I. INTRODUCTION: CSLAP DATA AND YOUR LAKE

Lakes are dynamic and complex ecosystems. They contain a variety of aquatic plants and animals that interact with each other and the environment. As water quality changes, so too will the plants and animals that live there, and these changes in the food web also may additionally affect water quality. Water quality monitoring provides a window into the numerous and complex interactions of lakes. While even the most extensive and expensive monitoring program cannot completely assess a lake's water quality, by looking at some basic chemical, physical, and biological indicators, it is possible to gain a greater understanding of the general condition of lakes. Such information is critical for managing lakes, assessing short- and long-term water quality conditions and trends, and for comparing lakes sharing common geographic settings and lake uses.

The Citizens Statewide Lake Assessment Program (CSLAP) is a volunteer lake monitoring program conducted by the NYS Department of Environmental Conservation and the NYS Federation of Lake Associations. Founded in 1986 with 25 pilot lakes, the program now involves more than 150 lakes, ponds, and reservoirs and 1000 volunteers from eastern Long Island to the Northern Adirondacks to the western-most lake in New York, including several Finger Lakes, Lake Ontario, and lakes within state parks. In this program, lay volunteers trained by the NYSDEC collect water samples, observations, and perception data every other week in a fifteen-week interval between May and October. Generally, water samples are collected from the lake surface at the deepest part of the lake, using standard limnological equipment and sampling procedures. Water samples are analyzed by the NYS Department of Health, although, as noted later in the report, additional analytical services have also been utilized, particularly in 1998. Analytical results are interpreted by the NYSDEC and utilized for a variety of purposes by the State of New York, local governments, researchers, and, most importantly, participating lake associations. **CSLAP was first conducted on Findley Lake in 1986.**

CSLAP collects some of the most important water quality indicators in lakes. Some of these indicators, particularly those related to **lake eutrophication** (literally lake nourishment), are collected to assess the aesthetic and ecological "health" of the lake, while others are used for generally characterizing lakes. Eutrophication indicators are most closely monitored because eutrophication represents the most common water quality problem in NYS lakes, and can be most closely linked to recreational and aesthetic uses of lakes. CSLAP also collects information about the perception of the lake, to link one of the objectives of water quality monitoring (to assess lake use impairment) to the data collected in these monitoring programs. Through vegetation and zebra mussel surveys, CSLAP also gathers information about exotic invasive organisms and macrophyte communities in each lake. These indicators collectively serve to provide a "snapshot" of conditions at each program lake, and, when collected over a longer period, serve to provide a contemporary assessment of each lake.

II. CSLAP SAMPLING PARAMETERS: WHAT AND WHY

CSLAP monitors several parameters related to the **trophic** (extent of eutrophication) state of a lake. Three parameters are the most important measures of eutrophication in most New York lakes: **total phosphorus, chlorophyll *a*** (measuring algal densities), and **Secchi disk transparency**. Because these parameters are closely linked to the growth of weeds and algae, they provide insight into "how the lake looks" and its suitability for recreation and aesthetics. Additional CSLAP parameters are chosen to optimize the need to characterize lakes while balancing fiscal and logistic necessities (i.e. "the biggest bang for the buck…"). In addition, CSLAP also uses **Field Observation Forms** to gauge perceptions of lake water quality. Most water quality "problems" arise from impairment of accepted or desired lake uses, or the perception that such uses are somehow degraded. As such, any water quality monitoring program should attempt to understand the link between perception and measurable quality.

The parameters analyzed in CSLAP (**Figure 1**) provide valuable information for characterizing lakes. By adhering to a consistent sampling protocol provided in the CSLAP Sampling Protocol, volunteers collect and use data to assess both seasonal and yearly fluctuations in these parameters, and to evaluate the water quality in their lake. By comparing a specific year's data to historical water quality information, lake managers can pinpoint trends and determine if water quality is improving, degrading or are remaining stable. Such a determination answers a first critical question posed in the lake management process. For most CSLAP lakes, these parameters are monitored biweekly from May through October, with samples collected by a Kemmerer bottle from a depth of 1.5 meters (5 feet) in the deepest part of the lake; however, deep water (hypolimnetic) phosphorus samples are occasionally collected from a depth 1-2 meters above the lake bottom in lakes that are thermally stratified.

Figure 1. CSLAP Sampling Parameters

PARAMETER	**SIGNIFICANCE**
Water Temperature (°C)	Water temperature affects many lake activities, including the rate of biological growth and the amount of dissolved oxygen. It also affects the length of the recreational season
Secchi Disk Transparency (m)	Determined by measuring the depth at which a black and white disk disappears from sight, the Secchi disk transparency estimates the clarity of the water. In lakes with low color and rooted macrophyte ("weed") levels, it is related to algal productivity
Conductivity (µmho/cm)	Specific conductance measures the electrical current that passes through water, and is used to estimate the number of ions (charged particles). 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. Generally, lakes with conductivity less than 100 µmho/cm are considered softwater, while conductivity readings above 300 µmho/cm are found in hardwater lakes.
pH	pH is a measure of the (free) hydrogen ion concentration in solution. Most clearwater lakes must maintain a pH between 6 and 9 to support most types of plant and animal life. Low pH waters (<7) are acidic, while high pH waters (>7) are basic
Color (true) (platinum color units)	The color of dissolved materials in water usually consists of organic matter, such as decaying macrophytes or other vegetation. It is not necessarily indicative of water quality, but may significantly influence water transparency or algae growth. Color in excess of 30 ptu indicates sufficient quantities of dissolved organic matter to affect clarity by imparting a tannic color to the water.
Phosphorus (total, mg/l)	Phosphorus is one of the major nutrients needed for plant growth. It is often considered the "limiting" nutrient in NYS lakes, for biological productivity is often limited if phosphorus inputs are limited. Many lake management plans are centered on phosphorus controls.
Nitrogen (nitrate, mg/l)	Nitrogen is another nutrient necessary for plant growth, and can act as a limiting nutrient in some lakes, particularly in the spring and early summer. For much of the sampling season, many CSLAP lakes have very low or undetectable (<0.02 mg/l) levels.
Chlorophyll *a* (µg/l)	The measurement of chlorophyll *a*, the primary photosynthetic pigment found in green plants, provides an estimate of phytoplankton (algal) productivity, which may be strongly influenced by phosphorus. In most lake monitoring programs, this is a better indicator of planktonic (floating or suspended cellular) phytoplankton than of filamentous (thread-like fixed) phytoplankton or other algae

Understanding Trophic States

All lakes and ponds undergo **eutrophication,** an aging process, which involves stages of succession in biological productivity and water quality (see **Figure 2**). **Limnologists** (scientists who study fresh water systems) divide these stages into **trophic** states. Each trophic state can represent a wide range of biological, physical, and chemical characteristics and any lake may "naturally" be categorized within any of these trophic states. In general, the increase in productivity and decrease in clarity corresponds with an enrichment of nutrients, plant and animal life. Lakes with low biological productivity and high clarity are considered **oligotrophic**. Highly productive lakes with low clarity are considered **eutrophic**. Lakes that are **mesotrophic** have intermediate or moderate productivity and clarity.

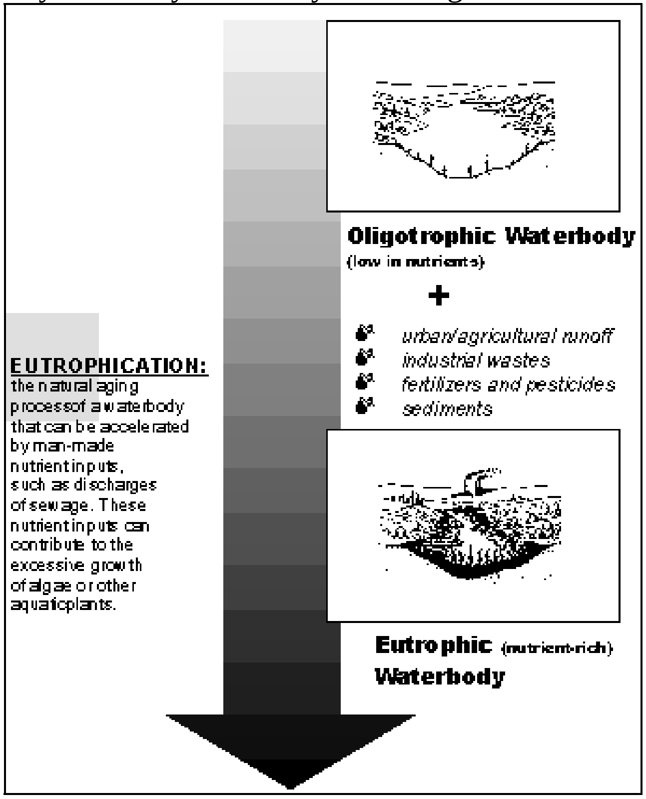

Figure 2. Trophic States

Eutrophication is a natural process, and is not necessarily indicative of man-made pollution. In fact, some lakes are thought to be "naturally" productive. It is important to understand that trophic classifications are not interchangeable with assessments of water quality. One person's opinion of degradation may be viewed by others as harmless or even beneficial. For example, a eutrophic lake may support an excellent warm-water fishery because it is nutrient rich, but a swimmer may describe that same lake as polluted. However, a lake's trophic state is still important because it provides lake managers with a reference point to view changes in a lake's water quality and begin to understand how these changes may cause **use impairments** (threaten the use of a lake or swimming, drinking water or fishing)**,** since changes in trophic status, particularly over a short period, are probably ecologically stressful and represent progression toward water quality degradation.

When human activities accelerate lake eutrophication, it is referred to as **cultural eutrophication**. Cultural eutrophication, caused by shoreline erosion, agricultural and urban runoff, wastewater discharges or septic seepage, and other nonpoint source pollution sources are examples of activities that greatly accelerate the natural aging process of lakes, and significantly impair the water quality and value of a lake. These changes can cause succession changes in the plant and animal life within the lake, along the shoreline and in the surrounding watershed. They may ultimately extend aquatic plants and emergent vegetation throughout the lake, resulting in the transformation of the lake into a marsh, prairie, and forest. The extent of cultural eutrophication, and the corresponding pollution problems, can be signaled by significant changes in the trophic state over a short period of time.

Expected Ranges in Trophic Indicators

The relationship between phosphorus, chlorophyll *a*, and Secchi disk transparency has been explored by many researchers, in hopes of assessing the trophic status (the degree of eutrophication) of lakes. **Figure 3** shows ranges for phosphorus, chlorophyll a, and Secchi disk transparency (summer averages) that are representative for each of the major trophic classifications:

Figure 3. Trophic Status Indicators

Parameter	Eutrophic	Mesotrophic	Oligotrophic	Findley Lake
Phosphorus (mg/l)	> 0.020	0.010 - 0.020	< 0.010	**0.036**
Chlorophyll a (µg/l)	> 8	2- 8	< 2	**35.5**
Secchi Disk Clarity (m)	2	2- 5	> 5	**1.6**

These classifications are valid for clear-water lakes only (waters with less than 30 platinum color units). Some humic or "tea color" lakes, for example, naturally have dissolved organic material with greater than 30 color units. This will cause the water transparency to be unexpectedly poor relative to low phosphorus and chlorophyll *a* levels. Water transparency can also be surprisingly lower than expected in shallow lakes, due to influences from the bottom. Even shallow lakes with high water clarity, low nutrient concentrations, and little algal growth may also have significant weed growth due to shallow water conditions. While such a lake may be considered unproductive by most standards, that same lake may experience severe aesthetic problems and recreational impairment related to weeds, not trophic state. Generally, however, the trophic relationships described above can be used as an accurate "first" gauge of productivity and overall water quality. It should be noted that trophic characterizations and categories place signposts in what is a productivity continuum- for example, lakes do not experience dramatically different conditions in the small range separating upper oligotrophy and slight mesotrophy. As such, these vaguely arbitrary boundaries dividing trophic states should not be assigned greater significance than warranted by the modest advantages afforded any "labeling" scheme.

By the trophic standards described above, **Findley Lake** would be considered to be a **eutrophic** lake**.**

Aquatic Vegetation

Figure 4. Types of Algae

Phytoplankton	Free-floating algae
Periphyton	Algae attached to surfaces
Charaphytes	Larger branched alga

Although the greatest portion of aquatic vegetation consists of the microscopic algae referred to as phytoplankton, and the other algal types listed in **Figure 4**, "aquatic vegetation" usually refers to the larger rooted plants called **macrophytes** (although large algae such as Chara or Nitella are common mistaken for macrophytes)**.**

Aquatic plants should be recognized for their contributions to lake beauty as well as providing food and shelter for other life in the lake. Emergent and floating plants such as water lilies floating on the lake surface may provide aesthetic appeal with their colorful flowers; sedges and cattails help to prevent shoreline erosion, and may provide food and cover for birds. Submergent plants like pondweeds and leafy waterweed harbor insects, provide nurseries for amphibians and fish, and provide food for birds and other animals. Macrophytes can be found throughout the *littoral zone*, the near-shore areas in which sufficient light reaches the lake bottom to promote photosynthesis. Plant growth in any particular part of the lake is a function of available light, nutrition and space, bottom substrate, wave action, and other factors, and may only be marginally be influenced by overlying water quality.

However, of particular concern to many lakefront residents and recreational users are the exotic, or non-native macrophytes that can frequently dominate a native aquatic plant community and crowd out more beneficial species. These plants may be introduced to a lake by waterfowl, but in most cases they are introduced by fragments or seedlings that enter from inflowing streams or remain on watercraft transported from already-infested lakes. Once introduced, these species have tenacious survival skills, frequently crowding out, dominating and eventually aggressively overtaking the indigenous (native) plant communities, interfering with recreational activities such as fishing, swimming or water-skiing. Some plant species can reduce water flow in lakes and canals. **Eurasian watermilfoil** *(Myriophyllum spicatum)* is the most common non-native species found in New York State Other non-native species found in NYS lakes are **Curly-leaf pondweed** *(Potamogeton crispus)*, **Eurasian water chestnut** *(Trapa natans)*, and **Fanwort** *(Cabomba caroliniana).* These species need to be properly identified for lake associations to effectively manage their lake. If these plants are not present, efforts should be made to continue protecting the lake from the introduction of these species.

Whether the role of the lake manager is to better understand the lake ecosystem or better manage the aquatic plant community, knowledge of the macrophyte species distribution is paramount to the management process. There are many procedures available for assessing and monitoring aquatic vegetation. The <u>CSLAP Sampling Protocol</u> contains procedures for a “semi-quantitative” plant monitoring program. Volunteers collect plant specimen and provide field information and qualitative abundance estimates for an assessment of the macrophyte communities within critical areas of the lake. While these techniques are no substitute for professional plant surveys, they can help provide better information for lake managers. Lake associations planning to devote significant time and expenditures toward a plant management program are advised to pursue more extensive plant surveying activities.

The following aquatic plants have been identified through CSLAP at Findley Lake, although contemporary information and data not collected through CSLAP have identified *Myriophyllum spicatum* (Eurasian watermilfoil) as the primary aquatic plant and nuisance species in Findley Lake.

Species	CommonName	Exotic?	Type	Date	Location	%Cover	Abundance
M.spicatum	Eurasian watermilfoil	yes	submergent	8/25/90	site 1-Paradise Bay	4	scarce
M.verticillatum	whorled watermilfoil	no	submergent	8/25/90	site 1-Paradise Bay	6	scarce
M.verticillatum	whorled watermilfoil	no	submergent	8/25/90	site 2-Paradise Bay	4	scarce
M.verticillatum	whorled watermilfoil	no	submergent	8/25/90	site 3-Paradise Bay	1	scarce
N.flexilis	bushy pondweed	no	submergent	8/25/90	site 1-Paradise Bay	90	abundant
N.flexilis	bushy pondweed	no	submergent	8/25/90	site 2-Paradise Bay	96	abundant
N.flexilis	bushy pondweed	no	submergent	8/25/90	site 3-Paradise Bay	99	abundant

The Other Kind of Aquatic Vegetation

As noted above, the microscopic algae referred to as phytoplankton make up the bulk of aquatic vegetation found in lakes. For this reason, and since phytoplankton are the primary producers of food (through photosynthesis) in lakes, they are the most important component of the complex food web that governs ecological interactions in lakes.

In a lake, phytoplankton communities are usually very diverse, and are comprised of hundreds of species having various and individually unique requirements for nutrients, temperature and light. In many lakes, including those of New York, diatom populations are greatest in the spring, due to a competitive advantage in cooler water and as a result of relatively high levels of silica. In most lakes, however, diatom densities rarely reach nuisance portions in the spring. By the summer, green algae take advantage of warmer temperatures and greater amounts of nutrients (particularly nitrogen) in the warm water and often increase in density. These alga are more frequently associated with higher densities, although they are often not the types of algae most frequently implicated in algae blooms. Later in the summer and in the early fall, blue green algae, which possess the ability to utilize atmospheric nitrogen to provide this required nutrient, increase in response to higher phosphorus concentrations, often after lakes destratify (turn over) in the fall. These alga are most often associated with taste and odor problems, bloom conditions, and the "spilled paint" slick that prompts the most complaints about algae. However, each lake possesses a unique brew of algal communities, often varying seasonally and from year to year, and with differing types, ranging from the aforementioned diatoms, green, and blue-green algae, to golden-brown algae to dinoflagellates and many others, dominating each lake community.

So what does this have to do with CSLAP? Phytoplankton communities have not been regularly identified and monitored through CSLAP, in part due to the cost and difficulty in analyzing samples, in part due to the difficulty in using these highly unstable and dynamic water quality indicators to assess short- or long-term variability in lake conditions, but mostly because CSLAP assesses algal biomass through the chlorophyll *a* measurement. While algal differentiation is important, many CSLAP lake associations are primarily interested in "how much?", not "what kind?". However, in 1992, nearly all CSLAP lakes were sampled once for phytoplankton identification, and since then some lakes have been sampled on one or more occasions. For these lakes, a summary of the most abundant phytoplankton species is included below, with more detailed information provided in Appendix D. Algal species frequently associated with taste and odor problems are specially notated in this table, although it should be mentioned that these samples, like all other water samples collected through CSLAP, come from near the center of the lake, a location not usually near water intakes or swimming beaches. Since algal communities can also be spatially quite variable, even a preponderance of taste and odor-causing species in the water samples might not necessarily translate to potable water intake or aesthetic impairments, although the threat of such an impairment might be duly noted in the "Considerations" section below.

Date: 7/18/92	Most Abundant Species/Genera- *Dinobryon divergens* (golden-brown alga, 42%), *Cyclotella planktonica* (diatom, 35%), *Gomphosphaeria aponina* (blue-green alga, 12%), *Anabaena circinalis* (blue-green alga, 6%)
	Most Abundant by Type- Golden Brown Algae (*Chrysophyta*)- 42%, Diatoms (*Bacillanophyceae)*- 36%, Blue-Green Algae (*Cyanophyta)*- 18%

III. UNDERSTANDING YOUR LAKE DATA

CSLAP is intended to help lake associations understand their lake's conditions and foster sound lake protection and pollution prevention decisions supported by a strong database. This individual lake summary for 1997 contains two forms of information. These raw data and graphs present a <u>snapshot</u> or glimpse of water quality conditions at each lake. They are based on (at most) eight sampling events during the summer. As lakes are sampled through CSLAP for a number of years, the database for each lake will expand, and assessments of lake conditions and water quality data become more accurate. For this reason, lakes participating in CSLAP for only one year will not have information about annual trends.

Raw Data

Two **"data sets"** are provided in **Table 1** and **Appendix A.** The data presented in **Table 1** show the entire CSLAP sampling history of your lake, including the minimum, maximum, average, and number of samples for each sampling year and parameter. These data may be useful for comparing a certain data point for the current sampling year with historical information. This table also includes data from other sources for which sufficient quality assurance/quality control documentation is available for assessing the validity of the results. **Appendix A** contains the “raw” data collected during all sampling seasons and years in which the lake was sampled as part of CSLAP.

TABLE 1: CSLAP Data Summary for Findley Lake

Year	**Min**	**Avg**	**Max**	**N**	**Parameter**
1986-98	**0.33**	**1.58**	**5.13**	**120**	**CSLAP Zsd**
1998	0.78	1.39	3.13	8	CSLAP Zsd
1997	1.28	2.30	5.13	8	CSLAP Zsd
1996	1.65	2.99	4.75	8	CSLAP Zsd
1995	0.33	0.90	2.00	6	CSLAP Zsd
1994	0.80	1.70	3.63	6	CSLAP Zsd
1993	0.75	1.22	1.50	6	CSLAP Zsd
1992	1.33	1.64	2.00	6	CSLAP Zsd
1991	0.33	0.68	1.00	6	CSLAP Zsd
1990	0.75	1.20	2.50	8	CSLAP Zsd
1989	1.00	2.12	3.25	13	CSLAP Zsd
1988	0.75	1.35	2.25	15	CSLAP Zsd
1987	0.50	1.14	3.00	15	CSLAP Zsd
1986	0.63	1.63	3.13	15	CSLAP Zsd
1985	1.00	2.12	4.00	5	LCI
1976	0.61	0.61	0.61	1	DEC
Year	Min	Avg	Max	N	Parameter
1986-98	**0.011**	**0.036**	**0.082**	**120**	**CSLAP Tot.P**
1998	0.020	0.048	0.070	8	CSLAP Tot.P
1998	0.211	0.564	0.960	4	CSLAP HypoTP
1997	0.013	0.026	0.032	8	CSLAP Tot.P
1996	0.013	0.024	0.056	8	CSLAP Tot.P
1995	0.020	0.047	0.082	6	CSLAP Tot.P
1994	0.015	0.036	0.059	6	CSLAP Tot.P
1993	0.030	0.046	0.063	6	CSLAP Tot.P
1992	0.013	0.026	0.035	6	CSLAP Tot.P
1991	0.049	0.061	0.079	6	CSLAP Tot.P
1990	0.037	0.049	0.062	8	CSLAP Tot.P
1989	0.015	0.024	0.038	13	CSLAP Tot.P
1988	0.020	0.032	0.042	15	CSLAP Tot.P
1987	0.018	0.041	0.060	15	CSLAP Tot.P
1986	0.011	0.027	0.039	15	CSLAP Tot.P
1985	0.010	0.011	0.012	3	LCI
1976	0.022	0.022	0.022	1	DEC

DATA SOURCE KEY

CSLAP	New York Citizens Statewide Lake Assessment Program
LCI	the NYSDEC Lake Classification and Inventory Survey conducted during the 1980s and again beginning in 1996 on select sets of lakes, typically 1 to 4x per year
DEC	other water quality data collected by the NYSDEC Divisions of Water and Fish and Wildlife, typically 1 to 2x in any give year
ALSC	the NYSDEC (and other partners) Adirondack Lake Survey Corporation study of more than 1500 Adirondack and Catskill lakes during the mid 1980s, typically 1 to 2x
ELS	USEPA’s Eastern Lakes Survey, conducted in the fall of 1982, 1x
NES	USEPA’s National Eutrophication Survey, conducted in 1972, 2 to 10x
EMAP	USEPA and US Dept. of Interior’s Environmental Monitoring and Assessment Program conducted from 1990 to present, 1 to 2x in four year cycles
Additional data source codes are provided in the individual lake reports	

CSLAP DATA KEY:

The following key defines column headings and parameter results for each sampling season:

L Name	Lake name
Date	Date of sampling
Zbot	Depth of the lake at the sampling site, meters
Zsd	Secchi disk transparency, meters
Zsp	Depth of the sample, meters
TAir	Temp of Air, °C
TH2O	Temp of Water Sample, °C
TotP	Total Phosphorus, in mg/l (Hypo refers to hypolimnetic (bottom) samples)
NO3	Nitrate nitrogen as N, in mg/l
TColor	True color, as platinum color units
pH	(negative logarithm of hydrogen ion concentration), standard pH
Cond25	Specific conductance corrected to 25°C, in µmho/cm
Chl.a	Chlorophyll *a*, in µg/l
QA	Survey question re: physical condition of lake: (1) crystal clear, (2) not quite crystal clear, (3) definite algae greenness, (4) high algae levels, and.(5) severely high algae levels
QB	Survey question re: aquatic plant populations of lake: (1) none visible, (2) visible underwater, (3) visible at lake surface, (4) dense growth at lake surface.(5) dense growth completely covering the nearshore lake surface
QC	Survey question re: recreational suitability of lake: (1) couldn’t be nicer, (2) very minor aesthetic problems but excellent for overall use, (3) slightly impaired, (4) substantially impaired, although lake can be used, (5) recreation impossible
QD	Survey question re: factors affecting answer QC: (1) poor water clarity; (2) excessive weeds; (3) too much algae/odor; (4) lake looks bad; (5) poor weather; (6) other

Table 1 (cont)

Year	**Min**	**Avg**	**Max**	**N**	**Parameter**
1986-98	**0.01**	**0.03**	**0.17**	**78**	**CSLAP NO3**
1998	0.01	0.04	0.14	7	CSLAP NO3
1997	0.01	0.03	0.10	8	CSLAP NO3
1996	0.01	0.03	0.08	8	CSLAP NO3
1995	0.01	0.01	0.01	1	CSLAP NO3
1994	0.03	0.08	0.12	2	CSLAP NO3
1991	0.01	0.01	0.01	4	CSLAP NO3
1990	0.01	0.01	0.02	6	CSLAP NO3
1989	0.01	0.07	0.14	3	CSLAP NO3
1988	0.01	0.01	0.03	15	CSLAP NO3
1987	0.01	0.03	0.17	9	CSLAP NO3
1986	0.03	0.05	0.12	15	CSLAP NO3
1985	0.01	0.05	0.13	4	LCI
1976	0.02	0.02	0.02	1	DEC
Year	Min	Avg	Max	N	Parameter
1986-98	**2**	**9**	**20**	**116**	**CSLAP TColor**
1998	2	7	14	8	CSLAP TColor
1997	7	9	10	8	CSLAP TColor
1996	5	11	20	8	CSLAP TColor
1995	5	7	10	5	CSLAP TColor
1994	4	8	12	6	CSLAP TColor
1993	2	6	7	6	CSLAP TColor
1992	6	8	11	6	CSLAP TColor
1991	7	10	14	5	CSLAP TColor
1990	10	12	17	6	CSLAP TColor
1989	2	8	15	13	CSLAP TColor
1988	6	9	14	15	CSLAP TColor
1987	6	12	15	15	CSLAP TColor
1986	2	9	15	15	CSLAP TColor
1985	5	7	10	5	LCI
Year	Min	Avg	Max	N	Parameter
1986-98	**6.92**	**7.94**	**9.05**	**119**	**CSLAP pH**
1998	7.51	8.38	9.05	8	CSLAP pH
1997	7.39	7.85	8.48	8	CSLAP pH
1996	7.84	8.02	8.43	8	CSLAP pH
1995	7.48	7.91	8.16	5	CSLAP pH
1994	7.70	8.01	8.60	6	CSLAP pH
1993	7.75	8.10	8.26	6	CSLAP pH
1992	7.81	8.12	8.34	6	CSLAP pH
1991	7.59	7.91	8.28	6	CSLAP pH
1990	7.24	7.74	8.23	8	CSLAP pH
1989	7.76	8.05	8.24	13	CSLAP pH
1988	7.71	8.02	8.32	15	CSLAP pH
1987	7.14	7.60	8.22	15	CSLAP pH
1986	6.92	7.85	8.98	15	CSLAP pH
1985	7.20	7.67	8.08	5	LCI
1976	7.27	7.27	7.27	1	DEC

Table 1 (cont)

Year	Min	Avg	Max	N	Parameter
1986-98	**173**	**210**	**237**	**118**	**CSLAP Cond25**
1998	173	183	194	8	CSLAP Cond25
1997	186	199	207	8	CSLAP Cond25
1996	210	217	225	8	CSLAP Cond25
1995	230	233	237	5	CSLAP Cond25
1994	206	215	224	6	CSLAP Cond25
1993	202	211	216	6	CSLAP Cond25
1992	218	227	237	6	CSLAP Cond25
1991	215	220	224	6	CSLAP Cond25
1990	199	206	222	7	CSLAP Cond25
1989	198	207	214	13	CSLAP Cond25
1988	213	224	234	15	CSLAP Cond25
1987	198	208	221	15	CSLAP Cond25
1986	180	197	215	15	CSLAP Cond25
1985	140	170	200	5	LCI
1976	140	140	140	1	DEC
Year	Min	Avg	Max	N	Parameter
1986-98	**0.80**	**35.53**	**274.00**	**112**	**CSLAP Chl.a**
1998	6.32	34.67	57.10	8	CSLAP Chl.a
1997	2.60	15.96	27.80	8	CSLAP Chl.a
1996	3.50	10.53	20.50	8	CSLAP Chl.a
1995	9.86	66.34	172.00	6	CSLAP Chl.a
1994	3.73	26.31	50.30	6	CSLAP Chl.a
1993	15.50	30.75	49.30	6	CSLAP Chl.a
1992	9.18	15.11	28.50	6	CSLAP Chl.a
1991	30.90	98.25	149.00	6	CSLAP Chl.a
1990	9.40	42.39	62.70	7	CSLAP Chl.a
1989	2.16	10.53	19.60	13	CSLAP Chl.a
1988	1.78	23.81	52.50	14	CSLAP Chl.a
1987	17.00	93.94	274.00	11	CSLAP Chl.a
1986	0.80	20.69	53.30	13	CSLAP Chl.a
1985	4.80	10.62	22.70	5	LCI
1976	40.90	40.90	40.90	1	DEC
Year	Min	Avg	Max	N	Parameter
1992-98	**1.0**	**2.8**	**5.0**	**46**	**QA**
1998	2.0	3.4	5.0	8	QA
1997	1.0	2.5	3.0	8	QA
1996	1.0	2.1	3.0	7	QA
1995	2.0	3.0	4.0	6	QA
1994	2.0	2.8	4.0	6	QA
1993	2.0	2.8	3.0	6	QA
1992	2.0	2.6	3.0	5	QA

Table 1 (cont)

Year	Min	Avg	Max	N	Parameter
1986-98	**2.0**	**2.7**	**4.0**	**46**	**QB**
1998	3.0	3.8	4.0	8	QB
1997	2.0	2.9	3.0	8	QB
1996	2.0	2.6	4.0	7	QB
1995	2.0	2.3	3.0	6	QB
1994	2.0	2.2	3.0	6	QB
1993	2.0	2.7	4.0	6	QB
1992	2.0	2.2	3.0	5	QB
Year	Min	Avg	Max	N	Parameter
1986-98	**1.0**	**3.2**	**4.0**	**46**	**QC**
1998	4.0	4.0	4.0	8	QC
1997	3.0	3.4	4.0	8	QC
1996	1.0	2.9	4.0	7	QC
1995	2.0	3.0	4.0	6	QC
1994	2.0	3.2	4.0	6	QC
1993	2.0	3.3	4.0	6	QC
1992	2.0	2.6	3.0	5	QC

Graphs

The second form of data analysis for your lake is presented in the form of **graphs**. These graphs are based on the raw data sets to represent a snapshot of water quality conditions at your lake. The more sampling that has been done on a particular lake, the more information that can be presented on the graph, and the more information you have to identify annual trends for your lake. Therefore, it is important to consider the number of sampling years of information in addition to where the data points fall on a graph while trying to draw conclusions about annual trends.

There are certain factors not accounted for in this report that lake managers should consider. These include:

- **Local weather conditions** (high or low temperatures, rainfall, droughts or hurricanes). Weather data summaries from the nearest NOAA station are provided below for 1998 and previous years to provide some context for understanding measured water quality conditions in the lake; however, for many lakes, the closest NOAA station, or the closest station with a consistent dataset, is too far away for assessing truly local conditions. The 1998 report does include, where appropriate, a more detailed discussion of the effect of weather conditions on the results at each program lake. Weather often most directly affects lakes by changing the amount of runoff entering the lake- while stream gaging stations are maintained by the US Geological Survey on many tributaries entering CSLAP lakes, these data have not yet been sufficiently computerized to easily utilize in CSLAP lake analyses.

- **Sampling season and parameter limitations**. Because sampling is generally confined to May-October, this report does not look at CSLAP parameters during the winter and other seasons. Winter and spring conditions can impact the usability and water quality of a lake, but for logistic reasons cannot be monitored through CSLAP. Each lake is monitored on a schedule compatible with volunteers' availability, weather conditions, sampling safety, and other factors, and this schedule often varies slightly from year to year, making annual comparisons somewhat problematic. In addition, there are other non-CSLAP sampling parameters (fecal coliform, dissolved oxygen, etc.) that may be responsible for chemical and biological processes and changes in physical measurements (such as water clarity) and the perceived conditions in the lake. Perhaps more importantly, many lakes experience marked intra-seasonal variabilities- the ultimate choice of sampling dates can significantly influence annual data summaries. For example, a lake with increasing productivity during the summer each year would demonstrate dramatically different "annual" averages for eutrophication parameters in years with relatively more early season sampling than in years with more late season sampling, although the overall conditions in these two years may be very similar. This clouds a purely statistical summary of the data, and requires a more detailed evaluation of the data specifics.

- **Other data**. While this report attempts to summarize all available historical data, some data may be available to some lake managers that are not summarized here. For example, this report does not generally include discussions of contemporary and historical non-CSLAP parameters, such as total nitrogen, alkalinity, and chloride, even though the monitoring programs summarized in this report may have collected this information. CSLAP staff continually searches for additional databases to include in individual lake analyses.

- **Statistical analyses**. True assessments of water quality trends and comparison to other lakes involve rigid statistical analyses. Such analyses are generally beyond the scope of this program, in part due to limitations on the time available to summarize data from nearly 100 lakes in the five months from data receipt to next sampling season, in part due to the inevitable inter-lake inconsistencies in sampling dates from year to year, and in part to the limited scope of monitoring. Where appropriate, some statistical summaries have been provided within the report and are documented in Appendix B of this report.

IV. BEFORE WE LOOK AT THE SAMPLING RESULTS…….

Was 1998 Different Than Most Other Years?

As noted above and in the 1997 CSLAP Annual Report for each lake, weather conditions can dramatically influence water quality, perception of lake conditions, and other lake activities. For example, 1997 was significantly drier than most of the previous sampling seasons, particularly the immediately preceding years (however, it should be noted that the winter and summer of 1997, on average, contained normal levels of precipitation, but much lower levels than in the last few years, which have been both warmer and wetter than the long-term NYS average). Perhaps not coincidentally, many NYS lakes experienced clearer water with lower nutrient concentrations in 1997 than in wetter years. While for many of these lakes, the variable conditions may have been the result of lower nutrient loads entering the lake, whether it be from reduced lake or watershed land usage, successfully implemented nutrient abatement strategies (better septic management, fewer lawn fertilizers,…), or "normal" and natural variability from one year to the next, the higher water transparency may have been enjoyed thanks to the good graces of Mother Nature. The annual variability of water quality conditions in each lake is likely due to a complex interaction of natural and unnatural variations in the core functions of the lake, and as a result can be very difficult to differentiate or even ascertain in any given sampling season.

Figures 5-8 show the variability in precipitation levels and major eutrophication indicators during each of the 13 years in which CSLAP has been conducted; Figures 6-8 define "significant" change (either high or low) as exceeding the standard deviation of the 1986-98 average for each of the water quality indicators. Figure 5 shows that, in marked contrast to 1997, the winter (January to April) and early summer (May and June) were significantly wetter than usual- in fact, 1998 appeared to be, on average, the wettest pre-sampling season year since before 1986. While the balance of the summer had closer to normal precipitation, 1998 could aptly be termed a “wet” year. However, while in 1997 the dry conditions translated into less productive water quality conditions, in 1998 the wetter weather did not appear to translate into higher biological productivity. Water clarity readings, on average, were not significantly higher or lower than usual. Although nearly 60% of all CSLAP lakes sampled in 1998 reporting clarity readings with greater than the “normal” deviation (either clearer or less clear), many of these lakes (appx. 30%) were first sampled in 1997. When comparing only those lakes with three or more years of data, less than 40% experienced significant change in water clarity in 1998, a percentage only slightly higher than in previous years. In general, CSLAP lakes showed slightly higher water clarity in 1998 than in most previous years. However, this trend (of slightly increasing water clarity) has occurred in four of the last six years (Figure 6), despite weather conditions that have been highly variable over the same period (Figure 5). This trend has been generally followed by phosphorus levels as well, despite the slight increase in 1998 (see below), though not as closely mirrored by the change in algae levels (as determined by chlorophyll *a*) over the same period (Figure 7). Algae levels, on average, were slightly lower than normal in 1998, consistent with the slight increase in water clarity. Part of this trend toward lower measured productivity may be a sampling artifact; many of the lakes reporting lower productivity in 1998 were either sampled earlier than usual (since algae growth is generally lower in the spring than in mid-summer, this tends to reduce the seasonal sampling average) or are relatively new to CSLAP, and thus experience more interseasonal variability than do many other longer-sampled lakes. This might also help to explain the apparently inconsistent increase in nutrient concentrations in 1998, since some lakes demonstrate slightly higher spring phosphorus concentrations as a residual effect of spring runoff entering the lake.

However, the trend toward lower productivity, as assessed by higher water clarity and lower algae and nutrient concentrations, has surfaced despite somewhat variable sampling schedules, combinations of new and continuing lakes in the monitoring pool, and highly variable weather conditions. This suggests that at least some of the increased water clarity and lower nutrient concentrations are the result of actual decreases in nutrient loading to lakes, which in turn might be the realized effect of better septic and stormwater management, reduced lawn fertilization, reduced shoreline and tributary streambank erosion, and other locally initiated and driven lake and watershed management activities. In other words, part of the “improvement” in water quality conditions in many of the monitored NYS lakes may be the result of the efforts of lake associations, local government, county agencies, and dedicated individuals to reduce nutrient inputs and other “pollution” to lakes.

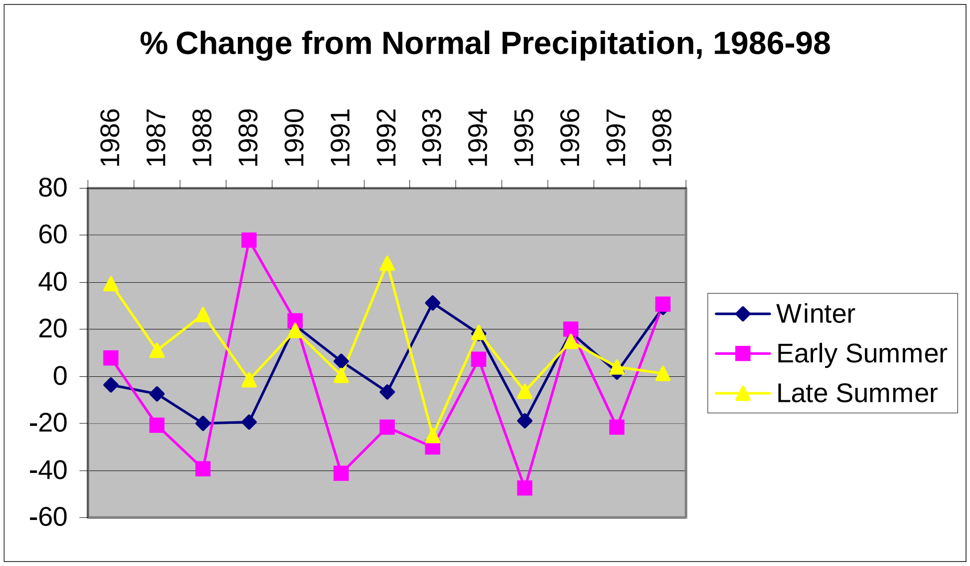

Figure 5. *Comparison of Change in Average NYS Precipitation From Normal Levels During The Winter (Jan-Apr), Early Summer (May-June), and Late Summer (July-August)*

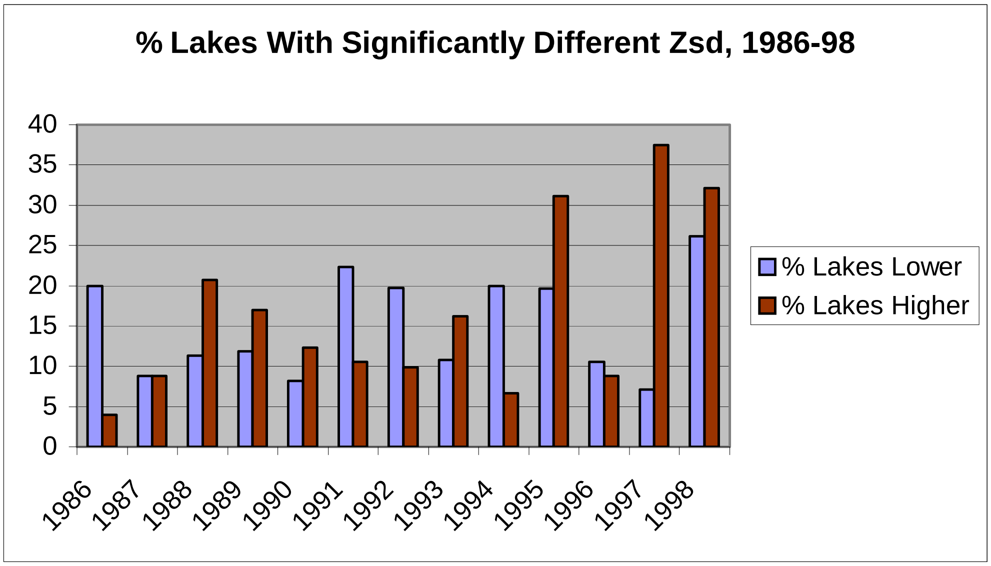

Figure 6. *Changes in Percentage of Lakes With Significant (>1SD) Deviation From 1986-98 Mean Secchi Disk Transparency*

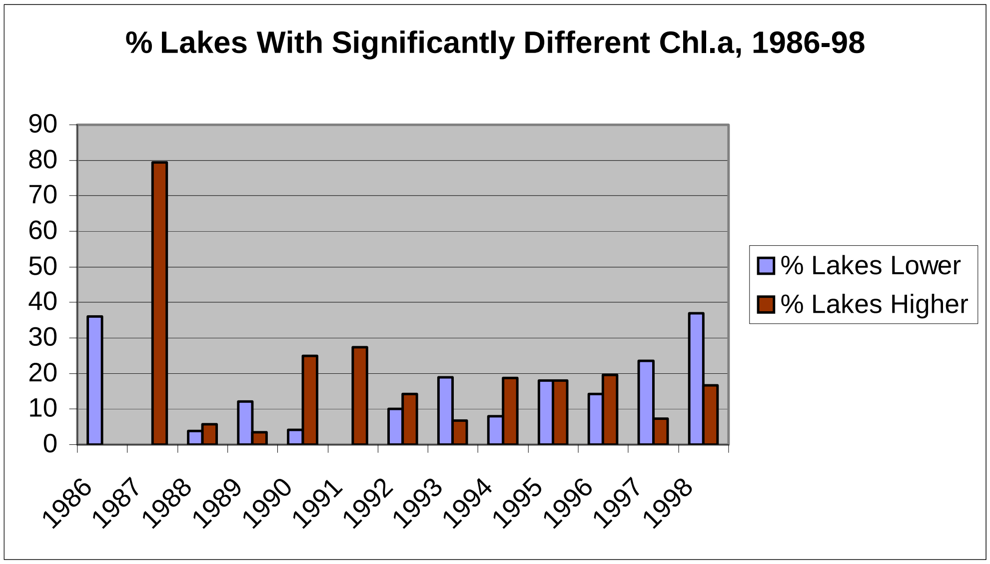

Figure 7. *Changes in Percentage of Lakes With Significant (>1SD) Deviation From 1986-98 Mean Chlorophyll a*

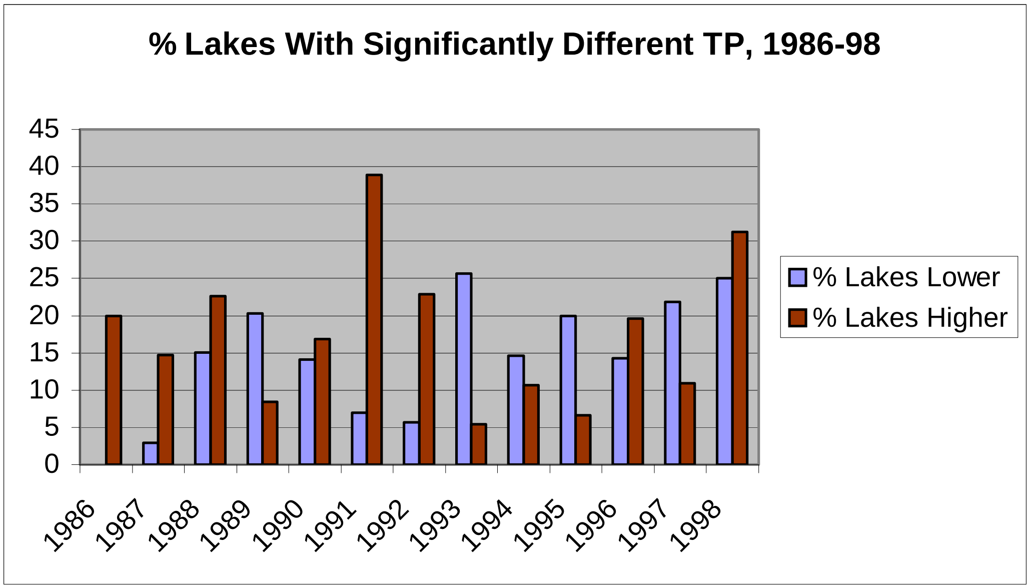

Figure 8. *Changes in Percentage of Lakes With Significant (>1SD) Deviation From 1986-98 Mean Total Phosphorus*

The slight increase in phosphorus concentrations (Figure 8) in many NYS lakes can be attributed, in part, to the variable sampling season, with some lakes sampled more during a period (spring) when nutrient levels might be elevated as a result of spring runoff. These early season readings moreso influenced the seasonal average because, in most cases, only the early (pre- mid June) and late (post mid-September) readings were utilized in the seasonal average due to the inconsistency in results between samples collected between June and September that were analyzed at a secondary laboratory and the results from samples collected early and late in the sampling season that were analyzed at the primary laboratory.

…What Was That About a Different Lab….?

Interpretation of the 1998 CSLAP dataset is somewhat marred by the need to transfer phosphorus samples collected from most CSLAP lakes between mid-June and mid-September to a second (private) laboratory. This ancillary use of the secondary laboratory was unexpectedly required by the inability of the primary CSLAP laboratory to analyze the large volume of phosphorus samples generated from the entirety of the environmental monitoring programs utilizing this laboratory, including CSLAP. A rigid quality control program conducted during and after this transfer determined that, while inter-laboratory comparisons are always challenging, some of the phosphorus analyses during this period may not be compatible with the high standard of accuracy consistently attained at other times. Since an independent process for correcting erroneous data or even identifying outlier data points has not yet been developed, CSLAP staff are not utilizing analyses from the questionable data sets in any long-term, and most short-term, data interpretations. Rather than compromise the integrity of the long-term data set and perhaps ascribing greater significance to some of the 1998 phosphorus data than is warranted by statistical analyses of these data, the 1998 phosphorus data analyzed within the window in question are utilized only within very limited confines. In short, the 1998 phosphorus data analyzed by a secondary laboratory are only included in data interpretations where noted. This helps to explain why the phosphorus data generally does not follow the above noted trends associated with the Secchi disk transparency and chlorophyll *a* monitoring. The specific differences for each lake are discussed below.

While the crisis that obviated the sample transfer has not completely subsided, CSLAP staff anticipate that the entire 1999 data set will meet same exemplary standards of accuracy and quality control found with all other historical CSLAP data. The NYSDEC and NYS Federation of Lakes deeply regrets the problems caused by this gap in completely verifiable data. It should be noted that CSLAP volunteers were instrumental in helping the NYSDEC to identify this quality control problem; while the “loss” of this partial phosphorus data set continues to be troublesome, there continue to be some limited uses of this data set, and, perhaps most importantly, other water quality parameters and indicators monitored by the CSLAP volunteers were not affected by this problem.

How About the 1998 Phosphorus Data at Findley Lake?

The following phosphorus samples collected at Findley Lake in 1998 were analyzed by the primary laboratory: the first (6/8) and last (9/14) samples. These sample analyses are included in all of the interpretations described below. The remaining phosphorus samples (from 6/22 to 8/31) were analyzed by the secondary laboratory. All of these other samples demonstrated phosphorus levels slightly higher than would be expected at Findley Lake given the date of sampling and the other (more reproduceable) chlorophyll *a* and Secchi disk transparency readings. However, since all of the eutrophication indicators vary slightly from one sampling session and year to the next, despite the relatively high correlation among these indicators, the discrepancy between the samples from the two laboratories might be relatively insignificant. As such, when appropriate, the questionable phosphorus data will be included in the below discussion about the 1998 data set when such data might help to enlighten the discussion.

Are There Any Seasonal Trends In The Water Quality Data For Findley Lake?

Seasonal Comparison of Eutrophication Parameters–1998

Figure 9-11 look at seasonal changes in 1998 and the typical year for eutrophication and perception.

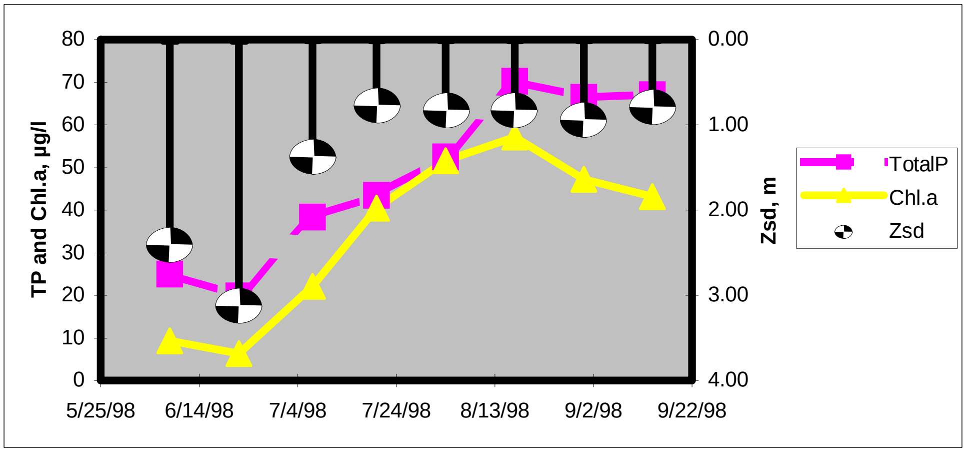

Figure 9. 1998 Eutrophication Data for Findley Lake

This graph illustrates the most recent condition of the lake.

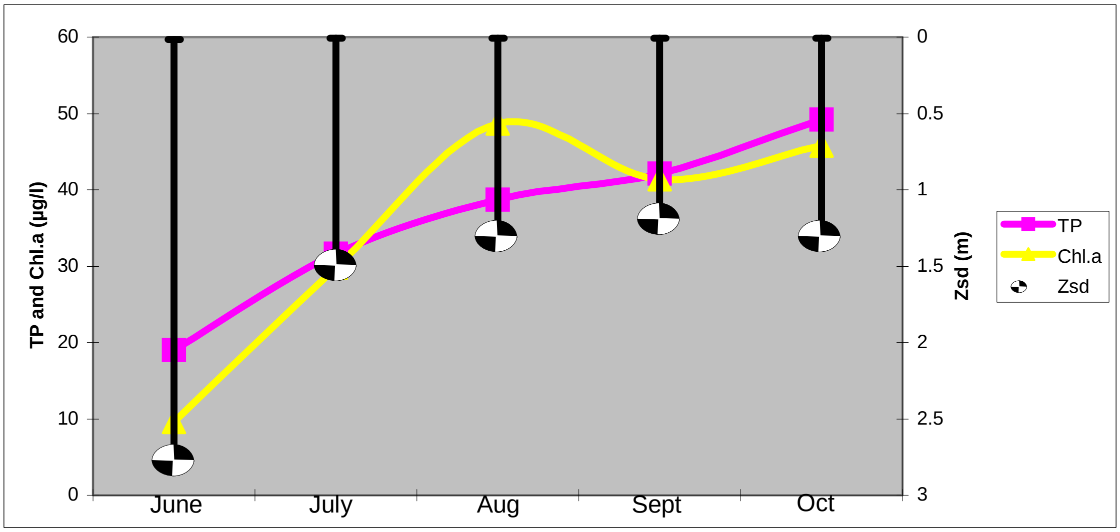

Figure 10. Typical Monthly Averages for Eutrophication Indicators at Findley Lake

This graph shows monthly averages compiled from all sampling seasons at the lake.

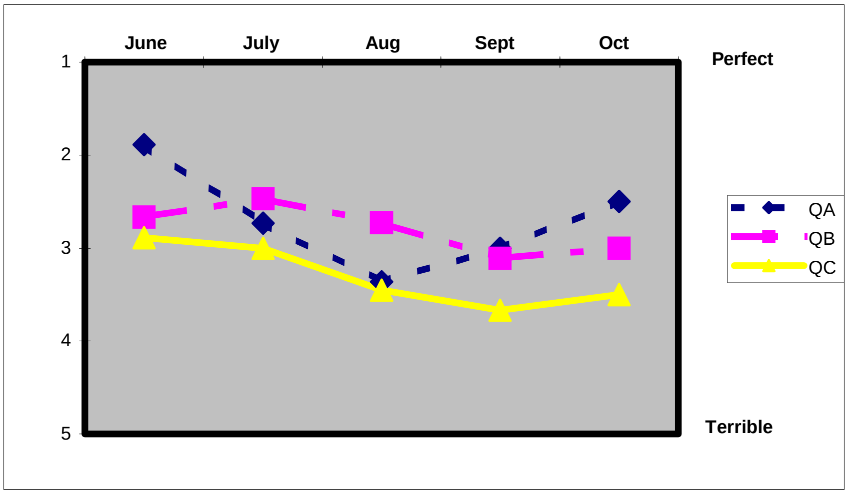

Figure 11. Typical Monthly Averages for Perception Indicators at Findley Lake

This graph shows monthly averages for QA (clarity), QB (weeds), and QC (recreation) for all years

These graphs provide evidence for the following conclusions about seasonal trends:

a) None of the measured eutrophication parameters demonstrated significant[1] change over the course of the sampling season, although water clarity (decreasing until mid-summer, then slightly increasing in the fall) and total phosphorus (increasing through the end of the sampling season) demonstrate "moderate" statistical association over time. Although chlorophyll *a* does not demonstrate any statistical change over the summer, it does, on average, increase during the sampling season, consistent with the more statistically valid changes in total phosphorus and Secchi disk transparency.

b) **There appears to be a strong seasonal correlation[1] between nutrients and algae** at Findley Lake, as also suggested above, and it is likely that algae growth is most often limited by phosphorus concentrations.

c) **There appears to be a strong seasonal correlation[1] between algae and water clarity** at Findley Lake, also as suggested above, and it is likely that algae levels frequently control water clarity.

d) There does not appear to be a strong correlation[1] between water color and clarity at Findley Lake, and it is likely that water color does not significantly influence water transparency.

e) Hypolimnetic phosphorus readings steadily increase over the summer, typical of productive lakes and consistent with the seasonal pattern associated with surface phosphorus readings.

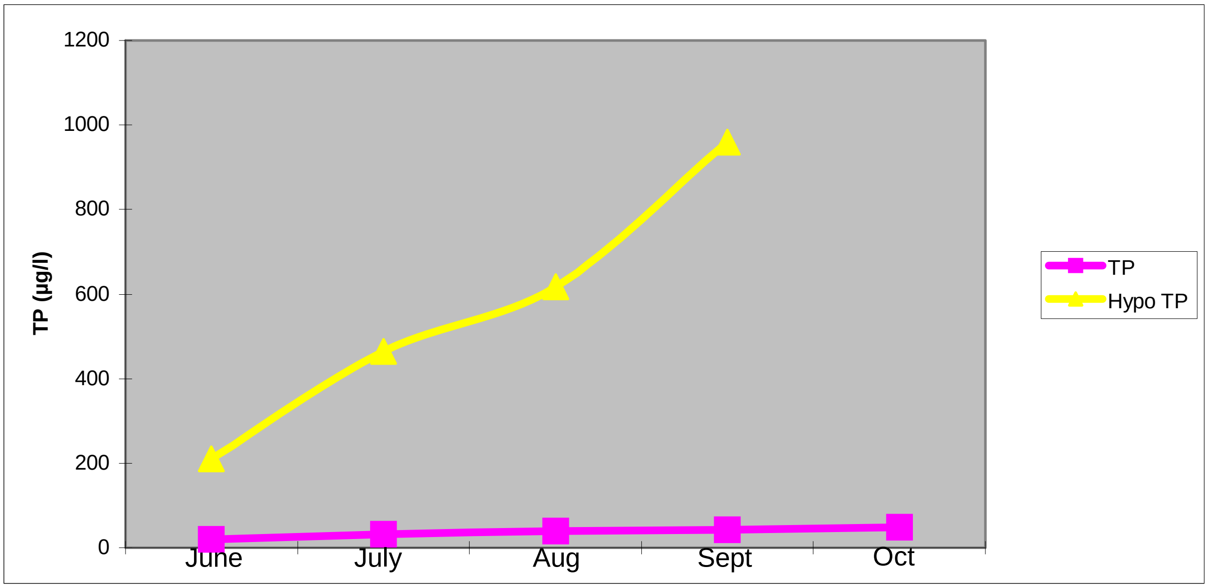

Figure 12. Typical Monthly Averages for Total Phosphorus at the Lake Surface and Hypolimnion

Discussion:

Water clarity, chlorophyll *a* and total phosphorus readings at the lake surface and in the bottom waters appear to change seasonally; although only nutrient concentrations and water transparency readings demonstrate even a moderate statistical association with time. This pattern has been relatively consistent in Findley Lake since at least 1986, and suggests that improvements in water clarity will necessarily need to address algae control, which in turn will require abatement of nutrient inputs from both external (watershed) and internal (bottom sediments) sources. Recreational perception of the lake (QC in Figure 11), steadily decreases through late summer, and stays at a level defined as "slightly" to "substantially" impaired, generally consistent with the perceived decrease in water clarity (QA) and increase in weed growth (QB) over the same period.

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[1] the definition of "significant" and "strong seasonal correlation", as defined here, are found in Appendix B

How has the lake changed since CSLAP began in 1986?

Annual Trends in Eutrophication Parameters and Recreational Assessment

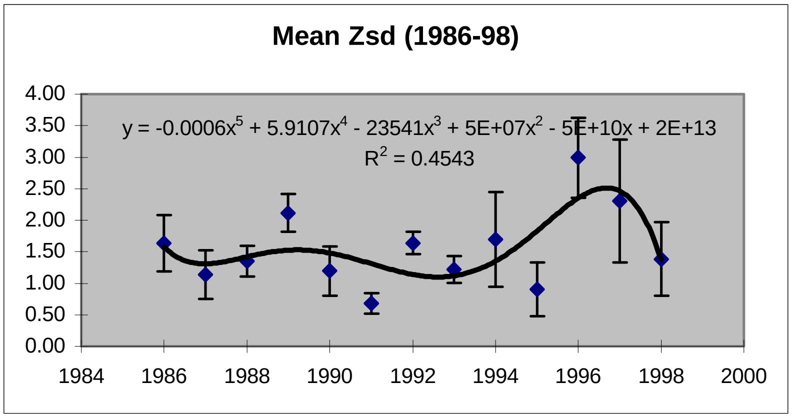

Figure 13
Mean Zsd (Water Clarity), 1986-1998

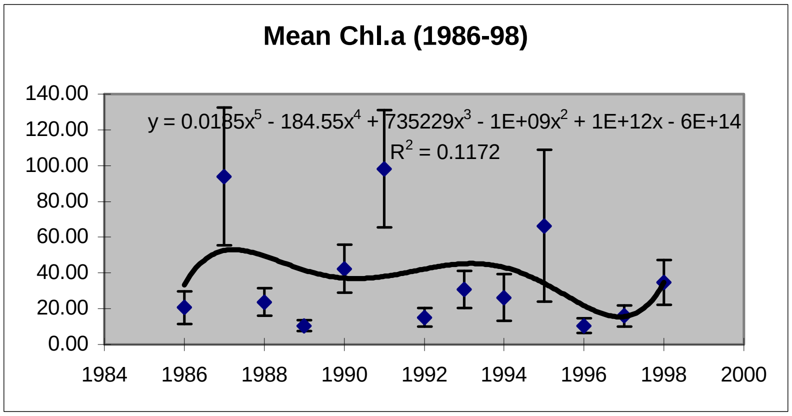

Figure 14
Mean Chl.a, 1986-1998

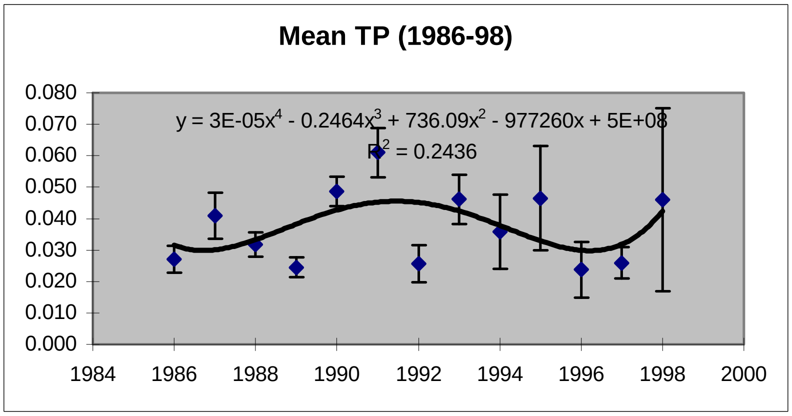

Figure 15
Mean TP, 1986-1998

Figures 13-16 compare the annual averages for each of the sampled eutrophication parameters, and provide information about the variability in each year's data and the best-fit lines for describing annual trends. Based on these four graphs, the following conclusions can be made:

a) None of the measured eutrophication parameters have demonstrated significant change since CSLAP sampling began on the lake

b) The statistically insignificant Secchi disk transparency pattern is consistent with the decrease in chlorophyll *a*, but somewhat inconsistent with the lack of change in phosphorus over the same period.

c) The statistically insignificant annual chlorophyll *a* decrease is inconsistent with the relative stability total phosphorus over the same period.

d) Phosphorus readings have not changed in any statistically meaningful way since 1986.

Discussion:

As note above, none of the measured CSLAP eutrophication indicators have demonstrated a significant change since 1986, although the intraseasonal and annual variation is often quite significant.

Recreational perception of the lake (on average) has been fairly consistent, and appears to be affected by the perception of both the physical condition of the lake (defined as water clarity) and the density and extent of aquatic plant growth.

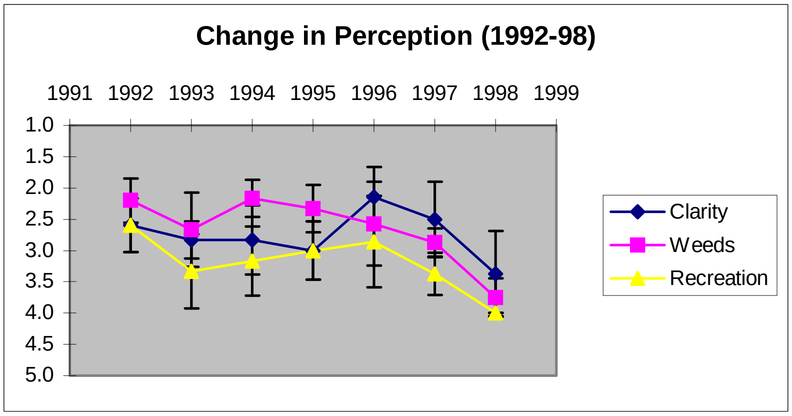

Figure 16
Mean Perception (Clarity, Weeds, and Recreation), 1992-1998

What About 1998 at Findley Lake?

As reported above, most of the CSLAP lakes sampled in 1998 showed no clear statewide or regional trends associated with eutrophication indicators (i.e. most CSLAP lakes did not demonstrate consistent changes in 1998 relative to previous sampling seasons). This does not mean that any given lake did not exhibit significant water quality changes, but only that any such changes were not mirrored by other lakes as a result of shared weather conditions, drainage basin changes, or other regional commonalities. The following section summaries the 1998 results for Findley Lake, and, where possible, postulates about the cause and/or source of data discrepancies from 1998 to previous CSLAP sampling seasons.

Findley Lake experienced water quality conditions that were similar to those from previous years. Nutrient (phosphorus) and algae levels were somewhat higher in 1998 than in the last three years, consistent with and probably contributory to the lower water clarity found during the 1998 sampling season. As noted above, the variability in 1998 was probably within the typical annual variation found in Findley Lake. This "typical" annual variability, however, seems to be closely related to weather patterns. In the three wettest years since CSLAP sampling began in 1986 (1992, 1996, and 1997, as recorded at the NOAA weather station in Sherman), three of the five highest annual water clarity averages and three of the four lowest phosphorus and chlorophyll *a* averages occurred. In the three driest years (1991, 1993, and 1995), more productive conditions prevailed, with three of the five lowest annual water clarity averages and three of the four highest nutrient averages occurring. This suggests that lake productivity increases (lower clarity, higher algae and nutrient levels) with decreasing amounts of rainfall. This might suggest that higher inputs from the watershed associated with increasing rainfall actually "improves" the lake, perhaps by diluting the internal nutrient loading (the migration of sediment-released nutrients from the lake bottom to the lake surface), although there is too little information about tributary nutrient levels to properly evaluate watershed impacts.

Findley Lake water quality did not respond in a consistent fashion, however, from sampling session to sampling session, by changing weather conditions- large storm events nor long dry periods seemed to significantly or predictably change water quality conditions.

Lake perception (Figure 16) appears to have been significantly influenced by the variability in water quality indicators, with changes in water clarity (and presumably weeds) strongly connected to changes in water quality.

None of the other sampling parameters (pH, conductivity, color, or nitrate) have changed significantly, and continue to characterize Findley Lake as an alkaline (stable and moderate to high pH), moderately hardwater, clearwater (moderately low levels of "staining" organic material), low nitrate lake.

How does this lake compare to other lakes?

Annual Comparison of Eutrophication Parameters and Recreational Assessment For Findley Lake in 1998 and Since 1986, With Neighboring Lakes, Lakes with the Same Lake Classification, and Other NYS or CSLAP Lakes

The graphs to the left illustrate comparisons of each eutrophication parameter and recreational perception at Findley Lake-in 1998, other lakes in the same drainage basin, lakes with the same water quality classification (each classification is summarized in Appendix C), and all of New York State. Please keep in mind that differences in watershed types, activities, lake history and other factors may result in differing water quality conditions at your lake relative to other nearby lakes. In addition, the limited data base for some regions of the state preclude a comprehensive comparison to neighboring lakes.

Based on these graphs, the following conclusions can be made about Findley Lake in 1998:

a) Using water clarity as an indicator, Findley Lake was more productive than other Allegheny River drainage basin lakes, other lakes with the same water quality classification (Class B), and other NYS lakes.

b) Using chlorophyll *a* as an indicator, Findley Lake is more productive than other Class B, Allegheny River basin, and other NYS lakes.

c) Using total phosphorus concentrations as an indicator, Findley Lake is more productive than other Class B, Allegheny River drainage basin and other NYS lakes.

d) Using QC on the field observations form as an indicator, Findley Lake is less suitable for recreation than other Class B, Allegheny River drainage basin lakes, and other NYS lakes.

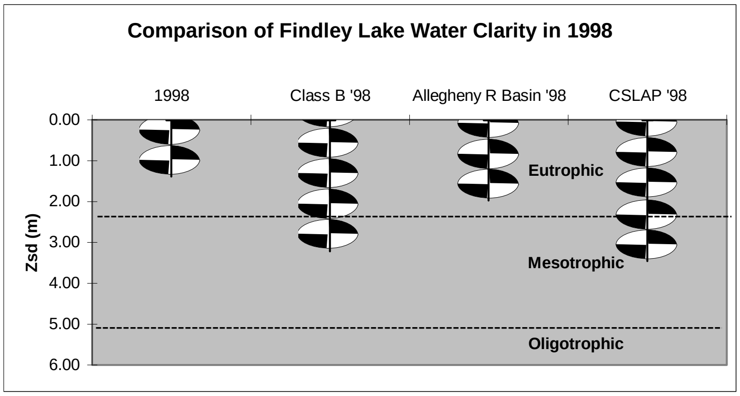

Figure 17. *Comparison of 1998 Secchi Disk Transparency to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 1998*

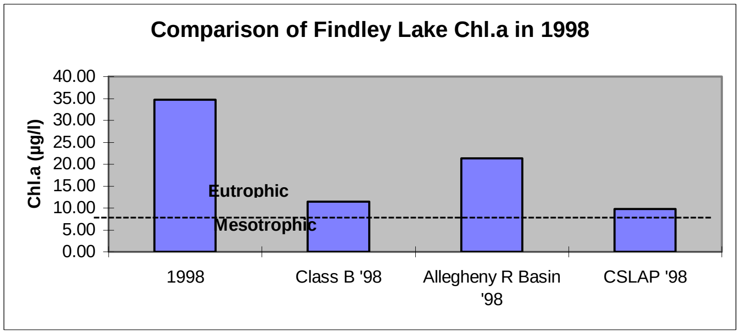

Figure 18. *Comparison of 1998 Chlorophyll a to Lakes with the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 1998*

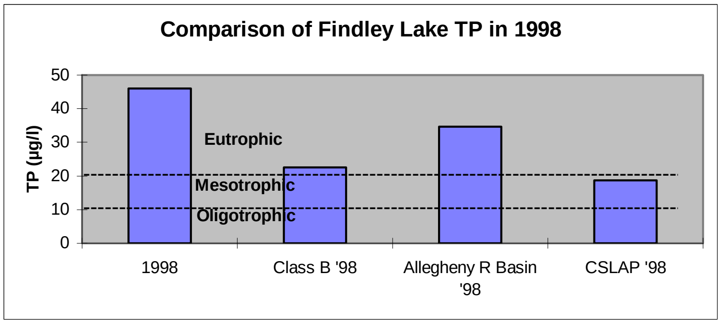

Figure 19. *Comparison of 1998 Total Phosphorus to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 1998*

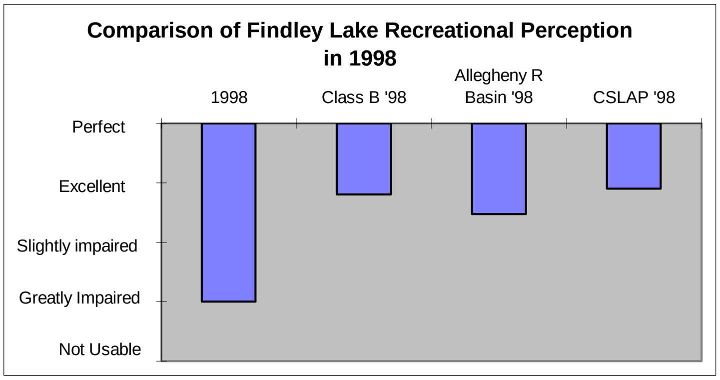

Figure 20. *Comparison of 1998 Recreational Perception*

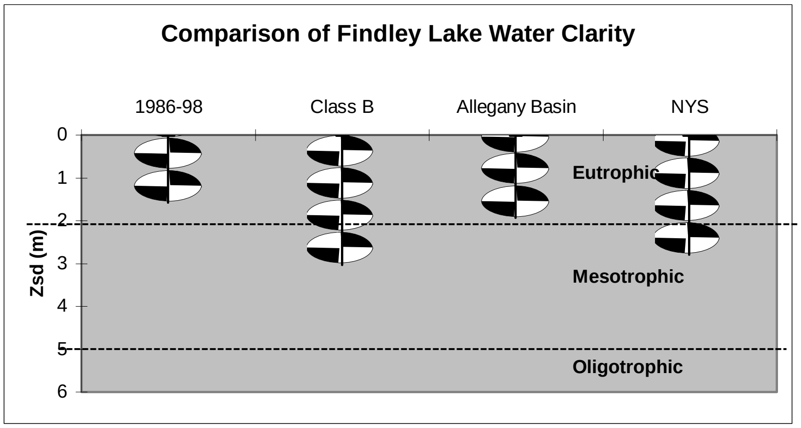

Figure 21. *Comparison of Average Secchi Disk Transparency to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

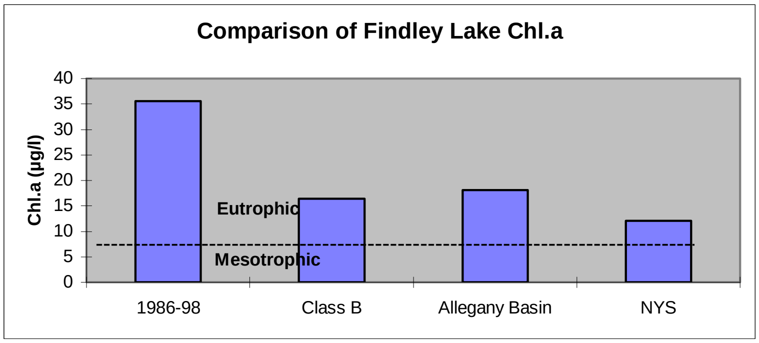

Figure 22. *Comparison of Average Chlorophyll a to Lakes with the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

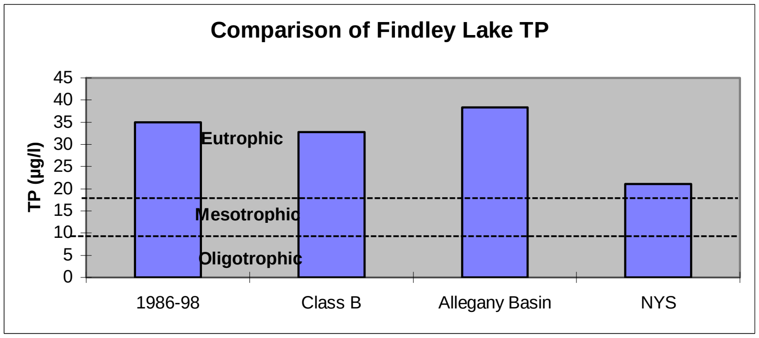

Figure 23. *Comparison of Average Total Phosphorus to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

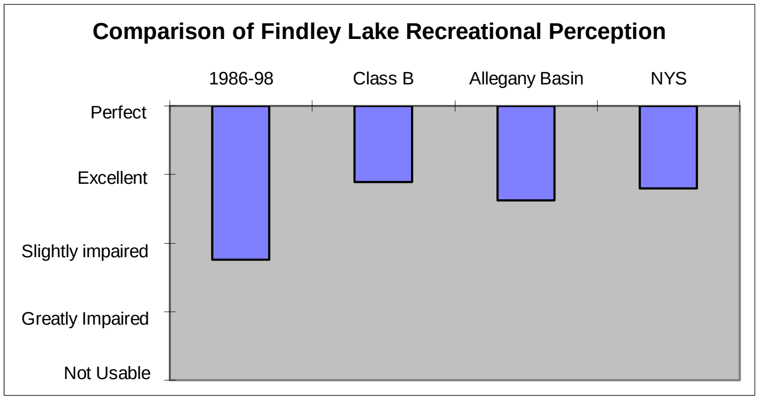

Figure 24. *Comparison of Average Recreational Perception*

Based on these graphs, the following conclusions can be made about Findley Lake since 1986:

a) Using water clarity as an indicator, Findley Lake is more productive than other Allegheny River drainage basin lakes, other lakes with the same water quality classification (Class B), and other NYS lakes.

b) Using chlorophyll *a* as an indicator, Findley Lake is more productive than other Class B, Allegheny River basin, and other NYS lakes.

c) Using total phosphorus concentrations as an indicator, Findley Lake is about as productive as other Class B and Allegheny River drainage basin, and more productive than other NYS lakes.

d) Using QC on the field observations form as an indicator, Findley Lake is less suitable for recreation than other Class B, Allegheny River drainage basin lakes, and other NYS lakes.

Discussion:

The generally unfavorable recreational assessment of Findley Lake is consistent with the water quality conditions in the lake, and the relatively high levels of weed growth in the lake. The comparison of Findley Lake to other lakes was similar in 1998 to such comparisons in previous CSLAP sampling season. The difference in comparisons in Figures 19 and 23 probably reflects the higher TP measurements in Findley Lake at the end of the sampling season, corresponding to half of the samples included in the 1998 averages (compared to most years, when the end of season peak readings account for << 50% of the readings)

Priority Waterbody List and Water Quality Standards Issues

The Priority Waterbody List (PWL) is an inventory of all waters in New York State known to have designated water uses with some degree of impairment of which are threatened by potential impairment, although it is slowly evolving into an inventory of all waterbodies for which sufficient information is available to assess the condition and/or usability of the waterbody. PWL waters 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 and agencies to evaluate lakes for inclusion on the PWL, and the process for incorporating lakes data is slowly becoming more standardized.

Although specific numeric criteria have not yet been developed to characterize sampled lakes in the available use-based PWL categories (precluded, impaired, stressed, or threatened), evaluations are starting to 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 the listing.

Findley Lake is presently among the lakes listed on the PWL, with impairments identified for fishing, fish survival, and aesthetics. CSLAP data cannot adequately address impairments associated with fishing or fish survival (except for the limited number of CSLAP lakes with dissolved oxygen data). The CSLAP data, including water quality samples, volunteer perceptions, and physical measurements, indicate that **Findley Lake might be a candidate for both bathing and boating impairment listings**. **The bathing listing may be closest to “impaired”**, caused by high nutrient concentrations (based on the evaluation criteria listed above, probably at a “stressed” or “impaired” level), recreational use perception (using the criteria above, probably at a “stressed” level), water clarity readings (probably consistent with “threatened”), algae levels (probably consistent with “impaired”), and weed density (probably consistent with “stressed”). **The boating listing may be closest to “stressed”**, based on weed density (see above). **CSLAP perception data suggest that the “impaired aesthetics” listing is probably correct**. These PWL “suggestions” may not be official or represent the categories for the final listing

Most of the water quality standards associated with the CSLAP sampling parameters (Figure 25) are either not easily quantifiable (in the case of narrative standards), not violated in lakes, since the standards address conditions rarely found in lakes. For example, nitrate concentrations have never exceeded 3 mg/L in any of the >6000 CSLAP samples collected since 1986, and in fact rarely exceed 1 mg/L. None of the major eutrophication indicators have true water quality standards- the “acceptable” Secchi disk transparency level corresponds to a NYSDOH sanitary code requirement for official swimming beaches (except the Great Lakes), and the numeric acceptable phosphorus level corresponds to a guidance value (to guide water quality management decisions, such as the level of phosphorus treatment requirement for wastewater treatment plants). However, these standards or acceptable levels provide an indication of present or potential water quality problems, and in part figure in the designation of PWL status.

Findley Lake regularly exhibits phosphorus concentrations above the state guidance value (appx. 88% of all samples since 1986) and Secchi disk transparency readings above the state bathing beach requirement (appx. 40% of all readings since 1986). The state upper pH water quality standard (=8.5) was exceeded on two occasions since 1986. It is now known if the narrative standards associated with nutrients and color could be interpreted as violated.

Figure 25. Water Quality Standards Associated With Class B Lakes

Parameter	Acceptable Level	To Protect…..
Secchi Disk Transparency	> 1.2 meters	Swimming
Total Phosphorus	< 0.020 mg/L and Narrative*	Swimming
Chlorophyll a	None	NA
Nitrate Nitrogen	< 10 mg/L and Narrative	Drinking Water
True Color	Narrative*	Swimming
pH	< 8.5 and > 6.5	Aquatic Life
Conductivity	None	NA

Narrative Standards – Color: None in amounts that will adversely affect the color or impair the waters for their best usages (for Class B waters, this is swimming)
Phosphorus and Nitrogen: None in amounts that will result in the growths of algae, weeds and slimes that will impair the waters for their best usages (Class B= swimming)
The 0.020 mg/l threshold for TP corresponds to a guidance value, not standard
The 10 mg/L Nitrate standard strictly applies to only Class A or higher waters, but is included here since some Class B lakes are informally used for potable water intake

IV. CONSIDERATIONS FOR LAKE MANAGEMENT

CSLAP is intended to be used for a variety of purposes, such as a means for collecting some information required for comprehensive lake management, although it is not capable of collecting all the needed information. The Five Year Summary Report was envisioned to provide an extensive summary and interpretation of all the water quality, survey, perception, and background information available for each CSLAP lake. The Reports also contained a recommendation section; a summary of the most pressing lake problems as identified by CSLAP, a compendium of strategies often used to address these problems, and identification of those strategies most likely to work at the lake, given various ecological, logistic, and economic considerations.

Staff limitations and the time intensive nature of such an in depth analysis precluded the development of more than a few of these reports. However, the report authors attempt to include in this report a ***broad summary of the major lake problems and "considerations" for lake management.*** These include only those lake problems which may have been defined by CSLAP sampling, such as physical condition (algae and water clarity), aquatic plant coverage (type and extent of weed populations), and recreational suitability of the lake, as related to contact recreation. These broad categories may not encompass the most pressing issue at a particular time at any given program lake; for example, local concerns about filamentous algae or site-specific algae blooms may not be addressed in CSLAP sampling. While there is some discretionary latitude for CLSAP trained volunteers to report and assess some of these site specific conditions or concerns on the CSLAP Field Observations Form, such as algae blooms or shoreline vegetation, this section is limited by the confines of the sampling program, and the categories represent the most common, broadest issues within the lake management.

If these summaries look like a compendium of Diet for a Small Lake, then (congratulations!) you have been doing your reading. Each summarized management strategy is more extensively outlined in Diet, and this joint NYSDEC-NYSFLA publication should be consulted for more details and for a broader context of in-lake or watershed management techniques. These "considerations" should not be construed as "recommendations", since there is insufficient information available through CSLAP to assess if or how a lake should be managed. Issues associated with local environmental sensitivity, permits, and broad community management objectives cannot be addressed here. Rather, the following section should be considered as "tips" should a lake association decide to undertake managing problems defined by CSLAP water quality data or articulated by perception data. In 1997 and 1998, NYSDEC queried each of the CSLAP lake associations for information about management activities, historical and contemporary, on their lakes. When appropriate, this information, and other lake-specific or local "data" (such as the presence of a controllable outlet structure) is reported in ***bold*** in this "considerations" section.

Management Focus: **Water Clarity/Algae/Physical Condition/Recreational Condition**

Problem	**Probable cause**	**Probable source**
Poor water clarity	Excessive algae	**Excessive phosphorus loading** from septics, watershed runoff (stormwater, construction sites, agriculture, ...)

Discussion:
The water sampling results indicate that recreational impairments in this lake are related to lower-than-desired water transparency. Water clarity in this lake appears to be strongly related to (planktonic) algae, which is linked to nutrient concentrations. A management focus to improve water clarity involves reducing algae levels, which is linked to reducing nutrient concentrations in the lake and within the watershed. These considerations do not constitute recommendations, since it is not known if the lake association is attempting to improve water clarity, but these considerations are a discussion of some management alternatives which may have varying levels of success addressing these problems.

Potential In-lake controls: **The strategies outlined below primarily address the cause, but not the ultimate source, of problems related to poor water clarity. As such, their effectiveness is necessarily short-term,** but perhaps more immediately realized, relative to strategies that control the source of the problem. The problems may continue or worsen if the source of the problem is not addressed, using strategies such as those described under **Watershed Controls** below. In-lake controls are listed in order of frequency of use in the "typical" NYS lake: *copper sulfate, precipitation/inactivation, hypolimnetic withdrawal, aeration, dilution/flushing, artificial circulation, food web manipulation*. **It is not known (by the report authors) how many of these activities have already been attempted or rejected at Findley Lake.**

- *Copper sulfate* is an algacide that is frequently used to control nuisance levels of planktonic algae (dots of algae throughout the water column) or filamentous algae (mats of algae on the lake surface, weeds, or rocks) throughout the lake. It is usually applied 1-3x per summer in granular or liquid form, usually by a licensed applicator. Many people feel that it is effective at reducing algae levels to below nuisance conditions, others feel it only "flattens the peak" of the worst blooms, and still others think it is merely a placebo. There are concerns about the long-term affect of copper on the macroinvertebrate communities that live on the lake bottom, and a deleterious affect of copper on the zooplankton (microscopic animals that feed on algae) community. This could, in some lakes, ultimately cause a "bounce-back" algae bloom that is worse than the original bloom.

- *Precipitation/Inactivation* involves adding a chemical binding agent, usually alum, to bind and precipitate phosphorus, removing it from the water column, and to seal bound phosphorus in the sediment, rendering it inactive for release to the overlying water (as often occurs in stratified lakes with low oxygen levels). It has a mixed rate of success in NYS, although when successful it usually provides long-term control of nutrient release from bottom sediments (it is only a short-term method for removing existing phosphorus from the water column). It is not recommended for lakes with low pH or buffering capacity (like most small NYS lakes at high elevation), for at low pH, aluminum can be toxic to fish. Since CSLAP does not conduct extensive deepwater monitoring, or any sediment release rate studies, the efficacy of this strategy, based on CSLAP data, is not known.

- *Hypolimnetic withdrawal* takes deoxygenated, high nutrient water from the lake bottom and discharges the water downstream from the lake. This strategy is sort of a hybrid of aeration and dilution/flushing, and is usually limited to lakes in which control structure (such as a dam) exists where the release valve is located below the thermocline. It has been quite successful and usually inexpensive when applied properly, but must only be employed when downstream waterbodies will not be adversely impacted by the pulse of low oxygen water (which may include elevated levels of hydrogen sulfide, ammonia, and iron). **It does not appear that a mechanism exists to conduct hypolimnetic withdrawal in Findley Lake, however**.

- *Aeration* involves pumping or lifting water from the lake bottom (hypolimnion) for exposure to the atmosphere, with the oxygenated waters returning to the lake bottom. The airlift device is usually quite expensive, and operating costs can be quite high. There is also a risk of breaking down the thermocline, which can result in an increase in algae levels and loss of fish habitat for many cold-water species. However, most of the limited number of aeration projects have been quite successful. Since CSLAP does not collect dissolved oxygen data for most program lakes, it is not definitively known whether aeration (or hypolimnetic withdrawal) would benefit this lake. *Artificial circulation* is the process by which air is injected into the hypolimnion to eliminate thermal stratification- it is aeration by circulation.

- *Dilution/flushing* involves using high quality dilution water to reduce the concentration of limiting nutrients and increase the rate at which these nutrients are flushed through the lake. This strategy requires the availability of high quality dilution water and works best when the lake is small, eutrophic, and no downstream waterbodies that may be affected by the pulse of nutrients leaving the lake. For these lakes, high quality dilution water is probably not available from the surrounding watershed, because such an input would already be flushing the lake. **It is unlikely that a significant source of dilute water exists for flushing Findley Lake.**

- *Food web manipulation* involves altering the population of one component within the food web, most frequently algae, by altering the populations of other components in the same web. For algae control, this would most frequently involve stocking the lake with herbivorous (algae-eating) fish, but this may be at the expense of other native fish. While this procedure has worked in some situations, it is inherently risky, and not recommended at lakes in which the native fisheries serve as a valuable local resource. **Although the authors do not possess specific information about fisheries concerns in Findley Lake, this strategy would probably not be recommended among the first to try at the lake.**

<u>Watershed controls</u>*:* **These strategies are effective at controlling the source of the problem, and thus provide more long-term relief, although implementation of these strategies usually takes much longer than in-lake controls**. *Watershed strategies include monitoring, controlling nutrient loading, instituting land use controls to limit runoff, limiting the use of lawn fertilizers, and reducing waterfowl feeding.* **As with in-lake controls, it is not known how many of these watershed controls have been implemented at Findley Lake.**

<u>Monitoring</u> may be necessary to quantify the problem and pinpoint the source of pollutants. This may be quantitative (water quality data in tributaries or near-shore areas), semi-quantitative (use of biological indicators to determine stressed stream segments), or qualitative (windshield surveys and stream walks to identify suspect areas). **Findley Lake has been involved in several lake association or academic-based water quality monitoring programs in addition to CSLAP.**

<u>Nutrient controls</u> can take several forms, depending on the original source of the nutrients:

- Septic systems can be regularly pumped or upgraded to reduce the stress on the leach fields which can be replaced with new soil or moving the discharge from the septic tank to a new field). Pumpout programs are usually quite inexpensive, particularly when lakefront residents negotiate a bulk rate discount with local pumping companies. Upgrading systems can be expensive, but may be necessary to handle the increased loading from camp expansion or conversion to year-round residency. Replacing leach fields alone can be expensive and limited by local soil or slope conditions, but may be the only way to reduce actual nutrient loading from septic systems to the lake. It should be noted that upgrading or replacing the leach field may do little to change any bacterial loading to the lake, since bacteria are controlled primarily within the septic tank, not the leach field.
- Stormwater runoff control plans include street cleaning, artificial marshes, sedimentation basins, runoff conveyance systems, and other strategies aimed at minimizing or intercepting pollutant discharge from impervious surfaces. The NYSDEC has developed a guide called <u>Reducing the Impacts of Stormwater Runoff</u> to provide more detailed information about developing a stormwater management plan. This is a strategy that cannot generally be tackled by an individual homeowner, but rather requires the effort and cooperation of lake residents and municipal officials.
- There are nearly an infinite number of agriculture management practices to reduce nutrient export or retain particles lost from agricultural fields, related to fertilizer controls, soil erosion practices, and control of animal wastes. These practices are frequently employed in cooperation with county Soil and Water Conservation District offices, and are described in greater detail in the NYSDEC's <u>Controlling Agricultural Nonpoint Source Water Pollution in New York State.</u> Like stormwater controls, these require the cooperation of many watershed partners, including farmers.
- Streambank erosion can be caused by increased flow due to poorly managed urban areas, agricultural fields, construction sites, and deforested areas, or it may simply come from repetitive flow over disturbed streambanks. Control strategies may involve streambank stabilization, detention basins, revegetation, and water diversion.

<u>Land use restrictions</u> . Development and zoning tools such as floodplain management, development clusters to less environmentally-sensitive areas in the watershed; deeded/ contractual access to the lake, and cutting restrictions can be used to reduce pollutant loading to lakes. This voluntary approach varies greatly from one community to the next and frequently involves balancing lake use protection with land use restrictions. State law gives great latitude to local government in developing land use plans.

<u>Lawn fertilizers</u> frequently contain phosphorus, even though nitrogen is more likely to be the limiting nutrient for grasses and other terrestrial plants. By using lawn fertilizers with little or no phosphorus, eliminating lawn fertilizers or using lake water as a "fertilizer" at shoreline properties, fewer nutrients may enter the lake. Planting a buffer strip (trees, bushes, shrubs) along the shoreline can reduce the nutrient load leaving a residential lawn.

Waterfowl introduce nutrients, plant fragments, and bacteria to the lake water through their feces. Feeding the waterfowl encourages congregation which in turn concentrates and increases this nutrient source

Management Focus: **The Impact of Weeds on Recreational Condition**

Problem	Probable Cause	Probable Source
Excessive weed growth	Excessive nutrients and sediment	Excessive pollutant loading from watershed runoff (stormwater, construction sites, agriculture, etc.), septics, bottom disturbance,...

Perception data indicate that aquatic weed growth is perceived to inhibit recreational use of this lake, at least in some parts of the lake or during certain times of the year. Nuisance weed growth in lakes is influenced by a variety of factors- water clarity, sediment characteristics, wave action, competition between individual plant species, sediment nutrient levels, etc. In most cases, excessive weed growth is associated with the presence of exotic, (non-native) submergent plant species such as Eurasian watermilfoil (*Myriophyllum spicatum*), although some lakes are inhibited by dense growth of native species. Some of these factors cannot be controlled by lake association activities, while others can only be addressed peripherally. For example, sediment characteristics can be influenced by the solids loading to the lake. With the exception of some hand harvesting activities, aquatic plant management should only be undertaken when lake uses (recreational, municipal, economic, etc.) are significantly and regularly threatened or impaired. Management strategies can be costly and controversial, and a variety of factors should be weighed. Aquatic plant management most efficiently involves a mix of immediate, in-lake controls, and long-term measures to address the causes and sources of this excessive weed growth.

Potential in-lake controls for weeds **The following strategies primarily address the cause, but not the ultimate source, of problems related to nuisance aquatic plant growth.** As such, their effectiveness is necessarily short-term. Until the sources of the problem are addressed, however, it is likely that these strategies will need to be continuously employed. Some of these are listed in the **Watershed Controls**, as discussed above. Except where noted, most of these in-lake techniques do not require permits in most parts of the state, but, as always, the NYDEC Regional Offices should be consulted before undertaking these strategies. These techniques are presented within the context of potential management for the conditions (types of nuisance plants, extent of problem) reported through CSLAP: In-lake control methods include*: physical/mechanical plant management techniques, chemical plant management techniques, biological plant management techniques*

Physical/mechanical control techniques utilize several modes of operation to remove or reduce the growth of nuisance plants. The most commonly employed procedures are the following:

- *Mechanical harvesters* physically remove rooted aquatic plants by using a mechanical machine to cut and transport plants to the shore for proper storage. Mechanical harvesters are probably the most common "formal" plant management strategy in New York State. While it is essentially akin to "mowing the (lake) lawn", it usually provides access to the lake surface and may remove some lake nutrients if the cut plants are disposed out of the watershed. However, if some shallow areas of the lake are not infested with weeds, they will likely become infested after mechanical harvesting, since fragments frequently wander from cut areas to barren sediment and colonize new plant communities. Harvesters are very expensive, but can be rented or leased. *Rotovators* are rotovating mechanical harvesters, dislodging and removing plants and roots. *Mechanical cutters* cut, but don't remove, vegetation or fragments. Box springs, sickles, cutting bars, boat props, and anchors often serve as mechanical cutters. Since Eurasian watermilfoil appears to be the most likely object of management, and since this plant spreads rapidly via fragmentation, these strategies will likely be effective only for temporarily opening navigational channels and/or if milfoil already occupies most of the available niches for plant growth.

- *Hand harvesting* is the fancy term for lake weeding- pulling out weeds and the root structure by hand. It is very labor intensive, but very plant selective (pull the "weeds", leave the "plants"); and can be effective if the entire plant is pullled and if the growth area is small enough to be fully cleared of the plant. *Diver dredging* is like hand harvesting with a vacuum cleaner- in this strategy, scuba divers hand-pull plants and place them into a suction hose for removal into a basket in a floating barge. It is also labor intensive and can be quite expensive, but it can be used in water deeper than about 5ft (the rough limit for hand harvesting). It works best where plant beds are dense, but is not very efficient when plant beds or stems are scattered. **In Findley Lake, this would likely be limited to common swimming areas or navigational channels.**
- *Water level manipulation* is the same thing as *drawdown*, in which the lake surface is lowered, usually over the winter, to expose vegetation and sediments to freezing and drying conditions. Over time this affects the growing characteristics of the plants, and in many cases selectively eliminates susceptible plants. This is obviously limited to lakes that have a mechanism (dam structure, controlled culvert, etc.) for manipulating water level. It is usually very inexpensive, but doesn't work on all plants and there is a risk of insufficient lake refill the following spring (causing docks to be orphaned from the waterfront). **It is not known if the dam on Findley Lake is sufficiently controllable to use this strategy.**
- *Bottom barriers* are screens or mats that are placed directly on the lake bottom to prevent the growth of weeds by eliminating sunlight needed for plant survival. The mats are held in place by anchors or stakes, and must be periodically cleaned or removed to detach any surface sediment that may serve as a medium for new growth. The mats, if installed properly, are almost always effective, with relatively few environmental side-effects, but are expensive and do not select for plant control under the mats. It is best used when plant communities are dense but small in area, and is not very efficient for lake-wide control. As with hand harvesting, this strategy would be limited to common swimming or navigational areas.
- *Sediment removal*, also referred to as dredging, controls aquatic plants by physically removing vegetation and by increasing the depth of the lake so that plant growth is limited by light availability. Dredging projects are usually very successful at increasing depth and controlling vegetation, but they are very expensive, may result in significant side effects (turbidity, algal blooms, potential suspension of toxic materials), and may require significant area for disposal. This procedure usually triggers an extensive permitting process.

Chemical control techniques involve the use of aquatic herbicides to kill undesired aquatic vegetation and prevent future nuisance weed growth. These herbicides come in granular or liquid formulations, and can be applied in spot- or whole-lake treatments. Some herbicides provide plant control by disrupting part of the plants life cycle or ability to produce food, while others have more toxicological effects. Aquatic herbicides are usually effective at controlling plants, but other factors in considering this option include the long term control (longevity), efficiency, and plant selectivity. Effectiveness may also depend on dosage rate, extent of non-target (usually native) plant growth, flushing rate, and other factors. The use of herbicides is often a highly controversial matter frequently influenced by personal philosophies about introducing chemicals to lakes. Some of the more recently registered herbicides appear to be more selective and have fewer side effects than some of the previously utilized chemicals. Chemical control of nuisance plants can be quite expensive, and, with only few exceptions, require permits and licensed applicators. **Herbicides such as Sonar or 2,4-D would probably be the most effective chemical agents in selectively controlling Eurasian watermilfoil in Findley Lake, although the relatively fast flushing rate in the lake may preclude the use of these herbicides within the "usual" application window (spring to early summer) and although other strategies may be more effective.**

Biological control techniques presently involve the stocking of sterile grass carp, which are herbivorous fish that feed exclusively on macrophytes (and macroalgae). Grass carp, when stocked at the appropriate rate, have been effective at controlling nuisance weeds in many southern states, although their track record in NYS is relatively short, particularly in lakes with shallow or adjacent wetlands or in larger (>100 acre) lakes. These carp may not prefer the nuisance plant species desired for control (in particular Eurasian watermilfoil), and they are quite efficient at converting macrophyte biomass into nutrients that become available for algae growth. **As such, this may not be the first choice for controlling weed growth in Findley Lake. This is, however, one of the less expensive means of plant control.**

Naturally occurring biological controls may include native species of *aquatic weevils and moths* which eat Eurasian watermilfoil. These organisms feed on Eurasian watermilfoil, and control nuisance plants in some Finger Lakes and throughout the Northeast. However, they also inhabit other lakes with varied or undocumented effectiveness for the long term. Because these organisms live in the canopy of beds and feed primarily on the top of the plants, harvesting may have severe negative impact on the population. Research is on-going about their natural occurrence, and as to their effectiveness both as a natural or deliberately- introduced control mechanism for Eurasian watermilfoil. **The Findley Lake community is strongly considering the use of stocked insects (weevils) to control Eurasian watermilfoil beds.**

Watershed controls: The primary watershed "pollutant" contributing to nuisance aquatic weed growth is probably sediment and silt, particularly since these particles frequently carry nutrients that are necessary for aquatic plant growth. **The Watershed controls noted above may also be effective at reducing pollutant loading to Findley Lake as related to excessive weed growth**. These strategies are effective at controlling the source of the problem, and thus afford more long-term relief. Implementation of these strategies usually takes much longer than in-lake controls.

- **Boat propellers** frequently get entangled by weeds and weed fragments. Propellers not cleaned after leaving an "infected" lake or before entering an "uncontaminated" lake may introduce plant fragments to the lake. This is a particular management consideration because many nuisance plant species spread by propagation, requiring only a fragment of the plant to grow**.**

- **Waterfowl** introduce nutrients, plant fragments, and bacteria to the lake water through their feces. Encouraging the congregation of waterfowl by feeding will increase the likelihood that these fragments, particularly plants like Eurasian watermilfoil that easy fragment and reproduce through small fragments, can be introduced to a previously uncolonized lake.

- **Weed watcher** ("...look out for this plant..") signs have been successful in reducing the spread of nuisance aquatic plants. They are usually placed near high traffic areas, such as boat launch sites, marinas, and inlets and outlets.

Appendix A. CSLAP Data for Findley Lake

(refer to CSLAP Data Keys on previous page)

LNum	PName	Date	Zbot	Zsd	Zsamp	Tot.P	NO3	TColor	pH	Cond25	Chl.a	TAir	TH20	QA	QB	QC	QD
24	Findley L	6/15/86	11.5	3.00	1.5	0.026	0.12	5	6.92	190	2.22	18	19				
24	Findley L	6/21/86	11.5	3.13	1.5	0.013	0.11	5	7.50	180	2.29	23	20				
24	Findley L	6/29/86	11.5	2.25	1.5	0.011	0.09	10	7.62	185	2.00	22	21				
24	Findley L	7/3/86	11.5	2.75	1.5	0.022	0.11	15	7.82	194	0.80	15	20				
24	Findley L	7/11/86	11.5	2.00	1.5	0.021	0.03	2	7.84	185	5.03	15	20				
24	Findley L	7/18/86	11.5	1.50	1.5	0.030	0.06	5	8.38	194		30	24				
24	Findley L	7/24/86	11.5	2.63								30	25				
24	Findley L	8/1/86	11.5	1.63	1.5	0.028	0.03	14	8.05	197		26	24				
24	Findley L	8/5/86	11.5	1.13	1.5	0.018	0.03	11	7.75	191	53.30	26	25				
24	Findley L	8/12/86			1.5	0.023	0.03	13	8.15	199	15.30						
24	Findley L	8/16/86	11.5	0.75	1.5	0.035	0.03	12	8.98	195	36.30	24	24				
24	Findley L	8/21/86	11.5	0.63	1.5	0.037	0.03	15	8.12	198	40.00	26	25				
24	Findley L	8/30/86	11.5	1.00	1.5	0.034	0.03	3	7.60	205	29.60	20	19				
24	Findley L	9/5/86	11.5	0.75	1.5	0.033	0.03	3	8.17	206	25.90	21	20				
24	Findley L	9/14/86	11.5	0.63	1.5	0.036	0.03	13	7.55	215	22.20	14	19				
24	Findley L	9/21/86	11.5	0.75	1.5	0.039	0.03	8	7.29	214	34.00	17	18				
24	Findley L	6/8/87	11.5	2.75	1.5	0.023	0.03	15	8.10	201		22	24				
24	Findley L	6/14/87	11.5	3.00	1.5	0.018		12	8.22	198		25	22				
24	Findley L	6/21/87	11.5	2.00	1.5	0.023	0.01	15	7.83	203	17.00	27	25				
24	Findley L	6/28/87	11.8	1.25	1.5	0.021	0.01	15	7.76	202	37.70	19	23				
24	Findley L	7/5/87	11.8	0.75	1.5	0.032	0.01	11	7.70	206		23	23				
24	Findley L	7/12/87	11.5	0.63	1.5	0.033		11	7.86	206	116.00	30	27				
24	Findley L	7/19/87	11.5	0.75	1.5	0.040	0.01	15	7.49	206	109.00	27	26				
24	Findley L	7/26/87	11.5	1.00	1.5	0.052		13	7.63	209	45.10	24	27				
24	Findley L	7/30/87	11.5	0.75	1.5	0.056		12	7.38	210	73.30	25	27				
24	Findley L	8/9/87	11.5	0.75	1.5	0.042	0.01	7	7.33	208	116.00	24	24				
24	Findley L	8/16/87	11.5	0.50	1.5	0.060		6	7.14	216	274.00	27	27				
24	Findley L	8/23/87	11.5	0.75	1.5	0.054	0.01	10	7.42	208		18	22				
24	Findley L	8/30/87	11.5	0.75	1.5	0.052		12	7.46	204	73.00	21	20				
24	Findley L	9/6/87	11.5	0.75	1.5	0.059	0.17	8	7.36	221	99.00	19	19				
24	Findley L	10/1/87	11.5	0.75	1.5	0.049	0.03	11	7.30	215	73.20	14	17				
24	Findley L	6/21/88	12.0	2.25	1.5	0.022	0.01	8	7.72	213	17.50	25	24				
24	Findley L	6/28/88	11.5	1.75	1.5	0.022	0.01	7	7.77	219	10.10	20	24				
24	Findley L	7/5/88	11.5	1.50	1.5	0.020	0.01	9	8.10	220	10.40	29	25				
24	Findley L	7/12/88	11.0	1.00	1.5	0.023	0.01	11	8.19	234		28	27				
24	Findley L	7/19/88	11.5	1.00	1.5	0.025	0.01	7	8.31	223	20.70	26	28				
24	Findley L	7/26/88	12.0	1.50	1.5	0.029	0.01	10	7.71	221	1.78	26	25				
24	Findley L	7/31/88	11.5	1.25	1.5	0.031	0.01	10	8.10	223	17.80	24	26				
24	Findley L	8/8/88	11.5	1.00	1.5	0.037	0.01	11	7.97	219	31.10	27	28				
24	Findley L	8/12/88	11.5	0.75	1.5	0.042	0.01	10	7.96	221	52.50	26	27				
24	Findley L	8/21/88	11.8	0.75	1.5	0.042	0.01	6	8.32	227	49.60	20	25				
24	Findley L	8/30/88	11.5	2.25	1.5	0.032	0.02	11	7.97	227	10.10	18	23				
24	Findley L	9/6/88	11.3	1.75	1.5	0.037	0.03	14	7.86	227	18.50	15	20				
24	Findley L	9/12/88	11.5	1.50	1.5	0.035	0.03	12	7.95	229	24.40	24	20				
24	Findley L	9/19/88	11.8	1.00	1.5	0.040	0.01	8	8.09	230	38.50	24	20				
24	Findley L	9/25/88	11.8	1.00	1.5	0.039	0.01	6	8.27	227	30.30	24	18				
24	Findley L	6/26/89	11.0	3.25	1.5	0.017	0.14	7	7.94	198	2.16	29	27				
24	Findley L	7/2/89	11.0	2.25	1.5	0.015		12	7.98	199	18.50	22	23				
24	Findley L	7/9/89	11.0	2.25	1.5	0.022		15	7.76	204	6.45	27	25				
24	Findley L	7/16/89	11.5	2.50	1.5	0.020		11	7.85	210	6.18	25	24				
24	Findley L	7/27/89	11.5	2.50	1.5	0.025		10	8.13	200	9.77	27	25				
24	Findley L	7/31/89	11.0	2.00	1.5	0.026		8	7.82	210	6.36	21	24				
24	Findley L	8/7/89	10.5	2.50	1.5	0.029	0.06	8	8.18	214	7.19	17	23				

LNum	PName	Date	Zbot	Zsd	Zsamp	Tot.P	NO3	TColor	pH	Cond25	Chl.a	TAir	TH20	QA	QB	QC	QD
24	Findley L	8/14/89	11.3	2.00	1.5	0.020		7	7.98	211	6.45	24	22				
24	Findley L	8/20/89	11.5	2.00	1.5	0.024		2	8.24	212	6.65	20	23				
24	Findley L	8/29/89	11.5	2.25	1.5	0.028		2	8.24	208	11.30	26	24				
24	Findley L	9/11/89	11.0	1.75	1.5	0.025	0.01	5	8.16	211	17.80	21	22				
24	Findley L	9/25/89	11.5	1.00	1.5	0.029		6	8.18	203	19.60	14	16				
24	Findley L	10/11/89	11.0	1.25	1.5	0.038		5	8.16	210	18.50	11	12				
24	Findley L	7/10/90	11.5	1.25	1.5	0.046	0.01		7.95			22	23				
24	Findley L	7/17/90	11.3	1.25	1.5	0.037	0.01	13	7.72	209	36.60	25	23				
24	Findley L	7/31/90	11.5	0.75	1.5	0.048	0.01	10	7.40	199	57.40	21	24				
24	Findley L	8/14/90	11.5	0.81	1.5	0.044		10	7.24	199	45.10	22	23				
24	Findley L	8/28/90	11.5	0.75	1.5	0.053	0.01	10	7.50	206	58.60	23	23				
24	Findley L	9/11/90	11.0	0.75	1.5	0.051	0.01	12	8.11	205	62.70	21	22				
24	Findley L	9/25/90	11.0	1.50	1.5	0.048	0.02	17	7.78	222	26.90	14	15				
24	Findley L	10/10/90	11.0	2.50	1.5	0.062			8.23	205	9.40	21	16				
24	Findley L	7/22/91	11.3	1.00	1.5	0.049	0.01	10	8.22	215	30.90	26	27				
24	Findley L	8/5/91	13.0	0.75	1.5	0.055	0.01	14	7.63	220	82.80	24	23				
24	Findley L	8/19/91	11.0	0.75	1.5	0.054	0.01	11	8.28	224	68.80	23	24				
24	Findley L	9/4/91	11.7	0.33	1.5	0.079	0.01	9	7.59	219	149.00	20	22				
24	Findley L	9/18/91	11.0	0.67	1.5	0.065			7.90	221	132.00	20	22				
24	Findley L	10/1/91	11.5	0.58	1.5	0.064		7	7.81	220	126.00	19	17				
24	Findley L	6/29/92	11.5	2.00	1.5	0.023		6	7.81	237	9.18	22	21	3	2	3	1
24	Findley L	7/18/92	11.5	1.50	1.5	0.013		6	8.05	232	15.40	22	23	3	2	3	14
24	Findley L	8/11/92	11.3	1.33	1.5	0.025		8	8.34	223	11.60	23	24				
24	Findley L	8/31/92	11.5	1.75	1.5	0.035		9	8.23	228	10.20	17	20	3	2	2	15
24	Findley L	9/28/92	11.5	1.75	1.5	0.024		8	8.24	218	15.80	20	18	2	2	2	5
24	Findley L	10/10/92	11.6	1.50	1.5	0.034		11	8.06	225	28.50	14	15	2	3	3	5
24	Findley L	7/6/93	11.5	1.50	1.5	0.030		7	8.20	210	21.70	26	25	3	2	2	
24	Findley L	7/20/93	11.5	1.50	1.5	0.043		2	7.75	210	15.50	21	24	3	2	3	5
24	Findley L	8/9/93	11.0	1.00	1.5	0.049		7	8.15	211	49.30	24	23	3	2	3	1
24	Findley L	8/30/93	11.3	0.75	1.5	0.063		7	8.16	202	45.90	27	26	3	3	4	123
24	Findley L	9/21/93	11.5	1.25	1.5	0.044		6	8.26	214	33.20	15	18	2	4	4	25
24	Findley L	10/4/93	11.5	1.29	1.5	0.048		5	8.07	216	18.90	17	14	3	3	4	125
24	Findley L	6/14/94	11.3	3.63	1.5	0.015	0.12	6	8.60	222	3.73	31	23	2	2	2	
24	Findley L	7/5/94	11.5	2.00	1.5	0.023		7	7.90	221	10.20	27	24	2	2	3	56
24	Findley L	7/25/94	11.5	1.50	1.5	0.031		4	8.04	224	21.50	23	25	3	2	3	14
24	Findley L	8/15/94	11.8	1.25	1.5	0.039	0.03	11	7.96	206	32.70	21	21	3	2	4	135
24	Findley L	9/5/94	11.5	1.00	1.5	0.048		10	7.70	206	39.40	19	20	4	2	3	134
24	Findley L	9/26/94	13.0	0.80	1.5	0.059		12	7.83	208	50.30	19	19	3	3	4	135
24	Findley L	6/5/95	11.0	2.00	1.5	0.020		6			9.86	25	22	2	2	2	
24	Findley L	6/20/95	11.0	1.00	1.5	0.028		7	8.16	230	24.40	30	27	3	2	4	14
24	Findley L	7/10/95	11.3	0.77	1.5	0.037			7.76	235	51.30	23	23	3	3	3	15
24	Findley L	7/17/95	11.4	0.75	1.5	0.053	0.01	5	8.07	237	53.80	28	27	3	2	3	14
24	Findley L	7/31/95	11.0	0.55	1.5	0.059		10	8.07	231	86.70	30	28	3	3	3	134
24	Findley L	8/14/95	11.5	0.33	1.5	0.082		5	7.48	232	172.00	31	27	4	2	3	134
24	Findley L	6/17/96	11.3	4.75	1.5	0.013	0.05	5	8.18	225	3.50	24	22	1	2	1	
24	Findley L	7/12/96	11.5	1.65	1.5	0.023	0.08	10	7.84	218	20.50	27	25	2	2	3	14
24	Findley L	7/17/96	11.0	3.25	1.5	0.015	0.07	20	7.85	220	8.20	32	25	2	2	3	
24	Findley L	7/29/96	11.0	3.25	1.5	0.018	0.04	10	8.03	218	5.90	22	23	2	2	2	5
24	Findley L	8/12/96	11.0	2.75	1.5	0.023	0.01	20	7.93	217	7.70	22	23	2	2	3	2
24	Findley L	8/26/96	11.0	3.75	1.5	0.018	0.01	5	8.43	214	5.20	23	24				
24	Findley L	9/9/96	11.0	2.25	1.5	0.024	0.01	10	7.95	212	14.10	25	22	3	4	4	24
24	Findley L	9/23/96	11.5	2.28	1.5	0.056	0.01	10	7.96	210	19.10	19	17	3	4	4	24
24	Findley L	6/9/97	11.0	4.25	1.5	0.013	0.10	10	7.52	190	2.60	24	19	1	3	3	2
24	Findley L	6/23/97	11.0	5.13	1.5	0.015	0.08	10	8.07	186	3.08	24	23	1	3	3	2
24	Findley L	7/7/97	11.3	1.50	1.5	0.031	0.01	10	7.56	200	18.50	20	23	3	2	3	1
24	Findley L	7/21/97	11.8	1.28	1.5	0.030	0.01	10	7.83	202	19.70	26	25	3	3	3	134
24	Findley L	8/4/97	11.0	1.42	1.5	0.029	0.01	10	7.39	207	27.80	20	23	3	3	3	2334
24	Findley L	8/18/97	11.5	1.71	1.5	0.032	0.01	7	7.56	206	20.20	19	22	3	3	4	124

LNum	PName	Date	Zbot	Zsd	Zsamp	Tot.P	NO3	TColor	pH	Cond25	Chl.a	TAir	TH20	QA	QB	QC	QD
24	Findley L	9/1/97	11.7	1.40	1.5	0.032	0.01	7	8.48	202	21.90	26	22	3	3	4	124
24	Findley L	9/15/97	11.3	1.75	1.5	0.025	0.01	9	8.41	200	13.90	24	21	3	3	4	12
24	Findley L	6/8/98	12.0	2.42	1.5	0.025	0.01	5	8.41	178	9.34	17	18	2	4	4	2
24	Findley L	9/14/98	10.8	0.80	1.5	0.067		6	7.80	194	43.20	22	20	4	3	4	1234
24	Findley L	6/22/98	11.5	3.13	1.5	0.020	0.01	3	7.51	185	6.32	25	24	2	4	4	24
24	Findley L	7/7/98	11.5	1.38	1.5	0.038	0.01	2	8.53	186	22.10	26	25	3	4	4	124
24	Findley L	7/20/98	11.5	0.78	1.5	0.044	0.14	5	8.61	173	40.50	29	26	3	4	4	1234
24	Findley L	8/3/98	11.5	0.83	1.5	0.053	0.01	5	8.13	181	51.60	25	23	5	4	4	1234
24	Findley L	8/17/98	11.8	0.83	1.5	0.070		14	9.05	183	57.10	30	25	4	3	4	124
24	Findley L	8/31/98	11.5	0.94	1.5	0.067		12	8.96	184	47.20	24	23	4	4	4	1234
24	Findley L	6/22/98			10.0	0.211							14				
24	Findley L	7/20/98				0.465							15				
24	Findley L	8/17/98				0.618											
24	Findley L	9/14/98				0.960							12				

CSLAP DATA KEY:

The following key defines column headings and parameter results for each sampling season:

L Name	Lake name
Date	Date of sampling
Zbot	depth of the bottom at the sampling site, meters
Zsd	average Secchi disk reading, meters
Zsp	depth of the sample, meters
TAir	Temp of Air, °C
TH2O	Temp of Water Sample, °C
TotP	Total Phosphorus, in mg/l
NO3	Nitrate nitrogen as N, in mg/l
TColor	True color, as platinum color units
pH	(negative logarithm of hydrogen ion concentration), standard pH
Cond25	specific conductance corrected to 25°C, in µmho/cm
Chl.a	chlorophyll *a*, in µg/l
QA	survey question re: physical condition of lake: (1) crystal clear, (2) not quite crystal clear, (3) definite algae greenness, (4) high algae levels, and.(5) severely high algae levels
QB	survey question re: aquatic plant populations of lake: (1) none visible, (2) visible underwater, (3) visible at lake surface, (4) dense growth at lake surface.(5) dense growth completely covering the nearshore lake surface
QC	survey question re: recreational suitability of lake: (1) couldn’t be nicer, (2) very minor aesthetic problems but excellent for overall use, (3) slightly impaired, (4) substantially impaired, although lake can be used, (5) recreation impossible
QD	survey question re: factors affecting answer QC: (1) poor water clarity; (2)

Appendix B: Summary of Statistical Methods Used in this Report

A variety of statistical methods have been used to present, analyze, and interpret data collected through CSLAP. Some of these methods are commonly used procedures (and have been used previous in Annual Reports), while others have been modified for use on this dataset. The following is a summary of the methods used, or the terms used to summarize a method:

A brief word about including all data points. Occasionally, a sample result indicates that a laboratory, transport, processing, or collection error has occurred; for example, a pH reading of 2.2 (a not-so-weak acid) or a conductivity reading of 4 (distilled water). These results are not included in the dataset. All other data points are retained unless there is strong independent evidence that the result is erroneous.

A slightly less brief note about the statistical tools. All of the statistical summaries used here assume a "normal" distribution of data. That means that the data collected constitute a subset of the data that describe the parameter (say total phosphorus readings) that, when graphed, are distributed in a bell-shaped (also called "normal" or "Gaussian") curve. In such a curve, the majority of the data points are concentrated near the average, and are less abundant near the extreme values. While an individual subset of data, such as the clarity readings for a particular year for a particular lake, may not be distributed normally (there may be too few points to plot a "normal" curve), they are a subset of a larger set of data (describing instantaneous lake water clarity, in this example) that does demonstrate a Gaussian distribution. Thus for all of these statistics, normal distributions are assumed. If no assumptions about the distribution of the data are made, then different and far less powerful, generally non-parametric, statistical tools need to be used. Fortunately, in describing data sets occurring in nature, industry, and research, assumptions of normal distribution are usually valid.

Mean- the statistical "average" of all samples in a particular dataset. Mean is determined by adding all of the data values within the dataset, and dividing by the number of samples in the dataset.

(Mean pH- since pH is not a direct analytical measure, but rather is a mathematical construct from a direct measure (it is the negative logarithm of the hydrogen ion concentration of the water), mean pH is determined by taking the negative logarithm of the mean hydrogen ion concentration)

(Mean NO_3- since nitrate is not detectable, an absolute reading for that sample is not obtainable. This becomes problematic when computing an average, or mean, for a set of samples that include undetectable values. For the purposes of calculating means, undetectable nitrate readings (reported as less than 0.02 mg/l) are assumed to be = 0.01 mg/l. Likewise, all other parameters reporting undetectable values are assumed to be 1/2 of the detection limit)

Standard Deviation is a measure of the variability of data points around the calculated mean. A large standard deviation indicates a wide variability in the data (and thus a lower assurance that the mean is representative of the dataset), while a small standard deviation indicates little variability in the data. The standard deviation presented here (the "brackets" on each data point in the **How the Lake Has Changed..** section) corresponds to a 95% confidence interval based on a *true population* standard deviation (Φ), and assumes a normal distribution of data (therefore the number of degrees of freedom approaches infinity)).

Linear Regression is a statistical method for finding a straight line that best fits a set of two or more data points, in the form y = mx + b, with m the slope of the line, and b the value for y when the line crosses the x axis (when x = 0). **R^2-** R is a correlation coefficient used to measure linear association. R shows the strength of the relationship between the regressed parameters—the closer the value of R to 1 or -1, the stronger the linear association (R ranges from -1 to +1. When R = 1, the data fall exactly on a straight line with a positive slope, while at R = -1, the data fall exactly on a straight line with a negative slope. This value is squared (R^2) in most statistical analyses, in large part so R values < 0 can be compared to R values > 0). Some non-linear regressions are used only when strongly supported by the data- in these cases, the R^2 values represent the strength of the non-linear relationship, whether they be exponential, logarithmic, or multiple order polynomial equations.

The "significance" of the data reported in linear regressions, standard deviations, and other more rigorous statistical data analyses have been long debated among statisticians. For this report, we hope to provide some rudimentary statistical basis for evaluating the data collected at each lake, and to evaluate larger questions about each dataset, such as water quality trends ("has the lake changed"). In this report, "significant" is defined as the range of the best-fit line exceeding 95% confidence interval of each monthly average, and "strong correlation" is defined as a correlation coefficient (R^2) for the best fit line describing the parameters exceeding 0.5. R^2 readings between 0.3 and 0.5 suggest a "moderate" correlation, and this terminology is used in this report when appropriate.

This definition of "significant" may appear to be too, well, wordy, but the justification for it is as follows. If the amount that a measure such as water clarity changes over time, as determined by a best-fit line, is less than it changes in any given year, than it is likely that this change is not statistically valid. As an example, if a persons weight fluctuates by 6 pounds (say from 144 to 150) any given day, a reported weight loss of 2 pounds (from 149 to 147) should be considered within the normal range of variability. If you are that person, then you may think you lost weight, and may have according to the scale, but, at least statistically, you didn't. The justification for "strong correlation" is not as easy to explain, but may be more verifiable- it appears to be a definition consistent with that used to compare other datasets.

Appendix C. New York State Water Clarity Classifications

Class N:	Enjoyment of water in its natural condition and where compatible, as source of water for drinking or culinary purposes, bathing, fishing and fish propagation, recreation and any other usages except for the discharge of sewage, industrial wastes or other wastes or any sewage or waste effluent not having filtration resulting from at least 200 feet of lateral travel through unconsolidated earth. These waters should contain no deleterious substances, hydrocarbons or substances that would contribute to eutrophication, nor shall they receive surface runoff containing any such substance.
Class $\text{AA}_{\text{special}}$:	Source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival, and shall contain no floating solids, settleable solids, oils, sludge deposits, toxic wastes, deleterious substances, colored or other wastes or heated liquids attributable to sewage, industrial wastes or other wastes. There shall be no discharge or disposal of sewage, industrial wastes or other wastes into these waters. These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.
Class $\text{A}_{\text{special}}$:	Source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. These international boundary waters, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to remove naturally present impurities, will meet New York State Department of Health drinking water standards and will be considered safe and satisfactory for drinking water purposes
Class AA:	Source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. These waters, if subjected to approved disinfection treatment, with additional treatment if necessary to remove naturally present impurities, will meet New York State Department of Health drinking water standards and will be considered safe and satisfactory for drinking water purposes
Class A:	Source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. These waters, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to remove naturally present impurities, will meet New York State Department of Health drinking water standards and will be considered safe and satisfactory for drinking water purposes
Class B	Suitable for primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival

Class C:	Suitable for fishing, and fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
Class D:	Suitable for fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
Class (T):	Designated for trout survival, defined by the Environmental Conservation Law Article 11 (NYS, 1984b) as brook trout, brown trout, red throat trout, rainbow trout, and splake

Appendix D. Phytoplankton Information

Whether you fish, swim, or sit and watch the dragonflies over the water, you are aware that the lake is a large ecosystem which supports a variety of life. At the bottom of this system, or food web, are the primary producers, called algae, which are basic for life at the lake. The primary producers are so named because this remarkable life form can produce biomass from energy (the sun) and produce oxygen in a process called photosynthesis, the first step in the food chain for all the other living things. The free floating form of algae called phytoplankton, are consumed by tiny animals, zooplankton, and bacteria, which in turn are consumed by insects and small fish, and so on throughout the food web. While the absence of phytoplankton or algae may make for a clean swimming pool, the loss of phytoplankton has serious implications to a lake. The lowering of the pH of several Adirondack Lakes from acid rain attests to the importance of maintaining sufficient water chemistry characteristics necessary to support algae. In some of those lakes the pH is now too low for survival of most phytoplankton species, and thus for much aquatic life throughout the food web. Predation by zebra mussels of phytoplankton is another environmental factor which may drastically change the biological character of a lake. These non-native species may clear the water of algae but will also undermine and jeopardize the entire lake food web. A variety of phytoplankton is needed for a healthy lake.

The life of algae

Algae may be attached to substrates (periphyton) or free floating (plankton) in the water. In a lake, phytoplankton communities are usually very diverse, and are comprised of hundreds of species having various requirements for nutrients, temperature and light. For instance, the diatom group of algae need silica for their cell wall structure; green algae cell walls are composed of cellulose and some blue green algae have little to no need for nitrogen in the water, being able to “fix” it themselves, called nitrogen fixing. Consequently, these populations fluctuate as variables such as water temperature, nutrient availability and predation levels of zooplankton fluctuate. In most lakes, including those of New York, diatom (*Bacillariophyceae*) populations are greatest in the spring, and decline in number to proportionately less of the overall biomass as the summer progresses. This is often related to silica concentrations in the lake. At that time, the smaller populations of green algae (*Chlorophyta*) take advantage of warmer temperatures and greater amounts of nutrients, particularly nitrogen, in the warm water and become the more dominant species of the overall population. As noted earlier, blue green algae (*Cyanophyta*) possess the ability to convert atmospheric nitrogen to forms more readily available for growth, so many NYS lakes experience blue green algae increases when nitrogen levels fall and phosphorus levels increase. Phytoplankton are somewhat mobile and opportunistic life forms displaying great versatility among genus and species. They can move around by changing their density. Some species of algae can adjust their cell walls, giving them buoyancy, and moving up and down the water column to find what they need. Some, particularly the blue green algae, are able to use their gas vacuoles (tiny pockets in the cells) to move, thus avoiding predation or in response to changing environmental conditions, and some algae are flagellated, meaning they are equipped with tiny ‘propellers’ hairs on the outside of the cell wall to aid in finding the niche in the water column which has their nutrient and sunlight needs.

The diverse algal species need varying levels of temperature, light and nutrients to grow, but phytoplankton in most lakes of New York State are limited by the availability of phosphorus in the water. An overabundance of phosphorus may provide opportunity for what are called pollution-resistant species of algae (mostly the blue-green and green algae) to dominate the overall phytoplankton population, resulting in the familiar green or blue green color of the lake. However, excess phosphorous alone often is not enough to cause a proliferation of alga growth at a lake.

Availability of sunlight for photosynthesis (decreased in highly tea-colored lakes), water temperature, total alkalinity (higher pH) and availability of silicon or other specific nutrients are a few of the non-biological factors which influence various species habitation in the water column. Therefore, although phosphorus is the major limiting factor there are many other factors which trigger phytoplankton behavior which are independent of trophic state. A variety of phytoplankton will occur in all types of lakes, but population numbers or proportions will vary greatly.

Phytoplankton and their predators, zooplankton

Sunlight and nutrient availability affect the algae populations at any given time, as does the number of predators, particularly **zooplankton** (the microscopic animals found in all lakes) around to consume them. Both zooplankton and phytoplankton populations are very dynamic, moving in the water column. As with any ecosystem, the most ecologically viable balance will occur when these populations fluctuate together. However, blue-green algae are not significantly consumed by zooplankton, upsetting this balance. Other factors, whether natural, such as predation on zooplankton by planktivorous fish, or the result of human manipulation of lakes, such as copper sulfate treatments, can tip the zooplankton-phytoplankton equilibrium to, at least temporarily, favor one of the other.

When phytoplankton becomes a "problem"

Too much of a certain kind of algae presents important considerations in lake management. The first is that the proliferating algal growth or predominance of one type of algae may indicate an excess of phosphorus available in the water at that particular time. This may result in a loss of water transparency and ultimately lead to accelerated eutrophication of the lake. Second, the proliferating algal growth itself can be troublesome; it may be unsightly, encumber swimming uses, clog intake screens and be a source of taste and odor problems and threat to the living conditions for other aquatic species, from benthic animals to cold water fish., particularly if anaerobic decomposition (of fallen algae by bottom-dwelling bacteria) occurs.

Is there an easy way to tell if the algae is a problem?

There is no general way of distinguishing algae, according to genus or species as to its benefit and importance to the lake. A total of almost 500 genera and species of algae are important according to their occurrence in water. Generally speaking, the blue-green algae are most pollution resistant and will tend to dominate an ecosystem with enough nutrients. On the whole, green algae are less often associated with tastes and odors problems in water, in fact their growth may help to keep in check the blue-green algae and the diatoms.

Beyond this, however, there is no general rule for algae. It is not possible to predict exactly the succession of algae, based on the trophic state. Research does indicate that trophic factors have the greatest influence on the total biomass of blue-green and green algae. The biomass of other genera rely on factors such as total ion concentration for dinoflagellates and golden-brown algae, and lake morphometry (shape and depth of lakes) for diatoms. Within phytoplankton life forms there is also segregation in the trophic spectrum, meaning that closely related species may be far apart in the trophic spectrum. For instance, while most diatoms are typical of a healthy lake, a few species of diatoms are associated with eutrophication, some imparting taste and odor problems. (This is not unusual in the plant kingdom; for instance *Potamogeton pectinatus* is rare and endangered in some northeastern states, while the *Potamogeton crispus* can dominate a plant community and is considered a nuisance species). Therefore, some genera have different species which have evolved to adapt to varying trophic situations, and thus one genera is not specifically indicative of a certain trophic status of a body of water.

A word about toxic algae:

Currently, the concerns about poisonous or toxic algae, especially as related to humans, are focused on marine algae, specifically that found on the coasts and affecting shellfish. The health and environmental concerns addressed in the CSLAP program relate to those phytoplankton which in abundance and frequency would affect the amount and availability of oxygen in the water, or in their dominance be toxic to other phytoplankton, and the consequent changes to the aquatic organisms, the degree to which it can dominate and block the available sunlight in the water column, affecting transparency and inhibiting growth of other photosynthesizing life forms such as macrophytes in the lake. There are a few algae that promote taste and odor problems in lakes, but the extent of their influence is largely controlled by the use of these lakes (with drinking water supplies more affected than swimming lights).

What does this mean for management considerations for my lake

For most CSLAP lakes, the chlorophyll *a* analysis of phytoplankton sampled twice a month is adequate to estimate the total amount or biomass of algae in the lake. This directly relates the algal biomass to the seasonal cycle of productivity at the lake, assisting in assessments of trophic status when used in conjunction with transparency (Secchi disk readings), and nutrient (phosphorus) indicators.

While chlorophyll *a* may assess the amount of algae in a lake, and is important in assessing the overall productivity of a lake, this measure alone will not tell us about the variations in the population of this important aspect of lake life. A phytoplankton analysis can provide a profile of species they may be indicative of a pollution problem or pristine conditions. Such an analysis, in turn, begs information about the source of the excess nutrients, determining if the loading is more localized (say malfunctioning septic systems) or from changes in land uses and drainage related to agricultural or grazing uses. The source may be from historical nutrient loading, just beginning to cause the release of phosphorous from bottom sediments. Whether a “local” phenomena or localized from a larger phenomena, the identification of the resulting algal growths may help to assess early indicators of accelerated eutrophication.

During the 1992 sampling season, CSLAP conducted phytoplankton sampling at various participating lakes, for a general inventory of existing conditions. On occasion, CSLAP volunteers will collect samples for microscopic examination, in response to a noticeable or problem algal growth. If you have had a phytoplankton analysis through CSLAP which was the result of a problematic proliferating algal growth at the lake or during the 1992 sampling cycle, the microscopic examination results appear in summary in the text of the report and at the end of this appendix. The listing of contemporary assessments below also includes the current research results regarding the relationship of that particular type of phytoplankton species to pollution or eutrophication of the water. Keep in mind that for most waters, comparatively low concentrations of a variety of most genera of algae reflects favorably on the healthy biodiversity of the lake, rather than a liability. Repeated results however, may warrant longer term management activities for maintaining current water quality.

Findley Lake Phytoplankton Results:

Date	**7/18/92**	**Units**
Biomass	6.2381	grams/L
%Bacteria	0.0	%
%Cyanobacteria	17.9	%
Anabaena circinalis	0.3814	grams/L
Gomphosphaeria aponina	0.7374	grams/L
%Chlorophyta	0.4	%
Oocystis spp.	0.0273	grams/L
%Chrysophyta	41.9	%
Dinobryon divergens	2.6152	grams/L

Date	**7/18/92**	**Units**
%Bacillariophyceae	36.3	%
Amphora spp.	0.0082	grams/L
Asterionella formosa	0.0845	grams/L
Cyclotella planktonica	2.1708	grams/L
%Cryptophyta	2.8	%
Cryptomonas spp.	0.1770	grams/L
%Pyrrophyta	0.6	%
Ceratium hirundinella	0.0090	grams/L
Gyrodinium spp.	0.0273	grams/L

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