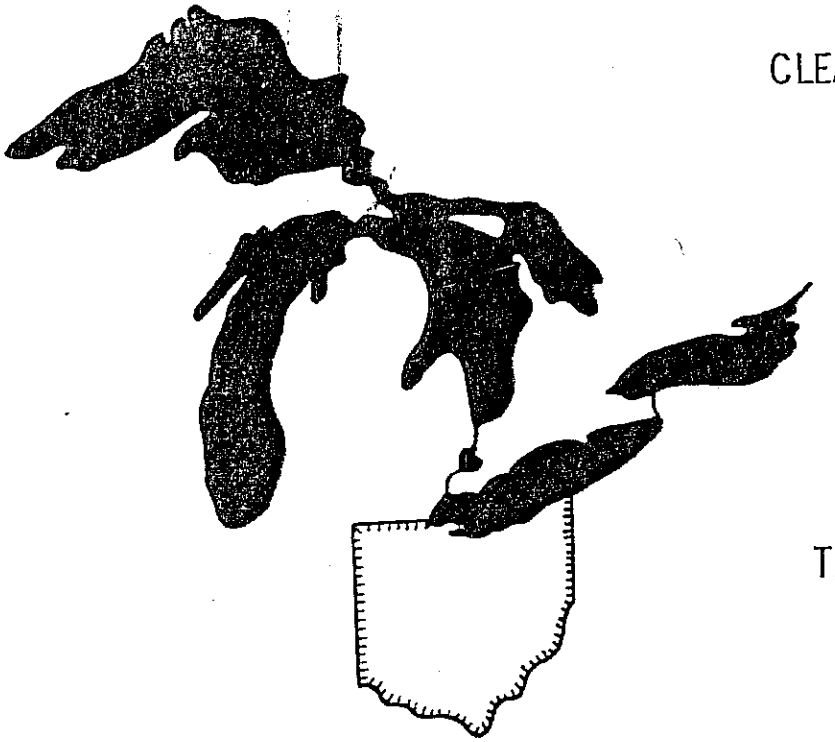

CLEAR TECHNICAL REPORT NO. 265

RECENT EVIDENCE FOR THE RECOVERY OF LAKE ERIE

Prepared by

Charles E. Herdendorf

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

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INTRODUCTION

In the early 1960's Lake Erie gained the reputation as a "dead lake." Its western basin was the consistency of "pea soup" due to dense algal mats which left green waves behind boats. Most municipal beaches were closed owing to high coliform bacteria counts or were rendered unusable by reeking masses of decaying seaweed (largely Cladophora glomerata). One of its major tributaries, the Cuyahoga River, was so polluted by industrial wastes that it periodically caught on fire. Anoxia in the central basin had caused the extirpation of virtually all cold-water fish species and detergent foam at the eastern end of the lake resulted in a disgusting spectacle in the plunge pool of Niagara Falls.

Today Lake Erie is beginning to respond to massive clean-up efforts started two decades ago. New sewage treatment plants have been constructed throughout the drainage basin and old plants have been modified to remove phosphates through tertiary treatment. Industries have been forced to reduce waste loads to the lake or in some instances cease operation, as in the case of chlor-alkali plants which discharged excessive amounts of waste mercury. Production and use of several toxic organic compounds have been banned. Agricultural practices are being modified to lessen soil loss to tributaries and to reduce fertilizer and pesticide requirements.

EVIDENCE FOR LAKE ERIE RECOVERY

Continuous monitoring of Lake Erie water quality and biota is beginning to provide some evidence of lake recovery. The first signs of a positive response to remedial programs have not been dramatic, but then the pollution of the lake also took many decades. Below are listed 18 indicators of improved lake conditions. Cause and effect relationships for all of these observed changes are not well understood and cannot be attributed to particular remedial efforts.

1. Water Levels

   Water levels in Lake Erie during the past decade have averaged 0.5 m above the 1960-1970 levels. The difference between the lowest year (1964) and the highest year (1973) was 1.1 m, an increase of approximately 7%. The dilution effect of more upper Great Lakes water flowing into Lake Erie, coupled with greater submergence of algal attachment sites, is thought to be partially responsible for the absence of basin-wide algal blooms and massive growths of the filamentous algae, Cladophora, that were so prevalent in the mid-1960's.

   Data Sources: Upchurch (1976) and Herdendorf and Fay (1981).

2. Water Clarity

The clarity of water in the western basin as measured by secchi disk, shows a slight improvement from the early 1970's to the end of the decade. The area-weighted transparency in July for 1973-1975 averaged 1.8 m with the maximum year (1974) at 2.2 m. For the same month in 1978-1980, transparency averaged 2.3 m with maximum year (1978) being 3.0 m. The central and eastern basins remained relatively stable throughout the decade with average July transparencies of 6.4 m and 7.0 m, respectively.

Data Sources: International Joint Commission (1981) and Herdendorf and Fay (1981).

3. Dissolved Substances

Nearshore records for the period 1900 to 1960 in central Lake Erie show dramatic increases in conductivity, chloride, calcium, sulfate and sodium plus potassium. From 1966 to 1980 conductivity indicates a low decline in the total amount of dissolved substances in central Lake Erie, falling from an annual mean of 311 to 287 μmhos/cm during this period. Chloride shows a more dramatic improvement, dropping from 25.0 mg/l in 1966 to 18.4 mg/l in 1979. Most of this decline can be attributed to elimination of waste brine pollution from the Grand River near Painesville, Ohio in the early 1970's. In the eastern basin, Presque Ile Bay at Erie, Pennsylvania, has experienced a marked decrease in alkalinity (largely bicarbonate ions) from 1945 to 1978, falling from 96 to 87 ppm. Other conservative major ions have ceased to increase in the lake and have remained relatively stable over the past decade.

Data Sources: Beeton (1965), International Joint Commission (1979 and 1981), and Herdendorf and Fay (1981).

4. Phosphorus Loading

Loading of total phosphorus to Lake Erie declined markedly during the period 1970 to 1979. The 1970 loading to the entire lake, from all sources except shore erosion, was estimated to be approximately 23,000 metric tons. By 1979, the total phosphorus load had decreased to an estimated 13,000 metric tons. The Detroit River, which supplies about 90% of the inflowing water to Lake Erie, has shown a remarkable improvement; phosphorus loadings have decreased 85% since 1968, primarily as a result of improvements to the Detroit wastewater treatment plant.

Data Sources: International Joint Commission (1981).

5. Phosphorus in Wastewater Discharge

In the early 1970's, the concentration of phosphorus in influent wastewater to municipal treatment plants averaged about 10 mg/l within the Lake Erie drainage basin and the mean effluent concentration was approximately 7 mg/l. By 1980, many plants had installed phosphorus removal systems which resulted in an average

effluent concentration of only 1.6 mg/l for all Ohio plants and concentrations as low as 0.7 mg/l for the Detroit sewage treatment plant in 1982.

Data Sources: King et al. (1982) and U.S. Environmental Protection Agency (1982).

6. Lake Concentrations of Phosphorus

Concentrations of total phosphorus in western Lake Erie have declined from 44.6 μg/l in 1970 to 28.8 μg/l in 1980. Similarly, the central basin has dropped from 20.5 to 13.7 μg/l and the eastern basin from 17.5 to 10.8 μg/l during the past decade.

Data Source: Herdendorf and Fay (1981).

7. Hypolimnion Oxygen

In the central basin of Lake Erie, the rate of hypolimnetic oxygen consumption more than doubled between 1930 and the mid-1970's. In 1930, the volumetric rate has been estimated at 0.054 g/m^2/day while in 1973 it was measured at 0.120 g/m^2/day. During the same period the area of the basin exposed to anoxic conditions rose from only 300 km^2 in 1930 to 11,270 km^2 in 1973. Surveys conducted in 1981 show that the demand rate has dropped to 0.085 g/m^2/day and the area of anoxia has been reduced to 4,820 km^2.

Data Sources: Dobson and Gilbertson (1971), Herdendorf (1980) and Fay (1982).

8. Mercury in Sediment Cores

Sediment cores taken at the mouth of the Detroit River and in western Lake Erie in 1971 yield surface mercury concentrations up to 3.8 ppm and generally decrease exponentially with depth to background concentrations of less than 0.1 ppm. High surface values were attributed to waste discharge from chlor-alkali plants (1950-1970) on the Detroit and St. Clair rivers. Several years after these plants ceased operation the area was again cored (1977). The analyses showed that recent deposits were covering the highly contaminated sediment with a thin layer of new material which had mercury concentrations approaching background levels.

Data Sources: Walters et al. (1974) and Wilson and Walters (1978).

9. Mercury in Fish

Mercury in fish of Lake St. Clair and western Lake Erie was a major contaminant problem in the early 1970's. Levels of total mercury in walleye (Stizostedion vitreum vitreum) collected from Lake St. Clair have declined from over 2 μg/g in 1970 to 0.5 μg/g in 1980. In western Lake Erie, 1968 levels of mercury were 0.84 μg/g as compared to only 0.31 μg/g in 1976. The rapid environmental response subsequent to the cessation of the point source discharges at Sarnia, Ontario and Wyandott, Michigan can be attributed to rapid

flushing of the St. Clair-Detroit River system and the high load of suspended sediment delivered to western Lake Erie.

Data Source: International Joint Commission (1981).

10. PCB and DDT in Fish and Wildlife

Levels of PCB and DDT in spottail shiners (Notropis hudsonius) and in herring gull (Larus argentatus) eggs have declined in the past decade, illustrating a system-wide response to controls on production and use of these compounds. PCB levels in shiners at Point Pelee dropped from 844 ng/g in 1975 to 150 ng/g in 1980 while during the same period DDT fell from 92 to 21 ng/g. At Port Colborne, gull eggs showed similar declines in PCB and DDT residues, but of a lesser magnitude.

Data Source: International Joint Commission (1981).

11. Algal Density and Composition

The basin-wide blooms of planktonic blue-green algae (Microcystis, Aphanizomenon and Anabaena) in western Lake Erie and massive growths of an attached, filamentous green algae (Cladophora glomerata) which were so prevalent in the mid-1960's, have decreased in intensity and number in the 1970's. No basin-wide blooms have been reported in recent years. Open lake phytoplankton analysis between 1970 and 1980 indicates a reduction in total phytoplankton biomass and a composition shift toward more oligotrophic species. Eutrophic species (Melosira granulata, Stephanodiscus tenius and S. niagara) were less abundant in 1979 than in 1970 and oligotrophic species (Dinobryon divergens and Ochromonas scintillans) were first observed in 1979.

Data Source: Federal Water Pollution Control Administration (1968) and International Joint Commission (1981).

12. Benthic Communities

The composition of the benthic macroinvertebrate communities of western Lake Erie has improved since 1967. Samples taken in 1979, when compared with 1967 data, showed that the bottom is still dominated by pollution tolerant tubificids (Limnodrilus hoffmeisteri, L. cervix and L. maumeensis); however, other less tolerant taxa of tubificids (Peloscolex spp.) were also common. The density of tubific worms has declined sharply at the mouth of the Detroit River between 1967 (13,000/m^2) and 1979 (2,400/m^2), while the number at the mouth of the Maumee River has remained stable. Midge (Chironomidae) larvae represented only 6% of the benthic population in 1967 but rose to 20% by 1979. A modest reestablishment of the burrowing mayfly (Hexagenia limbata) was also observed in 1979.

Data Source: Ontario Ministry of the Environment (1981).

13. Mayfly Recovery

Modest reestablishment of the burrowing mayfly (Hexagenia limbata), has been reported at the mouth of the Detroit River and adjacent areas of western Lake Erie. This species was extirpated from the western basin in the mid-1950's following periods of anoxia in this normally unstratified portion of the lake. Prior to 1953, bottom sediments yielded about 400 nymphs per square meter in the Bass Islands region. In 1979, 20 nymphs were collected near the mouth of the Detroit River and for the past several years a small emergence of adults has been observed on South Bass Island.

Data Sources: Britt et al. (1973) and Ontario Ministry of the Environment (1981).

14. Sportfishing Harvest

The annual sport angler harvest of fish in the Ohio waters of Lake Erie has increased from 9,094,000 lbs. (4,125,000 kg) in 1976 to 16,355,000 lbs. (7,419,000 kg) in 1981, an increase of 80%. During this six-year period, yellow perch (Perca flavescens) harvests rose from 6,451,000 lbs. (2,926,000 kg) to 11,300,000 (5,126,000 kg) while walleye (Stizostedion vitreum vitreum) production jumped from 671,000 lbs. (304,000 kg) to 2,963,000 lbs. (1,344,000 kg). The increased walleye production has been attributed to good young-of-the-year recruitment and international management approaches to control sport and commercial harvests.

Data Source: Ohio Division of Wildlife (1982).

15. Walleye Population

The abundance of walleye (Stizostedion vitreum vitreum) in western Lake Erie increased dramatically throughout the period 1970 to 1981. During the 1960's and early 1970's the "fishable" population of walleye, 14.5 inches (36.8 cm) in length and larger, was estimated at or below two million. The fishable population present in 1981 was nearly 20 million walleye.

Data Source: Ohio Division of Wildlife (1982).

16. Lake Trout Restoration

Modest success in lake trout (Salvelinus namaycush) restoration efforts was reported for the eastern basin of Lake Erie in 1981. Stocked fish were recovered in healthy condition over a year after release. Reproductive success has yet to be determined.

Data Source: Beer (1982).

17. Forage Fish

The abundance of young-of-the-year gizzard shad (Dorosoma cepedianum), one of the principle forage species utilized by sport and commercial fisheries, shows a several-fold increase since 1976 and was rated as excellent in 1981.

Data Source: Ohio Division of Wildlife (1982).

18. Bathing Beaches

In 1967, 11 Lake Erie bathing beaches on the United States side of the lake were posted unsafe because of high bacterial contamination. Another 12 beaches were deemed as questionable because of moderate bacterial pollution and 27 were considered generally safe with only slight pollution. Only 11 beaches were found to be uncontaminated throughout the swimming season. By contrast, in 1981, only 4 beaches were closed throughout the year, 8 were open for restricted use and 76 were open as safe, uncontaminated beaches.

Data Sources: Federal Water Pollution Control Administration (1968) and U.S. Environmental Protection Agency (1982).

CONCLUSION

The fundamental conclusion of this assessment is that during the first eight years of the past decade, no significant decrease in the loading of suspended solids, dissolved solids, or nutrients occurred. Therefore, during this period the concentration of solids, including nutrients, remained relatively stable. However, an encouraging sign of effective nutrient control was that although no reductions were observed, the continual increases of the previous several decades had been stopped. Other indicators of eutrophication, such as hypolimnetic oxygen rates, chlorophyll concentrations, plankton and benthos populations and turbidity have remained high but also relatively stable.

During the late 1970's changes began to occur which are continuing in the early 1980's: nutrient loading is declining, phosphorus concentrations in the lake are dropping, contamination by several toxic substances are being checked, levels of contaminants in lake sediments and biota are subsiding, "clean water" forms of plankton and benthos are showing modest signs of recovery and fish populations are rebounding. Cause and effect relationships of all of these changes are not obvious and most of the improvements have been small. But evidence for this trend is beginning to mount and it is becoming obvious to scientists, fishermen and shoreline dwellers alike that Lake Erie is recovering. The extent of future improvements will depend on continuing efforts to control loading of nutrients and toxic substances to the lake, particularly those associated with industrial and agricultural practices.

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