Monterey Bay Aquarium
Seafood Watch®

Arrowtooth flounder, Dover sole, English sole, Pacific sanddab, Petrale sole, Rex sole, Starry flounder

Atheresthes stomia, Microstomus pacificus, Parophrys vetulus, Citharichthys sordidus, Eopsetta jordani, Glyptocephalus zachirus, Platichthys stellatus

Image ©Monterey Bay Aquarium

California, Oregon, Washington

Bottom trawl

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About Seafood Watch®

The Monterey Bay Aquarium Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the North American marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's mission is to engage and empower consumers and businesses to purchase environmentally responsible seafood fished or farmed in ways that minimize their impact on the environment or are in a credible improvement project with the same goal.

Each sustainability recommendation is supported by a seafood report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's sustainability criteria to arrive at a recommendation of "Best Choice," "Good Alternative," or "Avoid." In producing the seafood reports, Seafood Watch utilizes research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch research analysts also communicate with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying seafood reports will be updated to reflect these changes. Both the detailed evaluation methodology and the scientific reports, are available on seafoodwatch.org.

For more information about Seafood Watch and seafood reports, please contact the Seafood Watch program at Monterey Bay Aquarium by calling 1-877-229-9990 or visit online at seafoodwatch.org.

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Guiding Principles

Seafood Watch® defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following **guiding principles** illustrate the qualities that capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species under assessment
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and score
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rating** for that criterion

Once a score and rating has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ratings and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

Best Choice/Green: Are well managed and caught or farmed in ways that cause little harm to habitats or other wildlife.
Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught or farmed.
Avoid/Red: Take a pass on these for now.

1 "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

Summary

This analysis encompasses the major commercial flatfish species that are caught in the U.S. West Coast commercial non-hake groundfish fisheries off the coast of California, Oregon, and Washington. Virtually all the catch is with bottom trawl (>99%) and remains on the U.S. market (>95%). The top-most landed species are Dover sole (63%), arrowtooth flounder (20%), and petrale sole (9%). This report does not cover halibut.

Dover sole, arrowtooth flounder, English sole, Pacific sanddab, rex sole, and starry flounder are all considered to be well above management targets for biomass and well below fishing mortality thresholds. Petrale sole biomass has been below limit reference points for much of the last three decades or longer. The most recent assessment indicates that biomass has increased to a level approaching the target reference point. Fishing mortality also remains relatively high for petrale sole, but below the level at which overfishing would be considered occurring.

Because of the multispecies nature of the U.S. West Coast non-hake commercial groundfish fisheries, the distinction between “targeted” and “bycatch” species is not often clear. The fish species included under Criterion 2 are either not groundfish (e.g., California sheephead), or groundfish that are primarily discarded in all fisheries in which they are caught in significant amounts. (For example, longnose skate is not included as a Criterion 2 species because it is primarily discarded in several fisheries but landed in significant amounts in the trawl fishery). In general, there are few true “bycatch” species that are caught in substantial amounts across all groundfish fisheries. Information availability informs the scores for Criterion 2 species (as it does for Criterion 1), and several species have conservative scores because of a lack of information.

The Seafood Watch criteria define effective management via a number of guidelines. Because of the multispecies nature of some West Coast groundfish fisheries, achieving all the requirements is challenging. But the management of the groundfish stocks caught in the West Coast groundfish fisheries is strong, because it is characterized by up-to-date stock assessments and management measures such as biomass reference points, harvest control rules, and incorporation of uncertainty when determining catch limits.

By their nature, “groundfish” tend to be demersal species (living on or near the seafloor), so the fisheries that target them use bottom-tending gear. A wealth of scientific information suggests that mobile bottom trawl gear should be expected to have the most significant impacts of all the gear used in the West Coast fisheries. These impacts are particularly great over hard substrate, which is the sort of habitat associated with arrowtooth flounder but not the other flatfish assessed here. In recognition of the potential for bottom-tending gear to damage habitat, a number of spatial restrictions on gear use are in place. These restrictions particularly limit the use of bottom trawl gear, so they offer a degree of mitigation of bottom trawl habitat impacts.

This assessment covers approximately 98%–99% of the flatfish catch on the U.S. West Coast. Dover sole, English sole, Pacific sanddab, rex sole, and starry flounder are all Best Choices, accounting for about 69% of the flatfish catch. Arrowtooth flounder and Petrale sole are Good Alternatives, and account for approximately 29% of the flatfish catch.

Some flatfish stocks in the U.S. West Coast groundfish fishery are certified sustainable to the Marine Stewardship Council standard. These are Dover sole, English sole, arrowtooth flounder, and petrale sole.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Arrowtooth flounder - Trawl, Bottom	Green (3.83)	Yellow (2.71)	Green (3.46)	Yellow (2.45)	**Good Alternative (3.063)**
Dover sole - Trawl, Bottom	Green (5.00)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Best Choice (3.469)**
English sole - Trawl, Bottom	Green (5.00)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Best Choice (3.469)**
Pacific sanddab - Trawl, Bottom	Green (5.00)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Best Choice (3.469)**
Petrale sole - Trawl, Bottom	Yellow (3.05)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Good Alternative (3.066)**
Rex sole - Trawl, Bottom	Green (5.00)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Best Choice (3.469)**
Starry flounder - Trawl, Bottom	Green (4.47)	Yellow (2.64)	Green (3.46)	Yellow (3.16)	**Best Choice (3.373)**

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, **and** no Red Criteria, **and** no Critical scores
- **Good Alternative/Yellow** = Final score >2.2, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern,[2] **and** no more than one Red Criterion, **and** no Critical scores, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern,[2] **or** two or more Red Criteria, **or** one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

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Introduction

Scope of the analysis and ensuing recommendation

This analysis encompasses the major commercial flatfish species that are caught in the U.S. West Coast commercial non-hake groundfish fisheries off the coast of California, Oregon, and Washington. Virtually all are caught with bottom trawl.

Overview of the species and management bodies

There are over 90 species listed in the West Coast Groundfish Fishery Management Plan (FMP), including rockfish, flatfish, and numerous other species caught off California, Oregon, and Washington. The fishery for these species has gone through several identifiable stages since World War II (Hanna, S. 2000). The first postwar stage was dominated by foreign fleets and characterized by increasing catches from the late 1940s through 1960 (Hanna, S. 2000). The fishery began to transition toward a domestic fleet after implementation of the Magnuson-Stevens Act and the establishment of the Exclusive Economic Zone (EEZ), but the rapid buildup of the domestic fleet during the 1970s and 1980s led to fleet overcapitalization (PFMC & NMFS 2010). A combination of fishery pressure and natural factors drove sharp downturns in the abundance of many commercial groundfish species during the 1980s and 1990s; to manage and reduce capacity, the fishery was differentiated into Limited Entry and Open Access programs in 1994 (Shaw, W. & Conway, F.D.L. 2007). In 2002, nine species of groundfish were declared “overfished,” and the entire shelf was closed to trawling (Shaw, W. & Conway, F.D.L. 2007). Since then, catches of rockfish (*Sebastes* spp.) have been low relative to historical levels, and flatfish have supplanted rockfish as the primary component of landings (Figure 1; (PFMC 2014)).

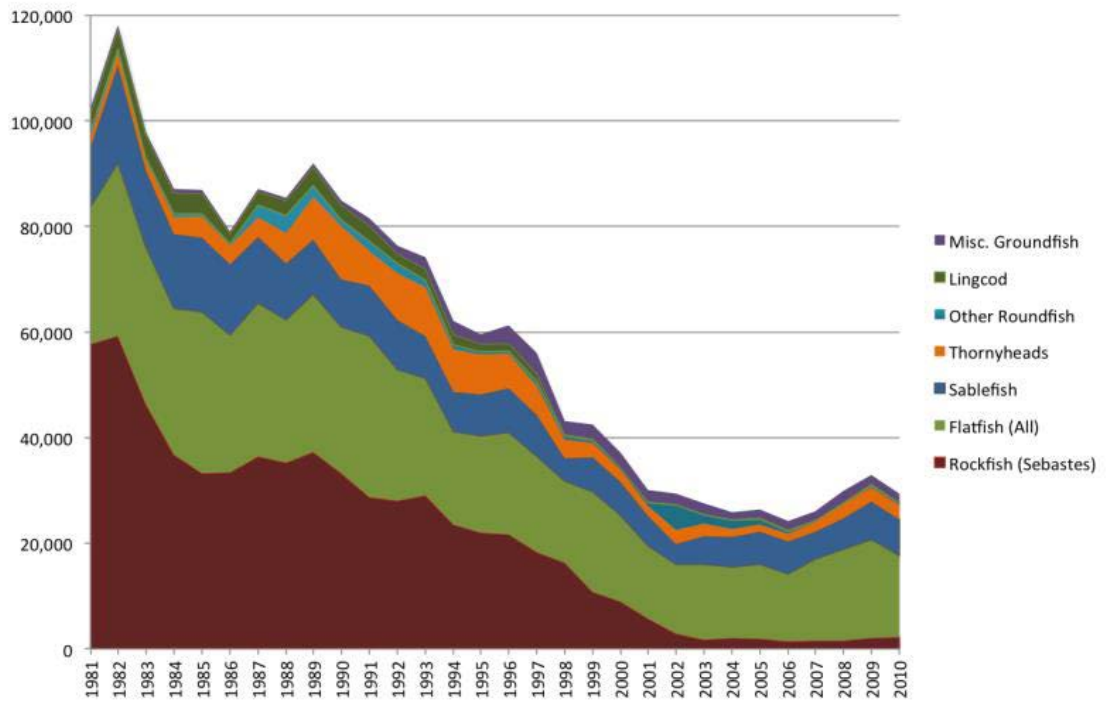


Figure 1. Composition of recent groundfish catches, 1981-2010 (Data from PFMC 2014).

Since 2002, management measures have allowed the overfished stocks to begin to rebuild, and fishing effort has been significantly reduced for many other stocks. Six stocks are currently classified as rebuilding.

The commercial groundfish fishery on the U.S. West Coast comprises Limited Entry (LE), Open Access (OA), and Nearshore (NS) components. The LE component is divided into sectors identified by gear/species endorsements: trawl, fixed gear with sablefish endorsement, and fixed gear without sablefish endorsement. The limited entry and open access sectors are managed by the Pacific Fishery Management Council (PFMC). The PFMC recommends measures to the Secretary of Commerce via the National Marine Fisheries Service (NMFS), and the measures are implemented by NMFS regional offices. The Nearshore North and Nearshore South fixed gear fisheries are jointly managed by the PFMC and state authorities in Oregon and California, respectively; there is no nearshore groundfish fishery in state-managed waters off the coast of Washington (NWFSC 2014).

As of 2011, limited entry trawl permit holders can participate in a new catch share program. One of the primary changes associated with the catch share program is an increase in at-sea and dockside monitoring; whereas the non-IFQ (individual fishing quota) fisheries have varying levels of at-sea observer coverage, the catch share program requires 100% at-sea and dockside monitoring. Participants in this program receive a share of the catch of 29 commercial species/species-area complexes (NMFS Northwest Region 2012). Entry into the program is limited to holders of LE trawl permits, but these participants can use non-trawl gear to catch their quota shares (NMFS Northwest Region 2012). Some fishermen in the IFQ program do appear to be switching from trawls to other gear, such as pots and

hook and line gears, to catch sablefish. Thus, as of 2012, the IFQ fisheries can be described as multispecies IFQ trawl, and two sablefish-focused IFQ fixed gear fisheries: one using hook and line gear, and the other using pot gear.

Production Statistics

Groundfish landings are dominated by flatfish (Figure 2), with Dover sole the primary flatfish species (Figure 3). Virtually all flatfish are caught with bottom trawl (>99% in 2012; Bellman et al. 2013). In recent years, rebuilding plans have curtailed catches of the *Sebastes* species that had once dominated rockfish landings (e.g., Pacific ocean perch, widow rockfish, canary rockfish, and yellowtail rockfish (J. Field, pers. comm.; Figure 1). Currently, rockfish and thornyhead landings are dominated by longspine and shortspine thornyhead (*Sebastolobus* spp.), with a number of *Sebastes* species also landed. Other species that are landed in significant amounts include longnose skate, spiny dogfish, lingcod, and Pacific cod.

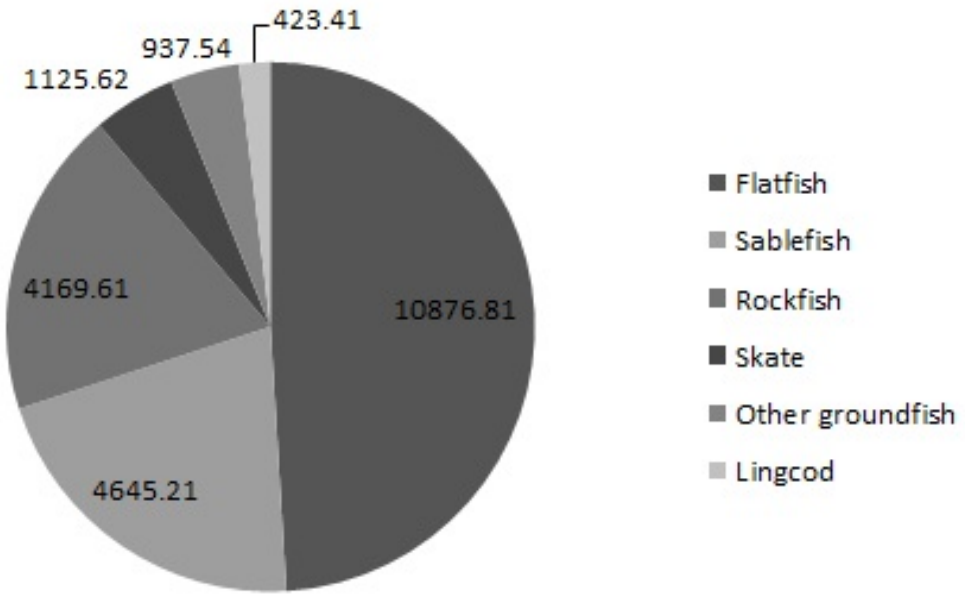


Figure 2. Composition of the catch in the non-hake commercial groundfish fisheries, 2012 (landings, tons) (Bellman et al. 2013)

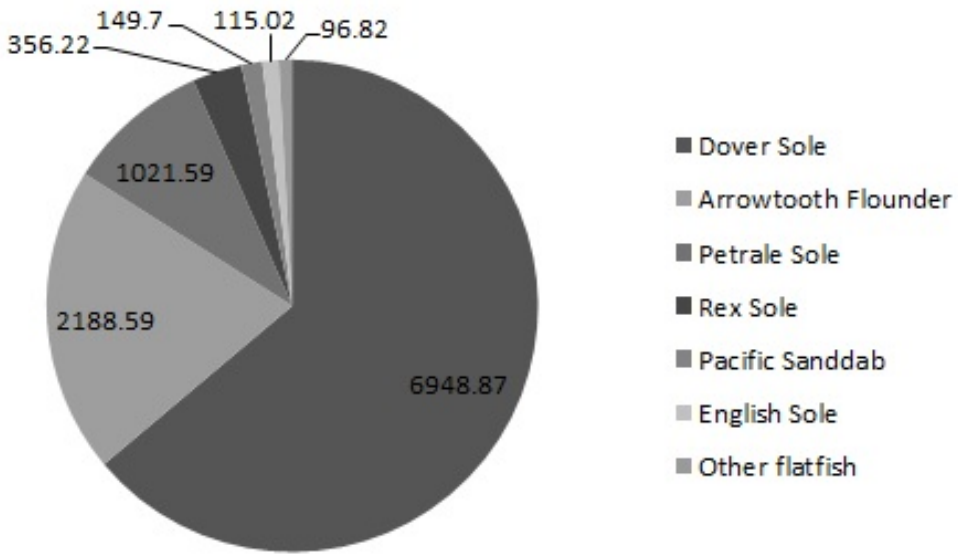


Figure 3. Species composition of flatfish catch in the non-hake commercial groundfish fisheries, 2012 (tons) (Bellman et al. 2013)

Importance to the U.S./North American market

The majority (probably 95%) of flatfish caught on the U.S. West Coast are consumed domestically (Brad Pettinger, Oregon Trawl Commission, pers. comm.; Frank Lockhart, NMFS, pers. comm. 2014).

Common and market names

Common name	Acceptable market names	Vernacular names
Arrowtooth flounder	Flounder, Arrowtooth	Turbot
Dover sole	Sole	Slime sole, Slippery sole
English sole	Sole	Lemon sole
Pacific sanddab	Sanddab	Mottled sanddab, Soft flounder
Petrale sole	Sole or Flounder	California sole, Brill
Rex sole	Sole or Flounder	Longfin sole, Witch
Rock sole	Sole or Flounder	Rock flounder
Sand sole	Sole or Flounder	Fringe sole
Starry flounder	Flounder	Great flounder, California flounder

Source: FDA 2012

Primary product forms

Flatfish products include fresh whole fish and fillets, and frozen whole, H&G (headed and gutted), and fillets (Pacific Seafood 2014).

Assessment

This section assesses the sustainability of the fishery(ies) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2 = Green or Low Concern*
- *Score >2.2 and <=3.2 = Yellow or Moderate Concern*
- *Score <=2.2 = Red or High Concern*

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

ARROWTOOTH FLOUNDER				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	4.00:Low Concern	3.67:Low Concern	**Green (3.831)**

DOVER SOLE				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**

ENGLISH SOLE				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**

PACIFIC SANDDAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	3.00:Low	5.00:Very Low	5.00:Very Low	**Green (5.000)**

		Concern	Concern	

PETRALE SOLE				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	4.00:Low Concern	2.33:Moderate Concern	**Yellow (3.053)**

REX SOLE				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**

STARRY FLOUNDER				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Trawl, Bottom	2.00:Medium	4.00:Low Concern	5.00:Very Low Concern	**Green (4.472)**

Inherent Vulnerability

Seafood Watch fishery assessments typically rate the inherent vulnerability of each stock included in the assessment based on the FishBase (www.fishbase.org) vulnerability score, or alternaitvely based on a set of pre-defined productivity attributes where FishBase scores are not available. This allows resilience to be rated in a consistent fashion across all fisheries globally. For the present assessment, fishbase scores are supplemented with productivity data from the region-specific productivity-susceptibility analyis conducted for many west coast groundfish species by Cope, J.M. et al (2011). Where there was a discrepancy between the productivity scores and the Fishbase vulnerability scores, the productivity scores were the final determinant of the inherent vulnerability score. The manner in which these productivity scores are interpreted is described below.

Cope and colleagues scored each species for 10 productivity attributes; for each attribute, the species was put into one of three "bins" based on its species-specific information for that attribute. Each bin had a score associated with it, and the three bins were: low productivity (score of 1), medium (2), and high (3) (Table 2 in Cope, J.M et al. 2011). The species' overall productivity score was then derived from its scores on these 10 specific attributes. Since a species' productivity score could range between 1.0 and 3.0 (i.e, no species could have an overall productivity score of less than 1 or more than 3), the "distance" over which a species' productivity score could range was 2. If this "distance" (i.e., 2) is divided equally between the three bins, we can say that the "low" productivity bin includes productivity scores of 1 to 1.67, the "medium" bin has scores of 1.68-2.33, and the "high" bin has scores of 2.34-3.0.

To inform this report's assessment of inherent vulnerability (rather than resilience), these scores are reversed to reflect vulnerability, as follows:

- *high vulnerability is indicated by a productivity score of 1.0-1.67*
- *medium vulnerability is a score of 1.68-2.33*
- *low vulnerability is a score of 2.34-3.0.*

Management reference points

The amount of information available varies considerably from stock to stock, and as such fisheries management classifies west coast groundfish stocks into one of three Categories based on information availability. Category 1 stocks have data-rich, quantitative stock assessments that support stock-specific estimates of overfishing level (OFL) and biomass reference points. In contrast, Category 2 stocks are those for which relatively less data are available or more uncertainty is present. Category 2 stocks tend to lack biomass reference points and are managed with OFLs that are based on historical catches and at least one index of abundance, such as survey biomass trends (PFMC 2011a), but may incorporate more data. Category 3 stocks are those that are more data-poor than Category 2 stocks. As survey data are often lacking for them, Category 3 stocks are managed with OFLs derived from historical catch-based methods and life-history information (Cope, J.M. In press; PFMC 2011a).

Unless otherwise specified, the management target biomass reference point for non-flatfish species is 40% of unexploited equilibrium spawning biomass or spawning output, and the overfished/rebuilding threshold (aka the minimum stock size threshold, or MSST) is 25% of unexploited spawning biomass or output. For flatfish, the target and overfished reference points have recently been defined as 25% and 12.5% of unfished biomass, respectively (PFMC 2011a). Care was taken by the author to properly differentiate between assessments of spawning output (SO), and spawning biomass (SB), as the former is more appropriate for species in which fecundity increases disproportionately to body mass (Taylor and Wetzel 2011).

For the Criterion 1 and 2 assessments, biomass reference points are thus defined as follows:

- *target reference point is $SB_{40\%}$ or $SO_{40\%}$ for non-flatfish species, depending on the whether biomass or output is the unit, and $SB_{25\%}$ for flatfish species*
- *limit reference point (also called the overfished or rebuilding reference point) is $SB_{25\%}$ or $SO_{25\%}$ for non-flatfish, and $SB_{12.5}$% for flatfish*
- *unexploited equilibrium spawning biomass and spawning output are SB_0 and SO_0, respectively.*

As the calculation of MSY requires information that is often lacking for west coast groundfish species, proxy values for fishing mortality target/limit refernce points expressed as the mortality rate that will result in an specified spawning potential ratio ($SPR_{X\%}$), are used by fisheries managers. Overfishing is said to be occuring if fishing mortality is greater than these target reference points.

- *Flatfish: $F_{MSY} = F_{SPR30\%}$*

- *Lingcod, spiny dogfish, sablefish:* $F_{MSY} = F_{SPR45\%}$
- *Rockfish and thornyheads:* $F_{MSY} = F_{SPR50\%}$

The Seafood Watch assessment criteria require a strong scientific rationale for target and limit reference points that are below $B_{30\%}$ and $B_{15\%}$, respectively. As such, a brief review of the flatfish reference points is necessary. The PFMC's recent adoption of the current flatfish reference points was driven by the 2009 petrale sole stock assessment, which showed that the stock had been below the old limit reference point ($SB_{25\%}$) since 1953, and had been experiencing 'chronic annual overfishing' (which was then defined as $F>F_{40\%}$) since 1943 (PFMC 2011a). However, this review also showed that the stock had maintained steady catches of greater than 2,000 t for several decades, and it was suggested that the proxy reference points of $F_{40\%}$ and $B_{25\%}$ were not appropriate for the productivity of the stock (PFMC 2011a). The assessment bodies therefore suggested the use of petrale sole stock-specific estimates of B_{MSY} ($SB_{19\%}$) and F_{MSY} ($F_{20\%}$) (PFMC 2011a). The discrepancy between these estimates and the established proxy values led to the development of new proxy values for all managed flatfish. A review of productivity information for several key west coast flatfish led to the following conclusions (PFMC 2011a):

a) Steepness for the reviewed species was ≥0.80,

b) The F_{MSY} associated with a steepness of 0.80 was approximately $F_{30\%}$, and

c) The B_{MSY} associated with $F_{30\%}$ was $B_{25\%}$

Following subsequent reviews and recommendations, the PFMC adopted the following proxy values for all managed flatfish species: a proxy B_{MSY} of $B_{25\%}$, a proxy limit reference point of ½ B_{MSY} ($B_{12.5\%}$), and a proxy F_{MSY} of $F_{30\%}$ (PFMC 2011a). For the purposes of this assessment, the scientific rationale for the revised flatfish reference points is considered to be strong.

Throughout this assessment, "total catch" refers to estimates of all removals (including those associated with recreational fisheries and research activities), whereas "commercial" refers to the catch in non-tribal, non-hake commercial groundfish-targeting fisheries on the U.S. west coast.

Criterion 1 Assessment

ARROWTOOTH FLOUNDER

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).*

  Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Trawl, Bottom

Medium

The Fishbase vulnerability score for arrowtooth flounder is 64, but the species' productivity rating in Cope et al., 2011 is 1.95 (Table 1 in (Cope, J.M., et al., 2011)). Arrowtooth flounder inherent vulnerability is therefore scored "medium".

Factor 1.2 - Stock Status

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*
- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*
- *1 (Very High Concern)—Population is listed as threatened or endangered.*

Trawl, Bottom

Low Concern

The available information suggests that arrowtooth flounder adult biomass is likely well above the target (SB2007/SB40%=1.98, projected SB2011/SB40%=1.65; (Kaplan, I.C. & Helser, T.E. 2007); (PFMC 2011a)), and the population is classified as 'not overfished' (NMFS 2012). The population has not been assessed since 2007, however, and there is a relatively high degree of scientific uncertainty regarding the assessment, which contributed to the population's classification as Category 2 by fisheries management (Chapter 4 in (PFMC 2011a)).

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*
- *0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.*

Trawl, Bottom

Low Concern

In 2011, total fishing mortality of arrowtooth flounder was well beneath catch limits (approximately 15% of that year's overfishing limit; Table 16 in (Bellman, M.A., et al., 2012)), and the population was classified as not experiencing overfishing for 2012 (NMFS 2012). The age of the most recent stock assessment (2007) and the uncertainty therein preclude a score of 'very low' concern, however.

DOVER SOLE

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Medium

The Fishbase vulnerability score for Dover sole is 42, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.80.

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Very Low Concern

Dover sole adult biomass was estimated to be well above the target for 2011 (95% C.I.=67-100% of SB_0; Tables b and e in (Hicks, A.C., & Wetzel, C. 2011)), and for 2012, Dover sole B/B_{MSY} was estimated to be 3.35 (NMFS 2012).

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Very Low Concern

For 2011, total fishing mortality of Dover sole was substantially less than the catch limits (18% of the overfishing threshold); Table 16 in (Bellman, M.A., et al., 2012)) and the stock was classified as not undergoing overfishing in 2012 (NMFS 2012).

ENGLISH SOLE

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Medium

The Fishbase vulnerability score for English sole is 43, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 2.25. The inherent vulnerability of English sole is therefore scored "medium".

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Very Low Concern

English sole adult biomass sharply declined between 1900 and the 1930s and declined again during the 1950s and 1960s; adult biomass is estimated to have been below the target reference point ($SB_{25\%}$) through the 1960s, 1970s, and 1980s (Figure 103 in (Cope, J., et al., 2013)). Spawning biomass has increased in the years since, however, and in the latest assessment, is estimated to be well above the management target (SB_{2013}:SB_0 is 0.88 (95% C.I. = 0.77-0.96; Table ES1 in (Cope, J., et al., 2013)).

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Very Low Concern

The 2011 total fishing mortality of English sole was minimal relative to the catch limits (<1% of the overfishing threshold); Table 16 in (Bellman, M.A., et al., 2012)). Estimated F_{2012}:F_{MSY} was 0.02 (Table ES1 in (Cope, J., et al., 2013)), and the continuation of recent catch levels is projected to allow spawning biomass to increase (Table 73 in(Cope, J., et al., 2013)).

PACIFIC SANDDAB

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Low

The Fishbase vulnerability score for Pacific sanddab is 35, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 2.40.

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Very Low Concern

An assessment of the Pacific sanddab stock was recently completed. While the results of that assessment were not considered to be sufficiently reliable to serve as a basis for harvest specifications, the weight of the evidence presented in that assessment was sufficient for the PFMC's Scientific and Statistical Committee to conclude that the stock's status was "well above" the flatfish target reference point ($SB_{25\%}$; (SSC 2013)). Furthermore, that assessment indicated that Pacific sanddab spawning biomass has never been lower than $SB_{25\%}$, and has been increasing in recent years (Figure d in (He, X., et al., 2013)).

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Very Low Concern

Catches of Pacific sanddab reached their highest point in 1995, and have generally declined from 2000-2012 (Table 1 in (He, X., et al., 2013)). While the recent stock assessment was not considered to be suitable for supporting harvest specifications (SSC 2013), it does indicate that Pacific sanddab SPR_{2012} was well above $SPR_{30\%}$ (i.e., mortality was less than the proxy used for F_{MSY}) (Table d in (He, X., et al., 2013)). Furthermore, a productivity-susceptibility analysis suggests that Pacific sanddab have one of the lowest vulnerability-to-overfishing scores of all west coast groundfish (PFMC 2011a).

PETRALE SOLE

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Medium

The Fishbase vulnerability score for Petrale sole is 55, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.70.

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Low Concern

Petrale sole adult biomass declined sharply from the late 1930s to the early 1960s, declined again in the 1970s and 1980s, and remained under the limit reference point during the 1980s, 1990s, and into the 2000s (Figure d in (Haltuch, M.A., et al., 2013)). After a brief period of rebuilding, adult biomass is estimated to have declined from 2005-2010, reaching a minimum of 10.4% of SB_0 in 2010 before increasing from 2010 to 2013 (Table b in (Haltuch, M.A., et al., 2013)). In the latest assessment, SB_{2013} is estimated to be 22.3% of SB_0 (95% C.I. = 15.1%-29.5%) (Table b in (Haltuch, M.A., et al., 2013)). This is above the limit reference point (SB12.5%), but less than the target reference point (SB25%) (Figure d in (Haltuch, M.A., et al., 2013)).

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Moderate Concern

Fishing mortality of petrale sole exceeded the current proxy for F_{MSY} for the last half of the 20th century and into the 2000s, and exceeded the overfishing proxy as recently as 2010. Estimates of SPR for recent years are very close to $SPR_{30\%}$, and total fishing mortality of petrale sole in 2011 was >90% of the OFL.

Rationale:
Petrale sole fishing mortality exceeded the current F_{MSY} proxy (i.e., SPR values were lower than $SPR_{30\%}$) from the 1950s through 2010 (Haltuch, M.A., et al., 2013). Estimates of recent SPR are very close to $SPR_{30\%}$ (Figure e in (Haltuch, M.A., et al., 2013)). Petrale sole fishing mortality in 2011 (953 t) was 93% of

the OFL and 98% of the ABC and ACL (Table 16 in (Bellman, M.A., et al., 2012)). Mortality in the non-hake commercial groundfish fisheries was 79% of the OFL, and the IFQ trawl fishery accounted for 85% of total estimated petrale sole mortality across all fisheries in 2011 (Bellman, M.A., et al., 2012).

REX SOLE

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Medium

The Fishbase vulnerability score for rex sole is 65, but the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 2.05. Rex sole inherent vulnerability is therefore scored "medium".

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Very Low Concern

Rex sole adult biomass sharply declined from the 1950s through the 1980s, approaching and perhaps going beneath the current flatfish target reference point ($SB_{25\%}$) in the late 1970s and through the 1980s (Figure 117 in (Cope, J., et al., 2013)). Biomass then sharply increased during the 1990s and 2000s, and in the latest assessment, estimated SB_{2013}:SB_0 is 0.80 (95% C.I. = 0.64-0.93; Table ES1 in (Cope, J., et al., 2013)).

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Very Low Concern

Total catches of rex sole exceeded 1,000 t (and often exceeded 2,000 t) in each year from 1952 through 1992; however, catches have been <1,000 t/year since 1997 and <500 t/year in 2011 and 2012 (Table 17

in (Cope, J., et al., 2013)). Estimated fishing mortality in 2012 was a fraction of the overfishing limit (F_{2012}:$F_{MSY=}$0.07 (Table ES1 in (Cope, J., et al., 2013)), and continued catches similar to those in the past several years are projected to allow adult biomass to increase (Table 74 in (Cope, J., et al., 2013)).

STARRY FLOUNDER

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines- see page 15

Trawl, Bottom

Medium

The Fishbase vulnerability score for starry flounder is 51, and the species is not assessed in (Cope, J.M., et al., 2011).

Factor 1.2 - Stock Status

Scoring Guidelines- see page 15

Trawl, Bottom

Low Concern

Starry flounder was last assessed in 2005 (Ralston. 2005). That assessment considered starry flounder as two populations, and estimated that both the northern and southern populations were well above the 40% of SB0 precautionary threshold (44% of SB0 in Washington-Oregon and 62% in California). NMFS classifies the popualtion as not overfished, with a B/BMSY of 1.25 (NMFS 2012). The age of the assessment precludes a rating of 'very' low concern, however.

Factor 1.3 - Fishing Mortality

Scoring Guidelines- see page 16

Trawl, Bottom

Very Low Concern

The 2005 assessment estimated that recent (at that time) exploitation rates were well below the FMSY proxy for flatfish (at that time F40%, now F30%) (Ralston. 2005). More recently, the catch has been a

fraction of the species-specific overfishing limit 17/1813mt in 2012 (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). Despite the age of the assessment, an exploitation rate this low is considered a 'very low' concern.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- *Score >3.2 = Green or Low Concern*
- *Score >2.2 and <=3.2 = Yellow or Moderate Concern*
- *Score <=2.2 = Red or High Concern*

Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix B.

Arrowtooth flounder: Trawl, Bottom

Subscore:: 2.709 **Discard Rate:** 1.00 **C2 Rate:** 2.709

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
MINOR SHELF AND SLOPE ROCKFISH COMPLEXES	High	2.00: High Concern	3.67: Low Concern	**2.709**

Dover sole: Trawl, Bottom

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

English sole: Trawl, Bottom

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Pacific sanddab: Trawl, Bottom

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Petrale sole: Trawl, Bottom

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Rex sole: Trawl, Bottom

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Starry flounder: Trawl, Bottom				
Subscore::	**2.644**	**Discard Rate:**	**1.00**	**C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**

Species included in the assessment

The U.S. west coast non-hake commercial groundfish fisheries catch a variety of species. A species was included in this assessment if the catch of the species in a given fishery composed >5% of that fishery's catch, or >1% of that fishery's catch and >5% of species' total mortality across all fisheries, or <1% of fishery's catch and >20% of species' total mortality across all fisheries. Species of concern, including overfished and rebuilding species and marine mammals and seabirds, were also included where appropriate. The intent was to include the 'main' species, and the species of concern, that are associated with the U.S. west coast non-hake commercial groundfish fisheries. Therefore, the analyst's discretion was used in some situations. The Criterion 2 score for each fishery is the score of the lowest scoring 'main' species caught in that fishery, multiplied by a modifier based on the discard rate in the fishery.

Criterion 2 Assessment

MINOR SHELF AND SLOPE ROCKFISH COMPLEXES

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

Other rockfish caught in the ITQ trawl fishery in relatively small quantities include those listed below

(for an exhaustive list see Appendix H). All are considered to have “high” inherent vulnerability.

Rationale:

Species/Stock	FishBase vulnerability score	Productivity score (Table 1 in (Cope, J.M, et al, 2011)
Rosethorn rockfish (*Sebastes helvomaculatus*)	66	1.10
Silvergrey rockfish (*S. brevispinis*)	68	1.22
Stripetail rockfish (*S. saxicola*)	65	1.39
Sharpchin rockfish (*S. zacentrus*)	64	1.36
Shortraker rockfish (*S. borealis*)	71	1.22
Yellowmouth rockfish (*S. reedi*)	63	

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

The rockfish listed here are managed in the minor shelf and slope rockfish complexes. None has been assessed (PFMC 2012b). An unknown stock status combined with a high vulnerability to overfishing score requires a rating of “high concern” for stock status.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Each of the minor rockfish complexes has an overarching overfishing limit associated with it, calculated

from the sum of the component species' overfishing limits (PFMC 2012b). Estimated fishing mortality in 2012 was well below (<33%) the overfishing limit for each complex (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013), so the complexes are classified as not undergoing overfishing. An overfishing limit is also set for each component species where possible, though the PFMC's Science and Statistical Committee recommends against using these "limits" to evaluate whether overfishing is occurring for component stocks (PFMC 2013b). Instead, in cases where overfishing limits are consistently exceeded for component stocks, the levels of concern for those stocks are raised by managers, thus allowing for discussion of additional management measures (e.g., reduced harvest guidelines), removing from the complex, prioritizing those stocks for assessment, and so on. The overfishing limits for most component species in the north and south minor shelf and slope rockfish complexes were not exceeded in 2012, but there were some exceptions: aurora, blackgill, rougheye, shortraker rockfish, and vermilion rockfish (Table 2-2 in (PFMC 2012d)). Stock assessments have been conducted on the former three species, so these are addressed individually in the present assessment.

Several factors are considered here when rating shortraker fishing mortality. Mortality of shortraker rockfish has been higher than the species' overfishing limit for most years since 2004 (PFMC 2013f). However, the overfishing limits have also been exceeded in most years since 2004 for blackgill and rougheye rockfish (PFMC 2013), and at least in 2012 for aurora (Table 2-2 in (PFMC 2012d)). Still, subsequent stock assessments indicate that overfishing is probably not occurring for those species (see species accounts in this assessment). Thus, the overfishing limits calculated for data-poor stocks may be more conservative than necessary. Further, the majority of the shortraker rockfish biomass and catch occurs north of the West Coast Exclusive Economic Zone (EEZ) in waters off British Columbia and Alaska. According to managers, it is likely that the small proportion of removals in West Coast fisheries will have little effect on overall stock status (PFMC 2014b).

Vermilion rockfish are mostly caught in the southern management area (south of 40°10´N) (Table 2-2 in (PFMC 2012d)). Although the component species overfishing limit was exceeded in the northern management region in 2012 (fishing mortality was 19 mt; overfishing limit was 11 mt), it was not in the south (fishing mortality was 233 mt; overfishing limit was 308 mt). The PFMC's Science and Statistical Committee notes that "combining northern and southern individual stock contributions to the OFL is more informative when determining management performance of these stocks coastwide" (PFMC 2013g). The coastwide overfishing limit was not exceeded in 2012.

A rating of "low concern" has been applied for the minor shelf and slope rockfish complexes (besides the species assessed individually in this assessment) because the complexes' overfishing limits have not been exceeded, and because there are few concerns over stocks that have exceeded their component overfishing limits even though high uncertainty exists from the lack of full stock assessments for the majority of them.

NON-FMP FLATFISH COMPLEX

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

Deepsea sole and slender sole compose the majority of the catch of "non-FMP flatfish" (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). The FishBase vulnerability scores for these species are 52 and 47, respectively.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

No stock assessments have been conducted on deepsea or slender sole, so stock status is unknown.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Moderate Concern

No information is available on fishing mortality of deepsea sole. Slender sole is considered of "Least Concern" by the IUCN, based on its wide distribution, abundance, and minimal take by commercial fisheries (Monroe 2010).

SABLEFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Low

The FishBase vulnerability score for sablefish is 49, and the species' productivity score is 1.61 in Table 1 of (Cope, J.M. et al. 2011).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

Estimated sablefish adult biomass dropped under the management target ($SB_{40\%}$) in 2009, and has diminished further during the subsequent two years (Stewart, I.J., et al., 2011). This continues a sharp downward trend that is entering its fourth decade (Figure 7). The estimated spawning biomass for 2011 is above the $SB_{25\%}$ overfished threshold (Figure 7), but the clear and persistent downward trend in abundance, the current sub-target status of spawning biomass, and the uncertainty in the biomass estimates compel a score of "moderate" concern for U.S. West Coast sablefish.

Rationale:
Estimated sablefish spawning biomass has been trending downward since the beginning of the 1980s; this trend is attributed to large catches during the late 1970s and early 1980s (Stewart, I.J., et al., 2011). In recent years, estimated sablefish biomass has declined from 47% of SB_0 in 2002 to 35% of SB_0 in 2010, and the 2011 assessment estimates that 2011 sablefish declined further, to 33% of SB_0 (95% C.I. = 18%–49% (Stewart, I.J., et al., 2011)). This is below the management target ($SB_{40\%}$) but above the overfished threshold ($SB_{25\%}$) (Figure 7). There is a high degree of uncertainty in the current assessment's estimation of spawning biomass: the estimate is 60,957 t, and the 95% confidence intervals are substantial (16,418 t to 104,495 t (Stewart, I.J., et al., 2011)). Because of its stock status, sablefish is one of three species classified in the "precautionary zone" (along with Pacific whiting and blue rockfish) (PFMC 2011a). Most recently, the NMFS has classified sablefish as "not overfished," with a ratio of $B:B_{MSY}$ proxy of 0.837 (NMFS 2012).

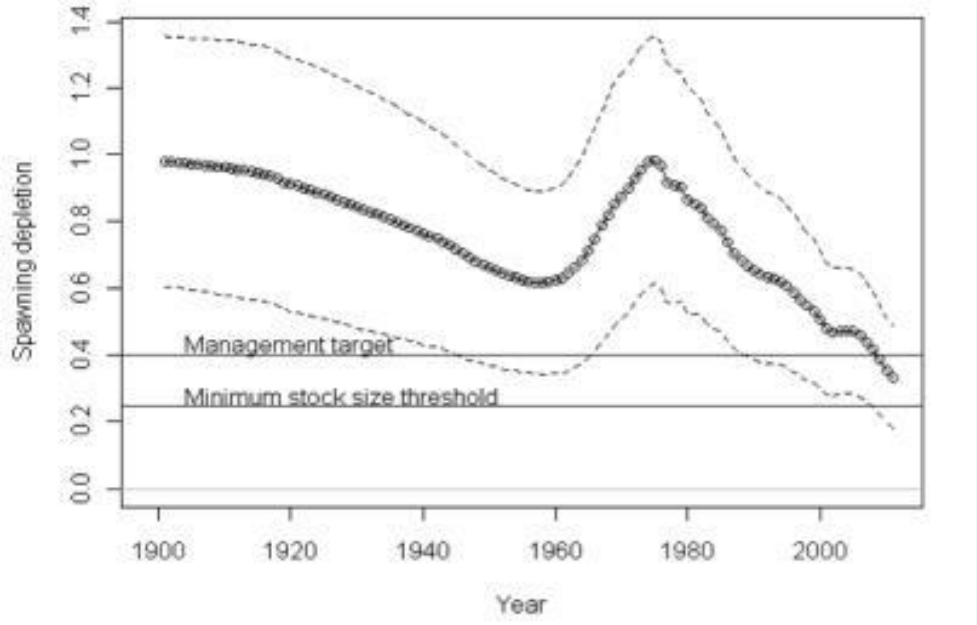


Figure 7. Estimated sablefish spawning biomass relative to SB_0, with 95% confidence intervals (figure from Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Moderate Concern

There are many pieces of information to consider when assigning a score to sablefish mortality. In 2009 and 2010, sablefish SPR was slightly less than the target ($SPR_{45\%}$); by definition, this constitutes overfishing for those years. However, the 2011 total fishing mortality of sablefish was less than catch limits, and the stock was classified as not experiencing overfishing in 2012. Given the high degree of uncertainty regarding the current stock assessment, the fact that fishing mortality seems to have been increasing over the four years preceding the recent stock assessment, and that estimated SPR for sablefish in 2010 was less than $SPR_{45\%}$ and the lowest since the late 1970s, fishing mortality for sablefish is scored “moderate” concern. This score is applied to any commercial groundfish fishery for which “north” or “south” sablefish accounted for >20% of fishery catch in 2011, or which accounted for >20% of total fishing mortality of “north” or “south” sablefish in the same year (see “Rationale” below). Thus, the IFQ trawl, IFQ hook and line, IFQ pot, LE endorsed longline, LE endorsed pot, LE non-endorsed longline, LE non-endorsed pot, OA longline, and OA pot fisheries receive scores of “moderate” concern for their catches of sablefish in 2011.

Rationale:

The most recent stock assessment attributes the continuing decline in sablefish abundance "primarily to relatively poor recruitments" because fisheries exploitation was below target rates from 1998 through 2008 (Stewart, I.J., et al., 2011). Yet the study also notes that the relative SPR (1-SPR/1-$SPR_{45\%}$) and the relative exploitation rate increased sharply over the four years prior to the assessment (Stewart, I.J., et al., 2011). The relative SPR for both 2009 and 2010 exceeded 100% (each with 95% C.I. of approximately 60%–146%; Table c in (Stewart, I.J., et al., 2011)). This means that, for these two years, overfishing was occurring (Stewart, I.J., et al., 2011). The 2009 and 2010 relative SPRs are the highest estimated since the large catches of the late 1970s and early 1980s (Figure 8), when the stock was more abundant (Figure 9).

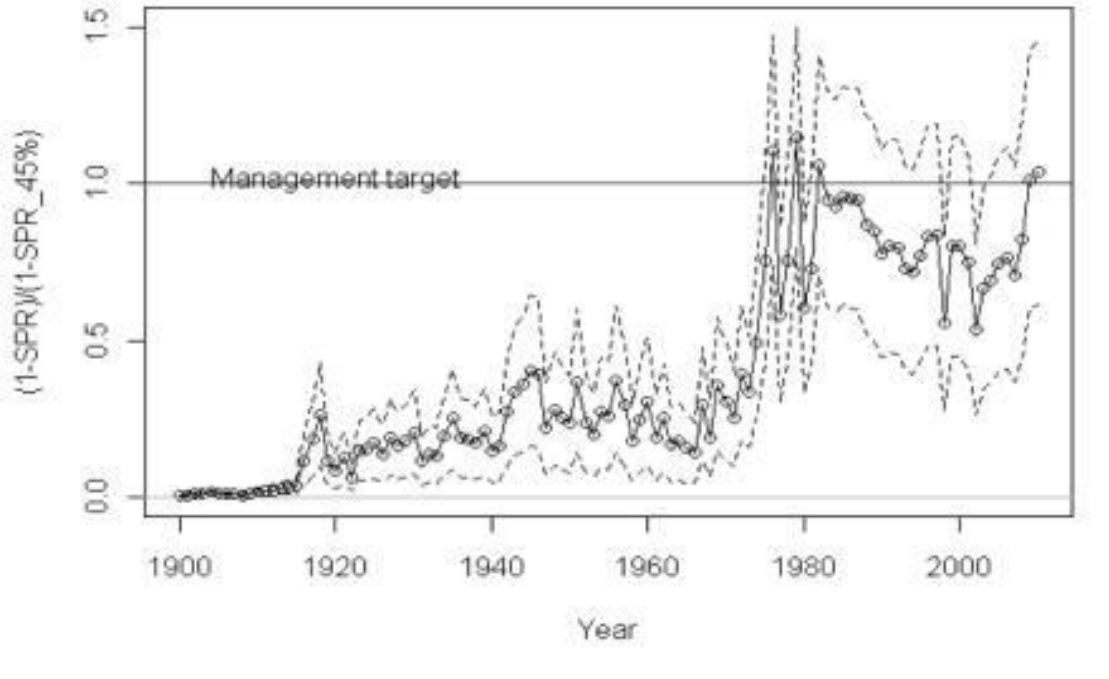


Figure 8. Relative Spawning Potential Ratio (1-SPR/1-SPR45%), with 95% confidence intervals. A relative SPR value of >1.0 indicates overfishing for that year (figure from Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

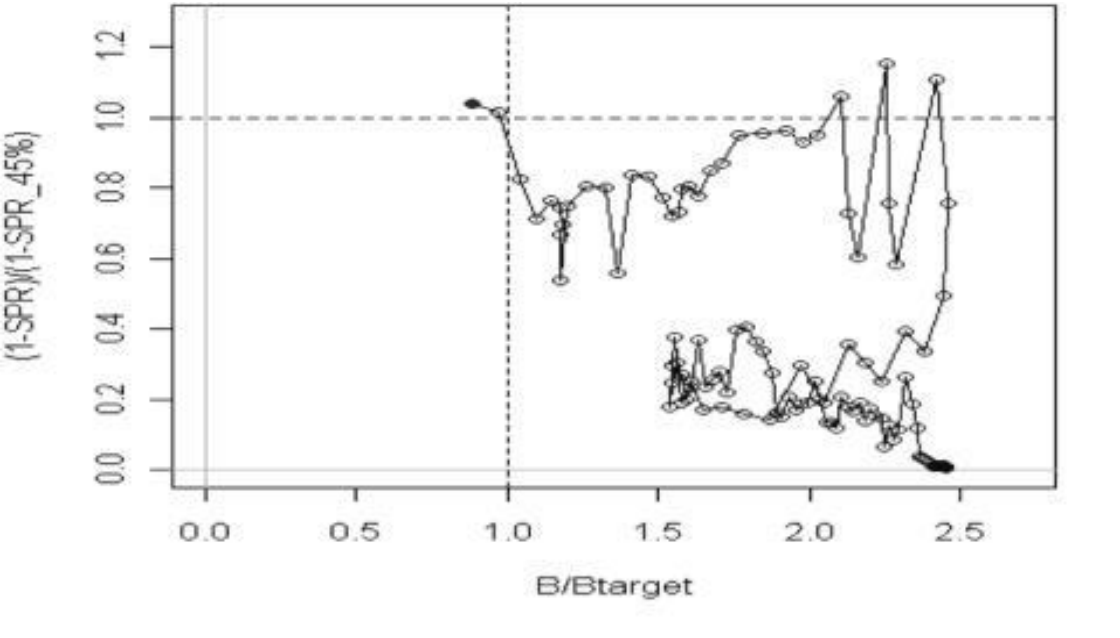


Figure 9. Fishery exploitation, expressed as Relative SPR (1-SPR/1-SPR45%), compared to stock status (SB/SB40%) (figure from Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

In an apparent contradiction to the SPR-based estimates of potential overfishing in 2009 and 2010, the assessment notes that, from 2001 to 2010, estimated "dead" catch (landings + modeled estimates of discarding) exceeded the overfishing limit in only one year (2008) (Table d in (Stewart, I.J., et al., 2011)). Furthermore, from 2010 through 2012, the NMFS classified U.S. West Coast sablefish as not experiencing overfishing (NOAA Fisheries 2012). Total fishing mortality of sablefish (coastwide) in 2011 was 75% of the OFL, 78% of the ABC, and 97% and 94% of the "north" and "south" ACLs, respectively (Table 16 in (Bellman, M.A. et al. 2012)). For that year, non-hake commercial groundfish fishing mortality of sablefish north of 36°N was 87% of uncertainty-adjusted ACL, and 94% of the ACL south of 36°N (Bellman, M.A. et al. 2012). The distribution of "north" sablefish catch among fisheries reflected allocations: the IFQ, LE sablefish-endorsed, LE sablefish non-endorsed, and OA fixed gear fisheries all caught more than 90% of their allocations of "north" sablefish in 2011 (the LE non-endorsed fishery exceeded its allocation because of catch in the LE non-endorsed longline sector) (Bellman, M.A. et al. 2012). The catch of "south" sablefish was primarily distributed among IFQ hook and line (12% of commercial groundfish fishery catch of "south" sablefish), IFQ pot (23%), non-endorsed longline (44%), and the OA longline (8%) and pot (5%) fisheries (Bellman, M.A. et al. 2012).

In most instances, determining a score for this factor requires considering the fishery's catch of a species relative to the total catch of the species; if the fishery's contribution to total mortality is relatively minor, the fishing mortality score is adjusted accordingly. The amount of sablefish caught in each commercial groundfish fishery varies considerably, so it would seem at first that sablefish requires several different mortality scores to reflect the fisheries' contributions to sablefish mortality. However, the analyst believes that the distribution of sablefish catch among these fisheries largely reflects allocation and

other management decisions, rather than more sustainable or less sustainable practices between the fisheries. Thus, the score for sablefish mortality is based on total sablefish mortality across all non-hake groundfish fisheries. This single score is applied either to the sablefish catch of any fishery for which sablefish constituted >20% of the catch, or to any fishery that caught >20% of total “north” or “south” sablefish. In 2011, the fisheries for which “north” and/or “south” sablefish constituted >20% of total catch were the IFQ hook and line, IFQ pot, LE endorsed longline, LE endorsed pot, LE non-endorsed longline, LE non-endorsed pot, OA longline, and OA pot. “North” sablefish constituted only 9% of the IFQ trawl fishery’s total catch, but because of the scale of this fishery, this still amounted to 31% of total fishing mortality of “north” sablefish. These are the fisheries for which a common score for sablefish mortality will be assigned.

Factor 2.4 - Discard Rate

Trawl, Bottom

>20%

Data from Bellman et al 2013.

Fishery	Landings	Total Mortality	Discard rate (%)
IFQ Bottom Trawl	16811.35	18485.45	10.0
IFQ Midwater Trawl	216.14	216.63	0.2

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2 = Yellow or Moderate Concern*
- *Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*

Rating is Critical if either or both ratings of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) are Critical.

Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Trawl, Bottom	4.000	3.000	Green(3.464)

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered.*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*
- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*

- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

Factor 3.1 Summary

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Trawl, Bottom	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Trawl, Bottom

Highly Effective

The management of the main retained species in the non-nearshore fisheries is scored "highly effective", as >50% of each of these fisheries' main species have biomass reference points, harvest control rules, and/or explicit buffering against risk and uncertainty built into catch limits. Less than 50% of the main retained species in the two nearshore fisheries achieve these standards, and therefore these two fisheries are scored "moderately effective".

Rationale:

Reference points

Appendix H shows which species have biomass reference points. Where they exist, these decision-making references meet the Seafood Watch standard for effective management

.*Incorporating Uncertainty and Risk Aversion: Determination of ABC and ACL*

A formal process is in place to buffer for uncertainty and risk aversion through the determination of the ABC and ACL. After the OFL has been determined (the process is described under the “Scientific Advice” section in subsequent pages), the ABC is derived from the OFL by applying a buffer against scientific uncertainty. For this step, the Scientific and Statistical Committee quantifies the stock assessment variability (σ) based on the species or stock’s Category (1, 2, or 3), and the Council determines the probability (P*) that the estimated OFL is too high, given the stock assessment variability. The scientific uncertainty buffer (the difference between OFL and ABC) is determined by applying σ to the appropriate P*. The ABC, then, is essentially the OFL minus the scientific uncertainty buffer.The Annual Catch Limit

(ACL) is the harvest specification that is derived from ABC. It can be equal to or less than ABC, but not greater. The ACL is derived from ABC by taking into consideration conservation objectives, socioeconomic and ecological concerns, management uncertainty, and other sources of uncertainty (PFMC 2011b). Due to the relative lack of information for Category 2 and Category 3 stocks, a greater degree of scientific uncertainty exists regarding the OFL and the scientific uncertainty buffer between the OFL and the ABC therefore tends to be correspondingly larger. These measures are consistent with Seafood Watch guidelines for addressing uncertainty.

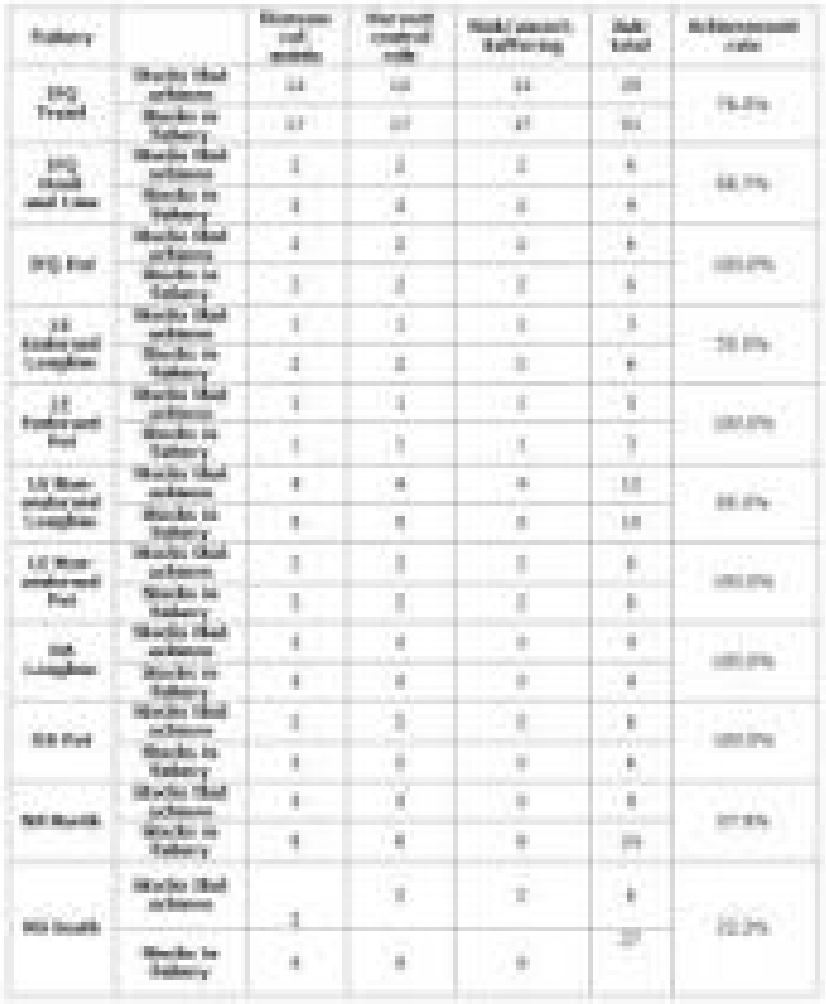
Harvest Control Rule

In order for management to receive a score of "highly effective", the Seafood Watch guidelines require a strategy for reducing mortality when biomass falls below a threshold, and for identifying a threshold at which mortality is reduced to zero. The management of many retained groundfish species meets this benchmark through the "40-10" (or, for flatfish, the "25-5") harvest control rule. For Category 1 species, when estimated biomass falls below the precautionary threshold, the harvest rate begins decreasing. The precautionary threshold that triggers the harvest control rule is either B_{MSY} or the proxy ($B_{40\%}$ for non-flatfish, and $B_{25\%}$ for flatfish), or another level determined by the Council (between 25% and 50% of B_0) (PFMC 2011b). If biomass falls below $B_{10\%}$ for non-flatfish or $B_{5\%}$ for flatfish, the allowable catch is set at zero (PFMC 2011a). The actual reduction in allowable harvest takes place when the Council determines the ACL for the stock (PFMC 2011b).There is no precautionary biomass threshold and no associated harvest control rule for Category 2 or Category 3 species.

Scoring for Management Strategy and Implementation

The West Coast groundfish fisheries vary in terms of the number of Criterion 1 stocks that they catch. Obviously, those that catch more stocks are more likely to catch a stock that does not currently have biomass reference points, an associated harvest control rule, etc. To avoid skewing the interpretation of "Management Strategy and Implementation" to favor fisheries with less-diverse catches, the following approach was used.The three key components of Management Strategy and Implementation were first broken out (Table 2). Then, for each fishery, the number of Criterion 1 stocks that met each of these components was determined. The number of Criterion 1 stocks that achieved the components was then totaled, and divided by the total number of the fishery's Criterion 1 stocks multiplied by the number of management components (i.e., the total number of Criterion 1 stocks in the fishery multiplied by 3) to indicate the fishery's "achievement rate". The achievement rate is an indication of the frequency with which a fishery's stocks achieve the requirements of "Management Strategy and Implementation".For example, three Criterion 1 stocks are caught in the IFQ Hook and Line fishery (Appendix H). Of these three stocks, two have biomass reference points, two have a harvest control rule, and two have catch limits that are explicitly buffered against uncertainty and risk (Appendix H). This fishery's Criterion 1 stocks therefore achieve six out of nine possible stock/management component combinations, for an achievement rate of 66.7% (Table 5).As Table 5 demonstrates, all but two of the fisheries assessed in this report have achievement rates ≥50.0%. The two fisheries that have lower achievement rates are the two nearshore fisheries.

Table 5. Fisheries' achievement of the components of highly effective management strategy and implementation



Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Trawl, Bottom

Highly Effective

Each of the seven stocks that were classified as "overfished" or "rebuilding" as of 2012 have a rebuilding strategy in place and receive regular status updates and rebuilding analyses. Harvest control rules are in place for each rebuilding species, and current mortality rates are in line with these rules. Current levels of fishing mortality have >70% probability of rebuilding the stock within the specific time frame.

Rationale:
As of 2012, there were seven Pacific coast groundfish stocks that were classified as "overfished" or "rebuilding" from an overfished state: bocaccio (south of 40°10'N), canary rockfish, cowcod (south of 40°10'N), darkblotched rockfish, Pacific ocean perch, petrale sole, and yelloweye rockfish (NMFS 2012). These stocks each have a rebuilding strategy in place, and receive regular status updates and rebuilding analyses. The rebuilding analyses include estimated probabilities of recovery at different time points, based on different harvest decisions. Harvest control rules are in place for each rebuilding species, and current mortality rates are in line with these rules; current levels of fishing mortality have >70% probability of rebuilding within the specific time frame.One species has been recently recovered: lingcod, which were declared overfished in 1999. A rebuilding plan was adopted in 2003 with a target rebuilding date of 2009 (PFMC 2011b); the stock was found to be rebuilt in the 2005 assessment (Jagielo, T.H. & Wallace, F.R. 2005).

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Trawl, Bottom

Highly Effective

The Seafood Watch criteria define stocks with up-to-date information as those that have stock assessments that are less than 3 years old, or regular monitoring every 1-3 years. As there are up-to-date stock assessments for over 66.0% of the main stocks caught in each of the non-nearshore groundfish fisheries, these fisheries receive a score of "highly effective".

Rationale:
The Seafood Watch criteria define stocks with up-to-date information as those that have stock assessments that are less than 3 years old, or regular monitoring every 1-3 years.

The composition of the groundfish fisheries' catch varies greatly from fishery to fishery, from 15 main retained species in the IFQ trawl fishery to one main retained species in the LE endorsed pot fishery

(Appendix B). Obviously, those fisheries that catch a greater diversity of species are more likely to catch species for which there are no up-to-date stock assessments. To ensure consistency when assigning a score for "scientific research and monitoring" and to prevent this score from favoring fisheries with less-diverse catches, the following approach was used: for each fishery, the number of main retained species with up-to-date (i.e., 2009 or newer) assessments was divided by the total number of main retained species (both of these numbers were determined from the information presented in Appendix H). Fisheries for which up-to-date assessments were available for 0-33.0% of main retained species received a sore of "ineffective", while a score of "moderately effective" was given to fisheries with 33.1-66.0% up-to-date assessments, and a score of "highly effective" was given to fisheries with >66.0% up-to-date assessments.

These calculations are shown in Table 6.

Table 6. Stocks with up-to-date stock assessments, by fishery (see Appendix H for information on stocks in each fishery).

Fishery	Stocks with new assessments	Stocks in fishery	% that are up to date
IFQ Trawl	13	17	76.5%
IFQ Hook and Line	3	3	100%
IFQ Pot	2	2	100%
LE Endorsed longline	2	2	100%
LE Endorsed Pot	1	1	100%
LE Non-endorsed longline	5	5	100%
LE Non-endorsed pot	2	2	100%
OA Longline	3	3	100%
OA Pot	2	2	100%
Nearshore North	3	8	37.5%
Nearshore South	5	9	55.6%

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Trawl, Bottom

Highly Effective

One of the primary avenues through which science informs management of west coast groundfish is through the determination of the OFL. The OFL sets a maximum limit on allowable catch, and ABCs and ACLs do not exceed OFLs. Therefore, compliance with science meets the standard for "highly effective" across all fisheries.

Rationale:
The manner in which OFLs are determined ensures that the science is not overridden by other concerns: *Category 1 species:* The OFL is determined by applying the F_{MSY} harvest rate (or proxy rate) to the current estimated exploitable biomass of the stock (PFMC 2011b).*Category 2 species:* Category 2 species often lack up-to-date stock assessments or have assessments that are relatively data-poor, and often lack information for stock status, exploitation rate, and recruitment. OFLs are typically determined by historical catch-based approaches or trends in an index of abundance (PFMC 2011b).*Category 3 species and Ecosystem Component species*: Category 3 and EC species are also data-poor; OFLs are set for Category 3 species based on historical catch or qualitative information, while EC species have no OFLs. The greater degree of uncertainty regarding Category 3 stocks is addressed through increasing the OFL to ABC uncertainty buffer over Category 2.In essence, this process ensures that the maximum acceptable mortality is determined by scientists and cannot be overruled, exceeded, or otherwise ignored by managers.

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Trawl, Bottom

Highly Effective

Methods to ensure compliance with regulations include the use of fish tickets, logbooks, and Vessel Monitoring System (VMS) (PFMC 2011b). Sorted landings and associated information are recorded on state-issued fish tickets, and dockside monitoring is conducted by state employees (PFMC 2011b). Logbooks are administered by the states, and are required of all trawl vessels (PFMC 2011b).

In order to enforce area closures, both limited entry and open access vessels are required to have VMS installed and operating while fishing (NMFS Northwest Region 2012). Vessels that are required to use VMS during trips must ensure that their VMS is successfully transmitting information before participating in the fishery (NMFS Northwest Region 2012).

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly

Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Trawl, Bottom

Moderately Effective

The long-term track record of the management of the U.S. west coast groundfish fisheries is less than highly effective. In particular, the management track record for the period 1970-2000 was demonstrably unsuccessful, culminating in the declaration that nine species of groundfish were "overfished". Since then, however, significant changes to the management of the fisheries have combined to improve matters in recent years. Fishing capacity is managed by the Limited Entry program, which was introduced in 1994. Rebuilding plans for the overfished stocks, which were adopted in 2003 and 2004, have significantly reduced fishing mortality for these stocks. The estimated biomasses for these overfished species have been increasing in the years since overfishing plans were implemented (Figure 6). On the other hand, the management trend for sablefish, especially, is less certain. Estimated spawning biomass has been declining since the early 1980s, and it is now below the management target (SB40%), and estimated fishing mortality is now fluctuating around the target. While management has shown it is able to respond to other concerns in the fishery, this uncertainty in the management of the fishery's impacts on a major target species precludes a rating of 'highly effective.'

Rationale:
Aggressive measures meant to build domestic fisheries capacity during the 1970s ultimately led to overcapitalization and overfishing, and these issues combined with environmental factors to result in steep declines in the abundance of many groundfish species during the 1970s, 1980s, and 1990s. Several species of rockfish were particularly diminished during this period (Figure 6). Subsequent management measures that significantly reduced allowable catch created economic and social turbulence, and the groundfish fishery was declared an economic disaster in January of 2000 (Shaw, W. & Conway, F.D.L. 2007). In 2002, nine species of groundfish were declared "overfished" (Shaw, W. & Conway, F.D.L. 2007).

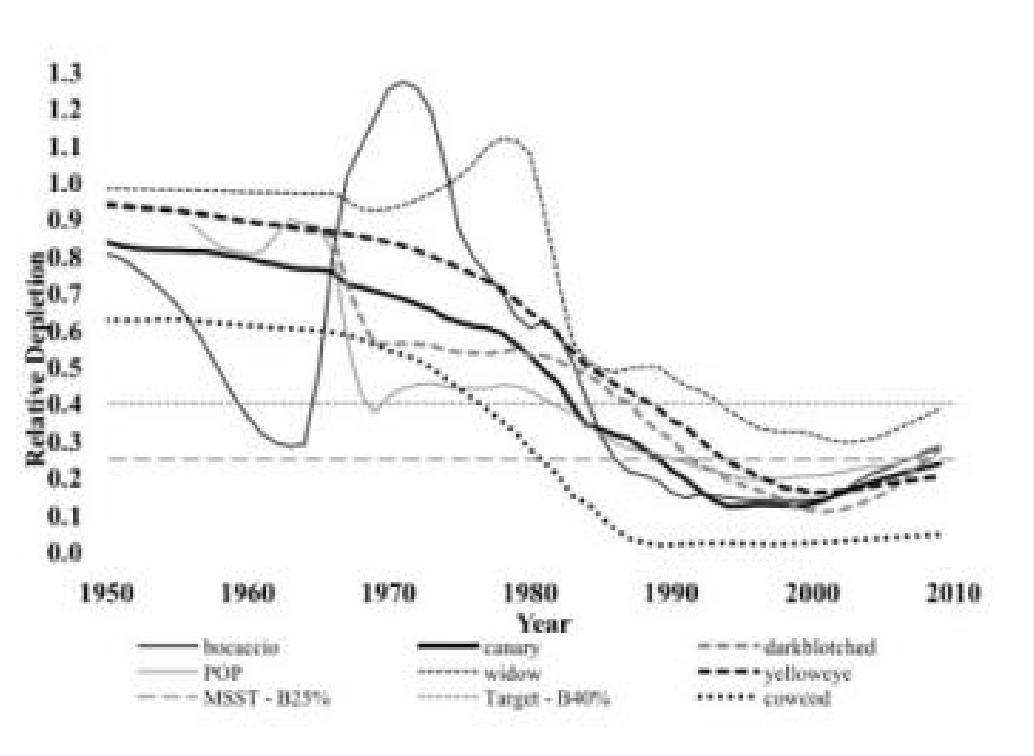


Figure 6. Estimated spawning biomass relative to SB0 for seven 'overfished' rockfish species (Figure from PFMC 2011a).

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

Trawl, Bottom

Highly Effective

The Pacific Fishery Management Council meets multiple times each year, in meetings that are open to the public (PFMC 2012). The Council receives advice from the Groundfish Advisory Subpanel, which represents the interests of commercial and recreational fisheries, tribes, conservationists, and the general public.

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Trawl, Bottom	No	No	Moderately Effective	Highly Effective	Highly Effective	Highly Effective

Subfactor 3.2.1 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

Trawl, Bottom

Moderately Effective

Reference points and associated harvest control rules are lacking for many of the primary "bycatch" species.

Rationale:
Several commonly caught bycatch species lack biomass reference points and associated harvest control rules. This is true for Pacific grenadier, which in 2011 were primarily caught in the IFQ trawl, IFQ hook and line, and LE non-endorsed longline fisheries; unidentified grenadier, which in 2011 were primarily caught in the IFQ trawl, LE non-endorsed longline, and OA longline fisheries; spiny dogfish, which were primarily caught in the IFQ trawl fishery and were caught in several other groundfish fisheries in smaller amounts, spotted ratfish, which were caught in the IFQ trawl fishery, and blue rockfish (south of 40°10’N), which were caught and primarily discarded in the Nearshore South fishery (Bellman, M.A., et al., 2012).Appropriate reference points are in place for longnose skate, which were mostly landed in the IFQ trawl fishery but were largely discarded in the LE endorsed longline and OA longline fisheries; canary rockfish, which were primarily caught in the Nearshore South fishery, and splitnose rockfish, which were caught almost entirely by the IFQ trawl fishery.

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on

species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

Trawl, Bottom

Highly Effective

The IFQ trawl and IFQ non-trawl sectors have 100% at-sea and dockside monitoring, and as such these sectors meet the “highly effective' standard.

Subfactor 3.2.3 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Trawl, Bottom

Highly Effective

As with factor 3.1, the process for the determination of OFLs, ABCs, and ACLs is designed to ensure that managers adhere to scientific advice regarding maximum allowable catch levels.

Subfactor 3.2.4 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Trawl, Bottom

Highly Effective

As with factor 3.1, a variety of mechanisms are in place to ensure "highly effective" enforcement.

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
Trawl, Bottom (soft substrate)	2.00:Moderate Concern	0.50:Moderate Mitigation	4.00:Low Concern	**Yellow (3.162)**
Trawl, Bottom (hard substrate)	1.00:High Concern	0.50:Moderate Mitigation	4.00:Low Concern	**Yellow (2.450)**

By their nature, 'groundfish' tend to be demersal species, and the fisheries that target them correspondingly use bottom-tending gears. While the U.S. west coast non-hake commercial groundfish fisheries use a variety of gears, including bottom trawl, longline, pot, and hook and line gears, the common denominator between the gears is that they are expected to contact the bottom during their normal use. As such, the potential for habitat disturbance and destruction is present for all of the gears. A wealth of scientific information suggests that mobile bottom trawl gear should be expected to have the most significant impacts of all of the gears used in these fisheries; bottom longline and trap gears may also cause damage but, being fixed gears, they do not sweep over the seafloor as does trawl gear. In recognition of the potential for bottom-tending gears to damage habitat, a number of spatial restrictions on gear use are in place. These restrictions particularly limit the use of bottom trawl gear, and as such offer a degree of mitigation of bottom trawl habitat impacts.

Justification of Ranking

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- *5 (None)—Fishing gear does not contact the bottom*
- *4 (Very Low)—Vertical line gear*
- *3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Trawl, Bottom (soft substrate)

Moderate Concern

The IFQ trawl fishery catches a variety of groundfish species, and these species in turn associate with a variety of habitats as adults (Appendix F, (PFMC 2005a)). Additional evidence of bottom trawl gear interactions with habitat include the observed bycatch of 3.09 tons of *Scleractinia* corals in the pre-IFQ LE bottom trawl fishery in 2010 (WCGOP 2012). The Seafood Watch criteria require a score of 'severe' for a fishery that uses trawls on cobble, boulder, or deep (>60 m) gravel; this score is applied via a "hard substrate" score for rockfish and arrowtooth flounder. The fishery's impact on substrate when primarily fishing for those species only found on soft or mixed soft/hard substrate is less of a conservation concern, and is thus deemed a "moderate" concern. This latter score is applied via a "soft substrate" score to all flatfish except rock sole and arrowtooth flounder.

Trawl, Bottom (hard substrate)

High Concern

See rationale above.

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.*
- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

Trawl, Bottom

Moderate Mitigation

There are several measures in place to mitigate the effect of bottom trawling on fish habitat on the U.S. west coast. Groundfish bottom trawling of any sort is prohibited in approximately 25% of the Essential Fish Habitat that is found in waters shallower than 700 fathoms, and expansion of groundfish bottom trawling into waters deeper than 700 fathoms is prohibited. Additionally, bottom trawling with footrope diameter that exceeds 19" is prohibited in the EEZ, and bottom trawling with footrope gear that exceeds 8" is prohibited in waters shallower than 100 fathoms.The IFQ trawl fishery receive a score of 'moderate mitigation', for the following reasons:- More than 20% of fishery-accessible EFH is protected from bottom trawling,- The fishery cannot expand into deeper waters, and- Nearly 4 out of every 5 habitats has more than 20% representation in the EFH Conservation Areas and/or the bottom trawl footprint closure.

See Appendix F for more information.

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*

- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.*
- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Trawl, Bottom

Low Concern

The fisheries addressed in this assessment do not target any species of exceptional ecological importance (see Appendix G for more information). While hake are indeed a groundfish species of exceptional ecological importance, they are not targeted by the fisheries addressed in this assessment and the bycatch of hake by these fisheries is minimal.There is not a substantial portion of the groundfish fishery area that is protected in no-take zones, and there are no ecosystem-based harvest controls in place for any species. Currently, a Fishery Ecosystem Plan (FEP) is being developed. This plan will inform the existing single-species management approach with information regarding the influence of ecosystem considerations on the managed species, and vice versa.

As the fishery does not catch exceptional species, and a fishery ecosystem plan is being developed with a clear timeline, a process for incorporation into existing management processes, and suggestions for research to elucidate some broader ecosystem considerations for the groundfish fishery, the score for ‘impacts on the ecosystem and food web' is 'low' for all west coast groundfish fisheries addressed in this assessment. See Appendix G for more information.

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Appendix A: Review schedule

This report will be updated no less frequently than every three years.

Appendix B: Full list and assessment of the main species

This appendix provides a list of all of the species assessed for each Criterion 1 species/fishery combination, as well as the rationale text for species that (1) are not included in Criterion 1 and (2) are not the lowest scoring species in any Criterion 1 species/fishery combination.

Arrowtooth flounder: Trawl, Bottom

Subscore:: 2.709 **Discard Rate:** 1.00 **C2 Rate:** 2.709

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
MINOR SHELF AND SLOPE ROCKFISH COMPLEXES	High	2.00: High Concern	3.67: Low Concern	**2.709**
BLACKGILL ROCKFISH	High	4.00: Low Concern	2.33: Moderate Concern	**3.053**
BOCACCIO ROCKFISH	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
CANARY ROCKFISH	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
FINESCALE MORA	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
PACIFIC OCEAN PERCH	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
YELLOWEYE ROCKFISH	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
ROUGHEYE ROCKFISH	High	5.00: Very Low Concern	2.33: Moderate Concern	**3.413**
ARROWTOOTH FLOUNDER	Medium	4.00: Low Concern	3.67: Low Concern	**3.831**
CHILIPEPPER ROCKFISH	Medium	4.00: Low Concern	3.67: Low Concern	**3.831**
GREENSTRIPED ROCKFISH	High	4.00: Low Concern	3.67: Low Concern	**3.831**
COWCOD ROCKFISH	High	3.00: Moderate Concern	5.00: Very Low Concern	**3.873**
SPOTTED RATFISH	High	3.00: Moderate Concern	5.00: Very Low Concern	**3.873**
DARKBLOTCHED ROCKFISH	High	4.00: Low Concern	5.00: Very Low Concern	**4.472**
SHORTBELLY ROCKFISH	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**
AURORA ROCKFISH	High	5.00: Very	5.00: Very	**5.000**

		Low Concern	Low Concern	
LINGCOD	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SPINY DOGFISH	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SPLITNOSE ROCKFISH	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
WIDOW ROCKFISH	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
YELLOWTAIL ROCKFISH	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Dover sole: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
LONGNOSE SKATE	High	4.00: Low Concern	3.67: Low Concern	**3.831**
STARRY FLOUNDER	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**

DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

English sole: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
LONGNOSE SKATE	High	4.00: Low Concern	3.67: Low Concern	**3.831**
STARRY FLOUNDER	Medium	4.00: Low	5.00: Very	**4.472**

		Concern	Low Concern	
DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Pacific sanddab: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
LONGNOSE SKATE	High	4.00: Low Concern	3.67: Low Concern	**3.831**

STARRY FLOUNDER	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**
DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Petrale sole: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
LONGNOSE SKATE	High	4.00: Low	3.67: Low	**3.831**

		Concern	Concern	
STARRY FLOUNDER	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**
DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Rex sole: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**

LONGNOSE SKATE	High	4.00: Low Concern	3.67: Low Concern	**3.831**
STARRY FLOUNDER	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**
DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Starry flounder: Trawl, Bottom

Subscore:: **2.644** **Discard Rate:** **1.00** **C2 Rate:** **2.644**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
NON-FMP FLATFISH COMPLEX	Medium	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
SABLEFISH	Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
BIG SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
CALIFORNIA SKATE	High	2.00: High Concern	3.67: Low Concern	**2.709**
GIANT GRENADIER	High	2.00: High Concern	3.67: Low Concern	**2.709**
NON-FMP SKATE COMPLEX	High	2.00: High Concern	3.67: Low Concern	**2.709**
PETRALE SOLE	Medium	4.00: Low Concern	2.33: Moderate Concern	**3.053**
PACIFIC GRENADIER	High	2.00: High Concern	5.00: Very Low Concern	**3.162**
OTHER FLATFISH COMPLEX	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**
PACIFIC COD	Medium	3.00: Moderate	3.67: Low Concern	**3.318**

		Concern		
LONGNOSE SKATE	High	4.00: Low Concern	3.67: Low Concern	**3.831**
STARRY FLOUNDER	Medium	4.00: Low Concern	5.00: Very Low Concern	**4.472**
DOVER SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
ENGLISH SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
LONGSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
PACIFIC SANDDAB	Low	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
REX SOLE	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SHORTSPINE THORNYHEAD	High	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

AURORA ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for aurora rockfish is 56, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.33.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

Aurora rockfish was assessed in 2013. At that time, adult biomass was estimated to be above the management target (SBcurrent/SB40%=1.6; Table ES-2 in (Hamel, O.S., Cope, J.M., & Matson, S. 2013)). The reconstruction of biomass trends presented in the assessment indicates that the population's

biomass has never been lower than the management target (Figure ES-4 in (Hamel, O.S., Cope, J.M., & Matson, S. 2013)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Fishing mortality was estimated to be less than the management target in the latest year assessed (1-SPR2012/SPR50%=1.38) and for the last 18 years (Hamel et al. 2013).

BIG SKATE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for big skate is 85, and the species' productivity rating in Table 1 of (Cope, J.M., et al., 2011)) is 1.37.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

No stock assessment has been conducted for big skate, so the species' stock status is unknown (PFMC 2012b). The 'high concern' rating reflects the unknown status of the stock combined with the high vulnerability of the species to overfishing.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

The overfishing limit for big skate was set for the first time for the 2013-2014 fishing season, at 458 mt (PFMC 2012b). The estimates were derived from survey biomass and MSY harvest rate estimates in a new methodology for assessing data-poor stocks. Total estimated mortality during the 2012 season across all fisheries was 77mt (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). Thus it is unlikely that overfishing is occurring, but uncertainty precludes a rating of 'very low concern.'

BLACKGILL ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase inherent vulnerability score for blackgill rockfish is 70, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.22.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

For 2011, estimated blackgill rockfish spawning output (30.2% of SO_0) was greater than the overfished threshold ($SO_{25\%}$) but less than the management target ($SO_{40\%}$; Table B.2 in (Field, J.C. & Pearson, D. 2012)). The stock assessment suggests that blackgill rockfish spawning output diminished sharply from the early 1970s through the mid-1990s and then increased in the 2000s, and was less than the overfished threshold from 1990 through 2005 (Table 20 in (Field, J.C. & Pearson, D. 2012)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Moderate Concern

While recent catches have been approximately 50% of a hypothetical overfishing limit, estimated SPR was below 50% in 8 of the 10 years from 2001-2010, including the two most recent years assessed (2009 and 2010; (Field, J.C. & Pearson, D. 2012)). While NMFS classifies blackgill rockfish as 'unknown' in regard to potential overfishing (NMFS 2012), recent SPR rates have been similar to the target $SPR_{50\%}$. The stock assessment projects that the stock will continue to recover through 2022 under current management measures that decrease the overfishing limit and annual catch limit when the stock falls below the target (the 40:10 ACL rule) (Field, J.C. & Pearson, D. 2012). Early estimates of total 2013 fishing mortality suggest that reducing landing limits in 2013 have had the desired effect of reducing blackgill mortalities (essentially by reducing targeting of the stock) (PFMC 2014b). Given the likelihood that blackgill rockfish has been experienceing overfishing for most of the decade through 2010, the close proximity of recent fishing mortality to the overfishing limit, the likely reduction in fishing mortality in 2013 and the projection that the stock will continue to recover over the next decade, the stock is rated a 'moderate concern.'

Rationale:
The total mortality of southern blackgill rockfish across all fisheries was 150 t in 2011 (Table 15 in (Bellman, M.A., et al., 2012)). Approximately 81% of the total southern blackgill rockfish fishery catch in 2011 was caught in the LE non-endorsed longline (48%) and the OA longline (33%) fisheries (Bellman, M.A., et al., 2012). While there is no species-specific OFL against which to compare the 2011 catch, the authors of the recent stock assessment state that total catch of the southern slope complex blackgill rockfish in 2010 was approximately 50% of an estimated OFL for that year (Table B.5 in (Field, J.C. & Pearson, D. 2012)). Estimates of SPR for the two most recent years assessed (2009 and 2010) were 42.4% and 40.4% of SPR_0, respectively, and as such indicate overfishing relative to the proxy F_{MSY} ($F_{SPR50\%}$) (Field, J.C. & Pearson, D. 2012). Similarly, estimated SPR for the years 2001-2006 were all under 50% (Table B.4 in (Field, J.C. & Pearson, D. 2012)).

BOCACCIO ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for bocaccio is 63, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.28.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

For 2013, estimated spawning output (a proxy for adult biomass) for the southern population of bocaccio (31.4% of SO_0) exceeded the overfished threshold ($SO_{25\%}$) but was less than the target ($SO_{40\%}$); the 95% confidence interval ranged from under the overfished threshold to slightly less than the target. The stock was classified as "not overfished-rebuilding" by NMFS for 2012. While the species' IUCN status could qualify it for a Factor 1.2 score of "very high" concern, the IUCN status is noted as requiring an update, and the recent trend in the status of the southern stock of bocaccio suggests that its abundance is increasing. Therefore, the stock status of bocaccio off of the coast of California is scored "high" concern for this assessment due to the proximity of the stock's biomass to the overfished threshold, the fact that the lower 95% confidence interval is under the overfished threshold, and the fact that the stock is listed as a "species of concern" by NMFS.

Rationale:
The spawning output of the California population of bocaccio declined sharply in the 1950s to the early 1960s, and then rose rapidly in the later 1960s due to strong year classes (Field, J.C., et al., 2009). By the early 1970s, spawning output had exceeded mean unfished levels and commercial fishery catches and exploitation rates peaked; subsequently, a sharp decline in spawning output occurred in the later 1970s and through the 1980s and 1990s, until spawning output reaching a nadir of 11.8% of SO_0 in 2001 (Table 12 in (Field, J.C. 2014)). Bocaccio were officially classified as overfished following the 1996 stock assessment (Field, J.C., et al., 2009), and starting in 2000, fishing mortality was constrained by several years of low OYs (Field, J.C., et al., 2009).

Spawning output has increased in the years since the stock was declared overfished. For 2013, the spawning output of southern bocaccio was estimated to be 31.4% (95% C.I.= 23.1-39.6%) of SO_0, which placed it above the overfished threshold for rockfish ($SO_{25\%}$) but below the target reference point ($SO_{40\%}$) (Field, J.C. 2014). The southern (California) unit of bocaccio was classified as "not overfished – rebuilding" by NMFS for 2012 (NMFS 2012). The southern unit is listed as a "species of concern" by NOAA Fisheries Office of Protected Resources (NOAA Fisheries 2013), and the species as a whole is listed as "critically endangered" by the IUCN, although the IUCN website notes that the status "needs

updating" (IUCN 2012a).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

The 2011 catch of southern bocaccio, which was spread across several gear sectors, was approximately 1% of the overfishing limit (Bellman, M.A., et al., 2012). Furthermore, the estimated SPR for southern bocaccio in 2012 was substantially greater than the MSY proxy of $SPR_{50\%}$. An analysis of rebuilding options suggests that recent SPR levels have a very high probability of rebuilding the stock within the next two decades.

Rationale:
After reaching a nadir of approximately 10% of SPR_0 in the 1980s, the SPR of southern bocaccio has steadily increased, passing the MSY proxy of $SPR_{50\%}$ in the late 1990s and approaching 100% of SPR_0 in recent years (Figure E5 in (Field, J.C. 2014)). There is evidence that the current SPR level will not impede recovery: the target SPR for rebuilding is 77.7% (PFMC 2011c), and in the 2009 analysis of bocaccio rebuilding efforts, an SPR of 95% (which corresponds to the SPR estimate for 2008) has a 77% chance of recovery by 2022 and a 99% chance by 2038 (Table 3 in (Field, J.C. & He, X. 2009)).

While the species as a whole remains classified as "critically endangered" by the IUCN (although this status is noted as requiring an update; (IUCN 2012a)), the southern stock appears to be rebuilding (see Factor 2.2) and its SPR values have been similar to or greater than 90% for several consecutive years. The total estimated non-hake commercial groundfish fishing mortality of southern bocaccio in 2011 was 7.7 t; this was approximately 1% of the OFL and less than 3% of the ACL, and was spread out in trace amounts among the IFQ trawl, LE non-endorsed longline, OA longline, and Nearshore South fixed gear fisheries (Bellman, M.A., et al., 2012).

CALIFORNIA SKATE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for California skate is 51, but the species' productivity rating in Cope et al., 2011 is 1.21 (Table 1 in (Cope, J.M., et al., 2011)).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

No stock assessment has been conducted for California skate, so the species' stock status is unknown (PFMC 2012b). The unkonwn stock status, in combination with the species' high inherent vulnerability, compels a stock status score of "high" concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

The overfishing limit for California skate was set for the first time for the 2013-2014 fishing season, at 86 mt (PFMC 2012b). The estimate was derived from survey biomass and MSY harvest rate estimates in a new methodology for assessing data-poor stocks. Total estimated mortality during the 2012 season across all fisheries was 2.93 mt (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). Thus it is unlikely that overfishing is occurring, but uncertainty precludes a rating of 'very low concern.'

CANARY ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for canary rockfish is 62, and the species' productivity score in Table 1

of (Cope, J.M., et al., 2011) is 1.28.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

Estimated adult biomass for canary rockfish in 2011 is below the overfished threshold (Wallace and Cope 2011), and the stock is classified by NMFS 'overfished' for 2012 ($B:B_{MSY}$ proxy ratio of 0.576) (NMFS 2012).

Rationale:
Canary rockfish spawning biomass decreased steadily from the 1940s through the 1990s, dropping below $SB_{25\%}$ in 1990 and reaching its minimum in 1999 at 10.87% of SB_0 (Table 13 in (Wallace, J.R. & Cope, J.M. 2011)). Estimated biomass for canary rockfish in 2011 is 6,458 t (95% C.I. = 4,506 – 8,411 t), which is 23.2% (95% C.I. = 17-30%) of SB_0 (Table b in (Wallace, J.R. & Cope, J.M. 2011)). This estimate is under $SB_{25\%}$, which constitutes an overfished status (Figure 7) (Wallace, J.R. & Cope, J.M. 2011). While the short-term trend over the past several years is a moderate increase, the trend is "very uncertain" in the words of the 2011 assessment's authors, and is likely to slow as recent below-average year classes come into the spawning biomass (Wallace, J.R. & Cope, J.M. 2011).

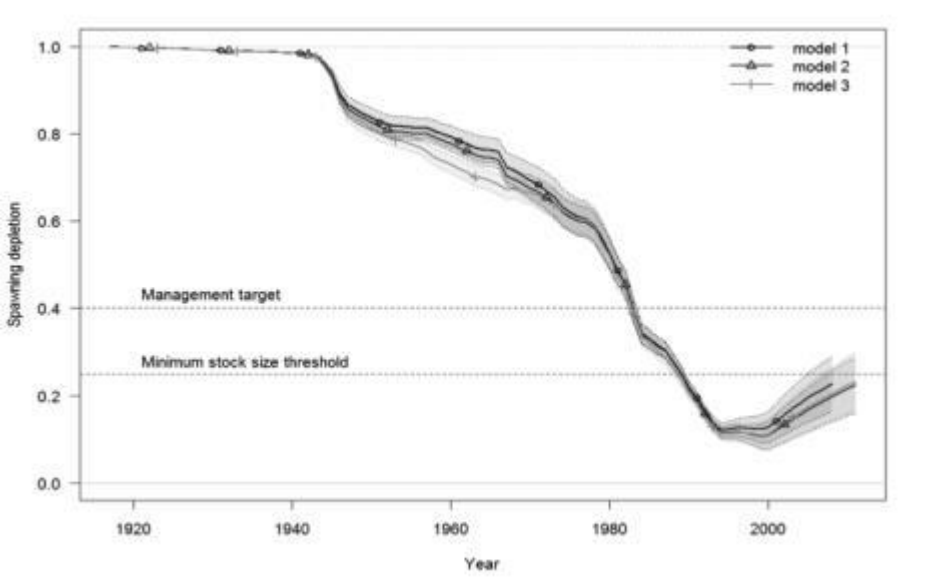

Figure 7. Modeled estimates of canary rockfish spawning biomass relative to SB_0 (Figure from Wallace and Cope 2011).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Estimated non-hake commercial groundfish fishing mortality of canary rockfish was 3.0% of the overfishing limit in 2011. Catches in recent years have been consistent with the harvest rule identified in the canary rockfish rebuilding plan, and are at a level that is modeled to have a greater than 70% probability of allowing the canary rockfish stock to rebuild.

Rationale:
The estimated canary rockfish SPR dropped below the management target ($SPR_{50\%}$) in 1977 and reached a minimum of 13.1% in 1992; SPR slightly increased over the next several years, but only began a substantial increase between 1999 (28.1%) and 2000 (71.2%) as a result of the implementation of the rebuilding plan (Table 13 in (Wallace, J.R. & Cope, J.M. 2011)). For 2010, estimated SPR was at 88% of SPR_0 (Table f in (Wallace, J.R. & Cope, J.M. 2011)). This is very close to the harvest rule in the rebuilding plan (88.7%; (PFMC 2011c)). Commercial landings have not exceeded the overfishing level during the last ten years, as catch was constrained by OYs that were set much lower than the corresponding overfishing levels (Table c in (Wallace, J.R. & Cope, J.M. 2011)). In 2011, estimated non-hake commercial groundfish fishing mortality of canary rockfish (18.4 t) was 3.0% of the OFL (614 t) and 18.1% of the ACL (102 t) (Bellman, M.A., et al., 2012). Finally, NMFS categorizes canary rockfish as not experiencing overfishing in the 2nd half of 2012 (NMFS 2012). It is also worth noting that the estimated 2010 SPR (88%) is nearly identical to one of the rebuilding alternatives (SPR = 88.7%) modeled in the 2007 canary rockfish rebuilding analysis (Stewart, I.J. 2007a); when this SPR was modeled, it resulted in a 75.0% chance of recovery within the maximum allotted timeframe, which was the same as the most stringent harvest control option that was modeled (F = 0) (Table 4 in (Stewart, I.J. 2007a)). (The 2007 rebuilding analysis is used in lieu of the 2009 rebuilding analysis due to the divergence between the 2009 assessment's biomass estimates compared to those in the 2007 and 2011 assessments). That modeling exercise indicates that the estimated 2010 SPR, and those of recent years, are at levels that will allow, with >70% probability, the rebuilding of the stock. In 2011, the Nearshore North fishery accounted for 73% of canary rockfish mortality in non-hake commercial groundfish fisheries, and 26% of total canary rockfish mortality across all fisheries (Appendix B; (Bellman, M.A., et al., 2012).

CHILIPEPPER ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

The Fishbase vulnerability score for chilipepper rockfish is 52, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.83.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

At the time of the most recent stock assessment (2006), the spawning biomass of chilipepper rockfish off of the coasts of California and Oregon was 70% of SB_0 (95% C.I.= 0.5-0.89% of SB_0), which exceeded the target for rockfish ($SB_{40\%}$) (Field, J.C. 2007). For 2011 and 2012, chilipepper rockfish spawning biomass is projected to be greater than $SB_{40\%}$ (63 and 64% of SB_0, respectively) (Table 3-6, Chapter 3 in (PFMC 2011a). The stock is classified as 'not overfished' by NMFS ($B:B_{MSY}$ proxy ratio of 1.784) (NMFS 2012). However, the stock has not been assessed since 2006, precluding a rating of 'very low concern'.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Recent exploitation rates for chilipepper rockfish have been at their lowest point since 1950 (Figure E4 in (Field, J.C. 2007)). Chilipepper rockfish catch did not exceed the overfishing limit between 1987 and 2006 (Table 1 in (Field, J.C. 2007)). In 2011, total fishing mortality was well below catch limits (approximately 16% of the OFL and 17% of the ABC and ACL; Table 16 in (Bellman, M.A., et al., 2012)), and the stock was classified as not experiencing overfishing in 2012 (NMFS 2012). Finally, in a productivity-susceptibility analysis of west coast groundfish, chilipepper rockfish have the 2^{nd}-lowest vulnerability-to-overfishing score of any rockfish, and the 12^{th} –lowest vulnerability score of all west coast groundfish (Table 4-4 in (PFMC 2011a)). It is therefore probable that fishing mortality is below a sustainable level but there is uncertainty due to the age of the stock assessment.

COWCOD ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for cowcod is 70, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.06.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

A recent assessment of the cowcod sub-stock in the Southern California Bight (SCB) indicates that this sub-stock is above $SB_{25\%}$ but below $SB_{40\%}$. The status of the stock between 40°10'N and the SCB is not known. The sub-stock in the SCB continues to rebuild, but the lack of information regarding the status of the stock north of the SCB moderates this score.

Rationale:
In 2000, cowcod were declared 'overfished' based upon an assessment of the SCB sub-stock (Dick, E.J. 2011). The SCB is the area between 34°27'N and the border of Mexico. Cowcod spawning biomass in the SCB has undergone two periods of steep reductions; the first came from 1900 through the early 1930s, when spawning biomass fell from 100% of SB_0 to less than 60%, and the second occurred from the late 1960s through the late 1980s, when spawning biomass fell again from over 60% of SB_0 in 1965 to approximately 10% in the late 1980s (Figure c in (Dick, E.J. & MacCall, A.D. 2013)). Spawning biomass has gradually increased in the years since. The estimated spawning biomass for 2013 is 33.9% of SB_0 (95% C.I. = 15%-65.6%; Table b in (Dick, E.J. & MacCall, A.D. 2013)). This is above the minimum stock size threshold for rockfish ($SB_{25\%}$), but less than the target reference point ($SB_{40\%}$).The status of cowcod north of Point Conception and south of Cape Mendocino (i.e., south of 40°10'N but north of the SBC) is not known ((Dick, E.J. & MacCall, A.D. 2013).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

For the sub-stock of cowcod found in the SCB, recent exploitation rates have been less than the exploitation rate limit determined for rebuilding purposes, and catches in line with the ACL are modeled to allow for continued rebuilding. Catches of cowcod in the total area south of 40°10'N are well under catch limits, as well: in 2011, cowcod mortality in non-hake commercial groundfish fisheries was less than 1% of the overfishing limit.

Rationale:
SCB cowcod exploitation rates have been ≤0.1% in each year since 2003 (Table h in (Dick, E.J. & MacCall, A.D. 2013)); for comparison, the 2013 assessment's estimate of the exploitation rate that produces MSY is 5.5% (Table d in (Dick, E.J. & MacCall, A.D. 2013)). For rebuilding purposes, the exploitation rate limit for 2013/2014 is set at 0.7% (Table 4 in (Dick, E.J. & MacCall, A.D. 2013). Catches in line with the current ACL are modeled to allow for spawning biomass to continue to increase (Table 6 in (Dick, E.J. & MacCall, A.D. 2013).Looking beyond the SCB, during the period 2003-2012, total fishing mortality (commercial and recreational) of cowcod south of 40°10'N was well under catch limits (Table e in (Dick, E.J. & MacCall, A.D. 2013)). In 2011, non-hake commercial groundfish fishing mortality of cowcod was 0.02 t (all of which was taken in the IFQ fishery); this was less than 1% of the OFL, ABC, and ACL and was approximately 2% of the total estimated cowcod fishing mortality across all fisheries (including recreational fisheries; (Bellman, M.A., et al., 2012)).

DARKBLOTCHED ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for darkblotched rockfish is 69, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.39.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

Darkblotched rockfish spawning output (a proxy dfor adult biomass) declined sharply from the 1970s through approximately 2000, and was below the limit reference point ($SO_{25\%}$) from 1992 through 2007 (Table 13 in (Gertseva, V.V. & Thorson, J.T. 2013)). Spawning output has increased since 2000, and darkblotched rockfish SO_{2013} was recently estimated to 36% of SO_0 (95% C.I. = 16%-56%; Table ES-2 in (Gertseva, V.V. & Thorson, J.T. 2013)). This is above the limit reference point (SO25%), but below the target reference point (SO40%), hence the rating of 'low concern'.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

The most recent stock assessment found SPR (86%) to be well above the target reference point (the F_{MSY} proxy of $SPR_{50\%}$; SPR has been above 50% for at least the past ten years (Gertseva, V.V. & Thorson, J.T. 2013)). For 2011, total fishing mortality of darkblotched rockfish was 26% of the OFL, 27% of the ABC, and 45% of the ACL (Bellman, M.A., et al., 2012).

FINESCALE MORA

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for finescale mora (AKA finescale codling/Pacific flatnose) is 68, and no assessment was conducted of the species in (Cope, J.M., et al., 2011).

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

There is no stock assessment for finescale codling. This information, combined with the species' 'high' inherent vulnerability, compels a score of 'high' concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Finescale codling is not targeted by any west coast groundfish fishery (PFMC 2014b). Total catch in 2012 were estimated at about 2.65 mt (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013), and about 13mt average from 2007-2012 (PFMC 2014b). This latter is approximately 4% of the estimated overfishing limit (PFMC 2014b).

GIANT GRENADIER

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

Giant grenadier have a Fishbase vulnerability score of 72.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

There is no stock assessment for giant grenadier. This information, combined with the species' 'high' inherent vulnerability, compels a score of 'high' concern for giant grenadier, and therefore for 'unknown grenadier', which are ilkely composed of Pacific and giant grenadier (Field, J.C. 2004).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Along with Pacific grenadier, giant grenadier are likely a substantial component of the 'unspecified grenadier' catch noted in Bellman et al., 2012. In 2011, total catch of 'unspecified grenadier' was well below recent overfishing estimates for Pacific and giant grenadier. Giant grenadier fishing mortality is therefore scored 'low' concern.

Rationale:
In 2011, a total of 125 t of ‘unspecified grenadier’ were caught in commercial non-hake groundfish fisheries (Bellman et al. 2012); giant and Pacific grenadier are expected to have made up the majority of the ‘unspecific’ catch (Field 2004).To date, grenadiers have been managed as part of the 'other groundfish’ complex, without species-specific catch limits. However, OFLs were recently estimated for Pacific grenadier (1,386.0 t), giant grenadier (638.6 t), and other grenadiers (40.1 t) (Taylor, I. et al. 2013). In 2011, the IFQ trawl, LE non-endorsed longline, and OA longline fisheries were responsible for 72%, 17%, and 6%, respectively, of all “grenadier, unidentified” catch in 2011 (Bellman et al. 2012).

GREENSTRIPED ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for greenstriped rockfish is 63, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.28.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

Greenstriped rockfish were last assessed in 2009 (Hicks et al. 2009). The assessment found adult biomass to be 81.4% of SB_0, above the management target of $SB_{40\%}$. Uncertainty in the assessment preculdes a rating of "very low concern."

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Spawning output was above the management target of 40% in 2008, and it is unlikely the stock has ever fallen below this threshold (Hicks et al. 2009). Fishing mortality generally increased and occasionally exceeded the current overfishing limit during the 1970s, 1980s and 1990s but decreased to very low levels in the late 1990s and 2000s to rebuild other species. Uncertainty precludes a score of "very low concern," however.

LINGCOD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

The Fishbase vulnerability score for lingcod is 63, but the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.75. Lingcod inherent vulnerability is therefore scored "medium".

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

The most recent assessment of west coast lingcod was conducted in 2009 (Hamel, O.S., et al., 2009); this

assessment took into consideration both commercial and recreational catch and generated separate assessments of lingcod in a southern area (California) and northern area (Oregon and Washington). Biomass estimates suggest that both stocks were overfished in the 1990s but had rebuilt by 2007 to levels above the management target ($SB_{North}/SB_{40\%}$=1.675; $SB_{South}/SB_{40\%}$=1.85) For 2012, northern and southern lingcod are projected to have spawning biomasses that are 62% and 71% of SB_0, respectively (PFMC 2011a). Most recently, lingcod were classified as 'not overfished', with a $B:B_{MSY}$ ratio of 1.676, in 2012 (NMFS 2012).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

The lingcod catch did not approach the coastwide overfishing limit from 2000 to 2008 (Table 1) (Hamel, O.S., et al., 2009). For 2011, non-hake commercial groundfish fishing mortality of lingcod was well under the overfishing limits for both the 'north' and 'south' regions (24% and 10%, respectively (Table 16 in (Bellman, M.A., et al., 2012)). The stock is classified as not experiencing overfishing in 2012 (NMFS 2012)..

Rationale:
Over 80% of the 'north' lingcod commercial groundfish fishing mortality was taken in the IFQ trawl fishery, which represented 43% of total 'north' lingcod mortality across all fisheries; the Nearshore North fishery contributed another 10% and 5% of the commercial and total fishing mortality, respectively, of 'north' lingcod (Bellman, M.A., et al., 2012). Non-hake commercial groundfish fishing mortality of 'south' lingcod was primarily taken in the California Nearshore (51% of commercial mortality, 7% of total mortality), IFQ trawl (19% and 3%), and Oregon Nearshore (10% and 2%) fisheries (Bellman, M.A., et al., 2012).

Table 7: Comparison of commercial lingcod landings (not including discards) and associated overfishing limits, 2000-2008.

Year	Commercial Landings (t) (South)	Commercial Landings (t) (North)	Commercial Landings (t) (Coast wide)	Overfishing limit (Coast wide)
2000	56	90	146	700
2001	63	93	156	1,120
2002	81	124	205	745
2003	51	107	158	841
2004	63	115	178	1,385
2005	61	140	201	2,922
2006	62	197	259	2,716

2007	79	190	269	6,706
2008	69	216	285	5,853

LONGNOSE SKATE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for longnose skate is 55, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.53.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

Estimated longnose skate adult biomass has been gradually declining since the early 20th century, but it still above the management target (SB40%). For the last year assessed (2007), the estimated spawning biomass for longnose skate was 66% of estimated SB_0 (Table ES-2 in (Gertseva, V.V. & Schirripa, M.J. 2008)). Longnose skate spawning biomass is projected to be 66% of SB_0 for 2011 as well (PFMC 2011a). For 2012, longnose skate is classified as 'not overfished', with a $B:B_{MSY}$ ratio of 1.647, by NMFS (NMFS 2012). The lack of a recent stock assessment precludes a score of 'very low' concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

For 2011, total fishing mortality of longnose skate was 36% of the OFL, 38% of the ABC, and 84% of the ACL; this mortality was at a level that is not expected to reduce spawning biomass to less than $SB_{45\%}$ within at least the next 6 years. Approximately 75% of all non-hake commercial groundfish fishing

mortality of longnose skate in 2011 was taken and mostly retained in the IFQ trawl fishery; smaller amounts were also taken and mostly discarded by the LE endorsed longline and OA longline fisheries. The stock is classified as not experiencing overfishing for 2012, but there is no recent stock assessment.

Rationale:
The fishing mortality rate associated with the target $SPR_{45\%}$ was calculated at 4.3% for longnose skate in the 2008 assessment (Gertseva, V.V. & Schirripa, M.J. 2008). Mortality rates from 2001 to the last year assessed (2007) ranged from 0.68% to 1.87% (Table ES-4 in (Gertseva, V.V. & Schirripa, M.J. 2008)). More recently, total fishing mortality of longnose skate in 2011 (1,133 t) was 36% of the OFL, 38% of the ABC, and 84% of the ACL (Bellman, M.A., et al., 2012). The stock was classified as not undergoing overfishing in 2012 (NMFS 2012).The authors of the most recent stock assessment suggest that the proxy harvest rate of $F_{SPR45\%}$ may not be appropriate for longnose skate, as it would be expected to result in a long-term spawning biomass of 12% of SB_0 (Gertseva, V.V. & Schirripa, M.J. 2008). Therefore, it is useful to review the potential for current harvest rates to reduce spawning biomass to less than $SB_{45\%}$.The OFL, ABC, and ACL for 2012 are 3,006 t, 2,873 t, and 1,349 t, respectively (Table 2a to Part 660, Subpart C,(NMFS Northwest Region 2012)); this corresponds to the lower, uncertainty-adjusted alternative harvest specifications presented in (PFMC 2011a) and the 'medium' harvest scenario presented in the 2008 assessment's decision table (Gertseva, V.V. & Schirripa, M.J. 2008). In that table, annual catches of 1,349 between 2009 and 2018 are not expected to reduce the spawning biomass to below $SB_{40\%}$ (Table 19 in (Gertseva, V.V. & Schirripa, M.J. 2008)). The 2011 total fishing mortality (1,133 t; (Bellman, M.A., et al., 2012)) was essentially the same as the 'medium' catch levels assessed in the 2008 stock assessment's decision table, and as such would not be expected to reduce longnose skate spawning biomass to less than $SB_{45\%}$ within the next 6 years.Fishing mortality of longnose skate in non-hake commercial groundfish fisheries was 36% of the OFL in 2011 (Bellman, M.A., et al., 2012). The IFQ trawl fishery was responsible for 76% of this catch, and 75% of total longnose skate catch across all fisheries for that year (Bellman, M.A., et al., 2012). In addition, the LE endorsed longline and OA longline fisheries also caught longnose skate in amounts that were not insubstantial (6% and 13% of total non-hake commercial groundfish fishing mortality of this species, respectively); these two fisheries discarded most of their catch of longnose skate (Bellman, M.A., et al., 2012).

LONGSPINE THORNYHEAD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for longspine thornyhead is 60, and the species' productivity score in

Table 1 of (Cope, J.M., et al., 2011) is 1.47.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

After declining from the 1970s through the end of the 1990s, longspine thornyhead adult biomass has steadily increased since the late 1990s (Figure d in (Stephens, A. & Taylor, I.G. 2013)). Longspine thornyhead SB_{2013} is estimated to be 75.2% of SB_0 (95% C.I. = 53.5%-96.9%), which is well above the target reference point of $SB_{40\%}$ (Stephens, A. & Taylor, I.G. 2013).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Total fishing mortality of longspine thornyhead in 2011 was below the catch limits (28% of the OFL and 33% of the ABC; (Bellman, M.A., et al., 2012)). The stock was also classified as not experiencing overfishing for 2012 by NMFS (NMFS 2012). Estimated SPR for 2012 was above $SPR_{50\%}$ (Table d in (Stephens, A. & Taylor, I.G. 2013)), which indicates that mortality was less than OFL levels.

NON-FMP SKATE COMPLEX

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The 'Non-FMP skate' complex comprises multiple species, several of which are caught in the IFQ bottom trawl fishery (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). The species that acounted for the majority of the catch of this complex in 2012 are listed below. All are considered to have a high

vulnerability to overfishing.

Rationale:
Table 3.

Species	FishBase Vulnerability score
Aleutian skate	86
Black skate	67
Pacific electric ray	78
Sandpaper skate	59

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

No stock assessments have been conducted on these species, so stock status is unknown (PFMC 2012b). The Seafood Watch criteria require a rating of high conservation concern for stocks of unknown status but that are highly vulnerable to overfishing.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Although no stock assessments have been completed for these species, all are listed as 'Least Concern' by the IUCN due to the majority of their biomass being in deeper waters outside of current fishing pressure eg (Davis et al. 2009).

OTHER FLATFISH COMPLEX

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

The other flatfish complex comprises several flatfish species, some of which are caught in the IFQ bottom trawl fishery (Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). The species that account for the majority of the catch of this complex in the fishery are listed below. Their FishBase vulnerability scores and productivity scores from Table 1in (Cope, J.M., et al., 2011) suggest they are typically of low to moderate vulnerability. An exception to this is rock sole, which is a high vulnerability species when using the FishBase score alone. However, (Cope, J.M., et al., 2011) suggest rock sole vulnerability is more moderate, with a prodcutivity score of 1.95 (Table 1 in (Cope, J.M., et al., 2011)).

Rationale:
Table 4

Species	FishBase Vulnerability score	Productivity scores (Table 1 in Cope, J.M, et. al, 2011)
Butter sole	35	2.45
Flathead sole	36	2.30
Rock sole	57	1.95
Sand sole	37	2.33

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

No stock assessments have been conducted for these stocks, so their status is unknown (PFMC 2012b).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Although no stock assessments have been conducted for the species in this complex (except Pacific sanddab and rex sole, assessed separately), managers have set an allowable biological catch and overfishing limit for each species which are then summed for the complex as a whole (PFMC 2012b). Catches in 2012 were below the 2012 overfishing limit for each species and for the complex as a whole (PFMC 2012b)(Bellman, M.A., Al-Humaidhi, J., Jannot, J. & Majewski, J. 2013). In addition, a

recent assessment to identify the likelihood that a number of data poor stocks are experiencing overfishing found a 0.00% chance that that rock sole, Pacific sanddab and sand sole were (the other species in the 'Other flatfish' complex were not included inthe assessment (Dick, E.J. & MacCall, A.D. 2010). The relatively high level of uncertainty precludes a score of 'very low concern.'

PACIFIC COD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

The Fishbase vulnerability score for Pacific cod is 50, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 2.11.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

There is no stock assessment for west coast Pacific cod (PFMC 2011a), the population is classified by NMFS as ‘unknown’ in regards to potential overfished status for 2012, and the inherent resilience of Pacific cod is not 'high.'. Stock status is therefore a 'moderate' concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Low Concern

Total fishing mortality of Pacific cod is well below catch limits, as 2011 total mortality across all fisheries was 19% of the overfishing limit (Table 16 in (Bellman, M.A., et al., 2012)). It should be noted that Pacific cod are a Category 3 species and as such the OFL is determined by maximum historical landings (NMFS

Northwest Region 2012). In a productivity-susceptibility assessment of over 80 west coast groundfish species, Pacific cod received the sixth-lowest vulnerability-to-overfishing score (Table 4-4 in (PFMC 2011a)).

PACIFIC GRENADIER

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

Pacific grenadier have a Fishbase vulnerability score of 79, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.44.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

There is no stock assessment for Pacific grenadier, and the status of the Pacific grenadier stock is classified as 'unknown' by NMFS for 2012. This information, combined with the 'high' inherent vulnerability of Pacific grenadier (Factor 1.1), requires a score of 'high' concern for Pacific grenadier stock status.

Rationale:
Throughout the 1990s, grenadier biomass estimates from trawl surveys were between 29,000-36,000 t; giant grenadier and Pacific grenadier were estimated to comprise 92% of grenadier biomass (Field, J.C. 2004). There are no recent assessments of the grenadier stock, and NMFS classifies Pacific grenadier as 'unknown' in regard to the potential for being overfished for 2012 (NMFS 2012).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

To date, grenadiers have been managed as part of the 'other groundfish' complex, without species-specific catch limits. However, overfishing limits were recently estimated for Pacific grenadier (1,386.0 t), giant grenadier (638.6 t), and other grenadiers (40.1 t) (Taylor, I., et al., 2013). These overfishing limits were derived from estimated natural mortality (M), F_{MSY}/M, and survey biomass estimates (Taylor, I., et al., 2013). In 2011, mortality of Pacific grenadier was approximately 8% of the overfishing limit (and 17% if all of the 'unspecified grenadier' were Pacific grenadier) (Bellman, M.A., et al., 2012).

Rationale:
In 2011, a total of 111 t of Pacific grenadier and 125 t of 'unspecified grenadier' were caught in commercial non-hake groundfish fisheries (Bellman, M.A., et al., 2012); giant and Pacific grenadier are expected to have made up the majority of the 'unspecific' catch (Field, J.C. 2004). The IFQ trawl fishery was responsible for 44% of all fisheries mortality of Pacific grenadier in 2011, the LE non-endorsed longline fishery was responsible for another 39%, and the IFQ hook and line fishery was responsible for 7% (Bellman, M.A., et al., 2012).

PACIFIC OCEAN PERCH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for Pacific Ocean perch is 60, and the species' score in Table 1 of (Cope, J.M., et al., 2011) is 1.44.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

Pacific Ocean perch spawning output (a proxy for adult biomass) dropped below the overfished

threshold ($SO_{25\%}$) in 1980 and has been there ever since; for 2011, Pacific Ocean perch spawning output was 19.1% of SO_0 (Table b in (Hamel, O.S., & Ono, K. 2011)). The stock is classified as 'overfished' by NMFS for 2012 ($B:B_{MSY}$ proxy ratio of 0.478, for 2012)(NMFS 2012).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Total fishing mortality of Pacific Ocean perch in 2011 was well below (6%) the overfishing limit (Table 16 in (Bellman, M.A., et al., 2012)). The stock is on a rebuilding plan that specifies a harvest control rule of 86.4% of SPR (i.e. fishing mortality be low enough that SPR remains at 86.4 or above). Since 2002, SPR has been above 80% and as high as 91.2%; in 2010 the SPR was 87.0% (Table 8 in (Hamel, O.S., & Ono, K. 2011)). According to modeled rebuilding scenarios, an SPR of 83.9% or greater has a >70% probability of rebuilding in the maximum timeframe; an SPR of 86.4% has a 73.2% probability (Table 4 in (Hamel, O.S. 2011)).

ROUGHEYE ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for rougheye rockfish is 69, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.17.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

In the first assessment of the rougheye/blackspotted rockfish complex, adult biomass is estimated to have sharply declined during the 1980s and 1990s before leveling out above the target reference point (Figure d in (Hicks, A.C., et al., 2013)). Rougheye/blackspotted rockfish SB_{2013} is estimated to be 47.3% of SB_0 (95% C.I. = 30.5%-64.2%; Table b in (Hicks, A.C., et al., 2013)). This is above the target reference point of $SB_{40\%}$(Figure d in (Hicks, A.C., et al., 2013)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Moderate Concern

Overfishing was occurring on rougheye rockfish from 2008 to 2011 (SPR was less than $SPR_{50\%}$) during the 2008-2011 period (Table d in (Hicks, A.C., et al., 2013)). For 2012, the estimated SPR was 51.0% (95% C.I. = 32.2%-69.8%; Table d in (Hicks, A.C., et al., 2013)), bringing rougheye rockfish out of overfishing status. However, the several years of overfishing before 2012 and the lower 95% CI bound in 2012 being higher than the overfishing limit preclude a rating of 'very low' or 'low' concern.

SABLEFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Low

The Fishbase vulnerability score for sablefish is 49, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.61.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

Estimated sablefish adult biomass dropped under the management target ($SB_{40\%}$) in 2009, and has diminished further during the subsequent two years (Stewart, I.J., et al., 2011). This is a continuation of a sharp downward trend that is entering its fourth consecutive decade (Figure 8). While the estimated spawning biomass for 2011 is above the $SB_{25\%}$ overfished threshold (Figure 8), the clear and persistent downward trend in abundance, the current sub-target status of spawning biomass, and the uncertainty in the biomass estimates, compels a score of "moderate" concern for U.S. West Coast sablefish.

Rationale:
Estimated sablefish spawning biomass has been trending downwards since the beginning of the 1980s; this trend is attributed to large catches during the late 1970s and early 1980s (Stewart, I.J., et al., 2011). In recent years, estimated sablefish biomass has declined from 47% of SB_0 in 2002 to 35% of SB_0 in 2010, and the 2011 assessment estimates that 2011 sablefish has declined further, to 33% of SB_0 (95% C.I. = 18-49%;(Stewart, I.J., et al., 2011). This is below the management target ($SB_{40\%}$) but above the overfished threshold ($SB_{25\%}$) (Figure 8). There is a high degree of uncertainty in the current assessment's estimation of spawning biomass: the estimate is 60,957 t, and the 95% confidence intervals are substantial (16,418 – 104,495 t)(Stewart, I.J., et al., 2011).Due to their stock status, sablefish are one of three species classified as being in the 'precautionary zone', along with Pacific whiting and blue rockfish (PFMC 2011a). Most recently, NMFS has classified sablefish as "not overfished", with a ratio of $B:B_{MSY}$ proxy of 0.837 (NMFS 2012).

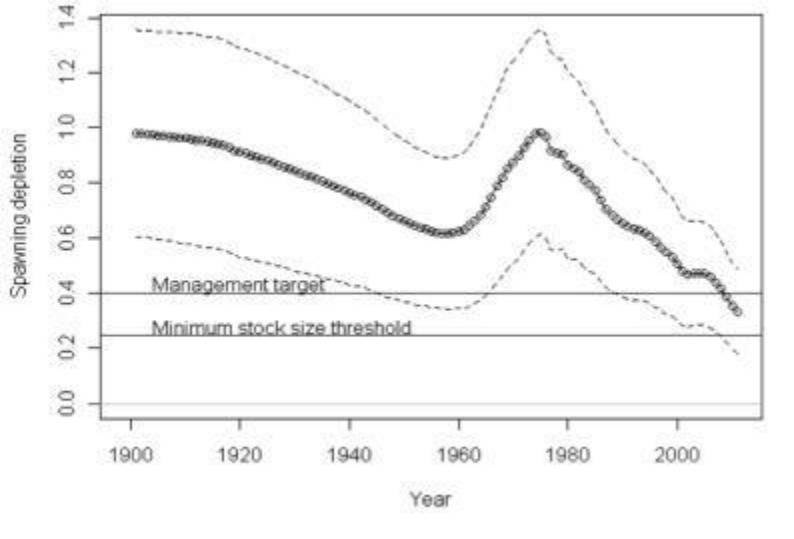

Figure 8. Estimated sablefish spawning biomass relative to SB0, with 95% confidence intervals (figure fromStewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Moderate Concern

There are many pieces of information to consider when assigning a score to sablefish mortality. In 2009 and 2010, sablefish SPR was slightly less than the target ($SPR_{45\%}$); by definition, this constitutes overfishing for those years. However, the 2011 total fishing mortality of sablefish was less than catch limits, and the stock was classified as not experiencing overfishing in 2012. Given the high degree of uncertainty regarding the current stock assessment, the fact that fishing mortality seems to have been increasing over the four years preceding the recent stock assessment, and the fact that estimated SPR for sablefish in 2010 was less than $SPR_{45\%}$ and was the lowest estimate since the late 1970s, fishing mortality for sablefish is scored "moderate" concern. For reasons explained in greater detail below, this score is applied to any commercial groundfish fishery for which 'north' or 'south' sablefish accounted for >20% of fishery catch in 2011, or which accounted for >20% of total fishing mortality of 'north' or 'south' sablefish in the same year. Thus, the IFQ trawl, IFQ hook and line, IFQ pot, LE endorsed longline, LE endorsed pot, LE non-endorsed longline, LE non-endorsed pot, OA longline, and OA pot fisheries receive scores of "moderate" concern for their catch of sablefish in 2011.

Rationale:

The most recent stock assessment attributes the continuing decline in sablefish abundance "primarily to relatively poor recruitments", because fisheries exploitation was below target rates from 1998 through 2008 (Stewart, I.J., et al., 2011). Despite this, the study also notes that relative SPR ($1\text{-SPR}/1\text{-SPR}_{45\%}$) and relative exploitation rate increased sharply over the 4 years immediately prior to the assessment (Stewart, I.J., et al., 2011). The relative SPR for 2009 and 2010 both exceeded 100% (with 95% C.I.s of approximately 60-146%; Table c in (Stewart, I.J., et al., 2011)). This means that, for these two years, overfishing was occurring (Stewart, I.J., et al., 2011). The 2009 and 2010 relative SPRs are the highest estimated since the large catches of the late 1970s and early 1980s (Figure 9) when the stock was more abundant (Figure 10).

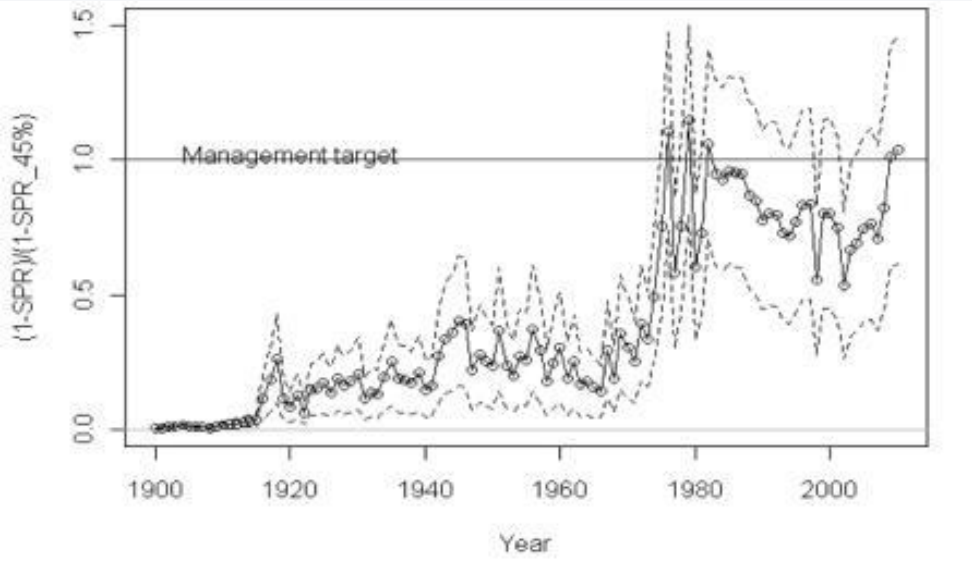

Figure 9. Relative Spawning Potential Ratio (1-SPR/1-SPR45%), with 95% confidence intervals. A relative SPR value of >1.0 indicates overfishing for that year. (Figure from Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

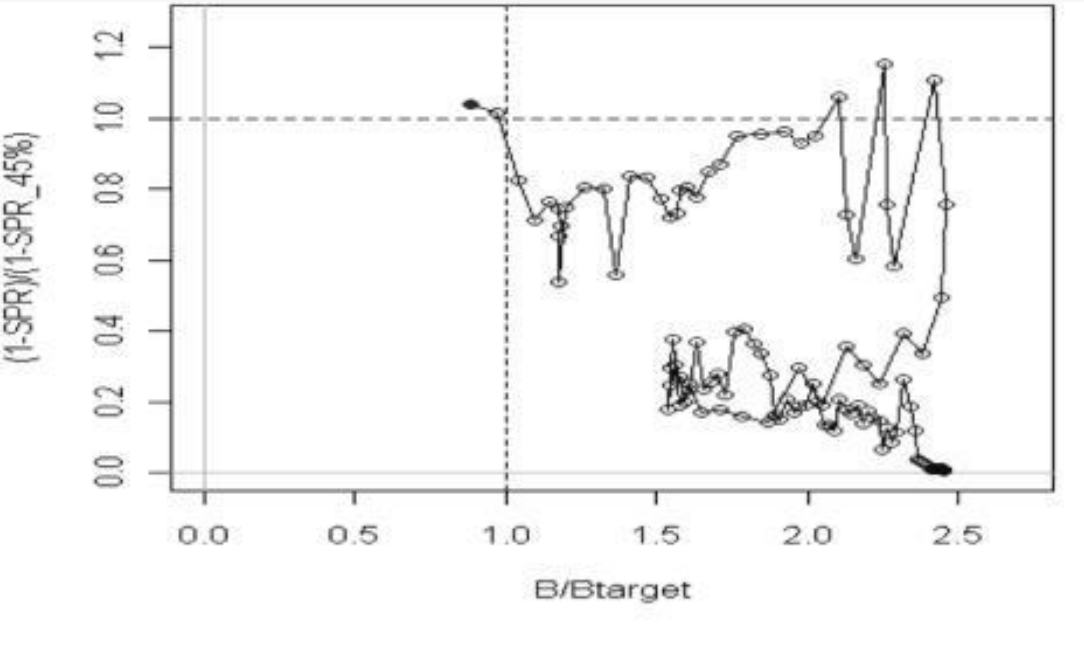

Figure 10. Fishery exploitation, expressed as Relative SPR (1-SPR/1-SPR45%), compared to stock status (SB/SB40%) (Figure from Stewart, I.J., Thorson, J.T., and Wetzel, C. 2011).

In apparent contradiction to the SPR-based estimates of potential overfishing in 2009 and 2010, the assessment also notes that from 2001-2010, estimated 'dead' catch (landings + modeled estimates of discarding) exceeded the overfishing limit in only one year (2008) (Table d in (Stewart, I.J., et al., 2011)). Furthermore, from 2010 through 2012, NMFS classified U.S. west coast sablefish as not experiencing overfishing (NOAA Fisheries 2012).Total fishing mortality of sablefish (coastwide) in 2011 was 75% of the OFL, 78% of the ABC, and 97% and 94% of the north and south ACLs, respectively (Table 16 in (Bellman, M.A., et al., 2012)). For that year, non-hake commercial groundfish fishing mortality of sablefish north of 36°N was 87% of uncertainty-adjusted ACL, and 94% of the ACL south of 36°N (Bellman, M.A., et al., 2012). The distribution of 'north' sablefish catch among fisheries reflected allocations: the IFQ, LE sablefish-endorsed, LE sablefish non-endorsed, and Open Access fixed gear fisheries all caught more than 90% of their allocations of 'north' sablefish in 2011 (with the LE non-endorsed fishery exceeding its allocation due to catch in the LE non-endorsed longline sector) (Bellman, M.A., et al., 2012). The catch of 'south' sablefish was primarily distributed among IFQ hook and line (12% of commercial groundfish fishery catch of 'south' sablefish), IFQ pot (23%), non-endorsed longline (44%), and the OA longline (8%) and pot (5%) fisheries (Bellman, M.A., et al., 2012).In most occasions, the determination of a score for this factor requires consideration of the fishery's catch of a species relative to the total catch of the species, and if it is found that the fishery's contribution to total mortality is relatively minor, the fishing mortality score is adjusted accordingly. The amounts of sablefish caught in the various commercial

groundfish fisheries varies considerably from fishery to fishery, and at first glance, it would seem that sablefish would require several different mortality scores to reflect the various fisheries' contributions to sablefish mortality. However, the analyst believes that the distribution of sablefish catch among these fisheries is largely a reflection of allocation and other management decisions, and does not reflect more or less sustainable practices between the fisheries. The score for sablefish mortality is therefore based on total sablefish mortality across all non-hake groundfish fisheries, and this single score is applied to the sablefish catch of any fishery for which sablefish constituted >20% of the catch OR to any fishery that caught >20% of total 'north' or 'south' sablefish.In 2011, the fisheries for which 'north' and/or 'south' sablefish constituted >20% of total catch were the IFQ hook and line, IFQ pot, LE endorsed longline, LE endorsed pot, LE non-endorsed longline, LE non-endorsed pot, OA longline, and OA pot. 'North' sablefish constituted only 9% of the IFQ trawl fishery's total catch, but due to the scale of this fishery, this still amounted to 31% of total fishing mortality of 'north' sablefish. These are the fisheries for which a common score for sablefish mortality will be assigned.

SHORTBELLY ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

Medium

The Fishbase vulnerability score for shortbelly rockfish is 43, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.94.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Low Concern

Shortbelly rockfish was estimated to be 67% of SB_0 in 2005 (Field et al. 2008). This is above the target reference point of $SB_{40\%}$. The age of the stock assessment precludes a rating of "very low concern."

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

There are no commercial or recreational fisheries for shortbelly rockfish. While the 2007 stock assessment did not provide fishing mortality reference points (Field et al. 2008), total fishing mortality is very low compared to the species' allowable biological catch (7.45/5789mt in 2012) (Bellman, M.A., Al-Humaidhi, J., Jannot, J. Majewski, J. 2013)(PFMC & NMFS 2010).

SHORTSPINE THORNYHEAD

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for shortspine thornyhead is 70, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.33.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

Shortspine thornyhead adult biomass has declined somewhat since the 1980s, but has stayed well above the target reference point (Figure d in (Taylor, I.G. & Stephens, A. 2013)). Shortspine thornyhead SB_{2013} is estimated to be 74.2% of SB_0 (95% C.I. = 56.1%-92.3%) (Table b in (Taylor, I.G. & Stephens, A. 2013)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Shortspine thornyhead fishing mortality was below catch limits in 2011 (42% of OFL, 44% of ABC, and 53% and 45% of north and south ACLs, respectively; Table 15 in (Bellman, M.A., et al., 2012)). In 2011, the ITQ trawl fishery and LE non-endorsed longline fishery together accounted for 40.7% of the coast-wide OFL, 42.6% of the ABC, and 61.7% of the ACL; combined, these fisheries accounted for some 94% of total fishing mortality (Bellman, M.A., et al., 2012). For 2012, shortspine thornyhead SPR exceeded $SPR_{50\%}$ (Table d in (Taylor, I.G. & Stephens, A. 2013)), which indicates that mortality was less than OFL levels. The stock was classified as not experiencing overfishing in 2012 (NMFS 2012).

SPINY DOGFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for spiny dogfish is 70 and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.11.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

Estimated spiny dogfish spawning output (a proxy for adult biomass) for 2011 was 63% of unfished spawning output; both this estimate and the associated lower confidence interval are above the target reference point ($SO_{40\%}$).

Rationale:
Spiny dogfish spawning output dropped sharply from approximately 1940 to 1950 (Figure ES-2 in (Gertseva, V. & Taylor, I.G. 2012)), due to removals by the target fishery for dogfish liver. Following the cessation of the liver fishery, a gradual and moderate increase in spiny dogfish spawning output persisted until the late 1970s, when a fishery began targeting dogfish for human consumption. For the past four decades, spiny dogfish spawning output has gradually but steadily declined due to fishing mortality and the stock's low productivity (Gertseva, V. & Taylor, I.G. 2012). For 2011, the spawning output is estimated to be 44,660 thousand fish (95% C.I. = 8,937 – 80,383 thousand). This is 63% of

SO_0 (Gertseva, V. & Taylor, I.G. 2012), and both the estimated spawning output and the associated lower confidence interval are above the management target of $SO_{40\%}$ and the overfished threshold of $SB_{25\%}$ (Figure ES-4 in (Gertseva, V. & Taylor, I.G. 2012)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

The estimated SPR for spiny dogfish in 2010 (79%) exceeds the target ($SPR_{45\%}$), and also exceeds a suggested alternate management target for spiny dogfish of $SPR_{77\%}$ (this suggestion reflects the very low fecundity of the species). Estimates of SPR for the period since 2001 have similarly exceeded $SPR_{45\%}$.

Rationale:
Estimated spiny dogfish mortality in non-hake commercial groundfish fisheries was 524 t in 2011, 70% of which was taken in the IFQ trawl fishery (Bellman, M.A., et al., 2012); this is a substantial reduction from catch levels in recent years (Table ES-1 in (Gertseva, V. & Taylor, I.G. 2012)).Estimated spiny dogfish SPR was well below $SPR_{45\%}$ for several years during the 1940s liver fishery, but for all other years it has exceeded $SPR_{45\%}$ (Figure ES-5 in (Gertseva, V. & Taylor, I.G. 2012)). Most recently, estimated SPR for the period 2001-2010 has been well above $SPR_{45\%}$, with the estimated SPR for 2010 being 79% (Table ES-4 in (Gertseva, V. & Taylor, I.G. 2012)). However, it is worth noting a concern raised by the authors of the stock assessment: $SPR_{45\%}$ may not be an appropriate target for spiny dogfish, as it is "expected to severely reduce the spawning output of spiny dogfish over the long term" (Gertseva, V. & Taylor, I.G. 2012). This is because spiny dogfish have very low productivity. The authors suggest that the Council consider an alternative SPR of approximately 77%, which would achieve the standard target spawning output of 40% (Gertseva, V. & Taylor, I.G. 2012). The authors' suggestion does not impact the recommendation in this assessment, as the estimated 2010 SPR (79%) exceeds this suggested management target as well.

SPLITNOSE ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for splitnose rockfish is 66, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.28.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

The estimated spawning output (a proxy for adult biomass) of splitnose rockfish has exceeded $SO_{40\%}$ since 2003, and has been increasing relative to SO_0 since 1999. For the last year assessed (2009), estimated splitnose rockfish spawning output was above $SO_{40\%}$.

Rationale:
Estimated splitnose rockfish spawning output declined from the 1960s through the 1990s (Gertseva, V.V., et al., 2009). Splitnose rockfish spawning output was below $SO_{40\%}$ from 1995-2003, but has been increasing since 1999 (35.8%) through the last year assessed (2009; 65.6%) (Table 19 in (Gertseva, V.V., et al., 2009)). The 2009 SO estimate is the highest since 1978 (Table 19 in (Gertseva, V.V., et al., 2009)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

For the most recent year assessed (2008), splitnose rockfish SPR was well above the target $SPR_{50\%}$, and the fishing mortality rate for splitnose rockfish was well below $F_{SPR50\%}$. Non-hake commercial groundfish fishing mortality of splitnose rockfish south of 40°10'N was less than 3% of the OFL in 2011, and the coast-wide stock of splitnose rockfish is classified as not experiencing overfishing for 2012.

Rationale:
As of the last year assessed (2008), splitnose rockfish SPR was 93.45%, which exceeds the target $SPR_{50\%}$ (Table ES-4 in (Gertseva, V.V., et al., 2009)). The 2009 assessment estimated that the exploitation rate associated with $SPR_{50\%}$ was 0.033; exploitation rates were less than 0.003 for the last two years assessed (2007 and 2008) (Table ES-4 in (Gertseva, V.V., et al., 2009)). More recently, non-hake commercial groundfish fishing mortality of splitnose rockfish south of 40°10'N was 2.7% of the OFL in 2011 (Bellman,

M.A., et al., 2012). For 2012, splitnose rockfish are classified by NMFS as not experiencing overfishing (NMFS 2012). The IFQ trawl fishery was the source for 95% of all fisheries catch of 'splitnose rockfish south of 40°10'N in 2011 (Bellman, M.A., et al., 2012).

SPOTTED RATFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for spotted ratfish is 50, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.63.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Moderate Concern

There is no information regarding the status of the spotted ratfish stock off of the west coast. The stock status of spotted ratfish is thus scored 'moderate' concern as its status is not known and the inherent vulnerability of the species is 'medium'.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

In 2011, non-hake commercial groundfish fishing mortality of spotted ratfish was approximately 73 t; the IFQ trawl fishery accounted for 95% of this mortality and 95% of total estimated mortality of spotted ratfish across all fisheries that year (Appendix B; (Bellman, M.A., et al., 2012)). The 2011 catch was well below the recently developed OFL estimate for ratfish (1,272.4 t; Table 1 in (Taylor, I., et al., 2013)). The

IFQ trawl fishery discarded over 99% of its spotted ratfish catch (Bellman, M.A., et al., 2012). In addition, ratfish received a score of 'low concern' regarding vulnerability to overfishing in a productivity-susceptibility assessment of west coast groundfish (PFMC 2011a).

WIDOW ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for widow rockfish is 65, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.31.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

After being considered overfished in the 1990s and early 2000s, an up-to-date stock assessment estimates that the 2011 adult biomass of widow rockfish is above the target reference point of $SB_{40\%}$ (51.1% of SB_0 in 2011; (He, X., et al., 2011)). Widow rockfish were classified as 'not overfished' for 102 ($B:B_{MSY}$ proxy ratio of 1.277; (NMFS 2012)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Total fishing mortality of widow rockfish was 216 t in 2011; this was 4% of the overfishing limit (Table 16 in (Bellman, M.A., et al., 2012)). Widow rockfish SPR has been above 95% since 2003, and SPR for 2010 was 97.5%, well above the management target of SPR50% (Table ES5 in (He, X., et al., 2011)). Since

2002, exploitation rates have been less than 1%, whereas three calculations of sustainable exploitation rate are all above 6.7% (Table ES4 in (He, X., et al., 2011)). Finally, the stock is classified as 'not overfished' by NMFS for 2012 (NMFS 2012).

YELLOWEYE ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for yelloweye rockfish is 73, and the species' productivity score in Table 1 of (Cope, J.M., et al., 2011) is 1.22.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

High Concern

Yelloweye spawning output dropped rapidly from the 1970s through the 1990s, dropped below the current management target ($SO_{40\%}$) in 1988 and below the overfished limit ($SO_{25\%}$) in 1994, and reached a minimum of 15.7% of SO_0 in 2000 (Table 21 in (Taylor, I.G. & Wetzel, C. 2011)). Estimated spawning biomass has increased in every year after 2001 due to harvest restrictions put in place after declaration of the species as 'overfished' in 2002. The 2011 estimated spawning output is 21.3% of SO_0 (Table 21 in (Taylor, I.G. & Wetzel, C. 2011)). This is below the overfished limit ($SO_{25\%}$), and as a result yelloweye is classified as 'overfished' by NMFS (NMFS 2012).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

Yelloweye SPR was estimated at 83.5% for 2010, which exceeds $SPR_{50\%}$, exceeds the selected rebuilding target, and is similar to two harvest scenarios that have >80% probability of allowing the stock to rebuild in the maximum time frame. Mortality in non-hake commercial groundfish fisheries has constituted approximately 35% of the total annual mortality of yelloweye over the past several years. Non-hake commercial groundfish fishing mortality in 2011 was approximately 3% of that year's OFL and was spread out among several commercial groundfish fisheries. As current levels of fishing mortality do not constitute overfishing and are not projected to hinder rebuilding, the score for yelloweye rockfish fishing mortality is a 'very low' concern for the IFQ trawl, IFQ hook and line, LE endorsed longline, and Nearshore North and South fisheries.

Rationale:
Exploitation rates, which reached a high of 12.3% in 1997, have been below 1% for all but one year after 2002 (Table 21 in (Taylor, I.G. 2011)). Yelloweye rockfish SPR was above 90% of SPR_0 during the 1930s, declined to 72% by 1968, and then commenced a rapid decline that would persist until 1997 (Table 21 in (Taylor, I.G. & Wetzel, C. 2011)). Yelloweye SPR dropped below the overfishing limit ($SPR_{50\%}$) in 1976, and reached its lowest level (9.4% of SPR_0) in 1992. Yelloweye SPR has increased in the years since 1999, exceeding $SPR_{50\%}$ in 2000 and continuing to climb until the last year in the data (2010), when SPR was estimated at 83.5% of SPR_0 (Table 21 in (Taylor, I.G. & Wetzel, C. 2011)). The 2010 SPR exceeds the SPR rebuilding target (76%) that was selected in 2010 (Taylor, I.G. & Wetzel, C. 2011). It is also worth noting that, in the most recent review of the yelloweye rebuilding plan, two modeled scenarios with SPRs (80.5% and 86.4%) that bracket the SPR_{2010} had probabilities of recovery of 82.8% and 93.7%, respectively, by the maximum year (Table 6 in (Taylor, I.G. 2011)).Commercial catch has accounted for an average of 35% of total annual mortality since the implementation of the rebuilding plan; recreational catch makes up the balance (Table 2 in (Taylor, I.G. 2011)). Non-hake commercial groundfish fishing mortality of yelloweye rockfish was 1.4 t in 2011; this catch represented approximately 3% of the OFL and ABC, and 8.3% of the ACL, and was 16% of total yelloweye mortality across all fisheries (Bellman, M.A., et al., 2012). The catch of yelloweye in the non-hake commercial groundfish fisheries was spread out in small amounts among the IFQ trawl, IFQ hook and line, LE sablefish longline, and Nearshore North and South fisheries (Bellman, M.A., et al., 2012).

YELLOWTAIL ROCKFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Trawl, Bottom

High

The Fishbase vulnerability score for yellowtail rockfish is 56, and the species' productivity score in Table

1 of (Cope, J.M., et al., 2011) is 1.33.

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Trawl, Bottom

Very Low Concern

Yelllowtail rockfish are separated into two stocks: one that is north of 40°30'N, and one that is south (Wallace, J. & Lai, H.L. 2005). In the information available for this assessment, catch of yellowtail rockfish is separated for catches north and south of 40°10'N. In 2011, catch of the 'south' stock in non-hake commercial groundfish fisheries was 2.2% of 'south' yellowtail rockfish total mortality across all fisheries (Bellman, M.A., et al., 2012). Therefore, the 'south' stock is not included in this assessment.

'North' yellowtail rockfish spawning biomass was essentially 100% of SB_0 prior to World War II, but declined thereafter, potentially approaching the target reference point (SB40%) during the 1980s and 1990s (Figure 89 in (Cope, J., et al., 2013)). Spawning biomass has increased in the 2000s, and estimated SB_{2012}:SB_0 was 0.69 (95% C.I. = 0.35-0.90; Table ES1 in (Cope, J., et al., 2013)).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Trawl, Bottom

Very Low Concern

For 2011, total fishing mortality of yellowtail rockfish north of 40° 10' N was 1,352 t, which was approximately 30% of the overfishing limit; Table 16 in (Bellman, M.A., et al., 2012)). Estimated F_{2012}:F_{MSY} was 0.14 (Table ES1 in (Cope, J., et al., 2013)). Continued catches at levels similar to recent years is projected to allow spawning biomass to increase (Table 72 in (Cope, J., et al., 2013)).

Appendix C: Chart of main species caught in West Coast groundfish fishery

Catch composition of west coast groundfish fisheries based on observer data (Bellman et al 2013). Excluding species that are caught only in trace amounts (less than 0.1 mt on average in recent years). The color coding denotes the filters used to identify the 'main species' included in the assessment (see Criterion 2 and SFW criteria for more detail).

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing and the fishery causes >1% of species' total mortality across all fisheries

Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Bocaccio rockfish (South of 40°10' N. lat.)	8.84			0.00	0.03		0.10	0.67		0.31	1.52				0.73	139.51
Canary rockfish	4.51	0.49		0.00	0.04	0.01				0.07				1.59	5.64	44.80
Cowcod rockfish (South of 40°10' N. lat.)	0.09															1.15
Darkblotched rockfish	81.04	0.07	0.22	0.03	6.75	0.04	1.34	0.10		0.79	0.02			0.07	0.02	104.95
Pacific Ocean Perch (North of 40°10' N. lat.)	36.13	0.03	0.08	0.01	0.30	0.04	0.03			0.04						55.79
Petrale sole	1030.50	1.69	0.32	0.08	0.53	0.00	0.06	0.13		0.07	0.02	0.01			0.00	1110.73
Yelloweye rockfish	0.03				0.23					0.06	0.04			1.71	0.08	11.56
Arrowtooth flounder	2357.15	1.90	4.38	1.22	35.05	0.15	0.97		0.09	3.01	1.93	1.10	0.24	0.01		2508.08
Black rockfish (North of 46°16' N. lat.)	0.72															249.40
Black rockfish (South of 46°16' N. lat.)	0.02													117.17	3.65	562.71

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing and the fishery causes >1% of species' total mortality across all fisheries

Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Cabezon (California)														1.70	28.88	73.93
Cabezon (Oregon)	0.08													28.97		46.83
California scorpionfish (South of 34°27' N. lat.)															3.19	120.18
Chilipepper rockfish (South of 40°10' N. lat.)	288.14			0.01	0.15		0.44	0.20		0.20	0.13		0.00		0.04	302.45
Dover sole	7015.24	4.17	0.41	3.28	4.55	1.11	0.94	2.33	0.03	0.55	0.20	0.17	0.04	0.00		7175.44
English sole	146.59	0.12			0.30											224.43
Lingcod (North of 42° N. lat.)	329.24	2.61	0.19	1.83	5.46	0.61	0.95		0.05	11.15		0.05		36.80		731.40
Lingcod (South of 42° N. lat.)	19.63			0.32	1.19	2.18	0.20	0.10		2.98	2.70	0.11	0.02	4.18	19.34	336.94
Longnose skate	890.79	1.56	14.98	0.00	44.39	0.69	9.07	3.20		5.39	2.41	0.05		0.03		990.99
Longspine thornyhead (North of 34°27' N. lat.)	891.84	0.12	0.20	0.03	0.77	0.02	0.67	4.23	0.00	0.13	0.05	0.00	0.09		0.00	912.04
Longspine thornyhead (South of 34°27' N. lat.)	0.40			0.00			0.00	15.00		0.00	0.66				0.05	17.53
Blue Rockfish (north)														12.28		43.64
Brown Rockfish (north)	0.01													0.30		0.92
China Rockfish (north)														9.41		17.11
Copper Rockfish (north)														2.24		14.07
Grass Rockfish (north)														0.22		1.72
Nearshore Rockfish Unid (north)	0.01															0.09
Olive Rockfish (north)														0.07		0.15
Quillback Rockfish (north)	0.10													3.38		18.31

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing and the fishery causes >1% of species' total mortality across all fisheries

Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Black and Yellow Rockfish (south)															11.39	16.85
Blue Rockfish (south)															1.41	50.70
Brown Rockfish (south)															26.19	95.99
China Rockfish (south)															3.14	15.56
Copper Rockfish (south)															4.72	85.38
Gopher Rockfish (south)																75.11
Grass Rockfish (south)															11.46	32.11
Kelp Rockfish (south)															0.59	19.70
Nearshore Rockfish Unid (south)															0.13	0.16
Olive Rockfish (south)															1.26	32.93
Quillback Rockfish (south)															0.21	2.93
Treefish Rockfish (south)															1.66	12.64
Bocaccio Rockfish (north)	1.66	0.01	0.00		0.04	0.00				0.08				0.01		4.73
Chilipepper Rockfish (north)	0.18	0.00	0.00		0.03					0.00						1.38
Greenblotched Rockfish (north)																0.00
Greenspotted Rockfish (north)	0.08	0.00			0.00											0.11
Greenstriped Rockfish (north)	28.20	0.57		0.00	0.20		0.03	0.00		0.14						31.89
Redstripe Rockfish	0.71	0.00	0.00													11.25

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

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Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
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(north)																
Rosethorn Rockfish (north)	3.09	0.00	0.08	0.01	0.79	0.01	0.02	0.00		0.04						4.66
Rosy Rockfish (north)	0.07				0.05	0.00								0.00		0.13
Shelf Rockfish Unid (north)	1.37		0.00	0.00	0.17	0.00	0.07	0.00		0.04		0.05		0.07		8.07
Silvergray Rockfish (north)	1.28	0.09	0.01		0.04	0.00	0.00	0.00		0.09						2.99
Squarespot Rockfish (north)	0.00															0.00
Stripetail Rockfish (north)	1.53				0.01		0.00			0.00						3.07
Yellowtail Rockfish (north)																0.75
Bronzespotted Rockfish (south)				0.02			0.00	0.10								0.12
Flag Rockfish (south)	0.00				0.05		0.00	0.01		0.00	0.18				0.11	14.53
Greenblotched Rockfish (south)	0.03						0.00	0.08		0.00	0.07				0.05	0.98
Greenspotted Rockfish (south)	0.41						0.00	0.23		0.01	0.95				0.07	19.89
Greenstriped Rockfish (south)	1.17						0.00	0.00		0.00	0.04				0.01	2.55
Honeycomb Rockfish (south)										0.00	0.00				0.00	6.23
Mexican Rockfish (south)	0.00						0.00	0.00		0.00	0.03				0.00	0.04
Pink Rockfish (south)	0.01						0.00	0.76								0.79
Redstripe Rockfish (south)	0.00															0.01

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing and the fishery causes >1% of species' total mortality across all fisheries

Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Rosethorn Rockfish (south)	0.04						0.00	0.39							0.03	0.48
Rosy Rockfish (south)	0.01				0.00		0.00	0.03		0.05	0.03				0.50	6.43
Shelf Rockfish Unid (south)	0.35			0.10	0.02		0.01	0.00		0.00	0.61		0.07		0.81	1.98
Speckled Rockfish (south)	0.00						0.00	0.09		0.00	0.01				0.02	9.76
Squarespot Rockfish (south)	0.00						0.00	0.16		0.00	0.03				0.00	4.64
Starry Rockfish (south)							0.00	0.10		0.05	0.17				0.27	24.01
Stripetail Rockfish (south)	11.32															13.38
Swordspine Rockfish (south)					0.04											0.05
Vermilion Rockfish (south)	0.01						0.00	0.64		0.74	7.62				7.05	233.09
Yellowtail Rockfish (south)	0.01						0.00	0.04		0.27	0.28				0.35	56.44
Aurora Rockfish (north)	18.87	0.01	0.07	0.04	0.18	0.00	0.00	0.00		0.00						20.06
Bank Rockfish (north)	0.28			0.00	0.01		0.00	0.00		0.00						0.32
Blackgill Rockfish (north)	4.73	0.00	0.48	0.06	2.93	0.03	0.20	0.00		0.20		0.00				8.98
Redbanded Rockfish (north)	5.90	0.00	0.71	0.06	17.55	0.09	2.41	0.00		1.80		0.00		0.00		35.86
Rougheye Rockfish (north)	47.35	0.07	19.36	0.09	46.55	0.06	3.13	0.00		2.79		0.00		0.00		236.70
Sharpchin Rockfish (north)	8.55		0.00		0.01	0.00	0.00	0.00		0.00						13.65
Shortraker Rockfish (north)	12.66	0.04	1.26	0.02	6.12		0.22	0.00		0.17				0.00		28.29

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

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Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Shortraker/Rougheye Rockfish (north)			2.16		36.24	0.00	0.12	0.00		0.02						38.54
Slope Rockfish Unid (north)	1.39	1.16	0.00	0.02	3.35	2.16	0.80	0.00		0.18		0.08		0.01		10.38
Splitnose Rockfish (north)	12.69	0.00	0.02		0.13	0.00	0.03	0.00		0.04						50.96
Yellowmouth Rockfish (north)	6.64		0.18	0.00	1.19		0.07	0.00		0.00						8.90
Aurora Rockfish (south)	24.38		0.00	0.19	0.11		0.00	0.11		0.03	0.03	0.00	0.02			25.21
Bank Rockfish (south)	16.58						0.00	0.00		0.00	0.42		0.01		0.01	18.74
Blackgill Rockfish (south)	73.11		0.76	5.28	9.87	0.03	10.61	33.40	0.01	1.37	58.11	0.06	0.23		2.31	195.44
Redbanded Rockfish (south)	0.70				0.88		0.00	0.00	0.01	0.03	0.02	0.06	0.01		0.00	1.71
Rougheye Rockfish (south)	0.24				0.17					0.03	0.02					0.46
Sharpchin Rockfish (south)	0.25								0.00	0.00	0.00	0.04	0.01			0.33
Shortraker Rockfish (south)	0.00															0.00
Slope Rockfish Unid (south)	1.64			0.04	0.94	1.88	0.04	0.00		0.00	0.54	0.01	0.07		0.07	6.14
Yellowmouth Rockfish (south)	0.05															0.05
Shortspine/ Longspine Thornyhead	1.64						0.01	0.52					0.01		0.03	2.42
Butter Sole	2.22															2.33
Curlfin Turbot	0.94															1.71
Flatfish Unid	2.06					0.00		0.06		0.00	0.00				0.01	26.82

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

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Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Flathead Sole	7.33	0.01					0.00									9.42
Pacific Sanddab	215.41	0.01						0.64		0.00	1.96				2.40	300.62
Rex Sole	374.40	1.15		0.01	0.32	0.00		0.02							0.00	443.84
Rock Sole	4.97	0.00								0.00	0.01				0.07	14.66
Roughscale Sole	0.00															0.00
Sanddab Unid	3.47									1.21	0.66		0.02		0.01	9.97
Sand Sole	70.70				0.22					0.01	0.00			0.00	0.13	87.81
Big Skate	47.69	0.00	0.03		2.38		0.02	3.52		0.38	0.24			0.01		76.53
Cabezon																7.97
California Scorpionfish															0.00	0.00
California Skate	2.11				0.00		0.00	0.01								2.93
Cod Unid	0.00															0.00
Grenadier Unid	70.21			0.01	6.87	0.00	14.71	23.48	0.00	5.78	0.02	0.02			0.62	126.23
Groundfish Unid	0.04															10.42
Kelp Greenling	0.15													19.85	4.54	65.07
Leopard Shark	0.26						0.00	0.10		0.07	0.72		0.08		0.24	38.43
Pacific Electric Ray																0.06
Pacific Flatnose	1.60		0.08	0.07	0.02	0.02	0.00	0.85		0.01	0.01					2.65
Pacific Grenadier	51.17		2.70	2.00	5.22	0.96	0.08	12.19	0.00	0.25	0.18	0.04	0.01			74.80
Ray Unid	0.01															0.01
Rockfish Unid					0.01		0.24	0.05		0.01	1.28		0.01	0.01	0.31	1.93
Roundfish Unid	0.00															0.05

The catch of the species in the fishery under assessment composes >5% of that fishery's catch

The species is >1% of that fishery's catch and the fishery causes >5% of the species' total mortality across all fisheries

The species is <1% of that fishery's catch and the fishery causes >20% of species' total mortality across all fisheries

The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing and the fishery causes >1% of species' total mortality across all fisheries

Species	IFQ bottom trawl	IFQ midwater trawl	IFQ bottom longline	IFQ pot	Sable-endorsed longline	Sable-endorsed pot	Non-endorsed longline, N	Non-endorsed longline, S	Non-endorsed Pot	Open Access longline, N	Open Access longline, S	Open Access pot, N	Open Access pot, S	Nearshore, N	Nearshore, S	Total mortality all fisheries
Total Catch -->	**18485.48**	**216.64**	**297.81**	**736.76**	**1511.72**	**333.43**	**269.28**	**597.83**	**10.27**	**215.16**	**148.81**	**112.74**	**23.03**	**248.92**	**212.01**	**210603.54**
Skate Unid	230.85	0.12	0.02	0.00	2.55	0.00	1.44	5.49		0.37	0.39		1.31		0.11	328.02
Soupfin Shark	0.62						0.00	0.11		0.00	0.04				0.25	2.66
Spotted Ratfish	78.99	0.21	0.12	0.01	3.22		1.25	1.13		0.64	0.46			0.00	0.00	86.28
Pacific cod	395.66	0.21			1.23	0.00	0.03	0.11		1.03	0.05	0.00				633.76
Pacific hake	248.94	0.68	0.00	0.00	0.94		0.01	2.42		0.01	0.00					160705.61
Sablefish (North of 36° N. lat.)	1406.04	1.62	205.06	521.72	1115.18	295.25	205.25		8.92	165.30		107.77		1.04	0.65	4701.40
Sablefish (South of 36° N. lat.)	22.68		1.94	198.02	35.88	27.25	0.00	340.86			51.82		20.66		4.39	704.73
Shortbelly rockfish	5.48															7.45
Shortspine thornyhead (North of 34°27' N. lat.)	686.92	1.12	11.94	1.19	29.18	0.44	9.03	20.64	0.01	1.79	1.90	0.04	0.02		0.12	801.43
Shortspine thornyhead (South of 34°27' N. lat.)	0.59			0.36	0.89		0.00	118.66			6.23				0.97	128.26
Spiny dogfish	340.04	0.21	28.75	0.05	70.45	0.03	2.84	0.45	0.01	5.09	3.36	0.08	0.02	0.01		830.78
Splitnose rockfish (South of 40°10' N. lat.)	59.87				0.00	0.00	0.01	0.10		0.01	0.19	0.00	0.00			61.91
Starry flounder	8.34				0.02					0.01	0.00			0.00	0.13	17.36
Widow rockfish	34.27	10.88			0.08		0.00	0.09		0.01	0.03			0.04	0.00	277.64
Yellowtail rockfish (North of 40°10' N. lat.)	389.45	185.62	0.01		0.53	0.00	0.02			0.05				1.76		1569.76
California halibut	18.78						0.00	0.04		0.12	0.39	0.00	0.02		1.35	346.08
California sheephead															58.74	102.27
Dungeness crab	196.44	0.07		0.56	0.02	0.34	0.07		1.14			3.02	0.09	1.47	1.42	20296.51
Bigmouth Sole										0.00	0.00					0.00
Deepsea Sole	16.29			0.02		0.01	0.00	0.02								16.55

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Diamond Turbot	0.11														0.00	0.24
Fantail Sole																0.14
Hornyhead Turbot	0.02														0.00	2.88
Slender Sole	37.22									0.00	0.00					130.79
Speckled Sanddab	0.00															0.08
Aleutian Skate	2.31		0.03		0.29											2.63
Bering Skate	0.00															0.00
Black Skate	18.42		1.01	0.00	0.24		0.00	3.84								23.50
Deepsea Skate	0.33															0.33
Pacific Electric Ray	1.10															1.39
Pelagic Stingray							0.00	0.12								0.12
Round Stingray																0.00
Sandpaper Skate	39.71	0.01	0.18	0.00	1.25		0.06	0.20		0.06	0.04					41.52
Shovelnose Guitarfish	0.00															8.94
Starry Skate	0.12				0.01											0.13
Thornback Skate	0.00															0.59
White Skate	0.43															0.43

Appendix D: Marine mammal and seabird bycatch

The U.S. West Coast fisheries rarely catch marine mammals, seabirds, or turtles; such catch was noted for 2% of all observed trips from 2002 to 2009 (Jannot et al. 2011). It should be noted that observer coverage rates varied substantially between the groundfish sectors from 2002 to 2009; coverage for LE trawl and LE sablefish fixed gear sectors consistently exceeded 20%, while coverage rates for the other fixed gear sectors generally did not exceed 5% (Jannot et al. 2011).

Marine mammals

From 2002 to 2009, observed bycatch of marine mammals in non-hake, non-California halibut commercial groundfish fisheries was as follows (all data from Jannot et al. 2011):

- Cetaceans

Bottlenose dolphin: one animal, LE non-sablefish fixed gear
Pacific white-sided dolphin: one animal, LE trawl
Risso's dolphin: one animal, LE trawl
Sperm whale: one animal (vessel strike with no apparent injury to whale), LE sablefish fixed gear

- Pinnipeds:

California sea lion: 44 animals, primarily in LE trawl fishery
Harbor seal: four animals, in LE non-sablefish fixed gear, nearshore fixed gear
Northern elephant seal: two animals, in LE trawl and LE sablefish fixed gear
Steller sea lion: six animals, in LE trawl fishery
Sea lion, unspecified: two animals, LE trawl and LE non-sablefish fixed gear

For each year, NOAA classifies commercial fisheries into one of three categories based upon their interactions with marine mammals. Category I are fisheries with frequent interactions, Category II for occasional interactions, and Category III for remote likelihood or no known interactions. For 2012, no West Coast groundfish fisheries were assigned to Category I, and one fishery was assigned to Category II; the remainder were Category III (NOAA 2012b). The Category II fishery is actually two fisheries, the LE and OA sablefish pot fisheries. The Category II designation of LE and OA sablefish pot fisheries is the result of an incident in which a humpback whale was entangled in sablefish pot gear in 2006 (NOAA 2012b). This incident gives the sablefish pot fisheries a sufficiently high rate of mean annual mortality and serious injury to qualify for Category II status. The sablefish pot fisheries are not subject to take reduction plans.

Turtles

One incident of turtle entanglement is noted in a review of West Coast groundfish fishery observer bycatch data from 2002 to 2009 (Jannot et al. 2011). In this instance, a leatherback turtle was entangled in open-access pot gear.

Seabirds

Seabird bycatch rates are highest for groundfish longline gear. From 2002 to 2008, the highest seabird

bycatch rate came from the LE sablefish longline fishery's bycatch of black-footed albatross (Jannot et al. 2011); however, no instances were observed of black-footed albatross bycatch in 2009. In 2009, the last year for which observer bycatch data were analyzed, total seabird bycatch in the non-hake, non-California halibut fisheries consisted of the following (all data from Jannot et al. 2011):

- Brandt's cormorant: one animal, nearshore fixed gear
- Common murre: one animal, nearshore fixed gear
- Western gull: one animal, LE non-sablefish fixed gear
- Seabird, unidentified: two animals, nearshore fixed gear

Several species that are listed on the Endangered Species Act have been caught in West Coast groundfish fisheries (Table D.1).

Table D.1. Species of marine mammal, seabird, and turtle that are listed under the Endangered Species Act and have been observed as bycatch species in the non-hake, non-California halibut west coast groundfish fisheries (all information from Jannot et al. 2011)

Species	ESA Status	Nature of incident(s)	Number of animals, 2002-2009	Fishery
Sperm whale	Endangered	Vessel strike	1	LE sablefish
Steller sea lion	Threatened	Catch	6	LE trawl
Black-footed albatross	Under review	Catch	123	LE sablefish
Leatherback turtle	Endangered	Entanglement	1	OA fixed gear

Black-footed albatross is the only species of concern that has been caught as bycatch in the non-hake commercial groundfish fisheries with any degree of regularity in recent years. Thus, black-footed albatross will be the only marine mammal, seabird, or turtle species included in this assessment.

Appendix E: Co-occurrence of groundfish species in the West Coast groundfish FMP

The tables below illustrate the number of hauls with occurrence and co-occurrences of FMP species in West Coast Groundfish Observer Program (WCGOP) data from bottom trawl fisheries covering the years 2002−2011. Species recorded by port samplers but not associated with specific hauls were not included in this analysis. Percentages indicate the percentage of hauls with any given species in the columns that also caught any given species in the rows. Data from Ian Taylor, NOAA Fisheries, September 2013. Analysis follows that given in the PFMC June Briefing Book at http://www.pcouncil.org/wp-content/uploads/F8b_GMT_JUN2013BB.pdf. Darker shades indicate higher co-occurrence.

These data indicate the likelihood of catching species A when catching species B. They are used here as an indication of the main species caught with each species assessed under Criterion 1 for the ITQ trawl fishery. A data request is pending with the WCGOP to answer this question more directly (as of October 2, 2013), and this assessment will be updated as necessary based on that data.

Co-occurrence patterns of big, California, and longnose skate are used as a proxy for "unspecified skates," and co-occurrence patterns of Pacific grenadier are used as a proxy for "unspecified grenadiers."

Common name (total catch)	Dover sole (32418)	Sablefish (29250)	Arrowtooth fl (22768)	Shortspine th (22059)	Rex sole (21300)	Longnose skate (19318)	Petrale sole (17273)	English sole (14637)	Longspine th (14532)	Lingcod (11202)	Pacific sanddab (9101)	Darkblotched rf (6933)	Pacific grenadier (6433)	POP (4358)	Pacific cod (4079)	Sand sole (3232)	Yellowtail rf 1786)	Chilipepper (1779)	Rougheye rf (1521)	Bocaccio (931)	Widow rf (793)	Cowcod (179)	Yelloweye rf (175)
Dover sole	100	94	93	97	89	91	80	67	97	78	62	93	97	91	81	17	81	67	95	64	78	68	80
Sablefish	85	100	83	98	73	82	62	47	99	62	35	90	99	94	53	2	62	61	96	61	77	66	58
Pacific whiting (hake)	68	69	75	70	71	75	65	52	63	60	45	81	52	85	53	9	50	76	89	68	74	83	55
Shortspine thornyhead	66	74	59	100	46	61	27	13	96	18	2	65	96	87	10	0	13	14	89	16	50	10	22
Arrowtooth flounder (turbot)	65	65	100	61	72	71	72	58	48	75	50	89	40	92	82	8	85	30	90	37	75	9	81
Rex sole	58	53	67	45	100	65	78	77	38	80	77	69	31	53	84	31	80	82	56	78	70	84	78
Longnose skate	54	54	60	54	59	100	56	47	49	56	45	65	43	60	44	8	49	76	66	66	51	76	49

Common name (total catch)	Dover sole (32418)	Sablefish (29250)	Arrowtooth fl (22768)	Shortspine th (22059)	Rex sole (21300)	Longnose skate (19318)	Petrale sole (17273)	English sole (14637)	Longspine th (14532)	Lingcod (11202)	Pacific sanddab (9101)	Darkblotched rf (6933)	Pacific grenadier (6433)	POP (4358)	Pacific cod (4079)	Sand sole (3232)	Yellowtail rf 1786)	Chilipepper (1779)	Rougheye rf (1521)	Bocaccio (931)	Widow rf (793)	Cowcod (179)	Yelloweye rf (175)
Ratfish	44	41	55	31	59	55	68	65	20	76	63	70	11	59	75	25	80	77	54	78	81	68	75
Longspine thornyhead	44	49	30	63	26	37	9	3	100	4	1	22	89	30	1	0	2	4	40	3	12	0	5
Spiny dogfish	43	42	55	35	51	53	63	56	23	64	52	66	18	67	72	37	72	59	60	62	72	61	67
Petrale sole	43	37	55	21	63	50	100	81	11	87	81	61	7	48	89	35	88	93	32	93	71	93	83
English sole	30	24	37	9	53	35	69	100	3	75	91	36	2	20	84	80	76	87	14	85	52	93	75
Lingcod	27	24	37	9	42	33	56	58	3	100	57	42	1	27	76	19	85	61	21	72	61	60	86
Darkblotched rockfish	20	21	27	21	23	23	25	17	11	26	10	100	7	62	15	0	28	16	65	17	49	12	29
Pacific rattail (Pacific grenadier)	19	22	11	28	9	14	3	1	39	1	0	6	100	8	0	0	1	1	8	0	3	0	1
Splitnose rockfish	18	21	23	25	21	22	19	13	15	17	2	45	7	55	7	0	9	25	58	30	49	28	17
Pacific sanddab	17	11	20	1	33	21	42	57	0	46	100	13	0	1	48	65	37	45	3	37	15	44	38
Aurora rockfish	17	19	20	24	17	21	8	3	23	4	1	26	14	30	1	0	1	5	44	4	12	2	4
Finescale codling (Pacific flatnose)	12	14	6	18	6	7	1	0	25	0	0	3	37	4	0	0	0	0	6	0	1	0	1
Pacific ocean perch	12	14	18	17	11	13	12	6	9	10	1	39	5	100	7	0	9	2	55	6	40	1	11
Greenstriped rockfish	11	10	14	3	16	13	21	21	1	29	19	23	0	8	24	1	42	50	10	48	32	67	57
Pacific cod	10	7	15	2	16	9	21	23	0	28	22	9	0	6	100	9	58	1	4	11	18	1	39
Big skate	9	6	11	1	17	13	23	34	1	25	45	7	1	1	26	70	18	10	1	10	5	17	13
Redbanded rockfish	9	10	12	12	10	10	9	6	5	10	1	29	2	36	4	0	7	9	45	11	30	7	14
Flathead sole	8	6	11	1	12	8	14	15	0	19	15	9	0	2	34	2	31	1	5	3	4	0	20
Canary rockfish	6	6	9	1	10	7	13	14	0	19	11	11	0	4	24	1	46	19	5	29	21	15	59
Rosethorn rockfish	6	7	8	8	6	7	6	4	4	7	1	19	2	30	4	0	8	4	30	8	26	3	24
Rougheye rockfish	4	5	6	6	4	5	3	1	4	3	0	14	2	19	2	0	3	1	100	1	9	0	4

Common name (total catch)	Dover sole (32418)	Sablefish (29250)	Arrowtooth fl (22768)	Shortspine th (22059)	Rex sole (21300)	Longnose skate (19318)	Petrale sole (17273)	English sole (14637)	Longspine th (14532)	Lingcod (11202)	Pacific sanddab (9101)	Darkblotched rf (6933)	Pacific grenadier (6433)	POP (4358)	Pacific cod (4079)	Sand sole (3232)	Yellowtail rf 1786)	Chilipepper (1779)	Rougheye rf (1521)	Bocaccio (931)	Widow rf (793)	Cowcod (179)	Yelloweye rf (175)
Yellowtail rockfish	4	4	7	1	7	5	9	9	0	14	7	7	0	4	25	1	100	4	4	11	23	0	30
Blackgill rockfish	4	4	4	5	4	5	3	1	4	2	0	9	3	7	0	0	0	3	12	3	6	2	1
Chilipepper	4	4	2	1	7	7	10	11	0	10	9	4	0	1	1	0	4	100	1	68	23	90	6
Stripetail rockfish	2	2	2	1	4	3	4	5	0	5	3	4	0	2	1	0	2	32	1	34	17	49	9
Sharpchin rockfish	2	2	3	3	3	2	3	2	1	4	0	8	0	12	3	0	6	4	12	7	18	4	7
California skate	2	2	0	0	5	5	8	14	0	7	20	0	0	0	0	28	1	27	0	20	3	42	2
Widow rockfish	2	2	3	2	3	2	3	3	1	4	1	6	0	7	3	0	10	10	5	17	100	12	10
Bocaccio	2	2	2	1	3	3	5	5	0	6	4	2	0	1	3	0	6	36	1	100	20	64	10
Shortraker rockfish	2	2	2	2	1	2	1	0	2	1	0	5	1	7	0	0	1	0	18	1	3	0	2
Curlfin sole	2	1	1	0	5	4	8	15	0	9	22	0	0	0	4	37	4	20	0	18	2	17	6
Sand sole	2	0	1	0	5	1	7	18	0	6	23	0	0	0	7	100	1	1	0	0	1	1	2
Rock sole	2	1	2	0	4	3	6	9	0	8	12	0	0	0	10	17	8	8	0	11	2	4	8
Shortbelly rockfish	1	1	1	0	2	2	2	3	0	2	2	1	0	0	0	0	1	22	0	24	9	32	2
Starry flounder	1	0	1	0	3	1	5	16	0	5	21	0	0	0	5	75	1	0	0	0	0	1	1
Bank rockfish	1	1	1	1	1	1	1	1	1	1	0	2	0	1	0	0	0	7	1	6	4	11	1
Redstripe rockfish	1	1	1	1	1	1	1	1	0	1	0	1	0	2	2	0	3	1	1	2	3	0	3
Silvergray rockfish	1	1	1	1	1	0	1	1	0	1	0	2	0	4	2	0	3	0	3	4	9	1	7
Butter sole	1	0	1	0	1	0	2	3	0	1	4	0	0	0	2	14	1	0	0	0	0	0	0
Greenspotted rockfish	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	1	7	0	10	4	19	11
Yelloweye rockfish	0	0	1	0	1	0	1	1	0	1	1	1	0	0	2	0	3	1	0	2	2	2	100
Cowcod	0	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	9	0	12	3	100	2
Halfbanded rockfish	0	0	0	0	1	1	1	1	0	1	2	0	0	0	0	0	0	9	0	7	1	26	1

Common name (total catch)	Dover sole (32418)	Sablefish (29250)	Arrowtooth fl (22768)	Shortspine th (22059)	Rex sole (21300)	Longnose skate (19318)	Petrale sole (17273)	English sole (14637)	Longspine th (14532)	Lingcod (11202)	Pacific sanddab (9101)	Darkblotched rf (6933)	Pacific grenadier (6433)	POP (4358)	Pacific cod (4079)	Sand sole (3232)	Yellowtail rf 1786)	Chilipepper (1779)	Rougheye rf (1521)	Bocaccio (931)	Widow rf (793)	Cowcod (179)	Yelloweye rf (175)
Kelp greenling	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	2	0	0	0	1	0	4
Rosy rockfish	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	2
Quillback rockfish	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	7
Yellowmouth rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1
Brown rockfish	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	2	0	1	0	0	0	1	0
Black rockfish	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1
Pygmy rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	2
Soupfin shark	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	0	1	0	1	0	0	1
Vermilion rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Greenblotched rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1
Chameleon rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cabezon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mexican rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pink rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tiger rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Flag rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Squarespot rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swordspine rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Harlequin rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leopard shark	0	0	0	0	0	0	0	2	0	1	3	0	0	0	0	9	0	0	0	0	0	1	0
California scorpionfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Common name (total catch)	Dover sole (32418)	Sablefish (29250)	Arrowtooth fl (22768)	Shortspine th (22059)	Rex sole (21300)	Longnose skate (19318)	Petrale sole (17273)	English sole (14637)	Longspine th (14532)	Lingcod (11202)	Pacific sanddab (9101)	Darkblotched rf (6933)	Pacific grenadier (6433)	POP (4358)	Pacific cod (4079)	Sand sole (3232)	Yellowtail rf 1786)	Chilipepper (1779)	Rougheye rf (1521)	Bocaccio (931)	Widow rf (793)	Cowcod (179)	Yelloweye rf (175)
Olive rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Pinkrose rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speckled rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bronzespotted rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starry rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black and yellow rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Calico rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
China rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dusky rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dwarf-red rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Freckled rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gopher rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grass rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honeycomb rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kelp rockfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Treefish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix F: Habitat impacts and mitigation of impacts

By their nature, “groundfish” tend to be demersal species (living on or near the seafloor), so the fisheries that target them use bottom-tending gear. Though the U.S. West Coast non-hake commercial groundfish fisheries use a variety of gear, including bottom trawl, longline, pot, and hook and line, the common denominator is that the gear is expected to contact the bottom during normal use. The potential for habitat disturbance and destruction is present for all the gear. A wealth of scientific information suggests that mobile bottom trawl gear should be expected to have the most significant impacts of all the gear used in these fisheries; bottom longline and trap gears may also cause damage but, being fixed gears, they do not sweep over the seafloor like trawl gear does. In recognition of the potential for bottom-tending gear to damage habitat, a number of spatial restrictions on gear use are in place. These restrictions particularly limit the use of bottom trawl gear, so they offer a degree of mitigation of bottom trawl habitat impacts.

IFQ Bottom Trawl

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

The IFQ trawl fishery catches a variety of groundfish species, and these species in turn associate as adults with a variety of habitats (Table F.1, PFMC 2005a). Additional evidence of bottom trawl gear interactions with habitat include the observed bycatch of 3.09 tons of *Scleractinia* corals in the pre-IFQ LE bottom trawl fishery in 2010 (WCGOP 2012). The Seafood Watch criteria require a score of “high” concern for a fishery that uses trawls on cobble, boulder, or deep (>60 m) gravel. The fishery’s impact on substrate when primarily fishing for those species only found on soft or mixed soft/hard substrate is less of a conservation concern, so it is deemed “moderate” concern. This latter score is applied to all flatfish except arrowtooth flounder, all skates, Pacific cod, thornyheads, and sablefish (see Appendix E for evidence for co-occurrence of different species groups).

Table F.1. Adult substrate associations (PFMC 2005a) of groundfish commonly caught in the IFQ trawl fishery.

	Rooted macrophytes, algae, or seagrass	Hard and mixed soft/hard bottom, shelf	Hard, mixed hard/soft, slope	Soft and mixed soft/hard, shelf	Soft, mixed hard/soft, slope	Canyon
Arrowtooth flounder		x	x	x	x	
Bocaccio		x		x		x
Chilipepper rockfish		x	x	x	x	
Cowcod		x	x			
Darkblotched rockfish		x	x	x	x	x
Dover sole				x	x	

English sole	x			x	x	
Lingcod	x	x				
Longnose skate				x	x	
Longspine thornyhead			(see note)		x	
Pacific cod				x	x	
Pacific Ocean Perch		x	x	x	x	x
Petrale sole				x	x	
Rex sole				x	x	
Rougheye rockfish		x	x	x	x	
Sablefish					x	x
Shortspine thornyhead		x	x	x	x	
Widow rockfish		x	x	x	x	x
Yelloweye rockfish		x	x	x		x
Yellowtail rockfish		x	x	x	x	

Note – While this source indicates that longspine thornyhead associate with hard substrates, other sources (e.g., PFMC 2008) indicate that the species associate with soft substrates, such as sand and mud.

Factor 4.2 Modifying factor: Mitigation of fishing gear impacts

Key relevant information:

There are several measures in place to mitigate the effect of bottom trawling on fish habitat on the U.S. West Coast. Groundfish bottom trawling of any sort is prohibited in approximately 25% of the Essential Fish Habitat (EFH) that is found in waters shallower than 700 fathoms, and expansion of groundfish bottom trawling into waters deeper than 700 fathoms is prohibited. Additionally, bottom trawling with footrope diameter that exceeds 19″ is prohibited in the EEZ, and bottom trawling with footrope gear that exceeds 8″ is prohibited in waters shallower than 100 fathoms.

Detailed rationale

The Magnuson-Stevens Act requires that fishery management plans identify habitat that is essential for the full life cycle of fish species, and to minimize “to the extent practicable” adverse effects on such “essential fish habitat.” In addition, federal EFH regulations also suggest the identification of Habitat Areas of Particular Concern (HAPCs), which are specific areas of EFH that have particular importance, sensitivity to disturbance, and/or rarity. Amendment 19 to the Fishery Management Plan, which was implemented in 2006, defined EFH and HAPCs for West Coast groundfish species. The current FMP defines all waters in the EEZ less than or equal to 3,500 m in depth as EFH (PFMC 2011c).

To minimize the adverse effects of bottom fishing gears on EFH, a number of gear closures have been implemented. The use of dredge, beam trawl, or bottom trawl with footrope diameters >19″ is prohibited in all EFH, and the use of bottom trawl gear with footrope diameter >8″ is prohibited in EFH shoreward of 100 fm; the latter prohibition covers 7.92% of all EFH (Table F.2; NOAA 2011). The following measures have also been implemented.

Bottom trawl footprint closure

Amendment 19 established a "bottom trawl footprint closure," which closed all waters seaward of the 700 fathom contour to all bottom trawling. This depth boundary was selected because it generally represented the boundary of the historical trawl footprint, and the implementation of the bottom trawl prohibition in waters deeper than 700 fathoms was not expected to alter current fishing practices (PFMC 2011c). Thus, the intent of this closure was precautionary, to prevent the bottom trawl fishery from expanding into these previously non-trawled areas (PFMC 2005b). The total areal extent of EFH that is protected by the bottom trawl footprint closure is 337,202 km^2, which is 71% of total EFH within the EEZ (Table F.2; NOAA 2011).

EFH Conservation Areas

Besides these general measures, Amendment 19 established EFH Conservation Areas to protect specific EFH areas. There are 50 such closures in place as of the 2011 FMP (PFMC 2011c; Table F.6). Each closure has one of three gear prohibitions: all bottom contact gears, bottom trawl only, or bottom trawl with the exception of demersal seine gear. Together, the EFH Conservation Areas contain 7.3% of the EFH within the EEZ, and have the effect of prohibiting bottom trawling in 25.3% of the EFH that lies shallower than 700 fathoms (Table F.2; for a detailed list of the EFH Conservation Areas, and the areal extent and gear prohibitions of each, see Table F.6).

Table F.2. Area restrictions on gear use (NOAA 2011; see Table F.6 for calculations of EFH Conservation Area closures)

Prohibition name (applicable portion of EFH)	**Gear prohibited**	**Area (km^2)**	**% of EFH (all depths)**
General Prohibitions (All EFH)	Dredge, beam trawl, bottom trawl with footrope diameter > 19"	475,454	100.0
Bottom Trawl Footprint Closure (EFH seaward of 700 fm)	Bottom trawl (all footrope)	337,202	70.92
Footrope Restriction (EFH shoreward of 100 fm)	Bottom trawl (footrope > 8")	37,669	7.92
EFH Conservation: Bottom Contact Closed Areas	Bottom contact gears	5,903	1.24
EFH Conservation: Bottom Trawl Closed Areas	Bottom trawl (all footrope)	5,593	1.18
	Bottom trawl (except demersal seine)	23,420	4.93
Summary of bottom trawl prohibitions			
Total bottom trawl prohibitions		**Area (km^2)**	**% of EFH in applicable depths**
Total EFH (all depths)		475,454	
Bottom trawl prohibitions in all EFH (all depths)		372,117	78.27
Total EFH in depths		138,253	
Bottom trawl prohibitions in EFH at depths		34,915	25.25

Habitat representation in closed areas

The representation of different habitats in the bottom trawl footprint closure and the EFH Conservation Areas varies substantially: in Amendment 19's final Environmental Impact Statement (EIS), 21 of 29 habitats identified north of Point Concepcion were more than 50% represented in the footprint closure and the EFH Conservation areas, but one habitat with the largest areal extent (sedimentary shelf) was only 4% represented (Table 4-16 in NMFS 2005). A more recent review reports that the majority of habitats (defined by substrate, depth zone, and biogeographic sub-region) have <50% representation in EFH gear prohibition areas, and a substantial proportion have <20% representation (Figure 2.4 in (NMFS 2013)). Furthermore, corals and sponges at some depths/biogeographic sub-regions are very well-protected by these EFH gear prohibition areas, but corals and sponges are <20% protected in three of nine such areas (Figure 2.6a in (NMFS 2013)).

IFQ Hook and Line and Pot Fisheries

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

As of June 2012, a small but increasing proportion of IFQ catch is being taken by the IFQ hook and line and IFQ pot fisheries (Matson 2012). The habitat types that are being accessed by these gears are not known, but it is known that sablefish, which associate with soft and mixed soft/hard substrates (see Table F.3), are a target of these fisheries (Matson 2012).

LE Endorsed Fixed Gear Fisheries

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

The LE sablefish-endorsed fisheries use bottom longline and pot gear to target sablefish on soft substrates in deep waters.

Detailed rationale:

Gear in this fishery is set at depths of 100–250 fathoms (WCGOP 2012). A review of the substrate associations of the primary species caught in the fishery shows overlapping preference for soft and mixed soft/hard substrates on the shelf and slope (Table F.3). In 2010, there were no observed instances of bycatch of corals or sponges in the LE sablefish-endorsed longline or pot fisheries (WCGOP 2012).

Table F.3. Adult substrate associations of several groundfish species (PFMC 2005a) caught in the 2011 LE endorsed fixed gear fisheries

	Rooted macrophytes, algae, or seagrass	Hard and mixed soft/hard bottom, shelf	Hard, mixed hard/soft, slope	Soft and mixed soft/hard, shelf	Soft, mixed hard/soft, slope	Canyon
Longnose skate				x	x	

Rougheye rockfish		x	x	x	x	
Sablefish					x	x
Shortspine thornyhead		x	x	x	x	

LE Non-endorsed Fixed Gear Fisheries

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

The LE non-endorsed longline and pot fisheries primarily catch species that associate with soft substrates. This fishery had no observed bycatch of corals or sponges in 2010.

Detailed rationale:

Gear in this fishery is set at depths of 250–450 fathoms (WCGOP 2012). A review of the substrate associations of the primary species caught in the fishery shows that most share an association with soft and/or mixed hard/soft substrates on the slope, with some others associating with hard substrates on the shelf (Table F.4). In 2010, there were no observed instances of bycatch of corals or sponges in the LE sablefish non-endorsed longline or pot fisheries (WCGOP 2012).

Table F.4. Adult substrate associations of species (PFMC 2005a) commonly caught in the 2011 LE non-endorsed fixed gear fisheries

	Rooted macrophytes, algae, or seagrass	Hard and mixed soft/hard bottom, shelf	Hard, mixed hard/soft, slope	Soft and mixed soft/hard, shelf	Soft, mixed hard/soft, slope	Canyon
Blackgill rockfish		x	x			x
Longspine thornyhead			(see note)		x	
Pacific grenadier					x	
Sablefish					x	x
Shortspine thornyhead		x	x	x	x	

Note – While this source indicates that longspine thornyhead associate with hard substrates, other sources (e.g., (PFMC 2008) indicate that the species associate with soft substrates, such as sand and mud.

OA Fixed Gear Fisheries

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

In 2011, the Open Access fixed gear fishery primarily caught sablefish, which associate with soft substrates. This fishery had no observed catch of corals or sponges in 2010.

Detailed rationale:

In 2011, sablefish comprised approximately 56% and 98% of the catch in the OA hook and line and pot fisheries, respectively, with blackgill rockfish and longnose skate composing much of the balance (Appendix C; Bellman et al. 2012). Sablefish associate with soft substrates (Table F.5; PFMC 2005a). There were no observed catches of corals or sponges in this fishery in 2010 (WCGOP 2012).

Table F.5. Adult substrate associations of species (PFMC 2005a) commonly caught in the 2011 OA fixed gear fisheries

	Rooted macrophytes, algae, or seagrass	Hard and mixed soft/hard bottom, shelf	Hard, mixed hard/soft, slope	Soft and mixed soft/hard, shelf	Soft, mixed hard/soft, slope	Canyon
Blackgill rockfish		x	x			x
Longnose skate				x	x	
Sablefish					x	x

Nearshore Fixed Gear

Factor 4.1 - Impact of the fishing gear on the substrate

Key relevant information:

Hook and line (including troll and longline gear) and trap gears may be used in the Nearshore North and South groundfish fisheries. The 2010 observer data show no instances of bycatch of corals or sponges to indicate habitat impacts by the nearshore fisheries.

All Fixed Gear Sectors

Factor 4.2 - Modifying factor: Mitigation of fishing gear impacts

Key relevant information:

Bottom longline and pot gears are prohibited from 15 EFH Conservation Areas that contain approximately 4.3% of the EFH in waters shallower than 700 fathoms. There are no habitats that have more than 20% representation in these closed areas. There are no other habitat impact mitigation measures in place for bottom longline and pot fisheries.

Detailed rationale

Bottom Contact Closed Areas prohibit bottom longline and pot gear from a total of 5,903 km^2 of EFH (Tables F.2 and F.6). This represents approximately 4.3% of the EFH that is in waters shallower than 700 fm (Table F.2). There are no habitats that have more than 20% representation in these EFH closures that prohibit bottom longline and pots (Table 4-18 in NMFS 2005).

Table F.6. Gear prohibitions in EFH Conservation Areas (NOAA 2011)

Site	Area (km2)	Gears Prohibited		
		Bottom contact gears	Bottom trawl (all footrope)	Bottom trawl (except demersal seine)
Anacapa Island EFH Conservation Area	65	x		
Astoria Canyon EFH Conservation Area	1773	x		
Bandon High Spot EFH Conservation Area	182		x	
Big Sur Coast/Port San Luis EFH Conservation Area	10390			x
Biogenic 1 EFH Conservation Area	1232		x	
Biogenic 2 EFH Conservation Area	234		x	
Biogenic 3 EFH Conservation Area	205		x	
Blunt's Reef EFH Conservation Area	58			x
Carrington Point EFH Conservation Area	33	x		
Catalina Island EFH Conservation Area	1192			x
Cherry Bank EFH Conservation Area	564			x
Cordell Bank EFH Conservation Area	68		x	
Cordell Bank/Biogenic Area EFH Conservation Area	386			x
Cowcod Conservation Area East EFH Conservation Area	384			x
Daisy Bank/Nelson Island EFH Conservation Area	66		x	
Davidson Seamount EFH Conservation Area	2013	x		
Deepwater off Coos Bay EFH Conservation Area	565		x	
Delgada Canyon EFH Conservation Area	41			x
East San Lucia Bank EFH Conservation Area	273			x
Eel River Canyon EFH Conservation Area	870			x
Farallon Islands/Fanny Shoal EFH Conservation Area	143			x
Footprint EFH Conservation Area	70	x		
Gray's Canyon EFH Conservation Area	164		x	

Site	Area (km2)	Gears Prohibited		
		Bottom contact gears	Bottom trawl (all footrope)	Bottom trawl (except demersal seine)
Gull Island EFH Conservation Area	91	x		
Half Moon Bay EFH Conservation Area	129			x
Harris Point EFH Conservation Area	130		x	
Heceta Bank EFH Conservation Area	423		x	
Hidden Reef/Kidney Bank EFH Conservation Area	773			x
Judith Rock EFH Conservation Area	12	x		
Mendocino Ridge EFH Conservation Area	1864			x
Monterey Bay/Canyon EFH Conservation Area	2158			x
Nehalem Bank/Shale Pile EFH Conservation Area	181		x	
Newport Rockpile/Stonewall Bank EFH Conservation Area	171		x	
Olympic 2 EFH Conservation Area	547		x	
Painted Cave EFH Conservation Area	5	x		
Point Arena North EFH Conservation Area	88			x
Point Arena South Biogenic Area EFH Conservation Area	257			x
Point Conception EFH Conservation Area	3288			x
Point Sur Deep EFH Conservation Area	219			x
Potato Bank EFH Conservation Area	287			x
President Jackson Seamount EFH Conservation Area	987	x		
Richardson Rock EFH Conservation Area	189	x		
Rogue Canyon EFH Conservation Area	886		x	
Santa Barbara Island EFH Conservation Area	147	x		
Scorpion EFH Conservation Area	48	x		
Siletz Deepwater EFH Conservation Area	538		x	
Skunk Point EFH Conservation Area	4	x		

Site	Area (km2)	Gears Prohibited		
		Bottom contact gears	Bottom trawl (all footrope)	Bottom trawl (except demersal seine)
South Point State EFH Conservation Area	39	x		
Thompson Seamount EFH Conservation Area	428	x		
Tolo Bank EFH Conservation Area	55			x
Total area with each protection (km^2)		**5903**	**5593**	**23420**
% EFH receiving each protection		**1.24**	**1.18**	**4.93**
Total % of EFH that is in an EFH closure				**7.34**

Appendix G: Ecosystem and food web considerations

The fisheries addressed in this assessment do not target any species of exceptional ecological importance. Though hake are a groundfish species of exceptional ecological importance, they are not targeted by the fisheries addressed in this assessment and the bycatch of hake by these fisheries is minimal (Appendix B).

There is not a substantial portion of the groundfish fishery area that is protected in no-take zones, and there are no ecosystem-based harvest controls in place for any species. Currently, a Fishery Ecosystem Plan (FEP) is being developed. This plan will inform the existing single-species management approach with information regarding the influence of ecosystem considerations on the managed species, and vice versa. Because the fishery does not catch exceptional species, and because a fishery ecosystem plan is being developed with a clear timeline, a process for incorporation into existing management processes, and suggestions for research to elucidate some broader ecosystem considerations for the groundfish fishery, the score for "impacts on the ecosystem and food web" is "moderate" for all West Coast groundfish fisheries addressed in this assessment.

Detailed rationale:

The ecosystem and food web

The available information suggests that groundfish biomass production on the U.S. West Coast is driven by bottom-up forces, with relative abundances of different groups of groundfish influenced by top-down effects including fisheries. Groundfish production in the northeast Pacific is tightly coupled to variations in primary production (Ware and Thomson 2005). Food web modeling of the Northern California Current (NCC) suggests that fisheries-induced biomass declines of some groundfish species may have released other, commercially viable groundfish species from predation pressure (Field 2004; Brand et al. 2007), and that this effect may have at least partially offset the effect of increased fisheries mortality on one species in particular (longspine thornyhead; Field 2004). Food web modeling also suggests that reducing fishing pressure on groundfish would result in a complex array of biomass tradeoffs between predator and prey species (Brand et al. 2007).

Among the non-hake components of the groundfish assemblage, no single species stands out as currently playing an outsized ecological role. An Ecopath model of the Northern California Current ecosystem (Field 2004) suggests that non-hake groundfish species assemblages (large flatfish, small flatfish, rockfish, roundfish, and elasmobranchs) have relatively minimal influence on each other or on the remaining species groups in the NCC ecosystem (Figure 2.11 in Field 2004). The influence of fishing is greater for many species groups in this model. Likewise, fisheries have a greater effect on the groundfish species assemblages than do most species assemblages in the model (Field 2004). Similarly, an Atlantis model of the California Current ecosystem (Brand et al. 2007) suggested that fishing mortality is the primary determinant of fish abundance.

It is possible that previous fisheries exploitation has reduced the current ecological influence of groundfish species. Field's model of the NCC shows that groundfish species constituted almost 100% of the identified species groups that experienced reduced biomass from 1960 to 2002; in contrast, the

biomasses of forage fish, salmon, and a number of marine mammals increased substantially over this time (Figure 3.14 in Field 2004). Field, referring to groundfish, suggests that "a large group of stocks in this ecosystem no longer fill the functional role that they used to" and presents information to suggest that fisheries have reduced the standing biomasses of three groundfish groups (gadids, sablefish, and rockfish) by over 50% (for sablefish, over 90%) (Figure 2.17 in Field 2004).

One example from this study suggests that fisheries-induced reductions of groundfish species of moderate-to-high ecological importance may have non-trivial effects on other species over long periods. Starting in the late 1970s, a reduction in sablefish abundance (and, to a lesser extent, shortspine thornyhead abundance) may have released at least one other groundfish species (longspine thornyhead) from a primary source of natural mortality and thereby allowed longspine thornyhead biomass to remain relatively constant in the face of increasing fishing mortality (Figure 3.17 in Field 2004). Even though longspine thornyhead has the classic characteristics of a species that would not be resilient to increasing fishing pressure, it is one of few groundfish species in the model to have maintained its biomass from 1960 to 2002 (Figure 3.14 in Field 2004).

In another model, using Atlantis ecosystem modeling software, Brand and colleagues (2007) similarly found evidence of biomass tradeoffs between different groundfish species groups. When this model was used to simulate a scenario in which F = 0 for 42 years, the results indicated that small deep rockfish (e.g., thornyhead) steadily declined through the time period—partly because of an increase in a major predator (sablefish)—and midwater rockfish initially increased but then declined after 25 years from increased predation pressure. Conversely, large demersal fish (e.g., lingcod) increased steadily until approximately year 20, and then showed a second, sudden increase as a result of release from predation pressure (Brand et al. 2007).

In summary, there is not information to suggest that the West Coast non-hake commercial groundfish fisheries are a primary source of mortality for any species that currently play an ecological role of exceptional importance.

Ecosystem-based fishery management of groundfish species

The Pacific Fishery Management Council is in the process of revising a draft Fishery Ecosystem Plan (FEP) for the California Current Ecosystem. The general purpose of the FEP is to bring broader ecosystem considerations and ecosystem science into the Council's existing species. The purpose and need statement for the FEP specifies that one of its roles will be to provide a basis for the consideration of management tradeoffs (PFMC 2011d); such consideration may address issues such as the apparent sablefish/longspine thornyhead biomass tradeoff identified above. The draft FEP's focus leans more toward improving understanding of the CCE on managed species; it also identifies areas for research, including the trophic dynamics of various commercial species (PFMC 2011d).

Appendix H: Biological reference points

Species/Stock	Last assessment or update	% of OFL caught in in non-hake comm. groundfish fisheries (2011)	ABC:OFL (2012)	ACL:OFL (2012)	Fishery exploitation and reference points			
					F_{MSY} Proxy	Target biomass (harvest control trigger)	Overfished threshold	Zero mortality threshold
Arrowtooth flounder	2007	13.92	0.83	0.83	$F_{30\%}$	$B_{25\%}$	$B_{12.5\%}$	$B_{5\%}$
Black rockfish (South of 46°16'N)	2007	10.21	0.96	0.86	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Black and yellow rockfish (South of 40°10'N)	None	NA	-	-	-	-	-	-
Blackgill rockfish (South of 40°10'N)	2012	NA	-	-	-	-	-	-
Blue rockfish (South of 40°10'N)	2008	NA	-	-	-	-	-	-
Blue rockfish (North of 40°10'N)	None	NA	-	-	-	-	-	-
Bocaccio (South of 40° 10' N)	2009	1.04	0.96	0.37	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Brown rockfish (South of 40°10'N)	2013	NA	-	-	-	-	-	-
Cabezon (OR)	2009	57.22	0.96	0.96	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Cabezon (CA)	2009	17.42	0.95	0.95	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
California scorpionfish (South of 34° 27' N)	2005	2.48	0.95	0.95	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
California sheephead	2004	NA	-	-	-	-	-	-

Species/Stock	Last assessment or update	% of OFL caught in in non-hake comm. groundfish fisheries (2011)	ABC:OFL (2012)	ACL:OFL (2012)	Fishery exploitation and reference points			
					F_{MSY} Proxy	Target biomass (harvest control trigger)	Overfished threshold	Zero mortality threshold
Canary rockfish	2011	3.00	0.95	0.17	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Chilipepper rockfish (South of 40° 10'N)	2007	15.35	0.96	0.96	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
China rockfish (North of 40°10'N)	2013	NA	-	-	-	-	-	-
China rockfish (South of 40°10'N)	2013	NA	-	-	-	-	-	-
Copper rockfish (South of 40°10'N)	2013	NA	-	-	-	-	-	-
Cowcod (South of 40°10'N)	2013	0.13	0.77	0.23	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Darkblotched rockfish	2013	20.79	0.96	0.60	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Dover sole	2011	17.57	0.96	0.56	$F_{30\%}$	$B_{25\%}$	$B_{12.5\%}$	$B_{5\%}$
English sole	2013	0.67	0.96	0.96	$F_{30\%}$	$B_{25\%}$	$B_{12.5\%}$	$B_{5\%}$
Gopher rockfish (South of 40°10'N)	2005	NA	-	-	-	-	-	-
Grass rockfish (South of 40°10'N)	None	NA	-	-	-	-	-	

Grenadier, unidentified	None	NA	-	-	-	-	-	-
Kelp greenling	None	NA	-	-	-	-	-	-
Lingcod (North of 42° N)	2009	12.76	0.96	0.96	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Lingcod (South of 42° N)	2009	1.51	0.83	0.83	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Longnose skate	2007	35.71	0.96	0.45	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$

Longspine thornyhead (North of 34°27'N)	2013	27.19 coastwide	0.83	0.59	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Longspine thornyhead (South of 34°27'N)	2013		0.83	0.11	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Pacific cod	None	7.93	0.69	0.50	-	-	-	-
Pacific grenadier	None	NA	-	-	-	-	-	-
Pacific hake	2012	NA	-	-	-	-	-	-
Pacific ocean perch (North of 40°10'N)	2011	4.59	0.96	0.18	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Pacific sanddab	2013	NA	-	-	-	-	-	-

Petrale sole	2013	79.47	0.96	0.91	$F_{30\%}$	$B_{25\%}$	$B_{12.5\%}$	$B_{5\%}$
Quillback rockfish (North of 40°10'N)	None	NA						
Rex sole	2013	NA	-	-	-	-	-	-
Rougheye rockfish (North of 40°10'N)	2013	NA	-	-	-	-	-	-
Sand sole	None	NA	-	-	-	-	-	-
Sablefish (North of 36°N)	2011	68.03 coastwide	0.96	0.77	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Sablefish (South of 36°N)	2011		0.96	0.77	$F_{45\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$

Shortspine thornyhead (North of 34°27'N)	2013	40.73 coastwide	0.96	0.66	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Shortspine thornyhead (South of 34°27'N)	2013		0.96	0.17	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Skate, unspecified	None	NA	-	-	-	-	-	-

Spiny dogfish	2012	NA	-	-	-	-	-	-
Splitnose rockfish (South of 40°10'N)	2009	2.71	0.96	0.96	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Spotted ratfish	None	-	-	-	-	-	-	-
Starry flounder	2005	0.88	0.83	0.75	$F_{30\%}$	$B_{25\%}$	$B_{12.5\%}$	$B_{5\%}$
Vermilion rockfish (North of 40°10'N)	None	NA	-	-	-	-	-	-
Vermilion rockfish (South of 40°10'N)	None	NA	-	-	-	-	-	-
Widow rockfish	2011	0.29	0.96	0.12	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Yelloweye rockfish	2011	2.93	0.96	0.35	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$
Yellowtail rockfish (North of 40°10'N)	2013	7.27	0.96	0.96	$F_{50\%}$	$B_{40\%}$	$B_{25\%}$	$B_{10\%}$