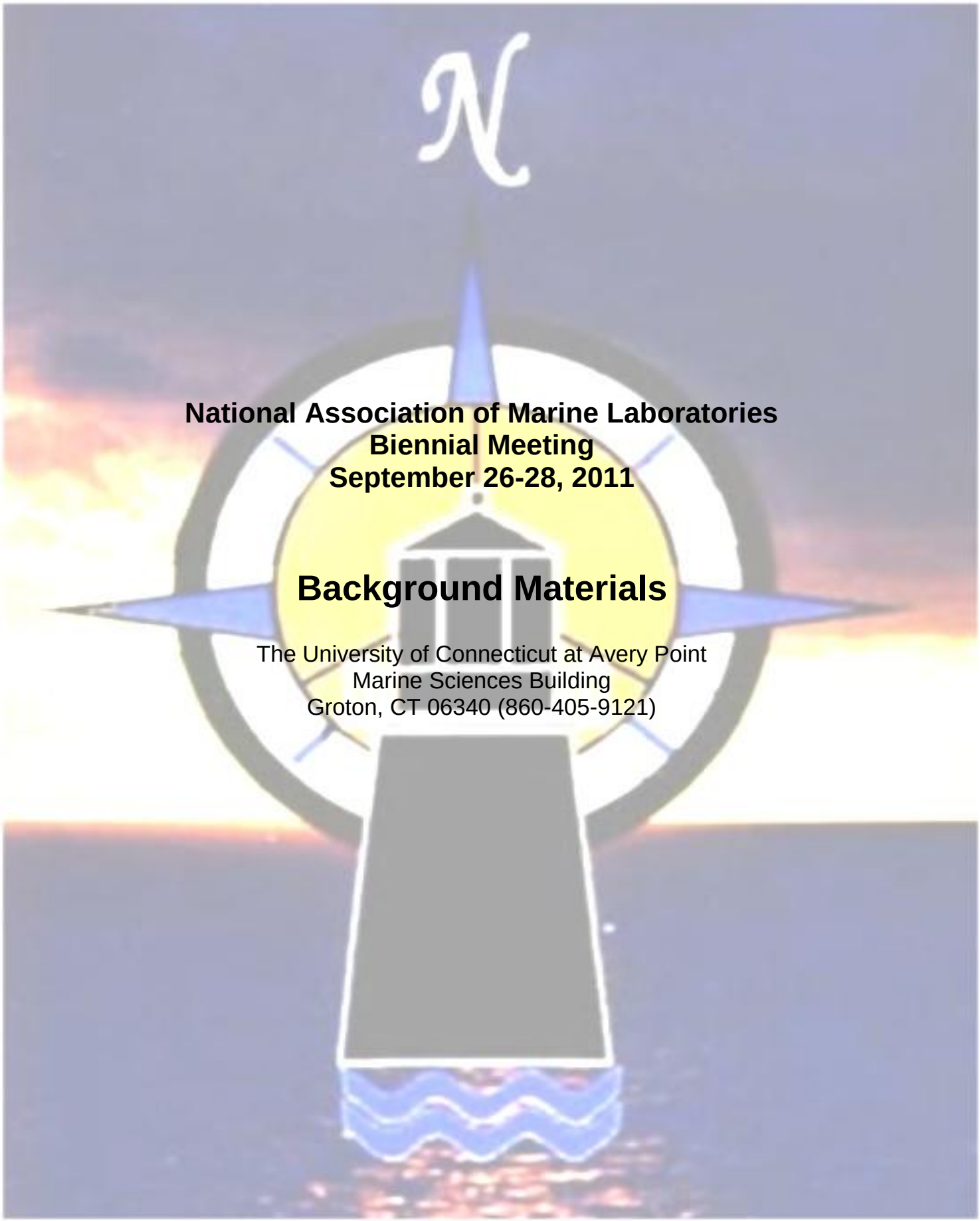
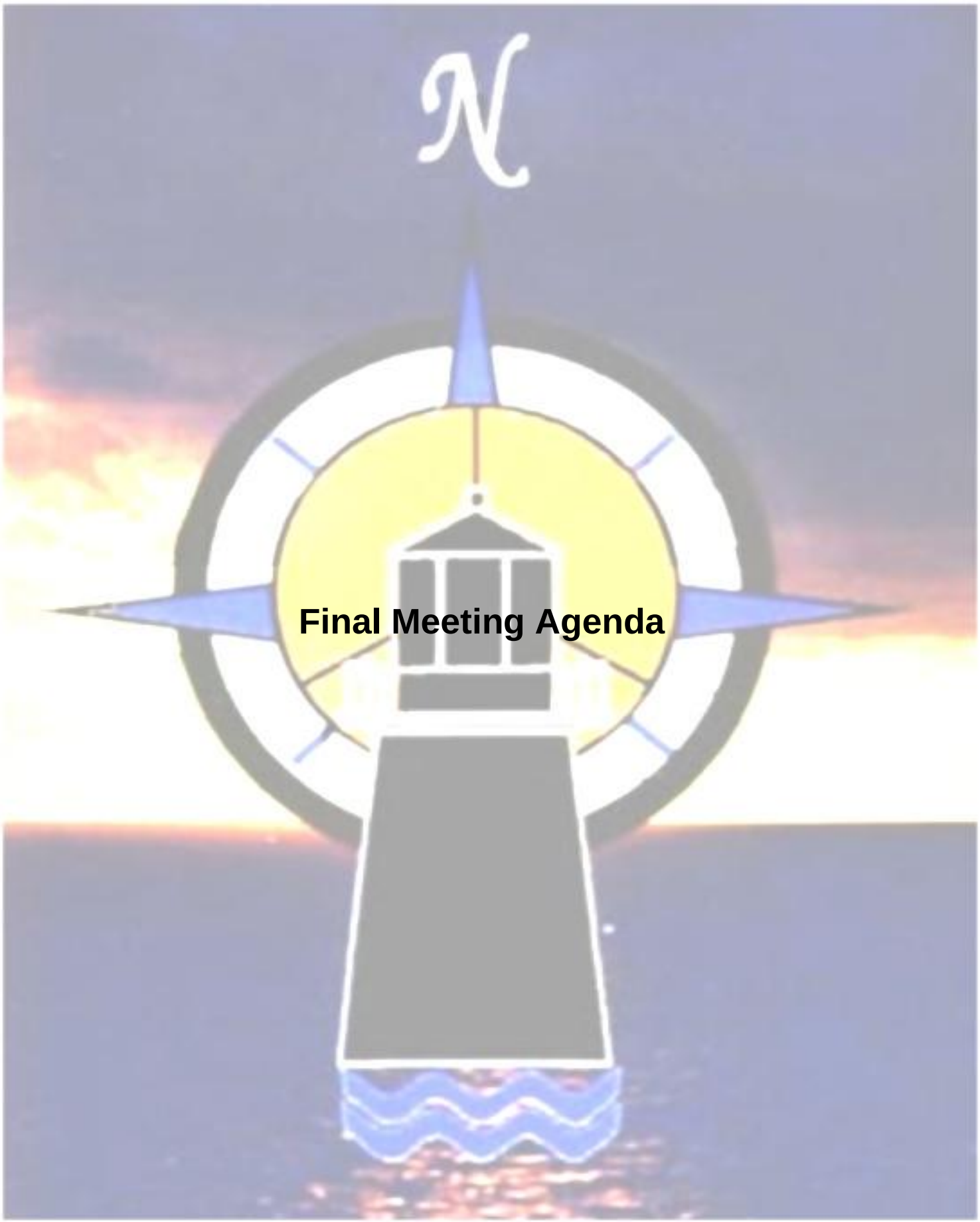


National Association of Marine Laboratories
Biennial Meeting
September 26-28, 2011

Background Materials

The University of Connecticut at Avery Point
Marine Sciences Building
Groton, CT 06340 (860-405-9121)


Final Meeting Agenda

NATIONAL ASSOCIATION OF MARINE LABORATORIES
BIENNIAL MEETING
UConn Avery Point Campus, Groton, CT
September 26-28, 2011

AGENDA

Monday, September 26th

1800 Reception - Go Fish Restaurant, Mystic, CT
1930 Dinner on your own (if needed)

Tuesday, September 27th

0800 Travel to UConn Avery Point – Please Carpool

0830 Continental breakfast – Room 312 Marine Sciences Building

0845 Review of Agenda/Logistics – Ivar Babb

0900 Welcome and Introductions – UConn President, Susan Herbst

0915 The National Perspective – Joel Widder and Frank Cushing, the Oldaker Group
Appropriations and Legislative Updates

1015 Update on National Ocean Policy and Discussion – Jerry Miller, Assistant Director for Ocean Science, Office of Science and Technology Policy

1115 Break

1130 NAML Public Policy updates and discussion of NAML's 2013 Public Policy Agenda – The Oldaker Group and Public Policy Committee

1215 Lunch on site

1300 NAML business meeting, Part 1
- Approval of minutes from last meeting
- Committees and reports
- Web update – Chris Dematos

1400 OBFS - NAML Workshop Update & Discussion – Ivar, Jim & Jo-Ann
- Overview & Attendees
- Discussion and Input on Research Priorities
- Discussion and Input on Infrastructure Needs

1500 Break for Tour of UConn Avery Point Campus

1630 Regional Breakout Meetings & Reception – Branford House

1730 New England lobster bake at the Branford House

2000 Travel back to hotel

Wednesday, September 28th

0745 Transport to UConn Avery Point

0800 Continental breakfast – Room 312 Marine Sciences Building

0830 Updates and Discussion of Like-Minded Organizations
- Labs 21 Marine Working Group – Ivar Babb,
- World Ocean Council – Jo-Ann Leong
- COL Scoping Effort - Ocean Leadership: Delivering the Next Generation of Ocean Sciences – Graham Shimmield and Ivar Babb
- Update and Discussion on the World Association of Marine Stations (WAMS) – Ivar Babb and Jo-Ann Leong

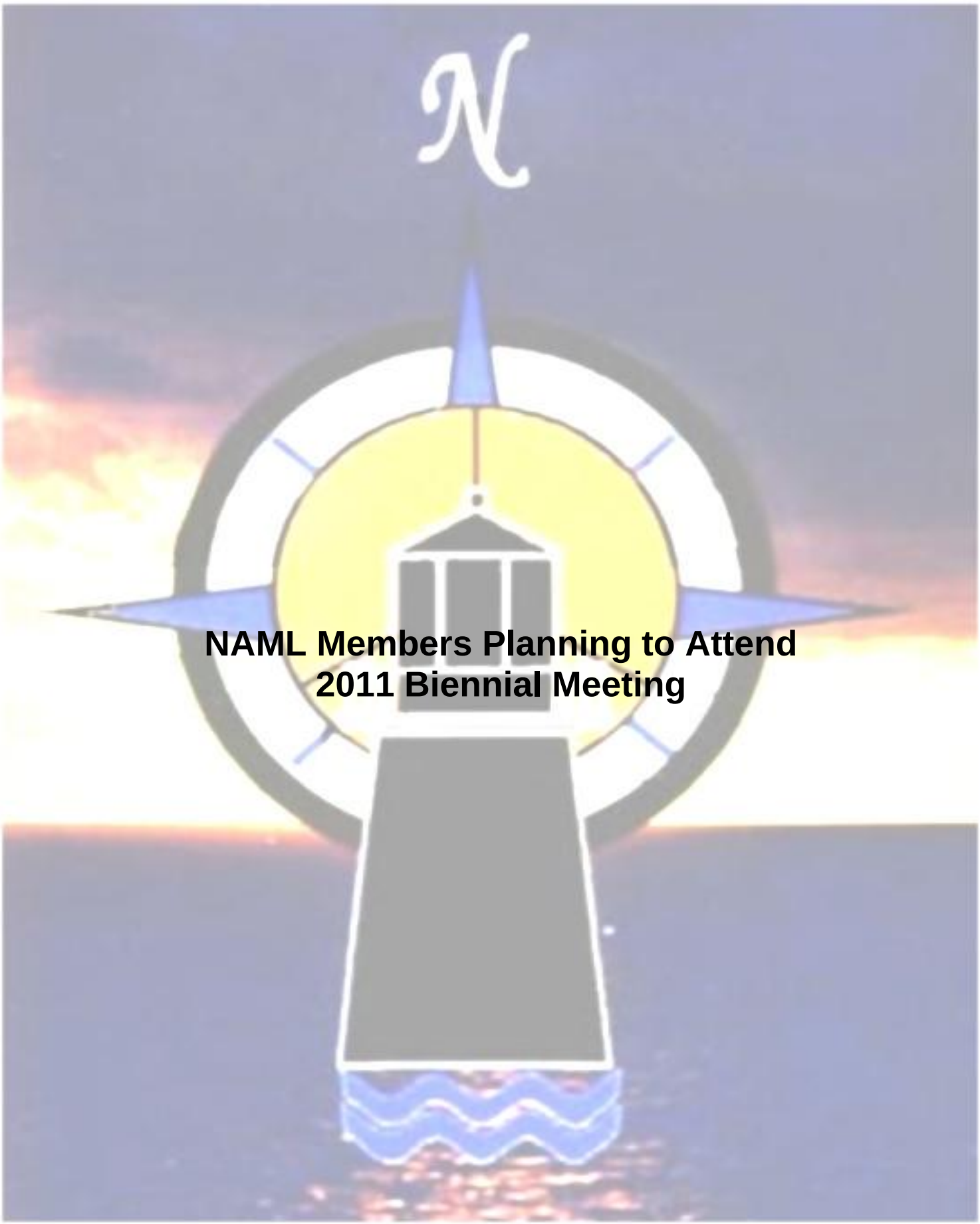
0915 Business meeting, Part 2
- Treasurer report – Alan Kuzirian
- 501c3 Update – Alan Kuzirian
- Regional reports – Regional Presidents
- Election of officers

1015 Break

1030 NAML Education Committee – Building Stronger Partnerships w/ COSEE – Matt Gilligan, Jim Yoder, Jan Hodder (via videoconference)
- Introduction to COSEE and COSEE's Partnership Working Group – Liesl Hotaling
- Roundtable of Best Broader Impact Practices with COSEE's and Marine Labs – All Lab Directors
- COSEE Community Meeting and Decadal Review Update
- Discussion of Future NAML-COSEE Collaborations

1200 Working lunch on site, recap "to dos", final thoughts and acknowledgements
Pass gavel to President-Elect

1300 Meeting adjourns



NAML Members Planning to Attend 2011 Biennial Meeting

NAML Members Planning on Attending 2011 Biennial Meeting

NAML Invitee	Email	University/ organization
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Yund, Paul	pyund@une.edu	University of New England

Appropriations Update
Joel Widder & Frank Cushing
The Oldaker Group

Budget Update Document

MEMORANDUM

Date: September, 2011
To: National Association of Marine Laboratories
From: Joel Widder, Frank Cushing, and Meg Thompson
Partners, The Oldaker Group

Subject: Budget Update – Covering FY 2011, FY 2012, and FY 2013

As the National Association of Marine Laboratories (NAML) prepares for its biennial meeting this month, the federal budget environment within which ocean and coastal research and education programs must operate is more challenging and more uncertain that at any time in recent history. To understand the challenges facing the ocean, coastal, and Great Lakes research and education community, requires an appreciation of the macro federal budget environment that surrounds the relevant agencies and programs. Below is a timeline or update on FY 2011 and FY 2012 funding to date followed by an update on the enactment and subsequent execution of the new Budget Control Act that will impact the completion of the FY 2012 process and funding possibilities in FY 2013 and beyond.

FY 2011

January 2011: The calendar year begins with the FY 2011 appropriations process incomplete with NSF, NOAA, NASA and every other federal agency operating under a continuing resolution (CR) at the FY 2010 level.

April 2011: FY 11 Omnibus Appropriations Act clears the House and Senate and is signed into law. This replaces the CR with actual agency funding levels for the rest of FY 2011. NSF is funded at $6.9 billion – about the same as the FY10 level. NOAA is funded at $4.5 billion – level with FY10 but about $1 billion below what they requested. The reduction is largely taken out of the NOAA's satellite programs. NASA science program are funded at $4.9 billion, also roughly level with FY 10. Agencies begin the process of allocating the funding finally provided down to offices and programs in the form of an operating plan. These operating plans are then submitted to OMB and then the Appropriations Committees for review and approval.

June 2011: NSF, NOAA, NASA, and most other agencies submit their operating plans. Agencies are reluctant to discuss the allocations they are proposing in these operating plans until the Appropriations Committees have a chance to review and approve the plans.

September 2011: Operating plans are approved for NSF and NOAA and most other agencies.

FY 2012

January 2011: NAML issues its FY12 public policy agenda and **begins advocacy efforts on behalf of the ocean, coastal, and Great Lakes research and education programs of relevant federal agencies**

February 2011: The Administration releases its FY 2012 budget request which includes substantial proposed increases for NSF, NOAA, and NASA research.

March 2011: NAML holds annual public policy meeting in Washington, D.C. and receives briefings and presentations from OMB, OSTP, NSF, NOAA, and the Staff Director of the House Commerce-Justice-Science Appropriations Subcommittee. Budget realities begin to set in.

May 2011: House Appropriations Committee sets overall spending level for FY 2012 providing the House CJS Subcommittee with an allocation for FY 2012 of $50.2B -- that is more than $3 billion (or 6%) **below the FY 2011 level and $7.4 billion or 13% below the level requested by the President**.

July 2011: House Appropriations Subcommittee marks up FY 2012 appropriations bill. The subcommittee is confronted with deep cuts to its overall allocation. As part of many budget reductions it must make within this allocation, the **House subcommittee recommends funding NSF at $6.9 billion – level with FY11. Subcommittee increases NSF research by $43M, reduces education and major research equipment and facilities below their FY11 levels. For NOAA, the House cuts many of NOAA's ocean and coastal programs below the budget request level while protecting weather-related programs. For NASA science, the Subcommittee recommends $4.5 billion, reduction of over one half billion dollars from the President's request.**

August 2011: Congress enacts and the President signs into law the new Budget Control Act which sets new overall discretionary spending limits for FY 2012 and out to FY 2021. Under the new BCA, Congress will initially have about $24 billion more to appropriate in FY 2012 (in total, defense and non-defense) than the House Appropriations Committee initially recommended in May 2011.

September 2011: Congress returns from August recess. Senate begins marking up their versions of FY 2012 appropriations bills, using the more generous overall allocation for total federal spending in FY 2012 in the new BCA. Senate CJS Subcommittee receives an allocation of $52.7B – an amount that is $2.5B more than their House Subcommittee counterpart is currently working with. **Senate CJS Subcommittee marks up and recommends ??????????.**

****

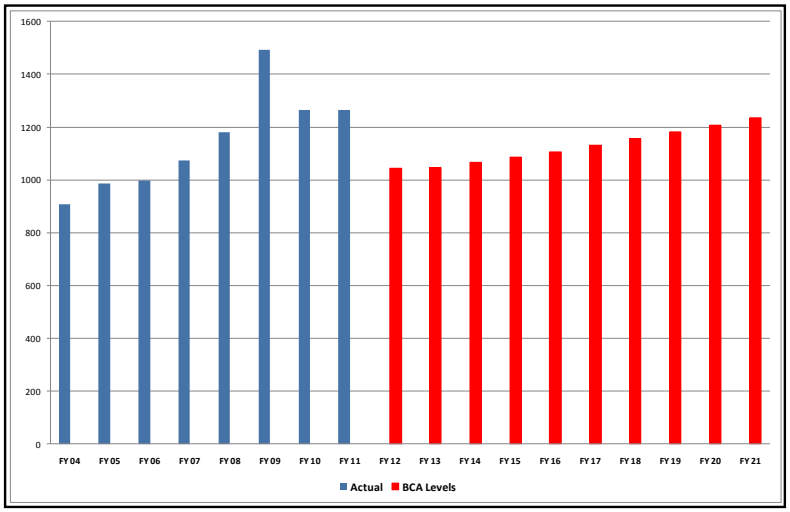
As this memorandum is written, we fully expect to begin the FY 2012 fiscal year under the terms and conditions of a continuing resolution (CR) as it is unlikely the House and Senate will finish their negotiations on FY 2012 appropriations matters in time for the start of the new fiscal year.

FY 2013 (and beyond)

On top of the FY 2012 appropriations process, it is important to appreciate the new Budget Control Act signed into law in August 2011 sets caps or statutory limitations, annually, on total discretionary spending for each of the next ten years – to FY 2021 -- as part of the overall effort to reduce the federal deficit.

The Budget Control Act is the result of the debt ceiling debate the White House and Congress engaged in all spring and summer.

Projected Initial Trends in Federal Discretionary Spending – per Budget Control Act Enactment



The Budget Control Act also set up a new joint House-Senate committee of 12 members who are charged with coming up with another set of actions to further reduce the deficit by another $1.2 trillion over the next ten years.

This so-called "super-committee" is supposed to report out a deficit reduction package by late November that will receive an up or down vote in the House and Senate by end of this calendar year (2012). If the super-committee fails to report out their recommendations or they are not adopted by the Congress, then in January 2012 a series of additional automatic cuts will fall on the discretionary spending side of the federal budget with estimates ranging to another 6 to 9% annually in cuts on top of the cuts already made and shown in the discretionary spending chart.

Discretionary spending is declining markedly in FY 2012 and is projected to, at best, grow only by inflation – under the most optimistic assessments one can find. Moreover, from within the discretionary spending category of the federal budget this country is going to be asked to support everything from the military to counter terrorism to law enforcement to elementary and secondary education to environmental protection to natural resource management to health research to science and technology and higher education.

Competition among those different interests has always existed but while that competition has been ongoing in prior years, the budget for discretionary spending overall has grown. Now we are faced with an environment where these national interests are going to compete within a **shrinking** budget category. It is one thing to advocate successfully when overall budgets are growing – it is a whole other kind of challenge when the overall spending bottom line is at best maybe keeping pace with inflation.

The annual decision making process to divide up what is available for ocean, coastal and Great Lakes research and education and everything else within the caps or statutory limitations on total federal discretionary spending will be made partly by the Administration (i.e. the White House and relevant agencies] and partly by the Congress – mainly within the relevant appropriations subcommittees that oversee relevant agencies and departments. That annual decision-making process is going to ultimately determine how much and where this Nation decides to invest its public resources – whether it be NSF, NOAA, NASA, law enforcement, transportation, etc.

Conclusion

The federal government is going to spend about $1 trillion annually on discretionary programs each year for the foreseeable future. Each year decisions will be made on how to distribute that $1 trillion among all sorts of important and competing agencies and programs. It will be very important for those concerned about the future of ocean, coastal and Great Lakes research to collectively elevate its advocacy efforts to ensure that we do everything we can to communicate the value and

contribution of such research and education to the health and vitality of our ocean and coastal economies.

National Ocean Policy Priority Outlines

See Appendix One

NAML 2012 Public Policy Agenda

FY 2012 PUBLIC POLICY AGENDA

The **National Association of Marine Laboratories (NAML)** *is a nonprofit organization representing the ocean, coastal and Great Lakes interests of about 120 member laboratories that employ more than 10,000 scientists, engineers, and professionals nationwide. NAML labs conduct high quality research and education in the natural and social sciences and translate that science to improve decision-making on important issues facing our country.*

Recommendations for a Robust Ocean Research & Education Enterprise

The Role of Marine Laboratories in the Nation's Research and Education Enterprise

Marine and Coastal laboratories are vital, cost-effective, community based "windows on the sea". They connect communities with cutting edge marine, coastal and social sciences, providing many thousands of students and citizens nationwide with meaningful, science-based learning experiences

The member institutions of the National Association of Marine Labs (NAML) work together to improve the quality, effectiveness and relevance of ocean, coastal and Great Lakes research, education and outreach. NAML labs provide reliable and relevant information to support wise local coastal management and the understanding and protection of natural resources. In particular, NAML seeks to:

- Promote and support basic and applied research of the highest quality from the unique perspective of coastal laboratories.
- Encourage wise utilization and conservation of marine and coastal habitats and resources using ecosystem-based management approaches.
- Recognize, encourage and support the unique role that coastal laboratories play in conducting education, outreach, and public service.
- Promote the efficient exchange of information, constructive cooperation, and productive coordination among NAML member institutions and across regional associations.
- Facilitate and coordinate the exchange of information and utilization of expertise between NAML member institutions and government agencies.

Oceans, Coasts, and Great Lakes Are Important for the Nation

Ocean-related activities contribute more than $117 billion to American prosperity and support well over two million jobs. Activities in coastal watershed counties extend this value dramatically to more than $4.5 trillion, or one-half of the Nation's GDP, accounting for 60 million jobs. Every year hundreds of millions of people visit America's coasts, spending billions of dollars and directly supporting millions of jobs, making coastal tourism one of the Nation's fastest-growing business sectors.

Meeting the Nation's stewardship responsibilities for the oceans, coasts, and the Great Lakes requires a robust ocean science and education enterprise. Increasingly, our coastal areas are facing challenges that threaten our fisheries resources, impact recreational and commercial values and change fundamental ecosystems. The Deepwater Horizon-British Petroleum oil spill in the Gulf of Mexico and its continuing impact on the natural resources of the region emphasizes the Nation's need for a robust ocean and coastal sciences enterprise. NAML believes that maintaining our nation's scientific leadership will be essential if we are to re-energize the economy and get Americans back to work. It is vitally important that we reinvest in the national research enterprise that has been responsible for our long-term prosperity and technological preeminence. Because they are so strongly inter-disciplinary, the marine sciences have often led the way in innovation. The ocean sciences span a landscape of disciplines, from physics to geology, chemistry to biology, engineering to social sciences, and modeling to observation.

The National Ocean Policy for the Stewardship of the Ocean, Coasts, and Great Lakes was established on July 19, 2010 by executive order. It calls for the best available science and knowledge to inform decisions affecting the ocean, our coasts, and the Great Lakes and foster the public understanding of the value of these resources. Marine Laboratories can contribute to this effort because they stand at intersection of scientific endeavors and public outreach. The NAML public policy agenda seeks to enhance the efforts of Marine Laboratories to conduct science and foster wise stewardship of these oceanic, coastal, and Great Lakes resources.

NAML's Public Policy Priorities

OCEAN, COASTAL AND GREAT LAKES RESEARCH

Federally-funded, peer-reviewed extramural research support ensures that the federal science enterprise benefits greatly from its extramural partnerships with the vast and diverse talents of the academic research community. The America COMPETES Act (Public Law 110-069) was enacted in 2007 to stimulate U.S. innovation and competitiveness through investments in the science, technology, engineering and mathematics (the "STEM disciplines"). As the Nation seeks to boost its economy, NAML strongly supports the reauthorization of this important legislation coupled with the appropriations essential for a sustained interagency investment in our nation's marine research and education enterprise.

In a time of change, it is critically important that the research budgets at the major federal science agencies — namely the National Science Foundation, the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration(NASA), the Department of Energy (DOE), the Environmental Protection Agency (EPA), the NIH's National Institute for Environmental Health Sciences (NIEHS), and the Department of Interior (DOI) — be strengthened to the maximum extent possible. Programs that enhance agency internal research capabilities and engage the extramural community in competitive, merit-based research provide highly cost-effective returns on investment and distribute economic and societal benefits over a broader array of communities.

National Science Foundation -- NSF funds vital basic research that enhances the public understanding of the Nation's oceans, coasts , and Great Lakes. Over 90 percent of NSF's budget directly supports research at universities and laboratories in all 50 states. A robust NSF fuels the economy, boosts competitiveness, supports a scientific and technologically literate workforce and provides new knowledge -- all of which are essential for national security and economic competitiveness. NAML supports proposals to double the NSF budget in the context of the America COMPETES Act. Marine labs believe that science and engineering research, education, and related infrastructure support provided by NSF should be viewed as a wise and priority investment for the long term health of the Nation.

National Oceanic and Atmospheric Administration -- NOAA is a critical leader in ocean, coastal and Great Lakes research and many NAML labs are co-located with, or linked to, NOAA laboratories. NOAA's extramural support for research at marine labs and universities greatly expands its access to world-class expertise and unique facilities, complementing and expanding the work carried out within NOAA labs. NOAA's extramural partnerships contribute invaluable information to our coastal resource managers. NOAA's internal and partnership education activities are also of vital importance to the communities that NAML serves.

NAML strongly recommends that the Administration and Congress maintain and, if possible expand NOAA support. In particular, NOAA's competitive, peer-reviewed programs including: the National Sea Grant College Program; the Ocean Exploration and National Undersea Research programs; the National Estuarine Research Reserve System; the Competitive Research Program within NOAA's Climate Program Office; and the more directed cooperative institute programs, are highly cost effective partners that greatly expand NOAA's capabilities. A robust NOAA budget, as recommended by the Friends of NOAA Coalition, coupled with solid support for extramural partnerships will greatly strengthen NOAA's ability to serve pressing national needs.

National Aeronautics and Space Administration - A balanced investment in NASA that will maintain a strong and vibrant earth and space science enterprise is critical, especially as priorities shift and research foci adapt to emerging issues like climate mitigation and adaptation. NASA's support for earth observations and research is vital in helping us better understand our planet and its processes.

Department of Energy -- DOE, through its Energy Efficiency and Renewable Energy division, has initiated significant efforts to understand and develop sources of renewable marine energy from tidal, wave, and current sources. Environmental effects and conflicts with existing ocean uses must be evaluated as these energy sources develop in U. S. coastal areas. The Nation's marine laboratories are uniquely distributed and serve as ideal locations for much of the research needed to rationally develop this energy source and opportunities to partner with the Department in these areas should be strongly encouraged.

Environmental Protection Agency -- EPA is an important source of support for marine laboratories and EPA's own labs are a critical part of the marine science community. EPA's Office of Research and Development and Office of Water provide essential resources to marine labs nationwide, funding research grants in various environmental science and engineering disciplines and engaging the Nation's best scientists and

engineers in targeted research complementary to EPA and other federal research activities. Unfortunately, support for research has declined dramatically over the past several years, and the EPA's Science Advisory Board has called for renewed investments. Given the emerging importance of issues related to global climate change, enhanced support for research programs at EPA will be essential in helping us to mitigate and adapt to environmental change.

National Institute for Environmental Health Sciences -- NIEHS, within the National Institutes of Health, supports important research via the Oceans and Human Health (OHH) program, a joint initiative with NSF. Ocean-related human illnesses are primarily caused by consumption of contaminated seafood, and additionally caused by inhalation of aerosolized toxins as a consequence of harmful algal bloom (HAB) outbreaks. Adverse health outcomes range from acute neurotoxic disorders to more chronic diseases such as liver disease caused by shellfish poisoning. Presently it is not known what is responsible for or triggers outbreaks of HABs. Methodologies for early detection or remote sensing of outbreaks would provide a major mechanism for reducing and preventing exposures to marine toxins released by HABs. Additionally, worldwide, human activities associated with point and non-point sources of pollution result in the discharge of billions of gallons of wastewater into oceans and coastal waterways. OHH and other NIEHS activities, such as the recently initiated study to assess the health effects of the Deepwater Horizon-British Petroleum oil spill in the Gulf of Mexico are of critical importance to the Nation and should be strongly supported.

Department of Interior -- DOI is an important federal player with respect to the ocean and coastal community. Through the research supported and conducted by the U.S. Geological Survey (USGS) via the Coastal and Marine Geology program or the support provided by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) through the Coastal Impact Assistance Program, USGS and BOEMRE need sound marine science to inform the management of ocean and coastal resources.

EDUCATION, DIVERSITY AND AN OCEAN LITERATE AMERICA

American students are in danger of being eclipsed by their peers in other industrialized countries. The U.S. has taken notice and ocean literacy and workforce diversity have become a focus of discussion at the federal level and throughout the environmental community thanks to a number of watershed events over the last several years. This includes the 2004 U. S. Commission on Ocean Policy report, which made recommendations about the importance of education and public awareness (literacy), the 2007 National Academy of Sciences report, *Rising Above the Gathering Storm,* and the 2010 update, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5,* which fueled the development of the America COMPETES Act. This legislation places a high priority on formal and informal education in science across the government, including a mandate for NOAA's and NASA's education programs. In September 2010, the President's Council of Advisors on Science and Technology (PCAST) released an important new report, *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future*, which makes specific recommendations to better prepare America's K-12 students in STEM subjects.

Engaging the demographically large sector of individuals from groups that have been historically underrepresented in ocean science research education and outreach (e.g., African Americans, Hispanic Americans, Pacific Islanders, and Native Americans) from a wider variety of colleges and universities in programs at marine laboratories and oceanographic institutions will be particularly important in filling the STEM pipeline for future ocean workforce needs.

Marine laboratories play an important role in formal education and workforce development by providing students with a place to learn, using a hands-on approach. Marine labs serve as primary training grounds for experiential ocean education and are committed to enhancing diversity within the field of ocean, coastal and Great Lakes research and education. By fostering relationships with community colleges and minority-serving institutions (MSIs), marine labs provide distinctive learning opportunities for underrepresented groups, allowing students to achieve a greater understanding of oceans and coastal ecosystems and providing them with a sense of stewardship for these important environments.

NAML and its member laboratories continue to strongly support partnerships with the Federal Government to address the ocean education needs of the Nation. Examples include the Centers for Ocean Science Education Excellence (COSEE), the Louis Stokes Alliance for Minority Participation, and the Research Experiences for Undergraduates programs at NSF, the Expanding Partnerships Program (EPP) in the NOAA Education Office, the Ocean Exploration and National Undersea Research programs, and National Sea Grant

College Program within NOAA, and the Science to Achieve Results (STAR) Fellowship program at EPA. Environmental literacy ensures that the American public is equipped with a fundamental understanding of natural systems and an appreciation for the relationship between human activities and the environment.

Investment is needed today in coastal, ocean, and Great Lakes education programs that support learning—both formal and informal—at all age levels, by all disciplines, and for all Americans.

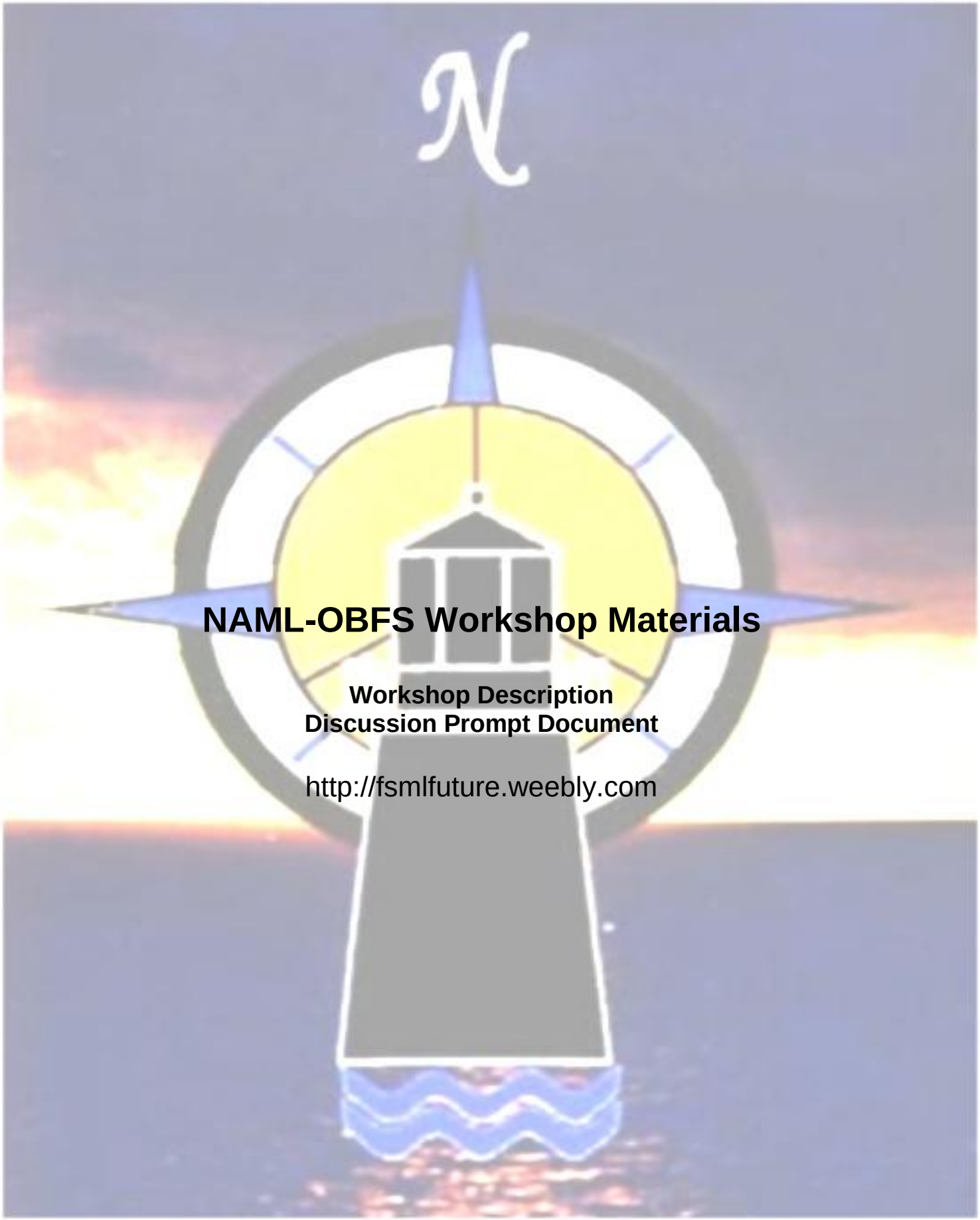
SUSTAINABLE OCEAN INFRASTRUCTURE

Support for infrastructure and instrumentation – including long term planning for the next generation of research infrastructure – is essential to the operation of marine labs and to the advancement of the research and education enterprise. NSF in particular provides essential support for basic laboratory facilities, instrumentation, support systems, computing and related cyber-infrastructure, and ship access through its Major Research Instrumentation (MRI) program and the Field Stations and Marine Laboratories (FSML) program. In addition the Ocean Observatories Initiative (OOI) at NSF and the Integrated Ocean Observing Systems (IOOS) initiative at NOAA will provide vital infrastructure support for coastal and ocean observing.

However, there is an urgent need for significantly enhanced infrastructure investments at all scales, from traditional systems such as laboratory improvements and modernization, ships, observation systems, and satellites, to the next generation infrastructure and technology that enable genomic, proteomic, robotic, nanotechnology, and other advanced computational approaches. As federal support for research and education undergoes increased scrutiny, support for research infrastructure and instrumentation must not be neglected. Finally, NAML strongly supports Congressional calls for NSF to examine the need for a mid-scale instrumentation program and the development of an initiative that responds to that identified need. Such a provision is included in the legislation reauthorizing America COMPETES.

For more information, please visit www.NAML.org or contact:

Ivar Babb, NAML President, 860-405-9121; ivar.babb@uconn.edu



NAML-OBFS Workshop Materials

Workshop Description
Discussion Prompt Document

http://fsmlfuture.weebly.com

Building the Field Stations and Marine Laboratories of the Future

A Workshop Hosted by the National Association of Marine Laboratories and the Organization of Biological Field Stations

Colorado Springs, Colorado Nov. 17-18th, 2011

Purpose The National Association of Marine Laboratories (NAML) and the Organization of Biological Field Stations (OBFS) will co-host a workshop as part of strategic planning for the future of field stations and marine laboratories (FSML's). Wisely using limited resources for research requires understanding the potential scientific payoffs of investing in different aspects of the infrastructure of FSMLs and ensuring that they are well managed. Additionally, because FSML's stand at the forefront of detecting and understanding long-term environmental change, investments in FSML's need to maximize long-term scientific productivity. The workshop will bring together a diverse set of scientists, directors of FSML's, educators, and conservation stewards to identify the role FSML's play in addressing critical emerging issues. The workshop will also set the stage for NAML and OBFS to identify the infrastructure investments that need to be made in FSML's to meet these emerging trends in research, education, and resource management. Furthermore, the strategic planning and workshop will seek to identify the mechanisms by which FSML's promote synergies among research, education, and management. Steering Committee for Strategic Planning The steering committee consists of 7 individuals. **Ian Billick**, 2010-2012 OBFS President and RMBL Executive Director, chairs the committee. Other members include: **Ivar Babb** 2010-2011 NAML President and Director of the University of Connecticut's National Underwater Research, Technology and Education Center; **Brian Kloeppel**, 2010-2012 OBFS Past President and former Director of the Coweeta Long-Term Ecological Research Program; **Jo-Ann C. Leong**, NAML President-elect 2010-2011 and Director of the Hawaii Institute of Marine Biology; **Jan Hodder**, OBFS Past President and WAML board member, faculty member at the Oregon Institute of Marine Biology; **James Sanders**, NAML Past President 2010-2011 and Director of the Skidaway Institute of Oceanography; and **Hilary Swain**, OBFS Past President and Director of the Archbold Biological Laboratory. Workshop Outcomes The primary outcome of the workshop will be a written report summarizing the role and needs of FSML's to address emerging issues in research, education, and resource management. Specifically, the report will include, though not necessarily be limited to:

1. An overview of the promising areas of research, education, and resource management that are best addressed by the FSML community; 2. Recommendations concerning additional information needed to assess the current capability of FSML's in meeting emerging issues; 3. Preliminary recommendations concerning the investments in FSML's infrastructure that will yield the greatest returns in terms of research, education, and management, including recommendations concerning collaboration and networking among FSML's. Workshop Organization The purpose of the workshop will be to facilitate dialogue and constructive engagement leading to input that informs a workshop report. There will be five breakout work groups, each focused on different research areas: ***Molecular Biology and Genomics***,

Ecosystem Dynamics, ***Macrosystems***, ***Organismal and Population Biology***, and ***Environmental Change***. Each of the work groups will be charged with examining the issues identified in the section on Workshop Outcomes, noted above, through the lens of their conceptual focus. Research, education, management, and the coupling of human and natural systems will be cross-cutting themes within each of the work groups. Participants will be provided with background information on the research areas in advance of the meeting and short stage-setting talks will be used to initiate conversation. The focus, however, will be on active engagement among the participants concerning the relationship between FSML's and emerging trends. The final workshop agenda will be established by the Program Committee, consisting of the Steering Committee, the Work Group Chairs (see below), and Andrew Robertson (Chief Science Officer of Keystone Symposia). Participants Each Work Group will be chaired by an individual chosen by the Steering Committee. These individuals will be recognized leaders in their field who have scientific strengths relevant to, and connections with FSML's. Additionally, they will be appreciative of the couplings between research-education and research-conservation. Group leaders will have strong communications and organization skills. Work Group Chairs have been chosen and can be viewed by clicking here. Workshop participants will be chosen jointly by the Steering Committee and the Work Group Chairs. A solicitation for workshop participants will be issued in early June via the NAML and OBFS list serves. Participants will be selected based on their experience and ability to speak to the role of FSML's in the conceptual area within which they are assigned. Participants will be chosen based upon their ability to link emerging issues in research, education, and resource management, to FSMLs. In order to have productive conversations that efficiently ground emerging trends in the realities of FSMLs, participants will include individuals with active research programs, individuals who actively integrate research with education and resource management, and individuals with an understanding of field station operations. Participants with a strong working knowledge of FSMLs will be chosen to expand the diversity of types of institutions participating in the workshop. Travel expenses of Work Group Chairs and Participants will be covered by NAML and OFBS by funding provided through the FSML program of NSF. Workshop Report The workshop report will be authored by the Steering Committee and the Workgroup chairs. A science writer will be responsible for generating an initial draft and incorporating feedback into the report. Before finalizing, a draft will be released to the larger scientific and FSML community for comment. Comments will be incorporated, as appropriate, into the final Workshop Report. Information For more information, contact Ian Billick, director@rmbl.org.

DISCUSSION PROMPTS FOR OBFS-NAML WORKSHOP
November 17-18, 2011

Background

The Organization of Biological Field Stations and the National Association of Marine Laboratories are conducting planning to ensure that field stations and marine laboratories (FSML's) are well-positioned for emerging issues in research, education, and resource management. Specifically, we plan on conducting a workshop and conducting a survey of existing facilities to address the following questions:

1. How important are FSMLs as scientific platforms for addressing critical emerging issues in research, education, and management?;

2. What are the most promising areas of research that could benefit from greater collaboration and networking amongst FSMLs?;

3. What components of FSMLs, e.g., living facilities, information technology, environmental sensors, laboratory equipment, research vessels, are most critical to meeting those emerging trends?;

4. What is the current status of critical infrastructure components at FSMLs?;

5. What investments in FSMLs will yield the greatest returns in terms of research, education, and management?

6. What are the critical best practices for management and operations of FSMLs to maintain the long-term value of FSMLs as long-term research platforms?

The workshop that we are hosting in Colorado Springs on Nov. 17th and 18th will focus on identifying emerging trends in the sciences for which FSML's need to be prepared. The emphasis will be on where science, education, and resource management is headed and the role FSML's have to play. Consequently the workshop will focus on the relationship between FSML's and emerging issues, scientific opportunities emerging from greater collaboration and networking among FSML's, and future priorities for investment. As a separate activity we will conduct a survey of existing facilities to assess the status of critical infrastructure. Additionally, we will address best practices for FSML's at a later time.

To initiate conversation, we have developed a set of prompts within each of the workgroups. We ask work group participants to work initially in a brainstorming mode, but then to rank enthusiasm for ideas into high, medium, low, as well as to identify ideas in which there is general agreement and ideas in which additional discussion is needed. This process should allow us to refine the agenda for the conference and make certain we are taking advantage of everybody's time when they come to Colorado Springs.

Work Group Prompts

What are the top ten emerging issues related to the work group or cross-cutting theme?

For which of those emerging issues do FSMLs have a role? Do FSML's play a primary or secondary role in those issues? What about FSML's make them critical to these emerging issues? If FSML's did not exist,

what science, educational activities, or resource management activities would not happen? What about FSML's are important to those emerging issues?

Is there transformational research emerging for which FSMLs will be important? What is the greatest opportunity for FSMLs to fuel transformational science?

How do activities at FSMLs translate to benefit for general society, for example in terms of public health, innovation, or improved decision-making concerning important resources?

[For Molecular Biology and Genomics]--- How important are field-based questions to molecular biology and genomics? What is the role of FSML's in facilitating molecular and genomic work in the field? What facilities are critically needed in the field (e.g., -80 C freezers) to bridge field systems and equipment in home institutions? Is there equipment that is cost ineffective to provide in the field?

[For Ecosystems and Macrosystems]--- As our ability to generate data from remote sensors, such as satellites and airplane-borne equipment increases, do FSML's become less or more important as sources of data? How important are FSMLs to ground-truthing data, or in integrating other human-collected observations or place-based sensors with remotely collected sensing data?

How important is the accumulation of knowledge about single locations, or place-based research, important to emerging issues? Is there value in having multiple research projects occur in single locations (e.g., FSML's), or would the value of the research be the same if individual projects were each to happen in different places?

To what extent do FSML's serve as opportunities for cross-pollination of ideas, across disciplines and institutions? Is that a common feature of FSMLs ? Is it an important feature?

[For Environmental Change]--- How important are FSML's in allowing scientists to detect and understand long-term change?

What role do sensor networks (including hardware, software, and statistical analysis) play in enabling FSML's to be sentinels of change?

Do FSML's provide unique collaborative or networking opportunities? Are those opportunities related to emerging or transformative issues? If they are related to emerging or transformative issues, please explain how. Are there other and/or more cost effective ways that collaborative or networking opportunities could be achieved without FSML's? Why or why not?

[For Macrosystems]—Are there geographic gaps in the distribution of FSML's that undermine our ability to answer important questions through FSML networks or collaborations?

Are FSML's currently configured to play their needed role for emerging issues, or are further investments needed? What is the importance of different types of infrastructure support, such as bandwidth, environmental sensors, data management, housing space, laboratory space, or high-end equipment (such as research vessels) to emerging issues?

If the accumulation of knowledge about single locations is important for emerging issues, what types of infrastructure is needed to maximize the value of place-based research? Would these be investments in data management, environmental sensors, or facilitating human engagement with the ecosystems?

Will the need to host scientists in the field increase, decrease, or stay the same? As it becomes possible to collect more data with automated sensors, will the need for a human presence in the field increase, decrease, or stay the same?

[For Pop and Organismal Biology]—How will new technology affect our ability to study population and organismal biology? Will FSML's be more or less important?

If no significant additional investments were made in FSML's, what research, education, or resource management activities would not happen? Would it matter if those activities did not happen? Why or why not?

Cross-Cutting Prompts

Resource Management

Within each work group, are there important field-based activities and/or knowledge that are contributing to to contemporary and potential future resource management challenges? Are there emerging issues within resource management for which FSML's will be critical? If so, why will they be critical?

Can each group develop a list of 3-5 specific, clearly articulated scientific questions for which FSML's are critical to addressing resource management issues? How important are those questions? Which issues are currently being addressed by FSML's and which have yet to be initiated? For projects which have yet to be initiated, what is needed to get those projects going? Are additional networks needed, including FSML's and/or partner facilities?

How important are FSML's to identifying resource management issues—e.g., the detection of a invasive species or the need to deal with land use changes?

Education

Do FSML's provide unique education opportunities? If so, what are those unique opportunities? Are they related to learning how to solve problems, collaborate, and/or be active scientists?

If FSML's did not exist, how would that affect the quality of education?

What is most important about education at FSML's? How important are characteristics such as the ability to interact directly with the environment, the immersive nature of the educational environment, and the ability to put students in a fresh setting?

Is there an educational audience for which FSML's are particularly important—e.g., K-12, informal adult science education, graduate training, or undergraduate training? If so, please explain.

International Institute for Sustainable Laboratories

Marine Lab Working Group Description

International Institute for Sustainable Laboratories (I2SL, http://www.labs21century.gov/)

Marine Laboratory Working Group

Current Lead: Phil Wirdzek

Coordinated by: I²SL

Working Group Projects

Learn about the activities of this working group

Working group members are committed to:

- Convening regularly to have discussions on marine laboratory projects, challenges, lessons learned, and strategies and finding ways to share this information with a broader marine laboratory community.
- Reviewing current sustainable marine laboratories and developing best practices for new and retrofit facilities.
- Identifying research needs and product development that could support development of sustainable marine laboratories.

Get Involved

The working group consists of and invites experts in marine laboratory design and engineering, consulting, facility management, operations, and ownership. Members are encouraged to contribute their technical expertise, facility information, and experiences.

If you would like to join the Marine Laboratory Working Group, please contact I²SL.

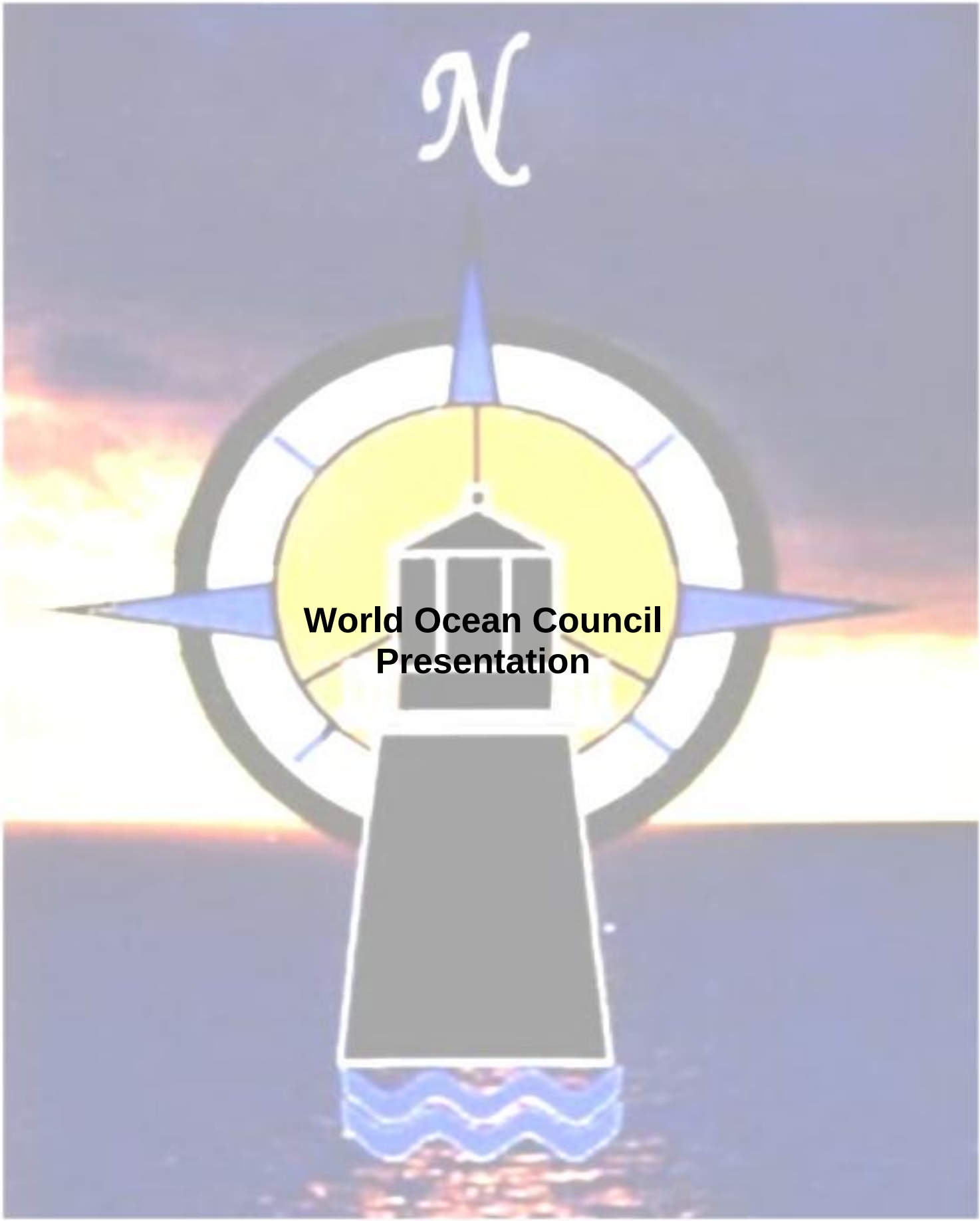
Working Group Activities

- The third call of the Marine Laboratory Working Group was held on April 26, 2011.
- The working group reviewed and commented on the benchmarking questionnaire developed after the last call, and will finalize and distribute the questionnaire in May 2011.

- The working group discussed the U.S. Virgin Islands Marine Research and Education Center (MREC) project and International Sustainable Laboratory Student Design Competition.
- The opportunity to tour the U.S. Environmental Protection Agency's Atlantic Ecology Division (EPA AED) Laboratory at the Labs21 2011 Annual Conference was also presented to the group.

- The second call of the Marine Laboratory Working Group was held on January 19, 2011. The working group discussed challenges for marine laboratory facilities around the world, which the group discovered tend to be similar no matter the location of the laboratory. The working group will aim to develop a marine laboratory questionnaire to find out more about the needs of this community and determine facility benchmarks. The next working group call will take place in Spring 2011.

This working group first convened on September 30, 2010, at the Labs21 2010 Annual Conference with a small meeting that covered a wide array of projects—from Canada's planned Arctic research station to the Marine Research and Education Center in St. Croix Virgin Islands. This group will hold regular calls over the next several months to discuss challenges and lessons learned on various marine laboratory projects.



World Ocean Council Presentation

The World Ocean Council
http://www.oceancouncil.org/site/

The World Ocean Council is an unprecedented international, cross-sectoral industry leadership alliance on "Corporate Ocean Responsibility".

The World Ocean Council (WOC) brings together the diverse ocean business community to collaborate on stewardship of the seas. This unique coalition is working to improve ocean science in support of safe and sustainable operations, educate the public and stakeholders about the role of responsible companies in addressing environmental concerns, more effectively engage in ocean policy and planning, and develop science-based solutions to cross-cutting environmental challenges that cannot be solved by one company or industry, such as: invasive species, ocean noise, marine mammal impacts, marine debris, the Arctic, and others.

The WOC is engaging a wide range of ocean industries, including: shipping, oil and gas, fisheries, aquaculture, tourism, renewable energy (wind, wave, tidal), ports, dredging, cables and pipelines, carbon capture and storage, as well as the maritime legal, financial and insurance communities, and others.

A growing number of companies and associations share the WOC vision of a healthy and productive ocean and its sustainable use and stewardship by responsible businesses. They are distinguishing themselves by becoming WOC Members and call on others to join them.

WOC MEMBERS

Corporate and Associate Members *as of 19 August 2011*

- Almi Tankers S.A.*
- A.P. Moller-Maersk
- Athens Group*
- BP
- Baird Publications
- Battelle Memorial Institute*
- Beveridge & Diamond, P.C.*
- Blank Rome*
- Center for Energy, Marine Transportation & Public Policy at Columbia University*
- Cruise Line International Association (CLIA)*

- Det Norske Veritas (DNV)*
- Eniram*
- EPJ Consulting*
- Exxon Mobil*
- FOB
- Global Trust Certification*
- Golder Associates*
- Heidmar, Inc.*
- Holman Fenwick Willan LLP*
- Hull Surface Treatment*
- International Chamber of Shipping (ICS)*
- Lloyd's Register*
- Nautilus Minerals, Inc.*
- North America Marine Environment Protection Association (NAMEPA)*
- Offshore Marine Group
- PanGeo Subsea*
- Professional Marine Explorers Society*
- RightShip*
- Rio Tinto*
- Shell
- Sinclair Knight Merz*
- Sustainable Oceans International*
- TORM USA*
- Transocean*
- Twin Dolphins*

* WOC Founding Member, i.e. joined 2009/2010

Consortium for Ocean Leadership Scoping Effort on Next Generation of Ocean Sciences

Scoping Group Charge

Consortium for Ocean Leadership
Ocean Leadership: Delivering the Next Generation of Ocean Sciences
A Working Group

endorsed by the Executive Committee, August 3, 2011

Terms of Reference for Ocean Leadership: Delivering the Next Generation of Ocean Sciences

Rationale. The Earth is known as the Blue Planet, simply because the global oceans dominate the features of the Earth. The ocean controls virtually all the essential processes that govern critically important systems vital to a planet that supports life, from productive food webs to a planetary hydrological cycle that controls weather and water supplies for all forms of life to providing most of the oxygen essential to life. Buried in and below the ocean is a library, a documented history of the planet from its earliest epochs to modern times. With our nation's investments in the Ocean Sciences, federally supported research has dramatically extended and deepened our understanding of all the essential processes important to our well-being and economic future. In short, the ocean provides food and a locus for a wide range of economic activities, a roadway for global commence and a coastal home for over three-quarters of the planet's population. Changes in oceanic processes are too often now outside historical norms and are increasingly interconnected with other sciences and fields of knowledge. Hence, it is critical that future support of our nation's Ocean Sciences institutions and supporting infrastructure will need to reflect these trends in science and recognize our nation's economic realities.

Our nation faces an unprecedented fiscal and policy environment that will place new demands on limited federal resources and policy priorities. Hence, it will be essential that we justify our needs for federal support in a context of these financial and policy priorities; the competition for financial resources will likely be rigorous and fierce, at best. Ocean Sciences is a community traditionally highly reliant on costly infrastructure and technical expertise, and the current fiscally- and operationally-constrained environment will demand that we present robust and convincing arguments for the importance of the Ocean Sciences to our nation and that, in this fiscally constrained environment, the Ocean Sciences community is committed to finding new ways of doing business, sharing infrastructure, and articulating the importance of our work in relation to national priorities.

To be successful in this new environment, it will be more important than ever to effectively articulate our scientific agendas in a context of national priorities in a receding environment for federal resources. Therefore, it is imperative that the Ocean Science community find ways to take a broader, more coherent approach. We must develop a community strategy and action plan that creatively delivers the *Next Generation of Ocean Sciences.* Such a strategy and action plan must: (i) recognize the current economic realities as the 'new reality' and the impact of such on our nation's Ocean Science enterprise, (ii) be realistic by articulating clear scientific research and infrastructure priorities, all of which embed an understanding of the fiscal and policy 'new realities,' and (iii) proactively evolve the next generation understanding of ocean sciences processes, approaches and business models. It is vital that the approach to delivering these tenets is founded on community engagement, and consultation with all stakeholders is undertaken.

Charge. Using Gagosian's March 2011 comments to the Membership and other strategic forward-thinking community documents as a starting point, the Ocean Leadership: Delivering the Next Generation of Ocean Sciences working group is established to explore and discuss strategies, areas and ways in which the Ocean Sciences community might evolve its current practices, approaches, and business models in order to achieve increased collaboration, efficiencies and leveraging capability in an environment of increased financial constraints that are both internal and external to individual institutions.

Membership Qualifications. The Ocean Leadership: Delivering the Next Generation of Ocean Sciences working group shall consist of self-identified members from among the Ocean Leadership membership and may include Voting Members, Associate Members and Affiliate Members. Individuals serving on the working group must be the formally designated Member Representative (or Alternate) for an Ocean

Leadership Member Institution. The Ocean Leadership President and Secretary shall both be non-voting members of the working group.

Duties and Implementation. The working group shall serve as an advisory committee of the Board of Trustees, as allowed under Article XII of the Ocean Leadership bylaws.

The working group shall meet via teleconference and/or webinar with regular frequency and may hold an in-person meeting in conjunction with the October Members Meeting. Important dates and milestones include:

Date	Activity	Status
by COB June 2	Castner sends rationale and revised Terms for comment by Co-Chairs	*Completed*
July 6 at 3 PM	Initial review of draft Terms by Excom	*Completed*
by July 12 COB	Castner creates email alias for the working group	*Completed*
July 13 COB	Castner sends draft Terms to self-identified group members for comment. Comments due by COB Wednesday, July 19.	*Completed*
August 3 at 3 PM	Formal Excom endorsement of the "final" Terms	*Completed*
August 5 at noon	Initial working group telcon	*Completed*
mid-August	Castner posts to the OL website the working group Terms, list of self-identified members and an updated Membership Directory	*Completed*
late-August	Castner creates a secure group webpage that will host discussion notes, schedule and a repository of related reports	*Pending*
mid-September thru mid-October	~2 telcons / webinars of the working group (dates TBD) to begin discussions and prep for the October Board Meeting. During one of the telcons, a core group will be identified.	*Pending*
October 9-12	**Geological Society of America Fall Meeting in Minneapolis**	
October 26 at 1:00-4:00 PM	In-person meeting in Ocean Leadership Conf ABC (confirmed). Box lunch will be available.	*Space confirmed*
October 27-28	Working group preliminary report at Members and Board meeting	
November thru December	~2 telcons / webinars (dates TBD) to deepen the discussion and reach out to other stakeholder communities / area experts	
November 17-18	**NAML/OBFS workshop on positioning field stations and marine labs (in Colorado Springs)**	
December 5-9	**AGU Fall Meeting in San Francisco**	
January 11, 2012 at 3:30 PM	Working group status update to the Board conference call	
mid-January thru February	~2 telcons / webinars to "conclude" discussions and develop recommendations / report	
February 20-24	**2012 Ocean Sciences Meeting in Salt Lake City**	
February 26-27	**NAML Annual Winter Meeting in Washington, DC**	
February 29 COB	Working group "final" report / recommendations provided to Amy	
March 1 COB	Castner sends "final" report / recommendations to the Board as prep for Board Meeting	
March 8	Discussion of "final" report / recommendations at the Board Meeting	

In addition to the above milestones, and at the discretion of the Executive Committee, the working group Co-Chairs shall report on progress during an Executive Committee conference call.

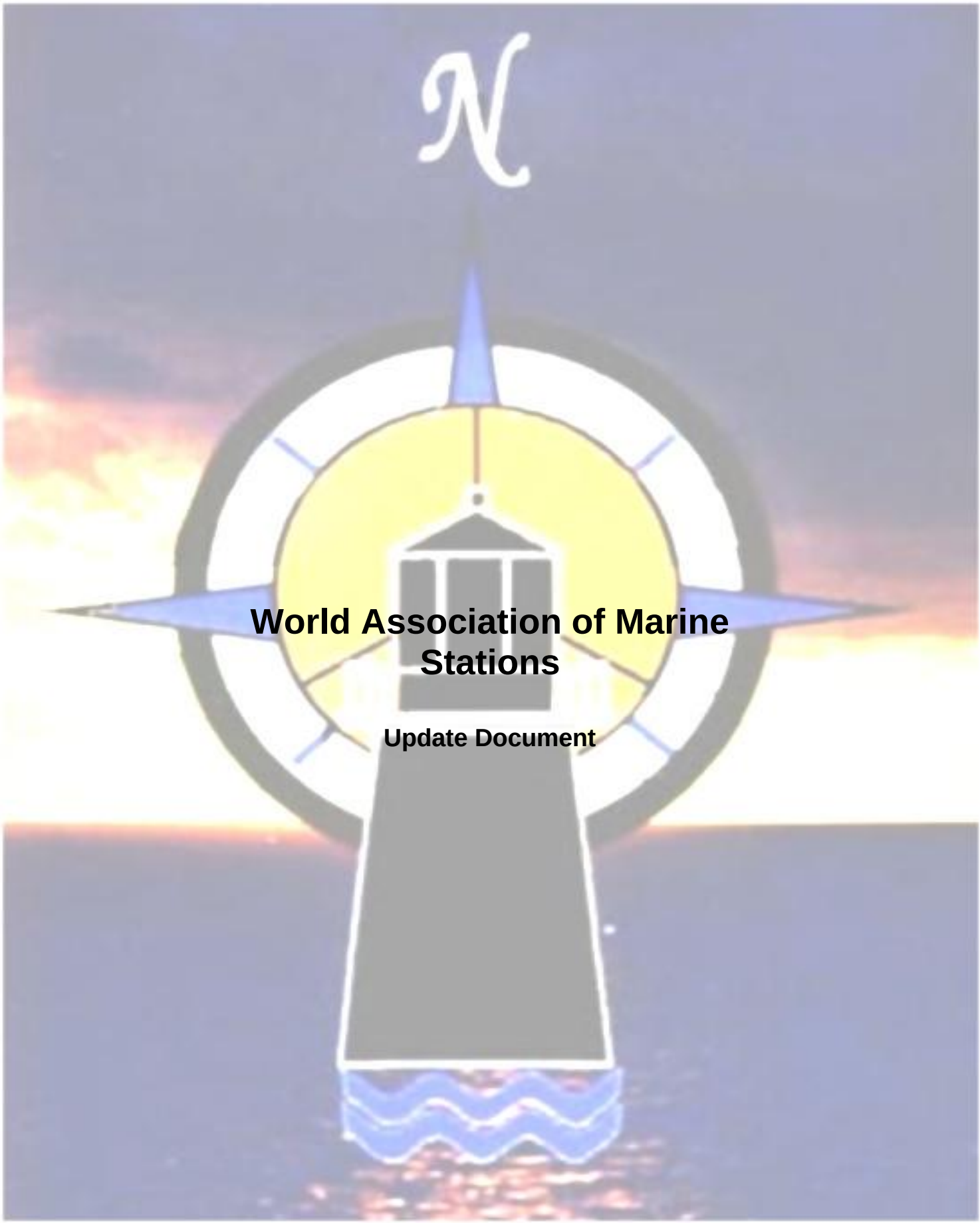
Procedure. The working group recognizes the vital role of engaging the variety of stakeholder groups relevant to study. The groups include, but are not limited to: domestic and international ocean conservation NGOs, domestic and international scientific organizations, the office of the President's Scientific Advisor, federal agencies responsible for ocean science, and regional ocean councils.

The working group recognizes that transparency is vital. All discussion notes from workshops and meetings are available from the Ocean Leadership Board Secretary, on request. All members of the working group have declared any real or perceived conflicts of interest under Ocean Leadership's governance procedures. The working group also reserves the right to consult with individuals with specific knowledge or experience to progress the objectives tasked above.

Leadership. The Chairperson of the Board shall appoint the Co-Chairs from among the working group members, based on recommendations from the Board and/or Ocean Leadership's executive leadership.

Term. Members of the working group shall serve a one-year term, or longer, as requested by the Board of Trustees.

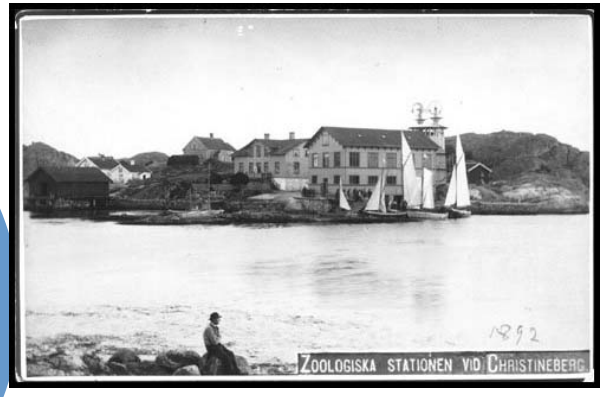
Vacancies. Vacancies in the membership or the chairpersonship may be filled for the unexpired term by appointment by the Chairperson of the Board.

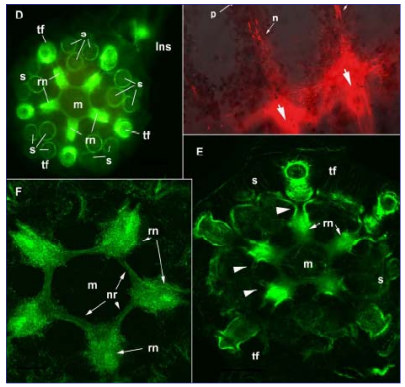


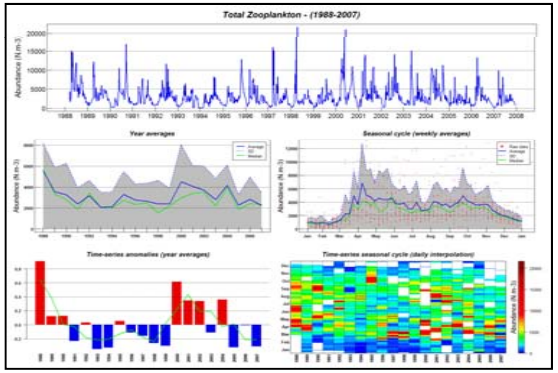
World Association of Marine Stations

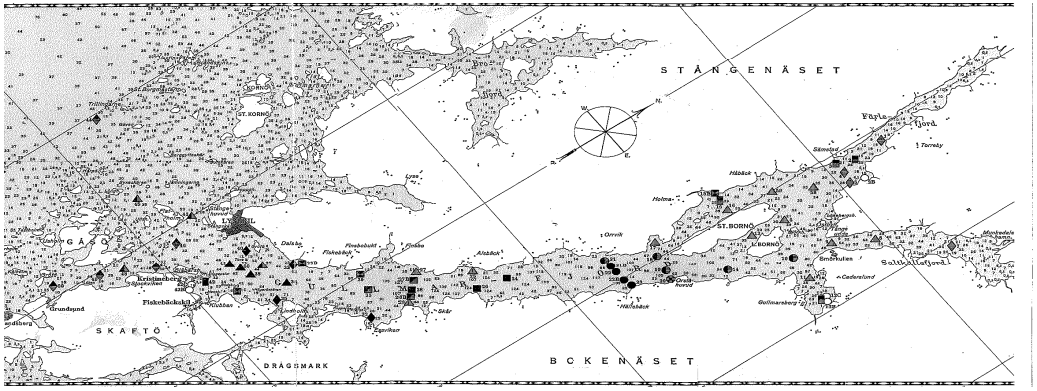
Update Document

Since the 1800's.....









”WAMS”

The World Association of Marine Stations

A Network of Marine Stations and Institutes for the 21st Century

Tropical Marine Network

MARS

NAML
National Association of Marine Laboratories

Association of Marine Laboratories of the Caribbean

pogo

Africa

PIMS

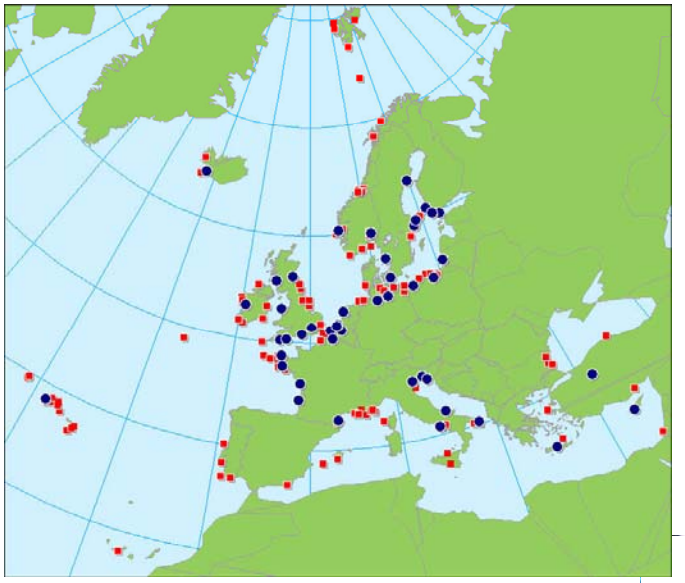
JAMBIO

UNESCO

UNESCO

MaB

The European Network of Marine Research Institutes and Stations
> 60+ Labs/Insts



SZN, Italy

SLC, Sweden

SAMS, UK

MBA, UK

SOI, UK

SARS, Norway

CCMAR, Portugal

AWI, Germany

SBR, France

OOVS, France

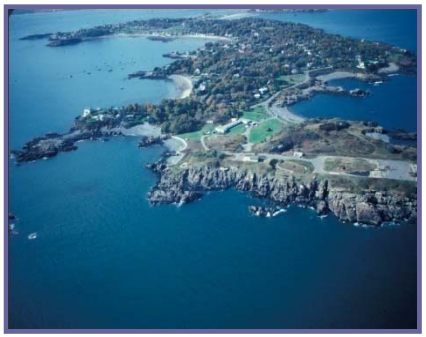
OOBS, France

HMRC, Greece

USA

120 labs/institutes

NAML
National Association
of
Marine Laboratories

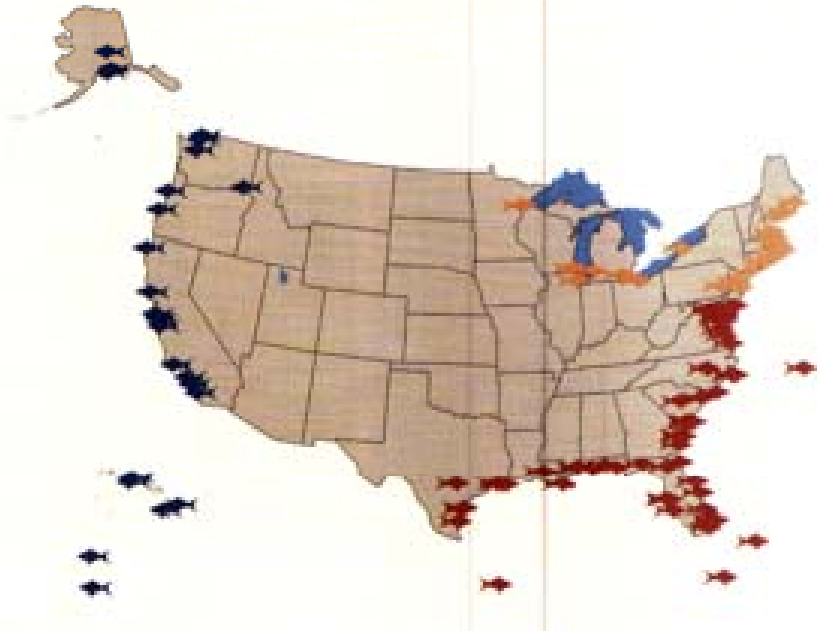


Regional Associations of NAML:

NEAMGLL, Northeastern Association of Marine and Great Lakes Laboratories, includes the Mid-Atlantic, New England, and the Great Lakes states;

SAML, Southern Association of Marine Laboratories, includes coastal states from Maryland to Texas, and Bermuda, Puerto Rico, Panama and the Antarctic;

WAML, Western Association of Marine Laboratories, includes the states of the West Coast, Hawaii, Guam and Palau.



Japan >150 (largely small) marine stations

Organization of Marine Stations in Japan

Hokkaido Honshu
Shikoku Kyushu
Okinawa

◆Marine Station - National University

Science

Graduate School of Science,
Field Science Center, University Institute (total 21)

Directors Congress

Agriculture/Fisheries

Graduate School of Agriculture/Fisheries,
Field Science Center, University Institute (total ~25)

Directors Congress

◆ Marine Station
- Prefectural or Private University (~10)

◆ JAMSTEC
(Japan Agency for Marine-Earth Science and Technology)

◆ Experimental Station
- Prefectural Fisheries Station (~100)

◆ Company; Corporation, etc

JAMBIO: Japanese Association for Marine Biology

◎ Core-center for Japanese Marine Biology Network
◎ Cooperative management by Univ. Tsukuba and Univ. Tokyo
◎ Hub for Japanese scientists and organization for marine biology

Shimoda Marine Research Center, University of Tsukuba: 10 faculty member

Main Facility Proteomics-center, Molecular and Cellular Biology, Transgenic animals, Marine diving, Experimental ecology system, Protein DB, Marine Bio-resource (*Ciona intestinalis*)

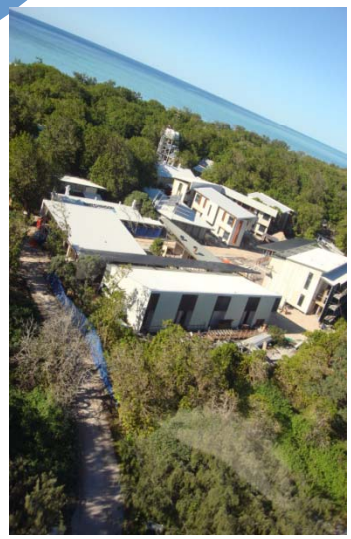
Misaki Marine Biological Station, University of Tokyo: 5 faculty member

Main Facility Marine Genomics and Resource, Molecular Phylogeny, Marine diving, Sagami-Bay DB、Marine Bio-resource (*Oxycomanthus japonicus*)

Australia

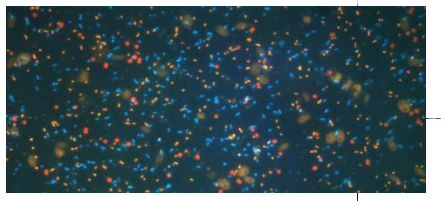
Tropical Marine Network

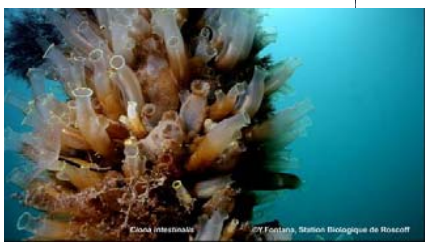
- Affiliation of Six Research Stations belonging to three universities and the Australian Museum
- Based largely on the Great Barrier Reef
- Delivers co-operative education programs and Joint infrastructure developments



Marine Stations are unique and essential for marine research (in partnership with vessels, satellites, remote systems etc.)

- Providing access to marine ecosystems including valuable (historical) time-series data
- Providing access to marine models for Biomedicine, ecotoxicology, biodiversity, gene discovery
- Providing logistics for ex situ experiments, including modern equipment for biology
- Providing logistics for hosting and catering





Marine Stations are:

- ideal places to study organisms in their habitat and in the lab
- great places for the public to see research happening, and to increase ocean literacy. Marine labs are "windows on the ocean"
- able to host large numbers of students at all stages (K-16+) during the year, often in all seasons (classes, field trips, tours, internships)
- accessible to researchers on a regular basis, short to long term
- places for graduate students to begin independent research
- home to experts in taxonomy, ecology, oceanography, biology etc.
- places to teach small intensive undergraduate/graduate classes

Marine Stations Are:

- excellent for research from molecular to ecosystem levels
  (genomics, biomedical, fisheries, development, ecology, neurobiology, physiology, biomaterials)

- ideal for long-term ecological research, real time data collection
-(e.g. to support OBIS), climate/ocean change impacts

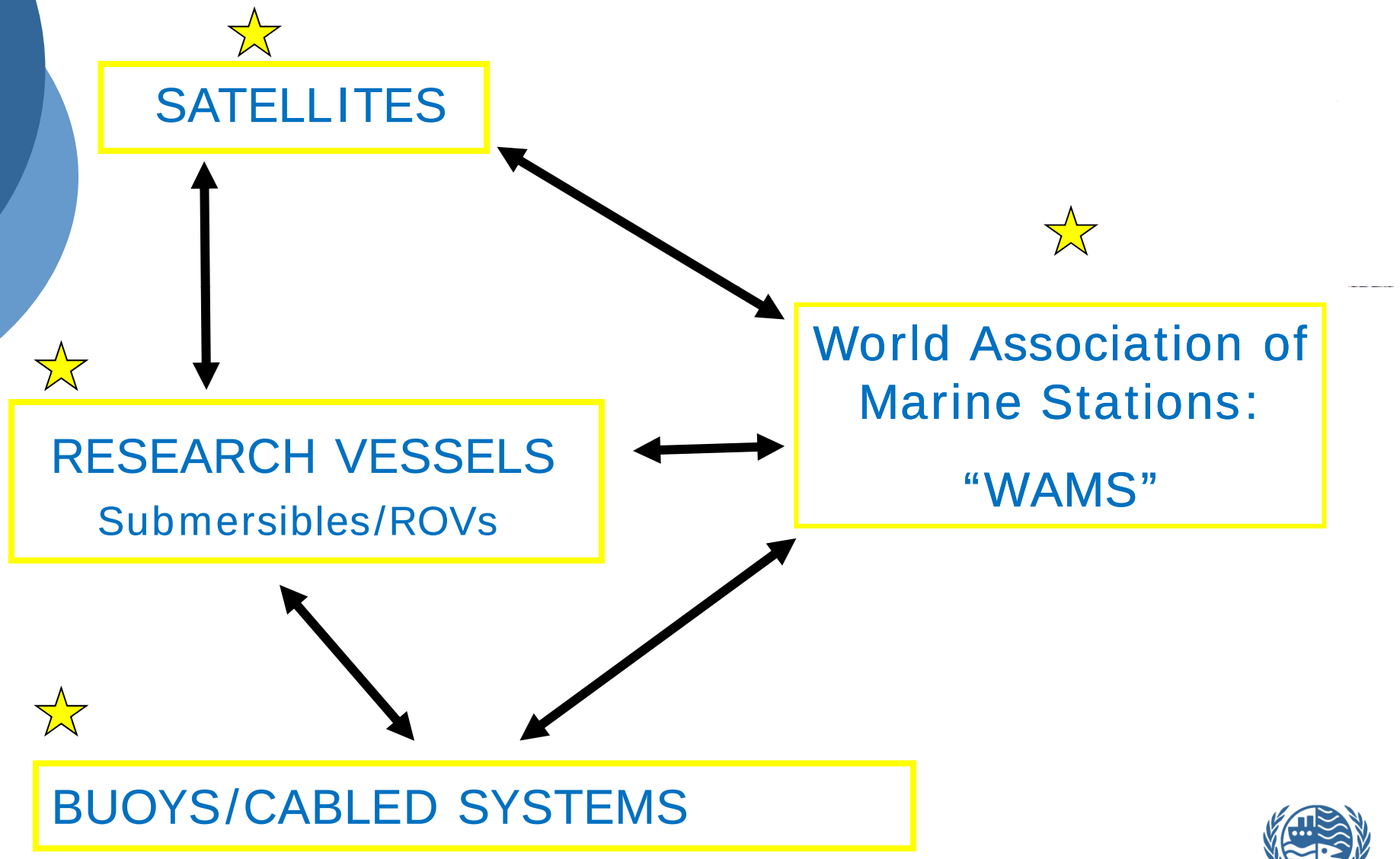
- inexpensive test-beds for new ocean instrumentation

- land base stations for OOS, buoys and cabled arrays, submersibles/ROVs

-support bases for research vessels, boats, diving research support

- places to integrate social science and natural science research/education

Infrastructure Needs for Ocean Research, for the Next Two Decades



What for the future?

- Global cooperation
- Regional diversity
- Capacity building
- Solidarity

WAMS Founding Steering Group:

- MARS, The European Marine Network of Marine Institutes and Stations
- NAML, The National Association of Marine Laboratories USA,
- AMLC and CARICOMP The Association of Marine Laboratories of the Caribbean,
- JAMBIO, The Japanese Association for Marine Biology , Japan,
- PIMS, The Pacific Institutes of Marine Science,
- POGO
- Tropical Marine Network (Australia)
- GOOS – Africa (representing African Marine Laboratories)
- UNESCO IOC
- UNESCO MAB

The scope of the activities within WAMS will address the theme of marine biodiversity and sustainability :

"From Genes to Ecosystems"

WAMS activities and mission

- Exchange programmes, (e.g. Global ERASMUS programme)
- Training and education,
- Capacity building
- "In kind" sharing of data and access to facilities,
- Joint development and harmonization of techniques and methods,
- Integrated research strategies.
- WAMS fellowships, (WAMS trust fund in cooperation with the IOC).

Particularly important activities for WAMS in its initial phase should be:

- Inventory of the WAMS membership marine sites
- Portal site for each marine station
- *Capacity building for Developing Nations*

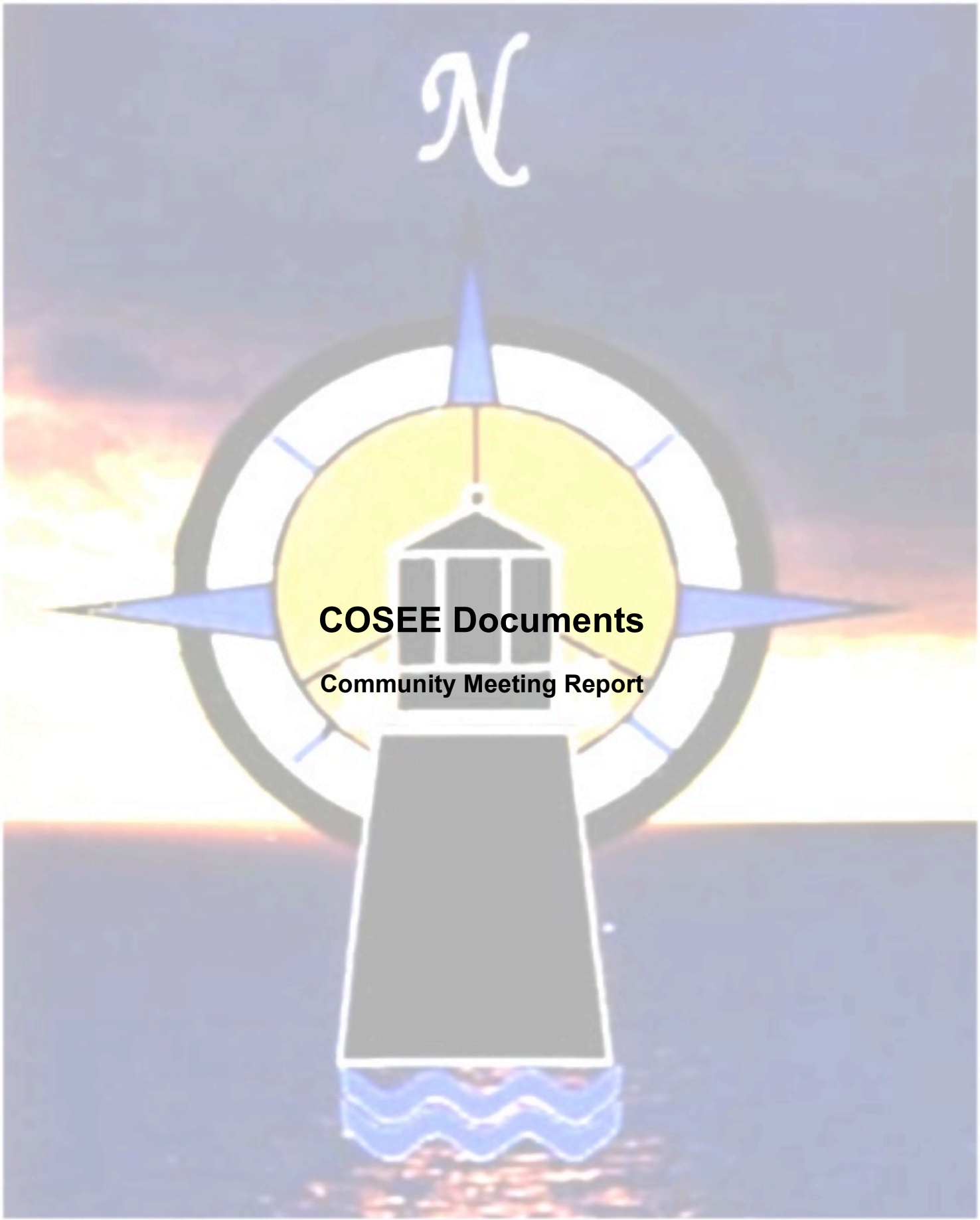
Where do we stand?

- WAMS established April 2010.
- Steering group formed.
- Governance structure formulated
- Appropriate enabling Statutes under development.
- Business and Funding plan under development.
- Next Steering group November 2011

The Time is right for WAMS

... "Knowledge about marine biodiversity ……is extensive owing to ….centuries of its study in many places and by a variety of enterprises. …….the innumerable academic institutions with shore facilities for study of the marine environment ……have provided foci of research and knowledge….." **Fautin et al. (2010) PLoS ONE 5(8)**

"Another point of consensus ……is the inventory of threats to marine biodiversity. Indeed, most threats identified …..are true for the entire world." **Birmingham Science News Examiner August 5th 2010**



COSEE Documents

Community Meeting Report

COSEE

COMMUNITY MEETING ON A FUTURE VISION FOR COSEE & NSF OCEAN SCIENCES EDUCATION

Meeting Report

NOVEMBER 3-4, 2010

THE COMMUNITY MEETING STEERING COMMITTEE

Cheryl Peach, *Scripps Institution of Oceanography, UC San Diego (Chair)*

Phil Bell, *University of Washington*

Annette deCharon, *University of Maine*

Danny Edelson, *National Geographic Society*

Carroll Hood, *Raytheon*

Cathy Manduca, *Carleton College*

Janice McDonnell, *Rutgers University*

Don Reed, *San Jose State University*

Sarah Schoedinger, *NOAA*

Gail Scowcroft, *University of Rhode Island, COSEE CCO*

Brian Smith, *Rhode Island School of Design*

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Executive Summary

More than ten years ago, a diverse group of research scientists and science educators came together under the auspices of the National Science Foundation (NSF) Ocean Sciences Division (OCE) to discuss the need for a nationally-coordinated effort to enhance ocean sciences education. The outcome was a community recommendation for the creation of a national network of regionally distributed Centers for Ocean Sciences Education Excellence (COSEE) that would build on exemplary ocean sciences education already taking place and look for opportunities to catalyze and leverage collaborations between ocean sciences researchers and educators. After almost a decade, the COSEE Network has grown and matured and has had a demonstrable positive impact on the ocean sciences research and education enterprise. As COSEE approaches its decadal review, it is apparent that while the vision articulated in the original workshop remains relevant, the landscape for ocean sciences education has changed in response to changes in national priorities, new directions in ocean sciences research, advances in technology, progress in learning sciences research, and transformation of social and professional networking by information and communications technology. Recognizing that the NSF investment in ocean sciences education should reflect this changing landscape, the NSF-OCE sponsored a Community Meeting in November 2010 to garner broad community input into the most promising new directions for NSF ocean sciences education and a next generation COSEE.

The Community Meeting on a Future Vision for COSEE and NSF Ocean Sciences Education was held November 3-4, 2010, at the Ronald Reagan Building in Washington, DC. The meeting included 65 participants from a cross-section of the science and education communities, including members of the National COSEE Network, the ocean sciences research community, the learning sciences community, and those with expertise in cyberinfrastructure for research and education. The Community Meeting's two days of lively discussions produced a set of recommendations that have been synthesized into this meeting report. Provided herein is the participants' consensus opinion on the critical priorities for NSF's ocean sciences education initiatives during the next decade and the role that a next generation COSEE can play in meeting these priority areas. The meeting was focused on thinking broadly about the future of ocean sciences education in the context of the NSF ocean sciences research and education enterprise, and in particular, on establishing clear alignment with major NSF investments in climate change and sustainability, ocean observing, education/outreach applications of cyberinfrastructure, research on learning, and the development of a diverse workforce.

The participants were divided into working groups, and during the group's deliberations *five overarching themes* emerged that were common to all working group discussions: 1) integrating current ocean sciences research and discovery into education initiatives; 2) broadening the participation of underrepresented populations in ocean sciences; 3) integrating emerging technologies; 4) recognizing the formal-informal continuum in science education; and 5) embracing an inclusive, multidisciplinary, team-based approach to ocean sciences education. These crosscutting themes serve as common "threads" that tie together the *four key focus areas* that the meeting participants identified as the most promising future directions for NSF ocean sciences education:

Delivering Clear, Compelling Ocean Sciences Information to the Public

Society is grappling with a large number of pressing environmental and sustainability issues that are often poorly communicated to the public by the scientific community and miscommunicated by the popular media. Advances in social sciences and science communications research are providing new insight into crafting and delivering clear, compelling science messages to reach and impact targeted audiences. These strategies, when combined with recent trends in mass media and information and communications technology, can help the ocean sciences research and education community dramatically increase their capacity to reach a broad cross-section of society with key ocean sciences information. The community should embark on a state-of-the-art, research-based initiative to dramatically increase the number of people who perceive understanding the ocean to be essential and who use ocean sciences information to make informed decisions about important ocean related issues. Highlighted in the initiative should be the vast potential ocean sciences research holds for informing solutions to some of the grand challenges facing society (e.g. climate change, sustainability of ocean fisheries, biodiversity, sea level rise).

Using Ocean Data to Teach Scientific Thinking: Engaging Non-scientists in Ocean Sciences Research

Advances in computing, cyberinfrastructure, and information and communications technology are changing the way ocean sciences research is conducted. In a parallel trend, recent advances in web-based, inquiry-driven formal and informal education have led to development of on-line platforms for instruction that engage learners in active scientific inquiry, incorporate computer simulations of real-world phenomena, and involve collecting and analyzing data. In combination, these research and educational advances provide the basis for a more fully integrated ocean sciences research and education enterprise and provide an unprecedented opportunity to immerse learners in ocean discoveries. As observatory systems (e.g. NSF's Ocean Observatories Initiative (OOI) and Rolling Deck to Repositories (R2R) programs) and other ocean sciences data collection, analysis, visualization and archiving systems become increasingly pervasive and automated, these systems provide a context for readily addressing fundamental questions in research on cyberlearning. Moreover, the answers to these questions can be applied to create effective ocean sciences learning experiences that are firmly grounded in both learning sciences and the evolving paradigm for ocean sciences research.

Elevating Ocean Sciences to a Place of Prominence in the Educational Continuum

Ocean sciences is both a distinct topic of instructional focus, and a system of important concepts that must be integrated across the mainstream science curriculum. Historically, ocean sciences has been marginalized in both national and state science standards. The U.S. Commission on Ocean Policy reported that the absence of ocean sciences in schools resulted in a generation of Americans ignorant of the importance of the ocean, placing our economy, environment, and national security at risk. While COSEE has made considerable progress in raising the prominence of ocean sciences in K12 and informal science education, the renewed focus on the oceans and ocean stewardship heralded by the National Ocean Policy provides the ocean sciences research and education community with a new basis for asserting that oceans sciences must be taught broadly and well. *Ocean Literacy: The Essential Principles of Ocean Sciences* is a transformative consensus document that needs to be more fully and systemically integrated into the mainstream formal and informal science education standards, curriculum, and learning materials. The community can play a central role in this integration by facilitating access to up-to-date, inspiring ocean sciences content, data, and interfaces. One avenue for undertaking this integrative role would be to establish an NSF *Science of Learning Center for the Oceans* (SLC) dedicated to how people learn about complex, interconnected, abstract systems, and that uses ocean systems and related ocean sciences learning progressions as its primary focus.

Broadening Participation in Ocean Sciences: Increasing Diversity in the Ocean Sciences Research and Education Enterprise

All individuals should be able to participate in ocean sciences research, learn about ocean science topics, and consider a career in one of the many contemporary research fields in the ocean sciences. Ocean sciences education is working to remove barriers to participation in ocean sciences research endeavors and to provide meaningful learning experiences. A strategy for supporting these diversity goals is focused on a range of specific efforts at different points in the science, technology, engineering and mathematics (STEM) education system. The development of future ocean sciences education efforts should include an enhanced effort to develop culturally appropriate messages, a deeper understanding of audience needs and instructional approaches that orient to cultural and indigenous knowledge. These efforts should leverage new research from the learning sciences community to determine the most effective means for broadening participation. COSEE's next generation should continue seeking and promoting strategic partnerships with organizations and networks that serve groups that are underrepresented in ocean research (e.g., Society for Advancement of Chicanos and Native Americans in Science, SACNAS; ASLO Multicultural Program, Institute for Broadening Participation, IBP).

Future ocean sciences education initiatives should integrate elements of all four of these focus areas so that the ideas, strategies and crosscutting themes embodied in each work in concert toward the broader aim of a more ocean literate society. Clear, compelling information about the ocean will make ocean sciences more engaging and accessible, and will heighten awareness of the ocean's influence on human wellbeing. Framing ocean sciences data, tools and scientific research in relevant contexts will encourage greater integration of ocean sciences into K-16 and informal education, and will support broader participation in ocean sciences. Increasing understanding of the ocean and ocean sciences research can help drive a Nation-wide commitment to sustaining a healthy ocean environment and will support informed decision making about critical ocean issues. Building on a firm foundation, and equipped with the fresh set of ideas and strategies articulated in this report, the National COSEE Network and the broader ocean sciences community stand well positioned to advance ocean sciences education into the next decade.

I. Introduction and Context for the Meeting

The ocean sciences research and education community is at a crossroads. On July 19th, 2010 President Obama signed an executive order creating the National Ocean Council (NOC), a body charged with setting national priority objectives and providing direction for implementing the National Ocean Policy (NOP). The vision of the NOP is *"An America whose stewardship ensures that the ocean, our coasts, and the Great Lakes are healthy and resilient, safe and productive, and understood and treasured so as to promote the well-being, prosperity, and security of present and future generation".*

The creation of the NOC and the articulation of the NOP vision underscore the critical need for advancing ocean sciences education to benefit the Nation. Widespread public stewardship of the ocean can only be realized through appreciation, understanding and knowledge-based decision making on ocean issues. Now more than ever, it is imperative that the ocean sciences community take a leadership role in supporting the National Ocean Policy.

Over the last decade, the NSF's COSEE program has played a central role in broad public understanding of the oceans by bridging the gap between those that practice ocean sciences research and those that teach and communicate ocean sciences. National COSEE Network initiatives have resulted in nationally recognized ocean sciences education programs that have united researchers and educators in developing the national Ocean Literacy Essential Principles, creating new undergraduate and graduate courses in communicating ocean sciences, providing real and virtual experiences that engage people in ocean sciences research, developing tools for constructing new curricula, applying advances in learning sciences, and bringing new information and communications technologies to bear on ocean sciences education.

Yet the ocean sciences education landscape continues to evolve, including major advances in ocean sciences research, an explosion in information and communications technology, and the evolution of a robust cyberinfrastructure (CI) for research and education. Moreover, a host of new NSF ocean sciences and cross-directorate programs are emerging as critical efforts that support the NOP goals and the advancement of scientific knowledge about the ocean.

Key new NSF programs include:

The Ocean Observatories Initiative (OOI): The OOI is a large, new infrastructure program that promises to advance ocean sciences by allowing researchers to collaboratively observe and study the oceans on space and time scales not possible using traditional seagoing research methods. This networked infrastructure of sensor systems will measure the physical, chemical, geological and biological variables in the ocean and seafloor. Greater knowledge of these variables is vital for improved detection and forecasting of environmental changes and their effects on biodiversity, coastal ecosystems, and climate. Combining state-of-the art observing systems with a sophisticated CI, the OOI is designed to provide continuous, interactive, open access to ocean data and data products for ocean scientists, educators, and the public. Importantly, development of the educational CI for the project is taking place in parallel with development of scientific observatory components, ensuring that data and other resources will be accessible to non-scientist users. COSEE PIs, in collaboration with others in the ocean sciences education community, are key players in the OOI Education and Public Engagement program and are already designing the next generation of educational products that incorporate near real-time data, provide observatory-based social/professional networking capabilities for educators, and provide broad access to OOI data products and services for the public.

New oceanographic research vessels: Proposed additions to the oceanographic research fleet will offer expanded opportunities for education at sea through new communication capabilities and data sharing through the NSF-funded Rolling Deck to Repository (R2R) program. The R2R program envisions the academic fleet as an integrated global observing system with routine underway data and documentation flowing directly from research vessels to a central shore-side repository. Key institutional partners in the project are also lead institutional partners in COSEE (e.g. Scripps Institution of Oceanography; the Woods Hole Oceanographic Institution) and key personnel are currently working to collaborate on public accessibility of R2R data and data products. Many of the strategies developed by the OOI Education and Public Engagement (EPE) program can be applied to R2R. COSEE has a history of facilitating educator at sea programs and for spearheading efforts that connect classrooms and science centers with ships conducting oceanographic research. As capabilities expand and new research vessels come online, COSEE has the experience and the prototype programs that can inform the next generation of research vessel-based tools and programs for education.

Climate Research Investment: One of the major new cross-directorate initiatives is the NSF's Climate Research Investment (CRI) program launched in 2009. CRI is a Foundation-wide activity that supports production of new knowledge that can lead to a more sustainable planet. The program comprises five components: 1) Water Sustainability and Climate Change; 2) Ocean Acidification; 3) Climate Change Education Partnership; 4) Decadal and Regional Climate Prediction using Earth System Modeling; and 5) Dimensions of Biodiversity. These programs support innovative research and education that will advance the Nation's capacity to understand and predict changes in Earths natural and human dominated systems, to assess the vulnerability and resilience of these systems to change, to foster workforce development, and to improve scientific literacy in these areas. The oceans and atmosphere are inextricably linked in controlling Earth's climate, and ocean sciences is integral to each of these program components. COSEE personnel and institutional partners are deeply involved in several of these initiatives, particularly those with a strong focus on communication, education and workforce development. Future efforts within the community will focus on more widespread and deeper integration of ocean related topics into the educational initiatives associated with each of these program components and COSEE is well poised to contribute to these initiatives.

Science, Engineering and Education for Sustainability: Looking beyond the climate research agenda, NSF is also broadening its scope to include sustainability. Announced in 2010, the Science, Engineering and Education for Sustainability (SEES) program will enable research and education activities that will build the scientific foundation for decision capabilities and the technologies aimed at mitigating and adapting to environmental change. CRI will be folded into SEES, which will address many of the challenges of sustainability at the energy, economy and environment nexus. Sustainability is a central tenet of ocean stewardship, encompassing wide-ranging issues such as ocean fisheries, offshore oil exploration, marine biodiversity, ecosystem-based management of marine environments, marine coastal planning, marine pollution and sea level rise among others. Ocean education is a crucial component of any sustainability-based initiative. COSEE and the broader ocean sciences education community have a long and successful track record of bringing sustainability issues into the public forum and is developing innovative new approaches for creating interdisciplinary teams to address challenging communications issues.

Cyberinfrastructure Framework for the 21st Century (CF21): Recognizing that CI is changing how research and education are conducted, this new NSF initiative will foster the development of a comprehensive, secure, and sustainable CI that will support transformative research and education in science and engineering. Ocean sciences is a leading contributor to CI for research and education through the OOI and its sophisticated integrating CI, the largest investment in NSF's CI history. By including creation of educational CI in the construction process, the OOI stands to set a precedent for science education by 1) thoroughly integrating education into a major NSF research investment from the start; and 2) creating a model for educational CI for future foundation wide research investments. COSEE experience and expertise is proving central to the development of education-focused cyberinfrastructure for ocean sciences (i.e. OOI).

Science of Learning Centers: NSF *Science of Leaning Centers* are engaged in research to advance the frontiers of current understanding of how people learn. Ocean sciences education can make unique contributions in this research arena in areas such as increasing understanding of 3D and 4D spatial thinking skills, development of graphical interfaces and data visualizations for science teaching and learning, and teaching using observatory systems and other sensor networks. Distinct from many other science disciplines, ocean sciences experts depend not only on a wide range of analytical skills, but on temporal and spatial thinking skills that allow them to visualize and interpret complex environmental data collected over a range of scales. Recently recognized as important skills to foster in the Nation's next generation of innovators (NSB, 2010), spatial reasoning skills are emerging as an important new area of education research. Ocean science education has a unique contribution to make in this arena and is well positioned to do so.

These emerging programs within NSF offer a robust framework to support the NOP by advancing both ocean sciences as well as public appreciation, understanding, and stewardship of the oceans. The ocean sciences research and education community must continue to seek out and investigate effective mechanisms for fully integrating research and education within these programs and must expand the capacity to tap into and build on their infrastructure to ensure meaningful uses of the data, programs, and resources for ocean sciences teaching, learning, and discovery.

As a well-established NSF network with a strong foundation in the integration of research and education, a next generation COSEE has a leadership role to play in this effort. COSEE can bring the prodigious expertise, resources and infrastructure of the National COSEE Network to bear on spearheading new and innovative approaches, as well as facilitating broad, national and international scale partnerships that combine efforts with other networks of educators, communicators, learning scientists and researchers dedicated to public understanding and stewardship of the ocean.

II. Community Meeting Structure

The Community Meeting was planned by a steering committee comprising an equal number of COSEE Network members and representatives from outside of the Network. Meeting participants were sought that would represent a diverse body of expertise. The selected group included science researchers, four-year and community college educators, CI experts, learning scientists and K-12 and informal educators. Approximately half of the participants are active members of the National COSEE Network. Participants were charged with looking toward the future and identifying the most promising opportunities for transforming and catalyzing ocean sciences education and with recommending innovative strategies to capitalize on those opportunities.

Specific workshop objectives included:

- Exploring a future vision for the next decade of NSF ocean sciences education that builds on existing capabilities and strengths, while capitalizing on opportunities afforded by the rapidly advancing ocean sciences research and science education enterprise.
- Articulating a vision that emphasizes the NSF commitment to the integration of ocean sciences research and education, and to catalyzing and sustaining collaborations between ocean sciences researchers and science educators.
- Generating a set of far-reaching, strategic recommendations for key focus areas for the future of NSF ocean sciences education that build on the programs, network capabilities and infrastructure of the National COSEE Network, that take into account the emerging CI for research and education, and that will support integration of ocean sciences education into the NSF ocean research portfolio and the broader Foundation-wide initiatives.

An introductory address by Dr. David Conover, Director of the Ocean Sciences Division in the NSF Geosciences Directorate, set the overarching context for the meeting by articulating the NSF perspective on key considerations for the future of ocean sciences education at the Directorate. This introduction was followed by two plenary presentations emphasizing the growing understanding of effective practices in science communication (Dr. Ed Maibach) and the rapidly evolving role of technology in science education (Dr. Roy Pea). Synopses of the presentations are presented below.

ED MAIBACH

Effectively Educating the Public and Decision-Makers about the State of our Oceans: Five Guiding Principles

THE FORMULA FOR PUBLIC EDUCATION EFFECTIVENESS:

- *"Simple clear messages, repeated often, by a variety of trusted sources."*

FIVE GUIDING PRINCIPLES:

- *The less you say, the more you're heard.*
- *The decision about what to say requires audience research.*
- *There is no such thing as "the public."*
- *If failure (of the public education effort) is not an option, create a public education team.*
- *Clearly identify which personal actions, and which societal actions, are most important.*

SUMMARY:

- *To get your public education content right, create a multi-discipline education team and study your audience carefully*
- *To ensure that your content is received & learned, develop simple clear messages, repeated often, by a variety of trusted source.*
- *To maximize the odds that your public education will influence people's actions appropriately, clearly identify which personal actions, and which societal actions, are most important.*

ROY PEA

Cyberlearning frontiers for the convergence of ocean science and education with the learning sciences

"Integration of ocean science research and education" needs to be two-way. Not only a one-way flow from ocean science to teaching about the science, but an engagement of learners in the science, as in student-scientist partnership projects.

IMPORTANT INSIGHTS FROM LEARNING SCIENCES CAN INFORM OCEAN SCIENCES EDUCATION:

- *Designing to encompass formal and informal learning contexts and pathways*
- *Using new insights into "expertise" development (e.g. understanding the social aspects of the acquisition of expertise)*
- *Teaching scientific reasoning in the context of the science disciplines (e.g. using their tools, academic language, inquiry methodologies, norms)*
- *Designing using an iterative research, development and testing process that includes long term partnerships with educators, districts, broader communities*

SUMMARY:

- *Advances in the learning sciences give us valuable insights into how people learn.*
- *Technology innovations give us the ability to act on these insights as never before.*
- *Life-long, life-wide learning ecologies requires new designs.*
- *Leverage best practices today AND invent your own future of cyberlearning for ocean sciences and education*
- *Cyberlearning for ocean sciences should leverage high interest features of ocean science (e.g. mystery, natural hazards, sustainability and stewardship)*

Breakout discussions following the plenary presentations were focused on identifying a big picture vision for the future of ocean sciences education based on the following overarching questions:

How can contemporary, consensus perspectives on science learning and teaching (learning insights, design principles, theoretical perspectives) be leveraged to better integrate ocean sciences research and education, and advance ocean sciences literacy?

How can the capabilities of selected, relevant cyberinfrastructures and/or the concept of a virtual community be leveraged to further the goal of integrating ocean sciences research and education?

What approaches can be used to best support education and outreach at the leading edge of ocean sciences research?

In the overall science education landscape of the future, what is the optimal position for NSF-supported ocean sciences education?

Each broad topic area above served as the basis for discussion in the Day 1 breakout sessions. The morning session discussions focused on the broader vision and the afternoon session on specific implementation strategies. Working group participants were assigned to the groups based on their area of expertise and the steering committee's efforts to achieve an appropriate balance of experience within each group. Day 2 was dedicated to eliciting the high-level, compelling, bold ideas that emerged during the Day 1 discussions. A breakout session in the morning led to the development of a list of 22 "big ideas" for future directions in ocean sciences education. These ideas were subsequently synthesized into 4 recommendations for key focus areas and implementation strategies for the future of NSF ocean sciences education. An important and unplanned discussion that took place during the morning plenary session addressed the question "What constitutes transformative change?". This discourse contributed significantly to framing subsequent breakout group discussions of the key focus areas. Also identified over the course of Day 2 was a set of 5 crosscutting themes that figured prominently in all plenary and breakout group discussions. The detailed meeting agenda and participant list are in Appendix I.

This report is a synthesis of the most promising opportunities identified at the meeting. It includes recommendations for *key focus areas* for the future of NSF ocean sciences education that build on the programs, network capabilities and infrastructure of the National COSEE Network, that take into account the emerging cyberinfrastructure for research and education, and that will support integration of ocean sciences education into the NSF ocean research portfolio and the broader Foundation-wide initiatives. It defines objectives for transformative change in ocean sciences education (Section III) and articulates key focus areas, suggested implementation strategies, and crosscutting themes that should figure prominently in future NSF ocean sciences education planning (Section IV).

III. Transforming Ocean Sciences Education
What will future success look like?

Effective practice in strategic planning and in educational design both emphasize the importance of articulating a desired end state and potential pathways to that end state. The National COSEE Network has executed this exceptionally well through strategic planning efforts that are goal and outcome oriented and that are examined and reevaluated regularly. The net result has been increased community capacity to effectively integrate research and education, and a distinct cultural change in the ocean sciences research community such that education and outreach has become a normal part of conducting research for many ocean scientists. Ocean sciences meetings are now filled with education and outreach strands, science education and ocean sciences education meetings are re-invigorated and regularly focus on bringing cutting edge science into classrooms, and ocean sciences now is recognized in the mainstream science education reform movement when standards and instructional materials are being discussed.

Meeting participants recognized that as the community continues to move forward, future progress depends on an outcome-oriented approach in which both desired end states and pathways are defined. Participants were encouraged to think boldly about new opportunities and strategies for NSF ocean sciences education by considering what would constitute *transformation* in ocean sciences education from its current state, and to use these ideas as a context for the discussion of specific implementation strategies. It was broadly agreed that advancing ocean sciences education to the next level would require yet more change in the culture and capacity of the ocean sciences research and education enterprise including:

- A radically expanded (i.e. three orders of magnitude or more) audience for ocean sciences education achieved by integrating and coordinating outreach, informal and formal education strategies to reach people of all ages.
- Changed public attitudes and behaviors that reflect increased respect for the oceans, recognition of the value of the ocean to their lives and appreciation of the ocean sciences research enterprise.
- A more cohesive and systematic merging of ocean sciences research and education
- Efficient and well-defined pathways for integrating the latest science discoveries into ocean education programs
- A unified ocean sciences research and education community that is collectively responsive to trends across ocean sciences research, social networking and social media, information and communications technology, learning sciences and STEM education

Inspired by this conceptualization, subsequent discussions yielded four “key focus areas” for the coming decade of NSF ocean sciences, a set of cross-cutting themes that were common to all, and key implementation strategies for reaching focus area objectives.

IV. The Future of NSF Ocean Sciences Education

A. ALIGNMENT WITH NSF AND NATIONAL PRIORITIES

Throughout the Community Meeting plenary and working group discussions, it was widely recognized that any plan for the future of ocean sciences education must reflect and complement National level policy and principals for STEM education and public understanding of science. The groups' recommendations are thus well aligned with the guiding principles for NSF's STEM efforts, with the Geosciences Directorate Education and Diversity 2010-2015 Strategic plan, and with the National Ocean Policy (NOP, 2010). This outcome reflects the community's recognition of the importance of integrating STEM education, outreach, and communications across NSF's portfolio of activities, while leveraging NSF's investments in scientific research.

> The National Science Board stated that the NSF STEM education road map and strategic priorities should reflect the Foundation's responsibilities to:
>
> - *Support research on learning and educational practices and the development of instructional materials.*
> - *Develop human capital (e.g. STEM workforce development).*
> - *Increase public appreciation for and understanding of science, technology, engineering, and mathematics.*
>
> *National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering and Mathematics Education System* (National Science Board, October 2007).
>
> The Geosciences Directorate 2010-2015 Strategic Plan has as its overarching goals:
>
> - *Advancing public literacy in Earth system science*
> - *Preparing the geoscience workforce of the future*
>
> The National Ocean Research Policy has two of its core objectives
>
> - *Foster a public understanding of the value of the ocean, our coasts, and the Great Lakes to build a foundation for improved stewardship (National Policy in: Final Recommendations of the Interagency Ocean Policy Task Force, 2010).*
> - *Better educate the public through formal and informal programs about the ocean, our coasts, and the Great Lakes (National Priority Objectives in: Final Recommendations of the Interagency Ocean Policy Task Force, 2010).*

Community Meeting recommendations align with the principles from each of these plans in that they focus on combining ocean sciences with learning and communications sciences to promote: 1) public understanding of ocean sciences and cultivation of ocean stewardship; 2) leveraging advances in ocean sciences research and cyberinfrastructure to enhance STEM learning of 21 st century science and technology skills; and 3) broadening participation in ocean sciences to expand the talent pool for the 21 st century workforce.

The crosscutting themes and key focus areas that emerged from the meeting discussions are described in detail below, along with specific implementation strategies that can be used in NSF ocean sciences and the next generation of COSEE.

B. CROSSCUTTING THEMES

Over the course of the Community Meeting, five overarching themes emerged as common to all of the discussions: 1) integrating current ocean sciences research and discovery into education initiatives; 2) broadening the participation of underrepresented populations in ocean sciences; 3) integrating emerging technologies; 4) recognizing the formal-informal continuum in science education; and 5) embracing an inclusive team-based approach. These themes constitute the "threads" that tie the key focus areas for the future of NSF ocean sciences education together and are an essential element of the participants' recommendations to the NSF.

1) Integrating current ocean sciences research and discovery into education initiatives

Emerging programs within the NSF offer unprecedented opportunities to integrate ocean sciences research and education in ways previously unimaginable. The last decade has seen an explosion in connectivity enabled by the Internet, as well as a pro-

found cultural change in the way researchers, students, teachers, and the public access information, collaborate professionally, and interact socially. These changes demand a concurrent evolution of the approaches used to establish partnerships in education around NSF science and of the strategies used to communicate ocean sciences to public audiences. Online scientific collaboration is rapidly becoming the norm and holds great promise for facilitating interactions between researchers and non-scientists across the formal-informal education continuum, including interactions from remote field sites and research vessels. New learning sciences research on using scientific data and visualizations in a variety of learning contexts is creating the basis for integrating authentic ocean sciences data from programs like R2R and OOI into classroom activities, citizen science projects, and science center exhibit elements. As NSF broadens its scope to include sustainability through SEES (and CRI), the community can capitalize on public interest and engagement in these highly relevant topics to devise ways to communicate how the ocean sciences research enterprise contributes to helping the nation meet grand challenges to society. Finally, Science of Learning Centers are paving the way for in-depth research into how to promote student learning in areas uniquely emphasized in ocean sciences such as spatial reasoning skills.

COSEE has had a significant role in the development of education programs associated with many of these initiatives and has been actively addressing many of the challenges presented by the rapidly evolving technology for research and education. A next generation COSEE is poised to provide both leadership and insight into effectively integrating research and education in large science and science infrastructure projects in this continuously evolving landscape.

2) Broadening the participation of underrepresented populations in ocean sciences

Although this theme was the focus for an individual working group, all groups felt that it deserved central consideration. With less than 6% of the ocean sciences work force comprising individuals from minority populations, it is imperative that ocean sciences education efforts continue to strive to reach the broadest audience possible. Access to ocean sciences learning experiences must be developed across the formal and informal science education spectrum. In addition, there is a critical need to increase the number of people who view ocean stewardship to be in their self-interest. The development of future ocean sciences education efforts should include an enhanced effort to develop culturally appropriate messages, a deeper understanding of audience needs and instructional approaches that orient to cultural and indigenous knowledge. These efforts should leverage new research from the learning sciences community to determine the most effective means for broadening participation. Emerging ocean observation technology may provide a gateway for reaching vast audiences. However, access by urban and rural youth must be considered when developing the delivery systems.

To reach broader audiences, non-traditional venues should continue to be explored and expanded for implementing ocean sciences education experiences (e.g. Boys and Girls Clubs of America, Girl Scouts, 4-H). Although formal and informal learning are part of an educational continuum, focusing on the out of school end of the continuum will promote large scale dissemination and applicability of ocean sciences to geographically, economically, racially, and linguistically diverse populations. Future ocean sciences education initiatives can build on COSEE's expertise and experience in how to reach underserved and under represented audiences (e.g. COSEE personnel who specialize in research on learning and COSEE Centers that focus on underserved audiences).

3) Recognizing the formal-informal continuum in science education

Most life long learning takes place outside of formal K-12 classrooms (Banks et al., 2007; Bell et al., 2009). COSEE must continue its push to integrate ocean sciences into formal classroom curriculum as supported by national science education standards, and non-school opportunities for learning need to be developed that explicitly enhance and connect to the formal education experience. Learning sciences research on bridging the gap between formal and informal science education should be more intentionally integrated into ocean sciences education efforts, particularly as it applies to out of school learning contexts, and creation of a comprehensive formal-informal ocean sciences learning pathway. In addition to K-12 educators, informal science educators need professional development to stay abreast of the rapid advances in ocean sciences research and to become familiar with the use of emerging technologies.

The emergence of the "free-agent" learner, a new kind of student who is less dependent upon traditional education institutions and more self-reliant in driving their own educational destiny, is beginning to reshape education and to drive the demand for technology-enabled learning both inside and outside of the classroom (Project Tomorrow, 2010). Opportunities for *ocean cyberlearning* need to be situated in the context of growing realizations of the importance of learning outside of school and new technologies that can provide linkages between the formal and informal learning sectors should be exploited.

4) Integrating emerging technologies

As technological advances in computing, cyberinfrastructure, and communications revolutionize both science research and science education, ocean scientists and educators are beginning to capitalize on these advances to engage learners more directly in ocean discovery. Network-capable computing devices are increasingly pervasive, increasingly capable and increasingly mobile. Advances in cloud computing are changing how people use the Internet and as a consequence where and how they learn (Horizon Report, 2010). Users can now access computational resources, web services, software, and storage no matter where they are or what device they choose to use. Coupled with increasingly open scientific data and resources, and more accessible open platforms for developing learning and educational tools, these trends are beginning to transform science education and are figuring prominently in the ocean sciences communities planning for future ocean education initiatives. Rapidly evolving ocean observing programs equipped with sophisticated, integrated cyberinfrastructure will allow for millions of people to *experience* the ocean in new ways. These programs and their products have great potential to be integrated throughout the formal to informal science education spectrum and across multiple platforms including handheld mobile devices, classroom and personal computers, internet-connected multimedia displays in informal science institutions, and gaming platforms, among others. Global Positioning System (GPS) equipped mobile technologies are particularly promising as teaching tools and can provide local context for ocean observations as well as simultaneous access to and interactivity with ocean data, imagery, and visualizations.

The explosion of participatory media (blogs, wikis, social networking, music-photo-video sharing, podcasts etc.) is blurring the boundaries between content providers and their audiences. This evolving online culture and continuing advances in information and communications technology hold promise for "harnessing the collective intelligence" and for a "digital commons". All of these trends and technologies are becoming increasingly important in reaching broader audiences as learners search for opportunities that allow for interest-driven learning.

As new ocean sciences initiatives emerge, many of COSEE's existing strategic goals are being enhanced and expanded by tapping into emerging infrastructures for scientific research and education, and by capitalizing on the rapidly evolving Internet culture. Over the next decade, ocean sciences education will have the opportunity to engage the public as active participants in the research enterprise through emerging information and communication technologies, including social media and online platforms that allow interaction with data, visualizations, remote and virtual laboratories, and science and technology experts.

5) Embracing an inclusive, team-based approach to ocean sciences education

Ocean sciences education plays a critical role in addressing grand challenges affecting humanity and the planet. Just as ocean sciences research is by its nature a multi-disciplinary enterprise that requires teams of people with diverse expertise and skills, so to does ocean sciences education. The needs of the audiences should inform the composition and purpose of a multi-disciplinary ocean science education team and its composition should be related to the context of the ocean science education and communication effort. To accomplish this, knowledge from the learning sciences community about how people learn should be used to determine modes of communication, misconceptions commonly held by target audiences should be identified, and active participation in the ocean sciences enterprise should be invited. This team-based approach will ensure that advances in ocean sciences, technology, and learning sciences intersect for the benefit of a wide and diverse audience. For example, embracing cyberlearning for ocean sciences requires collaboration across learning sciences, information and communications technology (ICT), educational software development, ocean sciences, and formal and informal education.

C) KEY FOCUS AREAS

Community Meeting participants were asked to generate a set of far-reaching, strategic recommendations for key focus areas for the future of NSF ocean sciences education. Below is a synthesis of these recommendations and strategies for implementation that came out of the two days of discussion. The recommendations and strategies reflect the charge to the participants to build on the programs, network capabilities and infrastructure of the National COSEE Network, to take into account the emerging CI for research and education, and to support integration of ocean sciences education into the NSF ocean sciences research portfolio and the broader Foundation-wide initiatives.

Delivering Clear, Compelling Ocean Sciences Information to the Public

"Simple clear messages, repeated often, by a variety of trusted sources." Ed Maibach

Society is grappling with a large number of pressing environmental and sustainability issues that are often poorly communicated to the public by the scientific community and miscommunicated by the popular media. Advances in social sciences and science communications research are providing new insight into crafting and delivering clear, compelling science messages to reach and impact targeted audiences. These strategies, when combined with recent trends in mass media and information and communications technology, can dramatically increase the ocean sciences research and education community's capacity to promote ocean literacy across a broad cross-section of society.

The community should embark on a state-of-the-art, research-based initiative to dramatically increase the number of people who perceive ocean literacy to be essential and who use ocean sciences information to make informed decisions about important ocean related issues. Highlighted in the initiative should be the vast potential ocean sciences research holds for informing solutions to some of the grand challenges facing society (e.g. climate change, sustainability of ocean fisheries, biodiversity, sea level rise). The outreach initiative should be led by a team(s) comprising a wide spectrum of experts from diverse fields (e.g. ocean sciences; communications sciences; social sciences; ocean education; multimedia and new media; etc.). Working closely with ocean science researchers, these experts can help draw clear linkages between science and society, and illustrate how the scientific enterprise is relevant to people's everyday lives. The ocean environment itself provides an exciting context for conveying this information – filled with beauty and mystery, largely unexplored, inhabited by creatures from the charismatic to the bizarre, and an endless source of stories about human connections to and dependence on the ocean. Complex science can be deconstructed into a small number of simple and flexible messages to be used by people both internal and external to the science community. Ocean sciences information can be tailored to be culturally relevant to groups who traditionally do not have strong connections to the ocean. The initiative should take advantage of both traditional mass media outlets and emerging communications devices (e.g., mobile devices) and networks (e.g., Facebook).

To impact the attitudes, understanding and actions of large segments of the population, the ocean sciences community must work on the scale of a unified, integrated, national-international effort that is organized and sustainable for the long term. The COSEE Network can be central to this process by 1) tapping into existing COSEE Network infrastructure and national and international partnerships; 2) capitalizing on COSEE expertise in deconstructing complex science using tools such as concept mapping; and 3) leveraging the COSEE knowledge base on crafting culturally relevant ocean sciences messages.

Key Strategies for Implementation:

- Develop multi-disciplinary ocean sciences communications teams dedicated to deconstructing complex ocean sciences concepts and to creating and communicating a few simple, clear ocean sciences messages to targeted audiences. In addition to ocean scientists and educators, communications experts (e.g. social scientists specializing in science communication) should be integral to the teams so that information is framed and communicated effectively.
- Identify and pro-actively train and support a generation of charismatic ocean scientists who can effectively deliver ocean sciences knowledge and stories. Build communications programs around them and the key messages they specialize in delivering.
- To reach the younger generation, strategically partner with mass media outlets (e.g. engage producers of Sesame Street) to disseminate key messages. Use a variety of communications platforms (e.g. mobile communication platforms) to reach these audiences.
- Redefine the COSEE education position at the Smithsonian Sant Ocean Hall to better integrate NSF ocean sciences research and education initiatives with the exhibits, activities, and programs.

Using Ocean Data to Teach Scientific Thinking: Engaging Non-scientists in Ocean Sciences Research

Science, mathematics, and engineering education could be profoundly transformed by placing far greater emphasis on learning that is based on student interactions with complex data and systems (in Report on the NSF Taskforce on Cyberlearning, 2008).

Advances in computing, cyberinfrastructure, and information and communications technology are changing the way ocean sciences research is conducted. As the emphasis shifts toward multi-scale, long-term observation of the ocean, ocean sciences is becoming a discipline that is increasingly characterized by fast, seamless, open access to data; the ability to integrate diverse data resources generated through field observations and quantitative modeling; and (soon) the capacity to collaborate in real-time with geographically dispersed colleagues on observatory-based

science missions. In a parallel trend, recent advances in web-based, inquiry-driven formal and informal education have led to development of on-line platforms for instruction that engage learners in active scientific inquiry, incorporate computer simulations of real-world phenomena, and involve collecting and analyzing data. In combination, these research and educational advances provide the basis for a more fully integrated ocean sciences research and education enterprise and provide an unprecedented opportunity to immerse learners in ocean discoveries. The community should capitalize on these trends to provide learners with new and engaging ways to participate in ocean sciences research activities and to interpret and personalize their connection to the ocean.

As observatory systems (e.g. OOI; R2R) and other ocean sciences data collection, analysis, visualization and archiving systems become increasingly pervasive and automated, these systems provide a context for readily addressing fundamental questions in research on cyberlearning. Moreover, the answers to these questions can be applied to create effective ocean sciences learning experiences that are firmly grounded in both learning sciences and the evolving paradigm for ocean sciences research. Fundamental learning science research questions posed in the report of the NSF Task Force on Cyberlearning include:

1. How can STEM instruction incorporate authentic and realistic data from research, models, simulations, and other sources to improve lifelong science learning?
2. What forms of user interfaces and interoperable resources will allow students to easily experiment with resources such as simulation models and datasets established by and for science experts?
3. What are the benefits for science learning of new data visualizations, immersive environments, modeling environments, sensor networks, and other technologies?
4. What are the general principles that can guide adaptation of computational resources to different education and learning settings?

(from *Report on the NSF Taskforce on Cyberlearning, 2008*)

The ocean sciences research and education community should create an ocean sciences cyberlearning initiative that capitalizes on the exciting context of the ocean to investigate how science data can be incorporated into STEM instruction to improve life-long science learning. Success will require highly interdisciplinary research teams comprising ocean scientists and modelers, learning scientists, educational software developers, ocean education experts (formal/non-formal), experts on learning with sensor networks, data visualization experts and teachers. The knowledge gained will be applied broadly as the Nation advances its efforts in global observing and on training the 21 st century workforce.

Promising potential projects include: 1) Incorporating data and data products such as video, visualizations, and scientific models into virtual research environments for education. Audio, video, and data feeds will stream to multiple platforms that allow users to manipulate the feeds with software tools designed for exploration or authentic scientific inquiry. Advances in the semantic web will allow developers to capture various users' stories on how these ocean research data make meaning to them; 2) Developing "serious games" focused on research scenarios that support authentic inquiry by students. Multiplayer games can involve teamwork with a mission-like atmosphere where learners can manipulate information (e.g. data, video, images, models, observations) to create their own knowledge; and 3) Designing citizen science and/or crowd sourcing activities that will benefit both researchers and learners. These education activities could utilize thin clients (e.g. a droid or smartphone application) for exploration, collaboration and reporting. Use of thin clients will enable broader access by meeting learners "where they are".

A next generation COSEE will play a leadership role in defining the protocols and effective practices for bringing real-time science and action to the classroom and other learning environments. These practices can be readily shared online with others and help the community better understand and adapt to how various audiences connect with ocean science.

Key Strategies for Implementation:

- Create opportunities for direct learner involvement in ocean sciences afforded by large investments in ocean research cyberinfrastructure (e.g. OOI, R2R) and advances in cyberlearning by creating a new ocean cyberlearning initiative. The initiative would promote creation of cross-disciplinary communities of cyberlearning researchers and practitioners, including software developers and IT staff, educators at all levels, domain scientists, and social scientists - and would

equip them for carrying forward cyberlearning effectively in new ocean cyberlearning programs at both the college and pre-college level.

- Bring real-time science and action to the classroom and other learning environments by creating online collaborative environments that serve as virtual spaces for linking researchers, educators, and learners of all ages for research, education, and outreach. Data streams, photos and videos, and personal stories comprise the catalytic conversations that can take place in this environment. Social media, live video links, and asynchronous interactions (e.g. Facebook, YouTube, Twitter, etc.) can bridge multiple learning environments and technologies.
- Partner with entities that specialize in 3D visual representation of geographical information (e.g. Google Ocean, Fledermaus) to reach a broader audience and to give access to place-based learning opportunities. These tools are not yet fully tapped for use in ocean sciences education, but have potential to support novel learning opportunities that connect users to the ocean.

Elevating Ocean Sciences to a Place of Prominence in the Educational Continuum

Ocean sciences is both a distinct topic of instructional focus, and a system of important concepts that must be integrated across the mainstream science curriculum. Historically, ocean sciences has been marginalized in both national and state science standards. The U.S. Commission on Ocean Policy reported that the absence of ocean sciences in schools resulted in a generation of Americans ignorant of the importance of the ocean, placing our economy, environment and national security at risk. While COSEE has made considerable progress in raising the prominence of ocean sciences in K-12 and informal education, the renewed focus on the oceans and ocean stewardship heralded by the National Ocean Policy provides the ocean sciences research and education community with a new basis for asserting that oceans sciences must be taught broadly and well.

The ocean sciences research and education community should play a leadership role in elevating ocean sciences to a place of prominence in the education system that is comparable to its prominence and importance in the scientific community. Vetted by scientists and educators nationwide, *Ocean Literacy: The Essential Principles of Ocean Sciences* is a transformative consensus document that needs to be fully and systemically integrated into mainstream formal science education standards, curriculum, and learning materials. The community can play a central role in this integration by facilitating access to up-to-date, inspiring ocean sciences content, data and interfaces. The challenge is to transform the existing educational systems and services to incorporate accurate and compelling ocean sciences content and practices.

To provide leadership in formulating science education policy and professional development, the ocean sciences education community must engage in a unified approach that involves a combination of educators, ocean sciences researchers, and learning sciences specialists. One avenue for undertaking this leadership role would be to establish an NSF *Science of Learning Center for the OCEAN (SLCO)* dedicated to how people learn about complex, interconnected, abstract systems, and that uses ocean systems and related ocean sciences learning progressions as its primary focus. Ocean sciences research depends heavily on the visual—including 4-Dimensional—representation of data and models; interpreting these requires specific training and skills. Targeted ocean sciences educational research at an ocean-themed SLC could be used to address several challenges in coordinating learning across the matrix of formal and informal learning: 1) developing and maintaining flexible and dynamic curricular standards that address basic ocean sciences topics, and current and emerging ocean sciences research; 2) identifying learning progressions that address requisite skills for success in studying ocean sciences concepts (e.g. spatial reasoning); 3) linking those learning progressions to interpretation of real data, ongoing data collection and new discoveries; and 4) using information and communications technology to facilitate user-generated, value added content and engagement strategies (e.g. strategies that support creation of culturally relevant contexts for teaching ocean sciences) that make the content easier to share, discover, evaluate, and enhance.

Lifelong learning occurs within a matrix of formal and informal educational environments within which curricula and standards are developed and enacted. We see a transformative role for COSEE in supporting a broad community in creating compelling ocean sciences content and interfaces that can be used across formal and informal educational environments.

Key Strategies for Implementation:

- Create an ocean-themed Science of Learning Center that identifies and coordinates its work around an ocean-related grand challenge facing society. Turn that into learning progressions for a wide variety of audiences, tapping into ICT to disseminate and get feedback. A next generation COSEE could empirically document the discovered progressions and apply that knowledge in new situations and to other ocean challenges.
- Proactively ensure ocean science participation in development of National Common Core Science Standards. Actively pursue the inclusion of an ocean scientist(s) involved in K-12 education on the *Achieve* design team that writes the standards. Enter into this effort in partnership with geoscience and geography education communities.
- Develop capacity to teach the discovery process of ocean sciences using local interests and values and get away from ocean content only. Use ICT tools that enable broader participation and apply learning science research on place-based, culturally relevant learning to ocean sciences education programs.

Broadening Participation in Ocean Sciences: Increasing Diversity in the Ocean Sciences Research and Education Enterprise

All individuals should be able to participate in ocean sciences research, learn about ocean science topics, and consider a career in one of the many contemporary research fields in ocean sciences. Ocean sciences education should remove barriers to and support participation in ocean sciences research endeavors and provide meaningful learning experiences to support the multiple goals of promoting ocean literacy for all, college-readiness, and pathways into STEM occupations. There is no single career or learning pathway or pipeline through STEM education (NRC, 2007, 2010). Therefore, a coordinated strategy for supporting these diversity goals would focus on a range of specific efforts at different points in the STEM education system.

The ocean sciences community should promote seamless learning experiences at a broad scale—across formal and informal learning settings—to provide access to compelling ocean sciences learning experiences to students from underrepresented groups in elementary through secondary schools and at undergraduate institutions. This could involve developing mobile technology learning platforms that sustain learning pathways for all learners and allow for more equitable participation in ocean sciences research. Social science studies indicate deeper use of social media and mobile technologies exist within specific underrepresented groups and can be leveraged in the design process. These learning experiences should allow for interest-driven learning, connect students into science-rich learning networks, and highlight the cultural and personal relevance of ocean science topics to their local communities.

The community should also apply and contribute to the social science literatures that inform efforts to broaden participation in the ocean sciences in order to most productively shape the educational activities in ocean sciences education. Some highly relevant literatures do exist, however, new empirical research should be conducted where relevant research does not exist including understanding the barriers to participation (e.g., through audience research, survey research) and creating meaningful learning experiences that attend to the cultural specifics (e.g., design-based research).

A next generation COSEE should continue seeking and promoting strategic partnerships with organizations that serve groups that are underrepresented in ocean research (e.g., Society for Advancement of Chicanos and Native Americans in Science, SACNAS; ASLO Multicultural Program, Institute for Broadening Participation, IBP). A two-prong strategy would include communicating ocean sciences research and career opportunities to those diverse communities. Secondly, individuals interested in ocean science topics should be provided with ongoing support (e.g., advising, mentoring, recruitment, and networking) to help establish the pathways for these individuals as they enter into the ocean sciences research and education community.

Key Strategies for Implementation:

- Support the "multiple publics" (Leiserowitz et al., 2010) in participating more deeply in ocean sciences research. Leverage social networking and participatory media to enable broader participation. Use a variety of research methods (e.g. communications, social and decision making science) to determine which pathways will be the most durable.
- Support broader audiences by creating and testing customizable, open source ocean science learning and communication materials that can be adapted and refined for new audiences. Scale successful materials to larger communities. Build on COSEE's experience with underserved audiences, and with online resources that are tailored for specific audiences, to support development of these materials.

- Develop/discover pathways for broadening participation in OS—including physical entry points to these pathways (i.e. where does one go to connect with research experiences). Engage the students where they are (e.g., in their middle school classroom, after school programs, in their community centers, etc.) Establishing partnerships with community-based organizations and minority-serving institutions are important pathways to doing this.
- Build on the COSEE Network experience in and infrastructure for collaborating with other organizations and networks that focus on broadening participation.

VI. Conclusions

The last decade saw tremendous progress in the integration of ocean sciences research and education, driven in large part by the catalytic programs and activities of the National COSEE Network. At the same time, advances in cyberinfrastrucuture and information and communications technology initiated profound paradigm shifts in the ocean sciences research and science education enterprises. Moving forward, the ocean sciences research and education community has the potential to build on past progress and to capitalize on a broad array of promising new opportunities afforded by these advances. The Community Meeting on a Future Vision for COSEE and NSF Ocean Sciences Education brought together a group of highly accomplished professionals to engage in far ranging, forward looking discussions on the most promising new opportunities for ocean sciences education and on key strategies for capitalizing on those opportunities. Participants included ocean scientists, science educators, learning science specialists, K-12 and college level instructors, and experts in cyberinfrastrucuture and information and communications technology. The discourse was brisk, stimulating and productive, and led to the articulation of a set of key focus areas and unifying crosscutting themes that together constitute a framework for *the future of NSF ocean sciences education and a next generation COSEE*.

The overarching community vision for the future is an American public that is more cognizant of the relevance of the ocean to their daily lives, and that perceives informed decision making about ocean related issues to be essential to the health, well-being and economic security of the Nation. Central to this vision is a dramatic increase in the number of people who are ocean literate, accompanied by heightened public awareness of the critical role ocean sciences research plays in advancing understanding of the ocean. Achieving this vision will require a multifaceted approach.

Learners of all ages and from all cultural, ethnic, and racial backgrounds can be engaged in ocean research and discovery. New ocean research initiatives provide exciting contexts for promoting scientific thinking and for allowing learners to tap into cutting edge scientific infrastructure and online data resources. Ocean sciences can be elevated to a place of prominence in the education system that is comparable to its prominence and importance in the scientific community. It should be fully integrated into national science standards and curricula across all of the science disciplines, and ocean scientists and educators should play a prominent role in this process. Finally, the community should continue to strive to remove barriers to participation in ocean sciences research endeavors and should provide meaningful, culturally relevant, place-based learning experiences that promote ocean literacy for a much broader cross-section of the public.

These efforts should emphasize the integration of ocean sciences research and education, with a focus on new NSF ocean science initiatives and cross directorate programs. Emerging technologies should be embraced when designing new programs as they provide mechanisms to connect researchers, educators and the public in ways that appeal to the new generation of continuously connected, mobile learners. Highly interdisciplinary teams should constitute a new paradigm in ocean sciences education as the community explores a rich new set of collaborations with experts that can help bridge the gap between science and the public. New initiatives must be carefully designed to leverage the existing infrastructure and expertise of the National COSEE Network, while integrating advances in ocean sciences research and research on learning. They must build capacity not only to reach new and larger audiences, but also to continually adapt as the landscape for ocean sciences research and education continues to evolve.

The ocean sciences research and education community is truly at a crossroads. The National Ocean Policy is a mandate to advance ocean sciences and ocean sciences education to benefit the Nation. Equipped with a set of strategies for increasing public appreciation and understanding of the ocean and ocean sciences, the National COSEE Network in partnership with the broader ocean sciences community is poised to take a leadership role in achieving the NOP vision while increasing public engagement in and support for the ocean sciences research endeavor.

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Appendix 2: Community Meeting Agenda

MEETING GOAL

To explore broadly a future vision for the next decade of NSF ocean sciences education that builds on existing capabilities and strengths, while capitalizing on opportunities afforded by the rapidly advancing ocean sciences research and science education enterprises. The vision must emphasize the NSF commitment to the integration of ocean sciences research and education, and to catalyzing and sustaining collaborations between ocean science researchers and science educators. The meeting outcomes will include a set of far-reaching, strategic recommendations for COSEE's role in achieving the vision that builds on the programs, Network capabilities, and infrastructure of the National COSEE Network; emerging cyberinfrastructure for research and education; and proven effective practices and programs of the larger ocean sciences and STEM education communities.

TUESDAY, NOVEMBER 2

Washington Marriott, Georgetown I

7:30-9:00 pm Community Meeting Introductory Gathering

WEDNESDAY, NOVEMBER 3

Ronald Reagan Building, Hemisphere A

8:30 am Breakfast *(Foyer)*

9:00 WELCOME: David Conover, Division Director, NSF Ocean Sciences

9:15 Introductions

9:45 PLENARY SPEAKER: *Edward Maibach, Director, Center for Climate Change Communication, George Mason University*

10:30 Break *(Foyer)*

10:45 PLENARY SPEAKER: *Roy Pea, Director, Center for Innovations in Learning, Stanford University*

11:30 Charge to the Community Meeting Attendees

11:45 DAY 1 WORKING GROUPS:

Group 1 (Continental C): How can contemporary, consensus perspectives on science learning and teaching be leveraged to better integrate ocean sciences research and education, and advance ocean sciences literacy?

Group 2 (Hemisphere B): How can the capabilities of selected, relevant cyberinfrastructures be leveraged to create or enhance a viable virtual organization to further the goal of integrating ocean sciences research and education?

Group 3 (Hemisphere A): What approaches can be used to best support education and outreach at the leading edge of ocean sciences research?

Group 4 (Meridian C): In the overall science education landscape of the future, what is the optimal position for NSF-supported ocean sciences education?

12:30 pm Lunch *(Foyer)*

1:30 CONTINUE WORKING GROUPS *(Hemisphere A, Hemisphere B, Continental C, Meridian C)*:

Output: 1-page draft summary response to vision questions (see Talking Points)

3:30 Break *(Foyer)*

3:45 CONTINUE WORKING GROUPS *(Hemisphere A, Hemisphere B, Continental C, Meridian C)*:

Output: Written document of implementation recommendations (see Talking Points) that can be shared among working groups

5:00 Adjourn

THURSDAY, NOVEMBER 4

Ronald Reagan Building

7:30 am Steering Committee Breakfast *(Hemisphere B)*

8:00 Breakfast *(Foyer)*

8:30 PLENARY: Reports from Day 1 and Discussion *(Hemisphere A)*

9:50 Break *(Foyer)*

10:00 SMALL GROUP DISCUSSION AND RECOMMENDATIONS *(Hemisphere A, Hemisphere B, Continental C, Meridian C):* In the context of the results from Day 1, identify an overarching vision, priorities and recommendations. Address the over arching questions.

Moving forward, what is our overall vision and strategy for making significant advances in the integration of ocean sciences research and education in the next decade? What are the highest priorities and key recommendations that will support achieving this vision?

11:00 Whole group report out and discussion *(Hemisphere A)*

12:00 pm Lunch and writing: Draft synthesis Vision and Recommendations document

1:30 SMALL GROUPS RECONVENE *(Hemisphere A, Hemisphere B, Continental C, Meridian C):* Comment on draft and identify outstanding issues

2:30 FINAL DISCUSSION *(Hemisphere A):* Edits of draft synthesis document; Next steps; Evaluation

3:30 Meeting adjourns

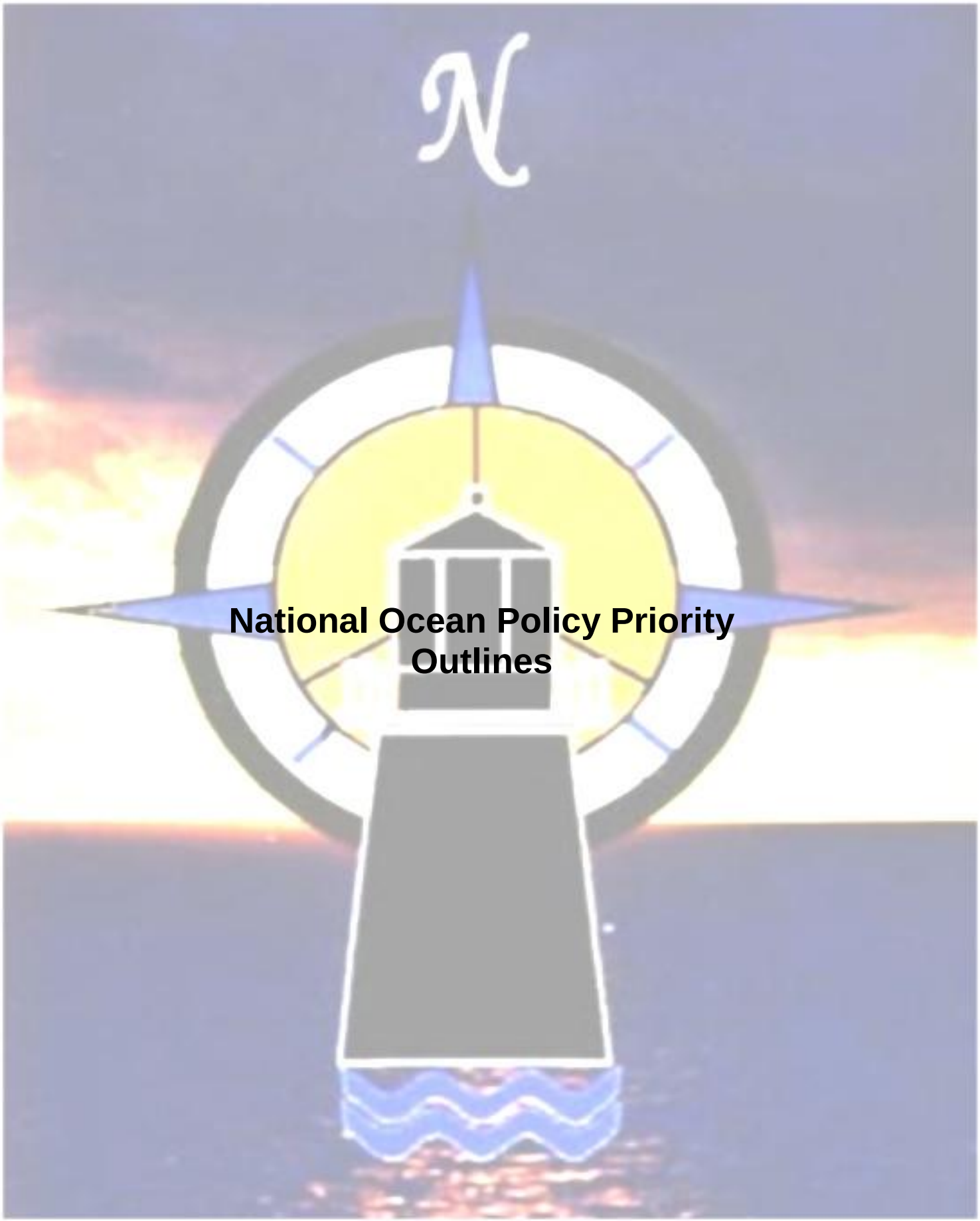
Appendix 3: Plenary Speaker Biographies

EDWARD MAIBACH, MPH, PHD

Ed Maibach is a professor of communication and director of the Center for Climate Change Communication at George Mason University. With over 25 years of experience as a researcher and practitioner of public health communication and social marketing, Ed now focuses exclusively on how to mobilize populations to adopt behaviors and support public policies that reduce greenhouse gas emissions and help communities adapt to the unavoidable consequences of climate change. Ed previously had the pleasure to serve as Associate Director of the National Cancer Institute, as Worldwide Director of Social Marketing at Porter Novelli, as Chairman of the Board for Kidsave International, and in academic positions at George Washington University and Emory University. He earned his doctoral degree at Stanford University and his MPH at San Diego State University.

ROY PEA, PHD

Roy Pea, D. Phil., Oxon. is David Jacks Professor of Education and the Learning Sciences at Stanford University, and Director of the Human Sciences and Technologies Advanced Research (H-STAR) Institute. He has published widely on research, development and theory concerning K-12 science and technology education fostered by advanced technologies. He served as President of the International Society for the Learning Sciences, is a Fellow of the National Academy of Education and the Association for Psychological Science, and co-founded Teachscape, a company providing K-12 teacher professional development with online communities using web-based video studies of standards-based teaching.



National Ocean Policy Priority Outlines

Ecosystem-Based Management
Strategic Action Plan
Full Content Outline

Objective: Adopt ecosystem-based management as a foundational principle for the comprehensive management of the ocean, our coasts, and the Great Lakes.

Definition: Ecosystem-Based Management (EBM) is an integrated approach to resource management that considers the entire ecosystem, including humans, and the elements that are integral to ecosystem functions. EBM is informed by science to conserve and protect our cultural and natural heritage by sustaining diverse, productive, resilient ecosystems and the services they provide, thereby promoting the long-term health, security, and well-being of our Nation.

I. Overview of Priority Objective: Ecosystem Based Management

- The National Ocean Policy recommended EBM as a foundational principle to promote more effective and sustainable stewardship of our Nation's oceans, coasts, and Great Lakes.
- The Strategic Action Plan (SAP) for EBM will enhance our Nation's efforts to understand, use, manage, and conserve our valuable coastal and marine ecosystems. This SAP will provide a conceptual framework for integrating the management of diverse human activities that are linked to or depend on coastal and marine resources (e.g., shipping, fishing, energy production, military operations, coastal development).
- EBM differs from current approaches that focus on single-sector management (i.e., a single species or type of activity) by considering the whole ecosystem, including humans. The foundation for sustaining the long-term capacity of these systems to deliver a range of ecosystem services depends on ensuring the health and function of ecosystems.
- EBM plans and strategies must incorporate the cumulative effects of multiple human activities and varying levels of those activities on entire ecosystems, and address explicitly approaches for assessing trade-offs among these activities with the goal of maintaining ecosystem health and services.

II. Context and Continuity

- The EBM SAP outlined below is founded on four themes:
  - EBM Leadership and Collaboration - Establishes a framework across Federal and non-Federal agencies and organizations at multiple levels to guide the implementation of EBM at multiple scales; defines the criteria for selecting the initial geographic areas where EBM will be implemented; and identifies a plan to phase EBM implementation into additional areas. This theme will complement the Coordinate and Support SAP.
  - Interagency EBM Science Framework - Develops and implements a hypothesis-driven, nation-wide framework of integrated observations, monitoring, and research to provide a sound scientific basis for understanding ecosystems and informing management decisions.

- Inform Decision-making - Promotes the sharing of knowledge regarding EBM by communicating the principles, best practices, and decision-support tools among the partners involved in the decision-making process. This theme will be integrated with the Inform Decisions and Improve Understanding SAP.
- Policy and Governance - Identifies legislative and regulatory impediments to implementing EBM, and identifies actions to incorporate EBM cohesively into the environmental statutory and regulatory regime, project planning, and management strategies at the Federal, regional, state, territorial, tribal, and local levels. This theme will be integrated with the Inform Decisions and Improve Understanding SAP.

III. Body of the Plan

A. Action 1- EBM Leadership and Collaboration.

A Federal interagency working group will: (1) develop and propose an explicit framework for working with regional, state, territorial, tribal, and local management entities; (2) ensure that Federal agencies integrate EBM approaches into their decision-making processes; (3) identify strategies to increase understanding of EBM within the federal workforce; and (4) serve as a forum that monitors the integration of ecosystem-based activities within Federal agencies.

1. Why Do This
   - This action will lay the foundation for more efficient and effective management of the oceans, coasts, and Great Lakes by promoting a common understanding of and competence in leading implementation of the EBM approach to: (a) eliminate duplication of effort across agencies; (b) inform management decision-making with the best available science and data about the diverse interests of partners and stakeholders; and (c) build capacity and promote cooperation and leveraging of data, resources, and tools across all levels of government (Federal, regional, state, tribal, territorial, and local) and between governments and diverse stakeholders, including industry, NGOs, and the general public.
   - This action will ensure the assimilation of EBM and its principles as the improved way of doing business and promote stewardship of our Nation's coastal and ocean resources. It will incorporate lessons from and promote the exchange of information derived from Federal and non-Federal EBM models that successfully use collaborative, stakeholder-driven, place-based tools and approaches to address coastal and ocean management issues. Examples of those efforts include, but are not limited to, regional fisheries management (e.g., State of Alaska, NOAA), the National Estuary Program (EPA), Landscape Conservation Cooperatives (DOI, NOAA, and NGOs), and regional Governors' agreements. This action will build on those regional, state, tribal, territorial, and local models that apply EBM principles and build leadership and collaborative decision-making competence in additional places/regions.

2. Timeframe –Mid-term

3. Outcomes

- Increased application of EBM by Federal and non-Federal agencies and organizations at multiple levels to support collaborative strategic planning and priority-setting in selected geographic areas. Federal and non-Federal parties will: a) develop and align place-based goals and plans; b) involve multiple stakeholder interests; c) improve the coordination of activities; and d) increase leveraging of each others' resources in support of outcome-oriented EBM. They will begin to better integrate and consider regional and local economic activity and human uses as well as the cumulative impacts on ecosystems. They will utilize scenario building, coastal and marine spatial planning (CMSP) tools, and other available decision-support tools.
- Enhanced integration of capabilities and resources among Federal and non-Federal parties. All partners will participate in the information sharing and promotion of holistic EBM and adaptive management approaches. Implementation of this action will promote the development and exchange of sound, accessible, and best-available scientific and socio-economic data regarding the condition and health of ecosystems and will highlight the results of efforts to apply EBM concepts at the regional, state, tribal, territorial, and local level.
- Criteria for identifying priority areas for EBM implementation will be selected. Representation on the working group will include consideration of unique marine environments, natural resources and cultural sensitivities as well as tribes' cultures, traditions, economic livelihoods, and public health.
- Place-based pilot projects will utilize best practices and promote understanding of and information about how to effectively implement EBM principles and concepts.
- A process is established to implement collaborative approaches to resource management, using EBM to set strategic goals and objectives and more effectively manage ecosystems. These processes will build upon the existing frameworks in those regions where Governors' agreements are in place.
- Educating and training a cadre of decision-makers and managers at all levels in EBM principles and practices will begin. The training and education will include transferring lessons learned from those entities already engaged in ecosystem-based management of coastal and ocean resources. These decision-makers and managers will be competent in leading the adoption of EBM approaches and of adaptive management principles and concepts.
- Regional, tribal, territorial, state and local stakeholders and decision-makers will begin collaborating to identify shared goals as well as common and divergent interests in each geographic region. They will develop and adopt strategies for addressing priority needs.

- As the EBM SAP is implemented, gaps in the coordination processes among state, tribal, territorial, and local authorities and regional governance structures will be identified and efforts undertaken to begin addressing those gaps.
- Efforts will be undertaken to align agency-specific and cross-agency EBM goals and objectives with existing regulatory and statutory management requirements.

4. Milestones

- Establish a joint interagency-regional EBM Working Group.
- Develop a course catalog of a recommended curriculum for developing competencies in leading the adoption of EBM and adaptive management approaches.
- Identify geographic priority areas for EBM implementation based on a clearly defined set of criteria determined through an interagency process.
- Establish criteria for identifying priority geographic areas to implement EBM in cooperation and consultation with Regional bodies and utilizing CMSP and other available tools.
- Compile and disseminate information depicting examples of EBM capacity, as well as resources and tools to further EBM implementation at all levels. Utilize local community partnerships and build on existing EBM networks to facilitate implementation.
- Complete agency-specific guidance that provides direction for using EBM to achieve management requirements with existing regulatory and legislative authorities.
- Decision-makers and managers complete the recommended EBM curriculum and share a common knowledge base of EBM concepts, principles, and practices. Key decision-makers and managers include individuals working in Federal coastal, ocean, and Great Lakes programs and their counterparts at the state, regional, tribal, territorial, and local level.
- Decision-makers and managers develop the skills to integrate technical and scientific knowledge into ecosystem-based approaches to management at a regional scale. This knowledge includes information and tools such as adequate scientific and socio-economic data and information, ecosystem modeling expertise, engagement of diverse stakeholders in collaborative processes designed to identify management priorities, and incorporating external, time-sensitive drivers of EBM (e.g., loss of critical Northeast groundfish, expansion of offshore energy development).
- Develop and implement model agreements (e.g., Memoranda of Agreement) to coordinate intergovernmental EBM implementation processes.

5. Gaps and Needs in Science and Technology

- Report on the status of marine and coastal ecosystems at a relevant scale through ecosystem research, monitoring, and observations, including key indicators of stresses on those ecosystems.
- Leadership and governance capacity: lack of knowledge about EBM and adaptive management on the part of policymakers, decision-makers, and managers could be an obstacle to agencies' support for the development of leadership competencies in EBM and adaptive management.

B. Action 2 - EBM Science Framework.

Establish an interagency EBM Science Framework of integrated research, observation, and monitoring capacity to improve understanding of ecosystem functions and the degree to which interactions among and within human and natural systems effects ecosystem health and services. This action will incorporate many of the actions of the Inform Decisions and Improve Understanding SAP into the EBM science framework.

EBM needs a science framework that will:

- Identify and facilitate the fundamental research needed to inform, implement, support, and advance EBM across the country.
- Emphasize the need to understand the basic physical, biological, ecological, and socio-economic aspects of marine and coastal ecosystems, to assess the more complex interactions, cumulative effects, and trade-offs required to maintain ecosystem health and services.
- Identify ecosystem services, describe hidden costs associated with human use of those services, assess trade-offs in benefits versus costs, avoid or reduce user and management conflicts, improve management outcomes, and promote sustainable use of ecosystems.
- Identify spatial extent of ecosystems, or boundaries, in terms of both management needs and the natural environment. Identify potential connections at multiple scales for ecosystems that connect across multiple jurisdictional boundaries, including international.
- Provide the scientific basis for managing people and their actions in a manner that sustains healthy, resilient ecosystems and ecosystem services. Among other things, this will require more effective alignment of the spatial characteristics of human activities with the environmental characteristics of marine ecosystems through marine spatial planning.
- Include all forms of scientific investigation, including short- and long-term observations, hypothesis testing, adaptive experimentation, and predictive modeling.
- Provide a range of science information tools and their appropriate application to the decision-making process. These tools can be broadly classified as modeling tools, decision analysis tools, and indicators of ecosystem status.

- Promote interdisciplinary research to understand the structure and function of marine ecosystems, including the complex interactions that shape them, rather than simply assessing their various components without regard to their role in ecosystems.
- Emphasize and enable applied research to address existing and anticipated management challenges, but also support basic research to promote scientific creativity and ingenuity.
- Utilize innovative technology (e.g., remote sensors) and field research programs, and build upon and complement existing Federal and non-Federal scientific programs.
- Leverage existing resources and capabilities from Federal and non-Federal agencies and organizations to provide stable and sustainable long-term financial support for EBM science framework.

1. Why Do This

An EBM approach depends on a strong scientific foundation that:

- Provides the physical, chemical, biological, ecological, and socio-economic data required to assess the linkages, interactions, interdependencies, and cumulative effects that are the metrics of ecosystem health, resilience, and productivity;
- Capitalizes on and complements the research capacity of Federal and non-Federal agencies and organizations at multiple levels;
- Elucidates benefits and costs associated with human activities within marine ecosystems;
- Centralizes research information to ensure that results are transparent, accessible, organized, and archived for future use;
- Promotes research targeted to specific regional ecosystems and sharing of information relevant to all regions and ecosystems;
- Utilizes targeted regional ecosystem projects to address specific knowledge gaps and inform place-based management needs;
- Develops new technology to enhance scientific and management efforts;
- Promotes a research-to-practice path for new technology; and
- Evaluates indicators of ecosystem health to provide the necessary assurance that our use of ecosystems is, in fact, sustainable.

2. Timeframe – Mid-term

3. Outcomes

- Establishment of a defined framework for guiding science, monitoring, and observations to inform and support EBM.
- Improved understanding of natural and human-related changes in ecosystems over time, as well as the implications of these changes for ecosystem and human health and for socio-economic well-being.
- Improved ability to forecast future conditions and outcomes.

- Establishment of a comprehensive repository of governmental, non-governmental and private sector data and resources (e.g., Marine Protected areas, NOAA stock assessments, Navy monitoring efforts).

4. Milestones
   - Establish interagency EBM Science Work Group; develop charters setting forth goals and objectives.
   - Coordinate with Federal and non-Federal agencies and organizations at multiple levels to initiate development of the EBM science framework.
   - Catalog and inventory existing governmental, non-governmental and private sector research, programs, and assets aimed at or related to EBM (e.g., Ocean Observing Systems), and identify (1) areas of unnecessary redundancy or overlap and (2) gaps in science related to EBM.
   - Establish a comprehensive repository of governmental, non-governmental, and private sector data and resources management (e.g., Marine Protected areas, resource stock assessments, monitoring efforts).
   - Identify, develop, and implement tools for the effective execution of EBM (e.g., Integrated Ecosystem Assessment (IEA) approach). The results will provide a basis for balancing those uses through spatially and temporally explicit marine spatial planning.
   - Set up an adaptive management process for the next-generation of EBM, based on lessons learned in the first two years of implementation of data architectures and IEA processes.
   - Conduct regular reviews of the initial EBM scientific framework, examining its strengths, shortcomings, and key research topics needed to promote more effective EBM. These review and recommendation processes would be coordinated with the Observations, Mapping, and Infrastructure SAP.

5. Gaps and Needs in Science and Technology
   - Identification of key indicators of ecosystem health and spatial areas of high or unique value.
   - Identification of existing and emerging technology that enables scientists, decision-makers, and the public to more easily input, archive, access, share, analyze, visualize, and explain data and information, such as mapping and geospatial analysis tools. This will be done in coordination with CMSP and Inform Decisions and Improve Understanding SAPs.
   - Continued development of ocean observing systems (e.g., the Integrated Ocean Observing System, the Ocean Observatories Initiative) to collect physical, chemical, biological, and ocean use data in (near) real-time.
   - Facilitation of data access by developing formal metadata standards and specific guidance for data input, integration, and preservation.

- Requirements for "open access" and "open science" for data and research methods.
- Development and adoption of protocols or standards for ecosystem service accounting and the valuation of EBM-relevant nonmarket goods and services that are not represented in the current economic literature.

C. Action 3 - **Inform Decision-Making to Support EBM.**

Develop and provide products and services to assist entities responsible for implementing EBM. Examples of products and services may include an interactive data portal, a synthesis and analysis of lessons learned from existing EBM initiatives, and an inventory of adaptive management approaches and tools. These products and services will enable Federal, state, territorial, tribal, regional, and local entities to share and discuss ecological, economic, social, physical, and other types of data and information that are needed to facilitate EBM and adaptive management approaches**.** This action will complement the actions of the Inform Decisions and Improve Understanding SAP.

1. Why Do This

Science-based products and services to support EBM are needed to:

- Ensure that decision-makers have access to the best available science, tools, and data;
- Ensure that the decision-making process reflects the interests of multiple stakeholders at Federal, state, territorial, tribal, regional, and local levels;
- Enable managers and stakeholders to consider all types of ecosystem services and the impacts to these services that may arise under alternative scenarios;
- Enable managers and stakeholders to assess the trade-offs associated with alternative policies and to minimize the conflicts that arise over multiple ecosystem uses;
- Promote collaboration and innovation among agencies responsible for managing our oceans, coasts, and Great Lakes; and
- Promote better informed and improved decision-making that will enhance our capacity to understand, respond, and adapt to a changing environment.

2. Timeframe – Mid-term

3. Outcomes

- Improved ability to balance the competing demands on ecosystems via improved understanding of ecosystem services, function, and resilience, and the interactions and feedbacks between human and natural systems.
- Enhanced management of resources due to the ability to evaluate trade-offs inherent in different management scenarios.
- An enhanced outreach and education program is available to inform stakeholders of EBM goals and underlying management and science principles.

- Promote sharing of data among all EBM constituencies (i.e., at the Federal, state, regional, local, tribal, and territorial levels).
- Improved ability to minimize environmental risk with the use adoption of adaptive management approaches.
- Improved understanding of data and information required to fully adopt an ecosystem approach to management.
- Enhanced societal resiliency in response to environmental changes via understanding of environmental trends, and the causes and consequences of change.
- Improved public partnership and increased environmental awareness through an understanding of the role of humans in ecosystems, including feedbacks that affect livelihood, human health and well being, and quality of life.

4. Milestones
   - Complete inventory, analysis, and synthesis of "lessons learned," EBM pilot projects, and adaptive management approaches and tools pertaining to oceans, coasts, and Great Lakes.
   - Assess agency data and information holdings related to management of oceans, coasts, and Great Lakes, and the development of data listings.
   - Develop and initiate the implementation of an outreach and education program to inform stakeholders of EBM goals and underlying management and science principles.
   - Implement and complete two to three pilot studies using adaptive management decision-making tools in selected geographic areas.
   - Prepare case studies and document results of the pilot studies.

5. Gaps and Needs in Science and Technology
   - Reasonable approximations (including a range) of uncertainty and/or the scientific confidence associated with management actions that are not currently available must be developed.
   - Mechanisms to provide comprehensive information from science and research to better inform EBM decisions.

D. Action 4: Incorporate EBM Principles into Policy and Governance.

Incorporate EBM principles into Federal, regional, state, territorial, tribal, and local project planning and environmental review processes to support rapid and effective implementation of EBM throughout our Nation's marine and coastal ecosystems. This will be coordinated with the Coastal and Marine Spatial Planning (CMSP) SAP.

1. Why Do This
   - EBM needs to be incorporated cohesively into the environmental statutory and regulatory regime and project planning and review processes (e.g., National Environmental Policy Act, Endangered Species Act, Coastal Zone Management Act,

Magnuson-Stevens Fishery Conservation and Management Act) to ensure a more holistic ecosystem-based approach.

- Management that is based on and more fully integrates physical, biological, ecological, and socio-economic information is more likely to meet human-related objectives while promoting healthier, more resilient, and productive ocean, coastal, and Great Lakes environments.
- Maintaining the health, resilience, and productivity of marine ecosystems is essential if our Nation's use of those ecosystems is to be sustainable for future generations.
- Opportunity exists to incorporate EBM principles into the regulatory regime under the Executive priority to improve regulation and regulatory review, which directs agencies to conduct a retrospective analysis of existing significant regulations (see Executive Order 13563, January 18, 2011).

2. Timeframe – Mid-Term

3. Outcomes

- Federal, state, tribal, territorial, and local project planning and review processes will incorporate EBM principles.
- An EBM approach will promote better stewardship because it takes into account the interactions among all the components of an ecosystem, including human activities.
- An EBM approach will provide a framework for managing multiple types of human activities in ways that do not diminish substantially the essential characteristics of marine ecosystems or undermine their ability to provide vital ecosystem services.
- Impacts to ecosystem services and functions will be addressed explicitly through environmental risk analyses, permits, and authorizations under the National Environmental Policy Act and other relevant Federal environmental legislation.
- Federal agencies will work collaboratively with regional, state, territorial, tribal, and local agencies and organizations through the regional CMSP process and other means to promote efforts such as the national system of Marine Protected Areas, Migratory Bird Joint Ventures, Landscape Conservation Cooperatives, the Marine Intertidal Network, and other ecosystem-based activities to conserve habitats.
- Targeted statutory and regulatory changes may be made to address relevant deficiencies in law and policy when deemed necessary in order to advance EBM.

4. Milestones

- Fully incorporate EBM into Federal agency environmental planning and review processes.
- Incorporate EBM principles into efforts responsive to legislative and regulatory environmental mandates.
- Review environmental statutory and regulatory regimes to determine areas of conflict and opportunities for integrating multiple agency management objectives towards achieving EBM goals.

- Prepare risk analyses and monitoring and mitigation plans that enable EBM to promote regulatory efficiency, consistency, and transparency across multiple management objectives.
- Issue model legislation and/or regulations.

5. Gaps and Needs in Science and Technology
   - Mechanisms for increasing awareness and understanding regarding EBM.
   - Getting near-term buy-in/agreement from Federal agencies that EBM is an integral approach towards integrating a science framework into current management.

Coastal and Marine Spatial Planning
Strategic Action Plan
Full Content Outline

Objective: Implement comprehensive, integrated, ecosystem-based coastal and marine spatial planning (CMSP) and management in the United States.

I. Overview of the Priority Objective

- This strategic action plan (SAP) addresses the National Ocean Policy priority objective to implement and expand the framework for effective CMSP as described in the Final Recommendations of the Interagency Ocean Policy Task Force (Final Recommendations), as adopted by Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes* (Executive Order).

- The Strategic Action Plan (SAP) for CMSP takes a different approach and has a significantly different structure than the other eight SAPs the other writing teams are developing.

    - This is appropriate, since much of the discussion in the Final Recommendations focuses on elements of the framework for implementing an effective CMSP process.

    - The National Ocean Policy calls upon the CMSP SAP Writing Team to reflect that approach and further develop those steps.

    - Moreover, the Executive Order and the framework for effective CMSP include specific expectations for additional guidance from the National Ocean Council (Council). The full content outline below provides a structure and some text in an effort to fulfill these expectations.

- As defined in the Executive Order, CMSP is a "comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. It identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives. In practical terms, CMSP provides a public policy process for society to better determine how the ocean, coasts, and Great Lakes are sustainably used and protected -- now and for future generations."

- The Executive Order adopts a clear set of objectives that our Nation should pursue to further the National Ocean Policy. CMSP is one of the nine priority objectives under this implementation strategy. In his June 2009 memorandum establishing the Interagency Ocean Policy Task Force, President Obama specifically called upon the Task Force "to develop a recommended framework for effective coastal and marine spatial planning." As a result, the Task Force spent considerable time and effort to develop such a framework, largely based on valuable input from

a wide spectrum of stakeholders, scientists, academics, and policy experts, as well as the general public.

- The Task Force members concluded that CMSP was a crucial element in a comprehensive national policy for the stewardship of ocean and coastal resources. The Task Force then outlined a comprehensive vision for CMSP in the ocean, coastal, and Great Lakes waters of the United States that is included in its Final Recommendations.

- The CMSP process that the Task Force identified aspires to significantly improve how we manage and protect our priceless coastal, marine, and Great Lakes waters and resources. At its core, CMSP begins with assembling all relevant stakeholders in each of nine coastal regions and gathering together all of the critical data elements. This includes mapping and assessing the ecological, economic, cultural, and societal resources as well as transportation, recreation, other off-shore uses, and security information within the context of an ecosystem model. Each of the nine regional planning bodies (RPBs) which will be established pursuant to the Executive Order, working with all interested stakeholders and the general public, will consider this assessment and associated maps and data, together with the current and projected uses of the entire planning area, to comprehensively and proactively identify those areas best suited for certain uses based on all relevant factors.

- The entire process is designed to be transparent, with close coordination between all State (defined to include the Territories), Federal, and tribal bodies, as well as a wide variety of domestic and foreign stakeholders. CMSP is intended to create a common shared vision for what all parties see as the best uses for these regional planning areas.

- This SAP will further explain the process of implementing the framework for effective CMSP. To help guide these regional CMSP efforts leading to the eventual development of coastal and marine spatial plans (CMS plans), this SAP will provide national CMSP objectives and performance measures. While the objectives and corresponding performance measures are national in scope, the CMSP process and CMS plans will be developed regionally, with regional objectives and performance measures which are informed by the national objectives. CMSP and CMS plans will be developed cooperatively among the Federal, State, and tribal partners on the RPBs—in consultation with indigenous community representatives, Regional Fishery Management Councils, and scientific, technical, and other experts—with substantial stakeholder and public input. The goal will be to provide specific, actionable, measurable, and cost-effective guidance to best achieve the many economic, environmental, security, and social benefits of CMSP throughout the ocean, coastal, and Great Lakes waters of the United States.

II. Context and Continuity.

- As the concept is implemented, CMSP will yield substantial economic, ecological, and social benefits. To do so, it must incorporate the principles of sound science for ecosystem-based and adaptive management, be transparent, and be informed by all stakeholders and the general

public. Rather than adding layers of review and delays, CMSP will significantly improve and build upon existing Federal, State, tribal, local, and regional decision-making and planning processes. CMSP is intended to facilitate sustainable economic growth in coastal communities by increasing transparency and predictability for economic investments in coastal, marine, and Great Lakes industries, transportation, telecommunications, public infrastructure, and related businesses. CMSP should promote national objectives such as enhanced national energy security and trade and provide economic incentives, such as more predictable and faster project implementation, for a wide range of commercial users. CMSP is intended to improve ecosystem health and services by planning human uses in concert with the conservation of important ecological areas, such as areas of high productivity and biological diversity, areas critical to ecosystem function and resiliency, areas if spawning, breeding, and feeding; and migratory corridors. CMSP can promote enhanced ecosystem services and benefits because they are incorporated into the CMS plans as desired outcomes of the process and not just evaluated in the context of individual Federal or State agency action. CMSP allows for a comprehensive look at multiple sector demands which will provide a more complete evaluation of cumulative effects.

- Working in concert with the other eight SAPs, CMSP is intended to promote society goals, including greater opportunities for community and citizen participation in open planning processes that would determine the future of the ocean, our coasts, and the Great Lakes. For example, the CMSP process would recognize the social, economic, public health, and conservation benefits of sustainable recreational use of ocean, coastal, and Great Lakes resources, such as fishing, boating, swimming, and diving, by providing improved coordination with recreational users to ensure continued access and opportunities to experience and enjoy these activities consistent with economic, safety, and conservation goals. Integrated engagement and coordination will result in stronger and more diverse ocean, coastal, and Great Lakes stewardship, economies, and communities. Moreover, CMSP can assist Federal, State, tribal, and local managers in planning activities to sustain economic, cultural, and recreational uses, human health and safety, and the continued security of the United States. Through empowering the RPBs, CMSP can overcome the obstacles and take advantage of the many opportunities present in our ocean, coastal, and Great Lakes waters.

III. National Objectives and Performance Measures [This section begins the main body of the SAP. It will list the key national strategic objectives of CMSP and describe specific performance measures for each.]

- **Introduction to the Concept**

    - As directed by the Executive Order, this SAP enumerates national objectives and associated performance measures to promote national and regional consistency in the development and implementation of regional CMS Plans. The following four national objectives are based on the national goals and guiding principles for effective CMSP under the Executive Order. Explicitly designed to tier off these goals and guiding principles, these national objectives and their performance measures should be

interpreted as a complement to them and not a stand-alone list of objectives. An appendix to this SAP will define key terms relevant to the CMSP process.

- While providing specific and measurable guidance, these national objectives as listed below are designed to permit flexibility for each RPB to craft regional objectives that address specific regional and local needs while helping to achieve the national goals. Due to the comprehensive nature of CMSP and the degree of external variables that could influence outcomes relative to national objectives, the approach taken here includes both outcome-based and output-based performance measures. Each national CMSP objective is accompanied by either performance measures that assess outcomes and/or milestones used to track specific outputs such as the establishment of RPBs. Index measures are used to help determine relative performance before plans are in place and after they are implemented in an effort to monitor changes attributable to CMSP according to individual agency specific mandates, authorities, and other requirements.

- The CMSP National Objectives and Performance Milestones and Measures will be designed to be as specific, measurable, achievable, realistic, and timely as possible given the nature of the planning process. They will also be designed to complement each other and guide CMSP development and implementation as well as monitoring and evaluating progress toward achieving the objectives and benefits of CMS plans.

- Under the Government Performance and Results Modernization Act of 2010, the Federal government will establish Federal performance goals deemed critically important to the Nation. Having national objectives and performance measures to track their achievement will be a benchmark for tracking interagency contributions as a whole and individually. This SAP identifies CMSP characteristics that should be reflected in its national objectives and measures such as regional scope; transparency; developed cooperatively among Federal, State, tribal, and local authorities, with stakeholders and the public working toward a shared vision; and incorporating ecosystem-based management for a more effective and cost-efficient means to guide and balance allocation of multi-sector activities. CMSP should reduce adverse cumulative impacts from human uses on marine ecosystems and provide more certainty in planning new investments. Further, it should reduce conflicts between how best to use and preserve the environment for sustainability and environmental stewardship.

- **Four Key National Objectives and Related Performance Measures**

  - **Objective 1 – Establish nine RPBs to undertake CMSP and develop by 2020 initial CMS plans for sustainable use and long-term protection of the ocean, coasts, and Great Lakes.** Per the Executive Order, CMSP is to be developed and implemented using a regional approach to allow for the variability of economic, environmental, and social aspects among the different areas of the United States. Each region is unique in geographic scope, cultural expectations and sensitivities, economic development, and

existing structures and planning for marine spatial planning, environmental protection, and resource management. Organizing, establishing, and beginning the work of the nine fully functional RPBs are critically important steps in carrying out CMSP and the overall National Ocean Policy. The members of each RPB will prepare and execute a CMSP Development Agreement early in the process, and then begin the planning process.

- **Objective 2 – By 2015, applicable non-confidential and other non-classified Federal data identified for inclusion will be incorporated into the National Information Management System and Data Portal.** The underpinning of the National Ocean Policy and CMSP framework is science-based decision making. While it is true that much additional research is needed, a significant amount of data and information already exists. However, not all of it is accessible or in a useable format for CMSP purposes. This second national objective calls for an innovative approach to data integration across the Federal government, as well as extending this approach to State, local, and tribal governments, industry, academia, and non-governmental organizations (NGOs). The National Information Management System (NIMS) as called for in the National Ocean Policy will not only target integration of diverse data sets, but it will also make this data readily available to decision makers, ocean users, stakeholders, and the public and support the development of new and/or improved decision support tools critical to the CMSP process. This section will include concrete action items to identify how Federal agencies will make data available and how the NIMS will support regional and local efforts. It will also describe how to best integrate data products available at State, regional, and local levels.

- **Objective 3 – Preserve and enhance opportunities for sustainable and beneficial ocean use through the promotion of regulatory efficiency, consistency, and transparency as well as improved coordination across Federal agencies.** Efficient regulatory processes are essential to preserve and enhance the sustainable use of the oceans. Improving efficiency and coordination across Federal agencies, with States, tribes, local governments, indigenous community representatives, and international partners, where appropriate, will minimize the burdens of regulatory delays on all levels of government and the regulated community. Most laws include strict time frames within which review and analysis of permitted activities must be completed. However, currently it is difficult to meet these time frames, which often leads to increased scrutiny, legal filings, and even financial constraints for both those industries that are seeking the permits, as well as the responsible Federal agencies. Using a well-designed and data-supported CMSP process can reduce these delays and costs by pre-assessing areas where certain activities may be better suited; providing frameworks for compiling all the relevant environmental, economic, and social data and information; and identifying in advance those activities that might have synergistic relationships. Coordinated efforts for integration of data as outlined in Objective 2 will also provide efficiencies and consistencies and will aid in the reduction of effort and time (by both Federal and private entities) required to support comprehensive National Environmental Policy Act

(NEPA) analyses. This objective will help meet the Administration's goal of reducing redundancy in Federal processes where appropriate, lead to more efficient regulatory review, and better support coastal economies into the future.

- **Objective 4 – Reduce cumulative negative impacts on environmentally sensitive resources and habitats.** Conducting an environmental impact assessment with a cumulative impact assessment is a mandatory step for any federally-regulated activity, yet assessing cumulative impacts quantitatively is challenging. Cumulative negative impacts on sensitive resources and habitats are those which result from adverse incremental impacts of human uses from the past, present, and foreseeable future. As stewards of the marine environment, Federal agencies are tasked with ensuring that beneficial environmental goods and services are not compromised by permitted activities. Similarly, a regional CMSP process involves defining and analyzing existing conditions and future conditions spatially—*before* any particular permitted activity is considered. As comprehensive, integrated assessment tools and analytical methods are developed and strengthened, so too will be the outputs of these efforts. Thus, this objective strives to avoid those impacts considered unacceptable, will lead to desirable activities being planned for those areas where resulting impacts are minimized or avoided, and will maximize existing sustainable and beneficial of the marine environment.

IV. Regional Implementation, Actions and Milestones, and Work Products. [This section will discuss regional implementation of CMSP consistent with the Executive Order and the framework for effective CMSP. Each of its elements should be clear and succinct; actionable; based on measurable and realistic outcomes within the stipulated milestones, timeframes, and limited resources; and adaptive, to allow for modification and addition of new actions based on new information or changing conditions. This section will also help identify the national and regional obstacles that must be overcome, including lack of adequate funding and other resources, better management data, and improved communications between all levels of government. An appendix will provide the timeline for the first five years of implementing CMSP at the national and regional levels.]

- **Organization of Federal, State, and Tribal Representatives by Region.** [This section will concisely describe the process that Federal agencies are using to identify, train, and authorize their regional representatives to participate effectively in the work of the RPBs. It will make brief reference to the lessons learned from the Council's National CMSP Workshop and Simulation Exercise. And, it will provide Council-approved guidance as to how State and tribal government representatives on the RPBs might be identified and selected by the States and tribes to represent their jurisdictional authorities as regional CMSP gets underway.]

- **Preparation of Regional CMSP Development Agreements.** [This section will include guidance on the collaborative process whereby the RPBs would prepare CMSP development agreements. The process for CMSP provides that once the Federal composition of RPBs is determined, the Council would coordinate with the appropriate State authorities and all Federally-recognized tribal representatives in the regions to establish RPBs, and enter into a development agreement.

The development agreement would constitute a commitment from the partners to participate in a cooperative, open, and transparent CMSP process leading to the eventual development of a CMS Plan, acknowledging that each partner may have different authorities and non-discretionary mission objectives that must be fully addressed. Each RPB will have the flexibility to tailor the agreements as necessary and appropriate to reflect regional considerations and priorities, including relevant State and tribal interests which are essential to the success of CMSP.

  - The agreement would not commit any Federal, State, or tribal partner to its approval of a regional CMS Plan. To this end, the Council, in consultation with the Governance Coordinating Committee, is preparing a model agreement to assist RPBs in developing their own such agreements, and to foster efficiency and consistency in forming the RPBs. The model will identify the minimum elements for inclusion in the regional development agreements to be executed by the RPBs to ensure consistency with the national framework for CMSP. The Council's Model CMSP Development Agreement will be included as an appendix.]

- **Regional Capacity Assessment.** [This subsection will include guidance in assessing regional capacity consistent with the Executive Order and the framework for effective CMSP. Among other things, it will note that some regions and regional bodies are well ahead of others in their governing structure, resources, experience, and progress toward implementing CMSP.]

- **Examples of Initial Regional Steps.** [Although the determination of the initial regional steps will be left to each RPB, this subsection will provide helpful examples and lessons learned in developing regional CMS plans. Among other things, it will provide examples in the process of identifying and organizing each RPB under the leadership of the Federal, State, and tribal RPB Co-Leads, the value in holding a regional CMSP workshop and simulation exercise early in the process, and the other initial necessary steps to get the RPBs organized, up-and-running, and ready to produce beneficial results. To the extent practicable and appropriate, it will detail relevant lessons learned from other nation's marine spatial planning experiences.]

- **Stakeholder and Public Engagement and Participation.** [This subsection will include how the CMSP process will engage and involve environmental and trade groups, commercial and recreational fishing interests, other stakeholders, and the general public, including traditionally underserved, low-income, indigenous, isolated, and minority populations. It will include a proposed timeline, with specific dates, during which the initial engagement with stakeholders in the process should be completed, and how it will continue as the CMS plans are reevaluated and updated over time.]

- **Consultation with Scientists and Technical and Other Experts.** [This subsection will describe how the RPB might best consult with scientists, technical experts, and those with traditional knowledge of or expertise in coastal and marine sciences and other relevant disciplines to ensure that the development of regional CMS plans is based on sound science and the best available information. To this end, the RPB should establish regional scientific, technical, and

other expert participation and consultation mechanisms to ensure that it obtains relevant information as required by the Executive Order and the framework for effective CMSP.]

- **Regional Advisory Committees (RACs).** [Consistent with the guidance in section 8 of the Executive Order, this subsection will describe how the Federal RPB Co-Lead, in consultation with the State and tribal Co-Leads and RPB members, could establish such advisory committees under the Federal Advisory Committee Act (FACA) as they may deem necessary to provide information and advice to the RPB on the development of regional CMS plans to better promote the purposes of the National Ocean Policy. In the end, each RPB would make the decision whether or not to establish any such FACA advisory body.]

- **Regional Work Plan Development.** [Although the development of a regional work plan will be left to the RPBs, this subsection will describe the process of how these bodies might choose to develop a regional work plan consistent with the Executive Order and the framework for effective CMSP. It will also outline how these bodies might plan to conduct their work in a wise and cost-effective manner, to enable them to produce a comprehensive, coherent, valuable, and consensus-based regional CMS plans as quickly and efficiently as possible.]

- **Council Certification of Regional CMS Plans.** [This subsection will describe the process of submitting the regional work plans and, eventually, the CMS plans to the Council to review, add value to, and then certify these plans in a timely and helpful manner. It will also explain what steps the RPB is to follow if the Council fails to certify all or part of a regional work plan or CMS plan. Finally, this subsection will provide details as to how the Council will review each regional CMS plan for national consistency after 30-days of public comment.]

- **Development of Regional CMS Plans.** [Although the development of the regional CMS plans will be left to the RPBs, this subsection will outline a recommended process for consideration. It will explain how the RPBs might choose to conduct their work in a wise and cost-effective manner, to enable them to produce a comprehensive, coherent, valuable, and consensus-based regional CMS plans as quickly and efficiently as possible. It will recognize that there will be different approaches, timetables, and expectations for developing these plans depending on regional conditions. It will also include possible target dates for the development of a preliminary draft, final draft, and final CMS plan. Finally, it will remind the regions of the need to include stakeholder engagement, scientific input, and public comment to ensure transparency and access the best possible ideas.]

- **Implementation of CMS Plans.** [Although the implementation of the CMS plans will be overseen by regional Federal, State, and tribal authorities with the necessary jurisdiction and authority, this subsection will provide appropriate guidance, along with the development of any monitoring and assessment mechanisms and any process for adaptive management. It will also recognize how CMS plans will be incorporated into the existing decision-making processes consistent with existing statutory authority, and describe opportunities for integration with existing and future State, tribal, regional, and local efforts.]

V. Council Guidance Regarding the Development of a National Information Management System and CMSP Portal. [This section will discuss CMSP-related data and informational requirements. It will be entirely informed, if not completely written, by the Council's interagency Data Management Working Group, which is now developing such information and data-related guidance under the auspices of the Council. The approved data standards and other information concerning the information system may be included as an appendix.]

VI. Legal Analysis and Guidance. [This section will set forth the Council's analysis of how various statutory authorities of particular agencies can be harmonized in order to support comprehensive, integrated regional CMSP. The analysis will include an effort to identify gaps and conflicts in existing Federal authorities and recommend potential steps to reconcile them. The Council will also consider how legal authorities of Federal, State, tribal, and local entities might collectively be used to support implementation of regional efforts. In this regard, the Council will coordinate with the Governance Coordinating Committee as appropriate to ensure full consideration of relevant State and tribal legal authorities. This section will also include guidance to assist RPBs in complying with various laws relevant to their operation, such as FACA and the Freedom of Information Act (FOIA).]

VII. Regional CMSP Dispute Resolution Mechanism. [This section will set forth the regional CMSP dispute resolution mechanism currently under development by the Council in cooperation with the Governance Coordinating Committee. As provided in the Executive Order, the Council will design the mechanism in a way to ensure that most disputes would be resolved at the regional level, while ensuring consistency between the RPBs. The mechanism will ensure that all State and tribal partners will exercise a vital role in resolution of disputes involving State or tribal interests in a particular region. The mechanism will account for decision-making by the RPB by consensus. The mechanism will require that the Council coordinate with the Governance Coordinating Committee on matters involving State or tribal interests in the event a dispute is elevated to the Council for resolution. The mechanism will also be included in Council's Model CMSP Development Agreement.]

VIII. On-the-Horizon Strategic Planning Guidance. [This section is designed to provide additional strategic, long-term guidance from the Council on implementing CMSP. It may describe the benefits and products that will flow from successful CMSP, including promoting the national and regional objectives and streamlining the process of sustainable economic development in the coastal regions. However, specific elements of this guidance will be included in this SAP only as the ORM-IPC (and OST-IPC) may deem necessary and appropriate. An appendix will provide technical and scientific information and resources likely to prove useful to regional CMS planners at the appropriate level of detail. The CMSP SAP Writing Team may consider the need for such guidance and draft appropriate language for coordination with other bodies and approval by higher authority, eventually including the Council.]

IX. Conclusion

- This SAP to implement the priority objective of CMSP is intended to help chart a new course for improved stewardship of the ocean, our coasts, and the Great Lakes. Specifically, this SAP is a way forward for implementing a comprehensive, science-based, integrated, transparent, and

ecosystem-based planning process to achieve the sustainable stewardship and optimum uses of these vitally important areas.

- The Council and the writing team preparing this SAP are aware that the Executive Order and National Ocean Policy—and this plan under development—may create a level of anxiety among those who rely on these resources and that it may generate questions about how this plan will align with existing processes, authorities, and budget challenges. Meaningful and frequent opportunities for stakeholder and public engagement throughout the implementation of CMSP will be an essential component of addressing these concerns.

- The Council and the writing team are confident that the investments and improvements described in this SAP will significantly advance the economic interests of the United States through sustainable and productive ocean uses; improve our capacity to address the long-term challenges and impacts of climate and environmental changes; and provide a lasting foundation for improving the stewardship of and further enhancing the many vital benefits our Nation can derive from these resources. With a clear, achievable, regionally-empowered approach to CMSP, we can achieve an America whose stewardship ensures that the ocean, our coasts, and the Great Lakes are healthy and resilient, safe and productive, and understood and treasured so as to promote the well-being, prosperity, and security of present and future generations.

Inform Decisions and Improve Understanding
Strategic Action Plan
Full Content Outline

Objective: Increase knowledge to continually inform and improve management and policy decisions and the capacity to respond to change and challenges. Better educate the public through formal and informal programs about the ocean, our coasts, and the Great Lakes.

I. Overview of the Priority Objective

This strategic action plan (SAP) addresses the National Ocean Policy priority objective to:

- Ensure the availability of cross-cutting scientific research and technological innovation for developing management and policy decisions for ocean, coastal, and Great Lakes ecosystems and processes;
- Engage in ocean exploration to expand knowledge that has the potential to lead to new discoveries for energy resources and improved human health and well-being;
- Develop a comprehensive awareness and understanding of current and emerging human activities, including traditional, cultural, and historical, that affect our coastal watersheds and the ocean; and
- Increase the understanding of the importance and benefits that the ocean, coasts, and Great Lakes provide to our Nation's people.

II. Context and Continuity

Meeting this priority objective requires:

- Supporting basic and applied disciplinary and interdisciplinary scientific research, mapping, monitoring, observation, and assessment, coupled with development of forecasts, models, interactive maps, and other decision-support tools to address priority issues in ocean, coastal, and Great Lakes environments, including climate change, risks, and vulnerabilities;
- Increasing understanding of existing, emerging, and future uses of coastal, marine, and Great Lakes resources, effects of such uses on the ecosystems, tradeoffs among uses, and ways to increase sustainability of uses;
- Increasing scientific knowledge and detailed understanding of current and emerging human activities taking place in and around our Nation's waters;
- Improving management of resources and uses through data integration, increased scientific knowledge supporting management, development and improvement of spatially-explicit decision-support tools, and transition of research results into information products and tools for management;
- Increasing human capacity, developing a knowledgeable workforce, and improving education in ocean-related fields, including a focus on disadvantaged and underrepresented communities;
- Increasing ocean literacy through formal and informal education and public outreach;
- Supporting fundamental research for ocean exploration and discovery; and

- Improving integration of social and natural sciences in developing policy and management actions for the ocean, coastal, and Great Lakes ecosystems.

III. Body of the Plan

A. Action 1 - Prioritize research activities based on "Science for an Ocean Nation: An Update of the Ocean Research Priorities Plan."

Federal agencies and partners will use the new "Science for an Ocean Nation: An Update of the Ocean Research Priorities Plan" ("Science for an Ocean Nation") as the primary basis for prioritizing research activities within their agencies. They will coordinate such activities across agencies to achieve maximum efficiencies in advancing the ocean sciences. Linkages between the research priorities in "Science for an Ocean Nation" and the National Ocean Policy priority objectives are explicitly identified in the new report, thereby allowing agencies to easily identify the connections between them. This action has connections to the data gaps and research needs identified in all eight of the other SAPs. (Note: While "Science for an Ocean Nation" has not yet been officially released, a preliminary draft was available to the SAP writing team and the full report will be available to the public within the next few months. Meanwhile, we urge readers to refer to the 2007 predecessor of "Science for an Ocean Nation" entitled "Charting the Course for Ocean Science in the United States for the next Decade." The new report differs from its predecessor by more strongly emphasizing the issues of ocean acidification and changing conditions in the Arctic, and by specifically linking the research priorities to the needs of the National Ocean Policy.)

1. Why Do This
   - The National Ocean Policy calls for use of "the best available science and knowledge to inform decisions affecting the ocean, our coasts, and the Great Lakes, and enhance humanity's capacity to understand, respond, and adapt to a changing global environment." It also calls on us to "improve our understanding and awareness of changing environmental conditions, trends, and their causes, and of human activities taking place in ocean, coastal, and Great Lakes waters."
   - The new "Science for an Ocean Nation" lays out research needs to inform policy decisions across six broad societal themes that directly connect with the objectives of the National Ocean Policy.
   - It therefore serves as a valuable framework to advance knowledge in a manner that will improve understanding and provide for informed decisions using the best available science.

2. Timeframe - Near-term

3. Outcomes
   - The recommendations in "Science for an Ocean Nation" significantly influence agency decisions about resource allocations and priorities within their science or education budgets.

- Increased knowledge leads to enhanced sustainable uses of and benefits from ocean, coastal, and Great Lakes resources.
- Better stewardship of resources is enabled by increased understanding of ecosystem processes, impacts of human uses, and vulnerabilities.
- Knowledge allows the creation of comprehensive and generic multi-hazard risk assessments and warning system tools to support policy and management, as well as models, policies, and strategies for mitigation of and/or finding adaptive solutions to coastal and ocean hazards, ecosystem variability, and climate change.

4. Milestones
   - Agencies reference "Science for an Ocean Nation" in budget documents used to justify and defend budget decisions and include priorities from the report in annual budget requests.

5. Gaps and Needs in Science and Technology
   - "Science for an Ocean Nation" identifies a number of gaps and needs.

B. Action 2 – Provide science to support emerging sustainable uses of resources.
Federal agencies and partners will provide science and services to support the development and production of emerging sustainable uses of ocean, coastal, and Great Lakes resources.

1. Why Do This
   - Fundamental and applied scientific information and technology are needed to characterize resources, their uses, and potential environmental impacts.
   - Providing scientific information and services will ensure that emerging and future uses of ocean, coastal, and Great Lakes resources are economically and ecologically sustainable.
   - This will also better inform the process of coastal and marine spatial planning (CMSP) regarding potential economic and environmental impacts of compatible uses, and inform ecosystem-based management (EBM) (see the CMSP and EBM SAP outlines).

2. Timeframe - Long-Term

3. Outcomes
   - Private industry, government agencies, and partners make better informed decisions about the feasibility and operations of sustainable uses of ocean, coastal, and Great Lakes resources based on environmental, social, and economic data and predictive modeling.
   - Increased opportunities for sustainable and emerging uses of ocean, coastal, and Great Lakes resources, resulting in increased opportunities for economic growth, creation of new jobs, and increased sustainability of traditional ocean uses.

4. Milestones
   - Develop joint agency aquaculture initiatives through the Joint Subcommittee on Aquaculture and other partnerships.
   - Design new renewable energy technologies using the integrated oceanic and atmospheric observation system and modeling programs.
   - Inventory the compiled nation-wide renewable energy potential and complete the national offshore wind energy resource map.
   - Develop test beds to provide enhanced wind energy forecasts via the High Resolution Rapid Refresh modeling system.

5. Gaps and Needs in Science and Technology
   - Research and technology development to support vibrant, profitable, and sustainable ocean, coastal, and Great Lakes resource and emerging technologies industries.
   - Information necessary for existing and emerging resource uses to make informed decisions through the CMSP framework.

C. Action 3 - Provide science support for managers and policy makers.

To enable and inform science-based decisions, Federal agencies and partners will regularly assess needs of resource managers and policy makers for research, data, and information, directly respond to those needs by providing data and information, developing and improving spatially-explicit decision-support tools (e.g., integrated ecosystem assessments), and expanding training and technical assistance. This action will connect with related training activities with the EBM SAP.

1. Why Do This
   - Robust decision-support tools and processes support rapid, effective, and publicly-supported management of growing uses of ocean, coastal, and Great Lakes resources.
   - Providing needed research, data, information, and traditional knowledge will help ensure sustainability of natural resources, biodiversity, and critical ecosystem services.
   - Assessing management and policy needs will also minimize the negative environmental and human health impacts (particularly due to climate change and sea-level rise) on vulnerable communities.

2. Timeframe - Mid-Term

3. Outcomes

   Ocean, coastal, and Great Lakes decision-makers use technically robust decision-support tools, processes, and services that:
   - Integrate scientific, environmental, and socio-economic information to support EBM and CMSP;

- Provide meaningful indicators of ecosystem health and societal goals; and
- Support prediction and scenario evaluation to make informed decisions, with particular focus on CMSP.

4. Milestones
   - Create an interagency (Federal, State, Tribal, regional, and local) team that will complete an assessment of existing and needed research, data, information, traditional knowledge, decision-support tools, and training to support ocean, coastal, and Great Lakes decision-makers.
   - Develop and provide appropriate training curricula, decision-support tools, and information services to meet the needs of ocean, coastal, and Great Lakes decision-makers and other stakeholders, as identified in the interagency assessment.

5. Gaps and Needs in Science and Technology
   - Social science research and application related to the effective design and application of tools, technologies and information services (See Action 7).
   - Quantification and valuation of ecosystem services related to coastal management decision making.

D. Action 4 - Develop human capacity and the workforce.
Develop human capacity and a knowledgeable workforce, and provide scholarships, internships, fellowships, and other opportunities for high school, undergraduate, and graduate students, particularly from underrepresented groups, pursuing degrees in ocean science, management, and related fields.

1. Why Do This
   - Current graduation rates in geosciences are low, particularly for underrepresented groups.
   - U.S. competitiveness depends on a well-educated workforce.

2. Timeframe - Mid-term

3. Outcomes
   - More students, particularly from underrepresented groups, graduate in academic fields related to ocean science and management at the undergraduate and graduate level.
   - The number of students entering the workforce through Federally-supported fellowship and internship programs related to ocean science and management is increased.
   - K-12 students are engaged in extracurricular ocean-related Science, Technology, Engineering, and Mathematics (STEM) activities.

4. Milestones

- Award scholarships, fellowships, and internships for high school, undergraduate, and graduate students that leverage Federal investment in research, laboratories, and natural areas to support education.
- Focus on underrepresented groups by working with professional societies, nonprofits, and minority-serving institutions when recruiting applicants for scholarship, fellowship, and internship programs.
- Develop a new post-doctoral program for ocean sciences.
- Host competitions and activities for high school students that demonstrate impact on students' choices of future academic and career paths.
- Support underwater and ocean technology programs for secondary and post-secondary education with Federal resources.
- Fund studies to track changes in the future ocean workforce.

5. Gaps and Needs in Science and Technology - None

E. Action 5 - Increase ocean literacy.

Increase ocean literacy and expand the accessibility and use of ocean content in formal and informal educational programming for students, teachers, and the public.

1. Why Do This
   - The Ocean Project study shows high public concern about but low understanding of ocean issues.
   - Studies by the National Research Council and others show effectiveness of formal and informal science education programs at raising levels of awareness and stewardship.

2. Timeframe - Mid-term

3. Outcomes
   - Greater access to Federally-funded ocean research for formal and informal education institutions.
   - Increased public awareness and understanding of ocean science issues.
   - Communities are better stewards of ocean, coastal, and Great Lakes resources.

4. Milestones
   - Support inclusion of ocean content in revised national science education standards.
   - Support regional ocean education plans.
   - Complete a study of environmental attitudes and knowledge in middle schools with environmental education programs.
   - Develop a comprehensive ocean science curriculum for middle school based on Ocean Literacy Essential Principles.

- Use data from surveys of community understanding and attitudes of ocean issues to inform future educational programming, communications, and public engagement.
- Increase the numbers of scientists engaged in ocean education.
- Engage students and public audiences in ocean science and management through innovative programs and emerging technologies.
- Create new professional development opportunities for educators that use Federal ocean research and data; train educators to reach multicultural audiences.
- Increase use of Ocean Literacy Essential Principles and related principles by networks and partners that engage students, teachers, and the public.
- Increase outdoor and experiential learning opportunities in coastal watersheds.
- Develop infrastructure and demonstration projects that deliver ocean observing data for formal and informal education.
- Support citizen science programs that engage participants in ocean sciences.
- Use inventories of Federal STEM education programs to identify additional partnership opportunities.
- Support efforts to incorporate as appropriate native and traditional knowledge into ocean education materials.

5. Gaps and Needs in Science and Technology - None

F. Action 6 - Engage in ocean exploration.

Federal agencies will engage in exploration to expand our knowledge of little-known Great Lakes and oceanic biodiversity, biogeochemical processes, ecosystem services, and climate interactions to bring new understanding and benefits to research, management, policy, and the public.

1. Why Do This
   - Ninety-five percent of the ocean is poorly known or essentially unexplored, and the potential for discoveries to expand knowledge, lead to new energy sources, develop new products, and inspire the next generation of ocean scientists is enormous.
   - For the U.S. to be a global leader in ocean exploration and knowledge of the connections between human well-being and the natural environment, we need to explore currently unexplored or poorly-known Great Lakes and oceanic biodiversity, biogeochemical processes, ecosystem services, and climate interactions at the global-scale.

2. Timeframe - Mid-term

3. Outcomes
   - New ocean discoveries expand our knowledge and understanding of Great Lakes and oceanic biodiversity, biogeochemical processes, ecosystem services, and

climate interactions, and this new knowledge informs management, policy, the public, and future research.
- Scientific insights and innovative technologies enhance the Nation's competitiveness by increasing scientific and technological capability and discovering new opportunities for biomedical and business development.
- The pace, efficiency, and scope of exploration are increased, and resulting discoveries are disseminated to the global scientific and societal enterprise.

4. Milestones
- Execute five expeditions in poorly-known or unknown Great Lakes and national and international ocean regions.
- Communicate new discoveries from five expeditions regularly to the public as well as to the scientific community.
- Establish five new cost-sharing partnerships with domestic and international governmental and nongovernmental entities that support global-scale systematic exploration.

5. Gaps and Needs in Science and Technology
- Innovative tools, technologies, and international partnership activities to provide the most cost-effective strategies for ocean exploration and discovery.
- A suite of common products related to ocean exploration and research agreed to by Federal agencies and partners.
- An easily accessible electronic library of scientific information and products related to ocean exploration, research, and education efforts**.**

G. Action 7 - Integrate social and natural scientific information.
Federal agencies and partners will integrate information from a broad range of social sciences with the natural sciences.

1. Why Do This
- Information from social sciences and economics must be routinely integrated with the natural sciences to inform research, policy development, and management decision-making, especially for ecosystem-based management and restoration, to improve public understanding of management actions.
- Incorporating social and natural sciences will support and enhance sustainable economies and other uses.
- Using social science research to apply decision theory to ocean issues will inform ocean policy decisions and assist in developing best management practices.

2. Timeframe - Long-term

3. Outcomes

- Methods and metrics that integrate the social and natural sciences are developed.
- Knowledge of human behavior, attitudes and preferences, societal values, economics, and human use of and dependence on ecosystem services is routinely acquired and incorporated into ecosystem assessments, decision-making, and management of ocean, coastal, and Great Lakes resources.
- Public attitudes and preferences are routinely incorporated into ecosystem assessments, policy, and management decisions.

4. Milestones

- Develop one or more pilot projects that use socioeconomics and natural sciences to identify, develop, and test valuation frameworks for ecosystem services.
- Based on the results of the pilot projects, develop a framework for valuing the ecosystem services of the Nation's critical ocean, coastal, and Great Lakes resources.
- Perform trends analyses to characterize human interactions with the ocean, coasts, and Great Lakes and identify 'cutting edge' issues, with intent to maintain relevant data collection and analyses for the long term.
- Apply, adapt, or develop two new decision-support tools that integrate information from natural and social sciences and are targeted toward improving the ability of Federal, State, and Tribal authorities to meet their economic, environmental, public health and safety, social justice, and equity objectives related to ocean, coastal, and Great Lakes resources and uses.

5. Gaps and Needs in Science and Technology

- More robust approaches to incorporate natural and social science perspectives and information in ongoing research, and policy development to support ecosystem-based management and restoration.
- More quantitative data on ecosystem processes, functions, and services, such as for different landscape and habitat types and under different environmental conditions.
- More broadly accepted methods for determining monetary and non-monetary values of ecosystem services that are relatively inexpensive and easy to implement and for the public to understand.

Coordinate and Support
Strategic Action Plan
Full Content Outline

Objective: Better coordinate and support Federal, State, Tribal, local, and regional management of the ocean, our coasts, and the Great Lakes. Improve coordination and integration across the Federal Government and, as appropriate, engage with the international community.

I. Overview of the Priority Objective

- One of the significant obstacles to effective management of the ocean, our coasts, and the Great Lakes is the complex set of Federal, State, Tribal, and local laws, authorities, mandates, and governance structures intended to manage their use and conservation.
- Consistent approaches to the management of resources, including ecosystem-based and adaptive management, are difficult to achieve given this shared, piece-meal, and overlapping jurisdictional model.
- The United States is party to numerous international agreements and subject to customary international law regarding use and protection of the ocean, coasts and the Great Lakes. The United States should engage both domestically and internationally to achieve increased cooperation and coordination on ocean issues.
- Through increased communication, coordination, and integration across all levels of government, we can streamline processes, reduce duplicative efforts, leverage resources, resolve disparities, and enhance synergy.
- In terms of coordination, the strategic action plan (SAP) will address:
    - Identification of needs, inconsistencies, and duplications in statutory authorities, policies, and regulations, and necessary and appropriate actions to address them;
    - Procedures to identify and align mutual and consistent management objectives and actions across jurisdictions, including those actions identified in other SAPs;
    - Tangible tools and procedures to prevent and resolve conflicts across jurisdictions and disagreements concerning jointly managed ocean, coastal, and Great Lakes resources; and
    - Opportunities for engaging the international community to further the objectives of the policy, as appropriate.
- In terms of support, the SAP will address:
    - Actions to assist the States, Tribes, territories, and local governments in advancing the network of regional partnerships to protect ocean, coastal, and Great Lakes health;
    - Evaluation of existing or new non-Federal funding sources and options to protect, maintain, and restore ocean resources; and
    - Legislative or regulatory changes necessary to simplify the sharing and transfer of resources among Federal, State, Tribal, and local agencies.

II. Context and Continuity

- This Plan will establish mechanisms to enhance communication and coordination among Federal, State, Tribal, territorial, regional, and local governments, external resource managers, and other interested parties. Taken collectively, the individual mechanisms for cooperation recommended in this SAP provide a framework for facilitating future cooperation.
- The analysis of legal, statutory, and regulatory gaps and overlaps will support efforts to reconcile existing authorities and provide recommendations to enact additional legislation or regulation where relevant. It will also help identify opportunities for future collaboration and coordination, as well as develop a shared set of principles and objectives, through identification of agency authorizing language.
- Development of a central repository for information accessible via the National Ocean Council's (NOC) National Information Management System (NIMS) between regions, territories, States, Tribes, and local governments will facilitate the development of networks between similarly aligned actors, and enhance coordination of efforts with regional entities.
- Coordination and revealing overlap will enable managers to effectively leverage funding, and provide a real benefit and incentive to increasing cooperative efforts. Dissemination of Best Management Practices will similarly enhance operations.

III. Body of the Plan

A. Action 1 – Develop a regional communication framework under the National Oceanographic Partnership Program (NOPP).

1. Why Do This
   - Constituents of Federal, State, Tribal, and local governments need consolidated, readily accessible and deliverable information regarding existing regional ocean partnerships, assets, and resources to advance regional ocean governance.
   - Over the years, various levels of government have come together to address issues related to ocean, coastal, and Great Lakes management on a regional basis. These groups address many similar overarching concerns, such as restoration, education, and science, and in many cases are in alignment with the National Ocean Policy.
   - As these groups have matured, it has become clear that enhancing communication among them, and with the Federal government, could further the priorities addressed in the National Ocean Policy. Specifically, the ability to simplify access to the breadth of Federal capacities (e.g., funding, expertise, programs) would greatly enhance regional ocean governance. The creation of a website would facilitate information exchange and improve communication.
   - A website that served as a repository for national and regional planning documents, available resources for collaboration support, and other relevant information would be a valuable communication tool among these various

identified regional entities, would facilitate information-sharing and mutual progress, and would help avoid duplication of efforts. To ensure that user group needs are met, input will be gathered from States, territories, Tribes, local governments, and Regional Ocean Governance (ROG) entities during website development. ROG entities include the Great Lakes Commission, the Governors' South Atlantic Alliance, the Gulf of Mexico Alliance, the Mid-Atlantic Regional Council on the Ocean, the Northeast Regional Ocean Council, and the West Coast Governors' Agreement on Ocean Health.

- This website will also be developed in coordination with the NIMS to facilitate the exchange of information and resources within and between Federal agencies and the various regional State, Tribal, and local government entities.
- Lastly, efforts will be coordinated with other SAP writing teams (e.g. Coastal Marine Spatial Planning, Ecosystem Based Management, Ocean, Coastal, and Great Lakes Observations, Mapping, and Infrastructure) to ensure the effective support and implementation of the National Ocean Policy.

2. Timeframe – Near-term

3. Outcomes

- Improved exchange of information between and among Federal, State, territorial, Tribal, and local government entities, as well as ROGs.
- Improved coordination and understanding among interested parties about which actions are underway at the national and regional level, and where partners could engage.
- Development of a website that includes*:*
    - Hotlinks connecting the various ROGs.
    - Lists of contact information for each ROG with e-mail info for all members.
    - Lists of key organizations that interface with the regional entities
    - Updated information about the activities of the NOC
    - Access by ROGs to funding, expertise, and program opportunities available to regional initiatives (e.g. National Environmental Policy Act projects).

4. Milestones

- Secure sufficient funding through NOPP for developing a website or web portal.
- Complete feasibility study of hosting the website or web portal via NOPP and integrating with the NIMS
- Complete a website or web portal that provides one-stop shopping for information about ocean governance.
- Enhance intra-Federal agency connection, and enhance interaction with States, through more regularly scheduled (quarterly as the ideal minimum) meetings.

5. Gaps and Needs in Science and Technology – N/A

B. Action 2 –Identify, prioritize, and seek to resolve legal barriers to implementation of the National Ocean Policy.

Working through the NOC Legal Interagency Working Group, address legal barriers inhibiting effective implementation of the National Ocean Policy, such as uncertainty, inconsistency, or overlap of authorities. Conduct an analysis of overlaps or sufficiency in statutory authority on particular topics identified through this process. Develop forums whereby Federal, State, Tribal, local officials, and non-governmental organizations (NGO) can interact and exchange information to work through barriers to collaboration.

1. Why Do This
   - There may be insufficient or redundant authorities in Federal, State, and Tribal ocean management regimes. This effort will address these issues and align and coordinate competing interests in ocean management, and increase efficiency and effectiveness of ocean management actions.
   - This will further the National Ocean Policy's direction to "ensur[e] a comprehensive and collaborative framework for the stewardship of the ocean, our coasts, and the Great Lakes that facilitates cohesive actions across the Federal government…." It also furthers the principles stated in the National Ocean Policy; in particular it will help "ensure and advance coordination and collaboration across Federal, State, Tribal, and local jurisdictional lines" and "eliminate redundancy and encourage efficiencies and synergies."

2. Time Frame: Near-term to Mid-term

3. Outcomes
   - Identification of the most significant redundancies, conflicts, and inefficiencies in the current ocean management regime with respect to State, Tribal, and local equities.
   - Deliverables may include:
     - Review of reports of the various entities that have already assessed the authorities in U.S. ocean management.
     - Identification of any critical issues not currently being addressed by the NOC Legal Interagency Working Group, and prioritization for closer examination or action.
     - Legal analysis of these issues, which may include recommendations for legislative, regulatory, or administrative changes.

4. Milestones
   - Conduct review of existing reports and analyses
   - Identify any critical issues requiring further analysis
   - Conduct analysis and make recommendations

5. Gaps and Needs in Science and Technology – N/A

C. Action 3 –Identify barriers and obstacles to successful collaboration efforts.
Examine barriers between and among Federal, State, Tribal, regional, territorial, and local entities. Conduct this activity in consultation with and with the participation of ROGs, Tribal, and representative groups and industries to achieve stakeholder perspectives as well as governmental perspectives. Determine the origin of obstacles to collaboration, be it gaps or overlaps in legislation, institutional culture of agencies, competition between entities, political pressure from select constituencies, or other possible reasons. Assess where there is the need for remedial engagement tools, and implement those tools in coordination with the NOC Legal Interagency Working Group, to achieve an early resolution of competing authorities and interests.

1. Why Do This
   - Effective management of ocean resources is sometimes delayed or obstructed by confusion, misdirection, and conflicts between agencies and laws.
   - Identifying barriers and obstacles among existing entities and proposing solutions will provide opportunities for greater collaboration and alignment.

2. Timeframe –Mid-term

3. Outcomes
   - Federal, State, Tribal, territorial, regional, local governments, and ROGs function in a more integrated manner and with greater efficiency.

4. Milestones
   - Engage the ROGs in this discussion, noting ROG methods of dispute resolution. Input from other levels of interest, including industry and insular islands and territories, should be sought.
   - Identify the most common conflicts and their causes. These might include jurisdictional overlap or uncertainty in statutes, tendencies toward mission creep, cultural differences in agencies and governments, or lack of communication among executing entities.
   - Identify solutions for the most problematic or frequent causes.

5. Gaps and Needs in Science and Technology – N/A

D. Action 4 – Identify and disseminate Best Management Practices (BMPs) utilized in Federal or regional partnerships.
Help ensure that National Ocean Policy implementation will be successfully and consistently managed despite the diverse planning groups with varied traditions and activities throughout the regions.

1. Why Do This
    - Federal agencies, States, Tribes, local governments, and ROGs and other regional ocean partnerships have varied governance structures and ways to encourage important collaborators to participate in regional ocean planning and implementation efforts.
    - This action will help to evaluate successful existing coordination practices among Federal, State, Tribal, local, university, private-public partnerships, NGOs, coastal communities, and Fishery Management Councils to share creative solutions and lessons learned.

2. Timeframe—Mid-term

3. Outcomes
    - Identification of successful practices and models of Federal partnerships between and among Federal agencies, ROGs and other regional ocean partnerships, Tribes, and local communities for successful practices within the partnerships. Assess the tools and techniques used by successful models of coordination, understand the timeline involved in establishing a framework for cooperation, and assess the costs and benefits of various alternatives.
    - Identification of existing coordination mechanisms, evaluated in terms of the National Ocean Policy priorities, and development of processes to use them to support the goals identified in the National Ocean Policy.
    - Promotion and adoption of the positive results of current successful coordination and support mechanisms.

4. Milestones
    - Publish guidance that identifies and outlines how to incorporate existing successful coordination practices for other interagency teams and partnerships.
    - Integrate BMPs into existing regional management plans at a Federal-level and encourage that they be stepped down into all plans.

5. Gaps and Needs in Science and Technology – N/A

E. Action 5 – Identify specific ways to prioritize and coordinate resources, reduce spending overlap, and leverage funding between and among Federal agencies, Tribes, and ROGs. Once those mechanisms are identified, encourage agencies to leverage resources through collaborative efforts using partnership organizations.

1. Why Do This

- Improved coordination within the Federal Government, between Federal, Tribal, State, regional, territorial, and local bodies, and through government-private partnerships will enable all parties to better leverage limited resources.
- This action will identify and inventory specific ways to leverage funding sources among and between Federal agencies, States, Tribes, local governments, ROGs, NGOs, and the private sector.
- We will explore existing capacity building collaborations, including but not limited to NOPP, Cooperative Ecosystem Studies Units (CESU) National Network, Landscape Conservation Cooperatives (LCC), the National Estuarine Research Reserve Program, the National Sea Grant Program, State coastal management programs, and NGOs to encourage stronger participation in using these programs to carry out the objectives of the National Ocean Policy.

2. Timeframe —Long-term

3. Outcomes

- Determination of how to best leverage existing and future ocean-focused budgets, as well as work plans within and across the Federal government through coordination with the Office of Management and Budget (OMB).
- Identification of overlapping or related resources that are being provided by State, Tribal, and local governments, as well as non-profits or private entities.
- Identification of programs and projects with greater opportunities for leveraging funding resources through partnerships with Federal agencies and ROGs.
- Reduction of obstacles and streamlining cross-Federal coordination processes (e.g., interagency agreements, General Services Administration smart buys, grants and cooperative assistance)
- Agencies better utilize and support existing collaborative partnerships.
- Leveraging of Federal, State, Tribal, local government, university, and nonprofit programs that work with coastal communities.

4. Milestones

- Produce a budget in coordination with OMB that identifies existing funding sources within the Federal budget that support the nine priority objectives.
- Identify and compile the common goals among the Federal agencies, States, Tribes, local governments, ROGs, and Federal partnerships. From the common goals, identify those funds which may be strategically leveraged to maximize the benefits relative costs.
- Evaluate existing efforts to streamline cross-Federal coordination processes to ensure that real or perceived obstacles among the agencies related to implementing the National Ocean Policy are addressed.
- Work with NOPP, CESU, the LCCs, and coastal management programs to identify opportunities for encouraging participation in these collaborative efforts.

5. Gaps and Needs in Science and Technology – N/A

F. Action 6 –Identify appropriate opportunities for engaging the international community about the National Ocean Policy.

Elicit international support for and improve coordination on ocean, coastal, and Great Lakes issues, in particular with countries that share the United States maritime boundaries.

1. Why Do This
   - Implementation of our National Ocean Policy will be facilitated by enhanced communication and collaboration with the international community.
   - Doing so will increase awareness of the National Ocean Policy by other countries and international organizations, and will increase support for the objectives of the National Ocean Policy from key international partners.
   - Coordination with international partners is critical in responding to projected changes from climate change.

2. Timeframe – Mid-term

3. Outcomes
   - Increased awareness of the National Ocean Policy by other countries and international organizations.
   - Increased support for the National Ocean Policy objectives and strategies from key international partners.
   - Development and implementation of similar policies by other countries and in other regions.

4. Milestones
   - Create an inventory of bilateral and multilateral agreements/discussions (including inter-agency, inter-ministerial, and inter-governmental) by a sponsoring Federal agency so that common interests and efforts may be more closely coordinated between agencies.
   - Develop additional international partnerships, where relevant, to effectively promote our National Ocean Policy.
   - Identify international organizations that address ocean and maritime issues in the National Ocean Policy
   - Identify countries that may have an interest in exchanging information on matters related to the National Ocean Policy.

5. Gaps and Needs in Science and Technology – N/A

Resiliency and Adaptation to Climate Change and Ocean Acidification
Strategic Action Plan
Full Content Outline

Objective: Strengthen resiliency of coastal communities and marine and Great Lakes environments and their abilities to adapt to climate change impacts and ocean acidification.

I. Overview of the Priority Objective

- Research, observations, and modeling needed to forecast regional and local scale climate change impacts and related vulnerabilities for natural resources, health, infrastructure, and livelihoods, including social and economic impacts.
- Better integration of ocean and coastal science into the broader climate dialogue and measures to improve understanding of the connections among land, water, air, ice, and human activities.
- Evaluation of potential social and economic costs related to sea-level rise, such as accelerating erosion, increased saltwater intrusion, and more severe coastal and inland flooding.
- Adaptive actions to identify climate change impacts and related vulnerabilities, such as ocean acidification, and the development of ecological and economic resilience strategies and priorities for research and monitoring to address these strategies.
- Changes to local and regional ocean and lake management systems that incorporate changing climate risks and elements of resilient systems.
- A comprehensive approach to understanding human health implications of policies for the ocean, our coasts, and Great Lakes, and for identifying opportunities for the protection and enhancement of human health.

II. Context and Continuity

- The National Ocean Policy calls for better understanding of the ocean, coastal and Great Lakes environments and the changes happening there.
- Strategies to act on this recommendation should be developed and implemented to reduce vulnerability, increase resilience, and improve the adaptation of systems to climate change impacts.
- This Strategic Action Plan includes a set of interdependent actions that will yield better understanding of, preparation for, and response to the impacts of climate change and ocean acidification impacts on communities and ecosystems. The Plan includes a coordinated approach of gathering observations, conducting foundational and interdisciplinary research to enhance understanding of the impacts of climate change and ocean acidification, developing improved models and forecasts at appropriate geographic and temporal scales, and conducting vulnerability assessments of human and natural systems. These advances will serve as a platform for the provision of accessible, timely, useful, and relevant science to inform and support the implementation of adaptation actions.
- This Strategic Action Plan outline was prepared in coordination with other strategies, plans, and assessments addressing climate change adaptation that are available, currently under preparation or nearing completion, including the National Fish, Wildlife, and Plants Climate Adaptation Strategy;

National Climate Assessment; the Freshwater National Action Plan called for by the Interagency Climate Change Adaptation Task Force; and U.S. Global Change Research Program Strategic Plan.

III. Body of the Plan

A. Action 1 – Improve understanding of the impacts of climate change and ocean acidification.
Advance scientific understanding of the impacts of climate change and ocean acidification on ocean, coastal and Great Lakes ecosystems and communities to provide an information basis for forecasting, vulnerability assessments, and adaptation efforts.

1. Why Do This
   - Preparing for and responding to the impacts of climate change and ocean acidification requires improved understanding of the scale, scope and intensity of these impacts on the Nation's valuable ocean and coastal ecosystems and the communities that depend on them.
   - This action will provide the information needed for improved forecasts of changes in ecological, economic, and social systems due to climate change and ocean acidification.
   - An integrated research agenda, including physical, natural, and social sciences, will address critical gaps in understanding and build a foundation for the development of models, tools, and services that support the needs of decision makers at all levels.
   - This action will also advance understanding and decrease the uncertainties surrounding the physical, chemical and biological impacts of climate change and ocean acidification and how humans would prepare for and respond to those changes.
   - This action supports and extends Action 1 in the Inform Decisions and Improve Understanding SAP.

2. Timeframe – Long-term

3. Outcomes
   - Improved scientific knowledge of the scale and scope of impacts from climate change and ocean acidification on coastal and ocean ecosystems to support the implementation of actions that strengthen resiliency of ocean and coastal ecosystems and communities.

4. Milestones
   - Conduct strategic research on the response of key species to multiple stressors (e.g. pH, temperature, and nutrients) in ocean and coastal ecosystems.
   - Improve understanding of how changes at the organismal level for key species will alter ecosystem structure and function using techniques such as evolutionary genetics, and laboratory, field, and mesocosm experiments on single and multi-species assemblages.
   - Improve understanding and valuation of the impacts of climate change and ocean acidification on ecosystem services (e.g., fisheries, storm protection) and the communities/economies that depend on them.

- Develop integrated (e.g., coupled natural and human system) research projects on regional ecosystem responses to climate change and ocean acidification impacts, including thermal and pH change, alterations in oceanic circulation patterns, variations in precipitation and freshwater input, and biogeographic range shifts.
- Integrate social, cultural, behavioral, and economic sciences into studies and models of climate change and ocean acidification impacts.
- Conduct research that assesses the roles and relative importance of coastal habitats in carbon storage and sequestration to increase the ability to incorporate these valuable ecological services into restoration, management, adaptation and mitigation efforts.

5. Gaps and Needs in Science and Technology
   - Understanding of potential for physiological acclimation and evolutionary adaptation, with emphasis on ecologically and economically important organisms.
   - Expanded implementation of alkalinity as a tracer and incorporation of particulate inorganic carbon (PIC) and remineralization formulations in the biogeochemistry ocean general circulation model (BOGCM).

B. Action 2 – Forecast the impacts of climate change and ocean acidification at decision-relevant scales.

Forecast the impacts of climate change and ocean acidification on ocean, coastal, and Great Lakes ecosystems and communities at temporal and spatial scales relevant for use in vulnerability assessments, adaptation planning, and decision-making.

1. Why Do This
   - The planning and management communities have identified a need for valid points of reference when preparing for future conditions and decisions are often made at state to local levels.
   - As current knowledge of climate change impacts is assimilated, and new knowledge is being produced, the ability to predict the future state of the ocean, our coasts, and the Great Lakes as they respond to the effects of climate change is becoming even more necessary to support planning and management
   - Projections are urgently needed to plan and conduct vulnerability assessments, to inform adaptation efforts, and to avoid maladaptive activities.
   - No single, reliable information broker is consistently meeting the demand, and the existing patchwork quilt of data, information, and services is inefficient and impedes a coordinated, ecosystem-based approach.
   - The federal government can fill an urgent need by assembling the best science from federal agencies and the greater research community into best projections of what changes to expect at different spatial scales in the coming decades.
   - These projections must be maintained through regular updates and recalibrated as new science and observations provide greater clarity; in addition, they must be disseminated to practitioners through an integrated framework of climate information and services.

2. Timeframe – Long-term

3. Outcomes
- For the upcoming 15, 30, 60 and 100 years, develop a "best" storyline for how the future will likely vary from historical/present conditions through projected impacts to:
  - Physical/chemical oceanography (e.g. temperature, salinity, and pH change, changes to currents and circulation patterns, wave climate, tidal range).
  - Geomorphology (e.g., shoreline erosion/progradation, tidal wetlands).
  - Hydroclimatology (e.g., variations in the timing of precipitation and freshwater input, storm frequency).
  - Biology and ecology (e.g. ocean and coastal biological resources, species composition, habitat shifts, potential for invasions).
  - Human and social systems (e.g. hazards, jobs, infrastructure, communities, cultural resources).
  - Coupled natural and human systems.
- Projected regional changes in relative sea-level and Great Lakes water levels.

4. Milestones
- Synthesize literature and compile existing data and models to provide the initial set of projections.
- Coordinate modeling and projections with the National Climate Assessment.
- Continue development of the Earth System Prediction Capability (NEON, IOOS, GEOSS, etc.) with respect to development of a fully coupled ocean observation, data assimilation, and modeling capability for the ocean, our coasts, and the Great Lakes.

5. Gaps and Needs in Science and Technology
- Better, more integrated scientific data and information to support the development of forecasts and projections.
- Federal capacity for maintaining, updating, disseminating and archiving model code and results to support management and decision making.

C. Action 3 – Strengthen and integrate observations from the Nation's existing array of protected areas, research sites and observing systems into a coordinated framework of "sentinel sites and systems" to provide information critical for improved forecasts, vulnerability assessments, and adaptation strategies.

Strengthening and integrating observational and monitoring networks from the Nation's existing array of protected areas (e.g., National Marine Sanctuaries, National Estuarine Research Reserves, National Estuary Program, coastal National Wildlife Refuges, coastal National Parks), research sites (e.g., coastal NEON, Long-Term Ecological Research sites, OceanSITES) and observing systems (e.g., IOOS, HAB and pathogen warning systems, NOAA fisheries and protected species stock assessments, NOAA Coral Reef Monitoring Network) into a coordinated set of "sentinel sites and systems" is a highly efficient and effective way to provide managers and communities with the information they need about how coastal and ocean conditions and resources are changing over time.

1. Why Do This
   - To effectively prepare for and respond to increasing risks and impacts, managers and stakeholders need credible and consistent information on how ecosystems are being impacted now and are likely to be in the future in order to develop, implement, evaluate, and adjust management efforts over time.
   - Linking and enhancing existing observations at protected areas and other key locations are efficient and effective ways to meet these needs.
   - This action will advance a coordinated set of "sentinel sites and systems" that deliver information on past and current conditions, early warnings of changes to come, and improved forecasting and ability to track changes in coastal and ocean ecosystems in a changing climate.

2. Timeframe – Long-term

3. Outcomes
   - A coordinated set of observations and monitoring in existing protected areas, research sites, and observation systems that allows for more comprehensive understanding of climate change and ocean acidification processes, impacts, and trends.
   - A system of "sentinel sites" that provide the management community with the information needed to develop and implement adaptation actions.

4. Milestones
   - Complete inventory and assessment of existing observations and monitoring capabilities in networks/systems of coastal and ocean protected areas, research sites, and observing systems.
   - Based on the inventory (above), determine critical gaps in information/coverage and solutions for addressing these gaps.
   - In collaboration with the National Climate Assessment, integrate existing observational and monitoring efforts into a suite of indicators of community and ecosystem impacts (physical, biological, chemical, cultural, social, economic) to track changes in vulnerability and resiliency through time.
   - Create and implement an interagency plan for standardized monitoring of the impacts of climate change and ocean acidification through existing networks of protected areas using standardized and/or interoperable techniques, databases, and indicators (see above) when and wherever possible, to maximize integration of information across networks and agencies.
   - Integrate relevant socioeconomic monitoring information (e.g., U.S. Census and Bureau of Labor Statistics data) with ecosystem monitoring information within regions to understand changes in coupled human-natural systems through time.
   - Identify existing observations on changes in species phenology (i.e., the annual timing of major life cycle events such as migration, reproduction, flowering) in coastal and ocean

ecosystems, and develop a plan to provide for incorporating and accessing this information as part of the National Phenology Network.

- Deploy chemical sensors at existing coastal/ocean observing systems to monitor the variability and change at local to regional levels in biogeochemistry, particularly with regard to carbon system parameters (pH, DIC, TA, pCO2), temperature, oxygen dynamics, and nutrients.
- Deploy biological sensors at existing coastal/ocean observing systems to monitor the seasonal measurements of calcification rates and other CO2-sensitive processes not currently measured at time-series sites in order to assess the long-term response of ecosystems to ocean acidification.
- Disseminate and implement best practices, including guidance for relevant parameters that should be measured at each observing system, standardized chemical and biological monitoring protocols, and quality assurance and quality control procedures. This milestone should be coupled with appropriate training opportunities.

5. Gaps and Needs in Science and Technology

- Comprehensive monitoring in protected areas with appropriate instrumentation, methods, and quality control to provide an integrated, geographically-distributed database that can be used to estimate poorly understood spatial and temporal patterns of ocean acidification and sea level rise in estuaries and coastal zones.
- Advancements in the design of chemical and biological sensors that will allow for ready and accurate *in situ* measurements of multiple carbon system parameters (pH, DIC, TA, pCO2) and biological responses, and automatic collection of metadata, where feasible.
- Strategies to eliminate or minimize biofouling of sensors so that they can be used in marine environments for extended periods.
- Incorporation of instrumentation for monitoring the impacts of climate change and ocean acidification into existing coastal and ocean observational and monitoring networks.
- Integration and coordination between existing social, behavioral, and economic monitoring efforts and ecosystem monitoring efforts.
- Management and delivery (access) of data and information.

D. Action 4 – Provide accessible, timely, and relevant climate change and ocean acidification information, tools, guidance, and services to support decision making at all scales.

1. Why Do This

- Federal agencies must work together to provide decision makers at all levels with pertinent, comprehensive, accessible, and timely information for understanding, planning for, and responding to the impacts of climate change and ocean acidification.
- This action will support efforts to build resilience across ocean, coastal, and Great Lakes ecosystems and communities.

2. Timeframe – Mid-Term

3. Outcomes

- Enhanced ability of individuals, communities, and governments at all scales to identify their needs, and ultimately, to implement forward-looking, adaptive actions that build ecosystem, societal, and economic resilience.

4. Milestones

- Make geospatial data, especially information on relative locations of water and land surfaces, shallow bathymetry, and cardinal habitat and ecological characteristics, available to ocean, coastal, and Great Lakes communities as a basis for adaptation planning.
- Develop an interagency plan for LiDAR mapping, to acquire and maintain more precise shallow bathymetry and terrestrial elevation data in order to ensure comprehensive and accurate topographic information for coastlines, enabling response to and planning for changing landforms, water levels, and other effects of coastal inundation.
- Provide accessible, standardized guidance for incorporating climate change and ocean acidification information into ecosystem management and coastal and marine spatial planning activities.
- Support economic and non-economic valuation of ecosystem services.
- Integrate information, tools, and services on coasts and oceans into the emerging online interagency climate information clearinghouse/portal, which will include:
    - Best-available scientific data and information.
    - User-friendly projections.
    - Transferable decision-support tools.
    - Best practices.
    - Relevant contacts from adaptation activities across the Nation.
    - An active support mechanism to facilitate dialogue among users.
- Foster a “community of practice” by bringing together coastal climate change adaptation practitioners to share strategies and lessons learned.
- Coordinate Federal climate services (e.g. data, guidance, tools, etc.) to maximize utility of information for decision-makers at all scales.
- Develop a strategic plan for continuously identifying information needs of decision makers and addressing them through a use-inspired, integrated research agenda.
- Provide a standard suite of regional and decadal climate projections at the scale appropriate for decision-making.
- Provide guidance on the effective use of best-available regional and decadal climate projections, including associated uncertainties.

5. Gaps and Needs in Science and Technology

- Geopositioning (LiDAR, shallow bathymetry, etc.) products, data and derived elevation products to support a wide range of operational needs and to establish a consistent baseline for planning assumptions, regulatory decision making, and scientific research.

- Expanded availability of geopositioning information and a unified portal for access to the data to support work to conduct robust national assessments of natural resource and landform response to sea-level change and of the vulnerability of infrastructure and human communities.

E. Action 5 – Assess vulnerability of the built and natural environments and their interactions in a changing climate.

1. Why Do This
   - Addressing the inherent links between the impacts of climate change on the natural environment and the consequences for human communities and infrastructure is fundamental to improving the resiliency of ecosystems, communities, and economies.
   - This action will support decision-makers with information they need to develop actions that reduce vulnerability and strengthen resiliency and adaptation of ocean and coastal ecosystems and communities in a changing climate.

2. Timeframe – Mid-Term

3. Outcomes
   - Strategically assessing the vulnerability of ocean and coastal ecosystems and coastal communities in a changing climate.

4. Milestones
   - Establish methods, best practices, and standards for vulnerability assessments, including the consequences of climate change and ocean acidification for economic, ecological, cultural, and social systems, infrastructure, and technology.
   - Conduct coupled vulnerability assessments that address the interactions of the built and natural environments in the face of a changing climate.
   - Complete comprehensive climate change vulnerability assessments for federally funded and/or managed coastal facilities, infrastructure, cultural resources, and ecosystems.
   - Identify the most vulnerable areas, as well as areas most likely to be resistant/resilient to climate change impacts, to help decision-makers design effective adaptation plans.
   - Develop partnerships, guidance, tools, and best practices to help support vulnerability assessments at local, state, tribal, and regional scales (See Action 4).

5. Gaps and Needs in Science and Technology
   - Pathways for incorporating improved knowledge about sensitivity, exposure, and adaptive capacity, as well as future environmental changes and impacts, into vulnerability assessments (See Actions 1, 2 and 3).

F. Action 6 – Design, implement and evaluate adaptation strategies in order to reduce vulnerabilities and promote risk-wise decisions.

1. Why Do This
   - The Nation's coastal and ocean resources are already being impacted by climate change and ocean acidification, and these impacts are expected to increase in the future.
   - Coordinated action is needed at all levels to reduce vulnerability and impacts to the built and natural environments.
   - There is an opportunity to make significant progress in this area through building on current efforts at local, state, tribal, and regional levels.
   - There is an urgent need for immediate and prolonged investment now in adaptation plans and actions for repair, replacement or expansion of existing critical infrastructure (e.g., water and waste water treatment plants, hospitals, coastal highways, etc.) to address current and future impacts as well as reduce future losses.
   - This action will help to reduce current and future vulnerabilities and impacts to climate change and ocean acidification by enhancing and increasing the design, implementation, and evaluation of adaptation plans for built and natural environments.
   - Accomplishing this action will directly advance the nation's ability to be "climate ready."

2. Timeframe – Long-term

3. Outcomes
   - Reduced vulnerability and improved resilience of communities, ecosystems, and infrastructure through actions that lead to "climate smart" siting and design, restoration and protection of ecosystem services, improved public health and safety, reductions in the loss of life and property, and decreased costs of responding to disasters.

4. Milestones
   - Promote, build on and incentivize design, implementation, and evaluation of adaptation strategies in local, state, regional, tribal, and federal decision making.
   - Develop tools, capacity, and best practices for adaptation planning at local, state, tribal, regional, and national scales.
   - Identify, protect, connect, and restore key areas needed to promote resilience, sustain biodiversity, ecosystem function and ecosystem services, and maintain plant, fish, and wildlife corridors along coasts and lakeshores.
   - Incorporate species migration patterns and ecosystem protection measures into all publicly funded infrastructure projects.
   - Promote regional frameworks (e.g., Interagency Climate Change Adaptation Task Force regional adaptation consortia, Landscape Conservation Cooperatives, CMSP Regional Planning Bodies) for coordinated adaptation planning, implementation, and evaluation across geographic scales and organizations.

- Promote ecosystem-based approaches to adaptation to use the adaptive services of natural systems to help reduce vulnerabilities and risks to people and the built environment.
- Achieve a no-net increase in the amount of property and infrastructure in high-hazard areas.
- Mitigate vulnerability of coastal communities to the effects of climate change and ocean acidification. Develop plans for fortification, retreat, or other strategies that ensure continuity of critical services and reduced exposure to hazards. Consider ecosystem-based approaches (as opposed to gray infrastructure) when feasible.
- Implement pre-disaster mitigation planning and recovery to prepare for climate change. Revise Federal guidelines and programs to encourage more resilient and sustainable forms of rebuilding or retreat.
- Reduce the impacts of stressors over which we have more direct control (e.g., pollution, habitat destruction and resource extraction) to enhance the resiliency of coastal, ocean, and Great Lakes ecosystems to climate change and ocean acidification.
- Modify policies, practices, programs or projects that promote maladaption (increased vulnerability and risks to communities or natural environments).
- Expand the interpretation, and where necessary, issue proposals to strengthen the Coastal Zone Management Act and the Stafford Act to include and better support climate change adaptation efforts.
- Develop strategies to address the unique needs for adaptation of cultural resources on shores and under water, including consultation with tribes and State Historic Preservation Offices.
- Ensure that coastal and ocean ecosystems and coastal communities are included, where relevant, in Federal agency adaptation planning efforts under Executive Order 13514.
- Complete development of the National Fish Wildlife and Plant Climate Adaptation Strategy to safeguard the nation's valuable natural resources and the communities that depend on them in a changing climate.
- Include consideration of climate change and ocean acidification impacts and costs in all federal financing (grants, loans) programs that support the maintenance or construction of public infrastructure in coastal areas.

5. Gaps and Needs in Science and Technology

- Feasible alternative scenarios for the future operations, maintenance, and relocation of built infrastructure (e.g., coastal roads, port facilities, dam operation) to mitigate the effects of climate change on ecosystems.
- Evaluation and prediction of new coastal migration corridors and potential new habitat for ecosystems.
- Methods and standards for evaluation of resilience and adaptation that include economic, ecological, cultural, and technological consequences of climate change and ocean acidification.

Regional Ecosystem Protection and Restoration
Strategic Action Plan
Full Content Outline

Objective: Establish and implement an integrated ecosystem protection and restoration strategy that is science-based and aligns conservation and restoration goals at the Federal, state, tribal, local, and regional levels.

I. Overview of the Priority Objective

- Ocean, coastal, and Great Lakes ecosystems continue to suffer significant adverse impacts resulting from urban and agricultural development and other human activities. These ecosystem threats are being exacerbated by other stressors like the impacts of climate change and invasive species. While progress has been made in addressing some of these challenges, fish and wildlife habitat continues to be degraded and destroyed. Because many of these threats cross jurisdictional boundaries, increasing Federal support for regional approaches to ecosystem protection and restoration is necessary.

II. Context and Continuity

Ocean, coastal, and Great Lakes ecosystem protection and restoration are being carried out at state and regional scales through implementation of Federal and state resource management and land-use planning initiatives. State plans include, but are not limited to, ocean plans, coastal zone management plans, wildlife action plans, and regional ocean governance plans.

- The Governors in five regions have established state-led regional ocean governance bodies to set coastal and ocean use, management, protection, and restoration priorities: Northeast Regional Ocean Council, Mid-Atlantic Regional Council on the Ocean, South Atlantic Alliance, Gulf of Mexico Alliance, and the West Coast Governors' Agreement on Ocean Health.
- Federal agencies are also engaged in various regions through interagency collaborations focused on ecosystem restoration and management, such as the Gulf Coast Ecosystem Restoration Task Force, Federal Leadership Committee for the Chesapeake Bay (Executive Order 13508), Great Lakes Inter-Agency Task Force (Executive Order 13340), Great Lakes Restoration Initiative, South Florida Ecosystem Restoration Task Force, Puget Sound, and the California Bay-Delta Conservation Plan. Additionally, through groups like the U.S. Coral Reef Task Force (USCRTF) and the Aquatic Nuisance Species Task Force (ANSTF), interagency efforts are coordinated across several regions to preserve and protect coral reef ecosystems and to prevent and control aquatic nuisance species, respectively. Regional initiatives and numerous local efforts are also supported by the 18 joint ventures, established under the *North American Waterfowl Management Act*, the National Fish Habitat Action Plan (NFHAP) network of Fish Habitat Partnerships, Landscape Conservation Cooperatives (LCCs), and the regional planning bodies being established to conduct coastal and marine spatial planning (CMSP). Through these diverse initiatives, Federal agencies are coordinating their activities and authorities, and ensuring that

their ecosystem protection and restoration projects use the best available science and promote resiliency and adaptation to the effects of climate change. These initiatives also provide a mechanism to facilitate coordination among the Federal, state, and local governments, and stakeholders, and to build shared capacity to address the threats to ocean, coastal, and Great Lakes ecosystems.

The National Ocean Policy (NOP) calls for development of a Regional Ecosystem Protection and Restoration Strategic Action Plan (SAP) to address project prioritization, collaboration and coordination, science-based planning, impacts of invasive species, and protection, maintenance, and restoration of populations and essential habitats. Future updates will provide an opportunity to include next steps to advance solutions to the issues in this SAP, identify different issues and priorities, and support actions in different geographic areas.

- This SAP is intended to provide a framework for Federal activities that support existing regional ecosystem protection and restoration efforts, strengthen and expand partnerships with non-Federal entities (i.e., state, tribal, local governments, regional ocean governance organizations, academic institutions, non-governmental organizations (NGOs), private and public entities) and jointly align regional priorities and goals.
- This SAP contains a discrete set of actions to address priority issues where increased coordination and prioritization among Federal agencies and their non-Federal partners, enhancement of program effectiveness, or development and improvement of methodologies and protocols will help achieve conservation success.
- Although this SAP is national in scope, several of the actions address issues specific to a region or a resource. The actions in this SAP will build upon, and be informed by, the processes, priorities, and ongoing programs at the regional, state, and local levels. It is meant to be a bottom-up process. Ongoing collaboration and coordination with the variety of regionally-focused ecosystem restoration efforts will also occur.
- This SAP will be coordinated with several other SAPs that include actions at a regional scale, including Ecosystem-Based Management (EBM) to adopt EBM principles in the regional planning and management of ocean and coastal resources, Coordinate and Support, Changing Conditions in the Arctic, Water Quality and Sustainable Practices on Land, and the Coastal and Marine Spatial Planning (CMSP) SAP work with relevant stakeholders in each of nine regions identified in the NOP.

III. Body of Plan

A. Action 1 – Support shared regional ecosystem protection and restoration priorities.

Federal agencies collaborate with state and regional ecosystem protection and restoration initiatives throughout the U.S., but do not always effectively coordinate with each other in these efforts. Agencies will align Federal resources to support the shared priorities among the Federal and regional ocean and Great Lakes plans.

Building on the existing geographic initiatives and regional activities and experience, the SAP will create mechanisms for the sharing of information, data, and ideas between

geographically based initiatives and provide opportunities for addressing areas of overlap, common concern, and mutual benefit. Activities under this action should be aligned with the Water Quality and Sustainable Practices on Land SAP.

This SAP will focus initially on regions where Federal agencies are working collaboratively with states, local governments, tribes, and other stakeholders to support regional ecosystem priorities, and be expanded to include other regions in future SAP updates. "Bottom-up" input from regions will be essential to updating the SAP. The Great Lakes, the Gulf of Mexico, and the Chesapeake Bay watershed are examples of geographic regions where efforts will be focused initially:

- Great Lakes: Building on existing partnerships, support the prioritization, development, and implementation of eight multi-agency aquatic nuisance species plans for early detection, rapid assessment and rapid response. If funds allow, a Federal interagency early detection, rapid assessment, and rapid response team will be established to conduct aquatic nuisance species response activities under Federal responsibility.
- Gulf of Mexico: Collaborate with the Gulf of Mexico Alliance and the Gulf Coast Ecosystem Restoration Task Force to support ongoing regional sediment management planning efforts. Beneficial use of sediment is a key tool for regional restoration projects (e.g., coastal wetlands, shellfish beds and living shorelines, sea grass beds, barrier islands). More detail on this action will be developed as the Gulf Coast Ecosystem Restoration Strategy is developed in the coming months.
- Chesapeake Bay: Support the land conservation goals under the Chesapeake Bay Executive Order 13508, by coordinating Federal programs supporting the conservation of public and private lands that provide important habitat and other ecosystem services, and sustain working landscapes and communities.
- Future SAPs will be coordinated with regional ocean and Great Lakes governance organizations to identify actions in (1) Mid-Atlantic region, (2) Puget Sound and San Francisco Bay and the West Coast region, (3) the Florida Everglades and the South Atlantic region, (4) the Gulf of Maine and the Northeast region, and (5) in regions where regional ocean governance organizations are not established (Alaska/Arctic, Caribbean, and Pacific Islands regions).

1. Why Do This

   Aligning resources will help to:

   - accomplish protection and restoration goals identified in both the Federal and regional ocean governance plans;
   - promote better coordination between Federal agencies and regional entities in identifying protection and restoration priorities, and implementing projects;
   - protect and restore ecosystem integrity and ecosystem services, support recovery of listed species, ensure sustainable populations of commercial

and recreational fish and other wildlife, build resilience to climate change, enhance recreational opportunities, and provide other societal benefits; and
- more effectively utilize sediments to restore wetlands and barrier islands in the Gulf of Mexico and develop information useful to improve sediment management in other areas of the country.

2. Timeframe – Mid-term

3. Outcomes
   - Lessons-learned analysis of successful protection and restoration projects.
   - Mechanism for sharing lessons learned and best practices in coastal and wetlands restoration between regionally and geographically based efforts.
   - Improved understanding of Federal opportunities and barriers to effective regional collaboration.
   - Identification of federal programs and efforts, competing mandates, and overlapping jurisdictions.
   - Support to efforts of the Great Lakes initiatives to reduce and control aquatic nuisance species.
   - Increased beneficial management and use of sediment for restoration projects in priority coastal areas, particularly in the Gulf of Mexico.
   - Strategic allocation of Federal land conservation funds in the Chesapeake Bay watershed.

4. Milestones
   - Complete and implement state and Federal interagency rapid assessment and response plans to prevent and control aquatic nuisance species in the Great Lakes.
   - Carry out a series of mock exercises to practice responses under the State and Federal plans and conduct actual responses throughout the Great Lakes Basin.
   - Assess, compile, and strategically integrate sediment management plans for priority coastal areas in the Gulf of Mexico and develop lessons learned documentation.
   - Conduct regular interagency meetings to align Federal assistance to support regional land conservation goals and identify opportunities for interagency collaboration.
   - Conduct a lessons-learned analysis of successful restoration and mitigation projects.
   - Compile assessment of regional and local initiatives, identifying Federal programs, grants and opportunities that can be brought to bear.

5. Gaps and Needs in Science and Technology
    - Inventory of aquatic nuisance species that could potentially be introduced into the Great Lakes, their biology and life histories, and vectors by which they could be introduced.
    - Benthic data and maps for coastal areas in the Gulf of Mexico, including sediment type, contaminated sediment, and biological communities.

B. Action 2 – Strengthen conservation partnerships

Numerous innovative partnering efforts exist that contribute to progress in regional ecosystem protection and restoration. Enhanced mechanisms to increase partnerships are needed to bring together resources from Federal and non-Federal organizations to support restoration projects and facilitate the stewardship of ocean, coastal, and Great Lakes resources. As a first step towards building these the following actions will be taken:

- Encourage increased corporate support for ocean, coastal, and Great Lakes ecosystem protection and restoration by aligning the priorities of the Corporate Wetlands Restoration Partnership (CWRP) with other public-private organizations, including the regional joint ventures and Fish Habitat Partnerships. The Federal agencies will assist the CWRP Board to broaden its mission, expand its membership nationally, and increase its support of ocean, coastal, and Great Lakes ecosystem protection and restoration.
- Support an umbrella structure for a network of Coastal Conservation Corps to build local capacity to provide jobs and workforce training for a new generation of natural resource professionals, and engage citizens in protection, restoration, and stewardship of ocean, coastal, and Great Lakes ecosystems.
- Formalize Federal participation in the National Fish Habitat Action Plan (NFHAP), to protect, restore, and enhance our waterways and fisheries throughout the country.

1. Why Do This
    - Partnerships are critical to achieving the protection and restoration needed for coastal habitats that provide ecosystem services. Entities that make significant contributions towards protection and restoration include corporate, citizen-based, and local, tribal and state-led partnerships.
    - Corporations can provide an important source of investment in the conservation of ocean, coastal, and Great Lakes habitats. The CWRP provides a vehicle for corporations to invest in conservation either by providing direct project support or through the CWRP Foundation. CWRP has successfully engaged the private sector in working with Federal agencies to support coastal habitat protection and restoration. To date, the CWRP has contributed $4.5 million, which has leveraged $112 million of Federal, state, tribal, local, and non-governmental funds.
    - Several states have Conservation Corps programs that promote environmental stewardship, create jobs, and foster a commitment to community service that aligns with the goals of the America's Great Outdoors Initiative. Benefits to

local economies and ecosystem health can be expanded by supporting a coordinated network of local Conservation Corps. This action is linked to Action 4 in the Inform Decisions and Improve Understanding SAP, which addresses development of human capacity and the workforce.

- The NFHAP is an existing nationwide partnership–based investment strategy to increase the return on fish habitat conservation. There are 21 partnerships across all 50 States that benefit jobs, recreational and commercial fishing communities, and address the impacts of climate change.

2. Timeframe – Long-term

3. Outcomes
   - The CWRP provides project support for ocean ecosystem protection and restoration.
   - CWRP membership is expanded by 50 percent with a chapter in all 29 coastal States.
   - Increased corporate partnerships through CWRP to complete Federal ocean, coastal, and Great Lakes ecosystem protection and restoration projects.
   - Coastal Conservation Corps coordinating body is established and aligned with other national and regional initiatives, notably the America's Great Outdoors Initiative, to enlist citizens, including low-income and disadvantaged youth, to conduct coastal ecosystem protection and restoration projects and expand opportunities and funding for youth employment and training.
   - As appropriate and to the extent allowed by law, regional ecosystem conservation projects funded by Federal grant programs are coordinated with the objectives of the Fish Habitat Partnerships.
   - Increased capacity of a non-governmental Coastal Conservation Corps to engage citizens in ecosystem protection and restoration projects.

4. Milestones
   - Amend the CWRP Charter to include support of ocean ecosystem protection and restoration.
   - Coordinate between Coastal America Regional Implementation Teams and CWRP to increase ocean, coastal, and Great Lakes protection and restoration project identification.
   - Increase, by 50 percent, annual CWRP financial and in-kind contributions to Federal ocean, coastal, and Great Lakes protection and restoration projects.
   - Enable one coastal Conservation Corps to participate in the network in each region of the U.S.
   - Clarify and formalize the respective roles of the agencies in supporting the National Fish Habitat Action Plan (NFHAP). Create an expanded NFHAP Federal Caucus that includes active participation by all Federal agencies whose activities affect fish habitat.

5. Gap and Needs in Science and Technology – None

C. Action 3 –Reduce coastal wetland loss and improve understanding of coastal wetland status and trends

To reduce, and work toward the goal of reversing, coastal wetland loss, the NOC (principally EPA, USACE, USFWS, and NOAA) will work together and in cooperation with states and tribes to identify the underlying factors responsible for the loss of wetlands in coastal watersheds. Pilot watersheds will be selected, in consultation with local, tribal, and state entities affected by their loss, based on where wetland loss is greatest due primarily to human activities and the availability of reliable and historic data. The NOC agencies will compile existing information for the pilot watersheds, including wetlands inventories, coastal change analyses, geospatial data, permits and other types of data on natural processes to assess the status of the coastal wetlands and the causes of observed losses. This assessment will result in recommendations on how all levels of government could collaborate to improve the management of coastal wetlands and reduce losses nationwide.

As an ongoing effort, NOAA and USFWS will produce an assessment of coastal wetland status and trends using data collected for the USFWS *Status and Trends of Wetlands* reports.

1. Why Do This

- Coastal wetlands are among the most productive ecosystems on Earth, providing critical services to communities and wildlife. According to the *Status and Trends of Wetlands in the Coastal Watersheds of the Eastern United States 1998-2004,* coastal wetlands were being lost at a faster rate than non-coastal wetlands. Development (urban, rural, and unclassified) was responsible for about 70 percent of the wetland loss in coastal watersheds. Remaining wetland losses occurred as a result of natural processes such as storms, erosion, subsidence, and sea-level rise.
- Of those wetlands lost as a result of development, some were authorized under Section 404 of the *Federal Water Pollution Control Act of 1972* (Clean Water Act) and offset by compensatory mitigation (programmatic no net loss). Others have resulted from unauthorized activities in violation of a variety of Federal and state environmental statutes. Still other losses may have occurred because the wetlands involved were not subject to any regulatory program. This assessment will more precisely identify causes of coastal wetland losses and potential program improvements to stem these losses.

2. Timeframe – Long-term

3. Outcomes

- A better understanding of the underlying causes of wetland losses in rapidly developing areas and areas that are expected to be impacted by future development.
- A better understanding of the magnitude of unauthorized coastal wetland losses and how Federal, tribal, and state agencies might collaborate to reduce and ultimately reverse these losses.
- A better understanding of the extent of the losses that were beyond the scope of Federal regulatory programs and how such losses might be reduced in the future.
- Recommendations of actions Federal agencies could take to improve the management of coastal wetlands (e.g., education, restoration, protection, regulation) and communication of this understanding to regional programs.

4. Milestones

- Identify coastal watersheds for pilot assessments with updated wetland inventories and high-quality geospatial data, if available.
- Complete analyses of data and information from the 2011 Status and Trends of Wetlands in the Conterminous United States, NOAA's Coastal Change Analysis Program, the Section 404 program, and geospatial sources.
- A report recommending actions Federal agencies can take, in coordination with state, and tribal agencies, to improve the management of coastal wetlands and reduce losses nationwide.
- An assessment of the status and trends of coastal wetlands. The assessment will be included as a chapter in future *Status and Trends* reports, published by the USFWS every decade.

5. Gap and Needs in Science and Technology

- Reliable and consistent data on the location, size, type, and cause of coastal wetland losses.
- High resolution imagery that can detect changes in land use status from undeveloped to developed.

D. Action 4 – Create carbon-based incentives for coastal habitat conservation

Coastal wetlands, mangroves, and sea grasses sequester vast amounts of carbon in their plant material and sediments (up to five times the rate of tropical rainforests per unit area). These carbon sequestration and storage capabilities are important ecosystem services that can be evaluated and considered to increase the restoration and avoided loss of these habitats. Key first steps to take advantage of these benefits are developing carbon sequestration/storage protocols for coastal wetlands and exploring policy options for incorporating the carbon sequestration services of these habitats into Federal decision-making.

1. Why Do This

- A more comprehensive understanding of the services provided by coastal wetlands promotes the conservation and restoration of these important habitats.
- Although carbon sequestration is a valuable ecosystem service, it is not explicitly quantified in Federal policies governing impacts to coastal habitats. Undertaking an analysis of policy options to potentially include carbon storage in the assessment of ecosystem services would be the first step in determining if policy changes could provide additional incentives for conservation (and disincentives for habitat destruction).
- Significant opportunities exist to channel private investment into coastal habitat protection and restoration, by bringing these projects into a voluntary carbon market or promoting the carbon services provided by these habitats; however, a protocol must first be developed that provides a reliable framework for evaluating and potentially quantifying carbon gains.
- This action supports the resilience of ecosystems to climate change, as presented in Action 6 of the Resiliency and Adaptation to Climate Change and Ocean Acidification SAP.

2. Timeframe – Near-term

3. Outcomes
   - Increased private investment is channeled into coastal habitat protection and restoration.
   - Increased protection and restoration of salt marsh, mangrove, and sea grass habitats and increased mitigation requirements for impacts to these systems.
   - Increased capacity for governments to implement voluntary restoration and protection programs.
   - Reliable framework developed for implementing coastal habitat conservation projects to create offset credits.
   - Greater understanding of Federal policy opportunities and barriers for including carbon sequestration in ecosystem service assessment calculations.

4. Milestones
   - Adoption of methodologies to assess carbon sequestration capacity for different coastal wetland types, mangroves, and sea grasses.
   - Identification of demonstration sites appropriate for carbon sequestration and emission research, with emphasis on sites already identified for the purposes of long-term ecological research (e.g., National Wildlife Refuges, National Estuarine Research Reserves, National Estuary Programs, and other sites that are part of the Long-term Ecological Research Network).
   - Development of a greenhouse gas offset protocol for coastal wetland conservation for use in voluntary carbon markets.

- Completion of assessment of Federal policy opportunities and barriers for including carbon sequestration in ecosystem service assessment calculations.

5. Gaps in Science and Technology
    - Research to compare rates of carbon sequestration and carbon emission in different regions and under varying conditions (e.g., degraded vs. restored) is needed to understand the full nature of coastal ecosystem carbon services. This research gap is being addressed by the Resiliency and Adaptation to Climate Change and Ocean Acidification SAP.

E. Action 5 – Ensure full mitigation for injuries to coral reef ecosystems

To improve the protection and restoration of coral reef ecosystems, Federal agencies responsible for coral reef protection, restoration, and mitigation will develop standard protocols for coral reef ecosystem mitigation options and execute an agreement to use them as the basis for coral reef mitigation efforts. The USCRTF state and territory members will play key roles in contributing to the actions outlined here.

1. Why Do This
    - Responsibilities for mitigation assessment and policies regarding mitigation of impacts to coral reef ecosystems are distributed among four Federal agencies (EPA, USACE, DOI, and NOAA). Enhanced coordination will increase efficiency and effectiveness and improve scientifically sound mitigation, protection, and restoration of coral reef ecosystems.
    - Establishing a common set of protocols for mitigating impacts of human activities to coral reef ecosystems will result in scientifically sound and consistent coral reef mitigation projects.

2. Timeframe – Long-term

3. Outcomes
    - Identify and recommend assessment metrics specific to coral reef ecosystem functions and services.
    - Adoption of standard coral reef ecosystem mitigation protocols by the four Federal agencies with mitigation responsibilities.
    - Performance criteria, monitoring protocols, and mechanisms to track success or failure of mitigation.
    - Regionally specific guidance of measures necessary to reduce and mitigate coral reef ecosystem degradation and to restore damaged coral reefs.
    - A *Reef Managers Guide to Mitigation and Restoration* that provides guidance for managers on best management practices related to mitigation.

4. Milestones

- Establish a restoration and mitigation working group (including USACE and EPA) to act as a convening body for the USCRTF and other interested parties for coral reef ecosystem restoration and protection issues.
- Conduct a lessons-learned analysis of successful mitigation projects.
- Compile standard protocols for mitigation options to facilitate sound, consistent, and replicable restoration and mitigation of affected coral reef ecosystems.
- Prepare recommendations for improved policies and practices regarding compensatory mitigation related to coral reef ecosystems.
- Develop Draft and Final Functional Assessment for Coral Reef Ecosystem Mitigation.
- Develop a draft and final *Reef Managers Guide to Mitigation and Restoration*.

5. Gaps and Needs in Science and Technology
    - Document successful mitigation/restoration efforts for coral reefs.
    - Develop a standardized, regionally scalable methodology for assessing coral condition and valuing impacted resources. Because coral reef ecosystems are complex and their services vary considerably, even within a local area, assessment of their ecological value and mitigation costs must be conducted on a case-by-case basis.
    - Evaluate declining baseline conditions of coral reefs as a complicating factor in the assessment of restoration and mitigation success.

F. Action 6 – Reduce the threat of aquatic nuisance species

Aquatic nuisance species damage ecosystems by reducing biological diversity and adversely affect humans by hindering economic development, interfering with recreational and commercial activities, decreasing aesthetic values, and serving as vectors of disease. Through the Aquatic Nuisance Species Task Force (ANSTF), Federal agencies are working together to control aquatic nuisance species through regulation, management, and education.

- Agencies will work with the ANSTF to identify priority nuisance species needing immediate action.
- As an example, one known priority is the Indo-Pacific lionfish. Federal agencies will collaborate with non-Federal partners and stakeholders to develop an innovative inventory and control plan for the Indo-Pacific lionfish that can be adapted for transfer to other marine invasive species.

1. Why Do This
    - Support of ANSTF efforts emphasizes the need to prevent the introduction and dispersal of aquatic nuisance species, and provides the opportunity to address priority issues on a regional basis.
    - Because each region poses a set of unique challenges and available resources, mechanisms to increase partnerships are needed to bring together the

expertise, strengths, and resources from Federal, state, international agencies, Fishery Management Councils, academic institutions, and other organizations to effectively control invasive populations.

- As an example of the benefits of addressing priority aquatic nuisance species, an initial programmatic response can address Indo-Pacific lionfish. In less than a decade, the Indo-Pacific lionfish has become widely established along the Southeast U.S. and Caribbean, and poses a threat to many native reef fish populations through direct predation and competition for food and space resources. The lionfish is the first marine aquatic invasive finfish to become established within Western Atlantic waters; thereby the species is capable of providing new information on fundamental ecological processes including dispersal, competition, and community structure. This information would benefit ecosystem-based management of native reef fisheries through improved understanding of dispersal and connectivity, prevention of future invasions, control of established invaders, and opportunity to implement a control plan across international boundaries.

2. Timeframe – Near-term

3. Outcomes
   - A list of priority aquatic nuisance species to address in key geographic areas.
   - A lionfish control plan with goals and actions to reduce their threat to native ecosystems is implemented.

4. Milestones
   - Develop an initial set of priority aquatic nuisance species coordinated with affected regional entities.
   - Establish a Lionfish Control Committee in coordination with the ANSTF, and that Committee completes a draft lionfish control plan.

5. Gaps in Science and Technology
   - Better tools for lionfish control and management, including a better understanding of lionfish ecology in its native habitat and understanding of impacts across different reef systems.

G. Action 7 – Identify nationally significant marine and Great Lakes aquatic areas in need of protection.

Healthy and productive ocean and Great Lakes ecosystems support a variety of species, promote recreational opportunities, provide resilience to the effects of climate change, and support coastal communities through economic growth and increased employment opportunities. Three actions will be initiated as a first step to strengthening place-based conservation of marine and Great Lakes resources:

- Consult with the states and the CMSP Regional Planning Bodies about the existing and potential uses of areas and appropriate levels of protection.
- Develop a process for identifying ecologically important areas via a pilot map analysis.
- Characterize and prioritize marine areas of national significance, including consideration of ecosystem services, by reactivating the National Marine Sanctuary Site Evaluation List (SEL).

1. Why Do This
   These actions inform planning for future marine protected areas and ocean planning:
   - A marine gap analysis is needed to identify areas that are nationally significant, ecologically important, and provide important ecosystem services. This analysis will integrate resource characterization and human use data at regional scales and inform the CMSP process.
   - The SEL is a decision support tool designed to evaluate areas nominated for designation as marine sanctuaries, and is one of a number of tools that could be used to identify areas that are nationally significant due to their qualities (e.g., conservation, cultural, esthetic).

2. Timeframes – Mid-term

3. Outcomes
   - A protocol for evaluating nationally significant and ecologically important marine areas for protection that is science-based and balances human uses with conservation.
   - Updated and repopulated Sanctuary Evaluation List (SEL).
   - Recommendations of mechanisms to provide the appropriate level of protection to sustain ecosystem services for the listed sites.

4. Milestones
   - Establish an interagency working group to develop the gap analysis protocol.
   - Reactivate and repopulate the SEL with marine areas that have been identified as nationally significant due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities.
   - Conduct an inventory of other information sources that could be integrated into the gap analysis.
   - Pilot the gap analysis protocol in two U.S. regions as part of the CMSP planning process.

5. Gaps in Science and Technology
   - Identification of potential protected areas requires using the best available scientific information and nominations from participating Federal and state

agencies and contributors. This will be coordinated with the Inform Decisions and Improve Understanding SAP.

H. Action 8 – Improving the effectiveness of coastal and estuarine habitat restoration projects

Several Federal agencies fund and implement coastal and estuarine habitat restoration projects. It is important that these efforts are coordinated, evaluated, and tracked to ensure that restoration implementation is effective and efficient. The Estuary Habitat Restoration Council, established under the *Estuary Restoration Act of 2000* (ERA), is an established vehicle to bring Federal agencies together to jointly solve habitat restoration issues. To further these efforts, Federal agencies, beginning with the Estuary Habitat Restoration Council members, will: (1) improve the effectiveness of coastal and estuarine habitat restoration projects by updating and adopting the ERA monitoring protocols; (2) work to identify socio-economic monitoring parameters; and (3) input estuary restoration project tracking information into the National Estuaries Restoration Inventory (NERI).

1. Why Do This
    - Monitoring allows practitioners to track project success, determine which restoration methodologies are the most successful and cost effective, document ecosystem services provided, and identify when adaptive management is required.
    - The ERA establishes a collaborative process among Federal agencies for addressing the threats to the health of our Nation's estuaries. The Act recognizes the importance of project monitoring and tracking to the success of any estuarine conservation program. The ERA established an interagency Estuary Habitat Restoration Council made up of DOI-FWS, NOAA, USACE, EPA, and USDA-NRCS.
    - The ERA required NOAA, in consultation with the Estuary Habitat Restoration Council (ERA Council), to establish minimum monitoring requirements for projects funded under the Act. These monitoring requirements have been established and are applicable to all coastal habitat restoration projects. Project effectiveness would benefit through consistent use of requirements for project monitoring.
    - The ERA also requires NOAA, in consultation with the ERA Council, to develop NERI, which maintains a publically accessible database of information concerning estuarine habitat restoration projects carried out under the Act, as well as for other projects that meet the minimum monitoring requirements. Using this database reduces duplicative and competing databases and helps to streamline restoration activities.

2. Timeframe – Mid-term

3. Outcomes
    - Adoption and implementation of the ERA coastal and estuarine habitat restoration monitoring protocols by Federal agencies involved in coastal habitat restoration.
    - Identification of socio-economic monitoring parameters for coastal and estuarine habitat restoration projects.
    - Incorporation of estuarine restoration data into NERI from all Estuary Habitat Council agencies' project tracking databases.

4. Milestones
    - With input from states and stakeholders, conduct review and subsequent update of ERA monitoring protocols; include suggestions for socio-economic parameters.
    - Evaluate interagency database needs and solutions, and update the existing NERI database accordingly to allow use by all restoration agencies.
    - Fifty percent of new estuarine restoration projects conducted by the Estuary Habitat Restoration Council agencies use ERA monitoring protocols.

5. Gaps in Science and Technology
    - Need to review and update restoration monitoring protocols at least once a decade.
    - Clarify Federal policy regarding geospatial data for projects on private lands.

Water Quality and Sustainable Practices on Land
Strategic Action Plan
Full Content Outline

Objective: Enhance water quality in the ocean, along our coasts, and in the Great Lakes by promoting and implementing sustainable practices on land.

I. Overview of the Priority Objective

- The Water Quality and Sustainable Practices on Land (WQ/SPL) strategic action plan (SAP) addresses the notable obstacles to and opportunities for enhancing water quality in the ocean, along our coasts, and in the Great Lakes:
    - The major impacts of urban and suburban development and agriculture, including forestry and animal feedlots, on ocean, coastal, and Great Lakes waters.
    - The relative contributions of significant land- and ocean-based sources of pollutants, sediments, and nutrients to receiving coastal and ocean waters, and ways to address them, including recommendations of how to integrate and improve existing land-based conservation and pollution programs.
    - Best management practices, use of conservation programs, and other approaches for controlling the most significant land- and ocean-based sources of nutrients, sediments, pathogens, toxic chemicals (e.g., oil, heavy metals, pesticides), solid waste, marine debris, and invasive species.
    - Implementation of a comprehensive monitoring framework and integration with state monitoring programs based on the strategy developed by the National Water Quality Monitoring Council.

II. Context and Continuity

- The Water Quality and Sustainable Practices on Land SAP outlined below is founded on four themes:
    - Theme 1: Enhance water quality through sustainable practices that reduce upstream sources of excessive nitrogen, phosphorus, and sediment, helping to reduce hypoxic zones and restore degraded ecosystems.
    - Theme 2: Reduce trash and marine debris in ocean, coastal, and Great Lakes waters to minimize impacts on natural and human environments.
    - Theme 3: Reduce harmful health impacts from water quality impairments in the ocean, our coasts, and the Great Lakes.
    - Theme 4: Identify, protect, and conserve high quality ocean, coastal, and Great Lakes waters.

III. Body of the Plan

The following actions are grouped by theme. Theme 1 includes Actions 1-3; Theme 2, Action 4; Theme 3, Actions 5-6; and Theme 4, Action 7. The first four Actions focus on reducing stressors to water quality. Actions 5 and 6 focus on assessing health impacts and improving communication, while Action 7 focuses on protecting high quality waters.

A. Action 1 – Reduce rural sources of excessive nutrients and sediments.

Implement measures to reduce the burden of excessive nutrients and sediments in coastal and Great Lakes watersheds from rural sources (e.g., agriculture, forestry) by focusing on locations where conservation practices have the greatest returns, in conjunction with tribes, regional partners, landowners, and other stakeholders.

1. Why Do This
   - Control of excess nutrients and sediments from rural sources can enhance aquatic ecosystem health, reduce costs to wastewater treatment plants, retain storage capacity in flood control structures, and enhance recreational opportunities.
   - Government investments to improve watershed health will result in enhanced coastal water quality.
   - This action will be connected with many of the other SAPs, notably Coastal Marine Spatial Planning (CMSP), Climate Change, and Regional Ecosystem Protection and Restoration.

2. Timeframe – Mid-term

3. Outcomes
   - Improved nutrient and sediment management in agriculture, including aquaculture, aquatic animal feeding operations (AAFO), concentrated animal feeding operations (CAFO), animal feeding operations (AFO), and crop agriculture, through focused use of best management practices.
   - Established priority watersheds for restoration and management through data, information collection, and assessment to better focus application of conservation practices.
   - Established integrated monitoring, modeling, and assessment partnerships of priority watersheds to measure water quality and conservation program effectiveness, building on regional landscape initiatives (e.g., U.S. Department of Agriculture (USDA) Mississippi River Basin Initiative).

4. Milestones
   - Evaluate Federal datasets (e.g., U.S. Geological Survey SPARROW) that will inform review of priority watershed locations (e.g., USDA Chesapeake Bay Watershed Initiative, USDA Mississippi River Basin Initiative).
   - Utilize Federal conservation programs, assess program effectiveness, and report results (e.g., Conservation Effects Assessment Project), with emphasis on the most vulnerable lands (e.g., USDA Chesapeake Bay Watershed Initiative, USDA Mississippi River Basin Initiative).
   - Develop a focused research strategy to strengthen science and management tools to support water quality improvement decision-making.
   - Explore with Federal and regional partners incentive-based ecosystem market programs for nutrient and sediment reduction, and implement pilot projects (e.g., USDA Chesapeake Bay Watershed Initiative).

- Develop remote sensing systems, models, and decision-support tools to better evaluate the effectiveness of conservation practices at the watershed scale.

5. Gaps and Needs in Science and Technology
   - Coordinated interagency monitoring framework to improve data collection and analyses.
   - Water quality monitoring data to validate predictive nutrient runoff/reduction models at the field scale, in-stream, and in large ecosystems.
   - Data on nutrient and sediment contributions from septic tanks, boat discharges, lawns, rural wastewater treatment systems, hardscape features, stream bank erosion, and other non-point sources.

B. Action 2 – Reduce urban sources of excessive nutrients and sediments.
Implement measures to reduce nutrient and sediment loadings in coastal and Great Lakes watersheds from urban sources (e.g., wastewater treatment plants, stormwater, impervious surfaces, septic systems, lawns) by targeting locations and practices with the greatest returns, establishing scientifically-based water quality targets, in conjunction with tribes, regional partners, landowners, and other stakeholders.

1. Why Do This
   - Cities, suburbs, and towns have large areas of impervious surfaces (e.g., paved streets, parking lots, rooftops) that do not allow rain to percolate into the ground, resulting in polluted stormwater runoff that negatively impacts aquatic habitat and organisms.
   - Wastewater treatment plants and combined sewers contribute significant amounts of nutrients to waterways, impacting downstream water quality.
   - Using a targeted approach that includes public reporting promotes progress and innovation in linking upstream actions to downstream impacts.
   - This action will be connected with many of the other SAPs, notably CMSP, Inform Decisions and Improve Understanding, and Regional Ecosystem Protection and Restoration.

2. Timeframe – Mid-term

3. Outcomes
   - Focused water quality assessments, including air deposition, in areas with the greatest water quality degradation and/or disproportionate impacts on disadvantaged communities.
   - Promotion of cost-effective stormwater controls, long-term control plans for combined sewers, and water quality-based effluent limits for other point sources.
   - Increased adoption, through coordinated Federal and regional partner efforts, of low-impact development, green infrastructure, smart growth strategies, and other innovations.
   - Reduced impacts of hydrologic alterations that change or disrupt the natural flow regime and delivery of flow to coastal wetlands.

4. Milestones
   - Engage communities in developing innovative market-based mechanisms to provide cost-effective nutrient reduction strategies.
   - Promulgate a more effective National Pollutant Discharge Elimination System stormwater rule, and expand the program to fast-growing suburbs and ex-urban areas to reduce discharges from developed lands.
   - Promote research and foster community education and training to adopt green infrastructure, low-impact development, and best management practices for wet weather events, and promote pilot programs to assess the socio-economic benefits of these activities, focusing on federal facilities and disadvantaged communities.
   - Standardize state and Federal water quality data collection to help assess the impacts of urban pollution and flow volume and timing, and report progress in reducing nutrient and sediment loadings.

5. Gaps and Needs in Science and Technology
   - Tools to characterize watershed-scale benefits due to implementing green infrastructure practices and low impact development.
   - Data on the amount of nitrogen and phosphorus discharged from wastewater treatment plants and combined sewers.
   - More detailed maximum daily load data that clearly identify the amounts of nutrients and other contaminants contributed by various sources, including stormwater runoff.

C. Action 3 – Assess hypoxia status, trends, and impacts nationwide.
Assess hypoxia status and trends in coastal, estuarine, and Great Lakes waters, and communicate the results to regional partners and other stakeholders.

1. Why Do This
   - Severe oxygen depletion or hypoxia is one of the most readily recognized symptoms of impaired ocean and marine water quality, evoking a strong public reaction to incidences of mass fish mortality, loss of bivalve and coral reefs, economic impacts on commercial and sport fisheries, and degradation of ecosystem health.
   - Cumulative economic losses associated with hypoxic conditions could amount to billions of dollars due to reduced commercial and recreational opportunities.
   - In most cases, human actions are the primary cause of increasing hypoxic conditions in coastal waters.
   - Hypoxia is reversible.
   - To support existing interagency efforts and foster information exchange between regions.
   - This action will be connected with many of the other SAPs, notably Environmental Based Management (EBM), CMSP, Inform Decisions and Improve Understanding, Regional Ecosystem Protection and Restoration, and Observations, Mapping, and Infrastructure.

2. Timeframe – Near-term

3. Outcomes
- Established partnerships (e.g., regional governance structures) to identify priority areas for assessing and forecasting effects of reduced nutrient flux on the onset, size, severity, and persistence of hypoxic conditions, and report findings.
- Measurable improvements in modeling and forecasting of hypoxic conditions under different nutrient control strategies, and analysis of ecological and socio-economic impacts of reduced hypoxia and improving watershed water quality.
- Coordinated monitoring in priority watersheds and adjacent coastal waters (e.g., Guanica Bay, Chesapeake Bay) to assure continuum of observations, quantify flow and flux of materials, and provide quality-assured data for determining trends.

4. Milestones
- Provide results of integrated modeling and resulting toolkits for communicating hypoxia-related information to coastal managers and other stakeholders.
- Develop a multi-parameter strategy for water quality monitoring, including frequency of observations.
- Develop methods and procedures for reducing uncertainty about the relationships between nutrient enrichment and hypoxia, and produce an interagency report on benefits to coastal communities of restoring hypoxic zones.
- States, Federal agencies, and other partners and stakeholders collaboratively develop and implement effective nitrogen and phosphorus pollution reduction strategies that: 1) assess watersheds; 2) demonstrate load reductions; and 3) provide accountability and transparency for tracking progress.

5. Gaps and Needs in Science and Technology
- Improved modeling and ecological forecasting that incorporate site-specific parameters as well as linkages between nutrient loading and hypoxia.
- Coordinated monitoring, shared data protocols, and sustained support for Federal and non-Federal monitoring programs.
- Research and assessments for improved evaluation of biological effects and ecological impacts of hypoxia, including effects of non-nutrient factors and scenarios (e.g., water availability).
- Integrated science, including assessment of socio-economic impacts of hypoxic conditions and cost-benefit analysis of alternative management strategies.

D. Action 4 - Reduce trash and marine debris through pollution prevention and removal.
Reduce the impacts of marine debris and trash on ocean, coastal, and Great Lakes waters, and associated watersheds, through pollution prevention efforts (e.g., waste management and minimization, stormwater management, education and outreach), mitigation, and removal activities.

1. Why Do This
   - Marine debris and trash are pervasive problems in and along our watersheds, Great Lakes, coasts, and the ocean.
   - Marine debris and trash enter our waterways through both land- and ocean-based sources, resulting in impacts to human health, the environment, and the economy. The issue is visible, preventable, and solvable using a comprehensive approach that engages communities in prevention, mitigation, and removal efforts.
   - This action will be connected with many of the other SAPs, notably EBM, CMSP, Inform Decisions and Improve Understanding, Regional Ecosystem Protection and Restoration, and Observations, Mapping, and Infrastructure.

2. Time Frame
   - Long-term

3. Outcomes
   - Measurable reduction in land- and ocean-based marine debris and trash (i.e., prevent items from becoming marine debris).
   - Measurable reduction in the impacts of marine debris and trash (i.e., preventing, mitigating, and removing marine debris) to Great Lakes, coastal, and ocean resources, human health, and affected communities.
   - Strengthened partnerships with affected communities, tribes, stakeholders, industry, and government to ensure development of a more comprehensive approach to marine debris and trash impact reduction and prevention.

4. Milestones
   - Work with governmental (including Federal, tribal, state, and territorial), industry, and non-governmental partners, and communities to develop and encourage behavior change, create incentives, and promote non-regulatory efforts to mitigate the impacts of marine debris and trash (e.g., enhanced recycling, composting, pay as you throw, waste to energy, tagging and identification of fishing gear, product design and packaging, green chemistry, education, other trash and marine debris removal and reduction programs).
   - Improve use of and expand existing regulatory tools (e.g., Total Maximum Daily Loads (TMDLs), Combined Sewer Overflow (CSO) controls, waste and recycling management, stormwater management, Superfund) to reduce land-based sources of marine debris and trash.
   - Identify the types of marine debris producing significant negative effects on the marine environment, and quantify these impacts to focus targeted prevention, removal, and mitigation efforts.
   - Establish marine debris location and amount baselines through standardized monitoring or existing data, and address specific trash and marine debris sources (e.g., vessels), pathways (e.g., CSOs, landfills), and accumulation points (e.g., urban areas, islands).

5. Gaps and Needs in Science and Technology
    - Innovation in product formulation, design, packaging, and handling to reduce the accumulation and toxicity of marine debris and trash.
    - Analysis of socioeconomic impacts of marine debris and trash.
    - Standardized land- and ocean-based monitoring protocols (i.e., develop and ensure consistent baseline by which to measure effectiveness of marine debris reduction efforts), databases, and statistically valid analyses quantifying the amount of marine debris in ocean, coastal, and Great Lakes waters at relevant spatial and temporal scales.
    - Assessment and quantification of trash and marine debris toxicity, both as a source and as a sink, including impacts on the food web, human health, ecosystem health, and our waterways.

E. Action 5 - Assess health risks of coastal waters.

Enhance disease surveillance, environmental/wildlife monitoring, and watershed/waterbody modeling to assess the health risks of degraded water quality and inform remediation efforts.

1. Why Do This
    - We now face numerous health threats to animal and human populations from impaired water quality, including degraded and less resilient ecosystems and the presence of human pathogens, algal toxins, chemical contaminants, and potentially zoonotic diseases (transmitted from animals to humans) in drinking water, recreational waters, marine organisms, and seafood.
    - To address these threats, enhanced support for surveillance and monitoring programs is necessary to better understand the linkages between upstream sources of pollution (i.e. land-based) and downstream impacts, along with effects of ocean-based sources of pollution.
    - This action will be connected with many of the other SAPs, notably EBM, CMSP, and Regional Ecosystem Protection and Restoration.

2. Timeframe – Mid-term

3. Outcomes
    - Improved inter- and multi-agency coordination, resource-leveraging, and capacity building to identify health risks from impaired water quality.
    - Enhanced understanding of current and emerging health risks from impaired water quality and the links between upstream land use practices and downstream impacts on human and wildlife health.

4. Milestones
    - Strengthen research and provide interdisciplinary training opportunities on the links between degraded water quality (e.g., harmful algal blooms) and human and wildlife health risks.
    - Identify baseline pollutant levels (including land-based sources) and health impacts for monitoring long-term trends.

- Establish a scientifically sound public health foundation for implementing best management and sustainable land practices to reduce upstream and coastal pollution inputs from non-point and point discharges (e.g., harmful algal bloom mitigation, stormwater management, vessel discharges, aquaculture systems management).
- Enhance existing activities, including disease surveillance, environmental monitoring, organism and toxin detection, pollutant source tracking, watershed/waterbody modeling, and assessment of health risks related to environmental pollution.
- Review existing best management and sustainable land practices to highlight successful remediation strategies for degraded water quality and associated health risks, and prioritize pilot regions to implement improved practices.

5. Gaps and Needs in Science and Technology
   - Identification and prioritization of the greatest risk factors related to water quality.
   - Identification of the sources of harmful microbes and chemical contaminants, and understanding of the causes of harmful algal blooms related to impaired water quality.
   - Availability of detection, tracking tools, sensors, and observations with adequate temporal and spatial coverage.
   - Building capacity for diagnosing marine wildlife health concerns, including those associated with potential zoonotic and other diseases that may be transferred from marine wildlife to humans or vice versa.
   - Identification of the impacts of pollutants and other discharge constituents, including invasive species, on the health and resiliency of ecosystems and food web stability and robustness.

F. Action 6 – Provide warning and reduce public health risks of coastal waters.

Provide warning and reduce public health risks from ocean, coastal, and Great Lakes water pollution through integration of disease surveillance and environmental/wildlife monitoring and improved forecasting capabilities.

1. Why Do This
   - There is a critical need to integrate environmental monitoring with disease surveillance and develop predictive models to enhance existing and advance new early warning systems for pathogens, algal toxins, and chemical contaminants.
   - Forecasts and warnings can help quickly identify threats and notify communities of risks associated with contaminated recreational and drinking waters, seafood, and beaches; reduce health risks from pollutants; and help safeguard coastal resource-dependent economies.
   - Improved risk warning systems will support informed decision-making by managers and local communities about coastal resource uses.
   - Improved intergovernmental coordination will promote informed risk management control strategies, including decision-making and identification of priority areas for remediation.
   - This action will be connected with many of the other SAPs, notably CMSP, Regional Ecosystem Protection and Restoration, and Observations, Mapping, and Infrastructure.

2. Timeframe – Mid-term

3. Outcomes

- Reduced health risks from impaired waters through early warning advisories made possible by improved collaboration within the Federal government, and with territory, regional, tribal, state, and local partners, and other stakeholders.
- Improved use and understanding of health-related environmental information by local communities and resource managers.
- Greater public confidence in drinking water, recreational waters, and seafood.
- Reduced public health costs associated with adverse health outcomes from impaired water quality, and enhanced coastal economies.

4. Milestones

- Strengthen coordination within the Federal government, and with tribes, regional partners, and other stakeholders, to increase capacity for holistic (i.e., societal, economic, ecological) and efficient decisions.
- Inventory existing tools and systems applicable to forecasting activities and health warning systems.
- Integrate activities and data related to human and animal/wildlife disease surveillance, environmental monitoring, organism and toxin detection, pollutant source tracking, watershed/waterbody modeling, and assessment of health risks.
- Improve and expand health early warning systems, forecasting capabilities, and existing advisories (e.g., harmful algal blooms, seafood contamination) through increased collaborations with states and within the Federal government.
- Launch pilot early warning systems or demonstration projects for a variety of current and emerging health risks in partnership with state and regional efforts.
- Improve communication, training, access, and use of information, including the development of new tools to effectively communicate risk, to increase public understanding of degraded water quality impacts.
- Explore expansion of the National Coastal Condition Report (NCCR) to: 1) address pollution problems resulting in human health impacts including fish and shellfish contamination, safe beaches, waterborne disease, and harmful algal blooms; 2) expand the Federal/state interagency team responsible for preparing the report to include public health agencies; 3) align the NCCR regions with the CMSP Regions; and 4) describe the actions that Federal agencies will take to address environmental and human health risks identified in the report.

5. Gaps and Needs in Science and Technology

- Integration of climate change predictions into health risk assessment and early warning systems.
- Better understanding of how and how often urban residents use contaminated coastal water bodies (e.g., subsistence fishing, swimming) and are thereby exposed to health threats.

- Improved assessment of socio-economic impacts of health threats, including public health costs related to impaired water quality.
- Development of new remediation techniques for preventing and controlling pollution and its impacts.

G. Action 7 - Identify and protect high quality coastal waters.

Promote and conduct collaborative, holistic assessments and initiate steps for the protection, conservation, and maintenance of high quality ocean, coastal, and Great Lakes waters, as well as the watersheds that affect those waters.

1. Why Do This
   - The protection, conservation, and maintenance of high quality waters and healthy watersheds is a cost-effective, long-term solution for assuring the sustainable conditions of the ocean, coastal waters, and Great Lakes and their associated environmental services, including human uses.
   - Maintaining the conditions of high quality waters is paramount to assuring the continued functionality and resiliency of aquatic life and its ability to adapt to environmental stressors such as climate change.
   - Preventing degraded water quality through coordinated response to coastal and offshore pollution helps to ensure the safety of aquatic life in high quality waters.
   - This action will be connected with many of the other SAPs, notably EBM, CMSP, and Regional Ecosystem Protection and Restoration.

2. Timeframe – Long-term

3. Outcomes
   - Identification of high quality waters for priority consideration in conservation efforts through assessments of chemical and physical parameters, hydrology, geomorphologic processes, shoreline modification, incidence of aquatic invasive species, natural disturbance regimes, landscape condition, and human uses.
   - Improved control and regulation of water pollutants and other constituents in discharges (e.g., invasive species, pathogens, toxics, sediments) from vessels and ocean dumping.
   - Coordination and integration of stakeholder/partner monitoring programs to encourage community involvement, education, and stewardship in the protection of healthy watersheds.
   - Improved coordination among Federal agencies in the prevention and response to coastal and offshore oil/chemical pollution from spills and industrial/shipping operations.
   - Enhanced coordination of water quality monitoring by promoting implementation of the strategy developed by the National Water Quality Monitoring Council and coordinating it more closely with the NCCR.

- Application of tools (e.g., climate change models) and water quality protection measures to help protect, maintain, and conserve high quality waters and healthy watersheds within existing programs.

4. Milestones
   - Develop collaborative action plans to protect, maintain, and conserve high quality waters on public and private watersheds (e.g., Forest Service National Watershed Condition Framework).
   - Develop or revise regulations and permits for discharges from vessels pursuant to the Clean Water Act.
   - Issue a biennial report card on water quality, quantity, and timing status, trends, and success stories in federally managed, protected, or funded areas.
   - Coordinate and enhance research, preparedness, and response to coastal and offshore oil/chemical pollution from spills and industrial/shipping operations.
   - Expand the scope of the National Water Quality Monitoring Network for U.S. Coastal Waters and their Tributaries to address the physical, chemical, and biological integrity of rivers and streams by leveraging the State/EPA National Aquatic Resource Surveys.
   - Initiate a demonstration project linking healthy watershed protection to estuary protection, and evaluate the success in protecting and conserving high quality coastal waters (e.g., National Estuary Program).

5. Gaps and Needs in Science and Technology
   - Improved ability to generate, manage, store, and display data and analyses generated by interagency collaborative protection and conservation efforts.
   - Improved understanding of the environmental impacts from vessel discharges.
   - Improved existing capabilities and assure closer collaboration between agencies in the identification and protection of high quality waters and healthy watersheds.
   - Improved capacity to accurately measure, display, and incorporate social/economic/ecological factors that affect values and decisions about land use, high quality coastal waters, and tradeoffs.
   - Robust sensitivity analyses to implement the activities recommended by the National Water Quality Monitoring Council in its National Monitoring Network for Coastal Waters and Inland Tributaries.

Changing Conditions in the Arctic
Strategic Action Plan
Full Content Outline

Objective: Address environmental stewardship needs in the Arctic Ocean and adjacent coastal areas in the face of climate-induced and other environmental changes.

I. Overview of the Priority Objective

- Address environmental stewardship needs in the Arctic Ocean (including contiguous Bering, Chukchi, and Beaufort Seas) and adjoining coastal areas in light of climate and environmental change, as well as increasing accessibility to human activity.
- Improve efforts to conserve, protect, and sustainably manage Arctic marine resources, effectively respond to the risk of increased pollution and other environmental degradation on humans and marine life, and adequately safeguard living marine resources.
- Develop new collaborations to better monitor and assess environmental conditions and to devise procedures to respond to emergencies such as environmental accidents.
- Achieve consistency and coordination with the implementation of the United States Arctic Region Policy as promulgated in the National Security Presidential Directive 66/Homeland Security Presidential Directive 25 (2009).
- Improve the scientific understanding of the Arctic system and how it is evolving in response to climate change and other forcers.

II. Context and Continuity

- The Arctic is a frontier. While it is considerably less developed than other U.S. maritime areas, access to the region is increasing rapidly. To achieve National Ocean Policy goals, the U.S. will require fundamental research, improved coordination, and new infrastructure.
- Alaska Native communities rely on the Arctic environment for important cultural, subsistence, and ceremonial practices. Identification and implementation of the strategic actions in this plan will be undertaken with their active engagement.
- Seven themes were identified as focus areas for this action plan:
  - An integrated Arctic observing network.
  - Arctic climate and environmental change (understand, forecast, predict).
  - Arctic mapping and charting.
  - A safe, secure, and reliable Arctic Marine Transportation System.
  - Stewardship of the Arctic marine environment and sustainable development of resources.
  - Resilient and healthy Arctic communities and economies.
  - Domestic and international policy and partnerships in the Arctic.
- As one of nine national priority objectives “Changing Conditions in the Arctic” is unique. It is the only one that is place-based, or focused on a single region. As a result, many topics in the Arctic strategic action plan are also addressed in other plans, or are even their primary focus. To be

fully successful, the actions in the Arctic plan must be considered and implemented within the broader context of the other eight objectives.

- This Strategic Action Plan outline is consistent with other efforts, including the U.S. Global Change Research Program Strategic Action Plan.

III. Body of the Plan

A. Action 1: Improve Arctic environmental response management.
Develop management systems and procedures to protect communities and ecosystems from oil spills and other accidents associated with resource extraction (oil and gas) and Arctic marine transportation (e.g., commercial shipping and tourism). Specifically, inform the development and implementation of response coordination mechanisms such as the Environmental Response Management Application (ERMA®), a geospatial decision-support tool.

1. Why Do This
   - Exploration and development of natural resources in the Arctic, and a rise in marine traffic will increase the probability of accidents.
   - Taking action to prevent, prepare for, and respond to environmental emergencies will better protect communities and ecosystems.
   - To protect subsistence resources which provide the nutritional benefits and cultural practices of Alaska Native communities.
   - Procedures to respond to Arctic Ocean oil spills are specifically called for in the "Report of the National Commission on the BP Deepwater Horizon Oil Spill."
   - Responds to the National Ocean Policy goals to "respect and preserve our Nation's maritime heritage, including our social, cultural, recreational, and historical values," and, "support sustainable, safe, secure, and productive access to, and uses of the ocean, our coasts. . ."

2. Timeframe – Mid-term

3. Outcomes
   - Better protection of sensitive areas of the U.S. Arctic through more efficient resource management and emergency preparedness.
   - Increased coordination among Federal agencies in cooperation with state agencies, local, and Tribal governments, and international bodies.
   - Specific plans and understanding of responsibilities to prepare and respond to emergencies related to resource development and marine transportation.
   - Community participation in the development of oil spill prevention planning and response measures and coordination mechanisms.
   - Well-coordinated sharing of resources and information related to pollution response within the U.S. and across the Arctic.

- Scientific support for prevention and management of a large pollution event in the Arctic is well coordinated among Federal and state agencies and local and Tribal governments.
- A comprehensive understanding of the impacts of a large pollution event in the Arctic on traditional livelihoods, sensitive ecosystems, economies, and security.

4. Milestones

- Complete the development and implementation of ERMA® to prepare for Arctic oil spill response, assessment, and restoration.
- Finalize and test contingency plans to ensure adequacy of response equipment, trained personnel, and nearshore protection strategies. Use existing response preparedness efforts, such as the Aleutian Island Risk Assessment.
- Cross-train emergency responders (for example, response to oil in sea ice).
- Assess and compile scientific research as well as traditional knowledge related to the impacts of resource development and pollution applicable to the Arctic.
- Integrate Federal efforts to study oil spilled in ice-covered waters.
- Support substantial U.S. participation in efforts to create an Arctic-wide agreement on oil spill preparedness and response that may ultimately lead to international standards for maritime activities including oil and gas operations in the Arctic.
- Participate in joint training and workshops with other Arctic nations on oil spill prevention and response mechanisms and procedures, including deployment exercises in Arctic conditions.
- Develop cooperative agreements with Tribal, local, State, Federal and other Arctic nations' governments for sharing response assets and resources across the Arctic in the event of a large pollution event, including: (1) worldwide inventory of equipment available for deployment in the Arctic; (2) command, control and communications strategies, and; (3) international guidelines for spill response in broken-ice and ice-covered environments.
- Partner with industry to ensure the development of oil spill prevention, containment, and response infrastructure, plans, and technology that are proven effective in ice-covered seas.

5. Gaps and Needs in Science and Technology

- Better spill containment technology that is suited for operation in the Arctic environment.
- Increased coordination among scientists, resource managers, and constituents on the potential effects of a large pollution event in the Arctic; for example, marine mammal biologists and scientists studying ice flows working together on impacts of oil in an ice environment or scientists working more effectively with resource managers to better articulate information needs facilitating better emergency response.
- Increased sharing across agencies of tools such as ERMA®.

- Participation of U.S. Federal scientists in development of spill containment technology already taking place within industry.
- Local community training and education related to the impacts of resource development.
- International participation in Arctic-wide spill response efforts.

B. Action 2 – Observe and forecast Arctic sea ice.
Observe, predict, forecast, and ultimately project the extent, thickness, and age of summer and winter sea ice in the Arctic Ocean and contiguous seas. The timeframe and extent of the forecasts will be designed for a variety of stakeholders, and will support safe operations and ecosystem stewardship.

1. Why Do This
   - Sea ice forecasting is the most urgent and timely ocean issue to address in the Arctic region; continued rapid loss of sea ice will be a major driver of changes across the Arctic. The loss of sea ice affects marine access, regional weather, global climate, marine and terrestrial ecosystems, and coastal communities.
   - This action advances ocean stewardship, the economy, and national security by providing situational and domain awareness, and improves foundational science to understand and detect climate and ecosystem change.
   - Improving daily to weekly sea ice forecasts will benefit community activities (e.g., safer subsistence hunting, storm preparation/defense), support the management of protected marine resources, and improve the safety of general maritime activity.
   - Longer-term sea ice forecasts are needed for infrastructure planning, ecosystem stewardship under rapidly changing conditions, and projection of global climate impacts forced by changes first occurring in the Arctic.
   - All-season observations from platforms and ice camps on and under Arctic sea ice will improve our understanding of Arctic environmental variability.

2. Timeframe – Long-term

3. Outcomes
   - Accurate, quantitative, daily forecasts to decadal predictions of sea ice support safe operations and ecosystem stewardship.

4. Milestones
   - Conduct workshop on sea ice forecasting to prepare initial implementation plan.
   - Initiate interagency activity to improve application of remote sensing and buoy/mooring data to sea ice forecasting (DOD funding pending).
   - Initiate cataloging for U.S. Arctic Sea Ice Atlas.

- Train and expand Volunteer Observing Ship and coastal community participation in sea ice observation program; catalogue user requirements for sea ice products, services and delivery.

5. Gaps and Needs in Science and Technology
   - Improved applications of remote sensing and buoy/mooring data for sea ice characteristics and sea ice vector analysis.
   - New real-time *in situ* observational technologies for atmosphere, ice, and ocean variables that control sea ice movement, melt, and growth.
   - Coordination with and access to charter and non-charter vessels capable of working in Arctic areas during spring, summer, and fall seasons.
   - Improved understanding of the links between sea ice an oceanography, such as through heat flux and circulation.
   - New sea ice models that: assimilate advanced observing data; output sea ice thickness, concentration, location with time at higher temporal and special resolution; and couple ice/ocean/atmospheric processes.

C. Action 3: Establish a distributed biological observatory.
Implement an international distributed biological observatory (DBO) in the Pacific Arctic sector focused on six locations along a latitudinal gradient from the northern Bering to the western Beaufort seas.

1. Why Do This
   - Scientific research will provide a better understanding of how climate change affects Arctic biology, and what steps will be necessary to improve stewardship of the Arctic marine ecosystem.
   - Changes in location and timing of the seasonal ice edge can have profound effects on benthic and pelagic marine ecology and human activity. These same changes also affect the ability of ice-dependent marine mammals to reproduce and rear young on ice.
   - Planktonic changes can affect distribution and abundance of baleen whales that are important to subsistence cultures. Likewise, stranding of ice-dependent species on land likely reduces their survival or reproductive rate and may make the animals less available to subsistence hunters.
   - Relationships between ice edge retreat, changes in plankton dynamics, loss of summer sea ice, and foraging success of whales and ice dependent species is poorly understood, as are the effects of these changes on Alaska Natives who depend upon these species.
   - Acidification of Arctic Ocean surface waters is projected to be greater than for any other marine waters on the planet, with largely unknown consequences.
   - The DBO will address the large uncertainties in the responses to climate and ecosystem changes in the biological domain including plankton, fish, birds, marine mammals and invasive species.

- The DBO will provide baseline information necessary to assess and mitigate potential impacts to subsistence activities of offshore resource development.

2. Timeframe – Long-term

3. Outcomes
- Biological information gained from an Arctic biological observatory network will improve the ability of all participating agencies to determine the effects of their actions on marine resources, resulting in improved conservation, protection, and management of Arctic coastal and ocean resources.
- Improved understanding of how Arctic ecosystem and climate changes will affect subsistence cultures in the region.
- New collaborations and partnerships formed in implementing this network will increase our ability to monitor and assess environmental conditions under changing climate scenarios.

4. Milestones
- DBO partners conduct DBO research cruises.
- Pacific Arctic Group (PAG) meeting to review results from 2010 and 2011 pilot activities, plan for 2012 pilot activities.
- DBO partners conduct DBO research cruises.
- PAG meeting to review all pilot activities, plan for 2013.
- International report on DBO activities and results to date.
- DBO partners conduct DBO research cruises.
- PAG meeting to review pilot activities; plan for 2014.
- Updated DBO concept and implementation plan for longer-term implementation.
- DBO partners perform DBO plans and prepare annual assessments on physical and ecological state of Pacific Arctic marine environment.

5. Gaps and Needs in Science and Technology
- New technologies for continuous, year-round, real-time observations of key physical, chemical, and biological variables.
- Coordination with and access to charter and non-charter vessels capable of working in Arctic areas during the spring, summer, and fall.
- Improved use of community-based observations and instrumented animals.
- Ecological implications of increasingly early ice edge retreat, absence of summer sea ice, increased severity of storms during the ice-free season.
- Ecological implications of ice-dependent species forced to spend time on land, including impacts of human disturbance.
- Ecological implications of ocean acidification on Arctic marine ecosystems, especially plankton and calcareous benthic organisms important as prey items to subsistence species.

D. Action 4: Improve Arctic communication.
Participate in cross-cutting efforts to improve existing maritime communication networks/architecture with a focus on support for scientific research, environmental risk reduction and incident management, and sustainable, safe, secure, and productive access to and uses of the Arctic.

1. Why Do This
   - Significant gaps exist in Arctic communication systems that increase the risk of environmental damage and loss of life and property at sea.
   - Effective communication systems are a cornerstone for devising "early warning and emergency response systems" to "respond to emerging event in the Arctic Region such as environmental disasters."
   - Ability of users, vessels, and aircraft to communicate with each other and to receive information, such as real-time weather and sea ice forecasts, will significantly decrease the risk of environmental damage and loss of life and property at sea.
   - Leverages similar efforts being undertaken for other national interests in the region, including implementation of National Ocean Policy as promulgated in Executive Order 1357, and National Security Presidential Directive 66/ Homeland Security Presidential Directive 25 (§§ III(B), (E), (F) and (H)).

2. Timeframe – Long-term

3. Outcomes
   - A system that addresses the most urgent gaps in communications and meets relevant user needs in the Arctic region.
   - Prevention of/Response to allisions, collisions, and groundings.
   - Prevention of/Improved Response to environmental disasters and loss of life and property at sea.
   - Minimize injury to marine mammals from vessels strikes and entanglement in fishing gear.

4. Milestones
   - All to be developed in coordination with other interagency efforts:
     - Inventory of existing communication capabilities and gaps.
     - Baseline of the performance capabilities of MF/HF/VHF/UHF communications systems to air and surface vessels in the Arctic.
     - Baseline of the performance of air, surface, and available shore-based sensors.
     - Analysis of communication capabilities and gaps in the Arctic Region.
     - Analysis and recommendations for the most cost-effective means to reduce communication gaps and boost capabilities in the Arctic Region.

- Implementation of recommendations to reduce communication gaps and boost capabilities in the Arctic Region commensurate with available resources and user needs.

5. Gaps and Needs in Science and Technology
   - Analysis of Arctic communications environment.
   - Analysis of alternatives.

E. Action 5: Advance Arctic marine mapping and charting.
This action will support accurate hydrographic surveys and biological/shoreline mapping that is essential for up-to-date nautical charts of U.S. Arctic waters and the Alaskan coastline, and for habitat characterizations for ecosystem stewardship and restoration.

1. Why Do This
   - Compared to the rest of the nation, the Arctic geospatial reference system (geodetic control, water level, hydrology, and shoreline) is poorly known.
   - This action contributes fundamental data essential for:
     - Nautical charting for safe navigation;
     - Sustainable, secure and productive access to the Arctic maritime environment;
     - Environmental management and emergency response planning;
     - Sea level change impact assessments;
     - Inundation modeling;
     - Biological assessments;
     - Awareness of environmental conditions in the Arctic domain;
     - Coastal community adaptation strategies for increased resilience to storm hazards and climate change impacts; and
     - Improve the resiliency of ocean economies and commerce.

2. Timeframe – Long-term

3. Outcomes
   - Improved maritime safety in the Arctic.
   - Resilient ocean economies and commerce.
   - Better tools for coastal communities to develop adaptation strategies and disaster planning.
   - Improvement to the underlying geospatial framework of data that supports scientific research and economic decision-making in the Arctic Ocean region.

4. Milestones
   - Complete airborne gravity data collection over the State of Alaska to help correct meters-level errors in positioning to centimeter level.

- Explore potential partnerships to establish Continuously Operating Reference Stations and water level stations for accurate datums and positions.
- Conduct Waterway Analysis and Management System (WAMS) assessments and Port Access Route Studies (PARS) of the Arctic region, focusing on areas indicted by risk/return analysis, to support decisions on mapping and charting priorities and waterways management.
- Prioritized list of Arctic maritime regions and shorelines for surveying.
- Establish mapping guidelines and/or standards to facilitate integrated ocean and coastal mapping.
- Coordinate mapping operations for maximal efficiency and coverage.
- Acquire Arctic hydrographic and shoreline data for accurate nautical charts and storm surge models.
- Update nautical charts, environmental sensitivity indices, and other Arctic feature maps.
- Archive data at national data centers to facilitate additional uses and scientific study.
- Continue to work with the International Maritime Organization to develop safe and secure shipping and prevention of marine pollution by ships in the Arctic.

5. Gaps and Needs in Science and Technology
   - New *in situ*, underwater, airborne, and satellite observing technologies able to withstand the rigors of the Arctic environment to fill gaps in hydrographic, shoreline, and biological datasets.

F. Action 6: Improve coordination on Arctic Ocean issues.

Implementing this strategic action plan requires coordination of scientific research, natural resource management, and national and international marine stewardship policies concerning the Arctic Ocean. The roles and responsibilities of Arctic interagency policy groups must be clearly defined to efficiently share information.

1. Why Do This
   - To clarify the sometime overlapping efforts of the following Arctic interagency policy groups within the Federal government: the Interagency Arctic Research Policy Committee (IARPC), the Arctic Policy Group (APG), and the Arctic Region Interagency Policy Committee (ARIPC) associated with NSPD-66/HSPD-25.
   - To support, as appropriate, U.S. participation in the working groups of the Arctic Council and to clarify the links between domestic and international Arctic activities.
   - Helps leverage existing resources, capabilities, and knowledge among agencies; shares information to reduce duplication and increase interagency coordination; and increases government efficiency by using established groups.
   - This action will be coordinated with the Coordinate and Support SAP.

2. Timeframe – Near-term

3. Outcomes

- Increased sharing of data and information to improve understanding of the changing Arctic Ocean and natural resource management decision-making.
- Clear communications among Federal agencies, the State of Alaska, Alaska Native communities, and international organizations through IARPC, APG, ARIPC, and bilateral activities with Arctic states.
- Incorporation of traditional and local knowledge into scientific research and decision-making.
- Integration of a wide-range of data types (satellite, *in situ* observations, charts).
- Coordination and leveraging of agencies' Arctic Ocean resources.
- Increase awareness of Arctic Ocean activities.

4. Milestones

- IARPC report released by the National Science and Technology Council that clarifies interagency roles, responsibilities, and mechanisms for coordinated decision-making.
- IARPC proposed structure for information sharing aligned with open.gov.
- Routine coordination with regional groups including the Alaska Climate Change Executive Roundtable (ACCER), North Slope Science Initiative (NSSI), Landscape Conservation Cooperatives (LCCs), Arctic Ocean Observing System (AOOS).
- Integrate national and international efforts by increasing coordination among IARPC, APG, and ARIPC.

5. Gaps and Needs in Science and Technology – None.

Ocean, Coastal, and Great Lakes Observations, Mapping, and Infrastructure
Strategic Action Plan
Full Content Outline

Objective: Strengthen and integrate Federal and non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system and integrate that system into international observation efforts.

I. Overview of the Priority Objective

- Our ability to understand weather, climate, ocean, geological/geophysical, and living marine resource processes and dynamics, to forecast key environmental conditions, and to strengthen ocean management decision-making at all levels is informed by a sound knowledge base and the integration of new tools and data.
- Efficient and effective coordination of tools, continued development of new tools and infrastructure, and their integration into a cohesive, unified, robust system is becoming increasingly difficult as more and more data collection and processing systems come on line.
- New observation technologies supported by robust infrastructure give us the ability to observe and study global processes at all scales, and advance our knowledge and understanding of the ocean, our coasts and the Great Lakes.
- The actions in this outline are intended to support acquisition and delivery of the knowledge and understanding needed to make progress on the other eight national priority objectives and further implement the National Ocean Policy.

II. Context and Continuity

- To be fully successful, the actions in this plan must be considered and implemented within the broader context of the other eight priority objectives in the National Ocean Policy. Observations, mapping, and infrastructure provide the means to gather information necessary to make progress in all areas of the policy's implementation.
- Meeting the objectives of the National Ocean Policy requires:
    - Geospatial information (data, charts and interpretive maps) obtained through coordination and leveraging of ocean and coastal mapping programs, resources and capabilities among federal and non-federal entities, including where appropriate, international collaborations.
    - Systems and associated infrastructure to improve data collection for national priority objectives, including the means to develop and test new technologies.
    - A framework for data integration across a diverse range of specialties and locations that will improve coordination for decision-making.
- Addressing our ability to observe the ocean, our coasts, and the Great Lakes and to deliver data needed to support informed decisions is an ongoing effort. This plan highlights the near-term

actions that will be undertaken now and lays the foundation for continuing efforts in the mid- and long-term.

- Ultimately this and successive plans are intended to result in progress in the following areas:
  - A nationally integrated system of ocean, coastal, and Great Lakes observing systems.
  - Delivery of data on key ocean, coastal, and Great Lakes variables.
  - Effectiveness of unmanned vehicles and satellite remote sensing platforms.
  - Improved capabilities and reduced gaps in the National Oceanographic Fleet of ships and related facilities.
  - Improved data management, communication, access, and modeling systems for the timely integration and dissemination of data and information products.
- These areas form the focus of the actions identified in this plan.

III. Body of the Plan

A. Action 1 – Examine the status of the National Oceanographic Fleet.

Provide a status report on the National Oceanographic Fleet, and identify ways to improve its utilization to achieve the priorities of the National Ocean Policy. The National Oceanographic Fleet is comprised of the federally-owned oceanographic ships operated by both Federal and academic organizations.

1. Why Do This
   - The National Oceanographic Fleet is essential to achieve the priorities of the National Ocean Policy.
   - This action seeks to identify fleet capabilities and gaps, and to improve coordination and management of existing fleet resources to close some of these gaps.

2. Timeframe – Near-term

3. Outcomes
   - Identification of National Ocean Policy at-sea survey (oceanographic and living-marine resource) and research missions, especially in the Arctic.
   - The current National Oceanographic fleet's status, capacities, and capabilities become the basis for planning survey and research work.

4. Milestones
   - Report on National Ocean Policy at-sea survey (oceanographic and living-marine resource) and research missions priorities.
   - Update the "Federal Oceanographic Fleet Status Report."
   - Complete analysis and selection of fleet effectiveness performance measurements.
   - Complete evaluation of a prototype platform allocation planning tool.

- Assess the capabilities for oceanographic ships to support multi-mission agency activities in the Arctic.

5. Gaps and Needs in Science and Technology
   - New ship designs to improve operational efficiencies at sea.

B. Action 2 – Examine the status of unmanned and satellite remote sensing systems.
Provide a status report on the use and application of unmanned and satellite remote sensing systems, and identify ways to improve utilization of these systems, to achieve the priorities of the National Ocean Policy. The current inventory of federal and non-federal unmanned systems includes Unmanned Undersea Vehicles (both tethered and autonomous), Unmanned Air Systems, and Unmanned Surface Vehicles.

1. Why Do This
   - Air and sea unmanned systems already available from federal and non-federal partners can extend or multiply the reach of survey (oceanographic and living-marine resource) and research missions.
   - The potential for these systems to aid in science and emergency response activities.

2. Timeframe – Mid-term

3. Outcomes
   - Improved and more cost effective data collection to meet National Ocean Policy survey and research mission requirements.

4. Milestones
   - Report on National Ocean Policy Priority Objective observation requirements suitable for accomplishment with unmanned systems.
   - Complete an inventory of available federal and non-federal unmanned systems.
   - Complete analysis and selection of unmanned system utilization performance measurements.
   - Complete evaluation of a prototype unmanned system inventory and planning tool.
   - Assess the potential of developing unmanned sub-ice data collection vehicles.
   - Report on regulatory restrictions or obstacles that limit use of federal and non-federal unmanned systems, and identify ways to enable better use of these systems to achieve NOP priorities.

5. Gaps and Needs in Science and Technology
   - Access to regulated airspace for unmanned aerial vehicle operations.
   - Improved battery technology for unmanned or autonomous underwater vehicles.
   - Integration of unmanned systems into multi-purpose observing systems.

- Coordination of autonomous operations of individual and swarms of unmanned systems.
- Sustained critical global and regional ocean time series observations.

C. Action 3 – Use advanced observation and sampling technologies to observe and study global processes.

Use advanced observation and sampling technologies currently funded to observe and study global processes at all scales and to further develop observational capabilities.

1. Why Do This
   - Short- to mid-term observing projects that utilize innovative observing tools and infrastructure provide significant advances in knowledge and understanding of the ocean, the coast, and the Great Lakes. These programs serve as a test-bed for addressing the science and technology gaps across the national priority objectives and the strategic action plans.
   - These activities are related to and will be coordinated with those listed under the Strategic Action Plan for Informing Decisions and Improving Understanding.

2. Timeframe – Mid-term

3. Outcomes
   - Scientific technique for integrating short-term data with sustained long-term ocean observing.
   - Scientific technique for integrating coastal and ocean, remote and in situ, physical and biological observations, and relating these observations to socio-economic data.
   - Real-time ocean data from the Ocean Observatories Initiative observing system for use in implementing the National Ocean Policy.
   - New scientific information for exploring the complexities of land, ocean, atmosphere, ice, biological, and social interactions.

4. Milestones
   - Implement data and/or modeling techniques which support a global mapping capability for seasonal changes in, for example, ocean surface topography, currents, waves, winds, phytoplankton content, nutrients, sea-ice extent, rainfall, sunlight reaching the sea, and sea surface temperature.
   - Release of report on Opportunities in Ocean Observations and Ecosystem Health.
   - Complete an inventory of unique national coastal and ocean facilities (and associated data) that fall outside normal assessments.

5. Gaps and Needs in Science and Technology
   - Improved battery technology for unmanned vehicles and moored buoy sensor systems.

- Improved data communication technology from moored buoy sensor systems.
- Improved optical and biological sensors.
- Improved understanding of interrelations between the physical ocean phenomenon, the ocean observational data and the data identifying socioeconomic impacts.

D. Action 4 – Implement the Integrated Ocean Observing System (IOOS).
Implement IOOS to sufficient functional capability to provide standardized data discovery and access to a minimum set of ocean observing data from federal and non-federal sources.

1. Why Do This
   - IOOS initial capability will provide long-term, sustained, verified and validated ocean observations to meet the data needs of the National Ocean Policy
   - In particular, it will contribute to the extensive data needs for monitoring requirements of ecosystem-based management, water quality and sustainable practices on land, changing conditions in the Arctic, and ecosystem restoration and protection, as well as the Coastal and Marine Spatial Planning (CMSP) decision-making processes and the inform decisions and improve understanding strategic area.

2. Timeframe – Mid-term

3. Outcomes
   - A sustained IOOS that is responsive to and reflects priorities identified across federal agencies, regional planning entities, and state and local stakeholder communities.
   - Coordinated development that advances the individual and shared objectives of, and provides for integration across, targeted observing efforts including, for example, biological (e.g. Ocean Biographic Information System) and water quality (National Water Quality Monitoring Network) communities.
   - Improved access to standardized data to support the following societal goals: maritime commerce, safety at sea, weather and climate forecasts and effects, national and homeland security, sustainable living marine resources, and monitoring ecosystem health.

4. Milestones
   - Release IOOS certification standards.
   - Provide an independent cost estimate to implement the Integrated Ocean Observing System.
   - Implement the “National Water Quality Monitoring Network for U.S. Coastal Waters and Their Tributaries” design, which represents an integrated, multi-disciplinary approach, leveraging State and other diverse sources of data, information, and programs and linking observational capabilities from land-to-sea.

5. Gaps and Needs in Science and Technology
   - Improved socio-economic information to quantify benefits of a long-term sustained global ocean, coastal, and Great Lakes capability and to refine products delivered to better meet needs.
   - Advancements in ability to synthesize outputs from models of different scales.
   - Common data management practices to effectively and efficiently utilize data from multiple, disparate collection systems and long-term data stewardship.

E. Action 5 – Coordinate and leverage ocean and coastal mapping efforts.
Coordinate and leverage ocean and coastal mapping programs, resources, capabilities, and capacities among federal and non-federal entities, for the provision of mapping data, value-added decision-support products, and state-of-the art mapping technologies.

1. Why Do This
   - Coordination and leveraging across mapping efforts will more efficiently and effectively meet National requirements for ocean and coastal mapping services, data, products, capabilities, tools, technologies, and research and development.
   - Addressing these requirements supports and advances priority objectives of the National Ocean Policy.

2. Timeframe – Long-term

3. Outcomes
   - Better informed decision-making as a result of improved user access to and identification of authoritative ocean and coastal mapping data.
   - Improved coordination in defining ocean and coastal mapping data gaps and efficiencies in allocating mapping acquisition resources.
   - Improved support for ocean and coastal decision-makers through improved mapping data integration and product development coordination.

4. Milestones
   - Complete development of a national ocean and coastal mapping inventory that will serve as a clearinghouse for mapping data and interpretive information and a registry of data acquisition activities.
   - Develop an annual national ocean and coastal mapping/data acquisition plan.
   - Make mechanisms available for leveraging the expertise, personnel, platforms, sensors, processing capabilities, etc. of federal and non-federal partners.

5. Gaps and Needs in Science and Technology
   - Autonomous air, surface and underwater technologies to support acquisition of mapping data.

- Ability to efficiently acquire seafloor data in shallow, turbid water and efficiently and accurately measure topography and shallow bathymetry in wetland and marsh environments.
- Improvements in automated seafloor and land characterization techniques.
- Improvements in capabilities to merge multiple source seafloor and land data and create seamless environmental characterizations.

F. Action 6 – Develop an integrated observation data management system.
Develop an integrated physical, biological, chemical, geological/geophysical, ecological and observation data management system as part of the larger, overarching observing infrastructure to support the national priority objectives.

1. Why Do This
- Meeting the data and information requirements of all the priority objectives in an integrated and collaborative manner will help enable the delivery of end-to-end data services including data collection, management, stewardship, integration, and product dissemination via Web based sources. This will maximize the utility of ocean and coastal observing capacity for the Nation.

2. Timeframe – Long-term

3. Outcomes
- National, enterprise-wide data and information management, archive, access, and long-term stewardship systems and supporting policies that ensure the full value of the Nation's investment in ocean, coastal, and Great Lakes data and information.
- A national data management and stewardship system that promotes the use of authoritative observations and mapping data.
- Support for an operational integrated National Information Management System by identifying existing systems and integrative functions and based on authoritative data to support coastal and marine spatial planning (CMSP).

4. Milestones
- Define Federal and non-Federal partners' data and information management, archive, access, and long-term stewardship systems modeled on the *U.S. IOOS®: A Blueprint for Full Capability*.
- Ensure data collected from existing systems are submitted to the relevant national archive centers for long-term stewardship in a manner that supports the National Information Management System and other activities, and are easily retrievable in a format useable for decision-making.
- Ensure mapping data are readily accessible through Federal geospatial systems, through support of the inventory work of the Interagency Committee on Ocean and Coastal Mapping.

- Agree to, among international stakeholders, formats for data transmission via the Global Telecommunications System (GTS), metadata and version control, as well as best practices for observing and quality.

5. Gaps and Needs in Science and Technology
    - Improved data interoperability between observing networks to facilitate sharing across agencies and partners.
    - Common data management practices to effectively and efficiently utilize data from multiple, disparate collection systems and long-term data stewardship.