Darrin Fresh Water Institute

A Research Center of Rensselaer Polytechnic Institute

THE 2008 LAKE GEORGE LAY MONITORING PROGRAM

by

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INTRODUCTION

The Lake George Lay Monitoring Program registered its 29th year in 2008. There were a few changes made in the location and number of sites measured due to the loss of volunteers. Overall, lay monitors collected 65 Secchi depth and surface water temperature readings from Lake George. In this report, 92 data measurements for Secchi depth and surface temperature taken by the Darrin Fresh Water Institute (DFWI) during the FUND for Lake George sponsored offshore chemical monitoring program were used to supplement the data set.

The goal of the Lay Monitoring Program continues to be the collection of a large amount of physical lake data over a long period of time through the voluntary efforts of Lake George basin residents. This allows for long-term monitoring of changes in physical characteristics of the lake. A beneficial side-effect of the Lay Monitoring Program has always been the opportunity to educate basin residents with hands-on experience about lake water quality and techniques used to study freshwater ecology.

The basic water quality parameters measured by all lay monitors included water temperature and transparency (Secchi depth). Weather and lake surface conditions were also reported. The lay monitors provided a great service by sampling the lake basin weekly, and supplying information that would not otherwise have been collected by the Darrin Fresh Water Institute.

SAMPLING SITES AND COLLECTION METHODS

Overall, sixteen separate areas of the lake were observed, with monitored sites spread throughout the lake. Measurements were taken primarily during the time of summer thermal stratification, mid-June to October, with additional readings taken in May and November. Five lay monitor sites from Cooper Point to the Narrows and four DFWI sites at Tea Island, Dome Island, Basin Bay and Northwest Bay covered the southern basin of Lake George. Three lay monitor sites and four DFWI sites from French Point in the Narrows to Windmill Point in the north covered the northern section of the lake. Figure 1 is a map of site locations and Table 1 is a list of lay monitors with their respective sites.

Figure 1. Location of the sampling sites on Lake George for 2008

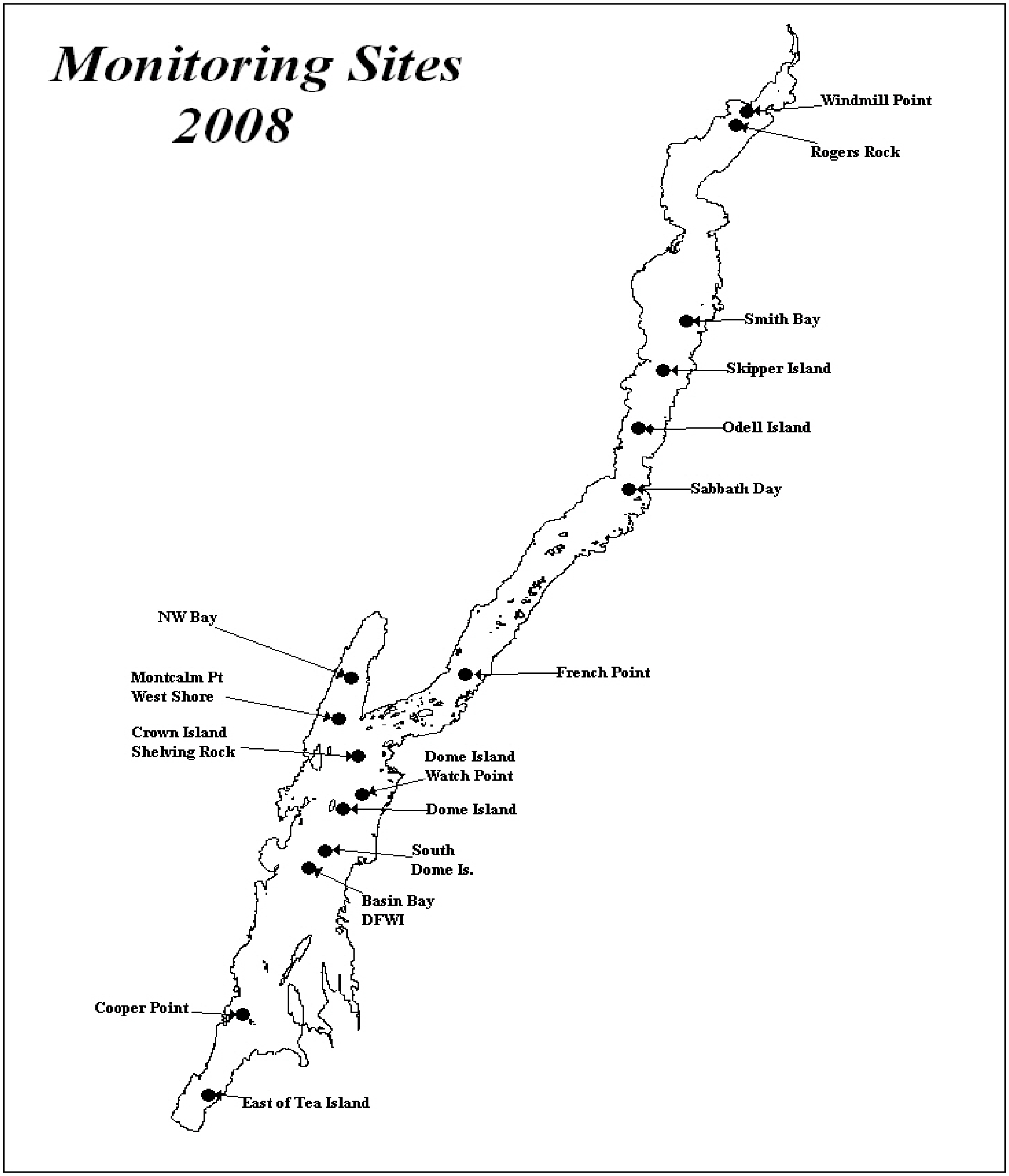


Table 1. DFWI and Volunteer Lay Monitor sites, Secchi depth and Surface temperature measurements, summer months only.

Monitor	Site No.	Site Name	Miles from LG Village	Average Summer Secchi (m)	Average Summer Temperature (C)
DWFI	1	East of Tea Island	1.45	7.9	20.1
Danese	2	Cooper's Point	3.10	7.4	22.3
DFWI	3	Basin Bay	7.50	8.1	20.3
Desantis	4	South Dome Island	8.80	6.2	24.0
DWFI	5	Dome Island	9.25	8.3	20.0
Summerhayes	6	Dome Is.:Watch Pt.	10.50	9.5	23.1
Summerhayes	7	Crown Is:Shelving Rock	11.25	9.5	23.0
Summerhayes	8	Montcalm Pt:West Shore	11.75	9.5	23.4
DFWI	9	Northwest Bay - Mid Bay	12.25	8.7	20.8
DFWI	10	French Point	18.25	9.7	21.3
DFWI	11	Sabbath Day Point	20.10	10.0	21.4
Harmon	12	Odell Island	21.50	8.6	24.6
Harmon	13	Skipper Island	23.00	9.3	23.8
DFWI	14	Smith Bay	24.25	10.5	22.2
DFWI	15	Roger's Rock	30.40	10.0	22.6
McLaughlin	16	Windmill Point	30.75	8.0	22.3
		Lakewide Average:		8.8	22.2

All lay monitors were equipped with a calibrated thermometer, Secchi disk, and data sheets. They were asked to record their observations and measurements of surface water temperature, Secchi depth and weather conditions -- wind, lighting, air temperature and precipitation -- on a weekly or biweekly basis during the months of June through September. Secchi depth is a measurement of water clarity determined by lowering an eight-inch diameter, black and white Secchi disk into the water until the viewer can no longer see it and recording the depth. Data were to be collected between 10 A.M. and 2 P.M. when the sun was as nearly directly overhead as possible. When convenient, measurements were to be limited to days with calm, clear weather in order to reduce the influence of waves and wind on the Secchi depth readings. Realistically, ideal conditions rarely occur, thereby affecting the results of the measurements.

RESULTS

Lay monitors recorded 65 Secchi depths and corresponding surface water temperatures, 11 less than in 2007 (Eichler et al., 2007). DFWI personnel, starting May 7th and ending November 5th, 2008 provided an additional 92 readings.

Temperatures

Surface water temperatures ranged from a spring low of 7.4^{o}C (45.3^{o}F) on April 22nd to a high of 26.0^{o}C (78.8^{o}F), occurring August 12th by Odell Island. A late autumn low of 10.9^{o}C (51.6^{o}F) was reported in early November. The average surface water temperature for Lake George during the 2008 sampling season was 18.8^{o}C (65.8^{o}F), a 0.6 degree centigrade decrease from the mean temperature for 2007 (Eichler et al., 2008). During the summer months, very little mixing occurs between the upper and lower layers of water in the open lake, allowing the upper layer to reach much warmer temperatures. Figures 2 and 3 demonstrate the changes in lake surface water temperature in 2008 for both basins in Lake George.

Figure 2. Water temperature records for the South basin in 2008

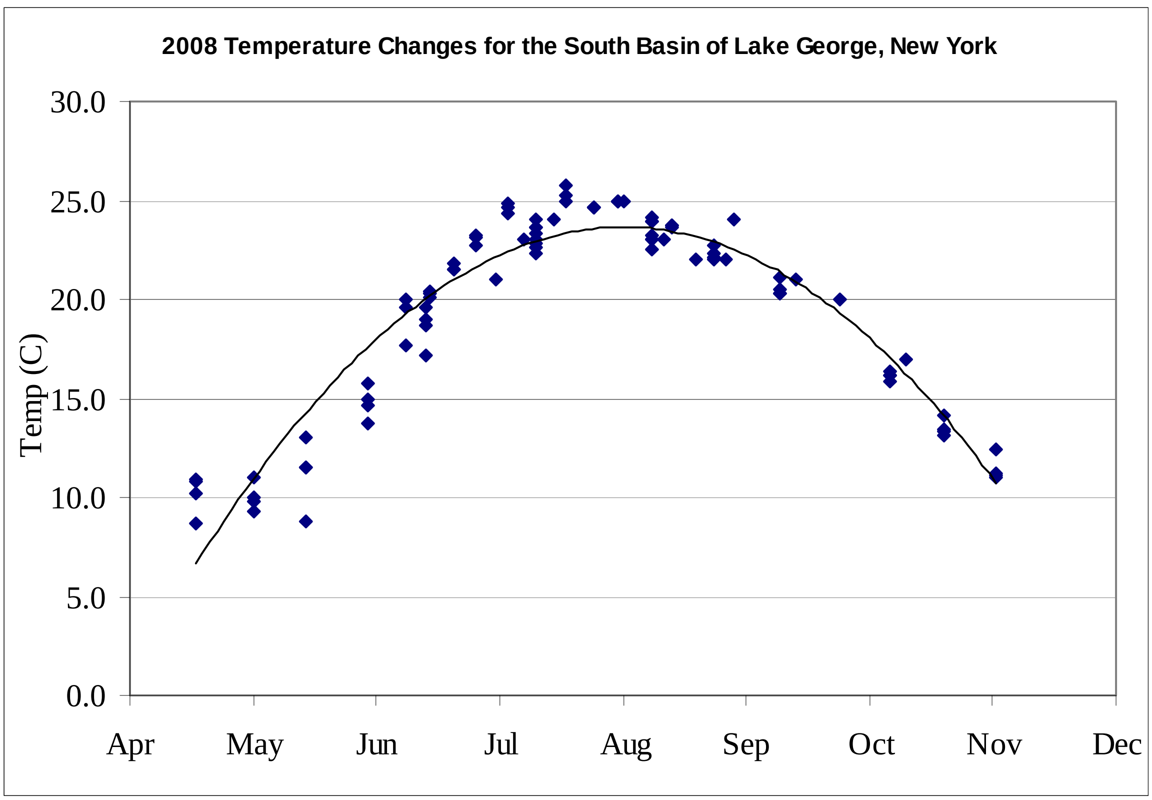


Figure 3. Water temperature records for the North basin in 2008.

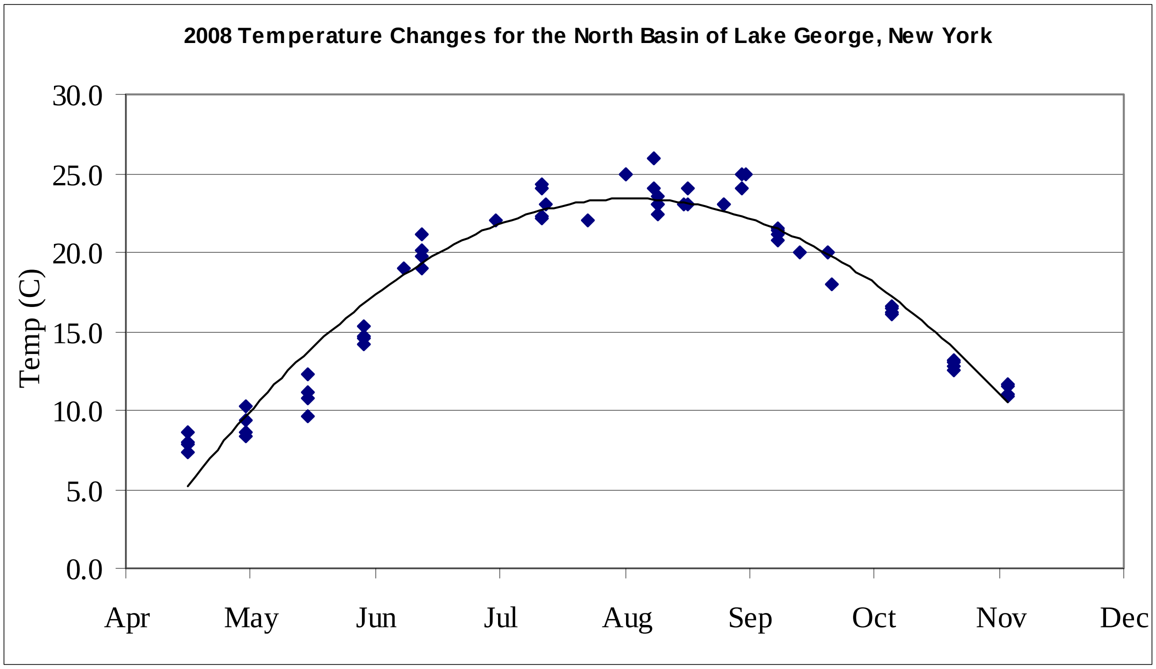
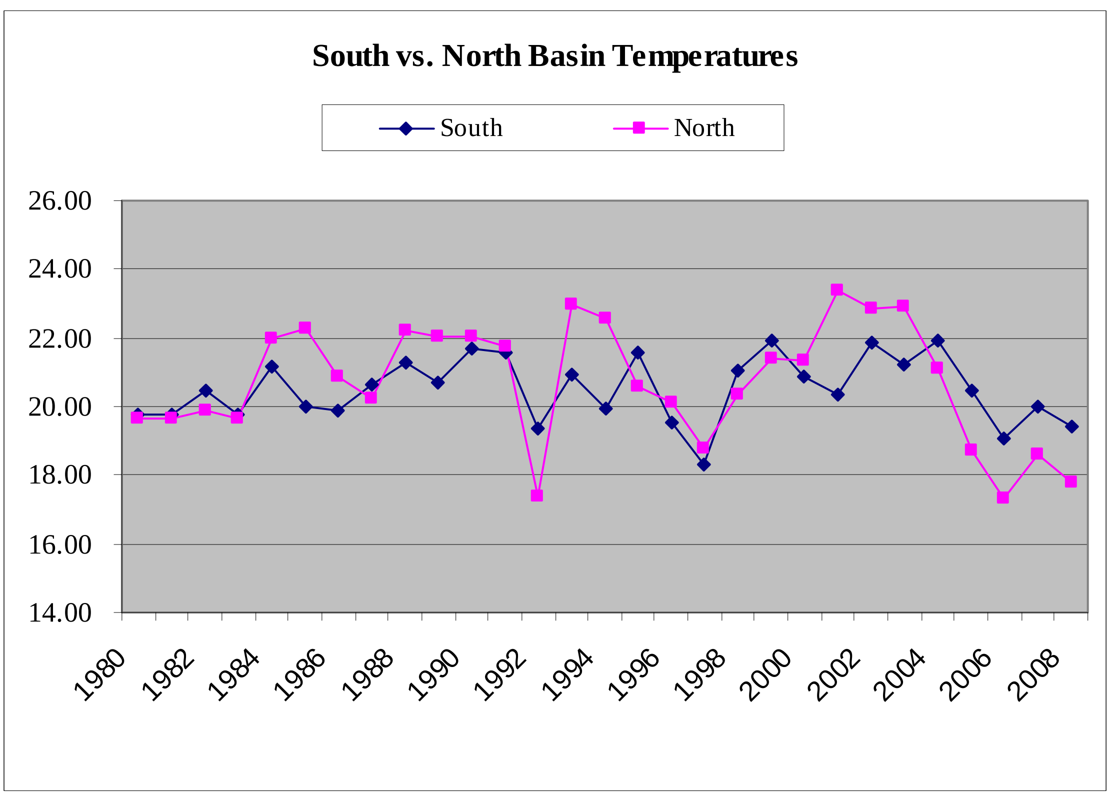


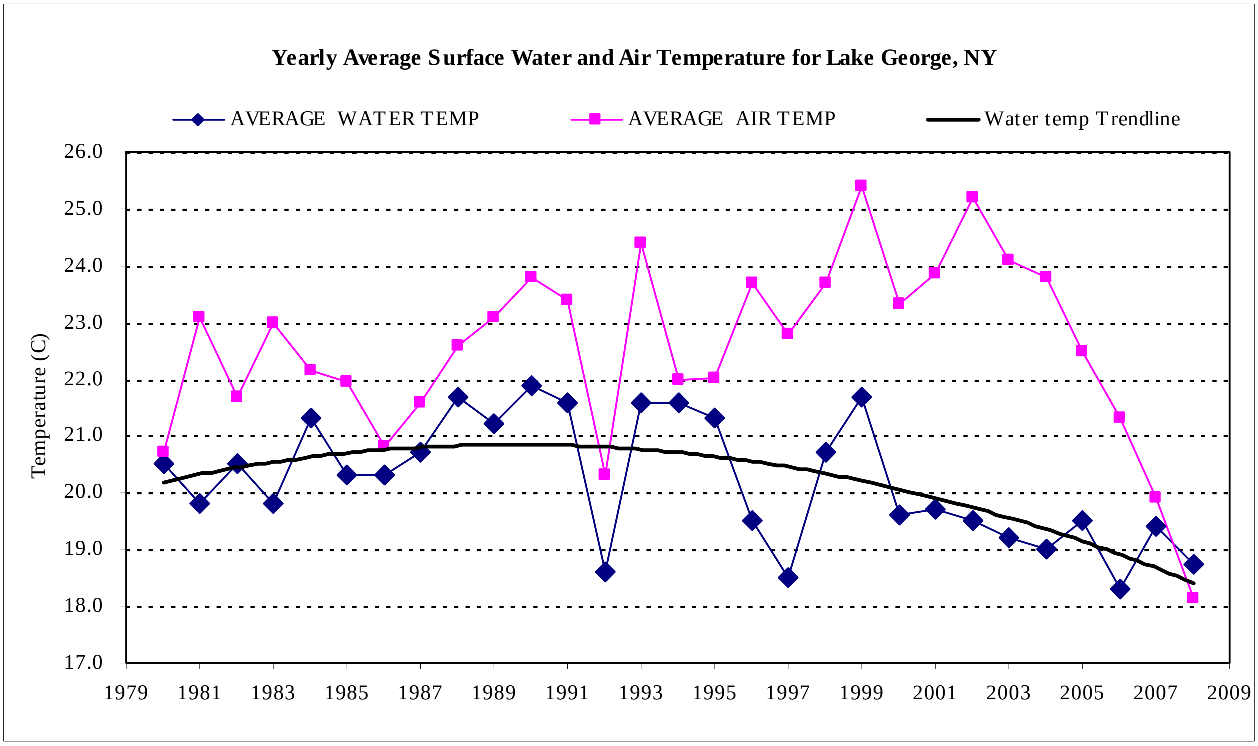
Figure 4. Historical South versus North Basin temperature comparisons.



Surface water temperatures in 2008 were generally lower than long-term averages, 0.6 degree Celsius less than last year, with the south basin having warmer temperatures than the north basin. Figure 4 does not indicate a consistent relationship with one basin being warmer than the other, although the South basin, for the fifth year, is warmer than the North basin. The south has registered warmer temperatures in 13 of 29 years (45%) while the north has registered warmer temps in 16 of 29 years (55%). The difference in mean summer basin temperatures continues to be 3.0 degrees Celsius or less. In more than half (62%) of the 29 years, the difference is 1.0 degree Celsius or less.

Also of interest is a comparison of air and surface water temperatures. Air temperature data is more variable, since the time of day can make a large difference. Surface water temperatures are also affected by time of day although water temperature tends to be more stable. For the first time, in 2008 the average air temperature was lower than the average water temperature. Trend lines for the temperatures from 1980 to 2008 are presented in Figure 5. For further comparison, the CSLAP program started on Lake George in 2004, shows slightly warmer and increasing temperatures for both air and water: in 2004, average air temperature was 22^0 C and water temperature was 16^0 C. In 2005, air temperature was 29^0 C and water temperature was 20^0 C. To have truly comparable data for temperatures, the time of day data is recorded would need to be consistent and more frequent collection is probably necessary.

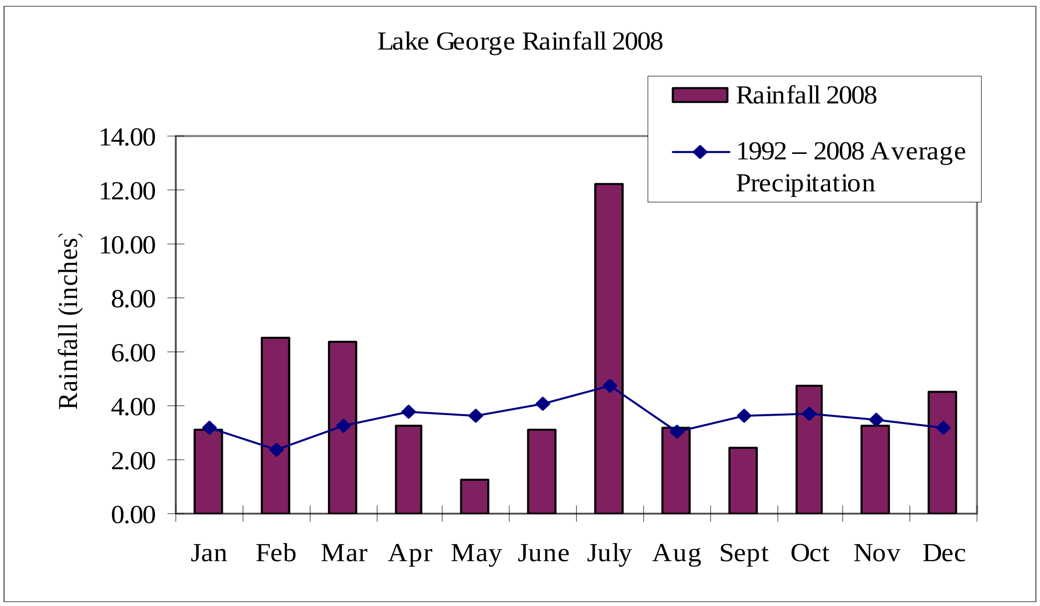
Figure 5. Yearly Air and Surface Water Temperature averages.



Rainfall

The amount of rainfall the Lake George region received in 2008 is compared to yearly averages in Figure 6. The overall total rainfall for 2008 was 54.0 inches, 13.2 inches more than the 40.8 inches that occurred in 2007. The average monthly rainfall for 2008 was 4.5 inches, 1.1 inches more than the 16 year (1992 to 2007) average of 3.4 inches per month. Major rainfall and storm water run-off increases sediment and nutrients in the water column, which in turn encourages the growth of algae and phytoplankton. The combination of increased sediment load and algal production reduces water clarity.

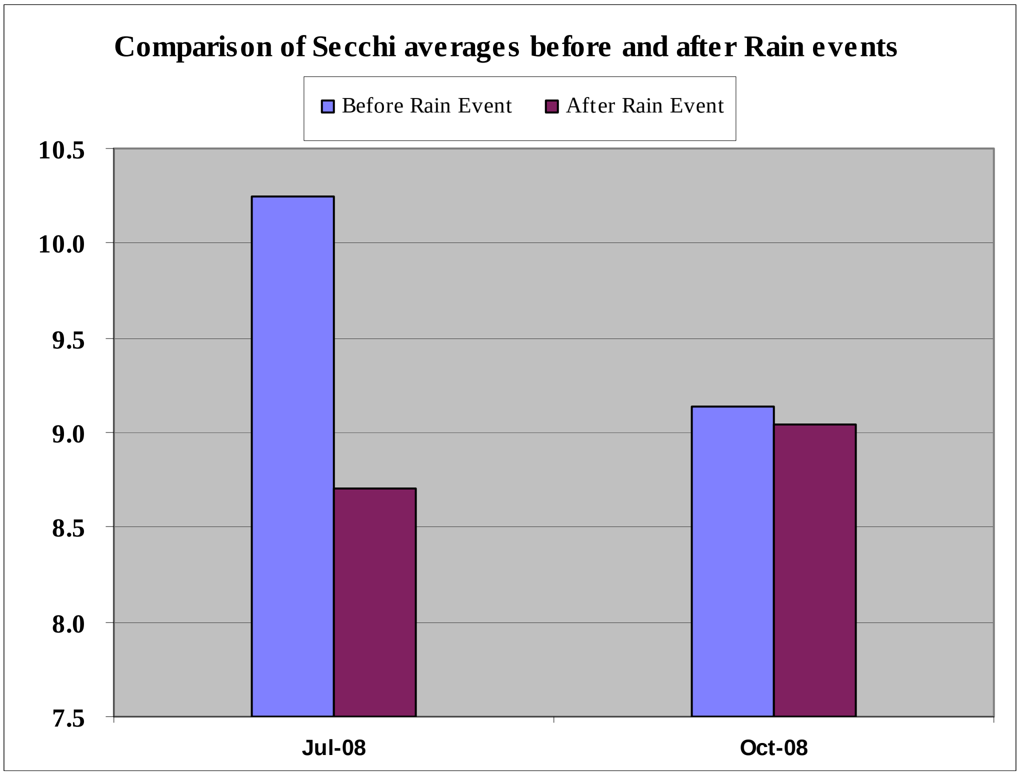
Figure 6. Lake George monthly rainfall as compared to yearly averages**.**



Secchi data

The Secchi disc data collected in 2008 by the lay monitors and DFWI shows water transparency ranging from a minimum of 5.8 meters (19.0 feet) at Tea Island in the month of April, to a maximum of 14.0 meters (45.9 feet) at Smith Bay on September 11th. The 2008 whole lake Secchi average decreased to 8.6 meters from 9.2 meters in 2007. An inverse relationship between rainfall volume and Secchi transparency generally has been demonstrated: when rainfall increases, Secchi readings decrease. There were two major rain events this summer and fall: July 23rd (9.1 inches), and October 25th (2.3 inches). Figure 7 compares the Secchi averages before and after the rain event. For both events, the inverse relationship is noted, although the difference is minimal for the October event.

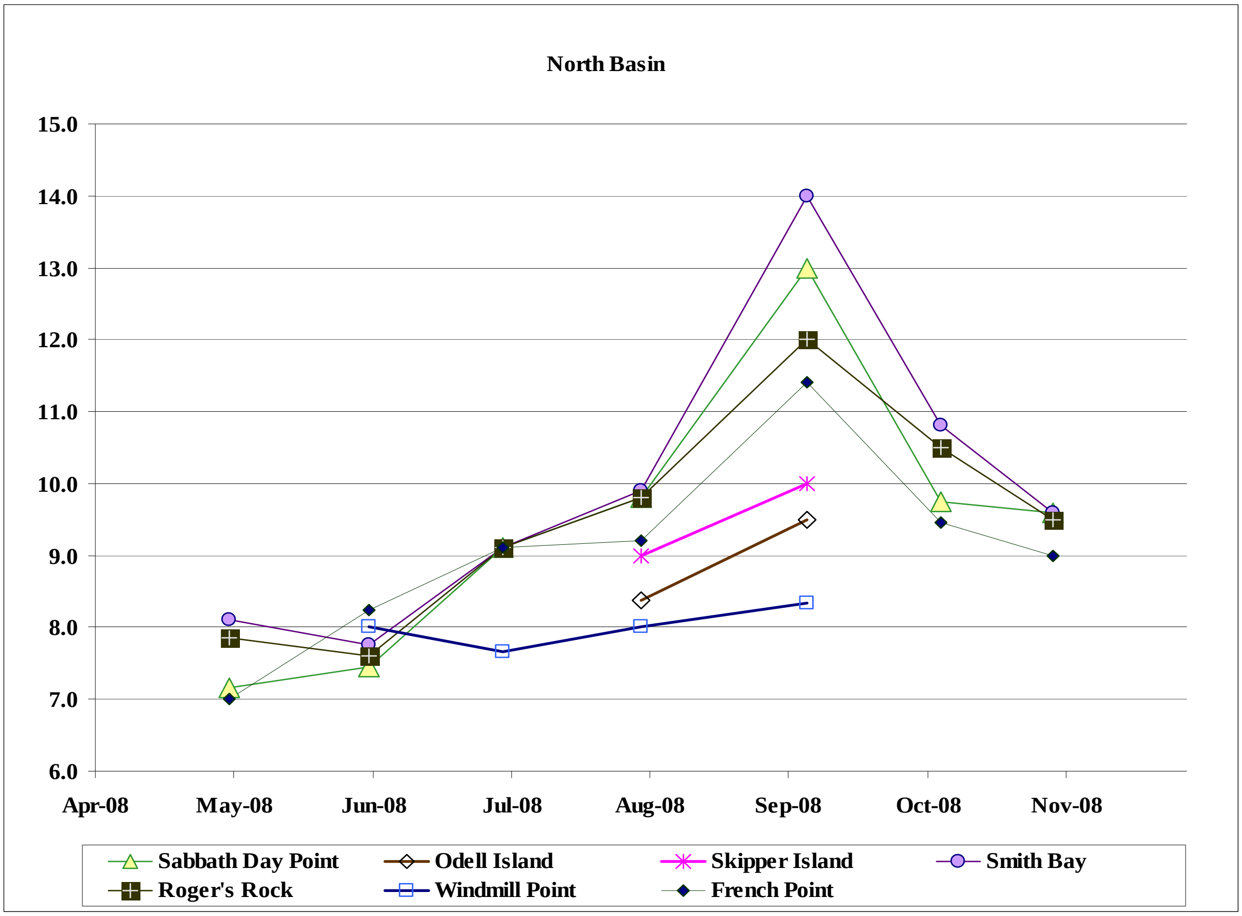
Figure 7. Comparison of Secchi averages before and after a rain event.



Another phenomenon to consider is the spring clearing phenomenon. In this region snowmelt generally occurs in April, flushing sediment and nutrients into the lake, spurring algal growth. Phytoplankton start to grow, causing a temporary turbidity in the water. Zooplankton start grazing on the phytoplankton soon after, thereby improving the water clarity. Figures 8 and 9 are detailed Secchi graphs for the sampling season, using monthly averages at a particular site. Note the low values in the beginning of May, followed by an increase by mid-June. A decrease occurs as a storm event hits in late July.

Figure 8. South Basin Secchi readings.

Figure 9. North Basin Secchi readings**.**



The trend of increasing light transparency (Secchi depth) from the southern margin of Lake George to the outlet in Ticonderoga has been documented by lay monitors over the duration of the program. Average Secchi depth for each site is plotted against distance from Lake George Village in Figure 10. This year, the graph shows a continuation of this trend. Average readings around Dome Island occurred this summer, although just south of the island were the lowest. In addition, at Windmill Point, the furthest point north, some very low values were also recorded. The lake bottom in this area is made up of fine-grained clay sediment, similar to Lake Champlain. Resuspension of sediments from the lake bottom is responsible for turbid water conditions periodically observed in this area. In 2003 the sediment plume had extended to Rogers Rock, a site with typically excellent clarity, and for the first time the north basin average (9.3 m) was lower than the south basin average (9.5 m). The second time this occurred was 2007: the average Secchi depth in the south basin was 9.3 meters and the average in the north basin was 9.1 meters. The average yearly Secchi depths (1980 to 2008) for the South basin is 8.4 m, the North basin is 9.3 m. This year the south basin transparency was right at the average at 8.4 m.The north basin Secchi average is 9.0, thereby continuing the trend of increasing light transparency from south to north. Figure 11 shows the trend since 1980 of south versus north basin differences. Three exceptions occurred: in 1996 when both the south average and north average was 9.0 meters, and 2003 and 2007 as previously described.

Figure 10. Average water transparency in miles from Lake George Village for 2008.

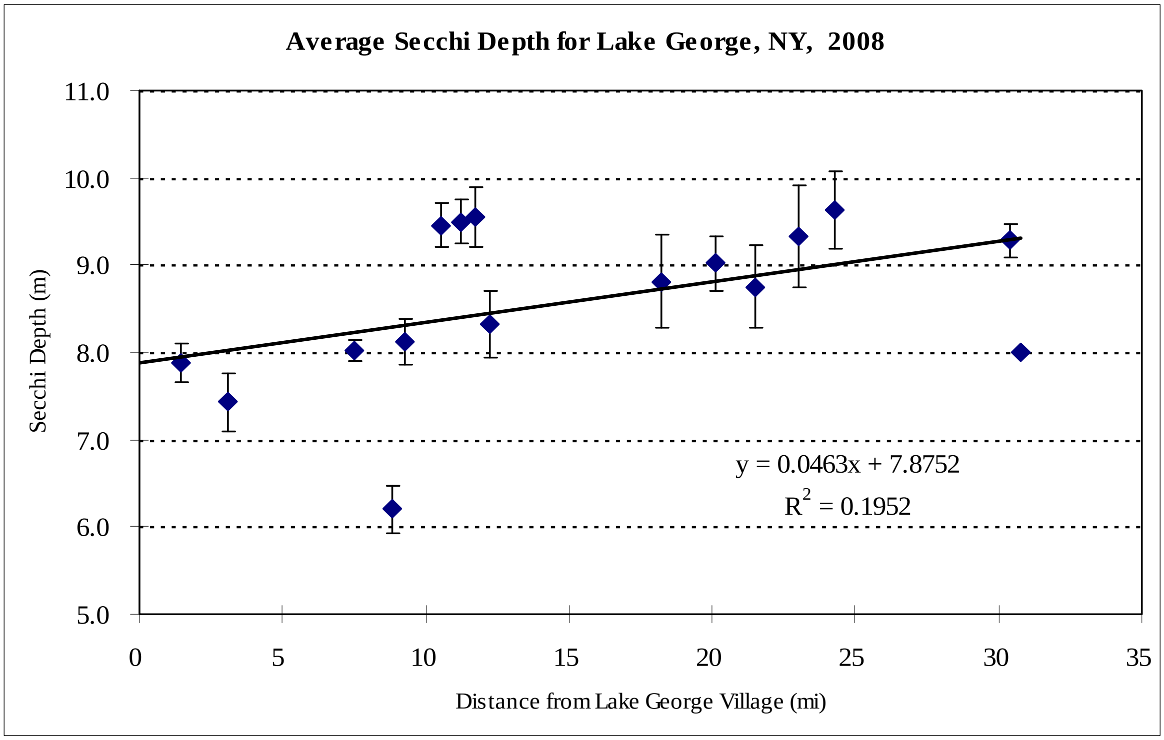
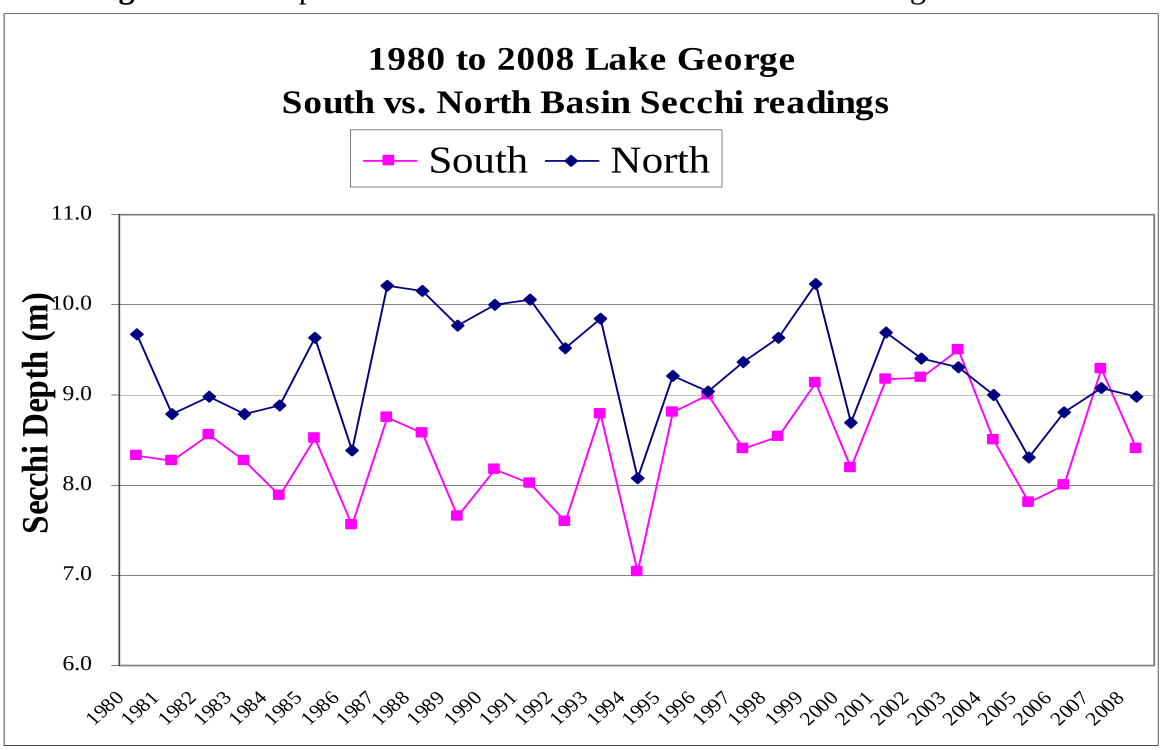


Figure 11. Comparison of South and North Basin Secchi readings.

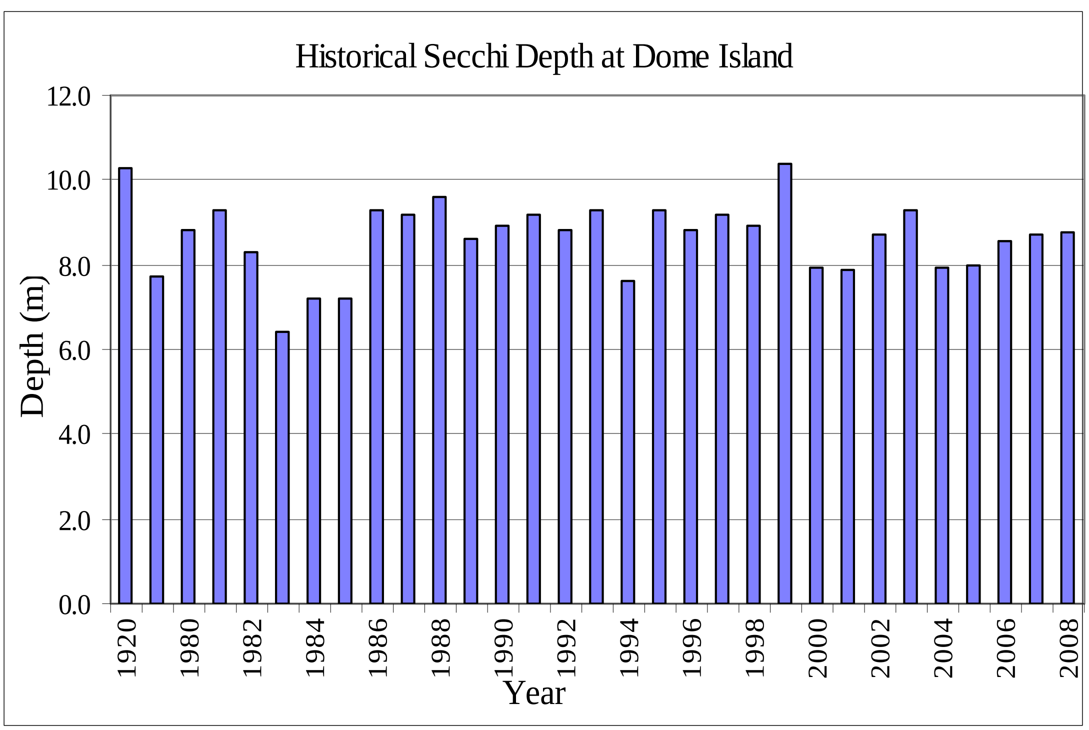


Accurate statistical analyses on the lay monitors' data are difficult due to the amount of variability in sampling conditions and differing number of volunteers and sites sampled each year. Secchi readings can be influenced by many factors. Poor weather conditions, choppy water, even eyesight may give different readings from one day to the next. Among our field technicians, those with better eyesight see the disk at a greater depth than those with glasses. Regardless, the data is important for long-term assessment of Lake George.

Dome Island

The earliest transparency data for Lake George (Needham et al., 1922) is a single value (10.3 m) taken at Dome Island in 1920 for a biological survey. The average annual Secchi readings on record for the Dome Island area are presented in Figure 12. In the past 29 years, 61 single measurements have exceeded 10.3 m, one as high as 12.8 m (June 28, 1981). Due to the variable nature of Secchi readings, only averages of data collected by lay monitors and DFWI for each year are graphed. Since most lay monitor data were taken during the summer months, all Secchi values averaged were from June through September's measurements.

Figure 12. Comparison of historical Secchi readings at Dome Island.



Trophic State Index

Figure 13 is a plot of trophic state indices comparing the two basins. The Carlson trophic state index (TSI) relates to the amount of nutrients available for consumption by various organisms in the lake. A lake with a high level of nutrients is generally known as eutrophic; conversely, a lake with low levels of nutrients and aquatic biota is called oligotrophic. The term mesotrophic is used to describe all lakes that fall between the two extremes. The index describes all shades of the trophic process on a scale ranging from 0 to 110 (0 being highly oligotrophic). A decrease of 10 points on the TSI scale (e.g., from 30 to 20) represents a doubling of Secchi depth in meters (e.g., from 9 to 18 meters). Chlorophyll and total phosphorus values can also be applied to the TSI model.

Figure 14 is an updated chart relating the Carlson trophic state index values to the classic definitions of trophic states (Natural Resources Facts, 96-2, 1996).

Figure 13. Trophic state indices for Lake George in 2008.

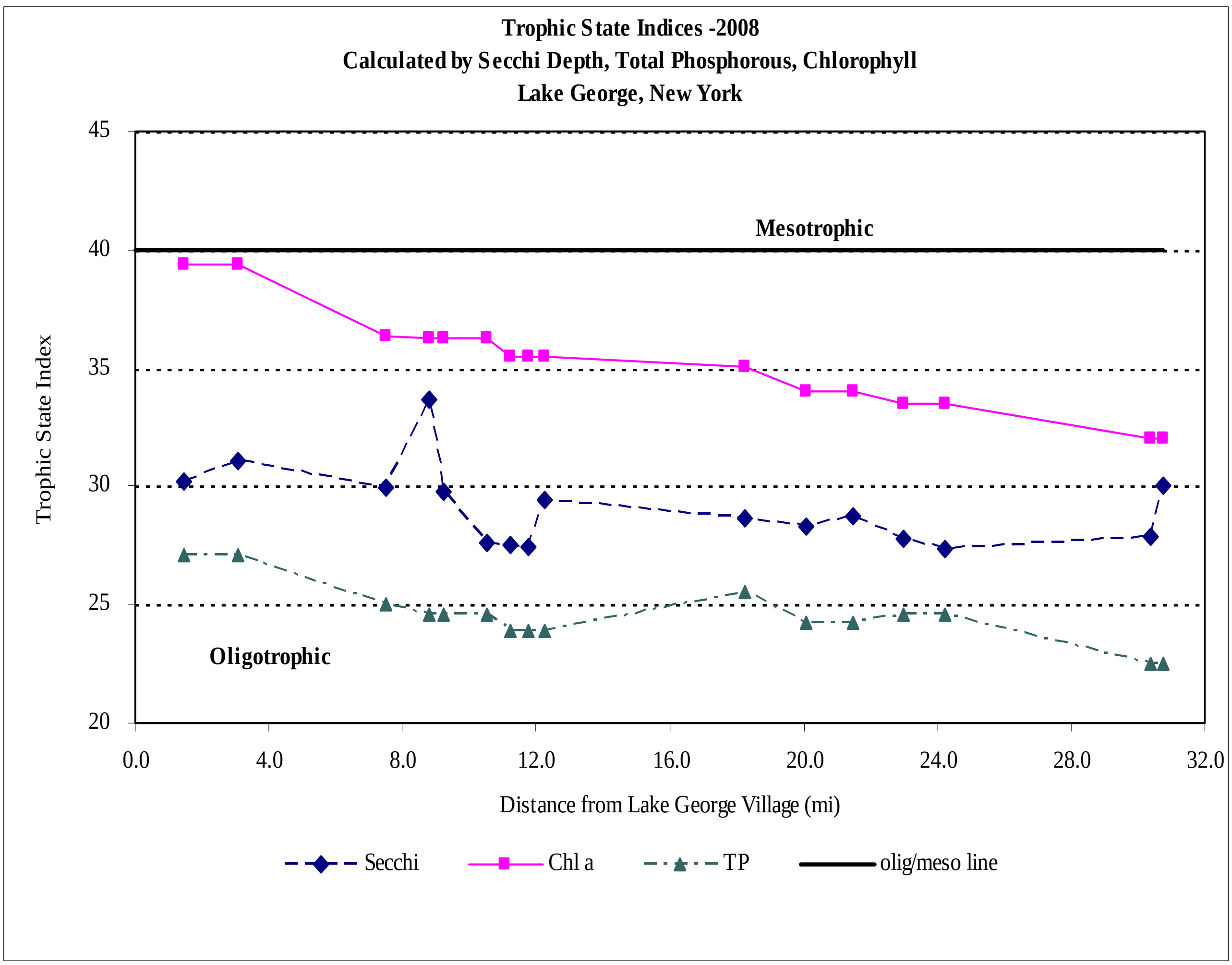
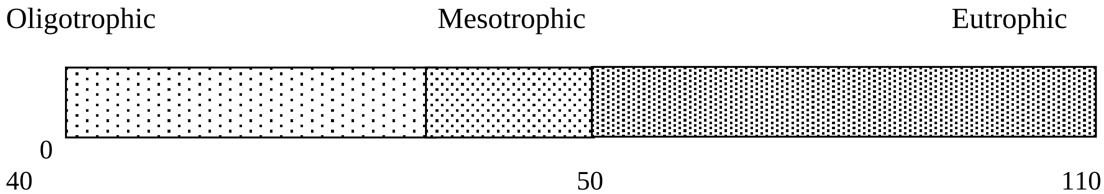


Figure 14. Carlson's trophic state definition chart.



TSI values were generated using the lay monitors Secchi readings and DFWI chlorophyll and total phosphorus data. Using the updated Carlson's Index, chlorophyll, Secchi transparency and total phosphorus content support a classification of oligotrophic or nutrient-poor for the entire lake. The area in the south known as the Caldwell basin, which runs from the steel pier in the village northward a distance of four miles to Diamond Island, typically demonstrates the highest TSI readings in the lake basin, along with south of Dome Island and Windmill Point. Higher total phosphorus and chlorophyll and lower Secchi readings have historically been found in the south basin. Elevated nutrient levels and reduced transparency in Lake George have been attributed to urbanization and resultant storm water runoff and its associated pollutants (Eichler et al., 1993; Sutherland et al., 1983). This section of the lake basin has the greatest amount of urbanization.

CONCLUSIONS

The results of the 2008 Lake George Lay Monitoring Program support long-term trends. These include:

- Greater Secchi transparency in the North basin than the South basin.
- Consistent differences in Secchi depths between basins.

The source of the elevated levels of nutrients in the south basin has been the subject of a number of studies (Gibble, 1974; Ferris and Clesceri, 1975; Aulenbach, 1979; Wood and Fuhs, 1979; Sutherland et al., 1983; Stearns and Wheler, 2001; and Dillon, 1983). Although estimates differ on the precise amounts of nutrient loading from various sources, all investigators agree that atmospheric deposition (rain, snow, and dryfall), erosion, and urban runoff are the major sources of nitrogen and phosphorus to the lake. In addition to these plant nutrients, erosion and urban runoff are the leading causes of sedimentation in Lake George. Urban runoff includes rainwater that washes tons of road sand and salt into the lake. This is particularly evident at the deltas of English, Finkle, East, West and Hague Brooks. Erosion, both natural and instigated, occurs all around the basin where bare soil is exposed to the elements. Wind, rain and snowmelt all contribute to an increase in suspended solids and, therefore, a decrease in water transparency in Lake George.

Erosion and urban runoff may be mediated in a variety of ways, including: sediment traps, planting a buffer zone of native plants in shoreline and riparian zones, replacement of impermeable with permeable surfaces, reduction in the amount of road sanding, and a host of other methods dependent on the type and quantity of surface runoff. It should be the responsibility of all persons interested in the water quality of Lake George to press for more effective runoff controls. For more information on how you can help reduce unwanted nutrients, refer to Diet for a Small Lake, a New York State Department of Environmental Conservation and Federation of Lake Association (FOLA) publication (www.NYSFOLA.org/diet).

ACKNOWLEDGMENTS

The staff of the Darrin Fresh Water Institute would like to thank all of this year's Lay Monitors for a job well done. The Lake George Lay Monitoring Program continues to provide an enormous amount of valuable data in a very cost-effective manner. Results of this program support conclusions generated through this and other DFWI research activities whose overall goal is protection of the water quality of Lake George. You should be justifiably proud of your efforts.

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