Monitoring Plan

Southern Basin
of
Cayuga Lake

2008

Prepared by the Water Resources Council-Cornell University Partnership

This monitoring plan represents the work of the Partnership. Once supported by the partners, comments will be sought from the community and from the monitoring associates. It is a document that will be frequently reviewed and adjusted to reflect the findings made based on monitoring efforts. Regular reports on findings and plan modifications will be made to the community.

On behalf of the Water Resources Council-Cornell University Partnership (The Partnership), I am pleased to present the Monitoring Plan for the Southern Basin of Cayuga Lake.

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

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

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

It has been my pleasure to serve as the chair of the Partnership for the last two years. By working together, we have identified a reasonable approach to understanding the dynamics of one of our community's most important resources: Cayuga Lake.

Roxy Johnston
Chair, The Partnership

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Glossary

ADCP Acoustic Doppler Current Profiler: type of sonar that produces a record of water current velocities over a range of depths.

CSI Community Science Institute: a nonprofit organization that organizes citizen volunteers to monitor water quality.

EC *Escherichia coli* (*E. coli*): a bacterium that is found in the lower intestine of warm blooded animals. Their ability to survive for brief periods outside the body makes them an ideal indicator organism to test for fecal contamination.

FC Fecal Coliform: bacteria that indicate the presence of sewage contamination of a waterway and the possible presence of other pathogenic organisms.

IAWWTP Ithaca Area Wastewater Treatment Plant: a sewage treatment plant located on Third Street Extension in the City of Ithaca, jointly owned by the City of Ithaca, the Town of Ithaca and the Town of Dryden and overseen by the Special Joint Committee.

Partnership Water Resources Council-Cornell University Partnership: a committee of representatives appointed by the Tompkins County Water Resources Council and Cornell University.

RUSS Remote Underwater Sampling Station: A continuous monitoring station for meteorological data and water parameters located in Cayuga Lake (usually May to October) and owned by Cornell University.

SRP Soluble Reactive Phosphorus: the phosphorus that is readily available for uptake by organisms. See Total Phosphorus (TP).

TC Total Coliform: Bacteria that are mostly harmless bacteria that live in soil, water, and the digestive system of animals. See Fecal Coliform (FC).

TMDL Total Maximum Daily Load: the maximum amount of a pollutant that a water body can receive and still meet water quality standards.

TP Total Phosphorus: the total phosphorus found including soluble reactive phosphorus (SRP) and phosphorus bound to sediment particles or locked up in large organic molecules that are unavailable for immediate uptake, but may become available over time.

TSS Total Suspended Solids: all particles suspended in water that will not pass through a filter.

WRC Water Resources Council: an advisory board to the Tompkins County Legislature.

INTRODUCTION

Plan Goals

This Monitoring Plan was developed with an overall eye towards understanding how the southern end of Cayuga Lake functions, how it responds to various inputs, both human-made and natural, and to provide data to support efforts to improve the lake's water quality. Specifically, the Plan has seven goals (not in priority order):

Reduce duplication in monitoring efforts

There are several locations in the Lake that are monitored by multiple agencies. By reducing duplicative efforts, more resources should be available to collect additional data.

Understand more about southern-lake and main-lake interactions

The relationship between the very shallow southern end of Cayuga Lake and the main deep body of the lake are poorly understood. A better understanding will increase the community's knowledge of water chemistry and living systems and of how human inputs affect different zones of the lake.

Understand circulation patterns

Understanding how water moves through and within the lake will provide information to determine the source of water quality problems and to identify potential solutions.

Capture forcing events and diurnal fluxes

Traditional monitoring efforts, i.e., periodic water sampling, do not provide a good understanding of the daily fluctuations in the lake or a good understanding of the impacts of storm events ("forcing events"). The use of the Remote Underwater Sampling Station (RUSS) will help increase our understanding.

Better understand the lake's "impairment"

Cayuga Lake was included on the 2002 and 2008 (draft) New York State section 303(d) list of impaired water bodies, for phosphorus and silt/sediment (in 2002) and also for pathogens (in the 2008 draft). This listing means that a total maximum daily load (TMDL), i.e., a regulatory limit specifying how much the lake can tolerate and still function acceptably, must be explored.

Begin baseline monitoring for toxics and emergent contaminants

Adding occasional sampling and monitoring for toxics and other contaminants will help us identify potential water-quality problems at an early stage before they can overwhelm our ability to address them.

Increase understanding of mussel, shrimp, and fish populations

Building an understanding of the lake biota and food-web interactions will help increase our knowledge of the overall ecology of the lake, as well as linkages between water quality and lake food webs.

Problem solve for algae and aquatic plant abundance

The Lake experiences occasional blooms of algae and aquatic plants that are related to changes in water quality and interfere with the community's enjoyment of the lake. Directing resources to study this problem will help the community to pursue potential solutions.

Plan Contents

This Plan contains four major parts. The first describes recommended **Regular Monitoring** efforts, including monitoring points and details. The recommended strategy would maintain the current set of monitoring data. The second part of the Plan identifies **Special Studies** that are recommended beyond the present regular monitoring efforts. Part three talks about the need for **Stream Monitoring** in the watershed, both supporting existing efforts and improving the use of the stream data to develop management strategies for the lake. And the final part of the plan talks about the need to provide **Outreach** to share the results of monitoring efforts, develop support for lake water quality initiatives, and support similar monitoring efforts throughout the Cayuga Lake watershed.

REGULAR MONITORING

WW1 to WW25; A2,A4,A6A,8; B2,B4,B6,B8; C2,C4,C6,C8; D2,D4,D6,D8; E2,E4,E8

Number of points monitored: 40, 37 of which are in the southern basin

Responsible Entity: Ithaca Area Wastewater Treatment Plant (IAWWTP)

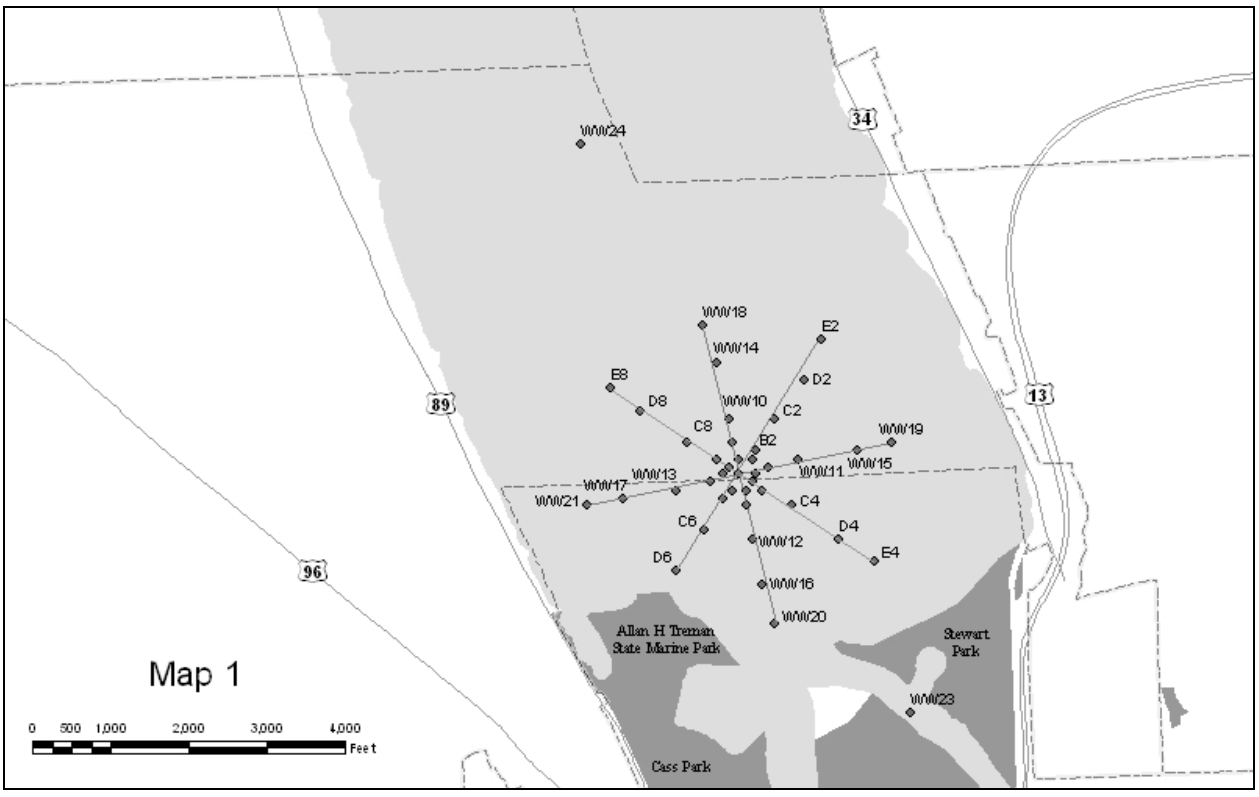
Location of Monitoring Points: 36 points radiating from the wastewater treatment plant's outfall (Map 1). An additional two points located mid-lake to the north, one opposite Indian Creek and one opposite Taughannock Creek (Map 8). Two additional points, not on the lake, one on Fall Creek one on Cayuga Inlet.

Notes: The IAWWTP monitors 37 points in the southern basin. The points are located in an "asterisk" around the plant's outfall. The N-S "cross" of the asterisk (WW1 through WW21) and the NE-SW "cross" (A,B,C,D,E points) are monitored on alternating months. This provides monthly data for the area around the outfall and data every two months for the more distant points. Several of these monitoring points overlap other monitoring efforts. IAWWTP will continue to monitor into the foreseeable future.

Recommendations: Continue this monitoring effort in the southern basin.

Monitoring Details

Parameter	Frequency	Notes
Coliforms (FC)	every 2 months	
Phosphorus (SRP)	every 2 months	filtered
Phosphorus (TP)	every 2 months	
Sediment (TSS)	every 2 months	
In-Situ Sensor Suite: Ammonia, Blue Green Algae, Chlorophyll a, Dissolved Oxygen, Nitrate, pH, Specific Conductivity, Temperature, Turbidity	every 2 months	



RUSS1

Number of points monitored: 1, continuously monitored.

Responsible Entity: Partnership

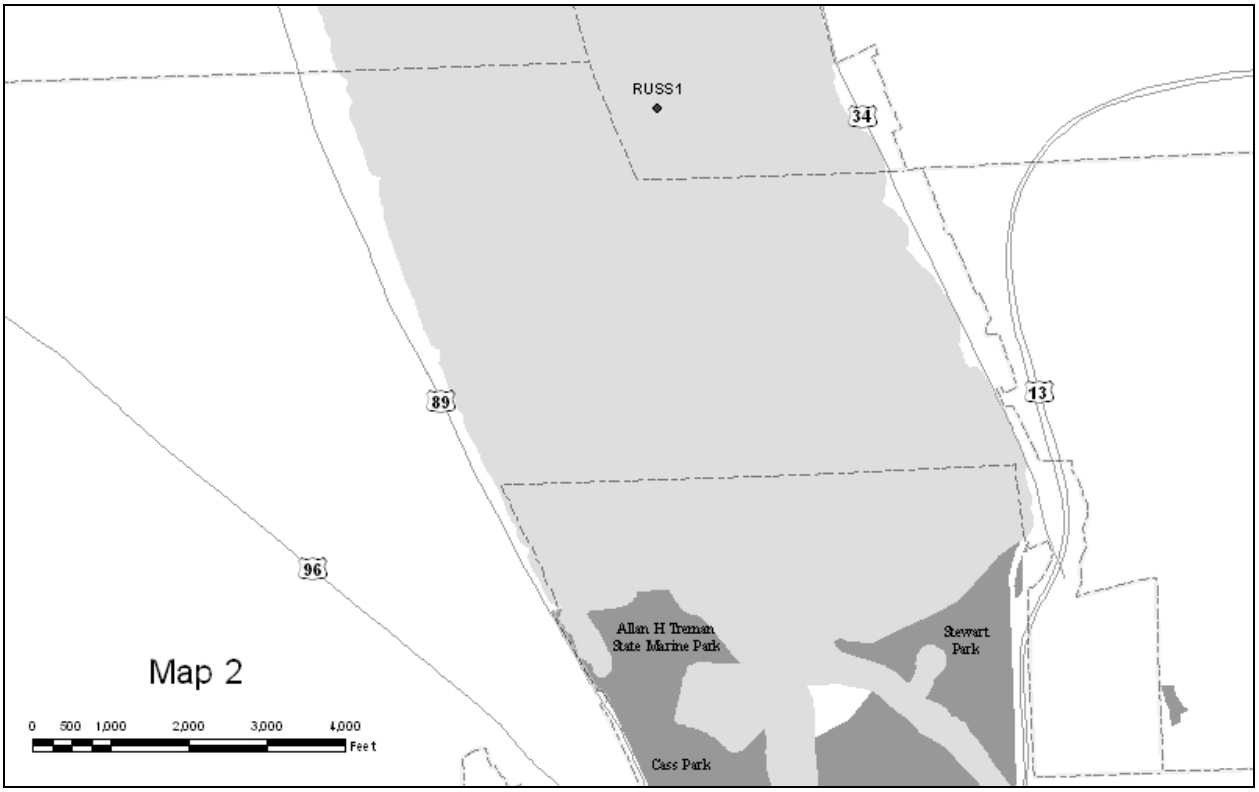
Location of Monitoring Points: The Remote Underwater Sampling Station (RUSS) is owned by Cornell University and is deployed annually at a single location, mid-lake (laterally) just north of the shelf break (Map 2, depth at location approximately 85 feet).

Notes: The RUSS unit provides near real-time and accessible data about water quality and meteorological data via the Internet (www.cayugalake.cornell.edu). The RUSS is particularly critical in understanding the impact of wind and rain events on the lake as it samples continuously. The RUSS unit is generally operational May to November.

Recommendations: Continue this monitoring effort.

Monitoring Details

Parameter	Frequency	Notes
In-Situ Sensor Suite: Depth, Chlorophyll a, Dissolved Oxygen, pH, Conductivity, Temperature, Turbidity	profile every 4 hours	
Meteorological Data	every 10 minutes	



CSI1 to CSI8, SCDA to SCDH

Number of points monitored: 16, 5 of which are in the southern basin

Responsible Entity: Community Science Institute (CSI), a private not-for-profit agency

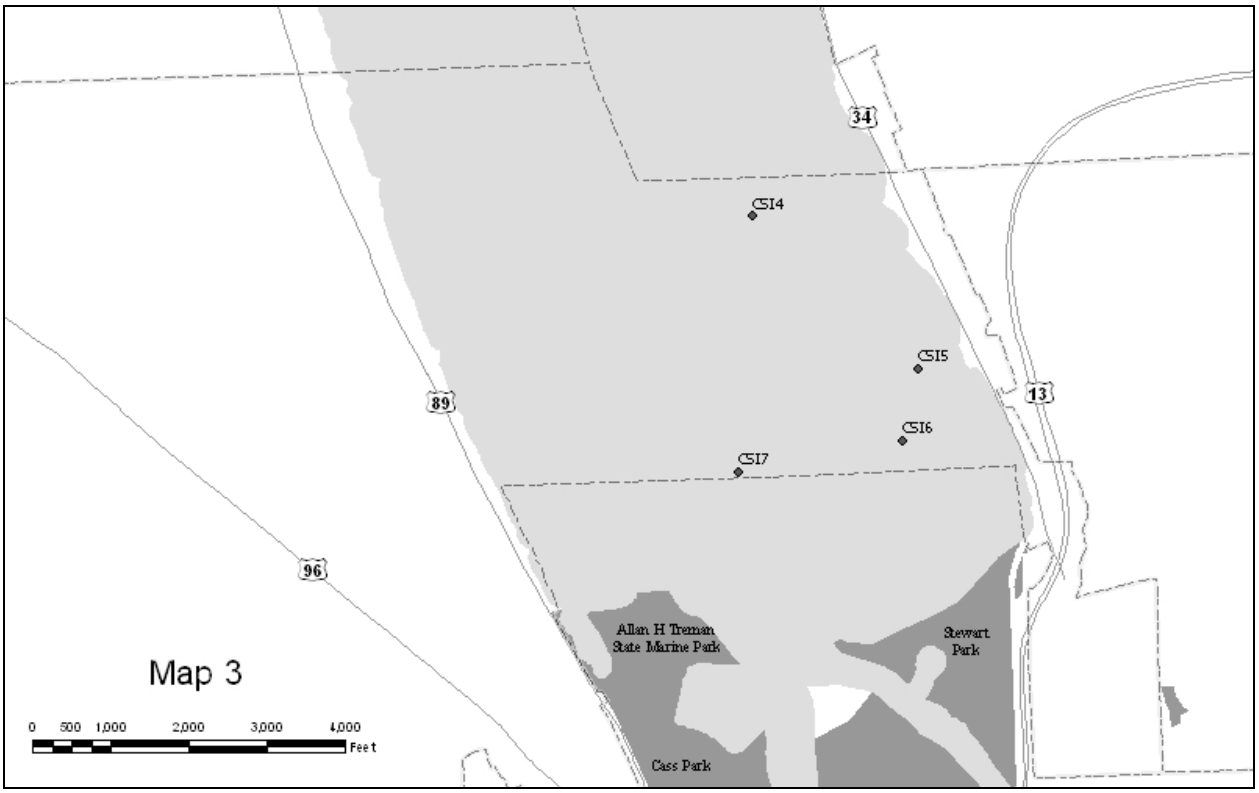
Location of Monitoring Points: One point at the City of Ithaca Wastewater Treatment Plant outfall, one at the Cayuga Heights Wastewater Treatment Plant outfall, one at the Lake Source Cooling outfall, one mid-lake near Indian Creek, and one at Stewart Park (Map 3). Several of these points overlap other monitoring efforts. Three points located near the Salmon Creek confluence with Cayuga Lake and eight points along the Cayuga Lake shoreline near Salmon Creek (SCDA to SCDH, Map 8).

Notes: CSI monitors these points using volunteers to collect samples and analyzes samples at their certified lab. CSI funding is dependent on contributions from multiple entities including several municipalities.

Recommendations: Continue this monitoring effort in the southern basin. Secure permanent funding.

Monitoring Details

Parameter	Frequency	Notes
Alkalinity, pH	twice a year	
Coliforms (EC and TC)	twice a year	
Total Hardness	twice a year	
Phosphorus (SRP and TP)	twice a year	
Turbidity, Secchi depth	twice a year	
Temperature	twice a year	
Dissolved oxygen	twice a year	
Chloride	twice a year	
Conductivity	twice a year	
Total nitrogen	twice a year	nitrite- + nitrite-nitrogen and total Kjeldahl nitrogen



COI1 to COI4

Number of points monitored: 4, none of which are in the southern basin

Responsible Entity: City of Ithaca

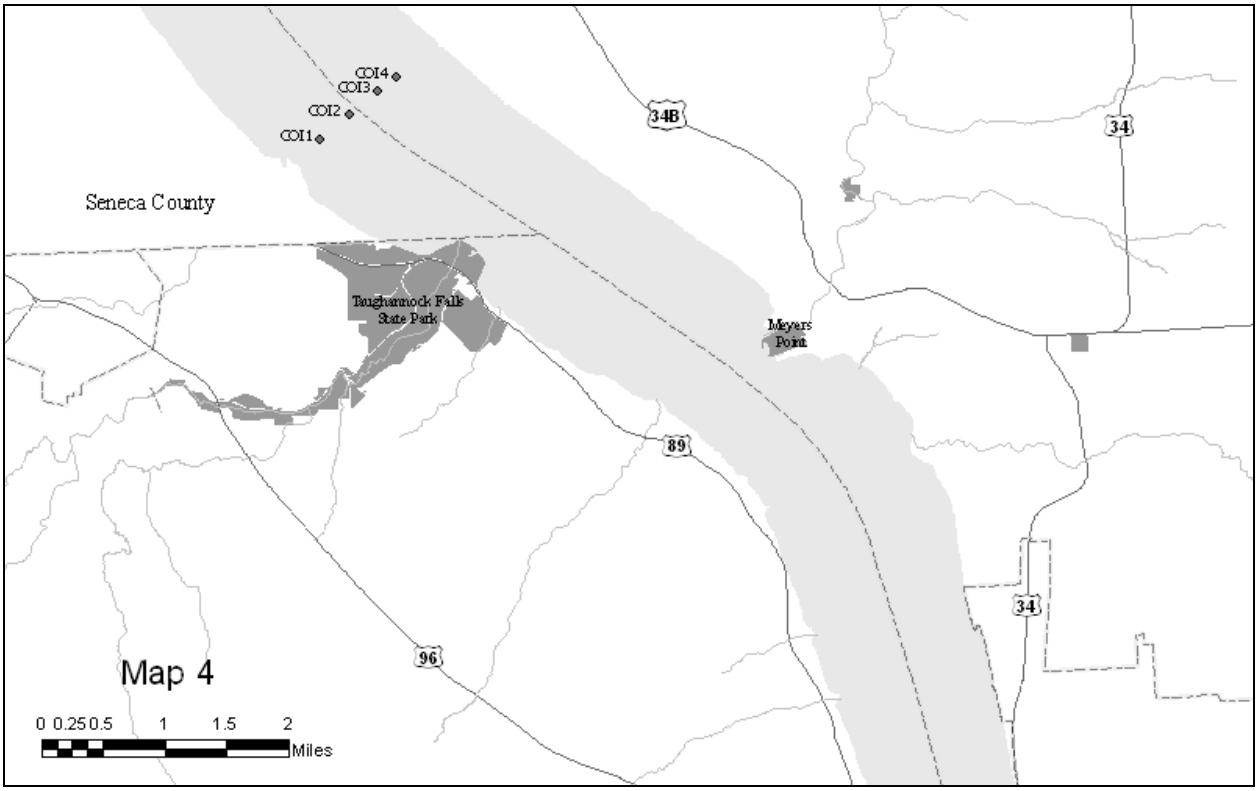
Location of Monitoring Points: These four points monitor an east-west cross-section of the lake, approximately two miles north of Taughannock Creek (Maps 4 and 8).

Notes: The City has received grant funds to monitor these points. These data have been used as a main lake reference set.

Recommendations: None.

Monitoring Details

Parameter	Frequency	Notes
Coliforms (EC)	once a month	
Phosphorus (SRP)	once a month	
Phosphorus (TP)	once a month	
Sediment (TSS)	once a month	USGS method
Turbidity	once a month	
In-Situ Sensor Suite:	once a month	
Ammonia, Blue Green Algae, Chlorophyll a, Dissolved Oxygen, Nitrate, pH, Specific Conductivity, Temperature, Turbidity		



LSC1 to LSC8 and LSC-Int

Number of points monitored: 9, 7 of which are located in the southern basin

Responsible Entity: Cornell University, Lake Source Cooling Permit

Location of Monitoring Points: Four points along a one-mile stretch mid-lake, stretching north from the City boundary (points LSC2, LSC3, LSC5, LSC6, from south to north). A cross-lake transect lies just north of the outfall of the cooling plant (LSC1, LSC4 which form an east to west transect with LSC3 in the middle)). There is an additional point south of the outfall (LSC7). LSC1 through LSC 7 are shown on Map 5. The other two monitoring points are located at the cooling plant's intake (LSC-Int) and at a point mid-lake opposite Taughannock Creek (LSC8) (Map 8).

Notes: Partnership

Recommendations:

LSC1 Continue to monitor in the short term. Compare monitoring results with the results from point P1.1 and from E2 (Map 7). If appropriate, phase out monitoring effort in favor of point P1.1. Add Coliforms (FC) and Sediment (TSS).

LSC2 This point is close to point WW3 (Map 6). Phase out monitoring effort in favor of point WW3. Monitor every month and add Coliforms (FC) and Sediment (TSS).

LSC3 This point is close to point WW14 (Map 6). Phase out monitoring effort in favor of point WW14. Monitor every two months and add Coliforms (FC) and Sediment (TSS).

LSC4 Continue to monitor in the short-term. Compare monitoring results with the results from point P4.1 and from E8 (Map 7). If appropriate, phase out monitoring effort in favor of point P4.1.

LSC5 Continue to monitor this point. Add Dreissenidae monitoring once per year.

LSC6 Continue to monitor this point. Add Dreissenidae monitoring once per year.

LSC7 Continue to monitor this point to better understand existing water quality issues. Monitoring efforts may be coordinated with CSI. Locate the ADCP unit here to help understand the situation.

LSC8 This point overlaps monitoring efforts by DEC and the Finger Lakes Institute. Coordinate monitoring with one of these entities or with the City of Ithaca (Map 8).

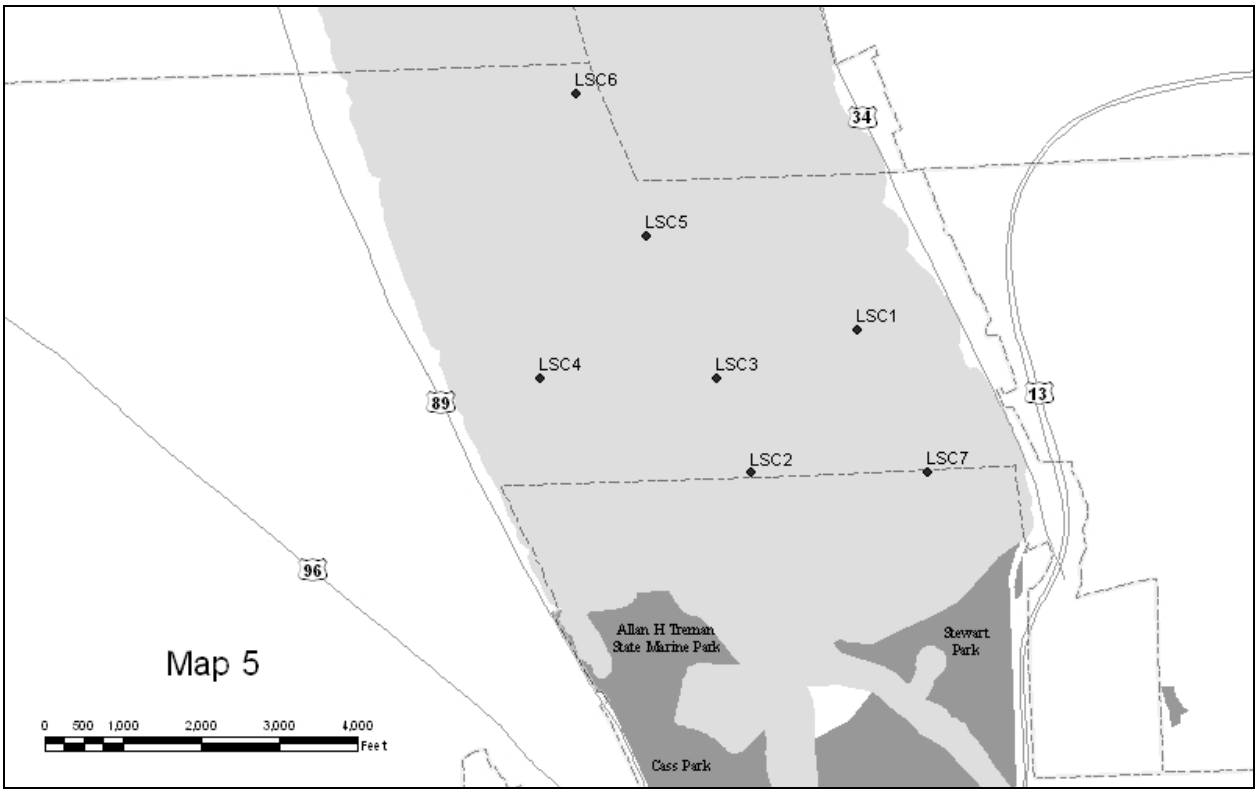
LSC-Int Continue to monitor this point. Add Dreissenidae monitoring once per year.

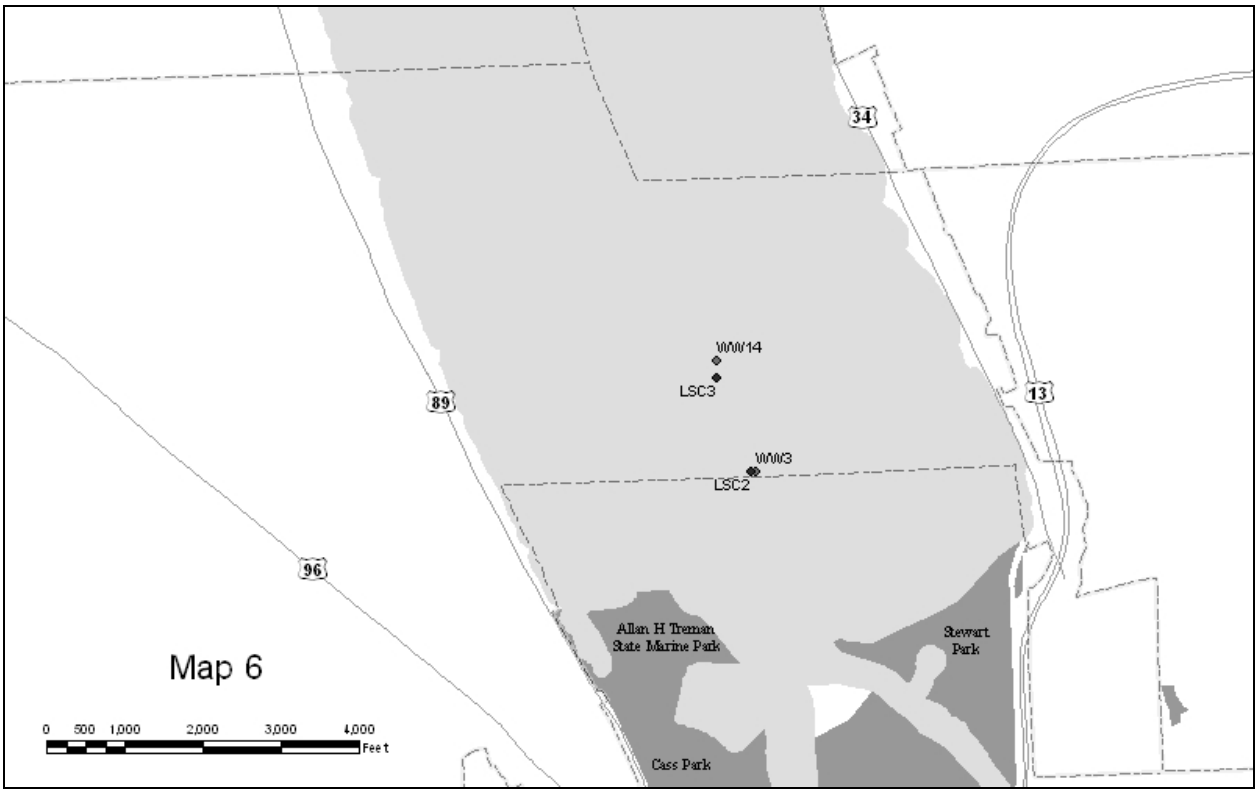
Monitoring Details (other than LSC-Int)

Parameter	Frequency	Notes
Alkalinity	monthly	long-term: 4/year
Hardness	monthly	long-term: 4/year
Phosphorus (SRP)	monthly	long-term: each 2 months at LSC1 and LSC3; monthly at LSC2, otherwise 4/year
Phosphorus (TP)	monthly	long-term: each 2 months at LSC1 and LSC3; monthly at LSC2, otherwise 4/year
In-Situ Sensor Suite Chlorophyll a, Dissolved Oxygen, pH, Specific Conductivity, Temperature, Turbidity	monthly	long-term: each 2 months at LSC1 and LSC3; monthly at LSC2, otherwise 4/year; (depending on which sensor suite used this list may vary)

Monitoring Details (LSC-Int)

Parameter	Frequency	Notes
Phosphorus (SRP)	4/year	
Phosphorus (TP)	4/year	
Sediment (TSS)	4/year	
Toxics	every 2 years	completed 2/08, due 2/10





P1.1 and P4.1

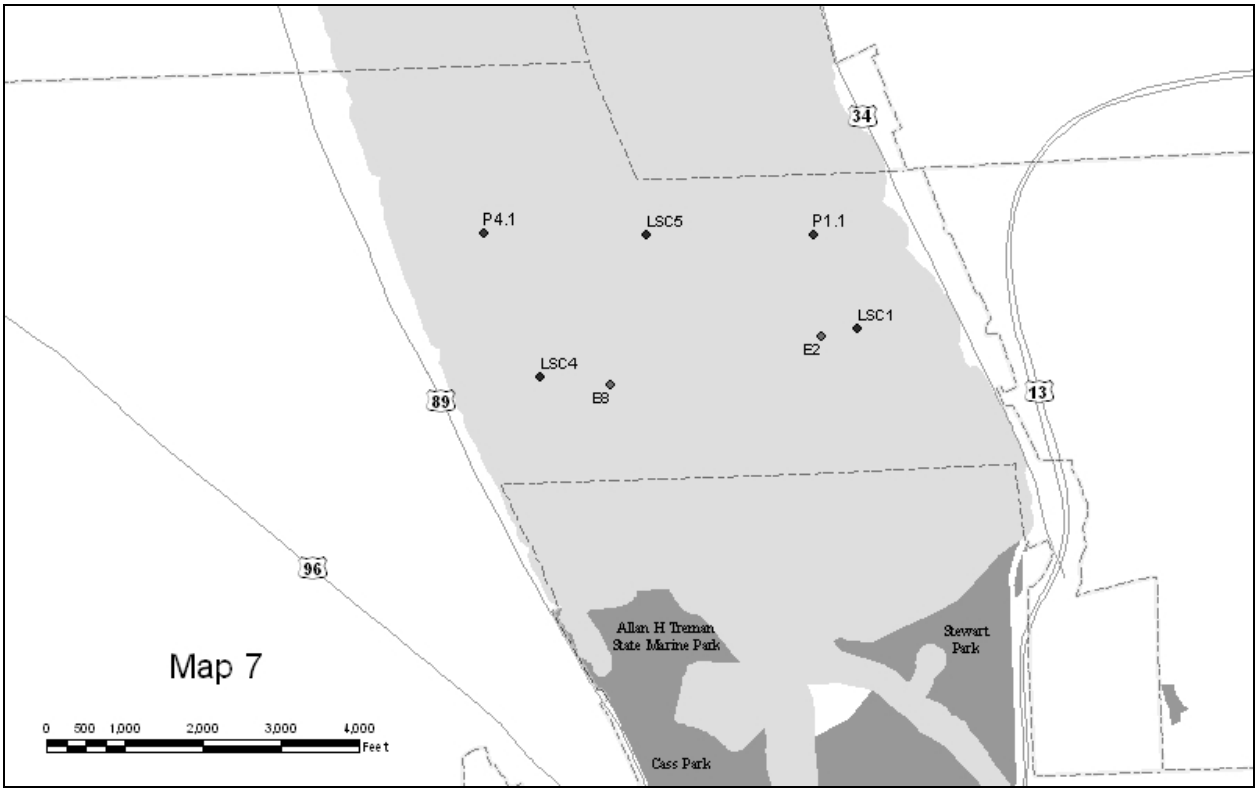
Number of points monitored: None, proposed new points

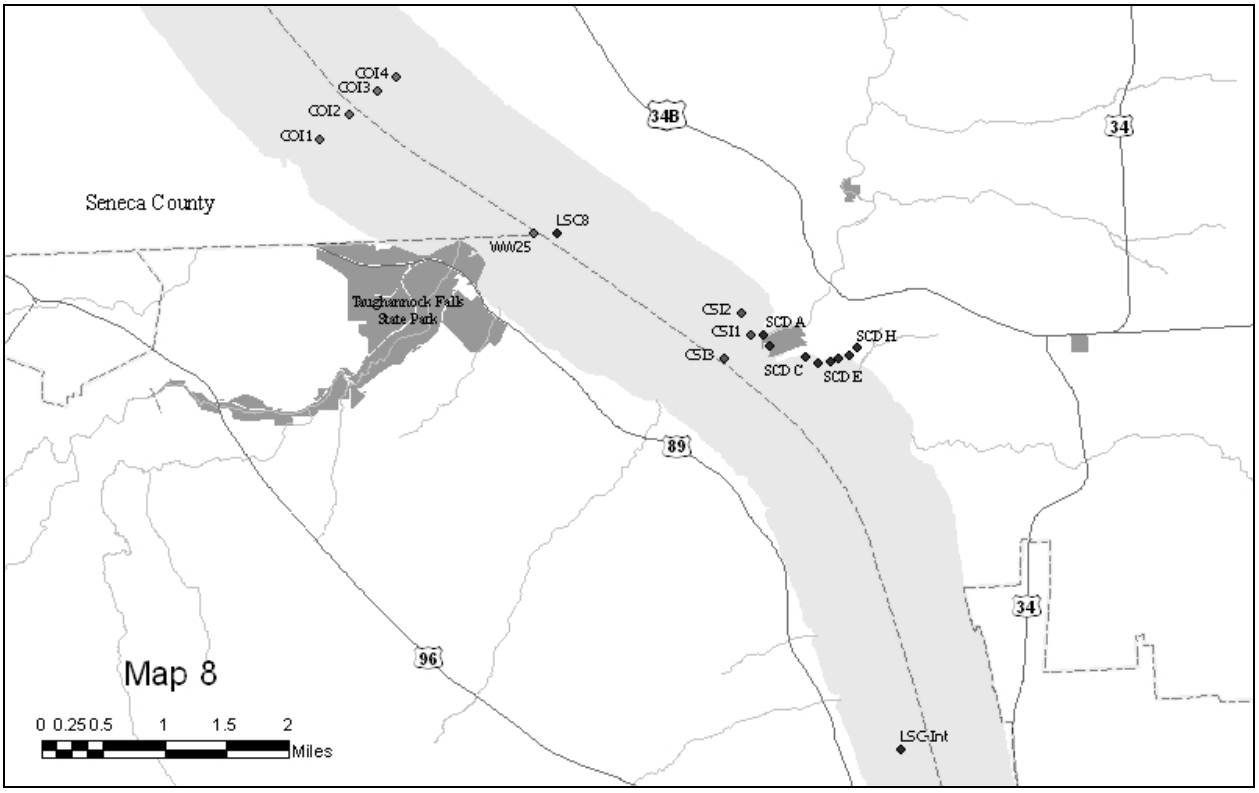
Responsible Entity: Partnership

Location of Monitoring Points: On the shelf break, north of LSC1 and north of LSC4 (Map 7).

Notes: The purpose of these two monitoring points is to gain a better understanding of what happens at the shelf break – where the shallow and deep portions of the lake meet.

Recommendations: Compare monitoring results with the results from points LSC1, LSC4, E2, and E8. If appropriate, phase out monitoring efforts of points LSC1 and LSC4. Appropriate means that P4.1 continues to act as well or better than LSC4 as an on-shelf reference site and P1.1 continues to be in the standard lake-circulation pattern down-current location of the LSC outfall.





Monitoring points located at deep lake locations.

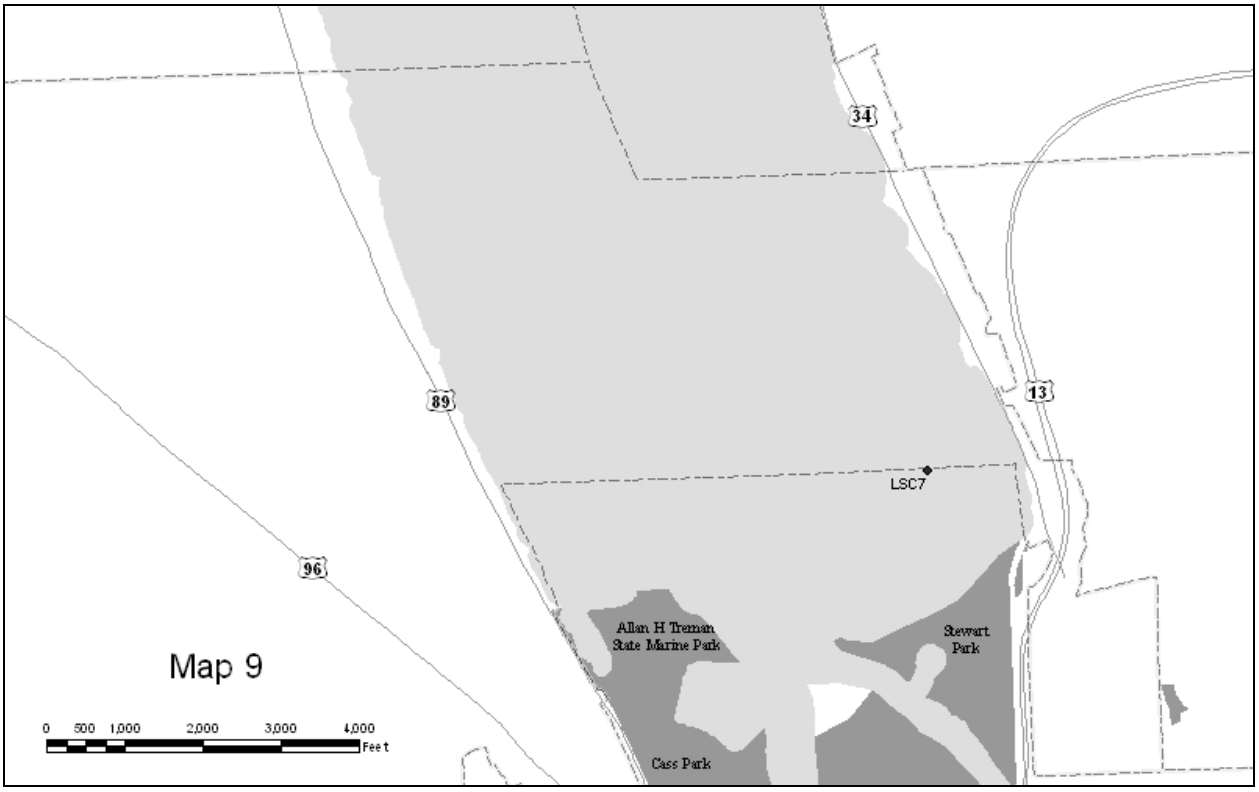
SPECIAL STUDIES

Acoustic Doppler Current Profiler

The Acoustic Doppler Current Profiler (ADCP), owned by Cornell University, is a movable unit that can monitor the vertical profile of at a specific point, aiding in understanding the circulation patterns within the lake. An understanding of lake circulation patterns will help build knowledge of how the lake functions, the transport and fate of point source and non-point sources outfalls, aid in stormwater management, and support possible TMDL regulations.

The Partnership proposes to deploy the unit to develop a better understanding of the lake. The first location to be monitored should be near monitoring point LSC7 (Map 9). In the alternative, the ADCP could be deployed at existing outfalls.

The ADCP unit will provide continuous monitoring of velocity profiles. It may be useful for assessing suspended sediment levels in a basic way as its signal strength is correlated with suspended sediment levels in a complex manner.



Food-web Monitoring

Existing monitoring efforts focus largely on monitoring chemical and physical characteristics of the lake. Our understanding of the overall health of the lake will be improved by looking at the Lake's food web, with a focus on organisms (e.g., Dreissenid mussels, alewife and grazing zooplankton) that can have major, "top down" influence on water clarity.

Macrophytes

Macrophytes are plants large enough to be seen by the naked eye. Their presence in the lake has raised aesthetic and recreation concerns, though many native macrophytes thrive in clear water conditions that are a sign of improving water clarity. These plants also provide key habitat for native fish and a food resource for migrating waterfowl. For about 15 years (from 1987 through 2001), data were collected to monitor the biomass of macrophytes at eleven locations in the south end of the lake. It is important to maintain an annual program to identify macrophyte species and measure the biomass of these species at the time of peak plant production each year. Replicate should therefore be collected along both the east and west sides of the southern shore of Cayuga Lake during the month of August.

Mysis relicta

Mysis relicta (common name: opossum shrimp), a species in the middle of the food web, on which larger fish depend, is an important component of the Cayuga Lake ecosystem. A program should be developed to monitor *Mysis relicta* abundance in order to better understand the population dynamics of this key organism. An acoustic (sonar) survey along a defined lake transect should be undertaken on a regular basis.

Diporeia

Diporeia is a tiny shrimp-like organism that lives in the bottom mud and relies on settling algae as a source of food. This invertebrate is another key component of the Cayuga Lake food web that is preyed upon by many native fish predators, yet has rarely been considered in previous studies of Cayuga Lake resources.

Dreissenidae

Dreissena are non-native mollusks, often referred to as zebra and quagga mussels, that have a large influence on water clarity due to their ability to filter large volumes of water as they consume algae that sustain their growth and survival. The European natives were first introduce to Cayuga Lake in the early 1990s, shortly after colonizing the Great Lakes. Annual surveys of settled adult mussels should be conducted according to a stratified (by depth) random sampling design. In addition, larval Dreissenid abundance should be surveyed annually in August zooplankton tows

Plankton

Plankton are the floating or weakly swimming animal and plant organisms that dominate open-water lake food webs; they often are microscopic in size. Twice each year, in May and August, vertical plankton tows should be collected at two sites (possible current LSC3 and LSC5) and at LSC-Int. Zebra mussel veligers should be counted in the August samples.

Fish

Alewives serve as prey for sport fish (trout, salmon) and, in turn, prey on zooplankton that have a large influence on the abundance of free-floating algae (phytoplankton). Alewife populations undergo large fluctuations in abundance, therefore if is important to conduct annual surveys of Cayuga Lake alewife population abundance and size structure. These acoustic (sonar) surveys would be conducted according to procedures developed by Cornell faculty (Rudstam) that have been implemented in previous surveys of Finger Lake alewife populations.

Lake trout and landlocked salmon are the native top fish predators in Cayuga Lake, therefore it is important to conduct annual short-term, fine mesh gill net surveys of the abundance of these populations. These non-lethal surveys would be implemented annually in May according to procedures developed and implemented by Cornell faculty (Kraft) in Adirondack surveys of lake trout and salmon abundance (e.g. according to a randomized stratified sampling design).

Also, annual shoreline electro-fishing surveys of near-shore fish abundance should be conducted. These surveys would be implemented annually in July according to a randomized stratified sampling design.

Sediment Transport

Suspended sediment that is transported by streams into the southern end of Cayuga Lake has an important impact on water quality. However, few data are available to identify the sources and the amounts of sediment that are fed into and circulating within the lake.

Determining sediment load that is transported by tributaries will require measurements closely spaced in time of both flow and sediment load during storm events. Stream gages are in place in several major tributaries, but temporary gages will need to be installed and operated in those tributaries that are without a gage or where the existing gage is not situated appropriately for evaluating sediment trasnport.

The turbidity plumes that circulate in the shallow southern shelf could be recorded by time-sequenced satellite imagery. As the plumes enter the deeper lake basin, they would be unable to be traced using imagery. Instead, they could be traced using spectroscopic turbidity measurements or potentially the ADCP used in what is known as bottom tracking mode. Turbidity plumes would need to be traced for several storm events.

STREAM MONITORING

Many input influence the Cayuga Lake system, including direct rainfall on the lake, runoff from the surrounding landscape, streams carrying water from the entire watershed, and human-made inputs, such as the Ithaca Area Wastewater Treatment Plant, the Cayuga Heights Wastewater Treatment Plant, and the Lake Source Cooling Facility. Current in-lake monitoring efforts prioritize understanding the impact of human-made inputs to the system.

However, by sheer volume alone, the streams that enter the southern end of Cayuga Lake are the dominant source of water, sediments and other materials into Cayuga Lake. The major streams entering the southern basin of Cayuga Lake are [from west to east] Taughannock Creek, Cayuga Inlet, Six Mile Creek, Cascadilla Creek, Fall Creek, and Salmon Creek.

Some monitoring efforts in these Cayuga Lake tributary streams are already underway.

For example, the US Geologic Survey (USGS) maintains gages on Fall Creek, Cayuga Inlet, and Six Mile Creek. The gages on Fall Creek and Cayuga Inlet provide flow information. The gages on Six Mile Creek provide loading information for sediment and other potential water quality parameters of interest as well as flow information.

There is a proposal in formative stages to install a gage on Cayuga Inlet similar to the one on Six Mile Creek. Such a gage will help enormously in understanding water quality in Cayuga Lake as well as the Cayuga Inlet watershed and should be vigorously pursued.

The Community Sciences Institute (CSI) manages a citizen monitoring effort in Cayuga Lake as well as in tributary streams. Continuing these efforts will provide two key benefits – providing additional data about the streams and building citizen stewardship of our community's water resources. CSI's programs provide a low-cost early warning system for problems and trends.

The biggest obstacle to expansion of stream monitoring efforts is the lack of regular funding. CSI's program is the most cost-effective, given its use of trained volunteer citizens in collecting water samples. However, laboratory costs for analyzing the samples are substantial. CSI has been working to develop funding sources from local municipal governments as well as others. These requests should be given high consideration.

OUTREACH

An important element of this Monitoring Plan is the recognition of the need to look beyond the individual scientific efforts to monitor Cayuga Lake resources. On important step is for the monitoring partners to share information among themselves. This sharing of data can serve as an important source of information to help identify key linkages between various aspects of the Cayuga Lake ecosystem. And also provide an opportunity to evaluate each other's observations.

While these scientific studies and data-sharing efforts are essential to our effort, they are not sufficient to address community interest and concerns. Information from these research efforts need to be available for review by members of the local community who are interested in taking action to improve Cayuga Lake water quality and other lake resources. This Plan recommends several important steps to improve outreach efforts.

Data-Sharing

A central location must be available for sharing historical and ongoing monitoring data, findings, and reports. Develop or expand an existing website for this purpose. For example, the website http://www.cayugalake.cornell.edu provides near real-time meteorological data from the RUSS unit. Also, CSI has a website where they post their data: http://www.communityscience.org/. CSI and the RUSS site hosts have expressed a willingness to consider porting data. Also, the Cayuga Lake Watershed Network and Cornell University Mann Library are discussing options for posting and sharing of local data. The Partnership plans to work with the monitoring associates, Intermunicipal Organization, and the Cayuga Lake Watershed Network to develop a protocol for and an agreement to support this effort. The next step would be to investigate periodic analysis and summarization of the regional data.

Existing Lake Proponents

Two existing organizations have a strong interest in and focus upon water quality issues in the Cayuga Lake watershed: the Cayuga Lake Watershed Network (CLWN) and the Cayuga Lake Intermunicipal Organization (CLIO).

The CLWN is an important partner with which to work to share information about the Plan and results of the monitoring efforts with a broad audience. The CLWN can help with news articles, coordination of public meetings, and other outreach efforts. The CLIO is, as the name suggests, an organization representing municipalities in the Cayuga Lake watershed. The CLIO can encourage municipalities to develop policies and fiscal support for a coordinated science-based approach to resource management.

In recent months, the CLWN and CLIO have developed a Monitoring Guidance Document to support monitoring efforts throughout the watershed. Monitoring efforts promoted by the Plan should support the policies espoused in the Guidance Document.

Floating Classroom

The Floating Classroom provides a mobile shipboard classroom that raises awareness and appreciation of Cayuga Lake through a hands-on experience. Floating Classroom efforts could be expanded to include public cruises featuring local researchers and presenting monitoring results. The CLIO, CLWN, Cayuga Wooden Boatworks, Wells College, Cornell University, Tompkins-Seneca-Tioga BOCES, and professional educators support the Floating Classroom program.

Finger Lakes Institute

The Finger Lakes Institute takes a multiple watershed view and makes available to the public research conducted by John Halfman, Ph.D of Hobart & William Smith College. It is important for the Partnership and monitoring associates to use this resource to help understand if our data represent local phenomena or are indicative of broader ecological trends. The Partnership will maintain a dialogue with the FLI researchers to share findings.