Ohio Sea Grant

OHSU-Q-83-002

A Report of Program Development

1977-1983

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The Ohio State University

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THE OHIO SEA GRANT PROGRAM
1977-1983

A Report of Program Development

Prepared by

Ohio Sea Grant Program
Center for Lake Erie Area Research
The Ohio State University

Submitted to

National Sea Grant College Program
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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May 1983

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May 8, 1984

Dr. Ned Ostenso, Director
National Sea Grant College Program
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
6010 Executive Boulevard
Rockville, Maryland 20852

Dear Dr. Ostenso:

With this letter I am pleased to transmit a composite of annual reports for the Ohio Sea Grant Program for the period 1977 to 1983. In this five-year period, we have grown from a single educational project the first year to a coherent project with research, education and advisory components in the second, third and fourth years, to an institutional program in our fifth year with a comprehensive approach toward marine and aquatic resources. The central theme of the Ohio Sea Grant Program focused on the resources of the Great Lakes and particularly how those of Lake Erie can be wisely utilized to enhance the quality of life in Ohio and in our neighboring states.

Ohio enthusiastically supports the concept and work of the Sea Grant Program. At our home here at The Ohio State University, we are gratified by this support at all levels of the faculty and administration. At the State level, cooperation with the legislature and state agencies has also been excellent as we have developed an effective program. Public support of Ohio Sea Grant, however, has been the most gratifying as evidenced by attendance at workshops and the volunteer efforts of many community leaders.

We have grown, developed and learned much in the past five years. The accompanying report will document some of our more important accomplishments. We appreciate the continuing guidance and support of the National Sea Grant Colege Program and look forward to a bright future. The Ohio State University has the potential and has set as its goal the achievements required to be designated a Sea Grant College.

Sincerely,

Charles E. Herdendorf

Charles E. Herdendorf
Director

CEH/cs

cc: Richard C. Kolf
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The Ohio Sea Grant Program had its official beginning in August 1977, when The Ohio State University received its initial award from the National Sea Grant College Program. But the University's commitment to a Sea Grant Program for Ohio extends back to 1971 when the Center for Lake Erie Area Research (CLEAR) was formed within the College of Biological Sciences. CLEAR was assigned the responsibility of coordinating interdisciplinary research and technical services on scientific, technological and socioeconomic problems associated with Lake Erie and its coastline. The Center provided, for the first time, a single focal point within the university for unified planning, development and logistical support for Great Lakes Research. Early in the development of the Center, the university provost designated CLEAR as the administrative unit within The Ohio State University for developing and operating an Ohio Sea Grant Program. Today, the activities of the Center are university-wide and directed towards the establishment of programmatic research objectives designed to stimulate faculty and students of various disciplines in attacking critical environmental and resource problems within the Great Lakes region. The Center also vigorously pursues cooperation with state and federal agencies, private and industrial organizations and other universities and colleges interested in Great Lakes problems.

During the second year of the program, CLEAR and the Ohio Department of Natural Resources, Division of Wildlife joined together for the purposes of conducting fisheries research and advisory services activities related to the fish and wildlife resources in the Lake Erie area. This successful Sea Grant arrangement has continued because of the similar missions and goals of these two organizations concerning Lake Erie resources.

In the third and fourth years of the Ohio Sea Grant Program similar links were established with the Ohio Cooperative Extension Service (OCES) and the Ohio Department of Education. A cooperative program with OCES has permitted Ohio Sea Grant to extend its advisory service through a well-established network. In a similar way, the infusion of marine and aquatic education into the Ohio school system has been facilitated by working through the Ohio Department of Education.

In the fifth year, the Ohio Sea Grant Program broadened its research base by conducting Great Lakes projects in the fields of (1) biological resources, (2) mineral resources, (3) water quality and lake processes, (4) coastal and offshore engineering, (5) aquaculture, (6) resource economics and marketing, and (7) cultural and recreational resources. Well-developed cooperative programs in marine and aquatic education and in marine advisory service were being strengthened with the establishment of state-wide networks. As our sixth year begins, we are proud of our institution's desire to provide a comprehensive Sea Grant Program to meet the mutual research, education and service objectives of the university and the National Sea Grant College Program.

RATIONALE FOR AN OHIO SEA GRANT PROGRAM

Lake Erie is one of Ohio's most valuable natural resources. The wise, yet maximum utilization and understanding of the many facets of this resource are goals of the Ohio Sea Grant Program. A number of critical environmental and resource problems have been identified within the Lake Erie basin which can be alleviated through the combined effort of Sea Grant research, education and advisory service activities. Some of the most prominent problem areas are outlined below.

Fisheries Resources

Ohio's Lake Erie fisheries, which have been showing positive signs of revitalization, are being utilized by various groups. Each user group has differing views on the quantity and quality of the resource that is "rightfully" theirs and what, if any, of the resource should be utilized by conflicting interest groups. Certain fish species cannot support a dual sport and commercial fishery which is acceptable to each group. Environmental, sport and commercial harvest regulations assist in protecting fish populations from becoming extinct. The extent of additional management regulations depends on the quantity and quality of the fish population desired for a primary user group or groups. The decision to manage for a user group or groups is affected by the numbers of people in those groups and the subsequent economic value the fishery resource provides. There is only sketchy knowledge of the economic value of the Lake Erie fisheries for the major user groups. Studies are needed to provide fish managers, resource planners and administrative personnel with an economic value of the resource.

A primary concern to resource managers is the dwindling commercial fishing industry in Ohio. The greatest cause of this collapse has been the gradual change in lake fish from high dollar-value species such as whitefish, lake trout and blue pike to low dollar-value fish such as carp, freshwater drum and gizzard shad. Competition with recreational fishermen has placed additional constraints on the commercial industry. To survive, the industry needs new ways to harvest, process and market several under-utilized but abundant species. The industry also needs to enhance its public image, develop a sound financial base and promote the potential importance of Lake Erie fish as a food resource. Although Lake Erie has experienced dramatic changes in fish stocks, its annual production of fish for human consumption is greater than the other Great Lakes combined.

Advances in aquaculture are needed in Ohio in order to maintain the population of game fish species in the waters of state, federal and private hatcheries. One of the critical problems in these hatcheries is the production of fingerlings for stocking, particularly if natural food is required during the rearing process. Research is needed to determine the optimal way to produce appropriate food organisms and bait fish.

Energy Facilities

The need for more and new sources of energy has led to the construction of 20 nuclear and fossil-fuel electric power plants along the shores of Lake Erie. The water withdrawn from the lake for cooling these facilities and the heated and chemically enriched waters discharged to the lake have ecological implications for Lake Erie. A lake-wide evaluation of the impact of entraining fish larvae and impinging adult fish is needed. The results of a comprehensive study of the first nuclear plant in Ohio, the Davis-Besse Nuclear Power Station at Locust Point on Lake Erie, should be projected to estimate the cumulative effect of the water intakes and discharges from all power plants in the lake ecosystem. Efficient and environmentally sound plant operating practices as well as adequate public awareness of plant operating procedures are the objectives of Sea Grant activities in this area. Nuclear waste disposal test sites in the salt mines under Lake Erie and exploitation of proven oil and natural gas reserves under the lake are also controversial issues which require attention.

Mineral Resources

The mineral resources of the Lake Erie basin are small in number, but important to the region's economy. The most prominent include: (1) sand and gravel, (2) clay, (3) limestone and dolomite, (4) sandstone, (5) gas and oil, (6) rock salt, and (7) gypsum. Sand and gravel deposits in the lake are extensively dredged for construction aggregate and beach nourishment. Exploration and testing is needed to determine if these deposits can be utilized by Ohio's glass industry. The Canadian government has permitted development of over 1,000 successful gas wells in Lake Erie. The same potential exists in Ohio with proper environmental safeguards. Two of the largest salt mines in the world send shafts from the shore out under Lake Erie near Cleveland. Related deposits of gypsum are being mined and quarried on the north shore of Sandusky Bay. A comprehensive investigation of the evaporite deposits under Lake Erie and their development potential is needed.

Water Resources

Water is perhaps the most important natural resource associated with Lake Erie, but its quality has been seriously degraded in the past several decades by excess nutrient enrichment and toxic pollutants. As a result the lake has experienced accelerated eutrophication, and several of its sport and commercial fish have been declared unfit for human consumption from time to time. The nearshore portion of the lake is the most degraded yet it is the least studied and most poorly understood. Because of the small volume of water in this zone and relatively short residence times for water masses, these waters could be rapidly improved by new pollution abatement programs. The importance of the nearshore zone cannot be overstated when one considers that it is the most biologically active zone in the lake; most water intakes are found here, most recreational activities take place here, more commerce is concentrated here and most waste discharges are located here.

Economic Revitalization

Commerce is vital to northern Ohio's economy. Two of the nation's largest ports, Toledo and Conneaut, are here. More shipping tonnage is carried on Lake Erie than on any other U.S. lake. For example, more than 32 million tons of coal are

transported on it annually. This inexpensive bulk shipping utilizes large vessels, which require harbor depths of at least 28 feet. Dredging sediments to maintain and enlarge ports which will accommodate these vessels sometimes poses environmental problems. Toxic chemicals which have accumulated in bottom sediments are released into the water and disturbed silt causes turbidity, polluting the water and interfering with fish spawning. Dredging also transforms the lake bottom and changes current patterns. Research into these areas is crucial to the continuance of the shipping industry.

Annually, millions of dollars are brought into the Lake Erie area by travelers and tourists. The once-poor image of Lake Erie is improving, but work must be done to make business leaders and the public aware of the lake's exceptional recreational and commercial assets. Abundant energy and water supplies, a moderate climate, beaches, campgrounds, numerous state and local parks, museums, wineries and vineyards, historical landmarks and flourishing industrial and business centers make it extremely attractive to both visitors and investors. The natural beauty of Lake Erie's beaches, harbors and islands encourages boating. But demand for recreational boating facilities far exceeds the supply. Studies of the internal profit structure of privately-owned marinas is needed. Results from such a study should strengthen the marina business by increasing the number of facilities and services by providing lending institutions and public officials with information necessary to make fiscal and policy decisions.

Lake Erie's fisheries are extremely valuable. More fish for human consumption are harvested from Lake Erie yearly than from the other four Great Lakes combined. And thousands of sportsmen, spending millions of dollars annually, revel in its gamefish. However, the economic value of this resource is poorly understood. Studies are needed to ascertain the relative contributions of the various fishing endeavors in order to develop sound resource management programs.

Coastal Protection and Enhancement

Recent record-high water levels in Lake Erie have caused severe damage to shore property, devastating many homes and other structures. From 1972 to 1976 approximately $60,000,000 of shore erosion and lake flooding damage occurred along the Ohio shoreline. The worst erosion is occurring along the high bluff areas east of Cleveland, whereas the most serious flooding takes place along the low marshy shore between Sandusky and Toledo. Better storm surge forecasting programs are needed to provide shore dwellers with an early warning of high-water storms. Investigations of existing erosion control structures show that action by individual property owners must be replaced by a coordinated shore protection effort by all of the shore owners along a particular bluff. Since no federal or state assistance programs are available within Ohio, the protection must be inexpensive and capable of being constructed with significant participation by the property owners. Research is needed to identify, design and evaluate optimal cost and construction techniques for effective bluff erosion prevention strategies.

Comprehensive planning for the wise use of Lake Erie shorelands and resources is sorely needed to prevent further misuse of the lake's coastal zone. In recent years there has been an increasing awareness of the resource value of our Great Lakes coastal wetlands and the urgent need to protect and conserve these ecosystems. Traditionally, wetland conservation efforts along the Great Lakes have been aimed at protecting waterfowl breeding, and to a lesser degree, fish spawning and nursery

habitat. More recent efforts toward preservation are based on the knowledge that wetlands provide additional benefits, including flood control, shore erosion protection, water management, control of nutrient cycles, accumulation of sediment and supply of detritus for the aquatic food web. Although the value of Great Lakes wetland areas has now been recognized, the need still exists for comprehensive studies to map, enumerate and characterize them and to catalog the physical, biological and cultural data base available for each wetland. Data bases such as these are necessary to understand the complicated processes occurring in these wetlands.

Recreational and Cultural Resources

Because of its natural beauty, numerous harbors and abundant sport fish, Lake Erie is extensively used for recreational boating. However, marinas have been unwilling or unable to keep pace with the demand for dock space due to the uncertainty of the profitability of such ventures. Investigations are needed to generate data which will not only help the private developer, but will provide lending institutions and public officials with information necessary to make fiscal and policy decisions. In addition to boating, the Lake Erie islands provide an aesthetic experience that is conducive to recreational pursuits and vacation retreats. Rocky cliffs, beaches, quaint cottages and the ever-changing conditions of the water from placid to stormy, all provide desirable attributes. Federal, state and local actions are needed to ensure that Lake Erie's islands retain their natural attractiveness while still providing their inhabitants with a viable economic base.

MISSION OF THE OHIO SEA GRANT PROGRAM

The Ohio Sea Grant Program seeks the wise utilization of marine and aquatic resources, particularly those resources associated with the Great Lakes, to enhance the quality of life in Ohio and our surrounding states. This mission is being implemented through comprehensive research, education and advisory service programs. These programs are designed to increase awareness and utilization of Lake Erie resources and to be capable of responding to critical marine and aquatic problems or issues facing the citizens of Ohio.

Administration Mission

The administrative office of the Ohio Sea Grant Program strives to provide sound management, business and logistical services, coordination and communication, and direction for program development (Figure 1). This office is charged with the responsibility of promoting and monitoring progress towards the accomplishment of the overall mission of the program. To meet this goal, an administrative structure has been established consisting of a director, associate director, coordinators for research, education and advisory services and liaison officers with the Ohio Department of Natural Resources, the Ohio Department of Education and the Ohio Cooperative Extension Service. To provide assistance with problem identification, long-range planning, coordination and scientific direction, various advisory councils and committees have been impaneled.

The accomplishments of the first five years of the Ohio Sea Grant Program demonstrate a steady growth from a single project to a comprehensive program with well-established research, education and advisory service components. The Ohio State University and the Ohio General Assembly have also demonstrated a long-term commitment to the program. In spite of severe financial constraints, the budget for the program administration amounts to over $100,000 from university sources. As described earlier, the university initiated the Center for Lake Erie Area Research in 1971, with the intent of developing a long-range Ohio Sea Grant Program. A more recent example of Ohio's concern for Great Lakes resources is the appropriation of $950,000 from the General Revenue to upgrade the facilities at the Franz Theodore Stone Laboratory, OSU's biological field station on Lake Erie and home of the Ohio Sea Grant's workshop program.

This financial support, plus demonstrated accomplishments in all three phases of the program and a long-term commitment by the institution and the state, are important considerations which resulted in advancement of Ohio Sea Grant from a "Coherent Project" to an "Institutional Program" in 1982. The Ohio Sea Grant Program has shown that a carefully planned, step-wise approach is the best method to achieve successful program development. We believe that this approach has led to the formation and operation of a sound program, comprehensive in nature, that is meeting its stated objectives. Recognition of The Ohio State University as a Sea Grant institution has enhanced the program's effectiveness and will provide the continued

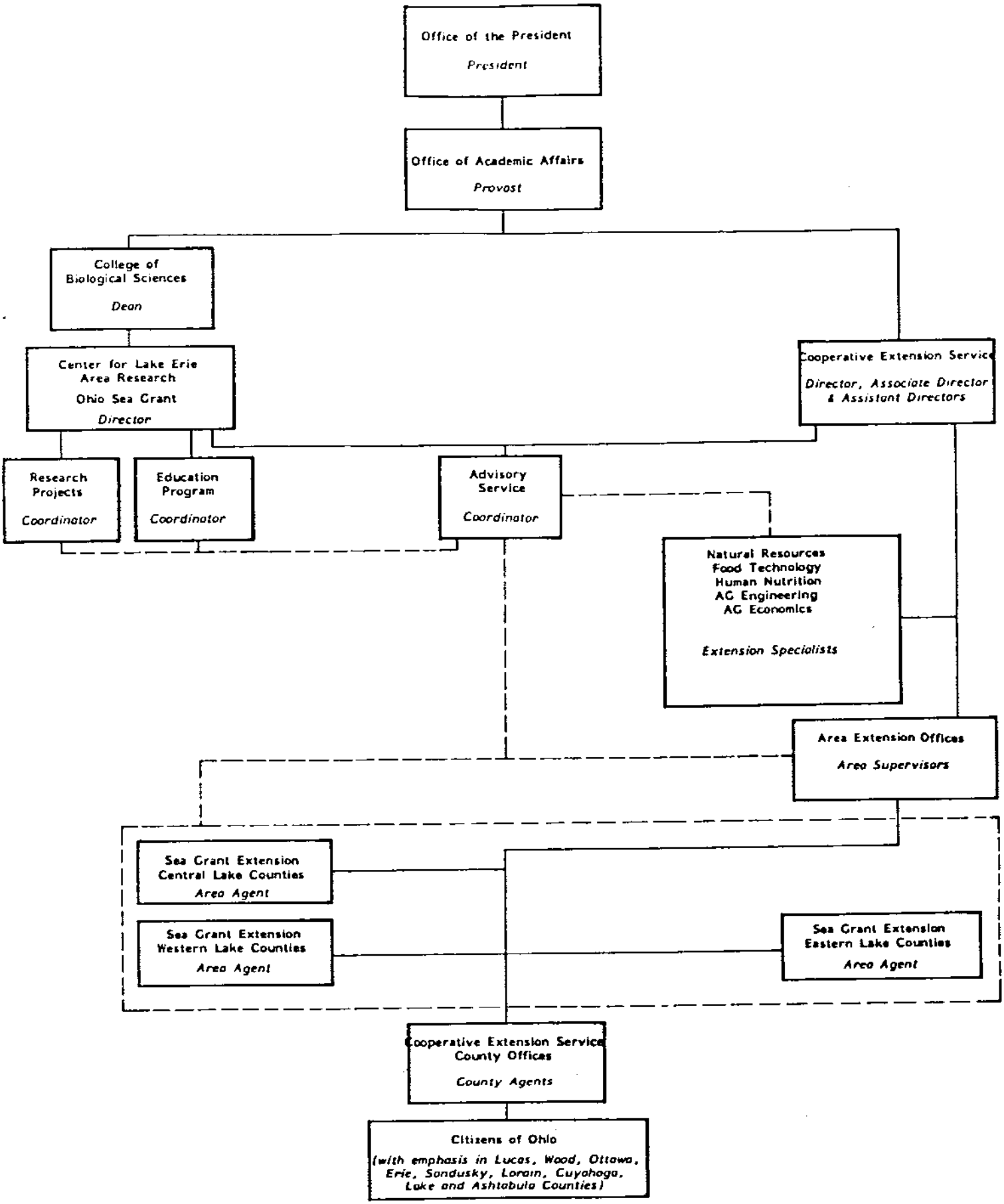

Figure 1. Administrative Organization of the Ohio Sea Grant Program

support which will permit us to develop program strength necessary to achieve "Sea Grant College" status within the next five years.

Research Mission

The research efforts of the Ohio Sea Grant Program are primarily directed towards the solution of Great Lakes problems in the seven areas of concern discussed earlier. Recently completed, current and proposed research emphasis includes the following topics:

1. Biological Resources:
   a. Ecology of freshwater estuaries and wetlands
   b. Impact of parasites on Lake Erie fish
   c. Fish community dynamics
   d. Fish stock discrimination and migration patterns
   e. Reconstruction of historic Lake Erie fish communities
   f. Impact of power generating facilities on the fisheries resources of Lake Erie
   g. Inventory of fish and wildlife resources of Great Lakes coastal wetlands
   h. Ecology of marine ecosystems

2. Mineral Resources:
   a. Sedimentary deposits and processes in Lake Erie
   b. Evaluation of sand and gravel resources in western Lake Erie
   c. Assessment of environmental concerns related to production of natural gas and oil from under Lake Erie

3. Water Quality and Lake Processes:
   a. Factors limiting productivity of the Lake Erie ecosystem
   b. Analysis of Lake Erie storm surge flooding
   c. Sediment loading, resuspension and transport
   d. Coherent turbulent structures in the benthic boundary layer of Lake Erie
   e. Lake Erie ice sheet formation, breakup and transport
   f. Toxic contaminants in the aquatic environment
   g. Analysis and depiction of limnological characteristics of large lakes

4. Coastal and Offshore Engineering:
   a. Bluff erosion abatement strategies for Lake Erie
   b. Development of Lake Erie storm surge forecasting models
   c. Meteorological radar investigations of Lake Erie storms
   d. Engineering attributes and impacts of flood-durable shore structures
   e. Reliability of foundations for offshore structures
   f. Development of an ultrasonic transducer for direct profiling of sediment concentration and grain-size distribution

5. Aquaculture:
   a. Zooplankton productivity in fish hatchery ponds
   b. Culturing fathead minnows for bait in Ohio
   c. Fish productivity in diked Lake Erie marshes

6. Resource Economics and Marketing:
   a. Economic value of Lake Erie fisheries
   b. Lake Erie information through radio broadcasting
   c. Economic analysis of the marina industry in Ohio
   d. Market acceptance of under-utilized Lake Erie fish species
   e. Marketing channels for seafood products in Ohio
   f. Economic value of fresh-fish protein as a substitute animal feed protein

7. Cultural, Recreational and Educational Resources:
   a. Recreational planning for Lake Erie coast
   b. History and architecture of the Bass Islands
   c. Recreational boating facilities and utilization of Lake Erie
   d. Traditions and customs of the commercial fishing industry on Lake Erie
   e. Great Lakes information through museum programming
   f. Lake Erie information through radio broadcasting
   g. Dissemination model for marine and aquatic education

To accomplish the research mission of the Ohio Sea Grant Program, continuous interaction takes place between the researchers and individuals involved in Sea Grant education and advisory service. It is this interaction which has transformed our initial efforts from a collection of projects to a coherent program.

Education and Training Mission

Education includes the entire variety of experiences through which people learn: formal educational activities from kindergarten to graduate school; continuing informal education through recreational, work, and life experiences; and all forms of communication from personal to mass media. It is viewed as a lifelong process by the Ohio Sea Grant Program. Education efforts of Ohio Sea Grant have two primary missions. One is the development of a citizenry in Ohio that is informed about the importance of the Great Lakes system (especially Lake Erie) and the marine environment to the economic, cultural and recreational well-being of the state of Ohio, of the Midwest and of the nation at large. Such an informed citizenry is important to assure that political and business leaders of the state will develop and follow policies that assure the best economic uses of the lake environment while protecting it from abuses that would limit its usefulness and be detrimental to public health. The second mission of education in Ohio Sea Grant is to provide manpower, trained in skills and knowledge, to effectively utilize the lake environments and to provide Ohio citizens with rewarding and fulfilling careers related to lake and marine environments. Both the advisory service and education components of Ohio Sea Grant are organized to meet this broadly defined educational commitment.

Two basic thrusts have been developed by Ohio Sea Grant to meet its educational commitment. One thrust is marine and aquatic education which has also been defined as that part of the total educational process which enables people to develop a sensitivity to, and a general understanding of, the role of the seas and fresh water in human affairs and the impact of society on marine and aquatic environments. Successful programs in marine and aquatic education will result in a public citizenry in Ohio which:

1) possesses a basic understanding of the marine and aquatic components as part of the whole environment, and of their importance to society;

2) has an awareness of, and sense of responsibility for, water and an understanding of the proper uses, protection and conservation of the oceans and Great Lakes, their coastal zones and freshwater resources; and

3) is motivated to take part in decisions affecting water resources, and is equipped with principles and information necessary to evaluate problems, opportunities and events.

Programs in marine and aquatic education will include efforts to develop a broad public understanding of marine and aquatic information and issues. Such programs will be statewide in impact and coordinated by the Ohio Sea Grant Education Office in cooperation with the Advisory Service. They include work with the formal education system of Ohio, such as the recently completed OEAGLS Project (Oceanic Educational Activities for Great Lakes Schools), a program to develop instructional materials for grades 5 through 9, the Marine Education Infusion Program (started in 1980-81), and a new course in oceanography and marine biology offered as part of the general education curriculum of The Ohio State University. The Education Program has also initiated informal programs in marine and aquatic education focusing on the adult population. An example is a current project entitled "Lake Erie Public Information Through Radio Broadcasting" which is conducted cooperatively with the Advisory Service. Included in this thrust is the project "Great Lakes Information Through Museum Programming." Future efforts will include adult education courses offered through science and technology centers and adult education centers. Such courses would develop general information about the marine and lakes environment. Courses similar in content have already been offered by the College of Education at Ohio State, but organized for the purposes of teacher education.

The second thrust is in education for marine- and lake-related careers. There are two basic goals to this thrust. The first is to provide a trained work-force for Ohio, for employment in lake-related activities with business, industry, government and education. Such a trained work-force base is essential to effectively develop Ohio's resources in Lake Erie in an environmentally sound manner. The second goal is to provide educational opportunities for those Ohio citizens who are interested in pursuing careers related to the marine environment. A successful careers thrust by Ohio Sea Grant will provide well-trained workers for Ohio and also provide many of its citizens with satisfying and fulfilling careers in lake-and marine-related occupations; careers in which they find themselves trained for continuing growth and advancement in their field as well as trained in the skills needed to function effectively upon entering their field.

Two projects were started in 1980-81: The Marine Technology Program of Bowling Green State University and the graduate program in coastal engineering at The Ohio State University. The Education Program has conducted a state-wide study of formal education programs for training individuals for aquatic oriented careers. This includes secondary school vocational programs, two and four year post-secondary school technical programs, and bachelors and graduate degree programs. This study provides a basis for identifying needed programs in the state. A directory of programs for marine-and lake-related careers will be developed and sent to all school counselors

in the state and to other interested parties. This career thrust also has an informal education component; the workshops and short courses offered by the Advisory Service to users of marine and aquatic information. This program serves as professional renewal, affording those who are involved in lake-related occupations the opportunity of keeping their skills and knowledge current. This component is being conducted by the Advisory Service and will remain a major thrust of the Advisory Service. The Education Program cooperates in this endeavor by providing assistance in developing workshop formats and in evaluating workshop effectiveness.

Advisory Service Mission

Ohio Sea Grant Advisory Service has several goals, but the overall mission is to maximize the benefits which society derives from Lake Erie, the other Great Lakes and the oceans. One way to accomplish this is to ensure that all user groups are aware of the opportunities available to them at Lake Erie, are utilizing the most up-to-date technology in their operations, are aware of current research efforts, and are able to provide input to the design of these research efforts to assure that the real problems are being addressed.

The Ohio Sea Grant Advisory Service functions as Ohio Sea Grant's interface with the public, and, in that capacity, transmits research results to resource users and carries public sentiment, needs, concerns and priorities back to Ohio Sea Grant to allow formulation of programs responsive to the needs of the people of Ohio. In this capacity the Ohio Sea Grant Advisory Service becomes the "hub" of Ohio Sea Grant, designed to both transmit the results from existing projects to users and assist in the development of new projects based on public needs. Another part of this effort includes cooperating with other state and federal agencies to maximize the benefits derived from each agency and avoid duplication of effort.

To be effective in this capacity, the Advisory Service must represent all user groups and all areas of the Ohio shoreline equally. Identification of user groups and development of effective lines of communication with these groups is an important part of the Advisory Service mission. Parallel to it is a broad public education program designed to increase public awareness and demonstrate that all Ohioans are members of marine-user groups since we are all affected by the oceans and Great Lakes in some way. Our plan is "increased utilization through education." Increasing public awareness is also a mission of the Ohio Sea Grant Education Program, and consequently, Advisory Service efforts of this nature are conducted in cooperation with the Education Program.

In 1981, area agents were placed in the three Ohio Cooperative Extension Service area offices bordering Lake Erie. This greatly increased the effectiveness of the program by placing staff in the proximity of user groups. These agents now serve 26 of Ohio's 88 counties, including the eight counties bordering Lake Erie.

Having achieved our initial goal of providing Sea Grant assistance to all lake counties, we can devote our efforts to the Advisory Service mission; greater awareness and utilization of Lake Erie through education. This includes workshops, newsletters, fact sheets, demonstrations and seminars, all of which will continue to be evaluated to determine effectiveness, as measured by increased resource utilization, earnings, dollar savings and new jobs.

GREAT LAKES SEA GRANT NETWORK

Six Sea Grant Programs are now operating on the Great Lakes: Illinois-Indiana, Michigan, Minnesota, New York, Ohio and Wisconsin. These programs represent Sea Grant's total involvement with the industrial heartland of America, and form what has been referred to as Sea Grant's Great Lakes Network. In addition to their geographic proximity, the programs represent Sea Grant's involvement with the major source of freshwater in the world.

Initially, it was recognized that communication and cooperation between the programs was necessary to assure that the maximum benefit would be derived from the available fiscal and personnel resources. Consequently, the Great Lakes Sea Grant Network was formed by a formal agreement in December 1976. At that time the Ohio and Illinois-Indiana programs were not in existence. By this agreement, the Network set its goals as follows:

1. the exchange of information and sharing of expertise in research, education, training and advisory services;

2. the coordination of ongoing activities;

3. the development of coordinated efforts to solve Great Lakes area resource problems;

4. the improvement of coordination of our efforts with those of federal and regional groups, including Canada;

5. to assist in development of new Sea Grant programs and projects in the Great Lakes region; and

6. to pursue other mutual goals and undertake activities supportive of the Sea Grant Program Improvement Act of 1976.

A network proposal was prepared and submitted to the National Sea Grant College Program. They concurred with the importance of the above goals and provided the first funding for the Great Lakes Sea Grant Network during the summer of 1978. This was prior to the development of the Ohio Sea Grant Program. The program, including Ohio, was again funded in 1979, but due to budget restrictions, has not been supported since that time although proposals have been submitted.

The management of the network is on a rotating basis. Ohio chaired the network in 1982 and early 1983. One of the responsibilities of the chair is the preparation of a network proposal for the following year. The 1983-84 Great Lakes Network proposal was submitted by Ohio to the National Sea Grant College Program in May 1983 on behalf of the other programs in the network and is currently being reviewed in Washington.

Since the inception of the Ohio Sea Grant Program in 1978, Ohio has received $6,000 for network activities which has fostered a great deal of activity, communication and interaction between programs.

1. An agent from Ohio lectured on walleye fishing in Lake Erie at a Michigan Sea Grant Charter Boat Workshop.

2. A survey developed by Ohio Sea Grant and designed to identify the needs of real estate appraisers for coastal erosion related information was adapted and used for similar audiences in New York.

3. We have exchanged a great deal of information on marine trades and charter boat operations with New York which has strengthened the educational programs for these audiences in both states.

4. New York and Michigan have provided current boat launch design criteria which have been transferred to local communities and used in the construction of four new ramps.

5. New York provided detailed information on County Fishery Advisory boards to help assess Ohio's potential role in local government. An Ohio agent was subsequently named to the Lorain County Economic Development Committee.

6. A New York agent assisted in conducting a floating tire breakwater workshop in Huron, Ohio. Subsequently, the largest floating tire breakwater in the world was constructed in the Port of Lorain.

7. Materials on contaminants provided by New York and Wisconsin have been used frequently to answer questions and educate our audiences in Ohio. These materials were extremely valuable when fish from the Ashtabula River were declared unfit for human consumption in 1983 due to PCB contamination.

8. Ohio has organized two workshops for educators, one held in Columbus and one in Milwaukee.

9. Network funding has also supported technical training workshops for new agents. At the most recent workshop of this type held in Traverse City, Michigan, all three of Ohio's agents received Superior Program Awards from the Network.

10. Periodic coordination meetings of the program directors and other NOAA components in the Great Lakes region have been supported with network funds.

FINANCIAL STATEMENT

The financial summary of the past five years of operation of the Ohio Sea Grant Program is contained in Tables 1 through 3. Table 1 provides a list of the individual projects awarded each year. Table 2 presents a summary of the annual awards by major program components and Table 3 lists the annual expenditures by budget category.

TABLE 1

OHIO SEA GRANT PROJECT AWARDS
1977-1983

1977-1978

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
E/CMD-1	Development of Supplemental Curriculum Materials Relating of Ocean Study	Victor J. Mayer	$36,900	$12,500

1978-1979

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
M/P-1	Development of the Core Administration for the Ohio Sea Grant Program	Charles E. Herdendorf	$ 0	$36,800
A/EP-1	Development of the Ohio Sea Grant Extension Program	Jeffrey M. Reutter Russell L. Scholl	$40,300	$ 9,600
E/CMD-1	Oceanic Education Activities for Great Lakes Schools	Victor J. Mayer	$33,700	$17,000
R/MD-1	Development of Markets and Methods of Marketing Freshwater Drum and Other Underutilized Species	Russell L. Scholl Jeffrey M. Reutter	$47,800	$ 4,500

1979-1980

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
M/P-1	Administration and Management of the Ohio Sea Grant Program	Charles E. Herdendorf Jeffrey M. Reutter	$20,000	$51,500
R/EM-1	Preliminiary Development of an Operational Lake Erie Storm Surge Flood Forecasting Program	Keith W. Bedford	$26,600	$16,300
R/SEL-1	Lake Erie Marina Business Analysis (Dry Rack Boat Storage: Potential Energy Savings)	Kenneth A. Wenner	$ 5,200	$ 0
R/F-1	The Life Cycle, Transmission and Pathology of Eustrongylides tubifex, a Common Nematode Parasite of Yellow Perch and Waterfowl in Lake Erie	John L. Crites	$ 8,600	$ 4,100
R/MD-1	Market Development of Underutilized Lake Erie Fish Species Including New Packaging Techniques	Jeffrey M. Reutter Michael T. Metcalf	$28,400	$ 2,200
E/CMD-1	Oceanic Education Activities for Great Lakes Schools (OEAGLS)	Victor J. Mayer Rosanne Fortner	$36,900	$ 7,800
A/EP-1	Development of the Ohio Sea Grant Extension Program	Jeffrey M. Reutter Walter E. Carey	$47,500	$19,500
A/P-1	Publication and Distribution of Fishes of Ohio, 2nd Edition, by Milton B. Trautman	Charles E. Herdendorf Weldon A. Kefauver	$12,000	$ 0

1980-1981

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
M/P-1	Administration and Development of the Ohio Sea Grant Program	Charles E. Herdendorf Jeffrey M. Reutter	$41,500	$76,700
R/EM-1	Lake Erie Storm Surge Forecasting: Model Intercomparison of Western Basin Effects	Keith W. Bedford	$26,000	$13,800
R/ME-1	Economic Value of Ohio's Lake Erie Fisheries	Leroy J. Hushak Frederick H. Hitzhusen	$27,000	$ 9,500
R/A-1	Aquaculture in Ohio: Zooplankton Productivity in Fish Hatchery Ponds	David A. Culver	$12,000	$ 4,700
R/SP-1	Lake Erie Public Information Through Radio Broadcasting	Rosanne Fortner	$11,500	$ 7,800
E/AID-1	Marine and Great Lakes Education: An Infusion Program for Ohio Schools	Victor J. Mayer John Hug	$37,000	$28,000
E/CD-1	Coastal Engineering Curriculum Development	Keith W. Bedford	$ 1,500	$ 0
T/CD-1	The Development and Implementation of a Curriculum for the Study of Marine Technology	William E. Brewer	$15,000	$28,500
A/EP-1	Ohio Sea Grant Advisory Service	Jeffrey M. Reutter Riley S. Dougan	$123,500	$85,200

1981-1982

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
M/D-1 M/P-1	Administration and Development of the Ohio Sea Grant Program	Charles E. Herdendorf Jeffrey M. Reutter Victor J. Mayer Keith W. Bedford	$52,900	$60,800
R/A-1	Aquaculture in Ohio: Zooplankton Productivity in Fish Hatchery Ponds	David A. Culver C. Susan Munch	$10,700	$ 2,000
R/A-2	Aquaculture in Ohio: Culturing Fathead Minnows for Bait	James R. Triplett David L. Johnson Charles F. Cole Thomas M. Stockdale	$10,000	$ 6,000
R/MR-1	Evaluation of Sand Resources in Western Lake Erie	Lester J. Walters Robert W. Anderhalt	$10,000	$12,200
R/ME-1	Economic Value of Ohio's Lake Erie Fisheries	Leroy J. Hushak Douglas Southgate	$25,000	$12,900
R/ME-2	Description and Analytical Marketing Study of Ohio's Lake Erie Commercial Fishery	Cameron S. Thraen	$ 8,700	$ 2,900
R/OE-1	Coherent Turbulent Structures in the Benthic Boundary Layer; Phase I: Development of an Ultrasonic Transducer for Direct Profiling of Sediment Concentration and Grain Size Distribution	Keith W. Bedford	$30,000	$15,500
R/MB-1	Chemical Characterization of the Antitumor Factor in the Clam Mercenaria m.	Derek Horton	$18,000	$10,561

1981-1982 CONT.

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
R/ER-1	Fish Community Structure, Movements, and Reproduction in Controlled and Uncontrolled Lake Erie Marshes	David L. Johnson Mark D. Barnes Charles F. Cole	$10,000	$ 6,000
R/EM-2	Summer Storm Studies Over Western Lake Erie and its Coastal Drainage Basin	Thomas A. Seliga	$ 8,700	$ 3,100
R/OE-2	Reliability of Foundations for Offshore Structures and its Relation to Decision Criteria	Tien H. Wu	$ 8,200	$ 4,300
E/EO-1	Ohio Sea Grant Education Office	Victor J. Mayer	$ 1,000	$ 4,100
E/AID-1	Marine and Great Lakes Education: An Infusion Program for Ohio Schools	Victor J. Mayer John Hug Rosanne Fortner	$39,000	$32,400
E/MP-1	Great Lakes Information Through Museum Programming	Rosanne Fortner	$ 5,100	$ 9,900
E/I-1	Ohio Sea Grant Internship	Jeffrey M. Reutter Charles E. Herdendorf	$29,900	$ 0
A/EP-1	Ohio Sea Grant Extension Program	Jeffrey M. Reutter Paul R. Thomas	$130,000	$74,600

1982-1983

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
M/P-1	Administration of the Ohio Sea Grant Program	Charles E. Herdendorf Jeffrey M. Reutter	$62,300	$76,500
M/D-1	Development of the Ohio Sea Grant Program	Charles E. Herdendorf Jeffrey M. Reutter	$20,600	$ 0
R/A-1	Aquaculture in Ohio: Zooplankton Productivity in Fish Hatchery Ponds	David A. Culver C. Susan Munch	$ 7,600	$ 4,800
R/A-2	Aquaculture in Ohio: Culturing Fathead Minnows for Bait in Ohio	Thomas M. Stockdale Charles F. Cole	$12,800	$ 8,800
R/ME-1	Economic Value of Ohio's Lake Erie Fisheries	Leroy J. Hushak Douglas Southgate	$26,100	$13,100
R/SP-2	The Traditions and Customs of the Commercial Fishing Industry in Erie, Sandusky and Ottawa Counties, Ohio: A Research and Publication Project	Timothy C. Lloyd Patrick B. Mullen	$ 7,000	$11,500
R/OE-1	The Analysis and Mitigation of Lake Erie Flooding Effects	Keith W. Bedford Ranbir Sandhu Robert Brodkey Vijay Varadan Vasundara Varadan	$30,000	$16,900

1982-1983 CONT.

PROJECT NO.	PROJECT TITLE	PRINCIPAL INVESTIGATOR(S)	FUNDING SEA GRANT	FUNDING NON-FEDERAL
R/OE-2	Site Exploration for Foundations of Offshore Structures	Tien H. Wu	$ 7,000	$ 3,500
R/ER-1	Fish Community Structure, Movements, and Reproduction in a Controlled Lake Erie Marsh	David L. Johnson Mark D. Barnes Charles F. Cole	$20,000	$ 3,300
R/ER-2	Programming for Graphic Interpretation of Water Quality Data	Charles E. Herdendorf Laura A. Fay	$ 3,300	$ 1,400
R/ES-1	Large Lakes of the World: An Inventory of Morphometric and Limnologic Data	Charles E. Herdendorf	$ 4,800	$ 3,800
E/EO-1	Ohio Sea Grant Education Program	Victor J. Mayer	$ 5,100	$ 7,000
E/AID-1	Marine and Great Lakes Educaton: An Infusion Program for Ohio Schools	Victor J. Mayer Rosanne Fortner	$32,600	$39,000
E/I-2	Ohio Sea Grant Internships (2)	Jeffrey M. Reutter Charles E. Herdendorf	$56,000	$ 0
A/EP-1	Ohio Sea Grant Advisory Service	Jeffrey M. Reutter Paul R. Thomas	$148,900	$72,800

TABLE 2

SUMMARY OF ANNUAL AWARDS BY PROGRAM COMPONENT

YEAR	COMPONENT	SEA GRANT	NON-FEDERAL	TOTAL	PERCENT
1977-78	Research				
	Education	$ 31,700	$ 16,070	$ 47,770	100.0
	Advisory Service				
	Communication				
	Management				
	Internships				
	TOTALS	$ 31,700	$ 16,070	$ 47,770	100.0
	%	66.4	33.6	100.0	
1978-79	Research	$ 47,807	$ 4,460	$ 52,267	27.6
	Education	33,708	16,949	50,657	26.7
	Advisory Service*	40,327	9,570	49,897	26.3
	Communication*				
	Management*		36,837	36,837	19.4
	Internships				
	TOTALS	$121,842	$ 67,816	$189,658	100.0
	%	64.2	35.8	100.0	
1979-80	Research	$ 63,600	$ 22,600	$ 86,200	29.7
	Education	36,900	7,800	44,700	15.4
	Advisory Service*	53,500	22,600	76,100	26.2
	Communication*	12,000		12,000	4.1
	Management*	20,000	51,500	71,500	24.6
	Internships				
	TOTALS	$186,000	$104,500	$290,500	100.0
	%	64.0	36.0	100.0	
1980-81	Research	$ 76,500	$ 35,800	$112,300	20.5
	Education	53,500	56,500	110,000	20.0
	Advisory Service*	123,500	85,200	208,700	38.0
	Communication*				
	Management*	41,500	76,700	118,200	21.5
	Internships				
	TOTALS	$295,000	$254,200	$549,200	100.0
	%	53.7	46.3	100.0	

TABLE 2 CONTINUED

SUMMARY OF ANNUAL AWARDS BY PROGRAM COMPONENT

YEAR	COMPONENT	SEA GRANT	NON-FEDERAL	TOTAL	PERCENT
1981-82	Research	$113,100	$ 60,600	$173,700	29.0
	Education	40,000	36,500	76,500	12.8
	Advisory Service*	130,000	74,600	204,600	34.2
	Communication*				
	Management*	52,900	60,800	113,700	19.0
	Internships	29,900		29,900	5.0
	TOTALS	$365,900	$232,500	$598,400	100.0
	%	61.2	38.8	100.0	
1982-83	Research	$103,500	$ 50,400	$153,900	22.8
	Education	37,700	46,00	83,700	12.4
	Advisory Service*	148,900	72,800	221,700	32.9
	Communication*				
	Management*	82,900	76,500	159,400	23.6
	Internships	56,000		56,000	8.3
	TOTALS	$429,000	$245,700	$674,700	100.0
	%	63.6	36.4	100.0	
TOTALS	Research	$404,507	$173,860	$578,367	24.6
1977-83	Education	233,508	179,819	413,327	17.6
	Advisory Service*	496,227	264,770	760,997	32.4
	Communication*	12,000		12,000	0.5
	Management*	197,300	302,337	499,637	21.3
	Internships	85,900		85,900	3.6
	TOTALS	$1,429,442	$920,786	$2,350,228	100.0
	%	60.8	39.2	100.0	

*The communication function was divided between administration and advisory service.

TABLE 3

EXPENDITURES OF THE OHIO SEA GRANT PROGRAM, 1977-1983

	1977-78	1978-79	1979-80	1980-81	1981-83*
Federal Sea Grant Dollars					
Personnel	$16,589	$ 58,308	$ 70,870	$134,529	$325,655
Retirement/Hosp.	1,441	7,495	8,097	15,544	39,186
Consultants	525			1,650	1,000
Tuition					32,978
Total Personnel	$18,555	$ 65,803	$ 78,967	$151,723	$398,819
Materials/Services	1,592	16,335	56,044	54,194	73,251
Equipment		5,594	1,335	15,780	544
Travel	886	3,749	9,729	17,610	40,090
TOTAL Direct Costs	$21,033	$ 91,481	$146,075	$239,307	$512,704
Indirect Costs	10,428	29,934	39,877	73,693	151,556
TOTAL FEDERAL SEA GRANT COST	$31,461	$121,415	$185,952	$313,000	$664,260
Non-Federal Contribution					
Personnel	$ 9,085	$ 38,046	$ 52,915	$129,418	$240,397
Retirement/Hosp.	1,315	6,417	9,499	22,661	40,553
Consultants				7,587	
Tuition				12,927	24,920
Total Personnel	$10,400	$ 44,463	$ 62,414	$172,593	$305,870
Materials/Services		6,243	8,500	2,248	27,101
Travel		40			
TOTAL Direct Costs	$10,400	$ 50,746	$ 70,914	$174,841	$332,971
Indirect Costs	5,755	24,651	34,924	69,018	112,909
TOTAL NON-FEDERAL	$16,155	$ 75,397	$105,838	$243,859	$445,880

*On 1 September 1982, $429,000 was added to the existing grant of $365,900 which began on 1 September 1981. The end date was changed to 31 August 1983.

RESEARCH

SEA GRANT RESEARCH

FISHERIES AND AQUACULTURE

Fishery research within the Ohio Sea Grant Program were first initiated in September 1978 and have since been a strong point of the program and quite diverse in nature. This research has included efforts to develop markets and methods of marketing underutilized species, efforts to improve fish hatchery production through a better understanding of zooplankton productivity, studies to develop economic evaluations of the various components of the Lake Erie fishery, efforts to produce bait minnows within farm ponds, and studies of fish communities and structure within controlled and uncontrolled marshes around Lake Erie.

Marketing Underutilized Species

The first fishery effort undertaken by Ohio Sea Grant was a marketing study designed to develop markets and methods of marketing the freshwater drum, Aplodinotus grunniens. The effort was designed to address public opinion and to show the acceptability of commercially developed products. After completion of the two-year research project, results were made available to advisory service agents for long-term transfer to fish producers and consumers.

Public Opinion. The freshwater drum is the approved common name by the American Fishery Society, but it appears the fish has about 30 common names across the country. In the Lake Erie region it is most frequently called sheepshead, and there is a strong bias against the fish. The origin of the bias is impossible to determine, but it is probably due to a higher fat or oil content than that found in the most popular sport species, walleye and yellow perch. The drum has a fat content of approximately five percent whereas the walleye and yellow perch are both quite lean at one percent or less. In warm weather, if fish are not iced immediately after capture, the fat begins to break down and gives the fish a strong taste. In general, the higher the fat content the stronger the taste. Consequently, un-iced drum will compare poorly to un-iced walleye or yellow perch. It should be noted that this fish is sold in southern Ohio and along the Ohio River as white bass, white perch, drum fish and silver bass, and in Louisiana as gaspergou.

Mass media, including newspapers, radio and TV, were used to address the problem of consumer acceptance in addition to newsletter articles and fishing clinics involving cleaning, cooking and tasting. Also prepared and discussed in greater detail in the publications section of this report, were a guide to utilizing drum and a cookbook emphasizing drum recipes.

These efforts have been quite successful. For example, when prepared as "Poor Man's Shrimp" at clinics, approximately 75 percent of those surveyed felt it could pass for shrimp. Charter boat captains also report that more of their clients are keeping

drum, and the commercial fishing industry showed an 81 percent increase in the amount of drum harvested between 1980 and 1981.

Markets and Methods of Marketing. Work in this area has been a cooperative effort between Sea Grant, commercial fishermen and fish processors. One method of avoiding the name bias associated with sheepshead is to produce a product which is simply called fish. A good example of this type of product is the breaded fish sandwich patty.

To test the fish patty market, Ohio commercial fishermen donated 5,000 pounds of drum which were shipped to Gloucester, Massachusetts where they were processed on typical cod processing lines and graded by National Marine Fishery Service inspectors. The product received a Grade "A" rating, which is very important because it allows the product to be sold in major institutional outlets in Ohio.

To date, commercial production of fish patties from drum has not occurred due to the capital outlays necessary to purchase the plate freezers and other equipment, and the seasonal nature of product availability. However, the results of the grading and taste evaluations were quite helpful in improving consumer acceptance.

Aquaculture: Fish Hatcheries

Recreational fishing is a significant use of water resources in the state of Ohio, particularly for gamefish species. Many species are raised by state and federal fish hatcheries in order to maintain populations of these species in established waters where conditions are not favorable for reproduction, to introduce them to newly-constructed impoundments, or to re-establish them in areas where they have become scarce for any of several reasons (e.g., over-fishing and pollution, etc.). Sauger stocked in Lake Erie in the past few years, for example, have grown to exceptionally large size, and are eagerly sought by sport fishermen. Sauger and many other gamefish species (walleye, northern pike, striped bass, muskellunge, white bass and some of their hybrids) must be fed live zooplankters during development from yolk-sac to fingerling stage, unlike trout and catfish which can be fed pelletized commercial diets. Accordingly, stocking programs for the former species depend upon pond culture that produces a reliable forage of zooplankton species that can grow and reproduce quickly enough to survive the predation by rapidly growing fish.

State and federal hatchery operators in Ohio have been unable to raise sufficient numbers of fingerlings of these species due to several problems in the production process, including high mortality of larval fish immediately upon introduction into the ponds, variability in fish production among ponds, and crashes in the zooplankton population toward the end of the production cycle. Our project concentrated on the processes involved in zooplankton growth and reproduction in the ponds and thus addressed all of the problems except the first one. It should be emphasized that these problems are common to all hatcheries using this type of pond culture.

Not only the quantity but also the quality of fingerlings produced is at issue. Fish are often distributed at one-inch sizes, whereas the states would prefer to have two- or three-inch fish which would be less susceptible to predation when newly stocked in a reservoir. Hatchery managers must often harvest the fish stocked at one inch because the zooplankton on which they are raised in the ponds have decreased to

a low level. Fish that are held in the ponds after the zooplankton crash lose weight rapidly so that they may be too weak to adapt to their new environment after stocking. If their reserve is used up in the hatchery ponds they may starve before they locate appropriate food sources in the reservoir. The lack of flexibility on harvest times from the ponds gives the hatchery manager very little choice about when the ponds are drained. Limitations on the total volume of water that can be drained from the hatchery at one time, personnel available to handle the fish, holding facilities, and transport to the lake to be stocked, all make it advantageous to be able to extend the time fish can be held in the ponds to one week instead of the 48 hours currently available.

The cost of maintaining these hatcheries is relatively large, since they require intensive management of large numbers of ponds (typically 20-40 one-acre ponds) and a good water supply for filling the ponds each spring. The capital investment in ponds, drains, etc., is on the order of millions of dollars per hatchery, but the value of the product is also significant. The value of each fingerling depends upon size. The 100,000 stocked per pond in each of 40 ponds yield a potential output of over a million dollars worth of fish -- if each fry survives to be stocked at one inch in size, and much more if each survives to be three inches. Variations in survival and the size at which the fish must be harvested contribute decidedly to the cost-benefit ratio of the hatchery operation, all of which depends upon zooplankton production in the ponds. The economic impact of improving the reliability of zooplankton production in the ponds is thus considerable, particularly when one considers the hundreds of fish hatcheries of this type in North America.

Since the availability of food for the fish depends upon zooplankton productivity, a study of the plankton dynamics in the system aided in identifying management practices that will maximize fish production. Management plans are currently being developed that will maximize zooplankton production through correctly timing the addition of fertilizer, inorganic nutrients and activated dry yeast to the hatchery ponds. The maximum attainable zooplankton production may be independent of fish predation. Therefore, implementation of such a program will result in the theoretically maximum amount of fish biomass being harvested from each pond.

Results. Results from the 1980 field season (Phase 1) suggest that a combination of inorganic fertilizer in small amounts throughout the culture period plus the addition of live yeast toward the end of the season should increase the amounts of zooplankton available and keep them abundant for a longer period of time. This was tested during the 1981 field season (Phase 2), yielding the largest fish production ever recorded from ponds at the Hebron National Fish Hatchery.

Implementation of the results of this program will significantly improve the cost-benefit ratio of fish culture in the state of Ohio and elsewhere. This improvement stems from two sources:

1. Reduction in the absolute cost of hatchery operations. The cost of fertilization per pond is reduced when inorganic fertilizer and active yeast are used in place of the current organic fertilizers (hay, alfalfa meal, brewer's yeast). For example, in two experimental ponds studied in 1981 the fertilizer cost per pond was reduced by 44-67 percent as compared with normal organic fertilization.

2. Increasing the absolute yield of fish biomass per pond. A comparison of fertilizer cost per unit fish yield shows a decrease in cost and an increase in total output. The cost per fish dropped from $0.0040 to $0.0006 per fish for walleye in the ponds fertilized with inorganic nutrients and active yeast. In terms of biomass, production cost of walleye decreased from $3.65/lb. to $0.35/lb.

Aquaculture: Bait Minnows

In 1969 it was estimated that over 6.5 million dozen minnows valued at $2.3 million were sold in Ohio as bait for crappie and bass fishing. The majority of these were fathead minnows (Pimephales promelas), and over 95 percent were imported from out-of-state suppliers. These minnows are hauled long distances to reach the Ohio market since they are trapped from wild populations in Minnesota or cultured in Mississippi and Louisiana. Harvesting schedules in culture operations and long distance hauling during warm weather create problems with bait quality and supply for nearly 35 percent of the retail bait dealers in Ohio.

Local propagation offers the potential of alleviating problems with quality and supply of minnows as well as the loss of dollars from Ohio to an out-of-state industry. Although increased transportation costs have resulted in higher wholesale prices and improved profit margins for Ohio growers, the number of minnow propagators has not increased over the last ten years. Production levels substantially lower than expected have apparently been a major impediment to the development of the industry. Ohio propagators are using culture technology which was developed for traditional culture systems in the South and has remained relatively unchanged in the last quarter century. Appropriate technology does not exist for minnow culture in Ohio.

Ohio propagators face many problems not shared by their southern counterparts such as shorter growing seasons and prolonged cloud cover. The approach to fish culture in Ohio uses a variety of small impoundments, few of which were constructed for culture. The inability to drain or seine many ponds makes it difficult to maintain nutrient levels and efficiently harvest the crop. Recent contacts with propagators indicate some have tried raising fathead minnows for the bait market. Their success was generally poor. Instead of realizing yields between 300 and 500 kg/hectare, many realized less than 100 kg/hectare.

The assistance of the Delaware County, Ohio County Coop. Extension Service and Soil and Water Conservation District offices was enlisted to locate farm ponds in close proximity to The Ohio State University for experimental use. Thirteen ponds were visited in the fall of 1981 and the spring of 1982 with the following measurements made: surface area, average and maximum depth, pH, hardness, dissolved oxygen, extent of aquatic vegetation growth and existing fish population.

Eight of these ponds, ranging in size from 0.08 to 0.24 hectares were renovated in May 1982 and following detoxification, all were stocked with 2.470 fathead minnows (Pimephales promelas) per hectare. Population estimates were completed on all ponds in October and minnow populations ranged from 16.8 to 237.6 kg/hectare. Populations of two other organisms which may be competitive with fathead minnows were also determined. Crayfish occurred in two ponds (8.5 and 10.9 kg/hectare) and tadpoles were recovered from six ponds with weights ranging from 45.9 to 319.5 kg/hectare.

All eight ponds were rotenoned and restocked at the rate of 2,470 fathead minnows per hectare following detoxification. Periodic water chemistry measurements were made on the eight ponds between May and October 1982. Minnows collected throughout the study period were analyzed to determine food preferences. The same minnows were examined at the time of collection for frequency of parasite infestations and symptoms of disease; neither were found. Predaceous insects were also collected for identification. Finally, each pond was checked weekly for the stage of growth of filamentous algae and submerged macrophytes, and five ponds required treatment with an algaecide following stocking.

This project is still underway, with the following plans for the future. The period of April through August 1983 will be used to collect a second growing season of data similar to that collected in 1982. In April all eight ponds will be sampled to determine the over-winter survival of fathead minnows. Populations will be re-established or supplemented where necessary. Minnow spawning structures will be introduced to all ponds at this time. Three to four ponds will be designated for the addition of supplemental food, and feeding will commence in May. Water chemistry and minnow and predaceous insect sampling will be accomplished as in 1982. Further testing of minnow harvest methods will also be completed in this growing season. Finally, the impact of predaceous insects and the role of tadpoles on minnow production ponds will be investigated.

Considerable interest has been expressed by the eight cooperators in this project to date. The son of one cooperator actually assisted with some of our data collection and, in addition, conducted some studies on his own as a special 4-H project. Although this project has not received wide publicity, the "word is out" and over 30 individual requests for information on minnow production in farm ponds have been received. Several bait and tackle stores have expressed interest in locally produced minnows however, they are reluctant to alienate their present wholesale supplier. One wholesaler initially expressed skepticism about our project; however, he was enthusiastic about 20 kg of bass-sized minnows supplied to him in October.

All 1982 data will be carefully evaluated before the 1983 season and theories as to the wide range in populations and growth rates will be proposed for further examination in 1983. Literature on the role of tadpoles in minnow culture units will also be critically examined and methods for reducing tadpole numbers will be considered for employment in 1983. All ponds were visited monthly through the 1982-83 winter for collection of water chemistry measurements.

Lake Erie Fisheries: Economic Value

The economic value of Lake Erie fisheries was discussed in the recreation and economics section of this report. To summarize, the western basin Ohio sport boat fishery has an economic value of approximately $325 million between May 15 and August 15. This is primarily a walleye fishery. The average fisherman travels 86 miles one way and comes to fish 7.7 times per year.

Future efforts in the economic area will include determination of the value of the salmonid river fisheries, the central basin private boat fishery and the walleye and white bass river fisheries.

Lake Erie Fisheries: Wetlands Utilization

This topic is covered in greater detail in the wetlands section of this report. However, it should be noted that the wetlands around Lake Erie allow Ohio to rank a perennial second in muskrat production nationwide, are used extensively for waterfowl hunting, and are important to fisheries. Preliminary results from a Sea Grant fisheries study in a controlled wetland indicated that 7,000 fish passed through the connecting culvert in a 28-day period during the spring.

WETLANDS MANAGEMENT

Great Lakes Coastal Wetlands Inventory

In recent years there has been an increasing awareness of the resource value of our coastal wetlands and the urgent need to protect and conserve these ecosystems. The wetlands of the Laurentian Great Lakes have been greatly altered by natural processes and cultural practices. The environmental impacts to coastal wetlands in the Great Lakes region have become a subject of particular concern for the emerging Coastal Zone Management programs in the eight states bordering the lakes. Traditionally, wetland conservation efforts along the Great Lakes have been aimed at protecting waterfowl breeding, or to a lesser degree, fish spawning and nursery habitat. More recent efforts toward preservation are based on the knowledge that wetlands provide additional benefits, including flood control, shore erosion protection, water management, control of nutrient cycles, accumulation of sediment, and supply organic detritus for the aquatic food web.

Although the intrinsic value of Great Lakes wetland areas has now been more fully recognized, no comprehensive studies have been undertaken to map, enumerate, and characterize them or to inventory the accumulated knowledge of the physical, biological and cultural aspects available for each wetland. In 1978, the Ohio Sea Grant Program, in cooperation with the U.S. Fish and Wildlife Service, began a study that would attempt to do these things. Specifically, the investigations had six objectives: 1) delineate and describe all wetland areas along the United States coast of Great Lakes, 2) inventory the fish and wildlife resources of these wetlands, 3) describe their physiographic and cultural setting, 4) determine voids in our knowledge of the resources found in Great Lakes wetlands, 5) provide projections of the future status of coastal wetlands, and 6) recommend wetland policy objectives and strategies for achieving them.

At the initiation of this investigation, we were somewhat surprised to find that earlier workers had not undertaken a general review of Great Lake Coastal wetlands; in fact no single lake review could be found. The comprehensive framework studies of the Great Lakes Basin Commission provided some insight, but the total number, distribution, and areas of the coastal wetlands had been hitherto unknown. The need for such information has been recognized nationally by the formation within the U.S. Fish and Wildlife Service (USFWS), Office of Biological Services, of a National Wetlands Inventory program. The long-term goal of the USFWS program is to provide a single, universally-applicable system of wetland information which will describe all wetlands in the United States, including territories and possessions, on an individual and/or cumulative basis in terms of their ecological and physical characteristics, geographic location and natural resources value.

The information base for the review was exceedingly diverse. Major sources included referenced journals, numerous technical and popular publications issued by agencies and institutions, aerial photographs, and maps. In some cases unpublished,

open-file data of various agencies or individuals were used, but the sheer volume and preliminary nature of the data precluded extensive use. However, personal contacts were made with federal and state agencies, and with local groups and individuals in all of the Great Lakes states in order to obtain pertinent wetlands information. Once assembled, location data were plotted on U.S. Geological Survey topographic maps of the most detailed scale available. Each wetland greater than one hectare in size and originating at the shoreline, or within 300 m of it, was considered as a distinct coastal wetland in this investigation. The study area included the entire United States shorelines of Lake Superior, Lake Michigan, Lake Huron, Lake St. Clair, Lake Erie, and Lake Ontario, as well as the connecting channels known as the Straits of Mackinac, St. Mary's River, St. Clair River, Detroit River, Niagara River, and St. Lawrence River. General location and existence of each wetland was later confirmed by aerial reconnaissance flights of the entire Great Lakes shoreline.

For the purposes of the inventory, wetlands were defined as areas which are periodically or permanently inundated with water and which are typically characterized by vegetation that requires saturated soil for growth and reproduction. This definition includes areas that are commonly referred to as bogs, fens, marshes, sloughs, swamps, and wet meadows. Great Lakes coastal wetlands are highly productive, diverse communities which interface between terrestrial and aquatic environments. The most obvious and unique feature of these wetlands is their characteristic vegetation, which provides a diverse community structure offering cover and food for the animal components of the system. Because of the ability of this vegetation to slow the flow rate of water passing through, wetlands are valuable for erosion control, trapping sediments before they reach the open lake, and attenuating the force of waves to lessen their destructive power. The same vegetation provides a natural pollution abatement mechanism by serving as a filter for coastal tributaries by reducing the quantity of nutrients and toxic pollutants being washed into the Great Lakes. Coastal wetlands are highly valued as recreational sites for activities such as hunting, trapping, fishing, boating access to larger bodies of water, birdwatching, and general aesthetic enjoyment. The combination of recreational desirability, agricultural and residential potential, and the proximity of coastal wetlands to larger bodies of water have contributed to their status as endangered environments. Their unique properties are susceptible to numerous natural and human-caused factors that are now causing coastal wetlands to disappear at an alarming rate.

The Laurentian Great Lakes system within the United States extends from Duluth, Minnesota at the western end of Lake Superior, to Massena, New York on the St. Lawrence River. It possesses a shoreline length of over 6,000 km and a water surface area of 158,000 sq km. The inventory disclosed a total of 1370 coastal wetlands which have been enumerated for the Great Lakes and their connecting channels, for a combined wetland area of 1209 sq km (Table 4). The greatest number and area of coastal wetlands ring Lake Michigan, the only Great Lake entirely within the United States. Lake Superior has the second highest number of wetlands, but they are relatively small in size. On the average, the largest wetlands are found along Lake Huron and its discharge channels to the south, particularly delta wetlands of the St. Clair River which cover approximately 35 sq km. The highly industrialized Lake Erie shore has the smallest number and area of wetlands while Lake Ontario has the smallest average size of wetlands, largely due to isolated marshes in the Thousand Islands area of the St. Lawrence River. The presence or absence of coastal wetlands is largely dictated by the geomorphology of a given shoreline and the recent history of

TABLE 4

COMPARISON OF COASTAL WETLANDS FOR THE FIVE LAURENTIAN GREAT LAKES

LAKE	TOTAL SHORE LENGTH (km)	TOTAL NUMBER OF COASTAL WETLANDS	PERCENT OF TOTAL GREAT LAKES WETLANDS (%)	TOTAL AREA OF COASTAL WETLANDS (km^2)	MEAN AREA OF COASTAL WETLANDS (km^2)	PERCENT OF TOTAL GREAT LAKES WETLAND BY AREA (%)
Lake Superior and St. Marys River	1598	348	25.4	267	0.77	22.1
Lake Michigan and Straits of Mackinac	2179	417	30.4	490	1.18	40.5
Lake Huron, St. Clair River, Lake St. Clair, and Detroit River	1086	197	14.4	285	1.45	23.6
Lake Erie and Niagara River	666	96	7.0	83	0.86	6.9
Lake Ontario and St. Lawrence River	598	312	22.8	84	0.27	6.9
TOTAL/MEAN	6127	1370	100.0	1209	0.88	100.0

water level fluctuations. Each lake has a particular set of geomorphic features which exerts control on the development of coastal wetlands.

The basin occupied by the Great Lakes was created by glaciation, and its physical features and hydrology differ greatly from regions not exposed to Pleistocene ice sheets. In terms of earth history, the construction of the basin has only recently been completed. The five Great Lakes, with their outlets and approximate lake levels as they are today, probably date back less than 5,000 years. The processes of streams and shoreline erosion/accretion have made only moderate changes in the original topography, but these slight changes are significant in the origin and development of coastal wetlands.

Prior to the Pleistocene Ice Age, the Great Lakes were non-existent; the area was dissected by well-developed valleys and several major streams. When the continental ice cap developed to a thickness of several thousand feet in northeastern Canada, it spread southward into the present Great Lakes region. Tremendous amounts of bedrock were eroded and the debris entrained in the ice mass. As the ice sheets slowly melted and retreated progressively northward, this entrained debris was released and vast irregular deposits of till were laid down on the scoured bedrock surface. Occasionally blocks of ice were also entrained in the till and eventually formed the kettle or bog lakes of the upland areas adjacent to the Great Lakes. Once the lakes became established, stream and shoreline processes provided favorable sites for wetlands. The most significant processes included a) delta formation, b) estuary formation, and c) sand bar/dune formation creating coastal lagoons. Although the gross configuration of the Great Lakes have been little altered since their glacial development, the above processes have established many favorable sites for wetlands. Except where bedrock is exposed or protective works are constructed, the glacial or lacustrine overburden comprising the shore is still vulnerable to changes which can work to the benefit or destruction of coastal wetlands. Water level in the Great Lakes is the ultimate factor controlling the development of coastal wetlands. The Great Lakes are noted for marked fluctuations in level which have had considerable impact on the stability of wetlands in the last decade.

In March 1980, the results of this study were published in six volumes. The first provides an overview and introduction to the Great Lakes wetlands; the remaining five cover one major lake and its connecting channel. The subject areas included in each are:

Volume 1: Overview of Great Lakes Coastal Wetlands
Volume 2: Lake Ontario and the St. Lawrence River Wetlands
Volume 3: Lake Erie and Niagara River Wetlands
Volume 4: Lake Huron, St. Clair River, Lake St. Clair, and Detroit River Wetlands
Volume 5: Lake Michigan and Mackinac Straits
Volume 6: Lake Superior and St. Mary's River

The total work is 5,700 pages long and contains a compilation of published information concerning the fish and wildlife resources and other environmental factors of the United States coastal wetlands of the Great Lakes in such a manner that it is readily available to professional biologists, environmental scientists, engineers, and planners as well as the interested general public. The Ohio Sea Grant publication number of this report is OHSU-TR-1-80.

Marsh Management on Lake Erie

The present system of coastal marshes around the western end of Lake Erie has a total area of approximately 25,000 acres. Almost all of the marshes are highly managed, protected areas used as wildlife refuges, nature preserves, public hunting and fishing areas and private hunting clubs and are mostly owned and managed by the U.S. Fish and Wildlife Service, Ohio Department of Natural Resources, Michigan Department of Natural Resources, and the Winous Point, Ottawa, and Erie Shooting Clubs.

The managed marshes provide excellent habitats for a great variety of wildlife, although their principal function is the attraction and production of waterfowl and furbearers. Ironically, these attractive and productive areas are presently of limited value as spawning and nursery areas for economically important Lake Erie fish populations. The historical importance of Lake Erie's wetlands in supporting fish populations in the open lake, has long been recognized. At least 40 species of fish, 25 of which are significant game or commercial species, are dependent to some degree on the lake's wetlands as spawning and nursery areas. Notable among these are northern pike, muskellunge, carp, bullheads, sunfishes, crappies, and largemouth bass. Species such as gizzard shad, emerald shiner, spottail shiner, channel catfish, white bass, yellow perch, and freshwater drum seem to make opportunistic use of wetlands, but their degree of dependence is not known.

As late as 150 years ago, the western end of Lake Erie was surrounded by an extensive marsh-swamp forest system known as the Black Swamp, which comprised over one million acres. American settlement of the area proceeded at a rapid pace after the War of 1812. Between 1850 and 1920 most of the wetlands were drained and filled to provide agricultural land and sites for urban and commercial development. Adverse environmental conditions to some extent engendered by this development, especially agricultural siltation, wave erosion, and water level fluctuations, contributed to wetland losses during this period. At the same time, the reputation of Lake Erie's wetlands as quality waterfowl hunting areas was spreading.

About 1920, groups of wealthy sportsmen and state and federal agencies, alarmed at the rate of wetland loss, purchased most of the remaining wetland areas. These areas were enclosed by dikes to protect them from wave erosion, siltation, and water level fluctuation. Gates, pumps, and flumes of various types were installed so that water levels within the marshes could be controlled. This made it possible to produce the right types and amounts of aquatic vegetation used by wildlife, thus enhancing the quality of the marshes as waterfowl and furbearer habitats. The result was the present system of controlled, managed marshes. Without controls, siltation and erosion would quickly eliminate most of the marshes.

The dikes and management practices essential to maintaining good, productive marshes are also generally believed to prevent fish from entering and using the marshes as spawning and nursery areas. Quantitative data to support this supposition are lacking. However, drastic declines over the last 50-60 years in the abundance of marsh-dependent fish populations have been attributed in large part to the wholesale draining and filling of marshes before 1920 and subsequently to the inability of fish to enter the remaining marshes because of dikes. Dikes are constructed of a solid clay base, covered with rip-rap, and are placed such that water can enter or leave the

marshes only through specially constructed channels. Screens are placed over flumes and gates to exclude carp. Carp not only consume aquatic vegetation, a food source for waterfowl, but muddy the water by their rooting behavior, thus inhibiting growth of new vegetation. Screens also keep desirable fishes from entering and leaving the marshes.

Regulatory and management agencies concerned with protecting Lake Erie fish populations generally oppose construction of dikes around shallow, estuarine bottomland areas because they supposedly keep fish from reaching spawning and nursery areas. This is a justifiably cautious approach to protecting an important resource. However, without dikes these bottomland areas are little more than flooded mud flats with little aquatic vegetation. The importance of these flooded mud flats as fish spawning areas is not known. Many coastal landowners would like to establish controlled marshes in such areas. This is desirable from the standpoint of creating economically valuable waterfowl and furbearer habitats where only "marginal" habitats presently exist.

Research comparing fish use of controlled marshes and shallow, uncontrolled estuarine bottomlands may help resolve this resource conflict. If the uncontrolled bottomlands are found to be of limited value as spawning and nursery areas, then perhaps their development into controlled marshes need not be discouraged. Conversely, if controlled marshes are in fact found to be of limited value as spawning and nursery ares, new management practices to improve them as such, without significantly interfering with their principal role as waterfowl and furbearer habitats need to be developed.

Ohio Sea Grant research was begun in 1981 to address part of this problem. The project is being conducted on a 250-acre controlled marsh at Winous Point Shooting Club on upper Sandusky Bay. The composition of fish communities residing in the marsh, in the adjacent Bay and access channel, and the exchange of adult and larval fishes between the Bay and the marsh are being quantified. Results of this project will elucidate the actual and potential (i.e. in the absence of control structures) roles of controlled marshes as a fish spawning and nursery area and will make possible the development of alternative controlled marsh management plans to improve them as such. Studies addressing fish use of shallow, uncontrolled estuarine bottomlands are a necessary corollary to the controlled marsh study and are currently being developed.

These studies are envisaged as being components of a larger, long-range research program aimed at quantifying the effects of nearshore spawning and nursery habitat availability, coastal structure, and environmental variables on hatching success, larval survival, and ultimately recruitment to offshore fish stocks. Such information could help increase the accuracy and lead time of year-class strength predictions made by fishery management personnel for important sport, commercial, and forage fish stocks.

The ongoing wetlands management research stems from earlier research conducted by the Ohio Agricultural Research and Development Center (OARDC) to determine if proper management of Lake Erie marshes can provide a good income for the people who own them, while at the same time remaining an important habitat for wildlife. A number of marsh owners earn some income during the autumn duck hunting season. Most charge hunters a fee for the right to build blinds. However, there is

another untapped income source in the marshes -- fish. The marshes have a natural fish popuation, primarily carp and brown bullheads. However, it is possible that bass can be raised in the marshes for use in a thriving pay pond industry.

As part of the OARDC study, Dr. David L. Johnson, Sea Grant researcher and associate professor of Natural Resources and his graduate students conducted a three-year investigation on an 80-acre marsh near Port Clinton on Sandusky Bay. In a population study of the marsh in 1978, he found that carp and brown bullheads made up 85 percent of the fish present by number and 98 percent by weight. There were some yellow perch and sunfish, but no bass. He found the water quality to be very favorable to fish production. Also favorable to fish production was the high concentration of plankton in the water.

To prepare for the study, all of the carp and bullheads were removed from the marsh using seine nets and the chemical rotenone. Rotenone is toxic to fish, but not to birds and mammals and it breaks down in a few days. The marsh was closed off from Sandusky Bay to keep fish from re-entering.

In the spring the marsh was stocked with 1,200 golden shiners and 5,500 fathead minnows. Researchers also placed 41 adult largemouth bass in a holding pond for bass brooding stock. After the bass in the holding pond spawned, they transferred about 100,000 fry to the marsh. Dr. Johnson observed the bass fry feeding on the plankton in the marsh for the first two weeks. At that point, they were about two inches in length and began to feed on the minnow fry. By August, the bass reached an average length of six inches.

The project has been designed to take advantage of dikes at the marsh already present for duck management. This fall, if all goes well, Johnson hopes to lower the water level of the marsh with pumps, and literally scoop six-inch bass out with seine nets. He believes there should be a considerable number of golden shiners and fathead minnows left, which will also be harvested. There is a great demand for fish bait minnows and the bass will command top dollar from wholesalers who sell fish for stocking pay and farm ponds.

Dr. Johnson feels that fish farming in these marshlands should, at the very least, pay the taxes for the landholders. The researchers will learn if the bass-minnow relationship is workable. It may be discovered that only the bass are harvestable and then again maybe the plan will work only with the minnows. Some landowners are draining marshes so they can grow soybeans. However, if an income can be made by leaving marshes intact then a desperately needed wildlife habitat stands a better chance of being preserved.

BIOTECHNOLOGY

Antitumor Factor in Marine Mollusks

In 1964, it was discovered that extracts from the common quahog clam (Mercenaria mercenaria) are capable of antineoplastic (antitumor) activity. Ohio Sea Grant researcher and professor of chemistry, Dr. Derek Horton, and his former student Dr. Stanley S. Stavinski have been investigating this extract (named mercenene) with the objective of isolating it and characterizing its properties. The ultimate goal of this research is the isolation of new, nontoxic antineoplastic agents for use in the treatment of cancer.

Previous attempts to isolate the active principle of mercenene had been unsuccessful because of the presence of both low and high molecular weight component which were hydrophilic (water-soluble). By using advanced fractionation and purification techniques, it was found that the low molecular weight antineoplastic principle was thymidine, a nucleoside of established chemotherapeutic value. Thymidine account for 24 percent of the total activity. The high molecular weight component exhibited 50 percent of the total activity and was characterized as a protein or protein-cofactor complex. Two other low molecular weight principles were also found to be present in mercenene, but their yield was too small to be purified to homogeneity.

The successful extraction, isolation and purification of these components from the liver of marine clams permitted the next steps in Dr. Horton's research plan. Preliminary tests on mouse lymphocytic leukemia tissues culture demonstrated the antineoplastic activity of mercenene. In collaboration, with Dr. Arline C. Schmeer, Director of Studies on Biological Active Agents of Marine origin, American Medical Center at Denver, in vivo assays of the antitumor activity of these components are now being tested on lymphocytic tumors.

The seas stand as a vast undeveloped resource for new biological products. Most previous work on natural products from marine organisms has been concerned with compounds extracted by using organic solvents. It is hoped that this investigation into a little-explored area of natural product chemistry, namely hydrophilic constituents of marine organisms, will contribute to the expansion of this potentially valuable area of research.

ENERGY AND MINERAL RESOURCES

Power Facilities

In the early 1970s, four nuclear power station sites were proposed for the Ohio shoreline of Lake Erie. The Davis-Besse Nuclear Power Station is located 30 miles east of Toledo, the Sandusky Bay site is 15 miles to the southeast of this station at the west end of the bay, the Erie site is to be built at Berlin Heights, and the Perry Nuclear Power Plant is 13 miles east of Painesville. Over the past ten years, The Ohio State University has been involved in research projects at each of the four sites.

Davis-Besse Nuclear Power Station. The Center for Lake Erie Area Research (CLEAR), in conjunction with the Ohio Division of Wildlife, U.S. Fish and Wildlife Service and the Toledo Edison Company, conducted a long-term study designed to monitor the aquatic environment in the vicinity of the Davis-Besse Nuclear Power Station. The objectives of the project are to determine the effects of the station on fish, plankton, and benthos populations in Lake Erie at Locust Point by monitoring the biota prior to discharge and after thermal effluents enter the lake.

The Davis-Besse Nuclear Power Station, located on Lake Erie near Port Clinton, Ohio, commenced operation in 1977. During the past ten years the Center for Lake Erie Area Research has documented population of fish, plankton and benthos in the lake in the vicinity of the thermal discharge. Fish species have been tested for seasonal temperature preference, response to temperature changes and critical maximum temperatures. Entrainment and impingement of fish were assessed and plant operation procedures are being evaluated to further reduce fish loss. A predictive model of the kinds and density of fish within the thermal plume has been completed and will be evaluated for accuracy based on operational data from the plant. The measurements of fish, plankton, benthos and primary productivity at this plant's intake and discharge structures will serve as guidelines in understanding their impacts and refinements in future installations. Utilizing this information, the Ohio Sea Grant Program has developed two types of workshops. The first is designed to address electric power generation and aquatic ecosystems for school teachers. The second is directed at power plant engineering and environmental staffs, covering monitoring programs and impact appraisal.

Sandusky Bay Site. CLEAR has completed a three-year study to determine the environmental suitability of a site on Sandusky Bay as the location for a major nuclear power plant to be operated by the Ohio Power Company (American Electric Power Service Corporation). The major components of the project include: 1) analysis of the natural and historic landmarks in the vicinity of Sandusky Bay, 2) investigations of the aquatic ecology in the vicinity of the Sandusky Bay, 3) laboratory estimates of biotic responses to the operation of a power plant on Sandusky Bay, 4) radionuclide uptake and equilibrium studies of organisms indigenous to Sandusky Bay and 5) hydrologic and geologic studies of a potential power plant site on Sandusky Bay. Based on environmental factors, construction was not recommended for this site.

Erie Site. The geology of the area surrounding the Erie site was investigated by researchers from CLEAR for the Ohio Edison Company. The structural features of the bedrock such as faults, folds and joints were of particular concern in this study. Information provided by this study was used to prepare environmental and safety reports for the Atomic Energy Commission and the Nuclear Regulatory Commission.

Perry Nuclear Power Plant. An interdisciplinary group of researchers from The Ohio State University performed evaluations of the possible beneficial uses of waste heat at the proposed Perry Nuclear Power Plant and recommended promising uses for further evaluation. The uses considered were: 1) agricultural, 2) fish production, and 3) recreational. During the formation excavation for the reactor building, complex folds and faults were discovered in the bedrock. Geologists from the Center for Lake Erie Area Research, Gilbert Associates and Case Western Reserve University investigated these features and concluded they were the result of ice movement during Pleistocene glaciation. Additional rock excavation and a concrete backfill were recommended to ameliorate the situation.

Sand and Gravel

Within Lake Erie, sand is currently being dredged from the estuaries of the Maumee and Sandusky rivers, off Lorain and Fairport, Ohio and near Erie, Pennsylvania for use in the construction industry. These deposit have been worked for over 80 years and they are now becoming depleted of high quality material. Pure quartz-sand is also needed for use in the glass industry. Technology is currently available to beneficiate many naturally occurring sand deposits, such as those derived from glacial moraines in the Lake Erie basin, to the stringent specifications of the glass industry. Large volumes of low-cost sand are also in demand to replenish wave-eroded beaches along the shore of Lake Erie.

In response to the needs of the glass and construction industries in the Toledo area, Professors Lester J. Walters and Robert W. Anderhalt of the Department of Geology, Bowling Green State University undertook a Sea Grant investigation in 1981 and 1982 to determine the location and mineralogical character of sand deposits in western Lake Erie. Samples were taken at 300 stations in the lake from aboard OSU's research vessel Hydra. One of the main objectives of the study was to evaluate the suitability of the deposits for various commercial uses and to estimate potential reserves available for extraction.

A large sand body, approximately 300 km^2, was located between Monroe, Michigan and West Sister Island, Ohio. The quartz content of most of the sand fractions ranged between 50 percent and 80 percent. The requirements for glass-grade sand are very stringent in terms of the minerals present; ideal sand consists of 99 percent or more quartz. Impurities in the lake samples primarily consist of plagioclase (sodium) and orthoclase (potassium) feldspar. The northern part of the sand body was found to contain more plagioclase while the southern sector is richer in orthoclase. Through consultation with representatives of the Libbey-Owens-Ford Company it was determined that in the beneficiation of natural sands to glass-grade quality, the feldspars can often be removed by flolition, or by a density separation if the feldspar is rich in sodium.

The study has also shown that the offshore deposits are comparable in their size distribution to Lake Erie beaches. This indicates that the lake material would serve as an ideal source of sand for beach nourishment projects. The Ohio Department of Natural Resources is considering the use of these deposits for construction of a beach at the newly-opened Maumee Bay State Park.

Petroleum Resources

With recent energy shortages, three of four U.S. states bordering Lake Erie are becoming interested in developing the recoverable natural gas from lands under Lake Erie. The growing scarcity of oil in this country will probably provide some incentive for removing any oil resource as technology provides safer means for doing so. The Canadians have been successful in drilling for natural gas since 1913, and 1,019 wells are in Canadian waters. As of 1978, 430 of these wells were producing or awaiting hook-ups to pipelines. Current production from Canadian wells annually yields 1.59 x $10^8 m^3$ or 5.6 billion cubic feet per year. Similar levels of production can be anticipated for the Ohio waters of central Lake Erie. Ohio accounts for 66.6 percent of the U.S. Lake Erie total. If such production is permitted, adequate environmental safeguards must be provided.

A study completed by Ohio Sea Grant researchers in 1980 analyzed some of the possible adverse biological consequences of a drilling program beneath Lake Erie concentrating on the Ohio central basin waters.

Ohio's state government will eventually have to decide whether or not to allow drilling for natural gas in Ohio's central Lake Erie waters. The process of drilling for hydrocarbon reserves beneath U.S. Lake Erie is laden with potential environmental impacts in the form of discharges associated with the drilling processes. Ohio Sea Grant reviewed many of the anticipated impacts. Some of the extrapolations to Lake Erie that were made may be a little far reaching, but the fact remains it will be difficult to decide if the benefits gained by instituting a drilling program at this time will outweigh the potential degradation of Lake Erie waters that are used as a resource by millions of people today.

Increased brine loading from salt beds encountered in drilling for hydrocarbons may lead to increased lake salinity, extended periods of anoxia and/or death to plants and animals in the lake. Secondary effects, as yet unknown, could alter ecological balances necessary for a healthy food chain to exist. Methane loading, although possibly insignificant, may lead to anoxic conditions in the lake due to methane oxidizing bacteria metabolizing dissolved methane. The possible impacts associated with sediment resuspension include toxic effects to fish due to damage or blockage of respiratory membranes. Although the study did not treat all possible impacts, it is the researchers' hope that many of the major impacts that will have adverse effects on the biota present in Lake Erie have been illustrated in such a way that informed decisions can be made.

WATER RESOURCES

Lake Erie Water Quality Assessment

Degradation and Recovery. 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 wakes behind boats. Most municipal beaches were closed owing to high coliform bacteria counts or were rendered unusable by reeking masses of decaying algae (largely Cladophora glomerata). One of its major tributaries, the Cuyahoga River, was so polluted by industrial wastes that it periodically caught 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 use.

Assessment Team. Ohio Sea Grant researchers have taken the lead in assessing the quality of Lake Erie by organizing a Lake Erie Technical Assessment Team (TAT). Under the auspices of the International Joint Commission (IJC) a two-year, intensive study of Lake Erie water, sediment and biotic quality was initiated in 1978, followed by an annual surveillance program. The study took the form of a diverse set of surveillance, monitoring and research projects undertaken by several Canadian and American agencies and institutions. Coordination of the data gathering and assessment efforts was the responsibility of TAT, a group of Great Lakes scientists from Canada and the United States assembled by the Water Quality Board of IJC and headquartered at The Ohio State University. Major organizations participating in these efforts included: IJC (Great Lakes Regional Office), Canada Department of Fisheries and Oceans, Environment Canada (Canada Centre for Inland Waters), environment and natural resources ministries of Ontario, NASA (Lewis Research Laboratory), NOAA (Great Lakes Environmental Research Laboratory), U.S. Army Corps of Engineers (Buffalo District Office), U.S. Environmental Protection Agency (Great Lakes National Program Office and Large Lakes Research Station), U.S. Fish and Wildlife Service (Great Lakes Fishery Laboratory), U.S. Geological Survey, natural resources and environmental protection agencies and health agencies in Michigan, New York, Ohio and Pennsylvania, City of Cleveland, Ohio (Water Quality Laboratory), City of Toledo, Ohio (Pollution Control Agency), Heidelberg College (Water Quality Laboratory), Ohio State University (Center for Lake Erie Area Research and Ohio Sea Grant Program), and State University College of New York at Buffalo (Great Lakes Laboratory).

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 took many decades. Below are listed some indicators of improved lake conditions. Cause and effect relationships for all of these observed changes are not well understood and in all cases cannot yet be attributed to any particular remedial effort.

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.

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.

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 umhos/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 Isle 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 (calcium, sodium and sulfate) have ceased to increase in the lake and have remained relatively stable over the past decade.

4. Phosphorus Loading and Lake Concentrations

   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, particularly in the past three years.

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 0.6 mg/l for the Detroit sewage treatment plant in 1982.

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

5. 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 (Table 5). During the same period the area of the basin exposed to anoxic conditions rose from 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 (Table 5).

TABLE 5

HYPOLIMNION OXYGEN DEMAND RATES AND AREAS OF ANOXIA FOR CENTRAL LAKE ERIE 1930 - 1981

YEAR	VOLUMETRIC OXYGEN DEMAND RATE (g/m^2/day)	AREA OF ANOXIA (km^2)
1930	0.054	300
1959	0.091	3,600
1961	0.095	3,640
1964	0.100	5,870
1970	0.110	6,600
1973	0.120	11,270
1974	0.130	10,250
*		
1976	0.130	7,300
1978	0.111	3,940
1980	0.109	4,330
1981	0.085	4,820
1982	0.111	5,470

* 1975 data excluded because of abnormal meteorological conditions resulting in a high demand rate and a small area of anoxia.

6. Toxic Metals and Organic Compounds

Sediment cores taken at the mouth of the Detroit River and in western Lake Erie in 1971 yielded surface mercury concentrations up to 3.8 ppm and generally decreased 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.

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 ug/g in 1970 to 0.5 ug/g in 1980. In western Lake Erie, 1968 levels of mercury were 0.84 ug/g as compared to only 0.31 ug/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.

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.

7. 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.

8. 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) has been observed 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.

9. Fishery

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 lbs. (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.

The abundance of walleye (Stizostedion vitreum vitreum) in western Lake Erie increased dramatically from 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.

Modest success in lake trout (Salvelinus namaycush) restoration efforts was reported for the eastern basin of Lake Erie in 1981. A few stocked fish have been recovered in healthy condition over a year after release, but reproductive success has yet to be determined.

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.

10. 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.

Assessment Conclusions. The fundamental conclusion of this assessment is that through 1977 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 the continual increases of the previous several decades had been stopped. During this period, other indicators of eutrophication, such as hypolimnetic oxygen rates, chlorophyll concentrations, plankton and benthos populations and turbidity also remained relatively stable, but high.

During the late 1970's changes began to occur which are continuing in the early 1980's: nutrient loading declined, phosphorus concentrations in the lake dropped, sources of contamination by several toxic substances have been 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. However, cause and effect relationships of all of these changes are not obvious, most of the improvements have been small, and for many parameters, conclusive trends have yet to be established. But evidence for improvement 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. Surveillance of Lake Erie water, biota, and sediment conditions must continue if we are to establish clear relationships between remedial actions and lake quality.

Acid Rain

Based on concerns over Ohio's role in the "acid rain" controversy, Governor James A. Rhodes created, by Executive Order on March 25, 1980, a Scientific Advisory Task Force on Acid Rain. The Task Force was charged with the responsibility of reviewing the current scientific information regarding acid rain and advising the Governor of appropriate actions by the State of Ohio. Dr. Charles E. Herdendorf, Director of the Ohio Sea Grant Program, was appointed by the Governor to the 13-member Task Force to consider effects of atmospheric deposition on aquatic ecosystems.

The Task Force issued their report to Governor Rhodes in September 1981. The essential findings and recommendations of the Task Force relative to aquatic ecosystems, particularly in the Great Lakes region, are presented below.

Atmospheric precipitaton contains a number of components which can affect aquatic ecosystems. The most significant components include: 1) lake acidification agents such as sulfuric, nitric and hydrochloric acid and 2) lake eutrophication agents such as nitrogen and phosphorus.

The effects of acid rain depend heavily on the geology of the terrain on which deposition occurs. Alkaline soils and limestone bedrock, which are typical in Ohio, can neutralize acids, releasing compounds such as calcium sulfate. However, the Precambrian Canadian Shield of Ontario and the Adirondacks region of New York are composed of granitic bedrock which can only slowly neutralize acidity, releasing metals such as aluminum, manganese and iron. Acid contributions to lakes and streams are generally of two types: 1) slow, cumulative inputs or 2) pulse inputs due to heavy rains and snow melts.

A significant number of lakes have been modified through acidification in North America and Scandinavia. Approximately 140 lakes in the Province of Ontario, particularly in the vicinity of the Sudbury metal smelting facilities, are fishless because highly acidic conditions have inhibited reproduction. An estimated 212 lakes and ponds in the Adirondacks of New York are similarly affected. At elevations above 2,000 feet, 52 percent of the 214 lakes have a pH below 5.0. Stability of aquatic fauna populations is difficult to maintain when the pH of water drops below pH 5.5 to 6.0. Researchers have also estimated a loss in yield of 22,000 pounds of fish per year in Adirondack lakes which they attribute to acid rain. Likewise, hundreds of lakes in southern Norway and Sweden are fishless.

Acid inputs have the most visible and pronounced effects on small lakes in the Precambrian Shield that borders the Great Lakes on the north. These lakes, occupying granitic bedrock basins, lack carbonate rocks and organic matter that can neutralize acidity. Because of poor buffering capacity, when acidified water enters these freshwater lakes or watershed, the pH declines. At pH 5 or lower, fish reproduction is adversely affected, and other aquatic organisms are jeopardized. Many of the small lakes and ponds to the north and east of the Great Lakes have reached this stage according to Canadians. The second effect is that toxic heavy metals, such as mercury and aluminum, can accumulate in aquatic organisms and eventually interfere with normal physiological processes.

In the Great Lakes region, where most of the area is characterized by alkaline soils and carbonate bedrock, comparable amounts of added acidity do not pose a problem because the acid is neutralized. The Ontario Ministry of the Environment points out, however, that although the Great Lakes are not threatened as whole bodies, aquatic life in the nearshore spawning areas and tributary streams can be severely affected in the spring by "shock" loading of acidic snow as it melts. Depressions in pH from spring runoff have been observed in the nearshore waters and streams flowing into Lake Huron, even though the lake has an annual mean alkaline pH (8.2). Environment Canada reports that in Georgian Bay, feeder streams have become acidic enough that many preferred fish species, including trout and walleye, will no longer enter them to spawn.

Acid rain is only one form of atmospheric pollution affecting lakes and streams. Besides contributing to acid rain, nitrogen is a nutrient that accelerates eutrophication of lakes. Phosphorus, which is often the limiting nutrient in lakes, is also contributed to surface waters.

Heavy metals are potentially toxic. Inputs to the Great Lakes region vary from lake to lake depending on mining activity and prevailing winds.

The amount of acid falling as acid rain is quite small with each rainfall, but its cumulative long-term effects, as well as its "shock" effects on aquatic life at the time of spring runoff could be significant. Precambrian rock can only slowly neutralize acids, but instead of calcium ($CaSO_4$, $CaNO_3$) they release aluminum, manganese, iron and other metals which can accumulate to levels toxic to fish and other forms of aquatic life. In areas of Precambrian rock and thin soil cover, which is the situation in much of northern Ontario and the Adirondack Region of New York, there is not enough buffering capacity to neutralize even small amounts of acids entering the soil. As a result, the runoff water is acidic. Additionally, the thin soil layer of predominantly

organic matter contributes significant amounts of acidity, even in the absence of acid rain.

The major effects of acidification of aquatic life are summarized below:

1. In acid-stressed lakes (those which experience pulses) and fully acidified lakes, there is a major disruption or complete destruction of the biological community.

2. Larval fish are susceptible to shock exposures of acid water or an acidic water containing high concentrations of metals.

3. Spring pulses are the most damaging feature of acid-stressed lakes; severity of damage varies from year to year.

4. Large fish can generally survive these pulses. Therefore, large dead fish are rarely observed.

5. Fish larvae of a sensitive species may experience high mortality one year and have a high survival rate the next; therefore, fish populations of acid-stressed lakes are characterized by the absence of certain age classes.

6. Trace metals such as mercury can increase in fish which do survive the pulses.

7. As a lake and watershed are more and more damaged by acidity, the effects of spring pH depression are consistently more severe. Fish larvae of sensitive species will be killed every year and normal spawning may be impeded so that existing populations die out from old age and predation. Several decades may pass from the onset of damage to the fishery until its eventual demise is realized.

8. Physiological effects on fish which have been observed in laboratory experiments include mucous coating over gills and gill damage which interferes with respiration. Also, loss of Ca^{+2} ions can lead to reproduction failure in females.

9. In Norway it has been observed that the number of algal species decreaes in water below a pH of 6.

10. Many zooplankters are eliminated below pH 5.0.

11. Water transparency increases with a decline in pH due to decrease in algal growth. Primary production decreases at 5.5 pH and is drastically reduced below 4.4.

12. Submerged (benthic) plant communities can be altered by acidic conditions; susceptible plants can be replaced by acid-tolerant ones.

13. Bacteria can be replaced by fungi. Organic matter decomposition then takes place at a slower rate, thus rendering essential nutrients unavailable.

14. High acidity can be detrimental to some amphibians. Spotted salamanders, bred in temporary pools in the spring, have high mortality in acid situations. Frog populations have also been found to have recruitment failure.

Reduced acid deposition to lakes in the Precambrian Shield will result in very slow natural restoration. Development of acid-tolerant fish, such as trout hybrids, shows some promise for restoring fishless lakes.

Based on these and other findings, the Task Force recommended that the State of Ohio take reasonable measures to ensure that emissions of acid-forming gases be further reduced. Coal washing is one such measure which would be particularly effective in Ohio. In addition, the Task Force believed that the State government should take a lead role in bringing other states and Canada together for discussions of this issue, give this issue increasing attention, and take steps to ensure that Ohio's universities become involved in developing a better understanding of such related topics as long range air transport and transformation, and the impact of acid deposition on plants, aquatic life and physical structures.

Toxic Substances

In 1979, Ohio Sea Grant, CLEAR and USEPA initiated an investigation to determine the contamination of common Lake Erie fish species by toxic organic compounds at major tributary mouths and the rate of contaminant uptake by hatchery-raised fish caged at several tributary mouths. The degree and rate of contamination of Lake Erie fish stocks by toxic organic compounds is relatively unknown particularly at the mouths of the lake's major tributaries. The nearshore areas of the lake adjacent to the stream mouths contain the highest concentration of toxic organic compounds in the water and sediment. This study is designed to assess the relationship between these concentrations and contamination of fish tissue.

Fish collections by gill netting and other methods are being made to obtain samples at 22 major tributaries. Preliminary results indicate PCBs or other toxic organic contamination may not be a widespread problem for Ohio fish, but isolated in a few areas such as the mouth of the Ashtabula River. The Ohio Sea Grant Program has issued a special bulletin on PCBs in Lake Erie fish.

Application of Satellite Data to Water Quality Predictions

Most of the major tributaries to the Great Lakes have estuarine-like mouths that have been flooded by rising lake levels in response to isostatic adjustment after deglaciation. These estuaries extend as far as 10 km inland (e.g. Maumee and Sandusky rivers in northwestern Ohio), forming excellent harbors and municipal sites. However, the presence of these estuaries makes the measurement of sediment, nutrient, and toxic material loading to the lakes difficult because stream gauges must be located above the estuary mouths and likewise above discharges from municipal sources. The key objective of this new initiative is to develop techniques using satellite data to more accurately define suspended sediment concentration in the estuaries and thereby predict major loading episodes to the lakes.

Dr. John Lyon, Professor of Civil Engineering and Sea Grant investigator, has initiated research to develop an operational approach for determining surface

suspended sediment concentrations from river runoff in coastal areas, using a combination of NOAA-NESS Landsat and Environmental Satellite data and on-site sampling. With an operational system, the objective is to provide data for modeling and forecasting sediment concentrations. In addition, Dr. Lyon will examine other possible relationships with variables including loadings of phosphorus. The anticipated benefits of this project include: 1) a methodology for surface suspended predictions and forecasting; 2) a determination of the value of satellite data for supplying input to modeling programs; 3) a determination of the value of this approach for quantifying variables including phosphorus loadings; and 4) a methodology for an operational approach to surface sediment predictions from runoff in coastal waters.

Large Lakes of the World

The International Association for Great Lakes Research (IAGLR) was founded in 1966 to stimulate interest in and facilitate information exchange on the Laurentian Great Lakes of North America. These objectives date back to the early 1950s when the first conferences on Great Lakes research were organized by several Canadian and United States institutions. However, during the past three decades several presentations of research conducted on the other large lakes of the world have been included at the annual conferences and published in the Journal of the Association. Recognizing this interest and the scientific importance of large lakes, in 1982 the Board of Directors of IAGLR announced that the Journal of Great Lakes Research will be "devoted to research on large lakes of the world." As an initial contribution to large lakes research, Dr. Charles E. Herdendorf, Professor of Limnology and Oceanography and Ohio Sea Grant Director, undertook an inventory of the large, natural lakes of the world.

This project included documentation of the distribution, origin and morphometry of the world's largest lakes (Figure 2). Natural lakes, fresh and salt, with a surface area greater than 500 km^2 are included; 253 such lakes have been identified. Large lakes occur on all continents, except Antarctica, but nearly half of them (48 percent) are found in North America (Figure 3) and most of these lie above the 40th parallel, attesting to the scouring action of continental glaciers. Tectonic belts, such as the Riff Valley of east Africa and the Lake Baikal region of Siberia, are the second most common loci of large lakes. Morphometric data have been compiled, including surface area, drainage basin, elevation, mean and maximum depth, volume, length and breadth, and orientation of longest axis. These data show that the large lakes of the world occupy a surface area of 1,456,000 km^2 and they have an estimated volume of 202,000 km^3. Large lakes account for approximately 90 percent of the total surface area and volume of water held in all lakes of the world. Table 6 presents a tabular listing of the 50 largest, greatest volume and deepest lakes of the world.

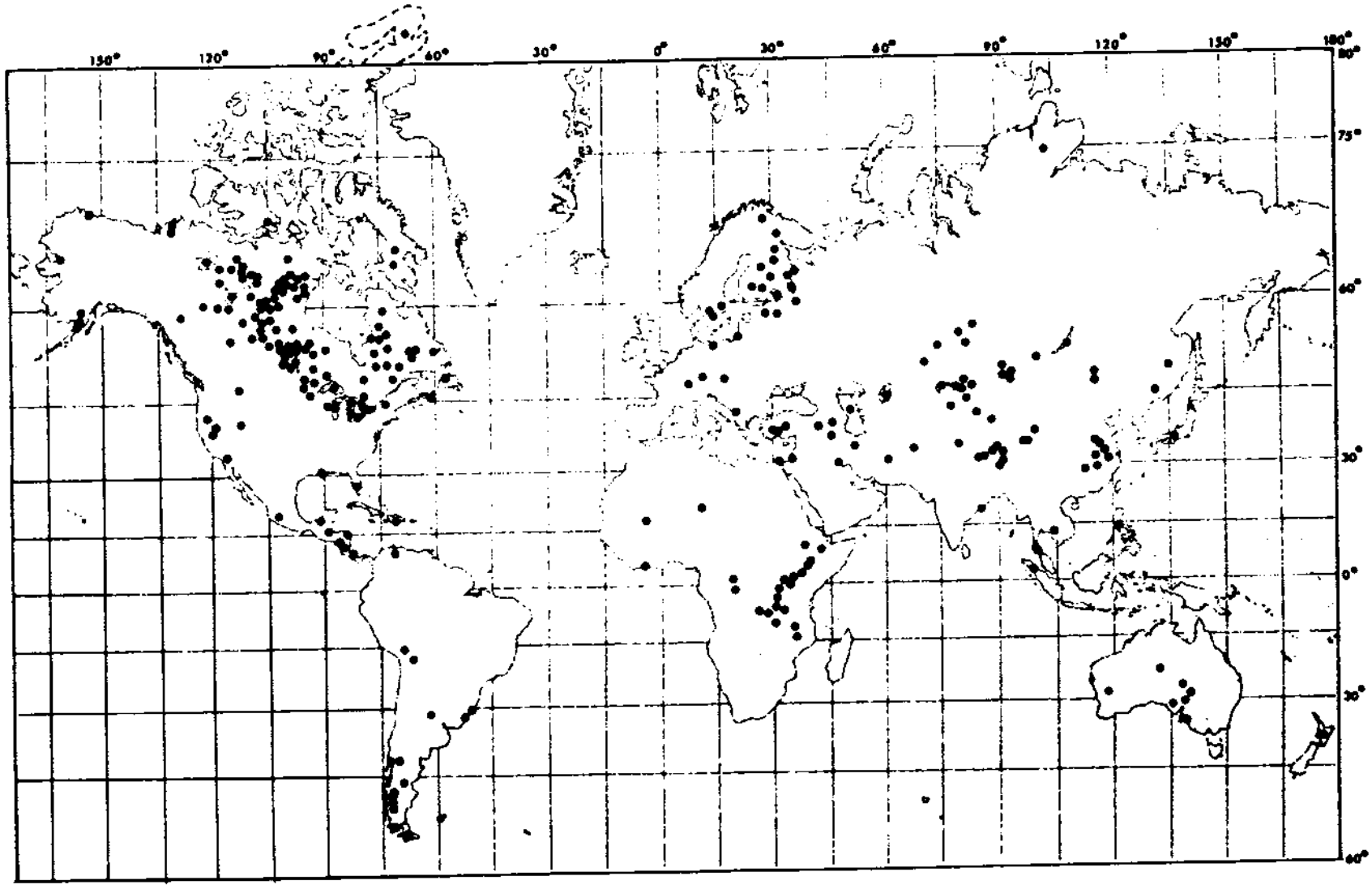

Figure 2. Global distribution of large lakes

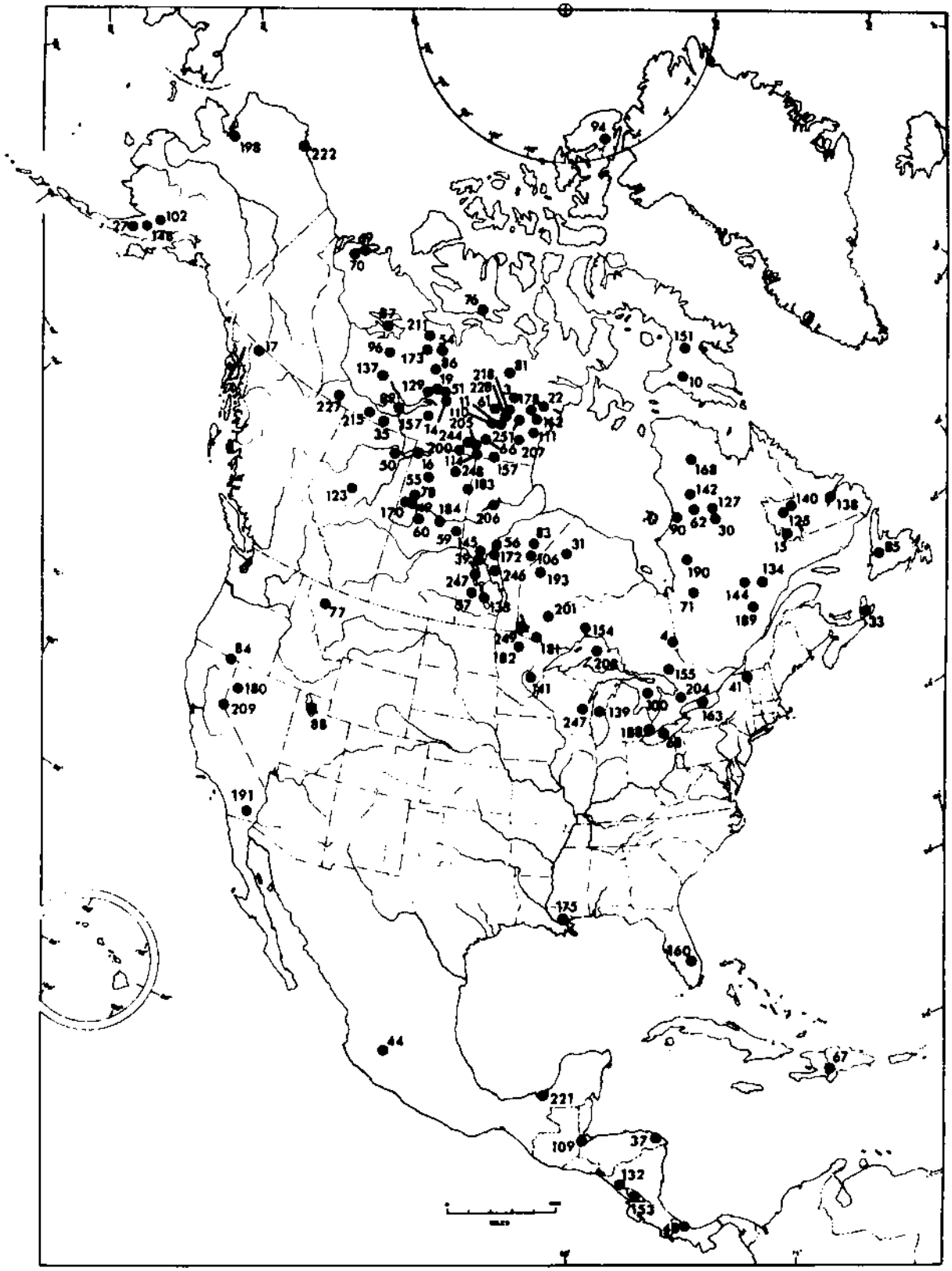

Figure 3. Distribution of large lakes in North America

TABLE 6

FIFTY LARGEST, GREATEST VOLUME, AND DEEPEST LAKES OF THE WORLD

AREA RANK	NAME	AREA (km^2)	VOLUME RANK	Name	VOLUME (km^3)	DEPTH RANK	NAME	MAXIMUM DEPTH (m)
1	CASPIAN	374,000	1	CASPIAN	78,200	1	BAIKAL	1,741
2	SUPERIOR	82,100	2	BAIKAL	22,995	2	TANGANYIKA	1,471
3	ARAL	64,500	3	TANGANYIKA	17,827	3	CASPIAN	1,025
4	VICTORIA	62,940	4	SUPERIOR	12,230	4	NYASA	706
5	HURON	59,500	5	NYASA	6,140	5	ISSYKKUL	702
6	MICHIGAN	57,750	6	MICHIGAN	4,920	6	GREAT SLAVE	614
7	TANGANYIKA	32,000	7	HURON	3,537	7	MATANA	590
8	BAIKAL	31,500	8	VICTORIA	2,518	8	CRATER	589
9	GREAT BEAR	31,326	9	GREAT BEAR	2,292	9	TOBA	529
10	SAP	30,000[2]	10	GREAT SLAVE	2,088	10	SAREZ	505
11	GREAT SLAVE	28,568	11	ISSYKKUL	1,738	11	TAHOE	501
12	CHAD	25,900	12	ONTARIO	1,637	12	HORNINDALSVATN	514
13	ERIE	25,657	13	ARAL	1,451	13	CHELAN	489
14	WINNIPEG	24,387	14	LADOGA	908	14	KIVU	480
15	NYASA	22,490	15	TITICACA	827	15	QUESNEL	475
16	BALKHASH	22,000	16	REINDEER	585	16	ADAMS	457
17	ONTARIO	19,000	17	HELMAND	510	17	FAGNANO	449
18	LADOGA	18,130	18	ERIE	483	18	MJOSA	449
19	BANGWEULU	15,100	19	HOVSGOL	480	19	SALSVATN	445
20	MARACAIBO	13,010	20	WINNIPEG	371	20	MANAPOURI	443
21	TUNGTING	12,000	21	KIVU	333	21	NAHUEL HUAPI	438
22	PATOS	10,140	22	NIPIGON	320	22	DEAD	433
23	ONEGA	9,700	23	MELVILLE	313	23	TAZAWA	425
24	MAI-NDOMBE	8,210	24	ONEGA	292	24	GREAT BEAR	413
25	NICARAGUA	8,150	25	MARACAIBO	280	25	COMO	413
26	TITICACA	8,030	26	VAN	217	26	SUPERIOR	407
27	ATHABASCA	7,935	27	DEAD	188	27	HAWEA	392
28	REINDEER	6,650	28	RUDOLF	187	28	MAGGIORE	372
29	RUDOLF	6,400	29	VANERN	180	29	CHILKO	366
30	ISSYKKUL	6,240	30	MISTASSINI	170	30	PEND OREILLE	366
31	URMIA	5,960	31	TAHOE	124	31	SHIKOTSU	363
32	ALBERT	5,590	32	BALKHASH	112	32	POWELL	358
33	VANERN	5,580	33	ATHABASCA	110	33	LLANQUIHUE	350
34	NETILLING	5,542	34	NICARAGUA	108	34	GARDA	346
35	WINNIPEGOSIS	5,375	35	GENEVA	90	35	TOWADA	334
36	CHANY	5,000	36	EDWARD	78	36	TELETSKOYE	325
37	TAYMYR	5,000	37	WOLLASTON	75	37	EUTSUK	323
38	NIPIGON	4,848	38	VATTERN	72	38	GENEVA	310
39	MANITOBA	4,625	39	KOKO	67	39	ORAR	310
40	KOKO	4,460	40	MICHIKAMUA	65	40	KURILE	306
41	KYOGA	4,430	41	ALBERT	64	41	WALKER	305
42	KHANKA	4,400	42	ALAKOL	57	42	TITICACA	304
43	GREAT SALT	4,360	43	ZAYSAN	53	43	ARGENTINO	300
44	MWERU	4,350	44	CONSTANCE	48	44	ILIAMNA	299
45	WOODS	4,350	45	TUNGTING	48	45	TYRIFJORDEN	295
46	PEIPUS	4,300	46	CHILKA	45	46	LUGANO	288
47	VAN	3,740	47	URMIA	45	47	TAKLA	287
48	TANA	3,600	48	MAI-NDOMBE	41	48	OHRID	286
49	POYANG	3,350	49	SAP	40	49	ATLIN	283
50	UVS	3,350	50	SEVAN	38	50	NUYAKUK	283
TOTAL		1,215,523			165,597		TOTAL	23,475

RESOURCE ECONOMICS

Resource economics and recreation will probably be the major area of emphasis within our program in the future. The opportunities and the needs in this area are very great to help managers manage the resource and to help communities plan for the growth of tourism.

Recreational Boating

One of the major thrusts or goals of the research program in this area is to provide data that will: (1) enhance the economic development of the Lake Erie community, and (2) provide the opportunity for a high quality social recreational experience. The research phases to accomplish these goals include: (1) baseline studies; (2) economic studies; and (3) special studies.

Phase 1. The first phase of the program was to collect and document baseline data on the number, type, and location of recreational boating facilities on Lake Erie, and document the level of usage of these facilities. This phase of the study was completed in 1977 and published as a "Guide to Boating Facilities on the Ohio Segment of Lake Erie" (Wenner 1978). Boaters wanting to locate specific boating facilities can use this as a guide. Community resource planners and developers can use the guide to help document and assess the need for additional facilities within their communities.

Phase 2. The second phase of the reserach program was designed to collect data that would assist communities in evaluating the economic importance of having recreational boating facilities located within their area. This phase of the research program was divided into two units. The first unit was designed to document the day-to-day expenditures of the boaters that related directly to the boating activity while within the Lake Erie area. Both units have been completed and will be presented in detail in later reports. Communities that are supporting publicly owned facilities or who have been requested to develop local facilities can utilize the data to point out the economic benefits to the entire community as a means of justifying the expenditures of public funds. Private or commercial establishments can use the economic data to enhance their requests for zoning and utility needs. The second unit is designed to document the value of the marina operations in terms of boat, motor and trailer sales, employment or payroll contributions to the local community, and the value of the local, state and federal taxes paid by the marinas in the Lake Erie area. These units may be combined to estimate the total economic importance of the recreational boating industry to the local economies.

Phase 3. The third phase of the research project consisted of a series of in-depth special studies. These special studies were designed to be of specific assistance to marina owners or operators, or communities wishing to expand their facility's capacity or for development of new operations. Specific studies that have been completed include:

1. a series of personal interviews with marina owners addressing the problems of marina expansion;
2. an analysis of alternative boat storage facilities and resulting potential energy savings;
3. determining the actual boating densities along the Lake Erie shoreline area in order to plan for facility dispersement which would retain the opportunity for high quality boating experiences; and
4. identifying environmentally fragile (i.e. fish spawning or waterfowl nesting) areas where boating facility development might be detrimental.

One of the completed special studies dealt with the problems associated with marina expansion. This was completed by McKinney in 1979. He reported that the primary factor listed by marina owners for not expanding their facilities was profitability. The owners recognized the current demand for more facilites but still questioned the long-run economics of additional capital investment for the expansion of the existing facilities. Also, the owners listed the lack of available land, agency regulation, water levels, high costs (finance, labor and construction) and additional staff requirements as factors inhibiting the expansion of the boating facility capacities.

As a follow-up to McKinney's work, the advantages and disadvantages of dry stack boat storage were examined. Dry stack storage provides several advantages to the marina owners and to the boat owner. With dry stack storage, the marina owner can accommodate a larger number of boats on the same land area and with a minimum of water frontage. Also, the marina owner has the opportunity to utilize the stack storage building on a year-round basis and boaters have the advantage of leaving their boats at the boating site in a dry secure area. Also, since boaters do not have to tow their boats, they can travel between the lake and their residence in a smaller car, thereby conserving gasoline. Several communities are investigating the possibility of implementing dry stack storage facilities within their areas where waterfront space and shoreline parking are at a minimum. The theory being that many of the local people would walk or ride a bicycle to the marina and rely upon the marina to launch their boat for them.

The return of good walleye and perch fishing in Lake Erie is encouraging more fishing and hence is creating an even greater demand for more boating facilities. If the development of these new facilities was to take place in environmentally fragile areas then fish populations could be affected. Therefore, it is imperative that new development not take place in areas that would damage the underlying cause for wanting the new development. Dry stack storage has the potential of concentrating a large number of boats in one area but too many boats could begin to cause physical hazards and overcrowding in harbors and channels. Existing boating densities and environmentally fragile areas were reported. This data may help planners disperse the development of new boating facilities without causing damage to the environment or creating a physically unsafe area.

Western Basin Sport Fishing

The estimation of the economic value of western basin sport fishing is focused on private-boat fishing in 1981 during the summer walleye period of May 15 to August 15, and the autumn yellow perch period of August 15 to November 15. During the summer

walleye period, about 650 private-boat anglers were contacted on randomly selected dates at randomly selected launching and docking sites in the western basin. During September, these anglers were mailed a questionnaire which asked them to report their western basin fishing activities and expenditures for the May 15 to August 15 period. After two follow-up mailings, 350 completed responses were obtained.

During the autumn yellow perch period, about 300 private-boat anglers were contacted in the western basin. In addition, some 200 respondents to the walleye questionnaire who indicated they also fished during the autumn for yellow perch were added to the sample. During November these 500 anglers were mailed a questionnaire which asked them to report their fishing activities and expenditures for the August 15 to November 15 period. After two follow-up mailings, 300 completed responses were obtained. In addition, about 50 members of the walleye sample indicated they did not go yellow perch fishing in 1981.

The walleye sample data has been intensively analyzed by Winslow (1982). A brief summary of her results follows. Nearly all respondents were male; 80 percent were the owners of the boats on which they were contacted. The average respondent was 43 years old, had an income between $20,000 and $25,000, and traveled 86 miles one-way to the western basin. The mean number of trips was 7.7 over the three-month period and the mean length of trip was 1.8 days. Over 80 percent of the trips were one or two days in duration. The respondents reported fishing an average of 7.4 hours per day with two other persons in the boat.

The mean on-site expenditure was $704 per group per season, i.e., expenditures for items used while at the lake in contrast to expenditures for travel. About 27 percent of these expenditures were for food and lodging, 23 percent for fishing equipment and bait, 47 percent for boat supplies and repairs, and 3 percent for other. In addition, the boat owners reported a mean inflation adjusted boat value (price) of about $8,000. Two-thirds of the boat owners indicated that 50 to 100 percent of their total boat use was in the western basin (which includes autumn yellow perch fishing).

The respondents reported keeping a mean of 2.3 walleye per person per day and 5.3 yellow perch per person per day during this summer period. About 75 percent of the respondents reported less than 10 walleye kept per trip for their groups.

The estimated total willingness to pay by private-boat sport anglers for western basin fishing during May to August, 1981 was $325 million. This compares to an estimate of $48 million for the same equation when only travel costs are included, but on-site costs are excluded. The $325 million estimate is considered to be the best estimate of the economic value of the western basin for this study.

Marine services (including bait and boat dealers) generated about $31 million income and employment of 3,800 workers, while 249 charter guides generated income of nearly $300,000 in 1981. Sport angling is a final demand sector and generates income or employment through purchases from production sectors. As a follow-up study, a sample of about 720 recreational boaters and private-boat anglers was obtained by the Sea Grant Advisory Service agents at launching sites in the central basin. This information will be helpful for developing the fishery resources of this economically depressed region of the state.

COASTAL AND OCEAN ENGINEERING

Coastal Engineering Laboratory

Dr. Keith Bedford has established the Coastal Engineering Laboratory (CEL) at The Ohio State University for investigating storm surges, coastal erosion, sediment resuspension, engineering structures and other associated aspects of the physical environment of the coast. He and several colleagues in the College of Engineering and their students have combined support from Sea Grant and other NOAA components, U.S. Army Corps of Engineering, Office of Water Research and Technology, U.S. Navy, Woods Hole Oceanographic Institution and U.S. Environmental Protection Agency to build a program which is addressing several of the most pressing needs in coastal research.

Some of the fascinating CEL projects have included studies of Lake Erie shoreline damage from the high-water storms of the mid-1970s. These storms resulted in $60 million worth of loss in Ohio alone. In an attempt to determine which type of engineering structure proved to be the most successful in combatting wave erosion a video record of the entire Ohio shore was taped from helicopters. These tapes are available for public use in the CEL library and form a valuable reference for many coastal investigations. Instrumentation development, particularly for measurement of sediment transport is another important function of the Laboratory. Ohio Sea Grant has participated in several CEL projects, which are described in greater detail below, and has worked with the Department of Civil Engineering in the creation of a Graduate Program in Coastal and Ocean Engineering.

Storm Surges on Lake Erie

Lake Erie is well-known because of its dramatic fluctuations in water level. Due to either long-term hydrologic variations or intense meteorological events, Lake Erie is subject to very damaging flooding events. The lake is quite shallow; therefore, the effects of such disturbances are quickly transmitted throughout the lake with the obvious result being severe storm surges. These surges occur most frequently in spring and fall when storm winds often match the directional orientation of the lake's long axis, causing flooding in Buffalo or Toledo for southwest or northeast winds, respectively. Observed water level differences between these two cities have been as great as 16 feet during a storm in 1979 with accompanying severe damage.

Advance forecasting of storm surges on Lake Erie is one of the goals of Ohio Sea Grant research. Dr. Keith Bedford has concentrated on intercomparing several existing models for various classes of storm surge events. He has identified the necessary improvements for accurate foreasting in the shallow western basin of the lake. Because of the lakes peculiar bathymetry, all earlier models have failed to correctly predict the impact of storm surges in the vicinity of Toledo, the area of the lake most vulnerable to storm damage.

Dr. Bedford's research has also revealed that storm surges can also occur in the winter, even when the lake is ice-covered. One of the most notable examples occurred during the January 1978 blizzard when a 12-foot Buffalo-Toledo water level differential was recorded while the lake was totally covered with ice. A low pressure disturbance caused the ice to fracture within a matter of hours causing not only flooding but accompanying transport of large blocks of ice landward resulting in significant property damage.

Working with the NOAA-Great Lakes Environmental Research Laboratory and the Weather Service, Ohio Sea Grant researchers are hopeful that operational predictive models will soon be perfected for use in western Lake Erie. Since the property damage has been so high, it is desirable, as is done for ocean hurricane surges, to be able to forecast such flooding. Only with an accurate forecast will property owners be able to take those steps necessary to protect themselves and their property.

Coastal Erosion and Protection

Sand beaches provide invaluable shore protection, recreation, and a transitional environment between the land and the lake along the shore of Lake Erie. Recent studies by Ohio Geological Survey and Ohio Sea Grant researchers have shown that the size and areal distribution of these beaches have changed dramatically from the 1870s to the present. In general, beaches have become narrower and less continuous along the shore. For example, in 1876 about 23 percent of the Ohio shore was fronted by beaches equal to or greater than 15 m wide, whereas in 1968 (at a time of comparable lake levels) only 13 percent of the shore was fronted by beaches with a similar width. Dr. Charles Carter, Lake Erie section head for the Ohio Geological Survey and Ohio Sea Grant research associate, believes that the principal cause of this decrease in beach size and distribution is the proliferation of man-made structures. His research has shown that harbor jetties and breakwaters have altered the longshore transport of sand and that groins and seawalls have reduced the amount of new sand coming into the littoral system by protecting the shore from erosion.

An examination of historic aerial photographs and shoreline survey data shows that the decreases in beach width and distribution have occurred so slowly along most of the coast (except for a few notable storms) that there is little public realization of the problem. For example, a scarcity of sand on the barrier islands, bars and spits along western Lake Erie shoreline has led to the erosion of these protection barriers. In places, such as Potter's Pond near Ottawa National Wildlife Refuge, erosion of the barriers has left sizeable bays open to the lake where productive wetlands and lagoons once existed. Thus, a decreased sand supply has contributed to smaller beaches with a resultant increase in wave energy reaching the shore, which causes greater erosion, a decline in coastal marshes, and a loss of recreational beach areas.

The long-term goal of this research is to measure and interpret the beach changes that have taken place in the past 100 years so that a comprehensive plan for beach preservation can be developed. Artificial beach nourishment is becoming a viable solution for shore protection and recreational needs. A knowledge of historic beach changes along a specific reach of shoreline will aid in the successful planning of restoration projects.

Sediment Transport

Each year over 30 million metric tons of fine-grained sediments (silt and clay particles) enter Lake Erie from many sources. Only 3 millino tons are transported to Lake Ontario, leaving behind the remaining tons as deposits on the lake bottom. These deposits result in two problems, both of which have expensive solutions. First, continual dredging is required to maintain harbors and channels. Over 50 percent of all the Great Lakes dredging is done in Lake Erie at an estimated annual cost of several million dollars per year, with additional costs of over $10 million per year required for the necessary spoil containment devices. The second problem is storm-induced sediment resuspension which is a stirring of the bottom deposits that occurs when the lake is affected by wind-generated waves, storm surges, or seiches. Since toxic substances often attach themselves to clay-particles or are incorporated in mud deposits, sediment resuspension is a significant pollutant transport mechanism.

Direct management of sediment resuspension is probably impractical; however, it is too necessary to understand this process if predictive models are to be constructed and if optimal control strategies are to be developed. Currently, the variability of sediment concentrations introduced by storm waves and seiches are estimated by empirical methods which are very inaccurate. A method is needed to directly measure the particles which are resuspended during storm conditions so that the fluid mechanics of the process can be accurately described. Drs. Keith Bedford, Robert Brodkey, Vijay Varadan, and Vasundara Varadan of the College of Engineering have been working on an experimental device to make such measurements. The instrument, known as a "sediment profilometer" consists of single- and multi-frequency ultrasonic transducers for direct profiling of sediment concentration and grain size distribution. A prototype of this instrument is currently being tested in Lake Erie in the vicinity of Old Woman Creek National Estuarine Sanctuary east of Sandusky, Ohio.

A combination of field work and numerical modeling is being used at the Old Woman Creek estuary site to determine what nearshore sediment disruption and transportation takes place during seiches and storm surges. The field data is being collected by a C-DART probe (coastal Data Acquisition and Retrieval Tower) which was developed by CEL researchers and consists of an easily flotable bottom sitting tower fitted with four Marsh McBirney current meters, four directional wave staffs, a pressure transducer, three thermistors, two dual-beam turbidimeter, and wind speed/direction and air temperature sensors. The tower is also fitted with the ultrasonic profilometer. A microprocessor/computer which was also built by CEL researchers to operate the entire system and store the data obtained from the sensors.

Climatology of the Lake Erie Basin

While the effects of the Great Lakes on the meteorology of the region during the cold seasons are reasonably well-known, comparatively little is known about their effects during the spring and summer months when recreational use of the region is at its peak. Dr. Thomas Seliga, Professor of Electrical Engineering, Director of the Atmospheric Sciences Program, and Sea Grant investigator, has directed his attention to this problem. He and his students have assembled the current body of knowledge concerning the meteorology and climatology of the Lake Erie basin, particularly during the months April through September. The effects of Lake Erie upon the climatology

of the lake basin are of particular interest to the researchers. The major driving force behind these effects appears to be the temperature difference between lake and land, the lake surface being cooler than the mean land temperature for all spring and summer months except September.

The investigation includes a number of important elements, including: 1) the major physical factors influencing climate, such as surface roughness, moisture supply, and temperatures of the lake versus the land surface, 2) meteorological effects of Lake Erie including lake and land breezes, invluence exerted by the lake on synoptic flow, and the lake effect on pressure patterns, and 3) specific climatic variables and possible lake influence upon them, such as temperature, humidity, solar radiation, wind evaporation, precipitation and severe weather. An Ohio Sea Grant technical bulletin on the climatology of the Lake Erie region for the months April through September is planned for the results of this investigation.

Offshore Structures

The increasing activity in offshore construction, particularly platforms for petroleum exploration, poses some serious engineering questions. First, many types of offshore structures have few or no precedents. Thus, design and construction decisions have to be made while established technolgoy and experience are inadequate. Second, the consequences of a failure are often serious and may lead to loss of life and environmental damage.

Dr. Tien H. Wu, Professor Civil Engineering and Ohio Sea Grant investigator, believes that one of the most important components in the design of offshore structures is site investigation. Because of the difficulties encountered in drilling and sampling in deep water and the lack of prior experience in the relatively new marine environment, site characterization for offshore structures involves a high degree of uncertainty. Dr. Wu's research is designed to meet these new challenges by applying new technologies such as geophysical methods and in-situ tests to these problems.

Starting in 1981, Dr. Wu has been examining offshore structures in the Gulf of Mexico, North Sea and other locations throughout the world. The overall objective of his project is to develop a systematic procedure for the interpretation of site investigation. Specifically, the following stages, arranged in the sequential order of site exploration, are being considered: 1) mapping of sea-floor materials from borehole data, 2) in-situ and laboratory measurements of sea-floor properties, 3) special laboratory and in-situ load tests, and 4) observations of performance of completed structures. Dr. Wu anticipates that this procedure will also account for the reliability of the information obtained in each phase, and will enable the designer to update the estimate of material properties and the uncertainties with each successive stage of the investigation. Long-term benefits of this work will be amore rational and systematic approach using reliability in the design of structures normally plagued with uncertainty. short-term benefits will come from improved efficiency in site investigation and design which should reduce cost on likelihood of failure.

RECREATIONAL AND CULTURAL RESOURCES

Old Woman Creek National Estuarine Sanctuary

The Center for Lake Erie Area Research in conjunction with Shoreline Management Section of the Ohio Department of Natural Resources conducted a survey of locations along the Ohio shoreline of Lake Erie to determine the most qualified site for consideration as an estuarine sanctuary. Matching grants are available from the NOAA Office of Coastal Zone Management for the purpose of establishing such sanctuaries as natural research laboratories. The intent of the grant is that research conducted at these sites will provide information useful in the development of effective management plans for the coastal zone.

Old Woman Creek mouth, a freshwater estuary in Erie County, was selected as the most desirable site for an estuarine sanctuary in Ohio. ODNR submitted an application to the U.S. Department of Commerce for funding of this site in early 1975 and received approval in July 1977. In September 1980 the site was dedicated as a National Estuarine Sanctuary.

The Old Woman Creek estuary, unlike most Lake Erie shoreline areas, continues to retain the natural and environmental qualities that once characterized Ohio's shore. In addition to its scenic beauty, this area provides a habitat for a myriad of floral and faunal species and serves as a spawning and nursery area for several commercially valuable fish species.

The Ohio Sea Grant Program has actively conducted ecosystem research in the estuary for the past five years. These studies have included botanical, geological, ichthyological and parasitological investigations. In addition to research, Sea Grant personnel have been instrumental in the development of educational and recreational facilities at the sanctuary.

Lake Erie Islands

Lake Erie has been described as the busiest, most traveled and most important lake in the world. While this description emphasizes the commercial importance of the lake, its importance to the people of Ohio extends far beyond these boundaries. This report outlines the diverse opportunities the lake, and, more specifically, its island region, offers Ohioans. Most importantly, the recreational, educational, and aesthetic features of this region are unique in the state and offer possibilities for personal growth and development to the great community residing throughout Ohio.

Ohio's jurisdiction of Lake Erie covers approximately 3,500 square miles of surface area. Within this jurisdiction are a number of islands and rocky outcrops covering an approximate area of 10.5 square miles (6,736 acres). Of Ohio's 262 miles of Lake Erie shoreline, 43.2 miles are island shoreline. These islands are concentrated entirely in the western basin of the lake and contribute to the shoreline of Lucas, Ottawa, Sandusky and Erie Counties.

In cooperation with the Coastal Zone Management Program of the Ohio Department of Natural Resources, Ohio Sea Grant undertook a study of the resources and special attributes of the Lake Erie Islands. Within the island region are a diversity of points of interest -- people, places, things -- which are both unusual in their own right and uncommon on either a local, statewide or regional basis. The points of interest with special attributes identified during this study are summarized in Table 65. Eleven of the 33 points of interest are utilized by local residents. The remaining 22 points compose a constellation of attributes which single out the island area as a focal point for Ohio citizens in search of the unusual within moderate distance.

Locally, Catawba Cliffs Drive is an impressive scenic drive along a high promontory on the west side of Catawba Island. The Johnson Island causeway is the only bridge connecting an Erie Island with a mainland point. The Colonial Hall in the villge of Put-in-Bay serves as a focal point for community activity during the winter months. During this period, many local residents participate as members of one or more bowling teams. The winter leagues use the Colonial Lanes, the only bowling lane in the island area. The Golden Pheasant Inn on Rattlesnake Island provides a small resort facility with an intimate, remote atmosphere. Although not well known, the Golden Pheasant Inn caters to members of this exclusive club. Over 2,000 philatelists subscribe to the annual Rattlesnake Island issue. The Kelley Mansion on Kelleys Island is used as a local community center. The Dollar and Miller Mansions on South Bass Island are private dwellings constructed in the grandiose manner of the late 1800's.

The winery ruins on Kelleys Island, the Lonz Winery Building on Middle Bass and the foundation ruins of the Victory Hotel on South Bass Island are points of interest to those who desire a knowledge of the history of the islands. The limestone quarries on Kelleys Island are a point of local interest for future economic utilization. Perry's Lookout on Gibraltar Island is a high vantage point providing a fine vista of the Bass Islands to Ohio State University students attending Stone Laboratory. Several sunken vessels in the area are examined by local SCUBA diving enthusiasts. Table Rock on the northeast point of Kelleys Island is a scenic outlier attracting local interest.

Turtle Island in Maumee Bay has had a comparatively large history in Indian lore for such a small island. Residents of the Toledo area seem to place a special importance on Turtle Island both for its role in local history and for personal memories of visits to the island. When the island is mentioned in local newspaper accounts, it is usually in reference to fishing or picnicking trips. Most Ohio residents have never heard of Turtle Island. Its importance for the citizens of Ohio rests with the role of marking the boundary between Michigan and Ohio.

A number of island attributes are of limited local interest but of considerable importance on a statewide/regional basis to special interest groups. Among these are the archeological sites on Kelleys Island and the Confederate Officer's Cemetery on Johnson Island. Stone Laboratory on Gibraltar Island is the oldest freshwater biological station in the United States. A diversity of students and visiting scientists utilizes its facilities. Ice fishing activity attacts hardy sportsmen from throughout the state during the months of January and February. During the summer months, reef fishing again attracts these sportsmen. The Interlake Yachting Association's Annual Regatta draws sailing enthusiasts and a diversity of sailing vessels each August. Put-in-Bay Harbor provides a focal point of interest to power boat enthusiasts based in Cleveland, Catawba-Marblehead, Toledo and Detroit. At one time the Ohio State

Music Camp held on South Bass Island each summer attracted talented high-school age performers from across the state. The intensive learning experience provided each camp group culminated with a recital performance open to the public.

The snail, Anguispira kochi strontiana, is unique to Green Island. This is the only known habitat for this subspecies. North Bass Island provides habitat for a rare population of triploid salamanders, Ambystoma texanum.

A number of attributes of the island region are of broad interest and general appeal. Large numbers of visitors tour Crystal Cave, Heineman's Winery, the Ohio State Fish Hatchery, Perry's Cave, Perry's Monument, and the Village of Put-in-Bay, all on South Bass Island. Considerable numbers visit the Glacial Grooves area and Inscription Rock on Kelleys Island. Most visitors are enthusiastic about the opportunity to ride aboard one of the ferry boats serving the islands or to fly to South Bass Island aboard the Ford Tri-motor Aircraft. The lighthouse structures on South Bass Island and at Marblehead Point add a romantic aura to the island region, and serve as points of interest for many visitors.

Visitors often question local residents about the local school systems. The obvious remoteness of the island situation combined with the small permanent population serve as topics of intrigue. The fact that such small independent school systems continue to function in the state is met with amazement and occasional disbelief.

The Bass Islands long have been known regionally for their vineyards and wines, and as a fashionable summer resort area. Consequently, the architecture is reflective of these characteristics. Each of the Bass Islands, however, retains certain qualities unique to their individual historical background.

North Bass, the most inaccessible and most sparsely populated, has never been commercialized. The structures are 19th century farmhouses and the old Isle St. George Congregational Church. Built between 1850 and 1900, the farm buildings generally are frame, two-story structures of the vernacular Greek Revival or vernacular Italianate style. The church features a bell tower, an oculus window, and an ogee arched window. The church and the Fox/Burris residence, the home of an original settler, merit review for nomination to the National Register of Historic Places.

Middle Bass Island can be separated into three well-defined areas historically and architecturally. The central and western-most tips of the island were developed into prosperous grape-producing regions, largely by German settlers of the likes of Peter Lonz, Andrew Wehrle, "Count" William Rehberg, and others. The well-built vernacular and classical structures typify the industrious and prosperous nature of their owners. These residences and their wine-related buildings also merit nomination for the National Register. The Middle Bass Town Hall and adjacent schoolhouse of Italianate style, fit beautifully into this architectural mode.

The eastern tip of Middle Bass, owned privately by only a few persons, contains the Frank Lloyd Wright-influenced stone house and outbuildings, i.e., stables and entrance gates, to the estate of Henry F. Payer, a former federal assistant secretary of state and noted Cleveland criminal lawyer. The westernmost area of the island

features an exclusive private clubhouse, "The Toledo and Lake Erie Fishing and Boating Association," with its surrounding cottages. The architecture is of an ornate Gothic and Italianate style. The club attracted many famous visitors, including Presidents Benjamin Harrison, Grover Cleveland, and Rutherford B. Hayes. The Middle Bass Association, as the complex is termed today, also has excellent qualifications for the National Register.

South Bass Island, which includes the town of Put-in-Bay, reflects the commercialized aspect of the wine industry. Some of the 19th century hotels, such as the Riebel House, the Crescent, and the Park, still exist. The fine island homes of Joseph de Rivera St. Jurgo, Valentine Doller, John Brown, Jr., George Orr, and others continue to reflect their traditions through Greek Revival and Italianate styles. The same can be said of the Put-in-Bay Town Hall and the United States Fish Hatchery.

On Gibraltar Island, which guards the entrance to Put-in-Bay harbor, stands the "castle" built by the noted financier Jay Cooke. The structure today is operated as a research adjunct by The Ohio State University.

Interrelated with the island traditions and the isolation imposed by the geographical conditions of the 19th century is that of maritime activities. This dependency upon water transportation for both passenger and freight movement has intensified the island heritage. Specific ships engaged in localized trade between Sandusky, Toledo and Detroit still are remembered with great nostalgia.

No definitive handbook exists which details the unique historical environment of the Bass Islands on the western end of Lake Erie. A Sea Grant project is being undertaken by the Center for Archival Collections at Bowling Green State University, to produce a high quality booklet detailing the history and historic architecture of the Bass Islands. Emphasis will be placed on South Bass (including Put-in-Bay), Middle Bass, and Gibraltar Islands. North Bass Island will be included to a lesser extent. The booklet will contain approximately fifty pages of good enamel quality, be heavily illustrated, and contain a limited number of four-color reproductions. Upon publication, the booklet would be made available for public consumption through various marketing sources at a nominal price.

The objective of this publication is to bring two factors -- structures and ships -- together to bring out this heritage. Because the islands are renowned throughout the Great Lakes region, such a publication should enjoy a wide range of appeal. The documentation and illustrations basically are available at the Center for Archival Collections. The greatest obstacle is one of selection in order to condense such a "blend" into one publication.

Other recreational related activities of the Ohio Sea Grant Program in the Lake Erie island region include the publication of a "Self-guided Hike/Bike Tour of South Bass Island." This booklet contains information on 25 points of interest in and around the village of Put-in-Bay. Another booklet is intended for visitors to Kelleys Island. Titled "Take a Glacial Grooves Fossil Walk," it contains illustrations of 18 common fossils found in the limestone that has been spectacularly sculptured by the glacier.

Traditions and Customs of Commercial Fishing

The Ohio Sea Grant Program in cooperation with the Ohio Foundation on the Arts, the Ohio Art Council and the Folkarts Program of the National Endowment of the Arts, is conducting a field research, documentation and publication project on the traditions and customs that are part of the commercial fishing industry in Erie, Sandusky and Ottawa counties, Ohio. The project is being headed by Timothy C. Floyd, director of the Folklife Program of the Ohio Foundation on the Arts and Dr. Patrick B. Mullen, professor English and Sea Grant research.

Research on commercial fishing in Lake Erie has been almost exclusively biological, technological or economic, and has rarely taken into account the human and social filter through which information, advice, regulations and decisions become real. Tim Lloyd and Pat Millin hope to balance our understanding of this industry by documenting and presenting its human side. Through field observation, taped interviews and photography, they will examine not so much the industry itself, but rather those individuals and groups whose informally learned skills, techniques, attitudes and values allow the industry to exist and function. In an area where commercial and sport fishermen vie for limited space and resources, they plan to focus on small-scale commercial fishing, documenting and describing traditions and customs which teach, reinforce and justify that livelihood and way of life. Through occupational traditions, to be further explained below, they hope to gain insight into the following occupational issues, among others:

1. The choice of occupation and occupational speciality, including age of entry and exit, ability or desire to switch specialities within the occupation, and match of job requirements with personal skill and temperament;

2. Judgments about relative occupational ability and preferred working style, including specific contexts and various means by which those skills are learned and judgments made;

3. Subjects of fear, respect and ridicule, as encountered in the workplace;

4. The fishermen's view of occupations, lifestyles or legal or economic structures which overlap with or impinge on their own, as expressed in stylized and traditional expressions or activities of the group;

5. Modes of entertainment, fantasy and playfulness which take place during work or which reflect the stresses and concerns of that work;

6. The means by which fishermen mark themselves off from others by adopting "in-group" customs of dress, jargon, demeanor and gesture; and

7. Judgments about how the methods and the identity of commercial fishermen have changed within the last generation.

To better understand such occupational expectations, patterns and concerns, they will record and photograph codified and conventionalized traditions which have longstanding and widespread usage in Erie, Sandusky and Ottawa counties, Ohio. These traditions will form the core of an illustated publication to be distributed by the Ohio Sea Grant Program to local business and economic-development interests, to tourist audiences and to the local public, to promote interest in and understanding of the local commercial fishing industry. It will also provide the data base for articles intended for scholarly publication in folklore and anthropological journals.

Lake Erie Recreational Planning Guide

In cooperation with NOAA's Great Lakes Environmental Research laboratory, the Ohio Sea Grant Program has embarked on a project to prepare an atlas which is descriptive of conditions, processes, and both natural and man-developed features of the coastal and offshore areas of Lake Erie. The guide will stress natural atmospheric and hydrospheric phenomena as they relate to users and developers of recreational facilities. It will highlight opportunities for coastal tours, shoreline vacations, and specific types of outings on both land and water. This publication will be of interest to those planning recreational activities in the region. Information on hazards and precautions will be interspersed throughout the publication. The atlas is scheduled to be completed in 1984.

Sport Fishing Reefs for Central Lake Erie

Anglers fishing the nearshore waters of the central basin of Lake Erie soon may be casting their lines over artificial reefs and bringing home larger catches as a result of a recently announced artificial reef program.

The Ohio Department of Natural Resources (ODNR), Division of Wildlife and the Ohio Sea Grant Program at The Ohio State University have embarked on a joint program to establish artificial reefs in the central basin of Lake Erie. The purpose of the reef program is to enhance sport fishing catches of walleye, perch, and bass in the nearshore waters of Lake Erie from Huron eastward to Conneaut, Ohio. Artificial reefs are man-made structures of various types of stable materials which provide cover, forage and spawning sites for many species of fish and lower forms of aquatic life.

Steven H. Cole, Chief of the Division of Wildlife, stated, "The Division of Wildlife recognizes the excellent work of the Ohio Sea Grant Extension Agents and their Advisory Committees in locating reef materials and developing preliminary recommendations for reef construction. We look forward to the continued efforts of these committees during the planning and implementation phases of the program." Dr. Charles E. Herdendorf, Director of the Ohio Sea Grant Program, commented, "The Sea Grant Advisory Committees have identified the need for artificial reefs in central Lake Erie as one of the highest priority items for the Sea Grant Program, and we are pleased to be joining with the Division of Wildlife to answer this need."

As a pilot study, the three reefs will be placed in Cuyahoga and Lorain counties, about one-half mile offshore in 30 feet of water. The reefs will be constructed of several hundred tons of concrete rubble. Concrete shore-protection dolos (2-3 tons each) and concrete I-beams will be placed on top to provide additional structure. This project was initiated by Sea Grant Agent David Kelch and his north central Ohio Sea

Grant Advisory Committee. The Ohio Department of Natural Resources is in the process of obtaining a permit from the U.S. Army Corps of Engineers for the reef structure so that it can be placed in the lake during 1983. Ohio Sea Grant and the Division of Wildlife plan to conduct a cooperative study of the effectiveness of this reef in attracting sport fish.

Information gained from the pilot study will be used to plan additional reefs for the five Ohio counties which border the central basin of Lake Erie. The continued efforts of the Ohio Sea Grant Advisory Committees in preparing site recommendations, procuring construction materials, and ensuring citizen participation in the planning and implementation processes will be an important part of the total artificial reef program.

EDUCATION

SEA GRANT EDUCATION

COLLEGE-LEVEL INSTRUCTIONAL PROGRAMS

Oceanography and Limnology

With assistance from the Ohio Sea Grant Program, instruction in oceanography and limnology has been enhanced at The Ohio State University. Four new courses in these fields have been added to the curriculum in the past three years:

1. Geology and Mineralogy 206: Physical Oceanography and Marine Geology
2. Zoology 505: Oceanography and Marine Biology
3. Math-Science Education 694: Marine and Aquatic Education
4. Zoology 750: Great Lakes Limnology

Graduate Program in Coastal Engineering

Ohio Sea Grant funds have been used to assist the development of a Graduate Program in Coastal Engineering at The Ohio State University. The program is housed within the Department of Engineering and is chaired by Dr. Keith Bedford. The program is built on a core of existing courses, but to complete the program seven new courses had to be developed:

1. Civil Engineering 624: Coastal and Ocean Engineering
2. Civil Engineering 723: Transport Phenomena in Water Resources Engineering
3. Civil Engineering 821: Sediment Transport and Engineering
4. Civil Engineering 823: Numerical Models in Water Resources Engineering
5. Civil Engineering 824: Advanced Coastal Engineering
6. Civil Engineering 894: Digital Signal Analysis for Geophysics -- Group Studies in Civil Engineering
7. Civil Engineering 990: Field Experience in Coastal Engineering -- Civil Engineering Practicum

In 1979, The Ohio State University initiated a graduate Coastal Engineering degree program within the Department of Civil Engineering. The program currently has nine students (four at the M.S. and five at the Ph.D. level) and has graduate one student, Daniel Lindsay, with a Master of Science degree.

Marine Construction Technology

The Ohio Sea Grant Program, with matching funds from industry, supported the development of a curriculum proposal for a Marine Construction Technology degree program with the School of Technology at Bowling Green State University. The completed proposal seeks the establishment of such a program to meet the demonstrated needs of industry and government.

The proposal was prepared by Professor William Brewer, chairman of Construction/Design Technology.

From the materials reviewed, the conferences attended and the correspondence and consultation with marine-related schools, Professor Brewer concluded that a marine construction program should be implemented at Bowling Green State University. The present construction program provides a natural linkage for a program in marine construction. The definition of marine construction has caused some confusion for those agencies and individuals surveyed. The proposed marine construction program will consist of the education of individuals for construction of marine facilities and related marine activities. The following project objectives have been met:

1. needs of industry and government ascertained;

2. curriculum content developed to meet industry's and government's needs, including positions of existing relevant programs at Bowling Green State University;

3. coordination of educators for program offerings; and

4. formation of an industry/government/education advisory committee.

This new program will help develop personnel who can be gainfully employed and who will also have developed skills that should make them well-adjusted, self-reliant individuals.

The program specialization takes place during the student's third and fourth years of study and incorporates three industry related co-ops. Twenty-five co-op stations have been designed into the program. Students will be given co-op assignments when entering the program. It is recommended, initially, only juniors be allowed to enter this program.

The growth of technology during the past thirty years has created a large number of educational needs. These educational needs are in the form of new educational programs, adjustment in current educational programs and educational programs for retraining. This curriculum study and curriculum program proposal takes all three educational needs into consideration. It creates a new program in technology while making use of parts of current programs. It also serves as a program for helping retrain individuals for new technological needs in industry.

The proposal covers a review of the needs of industry and an audit of any existing educational programs. It recommends a program curriculum which includes forty-four (44) courses; six (6) new courses and thirty-eight (38) existing courses. In the development of this proposal a twelve (12) member industry/education advisory committee has been formed and twenty-nine (29) cooperative education stations have been established.

The program could be initiated in the fall of 1983. This target date is possible; however, Bowling Green State University has placed a hold on any new programs because of financial restrictions by the State of Ohio and the requirement to reduce enrollment from 17,600 students to 15,000 students. Currently, the plan is to offer

marine/construction related courses within the construction curriculum. Final degree approval by BGSU remains uncertain because of the previously mentioned restrictions.

Professor Brewer recommends that Bowling Green State University implements the findings and suggestions contained in the proposal. This program will enable the University to use facilities at both campus locations: Bowling Green, Ohio and Huron, Ohio. It will also allow faculty the opportunity to develop research techniques in this new field. Lastly, it will develop individuals to meet the needs of an ever-growing industry -- marine construction.

K-12 EDUCATION

Oceanic Education Activities for Great Lakes Schools

Surveys of public school children enrolled in Ohio schools conducted in 1976 and again in 1979 indicated a lack of knowledge regarding the Great Lakes and the oceans. Educators at Ohio State University were disturbed by this deficiency in knowledge concerning 70 percent of the surface of our earth; an area that is critical for the survival of life on earth, and an area that has been fundamental in our history, culture, and economic development. Initial attempts at correcting these deficiencies entailed the offering of a series of workshops supported by the Columbus Council of the Navy League of the United States. In offering these workshops, it soon became apparent that the lack of available curriculum materials would seriously impair any effort in bringing more information concerning the Great Lakes and oceans to Ohio's school children. A proposal was therefore written to the National Office of Sea Grant for the support of a three-year long project to develop supplemental curriculum materials for middle school classes. This project, part of the first institutional submission to the National Sea Grant Program, was funded in 1977. Funding for the project entitled, Oceanic Education Activities for Great Lakes Schools (OEAGLS), continued for three years. The project has resulted in 23 different activities and accompanying teacher guides.

Since school curricula were already crowded with topics allowing little room for the introduction of new courses or units, an "infusion" approach was taken. Most concepts basic to understanding our water resources were already included in middle school curricula. The developers' problem then was to create materials focusing on concepts already being taught, but to imbed them in a marine and aquatic matrix. To do this, examples illustrating these concepts were drawn from the water world instead of the land as done in existing curricula. It was also felt that teachers by and large were satisfied with the curricula that they were teaching. For this reason as well, it would be difficult to get them to adopt a new curriculum or extensive new units. An aspect of the infusion strategy then was to develop short activities that would take at most three to four class periods to complete. It was felt that teachers would be willing to allocate this much time in their course of study for activities that they found useful and interesting.

Ideas for activities were obtained in a variety of ways. In all cases, however, development was a cooperative process. Some activities were initially written by teachers, some by content experts and some by the curriculum specialists. All were tested by teachers other than those involved in the writing. The curriculum specialists

were responsible for the evaluation process. They made observations of classes and interviewed individual students. This immediate feedback supplemented a more formal testing program involving pretests and posttests of both attitudes and knowledge. Using the evaluation feedback every activity and teacher guide was rewritten by the curriculum specialists to assure that all necessary information was included and that the style and level of writing was appropriate for middle school children. Prior to publication, each activity was given a final review by a content expert to assure the accuracy of the information.

These materials are now available to teachers through the Education Office of Ohio Sea Grant and in microfiche form through the national information dissemination systems of ERIC (Education Resources Information Center) and MEMS (Marine Education Materials System). Over 20,000 copies of the activities have been distributed by the Ohio Sea Grant Education Office alone. It is estimated that some 200,000 students in middle schools and high schools of Ohio are now using the OEAGLS materials.

Students are now able to study topics such as the life cycle of the yellow perch in Lake Erie through playing an exciting board game and the effects of state regulations on the perch fishery through a role playing simulation. They collect and analyze data from air photos on the erosion rate of a portion of the Lake Erie shore line. They can study the disappearance of ships and planes in the "Great Lakes Triangle" and experience the feelings of those seamen who disappeared along with the Edmond Fitzgerald. By role playing they can participate in Commodore Perry's victory on Lake Erie and learn the causes of the War of 1812 through the study of newspaper cartoons and reports of Congress published at the time of the war.

An evaluation of the usefulness of the activities is planned for the 1983-84 school year. Every teacher who has obtained copies of the OEAGLS activities will be sent a questionnaire. They will be asked to supply information on the uses made of the activities, on the quality of the activities and on their students' responses and interest in them. This information, along with the results of other studies of the effectiveness of OEAGLS will be analyzed for strengths and weaknesses of the activities themselves and for the insight such information will provide for the design of the development process. These results will then be published to assist future curriculum materials developers in designing projects to write and evaluate instructional activities.

Infusion Program for Ohio Schools

The first project initiated by Ohio Sea Grant resulted in the development of 23 different activities for use by teachers in Ohio middle schools. The Oceanic Education Activities for Great Lakes Schools (OEAGLS) project, completed in 1980, was the first step in improving the teaching of marine and aquatic topics in Ohio schools. Experience with the implementation of materials from other curriculum development projects, especially those supported by the National Science Foundation during the 1960's and 1970's, indicated the need for teacher training. This was especially critical for the OEAGLS materials since they were not to be marketed by a commercial publisher and therefore would not benefit from an advertising campaign. A program was needed to build awareness among Ohio educators of the availability of the materials and of the need for a greater focus, in Ohio classes, on marine and aquatic topics, especially those relating to the Great Lakes. Also needed was a program to improve the content and professional backgrounds of teachers in marine and aquatic education.

A three-year long project was funded by Sea Grant in 1980 to build awareness of marine and aquatic education and to seek to implement it in Ohio's schools. These goals were to be accomplished through the dissemination of OEAGLS materials on as broad a base as possible and through improving the background of teachers. The program entitled Marine and Great Lakes Education: An Infusion Program for Ohio Schools was developed in cooperation with the Oho Department of Education. The co-principal investigator during the first year and one-half was the environmental education coordinator for the Department. He developed the format for a series of one and one-half day awareness workshops that were subsequently conducted in 14 different locations around the state during the three years of the project. These workshops exposed over 500 teachers and administrators to the rationale, content and materials of marine and aquatic education. They have also served as the major dissemination system for the OEAGLS materials.

Two other programs under the Infusion program serve to provide teachers with a greater depth of background in content, materials, and methods. Three two-week long summer workshops have been conducted in Cleveland, Cincinnati, and Toledo. Almost 100 teachers have been enrolled in those workshops. Quarter-long workshops have been held in Westerville, Grove City, and Newark, training another 80 teachers to implement marine and aquatic topics in their classes. A major feature of these longer workshops is direct field experience with water and the industries that utilize water. Teachers have been able to sail, canoe, observe the effects of coastal processes, learn about the marina and sports fishing industries, and study port operations. These and other experiences have helped teachers to understand the importance of the Ohio River, Lake Erie and other water bodies in the recreaton, commerce, and history of Ohio.

Other accomplishments of the Infusion program have been to establish three teaching resource centers, at Columbus, Bowling Green, and Cincinnati. These centers have been made available to teachers in those areas enabling them to examine the various curriculum materials in marine and aquatic education that have been developed nationally as well as in the Great Lakes region. Instructors from five other institutions of higher education in Ohio have assisted in conducting workshops and through that process have become familiar with the rationale for marine and aquatic education. A statewide leadership team has been developed and remains active to guide programs and policy for the Sea Grant Education program.

The Infusion program has created a strong base for marine and aquatic education in Ohio. Over 1,700 teachers have been directly served by the program through workshops. Over 1,000 are reached via the newsletter, Middle Sea, which was begun during the OEAGLS program, continued during the Infusion project, and is now a continuing service of the Ohio Sea Grant Education Program. The overall effectiveness of the Infusion program will be evaluated with a unique design. A baseline study conducted in 1979 provided information on the knowledge and attitudes of Ohio's fifth and ninth grade students. A follow-up to be conducted in 1983 will be able to assess the overall impact of the Infusion program on Ohio schools. The results will be made available to the education community as a report on one of the few systematically designed curriculum development and dissemination programs ever implemented on a state-wide basis.

PUBLIC EDUCATION

The Great Lake Erie Treasure Hunt

A museum is a learning environment that has a great deal more freedom than many traditional educational institutions. No longer able to survive as simply repositories of artifacts, museums are broadening their function to include development of effective environments and innovative strategies for learning and teaching.

The Center of Science and Industry (COSI), in Columbus, Ohio, has as its purpose to provide an exciting and informative atmosphere for people of all ages to discover more about our environment, our accomplishments, our heritage and ourselves. With an annual attendance of over 300,000 visitors, COSI serves as an outstanding nonformal educational institution and a major communications medium.

In a project entitled "Great Lakes Information Through Museum Programming," Ohio Sea Grant supported the development of COSI's Super Summer Science Show for 1982. The "Great Lake Erie Treasure Hunt" program included the following:

1. Six major demonstration programs, on the topics of Lake Erie's geology; wildlife; importance in history, recreation and transportation; and use of the living resources of the lake.

2. Hands-on exhibits: knot tying, water sampling, microcomputer programs, salt cleavage, baby ducks and a scavenger hunt quiz.

3. Major display items: relief map of the Great Lakes, a living stream, an old boat to climb on, and a crow's nest to climb for sending flag messages.

4. Modification and addition of exhibits in other areas, a working model of a canal boat with on-board activities, and songs of canal days in Ohio.

5. Traveling exhibits from other museums and agencies, such as a visit by Lawrence the Lake Trout from Minnesota Sea Grant.

The small Sea Grant budget for this project served as seed money for the securing of grants from other local organizations. COSI Education Director William C. Schmitt and his staff exerted tremendous professional effort and personal energy to produce what COSI feels is the best such program it has ever developed. The Sea Grant Education Office provided content review of the scripts, and advisory agents assisted in procurement of materials for the shows.

Evaluation of the program was conducted by graduate student Judy Kauffeld, OSU Environmental Communications. Surveys of randomly selected adult visitors entering and leaving COSI were designed to determine visitor characteristics, knowledge of and attitudes toward Lake Erie, and visibility of the Great Lake Erie program.

The survey data revealed that the reason for visiting COSI most often chosen by the participants was "to browse generally through the exhibits." Most of the adults were visiting COSI for the first time and the majority of visitors surveyed reside in areas of Ohio outside of Franklin County where COSI is located. Response to an item about where visitors got information about COSI that prompted their visit indicated that friends and relatives served as sources of information more frequently than did media messages.

While 78% indicated they were unaware of the "Super Summer Science Show" when they arrived at COSI, 98% of those surveyed leaving COSI had visited the Lake Erie exhibits on the ground floor. Four questions devised to indicate knowledge of lake resources were included on both the entrance and exit surveys. The mean score on the entry surveys was 29% correct, compared to 51% correct on the exit survey. This particular museum program appears to have been effective in providing environmental knowledge as measured by the survey instrument.

Visitors were also asked whether they agreed or disagreed with the statement, "Lake Erie is a valuable resource for Ohio and the United States." A positive response (i.e. strongly agree or disagree) was indicated by 80% of the entrance survey participants and 92% of those surveyed leaving COSI. Twenty percent of entering visitors were neutral or had no opinion about Lake Erie's value as a resource while only 6% of those exiting were without an opinion.

The nonformal educational experiences of "The Great Lake Erie Treasure Hunt" thus appears to have been effective both in improving attitudes and in providing information about lake resources for the public.

Program attendance for July and August of 1982 was 46,000. COSI is now offering portions of the show to visiting school groups, and the possibility of developing a program to travel to other parts of Ohio is also being explored.

SEA GRANT CONGRESSIONAL FELLOWSHIPS

The Sea Grant Congressional Fellowship Program is designed to give graduate students interested in marine affairs the opportunity to work for one year in Washington, D.C. as a regular staff member of one of our country's representatives or senators or on a subcommittee in the House or Senate dealing with marine affairs. Each year 10-12 students are selected from applicants from across the country. The applicant must have a supporting letter from his or her academic advisor and from the Director of his or her Sea Grant Program in addition to a personal letter describing the applicant's reasons for seeking the position. The most important criteria are 1) how the experience will better allow the student to achieve his or her career goals, and 2) what the student can offer to the program in the way of expertise or experience. The program provides a monthly living allowance and stipend to each student.

Brian G. Burby received the first fellowship awarded to the Ohio Sea Grant Program in 1982. Ohio was fortunate to be the only state to have two students earn such an award in 1983, Timothy M. Bartish and Helen A. Brohl. Mr. Burby was working toward a Ph.D. in the Environmental Biology Program at The Ohio State University when this opportunity arose. Brian served on the Subcommittee for Natural Resources, Agriculture Research and Environment in the House of Representatives' Committee on Science and Technology. His goal was to become a part of the decision-making process relating to environmental quality. Brian used the experience gained from his fellowship to become the Environmental Policy Analyst for the Government Research Corporation in Washington, D.C.

Mr. Bartish and Ms. Brohl are currently fulfilling their fellowships. Tim is assigned to the Senate's National Ocean Policy Study of the Committee on Commerce, Science, and Transportation, while Helen is with the Oceanography Subcommittee of the House Merchant Marine and Fisheries Committee. Both are working toward Masters of Science Degrees at The Ohio State University and both are interested in environmental sciences. Tim is enrolled in the Environmental Biology Program of the College of Biological Sciences, while Helen is majoring in Environmental Policy Analysis, within the School of Natural Resources.

ADVISORY SERVICE

SEA GRANT ADVISORY SERVICE

INTRODUCTION AND BACKGROUND

Ohio is a state endowed with an abundance of coastal and aquatic resources. Ohio's coastline is on the southwest shore of Lake Erie, considered by many to be the most important lake in the world, and a large part of Ohio's heritage. Three million of Ohio's eleven million residents live in cities and communities along this shore. However, the most striking feature of the Ohio coastline and Ohio's use of Lake Erie is its diversity. The ports of Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport Harbor, Ashtabula and Conneaut ship a combined total of over 100 million tons of cargo per year. The Lake Erie coast is the home of Republic Steel, Jones and Laughlin Steel, American Ship Building, Morton Salt, Standard Oil of Ohio and 18 electric power plants including two nuclear plants and the largest fossil fueled plant in the world. Over 11 million people use Lake Erie for their drinking water supply; the largest swimming beach on the lake is in Mentor, Ohio; the resurgence of the walleye has made Lake Erie the "Walleye Capital of the World" and caused boaters to flock to her shores; the fisheries harvests are greater than those from the other four Great Lakes combined; and one of the largest amusement parks in the country is at Cedar Point near Sandusky. Since the beginning of the Ohio Sea Grant Program, the Advisory Service has acted as the program interface with the diverse community described above.

The Ohio Sea Grant Advisory Service was first suggested in 1974 in the final report of the "Governor's Task Force on Lake Erie Area Fisheries," (a task force composed of sport fishermen, commercial fishermen, and personnel from the Ohio Division of Wildlife, OSU, USFWS, and NMFS) which stated, "the long term productivity and profitability of the commercial fishing industry may be served through product and market development and economic information provided by OSU and the advisory service of an active Sea Grant Program."

GOAL

The goal of the Ohio Sea Grant Advisory Service is to maximize the development of and benefits from the resources of Lake Erie, the other Great Lakes and oceans. This is to be accomplished through educational and service programs.

STRUCTURE

Relationship to the Ohio Cooperative Extension Service

The Advisory Service came into being in the fall of 1978 with our first Sea Grant award. At that time, the program had one full-time agent and operated separately from the Ohio Cooperative Extension Service (OCES). A formal agreement to link the two organizations was reached in early 1980; that fall, two new agents were hired.

Ohio is divided into 88 counties. OCES groups these counties into 10 geographical areas (Figure 4) and has four major program areas -- agriculture, home economics, 4-H and community and natural resources development (CNRD). Each county and each geographical area can have agents from each of these program areas. The third tier of support above the county and area agents are state specialists who are located primarily on the Columbus campus and are part of the individual departments within the College of Agriculture and Home Economics at OSU.

Eight of the 88 Ohio counties border Lake Erie. These eight counties are in three of the 10 areas, and it is into these three areas that the agents were placed. Their title is Area Extension Agent, Sea Grant, and they are on regular tenure track appointments within OCES and OSU. The first Sea Grant Agent, Fred Snyder, moved from his office in Sandusky in October 1980 to the Fremont Area Extension Center. The second agent, Dave Kelch, was hired for the Wooster Area Extension Center in November 1980 but was placed within the Lorain County Extension Center in Elyria, Ohio which is in closer proximity to the coastline. The third agent, Frank Lichtkoppler, began working in the Lake County Extension Center in Painesville, Ohio within the Canfield Area in February 1981.

Specialist Support

Sea Grant agents have access to all of the specialists within OCES. In addition, Sea Grant researchers from other colleges within the University serve as subject matter specialists thereby augmenting the OCES specialists. Personnel from the Ohio Department of Natural Resources (ODNR) have also served as subject matter specialists, primarily within the Divisions of Geological Survey (erosion), Wildlife (fisheries), Water (CZM) and Natural Areas and Preserves (estuaries). When the personnel from CLEAR, of which Sea Grant is a part, are added, the agents have a very broad supporting network of subject matter specialists which they can and have used frequently.

OHIO COOPERATIVE EXTENSION SERVICE
THE OHIO STATE UNIVERSITY

Figure 4

EXTENSION AREAS

Personnel

The Ohio Sea Grant Advisory Service operates with a half-time program coordinator, three full-time agents and 10 percent time of a CNRD agent:

Staff	Man Months
Mr. David O. Kelch, Area Extension Agent, Sea Grant	12.0
Mr. Frank R. Lichtkoppler, Area Extension Agent, Sea Grant	12.0
Dr. Jeffrey M. Reutter, Coordinator and Fisheries/Limnology Specialist	6.0
Mr. Raymond A. Schindler, Area Extension Agent, CNRD and Sea Grant	1.2
Mr. Frederic L. Snyder, Area Extension Agent, Sea Grant	12.0

The Advisory Service can use all specialists within OCES. To date, specialists within the Division of Fisheries and Wildlife Management and the Department of Agriculture Economics and Rural Sociology have been used most frequently. Within Sea Grant and CLEAR, the most frequently used specialists have been coastal engineers, economists, limnologists and fisheries biologists.

SELECTED ACCOMPLISHMENTS

Table 7 summarizes some of the activities of the program during the past two and one-half years. A discussion of some of the more significant accomplishments from September 1978 to the present follows.

Advisory Committees

One of the most important accomplishments was the formation of formal advisory committees for each of the agents. Each agent was able to get the support of an influential and energetic group of citizens from his geographical area representing a diverse set of interests in Lake Erie. These are advisory committees, and not boards of directors. The functions of the committees are to:

1. legitimize and lend credibility to activities;
2. provide technical and socio-economic guidance;
3. advise on program and area needs;
4. prioritize Sea Grant activities;
5. help conduct programs; and
6. evaluate programs.

The committees are active. The members of the committees volunteer their time and are doing more than simply rubber-stamping Sea Grant suggestions. Each member:

1. receives information;
2. reacts to proposals;
3. initiates proposals;
4. makes decisions; and
5. helps in the execution of activities.

Every year each agent has been successful in strengthening his advisory committee. The Advisory Service also received support in this effort from Edward H. Jennings, President of The Ohio State University. President Jennings sent each member of the Sea Grant Extension Advisory Committees a personal letter thanking them for their time and effort, reaffirming the University's committment to protecting, developing and utilizing the resources of Lake Erie, and assuring them that their ideas and opinions were very valuable to both the Sea Grant Program and The Ohio State University.

The advisory committees have brought a much greater awareness of Sea Grant to the region and have already suggested modifications to several projects which have improved the efforts. These suggestions and others made by the committees will be discussed later under proposed activities for the coming year. In a way, the members of the advisory committees act as part-time agents within the community.

TABLE 7

SEA GRANT ADVISORY SERVICE FUNCTIONS 1981-1984

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
July 9, 1981	Lorain County Residents	123 Dave Kelch, Fred Snyder & Jeff Reutter	Walleye Fishing Clinic - Where, when, how to catch them; Fish Senses; Fish Preparation
July 10, 1981	General Public at Port Clinton Fish Co.'s Toledo Outlet	53 Dave Kelch	Freshwater Drum Recipes
July 11, 1981	Great Lakes Sport Fishing Council	22 Fred Snyder & Dave Kelch	Ohio Sea Grant
July 14, 1981	4-H Camp Conger	25 Fred Snyder	Aquatic Ecology Field Trip
July 14, 1981	Heidelberg YCC	40 Fred Snyder	Lake Erie Resources Problems
July 15, 1981	4-H Camp Conger	26 Fred Snyder	Aquatic Ecology Field Trip
July 15, 1981	TV 35 (Elyria)	7 Dave Kelch	Fish Preparation
July 16, 1981	Old Woman Creek Wetlands Workshop	22 Fred Snyder	Fish Production in Lake Erie Estuaries
July 21, 1981	Six Radio Tapes "WFUN" in Ashtabula	7 Frank Lichtkoppler	Lake Erie
July 22, 1981	Fairport Harbor Rod and Reel Club	10 Frank Lichtkoppler	Lake Erie and Sea Grant
July 30, 1981	Wellington, Ohio Kiwanis Club	24 Dave Kelch	Ohio Sea Grant and Lake Erie
August 4, 1981	4-H Camp at Kelley's Island	146 Fred Snyder	Aquatic Biology and Geological History Presentations
August 10, 1981	Youth Conservation Corps	51 Fred Snyder	Fishes of Old Woman Creek
August 15, 1981	Lindy-Li'l Joe Walleye Tournament	400 Fred Snyder, Dave Kelch & Frank Lichtkoppler	Judging
August 20, 1981	Fremont Ohio Kiwanis	36 Fred Snyder	The Ohio Sea Grant Program
September 10, 1981	Lake County residents	300 Fred Snyder, Dave Kelch & Frank Lichtkoppler	Trout and Salmon Seminar
Sept. 11-12, 1981	Lucas County Teachers	22 Fred Snyder	Teacher Development Seminar
September 18, 1981	Ottawa County 5th Grade Classes	535 Fred Snyder	Marsh Ecology
Sept. 25-26, 1981	Ohio Charter Captains	40 Fred Snyder, Jeff Reutter, Dave Kelch, Frank Lichtkoppler and Ed Herdendorf	Business Meeting Seminar
Sept. 28-29, 1981	Ohio Coop. Extension Service	18 Fred Snyder, Jeff Reutter & Ed Herdendorf	The Lake Erie Program
October 23, 1981	Baldwin Wallace College Students	13 Fred Snyder	Fishes of Old Woman Creek
October 25, 1981	Firelands Audubon Society	8 Fred Snyder	Field Studies at Sheldon Marsh
October 27, 1981	Firelands Audubon Society	37 Fred Snyder	Estuarine Fishes
November 3, 1981	Ohio Park and Recreation Association	35 Fred Snyder	The Ohio Sea Grant Program
November 4, 1981	Ohio Park and Recreation Association	28 Fred Snyder	Aquatic Ecology
November 5, 1981	St. Mary's High School (Sandusky)	25 Fred Snyder	Career Counseling
November 17, 1981	Wood County Science Students	210 Fred Snyder	Career Counseling
November 18, 1981	Ohio Fish Consumers Association	62 Fred Snyder & Dave Kelch	Organizational Advice
November 23, 1981	Berlin-Milan Middle School	48 Fred Snyder	Lake Erie Ecology
November 25, 1981	Port Clinton Kiwanis	33 Fred Snyder	The Ohio Sea Grant Program
December 1, 1981	General Public	102 Fred Snyder	Old Woman Creek Grounds-Breaking
December 2, 1981	PSA - WTOL-TV, Toledo	Thousands Fred Snyder	Ice Safety
December 2, 1981	PSA - WTOL-TV, Toledo	Thousands Fred Snyder	Sea Grant Newsletter
Dec. 3-4, 1981	Findlay Area Teachers	47 Fred Snyder	Lake Erie Resources
Dec. 5-7, 1981	Marine Management Conference	53 Fred Snyder & Ed Herdendorf	Marine Technology
December 8, 1981	Berlin-Milan Middle School	56 Fred Snyder	Lake Erie Ecology
December 8, 1981	Izaak Walton League	18 Fred Snyder	Ohio Sea Grant Program
December 10, 1981	Ohio Society of Professional Engineers	34 Fred Snyder	OSU Lake Erie Program
December 12, 1981	Lake Erie Charter Boat Association	150 Fred Snyder & Dave Kelch	Award Banquet
January 7, 1982	Berlin-Milan Middle School	52 Fred Snyder	Lake Erie Ecology
January 7, 1982	Lorain County Ice Fishermen	95 Dave Kelch	Ice Fishing Clinic
February 8, 1982	Horizon Garden Club	12 Dave Kelch	Estuaries
January 12, 1982	Cuyahoga County Ice Fishermen	125 Dave Kelch	Ice Fishing Clinic
Jan. 15-25, 1982	Cleveland Boat Show	Thousands Fred Snyder, Dave Kelch & Frank Lichtkoppler	Ohio Sea Grant Booth
January 20, 1982	Izaak Walton League	15 Fred Snyder	Tournament Planning
January 26, 1982	Toledo Sport Fishermen	80 Fred Snyder	Ice Fishing Clinic

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
February 6, 1982	League of Ohio Sportsmen	150 Jeff Reutter	Sensory Perception in Fish
February 8, 1982	Ohio Fish Producer's Association	45 Fred Snyder, Dave Kelch & Jeff Reutter	Update Sea Grant Activities
February 10, 1982	Fremont Area 4-H Agents	12 Fred Snyder	Propose New Projects
February 13, 1982	Sciota Bass Anglers	80 Jeff Reutter	Ohio State University Lake Erie Research
February 16, 1982	Ohio Commercial Fishermen	16 Fred Snyder & Dave Kelch	Discuss New Markets
February 17, 1982	PSA - WTOL-TV, Toledo	Thousands Fred Snyder	Sea Grant Education Assistance
February 17, 1982	PSA - WTOL-TV, Toledo	Thousands Fred Snyder	Sea Grant Research
February 18, 1982	Sandusky School Administration	17 Fred Snyder	Propose Education Programs
February 19, 1982	Ohio Fish & Wildlife Conference	75 Fred Snyder	Submit Resolutions
February 22-26, 1982	Louisiana Bait Dealers	20 Fred Snyder & Dave Kelch	Market Development
February 26-28, 1982	Fairport Sport Show	Hundreds Frank Lichtkoppler	Ohio Sea Grant Booth
March 2, 1982	Lorain County Fishermen	175 Dave Kelch	Steelhead Fishing Clinic
March 4, 1982	Columbus Power Squadron	75 Jeff Reutter	Lake Erie Fisheries
March 5, 1982	Ivy House Residents	25 Frank Lichtkoppler	Ohio Sea Grant/Lake Erie
March 9, 1982	Cuyahoga County Fishermen	225 Dave Kelch	Steelhead Fishing Clinic
March 9, 1982	Ashtabula Co. Soil and Water Water Conservation District	25 Frank Lichtkoppler	Ohio Sea Grant
March 9, 1982	Oakland Park Conservation Club	60 Jeff Reutter	Ohio State University Lake Erie Program
March 10, 1982	Eastlake City Council	6 Frank Lichtkoppler	Lake Erie Boat Ramp Design
March 10-14, 1982	North Olmstead Mall Outdoor Show	625 Dave Kelch	Booth and Fish Preparation Demonstrations
March 11, 1982	Westlake Sportsmen's Club	42 Dave Kelch	Ohio Sea Grant
March 12, 1982	Mansfield Teachers Workshop	49 Jeff Reutter	Lake Erie Water Quality
March 15-19, 1982	Great Lakes Mall Show	Hundreds Frank Lichtkoppler	Sea Grant Exhibit
March 16, 1982	Toledo Vocational Agriculture Students	44 Fred Snyder	Lake Erie Ecology
March 17, 1982	Dayton Area Home Economics Agents	35 Dave Kelch	Fish Preparation
March 17, 1982	Lake Erie Fishing Clinic-Dayton	450 Fred Snyder, Dave Kelch & Jeff Reutter	When, Where and How to Fish on Lake Erie
March 17, 1982	Radio Station WPVL, Ashtabula	Thousands Frank Lichtkoppler	Five 1-minute radio tapes on Lake Erie and Sea Grant
March 18, 1982	Conneaut Chamber of Commerce	56 Frank Lichtkoppler	Lake Erie/Ohio Sea Grant
March 19-20, 1982	Northeast Ohio Teachers Workshop	28 Frank Lichtkoppler	OEAGLS/Sea Grant
March 19-21, 1982	Ohio Outdoor Writers	46 Dave Kelch	
March 19, 1982	Cleveland Sport Show	Thousands Dave Kelch, Frank Lichtkoppler, Fred Snyder & Jeff Reutter	Sea Grant Exhibit
March 22, 1982	Elyria High School Biology Class	36 Dave Kelch	Lake Erie Ecology
March 22, 1982	Fremont Area Agriculture Agents	8 Fred Snyder	Sea Grant Program Update
March 24, 1982	Lucas County High School Students	84 Fred Snyder	Career Counseling
March 25, 1982	Delaware County Home Economists	175 Dave Kelch	Fish Preparation Demonstrations
March 25, 1982	Western Reserve Federation of Conservationists	20 Frank Lichtkoppler	Lake Erie Fisheries
March 27, 1982	Joint Meeting of Three Advisory Committees	28 Dave Kelch, Frank Lichtkoppler, Fred Snyder & Jeff Reutter	Ohio Sea Grant and Congressional Day
March 28, 1982	Chagrin River Salmon Association	35 Frank Lichtkoppler	Lake Erie Fisheries
March 31, 1982	Lake County Extension Advisory Committee	20 Frank Lichtkoppler	Sea Grant Update in Northeast Ohio
April 1, 1982	Lorain County Sportsfishermen	146 Dave Kelch	Smallmouth Bass Fishing Clinic
April 2, 1982	Padua Franciscan High School	20 Dave Kelch	Lake Erie Fisheries
April 3, 1982	Padua Franciscan High School	24 Dave Kelch	Limnology Field Trip
April 3, 1982	Henry County Sportsfishermen	98 Fred Snyder	Lake Erie Fishing Clinic
April 4, 1982	Rock Creek Conservation Club	31 Frank Lichtkoppler	Lake Erie and Sea Grant
April 5, 1982	Lakefront Real Estate Appraisers	70 C.E. Herdendorf, Frank Lichtkoppler, & Keith Bedford	Lake Erie Coastal Erosion
April 8, 1982	General Public Northeast Ohio	30,000 Frank Lichtkoppler	Five 1-minute programs on Radio WFUN
April 10, 1982	Ohio Sportsmen at Alladin Temple Shrine	300 Jeff Reutter and Bill Snyder	Sea Grant Exhibit
April 13, 1982	Fishing Tackle Representatives	8 Jeff Reutter	Fishery Promotion Program
April 14, 1982	Painesville High School Students	125 Frank Lichtkoppler	Marine Careers
April 20, 1982	Ohio Parks and Recreation Association	34 Fred Snyder	Aquatic Education Concepts

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
April 21, 1982	Lorain County Ducks Unlimited	21 Dave Kelch	Waterfowl Problems on Lake Erie
April 22, 1982	Huron High School Students	42 Fred Snyder	Lake Erie Management
April 22-23, 1982	Hocking Technical College	28 Fred Snyder	Commercial Fishing Workshop
April 25, 1982	Lucas County Fishermen	68 Fred Snyder	Walleye and White Bass Fishing Clinic
April 26, 1982	Lakeland Community College Students	35 Frank Lichtkoppler	Lake Erie Fisheries Economics
April 29, 1982	Padua High School	24 Dave Kelch	Old Woman Creek Field Trip
May 1, 1982	Ohio Audubon Council	94 Fred Snyder	Ecology of Lake Erie
May 2, 1982	Ohio Audubon Council	48 Fred Snyder	Natural History Tour of South Bass Island
May 3, 1982	General Public Northeast Ohio	30,000 Frank Lichtkoppler	Five 1-minute broadcasts on Radio WFUN
May 4, 1982	Margaretta School Administration	5 Fred Snyder	Program Planning
May 5, 1982	Red Bird Middle School	100 Frank Lichtkoppler	Marine Education
May 6, 1982	Lorain County Sportsfishermen	166 Dave Kelch	Walleye Fishing Clinic
May 6, 1982	Ohio State University Sierra Club	15 Jeff Reutter	Pollution and Lake Erie
May 7, 1982	Fremont Area EFNEP Aides	12 Fred Snyder	Fish Preparation
May 7, 1982	Red Bird Middle School	125 Frank Lichtkoppler	Marine Education
May 7, 1982	Polish Fishermen's Club	39 Dave Kelch	Sea Grant Research
May 8, 1982	Holden Arboretum	25 Frank Lichtkoppler	Marine Careers
May 11-13, 1982	Site Review Team	50 Entire Staff	Presentations on all projects
May 12, 1982	Central Ohio Fishermen	95 Dave Kelch, Frank Lichtkoppler, Fred Snyder & Jeff Reutter	Lake Erie Fishing Clinic
May 13, 1982	Padua High School	22 Dave Kelch	Stone Lab Field Trip
May 18, 1982	Lake County Soil and Water Conservation District	10 Frank Lichtkoppler	Ohio Sea Grant
May 20, 1982	Erie County Naturalists	27 Fred Snyder	Fishes of Old Woman Creek
May 20, 1982	Cuyahoga County Sportsfishermen	175 Dave Kelch	Walleye Fishing Clinic
May 20, 1982	Northeast Ohio General Public	25,000 Frank Lichtkoppler	Five 1-minute Radio broadcasts WPVL
May 20, 1982	Camp Issac Joques	225 Frank Lichtkoppler	Lake Erie
May 23, 1982	Mentor Marsh Board	12 Frank Lichtkoppler	Hidden Secrets of the Marsh
May 24, 1982	Lake County Extension Advisory Committee	12 Frank Lichtkoppler	Ohio Sea Grant
May 24, 1982	Sheffield Lake Lions Club	50 Dave Kelch	Ohio Sea Grant
May 24-28, 1982	Fishing Tackle Representatives	25 Dave Kelch & Fred Snyder	Fishery Promotion Activities
May 27, 1982	Lake County Rural Development Committee	10 Frank Lichtkoppler	Sea Grant Programming
May 27, 1982	Northern Ohio General Public	Thousands Dave Kelch	T.V. 5 Broadcast
May 27, 1982	Western Reserve Federation of Conservationists	10 Frank Lichtkoppler	Lake Erie
May 29-30, 1982	Lake Erie Charter Boat Association Tournament	Hundreds Dave Kelch, Frank Lichtkoppler & Fred Snyder	Walleye Biology and Judging
June 1, 1982	Gifted and Talented Students, McKinley School, Elyria	18 Dave Kelch	Lake Erie
ne 2, 1982	Lake Erie County Senior Citizens	31 Fred Snyder	Natural History of Sandusky Bay
e 2, 1982	Gifted and Talented Students, Windsor School, Elyria	21 Dave Kelch	Lake Erie
June 3, 1982	Berea Home Economists	37 Dave Kelch	Fish Preparation
June 4, 1982	Madison Memorial Middle School	78 Frank Lichtkoppler	Lake Ecology
June 4, 1982	Gifted and Talented Students, Jefferson School, Elyria	25 Dave Kelch	Lake Erie
June 6, 1982	League of Ohio Sportsmen	39 Jeff Reutter & Charles Herdendorf	Lake Erie Fisheries and Phosphorus
June 7, 1982	Geneva Schools, 6th Grade	304 Frank Lichtkoppler	Lake Ecology
June 9, 1982	Ashtabula County Sportsfishermen	160 Frank Lichtkoppler & Dave Kelch	Walleye Workshop
June 9, 1982	Cincinnati Businessmen's Club-Fin and Feathers	19 Jeff Reutter	Lake Erie Fisheries
June 10, 1982	Cleveland General Public	Thousands Dave Kelch	TV 5 Cleveland-Lake Erie
June 11, 1982	Erie County Students	53 Fred Snyder	Lake Erie Ecology
June 11, 1982	Elyria General Public	Thousands Dave Kelch	TV 35 Elyria-Lake Erie
June 13, 1982	Northeast Ohio Coastal Residents	25 Frank Lichtkoppler	Beach Walk
June 14 and 16, 1982	Lorain County Youth	70 Dave Kelch	Fishing Clinic
June 16, 1982	Municipal Officials	36 Frank Lichtkoppler	Coastal Littering
June 17, 1982	Northwest Ohioans	Thousands Fred Snyder	Congressional Day Talks on Radio WLEC, WOSE, WSPD

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
June 17, 1982	Ashtabula County Sportsfishermen	33 Frank Lichtkoppler & Dave Kelch	Fish Preparation
June 18-19, 1982	Congressional Representatives and Aides	50 Staff	Values of Lake Erie
June 24, 1982	Fremont Area 4-H	82 Fred Snyder	Tackle Making
June 24, 1982	General Public Northeast Ohio	30,000 Frank Lichtkoppler	Five 1-minute Radio broadcasts WFUN
June 24, 1982	General Public Northeast Ohio	25,000 Frank Lichtkoppler	Five 1-minute Radio broadcasts WPVL
June 25-26, 1982	League of Ohio Sportsmen Walleye Tournament	1,000 Dave Kelch & Fred Snyder	Walleye Biology and Judging
June 26, 1982	Medicinal Chemistry Graduate Symposium	250 Dave Kelch & Frank Lichtkoppler	Walleye Fishing Clinic
June 30, 1982	Northwest Ohioans	Thousands Fred Snyder	Noon News, WTVG-TV, Toledo-Lake Erie Walleye Fishing
July 1, 1982	Mentor Marsh Students	12 Frank Lichtkoppler	Marsh Ecology
July 1-2, 1982	Kelley's Island 4-H Youth	80 Dave Kelch	Lake Erie Ecology
July 5, 1982	Anchors Away Marina	39 Dave Kelch	Fish Preparation
July 7, 1982	Clevelanders-WCLV Radio	Thousands Dave Kelch	Lake Erie Fisheries
July 9, 1982	Ohio State University Board of Trustees	40 Jeff Reutter & Charles	Ohio State University Research and Value of Lake Erie
July 9, 1982	Elyria - TV 35	Thousands Dave Kelch	Ohio Sea Grant
July 15, 1982	Fremont Area Extension Agents	12 Fred Snyder	Bait Market Development
July 16, 1982	Cuyahoga County Commissioners Day	150 Dave Kelch	Fish Preparation
July 16, 1982	Interview on Radio WFUN	10,000 Frank Lichtkoppler	Beach Ecology
July 17, 1982	Northeast Ohio Coastal Residents	25 Frank Lichtkoppler	Beach Walk
July 19-20, 1982	Kelley's Island 4-H	55 Dave Kelch	Aquatic Education Programs
July 22, 1982	WTOL-TV Toledo	Thousands Fred Snyder	Marine Construction Permits and Hypothermia
July 22, 1982	Elyria Kiwanis Club	55 Dave Kelch	Lake Erie
July 23, 1982	Ottawa County Fishermen	112 Fred Snyder	Lake Erie Walleye Clinic
July 26, 1982	Amherst Rotary Club	62 Dave Kelch	Lake Erie
July 29, 1982	Radio Station WPVL-5 tapes	25,000 Frank Lichtkoppler	Lake Erie
July 30, 1982	Fremont Exchange Club	33 Fred Snyder	Bait Market Development
August 2-8, 1982	Ashtabula County Fair	Hundreds Frank Lichtkoppler	Sea Grant Exhibit
August 4, 1982	Sandusky CAC Interns	8 Fred Snyder	Natural History of South Bass Island
August 4, 1982	Ducks Unlimited-Lorain County	20 Dave Kelch	Steel Shot
August 5, 1982	Old Woman Creek Staff	6 Fred Snyder	Field Collection Training
August 6, 1982	Stone Lab Fish Ecology Class	8 Fred Snyder & Jeff Reutter	Field Trip
August 12, 1982	Stone Lab Guest Lecture	40 Jeff Reutter	Homothermia and Cold Water Drowning
August 9-15, 1982	Cuyahoga County Fair	Thousands Dave Kelch	Sea Grant Display and Fish Preparation
August 12, 1982	WOBL Radio-Oberlin	Thousands Dave Kelch	Ohio Sea Grant
August 13, 1982	TV 35- Elyria	Thousands Dave Kelch	Sea Grant Fact Sheets
August 18, 1982	Stone Lab Fish Ecology Class	8 Fred Snyder & Jeff Reutter	Field Trip
August 19, 1982	OCES Administrators	12 Frank Lichtkoppler	Lake Erie Erosion
August 21-29, 1982	Lake County Fair	Hundreds Frank Lichtkoppler	Sea Grant Exhibit
August 23-29, 1982	Lorain County Fair	Hundreds Dave Kelch	Sea Grant Exhibit
August 24-25, 1982	Sandusky School Administrators	26 Fred Snyder	Aquatic Education Inservice
August 26, 1982	Radio Station WPVL-5 tapes	25,000 Frank Lichtkoppler	Lake Erie and Sea Grant
August 26, 1982	Radio Station WFUN-5 tapes	30,000 Frank Lichtkoppler	Lake Erie and Sea Grant
August 27, 1982	TV 35-Elyria	Thousands Dave Kelch	Sea Grant Fact Sheets
August 31, 1982	Ruggles Beach Association	20 Frank Lichtkoppler & Dave Kelch	Coastal Erosion
September 1, 1982	Radio Station WOBL-Oberlin	Thousands Dave Kelch	Salmon and Trout Clinic
September 2, 1982	ARES, Inc.	7 Fred Snyder & Jeff Reutter	Firing Range Useage
September 3, 1982	TV 35-Elyria	Thousands Dave Kelch	Sea Grant and Salmon Fishing
September 7, 1982	Cuyahoga County Sportsfishermen	192 Dave Kelch	Salmon and Trout Clinic
September 8, 1982	Lake County Sportsfishermen	225 Frank Lichtkoppler & Fred Snyder	Salmon and Trout Clinic
September 9, 1982	Fremont Area 4-H Agents	9 Fred Snyder	Proposed Aquaculture Project
September 10-12, 1982	Bexley Junior High School	32 Fred Snyder	Aquatic Biology Workshop
September 15, 1982	Ashtabula County Sportsfishermen	155 Frank Lichtkoppler & Fred Snyder	Salmon and Trout Clinic
September 17, 1982	Ottawa County 5th Grade	550 Fred Snyder	Marsh Conservation Tour
September 19, 1982	Northeast Ohio Coastal Residents	26 Frank Lichtkoppler	Waves and Beaches/Beach Walk
September 21, 1982	Port Clinton Rotary	36 Fred Snyder	Bait Market Development
September 21-23, 1982	Farm Science Review	300 Jeff Reutter	Seafood Utilization Tour

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
September 22, 1982	Talkback Radio Show-WFUN	10,000 Frank Lichtkoppler	Coastal Drive-it-Yourself
September 23, 1982	TV 35-Elyria	Thousands Dave Kelch	Sea Grant Information
September 23, 1982	Camp Perry Range Officials	5 Fred Snyder	Firing Range Useage
September 25, 1982	WJW Radio-Cleveland	Thousands Dave Kelch	Lake Erie Discussion with D'Arcy Egan
September 25, 1982	Isaac Walton League and General Public	85 Fred Snyder	Sea Grant Exhibit
September 29, 1982	Mayfield Junior High School	39 Dave Kelch & Fred Snyder	Aquatic Biology Workshop
October 1, 1982	Charter Fishermen	10 Fred Snyder	Improvement of Toussaint Harbor
October 3, 1982	Northeast Ohio Coastal Residents	150 Frank Lichtkoppler	Drive-it-Yourself Tour
October 5, 1982	WOBL Radio-Oberlin	Thousands Dave Kelch	Lake Erie
October 5, 1982	Vermilion Lion's Club	46 Dave Kelch	Sea Grant
October 5, 1982	Lorain County Waterfront Hunters Association	26 Dave Kelch	Safety and Steel Shot
October 5, 1982	Isaac Walton League	6 Fred Snyder	Tournament Planning
October 7, 1982	Westlake Sportsmen's Club	43 Dave Kelch	Lake Erie
October 7, 1982	WPVL Radio-5 tapes	25,000 Frank Lichtkoppler	Sea Grant Update
October 7, 1982	Ashtabula County Extension Advisory Committee	15 Frank Lichtkoppler	Sea Grant Update
October 8, 1982	Lorain County Teachers	300+ Dave Kelch	Marine Education
October 8-9, 1982	Sandusky Teachers	14 Fred Snyder	Aquatic Education Workshop
October 11, 1982	Camp Terry Officials	6 Fred Snyder	Firing Range Warning Tests
October 12, 1982	Sandusky County 5th Grade	375 Fred Snyder	County Conservation Tour
October 13, 1982	Orain County Hunters	56 Fred Snyder	Waterfowl Hunting and Safety
October 13, 1982	Marion Power Squadron	43 Fred Snyder	Bait Market Development
October 14, 1982	Northeast Ohio Coastal Property Owners	7 Frank Lichtkoppler	Coastal Erosion
October 14, 1982	New Sea Grant Advisory Program Committee	9 Jeff Reutter	Ways to Save Money on Research Projects
October 14-15, 1982	Municipal Officials	40 Frank Lichtkoppler & C.E. Herdenhorf	Coastal Erosion
October 20, 1982	Ohio Cooperative Extension Agents	18 Dave Kelch, Frank Lichtkoppler, Fred Snyder & Jeff Reutter	Lake Erie Fish Utilization
October 22, 1982	General Public-Erie County	Hundreds Fred Snyder	Congressional Breakfast
October 27, 1982	Lorain and Cuyahoga County Hunters	135 Dave Kelch	3 Safety Clinics
October 28, 1982	Coastal Property Owners	7 Frank Lichtkoppler	Waves and Beaches
October 29, 1982	Northeast Ohio School Teachers	38 Frank Lichtkoppler	Lake Erie
October 30, 1982	Northeast Ohio School Teachers	38 Frank Lichtkoppler	Know Your Local Fish
November 3, 1982	WFUN Radio - 6 tapes	36,000 Frank Lichtkoppler	Lake Erie and Sea Grant
November 4, 1982	Coastal Property Owners	8 Frank Lichtkoppler	Coastal Erosion
November 6, 1982	Sandusky School Administration	6 Fred Synder	Seminars for Teachers
November 9, 1982	WPUG Radio - 5 tapes	25,000 Frank Lichtkoppler	Lake Erie and Sea Grant
November 9, 1982	American Walleye Association	20 Frank Lichtkoppler	Lake Erie Fisheries
November 15, 1982	Ashtabula City Council	12 Frank Lichtkoppler	Lake Erie and Sea Grant
November 16, 1982	Perry Township Trustees	10 Frank Lichtkoppler	Lake Erie/Sea Grant/Erosion
November 17, 1982	WTVG-TV Toledo	Thousands Fred Synder	Hypothermia
November 18, 1982	Notre Dame Academy	12 Fred Synder	Pollution
November 18, 1982	Fairport Rod and Reed Association	128 Frank Lichtkoppler	Lake Erie
November 20, 1982	Erie Co. Students	33 Fred Synder	Pollution
November 23, 1982	Painesville Twp. Trustees	8 Frank Lichtkoppler	Lake Erie Erosion and Sea Grant
November 24, 1982	Maumee City School Teachers	54 Fred Synder	Sea Grant Education Programs
November 29, 1982	N.E. Ohio Citizens	30 Frank Lichtkoppler	Hazardous Waste
November 30, 1982	Berlin-Milan Students	26 Fred Snyder	Phosphorus in Lake Erie
December 1, 1982	Vacationland Marine Trades Association	42 Fred Snyder	Economic Value of Lake Erie
December 2, 1982	N.E. Ohio Science Teachers	25 Frank Lichtkoppler	Teaching Aquatic Education
December 6, 1982	Fairport City Council	28 Frank Lichtkoppler	Lake Erie Erosion and Sea Grant
December 7, 1982	Lorain County Commissioners	23 Dave Kelch	Lake Erie and Sea Grant
December 7-8, 1982	Northern Ohio Teachers	35 Dave Kelch	Marine and Aquatic Education
December 8, 1982	Corps of Eng. Public Hearing	275 Dave Kelch	Breakwall Waterford Blinds
December 9, 1982	Ashtabula County Extension Committee	16 Frank Lichtkoppler	Sea Grant Update
December 9, 1982	Elyria Fire Department-Shift 1	32 Dave Kelch	Cold Water Near Drowning
December 9, 1982	American Walleye Association Cleveland Westside Chapter	29 Dave Kelch	Lake Erie

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
December 11, 1982	Rod Makers Shoppe	52 Dave Kelch	Rods
December 13, 1982	Berlin - Milan Students	28 Fred Snyder	Phosphorus and Lake Erie
December 13-16, 1982	Erie and Ottawa Co. Officials	32 Fred Snyder and Dave Kelch	Development of a Fish Protein Plant
December 14, 1982	Mentor-on-the-Lake City Council	30 Frank Lichtkoppler	Lake Erie Erosion
December 14, 1982	WFUN Radio-8 tapes	48,000 Frank Lichtkoppler	Lake Erie
December 16, 1982	Fairport Rod and Reel Association	138 Frank Lichtkoppler	Sand Dredging
December 16, 1982	Elyria Fire Department-Shift 2	35 Dave Kelch	Cold Water Near Drowning
December 17, 1982	Elyria Fire Department-Shift 3	29 Dave Kelch	Cold Water Near Drowning
December 17, 1982	Marine Operators	6 Fred Snyder	Harbor Improvement
December 19, 1982	Fishing Tackle Dealers	24 Fred Snyder & Dave Kelch	Fishery Promotion
December 20, 1982	Fairport Harbor Port Authority	6 Frank Lichtkoppler	Lake Erie and Sea Grant
December 21, 1982	Lake Co. Rural Dev. Com.	12 Frank Lichtkoppler	Lake Erie and Sea Grant
December 22, 1982	League of Ohio Sportsmen	9 Dave Kelch	Quota Management
December 29, 1982	Interagency Meeting	15 Frank Lichtkoppler	Lake Erie Harbor Dredging
December 31, 1982	WJW Radio--2 hour talk-show	Thousands Dave Kelch	Lake Erie
January 6, 1983	Lorain Co. Extension Advisory Committee	18 Dave Kelch	Ohio Sea Grant
January 6, 1983	WFVL Radio - 5 tapes	25,000 Frank Lichtkoppler	Lake Erie
January 6, 1983	Berlin - Milan Students	27 Fred Snyder	Phosphorus in Lake Erie
January 8, 1983	Charter Boat Captains	19 Fred Snyder	Tournament Planning
January 11, 1983	Gates Mills School Admin.	6 Fred Snyder	Inservice Development
January 12, 1983	Vermilion Rotary Club	39 Dave Kelch	Lake Erie
January 13, 1983	Northwest Ohio Teachers	54 Fred Snyder	Ohio Sea Grant
January 14, 1983	Northwest Ohio Teachers	54 Fred Snyder	PCB's in Lake Erie
January 18, 1983	North Ridgeville Fire Department	10 Dave Kelch	Cold Water Near Drowning
January 19, 1983	North Ridgeville Fire Department	12 Dave Kelch	Cold Water Near Drowning
January 19, 1983	WTOL-TV Toledo	Thousands Fred Snyder	Ice Safety
January 22, 1983	N. E. Ohio Teachers	25 Frank Lichtkoppler	What's Happening Under the Ice
January 24, 1983	Ottawa Co. Officials	18 Fred Snyder	Harbor Improvement
January 26, 1983	Division of Wildlife	27 Jeff Reutter, Fred Snyder, Frank Lichtkoppler and Dave Kelch	Ohio Sea Grant
January 26, 1983	Ducks Unlimited	35 Dave Kelch	Artificial Reefs
January 27, 1983	WFUN Radio - 1 tape	6,000 Frank Lichtkoppler	Lake Erie Ice
January 27, 1983	Lake County Rural Development Committee	20 Frank Lichtkoppler	Lake Erie
January 29, 1983	Lorain County Teachers	31 Dave Kelch	OEAGLS
February 1, 1983	North Ridgeville Fire Department	15 Dave Kelch	Cold Water Near Drowning
February 3, 1983	WKBL Radio	Thousands Dave Kelch	Cold Water Near Drowning
February 3, 1983	Lubrizol, Inc.	6 Frank Lichtkoppler	Hazardous Waste
February 10, 1983	American Walleye Association	35 Dave Kelch	Artificial Reefs
February 11, 1983	Lubrizol, Inc.	10 Frank Lichtkoppler	Hazardous Waste
February 14, 1983	WFUN Radio - 1 tape	6,000 Frank Lichtkoppler	Lake Erie Fishing
February 14, 1983	Ohio Fish Producers Association	70 Fred Snyder & Dave Kelch	Fish Protein Plant
February 16, 1983	Lorain County Economic Development Committee	14 Dave Kelch	Lake Erie Economic Value
February 17, 1983	Coast Guard Auxilliary	27 Jeff Reutter	Lake Erie as a Resource
February 17, 1983	WFVL - Radio 5 tapes	25,000 Frank Lichtkoppler	Lake Erie
February 17, 1983	Fremont Area Ext. Agents	26 Fred Snyder	Sea Grant Coop.
February 18, 1983	Lorain County Economic Development Committee	18 Dave Kelch	Artificial Reefs
February 18-20, 1983	Great Ohio Outdoor Show	Thousands Dave Kelch	Lake Erie
February 21, 1983	Fremont Area Advisory Committee	50 Fred Snyder	Sea Grant Activities
February 22, 1983	Cub Scount Pack 117	146 Dave Kelch	Lake Erie
February 22, 1983	Sheffield Lake City Council	159 Dave Kelch	Artificial Reefs and Boat Ramps
February 23, 1983	Lorain County Economic Development Committee	15 Dave Kelch	Artificial Reefs and Boat Ramps
February 23, 1983	Vermilion Rotary Club	46 Dave Kelch	Artificial Reefs and Boat Ramps
February 23, 1983	WTVG - TV - Toledo	Thousands Fred Snyder	Marsh Research
February 26-27, 1983	General Public-Sport Show	10,000 Frank Lichtkoppler & Dave Kelch	Lake Erie Fishes

TABLE 7 CONTINUED

DATE	GROUP OR AUDIENCE	NUMBER OF ATTENDEES AND SPEAKERS	TOPIC
February 28, 1983	Lorain County Economic Development Committee	15 D. Kelch	Shoreline Development
March 1, 1983	Muskies, Inc. Cleveland Chapter	41 D. Kelch	Lake Erie/Sea Grant
March 2, 1983	Vermilion Port Authority & Mayor	16 D. Kelch	Fishing Accesses, Boat Launches
March 4, 1983	Polish Fisherman's Club-Lorain	53 D. Kelch	Artificial Reefs
March 7, 1983	Reef Committee	12 D. Kelch F. Snyder F. Lichtkoppler	Artificial Reefs
March 7, 1983	Artificial Reef Committee/Tom Wasson	17 D. Kelch	Artificial Reefs
March 8, 1983	Great Lakes Tomorrow	35 F. Lichtkoppler	Lake Erie Resources
March 8, 1983	Vermilion Fish and Game Assoc.	125 D. Kelch	Lake Erie, Artificial Reefs and Ecology
March 8, 1983	Public-Ottawa County	75 F. Snyder	Lake Erie Walleye Clinic
March 9, 1983	TV-43, Lorain	Thousands D. Kelch	PSA, Artificial Reefs
March 9, 1983	Ducks Unlimited Lorain County Chapter	25 D. Kelch	Waterfowl, Lake Erie
March 10, 1983	Elyria High School	72 D. Kelch	Career Day: Outdoor Jobs
March 10, 1983	Defiance Area/4-H Agents	9 F. Snyder	Sea Grant 4-H Programs
March 10, 1983	John Sulpizio, Lorain Port Authority Director	4 D. Kelch	Artificial Reefs
March 10-11, 1983	Portsmouth Area Teachers	32 R. Portner & V. Mayer	Marine and Aquatic Awareness Workshop
March 11, 1983	Sandusky Elementary Teachers	16 F. Snyder	Sea Grant Education Programs
March 11, 1983	Lorain County Economic Development Committee	12 D. Kelch	Shoreline Development: When, Where and How
March 12, 1983	Western Basin Charter Boat Assoc	34 F. Snyder	Western Basin Update
March 12, 1983	General Public	72 F. Lichtkoppler	Hazardous Wastes
March 13, 1983	General Public--Logan, Ohio	35 F. Lichtkoppler D. Kelch F. Snyder J. Reutter	Lake Erie Fishing
March 15, 1983	Lake Erie Fishing Clinic	60 D. Kelch	Fish Lake Erie
March 17, 1983	Fairport B&R Assoc.	138 F. Lichtkoppler	Lake Erie Fishing
March 19, 1983	Public-Toledo Mall Show	2000 F. Snyder	Ohio Sea Grant Program
March 19-27, 1983	Cleveland Sports Show	00,000 D. Kelch F. Snyder J. Reutter F. Lichtkoppler	Lake Erie
March 20, 1983	3 Area Sea Grant Advisory Committee Meeting	40 D. Kelch	Sea Grant Programs
March 20, 1983	Tri-Area Sea Grant Advisory Meeting	30 C. E. Herdendorf J. Reutter Staff	Advisory Committee
March 23, 2983	Lorain County Economic Development Committee	129 D. Kelch	Artificial Reefs
March 25, 1983	Corps of Engineers Survey Team	6 F. Lichtkoppler	Lake Erie Coast Erosion Bottom Mapping
March 29, 1983	Artificial Reef Subcommittee	6 F. Lichtkoppler	Artificial Reef

One of the most valuable and successful efforts organized and conducted by our advisory committees in 1982 was the first "Congressional Day on Lake Erie." The committees invited both representatives and their aides for a program designed to aquaint them with the resources and values of Lake Erie and introduce them to Ohio Sea Grant. We were extremely pleased that two representatives and eight aides were in attendance. In addition to a series of brief presentations the program included a walleye fishing trip, a flight showing Lake Erie assets aboard Island Airlines' Ford Tri-motor, a tour of the Research Vessel Hydra and a question and answer session dealing with items of interest, allowing the congressional delegation to ask the experts.

In summary, input from the members of the advisory committees has been extremely valuable and has allowed the program to reach a much greater level of maturity more rapidly.

Charter Fishing

In 1981 the Lake Erie Charter Boat Association was assisted in developing and conducting two walleye fishing tournaments on Lake Erie. In addition, at the request of the association, Fred Snyder developed a two-day workshop for charter captains at F.T. Stone Laboratory at Put-in-Bay. At the workshop, Frank Lichtkoppler discussed hypothermia and cold water near-drowning, Dr. C.E. Herdendorf discussed the resources of Lake Erie, Dr. J.M. Reutter demonstrated biological field techiques, a specialist from the Department of Agriculture Economics, Dr. David Hahn, discussed "marketing your charter business," a specialist from ODNR, Carl Baker, discussed quota fisheries and ODNR stocking programs, and Dr. John L. Crites, Chairman of the Department of Zoology, discussed parasites in Lake Erie fish.

As a result of this workshop and other efforts with charter fishermen, Mr. Snyder was named "Most Valuable Person for 1981" by the Lake Erie Charter Boat Association. Many captains have redesigned business cards, changed advertisements, and reported that more people are keeping the freshwater drum. This is important to them, because every fish kept by their clients increases the value of the experience.

Fishing Clinics and Sport Shows

In an effort to increase utilization and development of our coastal and aquatic resources, and at the suggestion of advisory committees, a series of fishing clinics has been conducted. These are basic educational workshops stressing the biology of the species, the value of Lake Erie, and when, where and how to fish. The workshops have received glowing evaluations. Attendance at each has ranged from 95 to 450. Results from the evaluations indicate that the attitude of the participants toward Lake Erie has changed, their knowledge level has increased, and they all felt it was well worth their time and effort to attend.

Booth space has been donated to the Sea Grant Program yearly since 1980 at the Cleveland and Columbus Sport shows and several others. We have been fortunate in being able to obtain "Lawrence the Lake Trout" from Minnesota Sea Grant for many of these shows. These shows have been a great opportunity to disseminate information and determine public sentiment on current issues.

Erosion and Coastal Processes

In 1979, Fred Snyder, with the assistance of Agent Stan Boc from New York Sea Grant, conducted a "Floating Tire Breakwater Workshop." During the spring and summer of 1981, using the information from this workshop, the first FTB in Ohio was placed in the Port of Lorain. John Sulpizio, Director of the Port Authority and an advisory committee member, have been extremely pleased with the results.

In 1982, Frank Lichtkoppler conducted a workshop on erosion for real estate and bank appraisers. He first contacted real estate agents, but later found the information would be more valuable for appraisers. Frank formed a subcommittee of interested appraisers to help develop a one-day workshop which was so successful that all of the attendees (77) received accreditation from the appraisers association.

Frank Lichtkoppler has completed or revised the following fact sheets: "Tips for Shoreline-Protection Structure Construction and Maintenance," "Identifying Your Shoreline Erosion Problems," "Lake Erie Shore Erosion," "Waves, Beaches and Erosion," and "Permits Required for Lake Erie Erosion Abatement Works," during the past year. These were requested by shoreline land-owners on his advisory committee and have been very well received. Frank has also identified what could be the biggest breakthrough since the 1930s in reducing erosion in Lake and Ashtabula counties. It is a technique long practiced on the coasts. Each year since the 1930s, the Army Corps of Engineers has dredged the mouth of the Grand River at Fairport Harbor, Ohio and carried the material 3½ miles out into the lake for open water disposal. EPA has listed this as clean sand from the littoral drift currents along Mentor Headlands Beach and around the harbor breakwater. Frank enlisted the support of his advisory committee and ODNR to call for a public hearing to determine if this dredged material could be carried around the harbor and placed back in the littoral drift zone on the other side of the port where it would reduce erosion through beach nourishment.

As a result of Frank's activities, with the support of the Northeast Ohio Sea Grant Advisory Committee, the first sand was placed in the nearshore area during the spring of 1983. The amount dredged annually is 65,000 cubic yards.

Mass Media

During the spring of 1981 the Advisory Service hosted an Outdoor Writers Workshop at F.T. Stone Laboratory to present the most recent information on Lake Erie fisheries and water quality. As a result, these writers have been a tremendous help in increasing public awareness of the value of Lake Erie and Sea Grant. In 1982, we were requested to speak at their association meeting in Cleveland. Five outdoor writers are currently on our advisory committees. During 1982 we have also had almost 10 television shows and over 60 radio spots discussing Lake Erie, its resources and Ohio Sea Grant. These efforts have greatly increased awareness of Sea Grant and the value of Lake Erie.

Teacher Workshops

Most secondary school teachers have had little training in aquatic education, and even in coastal counties this subject is generally not included in existing curricula. Working with county boards of education, aquatic education workshops for graduate

credit were conducted for Lucas and Erie county teachers. Requests for similar workshops have been received from Ottawa, Lorain, Medina and Cuyahoga counties and Sandusky City Schools. As a result, more than 100 new teachers are using marine and aquatic education activities produced by Sea Grant in their classes.

Commercial Fishing

Development of markets for underutilized species has long been a goal of Ohio Sea Grant and a request from commercial fishermen. In fact, this past year Dave Kelch conducted taste tests and evaluations using freshwater drum with well over 7,000 people. These have been very successful as utilization of the drum is definitely on the upswing. But, of much greater benefit and an effort which truly shows the value of the National Sea Grant Program, is the development of a rough-fish market for crawfish bait in Louisiana.

The Louisiana crawfish industry is very large with thousands of acres in production and a value of $80 million per year. These crawfish are for human consumption and must be trapped. Oily freshwater fish are the preferred bait. This bait is in short supply during the spring of each year, which coincides with the greatest catches of rough-fish from Lake Erie.

Louisiana Sea Grant Agent Gerald Horst, while reading an article by Fred Snyder in our newsletter, "Twine Line," saw that we were looking for new markets for gizzard shad, carp, goldfish and other underutilized species. Gerald contacted Fred to discuss the possibilities of shipping these fish to Louisiana for bait. Fred brought Dave Kelch into the effort because Dave's program area is market development.

Working with Texas Sea Grant agents, Dave was able to get lists of all the bait dealers in the south to which he subsequently sent questionnaires to characterize their bait needs. Dave then presented these results to the Ohio Fish Producer's Association.

The Ohio Fish Producers sent two representatives with Fred and Dave to Louisiana to meet directly with bait dealers. Louisiana Sea Grant agents organized tours of the crawfish farms and meetings with bait dealers.

While in Louisiana, agreements were reached concerning price, product form and species. It is estimated that Lake Erie could safely produce 10 million pounds of rough fish per year which can be easily utilized in Louisiana. It means a badly needed supply of bait for Louisiana and new markets and jobs for the Ohio fishing industry. To date, 756,000 lbs. valued at over $107,700 have been shipped to Louisiana.

Publications

During the program's first five years of operation, the communications component was a part of the advisory service. Although much of this material is discussed more thoroughly in the communications component of this report, it is included here for completeness.

Since the program started in September 1978, 23 Fact Sheets have been developed by the advisory service and a series of guides which includes a "Lake Erie

Cookbook." Our most popular publication, "Guide to Fishing Reefs in Western Lake Erie" by C.E. Herdendorf has sold approximately 35,000 copies.

In 1980 market development for the freshwater drum ceased as a research effort and became an advisory service effort. Most recently, "A Guide to Utilizing the Freshwater Drum" was developed by Dave Keich. This guide, in addition to other efforts, resulted in an 81 percent increase in the drum harvest from 1981-82.

Power Plant Biology Workshop

In 1980 a power plant biology workshop was developed and presented to groups from the Toledo Edison Company, Consumers Power Company, the Ohio Department of Natural Resources, and Ohio EPA. It was a three-pronged effort starting with the distribution of written materials, followed by a one-day lecture/seminar and then an overnight, hands-on field trip to the Franz Theodore Stone Laboratory at Put-in-Bay, Ohio.

COMMUNICATIONS

SEA GRANT COMMUNICATIONS

CONFERENCES AND WORKSHOPS

The Ohio Sea Grant Program has arranged hundreds of workshops during the past five years. Nearly 50 aquatic ecology workshops for K-12 and college-level students are conducted by Sea Grant personnel at Franz Theodore Stone Laboratory, OSU's biological field station on Lake Erie at Put-in-Bay. In 1981, Ohio Sea Grant and the U.S. Environmental Protection Agency co-hosted the 24th conference on Great Lakes Research of the International Association for Great Lakes Research. Approximately 500 professional researchers and students attended this 3-day meeting. Of special interest to the Great Lakes is the phenomenon of ice formation and movement. In October 1983, Ohio Sea Grant and NOAA's Great Lakes Environmental Research Laboratory will co-host a symposium on Great Lakes ice to determine future research needs and directions.

BROADCAST MEDIA

The environmental movement of the late 1960's was responsible for bringing to the attention of Americans the condition of natural systems that had been largely negelected during the rapid technological growth of this century. Curiously, it was the use of that technology in the form of mass communications that created public awareness of the problems. Surveys of students and adults showed repeatedly that people saw the media as their major source of environmental information. If perceptions were correct, the avenues of providing for increased levels of such information might be at hand.

The most economical and efficient broadcast medium is commercial radio. Could radio programs also teach people about the importance of Lake Erie? A project entitled "Lake Erie Public Information Through Radio Broadcasting" was funded in 1980-81 by Ohio Sea Grant. Its objectives were to produce a series of one-minute audio tapes on Lake Erie topics, arrange for their broadcast on ten central Ohio radio stations, and provide additional material for interested listeners.

The project served as a training mechanism for four graduate and thirty-five undergraduate environmental communications students. Undergraduates, under the Principal Investigator's supervision, drafted and recorded thirty scripts in the format of public service announcements, (PSAs), prepared supplementary literature, and responded to phoned-in requests during the broadcast period of March, 1981. Graduate students conducted a telephone survey before and after the month of broadcasts to assess public knowledge levels and attitudes about Lake Erie, awareness of Ohio Sea Grant, and frequency of use of the cooperating stations. Their survey indicated that about 56% of the people contacted listened to one of the cooperating stations.

Most listeners believed that Lake Erie is "somewhat important" to Ohio and the nation. About 5% of the post-broadcast sample reported hearing at least one of the programs, and awareness of Ohio Sea Grant increased significantly over the period of the broadcasts. Interviewers reported that those surveyed seldom knew about the far-reaching impact on the lake in terms of climate modification, transport of goods, historical importance and such. A knowledge question about pollution problems in Lake Erie indicated that only 39% were aware of improved conditions in the lake. Seven percent thought the problems were worse now; 18% claimed they were unchanged over the last few years, and 35% answered "Don't know." Some who had heard of improvements were skeptical as to their reality, but numerous respondents volunteered comments of concern about cleaning up the lake. This knowledge question more than any other provided insight into the popular perception of Lake Erie's image.

As previously described, each radio script offered additional information for those using a call-in number. While few listeners took advantage of this offer, the materials developed were distributed to advisory agents and to several requesting radio stations. The printed materials thus served as the basis for numerous other broadcasts and news releases beyond the geographic scope of the original project.

The significance of this project lies in four factors. First, it provided excellent practical experience for environmental communications students. It also demonstrated that awareness may be significantly increased using radio messages, and that a substantial audience can be reached through the medium. Finally, it provided the background and impetus for further media research funded by other sources.

Complete results of this research were published as "Providing Resource Information Through Radio Public Service Announcements," Agricultural Communications in Education (ACE) Quarterly 64(4):19-34, Oct.-Dec., 1981.

In 1981-82 opportunities became available to test the effectiveness of television programming as a means of disseminating information about our water resources. The Cousteau Society agreed to allow the investigator and Anne Lyon, master's student in environmental communications, to have a preview of a new documentary on marine mammals so that these questions could be developed. Funding from two sources allowed for research using adult and student audiences.

For the adult study, the OSU Graduate School provided a University Research Grant to do adult audience testing using the interactive capability of Warner Amex QUBE, a cable television system in the Columbus area. A special program was produced by QUBE using multiple choice questions to which viewers responded by pressing buttons on a home console. The test included knowledge and attitude items specific to program content, followed by some demographic questions.

The test program was broadcast three times: as a pretest one week before the Cousteau program, as a posttest immediately following the Cousteau special, and as a retention test two weeks later. Two samples of viewers were randomly selected from the QUBE subscriber list to serve as treatment and control groups. Those in the treatment group took all tests and watched the special, while the control group took only the two posttests.

For the Student Study, the Spencer Foundation funded parallel projects involving, 1) the relative effectiveness of television versus classroom instruction, and 2) accuracy of perception of information source. Subjects for these studies were ninth grade science students at Kilbourne School in Worthington, Ohio.

In the first study, a teacher was given the Cousteau script and asked to teach its content in his own style to half his students. The other half of the students were requested to watch the Cousteau program on television at home. All students took the same tests on the same schedule as the adults in the QUBE.

The second study had all the students of a second teacher watch the program at home and receive additional, but not overlapping, information on the topic in class. The three tests for these students included the QUBE items plus others related to the classroom presentations. In addition, each posttest question was followed by a source perception item: Where did you get the answer to the question above? This was designed to determine whether students could accurately remember the source of their information.

Students of a third science teacher took all three tests and served as a comparison group for this study.

The knowledge scores of the adults and the students in the effectiveness study were remarkably similar. Both the students who viewed the Cousteau program ("Television Treatment") and those who were taught from the script ("Classroom Treatment") learned equivalent amounts and retained the new information for a least two weeks (Figure 3). The source perception group began with a higher knowledge level and did not show a great increase in scores. Neither the QUBE control group nor the student comparison group showed significant changes in knowledge levels.

Attitudes of both the treated students and adults were quite positive in the pretest, improved somewhat on the immediate posttest, but eroded almost to pretest levels within two weeks.

This research indicates that a television program can provide information and influence attitudes about our water resources. Television appears to have provided a comparable amount of information to classroom instruction, with equal retention rates and with equivalent performance by both adults and teenagers. This implies that educators and other communicators could make use of either dissemination mechanism for increasing public knowledge of water environments. Attitude changes, however, are affected much more slowly and may be short-lived.

QUBE results have been accepted for publication in Current Issues in Environmental Education VIII, Arthur Sacks, editor. A paper combining results of all three studies was presented at the annual meeting of the American Educational Research Assocation in April, 1983.

Through these projects the interactions with local communications media and with the international efforts of the Cousteau Society have served to broaden awareness of Ohio Sea Grant and increase knowledge of water resources. These projects have provided valuable information for the Ohio Sea Grant Education Program in terms of the effectiveness of public education through mass media.

PUBLISHED MATERIAL

Lake Erie Reef Fishing Guide

In March 1980, the Ohio Sea Grant Program initiated a new guide series of publications. The first in this series (no. OSG-GS-1-80) "Guide to Fishing Reefs in Western Lake Erie" was prepared by Dr. Charles E. Herdendorf to provide the recreational fisherman with the location of prominent bedrock reefs and shoals in the islands region of Lake Erie as well as information about bottom sediments, current patterns, and physical characteristics of the reefs. This has become one of the most popular publication of the Ohio Sea Grant Program, with approximately 35,000 copies distributed to date.

The recent resurgence of the walleye (Stizostedion vitreum vitreum) population has rekindled sport fishing interest in western Lake Erie. Each year for the past several years the number of recreational fishermen utilizing Lake Erie has greatly increased. Walleye have long been known for their abundance over gravel, bedrock and other types of firm bottoms, where the water is least turbid. The rock-bottomed reefs and shoals within the western Lake Erie island region are areas of particularly high concentration.

But why do walleye prefer reefs? Walleye apparently rely on sight to find their prey. Efficient sight feeding, especially for a large fish seeking moving prey, requires sufficiently clear water to discern the prey at some distance. Such relatively clear water is found over the bedrock reefs in the island region. Experienced sport fishermen expect to find walleye concentrated around clean, hard bottoms, such as rocky reefs, gravel or clean sand, and at the edge of weed beds. Reefs are good feeding places for walleye. Cladophora beds (a filamentous green algae) harbor emerging insects and zooplankters. Zooplankton attract small fish, usually shiners, upon which walleye prey.

Scuba divers who have inspected reefs in western Lake Erie have observed walleye lying motionless on the rocky bottom during daylight. This daily "resting requirement" may tend to limit them to reefs and other hard bottoms. Silty or muddy bottoms with high organic concentrations tend to have lower oxygen concentrations. This is especially true during calm periods when currents and water mixing are slight. Walleye prefer not to rest in these areas because of their additional requirement for high oxygen concentrations.

Walleye commonly spawn over rock, rubble or gravel in streams, shallow offshore reefs or along shorelines of lakes. Spawning runs of walleye persist in only two major Ohio streams, the Sandusky and Maumee Rivers. In the 1800s and the early part of this century many of the lake's other tributaries were productive spawning sites, but the construction of dams, siltation, excessive pollution and irregularity of stream flow due to man's activities have destroyed spawning sites. Today, the major existing

spawning grounds in the Erie Basin are found on the reefs of the island region. These reefs are free from oxygen-consuming mud.

Researchers have postulated that walleye fry imprint some essential characteristics of their birthplace and that most sexually mature adults return to that birthplace to spawn. These factors would also favor the continued utilization of the reefs by future walleye populations.

All of the submerged rock exposures within the region project above the surrounding bottom, and are generally swept clean of sediments by the currents. The relatively clean surface indicates that no permanent sedimentation is taking place on the reefs. However, sediment collectors that have been mounted on the reefs indicate that a considerable amount of sediment is being transported over the reefs to be deposited in deeper water. Because the reefs project above the bottom, they are generally areas of higher energy due to the forces of waves and currents. The habitat created closely simulates the environment found in the riffles of streams. Several fish species, particularly the walleye which commonly spawns in streams, appear to have enjoyed success in Lake Erie because of the availability of this type of habitat.

There are over 30 reefs or reef clusters in the islands region of western Lake Erie. They range in depth from a few feet which form small islands during low water periods to some which are 30 feet deep. Most of the reefs are conical in shape and elongated, as are many of the islands, in a northeast-southwest direction. Two factors appear to have influenced this elongation: (1) vertical joint systems in the bedrock are oriented parallel to the elongation and (2) the major movements of glacial ice, as deduced from grooves found on most of the islands, was from northeast to southwest.

Typically, the reefs consist of bedrock (limestone and dolomite deposited during the Devonian and Silurian Periods, 350-425 million years ago) and associated rock rubble and gravel. The topography of the reef tops ranges from rugged surfaces caused by bedrock pinnacles and large boulders to smooth slabs of horizontally bedded rock. In places the submerged bedrock has the appearance of low stairs, with the steps dipping slightly to the east from the fringe of the reef to its crest.

Because all of the bedrock formations that form the reefs are carbonate material, abundant solution cavities, many up to 1 or 2 cm in diameter, have formed in the rocks. These cavities are important features in that they are often the site of walleye egg deposition. Eggs held in these depressions are protected from wave attack and strong currents which could wash them onto soft sediment beds where they could be smothered.

The bedrock core of the reef is commonly masked by rubble composed of both local (broken fragments of the bedrock) and glacial origin, ranging from small pebbles to boulders up to 5 feet in diameter. On the upper portions of the reefs, isolated patches of sand and gravel commonly fill vertical joint cracks and small depressions in the bedrock; at the fringes of the reefs sand and gravel or glacial till lap over the rock. Glacial till consists of a random mixture of gravel, sand, silt and clay. Beyond the reefs, lacustrine (lake) sediments, largely fine sand, silt, clay and organic deposits such as peat, now cover most of the till and bedrock. Bedrock comprises only 6 percent of the bottom surface in the island region. Gravel accounts for another 9 percent, sand for 26 percent and silt/clay mud for 59 percent of the lake bottom. Peat

is a minor constituent found locally in nearshore areas. Consequently, it can be seen that a relatively small percentage of the water area of the island region is underlain by bottom types preferred by walleye. Therefore, careful selection of fishing sites should yield the best results.

Fishes of Ohio

In 1957, some 35 years of work by Professor Milton B. Trautman culminated in the publishing of The Fishes of Ohio. The original edition of 683 pages contained descriptions, detailed drawings, distribution maps, and habitat information for 172 forms of Ohio fish. This book was quick to gain the acclaim of ichthyologists worldwide. It provided documentation of the state's fish resources with a degree of precision and accuracy unequalled by any other study on the continent. Authorities called it a classic regional treatise that was the most complete ever published. The limited edition (5,000 copies) printed by the Ohio State University Press was sold out within ten years. Demand for this publication has been enormous in the past ten years causing used book prices to rise over 25 times the original new book price of $6.50.

Dr. Trautman did not favor a simple reprinting of The Fishes of Ohio, instead, in the late 1960s he and his wife Mary began work on a complete revision of the book. The revised edition contains several additional species and subspecies, revised distribution maps for all fish, more detailed habitat and life history information, and recent ecological findings. The new edition includes 179 forms of Ohio fish (166 species and 13 subspecies). Nothing has been eliminated from the first edition. The primary effort was to bring the book up to date by adding the fish data acquired in the 23 years since the original publication. The revised manuscript was skillfully molded into the printed form through the editorial efforts of Jane C. Shaw, of Woods Hole, Massachusetts, Robert S. Demorest, of the Ohio State University Press, and Dr. Charles E. Herdendorf of the Ohio Sea Grant Program. In 1981, the Ohio State University Press, in collaboration with the Ohio Sea Grant Program, printed 3,000 copies of the revised edition. In less than two years, approximately 2,000 copies have been sold to eager scientists and fishermen. Reviews of the book have been excellent.

The high standards set by Dr. Trautman in creating the revised edition of The Fishes of Ohio can serve as an inspiration to all students of ichthyology, young and old, amateur and professional. After 60 years of work as a field biologist, Dr. Tratuman's enthusiasm has not waned, as is demonstrated by his painstaking efforts to gather data from all reliable sources for this revision. His professional experience spans that period of Ohio's agricultural and industrial development in which many aquatic habitats have been radically altered. One of the great values in his habitat descriptions, in addition to characterization of present habitats, is documentation of optimal conditions for each species. This information will prove invaluable to future stream and lake restoration efforts.

Dr. Trautman's sweeping revision reflects the alarming effects of these ecological changes and supplies new and reexamined data, keys, maps, and figures covering the 166 species and 13 additional subspecies recorded for Ohio. Cumulatively, they chronicle the dismal history of our continued destruction of our natural heritage; but they suggest, too, how present exploitation might be reversed and conservation measures introduced to assist us in preserving what remains and recovering some of all that has been lost.

Publication and distribution of the revised edition of Fishes of Ohio, was made possible through a grant to the Ohio Sea Grant Program from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Resources of the Ohio State University, College of Biological Sciences, Graduate School, Museum of Zoology, University Press, and Center for Lake Erie Area Research and the Ohio Department of Natural Resources, Division of Wildlife were graciously provided to make the production of The Fishes of Ohio, Revised Edition, a reality.

Birds of Western Lake Erie

Dr. Milton B. Trautman, professor emeritus of zoology at Ohio State University, and the author of four books and over one hundred twenty articles, was not content to rest after completing the Fishes of Ohio. In the spring of 1982, he embarked on an ambitious new project to prepare a companion book to the Fishes of Ohio, to be titled the Birds of Western Lake Erie. This book will include over 300 species of waterfowl, shore birds, and terrestrial forms. The manuscript is planned for completion in 1983 with publication the following year.

Lake Erie Cookbook

In March 1983, Ohio Sea Grant published a major cookbook, Lake Erie Cookbook by Margaret L. Holland, Patrice Pelton, David O. Kelch, Fred L. Snyder, Frank R. Lichtkoppler, Robert Joseph and Jeffrey M. Reutter. The cookbook contains over 120 recipes with major sections on appetizers, soups, sandwiches, salads, baked, broiled and fried fish, casseroles and main dishes. There are also sections on nutrition, selecting fish for a recipe, market forms, selection of fresh fish, selection of frozen fish, contaminants in fish, handling and cleaning, preservation and quality, and cooking hints.

A Guide to Utilizing the Freshwater Drum

Our drum guide by David O. Kelch was completed in 1982. This guide contains information on the life history, feeding habits, and proper handling of the freshwater drum. The guide also contains several recipes and a series of photos describing the best ways to filet fish.

OHIO SEA GRANT PUBLICATIONS

Technical Bulletins

Delayed Mortality Following Transport of Lake Erie Freshwater Drum Captured Shore Seines. Michael T. Metcalf. OHSU-TB-1-78.

Fisheries Food Service Survey. Jeffrey M. Reutter. OHSU-TB-2-80.

Prospects for Aquaculture in Ohio. Charles E. Herdendorf and Jeffrey M. Reutter. OHSU-TB-3-81.

Dry Stack boat Storage: potential energy savings. Kenneth A. Wenner. 8 p. OHSU-TB-4-82.

The Economic Value of Recreational Boating of Lake Erie. Kenneth A. Wenner. 6 p. OHSU-TB-5-82.

Factors Influencing Growth and Development Decisions Made by Commercial Marina Owners. John C. McKinney and Kenneth A. Wenner. OHSU-TB-6-82.

A Spring-Summer (April-September) Climatology of the Lake Erie Basin. J.D. Carlson and Thomas A. Seliga. OHSU-TB-7-82.

Private-Boat Walleye Angling in the Ohio Waters of Lake Erie: An Economic Evaluation. Jane Winslow. OHSU-TB-8-82.

Factors Influencing Growth and Development Decisions Made by Marina Owners on Ohio's Lake Erie Shoreline. John Cooper McKinney. OHSU-TB-82.

Transport and Deposition of Sediment in Old Woman Creek Estuary of Lake Erie. David B. Buchanan. OHSU-TB-10-82.

Fisheries and the Design of Electric Power Plants: The Lake Erie Experience. Jeffrey M. Reutter and Charles E. Herdendorf. OHSU-TB-11-83.

Integrated Bluff Protective Systems for Lake Erie. Wayne Douglas Reynolds. OHSU-TB-12-83.

The Establishment and Decline of Aquatic Vascular Plants in Lake Erie's Western Basin. Dale Soltis and Ronald Stuckey. OHSU-TB-13-83.

Isolation and Characterization of the Water Soluble Antineoplasic Principles of the Common Quahog, Mercenaria mercenaria. Stanley Stephen Stavinski. OHSU-TB-14-83.

Workshop Manuals

Impacts of Power Generation on Aquatic Environments: A Workshop --
- Part I Introduction to Impact Assessment. Walter E. Carey and Jeffrey M. Reutter
- Part II Fossil-Fueled Plants. Robert H. Essenhigh
- Part III Nuclear-Fueled Plants. Walter E. Carey
- Part IV Aquatic Biology. Jeffrey M. Reutter
- Part V Compliance with Regulations. William J. Miller

OHSU-WM-1-80.

Guide Series

Guide to Fishing Reefs in Western Lake Erie. Charles E. Herdendorf. 32 pp. foldout. OHSU-SG-1-80.

A Guide to Utilizing the Freshwater Drum. David O. Kelch, 8 pp. OHSU-GS-2-82.

Ashtabula County Coastal Tour -- Drive it Yourself. Frank R. Lichtkoppler. 6 pp. OHSU-GS-3-82.

The Lake County Coastline. Frank R. Lichtkoppler. 6 pp. OHSU-GS-4-82.

Lake Erie Cookbook. Margaret L. Holland, et al. 130 pp. OHSU-GS-5-83.

Fact Sheets

Lake Erie Sport Fish Processors. Fred L. Snyder. 1 p. OHSU-FS-1-79.

Is it a Walleye or a Sauger? Fred L. Snyder. 2 p. OHSU-FS-2-79.

New Recipes for your Freshwater Catch -- 1. Patrice Pelton. 2 p. OHSU-FS-3-79.

Fishery Loans from the Farm Credit System. Fred L. Snyder. 2 p. OHSU-FS-4-80.

Is it a White Bass or a White Perch? Fred L. Snyder. 1 p. OHSU-FS-5-79.

Reducing "Red Worm" Parasites in your Lake Erie Yellow Perch Catch. John L. Crites and Fred L. Snyder. 2 p. OHSU-FS-6-80.

Reducing Levels of PCBs and other Contaminants in Fish for the Table. Fred L. Snyder. 6 p. OHSU-FS-7-80.

Live Hauling Freshwater Drum. Michael T. Metcalf and David L. Johnson. 3 p. OHSU-FS-8-80.

Lymphocystis and other Virus-related Skin Diseases in Walleye. John L. Crites and Fred L. Snyder. 2 p. OHSU-FS-9-80.

Finding Maps and Charts. Fred L. Snyder. 3 p. OHSU-FS-10-81.

Tips for Shoreline-Protection Structure Construction and Maintenance. Frank R. Lichtkoppler. 2 p. OHSU-FS-11-81.

Marine Related Careers. Frank R. Lichtkoppler. 2 p. OHSU-FS-12-81.

Using the Capital Construction Fund. Fred L. Snyder. 2 p. OHSU-FS-13-81.

Permits Required for Lake Erosion Abatement Works. Frank R. Lichtkoppler. 2 p. OHSU-FS-14-81.

Lake Erie: Phosphorus, Eutrophication and Oxygen. Jeffrey M. Reutter, Frank R. Lichtkoppler and Charles E. Herdendorf. 3 p. OHSU-FS-15-82.

Lake Erie Facts. Jeffrey M. Reutter. 2 p. OHSU-FS-16-82.

Fishery Management: Goals and Tools. Jeffrey M. Reutter. 2 p. OHSU-FS-17-82.

Identifying Your Shoreline Erosion Problems. Frank R. Lichtkoppler. 5 p. OHSU-FS-18-82.

Lake Erie Shore Erosion. Frank R. Lichtkoppler. 4 p. OHSU-FS-19-82.

Beaches as Shore Protection. Frank R. Lichtkoppler. 6 p. OHSU-FS-20-82.

Saugeye. William S. Snyder. 2 p. OHSU-FS-21-82.

Lake Erie Trout and Salmon: Handling and Preparation. David O. Kelch. 4 p. OHSU-FS-22-82.

New Recipes for Your Freshwater Catch -- II. David O. Kelch. 2 p. OHSU-FS-23-82.

New Recipes for Your Freshwater Catch -- III. David O. Kelch. 2 pp. OHSU-FS-24-83.

Brochures

Franz Theodore Stone Laboratory Summer Program
1979 - OHSU-B-1-79.
1980 - OHSU-B-3-80.
1981 - OHSU-B-6-81.
1982 - OHSU-B-8-82.
1983 - OHSU-B-9-83.

A Sea Grant Program for Ohio. An overall description and introduction to the Ohio Sea Grant Program. 4 p. OHSU-B-2-79.

Marine and Aquatic Education: A program for Ohio schools. An overview of marine and aquatic education in the state of Ohio. OHSU-B-4-80.

OEAGLS Catalog. OHSU-B-5-81.

Meet Ohio Sea Grant. An overall description and introduction to the Ohio Sea Grant Program and poster of "Lake Erie...the key to Ohio's future." OHSU-B-7-81.

Publications Catalog. Publications available through the Ohio Sea Grant Program. OHSU-B-10-83.

Newsletters

Lake Erie Program Newsletter. An inhouse bi-monthly to develop better understanding and communications between the center's three programs: Franz Theodore Stone Laboratory, CLEAR (Center for Lake Erie Area Research), and Ohio Sea Grant.

Volume 1, Number 1	June/July 1982
Volume 1, Number 2	Oct/Nov 1982

Making Waves. Ohio Sea Grant bi-monthly for the general public.

Volume 1, Number 1	Spring 1979
Volume 2, Number 2	Summer 1979
Volume 1, Number 3	Autumn 1979
Volume 2, Number 1	Spring/Summer 1980
Volume 2, Number 2	Fall/Winter 1980

Twine Line. Ohio Sea Grant bi-monthly for the Ohio fisherman.

Volume 1, Number 1	January 1979
Volume 1, Number 2	May 1979
Volume 1, Number 3	July 1979
Volume 1, Number 4	September 1979
Volume 1, Number 5	November 1979
Volume 2, Number 1	February 1980
Volume 2, Number 2	April 1980
Volume 2, Number 3	June 1980
Volume 2, Number 4	October 1980
Volume 2, Number 5	December 1980
Volume 3, Number 1	February 1981
Volume 3, Number 2	April 1981
Volume 3, Number 3	June 1981
Volume 3, Number 4	August 1981
Volume 3, Number 5	October 1981
Volume 3, Number 6	December 1981
Volume 4, Number 1	February 1982
Volume 4, Number 2	April 1982

** Ohio Sea Grant bi-monthly for the general public.

Volume 4, Number 3	June 1982
Volume 4, Number 4	October 1982

Middle Sea. Sea Grant quarterly for the Ohio educator, levels K through 12.

Volume 1, Number 1	January 1979
Volume 1, Number 2	Spring 1979
Volume 1, Number 3	Summer 1979
Volume 2, Number 1	Autumn 1979

Volume 2, Number 2	Winter 1980
Volume 2, Number 3	Spring 1980
Volume 3, Number 1	Autumn 1980
Volume 3, Number 2	Winter 1981
Volume 3, Number 3	Spring 1981
Volume 4, Number 1	Autumn 1981
Volume 4, Number 2	Winter 1982
Volume 4, Number 3	Spring 1982
Volume 4, Number 4	Autumn 1982

Education Publications

OEAGLS Activities

The Effect of Lake Erie on Ohio's Temperature. OHSU-EP-1.
The Effect of Lake Erie on Climate. OHSU-EP-2.
Ancient Shores of Lake Erie. OHSU-EP-3.
How to Protect a River. OHSU-EP-4.
Lake Erie and Changing Lake Levels. OHSU-EP-5.
Erosion Along Lake Erie. OHSU-EP-6.
Coastal Processes and Erosion. OHSU-EP-7.
Pollution in Lake Erie: An Introduction. OHSU-EP-8.
Yellow Perch in Lake Erie. OHSU-EP-9.
Evidence of Ancient Seas in Ohio. OHSU-EP-10.
To Harvest a Walleye. OHSU-EP-11.
Oil Spill! OHSU-EP-12.
Shipping on the Great Lakes. OHSU-EP-13.
Geography of the Great Lakes. OHSU-EP-14.
Ohio Canals. OHSU-EP-15.
The Estuary: A Special Place. OHSU-EP-16.
The Great Lakes Triangle. OHSU-EP-17.
Knowing the Ropes. OHSU-EP-18.
Getting to Know Your Local Fish. OHSU-EP-19.
Shipping: The World Connection. OHSU-EP-20.
We Have Met the Enemy. OHSU-EP-21.
It's Everyone's Sea: Or is it? OHSU-EP-22.
PCBs in Fish: A Problem? OHSU-EP-23.

Directory of Courses in Marine and Aquatic Topics Offered by Ohio Institutions of Higher Education. A.H. White-Predieri, V.J. Mayer and T.S. Leist. 58 p. OHSU-EP-24-81.

Great Lakes Information Through Radio (Scripts Broadcast April 1981)

By the "Sea." OHSU-EP-25-81.
Ohio Sea Grant. OHSU-EP-26-81.
The Lake Effect. OHSU-EP-27-81.
Fishing Lake Erie. OHSU-EP-28-81.
Fish Farming...in Ohio! OHSU-EP-29-81.
Warning: Storm Surge. OHSU-EP-30-81.
Lake Erie Wineries: Sweet Success. OHSU-EP-31-81.
Perry's Lake Erie Victory. OHSU-EP-32-81.
Lake Erie and Phosphorus. OHSU-EP-33-81.

Old Woman Creek: Your Estuary. OHSU-EP-34-81.
Great Lakes Agencies. OHSU-EP-35-81.
Lake Erie Shoreline -- Not Just Another Beach. OHSU-EP-36-81.
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HIGHLIGHTS

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OF THE
OHIO SEA GRANT PROGRAM

The Ohio Sea Grant program is a unique partnership of Ohio institutions, state agencies, private industry, the general public and the federal government, working to promote and implement research, education and advisory service in the sphere of Great Lakes resources. Ohio Sea Grant Program research combines the knowledge, talent and skills of the faculty and staff of over a dozen universities, colleges, and institutions across the state with the needs of the private sector in order to increase the utilization and development of Lake Erie resources.

The first five years of the Ohio Sea Grant Program have benefited the economy and the people of the state with a minimal commitment of state or federal funds. Recent representative accomplishments of Sea Grant Program efforts in research, education and advisory services are:

Fisheries and Aquaculture

Work with federal fish hatcheries in Hebron, Ohio, has resulted in the formulation of techniques for increasing hatchery productivity. Through zooplankton culturing, more fish food has been made available at critical growth periods.

Tests are underway to determine the feasibility of using Ohio's more than 60,000 farm ponds as rearing sites for bait minnows. Partial season tests yielded up to 200 pounds per acre with no feeding or aeration.

A totally revised edition of Dr. Milton B. Trautman's classic reference book, The Fishes of Ohio was published. This 760-page text represents more than half a lifetime of work and is probably the most complete regional treatise of North American ichthyology.

Increased use of underutilized Lake Erie fish species has been a continuing research effort. The utilization of freshwater drum increased 80 percent from 1980 to 1981 as a result of taste tests, cooking and filleting demonstrations and the publication of "A Guide to Utilizing the Freshwater Drum."

A market has just been developed for a commonly unused fish, the gizzard shad, as a crawfish bait in Louisiana. During the first month of this effort, 250,000 pounds of shad, with an approximate economic value of $35,000, were shipped south.

Permits for the construction of three artificial reefs in central Lake Erie off Lorain and Cuyahoga counties have been applied for by the Ohio Department of Natural Resources with the technical support of Ohio Sea Grant scientists and advisory committees. These reefs are expected to greatly enhance sport catches in this area and serve as a pilot project for planning future reef construction in Lake and Ashtabula counties.

Resource Economics

A study to determine the economic value of private-boat sportfishing in the western basin of Lake Erie determined that the value of the walleye sport fishery in this area from May to August was in excess of $325 million. Since Sea Grant began working with sportfishermen, fishing on Lake Erie has nearly doubled.

Investigations of the economics of recreational boating businesses along Lake Erie have pinpointed the value of the industry and identified the value of dry stack storage, enabling individuals and developers to plan accordingly. As a result of this work, the city of Fairport has found that it is economically viable to install two new launch facilities.

Since the Program began the number of charterfishing businesses has increased from 50 to more than 300. As a result of this effort, Sea Grant Advisory Service Agent Fred Snyder was named most valuable person of the year by the Lake Erie Marine Trades Assocation.

Coastal and Ocean Engineering

As a result of the Program's advisory service work in the area of shore erosion, more than $400,000 worth of dredged sand will not be lost to open-lake dumping but used to decrease erosion along the northeast Ohio shore.

Development of storm-surge models for use by NOAA weather service will improve predictions of flooding in low-lying shore areas of western Lake Erie. This research also included measurement of sediment transport as a result of lake storms.

Research to lessen the likelihood of offshore structure failure, e.g. oil rigs, is being conducted. As a first step, models to predict the variability of ocean bottom foundation material have been designed.

Wetlands Management

Research is underway to enhance fish production in managed wetlands of Sandusky Bay in the western basin of Lake Erie. Approximately 25,000 acres of wetlands along Lake Erie are now diked and managed for waterfowl.

In cooperation with the U.S. Fish and Wildlife Service, Ohio Sea Grant recently completed an inventory of the fish and wildlife resources of over 1,500 coastal wetlands of the Great Lakes. This work has been published as a six-volume technical bulletin.

Working with the Ohio Department of Natural Resources, Ohio Sea Grant was instrumental in obtaining NOAA designation for the first National Estuarine Sanctuary in the Great Lakes -- Old Woman Creek on the south shore of Lake Erie.

Research in Old Woman Creek National Estuarine Sanctuary is being plannd which will explore the value of wetlands to the total lake ecosystem. These studies will be undertaken in cooperation with the Ohio Department of Natural Resources, Division of Natural Areas and Preserves.

Recreation and Cultural Resources

The publication of "A Guide to the History and Architecture of the Bass Islands" will increase tourism in western Lake Erie while enhancing the enjoyment of tourists visiting that area.

"A Recreational Planning Guide to the Great Lakes" is being prepared in cooperation with the Great Lakes Environmental Research Laboratories, part of NOAA.

Public education is an important component of Sea Grant. During the summer of 1982 more than 45,000 visitors viewed a Great Lakes exhibit at the Columbus Center for Science and Industry which was developed in conjunction with Ohio Sea Grant.

Informative booklets such as "A Self-guided Hike/Bike Tour of South Bass Island" and "Take a Kelleys Island Fossil Walk" have been developed to enhance the enjoyment of tourists coming to the Lake Erie Islands.

Advisory Committees

Advisory committees, groups of concerned citizens from all walks of life, have been organized to advise and set priorities for Sea Grant and the Program's three extension agents. The committees successfully organized "Congressional Day on Lake Erie," an event to allow senators, congressmen and aides to see Lake Erie values, potentials and problems first hand.

These committees have also developed a plan to place artificial reefs in the central basin of Lake Erie. These artificial reefs will attract fish and improve fishing opportunities.

Marine and Aquatic Education

Sea Grant workshops and conferences, offer researchers, students, teachers, businessmen, media people, fishermen, industry personnel and the public the opportunity to increase their awareness and knowledge of Lake Erie.

More than 100 radio scripts and TV spots have been aired across the state on a variety of topics designed to increase the utilization of Lake Erie.

Twenty-three Oceanic Education Activities for Great Lakes Schools (OEAGLS), were developed for teachers and students and disseminated nationally and locally. It is estimated that over 200,000 students in Ohio schools are using these activities which focus on Lake Erie and its relationship to the state.

Approximately 600 teachers have been trained in the area of marine and aquatic education and three marine education learning-materials resource centers were recently established in universities throughout the state.

College level education is encouraged by Ohio Sea Grant. The following programs have been developed:

1. marine Construction Technology Program at Bowling Green State University and

2. graduate Curriculum in Coastal Engineering, Oceanography and Marine Biology courses, and Teacher Training in Marine and Aquatic Sciences at The Ohio State University.

In addition, a directory listing more than 500 college level courses offered throughout the state in the field of marine and aquatic sciences has been published.

A combined effort in research, marine advisory service and education makes Ohio Sea Grant Program's goals consistent with the goals of the National Sea Grant College Program of the National Oceanic and Atmospheric Administration. The economic benefits for the National Program taken as a whole are impressive and consistent with the Ohio experience. Over a ten-year period, National Sea Grant network projects have produced a direct economic dollar gain to the national economy of over $200 million per year.