# Limnological Investigations of Lake Pend Oreille, Idaho

Mike A. Beckwith
Idaho Department of Health & Welfare
Division of Environment Water Quality Bureau
Coeur d'Alene, ID 83814

**Abstract**

Degradation of Lake Pend Oreille water quality as evidenced by reduced water clarity and increased "slime" growth in near-shore areas has been reported in recent years. Increased industrial discharges and nonpoint source inputs to the Clark Fork River and continuing development around the lake have created considerable public and agency concern about potential eutrophication. This study was initiated to assess the validity of those reports and concerns and to provide the basis for the design of a comprehensive limnological investigation necessary for the formulation of effective water quality protection and resource management strategies.

**Introduction**

The decision by the State of Montana in early 1984 allowing increased industrial discharge to the Clark Fork River and continued citizen reports of water quality degradation as evidenced by reduced water clarity and increased "slime" growth have created considerable concern about the potential for accelerated eutrophication of Lake Pend Oreille. Therefore, the Water Quality Bureau of the Idaho Division of Environment initiated investigations of the Clark Fork River and Lake Pend Oreille during the 1984 field season to:

1. characterize the water quality of the lake's major tributary, the Clark Fork River
2. determine flow and nutrient/pollutant loads entering the lake through the river
3. characterize limnological conditions at four locations in the lake for which historical data are available
4. trends begin collecting the data needed to assess potential long-term
5. serve as the basis for designing a comprehensive investigation of the Lake Fend Oreille hydrologic basin required for the formulation and implementation of effective water quality protection and management strategies.

**Study Design and Methods**

The current investigations began in the 1984 field season. They will continue at the present level of effort through the 1985 field season. Determination of Clark Fork River flow and sediment load and sample collection for water quality analysis are being conducted by the U S Geological Survey (according to USGS river sampling and gaging methods) under a cooperative agreement at the existing gaging station below Cabinet Gorge Dam. Sampling and determination of flow on a monthly basis began in May 1984, it will occur on a weekly basis during spring runoff (May, June, early July).

Water samples for chemical analyses are from cross-sectional composites in an attempt to determine nutrient and pollutant loads delivered to the lake river sample variables include the nutrients nitrogen and phosphorus and heavy metals associated with contamination from upstream mining areas. Parameters analyzed are shown in table 1.

River water samples are acid-preserved in the field and transported on ice to the State of Idaho laboratory in Coeur d'Alene within 24 hours. standard analysis methods are employed as described by the American Public Health Association, American Water Works Association, Water Pollution Control Federation ("Standard Methods"), and the U.S. Environmental Protection Agency (EPA). Results are entered into the U.S. EPA STORET data system.

Four sampling stations corresponding as closely as possible to those of earlier investigations were established in the northern half of the lake (fig.1). Depth profiles of lake physical and chemical conditions are deter- mined at each of the lake sampling stations. Lake sample parameters emphasize euphotic zone nutrient and chlorophyll concentrations as well as algal growth potential (as determined by algal assay) and will include in 1985 characterization of the phytoplankton community. The extent of the euphotic zone is defined as 2.5 times the Secchi disk transparency. Sampling frequency is monthly except during June, July, and August when it will occur biweekly. Sampling through the winter will occur as conditions permit.

Samples for laboratory analyses include a depth-integrated composite of the euphotic zone and a sample collected at 50 m. Parameters are shown in table 2. They are acid-preserved upon return to shore and transported on ice to the State of Idaho lab where analysis is begun within 24 hours. Chlorophyll samples are filtered immediately on arrival at the lab, wrapped in foil, and frozen for analysis within specified holding times. Standard methods are employed

**Results to Date**

Monthly river flow and sediment data from May 1984 are available; results of nutrient, heavy metal, and other water quality analyses are available from July 1984. Flow has ranged from a little more than 8000 to 46,000 ft3/S. Sediment loads have ranged from 22 to 869 tons/day. Total nitrogen concentrations have ranged between 0.14 and 0.37 mg/L corresponding to loads ranging from 2700 to 21000 kg/day. Total phosphorus concentrations have generally been at or below the detection limit of 0.01 mg/L. When it was possible to calculate phosphorus loading, it has ranged from 200 to 1135 kg/day. Concentrations of arsenic, copper, cadmium, and zinc have generally been at or below the detection limits of the respective analyses.

Only three lake water chemistry data sets are available for 1984, corresponding to the three sampling trips made in September and October, Because very little data have been collected to date, they will not be presented in detail at this time.

Secchi disk transparencies measured on those three occasions in 1984 average 68% of those reported for the same time of year at the same locations in a study conducted in 1953 (3). Of course, no firm conclusions are possible on the basis of only three 1984 observations. Secchi disk transparencies reported in 1974 and 1975 (2) are slightly but probably not significantly less than those reported for 1953 at the same time of year at the same locations.

Nutrient levels in Lake Fend Oreille are quite low; its waters are also quite low in other dissolved substances. Algal growth potential of euphotic zone composite samples as determined by algal assays performed by the U.S. EFA Environmental Research Laboratory (Corvallis, OR) showed on one occasion moderate productivity at the station off the mouth of the Clark Fork River (1). On another occasion, inhibition of algal growth by zinc at a concentration of 0.016 mg/L was demonstrated at the station over

the deepest point of the lake; this result is surprising at this location, which was thought to be somewhat less influenced by Clark Fork River inflow. Concentrations of heavy metals were below detection limits at other lake sampling stations and at the deep- water station on other occasions.

**Discussion**

Because the study has recently been initiated, very little data have been collected. The limited data collected to date contain somewhat surprising and unexpected results. Several refinements in the study will be implemented to improve the quality and quantity of the data and to make most efficient use of limited resources. The sensitivity of the phosphorus and chlorophyll analyses will be increased and the phytoplankton community will be characterized. Periphyton production in shallow areas during the peak of the summer will also be estimated using artificial substrates.

The data collected through the 1985 field season will then be compared to those reported in the few previous studies for identification and assessment of trends in Lake Fend Oreille water quality. Gross estimates of nutrient loading to the lake by the Clark Fork River will be made. The results will then be compared to accepted trophic status criteria and models in an effort to determine if any gross changes in limnological conditions are imminent or if any direct effects on Idaho water quality of increased nutrient/pollutant loading to the Clark Fork River can be demonstrated. These results will be used as the basis for designing further studies by the State of Idaho and for the design of a comprehensive assessment of the Lake Pend Oreille/Clark Fork River hydrologic basin.

**Literature Cited**

Greene. J.C. 1985. Report on the results of algal assays performed on waters collected in Lake Pend Oreille. Idaho. U.S. Environmental Protection Agency. Corvallis (OR). Environmental Research Laboratory. Unpublished report to Idaho Division of Environment.

Rieman, B.E. 1976. Limnology of Pend Oreille Lake, Idaho, with an emphasis on the macrozooplankton community. M.S. Thesis. University of Idaho.

Stross, R.G. 1954. A limnological study of Lake Pend Oreille, Idaho with special consideration of the ecology of the Kokanee. M.S. Thesis. University of Idaho.

Table 1.--River water quality variables

| | |
|---|---|
| Total alkalinity (as $CaCO_3$) | Arsenic |
| Total hardness (as $CaCO_3$) | Calcium |
| Total suspended sediment (nonfilterable residue) | Cadmium |
| Volatile suspended sediment (volatile residue) | Copper |
| Turbidity | Magnesium |
| Total ammonia | Zinc |
| Nitrate + nitrite | Silica |
| Total Kjeldahl nitrogen | pH |
| Total phosphorus | |
| Soluble reactive phosphorus (ortho-phosphate) | |


Figure 1. Lake Pend Oreille sampling stations.

Table 2.--Lake water quality parameters

| | |
|---|---|
| **Field** | |
| Secchi disk transparency | |
| (0-50 m at 5-m intervals) | |
| Temperature | |
| Specific conductance | |
| Dissolved oxygen | |
| pH | |
| **Laboratory** | |
| Euphotic zone composite | |
| Total alkalinity (as $CaCO_3$) | Total and fecal coliform |
| Total hardness (as $CaCO_3$) | Chlorophyll |
| Turbidity | Arsenic |
| Total ammonia | Cadmium |
| Nitrate + nitrite | Calcium |
| Total Kjeldahl nitrogen | Copper |
| Total phosphorus | Magnesium |
| Soluble reactive phosphorus (ortho-phosphate) | Zinc |
| Silica | pH |
| Total and volatile suspended sediment | Specific conductance |
| **50-m sample** | |
| Total Kjeldahl nitrogen | Total phosphorus |
| Total ammonia | Turbidity |
| Nitrate + nitrite | |