# 2003 INTERPRETIVE SUMMARY

# NEW YORK
# CITIZENS STATEWIDE
# LAKE ASSESSMENT PROGRAM
# (CSLAP)

# GALWAY LAKE

NY Federation of Lake Associations
NYS Department of Environmental Conservation

March, 2004

## BACKGROUND AND ACKNOWLEDGMENT

The Citizens Statewide Lake Assessment Program (CSLAP) is a volunteer lake monitoring program conducted by the NYS Department of Environmental Conservation (NYSDEC) and the NYS Federation of Lake Associations (FOLA). Founded in 1986 with 25 pilot lakes, the program has involves more than 190 lakes, ponds, and reservoirs and 1000 volunteers from eastern Long Island to the Northern Adirondacks to the western-most lake in New York, including 10 acre ponds to several Finger Lakes, Lake Ontario, Lake George, and lakes within state parks. In this program, lay volunteers trained by the NYSDEC and FOLA collect water samples, observations, and perception data every other week in a fifteen-week interval between May and October. Water samples are analyzed by certified laboratories. Analytical results are interpreted by the NYSDEC and FOLA, and utilized for a variety of purposes by the State of New York, local governments, researchers, and, most importantly, participating lake associations. This report summarizes the 2003 sampling results for **Galway Lake**.

**Galway Lake** is a 518 acre, class B lake found in the Town of Galway in Saratoga County, in the Capital District region of New York State. It was first sampled as part of CSLAP in 1990. The following volunteers have participated in CSLAP, and deserve most of the credit for the success of this program at **Galway Lake: Cornell C. Cawley, William F. Topka, Bud and Andrea Gaudreau, Herb Kopper, J. Watt, P. Anderson, Marti Ohmart, Peter and Ursula Hilborn, and Bruce Kniskern.**

In addition, the authors wish to acknowledge the following individuals, without whom this project and report would never have been completed:

From the Department of Environmental Conservation, N.G. Kaul, Sal Pagano, Dan Barolo, Italo Carcich, Phil DeGaetano, and Dick Draper, for supporting CSLAP for the past eighteen years; Jay Bloomfield and James Sutherland, for their work in developing and implementing the program; and the technical staff from the Lake Services Section, for continued technical review of program design.

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

The New York State Department of Health (prior to 2002), particularly Jean White, and Upstate Freshwater Institute (since 2002), particularly Carol Matthews and Doug Gillard, provided laboratory materials and all analytical services, reviewed the raw data, and implemented the quality assurance/quality control program.

Finally, but most importantly, the authors would like to thank the more than 1000 volunteers who have made CSLAP a model for lay monitoring programs throughout the country and the recipient of a national environmental achievement award. Their time and effort have served to greatly expand the efforts of the state and the public to protect and enhance the magnificent water resources of New York State.

# GALWAY LAKE
# FINDINGS AND EXECUTIVE SUMMARY

Galway Lake was sampled as part of the New York Citizens Statewide Lake Assessment Program in 2003. For all program waters, water quality conditions and public perception of the lake each year and historically have been evaluated within annual reports issued after each sampling season. This report attempts to summarize both the 2003 CSLAP data and an historical comparison of the data collected within the 2003 sampling season and data collected at Galway Lake prior to 2003.

The majority of the short- and long-term analyses of the water quality conditions in Galway Lake are summarized in Table 2, divided into assessments of eutrophication indicators, other water quality indicators, and lake perception indicators. The 2003 data indicate that the lake continues to be best classified as mesotrophic, or moderately productive. Water quality conditions in 2003 were comparable (slightly higher water clarity and phosphorus levels and lower chlorophyll *a* readings) to those measured in the typical CSLAP sampling season. CSLAP data suggest that water clarity is probably closely influenced by both algae and nutrients; the nitrogen to phosphorus ratios indicate that algae levels in Galway Lake is probably controlled by phosphorus. The supplemental nutrient sampling in 2003 indicated that deepwater nutrient levels are elevated and increase over the summer, and highest surface readings correspond to the mouth of the inlets at North, West and South Bays; these data are discussed in more detail in Appendix E. The lake productivity does not change in a predictable manner over the course of a typical sampling season. Phosphorus levels in the lake occasionally exceed the state phosphorus guidance value, but water transparency readings consistently exceed the minimum recommended water clarity for swimming beaches. In short, water quality conditions in 2003 in Galway Lake appeared to be within the normal and expected range of variability for the lake.

The lake is moderately colored (low to intermediate levels of dissolved organic matter) and it is likely that these readings reflect the characteristics of the watershed (i.e. “natural” conditions at the lake). Color readings are not high enough to exert limits on the water transparency, even when algae levels are very low. Galway Lake has water of intermediate hardness, alkaline (above neutral) pH readings, and mostly undetectable nitrate readings. Conductivity readings have not varied significantly since 1990, and it is not believed that these small changes have resulted in water quality or ecological impacts. pH readings usually fall within the NYS water quality standards (=6.5 to 8.5), although slightly elevated pH readings occasionally occur. Nitrate and ammonia levels do not appear to warrant a threat to the lake, and the primary component of nitrogen appears to be organic (within algae cells). Calcium levels are high enough to support zebra mussels, although these have not been reported at the lake.

The recreational suitability of Galway Lake continues to be described highly favorably, consistent with assessments in recent years. Recreational conditions in the lake were described as “could not be nicer” to “excellent” for most uses, and the lake was also regularly described as “crystal clear” to “not quite crystal clear”, slightly more favorable than expected given the measured water clarity, but mostly typical of assessments in previous years. Aquatic plants mostly grow below the lake surface, and are not usually implicated in recreational use impacts. Recreational assessments are stable over the summer, coincident with seasonal consistency in productivity and weed densities and coverage.

The 2002 NYSDEC Priority Waterbody Listings (PWL) for the Mohawk River drainage basin do not include Galway Lake. The CSLAP datasets suggest that no listings appear to be warranted. The next PWL review cycle for the Mohawk River drainage basin will occur in 2006.

## *General Comments and Questions:*

- ***What is the condition of Galway Lake?***

Water quality conditions in Galway Lake appear to be adequate to support most recreational uses of the lake during the summer. Water clarity, nutrient and algae levels are typical of moderately productive lakes, and these conditions have been consistent or might even be improving slightly since CSLAP sampling began in 1990. Nutrient levels appear to be highest in the mouth of inlets at North, West, and South Bays. Recreational uses of the lake do not appear to be highly sensitive to changes in aquatic plants (weeds) or water clarity, and the lake continues to be most frequently described as “could not be nicer” to “excellent” for most recreational uses.

- ***What about the dark and murky bottom waters of the lake?***

Deepwater nutrient levels in Galway Lake appear to be slightly elevated, and increase over the course of the summer. This suggests that deepwater oxygen levels might be depleted (triggering the release of nutrients during the summer), although this has not been measured through CSLAP.

- ***How does this condition change from spring showers thru the changing of the leaves?***

The productivity of Galway Lake does not change in any predictable way over the course of the sampling season, and it is likely that the small changes in water transparency, phosphorus, and chlorophyll *a* are within the expected range for this lake. Recreational assessments are consistently favorable throughout the summer.

- ***How has the condition changed since CSLAP sampling began on the lake and/or relative to historical values?***

With the exception of a slight increase in water clarity and decrease in chlorophyll *a*, neither of which are statistically significant, none of the water quality indicators have exhibited long term trends. Readings in 2003 for all trophic indicators indicate productivity comparable (higher clarity and nutrient levels, lower algae levels) to that measured in most previous CSLAP sampling seasons.

- ***How does Galway Lake compare to other similar lakes (nearby lakes, same lake use, etc.)?***

Galway Lake continues to be less productive (re: clarity, nutrient and algae levels) than other nearby (Mohawk River basin) lakes, other NYS lakes, and other lakes classified for bathing and swimming (Class B). Recreational assessments, however, have been consistently more favorable than these other lakes, reflecting the lack of recreational impacts from excessive weed or algae growth.

- ***Based on these data, what should be done to improve or maintain Galway Lake?***

The recreational assessments of Galway Lake appear to be highly favorable and reflect relatively consistent water quality conditions. As such, lake management activities will likely focus on the control of excessive nutrient loading to the lake, via failing septic tanks, stormwater runoff, lawn fertilization, and eroded materials, particularly in the inlets (North, West, and South Bays) identified in the supplemental monitoring in 2003 as contributing higher nutrient loads to the lake. The introduction of exotic organisms, such as Eurasian watermilfoil and zebra mussels, should be minimized by close and aggressive surveillance of boats and launch areas (formal and informal).

# I. INTRODUCTION: CSLAP DATA AND YOUR LAKE

Lakes are dynamic and complex ecosystems. They contain a variety of aquatic plants and animals that interact and live with each other in their aquatic setting. 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 properties, it is possible to gain a greater understanding of the general condition of lakes. CSLAP monitoring is a basic step in overall water quality monitoring.

## 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 1). **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. It is important to remember that eutrophication is a natural process, and is not necessarily indicative of man-made pollution.

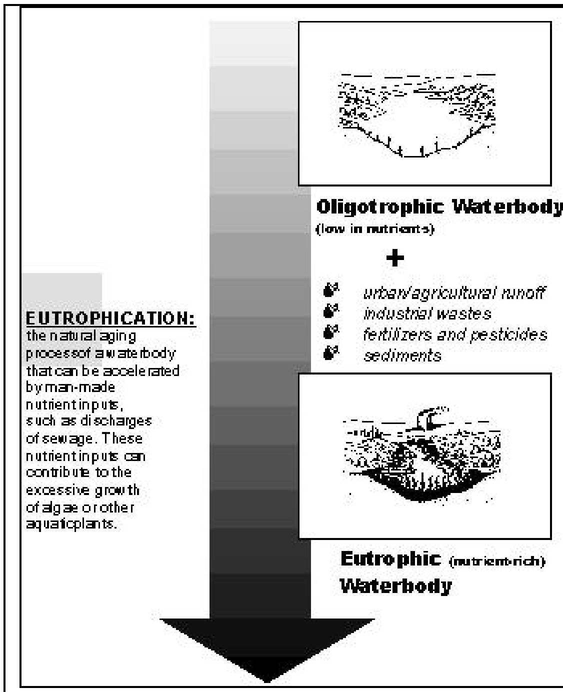



**Figure 1. Trophic States**

In fact, some lakes are thought to be "naturally" productive. 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. 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)**.**

When human activities accelerate lake eutrophication, it is referred to as **cultural eutrophication**. Cultural eutrophication may result from shoreline erosion, agricultural and urban runoff, wastewater discharges or septic seepage, and other nonpoint source pollution sources. These can greatly accelerate the natural aging process of lakes, cause succession changes in the plant and animal life within the lake, shoreline and surrounding watershed, and impair the water quality and value of a lake. 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.

# II. CSLAP PARAMETERS

CSLAP monitors several parameters related to the trophic state of a lake, including the clarity of the water, the amount of nutrients in the water, and the amount of algae resulting from those nutrients. Three parameters are the most important measures of eutrophication in most New York lakes: **total phosphorus, chlorophyll *a*** (estimating the amount of algae), 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. Other CSLAP parameters help characterize water quality at the lake while balancing fiscal and logistic necessities. In addition, CSLAP also uses the responses on the **Field Observation Forms** to gauge volunteer 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 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 remaining stable. Such a determination answers a first critical question posed in the lake management process.

## Ranges for Parameters Assessing Trophic Status and Galway Lake

The relationship between phosphorus, chlorophyll *a*, and Secchi disk transparency has been explored by many researchers, to assess the trophic status (the degree of eutrophication) of lakes. Figure 2 shows ranges for phosphorus, chlorophyll a, and Secchi disk transparency (summer median) are representative for the major trophic classifications:

**Figure 2. Trophic Status Indicators**

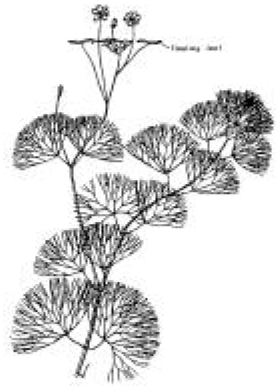
| Parameter | Eutrophic | Mesotrophic | Oligotrophic | Galway Lake |
|---|---|---|---|---|
| Phosphorus (mg/l) | > 0.020 | 0.010 - 0.020 | < 0.010 | **0.013** |
| Chlorophyll a (µg/l) | > 8 | 2- 8 | < 2 | **5.1** |
| Secchi Disk Clarity (m) | 2 | 2- 5 | > 5 | **3.4** |

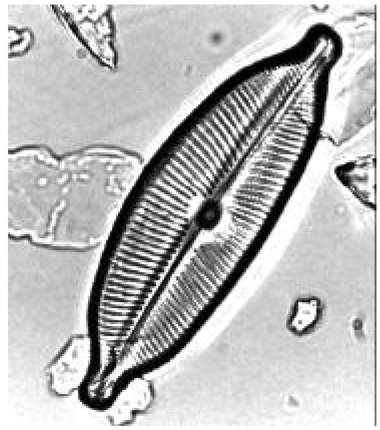
These classifications are valid for clear-water lakes only (with less than 30 platinum color units). Some humic or "tea color" lakes, for example, naturally have dissolved organic material with greater than 30 color units. This will cause the water transparency to be lower than expected given low phosphorus and chlorophyll *a* levels in the lake. Water transparency can also be unexpectedly lower in shallow lakes, due to influences from the bottom (or the inability to measure the maximum water clarity due to the visibility of the Secchi disk on the lake 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.

**Figure 3. CSLAP 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 indicate 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. Nitrogen to phosphorus ratios of >10 generally indicate phosphorus limitation. Many lake management plans are centered around phosphorus controls. It is measured as total phosphorus (TP) |
| **Nitrogen** (nitrate, ammonia, and total (dissolved), 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. Nitrogen to phosphorus ratios < 7 generally indicate nitrogen limitation (for algae growth). For much of the sampling season, many CSLAP lakes have very low or undetectable levels of one or more forms of nitrogen. It is measured in CSLAP in three forms- nitrate/nitrite ($NO_x$) ammonia ($NH_{3/4}$), and total nitrogen (TN or TDN). |
| **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 |
| **Calcium** (mg/l) | Calcium is a required nutrient for most aquatic fauna, and is required for the shell growth for zebra mussels (at least 8-10 mg/l) and other aquatic organisms. It is naturally contributed to lakes from limestone deposits and is often strongly correlated with lake buffering capacity and conductivity. |

By each of the trophic standards described above, Galway Lake would be considered to be a **mesotrophic**, or **a moderately productive**, lake**.**





# III. AQUATIC PLANTS

## Macrophytes:

Aquatic plants should be recognized for their contributions to lake beauty as well as for 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. Those who enjoy fishing at the lake appreciate a diverse plant population. Aquatic plants 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 extensive plant growth can occur in both “clean” and “polluted” lakes. A large portion of aquatic vegetation consists of the microscopic algae referred to as phytoplankton; the other portion is the larger rooted plants called **macrophytes.**

Of particular concern to many lakefront residents and recreational users are the *non-indigenous macrophytes* that can frequently dominate a native aquatic plant community and crowd out more beneficial plant species. The invasive plant species may be introduced to a lake by waterfowl, but in most cases they are introduced by fragments or seedlings that remain on watercraft from already-infested lakes. Once introduced, these species have tenacious survival skills, crowding out, dominating and eventually aggressively overtaking the indigenous (native) plant communities in a variety of water quality conditions. When this occurs, they interfere with recreational activities such as fishing, swimming or water-skiing. **These species need to be properly identified to be effectively managed.**

### Non-native Invasive Macrophyte Species

Examples of **the common non-native invasive species found** in New York are:

- **Eurasian watermilfoil** *(Myriophyllum spicatum)*
- **Curly-leaf pondweed** *(Potamogeton crispus)*
- **Eurasian water chestnut** *(Trapa natans)*
- **Fanwort** *(Cabomba caroliniana).*

**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 plant 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 specimens 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.

**Aquatic plant surveys conducted through CSLAP at Galway Lake have identified the following aquatic plants:**

| Species | CommonName | Subm/Emer? | Exotic? | Date | Location | %Cover | Abund. |
|---|---|---|---|---|---|---|---|
| Heteranthera dubia | water stargrass | submergent | no | 8/14/1993 | off Ohmarts dock | NA | NA |
| Potamogeton praelongus | clasping-leaf pondweed | submergent | no | 8/14/1993 | off Ohmarts dock | NA | NA |
| Potamogeton crispus | curly-leaf pondweed | submergent | yes | 6/30/03 | mid-lake- deep hole? | NA | NA |

***So What Does This Mean?***

**The aquatic plant communities in Galway Lake, at least historically, have been dominated by Eurasian watermilfoil, but the lake association reports that these plants have been well controlled by drawdown. The curly-leafed pondweed probably does not significantly impede recreational use of the lake, since it normally falls out of the water column by early summer. The water star grass and clasping leaf pondweed are native plants and are usually indicative of good water quality conditions; these plants usually support lake fisheries as well.**

## The Other Kind of Aquatic Vegetation

Microscopic algae referred to as phytoplankton make up much 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 different 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 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 often grow in higher densities than do diatoms or most other species, although they are often not the types of algae most frequently implicated in noxious 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. This often happens right before turnover, or destratification 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. Each lake possesses a unique blend of algal communities, often varying in population size from year to year, and with differing species proportional in the entire population. The most common types range from the aforementioned diatoms, green, and blue-green algae, to golden-brown algae to dinoflagellates and many others, with any given species able to dominate each lake community.

So how can this be evaluated through CSLAP? While algal differentiation is important, many CSLAP lake associations are primarily interested in “how much?”, not “what kind?”, and this is assessed through the chlorophyll *a* measurement. Phytoplankton communities have not been regularly identified and monitored through CSLAP, in part due to the cost and difficulty in analyzing samples, and in part due to the difficulty in using a one-time sample to assess long-term variability in lake conditions. A phytoplankton analysis may reflect a temporary, highly unstable and dynamic water quality condition.

In previous CSLAP sampling seasons, nearly all 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. Some algal species are frequently associated with taste and odor problems, 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.

**Phytoplankton surveys conducted through CSLAP at Galway Lake have identified the following algae:**

**Date: 8/16/92** **Most Abundant Species: Bacteria (no species ID)- 59%, *Melosira granulosa (*diatoms)- 19%, *Euglena spp. (*euglenoids)- 4%**
**Most Abundant Genera: Bacteria- 59%, Diatoms (*Bacillariophyta)*- 21%; Euglenas *(Euglenophyta)* –9%**

**Date: 9/6/95** **Most Abundant Species: *Synedra spp.* (diatoms), *Anacystis montana* (blue-green algae), *Anabaena circinalis* (blue-green algae) (alga not enumerated)**
**Most Abundant Genera: not reported**

***So What Does This Mean?***

**The majority of the plankton sample collected in 1992 consisted of non-algal material, such as bacteria and Euglenas. The diatoms found in that sample, constituting the majority of the algal material, are not normally associated with taste and odor problems. However, that was not the case with the sample collected in 1995- the diatoms and blue-green algae in this sample can contribute to taste and odor problems, although these were probably found at lower densities than those in the 1992 sample (which had much higher chlorophyll readings).**

# IV. NYS AND CSLAP WATER QUALITY DATA: 1986-2002

***Overall Summary:***

Although water quality conditions at each CSLAP lake have varied each year since 1986, and although detailed statistical analyses of the entire CSLAP dataset has not yet been conducted, general water quality trends can be evaluated after 5-18 years worth of CSLAP data from these lakes. Overall (regional and statewide) water quality conditions and trends can be evaluated by a variety of different means. Each of the tested parameters ("analytes") can be evaluated by looking at the how the analyte varies from year to year from the long-term average ("normal") condition for each lake, and by comparing these parameters across a variety of categories, such across regions of the state, across seasons (or months within a few seasons), and across designated best uses for these lakes. Such evaluations are provided in the second part of this summary, via Figures 4 through 13. The annual variability is expressed as the difference in the annual average (mean) from both the long-term average and the normal variability expected from this long-term average. The latter can be presented as the "standard error" (SE- calculated here within the 95% confidence interval) - one standard error away from the long-term average can be considered a moderate change from "normal", with a deviation of two or more standard errors considered to be a significant change. For each of these parameters, the percentage of lakes with annual data falling within one standard error from the long-term average are considered to exhibit "no change", with the percentage of lakes demonstrating moderate to significant changes also displayed on these graphs. These methods are described in greater detail in Appendix D. Assessments of weather patterns- whether a given year was wetter or drier than usual- accounts for broad statewide patterns, not weather conditions at any particular CSLAP lake. As such, weather may have very different at some (but not most) CSLAP lakes in some of these years.

Long-term trends can also be evaluated by looking at the summary findings of individual lakes, and attempting to extrapolate consistent findings to the rest of the lakes. Given the (non-Gaussian) distribution of many of the water quality parameters evaluated in this report, non-parametric tools may be the most effective means for assessing the presence of a water quality trend. However, these tools do not indicate the magnitude of the trend. As such, a combination of parametric and non-parametric tools are employed here to evaluate trends. The Kendall tau ranking coefficient has been utilized by several researches and state water quality agencies to evaluate water quality trends via non-parametric analyses, and is utilized here. For parametric analyses, best-fit analysis of summer (June 15 through September 15) averages for each of the eutrophication indicators can be evaluated, with trends attributable to instances in which deviations in annual means exceed the deviations found in the calculation of any single annual mean. The standard t-test can also be utilized to compare one set of data (such as the first five years of data versus the last five years of data, or data collected in the 1980s versus 1990s or 2000s data). It has been demonstrated in many of these programs that long-term trend analyses cannot be utilized to evaluate lake datasets until at least five years worth of data have been collected.

As of 2002, there were 135 CSLAP lakes that have been sampled for at least five years- the change in these lakes is demonstrated in Figures 4a through 4i. When these lakes are analyzed by this combination of parametric and non-parametric analyses, these data suggest that while most NYS lakes have not demonstrated a significant change, those lakes that have experienced some change show a trend toward less productive conditions. There does not appear to be any obvious shared characteristics among these lakes. Some are highly productive, others are quite unproductive, some have been actively managed, some have been sampled for only a few years or are small shallow lakes or are located in the western part of the state, while others are just the opposite.

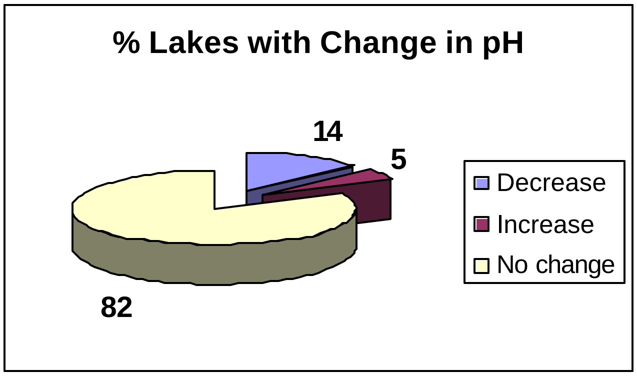



**Figure 4a. %CSLAP Lakes Exhibiting Long-Term Change in pH**

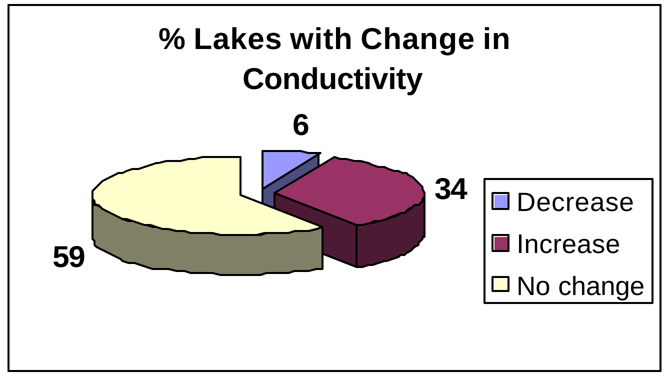



**Figure 4b. %CSLAP Lakes Exhibiting Long-Term Change in Conductivity**

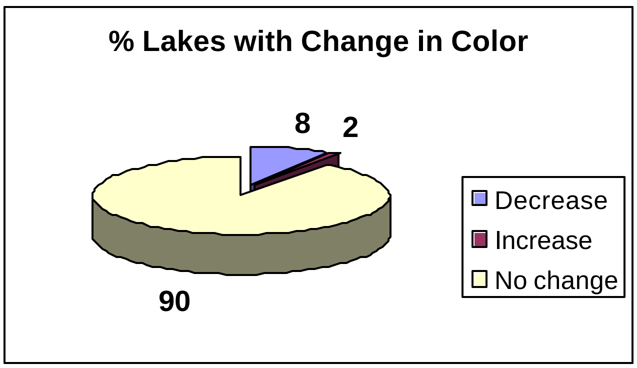



**Figure 4c. %CSLAP Lakes Exhibiting Long-Term Change in Color**

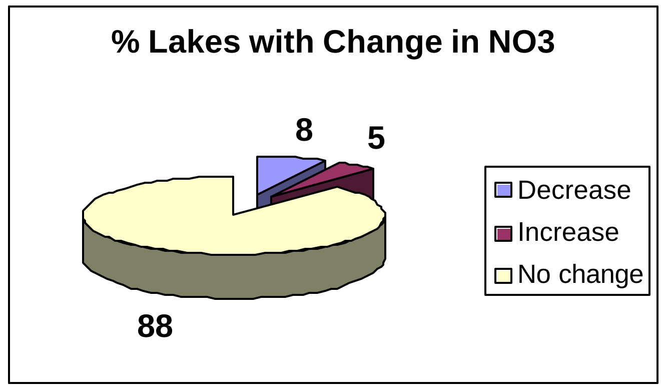



**Figure 4d. %CSLAP Lakes Exhibiting Long-Term Change in Nitrate**

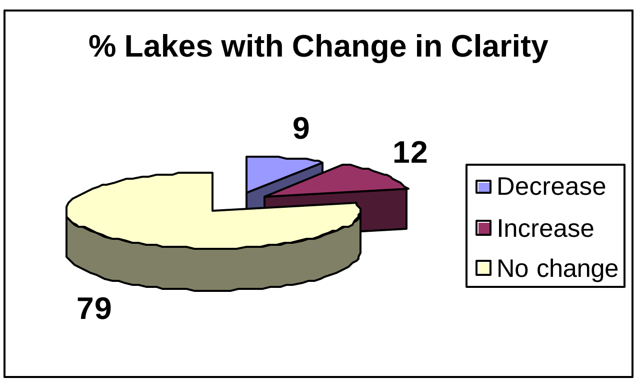



**Figure 4e. %CSLAP Lakes Exhibiting Long-Term Change in Water Clarity**

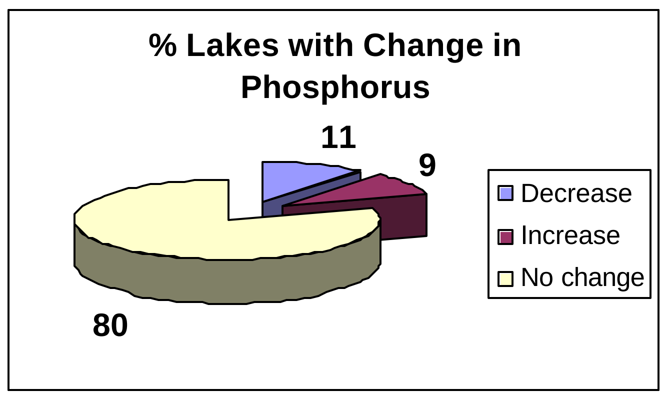



**Figure 4f. %CSLAP Lakes Exhibiting Long-Term Change in Phosphorus**

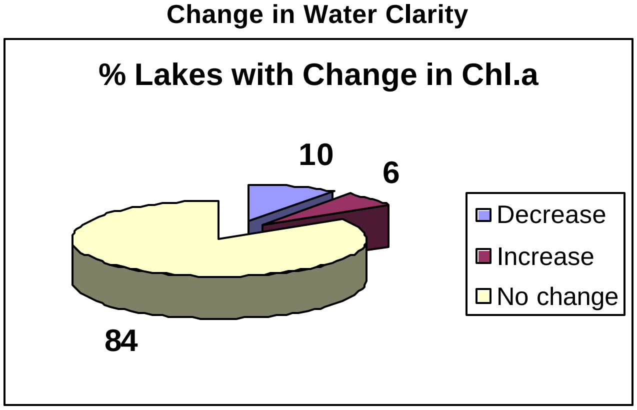



**Figure 4g. %CSLAP Lakes Exhibiting Long-Term Change in Chlorophyll *a***

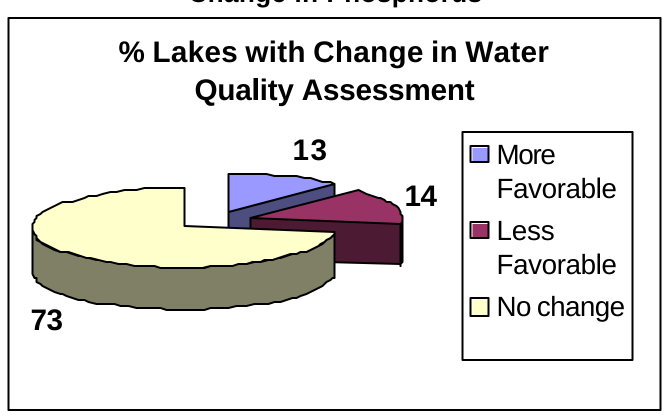



**Figure 4h. %CSLAP Lakes Exhibiting Long-Term Change in Water Quality Assessment**

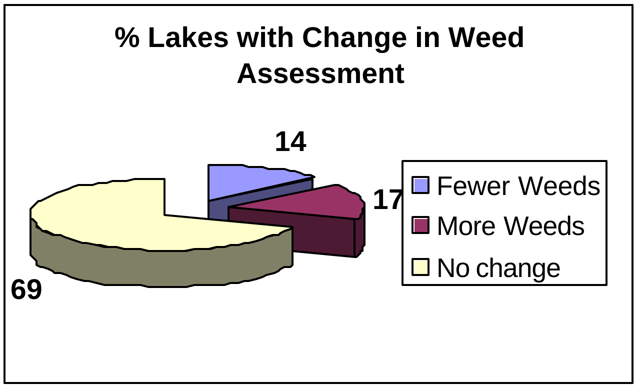



Figure 4i. %CSLAP Lakes Exhibiting Long-Term Change in Weed Assessment

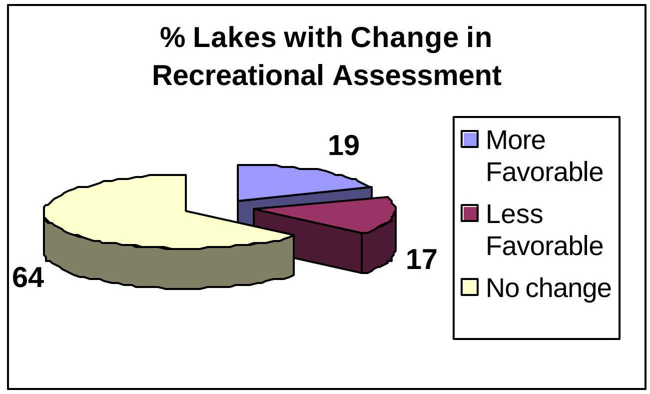



Figure 4j. %CSLAP Lakes Exhibiting Long-Term Change in Recreational Assessment

As noted above, there does not appear to be any clear pattern between weather and water quality changes, although some connection between changes in precipitation and changes in some water quality indicators is at least alluded to in some cases. However, all of these lakes may be the long-term beneficiaries of the ban on phosphorus in detergents in the early 1970's, which with other local circumstances (perhaps locally more "favorable" weather, local management, etc.) has resulted in less productive conditions. Without these circumstances, water quality conditions in many of these lakes might otherwise be more productive, in the creeping march toward aging, eutrophication, and succession.

Figures 4 demonstrate that significant changes have not occurred in most CSLAP lakes since sampling began on their lake. As might be expected, the most significant change occurred in conductivity, with about 1/3 of all CSLAP lakes exhibiting a significant increase in conductivity. This likely reflects a steady increase in materials (solids, nutrients, metals, etc.) loading to these lakes, although, as noted in other Figures shown above, this has not necessarily resulted in other water quality impacts.

Figures 4e, 4f, and 4g indicate that CSLAP lakes have, on average, become slightly less productive over time, although the majority of these lakes have not exhibited any significant change in trophic condition over the time of sampling. The patterns of change in water clarity, phosphorus, and chlorophyll *a* are all internally consistent (transparency increasing as algae and nutrients decreasing). Changes in other sampling parameters, such as pH and color, are relatively small and not readily explainable by any of the above phenomena, although lower pH in NYS lakes (at least until recently) has been studied at length within the Adirondacks and may continue to be attributable to acid rain.

Lake perception has changed more significantly than water quality (except conductivity), due in part to the shorter timeframe for evaluation and thus a lower statistical hurdle for quantifying change (11 years versus up to 17 years for some lakes), but perhaps due to the multiple influences of these phenomena. None of these indicators- water quality perception, weeds perception, or recreational perception- have varied in a consistent manner, although variability is more common in each of these indicators. The largest change is in recreational assessments, with more than 1/3 of all lakes exhibiting some change; a more detailed analysis of these assessments (not presented here) indicate that the Adirondacks have demonstrated more "positive" change than other regions of the state, due to the perception that aquatic weed densities have not increased as significantly (and water quality conditions have improved in some cases). However, the rapid spread of *Myriophyllum spicatum* into the interior Adirondacks will likely reverse this "trend" in coming years.

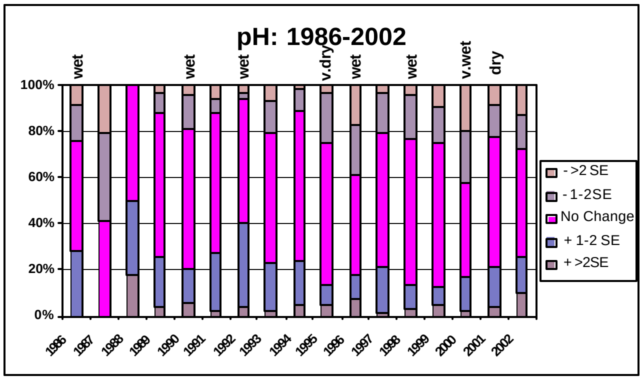



**Figure 5a.** *Annual Change from "Normal" pH in CSLAP Lakes (SE = Standard Error)*

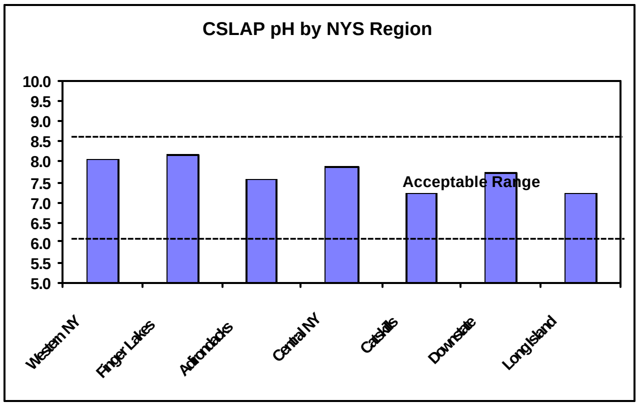



**Figure 5b.** *pH in CSLAP Lakes by NYS Region*

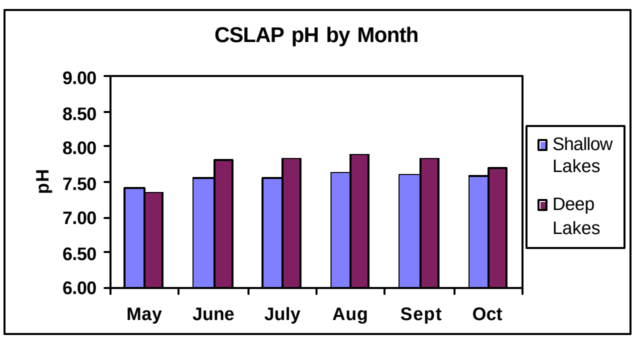



**Figure 5c.** *pH in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

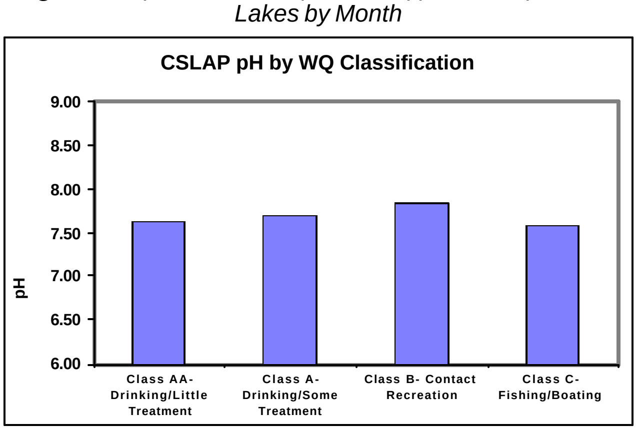



**Figure 5d**. *pH in CSLAP Lakes by Lake Use*

## pH

*Annual Variability*

The pH of most CSLAP lakes has consistently been well within acceptable ranges for most aquatic organisms during each sampling season. The average pH has not varied significantly from one sampling season to the next. There does not appear to be a strong connection between pH and weather; the years with the relatively highest pH, 1988 and 1992, and the lowest pH, 1987, correspond to years with relatively normal precipitation, although some of the other years with relatively low pH corresponded to wetter years (1996 and 2000). There does not appear to be any significant annual pH trends in the CSLAP dataset. 90% of all samples had pH between 6.5 and 8.5 (the state water quality standards); 6% of samples have pH > 8.5 and 4% have pH < 6.5.

*Statewide Variability*:

As expected, pH readings are lowest in the high elevation regions (Adirondacks and Catskills) or Long Island, which has primarily shallow and slightly colored lakes, and highest in regions with relatively high conductivity (Western NY and the Finger Lakes region). All of these readings are consistently within the acceptable range for most aquatic organisms. However, the CSLAP dataset does not reflect the low pH found in many high elevation NYS lakes overlying granite and poorly buffered soils, since the typical CSLAP lake resides in geological settings (primarily limestone) that allow for residential development.

*Seasonal Variability*:

pH readings tend to increase slightly over the course of the summer, due largely to increasing algal photosynthesis (which consumes $CO_2$ and drives pH upward), although these seasonal changes are probably not significant. Low pH depressions are most common early in the sampling season (due to lingering effects from snowpack runoff) and high pH spikes occur mostly in mid to late summer.

*Lake Use Variability*

pH does not vary significant from one lake use to another, although in general pH readings are slightly higher for lakes used primarily for contact recreation (Class B). However, this is probably more reflective of geographical differences (there are relatively more Class B CSLAP lakes in higher pH regions, and more Class A lakes in lower pH regions) than any inherent link between pH and lake usage.

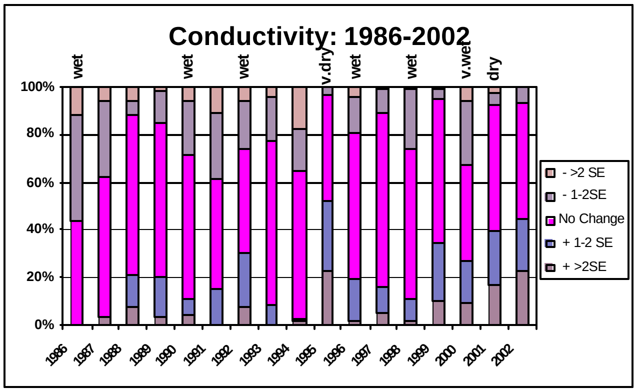



**Figure 6a.** *Annual Change from "Normal" Conductivity in CSLAP Lakes (SE = Standard Error)*

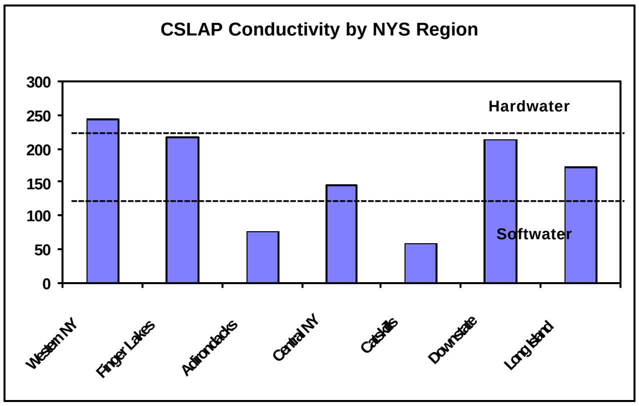



**Figure 6b.** *Conductivity in CSLAP Lakes by NYS Region*

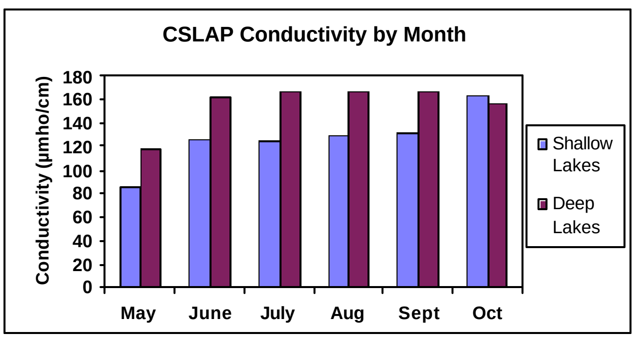



**Figure 6c.** *Conductivity in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

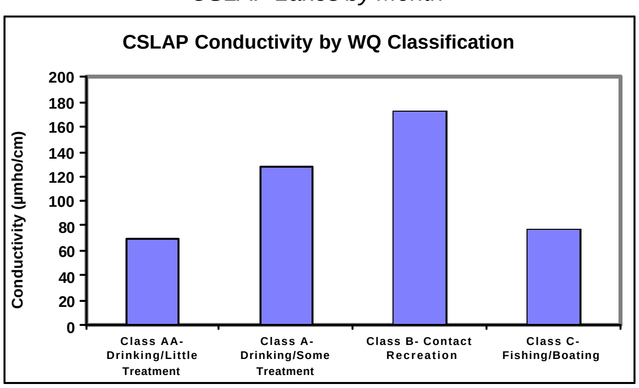



**Figure 6d**. *Conductivity in CSLAP Lakes by Lake Use*

## Conductivity

*Annual Variability*

The conductivity of most CSLAP lakes has varied somewhat from year to year, and has been (slightly) increasing overall and in specific lakes since 1986. Readings are generally higher in dry weather and lower in wetter weather, although the overall annual trend appears to be stronger than weather-impacted changes.

*Statewide Variability*:

Although "hardwater" and "softwater" is not consistently defined by conductivity, in general lakes in the Adirondacks and Catskills have lower conductivity (softer water), and lakes downstate, in Western NY, and in the Finger Lakes region have higher conductivity (hard water). These regional differences are due primary to surficial geology and "natural" conditions in these areas.

*Seasonal Variability*:

Conductivity readings were higher in the summer than in the late spring, and increased substantially in shallow lakes in the fall. Although lake destratification (turnover) brings bottom waters with higher conductivity to the lake surface in deeper lakes, this does not appear to have resulted in a consistent increase in surface water conductivity readings in the fall (although fully mixed conditions may be missed in some NYS lakes by discontinuing sampling after the end of October). Conductivity readings overall were slightly higher in deep lakes, although this is probably an artifact of the sampling set (more CSLAP deep lakes in areas that "naturally" have harder water)

*Lake Use Variability*

Conductivity readings are substantially higher for lakes used primarily for contact recreation (Class B), and somewhat higher for lakes used for drinking water with some treatment (Class A). However, this is probably more reflective of geographical differences (there are relatively more softwater CSLAP lakes in the Adirondacks, which tend to have more Class A or higher lakes, at least in CSLAP, and more Class B lakes in hardwater regions) than any inherent connection between conductivity and lake usage.

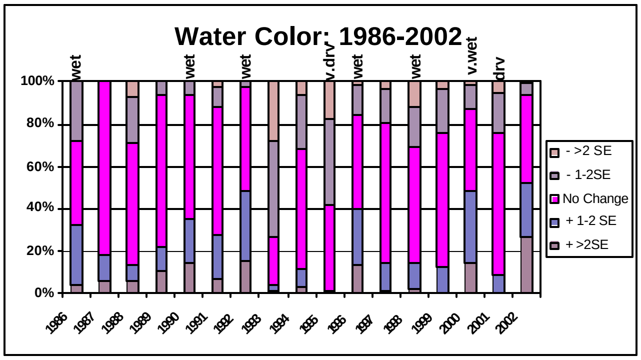



**Figure 7a.** *Annual Change from "Normal" Color in CSLAP Lakes (SE = Standard Error)*

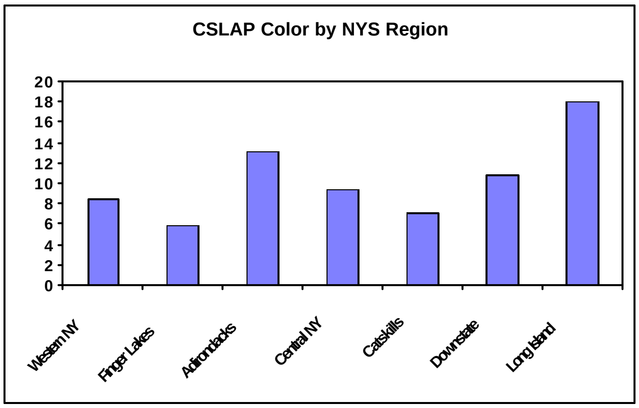



**Figure 7b.** *Color in CSLAP Lakes by NYS Region*

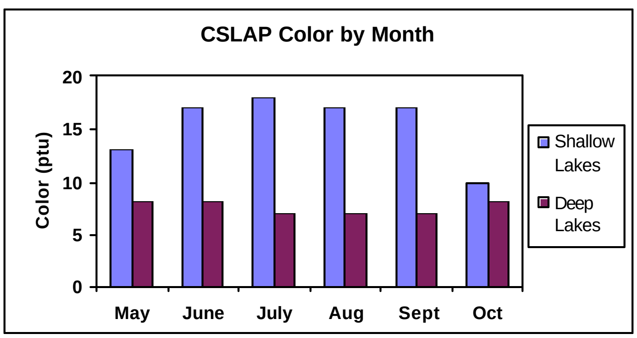



**Figure 7c.** *Color in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

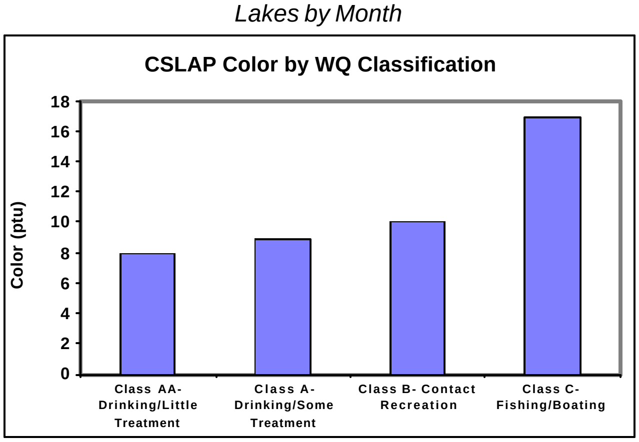



**Figure 7d**. *Color in CSLAP Lakes by Lake Use*

## Color

*Annual Variability*

The color of most CSLAP lakes has varied from year to year. Although the year with the lowest color readings (1993) and the highest color readings (2002) had "normal" levels of precipitation, in general the years corresponding to the mostly highly colored lakes were wet, and the least colored waters occurred during dry conditions. Most lake samples (92%) correspond to water color readings too low (< 30 ptu) to significantly influence water clarity.

*Statewide Variability*:

Water color is highest in Long Island and the Adirondacks, and lowest in the Finger Lakes and Western NY regions. This is mostly coincident with the statewide conductivity distribution (with softwater lakes more likely to be colored)

*Seasonal Variability*:

Color readings are significantly higher in shallow lakes than in deepwater lakes; these readings increase from spring to summer in these shallower lakes (perhaps due to dissolution of organic material, including algae, and wind-induced mixing during the summer) and then drop off in the fall. Color generally follows the opposite trend in deeper lakes, with slightly decreasing levels perhaps due to more particle setting in the summer and remixing in the fall, although the seasonal trend in the deeper lakes is not as significant as in shallow lakes.

*Lake Use Variability*

Color readings are substantially higher for lakes used primarily for non-contact recreation (Class C), but this is probably more reflective of morphometric differences, for Class C lakes tend to be shallow lakes (mean depth = 4 meters), while the other classes tend to be deeper lakes (mean depth = 9 meters). However, the elevated color readings correspond to elevated levels of dissolved organic matter, and may also reflect impediments (via economically viable water treatment, aesthetics, and potential formation of hazardous compounds during chlorination) to these use of these waters for potable water.

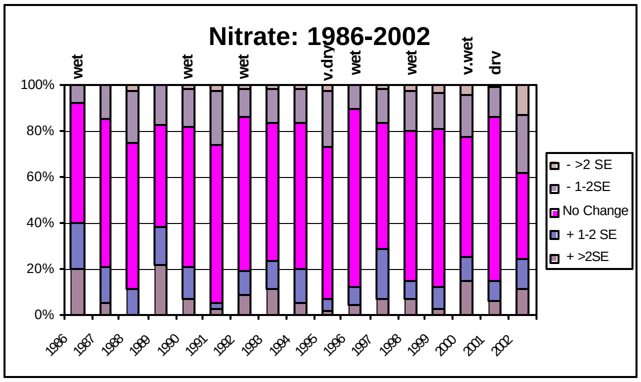



**Figure 8a.** *Annual Change from "Normal" Nitrate in CSLAP Lakes (SE = Standard Error)*

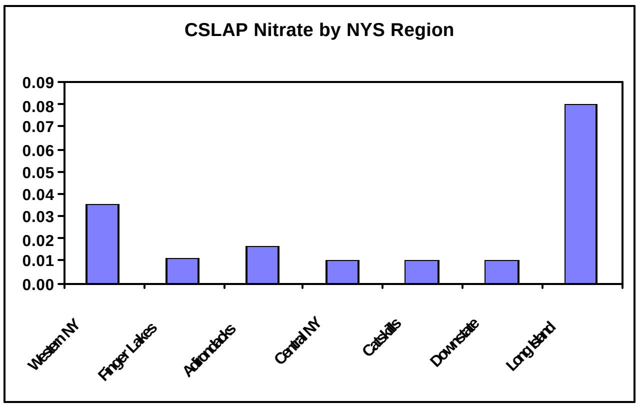



**Figure 8b.** *Nitrate in CSLAP Lakes by NYS Region*

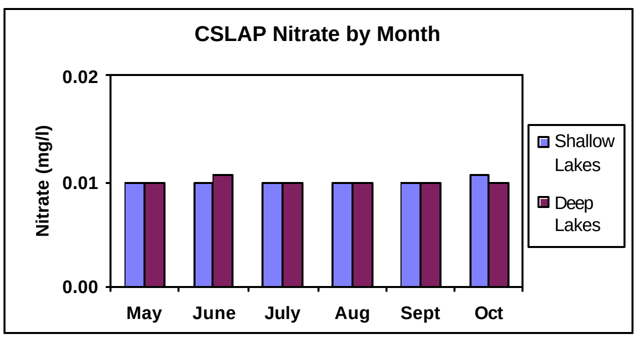



**Figure 8c.** *Nitrate in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

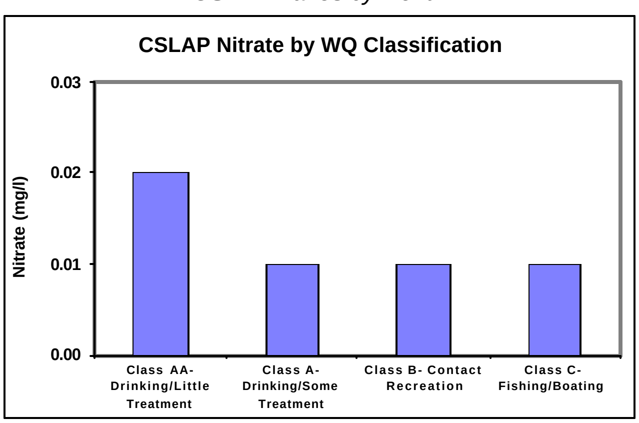



**Figure 8d**. *Nitrate in CSLAP Lakes by Lake Use*

## Nitrate

*Annual Variability*

Evaluating nitrate in CSLAP lakes is confounded by the relative lack of nitrate data for many sampling seasons (it was analyzed in water samples at a lower frequency, or not at all, in many years), and the high number of undetectable nitrate readings. The limited data indicated that nitrate was highest in 1986 and 1989, two early CSLAP years in which nitrate was analyzed more frequently (including a relatively large number of early season samples), and lowest in 1995 and 2002. Although nitrate levels are probably closely related to winter and spring precipitation levels (due to the higher nitrate readings in snowpacks), this is not apparent from Figure 7a. No readings approached the state water quality standard (= 10 mg/l).

*Statewide Variability*:

Nitrate levels are highest in Long Island, Western NY, and the Adirondacks, and lowest in the other NYS regions. However, none of these regions demonstrate readings that are particularly high. Individual lakes in the Long Island, Madison County, and the Adirondacks (spring only) are often elevated, although still well below water quality standards.

*Seasonal Variability*:

Nitrate readings are not seasonally variable as indicated in Figure 7c. However, in some individual lakes, in the regions listed above, nitrate is often detectable until early summer, and then undetectable through the rest of the sampling season (the large number of lakes with undetectable nitrate levels throughout the year overwhelm the statistics in Figure 7c).

*Lake Use Variability*

Nitrate readings are slightly higher for lakes used primarily for potable water (Class AA); this is due to regional differences, with many Class AA lakes in the Adirondacks, which exhibit some seasonal variability (as described above).

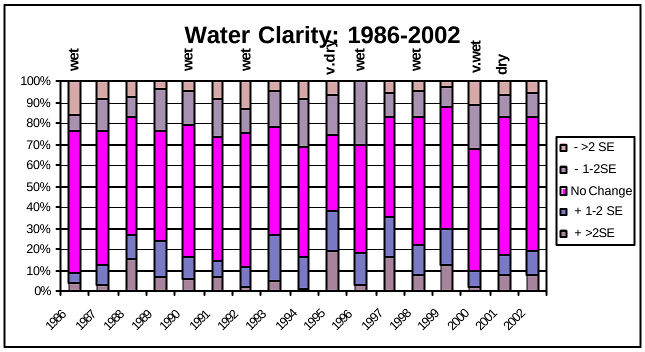



**Figure 9a.** *Change from "Normal" Water Clarity in CSLAP Lakes (SE = Standard Error)*

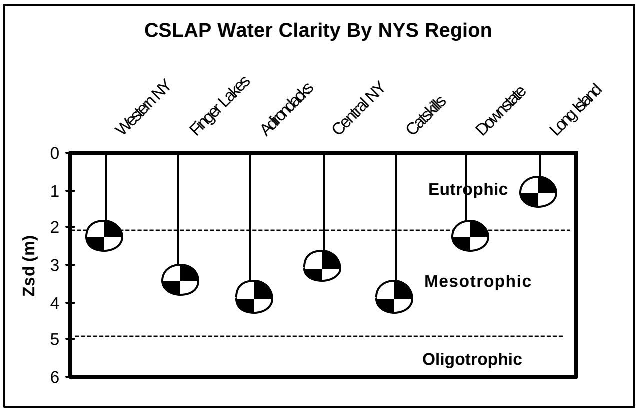



**Figure 9b.** *Water Clarity in CSLAP Lakes by NYS Region*

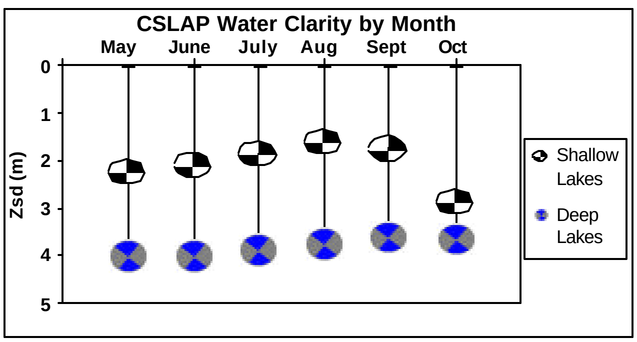



**Figure 9c.** *Water Clarity in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

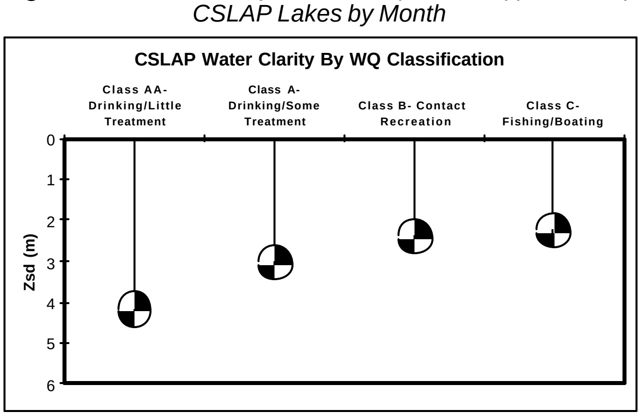



**Figure 9d**. *Water Clarity in CSLAP Lakes by Lake Use*

## Trophic Indicators: Water Clarity

*Annual Variability*

Water clarity (transparency) has varied annually in most CSLAP lakes. There appears to be at least a weak correlation between clarity and precipitation- the highest clarity occurred during the driest year (1995), and the lowest clarity during the two wettest years (1996 and 2000). There are no significant broad statewide water clarity trends, although (as described in other portions of this report), clear trends do exist on some lakes. The majority of water clarity readings in CSLAP lakes (56%) correspond to *mesotrophic* conditions (clarity between 2 and 5 meters), with 27% corresponding to *eutrophic* conditions (Zsd < 2) and 17% corresponding to *oligotrophic* conditions (Zsd > 5).

*Statewide Variability*:

As expected, water clarity is highest in the Adirondacks, Catskills, and Finger Lakes regions, and lowest in Long Island, Downstate, and Western NY. The differences are more pronounced (at least for the Adirondacks) when "naturally" colored lakes are not considered. However, except for Long Island (for which water clarity is at least partially limited by the shallow water depth), the "typical" lake in each of these regions would be classified as *mesotrophic.*

*Seasonal Variability*:

Water clarity readings are lower, as expected, in shallow lakes, even when water depth does not physically limit a water transparency measurement. Clarity decreases in both shallow and deep lakes over the course of the sampling season (the drop in clarity in shallower lakes is somewhat more significant), although clarity rebounds in shallower lakes in the fall, due to a drop in nutrient levels. The lack of "rebound" in deeper lakes may be due to occasional fall algal blooms in response to surface nutrient enrichment after lake turnover (see below)

*Lake Use Variability*

Water transparency decreases as the "sensitivity" of the lake use decreases, with higher clarity found in lakes used for potable water (Class AA), and lower clarity found in lakes used primarily for contact and non-contact (fishing and boating) recreation. As with many of the other water quality indicators, this is due to both geographical and morphometric (depth) differences, although the original designation of these uses may also reflect these measurable and visually apparent water quality differences.

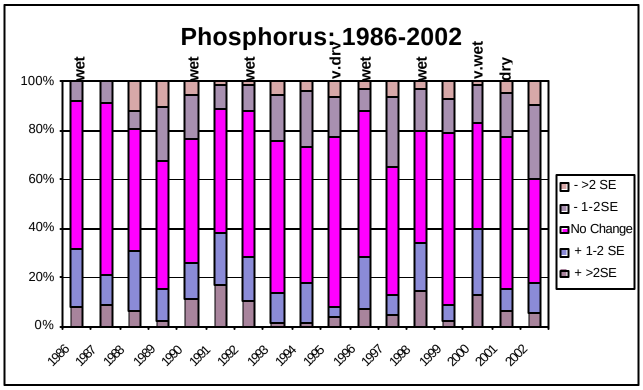



**Figure 10a.** *Annual Change from "Normal" TP in CSLAP Lakes (SE = Standard Error)*

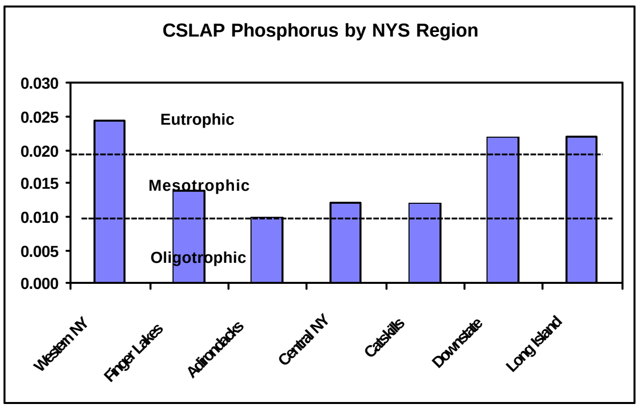



**Figure 10b.** *TP in CSLAP Lakes by NYS Region*

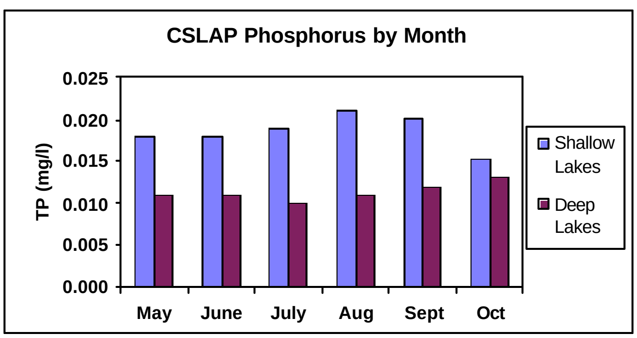



**Figure 10c.** *TP in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

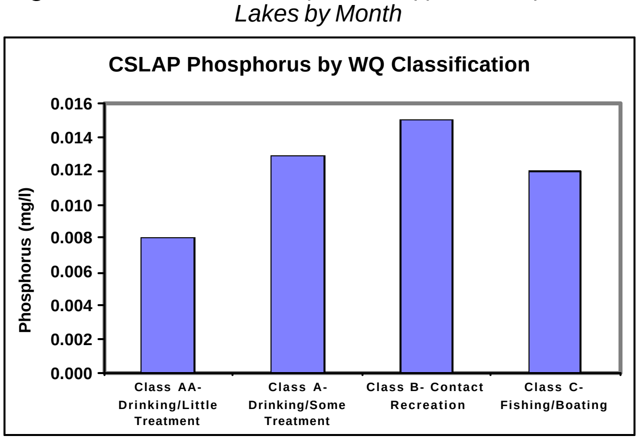



**Figure 10d**. *TP in CSLAP Lakes by Lake Use*

## Trophic Indicators: Phosphorus (TP)

*Annual Variability*

Total phosphorus (TP) has varied annually in most CSLAP lakes. As with clarity, there appears to be at least a weak correlation between phosphorus and precipitation- the highest phosphorus concentrations occurred during 1991, 1996, 1998, and 2000, the latter three of which corresponded to wet years. However, the lowest readings, from 1989, 1997, and 2002, did not correspond to unusually dry years (the latter might be due to the shift in labs). The majority of phosphorus readings in CSLAP lakes (39%) correspond to *mesotrophic* conditions (clarity between 2 and 5 meters), with 27% corresponding to *eutrophic* conditions (Zsd < 2) and 34% corresponding to *oligotrophic* conditions (Zsd > 5); the latter is a much higher percentage than the trophic designation for water clarity.

*Statewide Variability*:

As expected, nutrient levels are lowest in the Adirondacks and Catskills (where clarity is highest) and highest in Long Island, Downstate, and Western NY, where clarity is lowest. In the latter three regions, the "typical" lake in each of these regions would be classified as *eutrophic*, while only in the Adirondacks could the typical lakes be described as *oligotrophic*, at least as evaluated by nutrients.

*Seasonal Variability*:

Nutrient levels are higher, as expected, in shallow lakes, and phosphorus levels increase in shallow lakes over the course of the sampling season, until dropping in the fall. However, phosphorus levels in deeper lakes are lower and decrease slightly through July, then increase into the fall. The latter phenomenon is due to surface nutrient enrichment after lake turnover (high nutrient water from the lake bottom, due to release of nutrients from poorly oxygenated lake sediments in the summer, migrates to the lake surface when the lake destratifies).

*Lake Use Variability*

Phosphorus readings are lower in lakes used for minimally treated potable water intakes (Class AA), and are higher for other lake uses. Although Class B waters are utilized for a "higher" lake use than Class C lakes (contact recreation versus non-contact recreation), these lakes actually have higher nutrient levels, perhaps reflecting the influence of deepwater nutrient enrichments (these lakes are typically deeper) and the "unofficial" use of Class C waters for bathing and contact recreation.

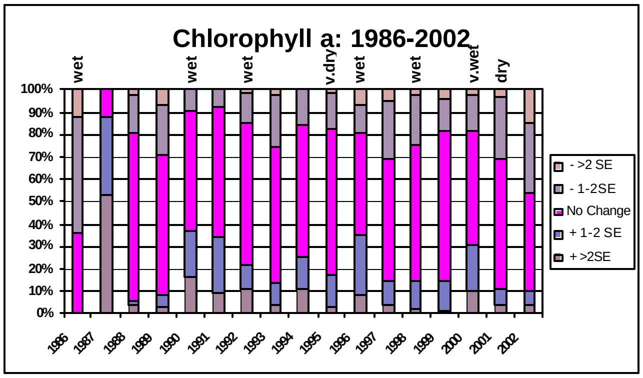



**Figure 11a.** *Annual Change from "Normal" Chlorophyll a in CSLAP Lakes (SE = Standard Error)*

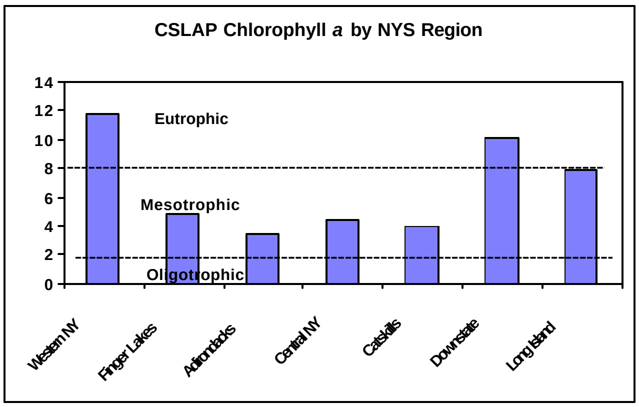



**Figure 11b.** *Chlorophyll a in CSLAP Lakes by NYS Region*

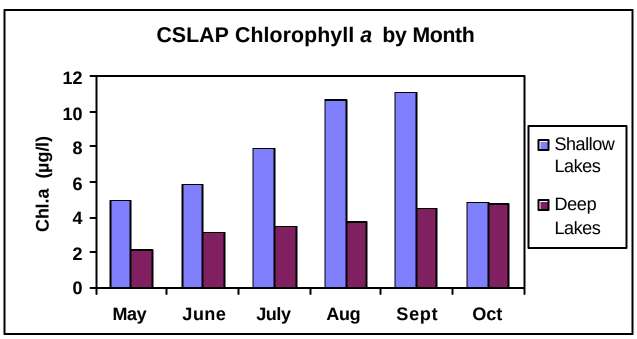



**Figure 11c.** *Chlorophyll a in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

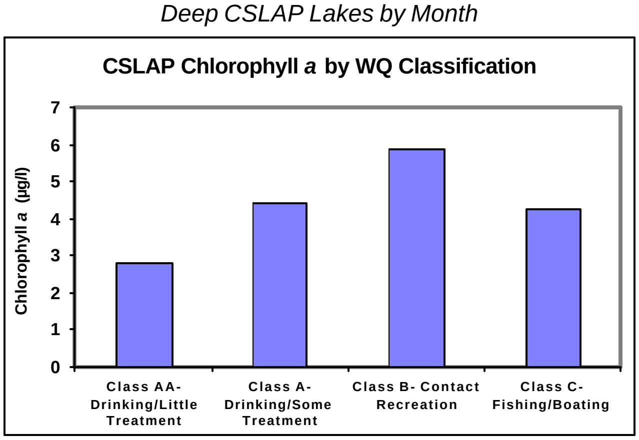



**Figure 11d**. *Chlorophyll a in CSLAP Lakes by Lake Use*

## Trophic Indicators: Chlorophyll *a* (Chl.a)

*Annual Variability*

Chlorophyll *a* (Chl.a) has varied in most CSLAP lakes more significantly that the other trophic indicators, as is typical of biological indicators (which tend to grow "patchy"). With the exception of the very high readings in 1987 (probably due to a lab "problem"), the highest phosphorus concentrations occurred during 1990, 1996, and 2000, corresponded to wet years. However, the lowest readings, from 1989, 1997, and 2001, and 2002, did not correspond to unusually dry years (except in 2001). The near majority of chlorophyll readings in CSLAP lakes (49%) correspond to *mesotrophic* conditions (clarity between 2 and 5 meters), with 33% corresponding to *eutrophic* conditions (Zsd < 2) and 18% corresponding to *oligotrophic* conditions (Zsd > 5); these percentages are more like those for water clarity rather than those for phosphorus.

*Statewide Variability*:

As with phosphorus, chlorophyll levels are lowest in the Adirondacks and Catskills (where clarity is highest) and highest in Long Island, Downstate, and Western NY, where clarity is lowest. In the latter three regions, the "typical" lake in each of these regions would be classified as *eutrophic*, while lakes in the other regions would be described as *mesotrophic*.

*Seasonal Variability*:

Chlorophyll levels are higher, as expected, in shallow lakes, and increase in both shallow and deep lakes over the course of the sampling season, with chlorophyll readings dropping in shallow lakes in the fall. The steady increase in chlorophyll in both shallow and deep lakes is consistent with the change in phosphorus over the same period, due to steady migration of nutrients released from poorly oxygenated lake sediments during the summer and especially in the fall.

*Lake Use Variability*

Chlorophyll readings are lower in lakes used for minimally treated potable water intakes (Class AA), and are higher for other lake uses. Although Class B waters are utilized for a "higher" lake use than Class C lakes (contact recreation versus non-contact recreation), these lakes actually have similar levels, perhaps reflecting the influence of deepwater nutrient enrichments (these lakes are typically deeper) and the "unofficial" use of Class C waters for bathing and contact recreation. This is similar to the use pattern for phosphorus.

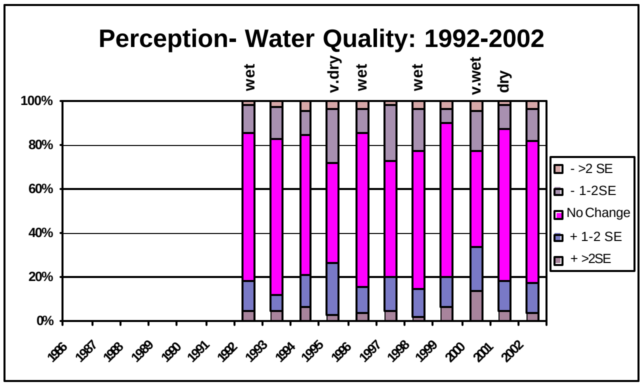



**Figure 12a.** *Annual Change from "Normal" Water Quality Assessment in CSLAP Lakes (SE = Standard Error)*

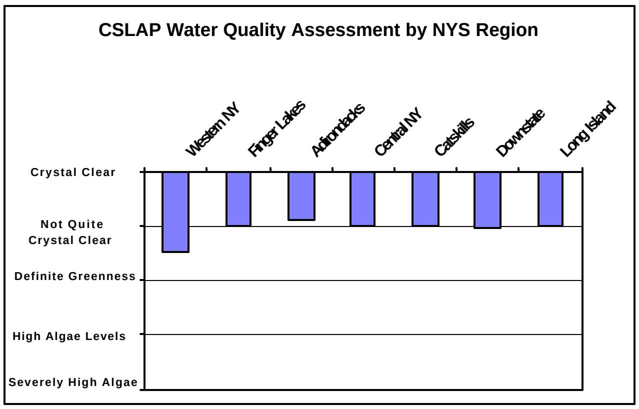



**Figure 12b.** *Water Quality Assessment in CSLAP Lakes by NYS Region*

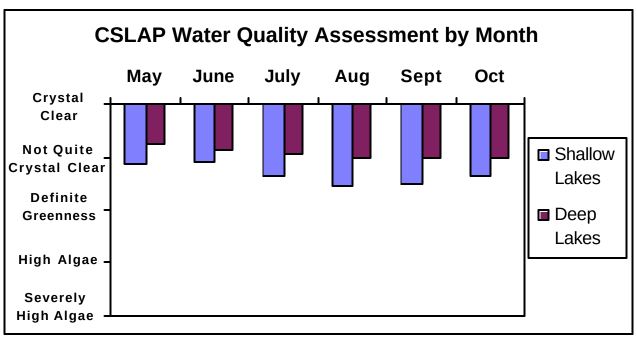



**Figure 12c.** *Water Quality Assessment in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

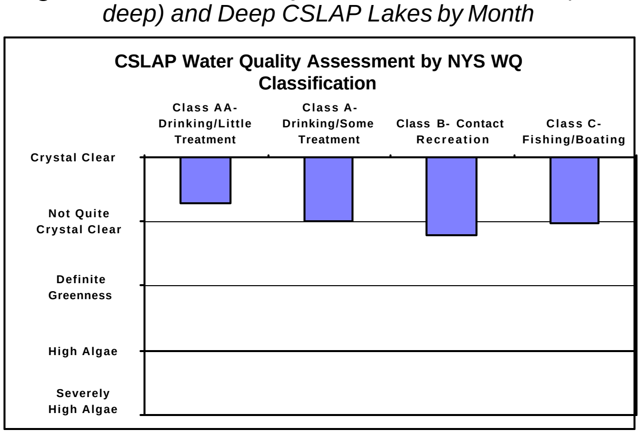



**Figure 12d**. *Water Quality Assessment in CSLAP Lakes by Lake Use*

## Water Quality Assessment (QA)

*Annual Variability*

Water quality assessments (the perceived physical condition of the lake, or QA on the use impairment surveys) were least favorable in the very wet (2000) and very dry (1995) years, suggesting the lack of correlation between weather and perceived water quality (although 1995 was also the year with the most "improved" conditions). Although there is a strong connection between measured and perceived water clarity in most CSLAP lakes, this is not closely reflected in Figure 12a.

*Statewide Variability*:

The most favorable water quality assessments (at least in support of contact recreation) occurred in the Adirondacks, as expected, although water quality assessments were comparable in all regions except Western NY. This suggests that the relatively low water clarity in the Downstate and Long Island regions (with similar readings to those in Western NY) may be considered "normal" by lake residents.

*Seasonal Variability*:

Water quality assessments become less favorable as the summer progresses in both deep and (especially) shallow lakes, coincident with similar patterns for the trophic indicators. These assessments become slightly more favorable in shallow lakes in the fall, consistent with the improved (measured) water clarity, although overall water quality assessments are less favorable all year in shallow lakes .

*Lake Use Variability*

Water quality assessments are more favorable in lakes used for minimally treated potable water intakes (Class AA), and are higher for other lake uses. Although Class B waters are utilized for a "higher" lake use than Class C lakes (contact recreation versus non-contact recreation), these lakes actually have similar water quality assessments, perhaps reflecting the influence of deepwater nutrient enrichments (these lakes are typically deeper) and the "unofficial" use of Class C waters for bathing and contact recreation. This is similar to the pattern seen for the trophic indicators.

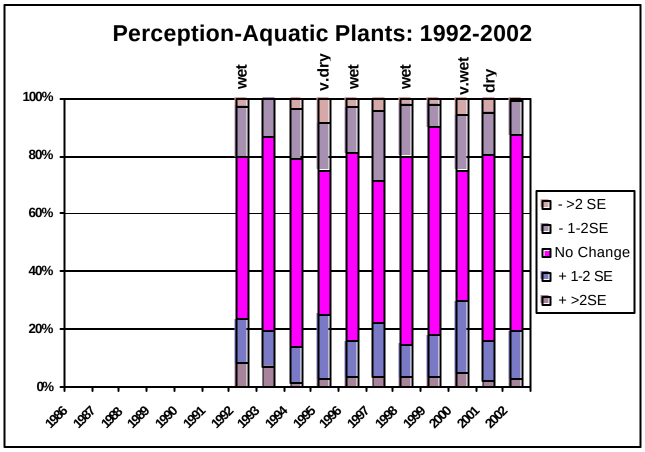



**Figure 13a.** *Annual Change from "Normal" Weed Assessment in CSLAP Lakes (SE = Standard Error)*

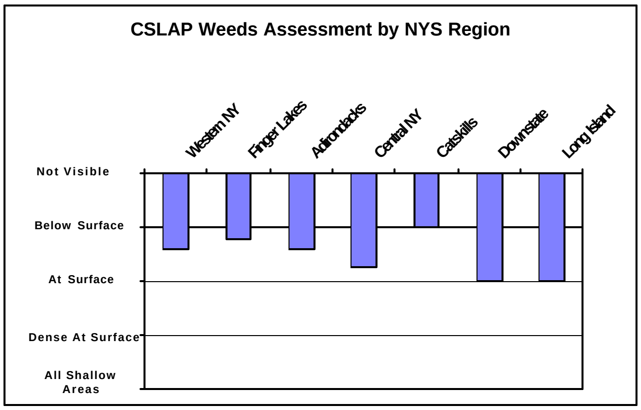



**Figure 13b.** *Weed Assessment in CSLAP Lakes by NYS Region*

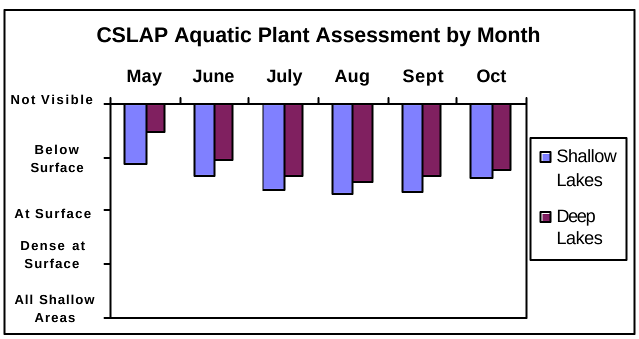



**Figure 13c.** *Weed Assessment in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

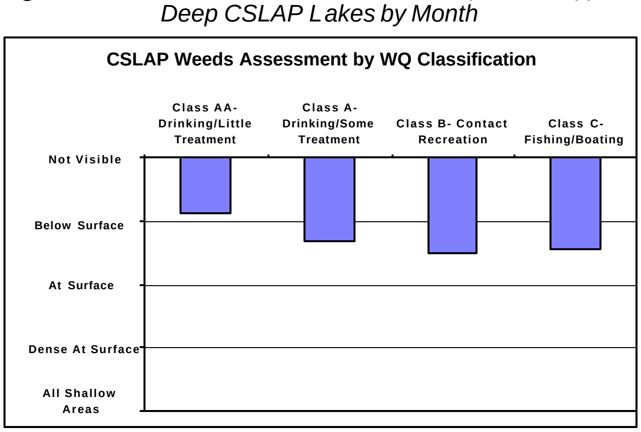



**Figure 13d**. *Weed Assessment in CSLAP Lakes by Lake Use*

**Aquatic Plant (Weed) Assessment (QB)**

*Annual Variability*

Aquatic plant assessments (the perceived extent of weed growth in the lake, or QB on the use impairment surveys) indicated that weeds grew most significantly in 1995 (very dry conditions) and 2000 (very wet conditions), and least significantly in 1994 and 1999, suggesting the lack of correlation between weather and weed densities. The highest weed growth occurred when the perceived physical condition (clarity) of the lake was also least favorable- these conditions may offer a selective advantage to invasive or exotic weeds (such as *Myriophyllum spicatum*).

*Statewide Variability*:

Aquatic plant growth was most significant in Long Island, Downstate, and in Central NY, and least significant in the Catskills and Finger Lakes area. The former may have a larger concentration of shallow lakes (Long Island) or preponderance of exotic weeds (Downstate and Central NY), while the latter may correspond to deeper lakes or fewer instances of these invasive weeds.

*Seasonal Variability*:

As expected, aquatic plant densities and coverage increase seasonally (through late summer) in both shallow and deep lakes, with greater coverage found in shallow lakes. The variability from one lake to another (from very little growth to dense growth at the lake surface) is more pronounced later in the summer. Despite higher clarity in shallow lakes in the fall, aquatic plant coverage decreases

*Lake Use Variability*

Aquatic plant coverage was more significant in Class B lakes than in other lakes, but this (again) is probably a greater reflection of geography or lake size and depth (Class B lakes tend to be found outside the high elevation areas in the Catskills and Adirondacks, and with Class C lakes tend to be shallower than Class AA or Class A lakes).

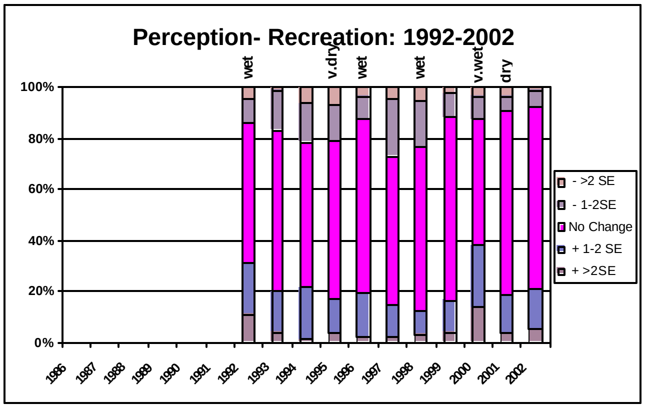



**Figure 14a.** *Annual Change from "Normal" Recreational Assessment in CSLAP Lakes (SE = Standard Error)*

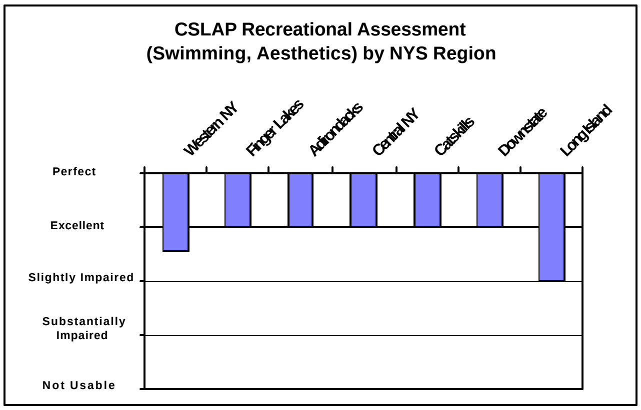



**Figure 14b.** *Recreational Assessment in CSLAP Lakes by NYS Region*

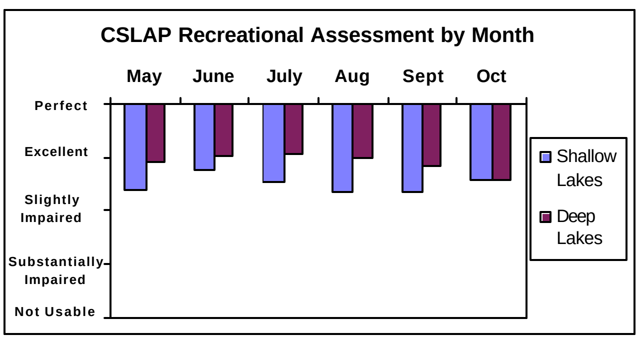



**Figure 14c.** *Recreational Assessment in Shallow (<20ft deep) and Deep CSLAP Lakes by Month*

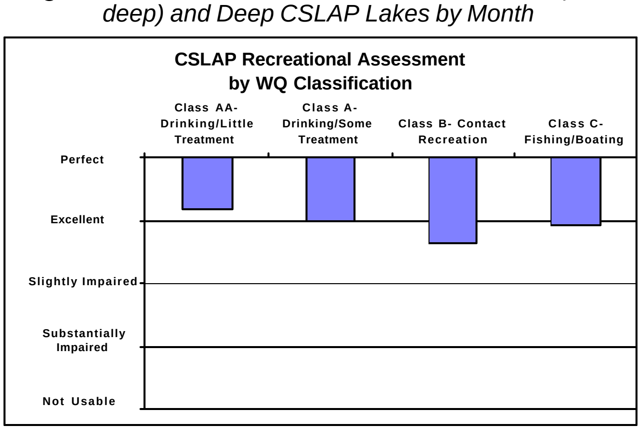



**Figure 14d**. *Recreational Assessment in CSLAP Lakes by Lake Use*

## Recreational Assessment (QC)

*Annual Variability*

Recreational assessments (the perceived recreational suitability of the lake, or QC on the use impairment surveys) have been less favorable in the last several years (prior to 2003), and have varied somewhat from year to year in response to changes in both the perceived physical conditions and aquatic plant coverages. The extent of "normal" conditions (the middle bar in Figure 14a) has generally not changed significantly since perception surveys were first conducted in 2002.

*Statewide Variability*:

Recreational assessments have been consistent in all but Western NY and Long Island, where these assessments have been slightly less favorable. This appears to be in response to less favorable assessments of water quality and aquatic plant growth, respectively. Except for (the small number of CSLAP lakes in) Long Island, overall recreational assessments in all regions are, in general, highly favorable.

*Seasonal Variability*:

Despite slight seasonal degradation in the perceived physical condition (coincident with increasing lake productivity) and seasonal increases in aquatic plant coverage and densities, recreational assessments in deep lakes are fairly stable in fall, although in shallow lakes, these assessments become less favorable (and more typical of degraded conditions) as the sampling seasonal progresses. In deeper lakes, recreational assessments are, in general, highly favorable throughout the sampling and recreational season.

*Lake Use Variability*

Recreational assessments become less favorable as the designated lake use becomes less sensitive (drinking water to contact recreation), although recreational assessments of Class C lakes are only slightly less favorable than in Class A lakes. This may be considered a validation of these classifications.

# V. GALWAY LAKE CSLAP WATER QUALITY DATA

CSLAP is intended to provide the strong database, which will help lake associations understand lake conditions and foster sound lake protection and pollution prevention decisions. This individual lake summary for 2003 contains two forms of information. The **raw data** and **graphs** present a snapshot or glimpse of water quality conditions at each lake. They are based on (at most) eight or nine 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 new to CSLAP for only one year will not have information about annual trends.

## Raw Data

Two **"data sets"** are provided below. The data presented in Table 1 include an annual summary of the minimum, maximum, and average for each of the CSLAP sampling parameters, including data from other sources for which sufficient quality assurance/quality control documentation is available for assessing the validity of the results. This data may be useful for comparing a particular data point for the current sampling year with historical data information. Table 2 includes more detailed summaries of the 2003 and historical data sets, including some evaluation of water quality trends, comparison against existing water quality standards, and whether 2003 represented a typical year.

## 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. For example, a lake that has been doing CSLAP monitoring consistently for five years will have a graph depicting five years worth of data, whereas a lake that has been doing CSLAP sampling for only one year will only have one. Therefore, it is important to consider the number of sampling years of information in addition to where the data points fall on a graph when trying to draw conclusions about annual trends. There are certain factors not accounted for in this report that lake managers should consider:

- **Local weather conditions** (high or low temperatures, rainfall, droughts or hurricanes). Due to delays in receiving meteorological data from NOAA stations within NYS, weather data are not included in these reports. It is certain that some of the variability reported below can be attributed more to weather patterns than to a "real" water trend or change. However, it is presumed that much of the sampling "noise" associated with weather is dampened over multiple years of data collection, and thus should not significantly influence the limited trend analyses provided for CSLAP lakes with longer and larger databases.

- **Sampling season and parameter limitations**. Because sampling is generally confined to June-September, this report does not look at CSLAP parameters during the winter and other seasons. Winter conditions can impact the usability and water quality of a lake conditions. In addition, there are other 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. **The 2003 CSLAP report attempts to standardize some comparisons by limiting the evaluation to the summer recreational season and the most common sampling periods (mid-June through mid-September), in the event that samples are collected at other times of the year (such as May or October).**

## TABLE 1: CSLAP Data Summary for Galway Lake

| Year | Min | Avg | Max | N | Parameter |
|---|---|---|---|---|---|
| **1990-03** | **1.75** | **3.34** | **5.45** | **78** | **CSLAP Zsd** |
| 2003 | 3.13 | 3.65 | 4.75 | 8 | CSLAP Zsd |
| 2002 | 2.53 | 3.88 | 5.15 | 9 | CSLAP Zsd |
| 2001 | 2.88 | 3.73 | 5.15 | 4 | CSLAP Zsd |
| 2000 | 2.78 | 3.41 | 4.25 | 7 | CSLAP Zsd |
| 1997 | 2.90 | 3.57 | 4.10 | 4 | CSLAP Zsd |
| 1996 | 2.15 | 3.51 | 4.15 | 4 | CSLAP Zsd |
| 1995 | 3.00 | 4.49 | 5.45 | 7 | CSLAP Zsd |
| 1994 | 2.23 | 3.43 | 4.50 | 6 | CSLAP Zsd |
| 1993 | 2.05 | 2.85 | 3.66 | 7 | CSLAP Zsd |
| 1992 | 1.90 | 2.25 | 2.90 | 8 | CSLAP Zsd |
| 1991 | 1.75 | 2.80 | 3.60 | 6 | CSLAP Zsd |
| 1990 | 1.80 | 2.85 | 4.25 | 8 | CSLAP Zsd |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1990-03** | **0.005** | **0.013** | **0.049** | **76** | **CSLAP Tot.P** |
| 2003 | 0.008 | 0.016 | 0.025 | 8 | CSLAP Tot.P |
| 2003 | 0.008 | 0.017 | 0.023 | 6 | CSLAP HypoTP |
| 2002 | 0.008 | 0.011 | 0.014 | 7 | CSLAP Tot.P |
| 2001 | 0.009 | 0.010 | 0.012 | 4 | CSLAP Tot.P |
| 2000 | 0.009 | 0.012 | 0.018 | 8 | CSLAP Tot.P |
| 1997 | 0.018 | 0.031 | 0.049 | 3 | CSLAP Tot.P |
| 1996 | 0.009 | 0.011 | 0.015 | 4 | CSLAP Tot.P |
| 1995 | 0.005 | 0.009 | 0.012 | 7 | CSLAP Tot.P |
| 1994 | 0.006 | 0.011 | 0.015 | 6 | CSLAP Tot.P |
| 1993 | 0.010 | 0.013 | 0.014 | 7 | CSLAP Tot.P |
| 1992 | 0.010 | 0.014 | 0.018 | 8 | CSLAP Tot.P |
| 1991 | 0.008 | 0.013 | 0.020 | 6 | CSLAP Tot.P |
| 1990 | 0.011 | 0.015 | 0.025 | 8 | CSLAP Tot.P |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1990-03** | **0.00** | **0.01** | **0.12** | **56** | **CSLAP NO3** |
| 2003 | 0.00 | 0.01 | 0.04 | 8 | CSLAP NO3 |
| 2003 | 0.00 | 0.00 | 0.01 | 6 | CSLAP HypoNO3 |
| 2002 | 0.00 | 0.02 | 0.12 | 9 | CSLAP NO3 |
| 2001 | 0.01 | 0.01 | 0.01 | 4 | CSLAP NO3 |
| 2000 | 0.01 | 0.01 | 0.01 | 8 | CSLAP NO3 |
| 1997 | | | | | CSLAP NO3 |
| 1996 | | | | | CSLAP NO3 |
| 1995 | 0.01 | 0.01 | 0.01 | 2 | CSLAP NO3 |
| 1994 | 0.01 | 0.01 | 0.01 | 4 | CSLAP NO3 |
| 1993 | 0.01 | 0.02 | 0.03 | 4 | CSLAP NO3 |
| 1992 | 0.01 | 0.01 | 0.01 | 4 | CSLAP NO3 |
| 1991 | 0.01 | 0.01 | 0.01 | 4 | CSLAP NO3 |
| 1990 | 0.01 | 0.01 | 0.01 | 8 | CSLAP NO3 |

### 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 as P, in mg/l (Hypo = bottom sample) |
| **NO3** | Nitrate + Nitrite nitrogen as N, in mg/l |
| **$NH_{3/4}$** | Ammonia as N, in mg/l |
| **TN-TDN** | Total Nitrogen = $NO_x$ + $NH_{3/4}$ + organic nitrogen, as N, in mg/l |
| **TP/TN** | Phosphorus/Nitrogen ratios |
| **Ca** | Calcium, 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) litter, surface debris, beached/floating material; (7) too many lake users (boats, jetskis, etc); (8) other |

## TABLE 1: CSLAP Data Summary for Galway Lake (cont)

| Year | Min | Avg | Max | N | Parameter |
|---|---|---|---|---|---|
| **2002-03** | **0.00** | **0.03** | **0.08** | **17** | **CSLAP NH4** |
| 2003 | 0.00 | 0.01 | 0.05 | 8 | CSLAP NH4 |
| 2003 | 0.00 | 0.01 | 0.02 | 6 | CSLAP HypoNH4 |
| 2002 | 0.01 | 0.04 | 0.08 | 9 | CSLAP NH4 |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **2002-03** | **0.08** | **0.39** | **0.55** | **16** | **CSLAP TDN** |
| 2003 | 0.08 | 0.33 | 0.53 | 7 | CSLAP TDN |
| 2003 | 0.06 | 0.28 | 0.41 | 5 | CSLAP HypoTDN |
| 2002 | 0.32 | 0.44 | 0.55 | 9 | CSLAP TDN |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **2002-03** | **4.61** | **29.82** | **52.86** | **15** | **CSLAP TN/TP** |
| 2003 | 4.61 | 24.60 | 46.60 | 7 | CSLAP TN/TP |
| 2003 | 2.69 | 21.20 | 50.74 | 5 | CSLAP HypoTN/TP |
| 2002 | 6.08 | 34.38 | 52.86 | 8 | CSLAP TN/TP |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1990-03** | **3** | **13** | **32** | **79** | **CSLAP TColor** |
| 2003 | 7 | 14 | 24 | 8 | CSLAP TColor |
| 2002 | 9 | 13 | 32 | 9 | CSLAP TColor |
| 2001 | 8 | 11 | 16 | 4 | CSLAP TColor |
| 2000 | 11 | 14 | 18 | 8 | CSLAP TColor |
| 1997 | 8 | 12 | 15 | 4 | CSLAP TColor |
| 1996 | 15 | 15 | 15 | 4 | CSLAP TColor |
| 1995 | 5 | 9 | 10 | 7 | CSLAP TColor |
| 1994 | 7 | 10 | 17 | 6 | CSLAP TColor |
| 1993 | 3 | 7 | 13 | 7 | CSLAP TColor |
| 1992 | 13 | 16 | 20 | 8 | CSLAP TColor |
| 1991 | 6 | 11 | 16 | 6 | CSLAP TColor |
| 1990 | 15 | 17 | 19 | 8 | CSLAP TColor |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1990-03** | **7.04** | **8.13** | **8.98** | **78** | **CSLAP pH** |
| 2003 | 7.81 | 8.24 | 8.98 | 8 | CSLAP pH |
| 2002 | 7.62 | 8.30 | 8.94 | 9 | CSLAP pH |
| 2001 | 7.80 | 8.13 | 8.52 | 4 | CSLAP pH |
| 2000 | 7.35 | 7.92 | 8.29 | 8 | CSLAP pH |
| 1997 | 7.96 | 8.15 | 8.49 | 4 | CSLAP pH |
| 1996 | 7.97 | 8.21 | 8.67 | 4 | CSLAP pH |
| 1995 | 8.00 | 8.13 | 8.36 | 6 | CSLAP pH |
| 1994 | 7.72 | 8.10 | 8.50 | 6 | CSLAP pH |
| 1993 | 7.92 | 8.11 | 8.29 | 7 | CSLAP pH |
| 1992 | 7.85 | 8.14 | 8.23 | 8 | CSLAP pH |
| 1991 | 7.04 | 7.82 | 8.37 | 6 | CSLAP pH |
| 1990 | 7.89 | 8.24 | 8.34 | 8 | CSLAP pH |

## TABLE 1: CSLAP Data Summary for Galway Lake (cont)

| Year | Min | Avg | Max | N | Parameter |
|---|---|---|---|---|---|
| **1990-03** | **133** | **177** | **201** | **78** | **CSLAP Cond25** |
| 2003 | 169 | 182 | 190 | 8 | CSLAP Cond25 |
| 2002 | 182 | 186 | 190 | 9 | CSLAP Cond25 |
| 2001 | 183 | 184 | 185 | 4 | CSLAP Cond25 |
| 2000 | 177 | 181 | 185 | 8 | CSLAP Cond25 |
| 1997 | 169 | 171 | 172 | 4 | CSLAP Cond25 |
| 1996 | 175 | 178 | 182 | 4 | CSLAP Cond25 |
| 1995 | 178 | 181 | 184 | 6 | CSLAP Cond25 |
| 1994 | 150 | 157 | 165 | 6 | CSLAP Cond25 |
| 1993 | 154 | 162 | 168 | 7 | CSLAP Cond25 |
| 1992 | 175 | 187 | 192 | 8 | CSLAP Cond25 |
| 1991 | 133 | 174 | 201 | 6 | CSLAP Cond25 |
| 1990 | 167 | 174 | 186 | 8 | CSLAP Cond25 |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **2002-03** | **6.6** | **12.5** | **18.0** | **4** | **CSLAP Ca** |
| 2003 | 16.0 | 17.0 | 18.0 | 2 | CSLAP Ca |
| 2002 | 6.6 | 8.0 | 9.3 | 2 | CSLAP Ca |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1990-03** | **0.84** | **5.12** | **23.20** | **74** | **CSLAP Chl.a** |
| 2003 | 1.21 | 2.48 | 5.31 | 7 | CSLAP Chl.a |
| 2002 | 0.84 | 2.43 | 4.40 | 8 | CSLAP Chl.a |
| 2001 | 2.47 | 2.75 | 3.02 | 2 | CSLAP Chl.a |
| 2000 | 2.26 | 5.14 | 10.40 | 8 | CSLAP Chl.a |
| 1997 | 2.08 | 2.82 | 3.81 | 4 | CSLAP Chl.a |
| 1996 | 2.40 | 7.70 | 13.40 | 4 | CSLAP Chl.a |
| 1995 | 1.02 | 3.03 | 5.44 | 7 | CSLAP Chl.a |
| 1994 | 1.29 | 7.16 | 23.20 | 6 | CSLAP Chl.a |
| 1993 | 2.80 | 6.77 | 11.30 | 7 | CSLAP Chl.a |
| 1992 | 3.93 | 7.69 | 12.10 | 8 | CSLAP Chl.a |
| 1991 | 3.66 | 5.39 | 8.09 | 5 | CSLAP Chl.a |
| 1990 | 3.13 | 6.63 | 11.70 | 8 | CSLAP Chl.a |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1992-03** | **1** | **1.7** | **4** | **62** | **QA** |
| 2003 | 1 | 1.3 | 3 | 9 | QA |
| 2002 | 1 | 1.2 | 2 | 9 | QA |
| 2001 | 1 | 1.5 | 2 | 4 | QA |
| 2000 | 1 | 1.6 | 2 | 8 | QA |
| 1997 | 1 | 1.5 | 2 | 4 | QA |
| 1996 | 2 | 2.3 | 3 | 4 | QA |
| 1995 | 2 | 2.1 | 3 | 7 | QA |
| 1994 | 1 | 2.3 | 4 | 6 | QA |
| 1993 | 1 | 2.0 | 3 | 7 | QA |
| 1992 | 1 | 1.5 | 2 | 4 | QA |

**TABLE 1: CSLAP Data Summary for Galway Lake (cont)**

| Year | Min | Avg | Max | N | Parameter |
|---|---|---|---|---|---|
| **1992-03** | **1** | **1.9** | **3** | **62** | **QB** |
| 2003 | 1 | 2.1 | 3 | 9 | QB |
| 2002 | 1 | 1.9 | 3 | 9 | QB |
| 2001 | 1 | 1.5 | 2 | 4 | QB |
| 2000 | 2 | 2.4 | 3 | 8 | QB |
| 1997 | 1 | 2.0 | 3 | 4 | QB |
| 1996 | 1 | 1.8 | 2 | 4 | QB |
| 1995 | 2 | 2.1 | 3 | 7 | QB |
| 1994 | 2 | 2.0 | 2 | 6 | QB |
| 1993 | 1 | 1.3 | 2 | 7 | QB |
| 1992 | 1 | 1.3 | 2 | 4 | QB |
| | | | | | |
| Year | Min | Avg | Max | N | Parameter |
| **1992-03** | **1** | **1.3** | **3** | **62** | **QC** |
| 2003 | 1 | 1.1 | 2 | 9 | QC |
| 2002 | 1 | 1.2 | 2 | 9 | QC |
| 2001 | 1 | 1.3 | 2 | 4 | QC |
| 2000 | 1 | 1.1 | 2 | 8 | QC |
| 1997 | 1 | 1.0 | 1 | 4 | QC |
| 1996 | 1 | 1.5 | 2 | 4 | QC |
| 1995 | 2 | 2.0 | 2 | 7 | QC |
| 1994 | 1 | 1.5 | 3 | 6 | QC |
| 1993 | 1 | 1.6 | 3 | 7 | QC |
| 1992 | 1 | 1.0 | 1 | 4 | QC |

- **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. This may be due in part 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, utilizing both parametric and non-parametric statistics, have been provided within the report (primarily in Table 2).

- **Mean versus Median-** Much of the water quality summary data presented in this report is reported as the **mean**, or the average of all of the readings in the period in question (summer, annual, year to year). However, while mean remains one of the most useful, and often most powerful, ways to estimate the most typical reading for many of the measured water quality indicators, it is a less useful and perhaps misleading estimate when the data are not "normally" distributed (most common readings in the middle of the range of all readings, with readings less common toward the end of the range).

  In particular, comparisons of one lake to another, such as comparisons within a particular basin, can be greatly affected by the spread of the data across the range of all readings. For example, the average phosphorus level of nine lakes with very low readings (say 10 µg/l) and one lake with very high readings (say 110 µg/l) could be much higher (in this case, 20 µg/l) than in the "typical lake" in this set of lakes (much closer to 10 µg/l). In this case, **median**, or the middle reading in the range, is probably the most accurate representation of "typical".

**This report will include the use of both mean and median to evaluate "central tendency", or the most typical reading, for the indicator in question. In most cases, "mean" is used most often to estimate central tendency. However, where noted, "median" may also be used.**

**TABLE 2- Present Year and Historical Data Summaries for Galway Lake**
***Eutrophication Indicators***

| Parameter | Year | Minimum | Average | Maximum |
|---|---|---|---|---|
| Zsd | 2003 | 3.13 | 3.65 | 4.75 |
| (meters) | All Years | 1.75 | 3.35 | 5.45 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| Phosphorus | 2003 | 0.008 | 0.016 | 0.025 |
| (mg/l) | All Years | 0.005 | 0.013 | 0.026 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| Chl.a | 2003 | 1.21 | 2.48 | 5.31 |
| (µg/l) | All Years | 0.84 | 5.12 | 23.20 |

| Parameter | Year | Was 2003 Clarity the Highest or Lowest on Record? | Was 2003 a Typical Year? | Trophic Category | Zsd Changing? | % Samples Violating DOH Beach Std?+ |
|---|---|---|---|---|---|---|
| Zsd | 2003 | Within Normal Range | Yes | Mesotrophic | No | 0 |
| (meters) | All Years | | | Mesotrophic | | 0 |
| | | | | | | |
| **Parameter** | **Year** | **Was 2003 TP the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Trophic Category** | **TP Changing?** | **% Samples Exceeding TP Guidance Value** |
| Phosphorus | 2003 | Within Normal Range | Yes | Mesotrophic | No | 25 |
| (mg/l) | All Years | | | Mesotrophic | | 5 |
| | | | | | | |
| **Parameter** | **Year** | **Was 2003 Algae the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Trophic Category** | **Chl.a Changing?** | |
| Chl.a | 2003 | Within Normal Range | No | Mesotrophic | No | |
| (µg/l) | All Years | | | Mesotrophic | | |

**+- Minimum allowable water clarity for siting a new NYS swimming beach = 1.2 meters**
**+- NYS Total Phosphorus Guidance Value for Class B and Higher Lakes = 0.020 mg/l**

**-The 2003 CSLAP dataset indicates that water quality conditions in Galway Lake were mostly comparable to those measured in previous CSLAP sampling seasons (higher clarity and nutrient levels, lower algae levels). Although water clarity readings have increased slightly, and algae levels (chlorophyll *a*) have decreased slightly since CSLAP sampling began in 1990, these changes do not appear to be statistically significant. There continues to be only a weak correlation between algae and clarity, and between algae and nutrients, although it is likely that any lake management activities undertaken to maintain or improve water transparency must necessarily address algae levels in and nutrient loading to the lake. Lake productivity does not seem to vary in any significant way over the course of a typical sampling season, although lake productivity may increase in the fall when slightly nutrient-enriched deepwaters migrate to the lake surface. Supplemental nutrient sampling in 2003 indicate that phosphorus levels are highest at the mouth of the North Bay, West Bay, and South Bay coves, and that deepwater nutrient levels increase over the summer (see Appendix E). Phosphorus levels in Galway Lake occasionally exceed the state guidance value for lakes used for contact recreation (swimming), but at no times have water clarity readings failed to exceed the minimum recommended water transparency for swimming beaches (= 1.2 meters). In short, water quality conditions in Galway Lake in 2003 appeared to be similar to and within the normal range found in previous years, and despite a slight (but significantly insignificant) longer-term increase in clarity and decrease in algae levels, these conditions appear to be fairly stable.**

**TABLE 2- Present Year and Historical Data Summaries for Galway Lake (cont)**
***Other Water Quality Indicators***

| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
|---|---|---|---|---|
| Nitrate | 2003 | 0.00 | 0.01 | 0.04 |
| (mg/l) | All Years | 0.00 | 0.01 | 0.12 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| Ammonia | 2003 | 0.00 | 0.01 | 0.05 |
| (mg/l) | All Years | 0.00 | 0.03 | 0.08 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| TDN | 2003 | 0.08 | 0.33 | 0.53 |
| (mg/l) | All Years | 0.08 | 0.39 | 0.55 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| True Color | 2003 | 7 | 14 | 24 |
| (ptu) | All Years | 3 | 13 | 32 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| pH | 2003 | 7.81 | 8.24 | 8.98 |
| (std units) | All Years | 7.04 | 8.13 | 8.98 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| Conductivity | 2003 | 169 | 182 | 190 |
| (µmho/cm) | All Years | 133 | 177 | 201 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| Calcium | 2003 | 16.0 | 17.0 | 18.0 |
| (mg/l) | All Years | 16.0 | 17.0 | 18.0 |

***- These data indicate Galway Lake is a moderately colored, alkaline (above neutral pH) lake with mostly undetectable nitrate levels and water of intermediate hardness. Color readings do not appear to limit water clarity, even when algae levels in the lake are extremely low. Nitrogen levels, primarily organic nitrogen, are probably high enough to ensure that phosphorus controls algae growth (nitrogen to phosphorus ratios frequently exceed 25), and overall nitrogen levels are low. Neither nitrate nor ammonia appear to represent a threat to human health and water quality. Conductivity readings have varied only slightly since CSLAP sampling began in 1990, and it is not suspected that this has resulted in any ecological impacts to Galway Lake. pH readings usually fall within the state water quality standards (=6.5 to 8.5), and should continue to support most aquatic organisms, although a small percentage (<10%) of samples exceed the upper standard. Calcium levels are high enough to support zebra mussels, although at present it is not believed that these exotic animals have colonized Galway Lake.**

# TABLE 2- Present Year and Historical Data Summaries for Galway Lake (cont)
## *Other Water Quality Indicators (cont)*

| Parameter | Year | Was 2003 Nitrate the Highest or Lowest on Record? | Was 2003 a Typical Year? | Nitrate High? | Nitrate Changing? | % Samples Exceeding NO3 Standard | |
|---|---|---|---|---|---|---|---|
| Nitrate | 2003 | Within Normal Range | Yes | No | No | 0 | |
| (mg/l) | All Years | | | No | | 0 | |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 Ammonia the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Ammonia High?** | **Ammonia Changing?** | **% Samples Exceeding NH4 Standard** | |
| Ammonia | 2003 | Lowest at Times | Not yet known | No | Not yet known | 0 | |
| (mg/l) | All Years | | | No | | 0 | |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 TDN the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **TDN High?** | **TDN Changing?** | **Ratios of TN/TP Indicate P or N Limitation?** | |
| TDN | 2003 | Lowest at Times | Not yet known | No | Not yet known | P Limitation | |
| (mg/l) | All Years | | | No | | P Limitation | |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 Color the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Colored Lake?** | **Color Changing?** | | |
| True Color | 2003 | Within Normal Range | Yes | No | No | | |
| (ptu) | All Years | | | No | | | |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 pH the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Acceptable Range?** | **pH Changing?** | **% Samples > Upper pH Standard** | **% Samples < Lower pH Standard** |
| pH | 2003 | Highest at Times | Yes | Yes | No | 13 | 0 |
| (std units) | All Years | | | Yes | | 8 | 0 |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 Conductivity Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | **Relative Hardness** | **Conduct. Changing?** | | |
| Conductivity | 2003 | Within Normal Range | Lower Than Normal | Intermediate | No | | |
| (µmho/cm) | All Years | | | | | | |
| | | | | | | | |
| **Parameter** | **Year** | **Was 2003 Calcium Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | | **Calcium Changing?** | | |
| Calcium | 2003 | Within Normal Range | Not yet known | | Not yet known | | |
| (mg/l) | All Years | | | | | | |

**+- NYS Nitrate standard = 10 mg/l**

**+- NYS pH standard- 6.5 < acceptable pH < 8.5**

# TABLE 2- Present Year and Historical Data Summaries for Galway Lake (cont)

## *Lake Perception Indicators (1= most favorable, 5= least favorable)*

| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
|---|---|---|---|---|
| QA | 2003 | 1 | 1.3 | 3 |
| (Clarity) | All Years | 1 | 1.7 | 4 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| QB | 2003 | 1 | 2.1 | 3 |
| (Plants) | All Years | 1 | 1.9 | 3 |
| | | | | |
| **Parameter** | **Year** | **Minimum** | **Average** | **Maximum** |
| QC | 2003 | 1 | 1.1 | 2 |
| (Recreation) | All Years | 1 | 1.3 | 3 |

| **Parameter** | **Year** | **Was 2003 Clarity the Highest or Lowest on Record?** | **Was 2003 a Typical Year?** | | **Clarity Changed?** |
|---|---|---|---|---|---|
| QA | 2003 | Highest | Yes | | Yes |
| (Clarity) | All Years | | | | |
| | | | | | |
| **Parameter** | **Year** | **Was 2003 Weed Growth the Heaviest on Record?** | **Was 2003 a Typical Year?** | | **Weeds Changed?** |
| QB | 2003 | Heaviest and Lightest | Yes | | No |
| (Plants) | All Years | | | | |
| | | | | | |
| **Parameter** | **Year** | **Was 2003 Recreation the Best or Worst on Record?** | **Was 2003 a Typical Year?** | | **Recreation Changed?** |
| QC | 2003 | Best at Times | Yes | | No |
| (Recreation) | All Years | | | | |

**- Recreational assessments of Galway Lake in 2003 were again highly favorable, mostly consistent with other assessments in recent years. The recreational suitability of the lake was described as “could not be nicer” to “excellent” for most recreational uses in 2003, coincident with conditions most often described as “crystal clear” to “not quite crystal clear”, and aquatic plant growth that only occasionally reaches the lake surface. The perceived physical condition of the lake (“crystal clear” to “not quite crystal clear”) is slightly more favorable than in other lakes with similar water transparency readings, but is mostly comparable to assessments from previous years (the slight “improvement” in 2003 might reflect the higher water clarity measured in the lake). These assessments typically change little as the sampling season progresses, consistent with the seasonal stability in the perceived water quality conditions of the lake (which themselves are consistent with the seasonal consistency in clarity and in algae growth) and lack of seasonal change in aquatic plant coverage.**

## How Do the 2003 Data Compare to Historical Data from Galway Lake?

*Seasonal Comparison of Eutrophication, Other Water Quality, and Lake Perception Indicators–2003 Sampling Season and in the Typical or Previous Sampling Seasons at Galway Lake*

Figures 15 and 16 compare data for the measured eutrophication parameters for Galway Lake in 2003 and since CSLAP sampling began at Galway Lake. Figures 17 and 18 compare nitrogen to phosphorus ratios, Figures 19 through 26 compare other sampling indicators, and Figures 27 and 28 compare volunteer perception responses over the same time periods.

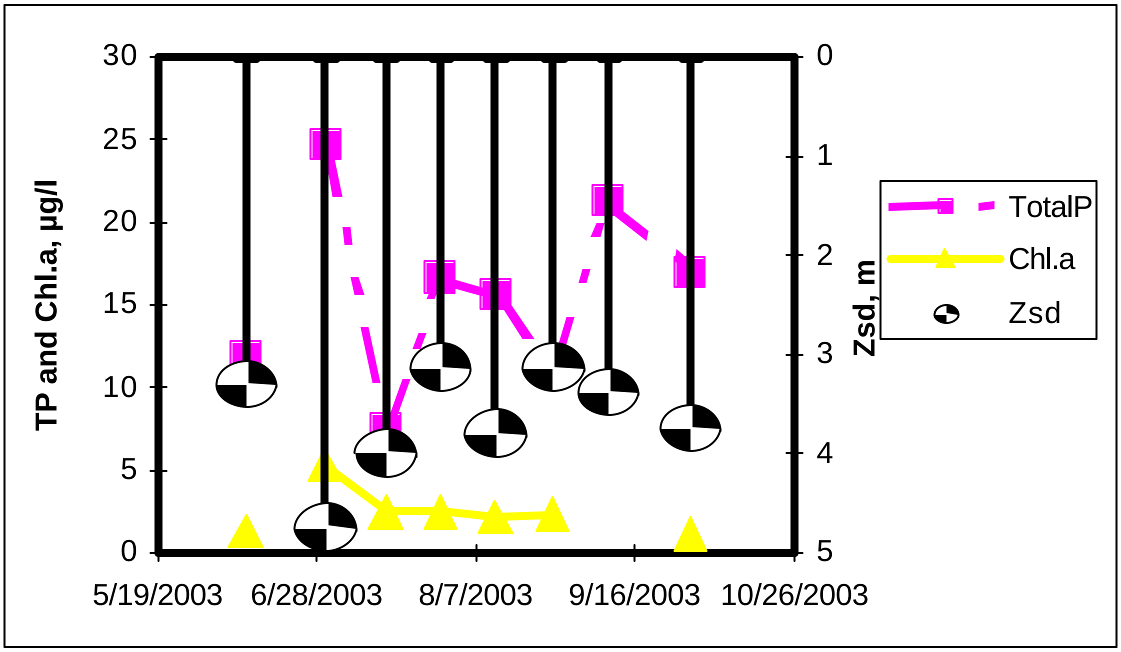



***Figure 15. 2003 Eutrophication Data for Galway Lake***

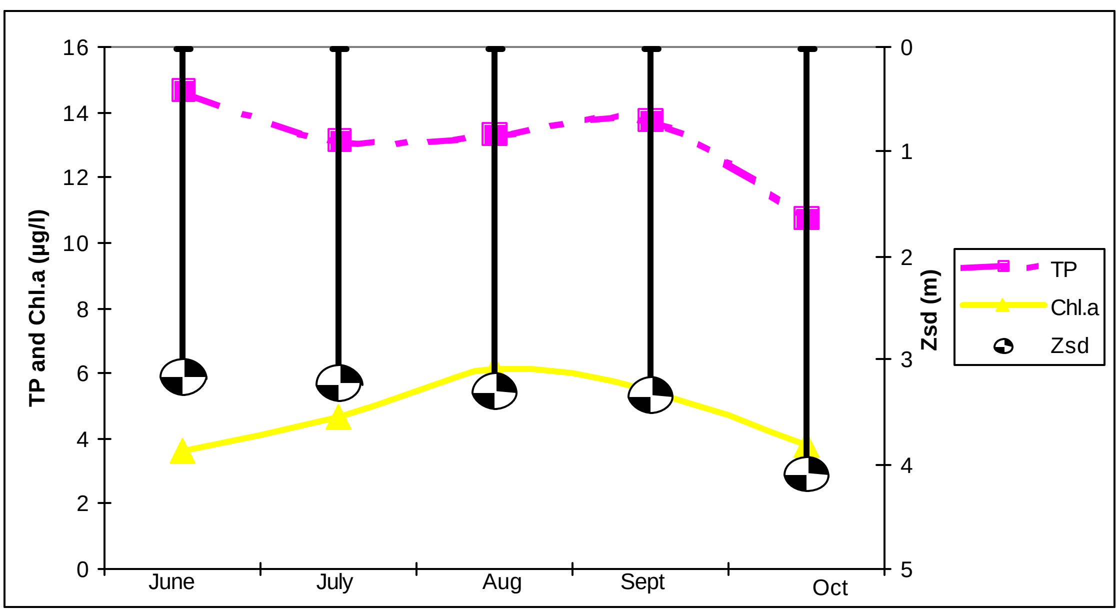



*Figure 16- Eutrophication Data in a Typical (Monthly Mean) Year for Galway Lake*

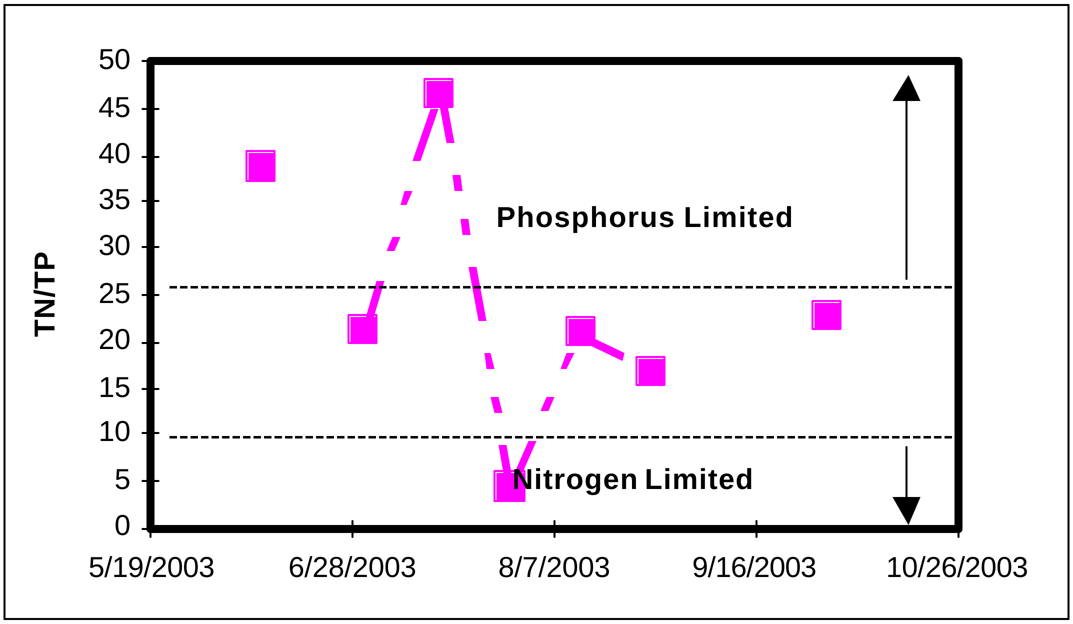



***Figure 17. 2003 Nitrogen to Phosphorus Ratios for Galway Lake***

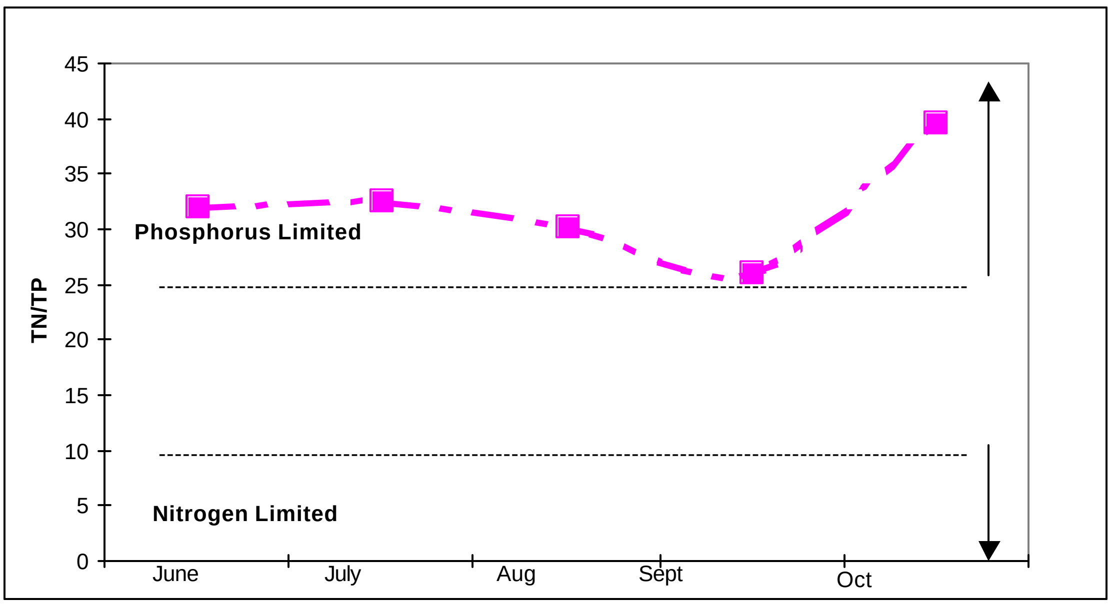



*Figure 18- Nitrogen to Phosphorus Ratios in a Typical (Monthly Mean) Year for Galway Lake*

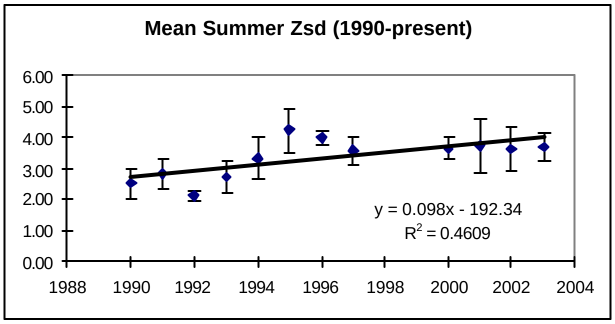



*Figure 19. Annual Average Summer Water Clarity for Galway Lake*

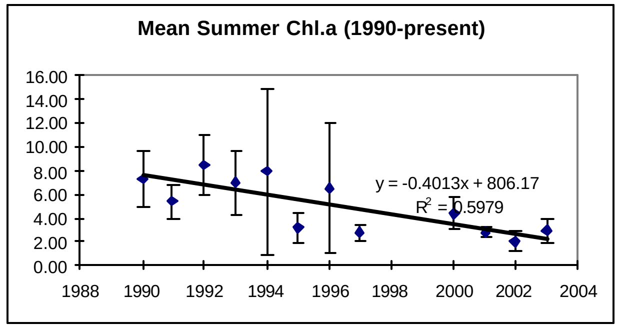



*Figure 20. Annual Average Summer Chlorophyll a for Galway Lake*

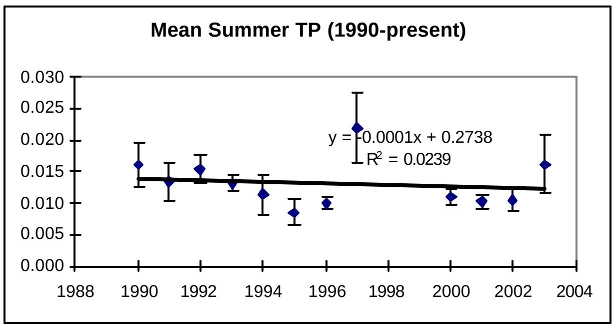



*Figure 21. Annual Average Summer Total Phosphorus for Galway Lake*

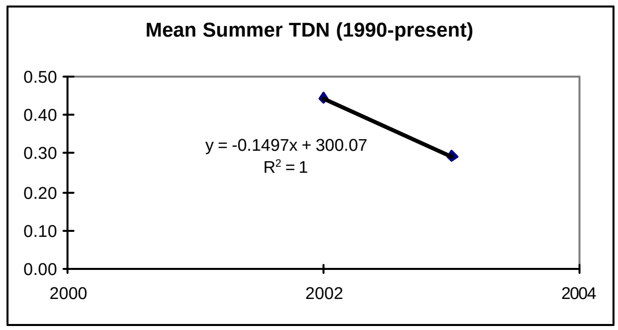



*Figure 22. Annual Average Summer Total Nitrogen for Galway Lake*

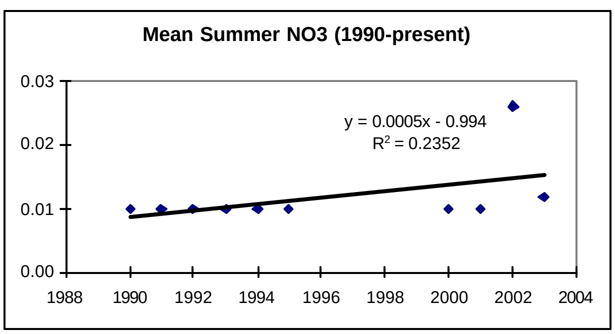



*Figure 23. Annual Average Summer Nitrate for Galway Lake*

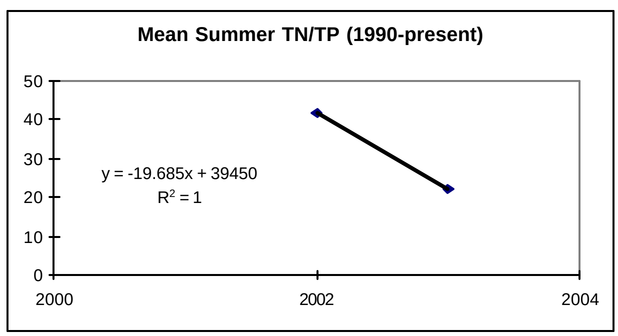



*Figure 24. Annual Average Summer TN/TP Ratios for Galway Lake*

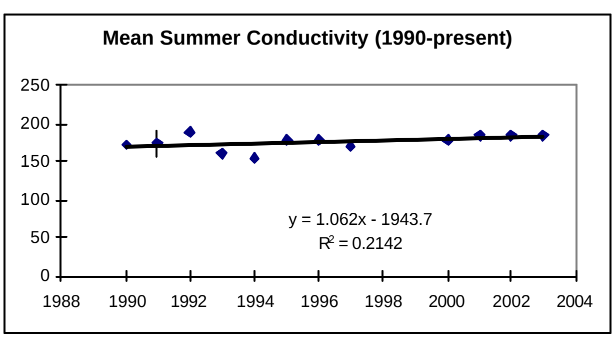



*Figure 25. Annual Average Summer Conductivity for Galway Lake*

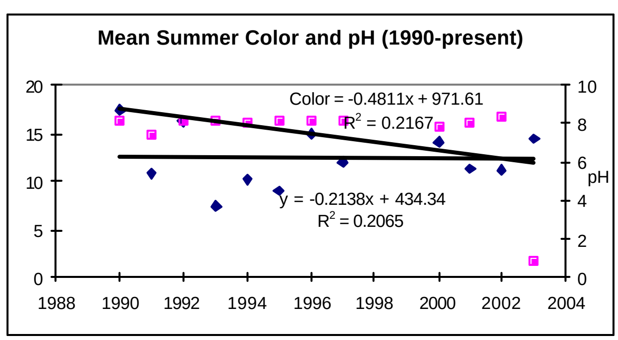



*Figure 26. Annual Average Summer pH and Color for Galway Lake*

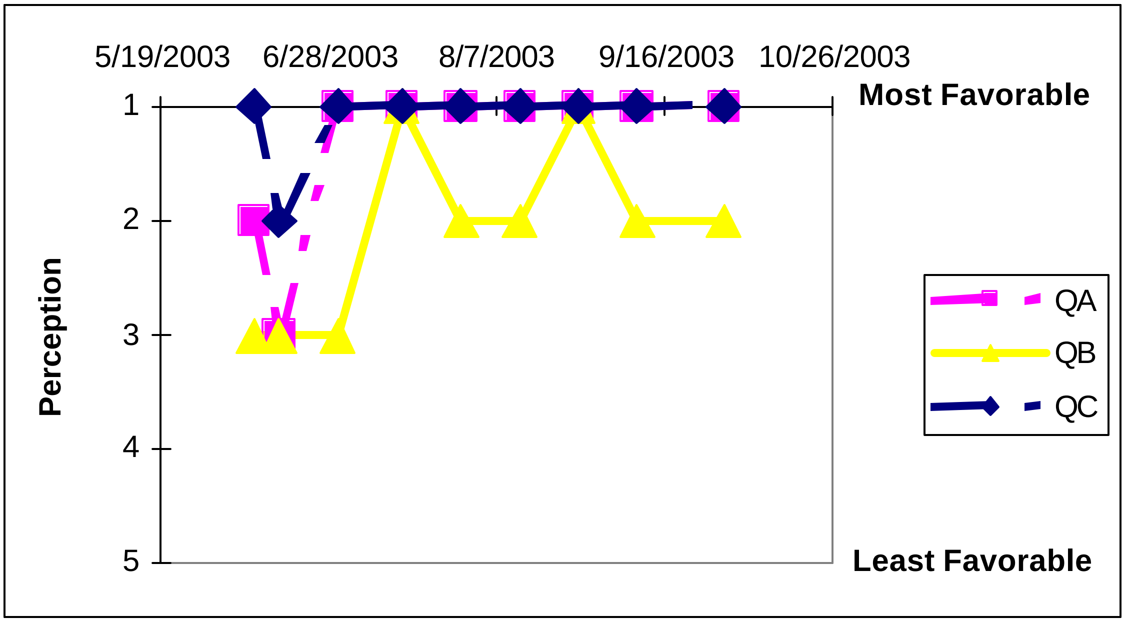



*Figure 27. 2003 Lake Perception Data for Galway Lake*

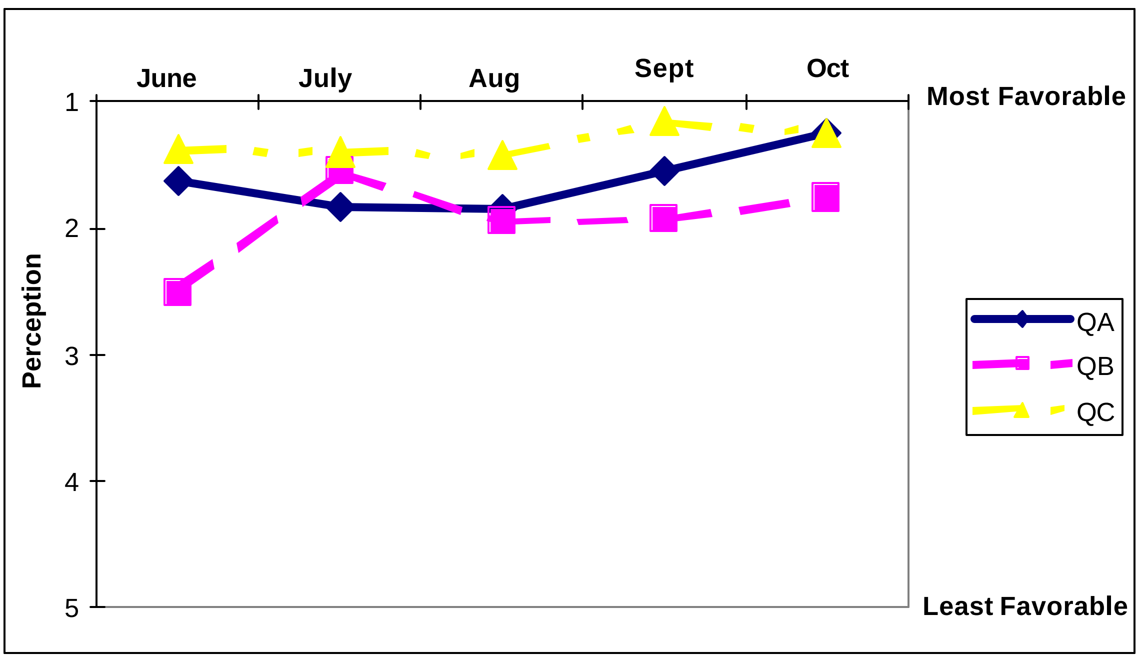



*Figure 28- Lake Perception Data in a Typical (Monthly Mean) Year for Galway Lake*

(QA = clarity, ranging from (1) crystal clear to (3) definite algae greenness to (5) severely high algae levels
QB = weeds, ranging from (1) not visible to (3) growing to the surface to (5) dense growth covers lake;
QC = recreation, ranging from (1) could not be nicer to (3) slightly impaired to (5) lake not usable)

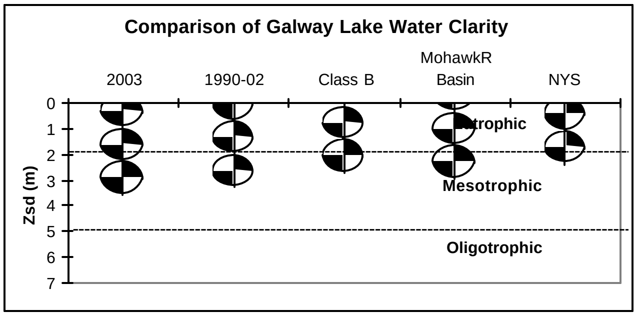



**Figure 29.** *Comparison of 2003 Secchi Disk Transparency to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 2003*

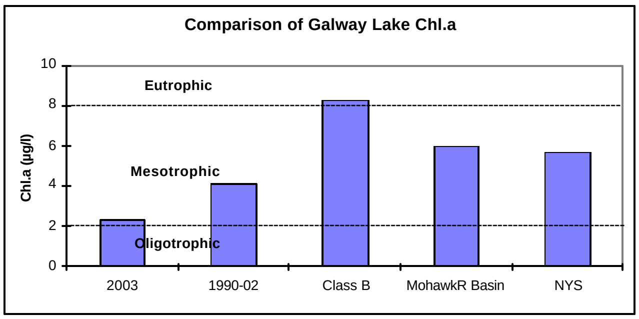



**Figure 30.** *Comparison of 2003 Chlorophyll a to Lakes with the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 2003*

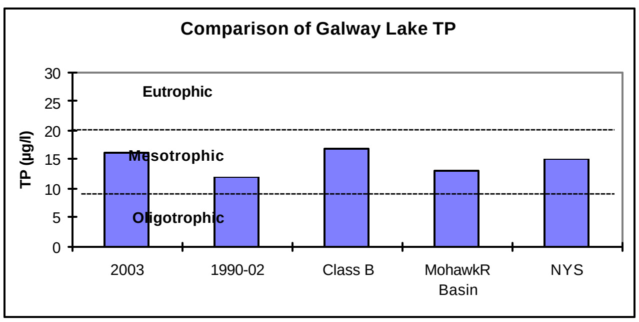



**Figure 31.** *Comparison of 2003 Total Phosphorus to Lakes With the Same Water Quality Classification, Neighboring Lakes, and Other CSLAP Lakes in 2003*

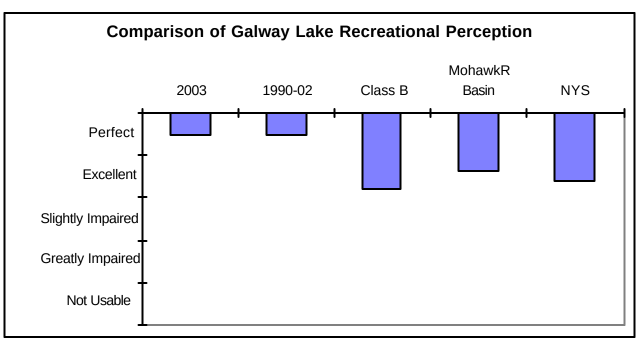



**Figure 32**. *Comparison of 2003 Recreational Perception*

## How does Galway Lake compare to other lakes?

*Annual Comparison of Median Readings for Eutrophication Parameters and Recreational Assessment For Galway Lake in 2003 to Historical Data for Galway Lake, Neighboring Lakes, Lakes with the Same Lake Classification, and Other CSLAP Lakes*

The graphs to the left illustrate comparisons of each eutrophication parameter and recreational perception at Galway Lake-in 2003, other lakes in the same drainage basin, lakes with the same water quality classification (each classification is summarized in Appendix B), and all of CSLAP. 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 Galway Lake in 2003:

a) Using water clarity as an indicator, Galway Lake continues to be less productive than other lakes with the same water quality classification (Class B), other Mohawk River drainage basin lakes, and other NYS lakes.

b) Using chlorophyll *a* concentrations as an indicator, Galway Lake is less productive than other Class B, other Mohawk River drainage basin, and other NYS lakes.

c) Using total phosphorus concentrations as an indicator, Galway Lake has been about as productive as other Class B lakes, other Mohawk River drainage basin, and other NYS lakes.

d) Using QC on the field observations form as an indicator, Galway Lake continues to be more suitable for recreation than other Class B, other Mohawk River drainage basin and other CSLAP lakes.

# VI: PRIORITY WATERBODY AND IMPAIRED WATERS LIST

The Priority Waterbody List (PWL) is presently an inventory of all waters in New York State (lakes, ponds, reservoirs, rivers, streams, and estuaries) known to have designated water uses with some degree of impairment of which are threatened by potential impairment. However, the PWL 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 waterbodies are identified through a broad network of county and state agencies, with significant public outreach and input, and the list is maintained and compiled by the NYSDEC Division of Water. Monitoring data from a variety of sources, including CSLAP, have been utilized by state and agencies to evaluate lakes for inclusion on the PWL, and the process for incorporating lakes data has become more standardized.

Specific numeric criteria have recently been developed to characterize sampled lakes in the available use-based PWL categories (precluded, impaired, stressed, or threatened). Evaluations utilize the NYS phosphorus guidance value, water quality standards, criteria utilized by other states, and the trophic ranges described earlier to supplement the other more antidotal inputs to the listing. The procedures by which waterbodies are evaluated are known as the Consolidated Assessment and Listing Methodology (CALM) process. This process is undertaken on an annual rotating basin, with waterbodies in several drainage basins evaluated each year. Each of the 17 drainage basins in the state are assessed within every five years. In general, waterbodies that violate pertinent water quality standards (such as those listed in Table 3) at a frequency of greater than 25% are identified as *impaired*, at a frequency of 10-25% are identified as *stressed*, and at a frequency of 0-10% are identified as *threatened*, although some evidence of use impairment (including through CSLAP lake perception surveys) might also be required. Evidence of restricted uses (thru beach closures, etc.) are often required to identify a waterbody as *precluded*.

Lakes that have been identified as *precluded* or *impaired* on the PWL are likely candidates for the federal 303(d) list, an “Impaired Waters” designation mandated by the federal Clean Water Act. Lakes on this list must be closely evaluated for the causes and sources of these problems. Remedial measures must be undertaken, under a defined schedule, to solve these water quality problems. This entire evaluation and remediation process is known as the “TMDL” process, which refers to the Total Maximum Daily Load calculations necessary to determine how much (pollution that causes the water quality problems) is too much.

**TABLE 3- Water Quality Standards Associated With Class B and Higher 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 |
| Ammonia Nitrogen | 2 mg/L* | Drinking Water |
| True Color | Narrative* | Swimming |
| pH | < 8.5 and > 6.5* | Aquatic Life |
| Conductivity | None | NA |

*- Narrative Standards and Notes:

Secchi Disk Transparency: The 1.2 meter (4 feet) guidance is applied for safety reasons (to see submerged swimmers or bottom debris), and strictly applies only to citing new swimming beaches, but may be appropriate for all waterbodies used for contact recreation (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 a standard; it strictly applies to Class B and higher waters, but may be appropriate for other waterbodies used for contact recreation (swimming). NYS (and other states) are in the process of identifying numerical nutrient (phosphorus, and perhaps Secchi disk transparency, chlorophyll *a*, and nitrogen) standards, but this is unlikely to be finalized within the next several years.

-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.

-For the form of ammonia (NH3+NH4) analyzed, a 2 mg/l human health standard applies to Class A or higher waters; while lower un-ionized ammonia standards apply to all classes of NYS lakes, this form is not analyzed through CSLAP

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)

pH: The standard applies to all classes of waterbodies

**pH readings exceeded the upper (=8.5) pH standard during about 8% of the CSLAP sampling sessions at Galway Lake since 1990 (and one sample in 2003), but it is not suspected that elevated pH represents an ecological problem at Galway Lake. Phosphorus levels at Galway Lake have exceeded the phosphorus guidance value for NYS lakes (=0.020 mg/l) during 5% of the CSLAP sampling sessions at the lake (but in two samples in 2003); as a result, water transparency readings exceeded the minimum recommended water clarity for swimming beaches (= 1.2 meters) during each of the CSLAP sampling sessions at the lake. It is not known if any of the narrative water quality standards listed in Table 3 have been violated at Galway Lake.**

**Galway Lake is presently among the lakes listed on the Mohawk River drainage basin PWL (2002) as having "No Known Impacts". The CSLAP dataset, including water chemistry data, physical measurements, and volunteer samplers' perception data indicate**

**that this listing is appropriate. The next PWL listing cycle for the Mohawk River drainage basin will occur in 2007.**

## VI: CONSIDERATIONS FOR LAKE MANAGEMENT

CSLAP is intended for a variety of uses, such as collecting needed information for comprehensive lake management, although it is not capable of collecting all the needed information. To this end, this section includes 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 CSLAP lake; for example, local concerns about filamentous algae or concerns about other parameters not analyzed in the CSLAP sampling. While there is some opportunity for CLSAP trained volunteers to report and assess some site-specific conditions or concerns on the CSLAP Field Observations Form, such as algae blooms or shoreline vegetation, this section is limited to the confines of this program. The categories represent the most common, broadest issues within the lake management as reported through CSLAP.

Each summarized management strategy is more extensively outlined in Diet for a Small Lake, 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 also cannot be addressed here. Rather, the following section should be considered as "tips" or a compilation of suggestions for a lake association to manage problems defined by CSLAP water quality data or articulated by perception data. When appropriate, lake-specific management 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.

The primary focus of CSLAP monitoring is to evaluate lake condition and impacts associated with lake eutrophication. Since lake eutrophication is often manifested in excessive plant growth, whether algae or aquatic macrophytes (weeds), it is likely that lake management activities, whether promulgated to reduce algae or weed growth, or to maintain water clarity and the existing makeup and density of aquatic plants in the lake, will need to address watershed inputs of nutrients and sediment to the lake, since both can contribute to either algal blooms or excessive weed growth. A core group of nutrient and sediment control activities will likely serve as the foundation for most comprehensive lake management plans and activities, and can be summarized below.

## GENERAL CONSIDERATIONS FOR ALL CSLAP LAKES

**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 numerous agriculture management practices such as fertilizer controls, soil erosion practices, and control of animal wastes, which either reduce nutrient export or retain particles lost from agricultural fields. 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, master planning to allow for development clusters in more tolerant areas in the watershed and protection of more sensitive areas; deed or contracts which limit access to the lake, and cutting restrictions can be used to reduce pollutant loading to lakes. This 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. Retaining the original flora as much as possible, or 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, and will increase the likelihood that plant fragments, particularly from Eurasian watermilfoil and other plants that easily fragment and reproduce through small fragments, can be introduced to a previously uncolonized lake.

Although not really a “watershed control strategy”, establishing **no-wake zones** can reduce shoreline erosion and local turbidity. Wave action, which can disturb flocculent bottom sediments and unconsolidated shoreline terrain is ultimately reduced, minimizing the spread of fertile soils to susceptible portions of the lake.

**Do not discard or introduce plants** from one water source to another, or deliberately introduce a "new" species from catalogue or vendor. For example, do not empty bilge or bait bucket water from another lake upon arrival at another lake, for this may contain traces of exotic plants or animals. Do not empty aquaria wastewater or plants to the lake.

**Boat propellers** are a major mode of transport to uncolonized lakes. Propellers, hitches, and trailers frequently get entangled by weeds and weed fragments. Boats not cleaned of fragments after leaving a colonized lake may introduce plant fragments to another location. New introductions of plants are often found near public access sites.

## SPECIFIC CONSIDERATIONS FOR GALWAY LAKE

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

| Issue | Through | By? |
|---|---|---|
| Maintain water clarity | Maintaining or reducing algae levels | Maintaining or reducing nutrient Inputs to the lake |

***Discussion:***
User perception and water quality data indicate a favorable physical condition and water clarity of the lake. This places the focus of water clarity management on maintaining present conditions, an enviable position for many other lake associations. Although some increase in nutrient loading is inevitable, the lake association should devote efforts to minimize the input of nutrients to the lake, or change activities that otherwise influence water clarity.

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

| Issue | Effect on Lake Use |
|---|---|
| Low weed growth | **No use impairments associated with weed growth** |

***Discussion:***
Weed growth in this lake is not dense enough to have an impact on recreational or aesthetic quality of the lake. **However, weed growth has slowly increased in recent years, and should continue to be closely monitored. It is not known by the report authors if this is in response**

**to a change in plant management strategies (drawdown) or for reasons not attributable to management decisions.** For many lake associations this is the ideal situation, even though an ideal condition for swimmers, boaters and lakefront residents may not be ideal for a significant sports fishery. For lakes in this condition, lake management is largely a task of maintaining course, of keeping siltation from the watershed at a very low level, and of keeping nuisance plants under control or out of the lake. The DEC publication, Common Nuisance Aquatic Plants in New York State, contains information about nuisance plants.

-*Naturally occurring biological controls* - may include native species of *aquatic weevils and moths* which eat aquatic plants. 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 weed 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. **It is not known by the report authors if any herbivorous insects are indigenous to Galway 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.

-*If you have a small amount of nuisance plant growth you may want to consider the following:*

-*Hand harvesting* is a very labor-intensive means for controlling weed populations. If only a very small number of nuisance plant stems exist, this may be the best means of control, removing the roots and stems of the entire plant, and disposing properly before they propagate into larger, uncontrollable beds that become the obnoxious neighbors of beneficial native plants**.**

-*Benthic barriers* are small opaque mats (usually constructed from plastic, burlap, or other materials) anchored down on top of plants to prevent sunlight from reaching the plants, thus eventually killing the plants. These are limited to only small areas, and the mats must be anchored and perforated to prevent gas bubbles from dislodging the mats.

# Appendix A. Raw Data for Galway Lake

| LNum | PName | Date | Zbot | Zsd | Zsamp | Tot.P | NO3 | NH4 | TDN | TN/TP | TColor | pH | Cond25 | Ca | Chl.a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Galway L | 7/1/1990 | 4.8 | 1.80 | 1.5 | 0.025 | 0.01 | | | | 18 | 7.89 | 178 | | 11.70 |
| 68 | Galway L | 7/14/1990 | 4.5 | 1.80 | 1.5 | 0.017 | 0.01 | | | | 18 | 8.28 | 168 | | 8.14 |
| 68 | Galway L | 7/29/1990 | 4.8 | 2.70 | 1.5 | 0.011 | 0.01 | | | | 18 | 8.34 | 176 | | 3.13 |
| 68 | Galway L | 8/12/1990 | 5.4 | 2.95 | 1.5 | 0.017 | 0.01 | | | | 15 | 8.29 | 167 | | 9.65 |
| 68 | Galway L | 8/26/1990 | 4.9 | 3.45 | 1.5 | 0.014 | 0.01 | | | | 16 | 8.27 | 174 | | 4.16 |
| 68 | Galway L | 9/9/1990 | 5.2 | 2.30 | 1.5 | 0.013 | 0.01 | | | | 19 | 8.29 | 169 | | 6.52 |
| 68 | Galway L | 9/23/1990 | 5.3 | 3.55 | 1.5 | 0.011 | 0.01 | | | | 17 | 8.28 | 177 | | 5.41 |
| 68 | Galway L | 10/8/1990 | 5.5 | 4.25 | 1.5 | 0.012 | 0.01 | | | | 18 | 8.26 | 186 | | 4.35 |
| 68 | Galway L | 6/30/1991 | 5.0 | 2.90 | 1.5 | 0.020 | 0.01 | | | | 16 | 7.87 | 176 | | 4.45 |
| 68 | Galway L | 7/15/1991 | 6.0 | 2.90 | 1.5 | 0.011 | 0.01 | | | | 16 | 8.20 | 171 | | 3.66 |
| 68 | Galway L | 8/4/1991 | 6.1 | 2.35 | 1.5 | 0.014 | 0.01 | | | | 11 | 7.04 | 196 | | 6.04 |
| 68 | Galway L | 8/18/1991 | 5.8 | 3.60 | 1.5 | 0.008 | | | | | 8 | 8.25 | 168 | | 4.71 |
| 68 | Galway L | 9/1/1991 | 6.0 | 3.30 | 1.5 | 0.014 | | | | | 6 | 7.16 | 201 | | |
| 68 | Galway L | 9/15/1991 | 5.8 | 1.75 | 1.5 | 0.013 | 0.01 | | | | 8 | 8.37 | 133 | | 8.09 |
| 68 | Galway L | 6/15/1992 | 5.6 | 2.40 | 1.5 | 0.012 | 0.01 | | | | 16 | 8.18 | 187 | | 5.49 |
| 68 | Galway L | 6/28/1992 | 5.8 | 2.30 | 1.5 | 0.016 | | | | | 20 | 8.18 | 191 | | 3.93 |
| 68 | Galway L | 7/19/1992 | 6.0 | 1.95 | 1.5 | 0.011 | 0.01 | | | | 16 | 8.18 | 188 | | 6.88 |
| 68 | Galway L | 8/16/1992 | 6.0 | 1.95 | 1.5 | 0.017 | | | | | 15 | 7.85 | 192 | | 11.30 |
| 68 | Galway L | 8/30/1992 | 5.8 | 1.90 | 1.5 | 0.018 | 0.01 | | | | 13 | 8.21 | 188 | | 10.80 |
| 68 | Galway L | 9/13/1992 | 5.8 | 2.20 | 1.5 | 0.018 | | | | | 17 | 8.19 | 190 | | 12.10 |
| 68 | Galway L | 9/25/1992 | 5.8 | 2.40 | 1.5 | 0.011 | 0.01 | | | | 16 | 8.23 | 175 | | 6.54 |
| 68 | Galway L | 10/9/1992 | 5.8 | 2.90 | 1.5 | 0.010 | | | | | 16 | 8.06 | 188 | | 4.51 |
| 68 | Galway L | 7/5/1993 | 6.8 | 2.75 | 1.5 | 0.013 | 0.01 | | | | 13 | 8.17 | 154 | | 10.60 |
| 68 | Galway L | 7/18/1993 | 6.3 | 2.10 | 1.5 | 0.014 | | | | | 3 | 8.01 | 159 | | 8.37 |
| 68 | Galway L | 8/1/1993 | 6.3 | 2.05 | 1.5 | 0.014 | 0.01 | | | | 3 | 8.15 | 160 | | 6.02 |
| 68 | Galway L | 8/15/1993 | 6.0 | 2.25 | 1.5 | 0.014 | | | | | 7 | 8.14 | 162 | | 11.30 |
| 68 | Galway L | 8/29/1993 | 6.0 | 3.63 | 1.5 | 0.010 | 0.01 | | | | 8 | 7.92 | 165 | | 2.80 |
| 68 | Galway L | 9/12/1993 | 6.0 | 3.50 | 1.5 | 0.014 | | | | | 10 | 8.29 | 166 | | 2.85 |
| 68 | Galway L | 10/3/1993 | 6.0 | 3.66 | 1.5 | 0.011 | 0.03 | | | | 7 | 8.12 | 168 | | 5.48 |
| 68 | Galway L | 7/14/1994 | 6.0 | 3.00 | | 0.008 | 0.01 | | | | 8 | 7.72 | 150 | | 1.29 |
| 68 | Galway L | 7/18/1994 | 5.8 | 2.23 | 1.5 | 0.015 | 0.01 | | | | 7 | 8.50 | 151 | | 8.12 |
| 68 | Galway L | 7/31/1994 | 4.8 | 3.25 | 1.5 | 0.014 | 0.01 | | | | 7 | 8.14 | 154 | | 3.89 |
| 68 | Galway L | 8/20/1994 | 5.0 | 4.50 | | 0.006 | | | | | 17 | 8.15 | 159 | | 23.20 |
| 68 | Galway L | 9/15/1994 | 5.0 | 3.63 | 1.5 | 0.014 | 0.01 | | | | 12 | 8.06 | 162 | | 3.19 |
| 68 | Galway L | 9/24/1994 | 5.8 | 4.00 | 1.5 | 0.009 | | | | | 10 | 8.01 | 165 | | 3.27 |
| 68 | Galway L | 7/18/1995 | 5.7 | 4.75 | 1.5 | 0.008 | | | | | 10 | | | | 1.02 |
| 68 | Galway L | 8/1/1995 | 5.5 | 3.70 | 1.5 | 0.008 | 0.01 | | | | 10 | 8.00 | 178 | | 3.03 |
| 68 | Galway L | 8/8/1995 | 5.7 | 3.00 | 1.5 | 0.012 | | | | | 10 | 8.02 | 180 | | 5.44 |
| 68 | Galway L | 8/22/1995 | 5.1 | 4.25 | 1.5 | 0.005 | 0.01 | | | | 5 | 8.36 | 180 | | 3.80 |
| 68 | Galway L | 9/5/1995 | 5.8 | 5.38 | | 0.010 | | | | | 10 | 8.14 | 180 | | 2.25 |
| 68 | Galway L | 9/18/1995 | 6.0 | 4.88 | 1.5 | 0.009 | | | | | 5 | 8.15 | 183 | | 2.37 |
| 68 | Galway L | 10/2/1995 | 5.8 | 5.45 | | 0.008 | | | | | 10 | 8.08 | 184 | | 3.27 |
| 68 | Galway L | 7/16/1996 | 6.0 | 3.65 | 1.5 | 0.011 | | | | | 15 | 7.98 | 175 | | 2.40 |

| LNum | PName | Date | Zbot | Zsd | Zsamp | Tot.P | NO3 | NH4 | TDN | TN/TP | TColor | pH | Cond25 | Ca | Chl.a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Galway L | 8/5/1996 | 6.0 | 4.15 | 1.5 | 0.010 | | | | | 15 | 8.20 | 182 | | 3.80 |
| 68 | Galway L | 8/26/1996 | 6.1 | 4.08 | 1.5 | 0.009 | | | | | 15 | 8.67 | 177 | | 13.40 |
| 68 | Galway L | 9/23/1996 | 6.0 | 2.15 | 1.5 | 0.015 | | | | | 15 | 7.97 | 179 | | 11.20 |
| 68 | Galway L | 7/14/1997 | 6.0 | 3.63 | 1.5 | 0.026 | | | | | 15 | 7.96 | 170 | | 2.37 |
| 68 | Galway L | 7/30/1997 | 6.0 | 2.90 | 1.5 | 0.018 | | | | | 15 | 8.04 | 172 | | 3.01 |
| 68 | Galway L | 8/11/1997 | 6.0 | 4.10 | 1.5 | | | | | | 10 | 8.49 | 169 | | 3.81 |
| 68 | Galway L | 8/26/1997 | 6.0 | 3.65 | 1.5 | | | | | | 8 | 8.11 | 172 | | 2.08 |
| 68 | Galway L | 6/14/2000 | 6.0 | 3.00 | 1.5 | 0.014 | 0.01 | | | | 18 | 7.65 | 185 | | 4.81 |
| 68 | Galway L | 6/27/2000 | 7.0 | 4.25 | | 0.009 | 0.01 | | | | 15 | 8.29 | 177 | | 2.26 |
| 68 | Galway L | 7/11/2000 | 6.3 | 3.75 | 1.5 | 0.010 | 0.01 | | | | 16 | 7.35 | 180 | | 3.00 |
| 68 | Galway L | 7/25/2000 | 6.0 | 3.63 | 1.5 | 0.010 | 0.01 | | | | 13 | 8.22 | 179 | | 6.75 |
| 68 | Galway L | 8/8/2000 | 6.3 | 3.50 | 1.5 | 0.012 | 0.01 | | | | 12 | 8.01 | 180 | | 3.87 |
| 68 | Galway L | 8/22/2000 | 6.0 | 3.00 | 1.5 | 0.012 | 0.01 | | | | 13 | 7.85 | 180 | | 3.64 |
| 68 | Galway L | 9/5/2000 | | | | 0.013 | 0.01 | | | | 16 | 8.04 | 183 | | 6.40 |
| 68 | Galway L | 9/19/2000 | 6.0 | 2.78 | 1.5 | 0.018 | 0.01 | | | | 11 | 7.92 | 185 | | 10.40 |
| 68 | Galway L | 7/17/2001 | 6.3 | 3.13 | 1.5 | 0.012 | 0.01 | | | | 12 | 7.80 | 185 | | 3.02 |
| 68 | Galway L | 7/31/2001 | 6.0 | 5.15 | | 0.009 | 0.01 | | | | 8 | 8.21 | 184 | | |
| 68 | Galway L | 8/15/2001 | 6.0 | 3.78 | 1.5 | 0.010 | 0.01 | | | | 16 | 8.52 | 185 | | |
| 68 | Galway L | 8/28/2001 | 6.1 | 2.88 | 1.5 | 0.011 | 0.01 | | | | 9 | 8.00 | 183 | | 2.47 |
| 68 | Galway L | 06/25/02 | 6.0 | 2.53 | 3.0 | 0.010 | 0.01 | 0.07 | 0.36 | 35.84 | 12 | 8.21 | 188 | 9.27 | 1.06 |
| 68 | Galway L | 07/09/02 | 6.2 | 4.15 | 1.5 | | 0.00 | 0.05 | 0.41 | | 10 | 8.09 | 187 | | 1.25 |
| 68 | Galway L | 07/23/02 | 6.1 | 4.70 | 1.5 | 0.008 | 0.00 | 0.05 | 0.39 | 46.29 | 12 | 8.72 | 187 | | |
| 68 | Galway L | 08/06/02 | 6.0 | | 1.5 | | 0.12 | 0.05 | 0.55 | | 10 | 8.61 | 186 | | 3.64 |
| 68 | Galway L | 08/20/02 | 6.0 | 3.88 | 1.5 | 0.010 | 0.00 | 0.04 | 0.53 | 52.86 | 11 | 8.94 | 184 | 6.63 | 2.60 |
| 68 | Galway L | 09/03/02 | 7.0 | 2.95 | 1.5 | 0.013 | 0.02 | 0.01 | 0.43 | 32.23 | 12 | 8.32 | 182 | | 1.55 |
| 68 | Galway L | 09/24/02 | 6.2 | 5.15 | 1.5 | 0.014 | 0.00 | 0.01 | 0.32 | 22.69 | 9 | 7.99 | 184 | | 4.13 |
| 68 | Galway L | 10/01/02 | 6.2 | 3.90 | 1.5 | 0.011 | 0.00 | 0.02 | 0.39 | 34.58 | 12 | 8.23 | 185 | | 0.84 |
| 68 | Galway L | 10/18/02 | 6.3 | 4.53 | 1.5 | 0.012 | 0.02 | 0.08 | 0.55 | 44.45 | 32 | 7.62 | 190 | | 4.40 |
| 68 | Galway L | 6/10/2003 | 6.1 | 3.30 | 1.5 | 0.012 | 0.003 | 0.018 | 0.46 | 38.72 | 16 | 7.81 | 184 | 18.0 | 1.392 |
| 68 | Galway L | 6/16/2003 | | | | | | | | | | | | | |
| 68 | Galway L | 6/30/2003 | 6.0 | 4.75 | 1.5 | 0.025 | 0.043 | 0.047 | 0.53 | 21.47 | 13 | 8.31 | 189.8 | | 5.306 |
| 68 | Galway L | 7/15/2003 | 6.5 | 4.00 | 1.5 | 0.008 | 0.003 | 0.018 | 0.35 | 46.60 | 9 | 8.16 | 186.8 | | 2.507 |
| 68 | Galway L | 7/29/2003 | 6.1 | 3.13 | | 0.017 | 0.003 | 0.003 | 0.08 | 4.61 | 24 | 8.12 | 187.5 | | 2.522 |
| 68 | Galway L | 8/12/2003 | 6.0 | 3.80 | 1.5 | 0.016 | 0.003 | 0.010 | 0.33 | 21.14 | 21 | 8.98 | 175.5 | 16.0 | 2.103 |
| 68 | Galway L | 8/26/2003 | 6.0 | 3.13 | 1.5 | 0.011 | 0.003 | 0.005 | 0.19 | 16.79 | 9 | 8.30 | 183.5 | | 2.306 |
| 68 | Galway L | 9/9/2003 | 6.1 | 3.38 | 1.5 | 0.021 | 0.019 | 0.003 | | | 11 | 8.31 | 183.6 | | |
| 68 | Galway L | 9/30/2003 | 6.1 | 3.75 | 1.5 | 0.017 | 0.003 | 0.014 | 0.39 | 22.88 | 7 | 7.89 | 168.8 | | 1.212 |
| 68 | Galway L | 6/10/2003 | | | 5.0 | 0.008 | 0.003 | 0.008 | 0.41 | 50.74 | | | | | |
| 68 | Galway L | 7/15/2003 | | | 5.5 | 0.020 | 0.003 | 0.008 | 0.24 | 11.95 | | | | | |
| 68 | Galway L | 7/29/2003 | | | | 0.023 | 0.003 | 0.003 | 0.06 | 2.69 | | | | | |
| 68 | Galway L | 8/26/2003 | | | 5.0 | 0.019 | 0.003 | 0.020 | 0.27 | 14.03 | | | | | |
| 68 | Galway L | 9/9/2003 | | | 5.1 | 0.018 | 0.012 | 0.008 | | | | | | | |
| 68 | Galway L | 9/30/2003 | | | 5.1 | 0.015 | 0.003 | 0.010 | 0.40 | 26.57 | | | | | |
| 68.11 | Galway L-North of Dike/Top | 6/16/2003 | | | | 0.009 | | | | | | | | | |

| LNum | PName | Date | Zbot | Zsd | Zsamp | Tot.P | NO3 | NH4 | TDN | TN/TP | TColor | pH | Cond25 | Ca | Chl.a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68.21 | Galway L-South Bay/Top | 6/16/2003 | | | | 0.008 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 6/16/2003 | | | | 0.010 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 6/16/2003 | | | | 0.011 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 6/16/2003 | | | | 0.009 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 6/16/2003 | | | | 0.010 | | | | | | | | | |
| 68.41 | Galway L-North Bay | 6/16/2003 | | | | 0.013 | | | | | | | | | |
| 68.51 | Galway L-West Bay | 6/16/2003 | | | | 0.009 | | | | | | | | | |
| 68.11 | Galway L-North of Dike/Top | 7/14/2003 | | | | 0.008 | | | | | | | | | |
| 68.21 | Galway L-South Bay/Top | 7/14/2003 | | | | 0.008 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 7/14/2003 | | | | 0.008 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 7/14/2003 | | | | 0.018 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 7/14/2003 | | | | 0.015 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 7/14/2003 | | | | 0.028 | | | | | | | | | |
| 68.21 | Galway L-South Bay/Top | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.11 | Galway L-North of Dike/Top | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 8/18/2003 | | | | 0.005 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 8/18/2003 | | | | 0.018 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 8/18/2003 | | | | 0.020 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 8/18/2003 | | | | 0.026 | | | | | | | | | |
| 68.121 | Galway L-Adabar | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.42 | Galway L-North Bay cove | 6/16/2003 | | | | 0.015 | | | | | | | | | |
| 68.52 | Galway L-West Bay cove | 6/16/2003 | | | | 0.015 | | | | | | | | | |
| 68.62 | Galway L-South Bay cove | 6/16/2003 | | | | 0.010 | | | | | | | | | |
| 68.131 | Galway L-Adabar Inlet | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.111 | Galway L-outlet | 8/18/2003 | | | | 0.009 | | | | | | | | | |
| 68.71 | Galway L-Rohlings | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.81 | Galway L-Maywood | 8/18/2003 | | | | 0.007 | | | | | | | | | |
| 68.91 | Galway L-Harts | 8/18/2003 | | | | 0.008 | | | | | | | | | |
| 68.101 | Galway L-Jeffers | 8/18/2003 | | | | 0.007 | | | | | | | | | |

| LNum | PName | Date | Zbot | Zsd | Zsamp | TAir | TH20 | QA | QB | QC | QD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Galway L | 7/1/1990 | 4.8 | 1.80 | 1.5 | 23 | 21 | | | | |
| 68 | Galway L | 7/14/1990 | 4.5 | 1.80 | 1.5 | 23 | 19 | | | | |
| 68 | Galway L | 7/29/1990 | 4.8 | 2.70 | 1.5 | 24 | 26 | | | | |
| 68 | Galway L | 8/12/1990 | 5.4 | 2.95 | 1.5 | 24 | 24 | | | | |
| 68 | Galway L | 8/26/1990 | 4.9 | 3.45 | 1.5 | 23 | 23 | | | | |
| 68 | Galway L | 9/9/1990 | 5.2 | 2.30 | 1.5 | 14 | 20 | | | | |
| 68 | Galway L | 9/23/1990 | 5.3 | 3.55 | 1.5 | 13 | 20 | | | | |
| 68 | Galway L | 10/8/1990 | 5.5 | 4.25 | 1.5 | 19 | 17 | | | | |
| 68 | Galway L | 6/30/1991 | 5.0 | 2.90 | 1.5 | 16 | 24 | | | | |
| 68 | Galway L | 7/15/1991 | 6.0 | 2.90 | 1.5 | 21 | 25 | | | | |
| 68 | Galway L | 8/4/1991 | 6.1 | 2.35 | 1.5 | 26 | 24 | | | | |
| 68 | Galway L | 8/18/1991 | 5.8 | 3.60 | 1.5 | 25 | 25 | | | | |
| 68 | Galway L | 9/1/1991 | 6.0 | 3.30 | 1.5 | 17 | 24 | | | | |
| 68 | Galway L | 9/15/1991 | 5.8 | 1.75 | 1.5 | 20 | 20 | | | | |
| 68 | Galway L | 6/15/1992 | 5.6 | 2.40 | 1.5 | 22 | 23 | 1 | 1 | 1 | 0 |
| 68 | Galway L | 6/28/1992 | 5.8 | 2.30 | 1.5 | 18 | 14 | 1 | 1 | 1 | |
| 68 | Galway L | 7/19/1992 | 6.0 | 1.95 | 1.5 | 23 | 23 | 2 | 1 | 1 | 0 |
| 68 | Galway L | 8/16/1992 | 6.0 | 1.95 | 1.5 | 18 | 20 | | | | |
| 68 | Galway L | 8/30/1992 | 5.8 | 1.90 | 1.5 | 17 | 22 | | | | |
| 68 | Galway L | 9/13/1992 | 5.8 | 2.20 | 1.5 | 15 | 20 | 2 | 2 | 1 | |
| 68 | Galway L | 9/25/1992 | 5.8 | 2.40 | 1.5 | 18 | 15 | | | | |
| 68 | Galway L | 10/9/1992 | 5.8 | 2.90 | 1.5 | 13 | 14 | | | | |
| 68 | Galway L | 7/5/1993 | 6.8 | 2.75 | 1.5 | 22 | 24 | 3 | 2 | 3 | 13 |
| 68 | Galway L | 7/18/1993 | 6.3 | 2.10 | 1.5 | 19 | 24 | 3 | 1 | 1 | 1 |
| 68 | Galway L | 8/1/1993 | 6.3 | 2.05 | 1.5 | 21 | 24 | 2 | 1 | 1 | 0 |
| 68 | Galway L | 8/15/1993 | 6.0 | 2.25 | 1.5 | 23 | 24 | 2 | 1 | 2 | 6 |
| 68 | Galway L | 8/29/1993 | 6.0 | 3.63 | 1.5 | 18 | 24 | 2 | 2 | 2 | 6 |
| 68 | Galway L | 9/12/1993 | 6.0 | 3.50 | 1.5 | 13 | 20 | 1 | 1 | 1 | |
| 68 | Galway L | 10/3/1993 | 6.0 | 3.66 | 1.5 | 9 | 14 | 1 | 1 | 1 | 5 |
| 68 | Galway L | 7/14/1994 | 6.0 | 3.00 | | 25 | 24 | 3 | 2 | 2 | 1 |
| 68 | Galway L | 7/18/1994 | 5.8 | 2.23 | 1.5 | 26 | 25 | 4 | 2 | 3 | 13 |
| 68 | Galway L | 7/31/1994 | 4.8 | 3.25 | 1.5 | 27 | 26 | 2 | 2 | 1 | |
| 68 | Galway L | 8/20/1994 | 5.0 | 4.50 | | 22 | 24 | 2 | 2 | 1 | |
| 68 | Galway L | 9/15/1994 | 5.0 | 3.63 | 1.5 | 17 | 20 | 1 | 2 | 1 | |
| 68 | Galway L | 9/24/1994 | 5.8 | 4.00 | 1.5 | 18 | 18 | 2 | 2 | 1 | 5 |
| 68 | Galway L | 7/18/1995 | 5.7 | 4.75 | 1.5 | 24 | 26 | 2 | 2 | 2 | |
| 68 | Galway L | 8/1/1995 | 5.5 | 3.70 | 1.5 | 28 | 26 | 2 | 2 | 2 | 2 |
| 68 | Galway L | 8/8/1995 | 5.7 | 3.00 | 1.5 | 22 | 25 | 3 | 2 | 2 | |
| 68 | Galway L | 8/22/1995 | 5.1 | 4.25 | 1.5 | 20 | 24 | 2 | 2 | 2 | |
| 68 | Galway L | 9/5/1995 | 5.8 | 5.38 | | 23 | 22 | 2 | 3 | 2 | |
| 68 | Galway L | 9/18/1995 | 6.0 | 4.88 | 1.5 | 15 | 18 | 2 | 2 | 2 | |
| 68 | Galway L | 10/2/1995 | 5.8 | 5.45 | | 15 | 17 | 2 | 2 | 2 | |

| LNum | PName | Date | Zbot | Zsd | Zsamp | TAir | TH20 | QA | QB | QC | QD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Galway L | 7/16/1996 | 6.0 | 3.65 | 1.5 | 23 | 21 | 2 | 2 | 2 | |
| 68 | Galway L | 8/5/1996 | 6.0 | 4.15 | 1.5 | 27 | 25 | 3 | 2 | 2 | |
| 68 | Galway L | 8/26/1996 | 6.1 | 4.08 | 1.5 | 24 | 24 | 2 | 2 | 1 | |
| 68 | Galway L | 9/23/1996 | 6.0 | 2.15 | 1.5 | 17 | 19 | 2 | 1 | 1 | 5 |
| 68 | Galway L | 7/14/1997 | 6.0 | 3.63 | 1.5 | 28 | 24 | 1 | 2 | 1 | |
| 68 | Galway L | 7/30/1997 | 6.0 | 2.90 | 1.5 | 19 | 24 | 2 | 1 | 1 | |
| 68 | Galway L | 8/11/1997 | 6.0 | 4.10 | 1.5 | 25 | 25 | 1 | 2 | 1 | |
| 68 | Galway L | 8/26/1997 | 6.0 | 3.65 | 1.5 | 21 | 22 | 2 | 3 | 1 | |
| 68 | Galway L | 6/14/2000 | 6.0 | 3.00 | 1.5 | 23 | 20 | 2 | 3 | 2 | |
| 68 | Galway L | 6/27/2000 | 7.0 | 4.25 | | 27 | 24 | 1 | 3 | 1 | |
| 68 | Galway L | 7/11/2000 | 6.3 | 3.75 | 1.5 | 25 | 22 | 1 | 2 | 1 | |
| 68 | Galway L | 7/25/2000 | 6.0 | 3.63 | 1.5 | 24 | 25 | 2 | 2 | 1 | |
| 68 | Galway L | 8/8/2000 | 6.3 | 3.50 | 1.5 | 25 | 24 | 1 | 2 | 1 | |
| 68 | Galway L | 8/22/2000 | 6.0 | 3.00 | 1.5 | 20 | 22 | 2 | 3 | 1 | |
| 68 | Galway L | 9/5/2000 | | | | | | 2 | 2 | 1 | |
| 68 | Galway L | 9/19/2000 | 6.0 | 2.78 | 1.5 | 19 | 19 | 2 | 2 | 1 | |
| 68 | Galway L | 7/17/2001 | 6.3 | 3.13 | 1.5 | 25 | 22 | 1 | 1 | 1 | 6 |
| 68 | Galway L | 7/31/2001 | 6.0 | 5.15 | | 26 | 26 | 1 | 1 | 1 | |
| 68 | Galway L | 8/15/2001 | 6.0 | 3.78 | 1.5 | 24 | 25 | 2 | 2 | 1 | |
| 68 | Galway L | 8/28/2001 | 6.1 | 2.88 | 1.5 | 25 | 25 | 2 | 2 | 2 | |
| 68 | Galway L | 06/25/02 | 6.0 | 2.53 | 3.0 | 25 | 26 | 2 | 3 | 2 | |
| 68 | Galway L | 07/09/02 | 6.2 | 4.15 | 1.5 | 28 | 25 | 1 | 1 | 1 | |
| 68 | Galway L | 07/23/02 | 6.1 | 4.70 | 1.5 | 29 | 26 | 1 | 1 | 1 | |
| 68 | Galway L | 08/06/02 | 6.0 | | 1.5 | 22 | 25 | 2 | 2 | 2 | |
| 68 | Galway L | 08/20/02 | 6.0 | 3.88 | 1.5 | 21 | 27 | 1 | 2 | 1 | |
| 68 | Galway L | 09/03/02 | 7.0 | 2.95 | 1.5 | 22 | 21 | 1 | 2 | 1 | |
| 68 | Galway L | 09/24/02 | 6.2 | 5.15 | 1.5 | 17 | 20 | 1 | 2 | 1 | |
| 68 | Galway L | 10/01/02 | 6.2 | 3.90 | 1.5 | 22 | 19 | 1 | 2 | 1 | |
| 68 | Galway L | 10/18/02 | 6.3 | 4.53 | 1.5 | 10 | 12 | 1 | 2 | 1 | 5 |
| 68 | Galway L | 6/10/2003 | 6.1 | 3.30 | 1.5 | 25 | 20 | 2 | 3 | 1 | 5 |
| 68 | Galway L | 6/16/2003 | | | | | | 3 | 3 | 2 | |
| 68 | Galway L | 6/30/2003 | 6.0 | 4.75 | 1.5 | 21 | 25 | 1 | 3 | 1 | |
| 68 | Galway L | 7/15/2003 | 6.5 | 4.00 | 1.5 | 30 | 25 | 1 | 1 | 1 | |
| 68 | Galway L | 7/29/2003 | 6.1 | 3.13 | | 25 | 24 | 1 | 2 | 1 | |
| 68 | Galway L | 8/12/2003 | 6.0 | 3.80 | 1.5 | 29 | 27 | 1 | 2 | 1 | |
| 68 | Galway L | 8/26/2003 | 6.0 | 3.13 | 1.5 | 28 | 24 | 1 | 1 | 1 | |
| 68 | Galway L | 9/9/2003 | 6.1 | 3.38 | 1.5 | 25 | 22 | 1 | 2 | 1 | |
| 68 | Galway L | 9/30/2003 | 6.1 | 3.75 | 1.5 | 12 | 17 | 1 | 2 | 1 | |
| 68 | Galway L | 6/10/2003 | | | 5.0 | | | | | | |
| 68 | Galway L | 7/15/2003 | | | 5.5 | | | | | | |
| 68 | Galway L | 7/29/2003 | | | | | | | | | |
| 68 | Galway L | 8/26/2003 | | | 5.0 | | | | | | |
| 68 | Galway L | 9/9/2003 | | | 5.1 | | | | | | |

| LNum | PName | Date | Zbot | Zsd | Zsamp | TAir | TH20 | QA | QB | QC | QD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Galway L | 9/30/2003 | | | 5.1 | | | | | | |
| 68.11 | Galway L-North of Dike/Top | 6/16/2003 | | | | | | | | | |
| 68.21 | Galway L-South Bay/Top | 6/16/2003 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 6/16/2003 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 6/16/2003 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 6/16/2003 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 6/16/2003 | | | | | | | | | |
| 68.41 | Galway L-North Bay | 6/16/2003 | | | | | | | | | |
| 68.51 | Galway L-West Bay | 6/16/2003 | | | | | | | | | |
| 68.11 | Galway L-North of Dike/Top | 7/14/2003 | | | | | | | | | |
| 68.21 | Galway L-South Bay/Top | 7/14/2003 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 7/14/2003 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 7/14/2003 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 7/14/2003 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 7/14/2003 | | | | | | | | | |
| 68.21 | Galway L-South Bay/Top | 8/18/2003 | | | | | | | | | |
| 68.11 | Galway L-North of Dike/Top | 8/18/2003 | | | | | | | | | |
| 68.31 | Galway L-Channel/Top | 8/18/2003 | | | | | | | | | |
| 68.22 | Galway L-South Bay/Bottom | 8/18/2003 | | | | | | | | | |
| 68.12 | Galway L-North of Dike/Bottom | 8/18/2003 | | | | | | | | | |
| 68.32 | Galway L-Channel/Bottom | 8/18/2003 | | | | | | | | | |
| 68.121 | Galway L-Adabar | 8/18/2003 | | | | | | | | | |
| 68.42 | Galway L-North Bay cove | 6/16/2003 | | | | | | | | | |
| 68.52 | Galway L-West Bay cove | 6/16/2003 | | | | | | | | | |
| 68.62 | Galway L-South Bay cove | 6/16/2003 | | | | | | | | | |
| 68.131 | Galway L-Adabar Inlet | 8/18/2003 | | | | | | | | | |
| 68.111 | Galway L-outlet | 8/18/2003 | | | | | | | | | |

| LNum | PName | Date | Zbot | Zsd | Zsamp | TAir | TH20 | QA | QB | QC | QD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68.71 | Galway L-Rohlings | 8/18/2003 | | | | | | | | | |
| 68.81 | Galway L-Maywood | 8/18/2003 | | | | | | | | | |
| 68.91 | Galway L-Harts | 8/18/2003 | | | | | | | | | |
| 68.101 | Galway L-Jeffers | 8/18/2003 | | | | | | | | | |

## Appendix B. New York State Water Quality 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

## APPENDIX C:
## SUMMARY OF STATISTICAL METHODS USED TO EVALUATE TRENDS

### *1. Non-Parametric Analyses*

Kendall tau ranking orders paired observations by one of the variables (say arranging water clarity readings by date). Starting with the left-hand (say earliest date) pair, the number of times that the variable not ordered (in this case clarity readings) is exceeded by the same variable in subsequent pairs is computed as P, and the number of times in which the unordered variable is not exceeded is computed as Q. This computation is completed for each ordered pair, with N= total number of pairs, and the sum of the differences S = S P-Q. The Kendall tau rank correlation coefficient **t** is computed as:

$$t = 2S/(N*(N-1))$$

Values for t range from –1 (complete negative correlation) to +1 (complete positive correlation). As above, strong correlations (or simply "significance") may be associated with values for t greater than 0.5 (or less than –0.5), and moderate correlations may be associated with values for t between 0.3 and 0.5 (or between –0.3 and –0.5), but the "significance" of this correlation must be further computed. Standard charts for computing the probabilities for testing the significance of S are provided in most statistics text books, and for values of N greater than 10, a standard normal deviate D can be computed by calculating the quotient

$$D= S\sqrt{18} /\sqrt{[(N(N-1)(2N+5)]}$$

and attributing the following significance:

$D > 3.29$ = 0.05% significance
$2.58 < D < 3.29$ = 0.5% significance
$1.96 < D < 2.58$ = 2.5% significance
$D < 1.96$ = > 2.5% significance

For the purpose of this exercise, 2.5% significance or less is necessary to assign validity (or, using the vernacular above, "significance" ) to the trend determined by the Kendall tau correlation. It should be noted again that this evaluation does not determine the magnitude of the trend, but only if a trend is likely to occur.

Parametric trends can be defined by standard best-fit linear regression lines, with the significance of these data customarily defined by the magnitude of the best fit regression coefficient ® or $R^2$). This can be conducted using raw or individual data points, or seasonal summaries (using some indicator of central tendency, such as mean or median). Since the former can be adversely influenced by seasonal variability and/or imprecision in the length and breadth of the sampling season during any given year, seasonal summaries may provide more realistic measures for long-term trend analyses. However, since the summaries may not adequately reflect variability within any given sampling season, it may be appropriate to compare deviations from seasonal means or medians with the "modeled" change in the mean/median resulting from the regression analyses.

When similar parametric and non-parametric tools are utilized to evaluate long-term trends in NYS lakes, a few assumptions must be adopted:

- Using the non-parametric tools, trend "significance" (defined as no more than appx. 3% "likelihood" that a trend is calculated when none exists) can only be achieved with at least four years of averaged water quality data. When looking at all summer data points (as opposed to data averaging), a minimum of forty data points is required to achieve some confidence in data significance. This corresponds to at least five years of CSLAP data. The "lesson" in these assumptions is that data trends assigned to data sets collected over fewer than five years assume only marginal significance.

As noted above, summer data only are utilized (as in the previous analyses) to minimize seasonal effects and different sampling schedules around the fringes (primarily May and September) of the sampling season. This reduces the number of data points used to compile averages or whole data sets, but is considered necessary to best evaluate the CSLAP datasets.

## *2. Parametric Analyses*

Parametric analyses are conducted by comparing annual changes in summer mean values for each of the analyzed sampling parameters. Summer is defined as the period from June 15 thru September 15, and roughly corresponds to the window between the end of spring runoff (after ice out) and start of thermal stratification, and the onset of thermal destratification. This period also corresponds to the peak summer recreational season and (for most lakes) the most critical period for water quality impacts. It also bounds the most frequent range of sampling dates for the majority of both the primarily seasonal volunteers and full time residents of CSLAP lakes.

Trends in the parametric analyses are determined by the least squares method, in which "significance" requires both a high correlation coefficient ($R^2>0.5$) and intra-seasonal variance to be lower than the predicted change (trend) over the period of sampling (roughly corresponding to ?y). Changes in water quality indicators are also evaluated by the two-sided t-test, in which the change (z statistic) in the mean summer value for each of the indicators by decade of sampling (1980s, 1990s, 2000s) is compared to the t statistic distribution within the 95% confidence interval, with the null hypothesis corresponding to no significant change.

# APPENDIX D: BACKGROUND INFO FOR GALWAY LAKE

| | |
|---|---|
| **CSLAP Number** | 68 |
| **Lake Name** | Galway L |
| **First CSLAP Year** | 1990 |
| **Sampled in 2002?** | yes |
| **Latitude** | 430134 |
| **Longitude** | 740501 |
| **Elevation (m)** | 259 |
| **Area (ha)** | 209.8 |
| **Volume Code** | 7 |
| **Volume Code Name** | Mohawk/Hudson Rivers |
| **Pond Number** | 563 |
| **Qualifier** | none |
| **Water Quality Classification** | B |
| **County** | Saratoga |
| **Town** | Galway |
| **Watershed Area (ha)** | 2392 |
| **Retention Time (years)** | 0.448789565 |
| **Mean Depth (m)** | 2.6 |
| **Runoff (m/yr)** | 0.508130081 |
| **Watershed Number** | 12 |
| **Watershed Name** | Mohawk River |
| **NOAA Section** | 5 |
| **Closest NOAA Station** | Saratoga Springs |
| **Closest USGS Gaging Station-Number** | 1321000 |
| **Closest USGS Gaging Station-Name** | Sacandaga River near Hope |
| **CSLAP Lakes in Watershed** | Canada L, Delta R, East Caroga L, Galway L, Leland P, Madison L, Mariaville L, Mountain L, Peck L, Pleasant L-F, Stewarts Landing, Summit L-S, W Caroga L |

## APPENDIX E:
## EVALUATION OF PHOSPHORUS DATA COLLECTED THROUGHOUT GALWAY LAKE IN 2003

The Galway Lake Association collected phosphorus samples from a number of lake and stream sites in 2003; the location of these samples are identified on Figure 33 below:

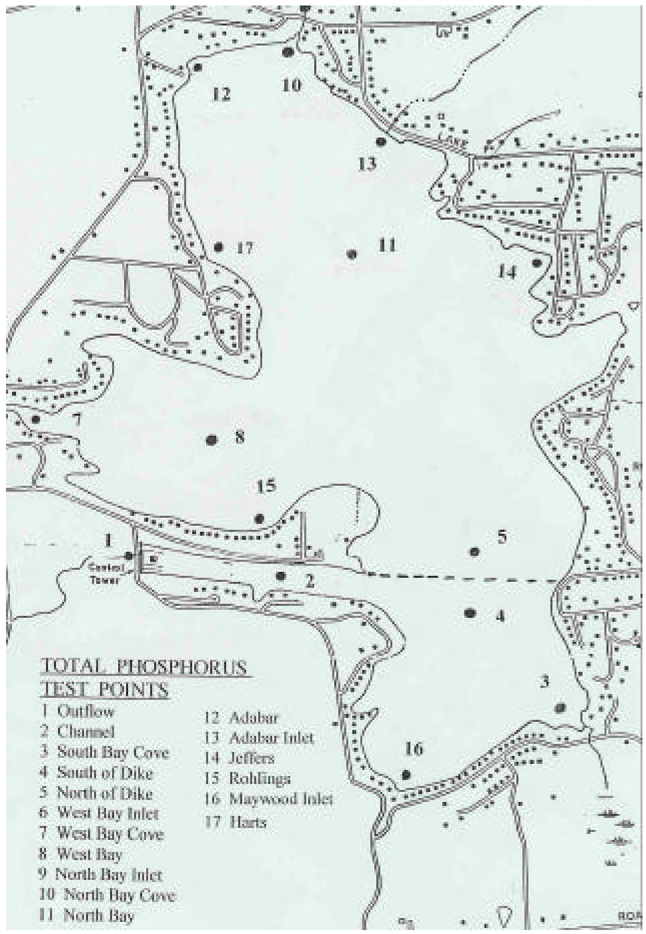


Figure 33- TP Sampling Locations on Galway Lake

Data from these samples are provided in Appendix A, under the site titles provided on Figure 33. These data were evaluated to assess the following:

(1) whether elevated TP readings were found at any of the sampling locations (surface or deepwater)
(2) how representative the main lake (CSLAP) sampling site is to characterize Galway Lake
(3) the approximate mass of phosphorus (in kg) in the lake
(4) how the mass of phosphorus in the lake changed during the summer (and the likely source of any increase in phosphorus loading to the lake)

(1) The majority of the spatial distribution of samples corresponded to the June $16^{th}$ sampling, when 15 sites were sampled. Surface phosphorus levels on this date ranged from 6.7 µg/l at Adabar along the northwest shore, and at Maywood along the southwest shore, to 16.6 µg/l at North Bay Cove at the mouth of the North Bay inlet (corresponding to the outlet from Lake Butterfield). The highest readings generally occurred at the mouth of inlets- the sample from the mouth of the West Bay Cove and

South Bay Cove inlets, which drains wetlands along the west and south side of the lake, had readings of 15.4 and 10.3 µg/l, respectively, although the mouth of the Adabar inlet had low readings. This results in higher TP readings in North Bay, since the North Bay cove represents loading from a large portion of the Galway Lake watershed (it can be estimated from the topographic maps that about 65-75% of the flow draining into North Bay enters through the North Bay Cove inlet- the nearshore data within the Bay indicates that the inlet contributes a high percentage of the nutrient load to the Bay).

Surface TP readings in the channel were slightly higher than those immediately north and south of the dike, but were probably not statistically different. No surface TP readings were found to exceed the NYS phosphorus guidance value (= 20 µg/l)- although the guidance was exceeded in some of the deepwater samples in the channel (see below), this guidance value only applies to surface water readings.

Deepwater nutrient data showed increasing phosphorus levels as the summer progressed at all sites sampled for surface and deepwater TP levels, and it is presumed that similar patterns would have been established at all sites corresponding to thermally stratified conditions (probably >12-15 feet). This pattern was generally observed in CSLAP sampling as well, although the difference was not as well defined. TP readings were highest in the deepwater samples in the channel; it is likely that the thermocline is closer to the lake surface in the channel, triggering earlier or more severe anoxia in the channel bottom (since there is probably less wind-induced mixing to drive the thermocline down)

(2) The main lake sampling site (closest to #5 on the map) is close to the average of the other two deepwater sites (south bay and channel) and the near shore sites. It is likely that the small difference between the main site and the other sites is not statistically significant. There does appear to be a difference between the data on site #5 and the CSLAP samples, although the 2003 data from site #5 and the historical CSLAP data from the primary sampling site (1990-2002) are very similar. Despite the differences between site #5 and the CSLAP site, it is likely that this site is useful in characterizing the lake.

(3) and (4) To determine the amount of phosphorus in the lake, several assumptions need to be made:

(a) the bathymetry for the lake is accurate, with approximate linear changes in elevation between contour lines
(b) the dike does not significantly alter the flow gradients or alter nutrient movement on either side of the dike
(c) sample locations represent the midpoint of polygons used to break up the surface of the lake into fourteen segments (nearshore samples are not true midpoint, but the boundary of the polygons are equidistant from adjacent points)
(d) the thermocline is assumed to be approximately 4 meters in depth, and fixed throughout the summer (while this is certainly not true, it is probably accurate enough for these calculations)
(e) TP variability between the base of the epilimnion (corresponding to the surface sample) and the deepwater sample (assumed 1.5 meters from the lake bottom) are exponentially related- this was been the case in other

lakes of similar depth- TP vs. depth relationships have been estimated from an exponential curve generated from the surface and depth data

Using these assumptions, and dividing the lake into three zones (north of dike, south of dike, and channel), the following data can be generated:

| Zone | % Lake Area | %Lake Volume | %Area <4m | %Area 4-5m | %Area 5-6m | %Area >6m |
|---|---|---|---|---|---|---|
| North | 80 | 79 | 53 | 21 | 19 | 8 |
| South | 17 | 18 | 50 | 10 | 24 | 17 |
| Channel | 3 | 3 | 45 | 15 | 15 | 26 |

…and the resulting phosphorus levels in each zone can be estimated as follows, for the samples collected on June 16th, July 14th, and August 18th:

| Zone | %Lake Volume | Pmass June 16 | Pmass July 14 | Pmass August 18 |
|---|---|---|---|---|
| North | 79 | 59 kg | 66 kg | 78 kg |
| South | 18 | 12 kg | 20 kg | 19 kg |
| Channel | 3 | 2 kg | 6 kg | 5 kg |
| TOTAL | 100 | 73 kg | 92 kg | 102 kg |

These data can be used to estimate the percentage of phosphorus found in the epilimnion and hypolimnion during these sampling sessions, assuming that the thermocline (dividing the epilimnion and hypolimnion) is fixed at a depth of 4 meters:

| Portion of Lake | %Lake Volume | %Pmass June 16 | %Pmass July 14 | %Pmass August 18 |
|---|---|---|---|---|
| Epilimnion | 50 | 48% | 36% | 27% |
| Hypolimnion | 50 | 52% | 64% | 73% |
| TOTAL | 100 | 100% | 100% | 100% |

These data indicate that phosphorus is slightly more concentrated in the channel than in the other parts of the lake, but this follows from the previous discussion, since it appears that phosphorus may be collecting in the channel due to increased nutrient release from sediments underlying anoxic water. The June data suggest that thermal stratification either has only started to stabilize, or that anoxia (and differential spatial (vertical) changes in nutrient levels) has only just begun to occur. It is expected that the change in surface loading of nutrients is minimal over this period, since this corresponds to relatively low overland flow, although some additional groundwater nutrient loading (from more extensively used septic systems) may be expected, and some nutrients drop from the epilimnion to the hypolimnion when algae growing at the lake surface dies and drops into the bottom of the lake. However, it is likely that at least some of the 30kg increase in nutrient loading during the summer may be attributable to anoxic release of nutrients from the lake bottom. This suggests that this might be a significant source of phosphorus to the surface waters of the lake after lake turnover, although it does not appear that this could be evaluated as part of CSLAP, since turnover probably occurs after the sampling season ends.