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AN EXPERIMENT WITH SOOT TO PREVENT OR ALLEVIATE WINTERKILL ON THE LAKE CADILLAC WEST LAGOON

By

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The Lake Cadillac West Lagoon (T. 21 N., R. 9 W., Section 7, Wexford County) has suffered various intensities of winterkill in past years. As Biologist in District No. 4, I was instructed to make frequent oxygen analyses during the late winter and spring of 1947-1948 and, if the dissolved oxygen at most stations reached as low as 2 p.p.m., to conduct an experiment with soot. The use of soot to prevent fish winterkill was first attempted by the State of Wisconsin.

Winterkill is caused by oxygen deficiency which occurs as a result of snow shutting out light from the oxygen-producing aquatic plants. It is typically a phenomenon occurring in rich and shallow lakes and ponds. The application of soot is intended to absorb heat from the sun's rays and consequently to melt the snow, allowing light rays to penetrate the ice.

The lagoon in question was created by the construction of a road across the western end of Lake Cadillac. In the first construction of the road, or causeway, two large bridges were included, which allowed considerable connection between the main lake and the lagoon. It is

understood that no winterkill occurred at that time. In 1937, however, these bridges were removed when the road was improved; and a six-foot (diameter) culvert was installed at the north end of the causeway. Since that time winterkill has occurred rather frequently.

The lagoon has a surface area of 17 acres. It is relatively shallow, the deepest water being nine feet; the average depth is approximately four feet. The bottom soil is sand and pulpy and fibrous peat. The margins of the lagoon, excepting the road bed on the east shore, are low and swampy and they support a growth of cattails, tamarack, and some cedar. Aquatic vegetation is abundant in the western half of the lagoon during the summer months, diminishing to only a scanty growth in the eastern half.

Oxygen analyses were made following the unmodified Winkler Method. Analyses were started on January 19 and discontinued after March 19. On March 5 the oxygen values at several stations were below 2 p.p.m.; and it was then decided that winterkill was quite probable for snow covered the lagoon at an average depth of about four inches, and the snow ice was from six to eight inches in thickness.

The soot used in this experiment is made by the Binney and Smith Company, Akron, Ohio, and was purchased from the B. F. Goodrich Company at Cadillac. The cost was seven cents a pound which was the cost price for carload lots. The trade name of this lampblack is Micronex W-6. It is reported to have a particle size of 29 millimicrons.

This soot was spread over the southwestern half of the lagoon on March 7, 1948. The southwest to northeast axis was divided so that the area to be sooted and the control areas (northeast half) would be similar as to bottom soil types, depths, and exposure to the prevailing wind. A lime-type fertilizer spreader was used, pulled by a tractor (Figure 1).

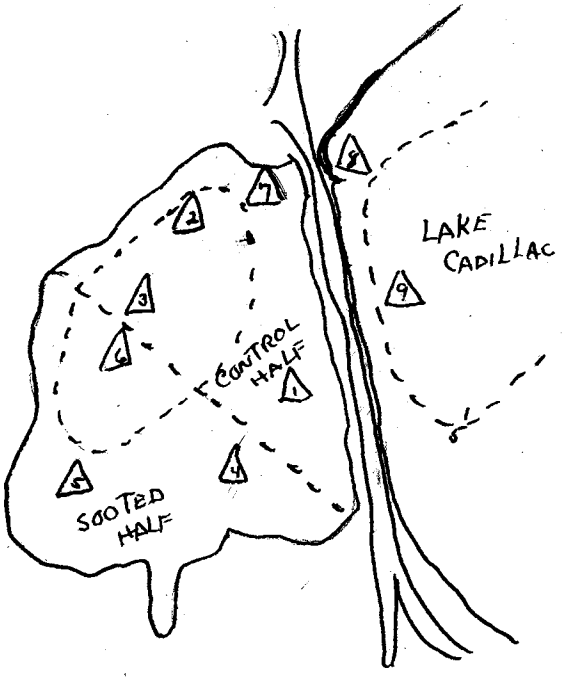
Lime-type fertili$_z$er spreader

Figure 1

The spreader hopper was 8 feet wide and had 16 holes 6 inches apart, capable of being entirely closed or opened to 1-inch squares. In the hopper, which was approximately 3 feet deep, there was a series of large screws, one over each hole, mounted on a main shaft. This shaft, and the screws, rotated with the wheels of the spreader; the screws forcing out the contents of the hopper. An area 1.7 acres in size was marked off and covered, using 25 pounds of soot. This was at the rate of approximately 15 pounds to an acre. From this initial covering the rate at which the soot was to be spread over the remaining area was estimated, by considering the size of the hole openings, the speed of the tractor, the amount of soot used, and the known remaining acreage. The soot was spread at a rate of 15 pounds to the acre for the first two acres and then increased in amounts until the last acre covered was spread at a rate of approximately 25 pounds to the acre. A total of 150 pounds of soot was used to cover $8\frac{1}{2}$ acres. Difficulties were encountered in spreading the soot, and much was learned to condemn the use of a lime-type fertilizer spreader for any similar experiment in the future. The hopper was found to be too low. This resulted in the soot being spread in rows, rather than diffused. The holes in the spreader were found to clog frequently from pieces of lime that peeled off the inside of the hopper. The control, regulating the size of the holes in the spreader box, was difficult to operate. The control lever had to be hammered and jerked until the desired opening was reached. It is recommended that some type of a spreader using centrifugal force, such as the highway sand spreaders, would be better adapted to this operation.

Oxygen analyses were made at nine stations (see Figure 2), which had the following characteristics:

LAKE CADILLAC WEST LAGOON



△ Chemistry Stations

Figure 2

Station No. 1 Non-sooted area, 9 feet deep, fibrous peat.

Station No. 2 Non-sooted area, 4 feet deep, fibrous peat.

Station No. 3 Non-sooted area, 8 feet deep, fibrous peat.

Station No. 4 Sooted area, $2\frac{1}{2}$ feet deep, sand, detritus.

Station No. 5 Sooted area, $4\frac{1}{2}$ feet deep, fibrous peat.

Station No. 6 Sooted area, $8\frac{1}{2}$ feet deep, fibrous peat.

Station No. 7 Non-sooted area, at culvert entrance, $1\frac{1}{2}$ feet deep sand bottom.

Station No. 8 Lake Cadillac, non-sooted area, at culvert from the lagoon, $1\frac{1}{2}$ feet deep, sand bottom.

Station No. 9 Lake Cadillac, non-sooted area, opposite the lagoon, 8 feet deep, pulpy peat bottom.

The winter oxygen values obtained at the various stations are presented in Table 1. Analyzing the data, it will be found that the application of soot apparently did not result in an increase in the dissolved oxygen in the experimental area. Stations No. 3 and No. 6, representing untreated and treated areas, were comparable in having a similar depth and bottom type, and may be cited for comparison. Samples were taken at depths of 2, 4, and 6 feet at these stations. It is noted that after the application of soot the oxygen values at station No. 6 were considerably higher than at station No. 3. However, the same situation existed prior to the spreading of the soot. Station No. 6 did not have increasing oxygen values immediately following the soot application. Later, however, the dissolved oxygen did rise, corresponding to the melting of the snow. It is seen that station No. 6 had a slightly faster rate of oxygen improvement than did station No. 3, but this cannot safely be attributed to the soot. Stations No. 1 and No. 2 of the control area and stations No. 4 and No. 5 of the sooted area similarly had oxygen increases corresponding to the melting of snow which resulted from general weather conditions. No significant difference between the amounts of oxygen at these stations can be recognized.

Table 1

Dissolved oxygen in p.p.m., Cadillac Lake West Lagoon
Stations, dates, and water depths are given in the table.

CONTROL AREA			SOOTED AREA			MISCELLANEOUS STATIONS (see diagram)			RANDOM STATIONS
Sta.#1	Sta.#2	Sta.#3	Sta.#4	Sta.#5	Sta.#6	Sta.#7	Sta.#8	Sta.#9	
									Jan. 19, 1948
...	...	...	...	...	...	...	...	...	4'=2.4
									Jan. 26, 1948
...	...	...	...	...	...	...	...	...	4'=2.1; 4'=5.2; 3'=5.1
				Feb. 3, 1948					
...	...	...	1½'=6.7	...	...	...	...	...	...
...	3'=4.4	3'=4.5	...	3'=4.9	3'=4.4	3'=4.4	...	...	...
...	...	...	...	...	4'=3.2	...	...	...	...
...	...	5'=2.7	...	...	...	5'=3.3	...	...	...
...	...	7'=2.5	...	...	...	...	...	...	...
				Feb. 17, 1948					
...	2'=1.6	2'=3.3	2'=2.1	2'=2.6	2'=3.0	...	...	...	...
...	...	4'=3.2	...	...	4'=2.3	...	...	...	...
...	...	6'=2.3	...	...	6'=0.7	...	...	...	...
				Feb. 27, 1948					
...	2'=1.6	2'=5.8*	2'=2.1	2'=2.0	2'=2.5	1½'=2.7	1½'=4.1	2'=8.3	...
...	...	4'=4.0	...	...	4'=2.4	...	...	...	...
				Mar. 5, 1948					
2'=1.6	2'=0.2	2'=0.7	2'=0.2	2'=0.7	2'=1.9	...	...	...	...
...	...	4'=1.2	...	...	4'=2.3	...	...	...	...
...	...	6'=1.1	...	...	6'=1.3	...	...	...	...
				Mar. 8, 1948					
...	2'=0.5	2'=0.2	...	...	2'=1.8	...	...	...	...
...	...	4'=0.7	...	...	4'=1.1	...	...	...	...
...	...	6'=0.7	...	...	6'=0.9	...	...	...	...
				Mar. 13, 1948					
2'=0.9	2'=0.3	2'=0.2	2'=0.7	2'=0.2	2'=1.0	...	...	...	...
...	...	4'=0.5	...	...	4'=0.9	...	...	...	...
...	...	6'=0.0	...	...	6'=0.5	...	...	...	...
				Mar. 14, 1948					
...	...	...	...	...	...	1½'=0.5	1½'=2.0	2'=11.2	...
...	...	...	...	...	...	...	...	4'=9.3	...
...	...	...	...	...	...	...	...	6'=8.4	...
				Mar. 17, 1948					
2'=1.6	2'=0.7	2'=0.5	2'=2.8	2'=0.9	2'=1.5	...	...	...	...
...	...	4'=0.5	...	...	4'=1.1	...	...	...	...
...	...	6'=0.4	...	...	6'=0.5	...	...	...	...
				Mar. 19, 1948					
2'=3.0	2'=3.5	2'=2.1	2'=4.4	2'=2.0	2'=2.6	...	...	...	...

* Believe value is too high, due to water possibly pouring through old sampling hole during thaw of February 26, 1948.

Stations No. 7 and No. 8 were located at either end of the culvert, station No. 7 on the lagoon side, and station No. 8 on the lake side. Although too few checks were made, the evidence is that the water flows from the lagoon to the lake. Station No. 9 is located in Lake Cadillac, opposite the lagoon. Samples were taken here merely for a comparison of the lake and lagoon oxygen concentrations. It can be noted the oxygen values were high in the two checks made.

As the air temperatures during the period of the experiment are a factor in the effectiveness of the soot, the maximum and minimum temperatures are given in Table 2 for the period March 7 to March 17. These temperatures were taken by the C. A. A. weather station at the Cadillac airport, which is approximately three miles from the lagoon. It is believed that temperatures at the lagoon were slightly higher than those at the airport.

It was quite evident that the experiment was unsuccessful. Although the soot did melt down some, it was not dense ehough to affect much snow surface (Figure 3). During March 7 to March 12, the soot "dug down" very slowly. On March 13 and until the experiment was concluded, the temperatures were high enough to cause the snow to melt regardless of the soot.

It was noted, after snow had melted as a result of the thaw which started March 13, that the soot did continue to "dig down" into the ice. This suggests that if the soot were applied more densely and had successfully melted the snow, it might also have cleared the snow ice. It was also noted that the soot did cause portions of the fresh snow of March 8 (the only precipitation after the application of soot) to melt, so that the soot continued being effective after a light snow. This was particularly evident in the more heavily sooted areas. It is believed that the use of soot has possibilities, provided that the soot is spread much more heavily and the air temperatures are not too low.

Table 2

Daily maximum and minimum air temperatures and cloudiness at Cadillac airport, March 7-17, 1948.

Date	Temperature Max. - Min.		Sky AM	PM
3-7-48	33	22		
3-8-48	31	21	Cloudy	Cloudy
3-9-48	25	-3	Cloudy	Clear
3-10-48	15	-6	Cloudy	Partly Cloudy
3-11-48	15	-19	Clear	Clear
3-12-48	23	-18	Clear	Clear
3-13-48	35	-10	Clear	Clear
3-14-48	40	16	Clear	Partly Cloudy
3-15-48	42	34	Cloudy	Cloudy
3-16-48	37	24	Cloudy	Partly Cloudy
3-17-48	37	19	Partly Cloudy	Partly Cloudy

Figure 3

(a) Picture taken March 13, first day of thaw after application of soot. Depth of snow at yardstick was 4 3/4 inches. The branches are stuck in tractor and spreader tracks. Note small snow area affected by soot. Also note, some soot is still covered by the snow of March 8.

(b) Sooted area and control area. Very little to no effect of soot can be noted. Picture taken March 13.

Summary

1. An experiment was conducted in applying soot on the Lake Cadillac West Lagoon, as an attempt to alleviate winterkill conditions (low dissolved oxygen).

2. The lagoon has only a 6 foot (in diameter) culvert connecting it to Lake Cadillac. Winterkill has been reported frequently since former bridges on the causeway, forming the lagoon, were removed.

3. The lagoon is 17 acres in size, has an average depth of approximately 4 feet, has bottom soils of pulpy and fibrous peat and sand, and has abundant to sparse aquatic vegetation.

4. Soot was spread on March 7 over the southwestern half of the lagoon. A lime-type fertilizer spreader was used, pulled by a tractor. The rate of spreading was from 15 to about 25 pounds to the acre. The lime-type fertilizer spreader was found unsatisfactory, chiefly because it is too low which causes the soot to be confined to narrow rows.

5. The application of soot had little to no effect on the dissolved oxygen of the water. The deeper station in the sooted area had considerably more oxygen than was found at a comparable station in the control area. However, this was true also before the spreading of the soot. Oxygen values increased at all stations, coincident with melting of the snow caused by warm weather which started on March 13.

6. Air temperatures were obtained from the C. A. A. weather station located at the Cadillac airport.

7. This application of soot was not successful in causing the snow to melt, because too little soot was used. Apparently more than 25 pounds per acre would be needed with climatic conditions comparable to the Cadillac area.

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