Part II

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MAKING ECOSYSTEM-BASED MANAGEMENT A REALITY: THE PACIFIC FISHERY MANAGEMENT COUNCIL AND THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT

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ABSTRACT

Implementing ecosystem-based management requires both scientific assessments of ecosystem interactions and policy analysis of the interactions between the laws that manage the ecosystem and its resources. The California Current Integrated Ecosystem Assessment (IEA) process brings together scientists from a host of disciplines to assess the interactions and status of the California Current Ecosystem. However, the generation of scientific information does not automatically lead to management action. U.S. fisheries law facilitates and allows ecosystem-based management but does not require it, a situation that can either encourage creativity or stifle action. The Pacific Fishery Management Council (Pacific Council) is engaged in an ecosystem-based fishery management process to better understand the California Current Ecosystem and how ocean resource management processes and priorities interact to affect the ecosystem. For the California Current IEA to support movement toward ecosystem-based management, it must better account for how our laws affect natural resources and drive management processes.

INTRODUCTION

"Implementation of the IEA process for the California Current is now underway. Potentially, it represents a major advance toward regional ecosystem-based management. To many, the reality, as opposed to the promise, of ecosystem-based management is far from clear. Integration of environmental considerations into the management of living marine resources has proven remarkably difficult, which leads us to examine how it can be best achieved in the California Current." J. A. Koslow, September 2011, instructions to speakers for the 2011 CalCOFI meeting.

The conundrum Koslow poses is familiar to scientists in many disciplines. If there is strong scientific opinion in support of a course of action, why is there not political movement toward taking that action? Answers to that question vary with the abilities of scientists to communicate their findings with policymakers and the general public, and with the laws and political frameworks that affect the desired legal or regulatory change. While ecosystem-based management certainly requires the support of a vast array of scientific efforts, it also fundamentally requires new ways of thinking about public policy and management processes. Scientists have developed models to help us think about the functions of ecosystems as a whole (e.g. Polovina 1984; Jorgensen 1986; Christensen and Pauly 1992; Walters et al. 1997; Aydin et al 2002; Christensen and Walters 2004; Fulton et al. 2004; Kishi et al. 2007). In doing so, they bring together data and ideas from diverse disciplines—biology, oceanography, chemistry, and physics, but often miss the essential human dimensions of ecosystem-based management (Fulton et al. 2011). For ecosystem-based management to become a reality, managers must see not just the applications of those models to the ecosystems and people they govern, but must also think about how to bring together the political minds, networks, and incentives that affect those ecosystems.

In recent decades, scientific literature has explored the general concept of ecosystem-based management (Slocombe 1993; Grumbine 1994; Kaufmann et al. 1994; Christensen et al. 1996) as well as the more specific application of ecosystem-based management to the marine environment (Larkin 1996; Botsford et al. 1997; Link et al. 2002; Pikitch et al. 2004; Arkema et al 2006; Crowder and Norse 2008; Levin and Lubchenco 2008). Link 2002 framed the question for living marine resources, suggesting that we are not actually attempting ecosystem management, but rather attempting fisheries management in an ecosystem context. This question of defining ecosystem-based management has captured the interest of ocean and fisheries scientists, as they have fleshed out definitions (Brodziak and Link 2002; Slocombe 1998), and made suggestions on how to do it (Leslie and McLeod 2007; Marasco et al. 2007), and provided analyses of the California Current Ecosystem (MacCall 1986; McGowan et al. 1998; Goericke et al. 2004; Field and Francis 2005; Goericke et al. 2005; Peterson et al. 2006; Goericke et al. 2007; DiLorenzo et al. 2008; McClatchie et al. 2008 McClatchie et al. 2009; Bjorkstedt et al. 2010). Scientists have been making suggestions on governance (Crowder et al. 2006; Ruckelshaus et al. 2008) and "commanding" other scientists on how to conduct ecosystem science (Francis et al.

2007). In the U.S., Congress ultimately paid attention to all of this literature and requested a summary of the state of science to support an ecosystem approach to fishery management (NMFS 2009). Given these and many other scientific efforts, what would move ecosystem-based fisheries management in the California Current and elsewhere beyond discussions within scientific publications and closer to a reality in practice? Our laws, policies, and economies are manifestations of how human societies and minds interact. If ecosystem-based management is to move toward reality, it must include examinations of human institutions and ideas about governance, cultural goals, and economic priorities.

THE MAGNUSON-STEVENS ACT, ECOSYSTEM-BASED MANAGEMENT, AND THE PACIFIC FISHERY MANAGEMENT COUNCIL

While U.S. laws initially come from the minds and will of Congress, they must be approved by the president, and then interpreted and implemented by one or more of the many agencies within the executive branch [U.S. Const. art. I–III]. Dissatisfied members of the public may then have the opportunity to request, through one or more lawsuits, that the judicial branch provide a new or differently nuanced interpretation of the law. A significant result of this process is that the meaning of a law, or the methods for interpreting that law, can change over time. In other words, a law cannot be understood by simply reading the text of the legislation itself; its meaning must be assessed within the frame of congressional will, executive implementation, and judicial interpretation.

One of the most influential federal laws shaping U.S. living marine resource management is the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). The Magnuson-Stevens Act governs fish and fisheries within the U.S. Exclusive Economic Zone, those marine waters within 3–200 nm offshore of the U.S. coast. While the act allows "integrating ecosystem considerations into fisheries management" [16 U.S.C. §1801(a)(11)], it does not explicitly require ecosystem-based management (MacPherson 2001; Parenteau et al. 2008; Salcido 2010). The act has no definition for the terms "ecosystem-based management," "ecosystem approaches to management," or even "ecosystem" [16 U.S.C. §1802], although the conservation and management requirements of the act comport with many of the principles of ecosystem-based management. Three major Magnuson-Stevens Act conservation objectives have spurred scientific efforts to expand our understanding of relationships between different species and between those species and their habitats: rebuild overfished stocks and end overfishing [16 U.S.C. §1853(a)(10)], monitor and minimize bycatch [16 U.S.C. §1853(a)(11)], and identify and protect essential fish habitat [16 U.S.C. §1855(b)]. Taken together, actions to meet those goals bring us closer to the principles that Grumbine 1994 ascribed to ecosystem management, particularly, "maintain viable populations of all native species in situ" and "represent, within protected areas, all native ecosystem types across their natural range of variation." However, MacPherson's (2001) explanation of ecosystem-based management within a Magnuson-Stevens Act context still applies today: the principles and policies of the act provide opportunities for implementation, but do not mandate the use of an ecosystem-based approach in fisheries management.

The Magnuson-Stevens Act retains many of the original principles from its first iteration in 1976, but it has also been significantly revised by each of the three branches of government, through congressional reauthorizations, through the executive branch implementing the law in highly varied U.S. marine ecosystems, and through judicial interpretation of the requirements of the law in different courts nationwide. The original language of the law also set up, and still maintains, a dynamic relationship between the science and management processes, requiring that fishery "conservation and management measures shall be based on the best scientific information available" [16 U.S.C. §1851(a)(2)]. This seemingly simple and common-sense requirement has supported decades of rigorous scientific inquiry. That dynamic relationship manifests as a large-scale conversation about how and what new scientific information can help us to better understand the fish stocks and habitat we manage. If the best available fisheries science can provide managers with science tools that supplement and complement such essential management tools as stock assessments, then those tools will influence how resource managers and policy-makers at every level of government think about marine ecosystems and the law. In other words, new scientific information can influence how the law is implemented, when and if that information is deemed "best available."

The Magnuson-Stevens Act authorizes eight regional fishery management councils to guide federal fisheries management in the United States, advising the National Oceanic and Atmospheric Administration (NOAA) in its implementation of the act. Jurisdictions of the eight regional councils roughly coincide with large marine ecosystems (Sherman 1991), possibly indicating some insight on the part of Congress into the notion of ecosystem-based fisheries management, or at least the concept that fisheries management should be spatially driven to avoid myriad potential jurisdictional conflicts. Fish and fisheries within the U.S. portion of the California Current Ecosystem are managed with the advice of the Pacific Council. Fishery management councils are

quasi-governmental bodies consisting of members of the public, representatives from U.S. states and tribes, and representatives from federal agencies [16 U.S.C. §1852]. Government and public interests are further represented on council advisory bodies with varying responsibilities: reviewing the strength of scientific information developed to serve the council process; representing the interests of particular fishing, environmental, or community groups; developing federal, and sometimes state and tribal, regulatory measures to implement the advice of the councils. Each council's Scientific and Statistical Committee is the arbiter of whether scientific information is appropriate for use in council management decisions [16 U.S.C. §1852]. The primary functions of the councils are to prepare, review, and amend fishery management plans for fisheries under their geographic areas of authority, working within venues that are both open to the public and in locations appropriate to the geographic areas managed [16 U.S.C. §1852]. Fishery management plans are required to meet ten national standards[16 U.S.C. §1851(a)], and to include a host of provisions ranging from describing and identifying essential fish habitat to describing the vessels and gear used, and revenues from, each fishery managed under the plan [16 U.S.C. §1853].

Fishery management councils are taking a range of creative approaches to implementing ecosystem-based management. Some councils have already developed fishery ecosystem planning documents (NPFMC 2007, SAFMC 2009, WPFMC 2009). Other councils without formal ecosystem plans are still using new scientific information and Magnuson-Stevens Act authority to implement ecosystem-based management measures through programs that—for example—better monitor and estimate fisheries' bycatch (Jannot et al. 2011), engage in a strategic planning process for fisheries' futures (MAFMC 2012), and establish overfished species rebuilding plans with multi-sector restrictions to account for directed and incidental catch (GMFMC 2011). The concept of the fishery ecosystem plan as a strategic fishery management planning document evolved from a 1998 report from the U.S. Ecosystem Principles Advisory Panel (EPAP 1998), a panel mandated and funded by the Magnuson-Stevens Act [16 U.S.C. §1882]. Although the act itself does not require fishery ecosystem plans, the panel's work inspired fishery management councils to explore ecosystem-based fishery management planning.

The Pacific Council's fishery management programs include an array of ecosystem-based fishery management measures (PFMC 2011a, PFMC 2012), and it is in the process of developing a fishery ecosystem plan. In part, the Pacific Council intends its fishery ecosystem plan to "enhance the Council's species-specific management programs with more ecosystem science, broader ecosystem considerations and management policies that coordinate Council management across its Fishery Management Plans and the California Current Ecosystem" (PFMC 2011b). The Pacific Council also intends its fishery ecosystem plan to "provide a framework for considering policy choices and trade-offs" as they affect managed species and the California Current Ecosystem, recognizing a need for improved understanding of how the ecosystem affects California Current Ecosystem fish and fisheries, and vice versa (PFMC 2011b). The fishery ecosystem plan is ultimately intended to complement, rather than supplement, the conservation and management measures the Pacific Council has already developed to improve the long-term sustainability of fisheries through protections to the stocks themselves and to habitat (PFMC 2012; Seagraves and Collins 2012).

THE CALIFORNIA CURRENT IEA IN THE POLICY PROCESS

In the U.S., NOAA has been developing its framework for Integrated Ecosystem Assessments (IEAs) to provide a scientific basis for ocean ecosystem-based management (Levin et al. 2008, 2009). IEAs are intended to provide a means of summarizing ecosystem status, screening and prioritizing potential risks, and evaluating alternative management strategies against a backdrop of environmental variability (Levin et al. 2008). Ocean ecosystem modelers have commented that large-scale ecosystem models, like those used within IEAs, can provide natural resource managers with strategic (long-term), rather than tactical (short-term), advice for management decisions (Fulton 2010; Link 2010; Kaplan et al. 2012). Most decisions made within the fishery management council process, however, are tactical and require fairly specific scientific advice. Table 1 details the Pacific Council's Scientific and Statistical Committee reviews conducted and reported on in 2011, illustrating that most scientific analyses reviewed for their utility in decision-making deal with tactical management decisions, often addressing near-term allowable harvest levels. Large-scale recent strategic decisions in the Pacific Council process have been related to the development of the fishery ecosystem plan, and to Magnuson-Stevens Act requirements to develop new processes for setting annual catch limits for all species [16 U.S.C. §1852] and to review requirements for essential fish habitat designations for its managed species [50 C.F.R. §600.815].

NOAA's California Current IEA program, described in more detail elsewhere in this report, is beginning to provide technical reports on the status of the California Current Ecosystem and on the interactions within the ecosystem between the physical environment, human activities, and ocean life (Horne et al. 2010; Ainsworth et al. 2011; Levin and Schwing 2011). California Cur-

TABLE 1
Scientific Analyses Reviewed by the Pacific Council's Scientific and Statistical Committee (SSC) in 2011

2011 Pacific Council Meetings	SSC reviews in 2011, based on SSC reports to the Pacific Council (available online: http://www.pcouncil.org/council-operations/council-meetings/past-meetings/)	Tactical (T)/ Strategic (S)
March	• 2011 experimental fishing permit for an aerial sardine survey	T
	• Review of 2010 West Coast salmon fisheries and summary of 2011 stock abundance forecasts	T
	• Identification of salmon stocks not meeting annual conservation objectives	T
	• Sacramento Fall Chinook overfishing assessment	T & S
	• 2011 Pacific whiting assessment and harvest specifications	T
	• Ecosystem-based management planning report	S
April	• 2011 experimental fishing permit for an aerial sardine survey	T
	• Acoustic–trawl survey methodology for coastal pelagic species abundance	T
	• 2011 salmon abundance estimation methodology review	T
	• 5-year review of salmon essential fish habitat designations	T & S
	• Harvest specifications and stock assessment considerations for 2013–2014 groundfish fisheries	T
	• 5-year review of groundfish essential fish habitat designations	T & S
June	• Classifying salmon harvest reference points and needed analysis in support of those classifications	S
	• Economic analysis of the North Pacific albacore fisheries	T
	• Groundfish stock assessments for 2013–2014 fisheries	T
	• Socioeconomic analyses needed for 2013–2014 groundfish harvest specifications and management measures	T
	• Socioeconomic analyses needed for trailing actions under trawl rationalization	T
	• Pacific mackerel management for 2011–2012	T
	• Ecosystem-based management planning report	S
September	• Albacore tuna stock assessment	T
	• Groundfish stock assessments for 2013–2014 fisheries	T
	• Biennial management process for and models used in development of 2013–2014 groundfish fisheries	T
	• Needed science improvements for the next groundfish management biennium	T & S
	• Columbia River tule and Sacramento River winter Chinook management	T & S
	• 2011 salmon abundance estimation methodology review	T
	• Estimating Pacific halibut bycatch in groundfish fisheries	T
November	• 2011 salmon abundance estimation methodology review	T
	• Groundfish stock assessments for 2013–2014 fisheries	T
	• Groundfish management specifications for 2013–2014 fisheries	T
	• Pacific sardine assessment and coastal pelagic species management measures for 2012	T
	• Integrated Ecosystem Assessment report	S
	• Fishery Ecosystem Plan—DRAFT	S

rent IEA scientists and the Pacific Council and its advisory bodies have been discussing where and how best to bring IEA products and reports into the Pacific Council process (Levin and Wells 2011; PFMC 2011c). Initially, IEA-generated information will likely enter the Pacific Council process through an annual report on the state of the California Current Ecosystem, much like the state of the California Current paper produced for CalCOFI Reports, but tailored to focus on those biophysical trends known to affect shifts in abundance of managed species (PFMC 2012).

NOAA's foundational description of the IEA process necessarily focused on the scientific processes needed to implement an IEA (Levin et al. 2008). Nonetheless, that process is intended to provide analysis of ecological interactions relative to "specified management goals" (Levin et al. 2008). Who then is to specify those management goals, and how? NOAA's vision for the IEA process proposes beginning with a scoping process that would be independent from any legal context, yet also a primary source for determining "specified management goals" (Levin et al. 2008, 2009; deReynier et al. 2010). For managers, however, scoping on policy issues occurs within frameworks created by the laws that authorize and guide policy discussions. Scoping on U.S. natural resource management issues commonly occurs as part of a process to review a potential management action using the National Environmental Policy Act (NEPA) review process. Under implementing regulations for NEPA, scoping is a process "for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" [40 C.F.R. 1501.7]. NEPA scoping does not occur independently from policy initiatives; NEPA provides the framework for analysis of potential actions authorized by other federal laws or programs. If IEA products are to be useful to a management process, they must consider policy questions (or specified management goals) that our laws require us to ask. For example, an IEA examination of the potential trophic effects of regularly harvesting managed species' populations at twice their optimum yield levels might be interesting, but managers are prohibited by law from setting such harvest levels and thus might not find such an examination useful.

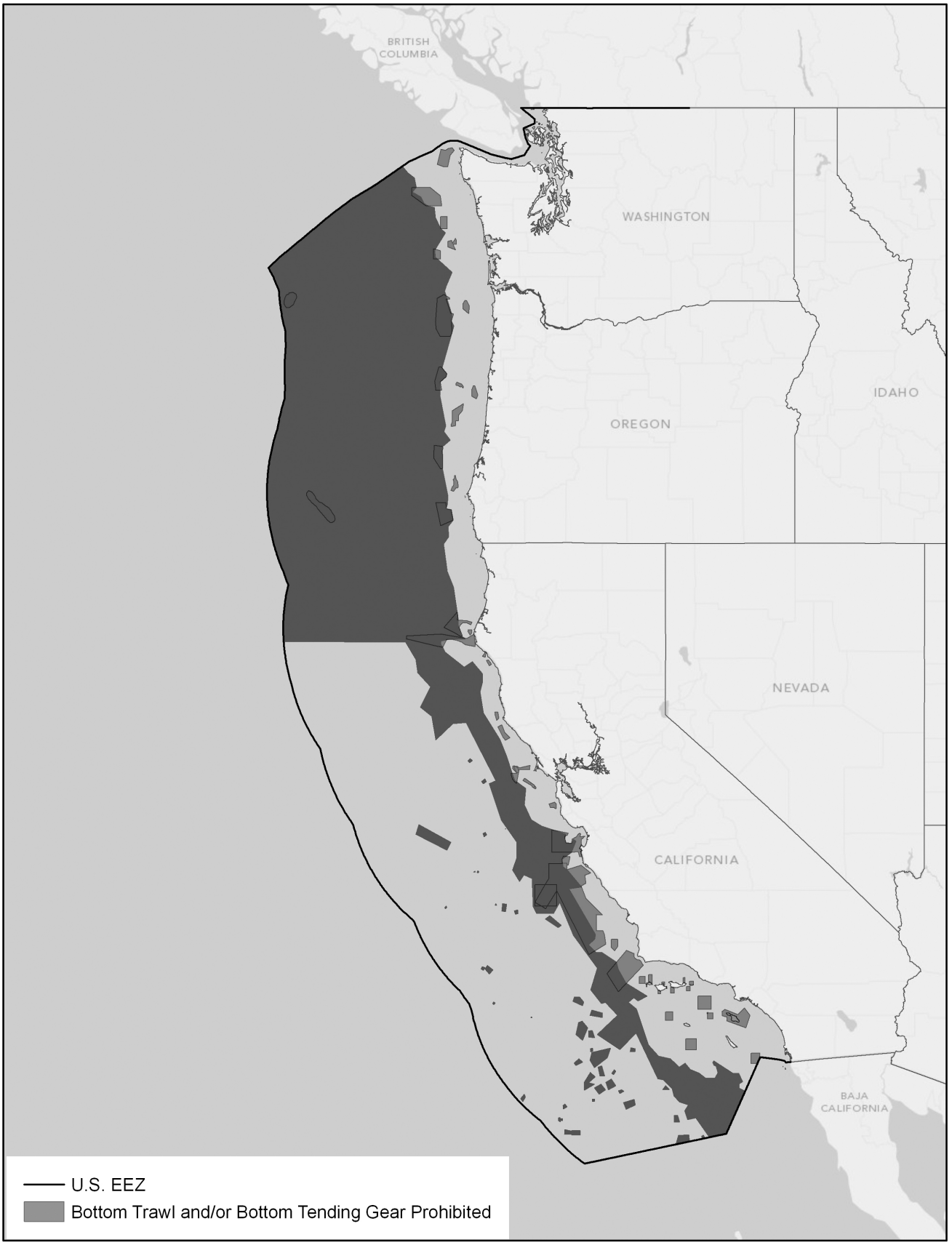

Figure 1. Groundfish Essential Fish Habitat Conservation Areas off the U.S. West Coast.

IEA scientists will need to better engage with managers if IEA products are to be useful to management decisions. And, managers will need to begin ecosystem-based assessments of how the laws and policies they implement affect regional ocean resource management priorities. Those policy assessments could well be just as complex and lengthy as the scientific assessments provided for IEAs. In 2004, the U.S. Commission on Ocean Policy's final report discussed how a range of U.S. laws affect ocean ecosystem management, and provided Appendix D, which briefly summarized federal ocean and coastal-related commissions, committees, councils, laws, and programs (USCOP 2004). According to that appendix, there are 45 major laws with varying degrees of specificity and influence that affect the use and management of ocean and coastal ecosystems and resources. The implementation of any law that addresses where and how humans interact with the natural environment will vary from region to region to accommodate the unique qualities of the managed resources and the human cultures and economies that interact with those resources. For IEAs to become essential management tools, there must be parallel policy assessment processes to determine the ecosystem-based management questions derived from current laws and relevant to management concerns within a given ecosystem. Some examples of how a policy analyst might ask cross-jurisdictional questions based on the federal laws and policies that affect California Current Ecosystem resources include:

- Under the Magnuson-Stevens Act, the Pacific Council is in the midst of the required 5-year reviews of the essential fish habitat components of its four fishery management plans [50 C.F.R. §600.815], and will face the same review requirements another 5 years hence. In preparation for that next round of review, could the California Current IEA assess the effects of fishing gear on essential fish habitat under a variety of fishing effort scenarios derived from the effort shifts that may result from the Pacific Council's trawl rationalization program?
- Under the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010, federal agencies have been required to draft a National Fish, Wildlife and Plants Climate Adaptation Strategy. Could the California Current IEA assess the potential effects of short-term climate shift and long-term climate change on the ability of marine mammal populations to achieve their optimum population levels under the Marine Mammal Protection Act? How might fisheries harvest levels authorized by the Magnuson-Stevens Act interact with climate change to affect marine mammal populations protected by the Marine Mammal Protection Act?
- The five National Marine Sanctuaries off the U.S. West Coast have adopted a joint Ocean Acidification Action Plan (Lott et al. 2011) that, among other things, calls for the selection of indicator species for the different sanctuary habitats in the five sanctuaries that would be appropriate for monitoring the environmental effects of ocean acidification, in keeping with the research requirements of the Federal Ocean Acidification Research and Monitoring Act of 2009 and the National Marine Sanctuaries Act. Could the California Current IEA help to identify appropriate indicator species for each of the sanctuaries and assess the trophic effects of changes in population levels of those species?

To actually be used in management decisions, results from any of these analyses would need to undergo more rigorous peer review processes than those provided through journal publication processes. The Magnuson-Stevens Act requires that science in support of fishery management council decisions be reviewed through council Scientific and Statistical Committees [16 U.S.C. §1852(g)]. As regional IEAs becomes more mature, the quality of their science products should be tested through a process similar to the Center for Independent Experts (CIE) process used so successfully for fish stock and mammal abundance assessments (Brown et al. 2006). For IEA products intended to support fishery management councils, advance CIE-type review would help already overburdened Scientific and Statistical Committees to focus the scopes of their own reviews of IEA products. For IEA products intended to support non-fisheries decisions, a CIE-type review would be essential to address managers' concerns about how much weight decision-making or long-term planning should give to a new science process and its products.

CONCLUSION

For management processes to embrace ecosystem-based management, they require not just scientific information about the state of an ecosystem and its component parts, but also analyses of how the laws and policies that affect the ecosystem interact with each other and steer the management of the ecosystem. The Pacific Council is using its fishery ecosystem plan development process to gain a better understanding of the California Current Ecosystem, and to more clearly assess how its management programs interact with each other across its fishery management plans. The work of developing the fishery ecosystem plan will ensure that the dialogue concerning the best available science for use in fisheries management includes increasing attention to ecosystem science. While the Pacific Council's efforts necessarily focus on fisheries, not the full range of human activities within the ecosystem, its work can serve as a solid base for more broad-scale efforts to make ecosystem-

based management a reality within the California Current Ecosystem. As the stewards of living marine resources, the Pacific Council can set the tone for a deeper regional understanding of the linked fortunes of sustainable human activity within the marine environment and the sustained long-term status of the marine ecosystem. For the Pacific Council and other policy-making bodies to make more full use of information derived from the California Current IEA requires policy analysts and legal scholars to join the IEA discussion and to assess how the laws they implement apply specifically within the California Current Ecosystem, and within an intellectual environment of new and changing scientific information.

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