Original: Fish Division
cc: Mr. Ruhl
Mr. George L. Egbert
Mr. Eschmeyer
Mr. Howard
Mr. Clark

INSTITUTE FOR FISHERIES RESEARCH
UNIVERSITY MUSEUMS
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN

March 12, 1936

REPORT NO. 346

FISH MORTALITY IN LAKES IN OR NEAR THE WATERLOO AREA

There have been numerous reports recently of fish mortality in some of the Michigan lakes. In all cases known to the writer the mortality was ascribed to lack of oxygen. That death was due to oxygen deficiency in all cases is quite probable, but the reasons given for this lack of oxygen have at times been questionable. It is considered desirable, therefore, that the causes of winter kill be briefly discussed.

In the fall before the lakes freeze over the water usually contains an abundance of oxygen. Cold water can hold more oxygen than warm water. The rate of decay is less in cold water, and usually the water is considerably agitated and therefore aerated by the fall winds. The deeper water is also aerated at the time of the fall turnover. In early winter, then, there is an abundance of oxygen in most lakes.

Where the lakes are deep or where there is very little decay, winter-kill does not occur. In lakes with extensive shoal area, with organic bottom and usually with an abundance of vegetation, winter-kill may be severe under certain conditions. When green plants have access to light they utilize carbon-dioxide and liberate oxygen (photosynthesis). This is true in winter as well as at other seasons. Under the ice, then, two processes are normally at work: decay - utilizing oxygen and giving off carbon-dioxide, and photosynthesis - using carbon-dioxide and liberating oxygen. The extent of decay depends partially on the amount of organic matter present; the extent of photosynthesis depends partially on the amount of light present. When the light is sufficiently reduced sc that the oxygen liberated by the plants is less

~~less~~ than that consumed by decay and respiration of both plants and animals the oxygen content of the water is gradually reduced.

The current mortality is not due to thickness of ice or to a "sealing" of the surface but to relative darkness for a prolonged period caused by the thick covering of snow on the ice in addition to the lack of transparancy of some of the ice. The utilization of oxygen has been more rapid than the release of oxygen in the rich, shallow, weedy, lakes and the oxygen originally present has been utilized to the point where not enough remains for fish respiration.

The term "green plants" as here used involves the microscopic plants (phytoplankton) as well as the coarse vegetation, it is probable that the microscopic plants are the more significant oxygen producers in winter, especially in some lakes.

The lakes most likely to be affected are those which are well along in their evolution, those containing primarily such fish as bullheads, mud-minnows, large-mouthed bass, warmouth bass, black crappies, sunfish, dogfish and bluegills.

With the assistance of O. H. Clark, in charge of fish and game work in the Waterloo Project, G. P. Cooper and the writer took oxygen tests on several lakes in and near the Waterloo area. The tests were taken on February 18th on Clear, Sugarloaf and Green lakes. The oxygen at one foot below the surface was as follows;

Clear Lake, center of lake	10.5 ppm.
Sugarloaf, near east shore	.3 ppm.
Green, center of lake	.9 ppm.

Clear lake obviously contained an abundance of oxygen, the other two lakes contained very little where the tests were taken. A sample taken several days later in the center of Sugarloaf Lake indicated a presence of 2.0 ppm. of oxygen.

A few dead fish were noted in Green and Sugarloaf lakes; many died in Mud Lake and according to reports, in Little Portage Lake. There was apparently no mortality in Clear Lake. To what degree fish were dying in other lakes in the area was not ascertained.

A rotary pump was obtained from the Drayton Plains Hatchery on February 19th and was placed in operation on Sugarloaf Lake on February 20th in an effort to

aerate the water. The water was pumped out of the lake, and allowed to return through holes cut in the ice as shown in the diagram. This system was used because of the possibility of adding oxygen to the water in several ways: the stream in passing through the air would probably absorb some oxygen, in melting the snow which probably contained an abundance of air the oxygen might be further increased, and, in melting the snow more light would be able to pass through the ice and photosynthesis might therefore be increased.

Oxygen tests taken before the operations indicated a presence of .4 ppm. of oxygen at one foot below the surface. Samples were taken at points A and B after the pump had been in operation for 2 hours and 50 minutes. Water for analysis was secured at one foot below the surface in the holes into which water from the hose had been running. The sample taken at A indicated a presence of 5.8 ppm., the one taken at B contained 8.5 ppm. Tests taken at points D, E and F showed no noticeable increase in oxygen. Samples taken at A and B about 28 hours later indicated that the oxygen here had returned to the former amount (less than 1 ppm.). Whether this was due to a general circulation of the water, to oxygen consumption or to the presence of springs near the margin could not be determined. Since a considerable number of small dead fish were present near the springs it is probable that these contained little oxygen.

All that can be stated at present is that, where the pumped water re-entered the lake the oxygen was locally and temporarily increased very decidedly. Further experimentation on the use of pumps is considered necessary before any recommendations regarding the use of this method can be made.

Mr. Clark continued the pumping for several days on a few of the lakes in the area. On the 25th, after several days of warm weather accompanied by very extensive melting of the snow, oxygen tests were again made in Sugarloaf Lake. The snow had melted on the surface and had entered the lake through holes cut in the ice by men from the Waterloo Project. The sample of water (melted snow) on the ice contained 13.1 ppm. of oxygen. A sample of water (taken at a depth of about 2 feet) from a

hole into which the water was draining from the ice had an oxygen content of 7.9 ppm. A sample was taken approximately 100 feet from this hole at a depth of 1 to 2 feet. This sample had 9.5 ppm. of oxygen.

Holes were also cut in the ice in several other lakes (during the thaw) to allow the surface water to enter the lake before subsequent low temperature might cause it to freeze again. Although more experimentation is needed in connection with this method of oxygenating the water, it is probable that the cutting of holes to allow any melted snow to enter the lakes is desirable, the effectiveness depending on the amount of melted snow entering the lake.

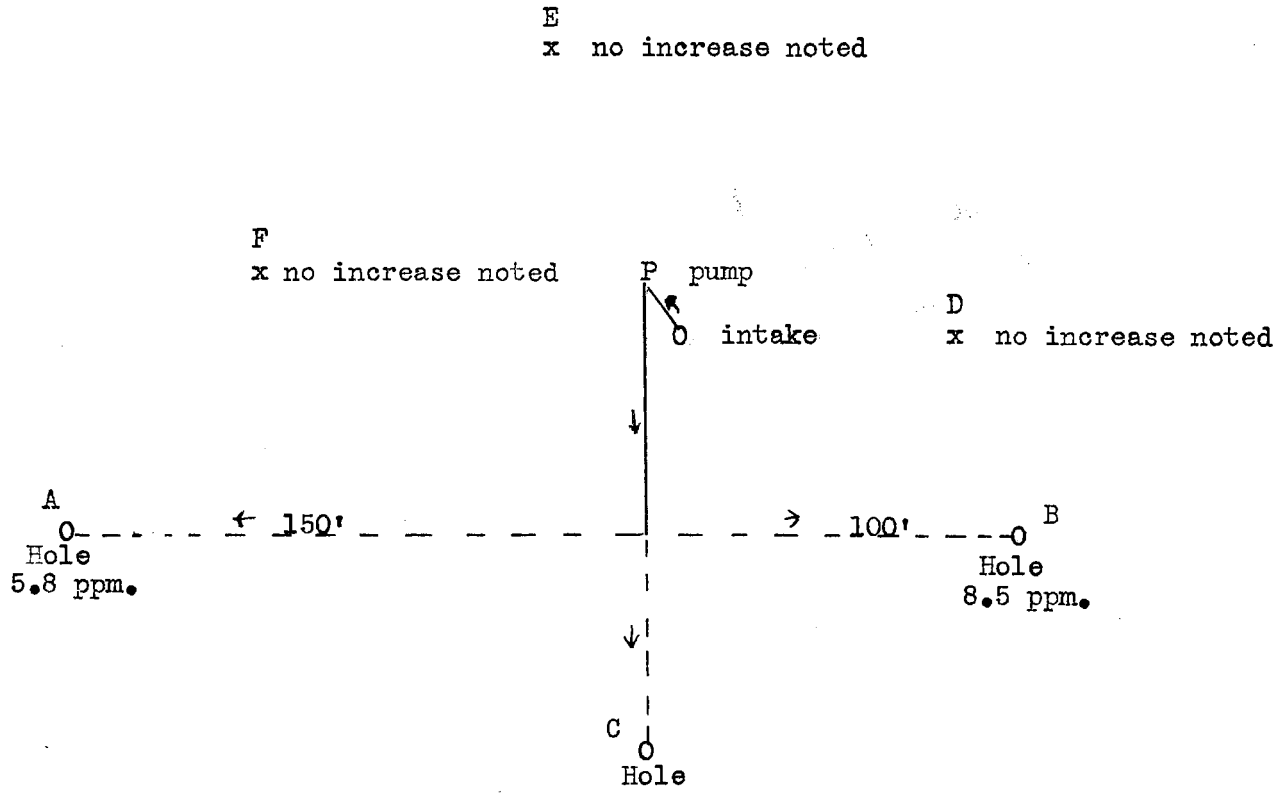
On Friday, February 28th, after a day or two of freezing weather several lakes were revisited. Green Lake, which contained .9 ppm. at 1 foot below the surface on the 18th, now contained 9.8 ppm. at the same spot. Batteese Lake, visited by an Institute party on February 14th (see Report No. 344) was re-examined. On the 14th, at one foot below the surface, on the S. W. side of the lake, the water contained only a trace of oxygen. On the 28th a sample taken at the same place and same depth showed an oxygen content of 10.3 ppm. At a depth of 7 feet the oxygen was only .7 ppm. however. At Sugarloaf Lake, on the 28th, the water near shore (where the previous samples were taken) showed an oxygen content of 2.4 ppm. at one foot in depth. Samples were taken over deeper water near the opposite side of the lake. These indicated a presence of 4.0 ppm. at 1 foot deep, .7 ppm. at 4 feet deep and .2 ppm. at 8 feet deep.

The data collected relative to increasing the oxygen were too meager to permit any generalization or any recommendation of methods to increase the oxygen. Pumping water onto the ice was temporarily effective but apparently the pumping benefited only a very small area of the lake and for a very short time (less than 28 hours). Cutting of holes in the ice to permit draining of the melted snow into the lake was probably beneficial. It is considered advisable that the problem of winter-killing be given further study.

INSTITUTE FOR FISHERIES RESEARCH

R W Eschmeyer

By: R. W. Eschmeyer



Sugarloaf Lake, February 20, 1936

Plan indicating where holes were cut and where oxygen samples were taken. Original oxygen .4 ppm.