Developing Regional Marine Ecosystem Approaches to Management

M.C. Holliday and A.B. Gautam, Editors

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Foreword

In August 2003, NOAA Fisheries created a Fisheries Ecosystem Plan Working Group (FEPWG), comprised of representatives from NOAA Fisheries (NMFS) regional offices, science centers, and headquarters offices to produce guidelines for the creation of Fisheries Ecosystem Plans (FEPs). The FEP guidelines were intended to serve as the agency's primary mechanism for adopting an ecosystem approach to living marine resource management. By April 2004, FEP guidelines were produced based on a review of existing ecosystem-based management plans; analyses of the literature on ecosystem management approaches; and a series of discussions and briefings among the science and management experts on the FEPWG and NMFS experts in fisheries, protected resources, habitat, National Environmental Policy Act (NEPA), and senior leadership.

However, review of these guidelines by senior NMFS leadership and the release of the preliminary report of the U.S. Commission on Ocean Policy suggested a significant broadening of the scope was needed. The guidelines needed to go beyond fisheries to more encompassing regional marine ecosystem strategies across many sectors. This would enable other agencies and stakeholders besides NOAA, with interests and regulatory authority for transportation, energy, water and air quality, permitting, etc., to participate in a common venue and use a collaborative process to develop integrated approaches to management for consumptive and non-consumptive uses of the ecosystem, not just those under NOAA's authority. A revised draft encompassing multi-sector approaches was prepared by August 2004.

By the close of the year an alternative leadership strategy was adopted: to prepare new guidelines for an ecosystem approach to fisheries management in direct collaboration with Regional Fishery Management Councils, overtaking the need for this document. Nonetheless, this research by the FEPWG represents a cogent set of ideas and recommendations of NOAA Fisheries Service experts from many disciplines that can be used to stimulate future discussion of how an ecosystem approach to management could move forward.

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List of Acronyms

APA	Administrative Procedures Act
COE	Corps of Engineers
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DOC	Department of Commerce
DOI	Department of the Interior
DOS	Department of State
EAF	Ecosystem Approach to Fisheries
EAM	Ecosystem Approach to Management
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement, NEPA
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FACA	Federal Advisory Committee Act
FAO	Food and Agriculture Organization of the United Nations
FEP	Fisheries Ecosystem Plan
FEPWG	Fisheries Ecosystem Plan Working Group, NOAA Fisheries
FERC	Federal Energy Regulatory Commission
FMP	Fishery Management Plan
FOCI	Fisheries Oceanography Coordinated Investigations
FWCA	Fish and Wildlife Coordination Act
FWS	Fish and Wildlife Service, DOI
GEOSS	Global Earth Observation System of Systems
GLOBEC	Global Ocean Ecosystem Dynamics
IFA	Interjurisdictional Fisheries Act
LME	Large Marine Ecosystem
LMR	Living Marine Resources
LNG	Liquefied Natural Gas
LO	Line office (NOAA)
NEPA	National Environmental Policy Act
MAFAC	Marine Fisheries Advisory Committee
MARAD	Maritime Administration

MBTA	Migratory Birds Treaty Act
MMA	Marine Managed Area
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
MOA	Memorandum of Agreement
MPA	Marine Protected Area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NERRS	National Estuarine Research Reserve System
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuaries
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service, USDA
PPI	Program, Planning and Integration Office (NOAA)
RFA	Regulatory Flexibility Act
RIA	Regulatory Impact Analysis (E.O. 12866)
RIR	Regulatory Impact Review
RFMC	Regional Fishery Management Council
RMEIP	Regional Marine Ecosystem Implementation Plan
RMES	Regional Marine Ecosystem Strategy
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSSD	World Summit on Sustainable Development

Executive Summary

One of the four cornerstone goals of NOAA's Strategic Plan is to "protect, restore and manage coastal and ocean resources through an ecosystem approach" (NOAA, 2003b). However, no single federal, state or local entity has full authority over all sectors impacting coastal and ocean resources or marine ecosystems. No one entity can succeed in protecting and conserving marine ecosystems by itself. Therefore, guidance would be helpful on how to promote cross-sector discussion and actions beyond NOAA that are necessary to implement an ecosystem approach to management (EAM) of the entire ecosystem. At the same time, guidance for advancing an EAM within NOAA Fisheries or any other entity's individual management authority would also be useful. This paper outlines two parallel EAM options to assist in the management of coastal and ocean resources.

The first EAM process is a top-down approach. The paper describes how multiple sectors with different interests, objectives and management authorities for components of a marine ecosystem can work together. The goal is to create a common strategy that results in the optimal sustainable value to society from the regional marine ecosystems of the nation. The paper describes a process that integrates the management authorities and interests in an ecosystem across traditionally separate management and use sectors. The result of this voluntary top-down process is called a Regional Marine Ecosystem Strategy (RMES). The targeted participants for this process include federal and state agencies, tribes, industry and resource users, community and NGO interest groups, academia and the general public. For example, Regional Fishery Management Councils and NOAA would represent the fisheries sector during generation of the RMES since they have the regulatory and governance authority over this sector in the Exclusive Economic Zone. This RMES would be a collaboratively-derived statement that defines strategic goals and objectives for a given ecosystem management area.

The second EAM process is bottom-up. For example, NOAA has an ongoing requirement to carry out its statutory responsibilities for stewardship of specific components of the ecosystem, (e.g., the fisheries sector) while cross-sector management evolves. Within the fisheries sector, work has already been initiated on developing fisheries ecosystem plans (FEPs) or their equivalent in partnerships with state, regional and international fisheries agencies, especially with the Regional Fishery Management Councils created by the Magnuson Stevens Act. Progress must continue in advancing this bottom-up approach to fisheries management in an ecosystem context. The fisheries sector (and other sectors) must continue to resolve issues under their own sector-specific authority since that is where the regulatory and governance authority exists. However, FEPs and other sector-specific plans must be coordinated and fit into the larger top-down cross-sector EAM for the entire ecosystem.

The paper identifies a possible mechanism of how this might occur: the RMES could be carried out via subordinate Regional Marine Ecosystem Implementation Plans (RMEIPs) created by management agencies using their existing authorities within each sector. For example, based on the goals and objectives in the RMES, subsequent implementation of FEPs and regulations would be the responsibility of Regional Fishery Management Councils and NOAA. The implementation plans would contain prescriptive actions to achieve the objectives, align with the

RMES, and include quantifiable measures to monitor performance. The process is scaleable for different levels of governance, from RMESs for the nation's large marine ecosystems (LMEs) (Sherman, 1994) to any of the smaller nested ecosystem units that comprise them. The proposed process draws on international and national ecosystem principles and mandates, and experience in the science and stewardship of coastal and marine resources.

The paper is organized into three sections. The first section describes the national and regional context for an ecosystem approach to management (EAM) in the U.S. Neither the concept nor the practice is new, but the proposed integration of management efforts across multiple sectors and various levels of government and the affected public is new territory. The recent history of progress in ecosystem science and management principles domestically and internationally is briefly described as background for the proposed process. The second section of the document outlines a voluntary collaborative planning process that aims to reconcile and manage the diverse interests and uses of marine ecosystems, describing the participants in the process and their respective roles and responsibilities. This section suggests a cycle of planning and consensus building around a core set of ecosystem principles. The output is a RMES. The third and final section describes an example of the implementation process for management within a sector. An FEP process is used as a case study to describe what stimulates modification or creation of new regulations, and in some cases new forms of governance, to achieve the objectives derived in the planning process.

Consideration of this process by other sectors than fisheries will enable agencies and stakeholders to participate in a common venue and use a collaborative process to develop integrated management approaches for both consumptive and non-consumptive uses of the ecosystem. The intent is to include multiple interests and regulatory authorities for sectors that impact the ecosystem such as transportation, energy, water and air quality, etc., not just those uses under one sector's authority. The paper suggests the key to success is collaboration with other federal, international, state, local, tribal and non-governmental organization (NGO) partners, as well as the public. A successful ecosystem approach to management is a combination of top down discussions on ecosystem goals and objectives, complemented by bottom up implementation of actions and regulations.

Section 1: Background and Context

1.1 An ecosystem approach to management

NOAA has adopted a common lexicon across its various line offices to promote a shared understanding and usage of ecosystem concepts (NOAA, 2003a). For the purpose of this document:

> An *ecosystem* is a geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics.
>
> The *environment* is the biological, chemical, physical, and social conditions that surround organisms. When appropriate, the term environment should be qualified as biological, chemical, physical, and/or social.
>
> An *ecosystem approach to management* (EAM) is management that is adaptive, geographically specified, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives.

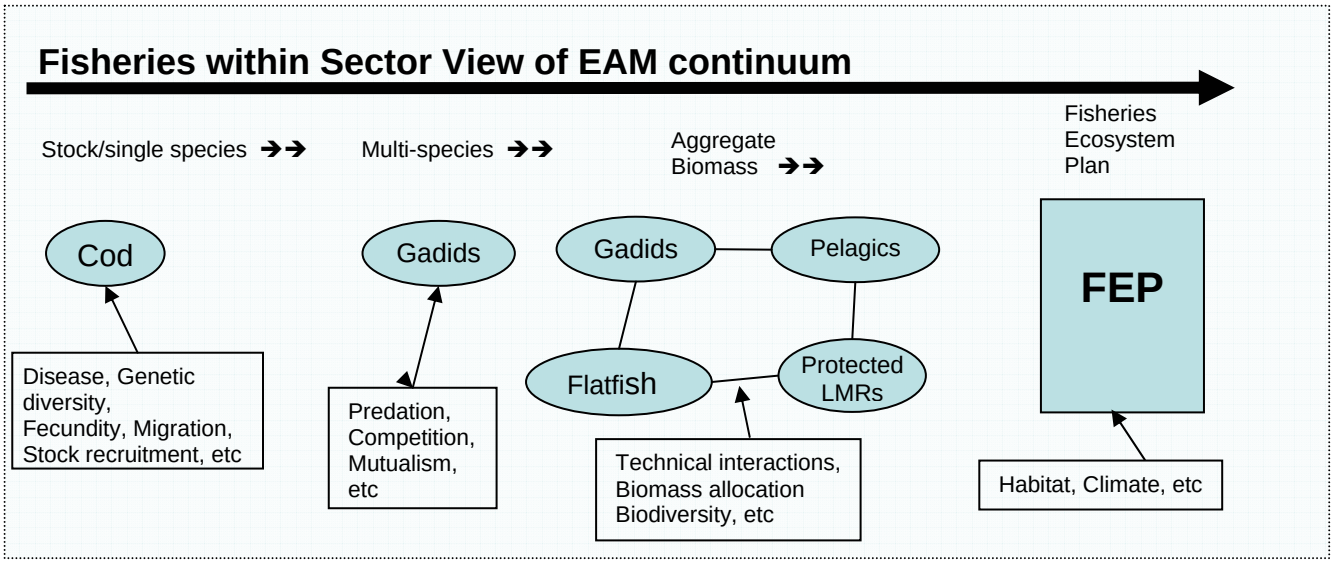
The phrase "ecosystem approach to management" (instead of "ecosystem management") is used throughout the document in deference to the preferred international convention. An EAM is incremental, as neither the scientific nor fiscal underpinnings are usually in hand to fully implement ecosystem approaches overnight in every region.

For example, progress towards an ecosystem approach can occur in stages along a continuum (see Figure 1). Management stages within the living marine resource (LMR) sector under an ecosystem approach can be categorized into at least three levels. The first level is single species management of targeted resources, with issues such as protected species, non-target species, and habitat factors incorporated into management decisions as important considerations. The second level is a multi-species aggregate and system level approach. This brings in important ecological and environmental factors, such as trophic structure, carrying capacity, climate anomalies or regime shifts as they influence the condition of the ecosystem. It is the interactions of the multiple species across these natural and anthropogenic factors that differentiates this level from single species management. The third level is a comprehensive, multiple *sector* approach that captures the human activities and values associated with all external influences (fishing and non-fishing sectors) that impact the condition and sustainability of ecosystems (not just focusing on living marine resource conservation or extraction, but including alternative uses of and impacts on marine ecosystems by transportation, military, and oil and gas sectors, for example).

Moving forward incrementally is suggested. While agencies should strive to achieve multi-sector regional ecosystem approaches in the long term, intermediate outcomes at both the first and second levels should be sought in the near term. For example, NOAA has already made progress in incorporating environmental indicators into stock assessments and subsequent management policies in several regions (see FOCI and GLOBEC references below for example). Resources, data and the management questions in a specific region will dictate where single species, multi-species and multi-sector management of fisheries can take place. What is most important is to adopt the overall context of an ecosystem approach in the science and policy making. Then, as the available science, resources and priorities dictate, incremental components

of an ecosystem approach can be worked on at whatever level of effort is chosen. This is preferred to forgoing any attempt at an ecosystem approach because a full multi-sector approach is unattainable. Specific examples of how NOAA has been contributing to the development of ecosystem management practices at all three levels simultaneously can be found in Section 1.2.

Figure 1. Single sector EAM continuum, (adapted from Link, 2002).



Lack of data is not a valid reason for inaction. Internationally, the precautionary principle has been interpreted to mean that insufficient data, models or governance structures to attain the full regional ecosystem level of management should not be used as an excuse to ignore some of the issues at the second level that sorely need to be addressed. In the U.S., this has generally not been a problem, as the MSFCMA and other statutes require that management proceed based on the best available science.

An EAM is also a collaborative process since the governance authorities for ecosystem management are distributed across many levels of government, and successful management requires participation of many different stakeholder groups in the public and private sectors. Unlike Canada, whose Oceans Act of 1997 provides it's Minister of Fisheries and Oceans with the responsibility and authority to implement a national strategy for the management of estuarine, coastal and marine ecosystems, the U.S. has distributed the equivalent authority among 20 different agencies under a myriad of statutes. As noted in the US Commission on Ocean Policy Report (2004, p. 46):

> "Ocean issues" include virtually every aspect of the government's duties, from promoting international commerce to protecting the environment, and from guarding national security to facilitating tourism and recreation. More than half of the fifteen existing cabinet-level departments, plus several independent agencies, play important roles in the development of ocean and coastal policy… Many individual programs within these departments and agencies administer specific initiatives that address varying, and sometimes overlapping, ocean and coastal issues…

The NOAA mission of LMR stewardship itself encompasses hundreds of statutory authorities cutting across many industries, interest groups, sectors of the economy, stakeholders,

constituents and partners. The value of these guidelines to NOAA and its partners is to help cut across these differences to create an agreed-upon set of LMR objectives, and ensure consistent and effective implementation of actions and regulations. Adoption of this process by other agencies will bring their regulatory and governance decisions into similar alignment, such that the sum of all ecosystem approaches to fisheries, water and air quality, agriculture, energy, forestry, coastal zone, and transportation activities produces the greatest benefit to the nation as a whole.

1.2 National and international advances in EAM

EAM is not a new concept. Many activities in the last decade have incorporated ecological and environmental effects into the management of fisheries, protected resources and habitat. Almost two decades ago NOAA published (NMFS, 1987) a program development plan for ecosystems monitoring and fisheries management that outlined management objectives, strategies, structure, reporting and coordination objectives for seven regional marine ecosystems within U.S. jurisdictions or containing resources of U.S interest (i.e., Antarctic). In the 1996 Sustainable Fisheries Act Amendments to the MSFCMA, Congress included amendments establishing an Ecosystem Principles Advisory Panel to expand the application of ecosystem principles in fishery conservation and management activities. Now, a growing international and domestic consensus has been developing on the application of ecosystem principles to LMR management challenges. Developments include:

- The eight Regional Fishery Management Councils (established under the Magnuson-Stevens Act) and NOAA have increasingly incorporated an ecosystem approach into the development and implementation of 48 Fishery Management Plans and numerous international fisheries management agreements. Further progress on incorporating ecological and environmental factors into their policy decisions along the continuum to a fully integrated multi-sector ecosystem approach will be based on recent successes, such as the Western Pacific Council Coral Reef Ecosystem Plan and the North Pacific Council Groundfish Plans.

- The United Nations Food and Agricultural Organization (FAO) has been advancing ecosystem principles under the auspices of its evolving Code of Conduct for Responsible Fisheries (FAO, 1995). For example, in October 2001, the Conference on Responsible Fisheries in the Marine Ecosystem held in Reykjavik, Iceland, produced a Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem (FAO, 2001) that asserted the need to:

  > "…strengthen, improve, and where appropriate establish, regional and international fisheries management organizations and incorporate in their work ecosystem considerations and improve cooperation between those bodies and regional bodies in charge of managing and conserving the marine environment."

  As further follow-up to promoting ecosystem approaches to fisheries (EAF), FAO (2003) also produced technical guidelines for responsible fisheries that:

  > "… describe how the current management process would change under EAF. Although the EAF management process uses essentially the same cycle of planning, implementation and evaluation, there is a need to provide for better consultation with a broader range of stakeholders, and for a

more rigorous setting of operational objectives, decision rules and evaluation of management performance."

- NOAA has been a world leader in defining, coordinating research and developing processes for stewardship of the world's 64 'Large Marine Ecosystems' (LMEs), seven of which are within U.S. waters. NOAA has pioneered the LME scale, which defines LMEs as "regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of the major current systems" (UNIDO, 2002). LMEs are relatively large regions, on the order of 200,000 km^2 or greater, characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations. At the 2002 World Summit on Sustainable Development (WSSD), over 100 countries adopted the following ecosystem related targets (U.N., 2002):

    - Substantial reductions in land-based sources of pollution by 2006;
    - Introduction of the ecosystems approach to marine resource assessment and management by 2010;
    - Designation of a network of marine protected areas by 2012; and
    - Maintenance and restoration of fish stocks to maximum sustainable yield by 2015.

- Another development at the WSSD was the commitment of nearly 50 countries, including the U.S., to develop a Global Earth Observation System of Systems (GEOSS), integrating earth observations from all countries to provide researchers and managers around the globe with access to comprehensive data streams on weather, climate, oceans, land, geology, natural resources, ecosystems, and natural and human-induced hazards. The quality and quantity of data available from GEOSS and the Integrated Ocean Observing System (the U.S. ocean component of the global system) will provide a substantial source of new and improved data for use in EAM.

- Multidisciplinary fisheries oceanography research by NOAA has already been integrated into management decisions through coordinated ecological research. These programs target the physical and biological processes (i.e., recruitment variability, compensatory mechanisms, and species interactions) that control the abundance of living marine resource populations. Secondarily, these projects enhance the ability to identify, understand and manage anthropogenic impacts to marine ecosystems against the background of natural system variability. Still other programs investigate the scientific bases for defining policy issues relative to climate-driven environmental change and renewable resource use over much longer time periods and greater spatial (global) scales. Relevant examples include:

    - U.S. GLOBEC (GLOBal ocean ECosystems dynamics), a research program that addresses how global climate change may affect the abundance and production of animals in the sea. Ocean circulation and other aspects of the physical environment are major factors controlling patterns of marine animal abundance.
    - FOCI (Fisheries-Oceanography Coordinated Investigations), investigating the recruitment of walleye pollock in the Gulf of Alaska and Bering Sea.
    - SABRE (South Atlantic Bight Recruitment Experiment), researching the relationship between variation in environmental factors and the variable recruitment of "estuarine dependent" fishes, principally menhaden, in the South Atlantic.

- Several recent policy reports have focused interest on ecosystem approaches (e.g., the 2003 Pew Ocean Commission report; the Marine Fisheries Advisory Committee's Ecosystem Approach Task Force report (2003); the report of the U.S. Commission on Ocean Policy (2004)). Each has advised NOAA and NOAA Fisheries to advance and adopt an EAM.

1.3 Scale and scope of the RMES and RMEIPs

The proposed process in section 2 is designed to promote integrated regional marine ecosystem approaches to management by federal and state agencies and their stakeholders. The *regional* focus of the process is important since many of the specific factors or drivers affecting ecosystems are unique to a region, such that the relevant stakeholders or prescribed actions and regulations are derived best as regional-level solutions. Nationwide processes and standards for the regional approaches are suggested, however, to provide consistency and efficiency. The *marine* focus of the process intentionally focuses the scope on a subset of the Earth's ecosystems for practical reasons, yet it is acknowledged that an EAM must include the complexity of air-sea-land interactions. Thus, while the focus is marine ecosystems, the reach of the proposed process includes coastal and estuarine areas including the associated watersheds, as well as inland areas where activities create consequences that impact marine ecosystems.

While the proposed process is generic enough to develop a RMES for an entire LME, for reasons of feasibility and tractability in implementation it is more likely the process will be applied at smaller scale management areas than a LME. While scientific information from LME-scale research can inform development of management strategies, the scale of the management area should be commensurate with management bodies that are empowered to set objectives. In other words, RMES boundaries should be based on the spatial extent of the ecosystem characteristics and/or dynamic processes that are to be studied or influenced through management. This includes accounting for natural discontinuities in oceanographic and/or bathymetric features, the geographic distribution of ecosystem characteristics and political/management jurisdictions. This will most likely lead to a suite of nested ecosystems, specified at a hierarchy of scales with boundaries that sometimes overlap. More specific guidance for delineation of boundaries is discussed in section 2.4.2.

Section 2: A Collaborative Planning Process

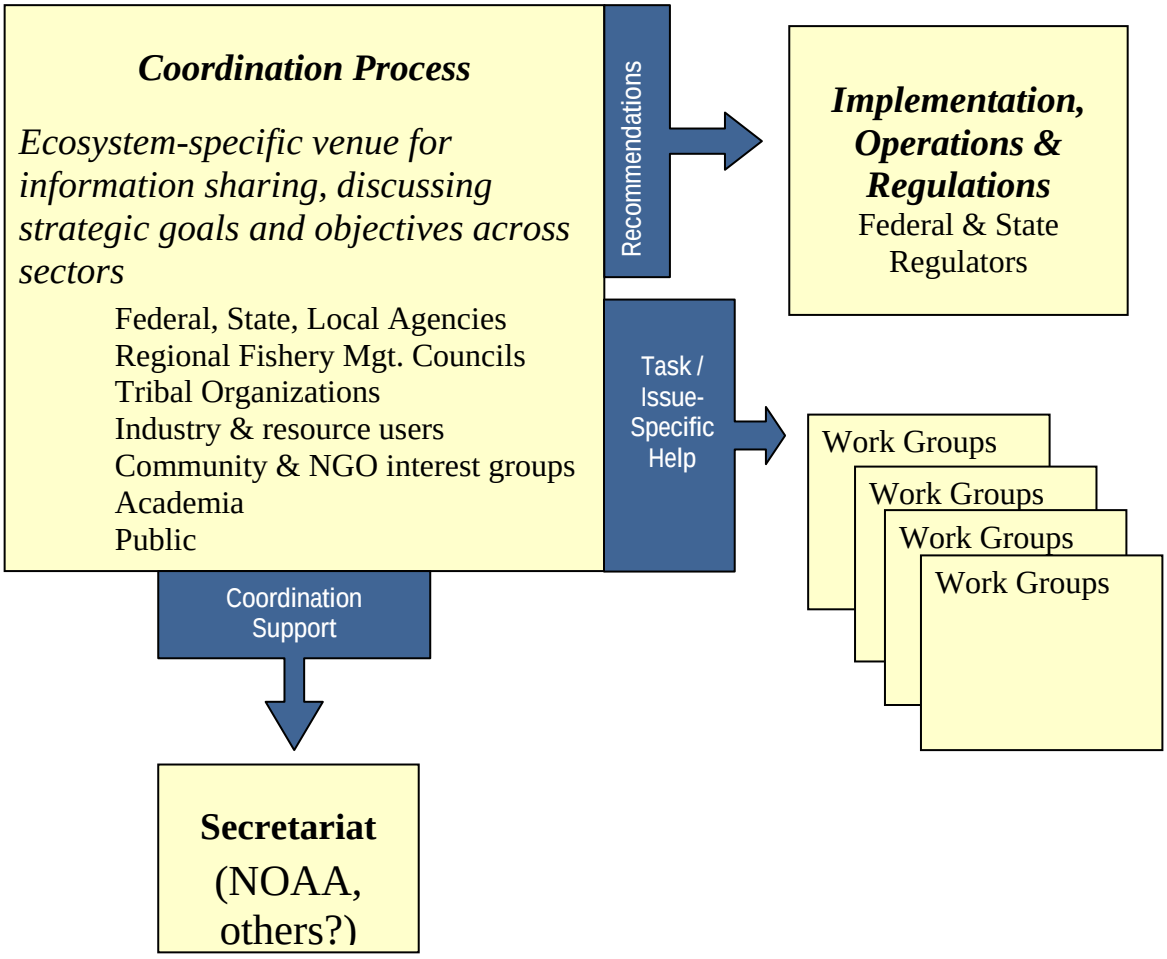
2.1 Coordination process for developing the RMES and RMEIPs

The institutional structure for producing a RMES and RMEIPs needs to acknowledge existing organizations, statutes and missions. However, for each marine ecosystem, some new venue is required to bring together diverse sectors for developing integrated strategic goals and operational objectives for the region being managed (Figure 2). Creation and participation in such a venue would be voluntary, and its purpose would be to promote communication and collaboration, integrating input from federal and state regulatory agencies and their stakeholders. It would not have any independent regulatory or statutory authority nor would any be required.

The exact form and structure would vary based on the needs and requirements of each ecosystem region. Since NOAA's research and management interests span all the targeted ecosystems, it makes sense for NOAA to consider serving as the secretariat for each venue to facilitate the process and document the results (this role for NOAA is not a requirement; some other entity

could volunteer). All stakeholders and partners with interest in the marine ecosystem would be represented (e.g., federal, state, local agencies, Regional Fishery Management Councils, commissions, boards; existing advisory bodies; industry/trade associations; conservation organizations; community and interest groups; academia/researchers; general public). Individual work groups would be created to research and discuss specific technical or management issues surrounding the strategic goals and objectives.

Figure 2. Proposed coordination process for cross-sector communication and planning.



The Federal Advisory Committee Act (P.L. 92-463, 1972) requires federal agencies creating an advisory body containing non-federal membership for purposes of deriving consensus recommendations to create a charter and seek prior approval at the highest levels in their Executive Branch and by the General Services Administration. The proposed coordination process would require such approval if it took the form of a federally-sponsored committee or board.

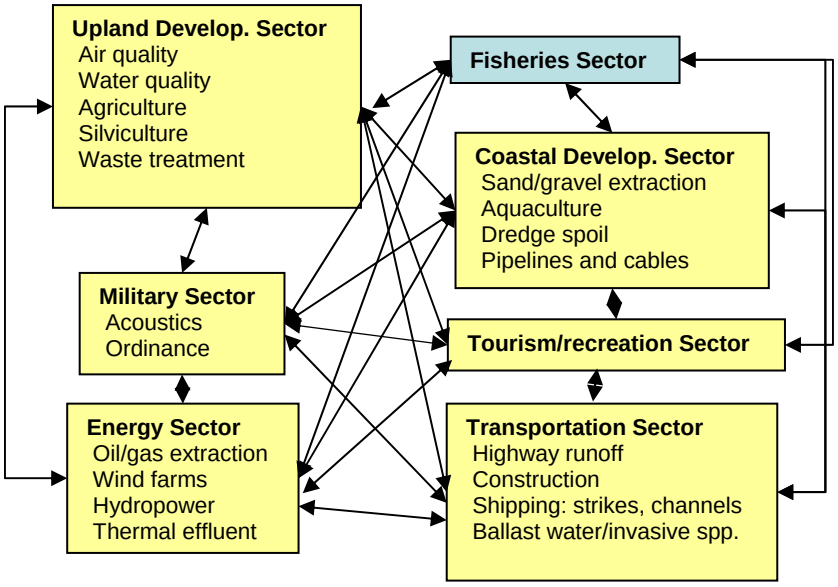
Unless or until FACA approval is obtained, an alternative regional ecosystem coordinating function would need to be organized and created by a non-federal entity. Nevertheless, federal agencies would still continue their intergovernmental consultations with each other and state, local and tribal governments, and solicitation of information and viewpoints from individual stakeholder groups (FACA prohibits unapproved groups from soliciting advice, opinions or recommendations from a group of stakeholder groups acting in a collective mode). This

coordinating function could still be supported by a NOAA secretariat function. In addition, using the current institutional framework would include access to existing FACA-approved advisory committees of individual agencies (over 1,000 already exist). Such groups could provide input to their respective federal agencies so they can bring such information forward to the intergovernmental group (an all-federal group would be FACA-exempt). For example, the eight Regional Fishery Management Councils established under the MSFCMA, the three Interstate Marine Fisheries Commissions and the FACA-approved Marine Fisheries Advisory Committee are examples of well-established collaborative partnerships in NOAA that could contribute inputs for creating goals and objectives for a RMES from the LMR perspective.

In the long term, Congressional action may resolve the FACA issue, or FACA approval could be obtained. A variety of Congressional opportunities are forthcoming (e.g., responses to findings of the U.S. Commission on Ocean Policy; authorization of a NOAA Organic Act; reauthorization of the MSFCMA) that could create new FACA-exempt venues, or the process for obtaining FACA approval could be satisfied over time.

The creation of such a venue will provide for a top-down EAM that brings together multiple sectors with different interests, objectives and management authorities for components of a marine ecosystem in one place (virtually if not geographically) to work together. Their goal would be to create a common strategy that results in the optimal sustainable value to society from the regional marine ecosystem of interest. This differs from the *status quo* in that it integrates the management authorities and interests in an ecosystem across traditionally separate management and use sectors. The result of this voluntary top-down process is called a Regional Marine Ecosystem Strategy (RMES). Figure 3 depicts the interactions in this top-down approach.

Figure 3. Multi-sector EAM, each line represents a stakeholder interaction or sector impact

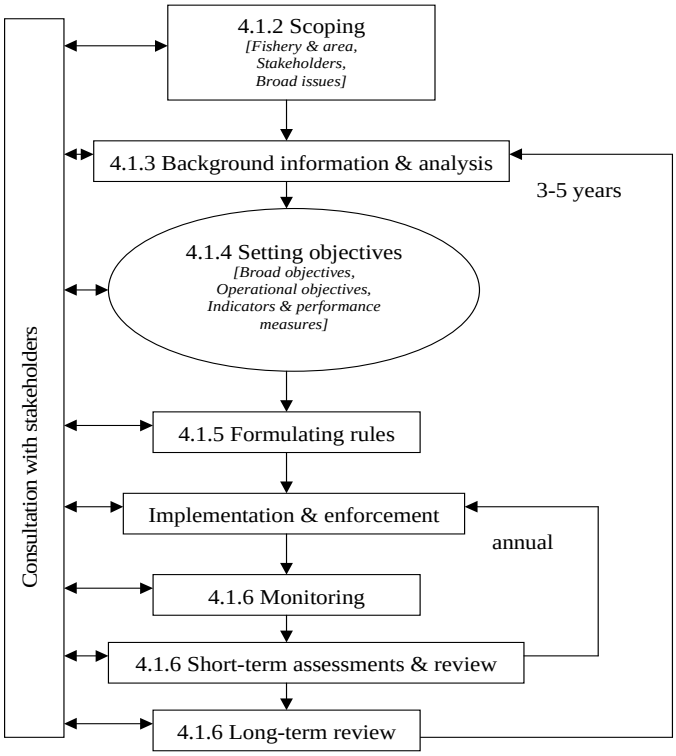


2.2 Process for developing the RMES and RMEIPs

Many models exist in the literature to describe the process for developing management plans in an ecosystem context. Figure 4 shows the approach suggested by FAO and is a useful starting point. Despite its strong linear/sequential approach, it emphasizes the underlying importance of

broadening stakeholder participation. Consultations with stakeholders occur continuously throughout the development and implementation process, not just in the initial scoping process or the final stages of implementation.

Figure 4. Process for Developing a Management Plan (FAO, 2003)



The integrated management framework of Canada for estuarine, coastal and marine environments (Fisheries and Oceans Canada, 2001) is a simpler variation and is comprised of five inter-related stages:

1. Define and assess the management area
2. Engage the affected interests
3. Develop the integrated management plan
4. Implement the plan
5. Monitor and evaluate outcomes

The strengths of this framework include its simplicity, and the feedback built into the progression through the stages. All stages occur simultaneously as the process advances. The adaptive nature of this cycle is desirable as the dynamics and uncertainties of ecosystems warrant a strong iterative approach.

Similarly, Australia's Oceans Policy (1998) outlines the following steps for development of Regional Marine Plans:

1. Assess our ocean resources, on a biogeographical basis
2. Understand the current uses of those resources and the emerging pressures on them
3. Evaluate what is needed to maintain ecosystem health and integrity, and the implications for sectoral activities and conservation reservation
4. Propose allocations of ocean resources, delivered principally through existing responsible sectoral management arrangements, using multiple use principles to generate income and employment and to optimize long-term benefits to the community
5. Assess and control the external impacts of proposed resources uses
6. Continually monitor the performance of ocean planning and management processes; and
7. Maintain flexibility to respond to emerging information within this broad framework

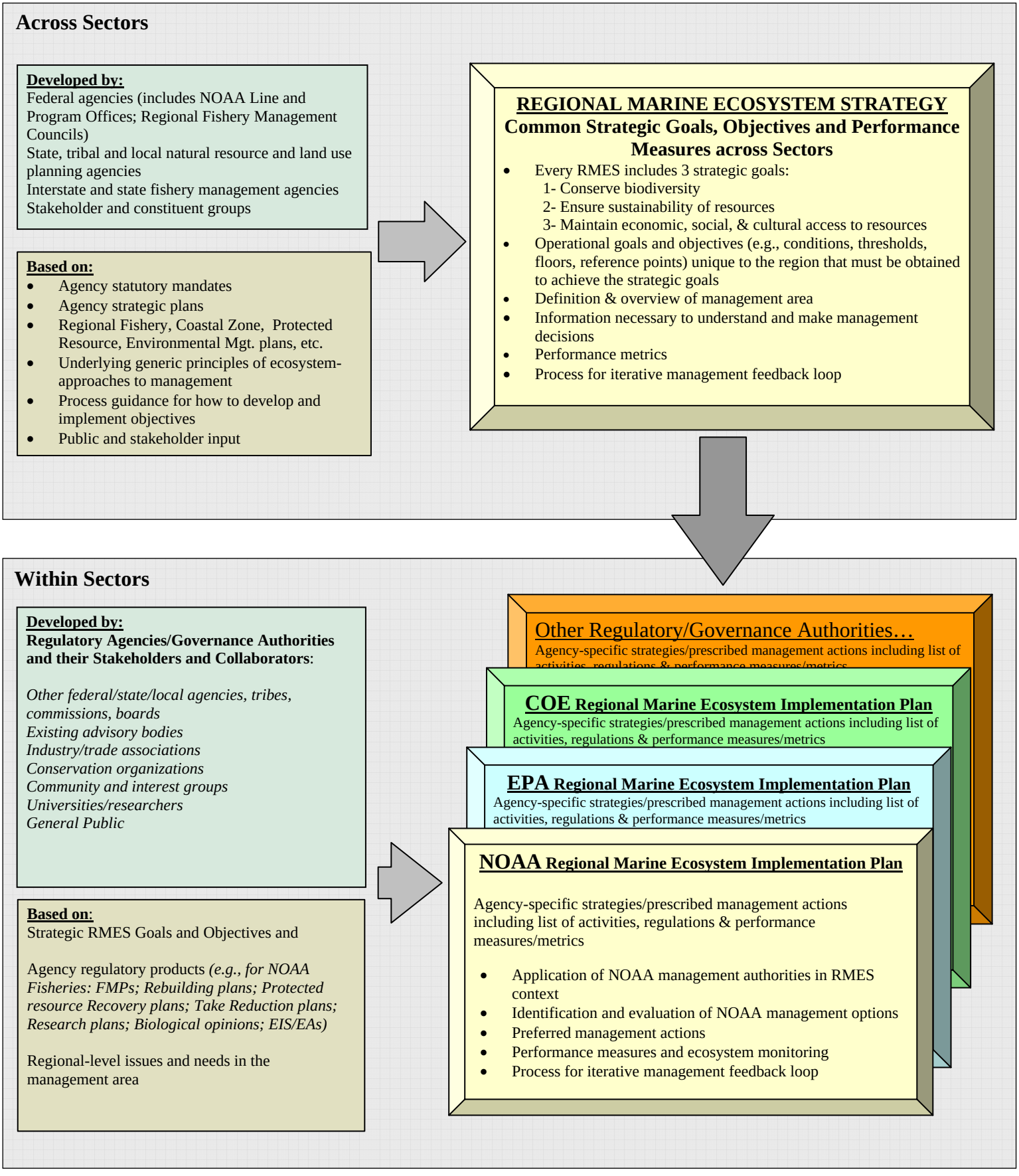
Following these precedents, nine operational steps are recommended for adoption. They are based on work within NOAA by a multidisciplinary team assigned the responsibility for ecosystems under the NOAA Strategic Plan (NOAA, 2004). Together, these steps refine the design, implementation and evaluation process for creating goals and objectives.

1. Formalize agreements on how ecosystem-oriented institutions will operate
2. Identify stakeholders and partners
3. Identify the ecosystem-level issues or problems to be addressed
4. Determine major factors/stressors that affect ecosystem performance and conduct ecological risk/benefit assessments
5. Establish objectives and targets for specific ecosystem parameters
6. Establish strategies for achieving targets and performance measures
7. Determine research, resource and information needs
8. Design ecosystem-level systems for information and monitoring
9. Implement, monitor and adapt plans as needed

Execution of these various steps results in the proposed process for producing a RMES and RMEIPs as shown in Figure 5. Multiple regulatory authorities and stakeholders would engage in a public process where statutory mandates and stakeholder interests would come together for discussion and debate. The public participation process would capture the informed input from all relevant stakeholders to evaluate options. A wide variety of public meetings and other mechanisms for eliciting stakeholder preferences for goals and objectives should be used (e.g., telephone and mail surveys, voice mail or email comments, WWW response site, town meetings, advisory committees, listening/focus groups, input from existing boards and organizations, individual interviews).

Broad participation in RMES development should be sought and include commercial interests, environmental interests, and the general public. The intent is to create a transparent and inclusive process for generating goals, objectives and performance measures. For each ecosystem management area, it will be necessary to identify which stakeholders need to be involved, in what capacity and to what extent. The following questions are suggested to help frame these decisions:

Figure 5. Development process for a Regional Marine Ecosystem Strategy, and creating Regional Marine Ecosystem Implementation Plans.



- At which points in the development process will stakeholders be involved (e.g., boundary setting, development of objectives, development of management alternatives, implementation, etc.)?
- How will stakeholders be selected for inclusion at each point? How will fairness and representativeness in the selection process be ensured? (e.g., create a list of criteria for ranking importance of stakeholders to involve.)
- At each point, what level of involvement will stakeholders have?
- What weight will be given to each participant's input? (i.e., will there be varying levels of involvement based on management authorities, commercial interests, citizens of coastal communities, etc., or will all involved have an equal voice?)
- How will local, state, tribal, regional, national, and international interests be weighted?
- How will differences of opinion be resolved?
- What existing institutional models or processes can/will be followed and what are the pros and cons of each? Identify the role of existing advisory bodies.

Following development of recommendations on operational goals, objectives and performance measures, individual federal, state, tribal or local regulatory or governance authorities would prepare RMEIPs for their sector using their existing statutory, governance and regulatory powers and processes. The resulting regulations, control rules and actions comprise the elements of the RMEIP. Associated performance metrics and reporting standards would be implemented, monitored and shared with all partners.

2.3 Timeframe for developing and revising the RMES and RMEIPs

The RMES and RMEIPs should be designed with at least a 5-year horizon in mind. This timeframe is based on a balance among:

- The feasibility of developing the documents;
- The need to react to and account for changes in the ecosystem and human uses of the marine environment (e.g., 10 years is too long given potential changes in proposed use);
- The ability to influence and plan for management actions in the future.

Therefore, in the RMES, operational objectives should be chosen such that a 5 year evaluation period is feasible; i.e., as a result of management, measurable changes could be expected to be detected in this time period. Similarly, in the RMEIPs, the action plan for addressing problems should focus on what is achievable over that same time period. The analysis of factors affecting the regional marine ecosystem area, however, can and should identify impacts (positive or negative) that might be incurred at any point in the future, depending on the nature of the impact (see Section 2.4.5).

2.4 Contents of the RMES

This section describes the contents of a RMES. Table 1 summarizes these contents and indicates the typical roles, responsibilities and the outcomes for the various steps for creating the RMES.

2.4.1 Statement of current management issues

Each RMES should begin with the need for creation of the strategy, including the specific management circumstances requiring action. This will establish a set of current reference points for comparison to the set of common goals and objectives being developed. Each RMES should:

1. Summarize the current management authorities, goals, and objectives across sectors.
2. Summarize the conditions affecting the achievement of current goals;
3. Examine specific examples of the problems, challenges, and impediments associated with the current management paradigm;
4. Describe examples, if any, of efforts to date of adopting an EAM.

Table 1. Roles and responsibilities for development and implementation of the Regional Marine Ecosystem Strategy

Document Section	Description	Who
	Regional Marine Ecosystem Strategy (RMES)	**Product of agencies & stakeholders across sectors**
Problem statement	Describes the general conditions in the ecosystem and major problems to be addressed	Responsible agencies & stakeholders
Definition of management area	Describes boundaries of the marine ecosystem management area, based on geopolitical/ecological considerations	Inter-agency work group on boundaries
Strategic goals	1) Maintain ecosystem structure & functioning 2) Conserve biodiversity 3) Maintain economic, social & cultural access to resources	Given
Operational goals and objectives	Development of operational goals and objectives (or thresholds) that the RMES must achieve to satisfy the strategic goals	Responsible agencies & stakeholders
Assessment of drivers and uses	Description/mapping of all relevant activities/uses of the management area. Identify forcing functions/drivers	Responsible agencies & stakeholders Secretariat
Performance Metrics	Performance measures associated with operational objectives	Responsible agencies & stakeholders
Iterative mgt. process	Process to be taken to monitor, evaluate & revise the RMES to ensure that strategic goals and operational goals and objectives are met	Responsible agencies & stakeholders

2.4.2 Definition of the regional ecosystem management area

The definition of the regional ecosystem management area should describe the boundaries of the ecosystem management area based on geopolitical and ecological considerations. Boundaries should be determined by evaluating the intersection of the following categories of information:

1. Geographic ranges of LMR including managed fish species and important prey species (at all key life stages)
2. Geographic ranges of endangered species, marine mammals, and sea birds.
3. Managed habitat ranges such as essential fish habitat (EFH), critical habitat, etc. Geological substrate types and biological habitat (such as submerged aquatic vegetation, wetlands, live hard-bottom, coral, etc.) should be considered if they demarcate relevant areas for management.
4. Watershed boundaries as defined by coastal drainage areas and estuarine areas.
5. Oceanographic or environmental phenomena (e.g., the California current).
6. Boundaries of existing jurisdictional or management authorities (e.g., Regional Fishery Management Council areas, coastal zone management areas, treaty boundaries, international boundaries (e.g., the EEZ)) to maximize/account for political feasibility.
7. Location of relevant existing managed areas (e.g., National Marine Sanctuaries, National Estuarine Research Reserves, marine mammal Dynamic Area Management closures, fishery spawning area closures, etc.)

The elements that define the boundaries for the management region (as described above) should be integrated into maps using spatial analysis software for ease of subsequent analysis. Where ecosystem boundaries and political boundaries do not coincide, the RMES should provide an analysis of the factors influencing the choice of boundaries. Based on this analysis, the RMES will produce a map(s) that delineates the management area and includes key features from the above list.

Note that not all factors need to be used to determine the management area. For example, while agricultural runoff from farmlands in the Midwest contributes to hypoxia in the Gulf of Mexico, it may be impractical to include the entire Mississippi watershed as part of the Gulf ecosystem management area. However, while the source of these impacts may be outside the practical regulatory reach of the partner agencies, the impacts will still be documented in the RMEIPs and accounted for when determining what actions to take. Also, since the boundary should be set based on the geographic ranges of fish and/or marine mammal populations, it is possible that species with extremely large ranges will be managed under multiple RMESs.

2.4.3 Strategic goals

The overarching outcome of an EAM for every regional ecosystem management area is to:

> *Derive the optimal sustainable value to society and future generations from the nation's regional marine ecosystems under stewardship.*

The ecosystem goods and services comprising this value include both uses and non-uses of the ecosystem (Alcamo, et al, 2003). They can be accounted for in four categories:

1) Provisioning services (e.g., products obtained from the ecosystem such as food, water, minerals, genetic resources);
2) Regulating services (benefits derived from regulation of ecosystem processes such as climate regulation, disease regulation);
3) Cultural services (nonmaterial or non-market benefits obtained from ecosystems, such as religious, recreation and ecotourism, aesthetic, cultural heritage); and
4) Supporting services (services necessary for the production of all other services, such as nutrient cycling, primary production).

To obtain this outcome, three strategic goals are proposed for inclusion in every RMES:

1) Ensure sustainability of resources
2) Conserve biodiversity
3) Maintain economic, social and cultural access to resources

In combination, these three goals capture society's desire to balance both the use and preservation of resources in marine ecosystems. While the specific wording may vary, the goals are analogous to Australian and Canadian models. The three "core objectives" from Australia's National Strategy for Ecologically Sustainable Development are: "to enhance individual and community well being and welfare by following a path of economic development that safeguards the welfare of future generations; to provide for equity within and between generations; and to protect biological diversity and maintain essential ecological processes and life-support systems (Commonwealth of Australia, 1998)." Similarly, the specific objectives for Canada's Eastern Scotian Shelf Integrated Management Initiative (Fisheries and Oceans Canada, 2001) are: "to integrate the management of all activities in the eastern Scotian Shelf area; to encourage the conservation, effective management and responsible use of marine resources; to support the maintenance of natural biological diversity and productivity; and to foster opportunities for economic diversification and sustainable wealth generation for coastal communities and stakeholders."

2.4.4 Operational goals and objectives

Each RMES should include specific operational goals and objectives. Sainsbury and Sumaila (2003) define an operational objective to be "an objective that has a direct and practical interpretation." As the type and intensity of anthropogenic and environmental factors influencing ecosystems will vary by region, the guidelines cannot prescribe what the operational goals and objectives for each RMES should be. Explicit, transparent, and inclusive stakeholder input is necessary to determine them; the process for obtaining such public input was described in the previous section.

Selection of operational goals and objectives should be based on an evaluation of how each contributes to achieving the three strategic goals listed above. Operational goals and objectives should describe exactly what will be achieved and in what time period for each ecosystem management area, including an outcome-based performance measure where possible.

Examples of operational goals (in italics) and objectives (bullets) are listed below. They are drawn from NOAA Fisheries experience, are not exhaustive and only represent one sector's possible contribution. In addition, many of the examples have roots in single species management. However, as part of a RMES, their precise outcomes and time frames for results

will be specified. They will then be evaluated relative to and integrated with goals and objectives from other sectors in the broader multi-sector ecosystem context.

Prevent Overfishing…

- Develop and implement conservation and management measures that prevent overfishing of species/species complexes in each region within X years.
- Maintain the status of species or species complexes relative to overfishing, overfished or other ecosystem limit reference points.
- Develop rebuilding plans by a certain date for those species or specific complexes deemed to be overfished.

Protect Sensitive Species…

- Implement conservation measures within X years to maintain protected species at optimum sustainable population levels.
- Develop conservation and recovery plans for ESA-listed species and depleted protected stocks by a certain date.

Conserve Genetic Diversity and Structure…

- Develop and implement measures to conserve non-target species.
- Ensure that no native species shall go extinct due to anthropogenic factors.
- Monitor and evaluate impacts of invasive species on native species.
- Establish conservation and management measures to reduce fishing mortality of non-target species (e.g., manage bycatch mortality and incidental catch rates to avoid overfishing of non-target species), and establish incidental catch thresholds that will allow non-target species to remain functioning components of the ecosystem.
- Establish measures to conserve species diversity where an observed and sustained decline in species diversity (e.g., mean species richness from fisheries independent surveys) is below the range of observed natural variability.
- Develop and implement harvest policies that protect genetic diversity of species or stocks by protecting Evolutionary Significant Units (ESUs) from excessive mortality.
- Establish measures for those species or stocks at risk of losing genetic diversity to protect the ESU.

Conserve Living Marine Resource Habitat…

- Develop and implement measures to conserve marine habitat, including Essential Fish Habitat, critical habitat, and anadromous fish habitat, for all targeted and protected species with respect to their ability to spawn, breed, feed and/or grow to maturity.
- Evaluate and manage potential cumulative adverse effects of fishing on habitat so as to maintain healthy functioning of the ecosystem.
- Manage adverse habitat perturbations (from both fishing and other user sectors) to be less than the range of natural disturbances for the appropriate physical and geological processes that operate in ecosystems.
- Monitor habitat quality and quantity, and its biological, chemical and physical characteristics, by habitat type.

Maintain Trophic Structure…

- Develop and implement measures to appropriately limit anthropogenic impacts on trophic structure and functioning. Ecological relationships between harvested, dependent and related species shall be maintained within the range of observed natural variability.
- Develop and implement X measures to take the trophic role of species into account when establishing harvest levels, including the effects of the combined removal of all targeted species on the ecosystem.
- Establish X measures to restore the fundamental ecological relationships in those food webs that have human-induced deterioration of trophic structure.
- Develop and implement harvest policies that sustain adequate forage base, in situations where fisheries potentially compete with top trophic level consumers (e.g., marine mammals, turtles, sea birds, or similar protected species) for shared resources (e.g., forage fish such as small pelagics), to ensure that sufficient quantities of the shared resource are available to sustain the top trophic level consumers at their population thresholds.

Prevent Systemic Over-exploitation…

- Prevent systemic over-exploitation of an ecosystem at relevant spatial and temporal scales. This may require development and implementation of a limit for the total combined removal of all targeted species or some equivalent means. It provides a buffer for uncertainty such that the total removal cap is established as less than the combined total of all targeted and non-target removals.
- Allocate tradeoffs in harvestable biomass among all targeted species subject to the constraint of the total removal cap, up to but not exceeding the total cap.
- Establish measures and policies to avoid exceeding the systemic cap and to reduce total system-wide exploitation if it is exceeded.

Improve knowledge of natural and anthropogenic processes controlling ecosystem structure and function to enable more accurate forecasts of living marine resources…

- Monitor the status of non-target species that are significantly impacted by anthropogenic activities.
- Monitor trophic relationships among targeted species, their predators, and their prey.
- Monitor population status of protected species and marine mammals at specific levels of assessment quality every X years.
- Monitor the status of species or species complexes relative to overfishing and overfished reference point at specific levels of assessment quality every X years.
- Improve our understanding of the importance of bottom-up forcing in determining episodic recruitment events in target species and the prey of target species.

These examples include a wide range of possible operational goals and objectives. For any given marine ecosystem, the specific operational objectives must support the achievement of the three strategic goals. Operational objectives should be set with reference to a specific time frame for evaluation and revision. As stated in Section 2.3, the default for operational objectives should be a 5-year evaluation period.

To achieve the strategic goals and operational objectives, specific management actions will be described in the RMEIP (see Section 3). Along with the actions will be a list of the agencies/partners responsible for undertaking the action, a specific date or timeline for accomplishing the action, and a means to measure the progress of the action as a performance monitoring tool.

2.4.4.1 Incorporating uncertainty and the precautionary approach into objectives

Marine ecosystems are almost always going to be more complicated than can be fully understood. The limitations of scientific knowledge will make it impossible to predict with absolute certainty the future state of any ecosystem or to understand the forces that created an observed state. Changes resulting from management measures will be compounded by other factors, not all of which will be known or even identifiable. It may not be possible to predict all of the interactions between forcing functions within an ecosystem. Management measures could fail to achieve their desired impact not because they were inappropriate, but because of a change in other factors beyond the control of regulators. Managers are limited to only regulating human activity in the ecosystem and not the ecosystem itself.

Given this uncertainty, a full and predictable understanding of the ecosystem is not feasible before management actions are taken. In some cases, scientists may only be able to describe in a qualitative way how changes in one component of the ecosystem will affect other components. It will not always be possible to make accurate quantitative predictions of the impacts of management measures on the ecosystem. Additionally, managers may not know if a particular ecosystem condition is achievable, even if it were desirable. Managers may not know how long it will take to achieve a particular state of the ecosystem, or what changes are needed to ensure the development of such a state. However, all this uncertainty does not absolve managers from managing. Managers must utilize all available information and make decisions, including what actions are necessary to "purchase" insurance against unforeseen negative impacts. Managers can also use this information to identify research priorities that inform future agency funding decisions.

Given this degree of uncertainty, many of the outcomes of management actions are probabilistic in nature. When there are identified gaps in knowledge, it is appropriate to manage risk using a precautionary approach that limits the risk that management measures will not achieve the desired goals and objectives. That is, when the probability of a specific outcome occurring at a specified time is uncertain, or there is some risk that the outcome will not be or will only partially be achieved, then employing a precautionary approach up-front in selecting goals, objectives and management measures is appropriate.

The adoption of a precautionary approach in fisheries management has gained favor in the last decade as societal preferences have leaned toward more conservative policies on LMR removals in the face of scientific and behavioral uncertainty. Applying conservation measures even in the absence of absolute scientific certainty that fish stocks are being overexploited has become a basic premise associated with fisheries sustainability (Restrepo *et al*., 1999). The elements of a precautionary approach include establishing limits to ensure resource conservation targets for management are safely below certain thresholds. Not exceeding limits takes precedence over achieving targets. This more conservative specification of removals of species in single-species fisheries management has analogous utility in the application of EAM.

The RMES operational objectives should account for this uncertainty explicitly in deciding among alternative uses (or non-uses) of ecosystem resources. Factors such as ecosystem resilience and the number and type of impacts to the ecosystem should shape the subsequent RMEIP management alternatives evaluated and ultimately selected. The following tenets of a precautionary approach from Australia's Ocean Policy (1998) are recommended for adoption:

- If the potential impact of an action is uncertain, priority should be given to maintaining ecosystem health and productivity.
- Incomplete information on possible impacts should not be used as a reason for postponing precautionary measures intended to reduce or avoid unacceptable levels of change or to prevent serious or irreversible environmental degradation of the oceans.
- In the application of the precautionary approach, public and private decisions should be guided by:
    - Careful evaluation to ensure that changes arising from a use or uses remain within limits considered acceptable, to avoid, wherever practicable, serious or irreversible damage to the environment; and
    - Assessment of the risk-weighted consequences of various options.
- If there is a risk of serious and irreversible environmental damage resulting from an ocean use, that use should be permitted only if the damage can be mitigated, or it is limited in its extent, and there is an overriding net community benefit from the use:
    - The higher the risk of unacceptable levels of change or of serious or irreversible environmental damage, the more conservative should be the measures required to reduce that risk.
- Ocean users carry a responsibility to assure the ecological sustainability of their operations and an obligation to identify and implement precautionary measures.

This approach suggests that when setting operational goals and objectives, a decision support framework is needed to evaluate the tradeoffs, measured as forgone benefits due to the more conservative precautionary approaches, compared to the probabilities of different ecosystem scenarios and conditions occurring. The benefits and costs (both social and economic) of a precautionary approach would be made visible and subject to discussion and choice by managers and stakeholders.

2.4.5 Assessment of drivers and uses

The status, performance or behavior of any regional marine ecosystem will be affected by a number of drivers or factors, including those that occur in adjacent terrestrial areas. These factors can be categorized as either anthropogenic (i.e., caused by human activity) or environmental. Examples of environmental factors include: regional rainfall variation; changes in oceanic currents; and catastrophic events (e.g., hurricanes). Anthropogenic factors include the harvest of fish (commercial and recreational), coastal development, and pollution. Appendix A describes a suite of anthropogenic and environmental factors for potential analysis in the RMES. While the main focus of the RMES will be on the anthropogenic activities in and uses of the ecosystem, the RMES should identify both types of factors. Changes in the environment can affect the success of management actions taken, and the option(s) evaluated should take into account the influence of these factors to the extent possible.

A two-stage process is suggested for evaluation and prioritization of these factors. This process will set up the framework for evaluating and selecting management strategies and alternatives in the RMEIP.

Stage 1: Define the scope of the problem(s)

In the first stage, the RMES should evaluate the impact of each factor (anthropogenic activity or environmental impact) on each of the operational objectives. For each factor, the spatial and temporal scale of the effects should be identified, as well as some measure of the intensity or degree to which the factor impedes or contributes to the achievement of the objective.

A matrix approach is proposed to evaluate the impacts of anthropogenic and environmental factors on operational objectives (Table 2). The degree of complexity of the analysis in an actual RMES will vary with the number of objectives to be achieved, the range of factors affecting the particular marine ecosystem, and the quality and quantity of scientific data available for analysis.

Table 2. Analysis of the Effect of Factors on Operational Objectives

	Operational Objective			
Factor	**Eliminate overfishing on species X**	**Protect sensitive spp. Y (fish) and Z (marine mammal)**	**Conserve habitat in ABC estuary for spp. Y recovery**	**➔ … Objective N**
Commercial fishery for X				
Recreational boating in estuary				
Military sonar testing				
Coastal development				
Factors x…n ⬇ ⬇ ⬇				

The type of information in each cell could be:

- Directional – e.g., "Regulating this activity would have _____ (a very positive significant effect, a somewhat significant effect, no effect, a somewhat negative effect, a very negative effect, an unknown effect) on achieving the objective of …"
- Ordinal – e.g., "Recreational boating in the ABC estuary results in substantial losses of submerged aquatic vegetation, which has impacted the survivability of larval Y."
- Parametric – e.g., "The commercial fishery for X results in 4 tons of bycatch of spp. Y annually, and also incurs interactions with marine mammal Z approximately 75 times per year. A 10% reduction of effort in the fishery would result in a decrease of bycatch of one ton and 15% fewer marine mammal interactions."

Whenever possible, the information should be linked to measures of value (see p. 16). As with the above examples, the ability to quantify value may vary. For example:

- Restricting recreational boating access in the ABC estuary would result in a loss of approximately $7 million annually to boaters. However, a closure of the area would enhance survivability rates of Y to a level that would allow it to be taken off the list of threatened species. Surveys and subsequent economic analyses have estimated willingness-to-pay for Y's survival of almost $50 million.
- A 10% reduction in effort in fishery X is estimated to produce a net benefit of $35 million to the nation. The gains from the reduced bycatch of Y (valued at $yy) and from reductions in marine mammal interactions (valued at $zz) more than offset the losses to the commercial fishing industry from the reduced harvest (estimated at $xx).

These examples are illustrative, but other qualitative and quantitative information could be used to analyze and compare the current and anticipated future effects of each factor on the objectives. In some cases, sophisticated models will be available to estimate the impacts of a particular factor(s); in others, only simple descriptive information may be available. The RMES should use and present the most useful information possible. Regardless of how the information is presented, the end result should be an identification of the most influential factors on the status of the ecosystem.

Stage 2: Prioritize the factors contributing to the problem(s)

The Stage 1 analysis will identify multiple factors with significant effects. However, it may be impractical to derive management actions for each one. In the 5-year timeframe, given existing/expected fiscal and staff resources, only a subset of factors might reasonably be addressed. Prioritization of which factors to manage is necessary. The RMES should develop a process and a list of criteria by which to evaluate the various factors. Criteria for evaluating whether to manage an activity or mitigate an environmental impact might include (but are not limited to):

- Quantity/quality/reliability of scientific data
- Timeframe for implementation and/or achievement of results (i.e., will the action be implemented in time to have its desired effect on the management problem?)
- Net economic benefits (including non-market values) and their distribution
- Social and cultural benefits and costs
- Enforcement feasibility (i.e., to what degree is it possible to enforce regulation of the activity?)
- Technical capacity (i.e., does a technical solution exist to address the problem?)
- Management feasibility (e.g., is more than one jurisdiction involved? If so, what degree of intergovernmental coordination is necessary? Do current mandates support this action or will it necessitate significant governance/statutory modifications?)
- Probability of success (e.g., is there broad based support to address the issue? Are there other significant impediments that would hinder success?)
- Ecological consequences of inaction (e.g., if an activity is not managed, are specific ecological thresholds exceeded?)

Application of the selected criteria to the identified factors should result in a prioritized list of factors to address in the RMEIPs. The RMES should list those factors that will be addressed in the RMEIPs versus those that will not. Documentation of the prioritization process will provide a transparent record of decision and useful information for the iterative feedback process on future actions.

2.4.6 Performance measures

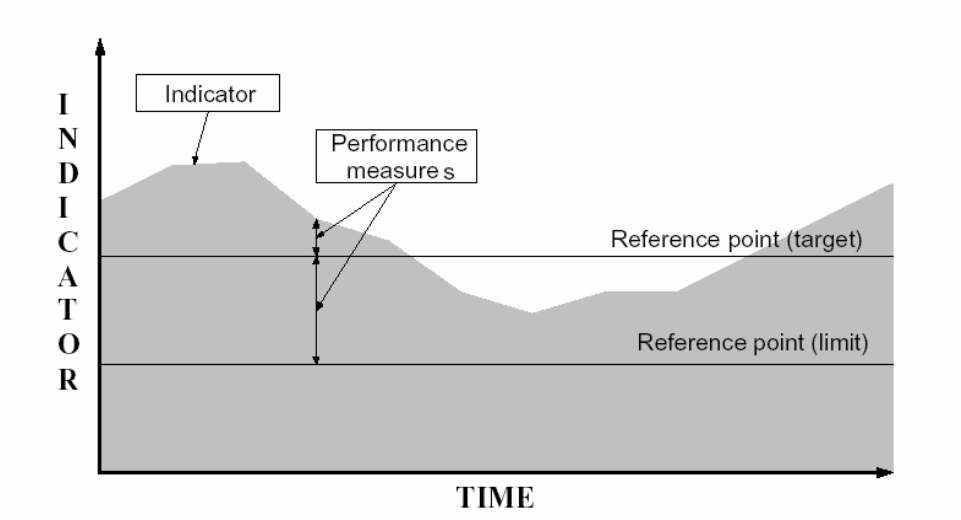
Performance measures are the key to evaluating management effectiveness. The performance measure does two things: it evaluates how well predicted outcomes are achieved after the fact, and it serves as a control on how well processes are performing as the work is being done. A good performance measure will have only one right answer, and its measurement will be taken at a defined point or at specific intervals in time. As applied to EAM, performance measures will be used to:

- Determine whether the three strategic goals are met;
- Evaluate how closely the RMEIP management actions achieve the operational goals and objectives proposed in the RMES; and
- Appraise how effectively the RMES and RMEIP processes are conducted.

The following definitions as illustrated by Figure 6 (Sainsbury and Sumaila, 2003) are recommended for developing performance metrics in the RMES and RMEIPs:

- *Indicator* – Something that is measured (not necessarily numerically) and used to track an operational objective. An indicator that does not relate to an operational objective is not useful in this context.
- *Reference point* – A 'benchmark' value of an indicator, usually in relation to the operational objective, such as desired targets, undesirable limits or triggers for specified management responses. A target reference point could serve as an operational objective.
- *Performance measure* – A relationship between the indicator and reference point that measures how well intended outcomes are being achieved.

Figure 6. Relationship between indicators, reference points and performance measures.



The RMES should list specific indicators and performance measures that relate directly to the operational objectives, which themselves are specific, measurable, agreed-to, and achievable within a defined time frame. While the objectives will usually attempt to have an indicator increase or decrease, in some cases "no change" will be the desired outcome. The RMES should assess the levels of change attributable to direct and indirect effects of resource uses, and decide on the level of change considered acceptable. Each RMES should include one or more performance measures associated with each and every RMES objective.

2.4.7 Iterative management process

The last section of the RMES should discuss the process to monitor feedback and evaluate and revise the RMES over time. It is expected that both the RMES and RMEIPs will be evaluated and updated every 5 years. Periodic assessments of the RMES operational objectives, performance measures, and expected outcomes should be undertaken in the light of new scientific and/or management information, or to address new types of use activities or interests in the regional ecosystem management area.

The evaluation process should include a comparison of actual outcomes to those that were expected based on the analysis in Section 2.4.5. The regional management authorities and their stakeholders should evaluate the reasons underlying any differences between actual and expected outcomes: were objectives met? If not, why not? The evaluation should also analyze to what degree tested hypotheses were supported by the results. This information should be documented and relayed back to RMES and RMEIP partners.

The information should be used to adjust the RMES and RMEIP accordingly. The original actions may be reviewed and adjusted to ensure that they remain consistent with the RMES goals and objectives. New operational goals or objectives, new management solutions or new questions to answer may be identified and initiated in the updated RMES. In adjusting subsequent management decisions and policies, the underlying differences between expected and actual outcomes should be taken into consideration, and subsequent actions should be based on which hypotheses were supported by results. The RMES and RMEIP should describe how evaluations and revisions will be made, by whom and how often (or under what conditions). The intensity and degree of response in a performance measure that will trigger a change in management actions or objectives should be defined and agreed to by all partners.

Finally, the evaluation process should be used to identify and highlight data and research gaps so that observation, scientific and management programs can be modified accordingly. The resources needed to fill these gaps as well as to accomplish revisions to the plan should also be assessed.

Section 3: Regional Marine Ecosystem Implementation Plans

The RMEIP translates the operational goals and objectives established in the cross-sector RMES into specific actions by each sector/agency. Each agency or partner associated with the RMES will develop its own within-sector RMEIP that supports the jointly-produced RMES, using its own regulatory authorities and public participation processes (recall Figure 4). The NOAA/living marine resource sector is used as an example throughout this section to illustrate the process and features of a RMEIP. However, the guidelines are sufficiently generic so they can be adopted as an ecosystem approach by other sectors/agencies with only minor modifications.

The rest of this section describes the contents of the RMEIP as follows:

3.1. Description of management authorities: Identification of the agency(ies) responsible for managing or controlling each of the factors to be addressed.
3.2. List of actions: A list of actions that must be taken to achieve each operational objective in the RMES, based on the assessment of factors and responsible parties, with specific steps to be taken to accomplish each action. Includes identification of responsible agencies/partners, requirements and resources needed, and dates/timelines for completing the steps.
3.3. Performance measures: Performance measures for each operational objective that will be used to measure progress towards its accomplishment.
3.4. Monitoring, evaluating and revising the RMEIP: A description of the steps to be taken to monitor, evaluate and revise the components of the RMEIP.

3.1 Description of management authorities

The RMEIP is designed to operate within the current governance structure and institutional framework to manage LMRs in the management area. For example, NOAA is guided in LMR stewardship by institutional arrangements and mandates that are determined by Congress.[1] Within this guidance, the Agency has the ability to determine many aspects of governance in the application of its mandates. With respect to creating RMEIPs, NOAA does not need to wait for new statutory authority to take an EAM, but can apply its current mandates in a way that adopts such an approach.

There are many agencies and sectors that have oversight over the ecosystem drivers and uses identified in Section 2.4.5 and Figure 3. In most cases, jurisdictions overlap. For the RMEIP to be effectively developed within this complicated institutional framework, the various jurisdictional authorities that affect application of each agency's management strategies need to be identified. Resolution of structural or process impediments and new governance strategies (absent new legislation) to address factors needing management should be identified in the plan.

For each of the factors to be addressed in an agency's RMEIP (as identified in Section 2.4.5), the RMEIP should:

[1] Including the Magnuson-Stevens Fishery Conservation and Management Act, the Marine Mammal Protection Act, the Endangered Species Act, the Coastal Zone Management Act, and the National Marine Sanctuaries Act.

- Document and evaluate current management authorities and responsibilities; and
- Identify formal and informal management processes and governance structures to resolve impediments and take action.

This evaluation will identify the issues within each agency's statutory authority and control. For example, the Regional Fishery Management Councils and NOAA will be the lead authority in the case of fisheries management in the EEZ. However, they are only a stakeholder to the Minerals Management Service (MMS) in the approval of oil and gas leases in coastal waters. The Council's and NOAA's stakeholder role in the latter case includes identifying fisheries goals and objectives to the Minerals Management Service in the RMES coordination process, and engaging in the MMS RMEIP process that develops leasing management decisions to ensure they are consistent with the fisheries and broader ecosystem goals and objectives within the RMES.

3.1.1 Management authorities and responsibilities

The RMEIP should identify the relevant management: 1) authorities, 2) jurisdictions and 3) areas that exist within the spatial boundary of the management area that are relevant to the ecological, economic, technological and environmental issues being managed by the RMEIP. The intersection of jurisdictions will identify necessary points of coordination among resource agencies, councils, commissions, and institutions for effective ecosystem management. These include:

- Federal authorities such as NOAA, Regional Fishery Management Councils, Environmental Protection Agency, Corps of Engineers, U.S. Department of Agriculture, U.S. Fish and Wildlife Service, U.S. Department of Defense, National Park Service, Maritime Administration, U.S. Coast Guard, Minerals Management Service, etc.
- State authorities such as Interstate Commissions, state coastal zone management agencies, state departments of fisheries management, other natural resource/wildlife agencies, etc.
- Local authorities such as planning commissions, zoning boards, etc.
- Tribes/tribal jurisdictions
- International commissions and institutions implementing international science and management agreements governing multiple countries.
- Management areas such as: marine managed areas (MMAs)/marine protected areas (MPAs); National Wildlife Refuges; National Marine Sanctuaries; National Estuarine Research Reserves; fishery management areas; habitat restoration and special habitat conservation areas; marine mammal management areas; threatened or endangered species management areas; marine parks or historic wreck areas; military exclusion or operations areas; transportation/navigation routes; oil and gas lease areas; and relevant terrestrial and upland protected areas such as parks, coastal reserves, etc.

Management authorities or areas are considered relevant if they contribute directly or indirectly to management or control of at least one of the factors identified in Section 2.4.5 as having an impact on the ecosystem management area. The RMEIP should identify the mechanism (e.g., legislation) that enables management action (e.g., MSFCMA, MMPA, ESA, and CZMA are principle NOAA authorities). Table 3 provides a template for summarizing this information, and gives a stylized example for NOAA.

Table 3. Example of Responsible Agencies and Mandates for Factors in the Regional Ecosystem Management Area

Factors	Lead Agency	Other Partners	Authorizing Legislation	Role of NOAA
Anthropogenic				
Commercial harvest of fishery X: overfishing occurring Bycatch of fish species Y in fishery X	NOAA/ RFMC	Interstate Fishery Commissions State fishery agencies	MSFCMA Interjurisdictional Fisheries Act (IFA)	Approval of federal FMP for X Consultative role in state/interstate FMP for X
Incidental take of marine mammal Z in fishery X	NOAA/ RFMC	State natural resource agencies DOI	MSFCMA, ESA, MMPA	Approval of federal FMP for X Management of take reduction team for Z Development of species recovery plan for Z
Alteration of essential fish habitat for endangered species S and commercial fishery X	COE; NOAA/ RFMC	NOAA, DOI, Interstate Fishery Commissions, State fishery agencies	ESA, MSFCMA, IFA	Section 7 consultations Development of species recovery plan for S Development of habitat restoration plan for critical habitat for S Approval of federal FMP for X Consultative role in state/interstate FMP for X
Aquaculture production of shellfish C: affects water quality for commercial fishery X; potential for escapement and cross-fertilization with wild stock of shellfish C	NOAA	USDA, EPA, Regional FMCs, Interstate Fishery Commissions, State fishery agencies	National Aquaculture Act, IFA	Approval of federal FMP for X Consultative role in state/interstate FMP for X Aquaculture siting and permitting
Naval testing of sonar equipment: impact on marine mammal Z	DOD	NOAA	MMPA	Consultative role
Nonpoint pollution / degraded coastal water quality: affects survival rate of juveniles in fishery X	EPA USDA	State CZM NOAA/Coastal Programs Div. USDA/NRCS Soil Conservation Districts Local planning or zoning boards	CWA CZMA	Consultative role
Environmental				
El Nino events: affect stock distributions and survival rates for commercial fishery X	NOAA		MSFCMA, FWCA	Scientific modeling and prediction

The RMEIP should note which factors the agency: (1) has direct control over (e.g., through legislative authority); (2) has indirect control over (e.g., through a consultative role with another agency); or (3) has no control over but needs to take into account because they affect the ability

to achieve an objective (e.g., climatic events). The integration of all agencies' RMEIPs will yield a comprehensive picture of factors, authorities, and authorizing legislation and management tools for managing impacts.

3.2 List of actions

The next section of the RMEIP is the roadmap for moving forward with EAM in the regional ecosystem management area. Each individual agency's RMEIP provides the framework for modifying existing or creating new actions to achieve the RMES operational objectives and establishes accountability for each agency.

Each RMEIP should account for: (1) the cumulative effects of each of the factors identified as affecting the RMES operational objectives, (2) the prioritization of factors to be managed, and (3) the legislative or other authority to directly or indirectly manage those factors. The plan should be publicly available. The contents should include:

- A description of the actions that must be taken to achieve each operational objective in the RMES. As background for identifying the appropriate actions, the plan should describe impediments to agency action in existing policy, legal mandates, or institutional arrangements, and list any outstanding unresolved issues.
- Specific steps necessary to accomplish each action, including identification of the existing, new or enhanced management processes, both formal and informal, to be used. Examples include: rulemaking; consultations; enhanced intra- and inter-agency communication, cooperation, and collaboration; creation of co-management systems and increased implementation of distributive governance; establishment of memoranda of agreements; development of regional operating agreements; education programs; technical assistance; financial incentives, etc.
- Identification of agencies/partners responsible for each step.
- Dates/timelines/milestones associated with each step.
- Specification of the monitoring protocol that will be followed.
- Identification of the fiscal, staff and other requirements needed to accomplish each action.

Many of the specific regulatory tools used for EAM will likely be the same as those traditionally used by an agency (e.g., for NOAA this includes Fishery Management Plans (FMPs), Species Recovery Plans, habitat protection plans, ESA Section 7 consultations, CZMA plans, etc.). However, the objectives to be considered could be quite different than those under traditional management. These guidelines for RMEIPs do not prescribe how implementation should occur. Each agency's process for public notification, public participation, analysis of reasonable alternatives, and selection of preferred alternatives is governed by a suite of federal and state regulations that guide this process (e.g., NEPA, the Administrative Procedures Act, Executive Order 12866, the Regulatory Flexibility Act, etc.). This doesn't mean an EAM should be interpreted as "business as usual." Rather, it is simply that as the goals and objectives change under EAM, the regulatory mechanics for implementation may not need to change. Changes in the regulatory process may be desired to accelerate or enhance EAM, but are not required before EAM is undertaken.

Special circumstances exist for management actions governing transboundary species. Species with ranges that cross management areas will not be fully represented in one RMEIP (or RMES). The Secretariats of the RMES should ensure that objectives relating to these species are coordinated among regional marine ecosystems such that all RMESs and RMEIPs that encompass the range of those species are consistent. Issues of concern, assessments and research activities, and management actions should be coordinated across the relevant RMESs/RMEIPs as much as possible.

3.3 Performance measures

As in the RMES, the RMEIP should include performance measures for evaluating management effectiveness. While the RMES performance measures capture the progress made towards achievement of the operational goals and objectives, the measures in the RMEIP should be aimed at measuring progress towards achieving the steps laid out in the action plan. The guidelines for development of performance measures presented in Section 2.4.6 are also relevant for the RMEIP.

The RMEIP should include one or more performance measures associated with each action or set of actions. For example, an RMES operational objective may be to "Eliminate overfishing on all target fisheries in the regional ecosystem management area by 2010." The associated action in the RMEIP might be to "Implement or modify FMPs to eliminate overfishing on fisheries A-K in the regional ecosystem management area by 2010 by setting total allowable catches and fishing mortality targets as follows..." The associated performance measure might then be "Number of FMPs implemented or modified to eliminate overfishing that have met specifications."

3.4 Monitoring, evaluating and revising the RMEIP

3.4.1 Monitoring

Two aspects of monitoring for the RMEIP are discussed below. The first relates to observation and monitoring of the physical and socio-economic components of the ecosystem and human environment. The second focuses on monitoring the effectiveness of the RMEIP process itself.

Monitoring protocols for abiotic, biotic, habitat and socio-economic factors

Appropriate time scales and monitoring frequency for all monitored phenomena should be specified and linked to the underlying processes of the objectives and their performance measures. Monitoring should extend spatially to the boundaries defined by the RMEIP.

The monitoring protocol should include the following elements (Nyberg, 1999):

- The type and amount of data required
- Frequency, timing and duration of monitoring
- Indicators or models to be monitored at each interval
- Appropriate spatial scales for monitoring different indicators
- Who is responsible for undertaking different aspects of monitoring

The protocol should be applied to monitoring programs for abiotic, biotic, habitat and socio-economic factors as follows:

- Abiotic (i.e., chemical, physical and meteorological/climatic) environmental data required to assess linkages between physical forcing functions and biological responses affecting LMRs, directly or indirectly (e.g., by altering trophic structure).
- Requirements that provide quantitative information on the relative or absolute magnitude of a population; life history data including rates of growth, average age of the onset of sexual maturity, maximum longevity, and the proportion of each age group dying each year due to natural causes; and other factors that affect stock productivity; temporal and spatial distribution and abundance of commercially-targeted and ecologically-important species; changes in species composition, size, sex, and age compositions over time and space; reproductive biology; trophic relationships; diet compositions of key indicator species; forage base faunal composition and availability; feeding guild structure and resource partitioning; feeding habitat and behavior; and community structure.
- Requirements to characterize and map habitat and monitor anthropogenic and natural substrate alteration.
- Requirements to characterize the economic, community and other social science attributes of the human environment affected by the RMEIP.
- Requirements to test specific hypotheses with adequate statistical power concerning trophic interactions and relationships within the RMES.

Monitoring the RMEIP process

An EAM includes the necessity to monitor how effective actions are in meeting management objectives, to evaluate actual outcomes against those that were predicted, and to interpret the reasons underlying any differences. By also doing this the RMEIP, it can be adjusted to reflect new understanding and develop new options that create a continual cycle of improvement. Each RMEIP should contain a description of the steps to be taken to monitor, evaluate and revise the components of the plan.

The RMEIP should monitor for (Nyberg, 1999):

- Implementation or compliance (Did we do what we planned?)
- Effectiveness (Did the plan meet objectives?)
- Validation of model parameters and relationships (How well did our models forecast what would happen?)

The time frames for evaluation of an RMEIP's success or failure should be conditioned on and closely aligned with the predicted response times of elements and processes of the ecosystem, including changes in human behavior. Thus, each RMEIP should set out a specific time schedule for when the RMEIP actions and performance measures will be evaluated to track RMEIP outcomes. The default maximum time interval is every 5 years. However, as specific actions and activities are likely linked to annual funding cycles, monitoring annual progress may be warranted.

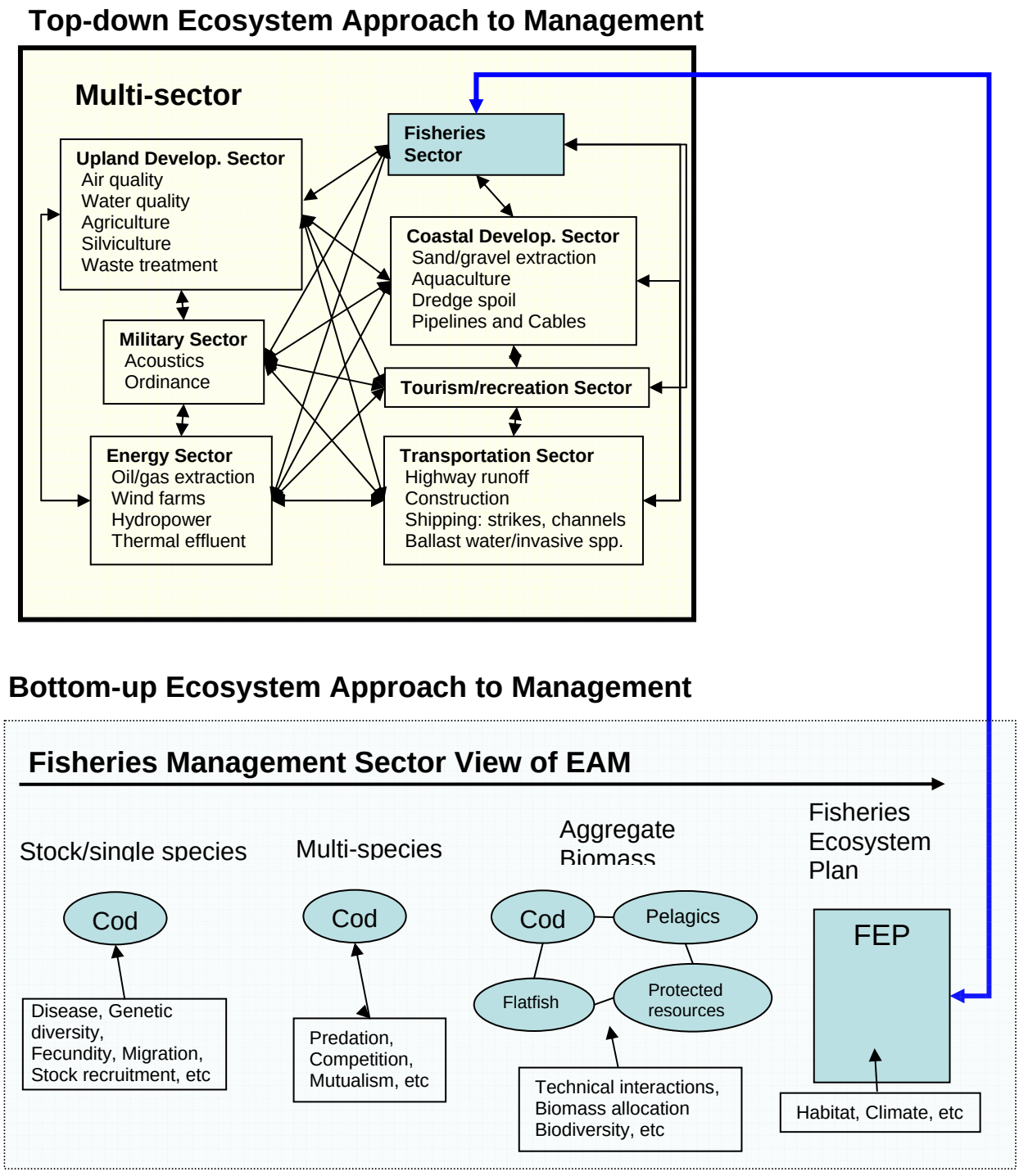
3.4.2 Evaluating and revising the RMEIP

The RMEIP should document the process to monitor feedback and evaluate and revise the plan over time. As described in Section 2.4.7, the RMEIP should describe how evaluations and revisions will be made, by whom and how often (or under what conditions).

Section 4: Summary and Conclusion

An ecosystem approach to management is a highly desirous goal for our nation's coastal and ocean resources. However, no single federal, state or local entity has full authority over all sectors impacting coastal and ocean resources or marine ecosystems. No one entity can succeed by itself. Therefore, guidance has been proposed on how to promote cross-sector discussion and actions across governance authorities and stakeholders. At the same time, guidance for advancing an EAM within a single sector was described. The combination of these two parallel EAM processes is considered essential to advance the management of coastal and ocean resources. This top-down and bottom-up approach is shown visually in Figure 7.

Figure 7. The integration of a top-down and bottom-up ecosystem approach to management



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Appendix A
Anthropogenic and Environmental Factors for Analysis

A framework for analyzing the impacts of a variety of anthropogenic and environmental factors on marine ecosystems is given in this appendix according to the outline below. Not all factors will be relevant in each regional ecosystem management area, and the list is not exhaustive.

Anthropogenic Effects

Marine Impacts

A. Living Marine Resource Harvest
   i. Effects of fishing and hunting
   ii. Effects of bycatch
   iii. Effects of fishing gear

B. Non-living Marine Resource Extraction
   i. Effects of oil and gas extraction
   ii. Effects of gravel mining

C. Marine tourism and recreation
D. Commercial shipping and cruise ships
E. Military activities
F. Offshore disposal activities/Dredged material disposal
G. Water uptake and discharge facilities
H. Submerged pipelines and cables
I. Aquaculture
J. Non-native invasive species
K. Scientific research
L. Other

Non-marine Impacts (coastal, upland, riverine)

A. Coastal development
B. Alteration to freshwater systems
C. Agriculture

Environmental Considerations (e.g., climate trends, regime shifts)

Anthropogenic Effects

Marine Impacts

A. Living Marine Resource Harvest

i. Effects of resource removal on target and non-target species

The RMES should identify the effects of fishing (both commercial and recreational) or collection (e.g., sponges, corals) on the abundance of targeted marine populations as well as known effects of current harvest practices on the age of maturity, size structure, sex ratio, and genetic makeup of those resources. The RMES should assess the impact of all directed takes of marine mammals on marine mammal stocks and should indicate how these takes affect marine mammal stock status.

The RMES should evaluate the effect of fishing, collecting or hunting on nontarget species including predator-prey relationships, competitive interactions, and marine food webs. Ecological models may be used to assess the significance of these changes, since the decline of one species may have immediate effects on food webs whereas the decline of another may be virtually unnoticed.

ii. Effects of bycatch

"Bycatch" is defined to mean the "discarded catch of any living marine resource due to a direct encounter with fishing gear." (NMFS, 2004). The RMES should assess the effects of bycatch and bycatch mortality in the management area, including the impact on commercially valuable species, protected resources, endangered species, socioeconomic conditions, and integrity of data.

iii. Effects of fishing gear on habitat

When analyzing the effects of fishing gear on habitat, the RMES should include: a description of the mechanisms or processes causing adverse effects on the ecosystem; what particular component of the ecosystem is affected; a description of known or potential ecosystem functions disturbed or disrupted by these effects; and the extent of such disturbance or disruption. In describing the ecosystem components and functions that may be disturbed, information should also be assessed related to the rates of recovery both structurally and functionally (NRC, 2002). Information relevant to Essential Fish Habitat, Habitat Areas of Particular Concern, and critical habitat should be included here.

B. Non-living Marine Resource Extraction

i. Effects of oil and gas extraction

The RMES should analyze the various components of oil and gas extraction activities (e.g., an oil or gas platform, a pipeline, and a transfer facility) together rather than separately. The RMES should analyze the effects of these operations not only while they are ongoing, but after they have ceased operation, since inactive structures often remain in place.

The RMES should analyze: noise impacts from seismic surveys, vessel traffic, and structure construction; physical alteration of seabed and coastal habitats; discharge of wastes, including drilling muds, drilling fluids, and human waste; and oil spills. The RMES should also include the impacts that occur when a structure such as a drill rig is removed. When analyzing the effects of offshore mineral mining, the RMES should include not only physical impacts from dredging but also the effects of chemicals such as flocculants.

ii. Effects of gravel mining

Gravel mining presents a number of potential impacts to LMR, not only at the site of extraction, but also at upstream and downstream locations and potentially throughout a watershed. Gravel removal alters the physical characteristics of the channel, either within the streambed, adjacent riparian buffer areas, or the floodplain, which can directly and indirectly affect structural components used by fish as spawning, juvenile rearing, and migratory habitat.

When evaluating the primary effects of gravel mining, the RMES should determine whether existing and proposed activities conform with the prioritized siting criteria and environmentally preferred methodology of gravel extraction operations presented in NOAA Fisheries National Gravel Extraction Guidance (Packer, 2004). The RMES should analyze the effects of gravel mining on water quality, including the detrimental effects of turbidity and sedimentation, the potential release of toxic or contaminated sediments, and the risk of oil, gas, and chemical spill associated with the heavy equipment used during operations.

When evaluating secondary and cumulative impacts of gravel mining, the RMES should consider that stream recovery is a slow and difficult to predict process that is dependent on upstream sediment supply and transport. The secondary impacts of gravel removal may be most obvious at the area of impact, upstream and downstream locations, but may be as far reaching as distant locations in the watershed. An evaluation of secondary impacts should analyze all life stages of affected fish species and should analyze the effects of reduced or replaced fish populations and associated impacts on food webs. The RMES should emphasize the important role of restoration and monitoring in reducing the long-term effects of gravel mining.

C. Marine tourism and recreation

The RMES should assess the impacts of recreational activities (other than recreational fishing) on the ecosystem within the management area. Examples of impacts include, but are not limited to: damage to coral reefs or other marine habitats from recreational boating/diving; shoreline damage due to excessive wakes from recreational boating; human interactions with or harassment of marine mammals (during whale watching; dolphin encounters, etc.); and marine pollution from recreational vehicles (boats, jet skis, etc.).

D. Commercial shipping and cruise ships

When examining the effects of marine transportation, the RMES should include: the effects of dredging to create deep-water channels; the loss of wetlands and shallow-water habitat to create docking and loading platforms; noise; the discharge of waste; increased turbidity; the introduction of non-native species in discharged ballast water; and collisions of ships with marine life.

E. Military activities

The RMES should analyze the impacts of any military activities in the management area if they impact the key LMRs within the area. Examples of activities include, but are not limited to: ship shock trials, detonations, air gun arrays, and sonar deployment, all of which may have noise impacts on marine mammals and other protected species; ship strikes of marine mammals; and ocean-based detonations that have residual impacts on marine habitat.

F. Offshore disposal activities/Dredged material disposal

The RMES should pay particular attention to the cumulative effects of dredged material disposal. The RMES should analyze the effects of designated disposal sites on the ecosystem even after the site is no longer being used.

The analysis should include not only the direct loss of habitat from burial, but also effects of sedimentation, turbidity and chemical contamination. The analysis should pay particular attention to whether the disposal activities coincide with migratory routes and whether the disposal activities are occurring at times when eggs and larvae (which are particularly sensitive to increased turbidity) are present. The analysis should also consider the effects of beach renourishment projects on nesting sea turtles.

G. Water uptake and discharge facilities

The RMES should assess the uptake and/or discharge of water associated with power plants, LNG (liquefied natural gas) facilities, sewage treatment systems, and the like. Particular attention should be paid to the proximity of the intake or discharge to migration routes and spawning or nursery habitat. The analysis should include the effects of entrainment and impingement of all stages of marine life by intake structures, and the efficacy of any impact minimization measures. The analysis should also include the effects of thermal differences in discharge water. When assessing the effects of treated or raw sewage discharge, the analysis should include nutrient enrichment, toxic chemicals (such as chlorine, formaldehyde, ammonium and zinc), pathogenic organisms such as bacteria, and effects on biological oxygen demand. The analysis should pay particular attention to the proximity of outfalls to public recreation areas such as beaches.

H. Submerged pipelines and cables

The RMES should evaluate the coastal habitat types that may be affected by submerged pipelines and cables. For example, nearshore portions of the submerged systems intersect with sensitive habitats such as wetlands, estuaries, beaches and dunes. The land clearing

and excavation activity required for installation can have a detrimental effect on these sensitive aquatic habitats. Examples of installation concerns that should be addressed by the RMES include: the need to perform thorough resource mapping prior to placement; restoration of wetlands and other habitats where excavation occurs; minimization of erosional effects; and the avoidance of marine resources such as submerged aquatic vegetation, corals, and live hardbottom. Maintenance and timely repair are critical requirements of submerged pipe and cable systems. The RMES should identify maintenance activities that will reduce the likelihood of damage, saltwater intrusion, and leaks, such as routine inspections and burial of pipes. The RMES should address when it is appropriate to leave inactive pipes and cables in place, such as when their removal would cause unnecessary damage to marine resources. The RMES should also address measures that should be taken to ensure that the abandoned pipes pose no future threat.

I. Aquaculture

The RMES should analyze the known and likely adverse effects of all aquaculture facilities in the ecosystem, paying particular attention to: biological pollution (escapement of farmed species and/or diseases and parasites associated with the farmed species); harvesting and potential overfishing of fish for fish feed; nutrient enrichment at aquaculture sites; release of antibiotics and pesticides; lethal or harmful interactions with wild species (such as predators); and habitat alteration (conversion of natural habitats to aquaculture facilities or alteration of habitat adjacent to aquaculture facilities).

J. Non-native invasive species

When evaluating the effects of non-native invasive species, the analysis should include an assessment of habitat alteration, trophic alteration, gene pool alteration, spatial alteration (physical displacement of native species), and introduction of disease.

K. Scientific research

Scientific research can have direct and indirect negative effects on LMR, such as marine mammals, threatened or endangered species, or targeted fish stocks and their habitats. The RMES should consider these effects if the research itself (e.g., through direct or incidental "take" or fish population sampling) has an impact on the entire species or stock or its habitat. Permitting processes used to authorize such activities can be used to gauge the extent of the potential impact.

L. Other

As the above list may not encompass all activities in or around the regional ecosystem, the RMES should analyze any other relevant uses or activities that impact achievement of the specific operational objectives.

Non-marine Impacts (coastal, upland, riverine)

A. Coastal development (loss of wetland and shallow estuarine habitats, pollution, loss of upland buffers)

When evaluating the effects of coastal development, the RMES should analyze the connectivity between coastal ecosystem components and marine components. The RMES should pay particular attention to the loss and degradation of aquatic habitat due to fill and runoff. Other types of coastal development impacts that the RMES should evaluate include: eutrophication; habitat fragmentation; shading (from docks and piers); loss of buffers, dunes, or shoreline protection; changes in water circulation, temperature, and salinity; and exclusion of marine species by tide gates or other flood control structures.

B. Alteration of freshwater systems

When analyzing the effects of activities that alter freshwater systems (e.g., construction of dams, loss of riparian buffers, flood control by channelization, dredging of rivers for deep water ports, building canals), the RMES should evaluate not only the physical impediments that structures (e.g., dams) present to upstream and downstream migrating fish, but also the changes that they cause in hydrology and water quality. The RMES should evaluate the extent to which these activities alter the patterns and timing of flow, and identify related effects on access to spawning habitat and reduced survival. The RMES should determine whether altered flow conditions are affecting normal water temperatures, or adversely affecting oxygenation and egg incubation. Since dams in particular also block downstream movement of nutrients and sediment, RMESs should determine whether food web dynamics, the movement of sediments and debris, or downstream erosion are being affected. In addition, known physical impacts associated with fish passage should be included, including gas bubble disease, fishway mortality, stranding, and others.

The RMES should describe the health and degree of alteration of streams that drain coastal watersheds. When analyzing the effects of the above-identified activities on the ecosystem, the RMES should also evaluate the changes that these activities cause in hydrologic and thermal regimes. The analysis should also include the effects of aggregate mining, which include substantial changes to stream morphology as well as the loss of spawning habitat.

C. Agriculture (including silviculture)

The RMES should assess the adverse effects of agricultural and nursery runoff resulting from: nutrient loading; introduction of animal wastes; erosion; and sedimentation. The impacts of these processes include increased turbidity, increased temperature, and the accumulation of dead organic material, which can result in decreased light penetration, decreased oxygen, and reduced growth of submerged aquatic vegetation.

With respect to silviculture, the RMES should assess changes in dominant vegetation, reduced permeability of soils, increased sedimentation from surface runoff and mass wasting processes, altered hydrologic regimes, and impaired fish passage through inadequate design, construction, and/or maintenance of stream crossings. The RMES should also assess the effects of deforestation and timber harvest, such as: altered or impaired instream habitat structure and watershed function, inadequate or excessive surface and stream flows, increased stream bank and stream bed erosion, loss of complex instream habitats, sedimentation of riparian habitat, increased surface runoff with

associated contaminants (e.g., herbicides, fertilizers, fine sediments), and changes in hydrologic characteristics (e.g., water temperature, annual hydrograph change, and instream discharge).

Environmental Considerations

Climate trends (both short- and long-term), catastrophic events (such as hurricanes), geotectonic factors (subsidence or glacial rebound), and other large-scale changes in the environment (e.g., regime shifts) may affect the degree to which specific threats affect the ecosystem, or the degree to which management alternatives succeed. To the extent possible, the RMES should analyze any overarching environmental trends or processes that may have those effects.