State of the Lake, 2004

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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 gC m -2 yr -1 (80 grams of carbon per square meter per year), 2) annual average chlorophyll *a* concentration shall not exceed 1 µg/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.

Primary productivity experiments measure Flathead Lake's ability to grow algae. Our long-term record of primary productivity in Flathead Lake is a robust indicator of long-term changes taking place in water quality. 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. Primary production in Flathead Lake in 2003 was the third highest value since monitoring began in 1977, exceeding the TMDL target value by 49%.

Growth of algae in the Lake is primarily influenced by loading of the nutrients, nitrogen and phosphorus. Numerous studies have shown that both stimulate algae in Flathead Lake to grow. Nutrients are transported into Flathead Lake via major and minor tributaries in the Basin, atmospheric dryfall and wetfall, groundwater seeps, point source discharges (e.g., sewage treatment plants) and nonpoint sources (e.g., old or poorly designed septic systems, runoff from land disturbances that are not protected with proper buffer strips—this can include roads, agricultural activities, forest harvest, homes, driveways or other impervious surfaces). Estimates for 2003 for nitrogen and phosphorus loading from the major sources will be made this fall (2004).

Initial experiments indicate the very high primary production for 2003 may have been due in part to high ammonium nitrogen concentrations from wildfire smoke. Loading of ammonium to the Lake during the heaviest period of smoke in August was about 40X that in June, when very little smoke was present. Ammonium is the most available form of nitrogen for algae in the Lake. The timing of this nutrient pulse to the Lake was also important. During late summer, all of the available forms of nitrogen are so low that they are below the detection limit. In fact, ammonium is rarely measured above the detection limit in Flathead Lake. In addition, the warmest water temperatures ever recorded for Flathead Lake occurred during this period, likely contributing to the elevated production.

With the high light and temperature conditions in addition to the low available nitrogen, the algae were poised to take advantage of the ammonium arriving from the atmosphere!

It is also important to remember that under certain conditions, food web changes may also influence primary production by altering the density of organisms that cycle these nutrients within the lake. The highest primary production measured in the Lake occurred in 1988, about two years after the peak in abundance of the introduced opossum shrimp, *Mysis*. The removal of several species of zooplankton by *Mysis* may have greatly reduced the predation of zooplankton on algae in the Lake. Thus, algal abundance could increase, thereby, increasing primary production. Clearly, alterations in the lake food web will continue as *Mysis* densities fluctuate. Experiments have shown that 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 the Lake.

The mean annual chlorophyll *a* (the pigment in algae) concentration in 2003 was very near the long-term average. Although there were very dense bands of algae at about 18–20 m depth during the summer months (with the highest levels of chlorophyll ever measured in the Lake), the low values for winter resulted in an average for 2003 that met the TMDL target.

Profiles of dissolved oxygen in Flathead Lake during the late summer and fall of 2003 revealed a decline in oxygen concentrations with depth as the period of thermal stratification in the lake continued through early fall. Percent oxygen saturation dropped to 72.0 % (8.50 mg/L) near the bottom at the deepest midlake site and 76.0 % (8.56 mg/L) at the Ross Deep site in Big Arm Bay. Thermal stratification at Ross Deep did not persist beyond early September, thus oxygen levels did not reach the low levels observed some years.

The TMDL interim targets recommend no measurable blooms of *Anabaena flos-aquae* (or other pollution algae) at the midlake deep site. Lack of sufficient funding since the TMDL targets were established has resulted in limited information concerning this particular target. No visible algal blooms were observed during the 2003 water year, but phytoplankton samples have not been examined microscopically to confirm this observation. We received several samples from concerned citizens at Lake Mary Ronan in late June 2004 and confirmed the presence of *Anabaena flos-aquae* in dense accumulations along the shoreline. It will be interesting to see if this species will be a problem in Flathead Lake this year as well.

The TMDL interim targets also state that there shall be no increase in the biomass (mass) of lakeshore periphyton (the algae attached to rock surfaces). Long-term monitoring of periphyton biomass began recently (1999). The mean chlorophyll *a* concentration at the East Shore "B" Beach site was 5.2 µg/cm 2 (micrograms per square centimeter of rock surface) in August 2003 compared to 1.2 in August 1987. However, a t this early stage of monitoring (years: 1987, 1999, 2000, 2002, 2003), it is not possible to determine a trend in periphyton biomass. Continued monitoring is needed to assess natural interannual variation.

During the 2003 water year, the Flathead Lake Biological Station was able to assess 4 of the 5 interim TMDL targets established for the protection of water quality in Flathead Lake. The mean chlorophyll *a* concentration in 2003 was right below the target value, but the dissolved oxygen target was not met (i.e., a decline in oxygen was observed) and primary production at midlake deep exceeded the target value by 49%. Continued monitoring of periphyton biomass will be necessary in order to assess a trend in that target parameter. In conclusion, of the 300 large 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 endowed Research and Monitoring Fund for monitoring Flathead Lake and other large lakes in the Basin should contact the Flathead Lake Biological Station for more information.