



## **2009 Report on the Health of the Norway Lakes**

The Lakes Association of Norway, with support from the Town of Norway, continued to monitor the health of the four Norway Lakes in 2009. Water quality monitoring was a combined effort of volunteers and lake professionals. Monitoring of the lakes takes place from early May through September, during the time of year when lakes and ponds are the most biologically productive, and water quality problems are most likely to occur. In addition to monitoring lake water quality, LAON also conducted a screening survey for invasive aquatic plants on the four lakes.

The weather that occurs during and preceding lake monitoring often has a strong influence on indicators of lake water quality, and is likely responsible for some of the variability that is seen within individual seasons and from one year to the next. The 2009 monitoring season, much like the previous year, was characterized by heavy snow melt during the spring, followed by heavy rain, which was extreme at times, from mid summer through the end of the monitoring season. In fact, according to National Weather Service data, Portland, Maine experienced the wettest summer in 138 years (period of record), a fact that would not surprise anyone who spent time on the Norway lakes last summer!

Rain and snow produce stormwater runoff, which is the primary means by which phosphorus and other pollutants are carried into lakes from their watersheds. One might expect that for years when excess precipitation has occurred during the spring and summer period, lakes might be less clear. Although that is often the case, each lake responds uniquely to the many factors that influence water quality. In 2009, the Maine Volunteer Lake Monitoring Program and Maine Department of Environmental Protection monitored the water clarity of 457 Maine lakes, which includes data from volunteers, agency personnel and other professionals. The four Norway Lakes are included in this group.

To put into perspective the 2009 lake monitoring season, consider the fact that out of 457 Maine lakes that were assessed last year, only 39.2% were clearer, 50.1% were less clear, and 10.7% were unchanged, compared to their historical average (Figure 2). The clarity of Maine's lakes has declined significantly during the past two years, compared to 2007 – a much drier year, when a much higher percentage of lakes were clearer than they had been historically.

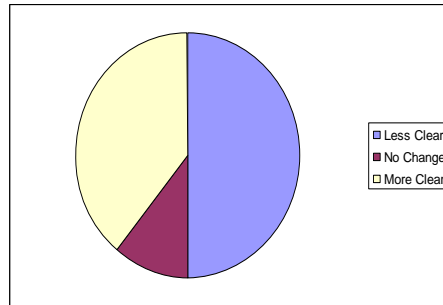
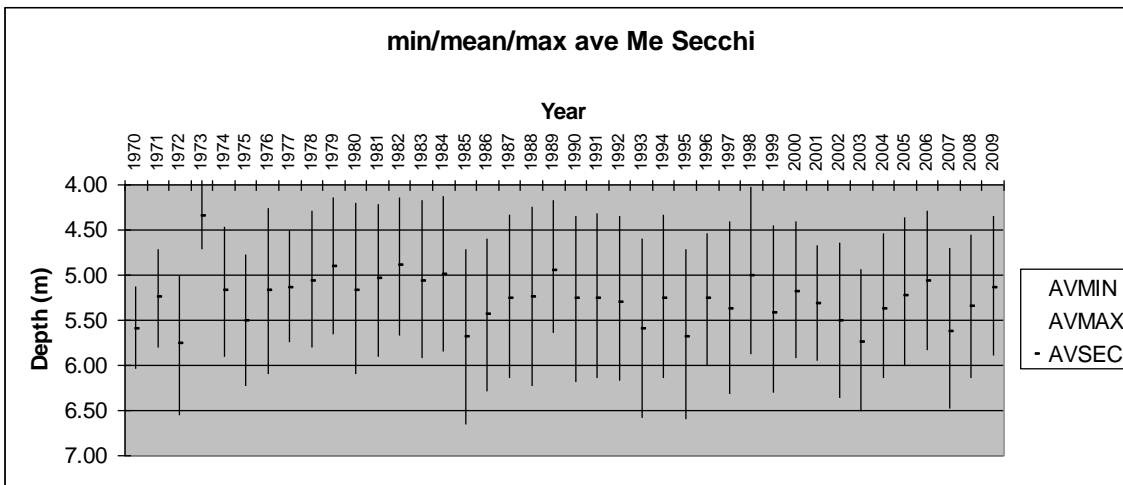


Figure 1: Percentage of 457 Maine Lakes that were clearer, less clear, or unchanged, compared to their historical average in 2009 (Source: MDEP and VLMP)

It is likely that the further decline in the number of lakes that were clearer than average in 2009 was the result of heavy snow melt during the spring, and moderate to severe rainfall throughout much of Maine during the summer period.

Spring runoff from melting snow and rain typically carries a high percentage of the annual phosphorus load to lakes from their watersheds. The annual phosphorus load to a lake from its watershed has a strong bearing on water clarity throughout the summer monitoring period.

The chart below shows the extent to which water clarity (Secchi transparency) has varied for Maine lakes over time. The chart shows the average water clarity for all Maine lakes monitored in a given year, denoted by the small dot on the solid line. Note that this average has, for a majority of the years since this information has been tracked, fallen between 5.0-5.5 meters. Although weather influences have a strong bearing on the overall clarity of Maine lakes, the natural rate of flushing, the extent of watershed development and other influences play an equally important role for individual lakes and ponds.



**Figure 2: Average, Maximum and Minimum Clarity for Maine Lakes**

The illustration above shows that for the period from 2004-2006, the “average” clarity of Maine lakes dropped substantially. This may have been due to the fact that much of the state experienced above average precipitation during the period. In 2007, Maine lakes as a whole were significantly clearer, most probably due to relatively little precipitation throughout the state during the winter, spring and early summer months. But in 2008 and 2009, along with a reduction in the percentage of lakes that were as clear as they were in 2007, the overall water clarity for Maine lakes declined, as shown in figure 3 above. Note that the average maximum and minimum lake water clarity for 2009 also dropped, compared to 2008 and 2007.

The graph shows that a number of similar changes have occurred historically. Some of the “clearest” years have been those during which drought has recently occurred, such as 1985 and 2002 and 2003, which followed the severe statewide drought of 2001.

Each lake and pond responds in a unique way to the influences of weather, changes in land use in the watershed, and other forces upon the ecosystem. That is because of the wide range of physical, chemical and biological characteristics of each lake basin and its watershed. Most lakes and ponds experience moderate levels of natural annual variability.

Water clarity (Secchi transparency) is one of four primary indicators of the biological productivity of lake ecosystems, in addition to the concentration of the nutrient phosphorus (TP), the concentration of chlorophyll *a* (CHL), a plant pigment used to measure of the concentration of algae in lake water, and dissolved oxygen levels in deep areas of the lake during the summer months. The combined information obtained from these critical indicators provide a general picture of the health of individual lakes.

## 2009 Monitoring Results for the Norway Lakes

### **Pennesseewassee Lake:**

Pennesseewassee Lake was slightly less clear in 2009, when compared to the historical average for the lake, but the water was actually clearer than it has been for the past two years – the clearest since 2006. Water clarity averaged 5.7 meters (about 19 feet) in 2009 during the five month period, ranging from a high reading of 7.5 meters in May, to a low reading of 4.3 meters in September. The average water clarity in 2008 was 5.4 meters, compared to 5.6 meters in 2007, 6.0 meters in 2006, and the historical average for the lake of 5.8 meters.

The concentration of phosphorus (the nutrient that is responsible for the growth of algae in lakes) was higher in 2009, averaging 11 parts per billion (ppb), compared to 8 ppb in 2008, 9 ppb in 2007, 7 ppb in 2006, 8 ppb in 2005, and the historical average of 9 ppb.

Chlorophyll-a (CHL) is a pigment that is measured to determine the concentration of algae in lake water. The 2009 average concentration measured 5.5 ppb, compared to 4.6 ppb in 2008, compared to 4.3 ppb in 2007, 4.4 ppb in 2006, and the 2005 average of 4.1 ppb. *The 2009 average was one of the highest on record for Pennesseewassee.* The average was strongly influenced by the July 23 sample, which measured 9.7 ppb. The phosphorus level in the lake was also relatively high in July.

Late July, and August and September dissolved oxygen levels were very low in the deepest region of the lake, as has been the case for a number of years. In August, the deepest eight meters of water, measured at the deepest point in the lake, were essentially devoid of dissolved oxygen. By September, conditions had improved only slightly, as water temperatures cooled. Low concentrations of late summer dissolved oxygen serve as a warning that the lake is sensitive and vulnerable to a decline in water quality, regardless of conditions near the surface, where wind and wave action keep oxygen levels high throughout the summer.

Natural water color levels were average in 2009, as were pH and total alkalinity. All were within the normal range of values for the lake.

*No invasive aquatic plants were found in the screening survey of Pennesseewassee Lake in 2009.* A native species of Milfoil is known to occur in this lake, and was documented in 2009. However, this plant is *not* invasive! A species of non-native, invasive snail, referred to as the “Chinese Mystery Snail” has been documented in the lake. This snail has now been observed in all four of the Norway lakes, as well as in a number of area waterbodies, including Thompson, the Range Ponds, and others. The ecological significance of this invader has not been determined. However, from a nuisance perspective, the large, dark green snails are offensive to the nose when they wash up on the shoreline, and there has been at least one report of oxygen depletion in a pond when a large number of the snails died over a short period of time.

Gleotrichia is a colonial blue-green algae that occurs naturally in many Maine lakes. Looking down into the water, “Gleo” has the appearance of tiny off-white dots, often likened to tapioca. In recent years, this algae has become problematic on some Maine lakes and ponds, and it may

be on the increase throughout Maine. Moderate green algae growth was observed in the surface water during the months of July and August. However, the concentration of this algae was extremely low in 2009.

### **Hobbs Pond (Little Penn):**

Water clarity in Hobbs Pond dropped sharply in 2009, compared to the previous six years. The water clarity average for the summer was 4.9 meters (about 16 feet), compared to 5.7 meters, in 2008, 6.1 meters in 2007 and 2006. The historical water clarity average for Hobbs Pond is 5.2 meters. Hobbs has been significantly clearer than its historical average for a number of years. However, in 2009 the pond experienced a sharp downward trend, most probably due to the cumulative effect of two years of very heavy precipitation and runoff.

Phosphorus levels were slightly lower than the average for this pond in 2009, averaging 9 ppb, compared to 8 ppb in 2008 and 2007. The historical average is 10 ppb. Phosphorus levels in the pond ranged from a high of 11 ppb in June 24, to the low reading of 6 ppb on August 26.

A phosphorus sample taken near the bottom of the deepest point in the pond on August 26 measured 18 ppb, indicating that this nutrient is being released from the bottom sediments as a result of very low dissolved oxygen levels.

The average concentration of chlorophyll-a in 2009 was 5.8 ppb – one of the highest annual averages on record for the pond. The highest reading of the summer, recorded on June 24 was 7.8 ppb, at which time the phosphorus level in the pond was also high; the lowest CHL level of 3.9 ppb was recorded on August 26. The CHL level in Hobbs has been climbing for the past several years. The 2008 average was 4.4 ppb. The historical average for the pond is 4.9 ppb.

During the past decade, the water quality of Hobbs Pond has improved quite notably. Back in the late 1970's and early 80's, the annual water clarity was nearly always in the mid 4 meter range (about 15 feet). At times, individual water clarity readings were as low as 2.0 meters (about 6 feet). LAON took the initiative to work with landowners in the watershed to implement conservation practices, which resulted in a nearly immediate turnaround in water quality.

The apparent decline in 2009 was likely due to two years of heavy precipitation and runoff from the watershed.

Late summer oxygen levels near the bottom of the pond were very low, and phosphorus samples taken near the bottom of the lake in August was moderately high (18 ppb) compared to surface concentrations at the time (6 ppb).

Other water quality indicators that are measured to help support the primary data (color, pH, and total alkalinity) were within the normal range of readings for Hobbs in 2009.

*No invasive aquatic plants were detected in Hobbs Pond in the 2009 screening survey that was conducted in August and September. However, as indicated above, the Chinese Mystery Snail was documented in the pond.*

### **Sand Pond:**

Sand Pond experienced a mixed year, with slightly below average water clarity, and slightly above average algae growth. Water clarity averaged 7.2 meters (about 23 feet), compared to 7.8 meters in 2008, compared to 7.0 meters in 2007, 7.7 meters in 2006, 8.5 meters in 2005, and the historical average of 7.4 meters. Sand Pond is the clearest of the four Norway Lakes, and in general, the water quality of this small pond is above average, compared to other Maine lakes. Consider that the average for all Maine lakes that were monitored in 2009 was 5.14 meters.

The average total phosphorus concentration in Sand Pond last summer was 6 ppb, compared to 4 ppb in 2008, 6 ppb in 2007, and the historical average of 7 ppb for the pond. The phosphorus average for Sand Pond in 2008 was slightly below average, and it was the lowest for the four Norway lakes. Sand Pond is also the clearest of the four lakes.

Chlorophyll-a levels were somewhat higher in 2009, averaging 3.0 ppb, compared to the 2.7 ppb historical average, and the 2008 average of 2.5 ppb. The relatively low level of CHL in Sand Pond is consistent with relatively low phosphorus levels and generally very good to excellent water clarity.

August and September dissolved oxygen levels in 2009 were similar to those documented in recent years. Substantial oxygen depletion was documented in the deepest area of the pond on August 26, and severe conditions were measured on September 25.

The maximum depth of Sand Pond is approximately 17 meters (56 feet). Phosphorus samples taken near the bottom of the deepest area of the pond in August were nearly five times as high (14 ppb) as a sample taken near the surface (3 ppb). This suggests that the pond is in a very sensitive state, and that water quality could change if conservation measures are not employed for both existing and new development in the watershed. The potential for phosphorus from the bottom of Sand Pond to become available to algae growing near the surface is moderate.

All additional support indicators of water quality were within normal ranges in Sand Pond during the 2009 monitoring season.

No invasive aquatic plants were detected in the 2009 screening survey of Sand Pond. Although the Chinese Mystery Snail has been documented in the pond in the past, none were observed during the 2008, or 2009 surveys.

## **North Pond:**

North Pond is relatively shallow, having a maximum depth of less than 15 feet. The shallow depth often limits the value of water clarity readings that are taken with a Secchi disk, because the disk reaches the bottom of the pond before it disappears from view. In the 1970's and 1980's, the Secchi disk was nearly always visible on the bottom of North Pond. However, when the pond started to experience algal blooms, the situation changed. Often the disk would disappear in the algae-laden water before it reached the bottom at only 12-13 feet.

In 2009, the Secchi disk was visible on the bottom of North Pond for four out of the five months, the exception being August, when the reading measured only 2.7 meters (about 8.9 feet). The threshold for a severe algae bloom is 2.0 meters or less.

The average phosphorus concentration for the year was 17 ppb, compared to the historical average of 17 ppb for North Pond. Phosphorus levels in the pond ranged from a low concentration of 12 ppb in September, to a very high level of 29 ppb in August. The 2009 average was the same as the 2008 and 2007 averages.

The concentration of algae in the water, as indicated by chlorophyll-a levels, was 6.0 ppb, which is slightly lower than the historical average of 6.3 ppb for North Pond. CHL ranged from a low of 4.2 ppb in September to a high of 6.1 ppb in June.

Phosphorus levels in North Pond are often higher than might be expected, based on water clarity and the actual concentration of algae in the water. This is most probably due to the fact that the very soft bottom sediments in this pond are easily resuspended in the overlying water, especially following periods of strong wind. The sediments raise the phosphorus levels in the water and reduce water clarity. But much of the phosphorus in the suspended sediment is not biologically available to the algae in the water.

Dissolved oxygen levels in North Pond are generally high throughout the summer monitoring period, due to the fact that the pond is very shallow, and easily circulated by the wind, which replenishes any oxygen that is consumed through the decomposition of organic matter in the water.

Overall, North Pond experienced an average year, with slightly reduced water clarity, average phosphorus levels and slightly lower than average algae growth.

No invasive aquatic plants were detected in the 200 screening survey of North Pond, which included the extensive attached wetland areas that drain to Pennessseewassee. The Chinese Mystery Snail has existed in North Pond for more than a decade.

## **Summary:**

Overall, there was a measurable decline in the Norway Lakes in 2009. This was most probably due to the cumulative effect of two years of very heavy precipitation and runoff, which carried phosphorus and sediment from the watersheds into the four lakes. The fact that both North and

Hobbs Ponds, and their watersheds drain into Penneesseewassee means that when either of the smaller ponds declines, Penneesseewassee is likely to experience a similar change.

Each lake and pond responds in a unique way to the influences of weather, changes in land use in the watershed, and other forces upon the ecosystem. This is because of the wide range of physical, chemical and biological characteristics of each lake basin and its watershed.

The following is a summary of findings for Penneesseewassee Lake, and Hobbs (Little Penn), Sand and North Ponds.

LAKE	Water Clarity in Meters	Core Total Phosphorus (ppb)	Core Chlorophyll-a (ppb)	Color (SPU)	pH	Total Alkalinity
Penneesseewassee	5.7	11	5.5	12	6.8	15.0
Hobbs (Little Penn)	4.9	9	5.8	15	6.9	12.0
Sand	7.2	6	3.0	10	6.7	7.0
North	Bottom (2.7+)	17	6	12	6.8	11.5

Special thanks are due to certified volunteer lake monitors Patti Ann Douglas on Sand Pond, and Warren Bryant on Penneesseewassee, and Ray Snedeker on Hobbs, who have contributed additional Secchi disk transparency (water clarity) data. Their efforts substantially improve our confidence in the monitoring results for the Norway Lakes.

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