Portland Water District
Sebago Lake Watershed Monitoring Program
Lake Monitoring
Presenting Periphyton data from 1995 to 2018

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Introduction;

Sebago Lake is the primary drinking water supply for nearly 200,000 people in eleven Greater Portland communities. Lake water was first delivered to Portland in 1869, from an intake located in the southernmost part of the lake, referred to as Lower Bay. In 1908, the Portland Water District was chartered by the Maine Legislature to provide water services to the cities of Portland and South Portland. The water system has gradually expanded to include eleven cities and towns in Greater Portland. Since its inception, the District has been actively monitoring and working to protect Sebago Lake.

In 1993, the District was granted a waiver to the filtration requirements of the Federal Safe Drinking Water Act (SDWA) based in part, on the purity of the water and the effectiveness of watershed protection efforts. This waiver agreement requires ongoing monitoring of lake water quality. The District maintains more than 10 monitoring and surveillance programs throughout the watershed and lake. In general, as one moves closer to the intakes, more samples are collected and tested for more parameters.

This report summarizes results of the Periphyton Monitoring Program

Methods

Periphyton and its use as a water quality indicator, is described in the reference manual Standard Methods for the Examination of Water and Wastewater 19th Edition.

Microorganisms growing on stones, sticks, aquatic macrophytes, and other submerged surfaces are useful in assessing the effects of pollutants on lakes, streams and estuaries. Included in this group of organisms, here designated periphyton, are the zoogleal and filamentous bacteria, attached protozoa, rotifers, and algae, and the free-living microorganisms that swim, creep, or lodge among the attached forms. Unlike the plankton, which often do not respond fully to the influence of pollution in rivers for a considerable distance downstream, the periphyton show marked responses immediately below pollution sources. Examples are the beds of Sphaerotilus and other "slime organisms" commonly observed in streams below discharges of organic wastes. Because the abundance and composition of the periphyton at a given location are governed by the water quality at that point, observations of their condition generally are useful in evaluating conditions in bodies of water. The use of periphyton in assessing water quality often is hindered by the lack of suitable natural substrate at the desired sampling station. Furthermore, it often is difficult to collect quantitative samples from these surfaces. To circumvent these problems, artificial substrates have been used to provide a uniform surface type, area, and orientation (Eaton, Clesceri, Greenburg, 1995).

Five near-shore locations around the lake, with different land use variables, have been monitored since 1995. Artificial habitat substrates made of rigid foam insulation are suspended 5' below the surface of the water. The substrates are placed in 10' of water and are generally within 100' of the shoreline. Periphyton naturally grows and accumulates on the artificial substrate for 28 days. In addition to periphyton, the substrates capture falling organic matter (small pieces of leaves, pollen etc…) and sediment which settles during the incubation period. The material is harvested and analyzed for dry weight and ash free weight. Dry weight represents the total mass of algae, detritus and sediment on the substrate. Ash free weight is the amount of organic matter on the substrate. Detailed information on substrate construction, deployment/retrieval, and laboratory analysis used in this study are explained in detail in the Portland Water District document: FURTHER INVESTIGATION OF THE PERIPHYTON OF SEBAGO LAKE (Koza, 1996).

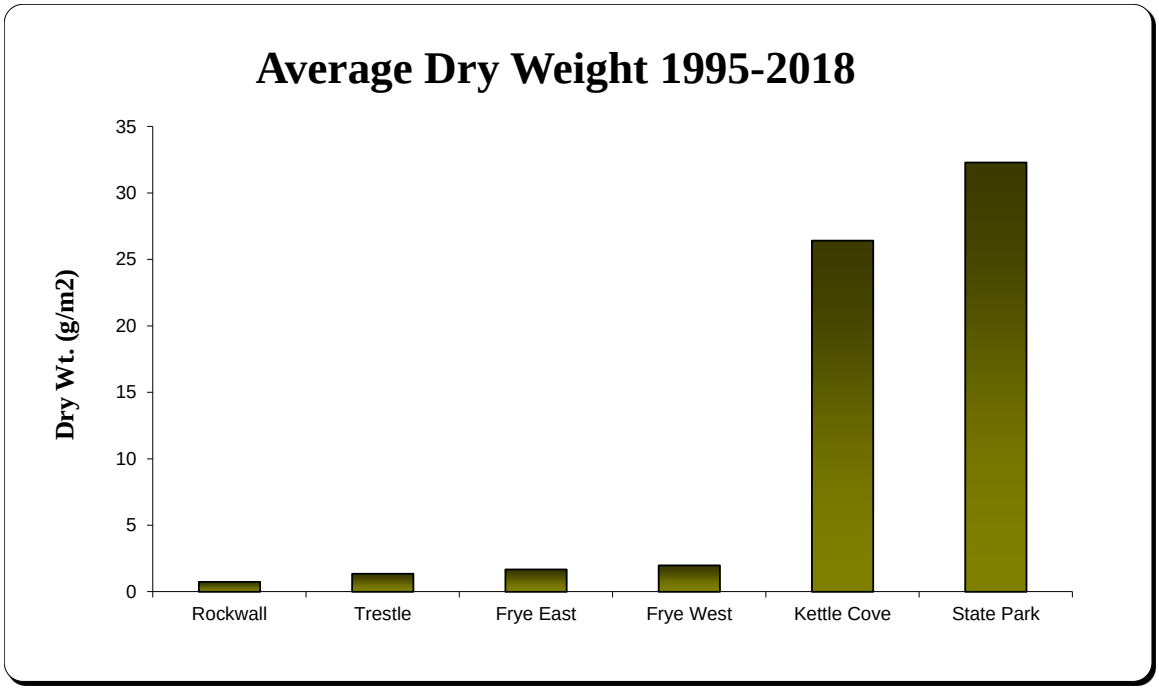
Staff harvesting periphyton from the substrates.

Results and Discussion

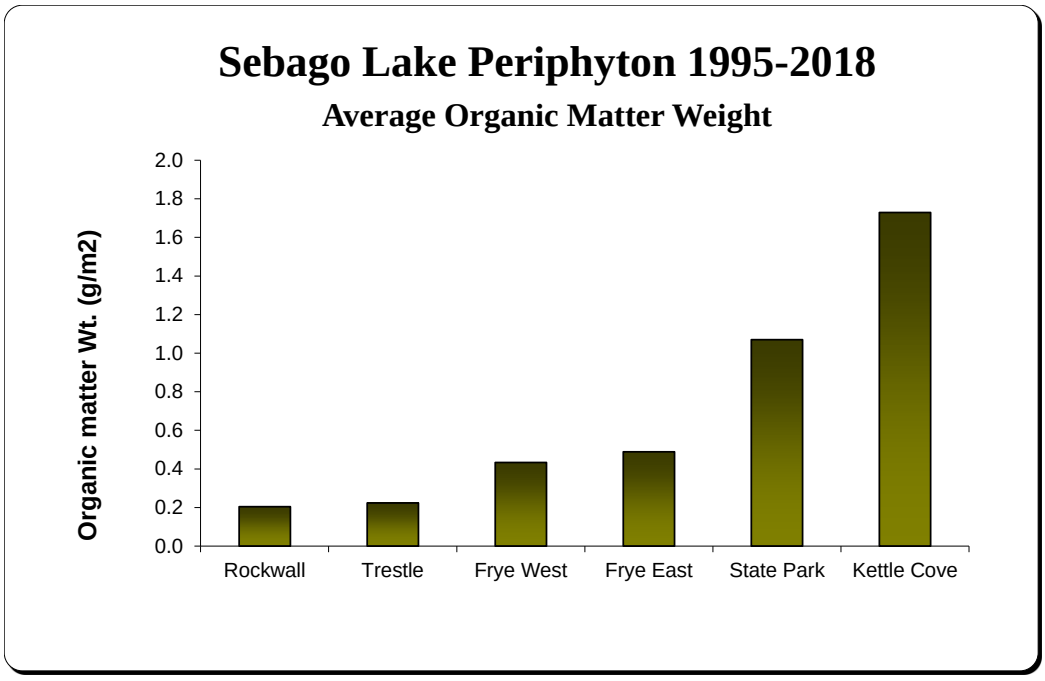
The periphyton community is an important component of the aquatic web of life. However, too much periphyton is indicative of poor water quality caused by hyper-nutrient conditions. Hyper-nutrient conditions on Sebago Lake generally are fueled by unchecked storm water run-off and poor septic tank maintenance. These unnatural conditions eventually lead to increased drinking water treatment costs, taste and odor complaints, slimy rocks, slimy docks, green boat hulls and decreased lake front property values.

Statistical analysis was performed on all data collected at five sites from 1995-2017. Since the variables contributing to periphyton growth are numerous and tend to dramatically fluctuate from year to year, statistically significant trends over time are atypical. Dry weight represents algal growth, detritus and sedimentation on the substrate surface in one month.

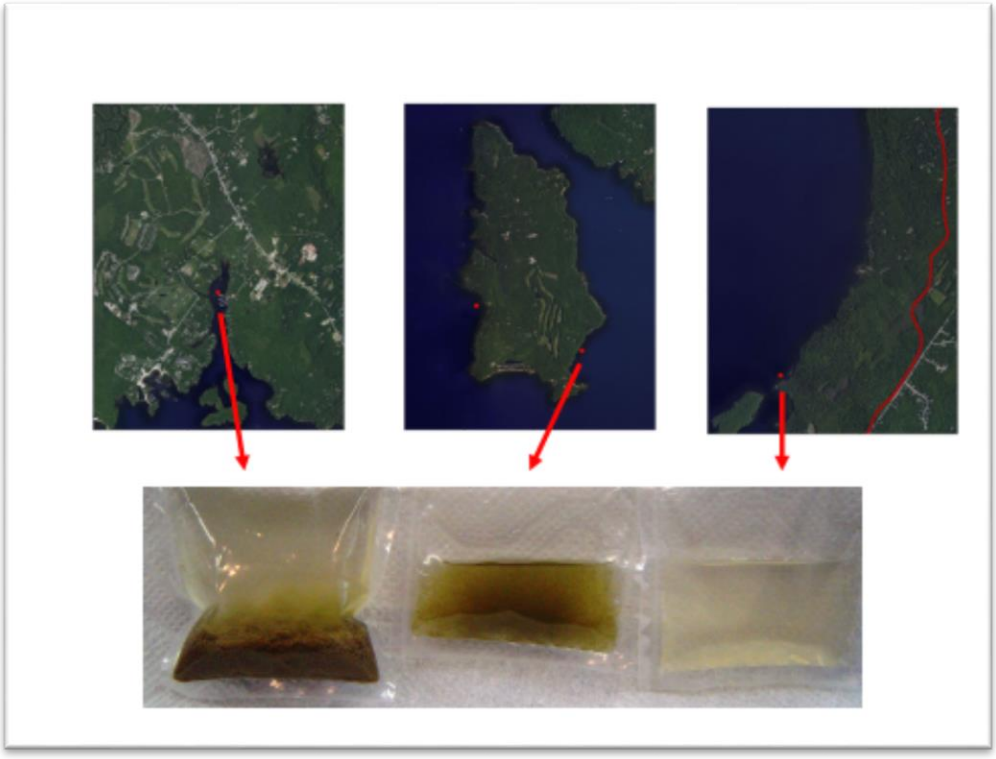
One way factor ANOVA (analysis of variance) statistical test reveals significant differences among sample locations. The average amount of periphyton in Kettle Cove and at the State Park has significantly more periphyton biomass than other sample locations tested. The sample locations were chosen because of their distinct adjacent land use variables.



The mouth of the Crooked/Songo River has the most material on the substrate.



Kettle Cove, which directly drains a golf course and is a highly developed cove, has the most organic matter on the substrate.



Visual representation of the material scrapped off the substrate at three distinctly different watershed locations.

Rockwall Beach represents the control area due to its location inside the two mile restricted area surrounding the PWD's water intake pipes. Bodily contact with the water in this area has been prohibited since 1913. It is a pristine, stable shoreline segment in a remote location at the southern end of the lake with minimized opportunity for natural or anthropogenic nutrient contributions. There are no waste disposal systems on this shoreline segment.

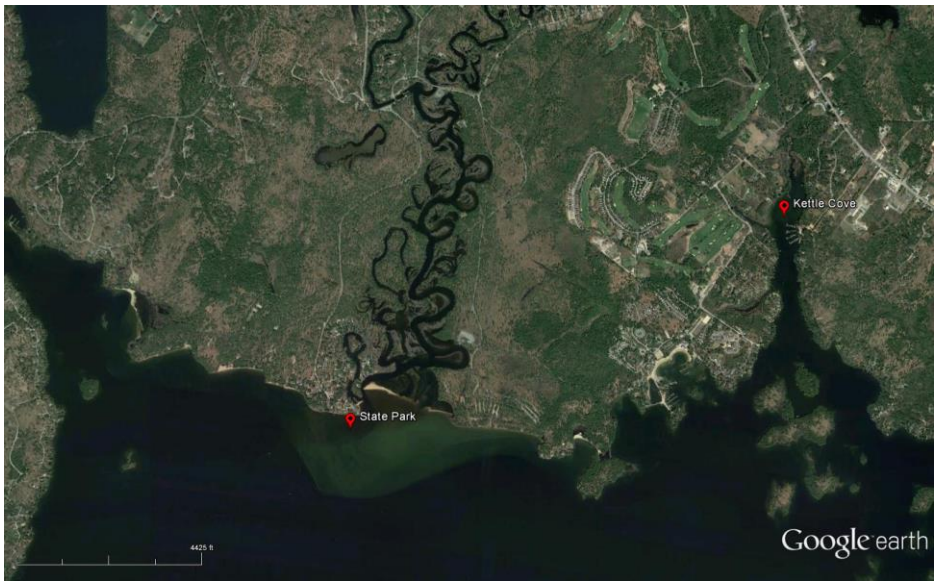
Trestle is located at the outlet of Smithmill Bog railroad trestle in Lower Bay. The immediate watershed area is owned by the water district and has limited residential development. A stream feeds the sample location has the Standish Wildlife Sanctuary as a watershed

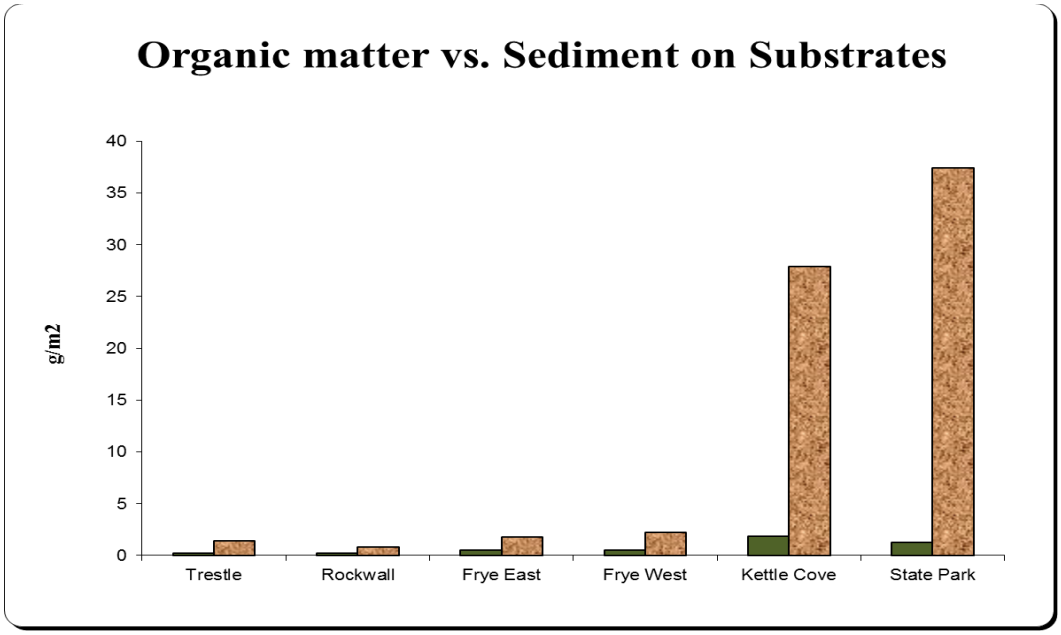
Kettle Cove, located at the north end of the lake, is a heavily populated area that has nutrient levels higher than the main lake. Approximately twenty waste disposal systems are in the immediate vicinity of the shallow water substrates. Numerous citizen complaints concerning poor water quality and increased macrophyte growth have arisen from this cove. A stream that drains a nearby golf course enters the lake in proximity to the study area.

Frye Island (west), located on the south west shore of the island, is plagued by the processes of erosion. The shoreline and shallows are comprised of clay deposits that create plumes when prevailing winds cause heavy surf. There are roughly fifteen waste disposal systems in close proximity to the shallow substrates.

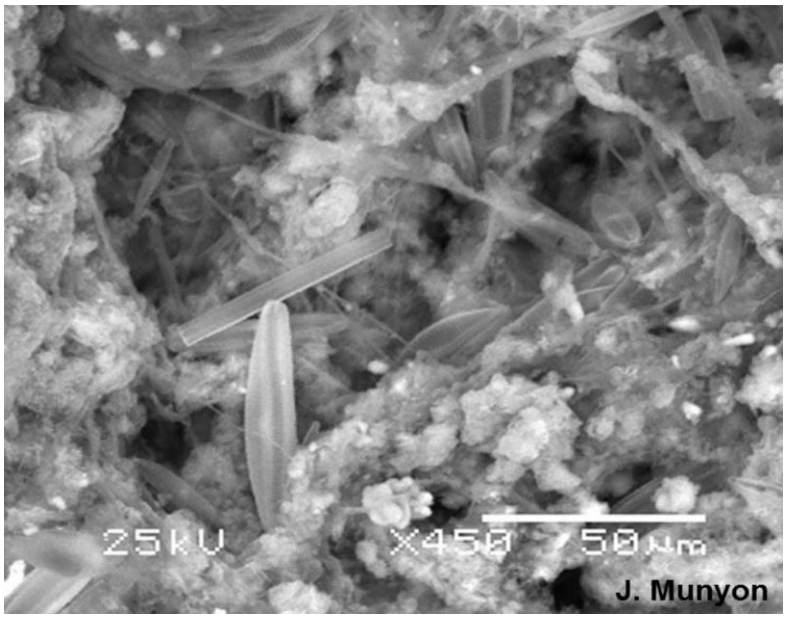
Frye Island (east) is located on the southeast shore of the island. Unlike the west side, this shoreline segment is not subject to heavy winds and long fetch, has a stable configuration of large and rip rap size rocks, and has light development. Less than five waste disposal systems are in the immediate area.

The State Park, located at the north end of the lake, is a sandy area near the mouth of the Songo/Crooked River. This river is the largest tributary entering the lake and consequently transports the largest amount of nutrients into the lake. Approximately ten septic systems are in use on the shoreline adjacent to the shallow water substrates. (Koza, 1996)

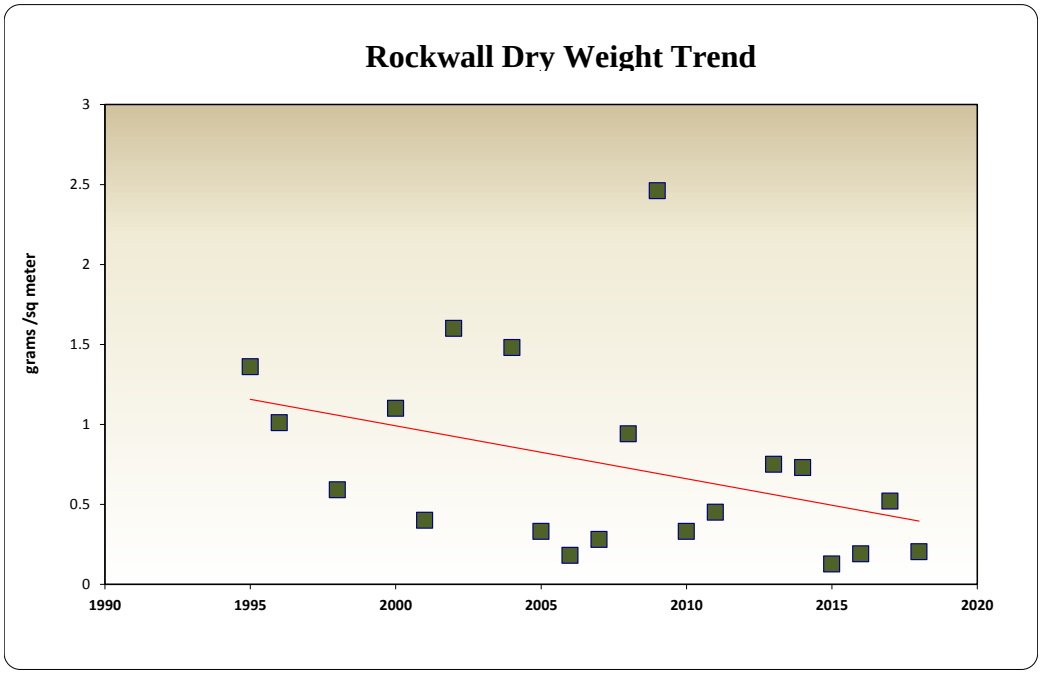




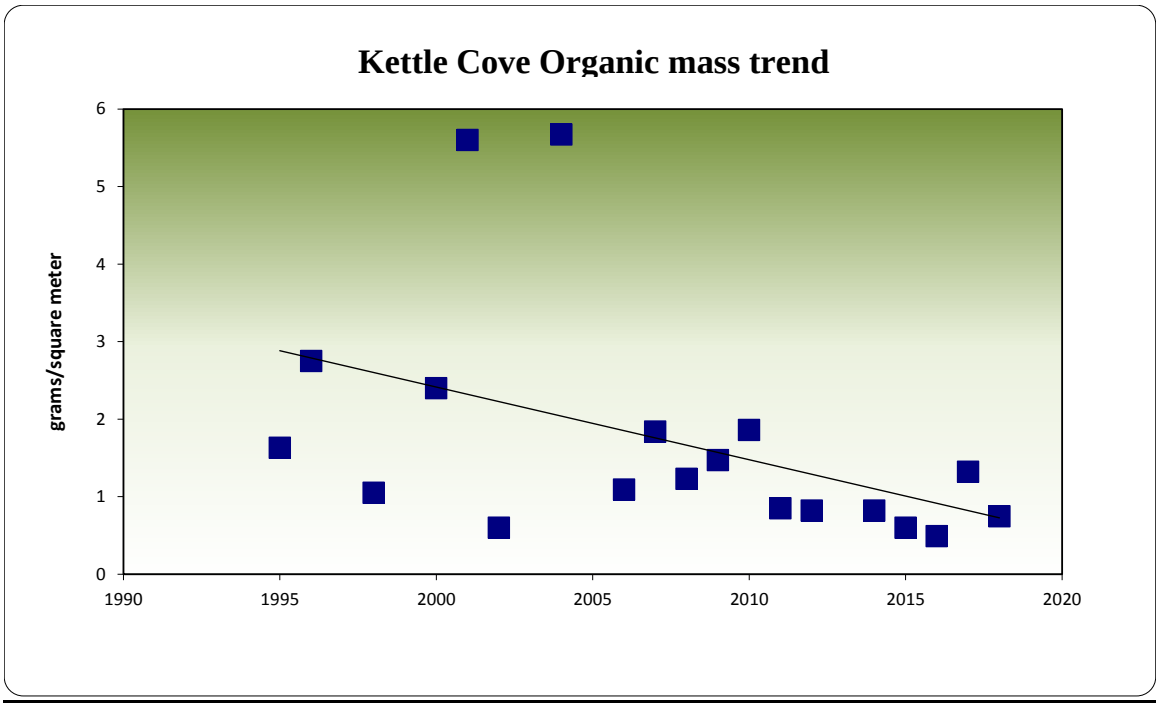
Most of the material on the substrates are fine sediment rather than organic matter.



Visual representation of what the material looks like under magnification.



Perphyton biomass on substrates seems to be in decline at most locations.



Organic biomass on substrates seems to be in decline at most locations.

Conclusion

Significant long-term trends in periphyton growth are often difficult to measure because the data are highly variable from year to year. Growth factors (sunlight, rainfall, water temperature, macro-nutrient levels, micro-nutrient levels, O^2/CO^2 concentrations, complex ecological interaction, etc…) can change drastically from year to year as well as during the 28 day incubation period. However, trends seem to be indicating less periphyton growth.

Presumably, environmental conditions for periphyton growth (as mentioned above) within each year are consistent within the lake (with one important difference; water quality conditions at specific site locations). Seventeen years of periphyton monitoring seem to show that dense residential development and large tributary inputs drastically increase the amount of periphyton growth and total mass attached to the submerged substrates, as seen in data from Kettle Cove and the Crooked River outlet. Shoreline areas without development show the least amount of biomass growth and total mass, as seen at the Rockwall sample location. Moderate controlled development as seen on Frye Island shows a moderate amount of periphyton growth. Data seem to show that human development density and land management have a correlation to adjacent water quality conditions as seen in periphyton growth.

References

Eaton, Clesceri, Greenberg (1995). Standard Methods for the Examination of Water and Wastewater, 19th Edition. American Public Health Association. USA.

Koza, Michael (1996). Further Investigation of the Periphyton of Sebago Lake. Portland Water District