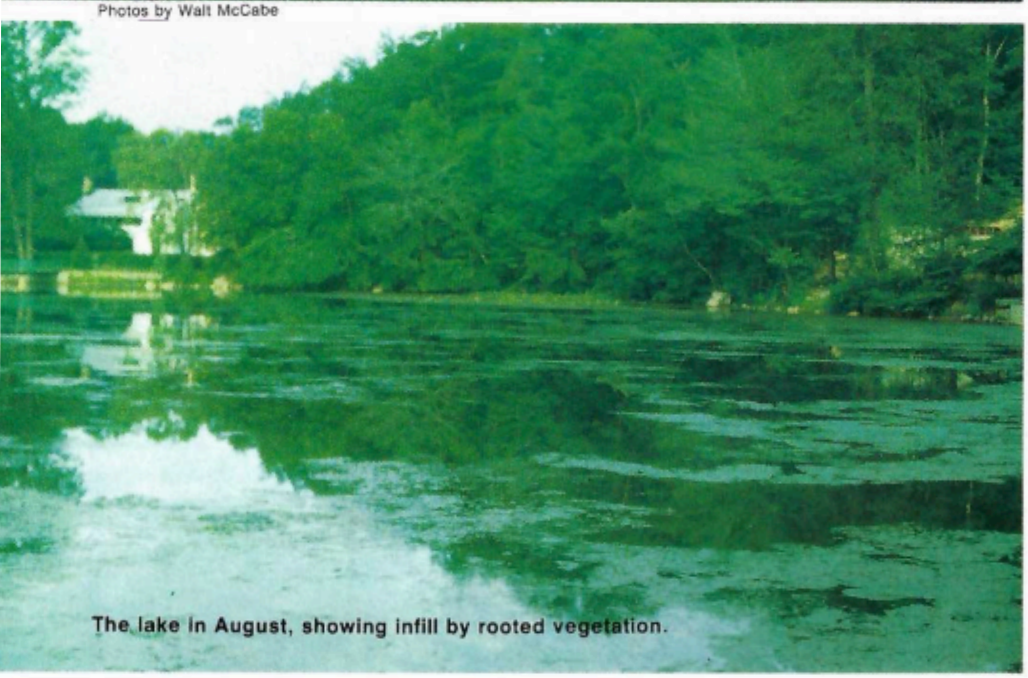
The lake in late May.

Photos by Walt McCabe



The lake in August, showing infill by rooted vegetation.

LAKE RESTORATION/ *a case study*

BY DR. OLIVER DONOVAN

Natural lakes may be formed by any number of processes ranging from glacial action to, unlikely as it may seem, strikes on the earth's crust by very large meteors. There are a number of examples of the latter around the world including Elgygytgyn (no kidding!) in northeastern Siberia. Not to worry though, since statistically, such a strike is probably only about once in 300,000 years.

No matter how the lake is formed, it, like everything else in our fertile, constantly oxidizing and eroding biosphere has a finite lifetime. A lake in its infancy generally has very clear water, a hard bottom, and low nutrient levels. Such a lake is known as an **oligotrophic** ("food-poor") lake. Lakes "trap" many nutrients from inflowing streams, however, and with time, buildup of nitrogen, phosphorus, and other nutrients encourages the growth of large masses of aquatic vegetation. Eventually the lake begins to fill from the sides in with submergent and emergent vegetation and from the bottom up with a rich organic ooze composed of a mixture of silt and the remains of organisms. This type of lake is known as **eutrophic** ("food-rich") because of its highly fertile nature and will in time give way in the process of ecological successon to freshwater marsh, swamp, and finally, upland habitat.

This natural aging process is common to all lakes and is called **eutrophication.** Like so many other processes in our biosphere, however, it can be, and frequently is, strongly influenced by the activities of our own species. For example, the lifetime of a large lake uninfluenced by human affairs may run into the tens, or even hundreds, of thousands of years. But given unnaturally heavy inputs of nutrients from such sources as storm water and treated sewage discharges, septic drainage, erosion from cleared land surfaces, cattle lot runoff, and agricultural and domestic fertilizers, a lake can be "pushed" into its eutrophic phase, complete with nuisance growths of rooted plants and algae, odors, and turbid waters in tens rather than thousands of years. This is "cultural" as opposed to "natural" eutrophication, a process which the President's Council on Environmental Quality has defined as one of the serious environmental problems facing the United States today.

Can anything be done to reverse the situation once a lake is experiencing obvious water-quality problems such as heavy plant growths and high bacterial counts? The answer is a qualified "yes," depending on, among other things, the nature of the problem, the size of the lake, and the willingness of the community to fund restoration efforts.

Since 1976, the Biology Department at Jersey City State College has been studying problem lakes at the request of concerned communities. Our most recent work was a biological and physiochemical survey of Lake Rogerine carried out during the summer of 1979. Extensive weed growth, turbid water caused by high algal densities, and occasionally high bacterial counts were (and are) making the little lake less and less appealing as a recreational and aesthetic resource. The Department managed to carry out the study free of cost to the community by using the lake as a living laboratory for its Limnology course and as a subject of study for a number of undergraduate students interested in the study of aquatic biology and chemistry.

It's an old axiom in the study of limnology (the study of lakes) that the productivity of a lake reflects its watershed. Somewhat simplified, this means that if the watershed is forested, and the inflow to the lake (tributary streams, stormwater runoff) is uninfluenced by human activities, the lake water will probably be clear and aesthetically pleasing, with excellent potential for recreational activities such as swimming, fishing, and boating. If the watershed is rapidly and thoughtlessly developed, however, destruction of vegetation may lead to erosion and rapid siltation of the lake water. If the development has taken place on steep slopes, delivery of drainage from poorly operating septic systems can be rapid following heavy rains. Runoff from roadways and other impervious surface (roofs, parking lots) is often routed directly into the lake with no treatment whatsoever.

Since these various drainages and runoffs are contaminated with silt, high bacterial levels from human and animal waste, and essential plant nutrients (especially compounds of nitrogen and phosphorus), deterioration of the lake water can be rapid and dramatic. Siltation will begin to hasten the filling-in process and provide a substrate on which aquatic vegetation can grow. Whereas in its pristine state the lake water was clean and clear, nutrient-induced algal growths will make it cloudy and turbid. High bacterial counts may make it unsafe for swimming. More desirable organisms, such as salmonid fishes (trout), will disappear and be replaced by more pollution-tolerant forms (carp).

In our study of Lake Rogerine we began by simply looking at a U.S. Coast and Geodetic survey quadrangle map. This revealed high development densities combined with steep slopes, indicating that the principal problem was probably

If problem continues, recreational use will undoubtedly be curtailed.

rapid delivery of septic drainage and storm water runoff to the lake after periods of intense precipitation. Bacterial and chemical testing during the summer of 1979 essentially confirmed this preliminary judgment. For example, coliform bacteria counts in the lake water shot up dramatically after heavy storms, indicating rather large inputs from septic and road drainage. That siltation was playing an important role in the aging process of the lake was made evident by observation of silt-laden runoff during storms. Also, the shallow, highly silted, flat bed of the lake, and conversations with long-term residents who remember a much clearer, deeper Lake Rogerine, further confirm recent high rates of sediment deposition.

Our studies on primary producers (plants) showed, that the entire volume of the lake was becoming choked by vascular plants such as pondweed, and that algal densities in the water column were high enough to constitute an almost summer-long algal "bloom." Also, on a number of occasions the phytoplankton (suspended microscopic plants, usually algae) of the lake was dominated by blue-green algae and/or dinoflagellates, a further indication of deteriorating water quality. At times phytoplankton blooms were so intense that a green floating scum washing up on the leeward side of the lake. Needless to say, one does not have to be an aquatic ecologist to observe these conditions. They were the primary reason that the Lake Rogerine Civic Association, chaired by George Tett and Ed Tis-

The lake still has a productive recreational fishery—yellow perch, bullhead, calico bass, bluegill, pumpkinseeds.

chner, had requested the College to do the study in the first place.

In November 1979 the Biology Department presented the results of its lake study to Civic Association in a technical document entitled, "A Study of Biological, Physiochemical, and Hydrologic Factors Influencing Eutrophication in Lake Rogerine." Although the report included sections on geomorphology, hydrology, water quality, finfish, invertebrate populations, plankton, and macrophytes, we also emphasized techniques by which the process of

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eutrophication might be arrested and the lake restored to its former high quality. Our recommendations were as follows:

(1) **Alter drainage patterns.** Uncontrolled road drainage delivers a considerable load of sediment to the little lake. This hastens the filling-in process, provides additional substrate for plant growth, and is a source of nutrients for unwanted plants. It was recommended that storm water be intercepted via either ditches or drains and passed through settling basins before being allowed to enter the lake. As long as the basins are inspected and cleaned periodically they will remain highly efficient in the removal of sediment and organic nutrient-bearing solids.

(2) **Alter the lake's outlet structure to allow periodic drainage for purposes of freezing and consolidation of lake bed sediments.** Wintertime drawdown is a proven method of improving water quality in shallow lakes. Freezing destroys the root structure of aquatic vegetation and thus enhances recreational use and aesthetic value during the following season. Also, consolidation of the bottom sediments by compaction and drying reduces nutrient exchange between sediments and water after the lake is refilled.

Not the least advantage of wintertime drawdown is the fact that it allows entry onto the lake bed for mechanical removal of dead vegetation and trash, and for deepening projects. Lake Rogerine's relatively high level over mean sea level assures hard freezing of the exposed bed for significant periods in January/February.

(3) **Remove biomass.** Aquatic plants and fish contain significant amounts of nitrogen and phosphorus incorporated into their tissue as protein and other organic compounds. After the plant or animal dies, the action of decomposers (bacteria, fungi) releases these critical nutrients to support new plant growth. For Lake Rogerine, the Biology Department recommended that masses of vegetation be removed mechanically during wintertime drawdown and that nongame fish not be returned to the lake. These actions could remove a significant mass of tissue-bound nutrients from the lake ecosystem.

Students testing and recording data in field and laboratory.

(4) **Institute sound land use practices.** We recommended that the Lake Rogerine Civic Association encourage land-use practices which would decrease the annual mass of nutrients entering the lake. More specifically, new septic systems on steep slopes should be discouraged. Grassy swales should be encouraged and maintained around the perimeter of the lake, for these have been shown to be very effective in reducing the nutrient content of runoff water before it enters a lake. Also, lawn fertilization should be kept to the minimum necessary to maintain the grass in good condition.

(5) **Use herbicides only if necessary.** If, even after implementation of the above measures, sufficient levels of nutrients to cause occasional algal blooms still enter the lake, then safe, carefully calculated dosages of a registered herbicide might be applied to control the blooms. Although this is a highly effective technique, herbicides should not be used carelessly. A firm registered with New Jersey's Department of Environmental Protection should be contracted with for the actual application. At Lake Rogerine, given the small lake volume, costs should be minimal.

So, even though it can truly be said that cultural eutrophication of lakes is one of the serious environmental problems facing New Jersey (and the nation) today, the problem on any given lake can at least be arrested. Many lakes, depending on a number of factors such as the size of the lake and the cohesiveness and will of the surrounding community, can be completely restored.

Funding, of course, is also important. For example, if our goal at Lake Rogerine was complete restoration, it would have been necessary to dredge the bottom sediments to some extent. The lake however, is a private one, and the Civic Association did not feel that it could bear the costs of dredging operations. Consequently, our recommendations were tailored to achieve maximum results at minimum expense. Indeed, the whole program could theoretically be carried out by the Assocition, given the availability of a certain amount of technical expertise, time, and strong backs.

If your favorite lake is having problems, and if it is a public lake, or if significant public access exists, then it is eligible for funding under the Federal Lakes Restoration Program. The Biology Department here at Jersey City State College, for example, is currently involved in a study of Braddock Lake in North Hudson County Park as a public serivce to the Hudson County Parks Commission. The Commission will use the data generated by the study to apply for a Lakes Restoration Grant.

Further information regarding lake restoration can be obtained through the Lakes Management Program of New Jersey's Department of Environmental Protection. The authors are also willing to provide guidance.

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Clean lakes, after all, are one of our state's most valuable natural resouces. □