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. Even the most extensive and expensive monitoring program cannot completely assess a lake's water quality. However, 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. 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 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 characterizing lakes. Eutrophication indicators are most closely monitored because eutrophication represents the most common water quality problem in NYS 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 standing crop), 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.

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.

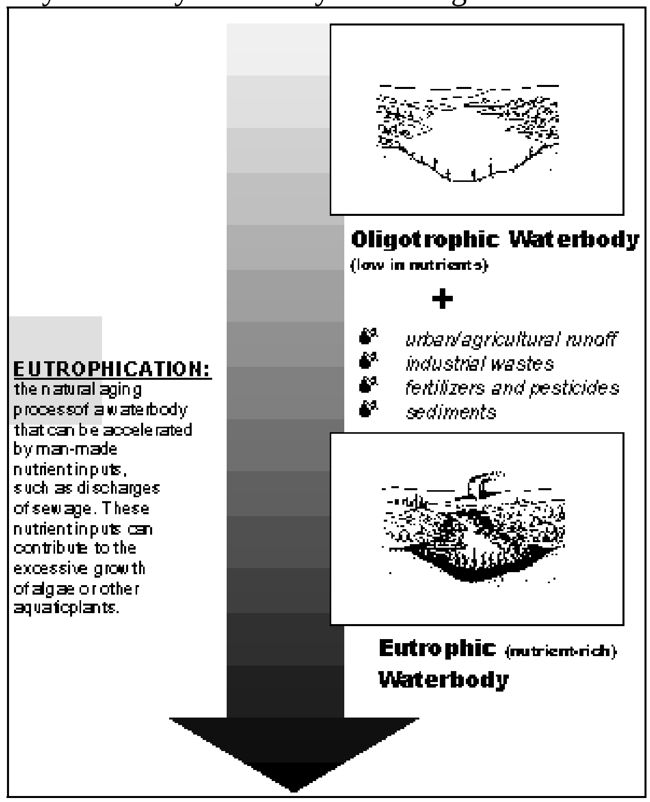

Figure 2. Trophic States

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	**0.035**
Chlorophyll a (µg/l)	> 8	2- 8	< 2	**35.6**
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.

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 Charaphytes 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.

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 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 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 CSLAP Sampling Protocol 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 plant species have been identified through CSLAP at Findley Lake:

Non-Native Species	Year First IDd	Perceived Abundance
Myriophyllum spicatum (Eurasian watermilfoil)	< 1990	abundant
Native Species		Perceived Abundance
Myriophyllum verticillatum (whorled water milfoil)		not reported
Najas flexilis. (bushy pondweed)		abundant

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 snapshot 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
1986-97	**0.33**	**1.59**	**5.13**	**112**	**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
1986-97	**0.011**	**0.035**	**0.082**	**112**	**CSLAP Tot.P**
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
Year	Min	Avg	Max	N	Parameter
1986-97	**0.01**	**0.03**	**0.17**	**71**	**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
1993	0.00	#DIV/0!	0.00	0	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

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
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 continued

Year	**Min**	**Avg**	**Max**	**N**	**Parameter**
1986-97	**2**	**9**	**20**	**108**	**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
1986-97	**6.92**	**7.91**	**8.98**	**111**	**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
Year	Min	Avg	Max	N	Parameter
1986-97	**180**	**212**	**237**	**110**	**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

Table 1 continued					
Year	Min	Avg	Max	N	Parameter
1986-97	**0.80**	**35.59**	**274.00**	**104**	**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
1986-97	**1.0**	**2.6**	**4.0**	**38**	**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
Year	Min	Avg	Max	N	Parameter
1986-97	**2.0**	**2.5**	**4.0**	**38**	**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
1986-97	**1.0**	**3.1**	**4.0**	**38**	**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 1997 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 1997 report does include, where appropriate, a more detailed discussion of the effect of weather conditions on the results at each program lake.

- **Sampling season and parameter limitations**. Because sampling is generally confined to June-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, 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.

- **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.

- **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. Where appropriate, some statistical summaries have been provided within the report and are documented in Appendix B of this report.

IV. SAMPLING RESULTS FOR FINDLEY LAKE

1997- …What a Crazy Year…!

While each sampling season could be rightfully called "unique", it can also be said that some years are more unique than others. More volunteers and other laymen reported their lakes clearer in 1997 than in any other years since CSLAP began in 1986. Most volunteers reported this belief with a smile, not a frown or even furrowed brow, though many requested an explanation for the good fate of their lakes. And while the change in NYS lakes in 1997 was mostly (sometimes even correctly) attributed to the weather (the convenience for this explanation is that it works both ways, explaining favorable and unfavorable conditions equally well), the frequency of this observation prompted a close analysis of the 1997 data.

First, the numbers for 1997:

	Prior to May	*May-June*	*July-Aug*	*Sept-Oct*
Water Clarity:				
% Lakes Higher	**NA**	**68**	**49**	**43**
% Lakes Unchanged	**NA**	**28**	**32**	**30**
% Lakes Lower	**NA**	**2**	**19**	**28**
Algae Levels				
% Lakes Higher	**NA**	**11**	**21**	**17**
% Lakes Unchanged	**NA**	**33**	**25**	**24**
% Lakes Lower	**NA**	**56**	**55**	**59**
Phosphorus Readings				
% Lakes Higher	**NA**	**11**	**13**	**21**
% Lakes Unchanged	**NA**	**35**	**45**	**28**
% Lakes Lower	**NA**	**54**	**42**	**51**
Precipitation				
% Lakes Higher	**23**	**25**	**17**	**NA**
% Lakes Unchanged	**63**	**31**	**30**	**NA**
% Lakes Lower	**13**	**44**	**53**	**NA**
Water Temperature				
% Lakes Higher	**NA**	**22**	**19**	**19**
% Lakes Unchanged	**NA**	**58**	**67**	**62**
% Lakes Lower	**NA**	**20**	**15**	**19**

From this table, it appears that, for most CSLAP lakes, 1997 water quality data, particularly in the early part of the sampling season, showed clearer water, lower levels of algae growth, and lower nutrient concentrations. This appears to be consistent with both the observations of the sampling volunteers and antidotal remarks from other (non-CSLAP) NYS lake residents and visitors.

In general, the winter of 1997 was colder than in a "typical" year, although February was much warmer than usual. May of 1997 was significantly colder than usual, while June had either normal or above normal temperatures. However, the winter throughout NYS was only slightly wetter than usual, while the spring was somewhat drier. This variability may account for the observation that water temperatures generally remained unchanged from previous years. However, although lake-specific daily temperature and precipitation data are not available, data from the closest NOAA meteorological stations to each lake can provide some indication about the relationship between weather and water quality in CSLAP lakes.

Number of 1997 CSLAP Lakes	*Water Clarity Higher*	*Water Clarity Unchanged*	*Water Clarity Lower*
Precipitation Higher	7	1	2
Precipitation Unchanged	12	1	2
Precipitation Lower	10	9	0

This table suggests that, although water clarity was higher in both "wetter" and "drier" CSLAP lakes, water clarity was more likely to increase in lakes where precipitation levels increased or remained unchanged, not lakes with lower precipitation. As such, it appears that higher early season runoff appeared to influence water clarity, although it also appears that other factors were important. It should also be noted that even lakes experiencing lower spring and early summer precipitation demonstrated an increase or stability in water clarity, further suggesting that non-weather factors may have also been important.

One of these factors appears to be hydraulic retention time, inversely related to the amount of time required for water to flush through the lake (also referred to as flushing time). If 0.5 years is defined as the cutoff between "low" (retention > 0.5 years) and "high" (retention <= 0.5 years) flushing rate, then the table below suggests that lakes with a low flushing rate were more likely than lakes with high flushing rate to be influenced by the weather conditions in 1997:

% of 1997 CSLAP Lakes	*Water Clarity Higher*	*Water Clarity Unchanged*	*Water Clarity Lower*
Low Flushing Rate	76	16	8
High Flushing Rate	44	44	13

An explanation for this phenomenon may be that, for lakes with low flushing rates, direct precipitation is more likely to constitute a greater percentage of the hydraulic (water) loading, relative to watershed runoff, than in high flushing rate lakes. This is because lakes with a low flushing rate frequently possess a small watershed relative to the size (area and volume) of the lake. Since the early season precipitation was higher in these lakes, and since this direct rainfall loading is likely to be more dilute than runoff waters, this increased precipitation may have resulted in a lower loading of nutrients to the lake. As a result, many lakes were clearer in 1997. It is equally clear that this explanation does not apply to all CSLAP lakes, for each lake is influenced by a complex interaction of factors, but it does appear to be phenomenologically plausible and consistent with the observations reported above.

The connection between weather and water clarity was also apparent in other years. Unfortunately, as alluded to above, precipitation may not be a consistent indicator of hydrologic loading to lakes, although precipitation data are consistently available from many sites near CSLAP lakes via the National Climatic Data Center at the National Oceanic and Atmospheric Administration (NOAA), while runoff data from the US Geological Survey (USGS) are neither as ubiquitous nor as temporally available. To assess the relationship between weather and water clarity, one can look at both NOAA and USGS sites near a cluster of CSLAP lakes. One such location is Madison County, where about a dozen CSLAP lakes have been actively monitored since 1988, and where both NOAA (at Morrisville) and USGS (at Oneida Creek) sites close to these lakes possess data back to 1988. From the precipitation data, it appears that the 1997 weather conditions (monthly patterns and seasonal changes) most closely resembles those from 1990, but the water quality data from those two years cannot be closely correlated. However, the gaging data show that 1997 was most like 1988, and the water quality data in those years were more closely related (and the 1988 data were more closely related to 1997 data than were the data from any other years since 1988):

	1997	1990	1988
% Lakes with Higher Clarity	67	27	40
% Lakes with Unchanged Clarity	22	45	60
% Lakes with Lower Clarity	11	27	0

Similar runoff patterns were also seen in 1996 and 1990 (where spring and particularly early summer runoff were extremely high), and in 1986 and 1994. The water clarity data for these paired years suggest that the similar runoff characteristics result in similar water quality data for these years.

	1996	1990	1994	1986*
% Lakes with Higher Clarity	30	27	0	0
% Lakes with Unchanged Clarity	50	45	36	0
% Lakes with Lower Clarity	20	27	64	100

*- only two CSLAP lakes sampled in 1986- both lakes had below-average clarity in 1986 and 1994

Unfortunately, for this set of lakes, and for many lakes in NYS, the precipitation data from the closest NOAA station and the gaging data from the closest USGS station, are not always closely aligned, although extreme peaks in flow (high or low) seem to correspond pretty well with extreme precipitation peaks (flood or drought). As noted above, it is clear that other factors are also influencing changing water quality conditions at each CSLAP lake, and that given the lack of runoff data for most CSLAP lakes, each lake cannot be evaluated in the same manner. However, where appropriate, the individual lake summaries below will assess the connection between precipitation, runoff, and water quality.

Are there any seasonal trends in the data?

Seasonal Comparison of Eutrophication Parameters–1996 and in the typical CSLAP Sampling Season

Figure 5 and Figure 6 compare data for the measured eutrophication parameters for Findley Lake. Figure 5 plots the data points for the current summer season. Figure 6 plots the monthly average of the data points for all the CSLAP sampling seasons at the lake. The second may give a more complete illustration of the seasonal conditions at your lake.

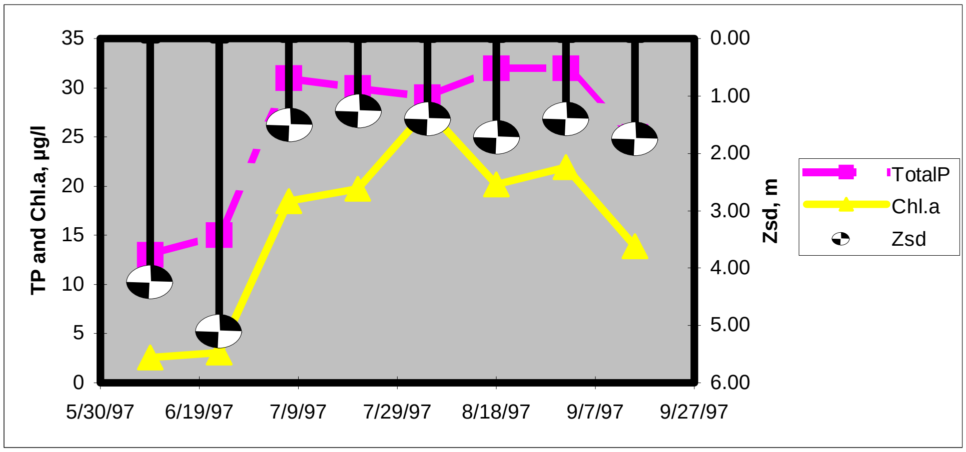

Figure 5. 1997 Eutrophication Data for Findley Lake
This graph illustrates the most recent condition of the lake.

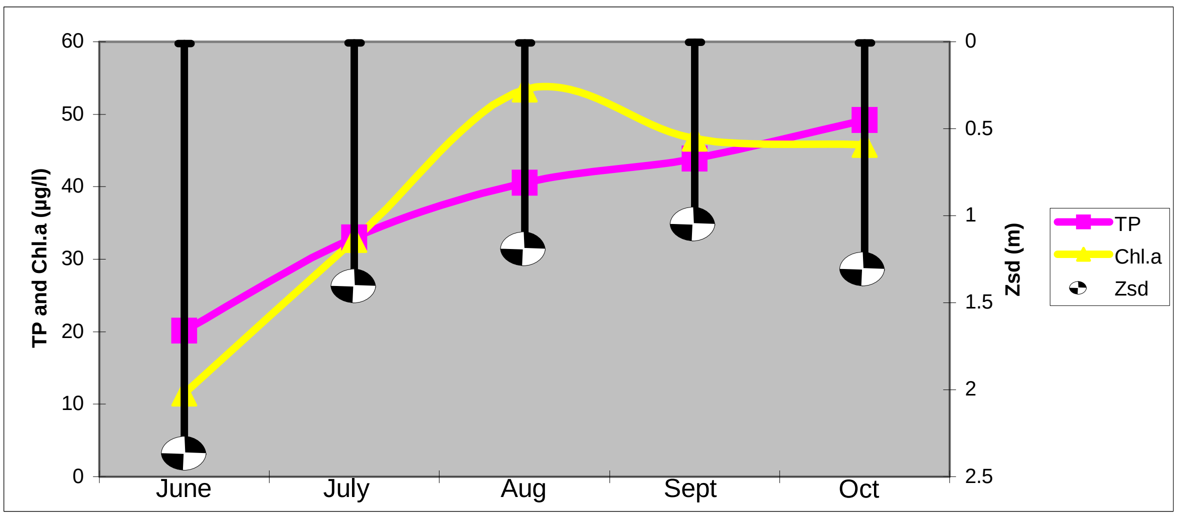

Figure 6. Typical Monthly Averages for Findley Lake
This graph shows monthly averages compiled from all sampling seasons at the lake.

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

a) None of the measured eutrophication parameters demonstrate significant[1] change over the course of a typical summer, although water clarity (decreasing) and total phosphorus and chlorophyll *a* (increasing) demonstrate seasonal tendencies, probably associated with fall turnover, that are not statistically significant.

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

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

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

Discussion:

The strong correlation between water clarity and algae (Secchi disk transparency and chlorophyll *a*), and between algae and nutrient concentrations (chlorophyll *a* and total phosphorus readings) suggest that lake management activities implemented to increase water clarity will necessarily need to address reductions of algae growth and nutrient loading to the lake.

[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

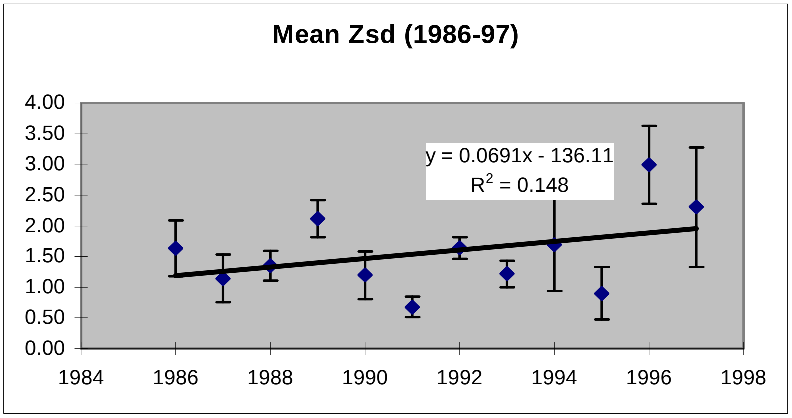

Figure 7
Mean Zsd (Water Clarity), 1986-1997

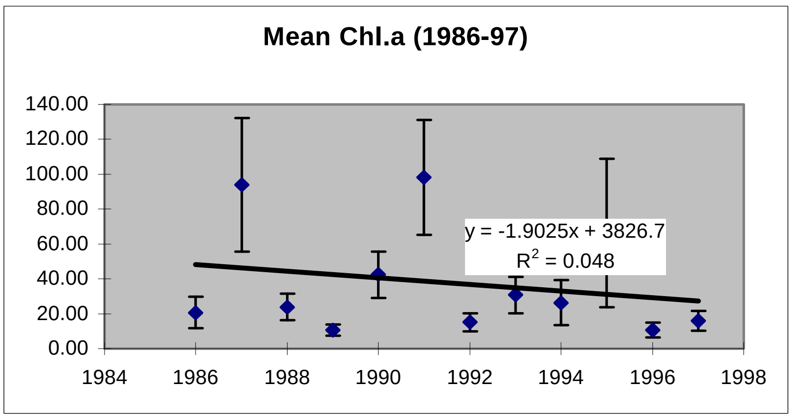

Figure 8
Mean Chl.a, 1986-1997

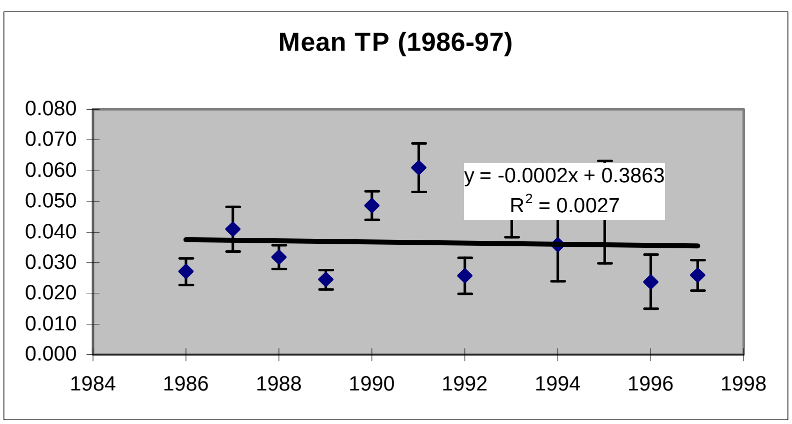

Figure 9
Mean TP, 1986-1997

Figures 7-10 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 three graphs, the following conclusions can be made:

a) None of the measured eutrophication parameters have demonstrated statistically significant change since CSLAP sampling began on the lake in 1986.

b) The annual Secchi disk transparency increase is consistent with the decrease in chlorophyll *a* and total phosphorus over the same period, though it is not statistically significant.

c) The annual chlorophyll *a* decrease is consistent with the decrease in total phosphorus and increase in water transparency over the same period, though also not statistically significant.

d) The annual phosphorus decrease is consistent with the changes in chlorophyll *a* and water transparency. Like the changes in the other eutrophication indicators, the decrease in phosphorus noted here is not statistically significant.

Discussion:

Figures 7 through 9 suggest that "conditions" at the lake, at least as related to eutrophication, are stable or improving. This is in contrast with the volunteers' observations noted in Figure 10, indicating that weed growth, and not water clarity, may be the strongest indicator of public perception of the lake. The weed growth appears to have increased while water clarity has increased (although weed growth is perceived to have increased over the last several years, while water transparency increases have occurred only in the last two years), a trade-off commonly experienced in NYS lakes.

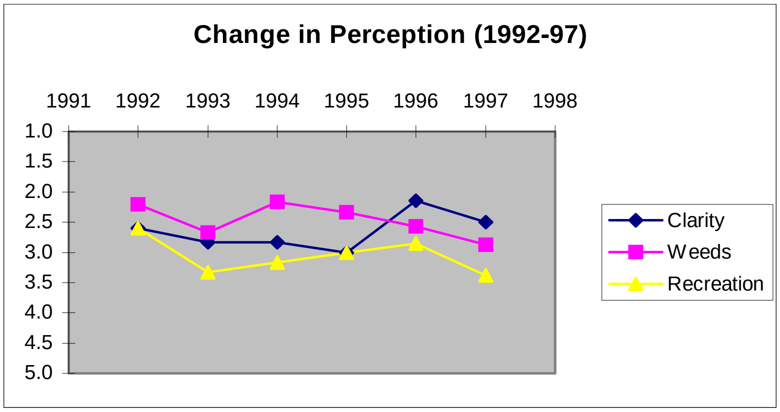

Figure 10
Mean Perception (Clarity, Weeds, and Recreation), 1992-1997

What About 1997 at Findley Lake?

As reported above, most of the CSLAP lakes sampled in 1997 showed clearer water, with low algae growth and lower nutrient concentrations. For some lakes, this clearer water resulted in more significant weed growth (either more dense growth or in deeper parts of the lake), while for others the "flip side" of clear water never occurred. For some of these lakes, particularly those with a small watershed relative to the size of the lake, these findings could be linked to a cooler and slightly wetter than normal winter, a drier spring, and/or rainier summer. And for some lakes, the "improvement" was due to other factors, such as changing biological communities or active lake management. Yet for other lakes, these general statewide conditions were not replicated. The following section summaries the 1997 results for Findley Lake, and, where possible, postulates about the cause and/or source of data discrepancies from 1997 to previous CSLAP sampling seasons.

Findley Lake was clearer, with lower algae growth and nutrient concentrations, in 1997 than in most of the previous CSLAP sampling seasons; as noted above, this was an observation common to many CSLAP lakes. On closer examination, while chlorophyll *a* levels were lower than normal during the entire sampling season, phosphorus readings were only marginally lower, and water clarity was significantly higher than normal only in the beginning of the sampling season. This contrasts with the trends in 1989 and 1996, the only other CSLAP sampling seasons with equally high water clarity- in 1989, water clarity was high until early August (probably corresponding to lake turnover), while in 1996 the transparency was high all year (and the weather was wet all winter and summer). It should also be noted that the weather in 1997 most closely resembled that from 1989, a year in which water quality data was similar to that in 1997. This suggests that the conditions noted in 1997 may be closely related to weather. An equally important factor may be water temperature- water clarity was highest in the years when water temperature was lowest (likely due to the critical temperature at which algae growth can be significant). However, it should also be noted that, during any given sampling season, there was not a strong correlation between precipitation intensity and these water quality indicators (clarity did not always increase or decrease after large storm events, for example), although it is clear that water quality is in general influenced by weather.

The "improvement" in clarity resulted in, or at least occurred simultaneously with, an increase in weed growth (as commonly occurs), and as a result the recreational assessment of the lake was adversely affected. It is not known if weed growth and therefore public perception of Findley Lake will change when the weather inevitable changes.

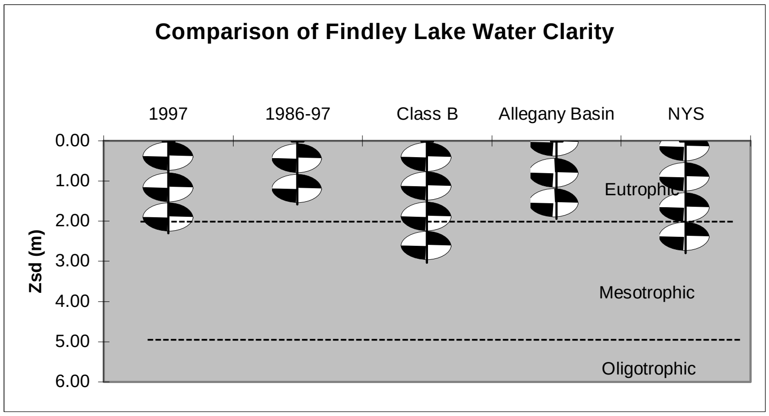

Figure 11. *Comparison of 1997 Secchi Disk Transparency to Previous Years at the Lake, Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

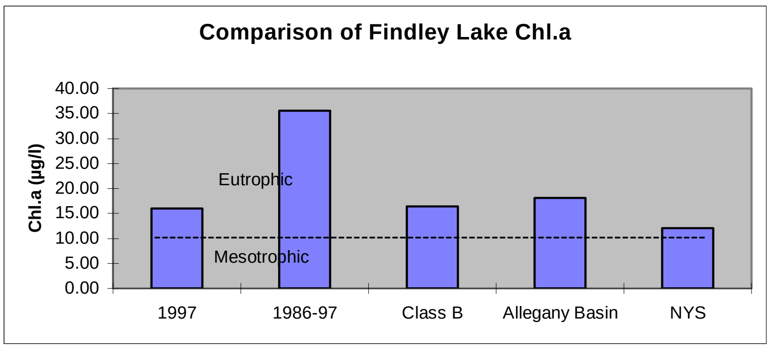

Figure 12. *Comparison of 1997 Chlorophyll a to Previous Years at the Lake, Lakes with the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

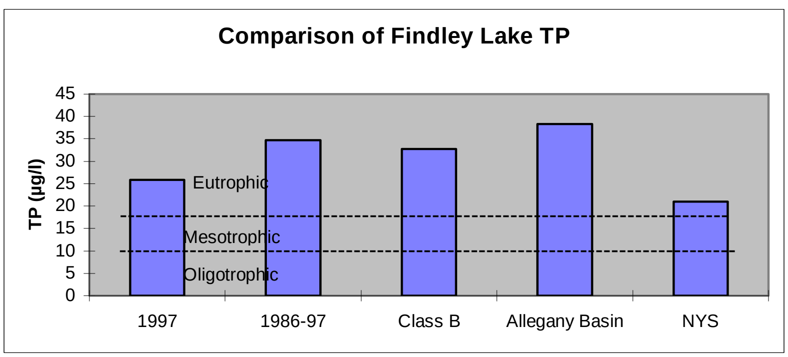

Figure 13. *Comparison of 1997 Total Phosphorus to Previous Years at the Lake, Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other NYS Lakes*

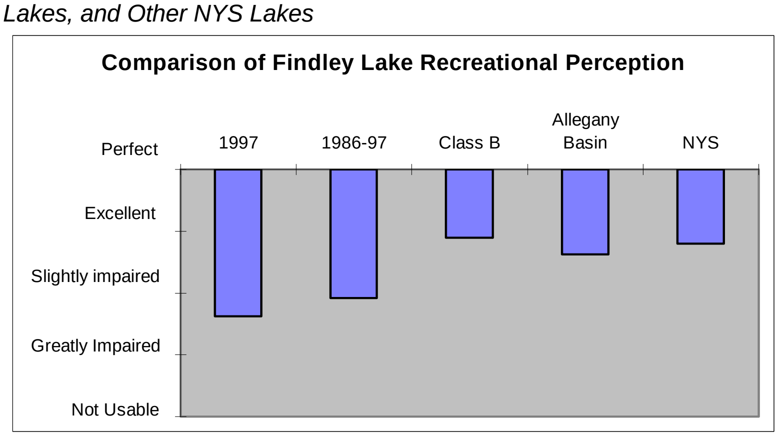

Figure 14. *Comparison of 1997 Recreational Perception*

How does this lake compare to other lakes?

Annual Comparison of Eutrophication Parameters and Recreational Assessment For Findley Lake—1996, the Typical CSLAP Sampling Season for this lake, Neighboring Lakes, Lakes with the Same Lake Classification, and Other NYS Lakes

The graphs to the left illustrate comparisons of each eutrophication parameter and recreational perception at Findley Lake-in 1996, relative to Findley Lake in previous CSLAP sampling seasons, 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:

a) Using water clarity as an indicator, Findley Lake is more productive than other lakes with the same water quality classification (Class B) and other NYS lakes, and about as productive as other lakes in the Allegany River Basin (although in 1997, Findley Lake would have been considered less productive than other Allegany basin lakes in these categories)

b) Using chlorophyll *a* as an indicator, Findley Lake is more productive than other lakes in the Allegany River basin, other Class B, and other NYS lakes (although the chlorophyll *a* readings in 1997 were generally typical of other Class B, Allegany River basin and NYS lakes).

c) Using total phosphorus concentrations as an indicator, Findley Lake is about as productive as other Allegany River basin lakes, and more productive than other Class B and NYS lakes (1997 readings in Findley Lake indicated less productive conditions than in other Class B and Allegany River basin lakes).

d) Using QC on the field observations form as an indicator, Findley Lake is less suitable for recreation than other lakes in the Allegany River basin, rest of the state, and other Class B lakes.

Discussion:
The less-favorable-than-expected historical assessment of recreational usability of Findley Lake appears to be due to the relatively high weed growth, a problem that may have been exascerbated by the slightly higher water clarity in 1997 (the overall relatively low water clarity continues to also influence recreational perception of the lake).

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. Also the Reports 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 realm of 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, 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*.

- *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.

Watershed controls: **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.*

Monitoring 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).

Nutrient controls 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 Reducing the Impacts of Stormwater Runoff 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 Controlling Agricultural Nonpoint Source Water Pollution in New York State. 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.

Land use restrictions . 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.

Lawn fertilizers 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)

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.

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.

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) excessive weeds; (3) too much algae/odor; (4) lake looks bad; (5) poor weather; (6) other

Appendix A. CSLAP Data for Findley Lake
(refer to CSLAP Data Keys on previous page)

PName	Date	Zbot	Zsd	Zsamp	Tot.P	NO3	TColor	pH	Cond25	Chl.a	TAir	TH20	QA	QB	QC	QD
Findley L	6/15/86	11.5	3.00	1.5	0.026	0.12	5	6.92	190	2.22	18	19				
Findley L	6/21/86	11.5	3.13	1.5	0.013	0.11	5	7.50	180	2.29	23	20				
Findley L	6/29/86	11.5	2.25	1.5	0.011	0.09	10	7.62	185	2.00	22	21				
Findley L	7/3/86	11.5	2.75	1.5	0.022	0.11	15	7.82	194	0.80	15	20				
Findley L	7/11/86	11.5	2.00	1.5	0.021	0.03	2	7.84	185	5.03	15	20				
Findley L	7/18/86	11.5	1.50	1.5	0.030	0.06	5	8.38	194		30	24				
Findley L	7/24/86	11.5	2.63								30	25				
Findley L	8/1/86	11.5	1.63	1.5	0.028	0.03	14	8.05	197		26	24				
Findley L	8/5/86	11.5	1.13	1.5	0.018	0.03	11	7.75	191	53.30	26	25				
Findley L	8/12/86			1.5	0.023	0.03	13	8.15	199	15.30						
Findley L	8/16/86	11.5	0.75	1.5	0.035	0.03	12	8.98	195	36.30	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				
Findley L	8/30/86	11.5	1.00	1.5	0.034	0.03	3	7.60	205	29.60	20	19				
Findley L	9/5/86	11.5	0.75	1.5	0.033	0.03	3	8.17	206	25.90	21	20				
Findley L	9/14/86	11.5	0.63	1.5	0.036	0.03	13	7.55	215	22.20	14	19				
Findley L	9/21/86	11.5	0.75	1.5	0.039	0.03	8	7.29	214	34.00	17	18				
Findley L	6/8/87	11.5	2.75	1.5	0.023	0.03	15	8.10	201		22	24				
Findley L	6/14/87	11.5	3.00	1.5	0.018		12	8.22	198		25	22				
Findley L	6/21/87	11.5	2.00	1.5	0.023	0.01	15	7.83	203	17.00	27	25				
Findley L	6/28/87	11.8	1.25	1.5	0.021	0.01	15	7.76	202	37.70	19	23				
Findley L	7/5/87	11.8	0.75	1.5	0.032	0.01	11	7.70	206		23	23				
Findley L	7/12/87	11.5	0.63	1.5	0.033		11	7.86	206	116.00	30	27				
Findley L	7/19/87	11.5	0.75	1.5	0.040	0.01	15	7.49	206	109.00	27	26				
Findley L	7/26/87	11.5	1.00	1.5	0.052		13	7.63	209	45.10	24	27				
Findley L	7/30/87	11.5	0.75	1.5	0.056		12	7.38	210	73.30	25	27				
Findley L	8/9/87	11.5	0.75	1.5	0.042	0.01	7	7.33	208	116.00	24	24				
Findley L	8/16/87	11.5	0.50	1.5	0.060		6	7.14	216	274.00	27	27				
Findley L	8/23/87	11.5	0.75	1.5	0.054	0.01	10	7.42	208		18	22				
Findley L	8/30/87	11.5	0.75	1.5	0.052		12	7.46	204	73.00	21	20				
Findley L	9/6/87	11.5	0.75	1.5	0.059	0.17	8	7.36	221	99.00	19	19				
Findley L	10/1/87	11.5	0.75	1.5	0.049	0.03	11	7.30	215	73.20	14	17				
Findley L	6/21/88	12.0	2.25	1.5	0.022	0.01	8	7.72	213	17.50	25	24				
Findley L	6/28/88	11.5	1.75	1.5	0.022	0.01	7	7.77	219	10.10	20	24				
Findley L	7/5/88	11.5	1.50	1.5	0.020	0.01	9	8.10	220	10.40	29	25				
Findley L	7/12/88	11.0	1.00	1.5	0.023	0.01	11	8.19	234		28	27				
Findley L	7/19/88	11.5	1.00	1.5	0.025	0.01	7	8.31	223	20.70	26	28				
Findley L	7/26/88	12.0	1.50	1.5	0.029	0.01	10	7.71	221	1.78	26	25				
Findley L	7/31/88	11.5	1.25	1.5	0.031	0.01	10	8.10	223	17.80	24	26				
Findley L	8/8/88	11.5	1.00	1.5	0.037	0.01	11	7.97	219	31.10	27	28				
Findley L	8/12/88	11.5	0.75	1.5	0.042	0.01	10	7.96	221	52.50	26	27				
Findley L	8/21/88	11.8	0.75	1.5	0.042	0.01	6	8.32	227	49.60	20	25				
Findley L	8/30/88	11.5	2.25	1.5	0.032	0.02	11	7.97	227	10.10	18	23				
Findley L	9/6/88	11.3	1.75	1.5	0.037	0.03	14	7.86	227	18.50	15	20				
Findley L	9/12/88	11.5	1.50	1.5	0.035	0.03	12	7.95	229	24.40	24	20				
Findley L	9/19/88	11.8	1.00	1.5	0.040	0.01	8	8.09	230	38.50	24	20				
Findley L	9/25/88	11.8	1.00	1.5	0.039	0.01	6	8.27	227	30.30	24	18				
Findley L	6/26/89	11.0	3.25	1.5	0.017	0.14	7	7.94	198	2.16	29	27				
Findley L	7/2/89	11.0	2.25	1.5	0.015		12	7.98	199	18.50	22	23				
Findley L	7/9/89	11.0	2.25	1.5	0.022		15	7.76	204	6.45	27	25				
Findley L	7/16/89	11.5	2.50	1.5	0.020		11	7.85	210	6.18	25	24				
Findley L	7/27/89	11.5	2.50	1.5	0.025		10	8.13	200	9.77	27	25				
Findley L	7/31/89	11.0	2.00	1.5	0.026		8	7.82	210	6.36	21	24				
Findley L	8/7/89	10.5	2.50	1.5	0.029	0.06	8	8.18	214	7.19	17	23				
Findley L	8/14/89	11.3	2.00	1.5	0.020		7	7.98	211	6.45	24	22				

Findley L	8/20/89	11.5	2.00	1.5	0.024		2	8.24	212	6.65	20	23				
PName	Date	Zbot	Zsd	Zsamp	Tot.P	NO3	TColor	pH	Cond25	Chl.a	TAir	TH20	QA	QB	QC	QD
Findley L	8/29/89	11.5	2.25	1.5	0.028		2	8.24	208	11.30	26	24				
Findley L	9/11/89	11.0	1.75	1.5	0.025	0.01	5	8.16	211	17.80	21	22				
Findley L	9/25/89	11.5	1.00	1.5	0.029		6	8.18	203	19.60	14	16				
Findley L	10/11/89	11.0	1.25	1.5	0.038		5	8.16	210	18.50	11	12				
Findley L	7/10/90	11.5	1.25	1.5	0.046	0.01		7.95			22	23				
Findley L	7/17/90	11.3	1.25	1.5	0.037	0.01	13	7.72	209	36.60	25	23				
Findley L	7/31/90	11.5	0.75	1.5	0.048	0.01	10	7.40	199	57.40	21	24				
Findley L	8/14/90	11.5	0.81	1.5	0.044		10	7.24	199	45.10	22	23				
Findley L	8/28/90	11.5	0.75	1.5	0.053	0.01	10	7.50	206	58.60	23	23				
Findley L	9/11/90	11.0	0.75	1.5	0.051	0.01	12	8.11	205	62.70	21	22				
Findley L	9/25/90	11.0	1.50	1.5	0.048	0.02	17	7.78	222	26.90	14	15				
Findley L	10/10/90	11.0	2.50	1.5	0.062			8.23	205	9.40	21	16				
Findley L	7/22/91	11.3	1.00	1.5	0.049	0.01	10	8.22	215	30.90	26	27				
Findley L	8/5/91	13.0	0.75	1.5	0.055	0.01	14	7.63	220	82.80	24	23				
Findley L	8/19/91	11.0	0.75	1.5	0.054	0.01	11	8.28	224	68.80	23	24				
Findley L	9/4/91	11.7	0.33	1.5	0.079	0.01	9	7.59	219	149.00	20	22				
Findley L	9/18/91	11.0	0.67	1.5	0.065			7.90	221	132.00	20	22				
Findley L	10/1/91	11.5	0.58	1.5	0.064		7	7.81	220	126.00	19	17				
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
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
Findley L	8/11/92	11.3	1.33	1.5	0.025		8	8.34	223	11.60	23	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
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
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
Findley L	7/6/93	11.5	1.50	1.5	0.030		7	8.20	210	21.70	26	25	3	2	2	
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
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
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
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
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
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	
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
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
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
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
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
Findley L	6/5/95	11.0	2.00	1.5	0.020		6			9.86	25	22	2	2	2	
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
Findley L	7/10/95	11.3	0.77	1.5	0.037			7.76	235	51.30	23	23	3	3	3	15
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
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
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
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	
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
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	
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
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
Findley L	8/26/96	11.0	3.75	1.5	0.018	0.01	5	8.43	214	5.20	23	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
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
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
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
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
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
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
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
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

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

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).

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 $AA_{special}$: 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 $A_{special}$: 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