Agenda Item H.1
Situation Summary
November 2006

CHANNEL ISLANDS NATIONAL MARINE SANCTUARY MARINE PROTECTED AREAS

The Council has been coordinating with Channel Islands National Marine Sanctuary (CINMS) and the State of California since April 2001 in their development of proposed marine protected areas (MPAs) which include no-take marine reserves and limited-take marine conservation areas. With regard to fishery regulations, a network of such MPAs has been established in California State waters of the CINMS via State regulation and in the contiguous Federal waters via the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), with the exception of the water column areas. At the September Pacific Fishery Management Council (Council) meeting, the Council considered removing implementation of these MPAs in Federal waters as proposed under the authority of the National Marine Sanctuaries Act (NMSA).

The Council continues to hold the position that the regulation of fisheries is best done under the authority of the MSA. In an October 10, 2006 letter to the CINMS (Agenda Item H.1.a, Attachment 1), the Council informed the CINMS of its intent to move forward with MSA regulations and recommended that should implementation of NMSA fishing regulations and associated CINMS Designation Document changes occur, provisions should also be adopted for rescinding the regulations and the CINMS authority to regulate fishing activities at the time fishing regulations are adopted under the MSA.

At its September meeting, the Council reviewed the potential of utilizing existing MSA provisions for extending fishery regulations in State MPAs established under State authority into the proposed MPAs in Federal waters. Possible factual bases for such action include the rationale for the original State action, the link to the stated need for better scientific information on the ecology and status of stocks in at least three Council fishery management plans (FMPs), and the role MPAs can play as control sites in research and monitoring programs. Without eliminating these options, the Council directed Council staff to begin development of new alternatives for promulgating MSA and/or State fishing regulations for these areas.

Concepts for Council consideration at the November meeting include; (1) initiating a process for developing an ecosystem based fishery management plan, (2) identifying essential fish habitat needs within the water column of the proposed MPAs for one or more species under any of the Council's four existing FMPs, (3) continuing work on extending State regulations into Federal waters, or (4) other mechanisms. One potential advantage of an ecosystem based fishery management plan could be providing the authority to regulate fishing for all species, on the water surface, the water column, and the benthos, including species in the existing FMPs and species not included in the current FMPs. Such an authority could extend to Federal waters in other National Marine Sanctuaries beyond the CINMS.

Several Regional Fishery Management Council's have either implemented or are considering ecosystem based fishery management plans which include spatial management and area closures as regulatory mechanisms (for examples of policy guidance, see Agenda Item H.1.a, Attachment 1 and Attachment 2; for recent examples for other Regional Fishery Management Council approaches to Fishery Ecosystem Plans, see Agenda Item H.1.a, Attachment 3 and Attachment 4). Notably, the Council's Scientific and Statistical Committee and Habitat Committee have begun considering ways to incorporate ecosystem status reports and ecosystem based fishery management concepts into Council decision making and will hold a joint session on Tuesday, November 14 , 2006, to review progress and plan possible next steps.

The Council is anticipated to discuss relevant materials and options and provide guidance on a recommended course of action regarding fishing regulations for the water column in the Federal water portion of the proposed MPAs of the CINMS.

Council Action:

Consider the Next Steps in Implementation of Fishing Regulations through the MSA.

Reference Materials:

1. Agenda Item H.1.a, Attachment 1: Ecosystem-Based Fishery Management, A Report to Congress by the Ecosystem Principles Advisory Panel. National Marine Fisheries Service.
2. Agenda Item H.1.a, Attachment 2: Strengthening Scientific Input and Ecosystem-Based Fishery Management for the Pacific and North Pacific Fishery Management Councils, Suggestions from a Panel Discussion. Pacific States Marine Fisheries Commission.
3. Agenda Item H.1.a, Attachment 3: Fishery Ecosystem Plan for the Aleutian Islands, A Discussion Paper. North Pacific Fishery Management Council.
4. Agenda Item H.1.a, Attachment 4: Draft Environmental Impact Statement, Towards an Ecosystem Approach for the Western Pacific Region: From Species-based Fishery Management Plans to Place-Based Fishery Ecosystem Plans. Western Pacific Fishery Management Council.
5. Agenda Item H.1.c, Public Comment.

Agenda Order:

a. Agenda Item Overview — Mike Burner
b. Reports and Comments of Advisory Bodies
c. Public Comment
d. **Council Action:** Consider the Next Steps in Implementation of Fishing Regulations through the Magnuson-Stevens Act

PFMC
10/26/06

Pacific Fishery Management Council

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October 10, 2006

Mr. Chris Mobley, CINMS Superintendent
NOAA, National Marine Sanctuary Program
113 Harbor Way, Suite 150
Santa Barbara, California 93109

RE: Proposed Marine Reserves in the Channel Islands National Marine Sanctuary.

Dear Mr. Mobley,

Thank you for the opportunity to review and comment on the draft environmental impact statement (DEIS) and proposed rule for the consideration of marine reserves and marine conservation areas within the Channel Islands National Marine Sanctuary (CINMS). The Pacific Fishery Management Council (Pacific Council) reviewed the DEIS and the *Federal Register (FR)* notice of the proposed rule at the September 10-15, 2006, Pacific Council meeting, where they took input from its advisory bodies and the public. The Pacific Council tasked me with providing this response, which is based on the results of the September 2006 Pacific Council meeting and the administrative record of Pacific Council meetings since 2001, when this matter was first brought before the Pacific Council.

It is important to note that the continuing premise of the Pacific Council is that fishing regulation is properly done in the Pacific Council forum, in a holistic manner that takes into consideration the full range and ecosystem of the fish stocks involved. The position that fishing regulation in the CINMS should be done in the Pacific Council forum under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) is consistent with original justification of the CINMS and terms of its Designation Document.[1] It is also consistent with advisory letters from Undersecretary of Commerce for Oceans and Atmosphere VADM Conrad Lautenbacher on behalf of the National Oceanic and Atmospheric Administration (NOAA).[2] Lastly, it is consistent with verbal testimony from National Ocean Service (NOS) and CINMS representatives over the course of Pacific Council meetings considering this matter, who have repeatedly stated that the CINMS does not have an *a priori* intent to regulate fishing, and is only in a position to propose doing so in this narrow situation as a result of advice that the past record of the Pacific Council is currently insufficient to enact fishery restrictions in the water column of the areas in question.

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[1] Article 5, Section 1 of the CINMS Designation document, as currently in place unchanged from 45 FR 65200, October 2, 1980, states, "The regulation of fishing is not authorized under Article 4." (Article 4 is the *Scope of Regulation*).

[2] Letters date October 19, 2005 and December 30, 2005, from the latter, "While NOAA plans to move forward with the NMSA process, and has concluded the section 304(a)(5) process, we encourage you to continue your efforts to address fishing activities in the water column under various other Fishery Management Plan authorities."

The proposed regulations and changes to the Designation Document do not specifically allude to only regulating fishing in the water column. However, we also note that the objectives and goals of the CINMS leading to the establishment of a network of marine protected areas in Federal waters have already been accomplished under the MSA with regard to the regulation of fishing associated with the sea floor.[3] We presume that the choice of fishery regulation language in the proposed rule, which does not specifically mention the regulation of fishing only in the water column, serves the purpose of including non-fishing use effects on the benthos as opposed to any intent to reserve the authority for further regulation of benthic fishing.

In general, the Pacific Council remains supportive of achieving the goals and objectives of the State of California and the CINMS with regard to establishing a network of marine protected areas in the CINMS. Again however, the Pacific Council feels strongly this should be accomplished under the authorities of the MSA and State jurisdiction and not by initiating new fishing regulation authority for the CINMS. Should fishery regulations be promulgated under the National Marine Sanctuaries Act (NMSA), the Pacific Council wishes to contribute its expertise to ensure that any Federal fishery regulations are enforceable, are clearly understood by the public, and meet the goals and objectives of the Pacific Council and the CINMS.

This letter provides notice of the Pacific Council intent to move forward with achieving the remaining necessary fishery regulations and protective measures in these areas though the existing authorities of West Coast States and the MSA. However, if the CINMS Designation Document modifications providing authority over fishing activities and accompanying NMSA fishing regulations are determined to be necessary, this letter also: 1) conveys the Pacific Council recommendation that the duration of any fishing regulations brought about by action under the NMSA, and changes to the Designation Document as they pertain to the regulation of fishing, automatically sunset at the time regulations are promulgated under MSA; 2) conveys the Pacific Council recommendation that the scope of the proposed authority to regulate fishing, as described in the DEIS, is too broad; and 3) conveys specific comments on the documents in support of the proposed action, i.e., the DEIS, the FR notice, and the proposed rule.

PACIFIC COUNCIL INTENT TO ESTABLISH PROPOSED RESERVES AND PROTECTED AREAS VIA THE MSA

The Pacific Council understands that past action under the MSA has achieved the desired fishing regulation necessary to accomplish the stated goals and objectives of the CINMS, with the exception of fishery regulation in the water column. Accordingly, the Pacific Council has scheduled further process to adopt fishery regulations in these areas. At the upcoming November 12-17, 2006 Pacific Council meeting in Del Mar, California, the Pacific Council will explore several potential avenues for such action under the authority of the MSA. Therefore, the Pacific Council continues to recommend the CINMS Designation Document not be changed regarding the authority to regulate fisheries.

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[3] 50 CFR 660.306(h)(9)

THE DURATION OF PROPOSED FISHERY REGULATIONS AND AUTHORITY TO REGULATE FISHING

If the CINMS Designation Document is modified to provide authority over fishing activities and the proposed NMSA fishing regulations are implemented, the Pacific Council provides both comment and a recommendation on the duration of such changes to regulate fishing in the water column of proposed marine protected areas. First, it appears the use of an "effective date" provision in the proposed regulation is unclear, burdensome, and inconsistent with the model language previously presented to the Pacific Council by NOS for inclusion under the NMSA 304(a)(5) process, and therefore should not be used. The Pacific Council recommends the duration of both the fishing regulations promulgated under the proposed action and the authority of the CINMS to regulate fishing should automatically sunset when fishery regulation action under MSA is taken.

Under Section 922.73 of the proposed rule, fishery prohibitions would be promulgated under NMSA authority unless those prohibitions were enacted under MSA regulations as of an inserted effective date in the NMSA final rule; sections 922.73(a) and 922.73(b) of the proposed rule state "Unless prohibited by 50 CFR Part 660 (Fisheries off West Coast States) as of [effective date of final rule], the following activities are prohibited…." This approach is unclear as to what happens if MSA regulations are promulgated after the inserted effective date. Although the preamble to the proposed rule attempts to clarify NOAA's intent to pursue rulemaking activities to reduce the scope of NMSA fishing regulations when MSA regulations can be promulgated, there is nothing in the proposed regulatory language to ensure it will happen. The approach is burdensome in that it requires a proposed and final rulemaking process under the NMSA to execute the transition to MSA authority. The approach is also inconsistent with regard to the model language presented to the Pacific Council in November 2005 by the CINMS for inclusion under the 304(a)(5) process. This model language included no date after which NMFS regulations under 50 CFR Part 660 are not considered without additional NMSA rulemaking.

If CINMS Designation Document modifications providing authority over fishing activities and accompanying NMSA fishing regulations are determined to be necessary, the Pacific Council recommends that a direct approach be used for sunsetting the NMSA regulations and Designation Document changes automatically at the time fishing regulations are promulgated under the MSA. For the proposed rule, it is recommended that the sentences in the first paragraphs of Sections 922.73(a) and 922.73(b) of the proposed rule beginning "Unless prohibited by 50 CFR Part 660 (Fisheries off West Coast States) as of [effective date of final rule], the following activities are prohibited…." be changed to direct language dictating the NMSA regulations be automatically sunset, such as "The following activities are prohibited until such date as regulations are adopted under 50 CFR Part 660. At that time, regulations promulgated under this rulemaking are rescinded and shall not be in effect." Similarly, it is recommended that a provision be included in any Designation Document changes to mandate automatic sunsetting of any fishery regulation authority of the CINMS. This would be accomplished by adding a new Article 7 to the CINMS Designation Document, such as: "Article 7. Automatic Sunsetting of Fishery Regulation Authority. At the time fishery regulations are promulgated under 50 CFR Part 660 that achieve the goals and objectives of the marine reserves, marine parks, or marine conservation areas established under [insert reference to regulations implemented in the NMSA final rule], all revisions in the Designation Document made under [insert reference to and date of FR notification of CINMS Designation Document changes] sunset and are rescinded and shall not be a functional part of the CINMS Designation Document from that date forward."

THE SCOPE OF PROPOSED AUTHORITY TO REGULATE FISHING

Regarding fishery regulatory authorities proposed for Articles 4 and 5 of the CINMS Designation Document, the Pacific Council found the language regarding the scope of such authority to be vague and unnecessarily broad. The Pacific Council understands the intent of the proposed Designation Document change is to limit CINMS authority to the present action of establishing specific marine reserves and marine conservation areas. The FR notice and the DEIS propose to limit the authority to regulate fishing "within the scope of the State of California's Final Environmental Document 'Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary' (California Department of Fish and Game, October 2002), certified by the California Fish and Game Commission." The Pacific Council notes that the scope of the referenced CDFG document includes a suite of action alternatives relative to establishing marine protected areas ranging from status quo, under which no new fishing regulations are implemented but can be changed at any time, to action alternatives covering larger areas than those in the current preferred alternative (DEIS Alternative 1a).

Testimony at Pacific Council meetings from NOS and CINMS representatives has indicated that the proposed fishing regulation rules and Designation Document changes would be limited just to the narrow scope of 1) the fishing regulations not currently accomplishable under the MSA and 2) only in the areas finally adopted to match marine protected areas created by State of California action in 2002. Towards that end, the Pacific Council recommends that should the CINMS Designation Document be modified to provide authority over fishing activities, the scope of such authority be limited to the areas and regulations in the preferred action alternative rather than the broad suite of alternatives contained in the "Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary" document as currently proposed.

SPECIFIC COMMENTS ON SUPPORT DOCUMENTS

DEIS Socioeconomic Analyses

The Pacific Council recommends improvements to the socioeconomic analyses presented in the DEIS. The Pacific Council notes that the economic data used in many of the analyses are dated and reports from both Pacific Council members and the Pacific Council's Groundfish Advisory Subpanel indicate estimates of lost revenue and maximum potential loss are lower than data from more recent fishing seasons.

Clarification on DEIS Language Regarding the Cowcod Conservation Area

The Pacific Council notes that language in the first full paragraph of page 80 of the DEIS refers to implementation of the Cowcod Conservation Area by the California Department of Fish and Game. As a point of clarification, these area closures were first implemented in Federal waters by the Pacific Council and NMFS and were followed by California State action in State-managed nearshore areas.

Changes to the Proposed Regulatory Language

The Pacific Council and its advisory bodies spent a great deal of time with CINMS staff during the NMSA 304(a)(5) process to cooperatively develop effective and enforceable fishing regulations that the fishing community could understand and comply with. The Pacific Council's Enforcement Consultant group reviewed the proposed regulations presented in the proposed rule at the September Pacific Council meeting. The Pacific Council recommends the proposed definition of "stowed gear" and the possession regulations with a marine conservation area be modified as follows.

Replace the current definition of "*Stowed and not available for immediate use*" in Section 922.71 with the following list of stowed gear definitions developed by the Enforcement Consultants:

922.71 Definitions.

Stowed Gear Definition. For the purposes of this regulation,

(a) *Stowed recreational hook and line fishing gear* is defined as hook and line gear with all line reeled to the reel or rod tip with hooks secured to the rod and not actively fishing.

(b) *Stowed recreational lobster fishing gear* is defined as un-baited hoop-net gear with all lines detached from the net.

(c) *Stowed spear guns*: unloaded, or partially disassembled (such as spear shafts being kept separate from spear gun).

(d) *Stowed Trawl gear* must be stowed either below deck, or if the gear cannot readily be moved, in a secured and covered manner, detached from all towing lines, so that it is rendered unusable for fishing; or remain on deck uncovered if the trawl doors are hung from their stations and the net is disconnected from the doors.

(e) *Stowed Commercial lobster fishing gear* is defined as an un-baited trap placed on or below a vessel surface and tied to such surface in a manner that would not allow immediate deployment.

Regarding the regulations limiting possession of legally harvested fish in a marine conservation area, Section 922.73(b)(3) prohibits "Possessing any living or dead organism, historical resource, or other Sanctuary resource, except legally harvested fish on board a vessel at anchor or in transit." The Pacific Council does not feel this is the intent of the regulation and recommends the phrase "at anchor or in transit" be removed because limited fishing opportunities are proposed for marine conservation areas with the expectation that fisherman would also possess legally harvested fish while continuing to fish, not only when anchored or in transit.

In conclusion, the Pacific Council looks forward to working with CINMS staff to achieve the goals and objectives of CINMS through the Pacific Council process and MSA and state authorities. If you or your staff have any questions regarding this letter, please contact me or Mr. Mike Burner, the lead Staff Officer on this matter at 503-820-2280.

Sincerely,

Donald McIsaac, Ph.D.
Executive Director

MDB:ckc

c:

Mr. Jack Dunnigan
Mr. Daniel Basta
Dr. Rodney Weiher
Mr. William Douros
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Ms. Eileen Cooney
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Mr. Mike Burner
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Mr. Sam Rauch
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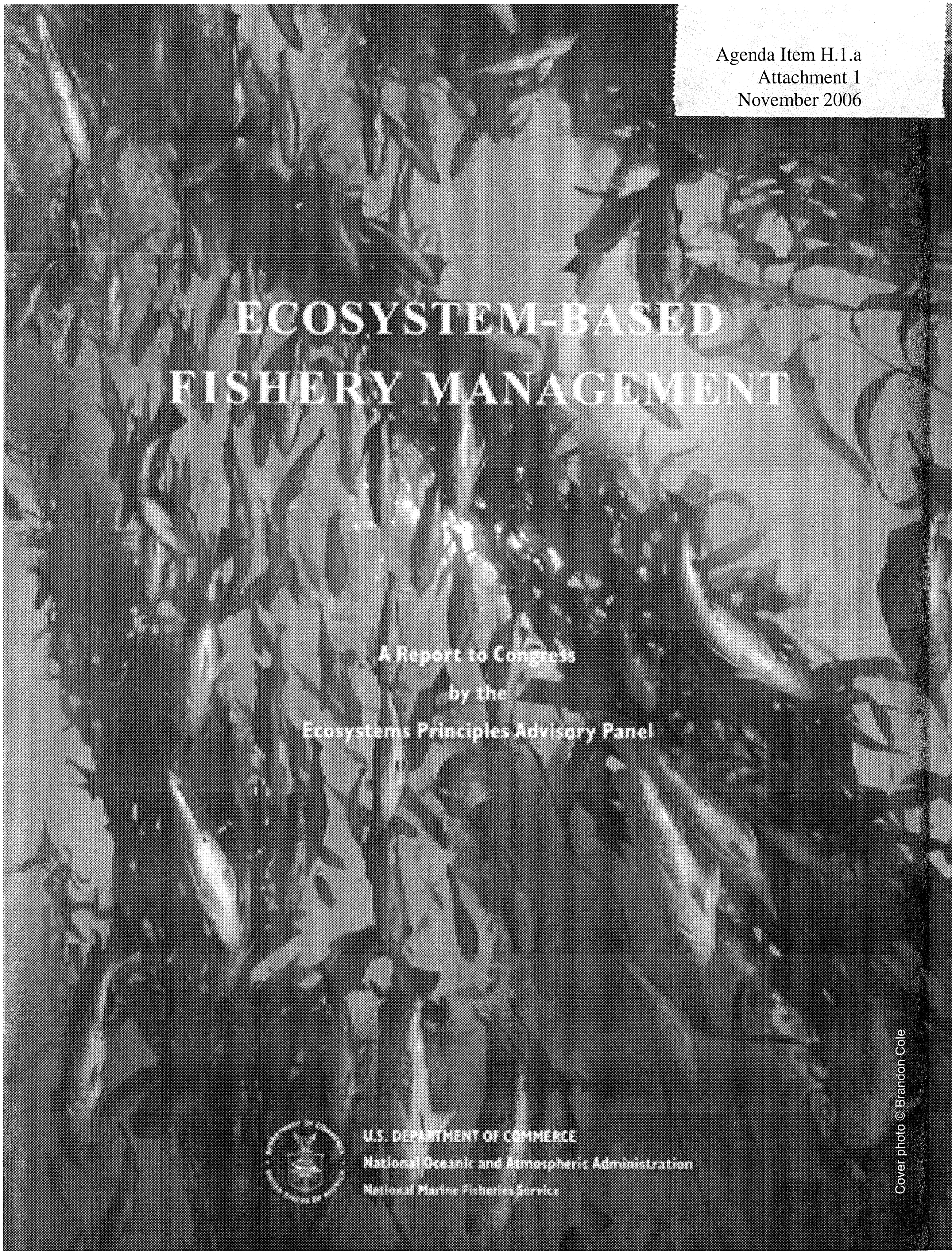
Agenda Item H.1.a
Attachment 1
November 2006



ECOSYSTEM-BASED FISHERY MANAGEMENT

A Report to Congress
by the
Ecosystems Principles Advisory Panel

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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ECOSYSTEM-BASED FISHERY MANAGEMENT

A Report to Congress

by the

Ecosystem Principles Advisory Panel

As mandated by the Sustainable Fisheries Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act of 1996

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

April 1999

NATIONAL MARINE FISHERIES SERVICE
ECOSYSTEM PRINCIPLES ADVISORY PANEL

Chair, David Fluharty .... University of Washington/North Pacific Fishery Management Council

Pete Aparicio .... Texas Shrimpers Association/Gulf of Mexico Fishery Management Council
Christine Blackburn .... Alaska Groundfish Data Bank
George Boehlert .... NMFS, Pacific Fisheries Environmental Laboratory
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Aliçon Morgan .... Atlantic States Marine Fisheries Commission

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ACKNOWLEDGMENTS

While the Ecosystem Principles Advisory Panel takes full responsibility for the content of this report, we would like to give thanks and credit to others for the assistance they so generously provided to us. The first thanks goes to members of Congress who responded to public and agency interests in expanding the use of ecosystem-based management in the fishery management processes in the United States. Next, we appreciate the help given to the National Marine Fisheries Service (NMFS) by the National Research Council in nominations for Panel membership. The Panel is extremely grateful to the NMFS staff, its regional Science Centers, regional administrative staffs, and Council staffs for their technical support and advice during this process. Similarly, a significant boost to our deliberations came from State and other agencies, individuals, and organizations who met with us (Appendix C) and provided considerable insight. A special thanks is due to Alec MacCall and four other (anonymous) reviewers of the report. Ned Cyr, David Detlor, and Aliçon Morgan, NMFS Office of Science and Technology, composed the core team who coordinated meetings, produced drafts, and attended to all the details of text manipulation. Willis Hobart and David Stanton, NMFS Scientific Publication Office, deserve special recognition for their editing assistance and development of a format for this presentation. Panel members owe a collective debt of gratitude to our respective institutions, colleagues, friends, and families who have supported and encouraged our participation in this endeavor.

PREFACE

Seeking solutions to reverse the decline of New England's fisheries in 1871, Congress created the U.S. Commission of Fish and Fisheries (Hobart 1995). The first appointed Commissioner, Spencer Baird, initiated marine ecological studies as one of his first priorities. According to Baird, our understanding of fish "... would not be complete without a thorough knowledge of their associates in the sea, especially of such as prey upon them or constitute their food...." He understood that the presence or absence of fish was related not only to removal by fishing, but also to the dynamics of physical and chemical oceanography.

Despite this historical, fundamental understanding of fisheries as part of ecosystems, we have continued to struggle to manage fish harvests while simultaneously sustaining the ecosystem. Recognizing the need for a more holistic management approach, Congress charged the National Marine Fisheries Service (a direct descendant of the U.S. Commission of Fish and Fisheries) with establishing an Ecosystem Principles Advisory Panel to assess the extent that ecosystem principles are used in fisheries management and research, and to recommend how such principles can be further implemented to improve our Nation's management of living marine resources. The resulting Panel was composed of members of industry, academia, conservation organizations, and fishery management agencies. The Panel's diversity played a substantial role in the development of a pragmatic approach to expand ecosystem-based fishery management within the context of the existing fishery management system.

The Panel attempted to build on the progress of past efforts, namely the 1996 Sustainable Fisheries Act's (SFA) amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (NMFS 1996). The provisions of the SFA require the Regional Fishery Management Councils to set harvest rates at or below maximum sustained yield levels; develop rebuilding plans for those species that are currently below the long-term sustainable yield; better account for and minimize bycatch and discard of fish; identify essential fish habitat and take measures to protect it; and determine the effects of fishing on the environment. These actions are being implemented and are vital to achieving ecosystem-based management. Still, it will take years to decades before the results are fully realized.

The Panel forged a consensus on how to expand the use of ecosystem principles in fishery management. We do not have a magic formula, but we offer a practical combination of principles and actions that we believe will propel management onto ecologically sustainable pathways. By asking more encompassing questions about fisheries management such as, "What are the effects of fishing on other ecosystem components?" and "What are acceptable standards for fisheries removals from ecosystems?" we are broadening the scope of management and ultimately making fisheries sustainable.

Ecosystem-based fishery management is likely to contribute to increased abundance of those species that have been overfished. It may, however, require reduced harvest of species of critical importance to the ecosystem. We expect that ecosystem-based fishery management will contribute to the stability of employment and economic activity in the fishing industry and to the protection of marine biodiversity on which fisheries depend. As a society, we are recognizing the limits of the sea to provide resources and of our abilities to stay within those limits. What are acceptable levels of change in marine environments due to fishing? This Report does not answer that question for society, but it does set a framework for beginning to take actions based on the insight of Baird 127 years ago.

David Fluharty
Chair, Ecosystem Principles Advisory Panel
Seattle, Washington
November 15, 1998

EXECUTIVE SUMMARY

Ecosystem-based management can be an important complement to existing fisheries management approaches. When fishery managers understand the complex ecological and socioeconomic environments in which fish and fisheries exist, they may be able to anticipate the effects that fishery management will have on the ecosystem and the effects that ecosystem change will have on fisheries. However, ecosystem-based management cannot resolve all of the underlying problems of the existing fisheries management regimes. Absent the political will to stop overfishing, protect habitat, and support expanded research and monitoring programs, an ecosystem-based approach cannot be effective.

A comprehensive ecosystem-based fisheries management approach would require managers to consider all interactions that a target fish stock has with predators, competitors, and prey species; the effects of weather and climate on fisheries biology and ecology; the complex interactions between fishes and their habitat; and the effects of fishing on fish stocks and their habitat. However, the approach need not be endlessly complicated. An initial step may require only that managers consider how the harvesting of one species might impact other species in the ecosystem. Fishery management decisions made at this level of understanding can prevent significant and potentially irreversible changes in marine ecosystems caused by fishing.

Recognizing the potential of an ecosystem-based management approach to improve fisheries management, Congress requested that the National Marine Fisheries Service (NMFS) convene a panel of experts to: 1) assess the extent to which ecosystem principles are currently applied in fisheries research and management; and 2) recommend how best to integrate ecosystem principles into future fisheries management and research. In response, NMFS created the National Marine Fisheries Service Ecosystem Principles Advisory Panel (Panel).

WHAT BASIC ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES CAN BE APPLIED TO FISHERIES MANAGEMENT AND RESEARCH?

To guide our deliberations, we developed a set of eight ecosystem operating principles (Principles) with societal goals for ecosystems (Goals), and a set of six management policies (Policies). These Principles, Goals, and Policies were used to evaluate the current application of ecosystem-based fisheries management and to develop recommendations for further implementation of such approaches.

BASIC ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES

Based on the Panel's experience and review of the fisheries ecosystem literature, we suggest that the following Principles, Goals, and Policies embody key elements for ecosystem-based management of fisheries.

Principles

- The ability to predict ecosystem behavior is limited.
- Ecosystems have real thresholds and limits which, when exceeded, can effect major system restructuring.
- Once thresholds and limits have been exceeded, changes can be irreversible.
- Diversity is important to ecosystem functioning.
- Multiple scales interact within and among ecosystems.
- Components of ecosystems are linked.
- Ecosystem boundaries are open.
- Ecosystems change with time.

Goals

- Maintain ecosystem health and sustainability.

Policies

- Change the burden of proof.
- Apply the precautionary approach.
- Purchase "insurance" against unforeseen, adverse ecosystem impacts.
- Learn from management experiences.

- Make local incentives compatible with global goals.
- Promote participation, fairness, and equity in policy and management.

TO WHAT EXTENT ARE ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES CURRENTLY APPLIED IN RESEARCH AND MANAGEMENT?

The Panel considered a management system based on the ecosystem Principles, Goals, and Policies, as a framework with which to evaluate the current application in U.S. marine fisheries management and research. This model was then compared to the current state of research and management.

We conclude that NMFS and the Regional Fishery Management Councils (Councils) already consider and apply some of the Principles, Goals, and Policies outlined above, but they are not applied comprehensively or evenly across Council jurisdictions, NMFS Regions, or ecosystems. The fact that the Principles are not applied consistently in U.S. fisheries management and research should not be interpreted as reluctance or intransigence on the part of these entities to adopt ecosystem approaches. Rather, these agencies lack both a clear mandate and resources from Congress to carry out this more comprehensive, but ultimately more sustainable approach. Furthermore, the ecosystem-based management of fisheries is a relatively new concept and there are considerable gaps in knowledge and practice.

HOW CAN WE EXPAND THE APPLICATION OF ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES TO FISHERIES RESEARCH AND MANAGEMENT?

Several practical measures can be implemented immediately to make U.S. fisheries management and research more consistent with the ecosystem Principles (see **Summary of Recommendations**). These measures comprise an incremental strategy for moving toward ecosystem-based fisheries research and management.

Councils should continue to use existing Fishery Management Plans (FMP) for single species or species complexes, but these should be amended to incorporate ecosystem approaches consistent with an overall Fisheries Ecosystem Plan (FEP). The FEP, to be developed for each major ecosystem under Council jurisdiction, is a mechanism for incorporating the Principles, Goals, and Policies into the present regulatory structure. The objectives of FEPs are to:

- Provide Council members with a clear description and understanding of the fundamental physical, biological, and human/institutional context of ecosystems within which fisheries are managed;
- Direct how that information should be used in the context of FMPs; and
- Set policies by which management options would be developed and implemented.

Fisheries management based on the ecosystem Principles, Goals, and Policies must be supported by comprehensive research. Significant ecosystem research is now conducted by the National Oceanic and Atmospheric Administration (NOAA) and other agencies, as well as the academic community. This research is critical and must continue, but must expand into several key areas. First, we must better understand the long-term dynamics of marine ecosystems and how they respond to human-induced change, particularly changes brought about by fishing. Second, we must develop governance systems which have ecosystem health and sustainability, rather than short-term economic gain, as their primary goals.

THE FUTURE OF ECOSYSTEM APPROACHES IN U.S. FISHERIES MANAGEMENT

Fisheries scientists and managers are beginning to grasp the potential of ecosystem-based fishery management to improve the sustainability of fisheries resources. Given the depressed state of many U.S. fisheries, this awareness must be expanded and actions taken to implement this approach. Our management recommendations and research actions provide a pragmatic framework within which to apply the ecosystem Principles, Goals, and Policies. The success of this approach depends on full implementation of measures already underway as a result of the passage of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (NMFS 1996), particularly the essential fish habitat (EFH) requirements and strengthened national standards. The recommendations contained in this report provide the required next steps.

While some of the recommended actions can start immediately, we believe that legislation is required to implement measures like the FEP. Given that legislative processes may require three to five years to enact the proposed regulations, we recommend interim actions by the Secretary of Commerce to develop demonstration FEPs and to encourage voluntary adoption by management Councils of the Principles, Goals, and Policies proposed herein. We also are aware that these new tasks will require additional human and financial resources for full implementation.

The benefits of adopting ecosystem-based fishery management and research are more sustainable fisheries and marine ecosystems, as well as more economically-healthy coastal communities. We have identified the actions required to realize these benefits. We urge the Secretary and Congress to make those resources available.

SUMMARY OF RECOMMENDATIONS

Fisheries management and policy recommendations are directed toward Congress for implementation by NMFS and the Councils. Interim measures and research recommendations are directed toward the Secretary of Commerce for implementation by NMFS and other appropriate agencies.

Develop a Fisheries Ecosystem Plan (FEP)

Require each Council to develop an FEP for the ecosystem(s) under its jurisdiction. The FEP is an umbrella document containing information on the structure and function of the ecosystem in which fishing activities occur, so that managers can be aware of the effects their decisions have on the ecosystem, and the effects other components of the ecosystem may have on fisheries.

Each FEP should require the Councils to take, at least, the following eight actions:

1. Delineate the geographic extent of the ecosystem(s) that occur(s) within Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems, and "zone" the area for alternative uses.

The first step in using an ecosystem approach to management must be to identify and bound the ecosystem. Hydrography, bathymetry, productivity, and trophic structure must be considered; as well as how climate influences the physical, chemical, and biological oceanography of the ecosystem; and how, in turn, the food web structure and dynamics are affected. Transfers across ecosystem boundaries should be noted.

Within each identified ecosystem, Councils should use a zone-based management approach to designate geographic areas for prescribed uses. Such zones could include marine protected areas, areas particularly sensitive to gear impacts, and areas where fishing is known to negatively affect the trophic food web.

2. Develop a conceptual model of the food web.

For each targeted species, there should be a corresponding description of both predator and prey species at each life history stage over time. FEPs can then address the anticipated effects of the allowed harvest on predator-prey dynamics.

3. Describe the habitat needs of different life history stages for all plants and animals that represent the "significant food web" and how they are considered in conservation and management measures.

Essential fish habitat (EFH) for target and non-target species at different life stages should be identified and described. Using habitat and other ecosystem information, Councils should develop zone-based management regimes, whereby geographic areas within an ecosystem would be reserved for prescribed uses. FEPs should identify existing and potential gear alternatives that would alleviate gear-induced damage to EFH, as well as restrict gears which have adverse affects. Further, FEPs should evaluate the use of harvest refugia as a management tool to satisfy habitat needs.

4. Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure.

Total removals (i.e., reported landings, unreported landings, discards, and mortality to fish that come into contact with fishing gear but are not captured) should be incorporated into qualitative food web and quantitative stock assessment models. These models will allow managers to reduce uncertainty, monitor ecosystem health and better predict relative abundance of species affected by the harvest of target species.

5. Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions.

Given the variability associated with ecosystems, managers should be cognizant of the high likelihood for unanticipated outcomes. Management should acknowledge and account for this uncertainty by developing risk-averse management strategies that are flexible and adaptive.

6. Develop indices of ecosystem health as targets for management.

Ecosystem health refers to a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization that has evolved naturally. Provided that a healthy state can be determined or inferred, management should strive to generate and maintain such a state in a given ecosystem. Inherent in this management strategy would be specific goals for the ecosystem, including a description of "unhealthy" states to be avoided.

7. Describe available long-term monitoring data and how they are used.

Changes to the ecosystem cannot be determined without long-term monitoring of biological indices and climate. Long-term monitoring of chemical, physical and biological characteristics will provide a better understanding of oceanic variability and how climate changes affect the abundance of commercially important species and their corresponding food webs.

8. Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/Department of Commerce (DOC) authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.

Councils and DOC have authority over a limited range of the human, institutional, and natural components of a marine ecosystem. It is important to recognize those components of the ecosystem over which fisheries managers have no direct control, and to develop strategies to address them in concert with appropriate international, Federal, State, Tribes, and local entities.

Measures to Implement FEPs

The following are general recommendations to ensure effective development and implementation of FEPs:

1. Encourage the Councils to apply ecosystem Principles, Goals, and Policies to ongoing activities.

In preparation for FEP implementation, Councils should begin to apply the ecosystem Principles, Goals, and Policies to the conservation and management measures of existing and future FMPs. Three actions are particularly important; specifically, each FMP's conservation and management measures should:

- Consider predator-prey interactions affected by fishing allowed under the FMP.
- Consider bycatch taken during allowed fishing operations and the impacts such removals have on the affected species and the ecosystem as a whole, in terms of food web interactions and community structure.
- Minimize impacts of fisheries operations on EFH identified within the FEP.

2. Provide training to Council members and staff.

To facilitate an ecosystem approach and to aid the development and implementation of FEPs, NMFS should provide all Council members with basic instruction in ecological principles. Further, training materials should be made available to the fishing industry, environmental organizations, and other interested parties.

3. Prepare guidelines for FEPs.

The Secretary of Commerce should charge NMFS and the Councils with establishing guidelines for FEP development, including an amendment process. NMFS and the Councils should conduct a deliberative process—similar to the process of developing National Standards Guidelines—to ensure that FEPs are realistic and adaptive.

4. Develop demonstration FEPs.

While encouraging all Councils to develop framework FEPs, the Secretary of Commerce should designate a Council or Councils to develop a demonstration FEP, as a model to facilitate rapid implementation of the full FEP when required in MSFCMA reauthorization.

5. Provide oversight to ensure development of and compliance with FEPs.

To ensure compliance with the development of FEPs, the Secretary of Commerce should establish a review panel for FEP implementation oversight. Implicit in this action is the establishment of a timetable for development of a draft FEP, its review by the panel, and any necessary revisions before the draft FEP becomes a basis for policy.

6. Enact legislation requiring FEPs.

To provide NMFS and the Councils with the mandated responsibility of designing and implementing FEPs, Congress should require full FEP implementation in the next reauthorization of the MSFCMA.

Research Required to Support Management

Require and provide support for NMFS and other appropriate agencies to initiate or continue research on three critical research themes which will provide the information necessary to support ecosystem-based fisheries management. These themes are:

1. Determine the ecosystem effects of fishing.

Fishing affects target species, non-target species, habitat, and potentially marine ecosystems as a whole. A directed program must be initiated to determine all effects of fishing on marine ecosystems.

2. Monitor trends and dynamics in marine ecosystems (ECOWATCH).

In order to detect, understand, and react appropriately to ecosystem changes, a broad-scale ecosystem research and monitoring program must be undertaken based on the best available technology. We refer to this program as "ECOWATCH" because it will enable scientists and managers to observe ecosystem changes in a comprehensive manner.

3. Explore ecosystem-based approaches to governance.

Many of today's fisheries problems stem from governance systems which create incentives that are incompatible with, or inimical to, ecosystem-level Goals (e.g., health and sustainability). Alternate governance systems must be identified which provide fishermen and others with incentives to consider the health and sustainability of the ecosystem as primary goals.

ECOSYSTEM-BASED FISHERY MANAGEMENT

SECTION ONE: INTRODUCTION

The National Marine Fisheries Service (NMFS) was charged by Congress to establish an Ecosystem Principles Advisory Panel (Panel) to identify ecosystem principles, evaluate how those principles are currently used in fishery management and research, and then to recommend measures that would expand their use in fishery management and research. Our Charter (Appendix A) describes the rationale for our effort and provides the charge to this Panel. Here we outline our views of the historical developments and current issues leading to this charge. We lay out a conceptual framework that includes management actions and research on marine resources and fisheries in an ecosystem context.

THE PROBLEM

The world's oceans are at or near maximum sustainable fishery yields. The number of overexploited stocks increased by 2.5 times between 1980 and 1990 (Alverson and Larkin 1994). Much of the global sustained yield is being accomplished by increased fishing for species at progressively lower trophic levels (Pauly et al. 1998). The prospect of increasing total sustained yield is unlikely (Pauly and Christensen 1995). Although fisheries provide direct or indirect employment to about 200 million people (Garcia and Newton 1997), overfishing is the most commonly observed result of fishery development. The consequences of overharvesting are expressed in social, economic, cultural, and ecological changes. The ecological consequences of overfishing often are undocumented and may be poorly known or overlooked.

Since 1990, annual harvests by U.S. fleets have been slightly in excess of 4.5 million metric tons, with nearly half of that coming from two fisheries—menhaden and Alaska pollock. In its annual report to Congress on the status of the fisheries of the U. S., NMFS states that of the 727 managed stocks in the United States, 86 are overfished, 10 are approaching overfished status, and 183 are not overfished (NMFS 1997). This leaves 448 stocks, for which the status is virtually unknown. NMFS (1997) also indicates that "additional stocks will likely be identified as overfished" under the new definition of overfishing in the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA).

While there are some encouraging recoveries (e.g., striped bass in the Atlantic and Pacific sardine), record-setting yields (e.g., Alaska salmon), and management successes (e.g., Pacific halibut), those cases are the exceptions rather than the rule. As in the global case, we should be concerned that overfishing will be a common consequence for most fisheries (Ludwig et al. 1993, Mooney 1998), although this need not be the case (Rosenberg et al. 1993).

This issue is urgent because the current harvest levels are high and because new fisheries will rise, be fully capitalized, and reach unsustainable levels of catch levels before the management process can establish effective constraints. That, unfortunately, is the too-common lesson of history (Ludwig et al. 1993). In many cases, the ecological correlates of changing fish populations could have served as evidence of intensified exploitation effects. Frequently, the advent of a fishery and implementation of catch restrictions have unknown ecological consequences. Too often, we learn about ecological consequences after the fact, because we do not consider them in our decision-making, nor do we monitor ecosystem changes due to increased exploitation. Those lessons are not unique to fisheries. Many Federal, regional and State resource management agencies are now moving toward or considering an ecosystem approach in their attempt to provide a holistic framework for resource management. Fisheries must do so as well (Langton and Haedrich 1997).

FISHERIES IN AN ECOSYSTEM CONTEXT

Much of the foundation of fisheries science provides a basis for determining maximum yields so that fishing can safely remove surplus production (Hilborn and Walters 1992). However, when fishing is examined in an ecosystem context, the rationale for harvesting surplus production is unclear. Marine ecosystems are effective at capturing energy, cycling nutrients, and producing biomass. Very little, if any of this biomass, is truly "surplus" to an ecosystem; before the advent of fisheries, it was recycled within the ecosystem. Consequently, our societal decision to harvest fish induces ecological changes among competitors, prey, and predators as the system responds to fishing and the trophically-induced changes fishing causes in ecosystems. These changes affect future levels of surplus production of the harvested population, including the possibility that there may be none.

We understand that fisheries must continue, because they provide food, desirable social and economic benefits, and because the cultural traditions of fishing are highly valued. However, we also understand that overutilized fisheries are a serious threat to those traditions and benefits (National Research Council 1999). Conflict thus develops when management agencies (e.g., NMFS, Regional Fishery Management Councils, etc.) seek to implement sustainable yield policies for open-access resources, when fishery effects extend to animals protected by our Endangered Species Act or Marine Mammal Protection Act, and, most recently, when conservation and management interests assert that the burden of proof should be placed on the fishing industry (i.e., to demonstrate that exploitation does not produce large-scale and long-term ecological changes) (Dayton 1998). Finding the balance between competing interests is a difficult challenge, and each fishery will have its unique solutions. On the Federal level, NMFS will be expected to provide the ecological insights that are essential for long-term protection of fish stocks and their ecosystems.

Decisions regarding fishing practices derive from our social, economic, political, and cultural context, and only secondarily from the ecological context that supports fisheries (Mooney 1998). A holistic view requires that we recognize fishery management and exploitation as a real and integral part of the marine ecosystem (Langton and Haedrich 1997). Because fishing actively removes a percentage of one or several species, it can affect the predators and prey of those species, their physical habitat, and it can change the growth and mortality rates of target and non-target species alike. In short, fishing can and is likely to alter the structure and function of marine ecosystems (Dayton 1998, Pauly et al. 1998). Humans are at the top of the global marine food chain. We thus have the obligation and opportunity to make choices to affect the marine environment positively.

While fishing has a long history, it is a relatively new force in the scales of evolutionary time. Fishing is typically a species-selective and size-selective agent of mortality and, therefore, is unlike the natural causes of mortality. Most of the fish removed by fishing activities are in the middle or near the top of their respective food webs. Fishing can be viewed as a keystone predator; the ecological effects of fishing are therefore substantially greater and more complex than simply the biomass removed. Thus, we should expect that substantial changes have or could occur in those ecosystems due to fishing. We have witnessed changes in the landscape around us with the advent of technology evolved from the axe and the plow. We should expect equally profound ecological changes from modern, large-scale uses of the hook and net.

Nature has limits

If nature is a shifting mosaic or in essentially continuous flux, then it may be wrong to conclude that whatever societies choose to do in or to the natural world is fine. The question can be stated as, "If the state of nature is flux, then is any human-generated change okay?" ... The answer to this question is a resounding "No!" ... Human-generated changes must be constrained because nature has functional, historical, and evolutionary limits. Nature has a range of ways to be, but there is a limit to those ways, and therefore, human changes must be within those limits. (Pickett et al. 1992).

MANAGING FISHERIES IN AN ECOSYSTEM CONTEXT

Ecosystem-based fisheries management does not require that we understand all things about all components of the ecosystem. We know that the traditional single-species approach of fisheries management is tractable, but we also know that it may not be sufficient. We know that an ecosystem perspective is desirable, but it is complex and unpredictable. There simply is not enough money, time, or talent to develop a synthetic and completely informed view of how fisheries operate in an ecosystem context. There will always be unmeasured entities, random effects, and substantial uncertainties, but these are not acceptable excuses to delay implementing an ecosystem-based management strategy.

Each fishery and each ecosystem is unique and yet, in all cases, we are confronted with four fundamental problems:

- We do not have a complete understanding of the ecological system that produces and supports fishes.
- We cannot forecast weather or climate and their effects on ecosystems.
- Systems evolve over time and knowing how the system works does not necessarily mean that an ecosystem would respond predictably to future changes in weather, climate, or fisheries.
- Our institutions are not configured to manage at the ecosystem scale. Fish and the fisheries that pursue them are not easily aligned with our political and jurisdictional boundaries.

These constraints are not unique to fisheries, they confront all attempts to manage natural resources in an ecosystem context. We know that the removal of one species can and does affect others, but rarely have we developed management plans that adequately account for those direct and indirect effects. We know that ecosystems have a limited carrying capacity that results in bounds on fish yields. We know that habitat loss contributes to declines in species abundance, but too often we only regulate catch, gear, or effort for one target species as a way to compensate for habitat loss and its effects on other species. We know that major, unexpected events (e.g., El Niño) can alter ecosystem processes, thus affecting species targeted by fisheries, but we have no method for integrating these events into our assessments of target species population trends (Mantua et al. 1997, Francis et al. 1998).

What are the potential gains of implementing an ecosystem approach to management, and how do we develop a holistic view that is both sufficient and tractable? In this report, we develop a strategy for implementing ecosystem-based management.

Legal Authorities for Ecosystem Management of Fisheries

The Magnuson-Stevens Fishery Conservation and Management Act allows fishery managers to consider ecosystems in setting management objectives. National Standard 1 requires conservation and management measures to "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery" (Sec. 301(a)(1)). The "optimum" yield is defined as providing "the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems" (Sec. 3(28)(A)). Moreover, the optimum yield is prescribed as "the maximum sustainable yield from each fishery, as reduced by any relevant economic, social or ecological factor" (Sec. 3(28)(B)). In addition, the Act states as one of its purposes "to promote the protection of essential fish habitat" (Sec. 2(b)(7)). To the extent that ecosystems are not being adequately considered in FMPs, it is not because of a lack of statutory authority so much as it is a lack of direction about what information is required and how it should be put into operation.

First, we develop a conceptual model that sets fisheries in the context of what we know about ecosystem theory (which is provided in the section on **Ecosystem Principles, Goals, and Policies**). Second, we provide a brief assessment of the extent to which ecosystem principles, goals, and policies are applied in U.S. fisheries research and management (**Current Applications of the Principles, Goals, and Policies**). Third, we offer a series of specific recommendations for applying these principles to the operational context of NMFS, the Regional Fishery Management Councils (Councils), their administrative structure and their management activities (**Recommendations for Implementing the Ecosystem Principles, Goals, and Policies in U.S. Fisheries Conservation, Management, and Research**). Finally, we recommend a comprehensive research program to provide the ecological and governance underpinnings for ecosystem-based fishery management.

Taken as a whole, the report presents our best advice about innovative approaches that can help set fisheries in an ecosystem context. Ecosystem-based management is an important new challenge. We expect that NMFS, Council managers, and scientists will develop creative ways to help meet that challenge. But these new approaches cannot substitute for compliance with existing mandates. Ecosystem-based management will require re-evaluation of the institutional structure necessary for effective management. It will also demand a strong political will expressed through Congress, NMFS and the Councils—one based on a broader appreciation of the ecosystem context within which we prosecute our fisheries (Hutchings et al. 1997).

SECTION TWO: ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES

There are two requirements for managing human interactions with marine ecosystems. One is to develop an understanding of the basic characteristics and principles of these ecosystems—what patterns they exhibit and how they function in space and time. The second is to develop an ability to manage activities that impact marine ecosystems, consistent with both their basic principles and with societal goals concerning the kinds of behavior we would like ecosystems to exhibit (i.e., health and sustainability).

This section lists eight basic ecosystem principles (Principles) and their parallels in human systems that are part of marine ecosystems. A discussion of societal goals (Goals) for ecosystem-based management follows. Finally, a list of general management policies (Policies) to achieve the Goals is provided.

BASIC ECOSYSTEM PRINCIPLES

Marine ecosystems are complex, adaptive systems composed of interconnected groups of living organisms and their habitats. Living organisms are constantly adapting and evolving to their environment (both to the physical environment, which varies on multiple scales, and to other living organisms with which they co-exist); this evolution leads to complex, sometimes chaotic dynamics.

Marine ecosystems are generally extensive and open. Their fluid environments are subject to variability in both local and remote inputs of energy (a consequence of physics operating on many spatial and temporal scales) which may dominate such systems. Highly variable and chaotic dynamics of living resources are often observed as well.

Today, humans are a major component in most ecosystems. The human component of the ecosystem includes the humans themselves, their artifacts and manufactured goods (economies), and their institutions and cultures. The human imposition of fishing mortality, at rates often higher than natural mortality, can have major impacts not only on targeted species but on the ecosystem itself.

The following eight Principles have analogs in both the human and nonhuman aspect of ecosystems:

1. The ability to predict ecosystem behavior is limited.

Uncertainty and indeterminacy are fundamental characteristics of the dynamics of complex adaptive systems. Predicting the behaviors of these systems cannot be done with absolute certainty, regardless of the amount of scientific effort invested. We can, however, learn the boundaries of expected behavior and improve our understanding of the underlying dynamics. Thus, while ecosystems are neither totally predictable nor totally unpredictable, they can be managed within the limits of their predictability.

Properties characterizing marine ecosystems may vary within wide bounds on decadal and longer time scales (Fig. 1). For example, El Niño events and decadal climate changes may displace species, restructure communities, and alter overall productivity in broad oceanic areas. Other phenomena, sometimes operating on smaller time scales, may precipitate regime shifts characterized by major fluctuations in constituent species (Steele 1996), but our ability to predict such events is only now evolving (Langton et al. 1996) and will always be shrouded in a degree of uncertainty. Nevertheless, management policies can be guided by the broad understanding we possess of marine ecosystem boundaries and production potential limits.

The ability to predict human behavior in fishery systems is also limited, but evolving. Many fishermen pass through rounds of fishing in regular annual patterns, markets respond in predictable ways to price changes, and fishermen often have predictable responses to policy proposals or regulatory changes. Fisheries systems respond to global mar-

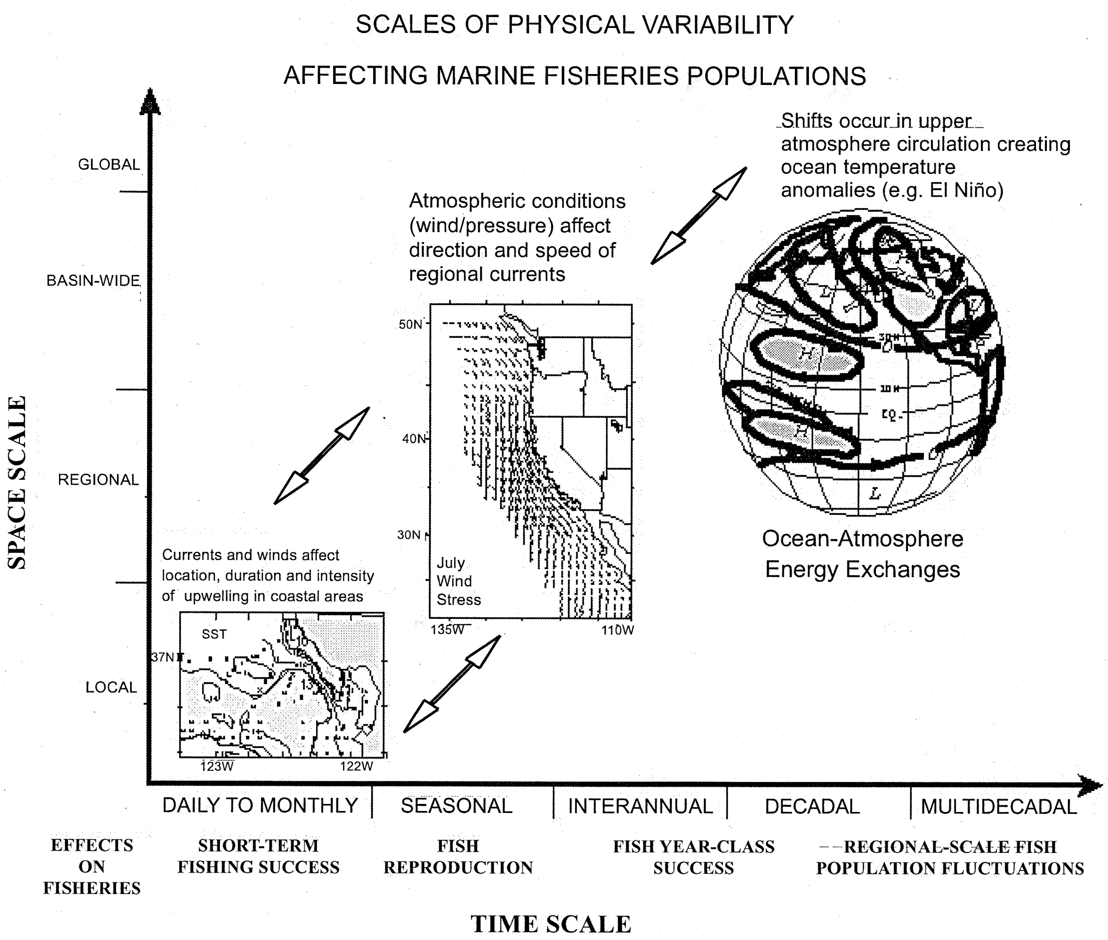

Figure 1. Scales of physical variability affecting marine resources. Variability in marine ecosystems is linked to variability in the physical environment on a continuum of time and space scales. We are often constrained to work on scales at which data are available, and long-term monitoring must be carefully designed to address appropriate scales. Figure courtesy of NMFS Pacific Fisheries Environmental Laboratory.

ket trends and economic changes, social preferences and philosophies. The ability to describe, explain, and predict these human behaviors, although the behaviors vary according to circumstance, is increasing with the growing body of social scientific data and information on fishery systems.

2. **Ecosystems have real thresholds and limits which, when exceeded, can effect major system restructuring (Holling and Meffe 1996).**

   Ecosystems are finite and exhaustible, but they usually have a high buffering capacity and are fairly resilient to stress. Often, as stress is applied to an ecosystem, its structure and behavior may at first not change noticeably. Only after a critical threshold is passed does the system begin to deteriorate rapidly. Because there is little initial change in behavior with increasing stress, these thresholds are very difficult to predict. The nonlinear dynamics which cause this kind of behavior are a basic characteristic of ecosystems.

The concepts of limits and thresholds have been misused in single-species fishery management in the sense that they have been viewed as targets for fish catches rather than levels to be avoided. Because single-species management has prevailed, limits and thresholds rarely have been applied in a broader ecosystem context. Limits in fisheries management often have been biological reference points such as prescribed fishing mortality rates or yields, that are set without concern for other components in the ecosystem. Many limits are in fact thresholds that, when exceeded, challenge the resilience of the managed stock and associated species. Experience has shown that some past target levels used by managers (e.g., maximum sustainable yield) ultimately lead to stock declines or damage to ecological communities because they are too close to critical thresholds (Caddy and Mahon 1995). Thresholds are to be avoided to maintain resilience at the species and community levels. Fishery targets should be set conservatively, well below the limits and critical thresholds that compromise the productive potential and stability of the ecosystem. Limits and thresholds of non-targeted organisms have only recently been considered through mandates of the Marine Mammal Protection Act, the Endangered Species Act, and in the new MSFCMA definitions of overfishing levels and provisions for bycatch and essential fish habitat.

Human systems (fishermen, their communities, and fishery management systems) are both resilient and generally resistant to change. Thresholds of profitability, tolerance of regulatory conditions, and risk or uncertainty-induced stress on fishery-dependent human communities are real. Thresholds must be determined through both constituent advice and independent research on individual and group responses to stress. Identification of reference points for the limits of human resilience may be possible.

3. Once thresholds and limits have been exceeded, changes can be irreversible.

When an ecosystem is radically altered, it may never return to its original condition, even after the stress is removed. This phenomenon is common in many complex, adaptive systems.

It is probable that some estuaries, coral reefs (Hughes 1994), and mangrove ecosystems have been irreversibly altered by fishing, aquaculture, and other habitat-destructive activities. Farther offshore, effects of fishing itself on abundances of target and non-target organisms may radically alter communities and ecosystems. It is too soon to know whether heavily fished systems, such as Georges Bank, will return to their previous states when fishing effort is relaxed (Fogarty and Murawski 1998). Fisheries scientists and managers have demonstrated an abiding faith in the ability of fish stocks to compensate for fishing effects by increasing their level of productivity. Implicitly, that faith is extended to ecosystems which support exploited stocks. Up to a point, recoveries are possible. In some coastal ecosystems, however, resilience and limits have been exceeded, often by the combined effects of habitat destruction and fishing, and it is doubtful if they will return to their original condition.

Changes in ecosystems may permanently alter human behaviors. When a fisherman goes out of business, when an annual season of fishing is disturbed, or when market flow is interrupted, it is often not possible to reestablish the former business, pattern, or market. Some aspects of human systems and behavior can be reestablished given enough time and attention, whereas changes in natural components of ecosystems are typically more enduring. In contrast, policy and management systems are continually subject to change and reversal.

4. Diversity is important to ecosystem functioning.

The diversity of components at the individual, species, and landscapes scales strongly affects ecosystem behavior. Although the overall productivity of ecosystems may not change significantly when particular species are added or removed, their stability and resilience may be affected.

Long-term consequences of diversity losses due to overfishing or poor fishing practices in marine systems are largely unknown. It is clear, however, that the economic value of specific components of catch change dramatically as some stocks are overfished, to be replaced in the ecosystem by lower-valued species (Deimling and Liss 1994, Fogarty and Murawski 1998). At the ecosystem level, drastic alterations of diversity certainly have occurred, and biological productivity has been redirected to alternative species, but it is not clear that these ecosystems are less productive or less efficient. However, such ecosystems are often valued less; witness the loss of tourist revenue in areas that have suffered damage to coral reef systems. It is prudent to presume that changes in biodiversity will decrease resiliency of species, communities and ecosystems, especially with perturbations that occur over long time scales (Boehlert 1996).

This principle also applies to the human element. An economy with more than one sector, a community with more than one industry, a fishing family with more than one income from different sources, or an industry large enough to foster technological innovation, are all aspects of the strength in diversity found in human society. Communities which lose such diversity are more susceptible to stress and unexpected sources of change.

5. Multiple scales interact within and among ecosystems.

Ecosystems cannot be understood from the perspective of a single time, space, or complexity scale. At minimum, both the next larger scale and the next lower scale of interest must be considered when effects of perturbations are analyzed.

Consequences of perturbations at one scale in marine systems may be magnified at larger and smaller scales (Langton et al. 1995). For example, destruction of a species' spawning habitat—typically a small fraction of its range—may translate into major impacts on species associations and trophic interactions in the broader feeding areas of recruited fish. Likewise, effects of fishing on a broad ecosystem scale may have profound impacts on components of ecosystems far removed in space and time—scientists are investigating the relationship between pollock fishing and the general decline of Steller sea lion populations in the eastern Bering Sea and Gulf of Alaska. Seemingly small human perturbations, applied at a point in time or in one part of a marine ecosystem, may have unforeseen impacts because of the open nature and fluid environment that characterize marine ecosystems. These features elevate the probability that a stress applied at one scale will be transmitted and may have unforeseen effects at other scales in the ecosystem.

Human impacts on ecosystems cannot be understood from the perspective of a single time, space, or complexity scale. A fishing community is subject to perturbations both from its own members and from outside forces. Fishery systems in one location are subject to environmental, social, economic, and regulatory forces far removed in time and space, especially with respect to markets.

6. Components of ecosystems are linked.

The components within ecosystems are linked by flows of material, energy, and information in complex patterns.

Critical linkages in marine ecosystems are sustained by key predator-prey relationships. Large, long-lived predators and small, short-lived prey (e.g., forage fishes) both contribute in major ways to marine fish catches. Heavy fishing may precipitate species replacements, both at lower trophic levels (e.g., sand lance replacing herring and vice-versa) and at upper trophic levels (e.g., sharks and rays replacing Atlantic cod) (Fogarty and Murawski 1998). Loss from ecosystems of large and long-lived predators is of particular concern because they potentially exercise top-down control of processes at lower trophic levels. Global data sets have indicated that the mean trophic level of fish caught declined significantly from 1950–1994 (Pauly et al. 1998). Fishing down food webs (i.e., fishing at lower trophic levels) disrupts natural predator-prey relationships and may lead first to increasing catches, but then to stagnating or declining yields.

Disruption of ecosystem linkages clearly may have resounding impacts on human economies and, in the worst cases, ecosystem stability and productivity are compromised. Components of human systems are linked by flows of material, energy, and information. The collapse of a market may drastically change fishing behavior. A technological innovation or entry of a new segment of a fishing fleet may cause far-reaching changes in dependent human communities.

7. Ecosystem boundaries are open.

Ecosystems are far from equilibrium and cannot be adequately understood without knowledge of their boundary conditions, energy flows, and internal cycling of nutrients and other materials. Environmental variability can alter spatial boundaries and energy inputs to ecosystems.

Productive potential of marine ecosystems is especially sensitive to environmental variability over a spectrum of temporal and spatial scales. The unbounded structure of marine communities provides the backdrop for the high (relative to terrestrial) variability that is observed (Steele 1991). Boundaries of ecosystems, or productive regions, shift with weather and longer-term climate change. Species abundances and distributions vary in accord with annual to decadal shifts in ocean features (e.g., Pearcy and Schoener 1987, Polovina et al. 1995, Roemmich and McGowan 1995, Francis et al. 1998, McGowan et al. 1998). In open systems, local heavy fishing in combination with major changes in ocean conditions (e.g., El Niño) can lead to fishery collapses and associated shifts in the partitioning of energy or biomass among trophic levels (e.g., Walsh 1981, Barber and Chavez 1983).

Human behavioral systems are also subject to variability over a spectrum of temporal and spatial scales, and cannot be understood without knowledge of their boundary conditions. Certain components of human systems (people) are closely related and interact regularly over time; others are only sporadically in contact and interact in cyclical or irregular patterns. The more intermittent or sporadic the contact or interaction, the less stable the human system (Axelrod 1984).

8. Ecosystems change with time.

Ecosystems change with time in response to natural and anthropogenic influences. Different components of ecosystems change at different rates and can influence the overall structure of the ecosystem itself and affect the services provided to society in the form of fish catch, income and employment.

Marine ecosystems experience directional changes. Shifts in climate are responsible for many such changes, but the role of biological interactions in the absence of human influence are largely unknown. Dramatic changes in coastal and estuarine ecosystems, attributable to long-term geological and erosional processes are easily observed (e.g., Chesapeake Bay, see Mountford 1996). Anthropogenic changes are all too common, especially in neritic and estuarine ecosystems or enclosed seas (e.g., San Francisco Bay (Nichols et al. 1986), Great Lakes, Black Sea, Aral Sea, Chesapeake Bay). Species introductions, excess nutrient loading, damming of tributaries, poor stewardship of bordering forests, bad agricultural practices, and poorly-managed fisheries are examples of factors that cause change. Rapid advances in fishing technologies (e.g., vessel power, navigation, sensing-locating, and harvest efficiency), the propensity for fisheries to selectively remove species, failure to control bycatch, and unintended damage to the physical structure of ecosystems, have changed the character of heavily fished ecosystems (e.g., Georges Bank) (Fogarty and Murawski 1998). Selective fishing, that often targets long-lived predators, can have cascading effects on community structure (Marten 1979, Laws 1977), while heavy industrial fishing on forage species may have unintended impacts on top predators, especially those (e.g., marine mammals) unable to adapt quickly to changes in the forage base. Removal of large whales through past whaling practices, likewise, may have lingering effects on the nature of ecosystem structures today (National Research Council 1996). Deterioration of coastal ecosystems may also generate active attempts at remediation or enhancement through aquaculture and other means (Morikawa 1994), which can also generate pollution and wastes (Wu 1995).

Human activities dependent on ecosystems may change in response to environmental change and changes induced by fishing and other activities. In the short run, these impacts may be considered the normal consequences of a highly variable activity. However, humans adapt to long-term changes in composition of fisheries by stopping fishing or shifting effort to other species; changes which may produce adverse impacts. In addition, changes in perception, values, preferences, patterns of use, and accumulation of knowledge or expertise may cause changes over time in the ways humans interact within ecosystems. Human components of ecosystems (especially technology and institutions) can change rapidly in ways that outstrip the capacity for change of other ecosystem components. Communities may continue to grow and consumption rates increase, for example, yet the capacity of the seas to increase yields of living marine resources is limited. Thus, fishery management policies must be prepared to take into account these factors.

BROADENING SOCIETAL GOALS FOR ECOSYSTEMS

Traditionally, societal goals have emphasized benefits to humans resulting from extractive uses of ecosystem components. For example, fishery management has typically had revenues, employment, recreational fishing opportunities, and/or maintenance of traditional lifestyles as explicit or implicit goals. From an ecosystem perspective, these goals need to be broadened to include concepts of health and sustainability (Lubchenco et al. 1991, National Research Council 1999). Ecosystem health is the capability of an ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region (Sparks 1995). This concept is also referred to as biotic integrity, which is defined as a system's wholeness, including the presence of all appropriate elements and occurrence of all processes at appropriate rates (Angermeier and Karr 1994, Angermeier 1997). While the concept of health applied to marine ecosystems is relatively new and untested, it has become a guiding framework in several areas, including forest ecosystems (Kolb et al. 1994), agroecosystems (Gallopin 1995), desert ecosystems (Whitford 1995), and others (Rapport et al. 1995).

A healthy ecosystem provides certain ecosystem goods and services, such as food, fiber, the capacity for assimilating and recycling wastes, potable water, clean air, etc. (International Society for Ecosystem Health, 1998). How do we extract from, and otherwise utilize ecosystems, while maintaining their health and the array of non-use services that they also provide (Costanza et al. 1997) into the indefinite future?

The challenge to scientists and managers is to develop useful, quantitative measures of ecosystem health which can guide management. What level of fishing, for example, can a "healthy" ecosystem sustain? How can vigor and resilience be expressed quantitatively so that managers can maintain them within healthy limits? These are difficult questions which will not be answered in their entirety in the foreseeable future, but incremental implementation of ecosystem-based fisheries management will begin to identify ecosystem variables (or indicators) that are unacceptable. These could be used to guide management away from unhealthy ecosystem states.

GENERAL ECOSYSTEM-BASED MANAGEMENT POLICIES

Ecosystem Principles to achieve societal Goals must be implemented through ecosystem-based management Policies. There are three overriding aspects of the Principles that are taken into account in the six Policies discussed below. These are the exhaustibility of ecosystems (reflected in Principles 2 and 3), uncertainty about ecosystems (reflected in Principles 1, 2, 4, and 8), and the role of humans within ecosystems (reflected in all of the Principles). The exhaustibility of the ecosystem requires a policy to change the burden of proof (Policy 1). Both the exhaustibility of ecosystems and uncertainty about ecosystems require policies to manage by a precautionary approach (Policy 2) and to "purchase insurance" (Policy 3) against adverse ecosystem impacts. Uncertainty about ecosystems also dictates that there is learning from management experiences (Policy 4). The role of humans within ecosystems requires policies to make incentives for human behavior consistent with societal goals for ecosystems (Policy 5). Acceptance and effective implementation of the policies and management is served by promoting participation, fairness and equity (Policy 6). Each of the Policies is discussed below.

1. Change the burden of proof.

We live in a world where humans are an important component of almost all ecosystems. Thus, it is reasonable to assume that human activities will impact ecosystems. The *modus operandi* for fisheries management should change from the traditional mode of restricting fishing activity only after it has demonstrated an unacceptable impact, to a future mode of only allowing fishing activity that can be reasonably expected to operate without unacceptable impacts.

To date, almost any type of fishing activity has been allowed until problems arise and regulations are established to solve them. Decision makers have to be convinced that management restrictions are needed. As W. F. Thompson (1919) wrote "... proof that seeks to change the way of commerce and sport must be overwhelming." Several authors have argued that a change is needed in this "burden of proof" (Sissenwine 1987, Mangel et al. 1996, Dayton 1998). The key elements of the change are: 1) that future fishing activity should be allowed, if and only if it is explicitly provided for by fishing regulations which take into account risk and uncertainty and are promulgated to protect all elements of the ecosystem, and 2) that to a substantial degree the responsibility for providing the information and other support (e.g., the cost of management) necessary to manage fisheries in a sustainable manner, lies with participants in the fishery.

The first part of the change is analogous to changing the "null" hypothesis from "marine fisheries are inexhaustible" (Huxley 1883), to today's reality that marine fisheries will usually evolve to a state of overfishing unless they are carefully managed (Garcia and Newton 1997). The second element of the change makes clear that the direct beneficiaries from fishing should accept a greater share of the burden (i.e., costs) of fishery management. The standard of proof associated with the change (i.e., how much certainty is needed before a fishing activity is allowed) should be commensurate with the severity of the risk of a mistake. Applying the proper standard of proof is implicitly an element of the precautionary approach (see Policy 2).

In practice, changing the burden of proof will mean that, when the effects of fishing on either the target fish population, associated species, or the ecosystem are poorly known (relative to the severity of the potential outcome), fishery managers should not expand existing fisheries by increasing allowable catch levels or permitting the introduction of new effort and should not promote or develop new fisheries for so-called "underutilized species."

2. Apply the precautionary approach.

The precautionary approach is a key element of the United Nations Agreement for Straddling Stocks and Highly Migratory Species (United Nations 1996) and the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries (FAO 1995). The U.S. is a signatory of both.

All ecosystems are complex and uncertainty is unavoidable. Within uncertainty, there is always a risk of undesirable consequences on fishery resources (e.g., overfishing) and/or on ecosystems. The precautionary approach was motivated by the widely accepted conclusion of scientists and fishery managers that many of the current problems of fisheries (i.e., a large number of overfished stocks) have been caused by the practice of making risk-prone fishery management decisions (i.e., to err toward overfishing) in the face of uncertainty (Garcia and Newton 1994). One approach to coping with uncertainty, which is widely applied to other human endeavors, is to encourage behaviors (often by enacting regulations) that reduce risk. Thus, the precautionary approach calls for risk averse decisions (i.e., to err toward conservation). FAO (1995) provides guidelines on the application of the precautionary approach.

3. Purchase "insurance" against unforeseen, adverse ecosystem impacts.

Even under the precautionary approach, there is a risk of unforeseen, adverse impacts on ecosystems. Insurance can be used to mitigate these impacts if and when they occur.

Insurance is a common method for guarding against the risks of unforeseen, adverse impacts of many human endeavors, and it has been proposed to guard against adverse ecosystem impacts (Costanza and Cornwell 1992). A requirement to purchase insurance provides an incentive to avoid risk-prone behavior (to reduce the cost of insurance). Thus, this management policy supports the precautionary approach.

Insurance can take many forms in addition to the traditional form of insurance policies or environmental bonds. Marine protected areas, for example, are a form of insurance. Protecting parts of the ecosystem from exploitation can insure future productivity and sustainability (Carr and Reed 1993, Dugan and Davis 1993, Agardy 1994, Bohnsack and Ault 1996, Roberts 1997, Lauck et al. 1998). Reserves also serve as baseline areas to evaluate natural variation in animal and plant populations that are free from fishing impacts.

Another form of insurance is a system to detect adverse impacts at an early stage so that actions can be taken to prevent further damage and/or to repair damage. This form of insurance is more effective if corrective actions have already been planned and adopted, such that there is minimal delay when a problem is detected.

Environmental bonding, marine protected areas, and a system to detect and respond to adverse impacts can serve as both insurance and elements of a precautionary approach.

4. **Learn from management experiences.**

   Management actions and policies can be considered as experiments and should be based upon hypotheses about the ecosystem response. This requires close monitoring of results to determine to what extent the hypotheses are supported.

Sustainable management of complex, adaptive ecosystems must itself be adaptive (Holling 1978). Management policies are experiments from which we can learn and improve, rather than absolute "solutions." Adaptive management in an "active" context would demand that hypotheses be put forward for testing and that alternative models be considered. Active, adaptive management often presumes that changes in fishing mortality rates will be imposed purposefully to induce a response in the fished stock or in the ecosystem under investigation (Walters 1986, Hilborn and Walters 1992). This "active" experimental approach to management is scientifically sound, but may have limited applicability in extensive marine ecosystems, at least within the time scales in which managers must act and in which fisheries operate. Walters (1997), while arguing eloquently about potential advantages of active adaptive management, recognizes the many arguments that detract from its adoption. For instance, modeling exercises and experiments required for the implementation of adaptive management have often been seen as excessively expensive or ecologically risky. A less aggressive form of the adaptive approach, however, is more generally acceptable and applicable. In this form, managers learn from actions to the greatest extent possible and respond expeditiously with alternative management actions. The willingness and institutional capability to respond are critical for this form of management to succeed.

5. **Make local incentives compatible with global goals.**

   Changing human behavior is most easily accomplished by changing the local incentives to be consistent with broader social goals. The lack of consistency between local incentives and global goals is the root cause of many "social traps," including those in fisheries management (Costanza 1987). Changing incentives is complex and must be accomplished in culturally appropriate ways.

Global goals, such as long-term sustainability of a fish population or ecosystem health, are generally beyond the control of people at a local scale. Their incentive for conservation is diminished if they have no assurance that others will conserve or if they will not share in future benefits from conservation. This phenomenon is illustrated by the well known "race for the fish" which can lead to overfishing and wasteful overcapitalization (Graham 1935, Gordon 1954, Sissenwine and Rosenberg 1993).

A key element of making local incentives consistent with global goals is to allocate shares of the fishery such that people at local scales (down to the scale of individuals) have the incentive to use their shares efficiently (i.e., not wasting resources by racing for a share) and to conserve the entire resource to enhance the value of their shares in the future. Shares can take many forms such as a fraction of the total allowable catch (known as an individual quota), units of fishing effort, or exclusive rights to fish specific areas. Share-based allocation schemes might be broadened to take account of indirect impacts on ecosystems. There are several options for the local scale to which shares are allocated, such as to individuals or to communities. The most effective configuration of a share-based allocation scheme depends on the specific fishery and ecosystem that is being managed, but some form of share-based allocation will usually be necessary to fulfill this management policy.

6. **Promote participation, fairness and equity in policy and management.**

   Ecosystem approaches to management rely on the participation, understanding and support of multiple constituencies. Policies that are developed and implemented with the full participation and consideration of all stakeholders, including the interests of future generations, are more likely to be fair and equitable, and to be perceived as such.

The level and quality of stakeholder participation in fishery management varies widely, as does the definition of "stakeholder." Participation varies from passive consultation to shared decision making authority (Sen and Nielsen 1996). Systems organized to promote the maximum involvement of stakeholders, including the interests of future generations, and to emphasize the maximum appropriate delegation of responsibility and authority to the lowest possible levels of the management system (e.g., the local or regional level), tend to have the highest credibility among fishery constituents (Pinkerton 1989). This often leads to such effects as better data sharing and lower enforcement costs.

SECTION THREE: CURRENT APPLICATION OF THE ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES

We reviewed how the Councils and NMFS currently apply the ecosystem Principles, Goals, and Policies in order to help shape strategies for greater application in the future. We could not undertake a comprehensive fishery-by-fishery assessment of the application of the ecosystem Principles in current research and management activities. Such a task was beyond our scope given the limited time and resources available, and was certain to be incomplete. In addition, we saw little to be gained by evaluating the past performance of agencies relative to a set of ecosystem Principles, Goals, and Policies that were not known to the organizations whose performance might be judged. Most importantly, the 1996 amendments to the MSFCMA substantially changed the guidelines for certain management actions so that past practices are no longer relevant.

Information for the assessment was solicited from a number of sources, including NMFS Regional Offices and Fishery Science Centers. NMFS was asked to consult with Councils and other appropriate organizations to prepare this information. At our first meeting, representatives from each NMFS Fishery Science Center briefed us on the application of general ecosystem principles. Relying on that input and on our own knowledge and experience we then prepared regional overviews which served as the basis for this assessment.

To organize the assessment, we posed a series of questions that reflect the application of the Principles. These questions and our answers to each are given below.

Q: Have science-based ecosystem boundaries been identified, and are they used to specify resource management units?

A: Marine ecosystem boundaries are generally open, but bathymetric and other oceanographic features create biological discontinuities or shape gradients that allow marine ecosystems to be defined. On a regional scale, the Council jurisdictions reasonably correspond to such bathymetric and oceanographic features. Within these jurisdictions, management unit boundaries generally parallel the scientific information about the distribution of exploited fish stocks. Because fish distributions are also affected by the topographic and oceanographic features that are important to other biological components of ecosystems, it is often the case that management units corresponding to stock distributions also correspond to ecosystem boundaries. For example, this occurs with cod in the Gulf of Maine ecosystem, which are managed as a single stock by the New England Fishery Management Council. There are many situations where this is not the case, and many cases where the scientific basis for defining stock boundaries is minimal. Exchange rates across boundaries are seldom known or explicitly considered in management. This is particularly true for highly migratory species such as tunas, swordfish, and billfishes. Exchange rates are important within ecosystems for some forms of management, such as area closures (including marine protected areas) that are used to conserve exploited stocks of fish, or more broadly, to conserve marine ecosystems.

The issue of ecosystem boundaries also has connections with human institutions. In some cases, the jurisdiction of management institutions does not match ecosystem boundaries or stock boundaries of some resources. This has led to various arrangements for interjurisdictional management of fisheries, such as international commissions, interstate fishery management commissions, and joint Fishery Management Plans (FMP) of two or more Councils. While some useful steps have been taken to deal with interjurisdictional issues, little consideration has been given to mobility of the fishing industry (both recreational and commercial) between jurisdictions, or to the diversity of people within the jurisdictions.

Another factor related to the definition of ecosystem boundaries is the impact that nonfishing sectors of society have on marine ecosystems. Management of coastal resources, agriculture and forestry, in addition to fisheries, is also required to effectively apply the ecosystem Principles, Goals, and Policies. If it is impractical to include these activities within ecosystem boundaries, exchanges across boundaries caused by these activities must be considered. In addition, institutional arrangements are needed to address cross-sectorial effects on ecosystems. Generally, such arrangements are lacking, although the recent MSFCMA amendment that calls for the identification of EFH should be an impetus for making such arrangements.

We conclude that ecosystem boundaries are generally defined and are reflected in management, but these definitions will have to be amended in order to integrate our recommendations for an ecosystem approach to management.

Q: Is scientific uncertainty in stock assessments and knowledge about marine ecosystems described to managers, and is this uncertainty considered in FMPs (such as by including buffers)?

A: Many sources of uncertainty affect stock assessments: 1) imperfections in catch statistics (sometimes from misreporting), 2) imprecise estimates of biological parameters, 3) variability in fishery independent resource surveys, and 4) natural variability in biological processes, particularly in recruitment. All these sources of uncertainty should be considered when determining the variance associated with estimates of current and future stock size. But, the uncertainty in stock assessment estimates is not always characterized, and even when it is, the true uncertainty is probably greater since it is difficult to account for all sources of uncertainty. Nevertheless, managers are usually made aware of at least some degree of uncertainty; their reaction to uncertainty varies among regions. For example, the North Pacific Fishery Management Council is noted for generally acting conservatively in the face of uncertainty (i.e., applying the precautionary approach), whereas some other Councils have consistently done the opposite (i.e., making risk-prone decisions) in the past. Recent changes in the MSFCMA and international agreements requiring the application of the precautionary approach should encourage risk-averse decisions by all Councils in the future.

Stock assessment uncertainty is only one of several areas of imprecision that should concern fishery managers. Uncertainty about fishery effects on ecosystems is high and generally is not characterized. There are some cases where fishery managers have attempted to account for ecological relationships in spite of uncertainty, such as prohibiting pollock trawling within 10–20 miles of islands that are occupied by endangered Steller sea lions, to minimize the risk that near-shore fishing will deplete their prey, however, these cases are rare.

Scientific uncertainty in stock assessments and ecosystems is an inherent reflection of highly complex systems that extend over vast areas and depths. We conclude that uncertainty is characterized to some degree. In the future, fishery managers need to consistently apply the precautionary approach in the face of uncertainty.

Q: Is there routine monitoring of ecosystems and are the results used to support management?

A: The fish component of marine ecosystems is monitored routinely for many stocks and in most U.S. regions. Standardized trawl surveys of the northeastern U.S., initiated in 1963 and now conducted three times per year, are the most extensive example of monitoring of the fish component, yet, some fish stocks are virtually unsampled by the current survey program. In other regions, fish stocks are only surveyed every third year. In addition, fishery-dependent monitoring is conducted.

Monitoring of fish is far more extensive than is the monitoring of other marine ecosystem components. Some systems such as San Francisco Bay, Chesapeake Bay, and the Northeast U.S. have longstanding ecosystem monitoring programs which measure ecosystem components other than fish, but the use of such programs is not widespread for ecosystems and fisheries under the jurisdiction of NMFS and the Councils.

Other ecosystem components that might be monitored are human demographics, marine mammals, birds, benthos, zooplankton, phytoplankton, and physical and chemical factors. While there is a significant amount of human census data and other information about people, changes in the demographics and cultural aspects of participants in fisheries are not routinely monitored, nor are there studies of economics. As a result of the Marine Mammal Protection Act, many populations of marine mammals are monitored, although this monitoring is limited in extent. Coastal sea birds are monitored in some regions. There are long-term time-series of plankton data, such as California Cooperative Oceanic Fisheries Investigations data off of California, and Marine Resources Monitoring Assessment and Prediction and Continuous Plankton Recorder data in New England waters. With advances in satellite remote sensing, it is now possible to monitor primary production and some physical variables synoptically over vast regions. There has been very little monitoring of benthos, except for a few sites and generally for only a few years. Lack of time-series data on the benthos is an impediment to understanding the effects of mobile fishing gear on benthic habitats.

Monitoring data are used in a variety of ways in the management process. Fish monitoring results constitute a critical input to stock assessments, which are used to support fisheries management. Limited socioeconomic data are used for various impact analyses that accompany fishery management decisions. Information on other ecosystem components is sometimes considered to help explain variability in fishery resources, but such relationships are usually uncertain or speculative and therefore are seldom used by managers.

Q: Have the food webs of target species been identified and is this information used in FMPs?

A: There are extensive databases on the stomach content of fishes in some regions, such as the Northeast and Alaska where hundreds of thousands of fish of many species have been sampled over several decades. Some multispecies predator/prey models have been developed, but generally these models are better at explaining the effects that trophic relationships might have had, rather than predicting future patterns and variations.

To date, use of food web information in fisheries management has been limited. This reflects the limited predictive power of existing multispecies predator/prey models. Knowledge of food webs is considered qualitatively in some management decisions, such as the Pacific Fishery Management Council's FMP for anchovies which sets aside some of the population as forage.

Q: Are total removals, including discards, taken into account in stock assessments and management?

A: Total removals are made up of the reported landings, unreported landings, discards, and mortality to fish that come in contact with fishing gear but are not captured. Stock assessments are routinely based on reported landings and discard estimates, if available. Discard estimates are derived from fishing vessel logbook reports and/or from at-sea observers on fishing vessels. Larger groundfish vessels operating in the northeast Pacific are required to have 100% observer coverage, and this improves the quality of discard data for these fisheries. Observers in the Gulf of Mexico shrimp fishery estimate that discards of finfish are over four times larger than the catch of shrimp. For at least one important Gulf species, red snapper, discards are the largest component of mortality. But there are many species where there are virtually no discard data (although discarding exists). Estimates of unreported landings and/or mortality of fish that come in contact with fishing gear, but are not captured, are very rare. Stock assessments are robust to under estimates of total removals so long as the proportion not included in removal estimates is constant, which is a reasonable assumption under some circumstances.

There are alternative ways for fisheries management to account for total removals. When discards are estimated, they are usually included in the stock assessments which support fisheries management. For example, discards of juvenile swordfish are factored into the swordfish stock assessments conducted by the member countries of the International Commission for the Conservation of Atlantic Tunas. The discards may be taken into account by reducing the allowable catch based on the expected level of discards, or by counting estimates of discards against the allowable catch. Alternatively, management might use measures that are less dependent on knowing total removals, such as gear restrictions, effort controls or area closures.

We conclude that total removals are probably underestimated, and significantly so in some cases. Therefore, more effort is needed to estimate total removals and to apply management strategies that are robust in the face of uncertainty about total removals.

Q: Have the effects of fishing on the ecosystem been studied?

A: This is a relatively new research endeavor. There is clear evidence that fishing alters species composition (e.g., fishing on Georges Bank appears to have shifted the community from predominately Atlantic cod to sharks and skates (Fogarty and Murawski 1998)). Pauly et al. (1998) recently showed that there has been a significant worldwide reduction in mean trophic level of species fished. Several studies that have demonstrated that mobile fishing gear alters benthic habitat (Auster and Langton 1999), but little is known about the implications of these changes. Further, there has been even less research conducted on other fishing gears.

Q: Are the habitat needs of different life history stages of target and nontarget species known and are they considered in FMPs?

A: The habitats that are used by some or all of the life-history stages of many species of fish are known. But habitat utilization does not mean that the habitat is obligatory (i.e., the species must have that habitat to successfully complete its life-cycle). The mechanistic relationship between a fish species at a particular life history stage, and the type of habitat it occupies, is unknown for most species and life-history stages. It is most critical to understand the essential habitat needs of fish near shore, where anthropogenic effects on habitat are likely to be most significant.

The relationships between fish and habitat are summarized as a basis of EFH determinations to be included in FMP amendments, as required by the MSFCMA. These amendments require that the habitat needs of fish populations be given serious consideration in the future when government agencies make decisions that are likely to adversely affect EFH. Fishing itself is an activity that has the potential to affect EFH. Taking account of these potential effects is a major challenge facing Councils.

SECTION FOUR: RECOMMENDATIONS FOR IMPLEMENTING THE ECOSYSTEM PRINCIPLES, GOALS, AND POLICIES IN U.S. FISHERIES CONSERVATION, MANAGEMENT, AND RESEARCH

In this section, we describe approaches for incorporating the Principles, Goals, and Policies established in Section II into the fisheries management and research processes of the current Council system. We strongly believe that the key to an effective ecosystem approach is to fish more conservatively. The depressed condition of many U.S. stocks is related primarily to unsustainable levels of fishing effort, rather than ecosystem effects. With few exceptions, scientists understand the levels of fishing effort required to produce sustainable yields, but fishery managers are challenged by a highly politicized process to exceed those levels for short-term gains. Setting maximum sustainable yield and optimum yield conservatively, and respecting these conservative goals in the face of political and economic pressure is essential in any ecosystem approach.

Many current U.S. fishery management problems such as overfishing, bycatch and protection of EFH are addressed in the Sustainable Fisheries Act (SFA) of 1996. Each of these SFA provisions is an important step toward the use of ecosystem principles in fishery management. However, these measures do not add up to an ecosystem approach.

FMPs for single species or species complexes should continue to be the basic tool of fisheries management for the foreseeable future. However, managements actions under FMPs alone are not sufficient to implement an ecosystem approach. A mechanism is required to integrate FMPs and include the ecosystem Principles, Goals, and Policies in a way that will be meaningful. That mechanism is the Fisheries Ecosystem Plan (FEP).

THE FISHERIES ECOSYSTEM PLAN (FEP)

Our primary recommendation is that each Council (including NMFS in the case of Atlantic highly migratory species) develop the FEP as a mechanism for incorporating ecosystem Principles, Goals, and Policies into the present fisheries management structure. The objectives of FEPs are to:

- Provide Council members with a clear description and understanding of the fundamental physical, biological, and human/institutional context of ecosystems within which fisheries are managed;
- Direct how that information should be used in the context of FMPs; and
- Set policies by which management options would be developed and implemented.

Councils would develop FEPs for each major ecosystem under their jurisdiction. For example, the North Pacific Fishery Management Council might have two FEPs—one for the Bering Sea/Aleutian Islands and one for the Gulf of Alaska. Councils with overlapping ecosystems, or with significant species migration across ecosystem boundaries would work together on a joint FEP. In the event of transnational ecosystems, appropriate international arrangements would be sought to implement an ecosystem approach.

The FEP should be used as a metric against which all fishery-specific FMPs are measured to determine whether or not management effectively incorporates the ecosystem Principles, Goals, and Policies. The FEP should also contain regulations or management measures which extend across individual FMPs. The FEP should serve as a nexus for existing FMPs and provide a context for considering Council management actions with respect to all living marine resources, whether managed or not.

FEPs must contain the information about ecosystem that allows managers to make informed decisions, but the primary purpose of the plans is to prescribe how fisheries will be managed from an ecosystem perspective. Careful consideration must be given to the structure and required content of an FEP to balance the needs for plans to be both substantive and realistic. It is appropriate that NMFS lead a deliberative and inclusive (of a broad range of interests and expertise) process to prepare guidelines for FEPs (analogous to the processes that have been used to prepare guidelines for implementing National Standards). Preparation of such specific guidelines was beyond the scope of our Panel Charter, but we did identify Council actions that must be taken when guidelines are prepared, to be consistent with the Panel's recommendations:

1. Delineate the geographic extent of the ecosystem(s) that occur(s) within Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems, and "zone" the area for alternative uses.

2. Develop a conceptual model of the food web.

3. Describe the habitat needs of different life history stages for all plants and animals that represent the "significant food web" and how they are considered in conservation and management measures.

4. Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure.

5. Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions.

6. Develop indices of ecosystem health as targets for management.

7. Describe available long-term monitoring data and how they are used.

8. Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/Department of Commerce (DOC) authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.

The eight FEP actions are elaborated below:

1. Delineate the geographic extent of the ecosystem(s) that occur(s) within Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems, and "zone" the area for alternative uses.

The ecosystems supporting fisheries in the United States vary markedly (Apollonio 1994), and the way in which fisheries are managed within them will vary according to their individual characteristics. Managers must be able to geographically delineate the systems under their authority, and have a scientific understanding of the structure, function, and processes that occur within their respective ecosystems, and between their systems and others. This delineation should include both ecological and human/institutional components and their interactions. This includes the extent of our knowledge of climate, how climate affects the physical and biological oceanography of the system, and how, in turn, these affect food web structure and dynamics.

Councils should use information from FEPs to develop zone-based management regimes. In a zoning approach, geographic areas within an ecosystem would be reserved for prescribed uses. For example, use of gears which are demonstrated to have an adverse effect on EFH could be limited to prescribed areas. Currently, FMPs are required to describe and mitigate gear effects on EFH, but FEPs should go further, not only identifying where habitat impacts occur, but also identifying specific zones where certain gears should be restricted. A zone-based approach could also limit fishing activities in areas where potential negative trophic impacts could occur. The North Pacific Fisheries Management Council's establishment of no-trawl zones in red king crab habitat is an example of such a measure. Zoning can also be used to limit bycatch, by restricting fishing activities in areas where high levels of bycatch are likely to occur.

A zoning approach should also include the establishment of marine protected areas. A species-specific approach to habitat protection, as currently practiced, may result in many small protected areas with occasionally conflicting regulations that are difficult to understand and often difficult to enforce. Complete protection of relatively large portions of marine ecosystems, in the form of harvest refugia, may provide the best way to characterize habitat needs and also serve as management tools (Bohnsack and Ault 1996, Roberts 1997). Each FEP should consider and evaluate the potential benefits of harvest refugia and support research to evaluate their use.

Marine Protected Areas

Marine Protected Areas (MPAs) offer promise as a means to implement the precautionary approach and mitigate the effects of fishing in an ecosystem (Yoklavich 1998). However, the utility of the approach depends on the way MPAs are defined and established. The concept of MPAs represents a continuum, from marine wilderness areas to areas in which only a few specific activities might be restricted. We use the term to mean the entire spectrum of usage, and suggest that managers carefully define their conservation and management objectives before determining the characteristics of a given MPA.

MPAs should be representative of the larger ecosystem and, as such, would serve as experimental sites for investigating processes and mechanisms that would be operable throughout the region. MPAs must be established with the understanding that ecosystems change over time and that research results have to be evaluated relative to this natural variability as distinct from variability resulting from human exploitation of a resource. MPAs represent a form of insurance against excessive exploitation. Although we aspire to a level of understanding that would allow for strategic management of our nation's fisheries, uncertainty and indeterminacy are fundamental ecosystem characteristics. Hence, research is needed on the optimal size of MPAs, sources and sinks for new recruits, and the social and management issues required for successful implementation.

2. Develop a conceptual model of the food web.

Fisheries managers cannot control the weather or long-term physical changes in the ecosystems that produce the managed resources. They can, however, control what species are fished and the total numbers and individual sizes of resources removed. Thus, managers should have a conceptual understanding of the food web, and should use that information in making decisions about harvest. For each species for which there is an FMP, there should be a description of both the prey species and the predators at each stage in the life cycle. Where information on certain species is not available for all life stages, managers should refer to species inhabiting similar ecological niches or their functional equivalents as the basis for defining trophic links. Following this, the FEP should contain an analysis of the anticipated impacts of the allowed harvest on predator-prey dynamics, even if data gaps force such a statement to be largely qualitative.

Ecosystem Modeling

Modeling is an essential scientific tool in developing ecosystem approaches for fishery management. Simple descriptions of prey and predator species and models of how they interrelate are good starting points but they are inadequate. What is required is a food-web based mathematical model. Such a model could examine factors that affect primary productivity and how changes in it affect the relationships that exist among all components of the ecosystem. Such a model could assist in assessing the trade-offs among harvests of fish species in different parts of the food web, how abundance of marine mammals relates to populations of its prey species, and how much of the total primary production is required to sustain ecosystem harvest. Recent models such as ECOPATH (Polovina 1984, Christensen and Pauly 1995, Pauly and Christensen 1995) have been applied and have provided insight into some fundamental ecosystem questions. ECOPATH provides a framework for summarizing natural rates of growth and consumption of marine populations. This allows small-scale studies or models (such as fish bioenergetics models or diet composition data) to be viewed in a common currency, in the context of the ecosystem as a whole.

Presently, dynamic mathematical models (e.g., ECOSIM (Walters et al. 1997)) are being developed but they have been applied only experimentally in actual fishery management situations. Using them as active parts of the FEP could facilitate model development and testing. Most importantly, models have the potential to provide managers with information about how ecosystems are likely to respond to changes in fishery management practices (Botsford et al. 1997). Like FEPs, these models will be unique to each system and its important attributes.

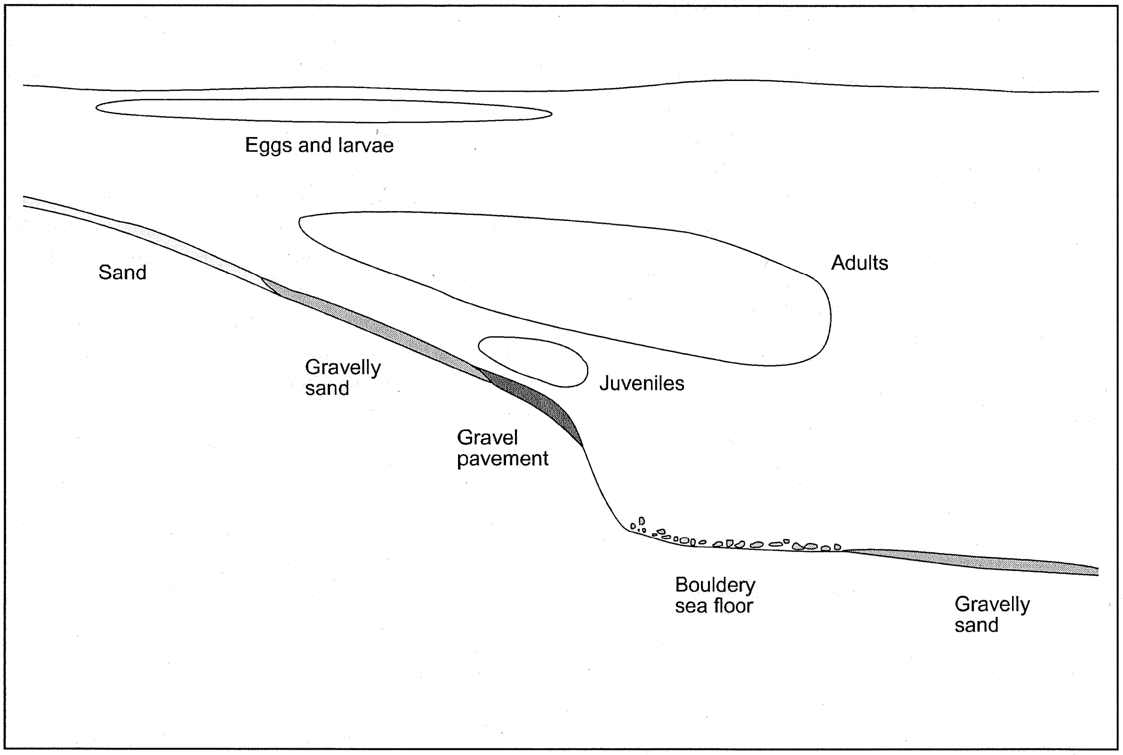

Figure 2. Life history stages of Atlantic cod versus habitat requirements as characterized for Georges Bank in the Northwest Atlantic (Adapted from Lough 1989).

3. Describe the habitat needs of different life history stages for all plants and animals that represent the "significant food web" and how they are considered in conservation and management measures.

Marine organisms generally have different dietary and habitat requirements for each life cycle stage (e.g., Atlantic cod on Georges Bank; Fig. 2). Traditional management practices often limit fishing effort in an attempt to protect spawning stock while ignoring management strategies that would prevent negative effects on survivorship at each life cycle stage. In an effort to address this issue, FMPs are now required to include a description of EFH. This is probably best considered in a multiple-species context, including overlapping habitats of suites of species with similar life cycles that occupy similar habitats as well as their prey. Thus, each Council should include EFH considerations within the FEP, using the ecosystem approach to describe such habitat based on the EFH descriptions from existing FMPs.

4. Calculate total removals—including incidental mortality—and show how they relate to standing biomass, production, optimum yield, natural mortality and trophic structure.

Ecosystem overfishing occurs when fishing directly or indirectly results in a reduction of ecosystem health. Direct impacts on target species include changes in the total population status, age structure, and sex ratio within the population. Indirect impacts can occur on component species or on ecosystem health. Pauly et al. (1998) describe trophic effects of fishing which yield apparently nonlinear, unanticipated results with potential negative effects on sustainability. Thus, a measure of total removals of a target species should include fish landed and fish caught and released (with some determination of mortality rates of released fish), predation at each life history stage, and loss through incidental capture.

Mortality associated with bycatch can produce significant biological losses and ecological shifts in community structure within ecosystems (Alverson et al. 1994). To address bycatch issues, FEPs should: 1) identify potential shifts in community structure and their consequences, and indicate how they should be mitigated; 2) identify bycatch associated with particular gear types, not just by providing a list of species, but also by identifying how bycatch in a given species changes both spatially and temporally; and 3) identify existing or potential alternative gear types which would reduce bycatch.

5. Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions.

The more complex an ecosystem, the greater the unpredictability. The ultimate uncertainty and risk is associated with those practices that affect ecosystem equilibrium, such as significant changes in climate or hydrology that have potentially significant global effects. Therefore, management actions that aim for specific outcomes should be accompanied by the anticipated probabilities associated with achieving those outcomes. Given the variability associated with ecosystem states and the general low precision, high variance, and unknown potential for bias in fisheries data—and thus in the models used to predict outcomes—managers must recognize the high likelihood for unanticipated results. Hence, decision-makers should account for this uncertainty with the development of flexible, adaptive, and risk-averse management strategies.

FEPs should identify those factors or issues which are likely to bear the greatest degree of uncertainty within that ecosystem. Stock assessment reports, prepared for each new or continuing FMP, should characterize uncertainty and indicate how that uncertainty is incorporated into the assessment. The characterization of uncertainty in stock assessments is an example of how the policy of the precautionary approach should be incorporated into the FEP, and one of the best example of insurance against unknowable ecosystem dynamics.

Although uncertainty may render management strategies that are effective in one system ineffective in another, the application of the precautionary approach is a policy which can be implemented in any ecosystem. Because each ecosystem will have different levels of uncertainty and risk associated with it, managers must develop specific risk criteria for application of the precautionary approach within each system.

6. Develop indices of ecosystem health as targets for management.

The use of a goal such as ecosystem health to guide fishery management forces resource scientists and managers to define desired ecosystem states, typically based on historical information reflecting ecosystem structure and yield. Once this has been accomplished, management strategies can be developed to generate and maintain these healthy states. Defining a healthy ecosystem is problematic in practice, so we also recommend that managers identify "unhealthy" ecosystem states which should be avoided. For example, FEP goals could be to prevent the extinction of any ecosystem component, to maintain a specific, high mean trophic level in the ecosystem, or to maintain benthic biomass within the range of natural variability. Each Council should be charged to develop its own FEP goals and metrics based on unique ecosystem characteristics.

7. Describe available long-term monitoring data and how they are used.

Although most physical and biological databases represent relatively short periods of time and therefore do not characterize long-term variability, the amount and quality of physical data available relevant to fisheries have improved markedly in recent years (Boehlert and Schumacher 1997). These data are essential for the development of models to predict changes in oceanographic conditions. Biological baseline data often are difficult to evaluate, given the current impacts of fisheries on marine ecosystems and the largely unpredictable outcomes of these impacts. However, reasonable estimates of preexploitation conditions can be made in some cases (Pauly 1995).

Each FEP should include a prioritized long-term monitoring plan, designed to allow the assessment of the changing states of ecosystem health relative to established baseline conditions. This will be facilitated through the implementation of the research recommendations. As discussed by Christensen et al. (1996), monitoring programs should include ways to determine whether management actions effectively protect ecosystem function. Thus, these programs must be empirically sound and supported by rigorous statistical sampling that avoids bias. While

Aquaculture and Stock Enhancement: Are Cautions being Heeded?

With declining fish stocks, there is growing pressure to artificially boost harvests, either through aquaculture in coastal waters or through stock enhancement. The potential benefits of aquaculture include: increased production of cultured fish which can contribute to food and economic security without placing additional pressure on wild stocks. In addition, stock enhancement may help rebuild or sustain depleted wild stocks.

However, many existing aquaculture programs have developed without attention to their impacts on marine ecosystems (Naylor et al. 1998). Salmon culture and ocean ranching provide good examples. Hatcheries have led to manifold problems, including interbreeding between native and non-native stocks (Lannan et al. 1989), decreases in genetic biodiversity (Ryman et al. 1995), introduced species problems, and threats to carrying capacity, even in the open ocean (Ogura and Ito 1994). Early calls to genetically "upgrade the wild stocks" (Moav et al. 1978) to improve production have given way to attention to the "usually negative" genetic impacts of aquaculture (Beveridge et al. 1994). Wilcove et al. (1992) captured this sentiment, stating "Introduced genes can be as harmful as introduced species, especially when hatchery-bred fish compete with wild populations."

Dramatic examples of human manipulation of coastal ecosystems are provided in Japan, where coastal fisheries have been maintained at a near constant level by increasing mariculture production and stock enhancement while natural production has declined (Morikawa 1994). Aside from potential genetic effects as noted above, high intensity coastal aquaculture decreases public access to the coastal ocean for recreation and other pursuits. Marine fish culture can also lead to additional pollution and wastes. Excess feed, feces and other organic matter from fish farms can accumulate in the benthos and result in a substantial alteration of the benthic community. (Wu 1995, Henderson and Ross 1995, Hansen 1994). In addition, some prophylactic chemicals and drugs used in fish culture have unknown impacts on marine ecosystems. Clearly, both stock enhancement and marine aquaculture must be approached carefully to maximize their benefits while ensuring the health of natural ecosystems and the continued production of wild stocks (Travis et al. 1998).

the probability of accomplishing this is low—because replication is often unrealistic and sample sizes are, of necessity, quite small—it does not justify avoidance of establishing long-term monitoring programs (Walters 1986). In particular, the issue of cumulative impacts cannot be addressed without baseline data. Monitoring programs are essential to the success of fisheries management, particularly if we are to discern effects due to fishery policies from those due to other factors.

8. Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/DOC authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.

In many cases the preponderance of the ecosystem relevant to a particular fishery is under the jurisdiction of the Councils and DOC, but in many cases significant portions of the ecosystem will be outside of that jurisdiction. Examples include salmon, where inland water and habitat issues are paramount and under the jurisdiction of other Federal, State, local and tribal authorities; highly migratory species, where significant parts of the ecosystem are under the jurisdiction of different nations; or ecosystems as extensive as the Gulf of Mexico, where general water quality is critically affected by inflow from ecosystems as broad as the Mississippi River drainage area. Some elements of the ecosystem may be outside of Council/DOC jurisdiction; human constituents may move in and out of Council/DOC jurisdiction and many institutions other than the Councils/DOC may share authority over parts of the ecosystem.

Accounting for the effects of these external influences in the FEP is a two-stage process. First, Councils must identify the most significant elements which are outside Council/DOC authority. This list should include the most significant external effects on ecosystem health. Second, Councils should develop a strategic approach to mitigate each of the major impacts. This approach could include the development of agreements with other agencies to address significant ecosystem impacts, or increased research on ecosystem functions or processes which are affected by outside influences, and which may require mitigation.

Institutional and Human Ecologies—
The Case of Pacific Coast Salmon

The ecology of a Pacific Coast salmon fishery includes not only the ocean environment but the rivers in which the fish spawn and the terrestrial habitat related to those rivers. The human ecology of that salmon fishery includes not only the commercial, tribal and recreational fishermen, but also their ancillary businesses and industries. There are also the businesses and industries which have direct effects on the ocean and the coastal riverine habitats (oil and gas, logging, hydroelectric power, development and construction, agriculture, and other water diverters) and the citizens who are concerned about the salmon and their habitat even though they do not directly interact with the fish.

The institutional ecology of this salmon fishery includes NMFS, other Federal and State fishery agencies, Native American tribes, and all those institutions which govern the behavior of all of the constituent groups of the human ecology. In fact, 37 Federal agencies, in 9 executive level departments, have some authority over activities affecting marine fisheries and their habitat (Hinman and Safina 1992). Not only is it important to recognize the critical role of this broader set of institutions, but also the role of information, education, and involvement of all of the individuals and groups within the broader set of human constituents whose behaviors are governed by those institutions.

MEASURES TO IMPLEMENT FEPS

The following are general recommendations to ensure effective development and implementation of FEPs:

1. Encourage the Councils to apply ecosystem Principles, Goals, and Policies to ongoing activities.

In preparation for FEP implementation, Councils should begin to apply the ecosystem Principles, Goals, and Policies to the conservation and management measures of existing and future FMPs. Three actions are particularly important; specifically, each FMP's conservation and management measures should:

- **Consider predator-prey interactions affected by fishing allowed under the FMP.**

  Optimum yields should be set considering ecological factors and the integrity of the ecosystem, and total allowable catches should be justified with respect to total ecosystem biomass, production and interspecies relationships.

- **Consider bycatch taken during allowed fishing operations and the impacts such removals have on the affected species and the ecosystem as a whole, in terms of food web interactions and community structure.**

  FMPs should identify bycatch taken by gear types and should not just provide a list of species, but describe how bycatch changes temporally and spatially in a given fishery. Management actions should consider the implications of such removals and their consequences. FMPs should identify and consider existing or potential alternative gear types or fishing practices which could reduce such bycatch.

- **Minimize impacts of fisheries operations on EFH identified within the FEP.**

  Gear effects on habitat can be considerable. Gear used to harvest a particular species may directly or indirectly affect other species—managed or unmanaged—within the ecosystem. FMPs should not only identify such impacts but should also identify existing or potential alternative gear types or fishing patterns, such as area closures, which could alleviate these impacts.

2. Provide training to Council members and staff.

To facilitate an ecosystem approach and to aid the development and implementation of FEPs, NMFS should provide all Council members with basic instruction in ecological principles. Further, training materials should be made available to the fishing industry, environmental organizations and other interested parties.

3. Prepare guidelines for FEPs.

The Secretary of Commerce should charge NMFS and the Councils with establishing guidelines for FEP development, including an amendment process. NMFS and the Councils should conduct a deliberative process—similar to the process of developing National Standards Guidelines—to ensure that FEPs are realistic and adaptive.

4. Develop demonstration FEPs.

Choose one or more of the Councils to develop a demonstration FEP. Convene a workshop involving all Councils and other relevant participants which would help develop useful demonstration FEPs.

Encourage all Councils to develop framework FEPs, consisting of such information as can be collected with little additional effort, to facilitate rapid implementation of the full FEP when required by the next MSFCMA reauthorization.

5. Provide oversight to ensure development of and compliance with FEPs.

To ensure compliance with the development of FEPs, the Secretary of Commerce should establish a review panel for FEP implementation oversight. Implicit in this action is the establishment of a timetable for development of a draft FEP, its review by the panel, and any necessary revisions before the draft FEP becomes a basis for policy.

6. Enact legislation requiring FEPs.

To provide NMFS and the Councils with the mandated responsibility of designing and implementing FEPs, Congress should require full FEP implementation in the next reauthorization of the MSFCMA.

RESEARCH REQUIRED TO SUPPORT MANAGEMENT

Our identification of the Principles and associated management Policies reflects a vast amount of scientific knowledge about marine ecosystems and their relationship to humankind. This knowledge is the result of more than 125 years of scientific investment. Yet, the current state of scientific knowledge is not sufficient to fully implement the Principles and Policies. To more fully benefit from the application of the Principles and Policies, there is an urgent need for a better understanding of ecosystem processes in general, and about the state and dynamics of specific ecosystems.

The Panel did not attempt to develop an exhaustive set of research recommendations. That is better left to more specialized groups of scientists. Instead, we highlighted three research themes based on several criteria. First, we selected themes that were clearly related to the Principles and the Policies that form the basis of an ecosystem approach to fisheries management. Second, we placed a priority on identification of new research directions, compared to current research programs that support fisheries management. These new research directions are not recommended as alternatives to the current research programs, rather they are an additional requirement. Third, we highlighted themes for which NMFS has a unique responsibility.

The three recommended research themes are: 1) determine the ecosystem effects of fishing, 2) monitor trends and dynamics of marine ecosystems, and 3) explore ecosystem-based approaches to governance. Each of the themes is briefly described and discussed below.

1. Determine the ecosystem effects of fishing.

The effects of fishing on the species that are landed are generally understood, although the data that are necessary to assess specific stocks of fish are sometimes minimal. It is well known that the effect of fishing on a "target species" can be severe, with abundance reduced by a factor of 10 or more. Fishing is a form of directional selection on fished species that may alter not only population characteristics (i.e., age structure), but also the genetic makeup of the population. Research on genetic changes from fishing is appropriate. It is also known that fishing can have significant effects on nontarget species and, potentially, on marine ecosystems as a whole. These effects occur as a result of bycatch and discarding of non-target species (including marine mammals, reptiles and birds), trophic linkages between target and non-target species, and alteration of habitat caused by fishing gear. All three of these effects need to be studied. The research should consider how fishing changes ecosystems (i.e., abundance and diversity of species, food web dynamics, amount of various habitat types, and the functional significance of changes). An important element of this research will be to explore the utility of quantitative ecosystem health indices as a tool for managers. The research should also include consideration of strategies for applying the precautionary approach in light of uncertainty about ecosystem effects of fishing, and mitigation of undesirable effects. One particularly promising approach for risk-averse management is the establishment of marine protected areas and through traditional fisheries management techniques like time/area closures.

2. Monitor trends and dynamics in marine ecosystems (ECOWATCH).

We recommend the initiation of a significant new ecosystem monitoring program. We refer to the program as "ECOWATCH" because it will enable scientists and policy makers to observe natural and human-caused changes in marine ecosystems in a comprehensive manner. Target fish species are routinely monitored using landings data and resource surveys that apply standardized sampling methods. But even for some important exploited species, landings data and/or resource survey data are limited. Data on other components of marine ecosystems are even more limited, although there are some valuable time series of plankton data for a few ecosystems and for some marine mammal populations. For these reasons, ECOWATCH should be scientifically designed to provide data to improve existing models (i.e., stock assessments), but also for input for future ecosystem models. Research on ecosystem models based on current concepts of important ecosystem linkages is a useful application of ECOWATCH monitoring data.

We recommend substantial expansion of existing programs that collect data on trends and dynamics of marine ecosystems and which characterize the biological and physical relationships pertinent to ecosystem-based management. This expansion is needed to fill gaps in current data collection programs for some target species where data are limited, and systematically observe how other components of ecosystems vary. There are several reasons to observe marine ecosystems holistically. Such observations are needed to determine and understand indirect effects of fishing within marine ecosystems. In a sense, these observations are a form of ecosystem insurance. Because we cannot currently predict all of the ecosystem effects of fishing, we should be watching for evidence of such changes so that it is possible to react if the changes are adverse or positive. Ecosystem observations are also needed to distinguish human caused changes from natural changes. Large spatial and temporal scale (over ocean basins and decades) changes in ecosystems, called regime shifts, are known to occur. Routine monitoring and analysis of key ecosystem variables are needed in order to detect regime shifts and, if possible, to forecast them.

We envision that ECOWATCH will assess the productive capacity of marine ecosystems, including data on fish, shellfish, primary production, plankton, benthic communities (impacts on fishing sites versus control sites), marine mammals, birds, and physical and chemical factors. It will be necessary to make a major investment in new technology to make ECOWATCH feasible. It will be necessary to employ several different sampling "vehicles," including research vessels; dockside and sea sampling of fisheries; remote sensing from satellites, aircraft, and buoys; submersibles; and autonomous underwater vehicles. It will be essential to develop modern data management systems so that variables can be related to each other and so that information is accessible. Models need to be developed to assimilate data and produce information products that enhance our ability to evaluate and make conscious decisions regarding marine ecosystems.

3. Explore ecosystem-based approaches to governance.

Many of today's fishery problems result from failed governance systems. One of the major shortcomings of past and most present governance systems is that they do not create incentives for humans to be prudent predators (i.e., efficient in the uses of natural resources and concerned about long-term conservation). A related problem is that members of the fishing industry and the concerned public often feel alienated from the institutions that govern fisheries. The challenge of achieving effective governance from an ecosystem perspective is even greater. From such a perspective, incentives for efficiency and conservation must apply to indirect effects of fishing on segments of society that are not directly concerned with fisheries, and to other industry sectors that indirectly affect fisheries. A broad array of stakeholders should have the opportunity to participate in the system of governance.

We envision a multifaceted research program including: 1) research on the social and economic importance of fisheries, and of other ecosystem uses that affect fisheries, to better understand social objectives, motivations for behavior, and options for creating effective incentive systems; 2) case studies and comparative studies (with other industry sectors) to identify factors that determine success or failure of governance systems; and 3) management experiments to test approaches for involving stakeholders in governance systems and for making decisions when faced with multiple objectives (i.e., from different societal perspectives and across sectors).

While NMFS clearly has lead responsibility for these themes, the research strategies should be developed and implemented as National interagency programs involving academic as well as government scientists. Because the ecosystem Principles apply globally, the U.S. should participate in, and initiate when necessary, international programs that further fisheries management objectives. A significant enhancement in resources (e.g., funding, staff, fishery research vessels) will be required if these research recommendations are to be fulfilled.

SECTION FIVE: SUMMARY AND CONCLUSIONS

Recognition of major problems in U.S. fisheries prompted Congress to legislate the Sustainable Fisheries Act (SFA) in 1996. This amendment strengthened the MSFCMA and gave new direction to NMFS and the Councils to halt overfishing, develop recovery plans for overfished fisheries, avoid and reduce bycatch mortality, identify and protect EFH, investigate ways to reduce fishing capacity, and implement numerous other conservation measures. These represent the beginnings of an ecosystem approach to fishery management. Rapid response and hard work by NMFS, the Councils, fishing industries, environmental groups, and other interested parties will produce change that eventually will result in marked improvements in the status and management of our fisheries resources. Still, there is more to be done.

The appointment of the NMFS Ecosystem Principles Advisory Panel is a key provision of the SFA. Congress called for an assessment of the extent to which ecosystem principles are being applied in fishery conservation, management, and research and for recommendations on how to use them further to improve management. Our review of the use of ecosystem principles finds some positive indications, but much room for further application. The fisheries ecosystem science being conducted is of high quality, but the types of research and assessments, and the geographic coverage are extremely limited and inadequate to inform fishery management. Where scientific information on fisheries ecosystems is produced, it is often used in the management process. However, it is inadequate relative to the scope of the problems and the geographic scale of our Nation's marine fisheries.

At present, NMFS and the Councils often are using the best available science to manage stocks on a single species or species-complex basis. If fishery management is to further incorporate ecosystem principles, Congress must provide a specific mandate to NMFS and the Councils to do so and must fund the scientific infrastructure required to support the decision-making process. Requiring Councils to prepare FEPs provides a mechanism to focus and inform fishery management, to measure progress toward implementation of ecosystem-based fishery management, to identify research needs and ultimately to insure healthy and productive ecosystems.

U.S. fisheries under an ecosystem-based management system are likely to be quite different than today's fisheries. New management tools will be employed including share-based systems. Fisheries and gear types that have significant adverse impacts on other ecosystem components may be modified or phased out and other types of fisheries and gears may replace them. In some cases, fish stocks may have to be exploited at lower harvest levels than presently indicated in order to sustain other ecosystem components. Some areas that are now fished may become fisheries reserves where harvests are restricted to protect a spawning stock or other sensitive life-history stages; this may result in changes to traditional fishing practices. The short-term consequences of such changes, which may be painful, must be balanced against future benefits in the form of sustainable fisheries and fishing communities.

The next ten years are critical for the future of U.S. fisheries. Already, important changes are underway as a result of the SFA, and the next round of legislation/reauthorization of the MSFCMA should provide additional impetus for reform. Implementation of an ecosystem-based approach will take time and there will be trials and errors. A great deal of education about this new approach will be required, and all involved must be prepared to learn. The two hardest lessons are likely to be shifting the burden of proof to the fishery to demonstrate that the ecosystem will not be damaged by fishing, and to develop a truly precautionary approach to fishery management. The learning curve will be steep for all involved; society as a whole, will be increasingly challenged to help define ecosystem health and the limits of acceptable change in marine ecosystems, while still allowing sustainable fishing practices.

GLOSSARY

Allowable Biological Catch—Catch that can be taken in a specific year that achieves the biological objectives, or avoids the biological constraints, of fishery management. Such objectives and constraints are usually set in terms of stock sizes that must be maintained and/or fishing mortality rates that shall not be exceeded. Estimates of allowable biological catch should be based on the best scientific advice available.

Burden Of Proof—The responsibility to demonstrate that a fishing activity will or will not lead to overfishing or negative effects on the ecosystem.

Bycatch—Unintentional catch; i.e., catch that occurs incidentally in a fishery that intends to catch fish with other characteristics (e.g., size, species).

Carrying Capacity—The numbers or biomass of resources that can be supported by an ecosystem.

Conservation and Management—The rules, regulations, conditions, methods, and other measures (A) which are required and useful to rebuild, restore, or maintain any fishery resource and the marine environment; and (B) which are designed to ensure that: (i) a supply of food and other products may be taken, and that recreational benefits may be obtained, on a continuing basis; (ii) irreversible or long-term adverse effects on fishery resources and the marine environment are avoided; and (iii) there will be a multiplicity of options available with respect to future uses of these resources (NMFS 1996).

Discards—A portion of what is caught and returned to the sea unused. Discards may be either alive or dead. There are many types of discards, such as economic discards (when a portion of the catch that it is not economically rational to land is discarded), regulatory discards (when discarding occurs because of a prohibition on retaining some of the catch), highgrade discards (discarding of the portion of the catch with a lower value than the portion retained in order to comply with regulations that limit how much catch can be retained). Highgrading is a form of regulatory discarding.

Ecosystem-based Fishery Management—Fishery management actions aimed at conserving the structure and function of marine ecosystems, in addition to conserving the fishery resource.

Essential Fish Habitat—Those waters and substrate necessary for fish to spawn, breed, feed and grow to maturity (NMFS 1996).

Fish—Defined herein as finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds (NMFS 1996).

Fishery—(A) One or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational, and economics characteristics; and (B) any fishing for such stocks (NMFS 1996).

Fishing—Any activity which can reasonably be expected to result in the catching, taking, or harvesting of fish; or any operations at sea in support of, or in preparation for, such activities.

Fishing Mortality—A measurement of the rate of mortality of fish in a population caused by fishing.

Fish Stock—A species, subspecies, geographical grouping, or other grouping of fish that is managed as a unit (NMFS 1996).

Maximum Sustainable Yield—A management goal specifying the largest long-term average catch or yield (in terms of weight of fish) that can be taken, continuously (sustained) from a stock or stock complex under prevailing ecological and environmental conditions, without reducing the size of the population.

Optimum Yield—(A) The amount of fish which will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; (B) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and (C) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery (NMFS 1996).

Overfishing—Fishing at a rate or level that jeopardizes the capacity of a stock or stock complex to produce maximum sustainable yield on a continuing basis (NMFS 1996).

Primary Production—Creation of organic matter by plants through photosynthesis (using inorganic carbon, nutrients and an external energy source) to form the base of the food chain.

Recruitment—A measure of the weight or number of fish which enter a defined portion of the stock such as fishable stock (those fish above the minimum legal size) or spawning stock (those fish which are sexually mature).

Regime Shift—Major changes in levels of productivity and reorganization of ecological relationships over vast oceanic regions which could be caused by various sources including climate variability or overfishing.

Resilience—The ability of a population or ecosystem to withstand change and to recover from stress (natural or anthropogenic).

Significant Food Web—A predator/prey interaction that is important to either the predator or prey population.

Stock Assessment—An evaluation of a stock in terms of abundance and fishing mortality levels and trends, and relative to fishery management objectives and constraints if they have been specified.

Surplus Production—Total weight of fish that can be removed by fishing without changing the size of the population. It is calculated as the sum of the growth in weight of individuals in a population, plus the addition of biomass from new recruits, minus the biomass of mortality of animals lost to natural mortality, during a defined period (usually one year).

Target Species—Those fish explicitly sought by fishermen to meet social and economic needs. Their catch are the direct consequence of targeted fishing effort. **Non-target Species** include all others.

Total Allowable Catch—The annual catch from a stock that is allowed according to fishery management regulations.

Trophic Web—The network that represents the predator/prey interactions of an ecosystem.

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APPENDIX A: CHARTER— NATIONAL MARINE FISHERIES SERVICE ECOSYSTEM PRINCIPLES ADVISORY PANEL

The Charter was provided to the Panel as initial guidance from NMFS. It was subsequently modified after Panel review.

INTRODUCTION

Section 406 of the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA) as amended through 1996 (Appendix B) requires the Secretary of Commerce to establish a Panel to provide advice to the Secretary and Congress on ways to incorporate ecosystem principles in fisheries conservation and management activities. The need for such a Panel has arisen from the perceived failure of traditional management approaches to ensure sustainable fisheries. Yields of many marine fisheries worldwide have declined in recent years; in the U.S., 42% of fish stocks are considered overutilized. The causes of these declines have been complex, and include overharvesting of target and non-target species, habitat alteration and loss, pollution and natural environmental change. Stocks in this condition are not able to provide the same sustained economic and social benefits as those in healthy fisheries.

A basic premise of ecosystem-based management is that the relationship between living marine resources and the ecosystem within which they exist must be well understood. This requires a more comprehensive approach to fisheries research than is necessary for traditional single-species management approaches, although single-species stock assessments have become increasingly sophisticated and some now incorporate environmental parameters. Successful implementation of ecosystem-based management will require consideration of, inter alia, essential habitat requirements, hydrography, trophic relationships and physical and biological processes. An important element of the Panel's duties will be to determine what information is essential to the task of ecosystem-based fisheries conservation and management, and how that information should be collected.

Managers must also understand the complex linkages between natural ecosystems and the economic, social and political dynamics of human systems. Humans are integral components of ecosystems and their interests, values and motivations must be understood and factored into resource management decisions. Information on human systems is as important as that from natural systems and must be included in any ecosystem research and management efforts.

Efficient use of existing information and information flow to management are important topics for Panel consideration. In developing an ecosystem approach to research and management, it is important to recognize that a great deal is already known about marine ecosystems, but that this information is not consistently applied in current management efforts. This is, in large part, because there is no agreed upon method or process for applying it. Therefore, emphasis must be placed not only on what new information is required, but also on how to apply existing information effectively. In addition, it must be recognized that both science and management are ongoing processes, and that mechanisms are required to incorporate new scientific, social, cultural, economic and institutional information into the management process as it becomes available. This may require managers to be trained in ecosystem approaches, so that valuable new information will be recognized and utilized where appropriate.

The complicated legislative and institutional framework that currently regulates resource management decision making poses a significant challenge to the implementation of ecosystem-based fisheries conservation and management. Although the MSFCMA is the principal legislation governing U.S. marine fisheries, other Federal legislation including the Marine Mammal Protection Act and the Endangered Species Act, as well as State laws and international agreements, provide for the conservation and management of marine resources. This geographic, legislative and institutional fragmentation of conservation and management responsibilities is not consistent with ecosystem principles, which ignore human boundaries and jurisdictions. It also indicates the need for an 'institutional ecology' and a 'legislative ecology' which parallel more closely the natural ecosystem. Coordination of these legislative and institutional responsibilities across jurisdictional lines, as well as the appropriate involvement of all stakeholders in the decision making process, will be a significant task in implementing ecosystem-based management.

The U.S. lacks a single and unifying legislative mandate or policy governing the use of resources from marine ecosystems. Consequently, decisions on resource management within marine ecosystems often are in conflict with one another. For example, it is axiomatic that fishery yields cannot be maximized for all species simultaneously. Likewise, the goal of protecting all marine mammals within an ecosystem may not be consistent with the goal of sustaining maximum fisheries yields, and vice versa. From the outset, resource managers must determine what values are placed on a marine ecosystem and its components, and which goods and services are expected to be produced from each ecosystem. The recommendations of this Panel regarding the development of such policies will be an important step towards improved fisheries conservation and management.

Numerous panels, committees and task forces have been constituted in the past to consider how ecosystem approaches should be applied to natural resource management issues. Many solid recommendations have emerged from these efforts, however few appear to be implemented in fisheries management, as evidenced by Congress' mandate for this Panel. While the reasons for this failure are probably multiple, an underlying cause may be that many of the recommendations have been more theoretical than practical, and have provided the practicing manager with little in the way of implementable management tools. Unlike these previous efforts, it is fully intended that the NMFS Ecosystem Principles Advisory Panel will develop specific, practical and implementable recommendations for the research, conservation and management of living marine resources, along with longer term goals and directions.

PURPOSE

The Panel's purpose is to advise NMFS and Congress on the application of ecosystem principles in fisheries conservation and management and research activities.

TERMS OF REFERENCE

The Panel will:

1. Conduct an analysis of the extent to which ecosystem principles are being applied in fishery[1] conservation and management[2] activities, including research activities. The analysis should include the following:

Conservation and management issues

A review of the extent to which ecosystem principles are being applied in: 1) the development of fishery management plans by the Councils; 2) the development of advice by NMFS to the Councils; and 3) other regulatory and rule-making activities of NMFS.

An identification and analysis of cases in which ecosystem principles have been successfully applied in fisheries conservation and management activities.

Research issues

A review of the status of ecosystem science within NOAA and other entities involved with research in the marine environment (e.g., academic institutions, other Federal and State agencies).

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[1]The term "fishery" means—(A) one or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational and economics characteristics; and (B) any fishing for such stocks.

[2]The term "conservation and management" refers to all the rules, regulations, conditions, methods, and other measures (A) which are required and useful to rebuild, restore, or maintain, any fishery resource and the marine environment; and (B) which are designed to ensure that:
(i) a supply of food and other products may be taken, and that recreational benefits may be obtained, on a continuing basis;
(ii) irreversible or long-term adverse effects on fishery resources and the marine environment are avoided; and
(iii) there will be a multiplicity of options available with respect to future uses of these resources.

An analysis of whether current research efforts within these agencies and institutions are adequate to support fisheries ecosystem conservation and management.

2. **Propose a specific, prioritized course of actions that the Secretary of Commerce, Congress and NMFS should undertake to expand the application of ecosystem principles in fishery conservation and management. For example, the following issues might be considered:**

Conservation and management issues

What specific, practical actions can be taken to apply ecosystem principles in fisheries conservation and management activities in the near term, before more complete information is available on ecosystem structure and function?

What barriers (scientific, social, institutional, economic, administrative, legislative) exist to the application of ecosystem principles in U.S. fisheries conservation and management activities? What solutions can be proposed?

Should changes be made to the Council structure or mission to better apply ecosystem principles in conservation and management activities? If so, what should the changes be?

Does the U.S. need additional legislation, or changes to current legislation, to improve the scientific and regulatory infrastructure to support ecosystem-based conservation and management?

Research issues

Which research topics should be priorities for the development of a long-term information base to support marine ecosystem management?

How can agencies and institutions involved in marine and fisheries science collaborate more effectively to take advantage of complementary research efforts, and synergize results from a broader ecosystem perspective?

What are the most meaningful time and space scales for marine ecosystem research which will directly support conservation and management efforts?

Is sufficient information available to determine the value of harvest refugia in fisheries ecosystem management? If not, what additional information is required?

3. **Produce a report to Congress by October 1998 which includes the above information, plus any other information as may be appropriate.**

The principal focus of the analyses in Section 1 above should be on conservation and management and research activities conducted within the U.S., including those marine ecosystems and their resources which are shared by the U.S. and other countries (e.g., transboundary stocks). However, the Panel should consider pertinent examples from other areas of the world where ecosystem approaches have been used. The Panel should focus on research, conservation and management activities which pertain to ecosystems or species under the jurisdiction of the MSFCMA.

Panel Membership

According to MSFCMA Section 406, the Advisory Panel shall consist of not more than 20 individuals and include:

Individuals with expertise in the structures, functions and physical and biological characteristics of ecosystems; and

Representatives from the Regional Fishery Management Councils, States, fishing industry, conservation organizations or others with expertise in the management of marine resources.

Nominations for panelists were solicited from the National Academy of Sciences, Councils, States, fishing industry and conservation organizations, as well as other appropriate regional and national stakeholders. The Panel membership is balanced geographically, so that regional issues can be addressed.

Travel Costs

Travel expenses for the panelists to attend panel meetings will be paid by the government at prevailing government rates.

Format and Panel Duration

The Panel will convene three two-day meetings in September 1997, November-December 1997, and February-March 1998. Additional meetings or conference calls may be held as required. The Panel may be requested to continue to advise NMFS on ecosystem issues after October 1998 if such advice is required.

All meetings will be open to the public, and each meeting will include a specific opportunity for public input. Members of the public wishing to make presentations or statements at the meetings must notify the NMFS Office of Science and Technology at least two weeks in advance of the meeting date, which will be published in the Register.

APPENDIX B: MSFCMA SECTION 406 FISHERIES SYSTEMS RESEARCH

(a) ESTABLISHMENT OF PANEL.—Not later than 180 days after the enactment of the Sustainable Fisheries Act, the Secretary shall establish an advisory panel under this Act to develop recommendations to expand the application of ecosystem principles in fishery conservation and management activities.

(b) PANEL MEMBERSHIP.—The advisory panel shall consist of not more than 20 individuals and include—

(1) individuals with expertise in the structures, functions, and physical and biological characteristics of ecosystems; and

(2) representatives from the Councils, States, fishing industry, conservation organizations, or others with expertise in the management of marine resources.

(c) RECOMMENDATIONS.—Prior to selecting advisory panel members, the Secretary shall, with respect to panel members described in subsection (b)(1), solicit recommendations from the National Academy of Sciences.

(d) ECOSYSTEM REPORT.—Within two years of the date of enactment of this Act, the Secretary shall submit to the Congress a completed report of the panel established under this section, which shall include—

(1) an analysis of the extent to which ecosystem principles are being applied in fishery conservation and management activities, including research activities;

(2) proposed actions by the Secretary and by the Congress that should be undertaken to expand the application of ecosystem principles in fishery conservation and management; and

(3) such other information as may be appropriate.

(e) PROCEDURAL MATTER.—The procedural matters under section 302(j) with respect to advisory panels shall apply to the Fisheries Ecosystem Management advisory panel.

APPENDIX C: MEETING PARTICIPANTS

First Meeting—September 9–10, 1997
Washington, D.C.

Presenters:

Dave Allison
Allison Associates

Larry Buckley
NMFS, Northeast Fisheries Science Center

David Evans
NMFS, Deputy Assistant Administrator

Karen Garrison
Natural Resources Defense Council

Craig Harrison
Pacific Seabird Group

Don Leedy
NMFS, Office of Sustainable Fisheries

Pat Livingston
NMFS, Alaska Fisheries Science Center

Jeff Polovina
NMFS, Southwest Fisheries Science Center

Mike Schiewe
NMFS, Northwest Fisheries Science Center

Jim Thomas
NMFS, Office of Habitat Protection

Nancy Thompson
NMFS, Southeast Fisheries Science Center

Guests:

Roger Griffis
NOAA, Office of Policy and Strategic Planning

Kate Wing
Staff, Senate Commerce Committee

Tom Eagle
NMFS, Office of Protected Resources

Second Meeting—December 15–16, 1997
Seattle, Washington

Presenters:

John Gauvin
Executive Director, Groundfish Forum

Chuck Fowler
NMFS, National Marine Mammal Lab

Lowell Fritz
NMFS, Alaska Fisheries Science Center

Peter Fricke
NMFS, Office of Sustainable Fisheries

Rod Fujita
Environmental Defense Fund

Tom Okey
Center for Marine Conservation

Ken Stump

Dave Witherell
North Pacific Fishery Management Council

Guests:

Kerim Aydin
University of Washington

Jim Balsiger
Director, NMFS Alaska Fisheries Science Center

Ed Casillas
NMFS, Northwest Fisheries Science Center

Tracy Collier
NMFS Alaska Fisheries Science Center

John Fell
University of Washington

Bill Hines
NMFS, Alaska Region

Loh-Lee Low
NMFS, Alaska Fisheries Science Center

Clarence Pautzke
Executive Director, North Pacific Fisheries Management Council

Mike Schiewe
NMFS, Northwest Fisheries Science Center

John Stein
NMFS, Northwest Fisheries Science Center

Usha Varanasi
Director, NMFS Northwest Fisheries Science Center

Kate Wing
Senate Commerce Committee

Third Meeting—February 26–27, 1998
Key Largo, Florida

Presenters:

Kimberly Davis
Center for Marine Conservation

Graeme Parks
Marine Resources Assessment Group Americas

Alexander Stone
Reefkeeper International

Guests:

Tom Eagle
NMFS, Office of Protected Resources

Chuck Fowler
NMFS, National Marine Mammal Lab

William Fox, Jr.
Director, NMFS Office of Science and Technology

Eduardo Martinez
NMFS, Southeast Fisheries Science Center

Strengthening Scientific Input and Ecosystem-Based Fishery Management for the Pacific and North Pacific Fishery Management Councils

Suggestions from a panel discussion
July 19-20, 2005
Seattle, Washington

Panel
Richard Marasco (chair)
Daniel Goodman
Churchill Grimes
Peter Lawson
André Punt
Terry Quinn

with assistance from
Dave Hanson
Fran Recht
Jodie Little

Pacific States Marine Fisheries Commission

July 2005

Abstract

A panel of scientists was convened by the Pacific States Marine Fisheries Commission for an intensive two day meeting to examine practical ways that the Pacific and North Pacific Fishery Management Councils (FMCs) could address two of the recommendations recently made by the U.S. Commission on Ocean Policy. One theme addressed ways to move towards an ecosystem-based approach to fisheries management. The other theme addressed the role of science in fishery management Council decisions, how to strengthen that role, and whether to separate conservation issues (how many fish are appropriate to catch) from allocation issues (who gets to catch them).

Recognizing that the process of incorporating ecosystem considerations into fishery management council decisions is an evolutionary one, the panel crafted a definition of ecosystem-based fishery management (EBFM), identified characteristics that were specific to an EBFM approach, and identified a process that would help the FMCs move forward in incremental ways, from the existing management approaches that generally consider ecosystem interactions in an implicit and often peripheral way, to a management system that, over time, would incorporate explicit EBFM considerations into the fishery assessments themselves.

The EBFM approach recognizes the broader uses and users of the marine environment (including fishing). There is a need to consult with, accommodate and, to the extent possible, reconcile the many societal goals and objectives of these users, so that future generations can also benefit from the full range of goods and services provided by the ecosystem. The development and testing of models that incorporate ecosystem considerations explicitly will focus attention on the research and monitoring needed to improve the models and reduce uncertainty. There also will be a need for a more rigorous setting of operational objectives and decision rules, and for the evaluation of management performance.

The panel noted that both FMCs, and particularly the North Pacific FMC, are already working to manage fisheries conservatively, to protect habitat, establish marine protected areas, protect forage fish, and to reduce bycatch--all tactics that are consistent with an EBFM approach. Additionally, the North Pacific FMC has established indicators of ecosystem health (and a monitoring plan for them). Further progress could be made with an approach that (1) recognizes, upfront, an expanded list of societal goals, (2) develops, tests, and uses new models for management that explicitly incorporate these goals (3) include factors such as oceanography, habitat productivity, food-web interactions, life- history, spatial variability, environmental trends, and uncertainty considerations, and (4) evaluates these measures to assure that specific goals are being met. Progress is critically dependent upon obtaining additional resources and funding to bridge the gap between current fishery management practices and EBFM.

The panel thought the existing mechanisms for scientific input into fishery management decisions worked well in the North Pacific and Pacific FMCs. In moving forward towards EBFM, the role of the FMC's Scientific and Statistical Committees (SSCs) will continue, however their workload will be greater and may require the addition of scientists with expertise in specialties that are not yet represented on the committees. The panel emphasized that important roles for SSCs include the specification of the acceptable biological catch (ABC), including reviews of the stock assessments and harvest formulas that are used to calculate ABC, and analysis describing relevant effects (including the extent of risk and uncertainty) of harvest alternatives and other management measures (Witherell, 2005).

The Panel noted that, while computation of an ABC is a scientific process, some of the key constraints in the calculation may be set by policy. In the future, as decision rules become more sophisticated, the quantification of uncertainty will become more formalized. That is, the stipulation of risk-related policy, namely the specification of how risk-averse or risk-tolerant the decision process should be, will become increasingly important. The formulation of such policy is not the role of scientific advisory bodies such as SSCs, but it should not be left to ad hoc decisions of the moment either. The goal of such formalized policy is to achieve consistency and stability across time and across districts, serving the best interest of society as a whole, in the long run, and putting more distance between the decision process and narrower considerations of expediency. For this reason, such policy should be the subject to national debate and independent scientific peer review. Regional differences must be recognized. Within such a framework, with its heavy technical demands, the role of scientific advisory bodies, such as SSCs, is to provide scientific quality control and quality assurance.

The panel concluded that SSCs should not be separated and insulated from the FMCs. Fisheries are not managed by science alone, but good fishery management cannot afford to ignore good science, and needs ready access to it. There will always be policy choices and tradeoffs that may be within the scope of the discretionary authority of the FMC, but the FMC will be in a position to better use that latitude if the SSC informs the FMC of the probable consequences of their choices. A close working relationship of a FMC with its SSC, which can be fostered by having both bodies meet at the same time, will facilitate such communication.

The Panel also suggested that the role of science and, thus, the SSCs would be strengthened if NOAA Fisheries and the Secretary of Commerce would ask for a rigorous justification from the FMC if decisions were contrary to scientific advice. It should be made clear that SSC members are to act independently as scientists (and at times may disagree with their agency positions). Additionally, there may be value in having periodic national or regional meetings of the SSCs to develop common operating procedures and to compare approaches to providing scientific advice.

Background

Echoing concerns of other reports and studies regarding the sustainability of marine ecosystems and the depletion of many fish species, the U.S. Commission on Ocean Policy (USCOP) recently recommended that the United States move towards an ecosystem based approach to management, including fisheries management. While this idea is good, there are substantial outstanding issues with defining what an ecosystem-based approach to management is and how it might be implemented.

Additionally, the USCOP recommended severing the Scientific and Statistical Committees (SSCs) from the Fishery Management Councils (FMCs), and separating "conservation issues" from "allocation issues", because of concerns that political and fishing industry pressure may have resulted in some FMCs setting catches higher than was prudent[1]. While some see this

[1] The U.S. COP notes that: "Although fishery data collection and stock assessment models can always be improved, a lack of adequate scientific information has not been the main culprit in most instances of overfishing. The Mid-Atlantic and New England FMCs [Regional Fishery Management Councils], which managed fourteen of the thirty-three stocks that experienced overfishing in 2001, have some of the best scientific support in the world. A 2002 National Research Council report concluded that the problem in most cases of overfishing was that the RFMCs

recommended separation as a way to promote the role of science in the fishery management decision making process, others see the potential for establishing conflicting bureaucracies and allowing political bodies more freedom to be subject to constituent influence.

There have been other reviews, workshops, and conferences that have addressed these topics and made recommendations (for example NMFS 1999, NRC 1999, Pew Oceans Commission, 2003, Busch 2003, FAO 2003, Witherell 2004, U.S. Commission on Ocean Policy 2004), most recently the Managing our Nation's Fisheries II conference in Washington, D.C. in March of this year (Witherell, 2005). However, there was interest in looking more specifically at these topics, considering the work that the North Pacific and Pacific FMCs[2] have already undertaken, in order to explore opportunities and mechanisms for additional progress towards Ecosystem-based Fishery Management (EBFM) and strengthening scientific input.

The Pacific States Marine Fisheries Commission (PSMFC) convened a panel of scientists to draft recommendations on these two topics, with a view toward specific applicability and utility to the FMCs. Panelists were chosen by PSMFC based on their technical qualifications, their familiarity with the operation of the North Pacific and Pacific FMCs, and their knowledge of the workings of their scientific and statistical committees. The list of panelists and short biographies are presented in Appendix 1. The panel was provided a briefing book of background materials and some additional documents at the meeting (see references). The panel discussion was held July 19th and 20th in Seattle, Washington at the SeaTac Marriott hotel. The discussion was chaired by Dr. Rich Marasco, and was organized around the specific questions stated by PSMFC in the charge to the panel (the questions are listed in Appendix 2).

The Marine Conservation Alliance (MCA) of Juneau, Alaska provided funding for this project. MCA has not been involved with developing or reviewing report contents. It is strictly a project of the PSMFC.

Discussion

Ecosystem-based Fishery Management

The first topic addressed by the Panel related to EBFM. Three questions were posed by the PSMFC. The first one was:

1. What is a practical definition of an ecosystem-based approach to fisheries management that could be used by fishery management councils?

Many definitions of an ecosystem-based approach to management and fisheries management have been suggested. Some are noted in Table 1. There are recurring themes in all of these definitions. For example, there is recognition that ecosystem-based approaches recognize broader uses and users of the marine environment (including fishing) and the need to accommodate and reconcile the many objectives of these users so that future generations can also benefit from the full range of goods and

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disregarded or downplayed valid scientific information when setting harvest guidelines. Neither NMFS nor the Secretary of Commerce used their authority to prevent the RMFCs from taking such actions.

[2] These FMCs manage fish off Alaska and Washington, Oregon, and California, respectively.

services provided by the ecosystem. The approach also recognizes that humans are an essential component of the ecosystem in which fishing takes place, and it focuses on the interactions within the system. This is in contrast to current fishery management practices which focus on individual species, and do not deal with ecosystem issues in a comprehensive way.

Therefore the purpose of an EBFM approach is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystem.

Finding

The panel noted that there was no lack of good definitions. However, there was a desire to craft one that would help indicate to the FMCs what is needed above and beyond what is already being done. Simplicity was considered an important characteristic of a good definition. There also was interest in constructing a definition that would recognize interactions among various parts of the system, as well as the need to consider a broader set of societal goals and values. In addition, there should be recognition of the importance of defining goals and recognizing that there would be trade-offs between potentially competing societal goals. Finally, the definition should be value-free, steer clear of narrowly specifying matters where the substance of the science is evolving, and be applicable to the whole spectrum of management approaches from the current single species focus to a more explicit approach to ecosystem-based management. The following definition was considered to satisfy these concerns:

"**Ecosystem-based fishery management recognizes the physical, biological, economic and social interactions among the affected components of the ecosystem and attempts to manage fisheries to achieve a stipulated spectrum of societal goals, some of which may be in competition.**"

Table 1—Definitions Used By Others

Ecosystem-based Approach to Management (or Fisheries Management)

The North Pacific Fishery Management Council :
"Ecosystem-based approach to fisheries management is defined as the regulation of human activity towards maintaining long-term system sustainability (within the range of natural variability as we understand it) of the North Pacific covering the Gulf of Alaska, the Eastern and Western Bering Sea and the Aleutian Islands region."

The Food and Agricultural Organization of the United Nations (FAO 2003):
"An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries."

The Scientific Consensus Statement on Marine Ecosystem-Based Management (McLeod et. al. 2005):
"Ecosystem-based Management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers cumulative impacts of different sectors. Specifically, ecosystem-based management:

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

The National Research Council (NRC 1999):
"Ecosystem-based management is an approach that takes major ecosystem components and services—both structural and functional—into account in managing fisheries. It values habitat, embraces a multispecies perspective, and is committed to understanding ecosystem processes. Its goal is to achieve sustainability by appropriate fishery management." (NRC 1999)

The second question addressed by the panel was:

2. What are the characteristics or management elements of an ecosystem based approach to fisheries management? Are the elements identified by the National Research Council (NRC 1999) and the Ecosystem Principles Advisory Council (NMFS 1999) still appropriate? Are there other elements or characteristics that should be included?

In considering this question, the panel reviewed a number of background documents regarding the characteristics of an EBFM approach. Table 2 is a sampling of some suggestions made by various panels and committees.

The Panel stressed that it is important to recognize that EBFM is neither inconsistent with, nor a replacement for, current fisheries management approaches. This means that EBFM is likely to be adopted as an incremental extension of current fisheries management approaches. The challenge will be to find ways to move forward given the high degree of uncertainty involved in employing new approaches, and not allowing this uncertainty to be a license to maintain the *status quo*. Rather, the uncertainty should be taken as a mandate to improve current understanding.

The single species assessment and management approach has a long empirical record. The approach has well defined models (Quinn and Deriso 1999), with research being conducted to fill data gaps to improve models (Quinn 2003, Quinn and Collie 2005). Properly used, it has been effective. Failures almost exclusively have not been due to the science and management approach, but rather due to political will and data limitations (Fogarty and Murawski 1998, Sissenwine and Mace 2001). The single species approach does incorporate ecosystem considerations. However, the ecosystem in these models is generally treated as a single collapsed background factor. The following are examples where ecosystem features have been included: a) a stock recruitment curve with density dependence for a given species may originate from predation by another species, b) time-varying natural mortality in a model may also be due to predation or disease effects, and c) the set of years used to define reference points may take account of perceived regime shifts (Quinn and Collie 2005).

It has been suggested that perhaps the most significant changes required for an EBFM would be an adjustment in thinking about goals to reflect a broader set of societal values than those involving the targeted fish species, and different (additional) scientific inputs that would be needed to help inform models to achieve those goals and the management strategies employed.

The panel agrees with the perspective expressed in a study conducted for the North Pacific FMC (Goodman et. al 2002) that:

> "…moving from the conventional assessment view towards an ecosystem view involves a shift in the components of fundamental underlying ecological science that is relied upon. In essence, for current fishery management, population ecology is the fundamental ecological science, but for an approach that takes ecological and ecosystem considerations into account, community ecology is the fundamental ecological science. For example, when one thinks about single species, there can be "excess production" from a stock, but when one thinks about the "needs" of all the other species in an ecosystem, the notion of excess production from a single member of the community becomes far more complicated."

Table 2—Suggestions from Others
Characteristics of an Ecosystem-based Fishery Management Approach

Ecosystem Principles Advisory Panel (EPAP) (NMFS 1999):
"A comprehensive ecosystem-based fisheries management approach would require mangers to:

- consider all interactions that a target fish stock has with predators, competitors, and prey species;
- the effects of weather and climate on fisheries biology and ecology;
- the complex interactions between fisheries and their habitat;
- And the effects of fishing on fish stocks and their habitat."

Scientific Consensus Statement on Marine Ecosystem-based Management (McLeod 2005) (from those suggested by the U.S. COP and Pew Commission reports):

- Make protecting and restoring marine ecosystems and all their services the primary focus, even above short-term economic or social goals for single services.
- Consider cumulative effects of different activities on the diversity and interactions of species.
- Facilitate connectivity among and within marine ecosystems by accounting for the import and export of larvae, nutrients and food.
- Incorporate measures that acknowledge the inherent uncertainties in ecosystem-based management and account for dynamic changes in ecosystems. In general, levels of precaution should be proportional to the amount of information available; the less that is known about a system, the more precautionary management decisions should be.
- Create complementary and coordinated policies at global, international, national, regional, and local scales, including between coasts and watersheds. (Appropriate scales for management will be goal-specific.)
- Maintain historical levels of native biodiversity in ecosystems to provide resilience to both natural and human-induced changes.
- Require evidence that an action will not cause undue harm to ecosystem functioning before allowing that action to proceed.
- Develop multiple indicators to measure the status of ecosystem functioning, service provision and effectiveness of management efforts.
- Involve all stakeholders through participatory governance that accounts for both local interests and those of the wider pubic.

The Marine Fisheries Advisory Committee's (MAFAC) Ecosystem Approach Task Force (Busch 2003) suggested these elements:

- Enhancing intra-and inter agency cooperation and communication
- Delineating geographic area(s) of the ecosystem
- Preparation of quantified natural resource goals and objectives
- Identify and apply specific indicators
- Socio-Economic data to evaluate management tradeoffs

In moving to EBFM, the challenge will be isolating the influence of individual ecological factors (e.g. climate and oceanographic conditions) and developing an understanding of important interactions. High levels of uncertainty will be associated with efforts focused on characterizing these relationships. The uncertainty results from the limitations of currently available data for estimating parameters for ecosystem models and for validating these models. A critical danger is that without any track record for such models, the assumptions could be completely wrong. There is little such danger with the current single-species approaches. For this reason, it is likely that when scientists and managers select management procedures based on a likelihood of achieving the management objectives, there will be a tendency to avoid this uncertainty and choose procedures similar to the present procedures which are based primarily on conservative single-species management. However, selection of new management system features that are robust to uncertainty is possible when there is consistency across a number of different models. In other words, there are technical means for filtering out the most risky aspects of new, unproven models, while still giving a fair trial for innovation.

Additionally, though the management systems may look similar during the transition to EBFM, the increased importance and use of ecosystem models will assist in the identification of approaches to consider when designing management procedures, defining decision rules, and planning investments in research and monitoring. The design and employment of new models will also assure that there is at least qualitative consideration of interactions before management decisions are made.

Until necessary research is done, it is not possible currently to know what the optimal model configuration and corresponding data requirements will be for an ecosystem-based management approach. It could be that a set of single-species models combined with collection of ecosystem indicators and prudent management strategies could suffice for many systems. For others, it may be necessary to develop complex ecosystem models with links among fish species, oceanography, climate, habitat, and human elements. It is also possible that the lofty goals of understanding the ecosystem and managing human uses sustainably are not achievable with finite resources and modeling capabilities. In that case, the goal may have to be limited to an achievable one, in which the risks of ecosystem harm are minimized through robust procedures that account for errors due to incomplete understanding.

Regardless, it is to be expected that substantial attainment of the goals of EBFM will require more and better data than are routinely available at present, and will involve more complicated scientific models than are routinely used for current management advice. To get this work done, funding and resources will be needed.

The panel considered various management methodologies (e.g. conservative single-species management, bycatch reduction, marine reserve establishment) as suggested by the NRC and EPAP (see Appendix 3). The panel noted that the items in these lists could be considered to be primarily tactical (how goals are achieved) rather than strategic elements of an EBFM approach (which set out the goals). Many of the suggestions include items that go well beyond those specific to EBFM approaches. The Panel noted that there was an absence of quantitative specificity associated with the lists. That is, though these tactical approaches may fit into an EBFM approach (i.e. a reduction of fishing capacity is desired), they don’t answer the question of effectiveness at meeting EBFM objectives.

Finding Question 2
The panel came up with a list of eight "key elements" that are believed to be particular to an EBFM approach. In the construction of this list, emphasis was placed on identifying elements that are either new or in need of elevated attention. It is recognized that it will take time and a significant commitment to fully address these eight elements. Additional resources and funding will be required. How this information can be used and integrated is addressed in the findings for Question 3, below.

Elements of an ecosystem-based fishery management approach

1. Employs spatial representation
2. Recognizes the significance of climate/ocean conditions
3. Emphasizes food web interactions
4. Ensures broader societal goals are taken into account (possibly by incorporating broader stakeholder representation)
5. Utilizes an expanded scope of monitoring (total removals, cumulative effects, non-target species, environmental covariates)
6. Acknowledges and responds to higher levels of uncertainty
7. Pursues ecosystem modeling/research
8. Seeks improved habitat information (target and non-target species)

The rationale for these elements is as follows:

Spatial representation: Accounting more explicitly for space ("spatial thinking") is a practical way of moving forward with EBFM. Currently, management focuses on temporal and age-structured considerations. Spatial thinking can help define how and where human activity (both fishing and non-fishing) affects the ecosystem (fishing as well as non-fishing impacts), and delineate the management needed to deal with different user groups (e.g. zoning and marine protected areas). It is at the heart of understanding spatially explicit population dynamics (e.g. fish movements over time and space) and stock structure. Without finer scale spatial subdivisions, species would all be managed as one homogeneous population, which functionally negates the rationale for good management measures such as spreading out catch over different areas and times to protect life-history characteristics and biodiversity, as has been done with the Bering Sea and Gulf of Alaska pollock fisheries (in consideration of localized availability of prey to Steller sea lion, for example).[3]

[3] To date, a wide variety of spatial models and approaches for fish and terrestrial populations have been used (Quinn and Deriso 1999). There has been limited application of these models due to the absence of necessary data on fish movement and population variables by spatial designation. Even when movement data are available (such as with Pacific halibut and Gulf of Alaska sablefish), spatial models are rarely used for stock assessment, because of the greater complexity and the lack of a substantial difference compared with the non-spatial assessment. However, in many cases, reasonable spatial distributions of harvest recommendations can be made from the whole area (non-spatial) assessment by partitioning with spatial survey biomass and catch information, as is done for many NPFMC stocks (e.g., GOA pollock, cod, sablefish).

Climate/ocean conditions: There is ample evidence of the importance of climate regime shifts and inter-annual variations in oceanographic conditions to the reproduction and survival of fish and other species. For example, it is known on the west coast that salmon, sardines, marine mammals, Alaska crab, pollock and other west coast groundfish are sensitive to regime changes (Beamish, ed. 1995, McGinn, ed. 2002). Some regimes favor some species over others, and this depends on life history characteristics, their position in the food chain, and other factors. Since the North Pacific and Pacific FMC's maximum sustainable yield calculations for groundfish are based on productivity, it would be prudent for management to change when the climate regime changes, and to anticipate changes if that proves possible. Much of the information on how climate/ocean patterns might impact species has been generated from retrospective analyses of oceanographic conditions. While predictive ability is still low, consideration of different strategies for management relative to climatic factors and species life histories is important in an EBFM approach. Further, research will help make these strategies more robust.

The North Pacific (the Gulf of Alaska and the Bering Sea), has experienced good environmental conditions for fish productivity since about 1976 due to a regime shift. There is speculation about other regime shifts (in 1989 and after), which could affect future productivity. It will be interesting to see how robust management strategies currently in place will perform. In contrast, the U.S. West Coast (Washington, Oregon, and California) has experienced poor environmental conditions over the same period. Alternative management strategies had to be put into place to deal with low productivity of many stocks (especially rockfish). It will be interesting to see if these strategies allow west coast stocks to fully recover.

Food Web Interactions: Food web considerations are important in EBFM because there have long been indications that harvesting low down on the food chain (lower trophic levels) has disproportionately larger impacts on species at the top of the food chain (higher trophic levels). For example, sensitive top predators such as sea birds may not be able to switch prey as quickly as their prey species are fished down, and impacts of forage fish depletion shows up as increased seabird mortality. Additionally, the present ability of the science to quantify the variable natural mortality of fish and other organisms at lower trophic levels is very limited, leading to a high degree of uncertainty and the need for precautionary management.

The National Marine Fisheries Service's Alaska Fisheries Science Center has maintained a food consumption database for fishes in the Gulf of Alaska and Bering Sea for over twenty years. As models become refined and better understanding of species interactions is obtained (through data analysis and field research programs), the implications of these changes for fisheries management may be better understood.
There is also some limited information of this type available for the west coast.

Broader goal specification and recognition: EBFM encompasses consideration of broader use and users of the ecosystem. Since fisheries goals are only a subset of societal goals, EBFM will involve consideration of a broader set of impacts. This may also require expanded participation and representation in the FMC process.

Moving from high-level policy goals to operational objectives is a major challenge in areas where the goals deal with concepts such as ecosystem integrity, ecosystem health and biodiversity. Given the broader stakeholder base under EBFM, there frequently will be a need for institutions to coordinate consultations. Joint decision making will be needed between fisheries that operate in the same geographic area and other non-fishery related user groups that interact with them.

Pertinent societal goals would include national, regional and fishery specific goals, but would also extend beyond fisheries goals to accommodate constraints imposed by legislation and regulatory "goals". These would include the Magnuson Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act)[4], the Endangered Species Act, and the Marine Mammal Protection Act. Within an EBFM approach, these broader goals will need to be reflected and accommodated more explicitly in management models and actions.

Expanded Scope of Monitoring and Research: Monitoring and research for EBFM will be qualitatively different than the current work (i.e. will involve new and different work and the use of that work in management decisions) but probably will not replace the need for continuing the current monitoring. Monitoring and research for EBFM will involve understanding interactions. It should include the amount of total removals of species associated with fishing (e.g. total removals of target species as well as non-target species including other fish, invertebrates, birds, etc.). There is also need to understand cumulative effects, including those from non-fishing activities (e.g. point and non-point pollution, habitat alteration, etc.) Additionally, monitoring is essential to determine the magnitude and timing of climatic variations and to understand how these patterns affect various target and non-target species.

Uncertainty (acknowledge and respond to higher levels of): High levels of uncertainty are associated with the current understanding of ecosystem functions, interactions and feedback loops. Additionally, present ecosystem models are rudimentary for marine systems. However, even if the interactions are poorly quantified, models can be used to help focus attention on ecosystem thinking, which is part of the attitude shift needed for an EBFM approach. It is important to note that while there will never be complete information, there needs to be a focus on what information can be collected to improve estimates of the level of uncertainty so that management can take realistic account of it.

Ecosystem modeling/research: On-going review of ecosystem models, from the perspective of quantifying uncertainty and identifying critical data needs to reduce uncertainty, should receive high priority. Ecosystem modeling will also require development of ways to quantify trade-offs among objectives. It could be helpful to identify the data types that are cheap or easy to collect (e.g. remote sensing data collected by others), as well as to set priorities for the most important information that is more expensive to collect but that would help separate out the "noise" from the "signal". For example, among other things, there is a need to collect ecosystem data that are not associated with data collected during fishing activities (i.e., "fishery-independent data"). Further, there is a need to continue research that is focused on how climate/ocean patterns impact different fish species.

Habitat: An increased and expanded focus on habitat considerations is needed for an EBFM approach. While the Magnuson-Stevens Act calls for the protection of essential fish habitat from fishing impacts, to the extent practical, current understanding of physical habitat for spawning, rearing, feeding, etc. of fishery resources is limited, and existing knowledge of ephemeral pelagic habitat, e.g. oceanographic features like fronts, eddies and other current patterns, is even

[4] The Magnuson-Stevens Act requires, among other things, the protection of Essential Fish Habitat, reduction of bycatch, the rebuilding of over-fished stocks and consideration of social and economic considerations.

more rudimentary. Similarly, it is known that habitat is an important consideration for marine mammals and presumably for many non-managed species, but habitat needs are understood only for a minority of these species.   There is also a need to focus more attention on understanding the cumulative effects on habitat and how it affects both the target and non-target species.

The third question addressed by the panel was:

3. Are there practical ways for the North Pacific and Pacific Fishery Management Councils to incorporate these elements or characteristics further into their respective fishery management programs? How can these Councils improve their incorporation of ecosystem factors in their decision making in the near term? What longer-term changes are needed?

The panel saw the process of incorporating EBFM elements in FMC decisions as an evolutionary one that will build on existing fishery management programs. Practical approaches are facilitated by considering the following continuum that describes adjustments that are needed in the fishery management process to reach the goal of EBFM (Goodman, et al, 2002).

Single species focus → Implicit treatment of ecosystem effects → Explicit treatment of ecosystem effects

In the first stage, consideration is focused on the status of the target species and its predators and prey. In the second stage attention is broadened to take into account environmental effects in a more direct fashion in determining the status of the target species and incorporates measures for the direct effects of fishing activities other than those on the target species, such as bycatch, incidental mortality and some direct effects on habitat. In stage three, the environment, target stock, and its predators and prey are integrated in the assessment before the management procedure is used to determine catch limits and other management measures.

<u>An implicit ecosystem approach</u>, stage two, recognizes the existence of ecosystem interactions, but doesn't make any specific attempts to quantify the surplus production that must be reserved to satisfy ecosystem needs, nor does it attempt to modify fishing behavior to specifically mitigate adverse impacts other than those on the target species. The focus of this approach is on the determination of the status of target and non-target species and the evaluation of measures for tractable problems (EFH and technical interactions).

<u>An explicit ecosystem approach</u>, stage three, differs from the implicit approach in that less tractable problems are added, such as, food web dynamics, predator requirements and regime shifts.

For fisheries under Federal management, the various FMCs are at different points on the continuum, but there has been movement towards EBFM, stage three. In the case of the North Pacific FMC, for example, an ecosystem considerations chapter has been included in its annual SAFE report since 1995. Currently, attention is being focused on methods that can be used to more fully integrate information contained in this chapter into the decision making process. For example, ways to inform the North Pacific FMC of climatic and oceanographic conditions and their importance in the decision making process are being developed. Information for use in the stock assessment processes is being provided to assessment scientists. Results of ecosystem model activities also are being refined to provide the FMC with information on important interactions. The FMC has also been active in implementing habitat protection and bycatch measures.

The Pacific FMC has instituted weak-stock management for groundfish (that is, managing for the "weakest link"), because it is not feasible to selectively harvest particular species. Further it has begun to consider prey interactions by protecting krill as a forage species. It has additionally protected extensive areas of habitat from trawling impacts via the EFH process. The Pacific FMC also has supported requests from the Monterey Bay National Marine Sanctuary, Cordell Bank National Marine Sanctuary and Channel Islands National Marine Sanctuary to prohibit or restrict fishing within parts of the sanctuaries for ecosystem protection.

The Pacific FMC could improve their progress towards EBFM by estimating total removals (this will involve additional observers) and adding ecosystem considerations and information into Stock Assessment and Fishery Evaluation (SAFE reports). It will also mean defining ecological goals, coming up with alternative tactical options to be considered to achieve these goals, and evaluating these alternatives. It would also involve a process to bring outside stakeholders into the process. As noted above, additional progress towards EBFM will be made at the North Pacific FMC as climate and oceanographic information and other information contained in the ecosystem considerations chapter of the SAFE report becomes integrated into the decision making process.

Clearly the task of progressing from the left side of the continuum to the right side becomes progressively harder and more costly. Management that takes ecological and ecosystem effects into account will require expanded monitoring, improvement in the understanding of behavioral relationships among fishers, the fish they catch and the prey of the harvested species. In return for this increased management complexity and expense, the FMCs can expect to see greater stability and predictability in fisheries, and possibly even greater productivity of managed stocks.

In considering actions that could be taken, the panel considered the eight recommendations that the Ecosystems Principles Advisory Panel provided in its report (EPAP, NMFS 1999). The Panel concluded that these action items could be considered a practical check list of ways for the FMCs to incorporate ecosystem considerations into their management programs:

1. Delineate the geographic extent of the ecosystem(s) that occur(s) within FMC authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems, and "zone" the area for alternative uses.
2. Develop a conceptual model of the food web.
3. Describe the habitat needs of different life history stages for all plants and animals that represent the "significant food web" and how they are considered in conservation and management measures.
4. Calculate total removals—including incidental mortality –and show how they relate to standing biomass, production, optimum yields, natural mortality and trophic structure.
5. Assess how uncertainty is characterized and what kinds of buffers against uncertainty are included in conservation and management actions.
6. Develop indices of ecosystem health as targets for management.
7. Describe available long-term monitoring data and how they will be used.
8. Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries and are outside FMC/Department of Commerce authority. Included should be a strategy to address those influences in order to achieve both Fishery Management Plan and Fishery Ecosystem Plan objectives.

Finding Question 3

The panel thought that the information associated with the eight items in the EPAP was practical and relevant, but didn't contain information about how the items would be used. The Panel offered the following suggestions that might be useful as additional steps that would further help the Councils incorporate EBFM considerations into their management process. Though the level of detail and data available will change over time, the considerations identified would apply in both the short term and long term. The numbers shown below refer to the original numbering of the EPAP report. Additional steps are indicated by bullets. The Panel again emphasized that the process of incorporating EBFM elements in FMC decisions will be an evolutionary one and build on existing fishery management programs.

Actions for achieving an ecosystem-based fishery management approach

1. & 8. Delineate and characterize *the* ecosystem *including* the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries.

- *Define the management goals to reflect the societal objectives*

2. Develop a conceptual model of the food web

- *Develop a conceptual model of the influence of oceanographic and climatic factors*

3. Describe habitat needs of different life history stages of significant food web plants and animals and how they are considered in conservation and management measures

- *Expand/modify the conceptual model of the ecosystem to include life history characteristics and spatial variation*

5. Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions

- *Identify alternative management procedures. A management procedure would include specifications for the data required as well as how those data are analyzed to determine management actions: e.g., how uncertainty is quantified statistically and how the extent of uncertainty is used in the decision rules (control rules).*

4. Calculate total removals, including incidental mortality and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure

- *Develop a numerical representation combining the food web model (which would include dynamic models of managed species), the oceanographic model, and explicit representation of management measures and quantities that have been identified as metrics of attainment of the management goals.*

6. Develop indices of ecosystem health as targets for management

- *Use models to identify indices that are relevant to the stated goals. Identify which indices* *can be used as the basis for decision making. 'Traffic light'[5] approaches may be useful.*

7. Describe available long-term monitoring data and how they are used *to estimate parameters for the model and to quantify the reliability of the model.*

- *Use the model to identify critical data gaps, and put plans in place to address them.*
- *Conduct evaluations of management procedures (Management Strategy Evaluations)[6] :*
  Use the model to evaluate the costs and benefits of management procedures in terms of their probability of achieving as many of the management goals as possible, calculated over a realistic range of uncertainty.
- *The Fishery Management Council would select from among these management procedures in light of their calculated performance.*
- *Implement the management procedure accordingly.*
- *Monitor to verify success of the management procedure and validity of the model.*
- *Revise the model and the management procedure wherever the monitoring data indicates that the initial approach was mistaken .*

It is recommended that this modified EPAP list of actions be used at least annually to determine progress being made in the implementation of EBFM. Discussing these items when setting catch levels and when considering management measures, will provide information to determine if any of the conditions contained in the following list exists (Murawski, 2000):

> • Biomasses of one or more important species assemblages or components fall below minimum biologically acceptable limits, such that (1) recruitment prospects are significantly impaired, (2) rebuilding times to levels allowing catches near maximum sustainable yield[7] are extended, (3) prospects for recovery are jeopardized because of species interactions, or (4) any species is threatened with local or biological extinction;

[5] Traffic light approaches turn ecosystem health indicators into "stop" or "go" recommendations for management. For example, if forage fish density falls below a set level, then fishing mortality would be reduced.

[6] Management Strategy Evaluation (MSE) is an approach that assesses the performance of a range of management strategies (for example how much harvest is appropriate) against a set of management objectives (for example maintaining biomass or a certain fishing rate), and allows the evaluation of the tradeoffs among different management strategies. They evaluate how sensitive these strategies are to uncertainty (for example, uncertainty about climate regime, how stocks are distributed spatially, and sampling effectiveness) and are also used to evaluate an implemented strategy against the predictions of the MSE.

[7] There are various definitions of maximum sustainable yield (MSY). The Pacific FMC uses the following: MSY is an estimate of the largest average annual catch or yield that can be continuously taken over a long period from a stock under prevailing ecological and environmental conditions. Since MSY is a long-term average, it need not be specified annually, but may be reassessed periodically based on the best scientific information available.

• Diversity of communities or populations declines significantly as a result of sequential "fishing-down" of stocks, selective harvesting of ecosystem components, or other factors associated with harvest rates or species selection;

• The pattern of species selection and harvest rates leads to greater year-to-year variation in populations or catches than would result from lower cumulative harvest rates;

• Changes in species composition or population demographics as a result of fishing significantly decrease the resilience or resistance of the ecosystem to perturbations arising from non-biological factors;

• The pattern of harvest rates among interacting species results in lower cumulative net economic or social benefits than would result from a less intense overall fishing pattern;

• Harvests of prey species or direct mortalities resulting from fishing operations impair the long-term viability of ecologically important, non-resource species (e.g. marine mammals, turtles and seabirds).

Goodman et al. (2002) suggest that the conditions listed above could be regarded as metrics for ecosystem status. These could provide the basis for thresholds that should be avoided in an attempt to prevent ecosystems from becoming "unhealthy".

It should be noted that the Councils and NOAA have the existing statutory and regulatory authority to move forward in these directions. In fact, as mentioned above, both the North Pacific and Pacific Fishery Management Councils have initiated actions identified in the modified EPAP list, although attention has been uneven among the items. Using these action items as a check list will serve to focus attention on important issues and facilitate the identification of critical management issues.

The panel noted that, as a practical matter, the Councils already have "full agendas," and adding new items, especially those with high levels of uncertainty, will be difficult. One fear is that new approaches and analyses will be rejected because of their uncertainties or demands for institutional resources unless things are done in small steps. Another concern is if the Council moves forward on new things, other things will need to be pushed aside. For example, when the North Pacific FMC did their Groundfish Programmatic Supplementary Environmental Impact Statement, some stock assessments didn't get done. Managing the increased workload will definitely be an issue, but shouldn't be an excuse to shy away from making progress.

To avoid a false sense of security, it should be understood that these aren't simple matters, and it is estimated that multiple-years will be required for implementation, testing, and adaptation.

However, there are ways of moving forward with all the elements outlined above. As a start, it will be important for the Councils to create and implement a process and institutional structure that will facilitate the identification of a broader set of goals and operational objectives that deal with concerns beyond the targeted fish species. Once the goals and objectives are clearly identified, the Councils can start by choosing the actions that can be done where the outcome reasonably can be assumed, i.e. 'if we do this, that will probably happen'. There are also activities in the Panel's list that could be implemented immediately, but there are limitations due to the unknown quality of the models. An important application of these models is to identify areas of high uncertainty and guide research or data collection to fill in these gaps. Therefore, despite the limitations, it is still important to generate these conceptual models. If a model is inaccurate and/or imprecise, its high uncertainty level will be noted, and will indicate where work is needed to improve its performance.

These models will evolve over time from population models (single species) to community models (taking into account food web considerations) and ecosystem models (taking into account environmental considerations such as habitat and climate). Additionally, as research progresses, the fishery management approach will evolve from implicit and non-quantitative consideration of the ecosystem to a more specific and explicit quantification of these features. It will also progress from consideration of these factors "outside" the fishery assessment itself to a system where these factors are fully integrated into the assessment and management process (Goodman et. al 2002). (Also see Appendix 4 for more information.)

The Role of Science in Fisheries Management

The panel also addressed a second and related topic: the role of science in fisheries management. To do so, they commented on four questions.

The first question was:

4. What is the appropriate role of science in fisheries management? How will this change as management programs move increasingly towards ecosystem based approaches?

The role of science is to inform the management decision process. The Science and Statistical Committees provide the Fishery Management Councils with reviews of documents, identify research issues and needs, and provide advice on conservation and management issues. The role of science with the implementation of ecosystem-based management will be the same. However, the breadth of information supplied by science will expand. The ability to use ecosystem approaches to sustain marine fisheries will depend on better information.

As management programs move towards ecosystem-based approaches, the role of science is to: facilitate the implementation of a decision analysis framework, to provide advice on drafting management procedures, use management strategy evaluations for contrasting and evaluating management procedures, and to provide data driven inputs (e.g. stock assessments with uncertainty quantification).

The second question regarding the role of science in fishery management was:

5. How do the scientists and the Councils interact now at the North Pacific and Pacific Fishery Management Councils ? What are the current institutional arrangements?

A detailed description of how the Pacific and North Pacific FMCs SSCs operate was prepared for the Managing Our Nation's Fisheries II Conference held in Washington, DC. (Witherell, 2005) is found in Appendix 5. The panel emphasized the following characteristics:

The institutional setting of the management process that both the North Pacific and Pacific Fishery Management Councils (FMCs) use is characterized by consideration of science as an integral part of the process. A tier approach best characterizes the way these FMCs receive scientific advice. The Plan Teams (PT), called Technical Teams in the Pacific FMC, represent the first layer. These groups are made up of academic, federal and state agency scientists. Each fishery management plan has a PT. They provide the FMC with reviews and allowable biological catch (ABC) information, and other information upon the request of the FMC.

The Scientific and Statistical Committee (SSC) is the second tier. As with the PTs, the SSCs are made up of academic, federal and state agency scientists. The North Pacific SSC has an equal split of agency and academic representatives. An effort is made in the North Pacific FMC to have all relevant disciplines represented on the SSC so that the Council is informed of how management might impact the various marine resources in the Bering Sea and Gulf of Alaska. The Pacific Council's SSC has more non-academic (agency) representatives. At the request of the Councils, the SSCs provide critical review of documents, advice on research issues and advice on conservation and management issues. They also review the models and methods used by the PTs. On occasion, the SSCs have taken the initiative to provide advice on issues considered to be of importance to decision making[8]. However, the usual approach is for the Councils to seek information from the SSCs[9]. Meetings of the SSCs are scheduled to occur concurrently with each FMC meeting to promote dialogue which will foster science based management.

Outside scientists make up the third tier. The North Pacific FMC has used outside scientists and the Center for Independent Experts (CIE) to review scientific documents, stock assessments, and its groundfish harvesting strategy. The Pacific FMC has used outside scientists, including scientists selected by the CIE, during the FMC-sponsored stock assessment review process (STAR panels) and in the harvest policy review workshop.

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[8] The North Pacific FMC's SSC for example provided a recommendation to implement an observer program for groundfish, held a workshop on multispecies management, and conducted a socio-economic study for the crab fishery limited entry plan. The Pacific FMC's SSC prepared a white paper on overcapitalization and conducted a harvest policy workshop.

[9] For example, at the request of the Pacific FMC, the SSC provided an evaluation of Marine Protected Area (MPA) objectives, rationales, fishery management implications and regulatory requirements.

The third question regarding the role of science in fisheries management was:

6. Are current institutional arrangements adequate to address the challenges of ecosystem based approaches to management? Should SSCs be separated and insulated from the Fishery Management Councils? Or should the working relationship be strengthened through closer ties between the SSCs and the Councils? What practical steps can be taken to strengthen the role of science in fisheries management? Are there steps that the Councils or the Secretary can take now? What about the longer term?

The structure, process and use of Science and Statistical Committees (SSCs) by regional fishery management councils (FMCs) vary. In the case of the North Pacific and Pacific FMCs, the panel believes that the institutional process used to deal with scientific information is working. The decision making process is science-based and their scientific review bodies (SSCs, Plan Teams) are active, visible, and important in the management process. Nevertheless, ecosystem-based fishery management will require the development of a more formal process governing trade-offs between competing objectives, and methods for explicitly dealing with high levels of uncertainty. Estimates of uncertainties will also be required, as these are inputs into the decision rules, and the SSCs will be involved in identification of methods that can be used to address uncertainty. Further, there will be a need to conduct and review Management Strategy Evaluations (MSEs). None of these steps are easy, and they will all require a lot of additional technical work. Though the institutional structure of the SSC is adequate, additional staffing will be needed, especially to conduct these MSEs. The existing disciplinary expertise may need to be examined to assure the presence of appropriate representation for the broader EBFM goals.

The panel believes that SSCs should not be separated and insulated from the FMCs. Fisheries are not managed by science alone, but good fishery management cannot afford to ignore good science, and needs ready access to it. There will always be policy choices and tradeoffs that may be within the scope of the discretionary authority of the FMC, but the FMC will be in a position to better use that latitude if the SSC informs the FMC of the probable consequences of their choices. A close working relationship of a FMC with its SSC, which can be fostered by having both bodies meet at the same time, will facilitate such communication.

The Panel also suggested that the role of science and, thus, the SSCs, would be strengthened if NOAA Fisheries and the Secretary of Commerce would ask for a rigorous justification from the FMC if decisions were contrary to scientific advice. It should be made clear that SSC members are to act independently as scientists (and at times may disagree with their agency positions). Additionally, there may be value in having periodic national or regional meetings of the SSCs to develop common operating procedures and to compare approaches to providing scientific advice

The last question regarding the role of science in fisheries management was:

7. The issue of the role of scientists in setting overall harvest levels is a fundamental question facing all fishery management councils nationwide. The North Pacific Fishery Management Council (FMC) has a long policy of having the SSC set the allowable biological catch (ABC) and the Council then setting catch levels (total allowable catch, TAC) at or below ABC [10]. Under what conditions (if any) should a FMC set catch levels (TAC) higher than the levels (ABC) recommended by the scientists? What institutional checks and balances (if any) or review procedures (e.g. peer review) should be in place prior to allowing any Council to exceed the scientifically recommended harvest levels?

In many parts of the United States, there has been long-standing concern with how science is used in the Council process. The 1986 Calio Report found that "fishery management will be markedly improved by a clear separation between conservation and allocation decisions." It recommended further that NOAA should determine ABCs using the best available science along with local and regional expertise, and Councils should make allocations that could not exceed the ABCs. Similar proposals have occurred almost continuously since then. Recently, the U.S. Commission on Ocean Policy (USCOP 2004) stated that, "…a lack of adequate scientific information has not been the main culprit in most instances of overfishing" and suggested that the SSCs set the allowable biological catch level and require the Councils to set harvest limits for the various fishing interests at or below this amount.

In a paper submitted for a Regional Fishery Management Council workshop, the executive director of the New England FMC (Howard, 2004) argued that decisions on such technical issues as annual catch limits and status determination criteria require an evaluation of risk to both stocks and fisheries. Further, he stated that risk evaluation is the responsibility of managers, not agency scientists. He commented that with its varied expertise, the Council considers the scientific recommendations, discusses the level of risk associated with various alternatives, and makes a management decision.

At the Fishery Management Conference held this past March in Washington, D.C. the Conference science panel (Conference's SSC) commented that important roles for SSCs in the specification of ABCs include peer review of the stock assessments and harvest formulas that are used to calculate ABC, and review of regulatory analysis describing relevant effects (including the extent of risk and uncertainty) of harvest alternatives (Witherell, 2005). That Committee noted that while computation of an ABC is a scientific process, how it is derived is based on formulations that already reflect policy choices. The Main Conference Panel stated that the FMCs should adopt the ABC determined by their SSCs and set the total allowable catch (TACs) at or below the ABC (Witherell, 2005).

At the same Conference, the Conference's science panel noted that defining and using the best scientific information available is an important goal in conducting fisheries science and

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[10] There are various definitions of TAC and ABC. The Pacific FMC uses the following:
TAC (Total allowable catch). The total regulated catch from a stock in a given time period, usually a year.
ABC (Acceptable biological catch). The ABC is a scientific calculation of the sustainable harvest level of a fishery and is used to set the upper limit of the annual total allowable catch. It is calculated by applying the estimated (or proxy) harvest rate that produces maximum sustainable yield to the estimated exploitable stock biomass (the portion of the fish population that can be harvested).

implementing fishery management objectives. It was stated also that having the best available science doesn't necessarily mean that it will be used. It was suggested that existing institutional mechanisms should be strengthened, for example, by having the Secretary of Commerce examine if management is consistent with scientific advice. This could be done, for example, as part of the Environmental Impact Statement (EIS) review. For instance, EISs prepared by the FMCs in setting their annual specifications could be required to include an explicit discussion of whether FMC recommendations deviated from SSC advice and why.

To assure that the best available scientific information is used, the National Research Council (2004) recommended that NOAA Fisheries should develop and implement guidelines on the production and use of scientific information in the fishery management process. It suggested that the guidelines be based on criteria of relevance, inclusiveness, objectivity, transparency and openness, timeliness and peer review.   The panel agreed that such guidance would be helpful.

The Panel also agreed that, while computation of an ABC is a scientific process, some of the key constraints in the calculation may be set by policy. In the future, as decision rules become more sophisticated, the quantification of uncertainty will become more formalized. That is the stipulation of risk-related policy, namely the specification of how risk averse or risk tolerant the decision process should be, will become increasingly important. The formulation of such policy is not the role of scientific advisory bodies such as SSCs, but it should not be left to ad hoc decisions of the moment either (e.g. where within the range of values provided by the Pacific Council's SSC is the appropriate ABC).   The goal of such formalized policy is to achieve consistency and stability across time and across districts, serving the best interest of society as a whole, in the long run, and putting more distance between the decision process and narrower considerations of expediency. For this reason, such policy should be the subject to national debate and independent scientific peer review. Regional differences must be recognized. Within such a framework, with its heavy technical demands, the role of scientific advisory bodies, such as SSCs, is to provide scientific quality control and quality assurance to the implementation. This role will include assuring that policy-determined constraints with respect to risk are met.

The Panel believes that important roles for the Scientific and Statistical Committees (SSC) in the specification of acceptable biological catch (ABC) include peer review of the stock assessments and harvest formulas that are used to calculate ABCs, and review analyses describing effects (including the extent of risk and uncertainty) of harvest alternatives and other management measures.

Both the Pacific and North Pacific Fishery Management Councils (FMCs) have attempted to be precautionary in their selection of harvest strategies. They have consistently set the total allowable catch (TAC) below ABC, thereby showing that they incorporate scientific advice into their harvest strategies. An interesting distinction is that the North Pacific SSC provides their FMC with a point estimate of ABC for a given stock, while the PFMC SSC provides a range of values for ABC. Further, the Pacific FMC reduces ABC linearly as fish biomass drops. In contrast, the North Pacific FMC reduces fishing mortality linearly as fish biomass drops, which results in a quadratic decrease in ABC. Ample scientific evidence exists to show that these biomass-based reductions serve to reduce the risk of over-harvesting and the time to rebuild to the target level of biomass. Management strategy evaluations should be conducted by the Councils to ensure that the use of either approach (point estimates or ranges of values) is suitably precautionary.

When a FMC selects a TAC from a range of ABC values, there should be sufficient justification and documentation for the choice. The Panel believes that TACs should be set above the value recommended by the SSC only when independent and credible peer review reveals fundamental flaws in a stock assessment analysis. The panel believes NOAA Fisheries and the Secretary of Commerce should be more diligent in their review of the actions taken by the FMCs.

Conclusion

The Panel addressed a series of questions that were designed to obtain advice on two questions related to the work of Fishery Management Councils (FMCs), and particular the North Pacific and Pacific FMCs. One set of questions related to the means by which FMCs could move further forward with an ecosystem-based fishery management (EBFM) approach; the other set of questions related to the role of science in fishery management in general and how this might change to meet the challenges of EBFM.

The Panel was able to provide practical suggestions regarding the elements and steps that can be taken to transition from a predominantly single-species approach, with some limited consideration of ecosystem factors, to a fully specified and integrated EBFM approach. This will not involve starting anew, but will move incrementally forward. This will involve recognition of a broader set of societal goals so that the desires of a larger group of users are addressed. It will also involve considering food web interactions, various spatial scales, climatic and oceanographic variations, the role of habitat, and the higher degree of uncertainty involved in these factors. It will also require new monitoring work to provide information on non-target species and other environmental factors. Similarly, there will be a need for new modeling and research to provide data and reduce the uncertainty involved in employing new management strategies. This will take commitment of additional resources and funding. The Panel also suggested a checklist of steps that could be followed to further EBFM considerations, including steps such as developing an integrated ecosystem model, developing indicators of ecosystem health and a program to monitor these indicators, developing decision rules based on the indicators, and defining, evaluating, and revising various management strategies to better meet goals. Though the level of detail and data available will change over time, the considerations identified can be applied in both the short term and long term.

The Panel commented on the role of scientific input in the FMC process. They noted that the existing process was working well in the North Pacific and Pacific. With EBFM there will be a need for additional resources and expertise to develop expanded decision rules, evaluate risk, and conduct management strategy evaluations to determine the basis for the eventual policy choices. The Panel believes that maintaining and strengthening ties between the Scientific and Statistical Committees (SSCs) and their respective FMCs, rather than severing them, as has been suggested, was important in assuring a scientific basis for fishery management, provided clarity about their respective roles is maintained and the scientific independence of the SSCs is upheld. Membership on the SSCs will need to be expanded to include individuals with expertise necessary for implementing EBFM.

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Appendix 1
Biographies of the Panel Members

Dr. Daniel Goodman: Dr. Goodman received has PhD from Ohio State University in 1972 and did post-doc work at Cornell University 1972-74. He worked as an Assistant Professor of Population Biology at Scripps Institution of Oceanography 1975-1983 and as an Assistant Professor of Biology at Montana State University 1981-1987. Since 1987 he has been a Professor of Biology at Montana State University His research includes work on population modeling, environmental statistics, Bayesian decision theory, population viability analysis, marine mammal conservation, and salmon fisheries management. He has published over 80 reports on this work.

He has served on numerous national and international science panels. Among other work, he served, between 1987 and 1994, on various Science Advisory Boards of the US Environmental Protection Agency including the research strategies subcommittee, long-term ecological research subcommittee, a global climate research subcommittee, and an ecological processes and effects committee. He has served on the Independent Science Advisory Board for Salmon Recovery and the Independent Scientific Review Panel of the Northwest Power Planning Council since 1996 and 1997, respectively. Since 2002 he has also served on National Marine Fisheries Service's (NMFS) Hawaiian Monk Seal Recovery Team.

He served as chairperson for the Review Panel for the Groundfish Fishery Control Rule for the North Pacific Fishery Management Council in 2002. Since 2002 he has also been a member of the Science Panel for the North Pacific Research Board.

Dr. Churchill Grimes: Dr. Grimes is the Director of the NMFS Southwest Fishery Science Center, Fishery Ecology Division in Santa Cruz, CA, where he directs the research program to provide the scientific basis for conservation and management of demersal fishery resources and the recovery and restoration of ESA listed anadromous species in California. Prior to assuming his present position Dr. Grimes served as Director and as Leader of Fishery Ecology Investigations of the NMFS, Southeast Fishery Science Center, Panama City Laboratory and was Associate Professor of Marine Fisheries at Rutgers University in New Brunswick, NJ.

He has published over 100 papers, on his research on life history and population dynamics (in particular habitat ecology, recruitment processes and fishery oceanography) of various fishery resources in the Southern New England-Mid Atlantic Bight, U.S. South Atlantic Bight, Gulf of Mexico and Pacific Ocean off California.

He has served on numerous international, national and regional scientific advisory bodies.
In 1987 he participated in developing the NMFS Ecosystem Initiative, throughout the 1990's he served on the Gulf of Mexico Fishery Management Council Scientific and Statistical Committee (SSC) and the Special Mackerel SSC, published papers on the utility of the Experimental Oculina Research Reserve off southeast Florida for managing reef fish stocks and on the use of marine reserves for fishery management. He also served on the steering committee of the American Fishery Society Symposium on Aquatic Protected Areas as Fishery Management Tools, organized and participated in the National Fisheries Conservation Center MPA Science Integration Workshop, and was the principal organizer of the NOAA MPA Science Integration Working Group process.

Dr. Peter Lawson: Dr. Lawson is currently a research fishery biologist at the NMFS Northwest Fisheries Science Center. He received an M.S. in 1984 and Ph.D. in stream ecology from Idaho State University in 1986. He then took a position as biometrician and modeler for the ocean salmon harvest team of the Oregon Department of Fish and Wildlife. In 1997, after ten years with ODFW, Pete joined NMFS.

He has served on technical advisory committees to the Pacific Fishery Management Council (PFMC) and the Pacific Salmon Commission since 1987. He served a two-year term as chair of the PFMC's SSC and several terms as vice-chair. He is currently chair of the SSC's salmon subcommittee.

Pete's models have been used to predict salmon runs, estimate harvest impacts, elucidate the non-landed mortality in selective fisheries, and explore coho salmon population dynamics with a fine-grained, habitat-based life-cycle model. Recent publications have treated climate effects on coho salmon survival in both freshwater and marine environments, with the goal of building a model that integrates across freshwater and marine phases of the life cycle.

Dr. Richard Marasco: Dr.Marasco received his bachelor's degree in 1965 from Utah State University in Applied Statistics and Computer Science. He received his doctor's degree from the University of California Berkeley in Agriculture and Natural Resource Economics is 1969. He served on the staff of the Agriculture and Natural Resource Economics of the University of Maryland from 1969 to 1977.

From 1977 to 2005, he served on the staff of the NMFS Alaska Fisheries Science Center, in Seattle, Washington. From 1981 to 2004 he was the Director of their Resource Ecology and Fisheries Management Division.

He was the U.S. delegate to PICES (North Pacific Marine Science Organization) from 1999-2004 and the chairman of its finance and administration committee from 1998 to 2004.
.
He also served on the North Pacific Fishery Management Council's Science and Statistical Committee from 1979 to 2004. He served several terms as Chairman of that body. Since 2002 he has also been Chairman of the Science Panel for the North Pacific Research Board.

Dr. André Punt: Dr André Punt is an Associate Professor with the School of Aquatic and Fisheries Sciences, University of Washington, Seattle and a Research Scientist with CSIRO Marine and Atmospheric Research in Hobart, Australia. He holds an M.S. and a Ph.D. in Applied Mathematics from the University of Cape Town, South Africa. André has been involved in research on marine population dynamics, stock assessment methods, and harvesting theory since 1986, and has published over 100 papers in the peer-reviewed literature along with over 300 technical reports. His current research focuses on the performance of stock assessment methods, application of Bayesian approaches in fisheries assessment and decision analysis, and management strategies for fish and marine mammal populations.

Until early 2001, when he left Australia to join the University of Washington, André was chair of Australia's Southern Shark Fishery Assessment Group and a member of the Shark Fishery Management Advisory Committee. He has been a member of several other stock assessment teams and is currently an at-large member of the Scientific and Statistical Committee of the Pacific Fisheries Management Council. He is also a member of the IUCN Shark Specialist

Group, participated in the review of the IUCN criteria for listing species at risk of extinction, and is currently a member of the IUCN Red List Standards and Petitions Committee.

André has participated in the Scientific Committees of the International Commission for the South East Atlantic Fisheries (ICSEAF) and the International Commission for the Conservation of Atlantic Tunas (ICCAT). He has been an invited participant to the International Whaling Commission (IWC) since 1990.

Dr. Terry Quinn II: Dr. Quinn received a BA in Mathematics from the University of Colorado in 1973, and an MS in Fisheries in 1977 and a PhD in Biomathematics in 1980 from the University of Washington. From 1977 to 1985 he was Biometrician at the International Pacific Halibut Commission. Since 1985, Dr. Quinn has served as a professor of Fish Population Dynamics at the University of Alaska Fairbanks.

He is the co-author or co-editor of 4 books, including the key reference for fishery models: Quantitative Fish Dynamics, with co-author Richard B. Deriso, published by Oxford University Press. He has also written about 100 peer-reviewed scientific publications. He has shepherded about 25 students through their post-graduate careers at either the M.S. or PhD levels.

He has been a member of the Statistical and Scientific Committee of the North Pacific Fishery Management Council since 1986 and is a former chairperson of that body. He is a former member of the Ocean Studies Board of the National Academy of Sciences and served on five of their committees, and has served as the chairperson or co-chairperson of two of these. He is an Associate Editor of the prestigious Canadian Journal of Fisheries and Aquatic Sciences.

Support Staff

Dave Hanson is the deputy director of Pacific States Marine Fisheries Commission (PSFMC). He is a non-voting member of both the Pacific and North Pacific Fishery Management Councils, and is currently chairman of the Pacific Council's Legislative Committee and Parliamentarian. He has been involved in the development of inter-jurisdictional fishery management plans for West Coast fisheries and has been involved in many international fishery issues for PSMFC.

Fran Recht is the habitat program manager for the PSMFC. She serves on the habitat committee of the Pacific Fishery Management Council, is involved with watershed restoration, protection, and education efforts, and was recently involved in helping prepare sections of the groundfish essential fish habitat document.

Jodie Little is a graduate student at the University of Washington's School of Aquatic and Fishery Sciences, working under the direction of Dr. Robert Francis. Her doctoral studies focus on modeling and evaluating interactions between the U.S. West Coast coastal marine ecosystem, economies and coastal communities.

Appendix 2: Questions for Panel

1. Ecosystem based Management

The United States Commission on Ocean Policy (USCOP) recommends moving towards an ecosystem-based approach to management but recognized that our limited knowledge of the marine environment and ecosystem relationships is a major hurdle. The National Research Council (NRC), also recognizing these limits, proposed eight specific elements of an ecosystem-based approach to fisheries management which could be used as guidelines in sustainable fishery management by regional management councils. Questions for Panel consideration include:

- **What is a practical definition of an ecosystem-based approach to fisheries management that could be used by fishery management councils?**

- **What are the characteristics or management elements of an ecosystem based approach to fisheries management? Are the elements identified by the NRC/EPAP still appropriate? Are there other elements or characteristics that should be included?**

- **Are there practical ways for the North Pacific and Pacific Fishery Management Councils to incorporate these elements or characteristics further into their respective fishery management programs? How can these Councils improve their incorporation of ecosystem factors in their decision making in the near term? What longer term changes are needed?**

2. Role of Science in Fisheries Management

With the emphasis of moving more and more towards an ecosystem based approach to fisheries management, the role of science will be increasingly important. The USCOP called for separating the scientists (SSC) from the managers (Councils) to separate "conservation" decisions from "allocation" decisions. Others have called for strengthening the interactive role of science and management, arguing that a stronger institutional tie between science and management provides for better informed decision making. At the recent Managing Our Fisheries II Conference, the panel on Science and Management called for the scientists to set the overall harvest level and limiting the Council decisions to setting final harvest levels at or below the level recommended by the scientists. This was modified by the final Panel to allow for exceeding the ABC only with appropriate justification. Questions for consideration by the Panel include:

- **What is the appropriate role of science in fisheries management? How will this change as management programs move increasingly towards ecosystem based approaches?**

- **How do the scientists and the Councils interact now at the NPFMC and PFMC? What are the current institutional arrangements?**

- **Are current institutional arrangements adequate to address the challenges of ecosystem based approaches to management? Should the SSCs be separated and insulated from the Councils? Or should the working relationship be strengthened through closer ties between the SSCs and the Councils?**

- **What practical steps can be taken to strengthen the role of science in fisheries management? Are there steps that the Councils or the Secretary can take now? What about the longer term?**

- **The issue of the role of scientists in setting overall harvest levels is a fundamental question facing all fishery management councils nationwide. The NPFMC has a long policy of having the SSC set the ABC, and the Council then setting the TAC at or below ABC. Under what conditions (if any) should a Council set catch levels (TAC) higher than the levels (ABC) recommended by the scientists? What institutional checks and balances (if any) or review procedures (e.g. peer review, others) should be in place prior to allowing any Council to exceed the scientifically recommended harvest levels?**

Appendix 3: Management Elements Suggested by EPAP/NRC

Both the Ecosystem Principles Advisory Panel (NRC 1999) and the National Research Council (NRC 1999) have suggested various methods to achieve ecosystem-based management (see below). Some of the mechanisms suggested include accounting for the total amounts and kinds of species caught (bycatch), managing single species conservatively, reducing excess fishing capacity, establishing marine protected areas, and employing alternative fishing gears and using various management areas to reduce impacts. The panel considered many of these suggestions to be useful tactical approaches, rather than strategic elements, and ones that could help meet EBFM objectives, but that were not necessarily confined to an EBFM approach. They also noted an absence of quantitative specificity in these approaches.

For example, the North Pacific and Pacific FMCs have already adopted or are considering tactics to manage conservatively, reduce capacity, protect habitat and forage fish. The North Pacific in particular has employed most of these methods. However one doesn't know if these methods are enough to achieve the strategic goals; i.e. it doesn't necessarily answer the question "are we doing enough"?

ECOSYSTEM-BASED FISHERY MANAGEMENT APPROACH RECOMMENDATIONS (summarized)

National Research Council report—Sustaining Marine Fisheries (NRC 1999)	***Ecosystems Principal Advisory Panel (NMFS 1999)***
Incorporate ecosystem goals into management	Develop an overall Fisheries Ecosystem Plan (FEP) that involve Councils taking 8 actions[11]
conservative single species management	Estimate MSY and set OY conservatively
account for uncertainty to favor long-term goals	Make risk adverse decisions, err toward conservation (apply precautionary approach)
	change the burden of proof when effects are poorly known (no expansi fisheries/catch levels, no development/promotion of fisheries for under species)
reduce excess fishing capacity	
establish marine protected areas	marine protected areas/reserves as insurance
	develop system to detect & respond to adverse impacts at early stage
Incorporate bycatch and discards in setting catch (TAC)	consider total bycatch removals, understand by gear type, temporal and spatial distribution;
Management/incentives to favor gears and technology that promote conservation	id existing or potential alternative gear types or fishing patterns such as area closures to alleviate habitat impacts; reduce bycatch
develop institutions to achieve goals; provide appropriate socioeconomic incentives	local incentives through share-based allocations (IQs, units of fishing effort, rights to fish specific areas etc.)
conduct research/get info on marine ecosystems, models, socioeconomics	support on-going comprehensive ecosystem research and expand it to include research to determine the ecosystem effects of fishing, monitor trends and dynamics of marine ecosystems, and ecosystem-based approaches to governance.
	Promote maximum involvement of stakeholders in fishery management, including the interests of future generations, and maximum appropriate delegation of responsibility to the lowest levels of the management system (i.e. local or regional level)
Provide ecological principles training to Council members/staff	

[11] The actions include: delineating and characterizing each ecosystem; developing a conceptual model of the food web; etc. (see full listing under question 3 of this document).

Appendix 4
Excerpts From Scientific Review Of The Harvest Strategy Currently Used In The BSAI And GOA Groundfish Fishery Management Plans (Goodman et. al 2002)

Summary of the information on moving from conventional fisheries assessments to assessments that explicitly incorporate ecosystem considerations

Given sufficient investment in carefully designed experiments and monitoring to improve the predictive power of the models, they will evolve over time from population models (single species) to community models (taking into account food web considerations and environmental considerations such as habitat and climate).

Additionally, as research progresses, the fishery management approach will progress from implicit and non-quantitative consideration of ecosystem considerations to more specific and explicit quantification of these considerations. It will also progress from consideration of these factors "outside" the fishery assessment itself to a system where these factors are fully integrated into the assessment and management process.

This process is conceptualized as occurring in stages. In the first stages (a single species focus), consideration is focused on the status of the target species and its predators and prey (as well as the socio-economic world of the fishing community which takes the stock) in an implicit way. "Safety margins" or buffers are built in to account for non-target species. This then progresses to more specific and explicit accounting for the environmental effects on the status of target species, with measures incorporate to account for the direct effects of fishing on the other non-target species (e.g. bycatch and incidental mortality). That is, the status of prey and predators are considered in setting the catch limit in the management procedure, but the analyses are not integrated with the analyses that focus on the target species.

In the second stages of explicit consideration of ecological and ecosystem effects, management procedures take into account the status of the target stock, predator and prey species, and some environmental information such as direct effects of fishing for the target species on EFH and bycatch. The mitigation of the direct effects of the fishery is addressed through such things as bycatch reduction devices, habitat protection measures, and taking into account the prey needs of other species. At this stage too, the analysis of these factors are also separate from the analytical process for the target species (that is there is no direct link made between the fishery and its effects on ecosystem properties or the effects of the environment on the ecosystem other than the direct effects on the target population). The North Pacific FMC, for example, has produced an annual report on ecosystem considerations to be incorporated into each year's Stock Assessment and Fishery Evaluation (SAFE) reports. This provides the FMC with information about the oceanographic conditions in the Bering Sea and Gulf of Alaska and the effects of environmental change on fish stocks, information on predator/prey interactions, and forecasts the ecosystem impacts of fishery management decisions. This information may limit the catch of target species, based on the ecosystem goals that Council has adopted, but the stock assessment and estimation of yield of the target species is still undertaken essentially in isolation of ecosystem considerations.

In the third stage, community ecology is directly incorporated into the analytical process for management of the target species, with information from the environment, including information about non-target species, integrated directly into the assessment process so that it directly influences the scientific advice provided to the Council. At this state there is a higher level of uncertainty in some factors (such as climatic regimes and inter-annual variation) and where indirect effects of fishing are more broadly considered (e.g. where cause and effect may be several steps removed from each other). Recognizing the high level of uncertainty and predictive power of these integrated models, there will also be a need to use additional techniques such as risk analysis and adaptive management to allow action in light of this uncertainty and the possibility of errors.

The following figures are from the Goodman et al. 2001 report:

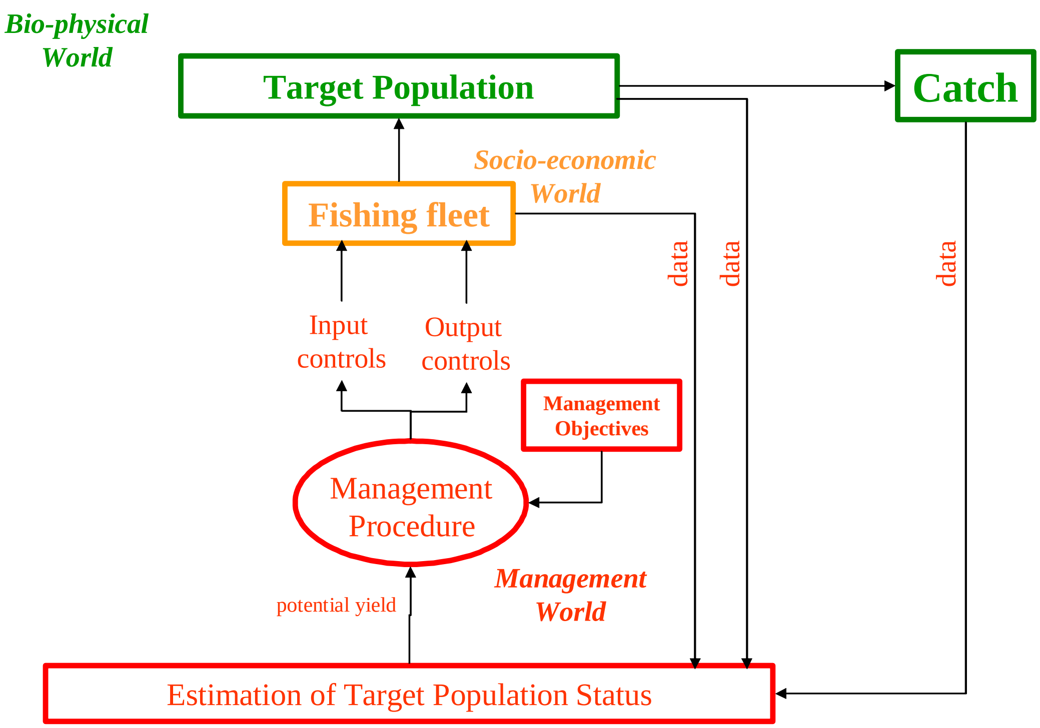


Figure 4.1. The conventional assessment world view, in which nearly all fishery management is currently done, recognizes the biophysical world in which the stock exists, the socio-economic world of the fishing community that takes the stock, and the management world in which catch limits are determined.

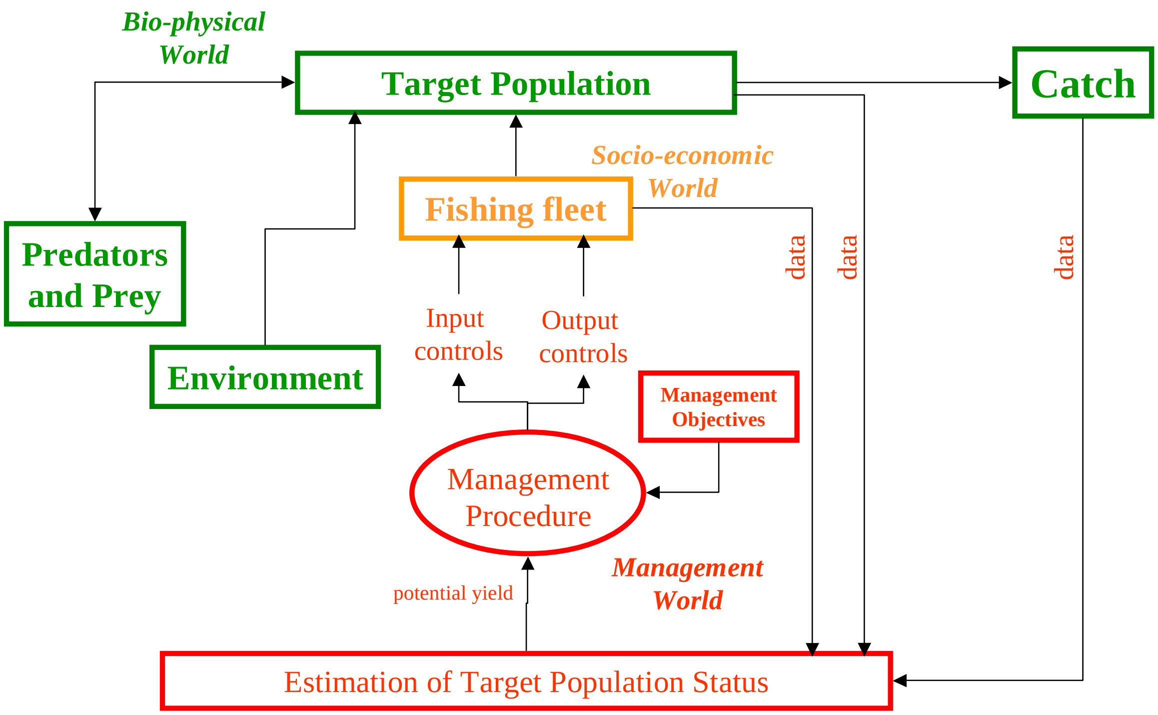


Figure 4.2. In the implicit ecosystem effects world view, we recognize that target species in fisheries are generally prey for other components of the ecosystem. While management objectives only take such predator needs into account in a very general way, the implicit view is cognizant of those needs.

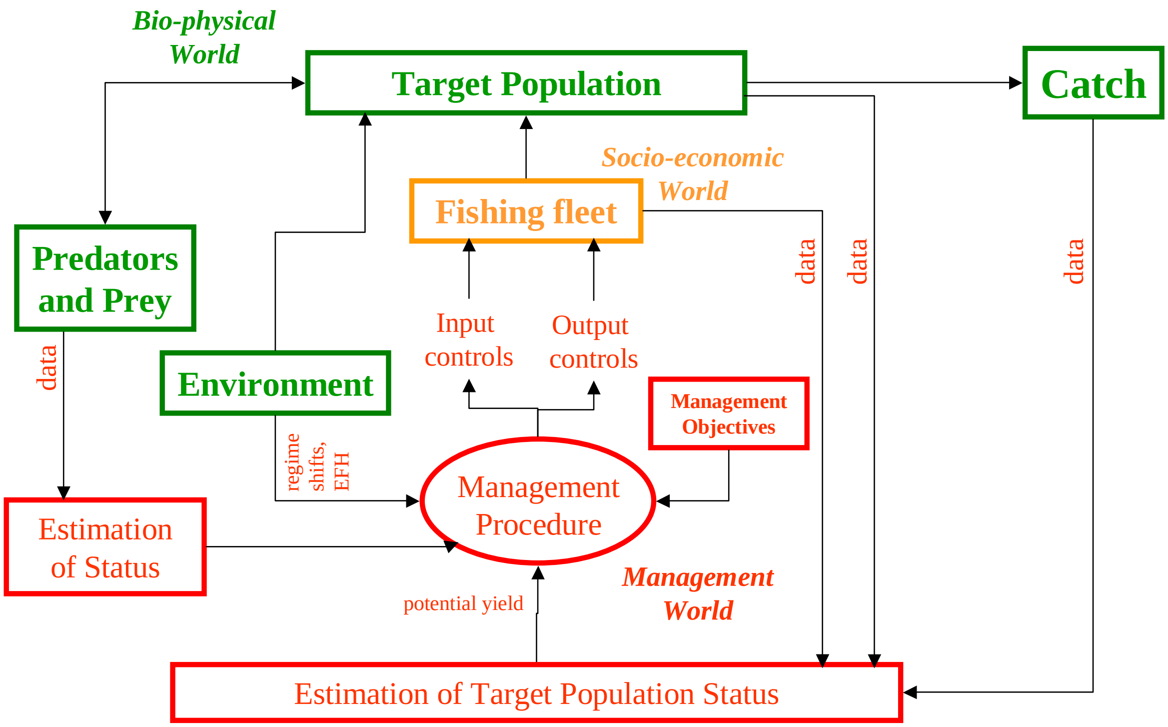


Figure 4.3. In the first stage of management that takes ecological and ecosystem considerations into account in an explicit manner, both the status of the target stock and its predators and prey are considered, but these are not integrated in a holistic management play. In some sense, then status of prey and predators thus constrain the catch limit from the management procedure.

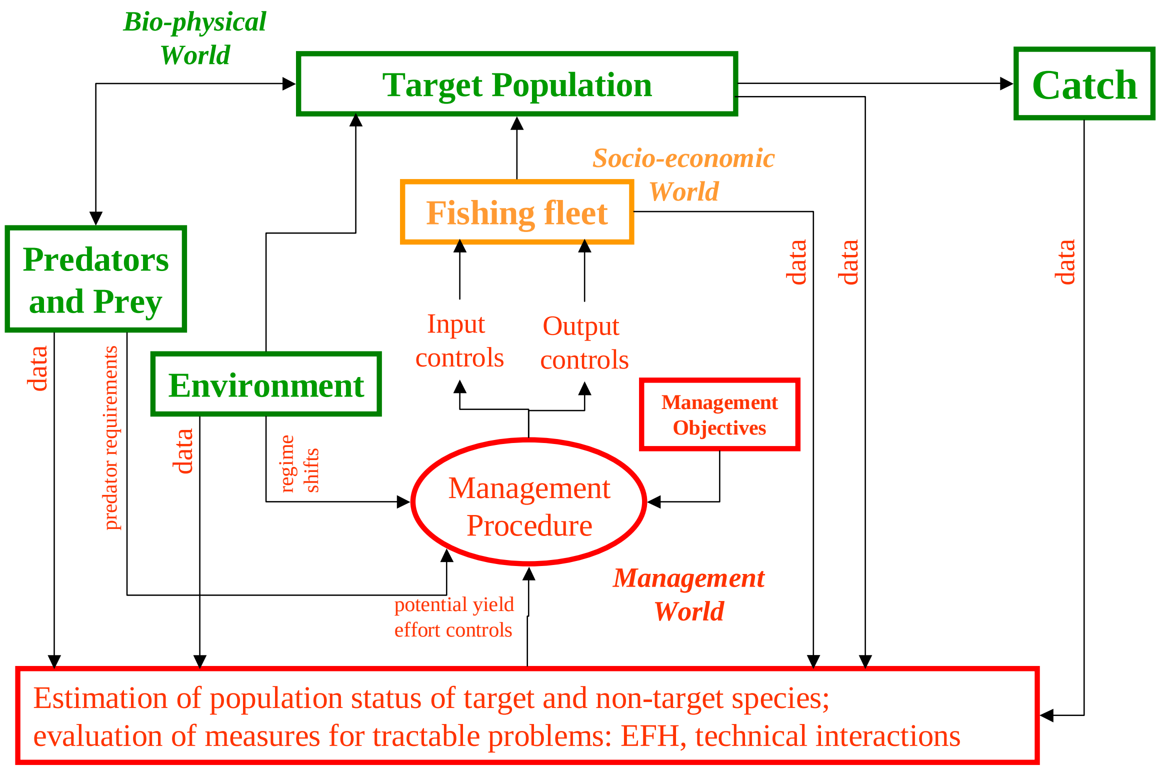


Figure 4.4. In the second stage of explicit consideration of ecological and ecosystem effects, one takes into account environmental effects in a more direct fashion in consideration of the status of the target stock and incorporates measures for the tractable problems described in Section 4.2.2.1.

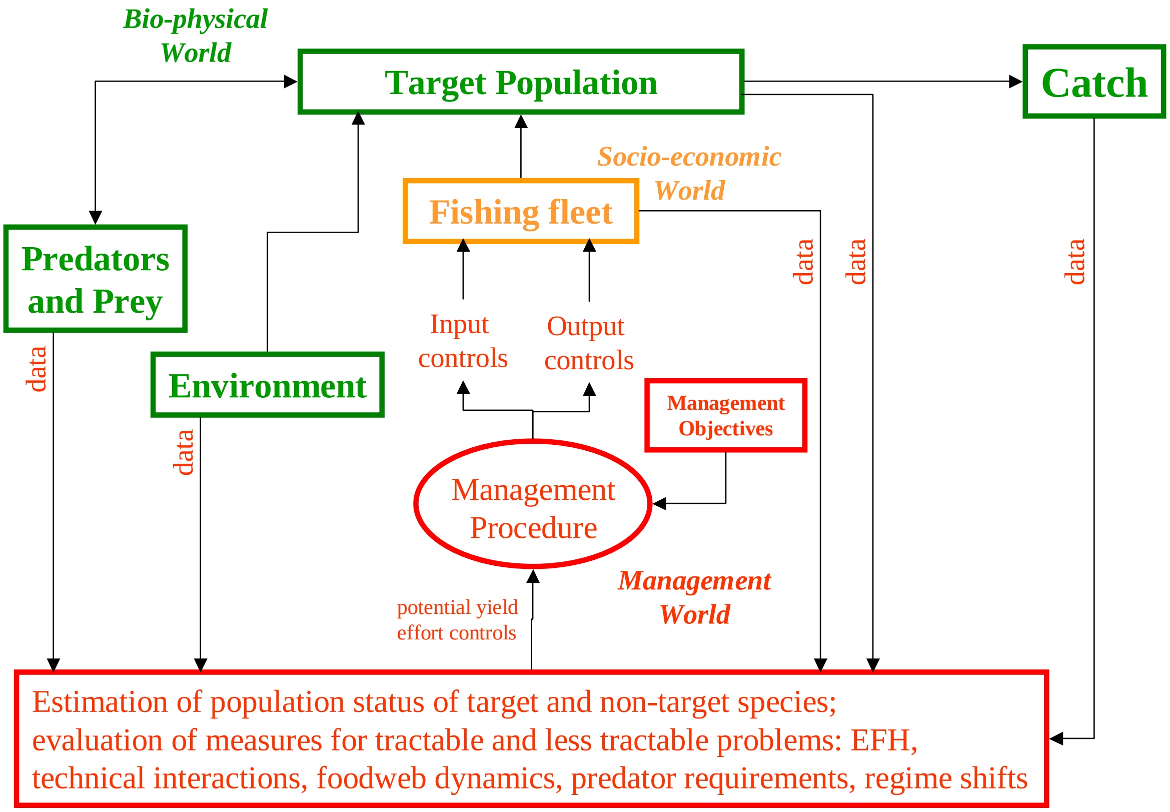


Figure 4.5. In the third stage, the environment, target stock, and its predators and prey are integrated in the assessment before the management procedure is used to determine catch limits. At the same time, the less tractable problems identified in Section 4.2.2.2 are included

Appendix 5

The following descriptions of the operations of the Science and Statistical Committees (SSCs) of the North Pacific and Pacific Fishery Management Councils (FMCs) was extracted from a larger document entitled "The Use of Scientific Review by the Regional Fishery Management Councils: The Existing Process and Recommendations for Improvement", which described the operations of the other FMCs in the country as well. It was prepared by David Witherell, deputy director of the North Pacific Fishery Management Council for the March 2005, Managing Our Nation's Fisheries II Conference held in Washington, D.C.

North Pacific Fishery Management Council

The North Pacific Council's SSC currently has 15 members, consisting of population dynamics biologists, ecologists, economists, and social scientists from academia and federal and state agencies, appointed on an annual basis. There are no SSC members from private businesses or other organizations.

While most members are drawn from the Pacific Northwest, the SSC includes members from California, Utah, and Rhode Island. In practice, the SSC is a self-appointing body that recruits new members as they see fit, although in practice there are members who serve in "agency" seats for Oregon, Washington, Alaska, and NOAA Fisheries. Although the Council has final approval authority regarding SSC membership, recommendations of the SSC regarding its membership have always been approved by the Council. Each year, SSC members elect a chair and vice-chair from among their membership. While most chairs serve for several years, few serve for more than 3-4 years. The current SSC includes two former chairs, who serve with the current chair as an informal chairman's council regarding the structure and operation of the SSC.

The SSC meets for 2 to 3 days, 5 times per year (or more frequently if the Council schedules additional public meetings). The SSC chair or vice-chair remain available to the Council for 2-3 days following the completion of the SSC meeting, to be able to present the minutes to the Council as each agenda item is reviewed by the Council and to respond to questions that Council members may have about the meaning and intent of those minutes. The SSC meetings occur at the same locale and begin just prior to each Council meeting to facilitate public participation and input. In addition, the SSC holds occasional workshops with agency analysts and researchers to explore analytic innovations or to encourage the development of new research programs.

The SSC reviews the scientific information for most actions that come before the Council[12]. The process for changing regulations begins with a proposal that may originate from the fishing

[12] Before each meeting, the Executive Director (or Deputy Director) and the SSC chair discuss Council agenda items and identify those items that are most likely to require scientific review. The SSC generally does not review housekeeping items or items that are in final review. If however, the SSC requested that draft analytic documents be released after revision, the SSC is often asked to review the final draft document for compliance with SSC requests. The SSC may also be asked to review final review documents if there have been substantive changes in the documents or information included in the documents.

industry, environmental groups, NOAA Fisheries, the Council, or other advisory groups including the SSC itself.

The proposal is evaluated in subsequent meetings through discussion papers, environmental assessments, and socio-economic analyses. At each stage, the SSC provides scientific input to improve the analysis, and also makes a recommendation as to whether the analytical document is ready for public review, meaning that it meets their standard of best scientific information available.

The process for SSC review is similar in most instances. First, the SSC receives the first draft of an environmental assessment or impact statement, regulatory impact review, or other analytical document, by mail about 1-4 weeks prior to a meeting. At the SSC meeting, the lead analytical staff for a particular agenda item presents a summary of the analysis, and answers questions from SSC members. The public is given an opportunity to testify, and frequently several fishery participants or environmental representatives may testify on the scientific and technical details of a given analysis. Following the staff reports and public testimony, SSC members deliberate the scientific content of a given analysis. Generally, the SSC focuses their deliberations to determine best available scientific information by examining the appropriateness of input data, the methodology applied, and the conclusions drawn from the analysis. To ease the workload for individual SSC members, the SSC chair generally assigns 2-3 members to be discussion leaders for each agenda item topic. These individuals also summarize the SSC discussion and deliberation, and then prepare the first draft minutes for that particular analysis or issue.

All SSC members have an opportunity to review the draft minutes before they are presented to the Council by the SSC chair. The turn around time for preparing written minutes is short; in some cases the issue may have been discussed by the SSC less than one day prior to reporting to the Council. SSC members, particularly the chair and vice-chair, often work long hours to complete their minutes for distribution at the Council meeting. The minutes of the NPFMC SSC are not a formal record of deliberation, but represent a consensus opinion regarding the scientific merit of the documents under consideration. These minutes are not adopted by formal vote. The minutes also provide recommendations to improve the scientific analysis to meet SSC approval.

Should analysis be deficient and major revisions be required, the SSC will recommend to the Council that it not be released for public review. With the exception of a few very technical scientific issues (e.g., establishing overfishing definitions and setting acceptable biological catch limits), the SSC does not generally provide the Council with an explicit recommendation on which alternative should be chosen, but rather provides guidance on relative strength of the scientific information available (i.e., uncertainty). For example, in February 2005, the SSC reviewed the revised analysis and evaluation of fishing effects on essential fish habitat, and commented that “The analysis found no evidence that Council-managed fishing activities have more than minimal and temporary effects on essential fish habitat for any FMP species. Yet, a significant proportion of the ratings for fishing effects were classified as unknown. Given this result, application of the precautionary approach is warranted.” Citing the SSCs recommendation in their deliberations, the Council voted unanimously to prohibit bottom trawling over vast areas, and establish ‘marine reserves’ in the areas shown to have dense deep water coral aggregations.

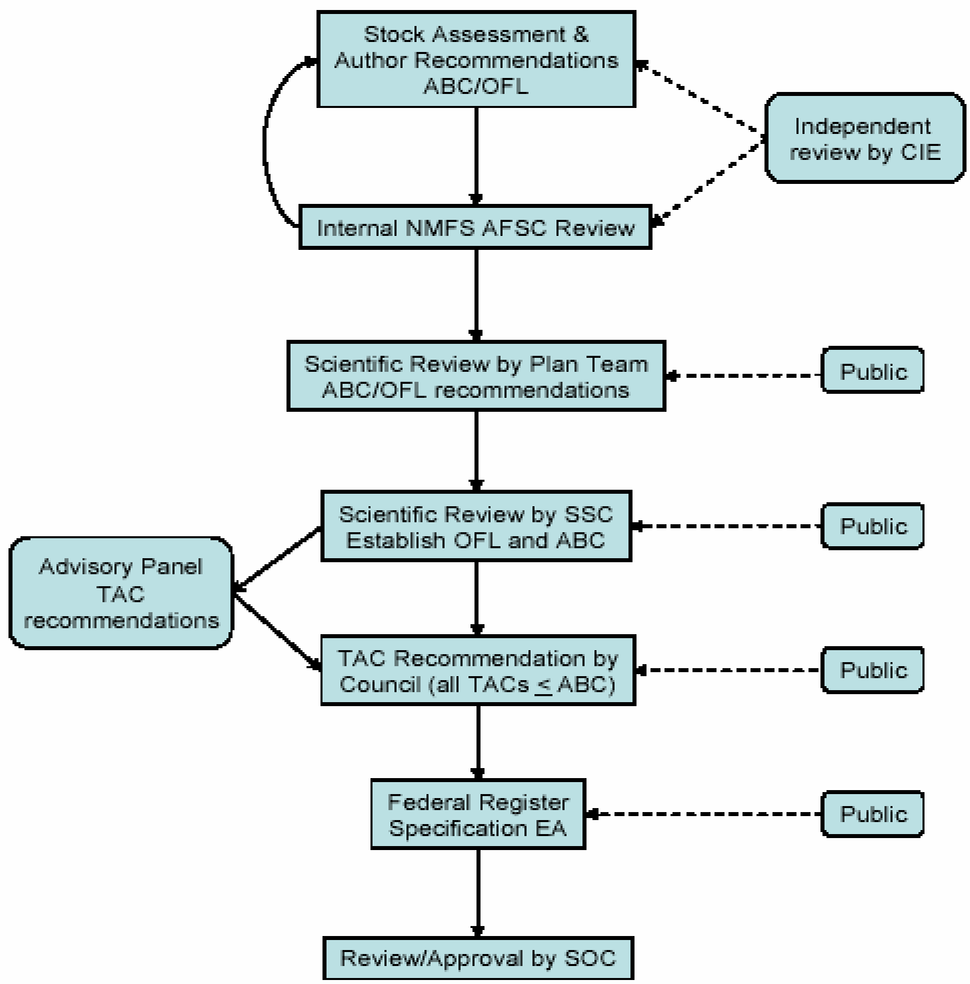
There are several levels of scientific review for stock assessments of North Pacific groundfish stocks (Figure 1). Nearly all of the stock assessments are conducted by highly competent and respected NOAA Fisheries scientists from the Alaska Fisheries Science Center. These assessments are subject to internal review process at the Science Center. As a further quality control measure, one or two assessments are sent each year to the Center for Independent Experts for further peer review. Following these review processes, the stock assessments are further vetted by the Council's Plan Teams established for each FMP. The plan teams consist of state and federal scientists and managers that meet twice annually to review the assessments, prepare stock assessment and fishery evaluation reports, and, for groundfish stocks, recommend acceptable biological catch limits. The SSC makes a final review of the stock assessments and acceptable biological catch limits (ABCs). The Council has had a long standing practice of adopting all of the SSC's ABC recommendations, and this process was formally incorporated into the groundfish FMPs by amendments 83/75.

On occasion, an independent review by scientists outside of the SSC has been requested to get additional insights into scientific information on particularly controversial scientific issues. Recent examples of independent review include an evaluation of the harvest rate strategies used for North Pacific groundfish (Goodman et al. 2002), reviews on potential competition of fisheries with Steller sea lions (Bowen et al., 2001, NRC 2003), and a review of the evaluation of fishing activities that affect essential fish habitat (Drinkwater et al. 2004). These reviews came at a cost of time and money (approximately $110,000 for the harvest rate review, $140,000 for the Steller sea lion Biological Opinion review, $500,000 for the NRC review of Steller sea lions and fisheries, and $130,000 for the review of fishing effects on benthic habitat). Although none of the conclusions of these peer reviews were contrary to earlier findings by the SSC on these same issues, they did provide other perspectives regarding scientific content and analytical procedures.

From this standpoint, the reviews were beneficial in that they provided additional scientific guidance for analysts and the Council, and increased confidence that the best scientific information was made available.

Council use of SSC recommendations (from Table 1 of full report): The Council follows the SSC advice wherever possible or feasible. Council always follows SSC catch limit recommendations (always a single number for each stock or complex)

Figure 1. Flow chart depicting the scientific review process for stock assessments and establishment of catch specifications in the North Pacific region. Catch specifications include the overfishing level (OFL), the acceptable biological catch level (ABC), and total allowable catch limits (TAC), where TAC≤ABC≤OFL.



Pacific Fishery Management Council

The Pacific Council has a single SSC, with a 16 member composition set by a representation formula established in the Council's operational procedures. There are four state representatives (ID, WA, OR, CA), five federal representatives (2 Southwest Fishery Science Center, 2 Northwest Fishery Science Center, 1 Alaska Fishery Science Center), and 1 representative from the Treaty Indian Tribes. These members have indefinite terms and are nominated by their home agencies. In addition, there are six "at large" members that serve 3-year terms. Current composition of the "at-large" seats is: 2 Southwest Fishery Science Center, Fisheries Research Biologists, 1 University of Washington faculty, 1 University of California, Santa Cruz faculty, 1 California State Monterey faculty, and 1 private sector (an economist not associated with an agency or academia). The SSC operating procedures further requires that the committee consist of three social scientists, of which at least two shall have economic expertise. Currently, there are 3 economists; other expertise includes fishery biology, population dynamics, biostatistics. In addition to the standing SSC, there are six SSC subcommittees, one for each or the four FMPs (salmon, groundfish, highly migratory species, coastal pelagic species), one for MPAs, and one for economics.

Nominations for at-large seats are sought through an open nomination process. Vacancies are announced and candidates are solicited via the Pacific Council's website and via mailings to the public, agencies, and universities. The nomination period opens at least one month (and often longer) before consideration at a Council meeting and nominations are due along with Council meeting briefing materials, approximately two weeks before the meeting. Anyone can nominate an individual and individuals can self-nominate. Nominations must include a cover letter and CV. The SSC reviews nominations and evaluates qualifications of candidates in closed session and presents review results to the Council. The SSC review results are provided during Council closed session before the Council makes the appointments. The SSC chair and vice-chair serve two-year terms. Officers are elected by the SSC and approved by the Council chairman.

The SSC meets at each of the five Council meetings in a year, usually for the first two days of the meeting, but sometimes longer. The subcommittees meet as needed at the direction of the Council chair or the Executive Director. In recent years, the SSC subcommittees have met frequently, on the order of a half-dozen meetings in addition to the five Council meetings. Meetings of the SSC and SSC subcommittees are open to the public, and public comment is taken during SSC agenda topics (at the discretion of the SSC chair). There is also a public comment period for items not on the SSC agenda on the Monday of each SSC meeting. The SSC produces written reports at the Council meeting, and the SSC chair (or other SSC member) provides an oral report of their findings and responds to Council questions. Public testimony on SSC recommendations to the Council are taken after each SSC statement. SSC minutes are made available in the subsequent Council meeting briefing materials and are available on the Pacific Council's website.

The Pacific Council's SSC provides scientific review of all science and technical matters that are a component of Council decision making including harvest levels, fishery and economic models used by Technical Teams, population prediction models, harvest guidelines, Terms of Reference for stock assessment processes, and technical portions of Fishery Management Plan amendments and National Environmental Protection Act documents. Examples of special projects by category include: the SSC's marine reserves subcommittee has completed a white paper, *Marine Reserves:*

Objectives, Rationale, Fishery Management Implications, and Regulatory Requirements, the groundfish subcommittee is working on terms of reference for reviewing rebuilding plans, the groundfish subcommittee and economics subcommittee jointly reviewed Groundfish Essential Fish Habitat analyses, completed an economic capacity report for the *Groundfish Strategic Plan,* and reviewed commercial fishery bycatch modeling methods, and the highly migratory species subcommittee reviewed methods for assessing sea turtle impacts in the high seas longline fishery. Additionally, each year, the salmon subcommittee reviews salmon fishery modeling, run size prediction, and harvest policy methodologies.

For specific recommendations, like harvest levels, if a single value is provided by the SSC the Council generally adopts the recommended harvest level. The SSC may provided a range of possible harvest levels derived from the stock assessment process to advise to the Council on inherent uncertainties and risk. The SSC reports to the Council the range of values, the uncertainty, and level of risk (e.g., risk prone, risk-neutral, risk-averse).

Outside review of scientific and technical matters for the Pacific Council occurs during the Council sponsored stock assessment review process (which has been used for coastal pelagic species and groundfish) included participation by Center for Independent Expert reviewers from outside the Pacific Council family. The SSC then reviews the results of the stock assessment process and reports to the Council. SSC statements to the Council are not subject to outside review.

In addition to the SSC, each FMP has both a technical (or management) team. Technical teams are composed of fishery managers, biologists, and statisticians from the federal, tribal, and state agencies. Technical teams monitor catch rates, recommend harvest levels, and analyze the impacts of various management measures. Models and methods used by Technical Teams are reviewed by the SSC.

<u>Council use of SSC recommendations</u> (from Table 1 of the full report): The Council follows the SSC advice wherever possible or feasible. Council always follows SSC catch limit recommendations for single catch limit value, and within SSCs ranges of values for ABC and OY (Council generally selects midpoint).

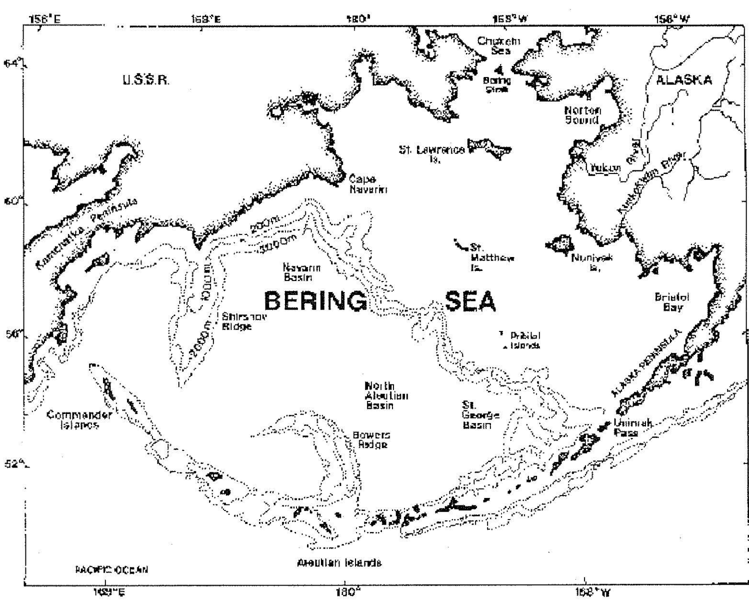
A DISCUSSION PAPER

Fishery Ecosystem Plan for the Aleutian Islands

This paper is organized as follows:

The Aleutian Islands represent the central and eastern portion of the Aleutian-Komandorski (Commander) archipelago that extends from the Alaska Peninsula across the U.S.-Russian boundary to the Kamchatka Peninsula (see Figure 1). Numerous straits and passes through the Aleutian Islands connect the Bering Sea to the North Pacific Ocean. The islands are volcanic, with a narrow shelf descending to a steep dropoff. Rich in marine life, the Aleutian Islands are home to seabirds, marine mammals, sessile invertebrates, and fish stocks. The Aleut peoples have inhabited the islands for over 10,000 years and subsisted on the marine bounty.

Figure 1 Bathymetric map of the Bering Sea, showing the Aleutian-Commander archipelago (Sayles 1979).



In recent years, the Aleutian Islands have been at the forefront of many issues before the North Pacific Fishery Management Council (Council). The Aleutian Islands area has figured in focused measures to protect Steller sea lions and seabirds, conservation of benthic habitats that support coral and other special resources of public interest, and allocation issues related to the Aleutian Islands pollock and Pacific cod fisheries. With national interest on ecosystem-based management of fisheries heightened through recent Ocean Commission reports and other national-level panels, the Aleutian Islands area has been recognized by the Council as meriting consideration as a candidate for an ecosystem-based fishery plan.

1 Purpose and Need

The Council is faced with a growing national momentum to adopt an ecosystem approach to fisheries (EAF). While many of the Council's management actions can arguably be considered to reflect an overall ecosystem approach, there is still progress to be made. There are many ways in which the Council could apply an ecosystem approach in its fishery management; however, much attention has been given to the concept of Fishery Ecosystem Plans (FEPs), or similar ecosystem-based fishery management documents. The Ecosystems Principles Advisory Panel touted FEPs as the way to move forward with ecosystem-based fishery management (EPAP 1999). Various draft legislative documents that have passed through Congress have suggested revisions to the Magnuson-Stevens Act that would require either FEPs or some other type of fishery ecosystem management document. To date, however, there are few examples of such documents, and there is no national template for their implementation, or their relationship to fishery management plans (FMPs).

The Council believes that applying a more explicit ecosystem approach to fisheries may be the appropriate way to move forward in fishery management. With regard to fishery ecosystem planning, the Council has the opportunity to help define the standard for implementing an EAF. As the practicalities of developing a fishery ecosystem planning document have yet to be worked out, the Council feels it is appropriate to designate an ecosystem area as a test case.

In recent years, the Aleutian Islands have been at the forefront of many issues before the Council. By its actions to date, the Council recognizes that the Aleutian Islands contain unique ecological values that the Council wishes to preserve. The Aleutian Islands area has figured in focused measures to protect Steller sea lions and seabirds, conservation of benthic habitats that support coral and other special resources of public interest, and allocation issues related to the Aleutian Islands pollock and Pacific cod fisheries. Recent scientific evidence indicates a clear ecological difference between the eastern Bering Sea shelf ecosystem and the western Aleutian Islands archipelago. Far less is understood about the ecological interactions in this area than in the eastern Bering Sea, yet the two areas are managed conjointly in all of the Federal fishery management plans. The Council may wish to consider fishery interactions within this ecosystem more directly, and applying an ecosystem approach to fisheries may promote this goal. For these reasons, the Aleutian Islands ecosystem area may merit consideration as a candidate for area-specific management, and could be an appropriate test case for the Council to develop a fishery ecosystem planning document.

The Council captured their rationale in a purpose statement, presented below. The SSC has recommended revising the purpose and need statement to explicitly emphasize that the FEP should consider aggregate, cumulative impacts on the Aleutian Islands ecosystem. One of the ways that a FEP might provide added value to the Council, in addition to the many ecosystem-based analyses that are already produced for each Council action, is to focus on the Aleutian Islands and look cumulatively at impacts from all fisheries and non-fishing impacts. The cumulative impact analysis in other documents, such as the Groundfish PSEIS, does look at cumulative fishing and external effects, but from the perspective of the groundfish fisheries rather than the Aleutian Islands ecosystem. A FEP for the AI would provide an opportunity for fishery management to coordinate actions across fisheries.

The Council might wish to consider a revision to the purpose statement, to reflect the SSC's concerns. The Council's original purpose statement is below, with the bold text representing additional language.

> The Council recognizes that an explicit Ecosystem Approach to Fisheries (EAF) is a desirable process for future management of the marine fishery resources in the Alaskan EEZ and therefore is a concept that it wishes to pursue and further implement. A primary component of an EAF is the development of ecosystem-based fishery planning documents, and the Council intends to move forward with such development on a pilot basis. The Council recognizes that the Aleutian Islands ecosystem is a unique environment that supports diverse and abundant marine life, and a human presence that is closely tied to the environment and its resources. The Council believes that in light of these features, EAF could be a useful guide for future fishery management decisions in the Aleutian Islands area. **Area-specific management associated with an EAF should specifically examine the aggregate effects of all fisheries within the Aleutian Islands ecosystem area, cumulatively with non-fishery inputs.** Enhancing our current ecosystem approach to fisheries in the Aleutian Islands could allow the Council to better focus on the unique features of and interactions within the Aleutian Islands ecosystem area.

2 Ecosystem-based Fishery Management

Ecosystem-based fishery management has been variously defined in the last decade. In June of 2000, the Council developed its own definition in conjunction with reviewing the groundfish fishery management program:

Council's current definition

> Ecosystem-based approach to fisheries management is defined as the regulation of human activity towards maintaining long-term system sustainability (within the range of natural variability as we understand it) of the North Pacific covering the Gulf of Alaska, the Eastern and Western Bering Sea and the Aleutian Islands region.

In July 2005, a panel of fishery scientists familiar with the North Pacific and Pacific met to discuss, among other things, issues relating to ecosystem-based fishery management. Their findings were published in a report by the Pacific States Marine Fisheries Commission (PSMFC 2005). The panel reviewed various ecosystem-based fishery management definitions, including those of the NPFMC, the United Nations Food and Agricultural Organization, and other national and international recommendations. Based on this review, the panel proposed a synthesized definition that would help provide direction to the fishery management councils:

PSMFC report definition

> Ecosystem-based fishery management recognizes the physical, biological, economic, and social interactions among the affected components of the ecosystem and attempts to manage fisheries to achieve a stipulated spectrum of societal goals, some of which may be in competition.
>
> Elements of an ecosystem-based fishery management approach:
>
> 1. Employs spatial representation

2. Recognizes the significance of climate/ocean conditions
3. Emphasizes food web interactions
4. Ensures broader societal goals are taken into account (possibly by incorporating broader stakeholder representation)
5. Utilizes an expanded scope of monitoring (total removals, cumulative effects, non-target species, environmental covariates)
6. Acknowledges and responds to higher levels of uncertainty
7. Pursues ecosystem modeling/research
8. Seeks improved habitat information (target and non-target species)

The PSMFC definition will be used as a working definition for the purposes of this analysis.

3 Fishery Ecosystem Plans

What is a Fishery Ecosystem Plan?

The Fishery Ecosystem Plan (FEP) was described in detail in the Ecosystems Principles Advisory Panel (EPAP)'s Report to Congress in 1999. Excerpted material from that report, describing the principles, goals, and policies of ecosystem-based fishery management, and the steps to develop a FEP, is included at the end of this appendix. In brief, the FEP is intended to provide the mechanism to integrate the ecosystem goals, principles, and policies into single species or species complex FMPs.

A FEP describes the interactions of the ecosystem, and the degree to which they are considered in conservation and management measures, including the efforts being made to monitor the effects of fishing. In order to address the goal of maintaining ecosystem health and sustainability, the FEP should develop indices of ecosystem health as targets for management.

The FEP is intended to:

- "provide Council members with a clear description and understanding of the fundamental physical, biological, and human/institutional context of ecosystems within which fisheries are managed;
- direct how that information should be used in the context of FMPs; and
- set policies by which management options would be developed and implemented," (EPAP 1999).

Comparison of guidelines for FEP content

Table 1 Comparison of guidelines for FEP content

Topic	Suggested Tasks for FEPs		
	Ecosystem Principles Advisory Panel Report, 1999	**Marine Fisheries Advisory Committee Task Force Report, 2003**	**Interim Report of the ad hoc Working Group, May 2005**
Ecosystem Boundary	• Delineate geographic extent of ecosystem	• Describe geographic area of coverage	• Define relevant ecosystem boundaries
Understanding of Ecosystem Area	• Characterize biological, chemical, and physical dynamics of ecosystem • Develop conceptual model of food web • Describe habitat needs of different life history stages for 'significant food web' • Assess uncertainty • Consider predator-prey affected by FMP fishing • Consider bycatch in terms of food web/community structure • Assess the ecological, human, and institutional elements of the ecosystem that are outside DOC authority and that most significantly affect fisheries	• Describe current natural resource/ socioeconomic conditions to provide status/ trends • Describe historic ecosystem	• Inventory ecosystem data and information sources, including all relevant federal and non-federal agencies, academic institutions, and others • Assess impacts of fishing and non-fishing activities on non-target species so no gaps in species protection • Define essential fish habitat • Determine effects of variability in marine environmental conditions (e.g. climate, oceanography)
Data gaps		• Identify/ prioritize crucial information needs	• Define gaps and priorities in ecosystem data
Objectives for Ecosystem Area	• Prescribed ecosystem objectives and principles • Zone ecosystem area for alternative uses • Minimize any impacts of fishing on EFH	• Describe Desired State of Natural ecosystem (objectives/ goal statements) • Describe Desired State of Socioeconomic ecosystem (long/ short term)	
Current Management Approach to Ecosystem Area	• Describe how habitat needs are considered in conservation and management measures • Assess buffers against uncertainty that are included in conservation and management measures		• Inventory management practices re ecosystem approach
Future Management Approach to Ecosystem Area	• Develop indices of ecosystem health as targets for management • Describe available long-term monitoring data and how they are used • Include a strategy to address the influences outside DOC authority	• Describe ecosystem management options: pros/cons • Apply indicators of ecosystem 'health' • Process for periodic evaluation	• Account for predator-prey interactions and other feedback effects, including impacts of fishing practices on habitat productivity • Account for variable marine environmental conditions when formulating management plans • Evaluate tradeoffs among fisheries (FMPs?) linked by interactions between species (e.g., bycatch interactions, predator-prey relationships) • Include economic and social factors in evaluating tradeoffs • Develop adaptive approaches to ecosystem management that e.g. take into account changes in knowledge, use of experimental approaches, etc.

Regulatory authority, and interaction with FMPs

FEPs are to be developed for each ecosystem area, and a FEP would likely apply to more than one FMP. In the North Pacific, for example, an Aleutian Islands FEP would apply to the Federal groundfish (BSAI and perhaps GOA, depending on the boundary of the Aleutian Islands ecosystem), king and tanner crab, scallop, and salmon FMPs. There is no explicit discussion in the EPAP report as to the interaction of the FEP with state water fisheries; however, it would be desirable for the Council to coordinate with the State when developing the FEP.

In terms of regulatory authority, the EPAP report generally recommends that specific management measures be included in the FMPs, and that the FEP provide an ecosystem policy and understanding from which management measures could be developed for the individual FMPs as necessary. Yet the report does suggest that those regulations or management measures which extend across individual FMPs be contained in the FEP. The example used is essential fish habitat protection measures, which may apply to all fisheries, and thus including them in the FEP would reduce redundancy.

The intent of the report was for FEPs to eventually become required by law, and to meld with FMPs in the long term. At present, however, there is no authority attached to a FEP, and only the FMP can authorize regulations to implement management measures. Therefore it would not be possible, without a change in statute, for a FEP to authorize regulations. Management measures must be incorporated at the FMP level, not the FEP level.

This means that the influence of the FEP would be to extend an ecosystem policy over the FMPs in the ecosystem area, but not to prescribe management measures. This policy would guide the development of management measures in each FMP. The FEP would also contain an assessment of how to determine whether the goals and objectives of the ecosystem policy are being met.

Examples of Fishery Ecosystem Plans

There are very few examples nationally of Fishery Ecosystem Plans, and they do not provide a clear template of how to do FEPs. The Chesapeake Bay FEP embraces many of the concepts of the Ecosystems Principles Advisory Panel, including developing a strategic plan that accounts for the role of habitat and predator-prey relationships, social and economic considerations, and unpredictable externalities such as climate impacts. The FEP does not specify what measures management agencies should undertake, but instead lays out what is known about the ecosystem, and the kind of research and monitoring needed by fishery managers. It also includes the impacts of non-fishery activities on, for example, fish habitat. The South Atlantic Council has taken a similar approach in developing their FEP. Their FEP expands upon their existing Habitat Plan to include a characterization of the biological and physical dynamics, an assessment of existing agencies and management institutions, development of a food web model, development of indices of ecosystem health, updated habitat requirements for managed species, determination of total removals, specification of research and monitoring needs, and further development of appropriate management measures.

A different concept was adopted by the Western Pacific Council, with their Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region. The 2001 plan is the first ever ecosystem-based plan for fisheries developed in the United States. It incorporates many of the principles and policies recommended by the EPAP. The goal of the FMP is to establish a management regime for the entire Western Pacific Region that will maintain sustainable coral reef fisheries while preventing adverse impacts to stocks, habitat, protected species, or the ecosystem. The FMP measures include the designation of zoned Marine Protected Areas (MPAs) for coral, a recommendation of the EPAP report.

In FY04, Congress allocated $1.98 million for NOAA Fisheries to conduct ecosystem pilot projects in four regions: New England, Mid-Atlantic, South Atlantic, and Gulf of Mexico. The plan is to 1) use a public process to determine management objectives, threats and alternatives, 2) hold technical workshops for establishing guidelines in applying ecosystem principles to fisheries management, and 3) develop quantitative methods and software (models and GIS tools) to aid in evaluating management options and consequences. Each of the four Councils (MAFMC, NEFMC, SAFMC, and GOMFMC) received $225,000 from NMFS to develop their pilot programs. The SAFMC is further along in this project, and is already developing an FEP; the other Councils are focusing on the development of ecosystem-based goals and objectives and for implementing the FEP approach.

BSAI and GOA Groundfish FMPs as an example of a FEP?

The Council's revised BSAI and GOA groundfish FMPs contain many elements of a FEP. The revised management policy, adopted by the Council following the PSEIS analysis, is a broad, ecosystem-based policy. It contains goals and objectives for each of the ecosystem components, and a management approach statement that provides a means to balance ecological, social, and economic objectives. Many of the recommendations of the EPAP are incorporated in the groundfish management program, such as buffers against uncertainty, indices for ecosystem health, long-term monitoring data, and the habitat needs of many of the ecosystem's fish species.

One difference between the groundfish FMPs and a FEP as intended by the EPAP is that the groundfish FMPs apply only to a single species complex in each management/ecosystem area, rather than all fisheries in that area. Also, much of the ecosystem information that is used in managing the groundfish fisheries is not contained in the FMP, but rather is available to managers in supplemental documents such as the SAFE reports, including the annual Ecosystem Considerations appendix. Including such information in the FMP could be restrictive as the knowledge base for such information is constantly expanding, and the formal process for amending the FMP may not be sufficiently efficient as to keep it up to date .

Fishery Ecosystem Plan for the Aleutian Islands

A Fishery Ecosystem Plan for the Aleutian Islands would be a stand alone document, developed along the lines of the EPAP. The AI FEP would provide an assessment of the Aleutian Islands ecosystem, and would provide guidance, through goals and objectives, to managers of all fisheries in the Aleutian Islands ecosystem area. The FEP would have no regulatory authority.

The FEP would allow the Council to include a focused consideration of the role of each ecological component of the region (e.g., seabirds, marine mammals, communities, industries) in the sustainability of the whole, when making decisions on Aleutian Islands management actions.

Possible issues that might be addressed under a FEP are briefly listed below.

- For management decisions that result in harvest of non-target species, to what extent are these non-target species important as prey for other fish, seabirds, or marine mammals?
- For management decisions that might result in incidental take of seabirds or marine mammals, what is the current population status of these seabirds and marine mammals? Are the trends up or down? Would the possible incidental take of seabirds or marine mammals, or removals of their prey items, have any measurable effect on their populations?
- For management decisions that result in harvest of target species, what are the population dynamics of those target species and to what extent would harvest change those dynamics? What other species of fish, seabirds, or marine mammals rely on these target species? How might

current harvests affect future geographic distribution of target species, spawning locations and success, juvenile production, and recruitment (to both a fishery and to the reproductive segment of the population)? How might fisheries affect the behavior of predators that rely on this target species biomass?

- The Council might consider ecosystem response to biomass (energy) removals by fishing, in time and space, as well as ecosystem response to biomass (nutrient) inputs from offal and discards at sea and point source nutrient input along the Coast (processor waste). In part, this is a redistribution of energy in the ecosystem – how is this affecting the marine system?
- The Council might consider the phenology of both target species and non-target species and how harvest might alter the timing of key events in the life cycle of these species. For example, could spawning be shifted in time because of harvest removals of spawning fish during a particular time period?
- The Council would consider uncertainty in the scientific knowledge of natural mortality for target fish and non-target species, and develop management policies to address uncertainty.
- What process might the Council employ to adaptively learn about ecosystem impacts of fishery management decisions and employ this new knowledge in future decision making? How might the Council adapt management measures to compensate for environmental change or regime shifts?

Spatial boundary and application

The definition of an ecosystem often includes a geographic component, but conspicuous boundaries in marine systems are rarely evident. Because the FEP does not authorize management measures, a specifically delineated boundary that can be charted in regulations is not necessary. Instead, the ecosystem boundary may be specified in other terms.

Recent publications have suggested that the size of an ecosystem might be considered to be the geographic extent of the foraging distances for a top consumer species in that area. Ciannelli et al. (2004) define the aerial extent of the Pribilof Islands ecosystem as that oceanic area that accommodates the energetic demands of the principal predatory species, the northern fur seal – that is, encloses the area of highest energy balance and lowest biomass import (which in this case is approximately a 100 nm radius around the islands). Certainly that boundary is not a precise 100 nm, but rather a less-well-defined boundary based on foraging, which may shift from season to season and year to year. Concepts such as central place foraging may be helpful perspectives in defining an approximate ecosystem boundary for management decisions. Section 4 discusses recent research on ecological divisions in the Aleutian Islands.

The AI FEP would apply to all fisheries within the Aleutian Islands ecosystem area, not just the BSAI Groundfish FMP. The FEP would consider the interactions of fisheries with each other, as well as with other components of the ecosystem.

Effect on existing FMP measures

The development of the FEP itself would not be disruptive to federal fishery management. Barring a change in statute, a FEP cannot authorize management measures, and such authority would remain vested in the FMPs. The associated paradigm shift that could increase the Council’s awareness of the ecological impacts of management actions, however, may result in amendments to the FMPs governing the Aleutian Islands fisheries.

The scope of the FEP is broader than either of the two previously considered options, as it would consider all components of the ecosystem, and provide goals and objectives for managing fishery impacts from all Federal fisheries. As such, fisheries other than the BSAI groundfish fishery may be affected.

The FMPs in the Aleutian Islands area would likely be amended to acknowledge the use of the FEP as a reference for ecosystem considerations, and the guidance of the FEP's ecosystem objectives.

Implementation

The FEP would describe the AI ecosystem, including spatial boundaries, predator-prey interactions, habitat needs of the significant food web components, and current and historic states of the ecosystem. Indices of ecosystem health, such as are included annually in the Ecosystem Considerations chapter of the groundfish SAFE report, would be used to assess all impacts, natural and anthropogenic, on the ecosystem. An excerpt from the EPAP's 1999 Report to Congress (Appendix A) describes the components of a FEP. Goals and objectives for the ecosystem would be developed by the Council.

The development of the FEP would require a cooperative effort among many agencies, as the AI FEP would need to consider impacts from other activities in the Aleutian Islands area relative to fishery impacts. Expert authorities from the State of Alaska, USFWS, and the Aleutian Islands communities would likely all be involved in developing the FEP. A mechanism for periodic re-evaluation of the FEP would also need to be devised.

Utility in conserving the Aleutian Islands

The FEP would give the Council an opportunity to examine and incorporate the impacts from all sources on the Aleutian Islands ecosystem, and take action to balance adverse impacts accordingly.

4 Defining a Boundary for the Aleutian Islands

This section discusses the management implications of an ecosystem boundary for the Aleutian Islands, and the evidence for where such a boundary would lie. Also, the section considers the Aleutian Islands as part of a Large Marine Ecosystem.

Management Implications of the Aleutian Islands Boundary

In considering area-specific management, an important element is to define a boundary for the Aleutian Islands management area. If the purpose is to consider a cohesive Aleutian Islands ecosystem separate from dissimilar habitat and oceanographic processes of the Bering Sea, the need to appropriately define the extent of the Aleutian Islands ecosystem seems critical. Although it is difficult to define unequivocal lines for an ecosystem, for the purposes of management the Aleutian Islands must have a distinct spatial boundary.

Geographically, the Aleutian Islands archipelago ranges from Attu Island to Unimak Island, approximately from 170º E. to 165º W. longitude (Figure 6, on page 19). The boundary defined for the Aleutian Islands in each of the Federal FMPs, however, is different (for further information, see discussion in Section 7.2.3). For groundfish, the BSAI FMP defines the Aleutian Islands subarea as that area of the EEZ that is west of 170º W. longitude and south of 55º N. latitude (Figure 11). This definition means that the Fox Islands, which include Dutch Harbor and Akutan, are not included in the AI subarea.

The subareas and regulatory areas of the BSAI and GOA Groundfish FMPs are based on statistical areas defined by the International North Pacific Fishery Commission (INPFC) in the 1950s. The INPFC Shumagin area (now statistical area 610, see Figure 2) includes waters south of the eastern Aleutian Islands and the Alaska Peninsula, between 170º W. and 159º W. longitude. This area is included in the GOA Groundfish FMP management area.

The BSAI Groundfish FMP originally defined four subareas, all based on INPFC statistical areas (Figure 3). Areas 1 and 4, now the southern portion of the Bering Sea subarea and the Aleutian Islands subarea, respectively, abut the Aleutian Islands. The four areas are still evident in the statistical areas used by NMFS to monitor groundfish catch in the management area (Figure 4).

Figure 2 Statistical areas for the groundfish fisheries in the GOA

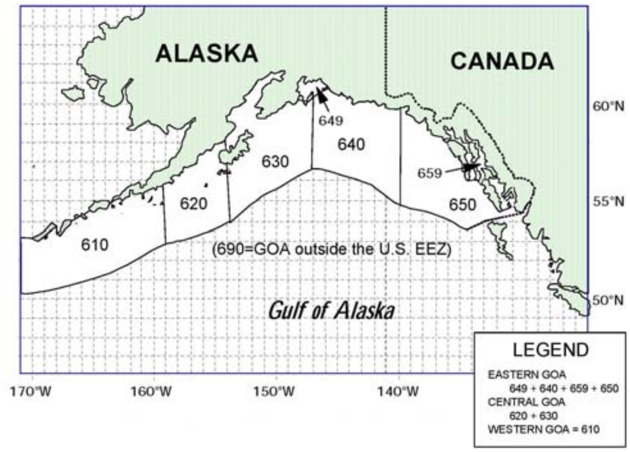


Figure 3 Fishing areas in original BSAI FMP, 1981

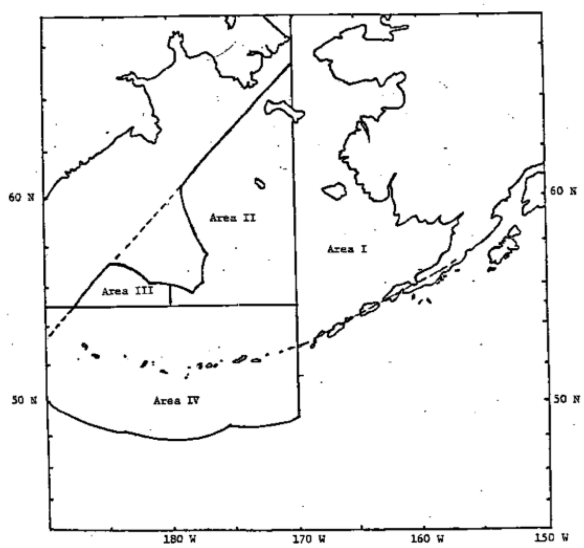
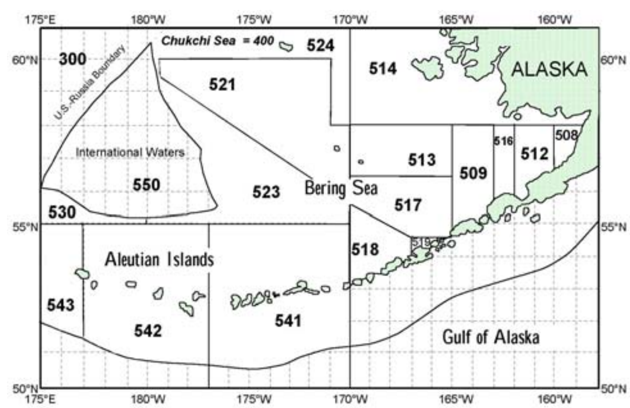


Figure 4 Statistical areas for the groundfish fisheries in the BSAI



None of the existing statistical area boundaries correspond exactly with a geographically-defined Aleutian Islands area. In the BSAI FMP, in addition to the Aleutian Islands subarea, statistical areas 517, 518, 519, and 509 all border the eastern Aleutian Islands to the north (Figure 4). In the GOA management area, the western half of statistical area 610 borders this area to the south (Figure 2).

In considering area-specific management for the Aleutian Islands, the question of an appropriate boundary for the area is a critical one. This is discussed in further detail under each of the management options below. However, it is worth noting some overarching considerations. First, any extension of the Aleutian Islands boundary beyond that of the AI subarea, for management purposes, will create a disconnect between data describing the Aleutian Islands before and after the change. The disconnect would be seriously compounded should the Council draw a boundary that does not correspond to one of the existing statistical areas. Inseason data are collected at many spatial levels, including Federal statistical areas, State of Alaska statistical areas and precise GPS haul locations for some directed fisheries; however, drawing new Federal statistical areas would make historical comparison of data for this area difficult.

The difficulty with managing data should not necessarily prevent the Council from defining an appropriate Aleutian Islands boundary, although it is an important consideration. For some of the management options discussed in this paper, the defined boundary of the Aleutian Islands may be allowed to differ between the area-specific plan and the management measures in the FMP. While such a solution is not ideal, as it increases the probability of confusion, it may provide the Council necessary flexibility.

Evidence of Aleutian Islands Ecosystem Boundaries

A recent volume of Fisheries Oceanography is devoted to the marine ecology of the Aleutian Islands, and is based on a series of research cruises along the archipelago. Results from the research indicate that there is evidence of an ecological division at Samalga Pass, which is at 169º W. longitude (Hunt and Stabeno 2005; Figure 5).

Figure 5 Eastern end of the Aleutian Archipelago, showing Semalga Pass

East of the Pass, waters from the Alaska Coastal Current predominate, and west of there waters from the Alaska Stream are the prevalent source. Weather east of 170º W. longitude is closely associated with the Aleutian Low Pressure, and to the west weather is more influenced by Asian circulation. Marine ecosystems of the Aleutian Archipelago show a strong discontinuity at Samalga Pass. Deep-water corals, zooplankton, fish, marine mammals, and seabirds show a step change in species composition there. Diets of groundfish, sea lions, and seabirds change there also. Fish growth and tissue composition studies suggest productivity declines westward along the Archipelago. Based on these findings, the authors suggest that marine waters of the Aleutian Archipelago are divided into at least two different ecological regions, with a break at Samalga Pass (Hunt and Stabeno 2005).

The authors also note that there are abrupt changes in the composition of fish communities at several of the major passes, and that Samalga Pass may represent only one of several ecological divisions in the Aleutian waters (Hunt and Stabeno 2005).

The Aleutian Islands Region and Large Marine Ecosystems

NOAA has adopted the Large Marine Ecosystem, or LME, concept for approaching regional marine ecosystem management. The agency has identified ten LMEs across the nation, three of which are in Alaska. The three geographic areas in Alaska are the Arctic, the Bering Sea, and the Gulf of Alaska. The Council actively manages fisheries in the GOA and the Bering Sea. No known commercially exploitable fish populations inhabit the Beaufort and Chukchi Seas (comprising the Arctic LME).

The Aleutian Islands do not fit neatly into the proposed LME categorizations. The region lies on the border of the Bering Sea and the GOA LMEs. However, although NOAA’s discussions on the practical applicability of the LME concept to ecosystem management have not progressed into actual guidelines, it has been acknowledged that in some instances, subregions may be appropriate to deal with unique areas.

The Council’s management of the North Pacific groundfish and shellfish resources of commercial value is centered in three regions, the Gulf of Alaska, the eastern Bering Sea, and the Aleutian Islands. Species complexes, environmental forcing mechanisms, productivity, ocean floor relief, and overall productivity and target species biomass levels are quite different in each of these three areas. Thus current fishery management basically focuses on three ecosystems in the North Pacific, not two. In a practical fishery-management context, the Aleutian Islands region west of about 165º W. longitude extends into an open oceanic environment much of which is distant from the actively fished eastern Bering Sea. The Aleutian Islands have different environmental characteristics than the eastern Bering Sea and the GOA, different target species fisheries, and unique marine mammal and seabird issues that fishery management must consider.

For these reasons, considering the Aleutian Islands as an LME subregion is likely to be compatible with the LME concept.

Options for an Aleutian Islands FEP Boundary

Based on the discussions above, there are several options available to the Council to identify a boundary for the FEP.

Option 1: Geographic extent of Aleutian Island archipelago

This definition would be based on the geography of the archipelago, and would include the Federal waters surrounding all of the Aleutian Islands from Unimak Island to the west. This option would perhaps cause the least public confusion. It would encompass groundfish fisheries occurring in the Bering Sea and Aleutian Islands subareas, and the western GOA. It would match up to crab and scallop management areas for the Aleutian Islands, and Areas 4A and 4B for halibut management.

Option 2: Aleutian Islands west of Samalga Pass (169° W. longitude)

Using this definition would most closely accord with the recent evidence of ecological boundaries in the Aleutian Islands. Hunt and Stabeno (2005) found a distinct ecological division occurring at Samalga Pass. There may be other ecological divisions, however, along that part of the Aleutian archipelago that would be included in this definition. This division would approximate the AI subarea of the BSAI groundfish fishery, but would divide the AI management area for scallop, crab, and halibut.

Option 3: Geographic extent of Aleutian Islands pollock stock (west of 174° W. longitude)

Defining the AI FEP according to a particular stock means that the ecological boundary fits for pollock, but does not necessarily accord with any other species or ecosystem components. This option does not accord with any existing management boundaries.

Option 4: No set boundary; for each species or ecosystem component, the FEP considers the appropriate ecological range of the species

Another approach to defining a boundary for the FEP is to define the boundary individually for each ecosystem component. This approach is possible because there are no regulations directly resulting from the FEP, but rather it is to be used as a guidance document for fishery management measures that will be put into effect through the FMP process. Therefore, the FEP will identify the appropriate ecological extent of each stock or stock unit that uses the Aleutian Islands.

5 Planning Process for developing a FEP

The development of an AI FEP, should the Council choose to proceed with such, would need to be a multi-stage process involving scientific support from the Alaska Fisheries Science Center (AFSC), and stakeholder input. Section 5.1 provides a discussion of the planning of the FEP.

The FEP is envisioned as a living document, which would be developed to guide the Council's fishery management actions in the Aleutian Islands area, and which would need to be kept updated in order to achieve its purpose. A process to accomplish this currency might be to use a Council advisory team. Such an approach is described in Section 5.2 below.

Additionally, the development of an AI FEP would be in part a test case of whether FEPs are a useful management tool for the NPFMC. Consequently, once an initial FEP is developed, a review should be conducted as to whether the FEP provides utility above and beyond current ecosystem considerations.

5.1 Approach to Developing the FEP

The PSFMC panel discussed practical ways for the NPFMC and the Pacific Fishery Management Council to incorporate ecosystem-based management practices in their fishery management programs. The panel (PSFMC 2005) discussed the evolutionary process as moving from:

Single species focus	- focus on target species, its predators, and prey
↓	
Implicit treatment of ecosystem effects	- determination of the status of target species recognizes ecosystem interactions - management measures address bycatch, incidental mortality, some direct effects on habitat
↓	
Explicit treatment of ecosystem effects	- the environment, target stock, predators, and prey are integrated into the assessment before the management procedure is used - food web dynamics, predator requirements, regime shifts are directly addressed

Source: PSMFC 2005.

The NPFMC is moving toward the third stage of the continuum. Management measures to implicitly treat ecosystem effects are already in place, and the Council is exploring mechanisms to address stage three. For example, the Alaska Fisheries Science Center is developing ways to inform the NPFMC of the importance and relevance of climatic and oceanographic conditions to fishery management decisions.

In order to guide the Councils' progress, the panel recommended practical actions to continue the evolution towards explicit treatment of ecosystem effects. Using as a basis the list of eight recommendations for developing a FEP provided by the Ecosystem Principles Advisory Panel (see also Appendix A), the panel provided a list of actions for fishery managers and scientists. This list is reproduced in Table 2.

Table 2 Actions for achieving an ecosystem-based fishery management approach, as recommended by a panel of fishery scientists of the North Pacific and Pacific[1].

Eight Recommendations from the EPAP report[2], *as modified by the Panel*	Panel's Recommended Actions
1. and 8. Delineate and characterize *the* ecosystem *including* the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries.	• Define the management goals to reflect the societal objectives
2. Develop a conceptual model of the food web	• Develop a conceptual model of the influence of oceanographic and climatic factors
3. Describe habitat needs of different life history stages of significant food web plants and animals and how they are considered in conservation and management measures	• Expand/modify the conceptual model of the ecosystem to include life history characteristics and spatial variation
4. Calculate total removals, including incidental mortality and show how they relate to standing biomass, production, optimum yields, natural mortality, and trophic structure	• Develop a numerical representation combining the food web model (which would include dynamic models of managed species), the oceanographic model, and explicit representation of management measures and quantities that have been identified as metrics of attainment of the management goals.
5. Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management actions	• Identify alternative management procedures. A management procedure would include specifications for the data required as well as how those data are analyzed to determine management actions: e.g., how uncertainty is quantified statistically and how the extent of uncertainty is used in the decision rules (control rules).
6. Develop indices of ecosystem health as targets for management	• Use models to identify indices that are relevant to the stated goals. Identify which indices can be used as the basis for decision making. 'Traffic light' approaches may be useful.
7. Describe available long-term monitoring data and how they are used *to estimate parameters for the model and to quantify the reliability of the model*	• Use the model to identify critical data gaps, and put plans in place to address them. • Conduct evaluations of management procedures (Management Strategy Evaluations): Use the model to evaluate the costs and benefits of management procedures in terms of their probability of achieving as many of the management goals as possible, calculated over a realistic range of uncertainty. • The Fishery Management Council would select from among these management procedures in light of their calculated performance. • Implement the management procedures accordingly. • Monitor to verify success of the management procedure and validity of the model. • Revise the model and the management procedure wherever the monitoring data indicates that the initial approach was mistaken.

[1] The panel met in July 2005 to examine practical ways that the Pacific and North Pacific Fishery Management Councils could move towards an ecosystem-based approach to fisheries management (PSMFC 2005).
[2] NMFS 1999

The first step, using this Sapproach, would be for the Council and AI stakeholders to articulate societal objectives for the AI ecosystem. Management goals for the area should then be examined to see whether they reflect the stated objectives. This task has already been started through the recent programmatic review of the groundfish fisheries, in which the Council identified a suite of ecosystem-based objectives for the BSAI and GOA groundfish fisheries as a whole. The groundfish objectives are reproduced in Appendix B. To adapt this process for the Aleutian Islands ecosystem area, the Council and stakeholders would need to reconsider the groundfish fishery objectives in light of societal goals for the Aleutian Islands area, and expand or revise them as necessary. The purpose of developing management goals or objectives is to allow the scientific content of the FEP to provide a measure, through the development of indicators, how those objectives or goals are being achieved.

The next step involves developing various oceanographic and food web models of the ecosystem area. Such models are currently in various stages of development by AFSC scientists. These models would be used to identify indicators and metrics of attainment of management goals, and management strategy evaluations of differing management procedures to achieve management goals.

PSMFC (2005) provides a number of suggested metrics that could be used to indicate levels of concern regarding ecosystem status. These metrics are:

- <u>biomasses</u> of one or more important species assemblages or components fall below minimum biologically acceptable limits;
- <u>diversity of communities or populations</u> declines significantly as a result of factors associated with harvest rates or species selection;
- changes in species composition or population demographics, resulting from fishing, significantly decrease <u>resilience or resistance of the ecosystem</u> to perturbations arising from non-biological factors;
- the pattern of harvest rates among interacting species results in lower <u>cumulative net economic or social benefits</u> than would result from a less intense overall fishing pattern;
- harvests of prey species or direct mortalities resulting from fishing operations impair the long-term viability of <u>ecologically important, non-resource species (e.g., marine mammals, turtles, seabirds)</u>.

Finally, the results of such evaluations would be made available to the NPFMC to incorporate into its decisionmaking, and management procedures would be implemented and monitored, and revisions and changes made to the models and evaluations as appropriate.

5.2 Council Advisory Team

The Council may choose to develop an advisory group that would become responsible for the AI FEP, would keep its information updated, and provide advice to the Council on actions relating to the Aleutian Islands in accordance with the outlined goals of the FEP. This advisory group could either be created as a new group, or the existing fishery management plan teams for groundfish, crab, and scallop, could be asked to serve this function in addition to their other duties.

Should an AI Ecosystem team be created, its initial charge, with the assistance of staff, would be to assist in the preparation of the Fishery Ecosystem Plan, and to periodically assist in updating it. Additionally, the team would provide advice on Aleutian Islands fishery management decisions facing the Council. The Aleutian Islands FEP and its goals would be used to evaluate future management actions affecting the AI SMA.

Option 1: Create an AI Ecosystem Team

The Council may choose to create a scientific 'team', under the oversight of the SSC and the Council, as an effective way to monitor its goals for AI fishery management. The AI Ecosystem Team could be similar to a Plan team, and would either meet on a regular, periodic basis, or ad hoc at the Council's request.

The Council would decide whether the team should be drawn from fishery management agencies, such as those that already participate on the Plan teams, or from a broader range of agencies with interest in the Aleutian Islands. If the Council chooses to broaden the participation, the Ecosystem Team could serve a broader ecosystem approach to ocean management function in addition to the specific role of guiding the Council regarding its Fishery Ecosystem Plan. Representatives on the team could come from several groups based on their activities in the region, special expertise in ecosystem values or functions that should be part of fishery management decision making, or special interests in the outcomes of management decisions. These might include representatives from the U.S. Fish & Wildlife Service, a CDQ group, a consortium of villages and communities, the Aleut Corporation, the University of Alaska Fairbanks, the Environmental Protection Agency or Alaska Department of Environmental Conservation or other entity involved in Amchitka Island research and remediation, the Alaska Fisheries Science Center, and NOAA-NOS.

An advantage of a new team would be that the membership can be specifically selected among those scientists working on the Aleutian Islands area. Additionally, representatives from each of the major fisheries, as well as other managers and researchers of resources that interact with the fisheries, can all meet together to provide advice to the Council.

Option 2: Use the existing FMP Teams as advisory teams on the AI FEP

The Plan Teams already represent a broad cross-section of fishery, mammal, and seabird biologists, ecologists, and economists. Membership in these groups has been chosen to represent the greatest expertise on these fisheries. As a result, the Plan Teams may be ideally suited to provide the Council with advice on AI management actions, using the FEP goals and assessments as a guide.

One disadvantage of using the Plan Teams as advisory bodies is that they rarely meet together, and doing so is logistically difficult. Therefore each team would be providing the Council advice independently without the benefit of interaction. This will place more responsibility on the SSC to sift and collate such advice.

Option 2.1: An adaptation of this approach could be for each Plan Team to appoint a representative to the Aleutian Islands Ecosystem Team. In this way, each of the Plan Teams would be represented on the AI Ecosystem Team, and would be able to provide FMP-specific advice regarding the Aleutian Islands. The Council would receive the benefits of Option 1 by having a dedicated group specifically focusing on the needs generated by the AI FEP, while at the same time drawing on the existing expertise already captured within the Plan Teams.

Although the USFWS and the State of Alaska are represented on the Council's groundfish Plan Teams, the Council may choose to invite a dedicated representative of these agencies to the AI Ecosystem Team, as created under this option.

6 Table of Contents for FEP

This preliminary table of contents for the FEP has been developed using the various guidelines for FEP content that are presented in Table 1, page 5, as well as the recommendations of the PSMFC panel (PSMFC 2005) in Table 2, on page 14. Based on these guidelines, a preliminary table of contents for the FEP is suggested as follows:

1 Purpose and need

- 1.1 What is the FEP
- 1.2 Council's purpose statement

2 Understanding the ecosystem area – what do we know about oceanographic and climate features of the AI ecosystem area, about species present in the ecosystem and their interactions, and about human activities influencing the ecosystem. This section should integrate existing models, and be a summary or inventory of other sources, rather than an encyclopedic listing.

- 2.1 Description of AI boundary
- 2.2 Oceanographic, climatic factors (oceanographic and climatic models)
- 2.3 Biological factors (food web model, with life history characteristics and spatial variation)
- 2.4 Fisheries and other human development activities

3 Management Goals – based on our understanding of the ecosystem area, what are our management goals? These should reflect societal objectives.

4 Ecosystem assessment – using the identified management goals, how can we define appropriate ecological indicators to assess the state of the ecosystem by integrating models and indicators. This section would be similar to the AFSC work in the PSEIS and the Ecosystem SAFE chapter.

- 4.1 For each management goal, identify indicators and assess status of ecosystem relative to management goal

5 Implications for fishery management – identify areas of uncertainty, conduct management strategy evaluations to assess management measures calculated over a realistic range of uncertainty

- 5.1 Assess areas of uncertainty
- 5.2 Consider tradeoffs and reconcile conflicting goals

6 Priorities – based on the above, what are priorities for future research or management

- 6.1 General
- 6.2 FMP-specific (groundfish, crab, scallop, state-water fisheries)

7 Strawman Information for FEP

Based on the preliminary Table of Contents identified in Section 6, this section provides some initial information such as will be found in the FEP, should it be developed. **NOTE: the following sections are incomplete, and will be substantially revised should the Council choose to initiate a FEP.**

7.1 Purpose and Need

The purpose and need for the FEP are identified in Section 1 above.

7.2 Understanding the Aleutian Islands Ecosystem Area

The Aleutian Islands region is a unique and, to many, a mystifying place. The Aleutian Islands form an archipelago that extends 1000 miles across the North Pacific and lies along the great circle routes used by vessels and aircraft transiting from the U.S. west coast to eastern Russia, Korea, and Japan. This island chain possesses special characteristics that set it apart from other areas in the North Pacific. It experiences some of the worst weather on the planet, it harbors abundant and diverse bird and mammal populations, and has an historic and cultural heritage that dates back to the last ice age when the region was likely colonized by peoples that crossed the Bering Land Bridge.

The Aleutian Islands themselves provide habitat for many species of nesting seabirds, rookery and haulout habitat for several species of marine mammals, and a migratory path for great whales, other marine mammals, and seabirds that occupy this region seasonally for feeding, nesting and fledging chicks. The region has a rich cultural heritage, and is poised to change as military, shipping, fishery, and community development proceeds in the coming decade.

7.2.1 Oceanography and Climate

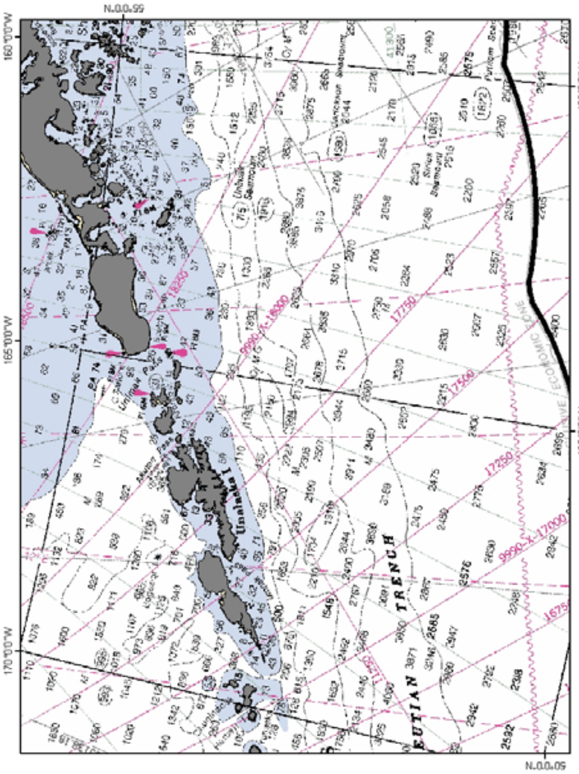
Physical and Biological Characteristics

The Aleutian Islands area or "ecosystem" possesses unique abiotic and biotic environmental features and an interdependent web of energy flow from terrestrial and marine primary production through top level consumer organisms in an island-dominated geographic region. The island chain forms a boundary between the open North Pacific Ocean and its Bering Sea, although the boundary is highly permeable with many inter-island passes that are pathways for water exchange and movement of marine organisms (Figure 6). The Aleutian Islands mark the furthest southward extent of seasonal sea ice of the Bering Sea, although in recent years warming trends have minimized formation of ice in the more southerly portions of the Bering Sea.

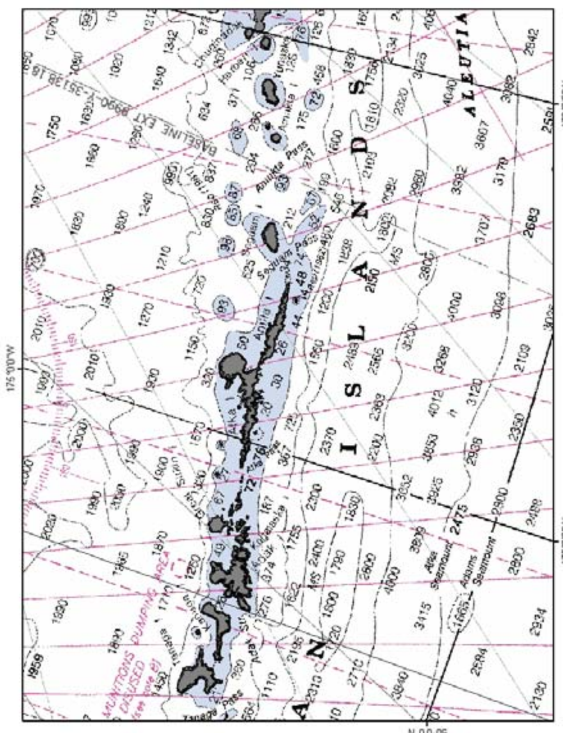
From 4,000 ft mountain peaks to the 24,000 ft depths of the Aleutian Trench, the Aleutian Islands offer a unique and dramatic diversity in landforms. Many of the Aleutian Islands are crests of submerged volcanoes. The region is highly volcanic and seismically active because of the tectonic convergence of the Pacific Plate and the North American Plate; the Aleutian Trench marks the convergent boundary of these plates. The region spawns some of the intense weather systems that greatly affect the oceanography and biological productivity in the North Pacific Ocean. The region supports a wide diversity of organisms, some in large numbers, including millions of seabirds, thousands of marine mammals, and abundant fish species, some of which support commercial fisheries.

The climate of the Aleutians is maritime and characterized by frequent cyclonic storms and high winds, and during calm periods the region often is covered by dense fog. Marine water flows through the various passes between islands, providing nutrients to fuel the productivity of the region and the adjacent Bering Sea. The Bering Sea and Aleutian Islands region is one of the most productive marine systems in the world. Plankton and forage fish species provide a nutritional base for millions of seabirds and marine mammals as well as abundant pelagic and demersal fish species.

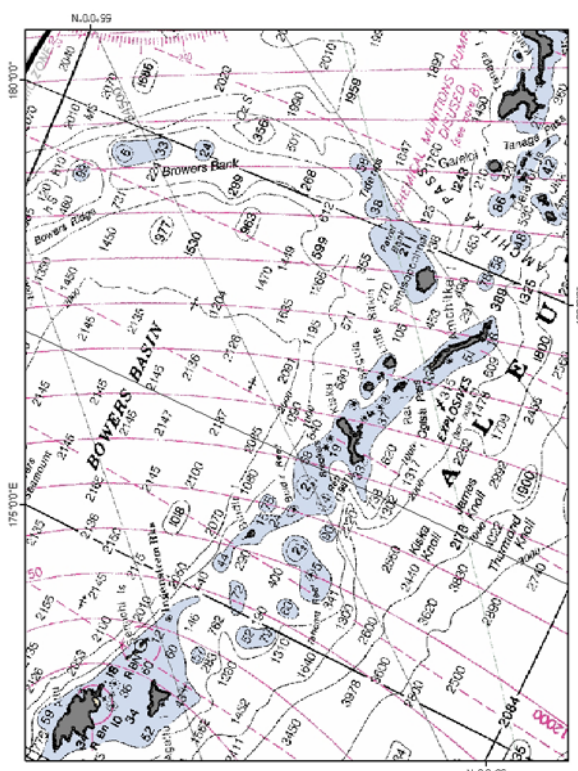
Figure 6 Map of the Aleutian Islands



Islands of Four Mountains to Unimak Island



Tanaga Island to Islands of Four Mountains



Attu Island to Tanaga

7.2.2 Species

The Alaska Fisheries Science Center's Resource Ecology & Ecosystem Modeling group researches food web models for Alaska region waters. Models have been in development for the eastern Bering Sea and the Gulf of Alaska for some time, however the unique characteristics of the Aleutian Islands require an area-specific food web model. Using ECOPATH/ECOSIM, a model is currently being developed for the Aleutian Islands.

Fish

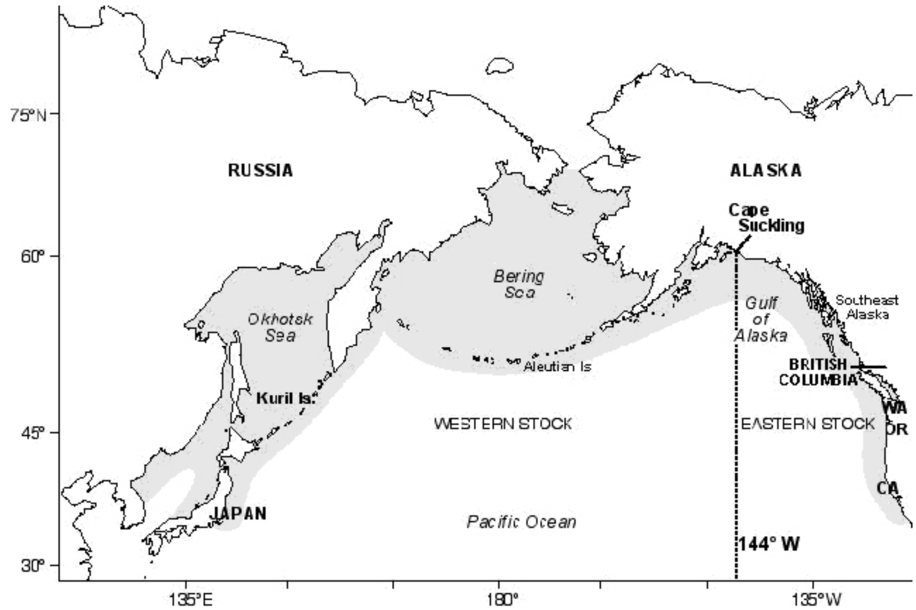
Marine Mammals and Seabirds

The Aleutian Islands are inhabited by diverse and abundant marine mammal and seabird populations. Many of these species feed on fish harvested in Federal or State fisheries, or otherwise interact with fishing activities, sometimes leading to injury or mortality. In the case of marine mammals, which are afforded special protection under the Marine Mammal Protection Act, any injury or mortality is illegal unless specially permitted. A similar situation exists for many of the seabirds in the area under the Migratory Bird Treaty Act. The Endangered Species Act also has considerable impact on activities in this region given the current listing status of many marine mammal and seabird species. The effects of these laws are magnified in the Aleutian Islands because of the abundance of species inhabiting this region, which are afforded these protections.

Steller sea lions

The Steller sea lion (*Eumetopias jubatus*) inhabits many of the shoreline areas of the Aleutian Islands, using these habitats as seasonal rookeries and year-round haulouts. Steller sea lions feed in the nearshore and offshore waters throughout the Aleutian Islands. The Steller sea lion was listed as threatened under the Endangered Species Act (ESA) on November 26, 1990 [55 FR 40204] and critical habitat for the species was designated August 27, 1993 [58 FR 45269]. In 1997 the SSL population was split into two stocks or Distinct Population Segments (DPS) based on genetic and demographic dissimilarities (Bickham et al 1996; Loughlin 1997)[62 FR 30772]. These are the western and eastern stocks. Because of a pattern of continued decline in the western DPS, the western DPS of SSL (wSSL) was listed as endangered on May 5, 1997 [62 FR 30772] while the eastern DPS remained under threatened status. The wSSL inhabits an area of Alaska approximately from Prince William Sound westward to the end of the Aleutian Island chain and into Russian waters (Figure 7).

Figure 7 Distribution of western and eastern distinct population segments of Steller sea lion



Throughout the 1990s, particularly after critical habitat was designated, various closures of feeding areas around rookeries and haulouts, and some offshore foraging areas, were designated to limit commercial harvest of pollock, Pacific cod, and Atka mackerel, which are important components of the wSSL diet. In 2001 a Biological Opinion was released that provided protection measures that would not jeopardize the continued existence of the wSSL nor adversely modify its critical habitat; that opinion was supplemented in 2003, and after court challenge, these protection measures remain in effect today (see Supplemental Figure A).

Over the past decade or more, the western Aleutian Islands wSSL sub-population was of particular concern. Non-pup counts declined from 14,011 in 1979 to just 817 animals in 2002. Although all other sub-populations in the western DPS increased between surveys conducted in 2000 and 2002, the western Aleutian Islands area group decreased by 23.7% in just two years. The cause of the steep decline observed in the area is unknown, although some researchers are finding links between prey composition and area. Other hypotheses involve changes in oceanic conditions such as salinity and temperature. Other possibilities for this sub-population include the taking of animals in Russian fisheries (e.g., herring). In 2004, scientists conducted another wSSL survey, and found that this Aleutian Islands sub-group is no longer declining. The overall wSSL population increased for a second consecutive survey (an increase was observed between the 2000 and the 2002 surveys.)

Because of the past declines observed in the wSSL population, special studies have been initiated in the Aleutian Islands area to determine the efficacy of the protection measures in providing areas closed to fishing where wSSLs can forage and obtain sufficient prey to meet nutritional requirements. These studies have been termed Fishery Interaction Studies, and have focused on fish movement patterns and the effect of commercial fisheries on Pacific cod and Atka mackerel in the Aleutian Islands. While results are very preliminary, no evidence of fishery-related localized depletion of these two species of fish have been detected, although the studies continue. These studies are unique in that they focus exclusively on fishery interactions with target species, with the objective of testing whether geographic closed areas are an appropriate tool for wSSL management.

While recent surveys show some possibility that the decline in abundance of the wSSL DPS may have halted, the entire DPS will be the subject of continued study and monitoring until persistent increases in this population occur. Undoubtedly studies will continue to explore whether geographic closed areas or other wSSL protection measures may be part of this turn around. The Aleutian Islands wSSL population likely will be an integral part of this ongoing work.

Northern fur seal

The Northern fur seal (*Callorhinus ursinus*) seasonally occupies rookeries on the Pribilof Islands for mating and rearing of pups. This marine mammal uses Aleutian Island passes as important migratory pathways to and from the Pribilof Islands. The fur seal is pelagic for the winter months, although its habitat use patterns when not on the Pribilofs is largely unknown. The Northern fur seal has declined considerably in the past decade and is the subject of special study by NMFS and special attention by the Pribilof Islands Collaborative.

Harbor seals

Three separate stocks of harbor seals (*Phoca vitulina richardsi*) are identified in Alaska, with the Gulf of Alaska stock inhabiting the Aleutian Islands (Angliss and Lodge 2003). Ongoing genetic stock identification studies suggest possibly more stock differentiation in the Alaskan harbor seal population, but sufficient data are not available to change the current three-stock structure. Harbor seals have declined in portions of their range in Alaska. The Aleutian Islands group has not been surveyed since 1994, so trends in the region are unknown. Given the declines in some areas, the use of harbor seals as a Native subsistence food item, and the unclear population structure in Alaska, harbor seals are the focus of ongoing research, most of it by the State of Alaska.

Sea otters

The southwest Alaska distinct population segment of the northern sea otter (*Enhydra lutris*) has been proposed for ESA listing as threatened because of a steep decline in abundance of sea otters, particularly in the Aleutian Islands area. If listed, the USFWS intends to develop criteria for designating critical habitat and to begin the species recovery process. Groundfish fisheries have not been implicated in the decline of sea otters, and interactions between this species and fisheries are not believed to be significant.

The Aleutian Islands area provides important habitat for this coastally-oriented marine mammal, where it remains year-round to feed and rear young. In the 1980s, the sea otter population in the Aleutian Islands ranged from 55,100 to 73,700 individuals (Calkins and Schneider 1985). A 1992 count in the Aleutian Islands area was 8,042 sea otters, and in the spring 2000 surveys the count for this area was 2,442 animals. On February 11, 2004, the USFWS published a Proposed Rule to list the southwest DPS as threatened [69 FR 6600]. The southwest DPS is designated as a strategic stock by the USFWS because of the possible ESA listing, and it is likely that special research and management attention will focus on this species in coming years, particularly in the Aleutian Islands.

Whales

Several species of whales use Aleutian Island passes as migratory pathways to feeding grounds in the Bering Sea and then to return to seasonal wintering and calving areas further south. Of these whales, the endangered North Pacific right whale is perhaps of most concern given its very small known population size. This whale moves through the Aleutian Island region annually to occupy feeding habitat in the eastern Bering Sea; it is very rare, and only up to 25 individuals have been seen annually in recent surveys.

Other whales move through the Aleutian Islands area, including blue whales, sei and minke whales, humpback whales, and gray whales. The blue whale is the subject of more focused acoustic studies designed to determine population size and habitat use patterns; blue whales may inhabit the Aleutian Islands area year-round. Sperm whales also inhabit the Aleutian Islands area, and are known to depredate longline-caught sablefish. Killer whales also have been known to depredate longline catches, and have been implicated as predators of Steller sea lions, sea otters, and other marine mammals in the Aleutian Islands. The extent to which whales utilize the waters around the Aleutian Islands is largely unknown, but the Aleutian Islands area appears to be important whale feeding and migratory habitat for many species.

Short-tailed albatross

The short-tailed albatross (*Phoebastria albatrus*) is listed as endangered [65 FR 46643] under the ESA because of its low population size compared to historic levels throughout its range. This albatross breeds primarily on a small island offshore the east coast of Japan. Telemetry studies indicate that after leaving their breeding and nesting grounds, short-tailed albatross move fairly quickly northward to the North Pacific and into the Bering Sea in spring and summer where these birds feed and may remain year-round. This seabird appears to concentrate particularly in the Aleutian Islands area, feeding on the continental shelf and slope and within passes between islands. Given the importance of the Aleutian Islands region as feeding grounds for this endangered seabird, continued research and management will likely emphasize at-sea capture and tracking movement studies in the Aleutian Islands (Rob Suryan, OSU, pers. comm., Oct. 2004) to better understand its year-round distribution and movement patterns. All longline and trawl groundfish fisheries managed by the Council are under an incidental take limit. Future groundfish fishery management in the Aleutian Islands area will likely give special attention to these concerns given the prominence of this species in the Aleutian Islands.

Steller's eiders

The Steller's eider (*Polysticta stelleri*) is listed as threatened under the ESA. This species of sea duck molts and then winters in nearshore marine waters throughout the Aleutian Islands where it mixes with the more numerous Russian Pacific population of Steller's eider (USFWS 2003). The species utilizes protected bays and inlets as refuge during a flightless period after molting, and then remains in many of these areas to feed throughout the winter. Causes for their decline are unknown but may include such factors as lead poisoning, predation on breeding grounds, contaminants, and ecosystem change. Concerns have been expressed over disturbance of this bird from vessel traffic or release of petroleum products into the marine environment in coastal areas where this species winters. There will continue to be elevated concerns over any human activity or development in or near Steller's eider habitat in the Aleutian Islands and Alaska Peninsula area.

Other seabirds

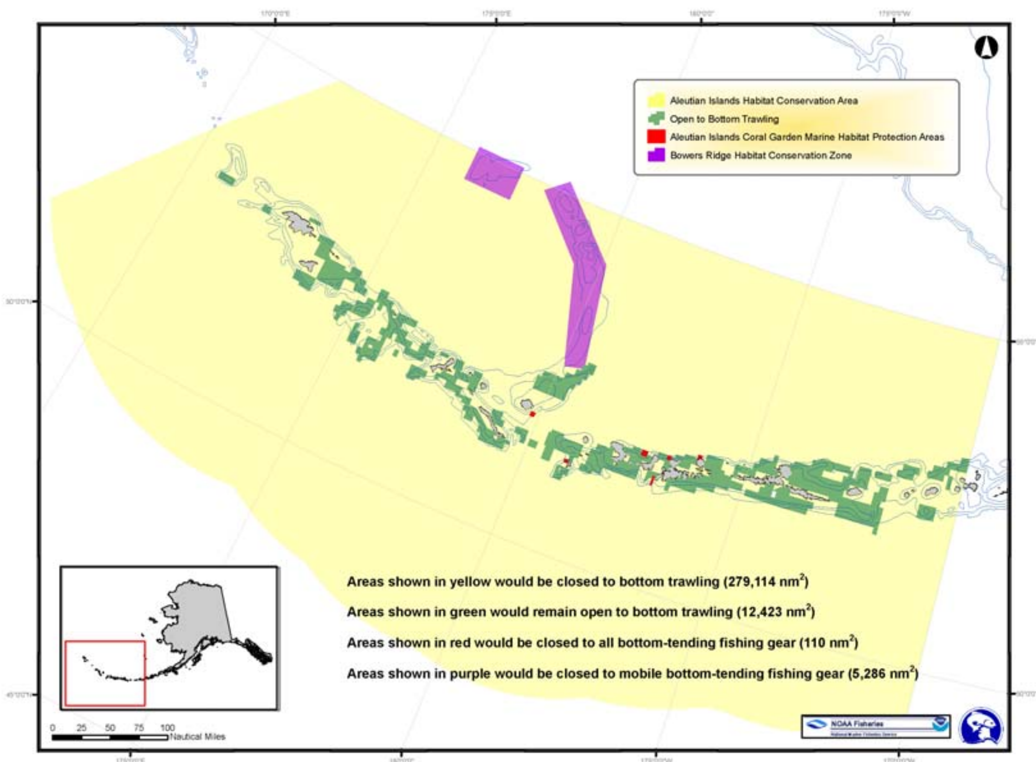
Millions of seabirds nest and fledge young from habitats on many of the Aleutian Islands. The Aleutian Islands area is considered one of the most important and significant seabird nesting areas in the North Pacific because of the unique habitats the islands provide. The Aleutian Islands marine waters over the continental shelf and slope and Aleutian Islands passes provide feeding grounds for millions of seabirds. The Aleutian Islands region seasonally supports thousands of cormorants, gulls, kittiwakes, guillemots, and murrelets and millions of storm-petrels, murres, auklets, and puffins. The Aleutian Islands also provide year-round habitat for large numbers of northern fulmar and smaller numbers of shearwaters and Laysan albatross and some black-footed albatross. One of the principal reasons the U.S. Congress established the Alaska Maritime National Wildlife Refuge, which encompasses nearly all land areas of the Aleutian Islands (and also other islands and coastal areas of Alaska; see heading at the end of this section), is because of the very high numbers of seabirds that nest and feed in this region.

Benthic Habitat

The continental shelf in this area extends only a small distance offshore, then breaks to an edge and slope descending to a seafloor that in some areas sustains unique assemblages of cold water corals, sponges, bryozoans, and other sessile invertebrates. Unlike the Bering Sea, the distribution of sediment type and texture is not known for the Aleutian Islands (NMFS 2004b), and these habitats have only recently been documented. The Aleutian Islands is thought to harbor the highest abundance and diversity of cold water corals in the world. Such benthic habitats and the fish and other organisms that associate with this habitat will likely be the focus of continued future research and observation, particularly using new submersible technology.

Under the Council's Essential Fish Habitat program, much of the Aleutian Islands area and several Habitat Areas of Particular Concern (HAPCs) have received special protection from fishing activities (Figure 8). In February 2005, the Council approved closing large areas in the Aleutian Islands to bottom trawling to protect unique seafloor biological assemblages, especially beds of cold water corals, sponges, bryozoans, and other associated organisms. These closed areas include six Aleutian Islands coral gardens, which are closed to all bottom contact gear, and Bowers Ridge, which is closed to mobile bottom contact gear that includes pelagic trawls that contact the sea floor, non-pelagic trawls, dredges, and troll gear that contacts the sea floor (including dinglebar gear).

Figure 8 Essential Fish Habitat mitigation areas and Habitat Areas of Particular Concern designated by the Council in February 2005



Gear on habitat

The Ecoystem Considerations chapter (Boldt 2005) provides information on the spatial pattern of fishing effort in the groundfish fisheries in the Aleutian Islands subarea. Figure 9 and Figure 10 demonstrate the spatial location and density of bottom trawl and hook and line effort in the AI between 1990 and 2004.

Figure 9 Spatial location and density of hook & line effort in the Aleutian Islands, 1990-2004

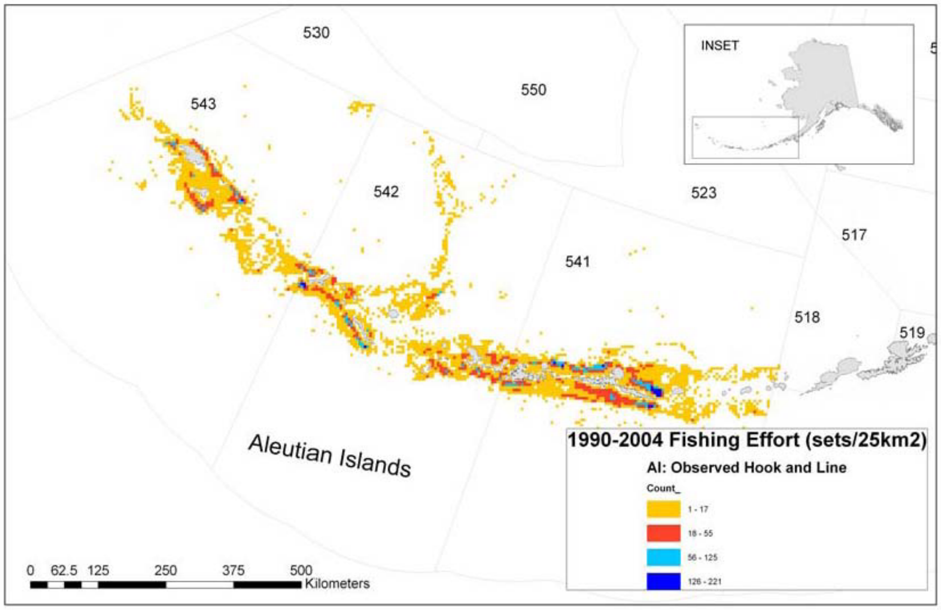
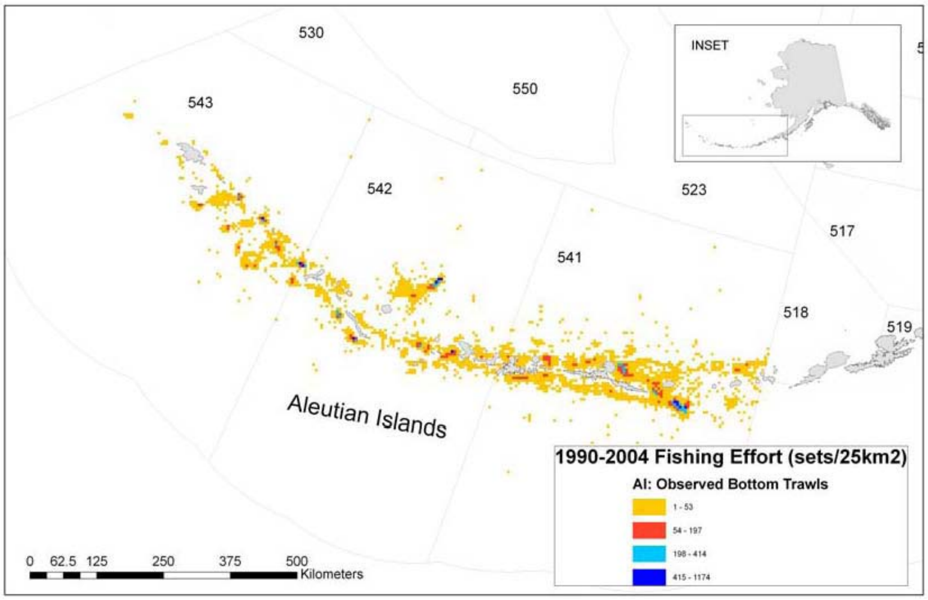


Figure 10 Spatial location and density of bottom trawl effort in the Aleutian Islands, 1990-2004



7.2.3 Human Activities

Fisheries

There are four federal fisheries that occur in the Aleutian Islands, for groundfish, halibut, scallops, and crab. The State of Alaska manages parallel and state-water fisheries for Pacific cod, salmon, herring, and black rockfish. Subsistence fisheries also occur for many marine species. Recreational fishing effort is small in the area.

Federal Groundfish Fisheries

Aleutian Islands groundfish fisheries are managed by the Council and the National Marine Fisheries Service (also referred to as NOAA Fisheries or NMFS) under the Bering Sea and Aleutian Islands (BSAI) Groundfish Fishery Management Plan (FMP). The Aleutian Islands is a subarea defined in the FMP as that area of the EEZ that is west of 170º W. longitude and south of 55º N. latitude, and it is divided into three districts (Figure 11).

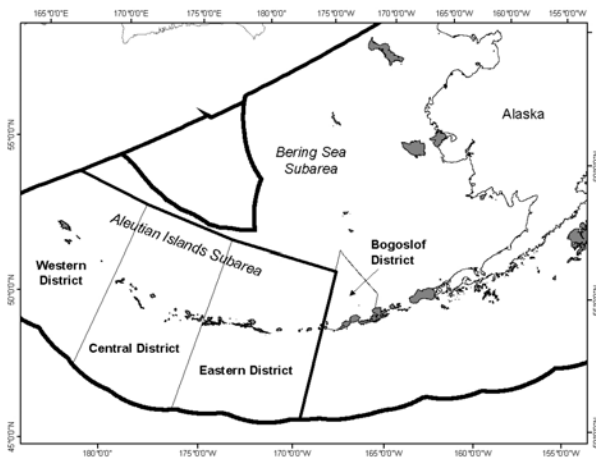


Figure 11 Aleutian Islands subarea of the BSAI Groundfish FMP

Table 3 lists the species managed under the BSAI Groundfish FMP, and the catch in 2003 for those species in the Aleutian Islands and Bering Sea subareas. For comparison, catch is also indicated for these groundfish in the western GOA regulatory area (which encompasses waters west of 170º W. longitude, to the south of the eastern Aleutian Islands) and the remainder of the GOA regulatory areas. Catches in the Aleutian Islands subarea (AI subarea) have always been much smaller than those in the Bering Sea subarea. Total catches from the AI subarea in recent years have been just over 100,000 mt annually, compared to over 1.8 million mt in the Bering Sea subarea. The historical species composition for each subarea is illustrated in . Management of these Federal fisheries is complex given the geographic size and extent of the region, its distance from research and management facilities, and enforcement and safety concerns.

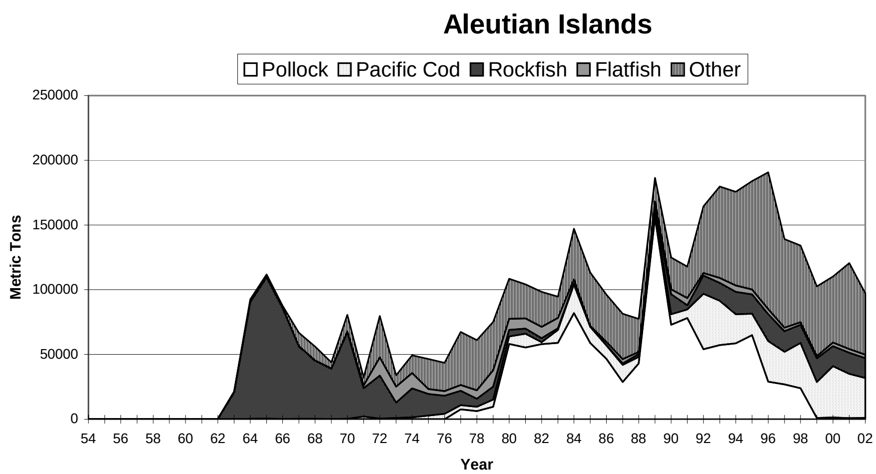
Table 3 Catch, in mt, of groundfish FMP-managed species in Alaska, in 2003.

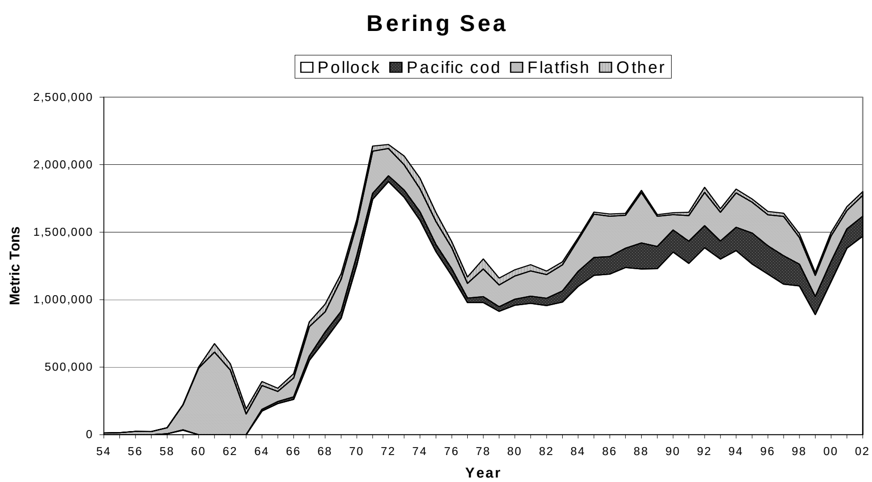
BSAI Groundfish FMP managed species	Aleutian Islands	Bering Sea	Western GOA	Other GOA
Pollock	1,653	1,489,997	16,508	33,008
Pacific cod	32,455	176,659	16,189	24,831
Sablefish	1,119	969	2,110	8,912
Atka mackerel	51,742 [4]	5,368 [4]	578 [5]	-- [5]
Yellowfin sole	0	79,961	4 [6]	55 [6]
Greenland turbot	993	2,515	8 [6]	5 [6]
Rock sole	972	35,003	196 [6]	3,186 [6]
Arrowtooth flounder	987	12,292	8,201	30,705
Flathead sole	0	13,792	515	1,910
Other flatfish [1]	81	3,137	788 [6]	1,967 [6]

BSAI Groundfish FMP managed species	Aleutian Islands	Bering Sea	Western GOA	Other GOA
Alaska plaice	0	9,964	1 [6]	13 [6]
Pacific ocean perch	12,760	1,151	2,149	8,712
Northern rockfish	4,582	72	533	4,810
Shortraker and rougheye rockfish	230	90	225	1,177
Other rockfish [2]	411	328	664	4,621
Squid	36	1,198	na [7]	na [7]
Other species [3]	1,411	26,305	na [7]	na [7]

[1] Includes starry flounder, rex sole, longhead dab, butter sole, and all species of flatfish caught in the management area, other than flathead sole, Greenland turbot, rock sole, yellowfin sole, arrowtooth flounder, and Alaska plaice.
[2] Includes light dusky rockfish, shortspine thornyheads, and all species of Sebates and Sebastolobus caught in the management area, other than Pacific ocean perch, northern rockfish, rougheye rockfish, and shortraker rockfish.
[3] Includes sculpins, skates, sharks, and octopus.
[4] Atka mackerel for the combined Eastern Aleutian Islands district and Bering Sea subarea was 11,010 mt in 2003; it is reported under the Aleutian Islands.
[5] The Atka mackerel TAC is for the whole GOA, but is mostly caught in the western GOA.
[6] Flatfish categories differ in the GOA; for flatfish catch breakdown, see Turnock et al. 2003; data is for 2003 through October.
[7] Breakdown not available for squid and other species in the GOA; GOA-wide total catch was 6,339 mt.

Figure 12 Groundfish catch by subarea, Bering Sea and Aleutian Islands, 1954-2002.





Although the BSAI groundfish fisheries are managed under a single FMP, many of the management measures apply at a subarea level. Table 4 describes those FMP measures that are specific to the Aleutian Islands subarea, and those that apply to the management area as a whole.

Table 4 Current management measures in BSAI groundfish fisheries that apply across the management area, and those that are AI subarea-specific

Issue	FMP measures that apply BSAI-wide	FMP measures that apply to the Aleutian Islands only
Allocation	AI TAC + BS TAC ≤ 2 MMT AI Fisheries with BSAI TAC: • Directed: Pacific cod • Incidental: Northern, shortaker and rougheye rockfish, flatfish, squid, other species	AI Fisheries with AI subarea TAC: • Directed: Pollock (as of 2005), Pacific ocean perch (by district), Atka mackerel (by district, jig 1% in Eastern AI/BS district), sablefish (trawl 25%, fixed gear 75%), Greenland turbot • Incidental: 'other rockfish'
Permit	BSAI license • certain vessels exempted: vessels fishing only in State waters, vessels less than 32' LOA, or jig gear vessels less than 60' LOA with specific effort restrictions.	Must have AI subarea endorsement
Closures/gear restrictions	Steller sea lions: • 3 nm no-transit zones around rookeries, no trawling for pollock, Pacific cod, or Atka mackerel within 20 nm of rookeries and haulouts during some or all seasons Prohibited species • Attainment of PSC limits for crab, salmon, and herring closes areas Gear: • Non-pelagic trawl gear prohibited in directed pollock fishery	Steller sea lions • Many of the rookeries and haulouts in the AI EFH and HAPC: • Council has designated various AI EFH and HAPC areas with protections such as no bottom-trawling Prohibited species: • One closure area in the AI: Chinook Salmon Savings Area 1.
Prohibited species and bycatch	Halibut, herring, salmon, king crab, and tanner crab are prohibited species. • BSAI-wide halibut PSC limit for trawl fisheries (3,675 mt)	• PSC limit for Chinook salmon in AI pollock trawl fisheries
Share-based programs	• Fixed-gear sablefish fishery is IFQ program. • some CDQ allocations BSAI-wide	• Directed pollock fishery in the AI subarea is fully allocated to the Aleut Corporation. • AI subarea-specific CDQ fisheries for pollock (as of 2005), POP, Atka mackerel, sablefish, Greenland turbot, rockfish;
Monitoring and Reporting	• 100%/30%/0% on vessels >125'/60-124'/<60' LOA • Fish tickets, C/P and processor reports	• 200% observer coverage on AFA vessels harvesting AI pollock

Historically, groundfish fisheries prosecuted in the AI subarea have included Atka mackerel, Pacific cod, sablefish, flatfish, and rockfish. Prior to 1999, pollock were harvested in this area. Pollock in the Aleutian Islands region is considered to be a separate stock from the eastern Bering Sea pollock, with a tentative boundary identified at 174º W. longitude, although there is some exchange between the stocks. From 1999 through 2004, the directed fishery was closed. Some pollock are harvested incidentally in other target fisheries (e.g., Atka mackerel, Pacific Ocean perch); in 2003, pollock bycatch in other directed fisheries was 1,653 mt.

Beginning in 2005, the Council has authorized allocation of pollock quota in a directed pollock fishery in the Aleutian Islands (Amendment 82). The allocation is to the Aleut Corporation per recent Congressional action (PL 108-199). The annual quota for this fishery currently is set at no more than 19,000 mt, less the CDQ apportionment and incidental catch allowances for other directed groundfish fisheries. The Council intends to re-visit this quota level and other aspects of the fishery in June 2006. Historically, harvests in the AI subarea pollock fishery have occurred in several areas of concentration, including areas north of Atka Island, northwest of Adak Island, and east of Attu Island and north of Shemya Island.

The Pacific cod fishery is managed under a quota apportioned to the entire BSAI management area, and there is no evidence of stock structure within the management area. Pacific cod catch statistics for the AI subarea for the period 2000-2003 showed harvests ranging from 28,649 to 39,684 mt (average 33,335 mt; Thompson and Dorn 2003). This fishery has historically occurred around Adak and Atka islands. Since 1999, when the AI subarea was closed to a directed pollock fishery, the Pacific cod fishery has been prosecuted under Steller sea lion (SSL) protection measures that allow Pacific cod fishing to occur closer to shore than a directed pollock fishery would be allowed. During 1997-2001, the AI subarea accounted for an average of about 16% of the BSAI Pacific cod quota.

The Atka mackerel fishery harvested 54,287 mt in 2003. The center of abundance of Atka mackerel appears to be the Aleutian Islands, although their distribution ranges from the Kamchatka peninsula to the Gulf of Alaska. The harvest quota has been distributed across the AI subarea districts since 1992, to minimize the risk of localized depletion. Although the fishery takes place primarily in the AI subarea, the fishery also occurs north of Akutan Island in the Bering Sea subarea. Areas of harvest concentration in the AI subarea in 2003 were south of Amukta and Tanaga passes, east of Attu Island, and scattered in the Rat Islands area (Lowe et al. 2003).

The sablefish fishery in 2003 harvested 1,008 mt, almost all of which from longline and pot fisheries. The population is considered to be a single stock throughout Alaska and northern British Columbia. The directed fishery is entirely under an IFQ management system and is prosecuted with fixed gear; a small amount is taken incidentally in some trawl fisheries (35 mt in 2003). The locations of the sablefish harvests from 1995-2003 suggest most of the fishing effort in the AI subarea occurs within 100 nm of Adak and Atka. This fishery is not under special restrictions for SSL protection, and occurs in waters within 20 nm of shore in the AI subarea.

The AI subarea rockfish fisheries include catch of Pacific ocean perch (POP), northern rockfish, shortraker and rougheye rockfish, and other rockfish. Rockfish harvested in the AI subarea in 2003 totaled 17,973 mt. Only the fishery for POP is directed, due to small harvest quotas; the other species are caught incidentally, primarily in the Atka mackerel and POP fisheries. 90% of northern rockfish are caught incidentally in the Atka mackerel fishery (Spencer and Ianelli 2003b). The Pacific ocean perch stock is spatially distributed in the AI subarea, where approximately 84% of the population is concentrated, according to survey data (Spencer and Ianelli 2003a). The fishery historically has occurred throughout the AI subarea with some concentration of harvests between Kiska and Agattu islands, around Amchitka Island and Petrel Bank, north of Atka Island, and in Amukta Pass. Shortraker and rougheye rockfish are caught incidentally in a variety of target fisheries. The majority of ‘other rockfish’ catch is light dusky rockfish and shortspine thornyheads. In the AI subarea, these species are mainly caught incidentally in the Atka mackerel trawl fishery, for light dusky rockfish, and in sablefish, grenadier or skate longline hauls or the POP trawl fishery, for shortspine thornyheads. ‘Other rockfish’ are also distributed in the Bering Sea subarea, north of Unalaska and Akutan Islands and on the slope (Reuter and Spencer 2003).

Most flatfish species are concentrated on the continental shelf of the Bering Sea, and have low abundance in the AI subarea. The only target flatfish fishery in the AI subarea is for Greenland turbot. About 25% of the Greenland turbot biomass is located in the area, and in 2003, the harvest total was 960 mt, mainly by hook and line gear. The fishery has historically occurred primarily within 100 nm of Adak and Atka islands.

Squid and other species (sculpins, skates, sharks, and octopi) are caught incidentally in other directed fisheries. Squid are caught primarily in the pollock trawl fishery. Skates represent the majority of the other species catch (over 21,000 mt for the BSAI in 2002), and are caught in the hook-and-line Pacific cod fishery (Gaichas et al. 2004).

CDQ fisheries occur in the AI subarea for sablefish, Atka mackerel, Greenland turbot, Pacific ocean perch, northern rockfish, shortraker and rougheye rockfish, and other rockfish. In 2005, there will also be a CDQ AI subarea pollock fishery. CDQ groups partner with commercial fishing corporations to harvest these allocations. Most of the CDQ groups have ownership interest in the partner corporations.

The Aleutian Islands has been surveyed biennially by bottom trawl since 2000, and was mostly surveyed triennially from 1980 to 1997. The 2002 survey area extends from Unimak Pass (165º W. longitude) to Statemate Bank (170º E. longitude), including Petrel Bank and Petrel Spur, and covers the continental shelf and upper continental slope to 500 m. The aims of the survey are to provide distribution and relative abundance data for the principal groundfish and commercially or ecologically important invertebrate species in the Aleutian Islands, and to collect data to define biological parameters such as growth rates, length-weight relationships, feeding habits, and size, sex, and age compositions. The most abundant species in the area are Atka mackerel, POP, northern rockfish, walleye pollock, Pacific cod, arrowtooth flounder, and giant grenadier. However, fish populations, such as many rockfish, which extend into areas that are either untrawlable with the survey gear or further up in the water column are not fully represented.

The Aleutian Islands has also been surveyed biennially by longline since 1996. Surveyed depths vary from 200m to 1000m. Survey objectives are to determine the relative abundance and size composition of sablefish, shortspine thornyhead, rougheye and shortraker rockfish, Pacific cod, arrowtooth flounder, grenadiers, and Greenland turbot. Tags to determine migration patterns of sablefish, shortspine thornyhead, and Greenland turbot are also implanted, and data to determine age composition of sablefish.

Ongoing groundfish research projects in the Aleutian Islands address the reproductive ecology of Atka mackerel, and the value of habitat, particularly coral and sponge habitat, to juvenile rockfish in the area.

Other Federal Fisheries

The halibut stock is managed by the International Pacific Halibut Commission (IPHC). Two of the IPHC statistical areas for the halibut fishery encompass portions of the Aleutian Islands, Areas 4A and 4B (Figure 13). Over the last five years, approximately 8,028,000 lb annually, or 14% of the Alaska halibut quota, have been allocated to these areas. Halibut allocations in Alaska are managed under an individual fishing quota program and a community development quota program.

The Federal scallop fishery is managed by the State of Alaska with Federal oversight. The Aleutian Islands scallop fishery is managed under registration Area O (Dutch Harbor). Area O extends from Scotch Cap Light (164º 44’ W. longitude) to the Maritime Boundary Agreement Line that separates U.S. and Russian waters, and encompasses both State and Federal waters. Scallop fishing in Area O generally occurs in the far east, to the north and south of Umnak Island (polygons marked on Figure 14). Area O was closed in 2000 due to management concerns over localized depletion. In 2002, the area was reopened with a reduced guideline harvest range ceiling of 10,000 lb, of which 61% was harvested. Area O represents approximately 1.5% of the statewide guideline harvest range for scallops.

Figure 13 Halibut Fishery Management Areas in the Aleutian Islands

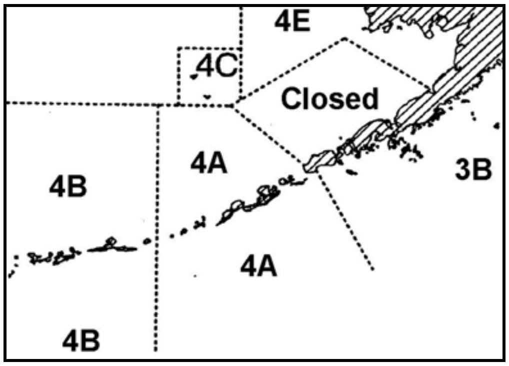
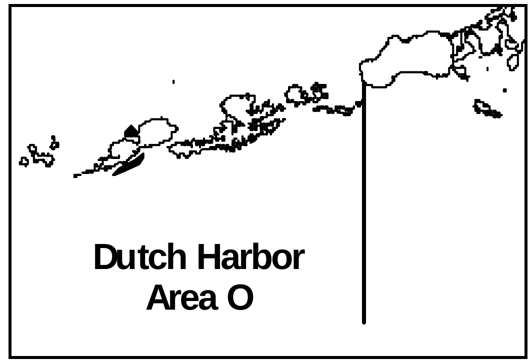
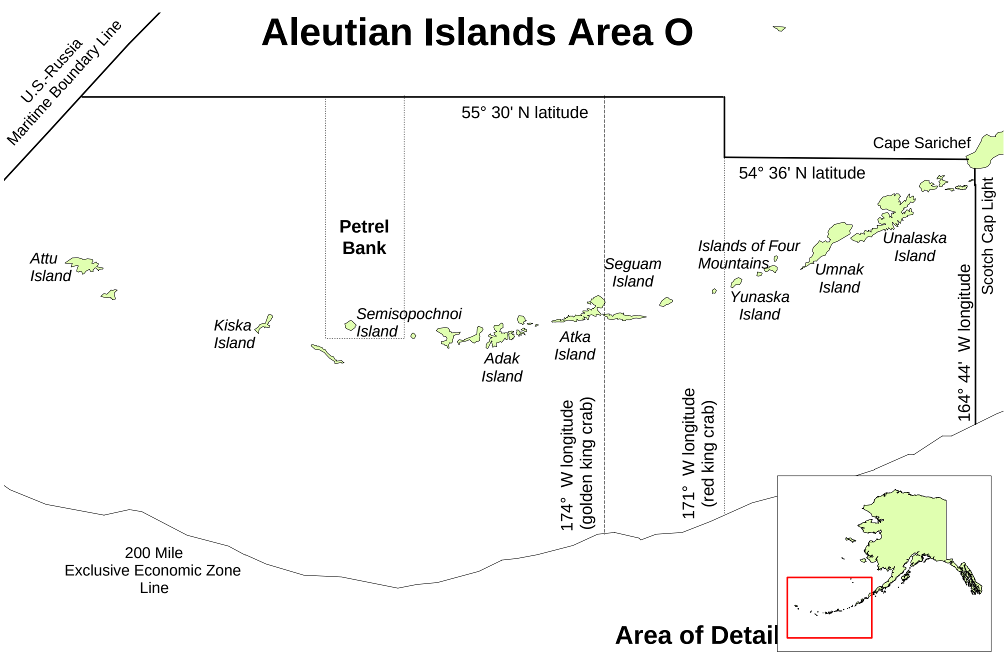


Figure 14 Scallop Registration Area O, with fishing concentration marked by the dark polygons.



The Federal king and tanner crab fishery is also managed by the State of Alaska with Federal oversight. In the Aleutian Islands, king crab fisheries are managed within registration Area O (Figure 15). The primary crab fishery that occurs in the region is the Aleutian Islands golden (brown) king crab fishery. Guideline harvest levels (GHLs), are established for the fishery east and west of 174º W. longitude. While effort and harvest have remained relatively stable in the eastern portion of the fishery, where the GHL for 2003-4 was 3.0 million lb, the western portion has experienced greater variability. The GHL for west of 174º W. longitude was 2.7 million lb, and both GHLs remain unchanged for 2004-5. Seasons in the golden king crab fisheries last several months, in contrast to other Bering Sea crab fisheries.

Figure 15 Aleutian Islands, Area O, king crab management area

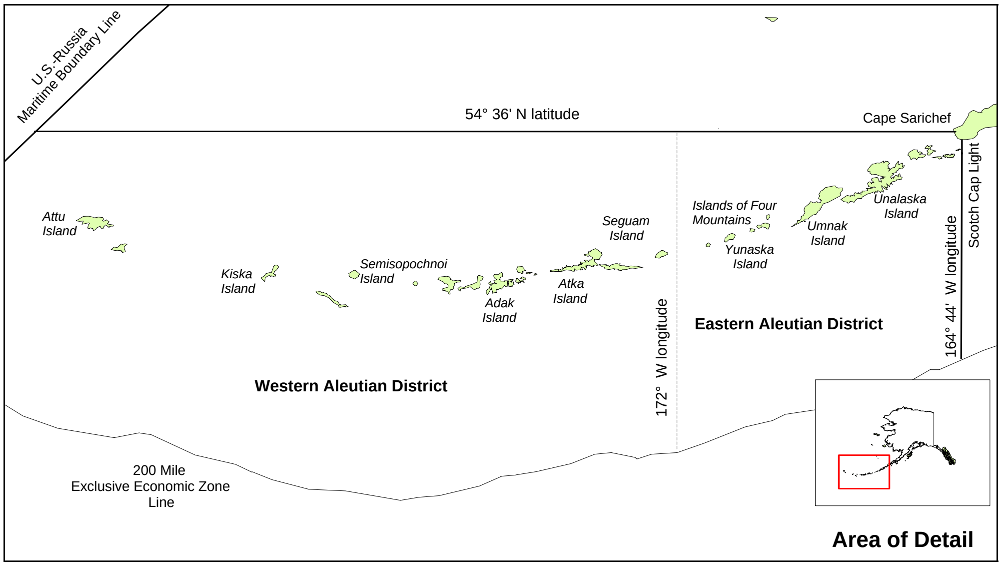


There is also an Aleutian Islands red king crab fishery in Area O. The eastern portion of the red king crab fishery has been closed since 1983, and the western portion, which operates in the Petrel Bank area, has opened sporadically in recent years. The fishery did not open in 2004.

Small tanner crab fisheries in the Aleutian Islands are managed in registration Area J (Figure 16). Tanner crab populations in this area are small, and, when open, are mainly authorized for incidental harvest only.

There are currently no CDQ crab fisheries in the Aleutian Islands. However, under crab rationalization, which will be implemented in 2005, CDQ groups will receive a 10% allocation of the western Aleutian Islands golden and red king crab fisheries.

Figure 16 Tanner crab Registration Area J, with Eastern and Western Aleutian Districts



State Managed or Parallel Fisheries

Future groundfish fishery management in the Aleutian Islands could include expanded parallel fisheries in State waters. Parallel fisheries are managed by the State of Alaska and may occur concurrently with the Federal groundfish fisheries, mirroring the Federal closures and harvest restrictions. Currently, the only directed parallel fishery in the Aleutian Islands occurs for Pacific cod, although other species are taken incidentally.

As outlined in the EA/RIR for Amendment 82 to the BSAI FMP, the potential exists for the State of Alaska to pursue a State-managed or State water pollock fishery in the Aleutian Islands, in which the State regulates the fishery and controls the closures and harvest restrictions. Were the State to initiate such a fishery without adopting the same restrictions as the Federal Steller sea lion protection measures, reinitiation of Section 7 consultation on the Steller sea lion protection measures likely would be required to determine the cumulative effects of the State-managed pollock fishery.

Other State-managed fisheries include sablefish (within State waters), salmon (primarily pink salmon and some sockeye salmon), herring for sac roe or food and bait, and black rockfish. These fisheries are prosecuted wholly within State waters. With increases in human populations in the Aleutian Islands that may accompany military, port, and community development, there may be additional participation in these fisheries and perhaps other, new State fisheries may evolve.

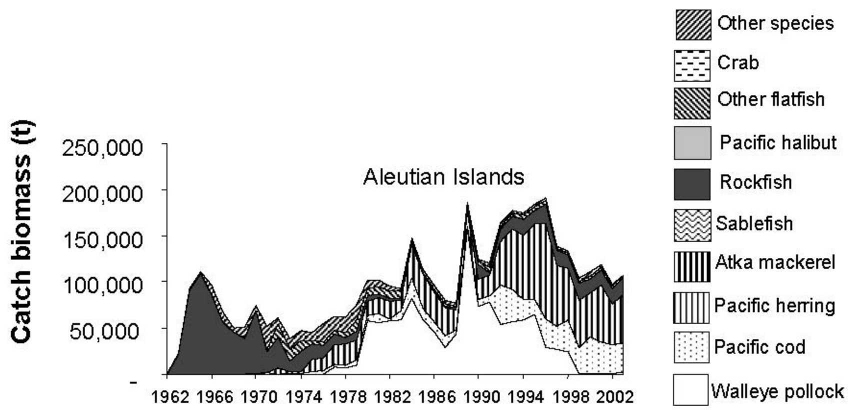
Subsistence and Personal Use Fisheries

The earliest fisheries in the Aleutian Islands were native subsistence fisheries. Today, subsistence fishing takes place in nearshore waters utilizing such species as cod, halibut, rockfish, and other species. These small-scale subsistence fisheries have continued to the present time. Subsistence activities continue to be a central element in contemporary village life and culture, and are also important to many of Alaska's non-Native residents. Total subsistence consumption ranges from about 200 lb per capita to over 450 lb per capita. Fish, including salmon, halibut, cod, and rockfish, contribute between 57 and 75% of total subsistence resource consumption in the Aleutian Islands. Other subsistence resources include marine and land mammals, seabirds, and marine invertebrates (NMFS 2004a).

Trophic Level of Catch

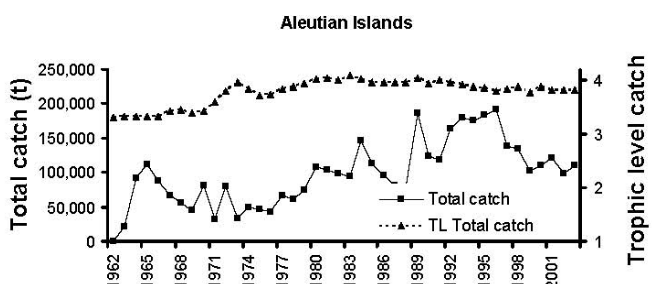
The Ecosystem Considerations chapter (Boldt 2005) looks at the trophic level of the catch to assess how well fishery management is meeting the goal of sustainability, for consumptive and non-consumptive uses. Figure 17 and Figure 18 indicate the catch composition of the total biomass in the Aleutian Islands from 1962 through 2003, and the trophic level of the catch, and concludes that the trophic level has been high and stable over the last 25 years.

Figure 17 Catch composition of total catch biomass (except salmon) in the AI through 2003



Source: Boldt 2005.

Figure 18 Total catch (groundfish, herring, shellfish, and halibut) and trophic level of catch in the AI through 2003



Source: Boldt 2005.

Marine Mammal and Fishery Management Issues

Two situations exist in the Aleutian Islands area that may merit special consideration. One is the geographic extent of the SSL protection measure closures. Over 41% of the AI subarea shelf and slope, to 1000 m, is closed to trawl fishing seasonally or year-round (NMFS 2004a). And a second is the potential changes in how pollock stocks are managed, which may have effects on how the AI subarea pollock fishery evolves in future years.

Steller Sea Lion Protection Measures

Steller sea lion protection measures include areas closed to all or some groundfish fisheries around rookeries and many haulouts along the Alaskan coast (see Supplemental Figure). These measures were put in place as a result of the steep decline in the SSL population and the hypothesis that this decline could be from nutritional stress. Fishing for pollock, Pacific cod, and Atka mackerel is restricted in these areas to limit fishing on prey items that are important in SSL diets. Closures are widespread in the Aleutian Islands. Recent concerns over the broad extent of closures, and recent research that suggests other hypotheses for the Steller sea lion decline, have led to public proposals for relaxing these measures and opening some areas to allow fishing.

A large proportion of the historical pollock harvest in the Aleutian Islands has come from waters that are now closed to pollock fishing by SSL protection measures. Under the current SSL protection measures, vessels generally must fish at least 20 miles from shore. The inclement weather conditions prevailing during the winter, when the AI subarea pollock "A" season fishery will occur, will likely impede growth of a small vessel pollock fishery that is a goal of Amendment 82. Proposals to change SSL protection measures in the Aleutian Islands area have been brought to the Council and its Steller Sea Lion Mitigation Committee, but the Council has decided not to pursue such changes at this time until more SSL research information becomes available. Nonetheless, it is likely that this issue will remain a concern given the Council's approval of Amendment 82 and the initiation of a directed pollock fishery.

Evolving Understanding of Pollock Stock Structure in the Aleutian Islands

Aleutian Islands pollock stock assessments are evolving, and in the near future, stock assessment biologists may recommend subdividing the Aleutian Islands subarea for the purposes of pollock management. Barbeaux et al. (2003) have examined the Aleutian Islands pollock stock and have suggested alternative approaches to assessing pollock resources in the AI subarea that account for spatial patterns in stock distribution. The population of pollock west of 174° W. longitude appears different in size structure and abundance, and it may be recommended that it be separated from the pollock stock east of 174° W. longitude. Barbeaux et al. (2003) recommend closing the area east of 174° W. to a directed pollock fishery, to form a contiguous closed area with the Bogoslof District (see Figure 11). This pollock conservation zone would provide a buffer between management areas and address uncertainties regarding stock structure. This proposal was discussed by the BSAI Groundfish Plan Team in 2003 and 2004.

Recent pollock stock assessment analyses have suggested that spatial considerations be reflected in recommending ABC levels. This may result in TAC recommendations for areas smaller than the AI subarea, which, in order to have catch proportional to biomass distribution, could impact the amount of pollock available to harvest in the central Aleutian Islands. There are currently three districts identified within the AI subarea in the BSAI Groundfish FMP (see Figure 11), and the 174° W. longitude line bisects the Eastern Aleutian Islands District. A recommendation for spatial apportionment of the AI pollock TAC is a reasonably foreseeable issue that the Council will need to weigh as decisions are made on future management of fisheries in the Aleutian Islands.

Cultural Heritage and Human Development Issues

The Aleutian Islands were likely settled by Aleut peoples that moved to Alaska across the Bering Land Bridge perhaps 15,000 years ago. Aleuts subsisted on what the Aleutian Islands and surrounding marine environment provided. With the arrival of Russian explorers and fur traders starting in 1742, the Aleutian Islands became a focus for fur harvests until 1867 when Russia sold Alaska to the United States. U.S. territorial management continued the fur trade and imposed many changes in the region. In the early

1940s, several islands became World War II battlegrounds and staging areas for the U.S. Aleutian Campaign, dramatically changing the landscape on many islands.

Thus the Aleutian Islands have a rich cultural heritage based on the early inhabitant Aleut peoples and subsequent waves of human occupation including the Russian fur trade, management of Alaska as a territory of the U.S., World War II and Japanese occupation, and in past decades a variety of human endeavors including defense installations, atomic energy research and testing, and commercial fisheries. These various human activities have left their mark on the Aleutians in a unique way, providing an historic and archeological heritage found nowhere else in North America.

Development at Adak

Adak Island was the site of a military naval air station until 1997. The site of an early Aleut community, the Aleut Corporation obtained a portion of the island and incorporated the City of Adak in 2001. With passage of PL 108-199 and the Council's recent action to provide for an Aleutian Islands directed pollock fishery, Adak community development will likely increase in the coming years. The Council's action, which allocates AI subarea pollock to the Aleut Corporation, will contribute to the growth of the port and community of Adak. Some connected with the Aleut Corporation have suggested that they would like to see Adak grow from a community of under 200 persons to a community of about 1,000 persons. The City of Adak and the Aleut Corporation are pursuing a wide range of development projects, seeking to take advantage of the facilities (harbor, airport, fuel storage, buildings) left behind by the Navy when the base was closed. Other regional development may result as Adak grows and services in the community expand.

Decontamination Work Resulting from Military Sites

A byproduct of the presence of military facilities throughout the Aleutian Islands has been varying levels of contamination from facility usage, military activities, and weapons testing. The US Navy, Army, and Air Force have developed installation restoration programs that are in varying stages of completion. Monitoring and cleanup is ongoing in many of these sites.

Amchitka Island was the site of three underground nuclear tests between 1965 and 1971. The Consortium for Risk Evaluation with Stakeholder Participation (CRESP), at the request of the DOE and the State of Alaska, designed and executed an *Independent Science Plan* to determine whether the foods from the marine environment around Amchitka were safe, to investigate the biological and geophysical aspects of potential radionuclide exposure, and to develop information for planning long-term biomonitoring. The key biological conclusions were that the foods tested are currently safe for human consumption, there is a rich and diverse marine ecosystem that may be at risk if there were significant seepage, and there are species at different trophic levels that could serve as bioindicators for a long-term stewardship plan at Amchitka. CRESP's recommendations, particularly with respect to what radionuclides to examine, what species should serve as bioindicators, where to monitor, and when to monitor, are under consideration by DOE and ADEC.

Other Regional Development

In addition to expansion of Adak and growth of a commercial fishery based there, the Aleutian Islands are slated for additional development. Military development in the Aleutian Islands may expand, possibly including missile defense systems in the region; development on Shemya Island, or possible activities on Amchitka Island to mitigate lingering effects of nuclear testing, also may occur. It would be speculative to determine any specific activity, since much of this is anecdotal or militarily classified. However, in April 2003, Adak was selected as the site for a $900 million radar system as part of the national missile defense system. This facility is expected to arrive in Adak by summer 2005. Port expansion is also being proposed in the Dutch Harbor/Unalaska area; the Little South America port facility is being studied and environmental and other studies are still progressing. A new port development at the head of Akutan Bay is the subject of a recent Corps of Engineers EIS; a decision on that development may be made soon. Continuing or new military activity, and these port developments, collectively would add vessel and aircraft traffic in the Aleutian Islands area.

Research, Scientific Issues, and Public Interest

Alaska Maritime National Wildlife Refuge

Most of the islands in the Aleutian chain are part of the Alaska Maritime National Wildlife Refuge, which is administered by the US Fish & Wildlife Service (Figure 19). The Refuge was established to protect breeding habitat for seabirds, marine mammals, and other wildlife. Some islands hold unique species not found elsewhere. The Refuge hosts seabird populations of national and international significance, providing nesting habitat for an estimated 40 million seabirds representing over half of all the nesting seabirds of the U.S. The Refuge also provides important habitat for Steller sea lions, harbor seals, and sea otters.

Figure 19 Map of the Alaska Maritime National Wildlife Reserve.

The Refuge also was established to make possible a program of scientific research on marine ecosystems. Scientists from the U.S. and other nations frequent the Aleutian Islands to conduct a variety of research projects. The region has high scientific visibility given its unique habitats and plants and animals. The research program and scientific activities within the refuge include the eradication of rats and foxes from the islands, and annual seabird and nesting surveys.

Public Interest and Ecotourism

Conservation organizations have been publicizing the unique environmental attributes of the Aleutian Islands for many years. Dozens of colorful publications, brochures, and website advertisements have highlighted the benthic habitats, coral and sponge assemblages, and fish habitat characteristics of the

Aleutian Islands. Cruise ship traffic has increased and brings the public closer to this region than has been the case in the past. Public awareness of these unique aspects of the Aleutian archipelago has increased, and thus the region is now more visible and the focus of public education campaigns for additional conservation, habitat and species preservation movements.

7.3 Management Goals

The Council would develop management goals for the FEP. Some work has already been done in this arena. Appendix B excerpts the management goals for the groundfish fisheries, which were extensively revised in 2004 to present a comprehensive, ecosystem-based policy approach. Appendix C excerpts the crab FMP management objectives, which have not been revised recently. Additionally, the Ecosystem SAFE chapter identifies some general ecosystem goals, which are used for the annual ecosystem assessment. These are provided in Appendix D.

7.4 Assessment of the AI Ecosystem

This section would identify ecological indicators that would tie in to the management goals selected in the section above. Assessment techniques developed by the AFSC in the SAFE chapter, would be used to describe the state of the ecosystem relative to the management goals. A selection of ecological indicators relating to the Aleutian Islands, from the Ecosystem SAFE chapter, is listed in Table 5.

Table 5 Extracts from Indicator Summary Table in the Ecosystem Considerations chapter (Boldt 2005)

INDICATOR	OBSERVATION	INTERPRETATION
AI summer bottom temperature	2004 temperatures were average	Average year
Area closed to trawling BSAI and GOA	2005 had same closures as 2004 plus new closures to protect EFH. Largest closure: AI Habitat Conservation area	Less trawling than prior to 1999 on bottom in certain areas though may concentrate trawling in other areas
Groundfish bottom trawling effort in AI	About the same in 2004 compared to 2003 generally stable trend since 1998	Less trawling on bottom relative to 1990-97
Scallop tows in EBS/AI	Number of tows decreased in 2001/02 in western AK	Generally decreasing number of scallop tows since 1997/98
Longline effort in BSAI	Higher in 2004 relative to 2003 in the BS; slight increase in 2004 relative to 2003 in AI	Generally increasing levels of longline effort in 1990's to present in the BS
HAPC biota bycatch in EBS/AI groundfish fisheries	Estimated at 2191 t for BSAI in 2002; ranged from 923 to 2548 t since 1997.	Similar to 2001 catches.
HAPC biota biomass indices in the AI bottom trawl survey	Survey may provide biomass index for seapens, anemones, and sponges.	More research needed to understand trends
Total groundfish catch AI	Total catch in 2003 shows decline since about 1996, Atka mackerel dominant	Total catch returning to lower levels
Total biomass EBS/AI	Total about the same in 2004 as in 2003, slight decreasing trend in pollock, pollock dominant	Relatively high total biomass since about 1981
BSAI groundfish stock status	In 2003, 0 overfished, 12 not subjected to overfishing	All major stocks are not overfished

INDICATOR	OBSERVATION	INTERPRETATION
Forage biomass indices from AI bottom trawl survey	Survey may not sample these well enough to provide biomass indices	
NMFS bottom trawl survey – AI	Increased jellyfish catches in all AI areas in 2004	More research needed to interpret trends
Crab stock status - BSAI	4 stocks overfished (BS Tanner, EBS snow crab, and Pribilof Is. and St. Mathew Is. blue king)	Mixed crab stock status
Scallop stock status	1 stock- not overfished	
Prohibited species bycatch	A large increase in bycatch rates of other salmon and herring in 2003 and 2004. Other 2004 bycatch rates show a decrease in bairdi, other tanner, and red king crabs; increases in Chinook salmon, and little change in halibut bycatch rates relative to 2003	Prohibited species bycatch rates are mixed.
Non-specified species bycatch	Non-specified species bycatch was the lowest in 2001 (11,122 t), compared to other years (13,368 to 24,634 t). Bycatch in 2002 was 13,368 t.	Dominant species in non-specified bycatch were jellyfish, grenadier and starfish
Alaskan sea lion western stock non-pup counts	2004 non-pup counts increased by 6-7% from 2002. Regional differences in trends.	Continued increase or stable counts in most areas; however, continued decline in central GOA
Seabird breeding chronology	Overall seabird breeding chronology was earlier than average or unchanged in 2002	Earlier hatching times are associated with higher breeding success
Seabird productivity	Overall, productivity of plankton feeding seabirds was average or above average in 2002; whereas, productivity of piscivorous seabirds was average or above average in 2002 (but varied across colonies and regions).	Variable chick production
Population trends	Mixed: majority showed no trend, 18 decreased, 17 increased through to 2002	Variable depending on species and site
Seabird bycatch	2003 BSAI longline bycatch is slightly higher than 2002, N. fulmars dominate the catch (GOA longline bycatch is small and relatively constant) Trawl bycatch rates are variable and perhaps increasing	Unclear relationship between bycatch and colony population trends
Trophic level catch EBS and AI	Constant, relatively high trophic level of catch since 1960's	Not fishing down the food web
Combined standardized indices of groundfish recruitment	Positive values 1976/77 - 1989, negative values in early 1970's and most of 1990's in GOA and BSAI	Above-average groundfish recruitments from 1976/77 - 1989, below average recruitments in early 1970's and most of 1990's.
Combined standardized indices of groundfish survival	Varying patterns	Relatively low survival of demersal stocks in 1990's

7.5 Implications for Fishery Management

7.5.1 Assess areas of uncertainty

Based on conceptual models and evaluations of fishery management measures, identify areas of uncertainty. Provide information on alternative management procedures, and conduct management strategy evaluations to allow the Council to realistically decide on the appropriate level of risk.

7.5.2 Consider tradeoffs and reconcile conflicting goals

The FEP would consider tradeoffs among sectors, fisheries, cumulative effects, external impacts to provide the Council with more information to reconcile conflicting goals.

Interactions among fisheries

BSAI Groundfish FMP and GOA Groundfish FMP

The BSAI and GOA groundfish fisheries are managed in close connetion with one another. While many of the same groundfish species occur in both the BSAI and GOA management areas, they are generally considered to be separate stocks. There is some overlap between participants in the BSAI and GOA groundfish fisheries. Many of the management measures and much of the stock assessment science are similar for the two areas. Management measures proposed for the BSAI groundfish fisheries are analyzed for potential impacts on GOA fisheries. Where necessary, mitigation measures are adopted to protect one area or the other (for example, sideboard measures in the AFA pollock cooperatives).

Groundfish FMP and crab FMP

Domestic fishing for crab for the most part predates the domestic groundfish fishery, and since the inception of the BSAI Groundfish FMP the consideration of crab bycatch in the groundfish fisheries has been paramount. The crab species are considered prohibited in the BSAI groundfish fisheries, with any catch required to be returned immediately to the sea with a minimum of injury so as to discourage targeting on those species. Other management measures have also been instituted to minimize the bycatch of crab in the groundfish fisheries, including area closures, gear modifications, and catch limits. Some participants in the BSAI crab fishery also target groundfish. The crab FMP contains sideboard measures constraining AFA pollock fishery participants from increasing their participation in the crab fishery.

Groundfish FMP and scallop FMP

There is very little interaction between the scallop FMP and the BSAI groundfish FMP. Virtually none of the vessels in the scallop fishery target groundfish. The scallop FMP contains sideboard measures constraining AFA pollock fishery participants from participating in the scallop fishery.

Groundfish FMP and salmon FMP

Pacific salmon are also a prohibited species in the BSAI groundfish FMP. There is no fishing of salmon allowed in the EEZ, therefore there is no overlap of participants or grounds conflicts. The BSAI groundfish FMP includes management measures to reduce the bycatch of salmon in federal waters, including catch limits and area closures.

Groundfish FMP and halibut

The fishery for Pacific halibut in the BSAI is conducted under an Individual Fishing Quota (IFQ) program, in conjunction with the FMP-managed sablefish resource. A realized benefit of the IFQ program is the reduction in halibut bycatch mortality. Much of the longline bycatch of halibut occurred in sablefish fisheries. To the extent that sablefish fishers have halibut IFQ, this halibut is now retained and counted against target quotas.

As long as Council and IPHC objectives concerning halibut utilization remain similar, coordination between the two organizations is easily affected. Should halibut management philosophies diverge – for example, because the broader-based Council constituency objects to constraints on fishery development caused by overriding halibut-saving measures – a major social, political, and, perhaps, diplomatic (because of Canadian involvement in IPHC and in the halibut fishery) confrontation could be precipitated. Furthermore, management actions taken in the Bering Sea that adversely affect halibut are likely to have a significant impact on the Gulf of Alaska halibut stock and fishery because of the interchange of halibut between the two regions.

Groundfish FMP and state groundfish

A parallel groundfish fishery occurs where the State allows the federal species TAC (total allowable catch) to be harvested in State waters. Parallel fisheries occur for pollock, Pacific cod, and Atka mackerel species, for some or all gear types. In addition, the State also has state managed fisheries for Pacific cod and rockfish species. Opening state waters allows the effective harvesting of fishery resources because many fish stocks straddle State and Federal jurisdiction and in some cases a significant portion of the overall federal TAC is harvested within State waters. Although the State cannot require vessels fishing inside state waters during the Federal fishery to hold a Federal permit, it can adopt regulations similar to those in place for the Federal fishery if those regulations are approved by the Board of Fisheries and meet State statute. An example of Federal fishery regulations that were concurrently adopted by the Board of Fisheries are the Steller sea lion protection measures implemented in 2001.

Groundfish FMP and other state fisheries:

State shellfish fishery: King and tanner crab species are considered prohibited species in the BSAI groundfish fisheries, with any catch required to be returned immediately to the sea with a minimum of injury so as to discourage targeting on those species. Other management measures have also been instituted to minimize the bycatch of crab in the groundfish fisheries, including area closures, gear modifications, and catch limits.

State salmon fishery: Pacific salmonids are prohibited species in the BSAI groundfish FMP, and must be immediately returned to the sea with a minimum of injury. Some controversy exists regarding the degree to which salmon bycatch in the groundfish fisheries affects State salmon runs, particularly in times of declining returns. The Council has established and reduced salmon bycatch limits in the BSAI groundfish trawl fisheries in response to increased salmon bycatch concerns.

State herring fishery: Pacific herring are considered a prohibited species in the groundfish fishery, and must be immediately returned to the sea with a minimum of injury. Historically, bycatch of herring was high in the Bering Sea pollock fishery. But, in the early 1990s the Council adopted a catch limit of 1 percent of the herring biomass. Once reached, the cap triggers closure of a predetermined "herring savings area" for the remainder of the season. This measure has succeeded in limiting herring bycatch in the pollock fishery. Herring bycatch in other target groundfish fisheries is very low.

State water subsistence fishery: Subsistence fisheries in Alaska are managed by the State, and take place primarily in state waters. Groundfish fishery participants and fishing communities engage in subsistence activities, however groundfish are a minor target of subsistence fishing (see Section 4.3.3 for a description of the subsistence groundfish fishery). Where appropriate, subsistence groundfish harvests are accounted for in annual groundfish stock assessment.

7.6 Priorities for the Aleutian Islands

Based on the above discussions, the FEP should identify priorities for research and management for the AI.

8 Summary: Plan of action for developing the AI FEP

The following provides a description of how the development of the AI FEP would unfold, should the Council decide to initiate the project. Table 6 provides a summary of those parts of the FEP for which the Council would need to provide direct input, and those which would need to be prepared by AFSC scientists.

1. Council initiates FEP development

Option 1: Council identifies specific options for the AI boundary and AI Ecosystem Team
Option 2: Council defers decision on AI boundary and AI Ecosystem Team

2. Council, perhaps through Ecosystem Committee, works on Council-portion of FEP content

- definition of AI boundary
- management goals

3. AFSC and staff work on AFSC portion of FEP content

- developing models (oceanographic, climatic, dynamic food web)
- developing indicators for Council's management goals, and ecosystem assessment based on goals

4. Feedback loop of AFSC work products through Council/Ecosystem Committee

- based on assessment of management goals, Council identifies priority areas for management evaluations: areas of increased uncertainty, or tradeoffs, or unreconciled goals
- management strategy evaluations on priority issues, using models (AFSC)
- Council decides whether changes to management are needed (e.g., changes to FMPs, contact with other agencies, etc.)

5. Council approves FEP

- not a legal requirement, as FEP is a guidance document; but Council may choose to approve the FEP and identify that it will follow its guidance in actions relating to the Aleutian Islands

6. Council creates AI Ecosystem Team to advise Council/SSC on AI issues, update FEP, etc.

- AI Ecosystem Team will monitor AI FEP to make sure it remains up-to-date, will advise Council on actions related to the AI
- Council will select composition of Ecosystem Team based on options in staff discussion paper

Table 6 Roles of responsibility regarding development of the FEP

FEP Content	Responsible Party
1 Purpose and need 1.1 What is the FEP 1.2 Council's purpose statement	**Council** – written up in staff discussion paper, and will be adopted as working draft when FEP is initiated; will be revised as necessary during course of project
2 Understanding the ecosystem area – what do we know about oceanographic and climate features of the AI ecosystem area, about species present in the ecosystem and their interactions, and about human activities influencing the ecosystem. This section should integrate existing models, and be a summary or inventory of other sources, rather than an encyclopedic listing. 2.1 Description of AI boundary 2.2 Oceanographic, climatic factors (oceanographic and climatic models) 2.3 Biological factors (food web model, with life history characteristics and spatial variation) 2.4 Fisheries and other human development activities	**2.1 – Council** to select one of the options in the discussion paper. May do so upon initiation of project, or wait until development of models and management goals provides more information. **2.2, 2.3, 2.4 – AFSC/staff** will develop models and analyses to mimic interactions in the AI, and support management strategy evaluations
3 Management Goals – based on our understanding of the ecosystem area, what are our management goals? These should reflect societal objectives.	**Council** – once FEP is initiated, Council (perhaps through Ecosystem Committee) will review existing management objectives and goals (groundfish, other FMPs, ecosystem assessment) to come up with management goals for the AI
4 Ecosystem assessment – using the identified management goals, how can we define appropriate ecological indicators to assess the state of the ecosystem by integrating models and indicators. This section would be similar to the AFSC work in the PSEIS and the Ecosystem SAFE chapter. 4.1 For each management goal, identify indicators and assess status of ecosystem relative to management goal	**AFSC/staff** – identify ecological indicators or metrics that assess the degree to which management goals are being met; analyze indicators compared to goals
5 Implications for fishery management – identify areas of uncertainty, conduct management strategy evaluations (MSE) to assess management measures calculated over a realistic range of uncertainty 5.1 Assess areas of uncertainty 5.2 Consider tradeoffs and reconcile conflicting goals	**Council** – based on assessment of management goals, identify priority areas of uncertainty or unreconciled goals **AFSC/staff** – using models, conduct MSE or other evaluations to address Council's priorities
6 Priorities – based on the above, what are priorities for future research or management 6.1 General 6.2 FMP-specific (groundfish, crab, scallop, state-water fisheries)	**AFSC/staff** – use model to identify critical data gaps **Council** – prioritize needs for future research or management

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Appendix A Excerpt from Ecosystem Principles Advisory Panel (1999)

Principles

- The ability to predict ecosystem behavior is limited.
- Ecosystems have real thresholds and limits which, when exceeded, can effect major system restructuring.
- Once thresholds and limits have been exceeded, changes can be irreversible.
- Diversity is important to ecosystem functioning.
- Multiple scales interact within and among ecosystems.
- Components of ecosystems are linked.
- Ecosystem boundaries are open.
- Ecosystems change with time.

Goals

- Maintain ecosystem health and sustainability.

Policies

- Change the burden of proof.
- Apply the precautionary approach.
- Purchase “insurance” against unforeseen, adverse ecosystem impacts.
- Learn from management experiences.
- Make local incentives compatible with global goals.
- Promote participation, fairness, and equity in policy and management.

Recommendations

Develop a Fisheries Ecosystem Plan

- Delineate the geographic extent of the ecosystem(s) that occur(s) within Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems, and “zone” the area for alternative uses.
- Develop a conceptual model of the food web.
- Describe the habitat needs of different life history stages for all plants and animals that represent the “significant food web” and how they are considered in conservation and management measures.
- Calculate total removals – including incidental mortality – and show how they relate to standing biomass, production, optimum yields, natural mortality, and tropic structure.
- Assess how uncertainty is characterized and what kind of buffers against uncertainty are included in conservation and management measures.
- Develop indices of ecosystem health as targets for management.
- Describe available long-term monitoring data and how they are used.
- Assess the ecological, human, and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/Department of Commerce (DOC) authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.

Measures to Implement FEPs

- Encourage the Councils to apply ecosystem Principles, Goals, and Policies to ongoing activities.
- Provide training to Council members and staff.
- Prepare guidelines for FEPs.
- Develop demonstration FEPs.
- Provide oversight to ensure development of and compliance with FEPs.
- Enact legislation requiring FEPs.

Research Required to Support Management

- Determine the ecosystem effects of fishing.
- Monitor trends and dynamics in marine ecosystems (ECOWATCH).
- Explore ecosystem-based approaches to governance.

Appendix B Excerpt from chapter 2 of the BSAI [GOA] Groundfish FMPs

2.2 Management Approach for the BSAI [GOA] Groundfish Fisheries

The Council's policy is to apply judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future, as well as current generations. The productivity of the North Pacific ecosystem is acknowledged to be among the highest in the world. For the past 25 years, the Council management approach has incorporated forward looking conservation measures that address differing levels of uncertainty. This management approach has in recent years been labeled the precautionary approach. Recognizing that potential changes in productivity may be caused by fluctuations in natural oceanographic conditions, fisheries, and other, non-fishing activities, the Council intends to continue to take appropriate measures to insure the continued sustainability of the managed species. It will carry out this objective by considering reasonable, adaptive management measures, as described in the Magnuson-Stevens Act and in conformance with the National Standards, the Endangered Species Act (ESA), the National Environmental Policy Act, and other applicable law. This management approach takes into account the National Academy of Science's recommendations on Sustainable Fisheries Policy.

As part of its policy, the Council intends to consider and adopt, as appropriate, measures that accelerate the Council's precautionary, adaptive management approach through community-based or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and where appropriate and practicable, increase habitat protection and bycatch constraints. All management measures will be based on the best scientific information available. Given this intent, the fishery management goal is to provide sound conservation of the living marine resources; provide socially and economically viable fisheries for the well-being of fishing communities; minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions.

This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for sustainable fishery management, including protection of the long-term health of the resource and the optimization of yield. This policy will use and improve upon the Council's existing open and transparent process of public involvement in decision-making.

2.2.1 Management Objectives

Adaptive management requires regular and periodic review. Objectives identified in this policy statement will be reviewed annually by the Council. The Council will also review, modify, eliminate, or consider new issues, as appropriate, to best carry out the goals and objectives of this management policy.

To meet the goals of this overall management approach, the Council and NMFS will use the Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement (PSEIS) (NMFS 2004) as a planning document. To help focus consideration of potential management measures, the Council and NMFS will use the following objectives as guideposts, to be re-evaluated, as amendments to the FMP are considered over the life of the PSEIS.

Prevent Overfishing:

1. Adopt conservative harvest levels for multi-species and single species fisheries and specify optimum yield.

2. Continue to use the 2 million mt optimum yield cap for the BSAI groundfish fisheries. [Continue to use the existing optimum yield cap for the GOA groundfish fisheries.]
3. Provide for adaptive management by continuing to specify optimum yield as a range.
4. Provide for periodic reviews of the adequacy of F_{40} and adopt improvements, as appropriate.
5. Continue to improve the management of species through species categories.

Promote Sustainable Fisheries and Communities:

6. Promote conservation while providing for optimum yield in terms of the greatest overall benefit to the nation with particular reference to food production, and sustainable opportunities for recreational, subsistence, and commercial fishing participants and fishing communities.
7. Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.
8. Promote fair and equitable allocation of identified available resources in a manner such that no particular sector, group or entity acquires an excessive share of the privileges.
9. Promote increased safety at sea.

Preserve Food Web:

10. Develop indices of ecosystem health as targets for management.
11. Improve the procedure to adjust acceptable biological catch levels as necessary to account for uncertainty and ecosystem factors.
12. Continue to protect the integrity of the food web through limits on harvest of forage species.
13. Incorporate ecosystem-based considerations into fishery management decisions, as appropriate.

Manage Incidental Catch and Reduce Bycatch and Waste:

14. Continue and improve current incidental catch and bycatch management program.
15. Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, vessel bycatch allowances, or other bycatch incentive systems.
16. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits, as information becomes available.
17. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch which includes economic discards.
18. Continue to manage incidental catch and bycatch through seasonal distribution of total allowable catch and geographical gear restrictions.
19. Continue to account for bycatch mortality in total allowable catch accounting and improve the accuracy of mortality assessments for target, prohibited species catch, and non-commercial species.
20. Control the bycatch of prohibited species through prohibited species catch limits or other appropriate measures.
21. Reduce waste to biologically and socially acceptable levels.

Avoid Impacts to Seabirds and Marine Mammals:

22. Continue to cooperate with U.S. Fish and Wildlife Service (USFWS) to protect ESA-listed species, and if appropriate and practicable, other seabird species.
23. Maintain or adjust current protection measures as appropriate to avoid jeopardy of extinction or adverse modification to critical habitat for ESA-listed Steller sea lions.
24. Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.
25. Continue to cooperate with NMFS and USFWS to protect ESA-listed marine mammal species, and if appropriate and practicable, other marine mammal species.

Reduce and Avoid Impacts to Habitat:

26. Review and evaluate efficacy of existing habitat protection measures for managed species.
27. Identify and designate essential fish habitat and habitat areas of particular concern pursuant to Magnuson-Stevens Act rules, and mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species.
28. Develop a Marine Protected Area policy in coordination with national and state policies.
29. Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.
30. Develop goals, objectives and criteria to evaluate the efficacy and suitable design of marine protected areas and no-take marine reserves as tools to maintain abundance, diversity, and productivity. Implement marine protected areas if and where appropriate.

Promote Equitable and Efficient Use of Fishery Resources:

31. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.
32. Maintain the license limitation program, modified as necessary, and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries.
33. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance.
34. Develop management measures that, when practicable, consider the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.

Increase Alaska Native Consultation:

35. Continue to incorporate local and traditional knowledge in fishery management.
36. Consider ways to enhance collection of local and traditional knowledge from communities, and incorporate such knowledge in fishery management where appropriate.
37. Increase Alaska Native participation and consultation in fishery management.

Improve Data Quality, Monitoring and Enforcement:

38. Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources.

39. Develop funding mechanisms that achieve equitable costs to the industry for implementation of the North Pacific Groundfish Observer Program.
40. Improve community and regional economic impact costs and benefits through increased data reporting requirements.
41. Increase the quality of monitoring and enforcement data through improved technology.
42. Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.
43. Cooperate with research institutions such as the North Pacific Research Board in identifying research needs to address pressing fishery issues.
44. Promote enhanced enforceability.
45. Continue to cooperate and coordinate management and enforcement programs with the Alaska Board of Fish, Alaska Department of Fish and Game, and Alaska Fish and Wildlife Protection, the U.S. Coast Guard, NMFS Enforcement, International Pacific Halibut Commission, Federal agencies, and other organizations to meet conservation requirements; promote economically healthy and sustainable fisheries and fishing communities; and maximize efficiencies in management and enforcement programs through continued consultation, coordination, and cooperation.

Appendix C Chapter 7 from the BSAI King and Tanner Crab FMP

7.0 GOAL AND OBJECTIVES

The Council, in cooperation with the State, is committed to developing a long-range plan for managing BS/AI crab fisheries that will promote a stable regulatory environment for the seafood industry and maintain the health of the resources and environment. The management system conforms to the Magnuson-Stevens Act's national standards as listed in Appendix B and the comprehensive Statement of Goals adopted by the Council on December 7, 1984.

7.1 Management Goal

The management goal is to maximize the overall long-term benefit to the nation of BS/AI stocks of king and Tanner crabs by coordinated Federal and State management, consistent with responsible stewardship for conservation of the crab resources and their habitats.

7.2 Management Objectives

Within the scope of the management goal, seven specific objectives have been identified. These relate to stock condition, economic and social objectives of the fishery, gear conflicts, habitat, weather and ocean conditions affecting safe access to the fishery, access of all interested parties to the process of revising this FMP and any implementing regulations, and necessary research and management. Each of these objectives requires relevant management measures (see Chapter 8). Several management measures may contribute to more than one objective, and several objectives may mesh in any given management decision on a case-by-case basis.

7.2.1 Biological Conservation Objective : Ensure the long-term reproductive viability of king and Tanner crab populations.

To ensure the continued reproductive viability of each king and Tanner crab population through protection of reproductive potential, management must prevent overfishing (see definition in Chapter 4). Management measures may also be adopted to address other biological concerns such as: restricting harvest of crabs during soft shell periods and maintaining low incidental catch of nonlegal crab. Other factors, including those currently under investigation, such as the effects of cold air temperatures on incidentally-caught egg bearing females and their resultant larvae (Carls 1987), could also be considered. The maintenance of adequate reproductive potential in each crab stock will take precedence over economic and social considerations.

7.2.2 Economic and Social Objective: Maximize economic and social benefits to the nation over time.

Economic benefits are broadly defined to include, but are not limited to: profits, income, employment, benefits to consumers, and less tangible or less quantifiable social benefits such as the economic stability of coastal communities. To ensure that economic and social benefits derived for fisheries covered by this FMP are maximized over time, the following will be examined in the selection of management measures:

1. The value of crab harvested (adjusted for the amount of crab dying prior to processing and discarded, which is known as deadloss) during the season for which management measures are considered,

2. The future value of crab, based on the value of a crab as a member of both the parent and harvestable stock,

3. Subsistence harvests within the registration area, and

4. Economic impacts on coastal communities.

This examination will be accomplished by considering, to the extent that data allow, the impact of management alternatives on the size of the catch during the current and future seasons and their associated prices, harvesting costs, processing costs, employment, the distribution of benefits among members of the harvesting, processing and consumer communities, management costs, and other factors affecting the ability to maximize the economic and social benefits as defined in this section.

Social benefits are tied to economic stability and impacts of commercial fishing associated with coastal communities. While social benefits can be difficult to quantify, economic indices may serve as proxy measures of the social benefits which accrue from commercial fishing. In 1984, 7 percent of total personal income or 27 percent of total personal income in the private sector in Alaska was derived from commercial fishing industries. However, in coastal communities most impacted by commercial fishing in the BS/AI area, the impacts were much greater. In 1984, 47 percent of the total personal income earned in the Southwest Region of Alaska (Aleutian Islands, Bethel, Bristol Bay Borough, Dillingham, and Wade Hampton Census Areas) or 98 percent of the total personal income in the private sector for this region was derived from commercial fishing activities (Berman and Hull 1987). Some coastal communities in this region are even more heavily dependent on commercial fish harvesting and/or processing than this. On a statewide basis, shellfish accounted for 21 percent of the total exvessel value of commercial fish harvested in Alaska in 1984. Therefore, social and economic impacts of BS/AI crab fisheries on coastal communities can be quite significant and must be considered in attempts to attain the economic and social objective.

Subsistence harvests must also be considered to ensure that subsistence requirements are met as required by law. Basically, State law requires that a reasonable opportunity be provided for subsistence use before other consumptive use is allowed. It is very difficult to evaluate the economic impact of subsistence fishing. Yet, fish, shellfish, and game harvested by subsistence users to provide food for the family or social group can greatly exceed the economic value of the product itself (R. Wolfe, ADF&G, Division of Subsistence, personal communication). Data on subsistence red king crab fishing have been obtained in the Norton Sound-Bering Strait area of the BS/AI management unit (Thomas 1981; Magdanz 1982, 1983; and Magdanz and Olanna 1984, 1985), and declines in subsistence harvests have been associated with changes in crab distributions, poor ice conditions, and reductions in crab stocks due to commercial harvest and poor recruitment (ADF&G 1986).

7.2.3 Gear Conflict Objective : Minimize gear conflict among fisheries.

Management measures developed for the king and Tanner crab fisheries will take into account the interaction of those fisheries, and the people engaged in them, with other fisheries. To minimize gear conflict among fisheries, the compatibility of different types of fishing gear and activities on the same fishing grounds should be considered. King and Tanner crab fisheries are conducted with pots, which are stationary gear. Many other fisheries in the fishery management unit, both domestic and foreign, are conducted with mobile trawl or seine gear. Seasons, gear storage, and fishing areas may be arranged to eliminate, insofar as possible, conflicts between gear types and preemption of fishing grounds by one form of gear over another.

7.2.4 Habitat Objective : Preserve the quality and extent of suitable habitat.

The quality and availability of habitat supporting the BS/AI area king and Tanner crab populations are important. Fishery managers should strive to ensure that optimal habitat is available for juvenile and breeding, as well as the exploitable, segments of the population. It also will be important to consider the potential impact of crab fisheries on other fish and shellfish populations. The BS/AI habitat of king and Tanner crabs, and the potential effects of changes in that habitat on the fishery are described in Appendix F of this FMP.

Those involved in both management and exploitation of crab resources will actively review actions by other human users of the BS/AI area to ensure that their actions do not cause deterioration of habitat. Any action by a State or Federal agency potentially affecting crab habitat in an adverse manner may be reviewed by the Council for possible action under the Magnuson-Stevens Act. The Council will also consider the effect on crab habitat of its own management decisions in other fisheries.

7.2.5 Vessel Safety Objective: Provide public access to the regulatory process for vessel safety considerations.

Upon request, and when appropriate, the Council and the State shall consider, and may provide for, temporary adjustments, after consultation with the Coast Guard and persons utilizing the fishery, regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safety of vessels.

7.2.6 Due Process Objective: Ensure that access to the regulatory process and opportunity for redress are available to all interested parties.

In order to attain the maximum benefit to the nation, the interrelated biological, economic and social, habitat, and vessel safety objectives outlined above must be balanced against one another. A continuing dialogue between fishery managers, fishery scientists, fishermen, processors, consumers, and other interested parties is necessary to keep this balance. Insofar as is practical, management meetings will be scheduled around fishing seasons and in places where they can be attended by fishermen, processors, or other interested parties.

Access to the FMP development and regulatory process is available through membership in a Council work group, testimony on the record before the Council's Advisory Panel or SSC, or before the Council itself, testimony before the Board, conversations with members of the plan team or officials of regulatory agencies, and by commenting on the FMP, any subsequent amendments and any regulations proposed for their implementation.
This FMP defers much of day-to-day crab management to the State. Means of access to the regulatory process at the State level and of redress of perceived wrongs by the State are necessary. Appendix C describes the State management system and mechanisms for public input. Chapters 9 and 10 of this FMP contain procedures for challenge of State laws or regulations regarding management of these fisheries alleged to be inconsistent with the Magnuson-Stevens Act, the FMP, or any other applicable Federal law.

7.2.7 Research and Management Objective : Provide fisheries research, data collection, and analysis to ensure a sound information base for management decisions.

Necessary data must be collected and analyzed in order to measure progress relative to other objectives and to ensure that management actions are adjusted to reflect new knowledge. Achieving the objective will require new and ongoing research and analysis relative to stock conditions, dynamic feedback to market conditions, and adaptive management strategies. For example, some possible research topics could include (1) the basis for exclusive registration areas, (2) the basis for sex restrictions in retained catch, (3) the basis for size limits, (4) the process for determining GHLs, (5) bioeconomic analyses of specific regulatory proposals, and (6) defining oceanographic conditions important to maximizing productivity of crab stocks.

An annual area management report to the Board discussing current biological and economic status of the fisheries, GHL ranges, and support for different management decisions or changes in harvest strategies will be prepared by the State (ADF&G lead agency), with NMFS and crab plan team input when appropriate. This will be available for public comment, and presented to the Council on an annual basis. GHLs will be revised when new information is available. Such information will be made available to the public.

Appendix D Ecosystem objectives from the annual Ecosystem SAFE chapter

Maintain predator-prey relationships by examining:

- pelagic forage availability
- spatial/temporal conc. of fishery impact on forage fish
- removals of top predators
- introduction of non-native species

Maintain diversity by examining:

- species diversity
- functional (trophic, structural habitat) diversity
- genetic diversity

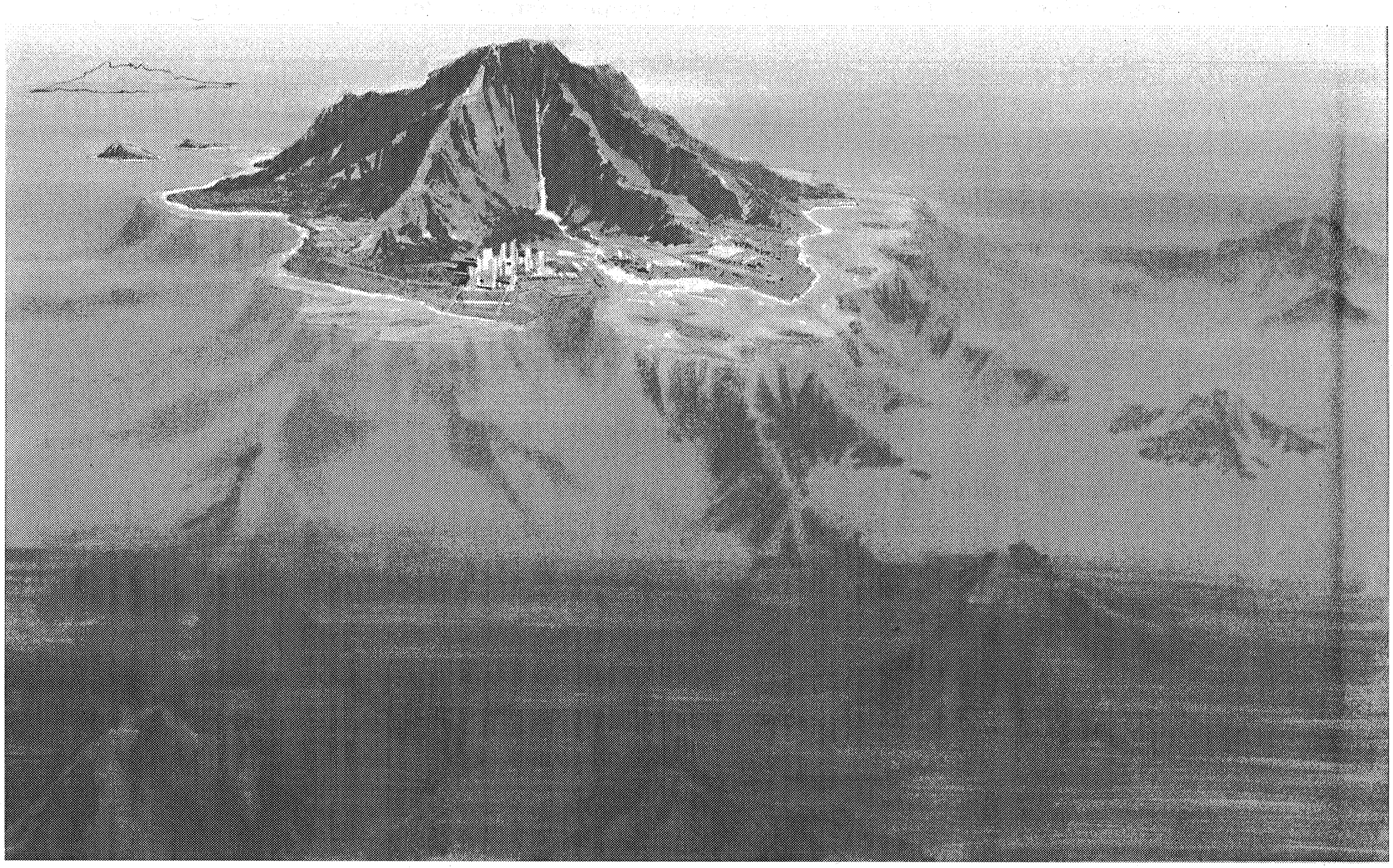
Maintain energy flow and balance by examining:

- human-induced energy redirection
- system impacts attributable to energy removal

Agenda Item H.1.a
Attachment 4
November 2006

Draft Programmatic Environmental Impact Statement

Towards an Ecosystem Approach for the Western Pacific Region: From Species-based Fishery Management Plans to Place-based Fishery Ecosystem Plans



October 27, 2005

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

OCT 27 2005

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act of 1969, we enclose for your review the Draft Programmatic Environmental Impact Statement – Towards an Ecosystem Approach for the Western Pacific Region: From Species-based Fishery Management Plans to Placed-based Fishery Ecosystems Plans (DEIS).

The DEIS analyzes the impacts on the human environment resulting from the first phase of the implementation of an ecosystem approach to fisheries management in the western Pacific region. The western Pacific region consists of America Samoa, Guam, Hawaii, the Commonwealth of the Northern Mariana Islands, and the United States Pacific remote island areas. The Pacific remote island areas include Baker Island, Howland Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Island. The objective of the Federal action considered in this DEIS is to take a practical and timely step towards an ecosystem approach, which fosters management that is specified geographically, adaptive, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and balances diverse social objectives.

Additional copies of the DEIS may be obtained from William Robinson, Regional Administrator; 1601 Kapiolani Boulevard, Suite 1110, Honolulu, Hawaii 96814, 808-973-2937. The document is also accessible electronically through the Pacific Islands Regional Office and Western Pacific Fishery Management Council websites at http://swr.nmfs.noaa.gov/pir and www.wpcouncil.org, respectively.

Comments or questions on this document submitted during the agency's 45-day review period for the DEIS must be received by December 19, 2005. Written comments should be submitted by mail to: William L. Robinson, Pacific Islands Regional Administrator, National Marine Fisheries Service, 1601 Kapiolani Blvd., Honolulu, HI 96814. Comments may be submitted by facsimile (fax) to 808-973-2941. Electronic comments may be submitted by e-mail to WPEAMPEIS@noaa.gov; include in the comment subject line the following document identifier: Draft Programmatic EIS. A copy of your comments should be submitted to me by mail to the NOAA Strategic Planning Office (PPI/SP), SSMC3, Room 15603, 1315 East-West Highway, Silver Spring, Maryland 20910; by fax to 301-713-0585; or by e-mail to nepa.comments@noaa.gov.

Sincerely,

Susan A. Kennedy
Acting NEPA Coordinator

Enclosure

Printed on Recycled Paper

Draft Programmatic Environmental Impact Statement

Towards an Ecosystem Approach for the Western Pacific Region: From Species-based Fishery Management Plans to Place-based Fishery Ecosystem Plans

October 27, 2005

Responsible Agency:

National Marine Fisheries Service
Pacific Islands Region
1601 Kapiolani Blvd., Ste. 1101
Honolulu, HI 96814
(808) 944-2200

Responsible Official:

William L. Robinson
Regional Administrator

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Kitty M. Simonds
Western Pacific Fishery Managemnt Council
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Abstract: This document analyzes the impacts on the human environment resulting from step one of the implementation of an ecosystem approach to fisheries management in the Western Pacific Region (American Samoa, Guam, Hawaii, the Commonwealth of the Northern Mariana Islands, and the U.S. Pacific Remote Island Areas[1]). The alternatives analyzed in this document are linked to the following five issues: the establishment of fishery ecosystem plan boundaries; the determination of appropriate management unit species; modifications to the Council's advisory structure; the establishment of and participation in Ocean Council type groups to foster regional coordination; and the participation of the Council in international fora such as meetings and workshops with neighboring nations. The objective of the Federal action considered in this document is to take a practical, timely step towards an ecosystem approach, which fosters management that is specified geographically, adaptive, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and balances diverse social objectives.

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[1]The remote island areas include Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Islands. Although physically located in Hawaii, Midway is considered part of the PRIAs because it is not a part of the State of Hawaii.

EXECUTIVE SUMMARY

Purpose and Need

On international, national, and local levels, institutions and agencies tasked with managing marine resources are moving towards an ecosystem approach to fisheries management. The National Oceanic and Atmospheric Administration (NOAA) defines an ecosystem approach as "management that is adaptive, specified geographically, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse social objectives" (NOAA 2004). The Food and Agriculture Organization of the United Nations provides that the purpose of an ecosystem approach to fisheries "is to plan, develop and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from a full range of goods and services provided by marine ecosystems" (Garcia et al. 2003).

The Council has been developing five place-based Fishery Ecosystem Plans (FEPs) to replace the existing species-based Fishery Management Plans for fisheries in the Western Pacific Region. Because fishery scientists and managers recognize that a comprehensive ecosystem approach to fishery management must be implemented through an incremental and collaborative process, a multi-step approach is being used to develop and implement the FEPs. To be successful, this will require increased understanding of a range of issues including biological and trophic relationships, ecosystem indicators and models, and the ecological effects of non-fishing activities on the marine environment. In addition, the organizational structure for developing and implementing Fishery Ecosystem Plans is broader than for Fishery Management Plans and explicitly incorporates the community input and local knowledge that is essential to good resource management. At this time the Council is undertaking its first step to implement the framework necessary to change from species-based fishery management plans to place-based FEPs. Specifically, the measures being considered by the Council at this time would establish Fishery Ecosystem Plans with appropriate boundaries, management unit species and advisory structures. The measures being considered would reorganize the current fishery regulations by geographic area, but would not result in substantive changes to the existing regulations. Future fishery management actions are anticipated to incorporate additional information as it becomes available. An adaptive management approach will be used to further advance the implementation of ecosystem science and principles.

Based on the preferred alternatives in this programmatic environmental impact statement (DPEIS), the Federal action that would be implemented is the realignment of the existing fishery regulations contained in the Council's five current species-based Fishery Management Plan (FMP) regulations into geographically-based Fishery Ecosystem Plan (FEP) regulations, with no substantive changes to current fishing regulations. This action will establish a place-based institutional structure upon which future fishery ecosystem management measures will be built. The development and implementation of future FEP amendments will comply with all applicable laws.

Alternative 3D (Preferred)	Replace the current FMP Plan Teams, Advisory Panels and four Standing Committees with FEP Advisory Panels, FEP Standing Committees and two FEP Plan Teams (Preferred)
Issue 4: Regional Coordination	***Non-Regulatory***
Alternative 4A	No Action - do not establish Ocean or Ecosystem Councils
Alternative 4B (Preferred)	Establish Regional Ecosystem Council Committees (Preferred)
Alternative 4C	Participate in and support existing Ocean Council type groups
Alternative 4D	Establish independent Regional Ecosystem Councils
Issue 5: International Coordination	***Non-Regulatory***
Alternative 5A	No Action- continue to participate in international management fora
Alternative 5B (Preferred)	Increase participation in international management fora and establish meetings/workshops with neighboring nations
Alternative 5C	Do not participate in international management fora

Reasons for choosing the preferred alternatives

The preferred alternatives would together implement a well-rounded first step towards an ecosystem approach to fisheries management in the Western Pacific Region. The main function of this step is to shift from species-based FMPs to place-based FEPs. Establishing theses place-based FEPs will provide the institutional framework upon which future fishery ecosystem management measures will be built. Reorganizing the Councils advisory structure to match a place-based framework as well establishing Regional Ecosystem Council Committees and participating in international meetings and discussions with neighboring nations will provide mechanisms for the full range of fisheries' impacts and other activities on marine ecosystems to be addressed in a manner which coherently considers each area's biological resources, physical conditions, socioeconomic needs and cultural traditions. In addition, shifting the management focus from species to a geographically defined place inherently recognizes the value of sustainable marine resources for island communities as well as the needs of various user groups.

The Council presently manages U.S. Pacific island-based pelagic fisheries and four demersal fisheries (bottomfish and seamount groundfish, crustaceans, precious corals and coral reef resources) under FMPs. While the 1996 Sustainable Fishery Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) did require regional fishery management councils to consider fishery impacts on other species not managed under FMPs (e.g. essential fish habitat), there are several limitations (discussed below) of the current management framework (i.e. species-based FMPs) that hinders the Council in conserving a wider range of marine resources as well as protecting marine ecosystems in which fisheries operate.

Current stock assessments generally do not explicitly recognize the significant natural variability in marine resources and habitats, although some models do incorporate spatial and temporal environmental effects. Under place-based FEPs, stock assessments will increasingly and

Alternatives

The alternatives analyzed in this document are linked to the following five issues: 1) boundaries for Fishery Ecosystem Plans in the Western Pacific Region, 2) lists of Management Unit Species (MUS) for each FEP 3) the Council's advisory process to reflect place-based FEPs, 4) regional coordination, and 5) international coordination. Issues 1 and 2 are considered the Federal action in this document because they have regulatory effect and involve the reorganization and consolidation of current FMP regulations into place-based FEP regulations. Issues 3, 4, and 5 are non-regulatory (i.e. they have no regulatory effect) and their consideration is included for identifying an appropriate place-based advisory structure as well as for planning purposes related to the Council's participation broader ecosystem initiatives. In general, each issue's alternatives range from low (no action or status quo) to high (implementation of a detailed and specific approach to the issue). The following table presents the alternatives considered in detail within this draft programmatic EIS.

Table 1: Alternatives Considered in Detail

Issue: Alternative	Description
Issue 1: FEP Boundaries	***Regulatory***
Alternative 1A	No Action - do not delineate or implement FEP boundaries
Alternative 1B	Delineate and implement separate FEPs surrounding each archipelago
Alternative 1C (Preferred)	Delineate and implement four separate demersal FEPs surrounding each archipelago as well as a single Pelagic FEP that includes the entire region (Preferred)
Alternative 1D	Delineate and implement separate FEPs for each biogeographic and pelagic zone
Issue 2: List of MUS	***Regulatory***
Alternative 2A	No Action – do not change the current MUS lists
Alternative 2B (Preferred)	Define FEP MUS as those current MUS that are believed to occur within each FEP boundary (Preferred)
Alternative 2C	Define FEP MUS as those current MUS plus incidentally caught and associated species that are known to occur within each FEP boundary
Alternative 2D	Define FEP MUS as those current MUS plus incidentally caught and associated species that are believed to potentially occur within each FEP boundary
Issue 3: Council Advisory Structure	***Non-Regulatory***
Alternative 3A	No Action - do not change the current advisory structure
Alternative 3B	Add a single FEP Plan Team to the current advisory structure
Alternative 3C	Replace the current FMP Plan Teams, Advisory Panels and four Standing Committees with FEP Plan Teams, Advisory Panels and Standing Committees

explicitly separate environmentally-driven resource variability (e.g. inter-annual, decadal, long-term ocean regime shifts) from fishery-driven and habitat-driven effects on target stocks and other components of ecosystems, thus improving fishery science and management.

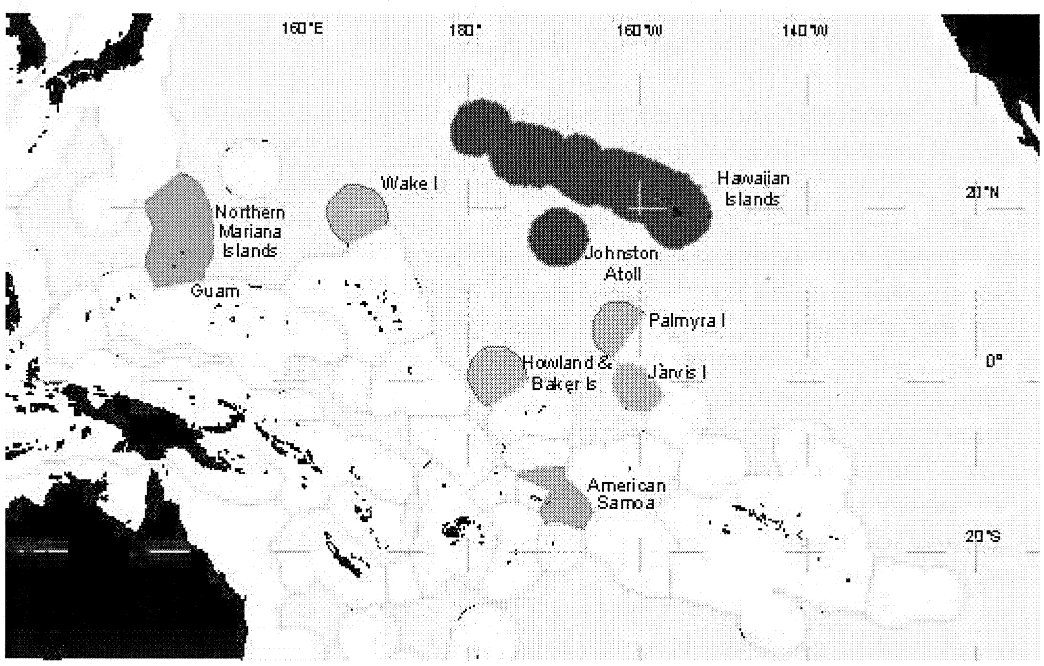
In addition, the majority of current monitoring under FMPs accounts for major resource removals by fishing, but not by other sources such as coastal development, which has destroyed or severely degraded inshore fish habitat and associated stocks around the more heavily populated islands of the U.S. Pacific. Through regional coordination efforts under place-based FEPs, all sources of resource removal, including those related to shoreline modification, waste discharge, watershed erosion, storm runoff, and other terrestrial activities will be considered. It is anticipated that FEP-based monitoring will ultimately include ecosystem indicators and models which take into account non-fishing uses, their impacts on resources, and even the tradeoffs among different user groups who depend on the same resource.

The preferred alternatives would promote a holistic view of marine resources through increased examination of meta-population resource dynamics and linkages between upland watershed activities, coastal habitats, nearshore waters, and oceanic variability. This in turn will lead to enhanced understanding and improved management of the relationships between different fish stocks and users of those stocks. In general, species-based FMPs focus on individual stocks of fish or related species and the people who harvest them. However, fish and fishermen do not act in isolation, and fishermen may be active in several fisheries targeting different resources seasonally or even over various years. Furthermore, the harvests of one species often influence the dynamics of fish markets (and subsequent fishing effort) for others. Place-based FEPs will provide fishery managers with comprehensive information on all fishery impacts within a given area and allow improved decision making with less unintended consequences due to poorly understood connections. By operating within an ecosystem context, fishery managers will also be better positioned to anticipate likely physical and biological responses to changing environmental conditions and to determine appropriate management actions to forestall adverse impacts to marine ecosystems, rather than reacting to changes after they occur. In addition, greater stability and predictability is more likely when resources are considered together rather than as independent units.

The ecosystem approach under the preferred alternatives is also anticipated to improve the management of coastal resources at both Federal and local levels through changes in the structure of resource management plans and the process by which these plans are developed and implemented. Because the organizational structure for developing and implementing a FEP is broader than for an FMP and inherently incorporates more local community input, it is more likely to make good use of local knowledge and experience in management strategies and tactics. This will strengthen cooperation and compliance with management measures which is especially important in the Western Pacific Region where enforcement capabilities are often low.

The southern and western Pacific Ocean is dotted with thousands of islands governed by several nations. American Samoa, for example, is surrounded by the exclusive economic zones (EEZs) of five independent nations and the Pacific Remote Island Areas (Wake, Howland/Baker, Jarvis, Palmyra) are part of larger archipelagic island chains. Several targeted pelagic species are considered highly migratory and management of these resources are increasingly becoming international issues. As marine ecosystems are generally considered "open" systems and large scale changes can be observed within smaller units, international coordination as well as coordination between the Council and neighboring nations of island areas in the Western Pacific Region will be a necessary component of the successful implementation of an ecosystem approach to fisheries management.

Western Pacific Region



Proposed Mariana Archipelago FEP

Proposed Hawaii Archipelago FEP

Proposed Pacific Remote Island Areas FEP

Proposed American Samoa Archipelago FEP

Proposed Pacific Pelagic FEP (applies within all EEZ waters and high seas)

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List of Acronyms and Abbreviations

ASG	American Samoa Government
^{0}C	Degrees Celsius
BMUS	Bottomfish Management Unit Species
BiOp	Biological Opinion
CFR	Code of Federal Regulations
CITES	Council on International Trade and Endangered Species
cm	Centimeters
CNMI	Commonwealth of the Northern Mariana Islands
CPUE	Catch Per Unit Effort
CRE	Coral Reef Ecosystem
CZMA	Coastal Zone Management Act
DAWR	Division of Aquatic and Wildlife Resources, Government of Guam
DBEDT	Department of Business, Economic Development and Tourism, State of Hawaii
DFW	Division of Fish and Wildlife, CNMI
DLNR	Department of Land and Natural Resources, Hawaii
DMWR	Department of Marine and Wildlife Resources, American Samoa Government
DOC	Department of Commerce
DOD	United States Department of Defense
DOI	Department of the Interior
DPEIS	Draft Programmatic Environmental Impact Statement
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENSO	El Niño Southern Oscillation
EO	Executive Order
EPAP	Ecosystem Principals Advisory Panel
ESA	Endangered Species Act
FAO	Food and Agriculture Organization
FEP	Fishery Ecosystem Plan
FDM	Farallon de Medinilla, CNMI
FFS	French Frigate Shoals
fm	Fathoms
FMP	Fishery Management Plan

Agenda Item H.1.b
Supplemental GAP Report
November 2006

GROUNDFISH ADVISORY SUBPANEL REPORT ON CHANNEL ISLANDS NATIONAL MARINE SANCTUARY MARINE PROTECTED AREAS

The Groundfish Advisory Subpanel (GAP) discussed the documents regarding a possible Ecosystem fishery management plan (FMP), and found good reasons to pursue this FMP and also some concerns about how it would work in practice.

An Ecosystem FMP would provide a single plan to deal with multiple proposals from the National Marine Sanctuaries for various closures and fishing regulations. The proposals from the Sanctuaries, and the implementation of the Marine Mammal Protection Act in California, have important consequences for fishery management. An Ecosystem FMP would allow the Council to coordinate all these proposals and integrate them with current fishery management practices. It would allow the Federal marine protected areas process to be conducted under the Magnuson Stevens Act. As we consider management measures for federally managed species, the GAP would like to take into account issues such as climate cycles, pollution, predator-prey relationships, and oceanographic conditions.

The GAP was concerned that since so little is known about ecosystem function, there may be data gaps and uncertainty that could lead to further fishing restrictions. The GAP also wants to consider the Ecosystem FMP separately from the issue of the marine reserves.

PFMC
11/14/06

HABITAT COMMITTEE REPORT ON CHANNEL ISLANDS NATIONAL MARINE SANCTUARY MARINE PROTECTED AREAS

The Habitat Committee (HC) discussed the objective of managing the water column within the sanctuary under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and is supportive of initiating an ecosystem-based fishery management planning effort. The HC believes such a plan could have many benefits in addition to achieving the objective of managing the water column under the MSA. The HC believes that ecosystem-based fishery management is a much broader topic that is appropriate for the Council to consider on its own merits.

At the same time, the HC thinks that pursuing a "research reserve" would be faster and could also have other benefits. The HC presumes that if the Council wishes to pursue a research reserve concept, appropriate legal counsel input would occur to ensure it can be done under the MSA.

PFMC
11/15/06

CALIFORNIA WETFISH PRODUCERS ASSOCIATION

Representing California's Historic Fishery

October 23, 2006

Dr. Don McIsaac, Executive Director
Mr. Don Hansen, Chair
Members of the Pacific Fishery Management Council
7700 NE Ambassador Place #101
Portland, OR 97220-1384

RE: Agenda H.1.c. Fishing Regulations within CINMS

Dear Dr. McIsaac, Chairman Hansen and Council members,

These comments reiterate and expand on our February 23 and September 8, 2006 comments submitted on behalf of the California Wetfish Producers Association, which represents the majority of wetfish processors and fishermen in Monterey and southern California. We appreciate this opportunity to comment further on Council options to regulate fisheries within the Channel Islands Marine Sanctuary.

We extend grateful thanks to Dr. McIsaac and the Council for the comprehensive letter submitted October 10, 2006 to CINMS, highlighting concerns expressed both by Council members, advisory bodies and industry groups including CWPA. As we have expressed in previous statements, we believe strongly that management of fishery resources is best achieved through the Magnuson-Stevens Act (MSA) and Council forum, with its broad scientific expertise and extensive public process.

As discussed at the Council's September meeting and noted in our September 8 letter, the MSA authorizes the Council to incorporate relevant state actions in Federal law. The rationale, including the use of MPAs as reference reserves to improve knowledge of fishery resources, is a valid approach that CWPA supports.

In further discussion on this issue at the CPS Advisory Subpanel meeting on October 19, we learned that the Council will consider several avenues to adopt fishing regulations under MSA authority in designated CINMS MPAs, including the option to create an overarching California Current System Fishery Management Plan, which could address biodiversity concepts and advance ecosystem-based management under the MSA venue in the Channel Islands and beyond.

One advantage that we foresee as emerging from a California Current Ecosystem FMP is the ability to integrate existing fishery management science with MPA theory in an objective process

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Email <dplesch@earthlink.net>

peer-reviewed by the SSC. As active participants in California's Marine Life Protection Act process, whose goals of biodiversity and maintenance of ecosystem function largely parallel those of the Sanctuaries, we note that to date MLPA science advice has not integrated the ecosystem benefits of existing fishery management, much to our dismay. Another benefit of a California Current Ecosystem FMP is its obvious linkage to improved ocean monitoring systems such as PaCOOS.

We encourage the Council to rank as high priority the development of regulations under MSA to manage fisheries in the water column of federal waters MPAs of the Channel Islands Sanctuary, under either, or possibly both, of the proposed scenarios. In our view, these options are not mutually exclusive: perhaps the integration of state regulations could be accomplished by regulatory amendment to an existing FMP as an interim step, allowing for development of a California Current Ecosystem FMP over the normal time required for a full FMP process. However, if the Council ultimately must approve one alternative over the other to minimize workload and budgetary requirements, we suggest that you set wheels in motion expeditiously to create the California Current Ecosystem FMP, as we believe this movement toward ecosystem-based fishery management will provide the Council with clear fishery management authority over the long term.

We urge the Council to take decisive action at the November meeting. As part of this request, we ask that you continue to pursue actively the modification of the proposed rule for the Channel Islands to provide an automatic sunset for any fishery regulations adopted under the National Marine Sanctuaries Act, and any interim change to the designation document, at the time regulations are promulgated under MSA. Please also continue to request the other recommendations itemized in the Council's October 10 letter to the CINMS Superintendent. Thank you very much for your consideration.

Best regards,

Diane Pleschner-Steele
Executive Director

Cc: Mr. Mike Chrisman, Secretary for Resources
V.Adm. Conrad Lautenbacher, Undersecretary of Commerce for Oceans & Atmosphere