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ENVIRONMENTAL IMPACT ASSESSMENT: AN AQUATIC BIOLOGIST'S POINT OF VIEW[1]

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In planning for water-use management or activities in coastal or offshore areas, it is necessary to identify, through impact assessment, the ecological hazards associated with specific types of tuilizations. It is the role of the *aquatic biologist* to predict any adverse effects of the proposed action. The U.S. Atomic Energy Commission has defined *adverse effects* to the ecosystem as follows:

> "Effects are considered adverse if environmental change or stress causes some biotic population or nonviable resource to be less safe, less healthy, less abundant, less productive, less aesthetically or culturally pleasing, as applicable; or if the change or stress reduces the diversity and variety of individual choice, the standard of living or the extent of sharing of life's amenities; or if the change or stress tends to lower the quality of renewable resources or to impair the recycling of depletable resources."

A balanced impact assessment includes not only adverse impacts but also an evaluation of positive ecological effects and the determination of their impact on human needs. However, in practice environmental impact studies have not necessarily provided this type of information or disclosure. In November 1973, Raymond L. St. Ores of the Environmental Review Branch, Ecological Services Division of the U.S. Fish and Wildlife Service presented a paper "Ecological Concepts in the Impact Statement" at a seminar on Environmental Impact Statements at Ohio State University. He made two rather startling statements based on over 2,000 environmental impact statements that he had reviewed in 3½ years:

> "I have never seen an environmental statement, either draft or final, that is adequate in the ecological sense, nor do I ever expect to see one."
>
> "The weakest part of environmental impact statements is that concerned with ecology and it will probably always be so."

What can the aquatic biologist do to improve this situation? To meet the challenge posed by Dr. St. Ores, Ohio State University's Center for Lake Erie Area Research (CLEAR) undertook an assessment project which considered the environmental impact of continued mineral extraction from Maumee River and Maumee Bay of Lake Erie. CLEAR serves the University as a focal point for action directed toward solutions of scientific and engineering problems of the lake and it is equally involved with societal and economic conditions of the adjacent coastal zone. The Center coordinates sponsored research in several major areas of man's concern, contemporary examples of which are: food resources from the lake, impact of energy development, coastal zone management and erosion control, pollution and eutrophication, and mineral resources from the lake.

The Maumee River estuary and Maumee Bay have distinct but interacting ecosystems. Taken together they represent a complex environmental unit that is only now beginning to be understood. In recent years several federal, state and local agencies and institutions have taken an interest in the environmental consequences of proposed actions in the lower river and bay. The results of these studies provided a foundation upon which the proposed investigations and subsequent assessment could be built. The assessment was of particular interest to clear because it provided an opportunity to bring together information from many other investigations in an at-

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tempt to develop a coherent discussion of the Maumee River/Bay ecosystems. Equally as challenging was the problem of assessing the extraction of an important mineral commodity in terms of the potential environmental degradation which could occur.

A lengthy series of field and laboratory procedures were designed and conducted to assess the impact of commercial dredg-

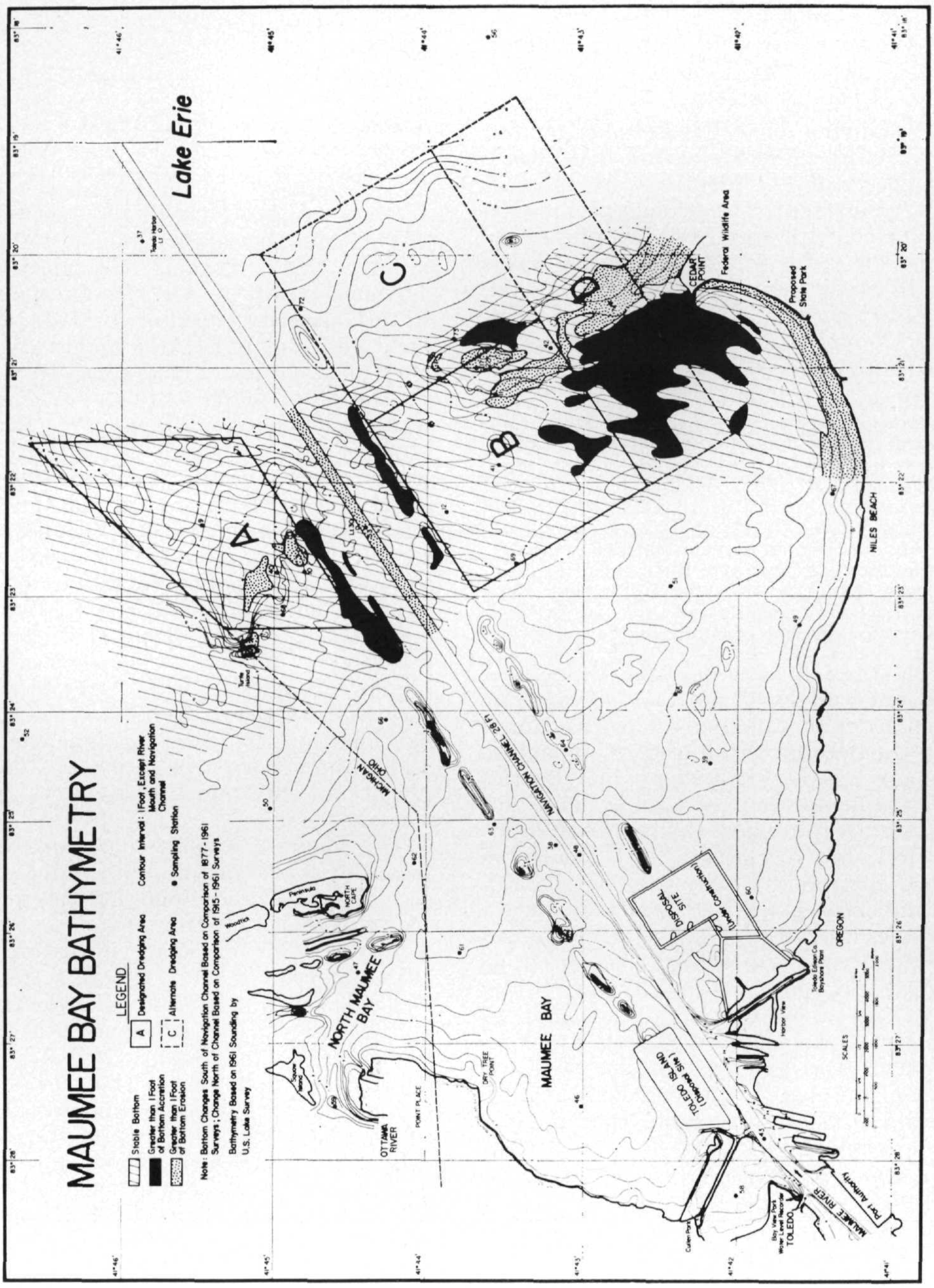

FIGURE 1. Location of individual stations in reference to designated dredging areas in Maumee Bay.

ing in designated areas within Maumee Bay and the Maumee River estuary by White Brothers Sand, Inc. A total of 58 separate sites were selected as environmental monitoring stations. The locations of individual stations were chosen in reference to designated dredging areas, the proximity of active dredging zones or as control sites separate from dredging areas (fig. 1). Three distinct types of environmental studies were conducted: sedmient, water quality, and biological monitoring.

Quarterly sediment samples were tested for 20 parameters to determine the quanities of potential pollutants currently locked in the sediments of the designated dredging areas. These analyses served to indicate the recent geological history and economic importance of the deposit through determination of sediment particle size. The role these deposits may play in depleting the dissolved oxygen in the overlying water column was another significant parameter considered in this portion of the study.

Prior to the initiation of commercial dredging (April 1975), an extensive series of water quality and biological monitoring samples were collected (March 1975) and analyzed at sample sites throughout the study area. Twenty field and laboratory determinations were made on samples from each of the stations to establish background readings for a broad spectrum of water quality and biological parameters during a period when active commercial dredging was in abeyance. The same series of determinations was made bi-monthly during the dredging season to measure seasonal changes in overall quality of the water mass and the possible effects of dredging.

Monthly replicate plankton and benthos samples were taken at 8 stations (at the time of collection water quality determinations also were made) to quantitatively determine and compare the density of fauna in the water column and substrate of actively dredged and adjacent areas. A tri-weekly sampling program was designed to collect and quantitatively determine the density of larval fish in the Maumee River estuary and Maumee Bay to allow little overlap of the size class being sampled. Sites were selected in Maumee Bay and the Maumee River estuary to assess the bay and the estuary as fish spawning and nursery areas. The design allowed for comparisons of the relative importance of the actively dredged and adjacent areas in supporting the early growth stages.

A bi-weekly sampling program was designed to sample the diversity and numbers of larger fish at 2 stations each in the Maumee River estuary and Maumee Bay dredging areas and 2 separate stations intermediate along the reach of the estuary between the two areas were selected. The purpose of this portion of the study was to determine the relative numbers, diversity, and apparent changes in numbers and composition of the fish populations in these areas and to assess the impact of commercial dredging on these factors.

To assess the direct impact of the dredging activities, two 5-day periods of intensive sediment and water quality studies were planned. Extensive field and laboratory determinations for sediment and water quality parameters were conducted in September and October 1975 and a series of monitoring stations separated in space and time were designed to sample sediment and water in the near vicinity before, during and after active dredging. During active dredging, sediment samples were taken in the fresh dredge cut.

A second series of sampling sites was designed to monitor a spectrum of parameters along a 4 mile (6.4 km) reach of the estuary to bracket the designated dredging areas by one mile, to bracket each operating dredge at distances ranging between 1200 and 2000 feet (370–600 m), and to include the maximum intensity of the effluent plume of each dredge. These sites were sampled in September and October. The determinations made during these studies were similar to those baseline series for water quality in March and the quarterly sediment series. In addition to these field studies, certain other assessment topics were investigated (see table 1).

Continued sand and gravel production would be of economic benefit to the Toledo metropolitan area. Short-term

TABLE 1

Assessment Topics
Maumee River and Bay Project

I. PROJECT DESCRIPTION
   - a. Location
   - b. Purpose of Project
   - c. Current Operations
   - d. Future Operations

II. ENVIRONMENTAL SETTING
   - a. Natural Environmental Setting
     - 1. Geology
       - Topography
       - Bedrock Geology
       - Mineral Resources
       - Sand and Gravel Deposits
     - 2. Hydrology
       - Climate
       - Maumee River Basin
       - River Flow Characteristics
       - Estuary Characteristics
       - Bay Characteristics
     - 3. Water Quality
       - Previous Investigations
       - Water and Sediment Quality Study
     - 4. Biological Elements
       - Previous Investigations
       - Biological Monitoring Study
       - Phytoplankton and Higher Aquatic Plants
       - Zooplankton
       - Benthos
       - Ichthyoplankton
       - Fish
       - Waterfowl
   - b. Man-Made Environmental Setting
     - 1. History
       - History of Region
       - History of Navigation Dredging
       - History of Commercial Dredging and Litigation
     - 2. Land Use Zoning
     - 3. Existing Water Uses
     - 4. Socio-Economics
       - Population Trends
       - Social Characteristics
       - Sand and Gravel Resources
     - 5. Aesthetics
       - Panoramic Aspects
       - Sensory Factors

III. RELATIONSHIP OF PROPOSED ACTION TO MAUMEE RIVER ESTUARY AND MAUMEE BAY USE PLANS
   - a. Maumee River Estuary and Maumee Bay Use Plans, Policies and Controls
   - b. Recreational Needs

IV. ENVIRONMENTAL IMPACT OF PROPOSED ACTION
   - a. Hydrologic Impact
     - 1. Estuary Impact
       - Slope Failure
       - Island Configuration
       - Cross-sectional Area and River Velocity
       - Navigational Hazards
     - 2. Bay Impact
       - Wave Impact
   - b. Water Quality Impact
     - 1. Previous Investigations
     - 2. Water Quality Impact Study
       - Standards
       - Maumee River Estuary
       - Maumee Bay
   - c. Biological Impact
     - 1. Plankton
     - 2. Benthos
     - 3. Ichthyoplankton
     - 4. Fish
     - 5. Waterfowl
     - 6. Ecosystem
   - d. Socio-Economic Impact
     - 1. Recreational Use Impact
       - Maumee River Estuary
       - Maumee Bay
     - 2. Other Water Uses
     - 3. Employment
     - 4. Sand and Gravel Industry
       - Company Rankings
       - Continuation of Present Operation
   - e. Historical and Archaeological Impact
   - f. Aesthetics
     - 1. Panoramic Aspects
     - 2. Visual Impact
     - 3. Noise Impact
     - 4. Air Quality Impact

V. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROJECT BE IMPLEMENTED

VI. ALTERNATIVES TO THE PROPOSED ACTION
   - a. Limit Dredging to Designated River Areas
   - b. Limit Dredging to Designated Bay Areas
   - c. Expand River Dredging
   - d. Expand Bay Dredging
   - e. No Action

VII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY
   - a. Short-Term Effects
   - b. Maintenance and Enhancement of Long-Term Productivity

VIII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE MADE SHOULD THE PROPOSED ACTION BE IMPLEMENTED negative effects, however, would include limited hydraulic and water quality impacts, minor noise and visual impacts, and the reduction of benthic and planktonic life forms. The long-term adverse impact would be slight. The scope of the proposed action is so limited in relation to the magnitude of the river and bay ecosystems that a negligible environmental impact is anticipated.

Dredging would increase the depths in both the river and the bay. As a result, river velocities would decrease, particularly during periods of high runoff and floods, causing the sedimentation of silt in the dredged excavations. In the bay, waves generated by intense storms would break closer to the shore if the entire submerged portion of Cedar Point spit were to be removed. This would not result in increased wave energy or erosion at the shore but might cause increased scour 1000 to 2000 feet (300–600 m) offshore.

There would be a temporary increase in turbidity and soluble constituents of the sediments in the water column adjacent to active dredges. The increased load of suspended solids would reduce light penetration and thus reduce the depth of photosynthetic activity by planktonic forms. Planktonic organisms, including larval fish, would be lost if they were entrained in the service water of the dredges. Likewise, benthic forms would be eliminated within the excavations.

Aesthetically, because dredges are industrial facilities not designed to be picturesque, there would be some unavoidable impact. Also, dredges would cause some navigational hindrance to pleasure craft operating in the estuary.

Plankton

Dredging activities would reduce the total numbers of phytoplankton and zooplankton in the immediate vicinity of the operations. This reduction in numbers is a result of the cellular disruption of phytoplankton and the mortality of zooplankton caught in the wash water used to process the dredged material. In addition, the increased turbidity in the immediate vicinity of the dredges reduces the photosynthetic zone and, hence, the multiplication of phytoplankton. At peak population levels, 96% of the phytoplankton enumerated was *Aphanizomenon* sp., a blue-green alga uiversally considered a nuisance species. Algal and zooplankton populations characteristically exhibit periodic population changes. Therefore, the greatest number of individuals of a given species would be destroyed during periods when the greatest numbers were present in the water column. The quantity of plankton which survives the wash process is not known but is suspected to be low.

Benthos

Dredging activities completely eliminate the macroinvertebrate populations in the area being excavated. Sandy substrates typically exhibit a fauna of limited numbers and diversity. Collections taken during this study from the Maumee River estuary and Maumee Bay revealed a fauna consisting largely of tubificid worms and midge larvae. These pollution tolerant organisms are not highly valued. The stationary dredges operate in a limited area for lengthy periods. The sweeper dredges operate primarily in previously dredged excavations. The surficial sediments are disrupted in relatively narrow zones without wholesale disruption of benthic habitat in the designated dredging areas. It is estimated that recolonization of the excavations occurs within a year or less of dredging. The impact on macrobenthic populations is extensive in the short term and minimal in the long run.

Ichthyoplankton

Dredging activities reduce ichthyoplankton numbers in the same way plankton numbers are reduced. Larval fish caught in the wash water processing of dredged materials are lost. Most fish larvae live a planktonic existence for several weeks post-hatching. It is only during this period when larvae are unable to freely move in the water column that they are vulnerable to the dredges. The principal larvae populations in the Maumee River estuary are, in order, gizzard shad and freshwater drum. The principal larval populations in the shallow water areas of Maumee Bay are, in order, gizzard shad and white bass. The Maumee River estuary was dominated by rough/forage and marginal value sport fish during the study period. The shallow water areas of Maumee Bay were dominated by forage fish and desirable Lake Erie sport fish. The numbers of larvae captured in the designated dredging areas and in Lake Erie at the mouth of the bay were considerably lower than those inshore in shallower water.

A few specimens of larval mooneye were taken from Maumee Bay during this study. The mooneye is listed by the Ohio Division of Wildlife as an endangered species as authorized by the *Ohio Revised Code, Section 1531.25*. The spawning area for this species is uncertain. The density of these larvae in the designated dredging area is the lowest computed for any fish species captured during this study. This low density means that the probability of dredges destroying a mooneye larva during dredging operations in the bay is remote.

The rapids zone of the Maumee River upstream of Perrysburg is considered by the Division of Wildlife as a principal spawning area for walleyes. Adult walleyes spawn in this area in April, larvae hatch within 3 weeks and are carried to the bay by currents in the elevated river stage predominating during this period of time. The personnel of the Division of Wildlife do not consider Maumee Bay a walleye spawning area. No evidence gathered in this study indicates that Maumee Bay is a significant walleye spawning area. The potential impact of dredging on planktonic walleye larvae is lessened by two factors: the high volume of water in the estuary reduces the density of larvae present, and many larvae will be carried in the current through the natural river channel, an area in which the dredges do not operate normally. During periods of elevated water levels due to spring runoff, the dredges are positioned in areas where the currents have the least effect.

Fish

Dredging activities have little direct impact on adult fish. The adults simply move away from the disturbance. Commercial fishing, with the exception of shore seining, is prohibited in Maumee Bay by the State of Ohio. There are no shore seining operations in Maumee Bay. Therefore, there will be no impact by the dredging activities on the commercial fisherman operating in the region.

No positive correlation between larval fish densities and subsequent adult populations, with the possible exception of yellow perch, has been demonstrated. Recruitment of young-of-the-year (Y-O-Y) fish of a number of species into their respective adult populations is not reflected by their initial densities as Y-O-Y.

Waterfowl

Waterfowl, like adult fish, will respond to the disturbance caused by dredging activities by avoiding the immediate area. No waterfowl habitat would be destroyed

Ecosystem

The flora and fauna of the designated dredging areas are largely pollution tolerant. The predominant fish species is the gizzard shad, a primary consumer. Freshwater drum, a secondary consumer, are also common in all of the dredging areas.

Limited diversity has been demonstrated in the dredging and adjacent areas. Food chains are short. Secondary and tertiary consumers are not common and those captured during this study were, for the most part, probable transients rather than permanent residents. The overall impact of dredging activities in the aquatic ecosystem studied is minor. The ecosystem of the river/bay would not be distinctly different if commercial dredging did not occur.

One particular project has been singled out here to demonstrate the diverse role that an aquatic biologist must play in a comprehensive environmental impact assessment. I have attempted to show that NEPA provides an excellent opportunity for aquatic biologists to expand our knowledge of aquatic systems and to have a direct input to the decision-making process which dictates the fate of these systems.