Lake & Watershed Resource Management Associates
P O Box 65; Turner, ME 207-336-2980
LWRMA@megalink.net

2008 Baseline Water Quality Monitoring and Assessment of Pemaquid and Biscay Ponds

At the request of the Pemaquid Watershed Association, LWRMA conducted baseline sampling of Pemaquid and Biscay Ponds in late summer, 2008. The purposed of this project was to gather lake water quality data for the two ponds to evaluate present conditions, and to compare the information with historical data for the two bodies of water.

In addition to the samples and readings that we collected on September 2, 2008, we have also included data collected by local volunteers on both ponds in our analysis. The volunteers have been certified to collect lake water quality data by the Maine Volunteer Lake Monitoring Program. The data obtained in 2008 have also been compared to similar results from several hundred lakes throughout Maine, for which data were gathered during the same period of time.

The primary focus of the sampling of the two ponds was to obtain water quality information that reflects the extent to which development pressures in the watersheds of the two ponds is influencing their ecosystems. Watershed development is considered to be the most pervasive threat to the health of Maine's lakes and ponds.

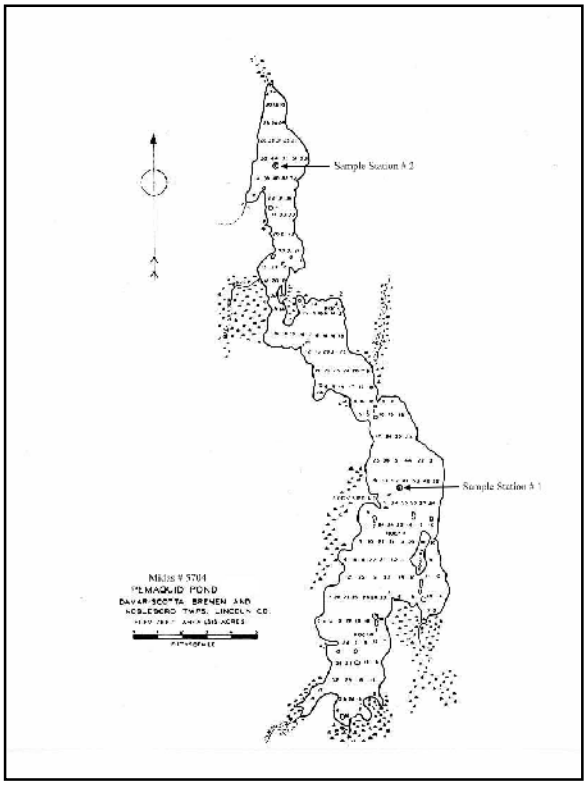
The primary effect of watershed development on lakes and ponds is increasing biological productivity, caused by the inflow of the nutrient phosphorus in stormwater runoff from developed areas of the watershed. Phosphorus stimulates the growth of algae, which in turn reduces water clarity. Water clarity has consistently been identified in public surveys as the most valued attribute of lakes and ponds. Shorefront property values have been strongly linked to the clarity of Maine lakes.

Over time, excess algal growth can also result in a decline in oxygen levels in the water during the warm summer months. Oxygen loss can stress the fishery, especially coldwater (salmonid) species. Pemaquid and Biscay Ponds support both warm and coldwater fish, and both experience significant dissolved oxygen loss during the late summer months, resulting in limited available habitat for the coldwater species.

The 2008 baseline sampling involved measuring water transparency (an indirect indication of the amount of algae in the water) at the deepest point in both ponds. Samples were collected to determine the concentration of the nutrient phosphorus, and the plant pigment chlorophyll-a, in order to determine the potential for algae growth, as well as the actual concentration of algae at the time of sampling. Surface to bottom profiles were taken for water temperature and dissolved oxygen. The natural color of the water was measured as well as the pH, and the alkalinity (a measure of the capacity of the water to resist, or buffer a change in pH).

Indicators of lake water quality vary considerably from season to season and year to year. This natural variability of lake ecosystems creates a significant challenge to interpreting lake data, and to identifying actual changes (trends) in the condition of individual lakes and ponds.

Pemaquid Pond



Pemaquid Pond was monitored at the deep station (01) on August 2, 2008. At that time, water clarity measured 4.60 meters in depth. Additional readings, taken by volunteer lake monitors during the season, averaged 4.3 meters for the five month monitoring period. The historical average for station 01 is 4.9 meters, based on 32 years of data. Water clarity readings from recent years appear to be lower (less clear) than for most years during the early years of monitoring the lake. However, this may be due to natural cycles that many lakes experience, and possibly to the influence of extreme weather in recent years. There is certainly value in the continued monitoring of this by volunteers monitors and the PWA.

A total phosphorus sample taken near the lake surface measured 8 parts per billion (ppb), compared to the next most recent sample from 2004, which also measured 8 ppb, and the historical average of 9 ppb. Relatively few phosphorus samples have been taken from the lake during the three decade monitoring history. Several historical samples have measured 8 ppb, which is the lowest concentration of any integrated core sample taken for the lake. The highest sample measured 17 ppb in 1999, which appears to be an anomaly.

A phosphorus sample taken near the bottom of the deep station measured 13 ppb, which, compared to the surface concentration, may indicate that phosphorus is being released

from the bottom sediments as a result of oxygen depletion in the deep areas of the water column (see below).

Chlorophyll-a (CHL), measured 5.4 ppb, compared to 5.3 ppb in 2004, and the long-term average of 3.9 ppb. Relatively few (7) CHL samples have been taken from this lake during the past three decades. The moderate concentration of CHL measured in 2008 is consistent with the result of the phosphorus sample, also considered moderate, and for the below average water clarity readings for the season.

The temperature and dissolved oxygen profile taken from the surface to the bottom of the pond at 17.2 meters depth showed a severe loss of dissolved oxygen from a depth of 9 meters to the bottom of the pond. Similar losses of late summer dissolved oxygen have been documented at this sampling location in the past. The extreme loss of oxygen in Pemaquid during the late summer is consistent with moderate biological productivity, as well as with the Secchi, phosphorus and chlorophyll sample results.

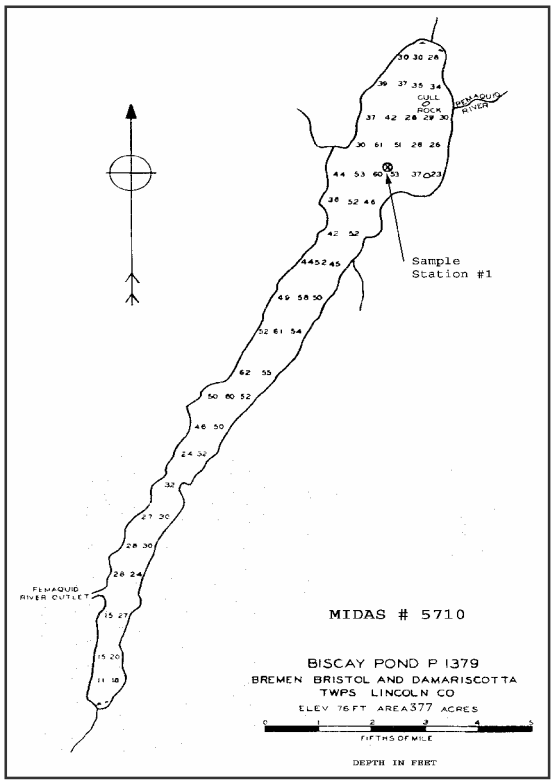
The level of natural water color measured 28 SPU, compared to the historical average for the lake of 25 SPU. Moderately concentrations of color in this lake may be reducing water clarity, and increasing phosphorus levels in the water. Water color is influenced by natural sources of humic acids from wetland plants and other vegetation in the watershed. Lake water color is a natural phenomenon that should be considered when assessing lake water quality data.

The August 2 pH sample measured 6.61, compared to the historical average of 6.68. Total alkalinity measured 5.5 mg/l, compared to the historical average of 7.3. Conductivity measured 42 uS/cm, which is also the historical average for the lake.

Biscay Pond

Biscay Pond was monitored at the deep station (01) on August 2, 2008. At that time, water clarity measured 5.7 meters in depth. The average for four months of monitoring water clarity in 2008 by volunteers was 5.0 meters, compared to the historical average of 5.2 meters for the pond. The average of three readings taken in 2007 was 5.1 meters.

A total phosphorus sample taken near the lake surface measured 6 parts per billion (ppb), compared to the next most recent samples from 2002, which measured 7 ppb, and the historical average of 7 ppb. A sample taken near the bottom of the lake was significantly higher (14 ppb),



suggesting that the oxygen loss described below may be contributing to the recycling of phosphorus from the bottom sediments.

Chlorophyll-a in the upper depths of the lake averaged 5.1 ppb, compared to an average of 5.3 ppb in 2002, and the long-term average of 4.2 ppb. This historical average recently increased as a result of the moderate CHL level measured during the 2008 sampling. With relatively few historical CHL samples in the database for this pond, single samples can have a noticeable influence on the historical average. It is worth noting that CHL samples taken during the early years of the 32 year sampling history for this pond were lower, which could suggest increasing productivity (algae growth) in the pond in recent years. Continued monitoring of the pond is recommended to determine whether or not levels measured in recent years will continue to increase.

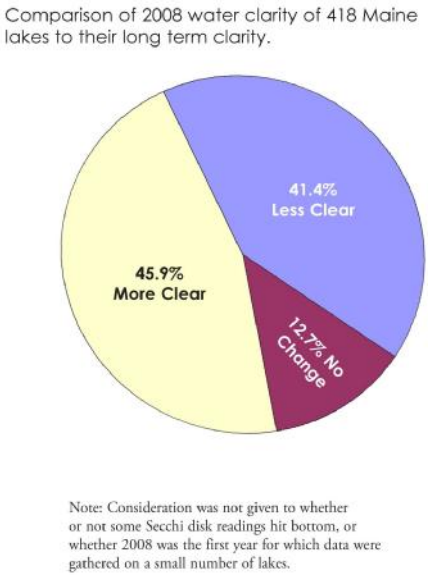
The temperature and dissolved oxygen profile taken from the surface to the bottom of the pond at 18.2 meters depth showed a moderate loss of dissolved oxygen from a depth of 7 meters to the bottom of the pond at 18.2 meters. Similar losses of late summer dissolved oxygen have been documented at this sampling location in the past. In addition to stresses to fish and the lake biota, low oxygen in the deep area of the pond may be influencing the release of phosphorus from the bottom sediments. As noted above, a sample taken near the bottom of the pond on August 2 was significantly higher than the phosphorus level measured near the surface.

The level of natural water color measured 19 SPU, compared to the historical average for the lake of 29 SPU. Although the 2008 color sample was relatively low, the historical average for the pond (based on a small number of samples) is moderate, suggesting that color may be having an influence on the indicators used to monitor lake productivity. Future sampling may help refine the "average" color level for the pond. Water color is influenced by natural sources of humic acids from wetland plants and other vegetation in the watershed. Lake water color is a natural phenomenon that should be considered when assessing lake water quality data.

The August 2, 2008, pH sample measured 6.83, compared to the historical average of 6.58. Total alkalinity measured 5.3 mg/l, compared to the historical average of 8.8. Conductivity measured 41 uS/cm, compared to the historical average of 39.

Statewide Perspective on 2008 Lake Water Clarity:

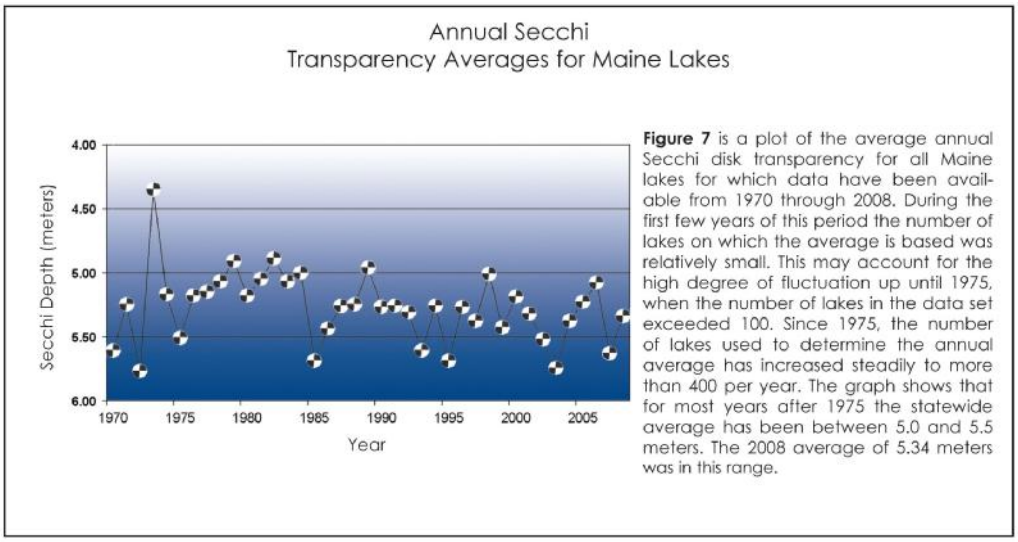
To put into perspective the significance of the 2008 water clarity findings, consider that out of 418 Maine lakes that were assessed last year, about 46% were clearer than their historical averages, and about 41 % were less clear than their average. *This represents a significant change from 2007, when a much higher percentage of Maine lakes were clearer than they had been historically.*



Percentage of Maine Lakes that were clearer, less clear, and the same as their Historical Average in 2008 (Source: Maine Volunteer Lake Monitoring Program Maine Lakes Report

It is likely that the reduction in the number of lakes that were clearer than average in 2008 was the result of heavy snow and runoff in the spring and moderate to severe rain throughout much of Maine during the mid to late summer period. Spring runoff from melting snow and rain typically carries a high percentage of the annual phosphorus load to lakes from their watersheds. Information obtained from the National Weather service indicated that Portland, Maine experienced the wettest summer period in 138 years.

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. Note that this average has, for most years since this information has been tracked, fallen between 5.0-5.5 meters. Variation from one year to the next is influenced by many factors, not the least of which is weather. Maine lakes may be relatively clearer during dry years because stormwater runoff from rainfall carries phosphorus and other pollutants from the watershed to the lake.



Source: Maine Volunteer Lake Monitoring Program 2008 Maine Lakes Report

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 reduced precipitation during the winter, spring and early summer months, when a high percentage of watershed phosphorus loading typically occurs for lakes. But in 2008, along with a lower percentage of lakes being as clear as they were in 2007, the overall water clarity for Maine lakes dropped to 5.35 meters, as the graph above illustrates.

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 nutrient phosphorus (TP), chlorophyll-a (CHL) and the concentration of dissolved oxygen in deep areas of the lake during the summer months.