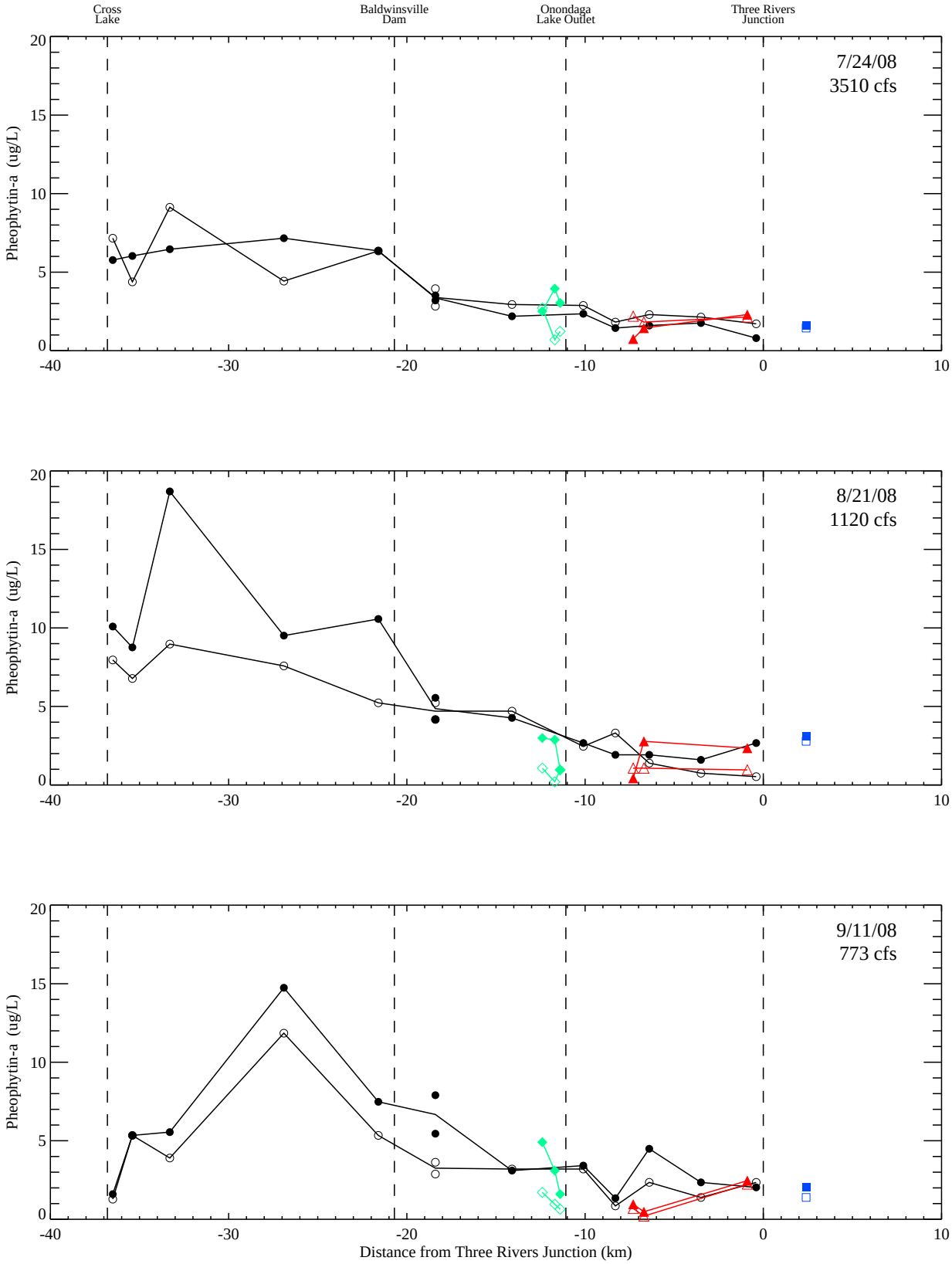
Pheophytin-a



Spatial profiles of pheophytin-a collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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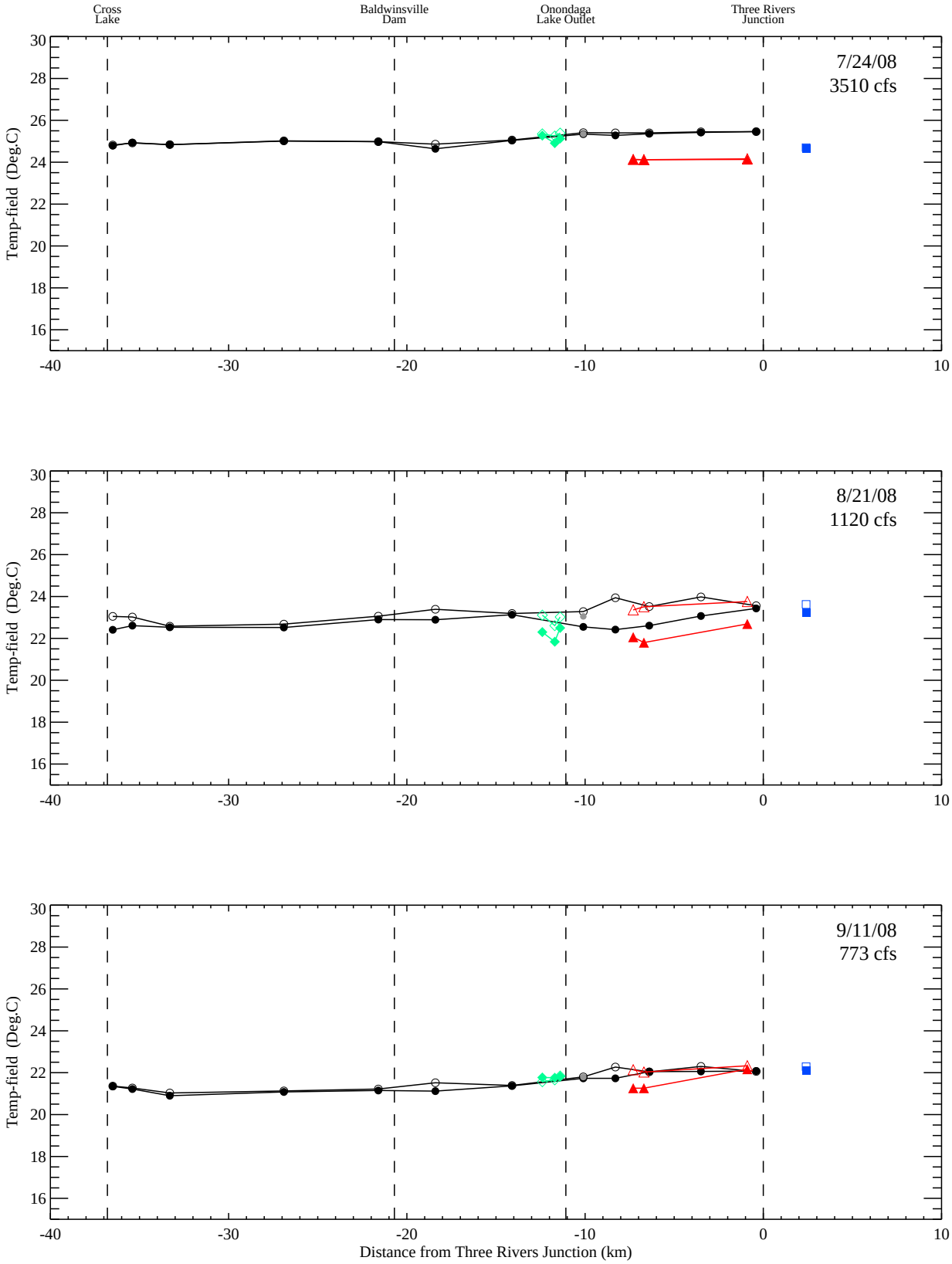
Temp-field



Spatial profiles of temperature collected from the Three Rivers System during 2008 .

Notes: (1)River km measured from Three Rivers Junction, upstream (-) for Seneca and Oneida / downstream (+) for Oswego; (2)Open symbols represent surface samples, filled symbols represent bottom samples, gray circles represent mid-depth samples, and open symbols with dots represent composite samples; (3)Baldwinsville flow on sampling dates shown in each panel.

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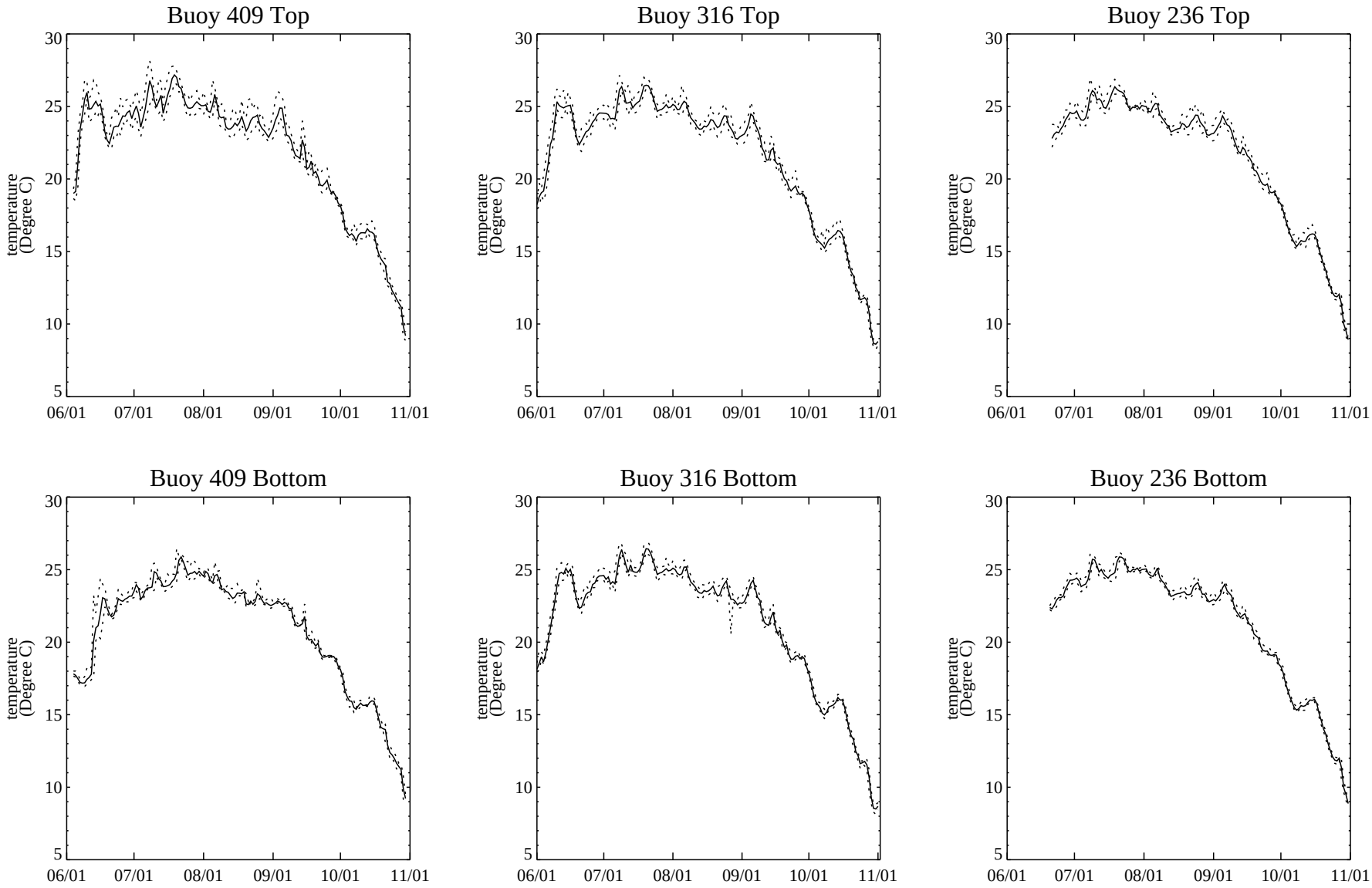

Temporal profiles of daily average and variations of temperature recorded by YSI sondes at Buoys 409, 316 and 236 during 2008 .

Notes: Results are only shown for days that at least half of the 15-minute instantaneous data were available.

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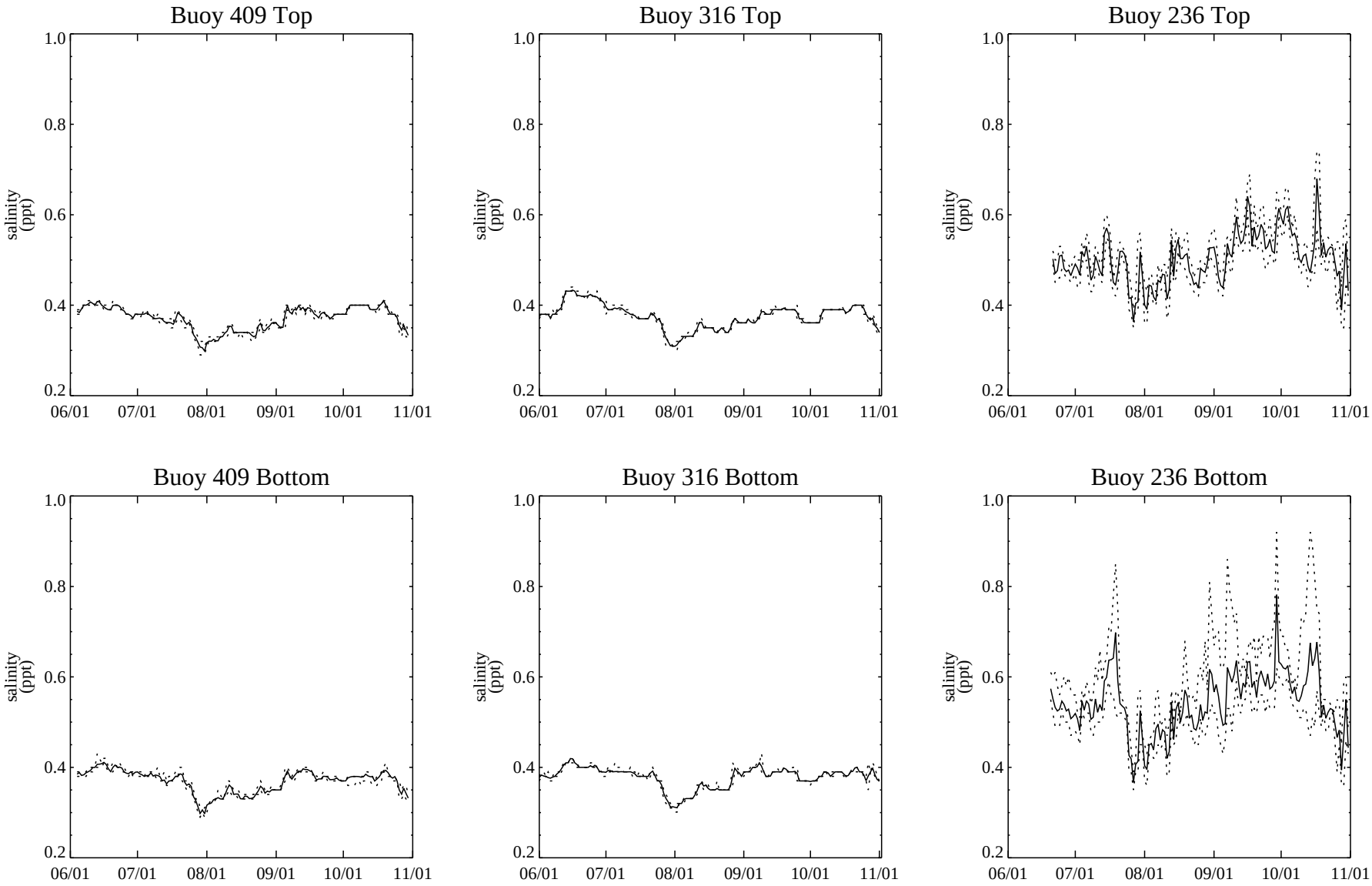

Temporal profiles of daily average and variations of salinity recorded by YSI sondes at Buoys 409, 316 and 236 during 2008 .

Notes: Results are only shown for days that at least half of the 15-minute instantaneous data were available.

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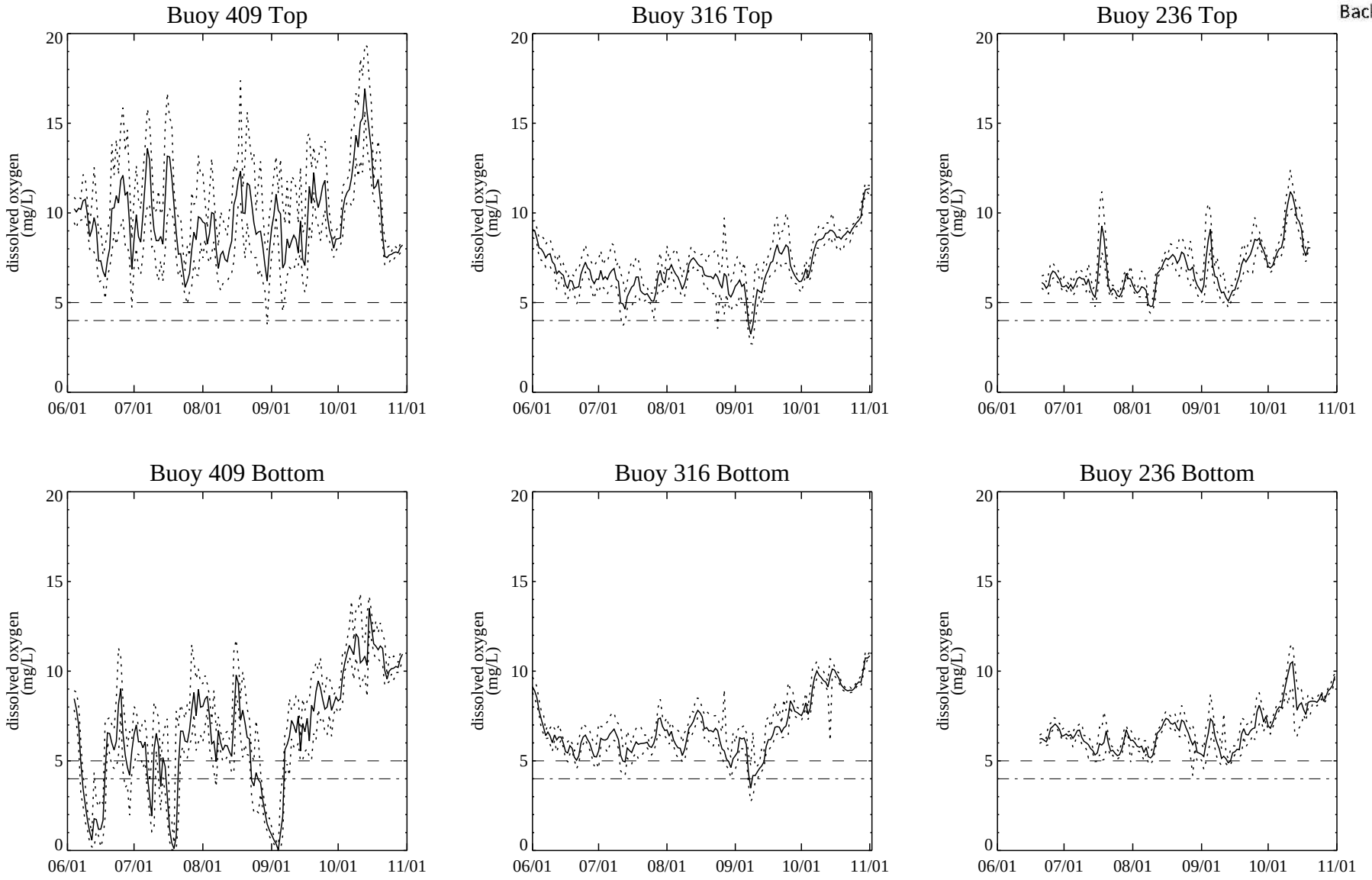

Temporal profiles of daily average and variations of dissolved oxygen recorded by YSI sondes at Buoys 409, 316 and 236 during 2008 .

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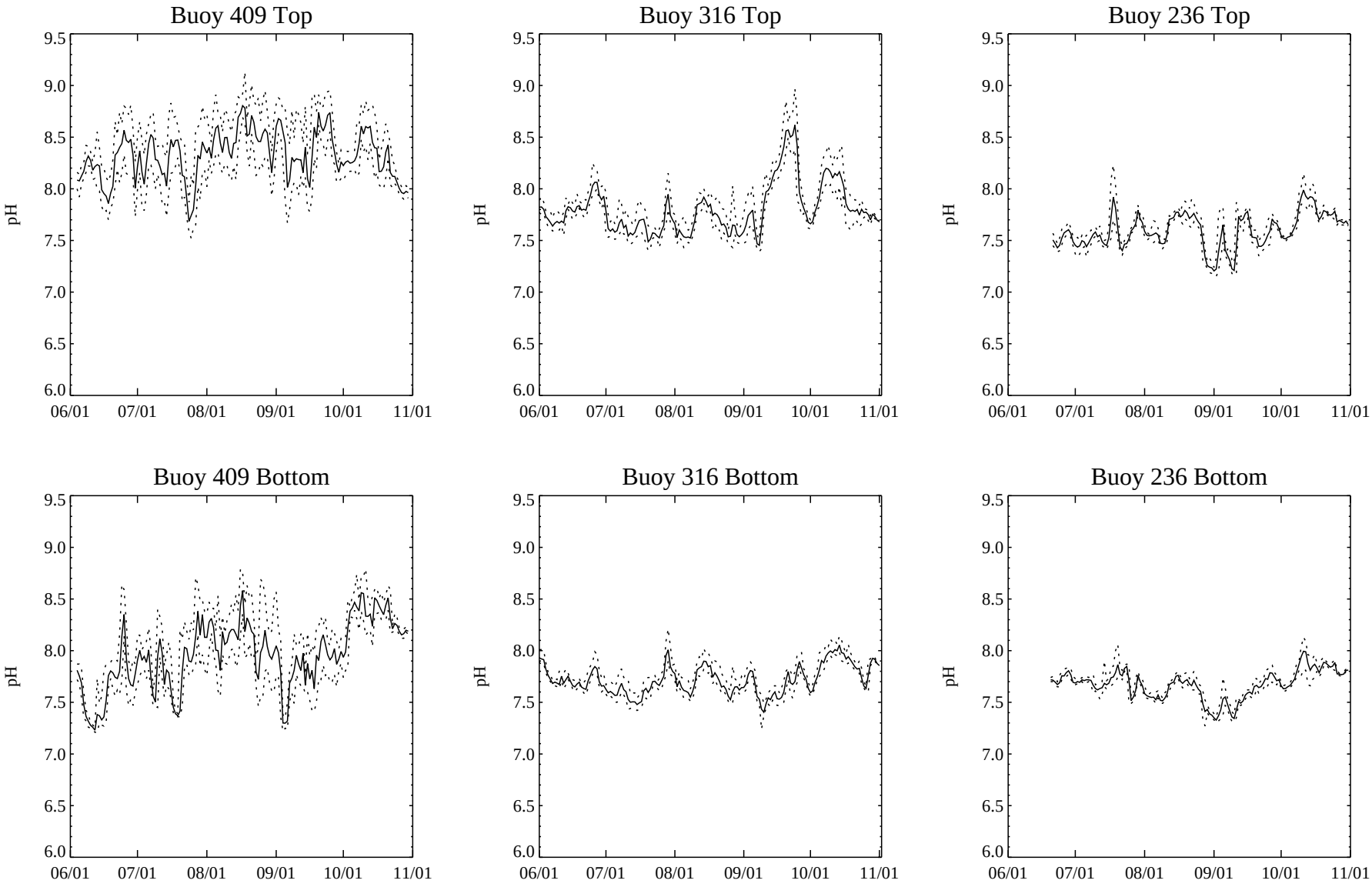

Temporal profiles of daily average and variations of pH recorded by YSI sondes at Buoys 409, 316 and 236 during 2008 .

Notes: Results are only shown for days that at least half of the 15-minute instantaneous data were available.

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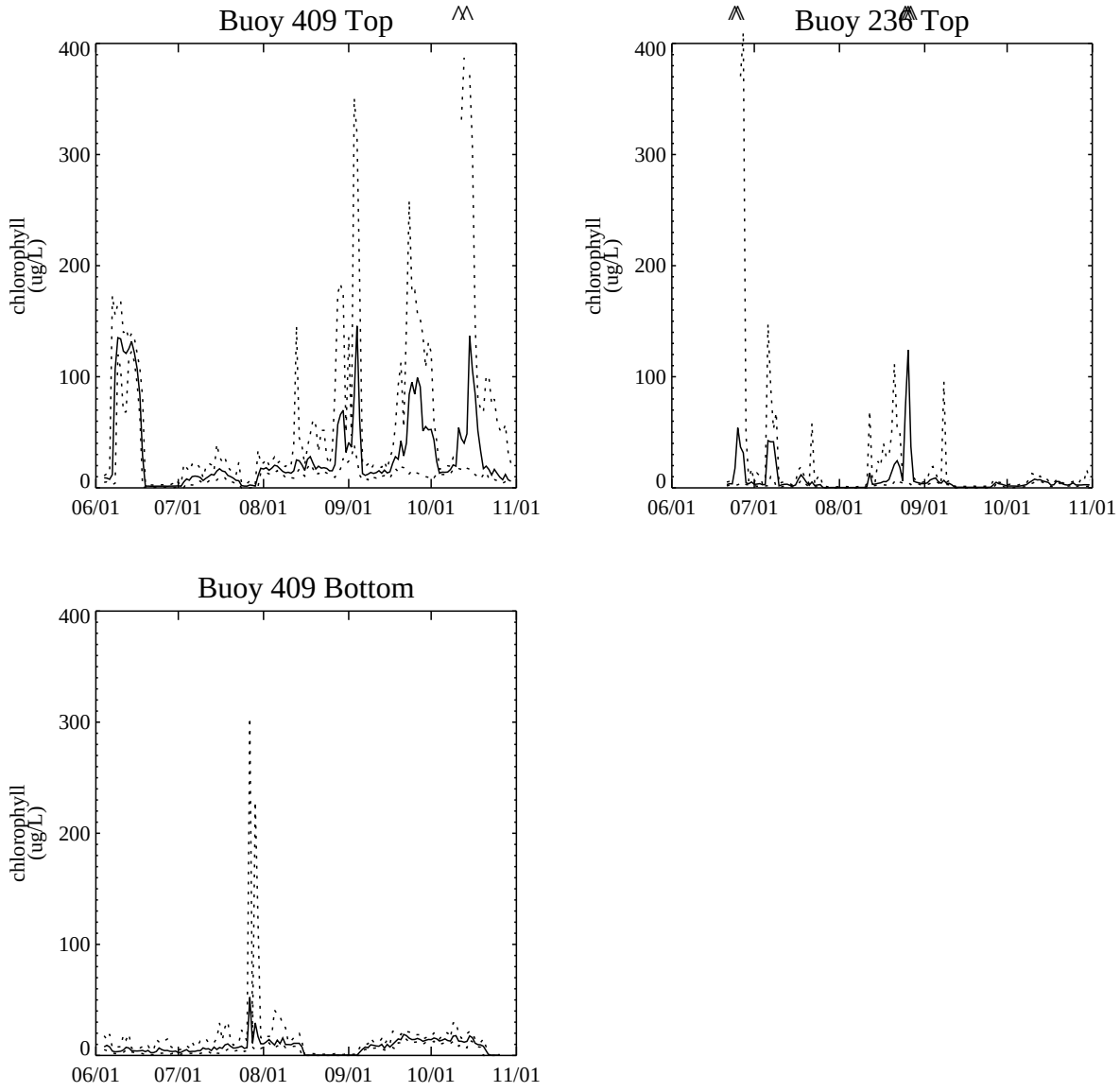

Temporal profiles of daily average and variations of chlorophyll recorded by YSI sondes at Buoys 409 and 236 during 2008 .

Notes: Results are only shown for days that at least half of the 15-minute instantaneous data were available.

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LIBRARY-SECTION 10
2008 ANALYTICAL DATA DISK

2008 AMP METROPOLITAN SYRACUSE WWTP MONITORING ANALYTICAL DATA

2008 AMP ONONDAGA LAKE IN_SITU MONITORING PROFILES DATA
2008 AMP ONONDAGA LAKE MONITORING ANALYTICAL DATA
2008 AMP ONONDAGA LAKE MONITORING LICOR DATA

2008 AMP ONONDAGA LAKE TRIBUTARIES FLOW DATA
2008 AMP ONONDAGA LAKE TRIBUTARIES IN-SITU MONITORING DATA
2008 AMP ONONDAGA LAKE TRIBUTARIES MONITORING ANALYTICAL DATA

2008 AMP SENECA RIVER IN_SITU MONITORING PROFILES DATA
2008 AMP SENECA RIVER MONITORING ANALYTICAL RESULTS
2008 AMP SENECA RIVER MONITORING LICOR DATA

2008 AMP STORM EVENTS MONITORING ANALYTICAL DATA

LIBRARY-SECTION 11
SUPPORTING DOCUMENTS

Library Reference 11.1

Chloride Evaluation Dewatering

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Lake South Deep: Chloride Concentrations Annual Averages (Std Error)

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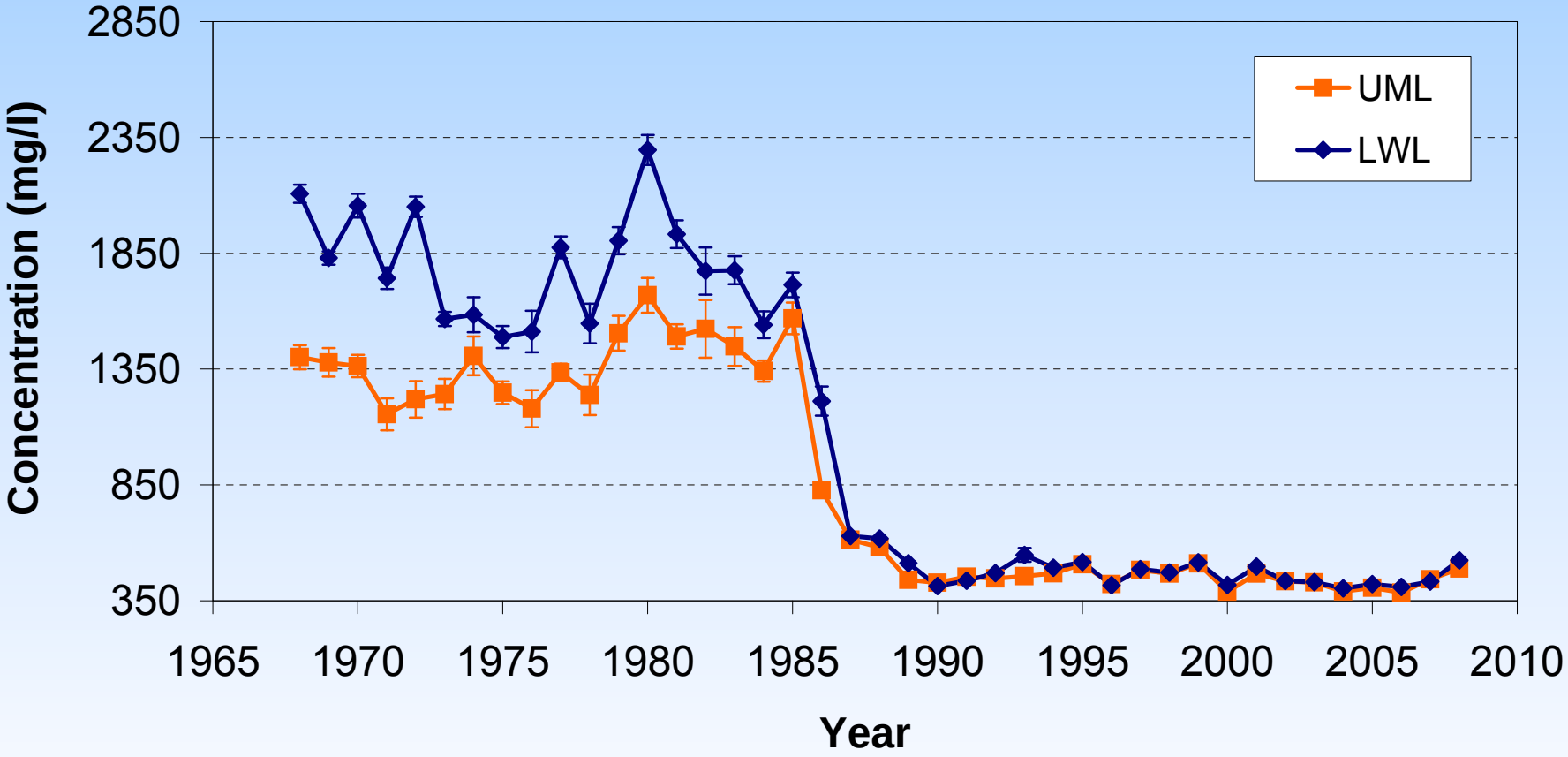

As part of the construction activities for the Clinton Regional Treatment Facility (RTF), major dewatering efforts were conducted. Significant chloride concentrations were measured in the dewatering effluent. The County obtained a special SPDES permit for the effluent, and has monitored chloride concentrations in the lake. Annual average chloride concentrations in upper and lower waters are shown here for the period 1968 to 2008. The Allied Signal soda ash production facility was closed in 1986, eliminating a significant source of chloride to the lake.

Library Reference 11.1.2

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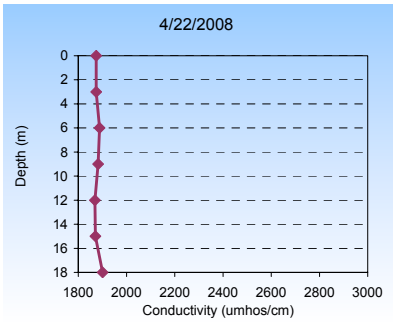
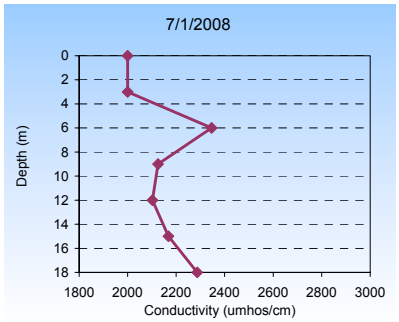
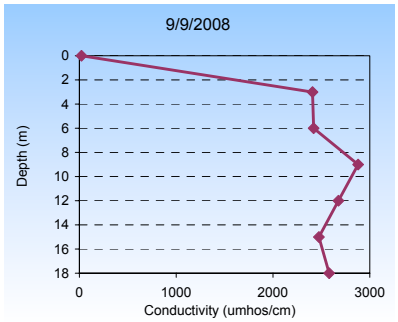
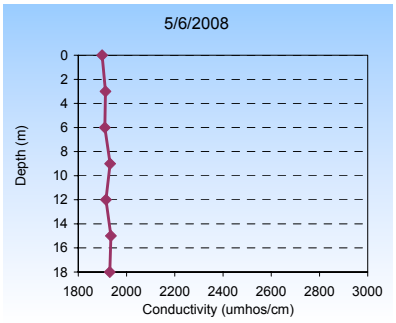
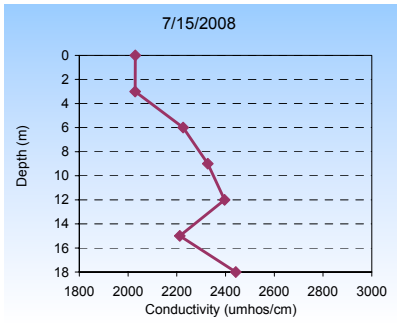
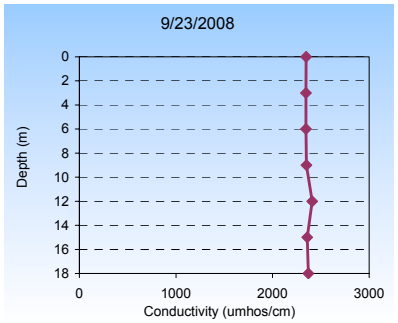


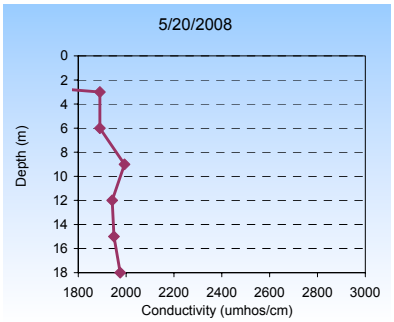


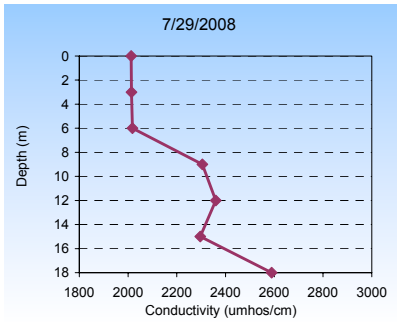


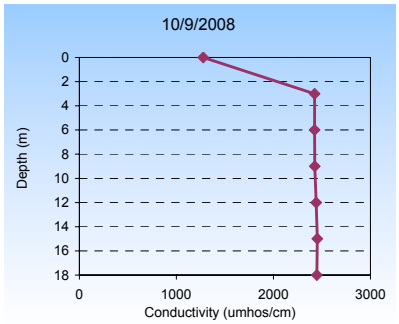


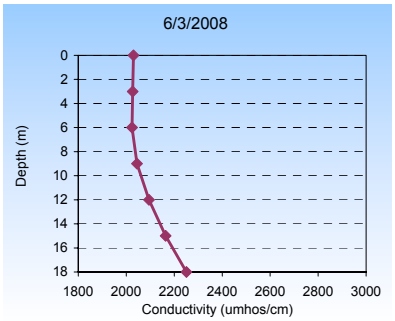


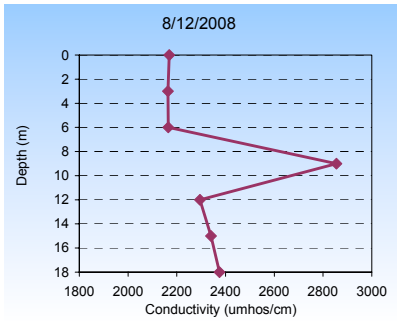


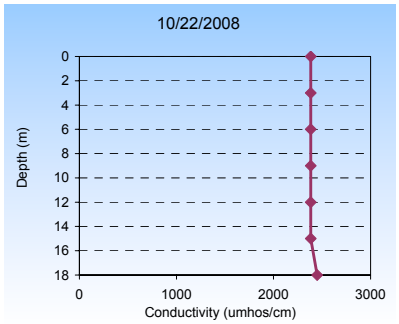


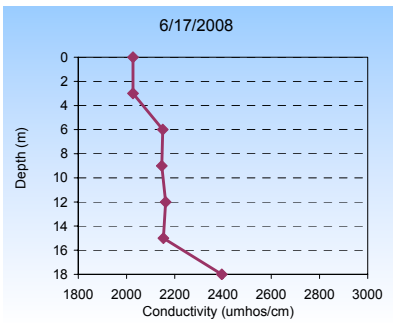


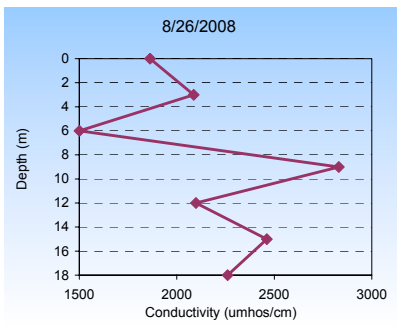




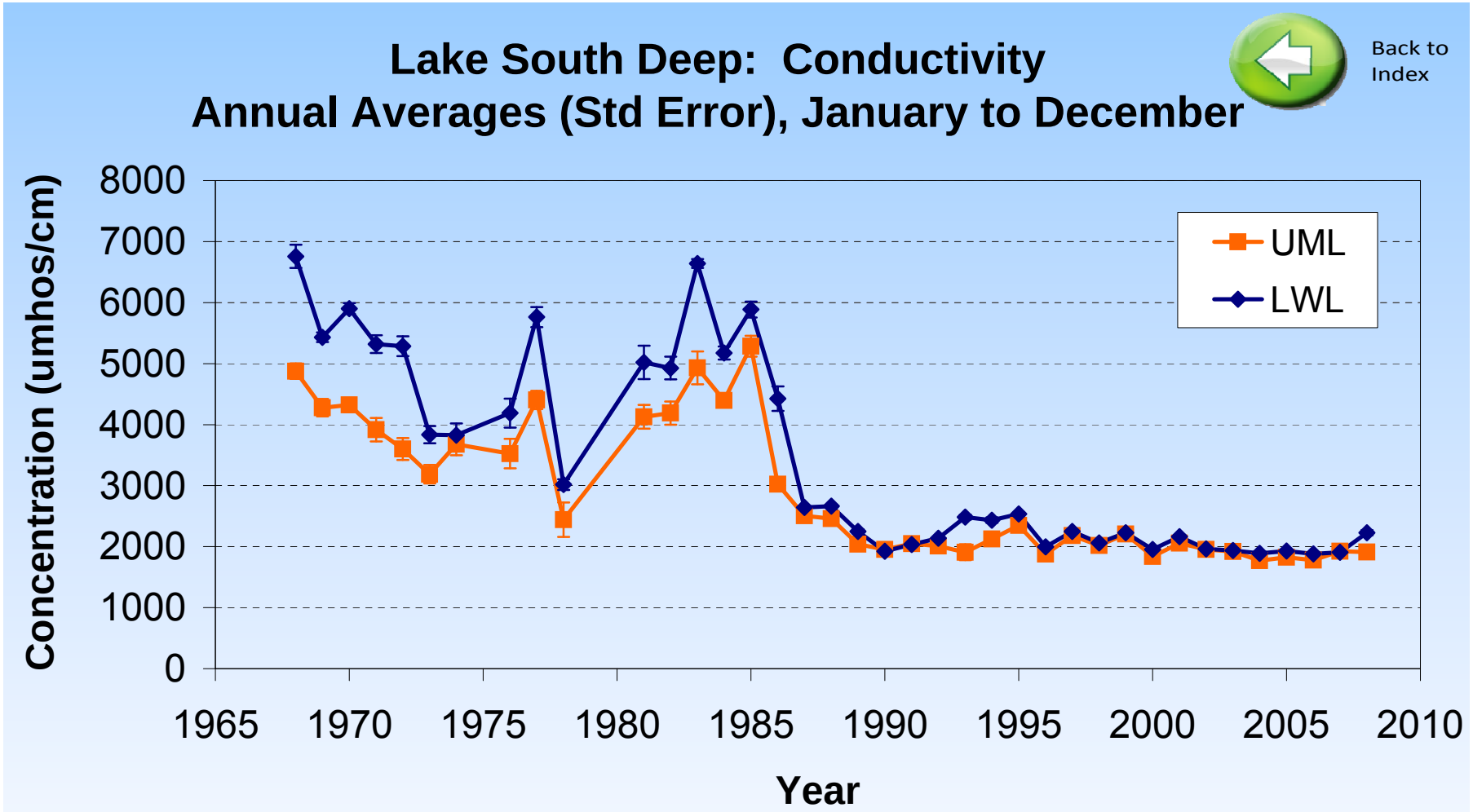








As part of the construction activities for the Clinton Regional Treatment Facility (RTF), major dewatering efforts were conducted. Significant chloride concentrations were measured in the dewatering effluent. The County obtained a special SPDES permit for the effluent, and has monitored chloride concentrations in the lake. Conductivity increases with increasing salinity, and is shown here as an indirect measure of salinity in the lake over time and with depth during 2008.



As part of the construction activities for the Clinton Regional Treatment Facility (RTF), major dewatering efforts were conducted. Significant chloride concentrations were measured in the dewatering effluent. The County obtained a special SPDES permit for the effluent, and has monitored chloride concentrations in the lake. Conductivity increases with increasing salinity, and is shown here as an indirect measure of average annual salinity in the lake for the period 1968 to 2008. The Allied Signal soda ash production facility was closed in 1986, eliminating a significant source of salinity to the lake.

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Lake and Tributary Compliance

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Regulatory compliance in Onondaga Lake tributaries, 2008.

Parameter (units)	NYSDEC Standard (Class C)[1]	2008 measured concentrations[2]		Measurements in Compliance
pH (standard units)	Shall not be less than 6.5 nor more than 8.5	NM :	7.54 - 8.46	100%
		OC :	6.18 - 8.21	99%
		LC :	6.62 - 8.16	100%
		HB :	7.22 - 8.36	100%
		5A :	7.42 - 8.4	100%
		EF :	7.98 - 9.01	38%
		BB :	7.59 - 8.25	100%
		SM :	7.34 - 8.01	100%
Dissolved Oxygen[3] (mg/l)	Minimum daily average 5.0 mg/l, at no time shall DO be < 4.0 mg/l	NM :	5.2 - 28.3	100% >4; 100% >5
		OC :	5.3 - 51.4	100% >4; 100% >5
		LC :	4 - 16.8	96% >4; 92% >5
		HB :	4.3 - 19.3	100% >4; 99% >5
		5A :	4.2 - 11.3	100% >4; 92% >5
		EF :	4.1 - 27.4	100% >4; 92% >5
		BB :	10.8 - 15.6	100% >4; 100% >5
		SM :	5.7 - 13.8	100% >4; 100% >5
Fecal Coliform[4] (cells/100 ml)	The monthly geometric mean of a minimum of five measurements not to exceed 200 cfu/100 ml.	NM :	5 - 1200	Not assessed, minimum sample number not met
		OC :	8 - 5800	
		LC :	109 - 6000	
		HB :	8 - 6000	
		5A :	5 - 530	
		EF :	5 - 1900	
		BB :	118 - 6000	
		SM :	40 - 1200	
Ammonia-N (mg/l)	Varies with pH and temperature.	NM :	0.12 - 0.46	100%
		OC :	< 0.01 - 0.41	100%
		LC :	0.13 - 0.66	100%
		HB :	< 0.01 - 0.19	100%
		5A :	0.07 - 0.22	100%
		EF :	0.08 - 1.02	54%
		BB :	0.05 - 0.15	100%
		SM :	0.03 - 0.31	100%
Arsenic[5,6] (µg/l)	150 µg/l	NM :	< 2 - 3.1	100%
		OC :	< 2 - 2.2	100%
		LC :	< 2 - 2.8	100%
		HB :	< 2 - 2.3	100%
		5A :	< 2 - 2.6	100%
		EF :	< 2 - 4.2	100%
		BB :	< 2 - 2.9	100%
		SM :	< 2 - 2.2	100%

Regulatory compliance in Onondaga Lake tributaries, 2008 (continued).

Parameter (units)	NYSDEC Standard (Class C)[1]	2008 measured concentrations[2]	Measurements in Compliance
Cyanide[6] (µg/l)	5.2 µg/l (Free CN)	NM : < 3.0	100%
		OC : < 3.0	100%
		LC : < 3.0 - 11.0	75%
		HB : < 3.0	100%
		5A : < 3.0	100%
		EF : < 3.0	100%
		BB : < 3.0	100%
		SM : < 3.0	100%
Nitrite-N (µg/l)	100 µg/l (Warm water fishery)	NM : < 10 - 80	100%
		OC : < 10 - 130	95%
		LC : < 10 - 80	100%
		HB : < 10 - 90	100%
		5A : < 10 - 120	96%
		EF : 280 - 3,200	0%
		BB : < 10 - 30	100%
		SM : < 10 - 30	100%
Copper[6,8] (µg/l)	0.96 exp (0.8545 [ln (ppm hardness)] - 1.702)		
	Standard Range (µg/l):		
	NM : 28 - 67	NM : < 3.1 - 4.2	100%
	OC : 20 - 36	OC : < 3.1 - 22.8	100%
	LC : 18 - 34	LC : < 3.1 - 5.6	100%
	HB : 29 - 71	HB : < 3.1 - 7.8	100%
	5A : 25 - 31	5A : 22.2 - 66.3	50%
	EF : 23 - 38	EF : < 3.1 - 6.5	100%
	BB : 10 - 49	BB : 3.3 - 7.2	100%
	SM : 12 - 46	SM : < 3.1	100%
Mercury[6,7] (µg/l)	0.0007 µg/l	NM : < 0.020	*See note*
		OC : < 0.020 - 0.056	*See note*
		LC : < 0.020 - 0.046	*See note*
		HB : < 0.020 - 0.025	*See note*
		5A : < 0.020 - 0.025	*See note*
		EF : 0.041 - 0.114	0%
		BB : < 0.020	*See note*
		SM : < 0.020	*See note*
Lead[6,8] (µg/l)	(1.46203 - [ln (hardness) 0.145712]) exp (1.273 [ln (hardness)] - 4.297)		
	Standard Range (µg/l):		
	NM : 16 - 43	NM : < 2.0 - 5.2	100%
	OC : 10 - 21	OC : < 2.0 - 18.9	100%
	LC : 9 - 20	LC : < 2.0 - 2.8	100%
	HB : 16 - 46	HB : < 2.0 - 2.6	100%
	5A : 14 - 18	5A : < 2.0 - 8.3	100%
	EF : 12 - 22	EF : < 2.0 - 2.8	100%
	BB : 4 - 30	BB : < 2.0 - 3.5	100%
	SM : 5 - 28	SM : < 2.0	100%

Regulatory compliance in Onondaga Lake tributaries, 2008 (continued).

Parameter (units)	NYSDEC Standard (Class C)[1]	2008 measured concentrations[2]	Measurements in Compliance
Cadmium[6,8] (µg/l)	0.85 exp (0.7852 [ln (ppm hardness)] - 2.715)		
	Standard Range (µg/l):		
	NM : 6 - 13	NM : < 0.80	100%
	OC : 4 - 8	OC : < 0.80	100%
	LC : 4 - 7	LC : < 0.80	100%
	HB : 6 - 14	HB : < 0.80	100%
	5A : 5 - 7	5A : < 0.80	100%
	EF : 5 - 8	EF : < 0.80	100%
	BB : 2 - 10	BB : < 0.8 - 2.9	100%
	SM : 3 - 9	SM : < 0.80	100%
Zinc[6,8] (µg/l)	exp (0.85 [ln (ppm hardness)] + 0.50)		
	Standard Range (µg/l):		
	NM : 256 - 616	NM : < 6.3 - 61.3	100%
	OC : 183 - 334	OC : < 1.8 - 55.5	100%
	LC : 165 - 310	LC : < 6.3 - 18.0	100%
	HB : 268 - 647	HB : < 6.3 - 18.8	100%
	5A : 231 - 288	5A : 7.4 - 33.8	100%
	EF : 208 - 344	EF : 12.4 - 27.8	100%
	BB : 94 - 448	BB : 8.6 - 34.5	100%
	SM : 109 - 419	SM : < 6.3 - 19.0	100%
Chromium[6,8] (µg/l)	0.86 exp (0.819 [ln (ppm hardness)] + 0.6848)		
	Standard Range (µg/l):		
	NM : 220 - 513	NM : < 2.5 - 2.7	100%
	OC : 160 - 285	OC : < 2.5 - 7.8	100%
	LC : 144 - 265	LC : < 2.5	100%
	HB : 231 - 538	HB : < 2.5	100%
	5A : 200 - 247	5A : 34.3 - 142.0	100%
	EF : 181 - 293	EF : < 2.5 - 2.6	100%
	BB : 84 - 378	BB : < 2.5	100%
	SM : 97 - 354	SM : < 2.5	100%
Iron (µg/l)	300 µg/l (current) ; 1000 µg/l (proposed)	NM : 309 - 1910	0% <300; 85% <1000
		OC : 152 - 14200	8% <300; 67% <1000
		LC : 472 - 7030	0% <300; 73% <1000
		HB : < 50 - 7350	69% <300; 89% <1000
		5A : 452 - 5620	0% <300; 42% <1000
		EF : < 50 - 1830	62% <300; 96% <1000
		BB : 147 - 936	46% <300; 100% <1000
		SM : 158 - 849	8% <300; 100% <1000

Regulatory compliance in Onondaga Lake tributaries, 2008 (continued).

Parameter (units)	NYSDEC Standard (Class C)[1]	2008 measured concentrations[2]	Measurements in Compliance
Nickel[6,8] (µg/l)	0.997 exp (0.846 [ln (ppm hardness)] + 0.0584)		
	Standard Range (µg/l):		
	NM : 160 - 384	NM : < 3.8	100%
	OC : 115 - 209	OC : < 3.8 - 12.4	100%
	LC : 103 - 194	LC : < 3.8	100%
	HB : 168 - 403	HB : < 3.8	100%
	5A : 145 - 180	5A : 75.8 - 180.0	100%
	EF : 131 - 215	EF : < 3.8	100%
	BB : 59 - 280	BB : < 3.8 - 4.1	100%
	SM : 69 - 262	SM : < 3.8	100%

Notes:

[1] Standard values are derived from NYSDEC Ambient Water Quality Standards and Guidance Values, 1993, for Class B and C surface waters and 6NYCRR Part 703, with Jan. 1994 updates for bacteria and zinc; and 1998 updates for metals.

[2] 2008 data are reported for each tributary. Samples were obtained at several sites on certain streams. Tributary abbreviations:
NM = Ninemile Creek at Lakeland Route 48, OC = Onondaga Creek at Kirkpatrick Street and Dorwin Avenue;
LC = Ley Creek at Park Street; HB = Harbor Brook at Velasko Road and Hiawatha Boulevard;
HB(H) = Harbor Brook at Hiawatha Boulevard; HB(V) = Harbor Brook at Velasko Road; 5A = Tributary 5A;
EF = East Flume; BB = Bloody Brook at Onondaga Lake Parkway; SM = Sawmill Creek at Onondaga Lake Recreation Trail
Unless otherwise noted, measured concentrations shown reflect the range from minimum to maximum for samples collected throughout the year. Where a single value is shown with a "<" beside it, results did not exceed the minimal reportable limit.

[3] Dissolved oxygen concentrations shown represent the results for individual samples for the period of measurement.

[4] Fecal coliform bacteria compliance in tributaries is not assessed. There are generally fewer than five samples collected at each location each month, therefore the geometric mean standard (which requires a minimum of 5 samples) cannot be applied.

[5] Standard value applies to dissolved fraction, though currently only acid soluble, total recoverable fraction is measured within the monitoring program. Standard values for all other metals apply to acid soluble, total recoverable fraction.

[6] Averages derived from observations made during quarterly sampling. All other averages derived from observations made during the bi-weekly sampling program. Calculations use the laboratory minimum reportable limit when observations are below that limit.

[7] Mercury limit of detection is 0.02 µg/l, which is two orders of magnitude greater than the compliance value of 0.0007 µg/l. 70% of the analytical results were below the limit of detection. Given this data set, it is impossible to ascertain whether mercury reported as non-detect to 0.02 µg/l was present in the samples at levels below the compliance value of 0.0007 µg/l; therefore an accurate percent compliance cannot be calculated.

[8] The actual values for sample hardness were used to calculate compliance. Federal criteria for metals cap the hardness at 400 mg/l. 2008 average hardness for tributaries (calculated from database; units ppm):

NM - 712	OC - 355	LC - 393	HB - 768
5A - 386	EF - 361	BB - 506	SM - 509

Regulatory compliance in Onondaga Lake waters (South Deep), 2008.

Parameter (units)	NYSDEC Standard (Class B&C)[1]	2008 measured concentrations[2]		Measurements in Compliance
pH (standard units)	Shall not be less than 6.5 nor more than 8.5	UML:	6.7 - 8.2	100%
		LWL:	6.9 - 7.9	100%
Dissolved Oxygen[3] (mg/l)	Minimum daily average 5.0 mg/l, at no time shall DO be < 4.0 mg/l (15-min buoy data, 2m and 12m depths)	UML:	6.7 (Daily)	100%>5
			5.8 (15-min.)	100%>4
		LWL:	0 (Daily)	47%>5
			0 (15-min.)	49%>4
Dissolved Solids (mg/L)	Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/L	UML:	1076 - 1508	0%
		LWL:	1086 - 1686	0%
Fecal Coliform[4] (cells/100 ml)	The monthly geometric mean, from a minimum of five examinations, shall not exceed 200 cfu/100ml during disinfection period Apr 1 to Oct 15. *showing monthly geometric mean with number of measurements used in geometric mean.*	0 m - Apr:	46 (5)	100%
		May:	8 (5)	
		Jun:	10 (5)	
		Jul:	8 (5)	
		Aug:	37 (5)	
		Sep:	13 (7)	
		Oct:	N = 2	
		Nearshore (Class B five stations) - Apr:	13 (25)	100%
		May:	6 (24)	
		Jun:	8 (25)	
		Jul:	11 (25)	
		Aug:	8 (25)	
		Sep:	10 (35)	
		Oct:	7 (10)	
Ammonia-N (mg/l)	Standard varies with pH and temperature	0 m:	0.03 - 0.03	100%
		3 m: <	0.04 - 0.46	100%
		6 m:	0.04 - 0.43	100%
		9 m:	0.04 - 0.46	100%
		12 m:	0.1 - 0.47	100%
		15 m:	0.07 - 0.55	100%
		18 m:	0.1 - 0.95	100%
Arsenic [5,6] (ug/l)	150 ug/l	UML:	< 2.0	100%
		LWL:	< 2.0	100%
Nitrite-N (ug/l)	100 ug/L (warm water fishery)	UML:	20 - 60	100%
		LWL:	< 10 - 100	95%
Copper [6,7] (ug/l)	0.96 exp (0.8545 [ln (ppm hardness)] - 1.702) Standard Range (ug/l): 28 - 34	UML:	< 3.1	100%
		LWL:	< 3.1 - 3.7	100%

Regulatory compliance in Onondaga Lake waters (South Deep), 2008. (continued)

Parameter (units)	NYSDEC Standard (Class B&C)[1]	2008 measured concentrations[2]	Measurements in Compliance
Mercury[9] (ng/l)	0.7 ng/l	3 m: 1.23 - 7.88 18 m: 1.77 - 12	0% 0%
Lead [6,7] (ug/l)	(1.46203 - [ln (hardness) 0.145712]) exp (1.273 [ln (hardness)] - 4.297) Standard Range (ug/l): 16 - 20	UML: < 2.0 LWL: < 2.0	100% 100%
Cadmium[6,7] (ug/l)	0.85 exp (0.7852 [ln (ppm hardness)] - 2.715) Standard Range (ug/l): 6 - 7.1	UML: < 0.80 LWL: < 0.80	100% 100%
Zinc [6,7] (ug/l)	exp (0.85 [ln (ppm hardness)] + 0.50) Standard Range (ug/l): 258 - 311	UML: < 6.3 - 11.5 LWL: < 6.3 - 62.5	100% 100%
Chromium[6,7] (ug/l)	0.86 exp (0.819 [ln (ppm hardness)] + 1.561) Standard Range (ug/l): 222 - 266	UML: < 2.5 LWL: < 2.5	100% 100%
Iron (ug/l)	300 ug/l (current) ; 1000 ug/l (proposed)	UML: < 50 - 536 LWL: < 50 - 416	95% <300; 100% <1000 95% <300; 100% <1000
Nickel[6,7] (ug/l)	0.997 exp (0.846 [ln (ppm hardness)] + 0.0584) Standard Range (ug/l): 161 - 194	UML: < 3.8 LWL: < 3.8 - 3.9	100% 100%
Total Phosphorus [8] (ug/L)	None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages. Guidance value of 20 ug/L summer average. *1 m, biweekly, June 1 – Sept 30 average*	1 m: 13	100%

Notes:

[1] Standard values are derived from NYSDEC Ambient Water Quality Standards and Guidance Values, 1993, for Class B and C surface waters and 6NYCRR Part 703, with Jan. 1994 updates for bacteria and zinc; and 1998 updates for metals.

[2] South Deep sample locations: UML = upper mixed layer; LWL = lower water layer; m = meters depth of a sample. Nearshore sample locations: Metro = mid-south near Metro/Outfall; Ley Crk = near mouth of Ley Creek; Bloody Brk = near mouth of Bloody Brook; Onondaga Lake Park = east side; Willow Bay = Willow Bay; Maple Bay = Maple Bay; Ninemile Crk = Ninemile Creek; Wastebeds = near Wastebeds on west side; Harbor Brk = Harbor Brook. Unless otherwise noted, measured concentrations shown reflect the range from minimum to maximum for samples collected throughout the year. Where a single value is shown with a "<" beside it, results did not exceed the minimal reportable limit.

[3] Dissolved oxygen concentrations shown represent the minimum daily average ("daily") and the instantaneous reading ("15 min") for the period of measurement throughout the year. Probe errors at 2m depth were replaced with 6m readings and verified with field profile data. Periods where this occurred: May 10-14 and October 4-9.

[4] Fecal coliform compliance was assessed as the geometric mean of a minimum of 5 samples a month during the period of disinfection from April 1 to October 15. NYCRR Part 895. Class B monitoring stations include North Deep, Bloody Brook, Onondaga Lake Park, Willow Bay, Maple Bay and Westside Wastebeds.

[5] Standard applies to dissolved fraction, though currently only acid soluble, total recoverable fraction is measured within the monitoring program. Standards for all other metals apply to acid soluble, total recoverable fraction.

[6] Averages derived from observations made during quarterly sampling. All other averages derived from observations made during the bi-weekly sampling program. Calculations use the laboratory limit of detection when observations are below that limit.

[7] Actual sample results for hardness were used to calculate compliance. Federal criteria for metals cap the hardness at 400 mg/l. 2008 average hardness for Onondaga Lake South Deep was 437 ppm.

[8] Guidance value of 20 ug/l from New York State Ambient Water Quality Standards and Guidance Values, June, 1998. TOGS 1.1.1.

[9] Range of 2008 total mercury concentrations shown for low-level analytical results by EPA Method 1631

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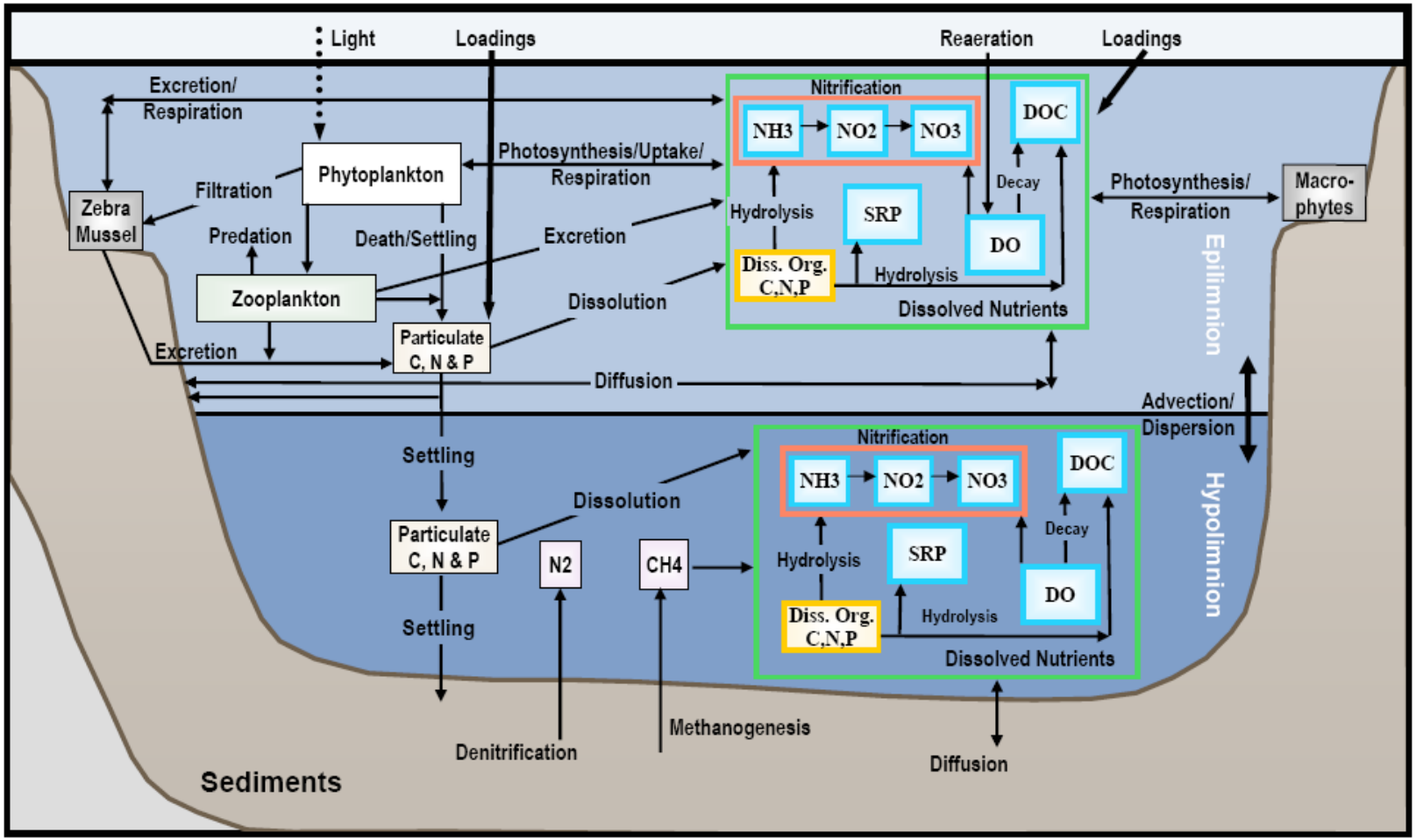

Conceptual diagram of major state variables and processes represented within the Onondaga Lake Water Quality Model (OLWQM).

Onondaga Ambient Lake Monitoring Program

Annual Report for 2008

Mass Balances

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prepared for

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http://www.wwwalker.net

March 2010

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Introduction

The development and structure of a mass-balance modeling framework for Onondaga Lake is described in previous lake monitoring reports (Ecologic et al., 2009). The framework facilitates computation and analysis of mass balances for nutrients and other water-quality components using hydrologic and water quality data collected in the Lake and its tributaries since 1986. Results provide a basis for:

- Estimating the magnitude and precision of loads from each source;
- Assessing long-term trends in load and inflow concentration from each source and source category (point, non-point, total);
- Evaluating the adequacy of the monitoring program, based upon the precision of loads computed from concentration and flow data;
- Developing and periodic updating of an empirical nutrient loading model that predicts eutrophication-related water quality conditions (as measured by nutrient concentrations, chlorophyll-a, algal bloom frequency, transparency, and hypolimnetic oxygen depletion) as a function of yearly nutrient loads, inflows, and lake morphometry (Walker, 2009; Ecologic et al., 2009).
- Developing simple input/output models for other constituents; and
- Developing data summaries to support integration and interpretation of monitoring results in each yearly AMP report.

This report updates the mass-balance framework to include data through 2008. Computations are linked directly to the AMP long-term water quality and hydrologic database (Figure 1). Recent mass balances for key water quality components are summarized. Long-term (1990-2008) and ten-year (1999-2008) trends are evaluated for each monitored inflow, as well as site aggregates (inflow vs. outflow, point vs. nonpoint, urban vs. rural watersheds, etc.).

With improvements to the monitoring program made since initiation of the AMP in 1999, the accuracy and precision of the load estimates and power for detecting trends has

steadily improved. In this update, the ten-year base period used to evaluate recent trends (1999-2008) reflect AMP improvements.

With implementation of point-source phosphorus controls, non-point loads have become increasingly important as factors driving eutrophication-related water quality in the Lake. In 2006-2008, when Metro operated under a 120 ppb discharge permit, nonpoint sources accounted for 68-74% of the Total P load to the Lake, as compared with 25-60% in 1990-2005. Evaluating trends in non-point source loads is complicated by random year-to-year variance, a high percentage of which is driven by variations in precipitation and streamflow, as opposed to variations in runoff water quality. Trend analyses employ refined statistical methods that account for year-to-year variations in precipitation, as developed in last year's AMP report (Ecologic et al, 2009).

As described in the main report (Section 6, Figure 6-4), lake water quality improved significantly in 2008 in response to the cumulative reductions in TP point and nonpoint loads that have been accomplished since 1990. The summer-mean upper-layer lake TP concentration in 2008 (15 ppb) was significantly below those measured in previous years with Metro operating under a 120 ppb discharge permit (2006-2007, TP = 25 to 41 ppb), despite the fact that the total annual P loads were similar in those years. A final section examines recent TP mass balances relative to the predictions of the Onondaga Lake Empirical Eutrophication Model (OLEEM; Walker, 2009). Potential mechanisms responsible for the favorable lake response are discussed.

Hydrology

Yearly variations in precipitation and watershed runoff are summarized in Figure 2. Over the 1990-2008 period, yearly runoff from the Onondaga Lake watershed varied from 31 to 75 cm and was strongly correlated with precipitation ($r^2 = 0.82$). Runoff and precipitation were slightly above average in 2008. Watershed runoff in 2008 (55 cm) was at the 50th percentile of the 1990-2008 data and precipitation (106 cm) was at the 70^{th} percentile. Increasing trends in both precipitation and runoff over the 1990-2008

period complicate interpretations of apparent trends in the tributary loads and lake responses in the most recent ten-year period.

Mass Balances

Historical variations in the mass balances of primary water quality components over the 1990-2008 period are summarized in the following figures:

Figure 3 Total Inflow & Outflow Concentrations
Figure 4 Total Inflow & Outflow Loads
Figure 5 Total Non-point & Total Metro Loads
Figure 6 Rainfall-Adjusted Non-Point Source Loads

The time series start in 1990 because that was the first year in which total phosphorus measurements were made in the lake tributaries. As indicated in Figure 6, trend analyses for some constituents are potentially influenced by variations in analytical detection limits over the years, in particular for Ammonia N, Nitrite N, SRP, and BOD-5 at sites with relatively low concentration ranges (Onondaga Creek, Ninemile Creek, and Harbor Brook).

The following tables describe lake mass balances for various constituents in the most recent 5-year period (2004-2008), as provided in previous annual reports:

Table 1 Chloride
Table 2 Total Nitrogen
Table 3 Ammonia Nitrogen
Table 4 Total Phosphorus
Table 5 Soluble Reactive Phosphorus
Table 6 Summaries for All Constituents

Because outlet samples measured at 2 feet are more heavily influenced by hydraulic exchanges with the Seneca River, outflow loads computed from 12-foot samples are considered more representative of net outflow from the Lake and are similar to those measured in the upper mixed layer at the Lake South station.

Since chloride and sodium are expected to be conservative, mass balances for these constituents provide a basis for testing the accuracy and completeness of the data and methods used to develop the mass balances. Whereas outflow loads typically exceeded inflow loads by ~5% historically, the mass balances gradually converged (inflow load ~ outflow load) over the 2000-2007 period, as described in the 2007 OLMP report. For both chloride and sodium, differences between inflow and outflow loads were not statistically significant in 2004-2008 (-0.4 +/- 2.2% and -0.3 +/- 2.4% of the total inflow loads, respectively). While the margins were not statistically significant, yearly inflow loads exceeded outflow loads for the first time both 2007 and 2008, as compared with 1990-2006 (Figure 4). Trends in the net retention of both sodium and chloride are correlated with increasing trends in loads from Metro, Harbor Brook, and Onondaga Creek (Table 9 below). The lower portion of Onondaga Creek (between Dorwin and Kirkpatrick) accounted for 35% of the total chloride load to the Lake in 2004-2008. This reach is influenced by salt springs (Kapel, 2003), although direct measurements of these sources are not available for this period. As discussed below, the apparent trend in Metro chloride loads is attributed to unusually high values in July-August 2008 associated with construction of CSO controls in the watershed (Figure 15)

Trends in Loads

Ten-year trends in annual loads and flow-weighted mean concentrations listed in Tables 7 and 8, respectively. Results are shown with and without adjustment for precipitation using the multiple regression technique described in the 2007 annual report (Ecologic et al, 2009). Table 9 lists adjusted trends in load expressed in mass units (i.e. kg/yr vs. %/yr); these reflect the relative impacts of the trends on the overall mass balance. Many of the apparent trends in load are removed when adjustments are made for the increasing

trend in precipitation over the 1999-2008 period (Figure 2). While the multiple regression technique increases the power of the tests for trends in the long-term means, all results are subject to uncertainty because the technique does not necessarily eliminate the confounding effect of the trend in precipitation. Addition of data from future drought years to the time series will provide a basis for distinguishing between trends and variations driven by precipitation.

Consistent with treatment plant improvements, decreasing trends in load and/or concentration are indicated for some nitrogen species (TKN, Ammonia N, Nitrite N) and phosphorus species (TP, TDP) in the Metro discharge and in the lake outflow. The absence of Total N trends in the Metro discharge and total inflow reflects the fact that decreasing trends in the above species were offset by increasing trends in Nitrate N load (Figure 5), which were of similar magnitude but just above the significance level cutoff ($p = 0.11$ and 0.13 vs. 0.10). With the exception of Harbor Brook, nonpoint source loads were generally stable over the 1999-2008 period. Increasing trends in phosphorus, nitrogen, and carbon species are indicated for the lower portion of Harbor Brook, between the Velasko and Hiawatha sites. As discussed in the 2007 report, increases in loads from this urban sub-watershed partially offset reductions in loads due to Metro improvements. Identification of specific sources and development of remedies are recommended.

Increasing trends in sodium and chloride are indicated for the total inflow and for the lower portion of Onondaga Creek and the Metro discharge. Unusually high chloride and sodium loads from the Metro discharge occurred during July and August 2008 in conjunction with construction of CSO controls. This unusual event was largely responsible for the apparent trends in 1999-2008, since significant trends were not observed in the previous ten-year interval (1998-2007). While there were apparent increasing trends in outflow sodium and chloride loads (Figure 4), the trends were not strong enough to be statistically significant, particularly in the context of the trend in precipitation.

As observed in the previous ten-year interval, significant increasing trends in outflow silica concentration and load are not paired with corresponding trends in the lake inflows. This may be an indirect consequence of reduced algal productivity in the Lake resulting from decreases in phosphorus load. If diatom growth were increasingly limited by phosphorus levels, silica uptake by diatoms and subsequent sedimentation would also to decrease. Increases in lake nitrate concentrations would also be expected from this mechanism, but are potentially masked by the extreme variations in the nitrate load from Metro (Figure 5).

Baseline Phosphorus Loads

TP concentrations in the Metro discharge averaged 180 ppb in 2004-2008 (Table 4), but decreased steadily from 540 ppb in 2004 to 88 ppb in 2008 as a consequence of treatment improvements (Figure 5). Total P mass balances for 1999-2008 reflect a wider range of precipitation and runoff concentrations that would be representative of long-term average non-point loads (Table 10). Total P mass balances for 2006-2008 reflect Metro operation under a 120 ppb discharge limit (Table 11). These results can be used to refine the long-term average P budget to serve as a basis for evaluating future management scenarios and tracking trends:

TP Load (metric tons / yr)	1999-2008	2006-2008	Long-Term*
Total Non-point	26.5	29.2	26.5
Industrial	0.3	0.2	0.2
Metro Discharge (Outfall 1)	24.2	9.6	9.6
Metro Bypass (Outfall 2)	2.2	1.7	1.7
Atmospheric Deposition	0.4	0.4	0.4
Total	53.7	41.1	38.4

The third column (*) combines 1999-2008 non-point with 2006-2008 Metro and industrial loads. This would be representative of the long-term average loads with the existing Metro treatment capabilities and an average discharge concentration of 110 ppb,

as observed in 2006-2008. If the 2008 Metro discharge concentration (88 ppb) were maintained, the projected load from Metro would decrease from 9.6 and 7.7 mt/yr at the 2006-2008 flow and the long-term load to the Lake would decrease from 38.4 to 36.5 mt/yr. Average Metro discharge concentrations similar to that measured in 2008 would be expected in order to maintain compliance with the recently-revised 12-month rolling-average permit limit (100 ppb).

Spatial variations in runoff and non-point phosphorus loads from each sub-watershed are shown in Figure 7. These results are based upon water and phosphorus balances for 1999-2008 listed in Table 10. Comparisons are made across sub-watersheds with respect to drainage area, total flow, load, concentration, runoff (flow per unit watershed area), and export (load per unit watershed area). Harbor Brook and Onondaga Creek are subdivided into upper (generally rural) and lower (generally urban) sub-watersheds. Phosphorus export rate from the three urban watersheds (lower Harbor, lower Onondaga, Ley) averaged 59 kg/km^2-yr and ranged from 54 to 127 kg/km^2-yr, as compared with a mean of 31 kg/km^2-yr and range of 15 to 38 kg/km^2-yr for the rural watersheds. Similarly, the urban watersheds had higher runoff concentrations (mean = 95 ppb, range = 91–535 ppb), as compared with rural watersheds (mean = 60 ppb, range = 41–67 ppb). Overall, urban watersheds accounted for 28% of the total non-point load, rural watersheds accounted for 66%, and un-gauged areas accounted for 6%.

Long-term trends in runoff, flow-weighted-mean TP concentration, and TP load from all non-point sources are shown in Figure 8 (1990-2008) and Figure 9 (1999-2008). Adjusting for variations in precipitation, decreasing trends in flow-weighted-mean concentration (-3.4% 0/- 1.0 %) and load (-3.0 +/-0.9 %) are indicated for the 1990-2008 period. Most of the apparent decreases occurred prior to ~2004. No significant trends are apparent for the most recent ten-year period (Figure 9), although the power of the regression test is limited by the increasing trend in precipitation (3.1 +/- 0.8 cm/yr, Figure 2).

Long-term (1990-2008) trends in precipitation-adjusted TP load from each source are shown in Figure 10. The overall reduction in nonpoint load is attributed to significant decreases in load from each tributary, with the exception of Harbor Brook, where TP loads have increased, particularly in recent years. The cumulative database provides a good baseline for evaluating the effects of implementing additional non-point source control measures in both the urban and rural portions of the watershed.

Mass Balance Modeling

TP concentrations in the upper and lower levels of Onondaga Lake responded dramatically to the decreasing external P loads over the 1990-2008 period (Figure 11), especially in the past few years. Despite the fact that annual TP loads were similar in 2006-2008, the lake and outlet TP concentrations were significantly lower in 2008. The flow-weighted-mean inflow concentration varied from 74 to 78 ppb as the outlet concentration decreased from 48 to 31 ppb and the summer-average concentration in the lake upper layer decreased from 41 to 15 ppb. The sharp decrease in lake TP in 2008 is unusual in the context of other lake restoration experiences, in which lake responses typically lagged behind load reductions due to storage and recycling of phosphorus within the lake and sediments (Sas, 1989)

The disproportionate lake TP response is inconsistent with assumptions of the phosphorus mass balance model (OLEEM = Onondaga Lake Empirical Eutrophication Model), which was updated in the previous AMP report (Ecologic, 2009; Walker, 2009). The model assumes that long-term annual-average TP removal per unit of lake surface area is proportional to the average outflow concentration. The proportion is reflected in the calibrated "settling rate" constant. A settling rate of 23 m/yr was calibrated to 2003-2007 data. Figure 12 shows yearly variations in settling rate computed from the measured P budgets over the 1990-2008 period. While random year-to-year variations in settling rate are expected due to uncertainty in the load estimates and lake dynamics, the 76 m/yr value in 2008 was well outside of the 7 to 50 m/yr range measured in previous years and approximately three times the 2003-2007 calibration. In contrast, the settling

rate for Total N in 2008 (15 m/yr) was within the historical range (11 to 20 m/yr) and similar to the 2003-2007 calibration (16 m/yr).

The unusually high TP settling rate in 2008 could reflect deviations from one or more of the model assumptions discussed in the model calibration report (Ecologic et al, 2009). Potential contributing factors include:

1. Non-Steady-State Conditions. OLEEM was designed to predict the long-term-average response to a stable TP loading regime. Trends in the lake P data over the 2005-2008 period (Figure 11) indicate that P cycling within the lake was still responding to the recent load reductions.

2. Differences in lake response to P loads from Metro as compared with lake tributaries. Such differences could reflect differences in P speciation (dissolved vs. particulate) and/or hydrodynamics (plunging inflows from tributaries driven by density differences). As shown in Figure 12, the fraction of the TP load attributed to Metro was lowest in 2008 when the settling rate was highest. Conversely, the fraction of the load attributed to Metro was highest in 1995 when the settling rate was lowest. This factor does not explain variations in the past few years, however, when the fraction of the load from Metro decreased by small percentage as the settling rate more than tripled.

3. Decreases in the bioavailablity of P loads. Figure 13 shows long-term trends in phosphorus loads partitioned into three components: soluble reactive (SRP), dissolved organic (TDP - SRP) and particulate (TP – TDP). Time series are shown for non-point, municipal (Metro + Bypass), total inflow, and total outflow. While there was significant decrease in the SRP fraction of the Metro discharge in 2006-2008, the SRP fractions of the nonpoint and total loads were relatively constant over the 1999-2008 period, with the exception of 2004, when the SRP fractions in both the Metro and total inflow loads were unusually high. Trends in

bioavailability, as related to TP speciation, do not appear to explain the lake response in 2008.

4. Lower TP concentration in the Metro discharge and lake during winter and spring of 2008. As shown in Figure 14, TP concentrations in the Metro discharge and lake were significantly lower in January-April of 2008 (70 to 100 ppb), as compared with the same period in 2006 and 2007 (100 to 200 ppb). This would have provided less fuel for the spring and early summer algal blooms, as well as decreased the initial P concentration in the hypolimnion at the start of the stratified period in 2008.

5. Changes in the vertical distribution of the Metro discharge. The density of the Metro effluent increased during July and August of 2008, when chloride concentrations increased several fold as a result of loads from RTF de-watering facility (Figure 15). Depending on the magnitude of the density changes and initial mixing, the higher density would have created a tendency for the Metro discharge to pass through Lake below the upper mixed layer. This hypothesis is consistent with the bulge in conductivity that developed at the Lake South station between 6-10 meters after the chloride content of the Metro discharged increased in mid July of 2008. The conductivity bulge was much more pronounced than those observed in 2007 and previous years. Transport at the 6-10 meter level would have decreased the P supply to surface algal populations and helped to flush P accumulating in the thermocline and lower layer out of the Lake. Based upon preliminary data, the summer average lake TP concentration in 2009 was similar to that observed in 2008, however. This suggests that unusually high salinity in the Metro discharge may not have been the major factor responsible for high TP settling rate in 2008.

6. Decreased P recycling from bottom sediments controlled by oxidation-reduction potential. Nitrate N concentrations in the bottom and surface waters remained high (>1 ppm) throughout the stratified period, as compared with previous years,

when nitrate levels were depleted (Figure 14). Higher nitrate levels would have decreased redox-driven P releases from bottom sediments (Cooke et al, 2005).

7. As consequences of the above factors, there was significantly less P buildup in the lower layers during the summer stratified period in 2008 (maximum = 70 ppb), as compared with 2006-2007 (maximum 180-200 ppb, Figure 11). The corresponding decrease in the vertical TP gradient would have decreased diffusive transport from the lower to the upper layers in early and mid summer, as well as decreased transport associated with thermocline erosion in late summer and fall.

8. Changes in biological factors (Cooke et al, 2005), as described in the main report:
    a. Increasing populations of Zebra mussels, which can remove filter out algal cells and other particulate material containing phosphorus.
    b. Shifts in phytoplankton to species that have higher settling rates and are more subject to predation, as compared with bluegreens, which were dominant historically.
    c. Increases in zooplankton populations and grazing due to variations in fish populations.

Updating the Onondaga Lake Water Quality Model (QEA et al, 2006) to include data through 2009 would provide a basis for evaluating some of the above mechanisms and their sensitivity to treatment efficiency and watershed management. The Metro chloride spike in 2008 would provide a particularly good signal for testing hydrodynamic components of the model. The existing calibration of OLEEM based upon data through 2007 will provide a basis for evaluating changes in the overall P budget dynamics relative to historical conditions. In the past, the OLEEM calibration has typically been updated every three years. Depending on results for 2009-2010, another periodic update of the model may be appropriate.

One critical question is whether the low TP concentrations observed in 2008 will be sustained in the future with the current TP loading regimes, or whether they were due to

unusual conditions. This question is most reliably assessed through continued monitoring and adaptive management. Meanwhile, maintaining high treatment efficiencies for ammonia and TP throughout the year and continuing to address non-point sources will increase the probability of achieving the lake TP goal on a consistent basis.

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Table 1 Chloride Balance for 2004-2008

Variable: Chloride **Average for Years: 2004 thru 2008**

Term	Flow 10^6 m3	Load mt	Std Error mt	Conc ppm	RSE %	Sampl per yr	Percent of Total Inflow Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export mt/ km2	
Metro Effluent	91.12	40679	1785	446	4%	74	17%	20%	24%				
Metro Bypass	1.80	671	116	373	17%	4	0%	0%	0%				
East Flume	0.84	417	18	498	4%	27	0%	0%	0%				
Trib 5A	1.23	451	11	368	2%	27	0%	0%	0%				
Harbor Brook	12.59	3297	202	262	6%	28	2%	2%	0%	31.4	40.2	105.1	
Ley Creek	41.36	14261	1379	345	10%	26	8%	7%	14%	66.1	62.6	215.8	
Ninemile Creek	170.89	49409	775	289	2%	30	31%	24%	5%	298.1	57.3	165.8	
Onondaga Creek	188.68	88024	2357	467	3%	27	34%	42%	42%	285.1	66.2	308.7	
Nonpoint Gauged	413.53	154991	2846	375	2%	111	75%	75%	61%	680.7	60.8	227.7	
Nonpoint Ungauged	28.17	10557	1431	375	14%		5%	5%	15%	46.4	60.8	227.7	
NonPoint Total	441.69	165548	3185	375	2%	111	80%	80%	76%	727.0	60.8	227.7	
Industrial	2.06	868	21	420	2%	54	0%	0%	0%				
Municipal	92.91	41350	1789	445	4%	78	17%	20%	24%				
Total External	536.67	207765	3653	387	2%	243	98%	100%	100%	727.0	73.8	285.8	
Precipitation	12.72	13	1	1	9%		2%	0%	0%	11.7	108.7	1.1	
Total Inflow	549.39	207778	3653	378	2%	243	100%	100%	100%	738.7	74.4	281.3	
Evaporation	8.86						2%			11.7	75.7		
Outflow	540.53	208508	2648	386	1%		98%	100%	53%	738.7	73.2	282.2	
Retention	0.00	-729	4512		619%		0%	0%					0.0%
Alternative Estimates of Lake Outflow													
Outlet 12 Feet	540.53	208508	2648	386	1%	26	98%	100%	53%	738.7	73.2	282.2	
Outlet 2 Feet	540.53	191439	4114	354	2%	26	98%	92%	127%	738.7	73.2	259.1	
Upstream/Downstream Contrast- Harbor Brook													
Upstream - Velasko	11.00	2562	88	233	3%	28	2%	1%		27.0	40.8	95.0	
Downstream - Hiawatha	12.59	3297	202	262	6%	28	2%	2%		31.4	40.2	105.1	
Local Inflow	1.59	735	220	462	30%		0%	0%		4.4	36.1	166.8	
Upstream/Downstream Contrast - Onondaga Creek													
Upstream - Dorwin	146.86	15853	270	108	2%	46	27%	8%		229.4	64.0	69.1	
Downstream - Kirkpatrick	188.68	88024	2357	467	3%	27	34%	42%		285.1	66.2	308.7	
Local Inflow	41.82	72171	2372	1726	3%		8%	35%		55.7	75.0	1295.0	
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed						
Total Watershed	413.53	154991	2846	375	2%		100%	100%		680.69	60.8	227.7	
Upper/Rural Watersheds	328.75	67824	826	206	1%		79%	44%		554.45	59.3	122.3	
Lower/Urban Watersheds	84.77	87167	2753	1028	3%		21%	56%		126.24	67.2	690.5	

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 46.20 m/yr
Lake Residence Time 0.24 years
Calib. Settling Rate -0.2 m/yr
Calib. Retention Coef. 0%

RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Error % = Percent of Variance in Total Inflow Load Estimate

Table 2 Total Nitrogen Balance for 2004-2008

Variable: **Total Nitrogen** **Average for Years:** **2004** **thru** **2008**

							Percent of Total Inflow			Drain.		Export
	Flow	Load	Std Error	Conc	RSE	Sampl	Flow	Load	Error	Area	Runoff	kg/
Term	10^6 m3	kg	kg	ppb	%	per yr	%	%	%	km2	cm	km2
Metro Effluent	91.12	1124192	30451	12338	3%	100	17%	61%	86%			
Metro Bypass	1.80	20072	797	11164	4%	4	0%	1%	0%			
East Flume	0.84	4730	126	5643	3%	27	0%	0%	0%			
Trib 5A	1.23	1816	125	1481	7%	27	0%	0%	0%			
Harbor Brook	12.59	25912	863	2057	3%	27	2%	1%	0%	31.4	40.2	826.2
Ley Creek	41.36	50627	2333	1224	5%	26	8%	3%	1%	66.1	62.6	765.9
Ninemile Creek	170.89	270300	7363	1582	3%	27	31%	15%	5%	298.1	57.3	906.8
Onondaga Creek	188.68	281670	7547	1493	3%	27	34%	15%	5%	285.1	66.2	987.9
Nonpoint Gauged	413.53	628510	10833	1520	2%	107	75%	34%	11%	680.7	60.8	923.3
Nonpoint Ungauged	28.17	42809	5811	1520	14%		5%	2%	3%	46.4	60.8	923.3
NonPoint Total	441.69	671319	12293	1520	2%	107	80%	36%	14%	727.0	60.8	923.3
Industrial	2.06	6546	178	3170	3%	54	0%	0%	0%			
Municipal	92.91	1144265	30461	12315	3%	104	17%	62%	86%			
Total External	536.67	1822129	32849	3395	2%	264	98%	99%	100%	727.0	73.8	2506.2
Precipitation	12.72	24164	2165	1900	9%		2%	1%	0%	11.7	108.7	2065.3
Total Inflow	549.39	1846294	32920	3361	2%	264	100%	100%	100%	738.7	74.4	2499.2
Evaporation	8.86						2%			11.7	75.7	
Outflow	540.53	1373248	29837	2541	2%		98%	74%	82%	738.7	73.2	1858.9
Retention	0.00	473046	44430		9%		0%	26%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	540.53	1373248	29837	2541	2%	26	98%	74%	82%	738.7	73.2	1858.9
Outlet 2 Feet	540.53	1287248	29252	2381	2%	26	98%	70%	79%	738.7	73.2	1742.5
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	11.00	22934	1347	2084	6%	27	2%	1%		27.0	40.8	850.7
Downstream - Hiawatha	12.59	25912	863	2057	3%	27	2%	1%		31.4	40.2	826.2
Local Inflow	1.59	2978	1600	1871	54%		0%	0%		4.4	36.1	675.9
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	146.86	235229	28779	1602	12%	38	27%	13%		229.4	64.0	1025.4
Downstream - Kirkpatrick	188.68	281670	7547	1493	3%	27	34%	15%		285.1	66.2	987.9
Local Inflow	41.82	46441	29753	1110	64%		8%	3%		55.7	75.0	833.3
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	413.53	628510	10833	1520	2%		100%	100%		680.69	60.8	923.3
Upper/Rural Watersheds	328.75	528463	29737	1607	6%		79%	84%		554.45	59.3	953.1
Lower/Urban Watersheds	84.77	100047	29887	1180	30%		21%	16%		126.24	67.2	792.5

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 46.20 m/yr Calib. Settling Rate 15.9 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.24 years Calib. Retention Coef. 26% Error % = Percent of Variance in Total Inflow Load Estimate

Table 3 Ammonia Nitrogen Balance for 2004-2008

Variable: **Ammonia Nitrogen** **Average for Years:** **2004 thru 2008**

Term	Flow 10^6 m3	Load kg	Std Error kg	Conc ppb	RSE %	Sampl per yr	Percent of Total Inflow Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export kg/ km2
Metro Effluent	91.12	72755	1520	798	2%	361	17%	48%	22%			
Metro Bypass	1.80	9452	553	5257	6%	42	0%	6%	3%			
East Flume	0.84	382	21	456	5%	27	0%	0%	0%			
Trib 5A	1.23	196	26	160	13%	27	0%	0%	0%			
Harbor Brook	12.59	960	91	76	9%	27	2%	1%	0%	31.4	40.2	30.6
Ley Creek	41.36	11229	746	271	7%	26	8%	7%	5%	66.1	62.6	169.9
Ninemile Creek	170.89	37217	2495	218	7%	27	31%	25%	59%	298.1	57.3	124.9
Onondaga Creek	188.68	13828	843	73	6%	27	34%	9%	7%	285.1	66.2	48.5
Nonpoint Gauged	413.53	63233	2738	153	4%	108	75%	42%	71%	680.7	60.8	92.9
Nonpoint Ungauged	28.17	4307	609	153	14%		5%	3%	4%	46.4	60.8	92.9
NonPoint Total	441.69	67540	2805	153	4%	108	80%	45%	75%	727.0	60.8	92.9
Industrial	2.06	579	33	280	6%	54	0%	0%	0%			
Municipal	92.91	82208	1618	885	2%	404	17%	54%	25%			
Total External	536.67	150327	3238	280	2%	565	98%	99%	100%	727.0	73.8	206.8
Precipitation	12.72	1272	114	100	9%		2%	1%	0%	11.7	108.7	108.7
Total Inflow	549.39	151599	3240	276	2%	565	100%	100%	100%	738.7	74.4	205.2
Evaporation	8.86						2%			11.7	75.7	
Outflow	540.53	141777	6310	262	4%		98%	94%	379%	738.7	73.2	191.9
Retention	0.00	9822	7093		72%		0%	6%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	540.53	141777	6310	262	4%	26	98%	94%	379%	738.7	73.2	191.9
Outlet 2 Feet	540.53	133728	6615	247	5%	26	98%	88%	417%	738.7	73.2	181.0
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	11.00	508	35	46	7%	27	2%	0%		27.0	40.8	18.8
Downstream - Hiawatha	12.59	960	91	76	9%	27	2%	1%		31.4	40.2	30.6
Local Inflow	1.59	452	97	284	22%		0%	0%		4.4	36.1	102.7
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	146.86	7169	363	49	5%	45	27%	5%		229.4	64.0	31.3
Downstream - Kirkpatrick	188.68	13828	843	73	6%	27	34%	9%		285.1	66.2	48.5
Local Inflow	41.82	6658	918	159	14%		8%	4%		55.7	75.0	119.5
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	413.53	63233	2738	153	4%		100%	100%		680.69	60.8	92.9
Upper/Rural Watersheds	328.75	44894	2521	137	6%		79%	71%		554.45	59.3	81.0
Lower/Urban Watersheds	84.77	18339	1187	216	6%		21%	29%		126.24	67.2	145.3

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 46.20 m/yr
Lake Residence Time 0.24 years
Calib. Settling Rate 3.2 m/yr
Calib. Retention Coef. 6%

RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Error % = Percent of Variance in Total Inflow Load Estimate

Table 4 Total Phosphorus Balance for 2004-2008

Variable: **Total Phosphorus** **Average for Years:** **2004 thru 2008**

Term	Flow 10^6 m3	Load kg	Std Error kg	Conc ppb	RSE %	Sampl per yr	Percent of Total Inflow Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export kg / km2
Metro Effluent	91.12	19792	283	217	1%	361	17%	38%	2%			
Metro Bypass	1.80	2048	73	1139	4%	42	0%	4%	0%			
East Flume	0.84	119	8	142	7%	27	0%	0%	0%			
Trib 5A	1.23	136	5	111	4%	27	0%	0%	0%			
Harbor Brook	12.59	1150	153	91	13%	28	2%	2%	1%	31.4	40.2	36.7
Ley Creek	41.36	3591	403	87	11%	26	8%	7%	4%	66.1	62.6	54.3
Ninemile Creek	170.89	9011	724	53	8%	30	31%	17%	12%	298.1	57.3	30.2
Onondaga Creek	188.68	13713	1841	73	13%	27	34%	26%	79%	285.1	66.2	48.1
Nonpoint Gauged	413.53	27465	2025	66	7%	112	75%	53%	96%	680.7	60.8	40.3
Nonpoint Ungauged	28.17	1871	287	66	15%		5%	4%	2%	46.4	60.8	40.3
NonPoint Total	441.69	29335	2045	66	7%	112	80%	57%	98%	727.0	60.8	40.3
Industrial	2.06	255	10	123	4%	54	0%	0%	0%			
Municipal	92.91	21841	292	235	1%	403	17%	42%	2%			
Total External	536.67	51431	2066	96	4%	569	98%	99%	100%	727.0	73.8	70.7
Precipitation	12.72	382	34	30	9%		2%	1%	0%	11.7	108.7	32.6
Total Inflow	549.39	51812	2066	94	4%	569	100%	100%	100%	738.7	74.4	70.1
Evaporation	8.86						2%			11.7	75.7	
Outflow	540.53	30429	896	56	3%		98%	59%	19%	738.7	73.2	41.2
Retention	0.00	21383	2252		11%		0%	41%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	540.53	30429	896	56	3%	26	98%	59%	19%	738.7	73.2	41.2
Outlet 2 Feet	540.53	30526	992	56	3%	26	98%	59%	23%	738.7	73.2	41.3
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	11.00	448	139	41	31%	28	2%	1%		27.0	40.8	16.6
Downstream - Hiawatha	12.59	1150	153	91	13%	28	2%	2%		31.4	40.2	36.7
Local Inflow	1.59	702	206	441	29%		0%	1%		4.4	36.1	159.3
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	146.86	10437	1840	71	18%	46	27%	20%		229.4	64.0	45.5
Downstream - Kirkpatrick	188.68	13713	1841	73	13%	27	34%	26%		285.1	66.2	48.1
Local Inflow	41.82	3276	2603	78	79%		8%	6%		55.7	75.0	58.8
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	413.53	27465	2025	66	7%		100%	100%		680.69	60.8	40.3
Upper/Rural Watersheds	328.75	19896	1982	61	10%		79%	72%		554.45	59.3	35.9
Lower/Urban Watersheds	84.77	7568	2642	89	35%		21%	28%		126.24	67.2	60.0

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 46.20 m/yr Calib. Settling Rate 32.5 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.24 years Calib. Retention Coef. 41% Error % = Percent of Variance in Total Inflow Load Estimate

Table 5 Soluble Reactive Phosphorus Balance for 2004-2008

Variable: **Soluble Reactive P** **Average for Years:** **2004 thru 2008**

							Percent of Total Inflow			Drain.		Export
	Flow	Load	Std Error	Conc	RSE	Sampl	Flow	Load	Error	Area	Runoff	kg /
Term	10^6 m3	kg	kg	ppb	%	per yr	%	%	%	km2	cm	km2
Metro Effluent	91.12	5907	724	65	12%	29	17%	54%	82%			
Metro Bypass	1.80	477	185	265	39%	4	0%	4%	5%			
East Flume	0.84	43	4	51	10%	27	0%	0%	0%			
Trib 5A	1.23	38	2	31	6%	27	0%	0%	0%			
Harbor Brook	12.59	420	42	33	10%	28	2%	4%	0%	31.4	40.2	13.4
Ley Creek	41.36	575	40	14	7%	26	8%	5%	0%	66.1	62.6	8.7
Ninemile Creek	170.89	1473	178	9	12%	30	31%	13%	5%	298.1	57.3	4.9
Onondaga Creek	188.68	1545	213	8	14%	27	34%	14%	7%	285.1	66.2	5.4
Nonpoint Gauged	413.53	4013	284	10	7%	112	75%	37%	13%	680.7	60.8	5.9
Nonpoint Ungauged	28.17	273	41	10	15%		5%	2%	0%	46.4	60.8	5.9
NonPoint Total	441.69	4287	287	10	7%	112	80%	39%	13%	727.0	60.8	5.9
Industrial	2.06	80	5	39	6%	54	0%	1%	0%			
Municipal	92.91	6384	748	69	12%	33	17%	58%	87%			
Total External	536.67	10751	801	20	7%	198	98%	98%	100%	727.0	73.8	14.8
Precipitation	12.72	191	17	15	9%		2%	2%	0%	11.7	108.7	16.3
Total Inflow	549.39	10942	801	20	7%	198	100%	100%	100%	738.7	74.4	14.8
Evaporation	8.86						2%			11.7	75.7	
Outflow	540.53	14909	1484	28	10%		98%	136%	344%	738.7	73.2	20.2
Retention	0.00	-3967	1687		43%		0%	-36%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	540.53	14909	1484	28	10%	26	98%	136%	344%	738.7	73.2	20.2
Outlet 2 Feet	540.53	13841	1006	26	7%	26	98%	126%	158%	738.7	73.2	18.7
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	11.00	116	17	11	15%	28	2%	1%		27.0	40.8	4.3
Downstream - Hiawatha	12.59	420	42	33	10%	28	2%	4%		31.4	40.2	13.4
Local Inflow	1.59	304	46	191	15%		0%	3%		4.4	36.1	69.0
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	146.86	845	112	6	13%	34	27%	8%		229.4	64.0	3.7
Downstream - Kirkpatrick	188.68	1545	213	8	14%	27	34%	14%		285.1	66.2	5.4
Local Inflow	41.82	700	241	17	34%		8%	6%		55.7	75.0	12.6
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	413.53	4013	284	10	7%		100%	100%		680.69	60.8	5.9
Upper/Rural Watersheds	328.75	2434	211	7	9%		79%	61%		554.45	59.3	4.4
Lower/Urban Watersheds	84.77	1579	248	19	16%		21%	39%		126.24	67.2	12.5

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 46.20 m/yr Calib. Settling Rate -12.3 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.24 years Calib. Retention Coef. -36% Error % = Percent of Variance in Total Inflow Load Estimate

Table 6 Average Loads by Source & Constituent, 2004-2008

Summary of Point & NonPoint Source Loads For Various Constituents Period: 2004 thru 2008

	Flow	Total Phosphorus	Total Dissolved P	Soluble Reactive P	Total Nitrogen	Total Kjeldahl N	Ammonia Nitrogen	Nitrate Nitrogen	Nitrite Nitrogen	5-Day BOD	Total Org Carbon	Filtered Total Org C	Calcium	Chloride	Sodium
Annual Loads	hm3	kg	kg	kg	kg	kg	kg	kg	kg	mt	mt	mt	mt	mt	mt
Ley	41.4	3591	1012	575	50627	32841	11229	16997	790	132	290	265	4329	14261	8618
Ninemile	170.9	9011	3282	1473	270300	100795	37217	166027	3478	378	548	487	31909	49409	17365
Harbor - Upper	11.0	448	176	116	22934	4304	508	18486	144	25	26	22	2253	2562	1433
Harbor - Lower	1.6	702	327	304	2978	1926	452	1004	48	7	8	8	222	735	440
Harbor - Total	12.6	1150	503	420	25912	6230	960	19490	192	32	34	30	2475	3297	1874
Onondaga - Upper	146.9	10437	1665	845	235229	68349	7169	144181	4304	317	422	382	11982	15853	10028
Onondaga - Lower	41.8	3276	1146	700	46441	20980	6658	43160	697	117	133	114	8904	72171	45025
Onondaga - Total	188.7	13713	2812	1545	281670	89329	13828	187341	5000	435	555	497	20886	88024	55053
Total Nonpoint Gauged	413.5	27465	7609	4013	628510	229195	63233	389854	9460	977	1426	1279	59599	154991	82909
Rural Watersheds	328.8	19896	5124	2434	528463	173448	44894	328694	7926	721	995	891	46144	67824	28826
Urban Watersheds	84.8	7568	2485	1579	100047	55747	18339	61161	1534	256	431	387	13455	87167	54083
Ungauged	28.2	1871	518	273	42809	15611	4307	26554	644	67	97	87	4059	10557	5647
Total NonPoint	441.7	29335	8127	4287	671319	244806	67540	416408	10105	1044	1524	1366	63658	165548	88556
Total Industrial	2.1	255	111	80	6546	1582	579	4138	779	7	10	9	270	868	545
Metro STP	91.1	19792	9268	5907	1124192	170619	72755	944847	8727	501	727	637	12528	40679	23832
Bypass	1.8	2048	682	477	20072	16875	9452	2994	203	89	27	21	180	671	424
Total Municipal	92.9	21841	9951	6384	1144265	187493	82208	947842	8930	590	754	658	12709	41350	24255
Precipitation	12.7	382	254	191	24164	12718	1272	10175	1272	0	13	13	64	13	13
Total Inflow	549.4	51812	18443	10942	1846294	446599	151599	1378562	21086	1641	2300	2045	76700	207778	113369
Total Outflow	540.5	30429	20424	14909	1373248	370179	141777	980699	22369	1147	2041	1881	70917	208508	113710
Retention	0.0	21383	-1981	-3967	473046	76420	9822	397863	-1283	494	260	164	5784	-729	-341
Unit Area Loads	cm	kg /km2	kg /km2	kg /km2	kg/km2	kg/km2	kg/km2	kg /km2	kg /km2	mt/km2	mt/km2	mt/km2	mt/km2	mt/km2	mt/km2
Ley	63	54.3	15.3	8.7	765.9	496.8	169.9	257.1	12.0	2.0	4.4	4.0	65.5	215.8	130.4
Ninemile	57	30.2	11.0	4.9	906.8	338.1	124.9	557.0	11.7	1.3	1.8	1.6	107.0	165.8	58.3
Harbor - Upper	41	16.6	6.5	4.3	850.7	159.7	18.8	685.7	5.4	0.9	1.0	0.8	83.6	95.0	53.2
Harbor - Lower	36	159.3	74.1	69.0	675.9	437.1	102.7	227.9	10.9	1.6	1.9	1.9	50.4	166.8	99.9
Harbor - Total	40	36.7	16.0	13.4	826.2	198.6	30.6	621.4	6.1	1.0	1.1	1.0	78.9	105.1	59.7
Onondaga - Upper	64	45.5	7.3	3.7	1025.4	297.9	31.3	628.5	18.8	1.4	1.8	1.7	52.2	69.1	43.7
Onondaga - Lower	75	58.8	20.6	12.6	833.3	376.5	119.5	774.4	12.5	2.1	2.4	2.1	159.8	1295.0	807.9
Onondaga - Total	66	48.1	9.9	5.4	987.9	313.3	48.5	657.0	17.5	1.5	1.9	1.7	73.2	308.7	193.1
Total Nonpoint Gauged	61	40.3	11.2	5.9	923.3	336.7	92.9	572.7	13.9	1.4	2.1	1.9	87.6	227.7	121.8
Rural Watersheds	59	35.9	9.2	4.4	953.1	312.8	81.0	592.8	14.3	1.3	1.8	1.6	83.2	122.3	52.0
Urban Watersheds	67	60.0	19.7	12.5	792.5	441.6	145.3	484.5	12.2	2.0	3.4	3.1	106.6	690.5	428.4
Percent of Total Gauged NonPoint Load															
Ley	10%	13%	13%	14%	8%	14%	18%	4%	8%	14%	20%	21%	7%	9%	10%
Ninemile	41%	33%	43%	37%	43%	44%	59%	43%	37%	39%	38%	38%	54%	32%	21%
Harbor - Upper	3%	2%	2%	3%	4%	2%	1%	5%	2%	3%	2%	2%	4%	2%	2%
Harbor - Lower	0%	3%	4%	8%	0%	1%	1%	0%	1%	1%	1%	1%	0%	0%	1%
Harbor - Total	3%	4%	7%	10%	4%	3%	2%	5%	2%	3%	2%	2%	4%	2%	2%
Onondaga - Upper	36%	38%	22%	21%	37%	30%	11%	37%	45%	32%	30%	30%	20%	10%	12%
Onondaga - Lower	10%	12%	15%	17%	7%	9%	11%	11%	7%	12%	9%	9%	15%	47%	54%
Onondaga - Total	46%	50%	37%	38%	45%	39%	22%	48%	53%	44%	39%	39%	35%	57%	66%
Total Nonpoint Gauged		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rural Watersheds	79%	72%	67%	61%	84%	76%	71%	84%	84%	74%	70%	70%	77%	44%	35%
Urban Watersheds	21%	28%	33%	39%	16%	24%	29%	16%	16%	26%	30%	30%	23%	56%	65%
FWM Concentrations		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppm	ppm	ppm	ppm	ppm
Ley	-	87	24	14	1224	794	271	411	19	3	7	6	105	345	208
Ninemile	-	53	19	9	1582	590	218	972	20	2	3	3	187	289	102
Harbor - Upper	-	41	16	11	2084	391	46	1680	13	2	2	2	205	233	130
Harbor - Lower	-	441	205	191	1871	1210	284	631	30	4	5	5	140	462	277
Harbor - Total	-	91	40	33	2057	495	76	1547	15	3	3	2	197	262	149
Onondaga - Upper	-	71	11	6	1602	465	49	982	29	2	3	3	82	108	68
Onondaga - Lower	-	78	27	17	1110	502	159	1033	17	3	3	3	213	1726	1077
Onondaga - Total	-	73	15	8	1493	473	73	993	27	2	3	3	111	467	292
Total Nonpoint Gauged	-	66	18	10	1520	554	153	943	23	2	3	3	144	375	200
Rural Watersheds	-	61	16	7	1607	528	137	1000	24	2	3	3	140	206	88
Urban Watersheds	-	89	29	19	1180	658	216	722	18	3	5	5	159	1028	638
Ungauged	-	66	18	10	1520	554	153	943	23	2	3	3	144	375	200
Total NonPoint	-	66	18	10	1520	554	153	943	23	2	3	3	144	375	200
Total Industrial	-	123	54	39	3170	766	280	2004	377	3	5	4	131	420	264
Metro STP	-	217	102	65	12338	1873	798	10370	96	6	8	7	137	446	262
Bypass	-	1139	380	265	11164	9386	5257	1666	113	50	15	11	100	373	236
Total Municipal	-	235	107	69	12315	2018	885	10201	96	6	8	7	137	445	261
Precipitation	-	30	20	15	1900	1000	100	800	100	0	1	1	5	1	1
Total Inflow	-	94	34	20	3361	813	276	2509	38	3	4	4	140	378	206
Total Outflow	-	56	38	28	2541	685	262	1814	41	2	4	3	131	386	210

Table 7 Total Phosphorus Balance for 1999-2008

Variable: **Total Phosphorus** **Average for Years:** **1999 thru 2008**

Term	Flow 10^6 m3	Load kg	Std Error kg	Conc ppb	RSE %	Sampl per yr	Percent of Total Inflow Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export kg / km2
Metro Effluent	90.14	24185	206	268	1%	363	18%	45%	3%			
Metro Bypass	2.00	2230	53	1116	2%	45	0%	4%	0%			
East Flume	0.65	99	5	153	5%	27	0%	0%	0%			
Trib 5A	1.91	245	6	129	3%	27	0%	0%	0%			
Harbor Brook	10.79	961	92	89	10%	30	2%	2%	1%	31.4	34.4	30.6
Ley Creek	39.02	3542	279	91	8%	30	8%	7%	5%	66.1	59.0	53.6
Ninemile Creek	149.89	8288	416	55	5%	30	30%	15%	12%	298.1	50.3	27.8
Onondaga Creek	169.39	12086	1051	71	9%	32	34%	23%	77%	285.1	59.4	42.4
Nonpoint Gauged	369.09	24877	1168	67	5%	123	74%	46%	95%	680.7	54.2	36.5
Nonpoint Ungauged	25.14	1694	181	67	11%		5%	3%	2%	46.4	54.2	36.5
NonPoint Total	394.23	26571	1182	67	4%	123	79%	49%	97%	727.0	54.2	36.5
Industrial	2.56	345	8	135	2%	55	1%	1%	0%			
Municipal	92.14	26415	213	287	1%	408	18%	49%	3%			
Total External	488.93	53331	1201	109	2%	585	98%	99%	100%	727.0	67.2	73.4
Precipitation	11.70	351	22	30	6%		2%	1%	0%	11.7	100.0	30.0
Total Inflow	500.63	53682	1201	107	2%	585	100%	100%	100%	738.7	67.8	72.7
Evaporation	8.86						2%			11.7	75.7	
Outflow	491.77	33680	712	68	2%		98%	63%	35%	738.7	66.6	45.6
Retention	0.00	20002	1396		7%		0%	37%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	491.77	33680	712	68	2%	26	98%	63%	35%	738.7	66.6	45.6
Outlet 2 Feet	491.77	32493	741	66	2%	26	98%	61%	38%	738.7	66.6	44.0
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	9.74	400	91	41	23%	30	2%	1%		27.0	36.1	14.8
Downstream - Hiawatha	10.79	961	92	89	10%	30	2%	2%		31.4	34.4	30.6
Local Inflow	1.05	561	129	535	23%		0%	1%		4.4	23.8	127.2
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	131.65	8759	962	67	11%	41	26%	16%		229.4	57.4	38.2
Downstream - Kirkpatrick	169.39	12086	1051	71	9%	32	34%	23%		285.1	59.4	42.4
Local Inflow	37.74	3327	1425	88	43%		8%	6%		55.7	67.7	59.7
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	369.09	24877	1168	67	5%		100%	100%		680.69	54.2	36.5
Upper/Rural Watersheds	291.29	17447	1052	60	6%		79%	70%		554.45	52.5	31.5
Lower/Urban Watersheds	77.81	7430	1457	95	20%		21%	30%		126.24	61.6	58.9

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 42.03 m/yr Calib. Settling Rate 25.0 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.26 years Calib. Retention Coef. 37% Error % = Percent of Variance in Total Inflow Load Estimate

Table 8 Total Phosphorus Balance for 2006-2008

Variable: **Total Phosphorus** **Average for Years:** **2006** **thru** **2008**

Term	Flow 10^6 m3	Load kg	Std Error kg	Conc ppb	RSE %	Sampl per yr	Percent of Total Inflow Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export kg / km2
Metro Effluent	86.83	9599	182	111	2%	362	16%	23%	0%			
Metro Bypass	1.36	1692	72	1244	4%	47	0%	4%	0%			
East Flume	0.77	103	10	134	10%	26	0%	0%	0%			
Trib 5A	0.80	87	4	108	5%	27	0%	0%	0%			
Harbor Brook	12.81	1292	212	101	16%	28	2%	3%	1%	31.4	40.9	41.2
Ley Creek	40.85	3405	505	83	15%	26	8%	8%	3%	66.1	61.8	51.5
Ninemile Creek	167.63	8996	1007	54	11%	32	31%	22%	14%	298.1	56.2	30.2
Onondaga Creek	184.93	13629	2425	74	18%	27	34%	33%	80%	285.1	64.9	47.8
Nonpoint Gauged	406.22	27322	2682	67	10%	113	76%	67%	98%	680.7	59.7	40.1
Nonpoint Ungauged	27.67	1861	371	67	20%		5%	5%	2%	46.4	59.7	40.1
NonPoint Total	433.89	29183	2708	67	9%	113	81%	71%	99%	727.0	59.7	40.1
Industrial	1.57	190	11	121	6%	53	0%	0%	0%			
Municipal	88.19	11291	195	128	2%	409	16%	28%	1%			
Total External	523.64	40664	2715	78	7%	575	98%	99%	100%	727.0	72.0	55.9
Precipitation	12.95	388	45	30	12%		2%	1%	0%	11.7	110.7	33.2
Total Inflow	536.59	41053	2715	77	7%	575	100%	100%	100%	738.7	72.6	55.6
Evaporation	8.86						2%			11.7	75.7	
Outflow	527.74	20381	784	39	4%		98%	50%	8%	738.7	71.4	27.6
Retention	0.00	20672	2826		14%		0%	50%				
Alternative Estimates of Lake Outflow												
Outlet 12 Feet	527.74	20381	784	39	4%	26	98%	50%	8%	738.7	71.4	27.6
Outlet 2 Feet	527.74	22009	937	42	4%	26	98%	54%	12%	738.7	71.4	29.8
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	10.69	416	152	39	36%	28	2%	1%		27.0	39.7	15.4
Downstream - Hiawatha	12.81	1292	212	101	16%	28	2%	3%		31.4	40.9	41.2
Local Inflow	2.13	876	260	412	30%		0%	2%		4.4	48.2	198.7
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	144.40	10095	1975	70	20%	55	27%	25%		229.4	62.9	44.0
Downstream - Kirkpatrick	184.93	13629	2425	74	18%	27	34%	33%		285.1	64.9	47.8
Local Inflow	40.53	3534	3128	87	88%		8%	9%		55.7	72.7	63.4
Nonpoint Source Summary - Gauged Watersheds							Percent of Total Gauged Watershed					
Total Watershed	406.22	27322	2682	67	10%		100%	100%		680.69	59.7	40.1
Upper/Rural Watersheds	322.72	19507	2222	60	11%		79%	71%		554.45	58.2	35.2
Lower/Urban Watersheds	83.50	7815	3179	94	41%		21%	29%		126.24	66.1	61.9

Upper Watersheds Ninemile + Onondaga(Dorwin) + Harbor(Velasko) - Primarily Rural / Agric Land Uses
Lower Watersheds Lower Watershed = Ley + Onondaga(Kirkpatrick-Dorwin) + Harbor (Hiawatha - Velasko) - Primarily Urban Land Uses

Lake Overflow Rate 45.11 m/yr Calib. Settling Rate 45.7 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.24 years Calib. Retention Coef. 50% Error % = Percent of Variance in Total Inflow Load Estimate

Table 9 Trends in Loads, 1999-2008

Load Trends (% / yr) 1999 to 2008 Precip Trend = 3.1 +/- 0.8 cm/yr

Term	FLOW	TP	TDP	SRP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA	TSS	BOD5
Metro		-14	-18	-34		-24	-34	-27	14	-5	-5				3	5	4	-7	-15
Bypass					-8				-10										
E Flume	11				8			7	11	8	8	12	9	11	13	13	13	12	12
Trib5A	-17	-21	-22	-28	-21	-17	-18	-15	-23	-14	-14	-15	-15	-14	-17	-19	-19		-12
Harbor/Velasko	5			9	4		-6	5	5			5	5	6	5	6	7		5
Harbor/Lower	36	11	58	18	28				60	14	15	18	13	17	30	9	8	39	
Harbor/Hiawatha	7	7	12	16	6		-4	5	7			6	7	7	6	7	7		7
Onondaga/Dorwin	5	7		11	5	5		10				5	6	5	6	2	3	13	6
Onondaga/Lower	3					-4						4	4	4	5	5	6		
Onond./Kirkpatrick	4	4		6	4		-4	7	5			5	5	5	6	5	5	8	
Ley/Park	3												4	3	4	5	6		6
Ninemile/Rt48	6	4		9							6	6	6	6					7
NonPoint Gauged	5	3		7				4	5			5	5	5	4	3	4	6	5
Total Gauged	4					-13	-23	-14	10			4	4	4	3	3	4	5	
Total NonPoint	5	3		7				4	5			5	5	5	4	3	4	6	5
Total Industrial	-9	-12	-13	-18		-7	-8			-7	-7	-8	-7	-7	-10	-9			
Total Municipal		-13	-16	-25		-23	-32	-27	14	-6	-5				3	5	3	-6	-14
Total Inflow	4					-13	-23	-13	10			4	4	4	3	3	4	5	
NonPoint_Rural	5	5		10				6				5	6	6	3			9	6
NonPoint_Urban	3											4	4	4	5	5	5		
Outlet2	4		-9	-11		-8	-16	-7	9			5	10	5	4	3	4	9	
Outlet12	4	-7	-11	-14		-10	-18	-8	8			4	10	5	3	2	3	9	

Load Trends (% / yr), Adjusted for Variations in Rainfall

Term	FLOW	TP	TDP	SRP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA	TSS	BOD5
Metro		-19	-26			-25	-39	-36		-7	-6			-5		6	6		-17
Bypass																			
E Flume																			10
Trib5A	-17	-19	-22	-26	-18	-17	-20		-19	-15	-15	-16	-15	-16	-18	-21	-20		
Harbor/Velasko							-10									6	7		
Harbor/Lower		17		19	54				58	19	17	25		21					23
Harbor/Hiawatha	5	8	9	14				8								6	7		6
Onondaga/Dorwin																			
Onondaga/Lower			9													5	5		
Onond./Kirkpatrick				7			-7									4	4		
Ley/Park			-8			-6													
Ninemile/Rt48																			
NonPoint Gauged							-5									3	3		
Total Gauged						-15	-25	-17								3	4		
Total NonPoint							-5									3	3		
Total Industrial		-14	-16	-20		-10	-13					-10		-9	-12				
Total Municipal		-17	-23			-24	-36	-35		-7	-6			-5		6	6		-15
Total Inflow						-14	-25	-16								3	4		
NonPoint_Rural																			
NonPoint_Urban						-5										5	5		
Outlet2		-11	-15	-19		-11	-17	-12					11						
Outlet12		-13	-17	-21		-12	-17	-12					12						

NonPoint_Rural = Ninemile + Harbor (Velasko) + Onondaga (Dorwin)

NonPoint_Urban = Harbor (Hiawatha - Velasko) + Onondaga (Kirkpatrick- Dorwin) + Ley

Based upon linear regression of annual values; trend magnitudes shown for significance level $p < 0.1$, two-tailed test.

Trend tests at sites in low concentration range influenced by variations in detection limits (NH3-N, NO2 N, TSS, BOD5)

Table 10 Trends in Flow-Weighted-Mean Concentration, 1999-2008

Concentration Trends (% / Yr) Precip Trend = 3.1 +/- 0.8 cm/yr

Term	TP	TDP	SRP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA	TSS	BOD5
Metro	-14	-19	-34		-24	-34	-28	14	-6	-5		1	-2	3	5	4	-7	-15
Bypass			17	-4	-3	-3		-6										
E Flume	-5	-10	-10	-3	-8	-12			-3	-3						2		
Trib5A	-4	-6	-12	-4				-7			2	2	2		-3	-3	12	4
Harbor/Velasko						-10							1			2		
Harbor/Lower	-25		-18		-31	-40		24	-22	-21	-18	-23	-19		-27	-28		-25
Harbor/Hiawatha		5	9		-4	-11								-1				
Onondaga/Dorwin			6			-8								1	-2	-2	8	
Onondaga/Lower					-7	-8								2				
Onond./Kirkpatrick		-5			-2	-9								1				
Ley/Park		-7	-3	-3	-4	-6	-6							1				
Ninemile/Rt48	-2		4	-2	-3	-7	-4							-4	-6	-5		1
NonPoint Gauged			2		-3	-7								-1				
Total Gauged	-7	-10		-3	-17	-27	-18	7	-4	-4								-8
Total NonPoint			2		-3	-7								-1				
Total Industrial	-3	-4	-9	5			14	4			1	2	2			4	9	5
Total Municipal	-13	-16	-25		-23	-32	-27	14	-6	-5		1	-2	3	5	3	-6	-14
Total Inflow	-7	-10		-3	-17	-26	-17	6	-4	-3								-8
NonPoint_Rural			5		-2	-7								-2	-5	-3		1
NonPoint_Urban				-2	-5	-7								1				
Outlet2	-9	-12	-14	-2	-12	-19	-11	5	-3	-3		6	1		-1		5	-3
Outlet12	-11	-15	-18	-3	-14	-22	-11	5	-3	-3		7	1		-2		5	-3

Concentration Trends, Adjusted for Variations in Rainfall (%/Yr)

Term	TP	TDP	SRP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA	TSS	BOD5
Metro	-19	-25			-25	-39	-35		-6	-5	-4		-5	2	7	7		-17
Bypass				-4				-9				-8	-4					
E Flume	-8	-11	-12	-6	-10	-14		-5	-5	-5								
Trib5A			-10												-4	-3	13	4
Harbor/Velasko						-12									4	5		
Harbor/Lower								29										
Harbor/Hiawatha		5	10			-7					-2							
Onondaga/Dorwin						-8					-1		-1					
Onondaga/Lower		11												4	7	7		
Onond./Kirkpatrick			7			-7					-1				4			
Ley/Park		-7		-4	-6	-4			-4	-4					6	6		
Ninemile/Rt48					-4	-6									-3			
NonPoint Gauged			4		-3	-5												
Total Gauged	-7				-15	-26	-18	9	-5	-4	-1		-1		3	4		-7
Total NonPoint			4		-3	-5												
Total Industrial	-4	-6	-10											-2		3	9	5
Total Municipal	-16	-22			-23	-35	-34		-6	-5	-4		-5	2	7	7		-14
Total Inflow	-7				-15	-25	-16	9		-4	-1		-1		3	4		-7
NonPoint_Rural						-6									-2			
NonPoint_Urban		3	6		-4									2	6	6		
Outlet2	-11	-16	-20	-2	-11	-18	-12		-4	-4		10					4	-4
Outlet12	-14	-18	-21		-13	-17	-12		-5	-4		11						-4

NonPoint_Rural = Ninemile + Harbor (Velasko) + Onondaga (Dorwin)

NonPoint_Urban = Harbor (Hiawatha - Velasko) + Onondaga (Kirkpatrick- Dorwin) + Ley

Based upon linear regression of annual values; trend magnitudes shown for significance level p < 0.1, two-tailed test.

Trend tests at sites in low concentration range influenced by variations in detection limits (NH3-N, NO2 N, TSS, BOD5)

Table 11 Trends in Load Expressed in Mass Units Per Year, 1999-2008

Term	FLOW	TP	TDP	SRP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA	TSS	BOD5
Units	hm^3	kg	kg	kg	kg	kg	kg	kg	kg	mt	mt	mt	mt	mt	mt	mt	mt	mt	mt
Metro		-4675	-2700			-109874	-108611	-7523		-56	-43			-871		2375	1368		-148
Bypass																			
E Flume																			0
Trib5A	0	-46	-23	-25	-536	-160	-62		-370	-1	-1	-12	-2	-45	-47	-154	-72		
Harbor/Velasko							-55									143	89		
Harbor/Lower		95		45	1150				344	1	1	13		44					1
Harbor/Hiawatha	1	82	37	46				13								177	113		2
Onondaga/Dorwin																			
Onondaga/Lower			102													3342	2073		
Onond./Kirkpatrick				97			-1043									3456	2061		
Ley/Park			-84			-2075													
Ninemile/Rt48																			
NonPoint Gauged							-3117									3748	2577		
Total Gauged						-100721	-89694	-5205								6165	3962		
Total NonPoint							-3329									4003	2753		
Total Industrial		-48	-26	-26		-188	-86					-10		-37	-39				
Total Municipal		-4499	-2501			-108321	-102660	-7480		-61	-47			-900		2367	1364		-145
Total Inflow						-100286	-89148	-5072								6423	4138		
NonPoint_Rural																			
NonPoint_Urban						-2908										4171	2568		
Outlet2		-3498	-3392	-2982		-51805	-41746	-2887					166						
Outlet12		-4392	-4132	-3667		-61741	-46319	-3137					185						

NonPoint_Rural = Ninemile + Harbor (Velasko) + Onondaga (Dorwin) NonPoint_Urban = Harbor (Hiawatha - Velasko) + Onondaga (Kirkpatrick- Dorwin) + Ley

Based upon linear regression of annual values, adjusted for variations in rainfall; trend magnitudes shown for significance level $p < 0.1$, two-tailed test.

Trend tests at sites in low concentration range influenced by variations in detection limits (NH3-N, NO2 N, TSS, BOD5)

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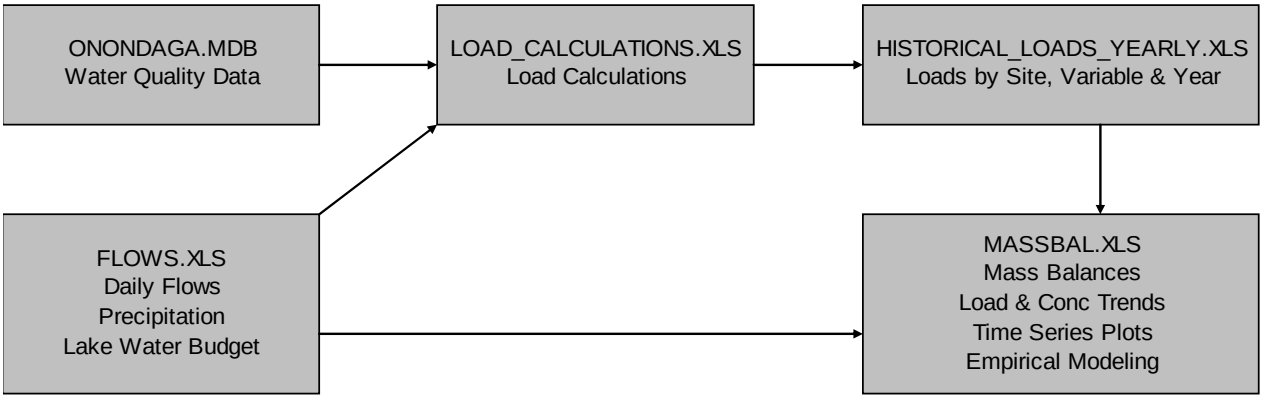
Figure 1
Mass Balance Computations Integrated with AMP Long-Term Database



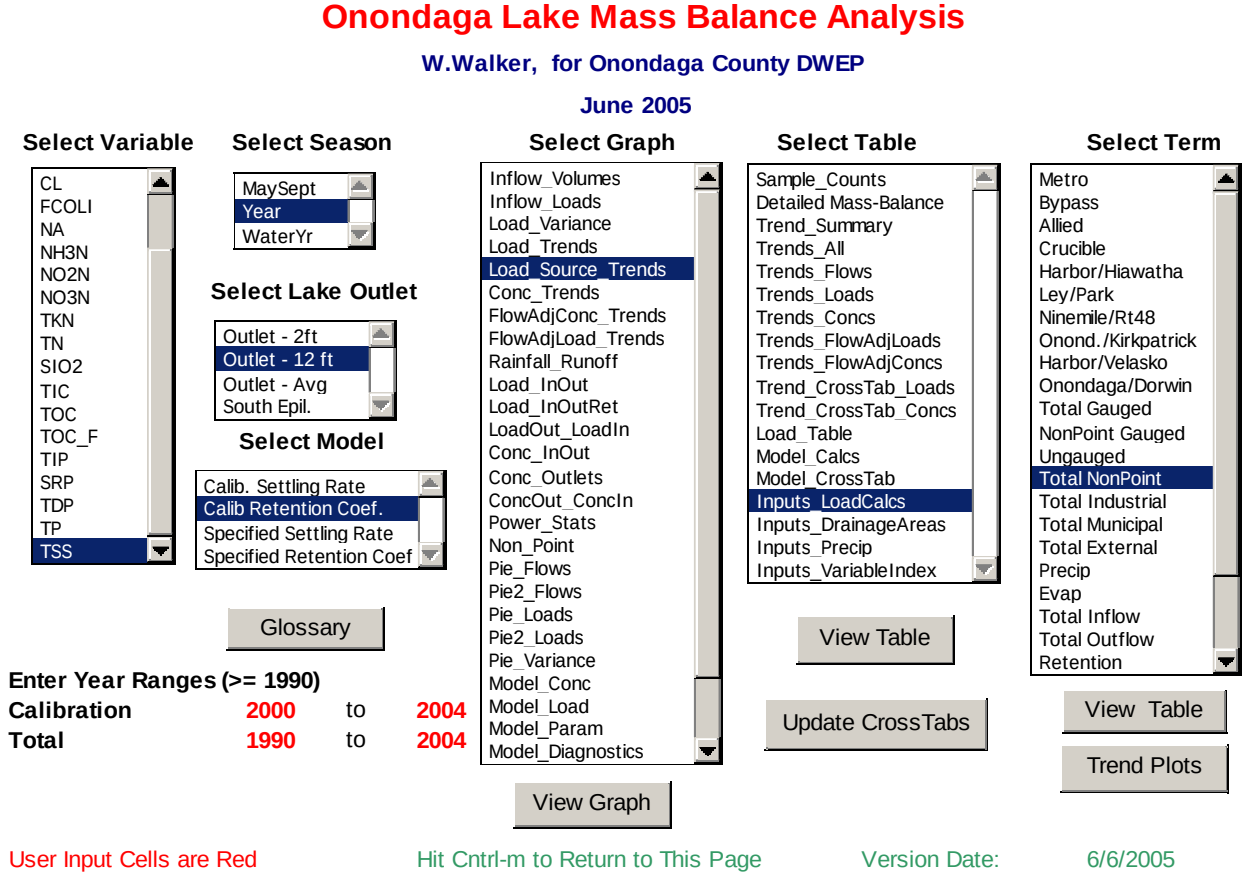
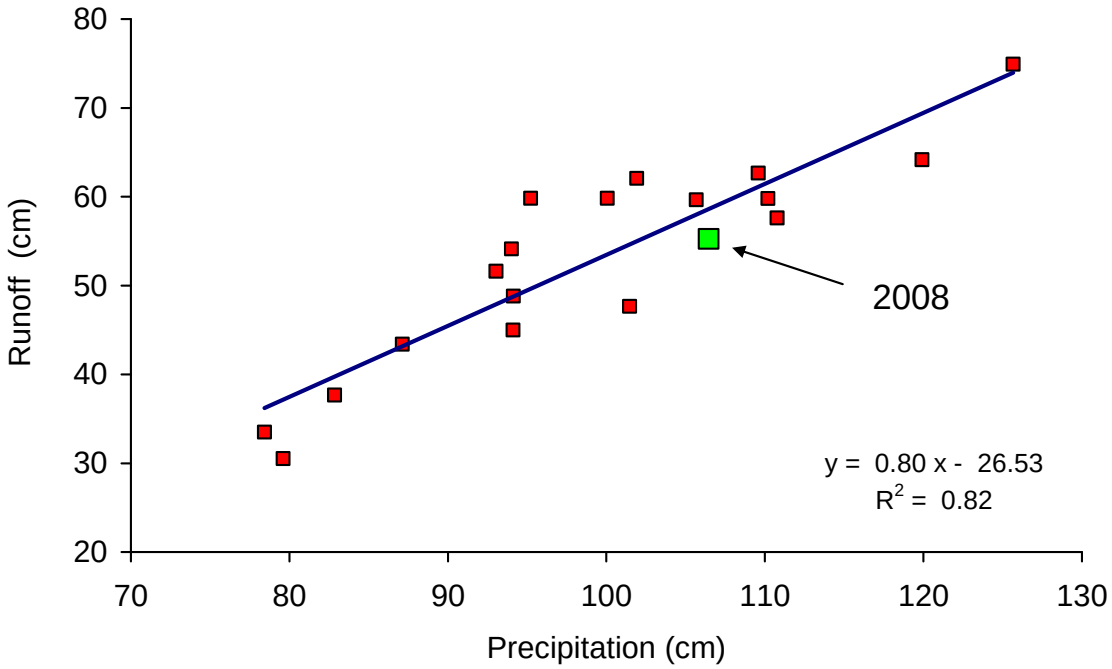
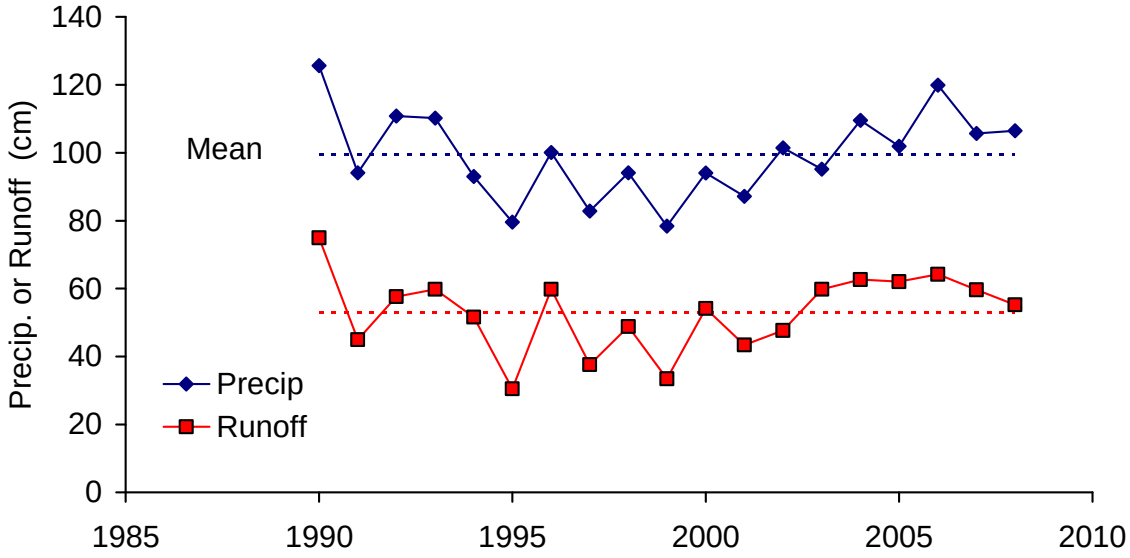


Figure 2
Precipitation and Runoff, 1990-2008





Summary Statistics	1990-2008 Mean	1990-2008 Min	1990-2008 Max	2008 Mean	2008 Percentile
Precipitation (cm)	99	78	126	106	70%
Runoff (cm)	53	31	75	55	50%

Figure 3

Long-Term Variations in Total Inflow & Outflow Concentrations

Squares = Inflow, Circles = Outflow Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

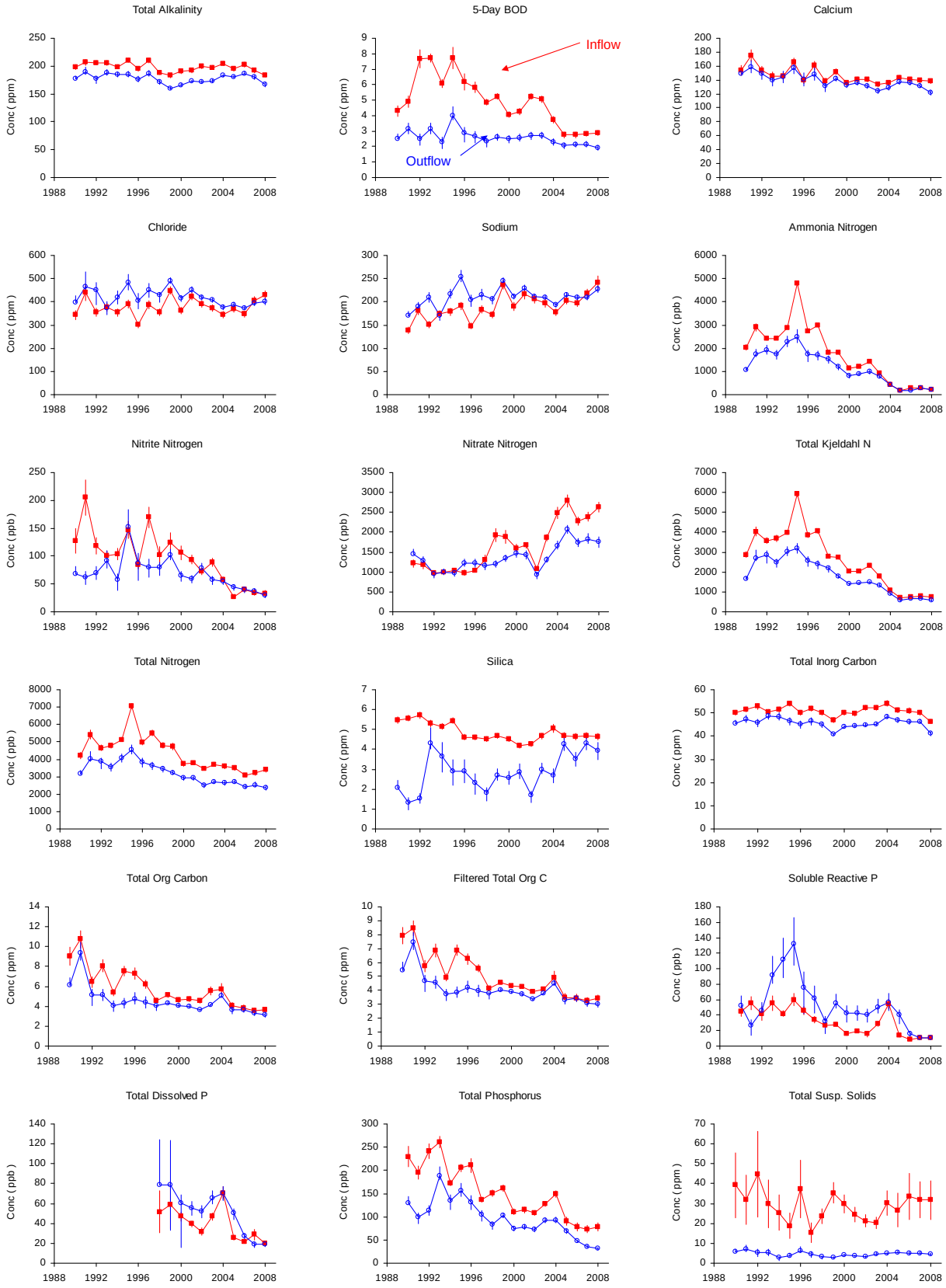


Figure 4

Long-Term Variations in Total Inflow & Outflow Loads

Squares = Inflow, Circles = Outflow Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

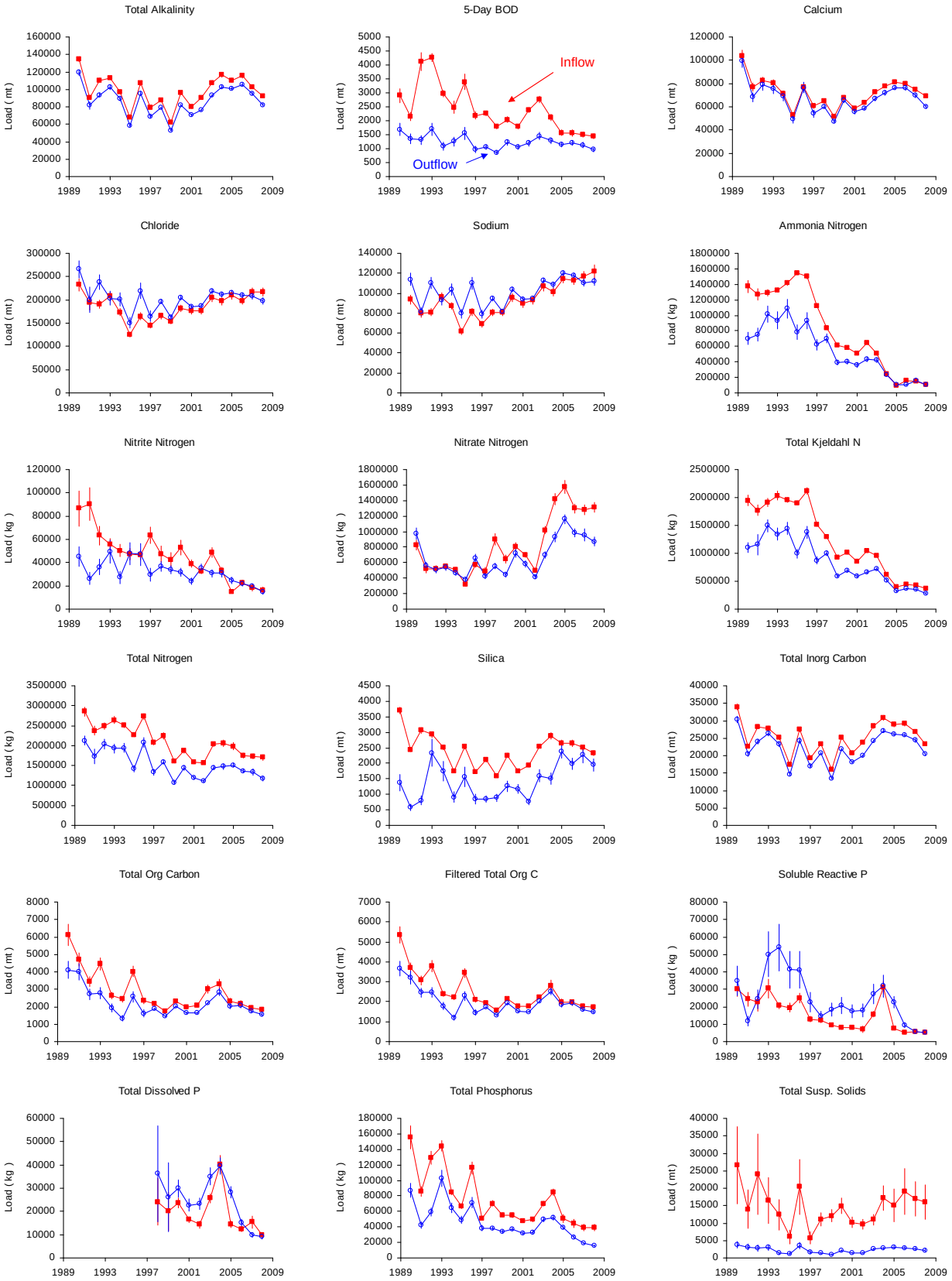


Figure 5

Long-Term Variations in NonPoint & Metro Loads

Squares = NonPoint Sources, Circles = Metro + Bypass Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

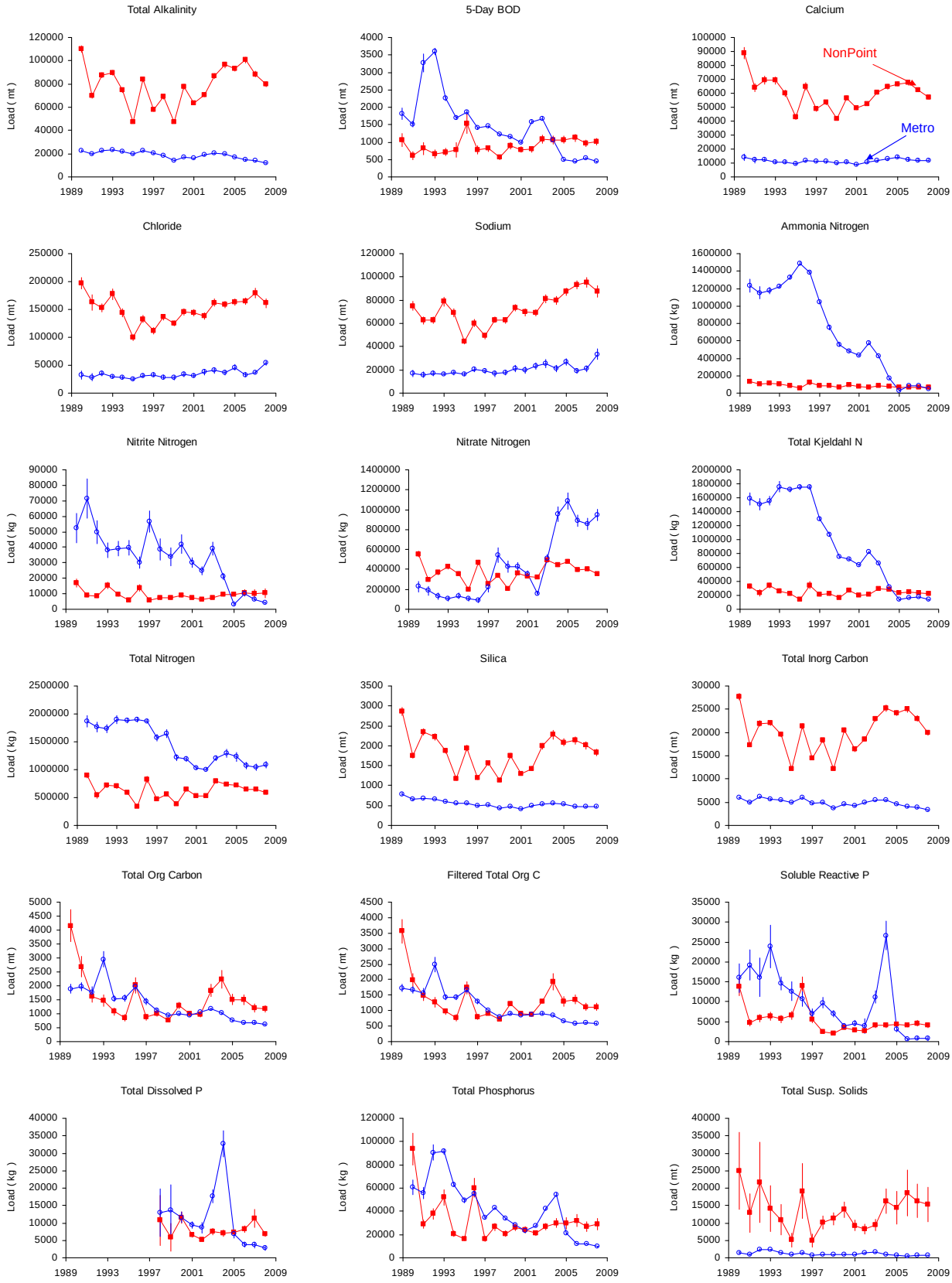
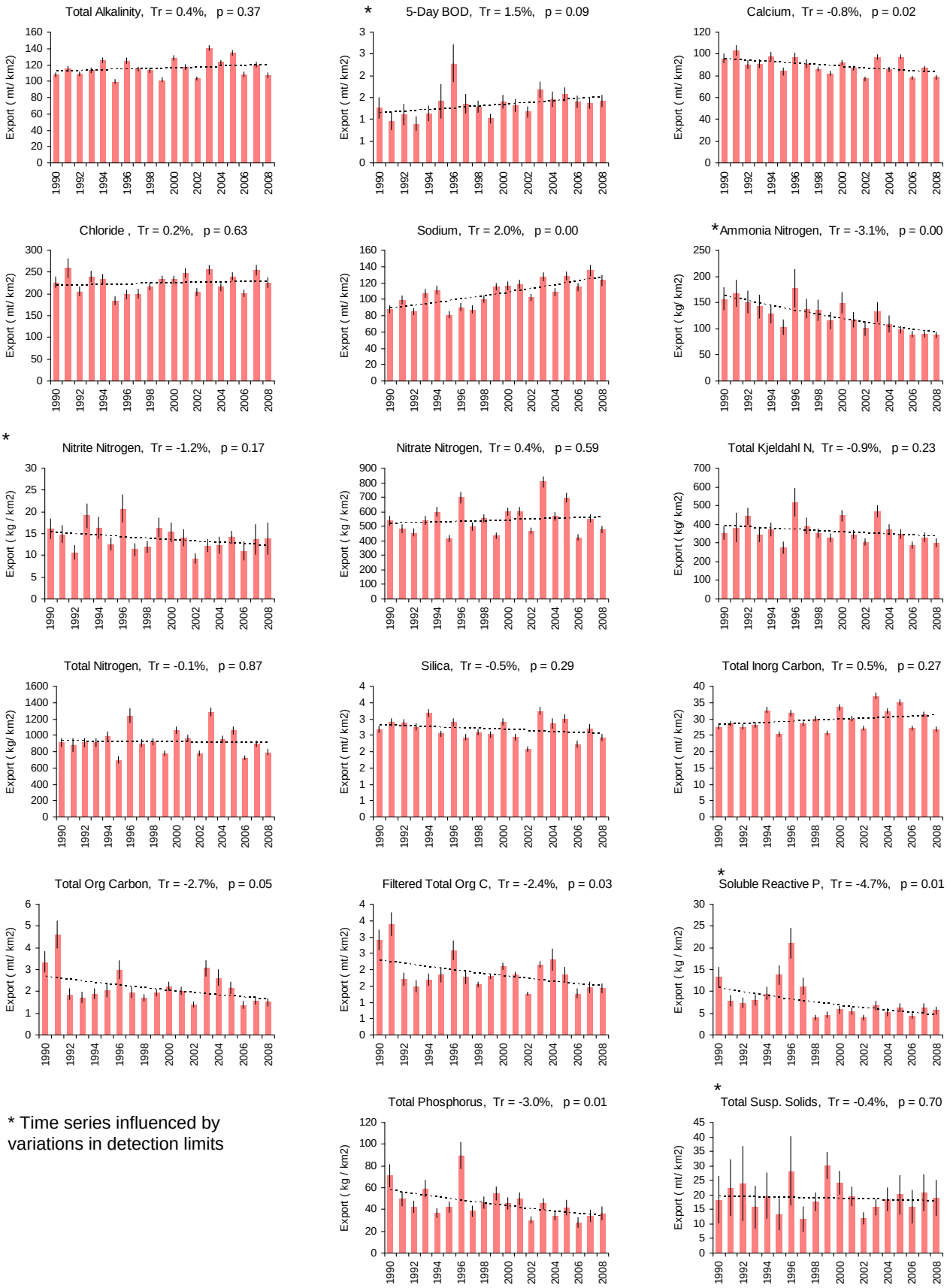


Figure 6 Trends in Rainfall-Adjusted NonPoint Loads by Variable, 1990-2008

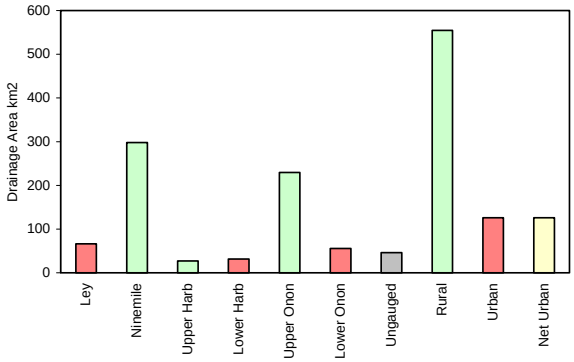


* Time series influenced by variations in detection limits

Figure 7 Spatial Variations in NonPoint Phosphorus Loads

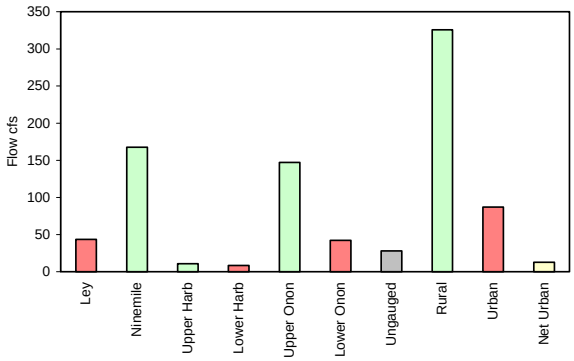
Variable: Total Phosphorus Period: 1999 - 2008

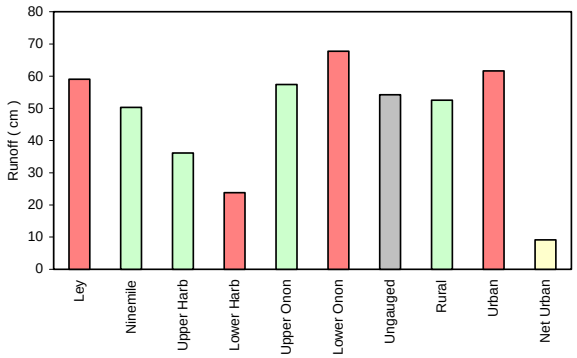
Total Values Unit Area Values

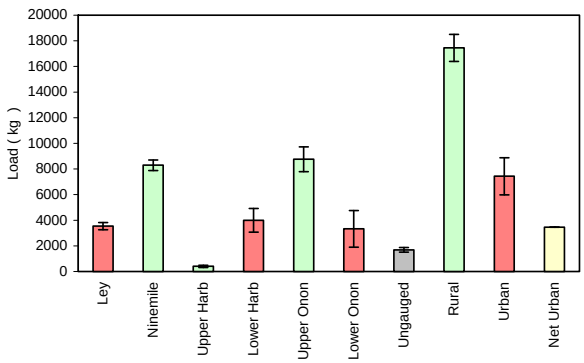


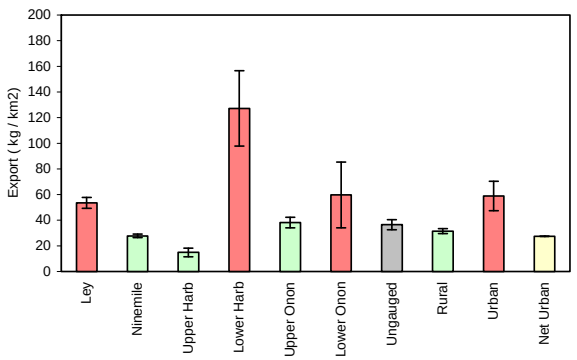
Label	Description
Ley	Above Park
Ninemile	Above Lakeland
Upper Harb	Above Velasko
Lower Harb	Between Velasko & Hiawatha
Upper Onon	Above Dorwin
Lower Onon	Between Dorwin & Kirkpatrick
Ungauged	Ungauged Watershed (Estimated)

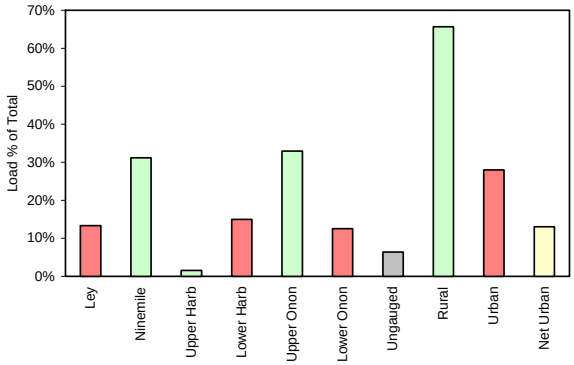
Red	Lower Watersheds (~ Urban)
Green	Upper Watersheds (~ Rural)











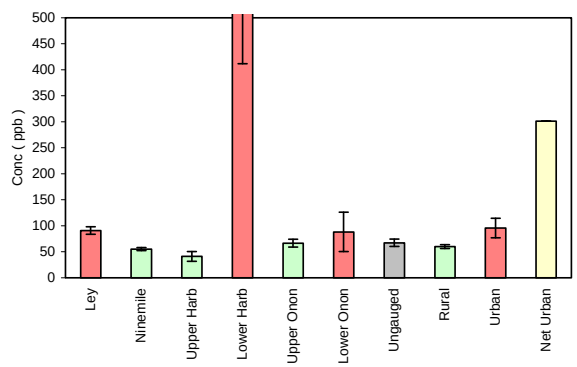
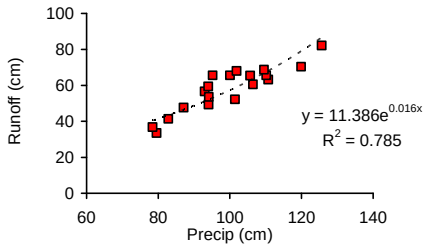
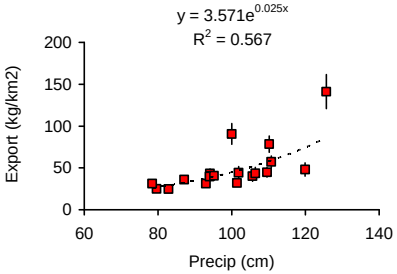


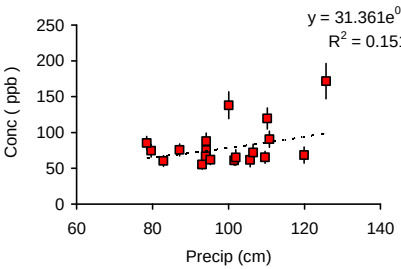
Figure 8 Trends in Nonpoint Runoff and Total P Load Adjusted for Rainfall Variations, 1990-2008

Site: T NonPoint Dr Area : 662.8 km^2 Variable : Total Phosphorus Period: 1990 - 2008

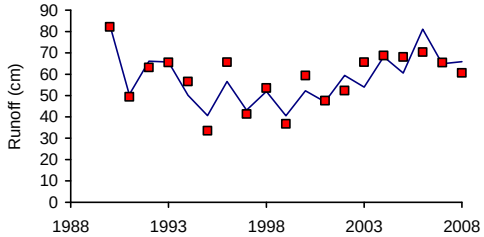
Correlations with Precipitation

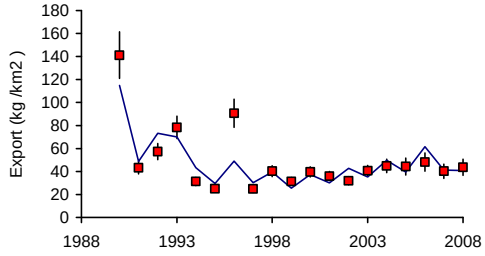


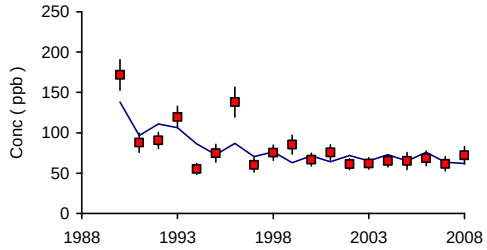




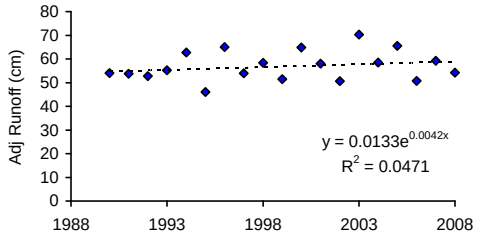
Observed & Predicted Time Series

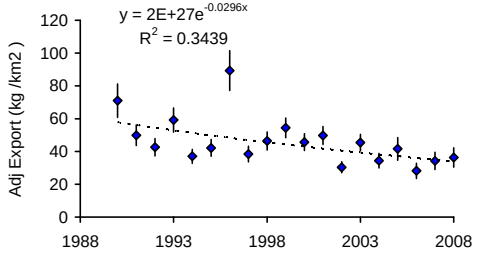


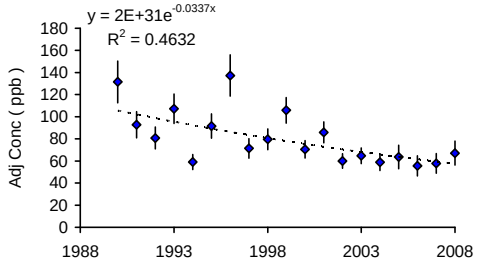




Adjusted for Variations in Precipitation







Dashed Line = Regression vs. Precip
Vertical Bars = +/- 1 Standard Error of Measured Yearly Value

Solid Line = Regression vs. Year and Precip

Dashed Line = Regressionof Adjusted Value vs. Year

Regression Model: Ln (Y) = A0 + A1 Year + A2 Precip Years: 19

Adjustment to Mean Precip: Ln (Yadjusted) = Ln (Y) + A2 (Mean_Precip - Precip) Mean_Precip = 99 cm/yr

Ln Runoff vs. Precip & Year

	Coef	SE	p
A0	-5.91055		
A1 (Yr)	0.00418	0.00471	0.39
A2 (Precip)	0.01603	0.00207	0.00
R^2	0.79517		
Std Error	0.11219		

Ln Export vs. Precip & Year

	Coef	SE	p
	60.26478		
	-0.02956	0.01023	0.01
	0.02623	0.00449	0.00
	0.71561		
	0.24368		

Ln Conc vs. Precip & Year

	Coef	SE	p
	70.78049		
	-0.03374	0.00910	0.00
	0.01021	0.00400	0.02
	0.54311		
	0.21675		

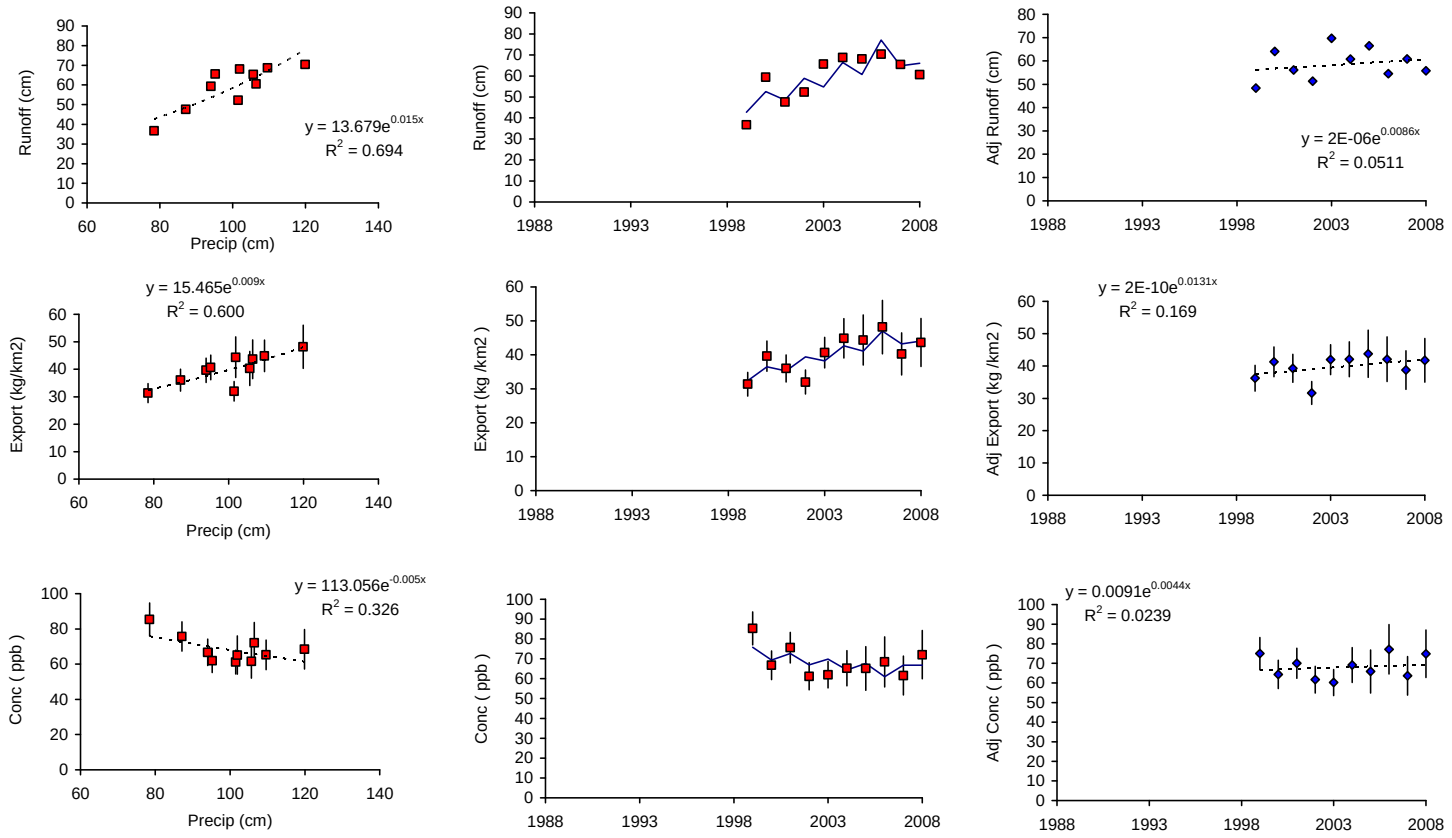
Summary of Trends (Percent / Year)

	Trend	p
Runoff	0.4%	0.39
Export	-3.0%	0.01
Conc	-3.4%	0.00

Figure 9 Trends in Nonpoint Runoff and Total P Load Adjusted for Rainfall Variations,1999-2008

Site: T NonPoint Dr Area : 662.8 km^2 Variable : Total Phosphorus Period: 1999 - 2008

Correlations with Precipitation | Observed & Predicted Time Series | Adjusted for Variations in Precipitation



Dashed Line = Regression vs. Precip
Vertical Bars = +/- 1 Standard Error of Measured Yearly Value

Solid Line = Regression vs. Year and Precip

Dashed Line = Regressionof Adjusted Value vs. Year

Regression Model: Ln (Y) = A0 + A1 Year + A2 Precip Years: 10

Adjustment to Mean Precip: Ln (Yadjusted) = Ln (Y) + A2 (Mean_Precip - Precip) Mean_Precip = 100 cm/yr

Ln Runoff vs. Precip & Year

	Coef	SE	p
A0	-14.52930		
A1 (Yr)	0.00865	0.02333	0.72
A2 (Precip)	0.01276	0.00597	0.07
R^2	0.70007		
Std Error	0.12796		

Ln Export vs. Precip & Year

	Coef	SE	p
A0	-23.23012		
A1 (Yr)	0.01310	0.01817	0.49
A2 (Precip)	0.00676	0.00465	0.19
R^2	0.62739		
Std Error	0.09969		

Ln Conc vs. Precip & Year

	Coef	SE	p
A0	-4.09566		
A1 (Yr)	0.00445	0.01780	0.81
A2 (Precip)	-0.00600	0.00456	0.23
R^2	0.33183		
Std Error	0.09766		

Summary of Trends (Percent / Year)

	Trend	p
Runoff	0.9%	0.72
Export	1.3%	0.49
Conc	0.4%	0.81

Figure 10 Trends in Rainfall-Adjusted Phosphorus Loads from Individual Sources, 1990-2008

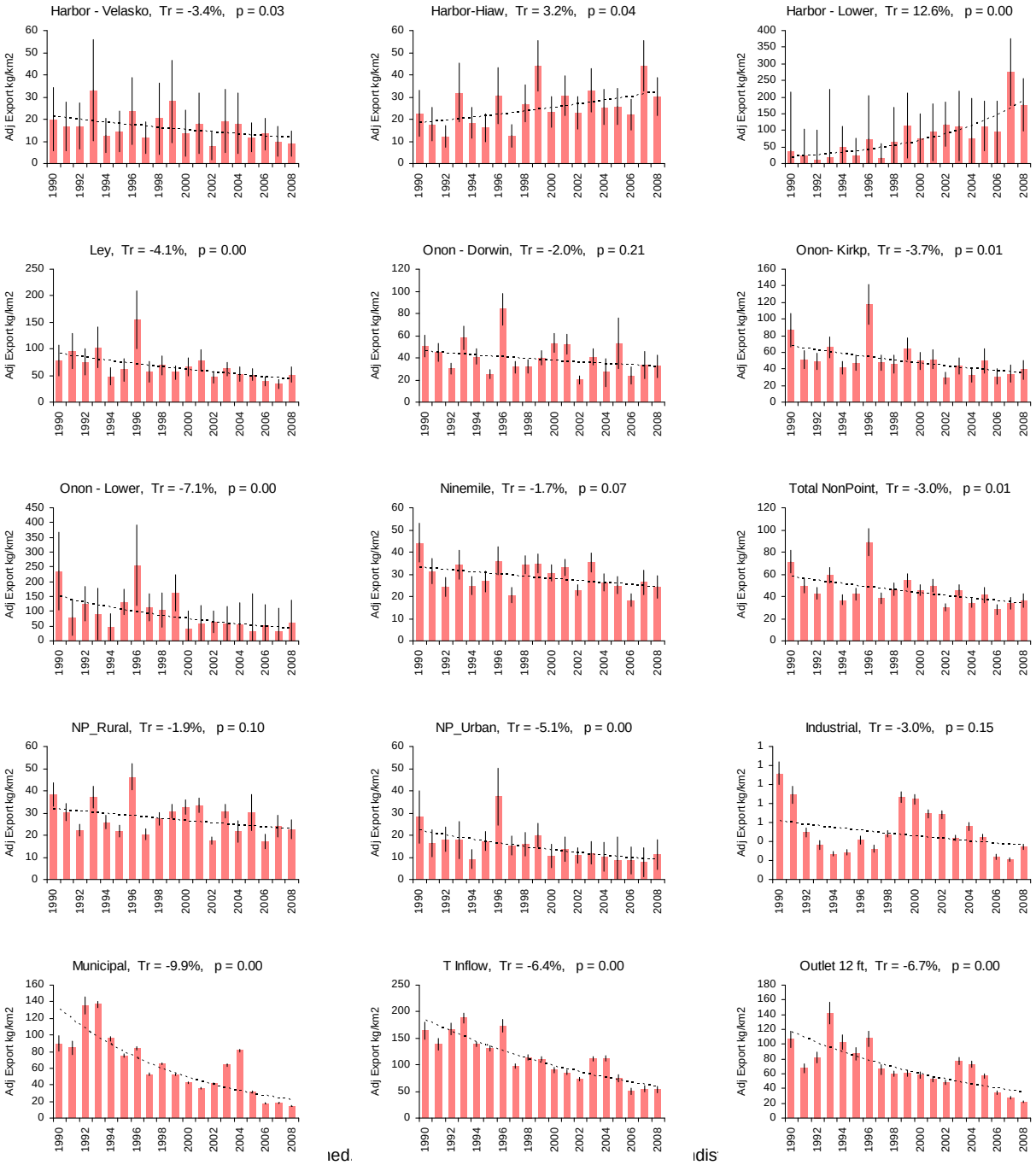


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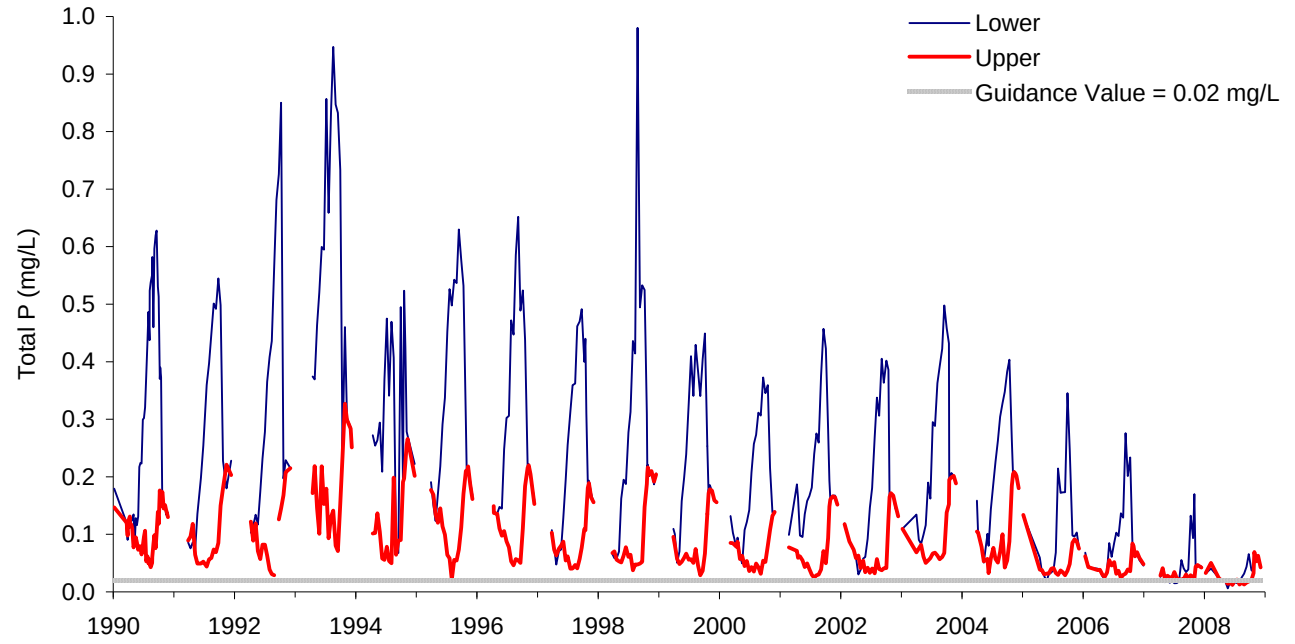
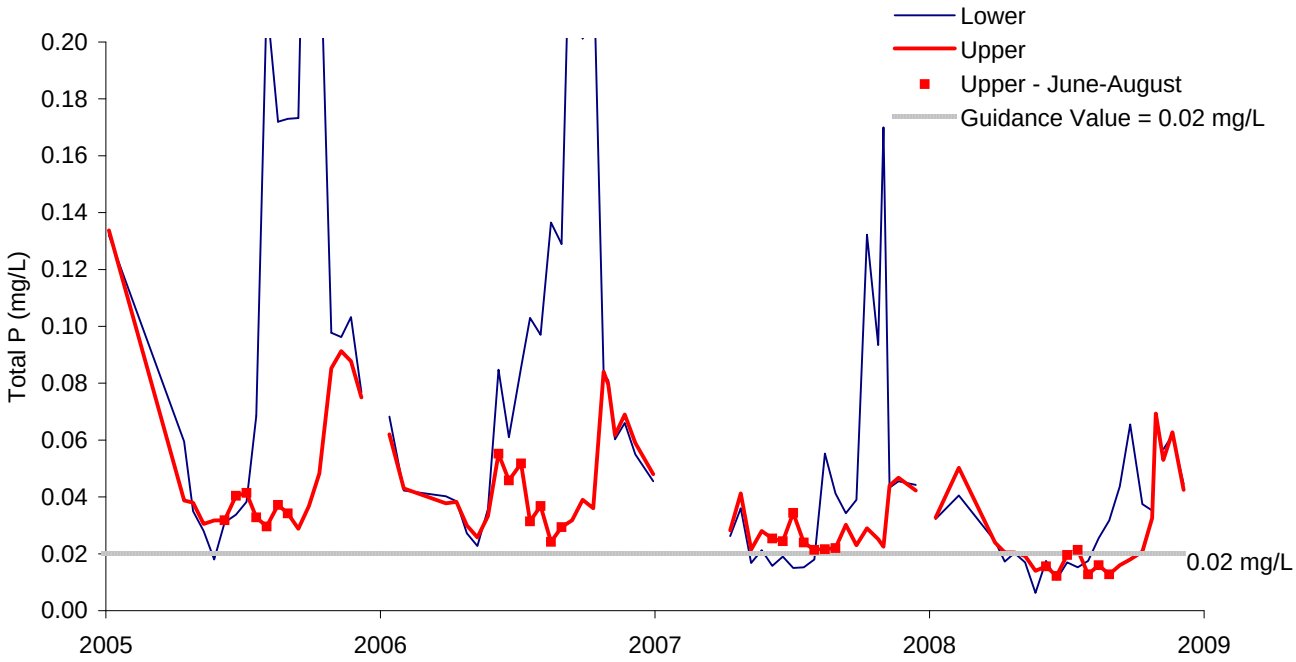
Figure 11 Trends in Lake Phosphorus Concentration, 1990-2008

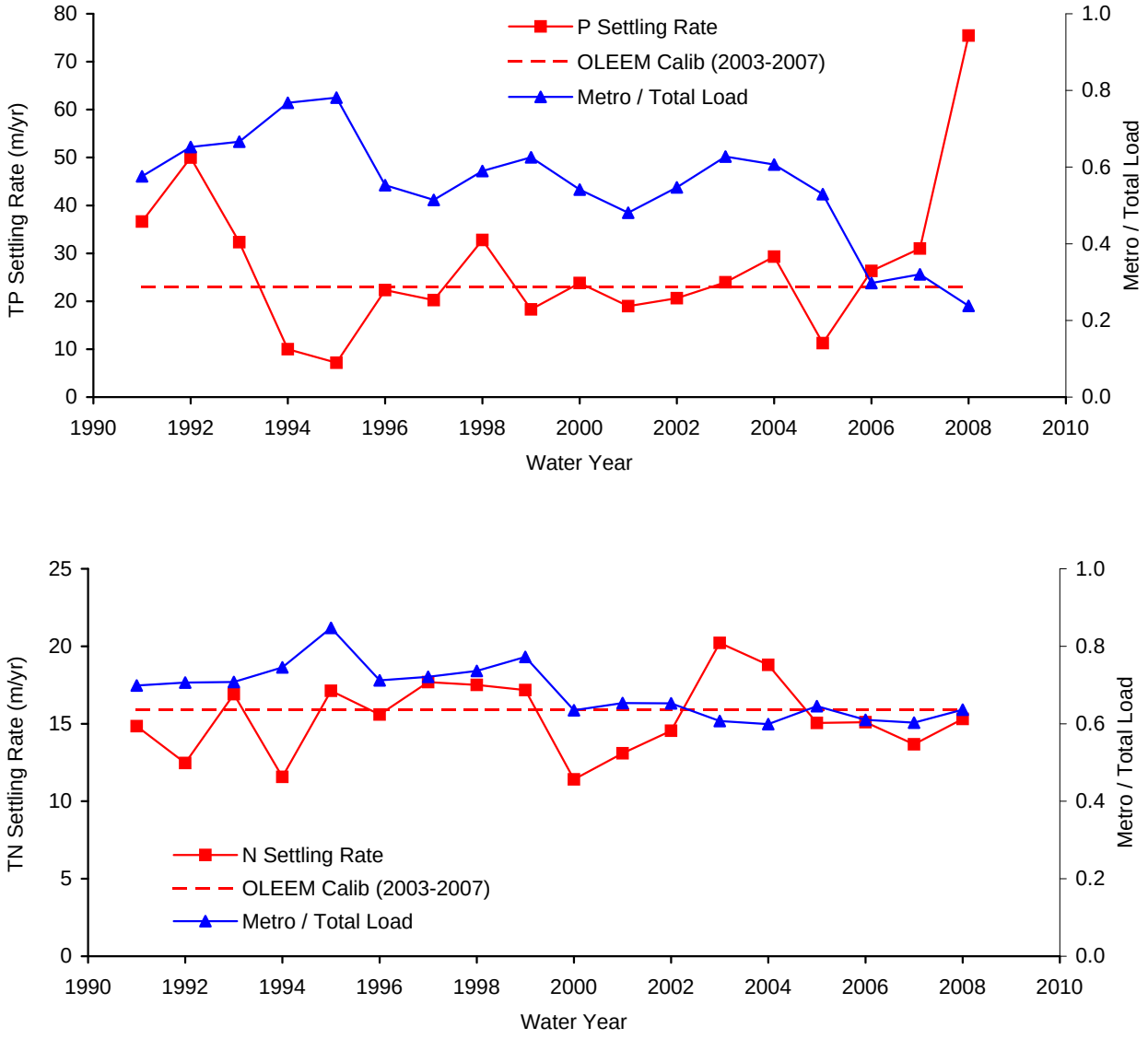




Lower 9 - 18 meters, South Deep station

Upper 0 - 3 meters

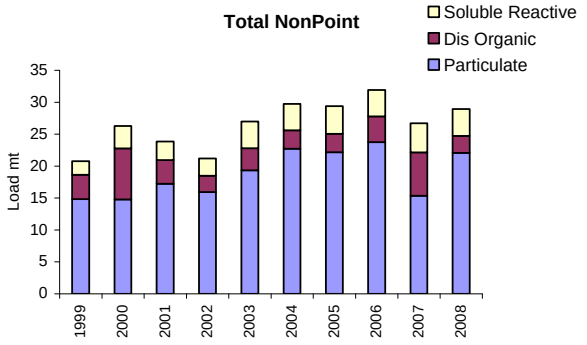
Figure 12 Phosphorus and Nitrogen Settling Rates, 1990-2008

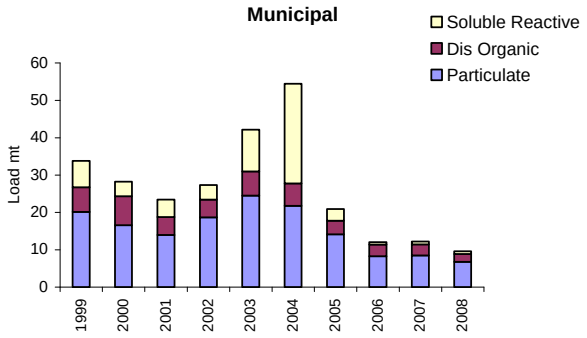


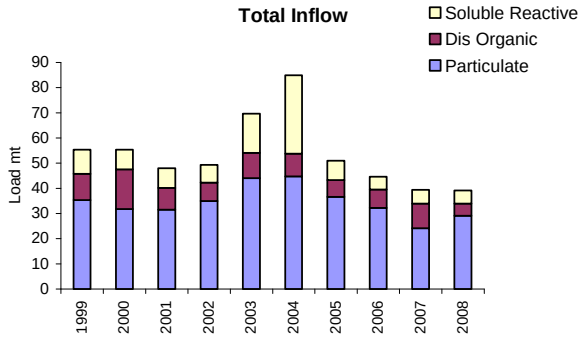
Settling Rate (m/yr) = Nutrient Retention Per Unit Area (g/m^2-yr) / Average Outflow Concentration (g/m^3)
Metro / Total Load = fraction of P or N load attributed to Metro Sources (Treated + Bypass)
OLEEM = Onondaga Lake Empirical Eutrophication Model, calibrated to 2003-2007 data (Ecologic et al, 2009).
P settling rate in 2008 significantly higher than those measured in previous years.

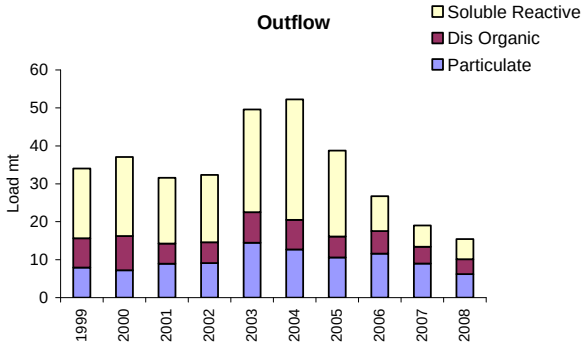
Figure 13 Trends in Speciation of Phosphorus Loads, 1999-2008

Total P Load

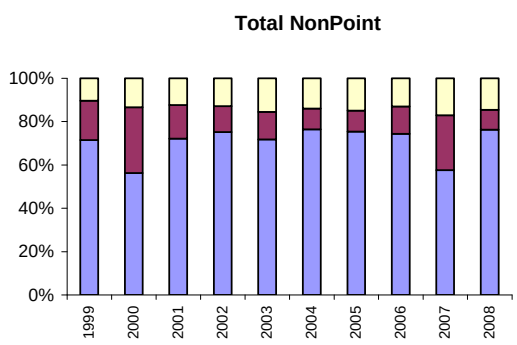


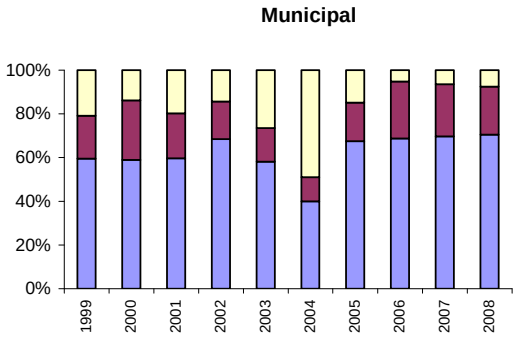


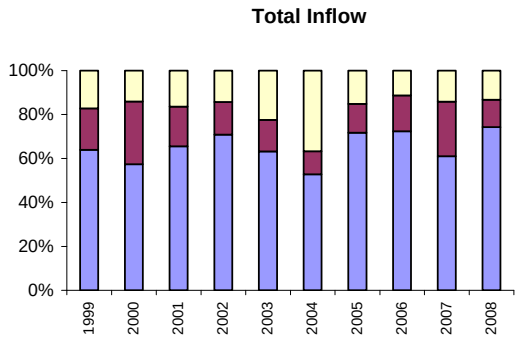




Percent of Total P Load







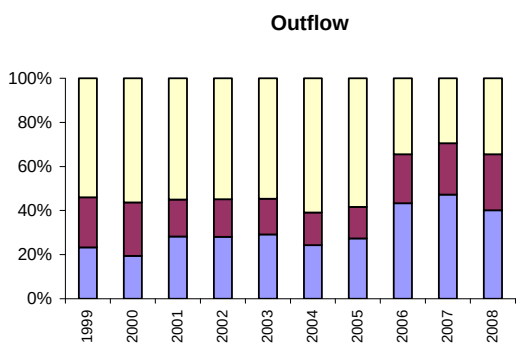
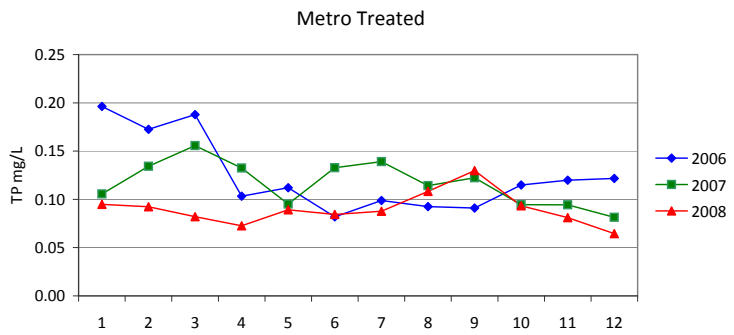
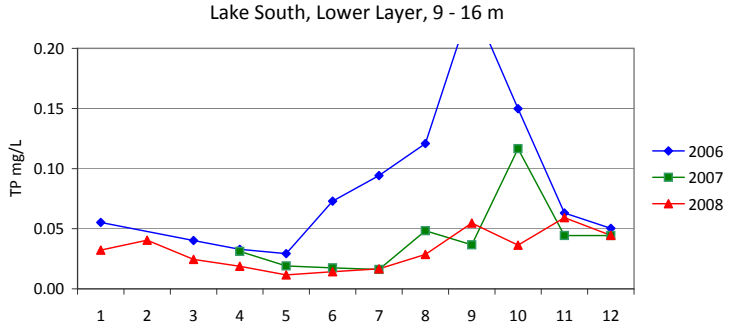
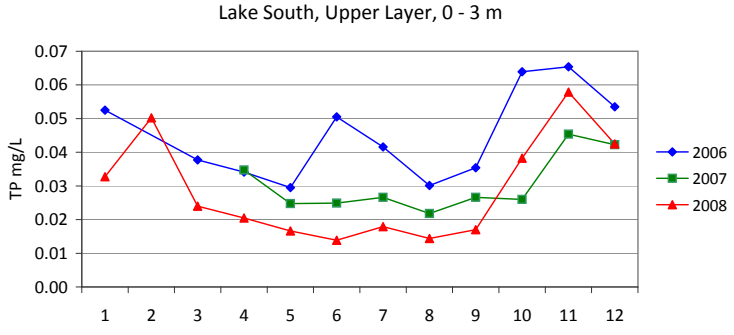
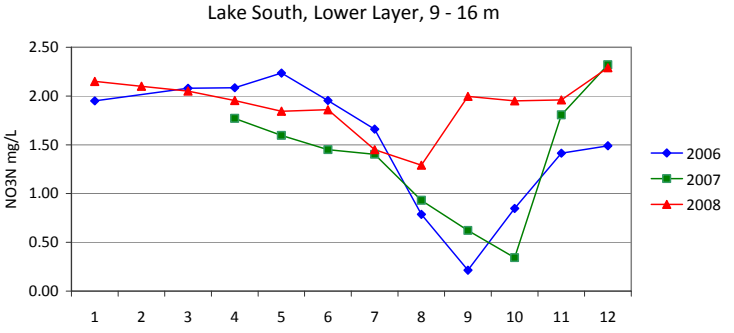


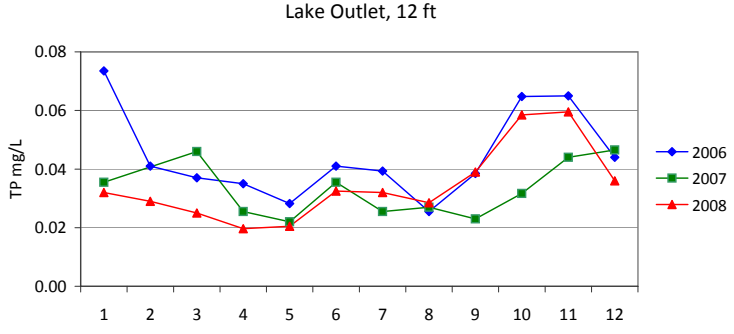
Figure 14 Monthly Mean Concentrations by Site & Depth, 2006-2008











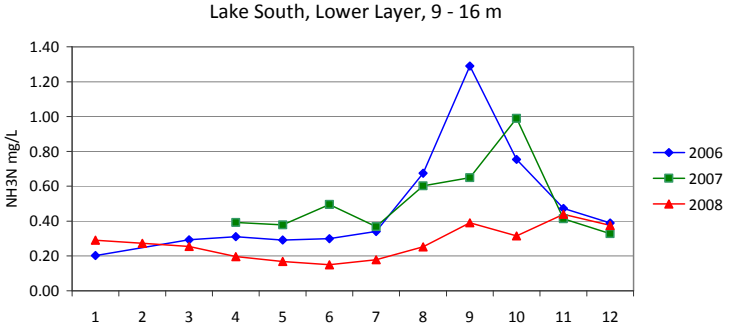


Figure 15 Metro Chloride Time Series and Lake South Conductivity Profiles, July-August, 2007 vs. 2008

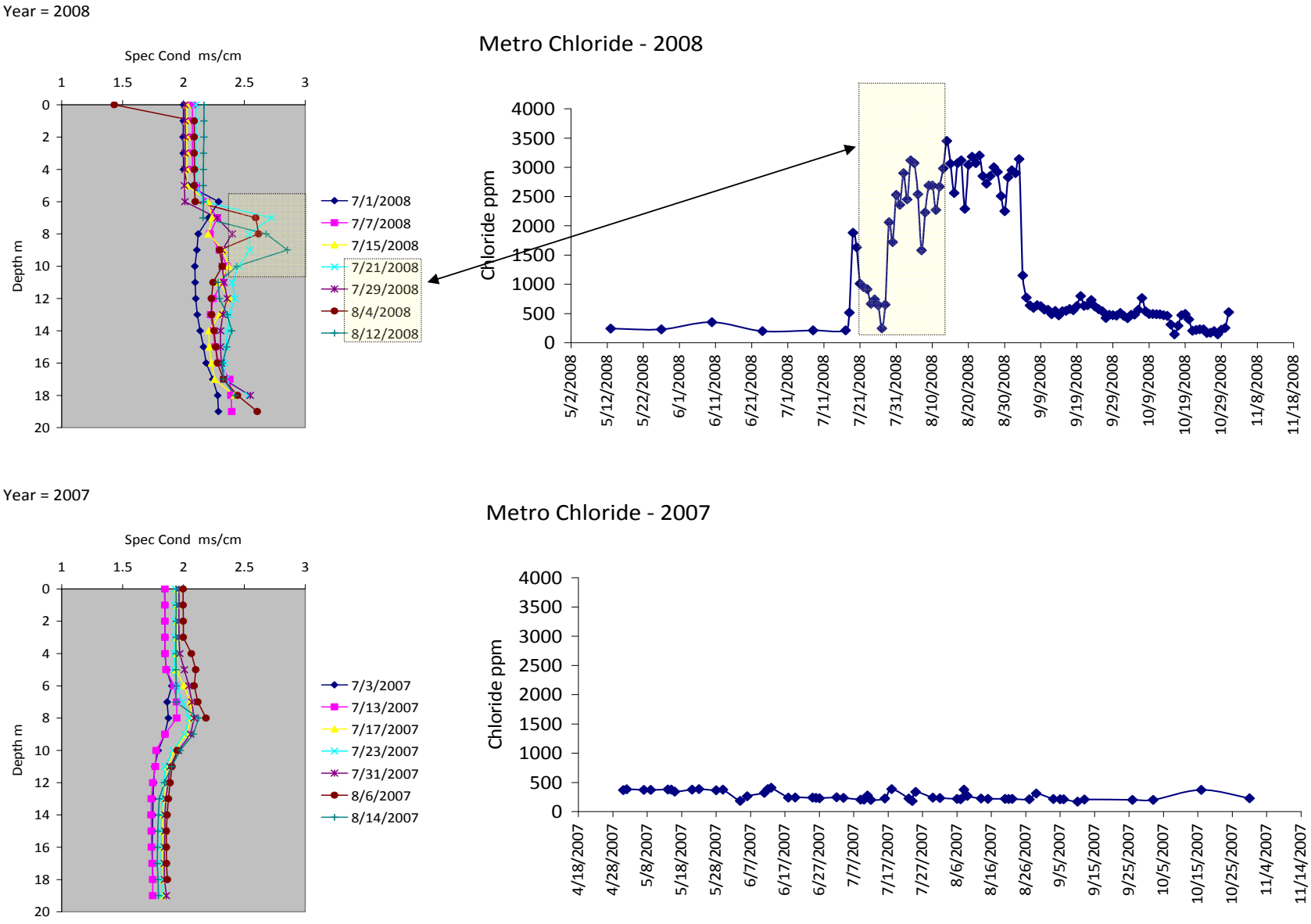


Table 9 Trends in Total Phosphorus for Each Mass Balance Term, 1990-2007

	Flow						Load								Concentration					
	Mean	Rainfall	Trend % / yr		p Levels		Mean	Rainfall	Trend (kg/yr)		Trend % / yr		p Levels		Mean	Rainfall	Trend % / yr		p Levels	
Source	hm3/yr	Correl	A	B	A	B	kg/yr	Correl	Mean	Std Error	A	B	A	B	ppb	Correl	A	B	A	B
Metro	91.9	0.42			0.55	0.50	38983	-0.03	-3394	628	-9	-9	0.00	0.00	424	-0.09	-9	-8	0.00	0.00
Bypass	3.3	0.28			0.26	0.25	5349	0.26	-462	190	-9	-9	0.03	0.03	1633	0.03	-4	-4	0.00	0.00
E Flume	0.9	0.63			0.43	0.29	143	0.63	-7	4		-5	0.17	0.07	164	-0.35			0.13	0.13
Trib5A	2.6	-0.31	-8	-8	0.00	0.00	213	-0.22		6			0.77	0.79	83	0.05	7	7	0.00	0.00
Harbor/Velasko	9.2	0.82		1	0.17	0.02	493	0.72	-14	8		-3	0.26	0.09	54	0.40	-4	-4	0.02	0.01
Harbor/Lower	1.1	0.46			0.82	0.77	341	0.17	43	8	13	13	0.00	0.00	325	-0.25	14	14	0.03	0.03
Harbor/Hiawatha	10.2	0.84		1	0.30	0.08	828	0.67	27	13		3	0.13	0.05	81	0.33			0.15	0.15
Onondaga/Dorwin	125.6	0.83		1	0.30	0.09	10277	0.78		174			0.50	0.25	82	0.60	-3	-3	0.09	0.03
Onondaga/Lower	36.6	0.88		1	0.29	0.04	5722	0.40	-448	128	-8	-8	0.01	0.00	156	0.16	-9	-9	0.00	0.00
Onond./Kirkpatrick	162.2	0.86		1	0.29	0.05	15999	0.72	-617	219		-4	0.11	0.01	99	0.42	-5	-5	0.00	0.00
Ley/Park	39.3	0.86			0.93	0.76	4616	0.55	-203	61	-4	-4	0.02	0.00	117	0.16	-4	-4	0.00	0.00
Ninemile/Rt48	148.5	0.88			0.78	0.68	9222	0.82		92			0.40	0.11	62	0.40	-2	-2	0.06	0.04
NonPoint Gauged	360.3	0.89			0.56	0.27	30665	0.76	-947	350		-3	0.15	0.02	85	0.40	-4	-4	0.01	0.00
Total Gauged	458.9	0.89			0.69	0.49	75353	0.40	-4750	723	-6	-6	0.00	0.00	164	-0.01	-7	-7	0.00	0.00
Total NonPoint	384.8	0.89			0.56	0.27	32753	0.76	-1012	373		-3	0.15	0.02	85	0.40	-4	-4	0.01	0.00
Total Industrial	3.4	0.02	-7	-7	0.00	0.00	356	0.21		8			0.22	0.22	104	0.26	4	4	0.01	0.01
Total Municipal	95.1	0.62		-1	0.11	0.04	44332	0.02	-4023	724	-9	-9	0.00	0.00	466	-0.05	-9	-9	0.00	0.00
Total Inflow	495.0	0.89			0.68	0.48	77790	0.41	-4808	732	-6	-6	0.00	0.00	157	0.00	-6	-6	0.00	0.00
NP_Rural	283.3	0.87			0.53	0.27	19992	0.82		245			0.44	0.15	71	0.57	-2	-3	0.05	0.02
NP_Urban	77.0	0.92			0.70	0.45	10679	0.52	-593	156	-5	-6	0.01	0.00	139	0.18	-6	-6	0.00	0.00
Outlet2	486.1	0.89			0.68	0.47	43440	0.41	-2050	504	-5	-5	0.00	0.00	89	-0.06	-5	-5	0.00	0.00
Outlet12	486.1	0.89			0.68	0.47	48570	0.27	-2802	623	-6	-6	0.00	0.00	100	-0.16	-6	-6	0.00	0.00

Methods: A = without adjustment for annual precipitation, B = with adjustment for precipitation using equations listed in Figure 9.

Shaded cells indicate trend slopes significantly different from zero at $p < 0.10$ for two-tailed and $p < 0.05$ for one-tailed hypothesis.

Table 10 Trends in Total Phosphorus for Each Mass Balance Term, 1998-2007

	Flow						Load								Concentration					
	Mean	Rainfall	Trend Slopes		p Levels		Mean	Rainfall	Trend kg /y		Trend Slopes		p Levels		Mean	Rainfall	Trend Slopes		p Levels	
Source	hm3/yr	Correl	A	C	A	B	kg	Correl	Mean	SE	A	C	A	C	ppb	Correl	A	C	A	C
Metro	91.3	0.30			0.78	0.57	27477	-0.42		2256	-11		0.05	0.15	301	-0.47	-11		0.04	0.14
Bypass	2.0	-0.36			0.34	0.80	2279	-0.29		154			0.38	0.72	1118	0.26			0.76	0.72
E Flume	0.6	0.67	13		0.01	0.13	93	0.60		6	9		0.06	0.43	163	-0.41	-4		0.05	0.12
Trib5A	2.1	-0.67	-17	-17	0.00	0.03	258	-0.72	-40	20	-19	-16	0.00	0.08	124	-0.59			0.27	0.70
Harbor/Velasko	9.7	0.79	6	4	0.00	0.08	418	0.36		25			0.69	0.56	43	-0.13			0.29	0.24
Harbor/Lower	0.9	0.69	28		0.04	0.47	505	0.38	84	22	11	17	0.01	0.01	570	-0.60			0.21	0.87
Harbor/Hiawatha	10.6	0.81	7	5	0.00	0.05	922	0.59	74	29	7	8	0.00	0.04	87	-0.17			0.85	0.41
Onondaga/Dorwin	129.5	0.81	5		0.01	0.41	8419	0.59		434	8		0.04	0.29	65	0.16			0.32	0.34
Onondaga/Lower	37.6	0.97	4		0.01	0.48	3445	-0.07		234			0.26	0.14	92	-0.41	-10		0.05	0.13
Onond./Kirkpatrick	167.1	0.86	5		0.01	0.39	11864	0.62		328	3		0.10	0.71	71	-0.41			0.28	0.80
Ley/Park	38.5	0.76	4		0.04	0.67	3567	0.24		111			0.69	0.13	93	-0.46	-4	-6	0.00	0.01
Ninemile/Rt48	148.5	0.81	5		0.03	0.68	8317	0.71		183			0.13	0.83	56	-0.67	-3		0.03	0.34
NonPoint Gauged	364.7	0.84	5		0.01	0.50	24671	0.75		454	3		0.08	0.99	68	-0.64	-2		0.04	0.37
Total Gauged	460.7	0.83	4		0.02	0.59	54779	-0.15		2288			0.23	0.19	119	-0.61	-7	-7	0.01	0.09
Total NonPoint	389.6	0.84	5		0.01	0.50	26351	0.75		485	3		0.08	0.99	68	-0.64	-2		0.04	0.37
Total Industrial	2.7	-0.58	-10	-10	0.01	0.07	352	-0.60		20	-10		0.02	0.16	132	-0.26			0.75	0.72
Total Municipal	93.3	0.26			0.87	0.56	29756	-0.42		2336	-10		0.06	0.17	319	-0.48	-10		0.04	0.15
Total Inflow	497.1	0.83	4		0.02	0.58	56805	-0.13		2298			0.26	0.19	114	-0.62	-7	-7	0.01	0.08
NP_Rural	287.7	0.82	5		0.02	0.53	17154	0.70		521	5		0.03	0.44	60	-0.28			0.79	0.61
NP_Urban	77.0	0.92	4		0.01	0.44	7516	0.03	-444	190		-6	0.26	0.05	98	-0.56	-6	-7	0.01	0.07
Outlet2	488.3	0.83	4		0.02	0.59	33873	-0.01		1683			0.63	0.49	69	-0.53	-6		0.06	0.31
Outlet12	488.3	0.83	4		0.02	0.59	35944	-0.18		1902			0.30	0.34	74	-0.61	-8		0.02	0.19

Methods: A = without adjustment for annual precipitation, B = with adjustment for precipitation using equations listed in Figure 9

Shaded cells indicate trend slopes significantly different from zero at $p < 0.10$ for two-tailed and $p < 0.05$ for one-tailed hypothesis.

Table 11 Trends in Load, 1998-2007

Load Trends (% / yr) 1998 to 2007 Precip Trend = 3.0 +/- 0.9 cm/yr

Term	FLOW	TP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA
Metro		-11		-23	-32	-23	11	-5	-5				3	4	
Bypass			-8	-8	-9										
E Flume	13	9	11			10	14	11	11	13	10	13	14	15	16
Trib5A	-17	-19	-24	-17	-17	-20	-27	-15	-15	-15	-15	-14	-17	-19	-20
Harbor/Velasko	6		6	5	-4	4	6	7	6	6	5	7	5	6	8
Harbor/Lower	28	11					56			14	13	13	31	12	10
Harbor/Hiawatha	7	7	7	4	-5		8	7	7	7	7	7	6	7	8
Onondaga/Dorwin	5	8	7	7		11	5			6	7	6	7	3	4
Onondaga/Lower	4					-6	7		11	5	5	5	6	6	6
Onond./Kirkpatrick	5	3	5	4		8	5			6	6	6	7	6	6
Ley/Park	4					-3		4	4	4	4	4	4	6	7
Ninemile/Rt48	5						6		6	6	6	6	2		
NonPoint Gauged	5	3	4			4	5	6	6	6	6	6	4	3	5
Total Gauged	4			-13	-23	-13	9			5	5	5	4	3	4
Total NonPoint	5	3	4			4	5	6	6	6	6	6	4	3	5
Total Industrial	-10	-10	-6	-7	-8	6	-7	-7	-8	-8	-7	-7	-10	-9	-6
Total Municipal		-10		-22	-30	-23	11	-5	-5				3	4	
Total Inflow	4			-13	-22	-12	9			5	5	5	4	3	4
NP_Rural	5	5	6			6	5	6	6	6	6	6	3		
NP_Urban	4					-4	6	6	6	5	4	5	6	6	6
Outlet2	4			-8	-16	-4	10			5	11	5	5	4	5
Outlet12	4			-10	-19	-6	9			5	12	5	4	2	3

Load Trends (% / yr), Adjusted for Variations in Rainfall

Term	FLOW	TP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA
Metro				-24	-35	-27		-5	-6						
Bypass															
E Flume															14
Trib5A	-17	-16	-24	-17	-17	-21	-26	-17	-16	-15	-15	-15	-17	-19	-20
Harbor/Velasko	4		4		-6									7	8
Harbor/Lower		17												12	
Harbor/Hiawatha	5	8	6				6					5	4	8	9
Onondaga/Dorwin						10									
Onondaga/Lower													4	7	7
Onond./Kirkpatrick													3	6	6
Ley/Park						-5								8	8
Ninemile/Rt48					-6										
NonPoint Gauged					-5									3	5
Total Gauged				-15	-24	-14								3	4
Total NonPoint					-5									3	5
Total Industrial	-10		-9	-10	-12		-10	-10	-10				-11		
Total Municipal				-23	-32	-27		-5	-6						
Total Inflow				-14	-23	-13								3	4
NP_Rural					-6										
NP_Urban		-6									2		4	7	7
Outlet2				-11	-18	-6					12				
Outlet12				-13	-19	-8					14				

Trend magnitudes shown for results with p < .10 for two-tailed hypothesis, p<05 for one-tailed hypothesis.
Shaded cells, trend analysis potentially impacted by variations in detection limits.

Table 12 Trends in Flow-Weighted-Mean Concentration, 1998-2007

Concentration Trends (%/Yr) Precip Trend = 3.0 +/- 0.9 cm/yr

Term		TP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA
Metro		-11	-3	-24	-32	-24	11	-5	-5				3	4	
Bypass			-4	-4	-5							2			
E Flume		-4	-2	-9	-14				-3		-4				2
Trib5A			-7				-10			2	2	3			-3
Harbor/Velasko					-9							1			
Harbor/Lower				-29	-34	-35	28	-21	-18						
Harbor/Hiawatha					-12	-5									
Onondaga/Dorwin					-9					1		1	1	-2	-2
Onondaga/Lower		-10		-6		-10				1			2		
Onond./Kirkpatrick					-8					1		1	1		
Ley/Park		-4	-3	-4	-6	-7							1		3
Ninemile/Rt48		-3		-3	-7	-4				1		1	-3	-6	-4
NonPoint Gauged		-2		-2	-7					1		1	-1		
Total Gauged		-7	-4	-17	-27	-17			-3			1			
Total NonPoint		-2		-2	-7					1		1	-1		
Total Industrial				2		16				2	2	2			4
Total Municipal		-10	-3	-23	-30	-23	11	-5	-5				3	3	
Total Inflow		-7	-4	-17	-26	-16			-3			1			
NP_Rural					-7					1		1	-2	-5	-3
NP_Urban		-6		-5	-6	-8				1		1	2		
Outlet2		-6	-2	-12	-20	-8	6			1	7	1	1		
Outlet12		-8	-3	-14	-23	-10	5			1	8	1		-2	

Concentration Trends, Adjusted for Variations in Rainfall (%/Yr)

Term		TP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA
Metro			-4	-23	-34	-26		-4	-5				2	5	5
Bypass			-4	-4	-5										
E Flume			-4	-11	-19				-4		-6				3
Trib5A			-7				-9			1		2			-3
Harbor/Velasko					-10									3	4
Harbor/Lower							37								
Harbor/Hiawatha					-8					-1				3	4
Onondaga/Dorwin					-9										
Onondaga/Lower													4	6	6
Onond./Kirkpatrick					-5								2	4	
Ley/Park		-6	-4	-6	-4	-6							1	7	7
Ninemile/Rt48					-7									-3	
NonPoint Gauged					-6										
Total Gauged		-7	-3	-16	-25	-15								2	3
Total NonPoint					-6										
Total Industrial						13				1		1			
Total Municipal			-4	-22	-31	-26		-5	-5				2	5	5
Total Inflow		-7	-3	-15	-24	-14								2	3
NP_Rural					-7									-2	
NP_Urban		-7		-4									3	6	6
Outlet2			-2	-12	-19	-7					11		1		2
Outlet12			-3	-14	-20	-9					13				

Trend magnitudes shown for results with p < .10 for two-tailed hypothesis, p<05 for one-tailed hypothesis.
Shaded cells, trend analysis potentially impacted by variations in detection limits.

Table 13 Trends in Load, Mass Units, 1998-2007

Load Trends (mass / yr) , Adjusted for Variations in Rainfall Precip Trend = 3.0 +/- 0.9 cm/yr

Term	FLOW	TP	TN	TKN	NH3N	NO2N	NO3N	TOC	TOC_F	TIC	SIO2	ALK	CA	CL	NA
Units	hm3	kg	kg	kg	kg	kg	kg	mt	mt	mt	mt	mt	mt	mt	mt
Metro				-125166	-120025	-6660		-45	-43						
Bypass															
E Flume															31
Trib5A	-0.35	-40	-860	-184	-58	-15	-649	-1	-1	-12	-2	-46	-47	-159	-81
Harbor/Velasko	0.37		914		-40									144	98
Harbor/Lower		84												69	
Harbor/Hiawatha	0.52	74	1342				1058					114	92	210	137
Onondaga/Dorwin						299									
Onondaga/Lower													315	4086	2443
Onond./Kirkpatrick													618	4384	2618
Ley/Park						-44								1020	634
Ninemile/Rt48					-2191										
NonPoint Gauged					-3205									4499	3293
Total Gauged				-113219	-101904	-4701								5904	4115
Total NonPoint					-3423									4805	3517
Total Industrial	-0.27		-654	-183	-82		-485	-1	-1				-38		
Total Municipal				-124351	-114449	-6628		-49	-47						
Total Inflow				-112654	-101400	-4581								6211	4340
NP_Rural					-2808										
NP_Urban		-444									9		432	5213	3140
Outlet2				-57743	-51999	-1555					179				
Outlet12				-74649	-63372	-2287					203				

Trend magnitudes shown for results with p < .10 for two-tailed hypothesis, p<05 for one-tailed hypothesis.

Shaded cells, trend analysis potentially impacted by variations in detection limits.

Table 14 Yearly Data Used for Model Calibration & Testing

Phosphorus Balance

Water Year	Net Inflow hm3	Metro+ Bypass kg	Total Load kg	Outflow Load kg	Inflow P Conc ppb	Outflow P Conc ppb	HLR m/yr	Res Time Yrs	Settling Rate m/yr	Lake P Conc ppb	SE ppb
1991	545	53056	97121	55123	178	101	46.5	0.23	35.5	61.5	4.8
1992	483	67573	108270	49880	224	103	41.3	0.26	48.4	63.6	11.6
1993	572	65756	168104	102535	294	179	48.9	0.22	31.3	125.2	15.7
1994	484	56071	81212	66203	168	137	41.3	0.26	9.4	98.2	31.8
1995	298	45061	62085	49542	209	166	25.4	0.43	6.4	70.8	8.4
1996	488	48734	98479	65066	202	133	41.7	0.26	21.4	69.1	6.1
1997	450	38423	79475	52948	176	118	38.5	0.28	19.3	56.9	6.0
1998	475	38388	69667	39197	147	82	40.6	0.27	31.6	54.7	4.7
1999	315	31559	54752	33412	174	106	26.9	0.41	17.2	56.0	5.3
2000	485	29953	58512	37741	121	78	41.5	0.26	22.8	43.5	3.4
2001	412	21357	47493	31423	115	76	35.3	0.31	18.0	38.9	7.4
2002	422	22059	45608	29530	108	70	36.1	0.30	19.7	41.5	3.3
2003	486	36510	62473	40235	129	83	41.6	0.26	23.0	66.6	1.5
2004	593	49786	87229	55931	147	94	50.7	0.21	28.4	59.0	4.1
2005	513	26301	53056	42727	103	83	43.8	0.25	10.6	35.6	1.3
2006	558	12037	46376	30244	83	54	47.7	0.23	25.4	40.7	5.1
2007	571	11239	39527	24318	69	43	48.8	0.22	30.5	25.1	2.1
2003-2007	544	27174	57732	38691	106	71	46.5	0.23	22.9	45.4	7.6

Nitrogen Balance

Water Year	Net Inflow hm3	Metro+ Bypass kg	Total Load kg	Outflow Load kg	Inflow P Conc ppb	Outflow N Conc ppb	HLR m/yr	Res Time Yrs	Settling Rate m/yr	Lake N Conc ppb	SE ppb
1991	545	1755992	2560250	1962682	4701	3604	46.5	0.23	14.2	4364	168
1992	483	1672009	2418004	1880217	5002	3889	41.3	0.26	11.8	4418	305
1993	572	1387500	2724153	2046168	4759	3575	48.9	0.22	16.2	3701	128
1994	484	1766085	2462262	1947854	5090	4027	41.3	0.26	10.9	4153	274
1995	298	1837802	2209321	1357467	7421	4559	25.4	0.43	16.0	5157	302
1996	488	1847815	2676295	1973197	5489	4047	41.7	0.26	14.8	3873	182
1997	450	1636220	2304162	1603544	5116	3560	38.5	0.28	16.8	3661	180
1998	475	1691731	2340156	1658378	4925	3490	40.6	0.27	16.7	3573	204
1999	315	1252391	1663682	1041103	5287	3309	26.9	0.41	16.1	3378	172
2000	485	1133824	1823711	1448012	3759	2985	41.5	0.26	10.8	2396	78
2001	412	1051118	1638335	1214090	3972	2944	35.3	0.31	12.3	2863	123
2002	422	929115	1478285	1070365	3500	2534	36.1	0.30	13.8	1951	182
2003	486	1112245	1883052	1285293	3873	2644	41.6	0.26	19.3	2549	110
2004	593	1242461	2127565	1568221	3587	2644	50.7	0.21	18.1	2403	128
2005	513	1229985	1935767	1459464	3774	2845	43.8	0.25	14.3	2584	116
2006	558	1074588	1790093	1373718	3207	2461	47.7	0.23	14.5	2477	124
2007	571	1054030	1769335	1397105	3101	2449	48.8	0.22	13.0	2951	49
2003-2007	544	1142662	1901163	1416760	3494	2603	46.5	0.23	15.9	2593	95

Chlorophyll-a Photic Zone or 0-3 m averages

Water Year	Sample Dates	Mean ppb	Std Dev ppb	SE ppb	CV -	Freq > 15 -	Freq > 20 -	Freq > 30 -	Freq > 40 -	Freq > 60 -
1991	20	30.0	25.2	5.6	0.84	60%	50%	45%	30%	10%
1992	18	16.3	10.6	2.5	0.65	56%	28%	17%	0%	0%
1993	9	18.8	19.3	6.4	1.03	33%	33%	33%	11%	0%
1994	9	33.3	42.5	14.2	1.28	44%	44%	44%	44%	22%
1995	9	7.9	4.7	1.6	0.59	0%	0%	0%	0%	0%
1996	8	34.0	28.4	10.0	0.83	75%	75%	63%	13%	13%
1997	9	13.5	13.2	4.4	0.98	44%	11%	11%	11%	0%
1998	12	19.4	10.1	2.9	0.52	50%	33%	17%	0%	0%
1999	19	26.4	18.0	4.1	0.68	74%	58%	42%	21%	5%
2000	17	21.9	16.6	4.0	0.76	59%	53%	24%	12%	0%
2001	17	27.3	25.7	6.2	0.94	47%	41%	35%	29%	18%
2002	18	25.8	15.1	3.6	0.59	72%	61%	28%	22%	0%
2003	17	37.2	28.9	7.0	0.78	76%	71%	53%	29%	18%
2004	18	25.5	13.2	3.1	0.52	67%	61%	39%	22%	0%
2005	17	12.8	4.1	1.0	0.32	35%	0%	0%	0%	0%
2006	17	17.4	5.9	1.4	0.34	53%	41%	0%	0%	0%
2007	17	9.6	5.7	1.4	0.59	6%	6%	0%	0%	0%
2003-2007	17	21	12	4.6	0.51	47%	36%	18%	10%	4%

Secchi Depth

Water Year	Sample Dates	Mean m	Std Dev m	SE m	CV -	Freq < 1.2 -	Freq < 1.5 -	HOD (mg/m^2-day) < 6 m	< 9 m	< 12 m
1991	7	1.44	1.02	0.39	0.71	57%	71%	1602	1484	1333
1992	9	1.99	1.33	0.44	0.67	0%	22%	1966	1795	1521
1993	9	2.31	1.24	0.41	0.53	11%	22%			
1994	9	2.13	1.01	0.34	0.48	33%	33%			
1995	8	1.99	0.58	0.20	0.29	0%	13%	1393	1364	1270
1996	8	1.56	0.95	0.33	0.61	38%	75%	1477	1354	1191
1997	9	2.97	2.09	0.70	0.70	0%	11%	1095	970	873
1998	9	1.82	0.60	0.20	0.33	22%	33%	927	922	899
1999	18	1.72	1.14	0.27	0.66	28%	44%	1699	1455	1196
2000	17	2.08	0.82	0.20	0.40	6%	24%	1041	988	888
2001	17	2.38	1.29	0.31	0.54	18%	41%	1146	1073	909
2002	16	1.96	0.72	0.18	0.37	0%	25%	1085	988	876
2003	17	1.35	0.49	0.12	0.36	35%	65%	968	946	860
2004	18	1.72	0.33	0.08	0.19	6%	17%	1160	1186	1073
2005	17	1.81	0.45	0.11	0.25	0%	24%	900	794	644
2006	17	1.71	0.34	0.08	0.20	12%	18%	1114	1145	1051
2007	17	2.14	0.75	0.18	0.35	6%	18%	984	866	723
2003-2007	17	1.75	0.47	0.08	0.27	12%	28%	1025	987	870

Nutrient Species

Water Year	Total Org. Carbon Mean ppm	Total Org. Carbon SE ppm	Organic N Mean ppb	Organic N SE ppb	Inorganic N Mean ppb	Inorganic N SE ppb	TP - SRP Mean ppb	TP - SRP SE ppb	SRP Mean ppb	SRP SE ppb
1991	6.4	0.47	1034	167	3330	140	58	4.8	3.1	0.1
1992	5.7	0.18	1303	126	3115	213	51	11.0	12.3	4.7
1993	5.3	0.21	941	80	2760	169	96	8.7	29.2	8.7
1994	9.3	4.52	1055	248	3098	137	80	32.3	18.3	6.0
1995	4.8	0.38	1015	154	4142	183	51	5.2	19.9	8.4
1996	6.0	0.34	1018	131	2855	177	62	5.1	7.2	1.9
1997	4.6	0.10	917	61	2745	155	48	3.5	9.0	3.4
1998	4.7	0.12	671	98	2901	200	51	4.4	4.2	0.9
1999	4.7	0.17	915	124	2463	190	50	5.4	5.5	1.7
2000	4.5	0.09	658	25	1739	70	39	3.9	4.6	1.1
2001	4.3	0.15	766	68	2098	177	36	7.4	3.0	0.0
2002	4.4	0.10	751	38	1200	201	39	3.3	3.0	0.0
2003	5.1	0.28	873	72	1676	95	62	1.4	4.5	0.8
2004	5.9	0.26	682	22	1721	140	48	3.3	10.8	3.8
2005	4.5	0.14	608	19	1976	114	33	1.3	3.1	0.1
2006	3.9	0.06	626	27	1852	122	38	5.1	3.0	0.0
2007	3.7	0.07	536	21	2414	32	22	2.1	3.0	0.0
2003-2007	4.6	0.40	692	57	1848	133	40	6.8	4.3	1.5

SE = Standard Error of Mean

Lake Summary Statistics from for South Station, 0-3 m for Grabs or Epil Composites, June-September

Table 15 Model Equations & Coefficients

Predicted Trophic Response Variables:

	Po =	Water Year Flow-Wtd-Mean Outflow Total P (ppb)
*	P =	Mean Total P (ppb)
	No =	Water Year Flow-Wtd-Mean Outflow Total N (ppb)
*	N =	Mean Total N (ppb)
*	B =	Mean Chlorophyll-a (ppb)
*	S =	Mean Secchi Depth (m)
	HOD =	Hypolimnetic Oxygen Depletion Rate (mg/m^2-day)
*	TON =	Total Organic Nitrogen (ppb)
*	TP-SRP	Total Phosphorus - Soluble Reactive P (ppb)

* June-August, 0-3 meters, Lake South Station

Lake Outflow Total P:

Reference: Vollenweider (1969) , Chapra (1975), Sas (1989)

$P_O = W_P / (Q_O + U_P A)$

W_P = Inflow P Load (kg/yr)

Q_O = Outflow = External Inflow + Precip - ET (hm^3/yr)

A = Lake Surface Area = 11.7 km^2

U_P = P Settling Rate = 22.9 m/yr

Calibrated to 2003-2007

Period	2003-2007	1998-2007	1991-2007
Residual CV	0.12	0.11	0.17
R^2	0.85	0.80	0.78

Lake Surface Total P:

Reference: Walker (1978), Sas (1989)

$P = F_P P_O$

F_P = 0.59 Calibrated to 2004-2007

Period	2003-2007	1998-2007	1991-2007
Residual CV	0.20	0.14	0.18
R^2	0.71	0.74	0.81

Lake Outflow Total N:

$N_O = W_N / (Q_O + U_N A)$

W_N = Inflow N Load (kg/yr)

U_N = N Settling Rate = 15.9 m/yr

Calibrated to 2003-2007

Period	2003-2007	1998-2007	1991-2007
Residual CV	0.04	0.05	0.05
R^2	0.50	0.84	0.94

Lake Summer Total N:

$N = F_N No$

F_N = 1.00 Calibrated to 2003-2007

Period	2003-2007	1998-2007	1991-2007
Residual CV	0.15	0.13	0.13
R^2	0.00	0.57	0.77

Lake Photic Zone Chlorophyll-a:

Reference: Jones & Bachman (1976)

$B = 0.081 P^{1.46}$

not recalibrated

Period	2003-2007	1998-2007
Residual CV	0.33	0.32
R^2	0.63	0.00

Algal Bloom Frequencies:

Reference: BATHTUB Walker (1984; 2004)

$F_X = 1 - Normal [(ln(X) - ln(B) - 0.5 S_B^2) / S_B]$

Normal Cumulative Normal Frequency Distribution

X = Bloom Criterion (15, 20, 30 or 40 ppb)

F_X = Frequency of Chl-a > X

S_B = Standard Deviation of ln (Chl-a)

$S_B = [ln (1 + C_B^2)]^{1/2}$

C_B = Within-Year Temporal CV = SD / Mean

C_B = 0.508 Calibrated to 2003-2007

Lake Secchi Depth:

Reference: BATHTUB, Walker (1985; 2004)

$S = 1 / (a + b B)$

a = 0.4014 1/m

b = 0.0091 m^2/mg

Calibrated to 2003-2007

Period	2003-2007	1998-2007
Residual CV	0.14	0.17
R^2	0.24	0.00

Secchi Interval Frequencies:

Reference: Walker (1984)

$F_Y = Normal [(ln(Y) - ln(S) - 0.5 S_S^2) / S_S]$

Normal Cumulative Normal Frequency Distribution

F_Y = Frequency of Secchi < Y

Y = Secchi Criterion (1.2 or 1.5 m)

S_S = Standard Deviation of ln (Secchi)

$S_S = [ln (1 + C_S^2)]^{1/2}$

C_S = Within-Year Temporal CV = 0.27

Calibrated to 2003-2007

Lake Summer Total P - SRP:

Reference: BATHTUB, Walker (1985; 2004)

TP - SRP = -4.1 + 1.78 B + 23.7a

Not recalibrated

Period	2003-2007	1998-2007
Residual CV	0.23	0.17
R^2	0.62	0.59

Lake Summer Organic Nitrogen:

Reference: BATHTUB, Walker (1985; 2004)

TON = K (157 + 22.8 B + 75.3 a)

K = 2003-2007 Calibration = 1.1

	2003-2007	1998-2007
Residual CV	0.19	0.20
R^2	0.00	0.00

Hypolimnetic Oxygen Depletion Rate:

Reference: BATHTUB, Walker (1985; 2004)

$HOD = 240 B^{0.45}$

not recalibrated

Period	2003-2007	1998-2007
Residual CV	0.22	0.19
R^2	0.00	0.00

Table 16 Model Inputs & Outputs

Lake Features

Lake Area	km2	11.7
Mean Hypol Depth	m	7.02
Stratified Period	days	183
Spring DO Conc	ppm	12

Coefficients Calibrated to 2003-2007 Data

P Settling Rate	m/yr	22.900
Summer UML / Outflow P	-	0.59
Total N Setting Rate	m/yr	15.900
Summer UML / Outflow N		0.996
Chla/P Slope	-	1.4600
Chla/P Intercept	-	0.081
Non-Algal Turbidity	1/m	0.401
Secchi/Chla Slope	m2/mg	0.009
Organic N Calib Factor		1.100
Chla Temporal CV	-	0.508
Secchi Temporal CV	-	0.269

Error Coefficients of Variation for Yearly Simulations, 1998-2007		**BATHTUB Calib***
Outflow P Error CV	0.105	0.364
Summer Epil P Error CV	0.139	0.272
Outflow N CV	0.051	0.230
Summer Epil N CV	0.128	0.219
Chl-a Error CV	0.318	0.350
Secchi Error CV	0.172	0.281
HOD Error CV	0.194	0.205
Organic N Error CV	0.200	0.253
TP-OP Error CV	0.173	0.350

Predicted Values			Confidence Intervals for Long-Term Means				Year-to-Year Variations		Observed Mean	
			50%	10%	90%		10%	90%	1998 - 2007	
Output Variable		Units	Mean	Low	High	Std Error	Low	High	Mean	Std Error
Outflow P Conc		ppb	75	72	79	2.5	47	102	76	5.8
Lake P Conc		ppb	44	41	47	1.9	40	86	46	4.0
Mean Chl-a		ppb	20.5	17.6	23.9	2.1	10	32	22	2.5
Algal Bloom Frequencies										
	>	15	66%	54%	77%		16%	91%	54%	7%
	>	20	43%	31%	55%		5%	77%	43%	7%
	>	30	15%	9%	24%		1%	45%	24%	6%
	>	40	5%	3%	9%		0%	23%	14%	4%
	>	60	1%	0%	2%		0%	6%	4%	2%
Mean Secchi Depth		m	1.7	1.6	1.8	0.1	1.4	2.0	1.9	0.09
Secchi Interval Frequencies										
	<	1.2	12%	19%	7%		3%	28%	13%	4%
	<	1.5	37%	49%	26%		16%	60%	31%	5%
	<	2.0	77%	86%	67%		54%	91%	64%	5%
Oxygen Depletion Rate		mg/m^2-day	1087	990	1195	66.7	773	1352	1036	60
Oxygen Depletion Rate		mg/m3-day	155	141	170	9.5	110	193	148	9
Days Hypol. DO < .5 ppm		days	0	0	11		79	123	50	
Days Hypol. DO < 2 ppm		days	0	15	33		92	131	68	
Days Hypol. DO < 5 ppm		days	49	66	78		119	147	102	
Organic N		ppb	721	654	794	45.6	466	1002	708	37
Total P - SRP		ppb	42	39	46	2.3	24	62	42	4

* Error coefficients for BATHTUB original calibration dataset based upon data from 40 reservoirs (Walker, 1985) shown for comparison with values for Onondaga Lake
Error CV's are for yearly predictions (lower for long-term means).

Table 17 Model Interface for Evaluating Management Scenarios

Onondaga Lake Empirical Eutrophication Model Version: April 27, 2009

Select Scenario:

Base 1998-2007
Metro =120
Metro=120, NPS=50
Metro=120, NPS=40
Metro=120, NPS=30
Metro=20
Metro =120, NPS=50
Metro Diverted
Metro Div, NPS=50
Metro =120, Model 2
Metro =120, NPS=40, Model 2

Scenario Index | Detailed Output | Yearly Simulation
Save Scenario | P Load Response | Documen-tation
Delete Scenario | Lake P Response | Sheet Index

User input cells are red

Press 'Ctrl-I' to return here from other worksheets

Define Historical Baseline Period: 1998 2007

Scenario Name: Metro =120

Historical Baseline: 1998 - 2007

Percent Reduction

	Flow cfs	TP ppb	TP Load kg/yr	Flow cfs	TP ppb	TP Load kg/yr	Flow cfs	TP ppb	TP Load kg/yr
Metro Effluent	102.1	120	10,957	102.1	306	27,919	0%	61%	61%
Metro Bypass	2.2	1118	2,228	2.2	1118	2,228	0%	0%	0%
East Flume	0.6	165	93	0.6	165	93	0%	0%	0%
Trib 5A	2.4	122	261	2.4	122	261	0%	0%	0%
Harbor Brook	11.6	86	891	11.6	86	891	0%	0%	0%
Ley Creek	42.6	94	3,575	42.6	94	3,575	0%	0%	0%
Ninemile Creek	163.9	55	8,076	163.9	55	8,076	0%	0%	0%
Onondaga Creek	184.4	69	11,449	184.4	69	11,449	0%	0%	0%
Nonpoint Ungauged	27.4	67	1,634	27.4	67	1,634	0%	0%	0%
Precipitation	10.8	30	290	10.8	30	290	0%	0%	0%
Evaporation	9.9			9.9			0%		
NonPoint Total	429.9	67	25,625	429.9	67	25,625	0%	0%	0%
Total Municipal	104.3	141	13,185	104.3	323	30,147	0%	56%	56%
Total Industrial	3.0	131	354	3.0	131	354	0%	0%	0%
Total External	537.3	82	39,164	537.3	117	56,126	0%	30%	30%
Total Inflow	548.1	80	39,454	548.1	115	56,416	0%	30%	30%
Outflow	538.2	53	25,345	538.2	76	36,341			30%
Retention			14,109			20,074			

Output Variable		Predicted	Std Error	Observed	Std Error	Percent Reduction
Outflow TP ppb	ppb	53	1.7	76	5.8	30%
Lake Total P	ppb	31	1.4	46	4.0	33%
Mean Chlorophyll-a	ppb	12.2	1.2	22.3	2.5	45%
Mean Secchi	m	2.0	0.1	1.9	0.1	-4%

Yearly Simulation Scenario: Metro =120

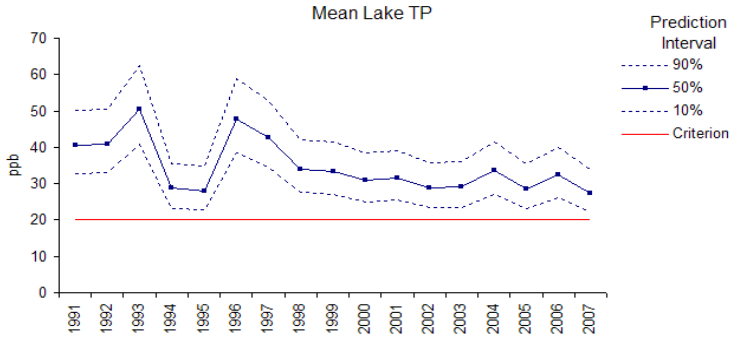
Select Scenario

Base 1998-2007
Metro =120
Metro=120, NPS=50
Metro=120, NPS=40
Metro=120, NPS=30
Metro=20
Metro =120, NPS=50
Metro Diverted
Metro Div, NPS=50
Metro =120, Model 2
Metro =120, NPS=40, Model 2

Go To Input Sheet

Plot Variable

Outflow TP Conc
Mean Lake TP
Mean Chlorophyll-a
Freq Chla > 15 ppb
Freq Chla > 20 ppb
Freq Chla > 30 ppb
Freq Chla > 40 ppb
Freq Chla > 60 ppb
Mean Secchi Depth
Freq Secchi < 1.2 m
Freq Secchi < 1.5 m
Freq Secchi < 2.0 m
Area O2 Depletion Rate
Vol. O2 Depletion Rate
Days Hypol. DO < .5 ppm
Days Hypol. DO < 2 ppm
Days Hypol. DO < 5 ppm
Organic Nitrogen
Total P - SRP



Criterion = AMP Goal or Guidance Value for Long-Term Mean

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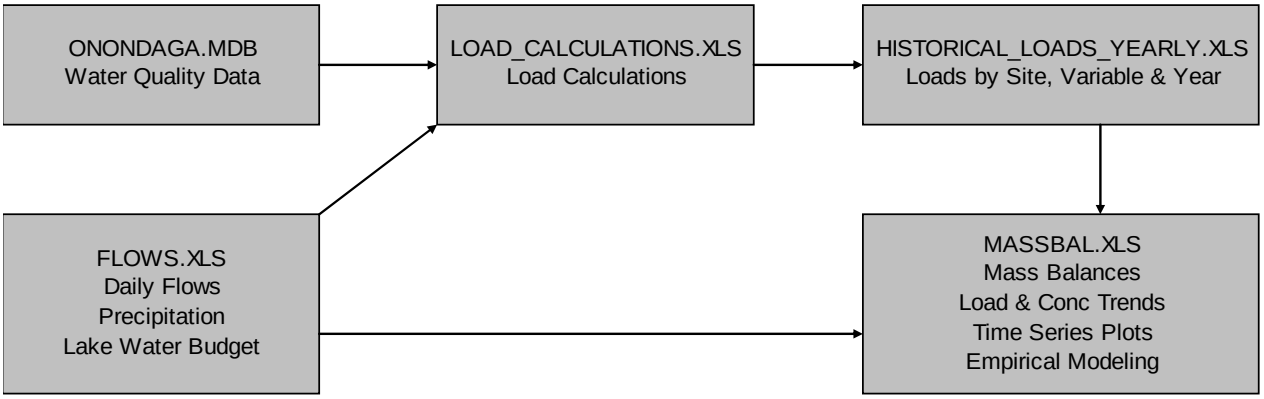
Figure 1
Mass Balance Computations Integrated with AMP Long-Term Database



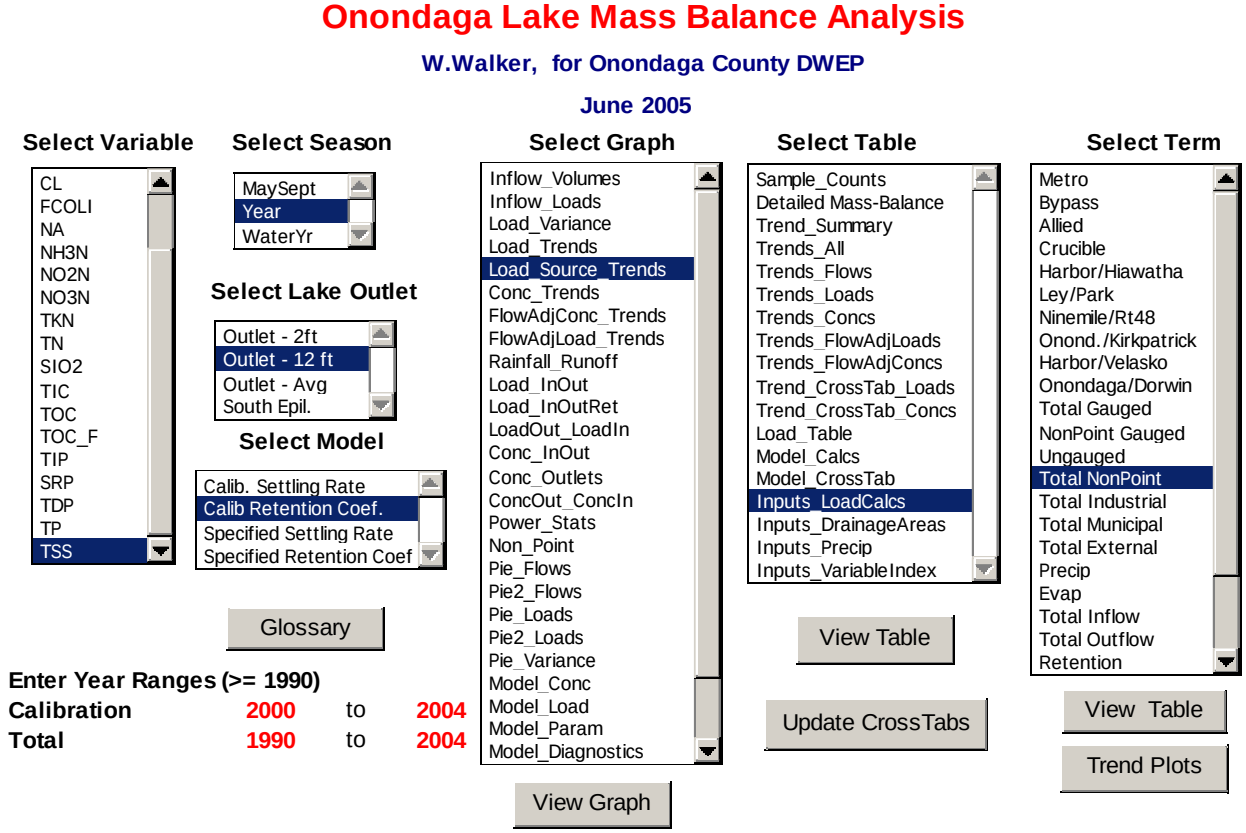
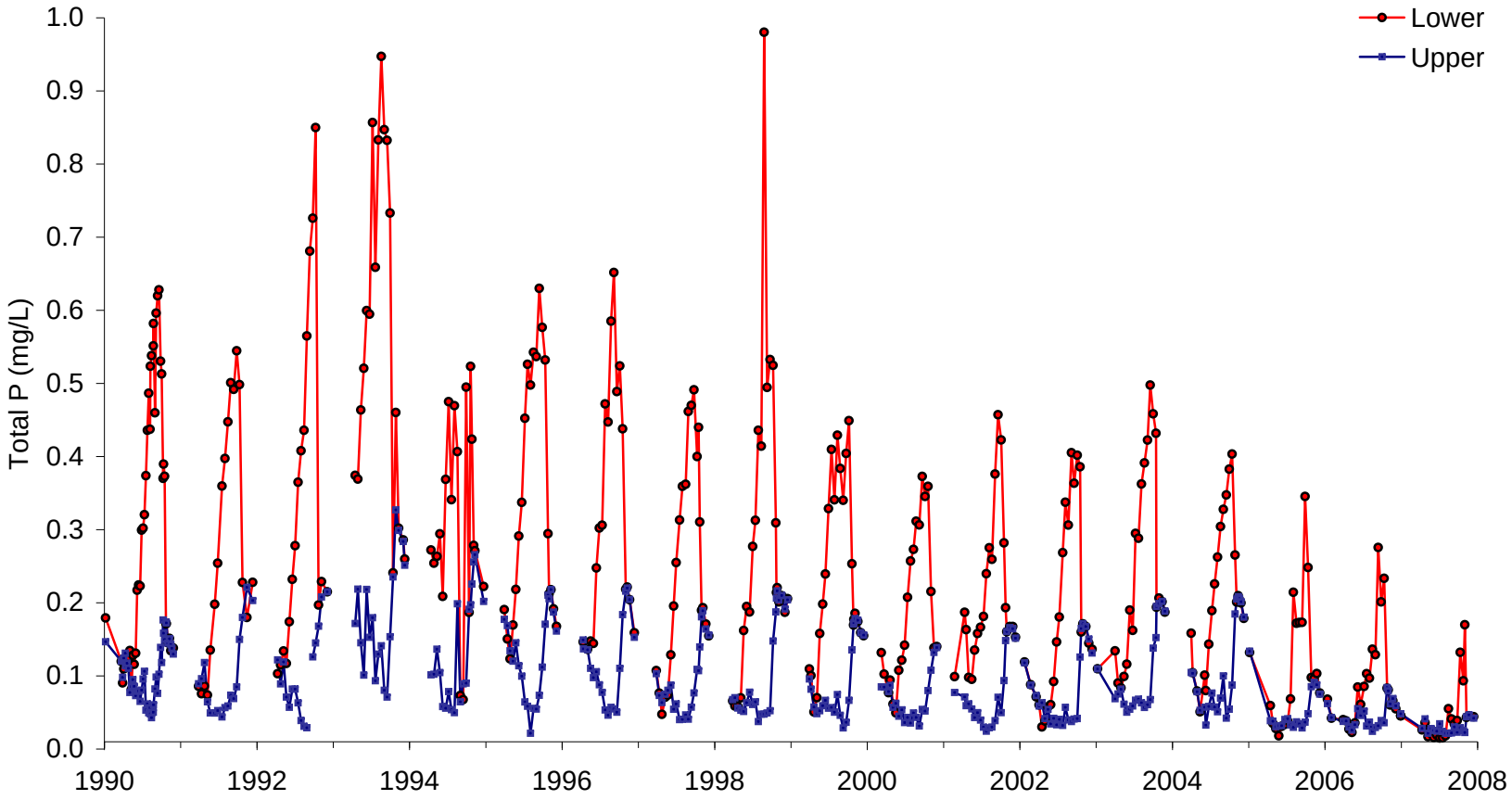
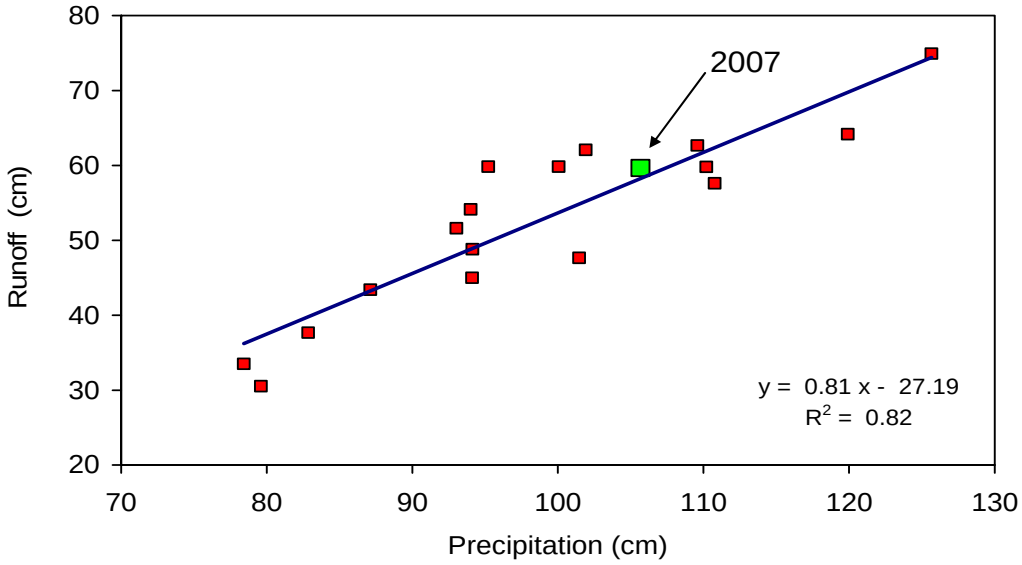


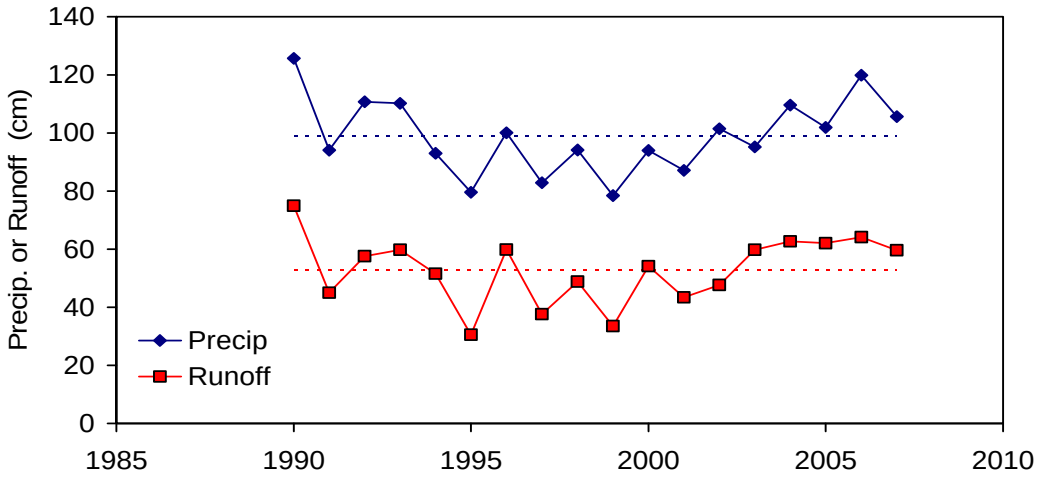
Figure 2
Long-Term Trends in Lake Phosphorus Concentration

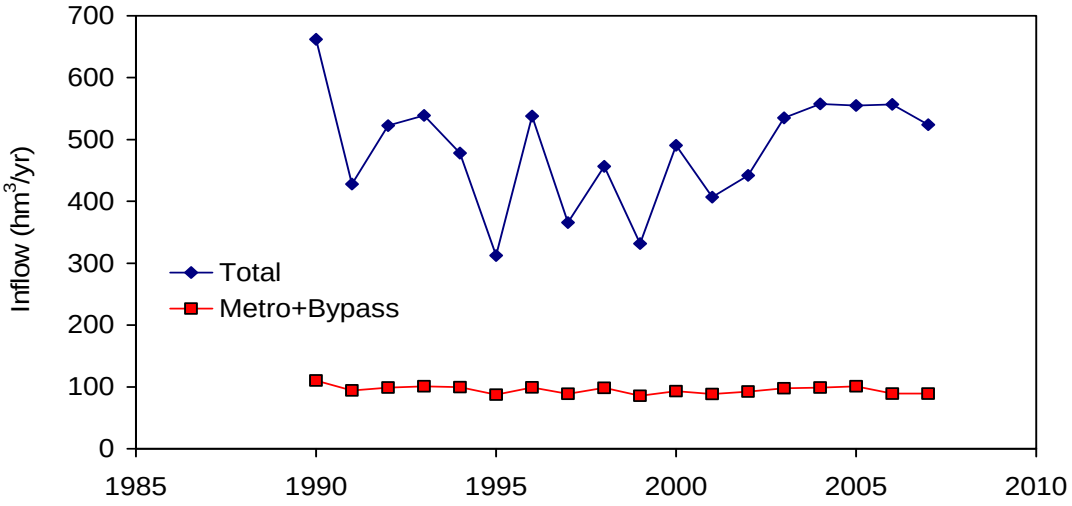


Lower 9 - 18 meters, South Deep station
Upper 0 - 3 meters

Figure 3
Precipitation, Runoff, & Lake Inflow Volumes







X Axis: Calendar Year

Figure 4

Long-Term Variations in Total Inflow & Outflow Concentrations

Squares = Inflow, Circles = Outflow Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

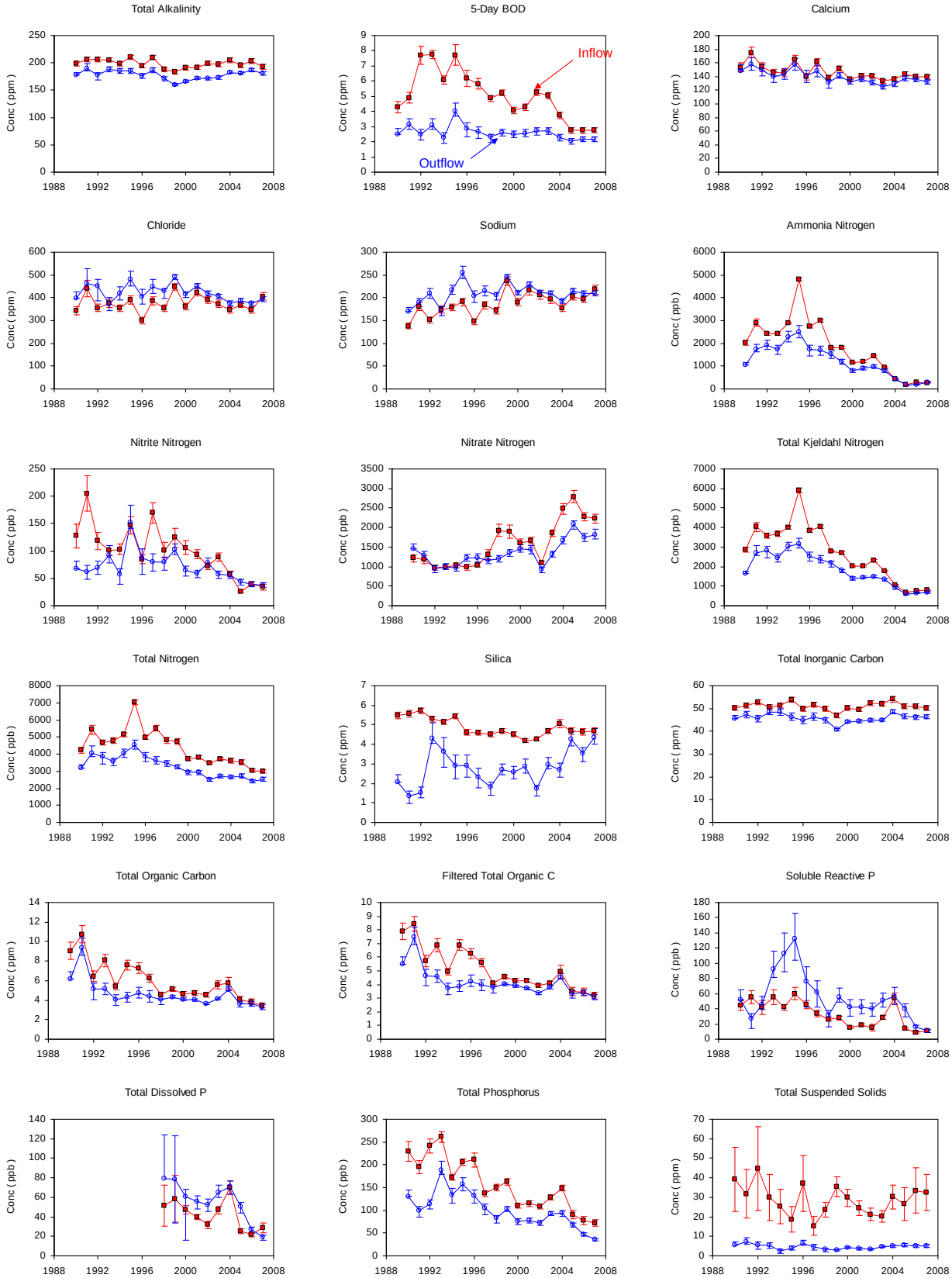


Figure 5

Long-Term Variations in Total Inflow & Outflow Loads

Squares = Inflow, Circles = Outflow Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

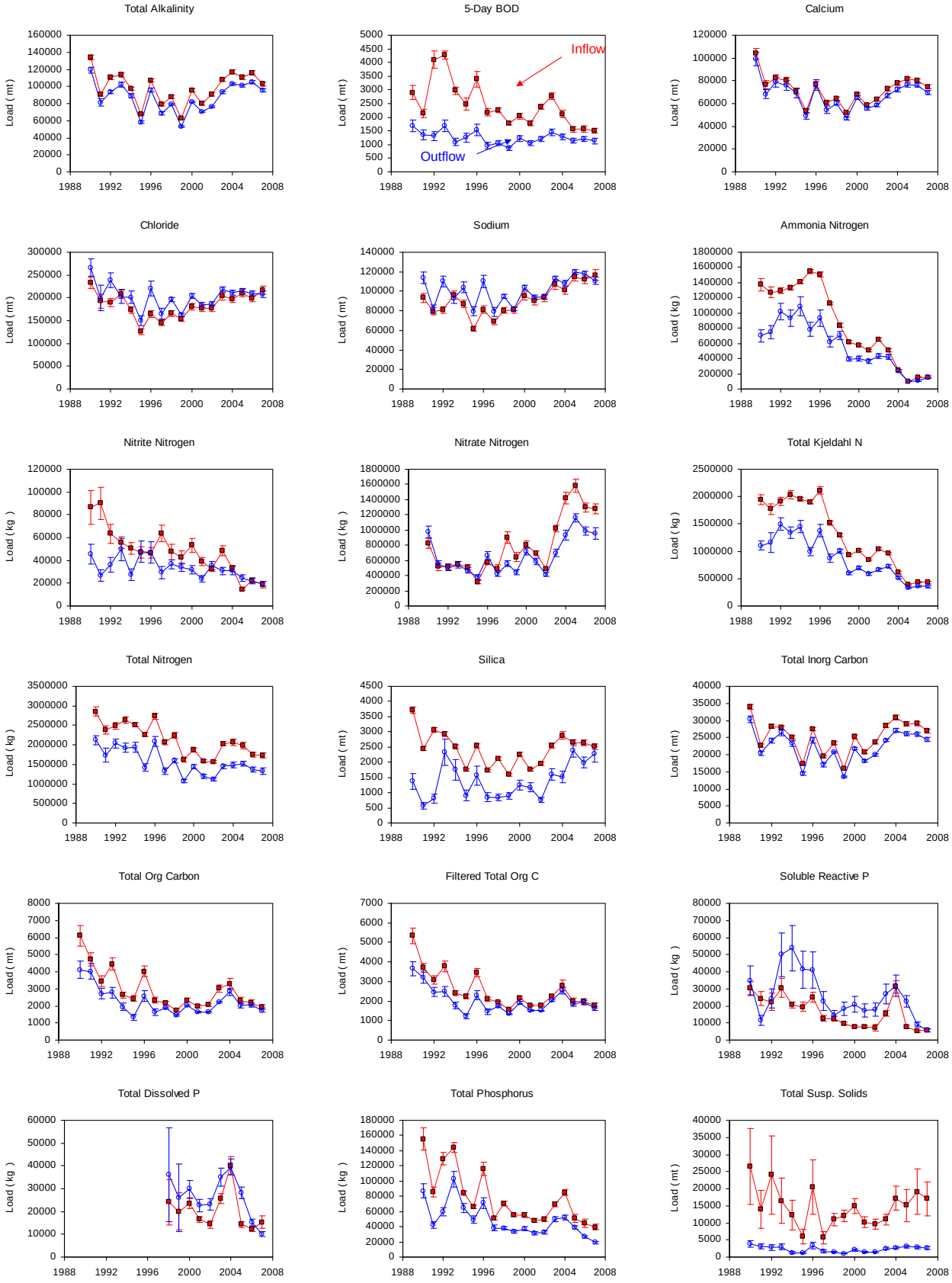


Figure 6

Long-Term Variations in NonPoint & Metro Loads

Squares = NonPoint Sources, Circles = Metro + Bypass Error Bars = +/- 1 Standard Error X-Axis = Calendar Year

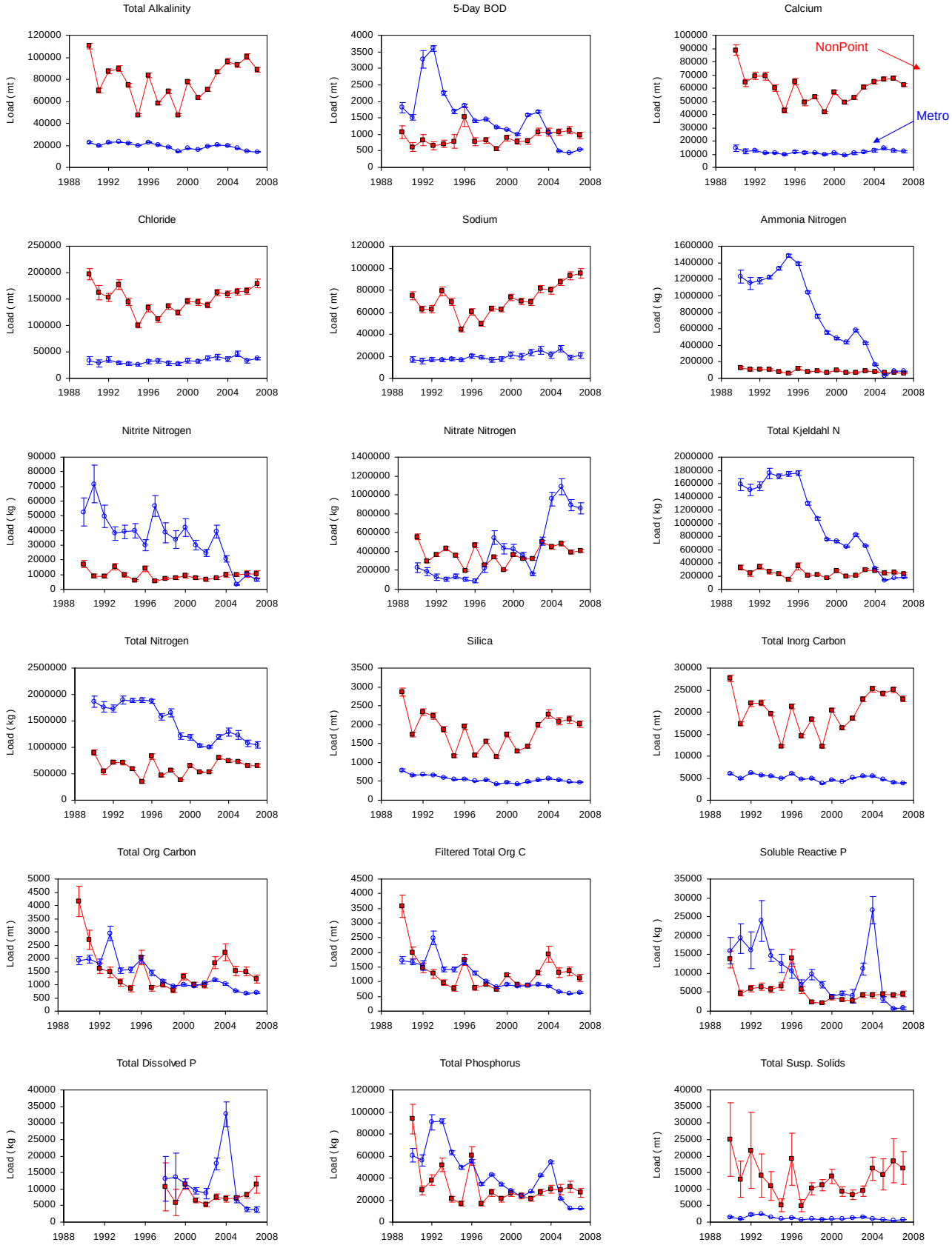
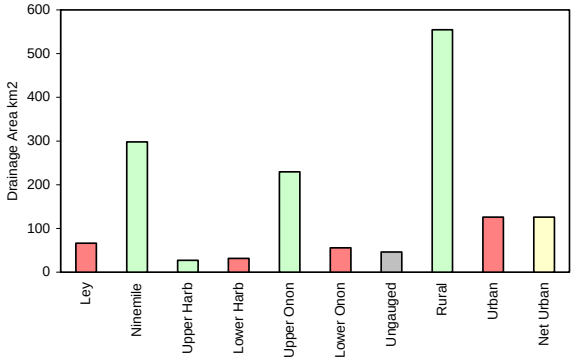


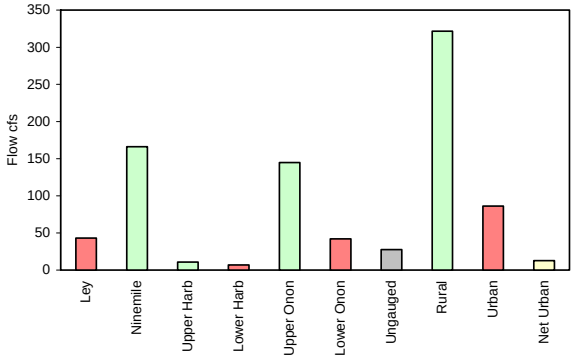
Figure 7 Spatial Variations in NonPoint Phosphorus Loads

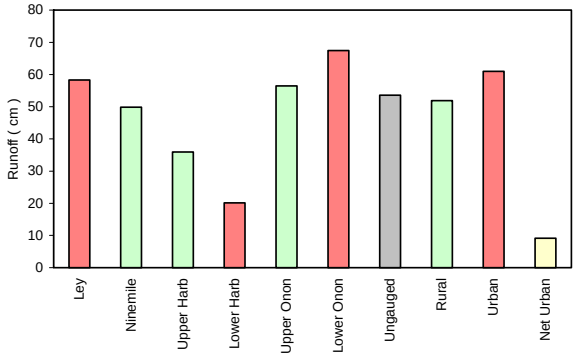
Variable: Total Phosphorus Period: 1998 - 2007

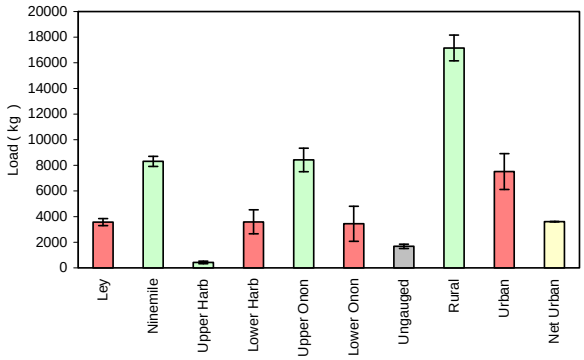
Total Values Unit Area Values

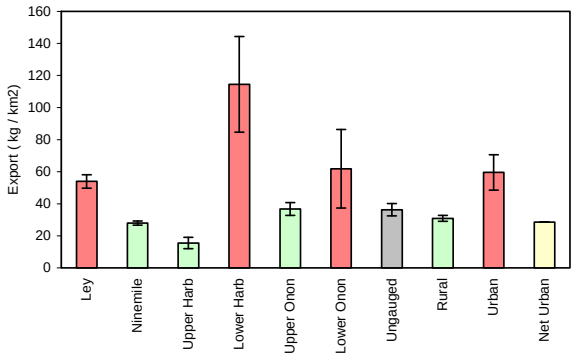


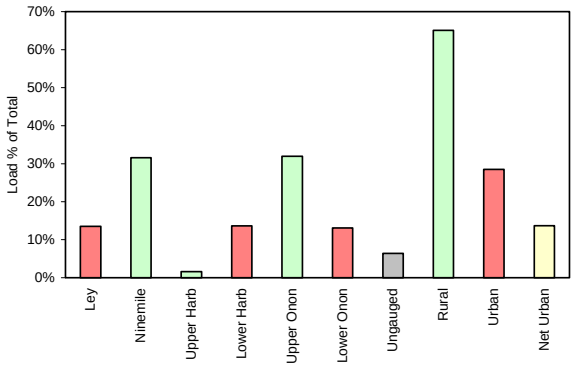
Label	Description
Ley	Above Park
Ninemile	Above Lakeland
Upper Harb	Above Velasko
Lower Harb	Between Velasko & Hiawatha
Upper Onon	Above Dorwin
Lower Onon	Between Dorwin & Kirkpatrick
Ungauged	Ungauged Watershed (Estimated)
Red	Lower Watersheds (~ Urban)
Green	Upper Watersheds (~ Rural)
Yellow	Net From Lower/Urban Areas vs. Rural Background











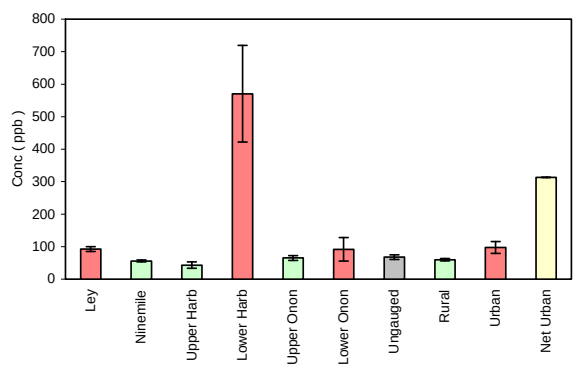
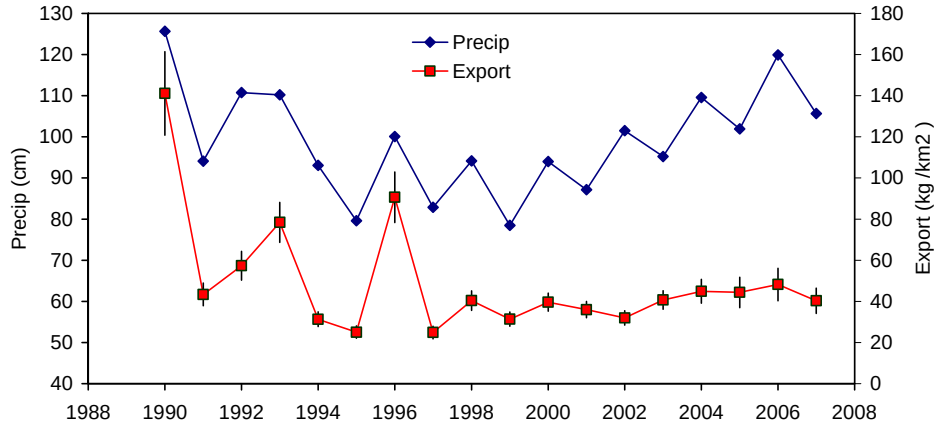
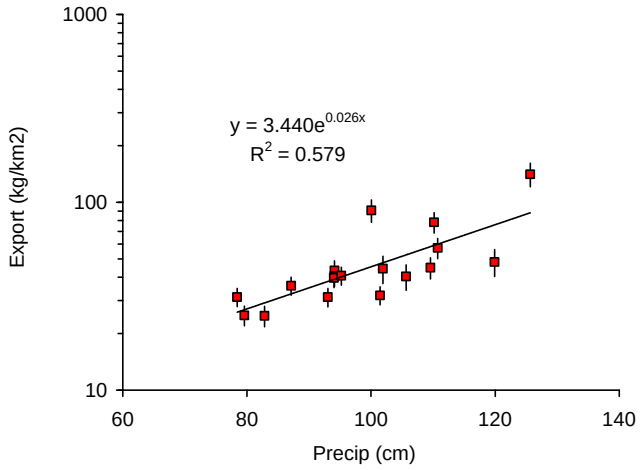
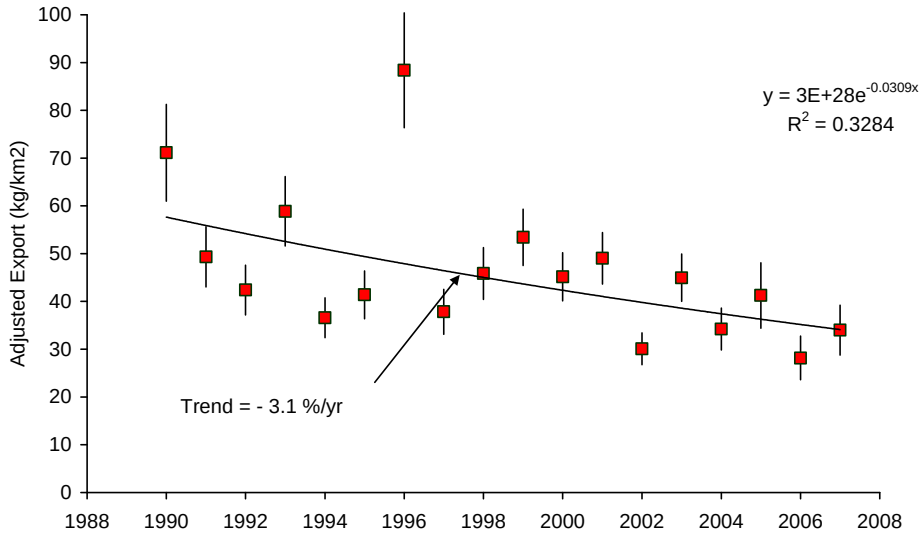


Figure 8 Adjustment of NonPoint P Loads for Variations in Rainfall







P_Export = Total Nonpoint Load (kg/yr) / Watershed Area (km2)

Precip = Hancock Airport Precipitation (cm)

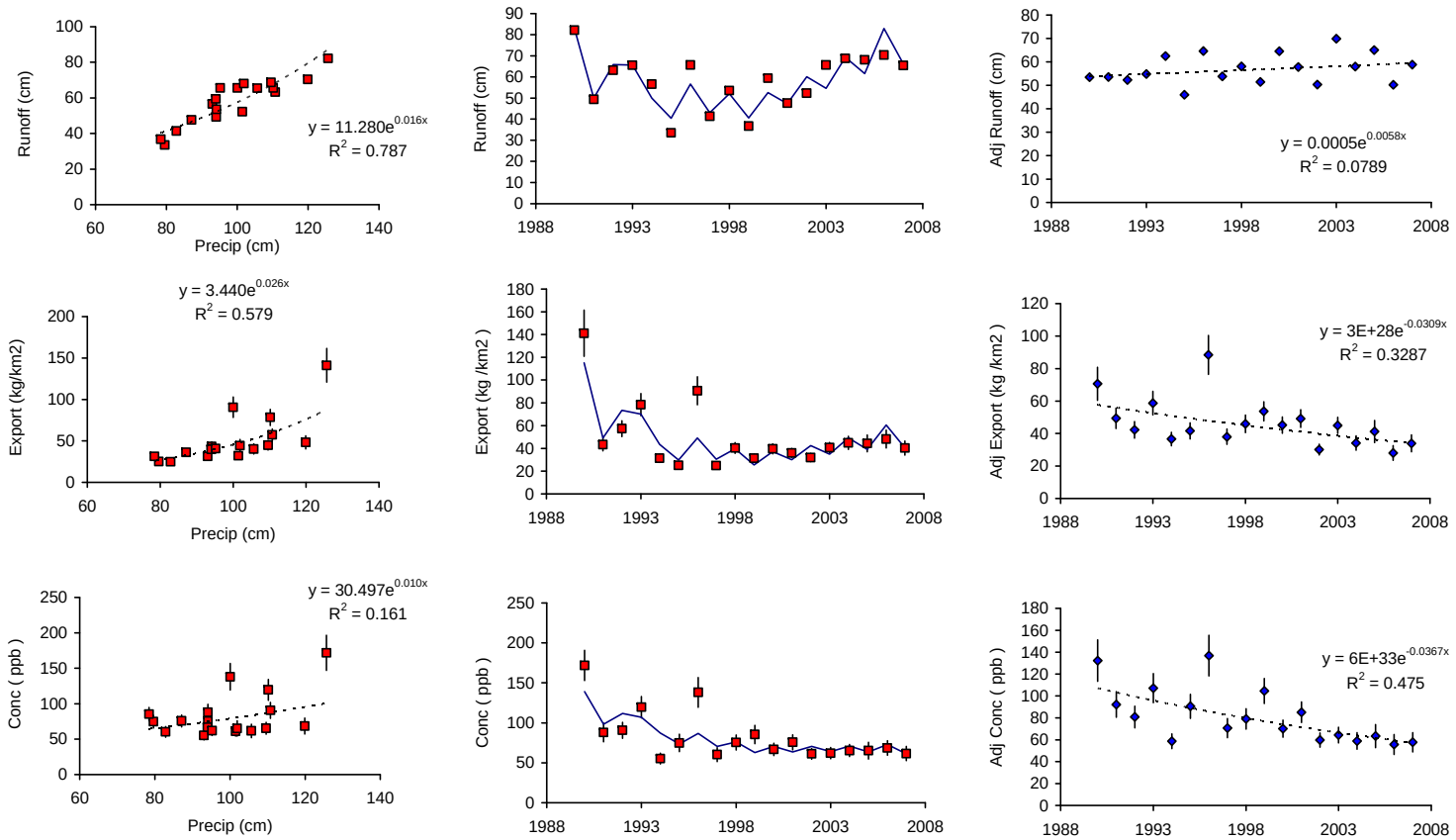
Adjusted_P_Export = P_Export Adjusted for Yearly Variations in Precipitation

Adjusted_P_Export = Measured_P_Export x Exp [.026 x (Mean_Precip - Precip)]

Trend in Adjusted_P_Export (% per year) = -3.1% +/- 1.1% n= 0.016

Figure 9 Trends in Nonpoint Runoff, Total P Load, & Concentration, 1990-2007

Correlations with Precipitation | Observed & Predicted Time Series | Adjusted for Variations in Precipitation



Dashed Line = Regression vs. Precip
Vertical Bars = +/- 1 Standard Error of Measured Yearly Value

Solid Line = Regression vs. Year and Precip

Dashed Line = Regressionof Adjusted Value vs. Year

Regression Model: Ln (Y) = A0 + A1 Year + A2 Precip Years: 18

Adjustment to Mean Precip: Ln (Yadjusted) = Ln (Y) + A2 (Mean_Precip - Precip) Mean_Precip = 99 cm/yr

	Ln Runoff vs. Precip & Year			Ln Export vs. Precip & Year			Ln Conc vs. Precip & Year		
	Coef	SE	p	Coef	SE	p	Coef	SE	p
A0	-9.22861			62.94281			76.77659		
A1 (Yr)	0.00583	0.00515	0.27	-0.03089	0.01140	0.02	-0.03672	0.00997	0.00
A2 (Precip)	0.01623	0.00210	0.00	0.02607	0.00465	0.00	0.00984	0.00407	0.03
R^2	0.80350			0.71735			0.55930		
Std Error	0.11324			0.25089			0.21942		

Summary of Trends (Percent / Year)		
	Trend	p
Runoff	0.6%	0.27
Export	-3.1%	0.02
Conc	-3.7%	0.00

Figure 10 Trends in Rainfall-Adjusted Phosphorus Loads from Individual Sources, 1990-2007

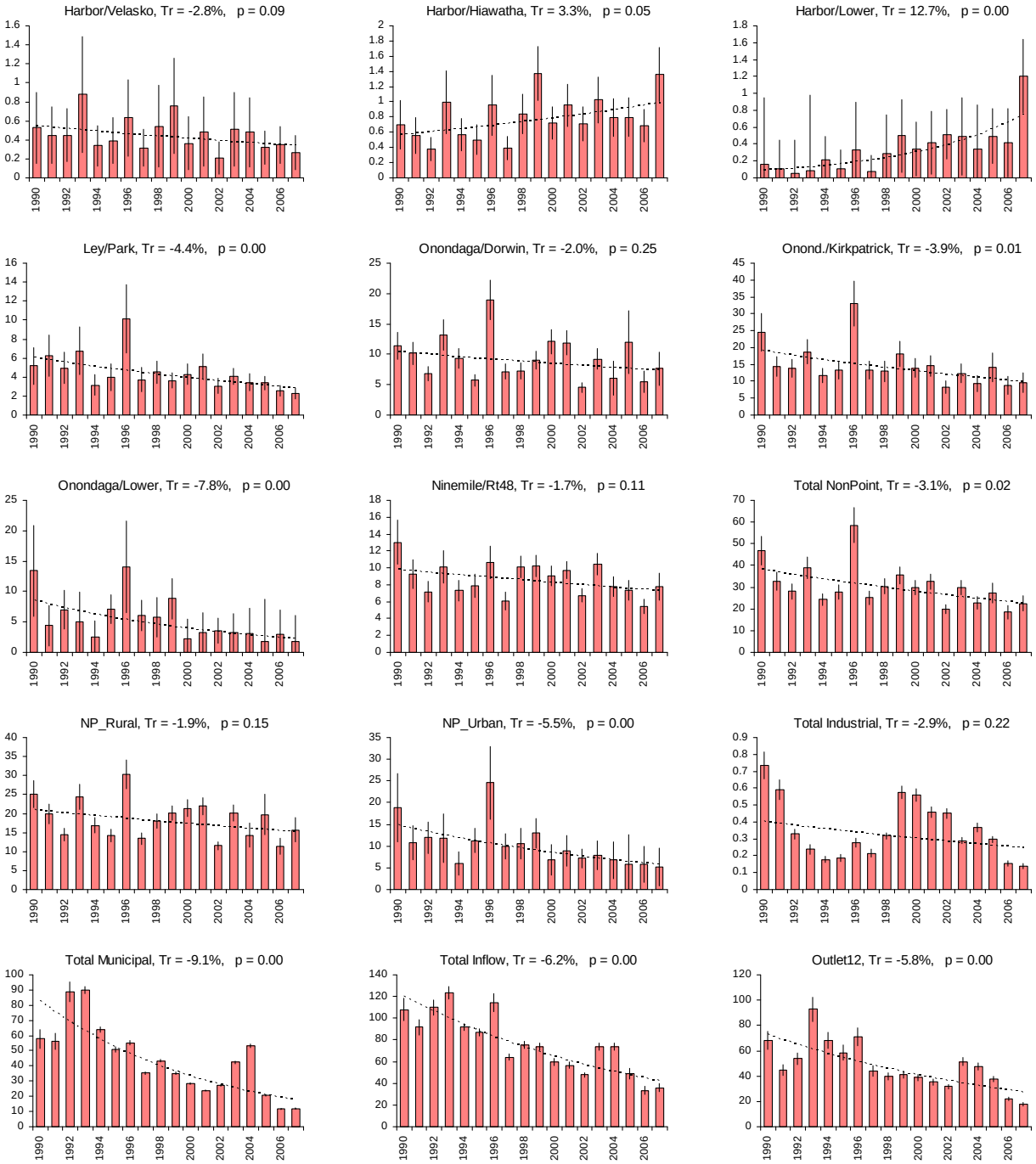
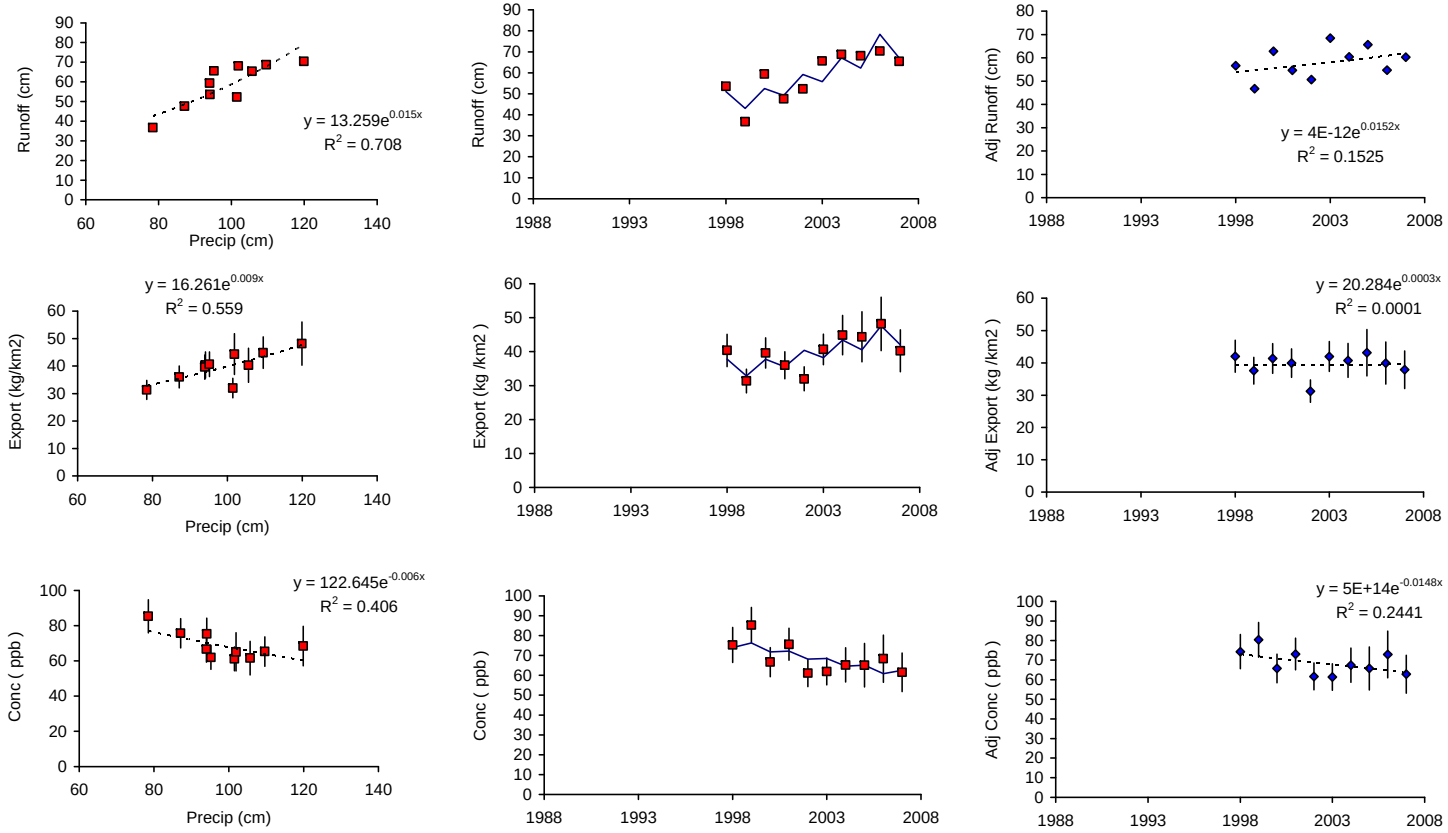


Figure 11 Trends in Nonpoint Runoff, Total P Load, and Concentration, 1998-2007

Correlations with Precipitation | Observed & Predicted Time Series | Adjusted for Variations in Precipitation



Dashed Line = Regression vs. Precip
Vertical Bars = +/- 1 Standard Error of Measured Yearly Value

Solid Line = Regression vs. Year and Precip

Dashed Line = Regressionof Adjusted Value vs. Year

Regression Model: Ln (Y) = A0 + A1 Year + A2 Precip Years: 10

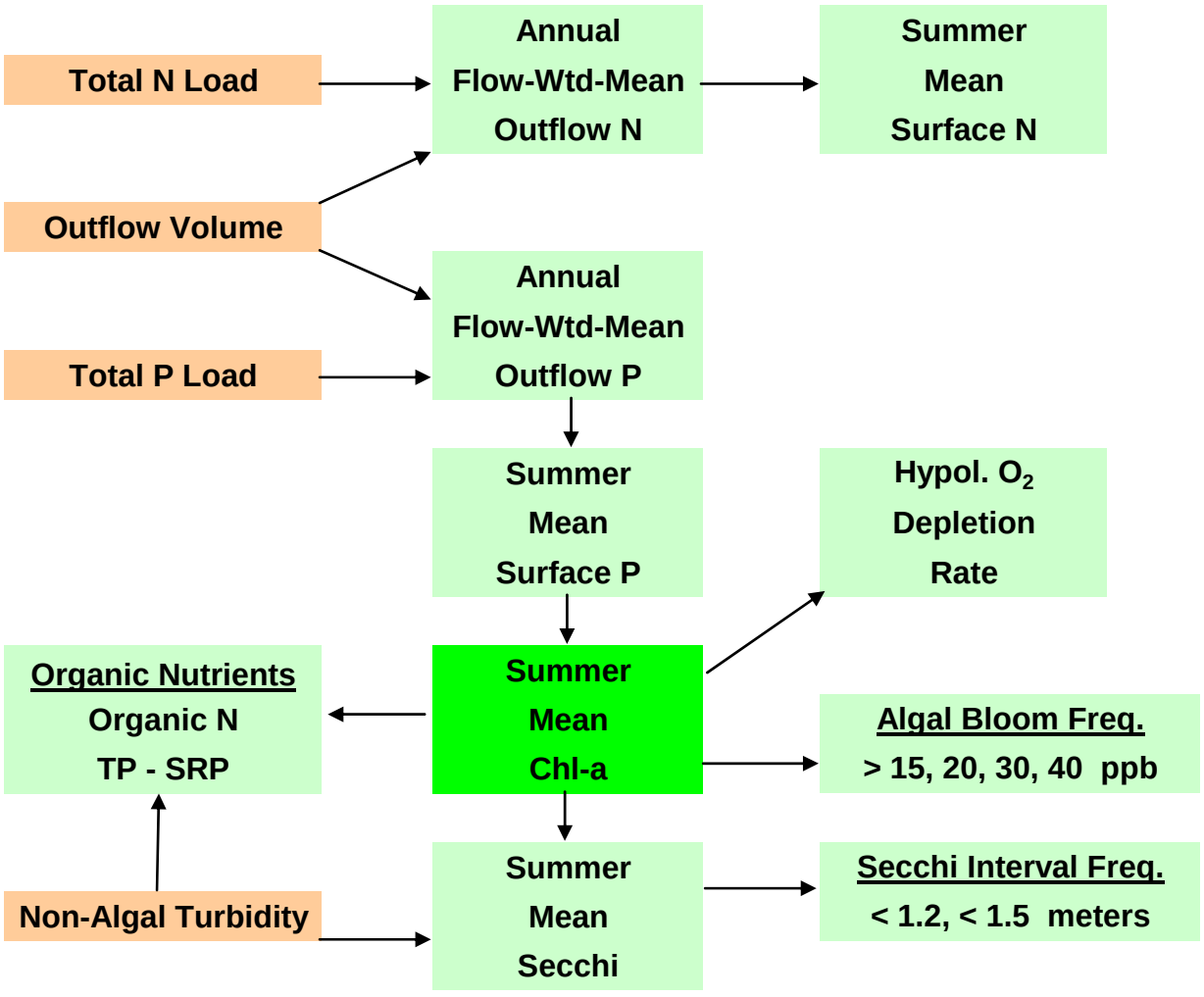
Adjustment to Mean Precip: Ln (Yadjusted) = Ln (Y) + A2 (Mean_Precip - Precip) Mean_Precip = 99 cm/yr

	Ln Runoff vs. Precip & Year			Ln Export vs. Precip & Year			Ln Conc vs. Precip & Year		
	Coef	SE	p	Coef	SE	p	Coef	SE	p
A0	-27.48206			2.13101			34.21824		
A1 (Yr)	0.01516	0.02139	0.50	0.00033	0.01842	0.99	-0.01483	0.01562	0.37
A2 (Precip)	0.01186	0.00553	0.07	0.00890	0.00476	0.10	-0.00296	0.00404	0.49
R^2	0.72751			0.55938			0.47408		
Std Error	0.12274			0.10568			0.08961		

Summary of Trends (Percent / Year)

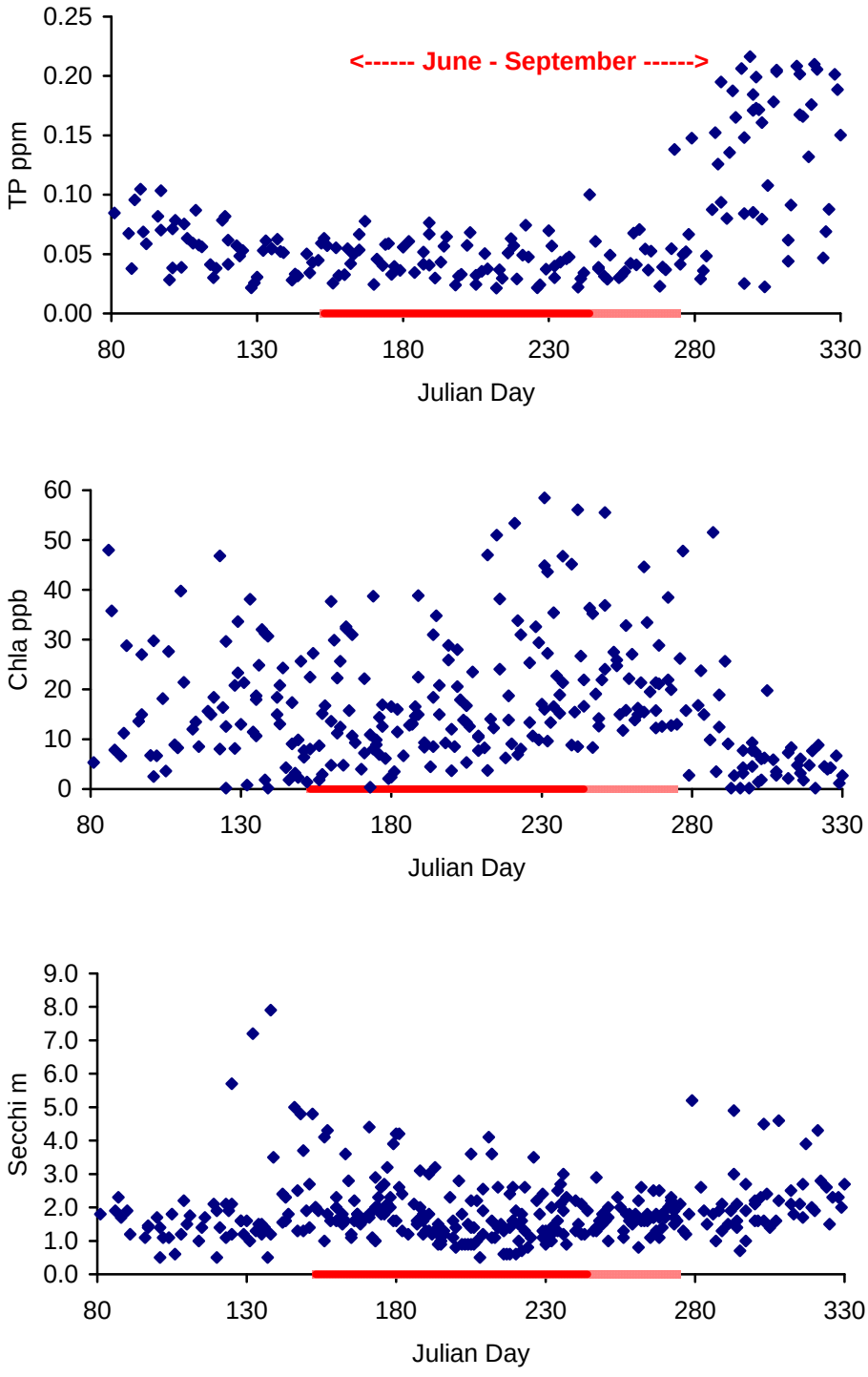
	Trend	p
Runoff	1.5%	0.50
Export	0.0%	0.99
Conc	-1.5%	0.37

Figure 12 Onondaga Lake Empirical Eutrophication Model



Adapted from BATHTUB (Walker, 2006)

Figure 13 Seasonal Variations in Trophic State Indicators



Red bars show June-September averaging period.
Data from Lake South Upper Mixed Layer, 1998 - 2007

Figure 14 Total Phosphorus & Chloride in Lake Upper Mixed Layer & Outlet

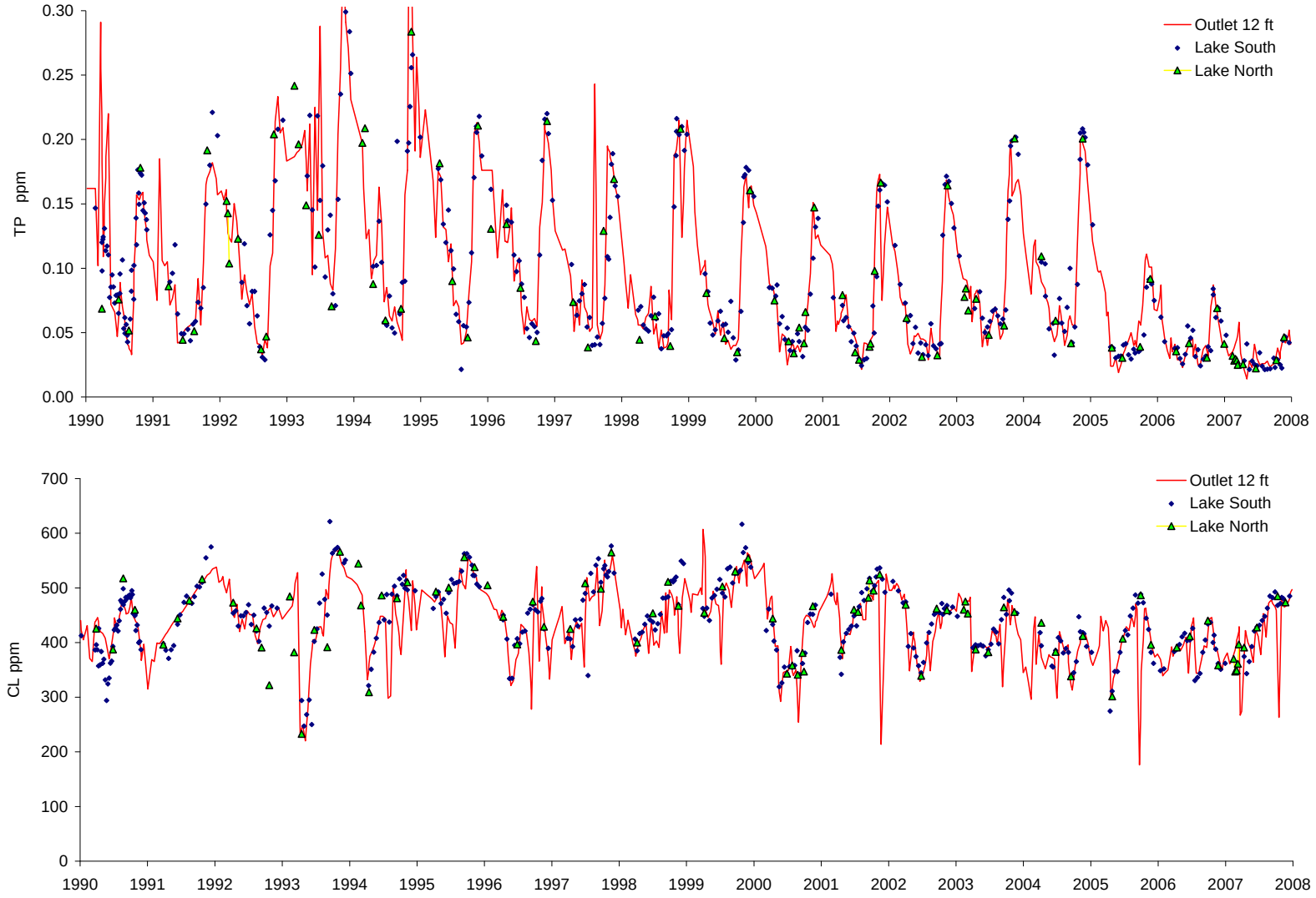


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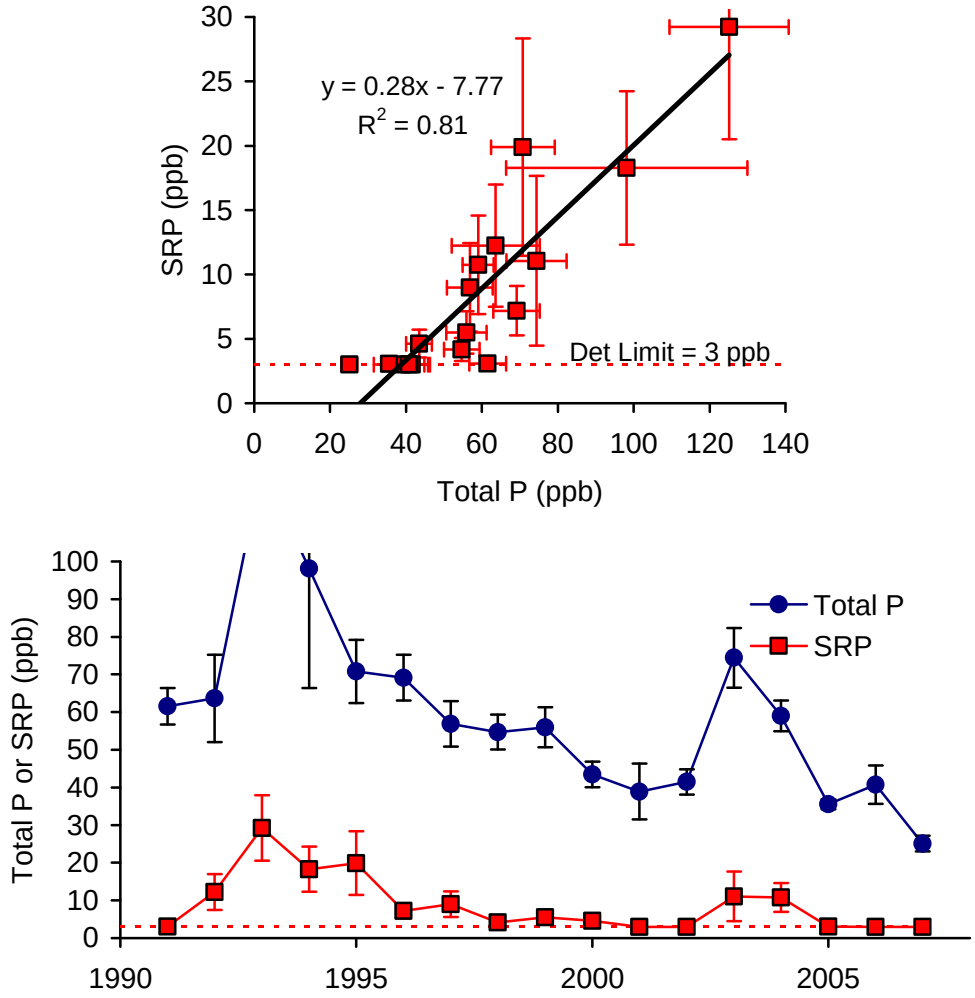
Figure 15 Soluble Reactive P vs. Total P Concentrations



June-September Means, 0-3 meters, Lake South Station
Error bars show mean +/- 1 standard error

Figure 16 Observed and Predicted Time Series

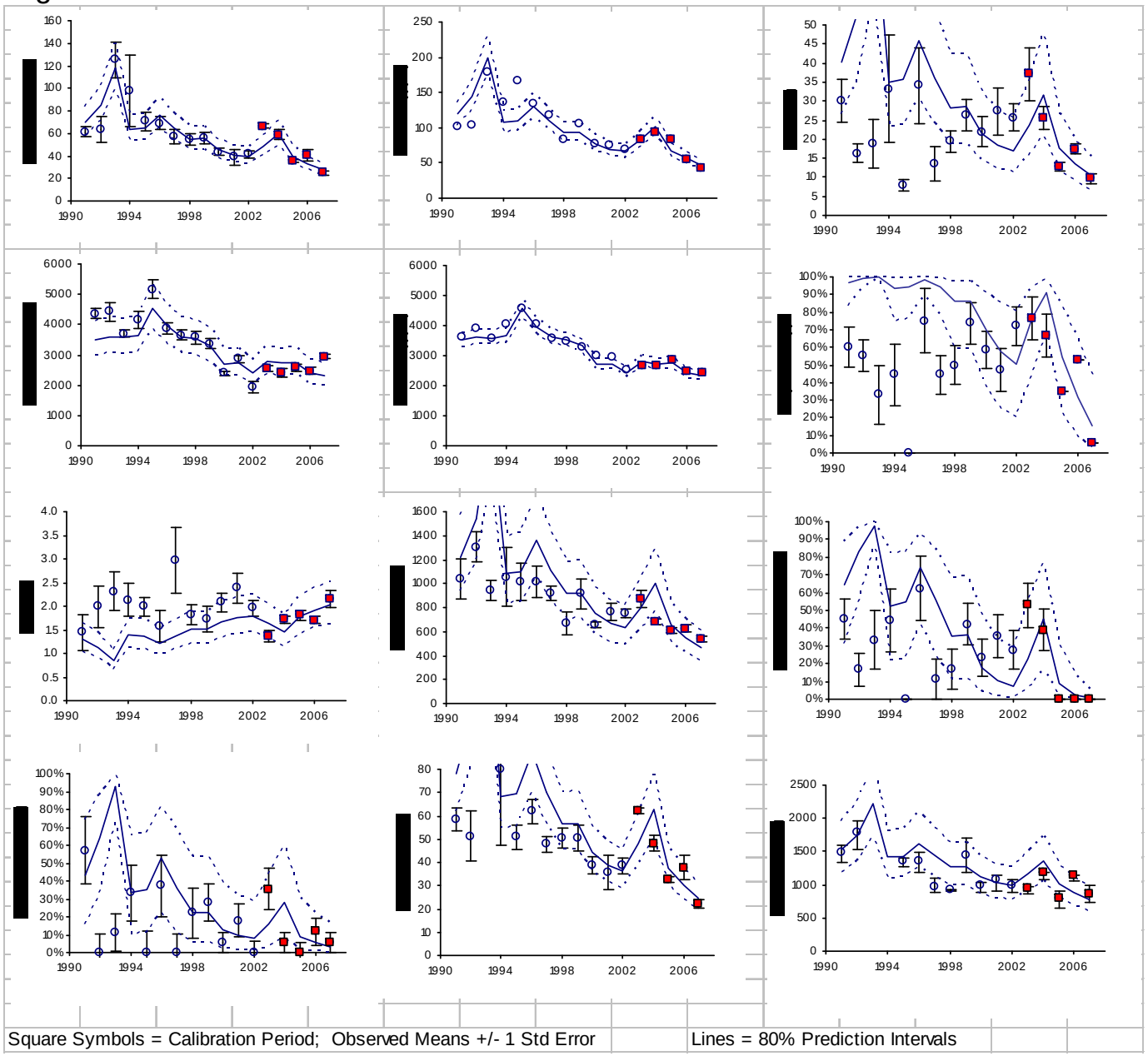
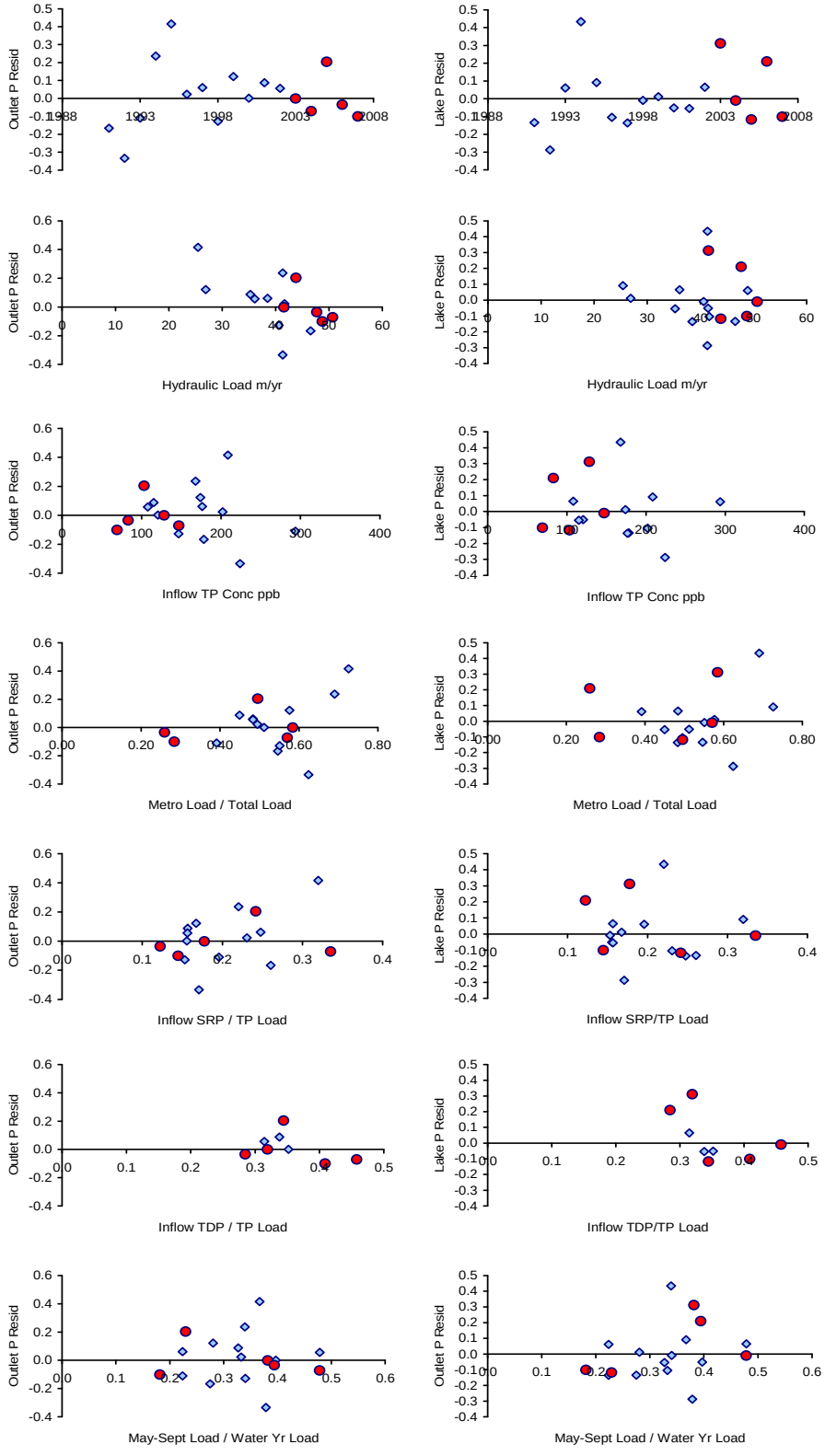


Figure 17 Phosphorus Residuals vs. Various Factors



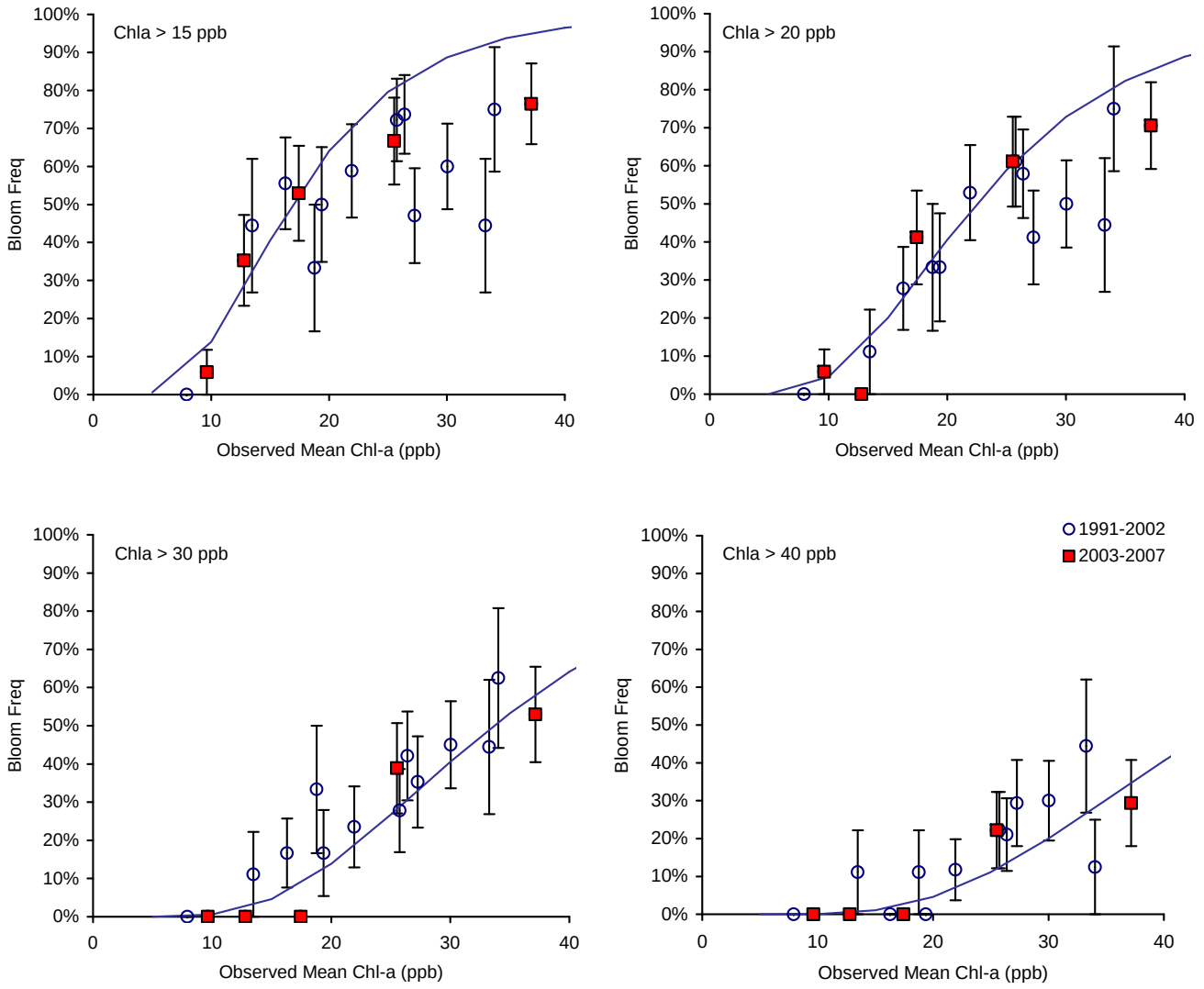
Residual = Observed - Predicted Concentration

Red symbols = calibration period (2003-2007)

Red circles = calibration period (2003 - 2007)

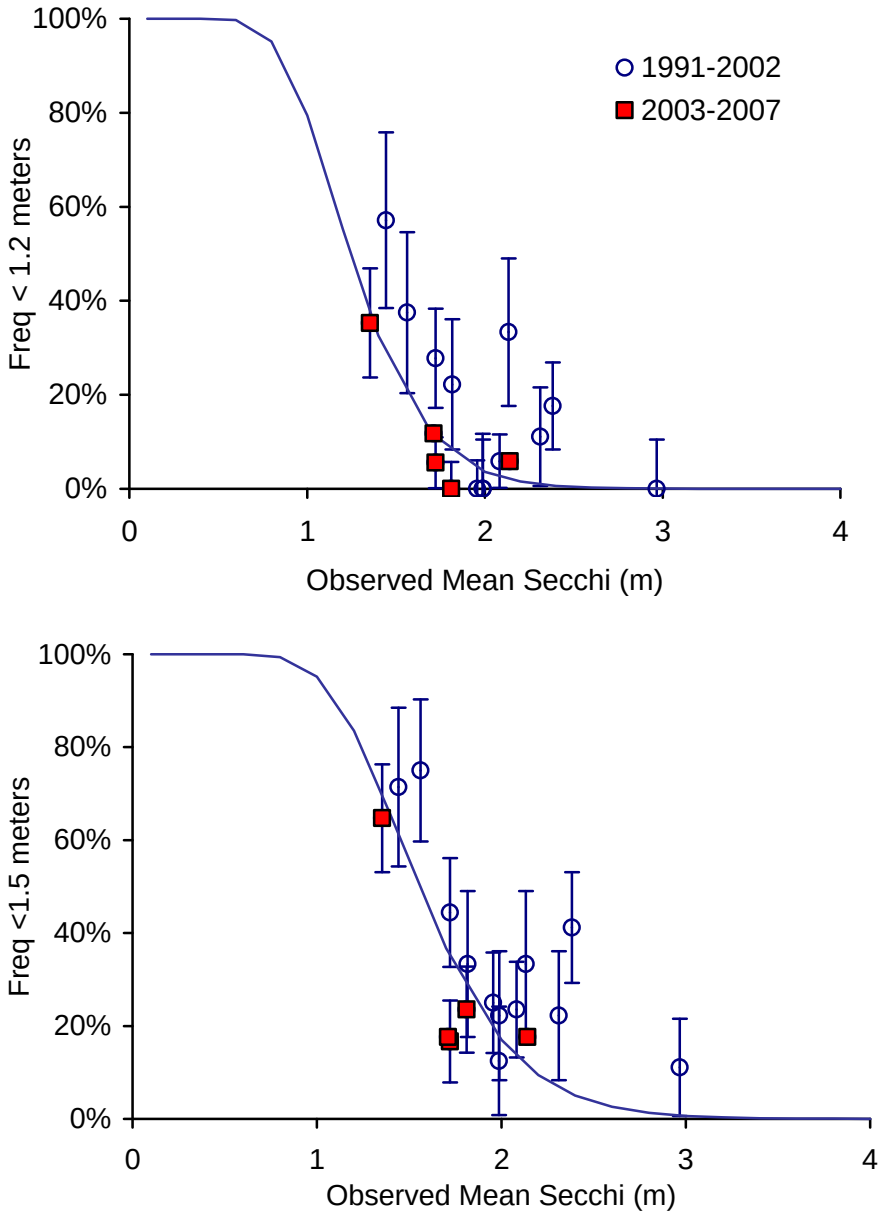
Residual = LN (observed/predicted concentration)

Figure 18 Algal Bloom Frequencies vs. Observed Mean Chlorophyll-a



Under-prediction of bloom frequencies in 1991-2002 is associated with decreases in chlorophyll-a variance, alweife populations, and late summer clearing events after 2003.

Figure 19 Secchi Interval Frequencies vs. Mean Secchi Depth



Under-prediction of exursion frequencies in 1991-2002 is associated with decreases in secchi depth variance, alweife populations, and late summer clearing events after 2003.

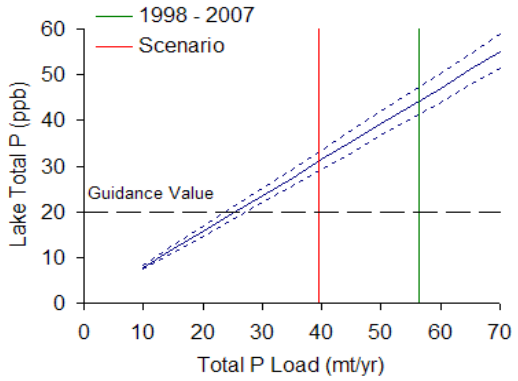
Model: Log-Normal Frequency Distribution, CV = 0.27

Months: 6 thru 9

Figure 20 Predicted Lake Responses to Reductions in Phosphorus Load

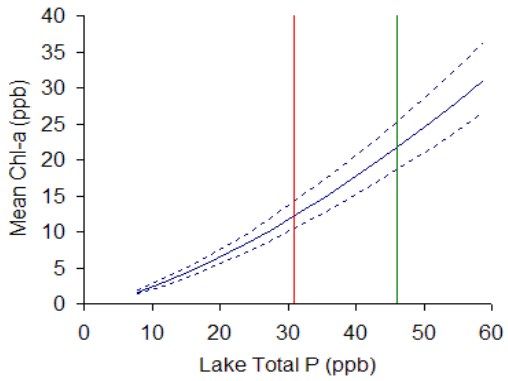
Onondaga Lake Empirical Eutrophication Model
Scenario: Metro =120

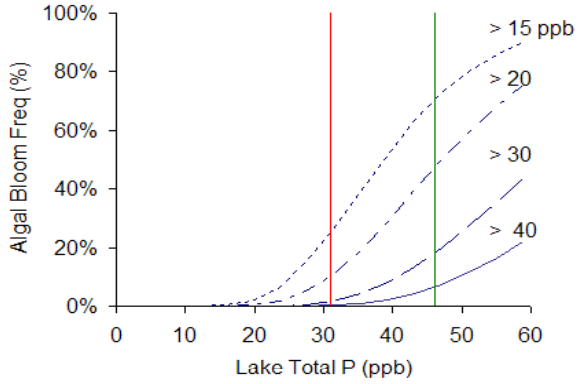
Responses to Phosphorus Load & Concentration
Historical Baseline: 1998 - 2007

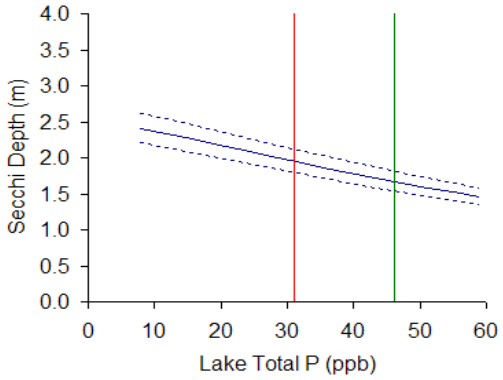


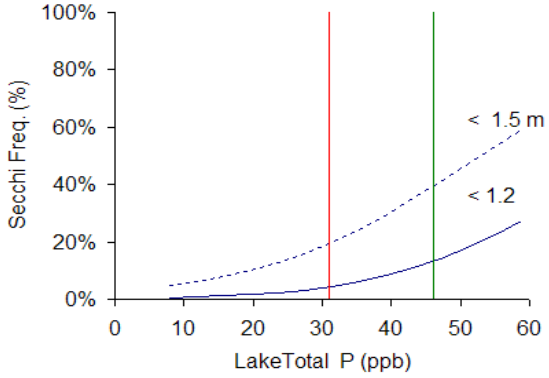
		Scenario	Baseline
Outflow Volume	cfs	538	538
Total P Load	kg/yr	39.5	56.4
Lake TP	ppb	31	46

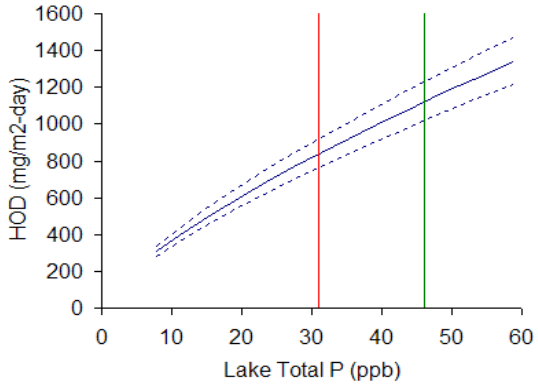
Dashed lines show 80% prediction intervals for long-term mean
Vertical Lines = Scenario & Historical Averages

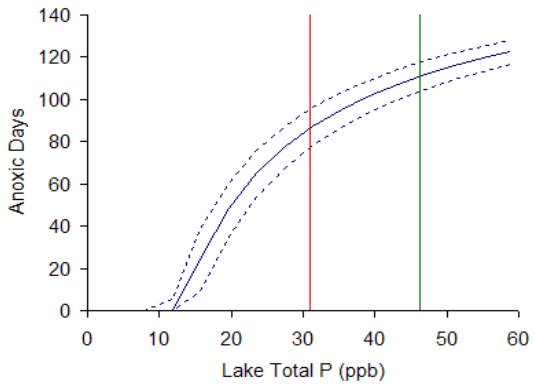












Library Reference 11.5

Phosphorus-Nitrogen Relations

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Library Reference 11.5.1

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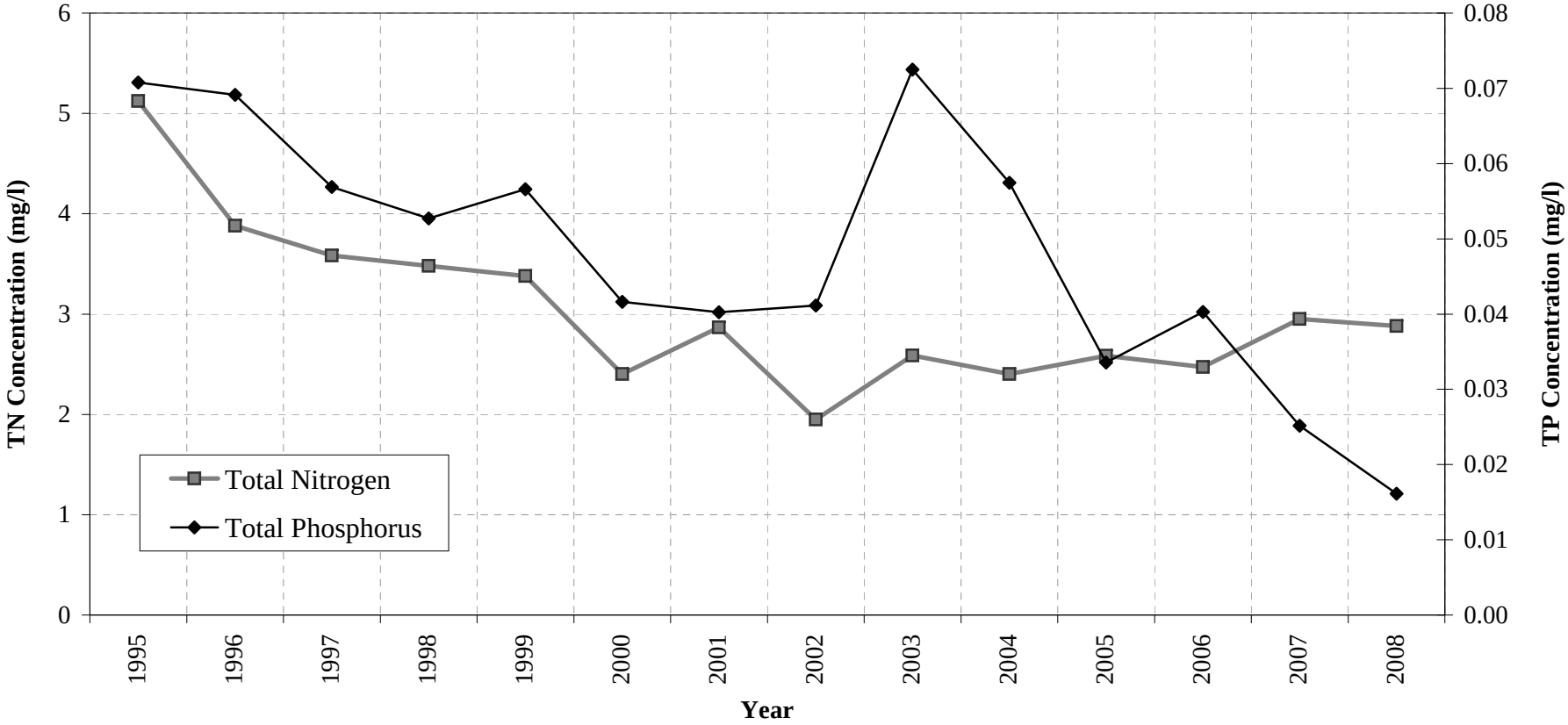

Summer average concentrations of total nitrogen and total phosphorus over time in the upper waters (0-3m) at Onondaga Lake South Deep. The summer average is calculated for the period from June 1 to September 30. Total nitrogen was calculated as the sum of Total Kjeldahl Nitrogen (TKN), nitrite-N and nitrate-N concentrations; total phosphorus was reported by the laboratory. Nitrite-N and nitrate-N samples were collected as composites of the upper mixed layer (UML); TKN and phosphorus were collected at discrete depths and the results were averaged for 0m and 3m depths to represent upper waters.

Library Reference 11.5.2

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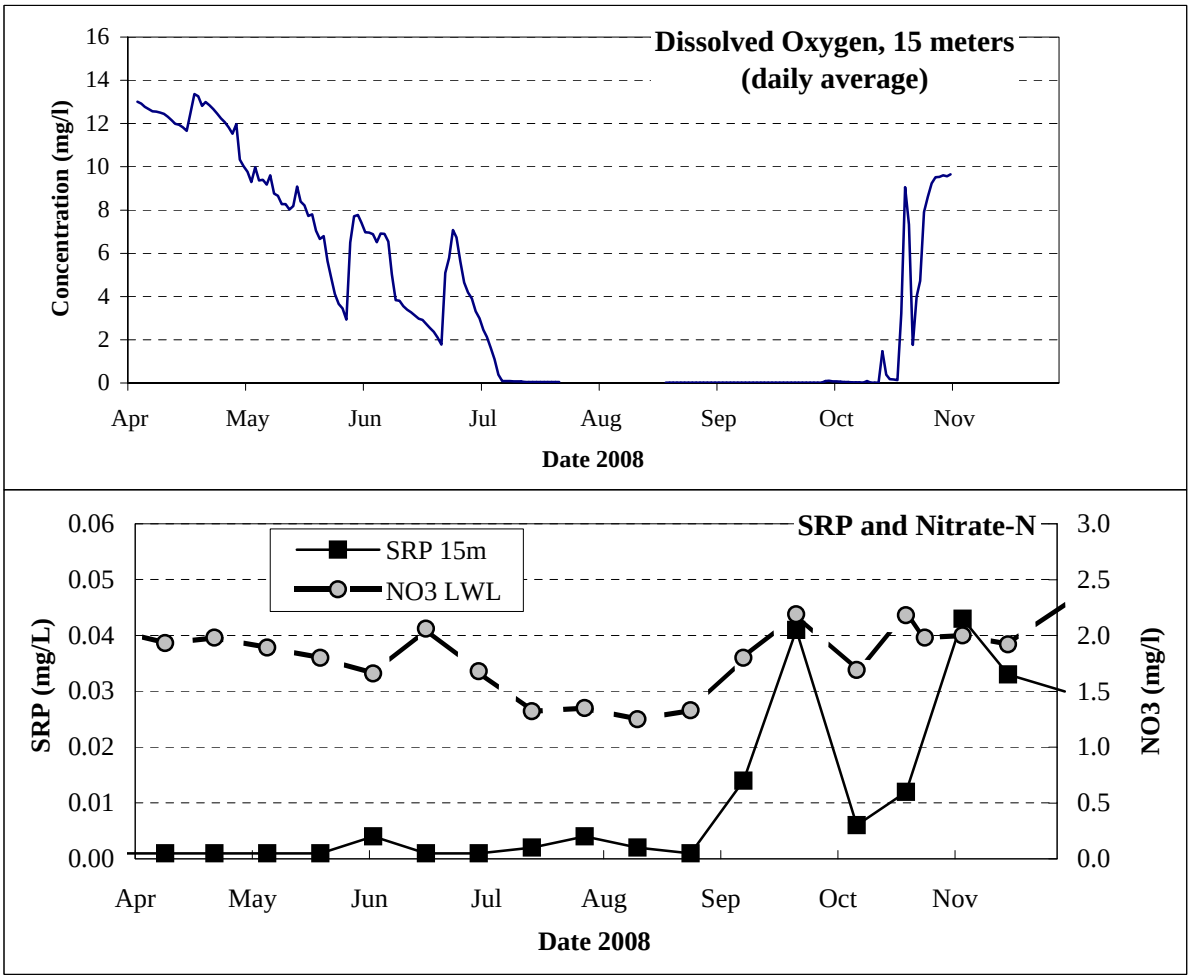

Comparison of soluble reactive phospohorus (SRP) and nitrate-N concentrations with dissolved oxygen concentrations in South Deep lower waters of Onondaga Lake during 2008. Phosphorus bioavailability is affected by low oxygen levels as microorganisms utilize oxidized forms of different compounds. Lower waters in Onondaga Lake become anoxic during the summer months as a result of biological decomposition and thermal stratification. As shown in the graph, nitrate-N concentrations decrease in early summer as dissolved oxygen becomes less available to microorganisms. As oxygen levels remain low during the summer, eventually the microorganisms begin to reduce iron; As this happens, phosphorus bound in ferric phosphate compounds is released into solution. This is measured as in the lake as an increase in SRP in late summer. During fall turnover, when oxygen-rich waters from the surface mix with the lower waters, nitrate concentrations rebound while SRP concentrations decrease.

Library Reference 11.5.3

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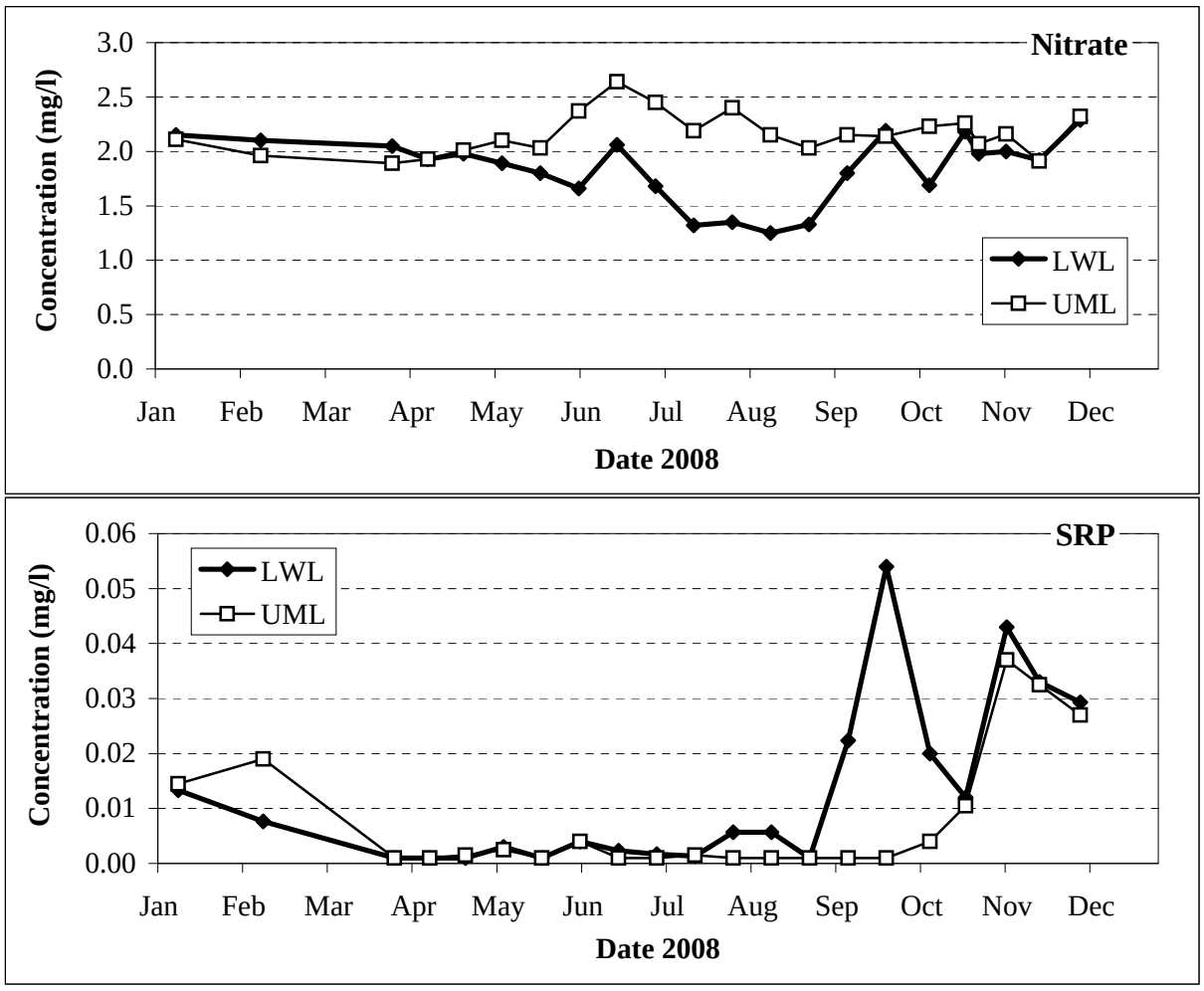

Concentrations of nitrate-N and soluble reactive phosphorus (SRP) in the upper mixed layer (UML) and lower water layer (LWL) of Onondaga Lake South Deep over time.

Library Reference 11.6

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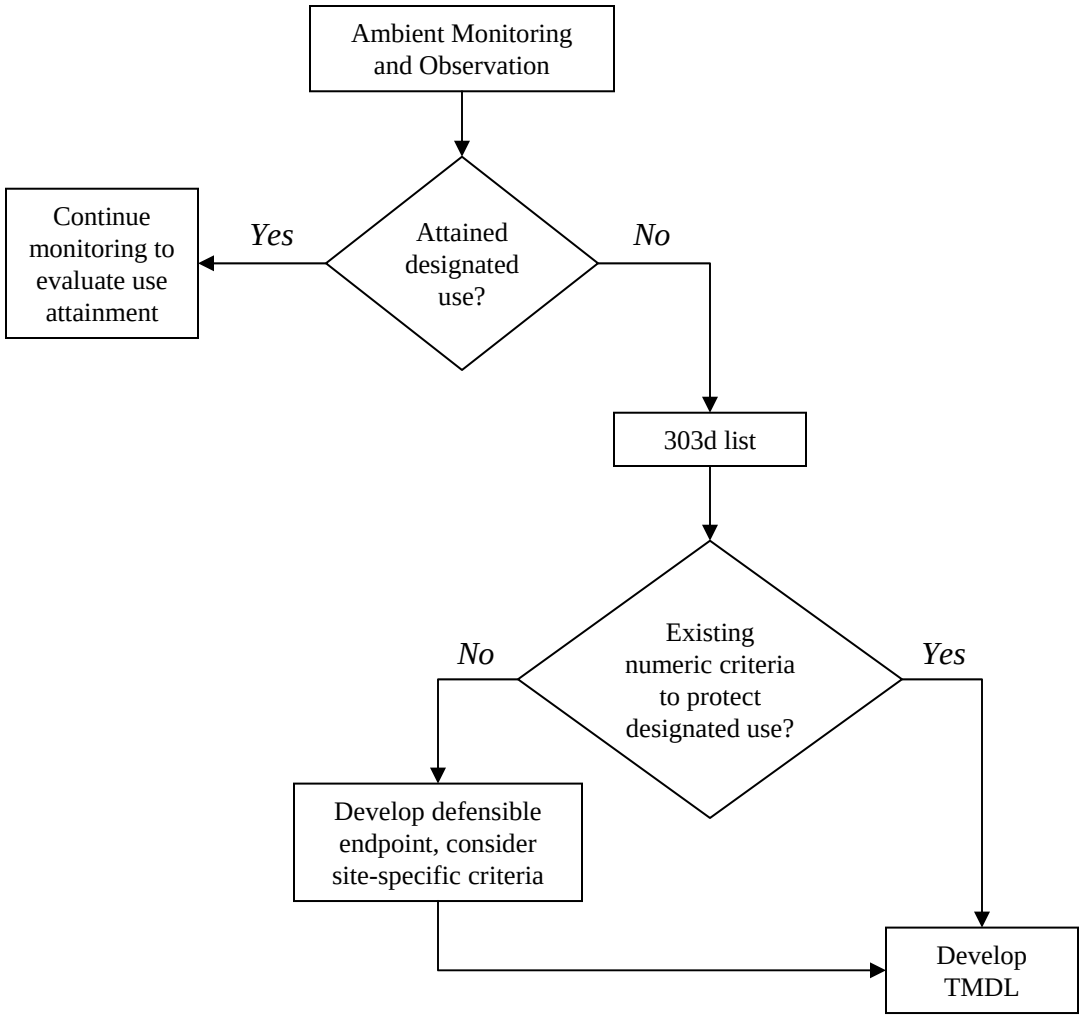
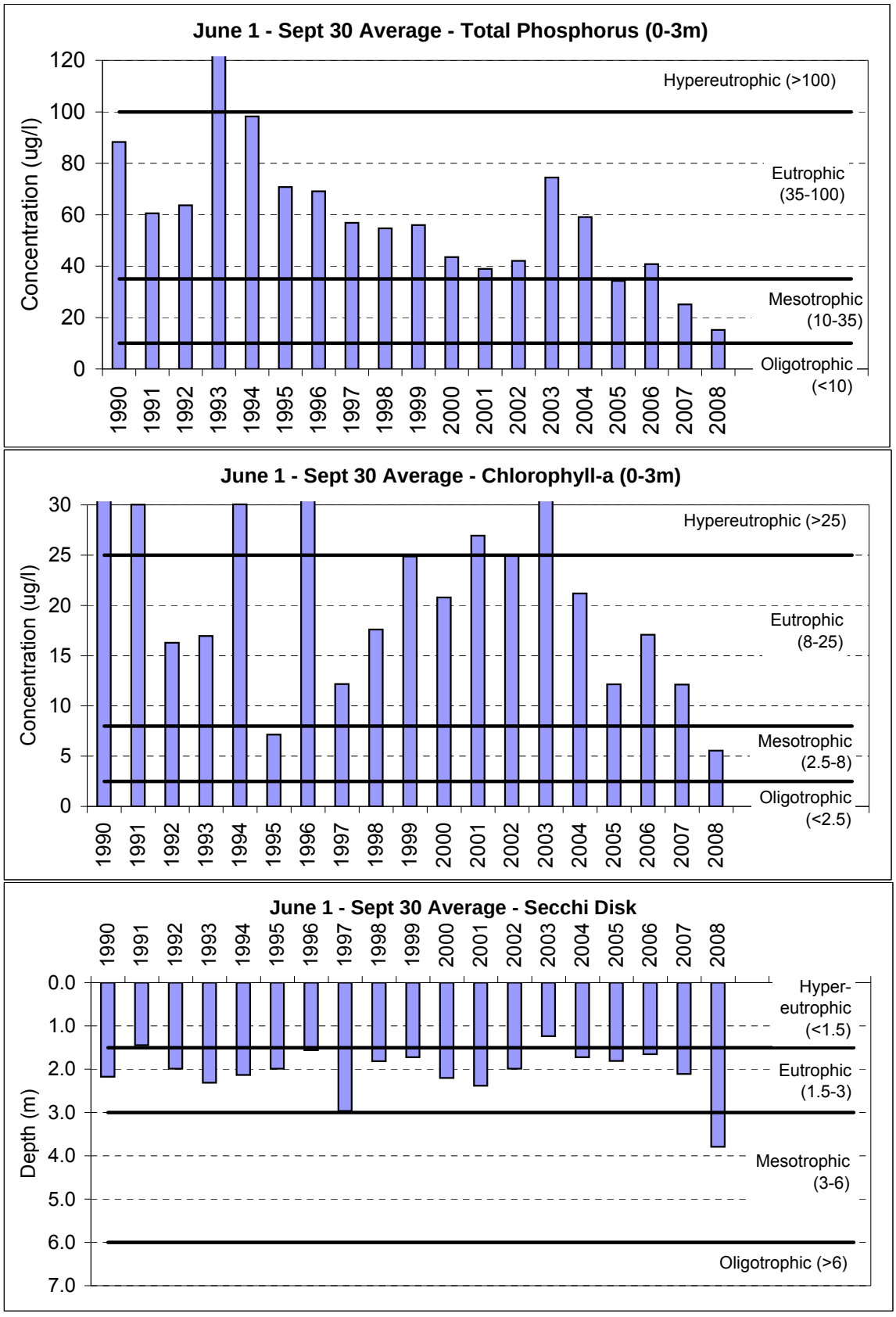


Site-specific nutrient criteria are relevant in cases where ecoregional or statewide criteria are either more stringent or less stringent than necessary to protect the designated use. In the case of Onondaga Lake, NYSDEC is committed to examining the applicability of the statewide phosphorus guidance value as it may be too stringent for this urban lake. The relationship between nutrient criteria, use attainment, and regulatory action is outlined in the flow chart above.



Three indicators of trophic status - phosphorus, chlorophyll-a, and transparency - shown over time (1990-2008), using data collected at South Deep Station in Onondaga Lake.

Onondaga Lake Technical Advisory Committee (OLTAC):

In addition to the team referenced above, the County will utilize a Technical Advisory Group composed of experts in several disciplines to discuss results and implications of the annual program. Current members, their areas of technical expertise, affiliation, and email addresses are as follows:

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2. Dr. James Hassett - Engineering Hydrology; Water Pollution Engineering; Water Quality Modeling SUNY College of Environmental Science and Forestry (ESF)
   email: jhassett@esf.edu
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   email: bill@wwwalker.net