

**Ohio Sea Grant
Education
Program:**

**Development
Implementation
Evaluation**

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THE OHIO SEA GRANT EDUCATION PROGRAM

**Development
Implementation
Evaluation**

by

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and

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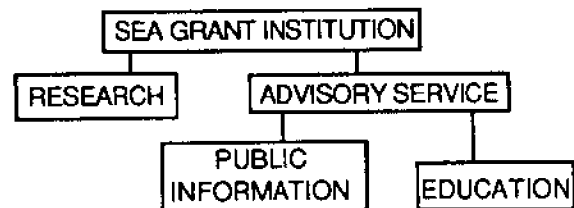
1. INTRODUCTION

In 1975, the Columbus Council of the Navy League of the United States provided a grant to the Ohio State University in support of a state survey to determine the level of understanding of marine information among the public school children of Ohio. In addition it supported a summer workshop in the Humanities of the Seas conducted for teachers in Ohio schools. Thirty teachers participated from all over the state. These events marked the beginning of the program in Marine and Aquatic Education now conducted through Ohio Sea Grant. They in turn led to the development of the Ohio Sea Grant Education Program. In the process of its development, a particular organization and philosophy has been implemented that may be of interest as a model for other Sea Grant Education programs and indeed for other programs seeking to improve education in any area of concern. This monograph has been designed to provide a detailed explanation of the organization and philosophy of the program and the rationale used in each of its elements. In addition a detailed description of the methods and results of extensive evaluation efforts are included.

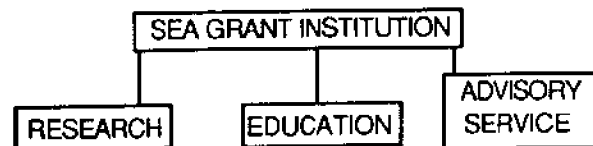
Although there has been some attention to curriculum development and teacher training in the national Sea Grant program, funding for Sea Grant education programs has most often focused on higher education and vocational and technical education (Fortner, 1984). Few Sea Grant organizations have targeted K-12 education as a priority area for development. Seldom are educators with training and experience at the elementary and secondary school levels, in teacher education and curriculum development, and also in nonformal public education involved in program development and supervision. These factors have led by and large to a lack of program philosophy and direction in Sea Grant education programs. In many cases this has resulted in poorly coordinated efforts which led to duplication and the failure to institutionalize programs. As a result programs disappear after Sea Grant funding is terminated. Although there have been some exceptional efforts in education that are having and will continue to have an effect upon elementary, secondary and higher education in certain states, with proper program organization and emphasis there could be many more effective programs. We hope that this monograph will provide

some insight into such effective program formats and thereby help to improve Sea Grant education programs in the future.

Part of the uniqueness of the Ohio Sea Grant Education program may lie in the fact that it was the first component funded in Ohio Sea Grant and led to the development of the other two components: Advisory Service and Research. This has given the education program a certain standing within the Sea Grant program office locally and nationally and therefore a stronger voice in policy and funding decisions. This is further institutionalized by the fact that education has been established as a separate program on equal standing with advisory service and research (see Figure 1-1). The education coordinator is a member of the seven person executive committee of Ohio Sea Grant and therefore shares in



A. Education functions housed within advisory service.



B. Separate and equal component (as in Ohio).

Figure 1

Placement of Education Components in
Two Different Models of Sea Grant Organization.

the responsibility for developing and implementing overall program policies. Even this would not ensure the effective organization of the education program except for the fact that trained and respected science educators, Dr. Victor J. Mayer and Dr. Rosanne W.

Fortner, have functioned as the education coordinators. Their backgrounds have provided a basis in experience and creativity that has produced programs attuned to the needs and organization of Ohio schools and adaptive to opportunities in nonformal educational institutions and the mass media. For formal education, close relationships have been established between the education program office, the Ohio Department of Education, the Environmental Education Office of the Ohio Department of Natural Resources and local school systems. In addition communication has been established with other Sea Grant educators in the Great Lakes Region. Only the lack of funding has prohibited the further development of productive channels of cooperation through a Great Lakes Education Network. Nonformal thrusts have introduced educational ventures with central Ohio radio stations, interactive cable television (Warner QUBE), the Cousteau Society, Old Woman Creek National Estuarine Research Reserve and Columbus' Center of Science and Industry. Expansion of these relationships promises opportunity for additional public education activities.

ESTABLISHMENT OF EDUCATION PROGRAM PRIORITIES

In establishing program priorities a basic question was asked to guide priority identification. With limited resources, what type of education program would have the greatest impact on the largest number of Ohio citizens? The institutions with the most prolonged contact with the largest number of families in any state are the pre-college schools. Through them an effective program would not only contact the students, but the adults in their families as well. A program focused on the schools would also impact every county in the state and not be restricted to those served by advisory service offices which are located only along the Lake Erie coast. Once schools are adequately served with appropriate marine and aquatic education programs a base of support will have been established for movement into other levels and kinds of education. Following the rationale of serving the largest citizenry possible with initial efforts, the program could expand to serve the informal education institutions, such as museums, and explore uses of the mass media for public awareness.

While these first-served organizations can function to build aquatic awareness among Ohio citizens as a priority within Sea Grant, it was not forgotten that there also needed to be a career component to the program. What needs exist for training programs focused on careers in marine science for Ohio citizens? This was a difficult question to answer, and one which still has not been resolved. This was clearly a second order priority, however. In other Sea Grant programs by contrast career training was and is the major focus of Sea Grant Education efforts. Because of Ohio's inland location, the strength of existing limnology and fishery programs in higher education and the availability of marine career programs at other Sea Grant institutions, the major focus of Ohio Sea Grant was and probably will remain on aquatic awareness programs.

INITIATION OF EFFORTS

With the schools identified as the first priority for a Sea Grant education program, the next question was how to effectively incorporate information of interest to Sea Grant into school curricula. Work with the Humanities of the Seas programs in 1976 through 1978 revealed few curriculum materials available for teaching marine and aquatic concepts to inland schools. These Humanities programs were teacher education workshops. Without teaching materials to present to the teachers, however, the effectiveness of the workshops, as indicated by the inclusion of new concepts into the teacher participants curricula, was minimal. Experience with these and other programs indicated that teachers simply do not have the time, nor in many cases the ability, to develop their own teaching materials in fields that are new to them. Therefore it was felt that the first step in a broad awareness program for Ohio was to develop teaching materials that could be used in the state. The OEAGLS project (Oceanic Education Activities for Great Lakes Schools) was initiated with Sea Grant funding in 1977 as the first project of Ohio Sea Grant.

Decisions were made on the grade level and format for the materials based on information generated through studies sponsored by the National Science Foundation (NSF) and from experience with previous curriculum development efforts, such

as the Crustal Evolution Education Project (CEEP), a program conducted through the National Association of Geology Teachers (Mayer and Stoeber, 1978) for developing supplemental curriculum materials for earth science classes. Studies indicated a dramatic drop-off of interest in science among children, especially among girls and minorities, during the middle school years. This decline in interest was of concern for the directorate of the NSF. As a result, most of their education efforts in the mid and late 1970s were directed at improving teaching materials and teacher backgrounds at the middle school level. The OEAGLS project was likewise focused on grades 5 through 9 to assist Ohio schools in improving curricula used during those critical years.

Since marine and aquatic education involves content from a variety of scientific fields, the humanities and the social sciences, its successful implementation into the school curriculum needed to be accomplished within an interdisciplinary framework. In the middle school years students are becoming old enough to handle more sophisticated information, yet most school programs are organized in such a way that teachers can easily teach in an interdisciplinary format. For example, many middle schools use a "house" approach where four academic teachers have the same group of children. The teachers meet periodically to determine the class schedule for those students and what is to be taught during a given period of time. Such joint planning facilitates the use of team teaching and the development of interdisciplinary courses. This was another reason for choosing the middle school years as a focus for Ohio Sea Grant efforts. Also, following 8th or 9th grade, the curriculum begins to diverge, with course options being offered to students. The middle school therefore is the last time to have all students enrolled in a given course as a "captive audience" for marine education facts and concepts.

Experience with the implementation of "new" curricula during the advent of the National Science Foundation sponsored curriculum development efforts, and subsequent experience with schools, indicated the difficulty of inserting new materials into existing curricula (Helgeson, et al., 1978). Teachers by and large are satisfied with what they are doing in the classroom. They are not looking for a

new curriculum, or even for major new units to teach. The concept of infusion therefore was adapted from efforts of the Crustal Evolution Education Project as a guiding theme for the development of OEAGLS materials. Instead of producing units, self-contained, short and supplementary modules were designed. These focused on concepts already taught in the curriculum, but imbedded them in a marine and Lake Erie, or Great Lakes, context. A module on shipping, for example, uses data from the Port of Toledo to develop ideas related to the worldwide involvement of Ohio in commerce. "Pollution in Lake Erie" uses articles from 1970 and 1980 for two language arts activities--reading in the science content area and critical reading.

Each module was designed to take only a few days of class time. A combination therefore of familiar



Fifth graders study a "plankton sample" during OEAGLS estuary activity.

concepts and the short time necessary for the full treatment of each topic facilitates the use of the materials and their incorporation into existing curricula. To further facilitate use of the materials teachers need to have information beyond what is normally included in a student guide. Therefore a fully detailed teacher guide was developed for each activity. The guides included descriptions of the necessary materials and where they could be obtained, answers to questions in the student guide and background information necessary for the teacher to understand the topic. Such fully detailed guides also decrease the necessity for teacher training in the use of the activities. A project incorporating these concepts was prepared and submitted with the 1977 Ohio Sea Grant proposal.

2. THE DEVELOPMENT PROCESS

Advisory Committee. Soon after the announcement of the grant an advisory committee was named to assist in overseeing the project. The primary functions of the committee were to establish priorities for topics of the activities, to help in identifying resource persons, and to review the content of the activities for accuracy, relevance and appropriateness. Individuals on the committee represented the Ohio Department of Natural Resources, the Ohio Department of Education, the Navy League of the United States, the Departments of Geography and Naval Science of the university and the Center for Lake Erie Area Research. The committee had several meetings to discuss general policy, but its primary mode of operation was for its members to serve in individual consulting roles with the principal investigator in deciding policy issues as they arose and in identifying individuals to aid in the development of certain topics and to review materials as they were developed.

Identification of topics. The development process was initiated with the identification of broad topic areas. This was done on a tentative basis in the proposal based upon the principal investigator's knowledge of the school curricula, experience with teacher workshops, and knowledge of research being conducted on the Great Lakes. These topics were reviewed and modified at the first advisory board meeting and then ranked by the members in order of priority for development. Subsequently the principal investigator and his two project assistants "brain stormed" more specific subjects within those broad topics that the board ranked as being most important. These more specific topics then became the bases for the development of activities during the first year of the project and provided guidance for the identification of activity topics in subsequent years as well.

Creation of activities. Once topics were identified, several different processes were used for the initial development of an activity. One such process started with activities that had been developed by teachers as course projects for the three Humanities of the Seas workshops conducted with Navy League sponsorship. Another process used during the first year involved a teacher seminar on OEAGLS development. Eight teachers were enrolled for three hours of graduate

credit. They met once a week during the University's Winter Quarter, 1978. Each meeting included a presentation on a priority development topic by a content expert. The experts included, among others, a geologist with the Ohio Department of Natural Resources who discussed his studies of beach erosion along the lake, a meteorologist from the Cleveland weather station of NOAA who discussed the weather and climate effects of the lake, and a geographer from the university who discussed the effect of waterways on the settlement of Ohio. Each of the teachers identified a topic area and designed an activity relating to that topic using the resources of the developing Marine and Aquatic Education Resource Center as a support library. Eleven of the activities were started in one of these two ways.



Curriculum development seminar produced some activities.

Beginning the second year greater initiative for activity development occurred within the project staff itself. This was in a large part due to the arrival on the staff of a professional qualified in Marine Education, Dr. Fortner. This change in procedures was also in part a response to the need to develop topics on emerging issues such as the PCB problem in the lakes. A fourth process used in three cases was the designation of either a teacher or a researcher on lake problems to initially develop an activity.

The original draft of any activity idea was submitted to a second and often a third person for revision and editing. If initially developed by a teacher, then one of the project staff completed

this second step. If started by a member of the project staff, then usually a teacher was asked to review the activity.



Teacher Dorothy Bliss originated "We Have Met the Enemy" for OEAGLS.

At various stages in the writing, content experts were consulted for additional information, for references to research that could assist in developing the content of the activity, and for opinions on the appropriateness of information.

Formative Evaluation. When reviews by critic teachers were completed a different teacher was identified and asked to use the activity with his/her classes. The teacher was identified by the principal investigator, based on his experience with teachers in local schools and through recommendations by his colleagues at the university and in the local school systems. An important criterion used in selection of teachers was the teacher's ability to identify strong and weak points in instructional programs.

Each activity was systematically evaluated through its use in the selected teacher's classes. Multiple choice items were developed to assess whether the objectives of the activity were met (Appendix A). These items were given to the students prior to the use of the activity and then again following its completion. The results were analyzed to identify any areas of low achievement. If such areas were found, the related objectives were examined and the sections of the activity relating to those objectives were analyzed for problems.



Students tested OEAGLS before final drafts were prepared.

In addition, students in the pilot classes responded to three attitude items. Their responses were analyzed to determine the interest level, difficulty and clarity of the activity. If problems were indicated, the activity was examined for ways in which it could be made more appealing or clearer to students. In addition to evaluation through test data, the teacher was asked to critique the activity and its various components using a standard form provided by the project (Appendix B).

Perhaps the most useful component of the evaluation process was the visits to the pilot classes by one of the two principal investigators. They were able to observe student reactions to the activity, interview selected students and discuss the activity personally with the teacher.

All of the information from the evaluation process was then used to rewrite the activity. If very extensive rewriting was necessary then the activity was retested in another classroom. The final stage in evaluation was the submission of the activity to a content expert who provided a final review of the accuracy of the subject matter. After adjustments made necessary by the content review were completed, the activity was then ready for distribution to teachers.

For many of the activities there continues to be an ongoing formative evaluation process. As activities are used in workshops, teachers note ways in which they can be improved. When the supply of an activity is exhausted, it is revised before reprinting to take into account suggestions by teachers.

The extensive and many faceted formative evaluation system used for OEAGLS has been more completely documented in a case study of the program written by Gregory Rhodes as a portion of his doctoral dissertation at Indiana University (Rhodes, 1983, Appendix C).

3. DISSEMINATION PROGRAMS

When the OEAGLS project was first proposed it was realized that there had to be a dissemination process to follow the development program. Since the format of the materials and the philosophy behind their development precluded publication by a commercial publisher, some mechanism had to be provided to make the materials known to Ohio teachers and to get them into their hands for use. This dissemination program took the form of a planned and coordinated series of workshops conducted over the three year period immediately following the completion of the OEAGLS Project in 1980.

ACTIVITIES DURING DEVELOPMENT PROCESS

Actually dissemination started as a part of the development process since educators were made aware of the availability of materials through a newsletter started during the second year of the project (Appendix D). Its publication continued uninterrupted until budgetary cuts required its curtailment in 1986. Entitled Middle Sea, it reached at its peak a quarterly distribution of about 2000 copies primarily in Ohio. Each of the OEAGLS was described in the newsletter upon its completion. Periodically selected activities were further described as they may have related to a feature article in the newsletter. Early in the project Middle Sea was a primary means of making teachers aware of their availability, and each issue resulted in a flurry of orders for new activities. After all activities were completed a catalog was written that included activity descriptions, a description of the development process and lists of authors and project personnel. In 1985, this catalog was superseded by an informational brochure and order blank published by the Ohio Sea Grant central office (Appendix E).

As materials became available, interest in their use was generated along Lake Erie through the work of the Ohio Sea Grant advisory agent. Many activities were disseminated through that office and through workshops organized by the agent. The principal investigators also accepted any opportunity to make presentations at teachers' meetings anywhere in the state. OEAGLS were invariably used in the workshops and presentations. Programs are given at school system inservice days, regional meetings of the Ohio

Education Association, and annual meetings of state science and social studies organizations. In addition, presentations have been made by the principal investigators at national and regional meetings of the National Science Teachers Association and national meetings of the National Marine Educators Association, the North American Association for Environmental Education and the American Educational Research Association. Such presentations continue through the present (1987). During the latter two years of the development project, these measures resulted in the distribution of several thousand copies of the OEAGLS materials.



Advisory agent Fred Snyder working with students at Old Woman Creek estuary.

As another element of the dissemination process, activities are published in a form that readily facilitates their inexpensive use by teachers. Only single copies are provided to teachers, who are then encouraged to have as many copies reproduced as necessary. To facilitate this all materials are printed in high contrast black and white. Illustrations are line drawings with occasional black and white photos and art work. This type of publication also facilitates a second method of dissemination through national microfiche based information dissemination networks. All activities have been included in both the Educational Resources Information Center (ERIC) and the Marine Education Materials System (MEMS). Both systems provide computer searches for materials. The ERIC system also publishes abstracts of the materials in a monthly publication Resources in Education. Most colleges and universities maintain ERIC microfiche collections as do state departments of education. Through these dissemination methods

the materials are made available throughout the country at no cost to the project. From 1985 through 1988 all activities are being reprinted using desk-top publishing techniques. Based upon comments by teachers, answer sheets have been developed so that a teacher needs to reproduce only one classroom set of the activity books, which can be used by several sets of students, each having their own answer sheets.

INFUSION PROGRAM

Enough experience has been gained with curriculum development projects, especially those funded by the National Science Foundation through the 1960's and '70's, to demonstrate the necessity of well planned and executed dissemination programs. This was realized from the inception of the OEAGLS development project and led to the early design and proposal for a dissemination program later referred to as the Infusion Program. This program was conceived as a three year cycle to promote awareness of the materials throughout the State of Ohio. It was designed to systematically introduce the materials to every section of the state through a series of awareness workshops and to develop a cadre of well trained teachers centered in the major metropolitan areas of the state through a series of implementation workshops. The program was designed with the cooperation of the Ohio Department of Education. The co-principal investigator on the project during its first year and one-half was Dr. John Hug, Coordinator of Environmental Education for the Department.

The two components of the program were designated the awareness component and the implementation component. The first was intended to develop broad awareness among teachers and administrators across the State of Ohio regarding the objectives of marine and aquatic education and a knowledge of the materials available for use in teaching toward those objectives, especially the OEAGLS materials. The implementation component was intended for in depth training of teachers to provide them with information and resources to implement marine and aquatic education in their classrooms. Many of these teachers could then serve as members of a trained cadre who could be called upon to assist others in such an effort.

The objectives of the awareness component as stated in the proposal were to:

- a. Create an awareness of marine and aquatic education among school administrators, supervisors, and teachers.
- b. Disseminate examples of curriculum materials available in marine and aquatic education.
- c. Create an awareness of marine and aquatic education among selected educators in Ohio colleges and universities.

These objectives were to be reached through several program elements:

- a. The establishment of a marine and aquatic education awareness program through the Ohio Department of Education.
- b. The planning and implementation of a statewide awareness program for local school administrators and faculty of colleges of education.
- c. Conducting a marine and aquatic education awareness program for Ohio teachers.

These objectives and program elements were characterized as the awareness component of the program and were led by the project's co-principal investigator, Dr. Hug, during the first year of the project, and by Dr. Fortner during the remainder of the program.

The implementation component led by Dr. Mayer had another set of objectives, to:

- a. Assist teachers to effectively use available curriculum materials and methods.
- b. Help teachers acquire appropriate background information in marine and aquatic topics.
- c. Provide teachers with marine and aquatic experiences through field trips.
- d. Assist administrators and teachers in redesigning curricula to infuse marine and aquatic education.

These objectives were to be accomplished through:

- a. Coordination of implementation activities by Ohio Sea Grant through the Ohio Department of Education.
- b. Provision of inservice and summer seminars and workshops in marine and aquatic education through The Ohio State University.
- c. Establishment of similar courses at other universities in Ohio.
- d. Provision of an educational specialist to work through the Ohio Department of Education in assisting teachers in implementing marine and aquatic education.
- e. Loaning marine and aquatic education materials from three resource centers.
- f. Publishing a quarterly bulletin in marine and aquatic education for Ohio teachers.

AWARENESS PROGRAM

This component had three major tasks: the further identification and organization of marine and aquatic education resources, the development of the capability to deliver services to educators in Ohio schools, and the planning and initiation of an awareness program for Ohio educators.



Oceanic Education Resource Center at The Ohio State University

During the first year the emphasis was upon the first two tasks. Lists of materials available through ERIC and MEMS were updated and microfiche copies

added to the Oceanic Education Resource Center. This resource center located at Ohio State began as an adjunct to the OEAGLS development project providing source materials for the development staff. Its resources had been expanded in support of early marine education workshops through funding by the Columbus Council of the Navy League of the United States. Additional books, curricular materials, slide-tape sets, laboratory and demonstration materials were added during the infusion program.

Also during the first year two additional resource centers were instituted, one at Bowling Green State University in the northern part of the state and the other at the University of Cincinnati. The holdings of the Columbus resource center were evaluated and those materials judged most useful were purchased for the two new centers. These satellite centers have been used in support of both awareness and implementation workshops held in those areas. Their major use, however, has been by local teachers and students at the two universities.

Personnel resources were also identified during the first year. Over 50 teachers had been involved in Oceanic Education programs conducted at The Ohio State University with support from the Navy League. Exceptional teacher leaders were identified from this group. The State Department of Education identified additional administrators, supervisors and faculty in institutions of higher education. A state-wide meeting of individuals selected from those groups was held in Columbus. At this meeting guidelines were developed for the conduct of the awareness program. This group, although its membership has changed a bit as the program has evolved, has continued to serve in an advisory capacity, reacting to ideas of the project staff and in some cases initiating programs in marine and aquatic education in colleges and universities in their areas of the state. Because of funding restrictions, meetings of this coordinating group ended in 1984.

To assist in disseminating an awareness of marine education throughout the state and defining the importance and scope of marine and aquatic education in Ohio, a position paper was developed with the Ohio Department of Education. "Occasional Paper #6: Marine and Aquatic Education" has been distributed to Department personnel and to educators contacted by the Sea Grant Education Program (Appendix F). The

document serves to introduce the subject, the program and the personal, geographic and educational resources of the state.

Workshop Format

Perhaps the major task during the first year was to develop a format for the awareness workshops. These were to offer one quarter hour of graduate university credit. This fact resulted in two requirements, first that they involve a minimum of 10 clock hours of instruction, and second that each participant write a paper. The format developed during this first year was piloted in two workshops, one held in Columbus and the other on Lake Erie at Ottawa National Wildlife Refuge. During the second year this program was modified to take into account recommendations by participants.

To meet the goals of the Education Program certain guidelines were followed in designing the final format for awareness workshops. First, a major portion of the time was devoted to active teacher involvement with OEAGLS activities. Accordingly, one introductory session with all workshop participants provided background on how OEAGLS were developed and involved teachers in the playing of a board game about factors influencing the yellow perch population of Lake Erie. This activity introduced teacher to the style and intent of the OEAGLS materials. Three sets of concurrent sessions conducted the following day presented up to nine additional modules. Since all OEAGLS are designed for in-class use, no outdoor activities were planned as a regular component of the workshops.



Dr. Fortner directing teachers in the use of OEAGLS.

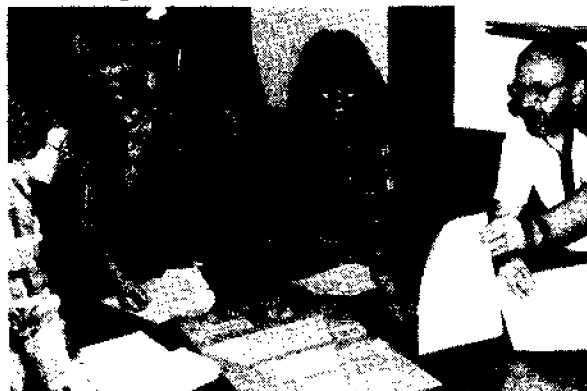
Second among the program goals was that teachers be provided with background knowledge about the characteristics of Lake Erie. This was achieved through two lecture presentations, one on the geology

of the lake and another on the characteristics of the lake's water. The lectures were carefully developed, refined to include the most important material and extensively illustrated in the form of slides or overhead visuals.

A third major goal was for teachers to develop an understanding of the breadth and scope of marine and aquatic education. The workshop itself helped to provide this, but an introductory lecture "Why Marine Education" provided an overview of the sources of the marine and aquatic education movement and its interdisciplinary nature.

Finally, it was expected that the workshops would provide teachers with opportunities to become familiar with a wide variety of activities and curriculum materials. Two sessions were held to accomplish this: one during the first evening in which participants could informally participate in a variety of activities set up as learning stations, and one the following day where teachers were given the opportunity of perusing the best of curriculum materials from other marine and aquatic education programs around the country.

During the two years that comprised the major thrust of the awareness workshop program, the authors served as the only continuing staff members. For each workshop local teachers were recruited as assistants for presenting concurrent sessions, and when available an Advisory Agent or administrator of Ohio Sea Grant was invited to provide an overview of Sea Grant research programs. A sample workshop schedule appears as Figure 3-1. The success of the format is such that it has continued to be used each year through 1987.



Dr. Mayer assisting participants in food pyramid game.

Marine and Aquatic Education Workshop
Miamisburg, February 11-12, 1983

SCHEDULE

February 11

6:30 p.m. Individual participation in marine and aquatic education activities
7:00 Welcome and workshop overview - Rosanne Fortner
7:10 Overview of Marine and Aquatic Education - Vic Mayer
7:45 Break
8:00 Yellow Perch in Lake Erie - Rosanne
8:30 The development of the OEAGLS materials - Vic
8:45 Programs and services of Ohio Sea Grant - Rosanne
9:05 Briefing on tomorrow's activities
9:15 Registration for credit
9:30 Have a safe trip home!

February 12

9:00 a.m. Formation of Lake Erie - Vic Mayer
9:30 Concurrent sessions: Erosion Along Lake Erie - Carol Winhusen
Ohio Canals - Jane Muhlenkamp
PCBs in Fish - Roberta Rupert
10:30 Break
10:45 Characteristics of Lake Erie - Rosanne Fortner
11:15 Concurrent sessions: Getting to Know Your Local Fish - Roberta
How to Protect a River - Vic
It's Everyone's Sea: Or Is It? - Jane
12:15 p.m. Lunch
1:15 View and browse displayed curriculum materials
1:45 Local resources for marine and aquatic education - Bob Earl
2:15 Concurrent sessions: The Great Lakes Triangle - Carol
Estuary: A Special Place - Rosanne
We Have Met the Enemy - Vic
3:15 Great Lakes Filmstrip
3:45 Workshop wrap-up
4:00 Adjourn

Figure 2
Awareness Workshop Schedule



NSF workshop participants studied on the lake shore as well as in classes.

To assist in conducting these workshops it was initially envisioned that 10 leadership teams would be trained. Each team would then conduct a workshop under the supervision of the Sea Grant staff. This training program was initiated in the summer of 1980 under a grant from the National Science Foundation. Nine administrator-teacher teams were invited to a six-day workshop at the University's Stone Lab facilities on South Bass Island in Lake Erie. Participants in this workshop ranged from a team consisting of an assistant principal with a fifth and a sixth grade teacher to one having a curriculum supervisor with junior high school science and social studies teachers. Though attempts were made to gain participation from a wide geographic area in order to have a statewide leadership cadre, applicants were largely from the lake shore areas.

The six-day program consisted of lectures on interdisciplinary topics in social studies, science and the arts, followed by OEAGLS sessions to illustrate methods of presenting those topics in middle schools. Field trips to island sites such as Perry's Victory and International Peace Memorial, and mainland features such as the Port of Toledo and the Kishman Fish Company reinforced class concepts and emphasized the importance of the lake to the state. Presentations by the Director of Ohio Sea Grant and by curriculum developers from Michigan Sea Grant helped to broaden the experience.

Although the program was a success in terms of participant enthusiasm, it subsequently became clear that very few of the teams were adequately prepared

to deliver the intense, high quality type of workshop envisioned by the Sea Grant staff. Instead a decision was made to reduce the number of workshops offered to six per year, and to have them staffed by the principal investigators of the program, both of whom were also graduate faculty at the university. Assisting the lead staff would be several local teachers. These individuals would conduct many of the OEAGLS activities presented at the workshops. They were selected from participants in previous workshops, such as the NSF supported program held in 1980.

A critical element in the planning and conduct of the one day workshops was evolved between the second and third year of the program. Prior to the second year, a team consisting of Dr. Hug and a graduate assistant working in the program visited each site that was to host a workshop. Their primary purpose was to review the facilities to be used and to renew contacts with local environmental educators who, it was thought, could assist in the presentation of the workshop and in recruitment of teachers. These visits were reasonably successful in accomplishing their purposes. At one location the local contact person was an assistant superintendent of the county school system. He was extremely effective in coordinating local arrangements for the workshop and in advertising it among the teachers in his county school system. Using that experience as a cue, prior to the third year of the program the two principal investigators visited each of the six localities chosen for the workshop and met with administrators from the city and county school systems. In all but two cases they were able to secure excellent cooperation from the administration, who agreed to inform school principals regarding the nature and objectives of the program, and to distribute information about the program to teachers through the school courier service.

Formative Evaluation

An important factor in the success of the awareness workshops was the continued attention of the project staff to workshop evaluations. Two types of evaluations were done for each program. First, a three item evaluation was completed by participants following each major presentation and each concurrent session (see Figure 3-2). The

Name of Presentation _____

1. The presentation was 1. very interesting
 2. interesting
 3. somewhat interesting
 4. not very interesting
 5. boring
2. My knowledge level
 1. increased greatly 2. increased somewhat 3. did not change
3. I (circle) will / will not use the material presented

COMMENTS: _____

Figure 3-2
Session Evaluation Form

items indicated interest in the session, the importance of the material and whether the participant planned to use the information presented. When all forms were collected for any one session, the presenter of that session was able to gain immediate feedback on its effects. The project staff was also able to perceive immediate needs of the total group and make adjustments in approach or scheduling to meet those needs. The short forms therefore served as a formative evaluation and to identify problem areas that might affect responses on the second type of evaluation. An analysis of data collected from these questionnaires was performed. Figure 3-3 contains a summary of the data for each of the sequence of twelve awareness workshops. Graph A is a summary of responses to the "interest" item. It can be seen that although there was variation between workshops on the degree of interest participants found, the mean response always ranged between interesting and very interesting.

The participants' perceptions of the knowledge levels gained from the workshops (Graph B) also were high throughout the workshops with the mean response ranging from increased somewhat (2) to increased greatly (1). Teachers also indicated that they would use the materials (Graph C) with the mean response focussing on the "yes" (1) end of the scale.

There does not seem to be a change in quality of the workshops with time. It was anticipated that there should be some type of improvement with experience. The lack of such a trend in the data can be explained in several ways. First there was not a

great deal of room for improvement on participant responses. Even the first workshops were very highly rated. Therefore any upward trend in the data would be difficult to obtain. There also may be a "fatigue" factor; that is the first several workshops were a new experience and so the presenters put extra effort and enthusiasm into them. Therefore, even though there may have been rough spots, this enthusiasm carried the participants over them. Later, and there does seem to be some type of sag in the data on the 5th through 8th workshop. This enthusiasm may have waned a bit, with experience and the now polished nature of the workshops influencing the data from workshop 9 on. Regardless, these data do show that the workshops were well received by the participants. It was a very successful program.

At the end of each awareness workshop all participants completed an open-ended questionnaire in which they expressed their attitudes about the atmosphere of the workshop, its value to their teaching, and changes that might be made to improve future workshops. Participants in inland workshops were also asked whether they felt that Lake Erie was important to teach about in their geographic area. This summative evaluation provided an overall indication of the workshops' impacts. The long evaluation forms are included as Appendix G. Records of the Education Program contain synopses of all the awareness workshop evaluations, from which it is possible to chart the continued growth and responsiveness that contributed to the Infusion Program's success. The results of these open ended evaluation forms support the conclusions above, that the

workshops were very successful in accomplishing their objectives. They were received with a great deal of enthusiasm by the participants. Their success indicates in part the value of the consistent and thorough formative evaluation techniques used. The workshop organizers were able to spot any problem areas and correct them during the workshop or by the time of the subsequent workshop thus leading to a consistently high quality program.

During the second and third years of the Infusion program 12 workshops were conducted over the State of Ohio. Figure 3-4 includes maps of Ohio showing the locations of each year's workshops and the areas from which participants were drawn. Over 600 teachers and administrators were enrolled and some 4000 OEAGLS activities distributed through the program. The effectiveness of these workshops in dissemination and use of materials was documented in a research project carried on in 1983-84. A summary and interpretation of the results is included in the chapter on summative evaluation.

Newsletter

Another awareness task of the Infusion Project was to continue publication of Middle Sea. This newsletter had become recognized as one of the best of its kind in marine and aquatic education. With the initiation of the infusion program, however, its focus changed from emphasis on new OEAGLS activities to one of broader service to teachers. Each issue included a feature article dealing with information on Lake Erie of use to teachers, a classroom activity, reviews of teaching materials or publications and announcements of events of interest to teachers. The variety of Middle Sea articles reemphasized the interdisciplinary nature of marine and aquatic education and highlighted the workshops, publications and plans of the Sea Grant program (Appendix D). This proved to be an excellent vehicle for keeping in contact with teachers who participated in the workshops. It served as a reminder of the availability of activities and materials in marine and aquatic education, and of the interest of the Sea Grant staff in the activities of the teachers it has served.

Implementation Component

The tasks of this component as specified in the proposal were to extend opportunities to Ohio

teachers for obtaining in-depth background in knowledge and curricular materials related to marine and aquatic education, and to provide continuing assistance to Ohio educators.

The implementation component was founded on two types of courses. The first was the Humanities of the Seas series of three summer workshops beginning in 1976. These were supported by the Columbus Council of the Navy League of the United States. The second was an inservice seminar in Marine and Aquatic Education piloted in the spring of 1979 in Mansfield, Ohio. The summer workshop was relatively expensive because it included an extended field trip along the Lake Erie shore. As Navy League funding was exhausted these costs had to be borne by the teacher participants. Also, tuition had to be charged. When field trip expenses plus tuition had to be paid by participants the cost became prohibitive. In the summer of 1978, with partial funding from the Navy League, only seven teachers took the workshop. The original rationale then was to bring both programs under Sea Grant, allowing the university to waive tuition and to provide funds to defray the expenses of the field trip. Under those conditions the courses would be accessible to a much larger number of teachers.



A Coast Guard cutter was included in a tour by Navy League workshop participants.

The inservice program was scheduled for ten 2.5-hour evening sessions and one all day field trip. The summer workshops met for one-half day every day for two weeks and included one all-day field trip. In addition the summer program included optional activities offered by the institution in which the sessions were being held. For example the staff of the Cincinnati Zoo conducted sessions on marine and aquatic reptiles, endangered species and several other

topics. These sessions included tours of the appropriate sections of the zoo. Both summer and inservice programs focus on use of OEAGLS materials in presenting information regarding the Great Lakes and the Oceans. A sample syllabus is included as Appendix H.



In-depth exploration of activities was possible in implementation sessions

The content of both types of programs is similar. Lake Erie and the Great Lakes are used as a focus for teaching content information about the world's large bodies of water. Implications of a concept for the oceans and lakes are drawn through the discussions, lectures, activities and visual aids. Content from all relevant disciplines is presented. In addition to the science related content usually associated with courses about water, significant time is devoted to the visual arts, music, literature and crafts. Concepts in history, economics and transportation are presented. Each topic is developed through an activity. Most are the OEAGLS activities, but others are drawn from the Crustal Evolution Education Project, Project COAST, and Ocean Related Curriculum Activities (ORCA). Each activity used becomes a basis for discussing the concept in greater depth, providing teachers with the confidence necessary to adequately teach the concept in their own classes. This type of approach requires a great deal of instructor time for dealing with the many personal interactions that result. Therefore either two faculty or one faculty and one graduate assistant have staffed each of the courses. This type of staffing seems adequate for class sizes up to about 40. At least one session of this course was offered each year through 1985 when funding levels became insufficient to continue them on a fee waiver basis. An adaptation was offered during the summer of 1987 at the University's field station on Lake Erie on a pay as you go basis.

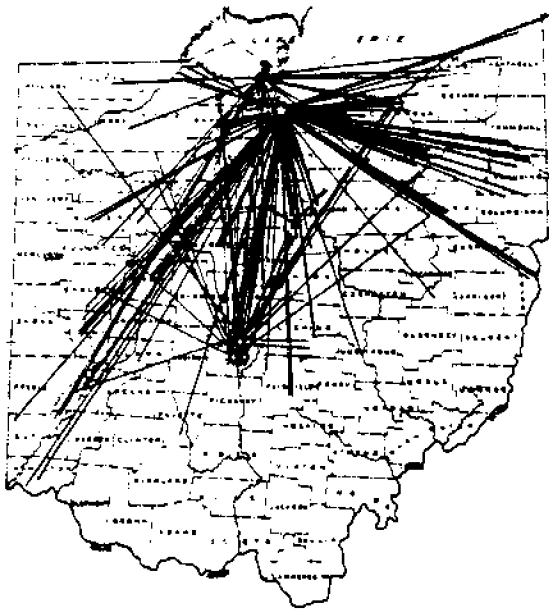


Teachers for Southwest City Schools had a sailing lesson as part of their course.

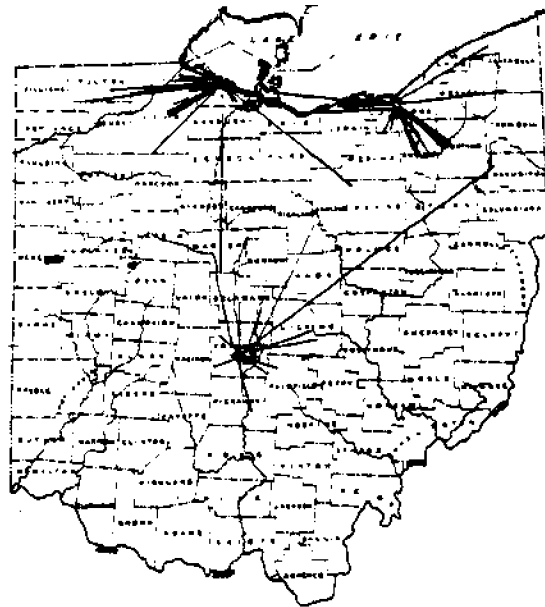
Field experiences have been incorporated into each of the implementation workshops. These normally consist of a one day field trip adapted to the locality. For example, in Cincinnati, along the Ohio River, the class visited a marina and docking facilities, and also a vocational program that trained workers for the river transportation industry. Since Cincinnati is a world famous collecting locality for Ordovician fossils, a lunch stop was planned so that teachers could observe and collect a variety of fossils. The Cleveland workshop included a trip along the lake shore to study erosional and depositional features, and visits to a marina, factory sites and a small marine museum. Field experiences are designed to reflect the interdisciplinary nature of marine and aquatic education, therefore not only science localities are visited but also those of economic and historic significance. The maps in Figure 3.3 indicate the locations of implementation workshops and field experiences for each year of the project.

FUTURE DIRECTIONS FOR INSERVICE TEACHER EDUCATION

The infusion program was terminated in August of 1983 as a focused effort of the Ohio Sea Grant Education Program. Experiences with the NSF science curriculum development projects and other innovative efforts in curriculum change have demonstrated that unless continuing assistance is provided to schools such new efforts ultimately are replaced by other curriculum developments or teachers revert to the older, more comfortable materials used prior to the implementation program. To avoid this, the Infusion Program as originally conceived proposed the eventual establishment of a marine and aquatic education specialist to work through a Sea Grant education office in cooperation



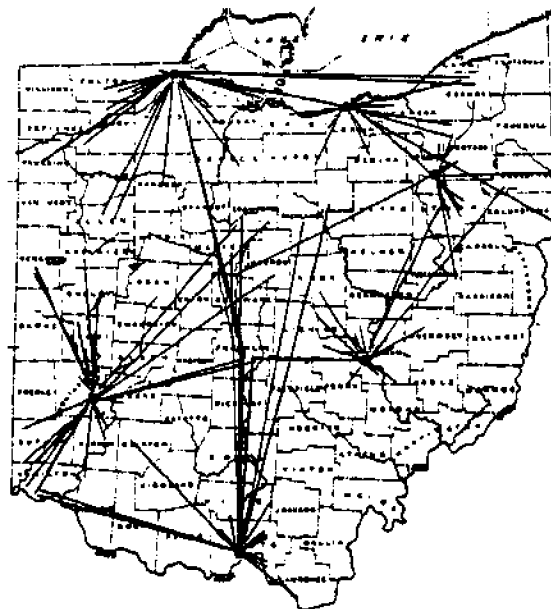
A. Pre-infusion Activities
1976-79



B. Infusion, Year 1



C. Infusion, Year 2



D. Infusion, Year 3

Figure 4.

Activity Sites with Attendance Areas, 1976-83

with the Ohio Department of Education. Because of cutbacks in funding and changing priorities of the national Office of Sea Grant, such a position has not been possible. Instead other ways needed to be found to insure that the efforts started with the OEAGLS and Infusion Programs were sustained. A course was designed and implemented called Marine and Aquatic Education. It has been offered at least once each year for graduate credit. Its average enrollment is now about 20, mostly inservice teachers. A second course has now been approved by the university, a Workshop in Great Lakes Education. These courses are now being offered on a regular basis through the university. In addition, Drs. Fortner and Mayer and many of their graduate students have continued the practice of presentations at state and national teacher meetings on Sea Grant related information and activities. Through these mechanisms, Marine and Aquatic Education has become a part of the continuing inservice program of The Ohio State University.

EFFORTS IN PRESERVICE PREPARATION OF TEACHERS

Several of the OEAGLS activities have been used in the preservice programs for the preparation of science teachers at the University. A particular effort is made during the first quarter of the Senior year, in which The Great Lakes Triangle is used in a unit on the Nature of Science, Its Everyone's Sea; or Is It? in a unit on Global Education, and Yellow Perch In Lake Erie in a session on the use of games and simulations. A session is also devoted to the nature of Marine and Aquatic Education and a review of teaching materials developed for infusing it into middle school and high school curricula. In addition, several other OEAGLS activities are used in the special methods component of that course, for earth science teachers and for biology teachers. About 40 students per year take this course.

It appears that the College of Education of The Ohio State University will adopt the Holmes Group proposals for teacher education. A proposal was developed for Sea Grant to design a teacher education model based on our Sea Grant Education program (1987). Through such a mechanism, preservice teachers would be trained in the procedures for developing activities based on aquatic information, taking advantage of the systems developed over the 10 years of the very successful Ohio State Grant Education Program. Changes in federal funding priorities prevented implementation of this proposal in 1987, but this could very well provide a national Sea Grant model for teacher education for the future.

4. SUMMATIVE EVALUATION OF OEAGLS AND INFUSION PROGRAMS

The major thrust of the Ohio Sea Grant Education Program has been at the middle school level and consists of the OEAGLS project and the Infusion project. A unique summative evaluation was planned and conducted for this entire program.

QUESTIONS TO BE ANSWERED

A variety of data sources were used to examine questions related to the effectiveness of the overall middle school program and its two components: the OEAGLS curriculum development effort and the Infusion program. The following questions have been examined:

1. Effectiveness of components:
 - a. Does a four week unit comprised of OEAGLS materials improve knowledge of Lake Erie and the world's oceans?
 - b. Do extended workshops increase the probability of sustained use of OEAGLS materials preferentially as compared to the one-day workshops?
 - c. Do workshops increase the probability of sustained use of OEAGLS materials over volunteer orders and distribution of activities through the Lake Erie program of the Center of Science and Industry (COSI)?
2. Overall effectiveness of the model:
 - a. Have student knowledge and attitudes regarding Lake Erie and the oceans improved over the interval in which OEAGLS materials were being actively disseminated through the Infusion program?
 - b. Have student perceptions of their sources of knowledge regarding marine and aquatic education changed during this interval?

DESCRIPTION OF RESEARCH

The evaluation program had three components, each with a different focus and methodology. The first component was designed to answer question 1a, above

It consisted of the evaluation of a four-week long earth science unit comprised of OEAGLS activities, using a unique time-series design for data collection. The second, designed to answer questions 1b and 1c, was a questionnaire survey of participants from four different dissemination programs. The last, designed to answer question 2a and 2b, was a survey of Ohio 5th and 9th graders to determine their level of knowledge of Great Lakes and ocean information and their attitudes toward Lake Erie and the oceans. The evaluation program was supported in part by a grant from the Sea Grant program and another from the Seed Grant Program of the Graduate School of The Ohio State University.

EFFECTIVENESS OF AN OEAGLS UNIT

The first component tested a four week long unit composed entirely of OEAGLS activities. In the formative evaluation, the OEAGLS materials had been evaluated individually using pre-post testing procedures with the classes of a single teacher. Although adequate for the purposes of the development process, this procedure did not provide the type of data that would permit an assessment of the overall effectiveness of the materials in changing student understanding of aquatic and oceanic information. This type of assessment can only be made when students have had sufficient time of exposure to such materials, more than the one or two days that a single OEAGLS activity typically takes.

Method

An earth science unit of four weeks duration was designed entirely from OEAGLS activities. This unit was used in a central Ohio junior high school with all of the students of an earth science teacher: six eighth grade classes totalling 105 students. These classes served as the pilot group. One other teacher was identified from the same school as the pilot teacher. His eighth grade earth science classes served as a comparison group numbering 35 students.

Data were collected regarding the pilot group's knowledge of the content of the unit through use of a unique daily testing system using six personal computers (see appendix J for a complete description of this system). Each student responded to a different

multiple choice item each day, beginning eleven days before the start of the unit and continuing for eight days beyond the end of the unit (Mayer and Raudabaugh, 1987). End of unit knowledge was assessed through the use of a multiple choice posttest. Items developed for use in the formative evaluation of the OEAGLS activities were used as the basis for both testing systems. A few additional items were developed and piloted prior to their use in the study. The same posttest was used with the pilot and comparison groups. The introduction of the OEAGLS unit was expected to positively affect the slope of the curve plotted from the data generated by the daily assessment of knowledge. A daily log of the classroom activities was also kept by the teacher to assist in the interpretation of the data.

Results and Discussion

Figure 4-1 displays the data accumulated concerning student knowledge of the unit objectives as reflected by performance on the multiple-choice items taken every day over the 44 days of the study. The first 11 days of the data are referred to as the baseline. They precede the introduction of the unit. The data exhibit a pattern of decreasing performance. This has been found in each of the studies using this unique data collection system. It appears that students begin to resent having to respond to questions on information that they have not been taught. As a result, they tire of trying to answer the questions correctly, and thus their performance falls. The positive influence of the unit on student knowledge is apparent from the gradual rise of the curve during the next phase of the data collection, the intervention phase (when the unit was being used). It is apparent that student knowledge increased gradually as the unit progressed. The highest class average was on day 36 (73.7 percent correct), the day that the unit posttest was given following the end of the unit. The mean percent correct on the unit posttest was 68.4 percent for the pilot group and 35 percent for the comparison group. Averaging the percent correct across the 11 days prior to the beginning of the unit, the baseline phase of the data collection period, yielded 42 percent. The pilot and comparison groups were similar in general academic achievement. It is therefore evident that the unit was indeed successful in raising student knowledge about Great Lakes and oceans by a significant amount.

The OEAGLS activities therefore seem to be effectively designed for facilitating student learning of information about the Great Lakes and oceans.

EVALUATING MODES OF DISSEMINATION

Four different procedures were used for disseminating OEAGLS activities. A research study, component 2, was conducted during the first half of 1984 to determine the relative effectiveness of the procedures in terms of the degree of usage of the materials by recipients (Mayer & Fortner, in press).

The four means of dissemination were as follows:

1. Awareness workshops. These were short 1 1/2 day workshops conducted for large groups of teachers in 14 different locations around the state of Ohio. Two university professors organized and conducted the workshops which consisted of several short lectures and a series of concurrent sessions using the OEAGLS materials. Many of the concurrent sessions were conducted by local teachers. Participants had the option of obtaining one quarter hour of graduate credit at no cost, however a small materials fee was charged. About 600 teachers enrolled in these programs.
2. Implementation workshops. These were the longer programs conducted every day for two weeks during the summer, or on a one-day a week basis for ten weeks during the regular academic year. Instruction was by the same two university professors and used the OEAGLS activities as a basis for communicating information about marine and aquatic topics and appropriate methods for teaching those topics. Participants received 3 to 4 quarter hours of graduate credit at no cost other than a small materials fee. About 180 teachers were enrolled in the 6 programs in this category.
3. Mail orders. Over a two year period of time, some 200 individuals ordered OEAGLS activities as a result of their being advertised in the project newsletter or in other sources. There was a nominal charge for the activities.

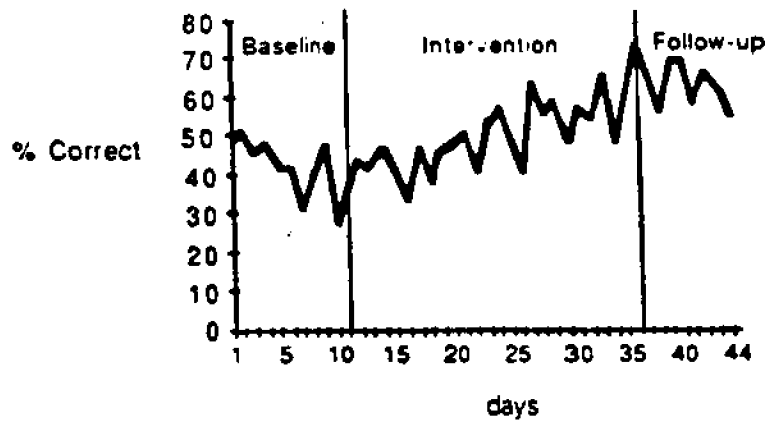
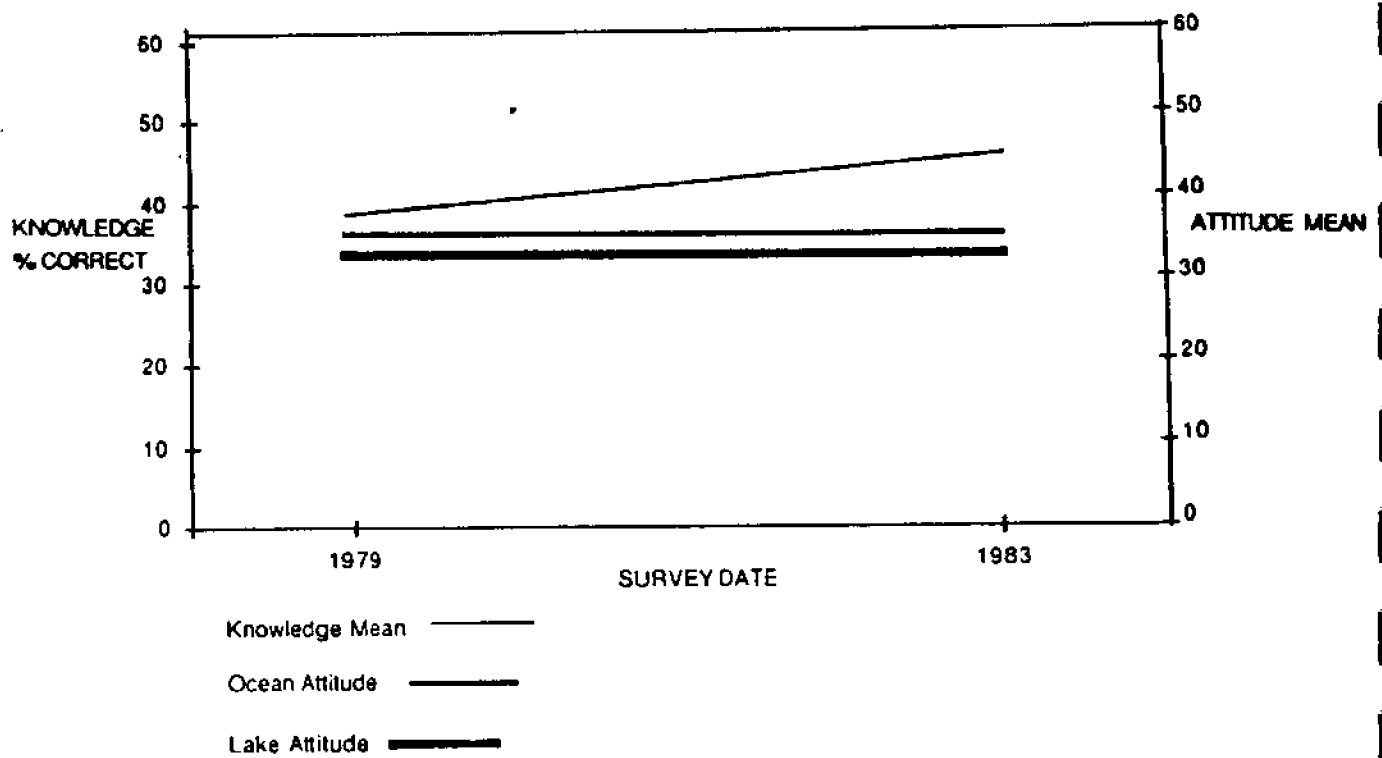


Figure 4-1. Trend of student knowledge during evaluation of the OEAGLS unit.

Figure 4-2. KNOWLEDGE/ATTITUDE CHANGES



4. Museum student program. A program on Lake Erie was offered by the Center of Science and Industry (COSI) in Columbus during the 1982-83 school year. About 400 teachers who brought their students to the program were given an OEAGLS activity of their choice.

Method

A questionnaire consisting of 20 items in an objective response format was developed to determine the relative effectiveness of the different modes of dissemination, and to obtain information on teacher background characteristics. The instrument was refined through its use by science education students enrolled in a first year doctoral seminar at The Ohio State University.

A 30% random sample was drawn from the awareness workshop, implementation workshop and mail order populations and a 20% random sample from the museum student program population. The questionnaire was mailed to the individuals drawn in the samples. A combination of follow-up techniques resulted in the following response rates: awareness 78%, implementation 76%, mail orders 61%, and museum 48%. A telephone survey of a 20% random sample of the non-respondents was conducted to determine the equivalence of the respondents and non-respondents on certain variables. The actual number contacted in each group was too small to do statistical comparisons, however it appeared that there were no differences between non-respondents and respondents on use of OEAGLS activities and on other items chosen from the questionnaire. Therefore the responses obtained can be considered representative of each of the populations.

Results and Discussion

A preliminary analysis was performed through the generation and examination of two-way tables using the groups as one of the variables. An intersection between awareness and implementation workshop groups occurred with a sizeable number of teachers having participated in both activities. Their data were separated out to form a fifth group.

Three usage variables were examined. In the first teachers were asked whether they were using the instructional materials during the current school year. Those who answered positively were then asked

if they had introduced them to other teachers in their school, and to teachers in other schools. Responses are included in Table 4-1.

A one-way analysis of variance was performed on the use variable between the five groups. The between group differences were significant at the 0.001 level. Therefore the various modes of dissemination were distinctly different in their effectiveness in terms of the subsequent use of the materials by the recipients. To determine which methods were most effective additional ANOVAs were run; between the awareness group, the implementation group, and the combined awareness-implementation group, and between the awareness and implementation groups. The results of the first were significant at the 0.08 level and the second at the 0.03 level. It therefore appears that the differences between the awareness and implementation groups on use of the OEAGLS activities are significant.

It is surprising to note that those teachers enrolled in the short awareness workshops had a significantly higher rate of usage, and also the highest rate of introduction of materials to other teachers in their schools. This is the reverse of what might be expected. In justifying the offering of the longer workshops it was believed that the longer time would permit greater depth of instruction resulting in more confidence with using the materials and thus higher usage. The relatively high usage by the mail order group was not expected since there was no direct contact nor teacher training. On the other hand it is not totally surprising, since these people had enough knowledge and interest in the activities to go to the trouble of ordering and paying for them. It is reasonable to assume that they would have the incentive to actually use them in the classroom.

Of further interest is the lack of usage among those teachers who were simply given an activity in the museum program without any formal workshop experience. The program was expected to raise interest in the subject matter to the point where teaching about it was stimulated. From these results it might be suspected that other short exposures on subject matter and materials, such as those offered at state or national conventions, may have similar low levels of impact on teachers.

TABLE 4.1
Use of Instructional Materials By Type of Dissemination Effort

Group	Use by Teacher		Introduced To Other Teacher		Introduced To Other School	
	N ¹	Percent	N	Percent	N	Percent
Awareness	102	78	82	73	74	16
Implementation	32	58	19	63	15	33
Awareness and Implementation	21	81	18	72	18	17
Mail Order	26	54	22	58	14	50
Museum	25	4	1	0	0	0
¹ N = Number of respondents on item						

Why the difference between the awareness and implementation groups? All workshops were conducted by the same people and followed similar philosophies using similar materials. Formative evaluations of the workshops indicate that the short and long ones were at least equally effective in training teachers. This leads to the conclusion that there must be differences in the teachers who elected to attend the two types of workshops.

Responses to items on the questionnaire permitted an examination of certain teacher background characteristics. A discriminant analysis program was run to determine which teacher background characteristics discriminated among the three workshop groups. Six characteristics (Table 4-2) were weighted on two functions with a Wilkes Lambda of 0.88 (12 df) significant at the 0.075 level for function 1 and a Wilkes Lambda of 0.094 (5 df) significant at the 0.095 level for function 2.

Background characteristics which were important in discriminating among groups were semester hours in education courses, number of years teaching, completion of Master's degree, number of education association meetings attended, and service on curriculum or textbook adoption committees.

The teachers selecting the short awareness workshops (Table 4-3) were less likely to have a Master's degree, more likely to attend professional education meetings and more likely to participate in curriculum and textbook adoption committees. It appears therefore that they are the type who are more interested in the professional benefits derived from such participation than in the academic credit given since it is greater in the longer programs. Those teachers taking the implementation workshops may be more concerned about gaining hours toward the Master's degree or toward the next level of their districts' salary scale. This is supported by the fact that teachers taking both workshops (hence accumulating the maximum amount of credit available) had the most education courses, were most likely to have a Master's degree and had been in the teaching profession the shortest time.

The results of this study provide some intriguing insights into the relative effectiveness of common dissemination modes. Simply giving an activity to a teacher is worthless. It won't be used. Those

individuals who order activities by mail will probably use them. What is surprising is that longer workshops do not lead to greater usage. This seems to be related to the type of individual attracted into each of the two types of workshops. Although similar in the usual teacher background characteristics, there seems to be a difference in several characteristics that together may imply a professional orientation that motivates the choices of workshops made by teachers.

For materials disseminators it is apparent that money is better spent on short workshops. They tend to attract those teachers who are more likely to use the materials presented. And obviously more workshops reaching more teachers can be offered for the money available.

EVALUATION OF STUDENT KNOWLEDGE AND ATTITUDES

Component three of the evaluation is a follow-up survey of knowledge and attitudes of Ohio children regarding the Great Lakes and the oceans (Fortner & Mayer, 1988). The Fortner and Mayer survey conducted in 1979 (Appendix I) provides baseline data for this research project.

Introduction

In 1979 the Ohio Sea Grant Education Program conducted a baseline study to determine the knowledge and attitudes of Ohio students about the oceans and Great Lakes (Fortner & Mayer, 1983). The study revealed a low level of knowledge, with fifth graders answering 37.6% and ninth graders 8.3% of questions correctly. Attitudes about the oceans and Great Lakes were related to knowledge, with high scorers having more positive attitudes. Students indicated that most of their information on the subjects was obtained through movies and television.

Results of that study were used to structure a program of curriculum development and dissemination. The Oceanic Education Activities for Great Lakes Schools (OEAGLS) were developed for infusion into the curriculum of grades 5-9, in part to address information needs identified through the 1979 survey. Dissemination of these materials through teacher training was done statewide, since Lake Erie is a statewide resource and regional differences in knowledge were identified in the study.

TABLE 4.2
Standardized Canonical Discriminant
Function Coefficients

<u>VARIABLE</u>	<u>FUNCTION 1</u>	<u>FUNCTION 2</u>
Education Courses	0.893	0.264
Masters Degree	-0.036	0.471
Years Teaching	-0.620	-0.373
Education Magazines	0.369	-0.381
Education Meetings	-0.049	-0.414
Committee Memberships	-0.248	0.693

TABLE 4.3
Means Of Variables Used In
Discriminant Analysis

<u>VARIABLE</u>	<u>GROUP</u>		
	<u>AW</u>	<u>IM</u>	<u>AW-IM</u>
Science Courses	3.79	3.69	3.76
Education Courses	4.79	4.53	5.33
Masters Degree	0.54	0.59	0.62
Years Teaching	14.99	14.50	12.67
Education Magazines	2.08	1.56	1.90
Education Meetings	1.26	0.81	0.71
Committee Memberships	1.15	1.34	1.24

In 1983 a second survey was conducted (Fortner and Mayer, 1988), offering a longitudinal study of awareness changes among Ohio students with regard to major water resources. Questions from the original test were administered in fifth and ninth grades, and a new body of information about Great Lakes concepts was also tested at both levels. The new knowledge items were drawn specifically from OEAGLS, providing a test of the materials themselves and developing a new baseline for future studies.

This study was designed to answer the following questions:

- (1) How had Ohio students' knowledge about the oceans and Great Lakes changed over the previous four years?
- (2) How had the attitudes of Ohio students toward the oceans and Great Lakes changed over the previous four years?
- (3) What did Ohio students know about specific Great Lakes topics being presented in new curriculum materials?
- (4) Had the perceived source of student knowledge about aquatic topics changed since the baseline study?

Methods

Research design. This was a longitudinal study with a comparison group. Students in Grade 5, 1979, and Grade 9, 1983, were the same cohort whose knowledge and attitudes over the period were subject to maturational and historical influences, possibly including exposure to the first Sea Grant curriculum materials for teaching about the Great Lakes. Students in Grade 9, 1979, served as a comparison group to determine if knowledge and attitude changes that appear among the age cohort reflected changes in general awareness or were related to specific happenings within the four year period. Finally, scores of students in both grades in 1983 provided a new baseline for future studies.

Survey development. The survey instrument consisted of the original 1979 instrument with some modifications. The final instrument contained the following:

(1) a test of knowledge--25 multiple choice questions on each of three test forms. Six items common to all forms served as a means of assessing equivalence of groups responding to the forms. Other items were classified as either science, social studies or humanities, and were equally divided among the three forms.

(2) an attitude assessment--2 sets of 10 semantic differential items with adjectival pairs describing the dimensions of potency, evaluation and activity of two referents, "The Ocean" and "Lake Erie." This portion was the same for all test forms.

(3) one item identifying the media source from which information was obtained relating to the content measured on the test of knowledge.

(4) test of knowledge from OEAGLS--multiple choice items specific to the content of OEAGLS, items which sought information about important economic, scientific, historic and geographic aspects of Lake Erie and the Great Lakes. The items were distributed ten to a test form, with science, social studies and humanities represented equally across forms.

Information about the participating schools' economic and geographic settings and about the classes' characteristics was obtained through a questionnaire sent to the cooperating teachers. These data were used for comparison of respondents in the two surveys, and to ascertain whether instructions were followed in the selection of classes for survey participation. Teachers also indicated whether they had participated in an Ohio Sea Grant workshop and whether they were using OEAGLS in their teaching.

Sample Selection. The State of Ohio was divided into Lake, Central and River regions as in the 1979 survey, since results in that project indicated that proximity to Lake Erie was related to higher knowledge scores (Fortner & Mayer, 1983). Schools listed in the Directory of Education for Ohio were numbered sequentially in two sets, one having schools that included grade five and the other that included

ninth grade. A computer program randomly selected the numbers of schools that would be invited to participate in the study, 5% of the fifth grade schools and 10% of the ninth grade schools. The principal of each school identified a cooperating teacher by a specified randomizing technique, and the teacher was asked to present the survey to the class that he or she taught during the last period of the day.

Analysis of data

Seventy-two fifth grade schools and 69 ninth grade schools returned usable answer sheets, a 64% and 62% response rate, respectively. A total of 1753 fifth graders and 1591 ninth graders participated in the study. A comparison of demographics for these students and the 1979 sample indicates no significant differences between the students sampled in the different years (Table 4-4).

Among the teachers whose classes answered the survey, 8% indicated that they had participated in a Sea Grant workshop (6 fifth grade teachers and 5 ninth). Eight percent also reported that OEAGLS were currently being used in their classrooms (4 fifth, 7 ninth).

An item analysis of each form of the knowledge test for each grade provided individual item frequencies and total test statistics. The KR-20 reliabilities for the fifth grade on the three test forms ranged from 0.38 to 0.51. Because of the low reliabilities, no analyses were attempted for the fifth grade data beyond the determination of summary statistics. For the ninth grade, KR-20 ranged from 0.56 to 0.72. A chi-square comparison of responses across forms for the six common items on the knowledge test revealed no significant difference ($p < .05$) between the groups that responded to test forms A, B and C. For summary analysis of this portion of the survey, therefore, responses to all test forms are averaged to determine a single knowledge score.

For analyses done as comparisons with the 1979 data, the knowledge test is divided into baseline knowledge, or that tested in the original 1979 test, and OEAGLS knowledge, the ten items per test form that were added in 1983. Another breakdown of knowledge items classified each as being related to science, social studies or humanities. Separate scores

for subtests of these subjects were generated for comparison with the baseline. Analysis of the attitude semantic differential portion of the instrument was based on the original 1979 instrument, for which a panel of experts identified the response that was most positive for each set of adjectives presented. Response frequencies were tabulated and summary statistics by grade level were prepared for each referent.

The single experience item, source of information about the oceans and Great Lakes, was analyzed for frequency of the responses and compared to knowledge and attitude scores. This was done to determine whether certain types of media use were related to knowledge and attitudes or whether respondents simply perceived media to be related.

Other comparisons between variables consisted of analysis of variance of knowledge scores in relation to sex, race and region of residence. These factors were related to oceanic knowledge in earlier studies (Fortner & Teates 1980, Fortner & Mayer 1983). Pearson's product-moment correlations were used to identify relationships between knowledge and attitudes for all students, and separately for high scorers ($X > 67\%$) and low scorers ($X < 33\%$).

Results

In the 1983 survey fifth graders answered 38.6% of the original questions about the oceans and Great Lakes correctly, and ninth graders answered 48% correctly (Table 4-6). These figures are essentially the same as those for 1979 (37.6% and 48.3% respectively). The percentages of correct responses for individual questions likewise remained the same for the 1983 survey, with a few exceptions. Scores of the 1979 fifth graders increased markedly over the four year period preceding 1983, culminating in a ninth grade cohort score of 48% correct.

Scores on the new items specific to OEAGLS were 28.2% in the fifth grade and 34.6% the ninth. Highest individual item scores were on social studies concepts, notably canals, why they were built and why they declined (60 and 61% correct among ninth graders), and the concept of cost efficiency in lake transport of cargo (61%). Lowest item scores were on items related to the lake effect (21%), type of

TABLE 4.4 Demographics of 1979 and 1983 Survey Respondents

Characteristic	5th 1979	9th 1979	5th 1983	9th 1983
Sex: Female	52.7%	49.1%	50.5%	51.0%
Male	47.3	50.9	49.5	49.0
Race: Nonwhite	7.6%	9.9	10.8	17.6
White	92.4	90.1	88.2	82.4
Region: Lake counties	30	28	31	30
Central counties	22	17	14	20
Ohio River counties	27	23	27	20
Number of students responding	1887	1750	1944	1579
Number of schools	79	68	72	69

TABLE 4.5 Knowledge Scores by Content Area

Content	5th 1979	9th 1979	5th 1983	9th 1983
Baseline items total	37.6%	48.3%	38.6%	48.0%
Science	41.0	50.6	40.5	49.9
Social Studies	36.8	50.0	40.5	50.6
Humanities	31.8	40.7	27.4	39.8
OEAGLS items total	NA	NA	28.2	34.6

goods shipped from the Port of Toledo (10%) and phosphates' responsibility for water quality problems in Lake Erie (8% correct).

Knowledge scores on baseline items were significantly related to attitudes ($P < 0.001$) (Table 4-6). High scorers had more positive attitudes than low scorers. As in 1979, the students' attitudes toward the ocean were more positive than those toward Lake Erie, and attitudes did not improve between fifth and ninth grades for the cohorts (Figure 4-2).

Certain demographic variables were related to knowledge scores. Analysis of variance indicated main effects of race in grade 5, with white students outscoring nonwhites. Main effects of region and race were noted in grade 9, with higher scores in the coastal area and among white students. A sex-race interaction was also detected in the ninth grade, white males scoring higher.

Perhaps the most important difference between the responses to the 1979 and 1983 surveys lies in the students' responses to the question, "Which of the following was the most important in teaching you about the oceans and Great Lakes?" In 1979, 28% of the fifth graders and 37% of the ninth graders perceived movies and television to be the greatest influence. This media category outranked all others including classes in school, reading outside of school, coastal activities, and public nonformal education such as in aquaria and museums. Respondents to the 1983 survey, however, credited school classes as their major information source (Figure 4-3), while movies and television ranked fourth and second for the fifth and ninth graders, respectively. Choice of information source was not significantly ($p < .05$) related to students' sex, race or region of residence. In the ninth grade, however, those 1983 students who identified classes in school or reading newspapers and magazines as information sources scored 49% or higher on the original items, while those selecting television, coastal activities and nonformal education institutions scored 47.6, 47.2 and 45.4% respectively.

Discussion

Over a four year period Ohio students in the age cohort beginning as fifth graders in 1979 and ending as ninth graders in 1983 exhibited an increase in knowledge about the oceans and Great Lakes, scoring almost 10% more on an interdisciplinary test in 1983 than on the same test in 1979. More information was gained in social studies than in science or humanities related to the aquatic environment. However, ninth grade scores in 1979 were almost identical to those in 1983, an indication that no progress was made during the period in increasing general awareness of the oceans and Great Lakes. Attitudes toward Lake Erie and the oceans, while remaining slightly positive, did not change commensurate with knowledge.

Immediate interpretation of these results would indicate that the teacher training efforts of the Ohio Sea Grant Education Program were not successful in reaching the target students, those who were fifth graders in 1979 and would be ninth graders in the follow-up of 1983. This may indeed be the case. However, several aspects of the study need to be considered before conclusions are drawn.

First, the magnitude of the Sea Grant effort, while great in terms of the outreach per dollar, was still small in relation to the size of the population, reaching only 8% of the state's teachers. Changes in the knowledge and attitudes of those teachers classes would not be likely to affect state averages markedly. Such changes should be documentable, however, in a subsample consisting of only the responses of classes in which the teacher had been in a workshop or was using OEAGLS. Those subsamples in 1983 were not large enough to use as a basis for judgement.

This leads to a second aspect of the study that warrants consideration in interpreting the results. The only demographic characteristics examined in the survey were race, sex, region of residence (proximity to bodies of water), and some macro-demographics of entire schools. In 1983 there were more non-white students respondents than in 1979, and the fact that non-white students scored lower as a group may have influenced the averages. It is likely, however, that there are other unmeasured demographic variables that could account for a lack of change over the period. For example, a

TABLE 4.6 Relationship of Aquatic Knowledge and Attitudes.
Attitude Means by Knowledge Level.

Group	All Students	High Scores (X > 67%)	Low Scorers (X < 33%)
5th 1979	3.76 N=1887	4.01 N=20	3.73 N=688
9th 1979	3.97 N=1786	4.15 N=207	3.75 N=289
5th 1983	3.72 N=1753	3.94 N=15	3.65 N=595
9th 1983	3.82 N=1591	3.94 N=153	3.056 N=269
5th 1979	3.49 N=1887	3.76 N=20	3.49 N=688
9th 1979	3.29 N=1786	3.34 N=207	3.20 N=289
5th 1983	3.49 N=1887	3.92 N=15	3.45 N=595
9th 1983	3.45 N=1590	3.60 N=153	3.28 N=269

*Maximum positive attitude = 5.00

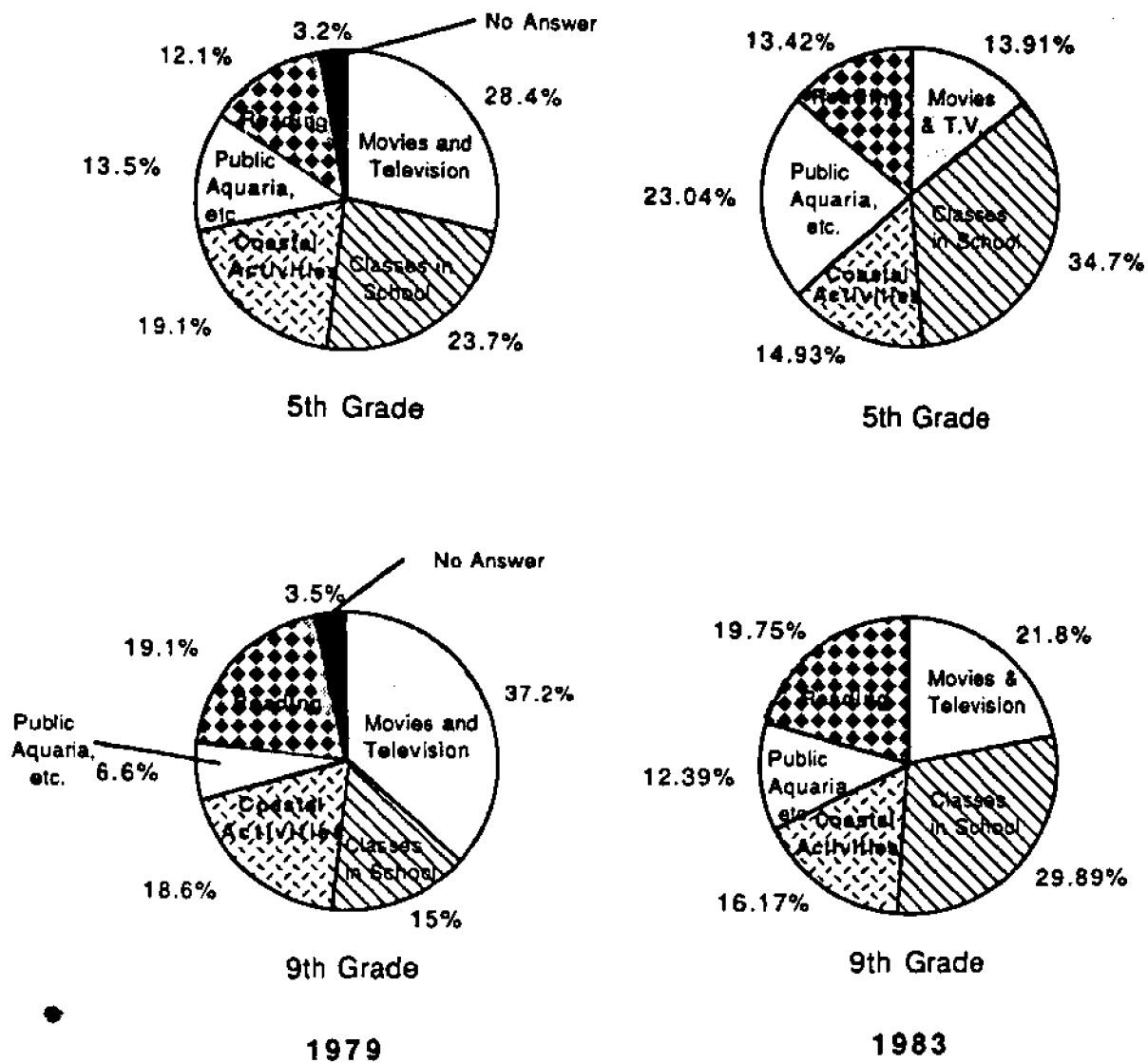


Figure 4-3. Perceived Influence of experiences on ocean and Great Lakes awareness

1982 study of ninth grade knowledge of marine mammals (Fortner, 1985) indicated a relationship of this attribute to language IQ. The potential threat to privacy that is involved with collection of such data as IQ scores makes their use in a statewide survey unmanageable, yet such characteristics may indeed be the limiting factor in assessing the success of teacher training efforts by this repeated survey method. Teachers themselves acknowledge notable differences in ability between entire classes of students that they teach from year to year. If 1983 was a "low" for ninth graders, this alone could cancel the effects of additional training in marine and aquatic topics for that group.

The main self-reported source of student information about the oceans and Great Lakes changed during the interim between tests, so that in 1983 the students were relying more on the classroom than on mass media sources. Changes in both classrooms and the media may be responsible for this. New curriculum materials for marine and aquatic education, such as OEAGLS, have become available, and teacher interest in inservice training programs is high. At the same time, the number of natural history programs on television has declined and fewer new programs are being developed (Steinhart, 1980). The popularity of media information sources will be an important factor to monitor in future administrations of this survey, as it will help aquatic educators target their efforts effectively.

The new items relating to the Great Lakes on the 1983 survey have established an additional baseline against which to compare the effects of educational programs over the next few years. Low numbers of correct answers on some very basic questions regarding Lake Erie provide an impetus for increased efforts in this direction. The ninth graders of 1983 are the voters of 1987 and beyond, and if only 8% know that phosphates have been responsible for Lake Erie's historic water quality problems, it is unlikely that they are well prepared for making responsible decisions about the future of our water resources.

This study has served the Ohio Sea Grant Education Program as a means of drawing attention to the need for aquatic education in the state. The student survey mechanism has indicated a need for further curriculum development in current topics related to Lake Erie and the oceans, and it has established classrooms as a recognized source for information on these topics. The expanded survey can be administered in future years, continuing a longitudinal study unique to marine and aquatic education in North America.

5. EFFORTS IN HIGHER EDUCATION

Because of the prospect of limited funding and the relative adequacy of university programs in limnology, fisheries and other aquatic degree oriented programs, the focus for the Ohio Sea Grant Education program has remained at the pre-college level. However, early in Ohio Sea Grant history, there were two major efforts focused at higher education. The first was a project at Bowling Green State University to develop a curriculum in marine technology. This began as an effort to be funded jointly by industries in the northern Ohio area, interested in obtaining well qualified personnel for employment in the building trades to work with construction problems along the lake shore. Because of the characteristics of materials and processes occurring along the lake shore, the unique problems associated with the construction of structures such as piers, break-water, groins, and building foundations, required the specialized training of foremen and construction engineers. Unfortunately, reorganization problems at Bowling Green delayed the initiation of this program. Although a curriculum was prepared, the program was never fully implemented.

With the major objectives of the pre-college program within sight of being firmly established, a decision was made in 1981 to conduct a needs assessment of courses and programs in higher education in the State of Ohio. It was felt that it was impossible to plan for the development of such programs without knowledge of what currently existed throughout the state. As a result a small grant was made available from Sea Grant discretionary funds to provide time for a graduate assistant to examine the catalogs of all higher education institutions in the state. At the same time key administrators of each institution were asked to identify an individual who had responsibility for coordinating their marine and/or aquatic programs. The list of courses compiled from the catalogs was sent to this individual who was asked to verify its content as accurately representing that institution's course offerings. Over 500 courses were found that dealt with marine and/or aquatic topics as the major focus of the course. There were offerings by over 50 institutions. It was found that there were many courses dealing with biological and geological aspects of the marine and aquatic environments, but few if any were available in the arts, humanities or social sciences.

The results of this survey have been assembled into a Directory available from the Ohio Sea Grant communications office. It was sent to individuals in each college and university in the state identified as program leaders in marine and aquatic programs in the survey. One function of the Directory is to assist individuals in identifying courses available at other institutions, allowing students to develop a more specialized background without having to offer such courses at each university. In addition it serves as a guide to counselors in the state in advising high school students of programs at the various state institutions. It has also been used by the Ohio Sea Grant staff in determining needs for new courses and programs in marine and aquatic topics in the state, thus serving as a guide for higher education efforts of the education program.

Several other developments sponsored by Sea Grant have occurred at The Ohio State University. A coastal engineering graduate program and a zoology course in oceanography have been developed with Sea Grant support. A cross-listed course and a workshop in marine and aquatic education have been established in Ohio State's College of Education and School of Natural Resources. These courses responds to the demand for more content-oriented material usable by formal and nonformal educators.

A recent (1987) effort is in response to the national demand for improvement of education programs. The College of Education at Ohio State has decided to join the Holmes Group, a group of 94 research oriented institutions of higher education who have agreed to make their teacher education programs into post-baccalaureate programs. Because of the success of the Ohio Sea Grant Education program locally and nationally, it was seen by college administrators as the basis for an innovative teacher education program. Accordingly a proposal was submitted as a component of the Ohio Sea Grant Program to secure planning time for the incorporation of the Ohio Sea Grant Education model into a graduate program for preparing biology and earth science teachers. A complete description of the proposed program is included as Appendix K. The proposal was not funded in 1987 because of changing emphases in education on a national level.

6. NONFORMAL EDUCATION EFFORTS

With an informed citizenry as a goal, Sea Grant programs frequently prepare news releases and informational media programming for general adult audiences. Such efforts typically originate within advisory service and are done mostly as current events reporting or as announcements of advisory programs. A few resource organizations such as Wisconsin Sea Grant and the Ohio Department of Natural Resources have approached media programming on a regular basis as an educational tool.

Radio. As a research project within Ohio Sea Grant, many of the major concepts from OEAGLS were put into the form of one-minute radio programs developed by environmental communications students. These programs were aired on central Ohio Radio stations over a one-month period and a telephone survey conducted to assess the effectiveness and the size of the general adult audience that was reached. The survey indicated low levels of knowledge about Lake Erie within the target group, but a desire to learn more (Fortner, 1981). Though the short broadcast period did not allow for high levels of measurable impact of the programs, the radio scripts and supporting literature have been used by advisory agents in subsequent program development. The level of audience interest encourages the belief that the general public as well as pre-college teachers and students may be receptive to Lake Erie information presented in short, attention-getting formats.



Museum Programming. Columbus' Center of Science and Industry (COSI) relies upon short, high-interest activities to provide educational experiences for its 300,000 visitors each year. During the summer of

1982, William C. Schmitt and his COSI Educational Department used some Sea Grant funds and the content assistance of the Ohio Sea Grant Education Program staff to produce "The Great Lake Erie Treasure Hunt." The program consisted of six demonstration shows plus hands-on exhibits to inform audiences about the historic, scientific and recreational importance of Lake Erie as well as its geology, climate effects and wildlife.

COSI judged the program to be the best summer show ever produced there, and visitor surveys done to evaluate the program's impact indicated significant increases in lake knowledge among the 46,000 summer visitors. Because of this success the program was modified specifically for school audiences and continued to be offered until 1985 (Fortner, 1986). During the first year of this program the OEAGLS modules most closely related to the program topics were distributed to teachers who brought classes to COSI to attend the program. This mechanism was expected to extend the use of OEAGLS and to increase the awareness of teachers and the general public of the importance of Lake Erie and the education role of Ohio Sea Grant. The subsequent evaluation, however, reported in the chapter on Summative Evaluation, indicated that the program was ineffective in encouraging teacher use of OEAGLS materials.



Visitors try water sampling at "The Great Lake Erie."

Television. An important finding of the baseline study conducted in 1979-80 was how students think they are getting their information about the oceans and Great Lakes. Movies and television are the most frequently reported information source (Fortner and Mayer, 1983).

The single experience shown to be most closely related to high knowledge scores was the number of Cousteau programs seen on television. When the Cousteau Society learned of this it agreed to cooperate in a research project testing the actual effectiveness of a television documentary in changing knowledge and attitudes on a marine topic.

With funding from The Ohio State University Small Grants Program and the Spencer Foundation, Dr. Fortner and a graduate student previewed an untelevised Cousteau Odyssey program, "Mammals of the Deep: The Warm Blooded Sea," and developed knowledge and attitude questions based on its content (Fortner and Lyon, 1985).

The questions were presented to two audiences, ninth graders at a suburban high school (Fortner, 1984) and adult cable television viewers, as a pretest, immediate posttest and delayed posttest. All the ninth graders responded interactively to televised tests using their home computer consoles from Warner Amex QUBE. Comparison groups in the school and a control group with QUBE took the test but did not watch the documentary.

Scores of the test groups indicated significant gains in knowledge, with most of the information retained on the two-week delayed posttest. Attitudes on marine mammal issues were positive before the program and temporarily shifted to a more strongly positive position following the broadcast. It was also found that a teacher could produce the same kinds of effects in a standard classroom situation by teaching from the script of the broadcast. The television documentary, then, was an effective information source, but so was a skillful and well-informed teacher.



School testing provided information on television's effectiveness for marine education.

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APPENDIX A

Sample Pretest

Used in OEAGLS Development

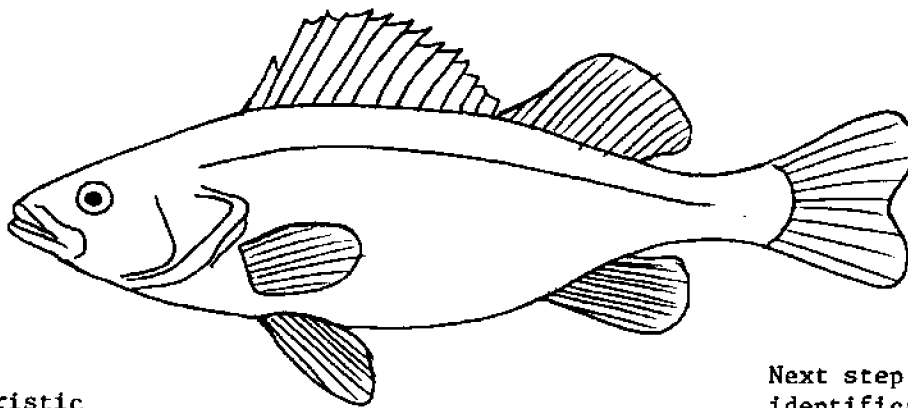
OCEANIC EDUCATION ACTIVITIES FOR GREAT LAKES STATES

PRETEST - Investigation # 24

Questions 1 through 3 contain words which could be used to describe the work which you do in class. Choose the number which best represents how you feel about the work that you have been doing. Record the number on the answer sheet.

1. Easy (1): (2): (3): (4): (5): Hard
2. Boring (1): (2): (3): (4): (5): Interesting
3. Clear (1): (2): (3): (4): (5): Confusing

The remaining questions in this test are about Ohio and/or Lake Erie. They deal with ideas that you will be discussing in class during the next few days. Since you probably have not covered this material, you are not expected to know all the answers. We want to find out how much you already know about these topics before you do the work in class. Please read each question carefully and decide which is the one best answer. Mark your answer on the separate sheet. If you do not know an answer, you may guess.



Characteristic

- 1A. Lateral line
- B. No lateral line
- 2A. Dorsal fins joined
- B. Dorsal fins separate
- 3A. Rounded tail
- B. Forked tail

Next step or identification

- 2
- Sunfish
- Sculpin
- 3
- Burbot
- Yellow Perch

Questions 4-6 refer to the box above; turn the page to find the questions.

4. The material inside the box is called a
 - a. crosslisting guide.
 - b. dichotomous key.
 - c. fish test.
 - d. category chart.
5. Using the information in the box, you can
 - a. identify the fish pictured.
 - b. find out some characteristics of the fish pictured.
 - c. find out some characteristics of all the fish named.
 - d. do all of the above.
6. The name of the fish pictured in the box is
 - a. Sunfish.
 - b. Sculpin.
 - c. Burbot.
 - d. Yellow Perch.
7. Dorsal fins are found on a fish's
 - a. underside.
 - b. back.
 - c. sides.
 - d. ventral side.
8. A lateral line is a
 - a. row of sense organs along the sides of some fish.
 - b. dark stripe running all the way around a fish.
 - c. line in a fin that helps make the fin stiff.
 - d. mark that shows where the gills are located.
9. About how many families of fish live in Lake Erie?
 - a. Thousands
 - b. Hundreds
 - c. 50
 - d. 25-30
10. A parasitic fish found in Lake Erie is the
 - a. sucker.
 - b. lamprey.
 - c. livebearer.
 - d. sculpin.
11. An adipose fin is
 - a. the ventral fin nearest a fish's tail.
 - b. an extra fatty fin on the back of some fish.
 - c. another name for the tail fin.
 - d. the thick flap that covers the gills.

12. Barbels are sometimes found on a fish's
- a. head.
 - b. tail.
 - c. sides.
 - d. back.
13. Which family of Lake Erie fish does not provide food for humans?
- a. Temperate Basses
 - b. Trout/Salmon
 - c. Herring
 - d. Killifish
14. Which family of Lake Erie fish is not commonly used as bait?
- a. Sunfish
 - b. Silversides
 - c. Sculpin
 - d. Mudminnow
15. The common name of a fish may be based on
- a. what it looks like.
 - b. where it lives.
 - c. a sound it makes.
 - d. any of the above.

APPENDIX B

Attitude study for pilot testing

Appendix B: Attitude study for pilot testing

Attitudes were assessed through the use of an innovative intensive time series design developed at Ohio State (Mayer and Monk, 1983). Items originally used in the baseline study (Fortner and Mayer, 1983, Appendix I) were adapted for use. These are of the semantic differential format and focus on attitudes children hold toward Lake Erie and the ocean. Additional items from ongoing studies using the intensive time series design were also used to assess attitudes toward the class and teacher. One item was randomly selected from each of the four types of items for each student for each day. Therefore each student in a given class had a different test and no student received the same test a second time until all items had been used. A computer program has been developed for selecting items and printing student test forms. Data are collected according to the following design:

Pilot group

O1, O2,...OK10,IO11,...IOK30,O31,...O45

Comparison groups

O1,O2,...OK10,O11,...OK30,O31,...O45

O=Observation (Attitude assesment)

K=Knowledge assessment

I=Treatment or unit

The numbers are class days. Daily means will be computed for each pilot group and for each comparison group. Data from the items focusing on Lake Erie and the oceans will be considered dependent variables. Those relating to teacher and class will be considered environmental variables. Analyses used will be time series analyses programs. Regression between environmental and dependent variables will be factored into the analysis programs to compensate for variances introduced into attitudes from those two sources.

APPENDIX C
"Water Education Curriculum"
(Description of OEAGLS Evaluation)

CHAPTER SIX

THE WATER EDUCATION PROJECT

Original Proposal and First Year

In the mid-1970s, Richard Henry, a professor of science education at Middle University, completed his association with the Earth Science Project (ESP), a program designed to write supplementary materials for middle school science classes. Henry felt the type of materials produced by ESP, short modules consisting of two to three lessons organized around a common theme, were very appropriate for subject matter not typically a part of the middle science curriculum. Henry believed such an instructional design would also be pertinent for marine education materials, another curriculum area usually neglected in middle schools. Henry prepared a proposal for Sea Grant, a research and educational agency of the U.S. Department of Commerce that supported pre-collegiate curriculum development in marine education. Sea Grant approved the project and Henry began work on the Water Education Project (WEP) in 1977. (Interview notes)

The main purpose of Henry's project was "to improve student understanding of important concepts related to oceanic study that would be appropriate to interior regions of the United States." In the proposal, he wrote topics would "relate to water bodies such as the Great Lakes and the larger river systems," and be "appropriate for students in the middle school years." Henry listed fourteen broad type areas that would be covered in the project's materials:

- 1) Water recreation
- 2) Shipping and shipbuilding industries
- 3) Uses of water and the effect of water use
- 4) History of water transportation
- 5) Food resources of lakes and rivers
- 6) Evolution of lakes and rivers
- 7) Ecosystems of lakes and rivers
- 8) Lakes and rivers as political boundaries
- 9) Lakes and rivers as energy sources
- 10) Aesthetic and cultural resources of lakes and rivers
- 11) Mineral resources of lakes and rivers
- 12) Land and water management of lakes and rivers
- 13) Lakes and rivers as wilderness areas
- 14) Human geography of lakes and rivers

Each topic would be the focus in one or more activity packages consisting of one to three days of instruction for students. The activities would be usable by teachers "with a minimum of inservice preparation" and use equipment and materials that were "currently available to most teachers." A teacher guide would accompany each activity. (Project document)

Henry proposed that each topic would be developed by a three-person team, consisting of the principal investigator (Henry), a government, university or industrial expert on the topic, and a middle school teacher. The principal investigator and the middle school teacher would be responsible for the "development and informal classroom teaching of each activity (formative

evaluation) and the 'topic expert' will check the accuracy of the material in the activity." (Project document)

Henry described the formative evaluation stage as "necessarily informal, using perhaps as many as three different classes chosen by the development team as being representative of the intended consumers of the activity." He listed three sources of evaluation information:

1. Pre- and post-tests of the cognitive objectives of the activity. These will be of the multiple-choice format. Item analysis information will be collected and items revised and improved and pre- and post-test forms developed. These items will ultimately be used in the summative evaluation.
2. Teacher-user feedback. This will take several forms:
 - a) Marginal notes and comments of student and teacher materials.
 - b) Completion of a 'Teacher Feedback' form.
 - c) An audio-tape prepared by the teacher of his reactions and suggestions.
3. Observations of project personnel during trials of the materials.
4. Student feedback. This would consist of a standard form to which all students would respond with respect to interest level generated, difficulty of the activity, etc.

Revisions based on these data would be performed "as often as necessary until the development team is satisfied that the materials are effective for teaching the objectives intended." Henry envisioned producing 20 activities during the first year of the project and a total of 80 by the end of the proposed three-year development cycle. (Project document)

During the first year of the project, Henry organized an advisory panel to help generate specific activity topics from his general list and react to other ideas from Henry or cooperating classroom teachers. Henry selected teachers based on their work with him in previous projects and identified others from a series of workshops he was presenting on marine education. Development work was begun on six topics, most involving the geography, hydrology, and meteorology of the Great Lakes. (Interview notes; Project publication)

During this period, the development and evaluation procedures that Henry authored in his proposal were implemented and only slightly modified. The formative evaluation instruments proved useful. The team approach to the development and testing of the materials worked well, although the subject matter expert did not participate until after the activity had been written and tested. However, rather than describing these first-year activities in detail when Henry served as the sole director of the project, the narrative will instead focus on the period 1978 to 1980 when Henry was joined by Marilyn Simpson as co-director. The development routine Henry established during the

first year remained intact in later years and development activities after Simpson arrived differed only in that Henry now had a permanent associate to share ideas and critique lessons. Other reasons for concentrating on this later period include the fact that nearly 75% of the activities were completed after Simpson arrived, and both developers considered the Water Education Project a team venture.

Building a Working Relationship

Simpson's faculty assignment at Middle University was to split her time 50-50 between teaching education courses and writing for the Water Education Project. Her previous development experience was limited to some work she had done for her own junior high teaching and school districts in another state. None had involved systematic field-testing or formative evaluation, and she judged WEP to be "considerably more sophisticated" than her earlier work. (Interview notes)

Simpson clearly looked to Henry to provide the direction on the team. He was a full professor with considerable experience in curriculum development and evaluation had designed this project, and already had one year of experience in preparing the materials. Henry remembered that, if anything, Simpson was too deferential. "The first year she was less critical and tended to take my suggestions as requirements. But then she learned better," Henry said. As Simpson became familiar with the project's routine and gained experience in writing materials and organizing field-tests, their relationship evolved into more of an equal partnership. (Interview notes)

Each took full responsibility for certain topics and guided the development of the lesson activities. Simpson noted that each activity listed one of them as an author, but the other "passed clearance" on all content. "We brought different skills into the project. I have a way of writing that is very precise and clear in the form of giving instructions. Dick's strength is in the pedagogical model; he is very creative, very open to new things." The two worked in offices directly across a hallway and met informally nearly every day to discuss new ideas, report on classroom observations, and react to earlier lessons.

Writing Lessons

Activities were either developed from the ideas of Henry and Simpson or were based on teacher-developed lessons. The activities begun by the co-directors came from Henry's original list of topics in the proposal, suggestions from the advisory committee, or ideas in books, articles, or scientific reports. Simpson's idea for the first lesson she developed came from a popular song, "The Wreck of the Edmund Fitzgerald," about a shipwreck on the Great Lakes. She had always liked the song ("From the first time I heard it, I thought this was a teachable moment"), and the content focus of the project allowed her to develop her interest into a full-blown instructional activity on the "Great Lakes Triangle", an area with supposedly mysterious forces, a la the "Bermuda Triangle." (Interview notes)

They also developed an initial list of objectives to guide their first draft based on the answers to the questions of "What do we want to teach?" and "What do we want kids to learn?" Henry didn't find strict behavioral

objectives useful ("Their value doesn't outweigh the amount of sweat it takes to write them"), and usually found it difficult "to identify objectives when we wrote them in the cycle at an early spot." But Henry felt that objectives helped identify "really vital, crucial learning points," and listing them gave the writing specific direction and provided the basis for the pre- and post-tests that accompanied each set of activities. "By the time you finished a first draft, you'd have the objectives. There were some minor changes in them after the pilot so they could be more precise and better reflect the nature of the activity." (Interview notes)

After completing the first draft, the author would submit it to the other co-director for review. Simpson said she critiqued these early drafts on the "basis of experience and background." She would estimate the length of time required for the activity to determine if it was too long for middle school students. Another concern for both Henry and Simpson was that activities not demand special classroom equipment or require logistical arrangements (such as field trips) that would make them difficult to implement. (Interview notes)

If an activity was to undergo major changes during its development, those changes were likely to come during these initial brainstorming and review sessions. Simpson believed, "Our internal collaboration was responsible for the most substantial changes. After we got into the field, the changes were mostly format changes or logistic changes. We couldn't anticipate timing and logistical problems in the review process. Dick and I tried, but we couldn't always do that, but classroom observation helped us there." Despite these limitations, Simpson estimated that most of the "substantive" changes occurred during the internal review sessions before the materials went to the field trial. (Interview notes)

Henry agreed. "Once we developed an activity, the basic structure stayed pretty much the same. I don't remember that we ever threw an idea out. We made minor changes explicating the activity better." Henry felt part of the reason for this was due to the fairly fast, consistent pace of development. He and Simpson typically had three or four modules in development at one time at different points in the cycle. The time restrictions and the modest funding for the project meant that once the general outline of an activity was set, the authors did not have the opportunities for large-scale revisions. Henry described these restrictions on the scope of revisions as "blinders." "You develop blinders in a sense, but that's OK. Brainstorming, reviewing, reworking is expensive. By and large, I don't think that's effective. What we've done on a modest scale is every bit as effective. We produced as much with this project as did ESP (the Earth Science Project) with ten times more money. Blinders can be helpful, economical, keep you on track." (Interview notes)

When the activity reached a point where the content was well-established, the primary author would arrange with a middle school teacher to serve as co-developer and pilot-teacher of the module. The teacher often began the process of preparing items for the pre- and post-tests. However, both Henry and Simpson would review these questions and usually write several items themselves. (Interview notes)

A second approach to the preparation of an activity began with an idea developed by a teacher. The co-director identified these teachers through

their masters-level courses at the university, inservice workshops, and Henry's contacts with teachers in the public schools. Teachers wrote up their ideas and submitted them to Henry or Simpson. Some teachers remained involved in the development process as Henry or Simpson reworked the original idea. Other teachers were not asked to participate in the revision process or chose not to be involved. (Interview notes)

Henry and Simpson approached the teacher-developed activities with the same criteria they used to judge their own lessons. In addition, they were concerned with revising lessons to make them usable for other teachers. In many cases, the original lesson was too narrowly written and not generalizable beyond the teacher-author's classroom. Lessons also had to be reduced in length and updated to account for recent research findings. (Interview notes)

Typically, Simpson and Henry did not use the original author as the pilot-teacher of the lessons. They believed it was essential to test the activities in another setting in order to determine their success. Simpson said, "The materials were written to stand alone and by testing them in the author's classroom, we wouldn't find that out." These pilot-teachers, however, were not considered co-authors. (Interview notes)

Field Tests

In his original proposal, Henry anticipated involving "as many as three different classes" representative of the intended users of the activities in the field-tests. In practice, the developers did use three to four classrooms, but typically they were all taught by the same teacher in the same school. Thus, each activity was tested by 100 students or more. (Project document; Interview notes)

Pilot teachers received a pre- and post-test assessing the content of the activities. Each test contained approximately 10 multiple choice items, and unless an item-analysis of the pre-test indicated major problems with an item, the pre- and post-tests were identical. These tests also contained three Likert scale items measuring students' opinion of the material's difficulty, clarity, and interest. (See Figure 7) Teachers also received an "Activity Evaluation Form," which asked them to rate the material's difficulty and interest, and the clarity of the teacher's guide. (See Figure 8) In addition to the data collected from the forms, Henry or Simpson observed each pilot-teacher on at least one occasion. Thus, the data collected from each field test included pre- and post-tests, questionnaires, and observations (Project document; Interview notes)

The developers felt each of these data sources provided useful information. But the glue holding the data together came from their participation with the complete evaluation process, especially their first-hand contact with the pilot classrooms. (Interview notes)

Simpson was firm in her belief that developers also had to be evaluators:

I would always do evaluations myself. You do curriculum development not just as a function to produce a product. You do development because you believe something needs to be taught. Developers have to ascertain personally that they do that. They see the light in the kids' eyes.

The project never considered an outside evaluator, but Simpson would have vetoed the idea anyway. An outside evaluator would not have shared their "commitment" or "zeal" and would not have been as aware of critical facets of the program as were she and Henry. Simpson argued,

Even though somebody else would have been objective and gone through the evaluation steps one-two-three-four, the thought processes and background and sense of urgency of getting the job done right would not have been there. I have a feeling--no, I know--you learn better by experience, and if I were to hear a report or see a written report, it wouldn't do the same thing for me. Knowing the kinds of affective results we were looking for, I can see more observing the classroom process directly. (Interview notes)

Henry shared Simpson's commitment to the "developer-evaluator" role and the need to be immersed in classroom activities. He compared the field-testing procedures in the Water Education Project with the larger Earth Science Project (ESP).

ESP was a nationwide expensive test. Pilot-teachers were representative, but the feedback we got from our own small group was no different in terms of quality or being useful. I lost confidence in the need for large-scale field tests. You must have a developer-evaluator who works in schools in a daily, regular basis. We know teachers; we supervise student teachers; we're out in the field a lot, and we know what kids can do. Some of these activities we did the piloting ourselves. If you have that characteristic, knowledge of a classroom, a developer can select teachers who can help you and develop the activity to generalize it. It also gives you the confidence to write good materials and make changes.

Henry's and Simpson's reliance on personal knowledge of the evaluation procedures and classrooms to help understand and interpret field-test results should not mask their use of the other data they collected. Simpson thought the test items were most useful in a confirming role, "assuring us the content was coming through." Henry found the test scores "sensitized" him to problem areas, especially in terms of content acquisition. However, the test results didn't necessarily explain why the problem was there. Once the item analysis gave him confidence in the item, Henry would next "relate the test items to objectives" and look generally at the materials to see if he could uncover a weakness in the instruction aimed at teaching that particular objective. Henry explained, "Maybe the reading level is too high. Maybe the activity didn't focus on the objective, it just missed the mark. You look at the teacher's guide. Maybe this is where the change has got to be made. You rely on observations. Classroom visits can flush out things not on the test. Somehow or another you ask does the activity handle the objective?" (Interview notes)

The teacher forms and comments were also valuable for Henry, especially in making procedures more generalizable. Teachers asked for "more information and better, clearer directions." Simpson recalled that teachers provided useful information about the extent of student involvement across an entire class. They also reported on the availability of the materials and the ease of implementing the activities. Simpson recalled making changes in some lessons based on teacher comments that procedures or logistics were cumbersome. (Interview notes)

Having just one pilot-teacher per activity did pose some data interpretation problems for Henry and Simpson. Henry recalled the pilot of a weather activity occurred in a "rather chaotic classroom, and so we weren't really sure how well the activity was doing." Simpson felt that in several trial classrooms the pilot-teacher represented, to some extent, an optimum user and not a typical teacher. But Simpson continually compared the performance of the pilot-teacher to her knowledge of other teachers and her own teaching experience in order to judge whether the materials would work in different settings. She did not expect the materials to be suitable for all teachers. "You know intuitively there are teachers who will never use these materials. The only thing that will change their routine is a school assembly." But the reliance on her experience and contact with teachers in WEP workshop settings helped convince Simpson that the materials could be used successfully beyond the pilot classrooms.

Post-Pilot Revisions

Generally, the activities did not undergo major changes after the pilot-testing. Henry remembered that by this time "the basic sequence of the activity was set." A pilot-teacher and co-author of an activity, Elaine Bright, agreed with Henry's assessment. "The pilot versions and final copy of the activities I participated in were basically the same." Bright saw more substantive changes between her original lesson (that she submitted for a Henry workshop) and the pilot version produced by Henry than between the pilot and the final copy. (Interview notes)

Simpson recalled revisions that provided more explanation and background for teachers and, in some instances, furnished additional content information for students. Question sequences in the student booklets were revised, teacher guide instructions improved, and in a few activities, entire lessons were "scrapped." (Interview notes)

Simpson's changes in her "Great Lakes Triangle" activity were typical of the scope of revisions and illustrated how evaluation data contributed to the process. In the original lesson students had to complete three activities, including designing a Great Lakes ship, forecasting and tracking storms, and mapping characteristics of lake bottoms. During the field test, Simpson observed that these three activities took too long and that the students finished at different times. She revised the activities to make them equal in length and rewrote the teacher's guide instructions to create three groups of students, each required to complete only one of the activities. (Interview notes; Project publication)

A second problem involved an activity in which students plotted the location of nearly 50 ship and plane disappearances in the Great Lakes area.

Simpson's observations of the field-test showed that this activity also took too much time and was too difficult. "Either the kids couldn't do it, or do it quickly enough. Watching them struggle with it, I knew it wasn't going to work." In the final version, the disappearances were printed on the map. (Interview notes; Project publication)

Henry and Simpson worked separately on their own topics, but they continued to exchange information and ideas. They each did the final editing of the other's materials. The teacher-author typically was not involved in the revision process. (Interview notes)

The revision process involved sifting through a considerable pile of data. Student workbooks were collected after each field test to assess the reading level. Students had been asked to circle each word they didn't understand. The student test pages and teacher questionnaire forms provided cues for certain changes. "One hundred forms," remembered Simpson, "and we went through every one of them trying to see where kids broke down. But we couldn't have figured it out if we hadn't been there." (Interview notes)

Some data they ignored. Simpson recalled this happened infrequently, but in a few activities when the teacher comments or the student data indicated a problem with something "crucial to the rest of the lesson," it was retained in spite of the results. Henry remembered that if there was a conflict between what he and a pilot teacher thought was appropriate, he placed his emphasis on his own experience and judgment. In a simulation game on the War of 1812 originally developed by a teacher-author, Henry felt the activity was too complex. He cut one-half the role cards and changed some of the game mechanics to shorten the teaching time. But, "the teacher wanted more role cards. It took her three weeks to do the lesson. I couldn't see other teachers taking that long." Henry wanted to do further revisions, but "it was good enough as it was, and needed to get out." (Interview notes)

After the instructional sequence was settled and content finalized, the final step in the revision process involved content reviewers. Henry generally selected reviewers from the university community who had worked with him on previous projects. As it turned out, the main contribution of the reviewers was to confirm the accuracy of the content, rather than suggest major changes. "We never had any major problems in terms of rewriting," said Henry. He modified a geography activity based on outside reviews, a sentence here, a sentence there." Other suggestions included specifying more recent data or different graphics. (Interview notes)

Each final activity included a student booklet and a teacher's guide. The materials were published by the Sea Grant Office of Middle University and generally distributed to teachers at workshops. As new activities were written, they were placed in publication. By 1980, the final year of development, 23 activities had been completed. (See Figure 9) "Not every activity is exciting, innovative and dynamic," said Henry. "Some we didn't like very well, and some we didn't get wildly enthusiastic reviews on, but all of them are good. Teachers are using them because they are better than anything else." (Interview notes)

This assessment was not a criticism of the evaluation methods the project employed. Both Henry and Simpson felt their use of different data sources was

a valuable decision. Henry said, "You have to do different kinds of review. You have to have feedback from kids. I would like to have had more pilot-teachers, but I doubt it would have changed the results much." Simpson would design a similar formative evaluation component for her next project. "It was very valuable. Very time-consuming. I tell my students now what all we did, and they can't believe it. They say they'll never get done on time. I tell them 'you'll never get a good product if you don't.'"

FIGURE 7: Sample Pre-test

PRETEST - Investigation #12

Questions 1 through 3 contain words which could be used to describe the work which you do in class. Choose the number which best represents how you feel about the work that you have been doing. Record the number on the answer sheet.

1. Easy (1): (2): (3): (4): (5): Hard
2. Boring (1): (2): (3): (4): (5): Interesting
3. Clear (1): (2): (3): (4): (5): Confusing

The remaining questions in this test are about Ohio and/or Lake Erie. They deal with ideas that you will be discussing in class during the next few days. Since you probably have not covered this material, you are not expected to know all the answers. We want to find out how much you already know about these topics before you do the work in class. Please read each question carefully and decide which is the one best answer. Mark your answer on the separate sheet. If you do not know an answer, you may guess.

4. The Great Lakes are
 1. wildly involved with international shipping.
 2. not involved with international shipping.
 3. very much involved with international shipping.
 4. involved only with shipping from one lake to another.
5. The flag always flown on a commercial ship shows
 1. where the ship unloads its cargo.
 2. where the ship picks up cargo.
 3. in what country that ship is registered.
6. The major types of cargo shipped to the Port of Toledo is
 1. food stuffs.
 2. manufactured goods.
 3. miscellaneous goods.
 4. raw materials for industry.
7. From the Port of Toledo, the products that are shipped are chiefly
 1. food stuffs.
 2. manufactured goods.
 3. miscellaneous goods.
 4. raw materials for industry.

8. What foreign continent provides most of the trade at the Port of Toledo?

1. Africa
2. South/Central America
3. Asia
4. Europe

9. Through the Port of Toledo,

1. more ships import products than export them.
2. more ships export products than import them.
3. the number of ships used to import and export are equal.
4. only ships exporting products are allowed to use the Port of Toledo.

10. Even though Lake Superior is 600 feet above the level of the sea, it is still used by ocean going ships. These ships reach this 600 ft. level by means of which of the following?

1. elevators
2. dikes
3. locks
4. water ladders

11. Water to fill the lock chamber comes from what source?

1. Through the valves that open to the lower level.
2. Through the valves that open to the upper level.
3. Through water pumps.
4. Through the gates that allow the ships in and out.

12. After a ship enters the lock chamber from the upper level and the gates are closed, which of the following happens to get the boat down to the lower level?

1. The exit gates are opened, allowing the water to rush out.
2. The water is pumped out through drainage hoses.
3. The empty valve is opened, allowing the water to seek its own level.
4. The lock chamber is lowered mechanically until the water level in the lock equals the lower level.

13. Registry flags of different countries are flown on some ships even though the ships aren't from those countries. This is done to save money on taxes. These flags are called

1. flags of proposal.
2. flags of convenience.
3. flags of trade.
4. flags of international regulation.

14. The annual shipping season in the Great Lakes closes down when:

1. the grain elevators along Lake Erie and Lake Ontario close.
2. the steel mills in Youngstown, Gary and Pittsburgh shut down.
3. ice closes the shipping lanes and locks.
4. the workmen aboard the ships take their annual leave.

FIGURE 8: Teacher Questionnaire Form

1. Activity Number: _____
Teacher I.D.: _____

The questions in this form ask for your opinion concerning several aspects of the WEB activity which you just taught. This information will help guide possible revisions of the activity.

2. How much class time, not including the testing, did you devote to this activity? Was it sufficient? Comment.

3. In the boxes provided below, give an estimate of the level of student involvement in this activity. If all the students participating in the activity, what percentage were highly involved, moderately involved, etc.

	5 of Students
High Involvement	
Moderate Involvement	
Indifference	
Slight resistance	
Strong dislike	
Unable to rate	

4. Equipment: ☐ none needed ☐ easy to get
☐ undesirable ☐ hard to get, (but I got it!)

5. Instructional level is: ☐ just right ☐ too childish ☐ too mature
Additional comments:

6. Vocabulary level is: ☐ just right ☐ too easy ☐ too difficult, (explain)

7. Was the teacher guide clear enough? ☐ Yes ☐ No. (Explain)

8. Did the activity fulfill the purpose stated in the teacher guide?
☐ Yes ☐ No. (Explain)

9. Did the students have difficulty with the activity? Yes _____ No _____
If so, with what? _____

10. Your rating of this activity:
a) understanding the objectives ☐ Of value -- needs the revision suggested.
b) following the directions ☐ Worthwhile -- keep as is.
c) understanding the questions ☐ Worth salvaging -- make major changes described.
d) other? (Explain)

11. Feel free to make specific suggestions--what you think should be changed. Think of what you needed, what you had to work out for yourself. As a reminder of things, read through the following list before writing your comments (we know that we don't have everything listed!):

1. Organization of materials
2. Anything you added or changed
3. Problems with equipment, supplies, visual aids, etc.
4. Things that went wrong
5. What would you have done differently?
6. Any specific characteristics of students that were "turned on" or "turned off"
7. Evidence of learning or application of ideas
8. Creative modifications by students or teacher

Space for your comments (use additional sheets if necessary):

FIGURE 9

Final List of Project Activities

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

APPENDIX D

Middle Sea



SEA GRANT INFORMATION FOR OHIO EDUCATORS

Autumn 1985

Vol. 8, No.1

The Great Lake Erie

One of the lesser known Great Lakes resources is the art of the region. From the engravings of R. S. Gifford to the ship paintings of Sprague to the work of the Canadian "Group of Seven," Great Lakes art depicts the beauty and importance of these resources in a way that words cannot.

Those whose hands are skilled in interpreting such wonders to others have an immense gift. In our schools art teachers are training hands to portray what eyes have seen or hearts have felt, and the Great Lakes offer subject matter to these novices as well. Ohio Sea Grant wants to encourage this expression through a special program for 1986.

To assist schools in presenting the topic of "The Great Lake Erie" in their classes, we have assembled a list of books containing Great Lakes Art (see Waterworks page), and a brief slide-tape program that can be obtained on free loan from our office.

Encourage your art teacher to participate in this important event. Through the eyes of Ohio's children we can show the beauty and importance of Lake Erie.

"The Great Lake Erie" is the theme for an art exhibition that will focus on two-dimensional media produced by Ohio students in grades 5-6 and 7-9. The work must portray Lake Erie's importance or beauty, or both, and be submitted by February 15 for judging by the Art Education department of Ohio State University.

The best art submitted will be featured on a poster to be distributed to schools and businesses. This and other winning art works will tour the state from April through August and be highlighted at the 1986 Convention of the National Marine Education Association in Cleveland. The artists and their teachers will be taken on a VIP tour of the Lake Erie shore, and the art programs submitting winners will receive copies of Goldstein's *Let's Get Lost in a Painting: Winslow Homer - The Gulf Stream*.

Details of the exhibition have been sent to art educators in most schools of the state. If your school did not receive information but would like to participate, please contact us for details on preparing and submitting entries.



"Lake Superior" by Franklin Carmichael, 1926

Waterworks



Books on Great Lakes Art

Art education student Martha Mercer worked this summer to compile a collection of the range of Great Lakes art. She discovered some exciting art reference materials that may be available in your public library. Those marked * are available on loan from our office.

The Group of Seven, by Peter Mellen, McClelland and Stewart Limited, 1970.

The Group of Seven consisted of seven Canadian landscape artists active during the first part of this century. Mellen describes their influences and history in this well illustrated book.

American Marine Painting, by Frederick R. Brandt, Virginia Museum, 1976.

An exhibit catalog for the Virginia Museum and the Mariners' Museum. It depicts themes relating to the sea, such as danger and tragedy, man's insignificance in relation to the sea, the sea's beauty, its coastline, harbors, canals, and ships.

Great Lakes Marine Painting of the Nineteenth Century, by J. Gray Sweeney, The Muskegon Museum of Art, 1983.*

The themes of this exhibit catalog include a chronological art historical survey of vessels on the Great Lakes, as well as harbor views and landscapes.

George Caleb Bingham: Frontier Painter of Missouri, by Albert Christ-Janer, Harry N. Abrams, Inc., 1975.

Christ-Janer gives an art historical view of George Bingham's paintings of everyday life on the Missouri River during the nineteenth century.

The McMichael Canadian Collection, The McMichael Canadian Collection, 1983.*

This exhibit catalog includes the work and biographies of many Canadian artists. The collection, housed just north of Toronto, Ontario, contains the largest selection of Group of Seven paintings displayed anywhere. (See above.)

The Canadian Earth, Roger Boulet, Prentice Hall, 1982.*

A collection of Group of Seven paintings, the majority of work in this book has never been reproduced before. Boulet's biographies of these Canadian artists accompany examples of their finest paintings.

Canada Illustrated, by Albert Moritz, Dreadnaught, 1982.*

This book presents the art of nineteenth-century engraving as a fine art form. The intricate illustrations include brief descriptions of the scenes portrayed by the artist.

—Martha A. Mercer and Karen D. Scranton

THE GREAT LAKE ERIE

Art Competition and Exhibition

sponsored by
The Ohio Sea Grant Education Program

The Great Lake Erie quenches the thirst of 11 million people, harbors 3/4 of all ships passing through the Great Lakes, provides 41 million gallons of water per day for growing crops, and produces more fish for human consumption than all the other Great Lakes combined. Lake Erie has helped make Ohio great.

In celebration of the Great Lake Erie, the Ohio Sea Grant Education Program is sponsoring a competition in two-dimensional art forms which will be displayed in a statewide tour during 1986. The art should focus on the beauty of Lake Erie, its opportunities for recreation and economic development; its importance in history, culture or commerce; or its link to our Canadian neighbors.

ELIGIBILITY: Ohio students in grades 5-9

MEDIUM: Two-dimensional media, including drawings, paintings, prints, collages and computer graphics.

FORMAT: Maximum size 18 x 24 inches, minimum 8 1/2 x 11 inches, on material durable enough for a traveling display

RECOGNITION:

- One first place winner. Work will be made into a poster for national distribution. Winner with teacher will spend a day on a special tour of Lake Erie's shore. A news release recognizing the winner will be sent to his or her local newspaper, and the art work will be included in the traveling display.
- Nine second place winners. Shoreline tour with teacher, news release, and traveling display.
- Forty showcase winners, along with first and second places above, will have their artwork on a tour of selected sites around Ohio from May-August, 1986.
- All entrants will receive certificates of participation.
- Each art teacher with a first or second place winner, or with three or more showcase winners, will be recognized with a plaque as having an Outstanding Art Program in Aquatic Subjects. The teacher will receive a copy of Goldstein's Let's Get Lost in a Painting. Winslow Homer — The Gulf Stream. The book is part of a noted series for art appreciation and discussion of works of art in the classroom. The teacher may choose to receive two other titles in the series, or the equivalent in other art books.

JUDGES: Faculty and graduate students of the Art Education Department, The Ohio State University

CRITERIA: Approach to the theme, use of media, originality and design qualities.

DEADLINE: Postmark February 15, 1986. Winners will be notified by March 15, 1986

Plan now to include this opportunity in your art education program for the coming year. Encourage your students to show for others what Lake Erie means to Ohio.


Attend our workshop at the OAEA convention in November, or contact us for entry forms as your school year begins. Visual aids will be available to assist your students with their projects.



Ohio Sea Grant Education Program
059 Ramseyer Hall
29 W. Woodruff Ave.
Columbus, Ohio 43210
(614) 422-1078

In keeping with the art theme of this issue, we offer the following idea for a Lake Erie art activity for primary grades. It was developed by Maureen Canning and Margie Dunlevy of Lakewood.

Art Activities ✂

1.  Lake Erie: ... big mural of its use
or -

1. Water color the 5 Great Lakes.
2. Potato prints of Lake Erie.
3. Glacier pictures - use mixture of Tide and water... paint with 2 fingers to create glaciers.
4. Water color Lake Erie - THEN use black marker or paper to illustrate a way one can enjoy Lake Erie.



5. Create ships, tankers, etc. out of milk cartons or styrofoam.
6. Create dioramas of Lake Erie influencing our weather, recreation etc.

Spotlight on OEAGLS

Middle Sea was developed in 1979 as a means of announcing new Oceanic Education Activities for Great Lakes Schools (OEAGLS) as they became available. We've come a long way in the scope and mission of the Ohio Sea Grant Education Program, but OEAGLS are still the backbone of the effort.

The 23 OEAGLS manuals encompass a total of 58 classroom activities. Do some of them fit into the subjects you teach? Order a copy at only \$1.00 per manual, then make as many copies as you need for your classes.

Ohio Canals

- A. How were canal routes determined?
- B. How did canals affect Ohio?

The Effect of Lake Erie on Ohio's Temperature

- A. What are heat sources and heat sinks?
- B. How do Lake Erie and the oceans affect climate?
- C. Can you make a general climate prediction?

Geography of the Great Lakes

- A. What is the geography of the Great Lakes Area?
- B. What is the St. Lawrence Seaway?
- C. What are the surface dimensions of Lake Erie?
- D. How can we find the volume of a lake or other container?

Pollution in Lake Erie: An Introduction

- A. How skillfully can you read a science article?
- B. How can you become a critical reader?

Ancient Shores of Lake Erie

- A. What evidence is there that the level of Lake Erie has changed?
- B. How have people used beach ridges?

Lake Erie and Changing Lake Levels

- A. Does the level of Lake Erie change?
- B. What would be the result of regulating the level of lake Erie?

Getting to Know your Local Fish

- A. How does a dichotomous key work?
- B. What are the characteristics of some Lake Erie fish?
- C. How do fish get their names?

We Have Met The Enemy

- A. Where did the important battles (in the War of 1812) take place?
- B. Why did we fight?
- C. Why did we win?

Coastal Processes and Erosion

- A. What causes the shoreline to erode away?
- B. Can erosion be stopped?

Erosion Along Lake Erie

- A. How fast can a shoreline change?
- B. How much land has been lost?

The Estuary: A Special Place

- A. What is the role of plants in an estuary?
- B. How does the estuary serve as a nursery?

The Great Lakes Triangle

- A. What is the Great Lakes Triangle?
- B. How can disappearances within the triangle be explained?

1. Great Lakes bulk carrier design
2. Storm tracking
3. Lake bottom characteristics

- C. What happened aboard the Edmund Fitzgerald?

Yellow Perch in Lake Erie

- A. What can happen to a growing perch?
- B. How can the perch fishery be managed?

It's Everyone's Sea: Or Is It?

- A. What is the shape of the Atlantic Ocean basin?
- B. Who owns the sea?
- C. How are boundaries over water determined?

Evidence of Ancient Seas in Ohio

- A. How were Ohio's minerals formed?
- B. What do Ohio's minerals tell about its history?

PCBs in Fish: A Problem?

- A. What are PCBs?
- B. How can the public health be protected?

(continued)

How To Protect A River

- A. What are some of the characteristics of the Olentangy River?
- B. How does a river qualify as a "scenic river"?

Knowing The Ropes

- A. How is a rope put together?
- B. How do sailors use ropes?
- C. How have ropes, ships and sailors influenced our language?

Oil Spill!

- A. Where does oil pollution come from?
- B. How can an oil spill be cleaned up?
- C. How does an oil spill affect living things?

To Harvest a Walleye

- A. Who can harvest a Walleye?
- B. What does a biomass pyramid tell us?
- C. What is a food web?

Shipping on the Great Lakes

- A. What products are carried on the lakes?
- B. What is the most economical form of transportation?
- C. Which transportation method uses the least energy?

Shipping The World Connection

- A. "Where go the boats?"
- B. How do locks work?
- C. Can you use your shipping knowledge?

The Effect of Lake Erie on Climate

- A. What causes the land-sea breeze?
- B. How does Lake Erie influence the climate of nearby land areas?
- C. Can you make a general climate prediction?

New OEAGLS are now being developed and pilot tested. Titles that should be available by spring include six activity books for primary grades including Lake Erie — Take a Bow, The Giver and Taker and Build a Fish to Scale. New titles for middle school grades will be A Great Lake Vacation, Storm Surges on Lake Erie, Waves, and an activity based on marina operations.

Aquatic Science Projects Recognized

Scientific thought, exploratory projects and investigative presentations resonated throughout Ohio Wesleyan College as Ohio's young scientists participated in the State Science Fair on the 27th of April. CAMEO (Consortium of Aquatic and Marine Educators of Ohio) sponsored a special awards category which recognized individuals whose projects were aquatically related. This year, 21 entries were judged by CAMEO and Ohio Sea Grant representatives, Linda and Tony Badzioch, Marilyn Lisowski, Sarah Schult, Karen Scranton and Laurie Usher.

Three outstanding projects were recognized. The young scientists were awarded certificates and also subscriptions to *Nautica*, a student oceanographic journal. The teachers of the awardees were honored with a complementary CAMEO membership. Recipients of the 1985 CAMEO award were Doug A. Wade, a 7th grader from Hastings Middle School who probed the question, "How Do Phosphates Affect Algae Growth?" Investigative techniques were employed by 9th grader Jessica Evans from Stow High School with her project entitled "Can Tetracycline Be Traced Through the Aquatic Food Chain?" The potential of desalination was explored in the project "Freshwater From the Sea" by Susie Flannery from Steven Vaile Middle School of Middleton.

These winners were invited to submit their projects for further judging for the National Youth World of Water Awards, which is sponsored by the National Marine Education Association, National Marine Fishing Service, Sea Grant College Program and Sea Grant Association. Selected winners would receive an expense paid trip to San Diego in November for the NMEA Youth Conference on Marine and Aquatic Science at the Oceans '85 Conference and Exposition.

—Marilyn Lisowski



Marietta Summer Workshop

History and the Ohio River were major emphases of this summer's two-week long Marine and Aquatic Education workshop held in Ohio's first city, Marietta. Twenty-four teachers from Marietta City, Washington County and Muskingum County Schools met at the Washington County Joint Vocational School mornings from June 17 to 27. Highlights of the workshop included a program at Campus Martius and the Riverboat Museum on the history of the Marietta Region. An all day field trip started at the Willow Island Locks where participants observed two tow-trains lock through and received information on the operation of the locks and dam. Other highlights included a tour of a power plant, observation of unloading operation at an oil barge terminal, and several local geology stops.



This was a highly productive group of teachers. The bases for at least two or three future DEAGLS activities were developed as projects, as well as two computer programs: one on the Ohio River and the operation of its locks, and the other a fish identification program. Both will be made available to other teachers through the Ohio Sea Grant Program.

It is unlikely that a similar workshop will be offered next summer because of the instructors' (Fortner and Mayer) involvement in the National NMEA convention to be held in Cleveland. However, look for offering of the workshop during the summer of 1987. If you want it to be in your area, let us know.



CAMEO Annual Meeting

Fourteen CAMEO members met Saturday, September 21, at Stone Lab on Gibraltar Island. Despite last minute changes in the ferry schedule and threatening skies, fourteen people managed to arrive safe and sound on Gibraltar Island to begin a day full of activities.

The occasion for the meeting was two-fold: it marked the First Annual Conference for the Consortium of Aquatic and Marine Educators of Ohio, and a major planning session for the National Marine Education Association (NMEA) conference was held.

Whenever marine educators get together, something aquatic must happen, and so it was at Stone Lab. Early morning participants were exposed to Lake Erie science and lore via a cruise on the R.V. Biolab. Scientific sampling methods for water depth and sediment compositions were first demonstrated and then practiced by enthusiastic CAMEO members.

After lunch the planning committee for the 1986 NMEA conference met. Dr. Rosanne W. Fortner, Co-chair of the conference and coordinator of the Ohio Sea Grant Education Program showed a slide-tape program advertising next summer's event, which will be held in Cleveland, August 4-9. Rosanne and Pam Sears, Education Director of Sea World, described the multiplicity of tasks that await us in CAMEO in planning the conference.

The participants in this meeting were dynamic, enthusiastic, eager and quite creative; massive brainstorming was a major event! More volunteers are welcome - please contact Dr. Fortner or Dr. Mayer at (614) 422-1078 for details.

—Claudia Melear and Margie Pless



Dabbling and Diving Ducks

When taking a field trip to the marshes of western Lake Erie, waterfowl will be a common sight. Ohio's western Lake Erie shore is edged by 30,000 acres of marshland. This area provides a variety of habitats including open ponds, cattail and reed beds, the tops of dikes, shrub and sapling thickets, and swamp forest remnants. Waterfowl are attracted to the wetlands in great numbers during migration, since both the Mississippi and Atlantic Flyways pass through the west end of Lake Erie.

Ducks, geese, and swans are collectively called waterfowl. There is a wide range of sizes within this group of birds. For example, a Blue-winged Teal weighs less than one pound while a Canada Goose may weigh up to 24 pounds. All waterfowl have characteristics related to an aquatic lifestyle. Webbed feet help propel these swimming birds. Each foot has three webbed front toes and a smaller, free hind toe. The neck is somewhat long and the bill is flattened, often with a rounded tip.

Ducks can be a challenge to identify due to their many different appearances. By learning the behavior of the two largest groups of ducks, duckwatchers can begin to distinguish one species from another.



The surface-feeding, or dabbling ducks, are the best known group in the duck family. Dabblers are typically found on fresh, shallow marshes and rivers. The nickname "puddle" ducks seems to fit when they are viewed while feeding. The ducks tip, rather than submerge, and grab aquatic plants growing just below the surface while their tails bob above the water. The legs of dabbling ducks are attached near the center of the body and because the legs are short they walk with a waddle. The ponds they live on are often bordered by trees or cattails, making open water limited. With a wide wing area to body weight ratio, the puddle ducks can spring almost vertically into the air upon take off. When landing, they drop more slowly into the exact area in which they want to swim. The diet is mostly vegetable, making dabblers a favorite target for duck hunters.

Common dabbling ducks in the Lake Erie region include the Mallard, Black Duck, Pintail, American Widgeon, Shoveler, Blue-winged Teal, and Green-winged Teal. These species all belong to the tribe Anatini. The male plumage is bright and elaborate. Most dabbling ducks have an iridescent patch of color, known as the speculum, on the wings of both sexes.

The second major group of ducks is called diving ducks, bay, or sea ducks. A diving duck dives for aquatic insects, plants, and mollusks, often to depths of 20 feet. Deep diving enables these ducks to utilize the larger deeper bodies of water. To aid the diving ducks in underwater swimming, divers have large webbed feet with a flap, or paddle, on the hind toe. The legs are set near the rear of the body, which makes them awkward on land. When divers float on the surface of the water the tail is usually held close to the water. Dabbling ducks hold their tails clear of the water. Divers have a small wing area to body weight ratio. This type of wing helps them fly swiftly, but makes take offs and landings more difficult. Using the open waters to their advantage, divers run, or "patter", along the surface for some distance while beating their wings before lifting off into the air. The large paddle feet of diving ducks may be used as rudders in flight and are often visible on flying birds. When landing, the feet are used like skis to slow the bird to a stop.

Ohio's common diving ducks belong to the tribe Aythyini. They are the Redhead, Canvasback, Ring-necked Duck, Greater Scaup, and Lesser Scaup. Divers lack the bright speculum of the dabbling ducks. The plumage of a male diving duck is not as colorfully patterned as a dabbler.

These tribes of ducks utilize the Lake Erie marshland either as a stopover on migration, wintering grounds, or for year round residence. This 30,000 acre Ohio marshland is now only one tenth of the original area once covering the western shore of the lake. The habitat that remains was purchased by private sportsmen while the rest of the area was drained or filled by 1951. Today several of the choice tracts are owned publically and administrated by the Ohio Department of Natural Resources Division of Wildlife or the U.S. Department of Interior. Ohio's Division of Wildlife operates Crane Creek Wildlife Experiment Station on the Magee Marsh Wildlife Area in Lucas and Ottawa counties. The U.S. Department of Interior manages Ottawa National Wildlife Refuge within the same counties.

As a result of the vision of the early marshland preservers, management for waterfowl has been very successful in this area of Ohio. These wetlands are more productive of wildlife than any other type of habitat in the Buckeye State.

In the spring and fall great concentrations of waterfowl will give a new duckwatcher numerous opportunities for study. Practice using the characteristics of divers and dabblers to make a trip to the marsh a rewarding experience.

—Mary Anne Smallwood



Cruising High Street—Just in case you think that Columbus, Ohio is an unlikely place for a Sea Grant headquarters, take a look at our local "aquatic environment." These pictures, taken by Vic Mayer on North High Street between 9th and 12th Avenues, show how we are surrounded by the influence of water. If we'd waited until Saturday night to take the pictures, we could probably have found a few marinated students too!

The New Crew

Claudia Melear brought her warm, sunny personality from Atlanta, Georgia, in September to enter the Ph.D. program in Science Education at The Ohio State University. Her experience has been extensive in the science education field; she has taught high school biology for four years and science for gifted students for three years. Throughout this time, Claudia has taken every opportunity to become involved with marine science education. Georgia's Barrier Islands, many of which are quite pristine, were visited at least twice a year by Claudia and her students for coastal field trips.



Claudia Melear

Claudia is the type of person who can manage to do many things all at once - and do them well too. She was a state recipient of the Presidential Award for excellence in Science Teaching in 1984, and has managed to raise two children who are now college students themselves. Her goal is to become a pre-college teacher educator.

Claudia's interests and hobbies include aquatic microbiology, bird watching, photography, shell collecting, and aquatic activities. She's already experienced Lake Erie's islands and dubs them "SUPER!" - a real compliment from this salty import to Ohio.

Margie Pless, a Master's/certification student in Natural Resources and Science Education, joined the Sea Grant Education staff in September. Margie has a B.A. in Biology from the University of Pennsylvania and experience as a naturalist for the National Park Service, with assignments at Channel Islands, CA, and Cape Hatteras, North Carolina. She also has biotechnical experience with the U.S. EPA and the Army Corps of Engineers. In addition, Margie was an instructor at the Newfound Harbor Marine Institute on Big Pine Key, Florida.



Margie Pless

Margie's long-term goal is to be the Director of Education at a nature center or aquarium. Her goal will be enhanced by practical classroom experience which she plans first. Margie's hobbies include playing musical instruments as well as all types of outdoor activities: hiking, biking, swimming, ice-skating, exploring and building sand castles.

In September, Ohio Sea Grant took aboard a new secretary, who helps keep the place shipshape. Sue Fisher, a senior in Environmental Communications, spends many hours at the computer doing filing and word processing. Her creativity and organizational skills are readily put to use in the office. Sue's home base is Cleveland, Ohio. Her hobbies include photography, hiking, bicycling, and she also enjoys spending lazy summer afternoons at "the lake" with friends. After graduation Sue plans to marry an adventurous man and travel around the world in a sailboat.

Peggy Fenner is a junior in Math Education who keeps busy at OSG by typing, answering the many phone calls and organizing pamphlets and brochures for workshops and meetings. In her spare time, she enjoys participating in basketball and softball and playing saxophone. She is expecting her first child in December. Peggy's plan for the future is to teach high school geometry.

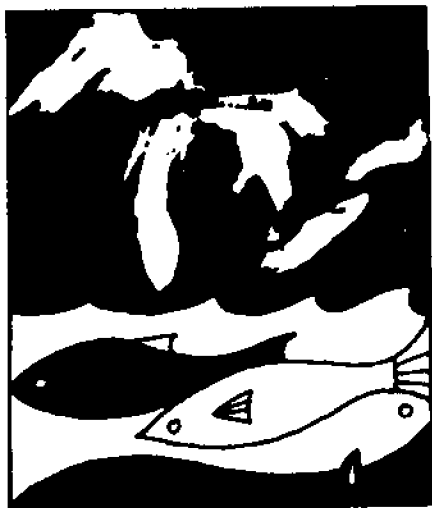


Sue Fisher



Peggy Fenner

THOSE MAGNIFICENT SWEETWATER SEAS



1986 Annual Conference

of the

**NATIONAL MARINE
EDUCATION
ASSOCIATION**

August 4 - 9, 1986

John Carroll University, Cleveland, Ohio

The Jesuits called them l'eau douce, sweet water. The diaries of the explorers extolled them, and Herman Melville compared them with the majesties of the oceans. The Great Lakes. Once mourned for the treatment they received from the cities and industries they supported, the Great Lakes are now praised for their beauty, honored for their place in our history, and sought for their precious water.

The Consortium of Aquatic and Marine Educators of Ohio (CAMEO) and the Ohio Sea Grant Education Program invite you to discover THOSE MAGNIFICENT SWEETWATER SEAS in Cleveland, their renaissance city.

PROGRAM HIGHLIGHTS

Marinated Micros software review
Sea Grant Curriculum Fair
State of the Lakes Symposium
Island Cruise
The Great Lake Erie children's art exhibit

Sea & Swap
Bilateral Issues Symposium
Luau at Sea World
Perch and Pike Picnic
Songs of the Seas/Lakes

For more information see a CAMEO member or contact:

Ohio Sea Grant Education Program
The Ohio State University
059 Ramseyer Hall
Columbus, Ohio 43210
(614) 422-1078.



Ohio Sea Grant Education
The Ohio State University
059 Ramseyer Hall
29 W. Woodruff Avenue
Columbus, Ohio 43210

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MIDDLE SEA

Just as musicians think outward from middle C to find direction for their music, Ohioans think outward from our middle sea, Lake Erie, in such a way as to trace its continuing impact on our lives.

MIDDLE SEA is published through a grant from the National Sea Grant Program of the National Oceanographic and Atmospheric Administration. Its purpose is to build among teachers and administrators a greater awareness of the important role the Great Lakes and marine education should play in school curricula. It therefore includes information about the marine and Great Lakes environments, classroom activities for marine education and news of current events of interest to teachers.

Copies are available from:

Ohio Sea Grant Education Program
The Ohio State University
059 Ramseyer Hall
29 W. Woodruff Ave.
Columbus, Ohio 43210
(614) 422-1078

Dr. Charles E. Herdendorf, Program Director
Dr. Rosanne W. Fortner, Education Coordinator

Dr. Victor J. Mayer, Research Director

NMEA '85

Beautiful and historic Williamsburg, VA, was host to the 1985 National Marine Education Association Conference. The weather was hot and muggy, but that didn't deter nearly 500 conferees from sampling the aquatic resources of the Chesapeake Bay area. This was by far the most successful NMEA conference ever. From the keynote address by Virginia Governor Charles Robb on the first day, to the business meeting on the last with a slide tape presentation on the 1986 Cleveland NMEA conference, attendees were able to participate in highly professional and useful activities. These included workshops on teaching materials, information about the history and environmental changes in the Bay, and field trips to a variety of places such as a river trip on a tugboat to the largest paper mill on the Bay. Sue Gammisch, conference coordinator, did an excellent job of pulling together human, financial, and material resources, setting a high standard for us in Ohio to meet or surpass for next year's meeting in Cleveland. If any of you are interested in helping with the meeting, contact Fortner or Mayer, the conference coordinators.

Winter Graduate Course

The course entitled Marine and Aquatic Education (ED/NR 614) will be offered again Winter Quarter on the Columbus campus of Ohio State. It will meet at a somewhat later time than in the past to accommodate teachers who may want to drive in from surrounding areas to take the course. The course meets from 6:30-9:00 p.m., and it offers 3 quarter hours of graduate credit. It introduces a wide range of information concerning the oceans and Great Lakes, touching on art, history, shipping, physical and living resources and the evolution of oceans and lake basins. A wide range of audiovisual materials and laboratory activities is used. The highlight is a one day field excursion to Lake Erie to study operation of a marina and a gypsum quarry and to study the life and geology of the lake area.

As an added benefit for course participants this year, those who enroll in 614 will be eligible for tuition waivers for a Spring Quarter course in marine and aquatic education curriculum development. Those interested in the courses should contact the Ohio Sea Grant Education office for further information.

APPENDIX E
OEAGLS Catalog

APPENDIX F

Marine and Aquatic Education

ENVIRONMENTAL EDUCATION

Occasional Paper #6

Marine and Aquatic Education



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Ohio Department of Education
Columbus, Ohio 43215

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Office of Environmental Education

AUTHOR

Diane Cantrell

The author began her career as a French and English teacher. She provided her students many interesting and worthwhile activities using the rich learning resources of the environment. These successful environmental education experiences led to extensive graduate studies in environmental education, teacher education, and curriculum development. Diane has developed a special interest in the global implications of environmental issues and how classroom teachers can improve their skills in this critical area of elementary and secondary education.

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FOREWORD

Marine and aquatic education has been a part of the curriculum in Ohio elementary and secondary schools for many years. Teachers and students have investigated ponds and streams, read about the early world explorers, studied the complexities of world trade and have been tuned in to such contemporary maritime happenings as the sinking of the Edmond Fitzgerald or the wreck of the oil tanker Torrey Canyon. This occasional paper is offered to Ohio educators to stimulate creative activities and thereby provide students an even deeper understanding and appreciation of the world of water.

The Ohio Department of Education is pleased to be cooperating with Ohio Sea Grant to bring to elementary and secondary students an increased awareness and understanding of marine and aquatic education.

The Office of Environmental Education invites and encourages comments on this paper.

WATER IN THE WORLD

Few of us realize to what extent we depend on the world of water in our daily lives. Every time we bite into a cream-filled cupcake, eat an ice cream cone, paint a wall or brush our teeth we are using a seaweed derivative which helps to maintain a creamy texture. When we feed our pet or eat a drumstick, we are benefiting from the use of fish meal in animal foods.

Oil is only one item for our cars which is shipped by water from overseas. The raw materials and parts for a single car come from over 70 different nations (1: 25). Consequently, the production and cost of land transportation are closely tied to the water transportation system.

Because of Lake Erie's effect on weather, the residents of Painesville, Ohio, have to shovel more inches of snow than the people living in Toledo. Even our language reflects the impact of water. Today's meanings for "making ends meet," "mind your p's and q's," or "skyscraper" bear little resemblance to their original maritime contexts.

The Limits to Water

A lack of awareness of our daily ties to water would pose little problem if we had unlimited quantities of water for domestic, industrial and agricultural use. But we do not. We are deceived by the vastness of the water world. Long before photographs from space showed the earth as a bluish marble, children were learning in school that three-fourths of our planet is covered by water. Few learn, however, that oceans, ice caps, and glaciers constitute 99.35 percent of that water (8: 11).

While the frozen water and the oceans are important in our lives, it is the remaining 0.65 percent which we use more directly for day-to-day activities.

Here lies another misconception. The limited amount of water would pose little problem if rain and rivers brought new water. But the earth is a closed system. There is essentially the same amount of water today as there was three billion years ago; we continue to use it over and over again. As we turn on the faucet in the morning to make a cup of coffee or mix orange juice, we assume that the water is safe to drink. Although we may know that it came through the local water treatment plant or filtered through the ground to our well, we seldom think beyond our local resources; yet, we should. As Anderson explains,

The water you drank this morning fell as rain on Lake Michigan two weeks ago. Three months prior to that the water was evaporating from a lake in central Asia. Two months prior to that it was part of the water a Korean mother was using to bathe her infant daughter. Now you have used it to satisfy your thirst. Two hours from now it will leave you as urine and two months later it may be part of a summer rain falling on the streets of Paris (1:29).

Where was it before Korea and where will it go after Paris?

Pushing the Limits

We live in a global society which is pushing the limits of water through growth and demand. Increases in population, shifts in population from inland to coastal areas and rising consumption have led to increasing demands for water and water resources. Since water is limited in quantity and recycled, efforts to keep up with human needs have often resulted in detrimental impact on the water environment.

For example, increasing demands for food may lead to water shortages due to irrigation. Lowered water quality because of soil, fertilizer and pesticide run-off and the depletion of fish populations due to over-harvesting also produce negative impacts. This in turn will affect the physical, sociological and economic well-being of people in the future. Other demands for water and water resources (e.g. energy, recreation, natural resources, transportation, defense) lead to similar repercussions.

When the negative effects appear obvious or dramatic, some people may only express concern while others may take action to correct the problem. This is often the case, for instance, when people see oil covered birds dying as a result of an oil spill or blowout. However, the gradual deterioration of the water environment goes unnoticed by most. For example, more oil enters the oceans from improperly disposed waste oil from automobile crank cases and machines than from oil spills or blowouts. (7:286). The run-off of petroleum chemicals from automobiles and other land sources is approximately 24 times as great as petroleum pollution from offshore drilling (4:13). In addition, this less visible pollution often impacts more on the water environment since it usually affects the most productive area of the ocean, the coastal zone.

Protecting the Limits

Our existence depends upon careful, planned use of oceanic and fresh water resources. However, we are hindered in our efforts to protect and responsibly use the water environment by a lack of awareness about our daily dependence on water, limited knowledge about this important life support system and lack of understanding about how society affects the water

environment. The quality and quantity of future water resources depends upon correcting these deficiencies. Marine and aquatic education represents one effort to address this very difficult and complex task.

AN OVERVIEW OF MARINE AND AQUATIC EDUCATION

Marine and aquatic education evolved from the science education movement which was spurred by the launching of Sputnik I and the environmental movement which was marked by Earth Day in 1970. The scope and goals of marine and aquatic education encompass much more than its roots indicate.

Dimensions of Marine and Aquatic Education

Much of our daily life is dependent upon water. Marine and aquatic education must reflect this fact. The following list indicates some of the various dimensions of marine and aquatic education. It is not intended as a comprehensive outline but rather as a stimulus in thinking about the broad scope of marine and aquatic education.

Culture:	art, music, literature, heritage
Energy Sources:	oil, coal, wind, waves, tides, hydro, solar, thermal, nuclear
Human Impact:	pollution, development, over-use
Marine & Fresh Water Ecology:	lakes, ponds, rivers, swamps, estuaries, seas, oceans
Maritime and Naval History:	explorers, wars, shipbuilding, shipwrecks
Physical Forces:	wind, waves, currents, tides, erosion, coastal processes, crustal evolution
Properties of water:	physical, chemical
Recreation:	fishing, boating, swimming
Transportation and Commerce:	shipping, world trade, canals, ports, imports/exports
Uses of Water:	domestic, industrial, agricultural
Weather and Climate:	temperature, precipitation, wind directions

Efforts to educate people about the world of water should include these and other elements and how they relate to ecological, political, economic, sociological and technological concerns.

Definition and Objectives

With the foregoing material as a background, the question becomes, What is marine and aquatic education? Goodwin and Schaadt (4:6) wrote one of the most accepted definitions:

Marine and aquatic education is 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 the marine and aquatic environments.

The primary objectives of marine and aquatic education are:

- * to develop a public which is aware of and knowledgeable about the proper use, protection and conservation of the oceans, coastal zones and fresh water resources and,
- * to motivate people to take part in decisions affecting the sea and fresh water.

The major intent, therefore, is not to produce a nation of marine biologists, oceanographers or hydrologists, but to develop a citizenry which is "marine literate."

The above explanation raises three important points. First, by using the term "marine and aquatic education," the definition addresses the total water system. The popular term "marine education" fails to explicitly include fresh water along with salty (marine) water. In reality most marine educators include both; however, the major focus usually remains on the marine environment.

Second, the emphasis on the "total educational process" indicates that this is not restricted to formal education. Aquariums, zoos, nature centers and other environmental education centers offer many nonformal opportunities for the general public as well as students to participate in marine and aquatic education experiences. Organizations and governmental agencies provide programs, materials and assistance. In addition, the mass media help to increase awareness and knowledge through news coverage, television serials, feature articles and productions, public service announcements, and specialized publications.

Finally, the use of the word "education" emphasizes that this is not a course, subject area or discipline. Within formal education, marine and aquatic education must shed its image as science or marine science and become a theme which permeates the total curriculum. Students who read *Moby Dick* or *Pagoo*, write a report about the War of 1812, create their own fish recipes, estimate the average number of organisms in an estuary, sing sea chanteys, draw their favorite marine animal or investigate the effect of Lake Erie on climate are all involved in marine and aquatic education.

FORMAL EDUCATION

Although many individuals and organizations support marine and aquatic education through nonformal approaches, most of the emphasis and efforts focus on formal education, beginning in kindergarten and continuing through post secondary work. Marine and aquatic

education does not take the form of a course but rather that of a theme which draws upon appropriate methods and materials to complement and enhance existing educational goals and curricula. The following discussion first demonstrates how marine and aquatic education helps to meet the goals of environmental education and general education and then describes ways in which it can be incorporated into the existing curriculum.

Environmental Education

The basic aims of environmental education are to help individuals understand the biological, physical, social, economic and political dimensions of the natural and built environments and acquire the knowledge, skills and values to make responsible decisions related to the future quality of the environment. As one component of environmental education, marine and aquatic education helps to meet these goals in two ways.

First, water-related issues of concern to marine and aquatic education cannot be separated from concerns of other major components of environmental education. For example, the alternative energy sources studied in energy education all deal with water either directly (e.g. tides, waves, ocean thermal) or indirectly (e.g. nuclear, wind, solar). When world hunger is discussed in population studies, the misconception of the oceans as the future panacea for food and water shortages must be corrected. Pollution-related activities must indicate the limitations of ocean dumping and the dangers of improperly designed landfills.

Second, marine and aquatic education focuses on one of the major

life support systems—water—and its interrelationship with the other systems—air, soil and life. Environmental education addresses all four equally.

General Education

In a similar way, both environmental education and marine and aquatic education help to achieve the goals of general education. While people do not always agree on what constitutes these goals, the Association for Supervision and Curriculum Development published the following list (2:9-12) which represents one view of current thinking in this area. It may be used to demonstrate how marine and aquatic education contributes towards meeting many of the educational goals of general education.

Goals of General Education

1. Basic skills
2. Self-conceptualization
3. Understanding others
4. Using accumulated knowledge to interpret the world
5. Continuous learning
6. Mental and physical well-being
7. Participation in the economic world of production and consumption
8. Responsible societal membership
9. Creativity
10. Coping with change

These goals, or similar ones suggested by other educators, are inherent in the primary objectives of marine and aquatic education identified in the preceeding section. In order for individuals to become aware of and knowledgeable about the water environment and its related issues, they must learn and practice basic skills, use accumulated knowledge to interpret the world, and cope with changes in the water environment,

especially those that result from human impact. In order for individuals to take part in decisions affecting the sea and fresh water, they must understand how each person's decisions affect everyone else, exhibit responsible societal membership, and understand how their participation in the economic world of production and consumption affects the present and future water environment. Both of these major marine and aquatic education objectives require lifelong learning.

In this way, the goals of marine and aquatic education correspond closely to those of general education. Consequently, marine and aquatic education efforts may readily complement existing curricula designed to meet the goals of general education.

Incorporating Marine and Aquatic Education into the Existing Curriculum

Because of the interrelatedness of marine and aquatic education with general education and environmental education, it is reasonable to ask if we need another kind of education, especially when the field is already deluged with so many others (e.g. consumer education, global education, citizenship education, career education). The answer would be no if any educational efforts were adequately meeting the need for marine and aquatic education but they are not. Presently, schools appear to emphasize the importance of land over water as evidenced by a notable lack of water related examples, activities, units and courses in the existing curriculum. Water seems to be taken so much for granted that we fail to perceive the importance of it in the curriculum.

Marine and aquatic education uses a variety of approaches for incorporating water-related information, ideas and concerns into the curriculum. These may be broadly identified as the example approach, activity or unit approach, multidisciplinary theme approach, and specific courses. Since teaching styles, curriculums, and philosophies differ, educators may find one method more appropriate than another. In the end, a combination of these may lead to the best results.

With the example approach, teachers use water-related examples in place of or in addition to some of the land-oriented ones to teach the same skills or concepts. For instance, instead of adding and subtracting bushels of apples math students may be asked to add and subtract baskets of fish. Or they could solve story problems about fuel efficiency or distance-time rates of water transportation. For English, grammar exercises could contain sentences about water. Reading selections could include poems, stories, books and other pieces with water themes or settings. These kinds of substitutions and additions can easily be made in many subjects to increase awareness about marine and aquatic ideas without detracting from the teaching objectives of the discipline.

With the activity or unit approach, the teacher uses one or more marine and aquatic education activities or lessons to enhance and expand upon an existing water-related idea or topic. As students study transportation systems in Ohio and their impact on the state's development, they might construct a model of a lock system or use a water drainage map to decide where they would have located Ohio's canals. In a world history class, they could complete a unit on the role of the oceans in the spread

of civilization. The activity or unit approach increases awareness, knowledge and understanding by deliberately teaching about water as it relates to the subject area.

With the multidisciplinary approach, teachers and students use skills and content information from several disciplines to investigate a theme or topic. This method lends itself well to both individual and team teaching. Students studying an estuary, for example, would draw upon science, math, social studies and English as they use a water testing kit, calculate averages or percentages, read a topographical or aerial map, interview local people (hunters, fishers, industrialists), use dichotomous keys and field guides, read local newspapers for evidence of land use conflicts, and observe and record signs of animals. An individual teacher can lead this kind of study or a team of teachers might coordinate a study of the oceans. For example, students in an English class could read Pearl Buck's "The Big Wave" as they study the physical forces of water in a science class, debate coastal zone management issues in a social studies class, calculate the rate of erosion along the coastline in math class and draw seascapes in art class. By drawing upon several disciplines, students not only use a variety of skills and information but they also gain a more comprehensive understanding of the world of water.

Finally, some schools and teachers prefer specific courses on a marine related topic (e.g. oceanography, literature of the sea) or a one-time marine education week. While these contribute to the efforts of marine and aquatic education, they fail to include it as an integral part of the

total educational process as is possible with the example, activity, and multidisciplinary theme approach.

Regardless of the approaches used to incorporate marine and aquatic education into the existing curriculum, the success of any effort depends heavily upon teachers. Most educators have neither the time nor the resources to develop their own programs in marine and aquatic education. Fortunately, Ohio has many resources so that teachers do not have to "reinvent the wheel."

PEOPLE, PLACES AND MATERIALS

Ohio has many organizations, agencies and institutions which provide a variety of services to educators including resource and curriculum materials, planning assistance, teacher education programs and field trips. Some of these relate to water in general while others emphasize places, topics or issues of special interest to Ohioans. For addresses and other sources of information, assistance and resource materials not listed below, see the appendices.

Ohio Sea Grant

Ohio Sea Grant is part of the National Sea Grant Program, which is a federal program committed to the better understanding, use, management, and protection of the resources of the seas and the Great Lakes. Similar to other state sea grant programs, Ohio Sea Grant has three components: research which investigates resource and management problems of Lake Erie and other water bodies; advisory services which convey these research findings to the public; and education which provides resource information and assistance to educators.

The Ohio Sea Grant Education Office directed the development and production of Oceanic Education Activities for Great Lakes Schools (OEAGLS--pronounced "eagles"). These 23 classroom activities for grades 5-9 cover a variety of topics including world shipping, oil spills, erosion, and the Great Lakes triangle. While many activities are science oriented, other subject areas included are geography, social studies, math, language arts, history, art and music. These allow students to better explore the economic, political, social, scientific and technological dimensions of the role of the Great Lakes and oceans in Ohio. Activity units usually take two to three class periods to complete. Materials include a teacher's guide and a student workbook which may be duplicated. In addition to the OEAGLS activities, the office distributes a quarterly newsletter entitled Middle Sea, conducts teacher workshops and courses, sponsors resource centers at three locations (Ohio State University, Bowling Green State University, University of Cincinnati) and provides consultation services.

Similar services are available from other Great Lakes sea grant programs. In particular, the Michigan Sea Grant Curriculum group has developed materials titled "Great Lakes Curriculum for Middle Schools." These are comprised of five individual units: The Sea Lamprey in the Great Lakes, Great Lakes Fishing in Transition, Water Quality, Great Lakes Urban Communities and Great Lakes Shipping. Complete units may take 10-30 class periods but most of the individual activities take one to three class periods. Materials include filmstrips and tapes, slides, simulation games, board games, wall maps and student materials for duplication.

Ohio Department of Education, Office of Environmental Education

For over 41 years, an environmental education consultant has provided assistance to Ohio teachers in elementary, secondary and teacher education. Curriculum and resource materials, consultation services, and pre- and in-service teacher programs focus on one or more of the interdisciplinary themes included within the broad scope of environmental education (e.g. energy, population, food, land use planning, ecology, conservation).

Since marine and aquatic education is also a component of environmental education, the Office of Environmental Education consultant has been federally designated as the marine education coordinator for the State of Ohio. In addition to the previously mentioned services, this person also co-directs several of the Ohio Sea Grant projects.

State Agencies

Two state agencies directly influence the use and management of water and water resources in Ohio. The Ohio Department of Natural Resources provides information and assistance about a variety of water-related topics including coastal zone management, fishing, watercraft safety, ground water, pond construction, glaciers and endangered aquatic species. The Ohio Environmental Protection Agency distributes brochures on public water supply and waste water. It also responds to inquiries about water regulations and their enforcement. Similar information is also available from the U.S. Environmental Protection Agency, Center for Environmental Research Information located in Cincinnati.

Universities and Colleges

Local institutions of higher education have two kinds of offerings useful to teachers. The first are content courses such as fresh water ecology, oceanography and marine biology. A directory of marine and aquatic content courses offered by Ohio colleges is available from the Ohio Sea Grant Education Office. The second are graduate and undergraduate method courses or workshops in environmental education and marine and aquatic education. In addition, university personnel and facilities may serve as a resource for teachers.

Other Organizations and Places

Numerous other resource people and places exist throughout the state. Some of these focus on features which are special for Ohio. For example, The Toledo Port Authority, the Great Lakes Historical Society and AmShip (American Shipbuilding Company) could be used to teach about Lake Erie, the Great Lakes and their connection to the Atlantic Ocean. The lock system on the Ohio River and the Ohio River Museum could also help teach about water transportation and ocean connections. Roscoe Village focuses on canals. Local zoos, aquariums, museums, parks, historical sites and environmental education centers may address local as well as general water-related topics. For more specific information, see Appendix C.

CONCLUSION

Ohio may not be located on the ocean but we are directly connected to the Atlantic and the rest of the world by the Great Lakes and the

Ohio River. In addition, we are indirectly connected in countless ways on a day-to-day basis. Our lives are dependent upon water and the future quality of our lives is dependent upon how well we understand, protect and conserve our water resources. Ohio has the people, places and resources for meeting the need for marine and aquatic education.

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APPENDIX A*

Sources of Information and Assistance

- Educational Resource Information Center, Clearinghouse for Science, Mathematics and Environmental Education (ERIC/SMEAC). The Ohio State University, 1200 Chamber Road, Room 310, Columbus, Ohio, 43212. A microfiche computerized collection of research and resource documents of use to educators at all levels. ERIC is located in most university libraries. Over 1500 documents have marine education significance.
- Marine Education Materials System (MEMS). Microfiche computerized collection of marine education material which is constantly being updated. Obtain "The Guide to Marine Education Materials" from Sea Grant Publications, VIMS, Gloucester Point, VA, 23062.
- National Oceanic and Atmospheric Administration, Department of Commerce, Washington, D.C., 20230. For meteorological and oceanographic information, contact the Office of Public Affairs.
- National Marine Education Association, Virginia Institute of Marine Science Education Center, Gloucester Point, VA, 23062. This office can direct you to regional organizations and individuals who can provide assistance. NMEA publishes Current: Journal of Marine Education which carries a wide range of marine education articles.
- Office of Sea Grant, NOAA. 6010 Executive Boulevard, Rockville, MD., 20852. The Maryland office can give you information concerning the nearest Sea Grant program and relevant Sea Grant supported educational projects. The Sea Grant program is located in thirty states; supported by federal/state funding it promotes the wide use of marine resources through research, education and advisory services.
- Ohio Department of Education. The state marine education coordinator, appointed by the chief state school officer, is available to conduct workshops, provide information and consult with educators. Office of Environmental Education, Ohio Department of Education, 65 S. Front Street, Room 811, Columbus, Ohio, 43215.
- Ohio Department of Natural Resources, Fountain Square, Columbus, Ohio, 43224. For general information or educational assistance, contact the Office of Public Information and Education. For specific information, contact one of the divisions. (Geological Survey, Natural Areas and Preserves, Parks and Recreation, Soil and Water Districts, Water, Watercraft, Wildlife).

* Some of the information in this appendix was adapted from 5:5.

Ohio Environmental Protection Agency, 361 E. Broad Street, Columbus, Ohio, 43215. Contact the Public Interest Center, the Office of Public Water Supply or the Office of Wastewater Pollution Control.

Ohio Sea Grant. Three branches provide research and education information and assistance to Ohioans.

- 1) Ohio Sea Grant Program, Center for Lake Erie Area Research, 484 West 12th Avenue, Columbus, Ohio, 43210;
- 2) Ohio Sea Grant Extension Program located at the above address with Sea Grant area extension agents at three locations:
 - a) Lorain County Extension Office, 1575 Lowell Street, Elyria, Ohio, 44035,
 - b) Lake County Extension Office, 99 East Erie Street, Painesville, Ohio, 44077, and
 - c) Fremont Area Extension Center, 1401 Walter Avenue, Fremont, Ohio, 43420; and
- 3) Ohio Sea Grant Education Office, 1945 N. High Street, Columbus, Ohio, 43210

U.S. Coast Guard. For information on boating and pollution control, contact Boating Safety, Ninth Coast Guard District Headquarters, Federal Office Building, Room 2061, 1240 E. 9th Street, Cleveland, Ohio, 44199.

U.S. Environmental Protection Agency, Center for Environmental Research and Information, 26 W. St. Clair, Cincinnati, Ohio 45268. Address inquiries to "Public Information."

APPENDIX B*

Resource Materials

Childrens' Literature-Passage to the Sea. N. Bagnall, 1980. Sea Grant/Texas A&M, College Station, Texas, 77843. Gives ideas for hands-on activities for learning stations which focus on three children's books—one for primary, one for upper elementary, and one for middle school.

Coastal Problems and Resource Management: A Secondary Social Studies Course. Curriculum Research and Development Group, University of Hawaii, Honolulu. 1979. Materials include a book of readings, student worksheets and a simulation game called Ostrich Bay.

Great Lakes Curriculum for Middle Schools. Michigan Sea Grant Curriculum Team, c/o Dr. Paul Nowak, School of Natural Resources, Dana Building, University of Michigan, Ann Arbor, Michigan, 48109. Contains multi-disciplinary units on the sea lamprey, fishing, water quality, urban communities and shipping.

High School Marine Science Study Project (HMSS). Curriculum Research and Development Group, University of Hawaii, Honolulu, 1979. Contains 10 chapters of activities which focus on three themes: fluid earth, living ocean and technology.

Investigating the Marine Environment: A Sourcebook. H. M. Weiss and M. W. Dorseg, 1979. Three volumes. Project Oceanology, Avery Point, Groton, Connecticut, 06340.

Investigating the Marine Environment and Its Resources. V. Lien, 1979. Texas A&M Sea Grant University Program, College Station, Texas, 77843. Two volumes of interdisciplinary activities and information on the Gulf Coast.

Marine Organisms in Science Teaching. J. D. Hunt, ed. Texas A&M College Program, College Station, Texas, 77843. Contains supplemental, hands-on investigations for a laboratory-oriented science program for grades four through twelve.

Marine Science Education Project. University of Maryland Sea Grant Program, H. J. Patterson Hall, Room 1222, College Park, Maryland, 20742. Three titles are available: Food Webs in an Estuary, The American Oyster, and Tides and Marshes.

North Carolina Marine Education Project. UNC Sea Grant College Program, 105 1911 Building, NCSU, Raleigh, North Carolina, 27650. Five volumes covering specific topics like coastal geology and history.

* Some of information in this appendix was adapted from 5:5.

Northern New England Marine Education Project. 1979. Sea Grant/College of Education, University of Maine, Orono, Maine, 04469. Over fifteen volumes covering interdisciplinary topics like whales, art, aquaculture, ships and aquariums.

Ocean Related Curriculum Activities (ORCA). Sea Grant/Pacific Science Center/Sea Grant, 200 2nd Avenue North, Seattle, Washington, 98109. Over eight volumes covering specific topics from navigation to Indians to beaches.

Oceanic Education Activities for Great Lakes Schools. Ohio Sea Grant Education Office, The Ohio State University, 283 Arps Hall, 1945 N. High Street, Columbus, Ohio, 43210. Collection of twenty-three multidisciplinary activities for grades five through nine on topics like climate, erosion, pollution, shipping, and fish.

Project COAST. Sea Grant/University of Delaware, University of Delaware, 310 Willard Hall, Education Building, Newark, Delaware, 19711. Series of over 125 topic-oriented packages covering various topics such as dune dances, marine stories and oysters. 1974.

"Sensing the Sea." (Grades Two-Three) E. Odell-Fisher and R. N. Giese, 1978. Virginia Institute of Marine Science, Gloucester Point, Virginia, 23062. Contains hands-on elementary activities which focus on the characteristics of the coastal area and the life which exists there.

Smithsonian Estuarine Activities (SEA). S. P. Gucinski, ed., 1979. Smithsonian Institution, P.O. Box 28, Edgewater, Maryland, 21037. A series of activities investigating marshes and estuaries.

The Source Book of Marine Sciences. S. Dobkin, ed., 1980. Florida Oceanographic Society, 1212 Riverside Drive, Stuart, Florida, 33494. Laboratory experiments of the oceans.

Wet, Wild and Deep, the Physical Ocean. Institute for Marine and Coastal Studies/Sea Grant, USC, University Park, Los Angeles, California, 90007.

APPENDIX C*

Ideas for Field Trips and Other Educational Opportunities

Boat Rides

- Canal Fulton: The St. Helena II, a full-size replica of a mule-drawn Ohio freight barge (in town on SR 93).
Cincinnati: Delta Queen and Mississippi, steamboat tours of the Ohio and Mississippi Rivers.
Cleveland: Goodtime II, sightseeing cruises on the Cuyahoga River and harbor (departs from E. 9th Street Pier).
Coshocton: Monticello II, canal boat ride near Roscoe Village (on SR 16 and 83 at jct. U.S. 16).
Piqua: A mule-drawn canal boat ride at the Piqua Historical Area (off SR 66, 2½ miles north).
Zanesville: The Lorena Sternwheeler, a replica of a turn-of-the century sternwheeler on the Muskingum River (Putnam Landing dock on Muskingum Avenue, ¼ mile from south end of 6th Street Bridge).

Historical Sites

- Coshocton: Roscoe Village, a restored 19th-century Ohio-Erie canal town (on SR 16 and 83 at jct. U.S. 16).
Garrettsville: Hopkins Old Water Mill (1804), an operating mill with authentically reproduced water wheel (in town on SR 82).
Put-in-Bay on South Bass Island in Lake Erie: Perry's Victory and International Peace Memorial, commemorates the Battle of Lake Erie during the War of 1812 (reached by automobile ferries from Catawba or Port Clinton).

Industry

- Lorain: American Shipbuilding Company (AmShip Division) Lorain Yard, tours of shipbuilding and repair facilities (400 Colorado Avenue, 44052).
Painsville: Morton Salt Company Fairport Mine, tour of facilities (near mouth of Grand River).
Toledo: AmShip, see Lorain, (2245 Front Street, 43605).

Locks

- Muskingum River: For information about locations, facilities and tours, contact Muskingum River Parkway, Parkway Office, Box 2806, Zanesville, Ohio, 43761.
Ohio River: For information about locations, facilities and tours, contact U.S. Army Corps of Engineers, Huntington District, Box 2127, Huntington, West Virginia, 25721.

* Some of the information in this appendix was adapted from the 1981 American Automobile Association Tour Book for Ohio.

Museums

Cleveland: Cleveland Museum of Natural History (Wade Oval in University Circle).
Cincinnati: Cincinnati Museum of Natural History (1720 Gilbert Avenue near the entrance to Eden Park).
Columbus: Center for Science and Industry (280 E. Broad Street).
Columbus: Ohio Historical Society (jct. I-71 and 17th Avenue).
Dayton: Dayton Museum of Natural History (2629 Ridge Avenue).
Fairport Harbor: Fairport Marine Museum (129 2nd Street).
Marietta: Ohio River Museum and the W.P. Snyder, Jr., one of the first all-metal, steam powered towboats on the Ohio River (Washington and Front Streets).
Vermilion: Great Lakes Historical Society Museum (480 N. Main Street).

Natural Areas, Preserves and Parks

Many organizations own properties which contain lakes, streams, marshes, bogs, estuaries or other bodies of water. Some of these organizations provide opportunities for individualized exploration while others make available naturalists or other personnel for guided tours. For specific information contact:

Ohio Department of Natural Resources, the Divisions of Natural Areas and Preserves, Parks and Recreation or Wildlife, Fountain Square, Columbus, 43224.
The Ohio Historical Society, Interstate 71 and 17th Avenue, Columbus, 43211.
The Nature Conservancy, Ohio Chapter, 1504 West First Avenue, Columbus, 43212.
Local Parks (city, county, metro), nature centers, camps, environmental education centers, school land labs.

Ports

Ohio has ports at five locations: Ashtabula, Cleveland, Conneaut, Lorain and Toledo. Guided tours may be arranged at Cleveland and Toledo Port Authorities.

Zoos

Aurora: Sea World, family entertainment, school programs and teacher workshops (3 miles northwest on SR 43).
Cleveland: Cleveland Aquarium, marine and fresh-water plants and animals (off I-90 at E 72nd Street exit in Gordon Park).
Cleveland: Cleveland Metroparks Zoo (in Brookside Park with entrance off W. 25th Street).

Cincinnati: Cincinnati Zoological Gardens (exit 6 off I-75, following signs to Vine Street and Erkenbrecher Avenue).
Columbus: Columbus Zoo, with aquarium (at O'Shaughnessy Dam on SR 257 at 9990 Riverside Drive).
Sandusky: Cedar Point's Oceana, performing dolphins and aquazoo (reached by toll causeway off U.S. 6, 10 miles north of Ohio Turnpike exit 7).
Toledo: Toledo Zoological Park, with a large fresh-water aquarium (3 miles southwest on U.S. 24 at 2700 Broadway).
Youngstown: For Nature Center, semiaquatic terrarium and aquariums with indigenous fish, plants and crayfish.

Miscellaneous

Castalia: Blue Hole, artesian spring of azure water of unknown depth, trout exhibit, and fish ($\frac{1}{2}$ mile north on SR 269).
Kelleys Island in Lake Erie: resort, grapes, quarries, glacial grooves (by ferry from Sandusky or Marblehead).
Marblehead: resort, fishing center, light house, quarries.

OCCASIONAL PAPERS

This is the sixth in a series of papers designed to provide interested people with some current information about environmental education. The occasional paper format was chosen because it provides for rapid production and, therefore, timeliness. The varied topics of these papers will allow them to be distributed to different and specific audiences.

Other topics now being considered for publication are:

An Explanation of Appropriate Technology .

School Land Laboratories: Their Use and Development

Resident Outdoor Education: Some Program Guidelines

Responsibilities of a School District Coordinator of Environmental Education

Suggestions for other topics will be welcome.

Authors for these papers will be Ohioans both in and out of the Ohio Department of Education and, therefore, the views expressed are those of the authors, and not necessarily those of the Ohio Department of Education.

APPENDIX G
Comprehensive Evaluation Form
for Awareness Workshops

Marine and Aquatic Education Teacher Workshop Evaluation Form

The leaders hope this has been a beneficial experience for you. We tried to plan it so it would be the most useful in your present teaching responsibility. Please give us information that will improve the workshops we are planning in the next two years for other teachers throughout Ohio. They will benefit from your candid responses. Thank you.

Your grade and/or subject _____

1. Please react to the general ATMOSPHERE we created. Warm, friendly, accepting, pleasant, helpful, relaxed, enjoyable, or the opposites. What should we do to change or improve it?
2. Please tell us if we have helped you increase your knowledge about and understanding of Marine and Aquatic Education and the need for it in the curriculum of Ohio's elementary and secondary schools. What else would be helpful?
3. Please tell us if we have given you sufficient help in finding the RESOURCES you will need in preparing future marine and aquatic education activities you will want to do with your students. What else would be helpful?
4. What else did we do well? Not so well? Your comments will help us to do a better job for teachers from all over Ohio.
5. Do you feel that Lake Erie is an appropriate topic for inclusion in your curricula? Has your opinion on this changed as a result of this workshop? Explain.

APPENDIX H

Sample Syllabus

for Implementation Workshop

ED 727P01
3 credits
Workshop in Marine and Aquatic Education
COURSE SYLLABUS
Spring 1983

Instructors

Dr. Victor J. Mayer, Professor of Science Education and Geology, OSU
Dr. Rosanne W. Fortner, Assistant Professor of Natural Resources, OSU

Office: 283 Arps Hall, 1945 N. High St., Columbus, Ohio 43210
(614) 422-4121

Objectives

Participants will:

1. learn information about Ohio's waterways and the world's oceans;
2. participate in activities useful for teaching water-related concepts in the arts, science and social studies;
3. study the current status of biological and physical resources of the seas and the Great Lakes;
4. design classroom activities that lead to an understanding of the importance of water in the history, culture and economy of Ohio and the nation;
5. participate in field experiences along the Lake Erie shore.

Topic Outline

A. The World's Oceans

1. Information
 - a. Origin of the ocean basins and continents
 - b. The water of the oceans
 - c. The influence of the oceans on weather and climate
 - d. The life of the oceans
 - e. The influence of the oceans on art, history and culture
2. Teaching materials
 - a. Materials of the Crustal Evolution Education Project
 - b. Materials developed by agencies such as National Oceanic and Atmospheric Administration, Project ORCA and Project COAST
 - c. Audio visual materials

B. The Great Lakes

1. Information

- a. Origin of the Lakes
- b. Characteristics of the lakes
- c. Effects on the lakes on history and culture of the area
- d. Economic importance of the lakes

2. Materials

- a. Materials developed by Michigan and Minnesota Sea Grant
- b. Selected materials of Ohio Sea Grant
- c. Audio visual materials

C. Lake Erie and Ohio Rivers

1. Information

a. Lake Erie

1. Its development and characteristics
2. Its effect upon the State's history
3. Its economic importance

b. The Ohio River and Its Tributaries

1. Origin and characteristics
2. Their Uses

2. Materials

- a. Teaching materials developed by Ohio Sea Grant
- b. Other teaching materials

Text Materials

Ohio Department of Education, "Marine and Aquatic Education," Environmental Education Occasional Paper #6, August, 1981.

Ohio Sea Grant, Oceanic Education Activities for Great Lakes Schools, a series of 23 activities and teachers' guides containing background information on various topics and teaching strategies.

Selected articles from current literature.

References

Lafferty, Michael B., editor. Ohio's Natural Heritage, The Ohio Academy of Science, Columbus, 1979.

Goodwin, Harold L. Americans and the World of Water. University of Delaware Sea Grant Program, Newark, 1977.

Evaluation will be based on

- | | |
|---------------------------------|-----|
| 1. Attendance and participation | 70% |
| 2. Completion of an activity | 30% |

ED 727P01
Schedule of Classes
Spring 1983

<u>Date</u>	<u>Topic</u>	<u>Activities</u>	<u>Assignment</u>
3/29	Overview of Marine and Aquatic Education Introduction to Sea Grant Geography of the Great Lakes	Slide presentation Film EP-14	Environmental Education #6
4/5	Effect of large water bodies on weather and climate Water level change in Lake Erie	EP-1 EP-16	EP-2 "Lake Erie and the Islands" 215-223 EP-5
4/12	No Class		
4/19	Origin of the Great Lakes Formation of Ocean Basins	Film EP-3 CEEP	Project Paragraph EP-6 EP-7 EP-10
4/26	Life in Sea and Lakes Economics of fisheries The great whales	EP-11 discussion ORCA	EP-19 EP-9 "Life of the Lake & Islands" 224-235
5/3	Problems of oceans and Lakes Pollution Acid rain Sea lamprey	EP-23 Minnesota S.G. Michigan S.G.	EP-8 EP-12 "State of the Lakes"
5/10	Impact of the seas on cultural heritage music arts language	Film songs Discussion	EP-18 "Images for a Sea People"
5/17	The Role of Lake Erie in the Nation's History Shipping on the Lakes and oceans	EP-21 slide presentation EP-17 EP-20	EP-15 EP-13
5/21	Field trip-Cleveland Lake front		
5/24	Law of the Sea Whaling	EP-22 slide presentation ORCA	
5/31	Marine Resources Seafood Smorgasboard	slide presentation meal	EP-4

SUGGESTED ACTIVITY FORMAT

1. Title
2. Instructional Goal: the main concept or idea.
3. Objective: the behaviors the students should achieve.
4. Introduction: reasons why students should do the activity;
interest grabber.
5. Procedures: steps the students perform in order to accomplish
the objectives.
6. Evaluation: how the students will be evaluated; did the students
achieve the objectives?
7. Resources and References: for students and teachers.
8. Extensions: additional assignments and enrichment activities (optional).

DEADLINES

April 19: a paragraph summarizing your activity and appropriate
grade level.

May 31: completed activity due

SUGGESTED TOPICS

- | | |
|-----------------------------------------|--------------------------------------------|
| 1. Water Sports | 15. Settlements along Coasts and
Rivers |
| 2. Legends of the Sea | 16. Others by request |
| 3. Sea and River Paintings | |
| 4. Literature of the Sea and Rivers | |
| 5. Songs of the Sea | |
| 6. Human Life Under the Sea | |
| 7. Problems in Uses of the Coastal Zone | |
| 8. Life in the Sea and Rivers | |
| 9. Transportation on Seas and Rivers | |
| 10. Sea Battles; Lake Battles | |
| 11. Uses of Water | |
| 12. Types of Ships and Ship Building | |
| 13. How Seas and/or Lakes were Formed | |
| 14. Sea and Lakes as Energy Resources | |

APPENDIX I

OJS article

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OHIO STUDENTS' KNOWLEDGE AND ATTITUDES ABOUT THE OCEANS AND GREAT LAKES¹

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ABSTRACT. A program to develop instructional materials for implementing marine and aquatic education in Ohio middle schools was begun by Ohio Sea Grant in 1977. This was followed 3 years later by a grant to disseminate the materials to schools in Ohio. To determine the effectiveness of the dissemination process a baseline study was conducted in the autumn of 1980. The survey obtained information on attitudes and knowledge of the Great Lakes and oceans from fifth and ninth grade students in randomly selected schools within 3 arbitrarily determined zones: the lake region, the central region and the Ohio River region. In addition, students responded to items to determine their perceptions of the sources of their knowledge.

Students exhibited low levels of knowledge of marine and aquatic topics, with the poorest performance in those topics related to the humanities. The ninth graders scored significantly higher on all topics. Knowledge scores were related to attitudes and high scorers had more positive attitudes than low scorers. Students in the lake region did not have appreciably more water related experiences than those students in the other 2 regions. In both grades television was rated the most important source of aquatic information.

A similar survey was begun in September of 1983 upon completion of the dissemination project. Any changes in ninth graders' knowledge and attitudes can in part be attributed to the program, provided fifth graders' behaviors have not changed appreciably.

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INTRODUCTION

The Office of Sea Grant, within the National Oceanic and Atmospheric Administration, supported a study resulting in a paper published in 1978 on the need for marine and aquatic education in the nation's schools (Goodwin and Schaar, 1978). The paper provided a definition of marine and aquatic education as a component of environmental education. The consensus of those contributing to the study was that since Earth Day, environmental concerns have resulted in an increased awareness of our air quality, mineral resources, drinking water and landscape, but too often the critical role of the oceans has been ignored.

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What do our children know about the world's oceans? What are their attitudes toward them? These questions must be answered for educators to be able to support the need for programs in marine and aquatic education and to effectively design such programs. Fortner and Teates (1980) conducted a study of children in Virginia, a coastal state, and concluded that "... some improvement in the level of student knowledge about the ocean is desirable, and specific ocean study courses have not been shown to be significantly related to marine knowledge or attitudes. Given this information, it is recommended that subject matter dealing with the ocean be infused into existing curricula ...

The Office of Sea Grant funded Ohio Sea Grant in 1977 to develop teaching materi-

als for students in grades five through nine of Ohio's schools. The need for this development project was in part based on the results of a survey conducted by Howe and Price (1976). The survey was completed by about 30 students from each tenth and each twelfth grade class in 40 selected Ohio high schools. While results differed within and between schools, the data indicated that most students had positive attitudes regarding the oceans, recognized the importance of the oceans in the future of the United States, and were aware of related environmental problems. On the other hand, most lacked factual and conceptual knowledge about the oceans and other bodies of water.

In designing the development project, Ohio Sea Grant staff felt that high quality teaching materials, focusing on factual and conceptual information about the oceans and the Great Lakes, would be a first step in facilitating increased learning among Ohio's school children about the marine and aquatic environments. Consistent with the recommendations of Fortner and Teates (1980), the materials developed were to be supplementary, 2-5-day modules, and infused into existing curricula. Because of the structure of Ohio schools, it was felt this could best be accommodated at the middle school or junior high school level. The modules were collectively titled Oceanic Education Activities for Great Lakes Schools (OEAGLS).

None of the studies previously cited dealt with documenting student background in marine and aquatic education during the middle school years, nor did they attempt to determine changes in such knowledge and attitudes over a period of time.

The study was designed to answer the following questions: (1) What do Ohio fifth grade and ninth grade children know about the oceans and the Great Lakes? (2) How does their knowledge change over the intervening four years of schooling? (3) What are the attitudes of Ohio fifth and ninth graders toward the oceans and toward Lake Erie? (4) How do these attitudes

change over the intervening four years of schooling? (5) What do children perceive as their sources of knowledge regarding the oceans and the Great Lakes? (6) Do these perceptions change over the intervening four years? Fortner and Teates (1980) found that students who lived in close proximity to the coast had higher knowledge scores. A further question to be answered in the Ohio survey was whether this "proximity effect" was found also in relation to the Lake Erie shoreline.

SURVEY DEVELOPMENT

Each of the survey instruments consisted of 3 parts: a knowledge component, an attitude assessment, and an experience inventory. A pool of 86 knowledge items was developed from those used in the earlier Ohio study, the Fortner and Teates (1980) study in Virginia, and a study conducted by Delaware Sea Grant (Leek 1980). Additional items were developed by staff of the Ohio Sea Grant OEAGLS project. The entire pool was reviewed by a panel of 12 experts in marine history, fisheries, and geography. Items were revised based on the experts' suggestions. The pool was divided into 4 tests and administered to 55 fifth grade students and 80 ninth grade students from a suburban Columbus school system.

Students were asked to make comments on each item relating to the language used and its difficulty. In addition, a random sample of fifth graders was selected and interviewed about items. Teachers were also asked to comment on each item. These informal comments were used to modify items to make them understandable to fifth graders. In addition, item analyses were performed on each of the 4 pilot versions of the survey. A final item pool of 63 items survived the pilot procedures. These items were divided among 3 forms. Six items were selected as a core and were included on all 3 forms. These items were of a broad, general nature and appeared to be of greater significance than most of the other items. The remaining 57 were categorized by content area and then equally assigned from among the 3 areas of science, social studies, and humanities to each of the 3 forms, making a total of 25 knowledge items on each.

The semantic differential format was selected for the assessment of attitudes. Two referent concepts were used, "The Oceans" and "Lake Erie." Ten adjectival pairs were selected for use with the 2 concepts. The pairs represented the 3 dimensions of potency, evaluation, and activity. A panel of 6 individuals critiqued the scale, and minor revisions were made. The third component of the survey was a series of items to determine student perceptions of their sources of knowledge regarding the oceans and the Great Lakes. The items developed

by Fortner and Teates (1980) were slightly modified and used with this survey. The same attitude items and experience items were used on each of the 3 forms.

Additional information about each school's geographic and economic setting and about the class in which the survey was conducted was obtained through a questionnaire completed by the teacher. This information was used to verify whether instructions were followed in the selection of classes. It also provided data on the socio-economic status of the groups involved in this survey.

In identifying the sample for the study, the State of Ohio was split into 3 regions. Those counties located within 50 miles of the Lake Erie shore comprised the "lake region," those within 50 miles of the Ohio River, the "river region," and the remaining counties, the "central region." Two lists were compiled by region, one with schools having fifth grade classes, and one with schools having ninth grade classes. A 4% random sample of the fifth grade schools was selected in each region. Since there are fewer ninth grade schools because of their generally larger size, a 10% random sample was chosen from these schools. This resulted in a sample of 120 fifth grade schools and 110 ninth grade schools. A letter was sent to the principal of each of the selected schools explaining the nature of the study and offering an invitation to participate. Each principal was asked to list the teachers in the school at the fifth or ninth grade level in alphabetical order and to select the teacher at the middle of the list to be the administrator of the test. The teacher's name was then sent to the investigators. The survey materials were sent to that teacher with a request to use them in the teacher's last class of the day and on or before a certain date.

Each teacher received sufficient survey forms for a class of students. They were arranged sequentially by form within the set received by the teacher, so that a third of the students in each class received

form A, a third form B, and the remainder received form C.

ANALYSIS OF DATA

Results were received from 79 of the originally selected fifth grade schools, a 66% response, and from 68 of the originally selected ninth grade schools, a 62% response. Totals of 1,887 fifth grade students and 1,786 ninth grade students participated in the survey.

The proportion of non-responding schools was relatively high despite the fact that intensive efforts were mounted to obtain responses from the original sample. Original response rates varied between a low of 59.0% from ninth grade river schools to a high of 84.6% from fifth grade central schools. It appeared that respondents differed in some respects from non-respondents. For example, it was more likely that non-respondent schools were from urban areas. This was particularly true of the river region. One factor was the strike of Cincinnati teachers which occurred during the testing period. Some caution must be exercised, therefore, in generalizing the results of the study, especially those from the river region.

Table 1 indicates the number of participating schools representing each community type and whether the funding source was public or private. Most of the schools in both grades were public

TABLE 1
Description of responding classes

	Grade 5			Grade 9		
	Lake	Central	River	Lake	Central	River
Number of schools	30	22	27	28	17	23
Setting						
Urban	20.0%	18.2	22.2	14.3%	17.7	4.3
Suburban	30.0	18.2	18.5	32.1	17.6	26.1
Town (pop. 100,000)	26.7	40.9	25.9	42.9	23.5	34.8
Rural	23.3	22.7	33.0	10.7	41.2	34.8
Funding						
Public	74%	83%	83%	81%	93%	91%
Private	26%	17%	17%	19%	7%	9%

schools. All types of community settings were well represented in the samples for each grade, although the proportions of schools in each setting varied between grade level and area.

Among the responding teachers, about 60% of the ninth grade teachers indicated that they complied with the request to give the survey in their last class period within the range of dates allowed. Determination of the time of day used by most of the fifth grade teachers could not be made since most had self-contained classes. In approximately 14% of ninth grade classes, teachers or principals noted that the survey was given in the class in which it could best serve as a learning experience to supplement the curriculum. Most apparently saw this experience to be related to science, and accordingly the most commonly reported subject area for survey administration was the science class (76% of ninth grade).

Five non-white racial categories were represented among students tested. Eighty-two percent of the non-white fifth graders and 90% of the non-white ninth graders were black. Because of the predominance of one race, the 5 categories were collapsed for analysis into a single non-white category.

Since response to the survey was divided over 3 forms of the knowledge test and therefore obtained from 3 different groups of students, it was necessary to assure the equivalence of the groups in order to combine results across test forms. The Crosstabs analysis of the Statistical Package for the Social Sciences (SPSS) was used to generate a chi-square analysis of response frequencies by grade on the 6 items common to forms A, B, and C. No significant differences occurred ($p < .05$) between the means of the 6 items on the 3 forms, confirming the equivalence of the 3 groups.

The Item Analysis program of the Statistical Analysis System (SAS) was used to tabulate response frequencies for each knowledge item by grade by region, and to produce total test statistics. Since the

items varied greatly in their content, subtest scores were calculated for the 3 subject areas of science, social studies, and humanities. The KR-20 reliabilities for the fifth grade respondents on the 3 versions of the test ranged from 0.35 to 0.47. Because of the low reliabilities, no analysis of the fifth grade data beyond means and standard deviations was performed. For ninth grade respondents the reliabilities ranged from 0.56 to 0.69.

To assist in analysis of attitudes a panel of reviewers was selected from among individuals involved in marine education in formal kindergarten through college settings and informal education programs. Panel members were asked to indicate what they considered to be the most positive response to each attitude item. The items were then recoded for analysis so that "positive" would always be at the high end of the scale of possible responses. Descriptive statistics were calculated for each item and for total attitudes about Lake Erie and the ocean.

The first 32 questions in the experience portion of the survey dealt with the wide range of experiences thought to influence knowledge or attitudes about water environments. Frequencies and means were calculated by region for the individual items to determine whether proximity to water was related to the frequency of each experience. A stepwise multiple regression analysis was conducted to determine whether any of the experience variables could serve as predictors for knowledge scores. For those that appeared to be related, Tukey's test of the mean was applied to assess the direction and strength of the relationship.

The final item in the experience profile asked for the type of information sources students felt was most important in teaching them about the oceans and Great Lakes. Student choices of information sources were compared by region, race, sex, knowledge score, and attitude mean using Pearson's correlation. This series of correlations was designed to indicate

first whether students with different demographic characteristics were utilizing different information sources, and second, which source was related to higher knowledge scores and more positive attitudes.

An analysis of variance indicated the significance of differences among knowledge scores according to region, race and sex of respondents. Pearson's product-moment correlation was used to determine whether there was a relationship between knowledge scores and attitudes. This process was repeated for high scorers ($\bar{X} \geq 67\%$) and low scorers ($\bar{X} \leq 33\%$).

RESULTS

Fifth graders answered 38% of the questions about the oceans and Great Lakes correctly, and ninth graders answered 48% correctly (table 2). When subtest scores were calculated, it was found that ninth graders' knowledge of aquatic concepts in social studies is about the same as that in science, about 50% correct. Knowledge of water-related humanities concepts, however, is considerably lower (41%). Among fifth graders, the highest scores were made on the science subtest (41%) and the lowest on humanities (32%).

Knowledge scores were shown to be significantly related to attitudes ($p < .001$), and the data in table 3 illustrate that high scorers have more positive attitudes than low scorers.

When specific attitude items were examined in relation to knowledge scores, it was found that those who scored higher were also those who felt that Lake Erie and the oceans were important and valuable.

TABLE 2
Knowledge of oceans and Great Lakes for total test
and by knowledge category

	Percent correct	
	5th	9th
Total knowledge test	37.6	48.3
Science	41.0	50.6
Social Studies	36.8	50.0
Humanities	31.6	40.7

TABLE 3
Relationship of marine and aquatic knowledge and
attitudes.* Attitude means by knowledge level

	Grade	All students ($N = 708$)	High scorers ($\bar{X} \geq 67\%$) ($N = 20$)	Low scorers ($\bar{X} \leq 33\%$) ($N = 289$)
Oceanic attitudes	5	3.76	4.01	3.75
	9	3.97	4.15	3.75
Lake Erie attitudes	5	3.49	3.76	3.49
	9	3.29	3.34	3.20

*Maximum positive attitude = 5

Overall, attitudes toward the oceans were more positive than those toward Lake Erie, even among residents of the lake region.

An analysis of variance was performed to identify relationships between demographic factors and knowledge scores. Main effects were significant ($p < .001$) for region and race in grade five and for region, race and sex in grade nine. Specifically, white students in coastal areas scored higher in both grades. In the ninth grade, males outscored females. For the ninth grade there was also evidence of an interaction between region and sex ($p < .05$) such that regional differences occurred primarily among males.

Students in the lake region did not appear to have appreciably more experience with water related activities than the river or central groups. Fifth graders generally reported lower frequencies of such activities except for those that involved reading books or magazines. The fifth graders also expressed a greater interest in learning more about the oceans and Great Lakes. Question 33 of the experience inventory collapsed the preceding items into 5 categories. Responses on this item by grade are reported as figure 1. In both grades the category of movies and television was selected most frequently as being the most important source of information about the oceans and Great Lakes. Classroom experi-

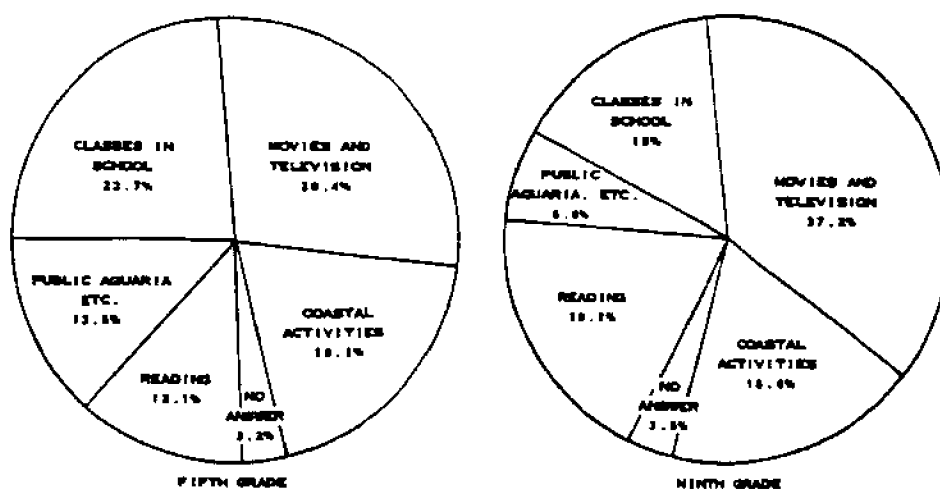


FIGURE 1. Perceived influence of experiences on ocean and Great Lakes awareness.

ences were more frequently chosen by fifth graders, as were non-formal institutions of learning such as museums. It is interesting to note that fifth graders, though they claimed to have been frequent readers of magazines, did not select that category as a major knowledge source.

Because Fortner and Teates (1980) reported that 3 experiences were shown to have a particularly strong positive relationship to marine knowledge, the same 3 experiences, the number of Cousteau programs seen on television, frequency of reading *National Geographic*, and ability to swim, were examined in this study. For the ninth grade data a stepwise multiple regression analysis identified nearly the same variables, substituting *National Wildlife* as the magazine, as accounting collectively for 13% of the variance in knowledge scores. Using Tukey's test it was found that knowledge scores were significantly higher with more experience in each of the activities.

DISCUSSION

The students tested had low levels of knowledge regarding marine and aquatic topics. The magnitude of this problem is illustrated by the responses of students when asked to identify Lake Erie on an outline map of the Great Lakes. Only 60%

of the ninth graders and 46% of the fifth graders correctly identified Lake Erie. Other questions indicated a lack of knowledge about the presence of PCBs in fish (29% correct in grade nine), how much of the world's food comes from the ocean (40% correct), and where energy comes from for life in the sea (45% correct). These topics are among the basic concepts that Picker (1982) compiled as the experts' consensus on a "Conceptual Scheme for Aquatic Studies."

Others of those concepts fared well. In the ninth grade, 54% knew what plankton are, 65% chose ships as the cheapest transport method for certain routes, 75% were aware of reasons why marine fossils are found on some mountaintops, and 60% could identify the binding interest of OPEC countries. Such information is important as a basis for responsible decisions, and the levels of knowledge indicated are encouraging.

The poorest performance occurred on items related to humanities, indicating that students are not encountering, or at least not remembering, information on the seas' and lakes' importance in our culture. While such information is perhaps not as important in the building of informed decision-makers as is the scientific, historic and economic value of waterways, ex-

posure to the cultural aspects can be a life-enriching experience. Exposure to this information also helps in informing students of the pervasive impact of the world of water in all aspects of human life and therefore can have implications in demonstrating the importance of decisions on water-related politics.

That ninth graders scored significantly higher on knowledge than fifth graders may be cause for optimism. This study has demonstrated a correlation between higher knowledge and more positive attitudes about the importance and value of water systems. Formal and informal experiences over the 4-year period between the grades are apparently producing desirable changes in the school population. If we can identify which of those experiences are the most effective information sources, then their use can be maximized to improve knowledge about the water world.

Thus, an important aspect of this report is a consideration of where the subjects' information might have originated. The largest percentage of the subjects felt they got their information from movies and television. The demographic factors shown to be related to knowledge scores were region and race in grade five, with sex also related in grade nine. An opportunity factor may be involved in the regional "proximity effect," with more aquatic experiences available in the coastal region, and a historic factor of dominance by white males in water-related careers may also be related. Combining these possibilities with the additional related factors of watching Cousteau programs, reading *National Wildlife* and being able to swim, it is not difficult to surmise the influence of socioeconomic factors on aquatic knowledge. Better clues to socioeconomic influences would be measures of family income and education level which were not collected in this study but should be included in future research.

This study has served the Ohio Sea Grant Education Office as a baseline of marine and aquatic knowledge and atti-

tudes and therefore as a guide to what information should be provided in curriculum materials and/or teacher training. It has shown that water-related knowledge, attitudes and experiences in a midwestern state are very similar to those in a coastal state such as Virginia. It has also suggested other mechanisms besides kindergarten through high school education as information vehicles and has thus served as justification for projects involving radio and museums as dissemination media. Finally, the survey will be treated as a pretest which preceded a 3-year program of teacher education in marine and Great Lakes education, grades five through nine. Repeating the survey in the 1983-84 school year, with a new sample chosen in the same way, should indicate whether this information has been passed on to the teachers' classes to the extent that ninth grade scores are substantially higher than the pretest scores. In the posttest the fifth grade will serve as a comparison group, since that grade level and below will be minimally impacted by the teacher education program and OEAGLS materials. In that regard, this study will serve as a summative evaluation for both projects.

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APPENDIX J

Pilot of a system for collecting daily
classroom data on learning by
using micorocomputers

PILOT OF A SYSTEM FOR COLLECTING DAILY
CLASSROOM DATA ON LEARNING BY USING MICROCOMPUTERS

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PILOT OF A SYSTEM FOR COLLECTING DAILY CLASSROOM DATA ON LEARNING BY USING MICROCOMPUTERS

Several studies have reported on the development of the intensive time series design which allows monitoring class achievement and attitudes on a daily basis (Mayer and Monk, 1983). The system involves the administration to each student in class of a few objective items on each of the characteristics to be measured. Total administration time takes less than five minutes and typically occurs at the end of the class period. It has been used to monitor concept achievement in six studies. The results have been consistent, indicating the validity of the design by showing no effect of frequency of testing upon the data (Mayer and Rojas, 1982). The discrimination of the design has also been demonstrated; that is its ability to yield data that discriminates between the learning patterns of two different groups of children (Farnsworth and Mayer, 1984).

Each of the studies has yielded information on learning patterns consistent with current understandings of learning and some intriguing new information suggestive of some post-treatment improvement in understanding. In the Farnsworth and Mayer study, for example, achievement in understanding of plate tectonics by children operating at the formal cognitive level continued stable or accelerated several days into the post-treatment phase. This was not true of those children at the concrete cognitive level. Kwon and Mayer, 1985, reported on a method for identifying and describing what they have called the "momentum effect". The design has also produced interpretable data on attitudes.

Thus far, data have been collected through the use of paper and pencil instruments. This has been very unsatisfactory because of the time needed to assemble the instruments and to administer them, students errors in coding their response and cumbersome methods of handling the data. To overcome these obstacles the use of microcomputers for collecting data was investigated. This is a report of two pilots of the microcomputer system that was developed for use in collecting classroom data for this design.

Description of Microcomputer System

A system was developed which uses several microcomputers for presenting the questions and collecting the response data. It consists of two computer programs. The first is an authoring disk for preparing up to two item pools of 80 items each. The items in each pool can be categorized on two dimensions, eg., by taxonomic level of item and by instructional objective. The second disk is a study organization program. It randomly assigns items to students for each day of the study, ensuring an equal distribution of items by dimension and also ensuring that no student will get the same item more than once during the study. The results and a study management program are then transferred by the study organization program to disks for each of the computers

that will collect the data. The study management program will present the question, allow up to a minute for response, record the student response, and also record the amount of time taken by the student to respond.

Six to eight Commodore 64 computers, each with a disk drive and green screen monitor, were used in the two pilots. The teacher was required to boot the program disk in the morning and back up data at the end of the day on a single back-up disk. The back-up procedure automatically resets each disk for the next days questions. The two procedures take no more than 20 minutes of the teacher's time each day. When a student types in an identification code, the program presents the question(s) assigned the student for that day.

Upon completion of the study, data is transferred to a data file on the university's main computer where it is analyzed. An added feature allows the teacher to summarize the data on each computer at the end of each day. Teachers, therefore, can monitor the performance of their classes on a daily basis.

Design of Pilot Studies

The two pilots were conducted in two different junior high schools in the central Ohio region. Both were performed with eighth grade earth science classes. The studies were to run for 40 days, with 10 days as a baseline, 20 days for the intervention and 10 days as a follow-up. An earth science unit was designed focusing on the geology, limnology and weather of Lake Erie and the Great Lakes. This comprised the intervention. A pool of 80 multiple choice items were selected from those used in previous studies. In the first pilot half of the items directly related to information contained in the unit whereas the remainder were related to Great Lakes topics but not to those contained in the unit. In the second pilot all eighty items related to topics taught in the unit. A pool of attitude items using the semantic differential format were also selected from those used in previous studies. There were four concepts each with 15 adjective pairs used as distractors. The four concepts were; Lake Erie, today's science class, today I feel, and answering questions using the computer. Each student responded to one multiple choice item and one attitude item each day.

At the end of the intervention, all achievement items were administered to all students in each of the pilots to obtain information for item analysis.

Results of Pilot #1

The first pilot study was conducted with four classes totaling 80 students, all taught by the same teacher. It was expected that the performance on the unit-specific achievement items would improve following the beginning of the intervention, whereas performance on the other multiple-choice items would remain constant. It was also expected that attitudes toward Lake Erie would improve as student knowledge of the topic increased. Such changes would be consistent with other studies reported in the literature. The remaining attitude concepts were expected to

vary daily in response to a variety of conditions. Unfortunately, the study could not be completed. Because of end of year scheduling problems, it started with only about 30 days left in the school year. Several of these days were lost because of school events. Only 26 days of the study were completed. In addition, the teacher moved through the unit much more slowly than originally planned. Therefore less than one-half of the unit had been completed when school ended.

When data for the two types of multiple choice items were plotted, no trends were apparent (Figure 1). Also there were no trends for either of the four attitude concepts. Only on response time was there a significant and consistent trend. Response time dropped as the study proceeded (Figure 2).

The major benefits from this pilot of the system were to debug the study management program, improve the documentation used by the teacher, modify the classroom setup and student identification procedures to decrease any problems with student use of the system, develop data analysis procedures, test the instructional unit, and obtain item analysis information on the item pools.

Results of Pilot #2

The earth science unit was used with all of the students of an earth science teacher. This included six eighth grade classes totalling 105 students. Figure three displays the data accumulated concerning student knowledge of the unit objectives as reflected by performance on the multiple-choice items taken every day over the 44 days of the study.

The first 11 days of the data is the baseline. The data exhibit a pattern of decreasing performance. This has been found in each of the studies using this data collection system. It appears that students begin to resent having to respond to questions on information that they have not been taught. As a result, they tire of trying to answer the questions correctly, and thus their performance falls. The positive influence of the unit on student knowledge is apparent from the gradual rise of the curve during the next phase of the data collection, the intervention phase (when the unit was being used). It is apparent that student knowledge increased gradually as the unit progressed. The highest class average was on day 36 (73.7 percent correct), the day that the unit posttest was given following the end of the unit. The mean percent correct on the unit posttest was 68.4 percent (50.4 average raw score out of 74 items; standard deviation of 9.98). It also appears that the student performance remained high following the end of the unit.

This is the same pattern of performance as reported with previous studies using this design with the paper and pencil methods.

Conclusion

In previous studies the intensive time-series design had shown promise for monitoring concept growth and changes in attitudes. However the cumbersome nature of the data collecting

procedures made it impractical for most classroom studies. The two pilot studies using the microcomputer based system have demonstrated its feasibility. Using the Commodores makes it relatively cost effective. The total investment for equipment was about \$6000. The first pilot demonstrated that students soon became accustomed to responding to the items as they were presented by the computer. This is indicated by the rapid decrease of response time. The first pilot also revealed bugs both in the software and hardware permitting them to be worked out. No such problems occurred during the second pilot, although one computer did cease to function and was replaced by a back-up placed at the school for that purpose. Results from the second pilot indicate that the data generated by the microcomputer system is comparable to that generated by the earlier system. Therefore it should be equally valid.

Using the microcomputer system, an intensive time-series study can be developed and administered in a short period of time assuming there exists a suitable set of multiple choice items. Using such a system it is conceivable that researchers and teachers may soon be given access to information, on a daily basis, which will indicate the growth of concept understanding and the fluctuations of attitudes within a class. For the first time it will be possible to assess the impact of teaching behavior, general classroom environment, and student characteristics of learning on a day to day basis.

Now that an efficient and easy to use data collection system has been devised researchers can design studies to examine the impact of a variety of teaching environments upon learning, not merely at single points before and after intervening but during the intervention, and on a constant basis, over whatever time interval seems appropriate to the study. Future research with this system will examine the types of variables that can be used and ways in which they can be measured. One of the next studies will focus on adapting it to collecting word association data permitting its use with concept mapping studies.

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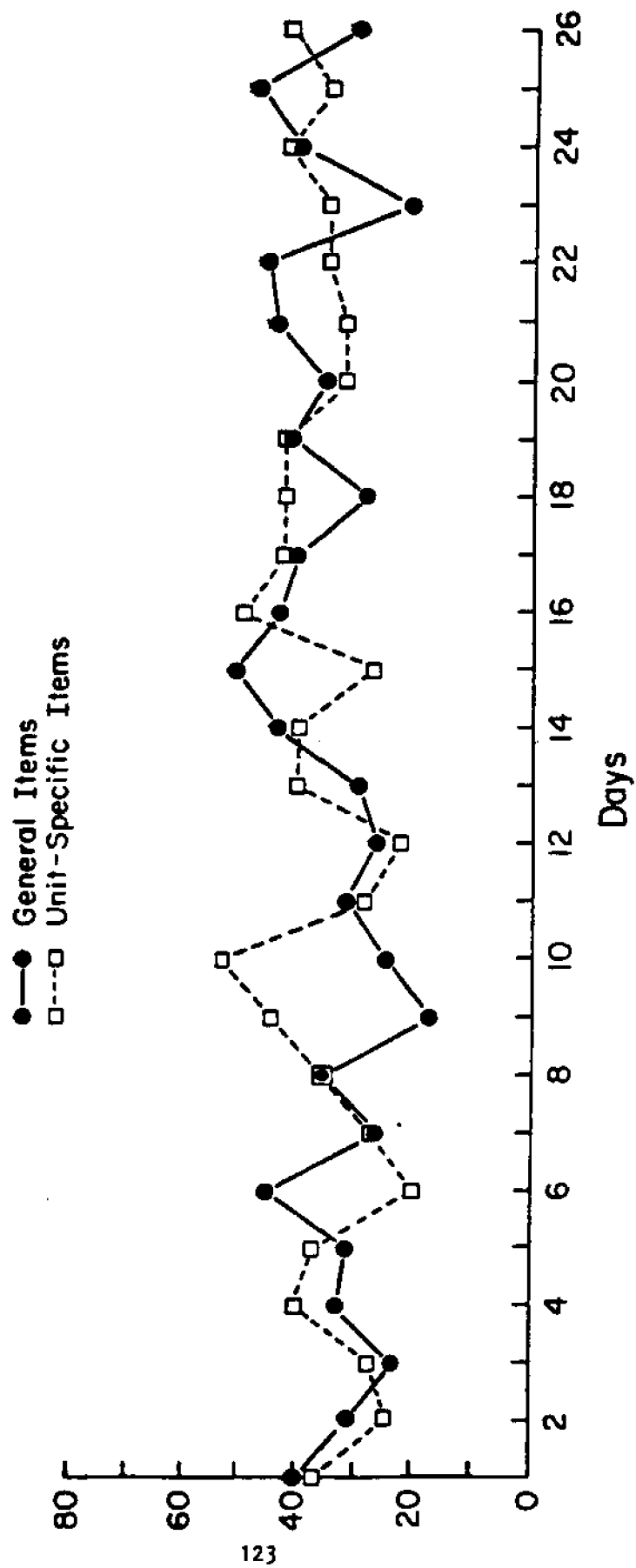


Figure 1. Changes in Knowledge

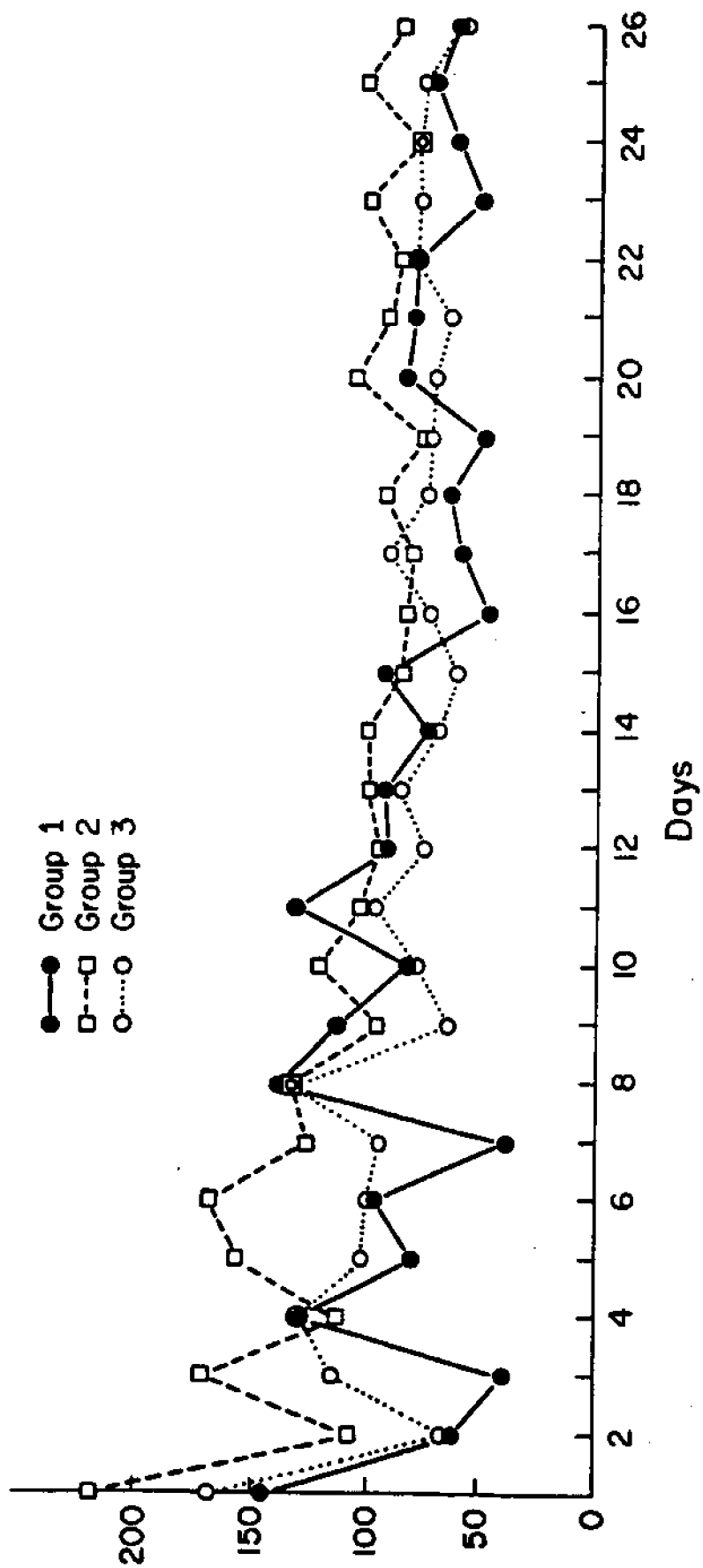


Figure 2. Response Time by Group

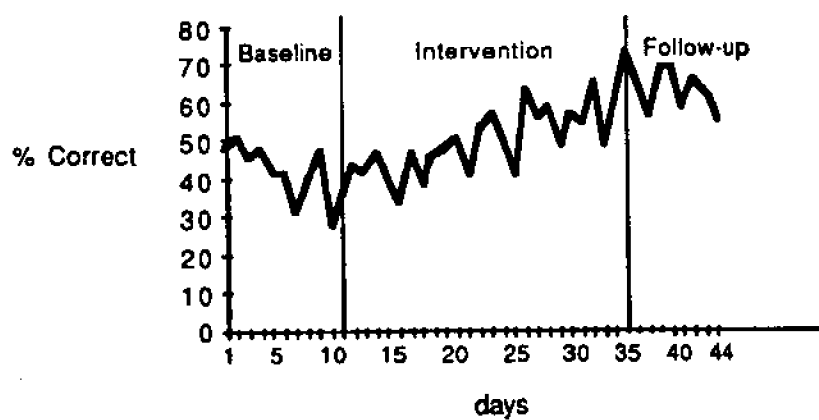


Figure 3. Trend of student knowledge during the Evaluation of the OEAGLS Unit.

APPENDIX K
Ohio Sea Grant Proposal

GRADUATE PROGRAM IN AQUATIC EDUCATION:
A SEA GRANT MODEL FOR TEACHER PREPARATION

E/CD-2

First year of a three year project

Responsible Investigators:

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Department of Educational Theory and Practice, The Ohio State University

The development of "educational programs to increase application of marine sector research" is one of the national needs identified by the Office of Sea Grant for 1987 and beyond (Federal Register, 1986). This offers additional evidence for a trend that has been noted by many others in the public and private sectors in the 1980s, namely that the nation is in need of more individuals better trained in science. Aspects of the trend, documented by studies by the Office of Education, the National Assessment of Educational Progress, the International Study of Science Education and others, include a decline in student enrollments in science courses, low levels of student achievement in science, demotivation for careers in science, negative attitudes toward science and scientists among the general public, and the vagueness of national policies on science and technology (Task Force on Precollege Science Education, 1983). Our own studies among Ohio students and adults indicate that knowledge levels about marine and aquatic topics range from 38% correct responses among fifth graders to about 49% among adults (Fortner and Mayer, 1983; Fortner, 1985).

Countering the negative publicity about education in general and science education in particular are the results of efforts of professional associations, such as the National Science Teachers Association, to identify exemplary science teachers and science programs. Many have been found and documented. At least one, the Hawaii Sea Grant Education program, was among those identified as being excellent. Analyses these programs provides clues as to the characteristics of excellent teachers and programs. At the same time, colleges involved in teacher training have recognized the limitations of many existing programs and of the poor incentive system that deters many well qualified individuals from accepting the challenges of a teaching career. From awareness of these problems has arisen a group of influential educators to say that the time has come to enact sweeping changes that will remedy some major ills of the present system.

In 1983 a group of Deans of Colleges of Education and chief academic officers from several of the major research universities in the U.S. began meeting to consider means of improving teacher education. Dr. Donald Anderson, Dean of the College of Education

of The Ohio State University was a member of this group. They decided to establish a consortium of educators and their institutions representing the premier research institutions in each of the states. It was named the Holmes group after a prominent professor of education at Harvard university. The goals of the Holmes Group are to

1. make the education of teachers intellectually more solid,
2. recognize differences in teachers' knowledge, skill and commitment, in their education, certification and work,
3. create standards of entry to the profession -- examinations and educational requirements -- that are professionally relevant and intellectually defensible,
4. connect their own institutions to schools, and
5. make schools better places for teachers to work and to learn (Tomorrow's Teachers, 1986).

Over 130 research universities, the top 10% of the nation's teacher training institutions, have been invited to join The Holmes Group in its move to restructure the training of teachers, and to date about 80 have indicated their intentions to accept. The Faculty of the College of Education voted in May, 1986, to endorse membership in the group. Discussions are now being held in the College regarding the design of programs meeting the Holmes objectives. As it has done in the past the Science Education faculty of the OSU College of Education is expected to assume a leading role in designing the innovations. Close association with the Environmental Science and Management faculty of the School of Natural Resources, and science faculty of the Colleges of Biological Sciences and Mathematical and Physical Sciences enhances the potential to develop the necessary education-within-science links that will make a new system function. The program area of Science and Mathematics Education has received an Academic Challenge Grant from the Board of Regents of the State of Ohio that is resulting in the development of new laboratory space and the purchase of science instructional materials and equipment that will make it the leading such science education facility in the nation. The grant has also established a joint appointment between the faculty and the College of Mathematics and Physical Sciences to enhance the communications and cooperative efforts of the two colleges. This grant will contribute greatly to the success of the project described in this proposal and is an indication of the strong commitment of the University to the Science Education program.

Since the beginning of the Ohio Sea Grant program in 1976, its education program has made continued strides in melding the results of Sea Grant research into formats that are useful for education of precollege students and teachers. The reputation of

Ohio Sea Grant Education rests on correct science information, current scientific research, usable formats for classrooms, innovative approaches to teaching adults, application of educational research in all program phases, and continued leadership by internationally recognized professional educators.

This proposal puts Sea Grant research information into the direct training of science educators through development of parallel graduate level programs in the School of Natural Resources and College of Education. Development of new graduate courses, revision of current courses, interaction with Sea Grant scientists, and continued curriculum progress will accomplish these project objectives over a period of three years:

- 1) Design and test a model for a 5-quarter series of courses to serve as the graduate education and research application training for prospective teachers who already have a strong science background in their baccalaureate. Well trained scientists can thus become well trained educators.
 - a) The courses will include components that address the certification requirement of the State of Ohio for multicultural education, field experience, reading in the content area, audiovisual materials, etc.
 - b) The courses will have aquatic sciences specific to Lake Erie, and aquatic research specific to Sea Grant, as their content basis.
- 2) Develop an initial cadre of Career Professional Teachers to serve as mentors in the teacher training program.
- 3) Design a parallel and complementary program leading to the MS in Natural Resources with aquatic education emphasis, for already certified teachers
- 4) Initiate new aquatic curriculum development efforts among both the preservice and certified teachers as an integral part of their professional training. A Holmes priority is the transmission of current subject matter through innovative methods. A Sea Grant national need is education programs to increase application of marine sector research.
- 5) Publicize the Holmes/Sea Grant aquatic education track and its Natural Resources counterpart through well-established program outreach mechanisms.

This approach will help the Ohio State University to meet the first two goals of the Holmes Group. Other goals such as #3, the creation of standards, are currently being worked on in

College-wide efforts. These will be integrated into all teacher education programs. The fourth goal, ties with local schools, has been a tradition in the science education program. In fact it won a national award in the 1970's for the quality of its school-based teacher education program. This tradition of good and close relationships with teachers and schools will form a foundation of efforts to establish quality school-based aspects of the new program. The fifth goal, changing school climate, is beyond the capabilities of a single programmatic effort, indeed beyond that of a single institution. This goal can be accomplished only through the concerted efforts of every institution in the Holmes group acting collectively.

The model will illustrate to other Holmes Group institutions one means of keeping subject matter fresh and foremost while pedagogy is taught and teacher certification requirements are met. It will also enable Sea Grant to take a lead in educational innovation that is national in its scope.

Approach

A three year project is proposed, with timeline provided in Figure 1. This time period is divided into periods of development, implementation and evaluation. The proposed program is designed around the following elements:

- The resource base and technical expertise of the Ohio Sea Grant Program.
- Experience in formal and nonformal educational settings.
- A sustained experience with an exemplary science teacher.
- The nature of science and the role of research in science.
- Enhancement of aquatic science and management background information.
- Applications of the results of research in how students learn science concepts.
- Experience in the development of educational materials.
- Selecting and sequencing instructional materials in existing science curricula.
- The integration of educational technology into science teaching.

FIGURE 1.
PROJECT TIMELINE

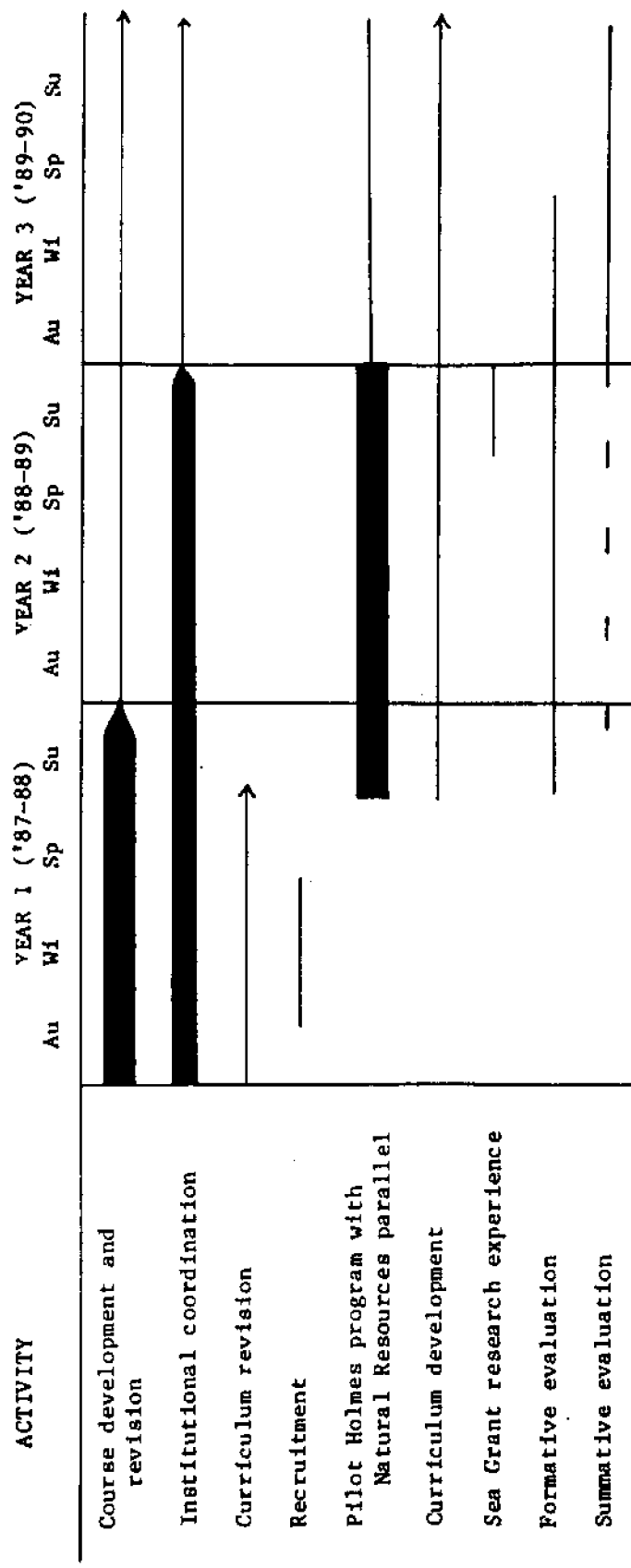


FIGURE 2.
COMPONENTS OF PARALLEL ACADEMIC PROGRAMS

M.Ed. in Aquatic Education Believes Implementation (Closed existing courses)				M.S. in Natural Resources Aquatic Resources Education			
QTP 88	TOPIC	COURSE	CREDIT	QTP 88	TOPIC	COURSE	CREDIT
<ul style="list-style-type: none"> * Great Lakes science concepts * Aquatic science in field settings * Variety of instructional materials for aquatic science * Computer database development for materials * DEAGLS as instructional tools * Educational psychology principles applied among students in field experience * Structured nonformal experiences (Sea Camp) * Aquatic science course 		MR 614	3	<ul style="list-style-type: none"> * Great Lakes science concepts * Aquatic science in field settings * Variety of instructional materials for aquatic science * DEAGLS as instructional tools * Computer database development for materials * Educational psychology principles applied among students in field experience * Structured nonformal experiences (Sea Camp) * Aquatic science course 		ETP 614	3
		ETP 611	2			MR 611	2
		ETP 721	3			ETP 721	3
		ETP 487.27	2			e.g. Zool	5
		e.g. Zool	5				13
<ul style="list-style-type: none"> * Clinical teaching, DEAGLS in schools * Experience in 4 schools: School organization, multicultural education seminar * Begin development of new aquatic education materials (DEAGLS: reading, multicultural) * Educational uses of word processing * Science curricula, strategies, materials 		ETP 627	3	<ul style="list-style-type: none"> * Natural resources policy analysis * Program development in environmental education * Begin development of new aquatic education materials (DEAGLS model) * Science curricula, materials, strategies 		MR 700	4
		ETP ???	6			MR 811	3
		ETP 693.01	2			MR 693.01	2
		ETP 752	4			ETP 752	4
			15				13
<ul style="list-style-type: none"> * Mentored teaching experience * Science education seminar * Educational uses of spreadsheets * Science competition activities 		ETP 884	15	<ul style="list-style-type: none"> * Environmental impact assessment * Watershed resource evaluation * Planning, conducting, reporting research * Continue materials development 		MR 601	4
			15			MR 602	5
			15			Ag Ed 885	3
			15			MR 693.01	2
			15				14
<ul style="list-style-type: none"> * Materials development for local curriculum * Desktop publishing * Audiovisual techniques for science communication * (Including videodisc technology) * Ethical problems in education * Aquatic science course 		ETP 693	2	<ul style="list-style-type: none"> * Materials development for Plan B project * Desktop publishing * Audiovisual techniques for science communication * (Including videodisc technology) * Evaluation of environmental communications 		MR 693.01	2
		MR 615	5			MR 615	5
		ETP 828	3			MR 810	5
		e.g. Zool 655	5				12
			15				12
<ul style="list-style-type: none"> * Participation in Sea Grant research * Seminar with Sea Grant investigators * Project completion: New aquatic education materials based on current research 		e.g. BIO 693	8	<ul style="list-style-type: none"> * Seminar with Sea Grant investigators * Project completion: new aquatic education materials in publishable form * Comprehensive exam 		MR 797	4
		MR 797	4			MR 693.01	3
		ETP 693	3				7
			15				7
			15				7

-- The various certification requirements of the Ohio Department of Education.

Year 1 tasks include 1) development of the institutional structures necessary to support the program, 2) announcement and recruitment of an initial population, and 3) implementation of the first quarter of training. Dates are Autumn 1987 through Summer 1988.

Institutional development. Implementation of The Holmes Group recommendations will include the elimination of baccalaureate programs leading to a degree in secondary science education and to certification for teaching. Instead, undergraduate programs will be pursued in other colleges for development of a strong subject matter background. In other words, the Bachelor's degree give the student WHAT to teach. This proposal and others arising from other sources will offer options for learning HOW to teach by taking a Master's degree in education that will also fulfill certification requirements in secondary science. A tentative outline of course components appears as Figure 2.

The mechanisms for changes of this magnitude have never been defined, and great amounts of faculty energy have already been focused on means by which to accomplish the Holmes goals. Much of Year 1 will be devoted to establishing the interdepartmental liaisons, the scheduling sequences, the credentialing requirements that must be built into courses to satisfy Holmes intentions. Realignment of faculty responsibilities, development of new courses to fill gaps, and identification of appropriate teaching techniques and materials must be done. There must be external activities as well, because without the support of the school systems that will place graduates of the new system, a reward structure will not be in place to recognize their enhanced capabilities.

Some of the teaching materials to be used in the program will be the Oceanic Education Activities for Great Lakes Schools, curriculum packages developed by the Ohio Sea Grant Education Program throughout its existence. The program is now in the process of updating, revising and adding computer applications to the existing OEAGLS as well as adding new topics based on current Sea Grant research. This process will continue through Year 1 so that incoming participants for the aquatic education program will be exposed immediately to examples of products developed through cooperative efforts between scientists and educators. The participants themselves will develop such materials in Year 2 for use in a dissemination program in Year 3. The model of successful curriculum development, evaluation and dissemination has been the strength of the Ohio Sea Grant Education Program, and this proposal offers the opportunity to extend the effort into classrooms following real research experience.

Recruitment. Two types of recruiting efforts will be done in Year 1 to identify an initial population of ten new science

graduates for the Holmes effort and ten experienced teachers for the Natural Resources parallel effort. First, undergraduate programs in science throughout the Great Lakes region, and especially in Ohio, will be notified by mailed poster that the program is beginning in Summer 1988. Follow-up will be through contacts with respondents as well as through Sea Grant scientists region-wide and state Academies of Science. Candidates for the program should have a genuine desire to become a classroom science teacher, have a grade point average of 3.0 or more, have a biology, geology, earth science or natural resources major, and agree to remain at OSU for the entire five-quarter sequence of courses. In addition their science coursework must meet the National Science Teachers Association (NSTA) recommended standards, or be no more than two courses short of meeting those standards. Ten participants will be identified by these criteria by March 1, 1988.

Another ten participants will be recruited through school systems in the Great Lakes region, again focusing on Ohio, for participation in the Natural Resources program that will parallel the Holmes program. Emphasis will be on state science teachers associations and recruitment at the regional meeting of NSTA. Candidates attracted in this way will be screened for science and education background courses, and those chosen will be the ones that are teaching science without a strong science background. Professional activity level, grade point average, and intention to complete the program and remain in teaching will be the selection criteria.

Program Quarter #1. Summer of 1988 will be the first quarter of both graduate programs, and all participants will be on the Lake Erie Islands for that experience. Both groups will begin at P. T. Stone Laboratory on Gibraltar Island for courses in Natural Resources/ Education 614: Marine and Aquatic Education, and Natural Resources/ Education 611: Workshop in Great Lakes Education. These courses are team taught by the project directors using OEAGLS and a new reference text funded by the George Gund Foundation of Cleveland (Fortner and Mayer, in progress).

After these courses the groups would take at least five hours of additional coursework in aquatic sciences, then enroll in courses for the study of learning. These would be taught in conjunction with structured experiences in the summer Sea Camp program on Kelleys Island and other informal and formal education experiences.

Year 2 tasks involve completion of Quarters 2-5 of the instructional sequence leading to the Master's degree and certification, development and testing of participant-constructed curriculum packages, introduction to instructional technologies and preparation of classroom teaching aids, and experience in a research setting with a Sea Grant scientist. This last experience will serve as a capstone for the program in Summer 1989.

The ten Holmes participants will be paired with researchers to participate in data collection, analysis and interpretation. A seminar would continue throughout the summer, in which the Sea Grant investigators would discuss the background and issues related to their research.

Some Sea Grant researchers who have indicated that their projects would be available for this capstone experience are Dr. David Culver (Effect of phosphorus loading on zooplankton), Dr. William Mitsch (Ecosystem approach to Lake Erie coastal wetlands), and Dr. David Garton (Impact of the introduction of Bythotrephes cederstroemi). A pilot project will be conducted in summer of 1987 with the placement of an intern teacher in one researcher's laboratory.

Year 3 activities include finalization of the curriculum materials developed by the newly trained teachers, presentations at meetings of The Holmes Group institutions to relate the project's success and invite similar programs by others, and follow-up evaluations among both the participants and the Sea Grant scientists. For the Holmes participants this will also be a supervised induction year as required by the new state certification requirements. Arrangements will be made with the hiring schools to provide a quality experience, in part supervised by science education faculty. Certification and the Master's degree will be granted upon the successful completion of this induction year.

It is anticipated that a number of new activities will have been developed by the program's participants. The investigators will work with the participants closely to assure a valuable product from each, and final writing and manuscript production will be completed in Year 3. All materials will be published and made available through Sea Grant.

Benefits

A number of different groups will benefit from this project:

1. The strength of The Holmes Group recommendations comes in part from their originating in research universities. This project will signal to those institutions that the innovations they are seeking can be facilitated by building upon existing successful programs within. Building upon Sea Grant can happen in other institutions in this way and benefit Colleges of Education in their outreach to the cognate colleges.
2. Scientists at OSU and in other universities can benefit from interacting with educators (Task Force 1983), since the scientists learn about the mechanisms that are used to train individuals before they enter science programs in college.

Empathy for precollege educators can lead to greater involvement of scientists in schools.

3. From #2 above, greater involvement of scientists and better trained science teachers will help to reverse the negative trends that science education has been experiencing in this decade. Science teachers will learn about science from the "inside," and be more prepared for teaching the process of science and its importance in all aspects of human existence. The teachers will also experience the applications of education theory and practice in a science context, with all parts of the training experience relating to each other.
4. Sea Grant's research focus has traditionally been an applied focus. This project offers another application of Sea Grant science, one with an exceptionally broad potential for reaching large numbers of resource users.
5. New curriculum materials can flow from teacher to teacher, emanating from the fresh science experiences of project participants into the classrooms of others in need of new approaches.
6. Project results will be presented and published for use by scientists and by professional educators. The investigators are active in both types of professional organizations.
7. Sea Grant support for education in Ohio has always yielded dividends to the entire national program. This project has exceptional potential for visibility and outreach in times when Sea Grant needs them most.

Budget Explanation

Year 1

Personnel. Much of the time for the investigators is donated because of the importance of this effort to their respective colleges. The funds requested of Sea Grant include 18% time for Dr. Fortner to direct the preparations for the program, including curriculum revision and development of recruitment efforts for the Natural Resources program components. The School of Natural Resources will donate an additional 22% of her time for continuing aspects of the Education Program. For Dr. Mayer, 10% release time is requested, matched by 40% from Educational Theory and Practice because of the importance of the Holmes effort as a model for other college programs being developed. Dr. Mayer will be primarily responsible for the course modifications and recruitment needed for the Holmes component.

Other project personnel include two graduate students, one at the Ph.D. level and one at the Master's level, and a part-time

student secretary. The intensity of development needed in Year 1 necessitates the assistance of these individuals.

Equipment. Funds are budgeted for a Level 3 Videodisc player with computer interface and authoring software. Participants in the program will learn to use the system to develop instructional programs using existing commercial discs, and production of an Ohio Sea Grant research disc will also be explored.

Travel. The investigators will travel to regional science and science teachers' meetings to promote the concept of the graduate aquatic education curricula. Instructor travel for the summer program is also included.

Recruitment expenses in addition to travel are budgeted to include the cost of production and distribution of announcement posters and follow-up for responses.

Stipends for participants. The OSU Department of Residence Halls and Dining has been approached as a co-sponsor of the Stone Lab portion of the training experience, and a proposal for support of the fifth quarter research experience is being developed for submission to the National Science Foundation. Nevertheless, this program will be an expensive one for the participants, who will not only be paying tuition and living expenses, but also having no income. A number of funding sources are being explored, but at this point it is necessary to include in the budget some individual assistance with the year's expenses. Approximately \$225 per participant has been budgeted. Except for this incentive, open to both Holmes and Natural Resources participants, no funds are requested for support of the Natural Resources program, since it will require little adjustment in current operating procedures.

Additional matching funds. Because the University's costs for the Summer 1988 program are all included in the grant, the University will waive tuition for the participants in the program for that quarter.

Years 2 and 3

The budget for Years 2 and 3 will have the same personnel needs plus an equipment request for a level 3 (programmable) videodisc player. Recruitment expenses will be deleted, but travel will begin to promote the program in Holmes meetings and to set up research experiences for Quarter 5 (Summer, Year 2). A major expense in year 2 will be stipends for each participant (10) in a Sea Grant research project. Sea Grant scientists have indicated that they would like to be able to pay their assistants for the summer's work.

Estimates of Year 2 amount to \$70,500, with an additional \$100,000 contributed, and for Year 3, \$65,300 with \$50,000 contributed. Funding sources are being sought for specific components of each year's project to make complete use of the opportunities afforded by initial Sea Grant investments. It is fully expected that following Year 3 the program will have proven its potential so that the College of Education will provide support for continuation.

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