

A NATIONAL STRATEGY TO IMPROVE OCEAN LITERACY AND STRENGTHEN SCIENCE EDUCATION THROUGH AN IMPROVED KNOWLEDGE OF THE OCEANS AND COASTS

**Prepared by the
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National Oceanographic Partnership Program (NOPP)**

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SUMMARY

Through strategic investment of the resources of the Congressionally-established National Oceanographic Partnership Program (NOPP¹), an effective National Strategy for ocean and coastal sciences education can be implemented, coordinated and sustained. The leadership of NOPP, in partnership with federal agencies, academia, industry and the private sector, will have far-reaching consequences for improved ocean literacy, outreach and science education in the United States. An ocean-literate populace is our vision.

INTRODUCTION

Quality of life, economic health, and security for people of our nation and the world are increasingly dependent upon the areas of science, technology, engineering, and mathematics. A well-informed, scientifically literate populace, capable of making judicious decisions, serves as the vanguard of our society. Yet many recent studies suggest that the general American public is not as knowledgeable about scientific and technical concepts as modern society requires, indicating the need for improved methods to address public education. Too few public education campaigns, severe shortages of well-trained teachers in scientific and technical subjects, and failure to substantially increase the numbers of underrepresented and underserved groups working in the fields of science, technology, engineering, and mathematics, pose significant obstacles to achieving broad science literacy. Coordinated national efforts are needed to address these obstacles and ensure the health of the education and research enterprises that fuel the prosperity of our nation.

The oceans and coasts are naturally fascinating to humans and have a vast impact on their lives. Ocean-related concepts and technologies offer captivating methods for educating the public about aspects of science, technology, engineering, and mathematics, and can serve as powerful tools for strengthening

¹ NOPP comprises the following federal agencies: United States Navy, National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), Department of Energy (DOE), Environmental Protection Agency (EPA), U.S. Coast Guard, U.S. Geological Survey (USGS), Defense Advanced Research Projects Agency (DARPA), Minerals Management Service (MMS), Office of Science and Technology Policy (OSTP), Office of Management and Budget (OMB), Department of State, and the U.S. Army Corps of Engineers. Additional information regarding NOPP programs is available at the website www.nopp.org.

scientific literacy. There is, however, an equally important, intrinsic need for ocean literacy itself. Within the realm of the oceans and coastal environment, the interdependence among public need, policy decisions, and scientific and technical knowledge is particularly compelling. It is essential that the public be made aware of the many ways in which the systems of Earth, in particular, the oceans, affect everyday life, as well as the significant influence that people have on the health of the oceans and their coasts. The public must:

- Understand the role of the coupled ocean-atmosphere-cryosphere system that drives our weather and climate;
- Appreciate that environmental pressures introduced on land have consequences that extend through the coasts to the ocean;
- Comprehend how oceanic conditions nurture the continued existence of marine ecosystems and maintenance of sustainable fish stocks; and,
- Encourage exploration into promising new biotechnologies and other yet-to-be-discovered societal benefits uniquely existing within the oceans.

Increasingly, scientific research in the oceans is focused on efforts to deploy observing systems that can monitor those processes of greatest impact on mankind. The use of such systems will require a better public understanding of ocean processes so that the public may use the information effectively, as well as ensure the availability of the technically trained workforce needed to operate these systems.

Public education² must be used to achieve the complementary goals of improving ocean literacy and strengthening scientific literacy across every facet of the socio-economic spectrum. Museums, aquariums, science centers, and public/cable television programming offer enriching opportunities for reaching large audiences; and, promoting lifelong learning about science and technology, and communicating the relevance of each to daily life. Existing initiatives promoting systemic reform and further implementation of the *National Science Education Standards*³ (NSES) offer promising opportunities for increased public knowledge of the oceans and coasts. The inherently multidisciplinary nature of coastal and ocean systems offers an exciting context in which to teach fundamental concepts of physics, biology, chemistry, geology, and mathematics. Ideally, increased exposure to the oceans and coasts using myriad approaches will both increase public support for ocean and coastal research programs and encourage more students from diverse educational and cultural backgrounds to consider pursuing careers in ocean-related professions.

In the United States, many individuals and institutions employ ocean and coastal sciences in the broader context of improving public understanding of science; however, these efforts have not been well coordinated on a national scale. To address this need, several recent meetings have been convened to consider a nationally coordinated effort, or “National Agenda”, for improving education about our coasts and oceans. Important programs initiated within the NOPP agencies offer many of the essential building blocks for a successful national program. Further, the U.S. Commission on Ocean Policy and the Pew Oceans Commission are actively engaged in assessing the status of national research and education as they relate to the oceans and coasts. Through the efforts of these intra-agency programs and Commission initiatives, a consensus is rapidly emerging that is catalyzing coordination of efforts to reform public education in the ocean and coastal sciences. The NOPP is a Congressionally established umbrella

² Public education [in ocean and coastal sciences] is defined as a proactive communication that imparts the knowledge and value of ocean and coastal sciences, products and services to people of the nation and the world; promoting environmental stewardship and public safety; and fostering a sustainable economy. [Adapted from National Oceanic and Atmospheric Administration education materials.]

³ *National Science Education Standards*, 1996, National Committee on Science Education Standards and Assessment, National Research Council, 276 pp.

organization linking the many agencies engaged in ocean sciences research and education. NOPP is thus ideally positioned to play a leadership role in the articulation and sustained implementation of this National Agenda for improving ocean literacy and strengthening scientific literacy through the use of ocean and coastal concepts.

NOPP AND ITS ROLE IN OCEAN AND COASTAL OUTREACH AND SCIENCE EDUCATION

In 1997, the Secretary of the Navy was charged, in Subtitle E of Title II, Division A, Public Law 104-201, to establish a National Oceanographic Partnership Program (NOPP) to:

1. Promote the national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication through improved knowledge of the ocean; and,
2. Coordinate and strengthen oceanographic efforts in support of those goals by:
 - a) Identifying and carrying out partnerships among Federal agencies, academia, industry, and other members of the oceanographic scientific community in the areas of data, resources, education, and communication; and,
 - b) Reporting annually to Congress on the Program.

Public Law 104-201 clearly delineates both the goal of NOPP in the area of science education and the strategy needed to achieve this goal. Since 1997, NOPP has sponsored six (6) education programs that are aimed at reaching these goals (see Appendix A). The challenge for NOPP is to clearly understand the role it plays relative to its member agencies and within the larger context of enhancing systemic efforts to strengthen public understanding of science in our nation. Many partners within NOPP have well-established or recently initiated programs concerning ocean and coastal sciences education that have been designed to address priorities aligned with their stated agency missions. Collectively, these funded initiatives serve to address many of the objectives emerging within the National Agenda to improve public knowledge of the oceans and coasts. In most cases, however, these programs have been established with limited inter-agency communication. The greatest strength of NOPP lies in its ability to offer a centralized infrastructure for coordinating initiatives so as to: (1) best use human and financial resources in a cost- and time-effective manner; (2) minimize duplication of programs across agencies; (3) identify and fill important gaps that are not covered by individual agency efforts; (4) facilitate continuation of and sustained support for the commitments of its partners; and, (5) initiate and/or expand programs that are beyond the missions of individual partners. Additionally, the pivotal role of NOPP, in the development of the next generation of infrastructure for ocean exploration, observing, monitoring, modeling and information management, provides an excellent opportunity to foster the use of such systems to enhance the public understanding of the oceans and coasts.

STRATEGIC AGENDA

OVERALL GOAL: To lead the Nation in articulating, implementing, coordinating, assessing, and sustaining a National Agenda that improves public ocean and coastal literacy and strengthens science and technology education through an enhanced understanding of ocean and coastal concepts and their interrelationship with the atmosphere, cryosphere, geosphere, hydrosphere and biosphere.

SPECIFIC GOALS: NOPP serves the Nation by coordinating federal agencies, academia, industry, and other members of the oceanographic, scientific and technical communities to:

- I. Catalyze, strengthen, and sustain effective outreach and public education programs that involve the ocean and coastal sciences;
- II. Facilitate the use of the national infrastructure for ocean exploration, observing, monitoring, modeling, and information management in advancing the overall goal of improving ocean literacy and strengthening science and technology education;
- III. Promote the development and diversity⁴ of the ocean-related workforce; and,
- IV. Formulate a policy/investment plan designed to maintain a viable ocean-related education infrastructure to address ocean and coastal literacy needs.

PLANNING STRATEGY: SPECIFIC GOALS

NOPP serves the nation by coordinating federal agencies, academia, industry and other members of the oceanographic scientific community to:

I. Catalyze, strengthen, and sustain effective outreach and public education programs that involve the ocean and coastal sciences.

Successful ocean and coastal sciences outreach and public education programs funded by the individual NOPP-member agencies exist; however, minimal coordination between agencies has resulted in duplication of efforts and failure to address some critical needs. Unfortunately, many highly successful federal programs falter after a few years of “start-up” funding because sustaining these efforts does not fall within the mission guidelines of the funding agency. Further, the lack of examples, identifying how ocean-related concepts can be used to support teaching, significantly hampers demand by teachers for the many ocean-related education products that NOPP and its member agencies have developed. Programs that promote lifelong learning about the oceans and coasts must be extended both in content and reach. Appropriate linkages between outreach and education programs and between pre-college, undergraduate, and graduate level training need to be better defined and encouraged. To improve outreach and public education programs, NOPP should:

- a. Promote broad dissemination of ocean and coastal sciences concepts via public outreach and educational opportunities;
- b. Define a slate of ocean and coastal concepts that serve to ensure that the public better understands the relationship of these concepts to areas of science, mathematics, geography, and history; This knowledge base will incorporate connections between the science of the oceans and coasts and quality of life, national security, and economic development;
- c. Document existing science education materials that align with existing academic content and technology standards and can be used to address the objectives of a National Agenda for ocean sciences education;

⁴ Diversity refers to all underrepresented or underserved groups in ocean-related careers, and includes ethnic and cultural minorities, persons with disabilities, and women.

- d. Encourage the development and use of *NSES*-aligned coastal and ocean sciences concepts within print and video materials in areas that include physics, chemistry, biology, mathematics, earth science, technology, economics, history, and public policy;
- e. Integrate ocean and coastal sciences research into all avenues of public education by incorporating it into existing education and outreach programs of NOPP agencies;
- f. Serve as a catalyst for developing partnerships between Schools of Education and Science within Institutions of Higher Education;
- g. Assess the need for teacher professional development programs aligned with national standards involving ocean and coastal concepts and encourage development of such programs where necessary;
- h. Develop a network of scientists and educators who can provide input at the state and local levels in defining local public outreach programs and science curricula, standards, and assessment methods that include the ocean sciences; and,
- i. Develop a framework for assessing the impact and effectiveness of ocean-related educational programs designed to improve ocean and coastal literacy.

II. Facilitate the use of the national infrastructure for ocean exploration, observing, monitoring, modeling, and information management in advancing the overall goal of improving ocean literacy and strengthening science and technology education.

On-going, real-time, collection of surface and sub-surface oceanographic data via coastal and ocean observing systems is a major thrust of the research programs supported by NOPP. Additionally, NOAA and other NOPP partners have been involved formally and informally with ocean exploration, an initiative with tremendous outreach potential. These data sets provide an opportunity for a variety of exciting simulations and hands-on learning experiences for the public, students, and teachers that will foster awareness and understanding about ocean sciences and technologies. Observatory and exploration data streams can be used as the foundation for an array of public service announcements, instructional materials, museum exhibits, and website activities that excite and engage a large segment of the public about the oceans. Public involvement in these activities will help “bridge the gap” between the public and research communities, thereby demonstrating the need for continued support of ocean and coastal systems. Effective use of observatory and exploration data for educational purposes will require careful consideration of the pre- and post data acquisition and management needs and early coordination during the development of infrastructure. To capitalize on the educational opportunities of ocean research, NOPP should:

- a. Develop projects that seamlessly link data acquisition and management structures and protocols to education and outreach activities and products;
- b. Establish and sustain a clearinghouse, aimed towards the enhanced integration of ocean and coastal sciences into outreach and education, to disseminate existing projects that use ocean and coastal data and are aligned with curricular resources;
- c. Encourage development of ocean sciences instructional materials that align with academic standards and complement national observatory and exploration efforts and/or utilize data generated by them; and,
- d. Facilitate participation by members of the public in ocean exploration, observing, and modeling, and information management-related projects.

III. Promote the development and diversity of the ocean-related workforce.

A large segment of the ocean research and technical communities will retire or leave the profession in the near future. Some federal laboratories, for example, the National Oceanographic and Atmospheric Administration, anticipate losses of greater than 30% of the workforce by the end of the decade. Conversely, demand for a well-trained population of ocean sciences and technology professionals will likely increase in response to growing concerns related to climate change, coastal development and pollution, and over-utilization of marine resources. New ocean observing systems will require a sustained corps of ocean literate, technically-trained personnel for routine operation and data management and interpretation. Projections based on current elementary school enrollments show that profound demographic shifts toward significantly higher minority populations are occurring in the United States. Currently, the ocean sciences community does not adequately attract minority students into its professions. Therefore, effective strategies for recruiting and retaining students from all population segments must be developed, implemented, and sustained. To maintain an effective ocean-related workforce, NOPP should:

- a. Assess the status of the existing workforce and identify the workforce needs of current and future oceanographic (and related industries) communities;
- b. Collect data for all NOPP-funded initiatives that define the demographics of personnel and students involved and encourage member agencies to collect these data as well;
- c. Encourage further development of high quality information on ocean sciences-related careers (both print and web-based) and facilitate the broad dissemination of this information, particularly in underrepresented communities;
- d. Facilitate establishment of additional internships, Model Congress programs, science fair projects and other ocean-related, lifelong learning experiences for people interested in science, technology, engineering, mathematics, economics, and public policy;
- e. Develop mechanisms to identify and increase the national visibility of ocean scientists as career role models; and,
- f. Use observatory infrastructure to provide opportunities for students and professionals to experience ocean-related careers.

IV. Formulate a policy/investment plan designed to maintain a viable ocean-related education infrastructure to address ocean and coastal literacy needs.

As the coordinating organization for the scientific community in areas of ocean and coastal sciences, NOPP resides at the apex of a pyramid of influence over its members and constituents. Included within the construct of NOPP are a variety of institutions that have different, and potentially competing priorities, such as:

- Federal agencies with distinct missions and operational strategies;
- Academic institutions that serve to educate and advance knowledge in all areas that impact quality of life, national security, and economic development; and,
- Private industries that provide goods and services under constraints dictated by consumer expectations and profitability.

If NOPP is to take a leadership position in articulating, implementing, coordinating, assessing, and sustaining a National Agenda to strengthen ocean science education, it must be cognizant of the principal focus of each member organization. NOPP must also develop programs that advance a shared vision of its members and communicate the reality that each member is critical to ensuring that the National Agenda is realized. The complexity of achieving this strategic goal

requires a systems approach. A well-designed implementation plan must build cooperation and partnerships among its varied members and constituents. In addition, a well-formulated, sustainable implementation plan must include assessment and evaluation metrics. To sustain effective ocean and coastal public education programs, NOPP should:

- a. Prepare a clear and concise annual report that delineates accomplishments related to implementation of a National Agenda; This report will provide a review of the partnerships and agency-specific initiatives that serve to advance the vision and purpose of NOPP;
- b. Develop criteria needed to assess and evaluate the performance and effectiveness of programs, initiatives, and projects as a mechanism to document national benefits and to project needed investments;
- c. Prepare an annual operational/tactical plan that guides the direction of the National Agenda and its programs and identify funds needed to achieve and sustain annual objectives; and,
- d. Develop a dissemination plan for programs, materials, and products that includes public and private media (e.g., National Public Radio, public television, and local weather broadcasts) and that both generates and benefits from co-marketing opportunities.

CONCLUSION

Public education in ocean and coastal sciences must be ongoing, since both the oceans and our knowledge about them are forever changing. Through combined outreach and public education channels, awareness of the ocean and coastal environments can be introduced to people throughout their lives and, therefore, can be infused into their lifelong consciousness. Strategic investment of the resources of NOPP can be used to implement an effective National Agenda for ocean and coastal outreach and education that will have far-reaching consequences for improved public understanding of science in the United States. Implementation of this strategy rests on the availability of a diverse, ocean-related workforce and is structured around three key components – effective coordination that builds on individual agency education and outreach programs; outreach and educational opportunities being advanced by NOPP collectively and by its members individually; and the inherent potential of using the oceans and coasts as a conceptual model for teaching national education standards.

Upon implementation of the National Agenda, the following major outcomes are expected:

- A well-educated and diverse workforce, motivated by the innate sense of wonder and excitement engendered by ocean exploration, that can fully exploit the knowledge harnessed by an integrated ocean observing system; and,
- An ability by the public to understand and communicate the significance of ocean and coastal events and to promote responsible policy decisions.

APPENDIX A: NOPP-FUNDED OCEAN SCIENCE EDUCATION PROGRAMS

Since its inception, NOPP has supported (in several cases with co-funding) six (6) main programs regarding ocean sciences education.

1. The Bridge is a central clearinghouse website maintained by the Virginia Institute of Marine Science (Principal Investigator (P.I.): Lee Larkin) that provides extensive information about ocean concepts; teacher-reviewed samples of classroom activities and educational resources involving ocean science; links to recent oceanographic data and research programs, including real-time ship and submersible expeditions; and subscription lists for discussing marine education with other interested parties. The National Marine Educators Association and the national network of NOAA/Sea Grant offices are among the co-sponsors.
2. Project Oceanography is a live, weekly television program, operated by the College of Marine Science at the University of South Florida - St. Petersburg (P.I.: Paula Coble) in which researchers discuss the scientific objectives associated with their on-going research projects with a middle school student audience. Interactive question and answer periods between the students and researchers and supporting materials for each program (teacher background material packets, examples of related classroom activities, and glossaries) are included in this program.
3. The Coastal Ocean Observatory Laboratory room, or COOL Classroom, is operated by the Rutgers University Institute of Marine and Coastal Sciences (P.I.: Michael DeLuca). This website offers on-line learning activities for middle and high school students in conjunction with the LEO-15 coastal observatory. LEO-15 provides real-time data on the temperature and currents off of the New Jersey coast, in formats that are easily used in the classroom, as well as information about the scientists involved in the research. In addition to educational users, many other public sectors, including fishermen, recreational boaters, and swimmers, use this site for up-to-the-minute conditions and forecasts.
4. The Consortium for Oceanographic Activities for Students and Teachers (COAST), maintained by The University of Southern Mississippi (P.I.: Sharon Walker), offers an array of educational and career information resources for middle and high school teachers that builds upon the nationally recognized Operation Pathfinder program. The website offers interactive oceanographic examples in the form of an Oceanography and Coastal Processes Resource Guide that includes visualization modules. This Resource Guide is *NSES*-aligned and facilitates integrating these examples with other aspects of the high school science curriculum by differentiating topics related to biota and biological processes from those concerning physical and chemical parameters and processes. COAST also places teachers on U.S. Navy oceanographic survey ships to work side-by-side with scientists.
5. In collaboration with the JASON Project (P.I.: Robert Ballard), NOPP supported efforts associated with the JASON IX Expedition. Key components of this project included using interactive Internet technologies to bring students and teachers into direct contact with researchers participating in a cruise to the East Pacific Rise and developing a permanently accessible set of ocean-oriented web-based educational resources for K-12 classrooms.
6. NOPP has also supported development of the National Ocean Sciences Bowl (NOSB[®]), now in its 6th year of existence. The quiz-bowl formatted NOSB[®] provides a nation-wide forum for high school students to excel in mathematics and science, particularly as they relate to the marine world, and promotes factual learning about the marine sciences using teamwork in a competitive environment. The NOSB[®] is run annually by the Consortium for Oceanographic Research and Education (CORE), which is an association of sixty-six (66) U.S. laboratories, universities, research institutions, and aquariums engaged in ocean research and education. Approximately 7700 students and teachers from 1000 U.S. high schools have participated since 1998 at one of the program's 22 regional sites. Rewards for participation include hands-on field experiences, material resources for the team's schools, and collegiate scholarships.