



ECOSYSTEM INITIATIVES
APPENDIX TO THE
PACIFIC COAST
FISHERY ECOSYSTEM PLAN

**FOR THE U.S. PORTION OF THE
CALIFORNIA CURRENT LARGE MARINE ECOSYSTEM**

APPENDIX A

**PACIFIC FISHERY MANAGEMENT COUNCIL
7700 NE AMBASSADOR PLACE, SUITE 101
PORTLAND, OR 97220
(503) 820-2280
(866) 806-7204
WWW.PCOUNCIL.ORG
MARCH 2017**

Contents

The Fishery Ecosystem Plan and Ecosystem-Based Fisheries Management Initiatives.....	4
A.1 Completed FEP Initiatives	5
A.1.1 FEP Initiative 1, Protection for Unfished Forage Fish	5
A.1.2 FEP Initiative 2, Coordinated Ecosystem Indicator Review	6
A.2 Potential Future FEP Initiatives for Council Consideration	7
A.2.1 Initiative on the Potential Long-Term Effects of Council Harvest Policies on Age- and Size-Distribution in Managed Stocks.....	7
A.2.2 Bio-Geographic Region Identification and Assessment Initiative.....	8
A.2.3 Cross-FMP Bycatch and Catch Monitoring Policy Initiative	9
A.2.4 Cross-FMP EFH Initiative	10
A.2.5 Cross-FMP Safety Initiative.....	11
A.2.6 Human Recruitment to the Fisheries Initiative.....	12
A.2.7 Cross-FMP Socio-Economic Effects of Fisheries Management Initiative	14
A.2.8 Cross-FMP Effects of Climate Shift Initiative	15
A.2.9 Indicators for Analyses of Council Actions Initiative	16
A.2.10 Optimum Yield Initiative	18
A.3 Sources for Appendix A.....	18

LIST OF ACRONYMS AND ABBREVIATIONS

CCE	California Current Ecosystem, or California Current Large Marine Ecosystem
CEBA	Comprehensive Ecosystem-Based Amendment
Centers	Northwest and Southwest Fisheries Science Centers
CFR	Code of Federal Regulations
Council	Pacific Fishery Management Council
CPS	Coastal Pelagic Species
EC	Ecosystem component (species)
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPDT	Ecosystem Plan Development Team
ESA	Endangered Species Act
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
FMU	Fishery management unit
HAPC	Habitat Area of Particular Concern
HMS	Highly Migratory Species
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OY	Optimum yield
U.S.	United States of America
USCG	United States Coast Guard

FEP Appendix A cover image: Blue Marble: Next Generation, Reto Stöckli, NASA Earth Observatory

The Fishery Ecosystem Plan and Ecosystem-Based Fisheries Management Initiatives

The Pacific Fishery Management Council (Council) adopted a Fishery Ecosystem Plan (FEP) and this appendix at its April 2013 meeting. From its *Purpose and Need Statement*, the FEP is intended in part to provide “management policies that coordinate Council management across its Fishery Management Plans (FMPs) and the California Current Ecosystem (CCE).” For FMP policies, the FEP is needed to “identify and prioritize research needs and provide recommendations to address gaps in ecosystem knowledge and FMP policies, particularly with respect to the cumulative effects of fisheries management on marine ecosystems and fishing communities.” This appendix’s ecosystem-based fishery management initiatives provide examples of how the Council could address issues that affect two or more Council FMPs or coordinate major Council policies across the FMPs to fulfill identified FEP needs. While ecosystem initiatives are likely to be cross-FMP in scope, some initiatives might primarily affect conservation and management measures within a single FMP.

As discussed in Section 1.3 of the FEP, the Ecosystem Initiatives Appendix (Appendix A) is separate from the FEP and may be modified without the Council having to also modify the FEP or reconsider its contents. The Council has an annual process for reviewing the ecosystem initiatives and assessing whether changes are needed to Appendix A, or whether analyses are needed to provide background work for new ecosystem initiatives. Annually at its March meetings, the Council and its advisory bodies will:

- review progress to date on any ecosystem initiatives the Council already has underway;
- review the list of potential ecosystem initiatives provided in Appendix A to the FEP and determine whether any of those initiatives merit Council attention in the coming year;
- if new initiatives are chosen for Council efforts, request background materials from the appropriate entities;
- in March 2015 and in each subsequent odd-numbered year, assess whether there are new ecosystem initiative proposals that could be added to the appendix; and
- in March 2018, assess whether to initiate a review and update of the FEP.

At its April 2013 meeting, the Council began developing FEP Initiative 1, an initiative to prohibit the future development of new directed commercial fisheries for unfished and unmanaged forage fish species. The Council completed Initiative 1 in September 2015, as described in Section A.1., below. In keeping with its ecosystem issues process in Section 1.3, the Council reviewed its suite of Ecosystem Initiatives at its March 2015 meeting. At that meeting, the Council decided to add an additional potential initiative to this FEP Appendix, listed herein as A.2.10, an initiative to review the ecosystem indicators used in the annual State of the California Current Ecosystem report.

Descriptions of the potential initiatives in Section A.2. include: 1) a brief discussion of the question or issue considered, with references to relevant discussions within the FEP, 2) suggestions on background analysis or materials the Council may wish to see in advance of developing the potential initiative, and 3) suggestions on the type of personnel and expertise that may be useful in an ad hoc committee tasked with developing the initiative. The Council will discuss whether to take on new initiatives each year at its March meetings. The FEP itself does not have regulatory authority. If the Council wishes to make changes to its regulatory programs after analysis and discussion of a cross-FMP initiative, those changes would need to be implemented under the authority of one or more of the Council’s existing FMPs. Comprehensive Ecosystem-Based Amendment (CEBA) 1, which implements Ecosystem Initiative 1 on protecting unfished and unmanaged forage fish, includes amendments to all four of the Council’s FMPs.

A.1 Completed FEP Initiatives

FEP Initiatives, or “ecosystem initiatives,” are multi-species or multi-fisheries science and policy processes to help coordinate Council policies across its FMPs and improve our understanding and management of the CCE. It is a living list that will change as some initiatives are completed and as new potential initiatives are added. This Section A.1 describes completed FEP Initiatives. Potential future initiatives are described in Section A.2.

A.1.1 FEP Initiative 1, Protection for Unfished Forage Fish

The Council began FEP Initiative 1 in September 2013 and completed it as Comprehensive Ecosystem-Based Amendment 1 (CEBA 1) in March 2015. The Council adopted the following purpose and need statement for CEBA 1:

The purpose of this action is to prohibit new directed commercial fishing in Federal waters on unmanaged, unfished forage fish species until the Council has had an adequate opportunity to both assess the scientific information relating to any proposed directed fishery and consider potential impacts to existing fisheries, fishing communities, and the greater marine ecosystem. This action is needed to proactively protect unmanaged, unfished forage fish of the U.S. West Coast Exclusive Economic Zone (EEZ) in recognition of the importance of these forage fish to the species managed under the Council’s FMPs and to the larger CCE. This action is not intended to supersede tribal or state fishery management for these species, and coordination would still occur through the existing Council process.

CEBA 1 amends each of the FMPs to bring these species and species groups into the FMPs as ecosystem component (EC) species shared between all four of the Council’s FMPs:

- Round herring (*Etrumeus teres*) and thread herring (*Opisthonema libertate* and *O. medirastre*)
- Mesopelagic fishes of the families *Myctophidae*, *Bathylagidae*, *Paralepididae*, and *Gonostomatidae*
- Pacific sand lance (*Ammodytes hexapterus*)
- Pacific saury (*Cololabis saira*)
- Silversides (family *Atherinopsidae*)
- Smelts of the family *Osmeridae*
- Pelagic squids (families: *Cranchiidae*, *Gonatidae*, *Histioteuthidae*, *Octopoteuthidae*, *Ommastrephidae* except Humboldt squid (*Dosidicus gigas*), *Onychoteuthidae*, and *Thysanoteuthidae*)

In the Council’s FMPs, this group of species is collectively referred to as the “Shared EC Species.” CEBA 1 includes these FMP amendments: Amendment 15 to the Coastal Pelagic Species (CPS) FMP, Amendment 25 to the Pacific Coast Groundfish FMP, Amendment 3 to the Highly Migratory Species (HMS) FMP, and Amendment 19 to the Pacific Coast Salmon FMP. CEBA 1 prohibits the development of new directed commercial fisheries for Shared EC species within the U.S. West Coast EEZ, while allowing existing incidental harvest of these species to continue to occur. However, CEBA 1 also includes Council Operating Procedure (COP) 24, which specifies conditions for exempted fishing permits to collect scientific information on the feasibility of future fisheries targeting Shared EC Species. COP 24 does not assume that future fisheries for Shared EC Species will occur; instead, it sets out conditions for collecting scientific information in case there is future public interest in beginning new fisheries for Shared EC Species.

A.1.2 FEP Initiative 2, Coordinated Ecosystem Indicator Review

FEP Initiative 2 was a Council-wide review of the annual California Current Ecosystem Status Report of the NOAA Fisheries Northwest and Southwest Fisheries Science Centers (Centers). Section 1.4 of the FEP asks that the Centers provide the Council, its advisory bodies, and the public with an annual report on the state of the CCE, with a focus on Council-managed species and fisheries, and their associated fishing communities. Under this initiative, the Council facilitated a year-long scoping process involving ecosystem scientists, fishery managers, and the public in a conversation about ecosystem science within the Council process.

The Council began FEP Initiative 2 in September 2015 and completed it in September 2016 as a suite of comments on and requests for information in the annual ecosystem status report. In its initial directions on this initiative, the Council tasked its Ecosystem Workgroup with coordinating a review of the ecosystem status report that would ask these questions:

- i. What can we reasonably expect to learn from or monitor with the existing indicators in the CCE Report?
- ii. How well do the existing indicators accomplish their intent? Are any redundant?
- iii. Are there alternate indicators (or information or analysis) that may perform better in context?
Are there additional indicators that could help inform Council decision-making under each of its fishery management plans (FMPs) and consistent with the purpose of the FEP?

Through the 2015-16 winter, the Ecosystem Workgroup hosted a series of webinars to review and discuss the various sections within and scientific information behind the Centers' annual ecosystem status report. Through these public webinars, the Centers briefed listeners on: physical and oceanography indicators; biological indicators; human dimensions indicators; freshwater, estuarine and marine habitat indicators; and, risk assessments and applications of indicators to decision-making.

Through spring and summer 2016, the Council's advisory bodies and the public reviewed the annual ecosystem status report and discussed their needs and goals for future ecosystem status reports. At the Council's September 2016 meeting, the advisory bodies and the public provided the Council and the Centers with their comments on future directions for the annual ecosystem status report. Part of that direction for future reports included the suggestion that the Council and Centers consider new focal areas for future reports, so that the Centers could revise report contents over time rather than all at once. In March 2017, the Centers presented an updated and revised ecosystem status report, taking into account revisions and additions requested through this initiative process.

Although this initiative focused on the ecosystem status report, it generated discussions about a host of other science products and tools that might support future Council decision-making. The Council particularly asked that the Centers develop a pilot management strategy evaluation on the effects of changes in the physical environment on sablefish productivity. The Centers also presented the results of this sablefish-focused work in March 2017.

A.2 Potential Future FEP Initiatives for Council Consideration

During its development process for the FEP, the Council and its advisory bodies discussed how a cross-FMP or ecosystem approach to management might assist the Council's long-term planning on a broad range of issues. The following potential future FEP initiatives for consideration by the Council and the public are based on the FEP's Purpose and Need Statement, the FEP's Objectives, and the MSA's national standards and other requirements, including environmental impact analysis under the National Environmental Policy Act (NEPA). Potential initiatives are based in the major themes of the MSA and consider cross-FMP issues, including: harvest level policies and overfished/overfishing, bycatch, EFH, and community effects of fisheries management.

A.2.1 Initiative on the Potential Long-Term Effects of Council Harvest Policies on Age- and Size- Distribution in Managed Stocks

This cross-FMP initiative, relevant for groundfish, HMS, and CPS, has several goals that could help the Council better address the larger-scale harvest issue of maintaining broad age- and size-distributions in managed fish stocks:

- Conduct a comprehensive literature review of the documented and potential consequences of shifting or truncating age or size structure on population reproductive potential, population stability and variability and interactions between these dynamics and climate variability
- Conduct a review and analysis of long term effects on the truncation of age- and size-distribution of managed stocks under the currently implemented harvest control rules;
- Conduct a review and analysis of the economic effects of harvest strategies that focus on different life stages of managed species, allowing those species to or preventing those species from reaching maturity, and the trade-offs between biological considerations and economic factors with respect to providing juvenile versus adult life stage CCE species to fish markets worldwide; and
- Conduct a management strategy evaluation that considers the performance of current harvest control rules as well as alternative harvest control rules that incorporate age- and length-structure into Council management reference points.

This initiative would help the Council consider how current harvest control rules behave with respect to the truncation of age- and size-distribution of managed stocks, and possible alternative harvest control rules that incorporate age- and length-structure into Council management reference points. Background work for this initiative should include an evaluation of the established, perceived and potential consequences of moderate to severe shifts in age and size structure to effective egg or larval production, population dynamics and stability. Analysis should also seek to quantitatively (where possible) evaluate the trade-offs between managing for a greater proportion of older and/or larger fish in a population relative to current management strategies that do not explicitly consider age composition. As discussed in the FEP at Section 4.1.1, simulation studies suggest that the consequences of truncation in age and size structure include but are not limited to reduced and/or more variable egg or larval productivity, real or likely increases in population or recruitment variability, and increased variability in catches. These effects in turn may be magnified as a result of changing environmental conditions or changes in the dominant modes of climate variability. Knowing how life histories and changes in population demographic structure could lead to changes in the sensitivity to environmental variability should be helpful to addressing fisheries management challenges stemming from scientific uncertainty in population-associated stock size estimates.

To implement this initiative, the Council could assemble an ad hoc advisory committee to develop an approach for a review and analysis of the long term effects on the truncation of age- and size-distribution of managed stocks under the currently implemented harvest control rules, an approach for conducting a

management strategy evaluation of harvest control rules, and to identify future research needs to help address this initiative. Conducting the management strategy evaluation would not be a small task, and would likely require dedicated time from a team of scientists before it would be ready for presentation to and review by the Council and its advisory bodies. The advisory committee for this initiative could help identify an appropriate team to implement the management strategy evaluation. The advisory committee could consist of federal, state, tribal and academic scientists, and others the Council deems appropriate to the task.

A.2.2 Bio-Geographic Region Identification and Assessment Initiative

Section 3.1.2 of the FEP identified three large scale bio-geographic regions of the CCE that could be further subdivided into finer scale nested sub-regions to provide the Council with a framework for undertaking finer scale fisheries management actions to implement ecosystem-based management and to facilitate linkages with other government policies and processes. One possibility for defining such spatial divisions could be based upon the functional distributions of species, for example:

- Estuarine habitats
- Nearshore habitats
- Inshore demersal habitats
- Offshore demersal habitats
- Pelagic habitats (coastal and offshore)

Within each finer scale sub-region, the Council may wish to undertake assessments of fishery removals, location of fishing activities, fishing capacity, evidence for past or present localized depletion of species as well as future susceptibility to localized depletion, and the impact of freshwater inputs to the CCE as well as land-based human impacts to the coastal ocean (for example the alteration of fresh water flow and nutrient loads). The delineation of finer spatial scale sub-regions is particularly important for nearshore species and fisheries, since the bio-geographic regions identified in the FEP at Section 3.1.2 are likely at too coarse a scale for effective implementation of localized ecosystem-based management. Further identification of smaller scale sub-regions could improve management outcomes and allow for stronger connectivity between biophysical and ecological processes.

Background work for developing this initiative could include identifying finer scale sub-regions to provide a framework for more spatially-explicit management. Serial depletion of species can be investigated by reconstructing catch histories within each fine scale sub-region and by examining changes in fishing patterns, for example, latitudinally and with depth. Central to the examination of fishery data is the need for strong, appropriately collected recreational fishing data, particularly in the estuarine and nearshore areas, to support integrated fisheries management at a finer spatial scale. Scientific work developed in support of this initiative could also provide a framework for investigating: 1) how fishing activity affects ecosystem structure and function, particularly spatial and temporal fishing patterns and their relation to changing patterns in the ecosystem (cumulative impacts of all FMP fisheries), 2) the impacts of marine spatial planning efforts on FMP species and fisheries, 3) changes in species distributions and migration patterns, and 4) fishing activity location patterns versus biomass distribution of managed species.

To implement this initiative, the Council could assemble an ad hoc advisory committee to assess: data availability and quality for identifying finer scale sub-regions nested within the large bio-geographic regions of the CCE, and whether any of those finer scale sub-regions are appropriate for smaller-scale ecosystem-based fishery science and management. Identifying finer scale sub-regions within the CCE could help scientists and managers better assess sub-populations, regional management issues, and how the effects of management decisions may vary between sub-regions. Identifying sub-regions could also help the larger natural resource science and management community to better assess and understand connections

between terrestrial and marine ecosystems at a smaller than coastwide scale. An advisory committee to develop this initiative could include federal, state, and tribal ecologists and habitat scientists, fishing community representatives, fishery participants from each of the Council's four FMPs, and others the Council deems appropriate to the task.

A.2.3 Cross-FMP Bycatch and Catch Monitoring Policy Initiative

The MSA's National Standard 9 states: *Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.* FMPs are also required to *establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority – (A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided* [§303(a)(11)].

Catch and bycatch monitoring programs vary between Council fisheries, as does the quantity and quality of information provided by these programs. The Council has historically had greater concern with bycatch in the groundfish and HMS fisheries than in the salmon and CPS fisheries, although salmon fishery management itself is largely a complex effort to conduct fisheries that minimize the bycatch of threatened and endangered runs of salmon. Under this initiative, the Council would take a cross-FMP look at its bycatch minimization and monitoring policies, to share information and methodologies across FMPs, and to develop cross-FMP bycatch minimization goals. A notable challenge with this initiative is that the gear types, fishing methods and locations, and target species of the different FMPs are so distinct from each other that there is a reasonable possibility that bycatch minimization methods that are effective in one fishery will not be effective in other fisheries.

FMP-based bycatch minimization policies necessarily focus on the bycatch within particular fisheries. Responding to the MSA by reducing the volume and rate of bycatch in individual Council-managed fisheries has most likely resulted in an overall reduction in the total volume of incidentally-caught and discarded CCE marine life. However, moving beyond the fishery-by-fishery approach could allow the Council to better assess issues like: the cumulative effects of the bycatch of non-Council species taken in Council-managed fisheries; whether gear innovation programs or products in one fishery could benefit other fisheries; and whether the timing and interactions of multiple Council-managed fisheries increase or decrease the likelihood of bycatch in these fisheries. The Council could also use a cross-FMP look at bycatch to help it prioritize its bycatch monitoring and minimization workload, perhaps prioritizing its work for those fisheries with greater amounts of bycatch, or greater numbers of incidentally caught protected species.

Background work for developing this initiative would require an assessment of the available bycatch monitoring and management information for Council-managed fisheries. Much of this information is already available in Council SAFE documents and in NMFS reports, particularly the National Bycatch Report (NMFS 2011). If agency staff were to review available literature to provide a cross-comparison of bycatch management programs within Council-managed fisheries, including an evaluation of where fisheries management and regulations for different fisheries might intersect to affect bycatch rates, that review could provide the Council with an initial assessment of where its greatest challenges might lie in reducing cumulative bycatch in Council-managed fisheries. The staff review of bycatch monitoring and management issues should, at a minimum, address:

- which fisheries have bycatch of protected species (mammals, birds, ESA-listed) and the measures taken to minimize bycatch of those species
- which fisheries have bycatch of Council-managed species and, if known, how much

- the state of the literature on unobserved fishing mortalities and applicability to West Coast fisheries
- whether management measures in any one Council-managed fishery affect the amount or type of bycatch in any other Council-managed fishery

To implement this initiative, the Council could assemble an ad hoc advisory committee to assess: commonalities and differences between catch and bycatch monitoring between FMPs, bycatch minimization practices between FMPs, whether regulatory programs under one FMP exacerbate bycatch rates under other FMPs, and the cumulative effects of bycatch in Council-managed fisheries. That committee would then report to the Council on whether there could be benefits to target or non-target species from integrating the Council’s bycatch minimization efforts across FMPs, whether amendments to fishery regulations could minimize inter-fishery conflicts that exacerbate bycatch, and whether science and management programs used under one FMP could also be used under any other FMP. That advisory committee could consist of federal, state, and tribal catch monitoring, gear development, and protected species programs; fishery participants from each of the Council’s four FMPs and different gear users, enforcement professionals, and others the Council deems appropriate to the task.

A.2.4 Cross-FMP EFH Initiative

The MSA defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” [§3(10)]. All four of the Council’s FMPs have described EFH for managed species, with the groundfish FMP having the most detail, including Habitat Area of Particular Concern (HAPC) designations and closed areas to protect EFH. Geographic maps of EFH have been developed for all FMPs, except CPS. The CPS and Salmon FMPs have also recently completed their first 5-year reviews of EFH (50 CFR 600.815(A)(10),) and the Groundfish EFH review is ongoing. Under this initiative, the Council would develop a plan to integrate its work between FMPs in future 5-year EFH review processes.

The Council has been engaged in 5-year EFH reviews for one FMP or another since 2009. The next round of EFH review would start in 2014-2015. An ecosystem-based Council approach to EFH would provide a better understanding of complex overarching issues such as: research needs, common threats to habitat quality, protected species interactions, or ocean acidification. An ecosystem-based EFH review would both provide required updates for FMPs, and would work across FMPs to identify habitat areas that are considered highly productive or biodiverse under more than one FMP. Habitats of importance to species from multiple FMPs could serve as focal points for Council efforts to assess and mitigate for fishing and non-fishing effects on EFH, and for research to better understand the complex interactions between FMP species and their shared habitat. One possible result of an integrated EFH review would be cross-FMP HAPC designations for areas that are important to species from multiple FMPs.

The Council could also expand or alter this initiative to consider spatial management policies more generally. Historically, the Council has implemented spatial management measures under its different FMPs without undertaking a cross-FMP assessment of how those measures may affect fish and fisheries managed under other FMPs. If area closures in various Council-managed fisheries could be better synched between FMPs, the Council could reduce regulatory confusion across fisheries, and better tailor closed areas for benefits under multiple FMPs.

Background work for developing this initiative would require an assessment of the commonalities and differences between how FMPs approach the 5-year EFH review requirements. If agency staff were to provide the Council with a summary of all of its EFH review requirements, the Council could more easily envision an integrated, cross-FMP EFH review. The staff review of FMP requirements should, at a minimum, address:

- whether the FMPs require species-by-species reviews, or if reviews can be tailored to larger complexes of species;
- the availability of EFH maps and other spatial data, including fishing activity location, for the four FMPs;
- commonalities between FMPs on which types of fishing and non-fishing activities are most likely to affect EFH for Council-managed species;

To implement this initiative, the Council could assemble an ad hoc advisory committee to conduct a post-mortem review of the lessons learned from the current round of EFH reviews. That committee would then develop a plan for the next round of EFH reviews that would allow the Council to consider all of its EFH designations through the same process, and to consider how and whether species within the different FMPs use the same habitats, and perhaps ultimately develop cross-FMP policies and amendments for EFH. That advisory committee could consist of representatives from the Council’s current Habitat Committee, Groundfish EFH Review Committee, and EPDT, plus any additional habitat scientists, restoration specialists, mapping specialists, and others the Council deems appropriate to the task.

A.2.5 Cross-FMP Safety Initiative

The MSA’s National Standard 10 states: *Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.* NMFS is considering revising and updating the federal National Standard 10 guidelines at 50 CFR 600.355, to better use and account for modern safety information and technology (77 FR 22342, April 21, 2011). The EPDT’s March 2011 report (Agenda Item J.1.c., Attachment 1,) included United States Coast Guard (USCG) West Coast vessel incident data for vessels participating in fisheries targeting species from the Council’s four FMPs. That data is updated, including parenthetical comments from USCG, and provided here in Table A.3:

	CPS	Groundfish	HMS	Salmon
Recorded safety issues, vessel incidents, and mortalities for fisheries under each FMP	<p>USCG District 11 2006-2011 data: 11 squid fishery vessel incidents, from which one life was lost and 8 vessels were lost.</p> <p>USCG District 13 2000-June 2012 data: 4 sardine fishery vessel incidents, from which 2 lives were lost and 4 vessels were lost.</p>	<p>USCG District 11 2006-2011 data: 11 groundfish fishery vessel incidents, from which 2 lives were lost and 9 vessels were lost.</p> <p>USCG District 13 2000-June 2012 data: 12 groundfish fishery vessel incidents, from which 11 lives were lost and 6 vessels were lost.</p> <p>(The F/V Lady Cecilia sinking in March 2012 caused the loss of 4 lives and one vessel.)</p>	<p>USCG District 11 2006-2010 data: 1 tuna fishery vessel incident, no lives nor vessels lost.</p> <p>USCG District 13 2000-2008 data: 11 tuna fishery vessel incidents, from which 2 lives were lost and 10 vessels were lost.</p> <p>(Fatigue continues to be a contributing factor to tuna vessel casualties.)</p>	<p>USCG District 11 2006-2011 data: 8 salmon fishery vessel incidents (3 of which were combination crab/salmon trips,) from which 3 lives were lost and 6 vessels were lost.</p> <p>USCG District 13 2000-June 2012 data: 24 salmon fishery vessel incidents, from which 11 lives were lost and 23 vessels were lost.</p>

The USCG and the National Institute for Occupational Safety and Health (NIOSH) regularly assess the causes of loss of life at sea for U.S. waters nationwide (Lincoln and Lucas 2008, Dickey 2011). With its non-voting seats on fishery management councils nationwide, the USCG regularly brings vessel incident

and safety concerns into Council conversations. However, a more directed engagement between the Pacific Council, the USCG, and other members of the West Coast enforcement, safety, fisheries, and weather prediction and advisory communities, could provide more and better information to the Council and the public on safety concerns within its fisheries. In 2010, for example, the USCG responded to a request from the New England Fishery Management Council for an analysis of fishing casualties and fatalities in the Atlantic Scallop fishery (De Cola 2010). That analysis helped that council to see some of the key safety challenges in the New England scallop fishery, and to better consider whether changes to fisheries regulations could help improve the fishery's safety.

An ecosystem-based, cross-FMP safety review would look at the safety implications of not just one fishery, but at all of the injuries and mortalities in West Coast fisheries. Although the Council does not manage the West Coast fishery that is usually considered as highest in mortalities, Dungeness crab (Lincoln and Lucas 2010,) fishermen and vessels from that fishery regularly participate in Council-managed fisheries. By looking across fisheries, the Council and the public will be better able to assess how fisheries regulations interact with each other, and whether those interactions have unsafe results for fishery participants. West Coast fishing vessels commonly engage in multiple fisheries, which means that vessel owners, captains, and crew have to think about the tradeoffs in participating in various fisheries throughout the year. Taking a broad, ecosystem-based approach to a safety review would better account for the challenges fisheries participants face as they plan their work in various West Coast fisheries.

Background work for developing this initiative would require some initial Council coordination with and through the USCG and other members of the Council's Enforcement Consultants. If the USCG and NMFS were to work with NIOSH to develop a safety risk assessment for West Coast fisheries, that assessment could provide the Council with information on where and when fisheries injuries and mortalities are occurring, some of the causes of the mortalities (e.g. vessel flooding, large wave strike, collision, vessel fire, engine failure, crew falls overboard, etc.). The results of that assessment should help the Council to consider whether West Coast fisheries safety could be improved through:

- revisions to fisheries regulations;
- modifications to technological equipment to provide fleets with more and better information on weather and ocean conditions;
- better at-dock compliance with and participation in available safety programs.

To implement this initiative, the Council could assemble an ad hoc advisory committee to develop draft Council actions in support of changes to regulations, or recommendations on changes in technology or on educating fleet participants about available safety resources. That advisory committee could consist of fisheries participants, and enforcement and regulations professionals, and others the Council deems appropriate to the task.

A.2.6 Human Recruitment to the Fisheries Initiative

The MSA's National Standard 8 states: *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meets the requirements of paragraph (2) [National Standard 2 requiring the use of best available science], in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.*

Since National Standard 8 entered the MSA in 1996, many Council decisions have been necessarily focused on meeting the conservation requirements of the Act, with little room in available harvest levels for

considering how best to provide for the sustained participation of fishing communities. West Coast fishing communities themselves range from a series of fishing piers within large urban areas with diverse income opportunities, to small coastal towns with few economic opportunities beyond industries related to natural resource extraction or tourism. These diverse communities have their own governance structures and planning efforts for their futures that may or may not include considerations for the ongoing presence of the fishing industry within their communities. Under National Standard 4, the MSA also states that *Conservation and management measures shall not discriminate between residents of different States...* For these reasons, the Council's conservation and management measures have, when practicable, focused on minimizing the overall adverse economic impacts of their decisions.

If, however, providing for the sustained participation of fishing communities in fisheries were considered at the coastwide level, the "graying" of West Coast fishing fleets may be a concern for the Council and all of the management entities participating in the Council process. As of October 1, 2012, approximately 94% of the West Coast groundfish trawl quota shares were owned by identifiable individuals, with the remaining 6% owned by corporations or trusts. The average age of groundfish trawl quota share owners, weighted by percentage of shares owned, is 60, and the median age is 59 – meaning that the ages of quota share owners are fairly evenly distributed around a center point of age 59. The average age of the owners of groundfish vessels carrying quota shares, weighted by percentage of vessel owned, is 57, and the median age of those vessel owners is also 57. Initial results from NMFS's Pacific Coast Groundfish Trawl Fishery Social Study also found a strong distribution of both quota and vessel owners in the 51-60 years-of-age decile (Russell et al 2012). Similarly, for permit owners in both Oregon's salmon troll fleet and in its pink shrimp fleet, average age is 58, with a median age of 59. According to U.S. Census data, the median age of Oregonians in 2010 was age 38.

Not all Council- or state-managed fisheries will have data on the ages of fishery participants. However, a cross-FMP look at both the ages of participants and the flexibility of movement between fleets could give the Council better information about the long-term viability of West Coast fleets. The State of Alaska is addressing the aging of its fisheries participants through its legislature (AK CSHCR 18 2012) and with a University of Alaska Fisheries, Seafood and Maritime Initiative to assess current and future maritime workforce needs. There are examples within the U.S. and elsewhere of apprenticeship programs to train new back deck crew and provide ongoing safety and gear training for rising skippers (e.g. DMR 2011, Whitby and District Fishing Industry Training School of the U.K., National Fishing Industry Education Centre of Australia). Educational programs like Clatsop Community College's Maritime Sciences – Vessel Operations program and Seattle's Maritime Academy can train aspiring crew members. There may, however, be longer-term financial and regulatory barriers to entry into and advancement within the fisheries. Council attention to long-term human recruitment to West Coast fisheries could help fishery participants and fishing communities better prepare for the future of the fishery itself.

Background work for developing this initiative would require an analysis of available demographic data on participants in Council-managed fisheries and research into nationwide programs for supporting new fishery entrants. If agency staff were to review available data, literature, and private and government efforts to bring new participants into fisheries, that review could help the Council assess whether the immobility between and entrance into West Coast fisheries is of significant enough concern to merit a new Council effort under National Standard 8. The staff review of human recruitment to the fisheries issues should, at a minimum, address:

- for those fisheries where the age-distribution of participants is known, how that distribution compares to age distribution in coastal counties
- information on costs, where known, of permits and vessels needed to participate in Council-managed fisheries

- what programs, private and public, are available nationwide to facilitate the entrance of new and younger participants into fisheries

To implement this initiative, the Council could assemble an ad hoc advisory committee to assess: mobility within and between Council-managed, and state/tribe-managed fisheries, barriers to entry in Council-managed fisheries, and nationwide efforts to facilitate the upward mobility of skilled crewmen to positions as skippers, vessel owners, and other leadership positions within the fishing fleet. That committee would then report to the Council on potential management programs to improve human recruitment to West Coast fisheries over time, addressing both programs the Council could implement through its FMPs and recommendations the Council could make to government agencies for initiatives outside of the Council's authority (e.g. low interest rate loans for permit purchasers meeting certain qualifications). That advisory committee could consist of fishery participants from each of the Council's four FMPs, representatives from fishing community organizations, social scientists, and federal, state, and tribal management program specialists, and others the Council deems appropriate to the task.

A.2.7 Cross-FMP Socio-Economic Effects of Fisheries Management Initiative

Like A.2.6, this initiative is also intended to support the MSA's National Standard 8, particularly where the standard refers to taking into account the importance of fishery resources to fishing communities by using economic and social data that meets National Standard 2. National Standard 2 states that: *Conservation and management measures shall be based upon the best scientific information available.* Analyses conducted in support of Council actions regularly include socio-economic analyses of the anticipated effects of those particular actions. This initiative, however, would look at the information the Council needs to better understand how communities may be affected by management actions across the FMPs.

This initiative would investigate the seasonality of fishing operations, temporal-spatial landings compositions, vessel displacement and mobility, operational tradeoffs when management decisions made under different FMPs affect the same communities. Readily available commercial landings data can be used to rank fishing ports in terms of their annual landings and exvessel revenues, by species management group and gear type. This information can then be used in conjunction with a regional economic input-output model under development for the West Coast commercial fisheries to assess the amount of economic activity generated by fish harvesters and processors operating within an inter-connected system of businesses comprising a particular West Coast port. The types of businesses within those systems would differ from port to port, depending on the level of local infrastructure development and maintenance.

Beyond assessing the economic effects of cross-FMP Council management programs, this initiative would also develop a framework for a cross-FMP social impact assessment of those programs. In combination with economic analyses of the dependency of West Coast communities on fishery resources, a social impact assessment can assess social factors such as community rates of poverty and personal disruption to assess the vulnerability of communities to changes in availability of fishery resources (Norman et al. 2013). Social science literature has been developing measures of community well-being and social capital (Helliwell and Putman, 2004), including efforts to develop social impact assessment methodologies to specifically look at well-being in and the effects of fisheries management programs on fishing communities (Jepson and Jacob 2007, Clay and Olson 2008, Hall-Arber et al. 2009, Sepez et al. 2007, Ross 2013). Ultimately, more and better information about the particular socio-economic challenges faced by fishing communities can help the Council to understand the cross-FMP effects their actions have on those communities.

Background work for developing this initiative would first require a literature review on the current state of knowledge about metrics used to assess the socio-economic effects of fisheries management on fishing communities, plus any information or analyses conducted specifically on West Coast communities. The Council would need information on whether social scientists could develop both current and ongoing

indices of fishing community vulnerability to changes in availability of fishery resources. The Council would also need to know which fishing communities are most closely tied to which fisheries, and whether those communities undergo cyclical within-year effects from shifts in fishery management programs. Should the Council wish to implement this initiative, it could begin with asking agency staffs to provide it with the above-described review of the state of scientific knowledge, including drawing upon information already developed for analyses of FMP actions.

To implement this initiative, the Council could assemble an ad hoc advisory committee to discuss both what is known within the scientific community, and the concerns of fishing communities with regard to the effects of fisheries management actions on fishing communities. That committee would then develop recommendations for forward-looking scientific investigations into the cross-FMP socio-economic effects of Council regulatory programs on West Coast fishing communities. That advisory committee could consist of economists, anthropologists, sociologists, a geographically diverse set of fisheries representatives, fisheries managers, and others the Council deems appropriate to the task.

A.2.8 Cross-FMP Effects of Climate Shift Initiative

As discussed in Section 3.1.1 and Chapter 4 of the FEP, the CCE is subject to both interannual and interdecadal climate variability that can have significant effects on seasonal and long-term productivity. Over the longer-term, three prominent properties of the environment are predicted to undergo significant change--temperature, ocean surface water pH (acidity versus alkalinity), and deep-water oxygen. Other physical changes are less predictable but relatively likely, including changes in upwelling intensification (generally expected to lead to greater, but potentially more variable, primary and secondary productivity), changes in both the phenology (timing) of the spring transition, and changes in the frequency and intensity of current modes of climate variability (such as the El Niño/Southern Oscillation and the Pacific Decadal Oscillation). Many Council-managed species are known to have developed life-history strategies that respond to shorter-term climate variability, such as large-scale shifts in the abundance of coastal pelagic species, shifts in the distribution of migratory species (including but not limited to most coastal pelagics, Pacific hake, and most highly migratory species), high interannual variability in recruitment rates of most groundfish, and diversified evolutionary strategies in salmon populations.

Under this initiative, the Council would assess and articulate its questions about the longer-term effects of climate change on its managed species, so as to better direct public and private efforts to provide management-relevant science. Whereas individual fisheries management plans will likely examine the potential impacts of climate change on particular species, the focus of this initiative would be on the combined, long-term effects of such changes on multiple species across all management plans. CCE fisheries support, to varying degrees, the economies and social fabric of at least 125 communities in California, Oregon and Washington. As fish populations and the ecosystems that sustain them are altered in response to climate change, there are potentially profound consequences for the fisheries and the communities that they support.

Vulnerability to climate change depends on three fundamental elements: 1) exposure to the physical effects of climate change; 2) the degree of intrinsic sensitivity of fisheries or dependence of the regional economy on socio-economic returns from fisheries, and 3) the extent to which adaptive capacity enables these potential impacts to be offset. Background work for developing this initiative would initially require a literature review on the current state of knowledge about the anticipated effects of climate change on Council-managed species and West Coast coastal communities. Using previous vulnerability assessments as a foundation, this review could focus on measures of exposure, sensitivity and adaptive capacity that best capture the natural and human systems of interest.

Choosing metrics of exposure to climate change, even at the scale of the CCE, is fraught with constraints and assumptions. Information useful to the Council would include a review of what is specifically known about estimated changes in temperature, ocean surface water pH, and deep-water oxygen within the CCE and the rates or speeds at which those changes may occur, not just global estimates of those changes. This review could also identify any additional environmental factors of importance to specific fisheries in the CCE that also might experience significant long-term variability. The Council would also need information about the current state of scientific investigations into the estimated effects of climate change on marine species, particularly CCE marine species. This review may also consider the potential for changes in fish species composition as a result of climate changes. For instance, analytical approaches that estimate the vulnerability of each target species to climate change as well as estimates of the probability that new species will expand into a region will be useful. The Council would also need to know how and whether scientists are assessing the effects of climate change on human communities, whether those effects include those from sea level rise, increasing storm intensity, or the loss or change of revenue from natural resource based industries.

The second key set of information useful in this review is sensitivity to the degree of fisheries dependence of communities. NOAA has already conducted an intensive study (Norman et al. 2007) to identify West Coast communities with some dependency on fishery resources. Dependence on commercial, recreational and subsistence fishing is based on information available from the U.S. Census as well as the weight and value of fisheries landings, the number of vessels, and the number of participants in the fisheries. While this study identifies those communities NOAA believes may be accurately characterized as “fishing communities,” further work is needed to assess the degrees to which each of those communities have economic dependencies on fishery resources, and the vulnerability of those communities to changes in availability of fishery resources.

Finally, an examination of the adaptive capacity of marine resources and human communities would tie together predicted changes to the environment with anticipated effects on the economies of West Coast fishing communities. Adaptive capacity is dependent on levels of social capital, human capital and governance structures. While there are global analyses of the adaptive capacity that are based on such factors as healthy life expectancy, education, and the size of the economy (Allison et al. 2009), a similar, rigorous assessment of adaptive capacity of CCE fishing communities to climate change has not been conducted.

To develop background information for this initiative, the Council could begin with a request that NOAA provide it with the above-described review of the state of scientific knowledge. To implement this initiative, the Council could assemble an ad hoc advisory committee to discuss both what is known within in the scientific community, and the concerns of fishing communities with regard to the longer-term effects of climate change. That committee would then develop recommendations for forward-looking scientific investigations into the effects of climate change on West Coast fish and fisheries. If that committee concludes that EFH, fisheries safety, or other major Council policy areas could be of concern under future climate-change scenarios, the committee would make recommendations to the Council on ways to address those concerns under the different Council policy arenas. That advisory committee could consist of fisheries, climate, and social scientists, a geographically diverse set of fisheries representatives, fisheries managers, and others the Council deems appropriate to the task.

A.2.9 Indicators for Analyses of Council Actions Initiative

Under NEPA, actions that may have an effect on the environment, such as federal fishery management actions, are required to be analyzed for the significance of the potential direct, indirect, and cumulative impact on the environment. The purpose of this requirement is to inform decisionmakers and the public about the greater potential environmental consequences expected from a proposed action or series of

actions, and to ensure that the entities proposing the action evaluate options for mitigating potential negative consequences of the action.

Under federal regulations at §1508.7, cumulative impact is defined as *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions*. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In Chapter 4, the FEP discusses broad categories of potential effects, whether from human actions or environmental shifts, of changes within the marine environment in areas of Council interest or responsibility: fish abundance within the CCE, the abundance of nonfish organisms within the CCE, changes in biophysical habitat within the CCE, changes in fishing community involvement in fisheries and dependence upon fishery resources, and aspects of climate change expected to affect living marine resource populations within the CCE.

The Council, its participating agencies, staff, and advisory bodies all participate to some degree in developing NEPA analyses for Council actions. One major challenge in analyzing the potential impacts of fishery management actions within the context of the cumulative effects of human activities on the environment is measuring and tracking the potential effects of fishery management actions on the structure and function of the CCE. Under this initiative, the Council and its advisory bodies would look for improvements to its process of assessing the direct, indirect, and cumulative impacts of actions taken by the Council on the CCE's structure and function. Ultimately, this initiative could help the Council to assess whether shifts in management measures are needed to help buffer against uncertainties resulting from the cumulative effects of human activities on the environment, and to support greater long-term stability within the CCE and for its fishing communities.

Concurrent with the development of the FEP, the Council has also been considering the form and content of an annual state of the CCE report. The intent of such a report would not be to discuss all known scientific information on the CCE; rather, it would be to report on specific indicators of the environmental or socio-economic conditions that affect or are affected by fisheries. As the Council and its advisory bodies refine the indicators included in the Council's annual state of the CCE report, it may wish to consider identifying indicators useful to the Council's decision-making processes. For example, the FMPs have indicators for major management goals, like tracking stock status against the objective of maximum sustainable yield, and thresholds for identifying when a stock should be considered overfished. Could ecosystem status indicators do more than simply illustrating the current and past states of the ecosystem by also identifying points at which management programs should change?

Background work for developing this initiative could include a cross-FMP assessment of commonalities between how NEPA work is conducted under each of the FMPs. In particular, background information is needed on how the different FMPs assess the effects of fishing activities on the CCE as a whole, both on the state of the CCE as it currently exists, and on the anticipated state of the CCE over time. The Council would need to determine whether ongoing refinements to the annual state of the CCE report should be targeted at providing source material for NEPA analyses on the effects of the fisheries on the status of the CCE. In addition to background materials on Council NEPA processes, the Council would likely need input from scientists on the availability scientific information on potential indicators of CCE status, and on the utility of such information to the Council's decision-making process.

To implement this initiative, the Council could assemble an ad hoc advisory committee to discuss recommendations for information products needed to support both short-term and long-term understanding of the cross-FMP effects of fishing activities on the CCE and of the biogeographic shifts in the CCE on fishery resource availability to the fisheries. That committee could also recommend improvements to Council NEPA analyses, with a particular emphasis on assessing indirect and cumulative effects and

accounting for the interactions between natural changes to the CCE and the effects of human activities on those changes. That advisory committee could consist of NEPA analysts, scientist contributors to the California Current Integrated Ecosystem Assessment, fisheries managers, and others the Council deems appropriate to the task.

A.2.10 Optimum Yield Initiative

An objective of the FEP is to “Build toward fuller assessment of the greatest long-term benefits from the conservation and management of marine fisheries, of optimum yield, and of the tradeoffs needed to achieve those benefits while maintaining the integrity of the CCE...” As described in National Standard 1, optimum yield (OY) must be assessed and specified in the FMPs and Councils should determine what the relevant social, economic, and ecological factors are in determining OY. An OY Ecosystem Initiative would provide a mechanism to fulfill National Standard 1 by identifying and describing the social, economic, and ecological factors relevant to each FMP. As a matter of process, this initiative could be considered through a comprehensive ecosystem-based amendment, like done with Ecosystem Initiative 1, if appropriate. In the future, on a periodic basis as needed, FMP management and Integrated Ecosystem Assessment teams could assess relevant OY factors and update information related to those factors. Specifying these social, economic, and ecological factors in the FMP could more clearly and transparently inform future decision-making on matters such as annual catch limits and fishery conservation and management measures necessary to achieve OY on a continuing basis.

Rationale

The MSA mandates that fisheries be managed at OY, 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.” OY is prescribed as maximum sustainable yield “as reduced by any relevant economic, social, or ecological factor.” The MSA further establishes National Standard 1, which states that OY shall be achieved “on a continuing basis.”

National Standard 1 interprets OY as a decisional mechanism for resolving the MSA’s conservation and management objectives, with the most important feature of OY being that it must prevent overfishing. NS1 defines OY as a long-term average and states that FMPs must contain conservation and management measures to achieve OY on a continuing basis. An FMP “must contain an assessment and specification of OY” and Councils should consider the objectives of their FMPs and their management framework to “determine the relevant social, economic, and ecological factors used to determine OY.” The assessment and specification of OY should be reviewed on a continuing basis so that it is responsive to changing circumstances in the fishery. NS1 guidelines include a list of potential considerations for social, economic, and ecological factors to take into account when reducing MSY to achieve OY.

A.3 Sources for Appendix A

- Alaska CSHCR. 2012. Relating to an examination of fisheries-related programs to facilitate the entry of young Alaskans into commercial fisheries careers and to collaborate with the University of Alaska fisheries, seafood, and maritime initiative.
- Berkeley S.A., M. A. Hixon, R. J. Larson, and M. S. Love. 2004b. Fisheries sustainability via protection of age structure and spatial distribution of fish populations. *Fisheries* (Bethesda) 29(8): 23–32.
- Berkeley, S.A. 2006. Pacific rockfish management: are we circling the wagons around the wrong paradigm? *Bull. Mar. Sci.*, 78(3): 655–668.
- Clay, P.M. and J. Olson. 2008. Defining “Fishing Communities”: Vulnerability and the Magnuson-Stevens Fishery Conservation and Management Act. *Human Ecology Review* 15: 143-160.

- Cope J.M., A.E. Punt. 2009. Length-Based Reference Points for Data-Limited Situations: Applications and Restrictions. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*. 1:169–186.
- DeCola, P. 2010. First Coast Guard District Report to the New England Fishery Management Council, September 28, 2010:
http://www.nefmc.org/press/council_discussion_docs/Sept%202010/100928_USCG%20Council%20Brief.pdf
- Department of Maine Resources. 2011. Maine Lobster Apprenticeship Program. Program Brochure online: <http://www.maine.gov/dmr/rm/lobster/apprenticebrochure.pdf>
- Dickey, D.H. 2011. Analysis of Fishing Vessel Casualties: A Review of Lost Fishing Vessel and Crew Fatalities, 1992-2010. United States Coast Guard Compliance Analysis Division:
http://www.fishsafe.info/FVStudy_92_10.pdf
- Froese, R. 2004. Keep it simple: three indicators to deal with overfishing. *Fish and Fisheries* 5:86–91.
- Hall-Arber, M., C. Pomeroy, and F. Conway. 2009. Figuring out the human dimensions of fisheries: illuminating models. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 1: 300-314.
- Jepson, M. and S. Jacob. 2007. Social indicators and measurements of vulnerability for Gulf Coast fishing communities. *NAPA Bulletin* 28: 57-68.
- Leaman, B. M., and R. J. Beamish. 1984. Ecological and management implications of longevity in some northeast Pacific groundfishes. *International North Pacific Fisheries Commission Bulletin* 42:85-97.
- Leaman, B. M. 1991. Reproductive styles and life history variables relative to exploitation and management of *Sebastes* stocks. *Environmental Biology of Fishes* 30:253–271.
- Lincoln, J. and D. Lucas. 2010. Commercial Fishing Deaths -- United States, 2000-2009. *Morbidity and Mortality Weekly, Report* 59(27): 842-845.
- Lincoln, J. and D. Lucas. 2008. Commercial Fishing Fatalities -- California, Oregon, and Washington, 2000-2006. *Morbidity and Mortality Weekly, Report* 57(16): 425-452.
- Link, J. S. 2005. Translating ecosystem indicators into decision criteria. *ICES Journal of Marine Science* 62:569–576.
- Myers, R. A., and G. Mertz. 1998. The limits of exploitation: a precautionary approach. *Ecological Applications* 8:S165–S169.
- National Fishing Industry Education Centre:
<http://northcoast.tafensw.edu.au/natfish/Pages/Natfish%20home.aspx>
- National Marine Fisheries Service. 2011. U.S. National Bycatch Report [W.A. Karp, L.L. Desfosse, S.G. Brokko, Eds]. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-117E, 508 p.:
http://www.nmfs.noaa.gov/by_catch/bycatch_nationalreport.htm
- Norman K., J. Sepez, H. Lazrus, N. Milne, S. Russell, K. Grant, R. Lewis, J. Primo, E. Springer, M. Styles, B. Tilt, and I. Vaccaro. 2007. Community profiles for West Coast and North Pacific fisheries: Washington, Oregon, California, and other U.S. States. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-85, 602 p.
- Norman, K., D. Holland, and S. Kasperski. 2013. Resilient and Economically Viable Coastal Communities. In: Levin, P. and B. Wells (eds). 2013. *California Current Integrated Ecosystem Assessment: Phase II*.
<https://www.integratedecosystemassessment.noaa.gov/Assets/iea/california/Report/pdf/Human%20Dimensions%20July%202013%20RevFinal.pdf>
- Punt, A. E., A. D. M. Smith, and G. R. Cui. 2001. Review of progress in the introduction of management strategy evaluation (MSE) approaches in Australia's southeast fishery. *Mar. Freshw. Res.* 52: 719–726
- Rochet, M. J., and V. M. Trenkel. 2003. Which community indicators can measure the impact of fishing? A review and proposals. *Canadian Journal of Fisheries and Aquatic Sciences* 60:86–99.

- Sepez, J., K. Norman, and R. Felthoven. 2007. A quantitative model for ranking and selecting communities most involved in commercial fisheries. *NAPA Bulletin* 28: 43-56.
- Russell, S., A. Varney, A. Arthur, K. Sparks, K. Kent, S. Wise, R. Moon, B. Carter, M. Stevens, and M. Galligan. 2012. Pacific Coast Groundfish Trawl Fishery Social Study: Baseline Study Preliminary Results. <http://www.nwfsc.noaa.gov/research/divisions/cbd/groundfish-study.cfm>.
- Smith, A.D.M., C.J. Brown, C.M. Bulman, et al. 2011. Impacts of fishing low-trophic level species on marine ecosystems. *Science* 333: 1147-1150.
- Whitby and District Fishing Industry Training School: <http://www.whitbyfishingschool.co.uk/>
- Wright, P. M. and F. J. Gibb. 2005. Selection for birth date in North Sea haddock and its relation to maternal age. *J. Anim. Ecol.* 74: 303–312.