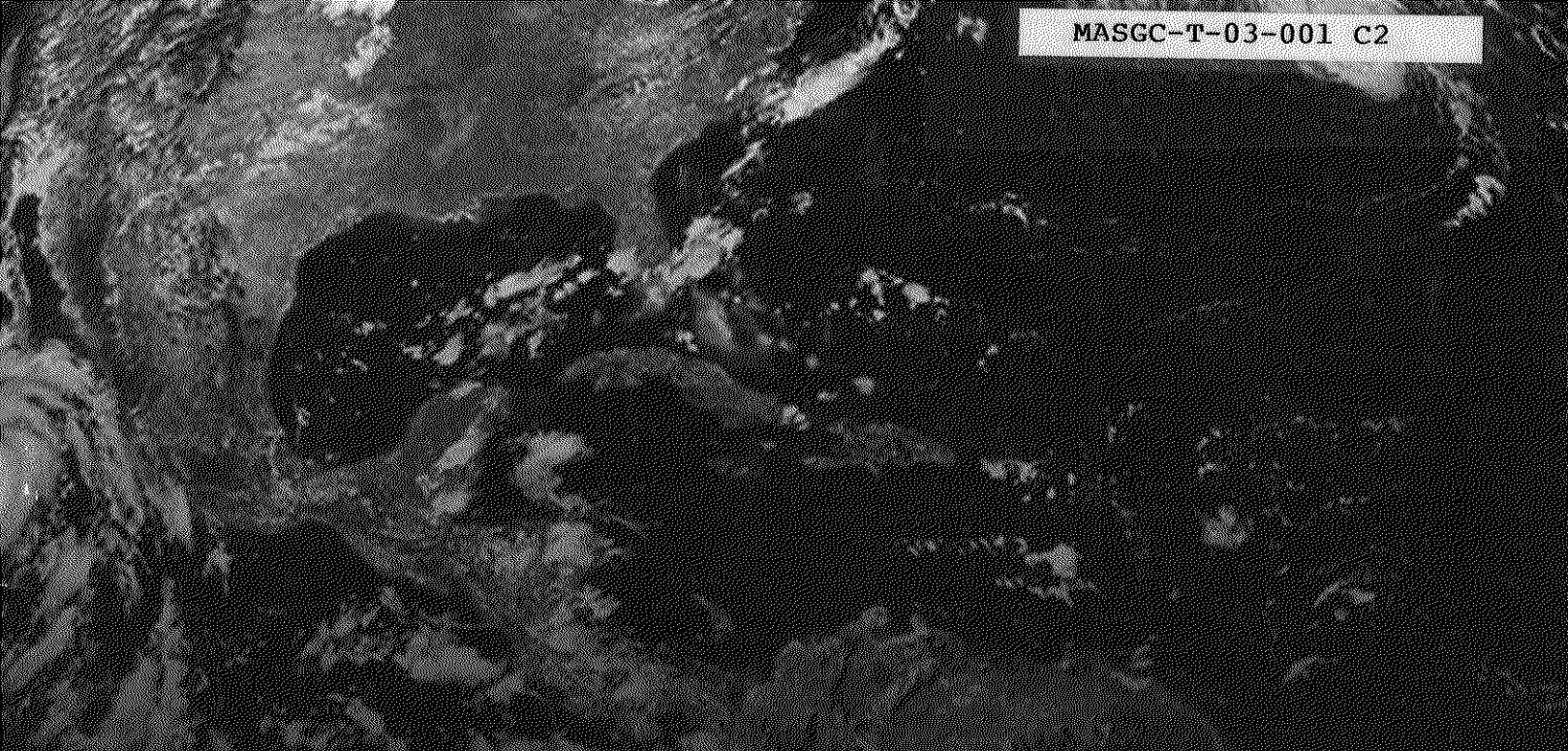

COAST:PILOT

A Final Report

SUBMITTED BY:

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TO:
The National Oceanographic Partnership Program
and The Office of Naval Research

February 14, 2003

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FINAL REPORT

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Submitted To The National Oceanographic
Partnership Program and
The Office of Naval Research

February 14, 2003

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In Cooperation With:

The University of Southern Mississippi

Mississippi State University

St. Norbert College

The Oceanographer of the Navy

The Naval Meteorology and Oceanography Command

The Naval Oceanographic Office

The Naval Research Laboratory

The Consortium for Oceanographic Research and Education

The National Sea Grant College Program

The National Marine Educators Association

Consortium of Oceanographic Activities for Students and Teachers:

Putting Interactive Learning On Target

(COAST:PILOT)-Final Report

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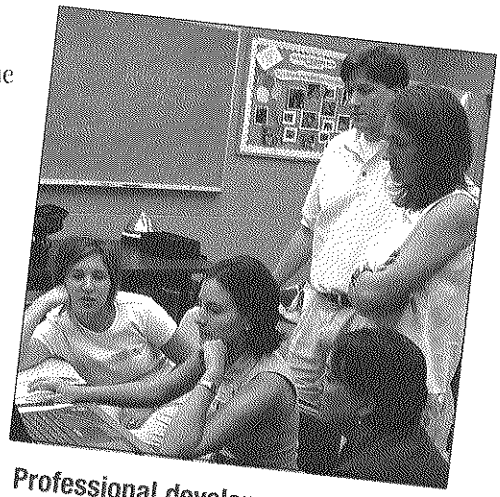
INTRODUCTION AND BACKGROUND

As excerpted from reports by Walker, et al. (2000 and 2001) and Walker (2002). . .science education in the United States continues to undergo fundamental change and reform directed at preK-12 levels of the precollege system. The need for science literacy has never been more critical for our citizenry than it is today. The evidence is clear. With continued new technologies; increased, global environmental stresses; precollege teacher shortages (200,000 teachers per year for this decade); math and science partnership initiatives involving preK-20 students and teachers in both urban and rural areas; the continued implementation of national and state science education standards; and the need for additional students representing enhanced ethnicities majoring in math, science, engineering, and technology—all require responsible decision-making at all levels of government, academia, industry, and the private sector. For the past two decades, science education literature has been and continues to be replete with research concluding that teaching and learning need to be improved nationally. As excerpted from an article by Walker, et al. (2000) in the National Oceanographic Partnership Program (NOPP) issue of the journal, *Oceanography*, three landmark studies during this period, i.e., *A Nation at Risk* (U.S. National Commission of Excellence, 1983), the *National Science Foundation (NSF) Survey Report* (1988), and the *Third International Math and Science Study [TIMSS]* (National Science Teachers Association [NSTA] Reports, 1996) have reinforced our country's awareness of the lack of competitiveness exhibited by this nation's public schools and its students in math and science when compared to other countries. This 20-year old statistic remains factual in more recent studies such as the *TIMSS - Repeated* (1999) and the *Report of the 2000 National Survey of Science and Mathematics Education* (2001). Further, in a report by NSTA (2000), it was revealed this nation's 52 million precollege students are being taught science by over 186,000 middle and secondary school



Professional development.... teachers sharing information technology...

teachers and 1.9 million elementary science teachers. Of these numbers, 37% of the high school, 83% of the middle school, and practically all of the elementary teachers are teaching without degrees in science. Of those teachers with science degrees, too few have studied the ocean sciences and these sciences are almost non-existent in the *National Science Education Standards [NSES]* (National Research Council [NRC], 1996); however, the ocean sciences are represented in *Benchmarks—Project 2061* (American Association for the Advancement of Sciences, 1993).

Two teachers and crew member preparing to deploy a sediment coring device from the starboard side of the *USNS BOWDITCH*...

Safety drill with teachers donning their water survival suits, used for slowing down hypothermia...

As stated by the National Science Board (1999), the future of this nation depends on setting a primary goal of having a strong, competitive science and engineering workforce and a citizenry equipped to function in a complex world. And, to achieve this goal, educational excellence in math and science education at all levels should enhance every American's life opportunities through productive employment, active citizenship, and lifelong learning. Precollege math and science education is a local, state, regional, and national concern.

Further, there exists today an achievement gap in math and science between majority and minority and/or disadvantaged students, which demands immediate action. As stated by the National Commission on Mathematics and Science Teaching for the 21st Century in *Before It's Too Late: A Report to the Nation* (2000), America's students must increase their performance in math and science if they are to succeed in today's world and if the United States is to stay competitive in an integrated global market. In 2000, the United States Commission on National Security/21st Century also reported that it supports the improvement in math and science education by this country's students as a national security issue. Therefore, in response to this national concern, in 2001 President Bush stated an educational vision in *No Child Left Behind* that among the underlying causes for poor performance by U.S. students in the areas of math and science, three problems must be addressed, i.e.,: 1) too many teachers teaching "out of his/her field;" 2) too few students enrolling in advanced coursework; and 3) too few schools offering a challenging curriculum and textbooks. President Bush's education reform agenda (2001) also recommended that partnerships between the preK-12 community and institutions of higher learning scientists, mathematicians, and engineers address the issues of improving teaching and learning in these areas for ALL children.

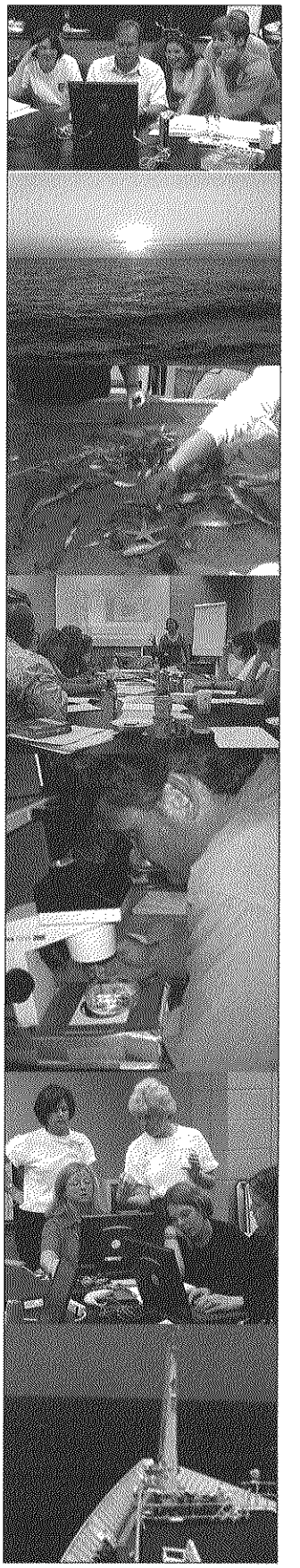
Similarly, the NRC (2001) reported that research clearly demonstrates that to deliver a competitive scientific and technical workforce, it

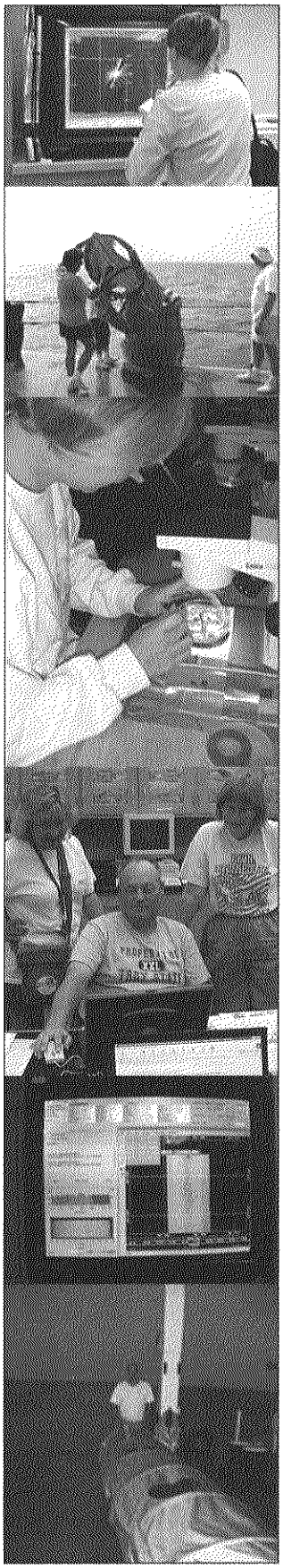
is imperative to develop and implement national strategies to improve the preK-12 instructional workforce. Due to this close relationship between student achievement and teacher knowledge and teaching skills, fundamental questions have been raised relative to the recruitment, training, and professional development programs for pre- and inservice teachers. The National Commission on Teaching and America's Future (1996) determined that improving teacher preparation (preservice teachers) in institutions of higher learning is at the core of sustaining and improving quality education for all students. These findings have resulted in many states encouraging alternative routes for entry into the teacher profession that still require preservice teachers to spend significant time in higher education at the baccalaureate and master's degree levels. The authors of this report can substantiate that teachers require unwavering support throughout the professional education process—from recruitment, through preparation, induction, and continued professional development in order to create and sustain a high-quality teacher workforce. As stated by NSF in its Math and Science Partnership Announcement of Opportunity, "there is a shared, vested interest by preK-12 and higher education communities in providing the best education possible to all learners throughout the preK-16 and beyond continuum (2002)." The authors of this report remain of the opinion the following 25-year old quote from the NSF (1978) is still accurate. . . .

. . . what science education will be in any one year for any one child, is most dependent on what that teacher knows, does, and believes... or doesn't know, doesn't do, or doesn't believe; for the teacher is the enabler, the inspiration, or the constraint for this nation's students."

As stated by Walker, et al., (2000 and 2001) and Walker (2002) . . . .teachers being well-prepared and well-supported will not by themselves improve student performance IF other components of the educational system that need to be addressed are not changed as well. These other components of the system include: the availability of challenging curricula and instructional materials; the appropriate use of technology to support instruction, evaluation, and assessment systems on "how" students learn; supportive administrative leadership; and a community that advocates and takes the responsibility for "raising the bar" for every student. It is well documented in science education literature, the future well-being of our country depends not only on how well we educate our children in general, but on how well we educate them in math and science, specifically. As indicated in *NOAA's Year of the Ocean Discussion Papers* (1998) and in the *U.S. Commission on Ocean Policy Mid-Term Report* (2002), the oceans are an unparalleled medium in which to excite and engage all audiences in learning all disciplines, particularly in math and science.

Over the last decade rich opportunities have been missed by the ocean sciences community by not having a proactive, nationally coordinated education program for the benefit of our country (Walker, et al., 1992; Consortium for Oceanographic Research and Education [CORE], 1996; Watkins, 1997; Danzig and Daley, 1999; *Turning to the Sea: America's Future*, 1999; Nowell, 2000; McManus, et al., 2000 <http://www.cosee.org>; Walker, et al., 2000;





Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration, 2000; *Centers for Ocean Sciences Education Excellence [COSEE] Current*, 2001; Walker, et al., 2001; and NOPP's *Draft Strategic Plan,* 2002).

Many of these same authors acknowledged the results of most ocean sciences research and the subsequent interpretation of those data and their importance are neither widely known nor used by precollege teachers. Therefore, it is critical that national strategies and complementary plans be implemented to lessen the disconnect between researchers and educators/teachers, thereby allowing this country's precollege students to become aware of and to more fully understand the relevance of the oceans to each day of their lives. It was also reported by Watkins (2000), "the exciting thing about the ocean is that its science is virtually all relevant to societal needs—quality of life, economic development, national security, education..."

Based on repeated acknowledgment of these missed opportunities, in May 2000, the NSF provided fiscal support for a three-day COSEE Workshop—implemented by The University of Southern Mississippi in Long Beach, MS—involving 73 attendees representing 21 states and the District of Columbia. These participants included scientific researchers, preK-16 teachers, information technology personnel, underrepresented groups, informal educators, and undergraduate students. The overarching goal of the May 2000 Workshop was "to create a document that recommended strategies for the NSF and other Federal agencies to use in a nationally coordinated effort to improve and promote ocean sciences education in response to the opportunities identified by this workshop." The Ocean Sciences (OCE) Division of the NSF proactively took the recommendations made by the attendees representing the ocean sciences community and developed an "Announcement of Opportunity" to which 26 groups throughout the United States responded. Of these 26 proposals, eight COSEE have been funded (one will serve as a Central Coordinating Office) and all are expected to initiate their implementation processes in January 2003. (It is noteworthy to mention both the *COSEE Workshop Report* and the *COSEE Implementation Report* may be found at <http://www.cosee.org>).

PARTNERS

COAST:PILOT was an innovative, collaborative program based on the former successes of Operation Pathfinder (1993-1997) and COAST (1997-2000), designed to deliver technology enriched, oceanographic and coastal processes education to pre- and inservice preK-12 teachers throughout this nation. The three primary COAST:PILOT partner institutions included: USM, St. Norbert College (SNC), and Mississippi State University (MSU). These three institutions of higher learning formed a collaborative program of integrative, preK-12 pre- and inservice opportunities in ocean sciences and coastal processes curriculum development and dissemination, as well as Web and visualization technology training support and at-sea experiences. Each of these programs individually created bridges between ongoing Naval, Sea Grant, university research, and formal and informal learning environments through focused teacher education.

The three primary COAST:PILOT components

and their respective institutions and locations were the Leadership Institute, facilitated through USM-COMS-J.L. Scott Marine Education Center and Aquarium (MEC&A), located in Biloxi; the Sea Scholars Program, based at SNC in De Pere, WI; and the Data Visualization activities represented by MSU located in Starkville. The COAST:PILOT components for delivery of strategies and resources for the teaching of oceanographic and coastal processes science included: 1) a 14-day, in-residence teacher preparation and professional development program; 2) a seven to 10-day, teachers-to-sea experience aboard the U.S. Navy's oceanographic survey vessels; and 3) a Web site containing data visualization tools, interactive curricular materials, communication resources, and related support materials to provide and facilitate integrated, ocean sciences and coastal processes, inquiry-based activities for pre- and inservice teachers from throughout this nation, to include Puerto Rico.

Other essential core partners in this collaboration ranged from various components of the U.S. Navy, i.e., the Naval Meteorology and Oceanography Command (NAVMETOCCOM), the Naval Oceanographic Office (NAVOCEANO), the Office of Naval Research (ONR), and the Oceanographer of the Navy's Office; the NOPP; the National Marine Educators Association (NMEA); and the National Oceanic and Atmospheric Administration's (NOAA)-Oceanic and Atmospheric Research (OAR)-National Sea Grant College Program and its 30 state programs. Supporting partners included the National Science Teachers Association (NSTA), the U.S. Geological Survey, the NOAA-National Estuarine Research Reserve System (NERRS), the Environmental Protection Agency (EPA), and various state Departments of Natural Resources. The U.S. Navy (NAVMETOCCOM and NAVOCEANO) provided its 329-ft. "state-of-the-art" oceanographic survey ships for teachers-to-sea (Sea Scholars) experiences, to include berthing space, food, ocean sciences instructional personnel for up to three cruises per year, involving a range of 12 to 14 teachers per voyage. Other COAST:PILOT core and supporting partners provided assistance with recruitment and/or curricular resources. These collective efforts provided the platform for the implementation of integrated content and resources aimed at strengthening teachers in three areas: oceanographic and coastal processes science, content-oriented technology integration, and curricular strategies to establish broad content integration, aligned with the *NSES.*

KEY PROJECT ELEMENTS:

- Formation of collaborative partnerships
- Enhanced learning of ocean sciences and coastal processes content through inquiry
- Integrated curriculum development
- Interactive methods of instruction
- Performance-based assessment
- Augmented pedagogy (teaching strategies)
- Increased use of computational science and visualization
- World Wide Web page construction and maintenance
- Reinforcement of content through teachers-to-sea (Sea Scholars) experiences
- "Bridging the gap" between the results of scientific data and the relevance of those data to the everyday lives of precollege teachers and their students

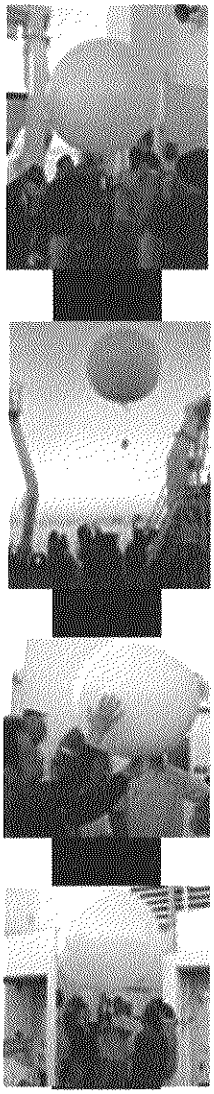
"Without the observations from this experience, we wouldn't have gained knowledge of the sharks' many adaptations.

It is so much easier to learn by actually doing the activities.

For some of the snorkelers it was a first-time experience and for others it was the first time seeing certain species of marine life.

The data collected from the soundings was processed into a three-dimensional map. What we found was surprising! We discovered that a part of the escarpment sheared away from the escarpment wall.

Fun was had by all and we had another great learning experience on this wonderful day."



GOAL AND OBJECTIVES

It should be re-emphasized that the predecessor of COAST:PILOT was a precollege study known as COAST (May 1, 1997 through April 30, 2000). Due to the national success achieved by COAST, it was apparent to the Principal Investigator and Co-Principal Investigators that this original effort was at a crossroad of opportunity and needed sustained funding. Therefore, a two-year extension was requested of NOPP/ONR for the continuation of these professional development and teacher preparation opportunities in ocean and coastal processes sciences for cadres of pre- and inservice teachers from across the nation. This extension request was granted by NOPP/ONR with the approval of COAST:PILOT. The principal goal of COAST:PILOT (May 1, 2000 through January 31, 2003) was to strengthen science and technology education in the United States. Further, there was a focused effort to include underrepresented and underserved districts, supported by instructional and communications technologies to bolster and link the efforts of these precollege teachers to one another..

To support this principal goal, COAST:PILOT was designed to meet the following objectives:

- Improve the content knowledge of 96 teachers in the ocean sciences and coastal processes via a series of unique classroom, research, and field-based opportunities (this effort actually reached 106 pre-and inservice teachers);
- Enhance state and national standards-based Science, Mathematics, and Technology (SMT) teaching through integrated educational strategies, assessment, and evaluation;
- Provide leadership education for teachers from partner school districts throughout the nation; and
- Expand the use of appropriate and effective educational technologies to support COAST:PILOT participant-educators in efforts to improve their leadership skills in ocean and coastal processes sciences.

Specifically, the COAST:PILOT activities included the implementation of :

- Three Leadership Institutes (one each summer) which drew elementary, middle, and high school pre- and inservice teachers from around the nation for focused preparation and/or professional development in the following areas: 1) improving teacher participants' educational leadership skills, 2) expanding advanced content knowledge in ocean sciences and coastal processes, and 3) developing skills to select and effectively use appropriate educational technologies to support classroom instruction and research opportunities.
- An enhanced Sea Scholars experience which linked directly to the visualization activities, the three Leadership Institutes, and provided an educational interface to the NAVMETOCCOM Virtual Library.

IMPLEMENTATION APPROACH AND PROJECT RESULTS—Leadership Institutes

Educational research clearly indicates there is a direct correlation between strong leadership and a school's ability to achieve success in the delivery of a strong educational program as well as the effective integration of appropriate educational technologies (Conyers, et al, 1999). The *NSES* (NRC, 1996) also stated that "...clearly defined leadership at the school and district levels is required for an effective science program" (p. 212). In addition to a carefully developed set of leadership skills, a "model" educational leader must possess a strong

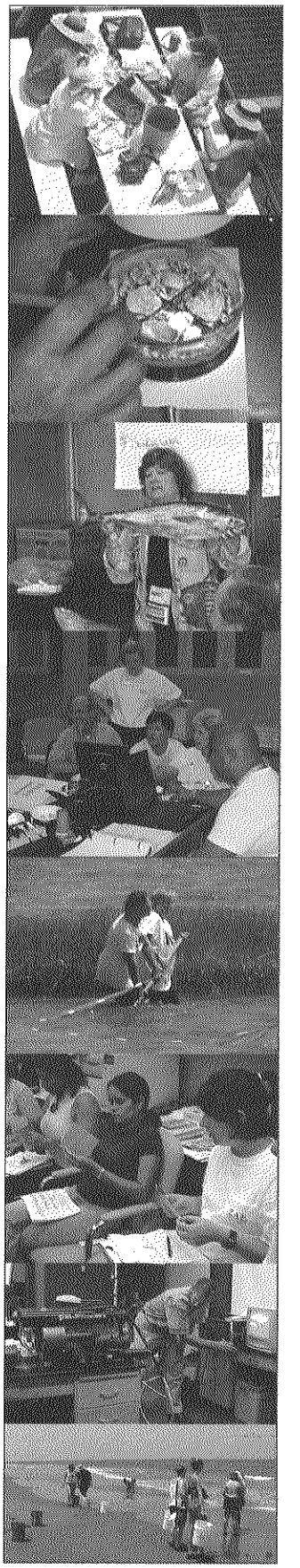
methodology foundation combined with an in-depth knowledge within a content area where he or she leads (Chapin, 1985; Darling-Hammond and McLaughlin, 1995; Haycock, 1999; and Murphy, 1988). The COAST:PILOT Leadership Institutes focused on building confidence in ocean sciences content and educational technology while attempting to enhance leadership skills. The 14-day COAST:PILOT Leadership Institutes provided a learning experience for 57 pre- and inservice teachers at two major universities.

The oceanography and coastal processes content and field-trip experiences of the Leadership Institutes were offered through USM-COMS-MEC&A in Biloxi. The primary objective in this portion of the COAST:PILOT Leadership Institutes was to provide more in-depth content knowledge in science, mathematics, and technology. This portion of the Institute was both content and project-based. For example, a project assignment required the teachers to choose a focus area (based on the six topic areas identified on page 10) and to research and develop instructional materials which focused on enhancing content knowledge in the area of physical parameters (which included waves, currents, bottom topography, and sea surface temperature). The participating teachers employed the following criteria in this sample project:

1) Conducted Internet searches on waves, currents, bottom topography, and sea surface temperature;
2) Designed a plan to demonstrate the relevance of this knowledge to the other teachers;
3) Conducted additional field-work with the digital camera for use in their PowerPoint presentations or in complementary Web page development;
4) Coordinated interviews with appropriate scientists;
5) Developed a PowerPoint presentation to share with colleagues or for a conference; and
6) Constructed wave tanks for teachers' respective classrooms.

Cooperative Learning Groups (CLG) of four or five participants made a one-hour presentation encompassing the six topic areas described on page 10 to their COAST:PILOT Leadership Institute team members and representatives of the COAST:PILOT instructional staff near the conclusion of the Institute on their CLG's respective project. The primary objective of these Leadership Institutes and the overall goal of the COAST:PILOT effort was achieved through similar application scenarios related to augmented knowledge in science, math, and technology.

Even though this effort was supposed to have 27 participants each of two summers, due to the timing of the receipt of fiscal support, 12, 17, and 28 pre- and inservice teachers were involved in the Leadership Institute in the summers of 2000, 2001, and 2002, respectively. An emphasis was placed on recruiting participants from those states identified as performing below the national average in science as reported in the *National Assessment of Educational Progress (NAEP) Report Card for the Nation and the States* (1997). As previously stated, the Leadership Institutes were implemented at MSU and USM-COMS-MEC&A in 2000 and 2001 and only at USM in 2002 with MSU faculty and staff traveling to USM-COMS-MEC&A. Participation in these Leadership Institutes conferred three hours of undergraduate or graduate credit to these 57 participants representing 10 states and Puerto Rico. In addition to the Gulf and South Atlantic region



INSTRUCTIONAL TECHNOLOGY

HARDWARE:

20 Dell Inspiron P4 wireless notebooks, a wireless workstation server, wireless access point, Internet access, 2 Infocus data projectors, 2 Olympus slide scanners, 2 Mirotek flatbed scanners, 6 Sony digital cameras, 2 Dazzle video capture systems, 3 Sony video camcorders and tripods, assorted cables, adapters, turntables, power strips, and other support supplies.

SOFTWARE:

20-user site license for Microsoft Windows 2000 and Office 2000, 10-user license for Photo Deluxe, 5-user license for Spin Object/Spin Panorama, and 2-user license for Dazzle Video Capture.

The prime focus of the technology component of the Leadership Institutes was in developing teachers' skills in effectively integrating emerging educational technologies in their instructional programs. The technology training was divided into three multi-hour sessions, each covering a different topic. Each Institute team rotated through different training sessions on Electronic Presentations, Digital Imaging, Video Capture Techniques, Visualization 3D Object, Web Page Development, and Effective Technology Integration. Emphasis was placed on technology integration to enhance learning rather than on teaching about the technology. Institute training was significantly enhanced with actual hands-on experiences for all participants and supported with a complete "cookbook" notebook of self-directed training modules so that the participants could continue their learning experiences once they returned home.

being represented each summer, over the three-summer, COAST:PILOT Leadership Institute implementation, the following five geographic regions also provided pre- and inservice teachers, i.e., the Pacific, the Great Lakes, the Heartland states, the Northeast, and the Mid-Atlantic. Over the duration of this effort, chapter members of the NMEA and marine education specialists within the National Sea Grant College network assisted in the recruitment of Leadership Teams of teachers (one elementary, one middle, and one high school), from the same school or school district. The preservice teachers (one elementary, one middle, and one high school) were recruited each year from MSU and SNC. The preservice and inservice teachers were selected from urban, rural, and resource-poor schools and/or school districts.

These Summer Leadership Institutes focused on: 1) oceanography and coastal processes taught through a combination of lectures, field trips, classroom demonstrations, hands-on research activities, and interactive, multimedia tutorial programs and 2) the development of science education leadership skills along with the expansion of instructional technology, curriculum integration skills. Participating pre- and inservice teachers used the *Oceanography and Coastal Processes Resource Guide* and complementary CD-ROM previously developed and field-tested by former Operation Pathfinder (1993-1997) and COAST (1998-2000) participants as part of the existing COAST:PILOT project. This *Resource Guide* was aligned with the NRC (1996) approved *NSES* during the 1998-1999 school year for the second edition printing. The *Resource Guide* was also pressed on CD-ROM and made interactive using NOAA and Navy (unclassified) data sets during the spring of 1999. The contents of the CD-ROM were also placed on the COAST Web site, <http://www.coast-nopp.org> at the same time. Each of the 81 hands-on lessons in the *Resource Guide* involves a minimum of two hours for implementation; these lessons are currently being infused into the former 975 Operation Pathfinder (504) and COAST (365), and COAST:PILOT (106) pre- and inservice teachers' curricula across the nation.

In addition to recruitment of the annual participants for each COAST:PILOT Leadership Institute by NMEA's chapter members and through the 30 individual state programs within the National Sea Grant College Program, colleagues within the NSTA, the North American Association for Environmental Education (NAAEE), and the NERRS also provided assistance in the recruiting process. Advertisements and articles in national science education newsletters and journals and Web sites of academia, agencies, and professional organizations also publicized the recruitment for the Leadership Institutes and Sea Scholars components.

A Selection Committee, comprised of the COAST:PILOT PI and Co-PIs with input from NMEA and Sea Grant representatives, discussed Leadership Team pre- and inservice teacher participation. The Leadership Teams selected were based on the following parameters: geographic locations; completeness of potential pre- and inservice participants' applications—to include essays, abridged resumes, and appropriate signatures by school administrators; potential participants' school/school level, rural, urban, and resource-poor representation, as well as each participant's (within the Leadership Team) willingness to:

- Enroll in a three-semester hour, 14-day graduate or undergraduate course and be in-residence at housing provided by

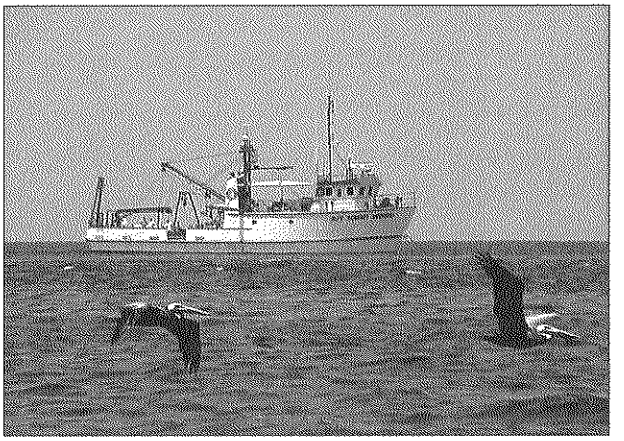
USM and/or MSU;

- Develop a minimum of one team teacher training workshop or staff development program within his/her respective school or school district;
- Infuse concepts and appropriate activities concerning oceanography and coastal processes within his/her classroom;
- Submit a journal article, present a paper, or demonstrate an activity at a state, regional, or national education conference;
- Infuse appropriate educational technologies into his/her existing science curricula; and
- Maintain strong participation in online follow-up activities.

The COAST:PILOT PI, Co-PIs, and associated personnel have and will continue to assist teacher participants in these tasks. The strategies listed below were employed in the annual COAST:PILOT, three-semester hour, 14-day, undergraduate/graduate Leadership Institutes.

Implementation Strategies:

- Presenting pertinent, experiential lectures by guest scientists and science educators centered around coastal processes and the associated biological, geological, physical, and chemical components of oceanography;
- Involving participants in a field trip aboard a research vessel to collect oceanographic data;
- Involving the participants in trawling and seining for marine/aquatic organisms and subsequent identification of these organisms and, where applicable, preservation of selected organisms to create a classroom reference collection for each participant;
- Involving the participants in field trips to various coastal habitats such as maritime forests, wetlands, and/or estuaries to study biota and associated resources;



The 97-ft. *R/V Tommy Munro* enroute to the Chandeleur Islands, off the LA coast....

- Introducing participants to the use of educational technologies and other materials and resources available for use in/on the *Resource Guide*/CD-ROM;
- Providing teachers with an abridged, staff development program with four or five participants working in CLG on one of the six topics listed below;
- Developing communications and a sense of camaraderie among the community of select learners and teachers throughout the nation;
- Fostering the sense that science is exciting and relevant to every student's life in and outside the classroom; and
- Establishing participant follow-up through an online support network, and through assistance at local, regional, and national meetings.

Six topics in oceanography and coastal processes were identified in 1993 by the Sea Grant Program faculty, the U.S. Navy, and the greater oceanographic community as the primary components for introductory education in ocean sciences (based on annual evaluation of these topics, they remain as precollege teaching priorities). These six topics were taught in an interdis-

"The lesson of experiencing life on the ocean could never be explained sufficiently in any book or captured on film."

An instructor enjoying one of many beautiful sunsets aboard the *USNS MARY SEARS...*

"Wow, and more wows for me. I feel like my knowledge of the ocean has increased so much. I have enjoyed the hands-on experience and of course I have bonded with an incredible group of bright people — feel so blessed to have been aboard the ship with such a wonderful crew...!

ciplinary manner, incorporating educational technology, mathematics, social studies, and the humanities where appropriate. An overview of each topic is delineated below:

- **PLATE TECTONICS**—This topic provided an overview of the evolution and geography of the world's oceanic basins, theories of plate tectonics, continental drift, sea floor spreading, hot spots, deep sea trenches, volcanism, and atolls using local and regional examples.
- **DEEP SEA TECHNOLOGIES**—Discussions and presentations included the technologies involved in the discovery and exploration of hydrothermal vents, unique deep sea benthic communities, and possibilities for ocean mining; topic content was emphasized through use of the JASON Foundation for Education/NSTA curricular materials.
- **MARINE AND AQUATIC HABITATS**—Near shore and coastal habitats such as the Great Lakes, salt marshes, mangrove swamps, barrier beaches, embayments, coastal lagoons, estuaries, and open water habitats such as continental shelf environments were the focus of this topic.
- **MARINE AND AQUATIC RESOURCES**—Living resources and their relationships to biotic and abiotic factors in their surrounding environments were the subject of this unit. The concept of sustainable coastal zone environments was used, i.e., the National Seashores/NERRS programs and emerging technologies, such as aquaculture.
- **PHYSICAL PARAMETERS AND COASTAL PROCESSES**—This topic focused on waves, wind action, currents, tides, substrate, water quality parameters, sea level rise, global change, El Niño, La Niña, natural hazards, and coastal processes such as erosion and its control.
- **MARINE AND ESTUARINE POLLUTION**—Presentations and activities encompassed sources of point and non-point pollution, environmental and man-made impacts, and possible solutions.

IMPLEMENTATION APPROACH AND PROJECT RESULTS—Instructional Technologies Integration

More current research continues to reaffirm the fact that administrative support is an essential factor in the effective integration of emerging instructional technologies to enhance learning in a school (Whitfield, 2002). One of the primary goals of the COAST:PILOT Leadership Institutes was to focus on building confidence in ocean sciences and coastal processes content and educational technology while establishing strong leadership skills. The 14-day COAST:PILOT Leadership Institutes were comprised of two major components woven around three content foci. One of the three focus areas of the COAST:PILOT Leadership Institutes was to develop skills to select and effectively use appropriate educational technologies to support classroom

instruction and research opportunities.

As a major element of the Leadership Institutes, participating teachers were heavily immersed in increasing their technological skills through extensive computer use in Internet searches and research, electronic presentation techniques, Web page development, digital imaging, 3D visualization, and multimedia development. The COAST:PILOT instructional team from MSU provided the technology emphases that assisted participants in selecting and effectively utilizing appropriate educational technologies to support classroom instruction and research opportunities. It was through these efforts that the application of this technology reinforced the pre- and inservice teachers' content knowledge of plate tectonics, deep sea technologies, marine and aquatic habitats, marine and aquatic resources, physical parameters and coastal processes, and marine and estuarine pollution.

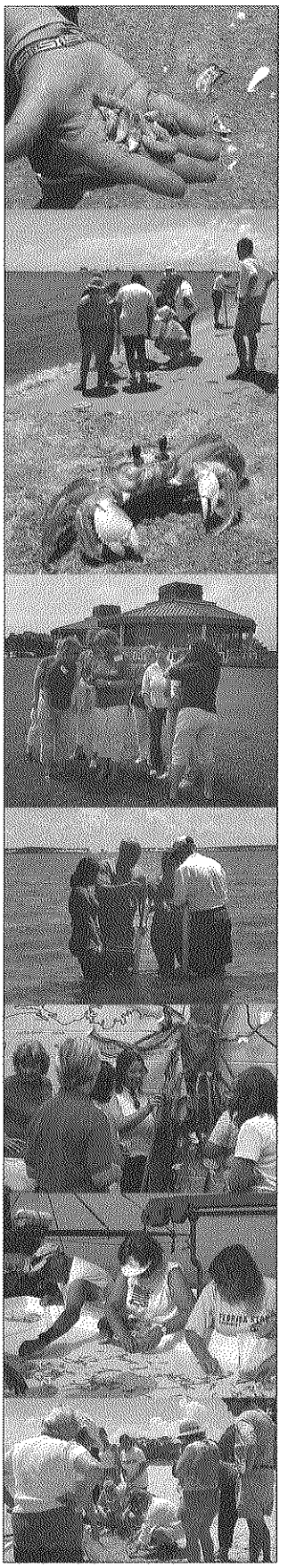
The first four and one-half days of the Institutes were directed toward teachers being heavily involved in increasing their technological and integration skills. In CLGs, teachers worked on focusing and expanding their oceanography and coastal processes content while at the same time developing new skills to enhance their abilities to effectively integrate innovative technologies into their instructional processes. Throughout this time frame each CLG worked to develop and present an instructional lesson focused on selected elements of the six thematic content areas.

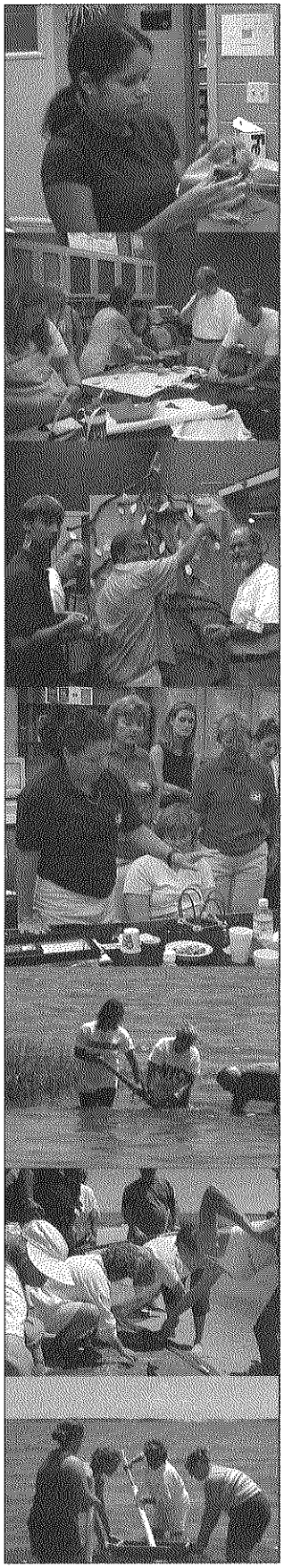
The original COAST visualization project (1997-2000) included the development and implementation of tools to allow students and teachers to access and manipulate data developed by the U.S. Navy, NOAA, and related agencies and to integrate these activities into curricular content. The original COAST project was successful in creating an infrastructure to support the development and implementation of specific tools and activities with a limited number of data sets. The COAST infrastructure was built around the Virtual Reality Modeling Language (VRML) and was implemented through standard Web browsers (Internet Explorer and Netscape) in conjunction with Java and the External Authoring Interface (EAI). The data sets implemented through this interface were limited to the TerrainBase and Leetmaa data types. Visualization activities proposed for COAST:PILOT efforts were designed to address two objectives:

- The integration of additional data sets and analytical tools in the existing COAST:PILOT resources; and
- The development of additional curricular activities that applied these tools and data in various classroom contexts.

Due to the unfortunate and premature death of Mr. Charles Calvo, the project visualization expert, combined with the departure of his young research associates from the Digital Research and Imaging Lab (DRIL) at MSU (as a result of Mr. Calvo's death), the first objective was not fully accomplished during the COAST:PILOT project. However, the second objective was accomplished through various technology-oriented reinforced activities.

A particular focus of the visualization activities was providing opportunities for teachers in the summer institutes, as well as providing complementary activities for land-based teachers across





the nation, to engage in utilizing the visualization resources found on the COAST:PILOT Web site. Significant use of these resources and visualization tools was tracked and recorded in the utilization statistics captured on the supporting network server that hosted the Web site. Additionally, feedback and daily reports to land-based teachers and students in their classrooms concerning the daily activities aboard the U.S. Navy's oceanographic survey ships via the Sea Scholars' Web site and frequent e-mail communications contributed toward achieving the second data visualization objective. Through these interactive communications media and the Web-based visualization modeling system, teachers and students in land-based classrooms had the opportunity to explore and investigate the same portions of the water column and ocean floor as teachers aboard the oceanographic survey vessels. While visualization technology provides tremendous resources for education, it is largely inaccessible to those teachers and students unfamiliar with Naval acronyms, authorization requirements, detailed oceanographic terminology, and similar situations. Therefore, the COAST:PILOT Web site <http://www.coast-nopp.org/> has served as an Internet glossary equivalent, i.e., a guidebook and a primer providing major resources that have been widely used in classrooms across the nation by both teachers and students. Since 2000, the COAST:PILOT Web site <http://www.coast-nopp.org> has received 106,000 page requests and 518,000 "hits" per month.

Through COAST:PILOT's active collaboration with Project Oceanography, also a NOPP Education Project, opportunities to enhance ocean sciences and coastal processes education were significantly expanded nationally. Dr. Paula Coble at the University of South Florida (USF) was the PI of the Project Oceanography NOPP effort. To leverage two NOPP educational efforts, COAST:PILOT and Project Oceanography—in conjunction with the Television Center at MSU—produced three, 30-minute video programs focusing on selected topics in oceanography and coastal processes, i.e., blue crabs, hurricanes, and horseshoe crabs. The three videotapes were broadcast during 2002, with complementary curricular materials developed by educators at the MEC&A and provided on the Project Oceanography Web site. Since 1996, Project Oceanography has been distributing TV broadcasts to classrooms across the nation via satellite and cable television broadcast networks. The number of registered sites, comprised of schools, school districts, and instructional TV stations receiving these broadcasts, now totals more than 420 in 40 states and nine foreign countries. These videotapes were rebroadcast in Louisiana through Louisiana Public Broadcasting (LPB) in November and December 2002 to a potential audience of 72 school systems comprising 878,320 students. Additionally, information regarding the curricular materials and videotapes was provided to the 2,100 members of the Louisiana Science Teachers Association and to 2,200 educators on the LPB listserv. The tapes will be rebroadcast twice in 2003 beginning in March.

IMPLEMENTATION APPROACH AND PROJECT RESULTS—Sea Scholars

The COAST:PILOT-Sea Scholars program, formerly titled Ocean Voyagers (COAST, 1997-2000), began as a five-day "Shakedown Cruise" Institute for 20 teachers, informal educators, and Naval personnel from Mississippi, Texas, Virginia, Wisconsin, and Washington, D.C. This original Sea Scholars

component was the "land-based" Institute focusing on oceanographic and integrative curricular content, which resulted in the development of future program strategies, and the formation of the teachers-to-sea/Sea Scholars component of COAST:PILOT. This teachers-to-sea component strengthened the potential for classroom teachers in their search for an increased understanding of oceanographic and coastal processes science and technological literacy.

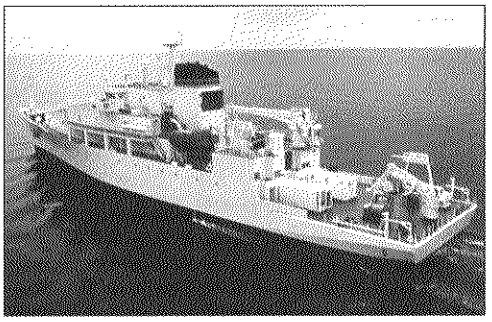
The Sea Scholars team worked closely with the COAST:PILOT partners and NAVOCEANO scientists to achieve and even exceed the original objectives over the two-year grant duration. The dynamic and collaborative nature of the COAST:PILOT partnership resulted in strategic modifications in the COAST:PILOT-Sea Scholars component. These changes both augmented the original objectives and guided an expansion of the focus of educational outreach from the proposed core of middle school teachers to the full range of preK-12 classroom educators.

The Sea Scholar efforts concentrated on the construction and maintenance of an integrated oceanographic Web site for educators, the provision of teachers-to-sea experiences, the collaboration with COAST:PILOT partners during the COAST:PILOT Leadership Institutes, including opportunities for preservice teacher involvement and the formation of partnerships with participating schools. The Sea Scholars Web site went online in the fall of 1997 at <http://voyager.snc.edu> and continues to serve COAST and COAST:PILOT participants. In the spring of 2003, this Web site will be transferred and continued under the sponsorship of the Central Gulf of Mexico COSEE. The Sea Scholars Web site continues to be dynamic and to consist of U.S. Navy oceanographic survey and fleet information, integrated curricular materials, documentation of Sea Scholar experiences, and annotated oceanographic resource lists.

The integrated curriculum section of the Sea Scholars Web site contains examples of preK-12 curricular projects that focus on oceanographic, coastal processes, and other marine-related concepts. The resource section contains an annotated list of online oceanographic resources for students and teachers, as well as the list of resource materials available from the Sea Scholar office for "loan" to partner schools and former Sea Scholar participants.

Selected oceanographic, coastal processes, and other marine science curricular activities were developed by pre- and inservice teachers to complement visualizations devised by the Stimulating Teachers About Resources for Broad Oceanographic Research and Discovery (STARBORD) component of the 1997-2000 COAST Project. This STARBORD component is now referred to as the Data Visualization component of the COAST:PILOT (2000-2002) effort. These Sea Scholar curricular activities are also located on the COAST Web site, <http://www.coast-nopp.org>.

These classroom experiences aboard the U.S. Navy's oceanographic survey ships advanced the scope and sequence of the original Operation Pathfinder (1993-1997) model in terms of oceanographic and coastal processes content knowledge, as well as augmenting the participants' technological literacy. These Sea Scholars opportunities placed teachers-to-sea for seven to 10 days aboard the U.S. Navy's TAG-60 series of oceanographic

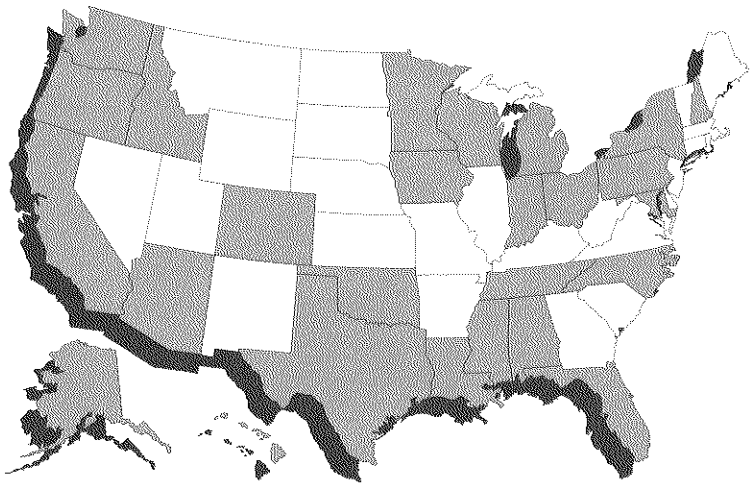


***USNS BOWDITCH* Oceanographic Survey Ship, 329 ft.in length...**

"We've made good friends and have been made better people and teachers for the experience! It's time now to carry our knowledge and experiences to our students and share the excitement of all that the study of the ocean has to offer."

Figure A

THE COAST: PILOT PARTICIPANTS



PARTICIPATING STATES & TERRITORIES

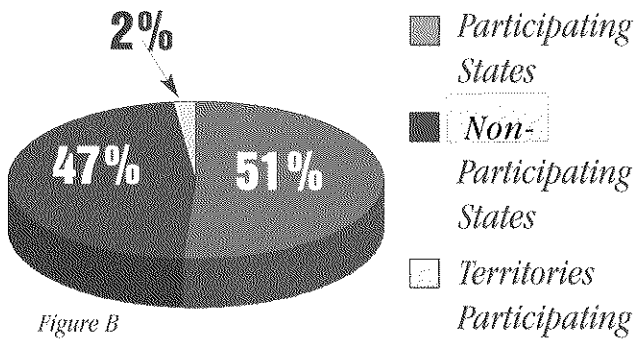


Figure B

"After lunch teachers shared the lessons they developed based on the knowledge gained from the classes in bio-oceanography, geology, bathymetry, acoustics, physical oceanography, and meteorology. The planned units turned out fantastic. It showed teachers, even in landlocked states, can apply oceanography."

survey ships, i.e., (the *USNS BOWDITCH,* the *USNS HENSON*, the *USNS PATHFINDER*, the *USNS HEEZEN*, the *USNS SUMNER* and the *USNS MARY SEARS*), thereby transforming these ships into oceanographic and technological learning centers for precollege teachers.

The COAST:PILOT-Sea Scholars initiative evolved programmatically over time, and five different teachers-to-sea voyages were conducted from 2000 through 2002. As the COAST:PILOT program progressed, PI and Co-PIs (Sea Scholars, Leadership Institutes, and Data Visualization) worked with the NAVMETOCCOM and NAVOCEANO partners to create a strong "ship to shore" connection during the missions that allowed participants to share their experiences with their students in their respective land-based classrooms over the Internet in near-real time and through multiple and varied electronic programs. As a result of these efforts, the COAST:PILOT-Sea Scholars component currently consists of a more collaborative effort, resulting in a "once-in-a-lifetime" opportunity for teacher participants. The teachers worked "side by side" with civilian Navy oceanographers, actively learning and sharing integrated ocean sciences and coastal processes surveys routinely implemented on typical missions.

Each Sea Scholars mission featured a balanced mixture of onboard classroom and collaborative hands-on oceanographic science, as well as directed port side activities—notably including tours of and briefings at NAVOCEANO at Stennis Space Center in southern Mississippi. Significant experiences and sites for research were the USM-COMS-MEC&A in Biloxi, MS, the Woods Hole Oceanographic Institute in Woods Hole, MA, the Annual Bowditch Festival in Salem, MA, snorkeling at the Dry Tortugas off the coast of Florida and off Viejos Island near Puerto Rico, and participation in the 2002 NMEA Conference in New London, CT, which provided sea-to-shore learning opportunities. The U.S. Navy also allowed the NMEA Board Members to have dinner aboard the *USNS MARY SEARS* and remained at the dock in New London an extra day to allow the NMEA Conference attendees the opportunity to tour the ship.

Over the course of the grant, the COAST: PILOT-Sea Scholars component developed into an engaging and effective experience for a total of 49 participants from 22 states. (It should be noted geographic representation in both the Institutes and Sea

Scholars involved 26 states and the U.S. Territory, Puerto Rico (Figures A and B). Initially the PI, Co-PIs, and Sea Scholars Coordinator proposed to serve a larger number of participants and conduct two Sea Scholar missions; however, the call for national defense and national security after the September 11, 2001, attack on America preempted two of the planned Sea Scholar voyages. Even though the final 2002 Sea Scholar mission occurred in July with 15 teachers participating and working with the NAVOCEANO surveyors and crew members of the *USNS MARY SEARS*, the Central Gulf of Mexico COSEE will continue the Sea Scholars program serving five Gulf of Mexico states.

The impact of the Sea Scholars program is measured not by the participants' success alone but more importantly by the educational reach of their newly acquired ocean sciences and coastal processes teaching skills, knowledge and dispositions into the classroom. Samples from journal entries written by Sea Scholars give testimony to their professional and personal growth as participants in the COAST:PILOT effort. The professional growth in terms of enhanced content knowledge, augmented instructional strategies, and increased technological literacy resulting from the combination of the Leadership Institute and the Sea Scholar voyages provided teachers with the enthusiasm, impetus, and self-confidence to better understand the relevance of ocean sciences research data. These experiences translate into a desire by these participants to share this enhanced content knowledge and increased instructional strategies with their preK-12 students in the classroom and with other professionals at national and state conferences. The Sea Scholars component continues to make significant contributions to the larger learning community through the implementation of innovative and integrated ocean studies curricula and programs in the participants' classroom, schools, and school districts.

COAST:PILOT EVALUATION

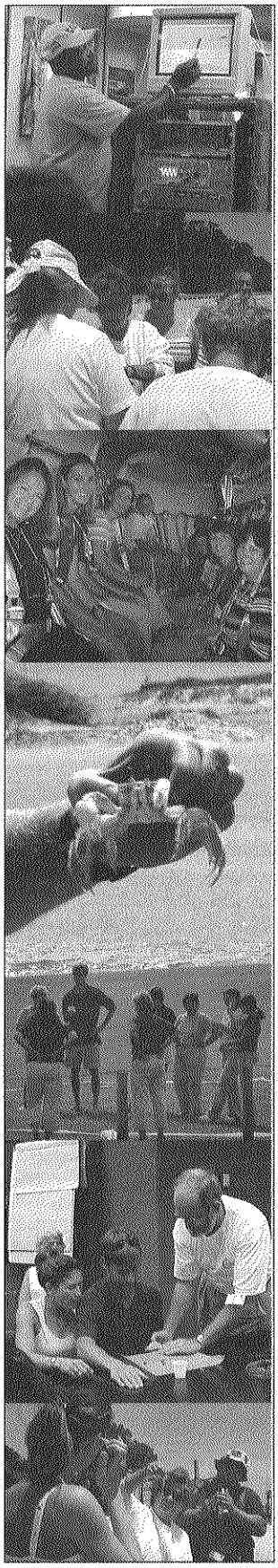
The COAST:PILOT evaluation consisted of multi-dimensional assessment techniques to evaluate, support, and enhance the professional growth and development of teachers during and after the program. Specifically the evaluation consisted of:

- Cognitive assessment methods sampled both content knowledge and performance. Participants were evaluated for cognitive and affective achievement in basic oceanography and coastal processes, as well as enhanced technological skills. Cognitive achievement was measured through a variety of methods including:

  (1) pre- and posttest scores of content knowledge,

  (2) performance based assessments of the participants' utilization of content knowledge, enhanced technological skills, and teaching strategies in classroom application, and

  (3) a portfolio compilation of participants' teaching modules.
- Affective achievement was assessed through participants' responses to a marine activity profile using a Likert-scale instrument.
- Technology usage inventories administered prior to each 14-day Leadership Institute.
- Educational and training technology evaluation instruments administered after participants completed the four and one-half day technology integration training components.



- Long-term assessment included communication through e-mail with participants and monitoring the use of the integrated curricula and other resources on the COAST:NOPP Web site <http://www.coast-nopp.org/>. Assessments have been in the form of surveys, use of Web sites, teachers-to-sea programs, and presentations at local, regional, and national conferences—designed to monitor ongoing progress, concerns, and successes.

EVALUATION—LEADERSHIP INSTITUTES

As shown in Figures C-E, gender distribution for the 2000, 2001, and 2002 Leadership Institutes was represented by 85% females and 15% males (2000-Figure C), 71% females and 29% males (2001-Figure D), and 75% females and 25% males (2002-Figure E).

As shown in Figures F-H, ethnic distribution was represented by 8% Hispanic and 92% Caucasian participants in 2000 (Figure F); 6% Native American and 94% Caucasian participants in 2001 (Figure G); and 18% Hispanic, 7% Native American, and 75% Caucasian participants in 2002 (Figure H).

For each of the three years in which the Leadership Institutes were implemented, the participants—based on Likert-scale surveys—were of the opinion 90% of the concepts, activities, field trips, and presenters were Very Valuable/Valuable, 8% Average Value, and 2% Limited/Very Limited Value

GENDER DISTRIBUTION IN

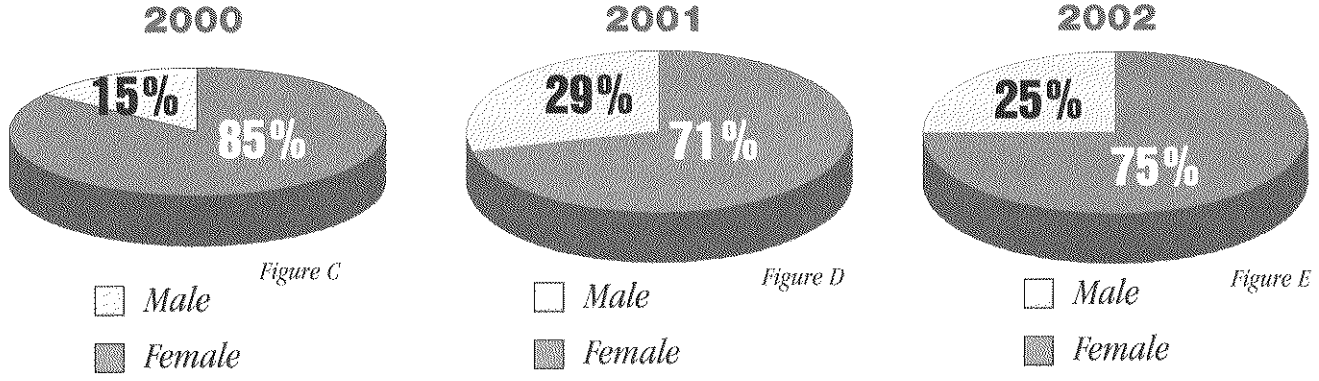


Figure C *Figure D* *Figure E*

ETHNIC DISTRIBUTION IN

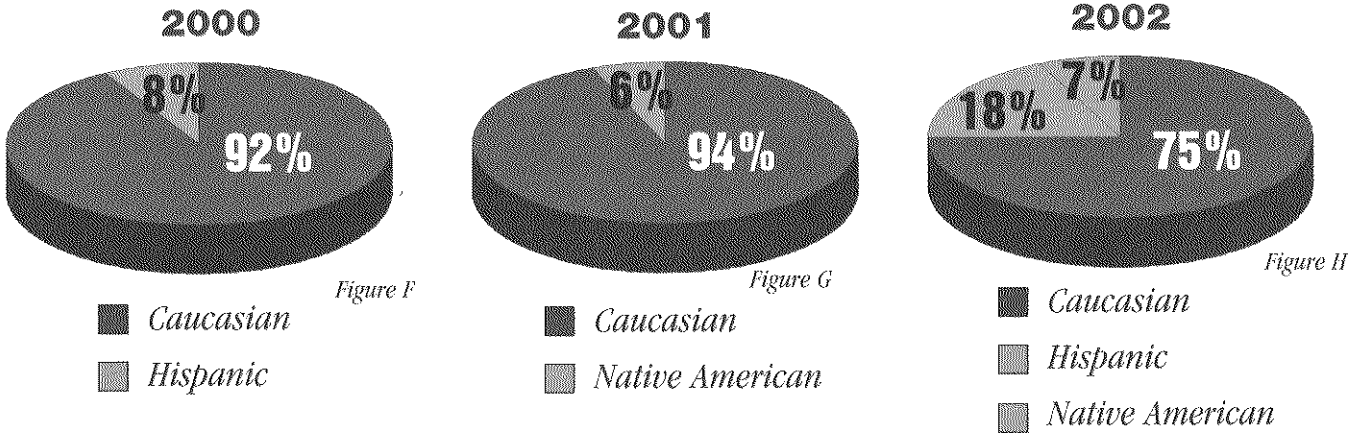


Figure F *Figure G* *Figure H*

(Figure I - 2000); in 2001 the participants' beliefs were reflected by 94% Very Valuable/ Valuable, 5% Average Value, and 1% Limited/Very Limited Value (Figure J); participants' perceptions were represented by 97% Very Valuable/Valuable and 3% Average Value in 2002 (Figure K).

The pre- and posttest instrument used for the COAST:PILOT Institutes included a total of 52 selective response items. Of this number, items 2, 3, 9, 14, 19, 22, 25, 26, 27, 30, 34, 35, 36, and 37 were not incorporated into the content instruction provided in each summer's institutes and were not considered in the statistical analyses of these instruments. Each year's pre- and posttests were analyzed independently using ANOVA procedures. As indicated in Tables 1-3 (see page 19), obtained F values

LIKERT SCALE EVALUATION

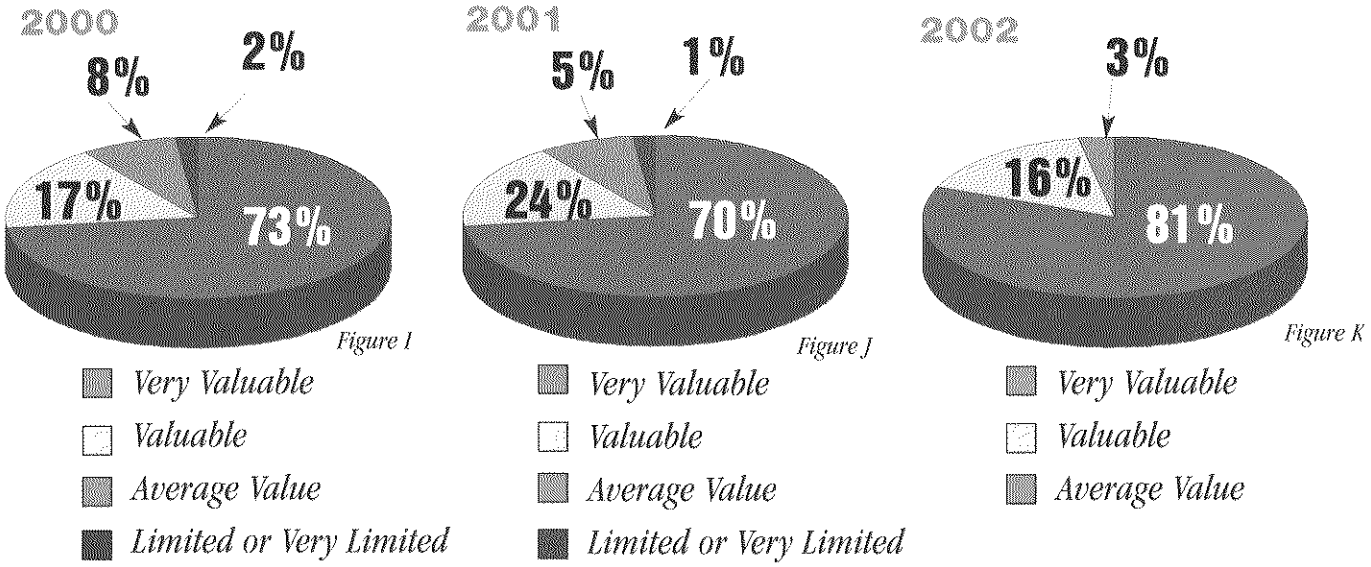


Figure I *Figure J* *Figure K*

SPEAKERS BY OCCUPATION

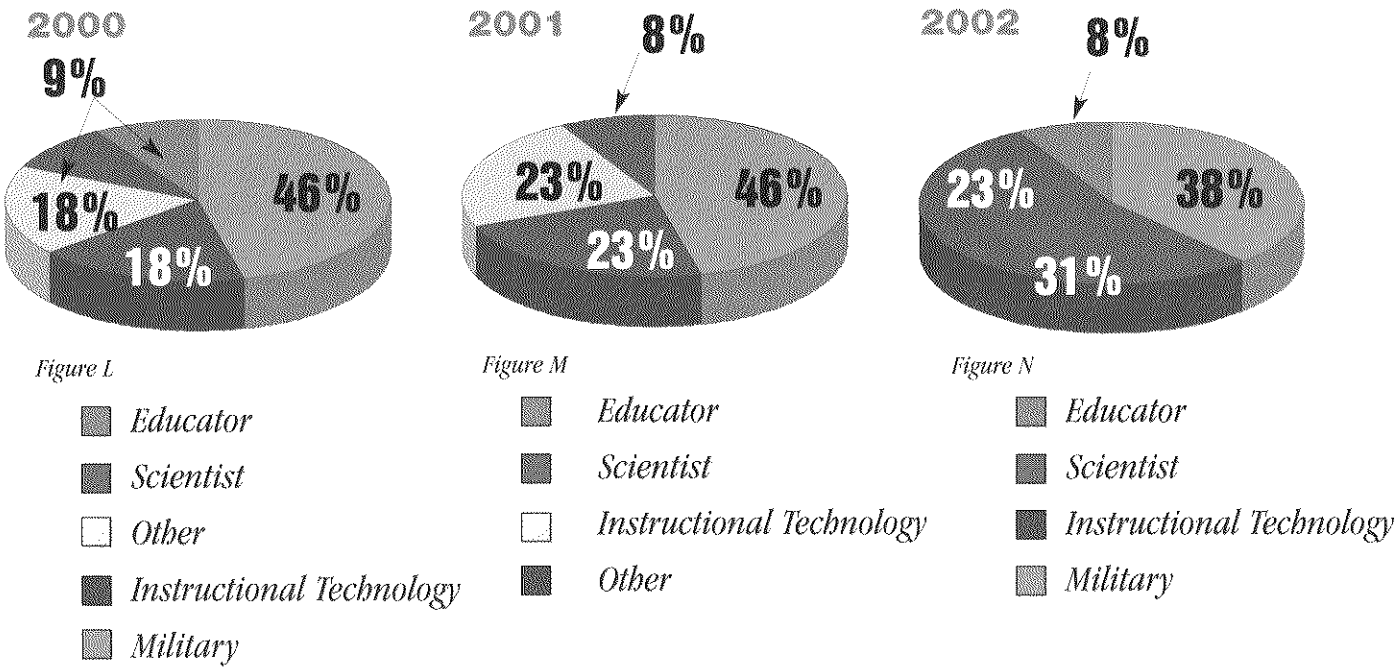


Figure L *Figure M* *Figure N*

GENDER DISTRIBUTION

2000-2002

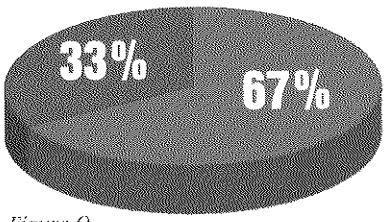


Figure O

- *Female*
- *Male*

GRADE DISTRIBUTION

2000-2002

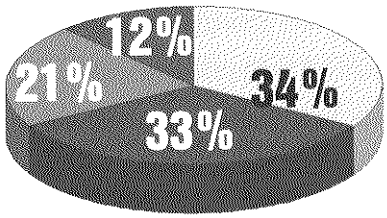


Figure P

- *Grades K-5*
- *Grades 6-8*
- *Grades 9-12*
- *Non Traditional*

ETHNIC DISTRIBUTION

2000-2002

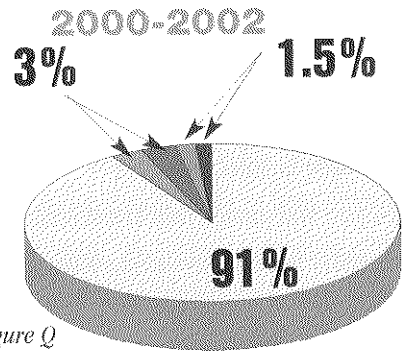


Figure Q

- *Caucasian*
- *African-American*
- *Hispanic*
- *Pacific Islander*
- *Native American*

for each year were statistically significant compared to critical values of F (Shavelson, 1988) using a p value of .05 to determine significance.

Guest speakers during the 2000-2002 institutes were primarily scientists and educators (Figure L, M, and N, page 17) with lesser percentages represented by instructional technologies and the military. The "other" category was usually represented by the private sector or business/industry.

The COAST:PILOT participants (Institutes and Sea Scholars for 2000-2002) represented 26 states and the U.S. Territory, Puerto Rico (Figures A and B, page 14). The Sea Scholars voyages during 2000-2002 were represented by 33% males and 67% females (Figure O). Grade distribution during this same time frame was represented by 34% elementary teachers, 33% middle school, 21% high school teachers and 12% non-traditional educators (Figure P). Ethnicity representation was 91% Caucasian, 3% African-American, 3% Hispanic, 1.5% Pacific Islands, and 1.5% Native American (Figure Q).

COAST:PILOT ACCOMPLISHMENTS AND BENEFITS:

- Participation by 106 precollege teachers (57 participants specifically in the COAST:PILOT Institutes, to include content and activities implemented by the Sea Scholars and Data Visualization team members, as well as the addition of 49 teachers participating in the COAST:PILOT-Sea Scholars component);
- 2,140 "second tier" teachers have been positively affected through the staff development programs implemented by the Institute and Sea Scholar participants. These 2,140 teachers have the potential—over a five-year teaching career—of impacting 1,179,200 precollege students;
- *Oceanography and Coastal Processes Resource Guide*—aligned with the *NSES*—developed by teachers for teachers in hard copy, CD-ROM, and on the COAST Web site, <http://www.coast-nopp.org/toc.html>;

- "Win-win" partnership involving sponsors from academia, state and federal government, businesses and industry, and the private sector;
- COAST Web site URLs include Operation Pathfinder at <www.aquarium.usm.edu/coast01.htm>, Sea Scholars at <http://voyager.snc.edu>, and STARBORD at <www.coast-nopp.org/coast_partners/starbord/ index.html>;
- On a monthly basis during 2000-2002, an average of 518,000 hits and 106,000 page requests for the *Resource Guide*—via its Web site—were received;
- Thirteen presentations at local, regional, national, and/or international meetings/conferences were made since the inception of COAST:PILOT;
- Over 700 related URLs, seven glossaries, career exploration data, and visualization tools for teachers were added to the *Resource Guide* Web site in 1999 and have been consistently used throughout the 2000-2002 time frame;
- Production of three, 30-minute videotapes developed cooperatively with Project Oceanography by USF, MSU, and USM were broadcast during 2002, with complementary curricular materials developed by educators at the MEC&A, and provided on the Project Oceanography Web site. These broadcasts now reach more than 420 registered sites in 40 states and nine foreign countries. Further, these videotapes were rebroadcast in Louisiana through LPB in November and December 2002 to a potential audience of 72 school systems comprising over 878,000 students. These tapes will also be rebroadcast twice in 2003 beginning in March.
- Evaluation and assessment analyses revealed significant, positive differences in pre- and posttest cognitive achievement scores by all participants; and
- Likert-scale attitudinal achievement revealed all participants perceived content, presenters, activities, and field trips with ranges between 90% to 97% Very Valuable and/or Valuable and between 3% to 10% Average and/or Limited Value.

OTHER BENEFITS:

For this COAST:PILOT effort and as reported by Walker, et al. in the *COAST Final Report* (2001), these unique collaboratives and augmented credibility for crossover activities, enhanced mutual respect, and improved communications between scientists and educators have resulted in a "win-

TABLE 1. Analysis of variance table for 2000 pre- and posttests.

Source of Variation	SS	df	MS	F
Between groups	-18,393.34	1	-18,393.34	927.55
Within groups	198.34	10	19.83	
Total	-18,195	11		
	p< .05			

TABLE 2. Analysis of variance table for 2001 pre- and posttests.

Source of Variation	SS	df	MS	F
Between groups	-24,351.31	1	-24,351.31	513.85
Within groups	710.84	15	47.389	
Total	-23,640.47	16		
	p< .05			

TABLE 3. Analysis of variance table for 2002 pre- and posttests.

Source of Variation	SS	df	MS	F
Between groups	-40,292.44	1	-40,292.44	1,039.80
Within groups	1,007.69	26	38.75	
Total	-39,284.75	27		
	p< .05			

"As I sailed upon these great waters I came to realize their great vastness and my great smallness. I was moved to come to terms with my own vulnerability, not only with the oceans but aalso with the land, as they are tied together like Siamese twins. For me, this ocean immersion experience became and is becoming a university without walls. My knowledge and appreciation of the sea has increased significantly during these 10 days aboard the Mary Sears. –I know in some profound way my life has and will continue to be wonderfully changed, so that I will be a flagship in the promotion of life-giving knowledge, by telling the story of the sea."

win" partnership for both groups and this country's precollege teachers, students, and the general public. Further, in a NOPP article by Walker, Coble, and Larkin (2000), it was reported that the advent of expanded electronic communication technologies has revolutionized the way educational materials are delivered to students in all stages of their education. This paradigm shift in technology is also bringing change to the fundamental nature of curricula and learning strategies. Increased numbers of studies are currently being implemented relative to multimedia distance learning programs, which integrate video, real-time data streams, and archived data to provide virtual "hands-on" learning experiences delivered directly to users via high speed Internet. One of these projects is the Digital Library for Earth Science Education (DLESE) jointly funded by NSF and the National Aeronautics and Space Administration (NASA) and is an initiative which has established a national digital library of Earth science education curricula, associated archived data sets, and tools for handling real-time data <http://www.dlese.org>. The authors of this report believe the ocean observing systems which have been and are being developed and/or implemented along this nation's coastlines are also excellent examples of technologies that are at the forefront of the United States' ability to more adequately address national security and defense, transportation, economic growth, sustainable fisheries, weather, and global change predictions, ocean modeling, and monitoring needs for both ecosystem and human health.

Other opportunities for the PI and Co-PIs resulting from the work of Operation Pathfinder, COAST, and COAST:PILOT (1993-2002) were: 1) Dr. Sharon Walker's appointment as co-chair and PI of the original 2000 NSF-COSEE grant; 2) Dr. Dan Brook's and Dr. Mary Alyce Lach's participation in the May 2000 COSEE Workshop; 3) Dr. Dan Brook's proposal submission to the U.S. Department of Education for "Challenging Regional Educators to Advance Technology and Education (CREATE)" in the spring of 2000; 4) Dr. Sharon Walker's appointment to the Ad Hoc Education Task Force (14 members) for the NOPP-Interagency Working Group to develop educational recommendations for the Ocean Research Advisory Panel in the fall of 2001-2003; 5) the request by the U.S. Commission on Ocean Policy for Dr. Sharon Walker to present testimony concerning ocean sciences education and her subsequent appointment to serve as a member of the Science Advisory Board for this Commission in March 2002; 6) an invitation from NASA to Drs. Sharon Walker and Mary Alyce Lach to participate in the LINK Consortium at Cape Canaveral in May 2002; 7) Dr. Walker's invitation to serve as one of 17 guest speakers comprising four panels for the Capitol Hills Ocean Week in Washington, D.C., in June 2002; 8) Dr. Walker's invitations to serve as a keynote speaker for two international conferences, i.e., the 21st Annual International Submerged Lands Management Conference and the Marine Technology Society's Annual Conference (both of these conferences were held in Biloxi, MS, in October 2002); 9) Dr. Lach's coordination of the "Mobile Lab" for preservice teachers in collaboration with local schools in DePere, WI; and 10) the partnership currently being developed to implement a workshop that will be conducted by Drs. Sharon Walker and Mary Alyce Lach in Kyoto, Japan,

during the summer of 2003.

As reported by Walker, Coble, and Larkin (2000), the NOPP-funded projects were ambitious and brought together for the first time a coordinated partnership of this country's leading marine education programs and ocean sciences research communities. These partnerships leveraged investments in technology and national networking to deliver relevant current research and ocean sciences expertise to teachers and classrooms nationwide. These partnerships—between hundreds of educators and scientists representing academia, government, industry, and the private sector—have been successful in working together to administer these projects. Hundreds of thousands of students and their teachers will benefit if similar projects continue.

Lastly, COAST:PILOT has been about one thing, our nation being prepared for the challenges of the 21st century. From centralized data collection and information sharing to increased education and a more focused approach, NOPP and the ONR, as well as numerous other governmental agencies, private organizations, industry, and academia are promoting emerging technologies and science competitiveness of this nation's precollege teachers and their students. It is important that we remember "those who send instructional technology and material down the information highway of the future must recognize that teachers are the most important link in the chain that connects technological innovation with improved science performance" (AAAS, 1998). Through Navy support and with the cooperation of NOAA-Sea Grant, and NMEA, COAST:PILOT has successfully equipped teacher participants to teach their students why emerging technologies and ocean sciences are relevant to their lives. This increased knowledge will empower our students to make responsible resource decisions relative to the interconnectedness of all species and our impact on the fragility of the global relationships of the sea, soil, and atmosphere.

ACKNOWLEDGMENTS:

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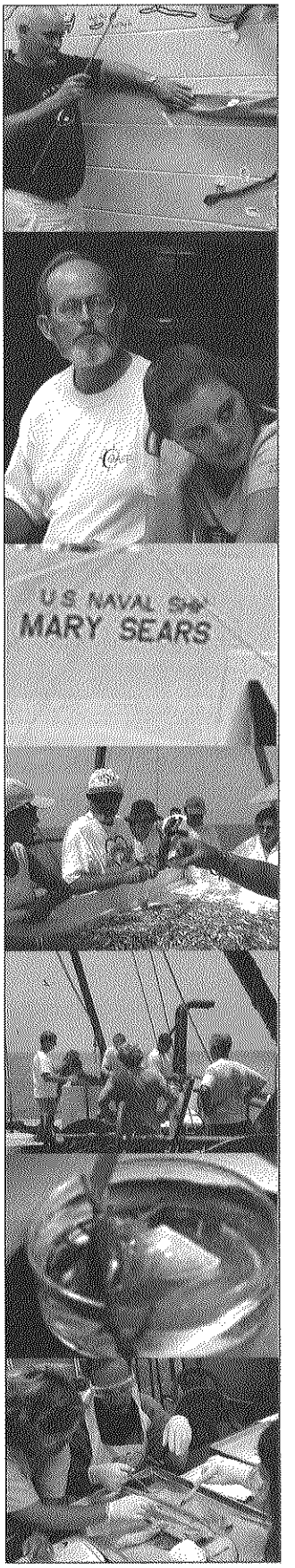

The 38-ft. *R/V Hermes* enroute to Horn Island off the MS coast...

"This is something that I will never forget: it has changed my life like nothing else. It showed me how to implement oceanography into the classroom , getting to know the ocean and how beautiful the silence of the world is."

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REFERENCES

American Association for the Advancement of Science. 1993. *Benchmarks for Science Literacy*, Oxford University Press: New York.

American Association for the Advancement of Science. 1998. *Blueprints for Reform*, Oxford University Press: New York.

Before It's Too Late: A Report to the Nation from The National Commission on Mathematics and Science Teaching for the 21st Century. 2000. <http:www.ed.gov/americacounts/glenn/report.pdf>.

Chapin, S.H. 1996. "Professional Development in Mathematics—Not Just For Teachers." *Journal of Education*, 178 (1), pp. 85-87.

Consortium for Oceanographic Research and Education (CORE). 1996. *Oceans 2000: Bridging the Millennia—Partnerships for Stakeholders in the Oceans.* A Report on the Interagency Partnership Initiative.

Conyers, J.P., T. Kappel, and J. Rooney. 1999. "How Technology Can Transform a School." *Educational Leadership*, 56(5), pp. 82-85.

Centers for Ocean Science Educational Excellence (COSEE). 2001. *Report of the COSEE Implementation Steering Committee.* National Science Foundation. <http://www.cosee.org>.

Danzig, R. and W.M. Daley. 1999. *Turning to the Sea: America's Ocean Future.* National Oceanic and Atmospheric Administration, Washington, D.C.

Darling-Hammond, L. and M.W. McLaughlin. 1995. "Policies That Support Professional Development in an Era of Reform." *Phi Delta Kappan*, Vol. 76, pp. 597-604.

Haycock, K. 1999. "Collaboration, Leadership and Technology." *Teacher Librarian*, 26 (5), p.32.

Martin, Michael O., Ina V.S. Mullis, Eugenio J. Gonzalez, Kevin D. Gregory, Teresa A. Smith, Steven J. Chrostowski, Robert A. Garden, Kathleen M. O'Connor. 2000. *TIMSS 1999 International Science Report; Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* International Association for the Evaluation of Educational Achievement (IEA). International Study Center Lynch School of Education Boston College. <http://www.timss.org>.

McManus, Dean A., Sharon H. Walker, Benjamin Cuker, Patricia Goodnight, Susan Humphris, Paula Keener-Chavis, Donald Reed, Veronique Robigou, Jerry Schubel. 2000. *Center for Ocean Science Education Excellence—The Report of a Workshop Sponsored by the National Science Foundation*, pp. 1-69. <http://www.cosee.org>.

Murphy, S.C. 1988. "Enhancing School Improvement: What Questions Need Answers?" *NASSP Bulletin.* 72(505), pp. 45-48.

National Commission on Teaching & America's Future. 1996. *What Matters Most: Teaching for America's Future.* <http://www.tc.columbia.edu/~teachcomm/WhatMattersMost.pdf>.

National Oceanic and Atmospheric Administration. 1998. *Year of the Ocean Discussion Papers.* Prepared by the U.S. Federal Agencies with Ocean Related Programs. "Marine Education U.S.A.: Overview," Section k-1, pp. 1-24.

National Oceanographic Partnership Program (NOPP). 2002. DRAFT *Strategic Educational Plan* Submitted by an Ocean Education Task Force to the NOPP-Interagency Working Group (IWG) to the NOPP-Ocean Research Advisory Panel (ORAP) for approval 9/6/02. Approval is currently pending.

National Research Council (NRC). 2001. *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium.* Committee on Science and Mathematics Teacher Preparation. <http://books.nap.edu/books/0309070333/html/R1.html>.

National Research Council (NRC). 1996. *National Science Education Standards.* Washington, D.C.: National Academy Press.

National Science Board. 1999. *Preparing Our Children: Math and Science Education in the National Interest.* <http://www.nsf.gov/nsb/documents/1999nsb9931/nsb9931.txt>.

National Science Foundation. 2002. *Math and Science Partnership (MSP),* Program Solicitation NSF-02-061. <http://www.nsf.gov/pubs/2002/nsf02061/nsf02061.html>.

National Science Foundation. 1978. *The Status of Pre-College Education in Mathematics and Social Science Educational Practices in U.S. Schools: An Overview and Summary of Three Studies.* Washington, D.C.; U.S. Government Printing Office.

National Science Foundation Survey Report. February 29, 1988. International Survey Gives U.S. a Failing Grade in Science Education. pp. 1-4.

National Science Teachers Association. 2000. *Science Education Statistics.* Available: <http://www.nsta.org/pressrel/factsheet.asp>.

National Science Teachers Association. 1996. *NSTA Reports—Third International Mathematics and Science Study.*

Nowell, A. 2000. Education in Oceanography: History, Purpose, and Prognosis. pp. 195-200. In: *50 Years of Ocean Discovery: National Science Foundation 1950-2000.* National Academy Press, Washington D.C.

Oceanography and Coastal Processes Resource Guide. 1999. <www.coastnopp.org/toc.html>.

O'Sullivan, C.Y., Reese, C.M., and Mazzeo, J. 1997. *NAEP 1996 Science Report Card for the Nation and the States,* Washington, D.C.: National Center for Education Statistics. <http://www.ed.gov/NCES/naep>.

Shavelson, Richard J. (1988). *Statistical Reasoning for the Behavioral Sciences,* Second Edition. Allyn and Bacon: Boston.

U.S. Commission on National Security/21st Century. 2000. *Seeking a National Strategy: A Concert for Preserving Security and Promoting Freedom.* <http://www.nssg.gov?Phasell.pdf>.

U.S. Commission on Ocean Policy. 2002. *Developing a National Ocean Policy: Mid-Term Report of the U.S. Commission on Ocean Policy.* <http://www.oceancommission.gov/documents/midterm_report/ReportCovREV10_01_02.pdf>.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 2000. *Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration.* The Report of the President's Panel on Ocean Exploration. NOAA no. NA87GP0105.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1999. *Turning to the Sea: America's Ocean Future.* Office of Public and Constituent Affairs. Washington, D.C., 64 pp.

U.S. Department of Education. 2002. *No Child Left Behind Act of 2001.* Washington, D.C. <http:www.nclb.gov/>.

U.S. National Commission of Excellence. 1983. *Nation at Risk: The Imperative Education Reform.* Washington, D.C.: U.S. Government Printing Office.

Walker, Sharon H., Issue Editor, COSEE issue of *Current: The Journal of Marine Education* 2001. Vol. 17, No. 2 pp. 1-45.

Walker, Sharon H., James I. Jones, Robert J. Shephard, Michael J. Pelzcar, Vicki Osis, and Linda Skupien. 1992. *Shaping the Future—Sea Grant, Science and Society: The Role of Marine Education.* Printed by NOAA-The Mississippi-Alabama Sea Grant Consortium, MASGP-92-0112. 21 pp.

Walker, Sharon H., John J. Dindo, Jessica Kastler, Michael Spranger, and Richard K. Tinnin. 2002. *Regional Center for Ocean Sciences Educational Excellence (COSEE) Gulf of Mexico.* A proposal submitted to the National Science Foundation on January 18, 2002 as NSF Proposal Number 0215341.

Walker, Sharon H., Paula Coble, and Frances Lee Larkin. 2000. "Ocean Sciences Education for the 21st Century." *Oceanography: The Official Magazine of the Oceanography Society.* Vol. 13, No. 2, pp. 32-39.

Walker, Sharon H., R. Dan Brook, and Mary Alyce Lach. 2001. *COAST: A Final Report.*

Walker, Sharon H. (March 7, 2002). *Ocean Science Education and Outreach.* Testimony presented at the meeting of the U.S. Commission on Ocean Policy, New Orleans, LA.

Watkins, James ADM (Retired). 2000. The Importance of Ocean Sciences to Society. In: *50 Years of Ocean Discovery: National Science Foundation 1950-2000.* National Academy Press, Washington D.C.

Watkins, James ADM (Retired). 1997. Keynote Presentation at the National Marine Educators Association Annual Conference, Chicago, Illinois. August 4-8.

Weiss, Iris R., Eric R. Banilower, Kelly C. McMahon, P. Sean Smith. 2001. *Report of the 2000 National Survey of Science and Mathematics Education.* Horizon Research, Inc. 2001. <http://2000survey.horizon-research.com>.

Whitfield, Cheryl. December 2002. Ph.D. Dissertation, *The Impact of Selected Components of the C*R*E*A*T*E for MS Schools Mentor Model on Technology Integration and the Technology Skills Level of Core Teachers.* Mississippi State University, Starkville, MS.

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