COMPASS
COMMUNICATION PARTNERSHIP FOR SCIENCE AND THE SEA

A Policy Relevant Science Vision for EBM in the Gulf of Maine

Meeting Summary & Recommendations

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Sea Grant Northeast

Massachusetts Ocean Partnership Fund

Fisheries and Oceans Canada
Pêches et Océans Canada

Gulf of Maine Council on the Marine Environment

RARGOM
REGIONAL ASSOCIATION FOR RESEARCH ON THE GULF OF MAINE

Northeast Consortium

EBM Tools Network

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Dear Colleagues,

On behalf of the sponsors, I'd like to thank you for attending the March 2007 COMPASS meeting, *Creating a Policy Relevant Science Vision for Ecosystem-based Management in the Gulf of Maine.* Based on the evaluations and your critical feedback, the meeting was successful in identifying some concrete action steps toward coordinating regional science that is relevant to management and policy.

Ecosystem-based Management is a complex concept but describes an approach to coastal ocean management that is much needed. One of the underlying characteristics of EBM is managing human activities across sectors and across jurisdictional boundaries to account for cumulative impacts of competing uses. Many of us have sat through EBM meetings and have been rallied to apply more holistic principles to management of the oceans. Some critical work in both the science and management domains has been accomplished toward this end. The seven regional action items that resulted from the COMPASS meeting provide an opportunity to take the discussions about EBM beyond conceptual to operational.

Nearly all meeting participants have signed up for work groups. We can't move forward without broad support. Recommendations for implementing the agreed-upon goals are given in this document. Use those as terms of reference for your planning and acknowledge that they are subject to change as the work groups evolve.

It is exciting to have concrete actionable goals for regional coordination and collaboration. I look forward to working with you over the course of the next year.

Sincerely,

Andrew A. Rosenberg
University of New Hampshire & Senior Scientist for Compass

Summary of Meeting Goals and Outcomes

This document is a summary of the meeting outcomes and recommendations for implementing the seven regional action items agreed upon in March, 2007.

Building on past efforts and to catalyze future efforts, nine organizations collaborated to advance a regional ecosystem-based approach to ocean management starting with a policy-relevant science vision. These organizations included:

1. COMPASS - Communication Partnership for Science and the Sea
2. NOAA – National Oceanic and Atmospheric Administration
3. DFO – Department of Fisheries and Oceans Canada
4. GoMC – Gulf of Maine Council on the Marine Environment
5. Sea Grant Northeast
6. RARGOM – Regional Association for Research in the Gulf of Maine
7. Northeast Consortium
8. Massachusetts Ocean Partnership Fund
9. EBM Tools Network

The goals of the meeting were to:

- Develop a shared understanding of the science needed to advance EBM in the Gulf of Maine using input from managers and scientists
- Envision the policy-relevant science that would guide scientific research to inform EBM decision-making
- Turn a shared vision into a blueprint for coordinated action throughout the region.

In order to achieve these goals, the planning committee asked for participant input on their personal visions for achieving a more ecosystem-based approach to management. Based on those responses, a draft vision statement for policy-relevant science was provided in the meeting briefing materials. During the meeting, participants had rich discussions to help crystallize the science needed to implement EBM and managers' needs related to that science. Participants specifically identified methods for better connecting science to management, overlaid current scientific understanding with what's

needed for coordinated action, and discussed the creation of an informal network to coordinate future efforts and develop an ongoing forum for regional communication.

Participants used the Scientific Consensus Statement (CITE) as a basis for discussing ecosystem-based management. Some of the underlying principles of EBM that were critical to meeting discussions were:

- A focus on ecosystem level goals across species and environments
- Consideration of the interconnections between ecosystem goods and services and human activities and well-being
- Consideration of natural boundaries
- Cumulative impacts of cross-sector activity
- Importance of acknowledging and making explicit the trade-offs between activities and sectors

Seven presentations kicked off the meeting including a keynote by Bob O'Boyle, Associate Director of Science at the Bedford Institute of Oceanography in Nova Scotia. Dr. O'Boyle's presentation highlighted the emerging paradigm shift in ocean management. He presented lessons learned from the Scotian Shelf Integrated Management (ESSIM) project and applied them to the Gulf of Maine. He also outlined the Canadian framework (being used in the Maritimes) for setting conceptual and operational objectives for EBM and for integrating science with policy and management at the regional scale. Other presentations included:

- Integrated Ecosystem Assessments – Steve Murawski, NOAA
- Science Requirements for Implementing EBM – Rob Stephenson, DFO
- Enabling EBM Approaches to Management: Census of Marine Life Program – Lew Incze, University of Southern Maine
- EBM in the Maritimes – Tana Worchester, DFO
- Massachusetts Ocean Partnership Fund (MOPF) – Stephanie Moura, MOPF
- Adapting EBM Principles for Maine's Near-shore Waters – Kathleen Leyden, ME Coastal Program

To provoke discussion and set some regional policy-relevant science goals, participants focused on three key themes:

Identifying ocean/land-based activities & services in the Gulf of Maine

Identifying spatial and temporal scales for an EBM approach

The Integration of Science and Management

Once the themes were discussed during the break-out sessions, participants met in plenary to develop action items related to the three themes. The goal was to create action items that could be coordinated, were practical and would advance the science needed for an EBM approach. Participants settled on seven key actions that encompassed needed research, data synthesis, decision-making tools, and decision-making frameworks.

Pre-Meeting Participant Feedback Statement

An Ecosystem Based Future for the Gulf of Maine: Ideas, Opinions, and Reflections

This document is a summary of a survey taken by participants involved in the March, 2007 COMPASS ecosystem-based management (EBM) meeting at the University of New Hampshire.

The Gulf of Maine is central to one of the world's most productive coastal and marine regions. The area faces increasing pressure from a growing coastal population, coastal development, global climate change, shifting demand and markets for seafood, new ocean and coastal technologies, and an influx of invasive species. The future and sustainability of coastal communities and the region's natural heritage will depend on bold initiatives today. Stakeholders could benefit by addressing management and science issues through a comprehensive strategic vision that encouraged and supported coordinated planning. Policy-relevant science can play an integral part in shaping a more ecosystem-based approach to management.

The ecosystem goods and services humans' gain from the Gulf of Maine, such as seafood, recreation, and storm protection, are impacted and even threatened by human activity. This not only affects human well-being but ecological integrity as well. There are critical natural and social science gaps that scientists and managers can address to gain comprehensive information about the interrelationships between ecosystem services and human activity in the Gulf of Maine. Some of them include a more complete understanding of:

- Food webs and their quantitative relationships
- Estimation and valuation of ecosystem services
- Cumulative impacts
- Key linkages across habitats and major components of an ecosystem
- Human behavior and values related to trade-offs

There are also needed tools and resources to have a more comprehensive understanding of services and activities in the Gulf of Maine. Some of them include:

- High resolution habitat maps
- Real-time oceanographic data
- Estimate of carrying capacity
- Comprehensive listing of ecosystem services
- Monitoring program based on a unified set of coast-wide indicators
- Overarching comprehensive ocean plan
- Comprehensive data and information management system

To fill some of these gaps in understanding, scientists and managers could benefit from a routine, on-going dialogue based on trust, mutual respect and a desire to manage together despite, and in the face of, differences. Scientific data could be transferred into meaningful tools and products to assist managers in making well-informed decisions. This would include a consistent framework across sectors for the provision of science advice.

If relationships were improved, gaps in understanding were filled and an ecosystem-based approach was taken, the coastal ocean environment would look differently in 2020 than today. This vision of the Gulf of Maine might include:

- Richer biodiversity
- Management priorities and expenditure of state and federal funds that are more closely linked to ecosystem-based needs
- EBM tools such as ocean zoning and area-based management
- Fish stocks restored to strong levels
- A sense of ownership (rather than entitlement) of ocean resources by the public with sustainability as a primary goal

Break-Out Session Highlights

Each break-out session focused on some aspect of the interconnections between human activities and provision of ecosystems goods and services by the marine environment. The discussions centered around themes such as drivers of ecosystem change and impacts of, connecting science and management scales for multiple ecosystem services and sectors, and providing a framework to better integrate science into management decisions and policy.

**Note that the lists below do not encompass all meeting comments*

Extractive & Non-Extractive Ecosystem Goods and Services in the Gulf of Maine

- Fishing
- Recreation
- Aquaculture
- Boating
- Oil/gas/non renewable resource extraction
- Emerging renewable resource development
- Tourism
- Sewage outflows
- Regulation of climate
- Cultural and historic resources
- Clean drinking water
- Wetlands protection
- Transportation
- Storm protection

Drivers of ecosystem change critical to the Gulf of Maine and the associated pressures and impacts to ecosystem services - Drivers (D), Pressures (P), Impacts (I)

Harvest / Seafood Demand (D)

- Harvest space (P)
- Removal of biomass (I)
- Non-target organisms (invasive Species) (I)
- Food web and water quality impacts (I)

Land use patterns in the coastal zone – watershed (D)

- Impervious surfaces (P)
- Increasing development (P)
- Non-point source pollution (P)
- Wetland mitigation/restoration (P)
- Habitat fragmentation (I)
- Loss of coastal wetlands and storm protection (I)

Energy needs and new and emerging uses (D)

- Energy independence (P)
- Population and economic growth (P)
- Contaminants (I)
- Construction (I)
- Contaminants (I)
- Wildlife mortality (I)

Transportation / Marine Traffic (D)

- Coastal/ocean space (P)
- Dredging (P)
- Recreational boating (P)
- Invasive species (I)
- Water quality (I)
- Marine Mammals (I)
- Noise (I)

Climate change (D)

- Sea level rise (P)
- Temperature change (P)

- Ocean chemistry (P)
- Water circulation (P)
- Rainfall (I)
- Property values (I)
- Changing disease vectors (I)
- International effects (P)
- Infrastructure (P)
- Coastal ocean space conflict (P)

Community traditions / cultural values (D)

- Changing demographics (P)
- Changing economic bases (P)
- Competition for coastal space (P)
- Social cohesiveness (roots) (P)
- Technology changes (P)
- Ecosystem integrity (I)

Tourism (D)

Gaps in Understanding Interactions between Ecosystem Goods and Services & Human Activities

Participants expressed a need to develop a baseline assessment to better understand the interconnections between human activities and ecosystem goods and services. This would include better decision support /synthetic tools such as a dynamic human use atlas and an ecosystem properties atlas. These comprehensive atlases of biological and oceanographic information could be used to better understand the interactions between drivers of ecosystem change, the cumulative effects (direct and indirect) on pressures related to human activity, and effects of mismatched science and management scales. They would enable us to synthesize ecosystem processes and function and characterize change through space and time.

Some other pertinent data gaps at both a regional and local scale include: economic valuation of ecosystem services, impacts of climate change, invasive species distribution, linkages between near shore and offshore, identification of critical habitat, and patterns of human use. Lastly, many felt the need to engage different disciplines of social science to further our understanding of EBM and that this piece is sorely missing from most regional discussions on the concept.

Summary of EBM Action Items

The following seven action items resulted from the March meeting and pre and post meeting feedback. These will evolve as they are shaped by the various work groups. Work group members are listed at the end of each action item.

One overarching goal of the action items is to better understand the scientific underpinnings of EBM and how to apply that science at different management scales. This will entail more effective decision-making tools, integration of current data collection and dissemination approaches, and more effective communication networks and infrastructure to bridge the science / management gap.

Action Item 1 – Develop and apply EBM approaches in pilot project areas

What: We need to demonstrate to ourselves and to EBM skeptics that we can develop and successfully apply EBM approaches. In particular, we want to refine approaches that objectively document our scientific understanding about the interaction between ecology and human activities in several spatially explicit places.

We seek to do this by supporting pilot projects in both countries – ideally two in the near-shore and two in the off-shore areas within the Gulf of Maine. This effort will likely require strong and effective partnerships with existing regional entities working in these areas as well as among them to facilitate learning and accelerate progress.

Given the large geography, we will need to create some site selection criteria to ensure we make progress in a reasonable period of time. Possible criteria include: the area has enough organized and pertinent information/data and the existing capacity to be a pilot. The area is representative of different sectoral activities, human uses and impacts and there are resources that can be leveraged to support any work there.

Goal
To learn about the implementation of EBM by understanding how best to manage the interactions between ecology and human activities in the pilot project areas

Objectives
1. Create and apply techniques/approaches that enhance our scientific understanding about these interactions;
2. Develop, apply and evaluate best practices that coordinate the development and dissemination of science for EBM when working under different governance structures in the U.S. and Canada;
3. Assemble natural and socio-economic baselines;
4. Develop and apply tools to visualize the interactions between human activities and ecosystem services and evaluate tradeoffs between human uses of the ecosystem

Examples of Possible Products:
- Natural and socio-economic baselines;
- Synthetic maps and models of ecosystem properties and species distributions as well as human uses and ecosystem impacts. The products might include a human use atlas, an ecosystem properties atlas, and a threats analysis.

Potential Pilot Sites
1. Biodiversity Discovery Corridor (Bay of Fundy to the seamounts)
2. Stellwagen Bank (could include region around this area as well)
3. Massachusetts Bay
4. Coastal Maine (e.g., Muscongus Bay, Taunton Bay, etc.)
5. Great Bay
6. Southwest New Brunswick Marine Initiative

7. Bay of Fundy
8. Scotian Shelf

How: To be determined by work group

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals/Entities

- Kats Haya – Department of Fisheries and Oceans Canada
- Les Kaufman – Boston University
- Lew Incze – University of Southern Maine / Census of Marine Life
- Ben Cowie-Haskell – Stellwagen Bank National Marine Sanctuary

Work Group Members

1. Kevin St. Martin – Ruetgers University
2. Rob Stephenson – DFO/St. Andrews Marine Biological Station
3. Heather Leslie – Brown University
4. Sally Yozell – The Nature Conservancy
5. Geoffrey Smith – The Nature Conservancy
6. Kathleen Leyden – Maine Coastal Program
7. Susan Farady – The Ocean Conservancy
8. Troy Hartley – Northeast Consortium
9. Jesse Mechling – NOAA
10. Kathy Mills – GBNERR
11. Stephanie Moura – The Massachusetts Ocean Partnership
12. Sarah Carr – EBM Tools Network
13. Kate Killerlain-Morrison – MA Coastal Zone Management
14. Jennifer Atkinson – QLF Atlantic Center for the Environment
15. Briana Brown – Boston University
16. Ray Konisky – The Nature Conservancy
17. John Annala – The Gulf of Maine Research Institute
18. Andy Rosenberg – University of New Hampshire
19. Heather Tausig – NEAQ
20. Judy Pederson – MIT Sea Grant

Note: Some, if not all, of the other action items will initially be developed in these pilot areas.

Action Item 2 – Modeling Consortium

What: Participants determined that enhanced modeling at various spatial scales could be helpful to managers and scientists as they approached a more ecosystem-based approach to management.

Goal:
To create and make accessible coupled human/ecosystem models for managers to assist in making coastal and ocean decisions.

Objectives

1. Develop the concept of an independent association / ecosystem modeling center that has the regional capacity to create and operate coupled human / ecosystem models
2. Enhance existing models to better understand the ecological linkages between the near-shore and off-shore areas of the Gulf of Maine
3. Use models to assess the cumulative impacts of human activities on ecosystem services
4. Create scenario models that can be used to communicate environmental issues and management actions to the public and other interests groups (potentially through maps)

Examples of Possible Products:
Experimental models for managers based on cross-sector cumulative impacts (and funding specifically to support them). Examples include:

- Scenario modeling for ecosystem impacts from coastal development
- Scenario modeling for ecosystem impacts based on predictive/historical stakeholder use
- Physical circulation models

An Opportunity: Participants agreed that the modeling capacity of the region was strong but that enhanced coordination and the acceleration of new products was needed. Reference was made to a RARGOM modeling workshop in southern Maine where the idea of a modeling center was discussed. Those workshop results can inform the modeling consortium work group.

How: To be determined by work group.

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals

1. Andy Rosenberg – UNH

Work Group Members

1. Bob Beardsley – WHOI
2. Kats Haya – DFO or
3. Fred Page – St. Andrews Biological Station
4. Jeff Runge – Gulf of Maine Research Institute
5. Sally Yozell – TNC
6. Ray Konisky – TNC
7. Stephanie Moura – MOPF
8. Beth Turner – NOAA
9. Briana Brown – Boston University
10. Les Kaufman – Boston University
11. Andy Pershing – Gulf of Maine Research Institute
12. Lew Incze – University of Southern Maine
13. Chris Manning – UNH
14. Sarah Carr – EBM Tools Network

Link to other EBM action items

The models will be linked to the dynamic atlases of the EBM pilot project as well as action item 3, coordination and integration of data.

Action Item 3 – Data Access, Coordination & Dissemination of Products

What: Accessible and well-documented data and information products are needed by the science and management communities to accelerate EBM approaches in the Gulf of Maine. Participants recognized that the Gulf of Maine Ocean Data Partnership was a key building block and that it needed to be augmented with additional resources among other things.

Goal
To integrate, disseminate, and encourage the use of the most relevant physical, social and economic data in decision-making by scientists and managers

Objectives
1. Identify the science and management communities priorities for data and information needs that enable EBM approaches; and
2. Enhance the existing infrastructure (e.g., access, coordination, dissemination, etc.) and create products to advance an EBM approach

Examples of Possible Products:
- Enhanced electronic access to existing (and new) coastal ocean data
- More robust data sharing agreements and collaborations
- Data products that managers use to support EBM approaches;
- Enhanced monitoring programs and improved access to their data

An Opportunity: Participants concurred the Gulf of Maine is a well studied area however the resulting data and information could be used more effectively. Specifically, participants discussed the need to significantly improve the region's data and information management infrastructure to better support EBM decision-making.

How: A consortium of scientists, managers and stakeholders will review applicable data management and dissemination efforts and develop a strategy that would enable/support a more ecosystem-based approach to management in the Gulf of Maine. (A starting point for this effort might be the pending Gulf of Maine Integrated Ecosystem Assessment being organized by DFO-NOAA/NMFS).

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals/Entities
- TBD – Work Group can play role in supporting the work of the Gulf of Maine Ocean Data Partnership (Dave Mountain, Chair)

Work Group Members
1. Kathryn Ford – MA Division of Marine Fisheries
2. Sally Yozell – The Nature Conservancy
3. Susan Farady – The Ocean Conservancy
4. Josie Quintrell – GoM Census of Marine Life
5. Stephanie Moura – MA Ocean Partnership Fund

6. Troy Hartley – Northeast Consortium
7. Chris Manning – UNH, Northeast Consortium
8. Kathy Mills – GBNERR
9. Gulf of Maine Council – Data Management Committee Representative
10. Amy Cline – UNH
11. Peter Taylor – GOMC
12. Betsey Nicholson – NOAA
13. Judy Pederson - SeaGrant

Link to other EBM action items
The integrated data will be linked to the dynamic atlases of the EBM pilot project

Action Item 4 – Ecosystem-based Management Toolkit

What: Participants concurred there was a need to both make existing EBM tools more accessible and to continue responding to coastal managers evolving needs. This would entail promoting and adapting other initiatives (e.g., EBM Tools Network, TNC EBM Toolkit, etc.). Further, there was concurrence that complimentary work in other areas of the world could be transferred to the Gulf of Maine. Examples of these tools include web-based visualization and decision-support tools, data integration techniques, watershed point and non-point source assessments, communication methods, mass-loadings, etc. In sum, there was a call for the development and dissemination of an EBM toolkit.

Goal: To develop an Ecosystem-based Management toolkit and/or adapt an existing toolkit to meet the needs of practitioners in the Gulf of Maine

Objectives

1. Create and support tools to help managers make more informed decisions that enables them to draw on the most relevant science
2. Create products that help decision-makers understand coastal/ocean status and trends
3. Empower stakeholders to bring relevant science to legislators, other sectors and the public

Examples of Possible Products:

- Enhancing the Gulf of Maine Ecosystem Indicator (ESIP) efforts to create indicators and state of the environment reports that describe ecosystem health and the state of human communities
- Data synthesis tools that provide monitoring and observing data products that are useful to managers
- A set of Gulf of Maine place-based case studies that apply, communicate, and reflect upon their experiences
- Decision-making tools for managers and policy-makers that evaluate cumulative impacts of human activities on coastal and marine habitats, assist in setting conservation and management priorities, assist in conducting scenario analyses to understand the effects of management decisions, and to analyze tradeoffs among different activities and services, for example.

An Opportunity: Participants indicated that a host of EBM tools were available (and evolving) yet they were difficult to locate and apply. There was a sense that managers would make more scientifically-informed policy decisions if these tools were more readily accessible. In addition, through sustained communication between scientists and managers the needed EBM resources would be better articulated.

How: To be determined by work group.

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals/Entities

- Peter Taylor, Waterview Consulting

Work Group Members

1. Sarah Carr – EBM Tools Network
2. Kathryn Ford – MA Division of Marine Fisheries
3. Mike Fogarty – NMFS
4. Kats Haya – DFO
5. Heather Leslie – Brown University
6. Z. Ferdana – The Nature Conservancy
7. Kimberly Heiman – COMPASS
8. Susan Farady – The Ocean Conservancy
9. Jesse Mechling – NOAA
10. Dan Dorfman – Intelligent Marine Planning
11. Kathy Mills – GBNERR
12. Betsey Nicholson – NOAA
13. David Keeley – Gulf of Maine Council

Link to other EBM action items

The EBM toolkit could be linked to all other potential action steps as the information transcends the others' goals and toolkit training could be brought to different locations throughout region.

Action Item 5 – A Common Vision for EBM in the Gulf of Maine

What: The Gulf of Maine region needs a shared vision of the goods and services society wants and needs for the various components of the Gulf's coastal and marine ecosystem (e.g., riverine, embayments/estuaries, near-shore, off-shore, etc.). This vision would begin to describe both the conceptual and operational objectives for implementing EBM.

Goal:

To have a vision statement for ecosystem-based management in the Gulf of Maine that is accepted by the region's stakeholders.

Objectives

1. Effectively engage a wide range of stakeholders in creating a vision of ecosystem-based management in the Gulf of Maine - build upon visioning exercises that already exist;
2. Better understand the range of institutional hopes and fears related to a more integrated approach
3. Summarize government statements (e.g., laws & policies) about desired ecosystem goods and services to establish a baseline from which to build on;
4. Produce a brief report that presents the elements of a shared vision for the GOM ecosystem and actionable items to advance this vision.

An Opportunity: Significant discussion has occurred within the region about developing and applying a more integrated approach to coastal/ocean management. However, there is no common currency about what it means and how it might be pursued. To achieve important legitimacy it was recognized that a wide range of stakeholders would need to be engaged in an inclusive and transparent process.

How: Participants called on the Gulf of Maine Council to facilitate this process and to actively engage government, non-profits, business interests and other stakeholders. The Council's Ocean Network (CON) will serve as a regional facilitator for this effort. (CON is being established in June 2007 and is open to all that want to participate.)

1. Engagement -- Drawing on multiple resources (e.g., Canadian EBM conceptual framework, etc.) CON will first prepare strawman vision statements for the components of the Gulf's ecosystem (e.g., riverine, embayments/estuaries, near-shore, off-shore, etc.). It will then engage the user communities (e.g., harvesters, recreators, conservationists, marine transport, government, etc.) in face-to-face exchanges as well as electronic surveys/polling to develop a shared vision.
2. Assessment – All levels of government have codified their perspective on desired ecosystem goods and services. This material will be used to establish a baseline from which to build on
3. Synthesis – CON will produce a brief report that presents the elements of a shared vision for the GOM ecosystem.

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals/Entities

- David Keeley - Gulf of Maine Council
- Susan Farady – The Ocean Conservancy

Work Group Members

1. Wendy Lull – Seacoast Science Center
2. Pam DiBona – COSEE – NEAQ
3. Bob O'Boyle – DFO, Bedford Institute of Oceanography
4. Rob Stephenson – DFO
5. Kats Haya – DFO
6. Kimberly Heiman – COMPASS
7. Stephanie Moura – MA Ocean Partnership Fund
8. Jesse Mechling – NOAA
9. Kathy Mills – GBNERR
10. Kate Killerlain-Morrison – MA CZM
11. Ben Cowie-Haskell – Stellwagen Bank National Marine Sanctuary
12. John Annala – Gulf of Maine Research Institute
13. Mike Fogarty – NMFS
14. Linda Mercer – ME Department of Marine Resources
15. Lew Incze – University of Southern Maine
16. Betsey Nicholson – NOAA
17. NEFMC - TBD
18. NE Consortium - TBD
19. Sea Grant - TBD

Link to other EBM action items

The EBM vision will be informed by the pilot projects and tools and communication can be coordinated around the vision objectives.

Action Item 6: Communications Infrastructure

What: There is an ongoing gap in communications between and among the science, management and policy communities. Participants at the recent COMPASS EBM meeting expressed the need to better understand each other's cultures, constraints, and opportunities to enhance dialogue about issues like ecosystem-based approaches to management. They recognized that some individuals and organizations could serve as bridge-builders, "enablers" and "free radicals" - in other words, organizations and/or individuals who can provide behind-the-scenes support for communication, convening, coalition-building, and partnering as it relates to the science and policy of EBM.

Goal
To make accessible the information that scientists, managers and lawmakers need to make informed decisions.

Objectives
- Create and sustain mechanisms that facilitate useful science-policy interaction and create trust among the parties (e.g., scientists, managers and policy staff at all career levels);
- Identify and enable the opinion leaders (i.e. movers and shakers to work more effectively with elected officials and senior management)
- Build linkages and ongoing dialogue among organizations working on communication, education and outreach

An Opportunity: Participants felt confused by the roles of the individuals and organizations that work within the science/policy interface. They expressed the need for more cohesion among these various groups so that it would be easier to access resources, information, and support to help them do their jobs better.

For example, COMPASS is a behind-the-scenes partnership that is a neutral force concerned with getting recent science more fully considered by policymakers, the media and others. COMPASS is not a non-profit but a partnership of academic scientists and institutions committed to working within that nexus of communication-science-policy. There are other groups doing science translation and communication as well but fill a slightly different niche. Coordination across these groups and others will help the science, management and policy communities understand who can assist them with their communication needs.

How? Participants listed the following actions and/or tools to enhance the existing communications infrastructure:
- COMPASS convenes 7-10 US and Canadian leading communication groups to collaboratively build a Gulf of Maine strategy that enhances coordination of their work in the region. One aspect of this might be to create a webpage and a mailing list of communication groups with updated information about their expertise as a resource for scientists – similar to what the Sea Grant programs have produced in the past.

Who: *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed.):*

Potential Lead Individuals/Entities

- Verna DeLauer - COMPASS
- Pam DiBona – COSEE / NEAQ

Work Group Members

1. Wendy Lull – Seacoast Science Center
2. Kim Heiman – COMPASS
3. Troy Hartley – Northeast Consortium & UNH
4. Billy Spitzer – COSEE NE
5. Catherine Cramer – COSEE NE
6. Laura Singer Taylor – Gulf of Maine Research Institute
7. Stephanie Moura – MOPF

Action Item 7 – Ecosystem-based Management Forum for Young Scientists

What: As many seasoned scientists reach the end of their professional careers, there is experience and knowledge to be shared with new scientists. Through an ongoing forum for young scientists and a mentoring program, those new to the field will learn about and wrestle with the concept of ecosystem-based management and all it entails from a natural and social science perspective.

Goals: To create an ongoing communication forum for young scientists to discuss the emerging field of ocean management from an ecosystem-based perspective.

Objectives:

1. Through regular dialogue and discussion, young scientists will better understand EBM principles as laid out in the Commission Reports and the COMPASS Consensus Statement and methods to apply those to future science and management decisions.

Examples of Possible Products:

- A network of young scientists and supporting infrastructure
- Communication training for scientists aimed at their interactions with the media and policymakers

An Opportunity: There are few existing mechanisms to nurture and mentor young scientists. Further, as senior scientists depart the field their collective memory/experiences are lost.

Who *(Note that the Planning Committee has tried to adequately represent those individuals who have expressed initial interest. There may, however, be some misinterpretations of interest and those will be changed as needed):*

Potential Lead Individuals/Entities

- Mike Fogarty – NMFS
- Andy Rosenberg – UNH
- Rob Stephenson – DFO
- Irit Altman – UNH
- Heather Leslie – Brown University
- Tana Worcester – DFO BIO

Work Group Members

1. Kathryn Ford – MA DMF
2. Heather Leslie – Brown University
3. Kimberly Heiman – COMPASS
4. April Blakeslee – UNH
5. Jesse Mechling – NOAA
6. Kathy Mills – GBNERR
7. Rick Murray – Boston University
8. John Annala – GMRI
9. Steve Murawski – NOAA
10. Lauren Mullineaux – WHOI
11. Ingrid Nugent – NOAA (DC)

Recommendations for Action Item Implementation

Role of COMPASS and Partner Organizations

COMPASS, in collaboration with its partners, will coordinate and support the seven action items. COMPASS will ensure actions are connected but may not necessarily take the lead on any one project. Because COMPASS' work is not limited to New England, connections to other EBM projects outside of the region can be made. The Planning Committee will convene regularly to oversee the launching of the work groups and can be used as a reporting mechanism for work group progress.

Suggested Timeline of Activities

1. Planning Committee meets with work group leader(s) to plan for first work group meetings and to set a draft agenda – *June/July*
2. Planning Committee contacts each work group member to confirm membership and understand what resources each member will bring to the group – *June/July*
3. First meeting of each work group (These may be conference calls or in-person depending on the geographical proximity of participants. Preference is in-person.) – *August/September*
4. Each work group develops a 6-month work plan that includes the dimensions of the action item – goals, objectives, actions, funding needs/sources, timeline etc. – *August/September*
5. Work groups begin to implement plan over the course of 6 months – *September through March.*
6. Progress will be communicated via a meeting with all work group leaders every three months.
7. All work groups will meet in-person March 2008 or perhaps immediately following AAAS in Boston (February) to reflect on plan for the next year

Appendix I

Presentation Abstracts

Title: **The New Oceans Management Paradigm: Lessons from the Scotian Shelf**
Presenter: **Bob O'Boyle**

Since the mid 1990s, there has been a paradigm shift in ocean management from a sector – focused approach to one that takes a more holistic view. This shift is being driven by perceived and real problems with the current paradigm, growing demands on the ecosystem services provided by the oceans and the potential impacts of climate change. While it is early to fully characterize this new paradigm, experience to date indicates that it involves both an ecosystem approach to management (EAM) and a management strategy evaluation (MSE). Experience with this emerging paradigm on the Scotian Shelf has lessons for the Gulf of Maine.

In the Eastern Scotian Shelf Integrated Management (ESSIM) project, through stakeholder and science engagement, our overarching objectives are being translated into regional priorities. Emerging challenges are the prioritization of these objectives and their translation into management actions, again with lessons for the Gulf of Maine. Notwithstanding these, governance institutions are developing that increase the chances of overall success of the initiative. The latter is critically tied to the scientific community developing the appropriate research agenda to fulfill the requirements of the new paradigm. Avenues of potential research covering the breadth of the objectives of an EAM will be discussed in the context of the Gulf of Maine.

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Title: **Integrated Ecosystem Assessments: A Tool, a Product, and Process Supporting Ecosystem Approaches to Management**

Presenters: **Steve Murawski, Emily Menashes, Phil Levin, Mike Fogarty**

Ecosystem approaches to management, or alternatively, ecosystem-based management has as their central tenets understanding how the physical, biological elements of a defined regional ocean geography are linked. These linkages are key to understanding the condition of the ecosystem relative to society's goals for those resources, and how human activities alter them. Integrated ecosystem assessments provide a link between indicators of pressures on the ecosystem, the state of the system components, and a risk assessment of failing to achieve long-term goals. IEAs require sustained ocean observing systems, conceptual and quantitative models and associated research, and links to an effective ocean governance system in order to be effective.

Contact Author: Steve Murawski, National Marine Fisheries Service , (tel:301-713-2239 x205; E-mail: steve.murawski@noaa.gov

Title: **Science requirements for implementing Ecosystem-Based management in the Gulf of Maine**
Presenter: *Rob Stephenson*

The ecosystem approach may be described as the management of human activities to ensure that marine ecosystems, their structure (e.g. biological diversity), function (e.g. productivity) and overall environmental quality (e.g. water and habitat quality) are not compromised and are maintained at appropriate temporal and spatial scales. It includes understanding how human activities impact the ecosystem and how the ecosystem affects those activities.

The Ecosystem Approach introduces two changes to management. The first change is an expanded suite of conservation, social and economic objectives and strategies for all managed activities. Conservation objectives, for example, under an ecosystem based approach must include not only strategies to maintain productivity but also to conserve biodiversity and habitat. The second change is the need to evaluate cumulative effects across managed activities, so as to be able to evaluate the overall performance of management (of all activities in an area), against the objectives for that area. These changes to management dictate the need for scientific development in 1) the performance indicators, reference points and sampling methodologies associated with a broader set of objectives and tactics used in management and 2) methods for evaluating cumulative effects (of multiple activities) and of evaluating overall performance of management against multiple objectives for a managed area (e.g. bio-geographic region).

We have been trying to develop the scientific basis required to support the evolution of management plans for application of an ecosystem-based approach to fisheries, and more recently to aquaculture, in the Gulf of Maine. We suggest there are five key scientific priorities:

1) Choose between two conflicting scientific approaches to the ecosystem approach (focus on the science required for management of human activities rather than on attempts to describe and understand the ecosystem) so as to develop a practical and tractable set of scientific priorities.

2) Better articulate the conservation objectives, strategies, performance indicators and reference points (ideally a common set for all managed activities) to define what needs to be monitored. This includes resolving the utility and practical role in management of any proposed 'contextual indicators' of overall ecosystem health or ecosystem change

3) Develop methods of evaluating cumulative effects across all managed activities, so as to be able to audit the performance of management in a biogeographic region

4) Modify surveys and data acquisition systems to begin time series of the data required for Ecosystem-Based Management

5) Develop methods of integrating conservation objectives with social and economic objectives.

Contact Author: Rob Stephenson, Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews, N.B. (tel: 506-529-5860; e-mail: StephensonR@mar.dfo-mpo.gc.ca)

Title: **Enabling Ecosystem-Based Approaches to Management, A Goal of the Census of Marine Life Program**
Presenter: **Lew Incze**

The Gulf of Maine Area Program, which includes the U.S. and Canada, has three focus areas: (1) to encourage and expand basic exploration of the GoM area, especially a better understanding of its biodiversity; (2) to help build an understanding of how these patterns contribute to over-all functioning of the GoM system and the provision of ecosystem services; and (3) to help establish a framework for applying this understanding toward ecosystem-based approaches to management. These large goals are not held by the GoM program alone; they are in part or in whole the subject of numerous activities and programs throughout the area as well as internationally. Our program probably is unique in trying to bring these objectives all together at the particular scale that we are. I will present a brief over-view of our past and developing approaches to this large challenge.

Contact Author: Lewis S. Incze, Research Professor and Director, Aquatic Systems Group, University of Southern Maine, and Chief Scientist, Gulf of Maine Census Program (tel: 207-228-1676; e-mail:lincze@usm.maine.edu)

Title: **Ecosystem-Based Management in the Maritimes – the ESSIM Initiative**
Presenter: **Tana Worchester**

The Eastern Scotian Shelf Integrated Management (ESSIM) Initiative is a collaborative ocean planning process being led by the Canadian Department of Fisheries and Ocean's (DFO) Maritimes Region. While this initiative is supported by a variety of governmental and non-governmental agencies, this presentation will focus on DFO Science's contribution, including our role in the development of ecosystem objectives, habitat characterization, the identification of ecologically significant areas and species, impact analysis, and selection of appropriate indicators and reference points for management.

The vision of ESSIM is "*of healthy and sustainable ecosystems, economies and communities, supported by collaborative, integrated and harmonized governance and management*" (ESSIM Management Plan, Jan 2007). Thus, the goals of this meeting appear to be consistent with the goals of ESSIM. Specifically, it is expected that this meeting will help to identify areas of future collaboration with other similar initiatives.

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Title: **Massachusetts Ocean Partnership Fund (MOPF)**
Presenter: **Stephanie Moura, Project Coordinator**

MOPF is a broadly representative public-private partnership created to support and advance ecosystem-based management of the Commonwealth's coastal ocean resources. MOPF's primary near-term goal is to support the development and implementation of an integrated, multi-use ocean

management plan for MA waters. Responsible state, local and federal agencies will develop, implement and enforce the integrated ocean management plan. An effective ocean management plan will:

- integrate management across sectors, resources and agencies;
- build on ecosystem management principles;
- reflect input from an intensive public process;
- establish a process for monitoring and adapting the plan; and
- support sustainable marine industries *and* ecosystem stewardship more effectively than the current management system.

Contact Author: Stephanie Moura, Project Coordinator - Massachusetts Ocean Partnership Fund, (e-mail: smoura.mopf@comcast.net, tel: 978-471-9078), www.mopf.org

Title: **Adapting Ecosystem Management Principles for Maine's Near-shore Waters – Results of the Maine Bay Management Study**
Presenter: **Kathleen Leyden**

Description: The Maine Coastal Program (MCP) is one of 34 voluntary federal-state-local partnership programs developed under the Coastal Zone Management Act of 1972. The Maine State Planning Office (SPO) is the lead agency for CZM in Maine, working with a larger network of other state agencies and project partners. The MCP has placed an emphasis over the last 8-10 years on several aspects of ocean management including – reforms in aquaculture policy, monitoring and leasing, development of fisheries co-management measures and dialogues about marine protected areas. The Maine Department of Marine Resources (DMR) is the primary partner on these efforts. From 2004-2006, DMR and SPO conducted the Maine Bay Management Study – a broad look at governance approaches and science needs for improved management of near-shore waters. This presentation will focus on the EBM relevant topics addressed in the study – management scale, local involvement, need for adaptation, integrated governance, and data/information needs.

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Appendix II

Scientific Consensus Statement on Marine Ecosystem-Based Management

Prepared by scientists to provide information about coasts and oceans to U.S. policy-makers

Executive Summary: **The current state of the oceans requires immediate action and attention. Solutions based on an ecosystem approach hold the greatest promise for delivering desired results. From a scientific perspective, we now know enough to dramatically improve conservation and management of marine systems through the implementation of ecosystem-based approaches.**

Coastal and ocean ecosystems are vitally important to U.S. interests and they are at risk. Over half of the U.S. population lives along the coast, and more than $200 billion in economic activity was associated with the ocean in 2000.[1] Despite their economic significance, U.S. oceans, like those around the world, are changing in unprecedented ways. Recently, the Pew Oceans Commission and the U.S. Commission on Ocean Policy concluded that a combination of human activities on land, along the coasts, and in the ocean are unintentionally but seriously affecting marine ecosystems by altering marine food webs, changing the climate, damaging habitat, eroding coastlines, introducing invasive species, and polluting coastal waters. These changes threaten the ability of ocean ecosystems to provide the benefits Americans expect from marine ecosystems. Currently, each activity or threat is typically considered in isolation; coordinated management of cumulative impacts is rare. **Both commissions call for a more comprehensive, integrated, ecosystem-based approach to address the current and future management challenges of our oceans**. Both commissions describe ecosystem-based management as the cornerstone of a new vision for healthy, productive, resilient marine ecosystems that provide stable fisheries, abundant wildlife, clean beaches, vibrant coastal communities and healthy seafood for all Americans.

WHAT IS ECOSYSTEM-BASED MANAGEMENT FOR THE OCEANS?

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. Specifically, ecosystem-based management:

- emphasizes the protection of ecosystem structure, functioning, and key processes;
- is place-based in focusing on a specific ecosystem and the range of activities affecting it;
- explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species;
- acknowledges interconnectedness among systems, such as between land and sea; and
- integrates ecological, social, economic, and institutional perspectives, recognizing their strong

BACKGROUND

The scientific understanding of marine ecosystems has advanced considerably over the last few decades. We now have a much greater appreciation of how the oceans support and sustain human life by providing services such as seafood; medicine; nutrient cycling; water purification; protection of shores from erosion and storm damage; moderation of climate and weather; recreation; and spiritual, religious, and other nonmaterial benefits. The interactions among species within ecosystems generate these services. Healthy, intact, resilient marine ecosystems are required to provide the full range of benefits that Americans say they want from oceans.

Management that emphasizes the protection of ecosystem structure, functioning, and key processes is much more likely to ensure the long-term delivery of these important services. From a governance perspective, implementation of an ecosystem approach will enable more coordinated and sustainable management of activities that affect the oceans. Ecosystem-based management should reduce duplication and conflicts, and in the long run will likely be more cost-effective. A delay in implementing management based on an ecosystem approach will result in continued conflicts over resources, degradation of ocean ecosystems, disruption of fisheries, loss of recreational opportunities, health risks to humans and wildlife and loss of biodiversity.

This document reflects our scientific understanding about marine ecosystems and the concepts of ecosystem-based management, specifically (1) what the term 'ecosystem-based management' means, (2) what is an ecosystem, (3) core scientific knowledge about ecosystems, (4) key elements of ecosystem-based management, and (5) actions consistent with an ecosystem approach.

WHAT IS AN ECOSYSTEM?

An ecosystem is a dynamic complex of plants, animals, microbes and physical environmental features that interact with one another. Humans are an integral part of ecosystems, marine and terrestrial. The "interconnectedness" within an ecosystem is provided both by the physical environment (for example, currents transporting larvae from one part of the ecosystem to another) and by biological interactions (for example, kelps or seagrasses creating habitat or predators consuming prey).

Ecosystems come in many sizes, often with smaller systems embedded within larger ones. For example, a kelp forest in southern California represents a small habitat ecosystem that is nested within the larger California Current Large Marine Ecosystem. At the largest scale, ecosystems are often categorized as Large Marine Ecosystems (LMEs). Approximately 64 LMEs have been recognized globally, and 10 of these are in U.S. waters[2]. The boundaries of each LME are defined primarily by oceanographic and topographic features. All LMEs include multiple habitats such as sandy beaches, kelp forests, rocky shores, seagrass beds, or pelagic habitat. Individuals of a few marine species spend their entire life within a single habitat such as a kelp forest, but most have larval or juvenile stages that are transported across habitats but within an LME. Thus, even if the adult stage is sedentary, the individual uses multiple habitats within an LME over its lifespan.

[2] The 10 Large Marine Ecosystems within the U.S. Exclusive Economic Zone (in whole or in part) are the Beaufort Sea, Chukchi Sea, Eastern Bering Sea, Gulf of Alaska, California Current, Insular Pacific Hawaiian, Gulf of Mexico, Caribbean Sea, South East U.S. Continental Shelf, and North East U.S. Continental Shelf.

Some wide-ranging animals, including certain large fish and marine mammals, cross LME boundaries just as migrating birds move across tundra, forest and prairie ecosystems on land.

CORE SCIENTIFIC KNOWLEDGE ABOUT ECOSYSTEMS

Our scientific understanding of ecosystems in general, and marine systems specifically, has advanced substantially over the last few decades. A wealth of experience with ecosystem-based management on land is available to inform implementation of marine ecosystem-based management. The following are key concepts that form the foundation for an ecosystem approach to management.

- **The key interactions among species within an ecosystem are essential to maintain if ecosystem services are to be delivered.** Ecosystems are highly interactive and strongly linked. Removing or damaging some species can dramatically affect others and disrupt the ability of the system to provide desired services. However, not all interactions are equally important. The consequences of some species' interactions strongly influence the overall behavior of ecosystems. Small changes to these key interactions can produce large ecosystem responses. For example, the absence of large-bodied predators at the apex of marine food webs can result in large-scale changes in the relative abundances of other species. Ecosystem-based management therefore entails identifying and focusing on the role of key interactions, rather than on all possible interactions.

- **The dynamic and complex nature of ecosystems requires a long-term focus and the understanding that abrupt, unanticipated changes are possible.** The abundances of species are inherently difficult to predict, especially over longer time periods, in part because they may change abruptly and with little warning. For example, decadal-scale changes (such as the North Atlantic Oscillation or the Pacific Decadal Oscillation) significantly alter ecosystem dynamics and population sizes. Such long-term changes tend to be less predictable because they are associated with large-scale environmental changes. Management must thus anticipate and be able to adjust to these changes.

- **Ecosystems can recover from many kinds of disturbance, but are not infinitely resilient.** There is often a threshold beyond which an altered ecosystem may not return to its previous state. The tipping point for these irreversible changes may be impossible to predict. Thus, increased levels of precaution are prudent as ecosystems are pushed further from pre-existing states. Features that enhance the ability of an ecosystem to resist or recover from disturbance include the full natural complement of species, genetic diversity within species, multiple representative stands (copies) of each habitat type and lack of stress from other sources.

- **Ecosystem services are nearly always undervalued.** Although some goods (fish and shellfish) have significant economic value, most other essential services are neither appreciated nor commonly assigned economic worth. Examples of services that are at risk because they are undervalued include protection of shorelines from erosion, nutrient recycling, control of disease and pests, climate regulation, cultural heritage and spiritual benefits. Current economic systems attach no dollar values to these services; they are typically not considered in policy decisions and many are at risk.

KEY ELEMENTS OF ECOSYSTEM-BASED MANAGEMENT

The U.S. Commission on Ocean Policy and the Pew Oceans Commission articulated a number of key elements of marine ecosystem-based management. They include:

- Make protecting and restoring marine ecosystems, and all their services, the primary focus, even above short-term economic or social goals for single services. Only intact, healthy ecosystems can provide the complete range of benefits that humans want and need over long periods of time.
- Consider cumulative effects of different activities on the diversity and interactions of species.
- Facilitate connectivity between and within marine ecosystems by accounting for the import and export of larvae, nutrients, and food.
- Incorporate measures that acknowledge the inherent uncertainties in ecosystem-based management and account for dynamic changes in ecosystems, for example as a result of natural oscillations in ocean state or shifts in the frequency or intensity of storms. In general, levels of precaution should be proportional to the amount of information available such that the less that is known about a system, the more precautionary management decisions should be.
- Create complementary and coordinated policies at global, international, national, regional, and local scales, including between coasts and watersheds. Ecosystem processes operate over a range of spatial scales, and thus appropriate scales for management will be goal-specific.
- Maintain historical levels of native biodiversity in ecosystems to provide resilience to both natural and human-induced changes.
- Require evidence that an action will not cause undue harm to ecosystem functioning before allowing that action to proceed.
- Develop multiple indicators to measure the status of ecosystem functioning, service provision and effectiveness of management efforts.
- Involve all stakeholders through participatory governance that accounts for both local interests and those of the wider public.

ACTIONS CONSISTENT WITH ECOSYSTEM-BASED MANAGEMENT

Implementing ecosystem-based management will involve many steps and the use of diverse tools. The following overarching actions are consistent with an ecosystem-based approach to management. Some of these individual steps are already being taken in the U.S. and around the world. However, they have not been implemented in a comprehensive, integrated way. Enough is known now about marine ecosystems to put an ecosystem-based approach into practice immediately.

- Initiate **ecosystem-level planning** that involves multiple stakeholders and takes into account the cumulative impacts of multiple important human activities on ecosystems, as well as the effects of long-term environmental changes.

- Establish **cross-jurisdictional management goals** through formal agreements and mechanisms across local, state, federal and tribal authorities. Goals within ecosystem-based management should reflect interagency management at all levels, as opposed to focusing on specific jurisdictions within an ecosystem (for example, parks, refuges, and sanctuaries).

- Initiate **zoning** of regions of the ocean, for example LMEs, by designating areas for particular allowable uses in both space and time, including networks of fully protected marine reserves. Zoning that reduces conflict among users of different services should account for and integrate the effects of key activities. This regional planning should be carried out in a comprehensive manner. Area-based management approaches are valuable tools for coordinating the management of multiple uses within the larger land- or seascape context. **Networks of marine reserves** are uniquely capable of protecting biodiversity and habitats, producing the large-bodied individuals who contribute disproportionately to reproductive output, providing insurance against management uncertainties, and providing a benchmark for evaluating the effects of activities outside of reserves.

- Expand and improve the coordination of **habitat restoration** in coastal ecosystems such as wetlands, seagrass beds, and kelp and mangrove forests where habitats have been lost or ecosystem functioning has been diminished. These activities, currently under the purview of a plethora of governmental agencies, should be coordinated in a comprehensive manner that considers their cumulative effects on ocean and coastal ecosystems and includes a rigorous program of research, monitoring and evaluation.

- Adopt **co-management** strategies in which governments (federal, state, local, and tribal) and diverse stakeholders (local resource users, academic and research scientists, conservation interests, community members with traditional knowledge, and other stakeholders) share the responsibility for management and stewardship. Potential advantages include decision-making that is better informed, more flexible, and incorporates traditional ecological knowledge.

- Incorporate **adaptive management** into ecosystem plans as an approach to learning from management actions that allows for scientifically based evaluation, testing of alternate management approaches, and readjustment as new information becomes available from carefully designed monitoring programs. Management should explicitly acknowledge that our current understanding is incomplete and will continue to improve. Likewise, institutions must be adaptable when ecosystems or knowledge change.

- Establish **long-term ocean and coastal observing, monitoring and research** programs to collect continuously and integrate relevant biogeophysical, social, and economic data. These programs are needed to better understand the workings of marine ecosystems, changes in ocean dynamics, and the effectiveness of management decisions.

FREQUENTLY ASKED QUESTIONS

WHAT BENEFITS DO HUMANS DERIVE FROM MARINE ECOSYSTEMS?

Humans depend upon oceans and coasts for their existence and well-being. Marine ecosystems benefit humans by providing services such as food (fish, shellfish and seaweed); medicines; water purification; protection of shorelines from erosion and storm damage; control of diseases and pests; nutrient cycling; moderation of climate and weather; recreation; and spiritual, religious and other nonmaterial benefits. The interactions within an ecosystem produce these services. Each ecosystem provides a range of services.

HOW DO HUMANS IMPACT MARINE ECOSYSTEMS?

Humans affect marine ecosystems through a wide variety of activities on land, on the coasts, and in the ocean. The impacts of these activities interact, often in synergistic ways. Land-based activities have major impacts on marine ecosystems via run-off and atmospheric deposition of nutrients and chemical pollutants, alteration of coastal habitats such as wetlands and estuaries, alteration of flows of water and sediment to coastal areas, deposition of marine debris, and global climate change. Among coastal and oceanic activities (such as aquaculture, coastal development, fishing, military activities, and shipping), fishing has the most obvious impact. Ecosystem effects of fishing result from the removal of substantial amounts of life, reduction of the average size and age of individuals within a population (thereby reducing productive capacity), removal of a large percentage of top predators (thereby altering the function of marine food webs), collateral damage to non-target species (often including endangered species) via bycatch, and degradation or destruction of bottom habitats by some fishing gear. These can in turn affect the structure and functioning of ecosystems, reduce productivity of the system, and impede the delivery of services.

IS 'ECOSYSTEM-BASED MANAGEMENT' DIFFERENT FROM 'ECOSYSTEM MANAGEMENT'?

The term "ecosystem management" implies that it is possible to control and manage an entire ecosystem. In view of the fact that humans cannot control ocean currents or most animals within a marine ecosystem, it is scientifically more accurate to speak of "ecosystem-based management" or an "ecosystem approach to management." Ecosystem-based management focuses on managing human activities, rather than deliberately manipulating or managing entire ecosystems.

HOW DOES 'ECOSYSTEM-BASED MANAGEMENT' (EBM) DIFFER FROM 'ECOSYSTEM-BASED FISHERY MANAGEMENT' (EBFM)?

EBM and EBFM are different, but complementary. Managing individual sectors, such as fishing, in an ecosystem context is necessary but not sufficient to ensure the continued productivity and resilience of an ecosystem. Individual human activities should be managed in a fashion that considers the impacts of the sector on the entire ecosystem as well as on other sectors. The longer-term, integrated, cumulative impacts of all relevant

sectors on an ecosystem must be evaluated, with a mechanism for adjusting impacts of individual sectors.

APPENDIX B: GENERAL REFERENCES

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Appendix III

Participant List

COMPASS

Ecosystem-based Management:
A Policy Relevant Science Vision for the Gulf of Maine

March 27th & 28th

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