

Profiles

Pioneering Interdisciplinary Research Initiatives for Oceans and Human Health

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Abstract: Following the release of the report *From Monsoons to Microbes* by the National Research Council in 1999, efforts began to promote federal sponsorship of research and education in a new scientific discipline focusing on how the ocean affects human health. The National Institute of Environmental Health Sciences (NIEHS) and the National Science Foundation (NSF) initiated a joint program to establish and sustain several research Centers for Oceans and Human Health (COHH) at nonfederal institutions. Shortly thereafter, the National Oceanic and Atmospheric Administration (NOAA) mounted a similar initiative to establish intramural centers at existing NOAA facilities as well as an extramural grants program. This profile reviews the history and current state of these developments.

Key words: ocean science, human health, National Science Foundation, National Institute of Environmental Health Sciences, National Oceanic and Atmospheric Administration

INTRODUCTION

The physical, chemical, and biological state of the ocean, including the somewhat loosely defined “health of the ocean” (IOC, 2003), impacts the health of human societies worldwide. The three-quarters of humanity who live and work in the maritime environment experience the benefits and the challenges of the ocean most acutely. Even human populations well inland are impacted by, and dependent upon, the ocean for the regulation of global climate and weather, for its pivotal role in the life-sustaining water

cycle, and for its bounty of food and other natural resources. Ironically perhaps, the same ocean that makes Earth the only known Eden among planets is also the ocean that serves as repository for the waste products of human civilization. Accordingly, our ability to prevent or mitigate ocean-related hazards and disease on one hand and our ability to manage precious marine natural resources on the other are interrelated (U.S. Commission on Ocean Policy, 2002).

Relatively well-integrated research, monitoring, and early warning systems have been in place for decades for some marine hazards such as tsunamis and hurricanes, but efforts to adopt similar measures to counter the threats of toxic algal blooms, pathogens, and contaminants in marine waters have been more recent and more limited. Although major research initiatives have been launched to under-

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stand the ecological and oceanographic factors leading to harmful algal blooms (Anderson, 1995), much remains to be discovered, and the hope for an integrated monitoring, prediction, and public health warning system remains a goal for the future (CENR, 2000). The situation for providing protection from human pathogens in marine waters is similar. There the line of defense usually involves monitoring of waters by fecal coliform assay and warnings to the public to avoid water contact. Because many human pathogens are known to have open-water survival and transport characteristics very different from coliform bacteria, such an approach to prevention is clearly inadequate (Colwell, 1996; Epstein et al., 1998).

The development of integrated research and surveillance systems has also been impeded by the practical difficulties of bringing together the appropriate expertise from the relevant biomedical and oceanographic research communities into a common interdisciplinary forum. For the advancement of science in the service of immediate societal needs, the development of interdisciplinary partnerships is crucial (NIEHS, 2002b; NRC, 1992; NSF, 2000, 2001; Pfirman and AC-ERE, 2003). Removal of the conceptual barriers among scientific disciplines and dissolution of barriers to communication and collaboration are not trivial undertakings. But development of, and support for, such an multidisciplinary community is critically important for advancing our understanding of the linkages between marine processes and public health, for developing predictive models and sentinel systems for the reduction of adverse health outcomes, and for promoting discovery of potentially life-saving resources from the sea (Watkins and Huq, 2001).

In recent years, three agencies of the United States Government—the National Institutes of Environmental Health Sciences (NIEHS), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF)—have worked with members of the U.S. scientific community to design and launch a set of new initiatives to promote innovative research to bridge gaps in our understanding of the relationships between ocean processes and resources and human health. One approach, that taken by the NIEHS–NSF partnership, features the creation and support of a set of research Centers for Oceans and Human Health (COHH) at U.S. research universities and marine laboratories. The other approach, taken by NOAA, features integration of a system of OHH research centers located at existing NOAA laboratories coupled with external research-grant programs for the

extramural research community. In the following, we review the events leading to the evolution of these OHH initiatives and present a vision for their future development.

EVOLUTION OF THE U.S. OHH INITIATIVES

The current drive to advance our understanding of oceans and human health was set into motion as the world was preparing to observe the first International Year of the Ocean in 1998. The previous year, the Board of Governors of the National Research Council (NRC) approved a formal study of “the ocean’s role in human health” proposed jointly by the Ocean Studies Board and the Institute of Medicine. A workshop was convened in June 1998, at the headquarters of the American Geophysical Union in Washington, DC. The final report made specific recommendations for prioritizing research in three areas: (1) improved prediction and prevention of marine public disasters (especially as related to climatic change, weather, harmful algal blooms [HAB], and infectious disease); (2) development of new technology to reduce risks to human health (especially chemical and biological sensors for in situ deployment, remote sensing platforms, and modern methods for testing seafood safety); and (3) marine organisms as biomedical resources (especially as biomedical models and for pharmaceutical discovery and biotechnological development). The following year, the workshop report was released under the title *From Monsoons to Microbes* (NRC, 1999). Also in conjunction with the International Year of the Ocean, the NIEHS cosponsored the U.S. pavilion—with oceans and human health as its theme—at the 1998 World’s Fair in Lisbon, and participated with NSF and other U.S. federal agencies in the Presidential Ocean Conference in Monterey, California. Both events served to focus attention on the links between marine processes and environmental health.

In 1998, before the publication of *From Monsoons to Microbes*, the Bermuda Biological Station for Research (BBSR) had already inaugurated an International Center for Ocean and Human Health to promote the study of the “health of the ocean” (HOTO) and its functional relationship to human health. With funding from the NIEHS and the Intergovernmental Oceanographic Commission (IOC), the Bermuda Center convened a workshop in November 1999, with three goals: (1) to explore the useful indicators of the impact of environmental change on

marine organisms, including implications for human health); (2) to identify research gaps in the application of indicators in studies of OHH phenomena; and (3) to establish OHH collaborations between governmental and private sector organizations. The workshop recommended the establishment of 10 international research centers to focus on the health of the ocean and its benefits and risks to human health, develop a global monitoring program, and institute a training program in associated state-of-the-art technology that could be deployed in developing countries (Knap et al., 2002). In February 2000, BBSR and the Consortium for Oceanographic Research and Education (CORE) cosponsored a briefing on the workshop deliberations in Washington, DC with members of the U.S. Congress and congressional staffers (BBSR, 2000). In addition to recommending the establishment of the international HOTO centers, the presenters also called on Congress to appropriate funding for HOTO and OHH research.

Recommendations from IOM, BBSR, and CORE set the stage for NSF–NIEHS dialogue on joint sponsorship of OHH research. During a meeting in June 2000, it became apparent that program officials at the two agencies had arrived at similar conclusions regarding the specific OHH research topics deserving priority attention: the dynamics of HABs, the dynamics of water- and vector-borne human diseases in marine environments, and the discovery of promising marine pharmaceuticals. Progress in these areas certainly would be facilitated by bridging the conceptual gap between the marine and geophysical science, and the biomedical and public health sciences, *and* by strengthening the lines of communication and collaboration between these disciplines. Inasmuch as one subcommunity traditionally receives most of its research support from NSF and the other from NIEHS, there was clearly a compelling reason for the two agencies to combine fiscal resources and work cooperatively.

Agency officials also agreed that rapid scientific progress, research community building, and education and training of predoctoral and postdoctoral students might be accomplished most efficiently and economically by encouraging researchers to organize themselves across disciplinary boundaries into “research centers for oceans and human health.” The goal was to secure the dual benefits of a continuing administrative presence at a lead institution and of a research team composed of the most appropriate experts who might have different institutional affiliations. Additionally, there was the explicit expectation

that such a structure would encourage the ready exchange of ideas and the development of collaborative research initiatives among the COHH, the extant network of NIEHS Marine and Freshwater Biomedical Centers, and the numerous marine laboratories in the U.S. and abroad.

In December 2001, NIEHS and NSF convened a workshop of 15 experts in epidemiology, pharmacology, biological oceanography, geochemistry, physiology, and biochemistry to review and discuss the priority problems and knowledge gaps in marine HAB ecology, pathogen dynamics, and natural products chemistry. Workshop participants, selected from an initial list of 56 candidates, were chosen to cover the breadth of the topical spectrum of OHH research other than those areas dealing specifically with marine meteorological and seismological hazards. The results of the deliberations were released in a report early in 2002 (Baden et al., 2001). As a follow-up, the workshop recommendations were presented to the scientific community at the American Geophysical Union–American Society of Limnology and Oceanography (AGU–ASLO) joint meeting in Honolulu, Hawaii, in February 2002, and at the joint International Society of Exposure Analysis–International Society for Environmental Epidemiology (ISEA–ISEE) meeting in Vancouver, British Columbia, in August 2002 (Baden, 2002; Fenical, 2002; Fuhrman and Noble, 2002; Vena, 2002). The thematic summaries and recommendations in the workshop report formed the basis for the joint NIEHS/NSF COHH program announcement released through NIEHS that set a proposal submission deadline in mid-March 2003 (NIEHS, 2002a).

In the months following the release of *From Monsoons to Microbes* and the BBSR/CORE briefing on Capitol Hill, congressional interest in interagency cooperation on OHH research developed quickly. In its deliberations on FY 2001 funding for the Department of Veterans Affairs, Housing, and Urban Development and Independent Agencies (the latter including NSF), the Committee on Appropriations of the U.S. House of Representatives “urg[ed] the NSF to work with the National Institute of Environmental Health Sciences and other relevant agencies and research institutions to examine this report [i.e., *From Monsoons to Microbes*] and identify specific areas of cooperation that should be jointly pursued to more fully understand and mitigate the impacts of the oceans on public health, particularly in the areas of lessening the human consequences of natural disasters, minimizing the outbreak and spread of epidemics and toxic algal blooms, keeping recreational beaches and seafood safe, and extracting life-saving prod-

ucts from the sea.” (U.S. House of Representatives, 2000). The NSF Directorate of Biological Sciences and NIH had already commenced a joint research initiative on the *Ecology of Infectious Disease*, but at that time the programmatic focus was primarily on the dynamics of disease and infection in terrestrial ecosystems.

Congressional interest in OHH also extended to NOAA. In 2002, after reviewing the objectives of, and progress on, the NIEHS–NSF COOH initiative, the CORE Office began work with congressional staffers to draft legislation to provide support for an OHH initiative in the NOAA Office of Global Programs. The NOAA call for proposals was eventually released in early 2004, and the first set of OHH proposals were submitted in April 2004.

OHH INITIATIVES NOW AND EXPECTATIONS FOR THE FUTURE

The effort to mount a concerted OHH research initiative that began nearly 7 years ago is now coming to fruition. Funding for the first NIEHS–NSF research Centers for Oceans and Human Health begins in early 2004. If all goes according to plan, the new NOAA OHH activities will be in place by the end of the year. Collectively, the new research centers, independent investigators, and students will constitute the core of a new kind of scientific community and will set the stage for the development of a new field of interdisciplinary research.

The NIEHS–NSF COHH program is organized around a small number of research centers with administrative and logistical support activities located at a university campus, marine laboratory, or other nongovernmental research institution. Each COHH has as its organizational principal either one of the three special emphasis areas (HABs, water- and vector-borne disease, or marine pharmaceuticals) or a specific geographical area or ecosystem in which two or more of the three special emphasis areas can be studied. Each Center will support at least three innovative interdisciplinary research projects. To complement major research projects and to foster creativity and facilitate implementation of novel research ideas, Centers will also receive up to \$200K per year to support locally selected pilot projects. To provide leadership and integrative support, each COHH will have a core administration headed by a director and a codirector, one of whom must be an individual with biomedical expertise and the other an individual with complementary marine science expertise. If

local circumstances require, each Center may also support a facility’s core activity to provide expertise in such areas as biostatistics, bioinformatics, genomics and proteomics, exposure assessment, and sensor development. In the interest of promoting dialogue informational exchange, and scientific collaboration, NSF and NIEHS encourage the Centers to develop an innovative plan for interacting with one another and require key project personnel to participate in annual COHH meetings.

The NOAA OHH initiative features a bipartite structure in the sense that both intramural science programs at NOAA laboratories and extramural activities in the non-federal research sector are part and parcel of the organizational plan. The overall plan calls for the establishment of OHH research centers at NOAA facilities that are analogous to the NIEHS–NSF COHH centers at universities and nongovernmental marine laboratories. Additionally the NOAA program provides for an external peer-reviewed grants program, distinguished scholars and traineeship program, workshops and community building activities, and a Small Business Innovative Research (SBIR) program to entrain the nonacademic scientific research and development sector.

Although the NIEHS–NSF and the NOAA organizational concepts differ in the details of implementation, the scientific and public health goals are similar. The agencies regard all such centers and investigators as part of an interdisciplinary research and educational network dedicated to the study of the ocean and human health. Extensive collaboration and communication among centers and investigators is regarded as integral to the network, as is provision for the support and training of a new generation of graduate students and postdoctoral associates intent upon pursuing careers in OHH research. By investing federal resources in activities designed to remove barriers of communication among researchers with different expertise and by promoting their close collaboration, we anticipate that understanding of OHH relationships will increase rapidly and that significant health benefits to society will accrue.

As national and international interest and technical capability in OHH research continue to grow, scientists and public health officials can look forward to the benefits promised by the implementation of global and coastal ocean observational networks (IOC, 2003). In both national and international planning efforts, there is provision for in situ and remote sensing platforms and sensor technology capable of delivering real-time information perti-

ment to OHH efforts in basic research, predictive modeling, and early warning systems. Five of the seven national needs to be met by the proposed Integrated Ocean Observing System (IOOS) in the U.S. relate directly to human health and safety; the other two relate to preservation and restoration of marine ecosystems (NOPP, 1999). To the extent that such marine observational and data acquisition networks can be coupled with epidemiological surveillance, vulnerability assessments, response strategies, and public communication systems, a fully integrated early warning system will be realized (NRC, 2001).

At the time that this report was preparing to go to press, selection of the NIEHS–NSF COHH institutions had been finalized, and the review of the candidate NOAA center and individual science proposals had just begun. By early February 2004, NSF and NIEHS had finalized the decision to make 5-year COHH awards to four institutions: University of Washington, University of Hawaii, University of Miami, and the Woods Hole Oceanographic Institution. Purely by coincidence, the four NIEHS–NSF Centers are distributed “to the four corners of the United States.” At this point, it is not possible to predict the outcome of the NOAA proposal review process, but it is certain that the final award decisions will provide for the support of NOAA OHH research centers as well as smaller extramural research projects. In any event, the groundwork has been laid for promoting a new interdisciplinary field of science in the public interest and for building a new kind of multidisciplinary community of research, education, and development to sustain it.

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