COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

The Pacific Fishery Management Council (Council) is considering ecosystem-based approaches to fishery management and is in the process of developing a Fishery Ecosystem Plan (FEP) as a vehicle for bringing ecosystem-based principles into the Council decision-making process under its existing Fishery Management Plans (FMPs). The Council has also been exploring the plan's potential to broaden its current authority to species and issues not currently addressed in existing FMPs.

The Council last reviewed the FEP in November 2011 and approved a draft outline and adopted a schedule for FEP development. The Council also heard a presentation from the National Marine Fisheries Service on the Integrated Ecosystem Assessment (IEA) for the California Current and considered ways to bring the IEA and ecosystem science into the Council process via an annual state-of-the-ecosystem report. Under the adopted schedule, the Council will review and refine the FEP in June and November of 2012 and will consider final adoption in March of 2013. It is envisioned that the FEP will then become a "living document" that evolves in response to changing Council needs and the availability of new information.

In keeping with Council guidance in November, the Ecosystem Plan Development Team (EPDT) has provided an initial draft of the FEP with an emphasis on the plan's goals and objectives and a description of the California Current ecosystem (Agenda Item H.1.a, Attachment 1). The EPDT has also provided a draft outline for a Council-focused annual report on the state of the California Current ecosystem (Agenda Item H.1.a, Attachment 2) and is requesting feedback on the report's content and format. The initial annual report is scheduled for completion in November 2012.

In a related administrative manner, the Council is scheduled to address the issue of the need for additional protective measures for forage species that are currently unexploited. Under Agenda Item G.1, the Council will consider a range of optional management responses, some which may directly affect FEP development. One proposed alternative is to convert the developing FEP to a regulatory Ecosystem FMP as a way of expanding the Council's jurisdiction to additional species. Another alternative is to update the Federal List of Fisheries and Gear allowed on the West Coast and to include, in the FEP, a description of the standards that the Council would use in assessing the likelihood that a proposed new fishery could compromise the Council's West Coast conservation and management measures. If the Council chooses to pursue future action on unexploited forage species under Agenda Item G.1, there could be direct implications for FEP development depending on what alternative(s) the Council selects.

At this meeting, the Council is being asked to provide feedback on the draft FEP, on the draft outline for an annual state-of-the-ecosystem report, and on priority tasks for further development of the FEP.

Council Action:

1. **Provide feedback on the Draft FEP.**
2. **Review and comment on the draft outline for an annual state-of-the-ecosystem report.**
3. **Provide guidance on priority tasks for future work on FEP development.**

Reference Materials:

1. Agenda Item H.1.a, Attachment 1, Draft Pacific Coast Fishery Ecosystem Plan.
2. Agenda Item H.1.a, Attachment 2, Draft Outline for an Annual State-of-the-Ecosystem Report.

Agenda Order:

a. Agenda Item Overview — Mike Burner
b. Report of the Ecosystem Plan Development Team — Yvonne deReynier
c. Reports and Comments of Advisory Bodies and Management Entities
d. Public Comment
e. **Council Action:** Review and Approve Draft FEP for Public Review and Provide Guidance on Annual State-of-the-Ecosystem Reporting

PFMC
05/31/12

Z:\!PFMC\MEETING\2011\November\Ecosystem\H2_SitSum_FEP.docx

Agenda Item H.1.a
Attachment 1
June 2012

PACIFIC COAST FISHERY ECOSYSTEM PLAN

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

DRAFT

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

JUNE 2012

LIST OF ACRONYMS AND ABBREVIATIONS

ACL	annual catch limit
AM	accountability measure
AP	advisory panel
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CCE	California Current Ecosystem, or California Current Large Marine Ecosystem
CDFG	California Department of Fish and Game
CFGC	California Fish and Game Commission
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Council	Pacific Fishery Management Council
CPS	Coastal Pelagic Species
CZMA	Coastal Zone Management Act
DLCD	Oregon Department of Land Conservation and Development
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ENSO	El Niño/Southern Oscillation
EPDT	Ecosystem Plan Development Team
ESA	Endangered Species Act
FAO	Food and Agriculture Organization (of the United Nations)
FEP	Fishery Ecosystem Plan
FMP	Fishery Management Plan
HAB	Harmful algal bloom
HAPC	Habitat Area of Particular Concern
HMS	Highly Migratory Species
ICES	International Council for the Exploration of the Sea
IATTC	Inter-American Tropical Tuna Commission
INPFC	International North Pacific Fisheries Commission
IPHC	International Pacific Halibut Commission
ISC	International Scientific Committee (of the WCPFC process)
JMC	Joint Management Committee (of the U.S./Canada Pacific Whiting Treaty process)
JTC	Joint Technical Committee (of the U.S./Canada Pacific Whiting Treaty process)
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NPAFC	North Pacific Anadromous Fish Commission
OCN	Oregon coastal natural (coho salmon)
ODFW	Oregon Department of Fish and Wildlife
ODSL	Oregon Deparment of State Lands
OFWC	Oregon Fish and Wildlife Commission
OPRD	Oregon Parks and Recreation Department
PacFIN	Pacific Fisheries Information Network
PDO	Pacific Decadal Oscillation
PICES	Pacific ICES; formally, the North Pacific Marine Science Organization
RCA	Rockfish Conservation Area
SRG	Scientific Review Group (of the U.S./Canada Pacific Whiting Treaty process)
SSC	Scientific and Statistical Committee
U & A	Usual and Accustomed (fishing areas, of Treaty tribes)
U.S.	United States of America
WCPFC	Western and Central Pacific Fisheries Commission
WDFW	Washington Department of Fish and Wildlife
WFWC	Washington Fish and Wildlife Commission

Contents

1 Introduction

1.1 Purpose and Need

At its June 2011 meeting, the Pacific Fishery Management Council (Council or Pacific Council) adopted the following Purpose and Need Statement for a Fishery Ecosystem Plan (FEP):

The purpose of the FEP is to enhance the Council's species-specific management programs with more ecosystem science, broader ecosystem considerations and management policies that coordinate Council management across its Fishery Management Plans (FMPs) and the California Current Ecosystem (CCE). An FEP should provide a framework for considering policy choices and trade-offs as they affect FMP species and the broader CCE.

The needs for ecosystem-based fishery management within the Council process are:

1. *Improve management decisions and the administrative process by providing biophysical and socio-economic information on CCE climate conditions, climate change, habitat conditions and ecosystem interactions.*
2. *Provide adequate buffers against the uncertainties of environmental and human-induced impacts to the marine environment by developing safeguards in fisheries management measures.*
3. *Develop new and inform existing fishery management measures that take into account the ecosystem effects of those measures on CCE species and habitat, and that take into account the effects of the CCE on fishery management.*
4. *Coordinate information across FMPs for decision-making within the Council process and for consultations with other regional, national, or international entities on actions affecting the CCE or FMP species.*
5. *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.*

1.2 How this Document is Organized

This FEP takes its organization from the Council's Purpose and Need statement, in Section 1.1. Chapter 2 provides the FEP's Objectives, a more detailed exploration of what the FEP would do to meet its Purpose and Need. Chapter 3 provides an overview of the CCE from a variety of physical, biological, and socio-economic perspectives and disciplines. Chapter 4 discusses the cumulative effects and uncertainties of environmental shifts and human activities on the marine environment and potential cross-FMP fishery management measures that could be used to buffer against those effects and uncertainties. Chapter 5 discusses Council CCE policy priorities across its FMPs, so that ocean resource management and policy processes external to the Council (e.g. West Coast Governors' Agreement on Ocean Health, National Ocean Council, international fishery and ocean resource management bodies) may be made aware of and may better take into account those priorities. Chapter 6 identifies and prioritizes research needs and provides recommendations to address gaps in ecosystem knowledge and FMP policies.

1.3 Schedule and Process for Developing the FEP

At its June 2011 meeting, the Council tasked its EPDT with drafting a schedule and process for developing the FEP. This FEP is a living document, which means that the Council anticipates periodically amending and updating the FEP. The following proposed process and schedule is intended to allow the Council to swiftly finalize an initial FEP, with the understanding that the Council will annually assess and update the FEP.

June 2011: Council decides to develop an advisory FEP, adopts Purpose and Need Statement. Advisory FEP is to be structured so that, if the Council wishes, it could be later converted to an Ecosystem FMP with regulatory authority.

November 2011: Council reviews EPDT's draft FEP outline, makes recommendations on additions to or subtractions from proposed FEP contents, makes recommendations on prioritizing issues to be considered within the FEP.

June 2012: Council reviews and initially comments on draft FEP, providing direction for future drafting efforts; Council sends FEP out for public comments.

November 2012: Council receives comments on draft FEP from its advisory bodies and the public, directs EPDT to revise FEP as appropriate, and adopts 2013 FEP workload priorities.

March 2013: EPDT provides draft initial FEP, as modified in response to Council direction from November 2012; Council adopts final initial FEP.

1.4 State-of-the-Ecosystem Reporting

At its November 2011 meeting, the Council expressed support for an annual state-of-the-ecosystem report to the Council. The Council suggested that the report should:

- Be bounded in terms of its size and page range, possibly as brief as 15-20 pages in length;
- Not wait for the "perfect" science, that there may be scientific information that does not come with definitive answers and numbers, but which may be useful for the Council to consider.

In its report at that meeting, the Council's Scientific and Statistical Committee noted that NMFS's West Coast fisheries science centers were working on an Integrated Ecosystem Assessment (IEA,) and recommended coordination between IEA scientists and the EPDT to ensure that they are "working from the same base data, avoid duplication of effort, and perhaps even consider producing a single joint report." The California Current IEA is an ongoing scientific effort that NMFS expects will produce and inform many reports. An annual state-of-the-ecosystem report in connection with this FEP would be informed by the IEA. The IEA process would not result in future annual state-of-the-ecosystem reports outside of the FEP-based annual ecosystem report.

November 2011: Council receives sample discussion document on developing an annual report on conditions in the CCE, highlighting processes and results from the California Current Integrated Ecosystem Assessment.

June 2012: Council receives a draft outline and list of potential indicators and information to be included in an annual ecosystem considerations report, to be made available for review and comment by the Council, its advisory bodies, and the public review. Council provides guidance on modifications to report outline and contents.

November2012: First annual ecosystem considerations report, to be repeated annually if acceptable.

2 Objectives

[The EPDT first provided draft *Goals and Objectives* in its September 2010 report to the Council (Agendas Item H.1.b., Attachment 1). For this June 2012 draft of the FEP, EPDT has modified its September 2010 draft, taking into account comments received from the Council, its advisory bodies, and the public. This section is now simply titled, *Objectives*, because the Council has adopted a Purpose and Need statement in Secion 1.1 that provides broad, over-arching goals for the FEP. The objectives provided for Council and public review, below, have been drafted within the context of the Council's June 2011 recommendation that the FEP be drafted as an advisory, not regulatory, document].

The FEP objectives, listed below, are intended to address the purpose and need statement in Section 1.1. This FEP and related activities are together expected to further integrate management across all Council FMPs, while recognizing that the Council's authority is generally limited to managing fisheries and the effects of fisheries on the marine ecosystem, protected species, and to consultations on the effects of non-fishing activities on essential fish habitat. The Council's work often requires Council members to think about their larger goals for the CCE, including and beyond goals they may have for managing fisheries. Chapter 5 of this FEP, *PFMC Policy Priorities for Ocean Resource Management*, discusses the Council's CCE policy priorities as they may apply to ocean resource management and policy processes external to the Council. Thus, this section provides Council objectives for Council work, while Chapter 5 provides the Council's aspirations for the work of others within the CCE, given Council priorities for the fish stocks and fisheries it manages.

The Council's four existing FMPs each have suites of goals and objectives that differ in their precise language, but have five common themes consistent with an ecosystem approach to fishery management: avoid overfishing, minimize bycatch, maintain stability in landings, minimize impacts to habitat, and accommodate existing fisheries sectors. The Coastal Pelagic Species FMP has an additional goal of providing adequate forage for dependent species. The following FEP objectives are intended to build upon the Council's four FMPs by recognizing that, through the Magnuson-Stevens Act, the United States supports the ongoing participation of its citizens in commercial and recreational fisheries off its coasts, while also requiring that fish stocks be conserved and managed for optimum yield.

1. Improve and integrate information used in Council decision-making across the existing FMPs by:

    a. Describing the key oceanographic, physical, biological, and socioeconomic features of the CCE and dependent fishing communities;
    b. Identifying measures and indicators, and informing reference points to monitor and understand trends and drivers in key ecosystem features;
    c. Identifying and addressing gaps in ecosystem knowledge, particularly with respect to the cumulative and longer-term effects of fishing on marine ecosystems;
    d. Examining the potential for a science and management framework that allows managing fish stocks at spatial scales relevant to the structure of those stocks.

2. Build toward fuller assessment of the greatest long-term benefits from the conservation and management of marine fisheries, and of the tradeoffs needed to achieve those benefits while maintaining the integrity of the CCE through:

    a. Assessing trophic energy flows and other ecological interactions within the CCE;
    b. Assessing the full range of cultural, social, and economic benefits that fish and other living marine organisms generate through their interactions in the ecosystem;

c. Improving assessment of how fisheries affect and are affected by the present and potential future states of the marine ecosystem.

3. Provide administrative structure and procedures for coordinating conservation and management measures for the living marine resources of the U.S. West Coast EEZ:

    a. Guiding annual and regular reporting of status and trends to the Council;
    b. Providing a nexus to regional and national ecosystem-based management endeavors, particularly to address the consequences of non-fishing activities on fisheries and fish habitat;
    c. Identifying ecological relationships within the CCE to provide support for cross-FMP work to conserve non-target species essential to the flow of trophic energy within the CCE.

3 The FEP's Geographic Area and the California Current Ecosystem

3.1 Geography of the Ecosystem

The geographic range for this FEP is the entire U.S. West Coast Exclusive Economic Zone (EEZ, shown in Figure 3.1.1.) The Council recognizes that the EEZ does not encompass all of the CCE, nor does it include all of the waters and habitat used by many of the Council's more far-ranging species. The Council also recognizes the importance of freshwater and estuarine ecosystems to the CCE and may expand this intitial effort to include these ecoregions in the future. The Council also does not believe that designating the EEZ as the FEP's geographic range in any way prevents it from receiving or considering information on areas of the CCE or other ecosystems beyond the EEZ.

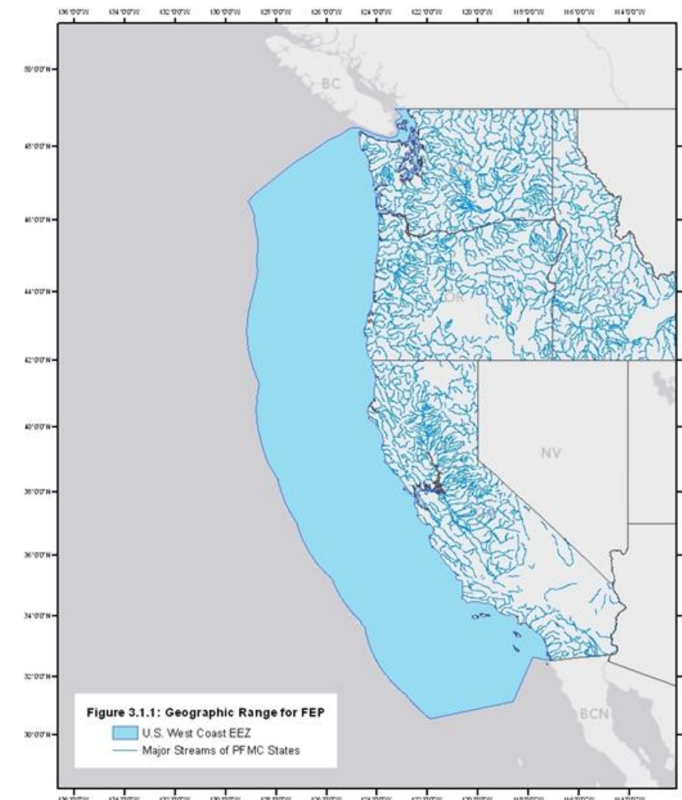


Figure 3.1.1: Geographic Range for FEP

3.1.1 General Description and Oceanographic Features of the CCE

The California Current is an eastern boundary current, an upwelling-dominated ecosystem, characterized by fluctuations in physical conditions and productivity over multiple time scales (Parrish et al. 1981, Mann and Lazier 1996). Food webs in these types of ecosystems tend to be structured around coastal pelagic species that exhibit boom-bust cycles over decadal time scales (Bakun 1996, Checkley and Barth 2009, Fréon et al. 2009). By contrast, the top trophic levels of such ecosystems are often dominated by highly migratory species such as salmon, tuna, billfish and marine mammals, whose dynamics may be partially or wholly driven by processes in entirely different ecosystems, even different hemispheres. Ecosystems analogous to the CCE include other shelf and coastal systems, such as the currents off the western coasts of South America and Spain.

The CCE essentially begins where the west wind drift (or the North Pacific Current) reaches the North American continent. The North Pacific Current typically encounters land along the northern end of Vancouver Island, although this location varies latitudinally from year to year. This current then splits into the southward-flowing California Current heading south (shown in Figure 3.1.2) and the northward-flowing Alaska Current. The "current" in the California Current is a massive southward flow of water ranging from 50 to 500 kilometers offshore (Mann and Lazier, 1996). Beneath this surface current, flows what is known as the California Undercurrent in the summer, which then surfaces and is known as the Davidson current in winter. This current moves water poleward from the south in a deep yet more narrow band of water typically close to and offshore of the continental shelf break (Hickey 1998, Checkley and Barth 2009). The southward-flowing California Current is typically considered distinct from the wind-driven coastal upwelling jet that develops over the continental shelf during the spring and summer, which tends to be driven by localized forcing and to vary on smaller spatial and temporal scales than offshore processes (Hickey, 1998). Jets result from intensive wind-driven coastal upwelling, and lead to higher nutrient input and productivity; they in turn are influenced by the coastal topography (capes, canyons and offshore banks), particularly the large capes such as Cape Blanco, Cape Mendocino and Point Conception. The flow from the coastal upwelling jets can be diverted offshore, creating eddies, fronts and other mesoscale changes in physical and biological conditions, and even often linking up to the offshore California Current (Hickey, 1998).

Superimposed on the effects of these shifting water masses that drive much of the interannual variability of the CCE, are substantive changes in productivity that often take place at slower rates, during multi-year and decadal periods of altering ocean condition and productivity regimes. Climatologists and oceanographers have identified and quantified both the high and low frequency variability in numerous ways. The El Niño/Southern Oscillation (ENSO) is the dominant mode of interannual variability in the equatorial Pacific, with impacts throughout the rest of the Pacific basin (including the California Current) and the globe (Mann and Lazier 1996). During the negative (El Niño) phase of the ENSO cycle, jet stream winds are typically diverted northward, often resulting in increased exposure of the West Coast of the U.S. to subtropical weather systems (Cayan and Peterson 1989). Concurrently in the coastal ocean, the effects of these events include reduced upwelling winds, a deepening of the thermocline, intrusion of offshore (subtropical) waters, dramatic declines in primary and secondary production, poor recruitment, growth and survival of many resident species (particularly salmon and groundfish), and northward extensions in the range of many tropical species.

While the ENSO cycle is generally a high-frequency event (taking on the order of three to seven years to complete a cycle), lower frequency variability has been associated with what is now commonly referred to as the Pacific (inter)Decadal Oscillation, or PDO (Mantua et al. 1997).

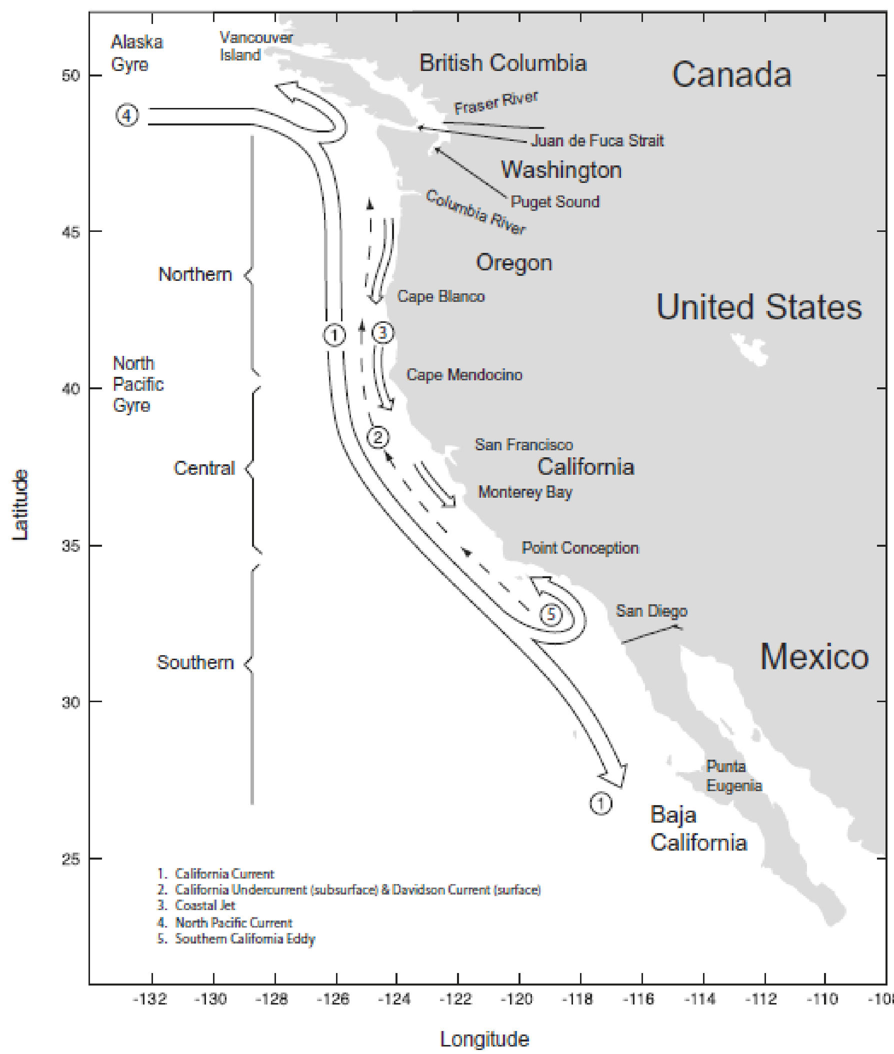


Figure 3.1.2: California Current

The PDO is the leading principal component of North Pacific sea surface temperatures (above 20° N. lat.), and superficially resembles ENSO over a decadal time scale. During positive regimes, coastal sea surface temperatures in both the Gulf of Alaska and the California Current tend to be higher, while those in the North Pacific Gyre tend to be lower; the converse is true in negative regimes. The effects of the PDO have been associated with low frequency variability in over 100 physical and biological time series throughout the Northeast Pacific, including time series of recruitment and abundance for commercially important coastal pelagics, groundfish and invertebrates (Mantua and Hare 2002).

3.1.2 Major Bio-Geographic Sub-Regions of the CCE

Although there are many different ways of thinking about dividing the CCE into sub-regions, Francis et al. (2008) have suggested three large-scale CCE sub-regions: a Northern sub-region extending from the northern extent of the CCE off Vancouver Island to a southern border occurring in the transition zone between Cape Blanco, OR and Cape Mendocino, CA; a Central sub-region extending southward from that transition zone to Point Conception, CA; and a Southern sub-region from Point Conception to Punta Baja, on the central Baja Peninsula. Francis and co-authors suggested these three sub-regions based on various oceanographic and ecological characteristics and in the context of the Council's Groundfish FMP. A different set of sub-regions may be more appropriate in the context of other issues and analyses.

Each of these three major CCE sub-regions experiences differences in physical and oceanographic features such as wind stress and freshwater input, the intensity of coastal upwelling and primary productivity, and in the width and depth of the continental shelf. Regional scale features like submarine ridges and canyons add to the distinct character of each sub-region. These physical and oceanographic differences then translate into differences in the ecosystem structure of each sub-region.

3.1.2.1 Northern sub-region: Strait of Juan de Fuca, WA to Cape Blanco, OR

The upwelling winds for which the CCE is known are relatively weak in this sub-region, yet at the same time, this region holds some of the CCE's most productive areas (Hickey and Banas 2008). The southward flowing California Current is also relatively weak in this sub-region and the flow can even shift poleward off the Washington coast.

The U.S./Canada border artificially divides this sub-region. Based on biological and oceanographic features, the Northern sub-region extends to north Brooks Peninsula on Vancouver Island , generally considered to be between the CCE and the Gulf of Alaska marine ecosystems (Lucas et al. 2007). The continental shelf is relatively wide in this sub-region and broken up by numerous submarine canyons and oceanic banks. Hickey (1998) describes two major canyons, Astoria and Juan de Fuca and one major bank, Heceta Bank, all of which are important both oceanographically and for fisheries productivity.

Freshwater input from the Strait of Juan de Fuca and the Columbia River is another key feature of this sub-region. Freshwater is more buoyant than seawater and transports a steady supply of nutrients from land into the euphotic zone. Features like the Columbia River plume, the Juan de Fuca eddy and Heceta Bank also help retain nutrients and plankton in coastal areas, as does the relative straightness of the coastline. In other sub-regions of the coast, major coastal promontories can create coastal jets and meanders that transport nutrients and plankton offshore. The many submarine canyons in the region can also intensify upwelling, adding to primary productivity. These and other factors combine to produce chlorophyll concentrations in this sub-region that can be five times higher than off Northern California, despite the weaker upwelling winds (Hickey and Banas 2008).

3.1.2.2 Central sub-region: Cape Blanco to Point Conception

In the region just north of Cape Blanco, the shelf begins to narrow, winds and upwelling intensify, and coastal waters move offshore. At or near Cape Blanco, what had been a simple, lazy southward current becomes a maze of swirling eddies and turbulent coastal flows continue south to Cape Mendocino (Botsford and Lawrence 2002). The area between Cape Blanco and Cape Mendocino experience the strongest winds and upwelling in the CCE. This transition area also includes the southern boundary of oil rich, subarctic zooplankton.

The Mendocino Escarpment is another key feature of this region, a large fracture zone that forming a huge submarine ridge near Cape Mendocino. There are also a number of large submarine canyons in the region between Monterey Bay and Point Sur. These features result in high diversity of shelf and slope structure and demersal fish habitats. Biogeographic barriers extend out to sea because of strong winds related to the high relief coastal mountains and the funneling of air at high speeds from the Klamath and Sacramento basins to the Coast.

3.1.2.1 Southern sub-region: Point Conception to Mexico border

This area is substantially different from the north and central areas. The topography is complex, the shelf is typically more narrow and shallow than to the north, and the coastline suddenly changes from north-south to east-west at Point Conception and enters an area sheltered from large-scale winds. Thus, Point Conception is a transition point between large-scale wind-driven areas to the north to the milder conditions of the Southern California Bight. There is also a cyclonic gyre in the Bight area that mixes cooler CCE water with warmer waters from the southeast (Hickey and Banas 2003). To the east of a line running south of Point Conception, winds are weak, while further offshore, to the west, wind speeds are similar to those along the continental shelf of the central sub-region. The Santa Barbara Channel remains sheltered from strong winds throughout the year.

In contrast to the relatively contiguous continental shelf in the central sub-region, the offshore region from Port San Luis to the Mexican border encompasses some of the most diverse basin and ridge undersea topography along the U.S. West Coast. Islands top many marine ridges and some of the most southerly topographical irregularities are associated with the San Andreas Fault.

Like in the Northern sub-region, the international boundary divides what could be considered a common region. Based on ecology and oceanography, the Southern sub-region extends south to Punta Baja, Mexico (30° N. latitude). A fourth sub-region of the CCE exists in Mexican waters, reaching from Punta Baja to the tip of the Baja Peninsula at Cabo San Lucas (U.S. GLOBEC 2004).

3.1.3 Political Geographic and Large-Scale Human Demographic Features of the CCE

From north to south, the CCE includes waters offshore of Canada's province of British Columbia, the U.S. states of Washington, Oregon, and California and Mexico's states of Baja California and Baja California Sur. This FEP is a product of a U.S. fishery management process, which means that it focuses on the effects of U.S. citizens, government entities, businesses, and economies on the U.S. portion of the CCE.

The Council has 14 voting members and five non-voting members. The voting Council members include:

- The directors of state fish and wildlife departments from California, Oregon, Washington, and Idaho, or their designees.
- The Regional Director of the National Marine Fisheries Service or his or her designee.
- A representative of a federally-recognized West Coast Native American tribe.
- Eight private citizens who are familiar with the fishing industry, marine conservation, or both. These citizens are appointed by the Secretary of Commerce from lists submitted by the governors of the member states. These eight members include one obligatory member from each state and four at-large members who may come from any state.

There are also five non-voting members who assist the Council decisionmaking. They represent: the Pacific States Marine Fisheries Commission, which coordinates data and research for the Pacific states; the U.S. Fish and Wildlife Service, which serves in an advisory role; the State of Alaska, because both fish and the people who fish for them migrate to and from Alaskan waters; the U.S. Department of State, which is concerned about management decisions with international implications; and the U.S. Coast Guard, which is concerned about enforcement and safety issues.

Marine waters off the U.S. are divided into an array of jurisdictions (Figure 3.1.3) under a host of laws. West Coast states have management responsibility for those ocean fisheries targeting species that

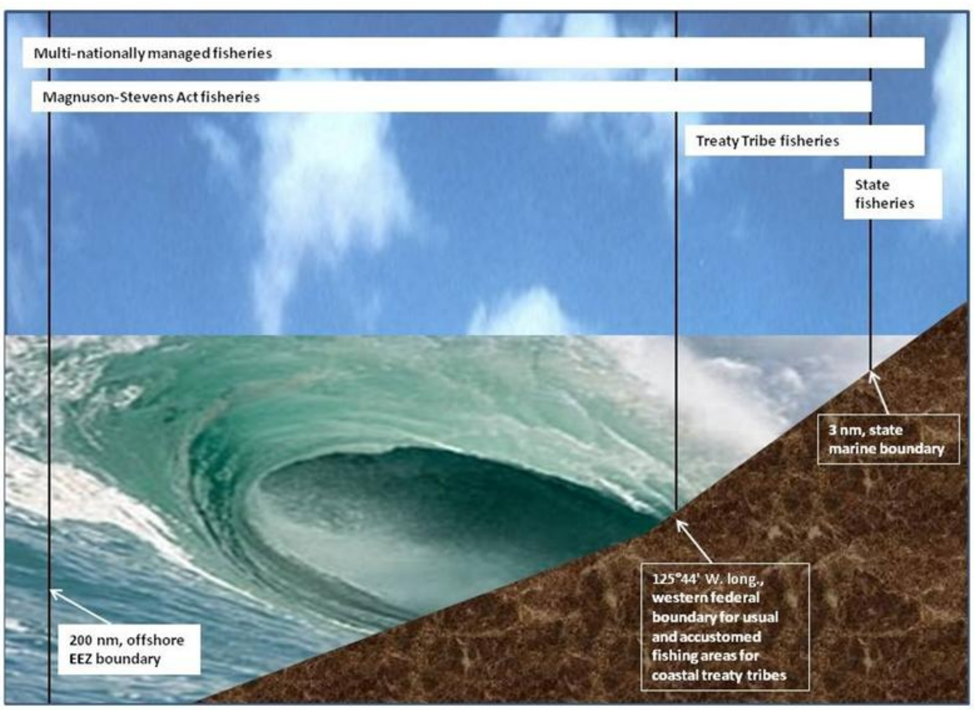


Figure 3.1.3: West Coast EEZ Fishery Management Authorities

primarily occur inshore of the state marine boundary of 3 nm. Off the northern Washington coast, four treaty Indian tribes have Usual and Accustomed fishing areas that include marine waters out to 40 nm offshore. Domestically, inter-state coordination for state fisheries managed separately from the Council process is facilitated by the Pacific States Marine Fisheries Commission. The federal government has explicitly extended non-tribal management authority over Dungeness crab, which occurs in both state and federal waters, to the states of Washington, Oregon and California (16 U.S.C. §1856).

The Council is responsible for managing fisheries that primarily occur within federal waters, 3-200 nm offshore, and separates management for those fisheries into four fishery management plans: coastal pelagic species, groundfish species, highly migratory species, and salmon species. Tribes and states that participate in the Council process also participate in U.S.-Canada bi-national management processes for Pacific halibut, Pacific whiting, and Pacific salmon, and albacore. The Council shares management of highly migratory species with the Western Pacific Fishery Management Council, and both councils and their member states and territories together participate in international management bodies for the central Pacific Ocean. More detailed information on Council, state, tribal, and international fisheries and management processes is available in Section 3.4.

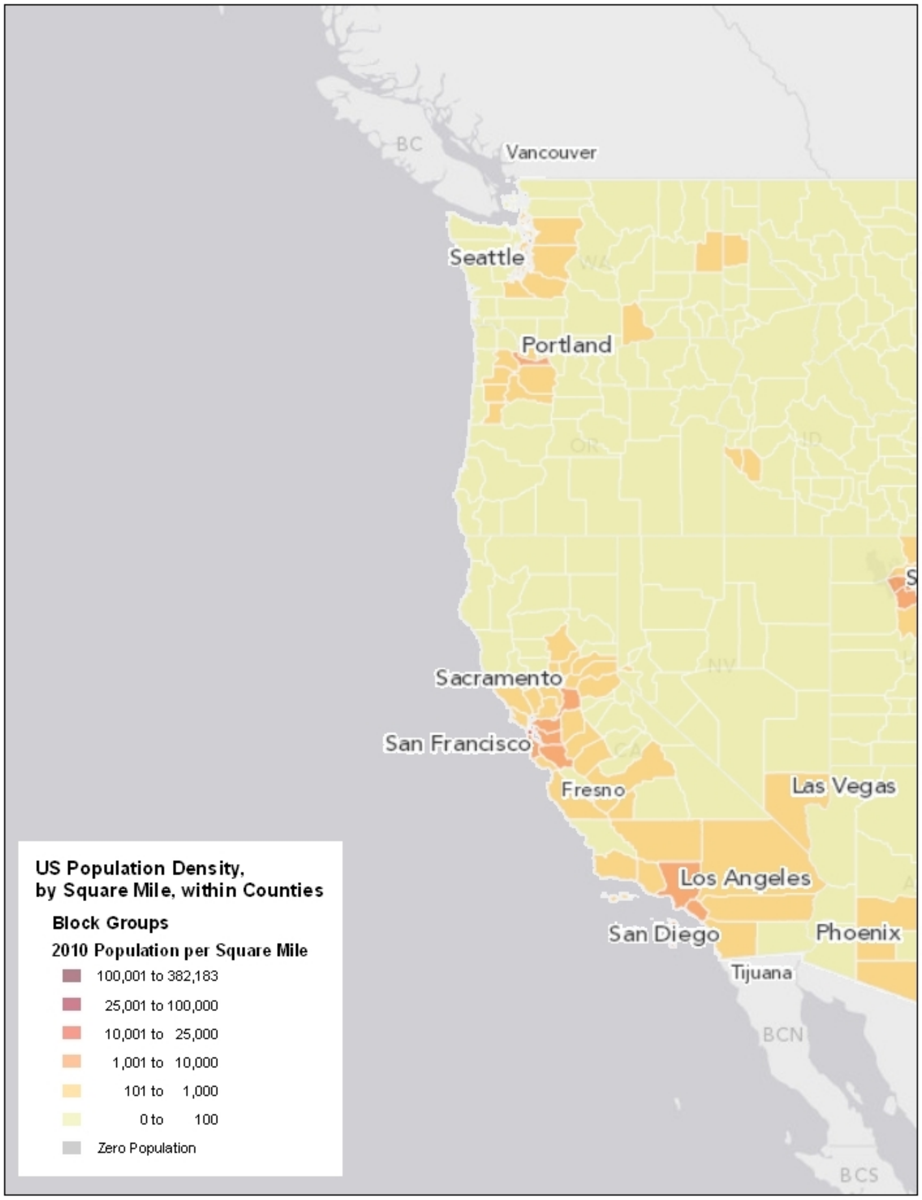


Figure 3.1.4: Human Population Density in the Western U.S.

Major West Coast commercial fishing ports over the 2000-2011 period, by volume, include: ports in the Southern California port area, mainly San Pedro, Terminal Island, Port Hueneme and Ventura; northern Oregon ports, mainly Newport and Astoria; and southern Washington ports of Chinook and Westport. Major West Coast recreational fishing ports over the 2004-2011 period include: [assessing RecFIN data for November 2012] For more detailed information, see Section 3.4.

West Coast urban areas, those with human populations greater than 1,000 people per square mile, include: the eastern and southern shore of Puget Sound, Washington; metropolitan areas of Oregon's Willamette Valley; California's capital in Sacramento, connecting into the counties surrounding San Francisco Bay; and the southern California metropolitan areas surrounding Los Angeles and San Diego. Figure 3.1.4 shows U.S. population density by square mile, from the 2010 U.S. census data.

Human activities that compete with fishing for ocean space include: non-consumptive recreation, dredging and dredge spoil disposal, military exercises, shipping, offshore energy installations, submarine telecommunications cables, mining for minerals, sand and gravel, and ocean dumping and pollution absorption. See Section 3.3.4 for additional discussion. In addition to human activities within the ocean, human institutions have created a host of different types of marine protected areas off the West Coast, many of which are closed to some or all fishing activities. The largest West Coast EEZ marine protected areas with fisheries restrictions or prohibitions are the Council's group of Essential Fish Habitat (EFH) Conservation Areas – also see Section 3.3.4. Also significant in size, and with varying types of protections, are the five West Coast National Marine Sanctuaries (NMSs): Channel Islands NMS, Cordell Bank NMS, Gulf of the Farallones NMS, Monterey Bay NMS, and Olympic Coast NMS. The Council works with the West Coast NMSs to develop EFH conservation areas within sanctuary boundaries (Figure 3.1.5).

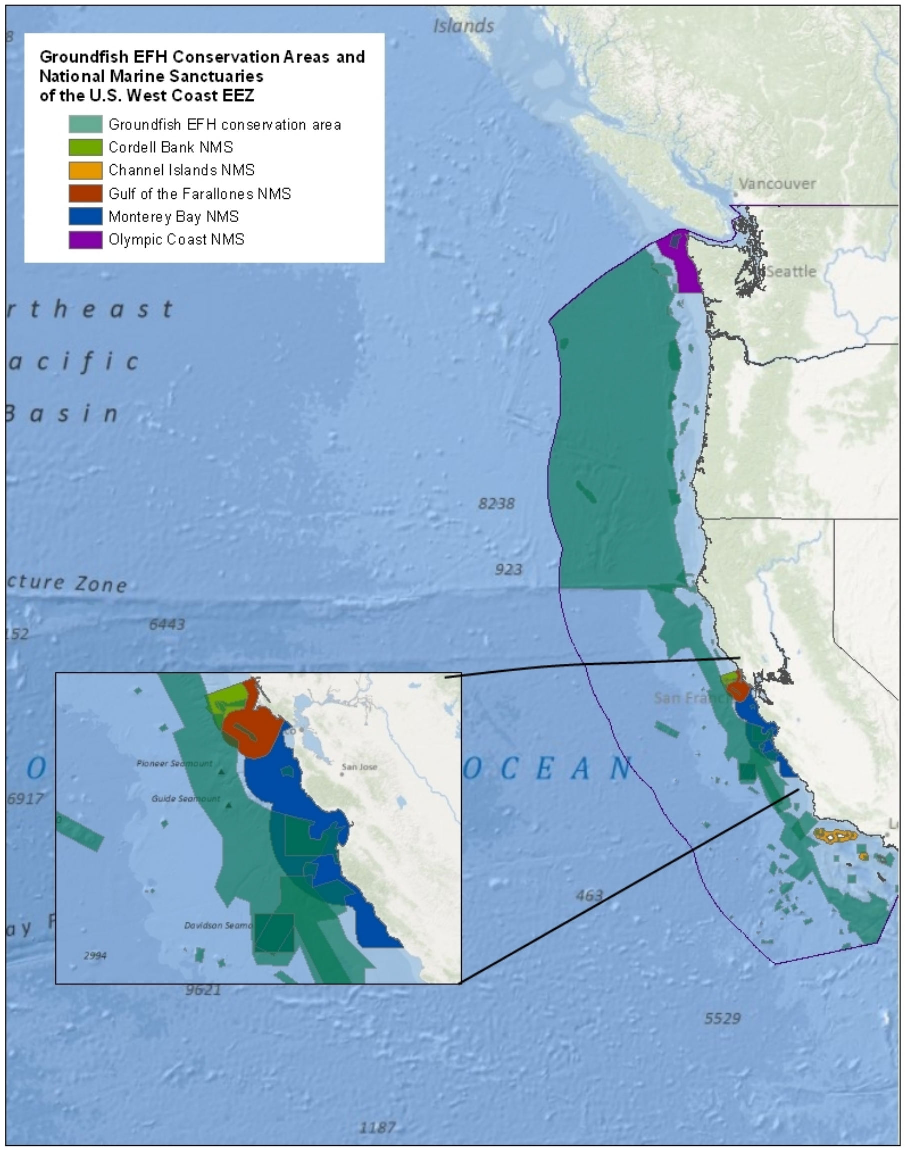


Figure 3.1.5: West Coast EFH Conservation Areas and National Marine Sanctuaries

3.2 Biological Components and Relationships of the CCE

3.2.1 Biological Components

This section defines the major biological components of the CCE in terms of trophic levels – a biological component's position within the larger food web. A biological component's trophic level is roughly defined by its position in the food chain. Lower trophic level species consist of or feed predominantly on primary producers (phytoplankton,etc.) Higher level trophic level species are largely top predators such as marine mammals, birds, sharks and tunas.

As shown in Figure 3.2.1 from Field and Francis (2005,) the CCE contains a diverse array of species, most of which make a relatively modest contribution to the energy flow within the ecosystem. Because the flow of energy is more of a "food web" than a "food chain", the species of the CCE do not neatly divide into clearly delineated trophic levels (for example, an organism may eat a prey item and also eat items that its prey eats), except at the highest and lowest levels. This FEP, below, discusses CCE species within broad trophic level categories, while recognizing that most CCE species do not occupy a single trophic level and may occupy multiple trophic levels, particularly when considering changes that occur over the course of their life as they change both their size and feeding preferences.

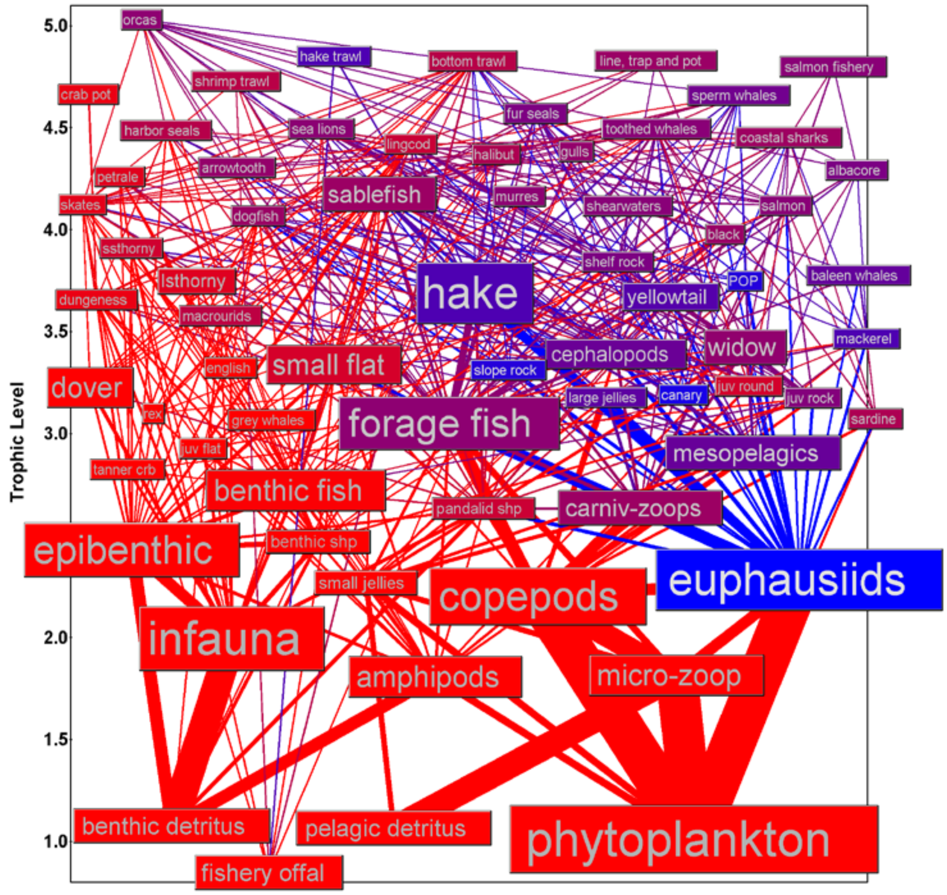


Figure 3.2.1: The significant food web of the Northern CCE: height of boxes is scaled to standing biomasses of species named; width of lines between species or species groups represents biomass flux of prey to predators; and benthic energy pathways are shown in red, while pelagic energy pathways are shown in blue. (Field and Francis, 2005)

3.2.1.1 Mammals, birds, and reptiles of the CCE

Marine mammals, seabirds and marine reptiles of the CCE tend to occupy the system's mid- to higher trophic levels, and are generally protected species, although many were also historically targeted for harvest. Many of the largest populations forage in the CCE seasonally, and breed elsewhere, such as fur seals (breed in the Bering Sea), Humpback whales (breed off Mexico or central America) sooty shearwaters (breed in New Zealand), leatherback turtles (breed in the western tropical Pacific) and bluefin tunas (breed in the western Pacific). Similarly, top predators that do breed in the CCE, such as sea lions and elephant seals, often migrate or forage elsewhere seasonally, although most of the larger seabird populations that breed within the CCE (such as common murres, auklets and gulls) typically do not have extensive foraging ranges. The literature on movements and migrations for any given population is substantial, but Block et al. (2011) provide an excellent synthesis of the range of movements for many of these (and highly migratory fish) populations based on a concerted effort to tag top ocean predators over the past decade. Additionally, Block et al. (2011) describe the seasonal patterns of productivity, thermal variability and other ocean processes that drive many of these movements. Seasonal patterns appear to be the greatest drivers of migrations and variable distributions, although inter-annual and longer term climate variability also shapes the distribution and abundance of many of these higher trophic level species. The response of populations that breed in the CCE to such variability is often difficult determine, although high sea lion pup mortalities have clearly been associated with El Niño events.

Both migrant (such as sooty shearwater and black-footed albatross) and resident seabirds (such as common murres and rhinoceros auklets) have been described as having either warm or cool water affinities, and vary their distribution, abundance, productivity and even diet accordingly (Sydeman et al. 2001; Sydeman et al. 2009). One of the most abundant migratory seabirds in the CCE, sooty shearwaters (*Puffinus griseus*), declined by as much as 90% immediately following the 1977 regime shift (Veit et al. 1996), although numbers have been variable since that time and it remains unclear whether there was an actual decline in population or a shift in distribution (Bjorksted et al. 2010). Understanding such changes in the population dynamics of sea birds is increasingly essential for effective fisheries management, providing the means to minimize interactions between fisheries and threatened or endangered species (Crowder and Norse 2008, Howell et al. 2008). Large-scale seasonal area closures to West Coast drift gill-net fisheries are an example of measures implemented to minimize interactions with leatherback sea turtles that forage intensively on jellyfish, particularly in Central California, from late spring through the fall (Benson et al. 2007). Since sea turtles likely represent one of the most vulnerable taxa in the CCE, and much of this vulnerability lies beyond the control of the PFMC and other U.S. management entities, issues relating to turtle conservation tend to be a high priority with respect to minimizing turtle-fisheries interactions.

Although the historical removals described earlier collectively kept most pinniped and whale populations at low to moderate levels until the middle to late 20th century, most populations have increased, many dramatically, over the last several decades. Humpback whales in the CCE are now thought to number over 2000, blue whales nearly 2500, elephant seals approximately 124,000, California sea lions on the order of 240,000, and short-beaked common dolphins over 400,000 animals (Carretta et al. 2010). Appreciation for the cumulative historical impacts of whaling and sealing, and the potential cascading impacts to marine ecosystems, has grown as marine mammal populations have recovered (NRC 1996, Estes et al. 2006). Currently, many populations appear to be approaching some level of carrying capacity, and there is no substantive evidence for indirect interactions with fisheries. Although most populations experience some incidental mortality as a consequence of fishing operations, and mortality sources generally do not exceed estimates of potential biological removals inferred by stock assessments, the mortality and serious injury rate in many instances cannot be considered to be insignificant, and overarching objectives are to approach a zero mortality and serious injury rate. In recent years there has been concern regarding high mortality rates for some cetaceans, particularly blue and humpback whales, caused by large ship strikes (Berman-Kowalewski et al. 2010).

Higher trophic level mammals, birds and reptiles represent important sources of predation mortality and energy flow in the CCE. Estimates of the role of cetaceans in the CCE suggest that they consume on the order of 1.8 to 2.8 million tons of prey (primarily krill, but also coastal pelagic fishes, squids, groundfish and other prey; Carretta et al. 2008), and simple bioenergetic estimates suggest that pinnipeds may consume as much as an additional million tons (Hunt et al. 2000), mostly fish and squid. Comparable estimates for seabirds are limited; Roth et al. (2008) estimated total annual consumption by common murres (the most abundant resident species in the CCE) at approximately 225,000 tons per year; however, Hunt et al. (2000) estimated summer consumption by all seabirds throughout the CCE at considerably lower levels. There have been few efforts to explicitly model interactions between fisheries and marine mammal population dynamics (although see Yodzis et al. 2001 and Bundy et al. 2009). However, there is a rich body of literature linking seabird productivity to prey availability that helped guide the development of harvest control rules for some of the earliest CPS fisheries (e.g., Anderson et al. 1980) and could be helpful in considering future refinements to such rules.

Much of the literature is synthesized in a recent manuscript that indicates a commonality in the non-linear response of seabirds to empirical changes in prey abundance, in which seabird productivity declines gradually at low to moderate levels of reduced prey availability, but declines steeply when prey abundance is below approximately one third of baseline levels (Cury et al. 2011). The Cury et al. (2011) results could be used to guide appropriate management limits or thresholds when managing high biomass forage species that seabirds depend upon. However, the question of what constitutes a baseline level was not explicitly addressed, and is a key factor for consideration in the management of stocks that undergo substantial low frequency variability such as coastal pelagic species. Smith et al. (2011) evaluated a similar question, using ecosystem models and altering harvest rates (rather than using empirical data and evaluating functional relationships). Substantial impacts on food webs and higher trophic level predators were found when fishing at maximum sustainable yield (MSY) levels, but impacts on marine ecosystem indicators were relatively modest given reduced exploitation rates (despite catches remaining at close to 80% of the maximum achievable levels). Although additional empirical analyses and modeling efforts will improve our understanding of trade-offs between high trophic level predator population dynamics and fisheries, it is clear that such trade-offs exist, can be estimated, and can be considered in the context of strategic decision making.

3.2.1.2 Mid-to High Trophic Level Fishes and Invertebrates

High trophic level fishes typically represent highly valued fisheries targets, rather than protected resources subject to conservation laws. A generalized breakdown would suggest three major communities of mid to high trophic level fish assemblages; highly migratory species, groundfish, and anadromous fishes (principally salmonids, but including sturgeon and other species as well). A large number of invertebrate species might be included at mid- to high trophic levels, however in considering invertebrates it is important to recognize that in many complex or specious communities (such as intertidal, kelp forest ecosystems, planktonic communities), small and generally overlooked species often represent high trophic levels and key roles that are well beyond the scope of this evaluation (such as various species of predatory copepods or jellyfish in pelagic ecosystems, or the predatory sun star, *Pycnopodia* spp., in intertidal ecosystems). Other mid- to high- trophic level invertebrates are more conspicuous elements of the ecosystem, such as predatory squids and various larger species crabs (including Dungeness). The competitive and predatory impacts of nonindigenous crab species on juvenile Dungeness crab survival may negatively impact recruitment into the fishery (McDonald et al. 2001). Changes in physical forcing in the CC have driven the recent poleward expansion of jumbo squid into the CC increasing the potential for high levels of squid predation for several fish species, many that are commercially important, and potentially resulting in changes across trophic levels (Field et al.2007). Seasonal patterns appear to be the greatest drivers of migrations and variable distributions for most mid- to higher trophic level species, both pelagic and benthic, although interannual and longer term climate variability also shapes the distribution and abundance of many of the pelagic species in particular. For example, warm years (and regimes) have long been known to bring desirable gamefish such as tunas and billfish farther north and inshore (MacCall 1996, Pearcy 2002).

The highly migratory species include swordfish,albacore and other tunas, several species of sharks (thresher, mako, blue, soupfin and salmon key among them; although great white, basking and sleeper sharks are also of high ecological and conservation concern) and a variety of (generally southern) large coastal piscivores such as black sea bass, white sea bass and yellowtail are all key targets for both commercial and recreational fisheries with long histories of exploitation. The PFMC's Highly Migratory Species (HMS) FMP is unique in that the relative impact and role of fishing activities under the jurisdiction of the PFMC for most HMS are generally modest, since many HMS species spend limited time subject to fisheries within the EEZ. Exceptions include north Pacific albacore, Pacific thresher sharks, and shortfin mako shark, where West Coast vessels harvest a significant fraction of North Pacific catches. The principle challenges associated with HMS resources (and the HMS FMP) are collaborating between the broad assemblage of nations and regulatory entities that are involved in HMS exploitation and management.

Although generalized to the entire North Pacific, Sibert et al. (2006) summarizes the variability and differences in tuna population trajectories, with western Pacific yellowfin and bigeye declining steadily to near target levels, skipjack and blue shark populations increasing, and albacore fluctuating in both directions. Importantly, Sibert et al. noted that increases in the biomass of some species are consistent with predictions by simple ecosystem models (e.g., Kitchell 1999, Cox 2002) as a result of declines in predation mortality that is consistent with a recent comparison of empirical data from fisheries statistics in the Central North Pacific region (Polovina et al. 2009). Specifically, with increasing fishing pressure, catch rates (and presumably biomass) of top predators such as marlin, spearfish, sharks, and large tunas (bigeye and yellowfin) declined, while the catch rates of mid-trophic level species such as mahimahi, pomfret and escolar increased. Polovina et al. (2009) suggested that the cumulative effect of fishing on high trophic levels and consistent response by mid trophic level predators indicates that the longline fishery may function as a keystone species in this system. The CCE portion of these stocks may have similar dynamics to those in the Eastern Tropical Pacific for some stocks, and those of the Central Northern Pacific for others (stock assessments are typically representative of the entire north Pacific, while some ecosystem models and data sources represent subsets of this region). However, in the foreseeable future the key "ecosystem" issues associated with HMS population dynamics are primarily associated with high and low frequency changes in the availability of target stocks in response to changes in climate conditions (as manifested by seasonal changes in water masses, changes in temperature fronts or other boundary conditions, and changes in prey abundance) management of the directed fishery, and the challenges associated with minimizing and managing the bycatch of high profile species (such as sea turtles, seabirds and marine mammals). A greater appreciation of the relationships among climate variables, gear selectivities and the spatial distributions of both target and bycatch species will continue to improve management of HMS resources, and will be key to both "single species" and ecosystem based management approaches.

Groundfish and salmon occupy a range of trophic niches and habitats, but most species are considered to be at either middling or higher trophic levels. Large groundfish, such as cowcod, bocaccio, yelloweye and shortraker, as well as Pacific halibut, California halibut, arrowtooth flounder, Petrale sole, sablefish, lingcod, cabezon, shortspine thornyheads, several of the skates and a handful of other species are almost exclusively piscivorous, and feed largely on juvenile and adult stages of other groundfish, as well as forage fishes, mesopelagic fishes, and squid. A broader range of species, including most rockfish, are ominovorous mid-trophic level predators that may be piscivorous at times but also feed on krill, gelatinous zooplankton, benthic invertebrates and other prey. Pacific hake, the most abundant groundfish in the CCE, shows strong ontogeny in food habits, since younger, smaller hake feed primarily on euphausiids and shrimps, switching to an increasing proportion of herring, anchovies and other fishes (as well as other hake) as they reach 45-55 cm length and are almost exclusively piscivorous by 70-80 cm.

Higher trophic level predators have a potential to play a structuring role in the ecosystem, particularly over smaller spatial scales (e.g., individual reefs or habitat areas). Despite the rarity of piscivorous rockfish relative to more abundant omnivorous or planktivorous rockfish, visual surveys have shown that the piscivorous species can be found at relatively high levels of abundance in many isolated and presumable lightly fished rocky reef habitats (Jagielo, et al. 2003; Yoklavich, et al. 2002; Yoklavich, et al.

2000). In rocky reefs, the concentration of smaller, fast-growing rockfish are considerably lower, while reefs thought to have undergone heavier fishing pressure tend to have greater numbers of smaller, fast-growing, and early-maturing species. Similar large-scale community changes are described by Levin et al. (2006), who found broad-scale changes in CCE groundfish assemblages sampled by the triennial bottom trawl surveys on the continental shelf between 1977 and 2001. Levin et al. (2006) found declining rockfish catches, from over 60 percent of the catch in 1977 to less than 17 percent of the catch in 2001, with greater declines of larger species, while flatfish catches increased by a similar magnitude. The potential for intra-guild competition or top-down forcing, in both small-scale rocky reef systems and throughout the larger ecosystem, is also supported by theoretical considerations and simulation models. For example, Baskett et al. (2006) developed a community interactions model that incorporated life history characteristics of pygmy and yelloweye rockfish to consider community dynamics within a marine reserve. Without interspecific interactions, the model predicted that larger piscivores would recover given minimal levels of dispersal and reserve size. However, when community interactions were taken into account, initial conditions such as the starting abundance of the piscivores and the size of the reserve became more important with respect to the ultimate stable state, such that under some circumstances (low piscivore biomass, or high planktivore biomass) recovery could be unlikely. Such results are consistent with similar simulations of the potential consequences of community interactions in marine systems (MacCall 2002, Walters and Kitchell 2001), and speak to the importance of considering such interactions in the design, implementation and monitoring of recovery efforts for rebuilding species.

Anadromous species such as salmonids and sturgeon, spend their early life stages in freshwater rivers and streams, then out-migrate to the ocean, where they mature before returning to their natal streams to spawn. Large variation in the abundance and life history characteristics of many anadromous fish populations have been attributed to climatic conditions (e.g. PDO or ENSO; Mantua et al. 1997, Finney et al. 2000, Peterson and Schwing 2003, Wells et al. 2006), although this relationship is not always strong for all salmonids populations (Botsford and Lawrence 2002). The fresh and saltwater ecosystems off of central California are generally the southernmost marine habitat occupied by Chinook and coho salmon, and climate fluctuations may contribute to additional stressor to that are at low abundance and have reduced life-history or habitat diversity (Lindley et al. 2009, Carlson and Satterthwaite 2011). Salmonids prey upon an array of lower trophic levels species including juvenile and adult stages of numerous fishes, squid, euphausiids, and various other invertebrates; in general salmon tend to forage on larger prey items at larger sizes (Pearcy et al., 1988; Daly et al. 2009).

The effects of climate variability on the feeding ecology and trophic dynamics of adult Pacific salmon (*Oncorhynchus* spp.) have shown that salmon are extremely adaptable to changes that occur in the ocean environment and their forage base (Kaeriyama et al. 2004). However, Pacific salmon populations can experience persistent changes in productivity, possibly due to climatic shifts, necessitating rapid and reliable detection of such changes by management agencies to avoid costly suboptimal harvests or depletion of stocks (Peterman et al. 2000, Dorner et al. 2008, Lindley et al. 2009). Changes in salmon productivity have been hypothesized to be a function of early natural mortality that is mostly related to predation, followed by a physiologically-based mortality when juvenile salmon fail to reach a critical size by the end of their first marine summer and do not survive the following winter (Beamish and Mahnken 2001). This growth-related mortality provides a link between total mortality and climate that could be operating via the availability of nutrients regulating the food supply and hence competition for food (i.e. bottom–up regulation) (Beamish and Mahnken 2001). Strong evidence of positive spatial covariation among salmon stocks within Washington, British Columbia, and Alaska and between certain adjacent regions, with no evidence of covariation between stocks of distant regions, suggests that environmental processes affect temporal variation in survival rates operate at regional spatial scales (Pyper et al. 2001).

Some subpopulations of green sturgeon (*Acipenser medirostris*) are listed as threatened under the ESA (71 FR 17757). This threatened determination was based on the reduction of potential spawning habitat, severe threats to the spawning population, the inability to alleviate these threats with the conservation measures in place, and the decrease in observed numbers of juvenile green sturgeon collected in the past two decades compared to those collected historically (NMFS 2006). Other subpopulations are listed as U.S. National Marine Fisheries Service Species of Concern, since insufficient information is available to indicate a need to list the species under the ESA. Little is known about green sturgeon life history, particularly at sea. Adult green sturgeon inhabit estuaries during the summer (ODFW 2005), feeding upon amphipods, isopods, shrimps, clams, crabs, and annelid worms (Ganssle 1966, Radtke 1966). Temperature has been shown to affect both green sturgeon embryos (Van Eenennaam et al. 2005), as well as juvenile sturgeon (Allen et al. 2006) suggesting a possible sensitivity to climate change. Bycatch of green sturgeon in the California halibut fishery is of management concern.

3.2.1.3 Low Trophic Level

Low Trophic Level species (secondary producers) are defined as species that feed either primarily or partially on the lowest trophic level and includes the following groups ordered roughly from largest to smallest by individual body size:

- Small pelagic fish -- includes baitfish and other forage fish, such as sardine, anchovy, smelts, etc., which are relatively small as adults and feed on phytoplankton and/or zooplankton
- Ichthyoplankton – small larval stages of fish that feed on both phytoplankton and zooplankton, including the larvae of the small pelagics listed above, plus the larval stages of large pelagic fish and groundfish, such as Pacific hake, jack mackerel, and rockfish
- Euphausiids – krill, relatively large, often swarm- or school-forming crustacean zooplankton that feed on both phytoplankton and zooplankton
- Gelatinous zooplankton- soft-bodied zooplankton, such as jellyfish, pelagic gastropods (primarily pteropods), salps, doliolids and apendicularians
- Other crustacean zooplankton – this group includes shrimps, mysids, and other less numerically dominant, but important organisms that consume both other zooplankton, phytoplankton, and microzooplankton
- Copepods – smaller crustacean zooplankton, often the numerically dominant multi-cellular organism in many areas of the CCE that feed on both phytoplankton, other zooplankton, and microzooplankton
- Microzooplankton – uni-cellular zooplankton that feed at high rates on phytoplankton, other microzooplaknton, and bacteria

Small pelagic fish, such as sardine and anchovy, comprise an integral part of the CCE, feeding nearly exclusively on phytoplankton (typically diatoms), small pelagic crustaceans, and copepods (Emmett et al., 2005). A large portion of what are known as the "forage fish" of the CCE are comprised of small pelagic fish; this group functions as the main pathway of energy flow in the CCE from phytoplankton to larger fish and the young life stages of larger predators (Crawford, 1987; Cury et al., 2000). Thus, small pelagic fish form a critical link in the strong, upwelling-driven high production regions of the CCE. Ichthyoplankton, the larvae of larger fish, are also a key resource for larger fish and other marine organisms. A summary of over 50 years of the ichthyoplankton community gives some sense of the relative abundance of various ecologically important species in the CCE (Moser et al. 2001). Six of the top 10 most abundant species throughout this long time period are northern anchovy, Pacific hake, Pacific sardine, jack mackerel, and rockfish (shortbelly rockfish and unidentified Sebastes, as most species are not identifiable to the species level). The persistent dominance of the icthyoplankton of relatively few CCE species indicates that the relative abundance and importance, at least in the southern part of the

CCE, of these key species is far greater than most other lower trophic level species. Notably, the remaining four species in the top 10 are mesopelagic species that further account for 12 of the top 20 most abundant species. There are considerably fewer ichthyoplankton data for central and northern California, although survey data suggest that anchovy, herring, sardine and whitebait smelt have been the most abundant and important forage species in this region over the past 13 years (Orsi et al. 2007, Bjorkstedt et al. 2010). Ichthyoplankton data are more limited for the CCE north of Cape Mendocino, but existing studies suggest that off Washington and Oregon, Osmeridae (smelts, typically not identified to the species level) are often highly abundant in the nearshore shelf waters, and that tomcod and sandlance are often fairly abundant (see Richardson and Pearcy 1977, Kendall and Clark 1982 and Brodeur et al. 2008).

Euphausiids, primarily the species *Euphausia pacifica* and *Thysanoesa trispinosa*, are another key link in the trophic web of the CCE (Brinton and Townsend, 2003). These species primarily eat phytoplankton (diatoms) and small zooplankton, and in turn are the food for many species of fish, birds, and marine mammals. Euphausiids can form large conspicuous schools and swarms that attract larger predators, including whales. Due to their high feeding rates, fast growth rates, and status as a key prey for many species, Euphausiids play a critical role in the overall flow of energy through the CCE.

When prevalent, gelatinous zooplankton provides an alternate pathway for energy flow that may or may not lead to production in higher trophic levels (Brodeur et al. 2011). Gelatinous zooplankton include in a variety of forms, from free-floating jellyfish that passively ambush zooplankton and small larval fish prey, to apendicularians that build large gelatinous “houses” used to filter large quantities of the smallest phytoplankton classes from the water column. While gelatinous zooplankton grow at high rates, and have high feeding rates, their bodies are mostly composed of water; as a result, gelantinous zooplankton are not typically a good food source for larger organisms, with the exception of certain turtles that specialize in gelatinous prey. Thus, systems dominated by gelatinous zooplankton as the primary predators of phytoplankton tend to have limited production of fish species, and are generally considered “dead-end” ecosystems. Typically, gelatinous zooplankton blooms are found offshore in oligotrophic regions, although blooms occasionally predominant nearshore during warmer periods. An exception are pteropods, pelagic gastropods that form large gelatinous nets, much larger than their body size, used to capture falling detritus in the water column. Unlike the other taxa in this group, pteropods are known to be an important food source for at least salmon, and possibly other fish species (Brodeur, 1990).

Copepods and other small crustacean zooplankton have similar roles to krill within the CCE. However, copepods and small crustacean zooplankton do not tend to form large dense schools. Copepods eat phytoplankton, microzooplankton, and other smaller crustacean zooplankton, and in turn are food for krill, fish larvae, and small pelagic fish. Other small crustaceans, such as shrimps and mysids, tend to be less abundant, however, they can be important in some areas. Mysids often form swarms in shallow nearshore waters, and may be an important food source for outmigrating smolts (Brodeur, 1990). Unlike many other zooplankton, several of the dominant species of copepods, those of the genus *Calanus* and *Neocalanus* in particular, undergo a wintertime dormant period, wherein they descend to great depths (~400-1000m) for anywhere from 4-8 months of the year (Dahms, 1995). These copepods then emerge in the springtime to reproduce. Thus copepods have a marked seasonality in their availability to higher trophic levels, often times leading to match-mismatch problems.

Unicellular microzooplankton include a diverse array of organisms, such as heterotrophic dinoflagellates, ciliates, and choanoflagellates. These organisms primarily eat other microzooplankton, phytoplankton, cyanobacteria, and bacteria. The CCE biomass of unicellular microzooplankton is not often high, however, their grazing rates are on par with the growth rates of phytoplankton (Li, Franks, and Landry, 2011). Thus, unicellular microzooplankton may often be the major grazer on phytoplankton within many areas of the CCE. A large portion of the energy that flows into microzooplankton does not reach higher trophic levels, but is returned to detrital pools, or recycled within the microozooplankton trophic level.

This retention of energy within the unicellular microzooplanton trophic level is known as the "microbial loop" and, when prevalent, decreases the overall productivity of higher trophic levels. Unicellular microzooplankton are a key prey source for copepods, gelatinous zooplankton, and other small crustacean zooplankton due to their enriched nitrogen relative to carbon, in comparison to similarly sized phytoplankton.

3.2.1.4 Lowest Trophic Level

Lowest Trophic Level species are those that carry out photosynthesis, i.e. phytoplankton (also known as primary producers). The most predominant phytoplankton groups within the California current include the single-celled phytoplankton classes:

- Diatoms – eukaryotic cells with hard silica based shells, dominant in upwelling areas, occasionally harmful algal bloom (HAB) forming
- Dinoflagellates – eukaryotic cells, many of which are slightly motile, often dominate in stratified regions, and more commonly form HABs than diatoms
- Cyanobacteria – prokaryotic cells, predominant in offshore regions, but still abundant in nearshore regions (~20% of phytoplankton productivity)

Along with large multicellular plants (described in more detail in section 3.3.2)

Diatoms are probably the most critical phytoplankton group in terms of overall productivity and importance as a food resource for higher trophic levels. Diatoms grow rapidly in nearshore regions where upwelling provides cool, nutrient-rich water. In turn, diatoms are grazed by most of the low trophic level species (described above). Occasionally, certain species of diatoms may constitute HABs. Specifically, the diatom *Pseudonitchia multiseries* produces a powerful neurotoxin known as Domoic Acid that can be bio-accumulated in the tissues of fish (described in more detail below in section 3.3.2). While diatoms are an important prey for copepods, their protective silica casing (known as a frustules) prevents them from being readily preyed upon by smaller microzooplankton. Dinoflagellates are an important resource in the CCE. Dinoflagellates may outcompete diatoms when silica is limiting, since dinoflagellates do not require silica for growth. Dinoflagellates are also typically preferred by other microzooplankton and small crustacean zooplankton as a food source as compared to diatoms, due to their relatively enriched nutrient content, and lack of a hard Si encasement. Because of this, when dinoflagellates predominate, there is a longer chain of organisms between phytoplankton and higher predators, hence a lower total transfer of energy to higher trophic levels (only about 30-35% of energy is transferred upwards from each trophic level, thus 65-70% of the energy is lost to recycling), as compared to diatom-dominated systems (nearshore upwelling) where the diatoms may be directly consumed by small fish and some fish larvae. Cyanobacteria are more important in offshore regions, where, although they do not have a high biomass, they may have high growth rates, providing for rapid nutrient turnover. Cyanobacteria are primarily consumed by uni-cellular microzooplankton that may be prey for other microzooplankton. Hence food webs dominated by cyanobacteria tend to have a low biomass of higher trophic levels due to the relatively large number of trophic links.

3.2.2 Species Interactions

In addition to their own internal dynamics, fish populations interact with, and are influenced by, other species. Species interactions can take a variety of forms summarized in Table 3.2.1.

Table 3.2.1: Species Interaction Types and Their General Effects

Nature of interaction	Species 1	Species 2
Mutualism	+	+
Commensalism	+	0
Predation / herbivory	+	-
Parasitism	+	-
Allelopathy	-	0
Competition	-	-

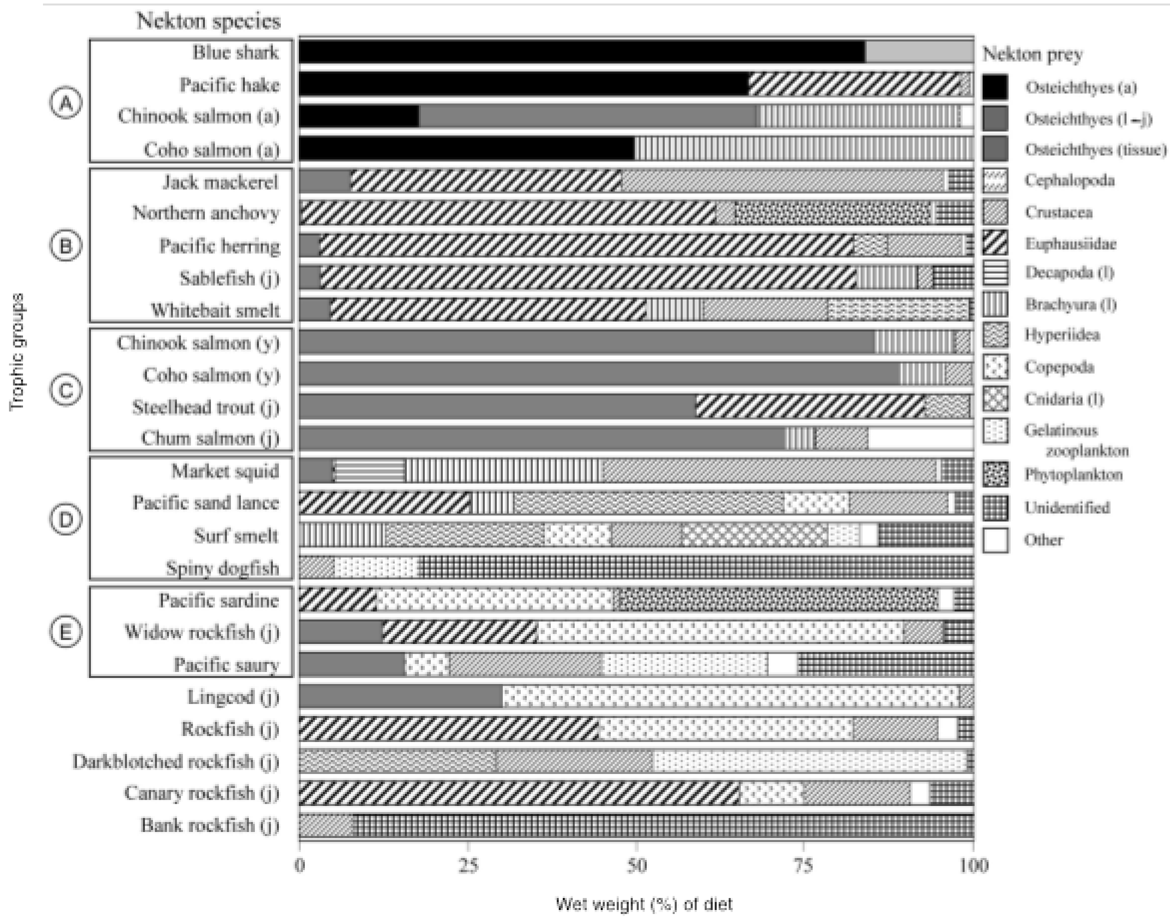
+ positive effect; 0 no effect; - deleterious effect

Predation, parasitism, and herbivory all have the same general effects—a positive effect on one species and a negative effect on another. Competition is defined as a species interaction that has a negative effect on both species. Allelopathy is related to competition, but only one species is negatively affected while the second species exhibits no effect. Mutualism and commensalism are less commonly discussed in the ecological (and especially fisheries) literature, but potentially play important roles for some species.

The vast majority of information we have on species interactions involving fisheries targets is on predation. As evidenced in the sections above, we have a strong general understanding of the trophic interactions among species in the CCE. In large part this is because it is technically simple to obtain stomach contents—the founding basis for an understanding of predation. However, it is important to remember that diet composition alone is a poor indicator of the importance of predation. That is, just because a predator's diet contains a small amount of a particular prey species, this does not mean that mortality from that predator is not important for prey dynamics. For example, harbor seals prefer herring and salmonids as prey; however, they also consume small numbers of rockfish. In some circumstances, this small level of predation by seals on rockfish could have important implications for rockfish population dynamics (Ruckelshaus et al. 2010).

In addition to understanding predation, diet information helps to inform analyses of potential competitive interactions. Interspecific competition may occur when individuals of two separate species share a limiting resource in the same area. If the resource cannot support both populations, then, by definition, both species will suffer fitness consequences in the form of reduced growth, survival or reproduction. A first step in understanding competitive interactions is to document overlapping resource use. In the case of competition for food, this means documenting the degree to which diets overlap. For example, Miller and Brodeur (2007) documented the diets of 20 nektonic species in the CCE and used cluster analysis to group species into trophic groups with similar prey. Miller and Brodeur's (2007) figure illustrating nekton diets is excerpted here as Figure 3.2.2. The strength of competition will be greater within trophic groups than among the groups, if food is a limiting resource. The difficulty in documenting whether or not food is indeed a limiting resource makes quantifying competition interactions difficult.

Competition for non-food resources may also occur. For instance, competition for space (e.g., refuges from predation) is common in a number of systems. However, such competitive interactions are difficult to demonstrate, and ecologists often rely on manipulative experiments to demonstrate competition. Clearly, because their habitats make sustained observations difficult, such experiments or related observations are difficult for many if not most of the targeted fish species in the CCE. As a consequence, we know little about the role of competition for space or other non-food resources in offshore waters of the CCE.



Summary of nekton diets analyzed from June and August 2002 northern California Current GLOBEC (GLOBal ocean ECosystems dynamics) cruises. Trophic groups based on cluster analysis of diets (percent wet weight) are blocked and labeled (**A**) to (E). Species not blocked lacked sufficient numbers and frequency of occurrence for analysis. Scientific names of species in the order they appear in the figure are the following: blue shark (*Prionace glauca*), Pacific hake (*Merluccius productus*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), jack mackerel (*Trachurus symmetricus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasi*), sablefish (*Anoplopoma fimbria*), whitebait smelt (*Allosmerus elongatus*), steelhead trout (*O. mykiss*), chum salmon (*O. keta*), market squid (*Loligo opalescens*), Pacific sand lance (*Ammodytes hexapterus*), surf smelt (*Hypomesus pretiosus*), spiny dogfish (*Squalus acanthias*), Pacific sardine (*Sardinops sagax*), widow rockfish (*Sebastes entomelas*), Pacific saury (*Cololabis saira*), lingcod (*Ophiodon elongatus*), rockfish (*Sebastes* sp.), darkblotched rockfish (*S. crameri*), canary rockfish (*S. pinniger*), and bank rockfish (*S. rufus*). Life history stages of nekton are shown in parentheses: j = juvenile, y = yearling, and a = adult; nekton and prey with no indication of life history stage are adult.

Figure 3.2.2: Nekton diet summar, Miller & Brodeur 2007

Another type of species interaction that we know little about, but that is likely to be important is parasitism. Parasitism in the most common consumer strategy in food webs (Lafferty et al. 2008); however, parasites may affect hosts differently than predators affect prey. While a predator kills multiple prey individuals during its life, a parasite obtains nourishment from a single host during a life stage. Parasitism is often density dependent, and thus fisheries can directly or indirectly influence the importance of predators. For example, Lafferty (2004) showed that fisheries for spiny lobsters resulted in an increase in densities of their prey, especially sea urchins. The increase in sea urchin density, however, resulted in an increase in disease (aka micro-parasites), which ultimately resulted in a sea urchin population crash.

In addition to the direct species interactions described above, there are a number of important indirect effects of species interactions (Table 3.2.2). In general, we know that these indirect effects are important in a number of systems, but as with parasitism and competition, evidence of their importance in the dynamics of target species is sparse, at best. Nonetheless, based on the evidence in other systems (including shallow waters of the CCE), we can surmise that these indirect interactions may play some role in the dynamics of the population dynamics of target species.

Table 3.2.2: Indirect Species Interaction Types

Type of interaction	Description
Keystone predation	Predation indirectly increases the abundance of species A by preying on its competitors
Tri-trophic interactions	Increases in abundance at one trophic level (e.g. plants) by predation on the consumers of that trophic level (e.g. by predation of herbivores)
Apparent competition	Reduction of species A that results from increases in species B, that shares a predator with species A.
Habitat facilitation	One species indirectly improves the habitat of a second by altering the abundance of a third interactor
Apparent predation	An indirect decrease in a nonprey produced by a predator or herbivore, e.g. when urchins reduce kelp cover they eliminate shelter for some rockfish species.

3.3 CCE Abiotic Environment and Habitat

The CCE encompasses over 2 million square kilometers of ocean surface. This large area includes many diverse habitat types that can be described in a variety of ways and at a variety of scales—from individual features like kelp beds, submarine canyons, and seamounts, to broader scale regions, like the continental shelf break, that share certain features coastwide. The Council's efforts with habitat to date have been largely shaped by the MSA's EFH provisions. As discussed in section 3.3.4 below, the Council has described EFH in detail for the species managed in all four of the FMPs.

In general, ocean habitat can be thought of as extending from the transition between land and sea to the abyssal plain 4,000 meters below the surface and deeper. Key habitat for harvested species exists throughout the bulk of this range. The Council's EFH for groundfish, for example, includes all waters from the high tide line and parts of parts of estuaries to 3,500 meters below the surface. When considering anadromous species like salmonids, the range of significant habitat then extends far into terrestrial watersheds. A wide range of marine and coastal habitat types can be found within relatively small areas of the coast (e.g. the Monterey Bay area) and within 100 or so nautical miles of shore in some places where the continental shelf is relatively narrow.

As described in this section 3.3, habitat can be defined by geologic sediments (e.g., rocky reefs, boulder fields, and sandy seafloors,) or by organisms, including microbes, algae, plants, and even fallen whales (Lundsten et al. 2010) that form biogenic habitats by creating structure or providing resources for other organisms. Geochemical features—such as methane seeps —also create important habitat in deep sea environments, as can artificial structures like jetties, piers, and offshore oil platforms in more coastal waters.

Another important characteristic of marine habitats is that they can vary as much by the motion and physical and chemical properties of seawater (e.g., temperature, salinity, nutrient content) as by particular locations and geologic and biogenic structures. They can also be highly dynamic. For example, EFH for coastal pelagic species is described by sea surface temperature and the thermocline/mixed layer. The location and extent of EFH—in terms of both depth and latitude—will therefore differ between seasons and years. As described in section 3.3.2, features like oceanic fronts and eddies, upwelling zones and shadows, river plums, meandering jets and so all form key habitats throughout the CCE. These features may show regularity of pattern yet are all marked by seasonal and annual variability in location and size, and in turn, in the type and quality of habitat that they provide.

The CCE's spatial environment can be divided along three main dimensions: from north to south (latitude, and generally in the alongshore dimension), from east to west (longitude, and generally in the onshore-offshore dimension), and from the sea surface to the ocean floor. One key division is between coastal waters and the open ocean (the oceanic area,) with the divide occurring roughly at the edge of the continental shelf break. Coastal waters can be further divided into the tidal or littoral zone—existing between the high and low tide marks—and the sublittoral, or neritic zone which includes the waters from the low tide mark to the continental shelf break. Benthic- or demersally-associated species are often limited to one or more of these zones.

The third major division in the marine ecosystem is between the benthic habitats of the seafloor and the pelagic habitats of the water column. Each of these can be further subdivided based on depth and other features. The epipelagic (photic, e.g. where light can reach) zone is the shallowest of the pelagic zones and covers those waters where sunlight is strong enough for photosynthesis to drive primary production. The depth of this zone will vary as a function of water column structure and water clarity, varying in depth from a few meters to tens of meters in the neritic zone, to 200 m in the far offshore oceanic zone. The mesopelagic zone is the next deeper layer and the start of the aphotic zone—sunlight penetrates into this layer yet not enough for photosynthesis to occur. The mesopelagic zone is also typically (but not always) the beginning of the main thermocline. Temperature changes drastically between the top and bottom of the layer. The bathypelagic zone begins at 1,000 m, and where the waters reach depths of 4,000 m and deeper, the abyssalpelagic zones follows. The relative divisions between these depth zones within the CCE change slightly in both the onshore-offshore dimension, and as a function on water column mixing and the east-west location of the major north-south currents. Hence these zones are dynamic in space and time. Delineation of these zones is of importance in that certain species and fisheries are limited at times to particular zones, due to temperature, feeding, or reproductive requirements.

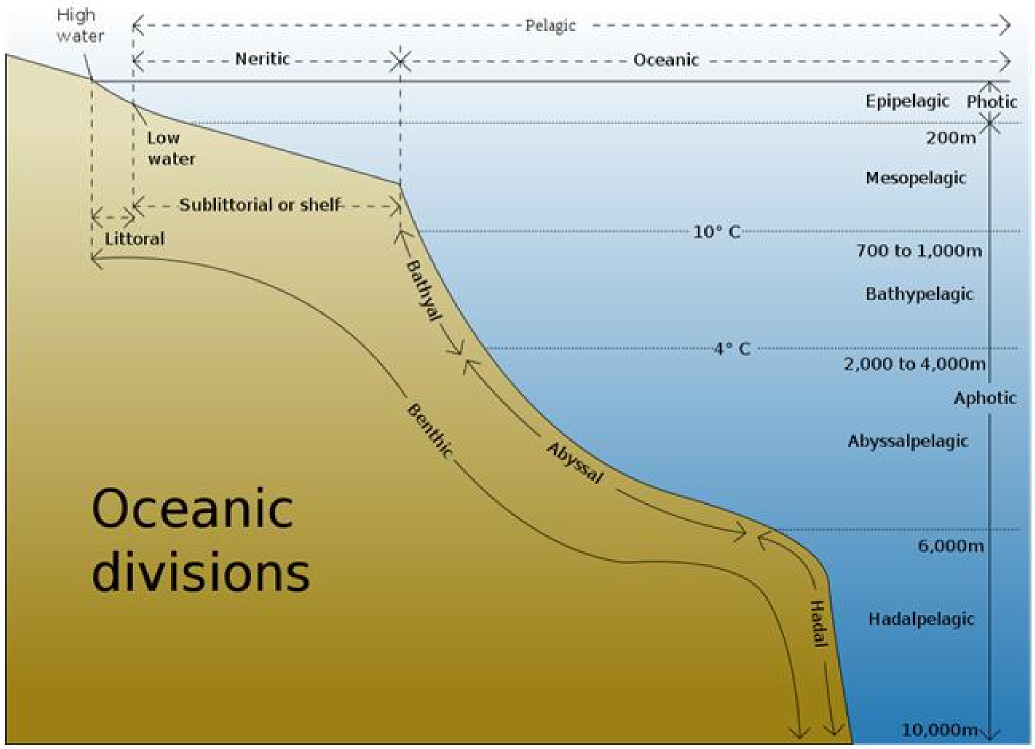


Figure 3.3.1: Divisions of coastal and oceanic zones, Wikimedia Commons

The benthic zone can be similarly divided (see Section 3.3.1). Discussions around the Council's Groundfish FMP—the most benthically-oriented of the four FMPs—tend to describe benthic habitats in relation to the continental shelf and slope. Habitats can be referred to as being in the nearshore, on the shelf (sometimes divided between the shallow and deeper shelf), or the slope. The continental shelf break, which describes the transition between the shelf and slope, provides key habitat for several managed species and is the main area covered by the Rockfish Conservation Area (RCA). The habitat of some commercially important species extends down the slope into the bathypelagic zone below 1,000 meters, e.g. sablefish (*Anoplopoma fimbria*) and longspine thornyhead (*Sebastolobus altivelis*). The Council has closed bottom trawling in waters deeper than 700 fathoms (~1,300 meters).

3.3.1 Geological Environment

Geologic features greatly influence current and wave patterns and provide habitats that influence species distributions and productivity within the CCE. The geology of benthic habitats is one among a variety of important ecological characteristics for managed fish species. The physical substrate or physiography of benthic habitats of the CCE can be described using a classification scheme developed by marine geology expert (Greene et al. 1999) for deep seafloor habitats, and this scheme was used for describing groundfish EFH. This classification system organizes benthic habitat according to physical features in a hierarchical system of levels: megahabitat, seafloor induration, meso/microhabitats, and modifiers. Specific types of habitats in each level are:

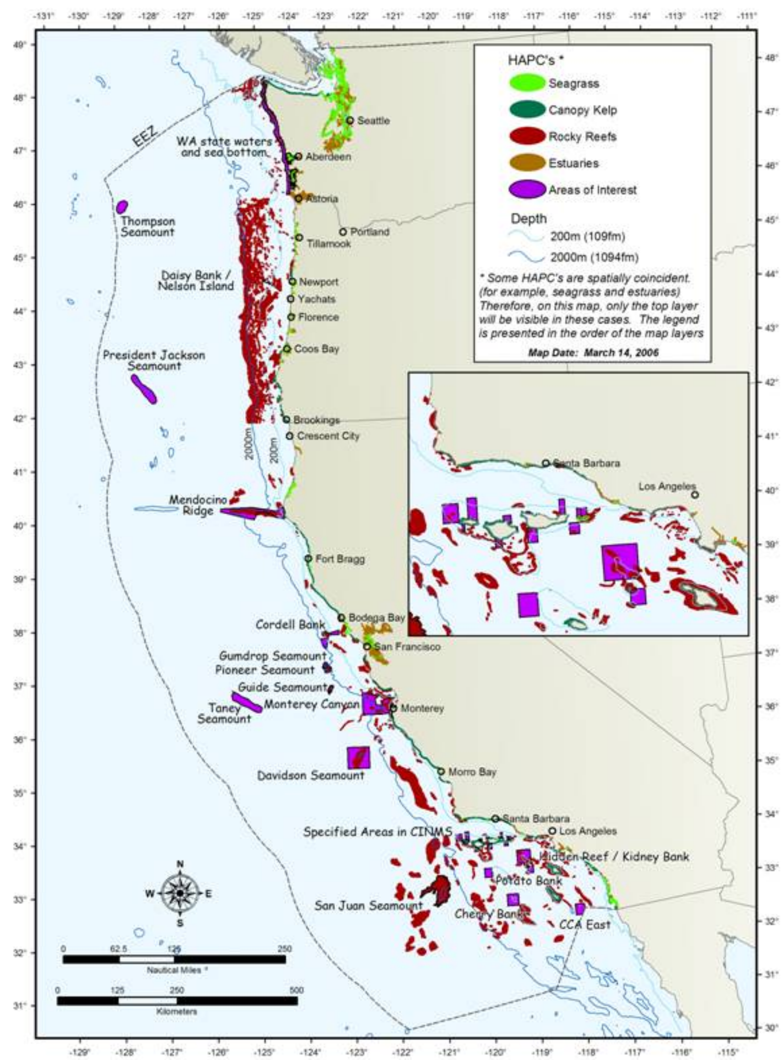


Figure 3.3.2: Groundfish HAPCs and Major Geological Structures [Figure 7-2 from Groundfish FMP]

- Level 1 megahabitat includes: continental rise/apron; basin floor; continental slope; ridge, bank or seamount; and continental shelf.
- Level 2 seafloor induration includes: hard or soft substrate.
- Level 3 meso/microhabitat includes: canyon wall; canyon floor; exposure and bedrock; gully; gully floor; ice-formed feature; and landslide.
- Level 4 modifier includes: bimodal pavement; outwash; and unconsolidated sediment.

[May 31, 2012, Note: The following description focuses primarily on Level 1 Megahabitats, but could include information for lower levels in a future version, if desired. Information including a West Coast map on substrates and some meso/microhabitats will become available as Groundfish EFH data in the next few months.]

Although salmon species range far inland from ocean waters, the description of the geology of the CCE in the following sections focuses on the marine and estuarine environments, primarily along the outer coasts of Washington, Oregon and California. Major estuaries along the West Coast include the Columbia River mouth, San Francisco Bay and Willapa Bay, as well as the Puget Sound and Strait of Juan de Fuca.

The West Coast EEZ is geologically diverse and active. It includes all three types of global tectonic plate boundaries: 1) transform or strike-slip, 2) convergence or subduction, and 3) divergence or spreading. The Mendocino Triple Junction where three plates meet lies just below the state boundary between California and Oregon, making the region geologically complex. Plate movements result in slipping, uplifting, landslides and other changes in the physiographic features off the West Coast.

In general, the West Coast EEZ has a relatively narrow shelf, steep slope and wide abyssal plain. Some important geologic features are shown in Figure 3.3.2. The shelf, ranging from shore to depths of about 2000 m, is generally less than 50 nm wide along most of the West Coast, but widens to about 100 nm wide off the southern California Bight and northern Washington. Most of the EEZ north of the California Bight also has a narrow slope with deep (abyssal depth) basins fringed on the west by volcanically active ridges. Cape Blanco, Cape Mendocino and Point Conception are prominent features of the coastline and significantly influence oceanographic conditions offshore. They are often identified as boundaries separating biogeographic regions of the coast. Smaller capes are also dotted along the coastline and have more localized influences.

Major offshore physiographic features of Washington and Oregon include the continental shelf, slope and Cascadia Basin. Low benches and hills characterize the upper slope. The lower slope intersects the deep sea floor of the Cascadia Basin at 2200 m depth off the north coast, and at about 3,000 m off the central and south Oregon coast. Off northern California, the Eel River Basin, located on the continental shelf and stretching from into the waters offshore of Oregon, has a high sedimentation rate, fed by the Eel, Mad, and Klamath Rivers.

The offshore region of the southern California Bight encompasses some of the most diverse topography along West Coast. It is unique in that a complex series of northwest-southeast-oriented basins and ridges characterizes the continental border south of Point Conception with islands topping most of the ridges.

3.3.1.1 Submarine Canyons

Submarine canyons are submerged steep-sided valleys that cut through the continental slope and occasionally extend close to shore. They have high bathymetric complexity, provide a variety of ecological functions, and affect local and regional circulation patterns. Submarine canyon habitats receive sediment and detritus from adjacent shallow areas and act as conduits of nutrients and sediment to deeper offshore habitats. Canyons are complex habitats that may provide a variety of ecological functions.

Many submarine canyons cut through the continental shelf along the West Coast. The Rogue, Astoria, Quinault, Willapa, Guide, and Grays submarine canyons intersect the continental shelf of Oregon and Washington. Off northern California, five submarine canyons occur between Cape Mendocino and Point Delgada, including Mendocino Canyon, Mattole Canyon, Spanish Canyon, Delgada Canyon and Eel Canyon. Off central California, Monterey Canyon is designated as a groundfish Habitat Areas of Particular Concern (HAPC). Arguello and Conception Canyons occur south of Point Conception. Submarine canyons in the Southern California Bight generally connect to river mouths on land and include the Hueneme-Magu Canyon system, Dume Canyon, Santa Monica Canyon, Redondo Canyon, San Pedro Sea Valley, San Gabriel Canyon, Newport Canyon system, Oceanside Canyon, Carlsbad Canyon, La Jolla Canyon, and Loma Sea Valley.

3.3.1.2 Submarine Fans

Submarine fans often occur in association with submarine canyons when sediment is fed to the canyon head by seasonal flowing currents. For example, the Astoria Fan lies at the base of Astoria Canyon and is fed by sediments carried to the canyon head by seasonal flowing currents. Along with a portion of the Astoria Fan, the Willapa Fan occurs off Washington. Although rivers such as the Klamath possess gently sloping deltas, most of the rivers in Oregon and Washington have drowned mouths and estuaries.

In California, the Delgado Canyon, near Point Delgado, is particularly important because it transports considerable sediment to the Delgado Deep Sea Fan. The large Tufts Submarine Fan occurs in the deep basin off northern California, west of the Gorda Ridge. South of Point Conception, submarine fans in the Santa Monica Basin include the large Hueneme Fan and the small Magu and Dume Fans. In Hueneme Canyon, the Santa Clara River has produced a substantial delta that feeds the canyons of the Hueneme-Magu Canyon system. Turbidity currents traveling down Redondo Canyon and the San Pedro SeaValley have created moderate-sized fans in San Pedro Basin. Turbidity currents in San Gabriel Canyon have constructed a submarine fan in the Catalina Basin.

3.3.1.3 Seamounts and Pinnacles

Seamounts rise steeply to heights of over 1,000 m from their base and are typically formed of hard volcanic substrate. They are unique in that they tend to create complex current patterns. Several unnamed seamounts exist along the mid- to lower-slope and on the abyssal plain in the Cascadia Basin. Within and adjacent to the Cascadia Margin, several major seamounts exist, including (from south to north) President Jackson, Vance, Cobb, Eickelberg and Union seamounts. Off California, significant seamounts include Gumdrop, Pioneer, Guide, Taney and Davidson off the central coast and Rodriguez, San Juan and San Marcos in the southern California Bight. Several of these seamounts have been identified in the Groundfish FMP as HAPCs, including Thompson Seamount and President Jackson Seamount off Oregon and Gumdrop Seamount, Pioneer Seamount, Guide Seamount, Taney Seamount, Davidson Seamount, and San Juan Seamount off California.

3.3.1.4 Ridges, Banks and Islands

A series of large ridges occur at the base of the continental slope offshore of Oregon and Washington with ridge crests elevated 400 m to 1000 m above the abyssal plain of the Cascadia Basin. The Gorda and Juan de Fuca ridges are major tectonic features that are volcanically active. The Gorda Ridge is a narrow shelf in the deep water offshore of northern California and southern Oregon. Near the coastline of Cape Mendocino, three active tectonic plate boundaries meet. These tectonic boundaries are the Cascadia Subduction Zone, the Mendocino Fracture Zone and the San Andreas Fault. The Mendocino Ridge associated with this boundary zone is designated as a groundfish HAPC off California. In southern California, the Patton Ridge, which supports Sverdrup Bank, is a major bathymetric feature that separates the shelf from the abyssal plain.

The continental shelf offshore of Oregon has several rocky submarine banks, creating shallow-water habitats within the deeper shelf waters. Four major banks include Nehalem Bank, Stonewall Bank, Heceta Bank, and Coquille Bank. In addition, Daisy Bank off Oregon and Cordell Bank off California have been designated as HAPCs for groundfish.

Islands and banks are more numerous in the southern California Bight than other areas along the West Coast. The major islands and banks include Richardson Rock, Wilson Rock, and San Miguel, Santa Rosa, Santa Cruz, and Anacapa Islands on the Santa Cruz Ridge which separates the offshore continental slope from the Santa Barbara Basin. The Catalina Ridge supports the Pilgrim Banks and Catalina Island; the San Clemente Ridge supports Santa Barbara Island, Osborn Bank, and San Clemente Island; the Santa Rosa-Cortes Ridge supports Begg Rock, San Nicholas Island, Nidever Bank, Dall Bank, Tanner Bank, and Cortes Bank.

3.3.1.5 Rocky Reefs and Pinnacles

Rocky habitat may be composed of bedrock, boulders, or smaller rocks, such as cobble and gravel. Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for groundfish. Pinnacles are vertical rocky features that are tens of meters in diameter and height, with a cone-shaped geometry. Pinnacles are generally a product of in-place erosional processes acting on rocky outcrops. Pinnacles can be important bathymetric features that attract fish and invertebrates.

3.3.2 Water Column Temperature and Chemical Regimes

Within the CCE there are roughly four common modes of water column structure:

- Well mixed nearshore waters
- Surface stratified nearshore waters
- Transition zones and fronts
- Deeply stratified offshore waters

Well-mixed (meaning that the water has only a very small change in density over depth) nearshore waters are typically the result of wind-driven mixing of upwelled water (Hickey, 1998). Such waters are often cold and nutrient rich, and are the basis for the high productivity of the coastal portions of the CCE, and making them one of the most critical environments within the CCE. Such waters are typically mixed to depths up to 50-75 m (or the bottom, whichever is shallower) depending on water column structure. Well-mixed waters may extend up to 10-20 km offshore in places, but are typically found within approximately 5 km of the coast. Seasonally, well-mixed waters tend to coincide with the spring-summer upwelling season, although wind-based mixing (and occasionally upwelling) can occur at any time of year (Hickey, 1998).

When not well-mixed (e.g. when winds are low, or upwelling is not occurring), nearshore waters may often be strongly stratified (meaning there are large or abrupt changes of water density vs depth). In the nearshore region, e.g. east of the main core of the California current, such stratified waters are often characterized by a shallow weakly-stratified layer near the surface (often on the order of 10-20 m), with a stronger pycnocline below the weakly-stratified layer, below which lies waters which are also weakly-to-moderately stratified down to the bottom. Such stratified waters may also be an important habitat, since they often occur after upwelling has decreased, and hence there may be significant residual production occurring in these waters, which often is focused and intensified near the depth of the pynocline. Hence total water column productivity may be lower, but often more concentrated within a particular depth strata, forming a type of vertical “hot spot” for biological interactions. Weakly-stratified nearshore waters that form upon the cessation of upwelling are also typically the areas where HABs may form.

Between the nearshore upwelling region and the far offshore region lies the transition zone of the main core of the California Current, typically defined by relatively strong horizontal fronts. The front itself is partly what leads to the strong southward flow of the core of the CCE (Hickey, 1998). Beyond the transition zone lies a region of fairly well stratified waters, with a deep pynocline, often at a depth of 100-200 meters. Surface waters are warm, and this region is characterized by low, yet steady primary production.

These four major vertical water column types form four distinct habitats, differentiated primarily in terms of their temperature and primary productivity within the surface layers where fisheries occur. Complicating the geographic location of these different vertical water column structures is the dynamic nature of the California Current. Upwelling strength and location varies considerably due to multiple factors. Additionally, the location and strength of the core southward flow of the California Current (and hence the frontal zone and delineation between the other vertical water column types) is variable, both in strength and location, particularly through the formation of coastal "jets" and large "eddies" which may spin off from the main current.

3.3.3 CCE Vegetation and Structure-Forming Invertebrates

Vegetation forms two major classes of large-scale habitats: large macro-algal attached benthic beds, and microalgal blooms. Seagrass beds are also an important macro-algal habitat within the CCE, and are considered EFH for groundfish. Much of the scientific information on structure-forming invertebrates has been collected in recent years, both as a result of improvements in scientific observation technology and as a result of funding and direction expressly provided within the 2007 MSA reauthorization (see §408.)

3.3.3.1 Seagrasses

Seagrass species found on the West Coast of the U.S. include eelgrass species (*Zostera* spp.), widgeongrass (*Ruppia maritima*), and surfgrass (*Phyllospadix* spp.). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries and occasionally in other nearshore areas, such as the Channel Islands and Santa Barbara littoral. Surfgrass is found on hard-bottom substrates along higher energy coasts. Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993; Hoss and Thayer 1993). Despite their known ecological importance for many commercial species, seagrass beds have not been as comprehensively mapped as kelp beds. Wyllie-Echeverria and Ackerman (Wyllie-Echeverria and Ackerman, 2003) published a coastwide assessment of seagrass that identifies sites known to support seagrass and estimates of seagrass bed areas; however, their report does not compile existing GIS data. GIS data for seagrass beds were located and compiled as part of the groundfish EFH assessment process.

Eelgrass mapping projects have been undertaken for many estuaries along the West Coast. These mapping projects are generally done for a particular estuary, and many different mapping methods and mapping scales have been used. Therefore, the data that have been compiled for eelgrass beds are an incomplete view of eelgrass distribution along the West Coast. Data depicting surfgrass distribution are very limited—the only GIS data showing surfgrass are for the San Diego area.

3.3.3.2 Macro-algal (kelp) beds

Along the Pacific coast, there are two major canopy-forming species of kelp, the giant kelp, *Macrocystis pyrifera*, and the bull kelp, *Nereocystis leutkeana*. These species can form kelp forests which provide habitat for a diverse mix of species including fishes, invertebrates, marine mammals and sea birds. Kelp forests provide cover or nursery grounds for many adult, young of the year, or juvenile nearshore and shelf rocky reef fishes, such as bocaccio, lingcod, flatfish, other groundfish, and state-managed species including kelp basses, white sea bass and Pacific bonito. Kelp is considered EFH for groundfish. Common invertebrates inhabiting kelp forests include abalone, sea urchins, spiny lobsters, and crabs. Sea otters are also found associated with kelp forests. Kelp plays an important role in the diet of some reef fishes and many invertebrates (e.g., urchins and abalone). In addition, when plants are ripped up after storms, kelp detritus functions as beach enrichment or contributes nutrients to the benthic environment when drifting plants sink.

Kelp forests are comprised of three main components—the holdfast that anchors the kelp to substrate, the stipes that grow upward from the holdfast toward the surface, and the canopy comprised of stipes and fronds that lay on the water surface, buoyed up by floats. Giant kelp forests are generally more dense, and three dimensional, supporting more diverse communities than bull kelp forests. While the surface canopy of giant kelp is often removed in winter, it is considered a perennial because often the holdfasts remain over winter and new stipes and fronds grow up in the spring. Bull kelp is an annual and the tangling of long stipes in winter storms rips up holdfasts removing entire plants.

Along the coasts of Washington and Oregon, and southward to northern California, kelp forests are predominantly comprised of bull kelp in nearshore rocky reef areas, although these occur as far south as Point Conception. Giant kelp is distributed from Sitka, Alaska to central Baja California, forming dense beds from central California southward through the Southern California Bight and off the Baja Peninsula. Kelp forests are normally found in association with nearshore, rocky substrate – bull kelp occurs in water as deep as 75 feet while giant kelp forests can occupy reefs at 120 feet in areas with excellent water clarity. In the Southern California Bight, kelp beds also occur on sandy surfaces, where they attach to worm tube reefs. Several other canopy-forming species are found in lesser abundance off southern California and the Channel Islands including *Macrocystis integrefolia*, the elk kelp—*Pelagophycus*, *Cystoseira* and *Sargassum*.

Kelp distribution, productivity, growth and persistence is dependent on a variety of factors including nutrient availability, severity of wave action, exposure, water quality, turbidity, sedimention, water temperature, geology, pollution, and grazer abundance (e.g. sea urchins). Nitrogen and light are two of the most important parameters affecting kelp productivity. Under ideal environmental conditions, giant kelp grows up to two feet a day. It prefers nutrient-rich, cool water (50° to 60° F); in wave-exposed areas, fronds may reach a length of 150 feet. Hence, warmer conditions, or conditions that decrease coastal upwelling, decrease kelp growth (Dayton et al., 1999). Warm water events such as El Niño, in combination with severe storms, can wreak havoc on kelp beds—ripping out plants, reducing growth, and leaving only a minimal or no canopy. Seasonal effects are often more localized, and more large-scale, low-frequency episodic changes in nutrient availability seem to result in the most significant changes due to cascading community effects. For example, the status and success of understory kelps such as *Pterogophora*, *Eisenia* and *Laminaria* can be affected through competition for light, affects on growth, reproduction, establishment, and survivorship.

Numerous studies explored the role of sea urchins in kelp forests and the dynamics of overgrazing by urchins on kelp resulting in loss of whole kelp forests or the creation of "urchin barrens" (North 1983, Tegner and Dayton 2000). Urchin grazing can destroy kelp forests at a rate of 30 feet per year. In California, there is an active commercial fishery for urchins. Kelp has been commercially harvested since the early 1900s in California, and there was sporadic commercial harvesting in Oregon although it is currently prohibited. Pharmaceutical, food, industrial and forage uses of kelp include—herring-roe-on-kelp, algin, stabilizers, aquaculture food for abalone, and human food products (bull kelp pickles).

Extensive studies since the 1960s addressed concerns regarding the impact of giant kelp harvesting on the nearshore ecosystem. Overall, there was no evidence of long term affects of harvesting (North and Hubbs 1968, Dayton et al 1998). Potential impacts include temporary displacement of adult or young-of-the-year fishes to nearby unharvested reefs, predation on those young-of-the-year by larger displaced fishes (Houk and McCleneghan 1968), increased growth of sub-canopy species, increased harvesting of fishes and invertebrates by anglers or divers when harvesters create pathways through the beds, delayed regrowth of kelp.

3.3.3.3 Microalgal blooms

The major phytoplankton classes within the CCE include diatoms, dinoflagellates, and cyanobacteria. Diatoms are mainly responsible for large productive blooms in the nearshore upwelling regions. Thus they often form the basis of the productive food webs in those areas. Dinoflagellates may also bloom in upwelling and other regions, and may also provide an important food source for microzooplankton. Dinoflagellates have a dual role, as certain dinoflagellates may form HABs (although a few species of diatoms may also form HABs as well). Cyanobacteria are the smallest "phytoplankton" and form only a minor portion of phytoplankton biomass, although their productivity rates may be high in offshore regions. Thus, cyanobacteria form an important link in offshore food webs, and may also fuel the growth of the smallest microzooplankton within nearshore regions as well.

Seasonally, diatoms tend to bloom in the later winter, early spring, in a progression from south to north in the nearshore region. The timing of this bloom tends to follow a change in upwelling strength, from the predominant downwelling condition during the fall and spring, to a net cumulative upwelling in the late winter early spring. This change from downwelling to upwelling and the resulting phytoplankton blooms are termed the spring transition. Year to year variability may occur in this timing, due to large scale changes in wind patterns across the Pacific basin. Occasionally, there are brief periods of mixing or upwelling which occur prior to the main spring transition, which may also result in localized phytoplankton blooms of short duration, which may disappear before the main spring transition time. Blooms of dinoflagellates and other phytoplankton types tend to occur significantly after the main spring transition. In particular, dinoflagellates often bloom in the fall period, upon the cessation of upwelling, as the waters stratify.

3.3.3.4 CCE Structure-Forming Invertebrates

A host of invertebrate species of varying sizes and trophic levels inhabit the CCE. The trophic roles of invertebrates and vertebrates are discussed in Section 3.2. In this section, the FEP considers the scientific literature on invertebrates serve that as habitat for other CCE species. The delineation of benthic structure forming invertebrates, in particular corals and sponges, is under more thorough discussion within the Groundfish EFH Review Committee, and this FEP will be updated as the results of that discussion become available during late 2012 and beyond. The major challenge with observing bottom-dwelling invertebrates to assess and analyze their population structure, qualities as habitat (or not), and roles within the marine ecosystem is that they can only be observed alive in the places where they occur, e.g. from a human-occupied submersible, remotely operated vehicle, or autonomous underwater vehicle, or via shallow water diving operations, any of which require deploying equipment that is challengings to use even on small geographic scales (Krieger and Wing 2002, Etnoyer and Morgan 2005, Whitmire and Clarke 2007, Yoklavich and O'Connell 2008). Most of NOAA's scientific work on deep sea corals and other structure-forming invertebrates has been conducted in the last four years, coming out of a deep sea coral research program established in the 2007 reauthorization of the MSA [16 U.S.C. §1884.] Laboratory studies can be used to examine habitat preferences in fishes under controlled conditions and provide the opportunity to introduce predation as a factor (e.g., Ryer et al. 2004).

Tissot and co-authors (2006) narrowed the question of which invertebrate taxa and associated morphologies should be viewed as having the potential to serve as habitat for other species by characterizing structure-forming invertebrates as those that, like some coral species, add functional structure to benthic habitats by nature of their large size (e.g. black corals, sponges, anenomes, and sea pens) and through having complex morphologies (e.g., black corals, sea pens, and basket stars). Megafaunal invertebrates that aggregate in high numbers, such as sea urchins and sea pens, could also be considered structure-forming in areas where the physical environment is otherwise low-relief (Tissot et al. 2006).

Whitmire and Clarke (2007) listed 101 species of corals identified in the U.S. West Coast EEZ, within which four species were classified as having adequate individual or colony size and morphological complexity to be considered of high structural importance: *Lophelia pertusa*, *Antipathes dedrochristos*, *Paragorgia arborea*, and *Primnoa pacifica*. Several additional classes and individual species of coral were identified as being of medium structural importance: *Dendrophyllia oldroydae*, *Bathypathes* sp., *Isidella* sp., *Keratoisis* sp. Corals of the West Coast EEZ are distributed over a variety of bottom habitats, with higher concentrations on hard-bottom (not sand) and medium-to-high relief rocky habitat. With their morphologically complex forms, corals can enhance the relief and complexity of physical habitat (Whitmire and Clarke 2007), although the literature remains divided on whether West Coast deep sea corals serve to aggregate fish (Etnoyer and Morgan 2005, Auster 2005, Tissot et al. 2006).

Marliave and co-authors (2009) found quillback rockfish (*Sebastes maliger*) using colonies of cloud sponges (*Aphrocallistes vastus*) as nursery habitat in southern British Columbia's coastal waters, which are within the northern extent of the CCE. Hixon and Tissot (2007) found variations between the fish and invertebrate species assemblages and associations in trawled and untrawled areas on Coquille Bank off central Oregon. Pirtle (2005) found fish co-occurring with a range of structure-forming invertebrate species on both the high-relief and mud habitats of Cordell Bank, off central California.

3.3.4 *Human Effects on Council-Managed Species' Habitat*

The MSA defines essential fish habitat (EFH) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Each of the Council's four FMPs has defined EFH for FMP species and, taken together, EFH of Council-managed species ranges from the salmon streams of Idaho to the international high seas habitats of highly migratory species. Figure 3.3.3 shows salmon and groundfish EFH, which together encompass a wide variety of terrestrial, coastal, and marine habitats. EFH for Council-managed species also ranges from the near-surface waters used by coastal pelagic and highly migratory species, through the mid-water domain of salmon and some groundfish species, down to the diverse bottom habitats used by many groundfish species. As discussed earlier, this FEP's designated geographic range is the West Coast EEZ. Therefore, this section will address the effects of human activities on CCE habitat within the EEZ. Extensive discussions of the effects of human activities on the freshwater habitat of Pacific salmon may be found in the habitat conservation plans for threatened and endangered salmon and steelhead managed under the Endangered Species Act (http://www.nwr.noaa.gov/Salmon-Habitat/Habitat-Conservation-Plans/Index.cfm).

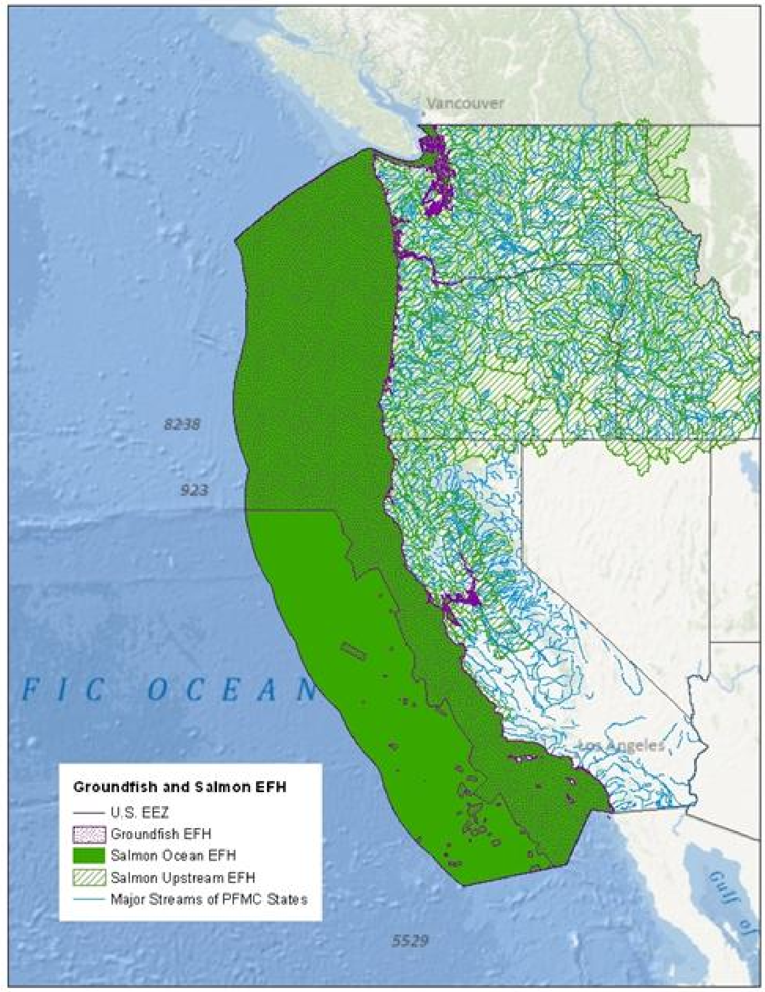


Figure 3.3.3: Groundfish and Salmon EFH of the West Coast

Humans have a variety of uses for the marine waters and substrate of the CCE, from direct uses like fishing, shipping, submarine cables, mining, recreation, or military maneuvers, to indirect uses like pollution and waste assimilation, oxygen-production, or nutrient cycling. The Council has direct responsibility for the effects of Council-managed fisheries on the EFH of FMP species. The Council is also required to comment upon and make recommendations on activities it views as likely to "substantially affect the habitat, including essential fish habitat" of anadromous species (salmon) under its authority. For all other species' EFH, the Council *may* make comments and recommendations. [16 U.S.C. §1855.]

3.3.4.1 Fishing Activities that May Affect Habitat

In addition to describing and identifying EFH, FMPs must "minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage conservation and enhancement of such habitat" [16 U.S.C. §1853]. The review of fishing effects on bottom habitat generally focuses on occurrences of fishing gear coming into contact with the sea floor, or with rocks or living structures attached to the sea floor. The review of fishing effects on pelagic habitat generally focuses on occurrences when fishing gear is lost at sea, or when fishing activities, including the discarding of bycatch and offal at sea, affect where prey is available in the water column. For bottom habitat, the Groundfish FMP, which includes gear and fisheries that may come into contact with the sea bottom, has the most detailed and restrictive EFH protections of the Council's four FMPs. In large portions of the EEZ, the use of bottom trawl gear or other bottom tending gear (for any species or fishery) is prohibited – see Figure 3.1.5.

3.3.4.2 Non-Fishing Activities that May Affect Habitat

The Council has reviewed the non-fishing activities that may affect the EFH of its FMP species under each of its FMPs. These reviews are not limited to ocean habitat and often consider effects of non-fishing activities within state and freshwater habitats, particularly for species in the salmon FMP. Using information from the four FMPs, Table 3.3.1 aggregates non-fishing activities that may negatively affect CCE species' EFH.

Table 3.3.1 Non-Fishing Human Activities that May Negatively Affect EFH for One or More Council-Managed Species

Coastal or Marine Habitat Activities	Freshwater or Land-Based Habitat Activities
Alternative Offshore Energy Development	Agriculture
Artificial Propagation of Fish and Shellfish	Artificial Propagation of Fish and Shellfish
Climate Change and Ocean Acidification	Bank Stabilization
Desalination	Beaver removal and Habitat Alteration
Dredging and Dredged Spoil Disposal	Climate Change and Ocean Acidification
Estuarine Alteration	Construction/Urbanization
Habitat Restoration Projects	Culvert Construction
Introduction/Spread of Nonnative Species	Desalination
Military Exercises	Dam Construction/Operation
Offshore Mineral Mining	Dredging and Dredged Spoil Disposal
Offshore Oil and Gas Drilling and Liquefied Natural Gas Projects	Estuarine Alteration
Over-Water Structures	Flood Control Maintenance
Pile Driving	Forestry
Power Plant Intakes	Grazing
Sand and Gravel Mining	Habitat Restoration Projects
Shipping Traffic and Ocean-based Pollution	Irrigation/Water Management
Vessel Operation	Military Exercises
Wastewater/Pollutant Discharge	Mineral Mining
	Introduction/Spread of Nonnative Species
	Pesticide Use
	Road Building and Maintenance
	Sand and Gravel Mining
	Vessel Operation
	Wastewater/Pollutant Discharge
	Wetland and Floodplain Alteration
	Woody Debris/ Structure Removal

Federal agencies are required to consult with NOAA when undertaking or permitting activities that may have adverse effects on EFH. While the Council does not have the staff or committee capacity to comment on every action that may affect EFH, it often uses its Habitat Committee to provide initial reviews of large-scale non-fishing projects of particular interest or concern to the Council. Taken together, the projects that particularly attract the Council's notice tend to be large-scale energy projects that have the potential to result in the installation of man-made structures within areas designated as EFH, any other land-based activities or planning processes that the Council believes may result in a significant loss of freshwater habitat or of the flow of freshwater itself within West Coast salmon streams. Some recent examples of non-fishing projects that have sparked Council review and comment have been:

- An Army Corps of Engineers policy on removing vegetation adjacent to its levees (2011)
- The Olympic Coast National Marine Sanctuary's management plan review process (2011)
- The U.S. Bureau of Reclamation's draft Environmental Impact Statement on the potential removal of four dams on the Klamath River (2011)
- The U.S. Bureau of Reclamation's implementation of the Central Valley Project Improvement Act and the effects of that project on water flow within affected streams (2010)
- NOAA's engagement in Pacific salmon restoration within the Columba River Basin and the Biological Opinion for the Federal Columbia River Power System (2010)
- The potential effects of a Federal Energy Regulatory Commission permitting process for the the Reedsport Ocean Power Technologies Wave Park on Council-managed species (2010)
- The U.S. Bureau of Reclamation's implementation of the Central Valley Project Improvement Act and the effects of that project on California's Central Valley salmon stocks (2010)
- The U.S. Bureau of Reclamation's consideration of the Council's EFH recommendations in its implementation of the Central Valley Project and State Water Project and the effects of those projects on Council-managed salmon stocks (2009)
- A U.S. Minerals Management Service proposal to lease areas off the outer continental shelf for alternative energy testing sites and the effects of that proposal on Council-managed species, fisheries, and EFH (2008)

3.4 Fisheries of the CCE

Fisheries for a broad range of species occur within the CCE, and have since humans first inhabited North America's western coastal lands. The Council's four FMPs and analysis document for actions taken under those FMPs provide details on the fisheries for managed stocks, including: gear used, landings locations, season timing and duration, prohibitions, technical challenges, and communities that dominate landings. This section of the FEP is intended to look at all of the FMP fisheries together, minimizing duplication of descriptions in the Council's FMPs. This section discusses cumulative CCE fisheries harvest, West Coast fisheries capacity levels, and the cumulative socio-economic effects of Council-generated fishery management measures on fishing communities.

3.4.1 Historical CCE Fisheries

The perception of the effects of fisheries exploitation on the environment, and Freon et al. (2005; see also MacCall et al. 2009) have defined a set of time periods that help frame the history of exploitation and the accompanying evolution of associated science. The period prior to the 20th century is best described as the "inexhaustible" period, when conventional wisdom held that fisheries could not have an appreciable impact on the resources that they exploited. Prior to the 1900s, global landings were minimal relative to contemporary catches. During the industrial exploitation period of 1900-1950, global landings for some species increased, then often decreased dramatically. The rise and fall of the California sardine fishery is a classic example of such industrial fisheries, and the collapses that followed led to what might be considered the conventional management period of 1950-1975. That period saw the development of most of the basic foundations of contemporary fisheries science: fisheries oceanography, spawner/recruit relationships, surplus production models and virtual population analysis. The conventional management period also saw some of the greatest development of industrial fisheries, coupled with the application of the newly developed science of fisheries management. However, the conventional management period also saw the world's largest fisheries failure, the crash of the Peruvian anchoveta fishery, which had been responsible for up to one quarter of global fisheries landings at the time. The anchoveta fishery collapse had tremendous ecosystem consequences (Jahncke et al. 1998) and led to what Freon described next as the "doubt" period from the mid-1970s through the mid-1990s. This period recognized the limitations and constraints of the sciences, and saw renewed emphasis on the role of climate as a driver of population and fishery dynamics. Based on the Freon et al. suggestion of major eras of fisheries management, the ecosystem-based management period has emerged from the mid-1990s to the present, although the transition has been gradual in most marine ecosystems, where ecosystem factors are widely recognized as important, but most management actions tend to be based in an assemblage-based context representing an integration of single-species assessment model results.

The marine and nearshore ecosystems of the CCE have been exploited at industrial levels for well over two centuries, and supported some of the most populous and culturally sophisticated Native American communities for millennia (McEvoy 1986, Trosper 2003). Figure 3.4.1 (from Field and Francis 2006) presents an accounting of the history of the most substantial marine resource removals over the past two centuries, illustrating both the magnitude of removals as well as the sequential nature of the development of the major fisheries in the region. European-era exploitation in this ecosystem began with the rapid conversion of the energy at the top of the food chain into commodities. The great whales, fur seals, elephant seals, sea lions, otters and many seabird colonies were transformed into oil, pelts and food. Exploitation continued with the depletion of many salmon populations due to fishing, the massive alteration of their freshwater habitat, and hatchery production. Next arose the classic tale of the rise and fall of the California sardine fishery, and subsequent fisheries for anchovy, mackerel, herring and squid. Throughout the past two centuries, some fisheries grew unsustainably fast, rapidly depleting resources (typically low turnover resources) in short pulses, including fisheries for: abalone, black and white seabass, and various elasmobranchs such as basking, soupfin and dogfish sharks. Fisheries for many groundfish, including Pacific (and California) halibut, sablefish, lingcod, Pacific Ocean Perch and other rockfish seemed to be sustainable at low levels prior to the development of modern industrial fisheries during the 1950s, after which high fishing effort depleted many stocks below sustainable levels.

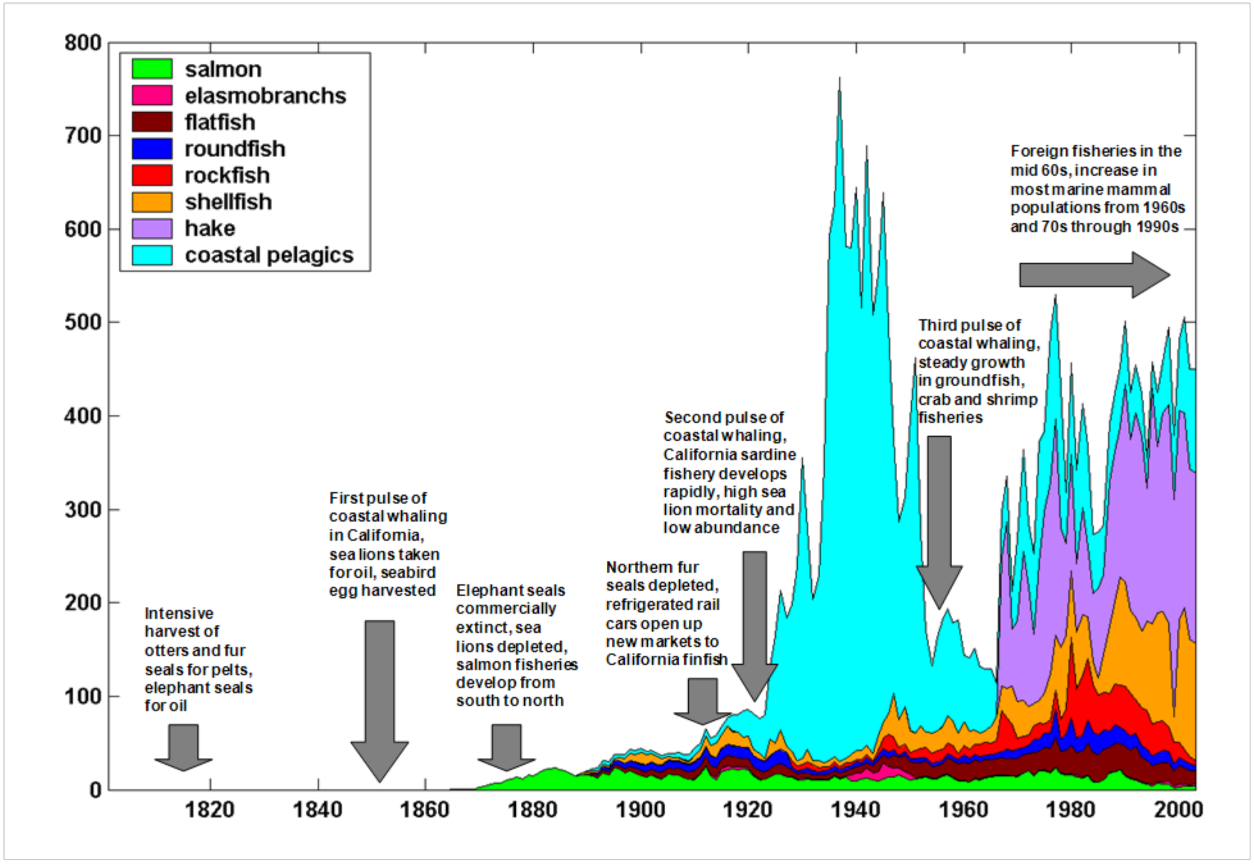


Figure 3.4.1: Major fisheries removals and developments within the U.S. portion of the CCE over the past two centuries

The large scale removals of marine mammal populations began in the late 18th and early 19th century, at the scale of the entire North Pacific (Scammon 1874, Ogden 1933). Although New England whalers had been operating in the North Pacific since the late 1700s, they initially avoided coastal waters of the CCE due to the "savage disposition" of California gray whales (Gordon 1987). However, whalers had been targeting CCE whale populations, and by the 1850s as many as a dozen shore-based whaling stations were spread out between Crescent City and San Diego, targeting a mix of grey, humpback and other whales encountered in coastal waters. Gray whales were subsequently harvested to near extinction in the lagoons of Baja California by the 1870s, and the first pulse of coastal whaling ended shortly thereafter. Similarly, exploitation of sea otters, fur seals and elephant seals began during the late 19th century, with all of these animals taken for a mix of pelts, food and oil. Many of these populations were commercially extinct by the late 1800s, during which time sea lions, harbor seals and seabirds were also exploited. For example, the harvest of seabird eggs on the Farallon Islands and elsewhere was as great as 14 million eggs between the mid-1800s and 1900, with the result that the common murre population on the Farallons may have declined from nearly half a million birds to less than 5000 by the 1920s (Ainley and Lewis 1974).

Both shoreside and at-sea whaling operations were widespread throughout the North Pacific during the second wave of whaling in the 1910s and 1920s, with catches of all species diminishing rapidly in the early 1920s (Tonnessen and Johnsen 1982, Estes et al. 2006). It is interesting to consider that these removals occurred in concert with the major expansion of the California sardine fishery, since stomach contents data from whales caught off California show humpback, as well as fin and sei whales, fed primarily on sardines, as well as euphausiids, anchovies, herring and other prey (Clapham et al. 1997). If whales historically represented a substantial fraction of sardine (and other coastal pelagic) mortality, the decline of whale and other predator populations (e.g., fur seals, sea lions, tunas) might have led to a greater than average production or availability of sardines, contributing to that fishery's expansion throughout the early 1920s and the early 1930s. The observation that current abundance of sardines and other coastal pelagic species is far lower than the historical abundance could be, in part, a function of the differences in predation mortality between these periods. Populations of most marine mammals in the CCE have recovered to, with some perhaps even exceeding, historical levels of abundance in recent decades. Appreciation for the historical impacts of whaling and sealing, and the potential cascading impacts to marine ecosystems, has grown as marine mammal populations have recovered (NRC 1996, Springer et al. 2003, Estes et al. 2006), and a basic understanding of the relative significance of both contemporary and historical trends and abundance of predators should be an integral component of an ecosystem approach to managing CCE fisheries.

Salmon fishing preceded sardine fishing as the first major finfish to be exploited throughout CCE (both inland and offshore) waters, and salmon represented the foundation of the livelihoods of native communities for thousands of years prior to settlement by Europeans (McEvoy 1986, Lyman 1988). Unsustainable salmon removals likely began with the rapid late 19th century development of the Sacramento river salmon fisheries, spreading rapidly northwards as Sacramento fisheries were overexploited (McEvoy 1986, 1996). Fishing and canning operations quickly developed on the Columbia River, where the salmon fishery grew from just tens of thousands of pounds in 1866 to over 20 million pounds by 1876 and over 40 million by 1885 (Cobb 1930). Salmon have continued to be among the most valued and vulnerable fisheries in the CCE with the associated fisheries management challenges and habitat issues remaining the subject of continual controversy. As the bridge between freshwater, estuarine and marine environments, salmon have evolved complex population structures and life histories to cope with the variability in each of these environments. Prior to western contact, Pacific salmon had evolved complex meta-population structures, and the physical template provided by high quality freshwater habitat is thought to have provided the insurance needed for such population structures to persist under highly variable ocean conditions (Nickelson and Lawson 1998). Ongoing degradation of freshwater and estuarine habitats and the current hatchery production have contributed to a decline in the diversity of populations and life history types, increasing the vulnerability of both the remaining populations and the associated fisheries to climate variability (Lindley et al. 2009).

Of the major historical fisheries in the CCE, probably the most notorious is the sardine fishery, immortalized by John Steinbeck in *Cannery Row*. Although sardines had been fished since the mid-1800s, markets for canned sardines (and later highly lucrative markets for fishmeal and fertilizer) did not develop until World War I, largely in response to declining salmon canning opportunities in California. Sardine fishing rapidly expanded throughout the coast, from British Columbia to Southern California, and coastwide landings grew from roughly 70,000 metric tons per year in 1920 to a peak of over 700,000 metric tons in 1936. Both the sardine population and the fishery began to decline sharply shortly after World War II, with the sardines disappearing sequentially from north to south, leading to debates that continue to this day regarding the relative contributions of fishing and environment with respect to the decline (Clark and Marr 1955, Murphy 1966, Smith 1994). By the time the fishery was closed in 1968, the sardine population had declined by several orders of magnitude. However fisheries for northern anchovy, Pacific mackerel and jack mackerel continued. Decades of studies devoted to understanding the proximate causes of the sardine decline, and comparable declines and dynamics in other ecosystems, have lead researchers to appreciate the role of climate in driving variability in the abundance and productivity of coastal pelagic species (MacCall 1996, Chavez et al. 2003, Checkley et al. 2010). The recovery of Pacific sardines in the 1980s and 1990s was generally associated with changes in environmental conditions, resulting in a resurgent fishery as well as a more conservative management regime. However, uncertainties remain with respect to understanding the principle drivers of sardine productivity and the optimal management measures for balancing conservation needs with fisheries.

Halibut and other groundfish were harvested by coastal native cultures throughout the CCE region, and soon became a staple of early explorers and traders throughout the Northeast Pacific. By 1892, coastwide catches of halibut and other flatfish, cod, rockfish and sablefish combined were over 10 million pounds per year, although the majority was taken from the coastal inland waters of San Francisco Bay, the Columbia River estuary, and Puget Sound. Through the early 20th century, longline fisheries for halibut and sablefish expanded, as did paranzella (two-boat trawl) fisheries that had begun as early as 1876 in San Francisco. The introduction of otter trawls to West Coast fisheries following World War I was associated with a gradual expansion of the trawl fleet northwards, and by the late 1930s the center of West Coast trawling had shifted from San Francisco to Eureka (Scofield 1948). A sharp increase in effort and landings occurred during World War II, spurred on by both a need for inexpensive protein from flatfish and rockfish (much of which was ordered by the U.S. Army), and engine lubricant from the livers of dogfish, soupfin and basking sharks. Demand for groundfish dipped slightly after the war, but trawlers kept busy as a market for mink food supplemented markets for fresh and frozen fish. The fishery grew steadily in the 1950s and 1960s following the postwar dip, and diversified as fisheries for Dungeness crab, pink shrimp and albacore tuna developed and expanded alongside existing fisheries for salmon and groundfish.

In the late 1960s through the 1980s massive fleets of Japanese, Russian and Polish trawlers, many of them recent expatriates of declining whale fisheries, began intensively fishing the CCE's continental shelf and slope waters. The size and capacity of these trawlers stood in sharp contrast to the coastal fleets of trollers, draggers and crab boats, and helped fuel the desire to nationalize marine resources and develop greater domestic fishing capacity. Senator Warren Magnuson captured the mood of the day, when he advised fishermen and scientists that "You have no time to form study committees. You have no time for biologically researching the animal. Your time must be spent going out there and catching fish… Let us not study our resources to death, let's harvest them" (Magnuson 1968). As the growing conservation movement of that era drove passage of a plethora of environmental legislation in the early 1970s, environmental concerns soon matched the desire to nationalize marine resources. The Fishery Conservation and Management Act of 1976 (later reauthorized as the Magnuson-Stevens Fishery Conservation and Management Act, or MSA) ultimately included objectives that included both developing domestic fisheries as well as attaining sustainability as defined by the concept of MSY, although the latter was treated as a "target" in the 1976 Act, and has since evolved to represent a "limit" reference point.

3.4.2 Current Fisheries

3.4.2.1 Commercial Fisheries

West Coast commercial fisheries landings data is collected within the Pacific States Marine Fisheries Commission's Pacific Fisheries Information Network (PacFIN) database. Commercial data represent landings recorded on state fish tickets (landings receipts,) but does not include any fisheries' biomass removals that may occur as bycatch to commercial fisheries, nor does it include recreational fisheries' removals. Thus, while commercial landings data cannot tell us about the cumulative effects of West Coast fisheries on the CCE, they can tell us about how the fisheries function within the CCE: species groups targeted by fisheries, how the volume of landings compares with exvessel revenues from those landings, and levels of fishery participation by vessels operating off the U.S. West Coast. This section of the FEP considers recent, 2000-1011 landings and ex-vessel revenues for U.S. West Coast commercial fisheries.

Commercial landings of all species for 2000-2011peaked at about 40,000 mt in 2000, 2006 and 2011, and reached lows near 31,000 mt in 2003, 2004 and 2008 (Fig. 3.4.2). Real exvessel revenues were generally increasing throughout the period (Fig. 3.4.2). Annual landings were dominated by CPS, mainly squid and sardine; by volume, CPS averaged 48% of total landings for the period. Groundfish followed CPS as a share of total landings, averaging 29% by volume for the period (Fig. 3.4.3). Dungeness crab accounted for the greatest share of exvessel revenues, an average of 31% for the period; groundfish had the next highest share at 17% (Fig. 3.4.4).

Figure 3.4.2: Total U.S. West Coast landings (mt) and real exvessel revenues (2005 $), 2000-2011.

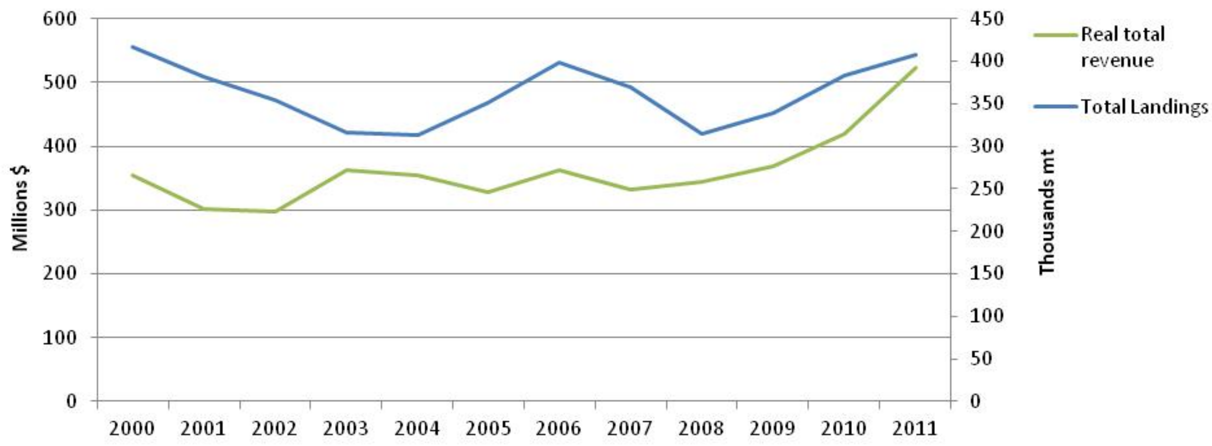


Figure 3.4.3: Percentage of total U.S. West Coast commercial landings by PacFIN management group, 2000-2011.

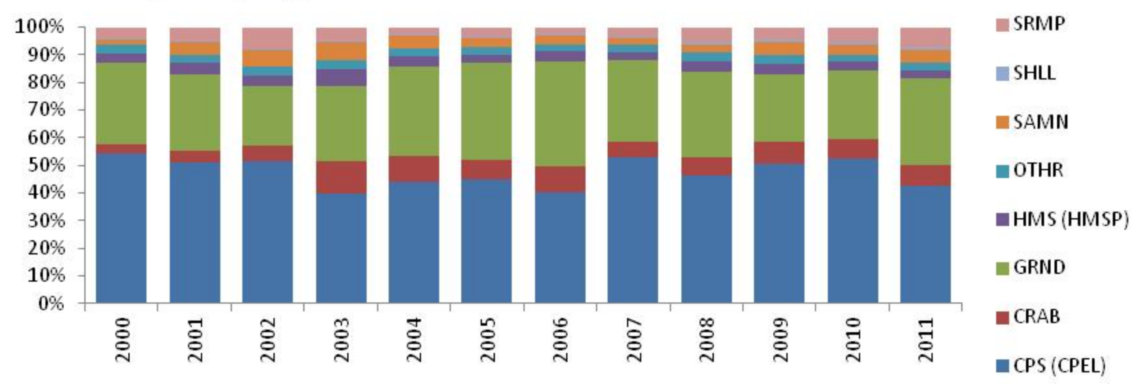
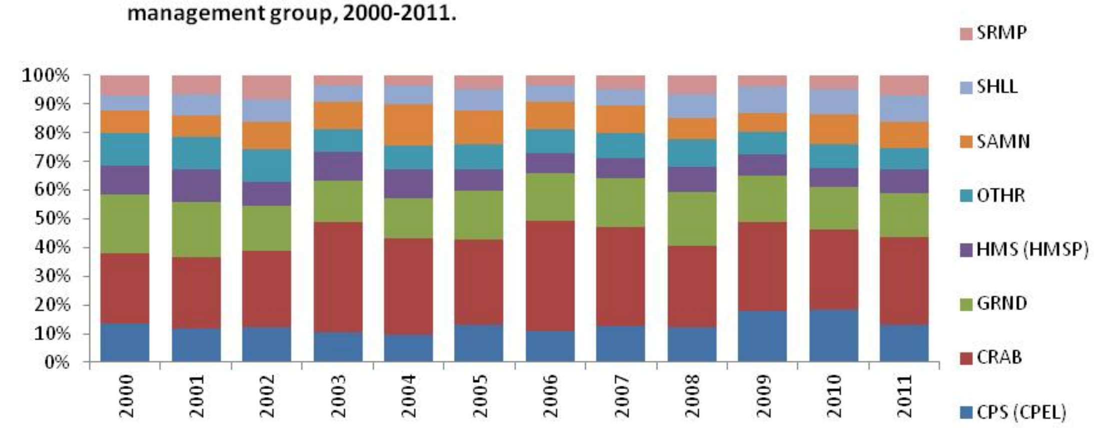
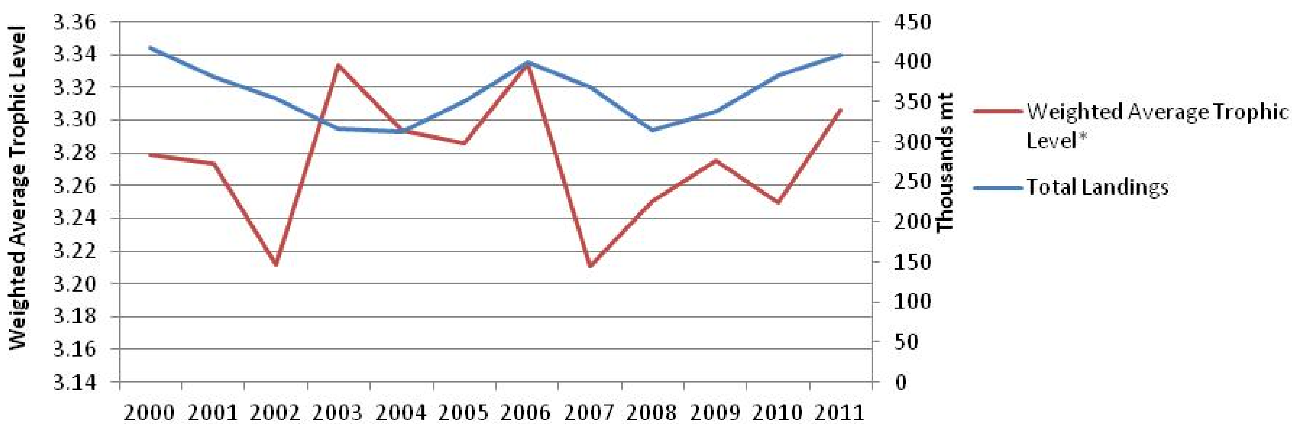


Figure 3.4.4: Percentage of total U.S. West Coast exvessel revenues by PacFIN management group, 2000-2011.



U.S. West Coast commercial landings for 2000-2011 cover a wide range of species' trophic levels, ranging from 2.0 to 4.5 with an arithmetic mean and median of 3.6. Ranking the PacFIN management groups by their mean trophic levels from lowest to highest, shellfish are at the bottom, moving upward to shrimp, crab, CPS, other, groundfish, salmon, with HMS at the top of the trophic scale. Based upon the species composition of the commercial landings, and trophic level measures for the individual species (Table 3.4.1,) the volume weighted mean trophic level (MTL) of the annual landings is shown in Figure 3.4.5. In both 2002 and 2007, the MTL was at its lowest level for the period, 3.2, and in both 2003 and 2006 it was at its highest level. In the low MTL years, species from the lower half of the trophic scale, predominately CPS, are above average in quantities landed, while species in the upper half of the scale, mainly groundfish, salmon and HMS are below average. For the high MTL years, the converse holds.

Figure 3.4.5: Total quantity (mt) and weighted average trophic level of U.S. West Coast landings, 2000-2011.



Ports in the Southern California port area, mainly San Pedro, Terminal Island, Port Hueneme and Ventura, accounted for the greatest share of landings volume by PacFIN port area over the 2000-2011 period. Ports along the northern Oregon coast, mainly Newport and Astoria, had the next highest share, followed by ports, primarily Chinook and Westport, in the Washington external marine port area (Fig. 3.4.6). CPS made up the significant bulk of the landings in Southern California while landings in the northern Oregon coast ports and in Washington external marine area consisted mainly of CPS, groundfish and shrimp. Exvessel revenues were more evenly divided among port areas for the period, with Southern California (CPS and HMS), the northern Oregon coast (crab, groundfish and shrimp) and Washington internal and external marine areas (crab, groundfish, salmon and shellfish) being the major receivers of commercial fisheries revenue (Fig. 3.4.7).

Figure 3.4.6: Percent total of U.S. West Coast landings by port area, 2000-2011

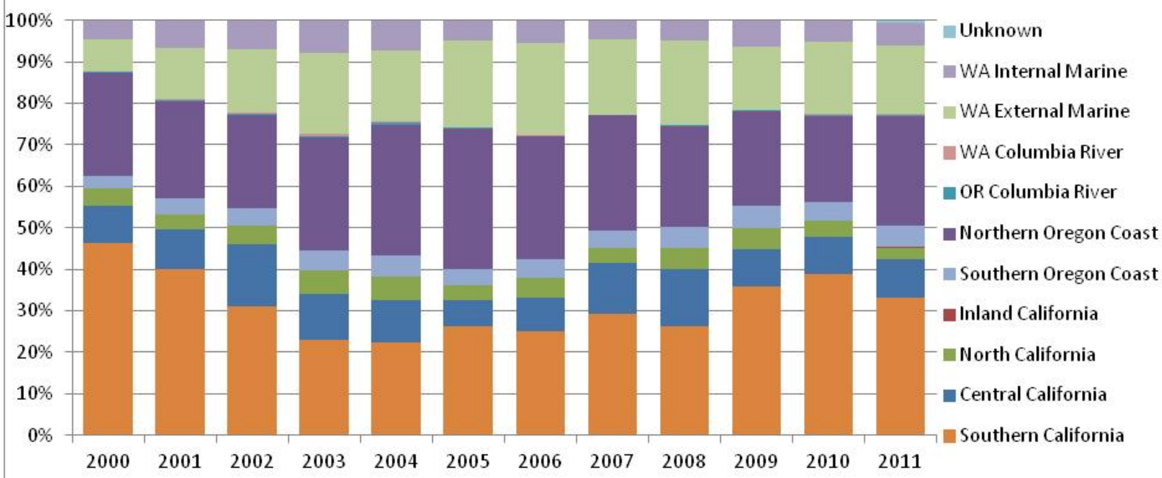
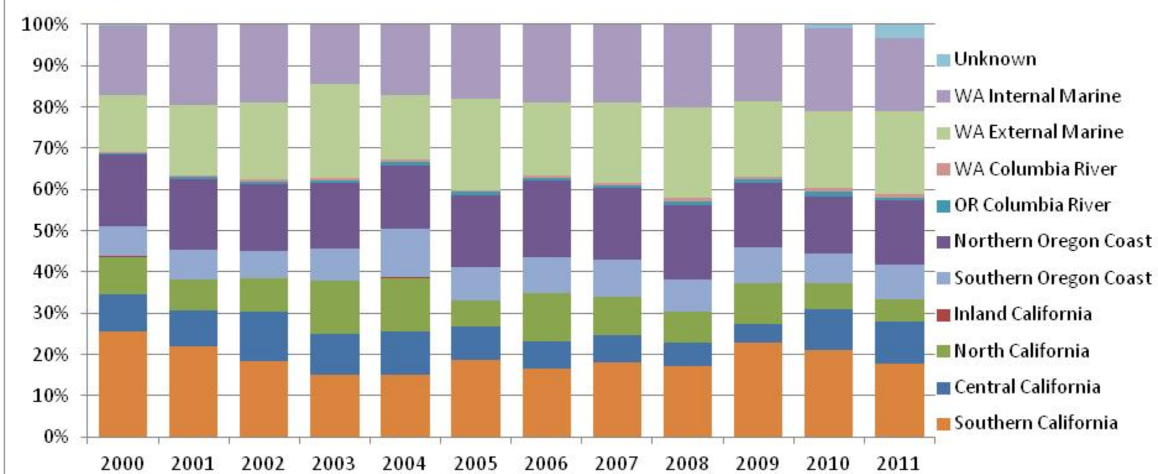
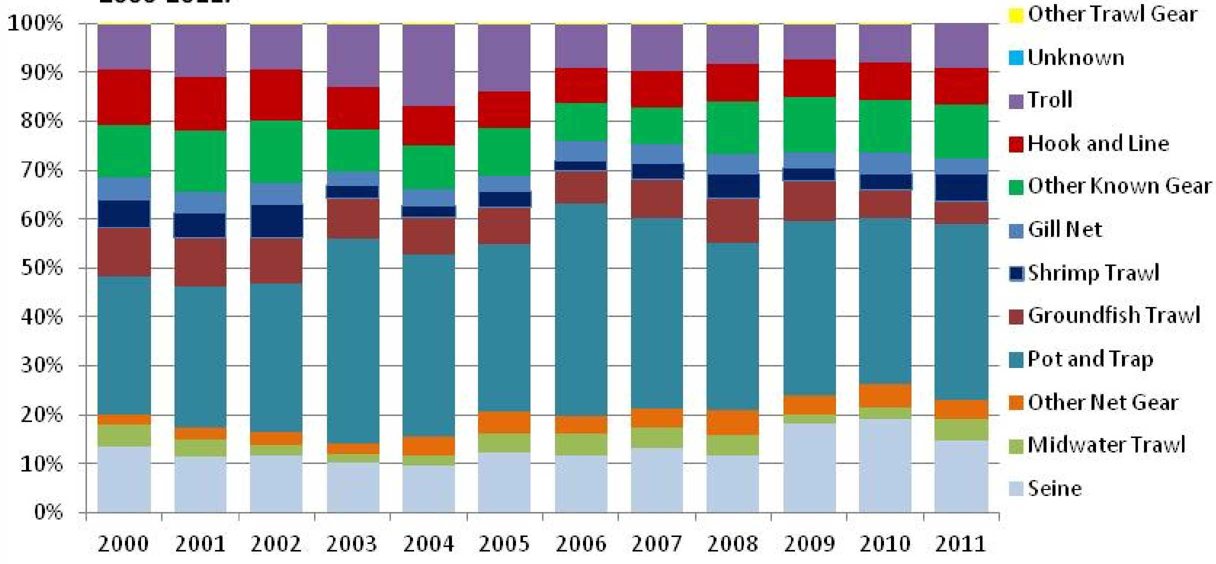


Figure 3.4.7: Percent total of U.S. West Coast total exvessel revenue by port area



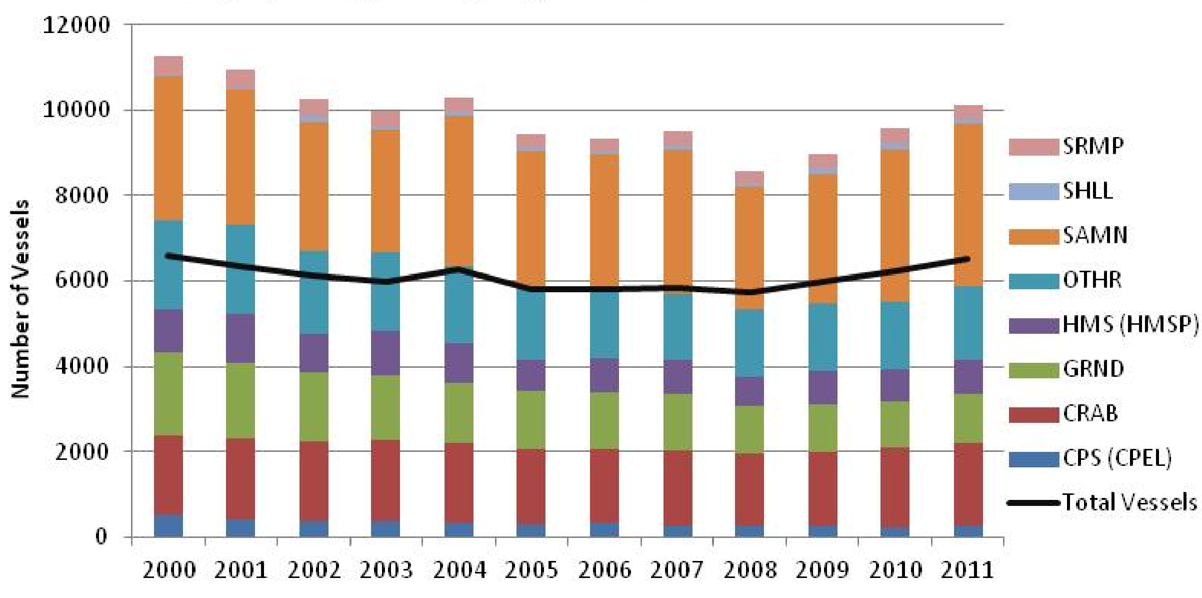
The greatest shares of landings volume by PacFIN gear category were in the seine and midwater trawl categories (Fig. 3.4.9). Purse seine is the primary gear used in the high volume CPS fisheries, while midwater trawl accounts for shoreside landings in the high volume Pacific whiting fishery. The pot and trap gear category accounted for the greatest share of exvessel revenues over the period. Pots and traps are used to harvest relatively high valued dungeness crab, shrimp, prawns, lobster and sablefish. Seine gear, based on the volume of CPS landings, also consistently accounted for a relatively high revenue share. The relatively high revenue share for the other known gear category can be mainly attributed to landings of high valued geoduck clams harvested using dredge gear, which falls in the “other known gear” category.

Figure 3.4.9. Percent total U.S. West Coast exvessel revenues by gear category, 2000-2011.



During the 2000-2011 period, the number of vessels that made landings in U.S. West Coast commercial fisheries remained fairly constant at around 6,000 annually (Fig. 3.4.10). Many of these vessels are capable of harvesting species in more than one management category, either using a single gear type (e.g. trawlers landing groundfish and shrimp) or multipurpose vessels that use different gear types (e.g. vessels landing: crab [pots] and groundfish [trawl]; crab [pots] and salmon [troll]). This multiplicity of fishing

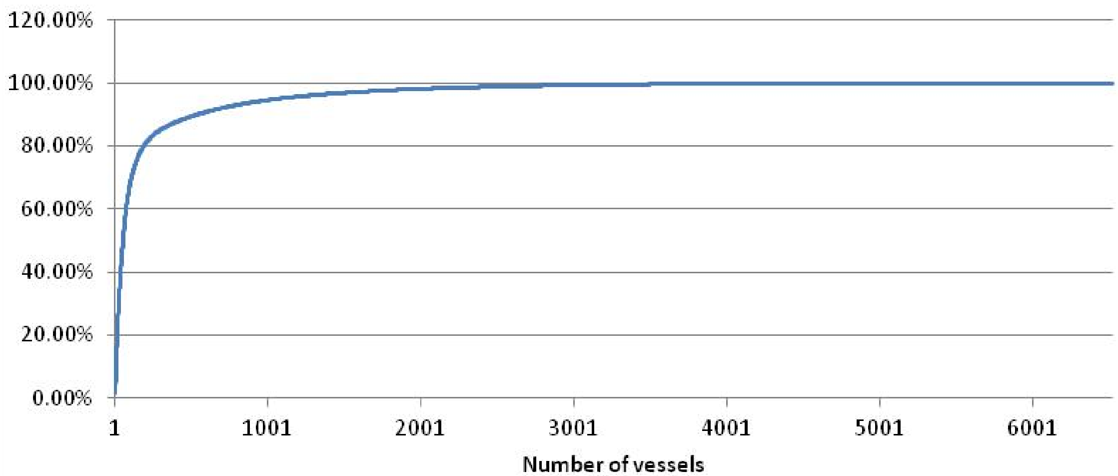
Figure 3.4.10: Total vessels with West Coast landings and number with landings by management group, 2000-2011.



operations by vessels is indicated by the vessel totals in each management category shown in Figure 3.4.10. In all years, more vessels participated in salmon fisheries, which are comparatively unrestricted in terms of participation, than in any other management group. On the other hand, limited entry CPS fisheries with the highest annual landings over the period had relatively few participants.

In 2011, 6,523 vessels made at least one West Coast shoreside commercial landing of one pound or more. It is questionable how many of these vessels would be considered to be engaged in a significant business enterprise in the conventional sense. Assigning a reasonable criterion for distinguishing a significant fishing business enterprise is not within the scope of this FEP. Using a gross revenue criterion for example, of the 6,523 vessels only 5,128 had exvessel revenues in excess of $1,000. Nonetheless, Figure 3.4.11 presents the distribution of the 6,523 vessels according to their share of the total shoreside landings in 2011 and shows that 1,064 vessels accounted for more than 95% of the total harvest. This suggests that in 2011 there were far more vessels than necessary to harvest the total landings. However, this finding for 2011 must be tempered by the temporal scale and scope of West Coast commercial fisheries, which are subject to the vagaries of ecosystems and economic systems alike.

Figure 3.4.11: Cumulative vessel share of total shoreside landings, 2011.



3.4.2.2 Recreational Fisheries

3.4.2.3 Fish Receivers and Processors

[May 31, 2012, Note: The EPDT plans to use its analysis of cumulative commercial fisheries activities within the West Coast EEZ as a model for developing analyses of recreational fisheries and of fish receivers and processors in future iterations of this Draft FEP.]

3.4.3 *Fisheries Socio-Economics*

The MSA places highest priority on conservation of fish stocks for the achievement of OY. However, the MSA's National Standard 8 requires conservation objectives to be achieved in a manner that provides for the sustained participation of fishing communities in fisheries and minimizes adverse impacts on fishing communities to the extent practicable (16 U.S.C. 1851). National Standard 8 also requires the Council to use the best available scientific information when weighing impacts to fishing communities and fishing participation.

Consideration of the effects of fisheries management on fishing communities has factored heavily in the Council's groundfish specifications and management measures process. The Council has addressed the Act's direction to place highest emphasis on rebuilding overfished stocks, while still taking into account the needs of fishing communities, by also looking at the vulnerabilities of fishing communities to changes in availability of groundfish harvest (PFMC 2010). The Groundfish FMP at 4.6.3.2 characterizes fishing communities as needing "a sustainable fishery that: is safe, well-managed, and profitable; provides jobs and incomes; contributes to the local social fabric, culture, and image of the community; and helps market the community and its services and products." Although that language is found within the Groundfish FMP, it reflects priorities expressed in other FMPs to manage fisheries so that both harvest and community participation in fisheries is sustainable over the long-term.

Under the MSA, a "fishing community" is a community that is "substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community" (16 U.S.C. §1802). Social scientists have used that definition to develop profiles of West Coast fishing communities (Norman et al. 2007), and to define and quantify community involvement in commercial fisheries and their vulnerability to changes in fishery conservation and management measures (Sepez et al. 2007, Clay and Olson 2008, Alsharif and Miller 2012). NOAA's Technical Memorandum NMFS-NWFSC-85, Community Profiles for West Coast and North Pacific Fisheries: Washington, Oregon, California and other U.S. States (Norman et al. 2007) provides detailed social and demographic analyses of over 100 West Coast communities, which the FEP will not repeat here. However, that document provides a framework for thinking about coastal communities' vulnerability to changes in available commercial fishery harvest levels and available recreational fishing opportunities.

Within the Council process, economic analyses often separate fishing communities by geography or by sector (e.g., commercial or recreational, treaty or non-treaty, fishing or processing, trawl or fixed gear, purse seine or longline, etc.) Regional economic models are employed to assess the amount of economic activity, in terms of sales, income and employment, that is generated by the business operations of economic entities within a particular geographic region. The input-output model is one type of economic impact model that tracks the flow of dollars within a regional economy. With respect to ecosystem-based management, an input-output model can help to evaluate, predict and assess goals and policies in an inter-connected system of sectors or industries comprising a regional economy. In this sense, it is akin to an ecological food web that characterizes predator-prey interactions within an ecosystem.

To understand the socioeconomic effects of fishery management actions the Council uses the Fishery Economic Assessment Model (FEAM,) a production oriented input-output model to estimate the contribution of West Coast commercial fishery sectors to the total income of the coastal communities of Washington, Oregon and California (Seung and Waters 2005). The FEAM allows for geographic resolution from the state level down to port area within each state. It distinguishes fishery sectors within each geographic area by their corresponding FMP, and where appropriate, disaggregates harvests within a sector according to vessel or gear type and the condition in which they were landed (e.g. alive or dead).

The FEAM[1] provides estimates of the income impacts stemming from the dollar value added to landings of West Coast commercial species as they make their way from the ocean, to the exvessel level, and through to the exprocessor level of the fishery. It does this by deriving input-output multipliers, which are used to convert the revenues at each stage of the production process into either: (1) direct income - exvessel income generated in the region of interest by the harvesting sector of the fishing industry from landings by species, by port and by gear; (2) indirect income - income generated in the region of interest by all industries, due to the iteration of industries purchasing from industries in response to landings of a particular species at the exvessel level; (3) induced income - the expenditures from new household income within the region of interest, generated by the direct and indirect income effects of landings of a particular species.

Here, the FEAM was used to estimate the total income impact from each state's 2011 landings of species targeted by the major fisheries occurring within the CCE (Table 3.4.1). From the quantities landed and the corresponding exvessel revenues for a specific fishery sector shown in Table 3.4.1, and the related value added from processing that volume of raw fish, the direct, indirect and induced incomes are calculated. These are then combined to estimate the total income impact generated by the fishery sector at the state and entire West Coast levels. For example, at the average exvessel price for each pound of Dungeness crab landed in Washington during 2011, the average total income impact was estimated to be $1.69 per dollar of exvessel revenue at the state level and $1.84 per dollar of exvessel revenue coastwide; for Oregon and California these impacts were $1.68 and $1.91 respectively at the state level and $1.78 and $1.93 respectively coastwide.

[1] The Fishery Economic Assessment Model (FEAM) was developed by Dr. Hans Radtke and Dr. William Jensen to estimate local, state and regional marginal and average income impacts for West Coast fishery landings. The FEAM model is based on the U.S. Forest Service IMPLAN model enhanced with fishing sector coefficients specific to West Coast fisheries. In its current configuration the FEAM was calibrated using coefficients from the IMPLAN's 1998 input-output database, and PacFIN landings extractions for Year 2000.

Table 3.4.1: Total FEAM-Estimated Income Impact from Each State's Fisheries

State and west coast income impact of 2011 commercial fishery landings.

Species/Gear	Washington				Oregon				California			
	Landings		Total Impacts		Landings		Total Impacts		Landings		Total Impacts	
Group Name	Pounds	Revenue	State	WOC	Pounds	Revenue	State	WOC	Pounds	Revenue	State	WOC
Groundfish												
Lingcod												
Non-trawl (dead)	22,062	$19,020	$33,172	$36,058	193,287	$217,171	$355,709	$378,451	31,915	$71,814	$114,643	$115,867
Trawl/net (dead)	307,958	$240,654	$428,430	$465,709	320,523	$226,885	$405,395	$431,312	14,049	$10,049	$19,454	$19,661
Live					38,788	$92,975	$139,766	$148,701	26,115	$64,792	$102,479	$103,573
Other rockfish and perch												
Non-trawl (dead)	233,444	$136,153	$260,307	$282,958	527,172	$398,006	$824,244	$876,940	580,820	$978,301	$1,613,742	$1,630,971
Trawl/net (dead)	2,128,503	$1,054,332	$2,112,815	$2,296,659	3,270,639	$1,571,485	$4,033,437	$4,291,304	2,132,747	$1,290,887	$2,615,782	$2,643,709
Live					179,767	$492,975	$759,810	$808,386	732,653	$3,353,884	$5,084,303	$5,138,584
Thornyheads												
Non-trawl (dead)	49,163	$35,660	$64,553	$70,170	15,959	$9,639	$21,723	$23,112	118,965	$274,480	$465,554	$470,525
Trawl/net (dead)	498,449	$239,226	$484,083	$526,205	1,617,217	$779,132	$1,997,354	$2,125,050	1,397,788	$816,276	$2,001,153	$2,022,518
Live									470,032	$1,919,264	$3,049,237	$3,081,791
Sablefish												
Non-trawl (dead)	29,559,164	$11,094,170	$31,951,002	$34,731,178	2,981,981	$12,307,143	$18,137,728	$19,297,316	4,308,858	$11,525,931	$19,158,359	$19,362,898
Trawl/net (dead)	471,413	$1,345,173	$2,172,404	$2,361,433	2,098,519	$5,044,158	$8,311,645	$8,843,028	1,157,161	$3,030,457	$5,096,744	$5,151,158
Live									81,262	$237,001	$389,762	$393,923
Sharks (soupfin, spiny dogfish)	472,089	$140,125	$397,146	$431,704	429,522	$45,800	$269,222	$286,434	6,835	$4,819	$10,607	$10,721
Skates (big, California, longnose, unspecified)	272,990	$66,779	$210,631	$228,958	1,751,147	$585,060	$1,577,253	$1,678,090	450,444	$152,094	$458,032	$462,922
Sole/flounder												
Arrowtooth flounder (incl. Kamchatka)	1,254,098	$129,470	$530,371	$576,520	36,996,719	$354,443	$11,033,506	$11,738,904	190,426	$19,671	$83,712	$84,605
Dover sole	1,455,043	$500,424	$1,114,050	$1,210,988	10,451,147	$4,271,299	$8,963,780	$9,536,856	5,307,930	$2,254,288	$4,716,447	$4,766,801
English sole (incl. butter, curlfin, flathead)	142,993	$49,101	$109,372	$118,888	198,563	$57,866	$137,664	$146,466	41,718	$17,469	$36,722	$37,114
Other sole/flounder					147,206	$133,461	$229,003	$243,644	29,438	$35,813	$58,720	$59,347
Petrale sole	515,858	$707,929	$1,150,416	$1,250,518	1,153,184	$1,649,713	$2,640,912	$2,809,752	383,393	$534,505	$859,864	$869,044
Rex sole (incl. rock sole and starry flounder)	102,304	$35,661	$79,007	$85,882	619,923	$208,327	$468,576	$498,534	169,647	$71,138	$149,469	$151,065
Sanddabs	44,961	$15,368	$34,289	$37,272	207,897	$104,288	$205,395	$218,526	104,534	$94,931	$163,478	$165,223
Pacific whiting												
Surimi					130,002,914	$14,177,097	$31,653,710	$33,677,407				
H&G	76,018,051	$7,190,224	$27,866,087	$30,290,819	21,461,455	$2,340,418	$8,472,652	$9,014,329	10,894	$487	$3,051	$3,084
Salmon												
Chinook												
Net	4,674,376	$10,062,164	$17,147,568	$18,639,642	1,457,621	$3,547,598	$6,011,501	$6,395,830	515	$1,985	$3,216	$3,251
Other	17,863	$71,637	$109,321	$118,834	2,348	$10,557	$16,118	$17,149	6,741	$33,520	$52,626	$53,188
Troll	805,192	$3,231,330	$4,873,065	$5,297,088	462,633	$2,397,985	$3,502,403	$3,726,320	1,125,792	$5,055,116	$8,030,756	$8,116,494
Chum												
Net	8,459,146	$9,988,428	$19,572,531	$21,275,610	193	$50	$213	$227				
Other	12,537	$10,463	$23,480	$25,523	9	$2	$10	$10				
Coho												
Net	3,443,119	$5,580,925	$9,742,415	$10,590,138	458,995	$754,073	$1,177,255	$1,252,520				
Other	88,705	$113,917	$213,783	$232,385								
Troll	106,830	$180,603	$308,810	$335,680	2,971	$5,171	$8,583	$9,131				
Pink												
Net	19,026,147	$9,074,586	$27,239,469	$29,609,677	18,813	$207	$16,113	$17,143				
Other												
Troll	6,336	$2,768	$8,740	$9,501	214	$243	$424	$451				
Sockeye												
Net	1,798,700	$3,034,980	$5,558,522	$6,042,189	2,723	$5,787	$8,083	$8,600				
Troll												
Steelhead												
Net	412,325	$793,143	$1,367,932	$1,486,961	12,496	$11,558	$22,112	$23,525				
Other	470	$828	$1,460	$1,587								
Unspecified												
Net												
Other												
Troll												

Table 3.4.1, continued

Page 2.	Washington				Oregon				California			
Species/Gear	Landings		Total Impacts		Landings		Total Impacts		Landings		Total Impacts	
Group Name	Pounds	Revenue	State	WOC	Pounds	Revenue	State	WOC	Pounds	Revenue	State	WOC
Crab/lobster												
California spiny lobster									748,633	$12,744,872	$19,858,601	$20,070,616
Dungeness crab	27,061,201	$86,412,836	$146,095,402	$158,807,708	17,261,960	$44,694,911	$74,936,589	$79,727,462	19,695,207	$49,446,691	$94,412,774	$95,420,746
Other crab (bairdi tanner, king)					817	$1,118	$2,217	$2,359	69,136	$80,091	$189,096	$191,115
Shrimp												
Other shrimp (blue mud, ghost, unspecified)	83,640	$99,394	$228,870	$248,785	19,244	$144,846	$202,244	$215,174	80,734	$332,547	$475,533	$480,610
Pink shrimp	9,573,408	$4,610,356	$9,419,976	$10,239,643	48,313,940	$24,610,503	$47,592,409	$50,635,105	7,375,139	$3,693,282	$7,299,344	$7,377,274
Prawns (ridgeback, spotted)	418,079	$2,273,720	$3,665,280	$3,984,210					534,291	$4,332,179	$7,049,039	$7,124,296
Coastal pelagic												
Anchovy	414,090	$67,429	$394,965	$429,332	46,843	$6,558	$33,519	$35,662	5,734,843	$617,647	$3,427,604	$3,464,198
Pacific mackerel												
Other					244	$32	$172	$182	952	$686	$1,280	$1,294
Round haul					15,136	$340	$8,297	$8,828	2,990,931	$325,775	$1,579,539	$1,596,402
Other mackerel (jack, unspecified)	23,359	$5,692	$27,045	$29,398	30,988	$2,838	$29,913	$31,826	176,926	$10,438	$81,644	$82,516
Herring (Pacific, round)												
Other									3,453,197	$431,949	$3,206,701	$3,240,937
Round haul	472,970	$167,999	$466,069	$506,623	100	$20	$80	$85				
Pacific bonito									243,496	$116,738	$390,219	$394,385
Pacific sardine	17,655,620	$2,144,099	$11,429,059	$12,423,544	24,302,389	$3,191,592	$17,089,720	$18,182,307	61,097,987	$4,398,389	$28,014,189	$28,313,275
Frozen bait												
Live bait												
Squid					54	$1	$47	$50	267,979,179	$66,565,234	$221,194,672	$223,556,197
Highly migratory												
Albacore tuna	13,255,017	$22,240,413	$35,898,854	$39,022,547	9,659,108	$18,714,004	$27,249,871	$28,992,020	1,410,098	$2,358,597	$4,139,031	$4,183,221
Sharks*					1,211	$15	$622	$661	199,452	$136,282	$303,208	$306,446
Swordfish									1,344,160	$3,290,282	$6,067,530	$6,132,309
Tunas not albacore**					93	$279	$444	$472	368,378	$582,097	$1,069,417	$1,080,835
Halibut (Pacific)	1,295,388	$6,503,204	$9,889,278	$10,749,781	216,842	$1,140,824	$1,736,538	$1,847,560	876	$5,332	$8,348	$8,437
Sea urchins (red, other, unspecified)	187,685	$167,559	$269,690	$293,157	588,235	$313,488	$494,546	$526,163	11,447,130	$8,080,025	$14,344,757	$14,497,905
Other												
Croakers (white, other)									6,649	$4,049	$12,948	$13,086
Clams and mussels***	6,403,634	$53,024,280	$72,248,464	$78,535,072	255,296	$169,978	$477,667	$508,206				
Oysters (Pacific, olympia)	556,030	$2,059,532	$3,148,101	$3,422,029								
Scallops												
Halibut (California, unspecified)									447,218	$2,185,922	$3,621,160	$3,659,821
Other												
Other echinoderms (sea cucumbers, unspecified)	921,518	$3,859,747	$6,279,461	$6,825,860	1,145	$60	$1,380	$1,468	849,641	$3,397,669	$6,040,560	$6,105,050
Other sharks (leopard, Pacific angel, brown cat)									29,212	$20,614	$45,361	$45,845
Pacific barracuda									79,514	$60,007	$159,442	$161,144
Sea bass (white, giant, other)									568,324	$1,637,068	$2,959,525	$2,991,121
Sturgeon (green, white, unspecified)	137,742	$333,398	$535,866	$582,494	107,150	$273,690	$423,119	$450,170				
Unspecified octopi	3,576	$2,537	$7,094	$7,712	3,414	$3,999	$8,118	$8,637	6,206	$8,602	$20,165	$20,380
Unspecified shad	17,599	$3,888	$19,863	$21,591	40,320	$9,192	$46,116	$49,065	13,924	$11,079	$28,662	$28,968
Unspecified smelt	76,664	$40,059	$116,159	$126,266					357,680	$163,910	$559,037	$565,005
Total	230,957,509	$249,161,383	$455,304,723	$494,922,486	317,947,074	$145,078,860	$281,734,929	$299,746,910	406,189,785	$196,887,025	$480,897,300	$486,031,471

*common & bigeye thresher, shortfin mako/bonito, blue

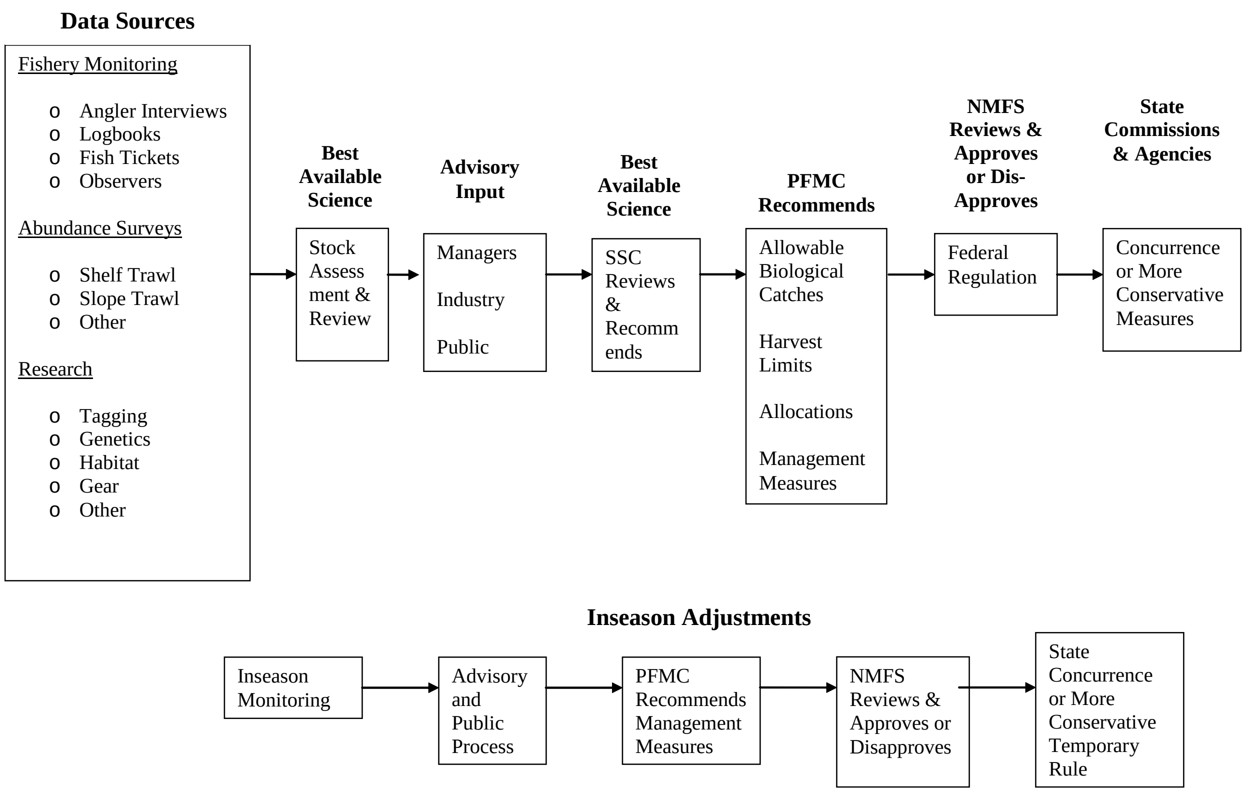
**bigeye, bluefin, skipjack, yellowfin, unsp.

***basket cockle, butter clam, California mussel, gaper clam, geoduck, horse clams, manila clam, native littleneck, razor clam and the rosy razor clam.

3.5 Fisheries and Natural Resource Management in the CCE

Many CCE fisheries are under the Council's jurisdiction, but the Council also shares jurisdiction over or management responsibility for the species it manages with other entities or institutions. While the states and tribes participate in the Council process, they also have separate management processes linked to and informing the Council's work. Beyond the EEZ, management processes for several Council species include multi-national processes with their own priorities and institutions. Figure 3.5.1 provides a general overview of the state/federal management process: the states, tribes, and federal government together organize and implement fisheries monitoring, data gathering, and research programs; scientific information is reviewed through the Council's SSC; management measures and programs are developed through the Council's advisory bodies and associated public processes; scientific analyses are again reviewed through the SSC for their utility within the management process; the Council uses the SSC recommendations and advice from its advisory bodies and the public to recommend harvest levels and other management measures; Council recommendations are then reviewed and partially or wholly implemented through federal, and then state, regulatory processes.

Figure 3.5.1: State / Federal Management Process Overview



3.5.1 Council Fisheries Management

Fishery management councils were first authorized by the Fishery Conservation and Management Act of 1976 [Pub. L. 94-265]. That act also established an ocean fishery conservation zone [later, the EEZ] beyond state marine waters out to 200 nautical miles offshore of U.S. coastlines, and gave councils areas of authority within the zone. The Pacific Council first met October 12-15, 1976, to begin discussions of shared state-federal management priorities for the fisheries within U.S. waters offshore of the U.S. West Coast. Over the last 30+ years, the Council has developed four FMPs and a Catch Sharing Plan for Pacific Halibut, and has addressed a wide range of fisheries and environmental issues through amendments to those plans discussed in over 200 formal meetings and in countless public hearings. Major fishery management planning events in the Council's history are shown in Table 3.5.1, many of which were developed in response to the 1996 and 2007 reauthorizations of the MSA, the current-day iteration of the Fishery Conservation and Management Act.

Table 3.5.1: Major fishery management planning events in PFMC history

Federal Fisheries Legislation-Related Events	Year	Major Council Events
Fishery Conservation and Management Act first enacted, including assertion of 200 nm fishery conservation zone (later EEZ)	1976	
	1977	Council's first meeting
	1978	Northern Anchovy FMP final
	1978	Salmon FMP final
	1982	Groundfish FMP final
	1984	Amendment 6 to Salmon FMP – preseason and inseason management framework
First West Coast salmon ESA listing: Sacramento Winter-run Chinook, threatened	1989	
	1990	Amendment 4 to Groundfish FMP – specifications and management measures process
	1992	Amendment 6 to Groundfish FMP – limited entry program
	1995	Pacific Halibut Catch Sharing Plan adopted
Sustainable Fisheries Act (SFA)	1996	
	1997	Combined Amendment 12 to Salmon FMP & Amendment 10 to Groundfish FMP – setting parameters for salmon bycatch in whiting trawl fisheries
National Standard Guidelines revised	1998	
	1999	Amendment 11 to Groundfish FMP – SFA provisions
	1999	Amendment 8 to Northern Anchovy FMP – expanded FMP scope to establish CPS FMP, SFA provisions
	2000	Amendment 14 to Salmon FMP – SFA provisions
	2001	Amendment 14 to Groundfish FMP –permit stacking program for limited entry fixed gear sablefish fishery
	2003	Amendments 16-1 & 16-2 to Groundfish FMP – established groundfish rebuilding plan framework, plus first four groundfish rebuilding plans (darkblotched rockfish, Pacific ocean perch, canary rockfish, lingcod)
	2004	HMS FMP final
	2005	Amendments 19 to Groundfish FMP – EFH identification and coastwide protection measures
MSA reauthorized	2007	
	2007	Amendment 1 to HMS FMP – bigeye tuna rebuilding plan and FMP reorganization
National Standard 1 guidelines revised	2009	
	2009	Amendment 12 to CPS FMP – prohibition on krill harvest
	2010	Amendment 20 to Groundfish FMP – trawl rationalization (catch share program)
	2011	Amendment 13 to CPS FMP, Amendment 23 to Groundfish FMP, Amendment 2 to HMS FMP, and Amendment 16 to Salmon FMP – annual catch limits (ACLs) and accountability measures (AMs)

3.5.1.1 Cross-FMP Goals and Management Measures

While the Council develops and considers management programs for West Coast fisheries in four separate FMPs, the ideas about and priorities for management come from the MSA and from a West Coast ethos that collaboration and cooperation in management discussions can better sustain fisheries now and into the future. The goals and objectives of the four FMPs share four common themes consistent with an ecosystem approach to fishery management: avoid overfishing, maintain stability in landings, minimize impacts to habitat, and accommodate existing fisheries sectors. Those four larger themes emerge in a variety of ideas that are common across the FMPs, divided roughly in this Table 3.5.2:

Table 3.5.2 FMP Shared Goals and Objectives, by FMP Objective/Goal Number

Ecological	CPS	Groundfish	Salmon	HMS
Prevent overfishing and rebuild depleted stocks.	X	X	X	X
Provide adequate forage for dependent species.	X			
Describe, identify and minimize adverse impacts on essential fish habitat		X		X
Minimize bycatch (incl. protected species) and encourage full utilization of resources	X	X	X	X
Economic				
Achieve greatest possible net benefit (economic or OY) from resource	X	X	X	X
Promote efficiency and profitability in the fishery, including stability of catch	X	X	X	X
Accommodate existing fishery sectors	X	X	X	X
Minimize gear conflicts.	X	X		X
Minimize adverse impacts on fishing communities and other entities		X	X	X
Use gear restrictions to minimize need for other management measures wherever practicable		X		
Management				
Acquire biological information and develop long term research	X			X
Foster effective monitoring and enforcement.	X	X		X
Establish management measures to control fisheries impacts, use management resources effectively	X	X		X
Encourage cooperative international and interstate management	X		X	X
Promote the safety of human life at sea		X	X	
Support enhancement of stock abundance			X	
Promote outreach and education efforts				X

Table 3.5.3 details the array of fishery conservation and management measures that the Council uses to implement its priorities for West Coast fish and fisheries.

Table 3.5.3 Conservation and Management Measures Across FMPs

	CPS	Groundfish	Salmon	HMS
Annual harvest limits	✓	✓	✓	
Harvest restrictions to provide prey base for other spp.	✓	✓		
Season limits for all or some species	✓	✓	✓	
Fishing area restrictions to minimize bycatch		✓	✓	✓
Fishing area restrictions to minimize effects on EFH		✓		
Gear restrictions to minimize bycatch	✓	✓	✓	✓
Participation/access limitation program(s)	✓	✓		
Bycatch monitoring for all or some species/fisheries	✓	✓	✓	✓

3.5.1.2 Ecosystem-Based Management Measures within FMPs

This section identifies existing ecosystem-based principles and management measures within current FMPs, particularly management measures that were either taken to mitigate the impact of fishing on the environment or ecosystem, or measures that take into account the effects of the biophysical environment on managed species. For each measure listed under the species group FMPs, we indicate in brackets the FMP species groups or protected species that may benefit from the measure listed. The following lists, separated by FMP, are current through February 2011.

Coastal Pelagic Species FMP

1. Krill harvest prohibition: The CPS FMP prohibits harvest of all species of euphausiids (krill) that occur within the U.S. West Coast EEZ to help maintain important predator-prey relationships and the long-term health and productivity of the West Coast ecosystem. These ecosystem conservation principle enhance fishery management by protecting, to the extent practicable, krill resources, which are an integral part the ecosystem [HMS, groundfish, salmon, CPS, marine mammals, birds]
2. Conservative Management Strategy: The Council has demonstrated a consistently conservative approach to CPS harvest management in response to their ecological role as forage and importance to West Coast fisheries. The Council frequently reviews new science in support of stock assessments and management strategies and conducts annual stock assessments for the actively managed species because of the annual variability that can occur in the biomass of CPS. In the late-1990's, the Council chose the most conservative harvest control rule for Pacific sardine when presented a wide range of FMP harvest policies. The rationale for this harvest policy, like the other harvest controls rules in the FMP, is oriented toward maximizing biomass versus maximizing catch. Because of this, the annual harvest levels that result from the rule never exceed 12 percent of the estimated biomass for that year. [HMS, groundfish, salmon, CPS, marine mammals, birds]
3. Environmental Indicators: The intent of the existing environmental parameter in the Pacific sardine harvest control rule is to explicitly adapt harvest levels in response to environmental variability. The existing environmental parameter is one of the Council's priority research needs and new science suggests a need to explore a broader range of ecological indicators of Pacific sardine productivity. Additionally annual SAFE document for CPS includes an 'Ecosystem Considerations' chapter that provides a summary of oceanographic trends and ecological indicators being tracked by NMFS in the CCE a Current and potentially having an effect on CPS stocks. [CPS]

4. Cutoff Parameters: CPS harvest control rules have long utilized "Cutoff" parameters to protect a core spawning population and prevent stocks from becoming overfished. The Cutoff is a biomass level below which directed harvest is not allowed. Cutoff values are set at or above the overfished threshold and have the effect of automatically reducing harvest rates as biomass levels decline. This mechanism serves to preserve a spawning stock size. For Pacific sardine, the Cutoff value is 150,000 mt or three times the overfished threshold and is part of the Council's conservative management approach. [HMS, groundfish, salmon, CPS, marine mammals, birds]
5. Monitored stock harvest strategy: The ABC control rule for monitored stocks consists of a 75% reduction from the species overfishing level. This precautionary approach is in response to greater scientific uncertainty about stock status or management. [HMS, groundfish, salmon, CPS, marine mammals, birds]
6. Essential fish habitat (EFH): EFH for CPS finfish species is temperature-based: The east-west geographic boundary of EFH for CPS is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the EEZ and above the thermocline where sea surface temperatures range between 10°C to 26°C. The southern boundary is the United States-Mexico maritime boundary. The northern boundary is more dynamic, and is defined as the position of the 10°C isotherm, which varies seasonally and annually. [CPS]
7. Ecosystem Component (EC) Species: The CPS FMP contains two EC species, jacksmelt and Pacific herring. In recognition of their role as forage, bycatch and incidental catch of these species is specifically monitored, along with all other bycatch/incidental catch, annual in the CPS SAFE document.

Groundfish FMP

1. EFH Conservation Areas: extensive, coastwide, long-term closed areas to protect groundfish EFH from bottom contact gear, particularly in rocky reef areas; extensive, coastwide, long-term closed area to freeze the footprint of West Coast trawl gear use to inshore of 700 fm depth contour. [Groundfish, salmon (particularly Chinook), marine mammals, seabirds]
2. Rockfish Conservation Areas: coastwide, seasonally-variable closed areas to minimize bycatch in all groundfish fisheries of rebuilding groundfish species. For cowcod and yelloweye rockfish, species-specific closed areas off the southern (cowcod) and northern (yelloweye) U.S. West Coast. [Groundfish, salmon (particularly Chinook), marine mammals, seabirds]
3. Salmon Conservation Zones: mid-coast, estuary-plume-focused closed areas to minimize bycatch in whiting fisheries of endangered and threatened salmon stocks. [Salmon, CPS, green sturgeon, marine mammals, seabirds]
4. Commercial fishery vessel monitoring system (VMS) requirements to better enforce closed areas and other regulations. [Groundfish, salmon, marine mammals, seabirds]
5. Coastwide, mandatory observer program to gather total catch data from commercial fisheries. [All FMP species, all protected species taken as bycatch]
6. Weak stock management to curtail allowable harvest of more abundant species in order to reduce opportunities for incidental catch of less abundant, co-occurring species. Harvest levels for species managed via an overfished species rebuilding plan are usually set at a fraction of FMSY harvest rate. [Groundfish, salmon]
7. For less abundant stocks and stocks with little scientific information, harvest policies become increasingly precautionary. [Groundfish]
8. Allowable harvest of shortbelly rockfish, an abundant species with high prey value to the CCE, is set extremely low to accommodate incidental catch while discouraging any fishery development, to ensure that it retains its role as prey for other (non-human) predator species. [Groundfish, HMS, salmon, marine mammals, seabirds]

9. Stock assessments include literature review and discussion of relevant ecological biological, social and economic factors and the interactions between them, to allow SSC and Council to weigh impacts of those factors under different potential harvest scenarios. [Groundfish]
10. Trawl gear regulations to constrain habitat damage through a small footrope requirement shoreward of the RCAs, and minimize catch of juveniles through a minimum mesh size requirement. Fixed gear regulations to prevent lost gear from ghost fishing through a gear attendance requirement and, for pots, a biodegradable escape panel requirement. [Groundfish, salmon (particularly Chinook), marine mammals, seabirds]
11. Regulations requiring fishery participants to sort their catch by species, ensuring better long-term data on the hugely varied groundfish species catch and landings. [Groundfish]
12. For whiting, participation in a U.S.-Canada bilateral treaty organization to jointly manage and conserve Pacific whiting to ensure that harvest of the cross-boundary resource remains within sustainable parameters. [Groundfish, marine mammals, seabirds]

Highly Migratory Species (HMS) FMP

1. FMP designates EFH for each species within the FMP, with sub-designations for the different life stages of those species. EFH designations for some HMS' life stages are temperature-based, recognizing those species' habits of associating with certain temperature ranges, regardless of where those temperatures may occur in any given season or year.
2. Sea turtle and marine mammal bycatch minimization and mitigation measures: swordfish longline fishery closure west of 150° W. long.; prohibition on light stick possession for longline vessels operating west of 150° W. long.; gear and operational modification requirements for HMS longline and drift gillnet vessels; seasonal area closures for longline and gillnet fisheries in times and areas where there have been prior fishery interactions with sea turtles, with additional closures during El Niño events; equipment and handling requirements for bringing incidentally caught turtles onboard, and resuscitating and releasing when possible. [sea turtles, marine mammals]
3. Seabird bycatch minimization and mitigation measures: gear configuration and setting requirements, offal discharge requirements, equipment and handling requirements for bringing incidentally caught short-tailed albatross onboard, and resuscitating and releasing when possible. [Seabirds]
4. Bycatch limitations for HMS taken with non-HMS gear. [HMS]
5. HMS permitting and record-keeping requirements for U.S. vessels operating in the EEZ and on the high seas and landing HMS in U.S. ports. [HMS]
6. Selected commercial fishery vessel monitoring system (VMS) requirements to better enforce closed areas and other regulations. [HMS]
7. Mandatory observer program to gather total catch data from commercial fisheries. [HMS, salmon, CPS, groundfish]
8. Nation-wide shark-finning prohibition. [Sharks]
9. Nation-wide dolphin-safe tuna import requirements. [Marine mammals]
10. Participation in international regional fishery management organizations to develop and implement multinational conservation measures, such as restricting fishing around fish aggregating devices (FADs) for tropical tunas, and area closures to minimize bycatch of mammals and turtles. [HMS, marine mammals, sea turtles]

Salmon FMP

1. FMP designates EFH from the ocean extent of the EEZ to the shore, and inland up to all freshwater bodies occupied or historically accessible to salmon in Washington, Oregon, Idaho, and California, with exceptions for dammed streams, recognizing the long-term potential for

managed stocks to recover in historically-used areas. [Salmon, and in marine waters, groundfish and CPS where EFH for those species intersects with salmon EFH]
2. Yelloweye Rockfish Conservation Area off Washington state to minimize bycatch of an overfished rockfish species in the salmon troll fisheries. Regulations restricting groundfish and halibut retention, coupled with inseason management to adjust those as needed. [Groundfish, halibut]
3. Geographic control zones that may be opened or closed to fishing on an annual basis, depending on a particular year's management objectives and run forecasts, used to constrain the catch of salmon from less abundant runs caught in common with salmon from more abundant runs. [Salmon]
4. Adaptive management process that allows swift inseason regulations changes to respond as catch information becomes available. That same process also includes an annual retrospective analysis of the effectiveness of modeling and management, ensuring an ongoing refinement of predictive and monitoring methodologies. [Salmon]
5. Oregon coastal natural (OCN) and Columbia River coho harvest matrices that use juvenile salmon ocean survival as a predictor of ocean conditions, ultimately providing allowable total fishery impacts rates based on the return of jacks (sub-adults) to spawning streams. Also for OCN coho, the Council's SSC has recommended a new predictor methodology that blends multiple parameters, including sea surface temperature and copepod assemblage abundance. [Salmon]
6. Participation in international regional fishery management organizations to ensure cooperation on both North American and high-seas multinational conservation measures to prevent overharvest. [Salmon]
7. Prohibition on the use of nets to fish for salmon within the EEZ to allow for live release of undersized salmon and to prevent bycatch of non-target species. [Salmon, HMS, groundfish]

3.5.2 Treaty Tribe and State Fisheries

3.5.2.1 Treaty Tribes' Fisheries Management

The Treaty Tribes of Oregon and Washington (Tribes) have both exclusive and shared authority to manage a wide variety of fisheries and natural resources affected by both current and future actions of the Council and by biophysical conditions within the CCE. The Tribes manage and harvest marine species covered by the Council's FMP's as well as other species governed by the Tribes' own exclusive authorities or by co-management agreements with the states of Oregon and Washington. The Tribes also retain property interests in species they do not currently manage or harvest but may choose to do so at a future time.

Tribal fisheries have ancient roots and their harvests are used for commercial, personal-use and cultural purposes. Authorities to plan, conduct and regulate fisheries, manage natural resources and enter into cooperative relationships with state and Federal entities are held independently by each of the Tribes based on their own codes of law, policies and regulations. The independent sovereign authorities of each Tribe were federally recognized initially in a series of treaties negotiated and signed during 1854-1855 (Treaty with the Tribes of Middle Oregon (1855), Treaty with the Walla Walla, Cayuse, and Umatilla Tribes (1855), Treaty with the Yakama (1855), Treaty with the Nez Perce (1855), Treaty of Medicine Creek (1854), Treaty of Neah Bay (1855), Treaty of Olympia (1855), Treaty of Point Elliot (1855) and Treaty of Point No Point (1855) and have been reaffirmed by judicial review (e.g., U.S. v. Oregon (SoHappy v. Smith) 302 Supp.899 (D. Oregon, 1969) and U.S. v. Washington 384 F. Supp. 312 (W. Dist. Wash., 1974) and administrative policies (e.g., Executive Order 13175 and Secretarial Order 3206).

Each Treaty Tribe exercises its management authorities within specific areas usually referred to as Usual and Accustomed (U&A) fishing locations. These areas have been adjudicated within the Federal Court System or confirmed by federal administrative procedures. The restriction of treaty-right fisheries to specific geographic boundaries creates place-based reliance on local resource abundance and limits the Tribes' latitude for response to variations in ecosystem processes, species distributions or fisheries management effects.

Each Tribe has established sets of laws and policies to achieve sustainable fisheries production through traditional and science-based management. Regulations to control conduct of each fishery (time, place, gear, etc.) are set through governmental procedures, and performance is monitored to ensure objectives are met. The Tribes participate as full partners with federal and state entities to ensure their criteria for resource conservation and sustainable fisheries are compatible. For example, the Tribes participate in the annual Pacific Salmon Commission process to preserve fishing opportunities on healthy salmon stocks and ensure conservation of depressed stocks of Chinook, chum and coho salmon. They also participate in the North of Falcon process with the State of Washington to achieve an annual set of co-management plans for salmon fisheries within both the EEZ and terminal areas for Council action.

The Tribes' combined regions of management interest and authority include areas outside the EEZ and the physical boundaries of the California Current. However, many of the species managed and harvested in these areas are affected by Council management and by conditions within the CCE. For example, Treaty salmon fisheries in the Columbia River watershed and interior (Strait of Juan de Fuca, Puget Sound and their watersheds) and coastal waters of Washington are significantly affected by salmon harvest quotas and schedules in the EEZ and by general marine conditions for growth and survival. All of the Tribes hold a vested interest in, and participate in, the Council's processes because salmon, other anadromous fishes (e.g., sturgeon spp., lamprey spp., smelt spp., trout and char spp.) and many migratory species of interest (e.g., marine mammals, herring, halibut) traverse and/or are affected by actions and activities within the EEZ and the California Current.

The four coastal Treaty Tribes (Coastal Tribes) of Washington (Makah Nation, Quileute Indian Tribe, Hoh Indian Tribe and Quinault Indian Nation) have broad interests in the CCE and more complex relationships with Council processes and decisions. The U&A's of the Coastal Tribes overlap with the EEZ and they have active ocean fisheries operating under the Council's current FMP's (Table 3.5.4). Harvests in the Coastal Tribes commercial fisheries (Figures 3.5.2 – 3.5.4) provide important employment and entrepreneurial opportunities for their remote communities and make significant contributions to the coastal economy of Washington.

Table 3.5.4: Coastal Treaty Tribes commercial fisheries

FISHERY	SPECIES	FMP	TRIBES
Longline	Blackcod, Pacific halibut	Groundfish	Makah, Quileute, Hoh, Quinault
Bottom Trawl	Groundfish	Groundfish	Makah
Mid-Water Trawl	Whiting, Yellowtail Rockfish	Groundfish	Makah, Quileute
Troll	Salmon	Salmon	Makah, Quileute, Hoh, Quinault
Purse Seine	Sardine	CPS	Quinault
Pot	Dungeness Crab		Makah, Quileute, Hoh, Quinault
Manual Intertidal	Razor Clam		Quinault

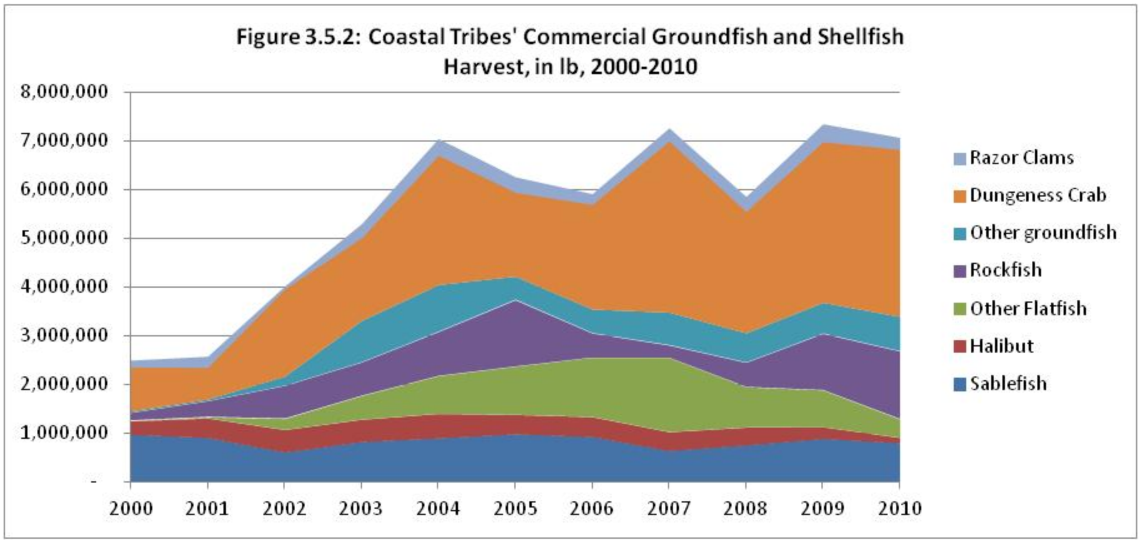


Figure 3.5.2: Coastal Tribes' Commercial Groundfish and Shellfish Harvest, in lb, 2000-2010

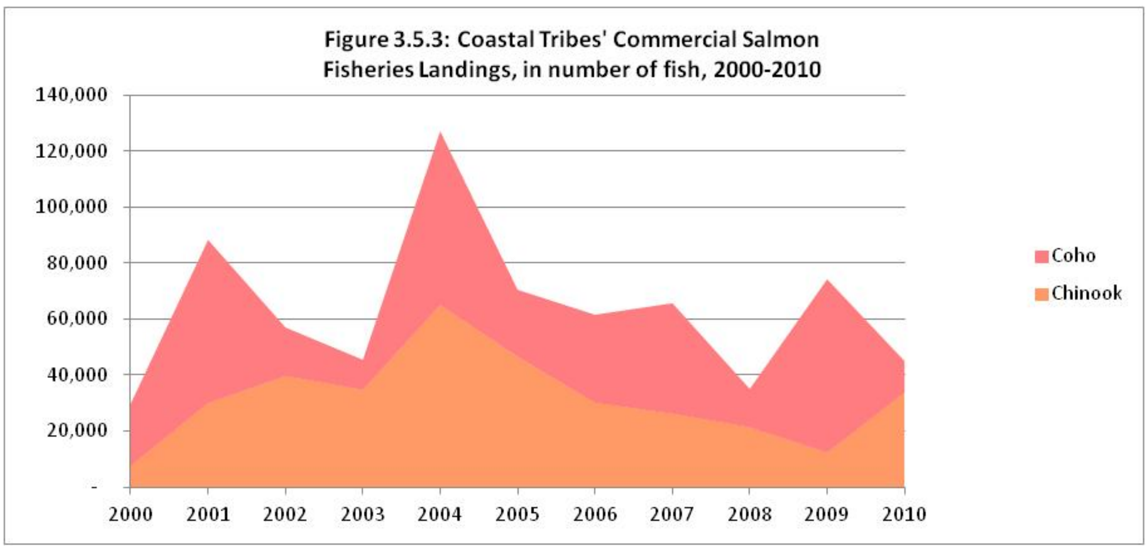


Figure 3.5.3: Coastal Tribes' Commercial Salmon Fisheries Landings, in number of fish, 2000-2010

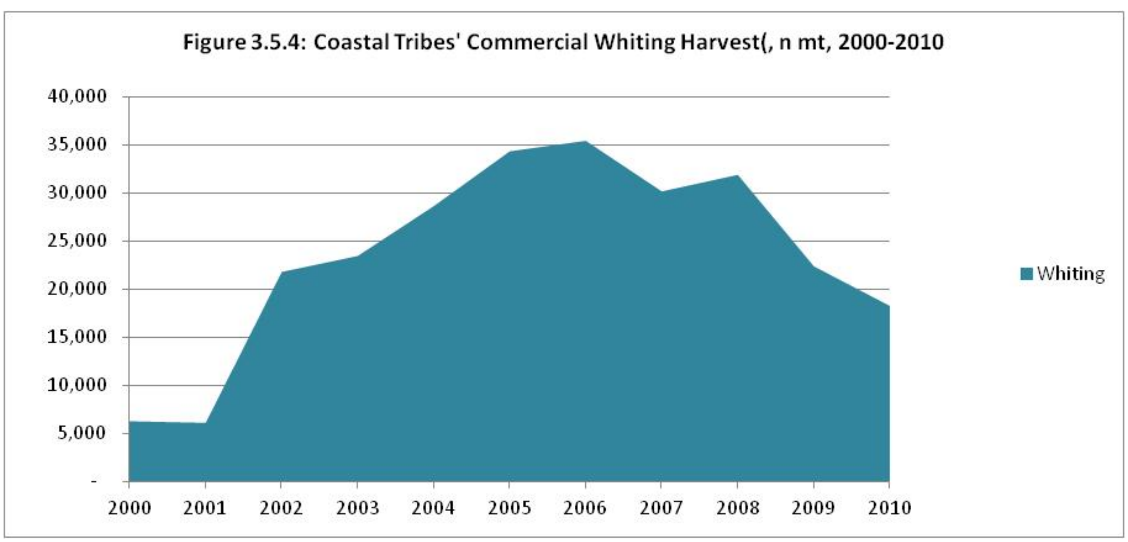


Figure 3.5.4: Coastal Tribes' Commercial Whiting Harvest(, n mt, 2000-2010

3.5.2.2 Washington Fisheries Management

Legislative Mandate and Management Areas

The Washington Department of Fish and Wildlife (WDFW) was created to “preserve, protect, perpetuate, and manage the wildlife and food fish, game fish, and shellfish in state waters and offshore waters” (Revised Code of Washington (RCW) 77.04.012). This legislative mandate also instructs WDFW to conserve fish and wildlife “in a manner that does not impair” the resources while also:

- seeking to “maintain the economic well-being and stability of the fishing industry in the state”;
- promoting “orderly fisheries”; and
- enhancing and improving the recreational and commercial fishing in the state.

WDFW recognizes this conservation mission also requires the protection, preservation, management, and restoration of natural environments and ecological communities as well as management of human uses for public benefit and sustainable social and economic needs (WDFW 2012[2]).

WDFW divides management of coastal fisheries from those in inner waters. Inner waters begin at Cape Flattery and include the U.S. portions of the Strait of Juan de Fuca and Strait of Georgia, the San Juan Islands, Hood Canal, and Puget Sound. Marine areas on the coast and in inner waters include estuaries with the transition to freshwater management areas occurring at the mouth of rivers and streams.

WDFW’s Council related activities focus mainly on the coastal region, although WDFW’s management activities for salmonids extend well into the inner marine and freshwater areas of the state. The Department’s legislative mandate covers “offshore waters” in addition to state waters, which the State Legislature defined as the “marine waters of the Pacific Ocean outside the territorial boundaries of the state, including the marine waters of other states and countries (RCW 77.08.010(33)). The state has direct authority to manage the offshore activities of state residents and vessels that are registered or licensed with the state. WDFW also pursues its mission in offshore waters through collaboration and coordination with federal, state, and tribal partners; formal engagement in intergovernmental forums, and interjurisdictional enforcement of state, federal, and international laws. WDFW’s collaborative efforts also include the co-management relationship the state has with tribal governments that hold rights to fish and to manage the fishing activities of their members.

WDFW’s management is, on the whole, highly integrated with Council managed fisheries. As in Oregon and California, the state is responsible for tracking commercial landings and recreational catch from vessels landing into state ports.

State Policy Process and Fisheries

WDFW consists of the Director, responsible for general operation and management of the agency, and the Washington Fish and Wildlife Commission (WFWC), which establishes policy and provides direction and oversight over the agency’s conservation and management activities. The WFWC consists of nine citizen members that are appointed by the Governor and subject to confirmation by the Washington State Senate.

[2] Washington Department of Fish and Wildlife. 2012.
—Mission and Goals: http://wdfw.wa.gov/about/mission_goals.html.
—Rules Information Center: http://wdfw.wa.gov/about/regulations.
—WFWC Policy Documents: http://wdfw.wa.gov/commission/policies.html.

The WFWC's policy role includes rulemaking over the time, place, and manner of fishing activities, although the authority to issue some rules has been delegated to the Director (RCW 77.12.047). Regulations are issued through the process established by the states' Administrative Procedure Act, Regulatory Fairness Act, and State Environmental Policy Act. The WFWC takes input and deliberates on proposed policies and regulations in formal meetings and informal hearings that are open to the public and held throughout the state. More information on the WFWC and the state's rulemaking process can be found on the WFWC's website (WDFW 2012).

The WFWC Policy C-3603 guides WDFW's involvement in the Council process. Preservation, protection, and perpetuation of the living marine resources through coordinated management of fisheries is WDFW's guiding principle. Among other things, this policy instructs WDFW's representatives to:

- Support harvest strategies that promote optimum long-term sustainable harvest levels.
- Seek the views of the public, including those who represent the consumptive and non-consumptive interest groups;
- Support initiatives and existing programs which more closely align the harvest capacity with the long-term sustained harvest quantities of marine resources, including individual quota programs and license and effort limitations programs;
- Support tribal fisheries which are consistent with the applicable federal court orders while recognizing the need for management flexibility to optimize fishing opportunity;
- Consider the social implications, impacts on fishing dependent communities, net economic benefits to the state , and other factors when taking positions on resource allocation issues;
- Take a precautionary approach in the management of species where the supporting biological information is incomplete and/or the total fishery-related mortalities are unknown; and,
- Support consideration of the use of risk-averse management tools to protect the resources in the face of management uncertainty.

To facilitate integration between state rules and Council management, the WFWC has delegated rulemaking authority to the Director over rules pertaining to the harvest of fish and wildlife in the Exclusive Economic Zone. WDFW incorporates many federal regulations issued through the Council process into state rules. Among other things, this allows for the enforcement of Council-recommended regulations in state courts.

Other WFWC policies that are of relevance to WDFW's engagement on the Council include:

- Policy C3012 – Forage Fish Management Policy, Goals and Plan
- Policy C3601 – Management Policy for Pacific Halibut
- Policy C3611 – Marine Fish Culture
- Policy C3613 – Marine Protected Areas
- Policy C3619 – Hatchery and Fishery Reform

The full set of policies can be viewed and tracked on the WFWC website (WDFW 2012).

The state has a few major commercial fisheries targeting species that are not included in Council's FMPs or for which Council management is limited. Dungeness crab is the highest value fishery followed by pink shrimp and spot prawn. The state also allows limited harvest of anchovy for holders of the baitfish fishery. The state has only one emerging commercial fishery program in place now targeted at hagfish. In conjunction with Council management, the state has closed state waters off the coast to commercial fishing for groundfish and Pacific sardines. The state does not have a commercial nearshore fishery and has also chosen to not allow the live fish fishery that has developed in Oregon and California. The major recreational fisheries on the coast are boat based and target primarily salmon, halibut, groundfish (a.k.a. bottomfish), sturgeon, and albacore tuna.

3.5.2.3 Oregon Fisheries Management[3]

The major policies affecting Council FMP species include: the Oregon Food Fish Management Policy, the Oregon Conservation Strategy, the Nearshore Strategy, and the Oregon Native Fish Conservation Policy. Oregon's statutory Food Fish Management Policy (ORS §506.109) is intended to provide for the optimum economic, commercial, recreational and aesthetic benefits for present and future generations of the citizens of the state. This policy includes the following broad goals:

- Maintain all species of food fish at optimum levels and prevent the extinction of any indigenous species.
- Develop and manage the lands and waters of this state to optimize the production, utilization and public enjoyment of food fish.
- Permit an optimum and equitable utilization of available food fish.
- Develop and maintain access to the lands and waters and the food fish resources thereon.
- Regulate food fish populations and the utilization and public enjoyment of food fish in a compatible manner with other uses of the lands and waters and provides optimum commercial and public recreational benefits.
- Preserve the economic contribution of the sports and commercial fishing industries, consistent with sound food fish management practices.
- Develop and implement a program for optimizing the return of Oregon food fish for Oregon's recreational and commercial fisheries.

Seven Oregon Fish and Wildlife Commission (OFWC) members are appointed by the Governor and formulate general state programs and policies concerning management and conservation of fish and wildlife resources. The Legislature has also granted the OFWC the authority to adopt regulations for seasons, methods and limits for recreational and commercial take and sale as well as other restrictions and procedures for taking, possessing or selling food fish, with the exception of oysters. Oyster production and commercial harvest is regulated by the Oregon Department of Agriculture.

In addition to federal license limitation programs for some FMP species, Oregon limits participation in ten state fisheries: sardine, salmon troll, Dungeness crab, pink shrimp (trawl,) black rockfish/blue rockfish/ nearshore fish, scallop, sea urchin, bay clams (diving,) roe-herring, and brine shrimp. Oregon fisheries are generally open, unless closed or otherwise restricted by regulation. Although fisheries currently fully utilize many food fish species in Oregon waters, some are underutilized. Under Oregon's Developmental Fisheries Program underutilized species are identified and categorized according to whether they are actively managed and whether they have the potential to support an economically viable fishery. Currently, there are no species that have been identified as not currently actively managed off Oregon under another state or federal management plan and that have the potential to be economically viable. Some underutilized species have been identified as underutilized yet have not shown the potential

---

[3] ODFW Fishery and Fish Resource Information: http://www.dfw.state.or.us/fish/
ODFW Nearshore Strategy: http://www.dfw.state.or.us/MRP/nearshore/strategy.asp
ODFW Conservation Strategy: http://www.dfw.state.or.us/conservationstrategy/
Oregon Fish and Wildlife Commission: http://www.dfw.state.or.us/agency/commission/
Oregon Revised Statutes (Chapters 496-501 & 506-513): http://www.leg.state.or.us/ors/
Oregon Fisheries Rules: http://www.dfw.state.or.us/OARs/index.asp#Fish
Oregon State Ocean Planning Information: http://www.oregonocean.info/

to be a viable fishery.   Fishing for these species is open and is regulated indirectly through fishery regulations for other species, gears, seasons and areas.

The Oregon Conservation Strategy is a blueprint, based on best available science, for conservation of the state's native fish and wildlife and their habitats. The Nearshore Strategy is a component of the Oregon Conservation Strategy for marine resources from shore to 55 meters. Its purpose is to promote actions that will conserve ecological functions and nearshore marine resources to provide long-term ecological, economic and social benefits. The Nearshore Strategy is also intended to contribute to the larger domain of marine resource management processes, such as the Council, by guiding management, research and monitoring, and education and outreach actions toward priority nearshore issues and areas that have not received adequate attention, rather than duplicate efforts by other management processes. The purpose of the Oregon Native Fish Conservation Policy is to ensure the conservation and recovery of native fish in Oregon. This policy identifies three goals: prevent the serious depletion of native fish, maintain and restore naturally produced fish, and foster and sustain opportunities for fisheries consistent with the conservation of naturally produced fish and responsible use of hatcheries.

ODFW has authority to manage and set harvest restrictions for marine protected areas, including marine gardens, habitat refuges and research reserves. Marine gardens are areas targeted for educational programs that allow visitors to enjoy and learn about intertidal resources. Habitat refuges are specially protected areas needed to maintain the health of the rocky shore ecosystem and are closed to the take of marine fish, shellfish and marine invertebrates.   Research reserves are used for scientific study or research including baseline studies, monitoring, or applied research. In addition, ODFW has authority to manage shellfish preserves, which are closed to clam harvesting.

For marine reserves, the state Legislature has authorized the establishment of five reserves to date. To implement these marine reserves, rule-making authorities of the Oregon Department of Fish and Wildlife, Oregon Department of State Lands (ODSL), and the Oregon Parks and Recreation Department (OPRD) must be coordinated. ODFW has authority to regulate fishing activities in the reserves. ODSL has authority for managing submerged lands and OPRD has authority for managing Oregon's ocean shore, which includes public beaches, state parks, and intertidal areas along the entire coast.

The federal Coastal Zone Management Act (CZMA) provides the Oregon Department of Land Conservation and Development (DLCD) with regulatory authority to review various federal actions in or affecting the state's coastal zone for consistency with the Coastal Management Program. DLCD reviews various National Marine Fisheries Service regulations, including those recommended by the Pacific Fishery Management Council, for consistency. Also under the Oregon Department of Land Conservation and Development's Coastal Management Program, the Oregon Territorial Sea Plan is designed to carry out Oregon's statewide planning goal for ocean resources: To conserve marine resources and ecological functions for the purpose of providing long-term ecological, economic, and social value and benefits to future generations. The Territorial Sea Plan provides an ocean management framework, identifies the process for making resource use decisions, provides a rocky shores management strategy, and identifies uses, including ocean energy, of the seafloor and the territorial sea.

3.5.2.4 California Fisheries Management[4]

[4] CDFG Nearshore Fishery Management Plan: http://www.dfg.ca.gov/marine/nfmp/
California Coastal Commission: http://www.coastal.ca.gov/whoweare.html
California Code of Regulations Title 14: http://ccr.oal.ca.gov/
California Fish and Game Code (Sections 2850-2863, 7050-7090, 8585-8589.7)

Within California's Natural Resources Agency there is the Fish and Game Commission (CFGC) and the Department of Fish and Game (CDFG) administered by the Director. While the Director can exercise some regulatory authority, the majority is accomplished by the CFGC. The CFGC is comprised of five commisisoners appointed by the governor and confirmed by the Senate, who have been granted increasing management authority for the state's marine resources by the Legislature. They regularly meet 11 times per year to address resource issues and adopt management measures, and they may schedule additional special meetings to gain infomation on specific issues or take emergency actions.
The Marine Life Management Act (MLMA) was enacted in 1999, and introduced a new paradigm in the management and conservation of California's marine living resources. The MLMA was developed in part based on many of the tenets of the MSA. The MLMA's overriding goal is to ensure the conservation, sustainable use, and restoration of California's living marine resources, including the conservation of healthy and diverse marine ecosystems. Through the MLMA, the Legislature delegated greater management authority to the CFGC and the CDFG. Key features of the MLMA include:
Application to entire ecosystems rather than only to exploited marine resources, with an over-arching priority of resource sustainability.

- Recognizing the state's resources for their use benefits, aesthetic and recreational enjoyment, and value for scientific research and education.
- Shifting the burden of proof towards initially demonstrating that fisheries and other activities are sustainable, rather than requiring demonstration of harm to initiate action.
- Requiring an ecosystem-based approach to management rather than focusing on single fisheries, and the development of fishery management plans (FMPs) as the framework for management—initially specifying development of FMPs for the nearshore fishery and white seabass.
- Requiring development of a master plan that prioritizes fisheries according to the need for comprehensive management through FMPs.
- Recognizing the importance of habitat by mandating its protection, maintenance, and restoration.
- Minimizing bycatch and rebuilding depleted stocks.
- Emphasizing science-based management developed in collaboration with all interested parties so that stakeholders are more involved in decision making and all aspects of management.
- Recognizing the long-term interests of people dependent on fishing; adverse impacts of management measures on fishing communities are to be minimized.
- Annual reporting on the status of the state's resources and their management.

With respect to regulating new or developing fisheries, the MLMA did not prohibit development of new fisheries. The MLMA recognized the need to be more precautionary in allowing existing fisheries to expand, or to encourage the initiation and growth of new fisheries that would be sustainable from the onset.

Developing FMPs was mandated by the MLMA—to date, fishery management and/or recovery plans are completed for the State's nearshore, white seabass, market squid and abalone fisheries. The state's fishery management plans are prepared by CDFG and adopted by the CFGC. A spiny lobster FMP is in progress and completion of an FMP for California halibut is a priority.

Concurrent with implementation of the MLMA, the Legislature enacted the Nearshore Fisheries Management Act (NFMA) to address the need to protect nearshore finfish species due to limited biological data, lack of stock status information and an expanding commercial live fishery. The NFA recognized the importance of recreational and commercial fisheries for nearshore finfish species and

---

California Fish and Game Commission: http://www.fgc.ca.gov/public/information/
California Ocean Protection Council, http://www.opc.ca.gov/
Marine Life Protection Act: http://www.dfg.ca.gov/mlpa/
Public Resources Code (Sections:30000-30900, 35500-35515): http://www.leginfo.ca.gov/calaw.html

provided management authority to the CFGC for those fisheries operating within state waters. The NFMA defined specific nearshore finfish species to be managed within one mile of the shoreline and established minimum size limits for nine species. All designated species, except for California sheephead, are also included in the federal Groundfish FMP. A state commercial limited entry nearshore fishery permit was established and annual fees associated with the permit are deposited into a dedicated fund established under the NFMA. Funds may be used for research or management purposes, such as developing fishery management plans or stock assessments, or for enforcement involving education and outreach. Imperative to nearshore management under the NFMA, and mandated under the MLMA, is the state's nearshore FMP, which provides a framework for managing 19 nearshore species (16 of which are also federally managed,) including fishery control rules more conservative than those in the federal Groundfish FMP and incorporating marine protected areas into fishery management.
The Marine Life Protection Act (MLPA) was enacted in 1998 and directs the state to reevaluate and redesign California's system of marine protected areas (MPAs) to: increase coherence and effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage, as well as to improve recreational, educational and research opportunities provided by marine ecosystems subject to minimal human disturbance. The MLPA also requires the best readily available science be used in the redesign process, as well as the advice and assistance of scientists, resource managers, experts, stakeholders and members of the public.
California has taken a regional approach to developing a network of integrated MPAs along its 1,100 mile coastline in accordance with the MLPA. The statewide coastal network includes 124 MPAs and 16 special closures covering approximately 848 sq mi of state waters and representing approximately 16% of all coastal state waters including those already adopted or proposed for the north coast (Point Arena north to the CA/OR border). Currently, almost 461 sq mi of state waters have been set aside as no-take marine reserves to observe their transition to an unfished state and evaluate ecosystem impacts on marine resources. These MPAs are expected to benefit California's marine resources including species under federal FMPs.
The California Coastal Act (or the Coastal Act) commenced California's coastal zone management rules as the means to regulate projects with possible impacts on use of land and water in the coastal zone. The Coastal Act permanently established the California Coastal Commission as the reviewing or governing body over the coastal zone. Along with the [San Francisco] Bay Conservation and Development Commission, the Coastal Commission is one of California's two designated coastal management agencies for the purpose of administering the federal Coastal Zone Management Act (CZMA) in California. The Coastal Commission mission is to: "…protect, conserve, restore, and enhance environmental and human-based resources of the California coast and ocean for environmentally sustainable and prudent use by current and future generations."
The California Ocean Protection Act (COPA) was implemented in 2003 to better integrate and coordinate regulations and agencies, both state and federal, responsible for protecting and conserving the state's ocean resources. One objective of the COPA is to "...encourage cooperative management with federal agencies, to protect and conserve representative coastal and ocean habitats and the ecological processes that support those habitats." The CPOA established the Ocean Protection Council (OPC), a cabinet level oversight body, which actively works to facilitate coordination among various agencies on activities promoting ocean health and helps prioritize ocean resource needs. In addition, a Trust Fund overseen by the OPC was developed to insure best use of the state's limited resources for ocean resource management.

Although the MLMA lays out policies for achieving sustainability, it does not provide a specific method for measuring sustainability of California's vast marine resources. In 2009, California's Legislature passed the Sustainable Seafood Act requiring the state's OPC to develop and implement a voluntary sustainable seafood program for California. The state program would be independent of the international Marine Stewardship Council's certification program. The directives of the state program include development of certification protocols for sustainable fisheries, a marketing and assistance program, a competitive grant and loan program for certification, an eco labeling component and an advisory committee. While the CDFG is not directly involved in the efforts to establish a California sustainable seafood certification program, it will provide biological data and expert consultation on the state's fisheries for sustainability determinations.

3.5.2.5 Idaho Fisheries Management

Although Idaho is landlocked, it contains much of the Columbia River basin's salmon and steelhead spawning and rearing habitat in the middle and upper Snake River system (Waples et al 1991). The Snake River provides EFH for ESA listed sockeye, spring, summer and fall Chinook salmon and summer steelhead (Ford et al 2011). Of these, only fall Chinook salmon are substantially affected by ocean fisheries. All are caught in fisheries in the lower Columbia and Snake Rivers.

The Idaho Department of Fish and Game manages sport fisheries for Chinook salmon and steelhead to minimize incidental take of wild fish and ensure adequate return of hatchery fish for brood stock needs (Hassemer, personal communication). The Nez Perce and Shoshone-Bannock tribes also pursue these anadromous fishes within Idaho. Historically, Idaho had an abundance of anadromous Coho salmon, Pacific lamprey and sturgeon. Snake River Coho were declared extinct in 1986. In the mid 1990s, the Nez Perce Tribe initiated a program to restore Coho to the Clearwater River. Lamprey have dwindled to near extirpation in Idaho with only 48 crossing Lower Granite Dam in 2011 (Columbia River DART). White sturgeon rarely use fish ladders but have maintained a landlocked population mostly in Hells Canyon of the Snake River.

Historically, the Snake River spring/summer Chinook run exceeded 1 million fish, but was reduced to near 100,000 fish by the mid 1950s (Mathews and Waples 1991). The Columbia's largest tributary, the Snake River and its tributaries lie mostly in Idaho and to a lesser extent in eastern Washington and Oregon. The Snake River fall Chinook run was about 72,000 in the 1940s and about 29,000 in the 1950s, but remained the most important natural production area for Columbia basin fall Chinook. Prior to the 1960s, the Snake River was considered the most important drainage in the Columbia River system for the production of anadromous fishes (Waples et al 1991). Dam construction on the upper Snake River substantially reduced the distribution and abundance of Snake River fall Chinook salmon (Irving and Bjornn 1981). Although considerable high quality spawning and rearing habitat remain in Idaho for spring and summer Chinook in the Salmon and Clearwater tributaries, their numbers have also declined in large part due to mortality during the outmigration through four mainstem reservoirs and dams on the lower Snake River.

Only limited Snake River fall Chinook spawning occurred downriver from Snake River km 439, the site of Oxbow Dam. The construction of Brownlee Dam (1959; RKm 459 [construction completed in 1959, location at approximately 459 km from river's mouth]), Oxbow Dam (1961; RKm 439), and Hells Canyon Dam (1967; RKm 397) eliminated the primary production areas of Snake River fall Chinook salmon. Chinook had been prevented from accessing 58% of prime spawning habitat as early as 1901 with the construction of Swan Falls Dam at RKm 734 (Parkhurst 1950). Habitat was further reduced with the construction of four additional dams on the lower Snake River: Ice Harbor Dam (1961; RKm 16), Lower Monumental Dam (1969; RKm 67), Little Goose Dam (1970; RKm 113), and Lower Granite Dam (1975; RKm 173). Apart from the possibility of deep-water spawning in lower areas of the river, the main-stem Snake River from the upper limit of the Lower Granite Dam reservoir to Hells Canyon Dam (approximately 165 km) and the lower reaches of the Imnaha, Grande Ronde, Clearwater, and Tucannon Rivers are the only remaining areas available to fall Chinook salmon in the Snake River Basin Waples et al 1991). In 2009, state, federal and tribal fisheries projects released 5.4 million fall Chinook smolts in the free flowing reach of the Snake River and tributaries between Lower Granite Reservoir and Hells Canyon

Dam[5]. In 2011, 25,541 adult Chinook salmon returned to this river reach (Columbia River DART), a smolt-to-adult return rate of 0.5%. Although most of these adults came from the smolt releases, Idaho Power's river flow management from Hells Canyon Dam since the early 1990s has benefited fall Chinook natural spawning and incubation in the Snake River. Additionally, cold-water releases from Dworshak Reservoir on the North Fork Clearwater River have improved migration conditions for juvenile fall Chinook. The main fisheries for Idaho-reared fall Chinook are in the ocean and lower Columbia River, with total exploitation rates of 40% to 50% (Ford et al 2010). Of the 25,541 adult fall Chinook crossing Lower Granite Dam in 2011, only 952 (4%) were caught and only 210 (<1%) were harvested in Idaho (IDFG unpublished data 2012). Only 28% of the adults caught were adipose fin-clipped and legal to harvest. The 2011 Joint Staff Report prepared by the Oregon and Washington Departments of Fish and Wildlife estimate that the 8,097 wild adult fall Chinook crossed Lower Granite Dam in 2011.This was the second largest run of naturally produced fall Chinook since their near collapse in 1975.

Habitat restoration, improved hatchery fish health, and improved juvenile fish passage technology at the lower Snake River dams have increased the return of spring and summer Chinook to an average of 56,000 from 1996 through 2004 (Columbia River DART), 40% (22,400) of which were wild fish (IDFG unpublished data). Although spring and summer Chinook are rarely harvested in the CCE, they are listed as threatened and managed under the ESA. When there is a harvestable surplus of hatchery spring and summer Chinook, and when there are sufficient natural spawners to allow for some incidental mortality, Idaho Department of Fish and Game opens state fisheries. After accounting for the number of spawners needed to fully seed hatcheries in the Snake River basin, the surplus production is allocated equally between sport and tribal fisheries. Sport allocation for spring/summer Chinook in Idaho was 17,300 in 2011 and is 29,490 in 2012 (IDFG unpublished data 2012). The lower value is closer to the average annual allocation for the recent decade.

Summer steelhead support the largest anadromous fishery in Idaho. Idaho's adult steelhead generally leave the ocean between June and October and are caught in state and tribal fisheries in the lower Columbia River. They are caught in fisheries in Idaho from mid-July through April. Spawning occurs in April and May. About 200,000 steelhead cross lower Granite Dam annually and about 76% are adipose fin clipped and available for harvest. In recent years, these fish are caught an average of 1.5 times, and about 50% of them are harvested (IDFG unpublished data).

3.5.3 Multi-State and State-Tribal Fisheries Authorities

In addition to the Council process, there are West Coast multi-state or state-tribal natural resource management processes that affect fisheries management within the CCE.

3.5.3.1 Tri-State Dungeness Crab Fishery Management

Under the MSA at Section 306, authority to manage the non-tribal ocean Dungeness crab fishery is delegated to the states of Washington, Oregon, and California. Each state may adopt and enforce State laws and regulations governing fishing and processing in the EEZ adjacent to that state in any Dungeness crab fishery for which there is no federal FMP in effect. By memorandum of agreement, the state fishery directors have agreed to take mutually supportive actions to further the management and maximize the sound economic and biological utilization of the crab resource when appropriately requested by the Director of one of the other three cooperating state agencies. Decisions about West Coast openings of the commercial season based on crab soft shell condition are made under this agreement. The Pacific

[5] Fish Passage Center: http://www.fpc.org/

States Marine Fisheries Commission is charged with convening the Tri-State Dungeness Crab Committee to discuss issues and with making reports to Congress.

3.5.3.2 North of Falcon Process

The "North of Falcon" process is an annual salmon management planning process involving representatives from salmon treaty tribes, the states of Washington and Oregon, and the federal government. Its name refers to the geographic area it addresses, salmon and fisheries management north of Cape Falcon, Oregon. The North of Falcon process is intended to support the Council's annual salmon management process by providing a series of advance public discussions of alternatives for the coming year's salmon seasons. Each November, the Council hears from its SSC and Salmon Technical Team on methodologies used to develop, support, and later assess the effects of, that year's salmon season management parameters. In the winter months, salmon scientists update the models intended for use in the subsequent year's fisheries. Beginning in February, managers working within the North of Falcon process start their review of new science and management information for salmon fisheries. The North of Falcon process allows managers to both prepare for Council action in March and April to set the year's salmon season parameters, and to prepare for shifts in state- or tribe-specific regulations intended to keep the applicable fisheries within their allocations.

3.5.3.3 West Coast Governors' Alliance on Ocean Health

The West Coast Governors' Agreement (later "Alliance" on Ocean Health (WCGA) was created in 2006 as a unique regional partnership among Washington, Oregon and California to protect and manage coastal and ocean resources and the economies they support along the entire West Coast. The WCGA's is intended to forward coastwide priorities on:

- Ensuring clean coastal waters and beaches;
- Protecting and restoring healthy ocean and coastal habitats;
- Promoting the effective implementation of ecosystem-based management of our ocean and coastal resources;
- Reducing adverse impacts of offshore development;
- Increasing ocean awareness and literacy among our citizens;
- Expanding ocean and coastal scientific information, research, and monitoring; and
- Fostering sustainable economic development throughout our diverse coastal communities.

Upon completing an action plan in 2008, ten Action Coordination teams, comprised of volunteers with expertise in priority areas, were created to develop and implement work plans to achieve high priority regional goals of addressing: climate change, integrated ecosystem assessments, marine debris, ocean awareness and literacy, polluted runoff, renewable ocean energy, seafloor mapping, sediment management, *spartina* eradication, and sustainable coastal communities. The recently adopted federal National Ocean Policy identifies the WCGA as the regional ocean governance partnership for the West Coast and one of nine such entities recognized throughout the United States.

3.5.4 Internationally Managed Fisheries

For FMP species, the United States is a party with Canada in three treaties addressing fisheries for transboundary stocks: Pacific salmon, Pacific whiting, and North Pacific albacore. The United States is also a party with Canada on the Pacific Halibut Convention. Pacific Halibut is not an FMP species, but is taken as bycatch in some FMP fisheries and the Council has Catch Sharing Plan for Pacific halibut taken off the U.S. West Coast. In addition, the U. S. is a party to several multi-lateral treaties addressing fisheries for HMS FMP species, and is a party to several agreements to conserve marine resources worldwide.

3.5.4.1 Pacific Halibut

The U.S./Canada Pacific Halibut convention established the *International Pacific Halibut Commission* (IPHC, originally called the International Fisheries Commission) in 1923 for the preservation of Pacific halibut in waters off Canada and the United States of America. Its mandate is research on and management of the stocks, including monitoring the fishery, conducting research, assessing stock condition and setting the allowable harvest for management areas. Halibut fisheries off Washington, Oregon and California are within IPHC's management area 2A. The states, halibut treaty tribes, and NMFS together develop an annual Catch Sharing Plan for Pacific halibut fisheries off the US West Coast, which the Council and IPHC review and adopt annually. worldwide.

3.5.4.2 Salmon

The U.S./Canada Pacific Salmon Treaty was signed in 1985 and sets long-term goals for the benefit of the salmon and the two countries. The *Pacific Salmon Commission* is the body formed by the governments of Canada and the United States to implement the Pacific Salmon Treaty. The Commission itself does not regulate the salmon fisheries, but provides regulatory advice and recommendations to the two countries. It is responsible for all salmon originating in the waters of one country that are subject to interception by the other, that affect management of the other country's salmon or that biologically affect the stocks of the other country. The Pacific Salmon Commission must also take into account the conservation of steelhead trout while fulfilling its other functions. The role of the Pacific Salmon Commission is to: conserve Pacific Salmon in order to achieve optimum production, to divide harvests so that each country reaps the benefits of its investment in salmon management.

High seas salmon management in the North Pacific Ocean, for waters beyond the EEZs of any countries, is conducted under the multi-lateral Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean. That Convention authorized the *North Pacific Anadromous Fish Commission* (NPAFC,) the parties to which are the U.S., Canada, Japan, South Korea, and Russia. The NPAFC replaced the 1952-1992 International North Pacific Fisheries Commission (INPFC,) the international high-seas salmon management commission that, among other things, first separated coastal waters around the North Pacific into scientific study areas. Off the U.S. West Coast, we still sometimes use and refer to INPFC science and management areas: Vancouver (north of 47°30' N. lat.), Columbia (between 47°30' and 43°00' N. lat.), Eureka (between 43°00' and 40°30' N. lat.), Monterey (between 40°30' and 36°00' N. lat.), and Conception (south of 36°00' N. lat.). The NPAFC's Convention recognizes that its participant nations invest in conservation and salmon freshwater habitat protection in accordance with their national priorities, so takes the stance that fisheries for anadromous stocks should be conducted within EEZs to ensure that the benefits of those investments accrue to the nations making the investments. To that end, the Convention prohibits directed fishing for anadromous fish within North Pacific high seas waters, and the NPAFC provides a forum for an international exchange of science, management, and enforcement information in support of its Convention.

3.5.4.3 Whiting

The U.S./Canada Pacific Whiting Treaty was signed in 2003 and establishes agreed percentage shares of the transboundary stock of Pacific whiting (also known as Pacific hake). It also creates a process through which U.S. and Canadian scientists and fisheries managers recommend the total catch of Pacific whiting each year. The agreement anticipates that stakeholders from both countries will have significant input into this process. The Agreement, implemented for the first time in 2012, created four bodies to assist in the assessment and sustainable management of the shared whiting resource:

- The Joint Management Committee (JMC) is charged with determining the total annual allowable whiting catch;
- An industry Advisory Panel (AP) is charged with reviewing the management of the fishery and making recommendations to the JMC regarding the overall total allowable catch;
- The Joint Technical Committee (JTC) is charged with annually providing the JMC with a stock assessment that includes scientific advice on the annual potential yield of the offshore whiting resource;
- The Scientific Review Group (SRG) is charged with providing an independent peer review of the work of the JTC.

Amendment 23 to the Groundfish FMP exempted the Pacific whiting stock from the FMP's annual catch limit requirements based on the harvest policies of the Agreement. However, the Agreement's harvest policy is based on the Groundfish FMP's original 40-10 harvest control rule, which involves a precautionary adjustment to the harvest rate when the stock drops below the 40 percent of its unfished stock size (i.e. B40%, the recommend abundance level for producing maximum sustainable yield from the stock). The main difference between this approach and the current harvest policies of the Groundfish FMP is that the Agreement does not require a scientific uncertainty buffer between the overfishing limit and the acceptable biological catch. Under the Agreement, the JMC may recommend a different harvest policy "if the scientific evidence demonstrates that a different rate is necessary to sustain the offshore hake/whiting resource."

3.5.4.3 HMS Species

Because of the wide-ranging movements of highly migratory stocks, all management unit species in the HMS FMP are covered under international agreements. Vessels from the U. S. and many other nations harvest HMS FMP species throughout the Pacific Ocean and effective management of the stocks throughout their ranges requires international cooperation. The MSA requires adoption of annual catch limits (ACLs) and accountability measures (AMs) and other provisions to prevent and end overfishing and rebuild fisheries. However, a stock or stock complex may not require an ACL and AMs if it qualifies for a so-called "international exception" for stocks managed under an international agreement to which the United States is a party. However, if the Secretary of Commerce determines that an HMS FMP Management Unit Stock is overfished or approaching overfished due to excessive international fishing pressure, and for which there are no management measures to end overfishing under an international agreement, the Secretary and/or the Council must take action under MSA Section 304(i). This section requires the Secretary, with the Secretary of State, to take action at the international level to end overfishing. Further, within one year, the Secretary and/or Council shall recommend domestic regulations to address the relative impact of U.S. vessels on the stock and recommend to Congress, international actions to end overfishing and rebuild, taking into account, the relative impact of vessels of other nations and vessels of the U.S.

The U.S. and Canada manage cross-border albacore fisheries interactions through a bilateral treaty. The U.S. is a member of the multi-lateral Inter-American Tropical Tuna Commission (IATTC), which is responsible for the conservation and management of fisheries for tunas and other species taken by tuna-fishing vessels in the eastern Pacific Ocean. The U.S. is also a member of the Western and Central Pacific Fisheries Commission (WCPFC), which plays a parallel role in the western and central Pacific (generally, west of 150° W. longitude).

The U.S.-Canada Albacore Treaty took effect in 1982 and has been renegotiated several times to address limitations on access to North Pacific albacore tuna by fishing vessels of one country operating in the jurisdiction of the other. The Treaty is a framework that allows fishing in the host country beyond 12 nautical miles during the fishing season. Until 2012, the two countries have agreed to a reciprocal fishing regime that specified conditions for vessels fishing of waters of the other country. Pursuant to the treaty, the United States and Canada annually exchange lists of fishing vessels that may fish for albacore tuna in each other's waters. The vessels agree to abide by the provisions of the Treaty, which include vessel marking, recordkeeping, and reporting. It also allows the fishing vessels of each country to enter designated fishing ports of the other country to conduct several types of business transactions including the landing of albacore without payment of duties; transshipment of catches to any port of the flag state; selling catches for export or locally; and obtaining fuel, supplies, repairs, and equipment on the same basis as albacore tuna vessels of the other country. The Treaty allows Canadian albacore vessels to land their catch in the U.S. ports of Bellingham and Westport, Washington; Astoria, Coos Bay, and Newport, Oregon; and Eureka, California.

The Inter-American Tropical Tuna Commission (IATTC) was established in 1949 for the conservation and management of fisheries for tunas, tuna-like species, and other species of fish taken incidentally by tuna fishing vessels in the eastern Pacific Ocean. Currently, there are 21 members of the IATTC: Belize, Canada, China, Colombia, Costa Rica, Ecuador, El Salvador, the European Union, France, Guatemala, Japan, Kiribati, Korea, Mexico, Nicaragua, Panama, Peru, Chinese Taipei, United States, Vanuatu, and Venezuela. The Cook Islands is a Cooperating Non-Member.

The IATTC is responsible for the conservation and management of fisheries for tunas and other species taken by tuna-fishing vessels in the eastern Pacific Ocean. The Tuna Conventions Act of 1950 provides the United States with the federal authority to implement the measures adopted by the IATTC. In 2003, the IATTC adopted a resolution that approved the Antigua Convention, a major revision of the original convention establishing the IATTC. It brings the convention current with respect to internationally accepted laws on the conservation and management of oceanic resources, including a mandate to take a more ecosystem-based approach to management. The Antigua Convention entered into force in 2010.

The Western and Central Pacific Fisheries Commission was created in 2004 under the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the western and entral Pacific Ocean. The objective of the Convention is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks. The United States signed the Convention in 2000 and ratified it in 2007, thereby becoming a member of the WCPFC. The U.S. domestic procedures for ratification of the Convention were completed in June 2007.

There are 25 Members of the Commission: Australia, China, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Korea, Republic of Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States, and Vanuatu. American Samoa, Guam, French Polynesia, New Caledonia, Tokelau, Wallis, Futuna, and the Commonwealth of the Northern Mariana Islands are Participating Territories, and Belize, Indonesia, Panama, Senegal, Mexico, El Salvador, Ecuador, Thailand, and Vietnam are Cooperating Non-members.

The International Scientific Committee (ISC), under the auspices of the WCPFC, enhances scientific research and cooperation for conservation and rational utilization of the species of tuna and tuna-like fishes which inhabit the North Pacific Ocean during a part or all of their life cycle. The ISC conducts HMS stock assessments that, within the U.S., are used to develop harvest management measures within the Pacific and Western Pacific Fishery Management Councils. The ISC also develops proposals for conduct of and coordinates international and national programs of research addressing such species.

Other International Fisheries Agreements and Action Plans: The HMS FMP provides a framework for the United States to meet its obligations under other international agreements to which the U.S. is a party. United Nations Implementing Agreement on the Conservation and Management of Straddling Fish Stocks and High Migratory Fish Stocks interprets the duties of nations to cooperate in conserving and managing fisheries resources, and dictates that coastal states (i.e., nations) may not adopt measures that undermine the effectiveness of regional measures to achieve conservation of the stocks. The U.S. is also a member of the Food and Agriculture Organization of the United Nations (FAO,) which has implications for HMS management. In 1995, the FAO's Committee on Fisheries developed a Code of Conduct for Responsible Fisheries, which more than 170 member countries, including the U.S., have adopted. Pursuant to this Code of Conduct, the U.S. has adopted the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas and four International Plans of Action:

- International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries
- International Plan of Action for the Conservation and Management of Sharks
- International Plan of Action for the Management of Fishing Capacity
- International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing

3.5.4.4 Other International Forums

The *Tri-National Sardine Forum* began in 2000 and provides an annual opportunity for international coordination and collaboration among industry, scientists, and managers from Mexico, the U.S. and Canada for the sardine stock. The forum promotes coordinated coastwide data collection for sardine stock assessments, and promotes science and fishery management information-sharing.

In 1902, northern Atlantic Ocean nations established the International Council for the Exploration of the Sea (ICES,) an international partnership for the cooperative exploration of ocean and fisheries science. In 1992, northern Pacific Ocean nations, including those that had long been ICES members, established the *North Pacific Marine Science Organization*, known as PICES for "Pacific ICES." PICES meets annually to promote and coordinate multi-national marine science within the North Pacific Ocean north of 30°00' N. lat. Its member nations are the U.S., Canada, Japan, China, South Korea, and Russia.

The *North American Migratory Bird Treaty Act* of 1918 decreed that all migratory birds and their parts (including eggs, nests, and feathers) were fully protected. The Migratory Bird Treaty Act is the domestic law that affirms, or implements, the United States' commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of a shared migratory bird resource. Each of the conventions protect selected species of birds that are common to both countries (i.e., they occur in both countries at some point during their annual life cycle).

The *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES, 27 U.S.T. 108) establishes a system of import/export regulations to prevent the over-exploitation of plants and animals listed in three appendices to the Convention. Different levels of trade regulations are provided depending on the status of the listed species and the contribution trade makes to decline of the species. Procedures are provided for periodic amendments to the appendices. CITES went into force worldwide in 1975. Within the U.S., the ESA is the implementing for CITES. Executive Order 11911, signed April 13, 1976, designated Management and Scientific Authorities to grant or deny requests for import or export permits.

Western Hemisphere Convention (Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere; 56 Stat. 1354; TS 981.) Under this 1940 treaty, the governments of the U.S. and 17 other American republics expressed their wish to "protect and preserve in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds" and to protect regions and natural objects of scientific value. The nations agreed to take actions to achieve these objectives, including the adoption of "appropriate measures for the protection of migratory birds of economic or esthetic value or to prevent the threatened extinction of any given species." Within the U.S., the ESA is the implementing for the Western Hemisphere Convention (16 U.S.C. 1531-1543; 87 Stat. 884).

3.6 Sources for Chapter 3

Ainley, D.G. and T.J. Lewis. 1974. The history of Farallon Island marine bird populations, 1954-1972. Condor 76: 432-446.

Allen, L.G., D. J. Pondella, M.H. Horn, (eds) 2006. The Ecology of Marine Fishes, University of California Press, Berkeley.

Allen, P. J., M. Nicholl, S. Cole, A. Vlazny, and J.J. Cech, Jr. 2006. Growth of Larval to Juvenile Green Sturgeon in Elevated Temperature Regimes. Transactions of the American Fisheries Society 135:89-96.

Alsharif, K.A. and N. Miller. 2012. Data Envelopment Analysis to Evaluate the Reliance and Engagement of Florida Communities on Gulf of Mexico Commercial Red Snapper Fisheries. Fisheries 37: 19-26.

Anderson, D.W., F. Gress, K.F. Mais, and R.R. Kelly. 1980. Brown pelicans as anchovy stock indicators and their relationships to commercial fishing. California Cooperative Oceanic Fisheries Investigations Reports 21:54-61.

Auster, P. J. 2005. Are deep water corals important habitat for fishes? Cold-water corals and ecosystems (A. Freiwald and J.M. Roberts (eds.), 1244 p. Springer, New York, NY.

Bakun, A. 1996. Patterns in the Ocean: Ocean Processes and Marine Population Dynamics. California Sea Grant.

Baskett, M.L., M. Yoklavich and M.S. Love. 2006. Predation, competition, and the recovery of overexploited fish stocks in marine reserves. Canadian Journal of Fisheries and Aquatic Sciences 63: 1214-1229.

Beamish, R.J., Mahnken, C. 2001. A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. Prog. Oceano. 49: 423-437.

Bedford, D. 2001. In California's Living Marine Resources: A Status Report, Leet, W.S., C.M. Dewees, R. Klingbeil and E.J. Larson (eds). California Department of Fish and Game, Sea Grant Publication SG01-11 University of California, pgs 277-281.

Benson, S. R., T. Eguchi, D. G. Foley, et al. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, Dermochelys coriacea. Ecosphere 2(7):art84. doi:10.1890/ES11-00053.1

Berman-Kowalewski, M., Gulland, F.M.D., et al. 2010. Association between blue whale (Balaenoptera musculus) mortality and ship strikes along the California Coast. Aquatic Mammals 36: 59–66.

Block, B., I.D. Jonsen, S. Jorgensen et al. 2011. Tagging of Pacific pelagics: tracking apex marine predator movements in a dynamic ocean. Nature 475: 86-90.

Bjorkstedt E, Goericke R, McClatchie S, Weber E, Wat- son W, Lo N, Peterson B, Emmett B, Peterson J, Du- razo R, Gaxiola-Castro G, Chavez F, Pennington JT, Collins CA, Field J, Ralston S, Sakuma K, Bograd S, Schwing F, Xue Y, Sydeman W, Thompson SA, San- tora JA, Largier J, Halle C, Morgan S, Kim SY, Merkens K, Hildebrand J, Munger L. 2010. State of the California Current

2009–2010: regional variation persists through transition from La Niña to El Niño (and back?). California Cooperative Oceanic Fisher- ies Investigations Report 51:39–69.

Bjorkstedt, E.P., R. Goericke, S. McClatchie et al. 2011. State of the California Current 2010–2011: Regional variable responses to a strong (but fleeting?) La Niña. California Cooperative Oceanic Fisheries Investigations Report 52: 36-69.

Blaxter JHS (1992) The effect of temperature on larval fishes. Neth J Zool 42:336–357.

Block, B., I.D. Jonsen, S. Jorgensen et al. 2011. Tagging of Pacific pelagics: tracking apex marine predator movements in a dynamic ocean. Nature 475: 86-90.

Bograd, S. J., C. G. Castro, E. Di Lorenzo, D. M. Palacios, H. Bailey, W. Gilly, and F. P. Chavez (2008), Oxygen declines and the shoaling of the hypoxic boundary in the California Current, Geophys. Res. Lett., 35, L12607, doi:10.1029/2008GL034185.

Botsford, L., and Lawrence, C.A. 2002. Patterns of covariability among California Chinook salmon, Coho salmon, Dungeness crab, and physical oceanographic conditions. Prog. Ocean. 53: 283-305.

Brinton, E. and Townsend, A. 2003. Decadal variability in abundances of the dominant euphausiid species in southern sectors of the California Current. Deep-Sea Research II 50: 2449-2472.

Brodeur, R.D. 1990. A synthesis of the food habits and feeding ecology of salmonids in marine wa- ters of the North Pacific. FRI-UW-9016, Fisher- ies Research Institute, University of Washington, Seattle, Wash.

Brodeur, R.D., W.T. Peterson, T.D. Auth, H.L. Soulen, M.M. Parnel, and A.A. Emerson. 2008. Abundance and diversity of coastal fish larvae as indicators of recent changes in ocean and climate conditions in the Oregon upwelling zone. Mar. Ecol. Prog. Ser. 366:187-202.

Brodeur, R.D. J. J. Ruzicka and J. H. Steele. Investigating Alternate Trophic Pathways through Gelatinous Zooplankton and Planktivorous Fishes in an Upwelling Ecosystem Using End-to-End Models Interdisciplinary Studies on Environmental Chemistry—Marine Environmental Modeling & Analysis, Eds., K. Omori, X. Guo, N. Yoshie, N. Fujii, I. C. Handoh, A. Isobe and S. Tanabe, pp. 57–63. © by TERRAPUB, 2011.

Bundy, A., J.J. Heymans, L. Morissette, and C. Savenkoff. 2009. Seals, cod and forage fish: A comparative exploration of variations in the theme of stock collapse and ecosystem change in four Northwest Atlantic ecosystems. Progress in Oceanography 81: 188-206

Carlson, S.M., and Satterthwaite, W.H. 2011. Weakened portfolio effect in a collapsed salmon population complex. Can. J. Fish. Aquat. Sci. 68: 1579-1589.

Carretta, J.V., K. A. Forney, E. Oleson et al. 2010. U.S. Pacific Marine Mammal Stock Assessments: 2010. NOAA-TM-NMFS-SWFSC-476. Available online at http://www.nmfs.noaa.gov/pr/pdfs/sars/po2010.pdf.

Cayan, D.R. and D.H. Peterson. 1989. The influence of North Pacific atmospheric circulation on streamflow in the west. Geophysical Monograph 55: 375-397.

Chan, F., J. Barth, J. Lubchenko, A. Kirincich, H. Weeks, W. Peterson, and B. Menge (2008), Emergence of anoxia in the California Current large marine ecosystem, Science, 319, 920.

Chavez, F.P., J. Ryan, S.E. Lluch-Cota and M.Niquen. 2003. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. Science 299: 217-221.

Checkley, D.M. and J.A. Barth. 2009. Patterns and processes in the California Current System. Progress in Oceanography 83: 49–64.

Checkley, D.B., J. Alheit, Y. Oozeki and C. Roy. 2009. Climate change and small pelagic fish. Cambridge University Press: Cambridge.

Checkley, D., J. Alheit, Y. Oozeki and C. Roy. 2009. Climate Change anCheckley, D., J. Alheit, Y. Oozeki and C. Roy. 2009. Climate Change and Small Pelagic Fish. Cambridge University Press: Cambridge.

Clapham, P.J., S. Leatherwood, I. Szczepaniak, and R.L. Brownell, Jr. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidatd, California, 1919-1926. Marine Mammal Science 13:3: 368-394.

Clark, F.N. and J.C. Marr. 1955. Population dynamics of the Pacific sardine. Progress report of the California Cooperative Oceanic Fisheries Investigations 1 July 1953 to 31 March 1955.

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.

Cobb, J.N. 1930. Pacific Salmon Fisheries. Appendix XIII to the Report of the Commissioner of Fisheries for 1930. Bureau of Fisheries Document No. 1092.

Cox, S.P., T.E. Essington, J.F. Kitchell, et. al. 2002. Reconstructing ecosystem dynamics in the central Pacific Ocean, 1952-1998. II. A preliminary assessment of the trophic impacts of fishing and effects on tuna dynamics. Canadian Journal of Fisheries and Aquatic Sciences 59: 1736-1747.

Columbia River DART (Data in Real Time) Columbia Basin Research, School of Aquatic & Fishery Sciences, University of Washington. Accessed 05/11/12: http://www.cbr.washington.edu/dart/

Crawford, R. J. M. 1987. Food and population variability in five regions supporting large stocks of anchovy, sardines, and horse mackerel. S. Afr. J. Mar. Sci. 5:735–757.

Crowder, L. and E. Norse. 2008. Essential ecological insights for marine ecosystem-based management and marine spatial planning. Marine Policy 32: 772-778.

Cury, P., A. Bakun, R. J. M. Crawford, A. Jarre, R. A. Quiñones, L. J. Shannon, and H. M. Verheye. 2000. Small pelagics in upwelling systems: patterns of interaction and structural changes in “wasp-waist” ecosystems. ICES J. Mar. Sci. 57:603–618.

Cury, P.M., I.L. Boyd, S. Sylvain Bonhommeau, et al. 2011. Global seabird response to forage fish depletion—one-third for the birds. Science 334 : 1703-1706.

Dahms HU (1995) Dormancy in the Copepoda — an overview. Hydrobiologia 306:199–211

Daly, E.A., Brodeur, R.D., and Weitkamp, L.A. 2009. Ontogenetic shifts in diets of juvenile and subadult coho and Chinook salmon in coastal marine waters: Important for marine survival? T. Am. Fish. Soc. 138: 1420-1438.

Dayton, P.K., Tegner, M.J., Edwards, P.B., and Riser, K.L. 1999. Temporal and spatial scale of kelp demography: The role of oceanographic climate. Ecological Monographs, 69:219-250.

Di Lorenzo E., Schneider N., Cobb K. M., Chhak, K, Franks P. J. S., Miller A. J., McWilliams J. C., Bograd S. J., Arango H., Curchister E., Powell T. M. and P. Rivere, 2008: North Pacific Gyre Oscillation links ocean climate and ecosystem change. Geophys. Res. Lett., 35, L08607, doi:10.1029/2007GL032838.

Dorner, B., Peterman, R.M., Haeseke, S.L. 2008. Historical trends in productivity of 120 Pacific pink, chum, and sockeye salmon stocks reconstructed by using a Kalman filter . Can. J. Fish. Aquat. Sci. 65(9): 1842-1866.

Dufault, A.M., K. Marshall, and I.C. Kaplan. 2009. A synthesis of diets and trophic overlap of marine species in the California Current. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-103, 81 p.

Emmett, R. L., R. D. Brodeur, T. W. Miller, S. S. Pool, P. J. Bentley, G. K. Krutzikowsky, and J. McCrae. 2005. Pacific sardine (Sardinops sagax) abun- dance, distribution, and ecological relationships in the Pacific Northwest. Calif. Coop. Oceanic Fish. Invest. 46:122–143.

Estes, J.A., D. P. DeMaster D.F. Doak, T.M. Williams R.L. Brownell (Editors). 2006. Whales, Whaling, and Ocean Ecosystems. University of California Press, Berkeley, CA.

Etnoyer, P. and L. Morgan. 2005. Habitat-forming deep-sea corals in the Northeast Pacific Ocean. Cold-water corals and ecosystems (A. Freiwald and J.M. Roberts (eds.), 1244 p. Springer, New York, NY.

Fabry, V.J., Seibel, B.A., Feely, R.A., and Orr, J.C. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES JMS, 65:414-432.

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

Field, J.C., Baltz, K., Phillips, A.J., Walker, W.A. 2007. Range expansion and trophic interactions of the jumbo squid, Dosidicus gigas, in the California Current. CalCOFI Rep. 48: 131-146.

Finney, B.P., Gregory-Eaves, I., Sweetman, J., Douglas, M.S.V., Smol, J.P. 2000. Impacts of Climatic Change and Fishing on Pacific Salmon Abundance Over the Past 300 Years. Sci. 290: 795-799.

Ford, M. (ed.), T. Cooney, P. McElhany, N. Sands, L. Weitkamp, J. Hard, M. McClure, R. Kope, J. Myers, A. Albaugh, K. Barnas, D. Teel, P. Moran and J. Cowen. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281 p.

Fréon, P., P. Cury, L. Shannon and C. Roy. 2005. Sustainable exploitation of small pelagic stocks challenged by environmental and ecosystem changes. Bull. Mar. Sci. 76: 385-462.

Fréon, P., J. Arístegui, A. Bertrand, R.J. Crawford, J.C. Field, M.J. Gibbons, L. Hutchings, H. Masski, C. Mullon, M. Ramdani, B. Seret, M. Simier and J. Tam. 2009. Functional group biodiversity in Eastern Boundary Upwelling Ecosystems questions the wasp-waist trophic structure. Progress in Oceanography 83: 97-106.

Ganssle, D. 1966. Fishes and Decapods of San Pablo and Suisun Bays. In: D.W. Kelley (ed.) Ecological Studies of the Sacramento San Joaquin Estuary: Part I; Zooplankton, Zoobenthos, and Fishes of San Pablo and Suisun Bays, Zooplankton and Zoobenthos of the Delta. California Department of Fish and Game. Fish Bulletin 133.

Gordon, B.L. 1987. Monterey Bay Area: Natural History and Cultural Imprints. Boxwood Press: Pacific Grove.

Greene, H.G., M.M. Yoklavich, R.M. Starr, V.M. O'Connell, W.W. Wakefield, D.E. Sullivan, J.E. McRea, and G.M. Cailliet. 1999. A classification scheme for deep seafloor habitats. Oceanologica ACTA. Vol. 22: 6, pp. 663-678.

Herke, W. H. and B. D. Rogers. 1993. Maintenance of the estuarine environment. Pages 263-286 in C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Hickey, B.M. 1998. Coastal oceanography of Western North America from the tip of Baja California to Vancouver Island. In A.R. Robinson and K.H. Brink (editors) The Sea, Volume 11. John Wiley and Sons: New York.

Holt, C.A., Mantua, N. 2009. Defining the spring transition: regional indices for the California Current System. Mar.Eco.Prog.Sers. 393:285-299.

Houde ED. 1989. Comparative growth, mortality, and energetics of marine fish larvae: temperature and implied latitudinal effects. Fishery Bulletin U.S. 87:471-495.

Howell, E., D. Kobayashi, D. Parker and G. Balazs. 2008. TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles Caretta caretta in the Hawaii-based pelagic longline fishery. Endangered Species Research 5:267-278.

Hoss, D. E. and G. W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium 14:147-158.

Hunt, G.L. Jr., H. Kato and S.M. McKinnell. 2000. Predation by marine birds and mammals in the subarctic North Pacific Ocean. PICES Scientific Report No. 14.

Irving, J. S., and T. C. Bjornn. 1981. Status of Snake River fall Chinook salmon in relation to the Endangered Species Act. Prepared for the U.S. Fish and Wildlife Service. Unpubl. manuscr., 55 p. Available: Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow, ID 83843.

Jagielo, T.H., A. Hoffman, J. Tagart and M. Zimmermann. 2003. Demersal groundfish densities in trawlable and untrawlable habitats off Washington: implications for the estimation of habitat bias in trawl surveys. Fishery Bulletin 101: 545-565.

Jahncke, J., D.M. Checkley Jr. and G.L. Hunt, Jr. 2004. Trends in carbon flux to seabirds in the Peruvian upwelling system: effects of wind and fisheries on population regulation. Fisheries Oceanography 13:208-223

Kaeriyama, M., Nakamura, M., Edpalina, R., Bower, J.R., Yamaguchi, H., Walker, R.V., Myers, K. W. 2004. Change in feeding ecology and trophic dynamics of Pacific salmon (Oncorhynchus spp.) in the central Gulf of Alaska in relation to climate events. Fish. Oceano. 13(3): 197–207.

Kaplan, B., C.J. Beegle-Krause, D. French McCay, A. Copping, S. Geerlofs, eds. 2010. Updated Summary of Knowledge: Selected Areas of the Pacific Coast. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2010-014.

Kendall, A.W. Jr. and J.R. Clark. 1982. Ichthyoplankton off Washington, Oregon, and Northern California April-May 1980. NWAFC Proc. Rep. 82-11, 44 p.

Kitchell, J. F., C. Boggs, X. He, and C. J. Walters. 1999. Keystone predators in the Central Pacific. In Ecosystem approaches to fisheries management, p. 665 – 683. Univ. Alaska Sea Grant Rep. AL - SG-99-01, Anchorage, Alaska.

Kleypas, J.A., Buddemeier, R.W., Archer, D., Gattuso, J.-P., Langdon, C., and Opdyke, B.N. 1999. Geochemical consequences of increased atmospheric cardon dioxide on coral reefs. Science, 284:118-120.

Lafferty, K.D.; Allesina, S.; Arim, M.; Briggs, C.J.; De Leo, G.; Dobson, A.P.; Dunne, J.A.; Johnson, P.T.J.; Kuris, A.M.; Marcogliese, D.J. 2008. Parasites in food webs: the ultimate missing links Ecology letters 11:533-546

Lafferty, K.D. Fishing for lobsters indirectly increases epidemics in sea urchins. Ecological Applications 14: 1566-1573

Levin, P.S., E.E. Holmes, K.R. Piner and C.J. Harvey. 2006. Shifts in a Pacific Ocean fish assemblage: the potential influence of exploitation. Conservation Biology 20: 1181-1190.

Li QP, Franks PJS, Landry MR (2011) Microzooplankton grazing dynamics: -parameterizing grazing models with dilution experiment data from the California Current Ecosystem. Mar Ecol Prog Ser 438:59-69

Lindley, S.T., Grimes, C.B., Mohr, et. al. 2009. What caused the Sacramento River fall Chinook stock collapse? NOAA Tech. Memo. NMFS NOAA-TM-NMFS-SWFSC-447.

Loggerwell, E. A., N. J. Mantua, P. W. Lawson, R. C. Francis, and V. N. Agostini. 2003. Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (Oncorhynchus kisutch) marine survival. Fish. Oceanogr. 126:554-568.

Lundsten, L., Schlining, K. L., Frasier, K., Johnson, S. B., Kuhnz, L. A., Harvey, J. B. J., Clague, G., and Vrijenhoek, R. C. 2010. Time-series analysis of six whale-fall communities in monterey canyon, california, USA. Deep Sea Research Part I: Oceanographic Research Papers 57:1573-1584.

Lyman, R.L. 1988. Zoogeography of Oregon coast marine mammals: the last 3,000 years. Marine Mammal Science 4:3: 247-264.

Magnuson, W.G. 1968. The opportunity is waiting… make the most of it. In D.W. Gilbert (editor) The Future of the Fishing Industry of the United States. University of Washington Publications in Fisheries 4: 7-9.

Mann, K.H. and J.R.N. Lazier. 1996. Dynamics of Marine Ecosystems. Blackwell: Cambridge.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bull. Am. Met. Soc. 78:6:1069-1079.

Mantua, N.J. and S.R. Hare. 2002. The Pacific Decadal Oscillation. Journal of Oceanography 58:1: 35-44.

MacCall, A.D. 1996. Patterns of low-frequency variability in fish populations of the California Current. CalCOFI Reports 37: 100-110.

MacCall, A.D. 2009. A short scientific history of the fisheries. In Checkley, D., J. Alheit, Y. Oozeki and C. Roy (editors) Climate Change and Small Pelagic Fish. Cambridge University Press.

Marliave, J.B., K.W. Conway, D.M. Gibbs, A. Lamb, and C. Gibbs. 2009. Biodiversity and rockfish recruitment in sponge gardens and bioherms of southern British Columbia, Canada. Mar. Biol. 156: 2247-2254.

Mathews, G. and R. Waples 1991. Status Review for Snake River Spring and Summer Chinook Salmon. U.S. Dept. of Commer. NOAA Tech. Memo., NMFS-F/NWC-200.

McClatchie, S., R. Goericke, G. Auad and K. Hill. 2010. Re-assessment of the stock-recruit and temperature-recruit relationships for Pacific sardine (Sardinops sagax). Ca. J. Fish. Aquat. Sci. 67: 1782-1790.

McDonald, P.S., Jensen, G.C., Armstrong, D.A. 2001. The competitive and predatory impacts of the nonindigenous crab Carcinusmaenas (L.) on early benthic phase Dungeness crab Cancermagister Dana. Journal of Experimental Marine Biology and Ecology. 258(1): 39–54.

McEvoy, A.F. 1986. The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980. Cambridge University Press.

McEvoy, A.F. 1996. Historical interdependence between ecology, production, and management in California fisheries. In D. Bottom, G. Reeves and M. Brookes (editors) Sustainability Issues for Resource Managers. USDA Forest Service Tech Rep. PNW-GTR-370. pp 45-53.

Miller, T.W.; Brodeur, R.D. 2007. Diet of and trophic relationships among dominant marine nekton within the Northern California Current ecosystem. Fishery Bulletin. 105: 548-559

Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson, S. R. Charter, and E. M. Sandknop. 2001.Distributional atlas of fish larvae and eggs in the Southern California Bight region: 1951-1998. CalCOFIAtlas 34. 166pp.

Murphy, G.I. 1966. Population biology of the Pacific sardine (Sardinops caerulea). Proceedings of the California Academy of Sciences 34: 1-84.

National Marine Fisheries Service. 2005. Endangered and Threatened Wildlife and Plants: Proposed Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. April 6, 2005. Federal Register 70(65):17386-17401.

National Research Council (NRC). 1996. The Bering Sea Ecosystem. National Academy Press: Washington DC.

Nickelson, T. E. and P. W. Lawson. 1998. Population viability of coho salmon (O. kisutch) in Oregon coastal basins: application of a habitat-based life history model. Canadian Journal of Fisheries and Aquatic Sciences 55:2383-2392.

Norman, K., J. Sepez, H. Lazrus, N. Milne, C. Package, S. Russell, K. Grant, R.P. 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.

North, W.J. and Hubbs, C.L. 1968. Utilization of kelp-bed resources in southern California. California Department of Fish and Game, Fish Bulletin, pp. 264.

Ogden, A. 1933. Russian sea-otter and seal hunting on the California coast: 1803-1841. Quarterly of the California Historical Society 12: 217-251.

Oregon Department of Fish and Wildlife. 2005. Wildfish: Chapter 6. Http://www.dfr.state.or.us/ODFWhtml/Research&Reports/WildFish/Chapter6.html.

Orsi, J. A., J. A. Harding, S. S. Pool, R. D. Brodeur, L. J. Haldorson, J. M. Murphy, J. H. Moss, E. V. Farley, Jr., R. M. Sweeting, J. F. T. Morris, M. Trudel, R. J. Beamish, R.L. Emmett, and E. A. Fergusson. 2007. Epipelagic fish assemblages associated with juvenile Pacific salmon in neritic waters of the California Current and the Alaska Current. Am. Fish. Soc. Symp. 57:105–155.

Pacific Fishery Management Council. 2011. Pacific Coast Groundfish Fishery Management Plan. 158 p. (excluding Appendices).

Pacific Fishery Management Council. 2010. Appendix E to the 2011-2012 Groundfish Harvest Specifications Draft Environmental Impact Statement: Update of the 2006 Community Vulnerability Analysis. (http://www.pcouncil.org/wp-content/uploads/1112GF_SpexFEIS_ApdxE_vulnerability_analyis_100806b.pdf)

Palacios, D.M., S.J. Bograd, R. Mendelssohn, F.B. Schwing. 2004. Long-term and seasonal trends in stratification in the California Current, 1950-1993. Journal of Geophysical Research, 109: 12 pp.

Parkhurst, Z. E. 1950. Survey of the Columbia River and its tributaries-Part VII. Snake River from above the Grande Ronde River through the Payette River. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 40, 95 p.

Parrish, R.H., C.S. Nelson and A. Bakun. 1981. Transport mechanisms and reproductive success of fishes in the California Current. Biological Oceanography 1:2: 175-203.

Parrish, R.H., F.B. Schwing, and R. Mendelssohn. 2000. Midlatitude wind stress: The energy source for climate regimes in the North Pacific Ocean. Fisheries Oceanography 9: 224-238.

Pearcy, W.G. 2002. Marine nekton off Oregon and the 1997-98 El Niño. Progress in Oceanography 54: 399-403

Peterman, R.M., Pyper, B.J., Grout, J.A. 2000. Comparison of parameter estimation methods for detecting climate-induced changes in productivity of Pacific salmon (Oncorhynchus spp.). Can. J. Fish. Aquat. Sci. 57(1): 181-191.

Peterson, W.T., Schwing, F.B. 2003. A new climate regime in northeast pacific ecosystems. GEOPHY. RES. LET. 30: 1896-1899.

Pirtle, J. 2005. Habitat-based assessment of structure-forming megafaunal invertebrates and fishes on Cordell Bank, California. http://cordellbank.noaa.gov/science/pirtle_invertfishhab_ms_thesis.pdf

Polovina, J.J., M. Abecassis, E.A. Howell and P. Woodworth. 2009. Increases in the relative abundance of mid-trophic level fishes concurrent with declines in apex predators in the subtropical North Pacific, 1996-2006. Fishery Bulletin 107: 523-531.

Pyper, B.J., Mueter, R.J., Peterman, R.M., Blackbourn, D.J., Wood, C.C. 2001. Spatial covariation in survival rates of Northeast Pacific pink salmon (Oncorhynchus gorbuscha). Can. J. Fish. Aquat. Sci. 58(8): 1501-1515.

Radtke, L.D. 1966. Distribution of Smelt, Juvenile Sturgeon, and Starry Flounder in the Sacramento San Joaquin Delta with observations on Food of Sturgeon. In: D.W. Kelley (ed.) Ecological Studies of the Sacramento San Joaquin Estuary: Part II; Fishes of the Delta. California Department of Fish and Game. Fish Bulletin 133.

Richardson, S. L., and W. G. Pearcy. 1977. Coastal and oceanic fish larvae in an area of upwelling off Yaquina Bay, Oregon. Fish. Bull., U.S. 75:125-145.

Riebesell, U., Zondervan, I., Rost, B., Tortell, P.D., Zeebe, R.E., and Morel, F.M.M. 2000. Reduced calcification of marine plankton in response to increased atmospheric CO2. Nature, 407:364-367.

Roth, J.E., N. Nur, P. Warzybok and W.J. Sydeman. 2008. Annual prey consumption of a dominant seabird, the common murre, in the California Current system. ICES Journal of Marine Science 65:1046-1056.

Ruckelshaus, M., Essington, T., and Levin, P.S. (2009) How science can inform ecosystem-based management in the sea: Examples from Puget Sound. In: Ecosystem-based management for the Oceans: Applying resilience thinking. (McLeod, K.L. and Leslie, H.M., eds.) Island Press. Pp 201-226.

Ryer, C.H., A.W. Stoner, R.H. Titgen. 2004. Behavioral mechanisms underlying the refuge value of benthic habitat structure for two flatfishes with differing anti-predator strategies. Mar. Ecol. Prog. Ser. 268:231-243.

Scammon, C.M. 1874. The marine mammals of the northwestern coast of North America. John H. Carrmany and Co. (Reprinted by Manessier Publishing Co. 1969).

Scofield, W.L. 1948. Trawling gear in California. California Department of Fish and Game Fish Bulletin 72.

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.

Sibert J, J. Hampton, P. Kleiber, and M. Maunder. 2006. Biomass, size, and trophic status of top predators in the Pacific Ocean. Science 314:1773–1776.

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.

Smith, T.D. 1994. Scaling Fisheries. Cambridge University Press: UK.

Springer, A.M., J.A. Estes, G.B. van Vliet, T.M. Williams, D.F. Doak, E.M. Danner, K.A. Forney, and B. Pfister. 2003. Sequential megafaunal collapse in the North Pacific Ocean: an ongoing legacy of industrial whaling? Proceedings of the National Academy of Sciences 100: 21: 12223-12228.

Sydeman, W.J., Hester, M.M., Thayer, J.A., et al. 2001. Climate change, reproductive performance and diet composition of marine birds in the southern California Current System. Progress in Oceanography 49: 309-329.

Sydeman, W.J., K.L. Mills, J.A. Santora, S.A. Thompson, D.F. Bertram, K.H. Morgan, J.M. Hipfner, B.K. Wells, S.G. Wolf. 2009. Seabirds and climate in the California Current – a synthesis of change. California Cooperative Oceanic Fisheries Investigations Report 50:82-104.

Tegner, M.J. and P.K. Dayton. 2000. Ecosystem effects of fishing in kelp forest communities. ICES Journal of Marine Science, 57: 579-589.

Tissot, B.N., M.M. Yoklavich, M.S. Love, K. York, and M. Amend. 2006. Benthic invertebrates that form habitat on deep banks off southern California, with special reference to deep sea corals. Fish. Bull. 104: 167-181.

Tonnessen, J.N. and A.O. Johnsen. 1982. The History of Modern Whaling. University of California Press: Berkeley.

Trosper, R.L. 2003. Resilience in pre-contact Pacific Northwest social ecological systems. Conservation Ecology 73:3:6.

Van Eenennaam, J.P., J. Linares-Casenave, X. Deng, and S.I. Doroshov. 2005. Effect of incubation temperature on green sturgeon, Acipenser medirostris. Environmental Biology of Fishes 72:145-154.

Veit, R.L., P. Pyle and J.A. McGowan. 1996. Ocean warming and long-term change in pelagic bird abundance within the California Current system. Marine Ecology Progress Series 139: 11–18

Walters, C. and J.F. Kitchell. 2001. Cultivation/depensation effects on juvenile survival and recruitment: implications for the theory of fishing. Canadian Journal of Fisheries and Aquatic Sciences 58: 39-50.

Waples, R, R.P. Jones, B. R. Beckman, and G. A. Swan. 1991. Status Review for Snake River Fall Chinook Salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-201. 73 p.

Washington Department of Fish and Wildlife. 2012. WDFW websites on its mission and goals, regulations, and policies: http://www.wdfw.wa.gov.

Weber, M.L. and B. Heneman. 2000. Guide to California's Marine Life Management Act. The California Marine Life Management Project and Commonweal. Common Knowledge Press, Bolinas, CA.

Wells, B.K., Grimes, C.B., Field, J.C., and Reiss, C.S. 2006. Covariation between the average lengths of mature coho (Oncorhynchus kisutch) and Chinook salmon (Oncorhynchus tshawytscha) and the ocean environment. Fish. Ocean. 15: 67–79

Whitmire, C.E. and Clarke M.E. 2007. State of Deep Coral Ecosystems of the U.S. Pacific Coast: California to Washington. pp. 109-154. In: S.E. Lumsden, Hourigan T.F., Bruckner A.W. and Dorr G. (eds.) The State of Deep Coral Ecosystems of the United States. NOAA Tech. Memo., CRCP-3, Silver Spring, MD 365 pp. http://coris.noaa.gov/activities/deepcoral_rpt/Chapter3_PacificCoast.pdf

Wyllie-Echeverria, S. W. and J. D. Ackerman. 2003. The seagrasses of the Pacific Coast of North America. Pages 199 – 206 in E. P. Green and F. T. Short, editors. World Atlas of Seagrasses. University of California Press, Berkeley.

Yoklavich, M.M., H.G. Greene, G.M. Cailliet, et al. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fisheries Bulletin 98: 625-641.

Yoklavich, M.M., G.M. Cailliet, R.N. Lea, et al. 2002. Deepwater habitat and fish resources associated with the Big Creek Ecological Reserve. CalCOFI Reports 43: 120-140.

Yoklavich, M.M., O'Connell, V., 2008. Twenty years of research on demersal communities using the Delta submersible in the Northeast Pacific. In: Reynolds, J.R., Greene, H.G. (Eds.), Marine Habitat Mapping Technology for Alaska. Alaska Sea Grant College Program.

Yodzis, P. 2001. Must top predators be culled for the sake of fisheries? Trends in Ecology and Evolution 16:2: 78- 84.

4 Cumulative Effects and Uncertainties of Environmental Shifts and Human Activities on the Marine Environment

Chapter 4 would consider the potential effects to the CCE from environmental processes and human activities, and could recommend safeguards in fisheries management measures to buffer against uncertainties induced by those effects. EPDT Report G.1.b, Attachment 1 provides an example, discussed under Option 2, of how the Council might use this Chapter to provide policy guidance on the cross-FMP issue of planning for future potential introductions of new fisheries to the EEZ.

5 PFMC Policy Priorities for Ocean Resource Management

Chapter 5 would discuss Council CCE policy priorities across its FMPs, as they may apply to ocean resource management and policy processes external to the Council (e.g. West Coast Governors' Agreement on Ocean Health, National Ocean Council, international fishery and ocean resource management bodies). Unlike Chapters 2 and 4, the purpose of Chapter 5 would not be to guide future Council work, but to better ensure that external entities are better aware of, and may better take into account, Council priorities for the CCE's health and function.

6 Bringing Cross-FMP and Ecosystem Science into the Council Process

[This Chapter has not been revised or updated since it last appeared before the Council and the public in November 2011 – see Agenda Item H.2.a, Attachment 1, available online. The EPDT intends to review and update this chapter for the next FEP draft, scheduled for Council review in November 2012.]

DRAFT OUTLINE FOR AN ANNUAL STATE OF THE CALIFORNIA CURRENT ECOSYSTEM REPORT

At its November 2011 meeting, the Council requested that the Ecosystem Plan Development Team (EPDT) provide a draft outline for an Annual State of the California Current Report. During its discussion, the Council focused on those biophysical trends known to affect shifts in abundance of Council-managed species. The Council recommended a length of no more than 15-20 pages for the annual report, recognizing that several scientific processes and institutions working within the California Current Ecosystem (CCE) already produce detailed technical reports on the state of the CCE. Annual reports should focus on clear, straightforward explanations of the trends and indicators most relevant to Council managed fisheries, and should essentially be Executive Summaries of the more technical documents and report produced either externally to, or by participants in, the Council process. Bearing those guidelines in mind, the EPDT drafted an outline, below, for an Annual State of the California Current Report. The EPDT would appreciate guidance from the Council and its advisory bodies on any revisions to the suggested report contents that might better focus the report on providing information that helps the Council to meet its mandates.

I. Basin-scale climate (physical) indicators: The El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) are widely recognized as representing dominant modes of interannual and interdecadal (respectively) variability in ocean temperatures and conditions throughout the equatorial and northern Pacific Ocean. Productivity and distribution of a wide range of organisms across multiple trophic levels are recognized to vary in conjunction with variability in the ocean conditions that are reflected by these indicators.

   a. Mulitivariate ENSO Index (MEI)
   b. Pacific Decadal Oscillation (PDO)
   c. North Pacific Gyre Oscillation (NPGO)
   d. Others? (North Pacific Index?)

II. CCE or regional climate (physical) indicators: Local wind fields that drive coastal upwelling ultimately drive the primary production at the base of the food web, and several indices explore how to best capture upwelling “signals” that associate with productivity. Similarly, relative sea level, the date of spring transition, and other more regional variables are often good indicators of productivity, distribution or recruitment patterns for many species of commercial and ecological interest.

a. Regional Upwelling Indices (BEUTI, TUMI, others?)
b. Relative sea level height anomalies (indicators of transport)
c. Sea Surface Temperature anomalies
d. Spring transition date (questionable for near term inclusion, varies by region and by methodology)
e. Dissolved oxygen levels (Oregon shelf? S. Cal. Bight? MBARI M1?)
f. River/streamflow indicators (Columbia, Sacramento, other rivers?)

III. CCE or regional biological (lower trophic level) indicators: These generally empirical indicators of lower trophic level productivity often co-vary with both physical indicators (e.g., ENSO, PDO) as well as with the productivity of higher trophic levels (e.g., salmon, seabirds).

a. Primary productivity indicators (Chl-a from satellite?)
b. CalCOFI zooplankton indices
c. Peterson Copepod anomalies (species richness index, others?)
d. MBARI Dinoflagellate index?
e. Micronekton (pelagic lower trophic level species, e .g., juvenile rockfish) index

IV. CCE or regional biological (higher trophic level) indicators: These indicators can be empirical or model based, and should either directly or indirectly relate to the productivity or condition of managed or protected species or assemblages. Ideally, they should offer some perspective on the relative condition of species, species assemblages or communities that might not necessarily be reflected by species-specific metrics.

a. Seabird reproductive success (multivariate index/indices?)
b. Population size (groundfish, CPS, other -integrated or compilation of trawl survey and/or assessment results)- and/or population growth rates
c. Trawl-survey based high trophic level predator index (currently reported in IEA)
d. Trawl-survey based (or other) biodiversity index
e. Cetacean and/or pinniped population trends (marine mammal assessments)
f. Ecosystem model indices (proportion unfished groups, scavenger ratios)
g. Surprises and /or outbreaks (Humboldt squid, jellyfish, disease or parasite outbreaks, etc.)

V. Human dimensions indicators: Indicators focusing on human dimensions should represent some range of the benefits that society derives from the ecosystem and the services it provides. These indicators might also provide insights with respect to additional human actions or activities relevant to management decisions, for example declines in catches or effort in some fisheries could represent an increased likelihood of greater effort in other fisheries.

a. Total landings and revenues by sector, including non-PFMC fisheries (groundfish, salmon, invertebrates- see figures in section 3.4.2.1 of draft FEP for examples)
b. Total revenues by sector (as above), may include indices of effort, or diversity of revenue by sector by region (ongoing research in this area by IEA human dimensions team)
c. Mean trophic level of catch
d. Non-fisheries anthropogenic activities or stressors (trends in shipping volume, offshore energy development, water quality or contaminant loading trends, recreational activity)

ECOSYSTEM PLAN DEVELOPMENT TEAM REPORT ON THE
COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

At its November 2011 meeting, the Pacific Fishery Management Council (Council) directed the Ecosystem Plan Development Team (EPDT) to continue drafting a Fishery Ecosystem Plan (FEP) and to develop a draft outline for an annual state of the ecosystem report (Agenda Item H.1.a, Attachment 2). At that meeting, the Council adopted a tentative schedule, depending on other Council scheduling priorities, of reviewing draft versions of the FEP in June 2012 and November 2012, and of adopting a final plan at its March 2013 meeting. Our main report, Agenda Item H.1.a, Attachment 1, is a draft FEP that has been updated and revised since November 2011 as follows:

Chapter 1, Introduction, includes: the Purpose and Need statement the Council adopted at its June 2011 meeting in Section 1.1; an explanation of how the document is organized at Section 1.2; the schedule and process for developing the FEP at Section 1.3, revised based on the Council's direction during its November 2011 discussion of the FEP; and a schedule and process for state-of-the-ecosystem reporting, also revised based on Council advice from November 2011. The EPDT report under this agenda item at Attachment 2, provides a draft outline for an annual state of the California Current Ecosystem (CCE) report.

Chapter 2, *Objectives*, has been revised and updated for this meeting. The EPDT had a detailed discussion of this chapter at its April 12, 2012, meeting, with much debate on how best to incorporate the many and varied comments provided by the Council, its advisory bodies, and the public.

Chapter 3, *The FEP's Geographic Area and the California Current Ecosystem (CCE)* has been completely revised for this June 2012 meeting. In drafting this chapter, the EPDT's goal was to describe the CCE from a broad variety of disciplines, giving readers a cross-Fishery Management Plan (FMP) perspective on the organisms and fisheries of interest to the Council. We used Link's (2010) "general list of issues that need to be considered for implementing ecosystem considerations into fisheries management" for initial inspiration in outlining the chapter. We tried to provide a level of detail that would allow the chapter to serve as a big picture discussion of the CCE that could be both used as background in Council analytical documents, and used by new participants in the Council process to familiarize themselves with the CCE as a whole, rather than just with its many and varied parts. A few sections of Chapter 3 are incomplete or missing, with the most significant being discussions of recreational fisheries (3.4.2.2) and of fish receivers and processors (3.4.2.3). The EPDT anticipates drafting those sections within the coming months, using the commercial fisheries discussion (3.4.2.1) as a model, to the extent that data availability and confidentiality requirements allow. Over the longer term, the FEP and the annual state-of-the-ecosystem report would become online resources, to be available for a variety of public education and analytical purposes.

The EPDT plans to draft Chapter 4, *Cumulative Effects and Uncertainties of Environmental Shifts and Human Activities*, for Council review in November 2012. Chapter 4 is intended to consider how the Council conservation and management programs interact with each other across FMPs, and to look at the large-scale and cumulative effects of fisheries management. For example, the Council could look at spatial management issues across FMPs to determine whether fishing areas or marine protected areas for different FMPs conflict or harmonize with each other, or the Council could look at whether regulations under its different FMPs combine to create safety conflicts for fishery participants. The EPDT provided an example of how Chapter 4 might address a cross-FMP issue in its report for Agenda Item G.1.b, Further Protection for Currently Unmanaged Forage Species, at Option 2 on pages 3-4 of that report.

The EPDT plans to draft Chapter 5, *PFMC Policy Priorities for Ocean Resource Management*, for Council review in November 2012. Chapter 5 is intended to provide the Council with a venue for a broad discussion of its priorities for West Coast resources. The EPDT plans to focus on human activities that might affect non-fisheries mortality of Council-managed species or fisheries access to managed stocks. Federal agencies outside of the Council process look to the Council and National Oceanic and Atmospheric Administration for guidance on priorities for their analyses on the potential effects of their proposed actions within the Exclusive Economic Zone on the environment. Chapter 5 would discuss the Council's cross-FMP issues of concern, so as to characterize Council priorities for living marine resource management over the near- and long-term. For example, projects proposing placing a permanent structure anchored to the ocean floor (regardless of the purpose of that structure) might be discouraged from citing that structure in an area that serves as both essential fish habitat for a rebuilding rockfish and as critical habitat for an endangered or threatened salmon species.

The EPDT has not updated Chapter 6, *Bringing Cross-FMP and Ecosystem Science into the Council Process*, since November 2011. We intend to update that chapter for November 2012, at which time we would include any changes or updates made to the state-of-the-ecosystem report outline provided under Attachment 2 to this agenda item.

Link, J.S. Ecosystem-based fisheries management: confronting tradeoffs. New York: Cambridge University Press, 2010. (See Table 4.1)

PFMC
06/21/12

Agenda Item H.1.b
Supplemental EPDT PowerPoint
June 2012

Ecosystem Plan Development Team Draft Fishery Ecosystem Plan

EPDT Presentation for H.1.

June 24, 2012


CALIFORNIA
BIOREGIONS
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC
OCEAN
Klamath
Modoc
Sacramento Valley
Bay-Delta
Sierra
San Joaquin Valley
Central Coast
Mojave
South Coast
Colorado Desert
Crecent City
Eureka
Redding
Susanville
Fort Bragg
South Lake Tahoe
Sacramento
Santa Rosa
Stockton
San Francisco
Oakland
San Jose
Fresno
Monterey
Ridgecrest
Bakersfield
San Luis Obispo
Needles
Oxnard
Los Angeles
San Bernadino
Palm Springs
Blythe
El Centro
San Diego
N
W
E
S

1.1 Adopted (by you, June 2011) ✓

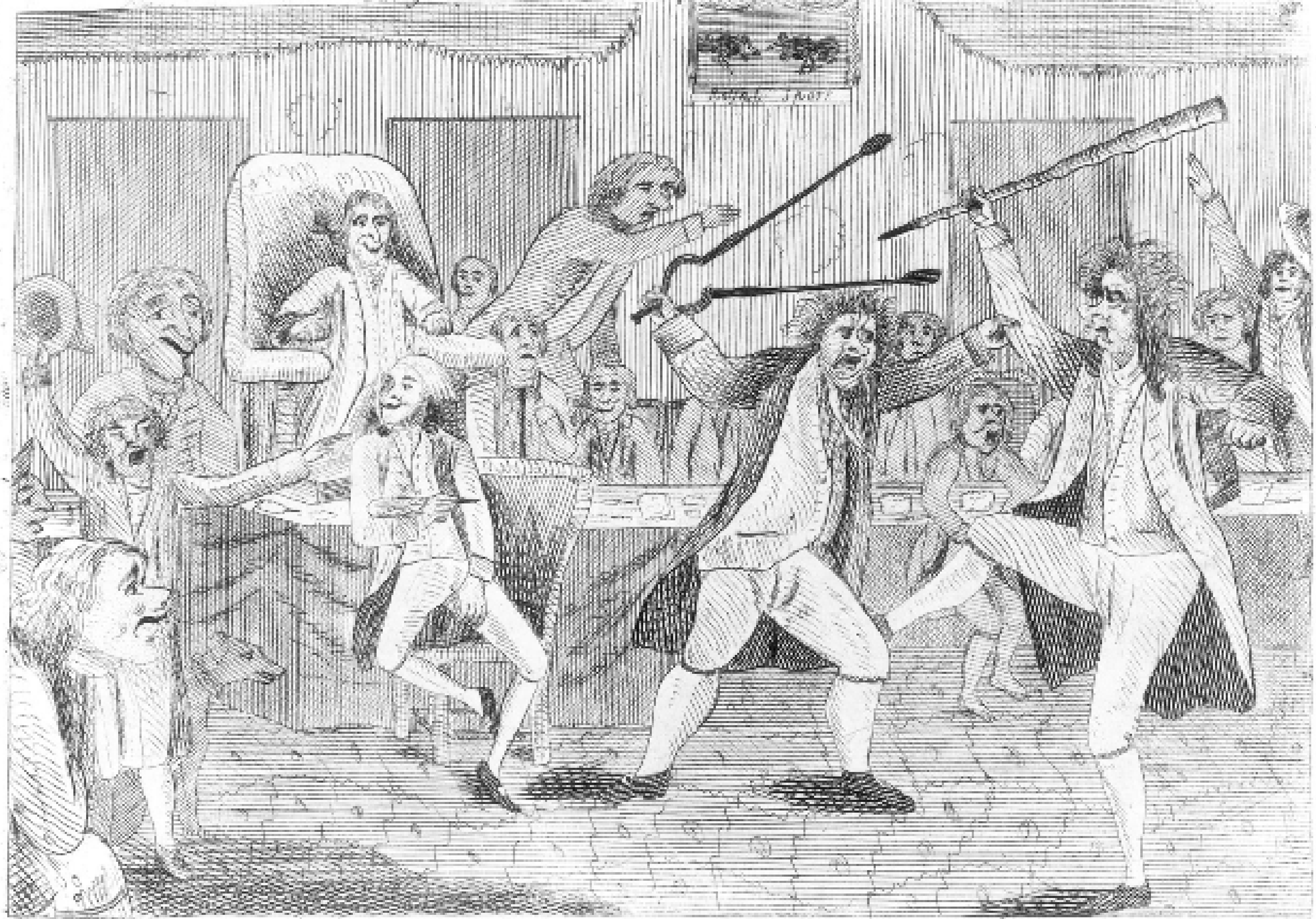
1.2 Updated (June 2012) ✓

1.3 Updated (June 2012) ✓

FEP

1.4 Updated (June 2012) ✓

Congressional Pugilists



He in a trice struck Lyon thrice
Upon his head, enrag'd sir,

Who seiz'd the tongs to ease his wrongs,
And Griswold thus engag'd, sir.

Congress Hall,
in Philad.a Feb. 15. 1798.

40 CFR §1502.15 Affected environment.

The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement.

4

Framework for scientific information to support EBFM

Every truth passes through three stages before it is recognized. In the first place it is ridiculed. In the second it is violently opposed. In the third it is regarded as self-evident.

Arthur Schopenhauer (attributed)

A TRIAGE LIST

It is not always appropriate to consider every ecosystem factor in living marine resource (LMR) management. So when is it appropriate, or even imperative, to consider the broader factors? It would be advantageous to have a set of criteria to use in making the decision to embark upon EBFM. A checklist of things to consider would be helpful, as would a set of examples of when EBFM has been shown to be important.

The case studies presented in Chapter 5 serve as generalizable examples for when the implementation of EBFM is needed. But more specifically, some of the characteristics noted in Table 4.1 can help delineate the major features of any particular ecosystem and set of species warranting an ecosystem approach. Forcing oneself to compile information on the geography, physics, biota, ecology, and fisheries for any given ecosystem is a valuable exercise in itself. Evaluating these factors is useful to determine the relative importance of trophic interactions, abiotic factors, fishing mortality, and so forth. No standard set of conditions and rules applies to all ecosystems, and attempting to prescribe a common set of goal functions for each ecosystem is imprudent. I will not advocate any particular methodology, model, or approach to address this list of issues, as their importance changes from ecosystem to ecosystem. Conversely, a generic list of issues should be considered when seeking to implement EBFM so as not to overlook

Table 4.1. *A general list of issues that need to be considered for implementing ecosystem considerations into fisheries management*

Geography of the ecosystem

- What are the key features of the ecosystem under consideration? For example, is the system relatively open (e.g. mid sea, continental shelf) or closed (e.g. river, small lake, bay)?
- How big is the ecosystem?
- What are the important, dominant, and unusual physiochemical factors in a system?
- Is there a prominent geographic, bathymetric, or similar feature that defines and dominates the system?
- What are the political boundaries and jurisdictions that govern the resources in a system?
- How dense is the human population in or near the ecosystem?

Key species

- What are the key species in the ecosystem? Certainly a list of commercially exploited species is required, but noncommercial yet ecologically valuable species should also be included.
- What are the key attributes of these species?
- Are the species involved relatively slow growing with a long life span, or are they more r-selected?
- What is the size of the species in the system?
- What is the extent or range of the species of interest in a system? How are they spatially distributed?
- How economically valuable are the exploitable species?
- Are there any keystone species? Are there any dominant species?
- What is the functional role of the key species?
- Have the life history parameters for a species changed over time (e.g. faster growth, earlier age-at-maturity, etc.)? Have they even been determined?
- Are there any species particularly susceptible to an ecological process?
- Are there any specialists?
- Are there any species that are near extinction?
- Are there any species that have an excessively high linkage density (high number of predators or competitors)?
- Are there any species that have sensitive or low-output reproduction?

Abiotic factors

- Are there certain spawning or nursery grounds that merit protection?
- Is there a particular habitat feature (e.g. stacked cobble, sea grass, or oyster beds) that enhance the survivability of juvenile fish?
- Is there a particular area that is optimal for growth?
- Are there particular features such as a thermocline or frontal boundary that aggregate prey for fish feeding?

N S. LINK

-Based

sheries

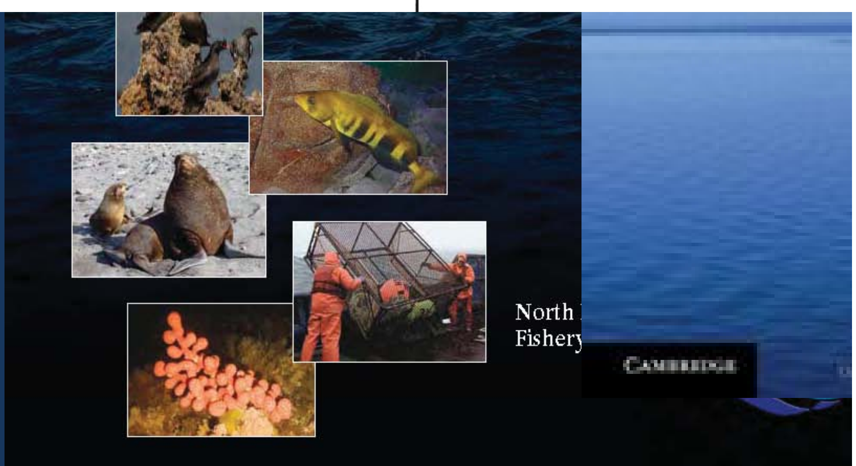
ement

g Tradeoffs

FISHERY ECOSYSTEM PLAN

THE SOUTH ATLANTIC REGION

E I: INTRODUCTION AND OVERVIEW



t.)

- itat been altered in any way?
- ny toxins in the system that can kill or chronically cies?
- Is the system susceptible to large-scale perturbations such as a hurricane?
- Is there the possibility that a hypoxic zone could develop?
- Are other forms of pollution prevalent and significant?
- Could harmful algal blooms develop, and if so, what effect would they have on key species?
- Is there evidence of a long-term regime shift in temperature, salinity, atmospheric pressure, upwelling, or similar meteorological factors? Have circulation and current patterns changed across time?
- How strong are tidal influences? Have they changed?
- Are certain life stages or certain species particularly susceptible to environmental change?

Species interactions

- Have the interactions between species been identified? If so, can they be quantified?
- What is the amount of food required to maintain a predator population at a certain size structure and abundance?
- What is the total number of individuals removed by all predators of a particular species?
- Are the interactions between species strong and tightly coupled, or is it a system of generalists with weak species interactions?
- Is there one species that is clearly a competitive dominant?
- Is there evidence of dietary, spatial, or other resource overlap?
- Is there an indication that resources may be limiting?
- What are the key resources in a system for fish, plankton, benthos, etc.?
- Is there a potential for conflict among fisheries targeting different species?
- Are there management protocols in place to objectively resolve these conflicts?

Aggregate properties

- What is the productivity of the ecosystem? Has it changed across the life span of key species? How does this affect carrying capacity for upper trophic levels?
- Similarly, have there been changes in secondary production in the system?
- Is an understanding of the dynamics of lower trophic levels such as benthos or zooplankton essential for the key fisheries?
- Is the food web tightly connected to the nutrient dynamics of a system such as an estuary or small lake?
- Are there significant guilds in the system?
- How is the energy and biomass of the ecosystem partitioned amongst different functional or aggregate groups?

Table 4.1. (cont.)

- What is the dominant group?
- Has this group remained dominant across time? If not, what caused the changes?

System-level properties

- Are there other ecosystem goods and services that compete with a fishery or a particular species? Conversely, are there synergisms between different user sectors?
- How does a fishery interact with other sectors that use an ecosystem (e.g. tourism)?
- Are there protocols to address these potential conflicts or encourage possible collaborations?

The fisheries context

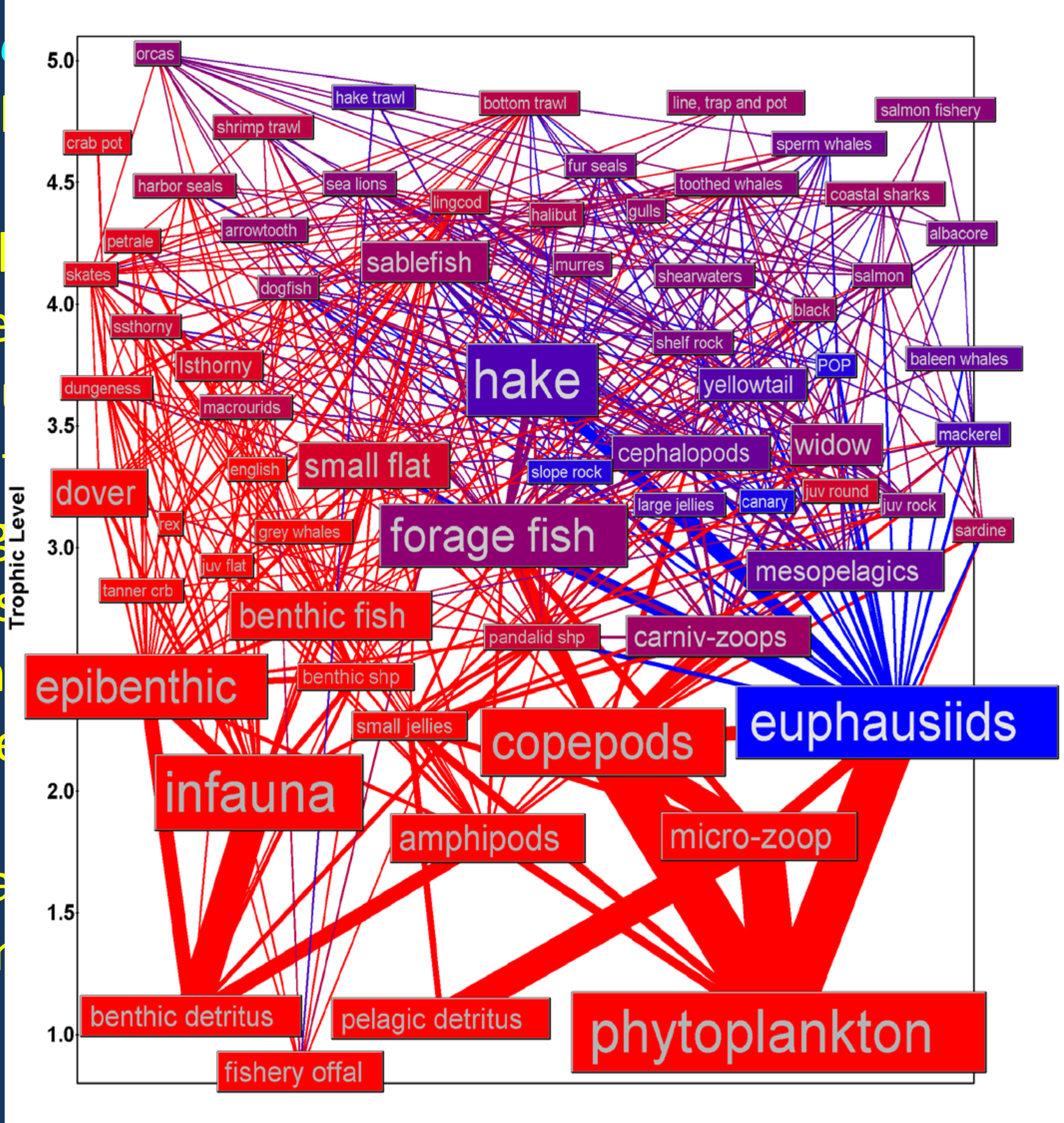
- What type of fisheries have been in the system (commercial, recreational, artisanal, etc.)?
- What type of gear has been and is being used?
- What is the historical level of fishing effort on key species in the system?
- What is the current level of fishing on key species in the system? How does this influence non-target species, trophic structure, habitat, etc.?
- What are current landings and discards?
- Can we adapt gear or else choose to target species as a group that have high technological interactions?
- Where are stocks relative to historical levels of abundance (declining, collapsed, or recovering)?

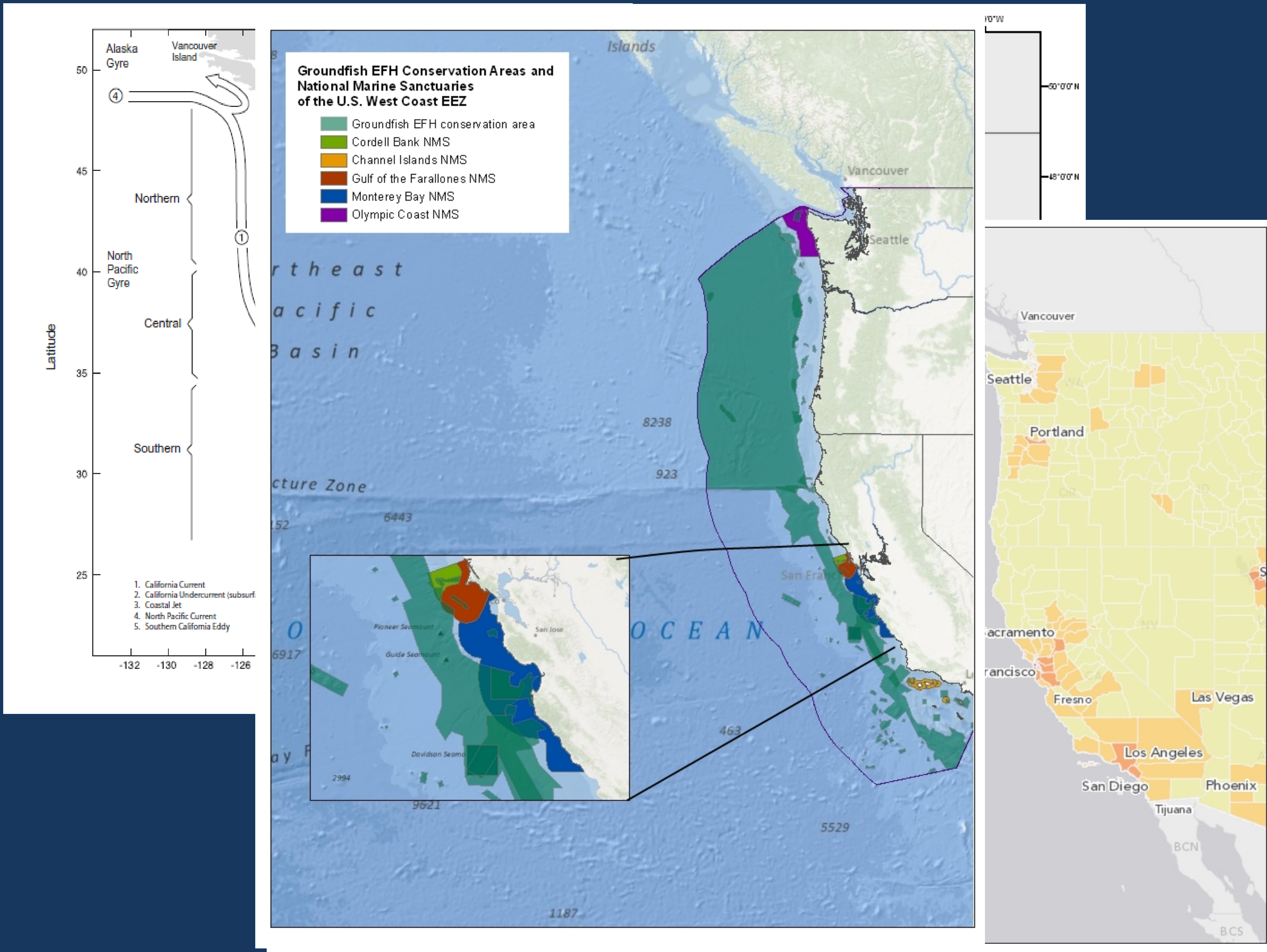
Source: Adapted from Link (2002b).

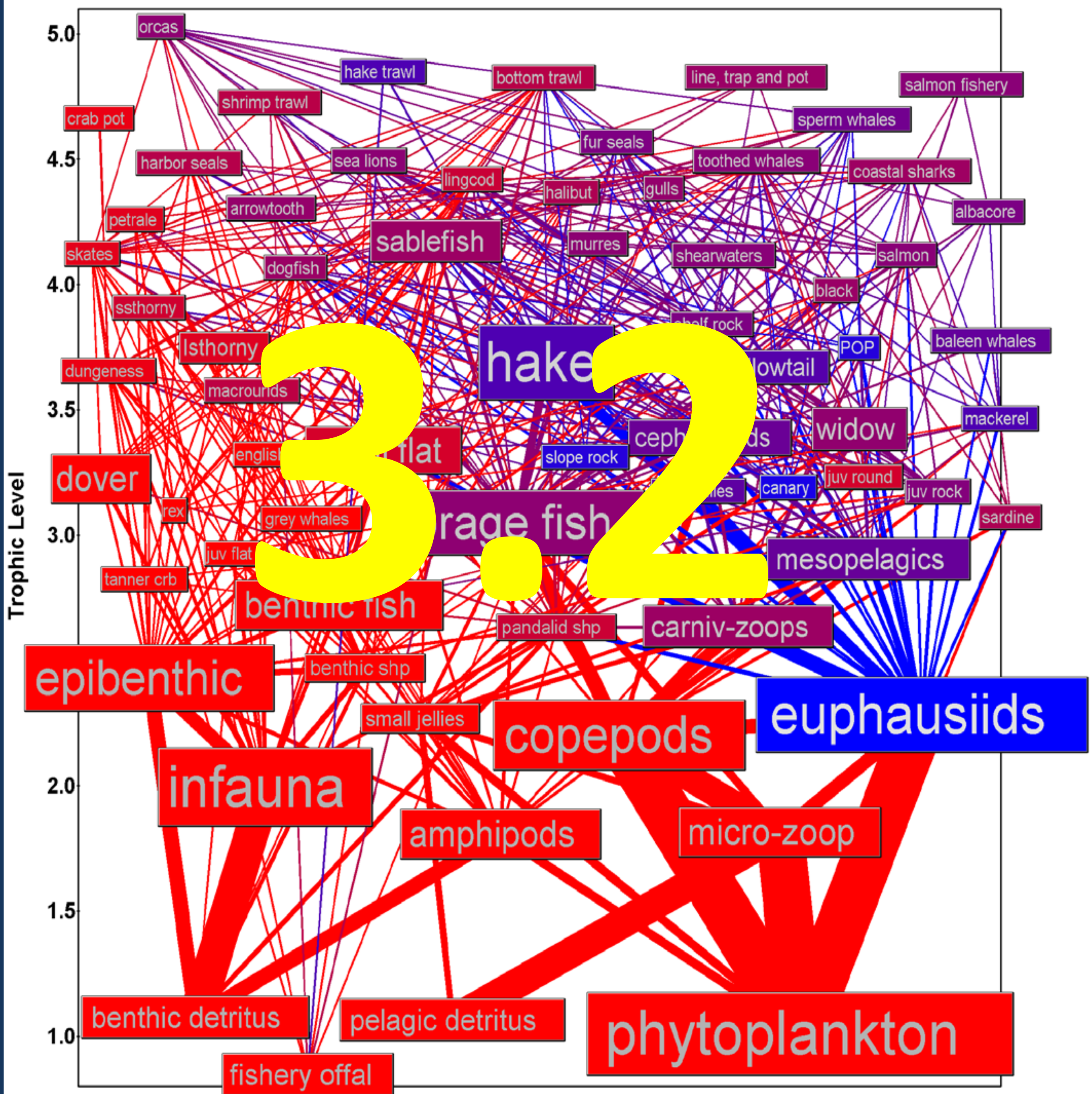
a dominant but understudied (or disciplinarily tangential) process (Table 4.1). So, on the one hand, each ecosystem is admittedly unique, yet, on the other, there is a need for a standardized set of processes and factors to be considered.

Thus, how can one use the issue-specific answers to questions posed in Table 4.1 to initiate EBFM? The primary answer is triage. Determining which process is the most important in an ecosystem is valuable and should not be discounted, as is knowing the magnitude and relative importance of the major processes in an ecosystem. Second, answers to these questions could be used to modify existing fisheries management advice in a quantitative way. For example, the International Commission for the Northwest Atlantic Fisheries (ICNAF) used two-tier quotas that set limits on single-species as well as aggregate biomass removals from the northwest Atlantic (Brown *et al.* 1976). In this vein, one could set aside a prescribed amount of a harvested forage

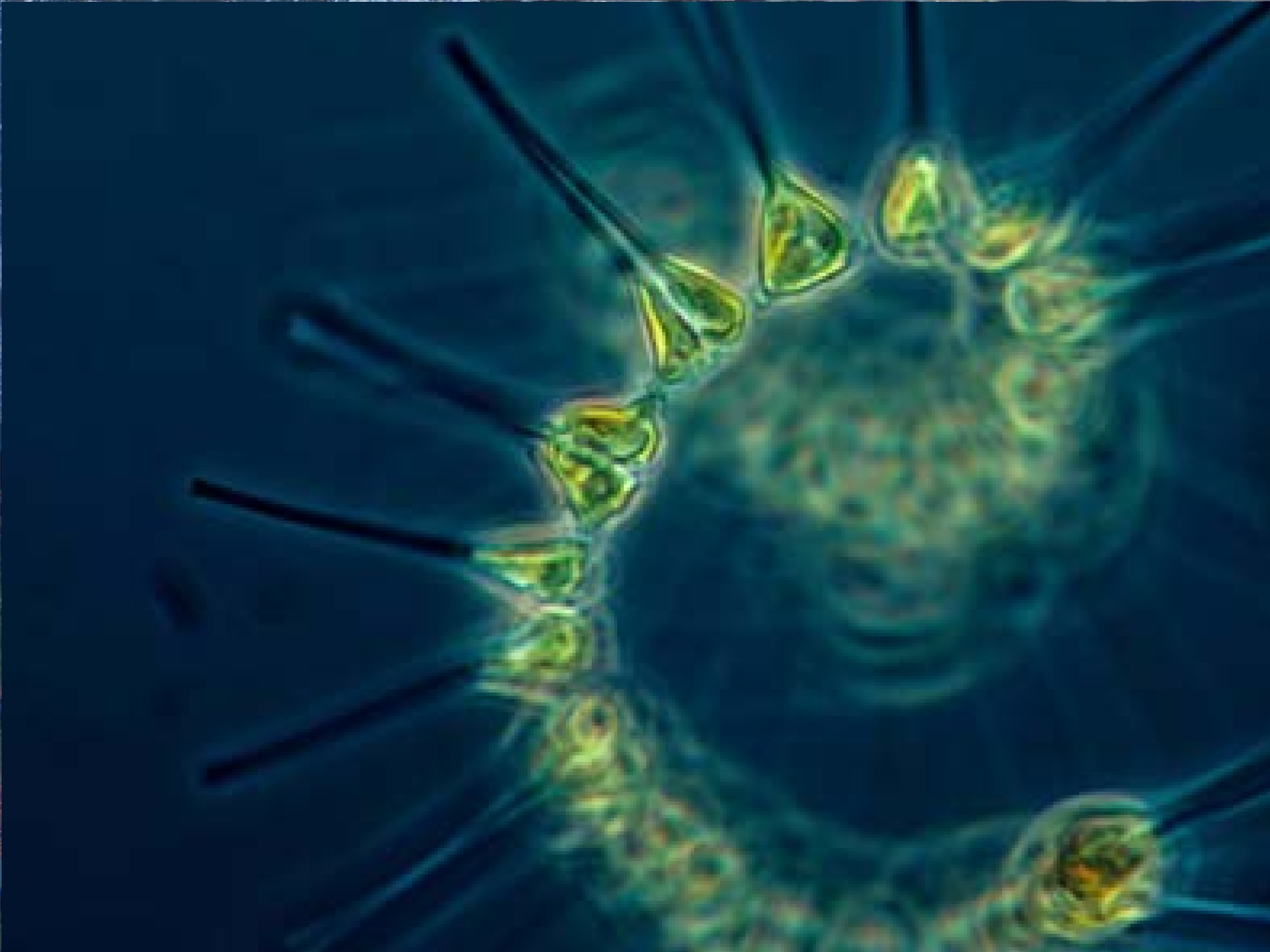
I, [*state y*
Regional … er the
Magnuso … ment
Act, herel … t
marine re … rrying
out the b … benefit
of the Na … a
knowledg … s
marine fis
competin … are and
protective … mmit
myself to … ements
of the Ma
Managem … ..and…
and…]



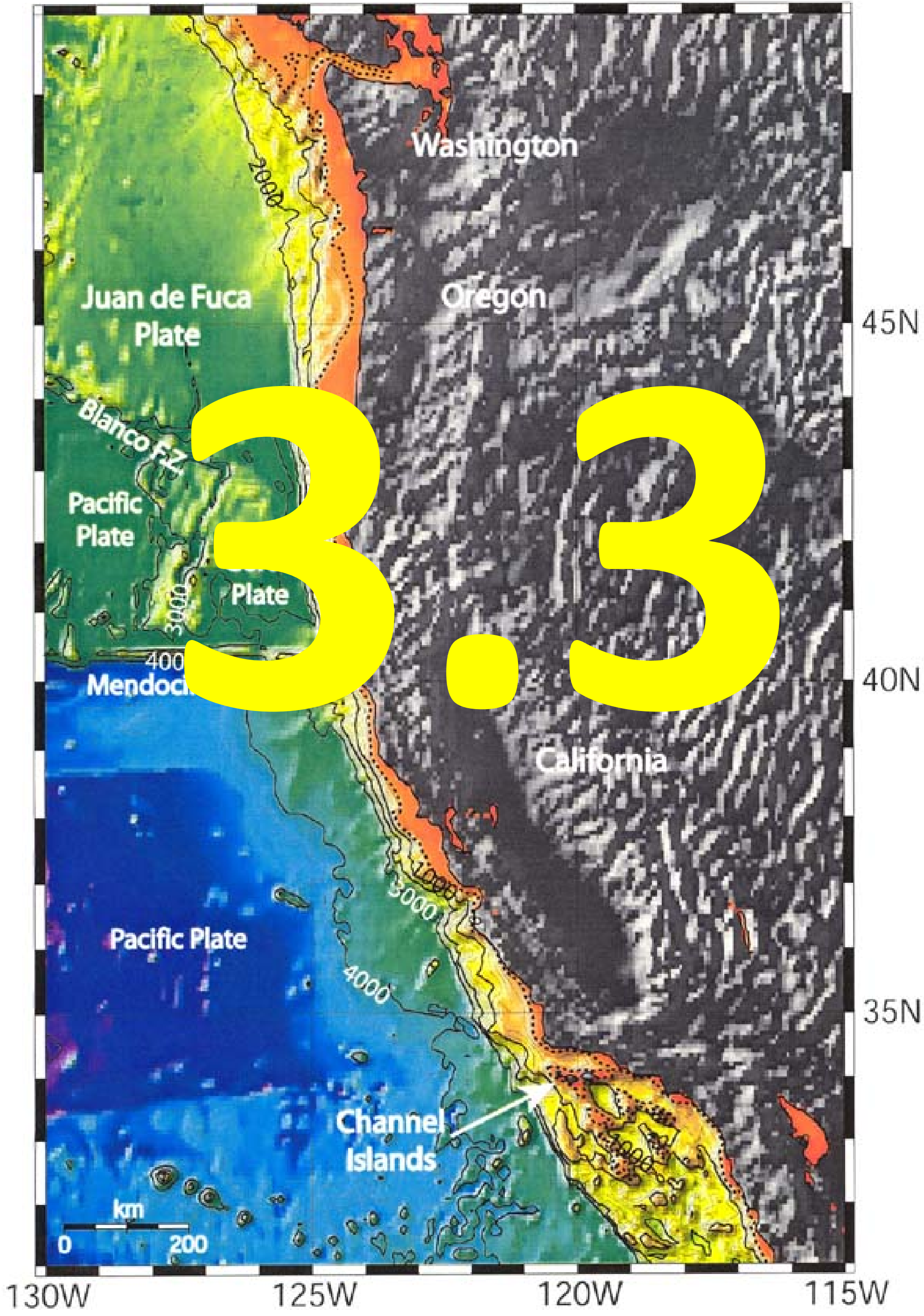

Groundfish EFH Conservation Areas and National Marine Sanctuaries of the U.S. West Coast EEZ
Groundfish EFH conservation area
Cordell Bank NMS
Channel Islands NMS
Gulf of the Farallones NMS
Monterey Bay NMS
Olympic Coast NMS
Alaska Gyre
Vancouver Island
Northern
North Pacific Gyre
Central
Southern
Latitude
1. California Current
3. Coastal Jet
4. North Pacific Current
5. Southern California Eddy
Vancouver
Seattle
Portland
Sacramento
Fresno
Las Vegas
Los Angeles
San Diego
Phoenix
Tijuana
OCEAN
Pioneer Seamount
Guide Seamount
San Jose



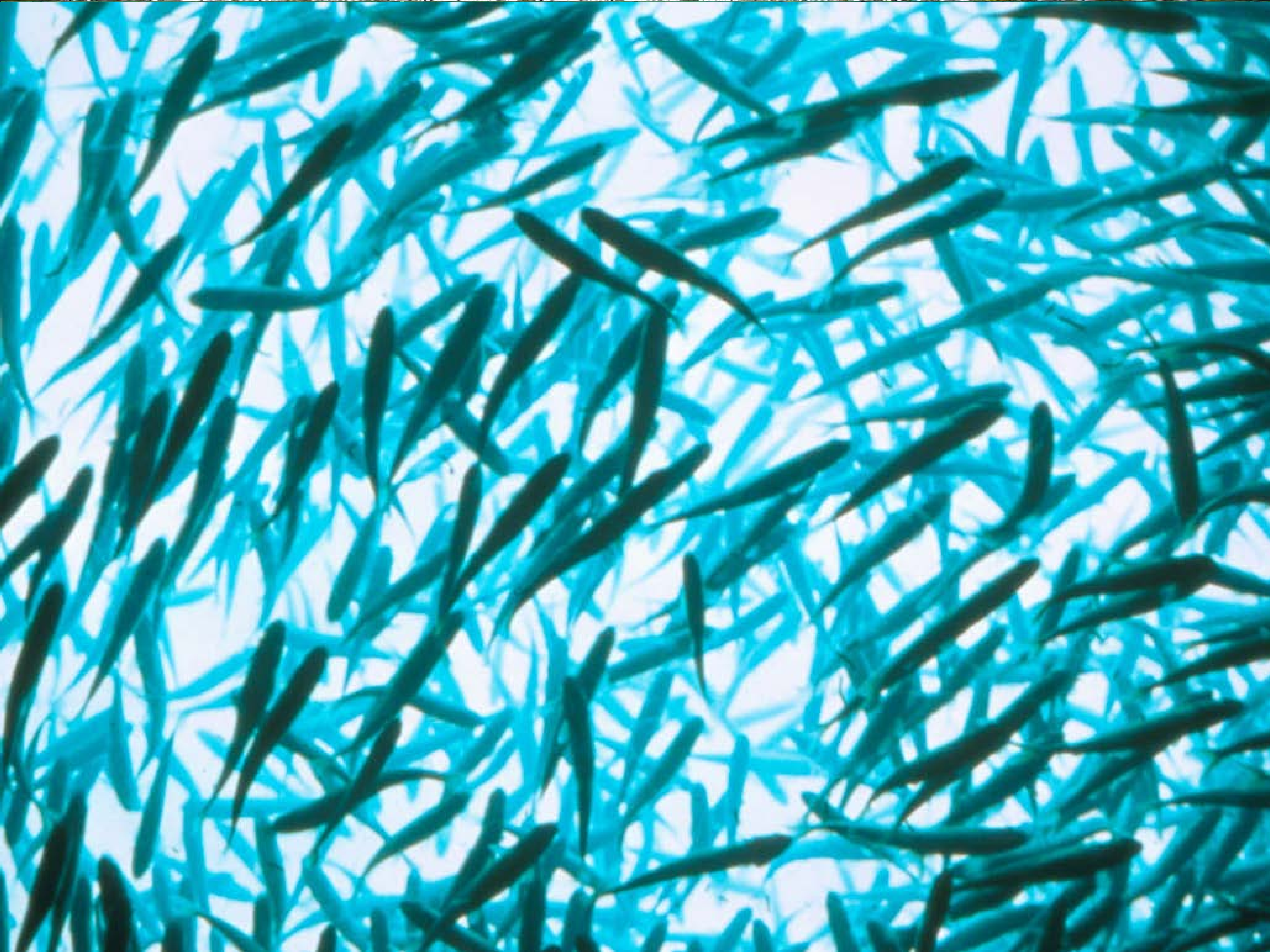
3.2
Trophic Level
5.0
4.5
4.0
3.5
3.0
2.0
1.5
1.0
orcas
hake trawl
bottom trawl
line, trap and pot
salmon fishery
shrimp trawl
crab pot
sperm whales
fur seals
harbor seals
sea lions
toothed whales
coastal sharks
lingcod
halibut
gulls
petrale
arrowtooth
albacore
sablefish
murres
skates
shearwaters
salmon
dogfish
black
ssthorny
lsthorny
baleen whales
POP
hake
dungeness
macrourids
widow
mackerel
flat
slope rock
dover
juv round
canary
juv rock
rex
grey whales
sardine
juv flat
mesopelagics
tanner crb
benthic fish
pandalid shp
carniv-zoops
epibenthic
benthic shp
euphausiids
small jellies
copepods
infauna
amphipods
micro-zoop
benthic detritus
pelagic detritus
phytoplankton
fishery offal

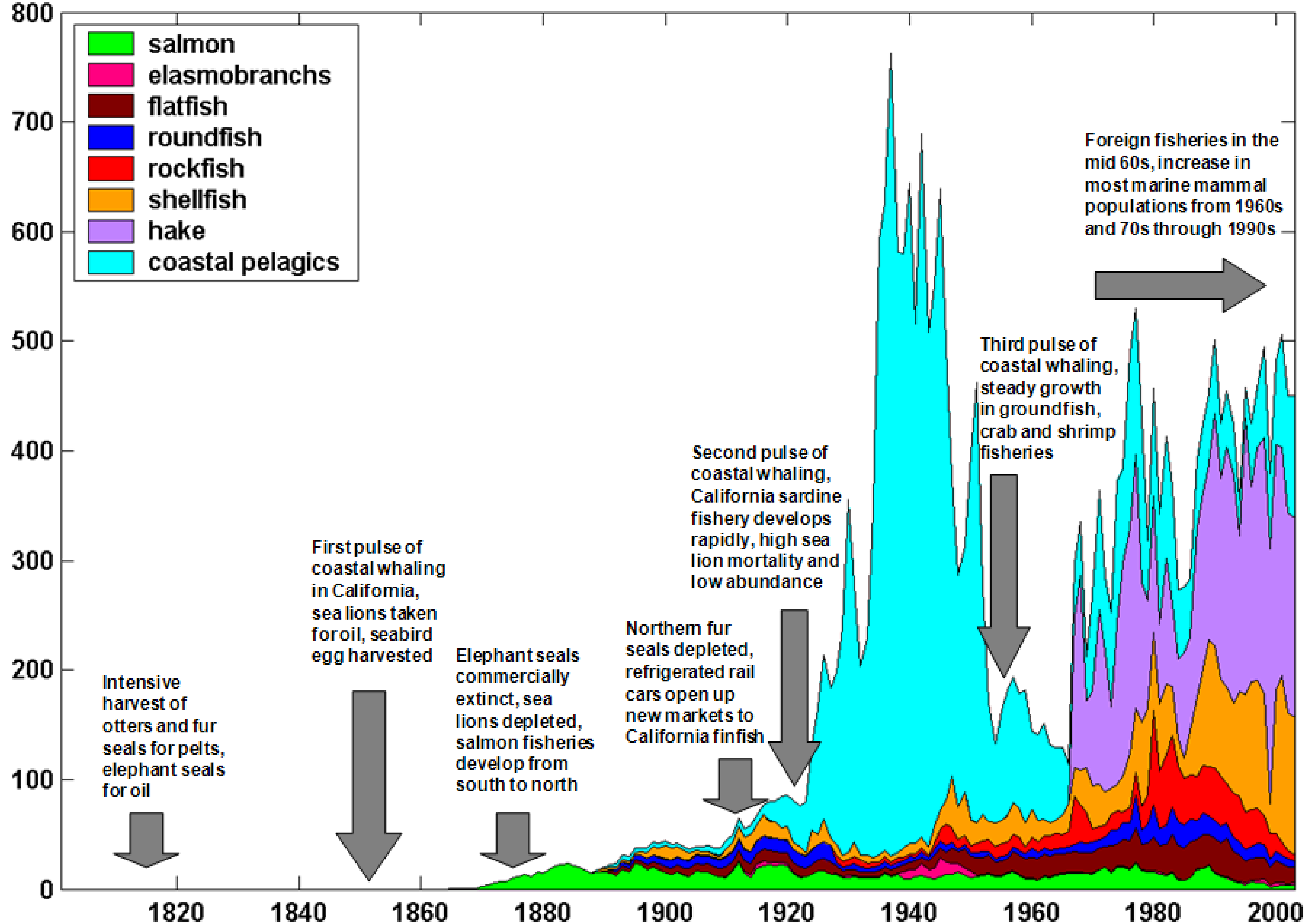


3.3



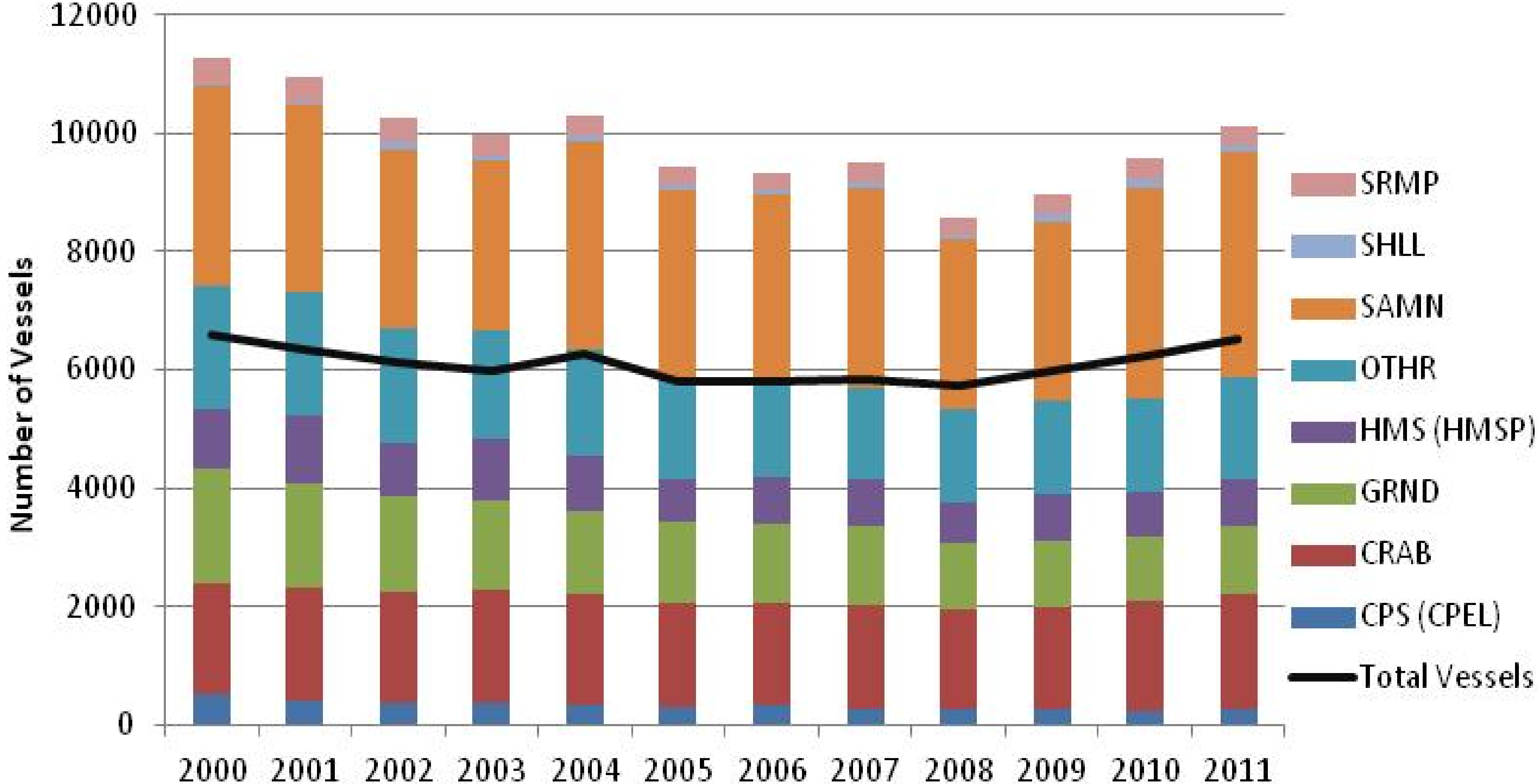
Washington
Oregon
California
Juan de Fuca Plate
Blanco F.Z.
Pacific Plate
Plate
Pacific Plate
Channel Islands
2000
3000
4000
3000
4000
km
0
200
45N
40N
35N
130W
125W
120W
115W





800
700
600
500
400
300
200
100
0
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000
salmon
elasmobranchs
flatfish
roundfish
rockfish
shellfish
hake
coastal pelagics
Intensive harvest of otters and fur seals for pelts, elephant seals for oil
First pulse of coastal whaling in California, sea lions taken for oil, seabird egg harvested
Elephant seals commercially extinct, sea lions depleted, salmon fisheries develop from south to north
Northern fur seals depleted, refrigerated rail cars open up new markets to California finfish
Second pulse of coastal whaling, California sardine fishery develops rapidly, high sea lion mortality and low abundance
Third pulse of coastal whaling, steady growth in groundfish, crab and shrimp fisheries
Foreign fisheries in the mid 60s, increase in most marine mammal populations from 1960s and 70s through 1990s

Figure 3.4.10: Total vessels with West Coast landings and number with landings by management group, 2000-2011.



		CA - South (San Diego - Los Angeles)			CA - Channel (Ventura & Santa Barbara)			CA - Central (San Luis Obispo - Santa Cruz)			CA - SF (San Mateo - Sonoma)			CA - Wino (Mendocino)			CA - Redwood (Humboldt & Del Norte)		
		A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT
year	COMMON	awe_d1	b1we_d1	b2we_d1	awe_d2	b1we_d2	b2we_d2	awe_d3	b1we_d3	b2we_d3	awe_d4	b1we_d4	b2we_d4	awe_d5	b1we_d5	b2we_d5	awe_d6	b1we_d6	b2we_d6
2004	ALBACORE	143.712	46.794	8.210				10.567		0.925	17.882		0.056	12.311			20.365		0.063
2004	ARROWTOOTH FLOUNDER																		
2004	BANK ROCKFISH	0.448	0.065																
2004	BARRED SANDBASS	415.565	41.702	188.527	54.588	1.982	8.810												
2004	BARRED SURFPERCH	0.029			0.022														
2004	BAT RAY	0.476	0.037	14.131	0.019		1.519	0.144		1.235	2.869	0.354	32.234			0.049			0.701
2004	BIG SKATE																		
2004	BIGMOUTH SOLE	0.520		0.046	0.002														
2004	BLACK AND YELLOW ROCKFISH	0.002			0.027			2.000		0.030	1.015		0.030	1.127		0.001	0.043		0.008
2004	BLACK CROAKER	0.056					0.001												
2004	BLACK PERCH	1.126		0.025	0.151		0.004	0.080		0.101	0.421		0.001						
2004	BLACK ROCKFISH			0.002		0.004	0.009	0.056	0.046	0.540	25.855	0.094	1.872	19.026	0.213	3.583	51.040	0.035	5.301
2004	BLACKGILL ROCKFISH	0.003																	
2004	BLACKSMITH	6.355	0.229	3.895	1.099	0.002	1.365												
2004	BLUE ROCKFISH	0.446		0.001	14.054	0.101	1.251	83.822	0.611	5.366	21.740	0.866	1.471	20.877	0.935	4.606	7.981	0.013	0.704
2004	BLUE SHARK	0.180		10.592												0.116			
2004	BLUEFIN TUNA	0.135	0.413								0.042						0.027		
2004	BOCACCIO	20.662	5.834	1.839	22.661	2.112	3.589	1.742	0.065	0.054	0.453	0.028	0.006				0.011		0.014
2004	BROWN ROCKFISH	1.177	0.063	0.336	5.275	0.064	0.882	18.806	0.082	1.050	5.246		0.982	8.612		0.367	0.109		0.032
2004	BROWN SMOOTHHOUND	0.455	0.008	0.372	0.033		0.405	0.004		0.030	1.132	0.026	12.608			0.032			0.084
2004	BUFFALO SCULPIN													0.008					
2004	BUTTER SOLE																		
2004	CABEZON	2.582	0.045	3.530	0.756	0.063	0.999	2.534	0.073	1.350	0.471		0.001	8.172	0.015	0.625	3.610		0.571
2004	CALICO ROCKFISH	0.020					0.004												
2004	CALIFORNIA CORBINA	0.009		0.018															
2004	CALIFORNIA HALIBUT	75.205	4.377	86.377	20.790	0.215	3.700	17.126	0.037	0.549	68.165	0.103	1.417	0.834		0.032	1.111		0.010
2004	CALIFORNIA LIZARDFISH	0.008		1.206			0.003												
2004	CALIFORNIA SCORPIONFISH	88.038	3.712	72.232	0.627	0.030	1.702			0.005				0.005					
2004	CALIFORNIA SHEEPHEAD	17.664	2.314	10.856	1.556	0.272	0.251	0.030		0.003									
2004	CANARY ROCKFISH	0.030			0.176			0.610	0.118	1.352	0.311	0.245	1.334	8.492	0.184	1.039	0.379	0.034	0.448
2004	CHILIPEPPER	8.347	0.142	0.029	1.692		0.177												
2004	CHINA ROCKFISH	0.003	0.030		0.023			1.531	0.017	0.081	2.136	0.032	0.090	3.601	0.030	0.494	0.565	0.012	0.088
2004	CHINOOK SALMON																		
2004	CHUB (PACIFIC) MACKEREL	24.526	111.468	178.370	1.709	1.392	1.785	0.311	0.603	0.301	0.066		0.035				0.004		
2004	CHUM SALMON																		
2004	COD FAMILY																		
2004	COHO SALMON	0.020						0.085		0.431	2.513	0.176	13.592	1.230	0.548	17.178	2.751	6.255	95.319
2004	COPPER ROCKFISH	2.636	0.019	0.022	10.771	0.140	0.084	5.151		0.070	3.221		0.009	5.840	0.067	0.164	1.226	0.003	0.014
2004	COWCOD	0.031	0.082	0.029	0.192	0.126	0.013						0.241			0.102			0.018
2004	CURLFIN SOLE				0.001														
2004	DIAMOND TURBOT	0.006																	
2004	DOLPHINFISH	14.753	1.630	7.964															
2004	DOVER SOLE																		
2004	FANTAIL SOLE	0.271		0.029	0.112		0.006	0.022											
2004	FINESCALE TRIGGERFISH	0.195	0.007	0.010	0.005														
2004	FLAG ROCKFISH	4.487	0.006	0.028	2.731	0.001	0.052	0.208		0.001									
2004	FLATFISH ORDER	0.012	0.002	0.061	0.007		0.121	0.003		0.029									
2004	FRECKLED ROCKFISH	0.003																	
2004	GIANT KELPFISH	0.018	0.017	0.454	0.002		0.520												
2004	GIANT SEABASS	0.100		0.768			0.502												
2004	GOPHER ROCKFISH	0.304	0.002	0.050	0.500		0.004	24.683	0.187	2.566	4.829	0.009	0.290	5.566	0.024	0.566	0.045		0.010
2004	GRASS ROCKFISH	0.646		0.004	0.215		0.139	0.246		0.024	0.265		0.040	0.058		0.062	0.035		0.001
2004	GRAY SMOOTHHOUND	0.241		0.317	0.219					0.076	0.088	0.076	4.184	0.079	0.156	0.020			0.004
2004	GREENBLOTCHED ROCKFISH	0.293			0.801														
2004	GREENSPOTTED ROCKFISH	5.526	0.078	0.012	0.575	0.000	0.016	0.075		0.003	0.022			0.055			0.004		
2004	GREENSTRIPED ROCKFISH	0.147	0.001		0.039						0.042								
2004	HALFBANDED ROCKFISH	0.465	0.039	0.013	0.014		0.002												
2004	HALFMOON	13.557	0.166	2.395	0.673	0.025	0.160												
2004	HONEYCOMB ROCKFISH	2.433	0.066	0.047	0.177	0.031													
2004	JACK MACKEREL	0.348	0.265	1.258				0.035		0.004	0.280		0.001						
2004	JACKSMELT	0.356	0.010	0.266	0.067	0.028	0.259	0.399	0.134	0.327	0.369	0.005	0.267	0.031		0.015	0.050		0.004
2004	KELP BASS	257.035	61.198	167.643	23.009	1.191	15.118	0.088		0.001			0.026						
2004	KELP GREENLING			0.002			0.013	1.430	0.028	0.438	2.218	0.041	0.439	3.955	0.084	0.344	0.682		0.464
2004	KELP ROCKFISH	1.112	0.018	0.050	1.634		0.180	1.145	0.307	0.045	0.009			0.046		0.004			
2004	LEFTEYE FLOUNDER FAMILY	0.004						0.001											
2004	LEOPARD SHARK	0.385	0.251	2.717	0.030	0.027	0.582	0.081		0.273	16.705	15.739	43.515		0.039	0.133	0.680		0.257
2004	LINGCOD	15.879	3.087	46.090	2.642	0.020	50.293	19.297	0.326	107.092	19.810	0.295	50.829	29.411	0.250	57.555	27.043	0.028	25.805
2004	LONGFIN SANDDAB	0.243		0.037	0.021														
2004	LONGNOSE SKATE																		
2004	MEXICAN ROCKFISH	0.036																	
2004	OCEAN WHITEFISH	12.857	0.575	2.122	5.136	1.514	2.069	0.134		0.006									
2004	OLIVE ROCKFISH	3.624	0.232	0.513	5.843	0.122	1.529	28.214	0.076	0.428	12.153	0.029	0.061	1.004		0.102	0.574	0.003	0.013
2004	OPALEYE	5.572	0.063	0.349	0.239	0.010	0.166												
2004	PACIFIC BARRACUDA	401.085	88.476	215.427	14.120	0.554	3.889	0.025		0.060									
2004	PACIFIC BONITO	121.831	25.008	101.395	4.222	0.153	2.585	0.524		0.024									
2004	PACIFIC COD																		
2004	PACIFIC HAKE	0.030						0.025		0.210	0.012		0.295	0.279	0.007	0.108	0.006	0.004	0.301
2004	PACIFIC HALIBUT																0.046		
2004	PACIFIC HERRING																0.001		0.000
2004	PACIFIC SANDDAB	16.680	1.071	0.598	2.079		0.196	19.696	1.256	1.224	1.650	0.006	0.080	0.148	0.003				
2004	PACIFIC SARDINE	0.022	0.114	0.001	0.005											0.001			
2004	PACIFIC STAGHORN SCULPIN										0.015	0.001	0.045	0.410		0.109			
2004	PACIFIC TOMCOD																		
2004	PETRALE SOLE				0.164			0.064						0.004			0.036		0.010
2004	PILE PERCH	0.038			0.003						0.060		0.002						
2004	QUEENFISH	0.027		0.035															
2004	QUILLBACK ROCKFISH							0.020			1.912	0.019	0.003	0.251		0.073	0.956		0.129
2004	RAINBOW SEAPERCH				0.001														
2004	RAINBOW TROUT																		
2004	RED IRISH LORD																		
2004	REDBANDED ROCKFISH																		
2004	REDSTRIPE ROCKFISH																		
2004	REDTAIL SURFPERCH										0.030						0.012		
2004	RIGHTEYE FLOUNDER FAMILY	0.034	0.007																
2004	ROCK GREENLING							0.030		0.010	0.073		0.016	0.135		0.009	0.006		0.011
2004	ROCK SOLE				0.183			0.302		0.002	0.005			0.064			0.020		0.007
2004	ROCK WRASSE	0.671		0.113															
2004	ROCKFISH GENUS	0.075	2.935	5.249	0.553	1.170	11.650	0.520	1.724	28.489	1.669	0.312	1.220	1.466	0.131	1.609	4.194	0.007	1.245
2004	ROSETHORN ROCKFISH	0.001												0.006		0.002			
2004	ROSY ROCKFISH	0.507	0.028		3.890	0.001	0.008	0.076		0.018	0.257	0.021	0.060	0.012	0.014	0.033	0.012		
2004	RUBBERLIP SEAPERCH	0.271	0.009	0.014	0.020	0.011		0.004			0.001		0.007						
2004	SABLEFISH	0.002																	
2004	SALEMA	0.001																	
2004	SALMON GENUS													1.877					
2004	SAND SOLE				0.015			0.455			0.011		0.003	0.057			0.001		

		OR - South (Curry - Douglas)			OR - Central (Lane - Lincoln)			OR - North (Tillamook - Clatsop)			WA - South (Pacific)			WA - Central (Grays Harbor)			WA - North (Jefferson - Clallum)		
		A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT	A MT	B1 MT	B2 MT
year	COMMON	awe_d7	b1we_d7	b2we_d7	awe_d8	b1we_d8	b2we_d8	awe_d9	b1we_d9	b2we_d9	awe_d10	b1we_d10	b2we_d10	awe_d11	b1we_d11	b2we_d11	awe_d12	b1we_d12	b2we_d12
2004	ALBACORE	10.281			129.354			5.120			13.627	0.043	0.171	85.396	0.007	0.050	1.935		
2004	ARROWTOOTH FLOUNDER				0.033														
2004	BANK ROCKFISH																		
2004	BARRED SANDBASS																		
2004	BARRED SURFPERCH																		
2004	BAT RAY																		
2004	BIG SKATE	0.817			0.063														
2004	BIGMOUTH SOLE																		
2004	BLACK AND YELLOW ROCKFISH	0.002																	
2004	BLACK CROAKER																		
2004	BLACK PERCH																		
2004	BLACK ROCKFISH	75.114	1.135	2.105	255.896	0.562	1.033	0.256	0.001	0.003	34.875	0.720	0.001	246.168	1.799	0.200	164.347	38.418	4.265
2004	BLACKGILL ROCKFISH																		
2004	BLACKSMITH																		
2004	BLUE ROCKFISH	8.151	0.336	0.429	12.144	0.084	0.107	0.048			0.004			0.344	0.001	0.000	1.267	0.144	0.016
2004	BLUE SHARK	0.022			1.311			0.040											
2004	BLUEFIN TUNA																		
2004	BOCACCIO	0.002			0.164									0.127			0.241	0.200	
2004	BROWN ROCKFISH				0.012														
2004	BROWN SMOOTHHOUND																		
2004	BUFFALO SCULPIN	0.005		0.001	0.009		0.023												
2004	BUTTER SOLE	0.012			0.008														
2004	CABEZON	3.071		0.435	13.647		1.399	0.654		0.068	1.173	0.019	0.358	1.107	0.021	0.393	5.322	0.083	1.576
2004	CALICO ROCKFISH																		
2004	CALIFORNIA CORBINA																		
2004	CALIFORNIA HALIBUT	0.008			0.003														
2004	CALIFORNIA LIZARDFISH																		
2004	CALIFORNIA SCORPIONFISH																		
2004	CALIFORNIA SHEEPHEAD																		
2004	CANARY ROCKFISH	0.067	0.955	0.382	0.076	2.121	0.848				0.006	0.051	0.027	0.048	0.205	0.106	0.182	1.796	0.925
2004	CHILIPEPPER				0.007														
2004	CHINA ROCKFISH	0.605	0.013	0.009	1.375	0.037	0.017	0.006			0.068	0.006	0.001	0.046	0.014	0.002	1.796	1.125	0.125
2004	CHINOOK SALMON	36.993		1.157	177.781		6.853	14.258		1.754	84.961	46.043	107.433	81.857	38.993	90.984	55.270	22.032	51.408
2004	CHUB (PACIFIC) MACKEREL	0.055		0.039	0.035		0.004	0.009		0.000									
2004	CHUM SALMON				0.002									0.033			0.110		
2004	COD FAMILY										0.093	0.011		2.987	0.119		5.442	1.613	
2004	COHO SALMON	3.999			149.525			71.842			292.617	64.315	150.075	135.902	24.593	57.243	173.727	69.465	162.034
2004	COPPER ROCKFISH	0.155			1.842						0.036			0.091	0.006	0.001	1.290	0.608	0.068
2004	COWCOD																		
2004	CURLFIN SOLE				0.001														
2004	DIAMOND TURBOT																		
2004	DOLPHINFISH																		
2004	DOVER SOLE	0.002																	
2004	FANTAIL SOLE																		
2004	FINESCALE TRIGGERFISH																		
2004	FLAG ROCKFISH																		
2004	FLATFISH ORDER				0.033						1.339	0.053	1.711	1.338	0.086	2.768	1.484	0.088	2.855
2004	FRECKLED ROCKFISH																		
2004	GIANT KELPFISH																		
2004	GIANT SEABASS																		
2004	GOPHER ROCKFISH																		
2004	GRASS ROCKFISH	0.015																	
2004	GRAY SMOOTHHOUND																		
2004	GREENBLOTCHED ROCKFISH																		
2004	GREENSPOTTED ROCKFISH				0.017														
2004	GREENSTRIPED ROCKFISH				0.051	0.068													
2004	HALFBANDED ROCKFISH																		
2004	HALFMOON																		
2004	HONEYCOMB ROCKFISH																		
2004	JACK MACKEREL	0.041			0.226														
2004	JACKSMELT																		
2004	KELP BASS																		
2004	KELP GREENLING	0.726		0.265	3.343		0.104	0.099		0.004	0.308	0.001	0.025	0.809	0.007	0.138	2.935	0.077	1.465
2004	KELP ROCKFISH																		
2004	LEFTEYE FLOUNDER FAMILY																		
2004	LEOPARD SHARK																		
2004	LINGCOD	27.426	0.358	4.062	76.727	2.554	34.688	0.781	0.007	0.100	1.745	0.056	1.065	26.811	0.675	12.817	41.923	1.724	32.763
2004	LONGFIN SANDDAB																		
2004	LONGNOSE SKATE				0.120														
2004	MEXICAN ROCKFISH																		
2004	OCEAN WHITEFISH																		
2004	OLIVE ROCKFISH																		
2004	OPALEYE																		
2004	PACIFIC BARRACUDA																		
2004	PACIFIC BONITO																		
2004	PACIFIC COD				0.004						0.012	0.028		11.888	0.162		12.057	3.118	
2004	PACIFIC HAKE	0.031	0.094	0.029	0.406	0.409	0.217		0.001	0.061									
2004	PACIFIC HALIBUT				138.329	0.021	21.178	4.274	0.022	0.762	5.072	0.077	2.487	38.279	0.172	5.566	168.300	0.814	26.333
2004	PACIFIC HERRING				0.045														
2004	PACIFIC SANDDAB	0.414			1.426														
2004	PACIFIC SARDINE				0.001														
2004	PACIFIC STAGHORN SCULPIN																		
2004	PACIFIC TOMCOD							0.011											
2004	PETRALE SOLE				0.049			0.091											
2004	PILE PERCH																		
2004	QUEENFISH																		
2004	QUILLBACK ROCKFISH	0.361	0.001	0.001	2.041	0.007	0.010				0.044	0.008		0.864	0.097		2.444	1.107	
2004	RAINBOW SEAPERCH																		
2004	RAINBOW TROUT				0.035			0.067											
2004	RED IRISH LORD	0.011		0.002	0.021		0.026	0.021											
2004	REDBANDED ROCKFISH				0.038														
2004	REDSTRIPE ROCKFISH				0.017														
2004	REDTAIL SURFPERCH				0.006														
2004	RIGHTEYE FLOUNDER FAMILY																		
2004	ROCK GREENLING	0.041			0.008			0.014											
2004	ROCK SOLE				0.006														
2004	ROCK WRASSE																		
2004	ROCKFISH GENUS				0.009						0.014			1.456	0.500	0.056	0.199	0.157	0.017
2004	ROSETHORN ROCKFISH				0.008	0.008													
2004	ROSY ROCKFISH	0.001			0.002														
2004	RUBBERLIP SEAPERCH																		
2004	SABLEFISH	0.008			2.609		2.985	0.164		0.291									
2004	SALEMA																		
2004	SALMON GENUS																		
2004	SAND SOLE	0.012		0.000	0.063		0.010												

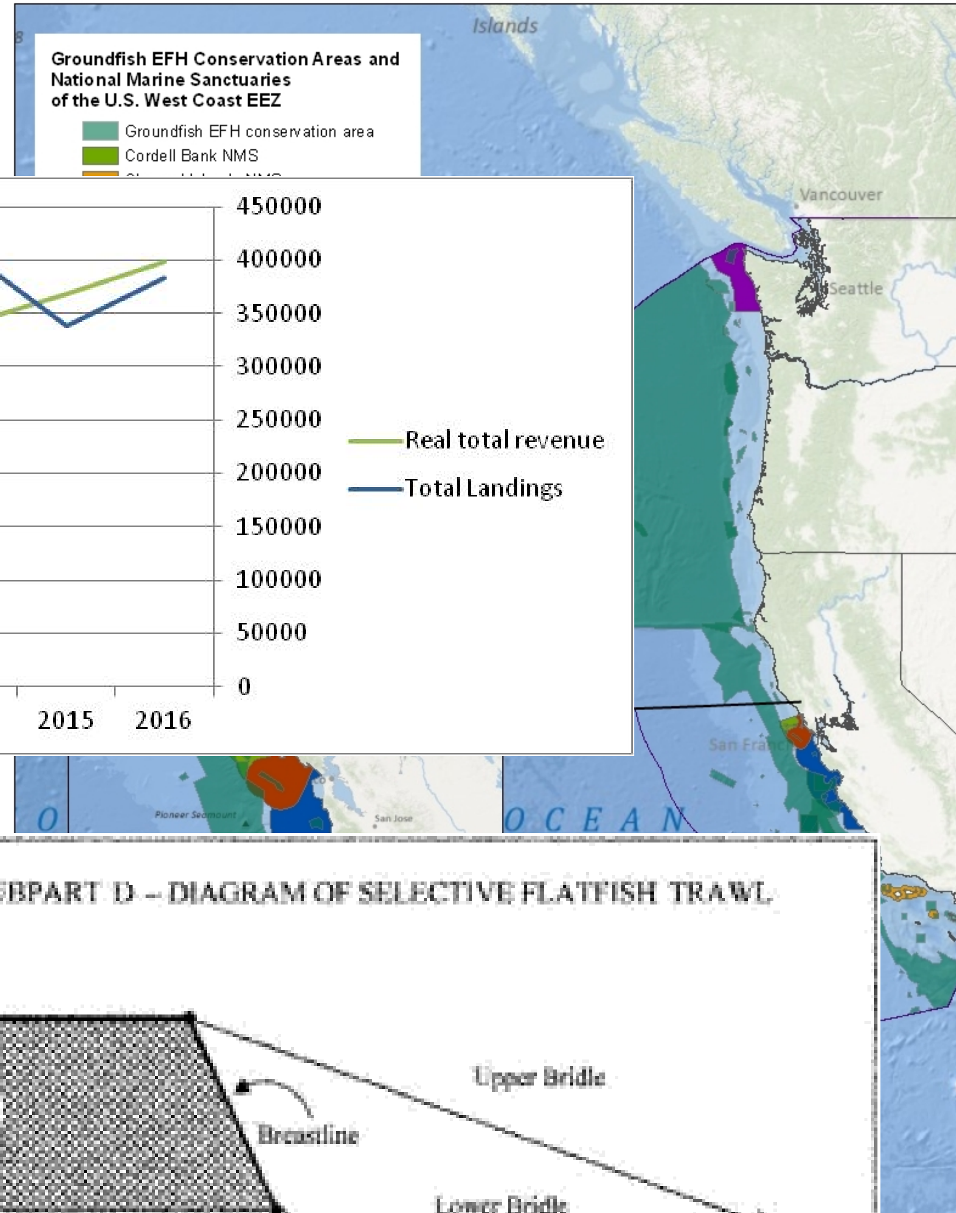
James Buchanan.

President of the United States of America.

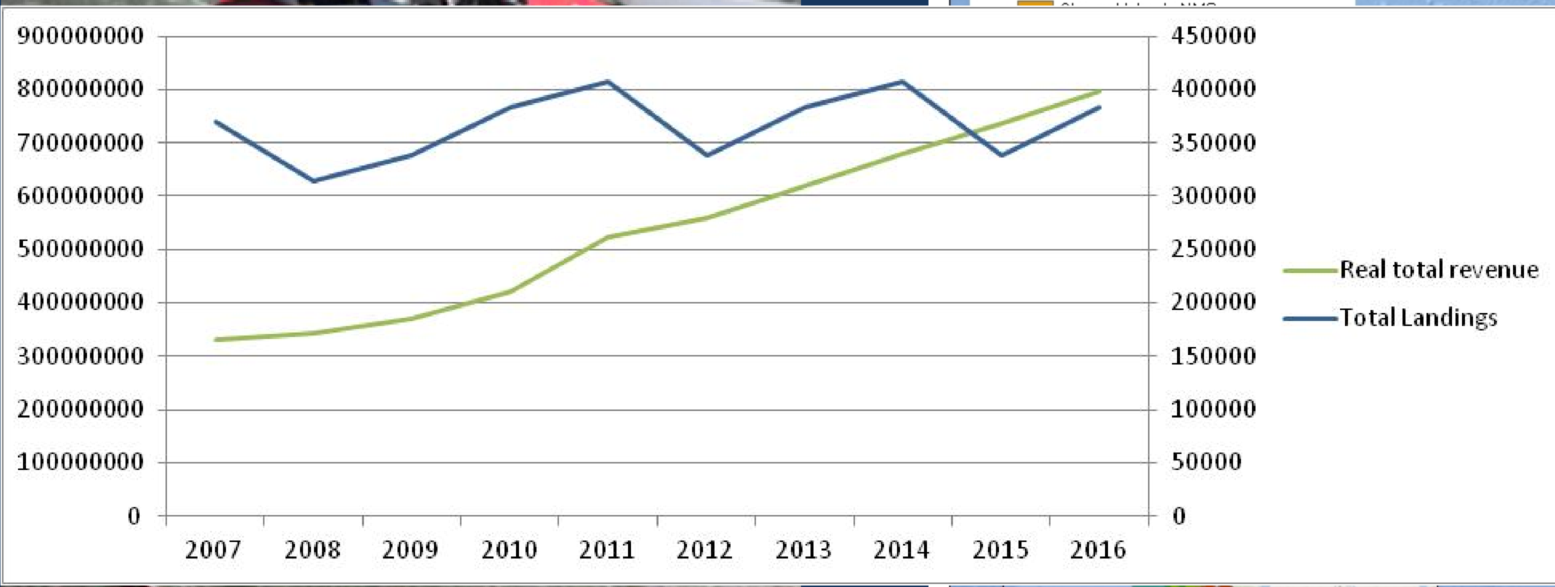
To all and singular to whom These Presents shall come Greeting:

Whereas a Treaty was made and concluded at Neah Bay, in the Territory of Washington, on the thirty first day of January, eighteen hundred and fifty-five, between Isaac I. Stevens, Governor and Superintendent of Indian Affairs for said Territory, on the part of the United States, and the hereinafter named Chiefs, Headmen and Delegates of the several villages of the Makah tribe of Indians, viz: Neah-Waatch, Tsoo-Yess and Osett, occupying the country around Cape Classet or Flattery, on behalf of the said


NPAFC
NORTH PACIFIC ANADROMOUS FISH COMMISSION
PACIFIC SALMON COMMISSION
International Pacific Halibut Commission
STATE OF WASHINGTON
GREAT SEAL OF THE STATE OF IDAHO
ESTO PERPETUA
STATE OF OREGON
THE UNION
1859
108TH CONGRESS 2d Session
SENATE
TREATY DOC. 108–24
AGREEMENT WITH CANADA ON PACIFIC HAKE/WHITING
MESSAGE
FROM
THE PRESIDENT OF THE UNITED STATES
TRANSMITTING
AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF CANADA ON PACIFIC HAKE/WHITING (THE "AGREEMENT"), DONE AT SEATTLE, NOVEMBER 21, 2003
JUNE 16, 2004.—The treaty was read the first time, and together with the accompanying papers, referred to the Committee on Foreign Relations and ordered to be printed for the use of the Senate
U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 2004
IDAHO • OREGON • ALASKA
PACIFIC STATES MARINE FISHERIES COMMISSION
WASHINGTON • CALIFORNIA
THE GREAT SEAL OF THE STATE OF CALIFORNIA
EUREKA
NV
Western and Central Pacific Fisheries Commission
CIAT
IATTC



Islands
Groundfish EFH Conservation Areas and National Marine Sanctuaries of the U.S. West Coast EEZ
Groundfish EFH conservation area
Cordell Bank NMS
Vancouver
Seattle
San Fra
OCEAN



900000000
800000000
700000000
600000000
500000000
400000000
300000000
200000000
100000000
0
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Real total revenue
Total Landings

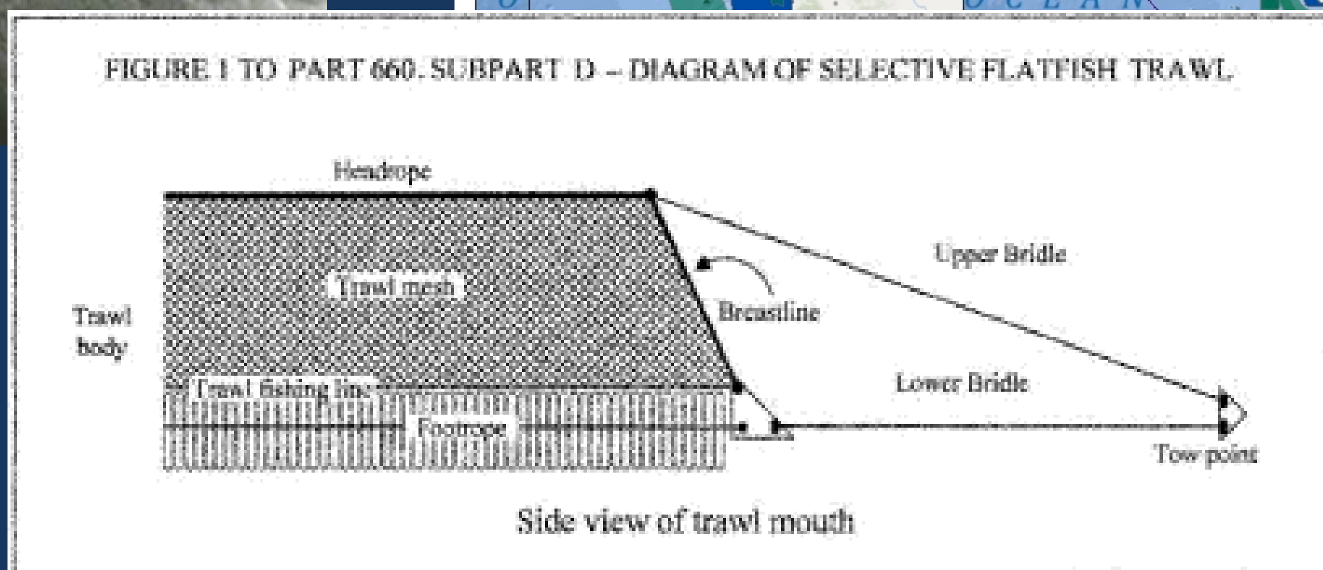
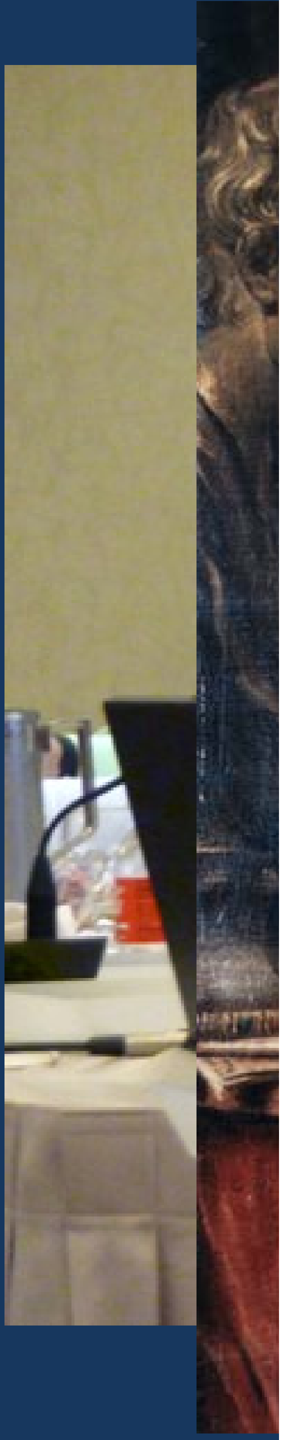


FIGURE 1 TO PART 660, SUBPART D – DIAGRAM OF SELECTIVE FLATFISH TRAWL
Headrope
Upper Bridle
Trawl mesh
Breastline
Trawl body
Trawl fishing line
Lower Bridle
Footrope
Tow point
Side view of trawl mouth

Table 3.3.1 Non-Fishing Human Activities that May Negatively Affect EFH for One or More Council-Managed Species

Coastal or Marine Habitat Activities	Freshwater or Land-Based Habitat Activities
Alternative Offshore Energy Development	Agriculture
Artificial Propagation of Fish and Shellfish	Artificial Propagation of Fish and Shellfish
Climate Change and Ocean Acidification	Bank Stabilization
Desalination	Beaver removal and Habitat Alteration
Dredging and Dredged Spoil Disposal	Climate Change and Ocean Acidification
Estuarine Alteration	Construction/Urbanization
Habitat Restoration Projects	Culvert Construction
Introduction/Spread of Nonnative Species	Desalination
Military Exercises	Dam Construction/Operation
Offshore Mineral Mining	Dredging and Dredged Spoil Disposal
Offshore Oil and Gas Drilling and Liquefied Natural Gas Projects	Estuarine Alteration
Over-Water Structures	Flood Control Maintenance
Pile Driving	Forestry
Power Plant Intakes	Grazing
Sand and Gravel Mining	Habitat Restoration Projects
Shipping Traffic and Ocean-based Pollution	Irrigation/Water Management
Vessel Operation	Military Exercises
Wastewater/Pollutant Discharge	Mineral Mining
	Introduction/Spread of Nonnative Species
	Pesticide Use
	Road Building and Maintenance
	Sand and Gravel Mining
	Vessel Operation
	Wastewater/Pollutant Discharge
	Wetland and Floodplain Alteration
	Woody Debris/ Structure Removal



Agenda Item H.1., Attachment 1
Draft FEP
November 2012

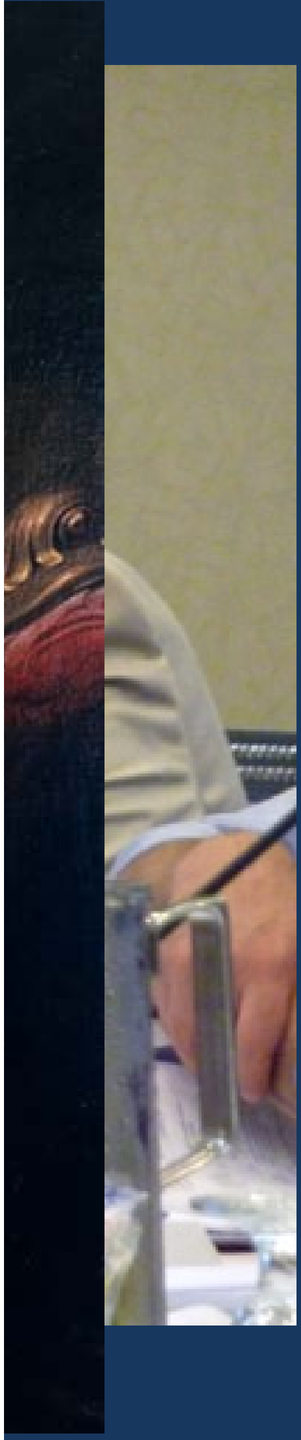
Pacific Coast Fishery Ecosystem Plan

for the U.S. portion of the California Current Large Marine Ecosystem

DRAFT

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

November 2012



For those images where sources are not shown directly on image, all were either created for the June 2012 Draft FEP, or courtesy of the U.S. National Oceanic and Atmospheric Administration, except:

Slide 2: California bioregions; California Natural Resources Agency
Slide 4: Northeast Pacific Ocean; NASA/Goddard Space Flight Center. Congressional Pugilists, 1798; Library of Congress.
Slide 7: California Current trophic pathways diagram, John C. Field, Status of California Current Ecosystem at a Glance, NOAA. (Repeated at Slide 9)
Slide 10: common murre; USFWS. snuggling lingcod; Alaska Department of Fish and Game.
Slide 13: Historic fisheries landings: Field, J.C. and R.C. Francis. 2006. Considering ecosystem-based fisheries management in the California Current. Marine Policy 30: 552-569.
Slide 16: 1970s era Pacific Fishery Management Council; PFMC. Treaty of Neah Bay; Washington State Department of State.
Slide 17: State seals from Idaho, Oregon, and Washington each from their respective Secretaries of State. California state seal; California State Library. Images and logos from websites of organizations indicated.
Slide 18: Council members; Pacific Fishery Management Council.
Slide 20: Northwest Training Ground Complex map; U.S. Navy. Ship discharge diagram; U.S. Environmental Protection Agency. Outer Continental Oil and Gas Strategy map; U.S. Department of Interior.
Slide 21: Earth from space: NASA.
Slide 22: Martin, David, artist, “Benjamin Franklin.” 1767; Library of Congress. Army NCO of the Year 2007, Jason Seifert, demonstrates proper push-up technique in presence of drill instructor; photo, U.S. Air Force Tech. Sgt. Larry. A. Simmons. Council members; Pacific Fishery Management Council

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON
COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

The Coastal Pelagic Species Advisory Subpanel (CPSAS) reviewed the current draft Pacific Coast Fishery Ecosystem Plan (Agenda Item H.1.a Attachment 1) and the draft outline for the Annual State of the California Current Ecosystem Report (Agenda Item H.1.a Attachment 2). We extend our thanks to the Ecosystem Plan Development Team (EPDT) for the time and effort they have dedicated to this work. The draft Fishery Ecosystem Plan was highly informative. We look forward to the next iteration of this document in November. The CPSAS offers a few comments on these documents.

Regarding priority work for the development of the Ecosystem Plan, the CPSAS was pleased to learn the EPDT has started to examine interactions between fisheries and some of the unmanaged forage fish discussed under Agenda Item G.1. We would encourage the EPDT to continue this work.

With respect to the outline for an Annual Report, the CPSAS concurs with the Council recommendation that the length of the annual report should be limited to no more than 20 pages, and should incorporate research from National Marine Fisheries Service Science Centers in addition to other relevant scientific processes and institutions.

The CPSAS is supportive of the content of the Annual Report as outlined and notes that the physical indicators such as sea surface temperature conditions, primary productivity, and river/stream outflows are particularly useful in understanding annual abundance and distribution of CPS species. We suggest also including water chemistry parameters such as pCO_2, pH, salinity and other measurements, now currently collected on a growing network of buoys along the west coast, as this information will be essential to understand future impacts of ocean acidification on marine resources and fisheries.

PFMC
06/23/12

ECOSYSTEM ADVISORY SUBPANEL REPORT ON
COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

The Ecosystem Advisory Subpanel (EAS) reviewed the Draft Fishery Ecosystem Plan (FEP) (Agenda Item H.1.a, Attachment 1) and received a report from members of the Ecosystem Plan Development Team. The Ecosystem Advisory Subpanel (EAS) appreciates the progress on development of the FEP and in particular, the depth of information describing ecosystem level attributes in Chapter 3.

Recommendations:

1. The EAS recommends adopting the FEP objectives as listed in Chapter 2 of the draft FEP (Agenda Item H.1.a, Attachment 1) with the following modifications.

   2. *Build toward fuller assessment of the greatest long-term benefits from the conservation and management of marine fisheries, <u>of optimum yield,</u> and of the tradeoffs needed to achieve those benefits while maintaining the integrity of the California Current Ecosystem (CCE) through:*

   3.b. Providing a nexus to regional, national, <u>and international</u> ecosystem-based management endeavors, particularly to address the consequences of non-fishing activities on fisheries and fish habitat;

2. Make the following modifications or additions to the FEP
   - Include a brief summary in Section 3.5 on species listed under the Endangered Species Act to better understand their status and interactions with fisheries.
   - Add a section to Chapter 3 on the relative severity of weather throughout the California Current Ecosystem with respect to safety at-sea.

3. Encourage inclusion of the following in further development of the FEP
   - Create clear linkages between ecosystem science and existing fishery management plans to improve management outcomes. For example, consider illustrations from other marine ecosystem management processes or frameworks such as, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), European Water Framework Directive, and the Alaska Region.
   - Consider greater use of figures and graphics to illustrate ecological relationships and processes.
   - Provide analyses that highlight key vulnerabilities and opportunities to enhance management.

PFMC
06/23/12

Agenda Item H.1.c
Supplemental GAP Report
June 2012

GOUNDFISH ADVISORY SUBPANEL REPORT ON COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

The Groundfish Advisory Subpanel (GAP) received a presentation from Mr. Mike Burner about the documents and issues under Pacific Fishery Management Council (Council) consideration. It appears the Ecosystem Plan Development Team is on the right track in developing an informational Fishery Ecosystem Plan (FEP), as directed by the Council. The GAP reiterates our previous recommendation that the FEP should be an informational document that provides a basis to broaden the scope of Council decisions. The FEP should not create new regulatory authorities at this time.

PFMC
06/21/12

Agenda Item H.1.c
Supplemental HC Report
June 2012

HABITAT COMMITTEE REPORT ON COUNCIL FISHERY ECOSYSTEM PLAN DEVELOPMENT

The Habitat Committee (HC) discussed Fishery Ecosystem Plan development. The HC believes that both the Fishery Ecosystem Plan and the annual State of the California Current Ecosystem Report should include, as an objective, ensuring that policy implications related to fisheries management decisions are clear. The biological implications of indices such as sea surface temperature anomalies, regional upwelling, and basin-scale climate indicators need to be explained so that managers can better understand the risks and benefits of policy decisions related to these changing conditions.

In addition, the annual report should include:

- state of ocean pH conditions (ocean acidification)
- information on the status of invasive species in the California Current Ecosystem
- information on harmful algae blooms

PFMC
06/20/12

Agenda Item H.1.c
Supplemental SSC Report
June 2012

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON COUNCIL FISHERY ECOSYSTEM PLAN (FEP) DEVELOPMENT

The Scientific and Statistical Committee (SSC) reviewed the latest version of the Pacific Coast Fishery Ecosystem Plan and the Draft Outline for an Annual State of the California Current Ecosystem (CCE) Report. Mr. Mike Burner outlined the proposed schedule for integration of ecosystem considerations into the Council.

The SSC notes that development of a description of biological, physical, geological, economic and other aspects of the CCE for the Ecosystem Plan is a formidable task and questioned whether it could be accomplished on the current schedule. The current version has missing chapters and the chapters present are often not adequate descriptions of the CCE. One example is that the material on the effects of increasing ocean temperature, acidification and areas with low dissolved oxygen in the version reviewed in November 2011 is not in the current version (but may have been moved to a chapter not yet included in the draft). A second example is the attribution of a description (on p. 8) of circulation features to a publication by Botsford and Lawrence (who are not physical oceanographers). A third is the description of bird population variability in the CCE that omits mention of the complete reproductive failure of Cassin's auklet in 2005 and the high variability in reproduction of Brandt's cormorant in the Gulf of the Farallons. There are additional examples. These suggest that the Ecosystem Plan Development Team (EPDT) should seek assistance from others with expertise in CCE processes, either through review or requests to write specific sections.

The SSC also recommends that the Draft Outline of the Annual State of the CCE should be reviewed by experts in the various areas. With regard to item IV.c, the trawl-survey referred to is likely the Groundfish Trawl Survey, and if so, the SSC cautions that selectivity and catchability be considered in formulating the Higher Trophic Level Predator Index. The SSC questioned the interpretation of item V.c, the mean trophic level of the catch, in an upwelling system where lower trophic level fish have such high population variability. With regard to item V.d, the SSC questioned how the stressors (e.g., shipping) were related to ecosystem effects. The SSC recommends that Section V be divided into benefits, stressors (including hatcheries and aquaculture releases, sewage and pollutants) and beneficial human interventions (including Marine Protected Areas).

The SSC looks forward to review of more complete, fully referenced and comprehensively reviewed versions of these two documents.

PFMC
06/23/12