Damariscotta Lake Water Quality Monitoring & Assessment Report 2001

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The water quality of Damariscotta Lake has been monitored for over two decades by trained volunteers, staff from the Maine DEP, and consultants for the Damariscotta Lake Watershed Association (DLWA). The focus of the monitoring has been to accurately characterize the existing quality of the lake, and to assess long-term trends. Both the *quantity* and *quality* of data have been carefully considered throughout this process. Quality assurance and quality control have been a key element to insure those who use the data that the information gathered accurately reflects the condition of the lake. And, a substantial volume of water quality data are generally required before it is possible to state with a degree of certainty that changes are occurring in the lake ecosystem. This is primarily because of the high degree of natural variability that occurs in the indicators used to assess lake systems.

There are numerous ways to evaluate lake water quality. The primary threat to the quality of Maine lakes is the potential for nutrient enrichment and excess plant growth to occur as a result of land use changes and development in the watershed. This process is called cultural eutrophication. As watershed development takes place, stormwater runoff from developed areas may carry elevated concentrations of nutrients and soil sediments to the lake, resulting in an increase in algae growth and the loss of dissolved oxygen in the water. The purpose of the DLWA lake monitoring program is to assess the "trophic state" of the lake. Trophic state is a measure of biological activity, as indicated primarily through algae growth, because algae are at the base of the lake food chain. A rapid increase in lake trophic state may indicate that a lake is ageing prematurely.

The loss of water clarity or transparency has both aesthetic and economic implications. Clear water is highly valued by the public, as indicated below. Excess algae growth can cause the loss of oxygen in lake water, especially during the warm summer months. Over time, the gradual decline of oxygen can have a negative impact on a lakes coldwater fishery (Trout and Salmon).

A number of natural factors, including the weather, can obfuscate efforts to identify changes in water quality. The 2001 field-monitoring season appears to have been a good example of the way in which weather can influence lake water quality indicators. Much of the State of Maine experienced a severe drought during the latter part of the summer. Precipitation was substantially below average for July, August and September. Because the primary means by which most pollutants reach lakes is via stormwater runoff, periods of drought may have a short-term beneficial effect on water quality. In some respects, this appears to have been the case for Damariscotta Lake last summer.

A primary indicator of lake water quality is transparency, or clarity – the distance that one can see down into the water. Transparency reflects plant growth (algae) in the water. Lake water clarity varies from season to season and year to year due to the influences of weather, disturbances and development in the watershed, and from natural cycles and rhythms of the plant and animal communities that live in the water. Studies conducted in Maine have shown that lakes with clearer water support higher shorefront property values, resulting in a boost to community tax bases. Conversely, lakes with less clear water, or water that becomes less clear over time, may experience a decline in shorefront property values and local revenues.

Damariscotta Lake is a complex system of three basins that behave like independent lakes. Great Bay (Basin 1), Muscongus Bay (Basin 2), and the South Arm (Basin 3) are unique areas of the lake that have exhibited similar, but measurably different water quality characteristics over time. Some of the differences are simply due to the natural variation in the morphology of the basins.

Although the long-term overall clarity of Damariscotta Lake is "average," compared to other Maine lakes, the 2001 drought appears to have caused each of the three basins to be exceptionally clear last summer. The long-term average for Secchi disk transparency for Damariscotta Lake is approximately 5.0 meters (~16 feet) for each basin. The variation between basins is typically in the order of a few tenths of a meter. Each of the three basins was substantially clearer than average in 2001. Basin 1 averaged 7.1 meters, Basin 2 was slightly less than 6 meters, and Basin 3 averaged 6.3 meters. Last summer the water was by far the clearest on record for Damariscotta Lake. Unusually clear individual readings were recorded early in the summer – easily the highest on record for this lake.

It is difficult to know all of the factors that may have contributed to the exceptional clarity of Damariscotta Lake during the summer of 2001. Relatively little data from other lakes have been assessed at the time of writing this report, so a comparison of possible similar changes for other lakes in the region has not yet been undertaken. It is important to bear in mind that the transparency readings taken in 2001 do not necessarily indicate a long-term improvement in overall water quality. If 2002 proves to be a very wet year, transparency averages for the lake could be much lower. This is a good example of why it is essential to obtain many seasons of data in order to accurately characterize the condition of the lake. One important message from the 2001 season appears to be that the control and treatment of stormwater runoff from developed areas of the watershed can cause a measurable improvement in water clarity.

Other indicators used to indicate the lake trophic state include total phosphorus, a nutrient that can stimulate algae growth and chlorophyll, a pigment that is found in plant cells. Both are measured to determine algae growth in the lake. During the 2001 field season, phosphorus levels near the surface were below average for Basins 1 and 3, and average for basin 2. Chlorophyll-a concentrations were below the long-term average for all three basins. This information is consistent with the excellent water clarity last summer.

It is interesting to note that phosphorus concentrations near the bottom of the lake were higher than average in all three basins. Phosphorus concentrations near the bottom of Basin 2 (Muscongus) were very high in August, and extremely high in October. Historically, this area of the lake has shown indications of phosphorus release from the bottom sediments. The release of soluble phosphorus from bottom sediments is often associated with oxygen depletion in the water. Basin 2 experiences severe oxygen depletion during the late summer months. The high concentrations of phosphorus from bottom samples may have been the result of the oxygen depletion documented during the summer. Sample contamination with bottom sediments must always be considered in cases where extreme high phosphorus concentrations are documented. However, great care is taken to insure that this does not occur. High concentrations of phosphorus from bottom samples were also documented in Basin 3 (South). The levels measured in this area of the lake were similar to those documented in previous years.

The release of phosphorus from the bottom sediments of Damariscotta Lake is most probably the result of the extreme oxygen loss that occurs in Basins 2 and 3 during the course of the summer. Dissolved oxygen loss also occurs in Basin 1, but to a lesser degree, and it occurs later in the field season. The progressive loss of oxygen during the summer months is a clear warning that the lake is stressed, in spite of appearances at the surface. Coldwater fishery habitat is compromised by the oxygen loss, and the potential for recycled phosphorus to stimulate algal growth near the surface is moderately high. Some of the oxygen loss in the lake may be the result of natural concentrations of organic acids in the water. Humic acids released from wetland vegetation may cause staining of the water and oxygen depression. However, this natural factor that may be contributing to the loss of oxygen does not reduce the vulnerability of the lake to a water quality decline from human influences.

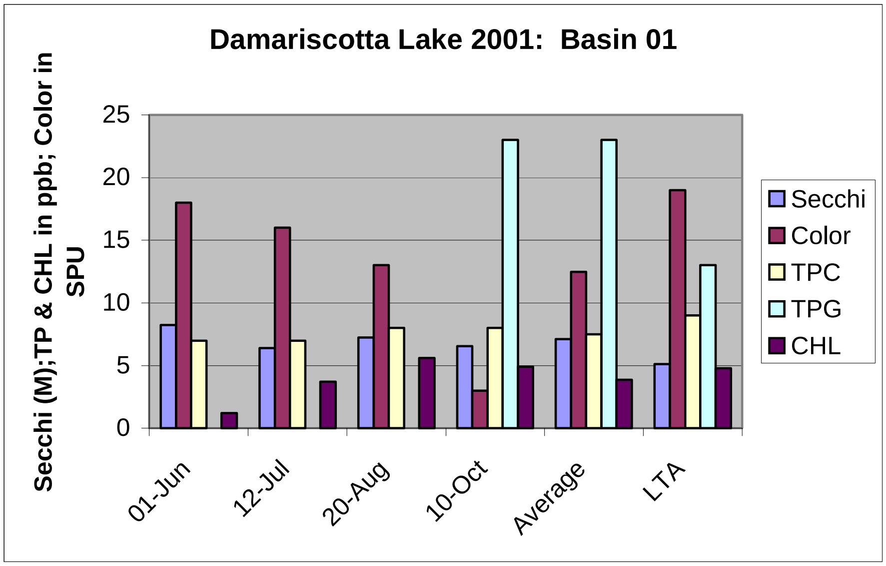
Additional indicators of water quality, such as pH and total alkalinity are measured to support or correlate with the primary indicators of trophic state. Both ph and alkalinity were within normal limits for Damariscotta Lake during the 2001 season.

The water quality-monitoring program is an important way to track Damariscotta Lake's “vital signs.” It is essential that we understand and document changes to the lake over time. It is equally important to maintain an ongoing program of prevention and protection in the watershed. The efforts of DLWA and the five watershed communities to implement the Watershed Management Plan for the lake represent a holistic approach to lake stewardship. Some of the improvements in water clarity observed during 2001 may very well be attributed to reduced sediment and phosphorus loading to the lake as a result of the numerous erosion problems that have been addressed by landowners in the watershed.

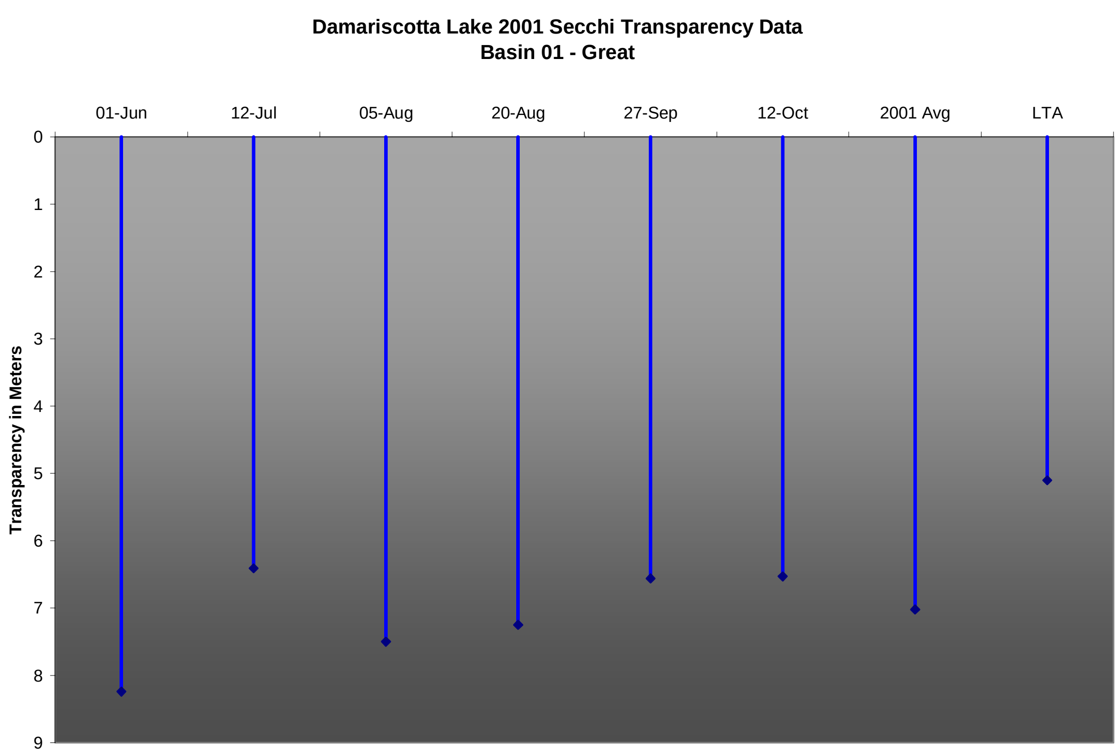
Many thanks to Ralph Knowles, Peter Streker, Ed Knapp, Marty Welt and Don Stanley for their assistance in collecting and coordinating data during the 2001 monitoring season. Volunteer data are an essential component of the annual assessment of Damariscotta Lake.

Attached to this report are graphic illustrations of the data. Figures 1, 2 and 3 illustrate trophic state data for the individual basins. Figures 4, 5 and 6 show Secchi transparency readings throughout the summer, and Figures 7, 8 and 9 illustrate progressive changes in dissolved oxygen concentrations throughout the season for the three basins.

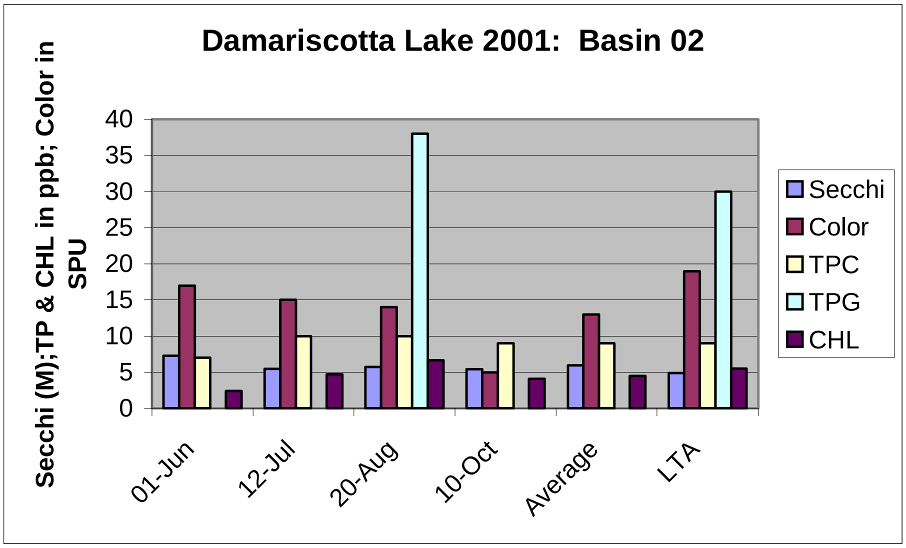
	01-Jun	12-Jul	20-Aug	10-Oct	Average	LTA
Secchi	8.24	6.41	7.25	6.53	7.11	5.1
Color	18	16	13	3	12.5	19
TPC	7	7	8	8	7.5	9
TPG				23	23	13
CHL	1.2	3.7	5.6	4.9	3.85	4.8



Note: TPC= Total Phosphorus integrated core sample
TPG = Total Phosphorus discrete sample taken near lake bottom
Average = Seasonal Average value of indicator
LTA = Long-Term Average value of indicator (From MDEP/VLMP Database)

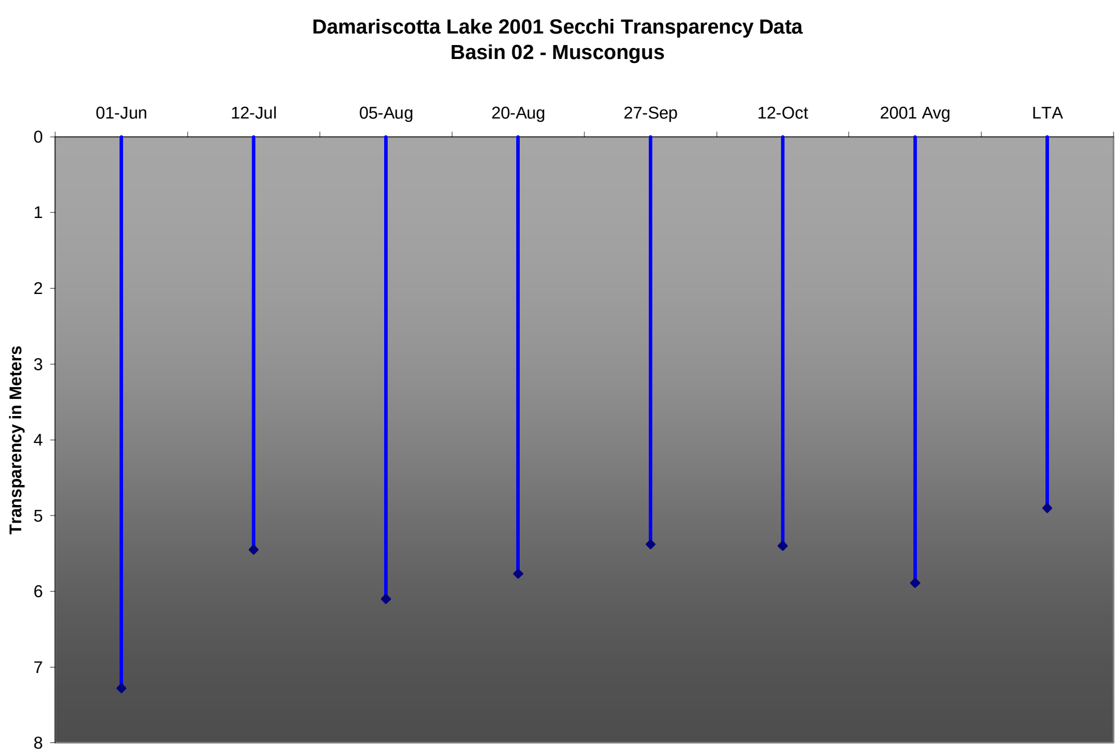


	01-Jun	12-Jul	20-Aug	10-Oct	Average	LTA
Secchi	7.28	5.45	5.77	5.4	5.98	4.9
Color	17	15	14	5	13	19
TPC	7	10	10	9	9	9
TPG			38	**NOTE**	**NOTE 2**	30
CHL	2.4	4.7	6.7	4.1	4.48	5.5



NOTE: TPG Sample Value on Oct 10 was 140 ppb. Omitted from Graph to preserve scale.

NOTE 2: Seasonal TPG average was 89 ppb. Omitted to preserve Scale



	01-Jun	12-Jul	20-Aug	10-Oct	Average	LTA
Secchi	8.2	5.85	5.49	5.82	6.34	5
Color	17		12	5	11	16
TPC	21	12	11	10	13.5	10
TPG			16	24	20	19
CHL	1.5	3.8	4.5	4.1	3.5	4.8