EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Winnisquam Lake, Laconia** this year! Your monitoring group sampled the Mohawk Island deep spot **twice** this year, the Pot Island deep spot **three** times this year, and the Three Island deep spot **once** this year.

We congratulate your group for sampling your lake this summer. However, we strongly encourage your monitoring group to sample **additional** times each summer. Typically, we recommend that monitoring groups sample the deep spot **three times** per summer (once in **June**, **July**, and **August**). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability, and your monitoring group's goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake at least once per month during the summer.

If you are having difficulty finding volunteers to help sample or to travel to one of the laboratories, please call the VLAP Coordinator and DES will help you work out an arrangement.

There have been several non-point source remediation projects that DES has been involved with along the Lake Winnisquam shoreline and watershed. These projects involve Ahern State Park in Laconia, stormwater improvement projects for Maple Circle and Gray Road in Sanbornton, the Black Brook sub-watershed, and U.S. Rt. 3/NH Rte 11/11A road construction.

Ahern State Park, Laconia

On December 10, 2002, Department of Environmental Services (DES) personnel met with the City of Laconia and the Ahern State Park Advisory Committee to discuss the water quality at Ahern State Park Beach. As a result of that meeting, DES developed and carried out a water quality monitoring plan for Ahern State Park, both at the beach area and in the Governor Park Stream watershed in Summer 2003. The purpose of the monitoring was to identify and quantify sources of *E. coli* bacteria to the beach area.

DES conducted a sanitary survey of the Governor Park Stream watershed. In addition, DES conducted multiple rounds of dry weather and wet weather sampling. Potential bacteria sources were identified, documented, and mapped.

It was determined that sources of *E. coli* bacteria originating from the Lakes Region Correctional Facility grounds is the probable cause of water quality standard violations at Ahern State Park Beach and in Governor Park Stream during and immediately after stormwater runoff events. The primary suspected source was leakage and exfiltration from old clay sewer pipes.

In 2005, DES, the Department of Corrections (DOC) and the Department of Resources and Economic Development (DRED) agreed to a beach advisory plan that allowed beach advisory postings to occur based upon the site-specific relationship of rainfall and bacteria loading at the beach. A rain gage was installed at the DES Air Monitoring Station located at the DOC Lakes Region Facility. Following a 0.25 inch rainfall event, an email notification was automatically generated and distributed to DES, DOC, and DRED. Beach advisories were then posted by DRED at the site and by DES on the Beach Program website. This agreement has continued through 2007.

In April 2005, the U.S. Environmental Protection Agency (EPA) issued an Administrative Order (AO) to DOC for the discharge of pollutants to Governor Park Stream without a National Pollution Discharge Elimination System (NPDES) permit. The AO required DOC to develop and implement an EPA-approved plan for identifying and eliminating the sources of unauthorized pollutants that discharge into Governor Park Stream. DOC hired Hoyle, Tanner and Associates, Inc. (HTA) to assist with fulfilling the requirements of the AO. HTA completed their investigation and issued a summary report in November, 2005 which recommended additional sampling and testing, to determine the origin source of the bacteria and several sanitary and storm water system repairs.

In 2006, HTA and DES conducted several rounds of additional stormwater testing, as required by EPA's AO. The additional testing focused on distinguishing between overland or subsurface bacteria loads using stormwater simulation events and EPA's Illicit Dishcarge, Detection and Elimination (IDDE) protocol.

The HTA draft report dated September 27, 2006 specifies that the most recent testing along with supporting evidence from the closed circuit television inspection, dye flood testing and smoke testing of the sanitary and stormwater system, indicates that the primary contributor of *E. coli* bacteria to the DOC stormwater system originates from wildlife populations, including Canada Geese. *E. coli* bacteria is picked up and transported by overland stormwater flow to the subsurface stormwater system where it discharges to Governor Park Stream and eventually Lake Winnisquam.

EPA completed a review of the above findings in January, 2007 and found that material in the September 27, 2007 Supplemental Sampling and Testing Report, prepared by HTA, was difficult to follow and did not adhere to EPA protocols. As a result, EPA requested a meeting to discuss specific concerns outlined in the January, 2007.

In March, 2007, DOC, DES, HTA and EPA met to discuss EPA's concerns about the September 27, 2007 report. Based upon this meeting, it was agreed that the E. coli bacteria originated from overland flow, captured in the stormwater system, and discharged to Governor Park Stream. As a result, DOC agreed to several measures towards designing and implementing stormwater runoff control including, feasibility analysis, stormwater treatment design, administrative reporting, and additional construction-phase engineering services. In addition, DOC agreed to repair a section of the sewer line adjacent to the stormwater infrastructure. The sewer line repair was completed in June, 2007. DOC secured the necessary funding to complete the stormwater design work in November, 2007. As a result, DOC did not meet EPA's September 30, 2007 deadline for submittal of design plans and specifications for the stromwater runoff controls for the DOC facility.

In a November, 2007 EPA revised the deadline schedule to June 21, 2008 to allow DOC to complete the implementation of the recommended alternatives to eliminate the sources of unauthorized pollutants in the DOC's stormwater system discharge to Governor Park Stream.

In response to the EPA AO, the NH Governor and Council approved more the 1 million dollars to improve wastewater and drinking water infrastructure. Unfortunately, this did not address the identified bacteria source. It is anticipated that any remaining funds and additional funding requests in 2009 upwards of $500,000 will be used to address the bacteria loads generated by on-site stormwater runoff. Currently, HTA is conducting a preliminary evaluation of stormwater runoff rates and treatment systems needed to meet water quality standards.

Maple Circle and Gray Road, Sanbornton

During 2005 and 2006, several storm events resulted in ditch line and road washouts, causing sediment to be deposited into Lake Winnisquam. Beyond the negative impacts to water quality related to the physical aspect of sediment deposition, sediment can transport phosphorus and other pollutants to Lake Winnisquam.

The Town of Sanbornton recognized the impact of these storm events to its residents and Lake Winnisquam. As a result, the Town temporarily installed a sediment barrier in the lake to retain the deposited sediment, hired a contractor to remove the sediment during the October, 2006 drawdown conditions and hired an engineer to perform a stormwater analysis for the Black Brook subwatershed that includes Maple Circle and Gray Road.

The sediment barrier was successfully installed by the Town Department of Public Works and approximately 100 yards of sediment deposited at the Maple Circle beach was efficiently removed from the Lake.

In October, 2006, Paul Fluet of Fluet Engineering was hired by the Town to perform the stormwater analysis. The Town received the draft comprehensive drainage report in December, 2006. In 2007, Fluet Engineering prepared a design plan for drainage improvements for the Gray Road and Maple Circle subwatershed. In October, 2007 the Town, DES and local residents met to discuss potential plan modifications. DES Wetlands issued an approval letter for the drainage upgrades. The Town will redesign the drainage between Maple Circle and the lake eliminating the small retention area and stormwater pipe with an open step-pool drainage channel and vegetated buffer. These designs were completed in 2008.

In October, 2008, DES Wetlands issued a permit for the culvert and road upgrades for Maple Circle. Unfortunately, the Maple Circle Association did not give the Town permission to improve and stabilize the stream and stormwater runoff between Maple Circle and the lake. DES Watershed and DES Wetlands would like the Maple Circle Association to continue to work with the Town on what modifications to the beach area are acceptable to stabilize the stream and stormwater runoff.

Black Brook, Lake Winnisquam Subwatershed, Sanbornton

In 2007, Lake Winnisquam Association members contacted DES with concerns of increased turbidity and sedimentation in Black Brook, eventually discharging to the lake.

In 2008, DES and association members combined efforts, mapping the Black Brook subwatershed and establishing several sampling stations. To date, water quality samples have been collected for two stormwater runoff sampling events. While additional best management practices and road improvements could benefit water quality, water quality samples collected do not indicate a great concern at this time.

However, DES encourages the lake association to continue monitoring the Black Brook watershed due to local observation that sedimentation to the stream may be intermittent in nature.

U.S. Route 3/ NH Rte 11/11A Reconstruction, Belmont

Between 2005 and 2007, DES met with Department of Transportation (DOT) personnel on several occasions, to discuss stormwater treatment and erosion control associated with the U.S. Route 3/ NH Rte 11/11A reconstruction between Hueber Drive and the Laconia Town Line along Lake Winnisquam. As a result of that meeting, DOT has incorporated both long-term and short-term water quality improvements into the project.

Long-term water quality improvements included installing stormwater retention areas at Hueber Drive and the Belmont Town Beach entrance to minimize the potential for sediment and other pollutant deposition into the adjacent tributaries and the lake.

Short-term water quality improvements included weekly and post-rain turbidity monitoring measurements, weekly erosion control planning meetings to address potential water quality concerns, project phasing, limiting site disturbance, two or three site inspections and sampling events per week by erosion control specialists and DES, on-site rainfall tracking and recording, and Best Management Practices (BMP) construction to manage intense rainfall events. These improvements were communicated throughout the project to prevent detrimental water quality impacts to wetlands, tributaries, and Lake Winnisquam. In addition, several "new" and simple BMPs were successfully implemented by DOT's contractor, Weaver Bros., Inc. throughout construction.

The first was the use of temporary asphalt berms. These berms were added to keep "clean" stormwater separate from construction site stormwater. This resulted in reduced volumes of construction site water which allowed for better storage, infiltration and treatment before discharging to surface waters.

Second, road grades were intentionally left low when the forecast called for rain. If significant rains were forecasted, berms were built across the exposed roadway, creating areas for stormwater retention on the site. This is a different approach from past road construction projects that graded the site to eliminate stormwater from the area, weather clean or dirty, as fast as possible.

Lastly, DOT and Weaver Bros., Inc. launched a tremendous effort to limit the spread of an invasive plant, Japanese Knotweed, listed on NHs invasive species list and known for limiting plant diversity and reduces stream bank stability where it becomes established. Upon being made aware of the plant on the construction site, these areas were avoided or treated by hand pulling and limited herbicide treatment to prevent further spread.

Project completion occurred during September, 2008, allowing sufficient time for grass growth and permanent stabilization on exposed soil areas, before the end of the growing season.

OBSERVATIONS & RECOMMENDATIONS

DEEP SPOT

➢ Chlorophyll-a

Chlorophyll-a, a pigment found in plants, is an indicator of algal or cyanobacteria abundance. Algae are typically microscopic plants that are naturally found in the lake ecosystem. The measurement of chlorophyll-a in the water gives biologists an estimation of the algal concentration or lake productivity. Table 14 in Appendix A lists the current year chlorophyll-a data.

Figure 1 depicts the historical and current year chlorophyll-a concentration in the water column.

The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.

MOHAWK ISLAND STATION
The current year data (the top graph) show that the chlorophyll-a concentration ***decreased*** from **August** to **September**. Please note that the 8/28/2008 data was used to represent September.

The historical data (the bottom graph) show that the **2008** chlorophyll-a mean is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***variable*** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has ***fluctuated between approximately 1.66 and 7.01 mg/m^3*** since **1987**.

POT ISLAND STATION
The current year data (the top graph) show that the chlorophyll-a concentration ***decreased gradually*** from **July** to **September**.

The historical data (the bottom graph) show that the **2008** chlorophyll-a mean is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***relatively stable*** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has ***remained relatively stable ranging between approximately 1.15 and 3.88 mg/m^3*** since **1987**.

THREE ISLAND STATION
The current year data (the top graph) show that the chlorophyll-a concentration was **1.99 mg/m³** in **August**.

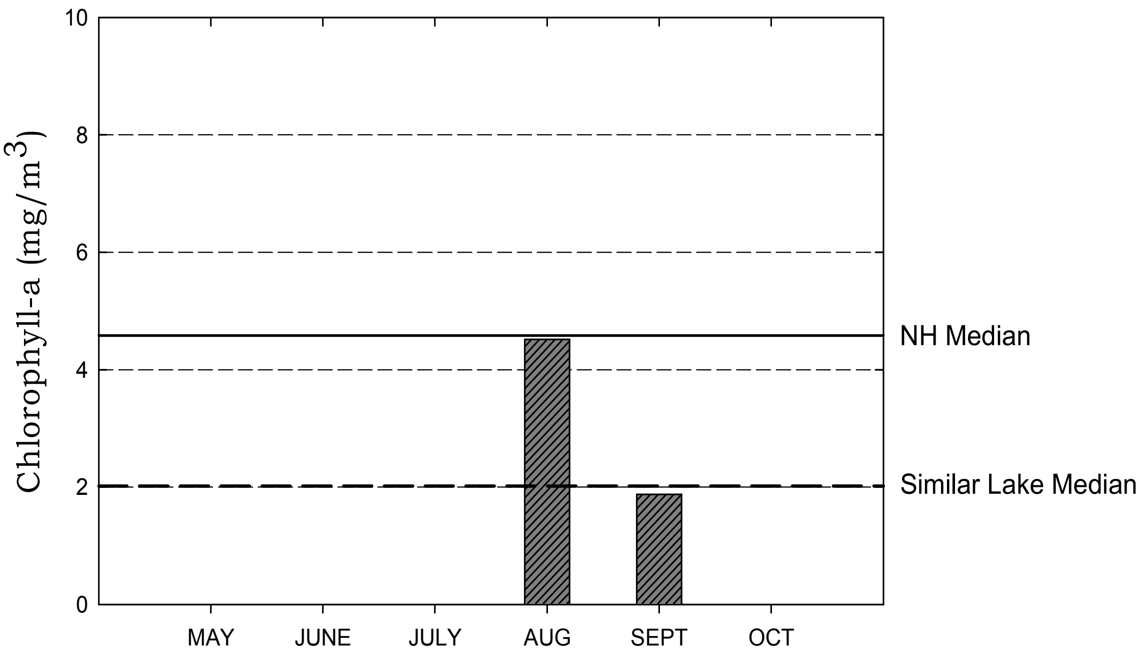
The historical data (the bottom graph) show that the **2008** chlorophyll-a mean is ***slightly less than*** the state median and is ***approximately equal to*** the similar lake median. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***variable*** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has ***fluctuated between approximately 1.59 and 4.40 mg/m³*** since **1987**.

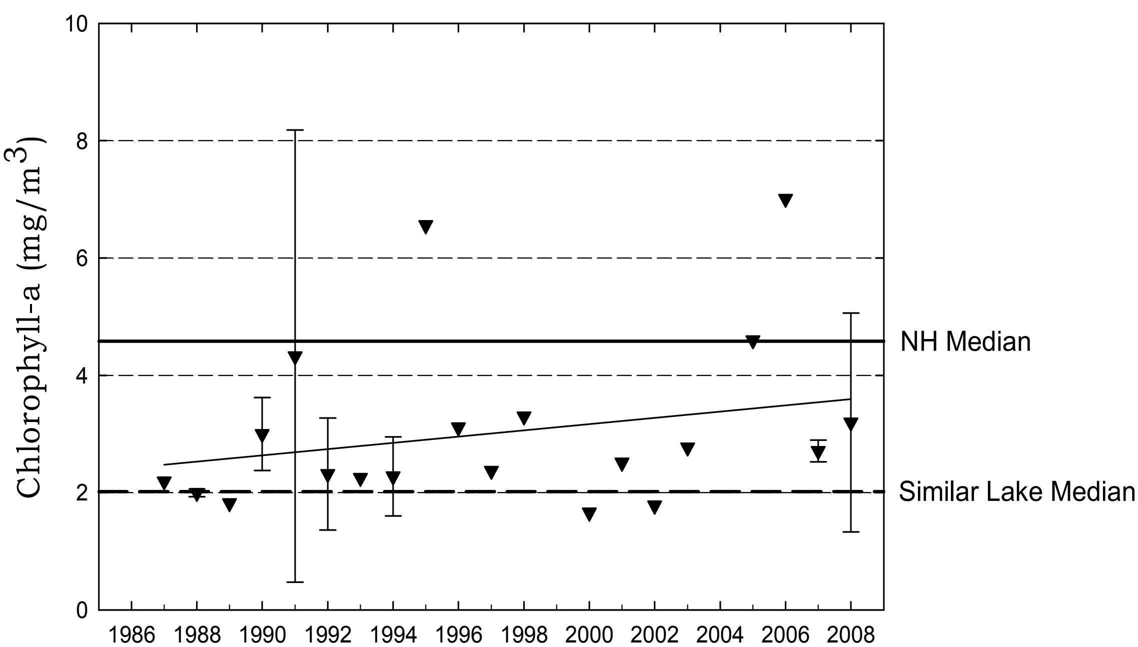
While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Increased Chlorophyll-a concentrations can also affect water clarity, causing Secchi-disk transparency to decrease (worsen) and turbidity to increase (worsen).
Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

Lake Winnisquam, Mohawk Island Stn.

Figure 1. Monthly and Historical Chlorophyll-a Results



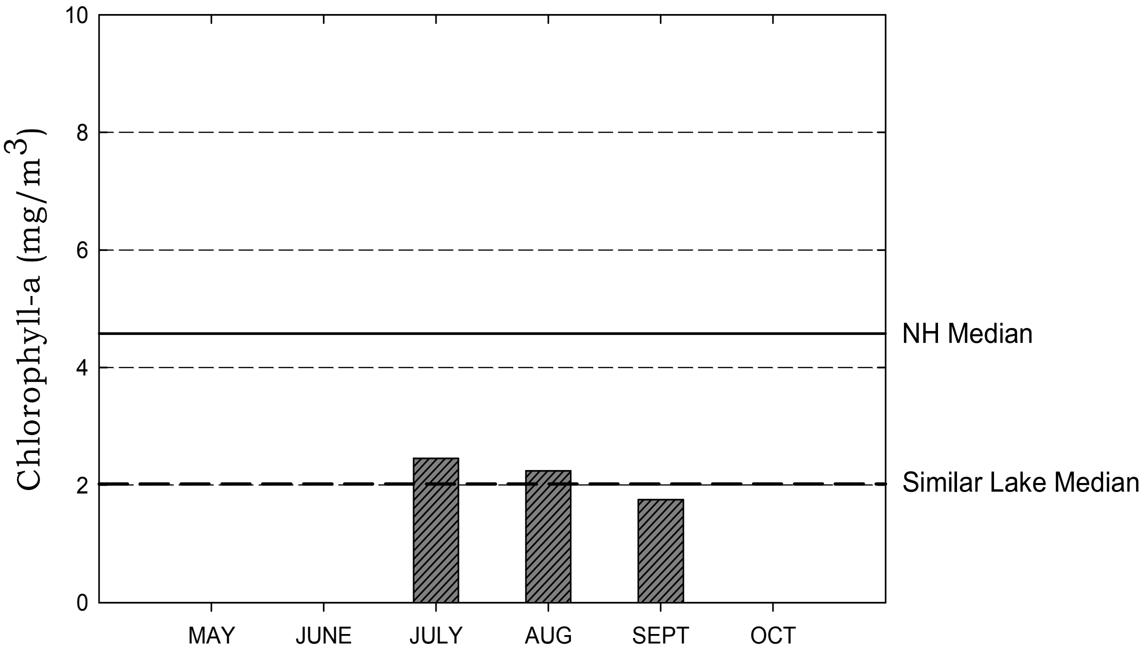
2008 Chlorophyll-a Results



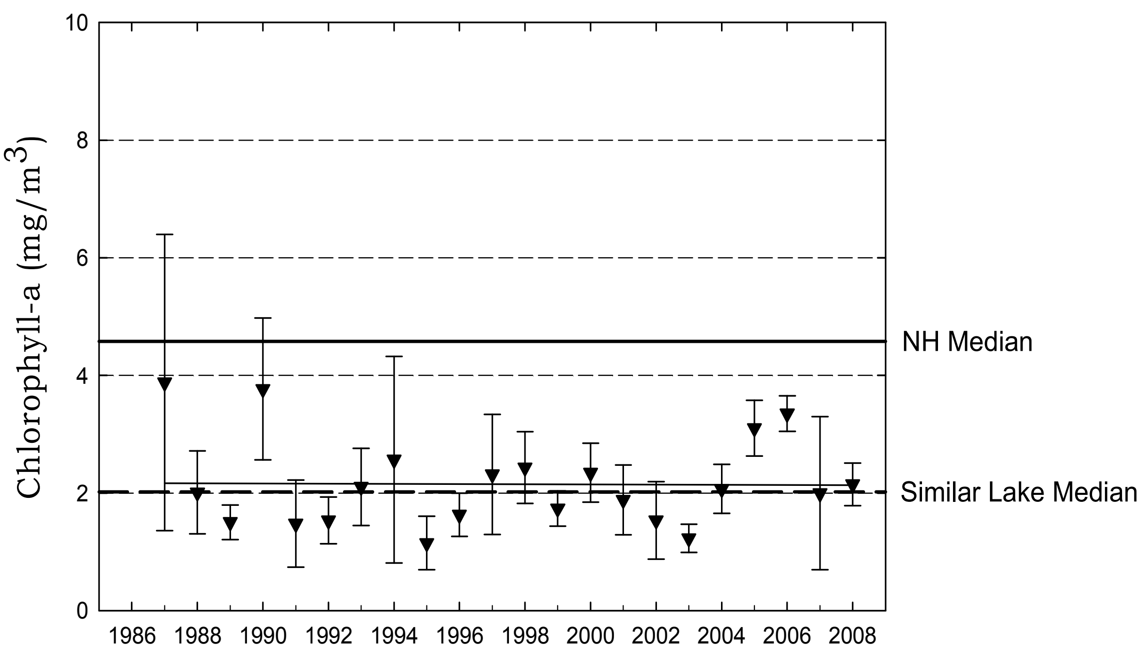
Historical Chlorophyll-a Results

Lake Winnisquam, Pot Island Stn.

Figure 1. Monthly and Historical Chlorophyll-a Results



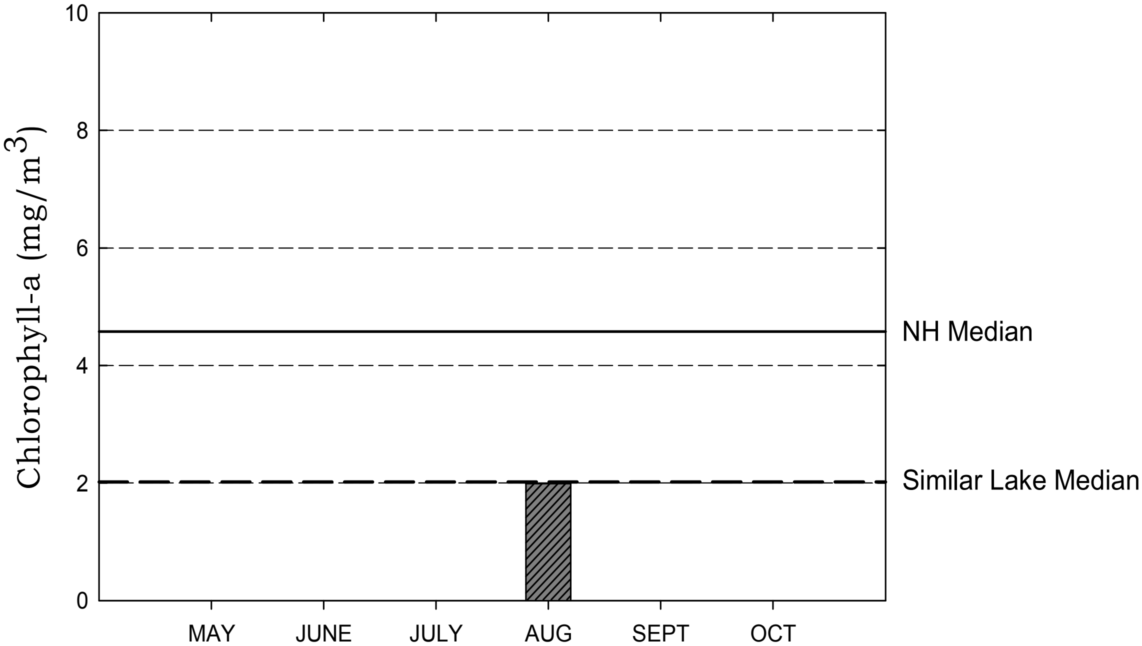
2008 Chlorophyll-a Results



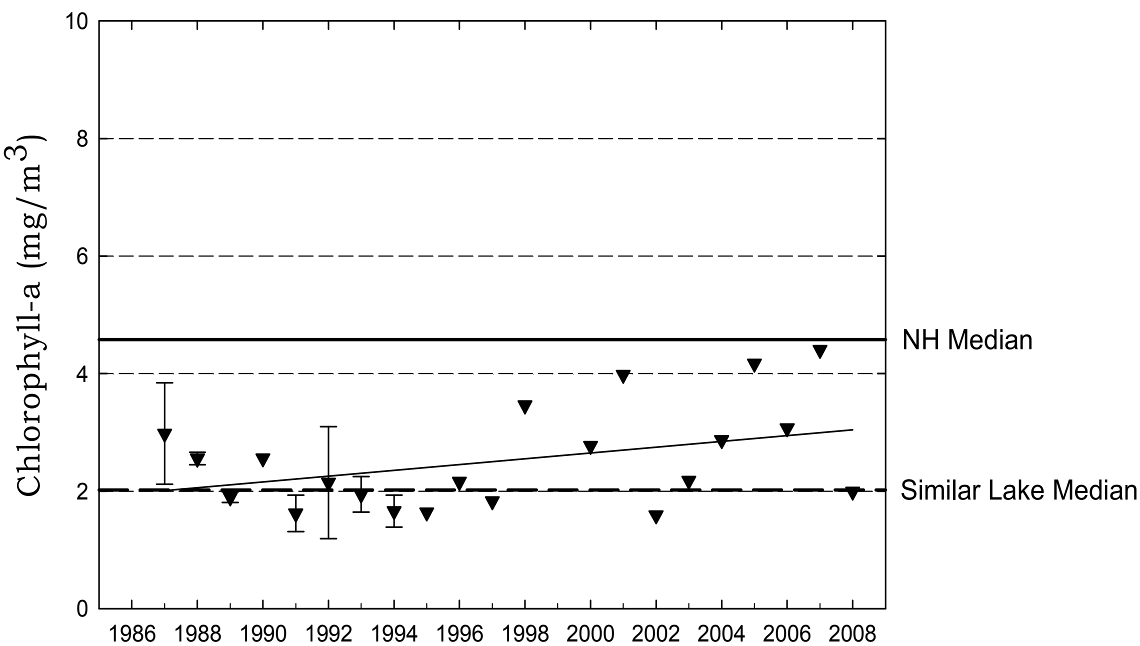
Historical Chlorophyll-a Results

Lake Winnisquam, Three Island Stn.

Figure 1. Monthly and Historical Chlorophyll-a Results



2008 Chlorophyll-a Results



Historical Chlorophyll-a Results

➢ Phytoplankton and Cyanobacteria

Table 1 lists the phytoplankton (algae) and/or cyanobacteria observed in the pond in **2008**. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed and their relative dominance in the sample.

Table 1. Dominant Phytoplankton/Cyanobacteria (2008)

Station	Division	Genus	% Dominance
Mohawk Island	Bacillariophyta	Asterionella	21.7
Mohawk Island	Chrysophyta	Synura	20.7
Mohawk Island	Chrysophyta	Chrysosphaerella	12.8
Pot Island	Cyanophyta	Anabaena	44.7
Pot Island	Bacillariophyta	Asterionella	10.0
Pot Island	Bacillariophyta	Rhizosolenia	9.0
Three Island	Bacillariophyta	Asterionella	46.5
Three Island	Bacillariophyta/Cyanophyta	Tabellaria/Anabaena	9.4
Three Island	Chrysophyta	Chrysospharella/Dinobryon	9.0

Phytoplankton populations undergo a natural succession during the growing season. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire's less productive lakes and ponds.

The cyanobacteria ***Anabaena*** were observed in the **Pot and Three Island** plankton samples in **September and August**. ***This cyanobacteria, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.*** Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria.

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased and favorable environmental conditions occur, such as a period of sunny, warm weather.

The presence of cyanobacteria serves as a reminder of the pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the pond by eliminating fertilizer use on lawns, keeping the pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the pond. If a fall bloom occurs, please collect a sample in any clean jar or bottle and contact the VLAP Coordinator.

➢ Secchi Disk Transparency

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural color of the water. Table 14 in Appendix A lists the current year transparency data. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

Figure 2 depicts the historical and current year transparency ***with and without*** the use of a viewscope.

MOHAWK ISLAND STATION
The current year ***non-viewscope*** in-lake transparency ***remained stable*** from **August** to **September**. Please note that the 8/28/2008 data was used to represent September.

The viewscope in-lake transparency was ***greater than*** the non-viewscope transparency on the **August** sampling event. The transparency was ***not*** measured with the viewscope on the **September** sampling event. As discussed previously, a comparison of transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

The historical data (the bottom graph) show that the **2008** mean non-viewscope transparency is ***greater than*** the state median and is ***slightly less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

Visual inspection of the historical data trend line (the bottom graph) shows an ***relatively stable*** trend. Specifically, the transparency has ***remained relatively stable ranging between 5.10 and 7.90 meters*** since monitoring began in **1987**.

POT ISLAND STATION
The current year ***non-viewscope*** in-lake transparency ***increased slightly*** from **July** to **August**, and then ***decreased slightly*** from **August** to **September**.

The viewscope in-lake transparency was ***greater than*** the non-viewscope transparency on the **September** sampling event. The transparency was ***not*** measured with the viewscope on the **July** or **August** sampling events. As discussed previously, a comparison of transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

The historical data (the bottom graph) show that the **2008** mean non-viewscope transparency is ***greater than*** the state median and is ***slightly less than*** the similar lake median, and was the lowest mean transparency recorded since monitoring began. Please refer to Appendix D for more information about the similar lake median.

Visual inspection of the historical data trend line (the bottom graph) shows a ***relatively stable*** trend. Specifically, the transparency has ***remained relatively stable ranging between 6.75 and 9.08 meters*** since monitoring began in **1987**.

THREE ISLAND STATION
The current year ***non-viewscope*** in-lake transparency was **7.90 meters** in **August**.

The transparency measured with the viewscope was ***greater than*** the transparency measured without the viewscope this summer. As discussed previously, a comparison of the transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

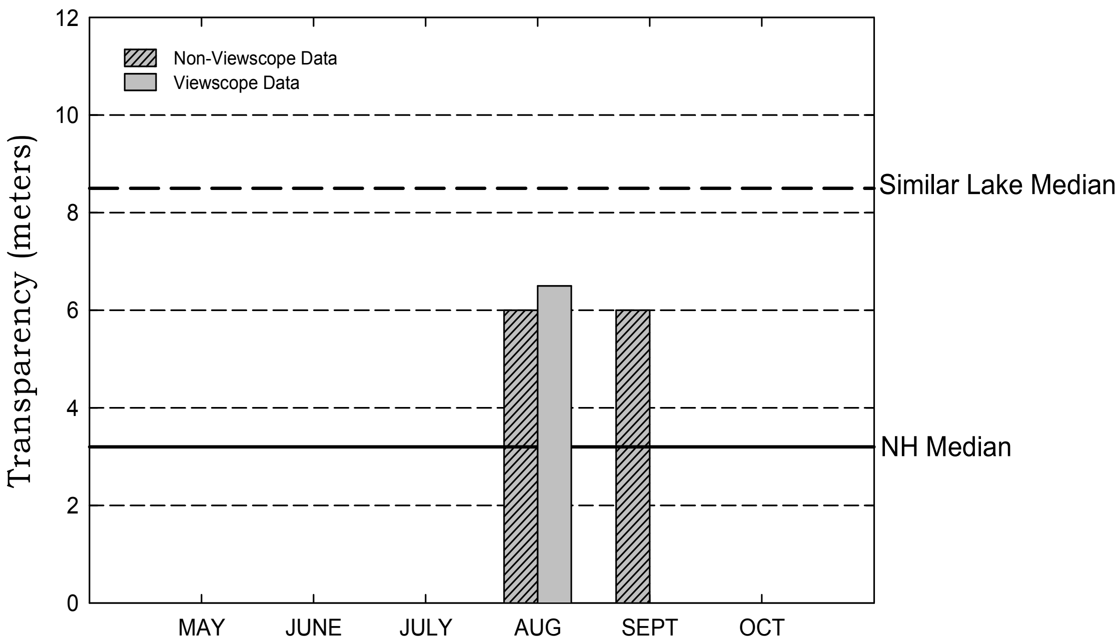
The historical data (the bottom graph) show that the **2008** mean non-viewscope transparency is ***much greater than*** the state median and is ***slightly less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

Visual inspection of the historical data trend line (the bottom graph) shows a ***variable*** trend. Specifically, the transparency has ***fluctuated between approximately 4.75 and 10.5 meters*** since monitoring began in **1987**.

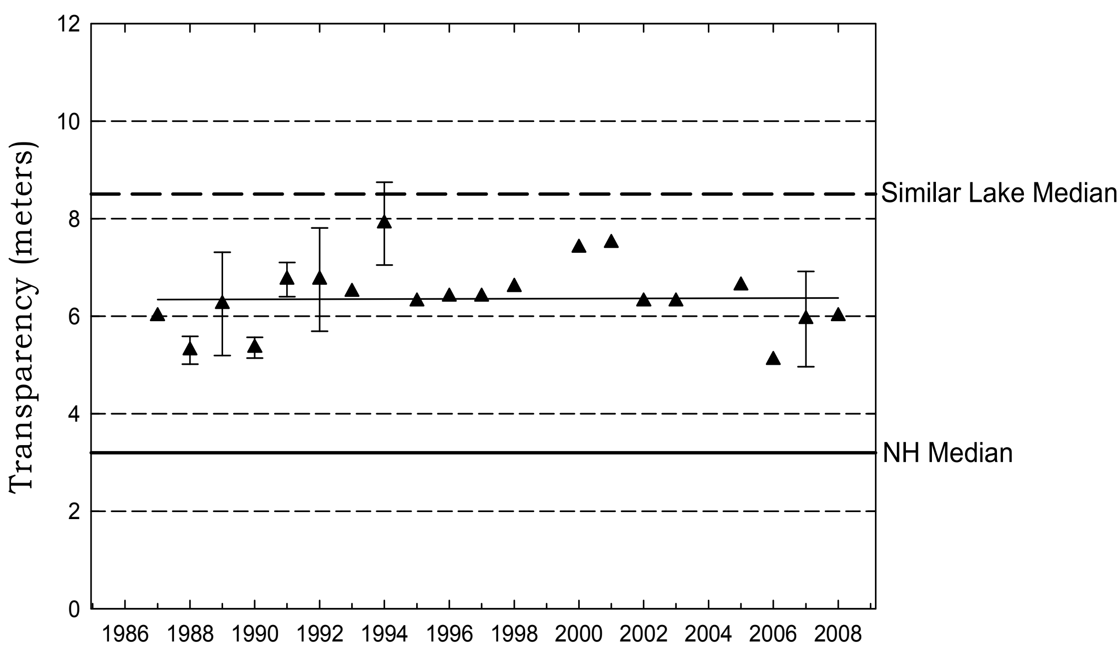
Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

Lake Winnisquam, Mohawk Island Stn.

Figure 2. Monthly and Historical Transparency Results



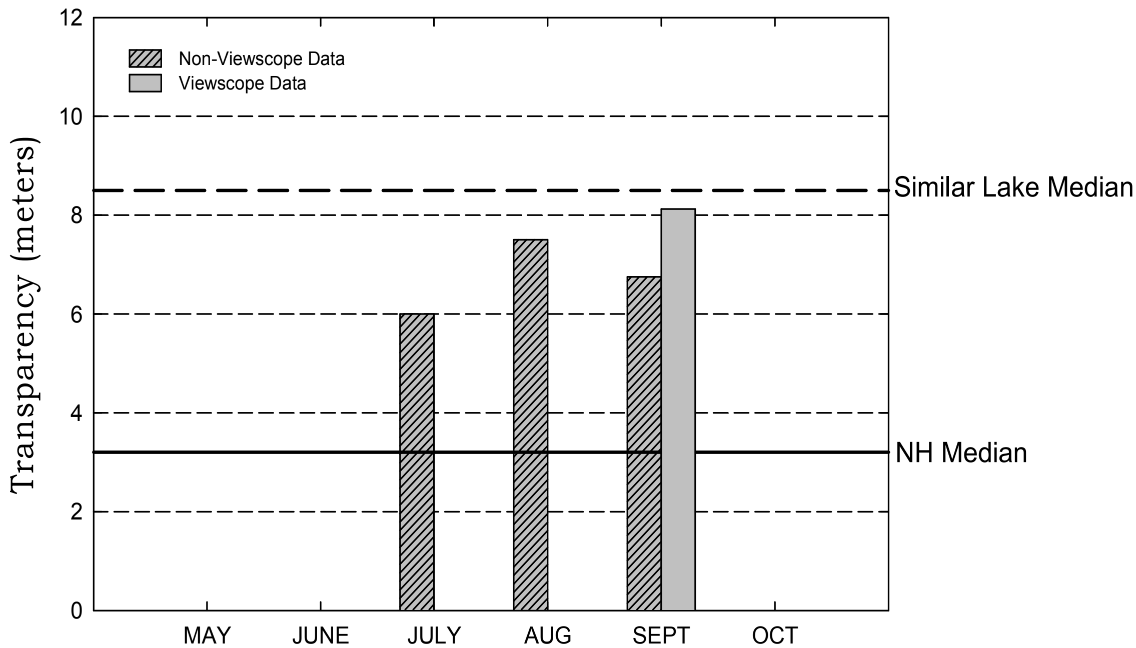
2008 Transparency Viewscope and Non-Viewscope Results



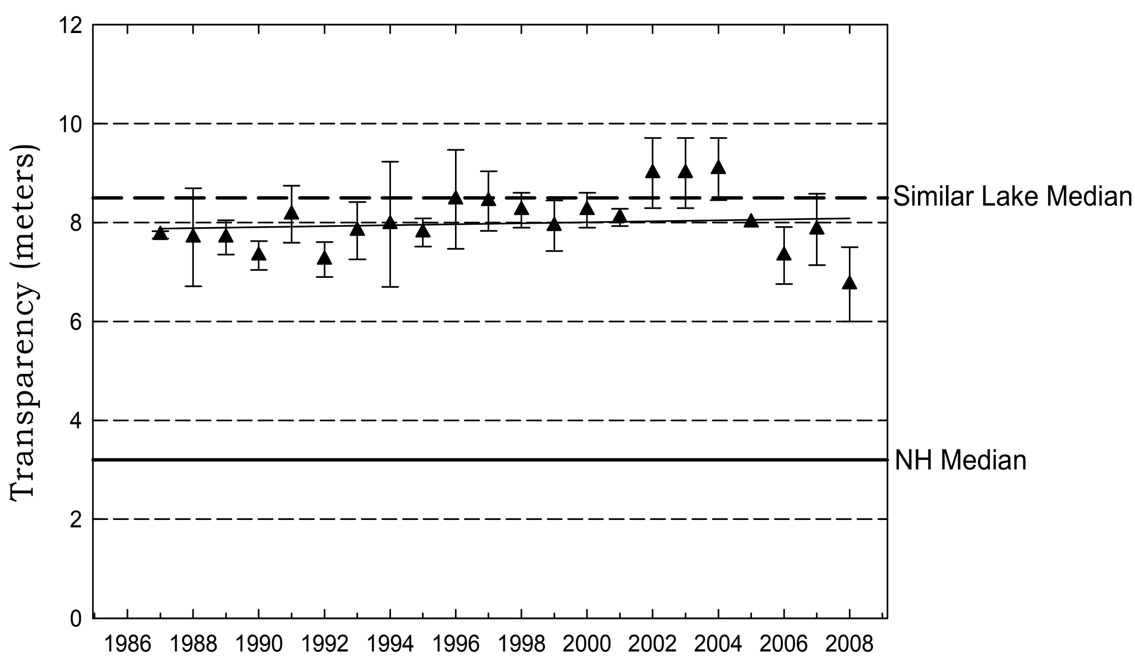
Historical Transparency Non-Viewscope Results

Lake Winnisquam, Pot Island Stn.

Figure 2. Monthly and Historical Transparency Results



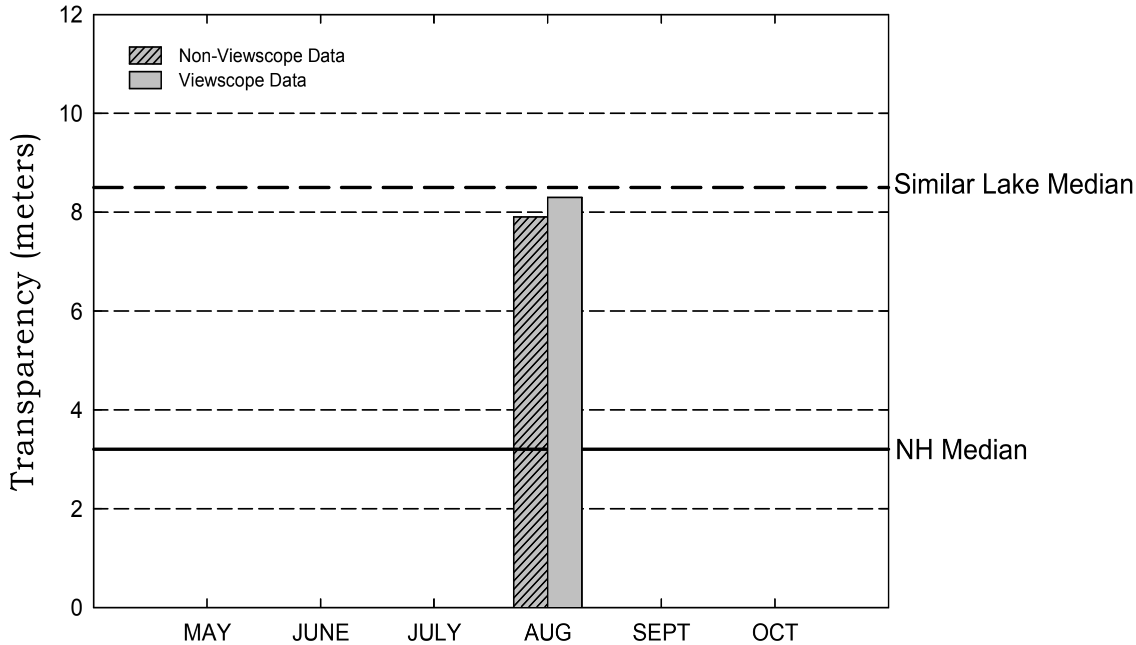
2008 Transparency Viewscope and Non-Viewscope Results



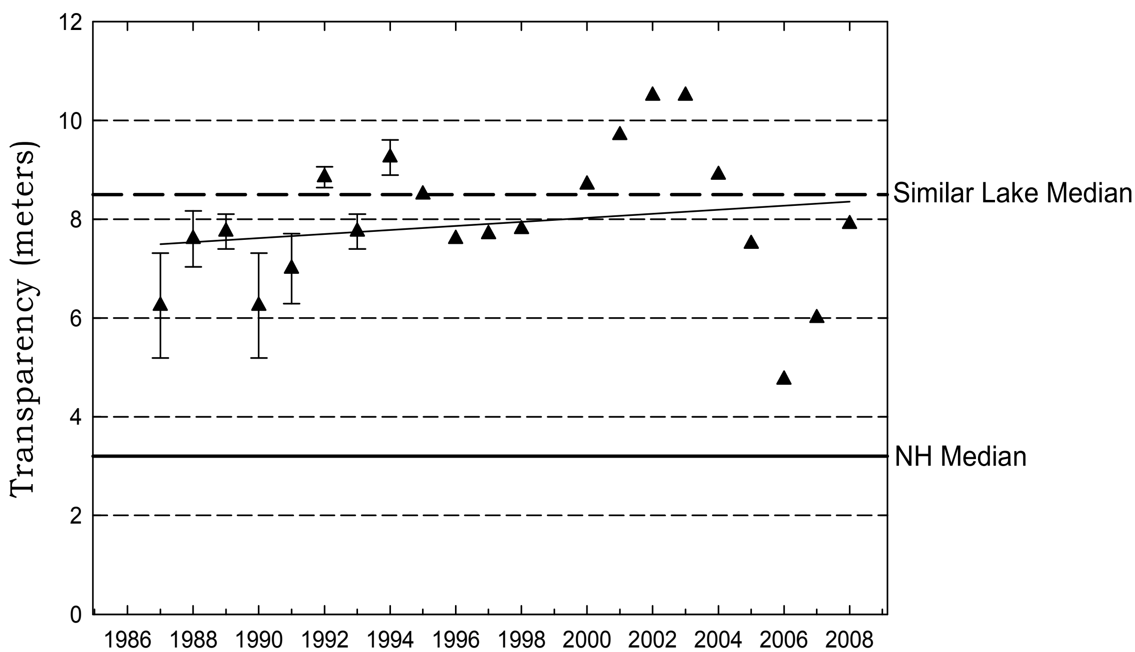
Historical Transparency Non-Viewscope Results

Lake Winnisquam, Three Island Stn.

Figure 2. Monthly and Historical Transparency Results



2008 Transparency Viewscope and Non-Viewscope Results



Historical Transparency Non-Viewscope Results

➢ Total Phosphorus

Phosphorus is typically the limiting nutrient for vascular plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. Table 14 in Appendix A lists the current year total phosphorus data for in-lake and tributary stations. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The graphs in Figure 3 depict the historical amount of epilimnetic (upper layer) and hypolimnetic (lower layer) total phosphorus concentrations; the inset graphs depict current year total phosphorus data.

MOHAWK ISLAND STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***remained stable*** from **August** to **September**. Please note that the 8/28/2008 data was used to represent September.

The historical data show that the **2008** mean epilimnetic phosphorus concentration is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***remained stable*** from **August** to **September**.

The hypolimnetic (lower layer) turbidity samples were ***elevated*** on the **August** and **September** sampling events (**8.41 and 9.67 NTUs**). This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the **2008** mean hypolimnetic phosphorus concentration is ***much greater than*** the state and similar lake medians. Please refer to Appendix D for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion shows a ***relatively stable*** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has ***remained approximately the same*** since monitoring began in **1987**.

Overall, visual inspection of the historical data trend line for the hypolimnion shows a ***variable*** phosphorus trend since monitoring began. Specifically the mean annual concentration has ***fluctuated between approximately 9 and 83 ug/L*** since monitoring began in **1987**.

POT ISLAND STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***decreased slightly*** from **July** to **August**, and then ***increased slightly*** from **August** to **September**.

The ***elevated*** epilimnetic phosphorus concentration measured on the **July** sampling event may have been due to phosphorus-enriched stormwater runoff that flowed into the surface layer of the lake. Weather records indicate that approximately **1.0 inch** of rainfall was measured **24-72 hours** prior to sampling.

The historical data show that the **2008** mean epilimnetic phosphorus concentration is ***slightly less than*** the state median and is ***slightly greater than*** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***remained stable*** from **July** to **September**.

The historical data show that the **2008** mean hypolimnetic phosphorus concentration is ***much less than*** the state median and ***slightly less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion shows a ***decreasing*** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has ***improved*** since monitoring began in **1987**.

Overall, visual inspection of the historical data trend line for the hypolimnion shows a ***variable*** phosphorus trend since monitoring began. Specifically the mean annual concentration has ***fluctuated between approximately 5 and 15 ug/L*** since monitoring began in **1987**.

THREE ISLAND STATION
The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration was **6.4 ug/L** in **August**.

The historical data show that the **2008** mean epilimnetic phosphorus concentration is ***less than*** the state median and is ***slightly greater than*** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration was **6.3 ug/L** in **August**.

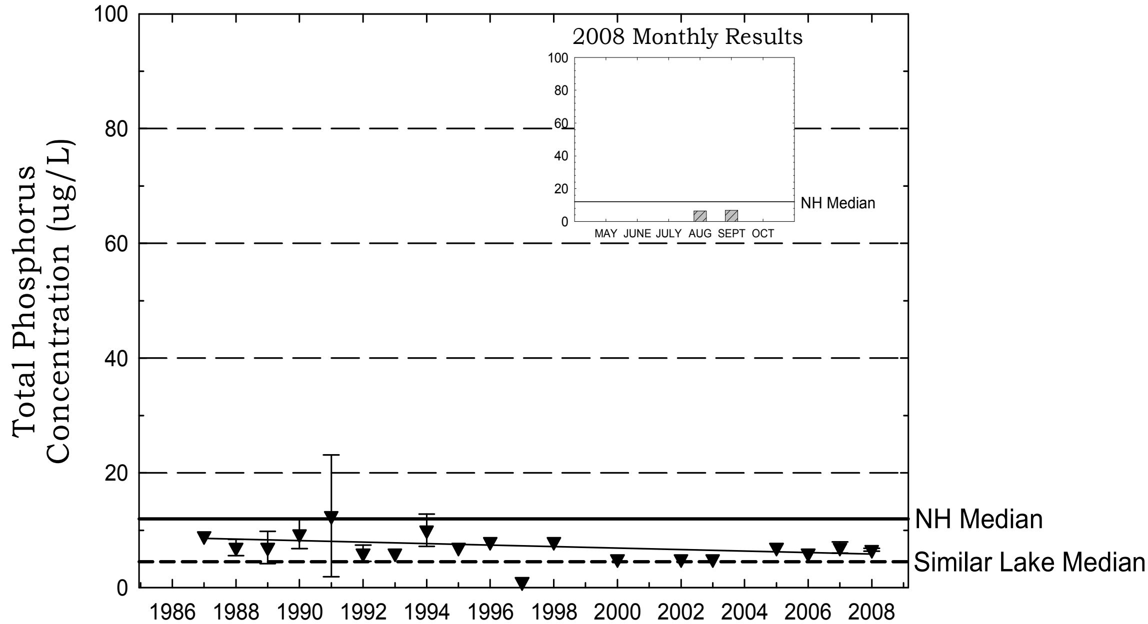
The historical data show that the **2008** mean hypolimnetic phosphorus concentration is ***much less than*** the state median and ***slightly less than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a ***decreasing*** phosphorus trend since monitoring began. Specifically the mean annual concentration has ***improved*** since monitoring began in **1987**.

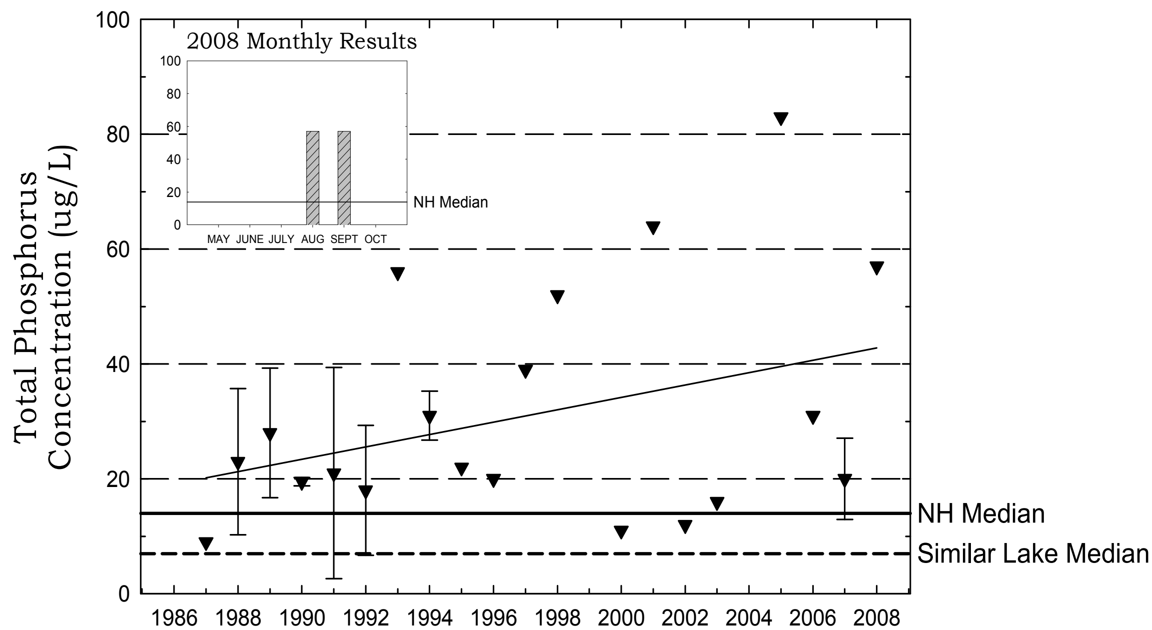
One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively affect the ecology and the recreational, economical, and ecological value of lakes and ponds.

Lake Winnisquam, Mohawk Island Stn.

Figure 3. Monthly and Historical Total Phosphorus Data



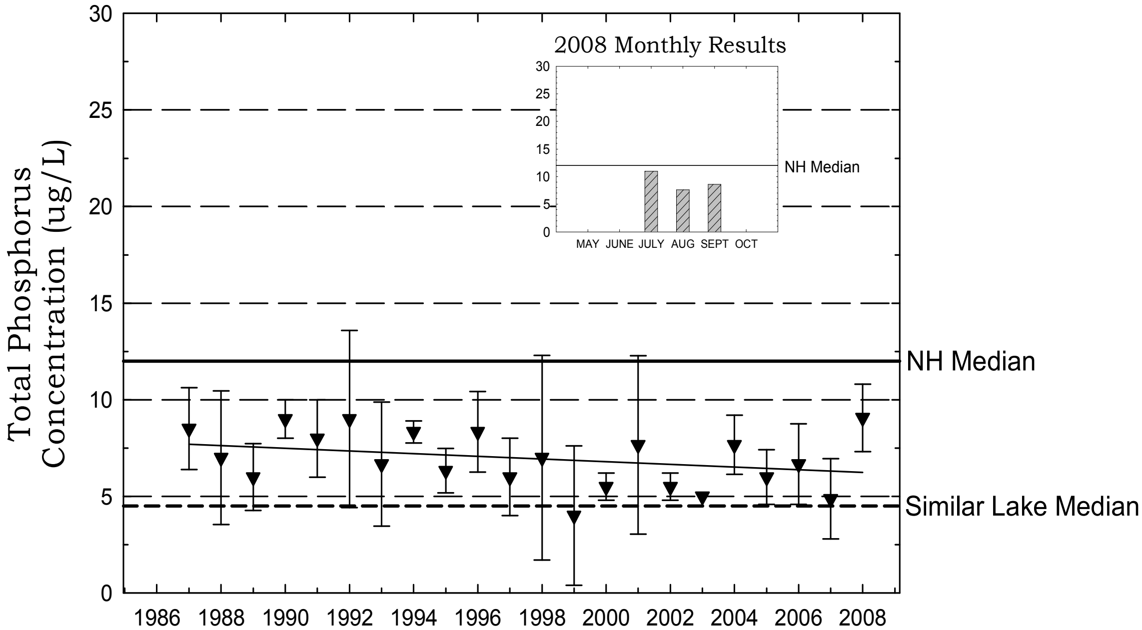
Epilimnion (Upper Water Layer)



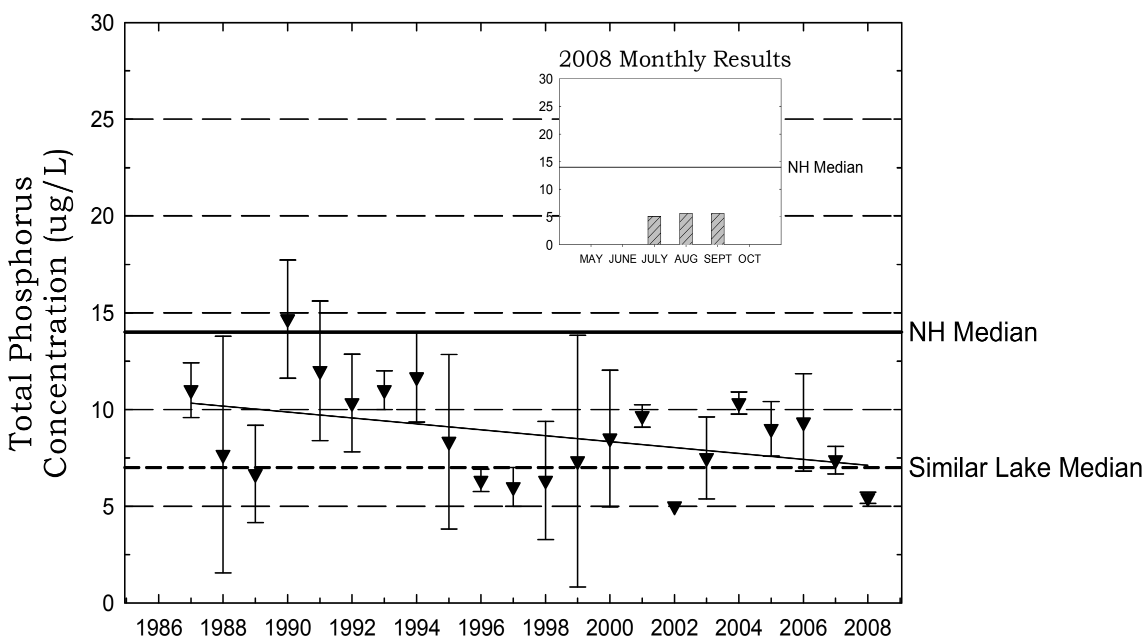
Hypolimnion (Lower Water Layer)

Lake Winnisquam, Pot Island Stn.

Figure 3. Monthly and Historical Total Phosphorus Data



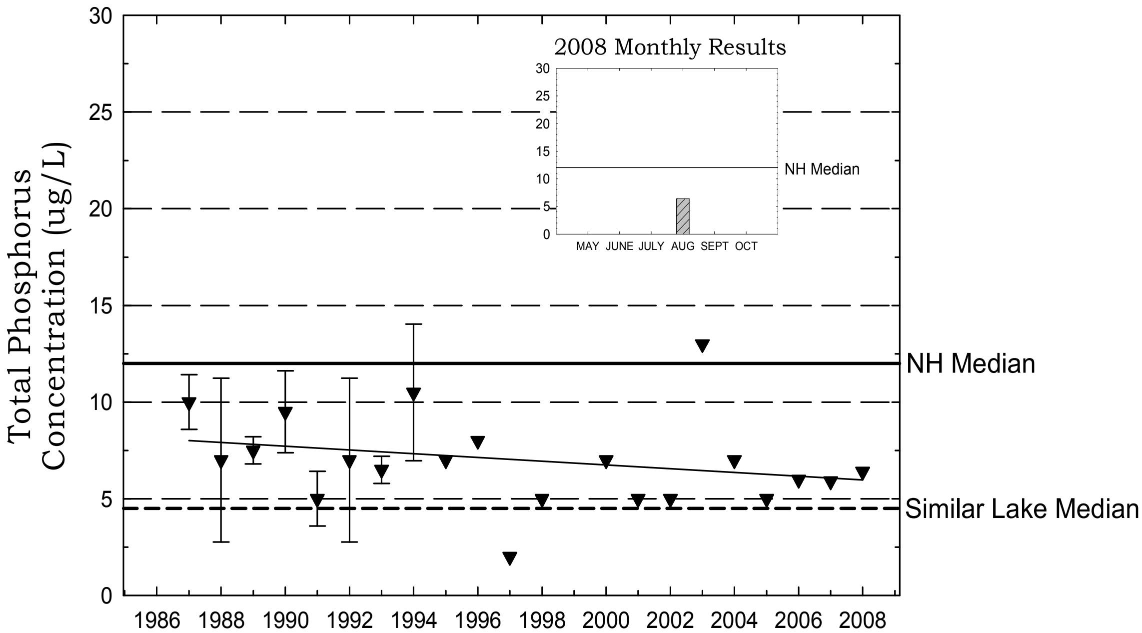
Epilimnion (Upper Water Layer)



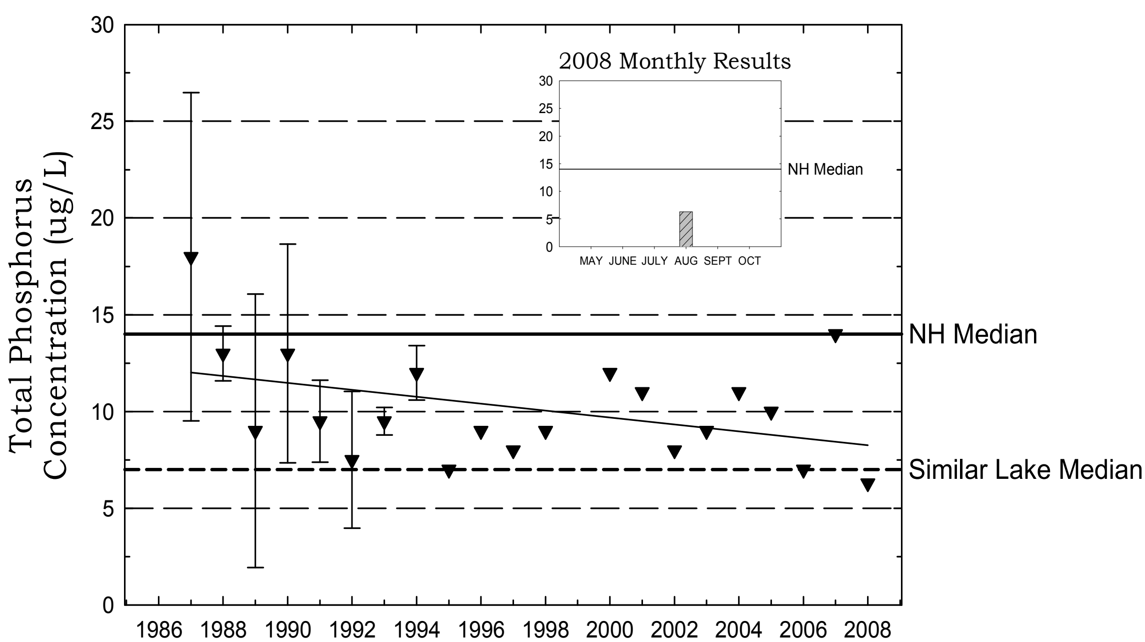
Hypolimnion (Lower Water Layer)

Lake Winnisquam, Three Island Stn.

Figure 3. Monthly and Historical Total Phosphorus Data



Epilimnion (Upper Water Layer)



Hypolimnion (Lower Water Layer)

➢ pH

Table 14 in Appendix A presents the current year pH data for the in-lake stations.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

MOHAWK ISLAND STATION
The pH at the deep spot this year ranged from **6.70 to 6.89** in the epilimnion and from **6.17 to 6.33** in the hypolimnion, which means that the water is ***slightly acidic***.

POT ISLAND STATION
The pH at the deep spot this year ranged from **6.58 to 7.08** in the epilimnion and from **6.16 to 6.45** in the hypolimnion, which means that the water is ***slightly acidic***.

THREE ISLAND STATION
The pH at the deep spot this year ranged from **6.74** in the epilimnion to **6.38** in the hypolimnion, which means that the water is ***slightly acidic***.

It is important to point out that the hypolimnetic (lower layer) pH was ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the state's abundance of granite bedrock and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase pond pH. The pH at the deep spot, however, is sufficient to support aquatic life.

➢ Acid Neutralizing Capacity (ANC)

Table 14 in Appendix A presents the current year epilimnetic ANC for the deep spot.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

MOHAWK ISLAND STATION
The acid neutralizing capacity (ANC) of the epilimnion (upper layer) ranged from **6.9 mg/L to 7.2 mg/L**. This indicates that the lake is ***moderately vulnerable*** to acidic inputs.

POT ISLAND STATION
The acid neutralizing capacity (ANC) of the epilimnion (upper layer) ranged from **6.2 mg/L to 7.8 mg/L**. This indicates that the lake is ***moderately vulnerable*** to acidic inputs.

THREE ISLAND STATION
The acid neutralizing capacity (ANC) of the epilimnion (upper layer) was **6.9 mg/L**. This indicates that the lake is ***moderately vulnerable*** to acidic inputs.

➢ Conductivity

Table 14 in Appendix A presents the current conductivity data for in-lake stations.

Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The conductivity has ***increased*** in the lake since monitoring began. In addition, the in-lake conductivity is ***greater than*** the state median. Typically, increasing conductivity indicates the influence of pollutant sources associated with human activities. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct a shoreline conductivity survey of the lake and tributaries with ***elevated*** conductivity to help identify the sources of conductivity.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

It is likely that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** (upper layer) be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that the DES Limnology Center in Concord is able to conduct chloride analyses, free of charge. As a reminder, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

➢ Dissolved Oxygen and Temperature

Table 9 in Appendix A depicts the dissolved oxygen/temperature profile(s) collected during **2008**.

The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

MOHAWK ISLAND STATION
The dissolved oxygen concentration was ***much lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)*** at the deep spot on the **8/5/2008** sampling event. As stratified lakes age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion by the process of decomposition. Specifically, the reduction of hypolimnetic oxygen is primarily a result of biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the lake where the water meets the sediment. When hypolimnetic oxygen concentration is depleted to less than 1 mg/L, **as it was on the annual biologist visit this year and on many previous annual visits,** the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

The ***low*** hypolimnetic oxygen level is a sign of the lake's ***aging*** and ***declining*** health. This year the DES biologist collected the dissolved oxygen profile in **August**. We recommend that the annual biologist visit for the **2009** sampling year be scheduled during **June** so that we can determine if oxygen is depleted in the hypolimnion ***earlier*** in the sampling year.

POT ISLAND STATION
The dissolved oxygen concentration was ***high*** at all deep spot depths sampled at the lake on the **September** sampling event. As thermally stratified lakes age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion (lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from biological organisms using oxygen to break down organic matter, both in the water column and

particularly at the bottom of the lake where the water meets the sediment. The ***high*** oxygen level in the hypolimnion is a sign of the lake's overall good health. We hope this continues!

THREE ISLAND STATION
The dissolved oxygen concentration was ***high*** at all deep spot depths sampled at the lake on the **August** sampling event. As thermally stratified lakes age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion (lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the lake where the water meets the sediment. The ***high*** oxygen level in the hypolimnion is a sign of the lake's overall good health. We hope this continues!

➢ Turbidity

Table 14 in Appendix A presents the current year data for in-lake turbidity.

Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

MOHAWK ISLAND STATION
As discussed previously, the hypolimnetic (lower layer) turbidity was ***elevated*** (**8.41 and 9.67 NTUs**) on the **8/5/2008 and 8/28/2008** sampling events. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the lake bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

POT AND THREE ISLAND STATIONS
The deep spot turbidity was ***relatively low*** this year, which is good news.

However, we recommend that your group sample the pond and any surface water runoff areas during significant rain events to determine if stormwater runoff contributes turbidity and phosphorus to the lake/pond.

For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

TRIBUTARY SAMPLING

➢ Total Phosphorus

Table 14 in Appendix A presents the current year total phosphorus data for tributary stations. Please refer to the "Chemical Monitoring Parameters" section of the report for a detailed explanation of total phosphorus.

Overall, tributary phosphorus concentration(s) were **low** in **2008** indicating that potentially damaging land use activities as a result of human disturbances in the watershed did not significantly impact the lake this year. This is great news considering the elevated stormwater runoff received this summer.

➢ pH

Table 14 in Appendix A presents the current year pH data for the tributary stations. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation of pH.

The pH of the tributary stations ranged from **6.39 to 7.0 (> 6)** and is sufficient to support aquatic life.

➢ Conductivity

Table 14 in Appendix A presents the current conductivity data for the tributary stations. Please refer to the "Chemical Monitoring Parameters" section of the report for a more detailed explanation of conductivity.

The tributaries have experienced elevated and fluctuating conductivity levels since monitoring began. We recommend that your monitoring group conduct a conductivity survey of tributaries with ***elevated*** conductivity and along the shoreline of the pond to help identify the sources of conductivity. As previously mentioned increasing conductivity typically indicates the influence of pollutant sources associated with human activities.

We recommend that your monitoring group conduct stream surveys and rain event sampling along the tributaries with ***elevated*** conductivity so that we can determine potential sources to the lake.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 special topic article, which is posted on the VLAP website at ***http://www.des.nh.gov/organization/divisions/water/wmb/vlap/categories/publications.htm****, or contact the VLAP Coordinator.*

➢ Turbidity

Table 14 in Appendix A presents the current year turbidity data for the tributary stations. Please refer to the “Other Monitoring Parameters” section of the report for a more detailed explanation of turbidity.

Overall, **2008** tributary turbidity levels were ***similar*** to historical tributary turbidity levels.

➢ Bacteria (*E. coli*)

Table 14 in Appendix A lists the current year data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present. Please refer to the “Other Monitoring Parameters” section of the report for a more detailed explanation.

The *E. coli* concentration was **very low** at **Jays Marina Inlet** sampled on the **8/28/2008** sampling event. Specifically, the result was **10 counts**, which is ***much less than*** the state standard of 406 counts per 100 mL for recreational surface waters that are not designated public beaches and 88 counts per 100 mL for surface waters that are designated public beaches.

➢ Chlorides

Table 14 in Appendix A lists the current year data for chloride sampling. The chloride ion (Cl^-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

Chloride sampling was **not** conducted during **2008**.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:
During the annual visit to your pond, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled-out an assessment audit sheet to document the volunteer monitors' ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor's Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, DES fact sheet WMB-10, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-10.pdf.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-1.pdf.

Impacts of Development Upon Stormwater Runoff, DES fact sheet WD-WQE-7, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/aot/documents/wqe-7.pdf.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-17, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-17.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-2.pdf.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, DES fact sheet SP-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-4.pdf.

Soil Erosion and Sediment Control on Construction Sites, DES fact sheet WQE-6, (603) 271-2975 or

www.des.nh.gov/organization/commissioner/pip/factsheets/aot/documents/wqe-6.pdf.

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, DES fact sheet WD-BB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-4.pdf.

Watershed Districts and Ordinances, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-16.pdf.