Agenda Item C.5
Situation Summary
April 2007

ECOSYSTEM FISHERY MANAGEMENT PLAN

In November 2006, the Council has initiated development of an Ecosystem Fishery Management Plan (E-FMP) that will incorporate ecosystem-based fishery management principles. The plan is intended to serve as an "umbrella" plan over the four existing fishery management plans (FMPs), helping with coastwide research planning and policy guidance, and creating a framework for status reports on the health of West Coast ecosystems. The plan envisioned by the Council would not replace the existing FMPs, but would advance fishery management under these FMPs by introducing new theories, new scientific findings, and new authorities to the current Council process.

Also in November 2006, members of the Habitat Committee and the Scientific and Statistical Committee met in a joint session to further the Council assignment to review the policies and science behind existing ecosystem-based management approaches. Summary minutes of the meeting are planned for supplemental distribution in April.

To facilitate early planning and stimulate discussion, Council staff drafted a white paper regarding issues related to the development of an E-FMP (Agenda Item C.5.a, Attachment 1). This paper draws on the recommendations in a recent article by John Field and Robert Francis, *Considering ecosystem-based fisheries management in the California Current* (2006) (Agenda Item C.5.a, Attachment 2).

Topics reviewed in the Council staff white paper include:

- Development of an E-FMP should be phased in over time and based on a strategic planning document rather than being implemented a fully fleshed out program all at once. The use of a programmatic environmental impact statement is discussed as the vehicle for developing this strategic vision. The concept of "tiering" is used to subsequently evaluate in detail and implement program elements.
- Plan development under institutional resource constraints is discussed. Seeking assistance from NMFS is identified. Creating a plan development team comprising members of existing FMP management teams, in part as a cost-saving measure, is discussed.
- Staff recommends the development of an umbrella plan that complements, but does not replace, existing FMPs. However, the statutory basis of an umbrella E-FMP needs to be clarified early in the process.
- The scope of the E-FMP needs to be determined in terms of policies and principals, geographic coverage, and management unit species.
- Consistent with the evolutionary approach, staff recommends ongoing development of an ecosystem information program. This program would draw on expertise within NMFS, and possibly outside research institutions, to provide on a regular basis an ecosystem SAFE document. An important issue to be considered in concert with development of the ecosystem SAFE is the development of a policy framework covering how such information would be used in Council decision-making.

In a potentially related matter, the Council and the State of Washington provided solicited comments (Agenda Item C.5.a, Attachment 3 and Agenda Item C.5.b, Attachment 1) on the Draft Framework for a National Network of Marine Protected Areas (MPAs)(on the internet, see mpa.gov for more information). Both letters recommend close coordination between the Council and the National MPA Center as goals and objectives for area-based and ecosystem-based fishery management concepts and policies are developed.

The Council is scheduled to review the Council staff white paper as well as comments of its advisory bodies and the public and provide guidance for future development of an E-FMP.

Council Task:

Council Guidance and Direction on Future Planning.

Reference Materials:

1. Agenda Item C.5.a, Attachment 1, Council Staff White Paper: Development of an Ecosystem Fishery Management Plan.
2. Agenda Item C.5.a, Attachment 2, *Considering ecosystem-based fisheries management in the California Current*, John Field and Robert Francis (2006).
3. Agenda Item C.5.a, Attachment 3, February 13, 2007 letter from Dr. Donald McIsaac to Mr. Joseph Uravitch conveying Council comments on the Draft Framework for a National Network of MPAs.
4. Agenda Item C.5.b, Attachment 1, February 28, 2007 State of Washington letter from Mr. Jonathan Kelsey to Mr. Joseph Uravitch conveying comments on the Draft Framework for a National Network of MPAs.

Agenda Order:

a. Agenda Item Overview — Mike Burner
b. Agency and Tribal Comments
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. Council Guidance and Direction on Future Planning

PFMC
03/16/07

Staff White Paper
Development of an Ecosystem Fishery Management Plan

Prepared by Pacific Council Staff

Background – Purpose of This Document

There is broad interest in the concept of an ecosystem fisheries management plan (E-FMP).[1] Furthermore, National Marine Fisheries Service's (NMFS) stated policy is to incorporate ecosystem considerations into fisheries management, and most councils have either implemented some version of an E-FMP or are in an active planning stage. Thus it is appropriate that at their November 2006 meeting the Pacific Fishery Management Council (Council or Pacific Council) moved to begin development of an E-FMP for waters off the three West Coast states, Washington, Oregon, and California. In part, the Council intends the E-FMP initiative to serve as a long term measure for developing fishing regulations to complete proposed marine protected areas within the Channel Islands National Marine Sanctuary. The new E-FMP is envisioned to be of an "umbrella" type structure, so as to allow the current four Council FMPs to continue while enabling comprehensive and coordinated fishery regulation in all EEZ ecosystems.

In order to stimulate discussion, Council staff has prepared this white paper covering procedural and substantive issues related to the development of an E-FMP. This paper draws on the recommendations in a recent article by John Field and Robert Francis, *Considering ecosystem-based fisheries management in the California Current* (2006) (Agenda Item C.5.a, Attachment 2), which is specific to the institutional environment of the Pacific Council, and more generally, the report of the Ecosystem Principals Advisory Panel (EPAP) (1999). The main points covered in the paper are:

- Development of an E-FMP should be "evolutionary, not revolutionary." This means, rather than implementing a fully fleshed out program all at once, ecosystem-based approaches to fishery management can be phased in over time, based on a strategic planning document. The use of a programmatic environmental impact statement is discussed as the vehicle for developing this strategic vision. The concept of "tiering" is used to subsequently evaluate in detail and implement program elements.

- Plan development under institutional resource constraints is discussed. Seeking assistance from NMFS is identified. Creating a plan development team comprising members of existing FMP management teams, in part as a cost-saving measure, is discussed.

- Staff recommends the development of an umbrella plan that complements, but does not replace, existing FMPs. However, the statutory basis of an umbrella E-FMP needs to be clarified early in the process.

[1] Another commonly used term is fisheries ecosystem plan (FEP). The name ecosystem FMP is chosen to emphasize its relationship to the core mission of the Pacific Fishery Management Council.

- The scope of the E-FMP needs to be determined in terms of policies and principals, geographic coverage, and management unit species.

- Consistent with the evolutionary approach, staff recommends ongoing development of an ecosystem information program. This program would draw on expertise within NMFS, and possibly outside research institutions, to provide on a regular basis an "ecosystem SAFE document." (SAFE, which stands for stock assessment / fishery evaluation, is a required product for all FMPs implemented under the Magnuson-Stevens Act.) Provision on an ecosystem SAFE could be the first program element to be implemented. An important issue to be considered in concert with development of the ecosystem SAFE is the development of a policy framework covering how such information would be used in Council decision-making.

- This paper concludes with a brief discussion of the types of management measures that might be implemented through an E-FMP, recognizing that its legal status needs to be resolved. Evaluating existing closures in a more integrated, ecosystem-based framework would seem a prerequisite for rationally considering future area-based measures in an ecosystem context. For example, when implementing fishery related closures within this framework the Council could consider State MPA initiatives and areas proposed for closure by National Marine Sanctuaries. The importance of considering the socioeconomic dimensions of ecosystem-based management is also mentioned.

Process Framework

A Strategic Approach

Field and Francis recommend "there should be an emphasis on an evolutionary, rather than revolutionary, move towards an ecosystem approach" (p. 563). They also argue that a programmatic environmental impact statement (PEIS) be the primary vehicle for implementing an E-FMP both because the National Environmental Policy Act (NEPA) offers a limited mandate that "suggests that ecosystem considerations should be evaluated" and it has intrinsic procedural benefits "as a result of legal requirements for analysis, disclosure, and transparency" (p. 555). They allude to the view of many in the Council process that NEPA merely imposes an administrative burden; and the PEIS has been a difficult concept to understand and execute within the fisheries management arena. For this reason careful thought should be given at the outset on how to approach development of a PEIS. First, for the integration of ecosystem-based fishery management to be evolutionary, the PEIS must be truly strategic; and in fact internationally this type of programmatic document is termed a "strategic environmental assessment" (SEA). Furthermore, in Council on Environmental Quality (CEQ) regulations, while there is no specific reference to a PEIS, review of policies, plans, and programs is discussed, and is strongly linked to the concept of "tiering" where "general matters are evaluated in broader environmental impacts statements (such as national program or policy statements) with subsequent narrow statements … concentrating solely on the issues specific to the statement subsequently prepared" (1508.28). Tiering can be used to move from a broad policy evaluation to an analysis of lesser scope or an analysis of a specific action at an early stage to a subsequent analysis at a latter stage. The regulations also identify the PEIS and tiering as a way to reduce paperwork by "[u]sing program, policy, or plan environmental impact statements and tiering from statements of broad scope to those of narrower scope, to eliminate repetitive discussions of the same issues" (1508.4(i)).

The foregoing suggests two key points: the PEIS should be a relatively brief strategic document establishing policies and broad program areas and should set the stage for subsequent evolutionary implementation of programs and management measures that are evaluated in tiered documents. A combination of both tiering rationales described at 1508.28 can be considered: moving from policies and program descriptions to management measures (i.e., requirements described in Federal regulations) and "evolving" from an early, strategic and schematic stage to more detailed implementation stages. In fact, the requirements for fishery management plans contained in the Magnuson-Stevens Act (MSA) would likely impose more barriers to a streamlined strategic document. The question of whether the MSA authorizes E-FMPs therefore becomes a two-edged sword. If an E-FMP does derive authority from the MSA must its contents conform to §303? Many of these requirements seem to have limited relevance and utility for developing an E-FMP.

In streamlining the PEIS it should be recognized that much of the bulk of NEPA documents may be taken up by an exhaustive description of the "affected environment" bearing a tenuous relation to the actual analysis of effects, which is often difficult because of predictive uncertainty. Another way to streamline the PEIS/E-FMP would be to limit description (incorporating by reference from completed NEPA documents). As discussed below, the PEIS should outline a process whereby this information can, if needed, be collated and delivered to the management process. Aside from the problem of bulking up the EIS, this descriptive information can rapidly become dated. Frame working a process highlights periodic update and tailoring information to current management issues.

The following table (from Wiseman 1996) offers an instructive contrast between a project-specific environmental impact assessment and a strategic environmental assessment.

Environmental Impact Assessment	Strategic Environmental Assessment
Is reactive to a development proposal	Is proactive and informs development proposals
Assesses the effect of a proposed development on the environment	Assesses the effect of the environment on development needs and opportunities
Addresses a specific project	Addresses area, regions, or sectors of development
Has a well defined beginning and end	Is a continuing process aimed at providing information at the right time
Assesses direct impacts and benefits	Assesses cumulative impacts and identifies implications and issues for sustainable development
Focused on the mitigation of impacts	Focused on maintaining a chosen level of environmental quality
Narrow perspective and high level of detail	Wide perspective and a low level of detail to provide a vision and overall framework
Focus on project-specific impacts	Creates a framework against which impacts and benefits can be measured

An important consideration is how to structure an impact evaluation. The typical EIS focuses on discrete and if possible measurable impacts to specific environmental components (e.g., projected fishing mortality on a fish stock). The E-FMP, or at least an initial strategic planning document covered by a PEIS, would not propose management measures to be implemented. Environmental effects are likely to be diffuse, cumulative, and long term. By the same token, the evaluation should be broad-scale, not detailed, and relatively brief.

Resources for Plan Development

At the moment the Council has no funding dedicated to E-FMP development and is confronting an array of other pressing issues demanding the time of Council members, committee members, and Council and agency staff. On the other hand, there is a growing body of research and preliminary thinking (as evinced in the Field and Francis paper) given over to ecosystem-based fishery management. In addition to the broad policy commitment by NMFS, there are also institutions, such as the Pacific Fisheries Environmental Laboratory in Pacific Grove, California, that could provide input if the Council were interested in integrating ecosystem principals into decision making. As outlined above, if a PEIS focuses on policies and program outlines, some of the development costs (e.g., staff or consultant time spent on writing, data collation, modeling, and other forms of detailed quantitative analysis) could be reduced. As Field and Francis put it "While an appropriately funded mandate to develop [E-FMPs] would be desirable from the perspective of truly developing an ecosystem perspective, this would not preclude the development of a road map toward adopting an ecosystem-based approach to management, or otherwise integrating ecosystem considerations into the current management regime to the greatest extent possible" (p. 563).

A second cost relates to meetings of any committees involved in plan development. For FMPs the practice has been to constitute a plan development team, which takes the lead on identifying principal elements of the plan (although much of the research, writing, and analysis also may be done by Council/agency staff and/or consultants). An advisory subpanel also may be convened to solicit input and review. These committees transition into the management team and advisory subpanel for the FMP once it is implemented. Field and Francis recommend formation of an ecosystems considerations technical team, which would advise the Council on the state of the environment and provide ecosystem guidance on management decisions (p. 563). If the E-FMP is to be an umbrella plan (discussed below), an alternative approach would be to constitute a plan development team by selecting one or more members from each of the existing management teams and the Habitat Committee. An advisory subpanel could be similarly constituted. This approach has the advantage of highlighting the relationship between the E-FMP and existing FMPs and may offer the possibility of some modest cost savings. Such savings could come about if these committees met during Council meetings on a day immediately following any concurrent management team meetings. (Potentially, some travel and meeting room cost savings could be realized.) A potential problem is if there are not enough members of current management teams with the expertise, interest, and commitment to developing an E-FMP. An alternative is to constitute a blended management team, composed of representatives from current management teams and the HC, and experts currently not in the process. Field and Francis's ecosystem considerations team plays an advisory rather than development role. It may be that such a team would serve the two functions concurrently, and this would support a phased, evolutionary process. Such a concurrent role would be well-served by a team with membership from current FMP teams, since these people are already versed in ongoing management issues before the Council.

Plan Development Issues

E-FMP Structure

Based on current examples there are two ways to consider the relationship between an E-FMP and existing FMPs. As Field and Francis advocate, one approach is to develop an umbrella plan that integrates ecosystem considerations across existing FMPs without supplanting them. This is the approach that has been taken in the North Pacific and makes the most sense on the West Coast. A second approach, exemplified by the Western Pacific, is to replace current FMPs with geographically-based E-FMPs. This makes sense for an insular area with multiple, widely-dispersed and discrete EEZs around islands or island groups and allows treatment of all ecosystems, habitats, and fisheries in a given area in one plan. Given the greater diversity and management complexity of Pacific Council FMPs, replacing them with a set of geographically-based FMPs would be a monumental task requiring the creation of what would be in any given context arbitrary boundaries between management areas (e.g., current management zones or measures that may cut across the most sensible delineation of ecosystem boundaries).

As alluded to above, an important consideration is whether the E-FMP would have sufficient legal basis for implementing pursuant regulations; alternatively, management measures would continue to be implemented through current FMPs using the E-FMP as the rationale. The E-FMP would establish processes to (1) inform management decisions made within FMP frameworks and (2) in some cases allow consideration and implementation of multiple-objective measures. This suggests two general elements of the E-FMP; a third element would be to describe the scope of the E-FMP, including its relationship to current FMPs. Under this approach, in the short term at least, no regulations would be expected to result from the E-FMP; in the long term multiple-objective measures (such as a marine protected area addressing management objectives across more than one FMP) might be implemented either directly through the E-FMP or through authority of one or more FMPs based on the rationale provided in the E-FMP.

E-FMP Scope

Establishing the scope of the plan involves identifying goals and related policies, determining geographic scope, and enumerating management unit species or species complexes.

Establishing a set of goals is a common and generally useful planning exercise describing desired end states that policies and programs are intended to maintain or achieve. As its name implies, the Ecosystem Principal Advisory Panel identified general principals, goals, and policies that can serve as a starting point for such an exercise. Any principals, goals, and policies enshrined in a Pacific Council E-FMP would indicate the overall scope of the plan in terms of procedures, activities, and instruments (management measures, regulations), which may be organized into programs.

Assuming an umbrella plan, the geographic scope of the E-FMP would be pre-determined as the West Coast EEZ, which is the management area for current FMPs. (The Highly Migratory Species FMP covers vessels fishing outside the EEZ but landing fish on the West Coast and so could broaden the geographic scope of the E-FMP.) Despite this constraint it may be worthwhile as part of planning to consider how the geographic scope can be best matched with ecosystem boundaries. If no regulatory authority is implied by the E-FMP, then the geographic scope could be potentially widened; for example, delineation of the northern California Current system includes waters off Vancouver Island, Canada, while the California Current System also influences waters off of Baja California, Mexico. It also may be useful to subdivide the EEZ by internal biogeographic boundaries such as Cape Blanco, Cape Mendocino, and Point Conception. Considerations of geographic scope should be made in the context of expected policies and programs. For example, differences in the ecosystem north and south of Cape Mendocino are implicit in groundfish FMP management measures such as cumulative trip limits.

The specification of management unit species (MUS) in an FMP establishes a legal nexus to determine regulatory scope. This was evidenced by the recent effort to include krill as a special category MUS in the Coastal Pelagic Species FMP so that a harvest prohibition could be established. If the E-FMP will meet the requirements of the MSA (in order to establish regulatory authority directly from it) it must enumerate MUS. How broad to cast the net, so to speak, would be part of plan development. Including more species in the MUS would broaden the scope, as indicated by the following examples:

- Include only the MUS in current FMPs
- Include the above plus species managed by the three West Coast states
- Include the above plus forage species not already included in an FMP (e.g., other forage fish, euphausiids, copepods)
- Include the above plus biogenic habitat (e.g., corals, sponges)

As the scope is broadened the connection to any regulatory purpose under the MSA becomes more tenuous. For example, it seems unlikely that any activity that could be regulated under the MSA would directly affect copepods. “Bycatch” of corals, on the other hand, can be regulated because they are part of essential fish habitat even if they are not an MUS under any FMP. To some degree the identification of MUS in the E-FMP may be more of symbolic value by recognizing the scope of ecosystem components that will be considered in management decision making. In keeping with the ecosystem approach, it would make sense to organize the enumeration of MUS by habitat or ecosystem. Alternatively, instead of enumerating MUS, some broader grouping of species would suffice.

Ecosystem Information Program

Field and Francis pose the question, “If fishery management councils were to embrace an ecosystem-based approach in principle, but were limited in the rate at which such an approach could be prescribed as policy, where might they start?” In response they recommend that fishery managers be provided with information about how information on how ecosystem dynamics affect and are affected by fisheries. This would provide additional context when making conventional management decisions, such as setting harvest limits. They describe two categories of information: (1) short- and long-term climate/ ocean conditions and trends, and (2) trophic interactions among fished and unfished species. (This second topic aligns with the EPAP recommendation that an E-FMP include a conceptual model of the food web.) This implies the development of a program or process to bring this information into the management arena and a related set of policies that would provide some guidance on how the information should be used. Currently the Council is strongly wedded to setting harvest limits based on single-species stock assessments. Although stock assessment scientists are increasingly integrating climate forcing into their models, it unlikely that models producing estimates of yield that are used to set harvest limits will, in the foreseeable future, include a detailed specification of both climate forcing and food web dynamics. On the other hand, there are potentially useful non-quantitative predictive outputs that could be used to expand the time horizon of management decision making. One such example is the “red light / green light” index for salmon returns based on Northern California Current ocean and ecosystem conditions as reported by Peterson, et al. (2006). Current stock assessment techniques would be used to derive an initial yield estimate and ecosystem policies would guide decision makers on how that yield estimate may be adjusted in light of non-quantitative predictions about trends and future states (either for the management period in question, or a future time that could be cumulatively affected by harvests during the management period).

The E-FMP (or strategic PEIS) would describe a program for the regular delivery of such information to the management process. A familiar model for such a process is the FMP SAFE (stock assessment / fishery evaluation) document. And in fact the North Pacific Council includes an ecosystem considerations chapter in the SAFE for their groundfish FMP (see http://www.afsc.noaa.gov/refm/docs /2006/EcoChpt.pdf). It includes both a discussion and evaluation of ecosystem model developments and reporting of a variety of trends/indices for both climate/ocean conditions and biota. The E-FMP management team would manage development of the document,[2] although as with other SAFE documents, models and data may be developed and compiled by agency staff at Science Centers or state agencies. Given current interest in ecosystem-based management, it would also be worth exploring relationships with organizations in the wider scientific community, such as PISCO (Partnership for

[2] Field and Francis advance the idea of a “regional fisheries oceanographer, whose primary responsibility would be to synthesize climate information into usable an understandable formats, orchestrate the development of a climate and ecosystem status and trends document, and act as a conduit between the climate research and the fisheries management communities” (p. 558). Given the list of duties, this sounds like a full time position, either as NMFS or Council staff. The relationship between this position and the management team (or Field’s and Francis’s ecosystem considerations technical team) would have to be worked out. For example, would the person in the position also function in the same relationship as Council staff currently does with respect to FMP management teams?

Interdisciplinary Study of Coastal Oceans), COMPASS (Communication Partnership for Science and the Sea) and MBARI (Monterey Bay Aquarium Research Institute), that are involved in ecosystem-related research. It might be possible to contract with these organizations for the provision of SAFE elements (although such a contract would likely be non-monetary). To the degree that this process includes a model development and evaluation component, the Council's current stock assessment review (STAR) process can serve as an example. This would have particular benefit for models or indices that provide outputs external to single species stock assessments, when such outputs are expected to inform decision making. A peer review process would give decision makers greater confidence in using such information and could also provide guidance on the best way to use it. A less crucial consideration is timing of delivery of the SAFE, given that management cycles vary under the different Pacific Council FMPs. A notional January 1 delivery date may make the most sense for use of the information through the calendar year.

Potentially the most difficult aspect of establishing such an ecosystem information program would be the development of policies related to how the information would be used. Some constituents would advocate policies that require specific actions (such as downward adjustment of harvest limits based on negative index/trend information). On the other hand, a set of policies that provide no concrete guidance on how ecosystem effects should be considered would diminish the benefit of such information. Field and Francis note that "quantitative modeling of trophic interactions has the potential to lead to changes in harvest or management strategies in the near term, and at a minimum represents a valuable contribution to a more holistic understanding of ecological connections and interactions" (p. 560). The challenge is to translate this sentiment (by extension including climate considerations) into a set of practical policies.

Multi-objective Management Measures

As discussed above, the implementation of management measures may be a later component in the "evolutionary" implementation of the E-FMP. One question is what types of management measures would actually require an E-FMP to implement; related to this is the question of the legal status of the E-FMP and whether its contents would support the promulgation of regulations. In considering ecosystem-related management measures, very broadly fishing has two effects: fishing mortality and habitat degradation due to gear contact (and the two may be interrelated for biogenic habitat). Many management measures that mitigate these two effects can be implemented through FMPs, by means of harvest management strategies and gear restrictions for example. Groundfish FMP Amendment 19, addressing essential fish habitat (EFH), offers a good example of how a range of ecosystem-related management measures (including closed areas and gear restrictions) can be implemented within the FMP framework. Thus, as already discussed, for many measures the E-FMP may only provide a strategic framework while their actual implementation would occur through existing FMPs. This approach has the added advantage that the E-FMP would not need to go through the content and procedural requirements (Secretarial Review) of the MSA. Therefore, this could be the preferred strategy in the early stages of E-FMP evolution. Later on the E-FMP could achieve the legal status necessary for promulgation of regulations. But at the outset it would be helpful to address these types of legal questions and construct a road map for how management measures meeting multiple objectives (ecosystem considerations across several FMPs) would be implemented. This would be a very appropriate subject for the PEIS.

When the Council initially called for E-FMP development one specific purpose they hoped it would achieve is establishing marine reserves within National Marine Sanctuaries under MSA authority. Although such actions may require an E-FMP to provide the legal basis for promulgation, there are other non-regulatory tasks that could be facilitated by an E-FMP. In a broader context, the EPAP recommends that an E-FMP should be the framework for developing zone-based management where "areas within an ecosystem would be reserved for prescribed uses." An initial task would be to evaluate existing area-based management measures and place them in a more holistic, ecosystem-based framework. Groundfish

EFH closed areas and Groundfish Closed Areas (GCAs) are examples of two types of closed areas implemented with different objectives but having the same practical effect. EFH closures may have some bycatch mitigation effect while GCAs protect habitat, at least in the core, permanently closed areas. Broadening this consideration to the full range of closures and management zones and developing such a framework would seem a prerequisite for rationally considering future area-based measures in an ecosystem context. For example, when implementing fishery related closures within this framework the Council could consider, State MPA initiatives and areas proposed for closure by National Marine Sanctuaries.

Management measures can also intentionally or unintentionally affect the socioeconomic characteristics of a fishery. Field and Francis also discuss the "socio-ecological perspective" that recognizes "the potential consequences to the ecosystem that may result from the activities undertaken by fisherman and sanctioned by management bodies" (p. 553-554). Field, et al. (2006) in a paper discussing an ecosystem model for the Northern California Current, mention the value of resilience, which suggests that rather than trying to manage for equilibrium, the fisheries system should be structured "to facilitate existing processes and variability, rather than attempt[ing] to control them" (p. 265). They cite a study by Hanna (1992) of Northern California Current fisheries demonstrating that diversification of fishing strategies promoted resilience. The implication is that less capital intensive (because they are less invested in one strategy) and more flexible fishing enterprises respond better to ecosystem dynamics. While not advocating a specific policy, it seems clear that another component of an E-FMP would be policies and related management measures that address such socioeconomic issues.

References

Ecosystem Principals Advisory Panel (EPAP). 1999. Ecosystem-based fishery management; A report to Congress. U.S. Department of Commerce. April 1999

Field, J. and R. Francis. 2006. Considering ecosystem-based fisheries management in the California Current. *Marine Policy* 30:552–569.

Field, J.C., R.C. Francis and K Aydin. 2006. Top-down modeling and bottom-up dynamics: Linking a fisheries-based ecosystem model with climate hypothesis in the Northern California Current. *Progress in Oceanography* 68:238-270.

Hanna, S.S. 1992. Interactions between shellfish and groundfish fisheries on the west coast: implications for system management. *Journal of Shellfish Research* 11:133-141.

Peterson, W.T., R.C. Hoof, C.A. Morgan, K.L. Hunter, E. Casillas, and J.W. Ferguson. 2006. Ocean conditions and salmon survival in the Northern California Current. November 2006.

Wiseman, K. 1996. Strategic environmental assessment (SEA): A primer. Division of Water, Environment and Forest Technology, CSIR, Stellenbosch, South Africa. CSIR Report ENV/S-RR 96001. September 1996.

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Considering ecosystem-based fisheries management in the California Current

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Abstract

Recognizing that all management decisions have impacts on the ecosystem being exploited, an ecosystem-based approach to management seeks to better inform these decisions with knowledge of ecosystem structure, processes and functions. For marine fisheries in the California Current, along the West Coast of North America, such an approach must take into greater consideration the constantly changing climate-driven physical and biological interactions in the ecosystem, the trophic relationships between fished and unfished elements of the food web, the adaptation potential of life history diversity, and the role of humans as both predators and competitors. This paper reviews fisheries-based ecosystem tools, insights, and management concepts, and presents a transitional means of implementing an ecosystem-based approach to managing US fisheries in the California Current based on current scientific knowledge and interpretation of existing law.
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Keywords: Ecosystem management; Fisheries management; California Current

1. Introduction

In the California Current ecosystem, a great many fish populations and the human communities that depend upon them are in a state of crisis as a result of a combination of factors. Many long-lived and slow growing groundfish stocks have been severely depleted, and obligatory rebuilding plans suggest that some could take decades to centuries to recover to target levels. The condition of several stocks is so poor that the Pacific Fishery Management Council (PFMC) found it necessary in 2003 to close a vast majority of the continental shelf to most fishing gears as an emergency measure; such actions have been criticized at ‘‘weak-stock management’’ by virtue of the foregone yield of healthy stocks in order to protect overfished species [1]. Salmon crises have been ongoing in the Pacific Northwest for decades, driven by a complex combination of factors, although recent changes in ocean conditions have boosted salmon production in some regions to record levels. The California sardine has recovered nearly half a century after its spectacular collapse, yet could enter into a period of low productivity if ocean conditions change, as past climate patterns suggest they might. Still other fisheries, such as those for Dungeness crab and pandalid shrimp, have demonstrated considerable short- and long-term fluctuations in abundance and productivity yet appear to be sustainably managed with relatively minimal regulatory measures.

While there has been a wealth of new initiatives to protect habitat, minimize bycatch and otherwise rationalize fisheries, there is increasingly a perceived need for the development of a more proactive approach to managing fisheries resources in an ecosystem context. Although efforts to develop an ecosystem focus in

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fisheries are far from new [2,3], the drive to do so has increased in recent years as perceptions of fisheries have evolved from limitless frontiers to systems with limits and thresholds [4–6]. Most marine ecosystems, and particularly upwelling ecosystems such as the California Current, are relatively open systems characterized by fluctuations in physical conditions and productivity over multiple time scales [7–9]. Food webs in these systems tend to be structured around species that exhibit boom–bust cycles over decadal time scales [10,11], and top trophic levels of such ecosystems are often dominated by highly migratory species such as salmon, tunas, shearwaters, fur seals and baleen whales, whose dynamics may be partially or wholly driven by processes in entirely different ecosystems.

2. What is ecosystem-based management?

As Larkin [12] recognized, "ecosystem-based management means different things to different people, but the underlying concept is as old as the hills." A common theme is that such an ecosystem approach involves a more holistic view of managing resources in the context of their environment than presently exists [5,6,13–16]. For marine fisheries management, this must include taking into greater consideration the constantly changing climate-driven physical and biological interactions in the ecosystem, the trophic relationships between fished and unfished elements of the food web, the adaptation potential of life history diversity, and the role of humans as both predators and competitors. Recognizing that all management decisions have impacts on the ecosystem being exploited, an ecosystem-based approach to management seeks to better inform these decisions with knowledge of ecosystem structure, processes and functions.

Ecosystem management has had a longer history in terrestrial resource management, where two general philosophies have been developed. Callicott et al. [17] describe these as the compositionalist and functionalist views, also at times referred to as the biocentric and anthropocentric views [18]. Although they exemplify the extremes of a continuum, a comparison of the two is useful when considering the interactions between competing objectives, mandates and scientific perspectives ("ecologies") in marine resource management. In general, the compositionalist view emphasizes the application of ecological science and knowledge, viewing the world "through the lens of evolutionary ecology," towards the goal of protecting diversity and integrity over the long term. From this perspective, humans are separate from nature, and anthropogenic needs are largely secondary. This is the view developed by Grumbine [19] when he detailed goals for sustaining ecological integrity. These goals included maintaining viable populations of native species, representing (within protected areas) all native ecosystem types across their natural range of variation, maintaining evolutionary and ecological processes, managing over time periods long enough to maintain evolutionary potential, and accommodating human use within these constraints. Grumbine recognized that these goals were in striking contrast to traditional, extraction driven resource management objectives. Consequently, the compositionalist philosophy may be more acceptable for wildlife refuges, wilderness areas, and similarly managed lands that include areas of high biodiversity, endemism or unusual community assemblages.

By contrast, a strict interpretation of the functionalist perspective is of a process-oriented, thermodynamic approach, with a foundation on the energy-transfer-based view of ecological function [17]. This functionalist view is focused on obtaining as much production from landscapes as possible, in order to achieve a high production to biomass efficiency [20]. This view is clearly more consistent with the current paradigm of contemporary fisheries management, which is premised on the assumption that populations (and subsequently the ecosystems in which they exist) are healthy if they are maintained close to the levels that provide the maximum amount of surplus production, or maximum sustainable yield (MSY). As such, the functionalist perspective is dependent on the assumption of equilibrium resilience, such that ecosystems and populations are capable of restoring themselves to (or close to) past equilibrium states given the opportunity to do so [21]. The fundamental belief of this perspective is the assumption that management can control multiple interacting population trajectories with enough precision to shift populations (and implicitly, ecosystems) into a mode that is as functionally beneficial to society as possible.

Beyond these two historically terrestrial perspectives, a third general philosophy that might guide ecosystem-based fisheries management (EBFM) is the social–ecological perspective. Based on his historical analysis of fisheries development in California, McEvoy [22] presented a model of a fisheries system as a combination of three elements: the physical and biological environment (ecosystem), a group of people working (economy), and a system of social control within which the work takes place (management). A conceptual schematic of McEvoy's model is presented in Fig. 1. McEvoy's key assertion is that management must equally weigh the many social and economic relationships within the fishery and how, in turn, they both influence and are influenced by marine ecosystem processes and dynamics. In this perspective, it is the human interactions with the environment that should be of particular concern to decision makers. Thus, McEvoy's model is a classic example of a social–ecological system [23], as

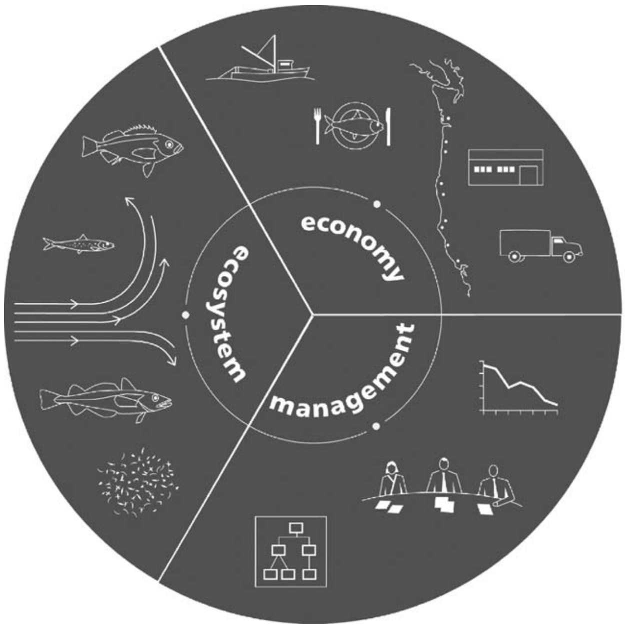

Fig. 1. Schematic of the key elements of a fisheries system; ecology (the physical and biological elements of the ecosystem), economy (fisheries and communities) and governance (the management system). Based on McEvoy [22].

representing an integrated concept of humans in nature, in which the essence of a sustainable fishery is the health of the interactions between the ecosystem, economy and management. Within the socio-ecological perspective, the role of EBFM is to provide decision makers with tools to recognize and respond to the potential consequences to the ecosystem that may result from the activities undertaken by fishermen and sanctioned by management bodies, given the recognition that there is risk of negative outcomes to both the ecosystem and the economy if poorly informed decisions are made.

3. Sustainable fisheries, ecosystem management, and the law

Ecosystem management, or ecosystem-based fishery management, means different things to different people largely as a result of the three philosophies discussed above, which simultaneously conflict with, yet complement, one another. In the discussions leading up the passage of the 1996 Sustainable Fisheries Act (SFA) amendments to the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA), there was increasing recognition of the potential for an ecosystem-based approach to improve fisheries management. Although the Congress did not explicitly adopt an ecosystem-based approach,[1] the SFA did require the National Marine Fisheries Service (NMFS) to convene a panel of experts to "expand the application of ecosystem principles in fishery conservation and management activities" (16 USC 1882, §406). This panel's primary recommendation was that the eight regional Fishery Management Councils develop Fisheries Ecosystem Plans (FEPs) for the ecosystem or ecosystems under their jurisdiction [5]. The FEP would act as an "umbrella document" containing detailed information on the structure and function of the ecosystem under consideration, and increase the awareness of managers and stakeholders on the effects that their decisions have on the ecosystem. Although the current system of fisheries management plans (FMPs) would remain the basic management tool in the near term, they would be amended to ensure compatibility with the ecosystem principles, goals and policies of the FEP. Since the completion of their report, the NMFS approach has continued to center around single-species assessments, but has increasingly supported ecosystem-based research and modeling efforts. The most recent National Oceanic and Atmospheric Administration (NOAA) Strategic Plan explicitly refers to a primary agency mission to "protect, restore and manage the use of coastal and ocean resources through ecosystem-based management," however, this plan also recognizes that management in the near term will continue to be on a species and site-specific basis [24].

The extent to which existing legislation, in particular the National Environmental Policy Act (NEPA) of 1972 (42 USC 4321), may or may not be interpreted as requiring that ecosystem considerations be evaluated in making management decisions is somewhat unclear. The Act requires an environmental impact statement (EIS), on the potential impacts of proposed federal actions that might affect the environment (across a reasonable range of impacts), detailing not only adverse impacts that could not be avoided if the proposal were implemented, but also reasonable and prudent alternatives to such actions. Fishery management councils have traditionally been required to develop a programmatic EIS (PEIS) for FMPs prior to their approval (PEIS are typically required for connected or closely related actions, such as the broad-scale management of multiple fisheries components). While there is no clear regulatory requirement to revisit past PEISs, questions regarding the longevity of these documents have arisen as the lifespan of past PEISs lengthens [25,26].

Currently, the only fishery management council to revisit their programmatic EIS is the North Pacific

[1]The SFA included no mention of ecosystem considerations in the National Standards or in fishery management plan (FMP) requirements, however, some authority is inferred in the definitions section of the Act where optimum yield is defined as "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" (16 USC. 1802, §3).

Table 1
Comparison of the focal elements of a fisheries ecosystem plan as envisioned by the Ecosystem Principals Panel (left) and the ecosystem elements considered under the NEPA programmatic review of NPFMC groundfish fishery management plans

Ecosystem Principles Advisory Panel	NPFMC Interpretation of NEPA
• Delineate and characterize ecosystems • Develop a conceptual model of the food web • Develop indices of ecosystem health	• Stability of the food web and (ecological) community structure • Seabird and marine mammal interactions
• Describe habitat needs and how they are considered in conservation and management measures	• Consider impacts on marine habitat, including benthic essential fish habitat
• Calculate total removals (including incidental mortality), and show how they relate to biomass, production, optimum yields, and trophic structure	• Sustainability of target stocks (prevent overfishing) • Bycatch (discards) and incidental catches
• Assess the ecological, human, and institutional elements of the ecosystem	• Sustainability of fisheries and communities • Alaska native participation in fishery management and traditional ways of life • Value of marine resources (both commercial and non-commercial)
• Assess how uncertainty is characterized and how buffers are included in conservation and management actions • Describe available monitoring data	• Data quality, monitoring, research and enforcement requirements

Fishery Management Council [27]. The principal objective of their Programmatic Supplemental Environmental Impact Statement (PSEIS) is to serve as the central environmental document for the groundfish fishery, and provide a ''big picture'' evaluation of both the impacts of fisheries and fisheries management objectives for North Pacific marine ecosystems. The PSEIS includes consideration of alternative fisheries management policies, and while all of the alternatives were designed to be compatible with other existing laws, they were also intended to bookend a reasonable range of what might be considered strictly compositionalist and functionalist harvest strategies and objectives. For example, the proposed alternatives ranged from fishing all stocks aggressively in order to maximize biological and economic yield from the resource (arguably a functionalist approach), to adopting a highly precautionary approach in which the burden of proof is shifted to resource users to demonstrate negligible impacts of fisheries to the ecosystem (arguably a compositionalist approach). The preferred alternative was the status quo: characterized as adaptive to new information and reactive to environmental issues, and based on the assumption that fishing at levels approaching, but not exceeding proxies for MSY, is compatible with ecosystem health and sustainability. The alternatives are accompanied by a suite of likely or expected impacts associated with their adoption, and there is also considerable overlap between the impacts evaluated in the PSEIS and those envisioned to be the principal elements of an FEP, as seen in Table 1.

Although past applications of the law indicate that neither NEPA nor the MSFCMA explicitly mandate an ecosystem approach, the language in both laws suggests that ecosystem considerations should be evaluated in making policy decisions within the context of the current fishery management system. As Livingston et al. [28] suggest, the original spirit of NEPA to provide an open and public process for advising decision makers is integral to any successful implementation of an ecosystem-based approach to fisheries management. Despite the fact that it has been viewed as primarily an administrative burden, NEPA remains one of the most powerful environmental laws in the nation as a result of legal requirements for analysis, disclosure, and transparency. Consequently, NEPA offers a means to scientifically evaluate the cumulative impacts of fisheries on marine ecosystems (Table 1).

It seems clear that the legislative authority exists to change the fundamental nature of how fisheries resources are managed, with the goal of sustaining both the resources and the interactions between the resources and the resource users. Given the opportunity, if fishery management councils were to embrace an ecosystem-based approach in principle, but were limited in the rate at which such an approach could be prescribed as policy, where might they start? For fisheries in the California Current, managed by the PFMC, we suggest that three elements would be key, these being:

- Increasing exposure to the management and user communities of short- and long-term climate and ocean status, trends and scenarios for the California Current.

- Consideration of trophic interactions among fished and unfished species and associated impacts on ecosystem structure and dynamics.
- The increasing application of new management approaches, including spatial management measures to protect life history characteristics and biodiversity.

Ideally these elements would complement, rather than replace, existing management efforts relative to single-species conservation objectives. While they admittedly add to the plethora of ongoing activities and developments currently being undertaken by the NMFS and the Council, they should rightly be considered critical elements of any future success at meeting NOAA and NMFS' current objectives. The following sections elaborate on these recommendations, followed by a potential blueprint for implementing ecosystem-based management on both short and long time scales.

3.1. Climate considerations

The effects of climate on the biota of the California Current ecosystem have been recognized for some time. Hubbs [29] believed so strongly in the correlation between water temperature and fish distributions that he felt "justified in drawing inferences, from the known data on fish distribution, regarding ocean temperatures of the past." In particular, Hubbs had already drawn distinctions between eras that seemed to be associated with the establishment of warm-water populations over long time periods, which may be associated with Pacific Decadal Oscillation (PDO) scale variability [30,31], and the occasional warm years that brought irregular tropical or subtropical fish much further north along the coast in response to interannual (El Niño) warm events [11,32,33]. Over decadal time scales, climate-driven changes in ocean conditions have long been attributed to both long-term variability in reproductive success and survival in sardine, anchovy and other coastal species that, in turn, appear to be responsible for some of the most spectacular boom and bust fisheries seen in the world's oceans [34–36]. Interestingly, there may be trophic interactions associated with these presumably climate-driven shifts as well, as MacCall [11] noted that peak abundances of predators such as mackerel and bonito seemed to follow their prey, anchovies and sardines, such that two given species never seemed to be abundant at the same time (Fig. 2). A similar sequence seems to occur in the Kuroshio Current off of Japan [37], as well as in large-scale currents off Peru and Chile [38]. This might suggest a trophic response to climate-induced changes in coastal pelagic species productivity on a basin scale.

In recognition of the role of climate in driving this productivity, the California sardine fishery is currently managed under an innovative harvest control rule based on the 3-year running average of the Scripps Pier sea surface temperature. The harvest rule allows for high harvest rates during favorable environmental conditions, and lower rates during periods of low productivity (harvest rates also reach zero when the biomass is at low levels regardless of climate conditions). Although there is no clear mechanism or process defining the strong relationship between SST and sardine productivity [39,40], this example demonstrates that provisional linkages and correlations can be successfully applied to generate management models within the bounds of the existing fisheries management regime. As such, the control rule is consistent with the implementation guidelines for the SFA, which include allowances for shifting biological reference points where evidence exists that the productivity of stocks has changed. Perhaps more importantly, this demonstrates that management is both willing and able to implement regulatory measures that recognize the impacts of climate on population productivity.

Pacific hake are also characterized by climate-induced variability in both production and distribution. Adults migrate from their winter spawning grounds off southern California to their summer feeding grounds off the Pacific Northwest coast, where they are the targets of the largest (by volume) fishery on the US West Coast. A much greater proportion of the hake biomass extends north of the US/Canada border during warm years than cold years, a distributional shift that has historically complicated management of this shared resource between the US and Canada [41–43]. These dramatic distributional shifts are matched by equally spectacular changes in abundance when recruitment conditions are good. In the early 1980s, two strong recruitment events (in 1980 and 1984) caused the stock biomass to nearly triple, from approximately 2 to 6 million metric tons (Fig. 3), and accounted for roughly 60% of the over 3 million tons of hake landed between 1983 and 1997 [based on 44]. Although an oceanographic mechanism explaining the success of these year classes (and the relative failures of others) has proven elusive [45,46], it is clear that such tremendous shifts in distribution and abundance have major impacts on the rest of the ecosystem. Pacific hake have been implicated as predators of juvenile salmon [47], inflict substantial predation pressure on commercially important pandalid shrimp and are voracious predators of krill, herring and other forage fish that are the primary prey of salmon, rockfish and other groundfish species [48–50].

Climate and oceanographic information is increasingly available in highly detailed, descriptive and meaningful forms to researchers and managers alike [51–53], including an annual review of the physical and biological state of the California Current ecosystem itself [54,55]. Biological indicators of productivity include time series of zooplankton abundance [9,56],

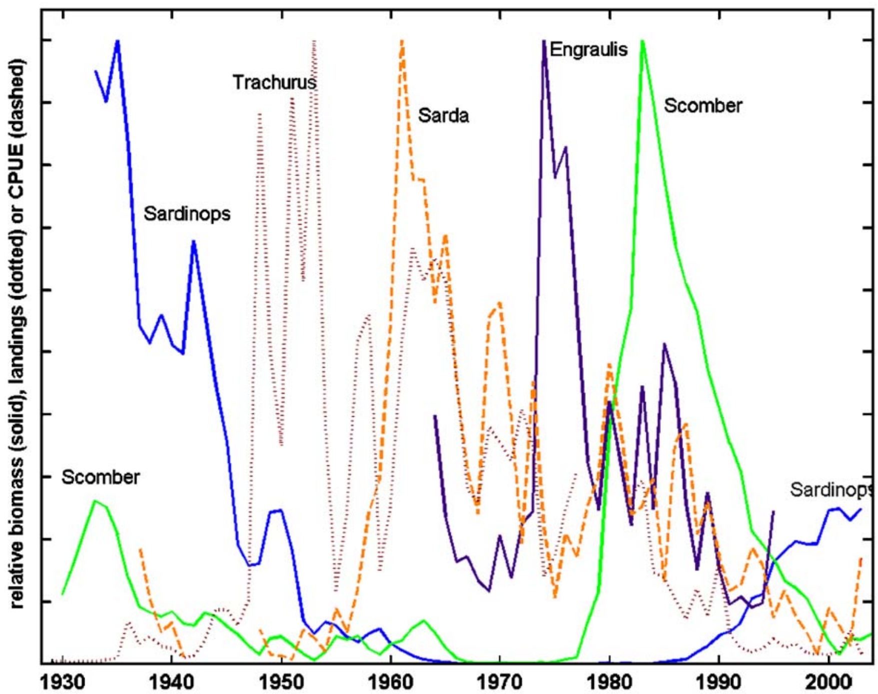

Fig. 2. Sequential nature of the relative abundance of coastal pelagic species in the California Current ecosystem, based on stock assessments (solid lines) and indices of relative abundance or landings (dotted lines). Species shown are Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symetricus*), bonito (*Sarda chiliensis*) and northern anchovy (*Engraulis mordax*). Updated from MacCall [11].

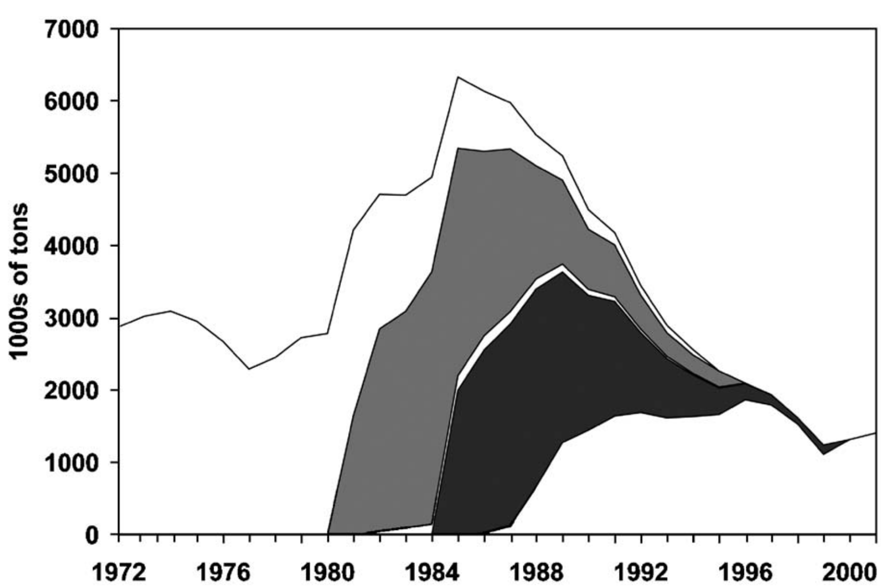

Fig. 3. Relative contributions of the 1980 (light gray) and 1984 (dark gray) year classes to the total estimated biomass of Pacific hake (*Merluccius productus*) population in the California Current System. Data from Helser et al. [44].

estimates of rockfish year class strength [57], and models of salmon survival based on physical and biological ocean indices [56,58]. A study group organized by North Pacific Marine Science Organization (PICES) in response to a formal request by the US government recently concluded that the time is long overdue for the formal inclusion of climate and ecosystem information into the management consciousness and decision-making framework [36]. The PICES group recommended four key actions for incorporating climate considerations into fishery management activities, which included acceptance of the regime concept for marine ecosystems, the development and maintenance of improved observation and monitoring efforts, the continued application of climate indices and research linking climate indices to predictable components of the climate system, and the evaluation of future regime scenarios in stock assessments to assess the vulnerabilities of fisheries and ecosystems under different management strategies and climate conditions [36].

As these elements of climate considerations are developed, a transitional approach to incorporating climate considerations into management would be to periodically brief the PFMC and the Council community with reports on climate and ocean observations, forecasts and scenarios for the California Current. This could include designating a regional fisheries oceanographer, whose primary responsibility would be to synthesize climate information into usable and understandable formats, orchestrate the development of a climate and ecosystem status and trends document, and act as a conduit between the climate research and the fisheries management communities. A blueprint for defining the role of regional fisheries oceanographers could be taken from the existing framework for the role of state climatologists, whose obligations include summarizing and disseminating weather and climate information to user communities, demonstrating the value of climate information, performing impact assessments, and conducting climate research and projections.[2] Currently, the users of such climate information include a wide array of business leaders and local government workers, including those involved with water management, agriculture, forestry, public utilities, and emergency response, for which short-term (seasonal to annual) forecasts have the potential to reduce or increase revenues by billions of dollars [59,60].

Given widespread recognition of the broad and large-scale impacts of climate on fish and fisheries, it seems rational that the consideration of climate information by the Council community could significantly improve the context in which management decisions are made. For example, an improved understanding of the relationship between salmon success and climate might suggest that greater precaution be taken under the expectation of an El Niño event, or a particular phase of the PDO. A regional fisheries oceanographer would also provide a channel for transmitting climate information and forecasts both to and from fishermen and fisheries-dependent communities, an important role given that a majority of California fishermen believe that climate is the most important factor in determining the productivity of many fish and shellfish populations [61]. Similarly, Dalton [62] found substantial direct impacts of climate on fishing effort, ex-vessel prices and future expectations of production and availability in Monterey Bay fisheries. This work showed that regulations that allowed fishermen to allocate their effort freely in response to climate and price variability would maximize the value of future climate information, and emphasized the importance of improving the understanding of complex physical, biological and economic feedbacks between fisheries and the ecosystem. Consideration of how managers might facilitate the response of resource users, without increasing the jeopardy of resources, would be one way to operationalize McEvoy's [22] key target for sustainability, as the long-term health of the interaction between nature, the economy and the legal system. Given the precedent set by the adoption of the sardine harvest policy, the increasing understanding of processes and mechanisms that drive variability in this ecosystem, and recognition of the importance of regime-scale variability on resource productivity, it seems clear that there is a growing need for the PFMC and other councils to more formally consider climate factors in management.

3.2. Ecosystem models and trophic considerations

As emphasized in the previous section, energetic and highly variable oceanographic processes shape the physical environment and drive production throughout the California Current food web over a range of time scales. Additionally, over the past 200 years, massive removals of whales, pinnipeds, salmon, coastal pelagics, groundfish, invertebrates and hake have taken place throughout the California Current (Fig. 4), often driving many populations to extremely low levels of abundance. It would be difficult to presume that such removals have not fundamentally disturbed energy pathways, and altered the basic structure and function of the ecological community. We now know that many of the living resources in the California Current are not capable of providing a steady and predictable surplus to humans year after year, and removals have often severely exceeded the productive capacity of many stocks. Yet, populations of whales, pinnipeds, sardines and other species have often made dramatic recoveries from past overexploitation, often under strong management constraints, providing us with opportunities to better appreciate the resilience of stocks, species and communities in this dynamic ecosystem.

Where trophic interactions among exploited species are documented or suspected, ecosystem modeling can provide a template to evaluate both the magnitude and consequences of removals of either predators or prey in the system of interest [63,64]. For instance, Walters et al. [65] have used ecosystem models to demonstrate that widespread application of contemporary (MSY proxy) single-species management approaches could lead to

[2] The role and affiliations of State climatologists are described by the American Association of State Climatologists (AASC) website (http://lwf.ncdc.noaa.gov/oa/climate/aasc.html#ABOUT).

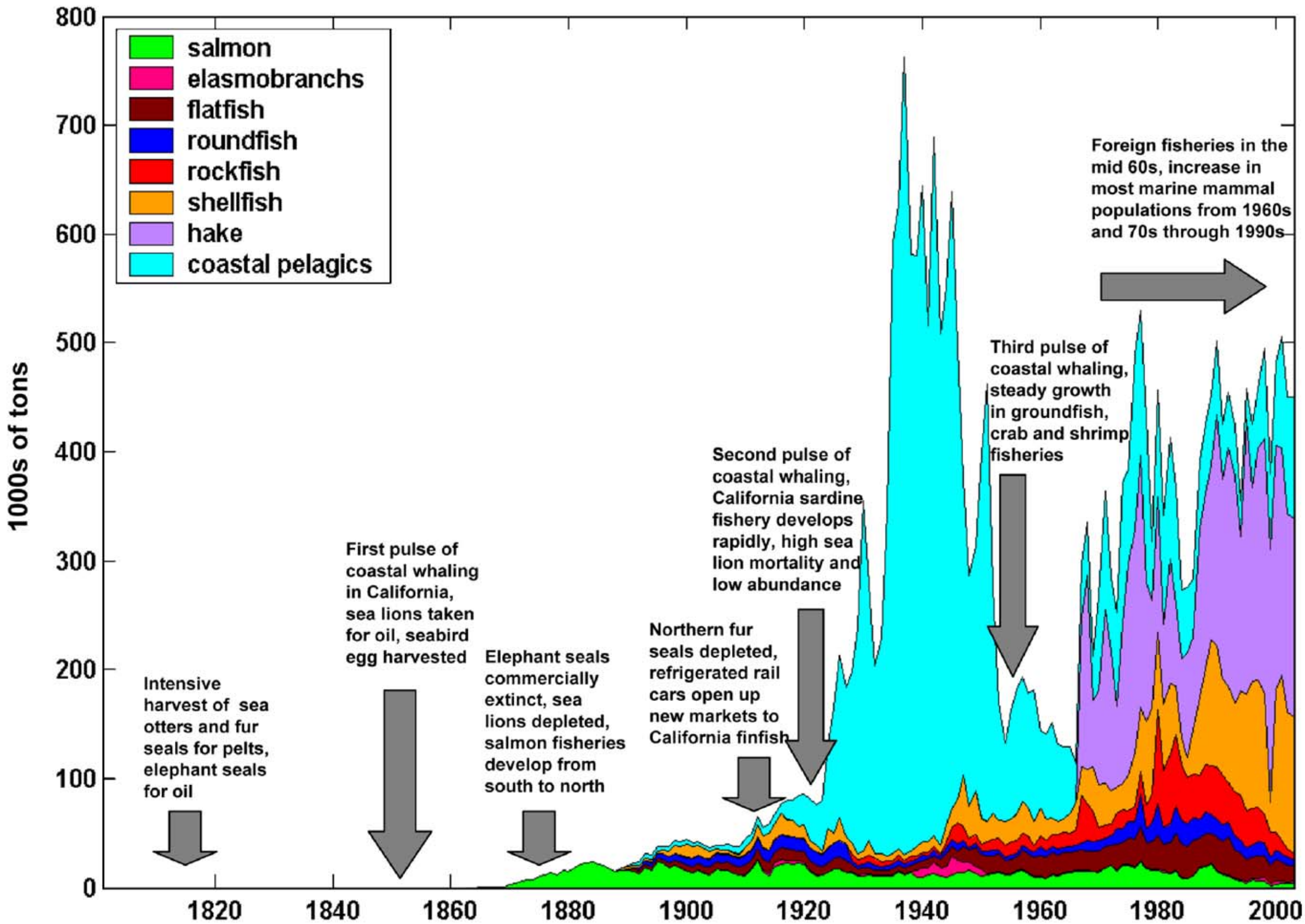

Fig. 4. Major removals, developments and fisheries catches throughout the US portion of the California Current Ecosystem over the past 2 centuries.

dramatic impacts on ecosystem structure, particularly where such approaches are applied to forage species. Their results add considerable weight to the perceived need to consider forage species as resources whose value is derived from their role as prey to commercially and recreationally important stocks. Petitions made to the PFMC to manage krill (euphausiids) as a forage species, and place either a temporary or permanent ban on krill harvests in recognition of their importance as a key prey item, would thus be consistent with an ecosystem perspective towards fisheries management in the California Current.[3] The significance of euphausiids as one of the most important vehicles for the movement of energy through this ecosystem is reflected in Fig. 5, which illustrates the key role that euphausiids play as forage for commercially important species such as hake, rockfish and salmon. Table 2 provides a summary of the more significant species or taxon in the aggregated functional groups shown in Fig. 5, as well as the scientific names of species commonly referred to throughout the text.

In another example, a model of the Newfoundland-Labrador ecosystem suggested that although overfishing drove massive declines in cod abundance, cod recovery was likely hindered by the increase in natural mortality rates associated with a nearly constant per capita consumption of cod by an increasing population of harp seals [66]. Although this model did not replicate all of the trends estimated by single-species models, it did suggest that the decline in cod and several other heavily fished species might have also resulted in the increase of shrimp and other large crustaceans, an outcome supported by empirical studies [67]. While these results alone may not provide sufficiently rigorous evidence to guide policy, they are informative for policy makers, especially where consistent with more empirical evidence of ecosystem changes. Other modeling efforts have also met with some success at replicating the behavior of key commercial fish populations over long time periods

[3]Correspondence between the Southwest Fisheries Regional Center, the Southwest Fisheries Science Center and the PFMC in 2004 and 2005 has resulted in a commitment to incorporate krill into the Coastal Pelagic Species Fisheries Management Plan, and to consider alternatives for krill management that would include a moratorium on directed fisheries for krill (http://www.pcouncil.org/bb/2005/0305/ag_g2.pdf).

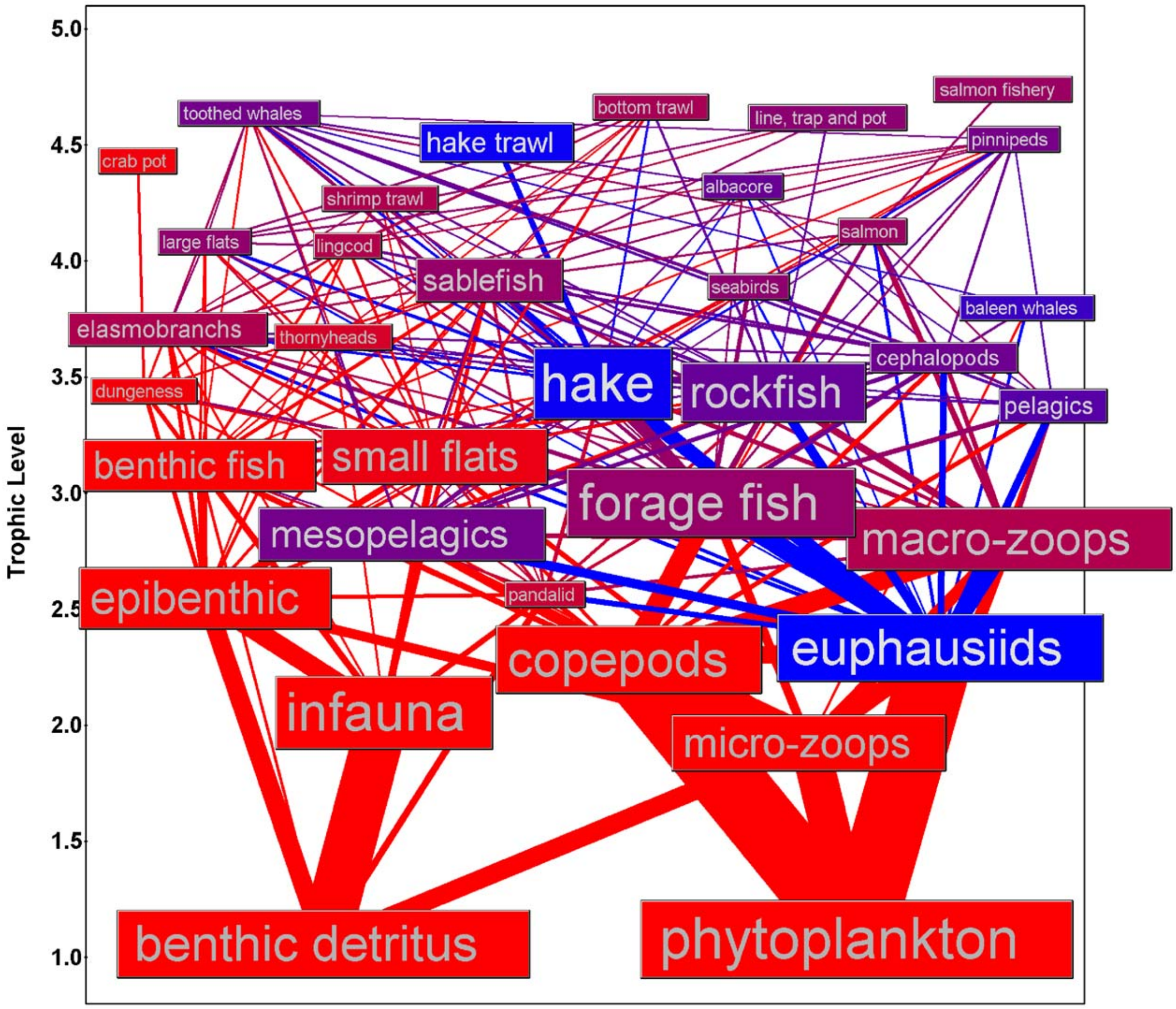

Fig. 5. Dispersal of energy from euphausiids with respect to other energy sources in the Northern California Current. The estimated trophic level is along the *y*-axis, and colors representing the alternative energy pathways such that energy derived from euphausiid production is blue and energy from other sources is red. The size of the boxes and the width of the bars connecting various boxes are scaled to the log of the standing biomass and biomass flow, respectively.

using fishing pressure and climate as forcing factors of ecosystem dynamics, including the Central North Pacific, Eastern Tropical Pacific, and Northern California Current ecosystems [68–70]. For the Northern California Current, observed trends for most groundfish can be fairly well replicated with a multi-species model, suggesting fairly weak trophic interactions among adult life history stages of most fishes relative to the impacts of fishing [70]. Stronger interactions were observed in forage species such as shrimp, salmon, and small flatfish, where there is greater population turnover and high predation, coupled with substantial changes in many of their key predators over the period modeled. Perhaps most importantly, model performance improved when climate was introduced as a driving force, given the a priori assumption that climate forcing is a critical factor in determining productivity and dynamics in this ecosystem.

In all of these examples, quantitative modeling of trophic interactions has the potential to lead to changes in harvest or management strategies in the near term, and at a minimum represents a valuable contribution to a more holistic understanding of ecological connections and interactions. Conveying to decision makers the significance of ecological processes may be just as important as monitoring and conducting process-oriented research into the causes and consequences of the same. Many criticisms of ecosystem modeling approaches are based less on the model structure, than on the misuse and misunderstanding of the model limitations [64,71,72], a characteristic shared with single-species models [73]. The far more important feature of ecosystem models is that if based on reasonable knowledge, and presented with an appropriate degree of skepticism, such models can serve as a stimulus for initiating dialogues with regard to both past population

Table 2
Summary of the more significant species or taxon in aggregated functional groups, and scientific names of commonly referred to species from the text and figures

Phytoplankton	Functional group of all photosynthetic primary producers, diatoms generally dominate
Infauna	Functional group of polychaetes, bivalves, small crustaceans, and some echinoderms
Epibenthic	Functional group including benthic crustaceans (decapods, isopods, amphipods), echinoderms (holothuroids, asteroids, ophiuroids), gastropods and other organisms
Micro-zoop	Functional group of small heterotrophic zooplankton, primarily protozoans such as gymnodiniods, dinoflagellates, ciliates, and nanoflagellates
Copepods	All developmental stages of species in the subclass Copepoda
Euphausiids	All developmental stages of species in the order Euphaussiacea
Macro-zoops	Functional group including pasiphaid, seregestid and other pelagic shrimps, chaetognaths, pelagic polychaetes, pelagic amphipods, and gelatinous zooplankton
Cephalopods	Functional group of cephalopods, such as *Loligo*, *Gonatus*, and *Octopus* species
Forage fish	Functional group of principally clupeids and osmerids, including northern anchovy, Pacific herring, sandlance, eulachon, surf smelt, and whitebait smelt
Mesopelagics	Functional group of many meso- and bathypelagic species, including northern lampfish, California headlightfish, blue lanternfish and longfin dragonfish
Benthic fish	Functional group including grenadiers (*macrouridae*), eelpouts (*Zoarcidae*), snailfish (*Cyclopteridae*), poachers (*Agonida*e), and sculpins (*Cottidae*)
Small flatfish	Functional group including Dover sole (*Microstomus pacificus*), english sole (*Parophys vetulus*), rex sole (*Glyptocephalus zachirus*), sanddabs (*Citharichthys* spp.), and others
Pelagics	Includes Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symetricus*) and Pacific mackerel (*Scomber japonicus*)
Pandalid shrimp	*Pandalus jordani*
Dungeness crab	*Cancer magister*
Salmon	Chinook and coho salmon (*Oncorhynchus* spp.)
Elasmobranchs	Includes dogfish (*Squalus acanthias*), cat sharks (*Apristurus* spp.), soupfin (*Galeorhinus galeus*) and thresher (*Alopias* spp.) sharks, and skates (*Raja* and *Bathyraja* spp.)
Rockfish	Includes all *Sebastes* species, most abundant species include widow (*S. entomelas*), yellowtail (*S. flavidu*s), canary (*S. pinniger*), and Pacific Ocean perch (*S. alutus*)
Thornyheads	Shortspine (*Sebastolobus alascanus*) and longspine (*S. altivelis*) thornyheads
Pacific hake	*Merluccius productus*
Sablefish	*Anoplopoma fimbria*
Lingcod	*Ophiodon elongates*
Albacore	*Thunnus alalunga*
Large flats	Includes arrowtooth flounder (*Atheresthes stomias*), Pacific halibut (*Hippoglossus stenolepu*s) and Petrale sole (*Eopsetta jordani*)
Seabirds	Includes shearwaters (*Puffinus* spp.), common murres (*Uria aalgae*), other alcids, gulls (*Larus* spp.), albatross, phalaropes, petrels and others.
Toothed whales	Primarily Dall's porpoise (*Phocoena dalli*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), sperm whales (*Physeter macrocephalus*), and Orcas (*Orcinus orca*)
Pinnipeds	Primarily Steller sea lions (*Eumetopias jubatus*), California sea lions (*Zalophus californianus*), fur seals (*Callorhinus ursinus*) and harbor seals (*Phoca vitulina*)
Baleen whales	Primarily humpback whales (*Megaptera novaeangiliea*), but including minke (*B. acutorostrata*), fin, (*B. physalus*), and gray whales (*Eschrichtius robustus*)

dynamics and plausible ecosystem futures [74]. Perhaps their greatest asset is that they can complement the insights gained from single-species models through a more strategic consideration of past and current abundance and productivity, and consequently provide a means to quantify the interconnectedness of parts within the system, and evaluate plausible trade-offs between these parts as a result management decisions.

3.3. Demographics, life history and biocomplexity

As suggested by the discussion of the compositionalist and the functionalist perspectives, even a robust and successfully implemented combination of single and multi-species data, models, reference points and thresholds would be insufficient to fully adopt an ecosystem perspective. The challenging but critically important measures of diversity, biocomplexity, and ecological integrity may be just as important to managing for an ecosystem perspective as more ''functionalist'' single-species reference points and objectives. Although models play a critical role by allowing the management community to relate to the consequences of their decisions, both single species and ecosystem models tend to reflect a functionalist perspective with regard to their presumed properties of resilience [21]. Yet, even the impacts of successfully implemented management measures to demographic and life history characteristics of some species may be contrary to perspectives of sustainability based on evolutionary ecology. Fishing has been widely accepted (and experimentally demonstrated) to be a form of artificial selection towards smaller size or younger age at reproduction [75,76], and the potential consequences of such selection are important for both conservation and economic reasons.[4] In particular, the assumptions of fisheries science and the stock assessments upon which management is based ignore the potential evolutionary consequences of harvesting, which could reduce the sustainable yield of a population by decreasing the amount of somatic growth relative to reproductive effort [77]. This has resulted in what some have dubbed the ''tropicalization'' of many marine fish populations, meaning the imposition of traits such as faster growth rates, smaller size, and earlier maturity schedules which may be ill-suited to the environment in which such populations live, and could result in reductions in long-term yield [78].

Lotka [79] was among the earliest to propose that the ability of populations to persist or recover is constrained if the distribution of age structure is pushed beyond a certain threshold, a threshold that has since been referred to as the ''boundary of sustainability'' [80]. In particular, longevity appears to be an archetypical life history adaptation of many temperate water populations to episodic recruitment failure in a variable and an uncertain environment, and it has consequently been suggested that age structure should not be forced to diverge far from the values that evolved for each stock prior to human exploitation [81–83]. Prior to the development of large-scale fisheries, a majority of the biomass of commercially important sablefish, Dover sole and many rockfish populations consisted of fish greater than 20 years of age, with individuals of many species capable of reaching ages of 80 or more [84,85]. As of 2005, seven species of rockfish (Sebastes spp.) as well as lingcod are managed under NMFS overfished species rebuilding plans. These species declined to depleted levels as a result of a combination of low productivity, poor environmental conditions, and high harvest rates, and have expected recovery times of several to many decades [86]. In addition, substantial community changes may also be associated with groundfish declines, as four of the species (cowcod, bocaccio, yelloweye rockfish and lingcod) are large, long-lived piscivores that may have played an important role in maintaining the community structure of the rocky reef ecosystems that they used to dominate [87,88].

There is also growing evidence of variability in the reproductive abilities of younger and older individuals of many species, the inference being that a broad distribution of age structure is beneficial to the recruitment and productivity of many stocks [89–91]. For example, it has been shown that older female black rockfish produce larvae with faster growth rates and greater larval survival than younger fish, with age being a more significant predictor than size alone [92]. Older females also gave birth earlier in the year than younger females [93]. Such considerations are not limited to long-lived species, as it has been demonstrated that the ''biocomplexity'' of stock structure in western Alaskan sockeye salmon plays a critical role in providing both stability and sustainability to fisheries [94], findings that echo those for West Coast salmon populations [95,96]. All of these examples reveal that for many fish populations, long-term sustainability is based on complementary patterns of production from different stock components under varying environmental conditions. Complementary patterns of production help sustain fishermen as well, as Hanna [97] found that the diversification of fishing strategies between groundfish, shrimp and crab benefited fishermen by reducing the variability of landings and earnings.

The application of marine protected areas (MPAs) and other spatially based management efforts (such as rotating closures and ocean zoning) have been increasingly proposed as potential tools in future marine resource management [16,98,99]. An NRC panel charged with investigating the potential application of MPAs in marine resource management concluded that there was compelling evidence for their use in managing fisheries, protecting habitat and biodiversity, and otherwise enhancing the anthropogenic value of marine habitat [100]. As management tools, MPAs offer a form of insurance against overexploitation and recruitment overfishing, help preserve a broad age distribution, and protect vulnerable non-target species and habitat. Both proponents and critics point out, however, that the nature of any implementation could be associated with increased fishing mortality and impacts outside MPA boundaries [101,102]. Yet, the need for spatial management to achieve current conservation objectives, such as rebuilding depleted rockfish stocks for the Pacific Council, suggests that such measures may have much to offer with regard to maintaining life history characteristics and biocomplexity in marine populations. Regardless of the mechanism, it is increasingly important for all stakeholders to recognize that maintaining life history traits and otherwise facilitating each population's insurance strategy for coping with the environment is a critical element of any sustainable approach to long-term fisheries management.

4. Moving towards ecosystem-based management in the California Current

The Sustainable Fisheries Act clearly altered the nature of fisheries management in the United States,

[4]Although the current National Standard guidelines recognize the significance of demographic and evolutionary impacts of fishing on both populations and ecosystems, this recognition does not require the gathering or analysis of new data to address life history uncertainties or the protection of marine ecosystems [120].

and in the California Current such changes came in the midst of an extended period of poor environmental conditions that contributed substantially to fisheries crises. These crises, in association with growing recognition of the low productivity of many stocks, brought about wave after wave of reductions in total allowable catches and trip limits. Consequently, much of the PFMC's current activities are focused on ongoing crises, resulting in substantial limitations on the ability to develop and implement new initiatives. Thus, regardless of whether the process is mandated or voluntary, there should be an emphasis on an evolutionary, rather than revolutionary, move towards an ecosystem approach [103]. As discussed earlier, there have been major improvements in the monitoring and management of California Current fisheries, including efforts to evaluate and protect essential fish habitat [104], new bycatch evaluation and reduction measures [105,106], the use of environmental indicators in setting harvest rates, capacity reduction programs [107–109], and the recently initiated consideration of rights-based fishing regimes [110]. Obviously, all of these developments have occurred in the context of the current management regime, which in turn suggests that movement towards an ecosystem-based approach is consistent with the current fisheries management institutions. While an appropriately funded mandate to develop FEPs would be desirable from the perspective of truly developing an ecosystem perspective, this should not preclude the development of a road map towards adopting an ecosystem-based approach to management, or otherwise integrating ecosystem considerations into the current management regime to the greatest extent possible.

As an active adaptive approach, McEvoy [22] suggested that the best managers might be able to do "is to monitor and adjust the interaction between a volatile ecology, a creative economy, and society's understanding and control as they go along." Similarly, Gunderson et al. [111] and Holling and Meffe [21] argue that the key to maintaining resilience in ecosystems is to facilitate existing processes and variability, rather than to try to control them. In other words, the key objective of an ecosystem approach is to facilitate healthy interactions between ecological, socio-economic and governance elements of the fisheries system. Clearly the need to recognize and assess the roles of climate and ecological complexity must be balanced with the need for understanding the socio-ecological interactions between fishermen and fishery resources and the sustainability of the fisheries system as a whole. Such recognition is increasingly widespread in the resource management community, which has led to the growth of a new discipline, dubbed the socio-ecological approach by Berkes et al. [23] and "sustainability science" by Kates et al. [112]. Although the ability to model the key interactions between humans and the ecosystem are critical to this emerging discipline, advances in modeling human processes have lagged far behind the modeling of biophysical processes [113]. The consequences of salmon and rockfish crises now resonate widely across fisheries sectors, where modeling the projected impacts of regulatory changes has required making increasingly tenuous assumptions regarding the behavior of both fishermen and the resources themselves, as managers struggle to balance the need to minimize mortality of overfished species against the need to maintain fishing opportunities on healthier stocks.

A useful framework for formally phasing in ecosystem considerations from a management perspective was presented by Goodman et al. [114], and here that framework is used to consider how the PFMC might phase from implicit to explicit consideration of ecosystem processes. In the conventional assessment worldview (Fig. 6), the ecosystem is considered principally in the context of target populations. There is both direct feedback between these populations and the fishing fleets (industry) and indirect feedback through the governance sector. This indirect feedback occurs through the evaluation of survey, effort and catch data, which is used to develop stock assessments and other evaluations of the status of resources. Where direct feedback between the resource and the fishery is strong (such as seems to be the case with pandalid shrimp and Dungeness crab in the California Current), the role of governance can be limited without substantial risk to the resource. However, where the direct feedback between resources and fisheries is weak, as it is with many of the long-lived and slow growing groundfish, sustainability is almost fully dependent on the indirect feedback of governance. If that feedback is too slow, or management actions are ineffective, the resource is far more likely to be overexploited, leading to negative impacts on both the ecosystem and the economy.

In the first stage of moving towards an ecosystem approach, described as the explicit ecosystem effects worldview, the status of target stocks, their prey, and their predators are formally considered by the governance sector in the context of environmental conditions and trophic interactions (Fig. 7). Fishing activities would continue to be largely governed by estimates of target stock status and yield as in the conventional worldview, and the governance sector would remain heavily dependent upon the indirect feedback of stock and target species status from catches, surveys and effort data. For the PFMC, an initial mechanism to implement this approach would be to establish an ecosystem considerations technical team, which would be tasked primarily with the responsibility for advising the Council on the state of the environment and providing ecosystem guidance on management decisions, just as management teams and advisory panels do for current FMPs. This team or panel could also potentially act as

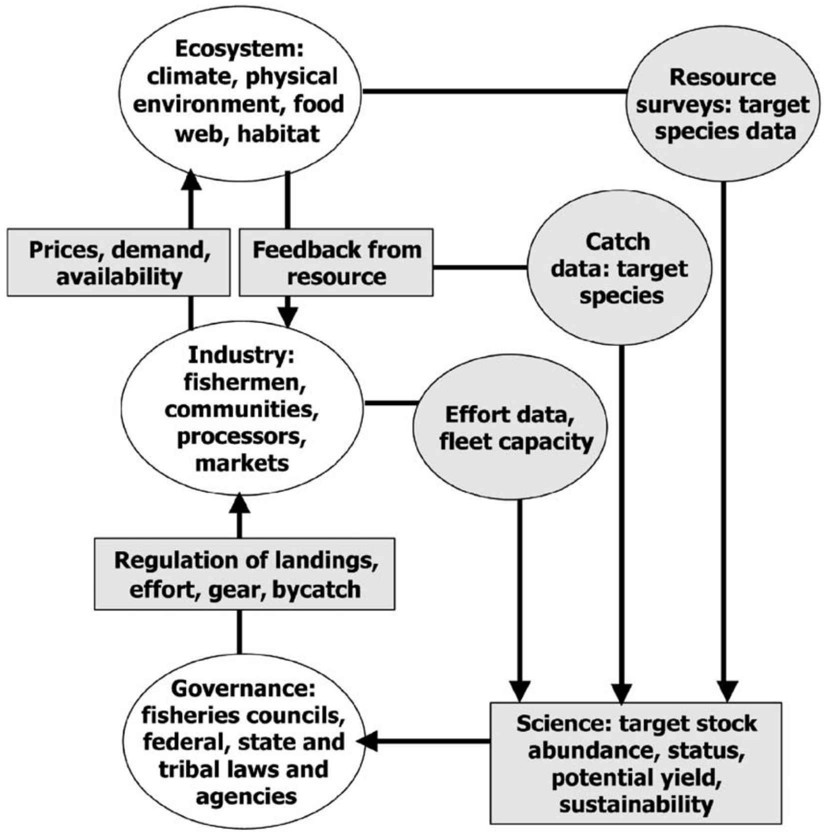

Fig. 6. The conventional fisheries management worldview, in which there is both direct feedback between these populations (the ecosystem) and the fishing fleets (economy) and indirect feedback through management (governance). This indirect feedback occurs through the evaluation of survey, effort and catch data, which is used to develop stock assessments and other evaluations of the status of exploited resources. Adapted from Goodman et al. [114].

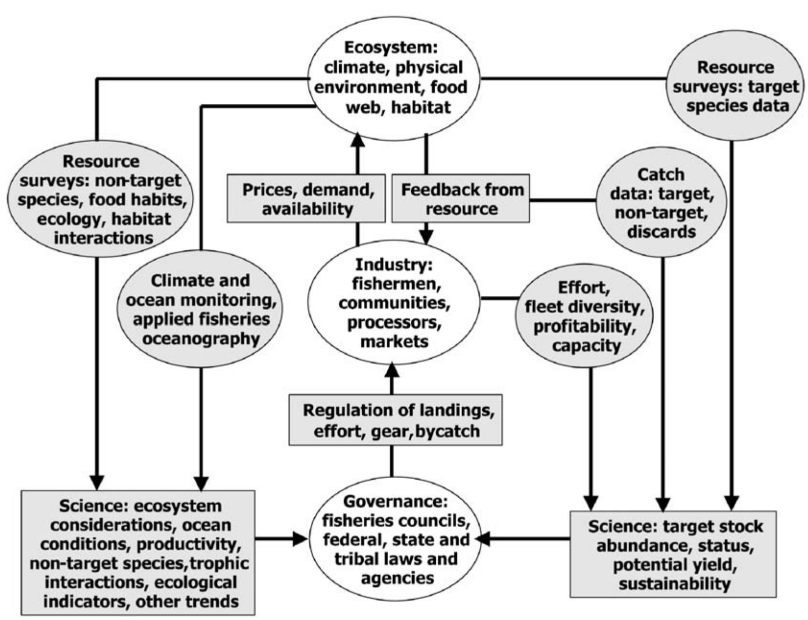

Fig. 7. A transitory stage between the conventional fisheries management view and a wholly ecosystem-based management perspective. Tractable problems are addressed by the governance sector to the extent practicable, while climate, productivity, habitat, and the needs of predators are implicitly considered in the context of making decisions. Adapted from Goodman et al. [114].

the primary source of skill and effort for crafting a FEP, revising a programmatic EIS, or otherwise coordinating management efforts across management plans or for species not currently managed by the Council (e.g., krill). The principal obligation of this team would be to provide ecosystem guidance, as related to climate, trophic, life history or other considerations, to the consideration of harvest guidelines and other decisions in the management cycle (advise relevant to habitat considerations, clearly critical to any ecosystem perspective, is currently provided by an existing habitat committee). By explicitly evaluating linkages between climate and productivity, or the role of the stocks in question as key predators or forage item for other species in the ecosystem, this body would also be capable of providing an ecosystem context for single-species assessments, and would serve as a conduit and intermediary for contemporary ecosystem information and research that might be directly relevant to Council activities or decisions.

This is essentially the current approach of the NPFMC, where a formalized system of assessing status and trends in the environment, and providing managers and decision makers with indicators of environmental and human impacts on the ecosystem, has been evolving over the last decade [28,51,115]. The key ecosystem objectives for the NPFMC have also been identified, and include maintaining predator/prey relationships, energy flows and balance, and diversity. Yet, despite the NPFMC's track record of largely maintaining harvest rates at or below MSY (or proxies thereof) levels, and with the majority of stocks managed by the Council at or above the target biomass levels, conservation concerns have dominated the North Pacific Council's management agenda. These concerns have been related to ecosystem changes that include altered productivity and distribution of many finfish populations, tremendous changes in the physical environment, and ongoing declines in marine mammals. To address these concerns, the NPFMC and the NMFS have had to integrate and apply scientific information across disciplines (marine mammals, finfish stock assessments, climate research) to the ecosystem level. The NPFMC experience demonstrates both the ability to achieve success in formally bringing ecosystem considerations to the table, and the challenges of actually using ecosystem models, data, or guidance within the contemporary fisheries management framework.

Clearly, there is a middle ground to be found in transitioning from a single species to a truly holistic ecosystem perspective, and this middle ground likely represents what may be feasible in any implementation of an ecosystem-based approach to fisheries management in the near future. In the idealized ecosystem management view, governance is provided with nearly complete knowledge regarding ocean conditions, productivity and the status of both target and non-target biota, as well as indicators of diversity and other measures of ecological health and integrity. In theory, this integrated ecosystem approach would make management decisions based on fully integrated estimates of ecosystem productivity and ecological interactions (such as the needs of other predators), and explicitly minimize the consequences of fishing on habitat, ecological structure, and life history traits. In practice, however, models may be able to offer some prediction of possible future trends under various climate scenarios and management strategies, but these models will in the near term unavoidably be constrained by a high degree of uncertainty. While the application of a range of models would increase the confidence in model scenarios, there are still far too many unanswered basic ecological questions to expect that such intimate knowledge of ecological processes, mechanisms or dynamics will soon be forthcoming [116]. The future of fisheries management may be one of increasing uncertainty, particularly as the cumulative impacts of localized and global change interact in patterns that vary from those in the historical past.

5. Conclusions

Management bodies and decision makers are making ecosystem management decisions every day, and there is increasingly relevant ecosystem information available that may help inform such decisions. Although management decisions will continue to be made with incomplete information, they can be improved upon with greater appreciation and knowledge of the state of the ecosystem, with respect to the role of climate, the complexity of trophic interactions, the importance of life history considerations, and the recognition of socio-economic interactions with these factors. In the short term, the Pacific Council could establish an ecosystem committee charged with developing and integrating existing ecosystem considerations as briefing materials, to inform and acclimate the Council community to existing data, knowledge, and potential directions for monitoring, modeling or research efforts. In the longer term, both the Council and the NMFS should develop a road map for phasing in ecosystem considerations within the current management context, and in the absence of a legal mandate for the development of FEPs, use the existing NEPA framework to assemble those elements proposed by the Ecosystem Principles Panel that have not already been initiated.

Despite the problems and challenges associated with today's fisheries crises, recognition of the important conservation role that MSY, reference points, and stock rebuilding requirements have made is key [117]. As Larkin [118] said in his premature eulogy to the theory of MSY, to appreciate what that single-species models and management based on MSY has done, we should consider what the state of the world's fisheries might be today if the concept had not been developed and widely implemented: "The fish, I'm sure, would shudder to think of it." Yet, the growing recognition for the role of the short- and long-term environmental variability, of habitat, trophic interactions and life history considerations leads one to the conclusion that there is much room for improvement. To paraphrase Gunderson and Holling [119], the single-species approach is not wrong, it is just incomplete. So too are the compositionalist, functionalist, and socio-economic approaches to ecosystem management described earlier: none are necessarily wrong, but all are based on worldviews that are to some extent incomplete. Consequently, each view may resonate with a different group of stakeholders. The real near-term contribution of any of these worldviews is that all would provide a greater ecosystem context for the existing set of single-species-based models and management strategies. In demonstrating the breadth of our uncertainty, ecosystem assessments, models, and management approaches should help to implement management strategies that are more robust to environmental and ecological variability and change.

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References

[1] Hilborn R, Punt AE, Orensanz J. Beyond band-aids in fisheries management: fixing world fisheries. Bulletin of Marine Science 2004;74:493–507.
[2] Laevastu T, Favorite F. Numerical evaluation of marine ecosystems Part I. Deterministic bulk biomass model (BBM). NOAA Processed Report, Northwest and Alaska Fisheries Center, NMFS, 1978.
[3] Evans WE, Douglas JE, Powell BA. National marine fisheries service program development plan for ecosystems monitoring and fisheries management, 1987.
[4] Hanna SS. The new frontier of American fisheries governance. Ecological Economics 1997;20:221–33.
[5] Ecosystem Principles Advisory Panel (EPAP). Ecosystem-based fisheries management: a report to congress by the ecosystem principles advisory panel. Silver Spring, MD: National Marine Fisheries Service, National Oceanic and Atmospheric Administration; 1999.
[6] National Research Council. Sustaining marine fisheries. Washington DC: National Academy Press; 1999.
[7] Parrish RH, Nelson CS, Bakun A. Transport mechanisms and reproductive success of fishes in the California Current. Biological Oceanography 1981;1:175–203.
[8] Chelton DB, Bernal PA, McGowan JA. Large-scale interannual physical and biological interactions in the California Current. Journal of Marine Research 1982;40:1095–125.
[9] McGowan JA, Cayan DR, Dorman LM. Climate, ocean variability and ecosystem response in the Northeast Pacific. Science 1998;281:210–7.
[10] Bakun A. Patterns in the ocean: ocean processes and marine population dynamics. La Paz, BCS, Mexico: California Sea Grant, Centro de Investigaciones Biologicas del Noroeste; 1996.
[11] MacCall AD. Patterns of low-frequency variability in fish populations of the California Current. CalCOFI Reports 1996;37:100–10.
[12] Larkin PA. Concepts and issues in marine ecosystem management. Reviews in Fish Biology and Fisheries 1996;6:139–64.
[13] Botsford LW, Castilla JC, Peterson CH. The management of fisheries and marine ecosystems. Science 1997;277:509–15.
[14] Pauly D, Christensen V, Guenette S, Pitcher TJ, Rashid Sumaila U, Walters CJ, et al. Towards sustainability in world fisheries. Nature 2002;418:689–95.
[15] Fowler CW. Tenets, principles, and criteria for management: the basis for systemic management. Marine Fisheries Review 2003;65:1–55.
[16] Pikitch EK, Santora C, Babcock EA, Bakun A, Bonfil R, Conover DO, et al. Ecosystem-based fishery management. Science 2004;305:346–7.
[17] Callicott JB, Crowder LB, Mumford K. Current normative concepts in conservation. Conservation Biology 1999;13:22–35.
[18] Stanley TR. Ecosystem management and the arrogance of humanism. Conservation Biology 1995;9:255–62.
[19] Grumbine RE. What is ecosystem management? Conservation Biology 1994;8:27–38.
[20] Odum EP. The strategy of ecosystem development. Science 1969;164:262–9.
[21] Holling CS, Meffe GK. Command and control and the pathology of natural resource management. Conservation Biology 1996;10:328–37.
[22] McEvoy AF. Historical interdependence between ecology, production, and management in California fisheries. In: Bottom D, Reeves G, Brookes M, editors. Sustainability issues for resource managers. USDA Forest Service Tech Rep. PNW-GTR-370, 1996.
[23] Berkes F, Colding J, Folke C, editors. Navigating social-ecological systems: building resilience for complexity and change. Cambridge: Cambridge University Press; 2002.
[24] National Oceanic and Atmospheric Administration (NOAA). New priorities for the 21st century: NOAA's strategic plan for FY 2005- FY 2010 and beyond, 2004 (http://www.spo.noaa.gov/pdfs/NOAA%20Strategic%20Plan.pdf).
[25] Walsh JP, Rieser A, Wilson H. Legal assessment of the Council's role under the Magnuson-Stevens Act, the Endangered Species Act, and the National Environmental Policy Act. Report to the

North Pacific Fishery Management Council, Anchorage, AK, 2002.

[26] Council on Environmental Quality (CEQ). Modernizing NEPA implementation: the NEPA task force report to the Council on Environmental Quality, 2003. http://ceq.eh.doe.gov/ntf/report/

[27] National Marine Fisheries Service (NFMS). Alaska groundfish fisheries final programmatic supplemental environmental impact statement. Juneau, AK: Alaska Regional Office; 2004.

[28] Livingston PA, Aydin K, Boldt J, Ianelli J, Jurado-Molina J. A framework for ecosystem impacts assessment using an indicator approach. ICES Journal of Marine Science 2005;62: 592–7.

[29] Hubbs CL. Changes in the fish fauna of western North America correlated with changes in ocean temperature. Journal of Marine Research 1948;7:459–82.

[30] Francis RC, Hare SR, Hollowed AB, Wooster WS. Effects of interdecadal climate variability on the oceanic ecosystems of the Northeast Pacific. Fisheries Oceanography 1998;7:1–21.

[31] Hare SR, Mantua NJ. Empirical evidence for North Pacific regime shifts in 1977 and 1989. Progress in Oceanography 2000;47:103–45.

[32] Pearcy WG, Schoener A. Changes in the marine biota coincident with the 1982–1983 El Nino in the northeastern subarctic Pacific Ocean. Journal of Geophysical Research 1987;92:14417–28.

[33] Lea RT, Rosenblatt RH. Observations on fishes associated with the 1997–98 El Niño off California. CalCOFI Reports 2000;41:117–29.

[34] Kawasaki T. Long term variability in pelagic fish populations. In: Kawasaki T, Tanaka S, Toba Y, Taniguchi A, editors. Long-term variability of pelagic fish populations and their environment. Tokyo: Pergamon Press; 1991.

[35] Schwartzlose RA, Alheit J, Bakun A, Baumgartner TR, Cloete R, Crawford RJM, et al. Worldwide large-scale fluctuations of sardine and anchovy populations. South African Journal of Marine Science 1999;21:289–347.

[36] King JR, editor. Report of the study group on fisheries and ecosystem responses to recent regime shifts. PICES Scientific Report No. 28. Sydney, BC, Canada: North Pacific Marine Science Organization (PICES); 2005.

[37] Matsuda H, Katsukawa T. Fisheries management based on ecosystem dynamics and feedback control. Fisheries Oceanography 2002;11(6):366–70.

[38] Muck P. Major trends in the pelagic ecosystem off Peru and their implications for management. In: Pauly D, Muck P, Mendo J, Tsukayama I, editors. The Peruvian upwelling ecosystem: dynamics and interactions. Callao, Peru: Instituto del Mar del Peru (IMARPE); Eschborn, Federal Republic of Germany: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), GmbH; and Manilla, Philippines: International Center for Living Aquatic Resources Management (ICLARM); 1989.

[39] Jacobson LD, MacCall AD. Stock-recruitment models for Pacific sardine (*Sardinops sagax*). Canadian Journal of Fisheries and Aquatic Sciences 1995;52:566–77.

[40] Pacific Fishery Management Council (PFMC). The coastal pelagic species fishery management plan; 1998.

[41] Swartzman G, Hickey B. Evidence for a regime shift after the 1998–1998 El Nino, based on 1995, 1998, and 2001 acoustic surveys in the Pacific Eastern Boundary Current. Estuaries 2003;26:1032–43.

[42] Dorn MW. The effects of age composition and oceanographic conditions on the annual migration of Pacific whiting, *Merluccius productus*. CalCOFI Reports 1995;36:97–105.

[43] Ware DM, McFarlane GA. Climate-induced changes in Pacific hake (*Merluccius productus*) abundance and pelagic community interactions in the Vancouver Island Upwelling System. In: Beamish RJ, editor. Climate change and northern fish populations. Canadian Special Publications in Fisheries and Aquatic Sciences 1995;121:509–21.

[44] Helser TE, Dorn MW, Saunders MW. Pacific whiting assessment update for 2001. In: Appendix to the status of the Pacific coast groundfish fishery through 2001 and acceptable biological catches for 2002: stock assessment and fishery evaluation. Portland, Oregon: Pacific Fishery Management Council; 2002.

[45] Mullin MM, Goetze E, Beaulieu SE, Lasker JM. Comparisons within and between years resulting in contrasting recruitment of Pacific hake (*Merluccius productus*) in the California Current System. Canadian Journal of Fisheries and Aquatic Sciences 2000;57:1434–47.

[46] Smith PE. Pelagic fish early life history: CalCOFI overview. In: Harrison PJ, Parsons TR, editors. Fisheries oceanography: an integrative approach to fisheries ecology and management. Oxford: Blackwell Science; 2000.

[47] Emmett RL, Brodeur RD. Recent changes in the pelagic nekton community off Oregon and Washington in relation to some physical oceanographic conditions. North Pacific Anadromous Fisheries Commission Bulletin 2000;2:11–20.

[48] Rexstad EA, Pikitch EK. Stomach contents and food consumption estimates of Pacific Hake, *Merluccius productus*. Fishery Bulletin 1986;84:947–56.

[49] Hannah RW. Variation in geographic stock area, catchability, and natural mortality of ocean shrimp (*Pandalus jordani*): some new evidence for a trophic interaction with Pacific hake (*Merluccius productus*). Canadian Journal of Fisheries and Aquatic Sciences 1995;52:1018–29.

[50] Robinson CLK, Ware DM. Simulated and observed response of the southwest Vancouver Island pelagic ecosystem to oceanic conditions in the 1990s. Canadian Journal of Fisheries and Aquatic Sciences 1999;56:2433–43.

[51] Boldt J, editor. Ecosystem Considerations for 2004: Appendix C of Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Stock Assessment and Fishery Evaluation. Anchorage, AK: North Pacific Fishery Management Council; 2003.

[52] Department of Fisheries and Oceans (DFO). Pacific Region State of the Ocean. Department of Fisheries and Oceans (DFO) Science Ocean Status Report 2003, Ottowa, Canada, 2002.

[53] North Pacific Marine Science Organization (PICES). PICES Report on Marine Ecosystems of the North Pacific. North Saanich, BC: PICES Secretariat; 2004.

[54] Schwing FB, Bograd SJ, Collins SA, Gaxiola-Castro G, García J, Goericke R, et al. The state of the California Current, 2001–2002: will the California Current keep its cool, or is El Niño looming? CalCOFI Reports 2002;43:31–68.

[55] Venrick E, Bograd SJ, Checkley D, Durazo R, Gaxiola-Castro G, Hunter J, et al. The state of the California Current, 2002–2003: tropical and subarctic influences vie for dominance. CalCOFI Reports 2003;44:10–27.

[56] Peterson WT, Schwing FB. A new climate regime in the northeast Pacific ecosystems. Geophysical Research Letters 2003;30:17528–33.

[57] Ralston S, Howard DF. On the development of year-class strength and cohort variability on two northern California rockfishes. Fishery Bulletin 1995;93:710–20.

[58] Logerwell E, Lawson P, Mantua N, Francis RC, Agostini V. Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (*Oncorhynchus kisutch*) marine survival. Fisheries Oceanography 2003;12: 554–68.

[59] Hamlet AF, Huppert D, Lettenmaier DP. Economic value of long-lead streamflow forecasts for Columbia River hydropower.

Journal of Water Resources Planning and Management 2002;128:91–101.
[60] American Association of State Climatologists (AASC). The state climatologist 2003 annual summary, 2003.
[61] Scholtz A, Bonzon K, Fujita R, Benjamin N, Woodling N, Black P, et al. Participatory socioeconomic analysis: drawing on fishermen's knowledge for marine protected area planning in California. Marine Policy 2004;28:335–49.
[62] Dalton MG. El Niño, expectations, and fishing effort in Monterey Bay, California. Journal of Environmental Economics and Management 2001;42:336–59.
[63] Christensen V, Walters CJ. Ecopath with Ecosim: methods, capabilities and limitations. Ecological Modelling 2004;172:109–39.
[64] Hollowed AB, Bax N, Beamish R, Collie J, Fogarty M, Livingston P, et al. Are multispecies models an improvement on single-species models for measuring fishing impacts on marine ecosystems? ICES Journal of Marine Science 2000;57:707–19.
[65] Walters CW, Christensen V, Martell SJ, Kitchell JF. Possible ecosystem impacts of applying MSY policies from single species assessments. ICES Journal of Marine Science 2005;62:558–68.
[66] Bundy A. Fishing on ecosystems: the interplay of fishing and predation in Newfoundland-Labrador. Canadian Journal of Fisheries and Aquatic Sciences 2001;58:1153–67.
[67] Worm B, Myers RA. Meta-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. Ecology 2003;84:162–73.
[68] Cox SP, Essington TE, Kitchell JF, Martell SJD, Walters CJ, Boggs C, et al. Reconstructing ecosystem dynamics in the central Pacific Ocean, 1952–1998. II. A preliminary assessment of the trophic impacts of fishing and effects on tuna dynamics. Canadian Journal of Fisheries and Aquatic Sciences 2002;59:1736–47.
[69] Olson RJ, Watters GM. A model of the pelagic ecosystem in the Eastern Tropical Pacific Ocean. Inter-American Tropical Tuna Commission Bulletin 2003;22:135–218.
[70] Field JC, Francis RC, Aydin K. Top down modeling and bottom up dynamics: linking a fisheries-based ecosystem model with climate hypotheses in the Northern California Current. Progress in Oceanography, in review.
[71] Fulton EA, Smith ADM, Johnson CR. Effects of complexity on marine ecosystem models. Marine Ecology Progress Series 2003;253:1–16.
[72] Plagányi ÁE, Butterworth DS. The global eco-epidemic: a critical look at what Ecopath with Ecosim can and cannot achieve in practical fisheries management. In: Shannon LJ, Cochrane KL, Pillar SC, editors. African Journal of Marine Science 2004;26:261–87.
[73] Schnute JT, Richards LJ. Use and abuse of fisheries models. Canadian Journal of Fisheries and Aquatic Sciences 2001;58:10–7.
[74] Francis RC. A web of small tensions. Fisheries 2003;28:20–3.
[75] Mangel M, Hofman RJ, Norse EA, Twiss JR. Sustainability and ecological research. Ecological Applications 1993;3:573–5.
[76] Conover DO, Munch SB. Sustaining fisheries yields over evolutionary time scales. Science 2002;297:94–6.
[77] Conover DO. Darwinian fishery science. Marine Ecology Progress Series 2000;208:303–7.
[78] Stergiou KI. Overfishing, tropicalization of fish stocks, uncertainty and ecosystem management: resharpening Ockham's razor. Fisheries Research 2002;55:1–9.
[79] Lotka AJ. Elements of physical biology. Baltimore: Williams and Wilkins; 1925.
[80] Longhurst A. Murphy's law revisited: longevity as a factor in recruitment to fish populations. Fisheries Research 2002;56:125–31.
[81] Gunderson DR. Population biology of Pacific ocean perch, *Sebastes alutus*, stocks in the Washington-Queen Charlotte sound region, and their response to fishing. Fishery Bulletin 1977;75:369–403.
[82] Leaman BM, Beamish RJ. Ecological and management implications of longevity in some northeast Pacific groundfish. Bulletin of the International North Pacific Fisheries Commission 1984;42:85–97.
[83] Longhurst A. Cod: perhaps if we all stood back a bit? Fisheries Research 1998;38:101–8.
[84] Munk KM. Maximum ages of groundfishes in waters off Alaska and British Columbia and considerations of age determination. Alaska Fishery Research Bulletin 2001;8:12–21.
[85] Love MS, Yolkavich M, Thorsteinson L. The rockfishes of the Northeast Pacific. Berkeley: University of California Press; 2002.
[86] Punt AE. Evaluating the efficacy of managing West Coast groundfish resources through simulations. Fishery Bulletin 2003;101:860–73.
[87] Yoklavich MM, Greene HG, Cailliet GM, Sullivan DE, Lea RN, Love MS. Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fisheries Bulletin 2000;98:625–41.
[88] Mangel M, Levin PS. Regime, phase and paradigm shifts: making community ecology the basic science for fisheries. Philosophical Transactions of the Royal Society B 2005;360:95–105.
[89] Trippel EA, Kjesbu OS, Solemdal P. Effects of adult age and size structure on reproductive output in marine fishes. In: Chambers RC, Trippel EA, editors. Early life history and recruitment in fish populations. London: Chapman & Hall; 1997.
[90] Murawski SA, Rago PJ, Trippel EA. Impacts of demographic variation in spawning characteristics on reference points for fishery management. ICES Journal of Marine Science 1997;58:1002–14.
[91] Berkeley SA, Hixon MA, Larson RJ, Love MS. Fisheries sustainability via protection of age structure and spatial distribution of fish populations. Fisheries 2004;29:23–32.
[92] Berkeley SA, Chapman C, Sogard SM. Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. Ecology 2004;85(5):1258–64.
[93] Bobko SJ, Berkeley SA. Maturity, ovarian cycle, fecundity, and age-specific parturition of black rockfish, *Sebastes melanops*. Fishery Bulletin 2004;102:418–29.
[94] Hilborn R, Quinn TP, Schindler DE, Rogers DE. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Sciences 2003;100:6564–8.
[95] Bisbal GA, McConnahah WE. Consideration of ocean conditions in the management of salmon. Canadian Journal of Fisheries and Aquatic Sciences 1998;55:2178–86.
[96] Nickelson TE, Lawson PW. Population viability of coho salmon (*O. kisutch*) in Oregon coastal basins: application of a habitat-based life history model. Canadian Journal of Fisheries and Aquatic Sciences 1998;55:2383–92.
[97] Hanna SS. Interactions between shellfish and groundfish fisheries on the west coast: implications for system management. Journal of Shellfish Research 1992;11:133–41.
[98] Murawski SA, Brown R, Lai HL, Rago PJ, Hendrickson L. Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. Bulletin of Marine-Science 2000;66:775–98.
[99] Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R. Effects of marine reserves on adjacent fisheries. Science 2001;294:1920–3.
[100] National Research Council (NRC). Marine protected areas: tools for sustaining ocean ecosystems. Washington, DC: National Academy Press; 2001.

[101] Botsford LW, Micheli F, Hastings A. Principles for the design of marine reserves. Ecological Applications 2003;13:S25–31.

[102] Hilborn R, Stokes K, Maguire JJ, Smith T, Botsford LW, Mangel M, et al. When can marine reserves improve fisheries management? Ocean and Coastal Management 2004;47:197–205.

[103] Jennings S. The ecosystem approach to fishery management: a significant step towards sustainable use of the marine environment? Marine Ecology Progress Series 2004;274:279–82.

[104] National Marine Fisheries Service (NMFS). Pacific Coast groundfish fishery management plan, essential fish habitat designation and minimization of adverse impacts: draft environmental impact statement. Seattle: NMFS Northwest Region; 2005.

[105] King SE, Hannah RW, Parker SJ, Matteson KM, Berkeley SA. Protecting rockfish through gear design: development of a selective flatfish trawl for the US west coast bottom trawl fishery. Canadian Journal of Fisheries and Aquatic Sciences 2004;61:487–96.

[106] Northwest Fisheries Science Center (NWFSC). West Coast observer program data report and summary analysis 2004.

[107] Rojas-Burke J. Murky waters—fishermen's benefits from reduced trawl fleet are uncertain. Portland, OR: The Oregonian; 2003.

[108] McDonald C. Buyouts deplete trawler fleet: last 4 Bellingham-based boats deliver their final catches. Bellingham, WA: The Bellingham Herald; 2003.

[109] Henion J. Buyout nets casualties. Crescent City, CA: The Daily Triplicate; 2003.

[110] Branch TA, Rutherford K, Hilborn R. Replacing trip limits with individual transferable quotas: implications for discarding. Marine Policy, in press, doi:10.1016/j.marpol.2004.12.003.

[111] Gunderson LH, Holling CS, Light SS, editors. Barriers and bridges to the renewal of ecosystems and institutions. New York: Columbia University Press; 1995.

[112] Kates RW, Clark WC, Corell R, Hall JM, Jaeger CC, Lowe I, et al. Sustainability science. Science 2001;292:641–2.

[113] Schellnhuber HJ. Earth system analysis and the second Copernican revolution. Nature 1999;C23402:C19–23.

[114] Goodman D, Mangel M, Parkes G, Quinn T, Retrepo V, Smith T, et al. Scientific review of the harvest strategy currently used in the BSAI and GOA groundfish Fishery Management Plans. Report prepared for the North Pacific Fishery Management Council, November 2002.

[115] Witherell D, Pautzke C, Fluharty D. An ecosystem-based approach for Alaska groundfish fisheries. ICES Journal of Marine Science 2000;57:771–7.

[116] May RM. Unanswered questions in ecology. Philosophical Transactions of the Royal Society of London B 1999;354:1951–9.

[117] Mace PM. A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management. Fish and Fisheries 2001;2:2–32.

[118] Larkin PA. An epitaph for the concept of maximum sustained yield. Transactions of the American Fisheries Society 1977;106:1–11.

[119] Gunderson LH, Holling CS. Panarchy: understanding transformations in human and natural systems. Washington, DC: Island Press; 2002.

[120] Macpherson M. Integrating ecosystem management approaches into federal fishery management through the Magnuson-Stevens fishery conservation and management act. Ocean and Coastal Law Journal 2001;6:1–32.

Agenda Item C.5.a
Attachment 3
April 2007

Pacific Fishery Management Council

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February 13, 2007

Mr. Joseph Uravitch
National MPA Center, N/ORM
National Oceanic and Atmospheric Administration
1505 East-West Highway
Silver Spring, MD 20910

Re: Pacific Fishery Management Council Comments on the Draft Framework for Developing the National System of Marine Protected Areas.

Dear Mr. Uravitch:

Thank you for the opportunity to review and comment on the National Marine Protected Areas Center's Draft Framework for Developing the National System of Marine Protected Areas. Your letter and Draft Framework were provided to the Pacific Fishery Management Council (Pacific Council) at its November 2006 meeting in Del Mar, California. Due to the heavy workload associated with the November 2006 meeting, placing this matter on the agenda for the Council and its advisory bodies was not possible. However, on behalf of the Council, I would like to take this opportunity to provide the following general comments on the Draft Framework.

As you are aware the Pacific Council and the National Marine Fisheries Service (NMFS) has implemented several area management concepts including coastwide Rockfish Conservation Areas closed to commercial and recreational fisheries for the protection of overfished groundfish species and areas closed to trawl or bottom contacting fishing gear to protect groundfish essential fish habitat. In developing the later, the Pacific Council worked closely with the National Marine Sanctuary Program to meet shared goals and objectives to protect habitat areas within the Channel Islands, Cordell Bank, and Monterey Bay National Marine Sanctuaries. Many, if not all of these area management actions meet the proposed criteria for marine protected areas (MPAs) in the Draft Framework and should be considered during Phase I efforts to build the initial network or existing MPAs. The Pacific Council is encouraged by this effort to inventory MPAs and marine managed areas and is optimistic that this comprehensive assessment will prove useful to the Pacific Council and the Nation as ecosystem-based fishery management and place-based area management concepts are further investigated.

The Pacific Council is in the initial stages of exploring ecosystem-based fishery management principles and is considering the development of a Fishery Ecosystem Plan, in part, to help coordinate, monitor, and assess the effectiveness of area and place-based management efforts. The goals and objectives of the proposed Fishery Ecosystem Plan will likely share attributes of the rational, goals, and objectives of the National System of MPAs. The Pacific Council would welcome collaboration with the MPA Center to ensure the goals and objectives of national and regional area management plans are based on the best available science and achieve healthy marine ecosystems and sustainable fisheries.

As development of a National MPA Network begins to identify potential gaps and additional conservation needs under Phase 2 of the Draft Framework, it will essential to maintain coordination between the National MPA Center and the Regional Fishery Management Councils, particularly in the early stages of considering new MPAs, if necessary. Should new MPAs or existing MPA's in West Coast National Marine Sanctuaries be deemed to require additional fishery restrictions, the Pacific Council maintains the position that regulation of marine fisheries should occur solely under the authority of the Magnuson-Stevens Fishery Conservation and Management Act via the Pacific Council forum and the regulatory authority of NMFS and the States.

The Pacific Council and I, look forward to continued work with the National MPA Center on the National System of Marine Protected Areas. If you or your staff should 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:rdd

c: Council Members
Dr. Charles Wahle

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February 28, 2007

Jonathan Kelsey
National System Development Coordinator
National Marine Protected Areas Center
NOAA's Office of Ocean and Coastal Resource Management
1305 East-West Highway
Silver Spring, MD 20910-3281

Dear Mr. Kelsey:

Thank you for the opportunity to provide comments on the National Marine Protected Areas (MPA) Center's *Draft Framework for Developing the National System of Marine Protected Areas*. This framework provides an outline to implement a presidential executive order[1] to develop a national system of marine protected areas (MPAs). It is clear that considerable consultation, public comment, and care went into drafting the framework. Based on consultation with the Washington State Department of Fish and Wildlife and other state agencies, the Washington State Department of Ecology offers the following comments on this draft framework on behalf of Washington State.

General

Overall, the framework provides a good balance between the many authorities and interests in our nation's marine areas. In general, the framework: 1) respects the authority of states, local, and tribal governments; 2) provides for voluntary involvement; and 3) promotes coordination. Washington considers all three of these to be key components to developing a national system of MPAs.

The State of Washington, along with four coastal tribes and the Olympic Coast National Marine Sanctuary, recently formed an Intergovernmental Policy Council to manage the marine resources of the Olympic Coast National Marine Sanctuary. The effort will improve government-to-government communication among the tribes, state, and sanctuary on management of these marine waters. As sovereign nations, many tribes have treaty fishing

[1] Executive Order No. 13158, May 2000.

rights and co-management responsibilities with the State of Washington for fish and other natural resources in the state. Thus, it is important, as recognized by the MPA Center, that MPAs in the national network and future MPAs recognize the authority and role of other entities such as tribes, states, and other governments in managing marine resources.

Two common types of regulatory action are typically needed in creating MPAs: prohibition of certain fishing activities and, potentially, additional measures for habitat protection. Depending on the regulatory action, there are different sets of overlapping jurisdictions. For example, for fishing regulations in Washington State, the overlapping authorities are the National Marine Fisheries Service, the treaty tribes, and the Washington Department of Fish and Wildlife. Establishing habitat protection measures on Washington's outer coast adds to the mix the authorities of the Olympic Coast National Marine Sanctuary, the U.S. Fish and Wildlife Service, and the Washington Departments of Ecology and Natural Resources.

While the draft framework provides an opportunity for these different authorities to coordinate, it is unclear whether the purpose is primarily for information sharing, or whether the collective group is expected to develop recommendations for each representative to take back to their respective agencies. It is also unclear how the National MPA Center will fit into existing processes, such as the Pacific Fishery Management Council process, which is currently handling much of the coordination relative to fishing regulations that this framework seems to address. **Recommendation: The MPA Center should clarify the purpose of coordination and how the MPA Center will fit into existing regulatory processes.**

In summary, Washington especially values the independence and voluntary involvement by states, tribes, and local governments that is described in the framework. Additionally, we recognize that increased coordination and communication among regulatory agencies regarding operation and development of MPAs can promote better partnerships that increase efficiency, maximize effectiveness, and improve resource management. Therefore, we support the information-sharing approach provided by the framework.

Section VI. Goals, Objectives, and Key Definitions for the National System of MPAs

All of the goals and objectives appear to center on an ecosystem-based management approach and, again, there appears to be considerable overlap with work that is being done in other arenas on the West Coast. At their November 2006 meeting, the Pacific Fishery Management Council initiated development of a Fishery Ecosystem Plan that will incorporate ecosystem-based fishery management principles. The intent of this plan is to recognize the importance of understanding both marine ecological principles and human interactions, while noting that striking a balance between competing goals will bring challenges. While the development of this plan appears consistent with the goals and objectives described in the MPA Center's framework, we believe that regional differences in ecosystems need to be taken into account when viewing this from a national perspective. **Recommendation: We advocate continuing to work through the Pacific Fishery Management Council process to develop and adopt the specific goals and objectives for ecosystem-based fishery management on the West Coast.**

Section VII. Developing the National System of MPAs

The draft framework document touches upon an important issue that needs to be considered when reviewing the comprehensive list of current MPAs on the West Coast—that is, many areas are de-facto MPAs. Many of these areas, however, may not be reflected in the current inventory of MPAs. These de-facto MPAs are in place for many different reasons—some protect habitat, others protect specific species of rockfish, and others provide tools for fishery management. A few areas are completely closed to all fishing activities, but the majority of them are closed to specific gear types and/or activities. These gear-specific closures have direct fishery allocation implications among many different governments and sectors—including state, tribal, non-tribal commercial, and recreational. This is one of the primary reasons that the creation of new MPAs, and/or the definition of a national system of current MPAs, that have a fishery closure component need to be developed through the regional fishery management council process.

To facilitate national coordination, the draft framework suggests establishing a national System Steering Committee. With regard to regulating fishing activities, the State of Washington continues to support the position described in the Pacific Fishery Management Council's correspondence with the Secretary of Commerce. That is, that fishing regulatory authority should be exercised under the Magnuson-Stevens Fishery Conservation and Management Act, rather than through the National Marine Sanctuary Act and, in this case, through a steering committee established by the National MPA Center. **Recommendation: We support the creation of the steering committee for the purposes of information sharing and potential development of recommendations that could be forwarded to the appropriate regulatory agencies for consideration.**

According to the draft, specifics on how to determine representation on the national steering committee will be based on comments received. Washington believes this committee must contain ample regional representatives from a wide array of interests. This includes representatives from regional fishery management councils; state and tribal governments; marine user groups such as fishing, shipping, and recreational interests; and managers of marine protected areas. **Recommendation: Include a wide range of regional representation on the national steering committee such as tribes, states, marine user groups, and fishery management councils.**

Section IX. Implementing MPA Executive Order Section 5. "Agency Responsibilities"
The executive order requires federal agencies to "avoid harm to the natural and cultural resources that are protected by an MPA." As outlined by the draft framework, this "avoid harm" provision will be implemented through existing authorities and review mechanisms and enforceable through annual self-reporting. Washington appreciates federal agencies' wanting to provide maximum efficiency by incorporating this review into existing work. Additionally, the executive order did not provide for additional authorities pertaining to agency review of a proposed activity for impacts to MPAs. The mechanism currently suggested that federal agencies request a review by the MPA Center using existing agency review procedures. The MPA Center will, in turn, provide voluntary technical guidance and best practices to federal agencies regarding marine protected areas.

One of the many federal laws identified as an existing authority for incorporating this MPA review is the Coastal Zone Management Act (CZMA) – a federal authority delegated to coastal states. The CZMA does not currently require federal agencies to consult with other federal agencies regarding federal consistency, unless a federal law is encompassed in the state's coastal program. Be aware that state programs have limitations in their ability to achieve the MPA Center's "avoid harm" provision. State programs vary widely in their enforceable policies for CZMA federal consistency determinations and many may not include provisions that address avoiding harm to MPAs. **Recommendation: The MPA Center must clarify and provide more details on how avoiding harm to MPAs will be addressed by CZMA's existing review process.**

The draft framework contends that no definitions exist for "avoid harm," "affect", or "to the extent permitted by law and to the maximum extent practicable." Furthermore, it suggests that an agency's requirement for "avoid harm" will depend on the nature of the activity and the legal framework for a particular MPA. Unfortunately, without a definition of "avoid harm" it will be nearly impossible to assess whether harm is being avoided by federal agency actions. The lack of a definition sets up a moving target for federal agencies, the public, and interested stakeholders. **Recommendation: We suggest developing a definition that encompasses the general conditions and requirements under the "avoid harm" provision for various classes of MPAs to provide greater clarity to all.**

Finally, the framework allows the determination of whether an agency is taking actions to avoid harm to be made by the individual agency itself. Washington State is concerned that this method for reporting lacks independent review against a defined standard. Ultimately, this will result in uncertainty and lack of accountability for federal agencies regarding "avoiding harm" to marine protected areas – the goal of this part of the executive order.

Section X. Evaluating the Effectiveness of the National System of MPAs

The framework suggests that results of monitoring and evaluating the National System will help identify and shape future initiatives including: "priority marine area and resources gaps to be filled." However, the framework is silent on how these gaps will be filled. The framework does not specify whether this gap analysis could be used to propose establishing new MPAs. **Recommendation: Washington requests clarification on the potential and expected outcomes of this evaluation method.**

Washington State appreciates the efforts of the MPA Center to provide a framework for developing a national system of marine protected areas. Thank you for considering our comments.

Sincerely,

Gordon White
Program Manager
Shorelands and Environmental Assistance Program