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February 28, 2017

Mr. Herb Pollard, Chair
Pacific Fishery Management Council
7700 NE Ambassador Place, #101
Portland, OR 97220

RE: Agenda Item F.3: Support for a Climate Shifts Fishery Ecosystem Plan Initiative

Dear Chair Pollard and Council Members:

Oceana is writing in support of the Pacific Fishery Management Council (Council) moving forward with a climate shifts ecosystem initiative that could directly inform fishery management decisions and reference points, including optimum yield. Protecting the health and biodiversity of our oceans, while managing for long-term, ecologically sustainable fisheries, requires an integrated, ecosystem-based approach. The Pacific Coast Fishery Ecosystem Plan (FEP) identifies prospective ecosystem-based initiatives and provides the Council with a process to determine whether to undertake one of these initiatives.

In 2015, the Council demonstrated its leadership in taking action to protect seven groups of unfished and unmanaged forage fish through Comprehensive Ecosystem-Based Amendment 1, which developed from the "Forage Species" initiative of the FEP. This initiative served as the basis for tangible management actions that amended each of the Council's four fishery management plans (FMP). New FEP initiatives provide the Council an opportunity for continued work to implement ecosystem-based fisheries management.

Of the existing FEP initiatives, the Ecosystem Workgroup identified two that are most ready for Council consideration, including an initiative on the effects of near-term climate shifts and long-term climate change on our fish, fisheries, and fishing communities.[1] Climate change and associated ocean acidification are increasing the vulnerability of fish stocks and protected species, impacting coastal and ocean habitats, and affecting the products, services, uses, and benefits people derive from marine, coastal and freshwater ecosystems.[2] Effective management of fishery resources will require information related to climate change, specifically how to monitor, respond to, and prepare for a changing ocean environment. The FEP initiative process would allow the Council to prioritize information it needs to design and

[1] Ecosystem Workgroup Report 2 (March 2017), *available at* http://www.pcouncil.org/wp-content/uploads/2017/02/F3a_EWG_Rpt_Mar2017BB.pdf. The second initiative identified by the Ecosystem Workgroup is a combined initiative on the socio-economic effects of fisheries management practices on fishing communities and on human recruitment to the fisheries.
[2] NOAA Fisheries, Climate Science Strategy 1-6 (Aug. 2015), *available at* http://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/NCSS_Final.pdf.

implement tangible management actions that account for the effects of climate change on Council-managed species.

The National Marine Fisheries Service (NMFS) Climate Science Strategy identifies seven key objectives to meet its mission in the face of a changing climate. The first is to identify appropriate climate-informed reference points for managing marine resources.[3] These "are the thresholds upon which . . . management decisions are made," and "[d]etermining how climate-related effects should be incorporated into . . . reference points is critical to advance climate-ready fisheries."[4] Such reference points include maximum sustainable yield and optimum yield.[5]

Under the Magnuson-Stevens Fishery Conservation and Management Act, the Council and NMFS must "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery."[6] Optimum yield is "prescribed on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor."[7] Presently, the Council's four FMPs neither specify relevant economic, social, or ecological factors, nor describe how these factors are evaluated to determine optimum yield. NMFS guidelines, however, specify that ecological factors include "environmental conditions that stress marine organisms or their habitat."[8] Optimum yield and other reference points must be responsive to changing climate and ecosystem conditions.

We support the Council moving forward in 2017 on a new ecosystem initiative to consider the effects of near-term climate shifts and long-term climate change on our fish, fisheries, and fishing communities. Although the FEP, by design, is informational rather than prescriptive, its ultimate success will be measured by the extent to which it can serve as a tool to advance and implement ecosystem-based management. We encourage the Council to initiate a comprehensive ecosystem-based amendment to revise one or more of its four FMPs to describe ecological factors used in management and to establish climate-informed biological and ecological reference points, as appropriate for the stocks managed under each plan.

Sincerely,

Ben Enticknap
Pacific Campaign Manager and Senior Scientist

[3] *Id.* at 19.
[4] *Id.*
[5] 50 C.F.R. § 600.310(b)(2)(iv).
[6] 16 U.S.C. §1851(a)(1).
[7] *Id.* § 1802 § 3(33)(B).
[8] 50 C.F.R. § 600.310(e)(3)(iii)(B)(3).

February 28, 2017

Mr. Herb Pollard, Chair
Pacific Fishery Management Council
7700 NE Ambassador Place, #101
Portland, OR 97220

RE: Agenda Item F.3: Review of Fishery Ecosystem Plan Initiatives

Dear Chair Pollard and Council Members:

Ocean Conservancy, The Nature Conservancy (TNC), Wild Oceans, the Pew Charitable Trusts and Natural Resources Defense Council thank the Pacific Fisheries Management Council (Council) for its continued work implementing ecosystem-based fisheries management (EBFM). A changing ocean environment has and will lead to unpredictable impacts on our valuable fisheries and the ecosystem upon which they depend. Consequences for coastal communities have already been felt as a result of natural variability in the California Current, and increasing variability due to a changing ocean conditions will likely exacerbate existing pressures and add to uncertainty. **For these reasons, we recommend that the Council start work on Fishery Ecosystem Plan (FEP) initiative *A.2.8 Cross-FMP Effects of Climate Shifts* to understand predicted impacts on the ecosystem, and explore tools and best practices that better prepare the Council to manage an increasingly variable future**.

Based on existing science, policy, and best practices, the following items (discussed in more depth below) can help the Council execute an FEP initiative that results in increased preparedness today:

1. **Use existing science to implement "climate-tested" management approaches that safeguard species, people, and the ecosystem**

2. **Put management best practices in place to prepare the Council to manage increased change in the future**

Background

Recent oceanographic events and their consequences on fishing-dependent communities have highlighted both the variability inherent in the California Current Large Marine Ecosystem (CCLME) and

the impacts that a changing ocean can have on people.[1,2] The warm blob, El Niño conditions, and raised domoic acid levels impacted West Coast fisheries and coastal communities in 2016.[3] The Fishery Ecosystem Plan catalogs some of the existing threats related to climate on target species and communities, and the wide-spread implications of climate change on fish and fisheries in the California Current is widely documented by multiple scientific and policy sources.[4,5]

Environmental variability and climate change affect multiple parts of the ecosystem, all of which are interrelated. Many of the direct impacts of climate change, such as sea-level rise or an increasing number of storms, are driven by forces beyond the jurisdiction of the Council. Approaching the question of "how to prepare west coast fisheries for climate change" then requires starting from the standpoint of what is possible. While most tools to combat climate change are beyond the control of fishery managers, for example the Council cannot implement cap-and-trade or other large-scale carbon limiting policies, other management tools and scientific information can increase readiness and improve outcomes in the face of change. Achieving optimum yield while ensuring a productive and healthy ecosystem, stable fleets and thriving communities, despite climate change, is possible.

Now is the time to focus an FEP initiative on preparing for climate change. With a better understanding of current variability and better ability to adapt to changing conditions in the future, we promote a more stable fleet and meet ecosystem protection goals. As the last two years have shown, conditions will change, often in surprising ways, and likely pose challenges for managers. Preparing now will help the Council meet those challenges, and limit adverse consequences on people and the environment.

Based on knowledge gained in the previous FEP initiative around ecosystem indicators, national and regional policies, and global best practices, we propose actions that the Council can take now to address environmental variability and prepare for climate change. We also propose structural improvements that will help the Council prepare for coming decades, and strongly endorse the climate workshop proposed by TNC and scheduled for summer 2017.

1. **Use existing science to implement "climate-tested" management approaches that safeguards species, people, and the ecosystem**

    a. *Use the National Marine Fisheries Service (NMFS) California Current climate vulnerability analysis to identify stocks of highest concern and conduct Management Strategy Evaluations (MSE) to develop management approaches that are robust to climate change.*

NMFS is concluding a vulnerability analysis to identify economically important West Coast stocks that are most vulnerable to climate change. Based on a methodology developed and first used in New England and supported for use by the NOAA Fisheries Climate Science Strategy Western Regional Action

[1] NMFS Climate Science Strategy Western Region Action Plan, Appendix B. *The 2012-2015 "climate change stress test" for the West Coast*. Pg. 63.
[2] Daniel Mintz, The Humboldt Independent. *Crab Disaster Could Reflect Long-Term Trend*. August 16, 2016.
[3] NOAA Fisheries. News and Features. *Commerce Secretary Pritzker declares fisheries disasters for nine West Coast species*. January 19, 2017. http://www.noaa.gov/news/commerce-secretary-pritzker-declares-fisheries-disasters-for-nine-west-coast-species.
[4] NMFS Climate Science Strategy Western Region Action Plan. Expected Impacts of Climate Change in the CCLME. Pg. 17.
[5] Sydeman, W.J., and S.A. Thompson. Potential impacts of climate change on California's fish and fisheries. Farallon Institute. 2013.

Plan (WRAP),[6, 7] the results could inform managers on what species should receive attention first. We support the Ad-hoc Ecosystem Workgroups (EWG) proposal that the Council could use the results of this investigation and conduct MSEs to identify management strategies that are robust to the long-term effects of climate change.[8] NMFS, at the Council's request as part of the ecosystem indicators initiative, is currently doing a similar project to identify ecosystem drivers of sablefish recruitment (Agenda item F.2).

b. *Develop climate-related spatially-appropriate indicators of ecosystem structure and function, and create warning systems that detect regime shifts and notifies fishermen and managers*.

Working with the California Current Integrated Ecosystem Assessment (CCIEA) team, and using existing data and monitoring oceanographic indicators appropriately scaled, monitoring can be set up that alerts fishermen and managers when threshold levels are reached. For example, new research is being conducted on the development of early warning indicators that can signal major shifts in oceanic regimes before they occur.[9] The spatial element is particularly important as many indicators are likely to be most useful at sub-regional resolutions, [10] including those related to climate.[11] Likely candidates include chlorophyll concentration (indicate harmful algal blooms),[12] pH, and oxygen levels (indicate ocean acidification and hypoxic zones),[13] and water temperature (indicates movement of stocks). Also included should be indicators of ecosystem integrity such as regionalized primary productivity,[14] stock demographics (age- and size- distribution of managed stocks),[15,16] and copepod anomalies,[17] all of which are linked to changes in climate and have cross-FMPs impacts.[18]

c. *Identify climate-ready indicators for specific ecosystem components based on ready science*.

A mechanistic understanding of how climate change affects specific species is lacking for many of the target stocks and ecosystem components within the Council's jurisdiction. However, with regards to the information we do have, incorporation into management is extremely valuable and desirable. We have high levels of knowledge around salmon, and moderate levels for groundfish. NMFS is planning to conduct a habitat risk assessment that will prioritize habitats that are most at risk to changing ocean conditions and are most important for conservation. Fishing community vulnerability is also a key aspect

[6] National Marine Fisheries Service, Office of Science and Technology. Assessing the Vulnerability of Fish and Invertebrate Species in a Changing Climate. https://www.st.nmfs.noaa.gov/ecosystems/climate/activities/assessing-vulnerability-of-fish-stocks.
[7] NMFS Climate Science Strategy Western Region Action Plan, pg. 41.
[8] PFMC, Ad-hoc Ecosystem Workgroup Report, March 2017, Agenda item F.3.a
[9] Litzow, M. A., and M. E. Hunsicker. 2016. Early warning signals, nonlinearity, and signs of hysteresis in real ecosystems. Ecosphere 7(12):e01614. 10.1002/ecs2.1614
[10] Consideration of sub-regional indicators recommended by the Scientific and Statistical Committee, Habitat Committee, Highly Migratory Species Management Team, Salmon Advisory Subpanel, and the Ecosystem Advisory Subpanel. PFMC meeting September 2016, Agenda item D.1.a.
[11] PFMC, Ad-hoc Ecosystem Workgroup Report, March 2017, Agenda item F.3.a
[12] Recommended by the Ecosystem Advisory Subpanel report, PFMC meeting September 2016, Agenda item D.1.a.
[13] Recommended by the Coastal Pelagic Species Advisory Subpanel, PFMC meeting September 2016, Agenda item D.1.a.
[14] Recommended by the Ecosystem Advisory Subpanel report, PFMC meeting September 2016, Agenda item D.1.a.
[15] Neuheimer, A. B., Thresher, R. E., Lyle, J. M., & Semmens, J. M. (2011). Tolerance limit for fish growth exceeded by warming waters. Nature Climate Change, 1(2), 110-113
[16] PFMC, Ad-hoc Ecosystem Workgroup Report, March 2017, Agenda item F.3.a
[17] Recommended by the GMT report, PFMC meeting September 2016, Agenda item D.1.a.
[18] Hoegh-Guldberg, Ove, and John F. Bruno. "The impact of climate change on the world's marine ecosystems." *Science* 328.5985 (2010): 1523-1528.

of the ecosystem and ripe for further exploration. We recommend that the Council ask NMFS to identify thresholds that trigger Council notification or action for data-rich key ecosystem components, and continue to improve understanding of prioritized components that are lacking necessary data or analysis.

2. Put management best practices in place to prepare the Council to manage increased change in the future

a. *Build management structures that support "climate-ready" single species management*.

The FEP chapter on bringing Cross-FMP and Ecosystem Science into the Council Process states that "…stock assessment and other harvest-level support science are the largest category of science products directly used in the Council process."[19] Recognizing the importance and centrality of stock assessment to the management process, we recommend three steps to strengthen the use of climate-related information within stock assessments and harvest control rules. 1) Task the scientific and statistical committee (SSC) with developing guidelines for how climate-related information can be included in stock assessments.[20] 2) Develop terms of reference for groundfish and Coastal Pelagic Species (CPS) Stock Assessment and Review (STAR) panels that include a review of climate-readiness and emerging climate concerns as recommended by the EBFM Road Map.[21] 3) Request that NMFS include ecologists and/or climate scientists on NMFS Stock Assessment Teams (STATs), STAR panels, and Council management teams where possible.

b. Make the EWG a permanent management team.

We recommend designating the EWG as a permanent and standing management team. To best achieve the benefits associated with EBFM and employ the FEP, a management team dedicated to advising the Council is essential. The EWG has performed a highly valuable role within the Council process, not only facilitating the organization and completion of two FEP initiatives, but also helping the Council review and address other important ecosystem-level items such as the NMFS climate science WRAP, the California Current Integrated Ecosystem Assessment State of the California Current Report, and the NMFS EBFM Road Map. To improve the ability of the group to advise the Council we recommend adding a NMFS Integrated Ecosystem Assessment seat, as well as a seat for the United States Fish and Wildlife Service.

c. *Implement FMP-specific ecosystem reporting to help focus scientific efforts and investments on practical management solutions.*

Similar to the Annual Ecosystem Report, FMP-specific reporting could cover indicators and ecosystem trends including information about the effects of climate change, but directly relate to each FMP and be delivered to each advisory body, management team, and the Council at the appropriate time in each FMP's management cycle. The EWG cites in their report for this agenda item, "One of the lessons learned through [FEP] Initiative 2 was that progress in the use of indicators for management would require continued and regular interaction of IEA contributors with the Council and its advisory bodies."[22]

[19] PFMC Fishery Ecosystem Plan, pg. 188.
[20] PFMC, SSC Report September 2010, Agenda item H.1.c. in reference to developing guidelines for how ecosystem information can be used in stock assessment.
[21] NMFS EBFM Road Map, pg. 26.
[22] PFMC, Ad-hoc Ecosystem Workgroup Report, March 2017, Agenda item F.3.a

As an example, a groundfish ecosystem report could be developed by the CCIEA program and reflect indicators and trends that most impact and are impacted by groundfish stocks and the fishery in the previous two years. The CCIEA program would then deliver and present the contents of the report to the Groundfish Advisory Panel, Groundfish Management Team, and Council at the meeting when it would be most relevant in the groundfish management cycle. Such reports would not be intended as replacements for the Annual Ecosystem Report, which provides a broad cross-FMP and cross sector overview, but will pull mainly from the same indicator database and would allow for a tailored and direct information flow.

d. *Develop an emerging fisheries policy to address movement of key stocks across international and jurisdictional boundaries*.

The geographical shift of stocks is one of the major predicted outcomes of climate change on fisheries.[23] As water temperature and other related oceanographic changes occur, many species will relocate either to deeper waters or move latitudes, seeking conditions suitable to their biology. We recommend developing a Council policy that outlines how the Council can best address this. Such a policy could include a protocol for more responsive and flexible partnership with Mexico and Canada as well as community engagement and tactics for empowering fishermen and communities to adapt. For example, this policy could inform new entrants on how to build climate-ready fishing portfolios or further streamline the EFP process. Part of this could include expansion of Council Operating Procedure #24 (regarding the development of new fisheries on forage species) to all species.

TNC Climate Workshop

TNC has secured funding for a workshop that will be structured to meet the needs of the Council in moving forward with the climate shift impacts discussion. A two-day workshop will be held in Portland, Oregon in July. The focus of the workshop will be on climate shifts in the California Current Ecosystem and the specific structure will depend on the discussion at the March Council meeting. This workshop will provide additional resources to complete the work needed on the Climate-Shifts initiative.

In the event a different initiative is chosen, the workshop will provide an avenue to evaluated climate related considerations for the chosen initiative (e.g., if a socio-economic initiative were chosen, the workshop could look at the impacts of climate change on the social and economic needs of coastal communities). In the event the Council is in need of more information before selecting an initiative, the workshop will be structured to generate the additional information needed to move forward with the initiative.

We strongly encourage Council member and stakeholder participation in this workshop. Stakeholder input is critical to successful implementation of EBFM, as societal needs and values are a foundational part of defining what management should achieve. [24, 25] The effects of climate change on stakeholders, as noted above, extend beyond the jurisdiction of the Council. Knowing what external pressures fishermen and communities will face in addition to those addressed through the Council, even if only in qualitative or narrative forms, is important for decision-making and prioritization of Council issues. The

[23] NMFS Climate Science Strategy Western Regional Action Plan, pg. 17.
[24] Levin PS, Fogarty MJ, Murawski SA, Fluharty D (2009) Integrated ecosystem assessments: Developing the scientific basis for ecosystem-based management of the ocean. PLoS Biol 7(1).
[25] Lenfest Fishery Ecosystem Task Force. *Building Effective Fishery Ecosystem Plans*. November 2016.

proposed workshop, in addition to identification of priority concerns, can also help increase EBFM and climate change science fluency among participants.

Conclusion

We recommend that the Council begin work on FEP ecosystem initiative *A.2.8 – Cross-FMP Effects of Climate Shifts*. In addition to the existing language that recommends an in-depth review to more fully and completely describe the effects of environmental variability and climate change on Council-managed species, we suggest that the Council consider the above actions that could be taken today to address the effects of a changing climate on the entire marine ecosystem. Finally, we strongly encourage Council member and stakeholder participation in the TNC sponsored workshop, as discussed above.

Sincerely,

Corey Ridings
Ocean Conservancy

Steve Marx
The Pew Charitable Trusts

Gway Kirchner
The Nature Conservancy

Theresa Labriola
Wild Oceans

Seth Atkinson
Natural Resources Defense Council

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BUILDING EFFECTIVE FISHERY ECOSYSTEM PLANS

A REPORT FROM THE LENFEST FISHERY ECOSYSTEM TASK FORCE

INTRODUCTION

Connections matter. That is the unifying principle of ecosystem-based fisheries management (EBFM). Ecological connections matter because fishing affects target species, predators, prey, competitors, bycatch species, and habitat. Economic connections matter because management affects fishermen, wholesalers, retailers, and recreational fishing guides. And social connections matter because fishing supports families and communities.

U.S. fisheries management has made tremendous strides under the current management framework, which centers on single stocks or stock complexes rather than ecosystems. In addition, fishermen, managers, and many others have cooperated to reduce bycatch, conserve habitats, and improve the equity and safety of fisheries.

However, conventional management has certain limitations. It generally focuses on one fishing sector at a time, which may unexpectedly lead to worse outcomes in another sector. It often considers a narrow range of issues, potentially overlooking other factors that shape fishery systems, such as loss of habitat and the behavior of people and markets. And fundamentally, the current system is atomized into individual fishery management plans (FMPs), often leaving little opportunity to consider overarching management goals or the trade-offs across fisheries that attend almost every decision.

EBFM provides mechanisms to address these issues and many others. Yet despite this, and despite many other reports and studies that have made the case for EBFM, it has not been widely adopted. The Task Force believes a major reason is that there is no clear way to put its principles into practice.

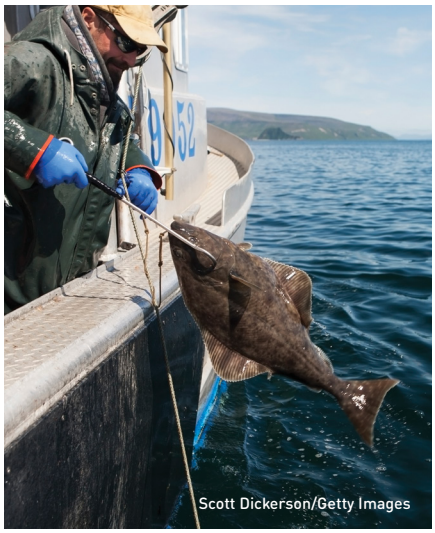
A BLUEPRINT FOR NEXT-GENERATION FEPS

This document summarizes a new report from the Lenfest Fishery Ecosystem Task Force, *Building Effective Fishery Ecosystem Plans*. The purpose of this report is to offer a blueprint for Fishery Ecosystem Plans (FEPs) as a means to translate EBFM into action. FEPs have been proposed for this purpose before, and most U.S. Regional Fishery Management Councils have since either started or completed an FEP. But these plans often focus on system description rather than management action.

The Task Force envisions FEPs as a structured planning process that uses adaptive management to operationalize EBFM. This "FEP Loop" process starts by identifying the key factors that shape a fishery system and considering them simultaneously, as a coherent whole. It then helps managers and stakeholders delineate their overarching goals for the system and refine them into specific, realistic projects. And it charts a course forward with a set of management actions that work in concert to achieve the highest-priority objectives.

This report contains no new science or policy innovations. This is because the Task Force found—through deliberation, document review, and conversations with managers and stakeholders—that EBFM is feasible today using existing science tools, policy instruments, and management structures. Not only that, nearly all of the steps in the proposed "FEP Loop" process are already being carried out by U.S. fishery managers.


Jonathan Nafzger/Shutterstock


Scott Dickerson/Getty Images

U.S. fisheries have taken steps to minimize bycatch, respond to climate change, and protect vulnerable habitats and species. Left: Commercial fishing boats in Dutch Harbor, Alaska. Right: Gaffing halibut in southwest Alaska.

THE FEP LOOP PROCESS

This section describes the FEP Loop and illustrates its steps. The process is a general guide rather than a detailed recipe, and what is most critical is that it begin with a big-picture understanding of the system to be managed and of stakeholders' goals, followed by the development of concrete, practical actions to address the highest-priority goals.

Figure 1

THE STRUCTURE AND PROCESS OF FISHERY ECOSYSTEM PLANS

Step 1: "Where are we now?"

Managers, scientists, and stakeholders should begin by looking broadly at the entire fishery system. The FEP Loop calls for creating a conceptual model of the fishery system, a set of "vital sign" indicators, and a list of threats.

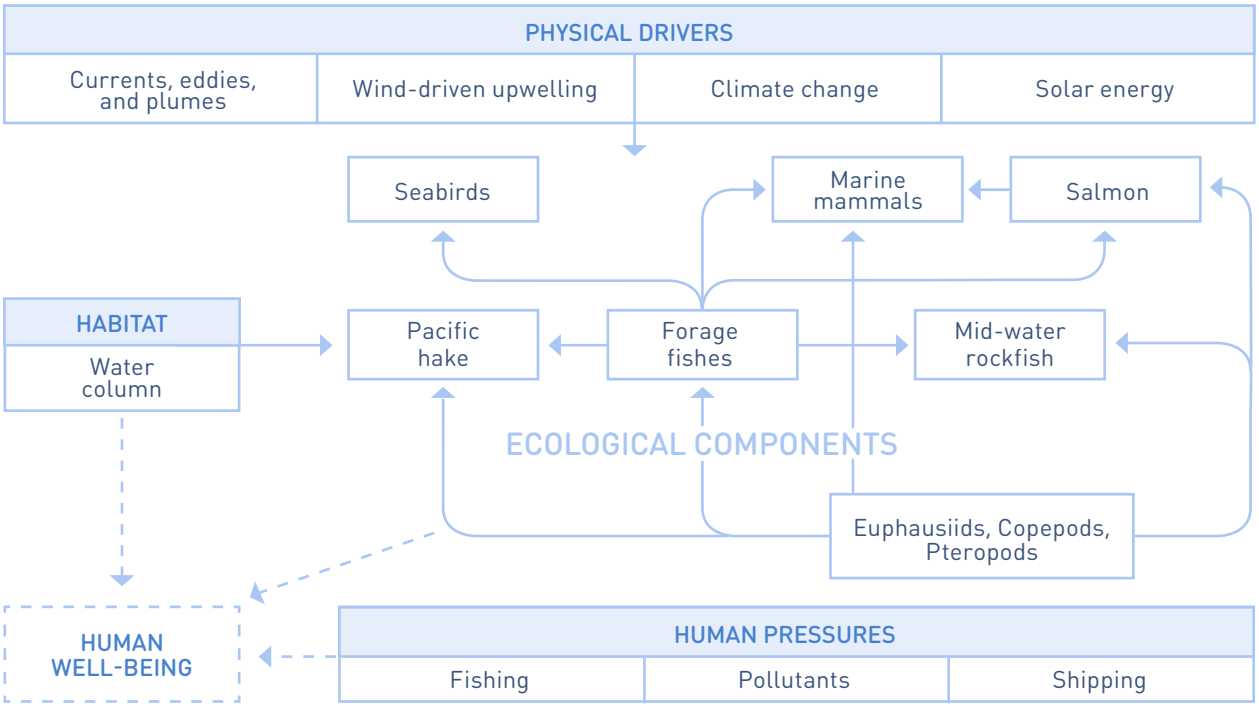
Conceptual models provide an inventory of system components and interactions and are already in use in several U.S. regions. The models should include the linkages between human and natural systems (Figure 2).

Another part of this step is the development of "vital sign" indicators, which provide a snapshot of health and are familiar tools in fisheries. For the California Current, one conceptual model proposed using indicators that draw on existing data. For example, forage fish biomass is an indicator of prey availability, rockfish population status reflects management effectiveness, and the Pacific Decadal Oscillation captures a suite of climate-driven environmental processes. The model also proposes two overall indicators based on existing data: diversity and mean trophic level.

This step should also include a list of threats to and pressures on the fishery system—for example, aquaculture, invasive species, or coastal development—to help prioritize objectives.

Figure 2

A CONCEPTUAL MODEL OF THE COASTAL PELAGIC SYSTEM IN THE NORTHERN CALIFORNIA CURRENT



Source: Andrews et al. (2013)

Step 2: "Where are we going?"

Next, managers, scientists, and stakeholders collaborate to develop and prioritize explicit, transparent goals for the fishery system. This kind of exercise is common in fisheries, and it is critical for EBFM because it helps pare down the potentially large scope of activities. Fundamentally, this involves moving from a shared broad vision for the fishery system to a clear set of specific, measurable, and actionable objectives.

Several management bodies already have overall vision statements. For example, the vision of the U.S. Mid-Atlantic Fishery Management Council is, "Healthy and productive marine ecosystems supporting thriving, sustainable marine fisheries that provide the greatest overall benefit to stakeholders."

Managers should next translate vision statements into action by setting and prioritizing high-level or "strategic" objectives. For instance, management might set objectives regarding habitat protection, preserving fishing-dependent communities, maintaining resilience, and preparing for climate change.

To complete this step, it is important to break the high-level objectives down into tangible desired outcomes, or operational objectives. These should include clear statements of what is to be achieved and how success will be measured. For example, the Puget Sound Partnership set the following objective: "Increase the overall abundance of spawning herring to 19,380 tons by 2020."

Step 3: "How will we get there?"

Managers and stakeholders must then create specific performance measures and use them to evaluate several alternative management strategies. This step allows for simultaneous consideration of multiple factors, their interactions, and their cumulative effects, which is a key benefit of EBFM.

The FEP Loop begins this step by developing performance measures that address the "triple bottom line" of ecological, socio-cultural, and economic objectives. A fishery in southeast Australia provides a useful set of examples. (See Performance Measures box.)

Managers and stakeholders then develop a range of alternative management strategies for reaching the operational objectives from step 2. The strategies should include management triggers in which reaching a predetermined value leads to a predetermined action, as well as a means of incorporating changes into FMPs. They should be adaptive, with plans built in for monitoring the system and responding to change.

The strategies should then be evaluated. A range of tools exists for evaluation, including management strategy evaluation (MSE), cost-benefit analysis, and expert judgment. The evaluation may uncover win-win strategies or expose unavoidable trade-offs inherent in a decision.

PERFORMANCE MEASURES

In Australia, an extensive management strategy evaluation involving 33 performance measures was undertaken for the southern and eastern scalefish and shark fishery. The following gives examples of those measures, along with the corresponding fishery objectives. (Management did not set target values for these measures, but in general higher values were considered desirable.)

Example 1

Objective: Maximize socio-economic impact

Performance measures:

- Level of port activity (as an indicator of social benefits of fishing).
- Total profits.
- Profit per ton landed.

Example 2

Objective: Ecologically sustainable development

Performance measures:

- Biomass of higher trophic level species.
- Proportional habitat cover.
- Demersal:pelagic biomass ratio.
- Piscivore:planktivore biomass ratio.

Source: Fulton et al. (2014)

Step 4: "Implement the plan"

Here, the managers initiate the alternative selected in step 3. This can be done entirely using existing processes for assessing scientific information and for amending regulatory documents such as FMPs. The Task Force recommends creating work plans that describe resources needed, timelines, and expected outputs for each of the actions identified in step 3.

Step 5: "Did we make it?"

Completing the cycle of adaptive management, policies are formulated not only to move the system to a more desirable state, but also to learn more about how the system works. For example, closing an area of critical habitat to fishing can promote species recovery and reveal the capacity of that species to rebound from depletion. The management alternatives formulated in step 3 should include a plan for monitoring that tracks progress toward objectives and produces data that can answer key questions about the system.

CASE STUDIES

The Task Force conducted 10 case studies of management bodies that have undertaken EBFM to identify tasks that such bodies are already undertaking that fit within the FEP Loop process. It found that managers are carrying out nearly every step of the process using existing management and regulatory processes, although no case included all five steps. (See Table 1.) In light of the case study data, the Task Force concluded that the FEP Loop is a realistic, practical way to implement EBFM.

It is important to note that much of the work represented in Table 1 was conducted for a subset of each system, such as a single species or the habitat for one group of species, rather than for the full system. Moreover, none of this work was carried out within the systematic framework of an FEP. The Task Force recommends that managers use a structured planning process such as the one described in the report to ensure that they consider all of the key drivers of the system and the highest priorities of stakeholders.

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Salmon fishing in Alaska (top). Male sea lions in Newport, Oregon, at the Historic Newport Docks (bottom left). Driftnet fishing for sockeye salmon along the Nushagak River, Alaska (bottom right).

Table 1

EXISTING CASE STUDIES OF THE FEP LOOP

This table shows 10 case studies of management bodies that have undertaken EBFM (see report for full details). A checkmark indicates that parts of the FEP Loop have been developed for one or more species. This illustrates that the process is feasible using existing tools. However, most of these actions did not take place within the systematic framework of an FEP and therefore did not realize the main advantages of EBFM.

STEPS	NEW ENGLAND GROUNDFISH	MID-ATLANTIC BUTTERFISH	ATLANTIC MENHADEN	GULF OF MEXICO GAG GROUPER
1. WHERE ARE WE NOW?				
System inventory and conceptual model	✓	✓	✓	✓
Select indicators		✓		✓
Inventory threats				
2. WHERE ARE WE GOING?				
Vision statement		✓	✓	
Strategic objectives	✓	✓	✓	
Assess risk to objectives				
Prioritize objectives				
Operational objectives	✓			
3. HOW WILL WE GET THERE?				
Performance measures	✓			
Management strategies	✓			
Evaluate strategies	✓			
Select strategy	*	✓	✓	✓
4. IMPLEMENTATION		✓	✓	✓
5. DID WE MAKE IT?				

* Management alternatives have been voted on by the council but not adopted.

	PACIFIC SARDINES	PACIFIC WHALES AND SALMON	ALASKA GROUNDFISH	SCOTIAN SHELF FISH AND INVERTEBRATES	BALTIC COD, HERRING, AND SPRAT	AUSTRALIAN SMALL PELAGICS
	✓	✓	✓	✓	✓	
	✓	✓	✓	✓	✓	
			✓			
			✓	✓	✓	
	✓	✓	✓	✓	✓	
		✓	✓			✓
			✓			✓
	✓		✓			✓
	✓	✓	✓			✓
	✓	✓	✓			✓
	✓	✓	✓		✓	✓
	✓		✓		✓	✓
	✓					

CONCLUSION

The Task Force report recommends that managers develop and use FEPs to initiate a structured process for establishing goals and translating them into action. It concludes that such a process is critical for overcoming many of the barriers to EBFM—arguably more so than the creation of scientific knowledge, management capacity, or legal authority. Finally, it finds that managers have the tools to create FEPs in light of evidence that they are already carrying out nearly all the necessary steps.

The full report and a companion Implementation Volume providing extensive guidance on developing FEPs are available at www.LenfestOcean.org/EBFM.

A school of mackerel.

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About the Lenfest Fishery Ecosystem Task Force

The Task Force is a 14-member panel of natural and social scientists convened by the University of Washington with support from the Lenfest Ocean Program. Its mission was to provide guidance to mangers on implementing EBFM. It held workshops with managers and stakeholders in four U.S. locations (Seattle; New Orleans; Portland, Maine; and Baltimore) from September 2014 to February 2016, deliberated on the benefits, challenges, principles, and best ways to implement EBFM, conducted numerous case studies, and reviewed the literature on EBFM. An advisory panel consisting of past and present fishery management council members, scientists from the National Oceanic and Atmospheric Administration (NOAA), and other management experts provided guidance throughout the process and reviewed the draft report.

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The Lenfest Ocean Program is a grantmaking program that funds scientific research on policy-relevant topics concerning the world's oceans and communicates the results. Supported research projects are motivated by policy questions for which additional scientific information could help inform decision makers of relevant marine science. The Program was established in 2004 by the Lenfest Foundation and is managed by The Pew Charitable Trusts (www.lenfestocean.org, Twitter handle: @LenfestOcean).

Founded in 1919, the **School of Aquatic and Fishery Sciences** (SAFS) is dedicated to sustaining healthy marine and freshwater environments. Our faculty conduct innovative research from the organism to the ecosystem scale and are recognized leaders in aquatic biology, sustainable fisheries management, aquatic resource conservation, and resource management. We study natural systems and species and present solutions to foster the sustainable use of aquatic resources.

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