WORKSHOP PROCEEDINGS

Marine Habitats in the Gulf of Maine: Assessing Human Impacts and Developing Management Strategies

   

Walpole, Maine
September 21–22, 2005

Gulf of Maine
Council on the
Marine Environment

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Gulf of Maine Council Mission
"To maintain and enhance environmental quality in the Gulf of Maine and to allow for sustainable resource use by existing and future generations"

Gulf of Maine Council on the Marine Environment

The National Oceanic and Atmospheric Administration (NOAA) Marine Protected Areas Center provided primary funding for the workshop. The Nature Conservancy provided additional funding.

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1.0 Executive Summary

The *Marine Habitats in the Gulf of Maine: Assessing Human Impacts and Developing Management Strategies* workshop (September 21–22, 2005) facilitated the work of many organizations toward ecosystem-based management and conservation of marine habitats in the Gulf of Maine.

Sixty-two invited participants convened in Walpole, Maine, and worked in small groups to

- **define and prioritize human impacts** to six habitat types (rocky, sandy, muddy, seagrass, kelp, shellfish beds/reefs) based on the degree to which their key ecological attributes are altered or threatened, and
- **identify ecosystem-based management strategies** to address human impacts on a regional scale.

Invitees were

- **scientists** who are experts on select habitats, human impacts, and the Gulf of Maine ecosystem,
- **managers** who are responsible for managing interactions between human activities and marine habitats in the Gulf of Maine, and
- **representatives of non-government organizations** (NGOs) that play a role in using, managing, or understanding the Gulf of Maine.

The workshop was organized by the Gulf of Maine Council on the Marine Environment's Habitat Conservation Subcommittee and The Nature Conservancy.

The workshop was a component of a multi-year process being coordinated by the Habitat Conservation Subcommittee to advance the conservation of marine habitats in the Gulf of Maine. The first component was the *Gulf of Maine Marine Habitat Primer* (Primer), released in 2005. The Primer provides an overview of habitat characteristics, ecological functions, economic and recreational values, and management considerations.

On Day One of the workshop, the habitat focus groups identified pollution, biological resource harvesting, habitat conversion/degradation, and invasive species as the highest-priority impact categories. Detailed outcomes of the habitat focus groups are summarized on the facing page and in Appendix 7.2.

On Day Two of the workshop, management strategy focus groups identified options that are categorized in these proceedings under focusing management, improving stewardship, and informing management. The groups' specific ideas for management are summarized in the box below and in Appendix 7.3.

The workshop concluded with a discussion of next steps and recognition that it will take the collaboration of many partners to achieve the management strategies discussed in the workshop. Two important and interrelated next steps are to determine the feasibility of the recommendations and to identify lead organizations and/or agencies to carry out specific actions.

Management Strategy Focus Group Outcomes
Crosscutting Themes for Management and Habitat Conservation

Focusing Management (see Section 5.1)
Transitioning to Ecosystem-based Management
Addressing Cumulative Impacts
Addressing Nonpoint Source Pollution

Improving Stewardship (see Section 5.2)
Stakeholder and Local Involvement
Messages for the Public

Informing Management (see Section 5.3)
Mapping Needs
Research Needs

For full discussion of crosscutting themes and specific ideas, see Section 5 and Appendix 7.3.

Habitat Focus Group Outcomes
Priority Human Impacts

Eelgrass

Habitat degradation affects nutrients, size of eelgrass beds, and light penetration.
Pollution affects nutrients and light.
Invasive species alter characteristic community structure and bed size.
Transportation, energy infrastructure, and mining affect bed size and light penetration.
Biological resource harvesting affects bed size and potentially light penetration.

Shellfish Beds

Fishing—specifically oyster harvest with handheld gear or dredges, mussel dredging, and scallop dredging—affects seabed habitat.
Development along the coastline, such as marina construction and dredging, may alter or destroy available habitat.
Persistent organic pollutants and metals affect organism health.
Climate change may increase shellfish disease and can change water temperature, hydrographic regimes, and characteristic community structure and size.
Invasive species have impacts are not yet highly evident but are difficult to reverse when they occur. These impacts include habitat alteration by invasive tunicates and predation by introduced crabs (green crab, Asian shore crab, and potential new invaders).

Soft bottom (mud and sand)

Intertidal and shallow subtidal habitats:
Coastal development—such as shoreline hardening, agriculture, dredging for marinas, wetland filling, and impervious surfaces—affects sediment and pollution in coastal waters.
Biological resource harvest by digging for clams and worms affects mud and sand habitats.

Deep subtidal habitats:
Biological resource harvest, particularly trawling in mud, and overfishing affect habitat structure and the ecological community in both sand and mud habitats.
Pollution can have a strong affect in mud habitats because mud retains pollutants.

Kelp and rocky substrate

Biological resource harvesting of urchins, groundfish, kelp, and rockweed directly affects food-web interactions, and dragging alters seabed habitat structure.
Loss of anadromous fish, occurring when dams restrict access to spawning habitat, has consequences for rocky habitats that are not well quantified.
Invasive species such as *Codium* and *Membranipora* affect food-web interactions by negatively impacting kelp.
Climate change may be implicated in die-offs of urchins.
Human population growth in the coastal zone results in cumulative impacts from habitat degradation, pollution, oil spills, energy and mining.

For full discussion of human impacts, see Section 4 and Appendix 7.2.

2.0 INTRODUCTION

On September 21-22, 2005, sixty-two invited participants from the Gulf of Maine region convened in Walpole, Maine, to define and prioritize human impacts to near-shore Gulf of Maine habitats and to identify ecosystem-based management options to address designated impacts. The workshop was organized by the Gulf of Maine Council Habitat Conservation Subcommittee in partnership with The Nature Conservancy and fulfilled an important role in the Habitat Conservation Subcommittee's work towards conservation of marine habitats of the Gulf of Maine. It also assisted The Nature Conservancy in moving forward in the development of a Key Ecological Attributes (KEA) framework for the marine environment. However, perhaps the greatest value of the workshop was the opportunity it provided to work with partners on conservation approaches for marine habitats and provide contexts for future collaboration.

In preparation for the workshop, participants were sent background material along with a homework assignment focusing on the critical aspects of selected habitats. Results from the completed homework assignments were compiled and a summary of responses was given to all participants to provide a starting point for focus group discussions on Day One. The agenda for both days included a plenary presentation, facilitated focus groups, a report out from each group, and opportunity for structured and unstructured discussion. A copy of the agenda is included in Appendix 7.1.

The Gulf of Maine Habitat Conservation Subcommittee's *Gulf of Maine Marine Habitat Primer*, the Conservation by Design approach of The Nature Conservancy, and a draft taxonomy for detailed classification of human impacts to marine ecosystems served as the basis for discussion during the workshop. Participants used these materials and drew on their own knowledge to develop recommendations on science, policy, and management approaches to marine habitat conservation.

3.0 PLENARY PRESENTATIONS

A plenary presentation was given at the start of each day of the workshop.

3.1 Dr. Bob Steneck, University of Maine, Darling Marine Center

"An Overview of Gulf of Maine Habitats/Species Associations and Interactions"

Referring to the current cast of 'characters', causes and consequences of change, and the importance of resilience, Dr. Steneck described the current state of the Gulf of Maine (GOM) ecosystem. He defined ecosystem resilience as the ability to resist negative changes, or to recover after negative changes.

Dr. Steneck identified the coastal zone as the most productive area of the Gulf of Maine. The coastal zone not only has the greatest fishery value, but also the greatest threat from sprawl. However, it is also potentially the most manageable area of the Gulf of Maine.

Next Dr. Steneck discussed native biodiversity and trophic cascade concepts. Although people once thought of the Gulf of Maine as an invertebrate-dominated system, prehistoric midden data identify it as fish dominated. No lobster shells were found in the middens. He presented strong evidence regarding trophic cascade effects in the Gulf of Maine ecosystem due to fishing impacts that have occurred over several centuries. Cod, which were once the top predator, have been overfished, and therefore many of their prey items, such as urchins, crab and lobster, have increased. Steneck continued by explaining that as the large fish declined, the ecosystem changed in favor of lobster. He stated that in comparison to historical data, we now have a low-diversity, out-of-balance ecosystem, with a hyper-abundance of a once-rare species. An alternate stable state can arise, where predators and competitors begin to dominate to fill an "ecological vacuum." To emphasize this idea, he stated that 70% of the catch in Maine comes from single species: lobster. He added that 7,000 lobstermen depend on this single species and suggested that there may be great socioeconomic consequences as a result of this dependence, considering the current state of the Gulf of Maine ecosystem.

Dr. Steneck suggested that management actions must be performed with a higher degree of prudence due to the current ecological fragility. He emphasized the need to:

- understand key ecosystem drivers,
- empower and educate stakeholders,
- consider the sustainability of the Gulf of Maine ecosystem, and
- work with all parties toward comprehensive ocean-use planning.

3.2 Dr. Stratis Gavaris, Department of Fisheries and Oceans Canada (DFO)

"Approaches to Ecosystem-based Management in the Gulf of Maine"

Dr. Gavaris focused his presentation on how to make ecosystem-based management (EBM) operational. He identified the following key requirements:

- manage human activities not ecosystems,
- build on existing management plans,
- develop operational strategies, and
- select indicators pertinent to the strategy.

He stated that Canada's Oceans Action Plan has an EBM focus and discussed the role of the Department of Fisheries and Oceans in implementing the plan. He stated that conservation has been the primary focus in DFO's operational strategies, which include the maintenance of productivity, preservation of biodiversity, and the protection of habitats. He emphasized using indicators appropriate for ecosystem-based management, which must be pertinent to the strategy and able to measure a response to managed activities.

In order to operationalize EBM, Dr. Gavaris also cited the need to classify habitats and to map habitat locations. He discussed the importance of understanding the specific and cumulative impacts of fishing and other activities on various habitats and the need for monitoring. He further spoke of the need for maps that show marine habitats classified by intrinsic value for supporting life (benign or adverse) and stability (disturbed or stable). He also emphasized the importance of focusing management efforts on these less sensitive habitats, in addition to those that are more vulnerable and disturbed.

DFO is using the eastern portion of Georges Bank, where there are few managed activities, to conduct a pilot study focusing on population productivity and population components. Emerging management priorities from the study include managing discards, incidental mortality, and limiting disturbance of benthic habitat.

A copy of this presentation is available on the Gulf of Maine Council Web site: www.gulfofmaine.org

4.0 CROSSCUTTING PRIORITIES FROM HABITAT FOCUS GROUPS

The intent of the Day One habitat focus groups was to reach consensus on the highest priority human impacts to specific habitats. These were then used to focus the management strategy discussions on Day Two.

Key ecological attributes (KEAs) are critical aspects of a habitat that, if missing or altered, would lead to severe degradation or loss. Their status may be measured directly or indirectly using indicators. Selection of draft KEAs before the workshop was based on literature review and discussions with experts.

On Day One, the habitat focus groups reviewed the draft KEA lists as modified by the homework assignment results, and confirmed or improved the KEAs (separately for each habitat type). Then participants evaluated which KEAs are most critical for maintaining habitat resilience and which are most altered by human impacts. To better understand the severity of impacts on specific habitats, groups assessed the current degree and geographic extent of each impact on each KEA. Focus groups further described the specific impacts that altered each KEA and, based largely on those discussions, determined which categories of impacts most degraded the habitat overall. Despite slightly different approaches and time constraints, each group was able to reach conclusions regarding the top-ranking key ecological attributes and impacts.

4.1 Key Ecological Attributes

The KEAs and impacts that each of the four habitat focus groups identified as most important were analyzed and compiled by the workshop planning team in order to direct discussion for Day Two of the workshop. Table 1 presents the KEAs by habitat type for each focus group.

4.2 Human Impacts

Based on the KEAs identified for each habitat type, priority human impacts were identified by each habitat focus group. Across the selected habitat types, pollution, biological resource harvesting, habitat conversion/degradation, and invasive species were the four most highly rated impact categories. Table 2 summarizes these

Table 1: Key ecological attributes by habitat type

Soft bottoms	Rocky bottoms and kelp beds	Eelgrass beds	Shellfish beds
Characteristic community structure/species composition	Trophic interactions	Nutrient regime	Trophic interaction
Flow regime	Characteristic community structure/species composition	Size	Water quality
Habitat structure	Habitat structure	Light penetration	Sediment regime
Size	Water temperature	Characteristic community structure/species composition	Size

Table 2: Top-ranked human impacts across habitat types

Pollution: • Waste dumping (outfalls, wastewater treatment, cruise ships) • Runoff (nutrients, heavy metals, and miscellaneous toxins from housing/urban development, impervious surfaces such as roads and parking lots, agriculture) • Sedimentation	**Habitat Degradation:** • Dredging: offshore and for marinas • Trawling • Shoreline armoring (soft and hard) • Wetland fill (sand and mudflats) • Marinas and docks • Commercial waterfront development
Biological Resource Harvesting: • Overfishing (including clamming and worming) • Oyster and mussel harvesting • Rockweed harvesting	**Invasive Species:** • Species: tunicates, green crabs, *Codium*, bryozoans • Pathways: ballast water, waterscaping, etc.

categories and examples of specific impacts that each encompasses. For detailed documentation of human impacts for each habitat type please refer to the Habitat Focus Group Summaries in Appendix 7.2.

5.0 CROSSCUTTING RECOMMENDATIONS FROM MANAGEMENT STRATEGY FOCUS GROUPS

The intent of the management strategy focus groups was to brainstorm approaches for improving management that would facilitate both use and conservation of the Gulf of Maine marine habitats. Most breakout groups selected one or more of the top-ranked impacts on which to concentrate their discussion of management options; groups also had the opportunity to select an alternate "wild card" impact for the basis of discussion. Below are several highlights and crosscutting themes from these discussions. For more details, please refer to the summaries for each focus group in Appendix 7.3.

5.1 Focusing Management

Transitioning to Ecosystem-based Management: Participants expressed a need to set small, achievable goals that would ultimately help the region accomplish the larger goal of ecosystem-based management. They also recommended that local groups be mobilized to answer questions related to the definition of and transition to ecosystem-based management. This would require the development of a structure to oversee the activities of the groups and to create uniform standards for data collection.

Some suggested the formation of a committee, consisting of federal, state, provincial and nongovernment stakeholders that could coordinate this effort. This committee could oversee the work of local groups on ecosystem-based management projects, establish uniformity, and ensure compliance with regulations/protocols. It was also suggested that this could be a role for the Gulf of Maine Council.

Addressing Cumulative Impacts: Groups emphasized the importance of dealing with cumulative impacts within the context of ecosystem-based management. Some suggested that a group such as the Gulf of Maine Council Habitat Conservation Subcommittee could define the term 'cumulative impact' and work to identify the cumulative impacts of specific activities. This could guide a pilot project to determine if, for example, there are cumulative impacts resulting from the construction of docks and marinas. The pilot project could also look at how these impacts affect specific habitats.

The cumulative impact of hardened shorelines arose as a particular concern. To address this, many agreed that best management practices (BMPs) for shoreline protection should be uniform throughout the Gulf of Maine and that Canadian and U.S. regulators should work together to implement strategies such as 'soft solutions for hardened shorelines'.

Groups noted that by collecting data on impacts as part of the permitting and zoning process, managers could track the cumulative impacts. Participants discussed the idea of developing a region-wide network to help coastal managers and decision makers to better understand and respond to cumulative impacts.

Addressing Nonpoint Source Pollution: Groups agreed that even though the technology is available and there are many programs in existence designed to address nonpoint source (NPS) pollution, many of them are not addressing the issue adequately or expeditiously enough. Participants discussed the need for funding to address the problem. Groups recognized the importance of providing financial assistance to municipalities for the purpose of monitoring NPS pollution, the construction of stormwater treatment facilities, and the implementation of existing state level NPS pollution plans. They also recognized the need to accelerate the implementation of best management practices (BMPs) and thought this could be done by making them a condition of permit approval or providing other incentives. The groups considered the possibility of charging fees for stormwater generation and accessing federal funds to raise capital necessary to support facilities and innovations.

Addressing Fisheries Issues: To address overharvesting, focus groups emphasized the importance of protecting spawning and nursery areas to safeguard species during critical life stages. Participants highlighted the need to select focal species and then determine special management protocols. They also suggested that catch regulation be established (where it has not already been) according to age, size class, spawning status, and subpopulation goals rather than by limitation on biomass or days at sea.

Participants stated that more research was needed in order to improve local management. The clam industry in particular requires information on population estimates, recruitment data, recovery rates, and optimum habitat structure to improve management.

Participants also discussed benthic habitat disturbance with a specific focus on bottom trawling gear types. They stated that there is a need to map benthic habitats and then document the occurrence of commercial and recreational fishing efforts. In relation to trawling, participants thought it was important to address regulatory efforts pertaining to specific habitat types. Participants thought particularly vulnerable habitats, such as eelgrass and cold water corals could be protected through regulations that designate some of these areas as off-limits to bottom tending gear. Other areas, like mud, gravel and cobble, which are much more widespread, could be subjected to rotational closures. It was noted that such actions may be more easily implemented if there were explicit federal mandates to manage not only for the conservation of commercial fisheries but also for biodiversity.

5.2 Improving Stewardship

Stakeholder and Local Involvement: Some groups identified the importance of keeping avenues for local input in marine habitat protection discussions open and to provide opportunities for decision-making at the local level. Participants agreed habitat protection would be more successful if diverse stakeholders participated in the decision-making process.

Participants felt that the premise "it takes a community to manage an ecosystem" could be the basis of an overarching strategy. A regional forum outside the New England Fisheries Management Council may be useful to discuss and address the spectrum of impacts on marine habitats. Such a forum would bring together diverse stakeholders to build relationships based on common interests and experience rather than focusing only on areas of contention. Ultimately such a dialogue could augment the ecosystem-based management process. For example, scientists and fishermen would be able to convene a panel to brainstorm research priorities and create career incentives for scientists and thus encourage research related to ecosystem-based fisheries. It was observed that there are too few non-fishing constituents participating in fisheries management.

Messages for the Public: Participants recognized the need for emphasizing public education and stewardship. They suggested creating a story that would show people, through the illustration of cumulative impacts, how they are part of the ecosystem. Participants also suggested using the human place in the food web as the basis of a strategy for increasing understanding of Gulf of Maine issues. They believed the public should be aware of the connection between stormwater runoff and impacts on watersheds, estuaries, and clam flats. Some also noted the need to bolster the public's ability to identify invasive species. To rally support for a multiplicity of actions, focus groups discussed the use of cod and perhaps one or two other iconic or keystone species that exemplify the interrelatedness of human actions and impacts on the marine environment. Participants also stressed the importance of getting these messages out in a coherent manner by distributing resources analogous to the *Gulf of Maine Marine Habitat Primer* but focused on particular topics like the importance of trophic interactions in resilient marine ecosystems. They also emphasized the need to have scientific involvement in the process of refining key messages.

5.3 Informing Management

Mapping Needs: Focus groups agreed that better spatial data on benthic habitats was needed. There was acknowledgement that this had already been recognized as a priority by diverse entities. However, participants felt it was time for these different agencies and organizations to come together to reach an agreement on formats and classification systems, to produce and distribute maps designed to address critical management needs, and to direct implementation of management strategies. Many cited a need for a wide variety of maps including ecological maps focused on benthic habitat classification, sensitivity, and biodiversity as well as human use maps focused on fishing and non-fishing activities and impacts, such as runoff and shoreline alteration.

Research Needs: The following list summarizes research needs discussed throughout the workshop. Participants were not specifically asked about research needs, although many were identified in both Day One and Day Two focus groups.

- Geographic representation, functionality, and resilience of benthic habitats
- Historic conditions in the Gulf of Maine ecosystem
- Impacts of fishing gear types on benthic habitat (sediment and biological composition) and light penetration through the water column
- Understanding of food webs and trophic interactions, especially for species such as cod and salmon
- Intertidal community structure assessed to better document impacts
- Availability and geographic extent of near-shore spawning and nursery areas
- Population estimates, recruitment (population replenishment) data, recovery rates, and socioeconomic values for clam fishery
- Quantification of impacts to marine habitats in terms of cost/benefit
- Connection between habitats and the species associated with them

6.0 NEXT STEPS AND CONCLUDING REMARKS

After the focus groups met on Day Two, a final session was held with all workshop participants to discuss the outcomes of the groups and next steps.

Participants spoke of the need to develop new tools to facilitate ecosystem-based management approaches. The matrices presented at the workshop by Stratis Gavaris (Canada Department of Fisheries and Oceans) and Irit Altman (University of New Hampshire) were favorably reviewed, as was the workshop's general analytical approach adapted from established TNC methods.

Participants, recognizing the importance of Gulf of Maine Council involvement, suggested that the Gulf of Maine Council receive proceedings and consider significant themes/issues from the workshop as they prepare their Action Plan for 2006-2011. They envisioned a partnership between Council and groups who are already focused on these issues, imagining that the Council could serve as a facilitator of potential collaborators. Participants mentioned the importance of continuing with Gulf of Maine mapping efforts.

The larger group also discussed the merits of using an iconic species such as cod as a 'poster fish' in a new outreach effort to raise public awareness of human impacts to Gulf of Maine ecosystems. This conversation evolved into the idea of using cod, a seabird, and several other species, and identifying and highlighting specific interactions and human impacts. Participants suggested the creation of a 'poster species' working group that would emulate the style of working groups that are used in the National Center for Ecological Analysis and Synthesis (NCEAS) projects. A 'poster species' working group could develop a campaign in coordination with groups already working to conserve or restore the potential poster species, to help build broad public support for strategic conservation and restoration actions.

Workshop participants also felt that fisheries management and the development of marine resources should be much more of a collaborative effort and not the sole responsibility of fishing industry constituents. However, participants recommended that it was critical for key players to encourage, continue and increase interactions and opportunities for dialogue between fishermen and scientists regarding research and management needs, noting that entire communities can suffer from one-sided planning, not just the fishermen. Workshop organizers expressed their intention to document the workshop results and seek ways to further develop and carry forward the management recommendations to appropriate policy bodies for potential funding and action.

APPENDIX 7.1: WORKSHOP AGENDA

Marine Habitats in the Gulf of Maine:
Assessing Human Impacts and Developing Management Strategies

Day One

8:00 – 9:00	**Continental breakfast**
9:30 – 10:00	**Registration – Brooke Hall lobby**
10:00 – 10:15	**Introductions and workshop overview** Katie Lund, Massachusetts Office of Coastal Zone Management
10:15 – 10:45	**Plenary – Bob Steneck, Darling Marine Center** An Overview of Gulf of Maine Habitats/Species Associations and Interactions
10:45 – 11:15	**Facilitator – instructions to focus groups** - Explain focus on four habitats - Identify examples of impacts from *Gulf of Maine Marine Habitat Primer* - Introduce handouts that summarize homework results - Describe methodology and go through an example habitat
11:15 – 12:30	**Habitat focus groups** Collect information on key ecological attributes and habitat impacts - Eelgrass – Faculty Suite Living Room Facilitator: Katie Lund - Rocky Substrate/Kelp – Brooke Hall Facilitator: Barbara Vickery - Shellfish Beds and Reefs – New Library, Upper Campus Facilitator: Jay Odell - Soft Bottom Habitats (Muddy and Sandy) – Mitchell Classroom Facilitator: Rachael Franks Taylor
12:30 – 1:30	**Lunch at the Darling Center**
1:30 – 3:00	**Habitat focus groups (continued)** Further discuss and prioritize impacts for each of the four habitats
3:00 – 3:15	**Refreshments**
3:15 – 3:30	**Project highlight – Mike Johnson, NOAA** Non-fishing impacts workshop held in January, 2005
3:30 – 4:30	**Impact summary from each habitat focus group**
4:30 – 5:00	**Facilitator – wrap-up** - Time for feedback, questions, and concerns - Provide direction and overview for day two
5:30	**Wine and oyster reception**
7:00	**Dinner at the Darling Center**

Day Two

7:00 – 8:00	**Breakfast at the Darling Center**
8:30 – 9:00	**Facilitator** - Summary from day 1 - Overview and objects of day 2
9:00 – 9:30	**Plenary – Stratis Gavaris, Dept. of Fisheries and Oceans, Canada** Approaches to ecosystem-based management in the Gulf of Maine
9:30 – 9:45	**Facilitator - instructions to focus groups**
9:45 – 10:45	**Management strategy focus groups** Discuss and identify management options to address human impacts recorded for each habitat on the first day - Group 1 – Faculty Suite Living Room Facilitator: Jay Odell - Group 2 – Brooke Hall Facilitator: Kate Smukler - Group 3 – New Library, Upper Campus Facilitator: Barbara Vickery - Group 4 – Mitchell Classroom Facilitator: Marianne Janowicz
10:45 – 11:00	**Coffee break**
11:00 – 12:30	**Management strategy focus groups (continued)** Further discuss and prioritize management options
12:30 - 1:15	**Lunch**
1:15 – 1:30	**Project highlight – Irit Altman, University of New Hampshire** Developing tools for ecosystem-based management in the Gulf of Maine
1:30 – 2:15	**Management summaries from each focus group**
2:15 – 3:00	**Group discussion on management options in an ecosystem context** Facilitator, Kathleen Leyden - Maine Coastal Program
3:00 – 3:30	**Concluding remarks and discussion of next steps**

Adjourn

Appendix 7.2
Habitat Focus Group Summaries

Workshop participants were assigned to one of the four habitat focus groups: eelgrass, shellfish beds, soft bottom (sandy and muddy), kelp and rocky substrates (intertidal and nearshore subtidal). The decision to focus on these habitats was made by the workshop planning team, based on the categorization of habitats in the *Gulf of Maine Marine Habitat Primer*. The groups based their discussions on a matrix of key ecological attributes (KEAs). KEAs are critical aspects of a habitat that, if missing or altered, would lead to severe degradation or loss. Status of KEAs could be measured directly or indirectly using indicators.

The workshop planning team made preliminary selections of key ecological attributes for each habitat type, based on literature review and discussions with experts. They also gathered pre-workshop input from participants to aid in the selection process.

The focus groups reviewed draft KEA lists and confirmed or modified them for their particular habitat. They then evaluated how KEAs that are most critical for maintaining habitat resilience are altered by human impacts. As reflected by the following summaries, groups used the matrix and taxonomy in different ways. They also had different methods for setting priority KEAs and human impacts.

Habitat Focus Group: Eelgrass

Habitat Description

Seagrass is a general term for flowering plants that live in low intertidal and subtidal marine environments. Roots anchor seagrass to the sediment, but unlike terrestrial plants, seagrass also absorbs nutrients from the water along the entire length of its blades, which can reach ten feet. Similar to horizontal stems, rhizomes connect the upright shoots.

Two species of seagrass live along the Gulf of Maine coast. Eelgrass (*Zostera marina*) is the dominant seagrass throughout the region, while widgeon grass (*Ruppia maritima*) is limited to low salinity waters. Eelgrass tolerates a wide range of temperature (0-30° C) and salinity regimes (10-30 parts per thousand) and takes root on substrates from coarse sand to mud. It even thrives among cobbles and boulders, in small patches of soft sediment. Eelgrass can live everywhere from tide pools along the shoreline to subtidal areas of several meters depth, as long as the water is relatively clear and allows sufficient light for growth. The most important factor in eelgrass survival and growth is light limitation.

Eelgrass beds are a critical habitat in the Gulf of Maine. Eelgrass also provides vital services to improve water quality by filtering suspended sediments and excess nutrients. The ecological importance of eelgrass beds along the Atlantic coast became clear after an outbreak of wasting disease in the 1930s. Caused by a slime mold that infects the leaves, the disease killed an estimated 90 percent of eelgrass in the region. The die-off led to massive erosion and dramatic changes in water quality. Scallops, American brant, and other animals that relied on eelgrass beds for food and shelter suffered extensive mortality. The eelgrass limpet (*Lottia alveus*) even apparently went extinct due to the eelgrass die-off, which is the only documented extinction of a marine invertebrate in North America. Some commercially valuable species, such as scallops, also reportedly declined as eelgrass disappeared.

Key Ecological Attributes

KEAs with the highest ecological importance were (1) nutrient regime, (2) size, (3) light penetration, and (4) characteristic community structure/species composition. The first three KEAs are widespread to patchy; the fourth is localized to Canada. This group defined characteristic community structure as the native community associated with the eelgrass. Community structure may also refer to the habitat that eelgrass makes for other flora and fauna, not the eelgrass itself.

The group added the following three attributes: (1) substrate (i.e., sediment, chemistry), (2) depth, and (3) hydrographic regime (i.e., waves, currents, fetch, energy). When the group rated importance of KEAs, these three were low compared to those KEAs already on the list.

Human Impacts to KEAs

Human impacts to eelgrass KEAs are hard to quantify or assess regionally because they are not necessarily site-specific. The most important KEAs were generally the ones most impacted and highly affected. However, the degree of impact in some instances varies depending on location. For example, nutrient impacts are more of an issue in the southern Gulf of Maine and upper parts of the estuaries.

Primary Impacts

- **Habitat degradation** primarily impacts nutrients, size, and light, but also indirectly affects characteristic community structure. For example, an unhealthy amount of dissolved nutrients leads to eutrophication, which results in change of community structure.
- **Pollution** most strongly affects nutrient and light. It also indirectly affects size and characteristic community structure. (Pumpouts were noted as a possible strategy for addressing this impact.)
- **Invasive species** primarily impact characteristic community structure and size. For example green crabs physically remove eelgrass, and *Codium* is taking over space in benthic communities.

Secondary Impacts

- **Transportation, energy infrastructure, and mining** affect both size and light penetration (mostly during the construction phases).
- **Biological resource harvesting** affects size and potentially light penetration. It was noted that more research is needed on indirect effects of overfishing filter-feeding organisms and aquaculture activities on nutrient levels, light penetration, and the health of the beds.

Overall messages

- Some impacts to eelgrass may need to be addressed at a local rather than regional scale, depending on the particular site, condition, and nature of the impact.
- Geographic differences/gradients of distribution
  - Decline/degradation in southern Gulf of Maine
  - Local variability needs to be considered
  - Canadian site-specific conditions are unknown except for the Atlantic coast of Nova Scotia
  - Canadian green crab population is changing the community structure more than in the U.S.
- Greatest changes (both increases and decreases) are taking place in upper reaches of estuaries.
  - Open ocean areas are most stable

Habitat Focus Group: Shellfish Beds

Habitat Description

Some bivalve mollusks form large, dense aggregations called shellfish beds or reefs that function as unique biogenic habitat. Small animals find refuge in the crevices, while others attach to the shells. Each species that forms shellfish beds has different environmental requirements, and therefore shellfish beds can be found in the intertidal and subtidal zones, and from estuaries to far offshore.

The Gulf of Maine has three types of shellfish beds that are especially noteworthy as biogenic habitats. Mussels secrete strong flexible threads that bind individuals together in clumps. Oysters settle onto the seabed in clusters, and as they grow, their shells attach permanently to the substrate, leading to formation of a calcareous reef. Scallops do not attach to each other or the substrate, but their dense aggregations are nevertheless referred to as shellfish beds. In some places, currents arrange the empty shells of dead shellfish into long rows on the seafloor where fish hide to ambush prey, avoid predators, or escape currents.

After discussion, the shellfish habitat group elected to consider key ecological attributes (KEAs) and impacts for all of these three types, with a primary focus on oysters and mussels in nearshore areas. There was some discussion on the need to include various clam species because of their social and ecological importance, but the group felt they should be evaluated separately at another time because they do not provide habitat structure like mussels, oysters, and scallops.

Key Ecological Attributes

The initial list of KEAs for shellfish beds included characteristic community structure/species composition, size (area and/or density), water quality, and temperature. Because predation rates on shellfish populations may in some cases be the single most important factor affecting their density and size, a new KEA was added: trophic interactions/predation. This addition raised the question of whether a KEA for characteristic community was still needed because the presence of predators at levels within natural ranges of variation could be considered a subset of the characteristic community. After discussion, the characteristic species KEA was retained because the species (in addition to predators) associated with shellfish bed habitats help to define their ecological integrity and biodiversity value, and these species may be affected by impacts that do not affect top predators.

Three additional KEAs were added to the initial list. Sediment regime was added because oyster populations require relatively hard substrates to persist and altered sediment regimes have contributed substantially to population declines. Habitat structure was added because the vertical relief of oyster reefs and the interstitial spaces of dense mussel beds are required to provide high value habitat for many species. Hydrographic regime was added because currents control larval and sediment transport processes. This key attribute was not considered particularly altered but was included because climate change and large marine construction projects (e.g. tidal power generators) might have significant impacts on currents.

The KEAs were ranked in the following order of importance, with importance defined by their relative ecological importance and vulnerability to human impacts (not necessarily the present degree of impacts).

1. Trophic interactions/predation
2. Water quality (not including sediment load)
3. Sediment regime
4. Size
5. Community structure/species composition
6. Habitat structure
7. Hydrographic regime
8. Temperature

Human Impacts to KEAs

Working under a substantial time constraint, group members indicated which of eight general classes of human impacts had a high impact on each KEA. Biological resource harvesting (fishing for oysters, mussels and clams) received the most number of high impact votes (30), followed by development (27, partly in consideration of upland pollution sources), pollution (23), climate change (20), invasive species (11), energy and mining (6), and transportation infrastructure (3).

Note: A strict interpretation of the human impacts taxonomy would classify all pollution-related development impacts under the pollution class. Development impacts would be limited to those projects that directly alter habitat; the group may not have been considering development in this limited sense.

Specific impacts and KEAs

Fishing: Impacts include oyster harvest with handheld gear or dredges, mussel dredging, and scallop dredging. These activities primarily affect size, community structure, trophic interactions, and habitat structure.

Development: Marina construction and dredging may alter or destroy available habitat (habitat structure, sediment regime, characteristic community structure).

Pollution: Most bivalve shellfish are considered fairly tolerant of pollution, but concern remains for sublethal and lethal impacts on growth, reproduction, disease tolerance, and larval survival. Persistent organic pollutants and metals are the main concern, rather than nutrients that affect water quality and characteristic community structure.

Climate change: Range extension for oysters, increased disease mortality, and other negative impacts are possible consequences of climate change. The group was unsure of how or whether climate change is currently affecting shellfish but was very concerned about associated impacts on water temperature, hydrographic regimes, and characteristic community structure, and size.

Invasive species: Similar to climate change, the possible impacts posed by invasive species are not yet highly evident, but they are difficult to reverse when they occur. They primarily relate to characteristic community structure, habitat structure, and trophic interactions/predation. Impacts discussed included habitat alteration by the spread of invasive tunicates and predation by introduced crabs (e.g., green crab, Asian shore crab, and potential new invaders).

Energy and mining; transportation infrastructure: These two impact classes were not considered to have significant widespread impacts to shellfish at this time, but large-scale projects or cumulative impacts of small projects could alter any or all of the shellfish KEAs. The group was primarily concerned with large-scale projects involving habitat conversion or alteration of currents.

Habitat Focus Group: Soft Bottom

This group's charge was to determine the Key Ecological Attributes (KEAs) and priority impacts for soft bottom habitats—both muddy and sandy substrates—from the intertidal zone to subtidal areas. Early on, the group discussed that this habitat could be broken down into six different habitats: muddy and sandy substrate in the intertidal, shallow subtidal, and deep subtidal zones. These differences were a theme through the discussions, and the group indicated that depth was in some ways a more important distinction than substrate type.

Habitat Description

Both sandy and muddy habitats are distributed throughout the Gulf of Maine.

Sandy Habitats Intertidal sandy habitats are eroded and sustained by dynamic forces; wind, waves, and storms all affect the development and stability of beaches. These areas are important habitat for shorebirds and crabs.

Subtidally, waves and currents play a role in sandy habitats; these forces create habitat complexity by forming ripples and ridges. Most inhabitants burrow into the sand, while others have cryptic coloring to avoid detection while living on the seabed.

Muddy Habitats: Intertidal muddy habitats form when fine sediments accumulate in areas that lack strong currents or waves. While this low-enegy flow of water permits tidal flats to develop—creating habitat for infaunal species such as polychaetes and clams—it can lead to a minimal flushing of toxins. Tidal flats are devoid of vegetation, or can have algal growth or diatoms. Often found adjacent to salt marsh and eelgrass beds, the flats can appear featureless, but just beneath the surface is an active community. Tidal flats are an important feeding area for shorebirds.

In the subtidal zone, these habitats can have more prominent features. Species associated with mud and sand habitats burrow or build protruding tubes in which to live. These structures can provide habitat for other species that live among them. In addition, several species visit muddy habitats to spawn, aggregating in high densities.

Muddy habitats tend to have lower diversity and productivity than some other marine habitats. However, they have an important role in the food web, making plankton and detritus available to higher trophic levels. Resident animals eat plankton and detritus from the water before being consumed by fish and other predators.

Key Ecological Attributes

1. Community structure/species composition
2. Flow regime
3. Habitat structure
4. Size
5. Sediment regime
6. Water quality

The group noted that while everything on the list is a key ecological attribute, an important series of interactions exists among them and they are far from discrete. All factors influence characteristic community structure. Flow regime affects habitat structure, which in turn influences characteristic communities and species. The group felt it would be useful to parse out differences according to depth (intertidal, shallow, deep) and grain size (mud, sand). "Freshwater flow regime" was modifed to "flow regime" so that it could capture tidal flow, and a water quality factor was also added.

The group indicated that all of the factors are important, but whether they are "KEAs" depends on which substrate type and depth is being considered. Community structure is different than the other factors, because it is biologically-based and broad. It interacts with all of the other factors. This was an overarching, highest priority impact for all soft bottom habitats. While points were not distributed among all of the KEAs, the group agreed that flow and size were more important factors for shallow habitats, and habitat structure was more important for deep habitats.

Human Impacts to KEAs

The top three impacts on soft bottom habitats in the intertidal and shallow subtidal zones are coastal development (shoreline hardening, agriculture, dredging for marinas, wetland filling, impervious surfaces), pollution associated with coastal development, and biological resource harvest (clamming, worming).

The top three impacts on deep soft bottom habitats are biological resource harvest/overfishing (in both sand and mud), habitat conversion (particularly trawling in mud), and pollution/waste dumping (particularly in mud).

Muddy habitats are generally considered more vulnerable than sandy habitats due to limited flushing of pollutants (coupled with attraction of charged particles) and reduced resilience to physical disturbance.

Habitat Focus Group: Kelp and Rocky Substrate

Habitat Description

Rocky habitats, broadly defined, make up more than 50 percent of the Gulf of Maine's seabed from the intertidal zone to depths of 100 meters. Rocky habitat includes a continuum from ledge through cobble to gravel and may include mixtures, all of which influences the species, abundance, and vulnerability of the rocky habitat. Rocky habitat dominated by cobble, for instance, is particularly important to lobsters. This group's definition of rocky habitat includes not only the physical substrate but the organisms that attach to it and those that live among the rocks.

Key Ecological Attributes

Highest Ranked

- **Trophic Interactions:** In terms of measurable demographic effects and published data there are few other attributes that are as critical and vulnerable at the Gulf of Maine scale as trophic interactions. Trophic interactions also drive the following two attributes.
- **Characteristic community structure/Species composition:** On the other hand, the community species composition can also impact the trophic structure. If the community has more than one species filling a functional or trophic niche, it is less vulnerable to changes in trophic structure. Some members of the rocky habitat community are more critical than others.
- **Habitat structure:** Ledge habitat might be more vulnerable than one would think. With increasing demand for more underwater cables and pipelines, ledge will be affected. However, the most vulnerable rocky habitats are cobble and the biogenic structure of rockweed or kelp growing on rocky substrates. Bottom-dragging fishing gear can have a dramatic effect on habitat structure, and impacts may be widespread. Even so, the most important factor affecting habitat structure may be consumption of kelp by urchins because the kelp forms biogenic habitat for many species.

Ranked Lower

- **Water temperature:** Impacts on water temperature can occur at local and global scales. For example, heated water from power plants is discharged into coastal waters, while broad-scale sea temperature rise may be promoting sea urchin disease in Nova Scotia. Present impacts are not well documented, but future impacts from climate change could be significant. The group noted that salinity and CO_2 concentrations are likely change with rising water temperatures. However, the causes and trends of climate change are not likely to be reversed in our lifetimes, so some management implications are less immediately actionable.
- Attributes of lesser importance include **light penetration, sediment regime, and nutrient regime**. These are often linked and caused by similar human activities. There is little evidence in the literature that any of these three attributes are being significantly affected for rocky habitats on the scale of the Gulf of Maine, although nutrient regime changes and associated changes in sediment and light penetration may occur in parts of some estuaries and bays.
- To sum up the discussion of KEAs, trophic interactions are most important, followed by community composition and habitat structure, and the three are interrelated.

Human Impacts to KEAs

Impacts to trophic interactions, characteristic community structure/species composition and habitat structure:

- Biological resource harvesting of urchins, groundfish, kelp and rockweed both through direct removal impacts on trophic structure and via indirect impacts of dragging on habitat structure.
- Additional impacts resulting from loss of anadromous fish because of dams that restrict access to spawning habitat are suspected but not well quantified in terms of consequences specific to rocky habitats.
- Invasive species such as *Codium* and *Membranipora* affect trophic structure by negatively impacting kelp. Other invasive species would also impact community composition.
- Climate change may be implicated in die-offs of urchins.
- Gravel mining, as proposed for Bay of Fundy, would impact habitat structure and sediment regime.
- The group was unsure whether chronic pollution or single catastrophic events such as oil spills were significant sources of impacts to rocky habitats.
- Climate change is the key driver for widespread sea temperature rise although there may be specific point sources of thermal pollution that may have local impacts.

The group noted that human population growth in the immediate coastal zone will increase the likelihood of cumulative impacts from habitat degradation, pollution, oil spills, energy, and mining.

Many of the comments reflected the difference in perspective at the scale of the whole Gulf of Maine, where the effects of overfishing on trophic interactions may dominate, versus the perspective of smaller scales, such as Boston Harbor or Casco Bay, where there may be greater, local impacts from other human activities such as pollution and dredging.

Appendix 7.3
Management Strategy Focus Group Summaries

On Day Two, four breakout groups brainstormed ecosystem-based management options to address the priority impacts identified on Day One. The groups were different than the Habitat Focus Groups on Day One. Each of the four breakout groups had two reference sheets, one on impact categories and a second for management strategies. They also had a blank sheet to list research priorities.

From a table of top-ranking impacts from Day One, each group chose three to five specific impacts on which to focus their discussion of management strategies. (Please refer to section 5.2 of this report to see a table of impacts presented to the groups.) In addition, groups were instructed to add a "wild card," if there was an impact they wanted to discuss that had not been categorized.

The facilitators in each group asked participants to take into account the following preferred characteristics for proposed management strategies:

- actionable
- cross-cutting
- innovative
- trust-building
- transferable
- specific/measurable
- lending to ecosystem-based management approach
- appropriate scale
- high leverage
- incentive based
- legal/regulatory
- cross-boundary coordination
- adaptive
- building on past success/existing programs.

Although the above list was used as a filter, all ideas were included in the summary regardless of feasibility.

Management Strategy Group One

Group One voted to focus on the following 5 specific impacts from the larger list developed by the workshop planning team:

1. Benthic disturbance (near shore and offshore)
   a. Fishing (trawling)
   b. Non-fishing (e.g., dredging, mining)
2. Overharvesting and incidental catch
3. Runoff (nonpoint source pollution)
4. Shoreline and wetland alterations (fill and armoring)
5. Invasive species

Management Strategies

Benthic Disturbances: Participants agreed that better spatial data and maps on benthic habitats are needed. The group acknowledged that diverse entities already recognize this as a priority, but now is the time for these different entities to reach agreement on formats and classification systems, and to produce and distribute maps designed to address critical management needs. The group agreed that several types of maps are needed to implement management strategies to address benthic impacts. The group also identified mapping needs relevant to runoff and shoreline alteration. See Appendix 7.2 for details.

1. Ecological maps
   a. Benthic habitat classification (using substrate type, depth, topography, etc.)
   b. Habitat sensitivity (degree of vulnerability and resilience to disturbance)
   c. Biodiversity (associate species-level data with habitat classification and sensitivity maps)
2. Human-use maps
   a. Commercial and recreational fishing effort (group acknowledged present efforts and that the need and degree of difficulty are high)
   b. Non-fishing benthic impacts (use permit records to map locations of historic and current projects, e.g., dredging, cables, mining)
   c. Runoff (models showing pollutant discharges, e.g., nutrients, metals, toxics, excess sediment, from coastal rivers, potentially combined with Gulf of Maine circulation models)
   d. Shoreline and wetland alterations (use permit records and aerial photograph interpretation to map location of historic and current projects, e.g., riprap, sea walls, wetland fills, docks)

The group suggested the following strategies to facilitate the development of ecological and human-use maps:

- Organize meeting with managers and GIS experts already working on some of these ideas (e.g., Gulf of

Maine Mapping Initiative, DFO Habitat Management Group, Ocean Data Partnership, NGOs) to facilitate collaboration and produce useful maps.
- Investigate feasibility of collecting US state and federal permit information for mapping non-fishing benthic impacts to complement existing DFO efforts.

Overharvesting and Incidental Catch: This group mainly considered two aspects of fishing impacts: the need to better protect some species during critical life stages, and the need to better manage incidental catch. The group agreed on the following strategies.

- Accelerate implementation of at-sea monitoring for incidental catch and discards, including recreational fishing. Consider best available new technology.
- Select focal species and criteria for special management. Participants noted that maps of critical habitat for all species would cover the entire Gulf of Maine; criteria need to be developed for how focal species are selected. The group felt that the ecological and human-use maps would be valuable for this process.
- For key species, identify measures (e.g., time/area restrictions, MPAs) to protect spawning areas and nursery grounds from the fishing impacts of disturbance and biomass removal.

Run-off /Nonpoint Source Pollution: The group favored building capacity for managers to control these impacts as described below. New maps would also inform selection of priority areas.

- Accelerate implementation of best management practices (BMPs) in select areas using permit attachment and incentive approaches.
- Develop methods to help managers consider cumulative impacts of responses to runoff impacts (e.g., permit decisions, zoning).
- Obtain funding to implement existing detailed plans for Maine, New Hampshire, and Massachusetts to control nonpoint source pollution.

Shoreline/Wetland Alterations

- Accelerate implementation of BMPs in focal areas identified using the maps described above using permit attachment, incentives, and outreach.
- Develop "soft solutions for hardened shorelines" program.
  a. Convene key coastal regulatory people in U.S. and Canada to implement this strategy.
  b. Use maps showing hardened shoreline to date to inform discussion on cumulative impacts.
  c. Develop strategies based on incentives (e.g., special easements), technological fixes, and building legal fortitude for managers to "just say no."

Invasive Species

- Accelerate distribution of information on identifying invasive species (and why we care) at all practical and relevant points of contact between government and citizens (e.g., boat registration, fishing licenses).
- Distribute summary information on existing efforts to monitor and control invasive species to managers and scientists. The group was aware of many separate initiatives but was unsure how effective or comprehensive they were overall. There was also a high level of concern over the potential impacts of Gulf of Maine species in other ecosystems when exported with fishery products or other vectors.

Management Strategy Group Two

When reviewing the most significant impact categories identified during Day One, this group added as a "wild card" that management itself was an impact, or impediment, to healthy marine ecosystems. Lack of coordination, failure to integrate, and insufficient accountability were all aspects of the existing structure that this group discussed as overarching problems that should be addressed along with other high priority impacts.

Management Strategies

- **Build trust from the bottom up:** A regional forum is needed outside the New England Fisheries Management Council to discuss impacts on marine habitats. Participants should commit to a minimum term of involvement so that stakeholders can build relationships and trust, and the group can retain institutional memory. To allow full participation, the forum may offer incentives, such as travel stipends, to facilitate attendance. The Gulf of Maine Council does not fulfill this role as its members are primarily from government and conservation groups.
- **Focus on the system, not just fishing:** Many diverse groups share mostly common goals and these commonalities should be advanced. Human activities should be considered for their impact on the system, rather than focusing only on impacts of and on fishing.
- **Reform management of marine ecosystems:** Both the U.S. Commission on Ocean Policy and the Pew Oceans Commission put forth strong recommendations in their reports. These recommendations should

be encouraged to be put into action. A coherent way to address all impacts in an integrated way is needed. Enforcement, communication, and accountability all need to be improved for effective management.

- **Provide bottom-up decision-making structures:** Habitat protection will be more successful if avenues for local input are created in which diverse stakeholders can participate. The Bay of Fundy Working Group and Northwest Atlantic Marine Alliance may serve as models for alternative structures.
- **Share data throughout the region:** Data should be disseminated in a timely way and made more accessible by being available in a variety of electronic and non-electronic formats. New data should be collected in a coordinated, applied way.
- **Set small, achievable goals toward the larger goal of ecosystem-based management:** Demonstrated progress, however incremental, will help keep people engaged and make the ultimate goal of ecosystem-based management in the Gulf of Maine more accessible.

Management Strategy Group Three

This group voted to focus on three specific impacts (1) habitat degradation from trawling, (2) overharvesting, and (3) nutrient pollution (nonpoint source pollution), focusing on stormwater.

Management Strategies

Trawling using bottom-tending mobile gear: Trawling can occur on any substrate or habitat type, but the habitat types that appear to be most vulnerable and most impacted by trawling are eelgrass, mud, gravel, cobble, and cold-water corals, all of which have low levels of natural disturbance. Cold-water corals are especially rare and vulnerable, and they may take decades to recover.

For both eelgrass beds and cold-water corals, the group felt the most effective "operational strategy" goal was to limit or restrict entirely trawling in the key areas, i.e., set such areas off-limits to trawling by regulation.

- Map the locations of the habitats.
- Document and educate about the importance of the habitat and severity of the impact.
- In eelgrass, promote alternative harvest methods for shellfish, e.g., diving and raking.

For sand, mud, cobble and rocky bottom with or without kelp the solution is more complex because these are broadly distributed habitats. It is neither necessary nor practical to stop trawling altogether. Instead, the focus should be on managing the scale of trawling impacts in terms of area and frequency.

- Consider rotational closures to allow recovery between trawling events.
- Establish some areas more permanently off-limits to trawling and give some incentives by allowing only alternative harvest methods such as long line or gill nets near such areas.
- Determine recovery time so as to set reasonable periods for rotational closures.
- Map benthic habitat to ensure that vulnerable bottom types such as cobble are included in areas reserved from trawling. Prioritize habitats in terms of habitat stability, vulnerability to specific threats, and value to organisms and ecosystem functions.

Actions would be easier to implement if federal management had explicit mandates to manage for habitat or biodiversity conservation and not just commercial fisheries.

Overharvesting: Overfishing is difficult to stop because there are such powerful economic drivers, and the system now has more people dependent on the resources for their livelihoods than can currently be supported sustainably.

- Protect spawning and nursery areas.
- Manage take by age, size class, spawning status, and subpopulation goals, rather than by biomass or by effort, e.g., days at sea.
- Reduce fishing capacity by buying boats and permits.

Run-off /Nonpoint Source Pollution (NPS): NPS primarily threatens nearshore habitats, including shellfish beds, eelgrass, mud, and sand. Many agencies and programs already work to address NPS. Generally, people know what needs to be done; more just needs to be done faster. One major problem is stormwater that bypasses municipal treatment. Technologies exist to address this issue. The main obstacle is town-by-town funding.

- Provide grants to municipalities for water-quality monitoring and stormwater treatment facilities.
- Monitor nutrients, sediments, and toxins to show that progress is being made—or not.
- Link monitoring results to biological indicators and to treatment investments.
- Educate the public about NPS impacts, connections between watersheds and estuaries, and links between stormwater treatment and closed clam flats.
- To get adequate funds to accomplish these goals, consider a utility-based system to generate funds, i.e.,

charge fees for stormwater generation.
- Get additional federal funds to support new facilities and innovations.

Overarching potential strategy: "It takes a community to manage an ecosystem."
Use cod and perhaps one or two other species as iconic species to show the interrelatedness of human actions and impacts on marine systems and to rally support for a multiplicity of actions. Use these iconic species to broaden the base of support for bringing back cod. Engage others by setting a goal of bringing back large cod in coastal populations and then consider all impact reductions and resources needed to achieve that goal. For example, habitat may be necessary for prey fish.

Management Strategy Group Four

This group decided to focus on the following four impact categories as well as a "wild card":

1. Habitat degradation and conversion
2. Biological resource harvesting
3. Invasive species
4. Pollution

However, time permitted discussion only of habitat degradation, biological resource harvesting, and the wild card topic, which was the impact of diesel on marine habitats.

Management Strategies

Habitat Degradation and Conversion

- Mobilize local groups to answer questions related to advancing ecosystem-based management by developing an organization that oversees activities of the groups and provides uniform standards for data collection, ensuring that the data can be applied.
- All partners of the Gulf of Maine Council should have effective conservation measures including:
  a. More enforcement
  b. Decision-support frameworks for local decision-making
  c. Devolution of decision-making
  d. Public education and stewardship (create a story to illustrate cumulative impacts and foster an understanding of how people are part of the ecosystem)
  e. Create regulations to fill regulatory gaps.
- The Habitat Conservation Subcommittee should take on the challenge of furthering our understanding of cumulative impacts. This could be done in the following stages:
  a. Define cumulative impacts.
  b. Identify the variables (e.g., water temperature, turbidity, loss of biodiversity) to predict and recognize cumulative impacts.
  c. Develop a pilot project to determine the cumulative impacts of a specific activity (possibly marinas and docks).
- BMPs for shoreline protection should be uniform throughout the Gulf of Maine.
  a. Efforts to develop them could be pursued jointly between the Habitat Restoration and Habitat Conservation Subcommittees.
  b. A compelling and interesting PowerPoint presentation could be developed by the GOMC science translators to be available to community groups and agencies showing proper methods and the consequence of not using them.
- Expand partnerships with commercial fishermen
  a. Create career incentives to encourage research so that information needs related to ecosystem-based fisheries management are filled.
  b. Identify obstacles preventing better collaboration between fishermen and scientists.
  c. Use existing fishermen/science research societies.
  d. Convene a panel of fishermen and scientists to brainstorm on research priorities.

Biological Resource Harvesting

- The clam industry needs more information for effective management. This information includes:
  a. Population estimates
  b. Population replenishment (recruitment) data
  c. Recovery rates
  d. Definition of optimum habitat structure
- There is a need to improve on-site sewage treatment because it is an issue for sustaining clam harvesting.
  a. Produce background information about the socio-economic value of the clam harvesting industry to coastal communities.
  b. Promote low-cost biological treatment.

Impact of Diesel on Marine Habitats

- Rethink tourism promotion, so coastal areas are not adversely impacted by increased tourism vessel traffic.
- Promote biodiesel through the marinas and docks that service recreational and tourist boaters.