FISH MANAGEMENT REPORT 117

June 1983

FERTILIZATION OF AN INFERTILE ACID LAKE

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ABSTRACT

In 1969, Gabriel Lake was treated with a combination of fertilizers to increase productivity. Total alkalinity increased significantly for 4-5 years and the pH increased from 5.8 to a mean of 7.2 (maximum of 8.1) for at least 11 years. The lake did not show an observed major increase in algae production due to fertilization, nor did it show any significant change in water transparency.

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INTRODUCTION

For many years, fisheries biologists in Wisconsin have discussed problems involving management of low fertility lakes. Slow growth rates and low fish production in these lakes limit the sport fishery potential. In addition, these same lakes often have poor buffering capacities because of low alkalinity and thus are especially sensitive to acid precipitation. Proposed solutions to either problem usually involve lake fertilization.

This study was conducted to determine the effects of lake fertilization with triple super phosphate, ammonium nitrate, hydrated lime, and agricultural limestone. The report describes fertilizer applications and changes in water chemistry that occurred on Gabriel Lake, Wisconsin. The results may have implications with regard to reversing the effects of acid rain precipitation in northern Wisconsin lakes.

DESCRIPTION OF STUDY AREA

Gabriel Lake is located in Langlade County, north central Wisconsin, on glacial till left by the Langlade lobe of the Cary Substage. It is a 14.7-acre seepage lake with a maximum depth of 8 ft. The lake has a total alkalinity of 1.5 ppm, a pH of 5.9, and clear water of moderate transparency. Its watershed is predominately forested. The immediate shoreline is predominately upland (90%) of mixed hardwoods and conifers with the remainder wetland (10%) of meadow and marsh. The littoral lake substrate is composed of sand (70%), gravel (10%), rubble (10%), muck (5%), and boulders (5%). Floating and emergent aquatic vegetation are moderate in density, consisting mainly of freshwater celery (Vallisneria americana) and water shield (Brasenia schreberi). No fish were present in the lake in 1967 when a spot chemical treatment was carried out. Low winter oxygen levels may have precluded their survival.

METHODS

In 1969, 9 applications of triple super phosphate (0-46-0), 3 applications of ammonium nitrate, and 1 application each of hydrated lime and agricultural limestone were made on Gabriel Lake (Table 1).

The first application of triple super phosphate was spread over the lake surface. This proved unsatisfactory as the material sank rapidly and the phosphate was probably immobilized in bottom sediments. Before the next application, 3 boxes (4 ft x 4 ft x 8 inches) were constructed with slotted bottoms to prevent the fertilizer from falling through. The boxes were then floated with two 4 ft x 6 ft x 8 inch blocks of styrofoam -- this allowed the fertilizer time to dissolve. The triple super phosphate and ammonium nitrate applications were made with the boxes, whereas the lime was spread over the lake surface.

TABLE 1. Amounts, rates and costs of materials in Gabriel Lake fertilization study.

Fertilizer	Amount Used (lb)	Application Rate (lb/acre)	Fertilizer Retail Cost* (per ton)	Application Cost
Triple super phosphate 0-46-0	7,000	500	$241	$843
Ammonium nitrate	2,100	150	180	189
Hydrated lime	1,400	100	80	56
Agricultural limestone	28,000	2,000	40	560
Total	38,500			$1,648

*1982 retail prices.

Water samples were collected at the time of each fertilizer application and periodically from 1969 to 1980. Samples were taken from surface water in mid-lake. These samples were analyzed for total alkalinity (methyl purple) and pH (Beckman meter). Only casual observations were made with regard to the occurrence of algae blooms and abundance of other aquatic vegetation. Dissolved oxygen levels were measured on 2 occasions.

RESULTS AND DISCUSSION

Total alkalinity and pH changed immediately following application of hydrated lime and limestone (Table 2). These parameters rose gradually from 1.5 ppm total alkalinity and a pH of 5.8 to a high of 56.0 ppm total alkalinity and a pH of 8.1 by the middle of the summer of 1970. Both parameters then gradually declined, with pH declining at a slower rate than total alkalinity.

TABLE 2. Fertilizer applications and resulting water chemistry parameters in Gabriel Lake, Wisconsin.

	Fertilizer Application					
Date	Triple Super Phosphate	Ammonium Nitrate	Hydrated Lime	Agricultural Limestone	Total Alkalinity (ppm)	pH
20 Jun 1969	X			(Pretreatment)	1.5	5.9
1 Jul 1969	X				2.0	5.9
9 Jul 1969	X	X			1.5	5.8
18 Jul 1969	X	X			1.0	5.8
23 Jul 1969	X		X		1.5	5.8
28 Jul 1969	X			X	5.5	7.2
6 Aug 1969	X				11.0	7.1
19 Aug 1969	X	X			14.5	7.1
28 Aug 1969	X				16.0	7.1
29 Sep 1969					23.0	
18 Nov 1969					14.0	7.0
5 Jun 1970					30.0	8.1
6 Jul 1970					56.0	7.5
19 Aug 1970					31.0	7.6
8 Aug 1971					23.0	
6 Sep 1972					18.0	7.3
13 Jun 1974					7.0	7.3
15 Jul 1978					3.0	7.2
14 Feb 1980					6.0	6.6

This study did not show an observed major increase in algae production. In addition, no significant changes in Secchi disk readings were observed (4.5-5.5 ft). If water transparency decreased because of the liming, primary productivity may have increased resulting in stable Secchi disk values.

In August 1969, filamentous algae growth did develop on the floating boxes. And on several occasions, light blue-green algae blooms were noticed along with considerable growths of duckweed (Lemna spp.). Many mosquito larvae (Culicidae) were also found attached to the boxes.

Oxygen levels were measured on 2 occasions. In February 1974, oxygen readings were relatively high -- 8.4 ppm under the ice, 1.4 ppm at 4 ft, and 0.2 ppm at 7 ft. In February 1975, dissolved oxygen was again measured and found to be 1.7 ppm under the ice and 0.2 ppm at 7 ft. No pretreatment data were available for comparison.

Although this project was not planned with regard to mitigating the problem of acid rain, the results may be of value when considering possible remedies for this problem. Fertilizer treatments can alter a lake's total alkalinity and pH significantly for a considerable length of time at a cost that may not be prohibitive. A treatment as described in this present study could be conducted at a cost of approximately $179/acre ($112/acre for chemicals, $67/acre for 9.5 hours of labor).

MANAGEMENT IMPLICATIONS AND SUMMARY

The results of this experiment indicate that the effects of acid deposition or naturally low pH levels can be temporarily delayed or possibly reversed by application of fertilizers, at least on small bodies of water like Gabriel Lake. Total alkalinity and pH levels for Gabriel Lake were raised significantly for 5-11 years at a cost of less than $3,000. It should be noted though that liming does not alter the heavy metal problems associated with acid deposition.

However, before this management technique is used, potential ecological consequences must be fully considered, such as pH shock and the effect of fertilizer applications on future oxygen levels. Private individuals should seek technical advice before attempting such management.

About the Author

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