

## EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Garland Pond** this year! Your monitoring group sampled the deep spot **three** times this year. As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the great work!

We encourage your monitoring group to continue utilizing the Plymouth State University Center for the Environment Satellite Laboratory in Plymouth. This laboratory was established to serve the large number of lakes/ponds in the greater North region of the state. This laboratory is inspected by DES and operates under a DES approved quality assurance plan. We encourage your monitoring group to utilize this laboratory next summer for all sampling events, except for the annual DES biologist visit. To find out more about the Center for the Environment Satellite Laboratory, and/or to schedule dates to pick up bottles and equipment, please call Aaron Johnson, laboratory manager, at (603) 535-3269.

We encourage your monitoring group to formally participate in the DES Weed Watchers program, a volunteer program dedicated to monitoring lakes and ponds for the presence of exotic aquatic plants. This program only involves a small amount of time during the summer months. Volunteers survey their waterbody once a month from **May** through **September**. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the waterbody and any islands it may contain. Using the materials provided in the Weed Watcher kit, volunteers look for any species that are suspicious. After a trip or two around the waterbody, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers immediately send a specimen to DES for identification. If the plant specimen is an exotic species, a biologist will visit the site to determine the extent of the problem and to formulate a management plan to control the nuisance infestation. Early detection is the key to controlling the spread of exotic plants.

If you would like to help protect your lake or pond from exotic plant infestations, contact Amy Smagula, Exotic Species Program Coordinator, at 271-2248 or visit the Weed Watchers website at [www.des.nh.gov/organization/divisions/water/wmb/exoticspecies/weed\\_watcher.htm](http://www.des.nh.gov/organization/divisions/water/wmb/exoticspecies/weed_watcher.htm).



# 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<sup>3</sup>.**

The current year data (the top graph) show that the chlorophyll-a concentration **increased** from **June** to **July**, and then **decreased slightly** from **July** to **September**.

The historical data (the bottom graph) show that the **2009** chlorophyll-a mean is **slightly greater than** the state median and is **slightly less 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 **decreasing** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has **improved** since **2007**.

Please keep in mind that this trend is based on only **three** years of data. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

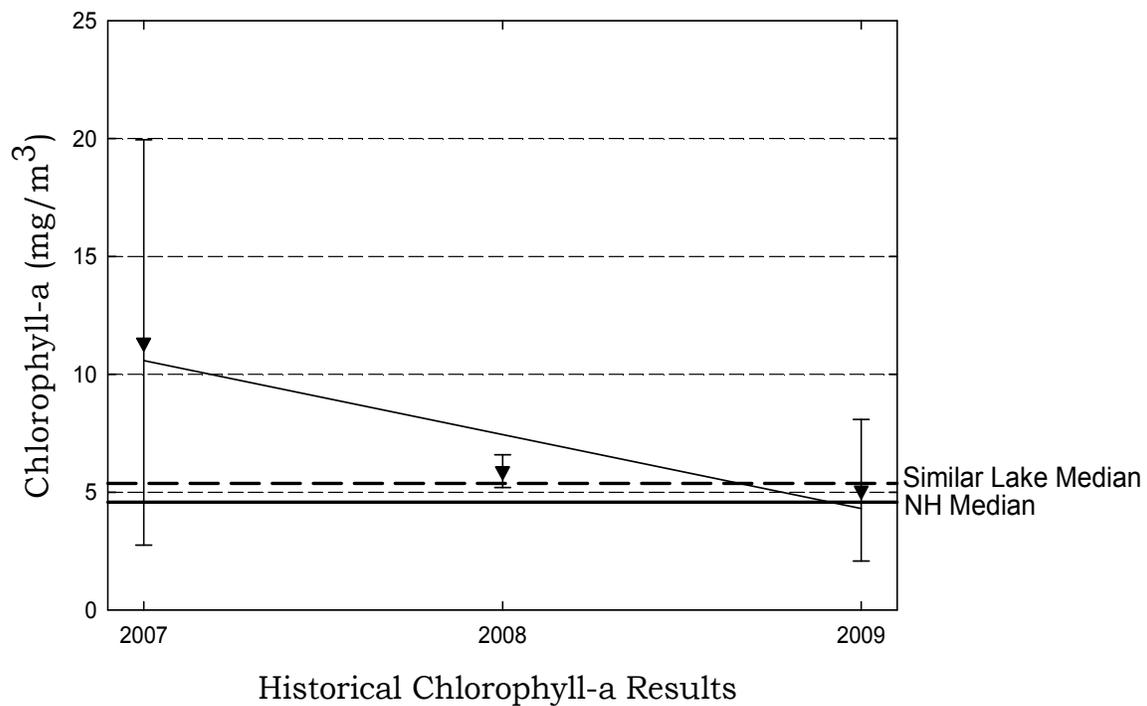
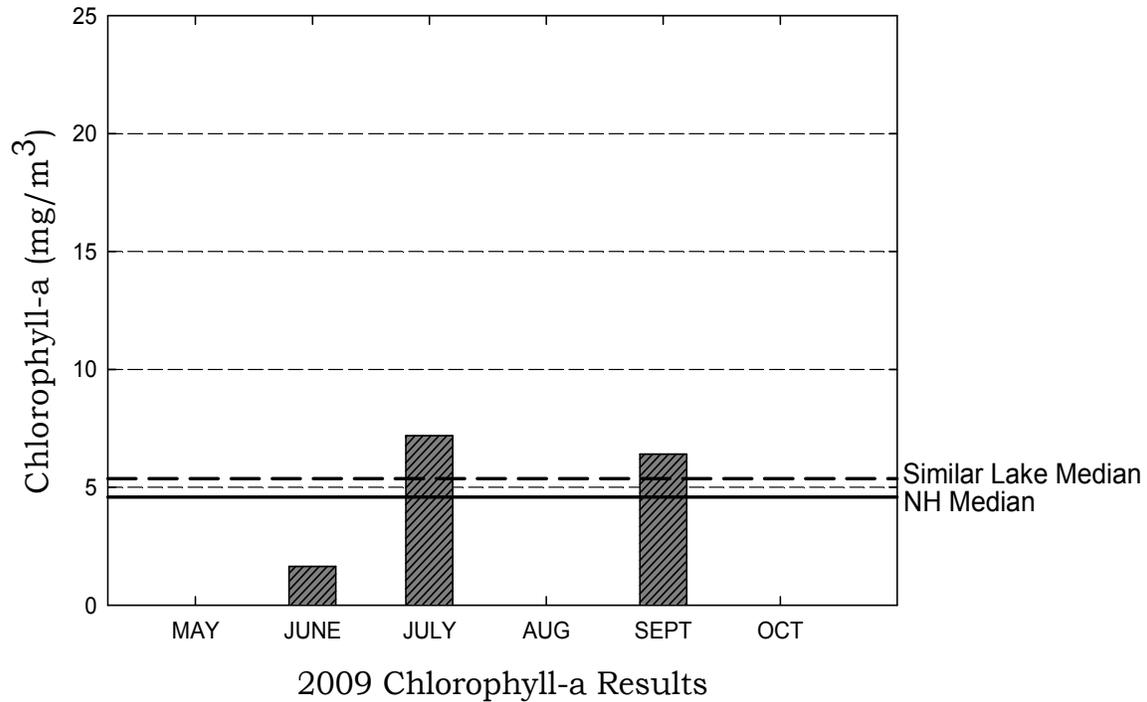
While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed 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

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residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

# Garland Pond, Moultonborough

**Figure 1.** Monthly and Historical Chlorophyll-a Results



### ➤ **Phytoplankton and Cyanobacteria**

Table 1 lists the phytoplankton (algae) and/or cyanobacteria observed in the pond in **2009**. 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 (July 2009)**

<b>Division</b>	<b>Genus</b>	<b>% Dominance</b>
Chrysophyta	Mallomonas	78.7
Chrysophyta	Dinobryon	16.4
Chrysophyta	Synura/Uroglenopsis	2.0

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.

### ➤ **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.

The current year *non-viewscope* in-lake transparency *increased* from **June** to **September**.

The current year *viewscope* in-lake transparency *increased* from **June** to **July** and then *decreased slightly* from **July** to **September**.

The transparency measured with the viewscope was generally *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 **2009** mean non-viewscope transparency is **less than** the state and similar lake medians. 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 **stable** trend. Specifically, the transparency has **remained relatively stable ranging between 1.65 and 2.03 meters** since monitoring began in **2007**.

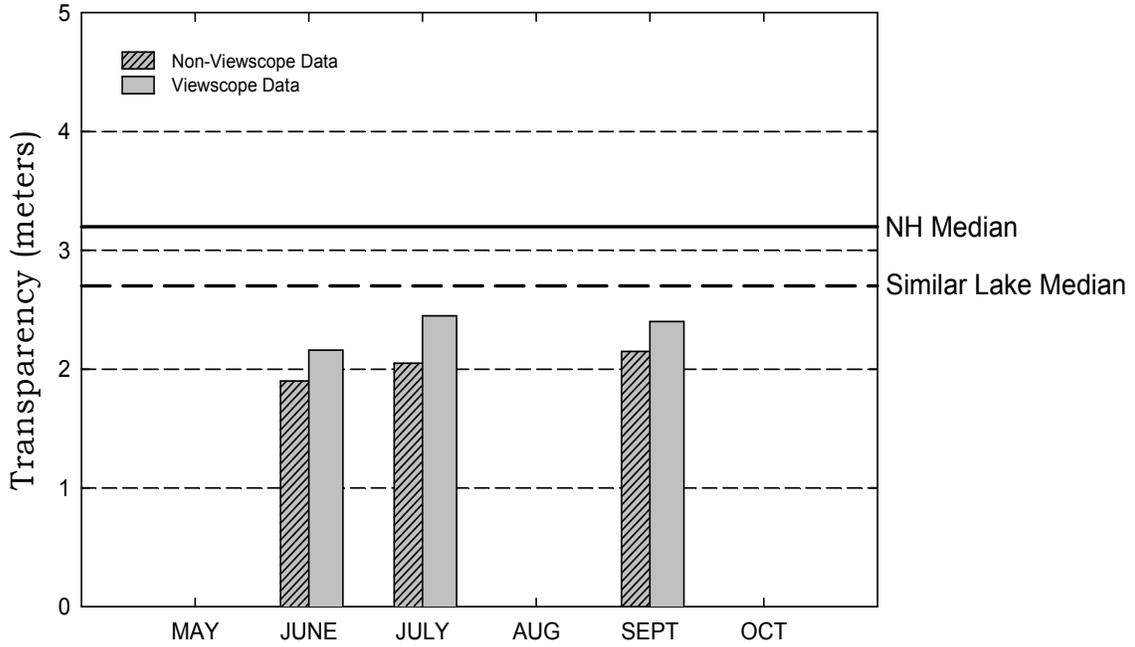
Please keep in mind that this trend is based on only **three** years of data. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

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.

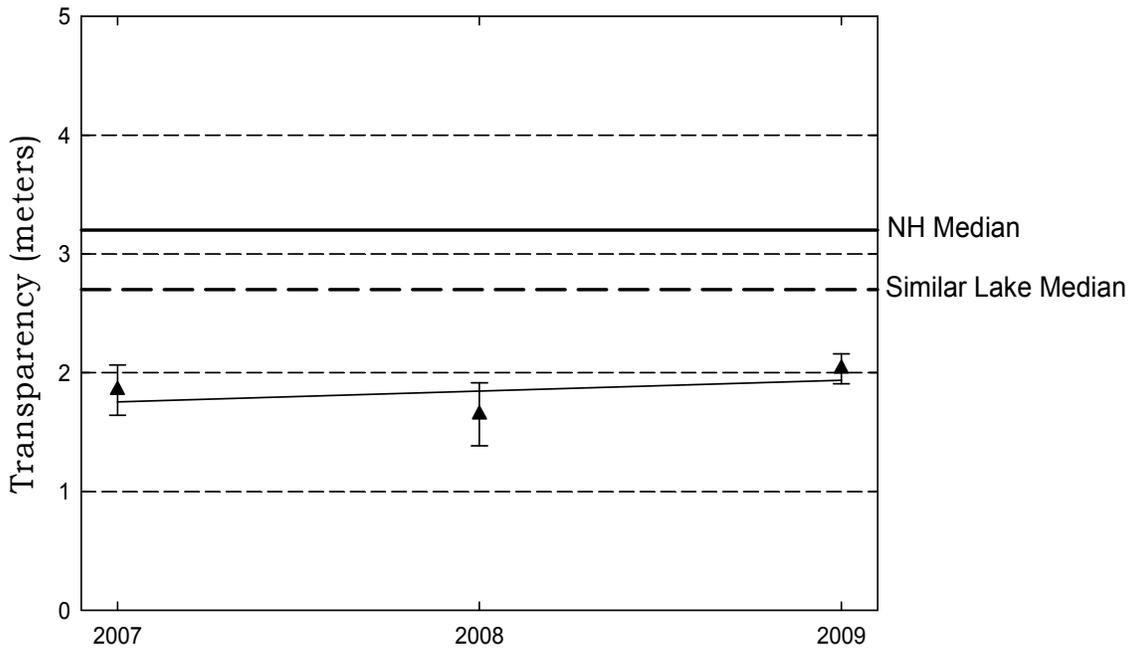
We recommend that your group continue to measure the transparency with and without the use of the viewscope on each sampling event. Ultimately, we would like all monitoring groups to use a viewscope to take Secchi disk readings as the use of the viewscope results in less variability in transparency readings between monitors and sampling events. At some point in the future, when we have sufficient data to determine a statistical relationship between transparency readings collected with and without the use of a viewscope, it may only be necessary to collect transparency readings with the use of a viewscope.

# Garland Pond, Moultonborough

**Figure 2.** Monthly and Historical Transparency Results



2009 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.

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration **increased** from **June** to **September**.

The historical data show that the **2009** mean epilimnetic phosphorus concentration is **greater than** the state and similar lake medians. 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 **increased** from **June** to **September**.

The hypolimnetic (lower layer) turbidity sample was **slightly elevated** on the **September** sampling event (**3.17 NTUs**). This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the pond bottom is covered by an easily disturbed thick organic layer of sediment. When the pond 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 **2009** 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 epilimnetic and hypolimnetic historical data trend lines shows a **relatively stable** phosphorus trend. Specifically, the mean annual epilimnetic and hypolimnetic phosphorus concentrations have **remained approximately the same** since monitoring began in **2007**.

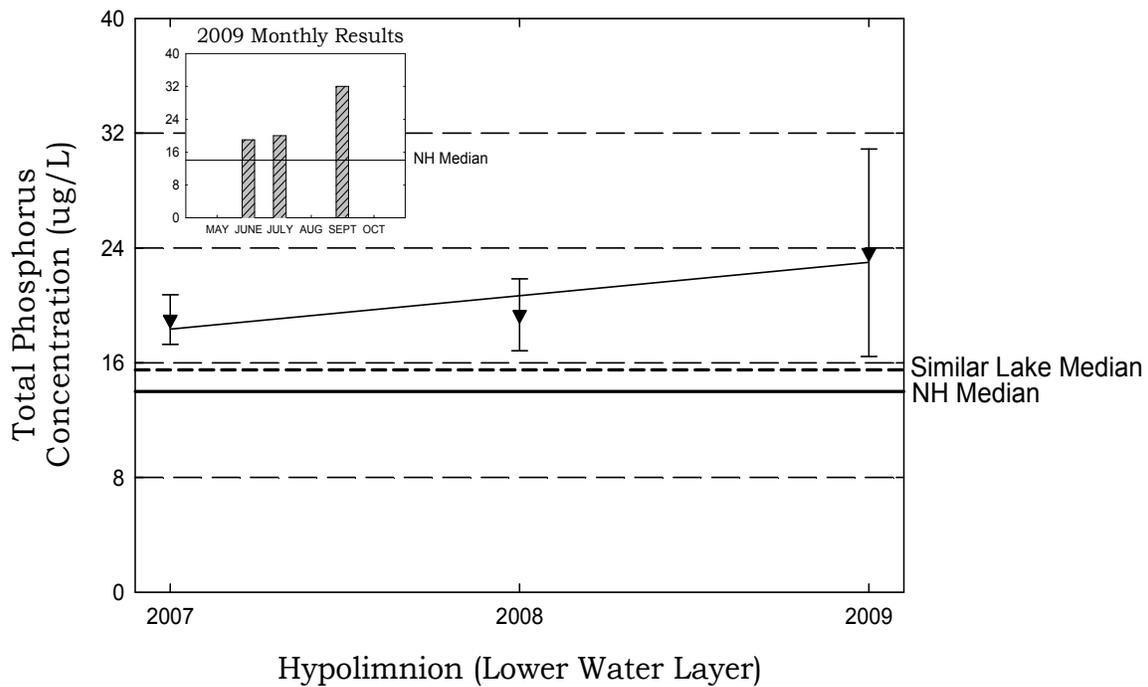
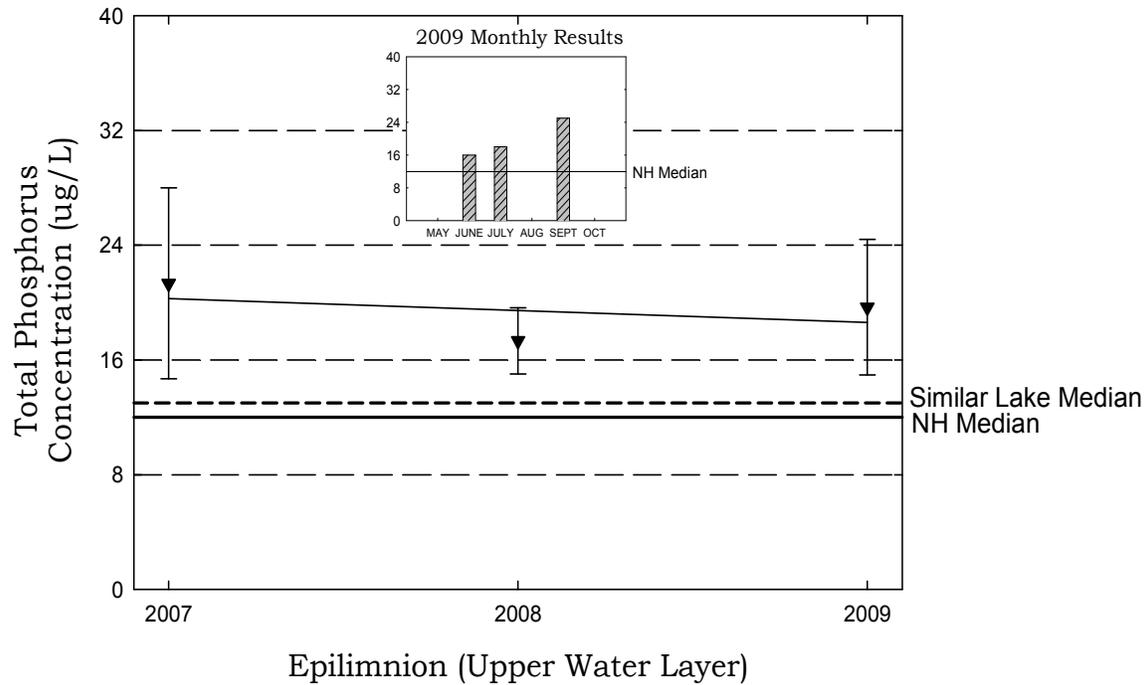
As discussed previously, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean phosphorus concentration since monitoring began.

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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.

# Garland Pond, Moultonborough

**Figure 3.** Monthly and Historical Total Phosphorus Data



## ➤ 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.

The pH at the deep spot this year ranged from **6.48 to 6.80** in the epilimnion and from **6.11 to 6.46** 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.

The acid neutralizing capacity (ANC) of the epilimnion (upper layer) ranged from **9.6 mg/L to 13.0 mg/L**. This indicates that the pond has a **low vulnerability** 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 **2009** conductivity results for the deep spot were **lower than** has been measured **since monitoring began**.

The record rainfall during the **2009 summer season** possibly diluted the ion concentration in surface waters throughout the watershed. Specifically, the significant summer rainfalls likely increased the flushing rate for many lakes/ponds allowing potential watershed pollutants to flush through the system and not concentrate in the stratified surface waters.

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the pond. 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 **2009**.

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.

The dissolved oxygen concentration was **much lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)** at the deep spot on the **July** sampling event. As stratified ponds 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 pond 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 pond's **aging** health. This year the DES biologist collected the dissolved oxygen profile in **July**. We recommend that the annual biologist visit for the **2010** sampling year be scheduled during **August** so that we can determine if oxygen is depleted in the hypolimnion **later** in the sampling year.

### ➤ **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.

As discussed previously, the hypolimnetic (lower layer) turbidity was **slightly elevated (3.17 NTUs)** on the **September** sampling event. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the pond 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 pond 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.

## 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.

The phosphorus concentration in the **Culvert** sample on the **July** and **September** sampling events was *elevated (57 and 29 ug/L)*, however, the turbidity was *not elevated (0.87 and 0.76 NTUs)*.

It had rained during the **24-72 hours** prior to the **July** and **September** sampling events. Rain events typically carry phosphorus laden watershed runoff to tributaries. Phosphorus sources in the watershed can include agricultural runoff, failing or marginal septic systems, stormwater runoff, road runoff, and watershed development.

Record summer rainfall likely increased stormwater runoff and nutrient loading to the tributary. As impervious surface cover increases in the watershed, stormwater runoff volumes increase. This transports phosphorus-laden stormwater into tributaries and eventually the pond. Efforts should be made in the watershed to reduce impervious surfaces and limit phosphorus sources such as fertilizer use, septic influences, agricultural impacts, and sediment/erosion control.

### ➤ **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 **Inlet** and **Outlet** ranged from **6.40 to 6.90 (> 6)** and is sufficient to support aquatic life.

The pH of the **Culvert** appears to be slightly acidic. This can be caused by the presence of humic, tannic and fulvic acids. Humic, tannic and fulvic acids naturally occur as a result of decomposing organic matter such as leaves. These acids may also cause the water to be tea colored. In New Hampshire the presence of granite bedrock and acid deposition also naturally lowers the pH of freshwaters.

### ➤ **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.

Overall, the conductivity **decreased** in the tributaries in 2009. The record rainfall during the **2009 summer season** possibly diluted the ion concentration in surface waters throughout the watershed. Specifically, the significant summer rainfalls likely increased the flushing rate for many ponds allowing potential watershed pollutants to flush through the system and not concentrate in the stratified surface waters.

However, the conductivity remains **slightly elevated** in the tributaries. It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the tributaries. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **tributaries** 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.*

#### ➤ **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, **2009** 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 **low** at the **Culvert** station sampled on the **July** sampling event. Specifically, the result was **40 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<sup>-</sup>) 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 **2009**.

## 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

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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**

*Acid Deposition Impacting New Hampshire's Ecosystems*, DES fact sheet ARD-32, (603) 271-2975 or [www.des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-32.pdf](http://www.des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-32.pdf).

*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](http://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf).

*Lake or Pond – What is the Difference?* DES fact sheet WD-BB-49, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-49.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](http://www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf).

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation*, DES fact sheet WD-08-20A, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf>

*NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design*, DES fact sheet WD-08-20B, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf>

*NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction*, DES fact sheet WD-08-20C, (603) 271-2975 or <http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.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](http://www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf).

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