

State of the Lake, 2005

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The Flathead Lake Biological Station (FLBS) has monitored water quality in Flathead Lake continuously since 1977. These studies have been the technical background for development of a Total Maximum Daily Load (TMDL) allocation for the purpose of managing nutrient loads reaching Flathead Lake.

Based on our research, the Flathead Basin Commission recommended the following interim targets for the protection of water quality in Flathead Lake: 1) annual primary production will not exceed $80 \text{ gC m}^{-2} \text{ yr}^{-1}$ (80 grams of carbon per square meter per year), 2) annual average chlorophyll *a* concentration shall not exceed $1 \text{ } \mu\text{g/L}$ (1 microgram per liter), 3) no declining trend in oxygen concentrations in the bottom waters of the Lake, 4) no measurable blooms of *Anabaena flos-aquae* (or other pollution algae) and 5) no increase in the biomass of lakeshore periphyton.

Our long-term record of primary productivity in Flathead Lake is a robust indicator of long-term changes taking place in water quality. Primary productivity experiments measure Flathead Lake's ability to grow algae. An increase in algal production reflects a decrease in water quality, thus high numbers reflect poorer water quality while low numbers reflect better water quality (Fig. 1). Primary production in Flathead Lake in water year (WY), October 1 through September 30, 2004, exceeded the TMDL target value by 40% or 39 grams of carbon per square meter per year.

Growth of algae in Flathead Lake is primarily influenced by loading of the nutrients nitrogen and phosphorus; numerous studies have shown that both stimulate growth of algae in Flathead Lake. Nutrients are transported into the lake via tributaries, atmospheric dryfall and wetfall, groundwater seeps, point source discharges (sewage treatment plants) and nonpoint sources (old or poorly designed septic systems). Runoff reaching the lake from inadequately buffered land disturbances such as roads, agricultural activities, forest harvest, homes, driveways or other impervious surfaces also contributes nutrients.

Under certain conditions, food web changes may also influence primary production by altering the density of organisms cycling these nutrients within the lake. The highest measured primary production occurred in Flathead Lake during 1988, about two years after the peak in abundance of the introduced opossum shrimp *Mysis* (Fig. 2). The removal of several species of zooplankton (by *Mysis*) may have greatly reduced the zooplankton predation on algae. Thus, algal abundance could increase thereby increasing primary production. Clearly, alterations in Flathead Lake's food web will continue as *Mysis* densities fluctuate.

Experiments have shown if nutrient levels in Flathead Lake increase, organisms such as *Mysis* will become more important in regulating primary production. But, at current nutrient levels, nitrogen and phosphorus appear to be more important in controlling the algal community in Flathead Lake.

The annual mean concentration of chlorophyll *a* for the depth integrated samples was below the interim TMDL target for Flathead Lake in WY 2004, but during July and August, a slight bloom of the blue-green algae *Anabaena flos-aquae* was visible in the surface waters. The TMDL interim targets recommend no measurable blooms of *Anabaena flos-aquae* (or other pollution algae) at the midlake deep site. Although surface phytoplankton (microscopic plants) samples were collected in 2004, quantitative enumeration of the extent of the visible algal bloom has not been completed. Lack of sufficient funding since the TMDL targets were established has resulted in limited information concerning this particular target.

It is also very important to examine possible factors that cause *Anabaena* to flourish in certain years, to gain insight into the conditions that favor the growth of this noxious species. Unfortunately, the continued shortfall in monitoring funds has not allowed us to extend our examination to those physical and food web factors driving algal blooms in the Lake.

Oxygen in oligotrophic lakes does not vary much from saturation in the epilimnion (upper, wind-mixed layer of a thermally stratified lake) or hypolimnion (bottom, most dense layer of a stratified lake). Thus, one of the TMDL interim targets states that there shall be no declining trend in oxygen concentrations in the hypolimnion of Flathead Lake. Profiles of dissolved oxygen at the midlake deep site during the late summer and fall of 2004 revealed a decline in oxygen concentrations with depth during the period of thermal stratification. Percent oxygen saturation dropped to 79.7% or 9.43 mg/L (milligrams per liter) near the bottom at midlake deep in mid August 2004. The lowest oxygen concentration measured at Ross Deep during WY 2004 was 68.6% (7.72 mg/L), also in mid August.

The TMDL interim targets also state that there shall be no increase in the biomass of lakeshore periphyton. Long-term monitoring of periphyton biomass began in 1999. The mean chlorophyll *a* concentration (± 1 standard deviation) at the "B" Beach site was $3.3 \pm 2.7 \mu\text{g}/\text{cm}^2$ (micrograms per square centimeter) when measured on August 8, 2004 (Figure 3). The mean for the Horseshoe Island (Bird Islands) site on the same date was $0.85 \pm 0.50 \mu\text{g}/\text{cm}^2$. At this early stage of monitoring, it is not possible to determine a trend in periphyton biomass. Continued monitoring is needed to assess natural interannual variation.

During the 2004 water year, the Flathead Lake Biological Station was able to assess three of the five interim TMDL targets established for the protection of water quality in Flathead Lake. The mean chlorophyll *a* concentration in WY 2004 was below the target value, but primary production at midlake deep exceeded the target value by 40% and oxygen in the hypolimnion declined below 90% saturation. In addition, a small bloom of *Anabaena flos-aquae* was observed at the midlake deep site but has not yet been quantified. Continued monitoring of periphyton biomass will be necessary in order to assess a trend in that target parameter. Two of the nutrient variables that were recommended by the FBC TMDL Technical Committee as targets, total phosphorus (TP) and total nitrogen (TPN), were measured and both exceeded the suggested targets.

In conclusion, of the 300 largest lakes of the world, Flathead Lake is one of the cleanest, but there are several water quality concerns that warrant continued monitoring. The monitoring of Flathead Lake has been routinely underfunded. Citizens interested in contributing to the Research and Monitoring Endowment Fund for monitoring Flathead Lake and other large lakes in the Basin should contact the Flathead Lake Biological Station for more information.

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