

NOAA Response To:

“One Ocean, One Health: NOAA in the Lead”

A Report from the NOAA Science Advisory Board’s

Ocean Health Working Group

March 2011

Introduction

In March 2009, the National Ocean and Atmospheric Administration's (NOAA) Science Advisory Board (SAB) convened the Ocean Health Working Group (OHWG) to review and provide advice on how to better define NOAA's role and actions to enhance ongoing and future human and organism health-related science and management efforts. The OHWG included experts in the fields of epidemiology, toxicology, public health, environmental modeling, veterinary science, marine biotechnology, economics, and ocean sciences. The OHWG met three times under the leadership of Dr. Stephen Weisburg and delivered their final report "*One Ocean, One Health: NOAA in the Lead*" to the NOAA SAB at its meeting in March 2010. A complete list of members of the OHWG, the charge to the Working Group, and other details can be found in their full report (attachment A).

The SAB adopted the final report of the OHWG, and on April 4, 2010 the SAB Chairman communicated it to the NOAA Administrator. The letter of transmittal (attachment B) included the following statements from the Board:

"At our March 2010 meeting the SAB approved the OHWG Report as advice to NOAA on implementation of its critical engagements in human health and organism health -- both within NOAA and among its many Partners. NOAA has a clear leadership role based on its unique qualifications to monitor certain aspects of the marine environment and to provide forecasts of conditions that potentially affect human and organism health."

"The NOAA SAB encourages you and NOAA to take these recommendations seriously and to implement them as soon as possible. It is pointed out that these concerns belong in NOAA's Next Generation Strategic Planning at the national level as well as at the regional level."

The OHWG report is organized into major findings that make the case for why NOAA should be engaged and invested in health issues.

Finding 1: There is an urgent and societal need for action to understand and mitigate ocean and human and organism health threats, and to enhance opportunities to derive ocean-related health benefits.

The OHWG specifically noted that changes in ocean environments are resulting in changes in geographic ranges of pathogens, increases in frequency and intensity of harmful algal blooms, increased intensity of tropical storms, decreased availability of domestically produced seafood with consequent concerns for food quality and safety, and increases in frequency and number of emerging diseases in corals, sea turtles and marine mammals. The OHWG suggested that NOAA adopt a "One Health" approach, which espouses enhanced collaboration among human health professionals and the veterinary and environmental health communities, with the prime tenet that "the health of the 'one ocean' is essential to the 'one health' of all life on earth, including that of humans."

Finding 2: NOAA is well positioned to meet the need articulated above. It has the mission, the legislative and other mandates, the necessary scientific and technical expertise, and partners well with other agencies that have complementary missions.

The OHWG suggested that NOAA is uniquely qualified to be a leader in understanding and forecasting ocean, coastal, Great Lakes human and organism health issues and to communicate those, and specifically noted that:

- “NOAA is the nation’s leader in oceanographic, meteorological, and atmospheric predictive science.”
- “NOAA is leading development of early warning systems to identify and forecast ocean conditions that can threaten human, marine organism, and marine ecosystem health.”
- “NOAA has incorporated these predictive capabilities into identifying how climate change may affect the extent and diversity of ocean-related public health impacts.”
- “NOAA also leads the nation’s efforts to monitor and preserve marine mammal health, which is closely linked to and serves as an important sentinel for human health.”
- NOAA’s role as a science and service provider enables the missions of other agencies and private business.

Finding 3: NOAA has a diverse health portfolio in place, but the pieces are scattered across many parts of the agency and need to be linked together to form a more comprehensive, coordinated program.

The OHWG acknowledged the impressive quality of NOAA research and leadership related to oceans and health and the significant potential to build upon existing competencies. However, the OHWG noted that most of the activities were biologically oriented with many related to the agency’s Oceans and Human Health Initiative (OHHI) and did not include social science assessments or threats to human health from physical oceanographic hazards. **In particular, the OHWG identified as an important gap the lack of a single entity within the agency that is responsible for linking the health-related pieces into a coordinated program.**

Finding 4: NOAA needs to better quantify and communicate the benefits of its investments in health-related activities.

Specifically, the OHWG noted that NOAA’s activities save lives and enhance health, but the agency does not effectively quantify and communicate these. The OHWG suggested that the agency develop metrics that would provide concrete measures of lives saved, illnesses avoided, and economic benefits of research, technology development/ transition, and management actions. The report further noted that “The lack of a unified program with clearly defined goals and benchmarks contributes to NOAA’s difficulty in communicating its successes to, and obtaining funding from, Congress.”

Based on these findings, the OHWG advanced three core recommendations for how NOAA should improve coordination of health efforts across the agency and with partners. This

document provides an overview of actions undertaken or proposed by NOAA to address the OHWG recommendations.

OHWG Report Recommendations and NOAA Actions

Recommendation 1: NOAA should establish health protection, preservation, and enhancement as an agency-wide goal:

OHWG Recommendation Narrative: *The OHWG recommends that NOAA should acknowledge that identification and protection of ocean-health linkages are critical to the agency's core mission and commit at the highest administrative level to a national leadership role appropriate to the agency's unique skill sets and capabilities. NOAA's Next Generation Strategic Plan provides an opportunity for the agency to incorporate health concerns into the agency's mission in a meaningful way. The newly formed Climate Service will also allow NOAA to highlight products useful to individuals who must make decisions on the long-term effects of climate change on health of humans and organisms.*

In addition, the OHWG stated the following: *“While many agencies have programs that address a subset of ocean health threats and opportunities, no individual organization takes a holistic approach to protecting lives and promoting health from ocean-related activities. NOAA's unique, multi-disciplinary capabilities are needed now more than ever to integrate disparate efforts and address the ocean's overall effects on health...” “NOAA's investment to date in their OHHI program has started them down the path of capitalizing on these opportunities. Moreover, OHHI has developed substantial partnerships with the academic centers funded through the National Science Foundation that will allow them to leverage additional development opportunities.”*

NOAA Action 1.1: Strengthen “Health” Language in the Next Generation Strategic Plan

NOAA's “Next Generation Strategic Plan” (NGSP) was completed in December 2010. As enunciated in the NGSP, NOAA's vision for the future is “healthy ecosystems, communities, and economies that are resilient in the face of change.” This vision is dependent on understanding, predicting, adapting to or preventing ocean, coastal, and Great Lakes-health threats and risks and promoting actions to achieve health-related outcomes, including benefits to improve the resiliency and health of ecosystems, communities, and economies. The NGSP also recognizes the health outcomes expected to result from better integration of atmospheric and ocean capabilities. Language about the importance of how human health, safety, prosperity, and well-being are dependent upon and linked to the health and resilience of natural ecosystems is reflected throughout the NGSP. This plan incorporates a stronger focus related to health threats and benefits, health-relevant decision support services, and resource management linkages than at any previous time in NOAA's history. Compared to the previous Strategic Plan, which mentioned human health or public health only five times, the NGSP uses these terms 19 times and speaks specifically to the connections between human and environmental health. The NGSP uses the words “health” or “healthy” a total of 86 times, compared to 19 in the previous plan.

NOAA's NGSP describes four overarching long-term goals: Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, and Resilient Coastal Communities and Economies. While NOAA's overall vision and increased context of health are reflected throughout the NGSP, the inclusion of health-specific examples of progress towards each goal's objectives is strongest in the "Resilient Coastal Communities and Economies" and "Weather-Ready Nation" goals as noted below.

Resilient Coastal Communities and Economies: Coastal and Great Lakes communities are environmentally and economically sustainable. NOAA is dedicated to "improving water quality to support human health and coastal ecosystem services". NOAA builds on its capabilities in assessing climate impacts to ecosystem services and human health, conserving habitat, and delivering integrated nationwide decision-support services for resource managers, public health officials and numerous others. To accomplish this goal, NOAA will examine the transport and fate of chemicals, nutrients, sediments, pathogens, harmful algal blooms, toxins, and marine debris; collect chemical, biological, economic, and social data; develop and deploy sensors to monitor, assess, and predict health threats to marine ecosystems and humans; identify impacts of marine debris and continue efforts to remove it; develop and implement advanced water quality monitoring; and provide data and information to partners to further inform their development and refinement of nationwide early warning efforts, predictions, and ecological forecasts. Through these ongoing efforts NOAA expects to improve understanding of the effects of natural and human-induced contaminants on health of humans and marine organisms and reduce air and water quality-related impacts to human health.

Weather-Ready Nation: Society is prepared for and responds to weather-related events. The NGSP states that NOAA should strengthen existing partnerships and build new ones, including with public health officials, to improve data integration in support of economic, environmental, and health activities. This implies leveraging local, regional, and national offices and centers and related infrastructure and operations to enable state and federal health agencies and nongovernmental organizations (NGOs), as well as to build on international and intergovernmental leadership, such as through the World Meteorological Organization. The NGSP also notes the agency's unique capacity to combine weather, water, climate, ocean, and coastal data and information to develop and deliver "integrated environmental predictions" to protect and improve community and ecosystem health and to enhance society's ability to deal with weather- and water-related health vulnerabilities.

The remaining two NOAA goals in the NGSP both contain language with strong health context but lack stated or explicit evidence of progress towards the goal's objectives.

Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts. NOAA is a national and global leader in understanding impacts of climate change to and linkages among ecosystem, wildlife, and human health and prosperity. The agency is widely recognized for its leadership on the Intergovernmental Panel on Climate Change (IPCC), the Interagency Climate Change Adaptation Task Force, and the U.S. Global Change Research Program. According to the NGSP, "NOAA's initial service development efforts will focus on producing climate predictions, information, and ecosystem

impact assessments for the water, coastal, and living marine resources sectors, including improved sea level rise and ocean acidification monitoring, predictions, and information on related ecosystem and infrastructure impacts. Over time, NOAA will also develop and improve similar services for other sectors, such as health...”

Healthy Oceans: Marine fisheries, habitats and biodiversity sustained within healthy and productive ecosystems. NOAA supports implementing ecosystem-based approaches to resource management that require increased understanding of complex linkages among environmental factors, marine wildlife, biodiversity, and human health. To preserve the numerous benefits humans receive from nature, NOAA needs additional information on how humans affect and are affected by ecosystem condition. In addition, NOAA is committed to improving seafood safety and food security by reducing health hazards related to seafood contaminated with harmful algal bloom toxins, industrial chemicals, and infectious disease organisms and improving recognition of health benefits from consumption of safe, high quality seafood.

NOAA’s Science and Technology Enterprise. The NGSP states: “NOAA’s vision centers on a holistic understanding of the interdependencies between human health and prosperity, and the intricacies of the Earth system. Achieving this level of understanding presents an overarching, long-term scientific and technical challenge to NOAA: *to develop and apply holistic, integrated Earth system approaches to understand the processes that connect changes in the atmosphere, ocean, space, land surface, and cryosphere with ecosystems, organisms, and humans over different scales.*” NOAA’s expanding capabilities in enhanced environmental monitoring, modeling, and predictive capabilities would support development of health early warning systems. Also, NOAA looks to advance social, behavioral, and economic research and how it relates to climate, weather, water, ocean, and coastal services of which understanding health impacts and adaptation responses will play a large role.

NOAA Action 1.2: Strengthen Health Language in NOAA’s Annual Guidance Memorandum

An increased emphasis on health is reflected in the new Annual Guidance Memorandum (AGM) issued by NOAA Administrator Dr. Jane Lubchenco in December 2010. This document establishes programmatic priorities for FY 11 and shapes plans for future years. The AGM includes an FY 11 execution focus on “working with other agencies and partners to increase understanding of and ways to mitigate or alleviate the impacts of the Deepwater Horizon (DWH) oil spill on human health and well-being”. Other activities noted in the AGM include efforts on ecosystem service valuation, biodiversity, and ocean health threats and benefits. Further, under the “Strengthening Science” heading, Dr. Lubchenco states: “In particular, NOAA should pursue new and enhanced capabilities to forecast high-impact events such as tornados, hurricanes, floods, air quality, winter storms, tsunami, and ocean health-related threats from harmful algal blooms, chemical contaminants, and pathogens. These high impact events may become more variable in their occurrence and intensity, which will require improved predictions based on robust intra-seasonal to inter-annual forecasts and regional-scale modeling.”

NOAA Action 1.3: Strengthen Strategic Partnerships to Achieve NOAA's Vision and Mission

Since the release of the OHWG's report, NOAA has made significant progress, both internally and externally, to better link its health-related programs, projects, and activities with those of other entities and agencies and to specifically play lead roles in identifying connections between environmental, marine wildlife, weather, water, and human health and between climate change and ocean, coastal, and Great Lakes-related health threats. NOAA has strengthened or advanced its partnerships in four key sectors related to health: One Health, Climate Change, Public Health, and DWH Oil Spill Response.

One Health

Within NOAA, the NMFS Marine Mammal Health and Stranding Response Program (MMHSRP), OHHI, and other NOAA programs, projects, and activities have continued to build partnerships, both across the agency and externally, to support a "One Health" approach, strongly linking marine fish and wildlife health research and assessments to human health effects. Toward that end, OHHI, MMHSRP, and associates in NWS and OAR have or are currently:

- Re-invigorating an *ad hoc*, cross-NOAA One Health Working Group to coordinate and jointly plan health activities across programs and to facilitate data sharing in a One Health construct.
- Developing plans for enhanced climate and adaptation services that include a One Health approach.
- Injecting a One Health approach into the new US Global Change Research Program (USGCRP) Interagency Crosscutting Group on Climate Change and Human Health and the USGCRP Strategic Planning Process.
- Leading interagency discussions on the One Health approach within the Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health (IWG-4H, which NOAA co-chairs), involving the National Research Council and leaders in the marine wildlife and veterinary community.
- At the request of World Health Organization (WHO), the OHHI Director is co-leading a working group on Leptospirosis, a re-emerging disease of concern to WHO, and for which NOAA has expertise in marine wildlife transmission and diagnosis. This group is bringing together experts in disease transmission, diagnosis, surveillance, and prediction to better understand and prevent a disease resurgence or epidemic.
- Working with National Institutes of Health (NIH), Centers for Disease Control and Prevention (CDC), academia, state public health, and wildlife partners, NOAA's MMHSRP and OHHI are involved in meetings to 1) assess research gaps on the ecology and impacts of several pathogens (*Leptospira*, *Coxiella*, and *Cryptococcus*) which are increasing in geographic extent in the Pacific and affect both people and animals, including marine wildlife and 2) improve communication of ocean health risks to both marine mammal workers and public health audiences.

- Continuing discussions with fish and wildlife health programs within other federal agencies, such as US Geological Survey (USGS), US Department of Agriculture (USDA), and US Fish and Wildlife Service (USFWS), specifically focused on using shared or interoperable data systems and graphical displays for monitoring terrestrial and marine fish and wildlife health data.
- Initiating discussions with US Agency for International Development (USAID) on collaboration regarding integrating ocean, climate, and marine mammal health data into their global wildlife disease surveillance program.

Public Health

- NOAA has increased local, regional, national, and international linkages with the public health community by participating in activities with numerous offices within the Department of Health and Human Services (such as in the CDC and NIH) and the WHO and through active participation in meetings of the American Public Health Association.
- OHHI established Memorandum of Understanding (MOU) with NIH Fogarty International Center to support the International Conservation and Bioprospecting Group (ICBG), a five-agency and seven-NIH Institute program supporting research on natural product and pharmaceutical discovery within a conservation framework.
- NOAA, led by OHHI, is drafting an MOU with CDC, involving all NOAA Line Offices and multiple CDC Divisions, addressing research, training, education, data sharing, surveillance, social science, modeling, forecasting, and communication.
- NOAA is implementing a joint NWS and CDC messaging effort designed to craft messages and initially distribute through NWS communication networks, such as Weather Forecast Offices and weather broadcasters, and eventually through CDC public communication networks.
- NWS issues heat health alerts and provides related interpretation, education, and outreach to counties nationwide as a part of routine operational services and is involved in research and development for improvements to forecast quality, understanding, and use.
- NOS and NWS are piloting outlooks and alerts for ecological health risks including those related to water quality, harmful algal blooms, and pathogens.
- Sea Grant, particularly in the Great Lakes and Gulf of Mexico regions, is playing important roles in connecting NOAA and academic researchers studying HABs, pathogens, and chemical contamination with the public health community.
- NWS, in partnership with US Veterans affairs and CDC, is advancing the integration of environmental data and geo-spatial tools to merge water information with health cases for prediction of infectious disease outbreaks, including dengue fever and lyme disease.
- NWS, in partnership with the EPA, provides air quality forecast guidance as part of routine operational services. NWS works with state and local air quality forecasters to improve understanding and use of this guidance and is involved with OAR and other research partners in development and testing to improve air quality forecasts with forecasts of additional harmful pollutants.

- NWS, NOS, and OAR are working with the Environmental Protection Agency (EPA), USGS, and academic institutions on the Great Lakes to advance a framework for health-relevant risk reduction, water quality and beach alerting, and related restoration.
- NWS is partnering with NGOs, including CARE, and various academic medical communities, including Emory University, to advance a framework for Global Health research and translation to service.
- NWS supports the Department of Homeland Security, in partnership with other agencies including CDC, in bio-surveillance and related operational syndromic surveillance and data fusion initiatives.
- NWS and WHO, with involvement of the OHHI, are developing methods and tools to integrate NOAA data into the WHO Global Information Management System, with the end goal of developing health early warning systems.
- Led by OHHI, NOAA is collaborating with WHO on assessing how climate change may influence resilience of water sources and sanitation facilities, which in turn may impact the global burden of disease. The effort is in support of evaluating the Millennium Development Goals.
- WHO and OHHI are working together to identify opportunities for the OHHI's graduate and postdoctoral trainees to receive additional training with WHO.
- NOAA is enhancing a well-established regional partnership, and building stronger national partnerships, with the EPA for collaboration on climate, oceans, health research and operations, and the Global Earth Observing System of Systems (GEOSS), as well as further developing connections with the Beaches Program and the Office of Water.
- NOAA's MMHSRP is working with states and public health communities as well as other federal agencies using marine mammals as sentinels of infectious and toxicological diseases that have potential impact on both wildlife and people.

Climate Change

- NOAA is engaged in national assessments of climate change impacts, including health impacts, and is providing information for improved management decision-making to multiple sectors, including the Department of Health and Human Services. NOAA and its partners have promoted climate change and health literacy and research needs via nationally acclaimed interagency reports and is delivering NOAA capabilities and information to multiple audiences concerned with climate impacts, adaptation, mitigation, and vulnerability.
- Along with three other agencies, NOAA led the establishment of the *ad hoc* Interagency Crosscutting Group on Climate Change and Human Health (CCHHG), which produced the first comprehensive report on human health research needs related to effects of climate change (Portier et al. 2010). This report is being widely used by health agencies, as well as NOAA, to guide research planning. In numerous places, the report cites the need for enhanced research, surveillance, monitoring, and prediction related to human health threats from the ocean. The CCHHG received a Presidential citation – the

GreenGov Presidential Green Dream Team Award – for its efforts, and NOAA was a major part of the team. As a direct result of efforts of this group, the USGCRP has established a formal CCHHG. The NOAA OHHI Director has just been asked to serve as a co-chair of the new CCHHG, reflecting the growing recognition by other Federal agencies of NOAA’s key roles at the climate change–human health nexus.

- The NOAA OHHI Director co-chairs the CDC-funded Environmental Public Health Tracking Network (EPHT) Climate Change Content Working Group. This group is charged with identifying and tracking indicators of health effects of climate change, including addressing those in coastal areas. Scientists from NWS and NESDIS are actively engaged in this effort as well.
- Through the EPHT, NWS is developing collaborations with state health departments, starting in the Northeast and California, to track the health effects of climate change related to heat waves by delivering heat information, and working together to improve development and communication of heat wave forecasts.
- NOAA personnel chaired or organized numerous climate change and oceans and human health sessions at high profile national science meetings including APHA, American Association for the Advancement of Science, and the National Council for Science and the Environment.
- NOAA’s MMHSRP is working with state, federal, tribal, and academic partners to enhance monitoring of marine wildlife, which serve as subsistence foods for Alaska native communities, and to understand the impacts that climate change may have on those marine wildlife resources (e.g., marine mammals).
- NESDIS/NCDC participates in the American State and Territorial Health Officials Climate Change Collaborative.
- The OAR Climate Program Office's Regional Integrated Sciences and Assessment (RISA) Program recently established a RISA focused on climate and urban health and Sea Grant has numerous research and extension efforts underway relating to climate change and ecosystem health, including humans.
- See One Health and Public Health sections for additional climate change information.

DWH Oil Spill Response

- Following the DWH oil spill, NOAA has engaged on health issues in four main areas: (1) ensuring seafood safety, (2) developing plans for assessing the short- and long-term health impacts for marine mammals in the region, (3) coordinating with the National Institute of Environmental Health Sciences (NIEHS) on their substantive longitudinal study of 55,000 people who undertook response and clean-up activities, and (4) ensuring that NOAA maintains readiness for responses to health issues in anthropogenic and natural disasters. NOAA also worked to ensure appropriate NOAA data and research are available to, or conducted in partnership with, NIH.
- NOAA is involved in multiple agency and private sector discussions on analytic methods for dispersant and other contaminants as well as related ecosystem and human health risks.

- The OHHI proposed integrated ecosystem, marine mammal, and human health risk assessment in the Gulf of Mexico involving all NOAA line offices, state health agencies, and NGOs.
- Sea Grant has worked across the spectrum to engage and inform partners, stakeholders, constituents and the public regarding a wide-range of potential spill-related environmental, animal, and human health issues

Recommendation 2: NOAA should develop a comprehensive plan for its health programs

OHWG Recommendation Narrative: The OHWG recommends that NOAA develop a comprehensive plan for its health programs that ties its health efforts to other federal agencies with complementary skills in environmental and public health. The plan should be based on a systematic risk characterization that identifies and quantifies potential health benefits and threats. This type of prioritization should identify which threats and benefits can best be addressed with short-term operational programs versus those that will require longer-term research investments. Such planning will ensure that agency investments provide the greatest societal benefit. The plan should also include provisions for transitioning research results to applications, consideration of intellectual property issues to enhance development of applications, incorporation of the health plan into larger NOAA planning efforts (e.g. NGSP, 5-Year Research Plan), and creation of a coordinating entity for health-related activities across the agency at a high enough organizational level to be effective. Finally, the OHWG recommended that NOAA provide a funding level commensurate with the plan, and particularly supported an increase from the FY11 President's Budget recommendation for the OHHI to its authorized level of ~\$12M/Year.

NOAA Action 2.1: Develop a comprehensive plan that links NOAA's health efforts into a coordinated "One Ocean, One Health" program that serves both NOAA's needs and the needs of other agencies and society

NOAA's first step in this process was to engage as fully as possible in ongoing planning efforts such as President Obama's National Ocean Policy, the NGSP, newly developed or developing plans for the Climate Service, the Weather Service, the Ocean Service, and the Interagency Working Group on Climate Change and Human Health. These efforts have identified health issues as important priorities, and NOAA has acknowledged a number of specific health-related priorities for this agency. Our next step is to expand and formalize a cross-NOAA effort to build upon the identified NOAA priorities and needs of public health partners and enhance institutional connections with other local, state, and federal agencies, the public health community, academic institutions, and NGOs. An excellent mechanism to achieve a cross-NOAA effort would be to charter a formal cross-NOAA, "One Health Working Group," building upon the existing *ad hoc* group. This working group would be led by the NOS Senior Scientist and would include the Director of the OHHI and senior personnel designated by the AA of each interested Line Office. Terms of Reference for the working group would be approved by the appropriate NOAA Council (e.g., the NOAA Ocean and Coastal Council (NOC-C)), and the

working group would report to that Council on a regular basis. An early step for this working group would be to convene an internal NOAA workshop aimed at reviewing on-going and future health activities, identifying areas of improved collaboration, and collectively identifying achievable short- and long-term health outcomes, products, and services. This would be the first step in development of a comprehensive NOAA-wide plan that links NOAA's health efforts into a coordinated "One Ocean, One Health" Program.

NOAA Action 2.2: NOAA will characterize risks associated with ocean health threats and prepare a business case for continuing investment in ocean health research and development and transition to applications

Dependent on budget stability, the OHHI is considering funding a competitive award for one or more Distinguished Scholars in OHH to analyze and characterize ocean health risks and benefits and, to the degree possible, assess their potential economic impacts in the U.S. The OHHI is also considering having one or more of its Centers of Excellence undertake a regional pilot project to gather economic and risk data. Given that these are substantial undertakings, NOAA will work with partners to leverage resources and will involve NOAA's Chief Economist and Social Science Committee to the degree they are willing to participate. Other Line Offices, Centers, and field offices are also developing and advancing proposed pilot programs and partnerships for ocean health-related research, communications, and services on local, regional, and global scales. Together these actions will better identify how NOAA should optimize investments, encourage collaboration, and efficiently direct agency resources towards sustainable activities and quantifiable outcomes that address the most pressing current or emerging health risks and/or how on-going activities have best served society.

NOAA Action 2.3: Build upon the existing OHH Initiative to improve coordination across NOAA and with partners

To address the OHWG's recommendation that NOAA create a coordinating entity for ocean health-related programs, the agency will utilize its existing OHHI as an initial "One Ocean, One NOAA, One Health" coordinating office. This approach will allow immediate progress, with final determination of coordinating mechanism to be made later.

The OHHI was specifically authorized by the Oceans and Human Health Act of 2004 and directed by the Act to cooperate with other agencies in the arena of ocean health, to work across NOAA to develop Centers of Excellence and new capabilities that link ocean and biomedical sciences, and to support cutting edge research and development in the non-federal sector. There are other important health-specific statutory, regulatory, and programmatic requirements across NOAA, but the OHHI is the only entity within NOAA that has been identified with the specific mandates for cross-agency coordination on health. OHHI is best positioned to become a core of support to continue coordinating health projects and activities in NMFS, NOS, OAR, NWS and NESDIS. The OHHI is widely recognized, both within NOAA and by other agencies and the external community, as a credible and dependable partner and effective leader in health, and use of its existing office and connections will accelerate efforts to formalize a new cross-NOAA Health Program. NWS, as the authoritative source for water and weather services and leader in the National Weather Enterprise and in delivery of climate information, recognizes healthy communities as a strategic goal and will also be a strong supporter and enabler contributing to

this NOAA-wide science, service, and stewardship program, as will NOS, NMFS, OAR, and NESDIS.

The One Health Working Group described above will have responsibility to work across and outside NOAA to ensure coordination, connection, and integration of its diverse ocean-health activities and assist in the rapid translation of findings to applications in the ocean management, public health, and private business sectors. In its role as the ocean-health coordinating office, the OHHI will work with its NOAA-wide network to help advance and nurture an agency-wide environment that encourages and supports the acquisition of new knowledge and the transition and translation of health research to applications and services for identified users.

Currently, the OHHI supports three Centers of Excellence within NOAA (one each in NMFS, NOS, and OAR) and, since its inception, has nurtured strong partnerships with the National Centers for Coastal Ocean Science, Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) and Monitoring and Event Response for Harmful Algal Blooms (MERHAB) programs, the Center for Operational Oceanographic Products and Services, the Coastal Services Center, NOAA Fisheries' MMHSRP, the Climate Program Office, and others within NOAA, as well as OHH-related programs in the National Science Foundation (NSF), the NIEHS, the CDC, and the EPA. The OHHI already identified and is exploring several opportunities to build upon and leverage its extensive existing network, including improved coordination with NOAA's Cooperative Institutes, the Regional Integrated Science and Assessment Program in the OAR Climate Program Office, Regional Climate Service Directors, the national Sea Grant Program Office and state Sea Grant Programs, NWS Climate Service Program Managers, and numerous others. The OHH Act identified the National Sea Grant Program as an important partner for designing and implementing a program to disseminate information developed by OHH researchers to interested parties and users. Sea Grant has been particularly effective in this regard in the Great Lakes, the Gulf of Mexico, the Pacific Northwest and the Southeast and is expected to continue to be a significant player going forward. The OHHI will work with the NOAA IOOS Office to extend work currently supported by the OHHI to develop and implement new marine sensors to detect biological and chemical threats to wildlife and human health in ocean and coastal waters.

As part of the comprehensive plan, NOAA is considering relocation alternatives for OHHI which would allow it to better serve and support the NOAA-wide, matrix-like program suggested above. It is presently attached to the Office of the NOS Assistant Administrator, which provides a high level of visibility, attention from senior leadership, and enhanced opportunities to integrate with offices and programs across the agency. However, this location does not provide for sufficient administrative and process support. NOAA and the FY 2012 President's Budget propose to merge the OHHI with the National Centers for Coastal Ocean Science (NCCOS), with the intent that the OHHI would continue to operate under the oversight of the NOS Senior Scientist as a matrix program supporting the entire Agency. The NCCOS mission and priorities are congruent with those of OHHI, and indeed NCCOS is home to the Hollings Marine Laboratory (HML), one of the OHHI Centers of Excellence. NOAA recognizes that it will be vital for the OHHI to continue to operate as it has with regard to relationships across NOAA, with other agencies, and with the external community. It will also be crucial to demonstrate that neither the HML nor any other part of NCCOS have any competitive advantage with regard to OHHI funding. The NOS Senior Scientist will work closely with the NCCOS Director to ensure

that the OHHI retains its objectivity and status as a trusted broker, and he will continue to provide oversight for the OHHI and its growing role in coordinating health-related research, development, and transition work across the agency and with external partners.

NOAA Action 2.4: NOAA has promoted a budgetary increase for the OHHI

Although NOAA was unable to meet the budgetary allocation of \$12M per year recommended by the OHWG, the FY12 President's Budget includes a 100% increase for the program, moving from a \$1M request to \$2M. Considering the present highly resource-constrained environment, NOAA views this as a notable achievement. NOAA will continue to look for the means to better support this efficient and effective program. Other NOAA health-related activities and projects are embedded within the overall agency budget. Many of the relevant activities of modeling, mapping, observation, analysis, assessment, communication, research, and education are not directly articulated as "health" in existing NOAA budget formulation, legislation, or policy. A comprehensive strategic and budget review of NOAA's efforts that support or could support health-related work would be useful to fully evaluate NOAA's emerging OHH roles and opportunities.

Recommendation 3: NOAA should focus initially on several priority projects

OHWG Recommendation Narrative: The OHWG recognizes that development of an effective comprehensive health plan may take several years to develop, particularly if NOAA develops a comprehensive risk prioritization and coordinates its planning with that of complementary agencies. As such, the OHWG identified a number of priority projects that are logical extensions of ongoing NOAA investments that will yield significant societal benefit.

Recommended projects are as follows: 1) Forecasting of Impending Threats; 2) Surveillance systems for emerging pathogens, contaminants, and toxins that affect health; 3) Climate change effects on ocean-related health; and 4) Health benefits from the sea.

The following are highlights of some of the projects undertaken while NOAA seeks to implement the longer-term recommendations.

3.1. Forecasts of impending threats

The OHWG reported that: *"As an established leader in developing early warning systems, NOAA should extend its skills in forecasting to predict emerging diseases, pathogens, toxins, and contaminants likely to have an impact on health."*

The current strategic plan for the OHHI includes development of ocean health early warning systems as its first goal. This has been a major focus of much research and development over the last several years, both within the OHHI and in other parts of NOAA, and this emphasis is expected to continue. The pace and extent of the research and the transition to users and operators is dependent on available funding, policy, and priority setting. The following provide some examples of recent and ongoing activities across NOAA to improve forecasting in different regions of the country, as well as forecasting capabilities in general.

Gulf of Mexico

NOAA's Harmful Algal Bloom (HAB) Forecasting System in the Gulf of Mexico, which supplies information on the location, extent, and potential for development or movement of HABs, is operational in NOAA's Center for Operational Oceanographic Products and Services (CO-OPS). The HAB forecast has been operational in the eastern Gulf of Mexico since 2004, and in September 2010, NCCOS scientists transitioned the western Gulf of Mexico forecast to operational status within CO-OPS as well.

For pathogen forecasting in the Gulf, a product to predict risk of exposure to *Vibrios* in northern Gulf of Mexico shellfish was developed as an outgrowth of an OHHI Grant. This product leveraged NOAA support with additional resources from FDA and NASA and is being transitioned with support from NCCOS to semi-operational status.

The OHH Center of Excellence in Charleston, South Carolina, validated applicability of its Tidal Creek Model as a component for a Gulf of Mexico ocean health early warning system. Analyses of tidal creek data from Grand Bay and Weeks Bay National Estuarine Research Reserves (NERR) have been completed and, in addition to providing early warnings of impending health issues, they also provided important pre-DWH oil spill baseline information. Sampling was repeated during summer 2010 after oil had reached the Grand Bay NERR and comparisons will be made to help assess any oil spill impacts.

Great Lakes

The NOAA Center of Excellence for Great Lakes and Human Health (CEGLHH) has increased its beach health forecasting research capacity in the past two years, going from two to four locations and encompassing 10 to 18 beaches, with operational tributary forecast models. These models predict fate of contaminated waters for swimming beaches, are updated six times per day, and provide forecasts five days in advance.

For HAB forecasting, CEGLHH and NCCOS are producing semi-operational forecasts during bloom season for toxic cyanobacteria in Lake Erie. The forecasts are disseminated on a regular basis to water utility managers, who use the information to inform water treatment decisions, as well as to state resource agencies, who use it to target sampling.

Northeast

NOAA NCCOS-funded scientists at the Woods Hole Oceanographic Institution (WHOI) and North Carolina State University (NCSU) produce a seasonal outlook each year (since 2008) for the size and extent of the toxic *Alexandrium* bloom, or “New England red tide,” in the Gulf of Maine. The annual prediction, along with weekly forecasts of bloom movement, are distributed to state and regional fishery and public health officials (in demonstration mode) to help them focus sampling and make more precise closures during events to minimize economic impacts to shellfisheries while protecting human health.

Mid- and South-Atlantic

The OHHI Center of Excellence at the Hollings Marine Laboratory in Charleston, SC, has a unique effort focused on the use of sentinel species and habitats to identify and track trends in land-use practices that may affect coastal and ocean threats to health of humans and marine animals. This work includes validation of Southeast coastal dolphins as valuable components of

health early warning systems. Dolphins along the Georgia coast provided a warning of high levels of PCBs in the coastal food web. The PCBs are associated with a Superfund site near Brunswick, Georgia, but the degree and extent of the PCB contamination was not realized until a joint study undertaken by NOAA's OHHI and MMHSRP documented PCB concentrations in dolphins higher than ever before reported in wildlife. This work led to ongoing collaboration with CDC to evaluate potential links to human health via a study involving seafood consumers on Sapelo Island.

NOAA program offices in the NWS, NOS, and NESDIS are collaborating with the University of Maryland, the Chesapeake Bay Program Office, and Maryland and Virginia health and natural resource agencies to advance forecasting of health threats in the Chesapeake Bay. These efforts have connected existing state monitoring with a new predictive modeling platform to produce forecasts for sea nettles, HABs, and pathogens, and it is now being considered for incorporation in the NOAA NWS transition to operation system.

West Coast

A web-based bulletin for the early warning of Washington coast HAB events has been developed by the University of Washington with the West Coast Center for OHH at the Northwest Fisheries Science Center and support from NOAA HAB programs in NCCOS. NOAA NCCOS is also currently supporting refinement and improvement of the predictive models to include the influence of the Columbia River estuary as well as documentation of protocols in support of transitioning the bulletin into an operational capability. Further, the West Coast Center for OHH is working with the Makah Tribal Members to understand human health risks from long term exposure to HAB biotoxins that cause paralytic shellfish poisoning.

Other Activities to Advance HAB Forecasting Capabilities

In response to the Ocean Research Priorities Plan, NOAA OHHI received FY10 funding to support the development of marine sensors for use in ocean health early warning systems. Projects will result in critical components to address diagnostic needs and advance forecasting capabilities for emerging health threats. These include field testing and advancing capabilities of the Environmental Sample Processor (ESP) developed by the Monterey Bay Aquarium Research Institute and others.

In addition, a new program in NCCOS, Prevention, Control, and Mitigation of HABs (PCM HAB) was established last year. One goal of the program is to transition new HAB forecasting approaches to operational use.

3.2. Surveillance systems for emerging pathogens, contaminants, and toxins that affect health

The OHWG stated that NOAA should be the lead agency for surveillance of ocean organism physiologic health, as well as mitigation of factors causing change in health. A formal interdisciplinary framework for ocean health should incorporate: 1) surveillance strategies for identifying novel diseases, biotoxins, contaminants, and emerging pathogens; 2) diagnostic laboratories to provide real-time processing of organism samples during mortality or morbidity

events, and 3) emergency response plans to address animal die-offs, reproductive failure, and, disease outbreaks.

Surveillance Systems: Strategies. NOAA, largely through the OHHI, has undertaken several recent activities and will continue and extend these as appropriate and practical depending upon funding. Examples include the following:

- As part of the Interagency Crosscutting Group on Climate Change and Human Health under the USGCRP, NOAA is leading development of the Monitoring, Early Warning, Data Integration and Surveillance System (MEDS) to provide a common comprehensive resource for integrating environment, marine and terrestrial animal, and human health data sources and meta information—but not actual data. This is intended to provide an overview of existing capacity across federal agencies and descriptions and points of contact for these data, improve the quality of climate and health research, and serve as a resource for the National Climate Assessment.
- One of the goals of the interagency One Health meeting, led by MMHSRP and OHHI through the IWG 4-H (also see NOAA Action 1.3), was to engage key partners to discuss roles and gaps in integrated disease surveillance.
- NOAA and CDC have ongoing discussions about information sharing and communication on marine emerging diseases (also see NOAA action 1.3). Further, they are working with the USGS and other partners to develop a framework for integrated surveillance for zoonotic disease threats. The collaboration also involved an international community of experts to assist in prioritizing pathogens of concern for surveillance.
- The Mussel Watch Program, working with the State of California, implemented a pilot project to integrate contaminants of emerging concern into Mussel Watch monitoring.
- A partnership between NOAA/NWS and DHSS' Department of Veterans Affairs, one of the largest health care providers in the United States, is being developed to deliver timely climate and weather information for integration with the DVA's health surveillance data.
- NOAA/NWS is working with the WHO to integrate climate and weather data into the WHO Global Information and Management System (GIMS) for managing health risks related to water sanitation and hygiene (also see NOAA Action 1.3).
- The NOAA OHHI is working through the GEOSS Health and Environment Team and with the WHO to integrate OHHI research and other relevant NOAA products into a Global Monitoring and Early Warning System for Cholera and related regional efforts for *Vibrios* and harmful algae.
- The five OHHI Academic Consortia for Graduate Training now support disease surveillance in sentinel marine species and are linking to terrestrial disease surveillance efforts in other agencies and international organizations.
- The OHHI recently established connections with the USAID's International Disease Surveillance Program.

To further engage state and local health agencies in strategies for health surveillance systems, NOAA is working with these health partners to plan several workshops to identify research, data, and operational needs and to support the National Climate Assessment. These include a Vector-

Borne Disease Workshop (July 11-15, 2011) to provide public health and vector control professionals with training on existing weather and climate tools, data systems and technologies, and to identify information requirements (co-led by the National Center for Atmospheric Research [NCAR], NIH, CDC, and OHHI). A Workshop on Water-Borne Diseases and Climate, led by OHHI, NIH, and the University of Maryland, is planned for summer 2011. Two complementary regionally focused workshops in Chesapeake Bay and Puget Sound are planned for summer and fall of 2011, with the goal of developing comparative Integrated Monitoring and Surveillance pilots to identify best observations to integrate into warning systems for harmful algal blooms and pathogens. These comparative pilots and workshops are led by Maryland and Washington Departments of Health, the CDC, and NOAA OHHI, and they will involve many other parts of NOAA and other federal and state agencies.

Surveillance Systems: Diagnostic Laboratories. While the support of diagnostic capability within NOAA remains limited, specific activities have been undertaken or are under consideration:

- The OHHI is refining a marine genomics tool that has diagnosed Leptospirosis infection versus domoic acid toxicity in California sea lions with 98% accuracy. This approach has potential application for development of diagnostic capacity for human cases.
- NOAA researchers have identified transcriptomic markers that offer promise for improving diagnosis of ciguatera exposure. The scientists are working with collaborators at the CDC, FDA, Woods Hole Oceanographic Institution, University of Maryland, University of Florida and others organizations, to investigate human exposures to Caribbean ciguateras.
- The MMHSRP is working collaboratively with multiple agencies, including CDC and states, on the development of tools for surveillance for specific pathogens of concern to the public and environmental health communities.
- NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) has leveraged a project to develop and refine sensor technologies for rapid identification of microbial contaminants in coastal waters into a partnership approach involving a private company, a private non-profit (MBARI), a state entity (SCCWRP), three academic institutions, and other NOAA offices.
- NOAA received FY10 funding to support the development of marine sensors for use in ocean health early warning systems. Several of these ongoing projects will help address diagnostic needs.
 - Remote assessment tools for detection of ocean health risks using the bottlenose dolphin as a marine biosensor (conducted by researchers at the University of Connecticut, NMFS Southwest Fisheries Science Center, and Mote Marine Laboratory in partnership with the Chicago Zoological Society).
 - Application of a toxicogenomic endpoint for improved speed and specificity of regulatory coastal sediment toxicity testing (Southern California Coastal Water Research Project).
 - Hand-held field equipment for detection of zoonotic pathogens (Caltech, University of California, Davis)

- Sample preparation and purification and probe development and validation for the Environmental Sample Processor
- Refine and deploy domoic acid field test kit and implement its use for detection of domoic acid in marine mammals
- Hand held, field deployable sensors for HAB organisms, *Karenia* and *Pseudo-nitzschia*
- Genomic barcoding for identifying marine pathogens and harmful algae
- Development of saxiphilin-based assay for paralytic shellfish poisoning toxins for use on autonomous subsurface sensors

Surveillance Systems: Emergency Response Plans for Die offs and Disease Outbreaks.

An unanticipated need for NOAA to respond to human, as well as animal, health issues came in the form of the DWH oil spill in April 2010, just a month after the OHWG reported out to NOAA's SAB. NOAA's weather forecasts, oil trajectory modeling, fisheries closures, seafood safety protocols, environmental sampling, and many other aspects of the agency's response contributed significantly to the protection of human life and health. In addition, NOAA's OHHI made important contributions to seafood safety discussions, the sharing of information with NIEHS for a major long-term study of the health of oil spill responders, a broad range of collaborations with other agencies and the academic research community, development of plans for post-spill tracking and assessment of marine mammal health and its potential implications for human health, and numerous other activities.

On another front, as part of the collaboration mentioned earlier between NOAA (MMHSRP, OHHI, NWS), CDC, and others on identifying and communicating emerging zoonotic disease risk, an effort is underway to more effectively communicate likely human health risks associated with marine disease outbreaks to emergency response workers as well as impacted communities.

3.3. Climate change effects on ocean-related health

The OHWG suggest that “NOAA should identify the ocean-related health impacts from climate change, anticipate their potential consequences, and develop prevention, mitigation, and adaptation measures. In addition ... NOAA should also characterize the impacts of climate change on water supplies, which are intricately tied into healthy communities and ecosystems.”

Climate change impacts on ocean condition and health threats are growing areas of interest throughout NOAA. For example, the NWS has a continuing and increasing emphasis on water resources and drought prediction. One of the eight major science challenges identified at the NOAA Science Workshop held in April 2010 is to “*improve understanding of the water cycle at global to local scales to improve our ability to forecast weather, climate, water resources, and ecosystem health.*” This challenge was included in the NGSP as well, demonstrating the long-term commitment of NOAA to this area, including the effects of climate change. Another Science Workshop challenge also incorporated into the NGSP is to “*understand and characterize the role of the oceans in climate change and variability and the effects of climate change on the ocean and coasts, including biological, chemical, and geophysical effects (e.g., sea level rise, ocean acidification, living marine resources)*”. Within OAR and elsewhere in NOAA, impacts of ocean acidification are receiving increasing attention. A few other examples of developing activities include the following:

- The OHHI is working with the WHO to address climate-related vulnerability of water sources and sanitation systems and the human health risks anticipated to be associated with such vulnerabilities (also see NOAA Action 1.3). This project may expand to address water quality as well through participation of academic partners at the CEGLHH.
- In South Carolina, the HML OHH Center is running climate change scenarios in its stormwater run-off model to begin examining potential interactive effects of climate change and coastal development on health of coastal ecosystems, including humans.
- A study at the West Coast Center for OHH is underway in Puget Sound to understand the environmental and climate conditions that may significantly accelerate the growth of harmful algal blooms and accumulation of paralytic shellfish toxins.
- NOAA will be addressing a broad range of ecosystem condition/human health issues through implementation of the National Ocean Policy, including but not limited to Coastal and Marine Spatial Planning.

3.4. Health benefits from the sea

Although this area is of significant interest to several offices in NOAA, including the OHHI, we have been relatively limited in our ability to undertake new efforts due to funding restrictions. Nonetheless, safe, high quality seafood is a continuing area of emphasis for NOAA, as particularly demonstrated by our agency-wide response to the DWH oil spill. In addition, the OHHI has funded a few extramural projects focused on marine natural products (e.g., targeted toward discovery of bioactive molecules that could potentially be the basis of new pharmaceuticals). To gain maximum leveraging for the limited funding available to invest in this area, the OHHI recently joined the multi-agency ICBG led by the NIH's Fogarty International Center. NOAA participates actively in the program's Technical Advisory Group which is comprised of representatives of the five agencies and seven NIH Institutes that support and oversee grants to the non-federal community. Beyond their important natural product discoveries, four of the ICBG grants exploring marine organisms have resulted in the development of marine conservation zones or protected areas at the national level in Fiji, Madagascar, Philippines, and Costa Rica. In addition, the OAR is now supporting a new Cooperative Institute for Ocean Exploration, Research, and Technology that is likely to include some biodiscovery work as well.

Summary and Conclusion

NOAA is pleased to have this robust guidance from the Science Advisory Board and is actively addressing each of the recommended actions. Given the timing of the delivery of this report to NOAA, and our strategic planning cycle, we were successful in getting explicit language about one health or human health in two of the four NSGP goals and securing a \$1M budget increase for the OHHI. We successfully re-invigorated an informal NOAA-wide programmatic group of approximately 40 people throughout the agency who work on human or marine animal health programs or projects. Largely through efforts of the OHHI and with active engagement from NWS, NESDIS, and NMFS, NOAA has collectively strengthened our partnerships with other health agencies, especially State Health Departments, the Centers for Disease Control, the NIH/NIEHS, and the World Health Organization. We have continued or undertaken numerous specific projects in the areas recommended by the OHWG for the near-term. In the

unprecedented circumstances of the Deep Water Horizon Oil Spill, the NOAA Fisheries' Marine Animal Health Stranding and Response Program was among the first NOAA programs to respond to oiled marine mammals and sea turtles. Through its academic network and internal Centers of Excellence, the OHHI was able to help NOAA deal with both marine animal and human health concerns raised throughout the oil spill response, and is now engaging regularly with the NIH in follow-on studies about risks to health of marine animals and humans. In addition, there is active engagement on One Health issues across the agency, and we continue to build partnerships with veterinary, wildlife, and public health researchers as well as decision-makers at local, state, regional, federal, and international levels. Depending on availability of funding, NOAA intends to support research to better characterize ocean health risks and benefits, including their economic context. Finally, NOAA is planning to use its existing OHHI as its "One Ocean, One NOAA, One Health" program coordination office. Our next step is for the OHHI to host a NOAA-wide workshop, tentatively planned for fall 2011, which will be focused on achieving additional improvements in coordination, visibility, integration, and budget planning for NOAA's health activities as envisioned by the SAB's Ocean Health Working Group.