New York State
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Water

New York
Citizens Statewide Lake Assessment Program
(CSLAP)

2009 Downstate
Region Report

New York State
Department of Environmental Conservation

2009
DOWNSTATE REGION REPORT

NEW YORK
CITIZENS STATEWIDE
LAKE ASSESSMENT PROGRAM
(CSLAP)

Scott A. Kishbaugh, PE

NYS Department of Environmental Conservation
NY Federation of Lake Associations

June, 2010

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Acknowledgments

The Citizens Statewide Lake Assessment Program (CSLAP) is a volunteer lake monitoring program conducted by the NYS Department of Environmental Conservation (NYSDEC) and the NYS Federation of Lake Associations (FOLA). Founded in 1986 with 25 pilot lakes, the program has involved nearly 230 lakes, ponds, and reservoirs and 1,500 volunteers from eastern Long Island to the northern Adirondacks to the western-most lake in New York, and from 10-acre ponds to several Finger Lakes, Lake Ontario, Lake George, and lakes within state parks. In this program, lay volunteers trained by the NYSDEC and FOLA collect water samples, observations, and perception data every other week in a 15 week interval between May and October. Water samples are analyzed by certified laboratories. Analytical results are interpreted by the NYSDEC and FOLA and utilized for a variety of purposes by the State of New York, local governments, researchers, and, most importantly, participating lake associations.

The author wishes to acknowledge the following individuals, without whom this project and report would never have been completed:

From the Department of Environmental Conservation, Margaret Novak and Glenn Milstrey for on-going support of the program; Jay Bloomfield and James Sutherland, for their work in developing and implementing the program, and the technical staff from the Inland Lakes and Freshwater Section, and the Statewide Waters Monitoring Section, for continued technical review of program design.

From the Federation of Lake Associations, Nancy Mueller, Dr. John Colgan, Don Keppel, the CSLAP Committee, and the Board of Directors, for their continued strong support of CSLAP.

The New York State Department of Health (prior to 2002) and Upstate Freshwater Institute (since 2002), particularly Steve Effler, MaryGail Perkins, and Elizabeth Miller, provided laboratory materials and all analytical services, reviewed the raw data, and implemented the quality assurance/quality control program.

Finally, but most importantly, the authors would like to thank the more than 1,500 volunteers who have made CSLAP a model for lay monitoring programs throughout the country and the recipient of a national environmental achievement award. Their time and effort have served to greatly expand the efforts of the state and the public to protect and enhance the magnificent water resources of New York State.

Chapter 1- Background

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There is a long history of water quality monitoring programs in New York state, starting with the State Conservation Department (predecessor to the New York State Department of Environmental Conservation, or NYSDEC) biological surveys from the 1920s and 1930s, The Adirondack Lake Survey Corporation (ALSC) involved a study of more than 1500 lakes in the Adirondacks, Catskills and surrounding areas primarily for evaluation of lake acidification in the 1980s. The NYSDEC Lake Classification and Inventory (LCI) survey has sampled more than 200 lakes 1-4x since the early 1980s. There have also been several academic and private studies of lakes throughout the state.

However, none of these programs conducted multi-year sampling at a frequency or duration capable of evaluating changes imposed by weather, by season, or by trends, and none of these programs looked at the rest of the more than 7500 lakes in the state. Perhaps most importantly, most of these programs were not directed toward the large number of lakes used daily by active lake communities, and none of these programs took advantage of the local knowledge and experience gained by lake residents observing first-hand the daily and generational changes in their lakes. These datasets were vitally important to gaining an understanding of what makes New York lakes tick, but they weren't enough.

In 1985, NYSDEC staff proposed the development of a volunteer monitoring program, referred to as CSLAP—the Citizens Statewide Lake Assessment Program. NYSDEC Commissioner Henry Williams committed full support for CSLAP, but efforts to secure funding for implementation were unsuccessful. In his 1986 State of the State address, New York State Governor Mario M. Cuomo provided his endorsement:

> " .. I propose creating a program within the Department of Environmental Conservation
> to use trained volunteers to collect information on the State's water bodies.
> With this information, the Department can more effectively
> manage and protect our invaluable water resources."

With this endorsement and the support of several organizations, New York State developed a volunteer-based monitoring program, adapted from models successfully developed in Vermont, Maine, Minnesota and Illinois. The New York State Citizens Statewide Lake Assessment Program (CSLAP) was established in 1985 by Jim Sutherland and Jay Bloomfield from the NYSDEC as a cooperative program between the DEC and the NY Federation of Lake Associations (NYSFOLA), a non-profit coalition of lake associations, individual citizens, park districts, lake managers, and consultants dedicated to the preservation and restoration of lakes and their watersheds throughout the state. CSLAP was founded with three primary objectives:

- collect high quality lake data
- identify lake problems and water quality trends
- educate the public about lake stewardship

The pilot began with a small ($80,000) grant awarded to NYSFOLA to fund the purchase of sampling equipment, sample analysis, and the hiring of a CSLAP Program Coordinator in late

1985. NYSFOLA, via then President Jack Colgan, were instrumental in securing the grant and generating an interested pool of lake associations and volunteers for the program. The NYSDEC Program Coordinator was charged with identifying pilot candidate lakes (in concert with NYSFOLA), developing the sampling protocol, ordering equipment and supplies, establishing on-site training schedules, creating sampling kits, and setting up contracts with the New York State Department of Health (NYSDOH) inorganics laboratory to receive and analyze samples, and with the U.S. Postal Service to ship samples. The 25 lakes included in the pilot program were solicited from the NYSFOLA membership pool, and intentionally included a mixture of private and public lakes; lake associations, fish and game clubs, and park districts; small ponds and large lakes; and lakes from downstate to the western boundary of the state.

In the last 24 years, nearly 230 lakes, ponds, and reservoirs have been sampled through CSLAP, some continuously since 1986 and most for a much shorter duration. The following report summarizes the water quality data from the 110 lakes sampled through CSLAP in 2009, and broadly summarizing the 2009 data in the context of data collected through CSLAP from 1986 to 2009. A much more detailed summary of the CSLAP data for the first twenty five years of the program will be included in a 25 Year Summary report expected to be completed in 2011, after the 25th year of CSLAP sampling in 2010.

Chapter 2 CSLAP Statewide and Regional Reports

Chapter 2.1 Introduction to Regional Summaries

Chapter 2.2 CSLAP Lakes in the Western Region Sampled in 2009

Chapter 2- CSLAP Statewide and Regional Reports

CSLAP data and interpretive summaries have been provided to CSLAP lake associations—the sampling volunteers and other lake residents, NYSDEC staff, sponsoring organizations—county planning departments and park districts—and other interested parties as annual reports after each year of sampling. From 1986 to 1995, these annual reports were constructed in a format roughly equivalent to the format outlined here—a general compendium summary of water quality conditions and special study results across the state, with a short and abbreviated synopsis of results from each sampled lake. Regional and trend analyses were limited in part by the relative lack of data, although some trend analysis was conducted on individual lakes with multiple years of data. In 1991, the NYSDEC began developing Five Year Reports for a select number of CSLAP lakes, in anticipation of more detailed lake and watershed analysis of CSLAP data, but these were curtailed after only a few reports had been completed, largely because these were deemed unsustainable.

Starting in 1996, the report format changed from a statewide report to more detailed summaries of individual program lakes, with more limited discussion of statewide conditions. In the reports prior to 1996 and in subsequent years, most statewide summaries consisted of compendia of individual lake results and trends. The typical individual lake report ranged from 50 pages (in the mid 1990s) to 100 pages (in the mid 2000s). Although the general format stayed the same from 1996 to 2008, additional lake background information was added every year or two to supplement the CSLAP database, particularly in the last several years. This included information about regulated activities in the area around the lake and a compendium of other state water quality data for the lake in 2005, information about fish stocking, fisheries regulations, and fish consumption advisory information, site location maps, information about rare, threatened, or endangered plant species in lake, and detailed discussions about lake use impacts and their implications for the state Priority Waterbody List in 2006. The 2007 report included RIBS water quality monitoring data, more detailed discussions about weather patterns and the implications of these patterns for water quality conditions in NYS lakes, historical aquatic plant identifications, more detailed discussions of nitrogen trends, and expanded exotic plant distribution maps. The 2008 CSLAP report included more detailed discussions about the connection between precipitation and water quality in CSLAP, and greater discussion about changes in water temperature and the potential connection between these findings and larger global climate change, an expanded discussion of most of the CSLAP sampling parameters, focusing on an "outstanding" question associated with each (usually in response to findings within the last few years), and a more detailed "So What Have We Learned Through CSLAP" section. By the time of the 2008 reports, the breadth of discussion and analysis far exceeded the information conveyed in the original Five Year Summary reports, although one of the key components of the Five Year reports—desktop nutrient budgets—had not yet been incorporated into the individual CSLAP lake reports by 2008.

Most of these reports were provided in paper format to the primary CSLAP sampling volunteer prior to the mid 2000s, but in the last several years have been issued primarily in electronic (PDF) format. In addition, the last several PDF reports are posted on the NYSFOLA website at www.nysfola.org, under the New York State Lake Association List directory. Reports have also been provided, primarily in electronic format, to DEC Regional staff and select county agencies.

Chapter 2.1- Introduction to Regional Summaries

The 2009 CSLAP Annual Report is divided into a single statewide report and four regional reports. These broad geographic categories are a modification of the statewide regional breakouts summarized in extensive detail in the 2nd Edition of *Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management*, but can be summarized here as follows:

1. **Downstate Region**- covers the two Long Island counties, the five counties constituting the boroughs of New York City, and the area on both sides of the Hudson River between New York City and the Central region, defined by the northern border of Sullivan, Ulster, and Dutchess Counties.

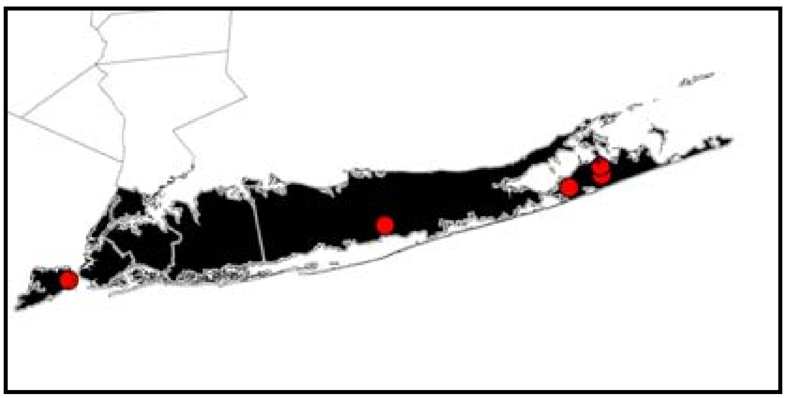


Figure 2.1.1 – Location of CSLAP Lakes in the Long Island/NYC portion of the "Downstate" region

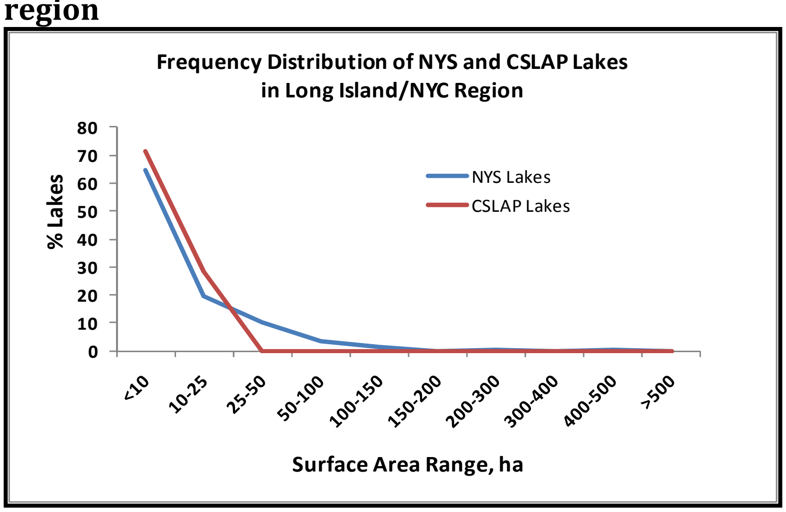


Figure 2.1.2 - Distribution of NYS and CSLAP Lakes in the Long Island/NYC portion of the "Downstate" region

Within the Long Island "sub" region, all but the eastern portion of this region is highly urbanized, and most (but not all) of the lakes are shallow, small and primarily support aquatic life, angling, and aesthetics. Most of these urban lakes do not support contact recreation or potable water use. 5 CSLAP lakes have been sampled among the approximately 150-200 lakes in Long Island (the named waterbodies greater than 2.6 hectares in surface area), or about 3% of the lakes. Within the New York City region, only one lake (from Staten Island) is sampled through CSLAP; this represents about 8% of the lakes in the five county region.

The geographic boundaries and CSLAP lake distribution in the Long Island and New York City region are shown in Figure 2.1.1 and 2.1.2. Although there are a small number of CSLAP lakes in this region, the size distribution of these lakes is similar to the overall size distribution of lakes in the region. However, the CSLAP lakes in this region, like most of those in other regions, are represented by lake associations and do not closely resemble the sociological profile of the typical Long Island or New York City region lake (which include a large number of lakes in state, county, or town parks). Both the Long Island and New York City regions are underrepresented in CSLAP, although this is almost entirely due to the very small number of lake associations found in this area.

The "Downstate" portion of this region is highly suburbanized, particularly southeast of the Hudson, and becomes increasingly rural (with some agriculture) and forested in the northern stretches of the region. The southeastern portion is dominated by the New York City drinking water reservoirs, which comprise the majority of the largest waterbodies, but the entire region is very lake rich and includes a large number of lake associations and park districts.

The geographic boundaries and CSLAP lake distribution in this "Downstate" portion of the region are shown in Figure 2.1.3 and 2.1.4. The highest percentage of CSLAP lakes in this region are found in the southeastern portion of the region—Westchester and Putnam Counties. The large number of Westchester County lakes in CSLAP originates in the active CSLAP sponsorship by the Westchester County Planning Department and the large number of lakes in this area. However, the large number of lakes in Orange and Sullivan Counties (are not well represented in CSLAP, again

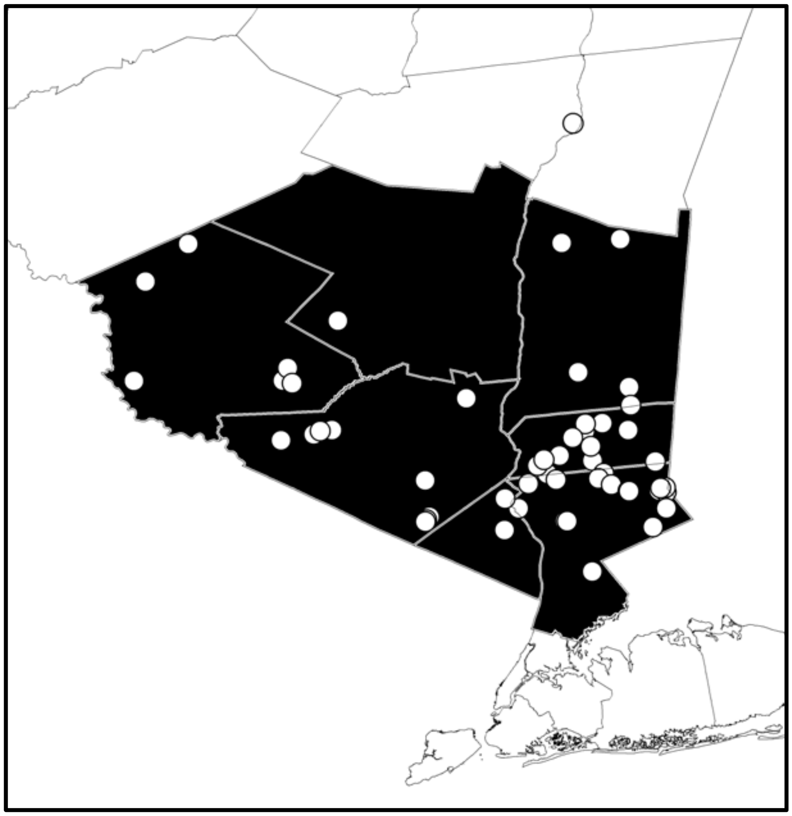


Figure 2.1.3 – Location of CSLAP Lakes in the northern portion of the "Downstate" Region

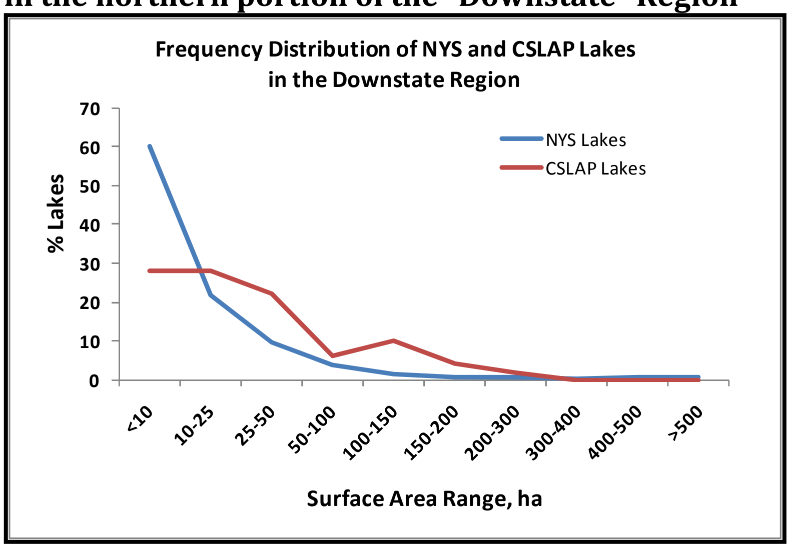


Figure 2.1.4 - Distribution of NYS and CSLAP Lakes in the northern portion of the "Downstate" Region

due in part to the small number of lake associations found in the NYSFOLA membership rolls).

None of the New York City reservoirs are sampled through CSLAP—these reservoirs are extensively sampled by the New York City Department of Environmental Protection, and none of the power generating reservoirs in the western areas are sampled, but many lakes within the watershed of these reservoirs (and thus subject to NYCDEP regulations) are sampled through CSLAP. A total of 54 CSLAP lakes have been sampled out of the approximately 800 lakes in this region, or about 7% of the lakes in the region. The CSLAP dataset includes a larger percentage of lakes between 10 and 300 hectares, particularly in the 10-50 hectare range, and a smaller percentage of lakes < 10 hectares in size. The latter range is generally underrepresented by lake associations and therefore in CSLAP.

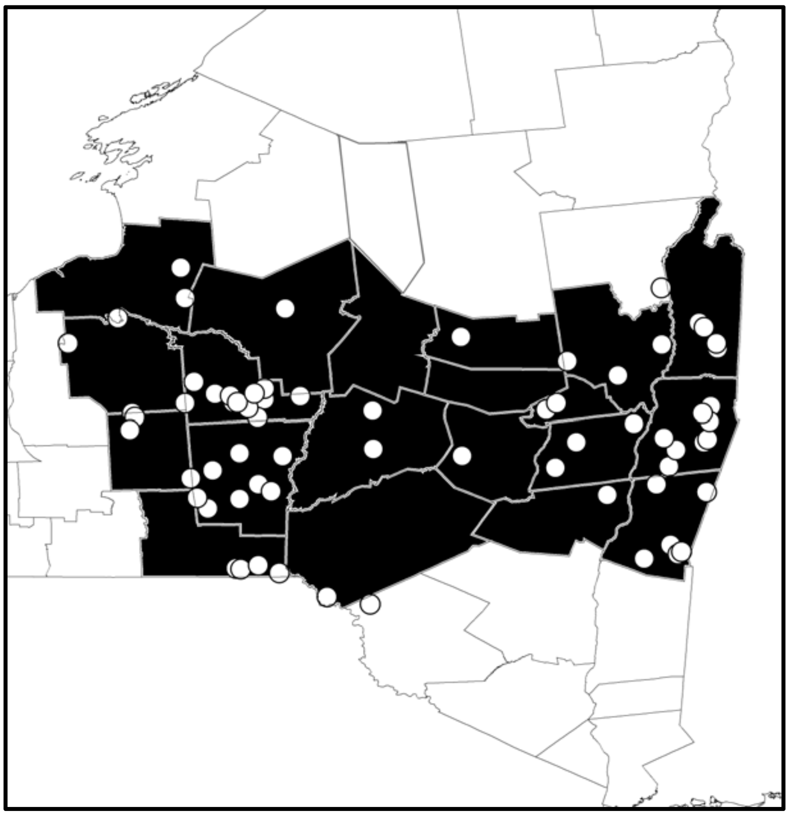


Figure 2.1.5 – Location of CSLAP Lakes in the Central Region

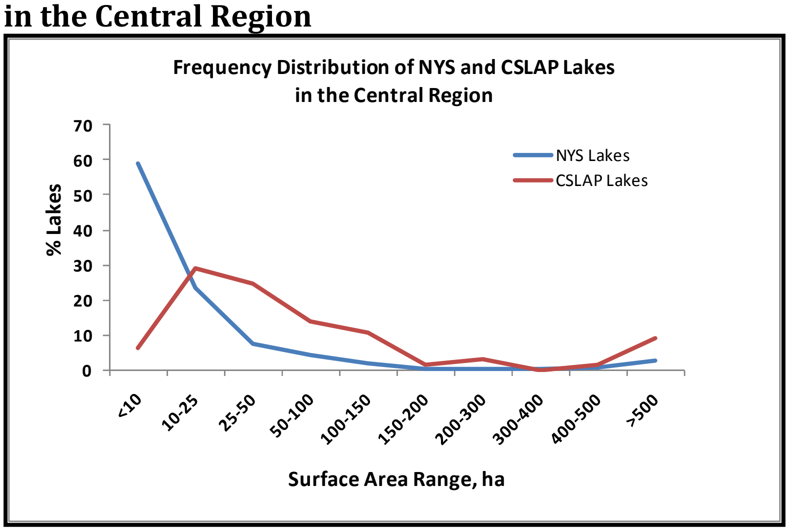


Figure 2.1.6 - Distribution of NYS and CSLAP Lakes in the Central Region

2. **Central Region**- this comprises the area between the Downstate, Adirondack, and Finger Lakes region, the latter two of which are well defined geographic areas. It is bounded on the south by the southern border of Delaware, Greene, and Columbia Counties, on the north by the southern edge of the Adirondack Park Boundary (the Blue Line), and to the west by the western border of Broome, Cortland, Onondaga, and Oswego Counties. The region includes a mixture of large and small, and shallow and deep lakes, although most of the lakes are in rural, forested areas, though mostly close to travel corridors and metropolitan areas. This region covers a large geographic area, but is not particularly lake rich, owing to the drainage areas dominated by the Hudson,

Mohawk, and Susquehanna Rivers. The highest density of lakes is generally found along the eastern and western portions of the region.

The geographic boundaries and CSLAP lake distribution in this region are shown in Figure 2.1.5 and 2.1.6. CSLAP lakes in the Capital District and along the eastern edge of the region—Columbia, Rensselaer and Washington Counties. There are relatively few CSLAP lakes in the interior portion of this region, an area also poorly represented by lakes and lake associations. This is also an area in which few invasive species have been reported—it is not known if the relative absence of lake associations is due to reduced impacts from exotic plants, or if the lack of invasive plant confirmations results from little surveillance from lake associations. As in most other New York state regions, there are a relatively small number of small (< 10 hectare) CSLAP lakes in the Central region, at least relative to non-CSLAP lakes in the region. This region also includes a slightly higher percentage of larger lakes, although these still comprise a small number of lakes in the region.

Approximately 600 lakes are found in this region; 66 of them have been sampled through CSLAP, approximately 11% of the lakes in the region.

3. **Adirondack Region-** this includes both the Adirondack Park region (defined by the Adirondack Blue Line, a geopolitical boundary codified in the state constitution) and the surrounding areas, particularly north to the U.S./Canadian border and west to the St. Lawrence River and the Indian River lakes region. This is among the most distinct of the New York state regions. The Adirondack region is as defined by lakes as any other geographic feature, and includes deep alpine and shallow wetland lakes, crystal clear lakes and dark tea colored ponds, and dammed rivers and power generating reservoirs to the west and south, and kettle ponds throughout the region. The diversity of lakes is enormous, but most tend to be highly rural and forested, with limited access. However, a large number of the larger lakes along the edge of region are heavily used by the public, due to state launch sites. There is a high density of lakes throughout the region, and many of the lakes are used for a variety of recreational purposes and serve as local water supplies.

The geographic boundaries and CSLAP lake distribution in this region are shown in Figure 2.1.7 and 2.1.8. This region also hosts a number of other volunteer monitoring programs, including the Adirondack Park Invasive Plant Program conducted by the Nature Conservancy of the Adirondacks, and the Adirondack Lake Assessment Program run by the Adirondack Watershed Institute of Paul Smiths College. These programs may draw some lakes out of CSLAP, particularly in the northern Adirondacks, although the APIPP program works closely with many CSLAP volunteers. Otherwise there is a wide distribution of CSLAP lakes throughout this region, with a particularly heavy concentration in the lake-rich areas of Warren, Franklin, and Fulton Counties, and large participation from the mix of deep and shallow lakes in the Indian River lakes region of northern Jefferson and southern St. Lawrence Counties.

The interior Adirondacks are not well represented in CSLAP. Many of these lakes are regularly sampled by the Hamilton County SWCD, and a large number of other lakes in this area do not support large populations or are otherwise not represented by lake associations. These lakes have also generally not suffered the water quality or invasive weed problems seen in much of the rest of the state, although this appears to be changing.

Figure 2.1.8 shows a very large number of small lakes not sampled through CSLAP—many of these are colored, acidic lakes sampled through the Adirondack Lake Survey Corporation study of >1500 high elevation lakes in the Adirondack and Catskill regions. Many of the larger, high profile, public access lakes within the Adirondack Park and Indian River Lakes region, particularly those in the 100-400 hectare range, are sampled through CSLAP. Of the approximately 2000 lakes in this region (named and larger than 2.6 hectares), 76 have been sampled through CSLAP, representing about 4% of the total number of lakes in the region.

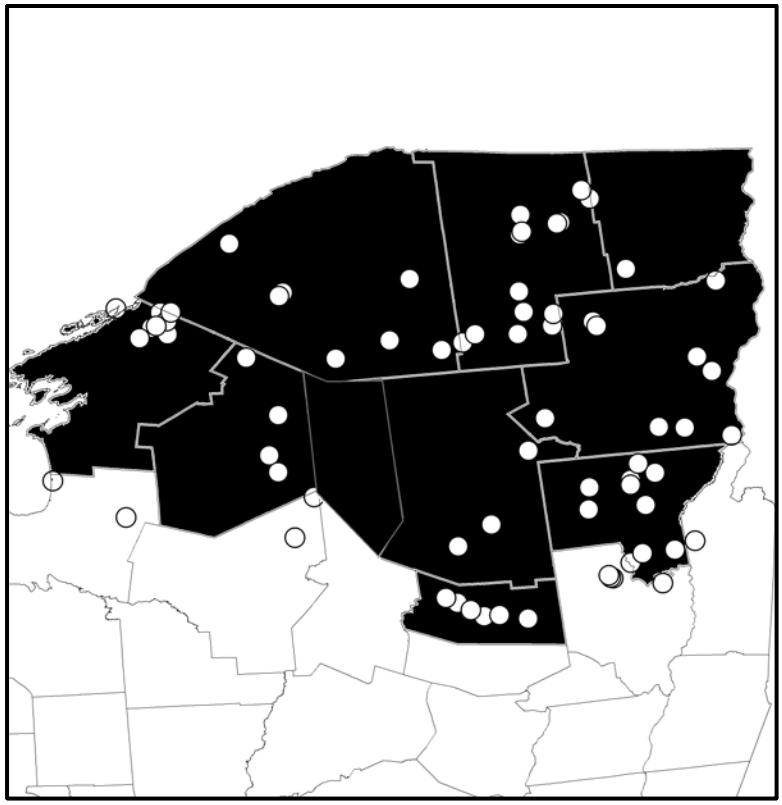


Figure 2.1.7 – Location of CSLAP Lakes in the Adirondack Region

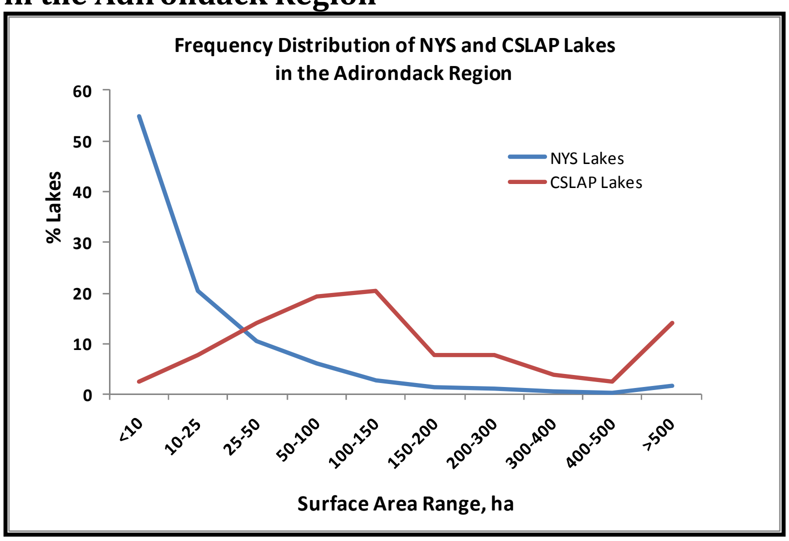


Figure 2.1.8 - Distribution of NYS and CSLAP Lakes in the Adirondack Region

4. **Finger Lakes and Western region**- this is comprised of the region bounded to the north by Lake Ontario, to the south and west by the Pennsylvania border, and to the east by "Central" region. This region can be subdivided into the Finger Lakes region, dominated by 11 very large north-south oriented very deep Finger Lakes, and the Western region, dominated by four very large lakes (Lake Erie, Lake Ontario, Allegheny Reservoir, and Chautauqua Lake). Most of the other waterbodies in the region are small and shallow, although there are also many enclosed embayments to Lake Ontario that otherwise are typical of many inland lakes. However, both the large and small lakes share many common problems and issues. Perhaps owing to the dominance of the Finger Lakes and the Great Lakes, this is not otherwise a very rich lake area.

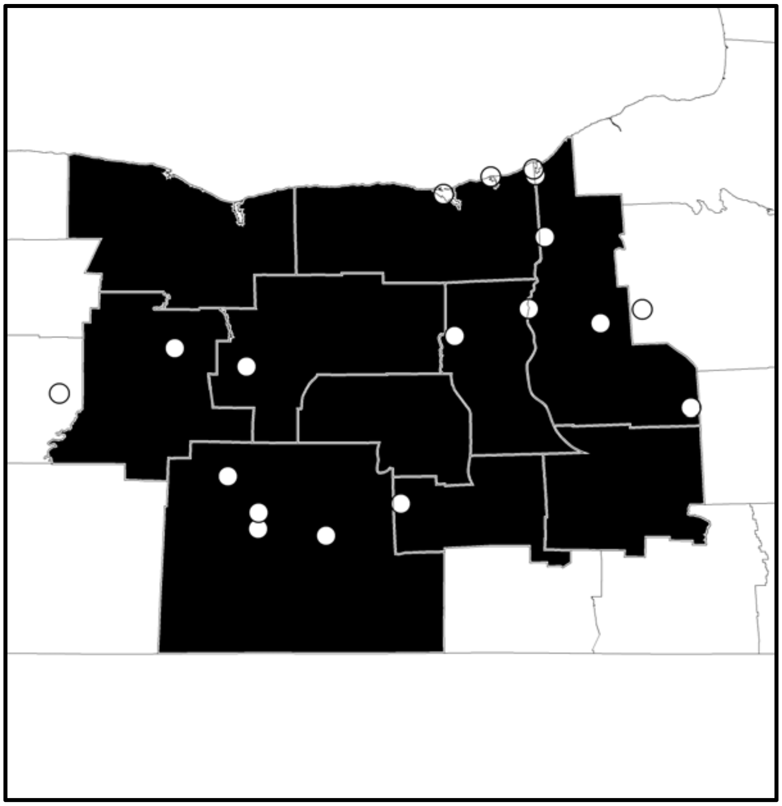


Figure 2.1.9 – Location of CSLAP Lakes in the Finger Lakes portion of the Western Region

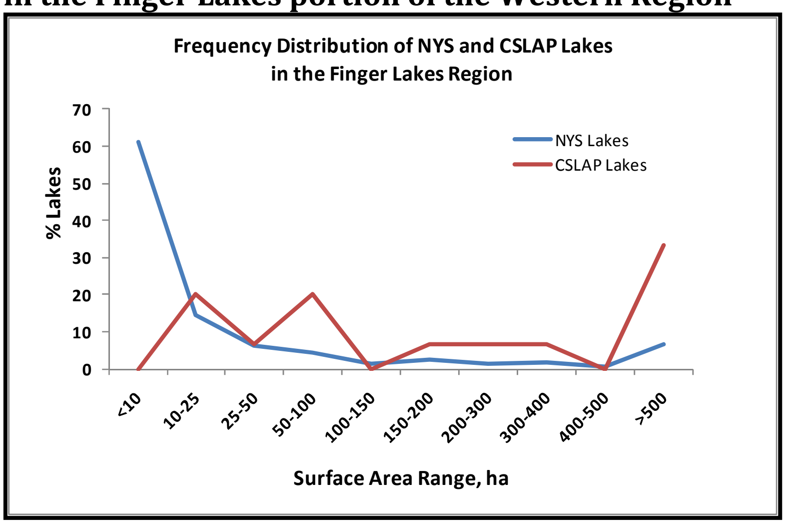


Figure 2.1.10 - Distribution of NYS and CSLAP Lakes in the Finger Lakes portion of the Western Region

The geographic boundaries and CSLAP lake distribution in Finger Lakes region are shown in Figure 2.1.9 and 2.1.10. Six of the eleven Finger Lakes have been sampled through CSLAP, including all but three of the Finger Lakes (Keuka, Canandaigua, and Otisco Lakes) which are multi-use waterbodies. In addition, five of the largest embayments to Lake Ontario have also been sampled through CSLAP, four of them in this region (North Sandy Pond in Oswego County is also a CSLAP lake). However, only a small number of other lakes in this region have been sampled through CSLAP. Of the 170 lakes and protected embayments (to Lake Ontario) in this region, 14 have been sampled through CSLAP. While this represents about 8% of the lakes in the region, a percentage typical of the rest of the state, less than 3% of the lakes not classified as Finger Lakes or Lake Ontario embayments in this region have been sampled through CSLAP.

Figure 2.1.10 shows a fairly even distribution of lake sizes represented in CSLAP, from the largest lakes (generally the Finger Lakes) to small ponds. As in most other regions of the state, most of the lakes in this region are less than 10 hectares in area, and the smaller size range is particularly underrepresented in the CSLAP pool, at least relative to most other regions of the state. This is due in large part to the paucity of small lake associations (as members of NYSFOLA or otherwise) represented in this region. It is not known if this is in response to the historical lack of problems frequently spawning the establishment of a lake association (issues related to water quality, invasive species, dam management, and fishing, for example) or the dominating presence of the larger associations and organizations connected to the Finger Lakes.

The geographic boundaries and CSLAP lake distribution in the Western portion of the region are shown in Figure 2.1.11 and 2.1.12. Multiple sites on both Lake Ontario (corresponding to beaches administered by the NYS Office of Parks and Recreation) and Chautauqua Lake have been sampled through CSLAP. Most of the other

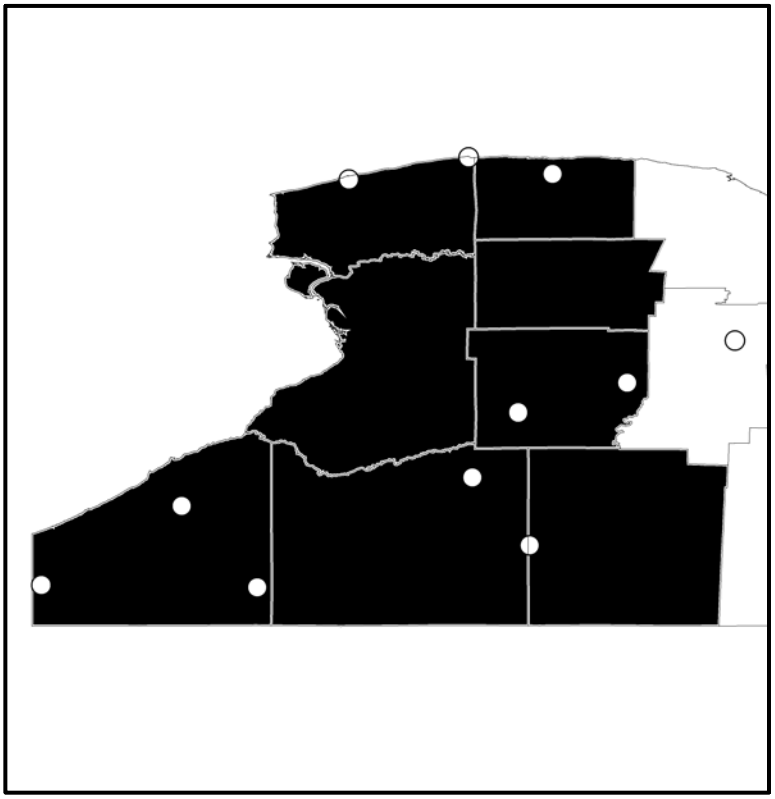


Figure 2.1.11 – Location of CSLAP Lakes in the western portion of the "Western" Region

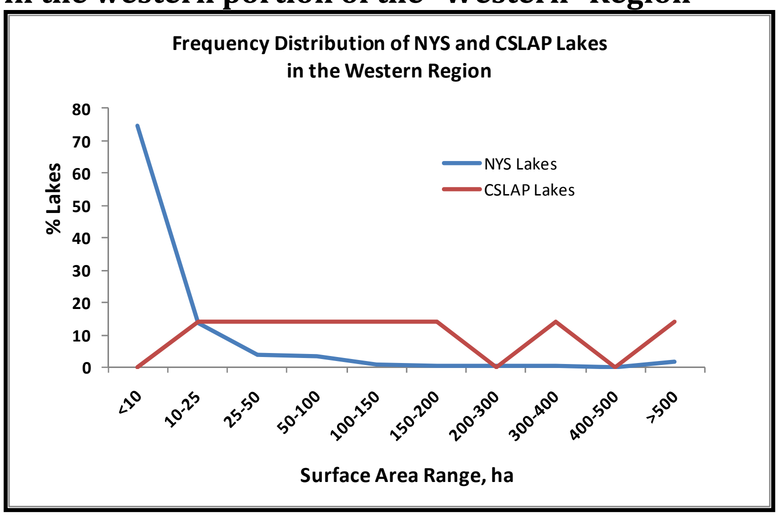


Figure 2.1.12 - Distribution of NYS and CSLAP Lakes in the western portion of the "Western" Region

CSLAP lakes in the region are on reservoirs or small ponds that support contact recreation and aquatic life, but not potable water usage. These lakes are scattered throughout the region, but except for the Lake Ontario sites at Golden Hill and Wilson-Tuscarora State Parks, the northwestern portion of this region has not been well represented in CSLAP (due largely to the small number of lakes and lake associations). There are, however, a number of lakes in the Buffalo area that have not been sampled through CSLAP, although most of these are in city or town parks and are not heavily populated by residences.

Figure 2.1.12 shows an even distribution of small and large lakes in this region, although the majority of lakes in the region have a surface area less than 10 hectares. As in the Finger Lakes portion of the region, lakes in the smaller size range are poorly represented in CSLAP. Of the approximately 180 lakes in this region, 13 have been sampled through CSLAP, representing about 7% of these lakes.

Table 2.1.1 summarizes the number of CSLAP lakes in each region, the percentage of lakes that this represents, and the areas within each region that have been most and least represented by CSLAP lakes (taking into consideration the actual distribution of lakes in the region). The areas or waterbody types listed as "over-represented" does not indicate a call to conduct less sampling; this merely reflects a higher percentage of these lakes relative to their representation in the regional distribution of lakes.

Table 2.1.1: CSLAP Lakes by Region, 1986-2009

Region	# CSLAP Lakes	% Lakes in Region	Under-Represented	Over-Represented
Downstate	60	6%	Urban lakes, Large reservoirs, Sullivan/ Orange Co lakes	Suburban lakes in Westchester/Putnam Co
Central	66	11%	Delaware and Schoharie Co. lakes	Rural lakes in Rensselaer and Washington Co
Adirondacks	76	4%	Colored and interior Adirondack lakes	Mid sized public access lakes on edges of region
Western	27	8%	Small urban and suburban lakes, Northwestern lakes	Finger Lakes?
CSLAP Statewide	**229**	**6%**		

% Lakes in region represents the percentage of CSLAP lakes among the named lakes > 2.6ha in surface area within the region

Regional Reports and the 2009 Dataset

The regional CSLAP reports cover the following region(s):

1. **"Downstate" region**- represents the Long Island/NYC and Downstate areas, as seen in Figures 2.1.1 and 2.1.3. These two "sub" regions are the most ecologically similar among the regions delineated above, and 32 CSLAP lakes in the Downstate region were sampled in 2009 (and 60 lakes in this region have been sampled since CSLAP began in 1986).
2. **"Central" region**- the Central region defined in Figure 2.1.5 and Diet for a Small Lake is sufficiently large (36 CSLAP lakes in 2009 and 66 CSLAP lakes sometime during the period from 1986-2009) to warrant a regionally-specific report.
3. **"Adirondack" region-** the Adirondack region defined in Figure 2.1.7 and Diet for a Small Lake is also sufficiently large (33 CSLAP lakes in 2009 and 76 CSLAP lakes in the period from 1986-2009) to warrant a regionally specific report.
4. **"Western" region**- represents the Finger Lakes and Western areas, as seen in Figures 2.1.9 and 2.1.11. These two "sub" regions are ecologically similar, and include 9 lakes sampled in 2009 and 27 lakes sampled at least one year in the period from 1986 to 2009.

Figure 2.1.13: CSLAP Lakes Sampled in 2009

CSLAP Lakes Sampled in 2009

Figure 2.1.13 shows the distribution of the 110 CSLAP lakes sampled in 2009. The list and distribution of lakes within each of the four regions listed above is provided in the regional summaries. The distribution of lakes is heaviest in the eastern and northwestern Adirondack region, along the Hudson corridor and in Madison and Chenango Counties in the Central Region, and in the southern portion of the Downstate region. The Western, Finger Lakes, and Long Island/NYC regions were not well represented in CSLAP in 2009, although these regions also generally have a smaller population of lakes.

Table 2.1.2 shows the regional summary of lakes sampled in CSLAP in 2009. The Long Island/NYC and Downstate regions include a disproportionate number of relatively new CSLAP lakes. The Long Island region includes three lakes associated with the Long Pond Greenbelt region, all of which became involved in CSLAP in recent years. The Downstate region includes a number of lakes sponsored by the Westchester County Planning Department and others introduced to CSLAP through the frequency regional NYSFOLA conferences in Putnam and Westchester Counties. The CSLAP lakes in the Central, Finger Lakes, and Western regions on average have been sampled longer than those lakes in other parts of the state, although the regional averages are no doubt influenced by the small number of lakes in the western regions of the state.

Table 2.1.2: Regional Summary of CSLAP Lakes Sampled in 2009

Region	#2009 Lakes*	Avg #Years in CSLAP	Avg #2009 Samples
Downstate	32	6.4	7.0
Central	35	13.5	7.8
Adirondacks	43	10.1	7.6
Western	10	14.0	8.0
CSLAP Statewide	**120**	**10.5**	**7.5**

*includes multiple sites sampled on three Adirondack region lakes and one Western region lake

Table 2.1.2 also suggests that the lakes sampled for the shortest period of time were also more likely to conduct less sampling in 2009. This may be due to a greater reliability associated with volunteers at longer-duration CSLAP lakes, indicating an "institutional" dedication to long-term monitoring.

Chapter 2.2- CSLAP Lakes in the Downstate Region Sampled in 2009

32 lakes from the northern (28 lakes) and Long Island (4 lakes) portion of the Downstate regions were sampled through CSLAP in 2009. This includes one lake—Lake Waccabuc—that was sampled in the CSLAP pilot project in 1986, but a large number of lakes—21—sampled fewer than five years. The latter is a much higher percentage of lakes than in other regions of the state, owing to the strong push from several organizations, including the Westchester County Planning Department and the Trustees of Southampton, to encourage participation in CSLAP. Since the criteria for evaluating water quality trends in CSLAP lakes is five years of data, many of these lakes have not been included in the full suite of analyses in the Downstate region report. The 2009 Downstate region database includes mostly medium-sized to small lakes, typical of the cross-section of lakes in the region. The Long Island region is poorly represented in the western urban/suburban portion of the region, corresponding to the large number of small, shallow ponds, often in urban parks, used for fishing and in support of wildlife. The New York City reservoirs are also not represented in CSLAP, although many of the lakes within the reservoir watershed area, including small potable water supplies, are included in CSLAP. Otherwise the distribution of CSLAP lakes in the Downstate region is mostly representative of the distribution of lakes in the corresponding drainage basins, particularly the Lower Hudson River basin.

Each of the Downstate region lakes sampled through CSLAP at one time since 1986 is listed in the statewide report, in the discussion of CSLAP activities associated with the timeframe in which the lake was first sampled. Table 2.2.1 below identifies the Downstate region lakes sampled through CSLAP in 2009, with a blank line separating the two subregions (northern lakes listed first, Long Island lakes listed last). Chapters 3 through 9 summarize the Downstate region sampling results from 1986 to 2009, with a special emphasis on the results from 2009.

Table 2.2.1: CSLAP Downstate Region Lakes Sampled in 2009

Lake Name	Years	#Years	#Samples	#2009 Samples	County[1]	Town[1]	Contact
Anawanda Lake	1988-2009	20	150	8	Sullivan	Callicoon Center	Joan Papa
Beaver Dam Lake	2008-2009	2	15	7	Greene	New Baltimore	Nathan Tumey
Highland Lake	2003-2009	4	32	5	Orange	Wallkill	Nick Klupacs
Indian Lake	1994-2009	14	76	8	Putnam	Putnam Valley	Ingrid Caruso
Katonah Lake	2006-2009	4	30	7	Westchester	Lewisboro	Diane Doesserich
Lake Lincolndale	1993-2009	16	113	5	Westchester	Somers	Joe Sellati
Lake Mohegan	1998-2009	12	89	8	Westchester	Yorktown	Russell Duggan
Lake Oscaleta	2006-2009	4	33	9	Westchester	South Salem	Janet Andersen
Lake Peekskill	1990-2009	17	98	7	Putnam	Putnam Valley	Ted Muniak
Lake Rippowam	2006-2009	4	33	9	Westchester	South Salem	Janet Andersen
Lake Truesdale	1999-2009	11	88	8	Westchester	Lewisboro	Vi Patek
Lake Waccabuc	1986-2009	13	112	9	Westchester	South Salem	Janet Andersen
Little We Wah Lake	2008-2009	2	15	8	Orange	Tuxedo	Susan Heywood
Monhagen Lake	2003-2009	4	31	5	Orange	Wallkill	Nick Klupacs
Roaring Brook Lake	2009-2009	1	8	8	Putnam	Putnam Valley	Ernst Demms
Sepasco Lake	1997-2009	12	96	8	Dutchess	Red Hook	Carl Parris
Shadow Lake	2008-2009	2	12	5	Westchester	Yorktown	Mike Rubbo
Shawangunk Lake	2003-2009	4	29	5	Orange	Mount Hope	Nick Klupacs
Shenorock Lake	2004-2009	4	48	8	Westchester	Somers	Dennis DiSanto
Sleepy Hollow Lake	2009-2009	1	8	8	Greene	Athens	Laurel Mann
Stissing Lake	2007-2009	3	19	8	Dutchess	Pine Plains	Marilyn Henry
Teatown Lake	1997-2009	12	84	5	Westchester	Yorktown	Mike Rubbo
Timber Lake	2006-2009	3	16	8	Westchester	Lewisboro	Eric Stand
Tuxedo Lake	2008-2009	2	15	8	Orange	Tuxedo	Susan Heywood
Ulster Heights Lake	2007-2009	3	14	4	Ulster	Wawarsing	John Hazard
We Wah Lake	2008-2009	2	16	8	Orange	Tuxedo	Susan Heywood
Weiden Pond	2004-2009	6	38	5	Sullivan	Tusten	Tim Wood
Yankee Lake	2006-2009	4	30	7	Sullivan	Mamakating	Georgia Rampe
Black Pond	2008-2009	2	13	8	Suffolk	Southampton	Dai Dayton
Lily Pond	2008-2009	2	13	8	Suffolk	Southampton	Priscilla Ciccariello
Little Fresh Pond	1989-2009	15	101	8	Suffolk	Southampton	John Gorman
Little Long Pond	2006-2009	4	13	3	Suffolk	Southampton	Bonnie Mahoney

[1]Locational information corresponds to the coordinates of the mouth of the outlet, except for the multiple site lakes—these town and county locations correspond to the approximate location of the sampling site

Chapter 3- Evaluation of Eutrophication Indicators

Phosphorus Fact Sheet

Chapter 3.1- Evaluation of Downstate Region Total Phosphorus

Chlorophyll *a* Fact Sheet

Chapter 3.2- Evaluation of Downstate Region Chlorophyll *a*

Water Clarity Fact Sheet

Chapter 3.3- Evaluation of Downstate Region Water Clarity

Chapter 3.4- Evaluation of Downstate Region Trophic State Indices (TSI)

Phosphorus Fact Sheet

Description:	total phosphorus represents a measure of both suspended and soluble (dissolved) forms of phosphorus, reported in milligrams per liter (parts per million) as phosphorus.
Importance:	phosphorus is one of the major nutrients needed for plant growth. It is often considered the "limiting" nutrient in NYS lakes, for biological productivity (as defined by algae) is often limited if phosphorus inputs are limited. Since excessive algae growth often leads to reduced water clarity and degraded water quality perception, many lake management plans are centered on phosphorus controls. Phosphorus limitation is assumed when phosphorus to nitrogen ratios exceed 25 (on a molar basis), although this simplified assessment should be accompanied by other analyses to determine factors that most affect algae growth.
How Measured:	total phosphorus is analyzed from the surface (1.5 meter grab) sample collected in CSLAP with the use of a Kemmerer bottle and transferred to a collapsible container and labeled sample aliquot bottles. Sample bottles were pre-acidified prior to 2004, but subsequent analyses showed that this was unnecessary if samples were kept cold (39ºC) shortly after collection and continuously until analysis within 28 days. Hypolimnetic (deepwater) samples are collected at a depth of 1.5 meters from the lake bottom in thermally stratified lakes. Phosphorus is analyzed using a spectrophotometer with a 10cm cuvette.
Detection Limit:	0.0007 mg/l (prior to 2002, detection limit = 0.002 mg/l)
Range in NYS:	undetectable (< 0.0007 mg/l) to 2.0 mg/l; 93% of readings fall between 0.005 mg/l and 0.075 mg/l (5-75 ppb).
WQ Standards:	the existing state guidance value for total phosphorus is 0.020 mg/l to protect contact recreation in Class B and higher lakes; this will likely be modified as part of the nutrient criteria development process. New guidance values will probably reflect differences in both regional water quality characteristics and lake uses.
Trophic Assessment:	New York State's trophic assessments differ slightly from the standard Carlson assessment criteria. Total phosphorus readings exceeding 0.020 mg/l in New York State and 0.024 mg/l using the Carlson indices, are considered *eutrophic*, or highly productive. Readings below 0.010 mg/l in New York State, and 0.012 mg/l using the Carlson indices, are considered *oligotrophic*, or highly unproductive. Lakes in the intermediate range are considered *mesotrophic*. The differences between the New York State and Carlson criteria are discussed in Chapter 3.4.

Chapter 3- Evaluation of Eutrophication Indicators

Chapter 3.1- Evaluation of Downstate Region Total Phosphorus: 1986-2009

Summary of CSLAP Total Phosphorus Findings in Downstate Region Lakes, 1986-2009

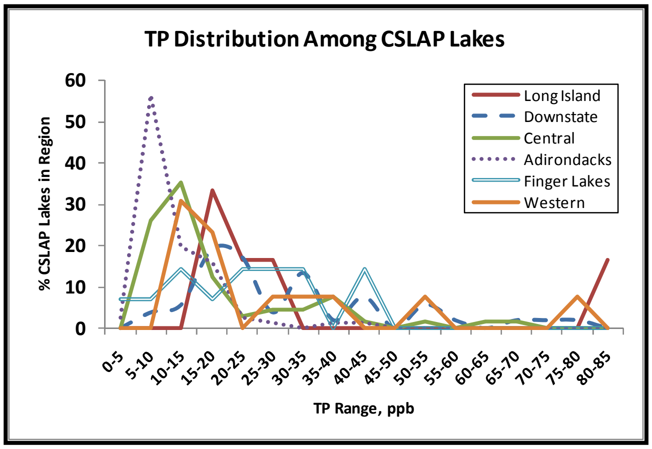
1. CSLAP lakes within the Downstate region have higher phosphorus readings than those in most other parts of the state, with the majority of lakes having typical total phosphorus levels from 15 to 35 ppb, corresponding to *mesotrophic* to *eutrophic* conditions.
2. CSLAP lakes within the Downstate region have similar phosphorus readings to those in non-CSLAP lakes in the same region, although TP levels are slightly higher in the non-CSLAP lakes in Long Island.
3. CSLAP lakes within the Downstate region are more likely to have higher phosphorus readings in drier years, and lower readings in wet years, although these relationships are not strong.
4. No long-term trends in total phosphorus readings have been apparent in CSLAP lakes within the Downstate region, although mid 1990s increases in phosphorus levels in Round Lake have been recorded.
5. Total phosphorus readings are highest in the interior portions of the region, corresponding to the highly urbanized New York City suburbs north and east of the city (although the latter is not well evaluated through CSLAP). Many of these lakes can be characterized as *eutrophic*.
6. Deepwater (hypolimnetic) phosphorus readings are highest, overall and relative to surface readings, in thermally stratified *mesotrophic* lakes, but this does not translate to a seasonal increase in surface phosphorus readings in most of these lakes.
7. Total phosphorus readings in Downstate region lakes were similar in 2009 to those reported in the typical CSLAP sampling season from 1986 to 2008.
8. Small changes in phosphorus levels in the Downstate region lakes have probably been mediated by weather patterns (most likely wetter weather and higher water levels).

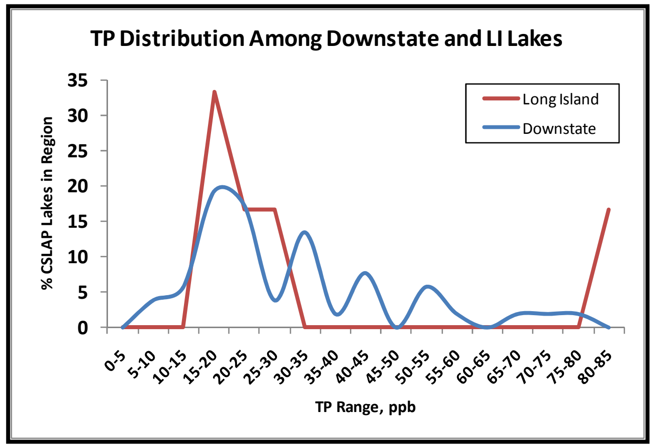
Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region are more productive than in most other regions of the state, as measured by higher phosphorus readings and as demonstrated in Figure 3.1.1. The most common range of TP readings in CSLAP Downstate region lakes is in the 15-35 ppb range, but a large percentage of Downstate lakes have higher TP readings. A large percentage of Long Island lakes have TP readings above 50 ppb, as seen in Figure 3.1.2.

Comparison of CSLAP to NYS Lakes in the Downstate Region

The distribution of total phosphorus readings in the northern portion of Downstate CSLAP was similar to the distribution of non-CSLAP lakes sampled in other New York state monitoring programs, as seen in Figure 3.1.3. While the Long Island CSLAP lakes have slightly lower nutrient levels than seen in other (non-CSLAP lakes), the overall distribution of phosphorus readings in CSLAP and NYS lakes were mostly comparable in the Downstate region, suggesting that the CSLAP dataset is a reasonable representation of normal conditions in this part of the state.





Figures 3.1.1 and 3.1.2: Distribution of Total Phosphorus Ranges in CSLAP and Downstate/ Long Island Region Lakes

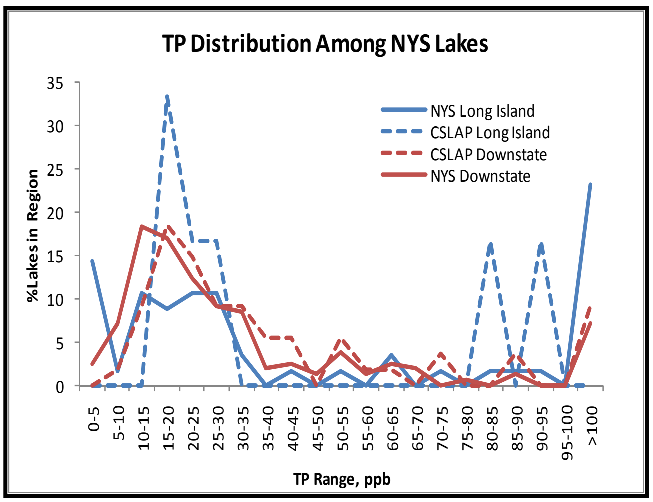


Figure 3.1.3: Average Distribution of Phosphorus Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

Total phosphorus has varied annually in Downstate region lakes, although less so than in most other regions of the state. The highest phosphorus readings measured through CSLAP occurred during 1991, 1996, 2008 and 1990. Most of these years were neither unusually wet nor unusually dry. The lowest phosphorus readings occurred in 2002, 1993, 2004, and 1997, years with mostly normal precipitation. Table 3.1.1 looks at the percentage of CSLAP lakes with high phosphorus (greater than 1 standard error above normal) and low phosphorus (greater than 1 standard error below normal) readings in wet and dry years. These data show that high phosphorus readings are more likely to occur in drier years and low phosphorus readings occur in wetter years. However, the relationship between precipitation and phosphorus readings in Downstate region lakes is not strong.

Table 3.1.1- % of CSLAP Lakes with Higher or Lower (than Normal) TP Readings During Dry and Wet Years in the Downstate Region

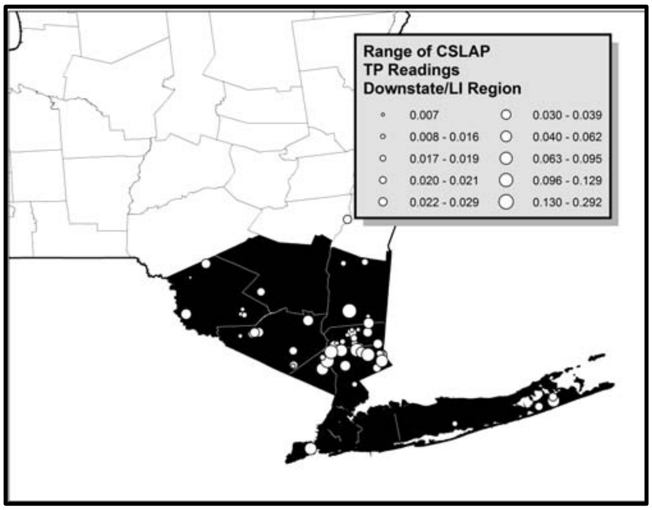
	Dry Years	Wet Years
Higher Phosphorus	22%	17%
Lower Phosphorus	17%	20%

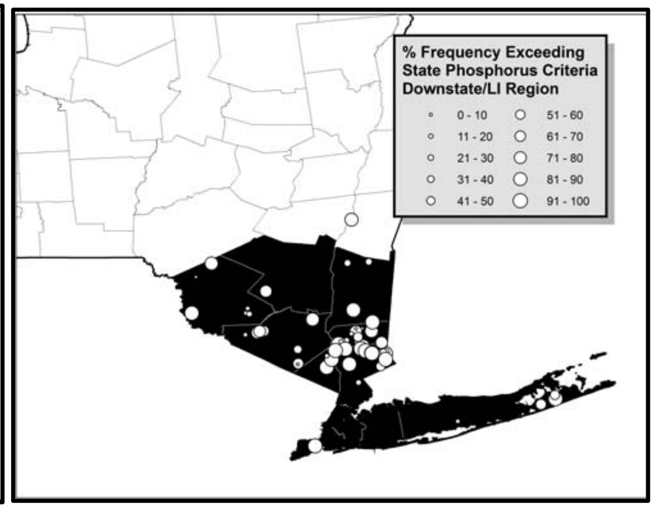
Dry Years: 1995, 2001

Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of moderately and significantly lower than normal TP readings has increased, although these trends appear to be statistically weak, as with the statewide database. These data indicate that lower TP readings have been slightly more common in recent years, although no clear long-term trends in phosphorus readings have been apparent. Long-term changes in phosphorus readings are more likely to be related to year to year changes in weather patterns than any true long-term trends.





Figures 3.1.4 and 3.1.5: Range of Phosphorus Readings and Frequency of Exceeding the State TP Guidance Value in the Downstate Region

Regional Distribution:

Total phosphorus readings with the Downstate region are highest in Putnam and Westchester Counties, although this also corresponds to the regions with the most CSLAP lakes data (and non-CSLAP data show high TP levels in highly urbanized areas throughout the region). The lowest phosphorus readings are found in the western portions of this region and eastern Long Island, as seen in Figure 3.1.4. Likewise the greatest frequency of exceeding the state phosphorus guidance value is found in the interior portion of the region, as seen in Figure 3.1.5. Most of these lakes are in the *eutrophic* range. Most CSLAP lakes found in Sullivan and Dutchess Counties do not regularly exceed this guidance value. Lakes in the lower Hudson River basins, however, particularly in the heavily populated region east of the River, more frequently exhibit TP levels above the state guidance value.

Table 3.1.2 shows the number of phosphorus samples, the minimum, average, and maximum phosphorus readings, the most common trophic assessment for the lake, the frequency of exceeding the state phosphorus criteria, the last year in which the lake was sampled through CSLAP, and whether phosphorus readings have changed since CSLAP sampling began in the lake (through 2009). The latter are only evaluated for those lakes sampled for at least five years through CSLAP.

Table 3.1.2: Surface Total Phosphorus Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	%Violating TP Criteria	Change?
Anawanda Lake	1988-2009	145	0.001	0.007	0.019	Oligotrophic	0	No
Anawanda Lake	2009	8	0.005	0.007	0.010	Oligotrophic	0	No
Blue Heron Lake	2005-2008	24	0.011	0.024	0.069	Eutrophic	54	
Cranberry Lake	2004-2004	8	0.008	0.017	0.036	Mesotrophic	25	
Gossamans Pond	2003-2005	23	0.015	0.044	0.131	Eutrophic	91	
Highland Lake	2003-2009	32	0.012	0.039	0.131	Eutrophic	72	
Highland Lake	2009	5	0.013	0.018	0.026	Mesotrophic	20	Lower
Hillside Lake	1994-1997	13	0.069	0.292	2.000	Eutrophic	100	
Indian Lake	1994-2009	75	0.007	0.016	0.040	Mesotrophic	15	No
Indian Lake	2009	8	0.015	0.018	0.024	Mesotrophic	25	No
Katonah Lake	2006-2009	31	0.037	0.103	0.344	Eutrophic	100	
Katonah Lake	2009	7	0.042	0.122	0.344	Eutrophic	100	No
Lake Carmel	1986-1990	58	0.012	0.038	0.120	Eutrophic	84	No
Lake Celeste	1993-1997	25	0.019	0.032	0.046	Eutrophic	92	
Lake Guymard	1996-2003	43	0.008	0.015	0.029	Mesotrophic	19	No
Lake Kitchawan	2008-2008	1	0.074	0.074	0.074	Eutrophic	100	
Lake Lincolndale	1993-2009	111	0.009	0.053	0.286	Eutrophic	95	No
Lake Lincolndale	2009	5	0.051	0.062	0.083	Eutrophic	100	No
Lake Lucille	1986-1990	62	0.008	0.086	0.479	Eutrophic	97	No
Lake Mahopac	1986-2002	73	0.007	0.020	0.052	Eutrophic	48	No
Lake Meahagh	1999-2001	10	0.048	0.129	0.210	Eutrophic	100	
Lake Mohegan	1998-2009	81	0.018	0.072	0.165	Eutrophic	98	No
Lake Mohegan	2009	8	0.043	0.100	0.149	Eutrophic	100	Higher
Lake Nimham	1991-1995	41	0.005	0.014	0.041	Mesotrophic	10	No
Lake Oscaleta	2006-2009	35	0.011	0.021	0.055	Eutrophic	37	
Lake Oscaleta	2009	8	0.014	0.016	0.019	Mesotrophic	0	Lower
Lake Oscawana	1991-1995	37	0.009	0.019	0.058	Mesotrophic	30	No
Lake Ossi	1996-2000	32	0.007	0.021	0.032	Eutrophic	56	No
Lake Peekskill	1990-2009	94	0.003	0.026	0.061	Eutrophic	64	No
Lake Peekskill	2009	7	0.022	0.038	0.048	Eutrophic	100	Higher
Lake Rippowam	2006-2009	35	0.012	0.021	0.049	Eutrophic	43	
Lake Rippowam	2009	8	0.012	0.020	0.033	Eutrophic	50	No
Lake Tibet	1991-1993	24	0.015	0.034	0.140	Eutrophic	75	
Lake Truesdale	1999-2009	86	0.018	0.058	0.125	Eutrophic	98	No
Lake Truesdale	2009	8	0.033	0.054	0.069	Eutrophic	100	No
Lake Waccabuc	1986-2009	109	0.003	0.019	0.040	Mesotrophic	33	No
Lake Waccabuc	2009	8	0.015	0.018	0.021	Mesotrophic	38	No
Lake Wanaksink	1991-1995	40	0.008	0.016	0.067	Mesotrophic	13	No
Little We Wah Lake	2008-2009	16	0.013	0.026	0.042	Eutrophic	63	
Little We Wah Lake	2009	8	0.013	0.020	0.039	Eutrophic	25	Lower
Monhagen Lake	2003-2009	33	0.010	0.031	0.076	Eutrophic	67	
Monhagen Lake	2009	5	0.014	0.020	0.027	Mesotrophic	40	Lower
Orange Lake	1994-2005	49	0.012	0.043	0.084	Eutrophic	84	No
Peach Lake	1999-2008	73	0.011	0.031	0.230	Eutrophic	79	No
Plum Brook Lake	2005-2008	30	0.030	0.053	0.089	Eutrophic	100	
Roaring Brook Lake	2009-2009	8	0.011	0.014	0.021	Mesotrophic	13	
Roaring Brook Lake	2009	8	0.011	0.014	0.021	Mesotrophic	13	No
Round Lake	1992-1996	40	0.009	0.022	0.073	Eutrophic	38	Increasing
Sagamore Lake	1994-1997	32	0.007	0.014	0.027	Mesotrophic	3	
Sepasco Lake	1997-2009	88	0.008	0.018	0.034	Mesotrophic	32	No
Sepasco Lake	2009	7	0.016	0.021	0.030	Eutrophic	57	No
Shadow Lake	2008-2009	12	0.034	0.062	0.183	Eutrophic	100	
Shadow Lake	2009	5	0.034	0.040	0.059	Eutrophic	100	Lower

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	%Violating TP Criteria	Change?
Shawangunk Lake	2003-2009	33	0.011	0.029	0.077	Eutrophic	79	
Shawangunk Lake	2009	5	0.022	0.026	0.030	Eutrophic	100	No
Shenorock Lake	2004-2009	48	0.012	0.124	0.401	Eutrophic	98	No
Shenorock Lake	2009	8	0.055	0.095	0.182	Eutrophic	100	Lower
Stissing Lake	2007-2009	23	0.012	0.021	0.065	Eutrophic	35	
Stissing Lake	2009	7	0.015	0.018	0.025	Mesotrophic	29	No
Teatown Lake	1997-2009	81	0.012	0.051	0.177	Eutrophic	95	No
Teatown Lake	2009	5	0.026	0.047	0.074	Eutrophic	100	No
Timber Lake (Sullivan)	2004-2008	28	0.016	0.032	0.059	Eutrophic	86	
Timber Lake (Westchester)	2006-2009	15	0.017	0.036	0.077	Eutrophic	93	
Timber Lake	2009	8	0.021	0.039	0.077	Eutrophic	100	No
Tomkins Lake	2001-2001	7	0.012	0.017	0.025	Mesotrophic	14	
Tuxedo Lake	2008-2009	15	0.007	0.012	0.018	Mesotrophic	0	
Tuxedo Lake	2009	8	0.012	0.015	0.018	Mesotrophic	0	No
Ulster Heights Lake	2007-2009	14	0.017	0.026	0.035	Eutrophic	79	
Ulster Heights Lake	2009	4	0.029	0.032	0.035	Eutrophic	100	No
Wallace Pond	2004-2008	29	0.030	0.104	0.427	Eutrophic	100	No
We Wah Lake	2008-2009	16	0.004	0.021	0.034	Eutrophic	44	
We Wah Lake	2009	8	0.004	0.019	0.028	Mesotrophic	38	No
Weiden Pond	2004-2009	37	0.011	0.043	0.106	Eutrophic	97	No
Weiden Pond	2009	5	0.011	0.038	0.087	Eutrophic	80	No
Whaley Lake	1998-2001	28	0.009	0.015	0.024	Mesotrophic	7	No
Wolf Lake	1987-2001	86	0.006	0.016	0.040	Mesotrophic	16	No
Yankee Lake	2006-2009	30	0.012	0.018	0.042	Mesotrophic	30	
Yankee Lake	2009	7	0.013	0.017	0.026	Mesotrophic	14	No
Black Pond	2008-2009	13	0.044	0.095	0.245	Eutrophic	100	
Black Pond	2009	8	0.044	0.072	0.095	Eutrophic	100	Lower
Bradys Pond	1997-2001	31	0.014	0.083	0.211	Eutrophic	97	No
Canaan Lake	1990-2005	80	0.004	0.019	0.250	Mesotrophic	19	No
Lily Pond	2008-2009	13	0.013	0.029	0.103	Eutrophic	54	
Lily Pond	2009	8	0.013	0.025	0.049	Eutrophic	63	No
Little Fresh Pond	1989-2009	100	0.005	0.024	0.052	Eutrophic	64	No
Little Fresh Pond	2009	8	0.005	0.022	0.035	Eutrophic	75	No
Little Long Pond	2006-2009	14	0.003	0.018	0.037	Mesotrophic	29	
Little Long Pond	2009	3	0.015	0.021	0.025	Eutrophic	67	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum total phosphorus readings, in mg/l
% Violating TP Criteria = % of samples at each lake with TP > 0.020 mg/l, corresponding to the existing NYS TP guidance value
Change? = exhibiting significant change in TP readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on TP readings >25% higher or lower than normal

The only lake in this region exhibiting long-term change is Round Lake in Orange County. Phosphorus readings in Round Lake from 1994 to 1996 were higher (average readings 0.027 mg/l) than in the period from 1992 through 1993 (average readings 0.015 mg/l). However, since the lake has not been sampled through CSLAP for nearly 15 years, it is not known if this pattern continued, or if the lake continues to exhibit phosphorus levels typical of *eutrophic* lakes.

No lakes in the Downstate region have exhibited a long-term decrease in phosphorus readings.

Tables 3.1.3a and 3.1.3b summarize the surface total phosphorus data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Total phosphorus readings in the CSLAP lakes in the Downstate region in 2009 were similar to those reported in previous years. Average TP readings were lower than normal in 2009, but a higher frequency of lakes exhibited higher than normal total phosphorus readings in 2009. These data suggest that, on a region-wide basis, total phosphorus readings in 2009 were comparable to those measured in previous CSLAP sampling seasons.

Table 3.1.3a: Surface Total Phosphorus Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical	%Violating TP Criteria
Downstate	32	0.004	0.037	0.043	0.344	*Eutrophic*	63
Central	36	0.001	0.016	0.018	0.050	*Mesotrophic*	24
Adirondacks	33	<0.001	0.011	0.011	0.047	*Mesotrophic*	10
Western	9	0.002	0.045	0.032	0.159	*Eutrophic*	73
CSLAP Statewide	**110**	**<0.001**	**0.023**	**0.024**	**0.344**	***Eutrophic***	**35**

Table 3.1.3b: Surface Total Phosphorus Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	0.037	0.043	22	13	25	16
Central	36	0.016	0.018	8	5	5	5
Adirondacks	33	0.011	0.011	13	16	9	16
Western	9	0.045	0.032	11	11	11	0
CSLAP Statewide	**110**	**0.023**	**0.024**	**14**	**11**	**11**	**11**

% Higher = percentage of lakes in region with TP readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with TP readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with TP readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with TP readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal TP in 2009:
Lake Peekskill, Lake Mohegan

Discussion:

Two Downstate region lakes exhibited higher than normal phosphorus readings in 2009. Neither of these lakes has exhibited a long-term increase in phosphorus readings that may be statistically significant. The volunteers at Lake Peekskill reported heavy waterfowl populations in 2009, while wet weather was reported throughout the summer at Lake Mohegan. Both factors may have influenced phosphorus readings in these lakes. Neither of these lakes exhibited higher than normal algae levels in 2009.

Downstate Region Lakes With Lower Than Normal TP in 2009:
Black Pond, Highland Lake, Lake Oscaleta, Little We Wah Lake, Monhagen Lake, Shadow Lake, Shenorock Lake

Discussion:

Phosphorus readings in 7 Downstate lakes exhibited lower than normal phosphorus readings in 2009. None of these lakes has exhibited any long-term changes in phosphorus readings. With only limited (short duration) water quality data available on most of these lakes, it is not yet known if the lower than normal TP readings in 2009 represent normal variability or an actual decrease in total phosphorus readings.

Deepwater Total Phosphorus

Table 3.1.4 shows the number of samples, and minimum, average and maximum reading deepwater (*hypolimnetic*) phosphorus reading. These readings were generally collected from a depth of 1-2 meters from the lake bottom in thermally stratified lakes. This table also compares the average surface and hypolimnetic phosphorus reading in each thermally stratified lake in this region. The most significant difference between surface and hypolimnetic readings was recorded at Anawanda Lake, Lake Waccabuc, Peach Lake, Sepasco Lake, and Tuxedo Lake.

Many of these lakes are *mesotrophic*, and nutrients may not regularly migrate from the lake bottom to the surface waters, at least in most years. This is apparent from the lack of seasonal change in surface nutrient readings in many of these lakes. These lakes do appear to exhibit deepwater anoxia that might lead to water quality problems if the lakes turn over earlier in the summer, particularly those lakes that are weakly stratified (generally 20-40 feet deep).

The productivity of Anawanda Lake and Tuxedo Lake is low, and there is no evidence that the elevated hypolimnetic nutrient levels trigger any other water quality problems in these lakes.

Table 3.1.4: Bottom Total Phosphorus Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Avg Surface TP	Max
Anawanda Lake	1993-2009	53	0.004	0.048	0.007	0.623
Anawanda Lake	2009	8	0.020	0.040	0.007	0.085
Gossamans Pond	2005-2005	6	0.034	0.054	0.044	0.114
Highland Lake	2005-2009	16	0.013	0.041	0.039	0.123
Highland Lake	2009	5	0.014	0.023	0.018	0.041
Indian Lake	2005-2009	40	0.015	0.038	0.016	0.071
Indian Lake	2009	8	0.015	0.037	0.018	0.051
Lake Oscaleta	2006-2009	34	0.013	0.062	0.021	0.096
Lake Oscaleta	2009	8	0.044	0.062	0.016	0.075
Lake Oscawana	1993-1994	8	0.014	0.046	0.019	0.140
Lake Peekskill	1998-2007	5	0.053	2.263	0.026	10.041
Lake Rippowam	2008-2009	19	0.010	0.026	0.021	0.046
Lake Rippowam	2009	8	0.018	0.028	0.020	0.034
Lake Truesdale	2005-2005	8	0.022	0.060	0.058	0.091
Lake Waccabuc	2006-2009	35	0.082	0.377	0.019	0.623
Lake Waccabuc	2009	8	0.312	0.435	0.018	0.545
Lake Wanaksink	1993-1994	7	0.013	0.015	0.016	0.018
Monhagen Lake	2005-2009	17	0.012	0.053	0.031	0.181
Monhagen Lake	2009	5	0.016	0.023	0.020	0.029
Orange Lake	2002-2002	2	0.031	0.040	0.043	0.049
Peach Lake	2000-2008	36	0.031	0.166	0.031	0.356
Round Lake	1993-1994	8	0.050	0.090	0.022	0.150
Sagamore Lake	1994-1994	4	0.013	0.025	0.014	0.052
Sepasco Lake	1998-2009	38	0.004	0.216	0.018	1.429
Sepasco Lake	2009	7	0.085	0.192	0.021	0.340
Shawangunk Lake	2005-2009	17	0.012	0.057	0.029	0.183
Shawangunk Lake	2009	5	0.034	0.057	0.026	0.124
Shenorock Lake	2005-2005	8	0.073	0.180	0.124	0.384
Stissing Lake	2007-2009	7	0.014	0.020	0.021	0.027
Stissing Lake	2009	5	0.014	0.019	0.018	0.025

Lake Name	Years	Num	Min	Avg	Avg Surface TP	Max
Tuxedo Lake	2009-2009	4	0.014	0.137	0.012	0.314
Tuxedo Lake	2009	4	0.014	0.137	0.015	0.314
We Wah Lake	2009-2009	3	0.036	0.039	0.021	0.043
We Wah Lake	2009	3	0.036	0.039	0.019	0.043
Whaley Lake	1999-1999	4	0.016	0.032	0.015	0.049
Canaan Lake	2005-2005	7	0.008	0.017	0.019	0.033
Little Fresh Pond	2005-2009	22	0.018	0.034	0.024	0.087
Little Fresh Pond	2009	7	0.024	0.047	0.022	0.087

Num = number of hypolimnetic phosphorus samples
Min, Avg, Max = minimum, average, and maximum hypolimnetic total phosphorus readings, in mg/l
Avg Surface TP = average surface total phosphorus readings, 1986-2009, in mg/l

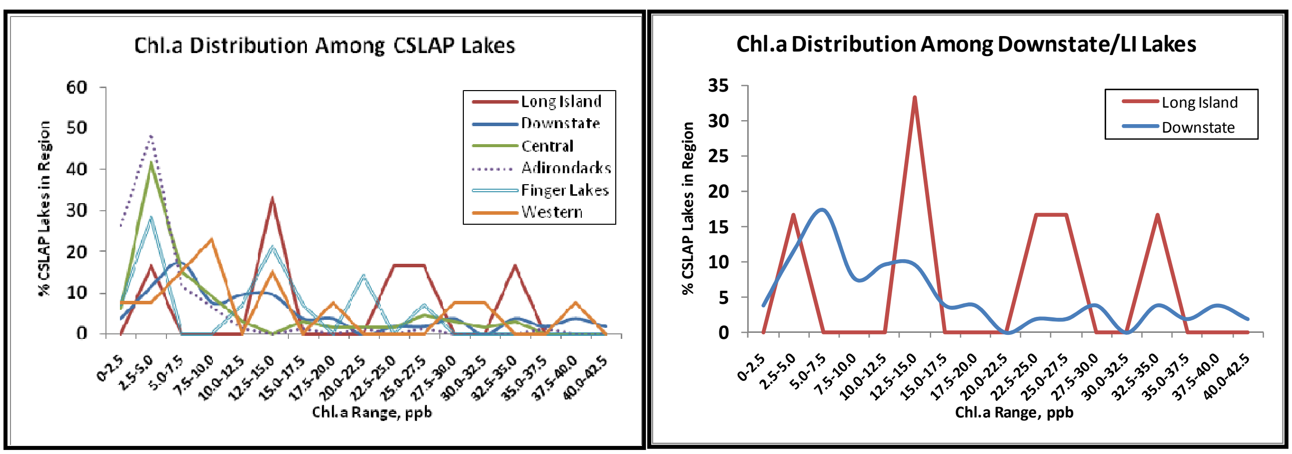
Chlorophyll *a* Fact Sheet

Description:	Chlorophyll is the photosynthetic pigment found in green plants, and chlorophyll *a* is the primary pigment found in freshwater algae. It constitutes 0.1-3.4% of the phytoplankton (algal) biomass and is a measure of primary productivity. The chlorophyll *a* analysis is much less time consuming than counting algal cells under a microscope, the most accurate measure of planktonic phytoplankton biomass in a lake.
Importance:	chlorophyll *a* is a measure of primary planktonic lake productivity and is closely related to both phosphorus and water transparency. Therefore, it is both a response variable to changes in phosphorus and a stressor to changes in water transparency. This makes it a critical trophic indicator and a representation of the building blocks for the entire ecological community in lakes. Since it measures only planktonic algae, however, it is not a good indicator of floating algae scums, benthic (bottom dwelling) algae, or epiphytes (algae growing on plants).
How Measured: in CSLAP	chlorophyll *a* is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container. 100ml are filtered through a 0.45 μ, 47 mm diameter mixed ester filter, placed in a labeled glass vial, and wrapped in aluminum foil. Once received by the laboratory, a chloroform-methanol extractant is added in anticipation of centrifugation and analysis with a spectrophotometer.
Range in CSLAP:	undetectable (< 0.01 μg/l) to 1020 μg/l; 88% of readings fall between 1 μg/l and 50 μg/l.
WQ Standards:	there are no water quality standards or guidance values for chlorophyll *a* in New York State. Guidance values will probably be implemented as part of the nutrient criteria development process; these values will probably reflect differences in both regional water quality characteristics and lake uses.
Trophic Assessment:	New York State's trophic assessments differ slightly from the standard Carlson assessment criteria. Chlorophyll *a* readings exceeded 8 μg/l in NYS and 6.4 μg/l using the Carlson indices, are considered *eutrophic*, or highly productive. Readings below 2 μg/l in New York State, and 2.6 μg/l using the Carlson indices, are considered *oligotrophic*, or highly unproductive. Lakes in the intermediate range are considered *mesotrophic*. The differences between the New York State and Carlson criteria are discussed in Chapter 3.4.

Chapter 3.2- Evaluation of Downstate Region Chlorophyll *a*: 1986-2009

Summary of CSLAP Chlorophyll a Findings in Downstate Region Lakes, 1986-2009

1. CSLAP lakes within the Downstate region have higher chlorophyll *a* readings than those in most other parts of the state, with the most typical chlorophyll *a* levels between 5 and 15 µg/l, corresponding to *mesotrophic* to *eutrophic* conditions. Long Island lakes exhibit higher chlorophyll readings than those in the northern portions of the region.
2. CSLAP lakes within the Downstate region have similar chlorophyll *a* readings to non-CSLAP lakes in the same region, although there are a high percentage of non-CSLAP lakes in Long Island with very high algae levels (in the more urban areas).
3. Chlorophyll *a* levels in CSLAP lakes within the Downstate region are not strongly influenced by precipitation.
4. The frequency of lower than normal chlorophyll *a* readings has increased slightly in CSLAP lakes within the Downstate region, although this long-term trend is not significant. It is not known if this reflects active management (through the use of algacides) or a real change, particularly since similar changes have not been apparent with either phosphorus or water clarity.
5. Chlorophyll *a* readings in the Downstate region are highest in the interior and southern portion of the region, and lowest in the northern and western portions of the region. Many of the lakes in the southern portion of the region are *eutrophic*, at least as defined by chlorophyll *a* readings.
6. Chlorophyll *a* readings were lower than normal in 2009 in the Downstate region, perhaps due to much stronger weather influences in this part of the state.



Figures 3.2.1 and 3.2.2: Distribution of Chlorophyll *a* Ranges in CSLAP and Downstate Region Lakes

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region, particularly in Long Island, are more productive than in most other regions of the state, as measured by higher chlorophyll *a* readings and as demonstrated in Figure 3.2.1. The most common range of chlorophyll *a* readings in CSLAP

Downstate region lakes is in the 5-15 ppb range, typical of *mesotrophic* to *eutrophic* lakes, although a small percentage of Downstate lakes exhibit higher (and lower) algae levels. A larger number of Downstate region lakes have chlorophyll *a* readings above 20 ppb, as seen in Figure 3.2.2.

Comparison of CSLAP to NYS Lakes in the Downstate Region

The chlorophyll *a* distribution of CSLAP and non-CSLAP lakes region lakes in the Downstate region is mostly similar, as seen in Figure 3.2.3. The exception to this is in Long Island, where many highly (sub) urban non-CSLAP lakes have very high algae levels. Otherwise, this suggests that the CSLAP dataset is representative of typical conditions in this region.

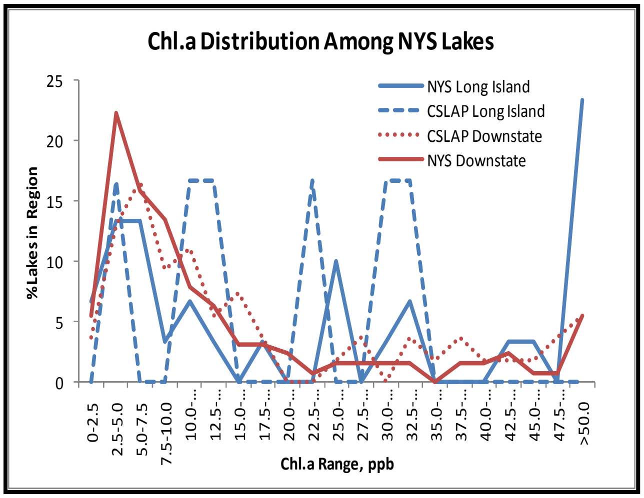


Figure 3.2.3: Average Distribution of Chlorophyll *a* Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

Chlorophyll *a* has varied significantly from year to year in Downstate region lakes, as in most other regions of the state. The highest chlorophyll *a* readings measured through CSLAP occurred during 1987, 1991, 1996, and 1990. These generally did not occur in very wet or very dry years. The lowest chlorophyll *a* readings occurred in 1986, 2002, 1997, 2003, and 2007, mostly neither dry nor wet years. Table 3.2.1 looks at the percentage of CSLAP lakes with high chlorophyll *a* (greater than 1 standard error above normal) and low chlorophyll *a* (greater than 1 standard error below normal) readings in wet and dry years. These data show that changes in chlorophyll *a* readings in the Downstate region are not strongly correlated to precipitation.

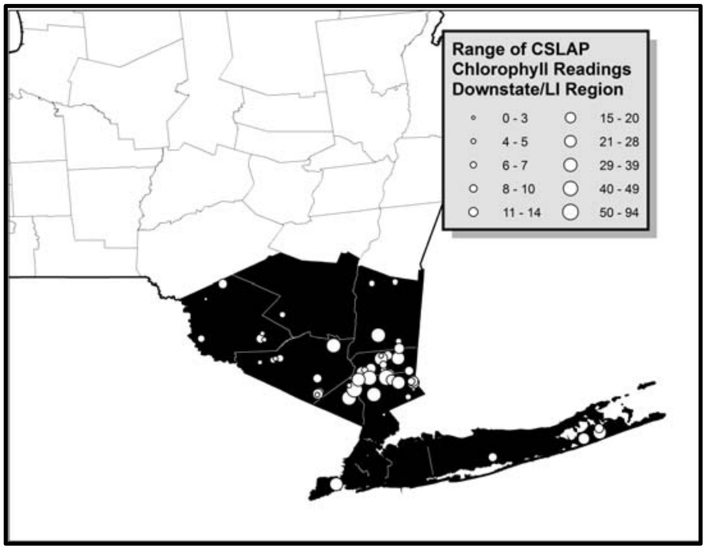
Table 3.2.1- % of CSLAP Lakes with Higher or Lower (than Normal) Chlorophyll *a* Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Chlorophyll *a*	22%	25%
Lower Chlorophyll *a*	22%	23%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of lower chlorophyll *a* readings has increased, particularly if the elevated (and perhaps erroneous) chlorophyll readings from 1987 are removed from the database. It is not known if this is due to algacides or more "natural" changes, but this "trend" is not statistically significant.



Figures 3.2.4: Range of Chlorophyll Readings in the Downstate Region

Regional Distribution:

Chlorophyll *a* readings with the Downstate region are highest in the "interior" portion of the region, consistent with the subregional pattern in total phosphorus readings. Lower algae levels are apparent in the northern and western portion of the region, corresponding to more rural or undeveloped portions of the region, as seen in Figure 3.2.4. Many of the lakes in the southern portion of this region (Putnam County and south) can be classified as *eutrophic*, or highly productive. The lowest readings in this region are found in lakes that can be classified as *mesotrophic* to *mesoligotrophic*, or moderately to highly unproductive. The trophic assessments of these lakes are discussed in the Trophic State Indicators section later in this report.

Table 3.2.2 shows the number of chlorophyll *a* samples, the minimum, average, and maximum chlorophyll *a* readings, the most common trophic assessment for the lake, the last year in which the lake was sampled through CSLAP, and whether chlorophyll *a* readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009.

Table 3.2.2: Surface Chlorophyll *a* Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	Change?
Anawanda Lake	1988-2009	144	0.06	2.93	40.50	Mesotrophic	No
Anawanda Lake	2009	8	1.85	2.97	6.10	Mesotrophic	No
Blue Heron Lake	2005-2008	24	1.92	7.23	28.90	Mesotrophic	
Cranberry Lake	2004-2004	7	1.00	1.89	2.70	Oligotrophic	
Gossamans Pond	2003-2005	22	0.61	16.40	39.80	Eutrophic	
Highland Lake	2003-2009	31	0.68	3.73	9.64	Mesotrophic	
Highland Lake	2009	5	2.19	4.63	6.90	Mesotrophic	No
Hillside Lake	1994-1997	13	2.70	41.66	136.00	Eutrophic	
Indian Lake	1994-2009	72	0.05	7.30	40.40	Mesotrophic	No
Indian Lake	2009	8	0.50	9.02	28.20	Eutrophic	No
Katonah Lake	2006-2009	31	2.29	38.00	105.12	Eutrophic	
Katonah Lake	2009	7	9.87	31.58	51.30	Eutrophic	No
Lake Carmel	1986-1990	51	3.94	38.80	259.00	Eutrophic	No
Lake Celeste	1993-1997	26	4.38	25.42	80.50	Eutrophic	
Lake Guymard	1996-2003	46	0.14	3.85	18.30	Mesotrophic	No
Lake Kitchawan	2008-2008	1	0.31	0.31	0.31	Oligotrophic	

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	Change?
Lake Lincolndale	1993-2009	109	3.70	35.60	176.02	Eutrophic	No
Lake Lincolndale	2009	5	7.63	19.58	40.00	Eutrophic	Lower
Lake Lucille	1986-1990	55	0.21	44.76	289.00	Eutrophic	No
Lake Mahopac	1986-2002	71	0.73	8.16	39.00	Eutrophic	No
Lake Meahagh	1999-2001	10	7.30	93.93	173.94	Eutrophic	
Lake Mohegan	1998-2009	80	0.73	47.59	160.00	Eutrophic	No
Lake Mohegan	2009	8	22.20	55.56	160.00	Eutrophic	No
Lake Nimham	1991-1995	41	1.40	11.84	72.20	Eutrophic	No
Lake Oscaleta	2006-2009	35	0.28	9.77	58.10	Eutrophic	
Lake Oscaleta	2009	8	4.20	7.04	15.27	Mesotrophic	Lower
Lake Oscawana	1991-1995	37	2.32	18.74	64.60	Eutrophic	No
Lake Ossi	1996-2000	36	1.57	10.23	28.00	Eutrophic	No
Lake Peekskill	1990-2009	93	0.29	12.35	47.20	Eutrophic	No
Lake Peekskill	2009	7	1.46	7.69	15.20	Mesotrophic	Lower
Lake Rippowam	2006-2009	34	3.20	15.94	107.22	Eutrophic	
Lake Rippowam	2009	8	6.20	12.54	26.45	Eutrophic	Lower
Lake Tibet	1991-1993	23	1.99	34.30	305.00	Eutrophic	
Lake Truesdale	1999-2009	85	0.24	27.82	116.00	Eutrophic	No
Lake Truesdale	2009	8	1.30	26.32	64.96	Eutrophic	No
Lake Waccabuc	1986-2009	107	0.17	8.92	41.01	Eutrophic	No
Lake Waccabuc	2009	8	4.30	8.61	21.45	Eutrophic	No
Lake Wanaksink	1991-1995	39	2.92	5.08	9.49	Mesotrophic	No
Little We Wah Lake	2008-2009	16	3.62	16.83	41.98	Eutrophic	
Little We Wah Lake	2009	8	3.62	9.58	19.25	Eutrophic	Lower
Monhagen Lake	2003-2009	30	1.59	7.91	25.24	Mesotrophic	
Monhagen Lake	2009	5	5.74	8.16	9.60	Eutrophic	No
Orange Lake	1994-2005	51	2.08	48.85	152.60	Eutrophic	No
Peach Lake	1999-2008	69	0.30	13.15	45.28	Eutrophic	No
Plum Brook Lake	2005-2008	30	1.34	19.89	91.45	Eutrophic	
Roaring Brook Lake	2009-2009	8	1.30	3.28	4.80	Mesotrophic	
Roaring Brook Lake	2009	8	1.30	3.28	4.80	Mesotrophic	No
Round Lake	1992-1996	40	1.99	12.09	63.30	Eutrophic	No
Sagamore Lake	1994-1997	32	0.54	5.06	18.00	Mesotrophic	
Sepasco Lake	1997-2009	89	0.11	5.78	26.80	Mesotrophic	No
Sepasco Lake	2009	7	1.02	8.46	26.80	Eutrophic	Higher
Shadow Lake	2008-2009	12	7.72	47.18	356.00	Eutrophic	
Shadow Lake	2009	5	8.15	14.48	17.80	Eutrophic	Lower
Shawangunk Lake	2003-2009	29	1.20	7.47	49.48	Mesotrophic	
Shawangunk Lake	2009	5	3.52	18.36	49.48	Eutrophic	Higher
Shenorock Lake	2004-2009	45	1.33	70.21	1017.20	Eutrophic	
Shenorock Lake	2009	8	2.65	58.77	363.00	Eutrophic	No
Stissing Lake	2007-2009	24	0.10	5.50	48.72	Mesotrophic	
Stissing Lake	2009	8	0.10	1.81	8.35	Oligotrophic	Lower
Teatown Lake	1997-2009	82	0.69	28.49	165.90	Eutrophic	No
Teatown Lake	2009	5	5.80	10.60	14.75	Eutrophic	Lower
Timber Lake (Sullivan)	2004-2008	28	1.10	12.06	25.58	Eutrophic	
Timber Lake (Westchester)	2006-2009	16	7.15	13.19	28.00	Eutrophic	
Timber Lake	2009	8	7.15	11.92	28.00	Eutrophic	No
Tomkins Lake	2001-2001	8	1.56	3.73	6.80	Mesotrophic	
Tuxedo Lake	2008-2009	16	0.10	4.26	9.24	Mesotrophic	
Tuxedo Lake	2009	8	0.10	4.77	9.24	Mesotrophic	No
Ulster Heights Lake	2007-2009	14	1.20	6.03	10.82	Mesotrophic	
Ulster Heights Lake	2009	4	1.20	6.25	9.70	Mesotrophic	No
Wallace Pond	2004-2008	29	2.30	33.10	99.52	Eutrophic	No
We Wah Lake	2008-2009	16	0.55	16.17	39.24	Eutrophic	

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	Change?
We Wah Lake	2009	8	4.35	17.66	39.24	Eutrophic	No
Weiden Pond	2004-2009	38	0.30	8.72	33.36	Eutrophic	No
Weiden Pond	2009	5	0.30	4.48	11.94	Mesotrophic	Lower
Whaley Lake	1998-2001	31	1.88	6.59	14.60	Mesotrophic	
Wolf Lake	1987-2001	90	0.51	13.48	94.90	Eutrophic	No
Yankee Lake	2006-2009	29	0.69	4.17	7.48	Mesotrophic	
Yankee Lake	2009	7	3.40	4.42	6.04	Mesotrophic	No
Black Pond	2008-2009	13	0.27	32.02	95.58	Eutrophic	
Black Pond	2009	8	10.80	36.28	62.00	Eutrophic	No
Bradys Pond	1997-2001	33	0.55	33.85	104.00	Eutrophic	No
Canaan Lake	1990-2005	79	0.17	13.82	472.00	Eutrophic	Decreasing
Lily Pond	2008-2009	13	1.20	11.51	46.20	Eutrophic	
Lily Pond	2009	8	1.20	9.35	46.20	Eutrophic	No
Little Fresh Pond	1989-2009	97	0.42	23.26	199.40	Eutrophic	No
Little Fresh Pond	2009	8	1.30	20.79	47.70	Eutrophic	No
Little Long Pond	2006-2009	14	0.10	2.52	10.14	Mesotrophic	
Little Long Pond	2009	3	0.10	1.16	3.28	Oligotrophic	Lower

Num = number of samples
Min, Avg, Max = minimum, average, and maximum chlorophyll *a* readings, in ug/l
Change? = exhibiting significant change in chlorophyll *a* readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on chlorophyll *a* readings >25% higher or lower than normal

Canaan Lake may be the only lake within the Downstate region that has exhibited significant long-term trends in chlorophyll *a* readings, although this trend was not mirrored by a similar change in phosphorus readings over the same period. The lack of long-term change in most lakes is due in part to the lack of statistical change from year to year due to high variability in chlorophyll *a* readings in lake surface samples, owing to the patchy growth of algae within the water column and throughout the surface waters or lakes.

The decrease in chlorophyll *a* readings in Canaan Lake may be in response to either reduced conversion of macrophytes (primarily variable watermilfoil and fanwort) to soluble nutrients and algae by stocked grass carp, or due to preferential use of nutrients by these rooted plants.

Tables 3.2.3a and 3.2.3b summarize the surface chlorophyll *a* data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Chlorophyll *a* readings in the CSLAP lakes in the Downstate region in 2009 were lower than those reported in previous years. The percentage of lakes with lower than normal chlorophyll *a* readings in 2009 was much higher than the percentage of lakes with higher than normal readings, although for most of these lakes, the lower algae levels in 2009 were still within the historical range for the lake. This occurred despite phosphorus readings in the Downstate region that were close to normal in 2009.

Table 3.2.3a: Surface Chlorophyll *a* Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical
Downstate	32	0.1	15.7	19.5	363	*Eutrophic*
Central	36	0.1	5.8	11.5	87.8	*Mesotrophic*
Adirondacks	33	0.1	3.9	4.9	26.2	*Mesotrophic*
Western	9	0.1	19.8	14.8	160	*Eutrophic*
CSLAP Statewide	**110**	**0.1**	**9.2**	**11.8**	**363**	***Eutrophic***

Table 3.2.3b: Surface Chlorophyll *a* Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	15.7	19.5	9	32	26	29
Central	36	5.8	11.5	6	64	6	18
Adirondacks	33	3.9	4.9	21	30	9	9
Western	9	19.8	14.8	33	44	22	33
CSLAP Statewide	**110**	**9.2**	**11.8**	**14**	**43**	**14**	**19**

% Higher = percentage of lakes in region with Chl.a readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with Chl.a readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with Chl.a readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with Chl.a readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Chlorophyll a in 2009:
Sepasco Lake, Shawangunk Lake

Discussion:

Two Downstate region lakes exhibited higher than normal chlorophyll *a* readings in 2009. The higher average chlorophyll *a* readings in Sepasco Lake in 2009 were driven by an early August algal bloom, consistent with higher than normal phosphorus readings and lower than normal water clarity. This also corresponded to a period of very wet weather and a recent herbicide treatment, although the chlorophyll *a* readings dropped back to normal within four weeks. Algae levels in Shawangunk Lake were consistently higher in 2009, particularly after an early August bloom (despite normal phosphorus readings). It is not known if this was due to normal variability or driven by unusual weather conditions.

Downstate Region Lakes With Lower Than Normal Chlorophyll a in 2009:
Lake Lincolndale, Lake Oscaleta, Lake Peekskill, Lake Rippowam, Little Long Pond, Little We Wah Lake, Shadow Lake, Stissing Lake, Teatown Lake, Weiden Pond

Discussion:

Chlorophyll *a* readings in 2009 were lower than normal in 10 Downstate region lakes, including three lakes (Lake Oscaleta, Little We Wah Lake, and Shadow Lake) with lower than normal phosphorus readings. None of these 10 lakes has exhibited any long-term decrease in algae levels, although the long-term database on some of these lakes is too short to evaluate long-term trends.

Lake Oscaleta, Lake Rippowam and Little Long Pond exhibited only slightly lower than normal chlorophyll *a* readings than normal in 2009. This was coincident with reports of very heavy rains, particularly through the middle of the summer, at most of these lakes. It is assumed that the drop in algae levels in these lakes was associated with either higher flushing rates or less sun.

Chlorophyll *a* readings were much lower than normal in the rest of these lakes. None of these lakes exhibited much higher than normal water clarity readings, and lower water clarity was reported in Lake Lincolndale and Weiden Pond. Although reports of high water level and wet weather were also common in the rest of the lakes in this group, the drop in algae levels was much higher than in other regions of the state and not accompanied by a significant change in water clarity or phosphorus readings. For these lakes, the decreasing chlorophyll *a* readings may not have been a real phenomenon, although it is possible that the drop in chlorophyll *a* readings in 2009 was due to a much strong effect of wet weather in this part of the state. The relationship between chlorophyll *a* and weather in CSLAP lakes will continue to be investigated.

Water Clarity Fact Sheet

Description:	a measure of the transparency of the water, as measured by the depth of disappearance of a 20cm black and white disk, using a method developed in the mid 1860s by Pietro Angelo Secchi and standardized through nearly all lake monitoring programs.
Importance:	in lakes with low color and rooted macrophyte ("weed") levels, water clarity is related to algal productivity and the greenness of water. Water clarity is closely related to public perception of lake conditions, and is a trigger for the development of lake restoration and protection plans. Water transparency also influences the depth of macrophyte growth, the depth of the thermocline (the zone separating the surface warm water and deeper cold waters), and in turn is influenced by dissolved organic matter (natural water color), and suspended inorganic turbidity, primarily sediment and silt.
How Measured: in CSLAP	Secchi disk transparency is computed as the average of the depth at which the Secchi disk disappears from sight from the lake surface and the depth at which the disk reappears, both measured to the nearest 0.1 meter. Samplers are instructed to take readings from the shady side of the boat (if available) and not to use viewscopes or polarized lenses.
Detection Limit:	limited only by size of disk. Larger disks are used in very (>20m) clear water—not needed in NYS.
Range in NYS:	0.1 meters to 16 meters; 93% of readings fall between 1 meter and 8 meters.
WQ Standards:	none in New York State, although numeric water clarity guidance values will likely be developed as part of the nutrient criteria development process. The state Department of Health requires 4 feet (=1.2 meters) of water clarity in three locations to site a new swimming beach, although this is not a DOH requirement for maintaining the beach.
Trophic Assessment:	New York State's trophic assessments differ slightly from the standard Carlson assessment criteria. Water clarity readings less than 2 meters, both within NYS and using the Carlson indices, are considered *eutrophic*, or highly productive. Readings exceeding 5 meters in New York State, and 4 meters using the Carlson indices, are considered *oligotrophic*, or highly unproductive. Lakes in the intermediate range are considered *mesotrophic*. The differences between the New York State and Carlson criteria are discussed in Chapter 3.4
Nomenclature:	The terms *water clarity* and *water transparency* (or *Secchi disk transparency*) are used interchangeably throughout this report.

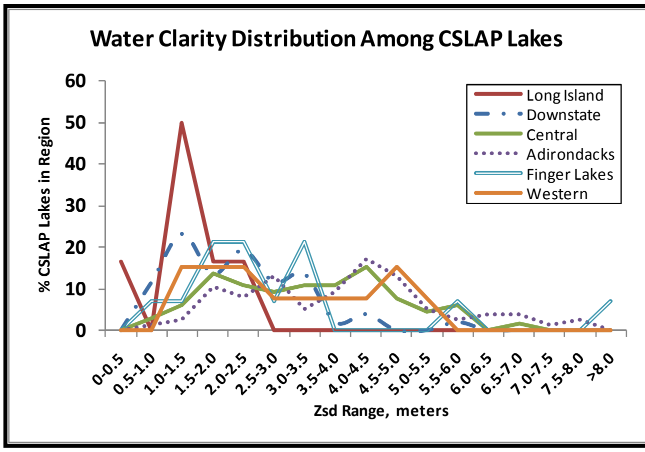
Chapter 3.3- Evaluation of Downstate Region Water Clarity: 1986-2009

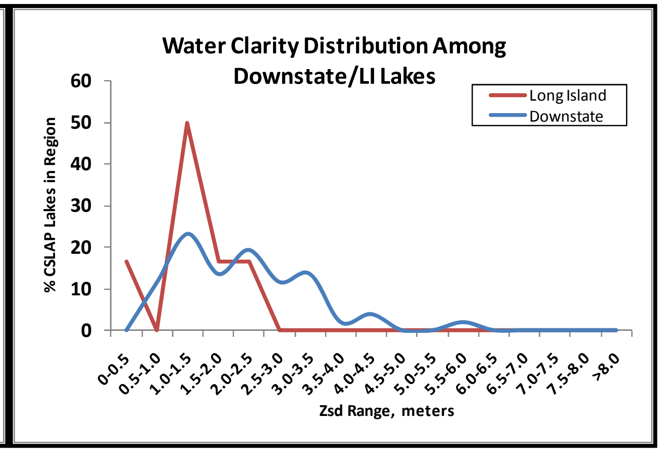
Summary of CSLAP Water Clarity Findings in Downstate Region Lakes, 1986-2009

1. CSLAP lakes within the Downstate region have lower water clarity readings than those in most other parts of the state, with the majority of lakes having typical water clarity readings in the 1-2.5 meter range, corresponding to *eutrophic* conditions.
2. CSLAP lakes within the Downstate region have similar water clarity readings than non-CSLAP lakes in the same region, although the Long Island lakes (sampled more intensively in non-CSLAP monitoring programs) tend to have lower water clarity.
3. The relationship between precipitation and water clarity in CSLAP lakes within the Downstate region is not strong.
4. The frequency of much higher and much lower than normal water clarity readings has decreased in CSLAP lakes within the Downstate region, suggesting an increasing stability in water clarity, although these trends are not statistically robust.
5. Water clarity readings are lowest in the southern (NYC suburb and Long Island) portions of the region, and highest in the northern and western portions of the region. This is consistent with the chlorophyll *a* and total phosphorus patterns. Lakes in the southern portion of the region regularly exhibit water clarity readings lower than the NYSDOH guidance for siting new swimming beaches.
6. Water clarity readings in Downstate region lakes were similar in 2009 to those reported in the typical CSLAP sampling season from 1986 to 2008, despite lower algae levels over the same period.
7. A higher percentage of Downstate region lakes exhibited lower than normal water clarity readings in 2009. For most of these lakes, small differences in water clarity from year to year are probably mediated by changing weather patterns (most likely wetter weather and higher water levels) rather than any real changes in the lake, although each of these lakes also exhibited lower algae levels (and higher water color readings).

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region, particularly Long Island, are less productive than those in most other regions of the state, as measured by lower water clarity readings and as demonstrated in Figure 3.3.1. The most common range of water clarity readings in CSLAP Downstate region lakes is in the 1-2.5 meter range, whether in shallow or deep lakes. A low percentage of Downstate region lakes have water clarity readings above 3.5 meters, as seen in Figure 3.3.2.





Figures 3.3.1 and 3.3.2: Distribution of Water Clarity Ranges in CSLAP and Downstate Region Lakes

Comparison of CSLAP to NYS Lakes in the Downstate Region

Water clarity readings in CSLAP lakes in the Downstate region are similar to those recorded in other (non-CSLAP) lakes in the region, as seen in Figure 3.3.3. The non-CSLAP dataset also includes slightly higher frequency of lakes with low (< 1 meter) water clarity, probably due to the higher frequency of shallow (Long Island) lakes sampled in monitoring programs outside of CSLAP. However, the general distribution of water clarity readings is similar in CSLAP and non-CSLAP lakes.

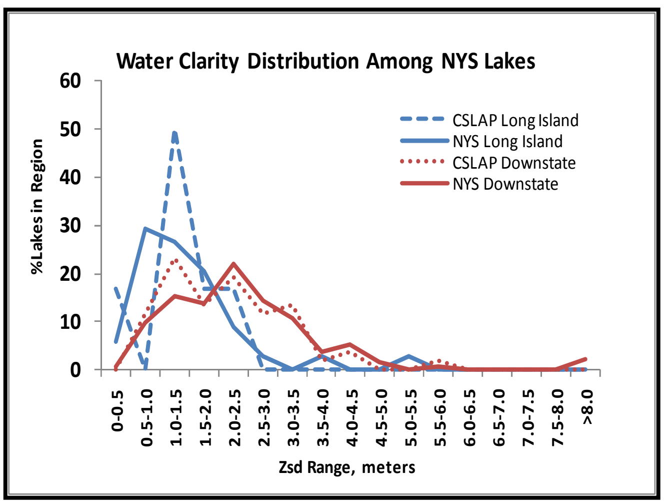


Figure 3.3.3: Average Distribution of Water Clarity Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

Water clarity has been fairly stable in most NYS lakes, including those in the Central region. The lowest water clarity readings measured through CSLAP occurred during 1987, 1996 and 2008 in the Downstate region, mostly wet years. The highest water clarity readings occurred in 1997, 1986 and 2003, also wet years. Table 3.3.1 looks at the percentage of CSLAP lakes with high water transparency (greater than 1 standard error above normal) and low water transparency (greater than 1 standard error below normal) readings in wet and dry years. These data show that high water clarity readings are somewhat more likely to occur in wet years, but the relationship between precipitation and water clarity is not strong.

Table 3.3.1- % of CSLAP Lakes with Higher or Lower (than Normal) Water Clarity Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Water Clarity	27%	25%
Lower Water Clarity	27%	18%

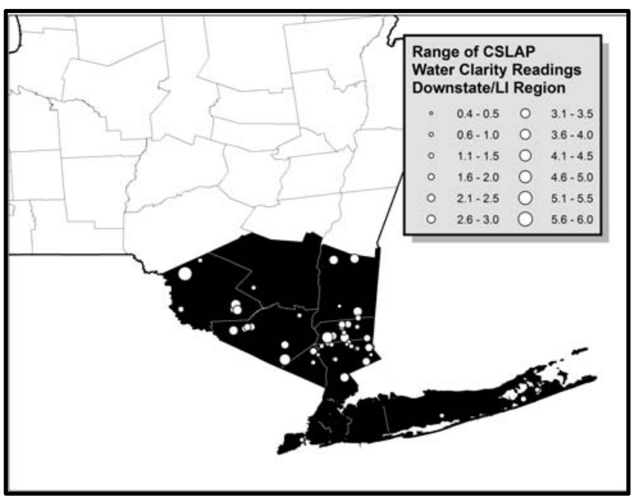
Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

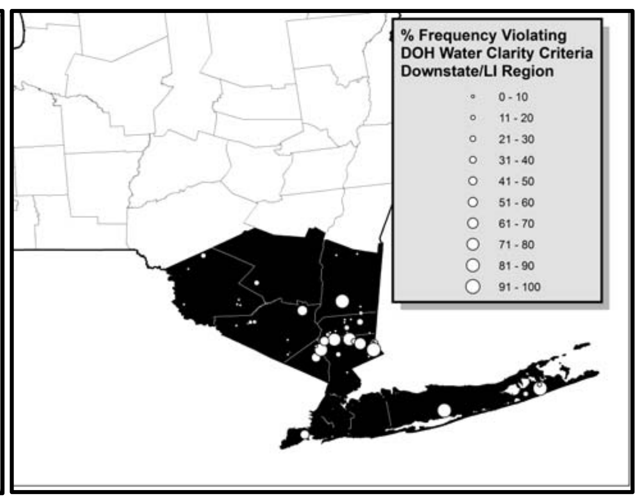
Long Term Trends:

The evaluation of long-term trends since 1986 in any specific region of the state, including Downstate region lakes, is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of significantly higher and lower than normal water transparency readings has decreased over time, although this trend is not strong. These data indicate that water clarity readings may be stabilizing over time, although it is likely that long-term changes in water transparency is more likely to be related to year to year changes in weather patterns than any true long-term trends.

Regional Distribution:

Water clarity readings are highest in the northern and western portions of the region, and lowest in the southern portion of the region, including Long Island, as seen in Figure 3.3.4. This is consistent with the (sub) regional patterns in algae and nutrient levels. A high percentage of lakes within the interior and southern portions of this region, corresponding to the NYC suburbs and Long Island, fail to reach the state water clarity criteria (to protect swimming safety), as seen in Figure 3.3.5. Most of these lakes can be characterized as *eutrophic*, although the range from *oligotrophic* to *eutrophic* is common in other lakes within this region.





Figures 3.3.4 and 3.3.5: Range of Water Clarity Readings and Frequency of Violating the DOH Water Clarity Criteria in the Downstate Region

Table 3.3.2 shows the number of water clarity samples, the minimum, average, and maximum water clarity readings, the most common trophic assessment for the lake, the frequency of violating the state water clarity criteria, the last year in which the lake was sampled through CSLAP, and whether water transparency readings have changed since CSLAP sampling began in the lake (through 2008).

Table 3.3.2: Water Clarity Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	%Violating Zsd Criteria	Change?
Anawanda Lake	1988-2009	150	2.00	5.85	8.78	Oligotrophic	0	No
Anawanda Lake	2009	8	4.06	5.24	6.55	Oligotrophic	0	No
Blue Heron Lake	2005-2008	24	1.60	2.96	4.00	Mesotrophic	0	
Cranberry Lake	2004-2004	8	2.45	3.06	3.38	Mesotrophic	0	
Gossamans Pond	2003-2005	23	1.08	1.61	2.40	Eutrophic	17	
Highland Lake	2003-2009	32	0.75	2.16	3.85	Mesotrophic	9	
Highland Lake	2009	5	1.65	2.21	2.85	Mesotrophic	0	No
Hillside Lake	1994-1997	13	0.30	0.60	1.00	Eutrophic	100	
Indian Lake	1994-2009	76	0.75	4.05	6.38	Mesotrophic	3	No
Indian Lake	2009	8	1.00	3.03	4.50	Mesotrophic	13	Lower
Katonah Lake	2006-2009	30	0.33	0.99	2.40	Eutrophic	80	
Katonah Lake	2009	7	0.71	0.98	1.33	Eutrophic	86	No
Lake Carmel	1986-1990	58	0.33	1.33	2.50	Eutrophic	40	No
Lake Celeste	1993-1997	26	0.50	1.62	3.05	Eutrophic	19	
Lake Guymard	1996-2003	46	1.30	3.07	4.50	Mesotrophic	0	No
Lake Kitchawan	2008-2008	1	0.65	0.65	0.65	Eutrophic	100	
Lake Lincolndale	1993-2009	113	0.50	1.35	3.50	Eutrophic	49	No
Lake Lincolndale	2009	5	0.75	0.95	1.00	Eutrophic	100	Lower
Lake Lucille	1986-1990	63	0.05	1.18	2.50	Eutrophic	57	No
Lake Mahopac	1986-2002	79	1.50	3.33	5.50	Mesotrophic	0	Increasing
Lake Meahagh	1999-2001	10	0.10	0.52	2.00	Eutrophic	90	
Lake Mohegan	1998-2009	89	0.48	1.00	2.90	Eutrophic	82	No
Lake Mohegan	2009	8	0.63	0.90	1.10	Eutrophic	100	No
Lake Nimham	1991-1995	41	1.00	2.09	2.75	Mesotrophic	5	No
Lake Oscaleta	2006-2009	33	0.50	2.82	4.05	Mesotrophic	3	
Lake Oscaleta	2009	9	1.85	2.84	3.55	Mesotrophic	0	No
Lake Oscawana	1991-1995	36	1.29	2.72	5.00	Mesotrophic	0	No
Lake Ossi	1996-2000	34	1.03	1.46	1.77	Eutrophic	21	No
Lake Peekskill	1990-2009	98	1.04	2.16	4.50	Mesotrophic	6	No
Lake Peekskill	2009	7	1.20	1.86	2.45	Eutrophic	0	No
Lake Rippowam	2006-2009	33	0.53	2.20	3.30	Mesotrophic	3	
Lake Rippowam	2009	9	1.80	2.44	3.30	Mesotrophic	0	No
Lake Tibet	1991-1993	23	1.25	1.68	2.00	Eutrophic	0	
Lake Truesdale	1999-2009	88	0.53	1.24	2.70	Eutrophic	59	No
Lake Truesdale	2009	8	0.68	1.22	2.68	Eutrophic	63	No
Lake Waccabuc	1986-2009	112	1.10	2.92	5.00	Mesotrophic	1	No
Lake Waccabuc	2009	9	1.90	3.07	3.90	Mesotrophic	0	No
Lake Wanaksink	1991-1995	40	2.63	3.68	6.50	Mesotrophic	0	No
Little We Wah Lake	2008-2009	15	1.20	2.01	2.90	Mesotrophic	0	
Little We Wah Lake	2009	7	1.35	2.30	2.90	Mesotrophic	0	No
Monhagen Lake	2003-2009	31	0.80	2.01	3.10	Mesotrophic	13	
Monhagen Lake	2009	5	1.10	1.59	2.15	Eutrophic	20	Lower
Orange Lake	1994-2005	59	0.45	1.17	3.44	Eutrophic	64	No
Peach Lake	1999-2008	74	1.13	2.15	4.15	Mesotrophic	1	No
Plum Brook Lake	2005-2008	30	0.75	1.12	1.25	Eutrophic	30	
Roaring Brook Lake	2009-2009	8	1.25	2.21	3.05	Mesotrophic	0	
Roaring Brook Lake	2009	8	1.25	2.21	3.05	Mesotrophic	0	No
Round Lake	1992-1996	39	1.25	2.97	4.68	Mesotrophic	0	No
Sagamore Lake	1994-1997	32	1.15	2.08	3.65	Mesotrophic	6	

Lake Name	Years	Num	Min	Avg	Max	Trophic Category	%Violating Zsd Criteria	Change?
Sepasco Lake	1997-2009	96	1.70	3.39	5.45	Mesotrophic	0	No
Sepasco Lake	2009	8	1.70	2.92	3.80	Mesotrophic	0	No
Shadow Lake	2008-2009	12	0.90	1.44	1.75	Eutrophic	17	
Shadow Lake	2009	5	1.45	1.61	1.75	Eutrophic	0	No
Shawangunk Lake	2003-2009	29	1.10	2.32	4.35	Mesotrophic	7	
Shawangunk Lake	2009	5	1.10	1.65	1.95	Eutrophic	20	Lower
Shenorock Lake	2004-2009	48	0.26	0.81	1.80	Eutrophic	73	
Shenorock Lake	2009	8	0.43	1.18	1.55	Eutrophic	25	Higher
Stissing Lake	2007-2009	19	1.00	2.93	6.00	Mesotrophic	5	
Stissing Lake	2009	7	1.93	2.39	3.20	Mesotrophic	0	No
Teatown Lake	1997-2009	84	0.70	1.57	3.50	Eutrophic	21	No
Teatown Lake	2009	5	1.30	1.66	2.40	Eutrophic	0	No
Timber Lake (Sullivan)	2004-2008	29	0.70	1.50	2.35	Eutrophic	24	
Timber Lake (Westchester)	2006-2009	16	0.99	1.62	3.00	Eutrophic	6	
Timber Lake	2009	8	1.25	1.54	1.80	Eutrophic	0	No
Tomkins Lake	2001-2001	8	1.50	2.12	2.79	Mesotrophic	0	
Tuxedo Lake	2008-2009	15	2.03	3.71	4.65	Mesotrophic	0	
Tuxedo Lake	2009	8	2.03	3.31	4.40	Mesotrophic	0	No
Ulster Heights Lake	2007-2009	14	0.78	1.28	2.30	Eutrophic	50	
Ulster Heights Lake	2009	4	0.78	0.95	1.05	Eutrophic	100	Lower
Wallace Pond	2004-2008	28	0.27	1.13	2.63	Eutrophic	57	No
We Wah Lake	2008-2009	16	1.55	2.26	3.50	Mesotrophic	0	
We Wah Lake	2009	8	1.55	2.24	3.35	Mesotrophic	0	No
Weiden Pond	2004-2009	38	0.85	1.76	2.55	Eutrophic	8	No
Weiden Pond	2009	5	1.25	1.36	1.60	Eutrophic	0	Lower
Whaley Lake	1998-2001	32	1.75	3.34	5.30	Mesotrophic	0	
Wolf Lake	1987-2001	95	1.50	2.54	4.40	Mesotrophic	0	No
Yankee Lake	2006-2009	30	1.75	2.93	8.15	Mesotrophic	0	
Yankee Lake	2009	7	2.00	2.65	3.13	Mesotrophic	0	No
Black Pond	2008-2009	13	0.27	0.41	0.53	Eutrophic	100	
Black Pond	2009	8	0.27	0.42	0.53	Eutrophic	100	No
Bradys Pond	1997-2001	35	0.45	1.04	2.00	Eutrophic	60	No
Canaan Lake	1990-2005	73	0.91	1.00	1.25	Eutrophic	99	No
Lily Pond	2008-2009	13	0.83	1.25	2.63	Eutrophic	46	
Lily Pond	2009	8	0.85	1.10	1.25	Eutrophic	63	No
Little Fresh Pond	1989-2009	101	0.50	1.93	7.25	Eutrophic	20	No
Little Fresh Pond	2009	7	1.15	1.45	1.90	Eutrophic	14	Lower
Little Long Pond	2006-2009	13	0.75	2.30	3.90	Mesotrophic	8	
Little Long Pond	2009	3	2.50	2.68	2.85	Mesotrophic	0	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum water clarity readings, in meters
% Violating Zsd Criteria = % of samples at each lake with water clarity < 1.2m, corresponding to the existing NYSDOH water clarity criteria for siting new swimming beaches
Change? = exhibiting significant change in water clarity readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on water clarity readings >25% higher or lower than normal

Only one lake in this region has exhibited any long-term change in water transparency readings. Water clarity readings in Lake Mahopac increased from 1986 to 1998, with an average water transparency of 2.9 meters in the 1980s and 3.9 meters in the 1990s. Water clarity was lower (average = 3.0 meters) in limited sampling in the lake in 2002, the last year of CSLAP sampling, so it is not known if the contemporary water transparency in the lake is closer to the 1980s or 1990s averages. It is also not known if the extensive grass carp stocking in the lake in the mid 1990s has resulted in any long-term water quality changes in the lake.

Tables 3.3.3a and 3.3.3b summarize the surface water clarity data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Water clarity readings in the CSLAP lakes in the Downstate region in 2009 were similar to those reported in previous years, whether evaluated by average water transparency readings or percent frequency of failing to reach the state water clarity criteria value (27% in 2009 and from 1986 to 2008). The percentage of lakes with lower than normal water clarity readings in 2009 was higher than the percentage of lakes with higher than normal readings, and a higher percentage of lakes established new maximum readings in 2009. This was consistent with the higher than normal water color readings in 2009, but inconsistent with lower than normal chlorophyll *a* readings over the same period. This may reflect (less favorable) changes in these lakes in response to wetter weather, particularly early in the 2009 CSLAP sampling season.

Table 3.3.3a: Water Clarity Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical	%Violating DOH Criteria
Downstate	32	0.3	2.0	2.0	6.6	*Mesotrophic*	27
Central	36	0.8	3.6	3.3	10.4	*Mesotrophic*	4
Adirondacks	33	1.0	3.8	3.9	9.8	*Mesotrophic*	2
Western	9	0.5	2.0	3.0	5.6	*Mesotrophic*	30
CSLAP Statewide	**110**	**0.3**	**3.1**	**3.1**	**10.4**	***Mesotrophic***	**12**

Table 3.3.3b: Water Clarity Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	2.0	2.0	4	21	21	25
Central	36	3.6	3.3	17	3	22	3
Adirondacks	33	3.8	3.9	6	12	9	6
Western	9	2.0	3.0	11	50	0	0
CSLAP Statewide	**110**	**3.1**	**3.1**	**9**	**15**	**17**	**10**

% Higher = percentage of lakes in region with water clarity (Zsd) readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with water clarity (Zsd) readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with Zsd readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with Zsd readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Water Clarity in 2009:
Shenorock Lake

Discussion:

Only one Downstate region lakes exhibited higher than normal water clarity readings in 2009. Water clarity readings in Shenorock Lake were slightly higher than normal in 2009, despite algae (chlorophyll *a*) readings that were close to normal and higher than normal water color. These data suggest that the rise in water transparency in 2009 reflects normal variability, since Shenorock Lake has not exhibited a long-term change in water clarity.

Downstate Region Lakes With Lower Than Normal Water Clarity in 2009:
Indian Lake, Lake Lincolndale, Little Fresh Pond, Monhagen Lake, Shawangunk Lake, Ulster Heights Lake, Weiden Pond

Discussion:

Water transparency readings were lower than normal in 7 Downstate region lakes in 2009. Water color readings in each of these lakes except Monhagen Lake were higher than normal, consistent with the pattern observed in many other New York State lakes (and perhaps reflecting wetter conditions). None of these lakes exhibited higher chlorophyll *a* or phosphorus readings in 2009, and none of these lakes has exhibited any clear long-term trends in water transparency. This suggests that the lower water clarity measured in these lakes in 2009 reflects normal variability or occurred in response to higher water color and/or wetter weather.

Chapter 3.4- Evaluation of Downstate Region Trophic State Indices (TSI)

Summary of Trophic State Findings in CSLAP Lakes

1. The percentage of CSLAP samples that are typical of *eutrophic* lakes, based on total phosphorus readings, is very similar to the percentage of samples characterized as *eutrophic* based on chlorophyll *a* and Secchi disk transparency readings
2. The strong correlation among the trophic indicators at the *mesotrophic-eutrophic* transition has significant implications for large scale water clarity monitoring to evaluate violations of the state phosphorus criteria, for reconciling differences between trophic category definitions in other regions of the country, and for evaluating similarities and differences among the trophic indicators.
3. Total phosphorus, chlorophyll *a*, and Secchi disk transparency readings yield similar trophic assessments in all regions of the state, although in the Downstate (Long Island/NYC) region, water clarity readings are lower than expected given the phosphorus and chlorophyll *a* readings in these lakes, due to the influence of water depth, turbidity, and rooted plants.
4. The Carlson Trophic State Index (TSI) calculations in New York state lakes have limited utility in determining trophic status, since trophic categories (*eutrophic, mesotrophic*, and *oligotrophic*) are defined differently in New York that in other states.
5. The most common trophic assessments in CSLAP lakes are between *mesoeutrophic* and *mesoligotrophic*.
6. The Adirondack region lakes have the lowest algal productivity, based on water clarity, phosphorus and chlorophyll *a* readings. This leads to lower TSI values than in the other regions.
7. The Downstate (Long Island/NYC) region has the highest algal productivity and the highest TSI values.
8. TSI-Phosphorus readings in the Adirondack region are lower than expected given the TSI values for water clarity and chlorophyll *a*. Water clarity may be reduced due to other factors (such as elevated color), and algae levels may be higher than expected in the Adirondack, Central and Western (Finger Lakes) regions due to efficiencies in converting nutrients to algae (relatively high soluble phosphorus)
9. Water clarity readings are slightly higher than expected in the Western region, perhaps due to the influence of zebra mussels.

What Is Trophic State?

The term *trophic* refers to nutrition, and originates from the Greek word *trophikos*, or food. In an ecological setting, it refers to the relationships among different organisms in the food chain. In a lake setting, the food chain, or more properly the food web, is based on phytoplankton, or algae. The amount of algae produced in a lake dictates the production of other organisms; hence, algae are referred to as the primary producers. Lakes with large amounts of algae (and other plants and animals) are called *eutrophic*, literally "well-nourished", and lakes with little biological production are called *oligotrophic*, or "scant(ly) nourished." Lakes with intermediate nourishment are called *mesotrophic*. *Eutrophication* is the process in which lakes become overly nourished, whether naturally or induced by human activities (*cultural eutrophication*). These definitions are not synonymous with water quality conditions or an indication of supporting lake use—many *eutrophic* lakes are highly productive sports fisheries, and many *oligotrophic* lakes do not support aquatic life, often due to high lake acidity imparted by acid rain. However, most ecologists and lake users will agree that either extreme conditions or a significant change in the *trophic state* of a lake represents a problem.

The trophic state of lakes can be defined both functionally—by measuring the actual biological production (*biomass*) in the system—and operationally—by measuring a few key indicators related to lake biomass. The former approach can be logistically difficult and costly. The latter approach can exploit a simple measure of algae biomass—chlorophyll *a*—and the relationship between algae and both the nutrients that drive algae growth—primarily phosphorus—and the lake changes observed by high algae production—changes in water transparency. Each of these water quality indicators—total phosphorus, chlorophyll *a*, and Secchi disk transparency—are measured through CSLAP in each water sampling session and can be used to quantitatively define the trophic state of the lake. Chapters 3.1, 3.2 and 3.3 in this report summarize the trophic condition of CSLAP lakes based on these indicators. Table 3.4.1 shows the trophic state ranges adopted in New York state and commonly used in other states (Carlson—see below). The small difference between these stems from the desire in New York state to use simple intervals, the recognition that trophic categories represent a continuum rather than clear delineations, and the fact that the New York state boundary between *mesotrophic* and *eutrophic* lakes are closely matched, as discussed later in this chapter.

Table 3.4.1: Trophic Ranges For Water Quality Indicators

	Oligotrophic		*Mesotrophic*		*Eutrophic*	
	Carlson	**NYS**	**Carlson**	**NYS**	**Carlson**	**NYS**
Phosphorus	<12 µg/l	<10 µg/l	12-24 µg/l	10-20 µg/l	>24 µg/l	>20 µg/l
Secchi Disk Transparency	>4 m	>5 m	2-4 m	2-5 m	<2 m	<2 m
Chlorophyll *a*	<2.6 µg/l	<2 µg/l	2.6-7.3 µg/l	2-8 µg/l	>7.3 µg/l	>8 µg/l

The relationship among these indicators has been explored by limnologists—lake scientists—for many years. Dr. Robert Carlson from Kent State University developed an index that places each of these trophic indicators on the same (logarithmic) scale. This allows each of these indicators to be used to define the trophic state of any lake, and to compare these indicators in a way that might provide some additional insights about the algal dynamics in lakes. The equations used by Dr. Carlson to define the *Trophic State Index (TSI)* for a set of midwestern US lakes in the mid 1970s are as follows (ln = natural logarithm in all equations):

TSI (water clarity) = 60 – 14.41 x ln(Zsd), where Zsd = Secchi disk transparency in meters
TSI (phosphorus) = 14.42 x ln(TP) + 4.15, where TP = total phosphorus in µg/l
TSI (chlorophyll *a*) = 9.81 x ln(Chl.a) + 30.6, where Chl.a = chlorophyll *a* in µg/l

Dr. Carlson developed these trophic state indices so that TSI values in a range between 40 and 50 would correspond to *mesotrophic* conditions for each of these trophic indicators, with higher TSI values corresponding to *eutrophic* conditions, and lower TSI values attributed to *oligotrophic* conditions. The same TSI values can be compared to the trophic categories defined in New York state and shown in Table 3.4.1; these TSI ranges are exhibited in Table 3.4.2.

Table 3.4.2: TSI Ranges For Trophic Categories

	Oligotrophic		***Mesotrophic***		***Eutrophic***	
	Carlson	**NYS**	**Carlson**	**NYS**	**Carlson**	**NYS**
Phosphorus	<40	<37	40-50	37-47	>50	>47
Secchi Disk Transparency	<40	<37	40-50	37-50	>50	>50
Chlorophyll *a*	<40	<37	40-50	37-51	>50	>51

A comparison of the TSI ranges in New York state (based on the trophic categories listed in Table 3.4.1) and the Carlson TSI ranges show that the transition from *oligotrophic* and *mesotrophic* consistently occurs at a TSI of 37, compared to a TSI of 40 for the Carlson trophic categories.

The transition from *mesotrophic* to *eutrophic* is somewhat more variable in the New York state TSI ranges, falling between a TSI of 47 (using phosphorus as the trophic status indicator) and a TSI of 51 (using chlorophyll *a* as the trophic status indicator). However, although the transitional TSI values for the New York state trophic categories may not be easy to remember—this was one of the reasons that 40 and 50 were chosen by Carlson for transitional values—the corresponding values for each of these water quality indicators are easily remembered integers (10 and 20 µg/l for phosphorus, 2 and 5 meters for water clarity, and 2 and 8 µg/l for chlorophyll *a*). More importantly, the transitional water quality values between mesotrophy and eutrophy are closely aligned in New York state lakes, and at least at present correspond to the state phosphorus guidance value.

Table 3.4.3 shows the regional frequency of CSLAP samples in which the *eutrophic* conditions are first reached (total phosphorus > 20 µg/l, chlorophyll *a* > 8 µg/l, and Secchi disk transparency < 2 meters). There are some regional differences—for example, the frequency of high algae levels is slightly lower in the Long Island/NYC region than expected given the phosphorus readings in these lakes. This is probably due to high turbidity in shallow lakes reducing light availability for algae growth, and due to the influence of excessive weeds that reduce algae growth without influencing the amount of phosphorus in the water (since most of these rooted plants either draw most of their nutrition from the water or pump sediment-bound nutrients into the water). Water clarity is also lower than expected, due in part to shallow water and wind-induced turbidity in these shallow lakes. But in every other region of the state, there is a very strong connection among these trophic indicators and the transitional values used in New York state to define the boundary between *mesotrophic* and *eutrophic* lakes. On a statewide basis, 33% of the CSLAP total phosphorus samples exceeded 20 µg/l, 32% of the chlorophyll *a* readings exceeded 8 µg/l, and 32% of the water clarity readings fell below 2 meters.

Table 3.4.3- Frequency of CSLAP Samples at the *Mesotrophic-Eutrophic* Boundary

	Number Lakes	% TP >20 µg/l	% Zsd <2 m	% Chl.a > 8 µg/l
Downstate	57	56	52	48
Central	68	30	29	33
Adirondacks	77	11	16	14
Western	27	49	40	48
CSLAP Statewide	**229**	**33**	**32**	**32**

%TP, Zsd, Chl.a = % of CSLAP samples in region in which total phosphorus (TP) and chlorophyll *a* (Chl.a) values exceed the *mesotrophic-eutrophic* transitional value, and water clarity (Zsd) readings fall below this transitional value

These findings have several important implications. First, there is a close connection between water clarity readings of 2 meters and total phosphorus readings of 20 µg/l, the latter of which corresponds to the present state phosphorus guidance value. This indicates that water clarity readings, which are simple and inexpensive to collect, can serve as a surrogate for the most critical range of phosphorus readings and provide an indication of eutrophication. Second, these data indicate that the present trophic designations used in New York state- water clarity less than 2 meters, chlorophyll *a* exceeding 8 µg/l, and total phosphorus exceeding 20 µg/l- are both mostly consistent with national definitions of trophic categories and internally consistent. Finally, the TSI for each of these indicators are close enough to allow a comparison of TSI values to gain greater information about the dynamics of these lakes.

Table 3.4.4 shows the trophic characterization for lakes in each of the six major geographic regions of the state. The trophic status of each lake is evaluated based on the trophic assessment of the total phosphorus, chlorophyll *a*, and Secchi disk transparency readings (Tables 3.1.4, 3.2.4 and 3.3.4, respectively, in the regional summaries). The "*mesoligotrophic*" and "*mesoeutrophic*" categories are for those lakes for which different trophic assessments for different trophic indicators preclude a single trophic state assessment for the lake. This table shows that the vast majority of CSLAP lakes can be characterized between *mesoeutrophic* and *mesoligotrophic*.

Table 3.4.4: Trophic Assessments in CSLAP Lakes

	Number Lakes	% Lakes *Oligotrophic*	% Lakes *Mesoligotrophic*	% Lakes *Mesotrophic*	%Lakes *Mesoeutrophic*	%Lakes *Eutrophic*
Downstate	54	0	4	20	31	45
Central	66	0	30	35	12	21
Adirondacks	76	12	46	25	13	4
Western	13	4	14	14	37	30
CSLAP Statewide	**229**	**4**	**27**	**25**	**21**	**23**

The trophic assessments vary somewhat from region to region. The Adirondack region has the highest percentage (58%) of *mesoligotrophic* to *oligotrophic* lakes, befitting a region in which the typical lake has the lowest algae and nutrient levels, and highest water clarity. The Downstate and Western regions have more than 50% of their CSLAP lakes characterized as *mesoeutrophic* to *eutrophic*, with the highest percentage of *eutrophic* lakes found in the Downstate (Long Island/NYC) region. However, although there are a small number of CSLAP lakes in this region, the CSLAP data are typical of those collected in other monitoring programs.

Table 3.4.5a shows the TSI calculations for each of the trophic indicators measured through CSLAP by major New York state region, as determined by the average of the TSI values for the CSLAP lakes in the region. This table also shows the percentage of CSLAP lakes in each region for which each of the TSI calculations are within 10 points ("consistent TSI"), and the trophic indicator(s) in each lake that deviates from the other TSI indicators, referred to here as the "outliers". Overall TSI values are lowest for the Adirondack and Central regions, corresponding to lower lake productivity, while the highest TSIs are associated with the Downstate regions. The average TSI values for each of the trophic indicators are similar in each region—meaning that TSI calculations for water clarity (Zsd), total phosphorus (TP) and chlorophyll *a* (Chl.a) are similar—and the percentage of lakes in which the TSI values for each indicator are within 10 points ranges from 63% (Western region) to 89% (Central region).

Table 3.4.5a: TSI Assessments in CSLAP Lakes

	Number Lakes	Avg TSI-Zsd	Avg TSI-TP	Avg TSI-Chl.a	%Consistent TSI	%Zsd Outlier	%TP Outlier	%Chl.a Outlier
Downstate	60	51	54	55	77	11	11	13
Central	66	44	44	49	89	6	5	11
Adirondacks	76	42	37	43	82	4	14	9
Western	27	47	49	53	63	30	7	30
CSLAP Statewide	**229**	**46**	**45**	**49**	**80**	**10**	**10**	**13**

Table 3.4.5b breaks out the TSI outliers into the whether the outlier—water clarity, total phosphorus, or chlorophyll *a*—is higher or lower than expected, summarized by the frequency of lakes within the region exhibiting the outlier. The sum of the percentages for each region often exceeds the regional average cited in Table 3.4.5a, since more than one TSI indicator may be an outlier. For example, for a lake with a TSI-Zsd of 40, and TSI-Chl.a of 50 and a TSI-TP of 60, both the Secchi disk transparency TSI and the total phosphorus TSI are outliers.

Table 3.4.5b: TSI Assessments in CSLAP Lakes

	Number Lakes	%Zsd Higher	%Zsd Lower	%TP Higher	%TP Lower	%Chl.a Higher	%Chl.a Lower
Downstate	60	10	2	7	5	12	2
Central	66	6	0	0	5	11	0
Adirondacks	76	0	4	0	14	9	0
Western	27	30	0	7	0	30	0
CSLAP Statewide	**229**	**8**	**2**	**2**	**8**	**13**	**<1**

An evaluation of the TSI outliers in each region can be instructive. For those waterbodies in which one of the trophic indicators (water clarity, total phosphorus, or chlorophyll *a*) is significantly different than expected given the magnitude of the readings for the other indicators, some other factor may be affecting the "production" of that indicator. This may have important management implications. Each of the six outlier categories—water clarity, total phosphorus or chlorophyll *a* higher than expected, or water clarity, total phosphorus, or chlorophyll *a* lower than expected—is explored below.

a. Water clarity higher than expected

In this scenario, water clarity readings are higher than expected (predicted) given the phosphorus and chlorophyll *a* readings in the lake. The most likely reason for this scenario is extreme patchiness in algae growth, where phosphorus readings are sufficiently high to create extensive growth of algae, but this algae growth is limited to isolated patches included in the water sample, but not representative of the open water of the lake, or suspended particles in the water that do not significantly affect water clarity (at least relative to the chlorophyll *a* and total phosphorus measurements in the lake). The latter may be associated with an epilimnetic band (strata) of water that only has a limited impact on water clarity, since the Secchi disk may still be visible below this strata of algae. Higher than expected water clarity, at least relative to phosphorus readings, may also reflect in the influence of zebra mussels.

b. Water clarity lower than expected

Lower than expected water transparency can be associated with a number of phenomena. The trophic assessments discussed above explore the relationship between water clarity and algae, the primary influence on water transparency on most New York State lakes. However, water clarity is also influenced by dissolved organic matter, as manifested in water color (brownness), non-algal turbidity (typically from suspended sediment), or whiting (light refraction from suspended calcium carbonate). Measured water clarity may also be limited by water depth, either by the inability to record an accurate water transparency reading if the Secchi disk is visible on the bottom, or due to sediment suspension in very shallow water.

c. *Total phosphorus higher than expected*

Phosphorus readings are very similar to chlorophyll *a* readings in many lakes, since all phosphorus is bound within algal cells. This is particularly common in lakes with relatively low total phosphorus readings and all phosphorus (initially) available for algae growth, usually in a dissolved form. In other lakes, algae growth is limited by nitrogen or temperature (in cold water) or other factors, rather than phosphorus, so increasing phosphorus inputs may not result in an increase in algae levels. This may also occur in some lakes with very short retention time (high flushing rate), since algae may not be able to grow with only limited exposure time to the needed nutrients. On the other hand, lakes with high flushing rates and limited nutrient inputs may exhibit lower phosphorus readings due to a rapid movement of water out of the lake. Higher phosphorus readings may also be associated with large amounts of dissolved organic matter, which may bind phosphorus and render it unavailable for algae growth (although these lakes tend not to have phosphorus identified as an outlier, since water clarity readings are usually low).

d. Total phosphorus lower than expected

Several CSLAP lakes exhibit lower than expected phosphorus readings, at least relative to the algae levels and water clarity readings in the lake. As discussed above, phosphorus readings in many of these lakes are comprised almost entirely of soluble phosphorus, so that the algae are highly efficient in utilizing any new phosphorus entering the lake. Higher flushing rates may also rapidly move small inputs out of the lake.

e. Chlorophyll a higher than expected

Many of the reasons for higher than normal chlorophyll *a* readings are similar to those for higher than normal water clarity. Patchy or isolated suspended planktonic algae, whether found in a specific depth strata or as individual algal colonies dotted throughout the water column, would result in higher chlorophyll *a* readings if associated with the water sampling depth and location, but might not be significant enough to control water transparency. Higher algae levels may also be associated with a few samples strongly influencing the average chlorophyll *a* value for a lake, since chlorophyll *a* has much higher variance (and therefore a tendency to unusually high algae readings that strongly influence average readings). Poor zooplankton crazing, perhaps due to an overabundance of planktivorous fish (plankton-eating fish), such as most young fish and alewives, can result in higher than expected algae levels.

f. Chlorophyll a lower than expected

Algae growth in a lake requires sufficient light for the algae to photosynthesize. Reduced algae growth may be associated with high water color, changing the wavelengths of light entering the water or restricting algae growth to the uppermost layers of the lake. Lower chlorophyll *a* readings may also be associated with lakes with high flushing rates, although these lakes may also have higher than expected phosphorus readings. Algae levels are also strongly influenced by intentional and natural biocontrol measures and biomanipulation, such as through the addition of algacides (copper compounds) to explicitly reduce algae concentrations, or through the presence of voracious piscivores (fish-eating fish), such as perch and pike, that may result in a loss of planktivorous fish that control zooplankton levels. These factors can be complex and dynamic, and changes in chlorophyll *a* readings can be difficult to predict even with a working knowledge of the fish and zooplankton communities in a lake.

Although a detailed regional or statewide evaluation suffers from small sample sizes—the limited number of lakes in each category seen in Table 3.4.5b—a few patterns are apparent. Higher than expected water clarity readings are more common than lower than expected water clarity readings in all but the Adirondack region. In the rest of the state, higher than expected water clarity is probably associated with algae cells dotting the upper waters of the lake without turning the water green, allowing the Secchi disk to be visible somewhat deeper in the water column. More detailed analysis of the phytoplankton community—perhaps through the DOH HAB study—may provide some insights about the algae "factors" leading to these conditions. In the Finger Lakes and Western regions, higher water clarity may also be associated with zebra mussels. Conversely, within the Adirondack region, the small number of lower than expected water clarity readings is associated with shallow, colored lakes.

Lower than expected phosphorus readings are more common than higher than expected phosphorus readings, particularly within the Adirondack region. This latter group of lakes has very high flushing rates, suggesting that any nutrient inputs move quickly out of the lake. A consistent pattern across the state appears to be higher than expected chlorophyll *a* readings.

There do not appear to be any clear reasons for this phenomenon, except that the average chlorophyll *a* readings in these lakes may be adversely influenced by a small number of much higher than normal samples. It is likely that much of this pattern would disappear if the trophic state indices (TSI) were calculated from median rather than mean values.

CSLAP Trophic State Indices (TSI) Evaluation in the Downstate Region

Trophic state indices (TSI) calculations in the Downstate region can be used to identify factors that influence lake productivity outside of the normal interrelationship between total phosphorus, chlorophyll *a,* and Secchi disk transparency. These factors include water depth, flushing rate, dissolved organic matter (natural brownness), and even the challenges in identifying the most representative (average? median?) measure of these trophic indicators, particularly chlorophyll *a.*

The six major categories of TSI outliers—higher than expected water clarity, total phosphorus or chlorophyll *a* readings, or lower than expected readings for the same three indicators—can be evaluated with the Downstate region dataset to identify additional factors influencing lake productivity. It should be noted that a very high percentage of Downstate region lakes—77% of the lakes—exhibit water clarity, total phosphorus, and chlorophyll readings that are "internally" consistent, leading to TSI values that are similar and lead to consistent trophic assessments.

a. Downstate Region lakes with higher than expected water clarity -
Katonah Lake, Round Lake, Shadow Lake, Shenorock Lake, Wallace Pond

Discussion:
As discussed above, the most common reasons for lakes to exhibit higher than expected water clarity readings, based on evaluation of TSI values, is either the presence of algae that grows patchy or as green "dots" throughout the upper portions of the water column, or the presence of zebra mussels. Chapter 3.2 shows that algal densities are lower in the Downstate region than in most other regions of the state, so the likelihood of lakes exhibiting heavy algae growth is slight. Chapter 4.7 shows that although lakes in parts of the Downstate region possess sufficient calcium to grow extensive colonies of zebra mussels, the few CSLAP lakes in the region with zebra mussels do not exhibit signs of significant algal stripping by zebra mussels. Nearly all of these lakes are extremely shallow, and each of the trophic indicators can vary significantly over the course of the summer and year to year.

b. Downstate Region lakes with lower than expected water clarity -
Canaan Lake

Discussion:
The only Downstate region lakes with lower than expected water clarity is the extremely shallow Canaan Lake in Long Island, in which measured water clarity is limited by water depth. For extremely shallow lakes, water clarity is not a good trophic indicator, given the limitations on the accuracy of water clarity measurements in these lakes.

c. Downstate Region lakes with higher than expected total phosphorus-
Katonah Lake, Shenorock Lake, Wallace Pond

Discussion:

Although there are a number of lakes in the Downstate region with high flushing rates (low retention time), there appears to be sufficient contact time in these lakes for phosphorus readings to be consistent with chlorophyll *a* and water clarity readings. However, in these three lakes, the very rapid flushing rate does not allow algae to "grow out" commensurate with the nutrient levels in the lake.

d. Downstate Region lakes with lower than expected total phosphorus -
Canaan Lake

(with higher than expected chlorophyll a*)- Wolf Lake, Lake Nimham*

Discussion:

Lower than expected phosphorus readings (relative to expected phosphorus readings based on chlorophyll *a* and Secchi disk transparency TSIs) in the Canaan Lake is probably more reflective of the "artificially" low water clarity readings associated with the very shallow depth of the lake. The higher than expected algae levels in Wolf Lake and Lake Nimham may indicate that the zooplankters in these lakes are not very efficient at controlling algae levels in these lakes, perhaps due to the presence of planktivorous fish. However, this does not appear to be region-wide phenomenon, since these lakes are not geographically proximate. None of these lakes has been sampled through CSLAP in recent years.

e. Downstate Region lakes with higher than expected chlorophyll a -
Lake Tibet, Little Fresh Pond, Round Lake, Shadow Lake

(with lower than expected total phosphorus)- Wolf Lake, Lake Nimham

Discussion:

4 lakes in the Downstate region exhibit higher than expected algae levels in the absence of lower than expected total phosphorus readings. These lakes represent a variety of depths and geographic settings. The comments above about "inefficient" zooplankton grazing may also apply to these lakes. The algal communities in these lakes do appear to be susceptible to small increases in phosphorus inputs to the lake.

f. Downstate Region lakes with lower than expected chlorophyll a -
None

Discussion:

No Downstate region lakes have lower than expected algae levels, based on the phosphorus and water clarity readings in the lake.

Table 3.4.6 shows the trophic state indices and outliers for each of the CSLAP lakes sampled in the Downstate region.

Table 3.4.6: TSI Assessments in Downstate Region CSLAP Lakes

Lake Name	Trophic Assessment	TSI-Zsd	TSI-TP	TSI-Chl.a	Outlier	Zsd Trophic Assessment	TP Trophic Assessment	Chl. *a* Trophic Assessment
Anawanda Lake	Mesoligotrophic	35	33	41	None	Oligotrophic	Oligotrophic	Mesotrophic
Blue Heron Lake	Mesoeutrophic	44	50	50	None	Mesotrophic	Eutrophic	Mesotrophic
Cranberry Lake	Mesoligotrophic	44	45	37	None	Mesotrophic	Mesotrophic	Oligotrophic
Gossamans Pond	Eutrophic	53	59	58	None	Eutrophic	Eutrophic	Eutrophic
Highland Lake	Mesoeutrophic	49	57	44	None	Mesotrophic	Eutrophic	Mesotrophic
Hillside Lake	Eutrophic	67	86	67	TP	Eutrophic	Eutrophic	Eutrophic
Indian Lake	Mesotrophic	40	44	50	None	Mesotrophic	Mesotrophic	Mesotrophic
Katonah Lake	Eutrophic	60	71	66	Zsd,TP	Eutrophic	Eutrophic	Eutrophic
Lake Carmel	Eutrophic	56	56	66	None	Eutrophic	Eutrophic	Eutrophic
Lake Celeste	Eutrophic	53	54	62	None	Eutrophic	Eutrophic	Eutrophic
Lake Guymard	Mesotrophic	44	43	44	None	Mesotrophic	Mesotrophic	Mesotrophic
Lake Kitchawan	Oligooeutrophic	66	66	19	Chl.a	Eutrophic	Eutrophic	Oligotrophic
Lake Lincolndale	Eutrophic	56	61	66	None	Eutrophic	Eutrophic	Eutrophic
Lake Lucille	Eutrophic	58	68	68	None	Eutrophic	Eutrophic	Eutrophic
Lake Mahopac	Mesoeutrophic	43	48	51	None	Mesotrophic	Eutrophic	Eutrophic
Lake Meahagh	Eutrophic	69	74	75	None	Eutrophic	Eutrophic	Eutrophic
Lake Mohegan	Eutrophic	60	66	68	None	Eutrophic	Eutrophic	Eutrophic
Lake Nimham	Mesoeutrophic	49	43	55	TP,Chl.a	Mesotrophic	Mesotrophic	Eutrophic
Lake Oscaleta	Mesoeutrophic	45	48	53	None	Mesotrophic	Eutrophic	Eutrophic
Lake Oscawana	Mesoeutrophic	46	47	59	Chl.a	Mesotrophic	Mesotrophic	Eutrophic
Lake Ossi	Eutrophic	55	48	53	None	Eutrophic	Eutrophic	Eutrophic
Lake Peekskill	Mesoeutrophic	49	51	55	None	Mesotrophic	Eutrophic	Eutrophic
Lake Rippowam	Mesoeutrophic	49	48	58	None	Mesotrophic	Eutrophic	Eutrophic
Lake Tibet	Eutrophic	52	55	65	Zsd	Eutrophic	Eutrophic	Eutrophic
Lake Truesdale	Eutrophic	57	63	63	None	Eutrophic	Eutrophic	Eutrophic
Lake Waccabuc	Mesoeutrophic	45	46	52	None	Mesotrophic	Mesotrophic	Eutrophic
Lake Wanaksink	Mesotrophic	41	44	47	None	Mesotrophic	Mesotrophic	Mesotrophic
Little We Wah Lake	Mesoeutrophic	50	51	58	None	Mesotrophic	Eutrophic	Eutrophic
Monhagen Lake	Mesoeutrophic	50	53	51	None	Mesotrophic	Eutrophic	Mesotrophic
Orange Lake	Eutrophic	58	58	69	Chl.a	Eutrophic	Eutrophic	Eutrophic
Peach Lake	Mesoeutrophic	49	54	56	None	Mesotrophic	Eutrophic	Eutrophic
Plum Brook Lake	Eutrophic	58	61	60	None	Eutrophic	Eutrophic	Eutrophic
Roaring Brook Lake	Mesotrophic	49	42	42	None	Mesotrophic	Mesotrophic	Mesotrophic
Round Lake	Mesoeutrophic	44	49	55	Zsd,Chl.a	Mesotrophic	Eutrophic	Eutrophic
Sagamore Lake	Mesotrophic	49	42	47	None	Mesotrophic	Mesotrophic	Mesotrophic
Sepasco Lake	Mesotrophic	42	46	48	None	Mesotrophic	Mesotrophic	Mesotrophic
Shadow Lake	Eutrophic	55	64	68	Zsd,Chl.a	Eutrophic	Eutrophic	Eutrophic
Shawangunk Lake	Mesoeutrophic	48	52	50	None	Mesotrophic	Eutrophic	Mesotrophic
Shenorock Lake	Eutrophic	63	74	72	Zsd,TP	Eutrophic	Eutrophic	Eutrophic
Stissing Lake	Mesoeutrophic	45	48	47	None	Mesotrophic	Eutrophic	Mesotrophic
Teatown Lake	Eutrophic	53	61	63	None	Eutrophic	Eutrophic	Eutrophic
Timber Lake (Sullivan)	Eutrophic	54	54	55	None	Eutrophic	Eutrophic	Eutrophic
Timber Lake (Westchester)	Eutrophic	53	56	56	None	Eutrophic	Eutrophic	Eutrophic
Tomkins Lake	Mesotrophic	49	45	44	None	Mesotrophic	Mesotrophic	Mesotrophic
Tuxedo Lake	Mesotrophic	41	40	45	None	Mesotrophic	Mesotrophic	Mesotrophic
Ulster Heights Lake	Mesoeutrophic	56	51	48	None	Eutrophic	Eutrophic	Mesotrophic
Wallace Pond	Eutrophic	58	71	65	Zsd,TP	Eutrophic	Eutrophic	Eutrophic
We Wah Lake	Mesoeutrophic	48	48	58	None	Mesotrophic	Eutrophic	Eutrophic

Lake Name	Trophic Assessment	TSI-Zsd	TSI-TP	TSI-Chl.a	Outlier	Zsd Trophic Assessment	TP Trophic Assessment	Chl. *a* Trophic Assessment
Weiden Pond	Eutrophic	52	59	52	None	Eutrophic	Eutrophic	Eutrophic
Whaley Lake	Mesotrophic	43	43	49	None	Mesotrophic	Mesotrophic	Mesotrophic
Wolf Lake	Mesoeutrophic	47	44	56	TP,Chl.a	Mesotrophic	Mesotrophic	Eutrophic
Yankee Lake	Mesotrophic	45	46	45	None	Mesotrophic	Mesotrophic	Mesotrophic
Black Pond	Eutrophic	73	70	65	None	Eutrophic	Eutrophic	Eutrophic
Bradys Pond	Eutrophic	59	68	65	None	Eutrophic	Eutrophic	Eutrophic
Canaan Lake	Mesoeutrophic	60	47	56	Zsd,TP	Eutrophic	Mesotrophic	Eutrophic
Lily Pond	Eutrophic	57	53	55	None	Eutrophic	Eutrophic	Eutrophic
Little Fresh Pond	Eutrophic	51	50	61	TP,Chl.a	Eutrophic	Eutrophic	Eutrophic
Little Long Pond	Mesotrophic	48	46	40	None	Mesotrophic	Mesotrophic	Mesotrophic

Zsd = Secchi disk transparency; TP = total phosphorus; Chl.a = chlorophyll *a*
Outlier – trophic indicator(s) for which the calculated TSI is more than 10 points different than the other TSIs
Trophic assessments based on NYS TSI calculations

An evaluation of the TSI outliers for individual waterbodies is included in the regional summaries.

Chapter 4: Evaluation of Limnological Indicators

NO_x Fact Sheet
Chapter 4.1: Evaluation of Downstate Region NO_x

Ammonia Fact Sheet
Chapter 4.2: Evaluation of Downstate Region Ammonia

Total Nitrogen Fact Sheet
Chapter 4.3: Evaluation of Downstate Region Total Nitrogen

True Color Fact Sheet
Chapter 4.4: Evaluation of Downstate Region True Color

pH Fact Sheet
Chapter 4.5: Evaluation of Downstate Region pH

Conductivity Fact Sheet
Chapter 4.6: Evaluation of Downstate Region Conductivity

Calcium Fact Sheet
Chapter 4.7: Evaluation of Downstate Region Calcium

NO_x (Nitrate + Nitrite) Fact Sheet

Description:	Nitrogen is a nutrient necessary for plant growth and can act as a limiting nutrient in some lakes, particularly in the spring and early summer. Nitrate (NO_3) is the form of nitrogen most readily available for biological uptake, including uptake by algae. It is more easily detected as NO_x, or nitrate + nitrite. Nitrite (NO_2) is rarely found in surface waters, and can be created as an intermediate step in denitrification, the conversion of nitrate into nitrogen gas in the absence of oxygen.
Importance:	nitrate can be a limiting nutrient for some forms of green algae and may be an important nutrient in some regions of the state, such as Long Island. Nitrate can be an important component of wastewater, stormwater, fertilizers, and soil erosion. Therefore, it can be an indirect surrogate for pollutant loading to lakes, although elevated nitrate readings may be natural in some parts of the state. Nitrite can be toxic to aquatic life, though it readily converts to nitrate (or other forms of nitrogen) in the presence of oxygen.
How Measured: in CSLAP	NO_x is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container and pre-labeled sample aliquot bottles. Deepwater NO_x samples were only collected during the 2002 CSLAP sampling season. NO_x is analyzed using a spectrophotometer.
Detection Limit:	0.005 mg/l NO_x, 0.003 mg/l NO_2 (prior to 1988, NO_x detection limit = 0.05 mg/l; from 1988 to 2002, NO_x detection limit = 0.02 mg/l)
Range in CSLAP:	undetectable (< 0.005 mg/l) to 3.9 g/l; 87% of readings are less than 0.1 mg/l.
WQ Standards:	the narrative standard for nitrogen is "none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages." No water quality standard exists for NO_x. The state water quality standard for nitrate is 10 mg/l, to protect babies from methamoglobonemia. The state water quality standard for nitrite is 20 µg/l to protect trout (in waterbodies classified for trout survival or spawning), 100 µg/l to protect (other) aquatic life, and 1 mg/l to protect human health (potable water).
Trophic Assessment:	New York State does not use NO_x (or the components NO_3 or NO_2) in its trophic assessments. Samples are evaluated only against the state water quality standards.

Chapter 4- Evaluation of Limnological Indicators

Chapter 4.1- Evaluation of Downstate Region NO_x: 1986-2009

Summary of CSLAP NOx Findings in Downstate Region Lakes, 1986-2009

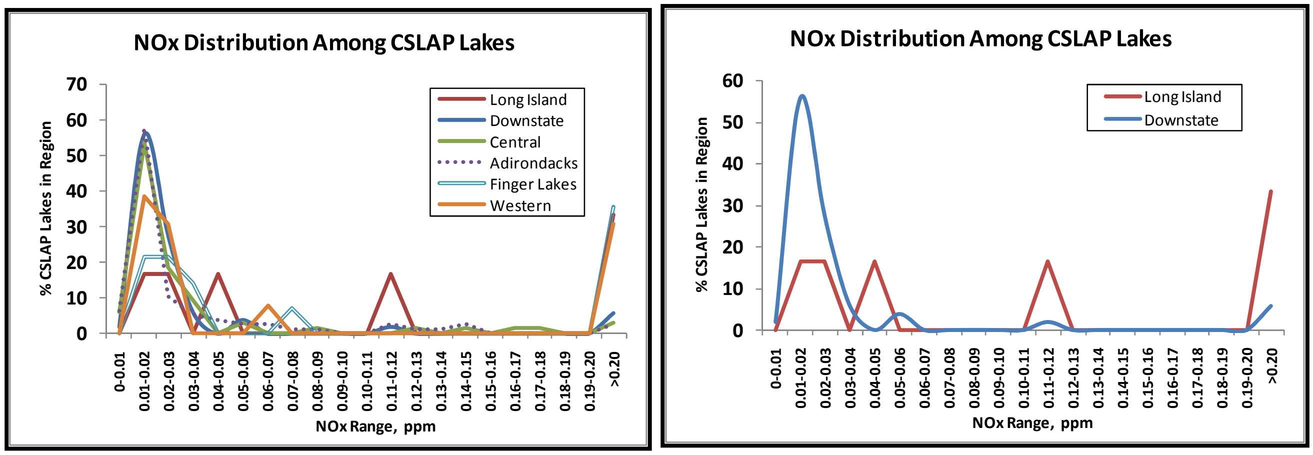
1. CSLAP lakes within the Downstate region have NO_x readings that are close to the analytical detection limit and similar to those in other parts of the state, except for higher NO_x readings in Long Island lakes.
2. CSLAP lakes within the Downstate region have NO_x readings similar to those in non-CSLAP lakes in the same region, except for the higher NO_x readings in non-CSLAP urban and suburban lakes in New York City and Long Island.
3. Slightly lower NO_x readings have been apparent in drier years in CSLAP lakes, and higher NO_x readings occur in wetter years. This pattern differs from the pattern in other parts of the state.
4. The frequency of higher than normal NO_x readings in CSLAP lakes in the Downstate region may have increased slightly over the last twenty five years, although this change may be masked by several changes in analytical detection limits over this period. This is the opposite of the trend observed in other parts of the state.
5. The highest NO_x readings within the CSLAP dataset in Long Island and the interior portion of the region (northern Westchester and eastern Rockland Counties). However, NO_x readings in most of these lakes are low.
6. Only a small number of CSLAP lakes in the Downstate region have exhibited a long-term change in NO_x readings, and in none of these lakes does this change appear to be statistically significant.
7. NO_x readings were probably close to normal in the Downstate region in 2009.

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region have NO_x readings similar to these measured in other regions of the state, as demonstrated in Figure 4.1.1. The most common range of NO_x readings in CSLAP Downstate region lakes is in the 0.01 to 0.02 mg/l range, very close to the analytical detection limit during most CSLAP sampling seasons. However, a number of Downstate (Long Island) region lakes have NO_x readings above 0.2 mg/l, as seen in Figure 4.1.2.

Comparison of CSLAP to NYS Lakes in the Downstate Region

The CSLAP Downstate region lakes in the northern portion of the region exhibit a similar distribution of NO_x readings as seen in other New York state monitoring programs, as seen in Figure 4.1.3. This reflects both the similarity in lakes sampled in the CSLAP and non-CSLAP programs and the consistency in NO_x readings across the range of lakes found in this region. The non-CSLAP Long Island lakes, however, have higher NO_x readings than those sampled through CSLAP, and it is assumed that this is indicative of a difference between CSLAP and non-CSLAP lakes in the region (although these lakes are all still phosphorus limited).



Figures 4.1.1 and 4.1.2: Distribution of NO_x Ranges in CSLAP and Downstate Region Lakes

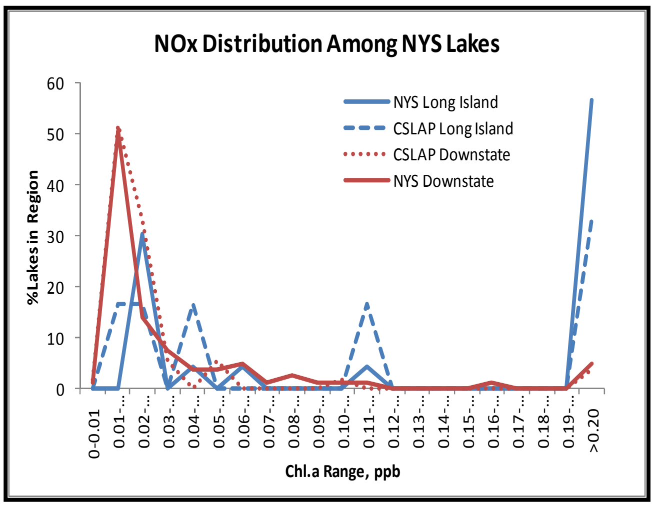


Figure 4.1.3: Average Distribution of NO_x Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

NO_x has been low and fairly stable in most Downstate region lakes, and most of the annual differences have been associated with changing detection limits. The highest NO_x readings measured through CSLAP occurred during 2005, 1986, 1989, and 2004. These years were not associated with very wet or very dry conditions. The lowest NO_x readings occurred in 1988, 1998, 1992 and 2001. Table 4.1.1 looks at the percentage of CSLAP lakes with high NO_x (greater than 1 standard error above normal) and low NO_x (greater than 1 standard error below normal) readings in wet and dry years. These data show that lower NO_x readings occur in drier years, and wetter years bring higher nor NO_x readings. This pattern was the opposite of the pattern observed in most other regions of the state.

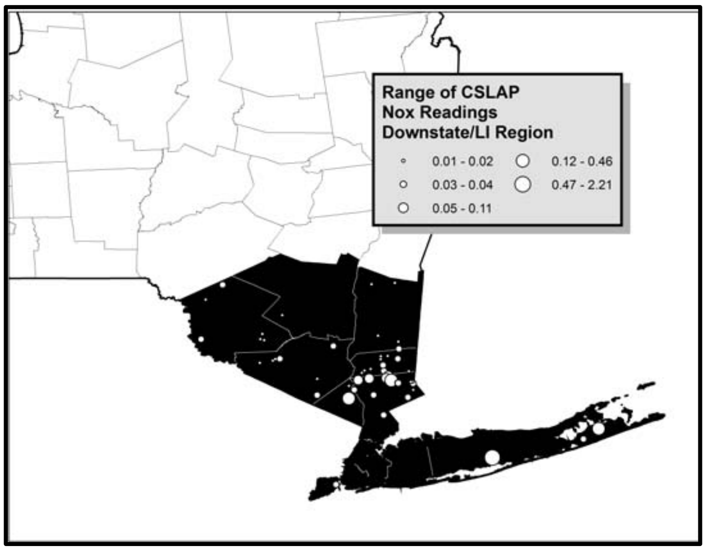
Table 5.1.1- % of CSLAP Lakes with Higher or Lower (than Normal) NO_x Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher NO_x	17%	29%
Lower NO_x	27%	19%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of higher than normal NO_x readings has increased slightly, although these trends are no doubt strongly influenced by the shift in analytical detection limits over the last 25 years. This trend is different than that observed in most other regions of the state, although this trend is also not statistically robust.



Figures 4.1.4: Range of NO_x Readings in the Downstate Region

Regional Distribution:

NO_x readings with the Downstate region are highest in Long Island and in the interior portion of the region in northern Westchester and eastern Rockland Counties. Lower readings are common throughout the rest of the region, with most readings at or below the analytical detection limit. This is demonstrated in Figure 4.1.4.

Table 4.1.2 shows the number of NO_x samples, the minimum, average, and maximum NO_x readings, and whether NO_x readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009.

A few lakes within the Downstate region have exhibited long-term trends in NO_x readings. Lake Guymard and Lake Lucille have exhibited increasing NO_x readings. Neither of these lakes has been sampled through CSLAP in recent years, so it is not known if this trend has continued. None of the lakes in the Downstate region has exhibited a long-term decrease in NO_x readings.

Table 4.1.2: Surface NO_x Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Change?
Anawanda Lake	1988-2009	144	0.00	0.02	0.15	No
Anawanda Lake	2009	8	0.01	0.02	0.07	No
Blue Heron Lake	2005-2008	24	0.01	0.03	0.10	
Cranberry Lake	2004-2004	7	0.01	0.02	0.04	
Gossamans Pond	2003-2005	22	0.00	0.03	0.11	
Highland Lake	2003-2009	31	0.00	0.02	0.13	
Highland Lake	2009	5	0.01	0.02	0.03	No
Hillside Lake	1994-1997	13	0.01	0.02	0.08	
Indian Lake	1994-2009	72	0.00	0.02	0.07	No
Indian Lake	2009	8	0.01	0.03	0.05	Higher
Katonah Lake	2006-2009	31	0.00	0.02	0.14	

Lake Name	Years	Num	Min	Avg	Max	Change?
Katonah Lake	2009	7	0.01	0.02	0.05	No
Lake Carmel	1986-1990	51	0.01	0.02	0.19	No
Lake Celeste	1993-1997	26	0.01	0.01	0.05	
Lake Guymard	1996-2003	46	0.00	0.02	0.13	Increasing
Lake Kitchawan	2008-2008	1	0.02	0.02	0.02	
Lake Lincolndale	1993-2009	109	0.00	0.06	0.62	No
Lake Lincolndale	2009	5	0.02	0.06	0.13	No
Lake Lucille	1986-1990	55	0.01	0.46	2.18	Increasing
Lake Mahopac	1986-2002	71	0.00	0.02	0.40	No
Lake Meahagh	1999-2001	10	0.01	0.02	0.10	
Lake Mohegan	1998-2009	80	0.00	0.06	0.78	No
Lake Mohegan	2009	8	0.00	0.12	0.78	Higher
Lake Nimham	1991-1995	41	0.01	0.01	0.03	No
Lake Oscaleta	2006-2009	35	0.00	0.01	0.04	
Lake Oscaleta	2009	8	0.00	0.01	0.02	Lower
Lake Oscawana	1991-1995	37	0.01	0.01	0.06	No
Lake Ossi	1996-2000	36	0.01	0.03	0.46	No
Lake Peekskill	1990-2009	93	0.00	0.02	0.10	No
Lake Peekskill	2009	7	0.01	0.02	0.05	No
Lake Rippowam	2006-2009	34	0.00	0.01	0.04	
Lake Rippowam	2009	8	0.01	0.01	0.03	No
Lake Tibet	1991-1993	23	0.01	0.01	0.03	
Lake Truesdale	1999-2009	85	0.00	0.02	0.14	No
Lake Truesdale	2009	8	0.01	0.01	0.02	Lower
Lake Waccabuc	1986-2009	107	0.00	0.02	0.16	No
Lake Waccabuc	2009	8	0.00	0.01	0.02	Lower
Lake Wanaksink	1991-1995	39	0.01	0.01	0.06	No
Little We Wah Lake	2008-2009	16	0.00	0.02	0.05	
Little We Wah Lake	2009	8	0.01	0.01	0.05	No
Monhagen Lake	2003-2009	30	0.00	0.03	0.29	
Monhagen Lake	2009	5	0.01	0.01	0.02	Lower
Orange Lake	1994-2005	51	0.00	0.02	0.24	No
Peach Lake	1999-2008	69	0.00	0.02	0.15	No
Plum Brook Lake	2005-2008	30	0.02	0.31	0.98	
Roaring Brook Lake	2009-2009	8	0.01	0.03	0.05	
Roaring Brook Lake	2009	8	0.01	0.03	0.05	No
Round Lake	1992-1996	40	0.01	0.01	0.03	No
Sagamore Lake	1994-1997	32	0.01	0.01	0.04	
Sepasco Lake	1997-2009	89	0.00	0.02	0.39	No
Sepasco Lake	2009	7	0.01	0.07	0.39	Higher
Shadow Lake	2008-2009	12	0.00	0.03	0.16	
Shadow Lake	2009	5	0.00	0.04	0.16	Higher
Shawangunk Lake	2003-2009	29	0.00	0.01	0.05	
Shawangunk Lake	2009	5	0.00	0.01	0.02	No
Shenorock Lake	2004-2009	45	0.00	0.11	1.34	
Shenorock Lake	2009	8	0.01	0.06	0.27	Lower
Stissing Lake	2007-2009	24	0.00	0.02	0.07	
Stissing Lake	2009	8	0.01	0.02	0.07	No
Teatown Lake	1997-2009	82	0.00	0.02	0.15	No
Teatown Lake	2009	5	0.00	0.01	0.03	Lower
Timber Lake (Sullivan)	2004-2008	28	0.00	0.03	0.15	
Timber Lake (Westchester)	2006-2009	16	0.01	0.02	0.08	
Timber Lake	2009	8	0.01	0.02	0.08	No
Tomkins Lake	2001-2001	8	0.01	0.02	0.04	
Tuxedo Lake	2008-2009	16	0.00	0.03	0.20	
Tuxedo Lake	2009	8	0.01	0.05	0.20	Higher

Lake Name	Years	Num	Min	Avg	Max	Change?
Ulster Heights Lake	2007-2009	14	0.00	0.02	0.05	
Ulster Heights Lake	2009	4	0.01	0.03	0.05	Higher
Wallace Pond	2004-2008	29	0.00	0.06	0.46	No
We Wah Lake	2008-2009	16	0.00	0.01	0.04	
We Wah Lake	2009	8	0.00	0.01	0.01	Lower
Weiden Pond	2004-2009	38	0.00	0.03	0.21	No
Weiden Pond	2009	5	0.02	0.03	0.03	No
Whaley Lake	1998-2001	31	0.01	0.01	0.01	
Wolf Lake	1987-2001	90	0.01	0.01	0.16	No
Yankee Lake	2006-2009	29	0.00	0.01	0.04	
Yankee Lake	2009	7	0.00	0.01	0.04	No
Black Pond	2008-2009	13	0.01	0.02	0.04	
Black Pond	2009	8	0.01	0.02	0.04	No
Bradys Pond	1997-2001	33	0.01	0.04	0.18	No
Canaan Lake	1990-2005	79	0.01	2.21	3.90	No
Lily Pond	2008-2009	13	0.01	0.26	0.86	
Lily Pond	2009	8	0.01	0.42	0.86	Higher
Little Fresh Pond	1989-2009	97	0.00	0.02	0.22	No
Little Fresh Pond	2009	8	0.01	0.01	0.03	Lower
Little Long Pond	2006-2009	14	0.03	0.11	0.18	
Little Long Pond	2009	3	0.07	0.12	0.18	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum NO_x, in mg/l
Change? = exhibiting significant change in NO_x readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on NO_x readings >25% higher or lower than normal

Tables 4.1.3a and 4.1.3b summarize the NO_x data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. NO_x readings in the CSLAP lakes in the Downstate region in 2009 were probably similar to those reported in previous years. The average NOx reading in the region was lower in 2009 than in the period from 1986-2008. However, the percentage of lakes with lower than normal NO_x readings in 2009 was lower than the percentage of lakes with higher than normal readings, and more lakes established new maximum readings in 2009. These data suggest that NO_x readings were close to normal in the Downstate region in 2009.

Table 4.1.3a: Surface NOx Summary in CSLAP Lakes, 2009

Region	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum
Downstate	32	<0.01	0.04	0.09	0.86
Central	36	<0.01	0.07	0.05	2.50
Adirondacks	33	<0.01	0.03	0.03	0.81
Western	9	<0.01	0.04	0.17	0.39
CSLAP Statewide	**110**	**0.00**	**0.05**	**0.07**	**2.50**

Table 4.1.3b: Surface NOx Summary in CSLAP Lakes, 2009

Region	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	0.04	0.09	37	27	43	14
Central	36	0.07	0.05	28	42	11	3
Adirondacks	33	0.03	0.03	19	65	10	6
Western	9	0.04	0.17	0	57	0	0
CSLAP Statewide	**110**	**0.05**	**0.07**	**25**	**44**	**18**	**6**

% Higher = percentage of lakes in region with NOx readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with NOx readings in 2009 <25% below normal (before 2009)

% Above Max = percentage of lakes in region with NOx readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with NOx readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal NOx in 2009:
Indian Lake, Lake Mohegan, Lily Pond, Sepasco Lake, Shadow Lake, Tuxedo Lake, Ulster Heights Lake

Discussion:
7 Downstate region lakes exhibited higher than normal NO_x readings in 2009. None of these lakes has exhibited any clear long-term increases (or decreases) in NO_x, and it is likely that the small increase in 2009 was part of normal variability for most of these lakes. The rise in NO_x readings in Lake Mohegan, Lily Pond and Sepasco Lake were more significant than at other lakes in the region, at least relative to normal readings in the lake, although the NO_x levels in all of these lakes were still low. The variability in NO_x readings Lily Pond from 2008 to 2009 was substantial, and NOx readings in the lake were consistently higher throughout the 2009 sampling season. It is not yet known if either year was more indicative of normal conditions in the lake. The higher NO_x readings in Lake Mohegan and Sepasco Lake in 2009 were probably reflective of heavier precipitation, which was cited in the weeks before the early fall NO_x spike in Sepasco Lake in 2009. In all three lakes, NO_x readings continue to be well below the state water quality standards.

Downstate Region Lakes With Lower Than Normal NOx in 2009:
Lake Oscaleta, Lake Truesdale, Lake Waccabuc, Little Fresh Pond, Monhagen Lake, Shenorock Lake, Teatown Lake, We Wah Lake

Discussion:
NO_x readings in 2009 were lower than normal in 8 Downstate region lakes. The typical NO_x reading in most of these lakes dropped from “very low” to “very very low”, and the change in 2009 probably represents normal variability. With the exception of Shenorock Lake, none of these lakes exhibited a significant drop in NO_x levels in 2009. Although the decrease in NO_x readings in Shenorock Lake was larger than in these other lakes, most NO_x readings in the lake in 2009 were close to normal.

Ammonia Fact Sheet

Description:	Ammonia is a micronutrient and a form of nitrogen (and hydrogen) represented by the formula NH_3. It is produced from nitrogen gas by nitrogen fixation and through the degradation of organic matter, found in wastewater, and generated through several biological processes.
Importance:	ammonia is toxic to aquatic organisms and (to a much lesser extent) humans at concentrations occasionally found in lake water, particularly at high pH or in the absence of oxygen (such as occasionally found in the bottom waters of productive lakes). High ammonia readings may also be a sign of other forms of pollution and indicate persistent problems with anoxia (lack of oxygen).
How Measured: in CSLAP	total NH_3 is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container and pre-labeled sample aliquot bottles. Deepwater NH3 samples were collected during the 2002 and 2009 CSLAP sampling seasons. NH_3 is analyzed using a spectrophotometer.
Detection Limit:	0.004 mg/l tNH_3 (total ammonia)
Range in NYS:	undetectable (< 0.004 mg/l) to 4.1 mg/l; 70% of surface readings are between 0.01 mg/l and 0.1 mg/l, and 24% of samples are less than 0.01 mg/l.
WQ Standards:	the narrative standard for nitrogen is "none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages." The state water quality standard for total NH_3 is 2.0 mg/l for potable water supplies. The standard for unionized ammonia is a function of pH and temperature, and is quantified within a matrix found in the published state water quality standards. It is as low as 0.7 µg/l at 0ºC at a pH of 6.5.
Trophic Assessment:	New York State does not use NH_3 in its trophic assessments. Samples are evaluated only against the state water quality standards.

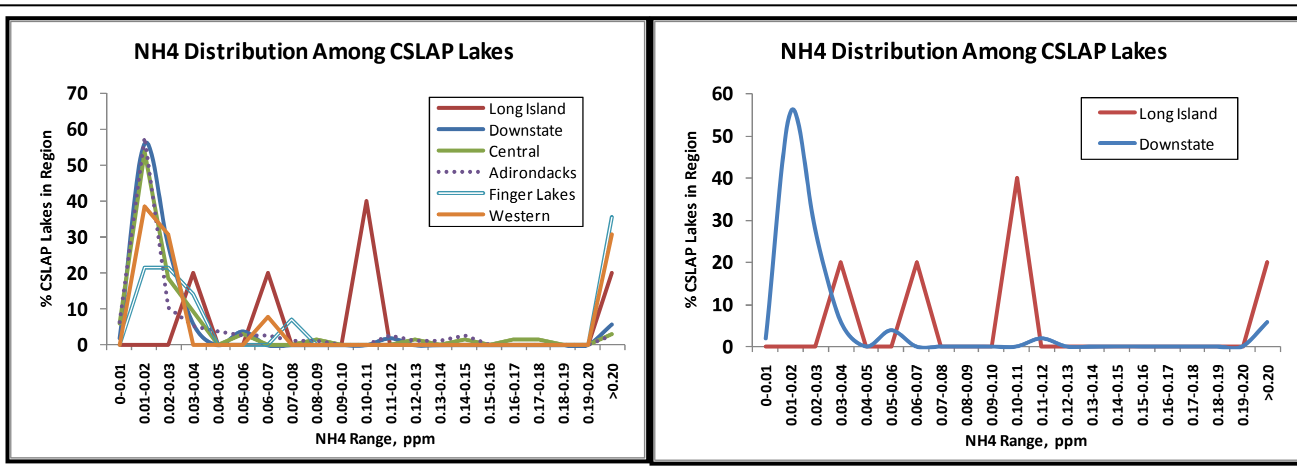
Chapter 4.2- Evaluation of Downstate Region Ammonia: 2002-2009

Summary of CSLAP Ammonia Findings in Downstate Region Lakes, 2002-2009

1. CSLAP lakes within the Downstate region have low ammonia readings, similar to those in most other regions of the state, although ammonia levels in Long Island may be higher.
2. Although higher ammonia readings seem to be associated with wetter years, there is insufficient data to evaluate the relationship between ammonia and precipitation in the Downstate region lakes.
3. Given the shore timeframe in which ammonia data have been collected, it is premature to evaluate any long-term trends (and no trends have been apparent over the last eight years).
4. Ammonia readings have been consistently low in the surface waters of CSLAP lakes through the Downstate region.
5. Only a few CSLAP lakes in the Downstate region have exhibited a long-term change in ammonia readings, and this change does not appear to be significant in these lakes (and may actually represent normal variability—this will become apparent with additional data).
6. The differences in ammonia readings between 2009 and the typical CSLAP sampling season was small in nearly all of these lakes in the Downstate region.
7. Deepwater ammonia readings were higher than those measured at the lake surface in a small number of moderately productive Downstate region lakes, and a few of these lakes exhibited ammonia readings near or above the state water quality standard. A few of the Downstate region lakes used as a potable water supply had high hypolimnetic ammonia.

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region have ammonia readings similar to those in the rest of the state, although ammonia readings in the Long Island lakes are more variable and slightly higher, as demonstrated in Figure 4.2.1. The most common range of ammonia readings in CSLAP Downstate region lakes is in the 0.01 to 0.03 mg/l (ppm) range, with decreasing frequency as ammonia levels increase, and few lakes outside of Long Island have surface ammonia readings over 0.05 mg/l, as seen in Figure 4.2.2. The slightly higher and more variable ammonia readings in Long Island lakes also reflects the relative lack of data in this (sub) region.



Figures 4.2.1 and 4.2.2: Distribution of Ammonia Ranges in CSLAP and Downstate Region Lakes

Comparison of CSLAP to NYS Lakes in the Downstate Region

Ammonia has not been collected in or evaluated through most of the non-CSLAP monitoring programs conducted within the Downstate region. Therefore, a comparison of ammonia readings between CSLAP and non-CSLAP lakes within the Downstate region is not (yet) possible.

Annual Variability:

The highest ammonia readings within the Downstate region measured through CSLAP occurred during 2002 and 2006, the latter of which was a wet year. The lowest ammonia readings occurred in 2004 and 2005, both of which generally had normal precipitation. Table 4.2.1 looks at the percentage of CSLAP lakes with high ammonia (greater than 1 standard error above normal) and low ammonia (greater than 1 standard error below normal) readings in wet and dry years. These data show that higher ammonia readings occur in wet years, but no dry years of data were available to evaluate any change in ammonia. Additional years of ammonia data (and broad ranges of precipitation data) may be needed to verify the relationship between ammonia and both wet and dry years.

Table 4.2.1- % of CSLAP Lakes with Higher or Lower (than Normal) Ammonia Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Ammonia		24%
Lower Ammonia		3%

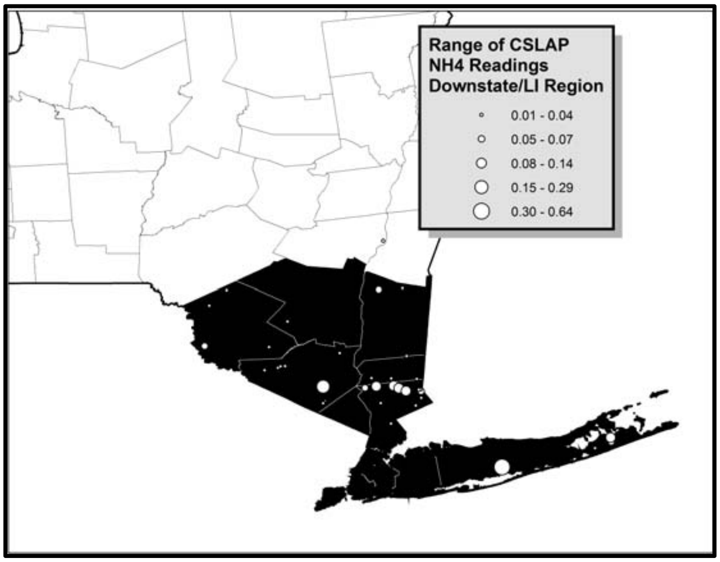
Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
“Higher” and “Lower” defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). This is less of an issue for evaluation of ammonia, total nitrogen, and calcium trends, since these data were first collected in 2002, but evaluation of trends with these indicators is affected by the short timeframe of data collection. Since 2002, the frequency of higher ammonia readings has decreased, although these trends appear to be statistically weak. These trends are essentially non-existent when the elevated ammonia readings from 2002 (the first year of ammonia analysis, at a subcontractor laboratory) are removed from the database. These data indicate no long-term trends in ammonia readings since 2002.

Regional Distribution:

Ammonia readings within the Downstate region are low throughout the region, with no clear seasonal patterns, as seen in Figure 4.2.3, although some lakes in the interior portion of the region (and at least one lake in Long Island) have higher ammonia levels. Nearly all of the lakes within this region have surface ammonia readings that are more than 200x lower than the state water quality standard, although some deepwater ammonia readings approach these standards.



Figures 4.2.3: Range of Ammonia Readings in the Downstate Region

Table 4.2.2 shows the number of ammonia samples, the minimum, average, and maximum ammonia readings, and whether ammonia readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009.

A few lakes within the Downstate region have exhibited significant long-term trends in ammonia readings. Ammonia readings in Shawangunk Lake and Wallace Pond have increased slightly over this period, although even the highest readings in Shawangunk Lake remain very low. Long-term changes in ammonia levels in this lake should continue to be evaluated, although it is not likely that the lake is exhibiting an ammonia trend. It should be noted that few lakes have been sampled long enough to evaluate these trends.

Ammonia levels have decreased slightly in Shenorock Lake, although it is also likely that this represents normal variability rather than a long-term trend.

Table 4.2.2: Surface Ammonia Summary in CSLAP Downstate Region Lakes, 2002-2009

Lake Name	Years	Num	Min	Avg	Max	Change?
Anawanda Lake	1988-2009	55	0.00	0.02	0.07	No
Anawanda Lake	2009	8	0.01	0.02	0.03	No
Blue Heron Lake	2005-2008	23	0.00	0.04	0.16	
Cranberry Lake	2004-2004	7	0.01	0.03	0.04	
Gossamans Pond	2003-2005	22	0.01	0.04	0.27	
Highland Lake	2003-2009	30	0.00	0.03	0.14	No
Highland Lake	2009	5	0.01	0.04	0.14	Higher
Indian Lake	1994-2009	52	0.00	0.03	0.31	No
Indian Lake	2009	8	0.01	0.02	0.05	Lower
Katonah Lake	2006-2009	30	0.01	0.13	0.75	
Katonah Lake	2009	7	0.18	0.35	0.75	Higher
Lake Guymard	1996-2003	7	0.00	0.04	0.10	
Lake Kitchawan	2008-2008	1	0.04	0.04	0.04	
Lake Lincolndale	1993-2009	38	0.00	0.11	0.54	No
Lake Lincolndale	2009	5	0.14	0.34	0.54	Higher
Lake Mahopac	1986-2002	0	0.01	0.01	0.02	
Lake Mohegan	1998-2009	53	0.01	0.11	0.58	No
Lake Mohegan	2009	8	0.02	0.07	0.17	Lower
Lake Oscaleta	2006-2009	35	0.01	0.03	0.12	
Lake Oscaleta	2009	8	0.01	0.02	0.06	No
Lake Peekskill	1990-2009	43	0.00	0.04	0.44	No
Lake Peekskill	2009	7	0.01	0.03	0.07	No
Lake Rippowam	2006-2009	34	0.01	0.04	0.23	

Lake Name	Years	Num	Min	Avg	Max	Change?
Lake Rippowam	2009	8	0.01	0.03	0.06	Lower
Lake Truesdale	1999-2009	62	0.01	0.06	0.35	No
Lake Truesdale	2009	8	0.01	0.08	0.20	Higher
Lake Waccabuc	1986-2009	35	0.01	0.02	0.10	
Lake Waccabuc	2009	8	0.01	0.01	0.03	Lower
Little We Wah Lake	2008-2009	16	0.00	0.03	0.09	
Little We Wah Lake	2009	8	0.01	0.02	0.09	Lower
Monhagen Lake	2003-2009	29	0.00	0.03	0.13	No
Monhagen Lake	2009	5	0.00	0.02	0.05	Lower
Orange Lake	1994-2005	11	0.01	0.02	0.05	
Peach Lake	1999-2008	45	0.01	0.04	0.21	No
Plum Brook Lake	2005-2008	30	0.03	0.14	0.41	
Roaring Brook Lake	2009-2009	8	0.01	0.04	0.10	
Roaring Brook Lake	2009	8	0.01	0.04	0.10	No
Sepasco Lake	1997-2009	51	0.01	0.05	1.57	No
Sepasco Lake	2009	7	0.01	0.24	1.57	Higher
Shadow Lake	2008-2009	12	0.01	0.04	0.18	
Shadow Lake	2009	5	0.02	0.03	0.04	Lower
Shawangunk Lake	2003-2009	29	0.00	0.02	0.10	Increasing
Shawangunk Lake	2009	5	0.01	0.04	0.06	Higher
Shenorock Lake	2004-2009	44	0.00	0.11	0.88	Decreasing
Shenorock Lake	2009	8	0.01	0.09	0.28	No
Stissing Lake	2007-2009	23	0.01	0.03	0.11	
Stissing Lake	2009	8	0.01	0.02	0.03	Lower
Teatown Lake	1997-2009	44	0.01	0.04	0.31	No
Teatown Lake	2009	5	0.02	0.02	0.05	Lower
Timber Lake (Sullivan)	2004-2008	28	0.00	0.02	0.17	
Timber Lake (Westchester)	2006-2009	15	0.01	0.06	0.21	
Timber Lake	2009	8	0.01	0.03	0.04	Lower
Tuxedo Lake	2008-2009	16	0.00	0.02	0.11	
Tuxedo Lake	2009	8	0.01	0.03	0.11	Higher
Ulster Heights Lake	2007-2009	14	0.00	0.02	0.05	
Ulster Heights Lake	2009	4	0.01	0.03	0.05	Higher
Wallace Pond	2004-2008	29	0.01	0.06	0.39	Increasing
We Wah Lake	2008-2009	16	0.01	0.03	0.10	
We Wah Lake	2009	8	0.01	0.03	0.07	Lower
Weiden Pond	2004-2009	35	0.01	0.07	0.40	Increasing
Weiden Pond	2009	5	0.03	0.14	0.29	Higher
Yankee Lake	2006-2009	28	0.00	0.03	0.18	
Yankee Lake	2009	7	0.00	0.05	0.18	Higher
Black Pond	2008-2009	13	0.02	0.07	0.23	
Black Pond	2009	8	0.02	0.04	0.07	Lower
Canaan Lake	1990-2005	26	0.00	0.64	4.10	
Lily Pond	2008-2009	13	0.00	0.10	0.43	
Lily Pond	2009	8	0.02	0.10	0.19	No
Little Fresh Pond	1989-2009	59	0.00	0.04	0.38	No
Little Fresh Pond	2009	8	0.01	0.01	0.03	Lower
Little Long Pond	2006-2009	14	0.04	0.10	0.27	
Little Long Pond	2009	3	0.06	0.07	0.07	Lower

Num = number of samples
Min, Avg, Max = minimum, average, and maximum NH_4 readings, in mg/l
Change? = exhibiting significant change in NH_4 readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on NH_4 readings >25% higher or lower than normal

Tables 4.2.3a and 4.2.3b summarize the surface ammonia data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Ammonia readings in the CSLAP lakes in the Downstate region in 2009 were similar to those reported in previous years. A slightly higher percentage of Downstate region lakes exhibited lower than normal ammonia readings in 2009, but a similar percentage of these lakes established new maximum and new minimum ammonia readings. The difference from 2009 from previous years was probably negligible.

Table 4.2.3a: Surface Ammonia Summary in CSLAP Lakes, 2009

Region	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum
Downstate	32	0.00	0.07	0.07	1.57
Central	36	0.00	0.04	0.03	0.53
Adirondacks	33	0.00	0.04	0.03	0.61
Western	9	0.01	0.07	0.07	0.56
CSLAP Statewide	**110**	**0.00**	**0.05**	**0.04**	**1.57**

Table 4.2.3b: Surface Ammonia Summary in CSLAP Lakes, 2009

Region	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	0.07	0.07	31	47	31	31
Central	36	0.04	0.03	25	36	28	19
Adirondacks	33	0.04	0.03	25	47	28	22
Western	9	0.07	0.07	22	22	33	11
CSLAP Statewide	**110**	**0.05**	**0.04**	**27**	**41**	**29**	**23**

% Higher = percentage of lakes in region with NH_4 readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with NH_4 readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with NH_4 readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with NH_4 readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Ammonia in 2009:

Highland Lake, Katonah Lake, Lake Lincolndale, Lake Truesdale, Sepasco Lake, Shawangunk Lake, Tuxedo Lake, Ulster Heights Lake, Weiden Pond, Yankee Lake

Discussion:

10 Downstate region lakes exhibited higher than normal ammonia readings in 2009. It is not known if the 2009 readings exceed the true normal range of ammonia readings in these lakes, since each of these lakes has a limited ammonia dataset.

Ammonia readings in all but Lake Lincolndale, Sepasco Lake and Weiden Pond were close to normal, and it is likely that the small increase in ammonia readings in these lakes represented normal variability. The rise in the average 2009 Sepasco Lake ammonia levels was driven by a single spike in early July, which probably represents an erroneous (non-representative) datapoint. The rise in ammonia levels in Lake Lincolndale and Weiden Pond was associated with consistently (but only slightly) higher ammonia levels. Additional data will help to determine if was due to wetter weather or represents part of a more endemic change in the lake. All of these readings remain well below the state water quality standards.

Downstate Region Lakes With Lower Than Normal Ammonia in 2009:

Black Pond, Indian Lake, Lake Mohegan, Lake Rippowam, Lake Waccabuc, Little Fresh Pond, Little We Wah Lake, Monhagen Lake, Shadow Lake, Stissing Lake, Teatown Lake, Timber Lake, We Wah Lake

Discussion:

Ammonia readings in 2009 were lower than normal in 13 Downstate region lakes, assuming that the 5-8 year average computed for each of these lakes prior to 2009 represents normal conditions for each lake. In each of these lakes, the 2009 readings were only slightly lower than the typical ammonia readings in the lake, and these differences probably represent normal variability.

Deepwater Ammonia

Table 4.2.4 shows the number of samples, and minimum, average and maximum reading deepwater (*hypolimnetic*) ammonia reading. These readings were generally collected from a depth of 1-2 meters from the lake bottom in thermally stratified lakes. This table also compares the average surface and hypolimnetic ammonia reading in each thermally stratified lake in this region sampled for deepwater ammonia. The most significant difference between surface and hypolimnetic readings was recorded at Anawanda Lake, Lake Oscaleta, Lake Waccabuc, Peach Lake, Sepasco Lake, and Tuxedo Lake, although only Lake Waccabuc exhibited consistently high deepwater readings.

The maximum hypolimnetic ammonia readings exceed 1 mg/l in Lake Oscaleta, Lake Waccabuc, Peach Lake, and Sepasco Lake. Most of these lakes are in the *mesotrophic* to *eutrophic* range. Lake Waccabuc is classified for potable water use, and was the only lake in region with ammonia readings in the lake exceed 2 mg/l, the state potable water quality standard for total ammonia. In the event of a hydrogen sulfide odor in the bottom water (corresponding to oxygen deficits and the potential for elevated ammonia), lake residents using bottom waters in the lake are advised not to use this water for drinking purposes, given the risk of these intake waters creating health and aesthetic problems. The same applies to the other lakes, although these lakes are not classified for potable water use.

Each of these lakes is in the 25-35 foot depth range, which appears to be particularly susceptible to anoxic buildup of nutrients. Although this does not appear to be affecting other *mesotrophic* lakes in the same depth range in this region, this phenomenon bears continued study.

Table 4.2.4: Bottom Ammonia Summary in CSLAP Downstate Region Lakes, 2002-2009

Lake Name	Years	Num	Min	Avg	Avg Surface NH4	Max
Anawanda Lake	1993-2009	10	0.04	0.32	0.02	0.79
Anawanda Lake	2009	8	0.29	0.53	0.01	0.79
Highland Lake	2005-2009	5	0.01	0.06	0.03	0.21
Highland Lake	2009	5	0.01	0.06	0.02	0.21
Indian Lake	2005-2009	8	0.01	0.13	0.03	0.32
Indian Lake	2009	8	0.01	0.13	0.02	0.32
Lake Oscaleta	2006-2009	8	0.03	0.66	0.03	1.42

Lake Name	Years	Num	Min	Avg	Avg Surface NH4	Max
Lake Oscaleta	2009	8	0.03	0.66	0.02	1.42
Lake Rippowam	2008-2009	8	0.02	0.02	0.04	0.03
Lake Rippowam	2009	8	0.02	0.02	0.02	0.03
Lake Waccabuc	2006-2009	8	1.69	2.36	0.02	3.31
Lake Waccabuc	2009	8	1.69	2.36	0.02	3.31
Monhagen Lake	2005-2009	5	0.00	0.01	0.03	0.01
Monhagen Lake	2009	5	0.00	0.01	0.02	0.01
Orange Lake	2002-2002	1	0.01	0.01	0.02	0.01
Peach Lake	2000-2008	6	0.07	0.66	0.04	1.20
Sepasco Lake	1998-2009	6	0.01	0.66	0.05	1.58
Sepasco Lake	2009	7	0.01	0.66	0.02	1.58
Shawangunk Lake	2005-2009	5	0.00	0.03	0.02	0.06
Shawangunk Lake	2009	5	0.00	0.03	0.03	0.06
Stissing Lake	2007-2009	3	0.01	0.01	0.03	0.02
Stissing Lake	2009	5	0.01	0.01	0.02	0.02
Tuxedo Lake	2009-2009	2	0.10	0.33	0.02	0.56
Tuxedo Lake	2009	4	0.10	0.33	0.01	0.56
We Wah Lake	2009-2009	3	0.03	0.05	0.03	0.07
We Wah Lake	2009	3	0.03	0.05	0.02	0.07
Little Fresh Pond	2005-2009	7	0.00	0.01	0.04	0.03
Little Fresh Pond	2009	7	0.00	0.01	0.02	0.03

Num = number of samples; Min, Avg, Max = minimum, average, and maximum NH_4 readings, in mg/l
Avg Surface NH_4 = average NH_4 readings in surface samples, 2002-2009

Total Nitrogen Fact Sheet

Description:	total nitrogen is the sum of all component forms of nitrogen—NOx (= NO_3 + NO_2) + total Kjeldahl nitrogen (or TKN, = tNH_3 + organic nitrogen). It can also be computed as an independent laboratory analysis, without first analyzing the nitrogen components. It is often a construct to compute nitrogen to phosphorus ratios, and is essentially equivalent to total dissolved nitrogen (= TDN) in most freshwater lake systems.
Importance:	total nitrogen can be compared directly to total phosphorus to evaluate which nutrient may be limiting algae growth. Comparing variations in total nitrogen and the component forms may also provide insights as to the potential sources of nitrogen.
How Measured: in CSLAP	total nitrogen is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container and pre-labeled sample aliquot bottles. Samples were analyzed for TDN prior to 2008, but split samples on several CSLAP lakes in 2008 demonstrated that TDN and TN results were comparable. TN samples were analyzed in 2008 and 2009, and will be the primary means for evaluating total nitrogen after 2009. Deepwater total dissolved nitrogen samples were collected during the 2002 sampling season. Total nitrogen is analyzed using a spectrophotometer.
Detection Limit:	0.05 mg/l TN or 0.04 mg/l TDN
Range in CSLAP:	undetectable (< 0.05 mg/l) to 5.2 mg/l; 92% of surface readings are between 0.1 mg/l and 1.0 mg/l.
WQ Standards:	the narrative standard for nitrogen is “none in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.” There are no state numeric water quality standards or “translator” guidance value for total nitrogen.
Trophic Assessment:	New York State does not use total nitrogen in its trophic assessments. Some other states include total nitrogen in their trophic classifications. One such assessment considered by some researchers to be applicable in a variety of lake systems, using National Eutrophication Survey data in Florida, indicated that readings exceeded 0.75 mg/l are typical of *eutrophic*, or highly productive lakes, while readings below 0.35 mg/l are typical of *oligotrophic*, or highly unproductive lakes. Lakes in the intermediate range would be considered *mesotrophic*, or moderately productive. However, as noted above, New York State does not use total nitrogen to assess lakes for trophic condition, mostly because algae growth in nearly all New York state lakes is not nitrogen limited.

Chapter 4.3- Evaluation of Downstate Region Total Nitrogen: 2002-2009

Summary of CSLAP Total Nitrogen Findings in Downstate Region Lakes, 2002-2009

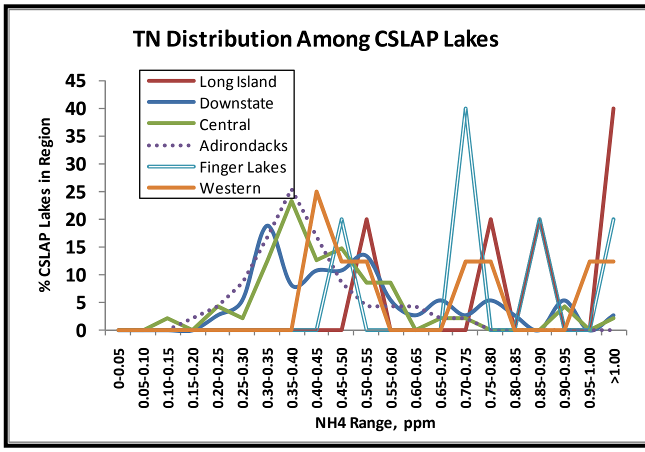
1. CSLAP lakes within the Downstate region have total nitrogen readings similar to those in other parts of the state, with the majority of lakes having typical chlorophyll *a* levels between 0.3 and 0.6 ppm. This generally corresponds to *mesotrophic* conditions.
2. The total nitrogen readings in CSLAP lakes within the Downstate region cannot be compared to non-CSLAP lakes, since the data for the latter have not yet been compiled.
3. CSLAP lakes within the Downstate region are more likely to have lower total nitrogen levels readings in wet years, although evaluation of the dataset against precipitation levels is limited by the lack of dry weather data.
4. TN readings in CSLAP lakes within the Downstate region have increased slightly over the last eight years, but it is premature to call this a trend, given the short timeframe.
5. The highest TN readings are seen in lakes in Long Island and in the "interior" parts of the region, such as CSLAP lakes in Westchester and Putnam Counties, but this evaluation is limited by the small number of CSLAP sampled for TN in the Downstate region.
6. TN readings are highest in the more productive lakes and those with the highest productive, as measured by total phosphorus, chlorophyll *a*, or Secchi disk transparency.

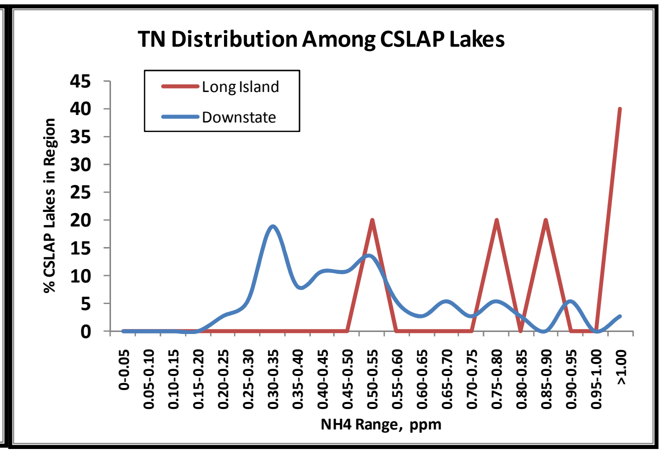
Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region have total nitrogen levels similar to those in most other regions of the state, although the Long Island lakes have higher readings, as demonstrated in Figure 4.3.1. The most common range of total nitrogen readings in CSLAP downstate region lakes is in the 0.3 to 0.6 mg/l (parts per million) range, with decreasing frequency above and below this range. Although total nitrogen data are not used for trophic evaluation, TN readings in this range are typical of *mesotrophic* lakes, an assessment indicating slightly less productive conditions than is apparent from the other trophic (water clarity, chlorophyll *a,* total phosphorus) readings. A small percentage of CSLAP Downstate region lakes have total nitrogen readings above 0.7 mg/l, particularly those from Long Island, as seen in Figure 4.3.2.

Comparison of CSLAP to NYS Lakes in the Downstate Region

Total nitrogen has not been collected in or evaluated through most of the non-CSLAP monitoring programs conducted within the Downstate region. Therefore, a comparison of total nitrogen readings between CSLAP and non-CSLAP lakes within the Downstate region is not (yet) possible.





Figures 4.3.1 and 4.3.2: Distribution of Total Nitrogen Ranges in CSLAP and Downstate Region Lakes

Annual Variability:

The highest total nitrogen readings within the Downstate region measured through CSLAP occurred during 2006 and 2007; the former was a particularly wet year. The lowest total nitrogen readings occurred in 2005, 2003 and 2008. Table 4.3.1 looks at the percentage of CSLAP lakes with high total nitrogen (greater than 1 standard error above normal) and low nitrogen (greater than 1 standard error below normal) readings in wet and dry years. These data show that lower nitrogen readings occur in wetter years, although there have not been any dry years since 2002 to provide a comparison. Additional years of total nitrogen data (and broad ranges of precipitation data) may be needed to verify the relationship between total nitrogen and weather.

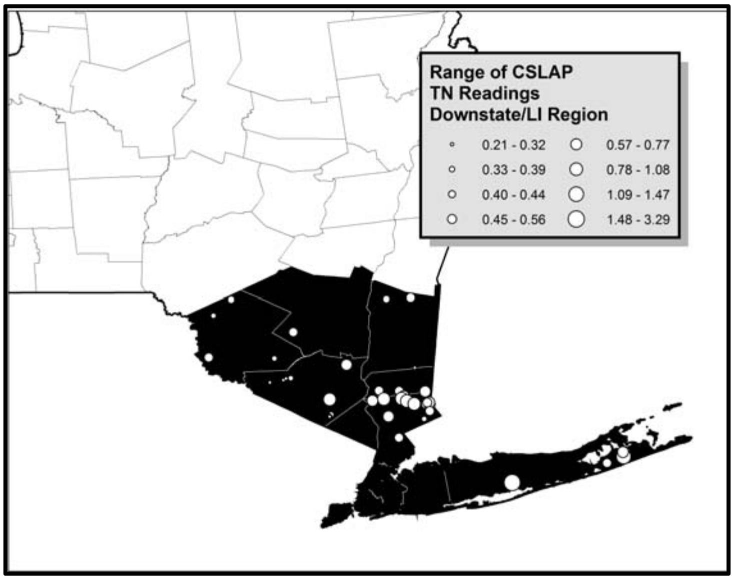
Table 4.3.1- % of CSLAP Lakes with Higher or Lower (than Normal) Total Nitrogen Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Total Nitrogen		12%
Lower Total Nitrogen		18%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). This is less of an issue for evaluation of ammonia, total nitrogen, and calcium trends, since these data were first collected in 2002, but evaluation of trends with these indicators is affected by the short timeframe of data collection. The frequency of higher total nitrogen readings has increased slightly, although these trends appear to be statistically weak. This is mostly similar to the pattern observed across the state. These data indicate total nitrogen readings may have increased since CSLAP sampling began for this water quality indicator in 2002, although it is still premature to call this a trend, given the short timeframe for TN data collection.



Figures 5.3.6: Range of Total Nitrogen Readings in the Downstate Region

Regional Distribution:

Total nitrogen readings with the Downstate region lakes do not exhibit any clear geographical patterns; lakes with higher total nitrogen readings are interspersed with lakes with low total nitrogen readings. TN data are not available for many "older" CSLAP lakes—those last sampled prior to 2002—and this limits an evaluation of geographic patterns within this region. The highest TN readings are found in either the most productive lakes or those with the highest (natural) NO_x readings—those in the interior portion of the region (Westchester and Putnam Counties) and Long Island.

Table 4.3.2 shows the number of total nitrogen samples, the minimum, average, and maximum TN readings, the typical (average) total nitrogen to total phosphorus (TN:TP) ratios, whether nitrogen or phosphorus is more likely to be the limiting nutrient for algae growth, and whether TN readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009. CSLAP lakes are considered to be phosphorus limited if the TN:TP ratios exceed 25, and are considered to be nitrogen limited if these ratios are less than 10. The limiting nutrient is less clear for ratios between 10 and 25. Although these ratios are not a definitive means for evaluating nutrient limitation—other factors can influence nutrient limitation and these ratios should be used with some caution—these data suggest that algae growth in Downstate region lakes is far more likely to be limited by phosphorus than by nitrogen.

Only one of the lakes within the Downstate region has exhibited long-term trends in total nitrogen readings, although few lakes have been sampled long enough to evaluate these trends. TN readings in Shawangunk Lake have increased over the last several years, largely independent of any other changes. TN readings should continue to be studied in the lake, but it is likely that this represents normal variability (particularly since the decrease in TN has not consistently occurred during each CSLAP sampling season).

Tables 4.3.3a and 4.3.3b summarize the total nitrogen data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Total nitrogen readings in the CSLAP lakes in the Downstate region in 2009 were slightly lower than those reported in previous years. Moreover, a much greater percentage of Downstate region lakes exhibited lower than normal total nitrogen readings in 2009. Lower TN readings in 2009 were also measured in most CSLAP lakes across the state in 2009, although it is not known if this is a consequence of wetter weather (particularly early in the summer), normal variability, or the start of a longer-term trend.

Table 5.3.2: Total Nitrogen Summary in CSLAP Downstate Region Lakes, 2002-2009

Lake Name	Years	Num	Min	Avg	Max	TN/TP	Limiting Nutrient?	Change?
Anawanda Lake	1988-2009	55	0.05	0.34	0.98	152	Phosphorus Limited	No
Anawanda Lake	2009	8	0.17	0.23	0.33	72	Phosphorus Limited	Lower
Blue Heron Lake	2005-2008	24	0.08	0.37	0.74	38	Phosphorus Limited	
Cranberry Lake	2004-2004	7	0.24	0.50	1.03	77	Phosphorus Limited	
Gossamans Pond	2003-2005	21	0.06	0.31	0.95	17	Phosphorus or Nitrogen Limited	
Highland Lake	2003-2009	27	0.07	0.30	0.70	22	Phosphorus or Nitrogen Limited	No
Highland Lake	2009	5	0.18	0.23	0.27	28	Phosphorus Limited	Lower
Indian Lake	1994-2009	51	0.01	0.48	1.06	65	Phosphorus Limited	No
Indian Lake	2009	8	0.27	0.44	0.73	53	Phosphorus Limited	No
Katonah Lake	2006-2009	29	0.43	0.94	1.79	23	Phosphorus or Nitrogen Limited	
Katonah Lake	2009	7	0.77	1.15	1.79	21	Phosphorus or Nitrogen Limited	No
Lake Guymard	1996-2003	7	0.06	0.30	0.50	41	Phosphorus Limited	
Lake Kitchawan	2008-2008	1	0.48	0.48	0.48	14	Phosphorus or Nitrogen Limited	
Lake Lincolndale	1993-2009	37	0.17	0.76	1.95	35	Phosphorus Limited	No
Lake Lincolndale	2009	5	1.08	1.41	1.95	50	Phosphorus Limited	Higher
Lake Mahopac	1986-2002	0	0.46	0.53	0.60	97	Phosphorus Limited	
Lake Mohegan	1998-2009	51	0.18	0.84	2.08	29	Phosphorus Limited	No
Lake Mohegan	2009	8	0.62	0.86	1.31	19	Phosphorus or Nitrogen Limited	No
Lake Oscaleta	2006-2009	29	0.22	0.45	0.80	53	Phosphorus Limited	
Lake Oscaleta	2009	8	0.30	0.34	0.39	46	Phosphorus Limited	Lower
Lake Peekskill	1990-2009	40	0.01	0.44	1.00	35	Phosphorus Limited	No
Lake Peekskill	2009	7	0.34	0.41	0.51	24	Phosphorus or Nitrogen Limited	No
Lake Rippowam	2006-2009	30	0.31	0.58	1.05	68	Phosphorus Limited	
Lake Rippowam	2009	8	0.39	0.46	0.64	50	Phosphorus Limited	Lower
Lake Truesdale	1999-2009	61	0.01	0.70	1.52	30	Phosphorus Limited	No
Lake Truesdale	2009	8	0.51	0.84	1.26	34	Phosphorus Limited	No
Lake Waccabuc	1986-2009	30	0.26	0.57	1.12	56	Phosphorus Limited	
Lake Waccabuc	2009	8	0.30	0.36	0.43	43	Phosphorus Limited	Lower
Little We Wah Lake	2008-2009	16	0.19	0.30	0.55	27	Phosphorus Limited	
Little We Wah Lake	2009	8	0.19	0.24	0.36	26	Phosphorus Limited	Lower
Monhagen Lake	2003-2009	28	0.07	0.35	0.66	31	Phosphorus Limited	No
Monhagen Lake	2009	5	0.24	0.33	0.43	36	Phosphorus Limited	No
Orange Lake	1994-2005	12	0.16	0.77	1.24	61	Phosphorus Limited	
Peach Lake	1999-2008	44	0.32	0.67	1.11	56	Phosphorus Limited	No
Plum Brook Lake	2005-2008	28	0.40	1.05	1.71	46	Phosphorus Limited	
Roaring Brook Lake	2009-2009	8	0.19	0.31	0.42	52	Phosphorus Limited	
Roaring Brook Lake	2009	8	0.19	0.31	0.42	50	Phosphorus Limited	No
Sepasco Lake	1997-2009	49	0.07	0.41	0.90	49	Phosphorus Limited	No
Sepasco Lake	2009	7	0.24	0.37	0.56	39	Phosphorus Limited	No
Shadow Lake	2008-2009	12	0.23	0.62	2.21	22	Phosphorus or Nitrogen Limited	
Shadow Lake	2009	5	0.23	0.44	0.71	24	Phosphorus or Nitrogen Limited	Lower
Shawangunk Lake	2003-2009	27	0.06	0.32	0.68	27	Phosphorus Limited	Increasing?

Lake Name	Years	Num	Min	Avg	Max	TN/TP	Limiting Nutrient?	Change?
Shawangunk Lake	2009	5	0.22	0.41	0.49	35	Phosphorus Limited	Higher
Shenorock Lake	2004-2009	43	0.38	0.94	1.78	23	Phosphorus or Nitrogen Limited	No
Shenorock Lake	2009	8	0.61	0.87	1.78	20	Phosphorus or Nitrogen Limited	No
Stissing Lake	2007-2009	24	0.30	0.51	0.94	63	Phosphorus Limited	
Stissing Lake	2009	8	0.30	0.41	0.49	50	Phosphorus Limited	No
Teatown Lake	1997-2009	44	0.16	0.49	0.98	30	Phosphorus Limited	No
Teatown Lake	2009	5	0.30	0.44	0.59	21	Phosphorus or Nitrogen Limited	No
Timber Lake (Sullivan)	2004-2008	27	0.12	0.44	1.02	31	Phosphorus Limited	
Timber Lake (Westchester)	2006-2009	16	0.27	0.45	0.93	32	Phosphorus Limited	
Timber Lake	2009	8	0.27	0.34	0.52	19	Phosphorus or Nitrogen Limited	Lower
Tuxedo Lake	2008-2009	15	0.16	0.24	0.49	48	Phosphorus Limited	
Tuxedo Lake	2009	8	0.17	0.27	0.49	41	Phosphorus Limited	No
Ulster Heights Lake	2007-2009	14	0.30	0.51	0.67	45	Phosphorus Limited	
Ulster Heights Lake	2009	4	0.34	0.54	0.67	37	Phosphorus Limited	No
Wallace Pond	2004-2008	27	0.09	0.66	2.87	19	Phosphorus or Nitrogen Limited	
We Wah Lake	2008-2009	16	0.20	0.36	0.54	45	Phosphorus Limited	
We Wah Lake	2009	8	0.21	0.32	0.47	38	Phosphorus Limited	No
Weiden Pond	2004-2009	37	0.01	0.52	1.40	30	Phosphorus Limited	No
Weiden Pond	2009	5	0.27	0.35	0.43	20	Phosphorus or Nitrogen Limited	Lower
Yankee Lake	2006-2009	28	0.16	0.38	0.65	50	Phosphorus Limited	
Yankee Lake	2009	7	0.20	0.29	0.36	38	Phosphorus Limited	Lower
Black Pond	2008-2009	13	0.95	1.38	2.13	37	Phosphorus Limited	
Black Pond	2009	8	0.97	1.32	1.68	40	Phosphorus Limited	No
Canaan Lake	1990-2005	28	0.83	3.29	5.21	653	Phosphorus Limited	
Lily Pond	2008-2009	12	0.34	0.88	1.47	81	Phosphorus Limited	
Lily Pond	2009	8	0.66	0.94	1.47	82	Phosphorus Limited	No
Little Fresh Pond	1989-2009	57	0.18	0.51	1.24	58	Phosphorus Limited	No
Little Fresh Pond	2009	8	0.28	0.38	0.43	37	Phosphorus Limited	Lower
Little Long Pond	2006-2009	11	0.45	0.78	1.40	143	Phosphorus Limited	
Little Long Pond	2009	3	0.54	0.61	0.69	64	Phosphorus Limited	Lower

Num = number of samples
Min, Avg, Max = minimum, average, and maximum TN readings, in mg/l
TN/TP = ratio of total nitrogen to total phosphorus, unitless (both nitrogen and phosphorus in molar concentrations)
Limiting Nutrient = phosphorus if TN/TP > 25; = nitrogen if TN/TP < 10; = uncertain if 10 < TN/TP < 25
Change? = exhibiting significant change in TN readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on TN readings >25% higher or lower than normal

Table 4.3.3a: Total Nitrogen Summary in CSLAP Lakes, 2009

Region	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum
Downstate	32	0.17	0.54	0.63	1.95
Central	36	0.05	0.41	0.45	1.31
Adirondacks	33	0.03	0.29	0.40	1.01
Western	9	0.24	0.65	0.74	1.75
CSLAP Statewide	**110**	**0.03**	**0.42**	**0.51**	**1.95**

Table 4.3.3b: Surface Total Nitrogen Summary in CSLAP Lakes, 2009

Region	Number Lakes	Average 2009	Average 1986-08	% TP Limited	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	0.54	0.63	73	7	40	27	23
Central	36	0.41	0.45	100	0	51	11	16
Adirondacks	33	0.29	0.40	100	3	68	3	24
Western	9	0.65	0.74	89	0	33	11	11
CSLAP Statewide	**110**	**0.42**	**0.51**	**92**	**3**	**52**	**13**	**20**

% TP Limited = percentage of lakes in region with TN:TP ratios exceeding 25
% Higher = percentage of lakes in region with TN readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with TN readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with TN readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with TN readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Total Nitrogen in 2009:
Lake Lincolndale, Shawangunk Lake

Discussion:

Two Downstate region lakes exhibited higher than normal total nitrogen readings in 2009. As noted above, few CSLAP lakes across the state exhibited higher than normal readings in 2009, perhaps due to wetter weather. The higher readings in Shawangunk Lake were part of the aforementioned slight increase in TN readings in recent years. The TN rise in Lake Lincolndale was much greater, and TN readings were consistently higher than normal throughout the 2009 sampling season. It is not known if this was due to unusual weather (and/or runoff) or is part of a longer-term trend at the lake (which is not yet apparent). This bears further observation, but it is likely that these readings were return to normal in subsequent sampling seasons.

Downstate Region Lakes With Lower Than Normal Total Nitrogen in 2009:
Anawanda Lake, Highland Lake, Lake Oscaleta, Lake Rippowam, Lake Waccabuc, Little Fresh Pond, Little Long Pond, Little We Wah Lake, Timber Lake, Weiden Pond, Yankee Lake

Discussion:

Total nitrogen readings in 2009 were lower than normal in 11 Downstate region lakes, assuming that the 5-8 year average computed for each of these lakes prior to 2009 represents normal conditions for each lake. This subset of lakes overlaps somewhat with the subset of lakes for which ammonia readings in 2009 were slightly lower than normal, an expected occurrence since ammonia is a component of total nitrogen (although there was less overlap with the lakes for which NO_x readings decreased over the same period).

In each of the listed above, the decrease in average TN readings in 2009 was small, and readings in 2010 are likely to be close to normal. None of these lakes has exhibited a long-term decrease in total nitrogen readings, so it is likely that this small decrease represented normal variability in these lakes.

True Color Fact Sheet

Description:	true color is a laboratory analysis used as a simple surrogate for dissolved organic carbon, since primary constituents of dissolved organic carbon—tannic and fulvic acids—impart a brownish color to water in direct proportion to their concentration in water. It involves either filtering or centrifuging a water sample and analyzing the filtrate. True color differs from apparent color, which includes suspended components, including algae and sediment, and dissolved components, including dissolved organic and inorganic matter.
Importance:	dissolved color can strongly influence water transparency, particularly in the absence of algal or inorganic turbidity (and color can significantly alter the light transmission in water, further limiting algae growth). However, this component of water clarity is not strongly linked to public water quality perception, since dissolved color is often "natural" in many lakes, particularly softwater, high elevation lakes in the northwestern Adirondacks, Catskills and other regions in the state overlying organic soils. Thus it is associated with *dystrophic* rather than *eutrophic* lake systems. Changes in color can also indicate changes in runoff patterns to lakes, but can be negatively correlated to conductivity, since dissolved organic matter is often comprised of neutrally charged particles that do not carry current.
How Measured: in CSLAP	true color is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container. Approximately 100ml of lake water is filtered through a 0.45µ mixed ester filter, and the filtrate is transferred to pre-labeled sample aliquot bottles. Color samples are visually compared to a scaled set of standards created from a platinum-cobalt solution.
Detection Limit:	1 platinum color units (ptu) prior to 2002; 2 ptu since 2002
Range in CSLAP:	undetectable (< 1 ptu) to 289 ptu. 75% of surface readings are between 5 ptu and 30 ptu, and 40% of surface samples have true color less than 10 ptu.
WQ Standards:	there are no state water quality standards for true color. The state narrative water quality standard for color of 15 platinum color units applies to only potable groundwater.
Trophic Assessment:	New York State exempts any lake with color greater than 30 ptu from a strict application of the trophic criteria due to the strong influence of high water color on water transparency. Lakes with less than 30 ptu true color are considered "clearwater" lakes and can be characterized by the traditional trophic indicators (water clarity, True color, and total phosphorus). Color readings less than 10 ptu are probably not visible to the casual observer.

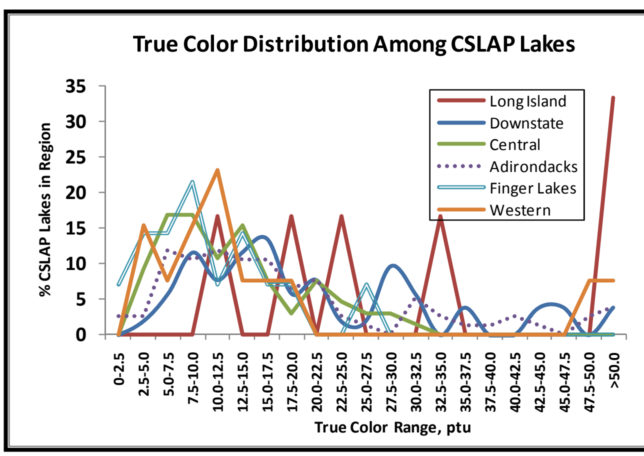
Chapter 4.4- Evaluation of Downstate Region True Color: 1986-2009

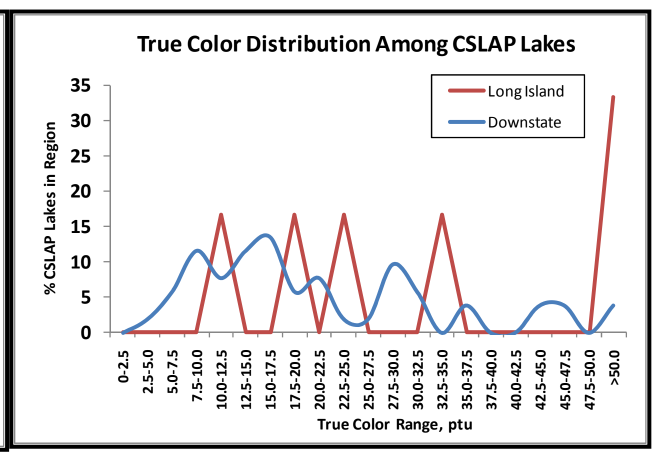
Summary of CSLAP True Color Findings in Downstate Region Lakes, 1986-2009

1. CSLAP lakes within the Downstate region have water color readings slightly higher than in most regions of the state.
2. CSLAP lakes within the Downstate region have similar water color readings than non-CSLAP lakes in the same region
3. CSLAP lakes within the Downstate region are more likely to have lower water color readings in drier years and higher color readings in wetter years.
4. Most lakes in the Downstate region have low water color readings. These lakes do not share any clear geographic, morphometric, or trophic similarities. The rise in color in these lakes may be due to the change in laboratories in 2002 or wetter weather in recent years.
5. True color readings in Downstate region lakes were much higher in 2009 than in the period from 1986 to 2008, an increase observed in other regions of the state. This is coincident with much wetter weather in most of the region, although this may also be, at least in part, a laboratory artifact.
6. The much higher water color in most lakes in the region was not accompanied by similar changes in water clarity or other measured water quality indicators in most lakes, although some lakes did have lower water transparency in 2009.

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region are slightly more colored than those in most other regions of the state, as seen in Figure 4.4.1. The most common range of color readings in CSLAP Downstate region lakes is in the 10-20 ptu range, although several Downstate region lakes exhibit color readings in the 30 ptu range. Few of CSLAP Downstate region lakes have average color readings above 50 ppb, as seen in Figure 4.4.2, although higher readings were recorded in 2009.





Figures 4.4.1 and 4.4.2: Distribution of True Color Ranges in CSLAP and Downstate Region Lakes

Comparison of CSLAP to NYS Lakes in the Downstate Region

The distribution of color readings in CSLAP and non-CSLAP lakes in the Downstate region has been similar, as seen in Figure 4.4.3. The slight differences more likely reflects the small number of lakes in some color ranges (due to the small number of lakes overall sampled through CSLAP) rather than a fundamental difference in these lakes.

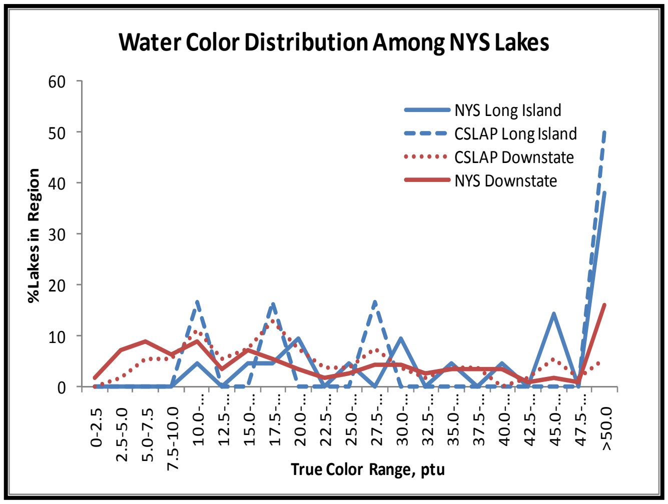


Figure 4.4.3: Average Distribution of True Color Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

True color readings vary significantly from lake to lake and year to year in each region of the state, including the Downstate region. The highest color readings measured through CSLAP occurred during 1990, 2006, 2004 and especially 2009. Some of these years, particularly 2006 and perhaps 2009, were very wet. The lowest color readings occurred in 1993, 2001, 1995, and 1997; these include the driest years. Table 4.4.1 looks at the percentage of CSLAP lakes with high water color (greater than 1 standard error above normal) and low water color (greater than 1 standard error below normal) readings in wet and dry years. These data show that high color readings are somewhat more likely to occur in wetter years, but low color was strongly associated with drier years.

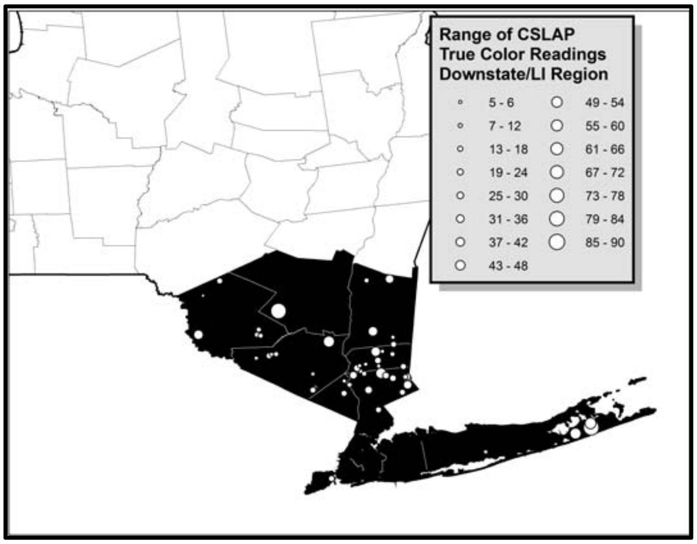
Table 4.4.1- % of CSLAP Lakes with Higher or Lower (than Normal) True Color Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Color Readings	4%	36%
Lower Color Readings	67%	21%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in any region, including the lakes within the Downstate region, is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). The frequency of higher than normal (moderately and significantly) color readings have increased. This may be due to some combination of wetter weather, the change in labs, and normal variability. The frequency of lower color readings has decreased, although these trends are weaker. These data indicate that water color has increased in the Downstate region lakes, although this has not translated into a significant change in water clarity.



Figures 4.4.4: Range of True Color Readings in the Downstate Region

Regional Distribution:

True color readings within the Downstate region are highest in Long Island and the northwestern portion of the region, although few lakes exhibit high enough color readings to strongly influence water transparency. The lowest color readings are found in the interior portion of the region, as seen in Figure 4.4.4, although most lakes in the region have relatively low water color. In most of these lakes, water color readings are not high enough to adversely affect water quality assessments or perceived recreational conditions in the lake.

Table 4.4.2 shows the number of water color samples, the minimum, average, and maximum water color readings in the entirety of the CSLAP dataset and in 2009, and whether water color readings have changed since CSLAP sampling began in the lake.

Table 4.4.2: True Color Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Change?
Anawanda Lake	1988-2009	144	0	5	20	No
Anawanda Lake	2009	8	3	8	11	Higher
Blue Heron Lake	2005-2008	24	5	23	52	
Cranberry Lake	2004-2004	7	15	19	24	
Gossamans Pond	2003-2005	22	2	18	30	
Highland Lake	2003-2009	31	2	12	70	
Highland Lake	2009	5	14	27	70	Higher
Hillside Lake	1994-1997	13	20	47	114	
Indian Lake	1994-2009	72	0	11	29	No
Indian Lake	2009	8	9	18	25	Higher
Katonah Lake	2006-2009	31	11	28	45	
Katonah Lake	2009	7	16	25	36	No
Lake Carmel	1986-1990	51	5	16	35	No
Lake Celeste	1993-1997	26	17	28	58	
Lake Guymard	1996-2003	46	4	11	54	No
Lake Kitchawan	2008-2008	1	37	37	37	
Lake Lincolndale	1993-2009	109	2	16	53	No
Lake Lincolndale	2009	5	15	23	28	Higher
Lake Lucille	1986-1990	55	9	21	65	No
Lake Mahopac	1986-2002	71	1	6	17	No
Lake Meahagh	1999-2001	10	8	15	24	
Lake Mohegan	1998-2009	80	2	18	43	No
Lake Mohegan	2009	8	17	22	34	No
Lake Nimham	1991-1995	41	1	10	19	Decreasing
Lake Oscaleta	2006-2009	35	8	17	35	
Lake Oscaleta	2009	8	18	20	25	No
Lake Oscawana	1991-1995	37	1	7	13	Decreasing

Lake Name	Years	Num	Min	Avg	Max	Change?
Lake Ossi	1996-2000	36	8	29	65	No
Lake Peekskill	1990-2009	93	2	11	50	No
Lake Peekskill	2009	7	8	23	48	Higher
Lake Rippowam	2006-2009	34	13	25	49	
Lake Rippowam	2009	8	24	35	49	Higher
Lake Tibet	1991-1993	23	13	22	35	
Lake Truesdale	1999-2009	85	11	33	88	Increasing
Lake Truesdale	2009	8	31	48	73	Higher
Lake Waccabuc	1986-2009	107	3	12	29	No
Lake Waccabuc	2009	8	13	17	20	Higher
Lake Wanaksink	1991-1995	39	5	12	25	No
Little We Wah Lake	2008-2009	16	8	25	63	
Little We Wah Lake	2009	8	21	36	63	Higher
Monhagen Lake	2003-2009	30	4	14	51	
Monhagen Lake	2009	5	14	17	22	No
Orange Lake	1994-2005	51	23	57	118	No
Peach Lake	1999-2008	69	6	19	106	Increasing
Plum Brook Lake	2005-2008	30	10	27	88	
Roaring Brook Lake	2009-2009	8	30	38	63	
Roaring Brook Lake	2009	8	30	38	63	No
Round Lake	1992-1996	40	1	8	20	Increasing
Sagamore Lake	1994-1997	32	9	43	100	
Sepasco Lake	1997-2009	89	0	17	53	No
Sepasco Lake	2009	7	20	32	48	Higher
Shadow Lake	2008-2009	12	10	31	79	
Shadow Lake	2009	5	10	34	79	No
Shawangunk Lake	2003-2009	29	4	18	31	
Shawangunk Lake	2009	5	13	24	29	Higher
Shenorock Lake	2004-2009	45	13	54	132	
Shenorock Lake	2009	8	44	84	126	Higher
Stissing Lake	2007-2009	24	20	38	100	
Stissing Lake	2009	8	20	50	100	Higher
Teatown Lake	1997-2009	82	0	36	138	No
Teatown Lake	2009	5	24	43	63	No
Timber Lake (Sullivan)	2004-2008	28	3	22	50	
Timber Lake (Westchester)	2006-2009	16	6	21	45	
Timber Lake	2009	8	20	26	45	Higher
Tomkins Lake	2001-2001	8	1	8	15	
Tuxedo Lake	2008-2009	16	1	19	41	
Tuxedo Lake	2009	8	20	28	41	Higher
Ulster Heights Lake	2007-2009	14	34	90	194	
Ulster Heights Lake	2009	4	114	159	194	Higher
Wallace Pond	2004-2008	29	12	30	79	No
We Wah Lake	2008-2009	16	6	28	60	
We Wah Lake	2009	8	28	45	60	Higher
Weiden Pond	2004-2009	38	8	47	228	No
Weiden Pond	2009	5	37	59	76	Higher
Whaley Lake	1998-2001	31	2	7	15	
Wolf Lake	1987-2001	90	2	13	22	Decreasing
Yankee Lake	2006-2009	29	7	18	40	
Yankee Lake	2009	7	19	27	40	Higher
Black Pond	2008-2009	13	37	88	247	
Black Pond	2009	8	41	75	105	No
Bradys Pond	1997-2001	33	12	19	45	Decreasing
Canaan Lake	1990-2005	79	1	12	55	No

Lake Name	Years	Num	Min	Avg	Max	Change?
Lily Pond	2008-2009	13	30	56	99	
Lily Pond	2009	8	45	68	99	No
Little Fresh Pond	1989-2009	97	11	57	203	No
Little Fresh Pond	2009	8	67	89	125	Higher
Little Long Pond	2006-2009	14	1	28	59	
Little Long Pond	2009	3	34	43	59	Higher

Num = number of samples
Min, Avg, Max = minimum, average, and maximum color readings, in ptu
Change? = exhibiting significant change in color readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on color readings >25% higher or lower than normal

There are several lakes in this region exhibiting long-term change in water color readings. Lake Truesdale, Peach Lake, Sagamore Lake all exhibited increasing water color readings over the duration of their CSLAP sampling. These lakes comprise small lakes in the eastern portion of the region, but since there are many other nearby CSLAP lakes, it is not likely that this geographic proximity is influencing the change in color. Lake Truesdale and Peach Lake have been sampled in recent years, and the rise in color in these lakes may be due at least in part to the change in laboratories (and recent wetter weather). Neither of these lakes has exhibited a long-term decrease in water transparency, suggesting that this rise in color has not otherwise strongly affected the lake.

Color readings in Bradys Pond, Lake Nimham, Lake Oscawana, and Wolf Lake decreased over the duration of the CSLAP sampling at their lake. All of these lakes were last sampled before the change in laboratories in 2002, and it is not known if the small drop in water color has continued into the present day.

Tables 4.4.3a and 4.4.3b summarize the surface true color data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. True color readings in the CSLAP lakes in the Downstate region in 2009 (and all other NYS regions) were much higher than those reported in previous years, at least as evaluated by average water color readings. It is likely that this reflects the very wet weather recorded throughout the state in at least the beginning of the summer. Unfortunately, at the time of this reporting, the majority of the 2009 meteorological data are not yet available. A high percentage (63%) of Downstate region lakes exhibited higher than normal water color in 2009, lower than in other regions of the state, and about half (52%) of the sampled lakes established a new maximum water color reading in 2009.

Table 4.4.3a: True Color Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical
Downstate	32	3	43	27	194	Highly Colored
Central	36	1	30	14	109	Highly Colored
Adirondacks	33	6	31	21	97	Highly Colored
Western	9	5	46	16	407	Highly Colored
CSLAP Statewide	**110**	**1**	**35**	**20**	**407**	**Highly Colored**

Table 4.4.3b: True Color Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	43	27	63	0	52	12
Central	36	30	14	84	0	27	5
Adirondacks	33	31	21	78	0	44	0
Western	9	46	16	100	0	44	0
CSLAP Statewide	**110**	**35**	**20**	**75**	**0**	**40**	**6**

% Higher = percentage of lakes in region with true color readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with true color readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with color readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with color readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Water Color in 2009:

Anawanda Lake, Highland Lake, Indian Lake, Lake Lincolndale, Lake Peekskill, Lake Rippowam, Lake Truesdale, Little Fresh Pond, Little Long Pond, Little We Wah Lake, Sepasco Lake, Shawangunk Lake, Shenorock Lake, Stissing Lake, Timber Lake, Tuxedo Lake, Ulster Heights Lake, We Wah Lake, Weiden Pond, Yankee Lake

Discussion:

Most Downstate region lakes exhibited higher than normal water color readings in 2009. The vast majority of these lakes reported higher than normal precipitation in 2009; only Highland Lake, Lake Lincolndale, Lake Peekskill, Shawangunk Lake, Stissing Lake, Ulster Heights Lake and Weiden Pond volunteers did not report wetter weather in 2009. Of these lakes, only Lake Truesdale has exhibited a long-term increase in water color. In most of these lakes, water color readings were consistently higher in 2009 than in previous sampling seasons. However, water clarity was lower only in Indian Lake, Lake Lincolndale, Little Fresh Pond, Shawangunk Lake, Ulster Heights Lake, and Weiden Pond in 2009, and did not decrease in any of these lakes over the long term. This suggests that either the increase in water color is still within the normal range of variability for the lake, or that these color readings are not accurate.

Downstate Region Lakes With Lower Than Normal Water Color in 2009:

None

Discussion:

None of the Downstate region lakes exhibited lower than normal water color readings in 2009.

pH Fact Sheet

Description:	pH is the abbreviation for "powers of hydrogen", and is a mathematical construct that characterizes the acidity of water on a simple scale. It is the negative logarithm of the hydrogen ion concentration, and is measured on a 14 point scale, from 0 (very highly acidic) to 14 (nearly highly basic). The effective scale for most waterbodies is 4 to 10, with 7 considered neutral (equal concentrations of hydrogen and hydroxide ions).
Importance:	the survival of most aquatic organisms is strongly dependent on pH. Many aquatic organisms do not properly function in water with pH below 6.5 or above 8.5, although impacts in low pH are more well understood. This sensitivity of aquatic organisms to pH also reflects the sensitivity of some chemical compounds to pH—the sensitivity of fish to low pH water is a function of aluminum compounds, which can clog gills once certain forms of aluminum predominate at lower pH values. Other compounds, such as ammonia, are more highly toxic at elevated pH.
How Measured: in CSLAP	pH is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container and labeled sample aliquot bottles. pH is more accurately measured directly in the field, since a number of factors (such as headspace in a sample bottle) introduce "contaminants" that change pH between collection and analysis. Laboratory pH is usually fairly accurate for most lakes with moderate to high buffering capacity, and is measured with a benchtop pH meter with buffer standards bracketing the expected range.
Detection Limit:	not applicable
Range in CSLAP:	4.40 to 9.85; 89% of readings fall between pH 6.5 and 8.5, corresponding to the state water quality standards.
WQ Standards:	the state water quality standards require pH to be above 6.5 and below 8.5.
Water Quality Assessment:	pH readings are evaluated against the state water quality standards. In addition, lakes are classified by acidity status. Lakes with pH less than 6 are considered strongly acidic, and lakes with pH readings between 6 and 6.5 are considered weakly acidic. Lakes with pH greater than 8 are considered alkaline, and lakes with pH between 7.5 and 8 are considered weakly alkaline. Lakes with pH between 6.5 and 7.5 can be considered circumneutral.

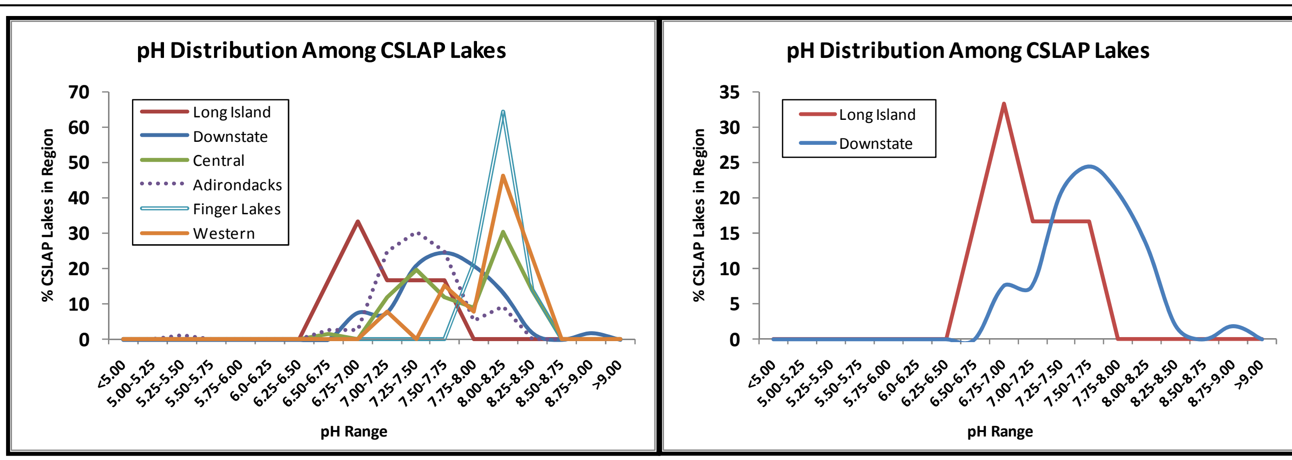
Chapter 5.5- Evaluation of Downstate Region pH: 1986-2009

Summary of CSLAP pH Findings in Downstate Region Lakes, 1986-2009

1. CSLAP lakes within the Downstate region have pH readings comparable to those in most other parts of the state, with the majority of lakes having pH levels between 7 and 8.5, corresponding to circumneutral to alkaline conditions. A few Long Island CSLAP lakes have slightly lower pH.
2. CSLAP lakes within the northern portion of the Downstate region have slightly higher pH readings than non-CSLAP lakes in the same region, but Long Island CSLAP lakes have slightly lower pH than non-CSLAP lakes.
3. CSLAP lakes within the Downstate region are more likely to have lower pH readings in both drier and wetter years, suggesting a strong influence of precipitation on lake pH in the region.
4. The frequency of lower than normal and higher than normal pH readings in CSLAP lakes within the Downstate region has not changed significantly since 1986.
5. The typical Downstate region lake exhibited lower than normal pH readings in 2009, and more lakes in the region have exhibited decreasing pH than increasing pH during the duration of CSLAP sampling on their lake.
6. pH readings with the Downstate region are highest in the interior portions of the region, corresponding to the highest lake productivity (and algae levels), and lowest in the western and southern portions of the region.

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region have similar pH readings to those in most other regions of the state, although Long Island CSLAP lakes have relatively low pH, as demonstrated in Figure 4.5.1. Most of the Downstate region CSLAP lakes have pH readings between 7 and 8.3, and can be characterized as circumneutral to alkaline. Very few CSLAP Downstate region lakes have pH readings below 6.8 or above 8.5, as seen in Figure 4.5.2. This spans the pH range seen in many other regions of the state, although a few Long Island lakes have slightly lower pH (this constitutes a high percentage but low number of Long Island CSLAP lakes).



Figures 4.5.1 and 4.5.2: Distribution of pH Ranges in CSLAP and Downstate Region CSLAP Lakes

Comparison of CSLAP to NYS Lakes in the Downstate Region

The CSLAP and non-CSLAP dataset exhibits a similar distribution of pH readings between pH of 7 and 8.5, although CSLAP lakes in the northern part of this region have slightly higher pH, and CSLAP lakes in Long Island have slightly lower pH, than non-CSLAP lakes in the region.

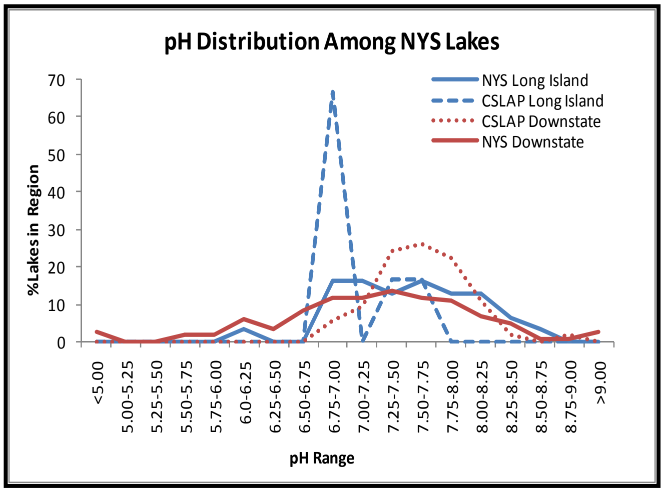


Figure 4.5.3: Average Distribution of pH Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

pH readings have usually stayed within a fairly tight range in most Downstate region lakes—generally between 7 and 8.5—but have varied from year to year within this range. The highest pH readings measured through CSLAP occurred during 1988, 1993, 2007, and 2006; the latter of these years was very wet in the Downstate region, but the other years were neither wet nor dry. The lowest pH readings occurred in 1987, 1996, 2004, and 1995, a mix of wet, dry, and normal years. Table 4.5.1 looks at the percentage of CSLAP lakes with high pH (greater than 1 standard error above normal) and low pH (greater than 1 standard error below normal) readings in wet and dry years. These data show that lower than normal pH readings are associated with both very dry and very wet years. This suggests that heavy acidic precipitation strongly influences pH readings in the lakes in the region.

Table 5.5.1- % of CSLAP Lakes with Higher or Lower (than Normal) pH Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher pH Readings	17%	15%
Lower pH Readings	26%	33%

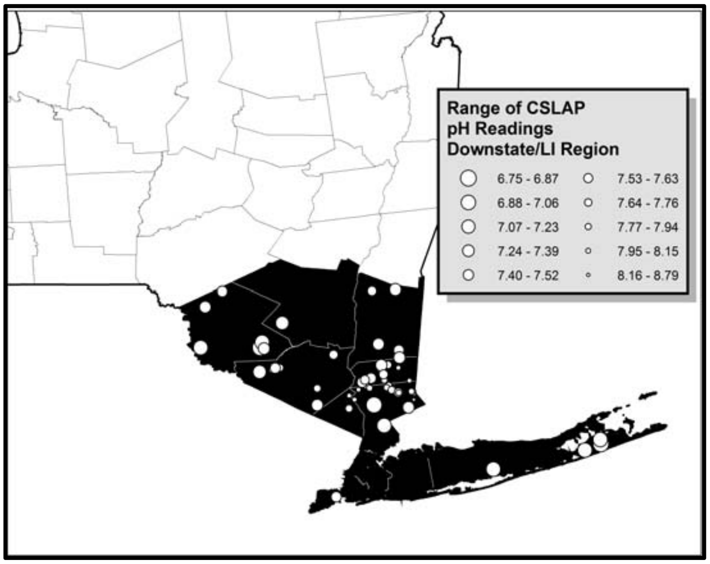
Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

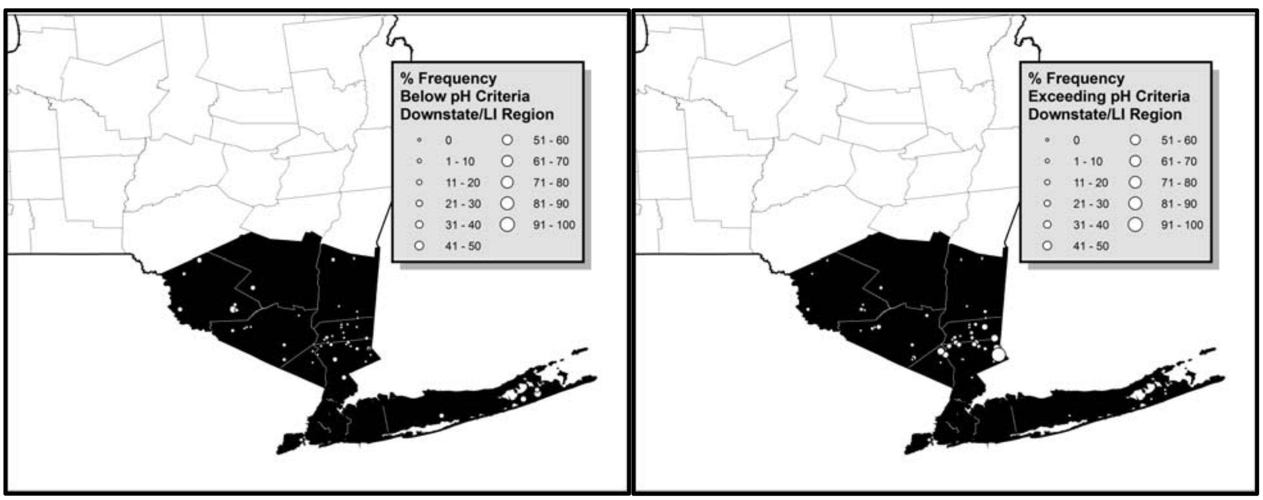
The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of lower and higher pH readings has not changed significantly. These data suggest that pH is either stable or is varying in a manner that is not statistically predictable.

Regional Distribution:

pH readings with the Downstate region are lowest in the western and southern portions of the region (Figure 4.5.4), although none of the CSLAP lakes in this region have exhibited very low pH readings. These lakes are consistently circumneutral to alkaline and very infrequency exhibit pH excursions below the state water quality standards (Figure 4.5.5). Lakes in the interior portion of the region occasionally exhibit elevated pH readings (Figure 4.5.6), and tend to have the highest pH readings in the region. Most of these lakes can be characterized as *eutrophic*, with high pH excursions associated with algal production.



Figures 4.5.4: Range of pH Readings in the Downstate Region



Figures 4.5.5 and 4.5.6: Frequency of Low and High pH Readings in the Downstate Region

Table 4.5.2 shows the number of pH samples, the minimum, average, and maximum pH readings, the most appropriate pH category for the lake, the frequency of pH readings below and above the state water quality standards (=6.5 and 8.5, respectively), and whether pH readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009.

Table 4.5.2: pH Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Category	% Samples <6.5	% Samples > 8.5	Change?
Anawanda Lake	1988-2009	144	5.20	7.32	8.31	Circumneutral	6	0	No
Anawanda Lake	2009	8	6.53	7.40	8.31	Circumneutral	0	0	No
Blue Heron Lake	2005-2008	24	6.62	7.31	7.90	Circumneutral	0	0	
Cranberry Lake	2004-2004	7	6.31	7.00	7.88	Circumneutral	13	0	
Gossamans Pond	2003-2005	22	6.71	7.33	8.08	Circumneutral	0	0	
Highland Lake	2003-2009	31	6.50	7.44	8.26	Circumneutral	0	0	
Highland Lake	2009	5	6.77	7.69	8.14	Alkaline	0	0	No
Hillside Lake	1994-1997	13	6.79	7.35	7.93	Circumneutral	0	0	
Indian Lake	1994-2009	72	6.11	7.58	9.53	Alkaline	4	8	No
Indian Lake	2009	8	6.11	7.56	8.74	Alkaline	13	13	No
Katonah Lake	2006-2009	31	6.03	7.80	8.84	Alkaline	3	3	
Katonah Lake	2009	7	6.03	7.18	8.01	Circumneutral	14	0	Lower
Lake Carmel	1986-1990	51	6.70	8.05	9.54	Alkaline	0	28	No
Lake Celeste	1993-1997	26	7.08	7.47	8.15	Circumneutral	0	0	
Lake Guymard	1996-2003	46	6.24	7.23	8.02	Circumneutral	8	0	No
Lake Kitchawan	2008-2008	1	8.79	8.79	8.79	Alkaline	0	100	
Lake Lincolndale	1993-2009	109	5.50	7.87	9.66	Alkaline	4	10	No
Lake Lincolndale	2009	5	5.50	5.89	6.52	Slightly Acidic	75	0	Lower
Lake Lucille	1986-1990	55	6.58	7.72	8.45	Alkaline	0	0	No
Lake Mahopac	1986-2002	71	6.79	7.85	9.50	Alkaline	0	9	No
Lake Meahagh	1999-2001	10	6.69	8.07	9.46	Alkaline	0	30	
Lake Mohegan	1998-2009	80	5.92	7.93	9.53	Alkaline	1	16	No
Lake Mohegan	2009	8	7.13	7.79	8.14	Alkaline	0	0	No
Lake Nimham	1991-1995	41	7.05	7.65	8.54	Alkaline	0	2	Decreasing
Lake Oscaleta	2006-2009	35	7.11	7.94	9.36	Alkaline	0	19	
Lake Oscaleta	2009	8	7.11	7.70	8.22	Alkaline	0	0	No
Lake Oscawana	1991-1995	37	6.77	7.52	7.77	Alkaline	0	0	No
Lake Ossi	1996-2000	36	6.65	7.61	8.99	Alkaline	0	8	No
Lake Peekskill	1990-2009	93	6.62	7.84	9.33	Alkaline	0	12	No
Lake Peekskill	2009	7	6.90	7.39	7.68	Circumneutral	0	0	Lower
Lake Rippowam	2006-2009	34	6.62	8.00	9.40	Alkaline	0	22	
Lake Rippowam	2009	8	6.62	7.71	8.64	Alkaline	0	13	No
Lake Tibet	1991-1993	23	6.63	7.63	7.98	Alkaline	0	0	
Lake Truesdale	1999-2009	85	6.99	8.02	9.17	Alkaline	0	19	Increasing
Lake Truesdale	2009	8	6.99	7.83	8.34	Alkaline	0	0	No
Lake Waccabuc	1986-2009	107	5.85	7.87	9.06	Alkaline	2	11	No
Lake Waccabuc	2009	8	7.26	7.88	8.32	Alkaline	0	0	No
Lake Wanaksink	1991-1995	39	5.24	7.06	7.70	Circumneutral	5	0	No
Little We Wah Lake	2008-2009	16	6.13	7.37	8.39	Circumneutral	6	0	
Little We Wah Lake	2009	8	6.13	7.07	7.84	Circumneutral	13	0	Lower
Monhagen Lake	2003-2009	30	6.81	7.76	9.17	Alkaline	0	16	
Monhagen Lake	2009	5	6.81	7.47	8.31	Circumneutral	0	0	No
Orange Lake	1994-2005	51	6.72	7.60	9.38	Alkaline	0	4	Increasing
Peach Lake	1999-2008	69	5.64	8.15	9.31	Alkaline	3	33	No
Plum Brook Lake	2005-2008	30	7.04	7.70	8.62	Alkaline	0	3	
Roaring Brook Lake	2009-2009	8	7.16	7.64	8.82	Alkaline	0	13	
Roaring Brook Lake	2009	8	7.16	7.64	8.82	Alkaline	0	13	No
Round Lake	1992-1996	40	5.65	7.85	8.99	Alkaline	3	5	No
Sagamore Lake	1994-1997	32	6.73	7.39	7.87	Circumneutral	0	0	
Sepasco Lake	1997-2009	89	6.14	7.58	8.23	Alkaline	1	0	No
Sepasco Lake	2009	7	6.87	7.62	8.08	Alkaline	0	0	No
Shadow Lake	2008-2009	12	6.21	6.87	7.28	Circumneutral	17	0	
Shadow Lake	2009	5	6.21	6.83	7.28	Circumneutral	40	0	No
Shawangunk Lake	2003-2009	29	6.80	7.67	8.76	Alkaline	0	9	

Lake Name	Years	Num	Min	Avg	Max	Category	% Samples <6.5	% Samples > 8.5	Change?
Shawangunk Lake	2009	5	7.18	8.04	8.76	Alkaline	0	20	Higher
Shenorock Lake	2004-2009	45	6.84	7.88	9.41	Alkaline	0	13	
Shenorock Lake	2009	8	6.84	7.55	7.95	Alkaline	0	0	Lower
Stissing Lake	2007-2009	24	6.83	7.35	7.86	Circumneutral	0	0	
Stissing Lake	2009	8	7.08	7.35	7.80	Circumneutral	0	0	No
Teatown Lake	1997-2009	82	6.10	7.18	8.58	Circumneutral	8	1	No
Teatown Lake	2009	5	6.49	7.15	7.84	Circumneutral	20	0	No
Timber Lake (Sullivan)	2004-2008	28	5.31	7.43	8.38	Circumneutral	14	0	
Timber Lake (Westchester)	2006-2009	16	7.06	7.56	8.16	Alkaline	0	0	
Timber Lake	2009	8	7.06	7.39	8.03	Circumneutral	0	0	No
Tomkins Lake	2001-2001	8	7.09	8.04	8.83	Alkaline	0	38	
Tuxedo Lake	2008-2009	16	5.88	7.29	8.23	Circumneutral	6	0	
Tuxedo Lake	2009	8	5.88	7.07	8.23	Circumneutral	13	0	No
Ulster Heights Lake	2007-2009	14	6.09	7.09	9.19	Circumneutral	14	7	
Ulster Heights Lake	2009	4	6.77	7.16	7.78	Circumneutral	0	0	No
Wallace Pond	2004-2008	29	7.17	7.99	9.11	Alkaline	0	14	No
We Wah Lake	2008-2009	16	6.64	7.70	9.20	Alkaline	0	13	
We Wah Lake	2009	8	6.64	7.61	8.86	Alkaline	0	14	No
Weiden Pond	2004-2009	38	4.96	7.01	9.25	Circumneutral	19	3	No
Weiden Pond	2009	5	6.22	7.17	7.72	Circumneutral	20	0	No
Whaley Lake	1998-2001	31	6.50	7.48	8.61	Circumneutral	0	6	
Wolf Lake	1987-2001	90	4.75	6.75	8.54	Circumneutral	36	1	No
Yankee Lake	2006-2009	29	6.29	7.35	8.43	Circumneutral	3	0	
Yankee Lake	2009	7	6.29	7.25	8.02	Circumneutral	14	0	No
Black Pond	2008-2009	13	5.65	6.76	7.84	Circumneutral	31	0	
Black Pond	2009	8	5.65	6.90	7.79	Circumneutral	13	0	No
Bradys Pond	1997-2001	33	6.38	7.46	8.86	Circumneutral	3	3	Decreasing
Canaan Lake	1990-2005	79	4.49	6.94	8.18	Circumneutral	18	0	No
Lily Pond	2008-2009	13	6.28	6.96	7.66	Circumneutral	15	0	
Lily Pond	2009	8	6.28	6.81	7.66	Circumneutral	25	0	No
Little Fresh Pond	1989-2009	97	5.20	6.91	8.16	Circumneutral	27	0	No
Little Fresh Pond	2009	8	6.40	6.93	7.94	Circumneutral	25	0	No
Little Long Pond	2006-2009	14	6.96	7.58	8.32	Alkaline	0	0	
Little Long Pond	2009	3	7.35	7.52	7.64	Alkaline	0	0	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum conductivity readings, in µmho/cm
Category= acidic if pH < 6.5; = circumneutral if 6.5 < pH < 7.5; = alkaline if pH > 7.5
Change? = exhibiting significant change in pH readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on pH readings >25% higher or lower than normal

A few lakes within the Downstate region have exhibited significant long-term trends in pH readings. pH readings in Lake Truesdale and Orange Lake have increased during the duration of the CSLAP sampling at the lake. Orange Lake has not been sampled through CSLAP since 2005. It is not known if the increasing pH noted by the end of the sampling at the lake has continued into the present day, or if this rise in pH is in response to Clean Air Act atmospheric sulfate and nitrate reductions, particularly since these mostly took place in the last ten years. The increasing pH in Lake Truesdale was not apparent in 2009. It is not known if this has resulted in any ecological impacts.

Bradys Pond and Lake Nimham have exhibited decreasing pH readings. Neither lake has been sampled through CSLAP for several years, and it is not known if the decreasing pH recorded during the last several years of sampling at each lake has continued to the present day.

Tables 4.5.3a and 4.5.3b summarize the pH data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. pH readings in the CSLAP lakes in the Downstate region in 2009 were slightly lower than normal, although the percentage of lakes with lower than normal pH readings in 2009 was low. This suggests that the variability in pH in the Downstate region lakes in 2009 was normal, and does not represent a long-term trend.

Table 4.5.3a: pH Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical
Downstate	32	5.50	7.38	7.54	8.86	Circumneutral
Central	36	4.68	7.45	7.76	9.41	Circumneutral
Adirondacks	33	5.74	7.52	7.41	8.98	Alkaline
Western	9	6.74	7.75	8.02	8.95	Alkaline
CSLAP Statewide	**110**	**4.68**	**7.48**	**7.63**	**9.41**	**Circumneutral**

Table 4.5.3b: pH Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	7.38	7.54	3	16	20	57
Central	36	7.45	7.76	14	27	19	32
Adirondacks	33	7.52	7.41	13	26	12	26
Western	9	7.75	8.02	0	22	0	22
CSLAP Statewide	**110**	**7.48**	**7.63**	**10**	**24**	**15**	**36**

% Higher = percentage of lakes in region with pH readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with pH readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with pH readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with pH readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal pH in 2009:
Shawangunk Lake

Discussion:
Only one Downstate region lakes exhibited higher than normal pH readings in 2009. The pH of Shawangunk Lake was not replicated in other nearby (Highland Lake, Monhagen Lake) in 2009, and was not part of a longer-term change. It is likely that the small increase in lake pH in 2009 was part of normal variability in the lake.

Downstate Region Lakes With Lower Than Normal pH in 2009:
Katonah Lake, Lake Lincolndale, Lake Peekskill, Little We Wah Lake, Shenorock Lake

Discussion:
pH readings in 2009 were lower than normal in 5 Downstate region lakes. None of these lakes has exhibited any clear long-term decrease in pH. pH readings in each of these lakes was only slightly lower than normal, and it is likely that this represents normal variability.

Conductivity Fact Sheet

Description:	Specific conductance is the temperature-corrected analysis of conductivity, with measures the electrical current that passes through water, and is used to estimate the number of ions (charged particles). Current is carried by ions, so specific conductance is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron.
Importance:	Conductivity is not a measure of pollution per se—some lakes naturally have high conductivity—and conductivity is not directly related to eutrophication or other indicators of water quality problems. However, changes (increases) in conductivity can be an indication of changing runoff to a lake, either through changing flow rates or increases in erodible material in the flow. Since these materials can often bring pollutants or change biological habitat, changes in conductivity can be an indication of pollution problems. It is somewhat related to both the hardness and alkalinity (acid-buffering capacity) of the water and may influence the degree to which nutrients remain in the water.
How Measured: in CSLAP	Specific conductance is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container and labeled sample aliquot bottles. It is measured in the laboratory using a conductivity meter comparing a sample to the conductivity of a known solution of potassium chloride (KCl) and corrected to 25ºC. Specific conductance is more accurately measured directly in the field using a conductivity bridge, although conductivity in many lakes is fairly stable.
Detection Limit:	1 µmho/cm
Range in CSLAP:	undetectable (<1 µmho/cm) to 2540 µmho/cm; 93% of readings fall between 26 µmho/cm and 400 µmho/cm.
WQ Standards:	there are no specific conductance (or conductivity) standards in New York State.
Water Quality Assessment:	conductivity readings are not evaluated against any state water quality standards. Conductivity is related to hardness, since many of the same cations (calcium, magnesium, etc.) that contribute to hardness also contribute to conductivity (and are found in similar proportions to other metals that also contribute to conductivity). Lakes with conductivity below 100 µmho/cm can be considered softwater lakes, and lakes with conductivity above 300 µmho/cm have hard water.

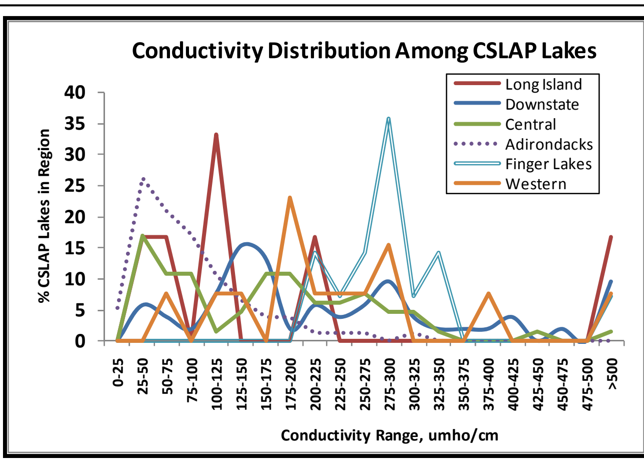
Chapter 5.6- Evaluation of Downstate Region Conductivity: 1986-2009

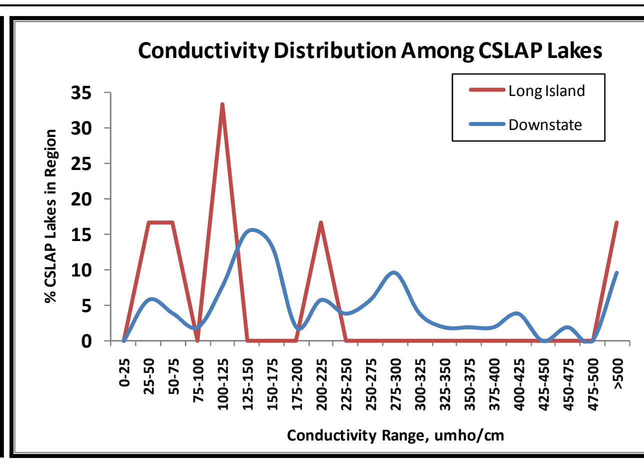
Summary of CSLAP Conductivity Findings in Downstate Region Lakes, 1986-2009

1. CSLAP lakes within the Downstate region have higher conductivity readings than in some regions but lower than in others. However, although the most common conductivity range in these lakes is between 125 and 175 µmho/cm, corresponding to intermediate hardness, many lakes have conductivity readings above 250 or below 200 µmho/cm, typical of hardwater conditions.
2. CSLAP lakes within the Downstate region have slightly higher conductivity readings than non-CSLAP lakes in the same region. CSLAP and non-CSLAP lakes in the same depth and size range have similar conductivity readings.
3. CSLAP lakes within the Downstate region are more likely to have higher conductivity readings in drier years, and lower readings in wetter years, similar to the statewide patterns.
4. Conductivity readings have increased slightly in CSLAP lakes within the Downstate region over the last twenty five years, whether evaluated by the increased frequency of lakes with higher than normal conductivity readings in recent years or the number of lakes with increasing conductivity readings.
5. More Downstate region lakes exhibited lower conductivity levels in 2009, perhaps in response to wetter weather. Lower conductivity was measured in most CSLAP lakes (throughout the state) in 2009.
6. Conductivity readings are highest in lakes in the interior portion of the region—the higher productivity lakes in Westchester and Putnam Counties, and are lowest in the western portion of the region and Long Island.

Downstate Region Data Compared to NYS Data

CSLAP lakes in the Downstate region have lower conductivity than in the Western region, but higher conductivity than in the Adirondack and Central regions, as demonstrated in Figure 4.6.1. A wide range of conductivity readings occurs, with the greater percentage of CSLAP lakes in the 125-175 µmho/cm range, corresponding to lakes of intermediate hardness.





Figures 4.6.1 and 4.6.2: Distribution of Conductivity Ranges in CSLAP and Downstate Region Lakes

While higher and low conductivity readings are less common, some Downstate region lakes have conductivity readings above 250 µmho/cm, corresponding to hardwater lakes, or below 100 µmho/cm, corresponding to softwater lakes, as seen in Figure 4.6.2.

Comparison of CSLAP to NYS Lakes in the Downstate Region

Most of the Downstate region lakes have conductivity readings near 150 µmho/cm, as seen in Figure 5.6.3. The Downstate region lakes sampled in the non-CSLAP monitoring programs in New York State have lower conductivity readings, although those in the same size and elevation range as CSLAP lakes appear to exhibit similar conductivity readings. The distribution of conductivity in CSLAP and non-CSLAP lakes in Long Island lakes appears to be comparable, although this comparison is compromised by the lack of Long Island CSLAP lakes.

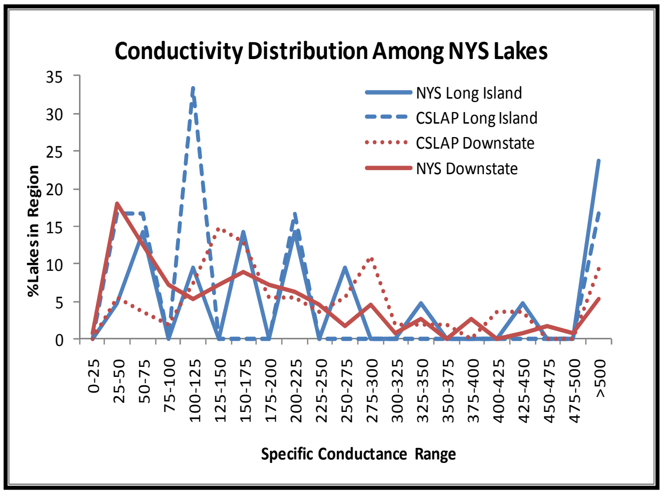


Figure 4.6.3: Average Distribution of Conductivity Readings in New York State and CSLAP Lakes in the Downstate Region

Annual Variability:

Conductivity readings have varied from year to year in many Downstate region lakes, as in other parts of the state. The highest conductivity readings measured through CSLAP occurred during 1995, 2003, 2002, 2001 and 1999, as in most other regions. This corresponds to a mixture of wet and dry years. The lowest conductivity readings occurred in 1986, 2006, 1987, 2008, 1994 and 2007, generally wetter years (and also similar to those from other regions). Table 4.6.1 looks at the percentage of CSLAP lakes with high conductivity (greater than 1 standard error above normal) and low conductivity (greater than 1 standard error below normal) readings in wet and dry years. These data show that higher conductivity readings occur in drier years, and lower conductivity occurs in wet years, similar to the statewide trend.

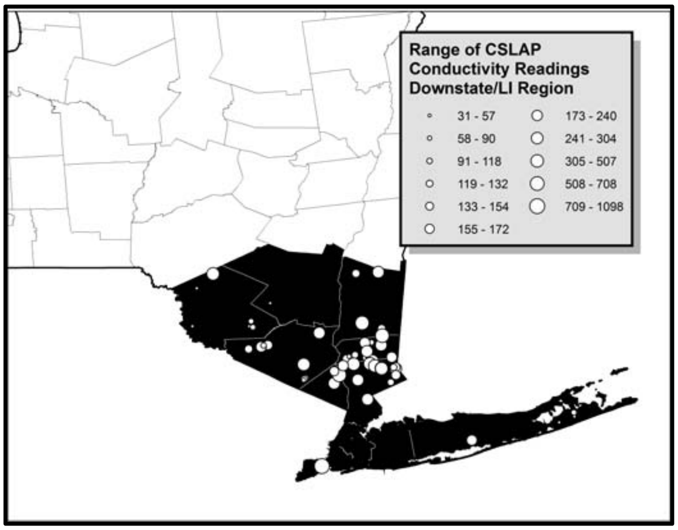
Table 4.6.1- % of CSLAP Lakes with Higher or Lower (than Normal) Conductivity Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Conductivity Readings	50%	19%
Lower Conductivity Readings	4%	30%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
“Higher” and “Lower” defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in the Downstate region lakes is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1986, the frequency of lower conductivity readings has decreased, and the frequency of higher conductivity has increased. Although these trends do not appear to be statistically strong, they are stronger than any statewide trends and suggest that conductivity may be increasing slightly. This may also reflect wetter weather in recent years.



Figures 4.6.4: Range of Conductivity Readings in the Downstate Region

Regional Distribution:

Conductivity readings with the Downstate region are highest in the lakes in the interior portion of the region, corresponding to Westchester and Putnam Counties. Many of these lakes can be classified as having hard water, and many of these lakes are *eutrophic*. Lower conductivity readings were found in the western portion of this region, and in Long Island, as seen in Figure 4.6.4. Most of these lakes can be classified as softwater lakes, corresponding to lakes with very low conductivity.

Table 4.6.2 shows the number of conductivity samples, the minimum, average, and maximum conductivity readings, the most common conductivity category for the lake, and whether conductivity readings have changed since CSLAP sampling began in the lake. This long-term assessment was limited to lakes sampled for at least five years through 2009.

Table 4.6.2: Conductivity Summary in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Category	Change?
Anawanda Lake	1988-2009	144	29	56	76	Softwater	No
Anawanda Lake	2009	8	48	54	61	Softwater	No
Blue Heron Lake	2005-2008	24	93	130	166	Intermediate	
Cranberry Lake	2004-2004	7	196	288	341	Hardwater	
Gossamans Pond	2003-2005	22	366	609	739	Hardwater	
Highland Lake	2003-2009	31	51	102	161	Softwater	
Highland Lake	2009	5	53	77	158	Softwater	Lower
Hillside Lake	1994-1997	13	603	708	943	Hardwater	
Indian Lake	1994-2009	72	29	65	406	Softwater	No
Indian Lake	2009	8	44	52	59	Softwater	Lower
Katonah Lake	2006-2009	31	85	447	596	Hardwater	
Katonah Lake	2009	7	85	382	577	Hardwater	No
Lake Carmel	1986-1990	51	176	282	335	Hardwater	Decreasing
Lake Celeste	1993-1997	26	111	151	175	Intermediate	
Lake Guymard	1996-2003	46	111	146	247	Intermediate	No
Lake Kitchawan	2008-2008	1	168	168	168	Intermediate	

Lake Name	Years	Num	Min	Avg	Max	Category	Change?
Lake Lincolndale	1993-2009	109	362	578	814	Hardwater	No
Lake Lincolndale	2009	5	478	571	680	Hardwater	No
Lake Lucille	1986-1990	55	133	297	452	Hardwater	No
Lake Mahopac	1986-2002	71	163	216	349	Intermediate	Increasing
Lake Meahagh	1999-2001	10	576	643	720	Hardwater	
Lake Mohegan	1998-2009	80	19	507	649	Hardwater	No
Lake Mohegan	2009	8	275	473	551	Hardwater	No
Lake Nimham	1991-1995	41	91	111	133	Softwater	Increasing
Lake Oscaleta	2006-2009	35	71	129	158	Intermediate	
Lake Oscaleta	2009	8	71	130	158	Intermediate	No
Lake Oscawana	1991-1995	37	104	126	140	Intermediate	Increasing
Lake Ossi	1996-2000	36	210	291	383	Hardwater	No
Lake Peekskill	1990-2009	93	143	304	558	Hardwater	Increasing
Lake Peekskill	2009	7	289	345	435	Hardwater	No
Lake Rippowam	2006-2009	34	103	164	203	Intermediate	
Lake Rippowam	2009	8	103	164	198	Intermediate	No
Lake Tibet	1991-1993	23	65	132	161	Intermediate	
Lake Truesdale	1999-2009	85	110	259	322	Hardwater	No
Lake Truesdale	2009	8	204	228	271	Intermediate	No
Lake Waccabuc	1986-2009	107	111	152	556	Intermediate	No
Lake Waccabuc	2009	8	125	146	163	Intermediate	No
Lake Wanaksink	1991-1995	39	95	106	129	Softwater	No
Little We Wah Lake	2008-2009	16	65	126	183	Intermediate	
Little We Wah Lake	2009	8	65	107	125	Softwater	No
Monhagen Lake	2003-2009	30	126	172	298	Intermediate	
Monhagen Lake	2009	5	132	173	298	Intermediate	No
Orange Lake	1994-2005	51	114	280	357	Hardwater	No
Peach Lake	1999-2008	69	166	238	293	Intermediate	No
Plum Brook Lake	2005-2008	30	76	361	505	Hardwater	
Roaring Brook Lake	2009-2009	8	173	212	243	Intermediate	
Roaring Brook Lake	2009	8	173	212	243	Intermediate	No
Round Lake	1992-1996	40	333	349	367	Hardwater	No
Sagamore Lake	1994-1997	32	160	208	248	Intermediate	
Sepasco Lake	1997-2009	89	47	149	188	Intermediate	No
Sepasco Lake	2009	7	122	138	158	Intermediate	No
Shadow Lake	2008-2009	12	177	261	322	Hardwater	
Shadow Lake	2009	5	183	265	322	Hardwater	No
Shawangunk Lake	2003-2009	29	58	199	269	Intermediate	
Shawangunk Lake	2009	5	58	146	185	Intermediate	Lower
Shenorock Lake	2004-2009	45	147	416	616	Hardwater	
Shenorock Lake	2009	8	325	421	532	Hardwater	No
Stissing Lake	2007-2009	24	126	266	337	Hardwater	
Stissing Lake	2009	8	126	250	300	Hardwater	No
Teatown Lake	1997-2009	82	121	199	314	Intermediate	No
Teatown Lake	2009	5	164	208	258	Intermediate	No
Timber Lake (Sullivan)	2004-2008	28	35	415	565	Hardwater	
Timber Lake (Westchester)	2006-2009	16	319	441	621	Hardwater	
Timber Lake	2009	8	319	482	621	Hardwater	No
Tomkins Lake	2001-2001	8	156	163	169	Intermediate	
Tuxedo Lake	2008-2009	16	52	90	116	Softwater	
Tuxedo Lake	2009	8	52	85	97	Softwater	No
Ulster Heights Lake	2007-2009	14	29	45	57	Softwater	
Ulster Heights Lake	2009	4	35	40	44	Softwater	No
Wallace Pond	2004-2008	29	120	240	348	Intermediate	No
We Wah Lake	2008-2009	16	96	128	153	Intermediate	
We Wah Lake	2009	8	104	125	145	Softwater	No

Lake Name	Years	Num	Min	Avg	Max	Category	Change?
Weiden Pond	2004-2009	38	23	43	66	Softwater	No
Weiden Pond	2009	5	30	36	44	Softwater	No
Whaley Lake	1998-2001	31	142	154	169	Intermediate	
Wolf Lake	1987-2001	90	13	44	81	Softwater	Increasing
Yankee Lake	2006-2009	29	65	118	156	Softwater	
Yankee Lake	2009	7	65	114	156	Softwater	No
Black Pond	2008-2009	13	15	31	42	Softwater	
Black Pond	2009	8	15	30	42	Softwater	No
Bradys Pond	1997-2001	33	465	1098	1740	Hardwater	Increasing
Canaan Lake	1990-2005	79	87	201	327	Intermediate	Increasing
Lily Pond	2008-2009	13	79	112	136	Softwater	
Lily Pond	2009	8	93	113	136	Softwater	No
Little Fresh Pond	1989-2009	97	14	57	97	Softwater	Decreasing
Little Fresh Pond	2009	8	32	43	50	Softwater	Lower
Little Long Pond	2006-2009	14	72	113	144	Softwater	
Little Long Pond	2009	3	72	92	109	Softwater	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum conductivity readings, in µmho/cm
Category = softwater if conductivity < 125; = moderate if 125 < conductivity < 250; = hardwater if conductivity > 7.5
Change? = exhibiting significant change in conductivity readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on conductivity readings >25% higher or lower than normal

A few of the lakes within the Downstate region have exhibited significant long-term trends in specific conductance readings. This sampling parameter has been much more variable than any other water quality indicator measured through CSLAP.

Conductivity readings in Bradys Pond, Canaan Lake, Lake Mahopac, Lake Nimham, Lake Oscawana, Lake Peekskill and Wolf Lake have increased during the duration of the CSLAP sampling at the lake. These lakes comprised a mix of softwater and hardwater lakes. Of these lakes, only Lake Peekskill has been sampled through CSLAP in recent, and it is not known if the rise in conductivity measured in these other lakes has continued in recent years. The rise in conductivity in Lake Peekskill has been associated with an increase in phosphorus and decrease in water clarity. This points to a possible change in runoff patterns or materials loading to the lake in recent years—lake residents should investigate potential sources of runoff to the lake.

Lake Carmel and Little Fresh Pond have exhibited decreasing conductivity readings. Lake Carmel has not been sampled through CSLAP for nearly twenty years, and it is not known if the drop in conductivity has continued in recent years. The decrease in conductivity in Little Fresh Pond has corresponded to a recent decrease in phosphorus readings in the lake; it is not known if these phenomena are related. The change in conductivity readings, and any resulting ecological impacts, should continue to be evaluated.

Tables 4.6.3a and 4.6.3b summarize the conductivity data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Conductivity readings in the CSLAP lakes in the Downstate region in 2009 were much lower than the long-term average for this region, and some of these lakes exhibited lower than normal readings. This is consistent with wetter than normal conditions in the region in 2009 (the complete 2009 regional and statewide precipitation dataset was not available at the time of this writing). This is borne out by the relationship between precipitation and conductivity in Table 4.6.1.

Table 4.6.3a: Conductivity Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	Typical
Downstate	32	15	190	244	680	Intermediate
Central	36	20	119	168	353	Softwater
Adirondacks	33	9	86	86	346	Softwater
Western	9	80	164	257	327	Intermediate
CSLAP Statewide	**110**	**9**	**134**	**173**	**680**	**Intermediate**

Table 4.6.3b: Conductivity Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	32	190	244	0	12	32	40
Central	36	119	168	0	42	8	26
Adirondacks	33	86	86	0	35	3	32
Western	9	164	257	0	44	0	33
CSLAP Statewide	**110**	**134**	**173**	**0**	**31**	**12**	**32**

% Higher = percentage of lakes in region with conductivity readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with conductivity readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with conductivity readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with conductivity readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Conductivity in 2009:

None

Discussion:

No Downstate region lakes exhibited higher than normal conductivity readings in 2009, as expected given that the overall average conductivity for lakes in the Downstate region was lower than the long-term average conductivity for the region.

Downstate Region Lakes With Lower Than Normal Conductivity in 2009:

Highland Lake, Indian Lake, Little Fresh Pond, and Shawangunk Lake

Discussion:

Conductivity readings in 2009 were lower than normal in 4 Downstate region lakes. Little Fresh Pond was the only lake with lower conductivity readings in 2009 exhibiting a long-term decrease in conductivity. None of these lakes exhibited lower than normal pH readings in 2009, but nearly all of the lakes reported much wetter weather and higher water levels in 2009.

Conductivity was consistently lower than normal in all of these lakes, with the maximum readings in 2009 lower than the long-term average for most of these lakes. This subset of lakes includes a mix of hardwater and softwater lakes, those with rapid flushing rates and slow retention times, and distribution over a wide portion of the Downstate region. The only common factor among these lakes was probably the heavy precipitation reported in 2009, particularly early in the sampling season. It is expected that conductivity readings in these lakes will revert back to normal if (or when) normal precipitation returns to these lakes.

Calcium Fact Sheet

Description:	calcium is a trace metal closely associated with limestone geology and strongly buffered, alkaline lakes.
Importance:	calcium can be considered a surrogate for alkalinity, or buffering capacity—lakes with high calcium levels are generally immune to swings in pH due to acid rain or other acidic inputs to lakes. Calcium is also a micronutrient required by freshwater mussels to grow their shells, and calcium may be one of the most significant limiting factors to colonization by zebra mussels. It is temporally stable in most lake systems, so it is analyzed in only two samples per year, although calcium levels may vary significantly spatially within a lake, due to inputs from concrete or limestone leaching. Open water calcium levels may be significantly lower than those measured near developed shorelines, thus underestimating the potential for "microhabitats" for zebra mussels.
How Measured: in CSLAP	calcium is analyzed from the surface (1.5 meter grab) sample collected with the use of a Kemmerer bottle and transferred to a collapsible container. Once received in the laboratory, it is immediately acidified with nitric acid. Calcium is analyzed using the atomic absorption spectrophotometric method.
Detection Limit:	0.3 mg/l. Calcium was not analyzed through CSLAP prior to 2002.
Range in CSLAP:	undetectable (< 0.3 mg/l) to 56.1 mg/l. 68% of surface readings are between 5 mg/l and 30 mg/l, and 20% of surface samples have calcium readings in excess of 25 mg/l.
WQ Standards:	there are no state water quality standards for calcium.
Water Quality Assessment:	calcium readings in CSLAP are evaluated for susceptibility for zebra mussel infestation. The calcium levels required to support zebra mussel shell growth is approximately 25 mg/l. However, open water sampling (as conducted through CSLAP) may indicate calcium levels lower than those measured along developed shorelines—some CSLAP lakes with open water calcium levels as low as 12 mg/l have been found to support zebra mussels, due to higher localized calcium readings. It is assumed that lakes with calcium levels above 20 mg/l, or those with known localized presence of zebra mussels or mussel veligers are susceptible to zebra mussel colonization.

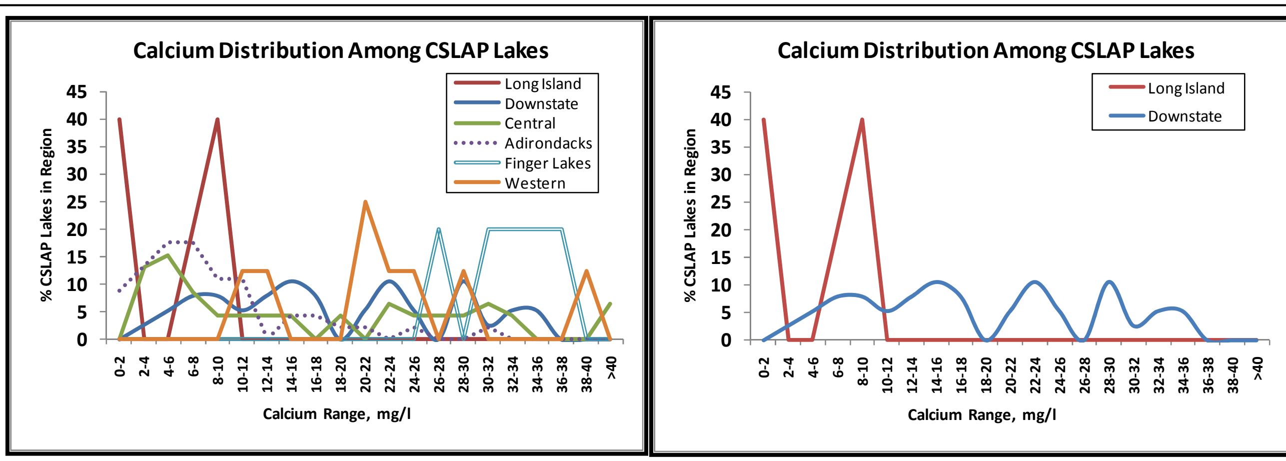
Chapter 4.7- Evaluation of Downstate Region Calcium: 2002-2009

Summary of CSLAP Calcium Findings in Downstate Region Lakes, 2002-2009

1. CSLAP lakes within the Downstate region have calcium readings that are lower than in Western region but higher than in the Adirondack region (and Long Island).
2. Calcium readings in CSLAP lakes within the Downstate region are higher in the wetter years, but it is not known how they vary in the drier years.
3. It is premature to evaluate long-term trends in calcium data, given the short timeframe in which data were collected and the small number of samples analyzed each year.
4. Few CSLAP lakes in the Downstate region have exhibited any long-term changes in calcium levels, and calcium readings in most of these lakes were close to normal in 2009.
5. Calcium readings with the Downstate region are highest in the interior portions of this region, coincident with the highest conductivity and lake productivity, and lowest in the western part of this region and Long Island.
6. Some lakes in the Downstate region appear to be susceptible to zebra mussel infestations, based on calcium levels in the lake, although no lakes in the region have documented zebra mussel populations.

Downstate Region Data Compared to NYS Data

Figure 4.7.1 indicates that CSLAP lakes in the Downstate region have lower calcium levels than lakes in the Western region, but higher than in the Adirondacks and Central regions (and Long Island). The typical calcium levels in CSLAP Downstate region lakes extend over a wide range, from 5-35 mg/l range (5-10 mg/l for lakes in Long Island), as seen in Figure 4.7.2. This indicates that there are some lakes in the Downstate region that are susceptible to infestation by zebra mussels.



Figures 4.7.1 and 4.7.2: Distribution of Calcium Ranges in CSLAP and Downstate Region Lakes

Comparison of CSLAP to NYS Lakes in the Downstate Region

Calcium has not been collected in or evaluated through most of the non-CSLAP monitoring programs conducted within the Downstate region. Therefore, a comparison of calcium readings between CSLAP and non-CSLAP lakes within the Downstate region is not possible.

Annual Variability:

The highest calcium readings measured through CSLAP in the Downstate region occurred during 2004. The lowest calcium readings occurred in 2002 (probably due to some erroneous data) and 2008. Table 4.7.1 looks at the percentage of CSLAP lakes with high water calcium (greater than 1 standard error above normal) and low calcium (greater than 1 standard error below normal) readings in wet and dry years. These data show some connection between precipitation and calcium, although this evaluation is limited by the lack of dry year data since 2002.

Table 4.7.1- % of CSLAP Lakes with Higher or Lower (than Normal) Calcium Readings During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
Higher Calcium Readings		18%
Lower Calcium Readings		3%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends for ammonia, total nitrogen, and calcium is affected by the short timeframe of data collection. Since 2002, the frequency of lower than normal (moderately and significantly) calcium readings has decreased. However, this trend disappears when the very low 2002 readings (subcontracted to a different laboratory) are removed from the dataset. These data indicate that no long-term trends in calcium data are apparent, although additional years of data may be needed before any trends become apparent.

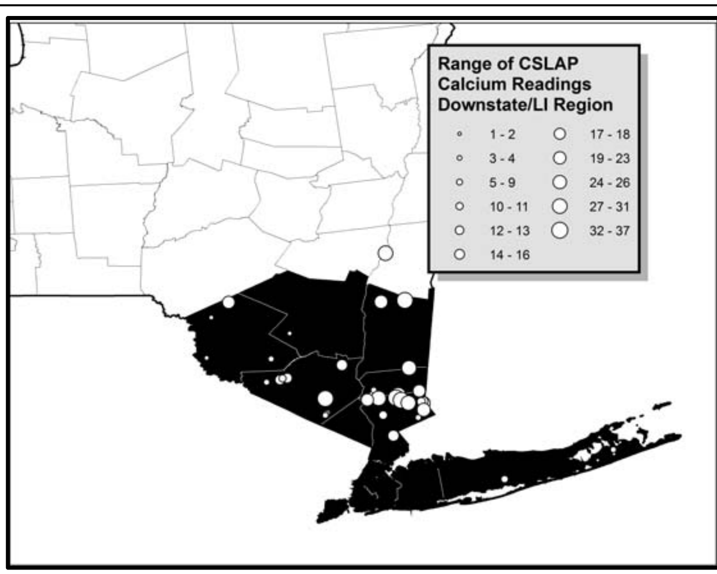


Figure 4.7.3: Range of Calcium Readings in the Downstate Region

Regional Distribution:

Calcium readings with the Downstate region are highest in the interior portions of this region, similar to the regional conductivity, pH and algal productivity patterns, as apparent in Figure 4.7.3. Some of these lakes have high enough calcium levels to support zebra mussel colonization, although these exotic bivalves have not been found in these lakes. The lowest calcium readings are found in the western part of this region and Long Island, although low calcium readings are found in many lakes throughout this region. None of these lakes in this part of the region is likely to be able to support zebra mussel colonization.

Table 4.7.2 shows the number of calcium samples, the minimum, average, and maximum calcium readings in the entirety of the CSLAP dataset and in 2009, whether the average calcium readings are high enough to support colonization by zebra mussels, and whether calcium readings have changed since CSLAP sampling began in the lake.

Table 4.7.2: Calcium Summary in CSLAP Downstate Region Lakes, 2002-2009

Lake Name	Years	Num	Min	Avg	Max	Susceptible to Zebra Mussels?	Change?
Anawanda Lake	1988-2009	15	0.8	4.3	5.9	No	No
Anawanda Lake	2009	2	2.7	3.9	5.1	No	No
Blue Heron Lake	2005-2008	6	7.9	8.7	9.6	No	No
Cranberry Lake	2004-2004	2	17.2	17.5	17.8	No	
Gossamans Pond	2003-2005	5	27.2	28.5	29.8	Yes	No
Highland Lake	2003-2009	9	4.2	9.6	14.7	No	No
Highland Lake	2009	2	4.2	9.5	14.7	No	No
Indian Lake	1994-2009	11	5.5	7.1	10.3	No	No
Indian Lake	2009	2	5.5	5.9	6.4	No	No
Katonah Lake	2006-2009	8	24.8	29.0	37.1	Yes	No
Katonah Lake	2009	2	24.8	30.9	37.1	Yes	No
Lake Guymard	1996-2003	2	7.1	7.2	7.2	No	
Lake Kitchawan	2008-2008	1	25.8	25.8	25.8	Yes	
Lake Lincolndale	1993-2009	11	4.9	34.8	47.9	Yes	No
Lake Lincolndale	2009	2	34.0	35.5	37.0	Yes	No
Lake Mohegan	1998-2009	13	1.2	29.2	38.8	Yes	No
Lake Mohegan	2009	2	32.6	34.2	35.8	Yes	No
Lake Oscaleta	2006-2009	8	11.7	13.6	17.5	No	No
Lake Oscaleta	2009	2	14.7	16.1	17.5	No	No
Lake Peekskill	1990-2009	11	15.8	22.3	29.1	Yes	No
Lake Rippowam	2006-2009	8	11.0	16.4	19.8	No	Increasing
Lake Rippowam	2009	2	18.4	19.1	19.8	No	No
Lake Truesdale	1999-2009	12	2.4	24.3	30.9	Yes	No
Lake Truesdale	2009	2	24.4	27.7	30.9	Yes	No
Lake Waccabuc	1986-2009	8	13.8	15.2	18.8	No	No
Lake Waccabuc	2009	2	15.5	17.2	18.8	No	No
Little We Wah Lake	2008-2009	4	9.8	11.7	13.1	No	
Little We Wah Lake	2009	2	9.8	11.4	13.1	No	No
Monhagen Lake	2003-2009	8	11.8	13.9	17.1	No	No
Monhagen Lake	2009	2	11.8	12.0	12.2	No	No
Orange Lake	1994-2005	2	8.7	17.7	23.2	No	
Peach Lake	1999-2008	12	18.0	22.4	24.2	Yes	Decreasing
Plum Brook Lake	2005-2008	8	26.3	32.6	36.1	Yes	
Roaring Brook Lake	2009-2009	2	14.3	14.5	14.6	No	
Roaring Brook Lake	2009	2	14.3	14.5	14.6	No	No
Sepasco Lake	1997-2009	15	19.7	23.8	27.7	Yes	No
Sepasco Lake	2009	2	24.3	26.0	27.7	Yes	No
Shadow Lake	2008-2009	4	12.6	14.3	16.6	No	
Shadow Lake	2009	2	12.6	14.6	16.6	No	No
Shawangunk Lake	2003-2009	8	8.0	14.5	18.1	No	No
Shawangunk Lake	2009	2	8.0	12.9	17.7	No	No
Shenorock Lake	2004-2009	9	28.5	33.2	43.4	Yes	Increasing
Shenorock Lake	2009	2	36.7	40.1	43.4	Yes	No
Stissing Lake	2007-2009	6	32.6	34.8	37.7	Yes	
Stissing Lake	2009	2	36.1	36.9	37.7	Yes	No
Teatown Lake	1997-2009	14	2.3	13.3	19.9	No	No

Lake Name	Years	Num	Min	Avg	Max	Susceptible to Zebra Mussels?	Change?
Teatown Lake	2009	2	10.7	12.1	13.6	No	No
Timber Lake (Sullivan)	2004-2008	6	2.4	21.0	25.3	Yes	
Timber Lake (Westchester)	2006-2009	4	18.4	24.0	28.0	Yes	
Timber Lake	2009	2	27.2	27.6	28.0	Yes	No
Tuxedo Lake	2008-2009	4	7.9	8.2	8.9	No	
Tuxedo Lake	2009	2	7.9	8.4	8.9	No	No
Ulster Heights Lake	2007-2009	4	2.7	4.2	5.0	No	
Wallace Pond	2004-2008	9	1.9	21.2	27.0	Yes	No
We Wah Lake	2008-2009	4	9.4	10.2	10.6	No	
We Wah Lake	2009	2	10.3	10.5	10.6	No	No
Weiden Pond	2004-2009	11	2.9	3.7	4.5	No	No
Yankee Lake	2006-2009	8	4.9	6.5	13.1	No	No
Yankee Lake	2009	2	5.2	5.7	6.1	No	No
Black Pond	2008-2009	4	0.1	0.7	1.5	No	
Black Pond	2009	2	0.1	0.3	0.6	No	Lower
Canaan Lake	1990-2005	5	6.2	10.9	12.7	No	No
Lily Pond	2008-2009	4	6.5	8.8	10.4	No	
Lily Pond	2009	2	8.1	9.3	10.4	No	No
Little Fresh Pond	1989-2009	15	0.3	1.7	2.9	No	Decreasing
Little Fresh Pond	2009	2	1.1	1.2	1.4	No	Lower
Little Long Pond	2006-2009	4	6.5	7.2	7.8	No	
Little Long Pond	2009	1	6.5	6.5	6.5	No	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum calcium readings, in mg/l
Susceptible to Zebra Mussels" = yes if average calcium > 20 mg/l
Change? = exhibiting significant change in calcium readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on calcium readings >25% higher or lower than normal

Only a few lakes in this region may be exhibiting long-term change in calcium readings. Calcium readings in Lake Rippowam and Shenorock Lake have increased since CSLAP sampling began on the lake. Neither of these lakes has exhibited an increase in conductivity, and it is likely that the small increase in calcium readings in these lakes represents normal variability. Shenorock Lake has high enough calcium readings to render the lake susceptible to zebra mussels.

Calcium levels in Little Fresh Pond and Peach Lake have decreased over the last several sampling seasons, and calcium readings in 2009 in Little Fresh Pond continued that pattern (Peach Lake was not sampled in 2009). This is coincident with decreasing conductivity readings over the same period in Little Fresh Pond. It is not likely that the slight drop in calcium levels over this period led to any other measurable ecological impacts, although these cannot be well evaluated through CSLAP.

Tables 4.7.3a and 4.7.3b summarize the calcium data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Calcium readings in the CSLAP lakes in 2009 were slightly higher than normal in the Downstate, and a higher percentage of Downstate region lakes established new maximum calcium thresholds in 2009. It is likely that the small change in calcium readings in the Downstate region lakes were still within the normal range of variability for these lakes.

Table 4.7.3a: Calcium Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	% Susceptible to Zebra Mussels
Downstate	29	0.1	17.7	16.7	43.4	31
Central	33	1.5	17.6	16.6	54.3	39
Adirondacks	32	1.7	9.7	8.8	34.6	9
Western	9	9.6	26.8	26.1	39.8	78
CSLAP Statewide	**103**	**0.1**	**16.0**	**15.2**	**54.3**	**32**

Table 4.7.3b: Calcium Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Higher	%Lower	%Above Max	%Below Min
Downstate	29	17.7	16.7	0	6	62	38
Central	33	17.6	16.6	9	3	35	26
Adirondacks	32	9.7	8.8	10	10	45	13
Western	9	27.1	26.1	11	0	33	11
CSLAP Statewide	**103**	**16.0**	**15.2**	**7**	**6**	**46**	**24**

% Higher = percentage of lakes in region with calcium readings in 2009 >25% higher than normal (before 2009)
% Lower = percentage of lakes in region with calcium readings in 2009 <25% below normal (before 2009)
% Above Max = percentage of lakes in region with calcium readings in 2009 above previous maximum (before 2009) for lake
% Below Min = percentage of lakes in region with calcium readings in 2009 below previous minimum (before 2009) for lake

Downstate Region Lakes With Higher Than Normal Calcium Readings in 2009:
None

Discussion:

No Downstate region lakes exhibited higher than normal calcium readings in 2009, despite slightly higher than normal calcium levels in the region.

Downstate Region Lakes With Lower Than Normal Calcium in 2009:
Black Pond, Little Fresh Pond

Discussion:

Two Downstate region lake exhibited lower than normal calcium readings in 2009, both located in eastern Long Island. The decrease in calcium levels in both lakes was small—calcium readings are usually (already) very low in these lake—and may have been consistent with the drop in conductivity and long term decrease in calcium in Little Fresh Pond. It is unlikely that this small change in calcium levels in the lake resulted in any ecological impacts.

Chapter 5- Evaluation of Biological Condition

Chapter 5.1- Evaluation of Phytoplankton

Chapter 5.2- Evaluation of Macrophytes

Chapter 5.3- Evaluation of Zooplankton

Chapter 5.4- Evaluation of Macroinvertebrates

Chapter 5.5- Evaluation of Zebra Mussels

Chapter 5.6- Evaluation of Fisheries

Chapter 5- Evaluation of Biological Condition

Summary of Biological Condition Downstate Region Findings

1. Biological condition can only be evaluated to a limited extent in CSLAP lakes, in large part because CSLAP is intended primarily as a water quality monitoring program. This is offset somewhat in the Adirondack region by the extensive ALSC biological dataset.
2. Primary productivity can be evaluated by phytoplankton and macrophytes—algae and rooted aquatic plants.
3. The primary means for evaluating phytoplankton are chlorophyll *a*, as discussed in detail in section 3.2, phytoplankton identification, paleolimnology, and an analysis of harmful algal blooms (HAB).
4. CSLAP phytoplankton identification was conducted only as a special study in 1992, and the 2008 paleolimnology portion of the NYSDEC biomonitoring study on a small subset of CSLAP lakes has not yet been completed.
5. The 1992 algal enumeration will be discussed in the 25 Year CSLAP report.
6. A five year HAB study conducted by DOH and DEC on about 65 CSLAP lakes began in 2009, but the initial results from this study are not yet available. This is discussed in the statewide report.
7. Macrophyte data are available for some Downstate region lakes, much of it collected through CSLAP or the state Lake Classification and Inventory Survey (LCI).
8. Moderate plant diversity was apparent in many of the sampled Downstate region lakes in the region, although it is not yet known if this reflects the influence of exotic plants or incomplete plant survey information for most of these lakes.
9. The CSLAP data indicate that the presence of exotic plants appears to trigger more extensive surface plant growth and more recreational use impacts.
10. There are insufficient lake zooplankton data for Downstate region lakes to warrant a "local" assessment
11. There are insufficient lake benthic macroinvertebrate studies for Downstate region lakes to warrant a "local" assessment, although this will no doubt change in the future. The statewide report presents the limited and preliminary statewide benthic findings.
12. Zebra mussels found in the Downstate region are limited to the Hudson River. However, many other lakes in the region may be susceptible to invasion due to high calcium levels.
13. Fisheries surveys on CSLAP lakes indicate a high percentage of warmwater and coolwater fish species in the Downstate region lakes.

Background

The biological condition of lakes can be evaluated in many ways. Ideally, these evaluations include assessments of primary producers, such as phytoplankton (algae) and macrophytes (rooted aquatic plants), and primary, secondary and tertiary consumers, including zooplankton, macroinvertebrates, mussels, fish, and mammals, and decomposers such as bacteria, as well as the interactions among these components of the food web. These assessments are largely beyond the scope of CSLAP and most standard water quality monitoring programs. Although most of these components have been evaluated in at least some CSLAP lakes, few were measured in CSLAP in 2009. The biological condition evaluation from each CSLAP lake sampled in 2009 is discussed in the individual lake survey. The 25 Year CSLAP report will discuss in detail the findings from the 1992 phytoplankton and zooplankton surveys, the macroinvertebrate surveys, and the fisheries surveys conducted by the NYSDEC, ALSC, and other monitoring programs. Since macrophyte surveys have been conducted every year in many CSLAP lakes, from semi-quantitative surveys to assessments of aquatic plant coverage during the field perception surveys conducted during each CSLAP sampling session, aquatic plant assessments are summarized in the statewide and regional reports.

Evaluation of Primary Producers

Chapter 5.1- Evaluation of Phytoplankton

The algal communities in lakes can be evaluated by looking at algal species composition—the frequency of various classes of algae—and algal abundance associated with the water surface, suspended in the water, and growing on rooted plants, rocks and bottom substrate. Floating algae, whether associated with surface canopies of rooted plants or buoyant algal mats, are highly temporally and spatially variable in lakes and are difficult to measure and characterize in standard monitoring programs. Benthic algae—those associated with the lake bottom—are increasingly becoming more problematic in New York state lakes, particularly in those lakes with either increasing water clarity (due to removal of suspended algae by algacides or algal precipitants such as alum) or removal of bottom macrophytes by drawdown or herbicides. However, these have also not been monitored through CSLAP, although some sampling volunteers report changes in benthic algal communities.

There are a wide variety of suspended algae genera found in New York state lakes. In general, water quality problems tend to be associated with cyanobacteria (also known as blue green algae), although algal blooms are occasionally associated with green algae and diatoms. The healthiest lake environment tends to exhibit low levels of a large number of algae species from several genera. Suspended algal abundance can be evaluated by looking at chlorophyll *a*, a photosynthetic pigment found in all freshwater algae. The CSLAP chlorophyll *a* analyses are discussed in the "Evaluation of Eutrophication Indicators" portion of this report (section 4.2). This is the dominant segment of the phytoplankton community in most New York state lakes, although it does not distinguish between "good" and "bad" algae.

The composition of the suspended algae community can be evaluated by enumerating algae under a microscope. Algae identification and enumeration is conducted by a small number of algologists—scientists studying algae, including the NYS Department of Health (NYSDOH)—but is usually limited to special studies investigating algal blooms or threats to potable water use.

Except for a special study conducted in most CSLAP lakes in 1992 and for some lakes in later years, phytoplankton have not been analyzed through CSLAP. A summary of the 1992 phytoplankton surveys will be included in the 25 Year CSLAP report issued in 2011, and with chlorophyll *a* evaluations are included in the individual lake appendices.

In addition to the one-time algae identification conducted through CSLAP in 1992, the NYSDOH received a five year grant from the Centers for Disease Control (CDC) to study the frequency and dynamics of harmful algal blooms and algal toxins, starting in 2009. In the pilot year of the program, all CSLAP lakes with historical evidence of algal blooms, nutrient conditions that render the lake susceptible to blooms, and lakes serving as potable water supplies were provided bottles to conduct algal bloom monitoring. This constituted about 65 CSLAP lakes in 2009. In the event of an algal bloom, algal scum and open water samples (from the grab water sample) were submitted to the NYSDOH. Background (non-bloom) samples in late summer were also collected to provide a comparison with bloom conditions. All HAB study samples were analyzed for the presence of microcystin-LR, a toxin commonly produced by cyanobacteria (blue green algae). In addition, these samples, and all CSLAP water samples submitted after mid August were analyzed at the water chemistry laboratory (UFI) with a handheld phycocyanin detector for the potential presence of cyanobacteria (phycocyanins are pigments found in blue green algae). By comparing both phycocyanin and Microcystin-LR (a toxic variant most associated with bloom conditions) results to water chemistry sampling data at the time of sampling, the environmental conditions and causes associated with harmful algal blooms may become more apparent, providing important information that may lead to strategies for controlling and minimizing these blooms.

67% of the samples submitted during year 1 have been analyzed for the presence of microcystin. 74% of these contained detectable levels of microcystin, and 37% were above 0.1 ppb. As a reference point, the World Health Organization has established a provisional guideline of 1.0 ppb to protect potable water supplies, and has identified a "*low probability*" of acute health effects from swimming in water with 10-20 ppb of microcystin-LR. It should be noted that some of these samples were collected from non-CSLAP lakes, including other lakes monitored by the NYSDEC and the NYS Office of Parks and Recreation. While all water samples associated with HAB concerns at regulated beaches (or other locations with reported potentially HAB related illnesses) were analyzed immediately, the regular monitoring samples were preserved and held for later analysis. These results will be summarized once all of the samples have been analyzed and the data have been interpreted.

Chapter 5.2- Evaluation of Macrophytes

As with phytoplankton, aquatic plants can be evaluated by looking at the total amount of vegetation in the lake, using biomass counts or semi-quantitative measures of aquatic plant densities or coverage, conducted through rake toss surveys. These rake toss surveys have been conducted at several CSLAP lakes, mostly in response to aquatic plant monitoring requirements through the DEC aquatic pesticides permitting program. In the absence of rake toss survey results for a large number of CSLAP lakes, other methods for evaluating plant abundance can be utilized. During each CSLAP sampling session, sampling volunteers evaluate aquatic plant coverage through the standardized recreational use perception surveys. The results from these surveys are discussed in detail in the "Evaluation of Lake Perception" section.

The number and type of aquatic plant species in lakes provide additional information about the health and stability of macrophyte communities. Aquatic ecologists generally view native plants more favorably than exotic plants, and a high diversity of plants more favorably than monocultures, particularly when the monoculture consists of invasive, exotic plants like Eurasian watermilfoil. Aquatic botanists in several midwestern states have developed a Floristic Quality Index (FQI) to assess the quality of the flora (aquatic and terrestrial) of their state. An FQI is developed by assigning a Coefficient of Conservation for each plant species on a 10 point scale, "representing an estimated probability that a species is likely to occur in a landscape relatively unaltered from what is believed to be a pre-settlement condition." Thus, a 0-3 represents species highly tolerant of disturbance, 4-6 are moderately tolerant taxa, 7-8 are found in a narrow range but can tolerate minor disturbance, and 9-10 represents highly intolerant of disturbance. The FQI for a plant community, whether in a lake or field or larger geographic area, is calculated from a simple algorithm involving the C values and the total number of plants.

An FQI can serve to:

(1) identify high quality lakes warranting protection;
(2) identify susceptible waterbodies (by finding many low FQI lakes in the neighborhood);
(3) establish a standardized way to evaluate plant control efficacy;
(4) allow state permit reviewers to identify a trigger point for management (once an FQI falls below an "acceptable" level, active management may be needed, particularly for "nuisance" versus "invasive" conditions)

However, since there are more than 1000 plant species found in New York state, and aquatic and terrestrial botanists in other states have not reached a consensus on C values for most of these plants (and in fact C values often vary significantly from state to state), FQIs cannot be easily developed in New York state. Until C values are established for plants in New York state or within several northeastern states, modified C value categories can be established for aquatic plants. One such grouping of categories could be as follows (Table 5.2.1):

Table 5.2.1- Modified C Values for Aquatic Plants in New York State

Category	Proposed Modified C Value	Representative Plants
Protected Plants	5	Water marigold, Farwellii's milfoil, Northern pondweed, Lesser bladderwort
Beneficial Native Plants	3	Eelgrass, Common waterweed, Water shield, Whorled watermilfoil, Slender naiad
Nuisance Native Plants	1	Coontail, Largeleaf pondweed, Duckweed, Watermeal, Southern naiad
Innocuous or Regionally Problematic Exotic Plants	-1	Water shamrock, Pond water starwort, Brittle naiad, Swollen bladderwort
Problematic to Regionally Invasive Exotic Plants	-3	Variable watermilfoil, Brazilian elodea, Curlyleaf pondweed, Starry stonewort
Invasive Exotic Plants	-5	Eurasian watermilfoil, Water chestnut, Hydrilla

For any lake, the average modified C value (mC) can be calculated from all of the aquatic plants observed or collected in the lake and verified through CSLAP or other monitoring programs. The modified Floristic Quality Index (mFQI) can be calculated from the formula:

mFQI = mean mC x $\sqrt{N}$, where N = number of plant species identified.

A "good" Floristic Quality Index (or modified Index) has not been defined for either aquatic or terrestrial ecosystems, particularly in the northeast, since the FQI does not account for plant abundance or the nuisance growth of good plants in some lakes. However, aquatic botanists from the state of Florida have defined the following broad classifications of aquatic plant communities, shown in Table 5.2.2:

Table 5.2.2- Typical Aquatic Plant Community Designations

Aquatic Plant Community Designation	Description
Outstanding	67% "sensitive", 0% "tolerant", 90% "native", 0% "invasive"
Excellent	20% "sensitive", 20% "tolerant", 85% "native", 0% "invasive"
Fair	15% "sensitive", 35% "tolerant", 70% "native", 10% "invasive"
Poor	0% "sensitive", 50% "tolerant", 60% "native", 25% "invasive"
Very Poor	0% "sensitive", 40% "tolerant", 40% "native", 40% "invasive"

Some waterbodies may not fall cleanly within a plant community classification—for example, a lake may have a high percentage of both "sensitive" and 'invasive" plants—but these designations provide a reference point for characterizing the quality of aquatic plants in a lake. In addition, although the broad categories of modified C values in Table 5.2.1 doesn't exactly match the plant community descriptions in Table 5.2.2, these modified C values can be used to characterize the modified FQIs for each CSLAP lake based on the number of plants in each lake.

The volunteers from each CSLAP lake have been offered an opportunity to submit plants for identification, using the procedures outlined in the back of the CSLAP sampling protocol to collect, preserve and transport the samples. Aquatic plant sampling has not been included in the CSLAP training sessions, and thus only about half (49%) of the CSLAP lakes have any aquatic plant survey data collected through CSLAP. However, many other CSLAP lakes have been sampled by consultants, academic institutions, and other monitoring programs, with varying degrees of intensity (as is the case with CSLAP plant surveying as well). In addition, there is some inconsistency in plant identifications, particularly protected plant species, from program to program. The largest Adirondack region monitoring program, the Adirondack Lake Survey Corporation survey of 1500 lakes, identified aquatic plants down to species level, limiting the ability to distinguish protected, beneficial, and invasive plants within the same genera (such as *Potamogeton* and *Myriophyllum*). Thus any comparison of plant sampling results across monitoring programs or even within the CSLAP dataset has limited utility. Nonetheless, to try to encourage more detailed monitoring on these lakes, and to provide at least a rudimentary evaluation of aquatic plant communities in CSLAP lakes, the mFQIs and general plant survey result summaries for each of the Downstate region CSLAP lakes with plant survey data are provided in Table 5.2.3.

The data from Table 5.2.3 suggest that moderate to low diversity is found in many Downstate region lakes, particularly those with exotic plant species (columns C01, C03, and C05). The few instances of "excellent" quality correspond to lakes with few if any exotic plant species. However, the region also has few lakes with aquatic plant community quality ratings of "poor" to "very poor." The statewide CSLAP report indicates that this diversity is probably lower than in other regions of the state. High diversity is apparent in a number of lakes scattered throughout the region, although at present this is probably more reflective of the more extensive survey work conducted at those lakes than of inherent differences in the quality of the aquatic plant community. Likewise, those lakes listed in Table 5.2.3 with relatively few aquatic plants no doubt reflects the lack of complete survey data, although some of these lakes may also not be as biologically diverse as other lakes in the region.

Table 5.2.3- Summary of Downstate Region Macrophyte Survey Data for CSLAP Lakes

Lake Name	Macrophyte Surveys	Survey via?	N	C5	C3	C1	C01	C03	C05	MeanC	mFQI	FQI Rating
Anawanda Lake	1990, 2009	CSLAP	12	1	11					3.2	11.0	Excellent
Blue Heron Lake	2005-2008		11	1	8	2				2.8	9.3	Excellent
Cranberry Lake	1998	Westchester County	1						1	-5.0	-5.0	no FQI
Gossamans Pond	2003-2005	CSLAP	5	2	2				1	2.2	4.9	Fair
Highland Lake	1987	ALSC	5		3	1			1	1.0	2.2	Fair
Indian Lake	1987, 2003-2005	CSLAP, ALSC	21		17	3			1	2.3	10.7	Fair
Lake Celeste	none		1					1		-3.0	-3.0	no FQI
Lake Guymard	2008	CSLAP	2		1			1		0.0	0.0	no FQI
Lake Kitchawan	2008-2008		14		9	2		1	2	1.1	4.3	Fair
Lake Lincolndale	1993-2008	CSLAP	14	1	7	2	1	2	1	1.1	4.3	Fair
Lake Mahopac	?	CSLAP	1						1	-5.0	-5.0	no FQI
Lake Meahagh	none	ALSC	4		1				3	-3.0	-6.0	no FQI
Lake Mohegan	1987	ALSC, NHP, Cedar Eden	18	1	10	3		1	3	1.1	4.7	Fair
Lake Nimham	none	ALSC, NHP	12	2	7	2			1	2.3	8.1	Fair
Lake Oscaleta	2008	Allied Biological	23	1	16	2	1	1	2	1.8	8.5	Fair
Lake Oscawana	2000, 1987	Northeast Aquatic Research, ALSC	20		16	2			2	2.0	8.9	Fair
Lake Ossi	2000	CSLAP	6	1	4	1				3.0	7.3	Excellent
Lake Peekskill	1991-2008	CSLAP	5		4	1				2.6	5.8	Excellent
Lake Rippowam	2008	Allied Biological	6		5				1	1.7	4.1	Fair
Lake Tibet	1991	CSLAP	1						1	-5.0	-5.0	no FQI
Lake Truesdale	2005	Allied Biological	7		5	1		1		1.9	4.9	Fair
Lake Waccabuc	2008	Allied Biological	24		15	4		2	3	1.2	5.7	Fair
Orange Lake	1987, 1995	ALSC, CSLAP	16		10	3		1	2	1.3	5.0	Fair
Peach Lake	1987-2008	CSLAP, ALSC	22		14	6			2	1.7	8.1	Fair

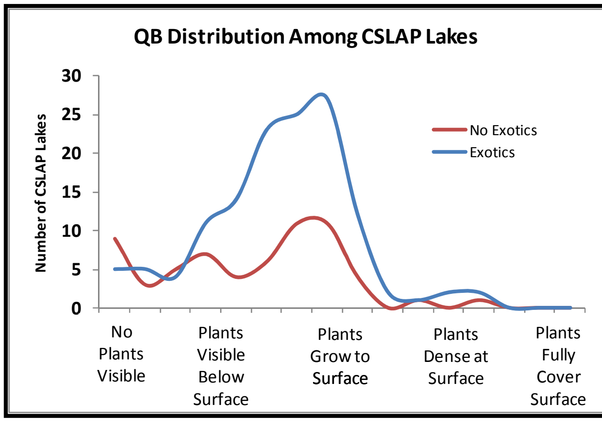
Lake Name	Macrophyte Surveys	Survey via?	N	C5	C3	C1	C01	C03	C05	MeanC	mFQI	FQI Rating
Roaring Brook Lake	1987, 2007	ALSC, LCI	8		2	3		1	2	-0.5	-1.4	Very Poor
Round Lake	1992?	CSLAP	2					1	1	-4.0	-5.7	no FQI
Sagamore Lake	none	?	3		2				1	0.3	0.6	no FQI
Sepasco Lake	1997-2009	CSLAP	13		9	2	1		1	1.8	6.4	Fair
Shawangunk Lake	1987	ALSC	6		3	2			1	1.0	2.4	Fair
Shenorock Lake	none		1		1					3.0	3.0	no FQI
Sleepy Hollow Lake	2008	LCI	5		1	1		1	2	-1.8	-4.0	Very Poor
Stissing Lake	2008	Allied Biological	26	1	19	4		1	1	2.2	11.4	Fair
Teatown Lake	1987	ALSC	17		14	3				2.6	10.9	Excellent
Timber Lake	2009	CSLAP	1		1					3.0	3.0	no FQI
Ulster Heights Lake	1987	ALSC	16		15				1	2.5	10.0	Excellent
Wallace Pond	1987	ALSC	7		5	2				2.4	6.4	Excellent
Weiden Pond		CSLAP	7	1	6	1				3.0	7.9	Excellent
Whaley Lake	2001	CSLAP	5		2	2			1	0.6	1.3	Fair
Wolf Lake	1990	CSLAP	1		1					3.0	3.0	no FQI
Yankee Lake	2004	LCI	4		4					3.0	6.0	no FQI
Black Pond	1985, 2008	ALSC, CSLAP	16		16					3.0	12.0	Excellent
Bradys Pond	1997	CSLAP	1		1					3.0	3.0	no FQI
Canaan Lake	1990-2005	CSLAP	13	1	10			1	1	2.1	7.5	Fair
Little Fresh Pond	1990-2009	CSLAP	27	4	22			1		3.1	16.0	Excellent

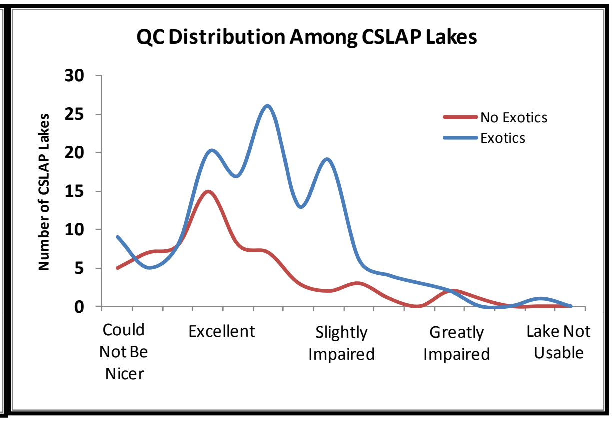
Surveyors- ACT = Aquatic Control Technology, AE = Aquatic Ecologists, ALSC = Adirondack Lake Survey Corporation, CCFY = Community College of the Finger Lakes, Cedar Eden = Cedar Eden Environmental Inc, Cornell = Cornell Experimental Ponds, DFWI = Darrin Freshwater Institute of RPI, SUNY Oneonta Biological Field Station
N = number of aquatic plant species (or genera for ALSC sampled lakes)
C5 = number of protected aquatic plant species
C3 = number of beneficial native aquatic plant species rarely associated with nuisance conditions
C1 = number of native aquatic plant species frequently associated with nuisance conditions
C01 = number of exotic aquatic plant species rarely associated with invasive conditions
C03 = number of exotic aquatic plant species occasionally or regionally associated with invasive conditions
C05 = number of exotic aquatic plant species frequently associated with invasive conditions in all regions
mean C = mean value for modified Coefficient of Conservation, scale from -5 (invasives) to +5 (protected)
mFQI = mean modified Floristic Quality Index
FQI rating = scale based on number of plants and number of sensitive, tolerant, and invasive plants

The FQI rankings show a low percentage (17%) of lakes in the Downstate region with "excellent" floristic quality, and few lakes (4%) with poor to very poor floristic quality, although about 50% of the lakes in the region have no or incomplete plant survey information. Although these assessments will no doubt change with additional information on these 50% of lakes and the eventual development of a true floristic quality index for New York state lakes, the preliminary assessment that the typical lake in the Downstate region can be characterized as having a "fair" floristic quality is probably accurate, and reflective of the widespread distribution of invasive, exotic plants—particularly Eurasian watermilfoil in the northern portion of the region, and fanwort in the Long Island region.

As discussed earlier, the FQI calculation provides one assessment of the "condition" of aquatic plants. It does not account for abundance, and for some lakes, such as Lake Mahopac in Putnam County after the grass carp stocking, the small quantity of aquatic plants may threaten the ecological health of the lake and may even contribute to occasional algae problems in the lake. This suggests that these FQI calculations must be considered in the context of other information about aquatic plant communities, or at least should be weighted to include relative frequency or abundance data that is increasingly collected as part of aquatic plant surveys conducted through CSLAP or other monitoring programs.

The number of lakes with protected plant species (column C5 in Table 5.2.3) is higher than expected given the statewide Natural Heritage Program (NHP) database, as noted in the statewide CSLAP report. This may be due in part to an incomplete NHP database for some of the smaller Downstate region lakes, and in part due to uncertainty in the identification of some protected species, particularly the narrowleaf pondweeds common in this region. However, the NHP database for Long Island is very comprehensive, and indicates a high percentage of lakes and ponds with protected plants.





Figures 5.2.1 and 5.2.2 –Typical Aquatic Plant Coverage and Recreational Assessments in CSLAP Lakes With and Without Exotic Plants

As expected, there is a strong connection between the presence of invasive plants and increased (overall) coverage of aquatic plants and recreational use impacts. Figure 5.2.1 shows that the extent of plant coverage is slightly greater for lakes with exotic plants than for lakes without exotics—lakes with exotic plants more consistently exhibit surface plant growth, and lakes without these invasive species exhibit a wider range of plant coverage conditions. Most of the lakes with surface weed growth in the absence of exotics are very shallow—often less than 10 feet deep.

Figure 5.2.2 indicates that lakes with exotic plants tend to have less favorable recreational assessments, with "slightly impaired" conditions much more common than in lakes without exotic plants. In lakes dominated by native plants, "excellent" recreational conditions are most frequently reported by the sampling volunteers.

Primary, Secondary and Tertiary Consumers

Chapter 5.3- Evaluation of Zooplankton

Zooplankton communities were studied in CSLAP lakes only in 1992, as part of graduate research conducted by Bruce Cady, a CSLAP training coordinator hired by NYSFOLA in 1992 and 1993. Vertical or horizontal plankton tows using a Wisconsin style net with a 12cm opening and 80µm mesh on 20 CSLAP lakes in mid-summer.

A summary of the 1992 zooplankton surveys will be included in the 25 Year CSLAP report issued in 2011, and in the individual lake appendices.

Chapter 5.4- Evaluation of Macroinvertebrates

The lake macroinvertebrate studies conducted in New York state in the last few years are discussed in the statewide CSLAP report. There are insufficient data in the Downstate region to include a regional discussion, although it is anticipated that with the collection of additional lake macroinvertebrate data, and an incorporation of the ALSC macroinvertebrate dataset, future generations of this report will include detailed discussions about lake benthic communities.

Chapter 5.5- Evaluation of Zebra Mussels

The Downstate region is traversed by one of the major aquatic pathways for zebra mussels—the Hudson River. However, the extent of zebra mussel infestations in this region is presently limited to the Hudson River—zebra mussels have not been documented in any of the lakes in the region. Many of the lakes in this region appear to be susceptible to zebra mussel colonization, and microclimates may also exist in concrete breakwalls and docks, and at the receiving end of streams draining watersheds overlying limestone deposits or other sources of calcium. A detailed discussion of zebra mussel distribution in CSLAP and New York state lakes is provided in the statewide CSLAP report.

Chapter 5.6- Evaluation of Fish

Fish surveys are not conducted through CSLAP. However, many CSLAP lakes have been surveyed as part of fisheries stocking activities, to assess or report on sports fisheries, or as part of general biological assessments. These surveys have been conducted by the NYSDEC Division of Fish and Wildlife, the Adirondack Lake Survey Corporation, private lake associations, and academic studies. In addition, incomplete species lists for many New York state lakes can be found on various fishing web sites. Inventories have been developed for nearly 75% of the CSLAP lakes, including nearly 35 lakes in the Downstate region. Since each of these surveys or limited inventories was developed to serve different purposes, some have been more comprehensive than others, and a detailed evaluation of the results from these inventories should be viewed with discretion. Nonetheless, a compilation of the survey and inventory results from CSLAP lakes can provide some useful insights.

A summary of the fisheries survey information available for CSLAP lakes will be included in the 25 Year CSLAP report issued in 2011, and in the individual lake appendices.

Chapter 6- Evaluation of Lake Perception

Lake Perception Fact Sheet

Chapter 6.1- Evaluation of Downstate Region Water Quality Perception

Chapter 6.2- Evaluation of Downstate Region Aquatic Plant Perception

Chapter 6.3- Evaluation of Downstate Region Recreational Perception

Lake Perception Fact Sheet

Description:	lake perception can be evaluated semi-quantitatively (using a standardized scale) to assess how the lake looks, aquatic plant populations, and recreational suitability.
Importance:	public perception of lakes is a critical component of lake management. Public dissatisfaction with (or desire to protect) the condition of the lake is frequently a strong impetus for the development of management, protection, or restoration plans for a lake, and often informs the desire to fund and implement management actions. Lake perception is often closely linked to measurable water quality or lake indicators, affording the opportunity to gauge progress and success, and to conduct cost-benefit analyses of specific management activities. Standardized scales can provide opportunities for comparison from year to year and across regional and state boundaries, since most New England and Upper Midwestern states use the same standardized tool for assessing lake perception.
How Measured: in CSLAP	lake perception is evaluated via a 4 question survey. The first and third questions relate to the physical condition of the lake (how it looks) and the recreational condition of the lake, respectively. These are graded on a 5 point scale, ranging from most favorable (1) to least favorable (5). The second question relates to the aquatic plant coverage in the lake, ranging from not visible (1) to densely covering the entire lake surface (5). The last question asks survey respondents to identify which factor(s) adversely affect recreational assessments. The surveys are completed during each sampling session prior to data or sample collection, to minimize bias.
Detection Limit:	not applicable
Range in CSLAP:	1 to 5 for all survey questions. 76% of all respondents described their lake as "not quite crystal clear" or having "definite algal greenness". 77% of all respondents said aquatic plants were visible from or grew to the lake surface, but not densely. 72% of survey respondents reported their lake as "excellent" or "slightly impaired" for recreational uses. However, these assessments varied widely regionally and from lake to lake.
WQ Standards:	no water quality standards or guidance values exist for lake perception. However, these data will likely be used to help determine the appropriate water clarity, chlorophyll *a* and total phosphorus readings to protect recreational uses of lakes, as part of the nutrient criteria development process.
Trophic Assessment:	the proposed guidance values for water clarity, chlorophyll *a*, and total phosphorus will likely be developed to prevent "impaired" conditions (as defined by the recreational perception survey data) at a frequency of greater than 10%-25% of the summer recreational season.

Chapter 6- Evaluation of Lake Perception

Chapter 6.1- Evaluation of Downstate Region Water Quality Perception: 1992-2009

Summary of CSLAP Water Quality Perception Findings in Downstate Region Lakes, 1992-2009

1. CSLAP lakes within the Downstate region have less favorable water quality assessments than in the Adirondack and Central region, and more favorable than in the Western region.
2. The water quality assessments of CSLAP lakes cannot be compared to those from lakes evaluated in other monitoring programs, since the assessment tools used in CSLAP have not been used in other programs for a long enough duration.
3. Water quality assessments in CSLAP lakes in the Downstate region are not strongly influenced by weather conditions, although less favorable assessments are associated with dry weather, and more favorable assessments are associated with wet weather.
4. The frequency of more and less favorable water quality assessments has decreased in Downstate region lakes in recent years, although this long-term trend is not statistically significant. This may be an indication that water quality assessments have become more stable in many of these lakes.
5. Water quality assessments are favorable in many of the Downstate region lakes, particularly in the western portion of the region and Long Island, with the least favorable water quality assessments in interior portion of the region (Westchester and Putnam Counties).
6. It is likely that changes in water quality assessments in 2009 and in the long-term exhibited by a small number of lakes within the Downstate region are within the normal range of variability for these lakes.
7. Water quality assessments in Downstate region lakes were slightly more favorable but otherwise similar in 2009 to those reported in the typical CSLAP sampling season from 1986 to 2008.

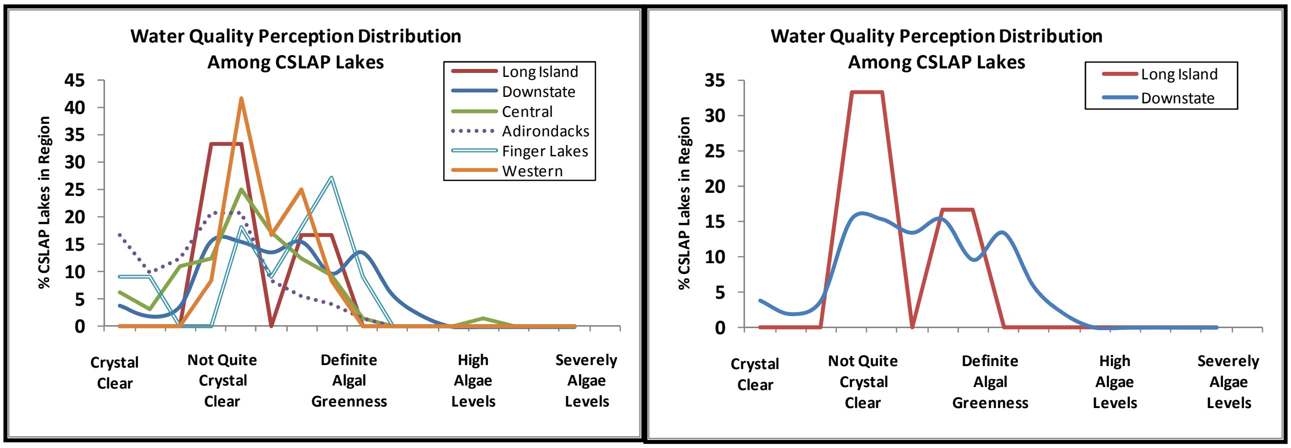
Downstate Region Data Compared to NYS Data

Water quality assessments in CSLAP lakes in the Downstate region are about as favorable as those in other regions of the state except the Adirondacks, consistent with the regional water clarity findings. The most frequent water quality assessment in these lakes is "not quite crystal clear," assessments also consistent with the water transparency readings in these lakes. Some lakes could be described as having "definite algal greenness," and even fewer lakes were reported as having "high algae levels" or "crystal clear."

Comparison of CSLAP to NYS Lakes in the Downstate Region

Lake perception surveys, modeled after the CSLAP user perception surveys, have been included in the Lake Classification and Inventory (LCI) survey work conducted in the Downstate region. It is not known if similar perception surveys have been included in other monitoring programs, including volunteer programs, conducted with this region. Given the paucity of data—

both water quality and lake perception data—collected in this program, a comparison of CSLAP and other NYS datasets within the Downstate region is premature at this time.



Figures 6.1.1 and 6.1.2: Distribution of Water Quality Perception in CSLAP and Downstate Region Lakes

Annual Variability:

Lake water quality perception is fairly stable in most lakes, but may vary significantly from lake to lake throughout the state, including the Downstate region. The most favorable water quality assessments recorded through CSLAP occurred during 1997, 1998 and 1994. These comprised neither very dry nor very wet years. The least favorable water quality assessments occurred in 1999, 2000, and 2006; the latter was a very wet year. Table 7.1.1 looks at the percentage of CSLAP lakes with less favorable water quality (greater than 1 standard error above normal) and more favorable water quality (greater than 1 standard error below normal) assessments in wet and dry years. These data show that less favorable water quality assessments were more likely to occur in dry years, and more favorable assessments are associated with wet years.

Table 6.1.1- % of CSLAP Lakes with Higher or Lower (than Normal) Water Quality Perception During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
More Favorable Water Quality Perception	13%	26%
Less Favorable Water Quality Perception	20%	11%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"More" and "Less" favorable defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in any region, including the lakes within the Downstate region, is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1992, the frequency of more and less favorable water quality assessments (higher and lower perceived clarity, respectively) has decreased, although this trend is not statistically significant. This suggests that water quality conditions in these lakes have stabilized, a long-term trend not apparent from the water clarity or chlorophyll *a* trend data.

Regional Distribution:

Water quality assessments within the Downstate region have been least favorable in the interior portion of the region, corresponding to lakes in Westchester and Putnam Counties, mostly consistent with the distribution of water clarity readings in the region. The most favorable assessments were found in the western portion of the region and Long Island. There are few lakes in the region that occupy the extremes of the water quality assessment spectrum—few "crystal clear" lakes and few lakes with "very high algae levels."

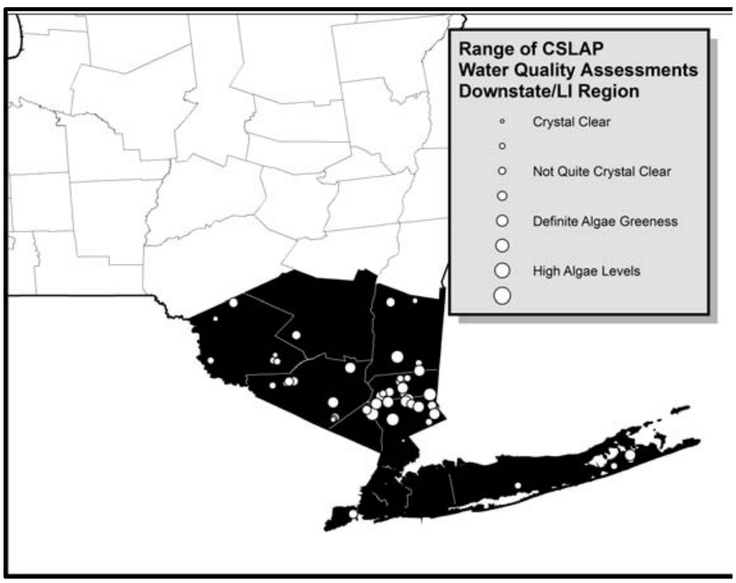


Figure 6.1.3: Range of Water Quality Assessments in the Downstate Region

Table 6.1.2 shows the number of sampling sessions with water quality assessments, the minimum (most favorable), average, and maximum (least favorable) water quality assessments in the entirety of the CSLAP dataset (since 1992) and the frequency with which "definite algae greenness" and "high algae levels" are observed in each region, and whether these assessments have changed since CSLAP sampling began in the lake.

Table 6.1.2: Water Quality Assessments in CSLAP Downstate Region Lakes, 1992-2009

Lake Name	Years	Num	Min	Avg	Max	%Definite Algae Greenness	% High Algae Levels	Change?
Anawanda Lake	1988-2009	98	1	1.6	3	7	0	No
Anawanda Lake	2009	8	1	1.5	2	0	0	No
Blue Heron Lake	2005-2008	24	1	1.9	3	4	0	
Cranberry Lake	2004-2004	7	1	1.1	2	0	0	
Gossamans Pond	2003-2005	21	2	3.2	5	91	27	
Highland Lake	2003-2009	29	2	2.5	4	42	3	Degrading
Highland Lake	2009	5	2	2.6	3	60	0	No
Hillside Lake	1994-1997	5	3	3.6	4	100	60	
Indian Lake	1994-2009	65	1	1.9	4	19	4	Degrading
Indian Lake	2009	8	1	1.9	4	29	29	No
Katonah Lake	2006-2009	30	2	2.7	4	63	10	
Katonah Lake	2009	7	2	2.6	3	57	0	No
Lake Celeste	1993-1997	25	1	2.3	3	38	0	No
Lake Guymard	1996-2003	44	1	2.1	3	26	0	No

Lake Name	Years	Num	Min	Avg	Max	%Definite Algae Greenness	% High Algae Levels	Change?
Lake Kitchawan	2008-2008	1	3	3.0	3	100	0	
Lake Lincolndale	1993-2009	106	1	3.0	5	77	20	No
Lake Lincolndale	2009	5	3	3.0	3	100	0	No
Lake Mahopac	1986-2002	16	1	1.8	3	21	0	Improving
Lake Meahagh	1999-2001	9	2	3.3	4	89	44	
Lake Mohegan	1998-2009	78	1	3.0	5	84	13	No
Lake Mohegan	2009	8	3	3.0	3	100	0	No
Lake Nimham	1991-1995	32	1	2.1	3	16	0	
Lake Oscaleta	2006-2009	32	1	2.3	4	24	6	
Lake Oscaleta	2009	8	2	2.2	3	22	0	No
Lake Oscawana	1991-1995	27	2	2.7	4	63	11	
Lake Ossi	1996-2000	32	1	3.1	5	75	25	No
Lake Peekskill	1990-2009	74	1	2.6	4	61	16	Degrading
Lake Peekskill	2009	7	2	3.0	4	71	29	No
Lake Rippowam	2006-2009	31	1	2.2	4	18	3	
Lake Rippowam	2009	8	1	2.1	3	22	0	No
Lake Tibet	1991-1993	10	2	2.6	4	50	10	
Lake Truesdale	1999-2009	83	1	2.8	4	69	17	No
Lake Truesdale	2009	8	3	3.3	4	100	25	No
Lake Waccabuc	1986-2009	36	1	2.2	4	30	3	No
Lake Waccabuc	2009	8	1	2.1	3	29	0	No
Lake Wanaksink	1991-1995	25	1	1.7	2	0	0	
Little We Wah Lake	2008-2009	15	1	1.8	3	27	0	
Little We Wah Lake	2009	8	1	1.4	3	14	0	More favorable
Monhagen Lake	2003-2009	28	2	2.4	3	42	0	Degrading
Monhagen Lake	2009	5	2	2.6	3	60	0	No
Orange Lake	1994-2005	49	1	2.9	5	70	19	Improving
Peach Lake	1999-2008	64	1	3.3	5	87	43	No
Plum Brook Lake	2005-2008	30	2	2.4	3	37	0	
Roaring Brook Lake	2009-2009	8	1	1.8	3	25	0	
Roaring Brook Lake	2009	8	1	1.8	3	25	0	No
Round Lake	1992-1996	34	2	2.9	5	68	21	No
Sagamore Lake	1994-1997	31	1	2.0	3	10	0	
Sepasco Lake	1997-2009	80	1	2.6	4	63	2	No
Sepasco Lake	2009	7	2	2.4	3	43	0	No
Shadow Lake	2008-2009	12	2	3.3	4	92	33	
Shadow Lake	2009	5	2	3.2	4	80	40	No
Shawangunk Lake	2003-2009	25	1	2.3	3	29	0	No
Shawangunk Lake	2009	5	2	2.6	3	60	0	No
Shenorock Lake	2004-2009	45	1	3.1	5	79	31	No
Shenorock Lake	2009	8	2	2.8	4	63	13	No
Stissing Lake	2007-2009	17	1	1.2	2	0	0	
Stissing Lake	2009	8	1	1.0	1	0	0	No
Teatown Lake	1997-2009	79	1	3.0	5	65	37	Degrading
Teatown Lake	2009	5	2	2.6	4	40	20	No
Timber Lake (Westchester)	2006-2009	16	2	2.6	4	56	6	
Timber Lake (Westchester)	2009	8	2	2.5	3	50	0	No
Timber Lake (Sullivan)	2004-2008	28	2	2.7	4	67	7	
Tomkins Lake	2001-2001	8	1	2.6	3	75	0	
Tuxedo Lake	2008-2009	15	1	1.3	2	0	0	
Tuxedo Lake	2009	8	1	1.3	2	0	0	No
Ulster Heights Lake	2007-2009	14	2	2.4	3	43	0	
Ulster Heights Lake	2009	4	2	2.3	3	25	0	No
Wallace Pond	2004-2008	26	2	3.0	5	81	19	No

Lake Name	Years	Num	Min	Avg	Max	%Definite Algae Greenness	% High Algae Levels	Change?
We Wah Lake	2008-2009	16	1	2.0	3	31	0	
We Wah Lake	2009	8	1	1.6	3	13	0	No
Weiden Pond	2004-2009	37	1	2.0	3	19	0	No
Weiden Pond	2009	5	1	1.4	2	0	0	More favorable
Whaley Lake	1998-2001	31	1	2.2	3	25	0	
Wolf Lake	1987-2001	28	1	1.9	3	10	0	No
Yankee Lake	2006-2009	29	1	1.8	3	6	0	
Yankee Lake	2009	7	1	1.9	2	0	0	No
Black Pond	2008-2009	13	1	2.2	3	31	0	
Black Pond	2009	8	2	2.4	3	38	0	No
Bradys Pond	1997-2001	32	2	2.7	4	71	3	No
Canaan Lake	1990-2005	59	1	1.9	3	5	0	No
Lily Pond	2008-2009	12	2	2.9	5	58	25	
Lily Pond	2009	8	2	2.8	4	63	13	No
Little Fresh Pond	1989-2009	55	1	2.0	4	17	2	No
Little Fresh Pond	2009	8	1	1.5	3	17	0	More favorable
Little Long Pond	2006-2009	13	2	2.2	3	15	0	
Little Long Pond	2009	3	2	2.0	2	0	0	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum water quality perception rating (QA on the perception survey), integer values 1-5
% Definite Algae Greenness = percentage of sampling session in which response to question QA was 3, 4, or 5
% High Algae Levels = percentage of sampling session in which response to question QA was 4 or 5
Change? = exhibiting significant change in QA readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on QA readings >25% higher or lower than normal

There are several lakes in this region exhibiting long-term change in water quality assessments. Lake Mahopac and Orange Lake have exhibited improving water quality assessments over the duration of their CSLAP sampling. The improved water quality assessments in Lake Mahopac are consistent with the increase in water clarity readings over the same period. The change in water quality perception in Orange Lake has not been mirrored by a change in water transparency.

Highland Lake, Lake Peekskill, Monhagen Lake, and Teatown Lake have all exhibited degrading water quality assessments. None of these lakes has exhibited any long-term changes in water clarity or chlorophyll *a*. This suggests that the less favorable water quality assessments in these lakes represent normal variability.

Tables 6.1.3a and 6.1.3b summarize the water quality assessment data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Water quality assessments in the CSLAP lakes in the Downstate region in 2009 (and all other NYS regions except the western regions) were about as favorable as those reported in previous years, at least as evaluated by average water quality assessments. This is consistent with a lack of significant change in either water clarity or chlorophyll *a* readings in the Downstate region. A higher percentage (9% versus 0%) of Downstate region lakes exhibited more favorable than less favorable water quality assessments in 2009, and a larger percentage of lakes exhibited their most favorable assessments in 2009. It is likely that this still represent normal variability, although this may have contributed to slightly more favorable recreational assessments in this region in 2009.

As in previous years, a moderately high percentage of lakes exhibit "definite algal greenness" and a low percentage exhibited "high algae levels" in 2009 in the Downstate region. This region of the state continues to have somewhat favorable water quality conditions, consistent with the relatively high water clarity and low algae levels in at least some lakes.

Table 6.1.3a: Water Quality Assessment Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	%Frequency Definite Algal Greenness	% Frequency High Algae Levels
Downstate	32	1	2.3	2.4	4	40	6
Central	36	1	2.1	2.2	4	28	3
Adirondacks	33	1	1.8	1.9	3	14	0
Western	9	1	2.7	2.3	5	64	7
CSLAP Statewide	**110**	**1**	**2.1**	**2.1**	**5**	**30**	**3**

Table 6.1.3b: Water Quality Assessment Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Less Favorable	%More Favorable	%Above Max	%Below Min
Downstate	32	2.3	2.4	0	9	46	75
Central	36	2.1	2.2	6	19	25	72
Adirondacks	33	1.8	1.9	9	18	45	67
Western	9	2.7	2.3	0	11	44	33
CSLAP Statewide	**110**	**2.1**	**2.1**	**5**	**15**	**39**	**68**

% Less Favorable = percentage of lakes in region with water quality assessments in 2009 >25% worse than normal (before 2009)
% More Favorable = percentage of lakes in region with water quality assessments in 2009 >25% better than normal (before 2009)
% Above Max = percentage of lakes in region with any water quality assessments in 2009 less favorable than normal (before 2009)
% Below Min = percentage of lakes in region with any water quality assessments in 2009 more favorable than normal (before 2009)

Downstate Region Lakes With More Favorable Water Quality Assessments in 2009:
Little Fresh Pond, Little We Wah Lake, Weiden Pond

Discussion:

Three Downstate region lakes exhibited more favorable water quality assessments in 2009. None of these lakes exhibited higher than normal water transparency readings in 2009, although Little We Wah Lake and Weiden Pond had lower algae levels (chlorophyll *a*) in 2009. None of these lakes has exhibited a long-term change in water quality assessments. No lakes exhibited higher than normal water clarity and lower than normal chlorophyll *a* readings without exhibiting more favorable water quality conditions.

Downstate Region Lakes With Less Favorable Water Quality Assessments in 2009:
None

Discussion:

None of the Downstate region lakes were less favorable in 2009 than in previous years.

Chapter 6.2- Evaluation of Downstate Region Aquatic Plant Perception: 1992-2009

Summary of CSLAP Aquatic Plant Coverage in Downstate Region Lakes, 1992-2009

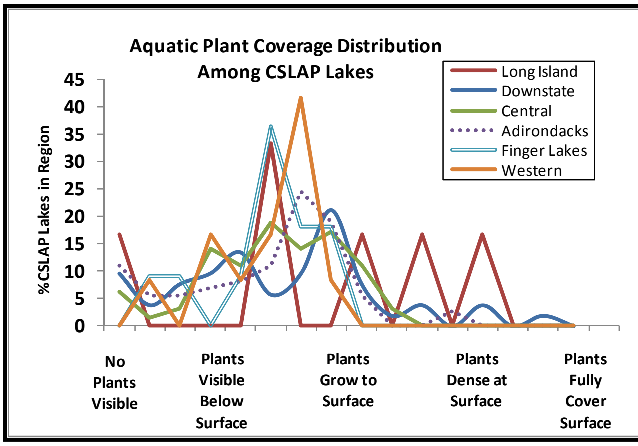
1. CSLAP lakes within the Downstate region have similar coverage of aquatic plants as seen in other parts of the state, at least outside of Long Island and the Adirondack region.
2. Aquatic plant coverage in CSLAP lakes within the Downstate region cannot be compared to non-CSLAP lakes in the same region, since similar aquatic plant assessments have not been conducted in most lakes throughout this region through other monitoring programs.
3. CSLAP lakes within the Downstate region appear to exhibit less weed growth during both very wet and very dry years.
4. The frequency of both greater and less weed growth in Downstate region lakes has decreased in recent years, perhaps due to the frequency of active management of plants in many of these lakes.
5. Aquatic plant coverage has been greatest in the interior portions of the region, and the most extensive coverage of aquatic plants in many of these lakes is associated with Eurasian watermilfoil (at least outside of Long Island).
6. A small number of lakes in the region have exhibited some long-term change in aquatic plant coverage. However, it is likely that most of these changes represent normal variability or the result of active lake management.
7. Aquatic plant coverage in Downstate region lakes was similar in 2009 to that reported in the typical CSLAP sampling season from 1986 to 2008.

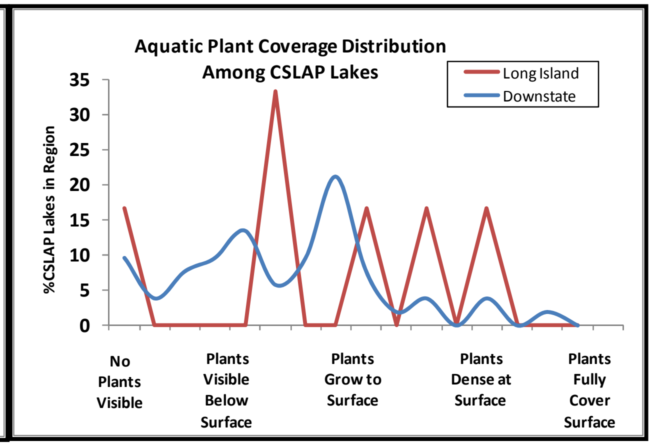
Downstate Region Data Compared to NYS Data

The data in Figure 6.2.1 show that, at least in CSLAP lakes, the extent of aquatic plant coverage in the Downstate region lakes is similar to plant coverage in lakes in most other regions of the state (except for Long Island, which is dominated by weed-filled shallow lakes). The CSLAP sampling volunteers from this region report that aquatic plants are visible below the lake surface and regularly grow to the lake surface. Dense plant growth at the lake surface is not commonly reported in Downstate region lakes, although surface plant growth is common. Figure 6.2.2 shows that there is a wide range of "normal" extent of plant growth in these lakes, owing to the large variety (shallow and deep, sandy and mucky shorelines, etc.) of lakes in the region.

Comparison of CSLAP to NYS Lakes in the Downstate Region

Although aquatic plant surveys are increasingly conducted in lakes throughout New York State, including the Downstate region, in support of plant management activities, the number of lakes throughout the state with extensive plant surveys is still small. Moreover, the CSLAP perception forms are generally not used in most Downstate region monitoring programs. Therefore it is not possible to compare CSLAP data regarding the extent of aquatic plant coverage to data collected through other monitoring programs.





Figures 6.2.1 and 6.2.2: Distribution of Aquatic Plant Assessments in CSLAP and Downstate Region Lakes

Annual Variability:

Aquatic plant coverage may be highly variable from lake to lake, but is usually stable in unmanaged lakes within the Downstate region. The most significant aquatic plant coverage recorded through CSLAP occurred during 1992, 1993, and 2003. These comprised both normal and wet years. The lowest (least) plant coverage occurred in 1996, 1999, and 1998, mostly wet years. Table 6.2.1 looks at the percentage of CSLAP lakes with higher aquatic plant coverage (greater than 1 standard error above normal) and lower plant coverage (greater than 1 standard error below normal) assessments in wet and dry years. These data show that less plant coverage generally occurs in both very dry and very wet years.

Table 6.2.1- % of CSLAP Lakes with Higher or Lower (than Normal) Aquatic Plant Coverage During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
More Coverage of Aquatic Plants	20%	22%
Less Coverage of Aquatic Plants	33%	37%

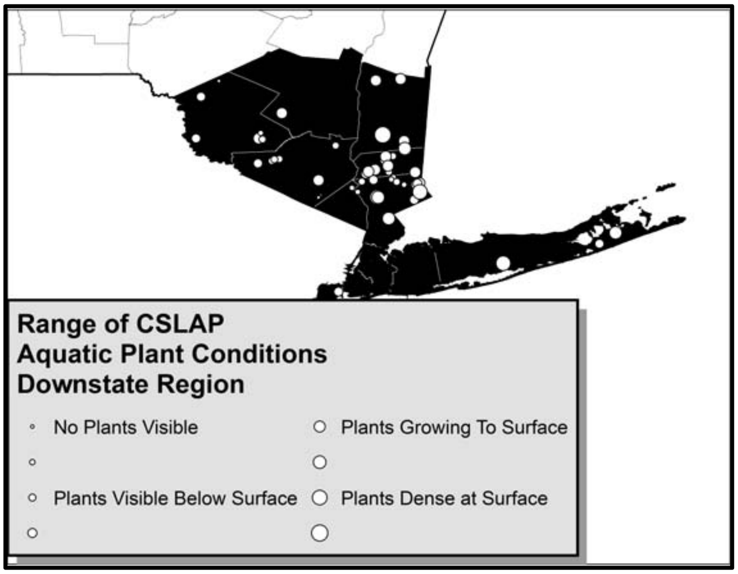
Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"More" and "Less" Coverage defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in any region, including the lakes within the Downstate region, is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). The frequency of both greater and lesser weed coverage has decreased, although none of these trends are statistically significant. These data indicate that the aquatic plant coverage may be stabilizing in these lakes, whether due to less normal variability or more active management of these lakes.

Regional Distribution:

Aquatic plants assessments within the Downstate region appear to be least favorable (most extensive weed coverage) in the interior portions of the region, although this also corresponds to the most heavily sampled parts of the region. Lakes with relatively low weed coverage are scattered throughout the region, and are mostly found in relatively deep lakes or shallow lakes dominated by algae, particularly in the western part of the region. Exotic plant growth is more common in Long Island than is apparent in the CSLAP dataset.



Figures 6.2.3: Range of Aquatic Plant Coverage in the Downstate Region

The primary "offending" aquatic plant in the northern part of the region is Eurasian watermilfoil, and in the Long Island portion of the region the most common exotic plant is fanwort. Most of the weedier lakes in the Downstate region have exotic species, or these exotic plants are among many plants that grow to the lake surface. The distribution of exotic species in this region is discussed in the "Evaluation of Biological Condition" section of this report. The aquatic plant coverage distribution is shown in Figure 6.2.3.

Table 6.2.2 shows the number of sampling sessions with aquatic plant assessments, the minimum (least extensive), average, and maximum (most extensive) aquatic plant coverage in the entirety of the CSLAP dataset (since 1992) and in 2009, the frequency with which "surface plant growth" and "dense surface growth" are observed in each region, and whether these assessments have changed since CSLAP sampling began in the lake.

Table 6.2.2: Aquatic Plant Coverage in CSLAP Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	% Surface Weeds	% Dense Surface Weeds	Change?
Anawanda Lake	1988-2009	98	1	2.7	3	74	0	No
Anawanda Lake	2009	8	2	2.9	3	88	0	No
Blue Heron Lake	2005-2008	24	2	2.7	3	67	0	
Cranberry Lake	2004-2004	7	3	3.6	4	100	63	
Gossamans Pond	2003-2005	21	3	3.3	4	100	27	
Highland Lake	2003-2009	26	1	2.0	3	29	0	Decreasing
Highland Lake	2009	5	1	1.5	2	0	0	Lower
Hillside Lake	1994-1997	5	4	4.6	5	100	100	
Indian Lake	1994-2009	65	1	2.9	4	87	1	No
Indian Lake	2009	8	2	2.9	3	86	1	No
Katonah Lake	2006-2009	30	1	1.3	3	7	0	
Katonah Lake	2009	7	1	1.1	2	0	0	No
Lake Celeste	1993-1997	25	1	2.7	4	73	4	Decreasing

Lake Name	Years	Num	Min	Avg	Max	% Surface Weeds	% Dense Surface Weeds	Change?
Lake Guymard	1996-2003	44	1	2.3	3	37	0	No
Lake Kitchawan	2008-2008	1	4	4.0	4	100	100	
Lake Lincolndale	1993-2009	106	1	1.4	5	15	2	No
Lake Lincolndale	2009	5	1	1.8	2	0	2	No
Lake Mahopac	1986-2002	16	1	2.2	4	42	21	Decreasing
Lake Meahagh	1999-2001	9	1	1.6	3	11	0	
Lake Mohegan	1998-2009	78	1	2.7	3	76	0	Increasing
Lake Mohegan	2009	8	3	3.0	3	100	0	No
Lake Nimham	1991-1995	32	1	2.1	3	19	0	
Lake Oscaleta	2006-2009	32	1	2.5	4	48	6	
Lake Oscaleta	2009	8	1	2.0	3	22	6	No
Lake Oscawana	1991-1995	27	2	2.9	3	93	0	
Lake Ossi	1996-2000	32	1	3.1	4	84	28	No
Lake Peekskill	1990-2009	74	1	1.7	4	19	4	No
Lake Peekskill	2009	7	2	2.0	2	0	4	No
Lake Rippowam	2006-2009	31	1	2.9	4	94	3	
Lake Rippowam	2009	8	3	3.0	3	100	3	No
Lake Tibet	1991-1993	10	2	2.9	3	90	0	
Lake Truesdale	1999-2009	85	1	1.8	4	18	5	Decreasing
Lake Truesdale	2009	8	1	1.8	2	0	5	No
Lake Waccabuc	1986-2009	37	2	2.9	4	89	3	No
Lake Waccabuc	2009	8	3	3.0	3	100	3	No
Lake Wanaksink	1991-1995	25	1	1.6	3	19	0	
Little We Wah Lake	2008-2009	15	1	1.1	2	0	0	
Little We Wah Lake	2009	8	1	1.0	1	0	0	No
Monhagen Lake	2003-2009	24	1	1.9	3	33	0	Decreasing
Monhagen Lake	2009	5	1	1.0	1	0	0	Lower
Orange Lake	1994-2005	50	1	2.1	5	31	5	No
Peach Lake	1999-2008	64	2	2.9	4	86	7	No
Plum Brook Lake	2005-2008	30	1	2.1	4	20	7	
Roaring Brook Lake	2009-2009	8	1	2.3	3	38	0	
Roaring Brook Lake	2009	8	1	2.3	3	38	0	No
Round Lake	1992-1996	34	2	3.1	4	85	26	No
Sagamore Lake	1994-1997	32	1	2.9	4	84	13	
Sepasco Lake	1997-2009	80	1	3.0	4	87	11	No
Sepasco Lake	2009	7	2	2.7	3	71	11	No
Shadow Lake	2008-2009	12	3	3.6	5	100	50	
Shadow Lake	2009	5	3	4.0	5	100	50	No
Shawangunk Lake	2003-2009	21	1	2.1	3	38	0	Decreasing
Shawangunk Lake	2009	5	1	1.0	1	0	0	Lower
Shenorock Lake	2004-2009	45	1	1.8	3	23	0	No
Shenorock Lake	2009	8	2	2.8	3	75	0	Higher
Stissing Lake	2007-2009	17	1	3.1	4	94	18	
Stissing Lake	2009	8	3	3.0	3	100	18	No
Teatown Lake	1997-2009	80	3	4.1	5	100	82	No
Teatown Lake	2009	5	5	5.0	5	100	82	No
Timber Lake (Sullivan)	2004-2008	28	1	1.0	1	0	0	
Timber Lake (Westchester)	2006-2009	16	1	1.0	1	0	0	
Timber Lake	2009	8	1	1.0	1	0	0	No
Tomkins Lake	2001-2001	8	1	1.5	2	0	0	
Tuxedo Lake	2008-2009	15	1	1.1	2	0	0	
Tuxedo Lake	2009	8	1	1.3	2	0	0	No
Ulster Heights Lake	2007-2009	14	3	3.1	4	100	7	
Ulster Heights Lake	2009	4	3	3.0	3	100	7	No

Lake Name	Years	Num	Min	Avg	Max	% Surface Weeds	% Dense Surface Weeds	Change?
Wallace Pond	2004-2008	26	1	2.1	3	31	0	Decreasing
We Wah Lake	2008-2009	16	1	1.1	2	0	0	
We Wah Lake	2009	8	1	1.1	2	0	0	No
Weiden Pond	2004-2009	37	1	2.5	4	51	3	No
Weiden Pond	2009	5	2	2.2	3	20	3	No
Whaley Lake	1998-2001	31	2	2.9	4	84	9	
Wolf Lake	1987-2001	28	1	2.8	3	83	0	No
Yankee Lake	2006-2009	29	1	1.9	3	35	0	
Yankee Lake	2009	7	1	2.0	3	29	0	No
Black Pond	2008-2009	13	1	1.0	1	0	0	
Black Pond	2009	8	1	1.0	1	0	0	No
Bradys Pond	1997-2001	32	1	2.5	3	59	0	No
Canaan Lake	1990-2005	59	2	4.2	5	97	76	No
Lily Pond	2008-2009	12	3	3.6	4	100	58	
Lily Pond	2009	8	3	3.5	4	100	58	No
Little Fresh Pond	1989-2009	55	1	2.3	4	52	3	No
Little Fresh Pond	2009	8	1	2.0	3	17	3	No
Little Long Pond	2006-2009	13	2	3.0	4	92	8	
Little Long Pond	2009	3	3	3.0	3	100	8	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum aquatic plant coverage rating (QB on the perception survey), integer values 1-5
% Surface Weeds = percentage of sampling session in which response to question QB was 3, 4, or 5
% Dense Surface Weeds = percentage of sampling session in which response to question QB was 4 or 5
Change? = exhibiting significant change in QB readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on QB readings >25% higher or lower than normal

There are several lakes in this region exhibiting long-term change in aquatic plant coverage, at least in the portion(s) of the lake evaluated through the CSLAP perception surveys. Lake Mohegan has exhibited increasing coverage of aquatic plants over the duration of their CSLAP sampling. It is not known if the Lake Mohegan plant community is dominated by native or exotic plants, although the ALSC and Cedar Eden plant surveys have identified some invasive species in the lake (including Eurasian watermilfoil and curly leafed pondweed).

Highland Lake, Lake Celeste, Lake Mahopac, Lake Truesdale, Monhagen Lake, Shawangunk Lake and Wallace Pond have all exhibited decreasing coverage of aquatic plants during the years of CSLAP sampling at the lake. Lake Mahopac was stocked with herbivorous fish (grass carp), and Lake Celeste and Lake Truesdale were treated with aquatic herbicides (Aquathol), which led to the decrease in aquatic plant coverage. It is not known why aquatic plant populations in the three Middletown reservoirs (Highland Lake, Monhagen Lake, and Shawangunk Lake) and Wallace Pond have decreased.

Tables 6.2.3a and 6.2.3b summarize the aquatic plant coverage data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Aquatic plant coverage in the CSLAP lakes in the Downstate region in 2009 was slightly lower in previous years, based on “average” assessments of plant coverage and frequency of greater and less than normal coverage. It is not believed that any of the CSLAP lakes in the Downstate region reported any invasive aquatic plant species for the first time in 2009.

As in previous years, surface plant growth was reported during nearly half of the CSLAP sampling sessions, a frequency slightly lower than the statewide average. The frequency of dense plant growth was again low in 2009. It is likely that the surface plant growth in many of these lakes is associated with exotic, invasive plants—in many of these lakes, the makeup of the aquatic plant community is not known. As discussed in the Recreational Perception section, despite the frequency of surface plant growth, the frequency of "slightly" and "substantially" impaired recreational conditions in this region is close to the statewide average.

Table 6.2.3a: Aquatic Plant Assessment Summary in CSLAP Lakes, 2009

	Number Lakes	Minimum	Average 2009	Average 1986-08	Maximum	%Frequency Surface Plants	% Frequency Dense Surface Plants
Downstate	32	1	2.2	2.5	5	45	8
Central	36	1	2.6	2.4	5	62	5
Adirondacks	33	1	2.3	2.3	4	52	4
Western	9	1	2.6	2.3	4	61	6
CSLAP Statewide	**110**	**1**	**2.4**	**2.4**	**5**	**54**	**6**

Table 6.2.3b: Aquatic Plant Assessment Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Less Favorable	%More Favorable	%Above Max	%Below Min
Downstate	32	2.2	2.5	3	11	42	61
Central	36	2.6	2.4	14	14	50	42
Adirondacks	33	2.3	2.3	4	8	45	45
Western	9	2.6	2.3	11	11	33	11
CSLAP Statewide	**110**	**2.4**	**2.4**	**9**	**15**	**45**	**46**

% Less Favorable = percentage of lakes in region with aquatic plant assessments in 2009 >25% greater than normal (before 2009)
% More Favorable = percentage of lakes in region with aquatic plant assessments in 2009 >25% less than normal (before 2009)
% Above Max = percentage of lakes in region with any aquatic plant assessments in 2009 less favorable than normal (before 2009)
% Below Min = percentage of lakes in region with any aquatic plant assessments in 2009 more favorable than normal (before 2009)

Downstate Region Lakes With More Extensive Plant Coverage in 2009:
Shenorock Lake

Discussion:
One Downstate region lake exhibited more extensive aquatic plant coverage in 2009. It is not known if the more extensive aquatic plant growth in Shenorock Lake in 2009 was associated with exotic or native plant species. The rise in plant growth in 2009 was not part of a long-term trend.

Downstate Region Lakes With Less Extensive Plant Coverage in 2009:
Highland Lake, Monhagen Lake, Shawangunk Lake

Discussion:
Aquatic plant coverage in the three Middletown reservoirs was lower than normal in 2009. As discussed above, the decrease in plant coverage in Highland Lake, Monhagen Lake, and Shawangunk Lake is part of a long-term trend, but it is not believed that the drop in plant coverage was due to active management of the lake.

Chapter 6.3- Evaluation of Downstate Region Recreational Perception: 1992-2009

Summary of CSLAP Recreational Use Assessments in Downstate Region Lakes, 1992-2009

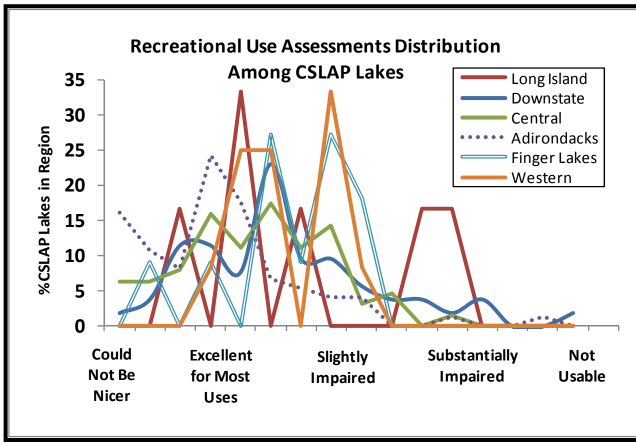
1. CSLAP lakes within the Downstate region have slightly less favorable recreational assessments than those in most other regions of the state, consistent with the lower productivity and nuisance weed growth, and more favorable water quality assessments in these lakes.
2. The recreational assessments of CSLAP lakes cannot be compared to those from lakes evaluated in other monitoring programs, since the assessment tools used in CSLAP have not been used in other programs for a long enough duration.
3. Recreational assessments in CSLAP lakes in the Downstate region are less favorable during dry years.
4. Recreational assessments have become less favorable in recent years in Downstate region lakes, based on the decreasing frequency of more favorable assessments and increasing frequency of less favorable assessments.
5. Recreational assessments are favorable in some of the Downstate region lakes, with the least favorable recreational assessments in the interior portion of the region, and the most favorable assessments in the western portion of the region.
6. It is likely that changes in recreational assessments in 2009 and in the long-term exhibited by the lakes within the Downstate region are within the normal range of variability for these lakes.

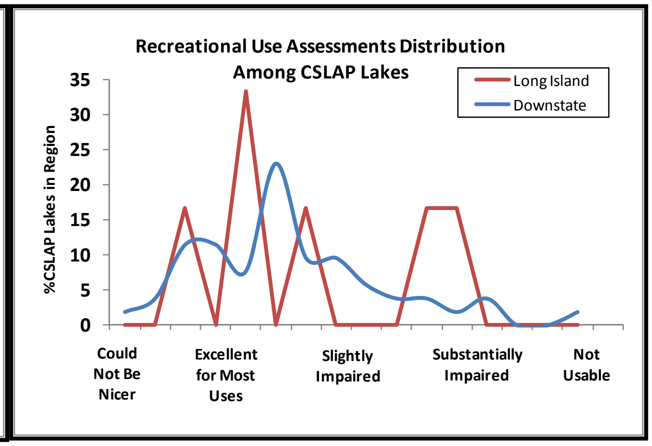
Downstate Region Data Compared to NYS Data

Recreational use assessments in CSLAP lakes in the Downstate region are more favorable than those in the Western region, but less favorable than in the Adirondack or Central region lakes. This is consistent with lower water clarity readings, higher algae levels, and occasional problems with invasive weeds. The majority of the lakes in this region can most frequency be described as “excellent” to “slightly impaired” for most recreational uses. The few instances of “substantially” impaired conditions are more likely to be associated with poor water clarity or excessive algae than with excessive weeds, with very few lakes in the region suffering from both excessive algae and weeds.

Comparison of CSLAP to NYS Lakes in the Downstate Region

Although recreational perception surveys are included within a few monitoring programs, including the state’s ambient lake monitoring program (the Lake Classification and Inventory Survey, LCI), the number of lakes throughout the state with recreational perception data is still small. Therefore it is not possible to compare CSLAP data regarding the extent of recreational use impacts to data collected through other monitoring programs.





Figures 6.3.1 and 6.3.2: Distribution of Recreational Perception in CSLAP and Downstate Region Lakes

Annual Variability:

Recreational use assessments are somewhat variable and generally favorable within most Downstate region lakes. The most favorable recreational use assessments recorded through CSLAP occurred during 1995, 1996, 1998, 2002, and 1997, a mix of wet and dry years. The least favorable recreational assessments occurred in 1992, 2005, and 2000, neither very wet nor very dry years. Table 6.3.1 looks at the percentage of CSLAP lakes with less favorable recreational perception (greater than 1 standard error above normal) and more favorable recreational perceptions (greater than 1 standard error below normal) in wet and dry years. These data show that less favorable recreational assessments are associated with dry years.

Table 6.3.1- % of CSLAP Lakes with More or Less (than Normal) Favorable Recreational Perception During Dry and Wet Years in the Downstate Region

	Dry Years	Wet Years
More Favorable Recreational Perception	13%	20%
Less Favorable Recreational Perception	28%	21%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 1999, 2003, 2006
"More" and "Less" Coverage defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

The evaluation of long-term trends since 1986 in any region, including the lakes within the Downstate region, is adversely affected by the small number of lakes sampled during some sampling seasons, particularly in the earliest years of CSLAP (from 1986 to 1990). Since 1992, the frequency of more favorable recreational assessments has decreased and the frequency of less favorable assessments has increased. This is in contrast to the lower frequency of both more favorable and less favorable water quality assessments and aquatic plant coverage in recent years. However, it should be noted that none of these trends are statistically significant.

Regional Distribution:

Recreational assessments within the Downstate region are most favorable in the western portion of the region, and least favorable in the highly productive lakes in the interior of the region, in Westchester and Putnam Counties (Figure 6.3.3). The least favorable assessments are associated with both nuisance algae and nuisance weeds.

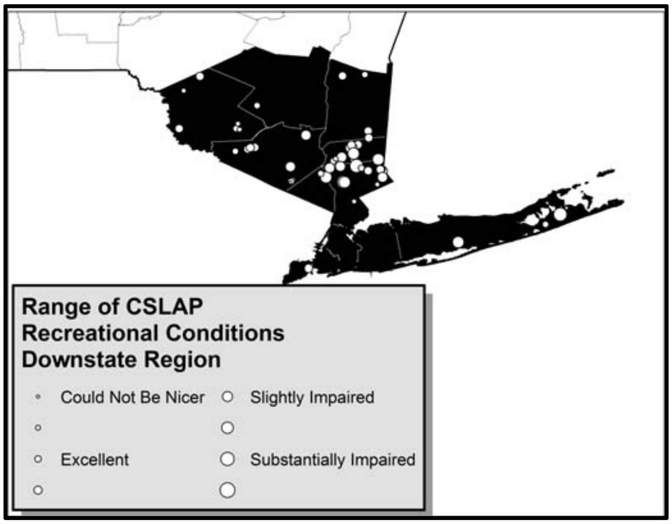
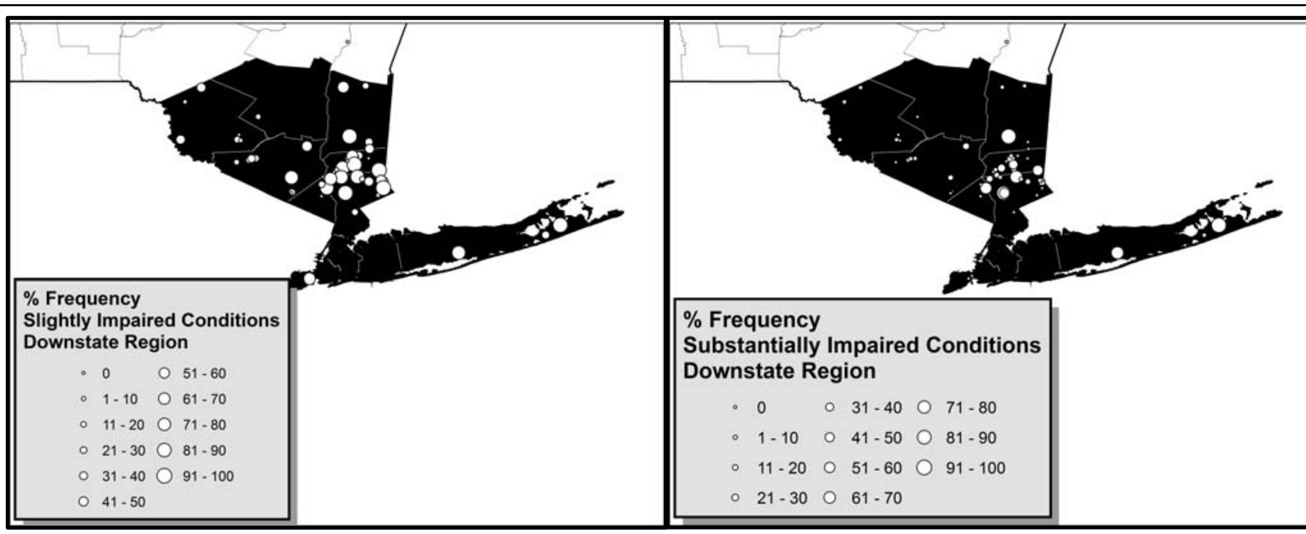


Figure 6.3.3: Range of Recreational Perception in the Downstate Region

Figures 6.3.4 and 6.3.5 show the distribution of "slightly impaired" and "substantially" impaired conditions in the Downstate region. As expected from the data presented in Figure 6.3.3, slightly impaired conditions are most common in the most highly productive lakes in the interior portion of the region. Substantially impaired conditions are commonly found in Westchester and Putnam Counties, and in Long Island. These impacts are associated with excessive algae in some lakes, excessive weeds in other lakes, and both stressors in a small number of lakes. The specific stressor- algae, weeds, or other stressors- do not follow clear geographic patterns, although all of the lakes impaired by excessive algae also have low water clarity and high nutrient levels.

Table 6.3.2 shows the number of sampling sessions with recreational use assessments, the minimum (most favorable), average, and maximum (least favorable) recreational conditions in the entirety of the CSLAP dataset (since 1992) and in 2009, the frequency with which "slightly" and "substantially" impaired conditions are observed in each region, whether impaired conditions are associated with excessive algae and poor water clarity, excessive weeds, or both, and whether these assessments have changed since CSLAP sampling began in the lake.



Figures 6.3.4 and 6.3.5: Frequency of Slightly and Substantially Impaired Conditions in the Downstate Region

Table 6.3.2: Recreational Use Perception in CSLAP Downstate Region Lakes, 1992-2009

Lake Name	Years	Num	Min	Avg	Max	% Slightly Impaired	%Highly Impaired	%Impaired By Algae	%Impaired By Weeds	%Impaired Algae/Weeds	Change?
Anawanda Lake	1988-2009	98	1	1.5	4	8	3	2	0	0	No
Anawanda Lake	2009	8	1	1.5	2	0	0	0	0	0	No
Blue Heron Lake	2005-2008	24	1	1.5	3	4	0	0	0	0	
Cranberry Lake	2004-2004	7	1	1.5	3	25	0	0	13	0	
Gossamans Pond	2003-2005	21	2	2.5	3	50	0	32	18	14	
Highland Lake	2003-2009	25	1	2.4	4	33	7	22	0	0	No
Highland Lake	2009	5	2	2.0	2	0	0	0	0	0	No
Hillside Lake	1994-1997	5	5	5.0	5	100	100	100	100	100	
Indian Lake	1994-2009	65	1	1.4	4	6	1	4	1	0	No
Indian Lake	2009	8	1	1.3	2	0	0	0	0	0	No
Katonah Lake	2006-2009	30	1	2.6	4	47	13	43	10	10	
Katonah Lake	2009	7	2	2.4	3	43	0	29	0	0	No
Lake Celeste	1993-1997	25	1	1.8	2	0	0	0	0	0	Improving
Lake Guymard	1996-2003	44	1	1.9	3	15	0	13	0	0	No
Lake Kitchawan	2008-2008	1	3	3.0	3	100	0	0	100	0	
Lake Lincolndale	1993-2009	106	1	2.7	4	56	15	45	11	5	No
Lake Lincolndale	2009	5	2	2.5	3	50	0	50	0	0	No
Lake Mahopac	1986-2002	16	1	2.3	4	42	11	11	32	11	Improving
Lake Meahagh	1999-2001	9	2	3.6	4	89	67	89	11	11	
Lake Mohegan	1998-2009	78	1	2.9	5	82	9	72	3	2	No
Lake Mohegan	2009	8	3	3.0	3	100	0	100	0	0	No
Lake Nimham	1991-1995	32	1	2.3	3	38	0	22	19	13	
Lake Oscaleta	2006-2009	32	1	2.5	4	42	6	9	36	6	
Lake Oscaleta	2009	8	1	2.1	4	11	11	0	0	0	No
Lake Oscawana	1991-1995	27	2	3.2	4	89	33	44	48	22	
Lake Ossi	1996-2000	32	2	3.5	5	94	47	53	63	41	No
Lake Peekskill	1990-2009	74	1	2.5	4	44	16	22	9	1	No
Lake Peekskill	2009	7	2	3.1	4	86	29	57	14	14	Less favorable
Lake Rippowam	2006-2009	31	1	1.9	4	12	6	3	6	0	
Lake Rippowam	2009	8	1	2.1	4	11	11	0	0	0	No
Lake Tibet	1991-1993	10	2	3.3	4	90	40	20	80	20	
Lake Truesdale	1999-2009	84	1	2.8	4	59	23	45	10	6	No
Lake Truesdale	2009	8	2	2.8	4	63	13	63	13	13	No
Lake Waccabuc	1986-2009	38	1	1.9	4	15	3	8	5	3	No
Lake Waccabuc	2009	8	1	2.1	4	13	13	0	0	0	No
Lake Wanaksink	1991-1995	25	1	1.5	2	0	0	0	0	0	
Little We Wah Lake	2008-2009	15	1	1.8	3	20	0	20	0	0	
Little We Wah Lake	2009	8	1	1.4	3	14	0	14	0	0	More favorable
Monhagen Lake	2003-2009	24	2	2.3	4	22	4	19	0	0	No
Monhagen Lake	2009	5	2	2.0	2	0	0	0	0	0	No
Orange Lake	1994-2005	49	2	2.8	4	54	21	40	12	4	No
Peach Lake	1999-2008	64	2	3.5	5	97	53	81	77	73	No
Plum Brook Lake	2005-2008	30	1	2.1	4	17	10	3	0	0	
Roaring Brook Lake	2009-2009	8	1	1.8	3	13	0	25	13	13	
Roaring Brook Lake	2009	8	1	1.8	3	13	0	25	13	13	No
Round Lake	1992-1996	34	2	3.0	4	82	15	44	56	24	No
Sagamore Lake	1994-1997	32	1	2.6	4	63	6	0	53	0	
Sepasco Lake	1997-2009	80	2	2.7	4	64	1	26	44	19	No
Sepasco Lake	2009	7	2	2.9	3	86	0	29	29	0	No
Shadow Lake	2008-2009	12	3	4.1	5	100	75	58	92	58	
Shadow Lake	2009	5	4	4.8	5	100	100	60	100	60	No
Shawangunk Lake	2003-2009	21	2	2.3	4	21	4	17	0	0	No
Shawangunk Lake	2009	5	2	2.0	2	0	0	0	0	0	No
Shenorock Lake	2004-2009	45	1	3.9	5	81	75	60	17	13	No

Lake Name	Years	Num	Min	Avg	Max	% Slightly Impaired	%Highly Impaired	%Impaired By Algae	%Impaired By Weeds	%Impaired Algae/Weeds	Change?
Shenorock Lake	2009	8	2	3.6	5	75	63	50	63	50	No
Stissing Lake	2007-2009	17	1	1.7	4	18	6	0	18	0	
Stissing Lake	2009	8	1	1.2	2	0	0	0	0	0	More favorable
Teatown Lake	1997-2009	80	2	4.0	5	98	84	49	81	47	No
Teatown Lake	2009	5	4	4.8	5	100	100	60	100	60	No
Timber Lake (Sullivan)	2004-2008	28	1	2.4	4	43	10	10	0	0	
Timber Lake (Westchester)	2006-2009	16	1	2.4	3	44	0	31	0	0	
Timber Lake	2009	8	1	2.3	3	38	0	13	0	0	No
Tomkins Lake	2001-2001	8	1	2.0	3	25	0	0	0	0	
Tuxedo Lake	2008-2009	15	1	1.1	2	0	0	0	0	0	
Tuxedo Lake	2009	8	1	1.1	2	0	0	0	0	0	No
Ulster Heights Lake	2007-2009	13	1	2.3	5	23	8	0	15	0	
Ulster Heights Lake	2009	4	1	2.7	5	33	33	0	0	0	No
Wallace Pond	2004-2008	27	2	3.1	5	74	30	48	33	22	Improving
We Wah Lake	2008-2009	16	1	1.7	4	13	6	6	0	0	
We Wah Lake	2009	8	1	1.5	4	13	13	13	0	0	No
Weiden Pond	2004-2009	37	1	2.3	4	43	3	5	22	0	No
Weiden Pond	2009	5	1	1.4	2	0	0	0	0	0	More favorable
Whaley Lake	1998-2001	31	2	2.3	3	31	0	19	19	13	
Wolf Lake	1987-2001	28	1	2.2	5	30	7	0	0	0	No
Yankee Lake	2006-2009	29	1	1.5	4	6	3	0	0	0	
Yankee Lake	2009	7	1	2.0	4	14	14	0	0	0	Less favorable
Black Pond	2008-2009	13	1	2.1	3	31	0	31	0	0	
Black Pond	2009	8	1	2.3	3	38	0	38	0	0	No
Bradys Pond	1997-2001	32	2	2.6	3	65	0	50	3	0	No
Canaan Lake	1990-2005	59	1	3.7	5	89	76	0	77	0	No
Lily Pond	2008-2009	12	3	3.9	4	100	92	58	100	58	
Lily Pond	2009	8	3	3.9	4	100	88	50	100	50	No
Little Fresh Pond	1989-2009	55	1	2.0	4	28	5	11	20	3	No
Little Fresh Pond	2009	8	1	1.3	2	0	0	0	0	0	More favorable
Little Long Pond	2006-2009	13	1	1.7	3	8	0	0	8	0	
Little Long Pond	2009	3	2	2.0	2	0	0	0	0	0	No

Num = number of samples
Min, Avg, Max = minimum, average, and maximum recreational perception rating (QC on the perception survey), integer values 1-5
% "Slightly Impaired" = percentage of sampling sessions in which response to question QC was 3, 4, or 5
% "Highly Impaired" = percentage of sampling sessions in which response to question QC was 4 or 5
% Impaired by Algae = percentage of sampling sessions in which "slightly impaired" conditions were attributed to "poor water clarity" or "excessive algae"
% Impaired by Weeds = percentage of sampling sessions in which "slightly impaired" conditions were attributed to "excessive weeds"
% Impaired by Algae/Weeds = percentage of sampling sessions in which "slightly impaired" conditions were attributed to "excessive algae" and "excessive weeds"
Change? = exhibiting significant change in QC readings (best fit line of annual means with $R^2 > 0.5$ and seasonal Kendall-Tau rank correlation coefficient > 0.5); 2009 change based on QC readings >25% higher or lower than normal

There are only a few lakes in this region exhibiting long-term change in recreational conditions. Lake Celeste, Lake Mahopac, and Wallace Pond exhibited improved recreational assessments over the duration of CSLAP sampling at the lake. All of these lakes exhibited decreasing coverage of aquatic plants—due to active management in the case of Lake Celeste and Lake Mahopac—and Lake Mahopac also exhibited improved water quality assessments. Neither Lake Celeste nor Lake Mahopac has been sampled through CSLAP in recent years; it is not known if these improved recreational assessments have continued into the present.

Tables 6.3.3a and 6.3.3b summarize the recreational perception data collected through CSLAP in 2009, and compare these data to the data collected for each program lake in the region prior to 2009. Recreational assessments in the CSLAP lakes in the Downstate region in 2009 were probably about favorable as those reported in previous years, at least as evaluated by average recreational assessments and frequency of improved (or degraded) conditions. A slightly higher percentage of Downstate region lakes in 2009 was reported as impaired by algae than were impaired by weeds, and a similar percentage of Downstate region lakes exhibited more favorable recreational assessments in 2009 (as exhibited less favorable assessments). There was also no clear change in water quality assessments in the majority of lakes in this region in 2009, although aquatic plant coverage may have been slightly lower. These findings suggest that lake perception, as defined by water quality assessments, aquatic plant coverage, or recreational assessments, were largely unchanged in 2009.

A slightly lower percentage of Downstate region lakes (about 35%, versus 46% from 1992 to 2008) exhibit "slightly impaired" conditions, and about 16% suffer "substantially impaired" conditions. More lakes in the region are impaired by excessive algae than by excessive weeds, and only a small percentage of lakes exhibit both excessive algae and weeds.

Table 6.3.3a: Recreational Use Perception Summary in CSLAP Lakes, 2009

	Number Lakes	Min	Average 2009	Average 1986-08	Max	%Frequency Slightly Impaired	% Frequency Substantially Impaired	% Impaired by Algae	% Impaired by Weeds	% Impaired Algae + Weeds
Downstate	32	1	2.3	2.5	5	35	16	21	14	8
Central	36	1	2.3	2.2	5	35	10	11	18	4
Adirondacks	33	1	1.8	2.0	4	16	2	5	9	2
Western	9	1	2.8	2.5	4	67	16	38	35	30
CSLAP Statewide	**110**	**1**	**2.2**	**2.2**	**5**	**32**	**10**	**14**	**15**	**6**

Table 6.3.3b: Recreational Use Perception Summary in CSLAP Lakes, 2009

	Number Lakes	Average 2009	Average 1986-08	%Less Favorable	%More Favorable	%Above Max	%Below Min
Downstate	32	2.3	2.5	9	9	59	64
Central	36	2.3	2.2	14	17	28	58
Adirondacks	34	1.8	2.0	9	35	26	65
Western	9	2.8	2.5	0	0	33	11
CSLAP Statewide	**110**	**2.2**	**2.2**	**10**	**19**	**36**	**58**

% Less Favorable = percentage of lakes in region with recreational assessments in 2009 >25% less favorable than normal (before 2009)
% More Favorable = percentage of lakes in region with recreational assessments in 2009 >25% more favorable than normal (before 2009)
% Above Max = percentage of lakes in region with any recreational assessments in 2009 less favorable than normal (before 2009)
% Below Min = percentage of lakes in region with any recreational assessments in 2009 more favorable than normal (before 2009)

Downstate Region Lakes With More Favorable Recreational Use Perception in 2009:
Little Fresh Pond, Little We Wah Lake, Stissing Lake, Weiden Pond

Discussion:

Four Downstate region lakes exhibited more favorable recreational assessments in 2009. The more favorable assessments in Little Fresh Pond, Little We Wah Lake, and Weiden Pond were associated with more favorable water quality assessments. It is not known why the recreational assessments in Stissing Pond were improved.

Downstate Region Lakes With Less Favorable Recreational Use Perception in 2009:
Lake Peekskill, Yankee Lake

Discussion:

Recreational use conditions in two Downstate region lakes were less favorable than normal in 2009. Neither Lake Peekskill nor Yankee Lake exhibited less favorable water quality assessments or more significant growth or coverage of aquatic plants. The volunteers at Lake Peekskill reported significant amounts of goose feces affecting recreational uses of the lake, and poor weather adversely affected recreational uses of Yankee Lake.

Chapter 7- Evaluation of Local Climate (Temperature) Change

Temperature Fact Sheet

Chapter 7.1- Evaluation of Statewide Air and Water Temperature

Chapter 7.2- Evaluation of Downstate Region Air and Water Temperature

Water and Air Temperature Fact Sheet

Description:	a measure of the thermal properties of a lake (and the primary influence on these properties) at the time of sampling. Given the relative stability of water temperature readings, the CSLAP water temperature reading is assumed to be representative of thermal conditions in the surface waters of the lake.
Importance:	biological productivity is enhanced by rising temperature, at least in the range found in most freshwater systems. Algae production generally increases as air and water temperatures increase, leading to higher oxygen demands when these algae die and are broken down by bacteria. In turn, as water temperatures increase, the amount of oxygen that can dissolve in water decreases, accelerating the biological stress on lake biota susceptible to low oxygen and high temperature conditions. Rising air and water temperatures are also a response to global climate change.
How Measured: in CSLAP	from 1986 to 1998, glass pocket thermocolor thermometers were used to measure air and water temperatures—thermocolor is a substance that becomes transparent when it exceeds a critical temperature. Since 1998, a dial bimetal pocket thermometer has been used
Detection Limit:	-40ºC to 50ºC (= -40ºF to 122ºF)
Range in CSLAP:	Air temperature: -10ºC to 40ºC (14ºF to 104ºF) Water temperature: 1ºC to 31ºC (34ºF to 88ºF)
WQ Standards:	none in New York State, although thermal discharges are regulated: "All thermal discharges to the waters of the State shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water"
Water Quality Assessment:	water temperatures are not included in the standard water quality assessments of New York state lakes.

Chapter 7- Evaluation of Local Climate (Temperature) Change

Chapter 7.1- Evaluation of Water and Air Temperature

Summary of CSLAP Water and Air Temperature Findings in New York State Lakes

1. Air and water temperature readings in lakes are a function of sample timing—time of day, month, and year—and cannot be easily compared from one lake to another absent comparable temporal patterns in sampling programs. Comparisons are possible within the CSLAP sampling framework
2. Annual variations in water temperature in CSLAP lakes were generally, but not universally, related to annual variations in air temperature.
3. Changes in temperatures were somewhat related to changes in precipitation, with lower temperatures occurring in wetter years and higher temperatures occurring in drier years.
4. **Since 1986, the frequency of higher than normal air and water temperatures has increased, and the frequency of lower than normal temperatures has decreased. This may be the strongest signal in the CSLAP dataset that global climate change has affected New York State lakes.**
5. Temperatures were highest in the Downstate region lakes, and lower in upstate waterbodies.
6. Water and air temperatures increase through late July to early August, and then decrease into the fall. The seasonal increase in deep lakes is greater than in shallow lakes, although by midsummer, the temperature of surface waters of most deep lakes are similar to those in shallow lakes, due to the influence of summer stratification (which effectively turns deep lakes into a shallow upper zone and deeper cold zone).
7. There does not appear to be a correlation between water quality classification and water temperatures.
8. Although increased algae growth may be triggered by warmer water, average chlorophyll *a* readings are not well correlated with average summer air or water temperatures.
9. As expected, there is a strong correlation between water temperature and air temperature.

Comparison of CSLAP to NYS Lakes:

The water temperature of CSLAP lakes cannot be easily compared to those in other New York State lakes, due to the significant differences in sample collection schedules. Most other New York State lake monitoring programs do not involve biweekly samples, so water temperature comparisons would require comparing a small subset of CSLAP lake samples to other NYS lakes sampled at the same time). However, given the similarity in the sampling schedules, CSLAP lakes can be compared to each other, and over time.

Annual Variability:

Air and water temperatures have varied annually in most CSLAP lakes. This annual variability can be evaluated by looking at the long-term change in frequency of temperatures readings above and below normal variability, as defined by standard error calculations. Based on these criteria, the highest air and water temperatures measured through CSLAP occurred during 2005, 2002, 1999, and 2001. These were neither dry nor wet years. The lowest temperatures occurred in 1986 and 1992. 1990, 1995, 2000, 2003 and 2004 were also cooler than normal, although these did not translate into cooler air temperatures. Likewise, 1998, 1987, 1989, and 1990 had cooler water temperatures without cooler air temperatures, at least as measured through CSLAP. Tables 7.1.1 and 7.1.2 look at the percentage of CSLAP lakes with high temperatures (greater than 1 standard error above normal) and low temperatures (greater than 1 standard error below normal) readings in wet and dry years. These data show that low temperature readings are more likely to occur in wetter years, although higher temperatures were not as common in drier years.

Table 7.1.1- % of CSLAP Lakes with Higher or Lower (than Normal) Air Temperature Readings During Dry and Wet Years

	Dry Years	Wet Years
Higher Air Temperature	29%	17%
Lower Air Temperature	26%	34%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Table 7.1.2- % of CSLAP Lakes with Higher or Lower (than Normal) Water Temperature Readings During Dry and Wet Years

	Dry Years	Wet Years
Higher Water Temperature	34%	13%
Lower Water Temperature	14%	30%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

Long-term trends cannot be evaluated simply by looking at changes in annual (or median) temperatures in CSLAP lakes, since the lakes sampled through CSLAP have changed from year to year. These data show that since 1986, the frequency of higher than normal temperatures has increased, and that the frequency of lower than normal temperatures has decreased. These data suggest that air temperatures are increasing in the period (generally June through September) evaluated through CSLAP, triggering an increase in water temperatures over the same period.

Statewide Distribution:

As expected, air temperatures were highest at the time of sampling in the Downstate region, as seen in Table 7.1.3. Likewise, Table 7.1.4 shows that water temperatures are highest in the same parts of the state. Air temperatures were lowest in the Adirondack and Western (Finger Lakes) region, and water temperatures were lowest in these regions and the western lakes. The slightly higher-than-expected water temperature readings in the Adirondack region may be due to the influence of shallow lakes (which generally have higher water temperatures, as shown below.

Table 7.1.3- Regional Summary of Air Temperature Readings for CSLAP Lakes, 1986-2009

	Number Lakes	Min	Avg	Max	%Increasing Significantly	%Decreasing Significantly
Downstate	60	1	23.5	38	4	2
Central	66	-3	21.8	40	12	6
Adirondacks	76	2	21.0	36	4	3
Western	27	-10	21.1	40	8	4
CSLAP Statewide	**229**	**-10**	**21.9**	**40**	**7**	**3**

Min, avg and max air temperature in ºC
% Increasing and Decreasing Significantly = % CSLAP lakes in region exhibiting significant change in air temperature readings (annual average linear regression $R^2 > 0.50$ and T tests results)

Table 7.1.4- Regional Summary of Water Temperature Readings for CSLAP Lakes, 1986-2009

	Number Lakes	Min	Avg	Max	%Increasing Significantly	%Decreasing Significantly
Downstate	60	1	22.9	33	4	2
Central	66	1	21.4	34	15	8
Adirondacks	76	1	20.4	30	3	8
Western	27	1	20.2	36	8	4
CSLAP Statewide	**229**	**1**	**21.3**	**36**	**7**	**6**

Min, avg and max water temperature in ºC
% Increasing and Decreasing Significantly = % CSLAP lakes in region exhibiting significant change in water temperature readings (annual average linear regression $R^2 > 0.50$ and T tests results)

Tables 7.1.3 and 7.1.4 also show the percentage of lakes in each region of the state exhibiting a long-term change in air and water temperatures. The overall percentage of lakes exhibiting change in air and water temperatures is low on a statewide basis and in most regions of the state. However, the temperature differences associated with global climate change over a 5-25 year period—less than 2ºC—is smaller than the variability within each sampling season and probably less than the criteria established here to indicate change. Therefore, these data might be need to be evaluated using different criteria (than used to evaluate changes in the other CSLAP water quality indicators) to assess change. A less rigid criterion—defining change based on simple linear regressions—is applied in Table 7.1.5. This suggests that lakes in the Downstate and Central regions are more likely to exhibit increasing water temperatures, while the changes in the other regions do not appear to be statistically significant (due to the small difference between percentages of increasing and decreasing lakes, or small number of lakes in the region).

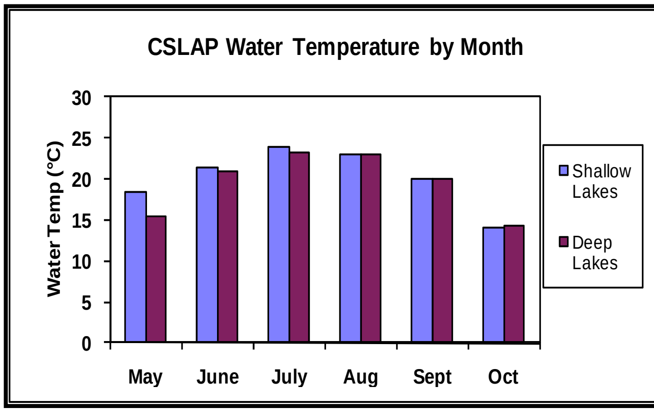
Table 7.1.5- Summary of Slight Changes in Water Temperature Readings for CSLAP Lakes

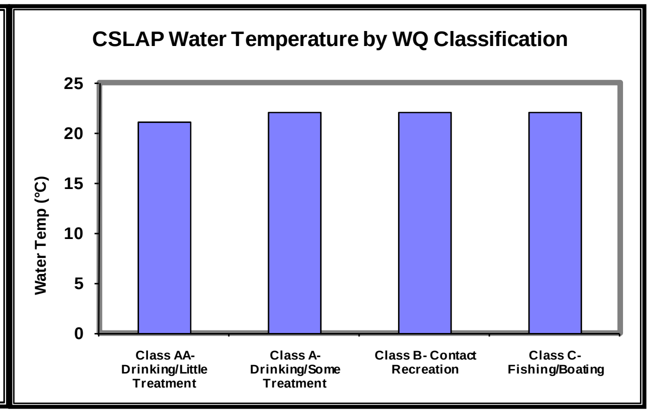
	Number Lakes	%Slightly Increasing Water Temp	%Slightly Decreasing Water Temp
Downstate	31	29	13
Central	57	23	12
Adirondacks	68	13	19
Western	21	15	25
CSLAP Statewide	**177**	**21**	**16**

% Change = % CSLAP lakes in region for which the change in mean water water temperature readings is statistically significant ($R^2 > 0.50$)

Seasonal Variability:

Water temperatures, as expected, are slightly higher in shallow lakes, since they possess a smaller volume of water to gain heat (Figure 7.1.1). The temperature of both deep and shallow lakes increase through late summer, peaking in late July or early August, and then decrease into the fall. By August, the temperature difference between deep and shallow lakes appears to disappear. This may be due to the stable thermocline in late summer, when temperature differences between the upper and lower layers of the lake become most pronounced. In effect, the upper layers of deeper lakes, where these temperature measurements are collected, act as shallow lakes distinct from the bottom waters. Recreational suitability in both deep and shallow lakes, at least as related to temperatures, cease in mid fall, corresponding (and in response) to colder air temperatures, effectively ending the (contact) recreational season.





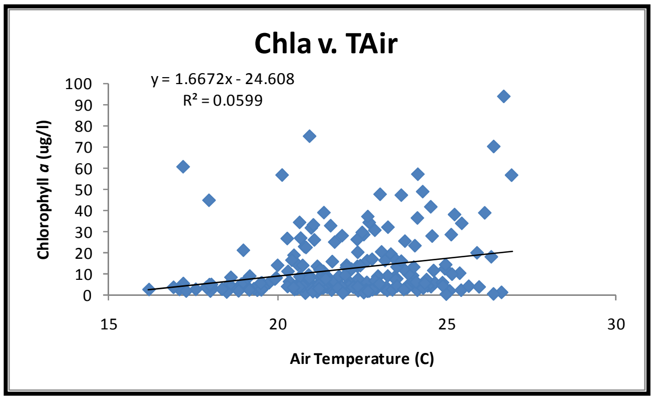
Figures 7.1.1 and 7.1.2: Water Temperature Readings by Month and Water Quality Classification

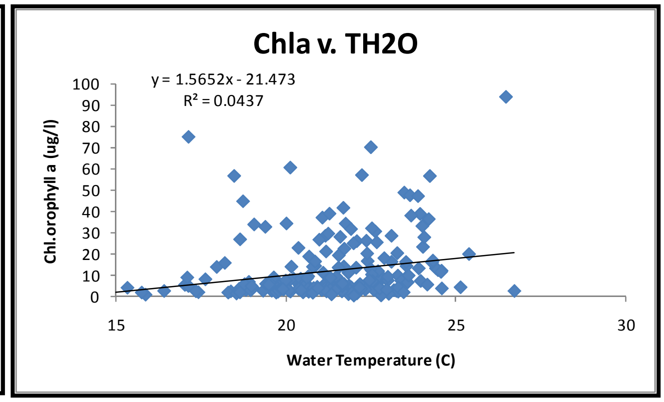
Lake-Use Variability:

Lakes in each of the classes of lake use—potable water, contact recreation, and non-contact recreation—do not exhibit differences in water temperature. This is to be expected, and the small differences in lakes from one classification to the next are more likely to be due to differences in lake depth or geography. This relationship is seen in Figure 7.1.2.

Relationship with Other Water Quality Indicators:

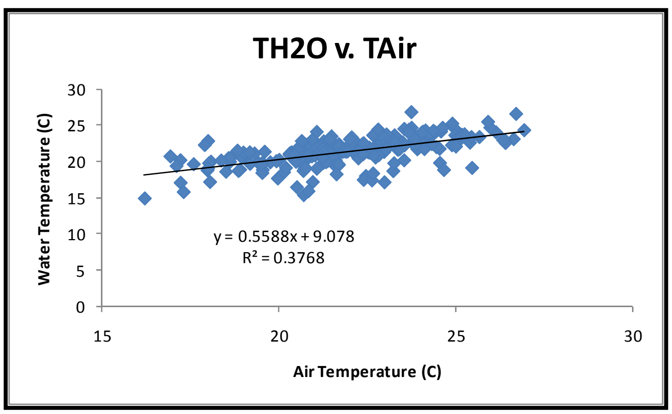
Water temperature may influence several water quality indicators. As discussed above, the maximum dissolved oxygen concentration in lakes is strongly influenced by water temperature—the maximum D.O. saturation in lakes, assuming no influence of photosynthesis, is more than 11 parts per million at 10ºC (at sea level) and less than 8 parts per million at 30ºC. However, in the typical range of summer water temperatures seen in New York state lakes, none of the CSLAP water quality indicators are strongly influenced by water temperature. For example, Figures 7.1.3 and 7.1.4 show that chlorophyll *a* readings are not strongly affected by lake average water temperatures, although for any given lake, algal productivity will increase if water temperatures increase.





Figures 7.1.3 and 7.1.4: Relationship Between Chlorophyll *a* and Air and Water Temperature

Figure 7.1.5 shows the stronger relationship between average air temperature and average water temperature in CSLAP lakes. The lakes experiencing the highest average air temperature—as seen in Table 7.1.1, these corresponds to the lakes in the southern part of the state—also exhibit the highest water temperatures. If local climate variations, as part of a global climate change, result in increases in air temperature, Figure 7.1.5 suggests that this will also lead to increasing water temperature readings.



Figures 7.1.5: Relationship Between Air and Water Temperature in CSLAP Lakes

Chapter 7.2- Evaluation of Downstate Region Water Temperature: 1986-2009

Summary of CSLAP Water Temperature Findings in Downstate Region Lakes, 1986-2009

1. Annual variations in water temperature in CSLAP lakes in the Downstate region were generally related to annual variations in air temperature.
2. Changes in temperatures were related to changes in precipitation, with lower temperatures occurring in wetter years and higher temperatures occurring in drier years. This pattern is slightly less apparent in Downstate region lakes than from a statewide perspective, although this may reflect the closer geographic connection between a single weather assessment (rainy or dry) in a regional setting than at a statewide scale.
3. **Since 1986, the frequency of higher than normal air and water temperatures has increased, and the frequency of lower than normal temperatures has decreased. This may be the strongest signal in the CSLAP dataset that global climate change has affected Downstate region lakes, although these trends are not statistically strong.**
4. Consistent with the lack of statistical rigor in the statewide trends assessment, changes in water temperature have not been strongly apparent in individual lakes, and a slightly larger percentage of lakes have exhibited a decrease in water temperatures than have exhibited an increase in these readings over the duration of CSLAP sampling at that lake.

Annual Variability:

Water temperatures have varied annually in most CSLAP lakes. This annual variability can be evaluated by looking at the long-term change in frequency of temperatures readings above and below normal variability, as defined by standard error calculations. Based on these criteria, the highest water temperatures measured through CSLAP occurred during 2002, 1988, 1999, and 1987, mostly consistent with statewide observations. These consisted of neither unusually dry nor wet years. The lowest temperatures occurred in 1986, 2000, 2004, and 1996, mostly wet years. Table 6.2.1 looks at the percentage of CSLAP lakes with high temperatures (greater than 1 standard error above normal) and low temperatures (greater than 1 standard error below normal) readings in wet and dry years. These data show that low temperature readings are more likely to occur in wetter years, and higher temperatures were found in drier years. This mirrored the statewide patterns identified in Table 6.1.1.

Table 6.2.1- % of CSLAP Lakes with Higher or Lower (than Normal) Water Temperature Readings in Downstate Region Lakes During Dry and Wet Years

	Dry Years	Wet Years
Higher Water Temperature	28%	12%
Lower Water Temperature	23%	26%

Dry Years: 1995, 2001
Wet Years: 1986, 1996, 2003, 2006
"Higher" and "Lower" defined as >1 SE higher than and lower than normal, respectively

Long Term Trends:

Long-term trends cannot be evaluated simply by looking at changes in annual (or median) temperatures in CSLAP lakes, since the lakes sampled through CSLAP have changed from year to year. Since 1986, the frequency of higher than normal temperatures has increased, although the frequency of lower than normal temperatures has only decreased slightly. These data suggest that air temperatures are increasing in the period (generally June through September) evaluated through CSLAP, triggering an increase in water temperatures over the same period.

Regional Distribution:

Table 6.2.2 shows the long-term and 2009 water temperature readings in CSLAP lakes in the Downstate region. The vast majority of these lakes have not exhibited any clear long-term trends, despite data indicating that the frequency of higher water temperatures has increased over the last 25 years.

Two Downstate region lakes (Lake Mahopac, Wolf Lake) in the region have exhibited increasing water temperature readings over the period of their participation in CSLAP; neither of these lakes was sampled through CSLAP in 2009. It is not known if the rise in water temperature readings in these lakes has persisted or represents local climate change or normal variability.

Only one Downstate region lake has exhibited decreasing water temperatures—Peach Lake was not sampled in 2009, and it is not known if these small changes are associated with a trend or normal variability.

Long-term changes in climate may be occurring in the Downstate region, as manifested in an increasing frequency of higher than normal water temperatures and a decreasing frequency of lower than normal temperatures. However, these trends are not (yet) statistically robust, and are not readily apparent when inspecting the temperature data from individual lakes. Continued evaluation of these data may provide some additional insights about the impact of larger scale climate change on the water temperatures in New York State lakes, and whether any local changes have triggered any significant biological changes in these lakes.

Table 6.2.2- Regional Summary of Water Temperature Readings for Downstate Region Lakes, 1986-2009

Lake Name	Years	Num	Min	Avg	Max	Change?
Anawanda Lake	1988-2009	144	6	21	27	No
Anawanda Lake	2009	8	17	20	24	No
Blue Heron Lake	2005-2008	24	13	24	29	No
Cranberry Lake	2004-2004	7	18	23	26	No
Gossamans Pond	2003-2005	22	16	21	25	No
Highland Lake	2003-2009	31	16	23	28	No
Highland Lake	2009	5	20	22	24	No
Hillside Lake	1994-1997	13	15	22	26	No
Indian Lake	1994-2009	72	16	23	28	No
Indian Lake	2009	8	20	25	28	No
Katonah Lake	2006-2009	31	14	24	30	No
Katonah Lake	2009	7	14	23	27	No
Lake Carmel	1986-1990	51	13	24	30	No
Lake Celeste	1993-1997	26	14	23	29	No

Lake Name	Years	Num	Min	Avg	Max	Change?
Lake Guymard	1996-2003	46	1	20	29	No
Lake Kitchawan	2008-2008	1	22	22	22	No
Lake Lincolndale	1993-2009	109	10	24	29	No
Lake Lincolndale	2009	5	24	25	29	No
Lake Lucille	1986-1990	55	11	19	25	No
Lake Mahopac	1986-2002	71	14	23	31	Increasing
Lake Meahagh	1999-2001	10	23	26	31	No
Lake Mohegan	1998-2009	80	13	24	29	No
Lake Mohegan	2009	8	13	22	26	No
Lake Nimham	1991-1995	41	13	23	29	No
Lake Oscaleta	2006-2009	35	13	24	31	No
Lake Oscaleta	2009	8	13	22	27	No
Lake Oscawana	1991-1995	37	10	21	27	No
Lake Ossi	1996-2000	36	13	23	31	No
Lake Peekskill	1990-2009	93	12	24	30	No
Lake Peekskill	2009	7	13	22	27	No
Lake Rippowam	2006-2009	34	13	24	30	No
Lake Rippowam	2009	8	13	24	30	No
Lake Tibet	1991-1993	23	9	20	27	No
Lake Truesdale	1999-2009	85	17	24	31	No
Lake Truesdale	2009	8	20	24	28	No
Lake Waccabuc	1986-2009	107	13	24	30	No
Lake Waccabuc	2009	8	13	24	30	No
Lake Wanaksink	1991-1995	39	12	21	25	No
Little We Wah Lake	2008-2009	16	14	24	31	No
Little We Wah Lake	2009	8	23	27	31	No
Monhagen Lake	2003-2009	30	16	23	27	No
Monhagen Lake	2009	5	20	22	24	No
Orange Lake	1994-2005	51	15	23	30	No
Peach Lake	1999-2008	69	15	24	29	Decreasing
Plum Brook Lake	2005-2008	30	18	25	29	No
Roaring Brook Lake	2009-2009	8	12	21	26	No
Roaring Brook Lake	2009	8	12	21	26	No
Round Lake	1992-1996	40	14	22	28	No
Sagamore Lake	1994-1997	32	13	22	28	No
Sepasco Lake	1997-2009	89	2	22	31	No
Sepasco Lake	2009	7	21	26	30	No
Shadow Lake	2008-2009	12	16	24	30	No
Shadow Lake	2009	5	16	23	27	No
Shawangunk Lake	2003-2009	29	16	23	28	No
Shawangunk Lake	2009	5	20	22	24	No
Shenorock Lake	2004-2009	45	16	23	27	No
Shenorock Lake	2009	8	19	22	27	No
Stissing Lake	2007-2009	24	18	24	29	No
Stissing Lake	2009	8	18	24	29	No
Teatown Lake	1997-2009	82	2	23	30	No
Teatown Lake	2009	5	17	24	28	No
Timber Lake	2004-2008	28	17	25	29	No
Timber Lake	2006-2009	16	19	24	28	No
Timber Lake	2009	8	19	24	27	No
Tomkins Lake	2001-2001	8	19	25	28	No
Tuxedo Lake	2008-2009	16	15	25	31	No
Tuxedo Lake	2009	8	24	27	31	No
Ulster Heights Lake	2007-2009	14	10	22	28	No
Ulster Heights Lake	2009	4	10	17	23	No
Wallace Pond	2004-2008	29	18	24	28	No

Lake Name	Years	Num	Min	Avg	Max	Change?
We Wah Lake	2008-2009	16	15	24	30	No
We Wah Lake	2009	8	21	26	30	No
Weiden Pond	2004-2009	38	5	21	30	No
Weiden Pond	2009	5	18	22	27	No
Whaley Lake	1998-2001	31	17	24	28	No
Wolf Lake	1987-2001	90	14	22	28	Increasing
Yankee Lake	2006-2009	29	15	22	32	No
Yankee Lake	2009	7	17	23	32	No
Black Pond	2008-2009	13	10	23	30	No
Black Pond	2009	8	19	24	30	No
Bradys Pond	1997-2001	33	2	19	28	No
Canaan Lake	1990-2005	79	6	18	25	No
Lily Pond	2008-2009	13	18	25	28	No
Lily Pond	2009	8	23	25	28	No
Little Fresh Pond	1989-2009	97	15	24	31	No
Little Fresh Pond	2009	8	18	24	28	No
Little Long Pond	2006-2009	14	22	27	31	No
Little Long Pond	2009	3	24	25	27	No

Minimum, average and maximum air temperature in ºC
% Change = % CSLAP lakes in region exhibiting significant change in air temperature readings (annual average linear regression $R^2 >$ 0.50 and T tests results)

Chapter 8- Evaluation of Impacts to Lake Usage

Chapter 8.7- Downstate Region Assessments

Chapter 8- Evaluation of Impacts to Lake Usage

Summary of Lake Usage Impacts in CSLAP Lakes

1. Lakes are assessed by the NYSDEC to determine whether they support the designated use for the lake—*potable water, contact recreation* (swimming and bathing), *non-contact recreation* (boating and angling), *aquatic life, aesthetics* and *fish consumption*.
2. These assessments lead to a characterization of use support as *precluded, impaired, stressed, threatened,* or *fully supporting*; the first two categories also meet the federal definition of *impaired* waters and lead to required management actions.
3. CSLAP data can contribute to these assessments, although the overall assessment should include all possible sources of data and information.
4. CSLAP data have only limited utility in evaluating potable water supplies, although data not yet available for review for the 2009 CSLAP report improve these assessments. **The assessment criteria for evaluating potable water conditions have not yet been finalized.** The **limited and preliminary** potable water assessments are discussed in the regional reports and the individual lake appendices and are derived from the chlorophyll *a* data.
5. Contact recreation is evaluated with the trophic indicators—water clarity, chlorophyll *a*, and total phosphorus. **The assessment criteria for evaluating contact recreation have also not yet been finalized. The limited and preliminary contact recreation assessments** are discussed in the regional reports and the individual lake appendices.
6. Non-contact recreational assessments are limited to evaluation of lakes with excessive weeds and/or exotic plants. These impacts are most significant in the Central region; the large number of threatened lakes in the Downstate and Adirondack regions is associated with both the large number of sampled lakes and the persistence of invasive plants.
7. Aquatic life assessments are derived from pH and inferred oxygen data, and are most significant in the Downstate and Central region, mostly due to oxygen deficits. Acidic lake conditions are uncommon in CSLAP lakes due to the small number of "developed" lakes with depressed pH, although elevated pH (and resulting threats to aquatic life) are more common in the Western (Finger Lakes) region.
8. Aesthetics impacts are limited to CSLAP volunteer reports that the "lake looks bad". These impacts are scattered throughout the state, but are generally associated with lakes with both nuisance algae and excessive weeds
9. Fish consumption is not evaluated through CSLAP.

Background on Lake Assessments

CSLAP is intended to be a long-term, standardized, trophic-based, water-quality monitoring program to facilitate comparison of water-quality data from season to season, year to year, and from lake to lake. The data and information collected through CSLAP can be utilized to identify water-quality problems, detect seasonal and long-term patterns, and educate sampling volunteers and lake residents about water-quality conditions and stressors at their lakes. It is particularly useful in evaluating the over-enrichment of aquatic plant (algae and rooted plant) communities in a lake, and the response of the lake to these trophic stressors.

Shorefront residents, lake managers, and government agencies are increasingly tasked to better assess and evaluate water-quality conditions and lake uses in NYS lakes, including those sampled through CSLAP, whether to address localized problems, meet water-quality standards, satisfy state and federal environmental reporting requirements, or enhance and balance a suite of lake uses. CSLAP data should be a part of this process, but only a part. For some lakes, particularly small lakes and ponds with limited public access by those who don't reside on the lake shore, CSLAP may be the sole source of data used to assess lake conditions. In addition, studies conducted through CSLAP find strong similarities between sampling sites in many, but not all, large lakes, and generally find a strong convergence of perceptions about lake and recreational use conditions within most lakes, based on a local familiarity with "normal" conditions and factors that might affect lake use. For the purpose of broad water-quality evaluations and understanding the connection between measured water-quality indicators and the support of broadly based recreational uses of the lake, CSLAP can be a singularly effective tool for standardizing the lake-assessment process. CSLAP volunteers, lake associations, and others engaged in lake assessment and management should continue to utilize CSLAP in this context.

However, for large, multi-use lakes, or those lakes that are threatened by pollutants not captured in eutrophication-based monitoring programs, CSLAP becomes a less effective primary tool for assessing lake condition and use impairments. For example, CSLAP data have only limited utility in evaluating the following:

(a) contamination from bacteria or other biological toxins, particularly related to the safety of water use for potable intake or swimming
(b) contamination from inorganic (e.g., metals) and organic (e.g., PCBs, DDT) compounds
(c) portions of a lake not well mixed with the "open water" or otherwise distant from the primary sampling site(s), including the shoreline, bottom sediment and isolated coves
(d) rooted aquatic plant impacts in areas of the lake not evaluated by the sampling volunteers
(e) diverging perceptions of recreational-use impacts, particularly in lakes with shorelines or isolated coves exhibiting conditions very different from those sampled or evaluated by the sampling volunteers
(f) impacts to fish or other fauna due to factors unrelated to eutrophication
(g) PWL or 303(d) listings for other pollutants or portions of the lake not sampled through CSLAP

For these waterbodies, CSLAP can and should continue to be part of an extensive database used to comprehensively evaluate the entirety of the lake and its uses, but absent a more complete dataset, CSLAP data should be used with caution as a sole means for evaluating the lake. Water-quality evaluations, recommended PWL listings, and other extrapolations of the data and analyses should be utilized in this context and by no means should be considered "the last word" on the lake.

Priority Waterbody List

The Priority Waterbody List (PWL) is an inventory of all waters in New York State (lakes, ponds, reservoirs, rivers, streams, and estuaries) known to have designated water uses with some degree of impairment, or those threatened by potential impairment. These designated uses include:

- *potable water*—drinking—for class AA or class A waterbodies
- *contact recreation*—swimming and bathing—for class B waterbodies
- *non-contact recreation*—boating and angling—for class C waterbodies
- *aquatic life*—for all classes of waterbodies
- *aesthetics*—for all classes of waterbodies
- *fish consumption*—for all classes of waterbodies

However, an overarching goal of the federal Clean Water Act is for the protection and propagation of fish, shellfish, and wildlife and recreation in and on all waterbodies, broadly characterized as making all waterbodies "swimmable (and) fishable." Therefore, any water quality criteria established for protecting swimming will apply to all waterbodies, unless explicitly precluded by natural conditions preventing swimming (or for water supply reservoirs on which contact recreational is restricted).

The PWL is a subset of the Waterbody Inventory, an inventory of all waterbodies in the state, which contains all available information on the condition and/or usability of the waterbody. PWL waterbodies are identified through a broad network of county and state agencies, with significant public outreach and input, and the list is maintained and compiled by the NYSDEC Division of Water. Monitoring data from a variety of sources, including CSLAP, have been utilized by state agencies to evaluate lakes for inclusion on the PWL, and the process for incorporating lakes data has become more standardized.

Specific numeric water quality criteria have been developed to characterize sampled lakes in the available use-based PWL categories. The following categories have been broadly defined as follows:

Precluded:	designated use cannot be conducted
Impaired:	designated use is strongly compromised but can still be conducted
Stressed:	designated use may be comprised during part of the summer or in part of the lake, but the designated use is still supported
Threatened:	designated use is supported but may become compromised by higher or more frequent occurrences of a pollutant
Fully Supporting: *(or No Uses Impaired)*	designated use is not compromised at any time or location

The latter category is a bridge to the equivalent federal (USEPA) assessment criteria, in which waterbodies are designated as *fully supporting, partially supporting* (the equivalent of the NYSDEC categories *threatened* or *stressed*), or *not supporting* designated uses.

Evaluations utilize the NYS phosphorus guidance value, water-quality standards, criteria utilized by other states, and the trophic ranges described earlier to supplement the other more antidotal inputs to these listings. The procedures by which waterbodies are evaluated are known as the Consolidated Assessment and Listing Methodology (CALM) process. This process is undertaken on an annual rotating basin, with waterbodies in several drainage basins evaluated each year. Each of the 17 drainage basins in the state is assessed within every 5 years. In general, waterbodies that violate pertinent water-quality standards at a frequency of greater than 25% are identified as *impaired* for the designated use intended to be protected by that standard, at a frequency of 10-25% are identified as *stressed*, and at a frequency of 0-10% are identified as *threatened*, although some evidence of use impairment (including through CSLAP lake-perception surveys) might also be required. Mean (average) phosphorus levels are evaluated against the state guidance value. Evidence of use prohibitions (via beach closures, etc.) is often required to identify a waterbody as *precluded*, while evidence of actual use restrictions or necessary management must accompany an *impaired* listing, at least for lakes evaluated in recent years.

Lakes that have been identified as *precluded* or *impaired* on the PWL are likely candidates for the federal 303(d) list, an "Impaired Waters" designation mandated by the federal Clean Water Act, under the federal designation of *not supporting* uses. Lakes on this list must be closely evaluated for the causes and sources of these problems. Remedial measures must be undertaken, under a defined schedule, to solve these water-quality problems. This entire evaluation and remediation process is known as the "TMDL" process, which refers to the Total Maximum Daily Load calculations necessary to determine how much (pollution that causes the water-quality problems) is too much.

Evaluation of Designated Uses in CSLAP Lakes

As noted above, the PWL assessment process involves a number of stakeholders and sources of information, from monitoring data to an inventory of management actions to recommendations and professional judgment from those familiar with each waterbody. The CSLAP dataset can play an important role in providing some of this assessment information, although it cannot be overemphasized that a comprehensive evaluation of these waterbodies should consider all sources of information. The following section of the report summarizes each of the designated uses in New York state lakes and a preliminary assessment of these uses in each CSLAP lake based solely on information collected through CSLAP (unless explicitly stated). These assessments should be considered preliminary in part because continued evolution of the program will provide better information and datasets to conduct this evaluation, in part because conditions change in these lakes, and in part because the dataset on many of these lakes is limited.

Comment on Preliminary Assessments-nutrient criteria development in New York state will likely not be completed until 2011. These numeric criteria for chlorophyll a, total phosphorus, and Secchi disk transparency data will identify conditions leading to impaired, stressed, and threatened conditions, and will be used to update the state Priority Waterbody List and federal Impaired Waters (303d) list. Until these criteria are established, any pertinent existing water quality standards, criteria, or guidance values will be used to identify use impairments.

Chapter 8.1- Evaluation of Impacts to Potable Water

The health and quality of potable surface waters can be influenced by a variety of factors. Most of these are not evaluated through CSLAP, a water quality monitoring program not intended to assess potable water supplies. However, some of the information collected through CSLAP has some utility in evaluating water quality conditions in lakes used for drinking water. The continuing evolution of the program involves collecting better information related to potable water quality, as demonstrated in the monitoring of harmful algal blooms and taste and odor compounds (iron and manganese) starting in 2009.

The CSLAP water quality indicators that can be used to assess potable water quality conditions include:

Assessment of Chlorophyll a Data

Discussion: High algae levels create a number of problems for surface water supplies, including additional treatment costs related to filtering and algae removal by copper compounds (or other algacides), reductions in dissolved oxygen concentrations from the bacterial breakdown of the organic remains of algal cells (leading to the production of taste and odor compounds and dangerous forms of some compounds, including hydrogen sulfide, ammonia, and arsenic), the production of algal toxins by some species of blue green algae, and the production of dangerous disinfection by-products (DBPs) that come from the chlorination of water with high organic content.

Evaluation Criteria: Research is on-going to evaluate the connection between excessive eutrophication and potable water impacts. It is anticipated that this research will lead to final assessment guidance criteria by 2011. Until this guidance works through public comment and the regulatory process, and promulgated into state water quality criteria, any evaluation is premature.

Availability: Extensive data; collected during every CSLAP sampling session

Assessment of Ammonia and Nitrite Data

Discussion: Ammonia and nitrite at high concentrations is toxic to both humans and aquatic life. The state water quality standard is 2 mg/l total ammonia and 1 mg/l nitrite. These levels are unlikely to be reached in the surface waters of most New York state waterbodies, at least those without direct wastewater inputs. However, deepwater ammonia and nitrite readings are elevated in some lakes with deepwater anoxia, due to the conversion of NO_x to ammonia or nitrite. This may adversely impact deepwater intakes in lakes serving as potable water supplies.

Evaluation Criteria: The depth of water intakes, and the extent of deepwater ammonia enrichment, is not readily available in New York state lakes. Absent this information, CSLAP lakes classified for potable water use (Class AA or Class A) are considered *threatened* if the state water quality standard for ammonia (= 2 mg/l) or nitrite (= 1 mg/l) is exceeded in more than 25% of the hypolimnetic samples, or if the average hypolimnetic ammonia or nitrite levels exceed 0.5 mg/l.

Availability: Limited data; only collected during some CSLAP sampling sessions in stratified CSLAP lakes in 2002 and in stratified potable water supplies in 2009. Nitrite data were only collected in 2009, and none of the results were close to the state standards.

Assessment of Algal Toxins Data

Discussion: Microcystin-LR is a toxin commonly produced by cyanobacteria (blue green algae), a form of algae commonly found in highly productive lakes. The World Health Organization (WHO) has recommended that microcystin-LR levels remain below 1 µg/l, based on their drinking water provisional guidelines to protect potable water supplies. The NYSDOH harmful algal bloom study on a number of CSLAP lakes is looking at microcystin-LR levels within blooms and in the open water of lakes.

Evaluation Criteria: The evaluation criteria for determining potable water impacts in CSLAP lakes as related to harmful algal blooms and the production of microcystin-LR has not yet been established. The most likely criteria will be to define any lake with microcystin-LR levels exceeding the WHO potable water criteria (= 1 µg/l) during more than 25% of the sampling sessions at the lake as *impaired*. Any lake violating this criterion at a frequency of 10-25% of the time will be identified as *stressed*, and any occurrence of microcystin-LR reading above this criterion will likely be identified as *threatened.*

Availability: HAB and microcysis-LR data were collected for the first time through CSLAP in 2009. Unfortunately, the data from the first year of studies on CSLAP lakes are not available at the time of this writing.

Assessment of Arsenic Data

Discussion: Arsenic is a carcinogenic metal found in low levels in many waterbodies, due to natural deposits in the earth or from agricultural and industrial practices. However, recent studies by the NYSDEC indicate that arsenic may migrate from bottom sediments and rise to dangerous levels in response to deepwater anoxia, particularly in lakes overlying arsenic-rich sediments, in a manner similar to anoxia-mediated changes in bottom phosphorus, ammonia, and arsenic lakes. This may adversely affect deep potable water intakes, and perhaps shallower intakes during and immediately after lake destratification.

Evaluation Criteria: There continues to be some debate about the most appropriate arsenic guidance needed to protect human health. The present maximum contamination limit (MCL), the highest level of a contaminant that is allowed in drinking water, is 10 μg/l. Evaluation criteria have not yet been established for evaluating CSLAP lakes. One possible criteria will be to define any lake with arsenic levels exceeding the MCL (= 10 μg/l) during more than 10% of the sampling sessions at the lake as *impaired*, any lake exceeding this MCL at any time will be identified as *stressed*, and lake with average arsenic levels at one half the MCL will likely be identified as *threatened.*

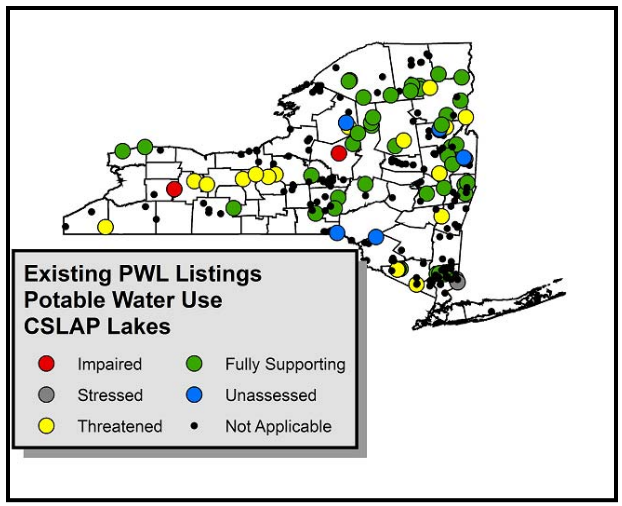


Figure 8.1- Existing PWL Potable Water Assessments in CSLAP Lakes

Availability: CSLAP data for arsenic were collected for the first time in 2009. Unfortunately, the data from the first year of studies on CSLAP lakes (2009) are not available at the time of this writing.

Summary of CSLAP Potable Water Assessment Data

Table 8.1 shows the existing statewide PWL summary of potable water assessments, and Figure 8.1 shows the statewide distribution of CSLAP lakes in relation to their PWL assessments for potable water supply. Some of the sampled lakes may have already been identified as impacted by some pollutant not measured through CSLAP, particularly bacteria, metals, or some organic compounds. As such, these data should only supplement the more extensive data collected by municipalities or other water purveyors for the purposes of assessing surface drinking water conditions as part of the PWL evaluation. However, it should be noted that PWL assessments are updated by basins (the 17 major drainage basins in the state) in approximately 5 year intervals. Assessments in some of these basins (and corresponding regions in Table 8.1) do not include recent CSLAP data, and CSLAP data related to potability have only been occasionally used in these assessments. An evaluation of the CSLAP data related to potable water impacts in these lakes is provided in the regional CSLAP reports.

The data from Table 8.1 suggest that potable water impacts are most frequently reported in the Downstate and Western (Finger Lakes) regions, consistent with the combination of a large number of Class AA and Class A lakes in this region. There are a few lakes in the Adirondack and Central regions reported to have potable water impacts, consistent with the larger number of CSLAP lakes classified for use as public water supplies in these regions.

A more detailed discussion of potable water impacts to individual CSLAP lakes is included in the regional CSLAP reports.

Table 8.1- Summary of Existing PWL Listings Based on Potable Water Impacts to CSLAP Lakes

Region	Number Lakes	Impaired	Stressed	Threatened	Fully Supporting	Not Applicable	Not Assessed
Downstate	57	0	1	3	5	48	3
Central	65	1	0	2	12	50	1
Adirondacks	75	0	0	6	23	46	1
Western	27	0	0	7	3	16	0
CSLAP Statewide	**224**	**2**	**1**	**18**	**43**	**160**	**5**

Chapter 8.2- Evaluation of Impacts to Contact Recreation

Swimming conditions are affected by a number of factors, some of which are evaluated through CSLAP. Some of these factors relate to swimming safety—the ability of swimmers to see bottom debris or lifeguards to see submerged swimmers, some relate to swimming health—the production of enough algae to greatly increase the likelihood of selecting for blue-green algae and the toxins they can produce, and other factors are related to aesthetic quality. The primary means for evaluating contact recreation—bacteria levels to assess whether swimming can be dangerous—cannot be evaluated through CSLAP, but the multiple "lines of evidence" evaluating these other factors provide useful information in identifying swimming and bathing impacts.

Assessment of Chlorophyll a Data

Discussion: Excessive algae leads to excessive greenness in the lake. As summarized in the "Evaluation of Eutrophication Indicators" section (Chapter 3), excessive algae greenness is strongly related to decreasing water clarity and in turn is triggered by increasing phosphorus concentrations in a lake. Moreover, there is a strong correlation between changes in these trophic indicators and recreational assessments, given the strong connection between measured and perceived water quality conditions. These data also show a strong depth and regional gradient in water quality and recreational assessments.

In addition, data collected by the NYSDEC and other researchers around the world suggest that elevated chlorophyll *a* readings increase the likelihood of the production of algal toxins, the frequency of unsafe swimming conditions (due to poor water clarity) and the frequency of intense algal blooms.

Evaluation Criteria: The NYS nutrient criteria development process is identifying the appropriate chlorophyll *a* readings necessary to protect recreational uses of lakes. "Reference conditions" (water quality conditions with minimal recreational use impacts) can be associated with lakes exhibiting less than 25% frequency of "slightly impaired conditions" in two distinct regional areas—the Adirondacks and rest of the state—and in deep (> 20 feet deep) and shallow lakes. The completion of the nutrient criteria development process will identify the chlorophyll *a* readings associated with *impaired* conditions. At present, there are no water quality standards, criteria, or guidance values associated with chlorophyll *a*.

Availability: Extensive data; collected during every CSLAP sampling session.

Assessment of Water Clarity Data

Discussion: Water clarity is strongly related to both recreational assessments and unsafe swimming conditions—the latter is associated with insufficient visibility for swimmers and lifeguards. These are discussed in the "Assessment of Chlorophyll *a* Data" above.

Evaluation Criteria: The background information for evaluating water clarity criteria to protect swimming quality in lakes is provided in the "Assessment of Chlorophyll *a* Data" section above. The completion of the nutrient criteria development process will identify the water clarity readings associated with *impaired* conditions. At present, the NYS Department of Health has established a guidance value of 1.2 meters (= 4 feet) for siting new swimming beaches, to allow swimmers to observe submerged debris and to allow lifeguards to view submerged swimmers. Lakes with water clarity readings failing to reach this criteria at a frequency of greater than 25% can, at present, be considered *impaired* for contact recreation. Lakes with water clarity readings below 1.2 meters at a frequency of 10-25% can be considered *stressed,* and lakes with any water clarity readings below this criterion can be considered *threatened.*

Availability: Extensive data; collected during every CSLAP sampling session.

Assessment of Total Phosphorus Data

Discussion: Total phosphorus is strongly related to both recreational assessments and unsafe swimming conditions, as the "stressor" that triggers these recreational use responses—high algae levels and low water clarity. These are discussed in the "Assessment of Chlorophyll *a* Data" above.

Evaluation Criteria: The background information for evaluating total phosphorus criteria to protect swimming quality in lakes is provided in the "Assessment of Chlorophyll *a* Data" section above. The completion of the nutrient criteria development process will identify the water clarity readings associated with *impaired* conditions. At present, the NYSDEC has established a guidance value of 0.020 mg/l (= 20 µg/l). Lakes with mean phosphorus readings exceeding this guidance value may be considered *impaired* for contact recreation. Lakes with phosphorus readings exceeding this criterion at a frequency of 25% can be considered *stressed,* and lakes with phosphorus readings exceeding this guidance value at a frequency of 10-25% can be considered *threatened***.**

Availability: Extensive data; collected during every CSLAP sampling session.

Assessment of Algal Toxins Data

Discussion: Microcystin-LR is a toxin commonly produced by cyanobacteria (blue green algae), a form of algae commonly found in highly productive lakes. The World Health Organization (WHO) has not yet established microcystin-LR levels above which recreational use impacts are likely to occur. The literature suggests that median chlorophyll a readings above 12 µg/l may be sufficient to render lakes unsafe for swimming during an unacceptable portion of the summer.

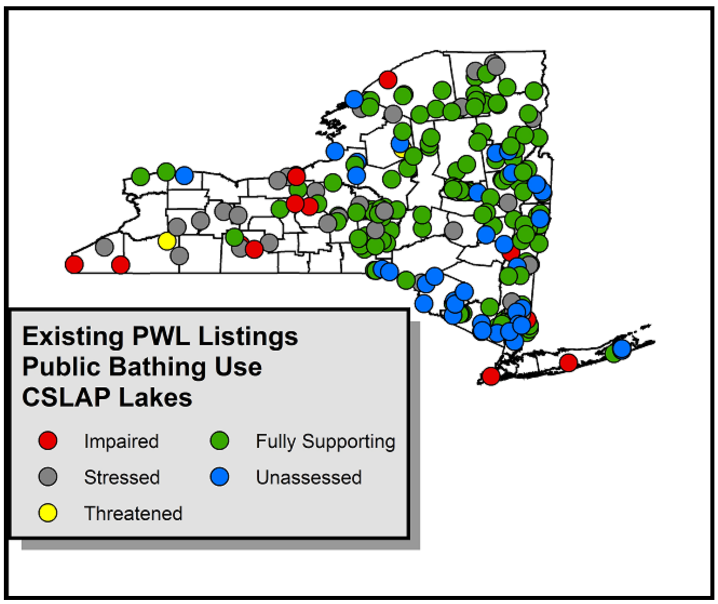


Figure 8.2- PWL "Public Bathing" Assessments in CSLAP Lakes

Evaluation Criteria: The evaluation criteria for determining contact recreational impacts in CSLAP lakes as related to harmful algal blooms and the production of microcystin-LR has not yet been established. It is anticipated that the NYSDOH harmful algal bloom study on a number of CSLAP lakes looking at microcystin-LR levels within blooms and in the open water of lakes will help to identify unacceptable microcystin-LR levels to protect swimming.

Availability: HAB and microcysis-LR data were collected for the first time through CSLAP in 2009. Unfortunately, the data from the first year of studies on CSLAP lakes are not available at the time of this writing.

Summary of CSLAP Contact Recreation Assessment Data

Table 8.2 shows the existing statewide PWL summary of contact recreational—swimming and bathing—assessments, and Figure 8.2 shows the statewide distribution of CSLAP lakes in relation to their PWL assessments for "public bathing". It should be noted that the existing PWL process identifies only those lakes with documented public health or safety impacts to swimming—such as elevated bacterial levels, unsafe water clarity, or wastewater discharges to the water—rather than aesthetic impacts. The latter category, including perceived poor conditions for swimming, and slightly (but persistently) elevated algae levels or reduced water clarity, is reflected in the PWL assessment of "recreation" cited in section 8.3. It is anticipated that, once nutrient criteria are finalized and adopted in New York state, "recreation" and "non-contact recreation" will be clearly distinguished within future generations of the PWL.

Some of the sampled lakes may have already been identified as impacted by some pollutant not measured through CSLAP. The most likely candidates for additional stressors of recreational uses in lakes are bacteria and nuisance weeds. The latter is assessed through CSLAP, but for the purposes of this assessment, it is assumed that recreational use impacts associated with nuisance weeds are associated with non-contact recreation rather than swimming or bathing. Although bacteria has been monitored on a number of CSLAP lakes, and will likely be included in future CSLAP reports (and has been discussed in previous reports), these data have not been consistently collected or reported to the NYSDEC.

The data from Table 8.2 suggest that the highest percentage of "public bathing" impacts are in the Western (Finger Lakes) region lakes, and the highest number of impacted lakes are in the Adirondack, Downstate and Central regions, the latter reflecting the larger number of CSLAP lakes sampled in these regions. The lowest percentage of lakes with impacted public bathing is in the Adirondacks, where the combination of high water clarity and low algae levels has resulted in fewer problems with poor swimming or bathing (notwithstanding the cold water during much of the summer).

However, it should be noted that PWL assessments are updated by basins (the 17 major drainage basins in the state) in approximately 5 year intervals. Assessments in some of these basins (and corresponding regions in Table 8.2) do not include recent CSLAP data, and CSLAP data related to potability have only been occasionally used in these assessments. An evaluation of the CSLAP data related to contact recreational impacts in these lakes is provided in the regional CSLAP reports.

Table 8.2- Summary of Existing PWL Listings Based on "Public Bathing" Impacts to CSLAP Lakes

Region	Number Lakes	Impacted	Stressed	Threatened	Fully Supporting	Unassessed
Downstate	43	4	3	5	31	17
Central	58	1	9	0	48	8
Adirondacks	69	1	8	1	59	7
Western	26	8	11	1	6	1
CSLAP Statewide	**196**	**14**	**31**	**7**	**144**	**33**

A more detailed discussion of swimming and bathing impacts to individual CSLAP lakes is included in the regional CSLAP reports and the individual lake appendices.

Chapter 8.3- Evaluation of Impacts to Non-Contact Recreation

Non-contact recreational conditions—boating and fishing—are strongly influenced by a number of factors not measured (or measurable) through CSLAP, from water depth and lake access to quantity and type of fish. Some of these factors, such as water quality effects on fish habitat, related to oxygen and pH, are discussed in the aquatic life section, and some of the factors contributing to CSLAP volunteers' assessments that "the lake looks bad" and discussed in the Aesthetics section are discussed below. However, the primary influence on boating and perhaps aesthetics is aquatic plant coverage and densities, and is discussed here.

Assessment of Aquatic Plant Coverage Data

Discussion: Boating and non-contact recreation, including fishing access, can be strongly influenced by the type and density of aquatic plants. Notwithstanding the plant survey and FQI information provided in the Biological Condition section (Chapter 6), the type of aquatic plants in many CSLAP lakes, or at least the type (species or invasiveness status) of the most dominant plants in the lake are not known. However, it is assumed that the presence of exotic submergent or floating leaf plant species—Eurasian watermilfoil, water chestnut, curly-leafed pondweed, etc.—represent at least a threat to non-contact recreation.

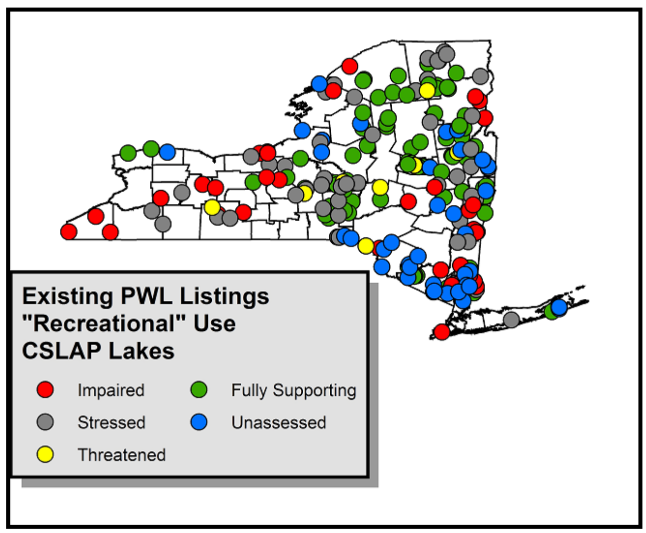


Figure 8.3- PWL "Recreation" Assessments in CSLAP Lakes

The more useful information comes from the CSLAP Field Observations form, which gauges volunteers' opinions about the extent of aquatic plant coverage and the impact of "excessive weeds" on recreational suitability. Matching recreational use impacts specifically to instances of excessive weed coverage (and limiting those matches to those times when volunteers explicitly cite "excessive weeds" as leading to poor recreational conditions) identifies the occurrence of non-contact recreational use impacts.

Evaluation Criteria: Standardized criteria have not been established for identifying non-contact recreational use impacts, but several approaches can be employed. These approaches must recognize that identifying lakes as *impaired* for boating and non-contact recreation may be problematic, since excessive weed growth is not necessarily associated with a known pollutant and therefore a management response may be limited to symptom management. This creates problems in matching New York state impairment assessments with federal criteria, as is often required, since the latter are usually linked to managing pollutant sources.

However, one such approach to assessing waterbodies used here is to identify lakes with "substantially impaired" conditions (response 4 on the recreational perception survey) at a frequency of > 25% as *impaired*, and lakes with "slightly impaired' conditions (response 3) at a frequency of > 25% as *stressed.* Lakes with "slightly impaired" conditions at a frequency of 10-25% or the presence of exotic plant species can be considered *threatened*.

Availability: Extensive data; collected during every CSLAP sampling session since 1992.

Summary of CSLAP Non-Contact Recreational Assessment Data

Table 8.3 shows the existing statewide PWL summary of "recreational" assessments—boating and swimming quality (as opposed to health), and Figure 8.3 shows the statewide distribution of CSLAP lakes in relation to their PWL assessments for "recreation." As discussed in Section 8.2, the existing PWL distinguishes between "public bathing", as measured by lake health, and "recreation", as measured by lake aesthetics. The latter includes both contact and non-contact recreation. It is anticipated that these will be clearly delineated in future generations of the PWL.

Additional information about some of these lakes regarding aquatic plant coverage or impacts to angling have been collected independent of CSLAP but are not included in this assessment. This information will likely appear in the PWL assessment for these waterbodies. The data in this table includes only the aquatic plant coverage collected through CSLAP and the invasive species inventory information identified in the Biological Condition section (Chapter 5). However, it is likely that future non-contact recreational assessments in CSLAP lakes will include information and assessments from outside sources.

The data from Table 8.3 suggest that non-contact recreational impacts are most likely in the Downstate and Central regions, although this also reflects the large number of CSLAP lakes sampled in these regions. A relative high percentage of contact recreational use impairments is found in all other regions of the state except the Adirondacks, although the increasing occurrence of exotic plant species in this region (though less so within the Adirondack Park itself) places a large number of lakes in the region in the *Threatened* category.

A more detailed discussion of non-contact recreational impacts to individual CSLAP lakes is included in the regional CSLAP reports and in the individual lake appendices.

Table 8.3- Summary of Existing PWL Listings Based on “ Recreation” Impacts to CSLAP Lakes

	Number Lakes	Impaired	Stressed	Threatened	Fully Supporting	Unassessed
Downstate	38	13	12	0	13	22
Central	58	8	21	4	25	8
Adirondacks	69	6	15	3	45	7
Western	24	13	8	1	2	3
CSLAP Statewide	**189**	**40**	**56**	**8**	**85**	**40**

Chapter 8.4- Evaluation of Impacts to Aquatic Life

CSLAP is not well designed for assessing the health of the aquatic life in lakes. Although there are some biological indicators measured or evaluated through CSLAP—chlorophyll *a* and macrophytes—these assessments are directed toward identifying thresholds for “too much” algae or weeds. Although excessive algae and macrophyte growth can strongly influence aquatic life, particularly if either is associated with invasive species, these are not strong measures of aquatic life. The Biological Condition section (Chapter 5) of this report also identifies some other potential indicators of aquatic life, and some of these are discussed below, but the primary means for evaluating impacts to aquatic life is the direct measure of pH and the indirect (inferred) measure of dissolved oxygen.

Assessment of pH Data

Discussion: pH strongly influences aquatic life. Much of the attention in New York state has been directed to low pH—acid rain may be the most extensive stressor in New York state lakes, affecting hundreds of small, poorly buffered, high elevation Adirondack lakes. Acidic lakes are not well represented in the CSLAP dataset, since the lake habitats most susceptible to lake acidification—poorly buffered watersheds at high elevation—do not accommodate development, since these thin soils cannot support septic leach fields and are often associated with steep slopes. The specific stressor in many of these lakes—elevated aluminum and mercury readings “magnified” in clear, acidic waters—can occur in developed areas, but few CSLAP lakes suffer from consistently depressed pH. High pH can also create problems, since some organisms are susceptible to elevated ammonia and scaling associated with highly alkaline waters. Although the state water quality standard for pH is 8.5 (see below), there is some uncertainty about whether ecological impacts occur at pH levels above this threshold.

Evaluation Criteria: New York state lakes do not meet the state water quality standards when pH is below 6.5 or above 8.5. The interpretation of these standards, which were largely developed to protect receiving waters, usually rivers and streams, from industrial and municipal discharges, is subject to interpretation. As discussed above, the assessment of most water quality standards complies with the “10-25” rule; *impaired* conditions are associated with exceeding the standard 25% of the time, and *stressed* conditions are defined as exceeding the standard 10% of the time. However, given the uncertainty associated with laboratory pH measurements and ecological impacts from high pH, the evaluation criteria may more appropriately define lakes as *impaired* by low pH if more than 50% of the pH readings fall below 6.5, and *stressed* by low or high pH if 25% of the pH readings fall below 6.5 or exceed 8.5, respectively. *Threatened* conditions are associated with pH failing to meet these standards at a frequency of 10-25% of the sampling sessions.

Availability: Extensive data; collected during every CSLAP sampling session.

Assessment of Dissolved Oxygen "Information"

Discussion: Dissolved oxygen is one of the bedrock water quality standards, although like pH, it is subject to interpretation. Low dissolved oxygen will adversely affect most aquatic organisms, with some fish, like salmonids (trout and salmon) most susceptible to depressed oxygen, particularly in combination with high temperatures. Although a few dissolved oxygen meters and dissolved oxygen test kits were provided for loan to some CSLAP lake associations in the early years of CSLAP, dissolved oxygen data are not available, at least through CSLAP, for the majority of CSLAP lakes (although the 25 Year CSLAP report will likely update this section to include all available oxygen profile data).

However, absent dissolved oxygen data, the absence of oxygen can be inferred from "observations" or a number of other CSLAP tests. *Anoxia*, or the absence of oxygen, often triggers the conversion of sulfate (SO_4) to hydrogen sulfide (H_2S), which impacts a rotten egg odor to the water. This can often be detected in hypolimnetic samples collected in mid to late summer, but this has not been collected in a systematic way in CSLAP lakes. The same *redox* (oxidizing-reducing) reactions that trigger the production of hydrogen sulfide can also result in phosphorus release from bottom sediments and the conversion of NO_x to ammonia. Elevated readings of hypolimnetic phosphorus and ammonia may be an indication of *hypoxic* (low oxygen) to anoxic conditions.

Evaluation Criteria: The New York state water quality standard for dissolved oxygen ranges from 7 parts per million (ppm) for trout spawning lakes to 6 ppm daily average or never to fall below 5 ppm for trout survival to never to fall below 4 ppm for non-trout waters. This has not been interpreted as a standard to be achieved at all times throughout the water column, since fish may not be naturally found in the deepest waters of some lakes. However, the interpretation of this standard continues to evolve, and New York state may ultimately invoke more precise standards and interpretation of these standards to protect aquatic life (and the 25 Year CSLAP report may provide both available dissolved oxygen data and updated assessments of aquatic life impacts). In the absence of these data in most CSLAP lakes, and in the absence of evidence of impaired aquatic life (which is not "measured" in most monitoring programs), lakes are classified here as *stressed* if there is evidence of hypolimnetic anoxia, defined here as hypolimnetic TP levels are more than 10x greater than those measured at the lake surface or hypolimnetic ammonia levels exceed surface readings by a factor of 25. *Threatened* conditions are equated to hypolimnetic hypoxia, with TP levels 5x higher than those at the lake surface and ammonia readings exceeding surface readings by a factor of 10.

Availability: Hypolimnetic phosphorus data collected periodically through CSLAP in thermally stratified lakes, and hypolimnetic ammonia collected in thermally stratified lakes in 2002 and 2009. Deepwater odors are periodically reported by CSLAP volunteers.

Assessment of Benthic Macroinvertebrates, Floristic Quality Indices (FQIs), and Zebra Mussels

Discussion: The 2008 and 2009 NYSDEC Biomonitoring study involved sampling in 8-10 randomly chosen (but equally distributed) benthic macroinvertebrate samples collected in 10-12 lakes each year, covering a variety of lake depths, geographic locations, and baseline nutrient conditions. This study is described in the Biological Condition section (Chapter 5). These data were collected primarily to establish the connection between lake eutrophication and changes in benthic communities. This process involves identifying a representative subgroup of benthic organisms in each sample and determining which organisms are most sensitive to variations in these conditions (nutrients, depth, latitude, etc.) and each other. Although the metrics established in this study to characterize biological sensitivity to nutrient inputs, other (multiple) metrics may also be identified to successfully characterize the overall biological community structure and health.

The Floristic Quality Indices (FQIs) discussed in Chapter 5 are a modified surrogate for the FQIs that New York state and several New England states are in the process of developing. One of the goals of establishing FQIs is to evaluate biological condition in lakes as they relate to the health of the floristic (aquatic plant) communities in lakes. Although FQI values have been evaluated as part of this report, continuing development of FQIs in New York state and the application of those FQIs to assessments of lake health will be needed before they can be used to provide a PWL recommendation for aquatic life support in these lakes.

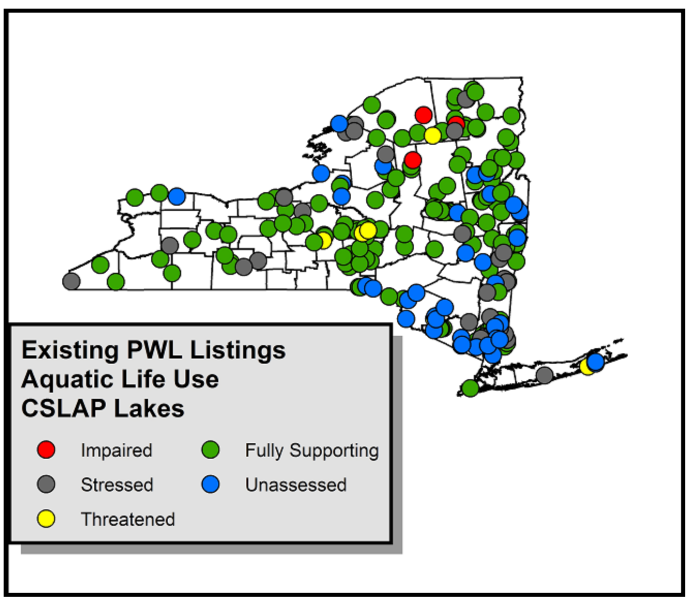


Figure 8.4- PWL Aquatic Life Assessments in CSLAP Lakes

Evaluation Criteria: The NYSDEC is in the process of evaluating the Biomonitoring Study data to establish multimetric indices to characterize biological health of a lake as defined by the benthic macroinvertebrate community. New York state, via the New York Nature Conservancy, will eventually establish FQIs that will be used to identify standard indicators of the biological health of a lake as defined by the aquatic plant community structure. At present, neither of these lake evaluation criteria is far enough along to summarize in this report.

Availability: not yet, but it is anticipated that at least preliminary assessments of biological health in CSLAP lakes will be discussed in the 2010 CSLAP annual report. .

Summary of CSLAP Aquatic Life Assessment Data

Table 8.4 shows the existing statewide PWL summary of aquatic life assessments, and Figure 8.4 shows the statewide distribution of CSLAP lakes in relation to their PWL assessments for aquatic life. Information in the Biological Condition section (Chapter 5) may also inform this discussion, and many lakes have information about impacts on lake fisheries due to other biological factors, such as plankton or spawning stress. As with most other sections of this report, it is likely that future aquatic life assessments in CSLAP lakes will include information and assessments from outside sources.

The data from Table 8.4 suggest that aquatic life impacts are most likely in the Downstate and Central regions. Most of the aquatic life impacts in this part of the state come from elevated hypolimnetic phosphorus and reduced oxygen levels, based on the CSLAP data, although these data largely did not inform these PWL listings.

A more detailed discussion of aquatic life impacts to individual CSLAP lakes is included in the regional CSLAP reports and individual lake appendices.

Table 8.4- Summary of Existing PWL Listings Based on Aquatic Life Impacts to CSLAP Lakes

	Number Lakes	Impaired	Stressed	Threatened	Fully Supporting	Unassessed
Downstate	38	0	15	2	21	22
Central	58	0	8	3	47	8
Adirondacks	69	3	7	1	58	7
Western	26	0	5	0	21	1
CSLAP Statewide	**191**	**3**	**35**	**6**	**147**	**38**

Chapter 8.5- Evaluation of Impacts to Aesthetics

Aesthetics are influenced by a large number of factors, several of which are measured through CSLAP. These include invasive weeds, whether growing up to the lake surface or forming surface canopies, and excessive algae growth, particularly when growing in bubbling mats on the lake surface. Aesthetics problems can be exacerbated when thick surface weeds serving as a platform for dense surface algal scums, and these conditions can lead to stagnant water, poor recreational conditions, and water quality problems. However, the CSLAP dataset cannot easily distinguish between these conditions and "excessive algae" or "excessive weeds." The CSLAP Field Observations form does provide an opportunity for sampling volunteers to evaluate aesthetic problems, and while these assessments clearly undercount incidences of unfavorable lake aesthetics, these can serve as the backdrop for evaluating aesthetics impacts.

Assessment of "Aesthetics" Data

Discussion: The CSLAP Field Observations form queries sampling volunteers about the recreational suitability of the lake during each sampling session (Question C), and the following questions asks the sampler to identify the factors that influence recreational assessments. One of the options is response 4, which allows the sampler to report that "the lake looks bad." Although other responses give the sampler the opportunity to identify problems with excessive algae or excessive weeds, the "…looks bad" option has a direct linkage to lake aesthetics and is the only one considered here.

Evaluation Criteria: It is assumed for the purposes of these evaluations that aesthetics cannot be *precluded* or *impaired*, at least independent of the other indicators previously discussed. Using the same approach described above, lakes are considered *stressed* for aesthetics if "slightly impaired" recreational use conditions are associated with reports that "the lake looks bad" during at least 25% of the CSLAP sampling sessions. *Threatened* conditions occur when "slightly" impaired recreational conditions are due to reports that "the lake looks bad" during at least 10% of the sampling sessions.

Availability: CSLAP volunteers have been asked to assess recreational conditions during each CSLAP sampling session since 1992, and "the lake looks bad" has consistently been an option for evaluating recreational use impacts.

Summary of CSLAP Aesthetics Assessment Data

Table 8.5 shows the existing statewide PWL summary of aesthetics assessments, and Figure 8.5 shows the statewide distribution of CSLAP lakes in relation to their PWL assessments for aesthetics. As discussed above, this does not necessarily include recreational impacts "presumed" to come from excessive algae or weeds, so actual impacts to lake aesthetics may be more significant in these lakes.

Figure 8.5 suggests that aesthetics impacts, as defined above, are not common in the state, although poor aesthetic conditions are no doubt more common in the state. For example, the sampling volunteers reporting that the lake "looks bad" are found at lakes scattered throughout the state, although nearly all of these lakes consistently exhibit problems with nuisance algae, and usually also exhibit problems with excessive weeds. It is likely that the statewide distribution of lakes with

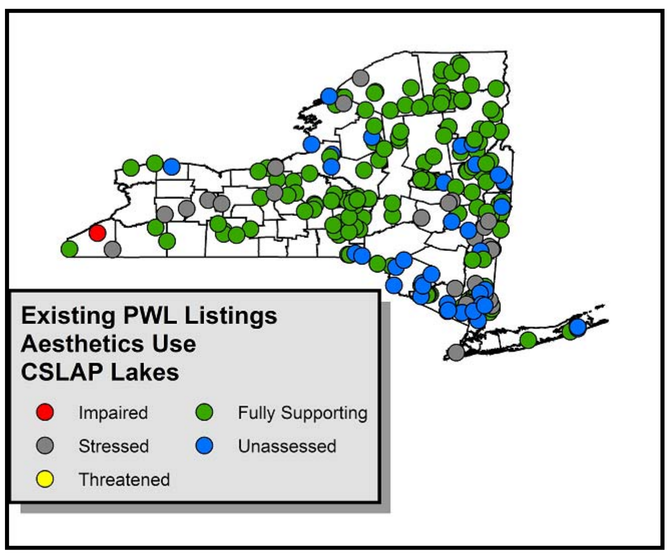


Figure 8.5- PWL Aesthetics Assessment in CSLAP Lakes

aesthetic impairments would look similar to the distribution of lakes with both contact recreational use impacts (Figure 8.2) and non-contact use impacts (Figure 8.3).

The data from Table 8.5 indicate a higher percentage of *stressed* lakes for aesthetics in the Downstate, Central and Western (Finger Lakes) regions, and a lower percentage of impacts in the Adirondacks regions. Although impacts to lakes aesthetics are no doubt underestimated in the existing PWL, the statewide distribution of impacted lakes is probably accurate.

A more detailed discussion of aesthetics impacts to individual CSLAP lakes is included in the regional CSLAP reports and individual lake summaries.

Table 8.5- Summary of Existing PWL Listings Based on Aesthetics Impacts to CSLAP Lakes

	Number Lakes	Impaired	Stressed	Threatened	Fully Supporting	Unassessed
Downstate	38	0	12	0	26	22
Central	58	0	8	0	50	8
Adirondacks	69	0	2	0	67	7
Western	26	1	7	0	18	1
CSLAP Statewide	**191**	**1**	**29**	**0**	**161**	**38**

Chapter 8.6- Summary of Fish Consumption Advisories

The lakes in New York state are used by many lake residents, anglers, and others for fish consumption. CSLAP does not collect any information to evaluate fish consumption. However, each year the NYS Department of Health issues fish consumption advisories for the waters (and fish) of the state. Several CSLAP lakes have been the subject of fish consumption advisories, usually due to the bioaccumulation of atmospheric pollutants such as mercury. Table 8.6a shows the regional summary of fish consumption advisories in CSLAP lakes. The distribution of CSLAP lakes with fish advisories suggests that these advisories are weighed heavily toward the Adirondack region. However, as seen in Table 8.6b, the statewide summary of fish consumption advisories for all New York state lakes shows that, while the largest number of advisories has been posted for Adirondack region lakes, the highest percentage of lakes with advisories is found in the Downstate (Long Island/NYC) region.

Table 8.6a- Summary of Fish Consumption Advisories in CSLAP Lakes

	Number Lakes	Precluded	Impaired	Stressed	Fully Supporting
Downstate	60	0	0	0	60
Central	66	1	1	0	64
Adirondacks	76	0	6	1	69
Western	27	0	2	4	21
CSLAP Statewide	**229**	**1**	**9**	**5**	**214**

Precluded = state advisory of "do not eat" one or more fish species in lake
Impaired = state advisory to "limit" consumption of one or more fish species in lake
Stressed = state advisories for Lake Ontario embayments for which migration from the main lake is likely
Fully Supporting = no state fish consumption advisories

Table 8.6b- Summary of Fish Consumption Advisories in New York State Lakes

	Number Lakes	Precluded	Impaired
Downstate	40	4	36
Central	28	4	24
Adirondacks	54	9	45
Western	13	2	11
Statewide	**135**	**19**	**116**

Precluded - state advisory = "do not eat" one or more fish species in lake
Impaired – state advisory = "limit" consumption of one or more fish species in lake

A more detailed discussion of fish consumption advisories to individual CSLAP lakes is included in the individual lake appendices.

Chapter 8.7- Downstate Region Assessments

Background

PWL assessments can be provided for the majority of Downstate region lakes for many of the designated lake uses in the region. A number of water quality indicators have been collected on some Class AA and Class A lakes in the region, including chlorophyll *a,* algal toxins, and deepwater ammonia, iron, manganese and arsenic. These data will eventually be used to improve the potable water and contact recreational assessments on these lakes, but for the purposes of this report, the trophic and hypolimnetic phosphorus and ammonia readings form the basis of preliminary CSLAP assessments. Some of these data are also used to evaluate aquatic life in the Downstate region.

Table 8.7 summarizes the existing PWL listings for potable water, public bathing (swimming), "recreation" (swimming and non-contact recreation), aquatic life, aesthetics and fish consumption advisories for each of the CSLAP lakes sampled in the Downstate region. The water quality findings from these assessments for each category of lake use are discussed below

Table 8.7- Summary of Existing PWL Listings for Downstate Region CSLAP Lakes

Lake Name	Potable Water PWL Listing	Public Bathing PWL Listing	Recreation PWL Listing	Aquatic Life PWL Listing	Aesthetics PWL Listing	Fish Consumption PWL Listing
Anawanda Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Blue Heron Lake	Not applicable	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Cranberry Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Gossamans Pond	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Highland Lake	Threatened	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Hillside Lake	Not applicable	Stressed	Impaired	Stressed	Stressed	Fully Supporting?
Indian Lake	Fully supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Katonah Lake	Not applicable	Fully Supporting	Stressed	Stressed	Fully Supporting	Fully Supporting?
Lake Carmel	Not applicable	Stressed	Impaired	Stressed	Stressed	Fully Supporting?
Lake Celeste	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Guymard	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Lake Kitchawan	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Lincolndale	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Lake Lucille	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?

Lake Name	Potable Water PWL Listing	Public Bathing PWL Listing	Recreation PWL Listing	Aquatic Life PWL Listing	Aesthetics PWL Listing	Fish Consumption PWL Listing
Lake Mahopac	Fully supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Meahagh	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Lake Mohegan	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Lake Nimham	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Lake Oscaleta	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Oscawana	Fully supporting	Impaired	Impaired	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Ossi	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Peekskill	Not applicable	Fully Supporting	Stressed	Stressed	Fully Supporting	Fully Supporting?
Lake Rippowam	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Tibet	Not applicable	Stressed	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Truesdale	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Lake Waccabuc	Fully supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Lake Wanaksink	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Little We Wah Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Monhagen Lake	Fully supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Orange Lake	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Peach Lake	Not applicable	Impaired	Impaired	Stressed	Stressed	Fully Supporting?
Plum Brook Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Roaring Brook Lake	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Round Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Sagamore Lake	Not applicable	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Sepasco Lake	Not applicable	Fully Supporting	Stressed	Stressed	Fully Supporting	Fully Supporting?
Shadow Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Shawangunk Lake	Threatened	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Shenorock Lake	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Stissing Lake	Not applicable	Fully Supporting	Stressed	Fully Supporting	Fully Supporting	Fully Supporting?
Teatown Lake	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
Timber Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Timber Lake	Unassessed	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Tomkins Lake	Not applicable	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Tuxedo Lake	Threatened	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Ulster Heights Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Wallace Pond	Not applicable	Fully Supporting	Impaired	Stressed	Stressed	Fully Supporting?
We Wah Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Weiden Pond	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Whaley Lake	Not applicable	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting?
Wolf Lake	Not applicable	Fully Supporting	Fully Supporting	Threatened	Fully Supporting	Fully Supporting?
Yankee Lake	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Black Pond	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Bradys Pond	Not applicable	Impaired	Impaired	Fully Supporting	Stressed	Fully Supporting?
Canaan Lake	Not applicable	Impaired	Stressed	Stressed	Fully Supporting	Fully Supporting?
Lily Pond	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?
Little Fresh Pond	Not applicable	Fully Supporting	Fully Supporting	Threatened	Fully Supporting	Fully Supporting?
Little Long Pond	Not applicable	Unassessed	Unassessed	Unassessed	Unassessed	Fully Supporting?

Chapter 8.7.1- Evaluation of Impacts to Potable Water in Downstate Region Lakes

8 of the 60 CSLAP lakes in the Downstate region are classified for potable water use (Class AA or Class A) and can be assigned a preliminary assessment for potable water impacts based on the limited CSLAP dataset. Most (about 75%) of these lakes may not be supportive of potable water use, as evaluated by the chlorophyll *a* and deepwater ammonia readings collected

through CSLAP. Those lakes identified as *potentially impacted* are found in the northern and western portion of the region, although there are other lakes in the region with higher algae levels or higher hypolimnetic ammonia levels not used for potable water. It is not known if these lakes have exhibited impacts from the production of disinfection-byproducts, algal toxins, or excessive turbidity, although this more detailed evaluation of potable water supplies may be available in the 2010 CSLAP report. It should again be emphasized that CSLAP does not focus on evaluation of drinking water assessments, and more extensive data (such as those collected in many of these lakes by municipal and private water purveyors and evaluated in local Consumer Confidence Reports, or CCRs) are needed for accurate evaluation of potable water uses in these lakes.

A discussion of the specific "citations" for impacts to potable water is provided below:

Preliminary Assessment- Potentially Impacted: Indian Lake, Lake Mahopac, Lake Oscawana, Lake Waccabuc, Monhagen Lake, Shawangunk Lake

Discussion: Each of these lakes exhibits chlorophyll *a* readings that may regularly be high enough to render the lake susceptible to taste and odor compounds or elevated DBP (disinfection by product) compounds that could affect the potability of the water, whether considering the long-term or 2009 CSLAP dataset (deepwater ammonia readings are elevated in Lake Waccabuc). It is not known if each of these lakes is used for drinking purposes, if these waters are chlorinated, and if DBPs (disinfection byproducts) are produced in the chlorination process. This information, if available, will help to determine if this is the appropriate PWL listing for the lake.

At present, potable water use in Shawangunk Lake and Tuxedo Lake is identified as *threatened* on the Lower Hudson (Raritan) River PWL.

Preliminary Assessment- Potentially Stressed: Highland Lake, Tuxedo Lake

Discussion: Each of these lakes has been identified here as *potentially stressed* due to average chlorophyll *a* readings that occasionally indicate elevated algae levels. Each of these lakes was sampled in 2009, and each of these lakes exhibited lower than normal chlorophyll *a* readings in 2009. This suggests that these lakes are not (presently) susceptible to potable water problems, although the historical CSLAP chlorophyll *a* data indicate that occasionally elevated algae levels can occur on these lakes. These lakes are scattered throughout the region.

At present, potable water use in Highland Lake is listed as *threatened* on the Lower Hudson River PWL.

Chapter 8.7.2- Evaluation of Impacts to Contact Recreation in Downstate Region Lakes

Each of the 60 CSLAP lakes in the Downstate region can be evaluated for their support of contact recreation—swimming and bathing. Although swimming and bathing are most accurately assessed with bacteria data, the CSLAP dataset provides useful information for evaluating the aesthetic quality and safety of contact recreation in these lakes. 19 of these 60 lakes (32%) in the Downstate region have been identified as fully supporting contact recreation, based on the CSLAP dataset.

A discussion of the specific "citations" for impacts to contact recreation is provided below:

Preliminary Assessment- Potentially Impacted: Black Pond, Bradys Pond, Gossamans Pond, Hillside Lake, Katonah Lake, Lake Carmel, Lake Celeste, Lake Lincolndale, Lake Lucille, Lake Meahagh, Lake Mohegan, Lake Tibet, Lake Truesdale, Little Fresh Pond, Orange Lake, Peach Lake, Plum Brook Lake, Shadow Lake, Shenorock Lake, Teatown Lake, Timber Lake (Sullivan), Timber Lake (Westchester), Wallace Pond

Discussion: The Downstate region lakes identified as *potentially impacted* for contact recreation include large and small lakes, nearly all shallow, located throughout the Downstate region. These lakes have all been identified as *potentially impacted* due to low water clarity readings and elevated total phosphorus and chlorophyll *a* readings. Unfavorable recreational assessments were linked to poor water clarity and excessive algae in Black Pond, Bradys Pond, Gossamans Pond, Hillside Lake, Katonah Lake, Lake Lincolndale, Lake Meahagh, Lake Mohegan, Lake Truesdale, Orange Lake, Peach Lake, Shadow Lake, Shenorock lake, Teatown Lake, Timber Lake (Westchester) and Wallace Pond.

Poor recreational assessments were linked to excessive weeds in Hillside Lake, Lake Tibet, Peach Lake, Shadow Lake, Shenorock Lake (in 2009), Teatown Lake, and Wallace Pond. Recreational uses were not reported as impacted in Lake Celeste, Plum Brook Lake, and Timber Lake (Sullivan), and recreational uses were not evaluated in Lake Carmel and Lake Lucille.

Black Pond, Katonah Lake, Lake Lincolndale, Lake Mohegan, Lake Truesdale, Little Fresh Pond, Shadow Lake, Shenorock Lake, Teatown Lake, and Timber Lake (Westchester) were sampled through CSLAP in 2009. In each of these lakes except Little Fresh Pond, the sampling volunteers again reported recreational use conditions typical of *impaired* lakes, despite some variability from normal water quality conditions and variable aquatic plant coverage. Despite productive conditions in the lake in 2009, the sampling volunteers at Little Fresh Pond did not report recreational use impairments.

Bradys Pond, Hillside Lake, Lake Carmel, Lake Lincolndale, Lake Meahagh, Lake Mohegan, Lake Shenorock, Lake Truesdale, Orange Lake, Peach Lake, Teatown Lake, and Wallace Pond are presently cited on the federal 303d list as *impaired* for contact recreation due to excessive algae and nutrients. In addition, Canaan Lake and Lake Oscawana are also cited on the federal 303d list as *impaired* for contact recreation due to excessive algae and nutrients. None of the other lakes listed above as *potentially impacted* are presently cited on the federal 303d list as *impaired*.

Preliminary Assessment- Potentially Stressed: Canaan Lake, Highland Lake, Lake Kitchawan, Lake Peekskill, Lake Rippowam, Lily Pond, Little We Wah Lake, Monhagen Lake, Ulster Heights Lake, We Wah Lake, Weiden Pond

Discussion: The Downstate region lakes cited here as *potentially stressed* indicate a potential problem with two of the three trophic indicators —Lake Peekskill and Little We Wah Lake exhibited sufficiently high water clarity criteria, Lake Rippowam and We Wah Lake exhibited relatively low total phosphorus readings, and Canaan Lake, Highland Lake, Lake Kitchawan, Lily Pond, Monhagen Lake, Ulster Heights Lake, and Weiden Pond have relatively low algae levels. Highland Lake, Lake Peekskill and Lily Pond exhibited recreational use impairments associated with excessive algae or poor water clarity, and Lake Kitchawan, Lily Pond and Weiden Pond exhibited recreational use problems due to excessive weeds (though not in Weiden Pond in 2009).

Highland Lake, Lake Peekskill, Lake Rippowam, Lily Pond, Little We Wah Lake, Monhagen Lake, Ulster Heights Lake, We Wah Lake, and Weiden Pond were sampled in 2009; the 2009 data suggest that the *stressed* assessment may be appropriate for Lake Peekskill, Ulster Heights Lake, We Wah Lake, and Weiden Pond.

Preliminary Assessment- Potentially Threatened: Lake Oscawana, Lake Ossi, Round Lake, Shawangunk Lake, Wolf Lake

Discussion- The five Downstate region lakes cited here as *threatened* exhibited "problems" with one of the trophic criteria. Low water clarity readings have been measured in Lake Ossi. Chlorophyll *a* readings have been elevated in Lake Oscawana, Round Lake, and Wolf Lake, and total phosphorus readings in Shawangunk Lake exceeded the state phosphorus guidance value.

Shawangunk Lake was sampled in 2009. These data indicated that each of the trophic indicators (water clarity, chlorophyll *a*, and total phosphorus) indicated water quality problems in 2009, suggesting *impaired* conditions, but the long-term data for the lake indicate that the lake is best classified as *threatened* for contact recreation.

Chapter 8.7.3- Evaluation of Impacts to Non-Contact Recreation in Downstate Region Lakes

59 of the 60 CSLAP lakes in the Downstate region can be evaluated for their support of non-contact recreation—including boating and angling. The CSLAP perception surveys query sampling volunteers about recreational conditions related to a variety of lake stressors, including water clarity, algae, and aquatic plants. 17 of these 59 lakes (29%) in the Downstate region have been identified as fully supporting contact recreation, based on the CSLAP dataset. This percentage is similar to the "compliance" for the other lake uses, in part due to the "automatic" designation of *threatened* for any lake with one or more exotic plants, even if there is no evidence that this lake has (yet) suffered from recreational use impacts.

A discussion of the specific "citations" for impacts to non-contact recreation is provided below:

Preliminary Assessment-Potentially Impaired: Black Pond, Bradys Pond, Hillside Lake, Lake Ossi, Lake Tibet, Peach Lake, Shadow Lake, Teatown Lake

Discussion: All of the Downstate region lakes identified as *impaired* for non-contact recreation based on CSLAP data are cited due to excessive weeds triggering "substantially impaired" recreational conditions during more than 25% of the CSLAP sampling sessions. *Myriophyllum spicatum* (Eurasian watermilfoil) has been identified on Lake Tibet and Peach Lake, and it is presumed that this exotic plant causes the excessive weed growth in these lakes. It is not known if the "offending" plant(s) on the other lakes are native or exotic—all of the others are very shallow and may exhibit extensive growth of native plants.

Black Pond, Shadow Lake, and Teatown Lake were the only lakes in this group sampled through CSLAP in 2009. The aquatic plant coverage in these lakes was significant enough to warrant these assessments in 2009, consistent with historical data from the lake.

Preliminary Assessment- Potentially Stressed: Lake Kitchawan, Lake Mahopac, Lake Oscaleta, Lake Oscawana, Round Lake, Sagamore Lake, Sepasco Lake, Wallace Pond

Discussion: The eight Downstate region lakes cited here as *stressed* typically report "slightly impaired" recreational conditions as a result of excessive weeds during at least 25% of the CSLAP sampling sessions. Lake Mahopac, Lake Oscawana, Round Lake and Sepasco Lake are (or were) dominated by Eurasian watermilfoil; it is not known if curly leafed pondweed is the dominant plant in Lake Kitchawan, Lake Oscaleta, and Wallace Pond. The plant community in Sagamore Lake has not been reported, at least through CSLAP.

The invasive plant communities in Lake Mahopac and Sepasco Lake have been active managed by the lake associations. Lake Mahopac has used grass carp to control Eurasian watermilfoil, and Sepasco Lake has stocked herbivorous insects and has used aquatic herbicides (fluridone and triclopyr) to control invasive plant growth in the lake. It is not known if the other lakes have been actively managed.

Lake Oscaleta and Sepasco Lake were sampled in 2009. Plant coverage was less than normal in both lakes (probably due to the 2009 triclopyr treatment in Sepasco Lake).

Preliminary Assessment-Potentially Threatened: Cranberry Lake, Gossamans Pond, Highland Lake, Indian Lake, Lake Carmel, Lake Celeste, Lake Guymard, Lake Lincolndale, Lake Meahagh, Lake Mohegan, Lake Nimham, Lake Rippowam, Lake Truesdale, Lake Waccabuc, Little Fresh Pond, Orange Lake, Roaring Brook Lake, Shawangunk Lake, Shenorock Lake, Stissing Lake, Ulster Heights Lake, Weiden Pond, Whaley Lake

Discussion- Many Downstate region lakes are cited here as *threatened.* These lakes can be divided into two overlapping categories—those with "slightly impaired" recreation due to excessive weeds at a frequency of 10-25%, and those with a documented presence of one or more exotic plant species.

Each of the former group—the lakes with slightly impaired recreation due to excessive weeds—include Cranberry Lake, Gossamans Pond, Lake Lincolndale, Lake Meahagh, Lake Nimham, Lake Truesdale, Little Fresh Pond, Orange Lake, Roaring Brook Lake, Shenorock Lake, Stissing Lake, Ulster Heights Lake, Weiden Pond, and Whaley Lake—has exotic plants, except for Shenorock Lake and Weiden Pond. It is not known if Shenorock Lake possesses any exotic plants—aquatic plant surveys have not been conducted through CSLAP on the lake—and plant surveys on Weiden Pond have not identified any exotic plants.

The second group—lakes identified as *threatened* due to the presence of exotic plants—include Cranberry Lake, Gossamans Pond, Highland Lake, Indian Lake, Lake Carmel, Lake Celeste, Lake Guymard, Lake Lincolndale, Lake Meahagh, Lake Mohegan, Lake Nimham, Lake Rippowam, Lake Truesdale, Lake Waccabuc, Little Fresh Pond, Orange Lake, Roaring Brook Lake, Shawangunk Lake, Stissing Lake, Ulster Heights Lake, Whaley Lake, and Wolf Lake. Eurasian watermilfoil is found in Gossamans Pond, Lake Carmel, Lake Lincolndale, Lake Rippowam, Orange Lake, Stissing Lake, Whaley Lake and probably Lake Meahagh and Ulster Heights Lake (*Myriophyllum* was identified in the ALSC study of these lakes in 1987).

Fanwort (*Cabomba caroliniana)* is found in Cranberry Lake, Little Fresh Pond and Roaring Brook Lake. Brazilian elodea (*Egeria densa*) is found in Lake Guymard and Lake Waccabuc. Water chestnut (*Trapa natans*) is found in Ballston Lake, Kinderhook Lake, Nassau Lake, Saratoga Lake, and Sleepy Hollow Lake; brittle naiad (*Najas minor*) is found in Lake Nimham, and curly leaf pondweed (*Potamogeton crispus*) is found in Lake Celeste, Lake Mohegan, Lake Truesdale, Lake Waccabuc, Roaring Brook Lake, Stissing Lake. Purple loosestrife (*Lythrum salicaria*) has been reported in Highland Lake and Shawangunk Lake through the ALSC project. Some of these plants, such as brittle naiad, have not been found to grow explosively in some New York state lakes, and explosive growth of other plants, such as curly leafed pondweed, is limited to spring or early summer. But the presence of exotic plants in each of these lakes may trigger recreational use impacts in at least part of the lake during part of the summer recreational season.

Chapter 8.7.4- Evaluation of Impacts to Aquatic Life in Downstate Region Lakes

Each of the 60 CSLAP lakes in the Downstate region can be evaluated for their support of aquatic life. As discussed earlier in this report, the CSLAP dataset provides only limited utility in evaluating aquatic life in CSLAP lakes, although the development of and collection of additional data for applying macroinvertebrate metrics and the continued development of a floristic quality index will improve these assessments. The existing pH and inferred D.O. dataset can be used to assess aquatic life in the CSLAP lakes. 29 of these 60 lakes (48%) in the

Downstate region have been identified as fully supporting aquatic life, based on the CSLAP dataset, a similar percentage to that seen in some of the other regions.

A discussion of the specific “citations” for impacts to aquatic life is provided below:

Preliminary Assessment- Potentially Impaired: none

Discussion: None of the Downstate region CSLAP lakes exhibited pH readings significantly (or frequently) below the state water quality standards, and thus none of these lakes has been identified as *impaired* for aquatic life.

Preliminary Assessment- Potentially Stressed: Black Pond, Lake Carmel, Lake Kitchawan, Lake Meahagh, Lake Oscaleta, Lake Peekskill, Lake Waccabuc, Little Fresh Pond, Peach Lake, Sepasco Lake, Tomkins Lake, Tuxedo Lake, Wolf Lake

Discussion: 13 Downstate region lakes are cited here as *stressed* for aquatic life. Lake Carmel, Lake Kitchawan, Lake Meahagh, Peach Lake and Tomkins Lake exhibited pH readings above the state water quality standards at a frequency of greater than 25%. It is not known if actual aquatic life impacts are apparent; CSLAP dos not collect sufficient biological data in most lakes to evaluate these impacts. Black Pond, Little Fresh Pond, and Wolf Lake exhibit pH readings below the state standards at a frequency of greater than 25%, rendering the lake susceptible to aquatic life impacts.

Lake Oscaleta, Lake Peekskill, Lake Waccabuc, Sepasco Lake, and Tuxedo Lake demonstrate evidence of low oxygen, based on hypolimnetic phosphorus or hypolimnetic ammonia readings that are significantly higher than those measured at the lake surface. It is not known if any of these lakes has exhibited actual aquatic life impacts, or simply pH or dissolved oxygen conditions that might lead to stressed conditions for aquatic life (particularly salmonids or other fish species).

Black Pond, Lake Oscaleta, Lake Peekskill, Lake Waccabuc, Little Fresh Pond, Sepasco Lake, and Tuxedo Lake were sampled through CSLAP in 2009. The pH readings in Lake Oscaleta in 2009 were also elevated, and pH in Black Pond and Little Fresh Pond were depressed in 2009, suggesting that aquatic life may be *stressed.* Hypolimnetic phosphorus readings in Lake Waccabuc, Sepasco Lake, and Tuxedo Lake in 2009 were much higher than those at the lake surface (although hypolimnetic ammonia readings were very high only in Lake Waccabuc), also suggesting that aquatic life may be *stressed.* Additional biological data from these three lakes will help provide better information about aquatic life impacts.

Preliminary Assessment- Potentially Threatened: Anawanda Lake, Canaan Lake, Cranberry Lake, Lake Mohegan, Lake Rippowam, Lake Truesdale, Lily Pond, Monhagen Lake, Roaring Brook Lake, Shadow Lake, Shenorock Lake, Timber Lake (Sullivan), Ulster Heights Lake, Wallace Pond, We Wah Lake, Weiden Pond

Discussion: Aquatic life in a large number of Downstate region lakes may be threatened by pH or dissolved oxygen. Depressed pH was occasionally (>10% of the time) measured in Cranberry Lake, Shadow Lake, Timber Lake (Sullivan), Ulster Heights Lake, and Weiden Pond, while elevated pH was occasionally measured in Lake Mohegan, Lake Rippowam, Lake Truesdale, Monhagen Lake, Roaring Brook Lake, Shenorock Lake, Wallace Pond, and We Wah Lake. All of these lakes except Cranberry Lake, Timber Lake and Wallace Pond were sampled through CSLAP in 2009. pH readings in Shadow Lake and Weiden Pond were somewhat depressed in 2009, and were slightly elevated in Lake Rippowam, Roaring Brook Lake, and Wallace Pond suggesting that aquatic life impacts may have occurred in these lakes in 2009 (although this impacts were not apparent through CSLAP).

Anawanda Lake exhibited signs of hypoxia, based primarily on nutrient-enriched hypolimnetic waters. It is not known if this lead to actual aquatic life impacts. The lake was sampled in 2009 and also showed some evidence of hypolimnetic nutrient enrichment and deepwater hypoxia (through the biomonitoring project).

Chapter 8.7.5- Evaluation of Impacts to Aesthetics in Downstate Region Lakes

Sampling volunteers from 59 of the 60 CSLAP lakes in the Downstate region completed the Field Observations forms and were given the opportunity to evaluate impacts to aesthetics. As discussed earlier in this report, the CSLAP dataset provides multiple opportunities for evaluating aesthetics in CSLAP lakes, but the reports of "excessive weeds" or "excessive algae" cannot be assumed to represent impacts to lake aesthetics. Reports of these impacts are therefore limited to those instances in which sampling volunteers recorded that the lake "looks bad."

A discussion of the specific "citations" for impacts to aesthetics is provided below:

Preliminary Assessment- Potentially Stressed: Canaan Lake, Hillside Lake, Lake Ossi, Peach Lake

Discussion: Canaan Lake, Hillside Lake, Lake Ossi and Peach Lake were the only CSLAP lakes in the Central region reporting that "the lake looks bad" during more than 25% of the CSLAP sampling sessions. Hillside Lake, Lake Ossi and Peach Lake suffer from high algae levels and/or poor water clarity, leading to recreational use impacts during 100%, 94% and 97%, respectively, of the CSLAP sampling sessions. Canaan Lake suffered from recreational use impacts during 89% of the CSLAP sampling sessions, 77% of the time due to excessive weeds. Canaan Lake, Hillside Lake and Lake Ossi have not been sampled through CSLAP for several years, so it is not known if these conditions have persisted. The statewide report indicates that problems with both algae and weeds appears to be prerequisite for aesthetics problems in most CSLAP lakes; this is largely borne out in the Downstate region lakes.

Preliminary Assessment- Potentially Threatened: Lake Lincolndale, Lake Meahagh, Lake Truesdale, Lily Pond, Orange Lake, Teatown Lake

Discussion: The sampling volunteers at Lake Lincolndale, Lake Meahagh, Lake Truesdale, Lily Pond, Orange Lake, and Teatown Lake reported problems with aesthetics, as defined by indications that the lake “looks bad,” during 10-25% of the CSLAP sampling sessions. Aesthetics in Lake Lincolndale, Lake Meahagh, Lake Truesdale, and Orange Lake are most strongly influenced by nuisance algae, and by both algae and weeds in Lily Pond and Teatown Lake.

Chapter 8.7.6- Summary of Fish Consumption Advisories in Downstate Region Lakes

Fish surveys—either creel surveys, fish netting, or fish flesh analysis—are not conducted through CSLAP. However, to provide at least limited assessments of each of the major designated uses in New York states, the New York State Department of Health fish consumption advisory inventory can be reported here for CSLAP lakes.

In the Downstate region, fish consumption advisories have not been established for any CSLAP lakes:

Chapter 9- CSLAP 2010 and Beyond- Where We Are Going

Chapter 9- CSLAP 2010 and Beyond- Where We Are Going

One of the (many) positive attributes of CSLAP is the consistent, unwavering collection of water quality data, at the same spot, at the same time, looking at the same indicators, year after year after year. It is this dependable, long-term database that provides insights about the condition of a lake, through the annual and weather-related variability—in essence, seeing both the trees and the forest. This stability provides an opportunity for assessing trends and responses to management actions that cannot be ascertained from single snapshots in time or even periodic peeks behind the curtains.

But while this monitoring program is first and foremost developed to gather the data and information needed to assess lake conditions over an expanded timeframe, there are other benefits that come from the samples collected by and long-term presence of volunteers on the water. Some of these—identification of individual lake problems and assessment of regional conditions, the development of nutrient criteria to protect recreational and aesthetic uses of lakes, a network of volunteers on the lookout for invasive species, to name a few—are already considered primary objectives of the program and are discussed within this report. This balance of steady data collection and application of specific assessment tools to evaluate individual waterbodies has served the CSLAP lake associations over the last twenty-five years, and will no doubt continue to direct the monitoring activities into at least the near future.

However, as CSLAP approaches the 25th year of sampling, the monitoring program needs to adapt to both the changing needs of the participating lake associations and the changing framework in which these samples are collected and analyzed. This has already been done several times over the last twenty five years, necessitated by emerging threats (invasive species, toxic algae), reduced sampling budgets, more rapid exchange of information through the internet, and the loss of the state Health Department laboratory for analyzing samples. These changing times provide both challenges and opportunities for CSLAP 2010 and beyond.

Some of the key changes to the program in the near and more distant future are as follows:

- **Moving from a one-size-fits-all program to a program tailored to individual lakes**

CSLAP has been slowing moving in this direction for the last twenty years. Starting in the early 1990s, phosphorus was analyzed in the hypolimnetic samples of thermally stratified lakes, and nitrogen (ammonia and NO_x) were occasionally analyzed in these samples. However, starting in 2009, CSLAP lakes were organized into five distinct groups for water sampling: shallow lakes, deep unproductive non-drinking water (Class B and C) and drinking water (Class AA and A) lakes, and deep productive non-drinking water and drinking water lakes. Water samples from each of these groups were analyzed for a different suite of water quality indicators, although all groups included the standard suite of CSLAP water quality parameters analyzed since at least 2002. The latter three groups, and the more productive shallow lakes, were also included in the NYSDOH harmful algal bloom (HAB)/algal toxins study conducted in cooperation with CSLAP (see below).

These "functional" groups within CSLAP will likely be continued into the future, and additional groupings may also be established to provide a program that addresses specific needs on each CSLAP lake. Although these groups will dictate a common platform of sampling indicators measured at each lake within the group, individual analytes may vary slightly from lake to lake depending on a more "real time" evaluation of water quality conditions during each sampling season.

- **"Near-real time" response to water quality problems**

Even within the confines of these functional monitoring groups, the present CSLAP program involves a pre-determined number of sampling sessions and suite of sampling parameters at each lake, based on expected water quality conditions and stressors and an even frequency and distribution (every other week) of sampling sessions. This is useful for evaluating general water quality conditions and comparing results from lake to lake and year to year, but is less useful in detecting unusual events, such as algal blooms. The NYSDOH HAB study provides the "tools" for assessing blooms that occur between sampling sessions, and for the laboratory to detect the potential for bloom conditions (via the phycocyanin analyses on all incoming water samples), but it does not provide a mechanism for collecting additional water chemistry samples or complementary water quality analytes that might provide insights to the cause of these problems, or providing some other response to these "findings." The former might include nutrient analyses at various depths in the water column, particularly for those lakes with water intakes that are not close to the lake surface or bottom, sampling closer to inlet streams to identify potential sources of pollutants triggering these blooms, or other specialized sampling. Appropriate responses may be advising lake residents to avoid swimming until the bloom dissipates or through a timetable outlined by the Health Department. Given the immediacy of the phycocyanin screening results and the ability to rapidly contact sampling volunteers, these "real time" responses may be best initiated with the HAB study.

At present, the CSLAP analytical services budget does not provide a buffer for additional analyses, but it is anticipated that such a buffer will be available starting in 2011. At that time, there may also be additional screening tools or a standardized "near-real time" reporting mechanism to direct additional monitoring resources in places to address specific and immediate problems.

- **Continuation of the NYSDOH HAB study through 2013**

The NYSDOH grant to study harmful algal blooms is slated to run for five years, through 2013. The CSLAP-NYSDOH partnership is beneficial to both parties—CSLAP lake associations receive information about the potential for harmful algal blooms (and the characteristics of the bloom conditions in the lake) and NYSDOH receives on-the-ground samples and information about blooms from throughout the state as they occur. There is a need for better communication and information exchange in this study, and a "near-real time" feedback about bloom conditions and the potential threat to swimmers, but it is anticipated that these problems will be resolved as the study continues. The evolution of the program will likely result in more targeted sampling of blooms, but this may be expanded to all CSLAP lakes, rather than just those "susceptible" lakes (those with histories of blooms, water quality conditions indicating a susceptibility to blooms, and potable water supplies). In the interim, a continuation of this partnership should continue through the duration of the study.

- **Expanded biological monitoring**

The summary of the biological condition in CSLAP lakes (Chapter 5) represents a first attempt at compiling information about the biological communities in CSLAP lakes. There is no doubt additional information on these lakes, particularly related to phytoplankton and zooplankton and fish populations, that will be accumulated and included in the 2010 CSLAP report, particularly since it is unlikely that there will be a mechanism for conducting plankton monitoring in at least the near future, and CSLAP is not devised to conduct creel surveys.

The lake macroinvertebrate study conducted by the NYSDEC starting in 2008 focuses on CSLAP lakes to take advantage of the extensive water quality database and local interest in these data. The 2008 and 2009 studies collected benthic samples at 18 CSLAP lakes, and it is anticipated that an additional 9-12 CSLAP lakes will be sampled for each of the next several years. The 2010 CSLAP report will likely include a more detailed evaluation of the existing dataset and more detailed characterization of the biological condition of these lakes.

The macrophyte summaries in Chapter 5 constitute a compilation of plant survey data from a variety of sources, including plant surveys conducted by CSLAP volunteers. The data summary includes a discussion of a modified floristic quality index (FQI) for these lakes, using a modified scale developed for easily classifying plants into one of six categories. The New York chapter of The Nature Conservancy is in the process of developing a plant specific FQI for both terrestrial and aquatic plants in the region. The utility of the FQI can be expanded by better inventories of aquatic plants throughout the state, and assessments of the relative composition (abundance) of plants within lakes throughout the state. Starting in 2010, CSLAP sampling volunteers will be strongly encouraged to participate in one or both of these activities—detailed inventories of all plants in their lake, and assessments of plant abundance in their lake. The quality of aquatic plant communities in individual lakes and throughout the state will be better understood with this expanded database.

- **Return to a Rotating Lake Schedule**

At several points during the last twenty five years, the CSLAP waiting list—the list of NYSFOLA lake associations interested in participating in CSLAP—has exceeded the capacity for expanding the program. In most cases, the waiting period has been less than a year, and in many years, the CSLAP waiting list has been fully emptied during the following sampling season.

To that end, the NYSDEC and NYSFOLA continue to seek resources to fully build out CSLAP, to include all interested lake associations and provided expanded monitoring at each program lake. Unfortunately, the additional funds for analytical services, equipment, sample transport, and staff to manage an expanded program are not available in 2010 and are unlikely to be available in at least the near future. As a result, a large number of lakes continue to languish on the 2010 CSLAP waiting list. In some previous years and in 2010, each of these "stalled" waiting list lakes will be offered an opportunity to participate in an updated version of "CSLAP Light"—Secchi disk transparency and water temperature measurements, lake perception surveys, aquatic plant identifications, and an opportunity to participate in the NYSDOH HAB study.

To keep moving lakes off the waiting list in light of a shortage of funds to support an expanded program, a rotational schedule for CSLAP participants will likely be resumed in 2011. This will differ in a few ways from the original "Five Year On-Five Year Off" plan:

a. CSLAP lakes will likely return to the active monitoring program after a recess of about 1-2 years, depending on funding availability.
b. All CSLAP lakes will be encouraged to retain their Secchi disk and thermometer to keep "low level" monitoring during the 1-2 year "off" period.
c. CSLAP lakes rotated out of the program cannot "buy in" to the program to continue sampling during the 1-2 year "off" period.
d. A subset of CSLAP lakes will not be rotated out of the program. These "index" lakes will be sampled each year, presuming that the corresponding lake association retains their NYSFOLA membership and pays the CSLAP participation fee.

- **Index Lakes**

The NYSDEC uses the CSLAP dataset to evaluate long-term statewide and regional trends, the former as part of the statewide water quality assessments required by the federal government. These statewide assessments are supported by other monitoring programs, including a rotating regional monitoring program conducted by the NYSDEC. However, a core group of sampling sites provides a consistency to these assessments. The statewide river monitoring program includes 19 large river sites that represent most of the major drainage basins in the state; these serve as "index" sites that are monitored multiple times every year. The statewide lake monitoring program does not have equivalent index sites. A subset of CSLAP lakes can serve that purpose.

The lake index sites cannot replicate the river sites, since very few lakes drain large swaths of the state (and thus would only be representative of the very large lakes in the state). Instead, the CSLAP index lakes should represent, as best as possible, a typical cross-section of lakes in the state. The choice of index lakes is somewhat limited due to the limited pool of lakes sampled through CSLAP. For example, as discussed in this report, there are few urban lakes, particularly in Long Island, and few acidic lakes sampled through CSLAP. However, these lakes can be included in other monitoring programs.

Four criteria are being established to identify CSLAP index lakes:

a. *Geography*- the state and CSLAP report can be divided into four regions—Downstate, Central, Adirondack, and Western regions. These should be represented in the subset of index lakes in roughly equivalent frequency to their distribution throughout the state, or at least as much as feasible given the distribution of CSLAP and NYSFOLA lakes.
b. *Lake Depth*- lakes can be characterized by broad categories of water depth. Shallow lakes—those less than 20 feet (= 6 meters) deep—behave differently than deep lakes—those more than 50 feet deep. Lakes in the intermediate depth range—from 20 to 50 feet deep—may be susceptible to anoxia-induced water quality problems. The subset of index lakes should be represented by lakes in each of these depth categories.
c. *Lake Size*- the CSLAP dataset includes lakes ranging in size from small ponds to Great Lakes. The index lake set should include small lakes—those less than 100 acres in surface area, intermediate sized lakes—those between 100 and 500 acres, and large lakes—those over 500 acres. These, however, should not be distributed in equal proportion to their distribution throughout the state, since the vast majority of New York state lakes are much less than 50 acres.
d. *Trophic State*- the CSLAP monitoring program focuses on eutrophication indicators. As discussed at length in this report, a wide range of trophic conditions occurs in New York state lakes. The subset of index lakes should include representation from the list of *eutrophic, mesoeutrophic, mesotrophic, mesoligotrophic*, and *oligotrophic* lakes.

It is anticipated that 40-50 CSLAP lakes will be chosen to represent these four categories as index lakes. These lakes will not be rotated out of the program, although it should again be noted that even rotational lakes will be in an "off" cycle for no more than 1-2 years. The specific composition of the index lake set will be identified during the summer of 2010.

- **CSLAP Reports**

The CSLAP reports presented here represent a significant departure from previous reports. The new reporting format is discussed in Chapter 2. It is anticipated that this reporting format will allow for the statewide and regional reports to be posted on the NYSDEC and NYSFOLA websites, and for better distribution of the individual lake appendices. This format will also allow for expanded discussion of regional and statewide findings, and individual lake impacts with continued data collection. Perhaps most importantly, this format will be used to report on the 25 years of CSLAP data results after the 2010 CSLAP sampling season.