

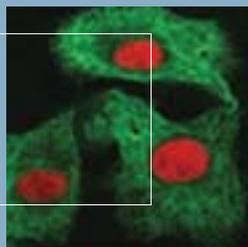
# Understanding the Connections



Between Oceans and Human Health:  
Causes, Consequences, Benefits,  
and Management



**CORE**



Results of a National Oceanic Atmospheric Administration workshop convened by the Consortium for Oceanographic Research and Education, October 9, 2003: Washington, D.C.

*The Congressionally mandated U.S. Commission on Ocean Policy dedicated a full chapter of its final report to connecting the oceans and human health, concluding that:*

*“Significant investment must be made in developing a coordinated national research effort to better understand the links between the ocean and human health, with research aimed at discovering new drugs and other useful products derived from marine organisms, and detecting and mitigating outbreaks of disease and other harmful conditions. Efforts must also be aimed at improving public awareness about how pollution and waste can contribute to the spread of seafood contamination and disease, and can decrease the diversity of species that provide new bioproducts.”<sup>1</sup>*

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<sup>1</sup> U.S. Commission on Ocean Policy. An Ocean Blueprint for the 21<sup>st</sup> Century. Final Report. Washington, DC, 2004 ISBN#0-9759462-0-X

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# Executive Summary

The more researchers learn about ocean processes and ocean life, the more they realize that the ocean plays a number of critical roles in human health and well being, and that human activity has impacts on the health of the ocean. Several recent reports have explored this intersection including the 1999 National Research Council report, *From Monsoons to Microbes- Understanding the Ocean's Role in Human Health* and the final report of the U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21<sup>st</sup> Century*. In 2003, Congress appropriated \$8 million to the National Oceanic and Atmospheric Administration (NOAA), directing the Undersecretary “to establish an ocean health initiative to coordinate and focus agency activities on critical areas of concern and identify critical gaps in coverage.”

On October 9<sup>th</sup>, 2003, the National Academies of Science and NOAA co-hosted a workshop to identify research priorities and implementation methods for a new initiative on the ocean and human health. The workshop brought together academic, private sector and government scientists with the goal of developing a program that: 1) explores the roles of oceans in human health; 2) supports NOAA's mission; and 3) ensures maximum integration within NOAA, across federal ocean agencies, and with the academic research community.

Four discussion groups were asked to identify research priorities related to: climate and weather and public health; infectious diseases and marine organisms as models; coastal ecosystems and human health; and marine-derived pharmaceuticals and related bioactive agents. These discussions resulted in research priorities in seven areas.

1. pathogens
2. marine biotoxins
3. chemical pollutants
4. seafood and public health
5. sentinel and model species
6. marine natural products, pharmaceuticals, and biomedical
7. climate, weather and coastal hazard information

Workshop participants later convened in three new discussion groups to consider appropriate program components for a NOAA initiative. These groups considered the program from the perspective of: extramural grants; centers of excellence and internal research; and education, traineeships and distinguished scholars. These discussions resulted in recommended program components in four areas.

centers of excellence in oceans and human health

external grants

internal NOAA awards

distinguished scholars and traineeships

The results of the workshop were subsequently included in the program structure and research priorities of NOAA's Oceans and Human Health Initiative.



# Introduction

The more researchers learn about ocean processes and ocean life, the more they realize that the ocean plays a number of critical roles in human health and well being, and that human activities have a number of impacts on the health of the ocean in return. At this ocean-human intersection, the ocean sustains human health by providing food resources, maintaining ecosystem services, and providing beneficial drugs and bioproducts. At the same time, marine processes and ocean organisms can provide a source of pathogens, invasive species, and weather hazards negatively impacting human health and safety. Increased human habitation in coastal regions and a rise in coastal human activity have resulted in increased human interaction with the oceans, altering the nature of the relationship itself. For example, excessive nutrients and pollution from human activity and localized ocean surface temperature rise have been shown to cause an increase in pathogens and also to affect ocean productivity in coastal areas. Understanding the many ways marine organisms and ocean processes affect human health, learning from these organisms and systems as models for human systems, and making informed decisions about human impacts to marine ecosystems, are all essential components to our sustainable future on this blue planet.

In 1999, the National Research Council (NRC) released its report, *From Monsoons to Microbes: Understanding the Ocean's Role in Human Health*.<sup>2</sup> The report establishes the basis for a national program to address ways in which the oceans directly affect human health. The first effect is primarily a challenge – public health problems stemming from climate, weather, coastal hazards, infectious diseases, and harmful algal blooms. The second is an opportunity – the contribution of marine biodiversity to medicine, including marine-derived pharmaceuticals and bioactive agents and marine organisms as models for biomedical research. Other NRC committees reported on the relationship among climate, ecosystems and infectious disease in 2001 and on marine biotechnology in 2000 and 2002.

In response to the NRC reports and at the urging of Congress in FY 2001, the National Institute of Environmental Health Sciences (NIEHS) and the National Science Foundation (NSF) together began a planning effort to assist in integrating the study of oceans and human health. Initiated at the level of the Director in both agencies, the plan culminated in a joint program development workshop held in December 2001. The final report was released in May of 2002 for implementation in FY 2003. In November 2002, the two agencies issued a joint request for proposals that will provide \$6 million annually for 5 years to establish national centers for oceans and human health.

Given its mission to understand and predict the oceans and manage marine resources, the National Oceanic and Atmospheric Administration (NOAA) has a significant role to play in interdisciplinary research to explore marine biological and physical processes and their implications for human health. The fiscal year 2003 appropriations law provides \$8 million for NOAA “to establish an Ocean Health Initiative to focus agency activities on critical areas of concern and identify critical gaps in coverage.” The language requires NOAA to submit a spending plan and directs the agency to:

- Work with the NSF and NIEHS to develop a joint program that builds on and complements existing NOAA programs;
- Establish an externally peer-reviewed grant process;
- Provide for the selection and funding of internationally recognized scholars to work in collaboration with NOAA researchers.

In response, the National Academies of Science and NOAA co-hosted a workshop on October 9, 2003 to identify research priorities and implementation steps for a new NOAA ocean health initiative.

<sup>2</sup> National Research Council. *From Monsoons to Microbes: Understanding the Ocean's Role in Human Health*. Washington, DC: National Academy Press, 1999.

# Organization of the Meeting

The one-day workshop convened by the Consortium for Oceanographic Research and Education (CORE) and held at the National Academies of Science brought together academic, private sector, and government scientists with the goal of developing a research program that:

- Explores the roles of oceans in human health;
- Supports NOAA's mission; and

Ensures maximum integration within NOAA, across federal ocean agencies, and with the academic research community.

Invited speakers addressed a plenary session of participants, providing background information essential to understanding the historical lead-up to the workshop and the organizational context under which NOAA research priorities could provide maximum benefit to federal ocean agencies, while complementing ongoing activities. Representatives of the following organizations provided introductory presentations:

- National Research Council;
- Senate Committee on Commerce, Science and Transportation;
- National Science Foundation;
- National Institute of Environmental Health Sciences; and
- National Oceanic and Atmospheric Administration.

Participants later formed discussion groups to consider the appropriate scientific scope of a NOAA initiative and identify research priorities in the following areas:

- Climate and weather and public health;
- Infectious diseases and marine organisms as models;
- Coastal ecosystems and human health; and
- Marine-derived pharmaceuticals and related bioactive agents.

In the afternoon session, participants convened in three new discussion groups to consider the appropriate program components for an effective NOAA initiative. These three groups considered the following topics respectively:

- Extramural grants;
- NOAA Centers of Excellence and internal research;
- Education, traineeships, and distinguished scholars.

The workshop concluded with a plenary presentation and discussion of the next steps in advancing NOAA's Oceans and Human Health Initiative, considering the valuable outcomes of the workshop.

# Outcomes of the Workshop

Congress established NOAA's Oceans and Human Health Initiative in 2003 to coordinate and focus agency activities on critical areas of concern and identify crucial gaps in coverage of the connection between the oceans and human health. Consistent with Congressional intent and NOAA's mission, the initiative will focus widely spread capabilities on common issues at the intersection(s) of the ocean and human health by bringing together expertise across NOAA offices, with academic and private partners, and in collaboration with NIEHS, NSF, and other appropriate federal and coastal State agencies. .

To contribute to this ambitious mandate, workshop participants identified seven areas of priority research and four core program components for the initiative.

## Research Priorities

**Pathogens** in the marine and coastal environment that may pose a risk of human disease occurrence as a function of exposure to pathogens (including water contact recreation and consumption of fish, shellfish, and other marine organisms)

**Marine Biotoxins** in the marine and coastal environment that may pose a risk of human disease occurrence as a function of exposure to marine biotoxins, and the effects of specific environmental stressors (e.g. changes in habitats, nutrient enrichment, environmental pollutants, climate, extreme events, land use, etc.)

**Chemical Pollutants** in the marine and coastal environment (including the Great Lakes) that may pose a risk to ecological and human health

**Seafood**, as a vector for chemical contaminants, biotoxins, and microbial pathogens that may pose a risk to human health

**Sentinel and Model Species** living in, or dependent on, the marine and coastal environment (including the Great Lakes) that may inform understanding of the risks to human health, or ocean health as it relates to changes in risk for human health

**Marine Natural Products, Pharmaceuticals, and Biomedical** uses of marine and coastal resources including, but not limited to, providing pharmaceuticals, medical devices, molecular probes, nutritional supplements, diagnostics and pigments

**Climate, Weather and Coastal Hazard Information** on temperature, tropical storms, rainfall and droughts, as they correlate to human health statistics in a region or the frequency and dates of human disease outbreaks



## Program Components

**NOAA Centers of Excellence in Oceans and Human Health** centers built on strong collaboration with both academic and private sector partners and focused on a suite of issues

**External Grants** to engage the academic and non-governmental communities in achieving program goals

**Internal NOAA Awards** that foster close collaborative and cooperative application of research findings among agency offices, particularly in the areas of marine, coastal, and socioeconomic research

**Distinguished Scholars and Traineeship Programs** that provide opportunities to develop and share scientific expertise to a range of candidates, from pre-doctoral candidates to internationally recognized scholars

# Discussion Group Reports - Research Priorities

Four discussion groups – climate, weather and public health; infectious diseases and marine organisms as models; coastal ecosystems and human health; and marine-derived pharmaceuticals and related bioactive agents – were charged to identify appropriate NOAA research priorities by considering the following questions:

What are the critical areas of concern and gaps in existing coverage of these issues?

Which critical areas or gaps are priorities that are directly related to, or supportive, of NOAA's mission?

What are some recommendations to assist in defining and building NOAA's contribution in an interagency research effort to address these issues over the next five years?

## Group - Climate, Weather, and Public Health

Critical areas of concern and gaps



- Better models for predicting environmental change and managing living resources
- Integrating disparate research on climate, weather, and public health to better understand ecosystems
- Disseminating information to those without easy access to computers (e.g. remote islands)
- Marine vectors of infectious diseases
- Impacts of climate change, interacting with land use/runoff, on incidence of disease in coastal regions
- Understanding the relationship between climate change and emerging diseases in marine species For example:
- Does genetic transfer result from high-density aquaculture and could such transfer lead to disease jumps (e.g. ebola, HIV/AIDS)?
- Will new strains of Cholera emerge as temperature rises?
- What are the climate limits for disease where transmission becomes more prevalent?
- Monitoring of unusual marine mammal mortality events, as sentinel species of detrimental ecosystem changes with potential human impact
- Accurate, highly resolved, analyses and predictions of physical environment (i.e. currents, transport of the upper ocean)
- Integration of data from disparate research, including upstream determinants
- Understanding of social factors, as they interact with climate, weather and public health

- Arctic monitoring capacity and integration of data necessary to better inform predictive capacity, particularly in the area of transboundary movement of contaminants
- Effects of warmer sea surface temperatures on coral reefs, fish and resulting human nutrition
- Potential effects of increasing El Nino effect due to climate change
- Economic benefits of improving visibility of climate, weather, public health

#### Priorities within NOAA's mission

Workshop participants concluded that components of each of these critical areas of concern and identified gaps are within NOAA's mission.

#### Recommendations for defining and building NOAA's interagency contribution

- Improve monitoring capacity
- Improve integration of data collection, management, and archiving across sectors and between agencies
  - Develop stronger links with the academic community
  - Encourage archiving of academic data within the NOAA National Ocean Data Centers (e.g. via liaison officers)
  - Increase the number of sensors in monitoring systems and field verify data
  - Provide educational component to researchers regarding National Ocean Data Centers and the World Ocean Database
- Improve communications among activities, initiatives, and agencies
- Develop better infrastructure in support of logistics and training
- Develop better connection between climate change science program and this initiative

## Group - Infectious Diseases and Marine Organisms as Models

#### Critical areas of concern and gaps

##### Infectious Diseases:

- Identifying and monitoring endemic diseases in marine organisms (i.e. many pathogens in marine mammals are shared by humans)
- Understanding disease dynamics in an unregulated system (i.e. comparative patho-biology)
  - □ Techniques and facilities for pathogen monitoring in ocean ecosystems (i.e. no comparable Center for Disease Control for ocean organisms)
- A central database or networked system with functional accessibility that offers interoperability of data types
- Risk assessments of critical concerns (e.g. immune competence, susceptibility, endocrine disruption)
- Understanding the ecology of pathogen "evolution" (e.g. pharmaceutical runoff)

### Marine Organisms as Models

- New organism models
- Developing aquaculture methods and other technologies for production of marine organism models
- Tissue culture and other growth systems for organisms and integrating these into research methodologies
- Educating public about marine models and their contribution to biomedicine

### Marine Organisms as Sentinels

- Evaluating compromised health, disease, or mortality events of marine organisms, as sentinels for potential human health impacts
- Central location, or support, for integrating information on marine organism health (i.e. disease “events” and “non-events”)
- Identifying organizational linkage with Centers on Disease Control, so as to communicate about marine organisms and human health (e.g. West Nile virus in birds vs. humans)
- Determining differences between marine and fresh water organisms that affect disease dynamics
- Determining differences among marine systems that affect disease transmission
- Central sample and data archiving system for future retrospective studies (e.g. biology, toxicology)

### Priorities within NOAA’s Mission

#### Infectious Diseases:

- Endemic diseases in marine organisms
- Disease dynamics in an unregulated system
- Risk assessments
- Ecology of pathogen “evolution”

#### Marine Organisms as Models:

- Development of aquaculture methods and technologies for use of marine organism models in natural setting
- Tissue culture and other growth systems
- Education about marine models and contribution to biomedicine



#### Marine Organisms as Sentinels:

- Evaluation of health, disease or mortality events of marine organisms
- Central location, or support, for integrating information on marine organism health
- Linkage between marine organisms and human health
- Determining the differences between marine and fresh water organisms that affect disease dynamics
- Determining the differences among marine systems that affect disease transmission
- Central sample and data archiving system for future retrospective studies

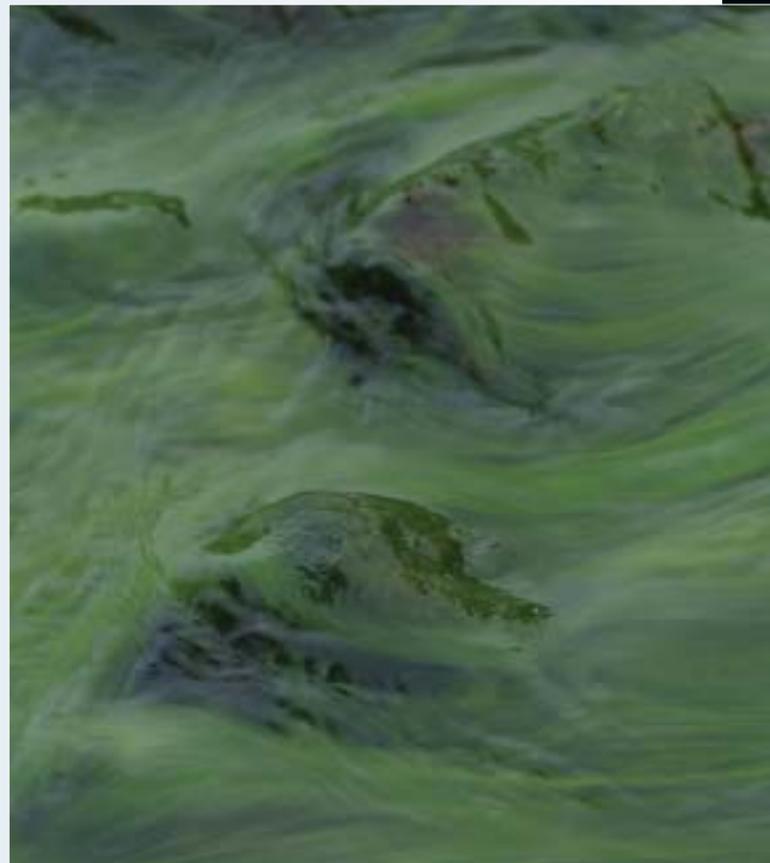
#### Recommendations for defining and building NOAA's interagency contribution

- Develop interagency working groups to overcome 'cultural' impediments
- Integrate issue effectively within NOAA
- Partner with academia and non-governmental organizations in development and implementation of program
- Hold annual, inter-sector, meeting for scientific exchange, comprised of one day of science presentations and panel (comprised of a mix of representatives from academia and federal agencies) discussion identifying annual priorities

## Group - Coastal Ecosystems and Human Health (including harmful algal blooms)

#### Critical areas of concern and gaps

- Understanding how atmospheric and coastal ocean coupling link to impacts on human health
- Understanding how multiple stressors, like contaminants and pathogens, impact biota, particularly with regard to loading and transport
- Seafood safety
- Common models to learn from what's been done in the past and to see common elements as the program moves forward



### Priorities within NOAA's mission

- Workshop participants concluded that components of each of these critical areas of concern and identified gaps are within NOAA's mission.

### Recommendations for defining and building NOAA's interagency contribution

- Develop links to key data sources and providers, in particular National Institutes of Health, Centers of Disease Control, and public health agencies
- Identify early in development where data and data gaps currently exist
- Develop unique data sources and clearinghouses
- Program should link to management from the federal to local levels using a variety of mechanisms
- Define smaller program components within the broader program (e.g., harmful algal bloom component could focus on toxin identification, chemistry and characterization as well as development of standards)

## Group - Marine - Derived Pharmaceuticals and Related Bioactive Agents

### Critical areas of concern and gaps

- Research, exploration and development activities related to bioactive marine products are inadequately positioned within any of the collaborative agency efforts being undertaken
- Issue currently lacks fit with existing NOAA research structure, creating a danger that it will not be represented in NOAA's broad initiatives



## Priorities within NOAA's mission

- NOAA's mission statement - to broadly explore and understand the world oceans - is consistent with the research goal of exploring new bioactive substances from the ocean
- NOAA's National Sea Grant Program has over 20 years of experience in supporting pilot examination in the marine bioactive area
- National Undersea Research Program and the NOAA Ocean Exploration program possess the facilities, platforms, and expertise to support the integration of biomedical research with collecting and sampling activities

## Recommendations for defining and building NOAA's interagency contribution

- Expand NOAA's mission to incorporate oceans and human health building upon the experience in components in existing programs
- Marine bioactive research could integrate all of the subcomponents of NOAA



# Discussion Group Reports - Program Components

Three discussion groups – extramural grants; centers of excellence and internal research; education, traineeships and distinguished scholars - were charged to identify the program component priorities by considering the following questions:

What are the existing programs, within NOAA, and with other federal agencies and academia, with which this program component should be coordinated and on which it can build?

What opportunities does this program component offer for building partnerships within NOAA and with other federal agencies and academia? What suggestions can you offer for taking advantage of such opportunities?

If funding is available, how do you see this program component developing over the next three to seven years? What are the most effective mechanisms and processes for implementing and sustaining this program component?

## Group - Extramural Grants

### Existing programs

- Monitoring and Event Response for Harmful Algal Blooms program (MERHAB)
- Ecology and Oceanography of Harmful Algal Blooms program (ECOHAB)
- National Sea Grant College program
- Prescott grant program
- Joint National Science Foundation/National Institute of Environmental Health Sciences Centers of Excellence in Oceans and Human Health
- Global Ocean Observing System
- National Oceanographic Partnership Program
- Superfund Program of the Environmental Protection Agency

### Opportunities for building partnerships

- Create ad hoc interagency working group (including academic partners) similar to the interagency working group of the National Ocean Partnership Program



- Hold an annual meeting, including representatives from NOAA Centers of Excellence in Oceans and Human Health, as well as individual investigators
- Develop traineeships to supplement the program and build future research capacity

#### Recommendations for implementing and sustaining the grant program

- Require recipients to have ties to NOAA Centers of Excellence in Oceans and Human Health
- Fund range of individual and team proposals
- Focus funding on narrower aspect of program in one year and rotate to with other priorities in out years to ensure sufficient funding to address the depth of individual issue
- Seek balance between long-term data collection efforts and short-term focused research
- Fund initial grants for more than one year
- Develop transparent granting process
- Distribute funding opportunities widely
- Include international scientists within eligibility criteria
- Use review panels under the National Ocean Partnership Program process to avoid need for review by multiple agencies
- Develop professional traineeships as mechanism for program sustainability
- Actively engage stakeholders to take proactive role in building program through the development of association
- Engage academic community in building external support
- Develop compelling science plan for building sponsor support

## Group - NOAA Centers and Internal Research

#### Examples of existing NOAA programs

- Climate Variability and Health Program
- Shellfish Program (Milford, CT)
- Prescott Grants Program
- Center for Coastal and Environmental and Biomedical Health (Charleston, SC)
- Hollings Marine Laboratory
- National Centers for Ocean Science/Coastal Ocean Programs
- Ecology and Oceanography of Harmful Algal Blooms program (ECO HAB)
- National Fisheries Science Centers
- National Sea Grant College Program(s)
- National Undersea Research Program
- Some NOAA matrix-managed programs (i.e. corals, observations systems)
- Coastal Storms Program(s)
- NOAA funded research under Census of Marine Life

## Opportunities for building partnerships

- Partner with NOAA Climate Variability and Health Program on socio-economic aspects
- Partner with U.S. Geological Survey on contaminant loading
- Partner with Census of Marine Life on understanding the roles of species in maintaining ecosystem health
- Partner across NOAA and with other agencies on sensors, probes, monitoring needs and data management related to the developing Integrated Ocean Observing System
- Link satellite data to shellfish closures to provide closure forecasts and warnings farther in advance
- Partner across NOAA and with academic community to develop improved modeling capability for studying virulence factors of harmful algal blooms
- Partner with the Environmental Protection Agency on contaminants and exposure
- Partner with U.S. Fish and Wildlife Service on contaminants in Arctic mammals and birds
- Partner with industry to develop better probes and sensors
- Partner with National Science Foundation bioinformatics program on infectious disease in marine environment
- Improve NOAA capacity to model and predict occurrence and distribution of infectious pathogens
- Develop catalog of infectious pathogens in marine organisms
- Explore bioactive compounds in microorganism and invertebrates from coral habitats
- Determine the role of corals (and other reefs inhabitants) as sentinels for human health impacts
- Develop better understanding of mechanisms involved in coral ecosystems, with a focus on societies dependent upon these ecosystems
- Partner with other agencies to develop series of compounds (based on chemistry and genetics) that could be bioactive, with a view to dual-use of samples
- Produce good assays of marine organisms for multiple purposes (e.g. bioactive agents)
- Partner with coastal storms budget initiative on protecting human health, as well as life
- Partner with aquaculture programs, with a view to propagating organisms for human health models, assays, etc
- Partner with federal, state, and local to establish national effort to disseminate explanations for beach closures
- Build off the National Environmental Education and Training Foundation and others efforts to establish better outreach to physicians, public health care workers, and veterinarians
- Partner to better integrate (centrally or through networks) the scattered datasets that currently exist at the National Science Foundation, National Fish and Wildlife Service, National Ocean Data Centers, Centers for Disease Control, among others

## Recommendations for implementing and sustaining the grant program

- Program should follow the matrix-management model of NOAA
- Program should consider internal grant proposals from all of NOAA line offices
- Program should consider holding conferences of both internal and external communities as potential recipients
- Program should consider developing an internal experts list
- Program should consider alternate methods for grant processing to that offered by the NOAA grants office
- Program should consider developing a joint forum with partners to improve communication and coordination

## Group - Education, Traineeships, and Distinguished Scholars

### Existing programs

*(None discussed)*

### Opportunities for building partnerships

- Partner with academic faculty, NOAA laboratories, and NOAA Centers of Coastal Ocean Science in establishing a distinguished scholars program to develop outreach, build capacity, and address critical research needs
- Establish a training program to be implemented by NOAA National Sea Grant College Program
- Partner with National Research Council post-doctoral program in implementing the education and traineeship needs of this program
- Use NOAA Centers of Excellence in Oceans and Human Health to support NOAA scientists' visiting/training at academic institutions

### Recommendations for implementing and sustaining the grant program

## Distinguished Scholar Program

- Academic faculty working at NOAA laboratories or centers
- NOAA scientists working in close collaboration with academic faculty
- Program priority areas given preference in selection
- In the first year, use established selection processes
- Two potential methods of collaboration are visiting at different times and for different durations, or remote collaboration through common projects

## Traineeship Program

- Pre- and post-doctoral
- Modeled on the National Institutes of Health traineeship program
- Implemented by NOAA's National Sea Grant College Program

## NOAA's National Research Council Program

- Post-doctoral program only
- Joint mentorship between NOAA and academic institution researchers
- Program reviewed by laboratory and advisors on regular basis

## NOAA Centers of Excellence in Oceans and Human Health

- Centers could pay for NOAA scientists to be trained at an academic institution

# Next Steps

The workshop was closed with a discussion of next steps. The outline of that discussion follows:

## Management of the NOAA Oceans and Human Health Initiative

- Establish ad hoc working group, with NOAA line offices
- Integrate oceans and human health across NOAA offices, with other agencies, and with academic institutions.
- Conduct briefings, seminars, meeting and workshops.
- Coordinate input into the program scope and process

## Immediate Steps

- Integrate input from workshop, regarding the scientific scope, research priorities, program components, and opportunities for integration
- Finalize calls for research scholarship program
- Publish workshop report
- Begin peer-reviewed programs

## Program Forward Timeline

October 9, 2003	Oceans and Human Health Initiative Workshop
October 2003	Federal Register Notice for External Peer-reviewed grants submitted, published in December
October 2003	Call for Centers of Excellence in Oceans and Human Health
November 2003	Call for Internal NOAA competition
December 2003	Centers of Excellence due
January 2003	Internal NOAA competition proposals due
December/January	Review panels
January 2004	Solicitation for Visiting Scholars Program
February 2004	External grants due
March/April/May	Review panel and funding decisions
June 2004	Ocean and Health Science Workshop

# Annex:

## Participants of the Workshop

Don Anderson	Woods Hole Oceanographic Institution
Daniel Baden	Center for Marine Science, University of North Carolina at Wilmington
Donald Boesch	Center for Environmental Science, University of Maryland
Suzanne Bolton	National Marine Fisheries Service, NOAA
Amy Carroll	House Committee on Science
Luis Cifuentes	College of Geosciences, Texas A & M University
Muriel Cole	Ocean.US (NOAA)
Tracy Collier	Northwest Fisheries Science Center, NOAA
Kathy Crane	Arctic Research Office, NOAA
Penelope Dalton	Consortium for Oceanographic Research and Education
Nancy Daves	National Marine Fisheries Service, NOAA
Gerald Dittberner	National Environmental Satellite, Data, and Information Service, NOAA
William Fenical	Center for Marine Biotechnology and Biomedicine, University of California
Bridget Ferriss	Senate Committee on Commerce, Science and Transportation
Margaret Fowke	National Weather Service, NOAA
Kathleen Frith	Health and Global Environment Landmark Center, Harvard Medical School
Rachel Gallant	Office of The Honorable Tom Allen
Dave Garrison	Division of Ocean Sciences, National Science Foundation
Mary Glackin	Program Planning and Integration, NOAA
Greg Glass	Bloomberg School of Public Health, Johns Hopkins
Jason Goldberg	Oceanic and Atmospheric Research, NOAA
Francis Gulland	Marine Mammal Center
Patrick Hagan	Bermuda Biological Station for Research, Inc.
Jonathan Kramer	Maryland Sea Grant College, University of Maryland
Jennie Kopelson	Consortium for Oceanographic Research and Education
Eric Lacy	Marine Biomedicine & Environmental Sciences, Medical University of South Carolina
Amanda Leland	Office of The Honorable Sam Farr
Jo-Ann Leong	Hawaii Institute of Marine Biology, University of Hawaii
Wayne Litaker	National Marine Fisheries Service Beaufort Laboratory, NOAA
Peter McCarthy	Harbor Branch Oceanographic Institution
Aurelia Micko	Office of Global Programs, NOAA
Juniper Neill	Oceanic and Atmospheric Research, NOAA
Jonathan Patz	Bloomberg School of Public Health, Johns Hopkins University
Susan Roberts	National Academy of Sciences
Richard Rosen	Oceanic and Atmospheric Research, NOAA
Teri Rowles	National Marine Fisheries Service, NOAA
Paul Sandifer	Hollings Marine Laboratory, National Centers for Coastal Ocean Science, NOAA
Terry Schaff	Woods Hole Oceanographic Institution
Geoff Scott	Center for Coastal Environmental Health and Biomolecular Research, NOAA
Noriko Shoji	Office of The Honorable Daniel K. Inouye
Randy Showstack	American Geophysical Union
Caitlin Simpson	Oceanic and Atmospheric Research, NOAA
Margaret Spring	Senate Committee on Commerce, Science and Transportation
Barry Stamey	Mitretek Systems
Carolyn Thoroughgood	Graduate College of Marine Studies, University of Delaware
Hank Trapido-Rosenthal	Bermuda Biological Station for Research, Inc.
Juli Trtanj	Oceanic and Atmospheric Research, NOAA
Frederick Tyson	National Institute of Environmental Health Services
Nathalie Valette-Silver	National Ocean Service, NOAA
Usha Varanasi	Northwest Fisheries Science Center, NOAA
Bob Wagner	Consortium for Oceanographic Research and Education
Pat Walsh	Rosenstiel School of Marine & Atmospheric Science, University of Miami
Randall Wells	Mote Marine Laboratory
Dick West	Consortium for Oceanographic Research and Education
Janet Whaley	National Marine Fisheries Service, NOAA
Kristen Yarincik	Consortium for Oceanographic Research and Education



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