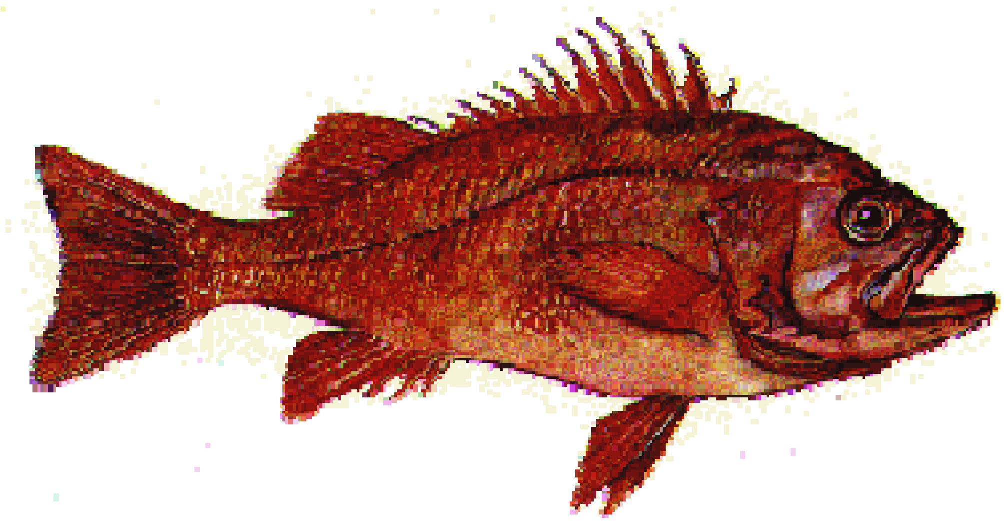
STATUS OF THE PACIFIC COAST GROUNDFISH FISHERY



STOCK ASSESSMENT AND FISHERY EVALUATION
VOLUME 1

DESCRIPTION OF THE FISHERY

PREPARED BY
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Donald K. Hansen, Chairman Donald O. McIsaac, Executive Director

March 20, 2008

Dear Reviewer:

The Pacific Fishery Management Council (Council) will develop three important decision documents in 2008 and 2009: the Trawl Rationalization Environmental Impact Statement; the Intersector Allocation Environmental Assessment; and the 2009-2010 Groundfish Harvest Specifications and Management Measures Environmental Impact Statement. The purpose of this 2008 Stock Assessment and Fishery Evaluation (SAFE) Volume 1 document is to publish a common set of data, tables, and descriptive text for use in these future Council decision documents. This document does not evaluate a Federal action.

The enclosed 2008 SAFE document provides species life history, historical catch, economic, and management information. This document is intended to provide a general understanding of Pacific Coast groundfish fishery management, including the status of stocks using the most current information available. The Council will publish additional 2008 SAFE Volumes that contain the 2007 and 2008 full and updated stock assessments; Stock Assessment Review (STAR) panel reports for full stock assessments; rebuilding analyses based on assessments of overfished groundfish species; and the Council's Scientific and Statistical Committee reports regarding stock assessments and rebuilding analyses.

Species assessed using full stock assessments or updated stock assessments in 2007 and 2008 include bocaccio, canary rockfish, cowcod, darkblotched rockfish, Pacific ocean perch (POP), widow rockfish, yelloweye rockfish, sablefish, arrowtooth flounder, black rockfish, chilipepper rockfish, English sole, Pacific whiting, shortbelly rockfish, blue rockfish, and longnose skate. Rebuilding progress for all the currently overfished species (i.e., bocaccio, canary rockfish, cowcod, darkblotched rockfish, POP, widow rockfish, and yelloweye rockfish) were evaluated in 2007 rebuilding analyses. Copies of these stock assessments and rebuilding analyses are available on the Council's website (http://www.pcouncil.org/groundfish/gfstocks.html) or upon request from the Council office, and will be published in subsequent 2008 SAFE volume(s).

Sincerely,

D.O. McIsaac, Ph.D.
Executive Director

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LIST OF ACRONYMS

ABC	Acceptable biological catch. The ABC is a scientific calculation of the sustainable harvest level of a fishery and is used to set the upper limit of the annual total allowable catch. It is calculated by applying the estimated (or proxy) harvest rate that produces maximum sustainable yield to the estimated exploitable stock biomass (the portion of the fish population that can be harvested).
AFSC	National Marine Fisheries Service Alaska Fisheries Science Center
APA	Administrative Procedures Act
B_{MSY}	The biomass that allows maximum sustainable yield to be taken. Also see $B_{40\%}$.
CCA	Cowcod Conservation Area(s)
CDFG	California Department of Fish and Game
CFGC	California Fish and Game Commission
CFR	Code of Federal Regulations.
Council	Pacific Fishery Management Council
CPFV	Commercial passenger fishing vessel (charter boat)
CPUE	Catch per unit of effort.
CRCA	California Rockfish Conservation Area.
CRFS	California Recreational Fisheries Survey
CV	Coefficient of variation
DEIS	Draft Environmental Impact Statement (see EIS, NEPA)
DRCA	Darkblotched Rockfish Conservation Area
DTL	Daily-trip-limit
DTS	Dover sole, thornyhead, and trawl-caught sablefish complex
EA	Environmental assessment (see NEPA, EIS).
EEZ	Exclusive Economic Zone.
EFH	Essential fish habitat.
EFP	Exempted fishing permit.
EIS	Environmental impact statement.
ENSO	*El Niño* Southern Oscillation.
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act.
ESU	Evolutionarily significant unit

F	The instantaneous rate of fishing mortality. The term “fishing mortality rate” is a technical fishery science term that is often misunderstood. It refers to the rate at which animals are removed from the stock by fishing. The fishing mortality rate can be confusing because it is an “instantaneous” rate that is useful in mathematical calculations, but is not easily translated into the more easily understood concept of “percent annual removal.”
F=0	Fishing mortality equals zero (no fishing).
FEAM	Fishery economic assessment model.
FEIS	Final Environmental Impact Statement (see EIS, NEPA).
FMP	Fishery management plan.
F_{MSY}	The fishing mortality rate that maximizes catch biomass in the long term.
FMU	Fishery management unit
FONSI	Finding of no significant impact.
FR	Federal Register.
GAP	Groundfish Advisory Subpanel.
GDP	Gross Domestic Product
GFA	Groundfish Fishery Area
GIS	Geographic Information System
GFA	Groundfish fishing areas
GMT	Groundfish Management Team.
GPS	Global Positioning System
HAPC	Habitat areas of particular concern.
HG	Harvest guideline(s).
HMS	Highly migratory species.
IFQ	Individual fishing quota.
IMPLAN	IMpact Analysis for PLANning - a regional economic impact model
INPFC	International North Pacific Fishery Commission.
IPHC	International Pacific Halibut Commission.
IRFA	Initial regulatory flexibility analysis.
LE	Limited entry fishery.
M	Instantaneous rate of natural mortality (as opposed to F, fishing mortality)
MBTA	Migratory Bird Treaty Act
MFMT	Maximum fishing mortality threshold.
MMPA	Marine Mammal Protection Act.
MPA	Marine protected areas

MRFSS	Marine Recreational Fisheries Statistics Survey.
MSA	Magnuson-Stevens Fishery Conservation and Management Act.
MSST	Minimum stock size threshold.
MSY	Maximum sustainable yield.
NEPA	National Environmental Policy Act.
NERR	National Estuarine Research Reserves
NGO	Non-government organization
NMFS	National Marine Fisheries Service.
NOAA	National Oceanic & Atmospheric Administration. The parent agency of National Marine Fisheries Service.
NOI	Notice of intent
NRDC	Natural Resource Defense Council
NSG	National Standards Guidelines.
NWR	National Marine Fisheries Service, Northwest Region
ODFW	Oregon Department of Fish and Wildlife
OFWC	Oregon Fish and Wildlife Commission
ORBS	Oregon Recreational Boat Survey
OY	Optimum yield
PacFIN	Pacific Coast Fisheries Information Network. Provides commercial fishery information for Washington, Oregon, and California. Maintained by the Pacific States Marine Fisheries Commission.
PDO	Pacific decadal oscillation.
P_{MAX}	The estimated probability of reaching $T_{MAX.}$ May not be less than 50%.
POP	Pacific ocean perch. A rockfish species that was declared overfished in 1999.
PRA	Paperwork Reduction Act
PSMFC	Pacific States Marine Fisheries Commission.
QSM	Quota species monitoring.
RCA	Rockfish Conservation Area
RCG	Rockfish, cabezon, and greenlings. A species grouping used in the management of California recreational fisheries.
RecFIN	Recreational Fishery Information Network. A database managed by the Pacific States Marine Fisheries Commission that provides recreational fishery information for Washington, Oregon, and California.
RFA	Regulatory Flexibility Analysis, or Regulatory Flexibility Act.
RIR	Regulatory Impact Review.
RLMA	Rockfish/lingcod Management Area

ROD	Record of Decision
SAFE	Stock assessment and fishery evaluation.
SCTA	Southern California Trawlers Association
SFA	Sustainable Fisheries Act of 1996. Amended the MSFCMA.
SPR	Spawning biomass per recruit
SSC	Scientific and Statistical Committee.
STAR Panel	Stock Assessment Review Panel. A panel set up to review stock assessments for particular fisheries. In the past there have been STAR panels for sablefish, rockfish, squid, and other species.
SWOP	Shoreside Whiting Observer Program
TAC	total allowable catch
TIQ	Trawl Individual Quota
$T_{F=0}$	The median time to rebuild a stock if all fishery-related mortality were eliminated beginning in 2007.
T_{MAX}	The maximum time period to rebuild an overfished stock, according to National Standard Guidelines. Depends on biological, environmental, and legal/policy factors.
T_{MIN}	The minimum time period to rebuild an overfished stock, according to National Standard Guidelines. Technically, this is the minimum amount of time in which a fish stock will have a 50% chance of rebuilding if no fishing occurs (depends on biological and environmental factors).
TNC	The Nature Conservancy
T_{TARGET}	The target year, set by policy, for a fish stock to be completely rebuilt.
U/A	Usual and accustomed (usually used when referring to tribal fishing, hunting or gathering areas)
UASC	United Anglers of Southern California
USFWS	U.S. Fish and Wildlife Service. A representative of USFWS is a non-voting member of the Council.
VMS	Vessel monitoring system.
WCGOP	West Coast Groundfish Observer Program
WDFW	Washington Department of Fish and Wildlife. A representative of WDFW sits on the Council.
WDNR	Washington Department of Natural Resources
WSPRC	Washington State Parks and Recreation Commission
WOC	Washington, Oregon and California
YRCA	Yelloweye Rockfish Conservation Area

CHAPTER 1 DESCRIPTION AND STATUS OF AFFECTED SPECIES

There are over 90 species of groundfish managed under the Groundfish Fishery Management Plan (FMP). These species include over 60 species of rockfish in the family Scorpaenidae, 7 roundfish species, 12 flatfish species, assorted shark, skate, and a few miscellaneous bottom-dwelling marine fish species. Table 1-1 depicts the latitudinal and depth distributions of groundfish species managed under the Groundfish FMP, and Figure 1-1 depicts management area divisions.

The following sections contain information on the life histories of a subset of the groundfish managed under the Groundfish FMP. While reading these sections, it is important to keep in mind how certain life history traits of the species have important implications on how the stocks are sustainably managed.

In contrast to the highly variable, and often volatile, population cycles of many coastal pelagic and invertebrate populations in the California Current, many of the resident groundfish in the California Current have evolved entirely different life history approaches to coping with environmental variability. Sablefish, Dover sole, spiny dogfish and a large number of rockfish (*Sebastes* and *Sebastolobus*) species have lifespans that typically span decades, and in some extreme examples may reach ages of 100 or greater (Beamish, *et al.* 2006; Love, *et al.* 2002). Although large initial catches of many rockfish had given the impression that these stocks were also highly productive, a growing body of scientific evidence soon made it clear that many of these species were incapable of sustaining high intensity fishing pressure using modern fishing methods (Francis 1986; Gunderson 1977; Gunderson 1984; Leaman and Beamish 1984).

Among the concerns raised in some of the early research and analyses were that the large standing stocks of older individuals were simply maintaining themselves within the dynamic bounds of their ecosystem, and that the failure to consider the role of such longevity in Northeast Pacific groundfish could lead to management challenges. Factors such as extreme longevity, low natural mortality, increasing fecundity with age, and infrequent reproductive success (recruitment) were explicitly considered when initial harvest rate strategies were developed for the Council (e.g. Clark 1991). However, the paucity of data and magnitude of some of these factors as related to the low productivity of many species were not fully appreciated in many early studies, and are now known to be important considerations in developing harvest rate guidelines and management policies (Clark 2002; Dorn 2002). Consequently, harvest rates for many species have been reduced repeatedly in recent years to account for the improved knowledge regarding the overall productivity of these stocks. As new information continues to emerge regarding the significance of diverse age structures and other factors in sustaining groundfish resources (Berkeley, *et al.* 2004; Berkeley 2004; Bobko and Berkeley 2004), such information continues to be evaluated and incorporated into the stock assessment and assessment review processes that provide the scientific basis upon which management decisions are made.

Management of these groundfish species is based on principles outlined in the MSA, Groundfish FMP, and National Standard Guidelines, which provide guidance on the 10 national standards in the MSA. Stock assessments are based on resource surveys, catch trends in west coast fisheries, and other data sources.

Table 1-1. Latitudinal and depth distributions of groundfish species (adults) managed under the Pacific Coast Groundfish Fishery Management Plan [a/] (Page 1 of 4)

Common name	Scientific name	Latitudinal Distribution		Depth Distribution (fm)	
		Overall	Highest Density	Overall	Highest Density
Flatfish Species					
Arrowtooth flounder	*Atheresthes stomias*	N. 34º N lat.	N. 40º N lat.	10-400	27-270
Butter sole	*Isopsetta isolepis*	N. 34º N lat.	N. 34º N lat.	0-200	0-100
Curlfin sole	*Pleuronichthys decurrens*	Coastwide	Coastwide	4-291	4-50
Dover sole	*Microstomus pacificus*	Coastwide	Coastwide	10-500	110-270
English sole	*Parophrys vetulus*	Coastwide	Coastwide	0-300	40-200
Flathead sole	*Hippoglossoides elassodon*	N. 38º N lat.	N. 40º N lat.	3-300	100-200
Pacific sanddab	*Citharichthys sordidus*	Coastwide	Coastwide	0-300	0-82
Petrale sole	*Eopsetta jordani*	Coastwide	Coastwide	10-250	160-250
Rex sole	*Glyptocephalus zachirus*	Coastwide	Coastwide	10-350	27-250
Rock sole	*Lepidopsetta bilineata*	Coastwide	N. 32º30' N lat.	0-200	summer 10-44 winter 70-150
Sand sole	*Psettichthys melanostictus*	Coastwide	N. 33º50' N lat.	0-100	0-44
Starry flounder	*Platichthys stellatus*	Coastwide	N. 34º20' N lat.	0-150	0-82
Rockfish Species [b/]					
Aurora rockfish	*Sebastes aurora*	Coastwide	Coastwide	100-420	82-270
Bank rockfish	*Sebastes rufus*	S. 39º30' N lat.	S. 39º30' N lat.	17-135	115-140
Black rockfish	*Sebastes melanops*	N. 34º N lat.	N. 34º N lat.	0-200	0-30
Black-and-yellow rockfish	*Sebastes chrysomelas*	S. 40º N lat.	S. 40º N lat.	0-20	0-10
Blackgill rockfish	*Sebastes melanostomus*	Coastwide	S. 40º N lat.	48-420	125-300
Blue rockfish	*Sebastes mystinus*	Coastwide	Coastwide	0-300	13-21
Bocaccio [c/]	*Sebastes paucispinis*	Coastwide	S. 40º N. lat., N. 48º N. lat.	15-180	54-82
Bronzespotted rockfish	*Sebastes gilli*	S. 37º N lat.	S. 37º N lat.	41-205	110-160
Brown rockfish	*Sebastes auriculatus*	Coastwide	S. 40º N lat.	0-70	0-50
Calico rockfish	*Sebastes dallii*	S. 38º N lat.	S. 33º N lat.	10-140	33-50
California scorpionfish	*Scorpaena gutatta*	S. 37º N lat.	S. 34º27' N lat.	0-100	0-100
Canary rockfish	*Sebastes pinniger*	Coastwide	Coastwide	27-460	50-100
Chameleon rockfish	*Sebastes phillipsi*	37º-33º N lat.	37º-33º N lat.	95-150	95-150
Chilipepper rockfish	*Sebastes goodei*	Coastwide	34º-40º N lat.	27-190	27-190
China rockfish	*Sebastes nebulosus*	N. 34º N lat.	N. 35º N lat.	0-70	2-50
Copper rockfish	*Sebastes caurinus*	Coastwide	S. 40º N lat.	0-100	0-100
Cowcod	*Sebastes levis*	S. 40º N lat.	S. 34º27' N lat	22-270	100-130

Table 1-1. Latitudinal and depth distributions of groundfish species (adults) managed under the Pacific Coast Groundfish Fishery Management Plan (continued) [a/] (Page 2 of 4)

Common name	Scientific name	Latitudinal Distribution		Depth Distribution (fm)	
		Overall	Highest Density	Overall	Highest Density
Darkblotched rockfish	*Sebastes crameri*	N. 33º N lat.	N. 38º N lat.	16-300	96-220
Dusky rockfish [d/]	*Sebastes ciliatus*	N. 55º N lat.	N. 55º N lat.	0-150	0-150
Dwarf-Red rockfish	*Sebastes rufinanus*	33º N lat.	33º N lat.	>100	>100
Flag rockfish	*Sebastes rubrivinctus*	S. 38º N lat.	S. 37º N lat.	17-100	shallow
Freckled rockfish	*Sebastes lentignosus*	S. 33º N lat.	S. 33º N lat.	22-92	22-92
Gopher rockfish	*Sebastes carnatus*	S. 40º N lat.	S. 40º N lat.	0-30	0-16
Grass rockfish	*Sebastes rastrelliger*	S. 44º40' N lat.	S. 40º N lat.	0-25	0-8
Greenblotched rockfish	*Sebastes rosenblatti*	S. 38º N lat.	S. 38º N lat.	33-217	115-130
Greenspotted rockfish	*Sebastes chlorostictus*	S. 47º N lat.	S. 40º N lat.	27-110	50-100
Greenstriped rockfish	*Sebastes elongatus*	Coastwide	Coastwide	33-220	27-136
Halfbanded rockfish	*Sebastes semicinctus*	S. 36º40' N lat.	S. 36º40' N lat.	32-220	32-220
Harlequin rockfish [e/]	*Sebastes variegatus*	N. 40 º N lat.	N. 51º N. lat.	38-167	38-167
Honeycomb rockfish	*Sebastes umbrosus*	S. 36º40' N lat.	S. 34º27' N lat.	16-65	16-38
Kelp rockfish	*Sebastes atrovirens*	S. 39º N lat.	S. 37º N lat.	0-25	3-4
Longspine thornyhead	*Sebastolobus altivelis*	Coastwide	Coastwide	167->833	320-550
Mexican rockfish	*Sebastes macdonaldi*	S. 36º20' N lat.	S. 36º20' N lat.	50-140	50-140
Olive rockfish	*Sebastes serranoides*	S. 41º20' N lat.	S. 40º N lat.	0-80	0-16
Pacific ocean perch	*Sebastes alutus*	Coastwide	N. 42º N lat.	30-350	110-220
Pink rockfish	*Sebastes eos*	S. 37º N lat.	S. 35º N lat.	40-200	40-200
Pinkrose rockfish	*Sebastes simulator*	S. 34º N lat.	S. 34º N lat.	54-160	108
Puget Sound rockfish	*Sebastes emphaeus*	N. 40º N lat.	N. 40º N lat.	6-200	6-200
Pygmy rockfish	*Sebastes wilsoni*	N. 32º30' N lat.	N. 32º30' N lat.	17-150	17-150
Quillback rockfish	*Sebastes maliger*	N. 36º20' N lat.	N. 40º N lat.	0-150	22-33
Redbanded rockfish	*Sebastes babcocki*	Coastwide	N. 37º N lat.	50-260	82-245
Redstripe rockfish	*Sebastes proriger*	N. 37º N lat.	N. 37º N lat.	7-190	55-190
Rosethorn rockfish	*Sebastes helvomaculatus*	Coastwide	N. 38º N lat.	65-300	55-190
Rosy rockfish	*Sebastes rosaceus*	S. 42º N lat.	S. 40º N lat.	8-70	30-58
Rougheye rockfish	*Sebastes aleutianus*	Coastwide	N. 40º N. lat.	27-400	27-250
Semaphore rockfish	*Sebastes melanosema*	S. 34º27' N lat.	S. 34º27' N lat.	75-100	75-100
Sharpchin rockfish	*Sebastes zacentrus*	Coastwide	Coastwide	50-175	50-175

Table 1-1. Latitudinal and depth distributions of groundfish species (adults) managed under the Pacific Coast Groundfish Fishery Management Plan (continued) [a/] (Page 3 of 4)

Common name	Scientific name	Latitudinal Distribution		Depth Distribution (fm)	
		Overall	Highest Density	Overall	Highest Density
Shortbelly rockfish	*Sebastes jordani*	Coastwide	S. 46º N lat.	50-175	50-155
Shortraker rockfish	*Sebastes borealis*	N. 39º30' N lat.	N. 44º N lat.	110-220	110-220
Shortspine thornyhead	*Sebastolobus alascanus*	Coastwide	Coastwide	14->833	55-550
Silvergray rockfish	*Sebastes brevispinis*	Coastwide	N. 40º N lat.	17-200	55-160
Speckled rockfish	*Sebastes ovalis*	S. 38º N lat.	S. 37º N lat.	17-200	41-83
Splitnose rockfish	*Sebastes diploproa*	Coastwide	Coastwide	50-317	55-250
Squarespot rockfish	*Sebastes hopkinsi*	S. 38º N lat.	S. 36º N lat.	10-100	10-100
Starry rockfish	*Sebastes constellatus*	S. 38º N lat.	S. 37º N lat.	13-150	13-150
Stripetail rockfish	*Sebastes saxicola*	Coastwide	Coastwide	5-230	5-190
Swordspine rockfish	*Sebastes ensifer*	S. 38º N lat.	S. 38º N lat.	38-237	38-237
Tiger rockfish	*Sebastes nigrocinctus*	N. 35º N lat.	N. 35º N lat.	30-170	35-170
Treefish	*Sebastes serriceps*	S. 38º N lat.	S. 34º27' N lat.	0-25	3-16
Vermilion rockfish	*Sebastes miniatus*	Coastwide	Coastwide	0-150	4-130
Widow rockfish	*Sebastes entomelas*	Coastwide	N. 37º N lat.	13-200	55-160
Yelloweye rockfish	*Sebastes ruberrimus*	Coastwide	N. 36º N lat.	25-300	27-220
Yellowmouth rockfish	*Sebastes reedi*	N. 40º N lat.	N. 40º N lat.	77-200	150-200
Yellowtail rockfish	*Sebastes flavidus*	Coastwide	N. 37º N lat.	27-300	27-160
Roundfish Species					
Cabezon	*Scorpaenichthys marmoratus*	Coastwide	Coastwide	0-42	0-27
Kelp greenling	*Hexagrammos decagrammus*	Coastwide	N. 40º N lat.	0-25	0-10
Lingcod	*Ophiodon elongatus*	Coastwide	Coastwide	0-233	0-40
Pacific cod	*Gadus macrocephalus*	N. 34º N lat.	N. 40º N lat.	7-300	27-160
Pacific whiting	*Merluccius productus*	Coastwide	Coastwide	20-500	27-270
Sablefish	*Anoplopoma fimbria*	Coastwide	Coastwide	27->1,000	110-550
Shark and Skate Species					
Big skate	*Raja binoculata*	Coastwide	S. 46º N lat.	2-110	27-110
California skate	*Raja inornata*	Coastwide	S. 39º N lat.	0-367	0-10
Leopard shark	*Triakis semifasciata*	S. 46º N lat.	S. 46º N lat.	0-50	0-2
Longnose skate	*Raja rhina*	Coastwide	N. 46º N lat.	30-410	30-340
Soupfin shark	*Galeorhinus zyopterus*	Coastwide	Coastwide	0-225	0-225
Spiny dogfish	*Squalus acanthias*	Coastwide	Coastwide	0->640	0-190

Table 1-1. Latitudinal and depth distributions of groundfish species (adults) managed under the Pacific Coast Groundfish Fishery Management Plan (continued) [a/] (Page 4 of 4)

Common name	Scientific name	Latitudinal Distribution		Depth Distribution (fm)	
		Overall	Highest Density	Overall	Highest Density
Other Species					
Finescale codling	*Antimora microlepis*	Coastwide	N. 38° N lat.	190-1,588	190-470
Pacific rattail	*Coryphaenoides acrolepis*	Coastwide	N. 38° N lat. Coastwide	85-1,350	500-1,350
Ratfish	Hydrolagus colliei	Coastwide	Coastwide	0-499	55-82

a/ Data from (Casillas, *et al.* 1998), (Eschmeyer, *et al.* 1983), (Hart 1988), (Miller and Lea 1972), (Love, *et al.* 2002), and NMFS survey data. Depth distributions refer to offshore distributions, not vertical distributions in the water column.

b/ The category "rockfish" includes all genera and species of the family Scorpaenidae, even if not listed, that occur in the Washington, Oregon, and California area.

c/ Only the southern stock of bocaccio south of 40°10' N. lat. is listed as depleted.

d/ Dusky rockfish do not occur on the U.S. west coast south of 49° N. lat. The species needs to be removed from the FMP.

e/ Only two occurrences of harlequin rockfish south of 51° N. lat. (off Newport, OR and La Push, WA; (Casillas, *et al.* 1998)).

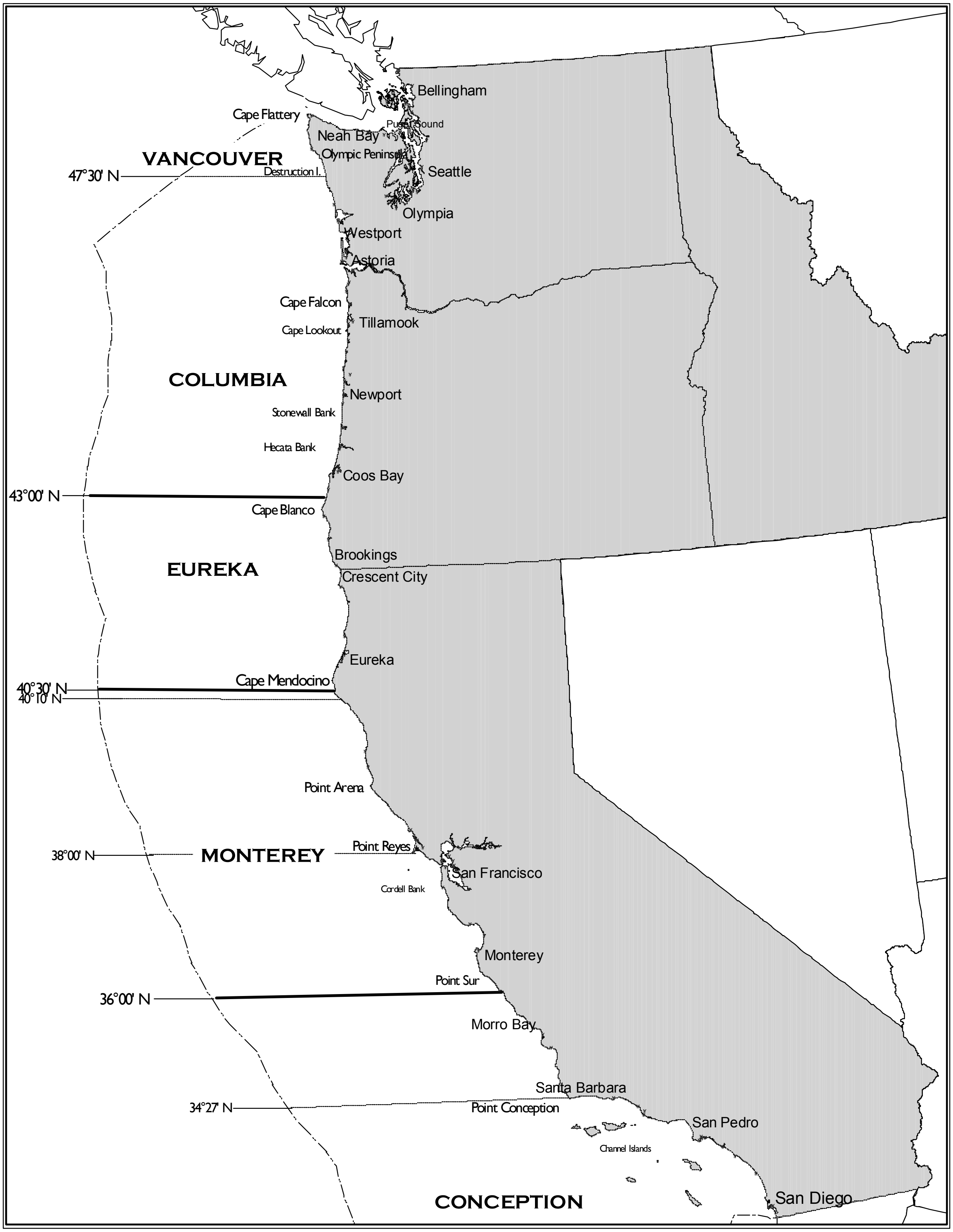

Figure 1-1. Fishery management lines used in west coast groundfish management

The passage of the Sustainable Fisheries Act in 1996 and the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) in 2006 incorporated the current conservation and rebuilding mandates into the MSA. These mandates—including abundance-based standard reference points for declaring the status of a stock (depleted; in a "precautionary" status; or at levels that can support MSY (healthy or "rebuilt"))—were subsequently incorporated in the Groundfish FMP with adoption of Amendments 11 and 12. These reference points are determined relative to an estimate of "virgin" or unexploited spawning biomass of the stock, denoted as $SB_{0,}$ which is defined as the average equilibrium abundance of a stock's spawning biomass before it is affected by fishing-related mortality.[1] SB_0 is then used to estimate MSY, as identified in the MSA and National Standard Guidelines. MSY represents a theoretical maximum surplus production from a population of constant size; National Standard Guidelines define it as "the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions." For a given population and set of ecological conditions, there is a biomass that produces MSY (denoted as B_{MSY}), which is less than the equilibrium size in the absence of fishing (B_0). (Generally, population sizes above B_{MSY} are assumed to be less productive, because of competition for resources or other density dependent factors.) The harvest rate used to achieve or sustain B_{MSY} is referred to as the Maximum Fishing Mortality Threshold (MFMT, denoted as F_{MSY}). Two harvest specification reference points, defined in the Groundfish FMP, provide guidance in setting the harvest rate: a total catch optimum yield (OY) and an acceptable biological catch (ABC). The Council identifies the OY as the management target for each species or species complex. When the stock biomass is determined to be lower than $B_{MSY,}$ the OY is set to less than the ABC in order to rebuild the stock to a healthy level (see the following discussion). The ABC, which is the maximum allowable harvest, is calculated by applying an estimated or proxy F_{MSY} harvest rate to the estimated abundance of the exploitable stock.

The biomass level that produces MSY (i.e. B_{MSY}) is generally unknown and assumed to be variable over time due to long-term fluctuations in ocean conditions, so that no single value is appropriate. Furthermore, F_{MSY} is tightly linked to an assumed level of density dependence in recruitment, and there is insufficient information to determine that level for many west coast groundfish stocks. Therefore, the use of approximations or proxies is necessary; absent of a more accurate determination of $F_{MSY,}$ the Council applies default MSY proxies. The Council-specified proxy MSY abundance for most west coast groundfish species is 40 percent of B_0 (denoted as $B_{40\%}$), meaning that the Council adopts management actions aimed to maintain abundance of each stock at or above approximately 40 percent of its virgin biomass. The Council-specified threshold for declaring a stock depleted or depleted is when the stock's spawning biomass declines to less than 25 percent of B_0 (denoted as $B_{25\%}$). The MSA and National Standard Guidelines refer to this threshold as the Minimum Stock Size Threshold (MSST). A rebuilding plan that specifies how total fishing-related mortality is constrained to achieve an MSY abundance level within the legally allowed time is required by the MSA and Groundfish FMP when a stock is declared depleted.

Stocks estimated to be above the depletion threshold, yet below an abundance level that supports MSY, are considered to be in the "precautionary zone." The Council has specified precautionary reductions in harvest rate for such stocks in order to increase abundance to $B_{40\%}$. The methodology for determining this precautionary reduction is described in the Groundfish FMP and is referred to as the 40–10 adjustment. As the stock declines below $B_{40\%}$, the total catch OY is reduced from the ABC until, at 10 percent of B_0, the OY is set to zero. However, in practice the 40-10 adjustment only applies to stocks

[1] The current abundance of a stock relative to its unfished level is commonly written as a percentage or a proportion; this value represents the stock's depletion level. In addition to using a comparison between current spawning biomass and unfished spawning biomass to determine this reference point, some stock assessment authors compare current and unfished levels of spawning output or of total stock biomass (B), depending on the information that is available.

above $B_{25\%}$ (the MSST) because once a stock falls below this level, an adopted rebuilding plan supplants it. Most stocks with an estimated abundance greater than $B_{40\%}$ are managed by setting harvest to the ABC. Figure 1-2 presents this framework graphically.

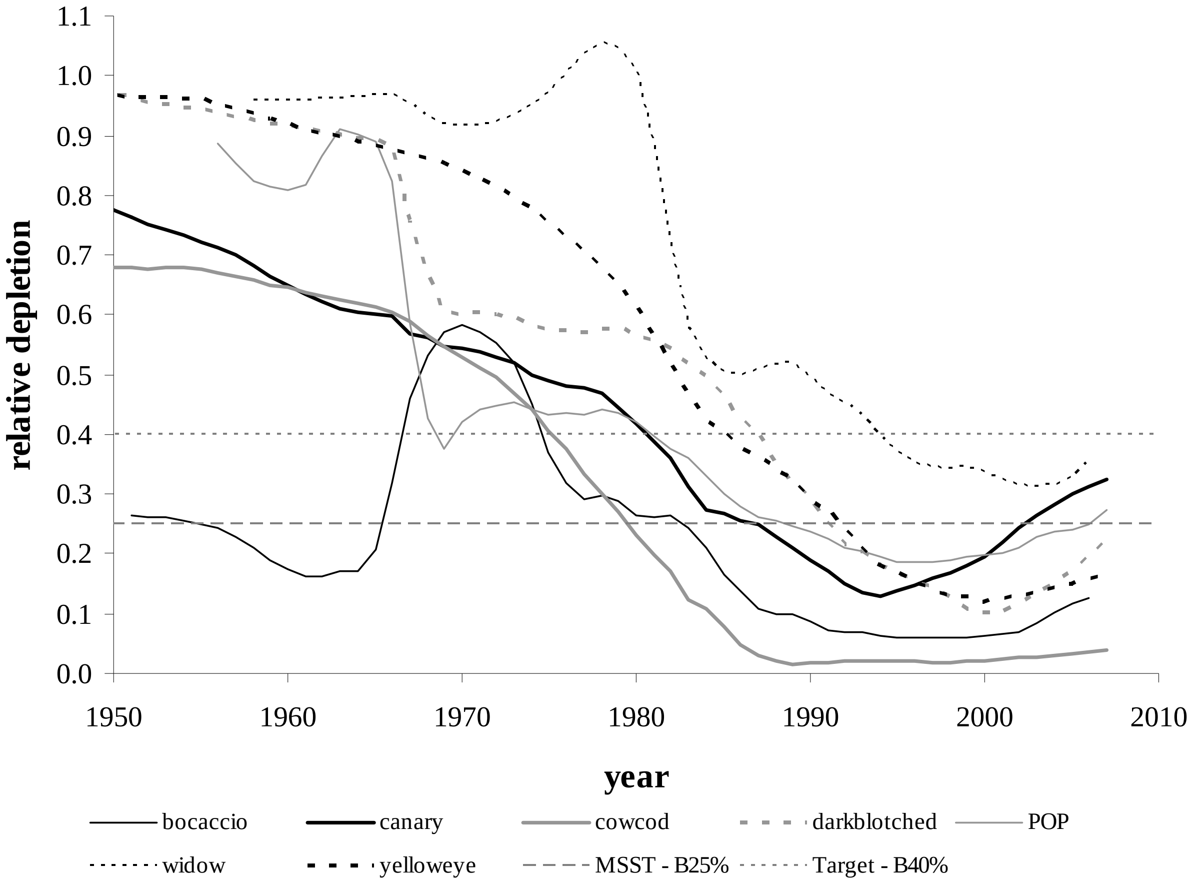

Figure 1-2. Relative depletion trends for rebuilding rockfish species

Sections 1.1, 1.2 and 1.3 describe groundfish stocks according to the categories just described: depleted, precautionary zone, and healthy. However, it is important to realize that of the more than 90 species in the management unit, only a portion are individually managed. Thus, the remaining species are managed and accounted for in groupings or stock complexes (discussed in Section 1.4) because individually they comprise a small part of the landed catch and insufficient information exists to develop the stock assessments necessary to set an OY based on yield estimates. (The Groundfish FMP identifies the OY for these species as an average of historical catch, based on the assumption that this is below MSY.)

Sixteen stock assessments were done in the 2007 stock assessment cycle. Stock assessments for Pacific ocean perch, yelloweye rockfish, English sole, widow rockfish, and bocaccio were simple updates, while the remaining species had changes to the modeling and warranted new full assessments, or had never previously been assessed (i.e., blue rockfish, longnose skate, and shortbelly rockfish).

Table 1-2 presents a summary of the results of the 2005 and 2007 assessments that were accepted as being suitable bases for management, including depletion (the estimated spawning biomass or output relative to the unfished condition), and the associated current and unfished spawning biomass, recent trends in abundance, and the estimated catch level at MSY. Table 1-3 lists life history parameters from the species assessed in 2005 and 2007; steepness of the spawner-recruitment curve (h), the von Bertalanffy Equation growth constant (k), and natural mortality (M) are each important contributors to the understanding of the productivity and resiliency of a species.

Complimentary to this overview, Table 1-3 provides the estimated or assumed value used in the stock assessment for the steepness of the spawner/recruit curve (generally an indicator of the productivity of the stock). In general, stock assessments for nearshore species tend to lack fishery-independent trend information, and rely primarily on catch per unit effort (CPUE) data and demographic data from recreational fisheries. By contrast, assessments for most shelf and slope species are informed by fisheries independent surveys and demographic information from commercial fisheries, and as such tend to be more data rich than those for nearshore species. Although fishery-dependent CPUE data exist for many commercial groundfish species, for most species such series have been truncated to the period prior to 2000, as a result of the difficulties interpreting catch rates given marked changes in management measures for west coast fisheries in recent years.

Figure 1-3 plots relative depletion of assessed groundfish stocks (from the most recent assessment for each stock) against the target fishing mortality rate, with lines delineating harvest policy targets and limits. Most groundfish stocks are above the target levels and below the target fishing mortality rates. This figure highlights that the majority of west coast groundfish stocks are not overfished or experiencing overfishing.

Table 1-2. Summary results from 2005 and 2007 groundfish stock assessments

Species	Depletion	Spawning Biomass (year)	Total Biomass	Unfished Spawning Biomass	Unfished Total Biomass	Spawning Biomass at MSY	Harvest Rate at MSY	MSY	MSY Basis
Arrowtooth flounder	0.79	63,302 mt ('07)	85,175 mt	80,313 mt	98,022 mt	30,780 mt	0.117	5,245 mt	F40%
Black rockfish (northern)	0.534	1,239 mt ('06)	7,558 mt	2,321 mt	11,390 mt	928 mt	0.110	408 mt	F50%
Black rockfish (southern)	0.705	3,227 M larvae ('07)	23,232 M larvae	4,578.5 M larvae	29,100 M larvae	1,831.4 M larvae	0.07227	1,035.4 mt	F50%
Blackgill rockfish	0.52	4,977 mt ('05)	13,051 mt	9,503 mt	21,558 mt	3,799 mt	0.029	223 mt	F50%
Blue rockfish	0.299	622 M larvae ('07)	5,447 mt	2,077 M larvae	13,223 mt	831 mt	0.0403	275 mt	F50%
Bocaccio rockfish	0.127	1,727 B eggs ('07)	10,752 mt	13,572 B eggs	71,195 mt	4,549 B eggs	0.0768	2,279 mt	F50%
Cabezon (CA)	0.38	516 mt ('05)	922 mt	1,361 mt	2,291 mt	522 mt	0.13	145 mt	F45%
California scorpionfish	0.80	816 mt ('05)	1,866 mt	1,024 mt	2,007 mt	259 mt	0.161	127 mt	Estimated
Canary rockfish	0.324	10,544 mt ('07)	25,995 mt	32,561 mt	86,036 mt	13,024 mt	0.0457	1,574 mt	F54.4%
Chilipepper rockfish	0.71	23,827 mt ('07)	32,401 mt	33,390 mt	45,057 mt	15,482 mt	0.088	2,099 mt	F50%
Cowcod	0.038	94 mt ('07)	224 mt	2,488 mt	5,251 mt	N/A	0.027	N/A	F50%
Darkblotched rockfish	0.224	6,853 B eggs ('07)	11,094 mt	30,641 B eggs	34,509 mt	12,256 B eggs	0.038	621 mt	F50%
Dover sole	0.632	188,987 mt ('05)	423,049 mt	299,054 mt	614,545 mt	117,281 mt	0.0672	16,505 mt	F40%
English sole	1.16	41,907 mt ('07)	62,172 mt	36,012 mt	59,944 mt	11,411 mt	0.17	3,877 mt	F40%
Gopher rockfish	0.97	1,931 mt ('05)	2,385 mt	1,995 mt	2,440 mt	798 mt	0.103	101 mt	F50%
Lingcod (N+S)	0.64	34,017 mt ('05)	NA	52,580 mt	NA	NA	NA	NA	NA
Longnose skate	0.66	4,634 mt ('07)	71,971 mt	7,034 mt	91,855 mt	844 mt	0.0426	787 mt	F45%
Longspine thornyhead	0.71	75,049 mt ('05)	162,642 mt	105,157 mt	228,275 mt	28,305 mt	0.055	3,687 mt	F50%
Kelp greenling (OR)	0.488	157 mt ('05)	597 mt	321 mt	1,295 mt	123 mt	0.125	82 mt	F45%
Pacific whiting a/	0.321-0.398	1.15-1.65 M mt ('07)	2.5-3.7 M mt	3.57-4.15 M mt	8.5-10.2 M mt	0.98-1.15 M mt	0.246	531,565 - 621,810 mt	F40%
Pacific ocean perch	0.275	10,168 mt ('07)	26,544 mt	36,983 mt	82,052 mt	14,793 mt	0.0388	1,411 mt	F50%
Petrale sole (N+S)	0.32	9,628 mt ('07)	23,056 mt	30,367 mt	54,085 mt	12,147 mt	0.1185	3,164 mt	F40%

Sablefish	0.383	93,831 mt ('07)	196,884 mt	244,797 mt	470,069 mt	41,544 mt	0.054	4,871 mt	F45%
Shortspine thornyhead	0.629	82,151 mt ('05)	144,513 mt	130,646 mt	230,500 mt	52,258 mt	0.0184	1,720 mt	F50%
Starry flounder (N+S)	0.50	3,566 mt ('05)	7,638 mt	7,158 mt	18,180 mt	2,864 mt	0.169	1,214 mt	F40%
Widow rockfish	0.355	17,999 M eggs ('07)	120,132 mt	50,746 M eggs	NA	20,298 M eggs	0.121	NA	F50%
Yelloweye rockfish	0.164	503 mt ('07)	1,327 mt	3,062 mt	7,043 mt	857 mt	0.022	48.9 mt	F50%
Yellowtail rockfish	0.55	16,915 mt ('05)	74,217 mt	31,016 mt	120,024 mt	12,407 mt	0.0863	4,680 mt	F50%

a/ The range of Pacific whiting values refer to point estimates from the equally plausible base (q=1) and alternative (q=0.7) models in the 2007 assessment.

Table 1-3. Summary of life history parameters identified in 2005 and 2007 groundfish stock assessments

Species	Steepness of S/R curve (h)		von-Bertalanffy growth coefficient (K)		Natural Mortality (M)	
	value	method	females	males	females	males
Arrowtooth flounder	0.902	fixed	0.17	0.39	0.166	0.274
Black rockfish (north)	0.6	fixed	0.164	0.194	0.16 < 10 yrs, 0.24 >15 yrs	0.16
Black rockfish (south)	0.6	fixed	0.17	0.26	0.16 < 10 yrs, 0.24 >15 yrs	0.16
Blackgill rockfish	0.65	fixed	0.068	0.04	0.04	0.04
Blue rockfish	0.58	fixed	0.147	0.295	0.1	0.12
Bocaccio rockfish	0.2	estimated	0.19	0.21	0.15	0.15
Cabezon	0.7	fixed	0.2	0.2	0.25	0.3
California scorpionfish	0.7	estimated	0.13	0.12	0.25	0.25
Canary rockfish	0.51	fixed	0.141	0.181	0.06 (young) 0.097 (old)	0.06
Chilipepper rockfish	0.573	fixed	0.2 - 0.32 a/	0.2 - 0.32 a/	0.16	0.16
Cowcod	0.6	fixed	0.052	0.052	0.055	0.055
Darkblotched rockfish	0.6	est. w/ prior	0.21	0.28	0.07	0.07
Dover sole	0.8	fixed	0.1189	0.0732	0.09	0.09
English sole	0.8	estimated	0.232-0.36 a/	0.29-0.48 a/	0.26	0.26
Gopher rockfish	0.65	fixed	0.186	0.186	0.2	0.2
Lingcod	0.9	fixed	LCN: 0.104 LCS: 0.145	LCN: 0.149 LCS: 0.223	0.18	0.32
Longnose skate	0.4	fixed	0.064	0.064	0.2	0.2
Longspine thornyhead	0.75	fixed	0.064	0.064	0.06	0.06
Kelp greenling	0.7	fixed	0.3 c/	0.4 /c	0.26	0.26
Pacific whiting	0.75	fixed	0.22-0.34 a/	0.22-0.34 a/	0.23	0.23
Pacific Ocean perch	0.652	estimated	N/A b/	N/A b/	0.053	0.053
Petrale sole	North: 0.88 South 0.72	estimated	0.08	0.08	0.2	0.2
Sablefish	0.428	estimated	0.246	0.298	0.07	0.07
Shortspine thornyhead	0.6	fixed	0.018	0.018	0.05	0.05
Starry flounder	0.8	fixed	0.251	0.426	0.3	0.45
Widow rockfish	0.29	estimated	North: 0.14 South: 0.2	North: 018 South: 0.25	0.125	0.125
Yelloweye rockfish	0.44	fixed	0.0664	0.0664	0.036	0.036
Yellowtail rockfish	N/A	N/A	0.07-0.23	0.08-0.25	0.11-0.28	0.11

a/The base case model allowed growth for each sex to differ between blocks of time, based on freely estimating the K parameter.
b/ Size at age was determined using an empirical matrix rather than a von Bertalanffy curve, so no value of k was set. linearly to estimate
c/ Values are for the Oregon substock analysis of the kelp greenling assessment, as the CA substock analysis was not adopted for mana
d/ 0.11 for ages 4-6; increases linearly to estimated max M (0.16-0.28) at age 25

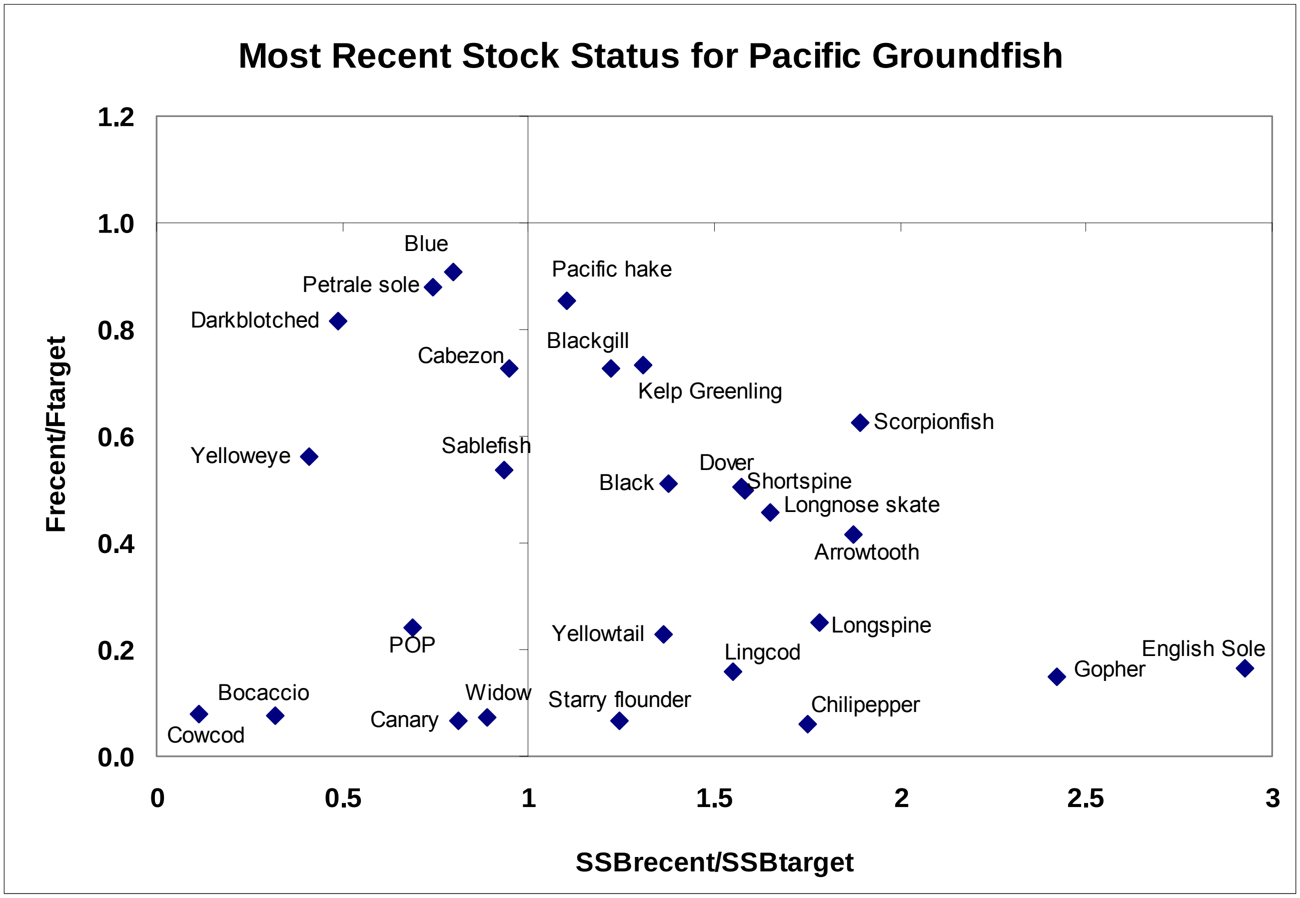

Figure 1-3. Relative depletion and current mortality rate of west coast groundfish stocks relative to the target fishing mortality rate and target spawning stock biomass

1.1 Depleted Groundfish Species

1.1.1 Bocaccio

Distribution and Life History

Bocaccio (*Sebastes paucispinis*) is a rockfish species that ranges from Krozoff and Kodiak Islands in the Gulf of Alaska to central Baja California, Mexico (Hart 1988; Miller and Lea 1972). Love, et al. (2002) and Thomas and MacCall (2001) describe bocaccio distribution and life history. Bocaccio are historically most abundant in waters off central and southern California. The southern bocaccio stock is most prevalent at the 54-82 fm depth zone (Casillas, *et al.* 1998).

Bocaccio are found in a wide variety of habitats, often on or near bottom features, but sometimes over muddy bottoms. They are found both nearshore and offshore (Sakuma and Ralston 1995). Larvae and small juveniles are pelagic (Garrison and Miller 1982) and are commonly found in the upper 100 m of the water column, often far from shore (MBC 1987). Large juveniles and adults are semi-demersal and are most often found in shallow coastal waters over rocky bottoms associated with algae (Sakuma and Ralston 1995). Adults are commonly found in eelgrass beds, or congregated around floating kelp beds (Love, *et al.* 1990; Sakuma and Ralston 1995). Young and adult bocaccio also occur around artificial structures, such as piers and oil platforms (MBC 1987). Although juveniles and adults are usually found around vertical relief, adult aggregations also occur over firm sand-mud bottoms (MBC 1987). Bocaccio move into shallow waters during their first year of life (Hart 1988), then move into deeper water with increased size and age (Garrison and Miller 1982).

Bocaccio are ovoviviparous (live young are produced from eggs that hatch within the female's body) (Garrison and Miller 1982; Hart 1988). Love et al. (1990) reported the spawning season to last nearly an entire year (>10 months). Parturition occurs during January to April off Washington, November to March off Northern and Central California, and October to March off Southern California (MBC 1987). Fecundity ranges from 20,000 to 2,300,000 eggs. In California, two or more broods may be born per year (Love, *et al.* 1990). The spawning season is not well known in northern waters. Males mature at three to seven years, with about half maturing in four to five years. Females mature at three to eight years, with about half maturing in four to six years (MBC 1987).

Maximum age of bocaccio was radiometrically determined to be at least 40 years, and perhaps more than 50 years. Bocaccio are difficult to age, and stock assessments used length measurement data and growth curves to estimate the age composition of the stock(Ralston and Ianelli 1998). Although recent assessments have described the true natural mortality rate as a key unknown for estimating stock status, recent assessments have used a value of 0.15 (which is associated with an 86 percent adult annual survival rate in the absence of fishing mortality).

Larval bocaccio eat diatoms, dinoflagellates, tintinnids, and cladocerans (Sumida and Moser 1984). Copepods and euphausiids of all life stages (adults, nauplii and egg masses) are common prey for juveniles (Sumida and Moser 1984). Both Phillips (1964) and Love et al. (2002) described bocaccio rockfish as almost exclusively piscivorous, and include other rockfish, Pacific whiting, sablefish, anchovy, mesopelagic fishes and squid as the key prey for large juvenile and adult bocaccio. Bocaccio are eaten by sharks, salmon, other rockfishes, lingcod, albacore, sea lions, porpoises, and whales (MBC 1987). Adult bocaccio are often caught with chilipepper rockfish and have been observed schooling with speckled, vermilion, widow, and yellowtail rockfish (Love, *et al.* 2002). As pelagic juveniles, they may compete with chilipepper, widow, yellowtail, shortbelly and other pelagic juvenile rockfishes for both food and habitat (Reilly, *et al.* 1992).

Stock Status and Management History

Bocaccio are managed as two separate west coast populations. The southern stock exists south of Cape Mendocino and the northern stock north of Cape Mendocino (the northern stock density is limited south of 48° N latitude with increasing abundance off Cape Flattery, Washington and points north). It is unclear whether this stock separation implies stock structure. The distribution of the two populations and evidence of lack of genetic intermixing suggests stock structure, although MacCall (2002b) sees some recent evidence for limited genetic mixing of the two populations. Nonetheless, assessment scientists and managers have treated the two populations as independent stocks north and south of Cape Mendocino. The northern stock of bocaccio has not been assessed.

Bocaccio have long been an important component of California rockfish fisheries. Catches increased to high levels in the 1970s and early 1980s as relatively strong year-classes recruited to the stock. The Council began to recommend increasingly restrictive regulations after an assessment of the southern stock in 1990 (Bence and Hightower 1990) indicated that fishing rates were too high. The southern stock suffered poor recruitment during the warm water conditions that prevailed off Southern California beginning in the late 1980s. The 1996 assessment (Ralston, *et al*. 1996b) indicated the stock was in severe decline. NMFS formally declared the stock depleted in March 1999 after the Groundfish FMP was amended to incorporate the tenets of the Sustainable Fisheries Act. MacCall et al. (1999) confirmed the depleted status of bocaccio and estimated spawning output of the southern stock to be 2.1 percent of its unfished biomass.

In the 2002 assessment (MacCall and He 2002) relative abundance increased slightly from the previous assessment (4.8 percent of unfished biomass), potential productivity (as evidenced from the steepness of the spawner/recruit relationship, which reflects the level of compensatory production at low stock sizes) appeared lower than previously thought, making for a more pessimistic outlook. Furthermore, the 2002 assessment revealed that although the 1999 year class was the strongest in several years, it was weak relative to the range of possibilities considered in the 1999 assessment.

The 2003 bocaccio assessment differed greatly from the 2002 assessment. The instantaneous rate of natural mortality was changed from 0.2 to 0.15, and additional California Cooperative Oceanic Fisheries Investigations (CalCOFI) data suggested an increasing abundance trend and provided a more complete understanding of the 1999 year class (MacCall 2003b). The results of these calculations suggested that recreational CPUE had increased dramatically in recent years and was at a record high level in central California north of Point Conception. The Stock Assessment Review (STAR) Panel recommended the use of two assessment models as a means of bracketing uncertainty from the very different signals between the Triennial Survey and the recreational CPUE data. Following the STAR Panel meeting, MacCall presented a third "hybrid" model (STATc) that incorporated the data from all of the indices. The SSC recommended and the Council approved the use of this third modeling approach. This resulted in modest improvement in estimated stock size, but significantly affected the estimated productivity of the stock. These results had substantial effects on the rebuilding outlook for bocaccio, which, under the 2002 assessment, was not expected to rebuild within T_{MAX} even with no fishing related mortality. Total mortality in 2003 fisheries was restricted to less than 20 mt as a means of conserving the stock while minimizing adverse socioeconomic impacts to communities. The 2003 rebuilding analysis (MacCall 2003a), using the "hybrid" model, suggested the stock could rebuild to B_{MSY} within 25 years while sustaining an OY of approximately 300 mt in 2004.

The 2003 assessment was updated in 2005 (MacCall 2006b). The assessment used the original Stock Synthesis model (SS1), and did not develop an equivalent new Stock Synthesis 2 (SS2) version of the assessment. In addition to new length frequency data, new data points were included from both the triennial survey and the CALCOFI larval abundance index, both of which suggested an increasing upwards trajectory for the stock. The updated base-case (STATc) model forecasts a slow increase in biomass (spawning output), with depletion (current spawning output divided by unfished spawning output) increasing from a current value of 10.7 percent to approximately 20 percent over the coming decade. The estimated 2005 total biomass (age1+) was 8,561 mt. The 2004 exploitation rate of 0.0103 was well below the maximum fishing mortality threshold (F_{MSY}). The 2004 OY was set at 199 mt, but due to constraints of co-occurring depleted stocks, realized catch was 78 mt.

The 2003 assessment was updated again in 2005 and 2007 (MacCall 2008b) using the original 2003 STATC model in SS1. The main differences from the 2005 assessment were additions and revisions of recent data and revision of historical commercial catches. The estimated 2006 total biomass (age1+) was 10,752 mt. The 2006 exploitation rate of 0.0062 was far below the maximum fishing mortality threshold (F_{MSY}). The 2006 OY was set at 218 mt and the retained catch was about 42 mt. Including mortality of estimated discards, estimated total catch was 68 mt. Estimated total mortality in 2006 was 67 mt, which was well below the OY and far below the ABC.

A bocaccio rebuilding plan was adopted by the Council at its April 2004 and submitted for incorporation in the Groundfish FMP under Amendment 16-3. The rebuilding plan established a target rebuilding year of 2023 and the harvest control rule of F = 0.0498 (with a P_{MAX} of 70 percent). (It was later clarified in the 2005 Rebuilding Analysis (MacCall 2006a) that the target rebuilding year had been incorrectly stated in the rebuilding plan to be 2023; since the 2003 rebuilding analysis indicated that a 50 percent probability rebuilding would require 23 years, and that this assumed a beginning date of 2004 (the first simulated year), the correct value of T_{target} is 2027.)

A new rebuilding analysis was conducted in 2007 (MacCall 2008a) based on the results of the 2007 stock assessment (MacCall 2008b). The 2007 bocaccio rebuilding analysis showed a similar rebuilding trajectory, which was adopted in Amendment 16-4. The SSC considered the progress toward rebuilding as adequate and did not recommend a redefinition of the target rebuilding time or to the rebuilding harvest rate. The rebuilding analysis showed that given the current SPR (77.7%) the median time to rebuild would be three years earlier (2023) than the originally estimated rebuilding schedule (2026) under Amendment 16-3.

1.1.2 Canary Rockfish

Distribution and Life History

Canary rockfish (*Sebastes pinniger*) range from northern Baja California, Mexico, to southeastern Alaska (Boehlert and Kappenman 1980; Hart 1988; Love 1991; Miller and Geibel 1973; Richardson and Laroche 1979). There is a major population concentration of canary rockfish off Oregon (Richardson and Laroche 1979). Canary rockfish primarily inhabit waters 91 m to 183 m (50 fm to 100 fm) deep (Boehlert and Kappenman 1980). In general, they inhabit shallow water when they are young, and deep water as adults (Mason 1995). Adult canary rockfish are associated with pinnacles and sharp drop-offs (Love, *et al.* 1991) and are most abundant above hard bottoms (Boehlert and Kappenman 1980). In the southern part of their range, canary rockfish appear to be associated with reefs (Boehlert 1980). In Central California, newly settled canary rockfish are first observed at the seaward sand-rock interface and farther seaward in deeper water (18 m to 24 m).

Canary rockfish off the west coast exhibit a protracted spawning period from September through March, probably peaking in December and January off Washington and Oregon (Hart 1988; Johnson, *et al.* 1982). Female canary rockfish reach sexual maturity at roughly eight years of age. Like many members of Sebastes, canary rockfish are ovoviviparous, whereby eggs are internally fertilized within females, and hatched eggs are released as live young (Bond 1979; Golden and Demory 1984; Kendall, Jr. and Lenarz 1986). Canary rockfish are a relatively fecund species, with egg production being correlated with size (e.g., a 49-cm female can produce roughly 0.8 million eggs, and a female that has realized maximum length (approximately 60 cm) produces approximately 1.5 million eggs (Gunderson 1971)).

Very little is known about the early life history strategies of canary rockfish. The limited research that has been conducted indicates that larvae are strictly pelagic (near the ocean surface) for a short period of time and begin to migrate to demersal waters during the summer of their first year of life. Larvae develop into juveniles around nearshore rocky reefs, where they may congregate for up to three years (Boehlert 1980; Sampson 1996). Evaluations of length distributions by depth demonstrate an increasing trend in mean size of fish with depth (Methot and Stewart 2006). Since 1990, stock assessments have assumed a base natural mortality rate of 0.06 (94 percent adult annual survival when there is no fishing mortality). Due to the rarity of old females in both survey and catch data, female canary rockfish have long been assumed to have increasing natural mortality rates with age (Golden and Wood 1990).

Little is known about ecological relationships between canary rockfish and other organisms. Adult canary rockfish are often caught with bocaccio, sharpchin, yelloweye, and yellowtail rockfishes, and lingcod. Researchers have also observed canary rockfish associated with silvergray and widow rockfish. Young-of-the-year feed on copepods, amphipods, and young stages of euphausiids. Adult canary rockfish feed primarily on euphausiids, as well as pelagic shrimp, cephalopods, mesopelagic fishes and other prey (Brodeur and Percy 1984; Lee 2002; Phillips 1964). Small canary rockfish are consumed by seabirds, Chinook salmon, lingcod, and marine mammals.

Stock Status and Management History

Canary rockfish have long been an important component of rockfish fisheries. The Council began to recommend increasingly restrictive regulations after an assessment in 1994 (Sampson and Stewart 1994) indicated that fishing rates were too high. In hindsight, work has estimated that the abundance of the canary rockfish stock dropped below $B_{40\%}$ (an abundance level used as a proxy for MSY) in about 1980, at which time the annual catch was more than double the current estimate of the MSY level. Harvest rates in excess of the current fishing mortality target for rockfish ($SPR_{50\%}$) is estimated to have begun in the late 1970s and persisted through 1999. Recent management actions appear to have curtailed the rate of removal such that overfishing has not occurred since 1999, and recent SPR values are in excess of 90 percent.

A 1999 stock assessment showed the stock had declined below the depleted level ($B_{25\%}$) in the northern area (Columbia and U.S. Vancouver management areas), (Crone, *et al.* 1999) and in the southern area (Conception, Monterey, and Eureka areas) (Williams, *et al.* 1999). The stock was declared depleted in January 2000. The first rebuilding analysis (Methot 2000) used results from the northern area assessment to project rates of potential stock recovery. The stock was found to have extremely low productivity, defined as production of recruits in excess of the level necessary to maintain the stock at its current, low level. Rates of recovery were highly dependent upon the level of recent recruitment, which could not be estimated with high certainty. The initial rebuilding OY for 2001 and 2002 was set at 93 mt based upon a 50 percent probability of rebuilding by the year 2057, a medium level for these recent recruitments, and maintaining a constant annual catch of 93 mt through 2002.

In 2002, a coastwide assessment of canary rockfish was conducted (Methot and Piner 2002a), treating the stock as a single unit from the Monterey management area north through the U.S. Vancouver area. This was a departure from the methodologies of past assessments. Although there is some evidence of genetic separation of the northern and southern stocks (Boehlert and Kappenman 1980; Wishard, *et al.*

1980), the observed variability in growth rate by sex and area was not significantly different at small versus large spatial scales.

A critical uncertainty in past and current canary rockfish assessments is the lack of older, mature females in surveys and other assessment indices. There are two competing explanations for this observation. Older females could have a higher natural mortality rate, resulting in their disproportionate disappearance from the population. Alternatively, survey and fishing gears may be less effective at catching them, perhaps because older females are associated with habitat inaccessible to most trawl gear. If this is the case, then these fish (which, because of their higher spawning output, may make an important contribution to future recruitment) are part of the population, but remain poorly sampled. The most recent assessment assumed a linear increase in female natural mortality from 0.06 at age 6 to approximately 0.09 at age 14 (Methot and Stewart 2006). The 2005 assessment was based on two equally plausible assessment models (as recommended by the SSC); one with differential male and female gear selectivities and one without gender-specific selectivities. The approved canary rockfish rebuilding analysis blended the two models by alternately re-sampling between the two input parameter sets. Both laboratory-based physiological studies and habitat-specific studies of the distribution of older male and female canary rockfish could better inform managers of the significance of these patterns and assumptions.

A full canary rockfish assessment was done in 2005 (Methot and Stewart 2006). As explained above, the assessment was based on two equally plausible models. In the base model (differential male-female selectivity) SB_0 is estimated to be 34,798 mt, resulting in a depletion level of 5.7 percent. In the alternate model (no difference in selectivity) SB_0 is estimated to be 33,872 mt, with a depletion level of 11.3 percent. The steepness of the spawner-recruitment relationship, which largely determines the rate of increase in recruitment as the stock rebuilds, was estimated to be 0.33 in the base model, and 0.45 in the alternate model.

The 2007 assessment (Stewart 2008c) utilized 2006 data, SS2, and modeled the resource as a single stock. New analysis of the triennial survey data led to separating the series into two parts (1980-1992, 1995-2004) to allow for potential changes in catchability due to timing of survey operations. Accommodation of potential changes in fishery selectivity due to management actions including the adoption of canary-specific trip limits in 1995, small footrope requirements in 1999, closure of the RCA in 2002 and use of selective flatfish trawl starting in 2005 was also added in the 2007 assessment. These and other changes have resulted in a change in the estimate of current stock status and large increase in the perception of uncertainty regarding this quantity in comparison to the most recent 2005 and earlier assessments. To address the uncertainty, the base case model (steepness = 0.51) and to two alternate states (steepness = 0.35, 0.72) were assessed. The estimated relative depletion level in 2007 was 32.4 percent corresponding to 10,544 mt of female spawning biomass in the base model. The unfished spawning stock biomass was estimated to be 32,561 mt in the base case model.

Research needs for the future canary rock fish assessment include a review of Canadian/Alaskan catches; reconstruction, consistent with all other rockfish species, of high and low values of catch history by gear and region; bi-lateral assessment with Canadian scientists; and investigate the importance of covariates on catch rates from the triennial survey and account for variation. In general, all future groundfish assessments would benefit from a meta database; online databases with raw data; database with historical catch histories including “best guesses” and estimates of uncertainty; defined common data sources and methods used for analysis; standard methods for modeling age and length data; and readily available supporting documentation for derived indices included in the stock assessment model.

A new rebuilding analysis was completed in 2005 (Methot 2006). Using the integrated ("blended") model explained above, the analysis estimated SB_0 to be 34,155 mt of female spawning biomass at the beginning of 2005 (corresponding to a depletion level of 9.4 percent). In this analysis, it was noted that following the constant harvest rate established under the canary rockfish rebuilding plan would produce an OY of 43 mt in 2007 and has a 57.4 percent probability of rebuilding by the current Ttarget (2074) and a 58.5 percent probability of rebuilding by the current Tmax (2076). The new structure of the analysis allowed for the incorporation of three sources of uncertainty, rather than one; the result of this is that it would take a large change in the constant harvest rate harvest rate (and short-term OY) to make a large change in the probability of rebuilding. For example, the harvest rate that would produce a 50 percent probability of rebuilding by the target rebuilding year (2074) is twice the level that would produce a 60 percent probability of rebuilding by T_{max} (2076).

A canary rockfish rebuilding plan was adopted by the Council in June 2003 and submitted for incorporation in the Groundfish FMP under Amendment 16-2. The rebuilding plan established a target rebuilding year of 2074 and the harvest control rule of F = 0.022 (with a P_{MAX} of 60 percent).

A new canary rockfish assessment was conducted in 2007(Stewart 2008c), which included major changes in the assessment data and modeling approach (i.e., a complete re-evaluation of the age data, simplification of time blocks for fishery selectivity, and splitting the triennial survey into two segments with separate catchability coefficients (*q*). Given the changes to the model structure, spawner-recruit steepness (*h*) could no longer be reliably estimated within the model, and a steepness prior from a hierarchical meta-analysis of west coast Sebastes was used instead (h = 0.511). Based on these revisions, the current depletion of canary rockfish is estimated to be 32.4 percent, compared with 9.4 percent from the 2005 assessment. The new rebuilding analysis conducted in 2007 (Stewart 2008a) based on the results of the 2007 stock assessment indicated a much more optimistic rebuilding outlook for canary rockfish. The rebuilding analysis showed that given the current SPR (88.7 percent) the median time to rebuild would be 42 years earlier (2021) than the originally estimated rebuilding schedule (2063). A modification of the Amendment 16-4 canary rockfish rebuilding plan is anticipated to be implemented in 2009 based on analyses in the 2009-2010 specifications and management measures EIS that will be developed in 2008.

1.1.3 Cowcod

Distribution and Life History

Relatively little is known about cowcod (*Sebastes levis*), a species of large rockfish that ranges from Ranger Bank and Guadalupe Island in central Baja California to Usal, Mendocino County, California (Miller and Lea 1972), and may infrequently occur as far north as Newport, Oregon.

Love et al. (2002) and Barnes (2001) described cowcod distribution and life history. Cowcod are most abundant in waters off central and southern California. They range from 22-491 m in depth and are considered to be parademersal (transitional between a midwater pelagic and benthic species). Adults are commonly found at depths of 180 m to 235 m and juveniles are most often found in 30 m to 149 m of water (Love, *et al.* 1990).

MacGregor (1986) found that larval cowcod are almost exclusively found in Southern California and may occur many miles offshore. Cowcod have always been among the rarest of *Sebastes* species larvae identifiable to species in the southern California Bight (the core CalCOFI survey area), with estimates of abundance as much as two orders of magnitude less than more abundant species (Moser, *et al.* 2000). Juveniles occur over sandy bottom areas, and solitary ones have been observed resting within a few centimeters of soft-bottom areas where gravel or other low relief was found (Allen 1982). Young-of-the-year have been observed on fine sand and clay sediment as well as oil platform shell mounds and other complex bottom features at depths ranging from 22-122 fm (40-224 m). Adult cowcod are primarily found over high relief rocky areas (Allen 1982). They are generally solitary, but occasionally aggregate (Love, *et al.* 1990). Although cowcod are generally not migratory, they may move, to some extent, to follow food (Love 1991).

Cowcod can live to be at least 55 years old. Maximum size is 94 cm (37 in) and 13 kg (28.5 lb). The instantaneous rate of natural mortality was fixed at 0.055 in the most recent stock assessments (95 percent adult annual survival when there is no fishing mortality) (Butler, *et al.* 1999b). Average size at age of mature females is similar to males. Females reach 90 percent of their maximum expected size by 42 years (Butler, *et al.* 1999b).

Cowcod are ovoviviparous, and large females may produce up to three broods per season (Love, *et al.* 1990). Spawning peaks in January in the Southern California Bight (MacGregor 1986). Fecundity is dependent on size and ranges from 181,000 to 1,925,000 eggs. Larvae emerge at about 5.0 mm (MacGregor 1986).

Little is known about ecological relationships between cowcod and other organisms. Small cowcod feed on planktonic organisms such as copepods. Juveniles eat shrimp and crabs, and adults eat fish, octopus, and squid (Allen 1982). Adults consume a wide range of prey items, but are primarily piscivorous (Love, *et al.* 2002).

Stock Status and Management History

While cowcod are not a major component of the groundfish fishery, they are highly desired by both recreational and commercial fishers because of their bright color and large size. The cowcod stock in the Conception area was first assessed in 1998 (Butler, *et al.* 1999b). Abundance indices decreased approximately tenfold between the 1960s and the 1990s, based on commercial passenger fishing vessel (CPFV) logs (Butler, *et al.* 1999b). Recreational and commercial catch also declined substantially from peaks in the 1970s and 1980s, respectively.

NMFS declared cowcod in the Conception and Monterey management areas depleted in January 2000, after Butler et al. (1999b) estimated the 1998 spawning biomass to be at 7 percent of B_0, well below the 25 percent overfishing threshold. Because cowcod is a fairly sedentary species, closed areas were established in 2002 to reduce cowcod mortality. These Cowcod Conversation Areas (CCAs), located in the Southern California Bight, were selected due to their high density of cowcod; while fishing for nearshore rockfish and pelagic species is allowed within the CCAs, fishing with most gear types that could catch cowcod is prohibited.

A cowcod rebuilding analysis was completed in 2003 which validated the assumption that non-retention regulations and area closures had been effective in constraining cowcod fishing mortality (Butler, *et al.* 2003). These encouraging results were based on cowcod fishery-related landings in recreational and commercial fisheries, although the assessment included discard information only with respect to CPFV observations (which indicated negligible discards in that sector). This rebuilding review pointed out a common problem among the analyses of depleted species: reliance on landings (fishery-dependent) data for providing relative abundance values becomes increasingly difficult as the allowable catch is decreased and fishery observer data remains low. Monitoring stock status and recovery thus becomes increasingly difficult in the absence of fishery-independent surveys.

As in the 1999 assessment, the 2005 cowcod assessment (Piner, *et al.* 2006) considered only the cowcod population in Southern California Bight (from the U.S.-Mexico border north to Point Conception) population, as this is the area in which cowcod are most abundant, adult habitat is most common, and catches are highest.. The 2005 assessment used only two data sources, the CPFV time series and the visual survey estimate data (Yoklavich, *et al.* 2007). The model was developed in SS2, and although the base model estimated only three parameters (two of which were "nuisance parameters," the other was equilibrium recruitment), the STAR Panel determined that this simplicity was appropriate given the paucity of data. The assessment provides a set of results corresponding to three different values for assumed steepness (h), the key parameter in the S-R relationship (h=0.4, 0.5, and 0.6). Although the model with assumed h=0.5 was deemed the most likely by the STAR Panel, there is still considerable uncertainty around both this value and the overall results of the assessment itself. The assessment estimated that the 2005 spawning biomass was 18 percent of unfished levels, within a range of 14 to 21 percent depending on the value assumed for steepness, a considerably more optimistic result than the 1999 assessment. The corresponding 2005 cowcod rebuilding analysis (Piner 2006) was used to develop the cowcod rebuilding plan adopted in the Groundfish FMP under Amendment 16-4. The rebuilding plan established a target rebuilding year of 2039 and an SPR of 90 percent.

The 2007 assessment (Dick, *et al.* 2008) was originally prepared as an "update" stock assessment; however, while preparing the update, an error was discovered in the previous assessment's specification of the selectivity curve. Several revisions were proposed, including new estimates of historical landings, a corrected growth curve, and a two-fishery model. The 2007 assessment used SS2, revised estimates of historical commercial catch, contained corrections to gear selectivity curves, utilized a revised growth curve, and separated the catch into commercial (all gears) and recreational fisheries rather than a single fishery. Recreational catches in the 2007 assessment are identical to those in the previous assessment, but estimates of commercial catches have been updated to reflect three additional data sources: 1) recovered port samples from Southern California (1983-1985), 2) regional summaries of total rockfish landings (1928-1968) provided by the NMFS SWFSC Environmental Research Division, and 3) California rockfish landings by region (1916-1927), published in California Department of Fish and Game (CDFG) Fish Bulletin No. 105 (1958).

Spawning biomass (SB) in 2007 is estimated to be between 3.4 percent and 16.3 percent of the unfished level. The poor precision of this estimate is due to 1) a lack of data to inform estimates of stock productivity, and 2) conflicting information from fishery-dependent and fishery–independent data. However, even the most optimistic model, which assumes a high-productivity stock and ignores declines in CPFV catch rates, suggests that spawning biomass was below 25 percent since 1980. Retention of cowcod is prohibited and bycatch is thought to be minimal, so it is unlikely that overfishing is currently an issue. In the 2005 assessment, spawning biomass was reported as mature biomass of males and females. In the 2007 assessment, the spawning biomass refers to the biomass of mature females only.

It is likely that the 2007 base model underestimates the uncertainty about this stock's status. Both steepness (*h*) and the natural mortality rate (*M*) are highly uncertain; however, both parameters are treated as fixed and known in the model. Addressing these uncertainties should be a priority for future research. Additionally, there is an urgent need for an informative abundance index that can monitor the recovery of this stock. The submersible line-transect survey and the acoustical-optical survey are non-lethal surveys that can estimate cowcod abundance (Yoklavich, *et al.* 2007). Finally, regional management issues that should be addressed in the future include that unknown magnitude of Mexican catches, and the untested assumption that cowcod in the Southern California Bight are isolated from cowcod north of Point Conception and south of the U.S.-Mexico border.

The most recent rebuilding analysis (Dick and Ralston 2008) estimated a new T_{max} of 2098, 24 years later than the date estimated by Piner (2006), due in part to the corrections described above, but only 1 year earlier than the 2099 date estimated previously (Butler and Barnes 2000). It is noted in the rebuilding analysis that rebuilding scenarios are extremely uncertain for this data-poor species, particularly with respect to steepness. Moreover, there is widespread concern about the ability to monitor the stock, and consequently to evaluate progress towards rebuilding in the future. The 2007 rebuilding analysis projections indicated that it would not be possible to rebuild the cowcod stock by 2039, even if all the catches are eliminated, and the estimated time to rebuild under the current harvest rate (SPR = 90 percent) is 26 years greater than the T_{target} adopted in Amendment 16-4. Therefore, a modification of the Amendment 16-4 cowcod rebuilding plan is anticipated to be implemented in 2009 based on analyses in the 2009-2010 specifications and management measures EIS that will be developed in 2008.

1.1.4 Darkblotched Rockfish

Distribution and Life History

Darkblotched rockfish (*Sebastes crameri*) are found from Santa Catalina Island off Southern California to the Bering Sea (Miller and Lea 1972; Richardson and Laroche 1979). They are most abundant from Oregon to British Columbia. Off Oregon, Washington, and British Columbia, darkblotched rockfish occur primarily on the outer shelf and upper slope (Richardson and Laroche 1979). Based upon genetic information and the absence of large scale gaps in catches, there are no clear stock delineations for darkblotched rockfish in U.S. waters. This does not mean there are not more fine scale groupings to be found, and in fact, darkblotched catches are characterized by infrequent large tows of larger fish. Distinct population groups have been found off the Oregon coast between 44°30' N latitude and 45°20' N latitude (Richardson and Laroche 1979). This species co-occurs with an assemblage of slope rockfish, including Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*).

Young-of-the-year recruit to bottom at depths ranging from 55-200 m after spending up to five months as pelagic larvae and juveniles in offshore waters (Love, *et al.* 2002). Off central California, young darkblotched rockfish recruit to soft substrate and low (<1 m) relief reefs (Love 1991). Darkblotched rockfish make limited migrations after they become adults (Gunderson 1977). Adults occur in depths of 25 m to 600 m, and 95 percent are found between 50 m and 400 m (Allen and Smith 1988). Adults are often found on mud near cobble or boulders. Darkblotched rockfish migrate to deeper waters with increasing size and age (Lenarz 1993; Nichol 1990; Rogers 2003a). Although aging is uncertain, analysis of 2003-2004 Northwest Fisheries Science Center (NWFSC) Shelf-Slope Survey data indicates depth migration is either more dependent upon length than age, or that the rate of growth changes with depth.

Maximum age of darkblotched rockfish is 64 years, and maximum size is 58 cm (23 in) and 2.3 kg (5.1 lb). Rogers, *et al*. (2000) estimated that the instantaneous rate of natural mortality was about 0.05 (95 percent adult annual survival when there is no fishing mortality). Females tend to be larger than males of the same age, and reach 90 percent of their maximum expected size by 13 years (Rogers, *et al.* 2000).

Darkblotched rockfish are ovoviviparous (Nichol and Pikitch 1994). Insemination of female darkblotched rockfish occurs from August to December, and fertilization and parturition occur from December to March off Oregon and California, and primarily in February off Oregon and Washington (Hart 1988; Nichol and Pikitch 1994; Richardson and Laroche 1979). Fecundity is dependent on size and ranges from 20,000 to 610,000 eggs.

Little is known about ecological relationships between darkblotched rockfish and other organisms. Pelagic juveniles feed on planktonic organisms such as copepods. Adults are often caught with other fish such as Pacific ocean perch and splitnose rockfish. Midwater animals such as euphausiids and amphipods dominate the diet of adult fish. Albacore and Chinook salmon consume pelagic juveniles (Hart 1988). Little is known about predation of adults.

Stock Status and Management History

Darkblotched rockfish has always been caught primarily with commercial trawl gear, as part of a complex of slope rockfish. Catch of darkblotched rockfish very likely first became significant in the mid-to-late 1940's, during which time it accelerated dramatically due to increases in gear efficiency and demand (Harry and Morgan 1963; Scofield 1948). During the mid 1960's to mid 1970s darkblotched rockfish were caught by both domestic and foreign fleets (Rogers 2003b). Domestic landings rose from late 1970s until the late 1980s, although limits on rockfish catch were first instituted in 1983, when darkblotched was rockfish managed as part of a group of around 50 species (designated as the Sebastes complex) (Rogers, *et al.* 2000). During the 2000's, progressive steps have been taken to reduce the catch of darkblotched rockfish, following the declaration of its depleted status in 2001. However, management goals (ABC or OY) for darkblotched rockfish were exceeded from 1997 through 2002. Although the 1996 assessment produced an ABC calculation for darkblotched, from 1997 through 2000 that amount was combined with yields for other species for purposes of managing a complex of species to combined ABC and OY amounts. Separate ABCs and OYs for darkblotched have been specified since 2001; however the species continues to be managed as part of a slope rockfish trip limit. Based on discard estimates now available from observer and logbook data for 2000-2003, the species-specific ABC was exceeded during 1997-2000 and the OY was exceeded in 2001 and 2002. However in 2004, the OY was not exceeded. Since September 2002, managers have used Rockfish Conservation Areas (RCA's) in addition to landings limits to control darkblotched rockfish fishing mortality. RCA's are large closed areas intended to protect overfished rockfish species. The RCA areas in 2003 appeared to effectively change the distribution of the catch. In 2004, trip limits were set 2-4 times higher than in 2003 during January-September, in conjunction with a seaward RCA boundary of 150 fm between May and September. This combination produced a sharp increase in catch that exceeded the ABC in 2004, but the larger retention allowances yielded a discard rate similar to that in the 2003 fishery. Since 2005, vessels using trawl gear shoreward of the RCA north of 40°10' have also been required to use nets that are designed to be more selective for flatfish.

There have been six previous assessments of darkblotched rockfish off of the U. S. west coast (Lenarz 1993; Methot and Rogers 2001; Rogers 2003a; Rogers 2006; Rogers, *et al.* 2000; Rogers, *et al.* 1996). These assessments began with life-history based analyses of sustainable catch rates and have progressed to statistical age-based modeling. The first full assessment of the darkblotched rockfish stock was conducted in 2000. That assessment was updated twice in 2001 and 2003, and 2005 and 2007 were full assessments for this species.

Rogers et al. (2000) completed an assessment in 2000 that employed a more extensive length-based stock synthesis modeling than had been used in the previous (1996) assessment (which had followed a simple F=M methodology verified by limited modeling using length based stock synthesis). This assessment determined the stock was at 14–31 percent of its unfished level, depending on assumptions regarding the historic catch of darkblotched rockfish in the foreign fishery from 1965-1978. More than any other issue of uncertainty, the uncertainty of historical foreign catch compositions had the greatest influence on the assessment model's calculation of stock status; as the proportion of the overall catch assumed to be composed of darkblotched was increased in the model, the estimates of B_0 also increased, bringing the current stock size estimate closer to a depleted level. Four accepted model runs varied the assumed foreign catch proportion from 0–20 percent, which resulted in significant differences in B_0 and the spawning index. Only one of those model runs (assuming 0 percent foreign catch of darkblotched) estimated the stock was not depleted. The STAR Panel (PFMC 2000) and the Groundfish Management Team (GMT) were unable to resolve the uncertainty in foreign catch composition. Therefore, the Stock

Assessment Team's (STAT) assumption that 10 percent of foreign catch was comprised of darkblotched (Rogers, *et al.* 2000) was accepted, leading to the conclusion that the spawning stock biomass was 22 percent of its unfished level.

Given that the stock was estimated to be below the depleted threshold ($B_{25\%}$), NMFS declared darkblotched rockfish to be depleted in 2001; the same year, the Council adopted a rebuilding analysis for the stock (Methot and Rogers 2001). On the earlier recommendation of the SSC (June 2001 Council meeting), the authors incorporated results of the 2000 triennial slope trawl survey conducted by the Alaska Fishery Science Center and modeled a more recent time series of recruitments. Incorporating these data resulted in a downward revision of the estimated recruitment and abundance, throughout the time series, compared to what had been used in the Rogers et al. (2000) assessment. For example, the mean recruitment in the 1983-1996 period was estimated to be about 67 percent of earlier estimates. Overall, this led to a revised estimate of spawning stock biomass at the beginning of 2002 of 14 percent of its unfished level. The minimum time to rebuild (T_{MIN}) in the absence of fishing was estimated to be 14 years with a median rebuilding year of 2014. The maximum time to rebuild (T_{MAX}) in accordance with the National Standard 1 Guidelines was 47 years (2047).

An assessment update for darkblotched rockfish, completed in 2003, suggested that the stock had not changed significantly from the previous assessment, but there was evidence of strong recent recruitment (Rogers 2003a). However these high numbers of fish added to the exploitable stock had not been validated by indices used in the assessment, so the spawning stock biomass was determined to be at 11 percent of it unfished level ($B_{11\%}$). New information in this update included revised estimates of the darkblotched rockfish catch in historical foreign fisheries, new fishery length and age composition information, a new Triennial Survey data point, and new slope survey data. Unresolved data discrepancies between these data sources, related to length and age composition, limited the amount of new data used in this assessment update. The SSC STAR Lite Panel requested progressive inclusion of 1997-1999, 2000, and 2001 recruitment estimates (Ralston, *et al.* 2003b). Risk of error progressively increased from including those recruitment estimates because they were based on increasingly limited data. Rebuilding results were sensitive to the high 2000 and 2001 recruitment estimates and including them allowed much greater 2004 OYs because those recruits enter the fishery and help rebuild the stock before the maximum allowable year; based on the recommendations of the SSC STAR Lite Panel, the assessment was amended to include the recruitment estimate for 2000.

The 2005 assessment (Rogers 2006) was a full assessment. It incorporated data from a large number of sources, allowing for the estimation of landings back to 1928. The major sources of uncertainty in this stock assessment include: 1) the assumed natural mortality rate (M), 2) the age-length relationship, 3) noisy survey indices and length compositions due to a few large survey catches which tend to have larger than average fish, 4) steepness (h) parameter for the spawner-recruit curve, and 5) the amount of historical landings prior to 1978. Uncertainty in the model results were explored primarily through examination of alternative natural mortality values. Estimates for M varied depending on the calculation method chosen, ranging from 0.025-0.5 (based on Hoenig's method (Hoenig 1983)) to 0.107 (from a linear relationship with reproductive effort). Investigating the range from 0.05 to 0.10, Rogers found that the best fitting M value conflicted among the different data sources; the primary source of this conflict was the Alaska Fisheries Science Center (AFSC) slope survey. The STAR Panel determined that the confidence intervals produced within the models underestimated uncertainty (Ralston, *et al.* 2006). The Panel concluded that uncertainty could be bracketed by assuming that an M value of 0.07 is likely (base model), while 0.05 and 0.09 are the unlikely extremes.

Higher natural mortality values bring about calculations of smaller historical declines in stock abundance and larger current biomass levels. Applying the STAR Panel selected value of M=0.07, the assessment determined the biomass of age 1+ darkblotched rockfish to have declined by 84 percent from 1928 to 1999; since 1999, the age 1+ biomass has more than doubled. There were several strong recruitments in recent years, even though spawning stock has been at a low level. The 1999 year class is the strongest since the 1980 year class. The estimated spawning stock biomass depletion at the beginning of 2005 was 16 percent of unfished biomass ($B_{16\%}$).

The 2007 darkblotched rockfish assessment (Hamel 2008c), using Stock Synthesis Model 2 version 2.00f, updated much of the data used in the 2005 assessment, incorporated new data, and made certain sources of uncertainty explicit. Changes in data for this assessment included updated landings data for 1980-2004 (minor changes) and new 2005 and 2006 landings data; updated 2003 and 2004 discard rate estimates, and a new 2005 discard rate estimate; new 2005 and 2006 NWFSC Slope Survey data; addition of the 2003-2006 NWFSC Shelf Survey data; and new GLMM estimates for all surveys. Conditional age-at-length data are used for the first time in this assessment from the fishery for 1991, 1998 and 2003-2006; from observer data for 2004 and 2005, from the AFSC Slope Survey for 2001; and from both the shelf and slope portions of the NWFSC Survey for 2003-2006. Data from the two years of the Pacific ocean perch (POP) Survey are no longer used in this assessment. Mean weight data from the discard fishery and mean size-at-age data are no longer used as the conditional-age at-length data encompasses the same data sources and provide similar information. Natural mortality (M=0.07) was not changed from the value used in the last assessment. The value for steepness (h=0.6) is somewhat different than in previous assessments which assume a linear function. In the 2007 assessment model, spawning output is assumed to be quadratic function of individual female weight (or biomass), and that accounts for the change in interpretation of steepness from previous years.

Allowance was made for uncertainty in natural mortality and the parameters of the stock-recruitment relationship. Sources of uncertainty that were not included in the 2007 assessment model include the degree of connection between the stocks of darkblotched rockfish off British Columbia and those in U.S. waters; the effect of the Pacific decadal oscillation (PDO), El Niño Southern Oscillation (ENSO) and other climatic variables on recruitment, growth and survival of darkblotched rockfish; and gender-based differences in survival.

The 2007 ABC would be 456 mt, and the OY would be 290 mt. The point estimate for the depletion of spawning output at the start of 2007 is 22.4 percent. Based on this assessment, darkblotched rockfish on the West Coast remain below the overfished threshold, but the spawning biomass appears to have increased steadily over the past 5 or 6 years. Since 2001, overfishing occurred only once, with estimated catch exceeding the ABC by 14 mt (5.8 percent) in 2004. The 2007 point estimate of summary (age +1) biomass is 11,094 mt, and this continues the upward trend over the past ten years. The exploitation rate has fallen over the past ten years, from over 13 percent to under 2 percent. Future stock management and assessment might be improved through greater cooperation with British Columbia because the stock extends northwards into Canadian waters. Future research needs include a thorough review of species composition in historical landings and of mortality in the shrimp fishery; constructing and using conditional age at length compositions with best available methods and data; and mapping of trawlable and untrawlable habitat.

A darkblotched rockfish rebuilding plan was first adopted by the Council in June, 2003 and submitted for incorporation within the Groundfish FMP under Amendment 16-2. That rebuilding plan established a target rebuilding year of 2030 and a harvest control rule (fishing mortality rate for fully selected sizes and/or ages) of F = 0.027, with a probability of rebuilding by T_{MAX} (2047) of 80 percent. Applying the results from the 2003 rebuilding analysis (Rogers 2003a), the harvest control rule was changed beginning in 2004 via a regulatory amendment. The new harvest control rule of F = 0.032 (equivalent to ABC harvest rate) was used to set annual darkblotched OYs in 2004-2005 and resulted in an updated P_{MAX} (by the new T_{MAX} (2044) of >90 percent.

The results from the 2005 rebuilding analysis (Rogers 2006) were adopted in 2006 to set 2007-2008 OYs. The council was under a new mandate to rebuild as quickly as possible while meeting community needs. The resulting OYs were based on a harvest rate (now below the ABC harvest rate) given a spawning potential ratio (SPR) of 0.607, equivalent to a harvest rate of F = 0.029 under the 2005 assessment. This resulted in an updated P_{MAX} of >90 percent (with a new T_{MAX} of 2033) incorporated in a new rebuilding plan adopted under Amendment 16-4.

A new rebuilding analysis was conducted in 2007 (Hamel 2008a) based on the results of the 2007 stock assessment (Hamel 2008c). The 2007 darkblotched rebuilding analysis departed strongly from the target rebuilding year adopted under Amendment 16-4. The rebuilding analysis showed that, given the current SPR, the median time to rebuilding would be 19 years later (2030) than the originally estimated rebuilding schedule (2011) adopted under Amendment 16-4. This deviation is primarily due to changes in our understanding of stock productivity and depletion. Additionally, rebuilding is estimated to occur seven years longer than the established target rebuilding year, even with zero catch. These changes represent fundamental revisions to our understanding of the productivity of the stock, warranting a revision of T_{target} and T_{max}. Rebuilding will occur well before the new T_{max} if the current target SPR harvest rate (60.7 percent) is maintained. The SSC suggested the status quo harvest rate as a reasonable starting point for the Council's deliberations when developing OYs for overfished groundfish stocks for the 2009-2010 biennial specifications cycle.

1.1.5 Pacific Ocean Perch

Distribution and Life History

Pacific ocean perch (POP, *Sebastes alutus*) are found from La Jolla, California to the western boundary of the Aleutian Archipelago (Eschmeyer, *et al.* 1983; Gunderson 1971; Ito, *et al.* 1986; Miller and Lea 1972), but are common from Oregon northward (Eschmeyer, *et al.* 1983). They primarily inhabit waters of the upper continental slope (Dark and Wilkins 1994) and are found along the edge of the continental shelf (Archibald, *et al.* 1983). Pacific ocean perch occur as deep as 825 m, but usually are at 100 m to 450 m and along submarine canyons and depressions (NOAA 1990). Throughout their range, POP are generally associated with gravel, rocky, or boulder type substrate (Ito 1986). Larvae and juveniles are pelagic; subadults and adults are benthopelagic (living and feeding on the bottom and in the water column). Adults form large schools 30 m wide, to 80 m deep, and as much as 1,300 m long (NOAA 1990). They also form spawning schools (Gunderson 1971). Juvenile POP form ball-shaped schools near the surface or hide in rocks (NOAA 1990).

Pacific ocean perch winter and spawn in deeper water (>275 m). In the summer (June through August) they move to feeding grounds in shallower water (180 m to 220 m) to allow gonads to ripen (Archibald, *et al.* 1983; Gunderson 1971; NOAA 1990). They are slow-growing and long-lived; the maximum age has been estimated at about 98 years (Heifetz, *et al.* 2000). The can grow up to about 54 cm and 2 kg (Archibald, *et al.* 1983; Beamish 1979; Eschmeyer, *et al.* 1983; Ito, *et al.* 1986; Mulligan and Leaman 1992; NOAA 1990). POP are carnivorous. Larvae eat small zooplankton. Small juveniles eat copepods, and larger juveniles feed on euphausiids (krill). Adults eat euphausiids, shrimps, squids, and small fish. Immature fish feed throughout the year, but adults feed only seasonally, mostly April through August (NOAA 1990). POP predators include sablefish and Pacific halibut.

Stock Status and Management History

POP were harvested exclusively by U.S. and Canadian vessels in the Columbia and Vancouver Internation North Pacific Fishery Commission (INPFC) areas prior to 1965. Large Soviet and Japanese factory trawlers began fishing for POP in 1965 in the Vancouver area and in the Columbia area a year later. Intense fishing pressure by these foreign fleets occurred from 1966 to 1975. The MSA, passed by Congress in 1976, ended foreign fishing within 200 miles of the United States coast.

The POP resource off the West coast was depleted before implementation of the Groundfish FMP in 1982, and Council actions to conserve the resource likewise predate the FMP. Large removals of POP in the foreign trawl fishery, followed by significant declines in catch and abundance, led the Council to limit harvest beginning in 1979. A 20–year rebuilding plan for POP was adopted in 1981. Rebuilding under this original plan was largely influenced by a cohort analysis of 1966-1976 catch and age composition data (Gunderson 1979), updated with 1977-1980 data (Gunderson 1981), and an evaluation of trip limits as a management tool (Tagart, *et al.* 1980). This was the first time trip limits were used by the Council to discourage targeting and overharvest of a depleted stock, and it remains a management strategy in use today in the West coast groundfish fishery. In addition to trip limits, the Council significantly lowered the OY for POP. After twenty years of rebuilding under the original plan, the stock stabilized at a lower equilibrium than estimated in the pre-fishing condition. While continuing stock decline was abated, rebuilding was not achieved as the stock failed to increase in abundance to B_{MSY}.

Ianelli and Zimmerman (1998) estimated POP female spawning biomass in 1997 to be at 13 percent of its unfished level, thereby confirming that the stock was depleted. NMFS formally declared POP depleted in March 1999 after the Groundfish FMP was amended to incorporate the tenets of the Sustainable Fisheries Act. The Council adopted and NMFS enacted more conservative management measures in 1999 as part of a redoubled rebuilding effort.

A 2000 POP assessment suggested the stock was more productive than originally thought (Ianelli, *et al.* 2000). A revised POP rebuilding analysis was completed and adopted by the Council in 2001 (Punt and Ianelli 2001). This analysis estimated a T_{MIN} of 12 years and a T_{MAX} of 42 years. It was noted in the rebuilding analysis that the ongoing retrospective analysis of historic foreign fleet catches was likely to change projections of POP rebuilding.

The 2003 POP assessment (Hamel, *et al.* 2003) incorporating updated survey and fishery data including the retrospective of foreign fleet catches (Rogers 2003b). The assessment covered areas from southern Oregon to the U.S. border with Canada, the southern extent of POP distribution. The overall conclusion was that the stock was relatively stable at approximately 28 percent of its unfished biomass ($B_{28\%}$). Of all the changes and additions to the data, the historical catch estimates had the greatest effect, resulting in lower estimates of both equilibrium unfished biomass (B_0) and MSY.

Many cases were presented in the 2003 rebuilding analysis and, based on SSC advice, the Council chose the one based on the full Bayesian posterior distribution, in which recruits were re-sampled to project future recruitment. Re-sampling recruits rather than recruits per spawner was recommended because only the southern fringe of the stock occurs in waters off the U.S. West coast. One would want to resample recruits per spawner if measured recruitment is a function of measured stock size. However, it is unlikely that the recruitment measured off the U.S. West coast is wholly from the portion of the parental stock occurring in these same waters.

The 2005 assessment (Hamel 2006b) is an update and uses the same model as in the 2003 assessment, a forward projection age-structured model (Hamel, *et al.* 2003). The assessment incorporates new data and changes to the data used in the previous assessment. As was the case in the previous assessment, a number of sources of uncertainty are explicitly accounted for, such as that associated with natural mortality, the parameters of the stock-recruitment relationship, and catchability coefficients for the different surveys. However, sensitivity analyses based upon alternative model structures/data set choices suggested that the overall uncertainty may be greater than that predicted by a single model specification, as was also the case in the 2003 assessment. There are also other sources of uncertainty that are not included in the current model. These include the degree of connection between the stocks of POP off British Columbia and those in Council waters; the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of POP; gender differences in growth and survival; a possible non-linear relationship between individual spawner biomass and effective spawning output and more complicated relationship between age and maturity. In order to provide the Council with a means to incorporate this uncertainty into its decision making, Hamel undertook the following analysis: he estimated, based on a reference case, the Bayesian posterior distributions for key management and rebuilding variables. These distributions best reflect the uncertainty of the assessment's analysis, and are suitable for probabilistic decision making. The assessment estimated the following values based on the maximum of the posterior density function (MPD) point estimate: spawning biomass depletion at the start of 2005 equal to 23.4 percent and a 2007 ABC equal to 746 mt. Overfishing for POP is considered to be occurring when F is above F_{MSY} = 0.0310 according to the current assessment base model. The 2005 rebuilding analysis (Hamel 2006a) re-estimated T_{MIN} to be 2015.

The 2007 assessment (Hamel 2008d) is an update and uses the forward projection age-structured model used in the 2003 and 2005 assessments. Catch data for 2003 and 2004 was updated, and new catch data for 2005 and 2006 was added. The 1999-2004 NWFSC slope survey biomass indices and age compositions were recalculated with the 2005 and 2006 information added. The same sources of uncertainty, both incorporated and not incorporated, for the 2005 assessment are present for the 2007 assessment and were dealt with through the same Bayesian distributions analysis. The assessment estimated the following values based on the MPD point estimate: spawning biomass depletion at the start of 2007 equal to 27.5 percent and a 2007 ABC equal to 1,009 mt. The OY for 2007 based on the 40-10 rule is 588 mt. Overfishing for POP is considered to be occurring when F is above F_{MSY} = 0.0382 according to the current assessment base model. Based on the 2007 assessment, POP on the west coast are recovering, and overfishing is not occurring. Research and data needs for future assessments include information on the relationship of individual female age and biomass to maturity, fecundity and offspring; information on the accuracy of POP ageing; information on the relative density of POP in trawlable and untrawlable areas and difference in age and/or length compositions between those areas; and information on the British Columbia POP stock and its relationship to the Oregon and Washington stock.

A POP rebuilding plan was adopted by the Council in June 2003 and submitted for incorporation in the Groundfish FMP under Amendment 16-2 (approved by NMFS in January 2004). The rebuilding plan established a target rebuilding year of 2027 and a harvest control rule of F = 0.0082 (with a P_{MAX} of 70 percent). The 2003 assessment (Hamel, *et al.* 2003) and rebuilding analysis (Punt, *et al.* 2003) was used to amend the harvest control rule and set annual POP OYs for the 2004-2006 period. The amended harvest control rule was F = 0.0257, which increased the estimated P_{MAX} to slightly over 70 percent.

A POP assessment (Hamel 2006b) and rebuilding analysis (Hamel 2006a) were conducted in 2005. These were used to set the harvest control rule for 2007-2008 under the new mandate to rebuild as quickly as possible while taking into account west coast fishing community needs. The resulting OYs were based on an SPR harvest rate of 86.4 percent (equivalent to a harvest rate of F = 0.0085). This resulted in an updated P_{MAX} of >90 percent (with a new T_{MAX} of 2043) in the modified rebuilding plan adopted under Amendment 16-4.

A new rebuilding analysis was conducted in 2007 (Hamel 2008b) based on the results of the 2007 stock assessment (Hamel 2008d). Estimated mortality of POP has been very low relative to the available OY, averaging 42 percent over the period 2000-2006. The estimated time to rebuild the stock, if the current harvest rate is maintained at an SPR of 86.4 percent, is 2011, which is six years ahead of schedule (T_{target} = 2017) in the current rebuilding plan. The calculated time to rebuild is very similar to the T_{target}

adopted under Amendment 16-4. In general, management has been quite effective at minimizing fishing mortality on this overfished stock as per the adopted rebuilding plan. Progress toward rebuilding is considered adequate by the SSC and they recommend no redefinition of T_{target} or adjustment to the rebuilding harvest rate.

1.1.6 Widow Rockfish

Distribution and Life History

Widow rockfish (*Sebastes entomelas*) range from Albatross Bank off Kodiak Island to Todos Santos Bay, Baja California, Mexico (Eschmeyer, *et al.* 1983; Miller and Lea 1972; NOAA 1990). They occur over hard bottoms along the continental shelf (NOAA 1990) and prefer rocky banks, seamounts, ridges near canyons, headlands, and muddy bottoms near rocks. Large widow rockfish concentrations occur off headlands such as Cape Blanco, Cape Mendocino, Point Reyes, and Point Sur. Adults form dense, irregular, midwater and semi-demersal schools deeper than 100 m at night and disperse during the day (Eschmeyer, *et al.* 1983; NOAA 1990; Wilkins 1986). All life stages are pelagic, but older juveniles and adults are often associated with the bottom (NOAA 1990). All life stages are fairly common from Washington to California (NOAA 1990). Pelagic larvae and juveniles co-occur with yellowtail rockfish, chilipepper, shortbelly rockfish, and bocaccio larvae and juveniles off Central California (Reilly, *et al.* 1992).

Widow rockfish are ovoviviparous, have internal fertilization, and brood their eggs until released as larvae (NOAA 1990; Reilly, *et al.* 1992). Mating occurs from late fall-early winter. Larval release occurs from December through February off California, and from February through March off Oregon. Juveniles are 21 mm to 31 mm at metamorphosis, and they grow to 25 cm to 26 cm over three years. Age and size at sexual maturity varies by region and sex, generally increasing northward and at older ages and larger sizes for females. Some mature in three years (25 cm to 26 cm), 50 percent are mature by four years to five years (25 cm to 35 cm), and most are mature in eight years (39 cm to 40 cm) (NOAA 1990). The maximum age of widow rockfish is 28 years, but rarely over 20 years for females and 15 years for males (NOAA 1990). The largest size is 53 cm and about 2.1 kg (Eschmeyer, *et al.* 1983; NOAA 1990).

Widow rockfish are carnivorous. Adults feed on small pelagic crustaceans, midwater fishes (such as age-one or younger Pacific whiting), salps, caridean shrimp, and small squids (Adams 1987a; NOAA 1990). During spring, the most important prey item is salps, during the fall fish are more important, and during the winter widow rockfish primarily eat sergestid shrimp (Adams 1987a). Feeding is most intense in the spring after spawning (NOAA 1990). Pelagic juveniles are opportunistic feeders, and their prey consists of various life stages of calanoid copepods, and euphausiids (Reilly, *et al.* 1992).

Stock Status and Management History

Widow rockfish are an important commercial species from British Columbia to central California, particularly since 1979, when Oregon trawl fisherman demonstrated the ability to make large catches at night using midwater trawl gear. Many more participants have entered the fishery since that time, and landings of widow rockfish have increased rapidly (Love, *et al.* 2002). Widow rockfish are a minor component of the recreational groundfish fisheries.

Williams et al. (2000) assessed the coastwide stock of widow rockfish in 2000. The spawning output level (8,223 mt eggs), based on that assessment and a revised rebuilding analysis (Punt and MacCall 2002) adopted by the Council in June 2001, was at 23.6 percent of the unfished level (33,490 mt eggs) in 1999. The widow rockfish stock was declared overfished in 2001 based on this assessment result.

The 2003 assessment (He, *et al.* 2003b) concluded that the widow rockfish stock size was at 24.65 percent of the unfished biomass, but indicated that stock productivity was considerably lower than previously thought. Data sparseness was a significant problem in this widow rockfish assessment (Conser, *et al.* 2003; He, *et al.* 2003b). Results from the 2003 widow rockfish rebuilding analysis (He, *et al.* 2003a) were used to develop the first widow rockfish rebuilding plan, which was adopted in April 2004 under Amendment 16-3 to the Groundfish FMP. The rebuilding plan established a target rebuilding year of 2038 and a harvest control rule of F = 0.0093 (with a P_{MAX} of 60 percent).

A full assessment was completed in 2005 for widow rockfish (He, *et al.* 2006a). In addition to including the new data from 2003 to 2004, this assessment added an index of relative abundance based on the triennial survey data and estimated the power coefficient of the midwater juvenile survey index instead of using a fixed value. The base model estimated that spawning biomass declined steadily since the early 1980s and that spawning output in 2004 was 31 percent of the unexploited level, above the Council's depleted threshold. Further, spawning output in the base model was estimated to have never dropped below the 25 percent depleted threshold. Alternative model runs, which were considered to be only slightly less plausible than the base model, however, indicated that the stock had been below $B_{25\%}$. The 2005 rebuilding analysis indicated that the stock was much closer to reaching a rebuilt biomass than previously estimated: under the 2005 rebuilding analysis (He, *et al.* 2006b), T_{MIN} was estimated to be 2013, compared to a T_{MIN} of 2026 in the 2003 analysis (He, *et al.* 2003a). This rebuilding analysis was used to modify the widow rockfish rebuilding plan, which was adopted under Amendment 16-4 in 2006. The target rebuilding year under the modified rebuilding plan was 2015 and the harvest control rule was an SPR harvest rate of 95 percent.

An updated assessment was done in 2007 (He, *et al.* 2008) using the same age-based model (written in ADMB) and data compiling procedures used in the previous assessment. New data from 2005 and 2006, including catches, age composition, and a CPUE time series, were included in the 2007 assessment. Sources of uncertainty include a questionable source of information (Oregon bottom trawl logbook data); the validity of the fixed natural mortality rate used; the estimation of stock-recruitment relationships, which also led to uncertainty in the rebuilding analysis; the appropriateness of using the Santa Cruz juvenile survey data; and stock structure issues including relationship to the Canadian stock. The estimated total biomass in 2006 was 120,132 mt and the estimated 2006 spawning biomass was 47,478 mt. Spawning biomass in the 2007 assessment is higher than in the 2005 assessment primarily because of the relatively strong recruitment in 2003 by the 2000 cohort. The estimated current depletion rate is 35.5 percent of the unfished spawning output. The ABC for 2007 is 5,334 mt and the harvest guideline is 368 mt. It is estimated that the population will recover to the target in 2009, which is six years earlier than the target year in the rebuilding plan. Based on these results, the SSC recommended no changes to the rebuilding plan.

Future research needs include reliable abundance indices, continue the long-term recruitment index and midwater juvenile trawl survey, ability to infer direct and indirect estimates of year class strengths, better understand the relationship between environmental conditions in the California Current Ecosystem, improve short-term forecasts of productivity, biomass levels and allowable catches from stock assessments, new discard data, evaluate the utility of hydro-acoustic surveys, increase age-collection programs to increase sample size, and determination of age-composition for the triennial survey.

1.1.7 Yelloweye Rockfish

Distribution and Life History

Yelloweye rockfish (*Sebastes ruberrimus*) range from the Aleutian Islands, Alaska, to northern Baja California, Mexico, and are common from Central California northward to the Gulf of Alaska (Eschmeyer, *et al.* 1983; Hart 1988; Love 1991; Miller and Lea 1972; O'Connell and Funk 1986). Yelloweye rockfish occur in water 25 m to 550 m deep with 95 percent of survey catches occurring from 50 m to 400 m (Allen and Smith 1988). Yelloweye rockfish are bottom dwelling, generally solitary, rocky reef fish, found either on or just over reefs (Eschmeyer, *et al.* 1983; Love 1991; Miller and Lea 1972; O'Connell and Funk 1986). Boulder areas in deep water (>180 m) are the most densely populated habitat type, and juveniles prefer shallow-zone broken-rock habitat (O'Connell and Carlile 1993). They also reportedly occur around steep cliffs and offshore pinnacles (Rosenthal, *et al.* 1982). The presence of refuge spaces is an important factor affecting their occurrence (O'Connell and Carlile 1993).

Yelloweye rockfish are ovoviviparous and give birth to live young in June off Washington (Hart 1988). The age of first maturity is estimated at six years and all are estimated to be mature by eight years (Wyllie Echeverria 1987). They can grow to 91 cm (Eschmeyer, *et al.* 1983; Hart 1988) and males and females probably grow at the same rates (Love 1991; O'Connell and Funk 1986). The growth rate levels off at approximately 30 years of age (O'Connell and Funk 1986) but they can live to be 114 years old (Love 1991; O'Connell and Funk 1986). Yelloweye rockfish are a large predatory reef fish that usually feeds close to the bottom (Rosenthal, *et al.* 1982). They have a widely varied diet, including fish, crabs, shrimps and snails, rockfish, cods, sand lances, and herring (Love 1991). Yelloweye rockfish have been observed underwater capturing smaller rockfish with rapid bursts of speed and agility. Off Oregon the major food items of the yelloweye rockfish include cancroid crabs, cottids, righteye flounders, adult rockfishes, and pandalid shrimps (Steiner 1978). Quillback and yelloweye rockfish have many trophic features in common (Rosenthal, *et al.* 1982).

Stock Status and Management History

The first ever yelloweye rockfish stock assessment was conducted in 2001 (Wallace 2002). This assessment incorporated two area assessments: one from Northern California using CPUE indices constructed from Marine Recreational Fisheries Statistical Survey (MRFSS) sample data and CDFG data collected on board commercial passenger fishing vessels, and the other from Oregon using Oregon Department of Fish and Wildlife (ODFW) sampling data. The assessment concluded yelloweye rockfish stock biomass in 2001 was at about seven percent of unexploited biomass in Northern California and 13 percent of unexploited biomass in Oregon. The assessment revealed a thirty-year declining biomass trend in both areas with the last above average recruitment occurring in the late 1980s. The assessment’s conclusion that yelloweye rockfish biomass was well below the 25 percent of unexploited biomass threshold for depleted stocks led to this stock being declared overfished in 2002. Until 2002, yelloweye rockfish were listed in the “remaining rockfish” complex on the shelf in the Vancouver, Columbia, and Eureka INPFC areas and the “other rockfish” complex on the shelf in the Monterey and Conception areas. As with the other depleted stocks, yelloweye rockfish harvest is now tracked separately and managed against a species-specific OY.

In June 2002 the SSC recommended that managers should conduct a new assessment incorporating Washington catch and age data. This recommendation was based on evidence that the biomass distribution of yelloweye rockfish on the west coast was centered in waters off Washington and that useable data from Washington were available. Based on that testimony, the Council recommended completing a new assessment in the summer of 2002, before a final decision was made on 2003 management measures. Methot et al. (2003) did the assessment, which was reviewed by a STAR Panel in August 2002. The assessment result was much more optimistic than the one prepared by Wallace (2002), largely due to the incorporation of Washington fishery data. While the depleted status of the stock was confirmed (24 percent of unfished biomass), Methot et al. (2003) provided evidence of higher stock productivity than originally assumed. The assessment also treated the stock as a coastwide assemblage. This assessment was reviewed and approved by the SSC and the Council at the September 2002 Council meeting. Based on the results of the accompanying rebuilding analysis (Methot and Piner 2002b), the Council adopted, a yelloweye rockfish rebuilding plan in 2004 was adopted by the Council under Groundfish FMP Amendment 16-3. The rebuilding plan established a target rebuilding year of 2058 and a harvest control rule of F = 0.0153.

A yelloweye rockfish assessment was among those completed during the 2005 assessment cycle (Wallace and Tsou 2005). While the assessment was scheduled to be an update, it migrated to a new modeling platform, which is allowed only in full assessments. At their November 2005 meeting, the Council heard testimony that there were additional data sources that might better inform a yelloweye assessment, but had not been included due to the terms of reference constraints on update assessments. Therefore, the Council asked the assessment team to undertake a further, full assessment effort that would include all possible sources of information.

The re-assessment of the stock (Wallace, *et al.* 2006) used the SS2 model that had been introduced in the 2005 assessment. The assessment updated all data sources in the previous model, including a substantial effort to examine multiple data sources to further define and extend the historical catch stream. New data sources were also included (WDFW 2002 submersible survey and the International Pacific Halibut Commission annual longline survey). Further revisions in the assessment included reducing natural mortality from 0.045 to 0.036 and increasing steepness from 0.437 to 0.45. The assessment model treated the west coast population of yelloweye rockfish in two different ways: as a single coastwide stock (consistent with the 2002 and 2005 assessments) and as separate and distinct sub-populations for the States of California, Oregon and Washington. The assessment is considered to be data poor, however the sparseness of data is particularly acute in the Washington model. As such, the SSC recommended to the Council that the coastwide model be used for setting the OY of the stock. During the March 2006 meeting, the Council deliberated over which of the past assessments represented the best available science for use in decision-making; the Council selected the coastwide model from the 2006 assessment. Under this model, the 2006 coastwide biomass is calculated to be at 17.7 percent of the unfished level (with depletion rates of 8.5 percent, 21.8 percent and 20.8 percent for California, Oregon, and Washington respectively). The rebuilding analysis (Tsou and Wallace 2006) re-estimated other parameters: Tmax increased to 2096 with a harvest control rule of F=0.0101, and a projected OY in 2007 of 12.6 mt.

The Council used the 2006 rebuilding analysis to modify the yelloweye rebuilding plan under FMP Amendment 16-4. Given the significant negative socioeconomic impacts associated with the projected OYs under the constant harvest rate modeled in the rebuilding analysis, the Council elected to gradually ramp down the harvest rate beginning in 2007 before resuming a constant harvest rate rebuilding strategy in 2011. The harvest rate ramp-down strategy, which projected annual OYs of 23 mt, 20 mt, 17 mt, and 14 mt, respectively in 2007-2011, was projected to extend rebuilding by less than one year relative to the more conservative constant harvest rate strategy analyzed. The ramp-down strategy afforded more time to consider new Yelloweye Rockfish Conservation Areas and other management measures designed to reduce the harvest rate to prescribed levels. Therefore, the Amendment 16-4 rebuilding plan incorporated the ramp-down strategy before resuming a constant harvest rate (SPR = 71.9 percent) in 2011. The rebuilding plan also specified a target rebuilding year of 2084.

The 2007 updated stock assessment for yelloweye rockfish (Wallace 2008b) used a new natural mortality estimated value, updated and corrected age and length composition data, new catch data for 2006, and refreshed catch histories for 1983-2005. In the process of refreshing data for use in the updated assessment, several errors were uncovered in the data and input files used for the previous assessment. These include the misspecification of the age- and length-bin values in the SS2 input file and the inclusion of Washington trawl ages in constructing age-composition inputs for the Washington hook and line fishery. These problems were corrected in developing the 2007 base model. Since the corrected bin values were lower than those used in the previous assessment and the Washington trawl data contained a higher proportion of old fish, all three of these corrections led to downward revisions in the amount of spawning biomass and the level of depletion, relative to the 2006 assessment. In converting the model to SS2, the prior assessment's old SS1 "super-year" approach for dealing with small sample sizes for age and size compositions in some years was updated using the recommended SS2 method. This change had little effect on model results.

During the 2006 STAR Panel review, a representative from the Canadian Department of Fisheries and Oceans, who was present, reported that their current model's estimated value for yelloweye natural mortality (M) off British Columbia was 0.033. This information led the Panel to recommend lowering the value of M in the U.S. model from 0.045 (as used in 2005) to 0.036. Subsequently, the Canadian model was updated and a new value of M was estimated at 0.043. As a result, current and projected biomass and depletion levels for an alternative base case (with M=0.043) are also reported in the 2007 updated assessment.

The long-term biomass trajectory in the 2007 updated assessment is very similar to that in the 2006 assessment. The unfished spawning stock biomass is estimated to be 3,019 mt in the base model, and 3,062 mt in the alternative (M=0.043) model. The spawning biomass targets for these models are 1,208 mt and 1,225 mt, respectively. The overfished biomass levels for these models are 755 mt and 766 mt, respectively. The current spawning biomass is estimated to be 422 mt with the base model and 485 mt with the alternative model. Current depletion estimates for these models are 14.5 percent and 16.4 percent, respectively. Ultimately, the Council adopted the alternative assessment model using M=0.043 as recommended by the SSC. The subsequent rebuilding analysis (Wallace 2008a), which incorporated the endorsed alternative assessment model and the harvest rate ramp-down strategy in the rebuilding plan. Based on that analysis, the SSC concluded that rebuilding progress was on track and did not recommend any changes to the rebuilding plan.

The yelloweye assessment can be categorized as quite data poor; it relies primarily on recreational CPUE information with varying data gaps even in those data series among the three states. Very little fishery independent information exists. Additionally, since retention of yelloweye has been prohibited in recreational fisheries; even the limited CPUE series that do exist were truncated in 2001. In order to resolve the uncertainty in the current assessment as well as to track rebuilding, it will be necessary to implement additional strategies to collect yelloweye abundance, age and maturity information. Collection of these data can only be accomplished through research studies and/or by onboard observers because this species is now prohibited. In 2006, International Pacific Halibut Commission (IPHC) and Washington Department of Fish and Wildlife (WDFW) scientists are conducting a study to increase our knowledge of current stock biomass off Washington coast. Loss of the study due to declining OY will have significant detrimental effects on our ability to adequately assess this stock in the future.

1.2 Precautionary Zone Groundfish Species

Groundfish species managed under the FMP, with an estimated spawning stock biomass less than 40 percent of its unfished level but greater than 25 percent of its unfished level, are categorized as species managed in the "precautionary zone". A depleted species is managed under its rebuilding plan even if it has partially rebuilt to above $B_{25\%}$; it remains under its rebuilding plan until it is assessed to have attained the B_{MSY} abundance level of 40 percent of unfished biomass. Precautionary zone species are managed using the 40-10 adjustment in which the OY is set less than the ABC, as described earlier in this chapter; depleted species are managed under the mortality schedule specified in rebuilding plans.

1.2.1 Cabezon (in Waters off California)

Distribution and Life History

Cabezon (*Scorpaenichthys marmoratus*) are distributed along the entire west coast of the continental United States. They range from central Baja California north to Sitka, Alaska (Love 1996; Miller and Lea 1972). Cabezon are primarily a nearshore species found intertidally and among jetty rocks, out to depths of greater than 100 m (Love 1996; Miller and Lea 1972).

Cabezon are known to spawn in recesses of natural and manmade objects, and males are reported to show nest-guarding behavior (Garrison and Miller 1982). Spawning is protracted, and there appears to be a seasonal progression of spawning that begins off California in winter and proceeds northward to Washington by spring. Spawning off California peaks in January and February (O'Connell 1953) while spawning in Puget Sound (Washington State) occurs for up to 10 months (November-August), peaking in March–April (Lauth 1987). Laid eggs are sticky and adhere to the surface where deposited. After hatching, the young of the year spend 3–4 months as pelagic larvae and juveniles. Settlement takes place after the young fish have attained 3–5 cm in length (Lauth 1987; O'Connell 1953). It is apparent that females lay multiple batches in different nests, but whether these eggs are temporally distinct enough to qualify for separate spawning events is not understood (Lauth 1987; O'Connell 1953).

Stock Status and Management History

The status and future prospects of cabezon were first assessed in 2003 (Cope, *et al.* 2004). The assessment delineated two stocks (north and south) at the Oregon-California border, a distinction based on differences in the catch history, CPUE trends and biological parameters (mainly growth) between the two areas. Due to the lack of data on the northern population, the assessment focused on only the southern population. As with most nearshore groundfish stocks, this assessment lacked a fishery-independent index of abundance, and consequently relied on recreational CPUE indices and information about larval abundance. The 2003 depletion level of cabezon off California was estimated at 34.7 percent (under the base-case posterior density function, or MPD, point estimate).

In the 2005 assessment (Cope and Punt 2006), the California cabezon stock was further divided north and south of Point Conception into the northern California substock (NCS) and the southern California substock (SCS). Historically, the recreational fishery has been the primary source of removals of cabezon in California; however commercial catches have become a major source of removals in the last ten years because of the developing live-fish fishery. Recreational removals were reconstructed back to 1916, when the commercial fishery began. When investigating the uncertainty related to the various data sources, Cope and Punt determined that excluding the mean weight value for the recreational man-made fleet for 2000 led to a major reduction in the status of the SCS (to 5.8 percent of virgin biomass in 2005); the use of this data point may be the most important uncertainty of the SCS assessment. The unfished spawning biomass of the California cabezon substocks were estimated to be 1110 (NCS) and 251 (SCS) mt, with estimated reproductive outputs of 445 (NCS) and 71 (SCS) mt in 2005; this leads to an estimated depletion level of 40.1 percent (NCS) and 28.3 percent (SCS). Although the assessment provides information on two substocks within California, cabezon are managed on a coastwide basis for the state. The assessment authors noted that regional management is an important consideration for relatively sedentary nearshore reef species such as cabezon and that future assessments should continue to provide scientific analyses on increasingly finer spatial scales in order to investigate such a potential shift in management.

1.2.2 Petrale Sole

Distribution and Life History

Petrale sole (*Eopsetta jordani*) are found from Cape Saint Elias, Alaska to Coronado Island, Baja California, Mexico. The range may possibly extend into the Bering Sea, but the species is rare north and west of southeast Alaska and in the inside waters of British Columbia (Garrison and Miller 1982; Hart 1988). Nine separate breeding stocks have been identified, although stocks intermingle on summer feeding grounds (Hart 1988; NOAA 1990). Of these nine, one occurs off British Columbia, two off Washington, two off Oregon, and four off California. Adults are found from the surf line to 550 m depth, but their highest abundance is deeper than 300 m. Adults migrate seasonally between deepwater winter spawning areas to shallower spring feeding grounds. They show an affinity to sand, sandy mud, and occasionally muddy substrates (NOAA 1990).

Spawning occurs over the continental shelf and continental slope to as deep as 550 m. Spawning occurs in large spawning aggregations in the winter. Eggs are pelagic and juveniles and adults are demersal (Garrison and Miller 1982). Eggs and larvae are transported from offshore spawning areas to nearshore nursery areas by oceanic currents and wind. Larvae metamorphose into juveniles at six months (22 cm) and settle to the bottom of the inner continental shelf (Pearcy, *et al.* 1977). Petrale sole tend to move into deeper water with increased age and size. Petrale sole begin maturing at three years. Half of males mature by seven years (29 cm to 43 cm) and half of the females are mature by eight years (>44 cm) (Pearcy, *et al.* 1977; Pedersen 1975a; Pedersen 1975b). Near the Columbia River, petrale sole mature one to two years earlier (Pedersen 1975a; Pedersen 1975b).

Larvae are planktivorous. Small juveniles eat mysids, sculpins, and other juvenile flatfishes. Large juveniles and adults eat shrimps and other decapod crustaceans, as well as euphausiids, pelagic fishes, ophiuroids, and juvenile petrale sole (Garrison and Miller 1982; Hart 1988; Pearcy, *et al.* 1977; Pedersen 1975a; Pedersen 1975b). Petrale sole eggs and larvae are eaten by planktivorous invertebrates and pelagic fishes. Juveniles are preyed upon (sometimes heavily) by adult petrale sole, as well as other large flatfishes. Adults are preyed upon by sharks, demersally feeding marine mammals, and larger flatfishes and pelagic fishes (NOAA 1990). Petrale sole competes with other large flatfishes. It has the same summer feeding grounds as lingcod, English sole, rex sole, and Dover sole (NOAA 1990).

Stock Status and Management History

Petrale sole are harvested almost exclusively by bottom trawls in the U.S. west coast groundfish fisheries. Petrale sole fishing grounds range from Cape Flattery off northern Washington, to Point Conception off southern California. Recent petrale sole catch statistics exhibit marked seasonal variation, with substantial portions of the annual harvest taken from the spawning grounds in December and January. Petrale sole off the U.S. west coast have been managed historically using a coastwide ABC which represents the sum of ABCs calculated for the four INPFC areas.

In 2005, an assessment of the petrale sole stock in U.S. waters off California, Oregon, and Washington was completed (Lai, *et al.* 2006). Previous assessments of petrale sole in the U.S. Vancouver and Columbia INPFC areas had been conducted by Demory (1984), Turnock et al. (1993), and Sampson and Lee (1999). In this assessment, petrale sole in the Eureka, Monterey and Conception INPFC areas (the Southern assessment area) are assessed separately from those in the U.S. Vancouver and Columbia areas (the Northern assessment area). Although genetic information and stock structure are not well known for this species, the available data on growth, CPUE, and geographical distribution along the U.S. Pacific coast support the use of two separate assessment areas. The assessment used the length-and-age structured SS2 Model.

Petrale sole in the north was estimated to be at 34 percent of unfished spawning stock biomass in 2005. In the south, the stock was estimated to be at 29 percent of unfished spawning stock biomass. Biomass trends were qualitatively similar in both areas, and also showed consistency with petrale sole trends in Canadian waters. Both stocks were estimated to have been below the Pacific Council's depleted threshold of 25 percent of unfished biomass from the mid-1970s until very recently. Estimated harvest rates were in excess of the target fishing mortality rate of $F_{40\%}$ during this period as well. Petrale sole in both areas showed large recent increases in stock size, which is consistent with the strong upward trend in the shelf survey biomass index. In comparison to previous assessments of petrale sole, this assessment represents a significant change in our perception of petrale sole stock status. For example, in the 1999 assessment, spawning biomass stock biomass in 1998 was estimated to be at 39 percent of unfished stock biomass. The current assessment now estimates biomass in 1998 to have been at 12 percent of unfished stock biomass.

1.2.3 Sablefish

Distribution and Life History

Sablefish, or black cod, (*Anoplopoma fimbria*) are distributed in the northeastern Pacific ocean from the southern tip of Baja California, northward to the north-central Bering Sea and in the Northwestern Pacific ocean from Kamchatka, southward to the northeastern coast of Japan. Although few studies have critically evaluated issues regarding the stock structure of this species, it appears there may exist at least three different stocks of sablefish along the west coast of North America: (1) a stock that exhibits relatively slow growth and small maximum size that is found south of Monterey Bay (Cailliet, *et al.* 1988; Philips and Inamura 1954); (2) a stock that is characterized by moderately fast growth and large maximum size that occurs from northern California to Washington; and (3) a stock that grows very quickly and contains individuals that reach the largest maximum size of all sablefish in the northeastern Pacific ocean, distributed off British Columbia, Canada and in the Gulf of Alaska (Mason, *et al.* 1983; McFarlane and Beamish 1990; Methot, *et al.* 2000). Large adults are uncommon south of Point Conception (Hart 1988; Love 1991; McFarlane and Beamish 1983a; McFarlane and Beamish 1983b; NOAA 1990). Adults are found as deep as 1,900 m, but are most abundant between 200 m and 1,000 m (Beamish and McFarlane 1988; Kendall, Jr. and Matarese 1987; Mason, *et al.* 1983). Off southern California, sablefish are abundant to depths of 1,500 m (MBC 1987). Adults and large juveniles commonly occur over sand and mud (McFarlane and Beamish 1983b; NOAA 1990) in deep marine waters. They were also reported on hard-packed mud and clay bottoms in the vicinity of submarine canyons (MBC 1987).

Spawning occurs annually in the late fall through winter in waters greater than 300 m (Hart 1988; NOAA 1990). Sablefish are oviparous with external fertilization (NOAA 1990). Eggs hatch in about 15 days (Mason, *et al.* 1983; NOAA 1990) and are demersal until the yolk sac is absorbed (Mason, *et al.* 1983). Age-zero juveniles become pelagic after the yolk sac is absorbed. Older juveniles and adults are benthopelagic. Larvae and small juveniles move inshore after spawning and may rear for up to four years (Boehlert and Yoklavich 1985; Mason, *et al.* 1983). Older juveniles and adults inhabit progressively deeper waters. Estimates indicate that 50 percent of females are mature at five years to six years (24 inches) and 50 percent of males are mature at five years (20 inches).

Sablefish larvae prey on copepods and copepod nauplii. Pelagic juveniles feed on small fishes and cephalopods—mainly squids (Hart 1988; Mason, *et al.* 1983). Demersal juveniles eat small demersal fishes, amphipods, and krill (NOAA 1990). Adult sablefish feed on fishes like rockfishes and octopus (Hart 1988; McFarlane and Beamish 1983b). Larvae and pelagic juvenile sablefish are heavily preyed upon by seabirds and pelagic fishes. Juveniles are eaten by Pacific cod, Pacific halibut, lingcod, spiny dogfish, and marine mammals, such as Orca whales (Cailliet, *et al.* 1988; Hart 1988; Love 1991; Mason, *et al.* 1983; NOAA 1990). Sablefish compete with many other co-occurring species for food, mainly Pacific cod and spiny dogfish (Allen 1982).

Stock Status and Management History

Formal stock assessments of sablefish began in 1984. The first coastwide-established regulations on the sablefish fishery off the U.S. Pacific coast were implemented as trip limits in October 1982. Since 1982, the sablefish fishery has been managed intensively, with limited-entry and open-access programs used in various manners to limit catches.

In 2001, two assessments were completed and reviewed by a STAR Panel: one by NMFS (Schirripa and Methot 2001) and one by the Pacific Groundfish Conservation Trust (Hilborn, *et al.* 2001). The two assessments were in agreement, and the Council adopted the NMFS assessment for management purposes. The Schirripa and Methot assessment focused on evaluating the sensitivity of the model and the outcomes to changes in the survey data. These changes include the combining of the AFSC slope survey data and the NWFSC Industry Co-operative Survey data using a statistical Generalized Linear Models (GLM) procedure. This analysis made it possible to extend the southern boundary of the assessment south to Point Conception (34°27' N latitude) rather than 36° N latitude, used in previous assessments. The assessment indicated a normal decline in biomass since the late 1970s due to the fishing down of the unfished stock and an unexpected decline in recruitment during the early 1990s. It introduced, for the first time, the possibility that sablefish recruitment may be linked to environmental factors. A seemingly meaningful relationship was demonstrated between changes in northern and southern copepod abundances and sablefish recruitment. Conditions and projections in the model considered two competing “states of nature” to calculate the mean virgin recruitment: a “density-dependent” state that used the average of 1975-1991 recruitments, and a “regime shift” state that used the 1975-2000 recruitments. To account for this uncertainty, the Council adopted a 2002 ABC based on the proxy harvest rate ($F_{45\%}$,) adjusted to reflect the distribution north and south of 36° N latitude. This was done because a plan amendment would be needed to change the management area since Groundfish FMP Amendment 14, permit stacking, specified only the area north of 36° N latitude.

The Council also wanted to verify industry reports of a large abundance of juvenile sablefish, an observation that was confirmed to some extent by preliminary results from the 2001 NMFS slope survey. Based on these considerations, the Council recommended a new expedited assessment be done in 2002. This update assessment (Schirripa 2002), by definition, sought to document changes in the estimates of the status of the stock by only considering newly available data for 2001 while not considering any new changes in the model structure or model assumptions. The expedited assessment confirmed fishermen’s anecdotal reports of a large 1999 year class, which was also apparent in the preliminary results of the 2001 slope survey. The 2005 assessment also suggested that a relatively strong year class was produced in 2000, and the 2007 assessment also identifies 1999 and 2000 as strong year classes which are now recruiting into the population. Whether these two year classes are due to past management actions or merely favorable oceanographic conditions is not clear (Schirripa 2008).

The 2005 assessment (Schirripa and Colbert 2006) made several changes to the format used in the previous full assessment. Landings were either taken from written records or reconstructed back to the year 1900 (the assumed model start date of the fishery). Inspection of length compositions from the AFSC and the NWFSC slope surveys led to the conclusion that the two surveys had different gear selectivities. Consequently, a separation of the data was maintained and the surveys used individually.

Sufficient observer data was available in which to estimate discards from all three fisheries. To compliment these discards rates, a release mortality function based on sea surface temperature was developed from which to estimate dead discards by each of the three fisheries. Pursuing the connection between ocean conditions and recruitment, the model fit a relationship between sea level and recruitment deviations for the period 1973-2003 and used that relationship to hindcast recruitment variability back to 1925. The 2005 assessment found that spawning stock biomass has steadily declined since 1900 and suggested that there is little evidence that recruitment from 2001-2005 was as high as that for the strong 1999 and 2000 year classes. As a result, the assessment's biomass projections indicate a short-term increase, followed by a continued decline. With an estimate of current spawning biomass of 75,070 mt (compared to an unfished spawning biomass of 218,860 mt), the 2005 depletion is estimated to be 34.3 percent

The 2007 updated assessment (Schirripa 2008), using Stock Synthesis Model 2b, finds the overall status of the west coast sablefish stock to be improved relative to the 2005 assessment. The following sources of information were considered for use in the 2007 updated assessment: (1) commercial landings (1933-2006); (2) fishery-related biological data (1986-2006); (3) commercial fisher logbook data (1978-88); (4) pot survey data (1979-91); (5) shelf trawl survey data (1980-2004); (6) slope trawl survey data (1988-2006); (7) sea-surface height (1925-2006); and (8) independent research studies that addressed sablefish growth, maturity, mortality, and fishery-related discard.

With an estimate of current spawning biomass of 93,895 mt (compared to an unfished spawning biomass of 244,688 mt), the 2007 depletion is estimated to be 38.3 percent. This increase from 2005 can be attributed in part to the continued progression of the strong 1999 and 2000 year classes into the population, as well as into the spawning stock biomass. However, based on somewhat erratic levels of estimated recruitment from 2001-2006, the previously mentioned increasing trend should be viewed with caution. Furthermore, because of a series of poor recruitments in the mid- to late-1990's, if fished at the full OY level, depletion is forecasted to decrease for the next five years.

Evidence continues to suggest that larval survival is modulated in part by climate change as expressed by annual fluctuations in the California Current System. Forecasts of the possible future status of the stock beyond the year 2006 do not take into account any possible future trends in either climate change or conditions of the California Current System.

1.3 Healthy Groundfish Species

1.3.1 Arrowtooth Flounder

Distribution and Life History

Arrowtooth flounder (*Atheresthes stomias*) range from the southern coast of Kamchatka to the northwest Bering Sea and Aleutian Islands to San Simeon, California. Arrowtooth flounder is the dominant flounder species on the outer continental shelf from the western Gulf of Alaska to Oregon. They are members of the family Pleuronectidae, the right eyed flounders. Arrowtooth reach sizes of nearly 90 cm and can live to 27 years. Eggs and larvae are pelagic; juveniles and adults are demersal (Garrison and Miller 1982; NOAA 1990). Juveniles and adults are most commonly found on sand or sandy gravel substrates, but occasionally occur over low-relief rock-sponge bottoms. Arrowtooth flounder exhibit a strong migration from shallow water summer feeding grounds on the continental shelf to deep water spawning grounds over the continental slope (NOAA 1990). Depth distribution may vary from as little as 50 m in summer to more than 500 m in the winter (Garrison and Miller 1982; NOAA 1990; Rickey 1995).

Arrowtooth flounder are oviparous with external fertilization and eggs are about 2.5 mm in diameter. Spawning may occur deeper than 500 m off Washington (Rickey 1995). Arrowtooth are batch spawners (Rickey 1995). They spawn in the deeper continental shelf waters (>200 m) in the late fall through early spring and appear to move inshore during the summer (Zimmerman and Goddard 1996). The larvae spend approximately four weeks in the upper 100 m of the water column (Fargo and Starr 2001) and settle to the bottom in the late winter and early spring. Larvae eat copepods, their eggs, and copepod nauplii (Yang 1995; Yang and Livingston 1985). Juveniles and adults feed on crustaceans (mainly ocean pink shrimp and krill) and fish (mainly gadids, herring, and pollock) (Hart 1988; NOAA 1990).

Arrowtooth flounder exhibit two feeding peaks, at noon and midnight. Arrowtooth are piscivorous, but they also eat shrimp, worms, and euphausiids (Love 1996). Buckley *et al.* (1999) analyzed 380 arrowtooth stomachs that were collected in 1989 and 1992 from Oregon and Washington and found that hake (*Merluccius productus*) and unidentified gadids dominate their stomach contents (45 percent and 22 percent respectively) followed by herring (19 percent; *Clupea pallasi*), mesopelagics (0.5 percent), rex sole (1 percent; *Glyptocephalus zachirus*), slender sole (*Lyopsetta exilis*) and other small flatfish (3 percent), other arrowtooth (1.5 percent), other unidentified flatfish (1 percent), pandalid shrimp (~3 percent), and euphausiids (3 percent). Yang (1995) analyzed 1144 stomachs from arrowtooth collected in the Gulf of Alaska, and found that walleye pollock (*Theragra chalcogramma*) composed 66 percent of the arrowtooth diet, although arrowtooth smaller than 40 cm primarily feed on capelin (*Mallotus villosus*), herring, and shrimp. Gotshall (1969) examined 425 arrowtooth stomachs from northern California throughout the 1960s and found that pandalid shrimp made up nearly 40 percent of the prey by volume, along with other shrimps, crabs, euphausiids, sanddabs (*Citharichthys sordidus*), and slender sole. However, Gotshall's samples were taken directly from shrimp beds, so higher concentrations of shrimp would be expected. It is clear that arrowtooth have a broad diet, consuming most of the common fish and invertebrates found on soft bottom substrate and in the water column.

Predators of juvenile arrowtooth include skates, dogfish, shortspine thornyhead, halibut, coastal sharks, orcas, toothed whales, and harbor seals (Field, *et al.* 2006b). Adult arrowtooth are likely to be vulnerable only to the largest of these predators.

Female arrowtooth off Oregon reach 50 percent maturity at 8 years of age, and males at four years (Hosie 1976). Rickey (1995) found that the arrowtooth reach 50 percent maturity at lengths of 36.8 cm for females and 28 cm for males off Washington, and 44 cm for females and 29 cm for males off Oregon. As a comparison, female length at 50 percent maturity is 47 cm in the Gulf of Alaska (Turnock, *et al.* 2005) and 38 cm in British Columbia (Fargo and Starr 2001).

Stock Status and Management History

Arrowtooth are commonly caught by trawl fleets off Washington and Oregon, but they are frequently discarded due to low flesh quality. For this reason, the market for arrowtooth has been fairly limited over the last 50 years. It is likely that the stock off the U.S. west coast is linked to the population off British Columbia and, possibly, to the stock in the Gulf of Alaska. However, for assessment purposes it is assumed that the U.S. west coast population is a unit stock.

The west coast stock of arrowtooth flounder was assessed in 1993 (Rickey 1993), and a full stock assessment was done in 2007 (Kaplan and Hesler 2008) to inform the 2009–10 management specifications process. Using SS2 version 2.0g, the 2007 assessment model assumed a single mixed stock with one area. Three components of the arrowtooth fishery were used in modeling: the mink food fishery in the 1950s-70s; a targeted fillet/headed-and-gutted fishery that began around 1981; and a "bycatch fleet" that represents west coast trawl effort with arrowtooth bycatch, but no landings. Estimates of historical catch are highly uncertain. The model contains assumed fixed values for natural mortality and steepness of the stock-recruitment relationship. Likelihood profiles suggest that the estimates of biomass and depletion are not sensitive to values of steepness. Assumed values of natural mortality have a small effect on estimated depletion, but strongly influence the estimates of absolute biomass.

The base model shows a period of moderate depletion through the 1950s and 1960s, followed by a rebuilding of the stock beginning in the late 1970s. Recent strong year classes, in particular the 1999 year class, have led to an increase in the stock since the late 1990s. The spawning biomass at the beginning of 2007 is estimated to be 63,302 mt. This level represents 79 percent of the estimated unfished spawning biomass. Total biomass at the start of 2007 was estimated to be 85,175 mt. The 2007 stock assessment estimated that the arrowtooth stock has never fallen below the overfished threshold.

Landings of arrowtooth flounder are currently limited by market and bycatch, and 2006 catches are below the ABC of 5,800 mt and M of 5,245 mt. Catches exceeded MSY levels in just one year (1999) in the last decade.

Future research needs include: an additional study on length at maturity, since the values used are from 1993; more refined quantification of aging error and further comparative aging studies; additional historical research and modeling to reduce the uncertainty in the early catch and bycatch reconstructions; support ongoing efforts to standardize historical landings reconstructions for all west coast groundfish; for the bycatch fleet, a GLM analysis of observer data that would relate arrowtooth bycatch to latitude, depth, season, and landings of other species; and an assessment comparison to assessments from the Gulf of Alaska and British Columbia in order to identify different modeling assumptions and solve common problems. Collaboration with Canadian scientists is needed since arrowtooth are likely a trans-boundary stock.

1.3.2 Black Rockfish

Distribution and Life History

Black rockfish (*Sebastes melanops*) are found from Southern California (San Miguel Island) to the Aleutian Islands (Amchitka Island) and they occur most commonly from San Francisco northward (Hart 1988; Miller and Lea 1972; Phillips 1957; Stein and Hassler 1989). Black rockfish occur from the surface to greater than 366 m; however, they are most abundant at depths less than 54 m (Stein and Hassler 1989). Off California, black rockfish are found along with the blue, olive, kelp, black-and-yellow, and gopher rockfishes (Hallacher and Roberts 1985). The abundance of black rockfish in shallow water declines in the winter and increases in the summer (Stein and Hassler 1989). Densities of black rockfish decrease with depth during both the upwelling and non-upwelling seasons (Hallacher and Roberts 1985; PFMC 1996). Off Oregon, larger fish seem to be found in deeper water (20 m to 50 m) (Stein and Hassler 1989). Black rockfish off the northern Washington coast and outer Strait of Juan de Fuca exhibit no significant movement. However, fish appear to move from the central Washington coast southward to the Columbia River, but not into waters off Oregon. Movement displayed by black rockfish off the northern Oregon coast is primarily northward to the Columbia River (Culver 1986). Black rockfish form mixed sex, midwater schools, especially in shallow water (Hart 1988; Stein and Hassler 1989). Black rockfish larvae and young juveniles (<40 mm to 50 mm) are pelagic, but are benthic at larger sizes (Laroche and Richardson 1980).

Black rockfish have internal fertilization and annual spawning (Stein and Hassler 1989). Parturition occurs from February through April off British Columbia, January through March off Oregon, and January through May off California (Stein and Hassler 1989). Spawning areas are unknown, but spawning may occur in offshore waters because gravid (egg-carrying) females have been caught well offshore (Dunn and Hitz 1969; Hart 1988; Stein and Hassler 1989). Black rockfish can live to be more than 20 years in age. The maximum length attained by the black rockfish is 60 cm (Hart 1988; Stein and Hassler 1989). Off Oregon, black rockfish primarily prey on pelagic nekton (anchovies and smelt) and zooplankton such as salps, mysids, and crab megalops. Off Central California, juveniles eat copepods and zoea, while adults prey on juvenile rockfish, euphausiids, and amphipods during upwelling periods. During periods without upwelling they primarily consume invertebrates. Black rockfish feed almost exclusively in the water column (Culver 1986). Black rockfish are known to be eaten by lingcod and yelloweye rockfish (Stein and Hassler 1989).

Stock Status and Management History

Two populations of black rockfish have been assessed over time on the west coast. The northern population has traditionally been assessed for the portion of the stock occurring between Cape Falcon, Oregon and U.S.-Canada border. The southern population has been assessed for the portion of the stock occurring off California and Oregon. The GMT has used historical catch data and other information sources from the area between Cape Falcon and the Oregon-Washington border at the Columbia River to determine the appropriate adjustment to OYs that have been specified north and south of the Columbia River since the first southern black rockfish assessment was done in 2003. Separate assessments stratified north and south in this way do not imply that genetically distinct stocks exist north and south of Cape Falcon or the Columbia River.

Northern Black Rockfish

The black rockfish stock found between Cape Falcon, Oregon and the U.S. Canadian border was first assessed in 1994 (Wallace and Tagart 1994). Estimated biomass was 60 percent of the unfished level and female egg production was estimated to be 43 percent of the unfished level. A harvest guideline of 517 mt for this area was specified beginning in 1995 based on assessment results. Catches remained well below the harvest guideline in the years subsequent to the assessment.

The status of the northern black rockfish stock north of Cape Falcon, Oregon was again determined in 1999 (Wallace, *et al.* 1999). The population was assessed using an AD model configuration where tag recovery was modeled explicitly. The population was regarded as healthy and stock abundance was estimated to be slightly increasing after a period of low abundance in the late 1980s and early 1990s. The recommended allowable annual yield was 577 mt based on an F_{45} percent exploitation strategy and a tag recovery rate of 50 percent. The estimated stock biomass ranged between 9,500-10,100 mt, depending on assumptions on tag reporting rates.

The most recent assessment of the northern stock was done in 2007 using the SS2, version 2.00c assessment program (Wallace, *et al.* 2008). The base model for the 2007 assessment assumes a female natural mortality rate to be age-specific for females using age at first and full maturity for inflections (10 and 15). A constant natural mortality rate of 0.16 was assumed for males and young females (< 10 years of age), and a rate of 0.2 was assumed for old females (>=15 years of age). This is higher than that used in the 2003 black rockfish assessment off Oregon and California (Ralston and Dick 2003) which used a natural mortality of 0.1 and 0.2 for males and old females, respectively. Model sensitivity analysis showed that model configurations using higher natural mortality for older females provided better overall fits to the data. In the model, spawning biomass and age 3+ biomass reached the lowest levels in 1995, following poor recruitment and intense fishing in the late 1980s. The best fit model estimates current spawning biomass as being 1,239 mt and unexploited spawning biomass at 2,321 mt, resulting in a current stock level that is 53.4 percent of the unfished. The population trajectory remained just above minimum stock size threshold, and the model indicated that the stock is currently well above the management target of $B_{40\%}$.

Recent increases in biomass are the result of two prominent year classes in 1994 and in 1999. Exploitation of black rockfish reached a peak in 1988 of 13 percent of the Age 3+ biomass and remained near that level for 7 years, dropping precipitously between 1995 and 2000. In recent years exploitation has been relatively low (4-6 percent). Exploitation rate relative to spawning biomass indicate that harvest rates exceeded management targets between the mid 1980s through the mid 1990s for the northern stock of black rockfish.

Research and data needs include information on habitat distribution within the stock boundary to objectively evaluate a prior on q for the tagging, and the nearshore assessment should be completed using side-scan, backscatter and multi beam methods so that new information can be integrated. Black rockfish is highly resident to specific reefs and are therefore susceptible to localized depletion especially during times of population decline. Because of this, relatively higher levels of abundance may be needed to meet recreational fishery objectives. For example, the recreational fishery industries need to maintain a sufficient success rate to be economically feasible.

Southern Black Rockfish

A black rockfish assessment was completed in 2003 and pertains to the portion of the coastwide stock occurring off the coasts of Oregon and California (Ralston and Dick 2003) or the southern stock unit. Alternative harvest levels in the 2003 assessment were ranged to capture the major uncertainty of historical landings prior to 1978. Black rockfish catches prior to 1945 were assumed to be zero in the assessment. Many gaps in historical landings of black rockfish since 1945 were evident, and these landings were reconstructed using a variety of data sources. The base model assumed cumulative landings of black rockfish from all fisheries was 17,100 mt from 1945 to 1977.

In 2003, the southern California-Oregon stock of black rockfish was concluded to be in healthy condition; its 2002 spawning output, estimated to be at 49 percent of its unexploited level, meant that the stock was well above the management target level of $B_{40\%}$.

The southern stock of black rockfish was again assessed in 2007 with the SS2, version 2.00g (Sampson 2008). The 2007 assessment used a similar approach and structure as the 2003 assessment. The 2007 assessment is structured into six fisheries: a set of trawl (TWL), commercial non-trawl (HKL), and recreational (REC) fisheries for Oregon and a similar set for California. The fisheries for each state are based on fish capture location rather than place of landings and therefore represent separate geographic areas. The model in the 2007 assessment, however, does not include any underlying spatial structure in the population dynamics. Like the previous southern stock assessment, abundance indices for tuning the assessment are based on recreational CPUE data with two independent indices available for each state. The standard research trawl surveys along the U.S. west coast do not operate in shallow enough water to catch appreciable numbers of black rockfish and therefore do not provide any fishery independent index of stock biomass for black rockfish. The 2007 assessment had two additional abundance indices that were not available for the previous assessment: a black rockfish pre-recruit index for 2001-2006 and estimates from a tag-recapture study of exploitable black rockfish abundance off Newport, Oregon for 2003-2005.

The 2007 assessment for the southern stock of black rockfish used the same sex- and age-specific formulation for natural mortality (M) that was used in the assessment for northern black rockfish, but there is little evidence to confirm that the assumed formulation is correct. The 2003 assessment for southern black rockfish used much smaller values for M that were more consistent with observed values for the maximum age of southern black rockfish. The 2007 assessment used a fixed value (0.6) for the steepness parameter, which controls the curvature in the relationship between spawning biomass (output of larvae) and the resulting recruitment, and which thus governs how rapidly the stock responds to fishery removals or other perturbations. Although the steepness value assumed for the 2007 assessment is consistent with values estimated for other rockfish stocks, steepness for this stock could not be directly estimated from the available data. The 2007 assessment estimates of current stock status are largely driven by above-average recruitment throughout the 1990s, including two very strong year-classes. Over most of the stock's history the fishing rate has been smaller than the $F_{50\%}$ target fishing rate. The estimated spawning output has been above the target level during all years except 1991 to 1998, and has never dropped below the overfished level. The southern stock of black rockfish is estimated to be well above the overfished level.

1.3.3 California Scorpionfish

Distribution and Life History

California scorpionfish (*Scorpaena guttata*), also known locally as sculpin, is a generally benthic species found from central California to the Gulf of California in depths between the inter-tidal and about 170 m (Eschmeyer, *et al.* 1983; Love, *et al.* 1987). It generally inhabits rocky reefs, but in certain areas and seasons it aggregates over sandy or muddy substrate (Frey 1971; Love, *et al.* 1987). Catch rate analysis and tagging studies show that most, but not all, California scorpionfish migrate to deeper water to spawn during May-September (Love, *et al.* 1987). Tagging data suggest that they return to the same spawning site (Love, *et al.* 1987), but information is not available on non-spawning season site fidelity. California scorpionfish are quite mobile and may not be permanently tied to a particular reef (Love, *et al.* 1987).

California scorpionfish spawn from May through August, peaking in July (Love, *et al.* 1987). The species is oviparous, producing floating, gelatinous egg masses in which the eggs are embedded in a single layer (Orton 1955). California scorpionfish utilize the "explosive breeding assemblage" reproductive mode in which fish migrate to, and aggregate at traditional spawning sites for brief periods (Love, *et al.* 1987). These spawning aggregations have been targeted by fishermen. Few California scorpionfish are mature at one year of age, but over 50 percent are mature by age two and most are mature by age three (Love, *et al.* 1987).

The species feeds on a wide variety of foods, including crabs, fishes, octopi, isopods and shrimp, but juvenile *Cancer* crabs are the most important prey (Limbaugh 1955; Love, *et al.* 1987).

Stock Status and Management History

Before the 2005 assessment (Maunder, *et al.* 2006), no assessment had been carried out for California scorpionfish. Given that in most years, 99 percent or more of the landings occur in the southern California ports, only the stock off of southern California is assessed. Although a substantial, but unknown, proportion of the stock is in Mexican waters, this assessment truncates the stock to the south at the international border. Data used in the model (SS2 version 1.18) included commercial and recreational landings, a fishery dependent CPUE statistic determined from analysis of CPFV logbook trip data from 1980-1999, a fishery independent index of abundance determined from trawl surveys carried out by the sanitation districts, and length-frequency data from the hook and line and trawl commercial fisheries, the recreational fishery, and the sanitation district trawl surveys. Based on the life history characteristics of the species (e.g. using "explosive" breeding assemblages), and limited information on related species, a steepness value of 0.7 was assumed for the assessment. The assessment noted that there is a large amount of variation in recruitment levels and recent recruitments are estimated to be substantially higher than average. Predictions of future biomass will be dependent on what recruitment level is assumed in the future. The estimate of the 2004 stock status was sensitive to the inclusion of the sanitation index in the stock assessment; removing the sanitation index reduced the current biomass level. The STAR Panel and STAT Team gave relative probabilities to models including and excluding the sanitation index of 74 percent and 26 percent, respectively. Including the sanitation index, the assessment estimated the 2005 biomass to be at 80 percent of its unfished level.

1.3.4 Chilipepper Rockfish

Distribution and Life History

Chilipepper rockfish (*Sebastes goodei*) are found from Magdalena Bay, Baja California, Mexico, to as far north as the northwest coast of Vancouver Island, British Columbia (Allen 1982; Hart 1988; Miller and Lea 1972). The region of greatest abundance is found between Point Conception and Cape Mendocino, California. Chilipepper have been taken as deep as 425 m, but nearly all in survey catches were taken between 50 and 350 m (Allen and Smith 1988). Adults and older juveniles usually occur over the shelf and slope; larvae and small juveniles are generally found near the surface. In California, chilipepper are most commonly found associated with deep, high relief rocky areas and along cliff drop-offs (Love, *et al.* 1990), as well as on sand and mud bottoms (MBC 1987). They are occasionally found over flat, hard substrates (Love, *et al.* 1990). Love (1991) does not consider this to be a migratory species. Chilipepper may travel as far as 45 m off the bottom during the day to feed (Love 1991). Chilipepper rockfish are described as an elongate fish with reduced head spines similar in appearance to both shortbelly rockfish (at smaller sizes, although shortbelly tend to be slimmer) and bocaccio rockfish (bocaccio tend to have larger mouths).

Chilipeppers are ovoviviparous and eggs are fertilized internally (Reilly, *et al.* 1992). Chilipepper school by sex just prior to spawning (MBC 1987). In California, fertilization of eggs begins in October and spawning occurs from September to April (Oda 1992) with the peak occurring during December to January (Love, *et al.* 1990). Chilipepper may spawn multiple broods in a single season (Love, *et al.* 1990). Females of the species are significantly larger, reaching lengths of up to 56 cm (Hart 1988). Males are usually smaller than 40 cm (Dark and Wilkins 1994). Males mature at two years to six years of age, and 50 percent are mature at three years to four years. Females mature at two years to five years with 50 percent mature at three years to four years (MBC 1987). Females may attain an age of about 27 years, whereas the maximum age for males is about 12 years (MBC 1987).

Larval and juvenile chilipepper eat all life stages of copepods and euphausiids, and are considered to be somewhat opportunistic feeders (Reilly, *et al.* 1992). In California, adults prey on large euphausiids, squid, and small fishes such as anchovies, lanternfish, and young Pacific whiting (Hart 1988; Love, *et al.* 1990). Chilipepper are found with widow rockfish, greenspotted rockfish, and swordspine rockfish (Love, *et al.* 1990). Juvenile chilipepper compete for food with bocaccio, yellowtail rockfish, and shortbelly rockfish (Reilly, *et al.* 1992). Pelagic juveniles are preyed upon by a wide range of predators, including seabirds, salmon, lingcod and marine mammals. Larger piscivorous fishes, marine mammals, and in recent years jumbo squid are among the predators of larger adults.

Stock Status and Management History

Chilipepper have been one of the most important commercial target species in California waters since the 1880s and were historically an important recreational target in Southern California waters. With the exception of excluding foreign fishing effort from the U.S. EEZ in the late 1970s, management actions were modest (and usually general to all rockfish and other groundfish) prior to the implementation of the Groundfish FMP in 1982. When the Groundfish FMP was implemented, management for the groundfish trawl fishery was based on individual vessel trip limits, which were set at 40,000 lbs per trip on the *Sebastes* (all rockfish species) complex. These limits were maintained until 1991, when they were reduced to 25,000; in 1993 the trip limit system was revised from daily to biweekly trip limits, which were set at 50,000 lbs (south of Cape Mendocino). The trip limit regime continued to evolve in their absolute amounts and temporal duration (monthly, bimonthly) throughout the 1990s, with a general trend towards lower limits as conservation concerns arose for other rockfish species (particularly bocaccio rockfish in the region south of Mendocino).

Throughout most of the past three decades, domestic landings have ranged between approximately 2000 and 3000 tons, however since 2002 landings have averaged less than 100 tons per year. The highest exploitation rates occurred from the late 1980s through the mid 1990s, when they were above target levels and the stock was approaching its lowest estimated historical levels. From the late 1990s through the present, exploitation rates have been declining significantly down to incidental levels, as a result of management measures implemented to rebuild co-occurring depleted rockfish species (particularly bocaccio, but including canary, widow, cowcod and yelloweye). Discards are assumed to be negligible in the historical period; however regulatory discards have been substantial in recent years, more than doubling the total catch relative to landings since 2002.

Chilipepper rockfish were assessed in 1998 (Ralston, *et al.* 1998), at which time the stock was estimated to be at 46 percent to 61 percent of unfished biomass. Chilipepper rockfish underwent a full assessment in 2007 for the 2008–09 stock assessment cycle (Field 2008) using an age and size structured statistical model, SS2 version 2.00c, the modeling framework used for most west coast groundfish assessments. The 2007 assessment estimates that the spawning biomass of chilipepper rockfish has increased substantially in recent years, due to a strong 1999 year class as well as greatly reduced harvest rates in commercial and recreational fisheries. The 2007 assessment's base model result suggests a spawning biomass of 23,889 tons in 2006, corresponding to approximately 70 percent of the unfished spawning biomass of 33,390 tons and representing a near tripling of spawning biomass from the estimated low of 8696 tons (26 percent of unfished) in 1999. The strong 1999 year class represents the largest estimated historical recruitment, and is the primary cause for the current population trajectory. There are no obvious signs of strong year classes since 1999, and coastwide pelagic juvenile surveys suggest average to low recruitment in recent years, suggesting that the stock may dip slightly in the near term.

Future research needs include: additional investigations into the catch history as a part of a greater reconstruction of historical rockfish landings for all species; greater exploration of methods for modeling time-varying growth influenced by environmental factors with data from historical (triennial trawl) and recent (NWC combined) surveys; evaluation of effects of spatial management measures on patterns of vulnerability and selectivity over time with information derived from generic simulation studies of the consequences of spatially explicit management measures to the basic assumptions of stock assessment models. Regional management concerns include the lack of data to consider spatial structure in the model, limited fisheries dependent information, and only a very short (four years) time series of fishery independent information (with low sampling density). However, as abundance appears to drop sharply towards the U.S./Mexico border, trans-boundary issues are minimal for this stock.

1.3.5 Dover Sole

Distribution and Life History

Dover sole (*Microstomus pacificus*) are distributed from the Navarin Canyon in the northwest Bering Sea and westernmost Aleutian Islands to San Cristobal Bay, Baja California, Mexico (Hagerman 1952; Hart 1988; NOAA 1990). Dover sole are a dominant flatfish on the continental shelf and slope from Washington to Southern California. Adults are demersal and are found from 9 m to 1,450 m, with highest abundance below 200 m to 300 m (Allen and Smith 1988). Adults and juveniles show a high affinity toward soft bottoms of fine sand and mud. Juveniles are often found in deep nearshore waters. Dover sole are considered to be a migratory species. In the summer and fall, mature adults and juveniles can be found in shallow feeding grounds, as shallow as 55 m off British Columbia (Westrheim and Morgan 1963). By late fall, Dover sole begin moving offshore into deep waters (400 m or more) to spawn. Although there is an inshore-offshore seasonal migration, little north-south coastal migration occurs (Westrheim and Morgan 1963).

Spawning occurs from November through April off Oregon and California (Hart 1988; NOAA 1990; Pearcy, *et al.* 1977) in waters 80 m to 550 m depth at or near the bottom (Hagerman 1952; Hart 1988; Pearcy, *et al.* 1977). Dover sole are oviparous and fertilization is external. Larvae are planktonic and are transported to offshore nursery areas by ocean currents and winds for up to two years. Settlement to benthic living occurs mid-autumn to early spring off Oregon, and February through July off California (Markle, *et al.* 1992). Juvenile fish move into deeper water with age and begin seasonal spawning and feeding migrations upon reaching maturity.

Dover sole larvae eat copepods, eggs, and nauplii, as well as other plankton. Juveniles and adults eat polychaetes, bivalves, brittlestars, and small benthic crustaceans. Dover sole feed diurnally by sight and smell (Dark and Wilkins 1994; Gabriel and Pearcy 1981; Hart 1988; NOAA 1990). Dover sole larvae are eaten by pelagic fishes like albacore, jack mackerel and tuna, as well as sea birds. Juveniles and adults are preyed upon by sharks, demersally feeding marine mammals, and to some extent by sablefish (NOAA 1990). Dover sole compete with various eelpout species, rex sole, English sole, and other fishes of the mixed species flatfish assemblage (NOAA 1990).

Stock Status and Management History

Dover sole have been the target of trawl operations along the west coast of North America since World War II and were almost certainly caught prior to the war as incidental take in directed fisheries for English sole and petrale sole. Almost all of the harvests have been taken by groundfish trawl, and in particular as part of the Dover sole, shortspine thornyhead, longspine thornyhead, and sablefish (DTS) trawl fishery. Annual landings from U.S. waters averaged 6,700 mt during the 1960s, 12,800 mt during the 1970s, 18,400 mt during the 1980s, 12,400 mt during the 1990s, and 7,200 mt since 2000. Discarding of small, unmarketable fish is an important, but poorly documented feature of the fishery.

The 1997 Dover sole stock assessment (Brodziak, *et al.* 1997) treated the entire population from the Monterey area through the U.S./Vancouver area as a single stock based on research addressing the genetic structure of the population. Under a range of harvest policies and recruitment scenarios, the 1997 model projected that spawning biomass would increase from the estimated year-end level in 1997 through the year 2000 due to growth of the exceptionally large 1991 year class and to the lower catches observed in the fishery since 1991. Dover sole were next assessed in 2001, resulting in an estimated spawning stock size of 29 percent of the unexploited biomass (Sampson and Wood 2001). Although there was no clear trend in abundance, stocks steadily declined from the 1950s until the mid-1990s. The 1991 year class was the last strong one, consistent with the 1997 assessment. The 2001 assessment authors projected five years of Dover sole harvest levels based on preferred, optimistic, and pessimistic projections of recruitment. These options varied the harvest rate from $F_{40\%}$ (the current F_{MSY} proxy) to $F_{50\%}$. The Council adopted an ABC of 8,510 mt and an OY of 7,440 mt in 2005 and 2006, which was calculated using the current F_{MSY} proxy and the 40-10 adjustment.

A new Dover sole assessment was done in 2005 (Sampson 2006) which indicated the stock was above target levels and had an increasing abundance trend. The final base model estimated the unexploited spawning stock biomass to be slightly less than 300,000 mt and spawning biomass at the start of 2005 was estimated to be about 189,000 mt, equivalent to 63 percent of the unexploited level. Spawning biomass and age 5+ biomass (roughly corresponding to the exploitable biomass) were estimated to have reached their lowest points in the mid-1990s and have been rising steadily since. The estimated increases in biomass since the mid-1990s are due primarily to strong year classes in 1990 and 1991, and exceptionally strong year classes in 1997 and 2000.

1.3.6 English Sole

Distribution and Life History

English sole (*Parophrys vetulus*) are found from Nunivak Island in the southeast Bering Sea and Agattu Island in the Aleutian Islands, to San Cristobal Bay, Baja California Sur, Mexico (Allen and Smith 1988). In research survey data, nearly all occurred at depths greater than 250 m (Allen and Smith 1988). Adults and juveniles prefer soft bottoms composed of fine sands and mud (Ketchen 1956), but also occur in eelgrass habitats (Pearson and Owen 1992). English sole use nearshore coastal and estuarine waters as nursery areas (Krygier and Pearcy 1986; Rogers, *et al.* 1988). Adults make limited migrations. Those off Washington show a northward post-spawning migration in the spring on their way to summer feeding grounds and a southerly movement in the fall (Garrison and Miller 1982). Tagging studies have identified separate stocks based on this species' limited movements and meristic characteristics (Jow 1969).

Spawning occurs over soft-bottom mud substrates (Ketchen 1956) from winter to early spring, depending on the stock. Eggs are neritic and buoyant, but sink just before hatching (Hart 1988); juveniles and adults are demersal (Garrison and Miller 1982). Small juveniles settle in the estuarine and shallow nearshore areas all along the coast, but are less common in southerly areas, particularly south of Point Conception. Large juveniles commonly occur up to depths of 150 m. Although many postlarvae may settle outside of estuaries, most will enter estuaries during some part of their first year of life (Gunderson, *et al.* 1990). Some females mature as three-year-olds (26 cm), but all females over 35 cm long are mature. Males mature at two years (21 cm).

Larvae are planktivorous. Juveniles and adults are carnivorous, eating copepods, amphipods, cumaceans, mysids, polychaetes, small bivalves, clam siphons, and other benthic invertebrates (Allen 1982; Becker 1984; Hogue and Carey 1982; Simenstad, *et al.* 1979). English sole feed primarily by day, using sight and smell, and sometimes dig for prey (Allen 1982; Hulberg and Oliver 1979). A juvenile English sole's main predators are probably piscivorous birds such as great blue heron (*Ardia herodias*), larger fishes, and marine mammals. Adults may be eaten by marine mammals, sharks, and other large fishes.

Stock Status and Management History

English sole have been captured by the bottom trawl fishery operating off the western coast of North America for over a century. Stewart (2006) found that peak catches from the southern area occurred in the 1920s with a maximum of 3,976 mt of English sole landed in 1929, and peak catches from the northern area occurred in the 1940s to the 1960s with a maximum of 4,008 mt landed in 1948. Landings from both areas have generally declined since the mid 1960s and have been at nearly historical lows in recent years

The most recent stock assessment of English sole prior the current 2005 assessment was performed in 1993 (Sampson and Stewart 1993), using an earlier version of the Stock Synthesis program (Methot 1989). That assessment considered the female portion of the stock off Oregon and Washington during the years 1977-1993. The English sole spawning biomass was found to be increasing and it was concluded that the fishery was sustainable at (then) contemporary harvest levels.

The 2005 assessment of English sole (Stewart 2006) modeled a single coastwide stock, although both commercial and fishery independent data sources were treated separately for a southern (INPFC Conception and Monterey) and a northern (INPFC Eureka, Columbia and U.S. Vancouver) area. The assessment found that English sole spawning biomass has increased rapidly over the last decade after a period of poor recruitments from the mid 1970s to the mid 1990s, which left the stock at nearly historically low levels. Strong year classes were estimated for 1995, 1996, and 1999. The data indicate that the 1999 year class may be the largest in the time-series, and the 2007 updated assessment confirmed the magnitude because a large quantity of age data through 2006 became available. There is substantial uncertainty related to certain parameters in the assessment, specifically biomass, recruitment, and relative depletion, as indicated by the wide confidence intervals for those parameters. Nevertheless, sensitivity analyses indicated that the conclusion that current spawning biomass exceeds the target level ($B_{40\%}$) was robust to all three of these sources of uncertainty. The spawning biomass at the beginning of 2005 was estimated to be 31,379 mt, which corresponds to 91.5 percent of the unexploited equilibrium level. Total catches for 2004 were estimated to be 1,341 mt, of which 950 mt were landed.

The 2007 updated assessment (Stewart 2008b) modeled a single coastwide stock using the newest SS2 (2.00e) modeling framework. Lack of data prevents the modeling the northern and southern areas separately, specifically length frequency of discards, maturity, and age data (mainly in the south). Without these data and spatially complex models, speculation on the appropriateness of regional management is difficult. The 2007 assessment updated landings from 1981 to 2006 to reflect the best available estimates as of May 2007. The 2007 assessment also included data on fishery length and age (primarily from Washington) that was previously unavailable. These new data provide substantially improved information regarding recent year class strengths and current stock status. The 2007 assessment used the same approach to address uncertainty as the 2005 assessment. The spawning biomass at the beginning of 2007 was estimated to be 41,906 mt, which corresponds to 116 percent of the unexploited equilibrium level. Current (2006) total catches were estimated to be 1,078 mt, of which 886 mt were landed. Recent English sole landings and estimated discards have been below both the coast wide ABC of 3,100 mt and the estimated MSY harvest level of 4,080 mt.

1.3.7 Lingcod

Distribution and Life History

Lingcod (*Ophiodon elongatus*), a top order predator of the family Hexagrammidae, ranges from Baja California, Mexico, to Kodiak Island in the Gulf of Alaska. Lingcod are demersal at all life stages (Allen and Smith 1988; NOAA 1990; Shaw and Hassler 1989). Adult lingcod prefer two main habitat types: slopes of submerged banks 10 m to 70 m below the surface with seaweed, kelp, and eelgrass beds and channels with swift currents that flow around rocky reefs (Emmett, *et al.* 1991; Giorgi and Congleton 1984; NOAA 1990; Shaw and Hassler 1989). Juveniles prefer sandy substrates in estuaries and shallow subtidal zones (Emmett, *et al.* 1991; Forrester and Thomson 1969; Hart 1988; NOAA 1990). As the juveniles grow they move to deeper waters. Adult lingcod are considered a relatively sedentary species, but there are reports of migrations of greater than 100 km by sexually immature fish (Jagielo 1990; Mathews and LaRiviere 1987; Matthews 1992; Smith, *et al.* 1990).

Mature females live in deeper water than males and move from deep water to shallow water in the winter to spawn (Forrester 1969; Hart 1988; Jagielo 1990; LaRiviere, *et al.* 1980; Mathews and LaRiviere 1987; Matthews 1992; Smith, *et al.* 1990). Mature males may live their whole lives associated with a single rock reef, possibly out of fidelity to a prime spawning or feeding area (Allen and Smith 1988; Shaw and Hassler 1989). Spawning generally occurs over rocky reefs in areas of swift current (Adams 1986; Adams and Hardwick 1992; Giorgi and Congleton 1984; LaRiviere, *et al.* 1980). After the females leave the spawning grounds, the males remain in nearshore areas to guard the nests until the eggs hatch. Hatching occurs in April off Washington, but as early as January and as late as June at the geographic extremes of the lingcod range. Males begin maturing at about two years (50 cm), whereas females mature at three plus years (76 cm). In the northern extent of their range, fish mature at an older age and larger size (Emmett, *et al.* 1991; Hart 1988; Mathews and LaRiviere 1987; Miller and Geibel 1973; Shaw and Hassler 1989). The maximum age for lingcod is about 20 years (Adams and Hardwick 1992).

Lingcod are a visual predator, feeding primarily by day. Larvae are zooplanktivores (NOAA 1990). Small demersal juveniles prey upon copepods, shrimps, and other small crustaceans. Larger juveniles shift to clupeids and other small fishes (Emmett, *et al.* 1991; NOAA 1990). Adults feed primarily on demersal fishes (including smaller lingcod), squids, octopi, and crabs (Hart 1988; Miller and Geibel 1973; Shaw and Hassler 1989). Lingcod eggs are eaten by gastropods, crabs, echinoderms, spiny dogfish, and cabezon. Juveniles and adults are eaten by marine mammals, sharks, and larger lingcod (Miller and Geibel 1973; NOAA 1990).

Stock Status and Management History

Lingcod have been a target of commercial fisheries since the early 1900's in California, and since the late 1930s in Oregon and Washington waters. Recreational fishermen have targeted lingcod since the 1920s in California. A smaller recreational fishery has taken place in Washington and Oregon since at least the 1970s. Although historically the catches of lingcod have been greater in the commercial sector than in the recreational sector, this pattern has been reversed since the late 1990s.

In 1997, U.S. scientists assessed the size and condition of the portion of the stock in the Columbia and Vancouver areas (including the Canadian portion of the Vancouver management area), and concluded the stock had fallen to below ten percent of its unfished size (Jagielo, *et al.* 1997). The Council responded by imposing substantial harvest reductions coastwide, reducing the harvest targets for the Eureka, Monterey, and Conception areas by the same percentage as in the north. In 1999, scientists assessed the southern portion of the stock and concluded the condition of the southern stock was similar to the northern stock, thus confirming the Council had taken appropriate action to reduce harvest coastwide (Adams, *et al.* 1999). Based on these assessments, the lingcod stock was declared depleted in 1999.

Jagielo et al. (2000) conducted a coastwide lingcod assessment and determined the total biomass increased from 6,500 mt in the mid-1990s to about 8,900 mt in 2000. In the south, the population had also increased slightly from 5,600 mt in 1998 to 6,200 mt in 2000. In addition, the assessment concluded previous aging methods portrayed an older population; whereas new aging efforts showed the stock to be younger and more productive. Therefore, the ABC and OY were increased in 2001 on the basis of the new assessment. A revised rebuilding analysis of coastwide lingcod (Jagielo and Hastie 2001) was adopted by the Council in September 2001. It confirmed the major conclusions of the 2000 assessment and rebuilding analysis, but slightly modified recruitment projections to stay on the rebuilding trajectory to reach target biomass in 2009. This modification resulted in a slight decrease in the 2002 ABC and OY.

A coastwide assessment for lingcod was completed in 2003 (Jagielo, *et al.* 2004) and approved by the Council in March 2004 for use in setting harvest specifications for the 2005–06 biennium. This assessment updated the previous coastwide lingcod assessment (Jagielo, *et al.* 2000). As in the previous assessment, separate age-structured assessment models were constructed for northern areas (Columbia and U.S.-Vancouver areas) and southern areas (Conception, Monterey, and Eureka areas). Results from these two models were combined to obtain coastwide estimates of spawning biomass, the depletion level, and other relevant assessment outputs. This assessment indicated that the lingcod stock had achieved the rebuilding objective of $B_{40\%}$ in the north (actually 28 percent above $B_{40\%}$), but was at $B_{31\%}$ in the south. However, the adopted lingcod rebuilding plan specified a coastwide rebuilding objective. The Council's SSC, working in concert with the lead assessment author, recalculated the coastwide lingcod stock status in March 2004 using actual 2003 harvests (the assessment, which was completed during 2003, assumed harvest would be equal to the specified OY in 2003). Their calculations indicated that the spawning biomass at the start of 2004 was within 99.3 percent of B_{MSY} (or $B_{40\%}$) on a coastwide basis. Therefore, the Council could not recommend to NMFS that the stock should be declared rebuilt. The lingcod rebuilding plan was adopted by the Council and incorporated into the Groundfish FMP under Amendment 16-2. The rebuilding plan had established a target rebuilding year of 2009 and the harvest control rule of F = 0.0531 for fisheries in the northern areas and F = 0.0610 for fisheries in the southern areas (with a PMAX of 60 percent). However the 2003 assessment (Jagielo, *et al.* 2004) was then used to recalculate the harvest control rule .to be F = 0.17 for fisheries in the northern areas and F = 0.15 for fisheries in the southern areas.

The 2005 assessment (Jagielo and Wallace 2006) used the SS2 program and, as in previous lingcod assessments, constructed separate models of the stock for northern and southern areas. With respect to uncertainty within the assessment, the authors pointed in particular to the estimation of assessment parameters for the southern (LCS) model due to the sparseness of data (in particular, the short time series of fishery age data and small sample sizes). On a coastwide basis, the lingcod population was concluded to be fully rebuilt, given that the spawning biomass in 2005 was estimated to be 64 percent of its unfished level (B_{2005}=34,017 mt; B_0= 52,850 mt). Within the separate area models, current biomass is closer to unfished biomass in the north (87 percent of B_0) than in the south (24 percent of B_0). Given that the lingcod stock is managed on a coastwide basis, the Council announced the lingcod stock to be fully rebuilt in 2005, which is four years earlier than the target rebuilding year established in the rebuilding plan.

1.3.8 Longspine Thornyhead

Distribution and Life History

Longspine thornyhead (*Sebastolobus altivelis*) are found from the southern tip of Baja California, Mexico, to the Aleutian Islands (Eschmeyer, *et al.* 1983; Jacobson and Vetter 1996; Love 1991; Miller and Lea 1972; Smith and Brown 1983), but are abundant from Southern California northward (Love 1991). Juvenile and adult longspine thornyhead are demersal and occupy the benthic surface (Smith and Brown 1983). Off Oregon and California, longspine thornyhead mainly occur at depths of 400 m to 1,400 plus m, most between 600 m and 1,000 m in the oxygen minimum zone (Jacobson and Vetter 1996). Thornyhead larvae (*Sebastolobus* spp.) have been taken in research surveys up to 560 km off the California coast (Cross 1987; Moser, *et al.* 1993). Juveniles settle on the continental slope at about 600 m to 1,200 m (Jacobson and Vetter 1996). Longspine thornyhead live on soft bottoms, preferably sand or mud (Eschmeyer, *et al.* 1983; Jacobson and Vetter 1996; Love 1991). Longspine thornyheads neither school nor aggregate (Jacobson and Vetter 1996).

Spawning occurs in February and March at 600 m to 1,000 m (Jacobson and Vetter 1996; Wakefield and Smith 1990). Longspine thornyhead are oviparous and are multiple spawners, spawning two to four batches per season (Love 1991; Wakefield and Smith 1990). Eggs rise to the surface to develop and hatch. Floating egg masses can be seen at the surface in March, April, and May (Wakefield and Smith 1990). Juveniles (<5.1 cm long) occur in midwater (Eschmeyer, *et al.* 1983). After settling, longspine thornyhead are completely benthic (Jacobson and Vetter 1996). Longspine thornyhead can grow to 38 cm (Eschmeyer, *et al.* 1983; Jacobson and Vetter 1996; Miller and Lea 1972) and live more than 40 years (Jacobson and Vetter 1996). Longspine thornyhead reach the onset of sexual maturity at 17 cm to 19 cm total length (ten percent of females mature) and 90 percent are mature by 25 cm to 27 cm (Jacobson and Vetter 1996).

Longspine thornyhead are ambush predators (Jacobson and Vetter 1996). They consume fish fragments, crustaceans, bivalves, and polychaetes and occupy a tertiary consumer level in the food web. Pelagic juveniles prey largely on herbivorous euphausiids and occupy a secondary consumer level in the food web (Love 1991; Smith and Brown 1983). Cannibalism in newly settled longspine thornyhead may occur, because juveniles settle directly onto adult habitat (Jacobson and Vetter 1996). Sablefish commonly prey on longspine thornyhead. Sablefish and shortspine thornyhead commonly prey on longspine thornyhead (Buckley, *et al.* 1999).

Stock Status and Management History

Longspine thornyhead are exploited in the limited entry deep-water trawl fishery operating on the continental slope that also targets shortspine thornyhead, Dover sole and sablefish (called the DTS fishery). A very small proportion of longspine landings is due to non-trawl gears (gillnet, hook and line). Longspine and shortspine thornyhead make up a single market category, however they have been managed under separate harvest specifications since 1992. The thornyhead fishery developed in Northern California during the 1960s. The fishery then expanded north and south, and the majority of the landings of longspine thornyhead have since been in the Monterey, Eureka, and Columbia INPFC areas, with some increase in landings from the Conception (southern CA) and Vancouver (northern WA) INPFC areas in recent years (Fay 2006).

Longspine thornyhead were assessed for the fourth time in 2005 (Fay 2006); the previous assessment was conducted in 1997 (Rogers, *et al.* 1997). The model assumed one coastwide stock with one coastwide trawl fishery. Data sources included commercial landings and length composition, three sources of discard rates, and biomass indices and length composition information from the AFSC and Northwest Fisheries Science Center slope surveys. Results from the base model suggested that the length compositions from the slope surveys were influencing recruitment in the model, such that the model estimated slightly higher recruitment in the early 1990s, which then declined in the mid to late 1990s. The spawning biomass in 2005 was approximately 71 percent of unfished spawning biomass, but this estimate is highly uncertain as is evident in the comparatively large 95 percent confidence interval for the spawning biomass. A suite of sensitivity analyses bracketed some of the areas of uncertainty in catchability, selectivity, mortality and steepness that formed a basis for considering and discussing major areas of uncertainty for the decision table.

1.3.9 Pacific Whiting

Distribution and Life History

Pacific whiting (*Merluccius productus*), also known as Pacific hake, are a semi-pelagic merlucciid (a cod-like fish species) that range from Sanak Island in the western Gulf of Alaska to Magdalena Bay, Baja California Sur, Mexico. They are most abundant in the California Current System (Bailey 1982; Hart 1988; Love 1991; NOAA 1990). Smaller populations of Pacific whiting occur in several of the larger semi-enclosed inlets of the northeast Pacific ocean, including the Strait of Georgia, Puget Sound, and the Gulf of California (Bailey, *et al.* 1982; Stauffer 1985). The highest densities of Pacific whiting are usually between 50 m and 500 m, but adults occur as deep as 920 m and as far offshore as 400 km (Bailey 1982; Bailey, *et al.* 1982; Dark and Wilkins 1994; Dorn 1995; Hart 1988; NOAA 1990). Pacific whiting school at depth during the day, then move to the surface and disband at night for feeding (McFarlane and Beamish 1986; Sumida and Moser 1984; Tanasich, *et al.* 1991). Coastal stocks spawn off Baja, California in the winter, then the mature adults begin moving northward and inshore following food supply and Davidson Currents (NOAA 1990). Pacific whiting reach as far north as southern British Columbia by fall. They then begin a southern migration to spawning grounds further offshore (Bailey, *et al.* 1982; Dorn 1995; Smith 1995; Stauffer 1985).

Spawning occurs from December through March, peaking in late January (Smith 1995). Pacific whiting are oviparous with external fertilization. Eggs of the Pacific whiting are neritic and float to neutral buoyancy (Bailey 1982; Bailey, *et al.* 1982; NOAA 1990). Hatching occurs in five days to six days, and within three months to four months juveniles are typically 35 mm (Hollowed 1992). Juveniles move to deeper water as they get older (NOAA 1990). Females mature at three years to four years (34 cm to 40 cm) and nearly all males are mature by three years (28 cm). Females grow more rapidly than males after four years; growth ceases for both sexes at 10 years to 13 years (Bailey, *et al.* 1982).

All life stages feed near the surface late at night and early in the morning (Sumida and Moser 1984). Larvae eat calanoid copepods, as well as their eggs and nauplii (McFarlane and Beamish 1986; Sumida and Moser 1984). Juveniles and small adults feed chiefly on euphausiids (NOAA 1990). Large adults also eat amphipods, squid, herring, smelt, crabs, and sometimes juvenile whiting (Bailey 1982; Dark and Wilkins 1994; McFarlane and Beamish 1986; NOAA 1990). Eggs and larvae of Pacific whiting are eaten by pollock, herring, invertebrates, and sometimes Pacific whiting. Juveniles are eaten by lingcod, Pacific cod, and rockfish species. Adults are preyed on by sablefish, albacore, pollock, Pacific cod, marine mammals, soupfin sharks, and spiny dogfish (Fiscus 1979; McFarlane and Beamish 1986; NOAA 1990).

Stock Status and Management History

The history of the coastal whiting fishery is characterized by rapid changes brought about by the development of foreign fisheries in 1966, joint-venture fisheries in the early 1980s, and domestic fisheries in 1990s. The coastwide (U.S. and Canada) whiting stock is assessed annually by a joint technical team of scientists from both countries. The 2001 assessment (Helser, *et al.* 2002) incorporated 2001 hydroacoustic survey data and showed the spawning stock biomass declined substantially and had been lower during the past several years than previously estimated. The stock assessment estimated the biomass in 2001 was 0.7 million mt, and the female spawning biomass was less than 20 percent of the unfished biomass. This was substantially lower than indicated in the 1998 assessment (Dorn, *et al.* 1999), which estimated the biomass to be at 39 percent of its unfished biomass. Therefore, NMFS declared the whiting stock depleted in April 2002. The stock was projected to be near 25 percent of the unfished biomass in 2002 and above $B_{25\%}$ in 2003.

The 2004 whiting stock assessment (Helser, *et al.* 2004), incorporating new data from the 2003 hydro-acoustic survey, estimated the spawning stock biomass at the beginning of 2004 between 47 percent and 51 percent of unfished biomass; the stock was therefore declared rebuilt. Furthermore, because the 1999 year class was larger than previously estimated, estimates of the 2001 biomass in this assessment ranged from 27 percent to 33 percent of unfished biomass, indicating that the stock approached, but never fell below, the $B_{25\%}$ minimum stock size threshold (Whiting STAR Panel 2004).

The 2005 whiting stock assessment considered two alternative and equally plausible models based on the value for the catchability coefficient (*q*) for the hydroacoustic survey, q=1 and q=0.6. Within a stock assessment model, a higher catchability coefficient brings about a lower the estimate of current biomass. Under the base model (q=1), which the Council adopted, the 2004 coastwide depletion level was estimated to be 0.50 (given that age 3+ biomass was estimated to be 2.5 million mt in 2004).

Unlike the 2005 assessment, the 2006 assessment was based on the stock assessment package SS2. The assessment considered two alternative and equally plausible models based on the value for the catchability coefficient (*q*) for the hydroacoustic survey, q=1 and q=0.69. One of these values (*q*=1) is the same as that included in the 2005 assessment. The second value, q=0.69, was estimated taking into account a prior distribution on *q* selected by the STAR Panel. Although the SSC endorsed the option of combining of results from both models (giving each model equal weight) to form the basis for management advice, the Council adopted 2006 ABC and OY values based on the base model that used the more conservative q=1 value. The base model estimated the depletion level of the coastwide stock to be 31 percent. The assessment reinforced the importance of the 1999 year class, noting that it was the single most dominate cohort since the late 1980s and it in large part supported fishery catches during the last few years; over the coming years its proportion within the overall stock will decrease, however, and therefore the spawning biomass is predicted to decline in the future for almost any level of harvest.

The 2007 stock assessment (Hesler and Martell 2008) used an updated version of the SS2 model (version 1.23E) and incorporates a new coastwide recruitment index that draws upon data from the expanded SWFSC Santa Cruz and PWCC/NMFS mid-water trawl surveys. As in the previous year's assessment, two models are presented to bracket the range of uncertainty in the acoustic survey catchability coefficient, *q*. The base model with steepness fixed at *h*=0.75 and *q*=1.0 represents the endpoint of the lower range while the alternative model which places a prior on *q* (effective *q*=0.7) represents the upper endpoint of the range. Removal of the 1986-2000 SWFSC Santa Cruz pre-recruit time series (due to the extremely limited spatial coverage during those years) and inclusion of the new coast wide pre-recruit index has resulted in a slightly higher 1999, as well as 2003-2004, recruitment strengths. As such, spawning biomass in the most recent years is slightly greater than predicted from the 2006 assessment.

In 2007 (beginning of year), spawning biomass is estimated to be 1.15 – 1.65 million mt and approximately 32.1 percent-39.80 percent of the unfished level. Estimates of uncertainty in level of depletion range from 24.3 percent-39.7 percent and 30.7 percent-48.8 percent of unfished biomass for the base and alternative models, respectively. Unexploited equilibrium Pacific hake spawning biomass (Bzero) from the base model was estimated to be 3.57 million mt, and under the alternative model it was estimated to be 4.15 million mt. Forecasts were generated assuming the maximum potential catch would be removed under 40:10 control rule for both the base and alternative models. For the base case model, the 2007 coastwide ABC is estimated to be 612,068 mt with an OY of 575,090 mt. Under the alternative model, the 2007 coastwide ABC is estimated to be 879,000 mt with an OY of 878,670 mt. Spawning stock biomass is projected to decline with a corresponding relative depletion of 24.5 percent and 29.3 percent for the base and alternative models, respectively in 2008.

1.3.10 Shortbelly Rockfish

Distribution and Life History

Shortbelly rockfish (*Sebastes jordani*) are found from San Benito Islands, Baja California, Mexico, to La Perouse Bank, British Columbia (Eschmeyer, *et al.* 1983; Lenarz 1980). The habitat of the shortbelly rockfish is wide ranging (Eschmeyer, *et al.* 1983). Shortbelly rockfish inhabit waters from 50 m to 350 m in depth (Allen and Smith 1988) on the continental shelf (Chess, *et al.* 1988) and upper-slope (Stull and Tang 1996). Adults commonly form very large schools over smooth bottoms near the shelf break (Lenarz 1992). Shortbelly rockfish have also been observed along the Monterey Canyon ledge (Sullivan 1995). During the day shortbelly rockfish are found near the bottom in dense aggregations. At night they are more dispersed (Chess, *et al.* 1988). During the summer shortbelly rockfish tend to move into deeper waters and to the north as they grow, but they do not make long return migrations to the south in the winter to spawn (Lenarz 1980).

Shortbelly rockfish are viviparous, bearing advanced yolk sac larvae (Ralston, *et al.* 1996a). Shortbelly rockfish spawn off California during January through April (Lenarz 1992). Larvae metamorphose to juveniles at 27 mm and appear to begin forming schools at the surface at that time (Laidig, *et al.* 1991; Lenarz 1980). A few shortbelly rockfish mature at age two, while 50 percent are mature at age three, and nearly all are mature by age four (Lenarz 1992). Although shortbelly rockfish have been aged to 30 years, very few individuals have ever been described as greater than 20 years of age, and 95 percent of all aged shortbelly available used in the latest assessment were 12 years of age or less (Field, *et al.* 2007).

Shortbelly rockfish feed primarily on various life stages of euphausiids and calanoid copepods both during the day and night (Chess, *et al.* 1988; Lenarz, *et al.* 1991). Shortbelly rockfish play a key role in the food chain as they are preyed upon by Chinook and coho salmon, lingcod, black rockfish, Pacific whiting, bocaccio, chilipepper, pigeon guillemots, western gull, marine mammals, and other taxa (Chess, *et al.* 1988; Eschmeyer, *et al.* 1983; Hobson and Howard 1989; Lenarz 1980). In particular, many resident Central California seabirds depend heavily on juvenile rockfish, which may comprise up to 90 percent of their diet during the late spring and early summer breeding seasons. Shortbelly rockfish may account for more than two-thirds of the juvenile rockfish identified to the species level (Ainley, *et al.* 1993; Miller and Sydeman 2004; Sydeman, *et al.* 2001). However there is considerable interannual and interdecadal variability in the frequency of rockfish in seabird diets. Throughout the 1990s, foraging rates on juvenile rockfish by central California seabirds declined for both exploited and unexploited rockfish species primarily in response to changes in ocean conditions associated with poor recruitment for rockfish (Miller and Sydeman 2004; Sydeman, *et al.* 2001).

Stock Status and Management History

Shortbelly rockfish has not been the target of commercial fisheries, and consequently catch data are limited. Nevertheless, available evidence suggests that the population has undergone significant fluctuations in abundance over the last several decades. The expectation of eventual development of a domestic commercial fishery (Kato 1981) led to past efforts to estimate stock abundance and productivity (Lenarz 1980; Pearson 1989; Pearson, *et al.* 1991) as well as evaluations of commercial potential. The first ABC for shortbelly rockfish was set by the Council at 10,000 mt for 1983 through 1989. A stock assessment by Pearson et al. (Pearson 1989; Pearson, *et al.* 1991) estimated that allowable catches for shortbelly might range from 13,900 to 47,000 tons per year, based on life history data and hydroacoustic survey estimates of abundance. Subsequently, the Pacific Fishery Management Council established ABC of 23,500 tons, which was reduced to 13,900 tons in 2001 based on observations of poor recruitment throughout the 1990s and the continued lack of a targeted fishery. Yet despite several attempts to develop a commercial fishery for shortbelly, domestic fishery landings have never exceeded 80 tons per year along the west coast.

The available data for bycatch rates of shortbelly rockfish are extremely sparse. Shortbelly can be caught incidentally, at times in large numbers, by trawlers targeting other semi-pelagic rockfish (usually chilipepper and widow rockfish). As large hauls of shortbelly are not marketable but occasionally foul the mesh of typical groundfish trawls, more experienced fishermen generally recognize shortbelly sign (as well as habitat preferences) on their acoustics, and work to actively avoid schools. Bycatch monitoring programs conducted north of Cape Mendocino in the mid-1980s suggested very negligible levels of bycatch. Very little contemporary information is available for the region south of Mendocino. As regulatory measures have closed the vast majority of habitat optimal to adult shortbelly, such trace landings are to be expected in recent years, and comparable data prior to these closures does not exist. Information used in the 2007 assessment include biomass point estimates, larval abundance data, the west coast triennial trawl survey conducted between 1977 and 2004, a standardized midwater trawl survey, and food habits of seabirds and sea lions.

The shortbelly rockfish population was modeled using an age and size structured statistical model, SS2, and the parameters for growth, fecundity and maturity were estimated externally from the model and input as fixed values (Field, *et al.* 2007; Field, *et al.* 2008). The model estimated a mean unfished total biomass of 98,400 tons and a mean unfished spawning biomass of 49,500 tons. The depletion level in 2005 relative to the mean spawning biomass was 67 percent, however the 2005 spawning biomass was only 17 percent of the 1950 spawning biomass and was only 43 percent of the estimated 1993 spawning biomass. The consequence of fisheries, including high and low estimates of plausible discards, were estimated to be negligible (<0.01) in all years with the exception of the foreign fisheries of the mid-1960s. This suggests that it is unlikely that fishing mortality has had any substantive impact on this stock since the days of the foreign fisheries. The most robust result was a substantial decline in relative abundance between the late 1980s through the 1990s and into the present (~2006). The model also included a total biomass point estimate, based on the work of Ralston et al. (2003a), who used an estimate of larval production (essentially daily larval production and population weight-specific fecundity). Their work estimated that the spawning biomass in the Monterey to San Francisco area was approximately 67,400 tons in 1991, considerably less than the earlier hydroacoustic survey estimates of 295,000 and 153,000 mt in 1977 and 1980 respectively (which were the basis for the earlier OY estimates).

Collection and analysis of age composition data, particularly from the annual NWFSC combined trawl survey, would provide the opportunity to evaluate whether a time series of an annual bottom trawl survey is capable of generating a trend index and internally consistent length or age composition data for an abundant, yet patchy and semipelagic, species. If so, the survey data should allow us to assess whether the age structure and recruitment variability inferred from both the seabird, sea lion, and juvenile trawl survey are consistent with that seen in the adult population as indexed by the trawl survey.

1.3.11 Shortspine Thornyhead

Distribution and Life History

Shortspine thornyhead (*Sebastolobus alascanus*) are found from northern Baja California, Mexico, to the Bering Sea and occasionally to the Commander Islands north of Japan (Jacobson and Vetter 1996). They are common from Southern California northward (Love 1991). Shortspine thornyhead inhabit areas over the continental shelf and slope (Erickson and Pikitch 1993; Wakefield and Smith 1990). Although they can occur as shallow as 26 m (Eschmeyer, *et al.* 1983), shortspine thornyhead mainly occur in depths between 100 m and 1,400 m off Oregon and California, most commonly between 100 m to 1,000 m (Jacobson and Vetter 1996).

Spawning occurs in February and March off California (Wakefield and Smith 1990). Shortspine thornyhead are thought to be oviparous (Wakefield and Smith 1990), although there is no clear evidence to substantiate this (Erickson and Pikitch 1993). Eggs rise to the surface to develop and hatch. Larvae are pelagic for about 12 months to 15 months. During January to June, juveniles settle onto the continental shelf and then move into deeper water as they become adults (Jacobson and Vetter 1996). Off California, they begin to mature at five years; 50 percent are mature by 12 years to 13 years; and all are mature by 28 years (Owen and Jacobson 1992). Although it is difficult to determine the age of older individuals, Owen and Jacobson (Owen and Jacobson 1992) report that off California, they may live to over 100 years of age. The mean size of shortspine thornyhead increases with depth and is greatest at 1,000 m to 1,400 m (Jacobson and Vetter 1996).

Benthic individuals are ambush predators that rest on the bottom and remain motionless for extended periods of time (Jacobson and Vetter 1996). Off Alaska, shortspine thornyhead eat a variety of invertebrates such as shrimps, crabs, and amphipods, as well as fishes and worms (Owen and Jacobson 1992). Longspine thornyhead are a common item found in the stomachs of shortspine thornyhead. Cannibalism of newly settled juveniles is important in the life history of thornyheads (Jacobson and Vetter 1996).

Stock Status and Management History

Shortspine thornyhead are a major component of the deepwater fishery on the continental slope, especially the trawl fishery for DTS. The species is one of the most numerous components of the slope ecosystem; however, this is an especially long-lived species and cannot sustain aggressive harvest rates. It is taken coincidentally with Dover sole, sablefish, and longspine thornyhead, especially in the upper slope and lower shelf; in deeper water, longspine thornyhead is a more predominate species. The two thornyhead species are often difficult to distinguish, and historical landings data combine the two into a single category; nevertheless, the species have been managed under separate harvest specifications since 1992.

The assessment of shortspine thornyhead in 1997 covered the area from Central California at 36° N latitude to the U.S./Canada border (Rogers, *et al.* 1997). The STAR Panel expressed concern that management requires more detailed information on thornyheads than could be obtained from the available data. In 1998, two separate stock assessments covering the area north of 36^{o} N latitude were prepared and accepted by the Council (NMFS STAT and OT STAT 1998; Rogers, *et al.* 1998). A synthesis of these two assessments was used to set the harvest specifications 1999 and 2000; given that the synthesis estimated 1999 depletion at 32 percent of virgin biomass, the Council used the precautionary 40-10 policy to set the OYs for those two years.

There were a range of uncertainties in the 2001 assessment of shortspine thornyhead, in 2001, not the least of which was the estimated biomass (Piner and Methot 2001). The assessment was extended south to Point Conception (in contrast to past surveys, which were limited to stocks north of the 36° N latitude management area boundary). The authors concluded the 2001 spawning biomass ranged between 25 percent and 50 percent of unexploited spawning biomass. As was also the case in the 1998 assessment (Rogers, *et al.* 1998), the uncertainty in abundance largely revolved around the uncertainty in recruitment and survey *q*, or catchability, of shortspine thornyhead in slope surveys. The authors also concluded that the trend in stock biomass was increasing and the stock was not depleted. Based on estimated biomass and application of the GMT-recommended F=0.75M principle (which approximates an $F_{50\%}$ proxy harvest rate for shortspine thornyhead), the assessment authors and GMT recommended a slight increase in the ABC and OY for 2002. They also recommended that the harvest specifications be set for two areas divided by Point Conception (34°27'N latitude), rather than the previous policy to separate the management areas at the Conception-Monterey border (36° N latitude). Despite the uncertainty in biomass estimates and determination of whether shortspine thornyhead should be treated as a "precautionary zone" stock, these recommendations did treat the stock as such by applying the 40-10 adjustment.

The 2005 assessment (Hamel 2006c) extended the southern border of the assessment area from Point Conception to the Mexican border (32.5º N latitude). Including the entire Conception area resulted in a larger basis for unfished biomass, given that this area was estimated to contain nearly half of the stock's total west coast biomass. Another key modeling change from the previous assessment was to model the slope surveys as having dome-shaped selectivity. Because of the sparseness and quality of the data, natural mortality, steepness and the catchability coefficient were all fixed. The catchability coefficient for the slope survey was fixed at q=1 based on findings by Lauth et al. (2004). The STAR Panel (Barnes, *et al.* 2006) noted that because the supporting data and subsequent assessment were just marginally sufficient to estimate the resource status, the biological reference points (e.g. biomass levels) should be considered with caution. The assessment estimated the spawning biomass for 2005 to be 63 percent of unfished abundance, with a weakly falling recent trend. It was also noted that there could be regional management concerns with this stock because while the assessment OY is coastwide, there are differences in historic exploitation rates north and south of Point Conception.

1.3.12 Splitnose Rockfish

Distribution and Life History

Splitnose rockfish (*Sebastes diploproa*) occur from Prince William Sound, Alaska to San Martin Island, Baja California, Mexico (Miller and Lea 1972)). Splitnose rockfish occur from zero m to 800 m, with most survey catches occurring in depths of 100 m to 450 m (Allen and Smith 1988). The relative abundance of juveniles (<21 cm) is quite high in the 91 m to 272 m depth zone and then decreases sharply in the 274 m to 475 m depth zone (Boehlert and Kappenman 1980). Splitnose rockfish have a pelagic larval stage, a prejuvenile stage, and a benthic juvenile stage (Boehlert 1977). Benthic splitnose rockfish associate with mud habitats (Boehlert 1980). Young occur in shallow water, often at the surface under drifting kelp (Eschmeyer, *et al.* 1983). The major types of vegetation juveniles are found under are *Fucus* spp. (dominant), eelgrass, and bull kelp (Shaffer, *et al.* 1995). Juvenile splitnose rockfish off Southern California are the dominant rockfish species found under drifting kelp (Boehlert 1977).

Splitnose rockfish are ovoviviparous and release yolk sac larvae (Boehlert 1977). They may have two parturition seasons, or may possibly release larvae throughout the year (Boehlert 1977). In general, the main parturition season get progressively shorter and later toward the north (Boehlert 1977). Splitnose rockfish growth rates vary with latitude, being generally faster in the north. Splitnose rockfish mean sizes increase with depth in a given latitudinal area. Mean lengths of females are generally greater than males (Boehlert 1980). Off California, 50 percent maturity occurs at 21 cm, or five years of age, whereas off British Columbia 50 percent of males and females are mature at 27 cm (Hart 1988). Adults can achieve a maximum size of 46 cm (Boehlert and Kappenman 1980; Eschmeyer, *et al.* 1983; Hart 1988). Females have surface ages to 55 years and section ages to 81 years.

Adult splitnose rockfish off Southern California feed on midwater plankton, primarily euphausiids (Allen 1982). Juveniles feed mainly on planktonic organisms, including copepods and cladocerans during June and August. In October, their diets shift to larger epiphytic prey and are dominated by a single amphipod species. Juvenile splitnose rockfish actively select prey (Shaffer, *et al.* 1995) and are probably diurnally active (Allen 1982). Adults are probably nocturnally active, at least in part (Allen 1982).

1.3.13 Starry Flounder

Distribution and Life History

Starry flounder have a very broad geographic distribution around the rim of the north Pacific ocean and have been recorded from Los Angeles to the Aleutian Islands, although they are rare south of Point Conception (Kramer and O'Connell 1995; Orcutt 1950). Off the west coast of the United States starry flounder are found commonly in nearshore waters, especially in the vicinity of estuaries (Baxter 1999; Kimmerer 2002; NOAA 1991; Orcutt 1950; Pearson 1989; Sopher 1974). It has a quite shallow bathymetric distribution, with most individuals occurring in waters less than 80 m, although specimens have been collected off the continental shelf in excess of 350 m (Kramer and O'Connell 1995; Orcutt 1950). They are most often found on gravel, clean shifting sand, hard stable sand, and mud substrata.

Spawning occurs primarily during the winter months of December and January, at least in central California (Orcutt 1950); it may occur somewhat later in the year (February-April) off British Columbia and Washington (Hart 1988; Love 1996). Egg/larval development apparently takes about 2-3 months to occur. Offspring principally remain within the estuaries until age two, when many have migrated to the adjacent ocean habitats (Baxter 1999; Kimmerer 2002; Orcutt 1950). Reproductive maturity occurs at age two years for males and age three years for females, when the fish are 28 cm and 35 cm, respectively. Tagging studies have shown that fish are relatively sedentary and move little during their adult lives (Love 1996), however there is little information on regional variation in stock structure.

Starry flounder consume crabs, shrimps, worms, clams and clam siphons, other small mollusks, small fish, nemertean worms, and brittle stars (Hart 1988).

Stock Status and Management History

The U.S. west coast starry flounder stock was first assessed in 2005 (Ralston 2006). The assessment is based on the assumption of separate biological populations north and south of the CA/OR border; it uses catch data, relative abundance indices derived from trawl logbook data, and an index of age one abundance from trawl surveys in the San Francisco Bay and Sacramento-San Joaquin River estuary. Unlike most other groundfish stock assessments, no age- or length-composition data are directly used in the assessment. Both the northern and southern populations are estimated to be above the target level of 40 percent of virgin spawning biomass (44 percent of SB_0 in Washington-Oregon and 62 percent in California), although the status of this data-poor species remains fairly uncertain compared to that of many other groundfish species. One of the most significant areas of uncertainty in the assessment is the estimate of natural mortality rate, which was quite high (0.30 year$_{-1}$ for females and 0.45 year$_{-1}$ for males).

1.3.14 Yellowtail Rockfish

Distribution and Life History

Yellowtail rockfish (*Sebastes flavidus*) range from San Diego, California, to Kodiak Island, Alaska (Fraidenburg 1980; Gotshall 1981; Lorz, *et al.* 1983; Love 1991; Miller and Lea 1972; Norton and MacFarlane 1995). The center of yellowtail rockfish abundance is from Oregon to British Columbia (Fraidenburg 1980). Yellowtail rockfish are a common, demersal species abundant over the middle shelf (Carlson and Haight 1972; Fraidenburg 1980; Tagart 1991; Weinberg 1994). Yellowtail rockfish are most common near the bottom, but not on the bottom (Love 1991; Stanley, *et al.* 1994). Yellowtail rockfish adults are considered semi-pelagic (Stanley, *et al.* 1994; Stein, *et al.* 1992) or pelagic, which allows them to range over wider areas than benthic rockfish (Pearcy 1992). Adult yellowtail rockfish occur along steeply sloping shores or above rocky reefs (Love 1991). They can be found above mud with cobble, boulder and rock ridges, and sand habitats; they are not, however, found on mud, mud with boulder, or flat rock (Love 1991; Stein, *et al.* 1992). Yellowtail rockfish form large (sometimes greater than 1,000 fish) schools and can be found alone or in association with other rockfishes (Love 1991; Pearcy 1992; Rosenthal, *et al.* 1982; Stein, *et al.* 1992; Tagart 1991). These schools may persist at the same location for many years (Pearcy 1992).

Yellowtail rockfish are viviparous (Norton and MacFarlane 1995) and mate from October to December. Parturition peaks in February and March and from November to March off California (Westrheim 1975). Young-of-the-year pelagic juveniles often appear in kelp beds beginning in April and live in and around kelp in midwater during the day, descending to the bottom at night (Love 1991; Tagart 1991). Male yellowtail rockfish are 34 cm to 41 cm in length (five years to nine years) at 50 percent maturity, females are 37 cm to 45 cm (six years to ten years) (Tagart 1991). Yellowtail rockfish are long-lived and slow-growing; the oldest recorded individual was 64 years old (Fraidenburg 1981; Tagart 1991). Yellowtail rockfish have a high growth rate relative to other rockfish species (Tagart 1991). They reach a maximum size of about 55 cm in approximately 15 years (Tagart 1991). Yellowtail rockfish feed mainly on pelagic animals, but are opportunistic, occasionally eating benthic animals as well (Lorz, *et al.* 1983). Large juveniles and adults eat fish (small Pacific whiting, Pacific herring, smelt, anchovies, lanternfishes, and others), along with squid, krill, and other planktonic organisms (euphausiids, salps, and pyrosomes) (Love 1991; Phillips 1964; Rosenthal, *et al.* 1982; Tagart 1991).

Stock Status and Management History

Until the late 1990's, yellowtail rockfish were harvested as part of a directed midwater trawl fishery. However because it co-occurs with several other rockfishes, including the depleted species canary rockfish and widow rockfish (Nagtegaal 1983; Rogers and Pikitch 1992; Tagart 1987), yellowtail rockfish fishing opportunity has been substantially curtailed. Since the end of 2002, there have been no landings limits that provide directed mid-water fishing opportunities for yellowtail rockfish in non-tribal trawl fisheries.

The stock assessment of yellowtail rockfish was most recently updated in 2005 (Wallace and Lai 2006). The last full assessment of the northern stock areas was conducted in 2000 (Tagart, *et al.* 2000), and it was then updated in 2003 (Lai, *et al.* 2003). The Council manages the U.S. fishery as two stocks separated at Cape Mendocino, California; as in the past, the 2005 update assessment includes only the northern stock (which is divided for assessment purposes into three areas: South Vancouver, Northern Columbia, and Eureka/South Columbia). The purpose of an assessment update is to add the most recent data into the model used in the full assessment. This update, therefore, continued the use of the age-structured model written with AD Model Builder software and extended the various data time series. Abundance trends were estimated to be somewhat different by area (little trend in South Vancouver and declining trends in the other areas). However following the recommendations of the SSC and 2003 STAR Panel, the coastwide estimates of biomass and ABC/OY are the summation of estimates from the three assessed areas. The estimated age-4+ biomass in year 2004 was 72,152 mt with a 26 percent coefficient of variation (CV), which is an increase from 58,025 mt in 2003. Since 1995 the spawning biomass has remained above 40 percent of unfished levels.

1.4 Unassessed Groundfish Species and Those Managed as Part of a Stock Complex

1.4.1 Minor Rockfish South

Southern Nearshore Species

The complex, Minor Nearshore Rockfish south of 40°10' N latitude, is further subdivided into the following management categories: 1) shallow nearshore rockfish [comprised of black and yellow rockfish (*S. chrysomelas*); China rockfish (*S. nebulosus*); gopher rockfish (*S. carnatus*); grass rockfish (*S. rastrelliger*), and kelp rockfish (*S. atrovirens*)]; 2) deeper nearshore rockfish: [comprised of black rockfish (*S. melanops*), blue rockfish (*S. mystinus*); brown rockfish (*S. auriculatus*); calico rockfish (*S. dalli*); copper rockfish (*S. caurinus*); olive rockfish (*S. serranoides*); quillback rockfish (*S. maliger*); and treefish (*S. serriceps*)] and 3) California scorpionfish (*Scorpaena guttata*).

Of the species listed above, two were assessed for the first time in 2005, gopher rockfish, and California scorpionfish. Because of this new information, California scorpionfish has been removed from the stock complex and will be managed under its individual harvest specifications beginning in 2007. However gopher rockfish cannot be managed separately from other nearshore rockfish species without significantly increasing bycatch; in addition, the assessment is considered uncertain due to its poor data quality. Gopher rockfish, therefore, will continue to be managed from within the southern minor nearshore rockfish species complex, but the information provided in the stock assessment will be used to inform the harvest specifications set for that complex.

1.4.1.1 *Gopher Rockfish*

Gopher rockfish was assessed for the first time in 2005 (Key, *et al.* 2006). Although the distribution of gopher rockfish extends south into the Southern California Bight, the assessment was restricted to the stock north of Point Conception. The assessment is based on landings and length composition data from commercial and recreational fisheries (primarily hook and line gear) and an index of relative abundance (CPUE) from the CPFV Sportfish Survey database. These data sources were used to estimate population trends from 1965 to 2004. There are no fishery-independent indices of stock biomass for gopher rockfish. Assessment results indicate an upward trend in gopher rockfish biomass since the 1980s and estimates of 2005 abundance ranged between 60 percent and 110 percent of average unfished stock size; this range of depletion levels is the result of alternative emphases in the model given to the CPFV in the CPUE index, a data element identified as a major source of uncertainty. Recent exploitation rates are estimated to have been well below the F_{MSY} proxy for rockfish.

1.4.1.2 *Blue Rockfish*

Blue rockfish (*Sebastes mystinus*) was assessed for the first time in 2007 using the SS2 (version 2.00g) integrated length-age structured model (Key, *et al.* 2008). The assessment determines the status of the California stock from the Oregon border to Point Conception where blue rockfish are most commonly found. The assessment treats these fish as a single stock. The variability in growth over time and between areas along the coast of California were evident while assessing this stock, but sufficient data did not allow the complex modeling needed to appropriately assess blue rockfish. Genetic evidence has also suggested two species of blue rockfish in California, so the 2007 stock assessment is in effect an assessment of a blue rockfish “complex” instead of a single species. The abundance of blue rockfish was at the management target ($SB_{40\%}$) in 1980 and the overfished threshold in 1982. Blue rockfish have not been considered a “point of concern” in management; hence no ABCs or OYs have been set particularly for this species in the past.

Blue rockfish, the primary recreational (CPFV/private) caught species in California, is also caught in the commercial hook and line fishery. There is no reporting of blue rockfish landed in trawl gear. The catch history of blue rockfish is highly uncertain, especially in the earlier years. There was not enough recent data to support the use of time-varying growth for a base model. Natural mortality is highly uncertain and cannot be reliably estimated. The scarcity of males in the landings could be either due to higher male natural mortality or lower fishery selectivity for the males. The 2007 blue rockfish assessment had limited information to measure stock abundance. The results of this assessment depended on the assumption of constant proportionality between the recreational CPFV CPUE indices and stock abundance. Items of major uncertainty in the assessment included emerging evidence for two separate blue rockfish species, infrequent encounters of male blue rockfish, evidence for variable growth over space and time, uncertainties regarding historical catches, and uncertainties regarding the true value for natural mortality.

The 2007 blue rockfish assessment used the default target rate of $F_{50\%}$ used for rockfishes on the west coast of the U.S. Unfished spawning biomass was estimated to be 2077 millions of larvae in the base model, with the target stock size at 831 millions of larvae. The base model estimated that the stock could support an MSY of 275 mt. The base model estimated spawning output and relative depletion level in 2007 at 622 (millions of larvae) and 29.7 percent, respectively. The forecasts predict a slight increase in abundance but not enough to support increase harvesting of blue rockfish in the future. However, the state of nature corresponding to higher natural mortality (M females = 0.13, M males = 0.15) remains above 40 percent and would allow about 370 mt to be taken in 2009. According to the base model, blue rockfish may be experiencing overfishing (current F exceeds proxy F_{MSY}), and the total catch should be reduced. However; overfishing is not occurring under the model's upper bracket scenario. The STAT advised that the uncertainty in the model appears to be asymmetrical, such that the high productivity scenario is considerably more plausible than the low productivity scenario, an observation supported by the likelihood values in the fits to each scenario.

Research and data needs for future blue rockfish assessments include, reconstruction of the historical landings using a standardized method; genetic studies to confirm that blue rockfish is two species (including supporting research on aging to determine differences in growth and longevity, fecundity, maturation schedules and their spatial distributions); biological sampling (age composition information, changes in life history parameters over time and space); differences in catch of males; and factors that affect survival of juvenile blue rockfish.

Southern Shelf Species

The minor shelf rockfish complex south of 40°10' N latitude is composed of the following species: bronzespotted rockfish (*S. gilli*); chameleon rockfish (*S. phillipsi*); dusky rockfish (*S. ciliatus*); dwarf-red rockfish (*S. rufianus*); flag rockfish (*S. rubrivinctus*); freckled rockfish (*S. lentiginosus*); greenblotched rockfish (*S. rosenblatti*); greenspotted rockfish (*S. chlorostictus*); greenstriped rockfish (*S. elongatus*); halfbanded rockfish (*S. semicinctus*); harlequin rockfish (*S. variegatus*); honeycomb rockfish (*S. umbrosus*); Mexican rockfish (*S. macdonaldi*); pink rockfish (*S. eos*); pinkrose rockfish (*S. simulator*); pygmy rockfish (*S. wilsoni*); redstripe rockfish (*S. proriger*); rosethorn rockfish (*S. helvomaculatus*); rosy rockfish (*S. rosaceus*); silvergray rockfish (*S. brevispinis*); speckled rockfish (*S. ovalis*); squarespot rockfish (*S. hopkinsi*); starry rockfish (*S. constellatus*); stripetail rockfish (*S. saxicola*); swordspine rockfish (*S. ensifer*); tiger rockfish (*S. nigrocinctus*); vermilion rockfish (*S. miniatus*); and yellowtail rockfish (*S. flavidus*).

In 2005, vermilion rockfish was assessed for the first time. However there were significant concerns about the reliability of the assessment. Given these concerns, the SSC did not endorse the results as being suitable for setting OYs and the Council did not accept the assessment for use in management. Vermilion rockfish, therefore, is still managed within the southern minor shelf rockfish complex.

Southern Slope Species

The minor slope rockfish complex south of 40°10' N latitude is composed of the following species: aurora rockfish (*S. aurora*); bank rockfish (*S. rufus*); blackgill rockfish (*S. melanostomus*); Pacific ocean perch (*S. alutus*); redbanded rockfish (*S. babcocki*); rougheye rockfish (*S. aleutianus*); sharpchin rockfish (*S. zacentrus*); shortraker rockfish (*S. borealis*); and yellowmouth rockfish (*S. reedi*).

1.4.1.3 *Bank Rockfish*

Distribution and Life History

Bank rockfish (*Sebastes rufus*) are found from Newport, Oregon, to central Baja California, Mexico, most commonly from Fort Bragg southward (Love 1992). Bank rockfish occur offshore (Eschmeyer, *et al.* 1983) from depths of 31 m to 247 m (Love 1992), although adults prefer depths over 210 m (Love, *et al.* 1990). Observations of commercial catches indicate juveniles occupy the shallower part of the species range (Love et al. 1990). Bank rockfish are a midwater, aggregating species and are found over hard bottoms (Love 1992), over high relief or on bank edges (Love, *et al.* 1990), and along the ledge of Monterey Canyon (Sullivan 1995). They also frequent deep water over muddy or sandy bottoms (Miller and Lea 1972). Spawning occurs from December to May (Love, *et al.* 1990). Peak spawning of bank rockfish in the Southern California Bight occurs in January and a month later in Central and Northern California. Off California, bank rockfish are multiple brooders (Love, *et al.* 1990). Females grow to a larger maximum size (50 cm) than males (44 cm), but grow at a slightly slower rate (Cailliet, *et al.* 1996). Males reach first maturity at 28 cm, 50 percent maturity at 31 cm, and 100 percent at 38 cm. Females reach first maturity at 31 cm, 50 percent at 36 cm, and 100 percent maturity at 39 cm (Love, *et al.* 1990). Bank rockfish are midwater feeders, eating mostly gelatinous planktonic organisms such as tunicates, but also preying on small fishes and krill (Love 1992).

Stock Status and Management History

At one time, bank rockfish was thought to be two separate species; bank rockfish and red widow rockfish. Robert Lea with CDFG was able to show through a morphometric study that fishes were of a single species. Bank rockfish are of minor importance in the recreational fishery, and are landed commercially in the Monterey and Conception areas. Estimated average annual landings between 1981 and 1992 were 1015 metric tons.

Bank rockfish was assessed in 1994 (Pearson 1994). Few studies had been done at that time on bank rockfish, but the assessment consulted a master’s thesis for some age and growth information (Watters 1993). Watters’ estimates of maximum age and growth parameters were not considered to be precise because they were based on 167 fish. The 1994 assessment used the length-structured Stock Synthesis model to estimate gear selectivity curves and some parameters of the von Bertalanffy growth model. Natural mortality was fixed at 0.08 for both sexes, based on the method of Hoenig (1983) for estimating total mortality. The fishing mortality rate that would reduce spawning potential to 35 percent of the unfished level ($F_{35\%}$) was estimated at 0.19. The assessment also noted declines in mean length over time in the trawl and gill net fisheries.

A second bank rockfish assessment for the Eureka, Monterey, and Conception INPFC area north of Point Conception was completed in 2000 to inform the 2001 ABC recommendations (Piner, *et al.* 2000). Data was limited at the time of the 2000 assessment and consisted of fishery dependent data from trawl and setnet catch age and length compositions. Additional work was done to evaluate ageing methods and error, potential stock differences and boundaries, and maturity schedules. No reliable external measure of population abundance was available. Two Stock Synthesis models were run, with model differences based on whether the stock/recruit curvature was assumed (0.87) or estimated (0.7) - both yielded similar population trends. Both models used a natural mortality (M) of 0.08, female rate of growth (K) of 0.062, and male K of 0.072. The modeling indicated the spawning output and stock biomass have declined throughout the time series (1981 to 1999), with the majority of the decline occurring prior to 1990. Target fishing mortality rates were not computed because of an inability to separate F, selectivity and recruitment effects. There was no clear signal in the age or length distributions that would indicate potential strong year classes, and no information on recruitment, changing population size, or changing selectivities. An $F_{50\%SPR}$ = 0.06 was calculated based on available biological information, estimated rates of growth and selectivity within the model, and estimated ratio of fishing mortality from setnets and trawls.

1.4.1.4 *Blackgill Rockfish*

Although blackgill rockfish has been formally assessed, it is still managed as part of the southern Sebastes complex; aggregate ABCs and OYs are established from this complex using the harvest targets of some component individual species, such as blackgill rockfish.

Blackgill rockfish landings can be attributed almost entirely to the commercial fishery in California. Since the late 1970s, hook and line has accounted for 56 percent of total landings in California, set nets has accounted for 12 percent; and trawl has accounted for 32 percent. The first assessment for blackgill rockfish was conducted in 1998 (Butler, *et al.* 1999b). That assessment assumed a unit stock in southern and central California (Conception INPFC area) and was based on a stock reduction analysis assuming constant recruitment. The dynamics of the simple model were tuned to average mortality rates from catch curves and landings data. Fishery selectivity was assumed to mirror maturity at size/age; trends in fishable/mature biomass were then estimated.

In 2005, the second and most recent stock assessment of blackgill rockfish was completed (Helser 2006). This assessment expanded the geographic range of that in Butler et al. (1999a), including both the Monterey and Conception INPFC areas, where over 90 percent of the landings have occurred. The assessment is based on catch and length composition data from commercial fisheries and indices of relative abundance and size composition from the AFSC shelf trawl survey and the AFSC slope survey. The modeling approach, SS2 (Ver. 1.19), takes advantage of fishery and survey length compositions to explicitly estimate selectivity. The base model estimated depletion to be 52.3 percent of the unfished spawning biomass, within a range of 36 percent to 67 percent depending upon the assumed natural mortality rate (identified as a key axis of uncertainty for this stock). Assessment results indicate that recent exploitation rates have been slightly below the F_{MSY} proxy for rockfish.

1.4.2 Minor Rockfish North

Northern Nearshore Species

The minor nearshore rockfish complex north of 40°10' N latitude is composed of the following species: black and yellow rockfish (*S. chrysomelas*); blue rockfish (*S. mystinus*); brown rockfish (*S. auriculatus*); calico rockfish (*S. dalli*); China rockfish (*S. nebulosus*); copper rockfish (*S. caurinus*); gopher rockfish (*S. carnatus*); grass rockfish (*S. rastrelliger*); kelp rockfish (*S. atrovirens*); olive rockfish (*S. serranoides*); quillback rockfish (*S. maliger*); and treefish (*S. serriceps*).

Northern Shelf Species

The minor shelf rockfish complex north of 40°10' N latitude is composed of the following species: bronzespotted rockfish (*S. gilli*); bocaccio (*Sebastes paucispinis*); chameleon rockfish (*S. phillipsi*); chilipepper rockfish (*S. goodei*); cowcod (*S. levis*); dusky rockfish (*S. ciliatus*); dwarf-red rockfish (*S. rufianus*); flag rockfish (*S. rubrivinctus*); freckled rockfish (*S. lentiginosus*); greenblotched rockfish (*S. rosenblatti*); greenspotted rockfish (*S. chlorostictus*); greenstriped rockfish (*S. elongatus*); halfbanded rockfish (*S. semicinctus*); harlequin rockfish (*S. variegatus*); honeycomb rockfish (*S. umbrosus*); Mexican rockfish (*S. macdonaldi*); pink rockfish (*S. eos*); pinkrose rockfish (*S. simulator*); pygmy rockfish (*S. wilsoni*); redstripe rockfish (*S. proriger*); rosethorn rockfish (*S. helvomaculatus*); rosy rockfish (*S. rosaceus*); silvergray rockfish (*S. brevispinis*); speckled rockfish (*S. ovalis*); squarespot rockfish (*S. hopkinsi*); starry rockfish (*S. constellatus*); stripetail rockfish (*S. saxicola*); swordspine rockfish (*S. ensifer*); tiger rockfish (*S. nigrocinctus*); and vermilion rockfish (*S. miniatus*).

Northern Slope Species

The minor slope rockfish complex north of 40°10' N latitude is composed of the following species: aurora rockfish (*S. aurora*); bank rockfish (*S. rufus*); blackgill rockfish (*S. melanostomus*); redbanded rockfish (*S. babcocki*); rougheye rockfish (*S. aleutianus*); sharpchin rockfish (*S. zacentrus*); shortraker rockfish (*S. borealis*); splitnose rockfish (*S. diploproa*); and yellowmouth rockfish (*S. reedi*).

1.4.3 Pacific Cod

Distribution and Life History

Pacific cod (*Gadus macrocephalus*) are widely distributed in the coastal north Pacific, from the Bering Sea to Southern California in the east, and to the Sea of Japan in the west. Adult Pacific cod occur as deep as 875 m (Allen and Smith 1988), but the vast majority occurs between 50 m and 300 m (Allen and Smith 1988; Love 1991; NOAA 1990). Along the west coast, Pacific cod prefer shallow, soft-bottom habitats in marine and estuarine environments (Garrison and Miller 1982), although adults have been found associated with coarse sand and gravel substrates (Garrison and Miller 1982; Palsson 1990). Larvae and small juveniles are pelagic; large juveniles and adults are parademersal (Dunn and Matarese 1987; NOAA 1990). Adult Pacific cod are not considered to be a migratory species. There is, however, a seasonal bathymetric movement from deep spawning areas of the outer shelf and upper slope in fall and winter to shallow middle-upper shelf feeding grounds in the spring (Dunn and Matarese 1987; Hart 1988; NOAA 1990; Shimada and Kimura 1994).

Pacific cod have external fertilization (Hart 1988; NOAA 1990) with spawning occurring from late fall to early spring. Their eggs are demersal. Larvae may be transported to nursery areas by tidal currents (Garrison and Miller 1982). Half of females are mature by three years (55 cm) and half of males are mature by two years (45 cm) (Dunn and Matarese 1987; Hart 1988). Juveniles and adults are carnivorous and feed at night (Allen and Smith 1988; Palsson 1990) with the main part of the adult Pacific cod diet being whatever prey species is most abundant (Kihara and Shimada 1988; Klovach, *et al.* 1995). Larval feeding is poorly understood. Pelagic fish and sea birds eat Pacific cod larvae, while juveniles are eaten by larger demersal fish, including Pacific cod. Adults are preyed upon by toothed whales, Pacific halibut, salmon shark, and larger Pacific cod (Hart 1988; Love 1991; NOAA 1990; Palsson 1990). The closest competitor of the Pacific cod for resources is the sablefish (Allen 1982).

1.4.4 *Other Fish*

The Other Fish stock complex contains all the unassessed Groundfish FMP species that are neither rockfish (family *Scorpaenidae*) nor flatfish. These species include big skate (*Raja binoculata*), California skate (*Raja inornata*), leopard shark (*Triakis semifasciata*), longnose skate (*Raja rhina*), soupfin shark (*Galeorhinus zyopterus*), spiny dogfish (*Squalus acanthias*), finescale codling (*Antimora microlepis*), Pacific rattail (*Coryphaenoides acrolepis*), ratfish (*Hydrolagus colliei*), cabezon (*Scorpaenichthys marmoratus*) (north of the California/Oregon border at 42° N latitude), and kelp greenling (*Hexagrammos decagrammus*).

1.4.4.1 *Kelp Greenling*

Kelp greenling was assessed for the first time in 2005. Although the assessment covered both California and Oregon, the Council adopted only the Oregon substock assessment for use in management. Due to the considerable uncertainty associated with the assessment, the Council furthermore decided not to set independent harvest specifications for kelp greenling.

The first and only assessment of kelp greenling was completed in 2005 by Cope and MacCall (2006). The assessment treated the stock as two completely independent sub-stocks divided at the California-Oregon border (excluding Washington, as there have been no substantial fisheries off its coast). There are substantial differences between the two assessments with respect to assessment period, model assumptions, results, and uncertainties. An important difference between the two sub-stocks is the first year for which historical catch data are available (1916 for California and 1981 for Oregon). The Oregon sub-stock has some age-at-length data, which were included in the assessment. The estimate of depletion for the Oregon sub-stock (the current biomass is at 49 percent of its unfished) is more certain than estimates of absolute abundance, which are highly imprecise. For the California sub-stock, substantial uncertainty could not be resolved regarding growth and natural mortality rates, as well as the shape of the selectivity pattern for the shore mode fishery. Due to these factors, it was not possible to formulate a model for California.

1.4.4.2 *Longnose Skate*

Distribution and Life History

Skates are the largest and most widely distributed group of batoid fish with approximately 230 species ascribed to two families (Martin and Zorzi 1993; McEachran 1990). Skates are benthic fish that are found in all coastal waters but are most common in cold temperatures and polar waters.

There are about 12 species of skates from either of two genera (*Raja* and *Bathyraja*) present in the northeast Pacific Ocean off California, Oregon and Washington. Of that number, just three species longnose skate (*Raja rhina*), big skate (*Raja binoculata*), and sandpaper skate (*Bathyraja interrupta*) make up over 95 percent of survey catches in terms of biomass and numbers, with the longnose skate leading in both categories (62 percent of biomass and 56 percent of numbers). Species compositions of fishery landings also show that longnose skate dominates commercial catches. On average, longnose skate represents 75 percent of total skate landings in Oregon for the last 12 years and 45 percent in Washington for the last three years. There are no species composition data available for commercial landings in California, but anecdotal evidence suggests that the majority of skates landed there are longnose skates.

The longnose skate to the family Rajidae (skates), the order Rajiformes (skates and rays), and the subclass Elasmobranchii (cartilaginous fish) that includes skates, rays, and sharks (Compagno 1999; McEachran and Aschliman 2004). Like other skates, longnose skate is a dorso-ventrally compressed animal with large pectoral fins (often called "wings"), a long whip-like tail and a stiff, long snout (Compagno 1999).

The distribution of the longnose skate is limited to the eastern Pacific Ocean between 61° N Latitude and 28° N Latitude. It is found as far north as Navarin Canyon in the Bering Sea and Unalaska Island in Alaska to as far south as Cedros Island, Baja California in Mexico at depths of 25–684 m (Lamb and Edgell 1986). Longnose skates do not exhibit a size-specific pattern in distribution relative to bottom depth; average fish size does not vary greatly with depth.

Currently, there is no information available that indicates the existence of multiple breeding units in the Northeast Pacific Ocean. Several tagging studies have found that elasmobranchs, such as sharks and skates, can undertake extensive migrations within their geographic range (Martin and Zorzi 1993; McFarlane and King 2003). This behavior suggests the likelihood that there is a high degree of genetic mixing within the population, across its range. As a result, the longnose skate population off California, Oregon, and Washington is modeled in this assessment as a single stock.

The life history of skates is characterized by late maturity, low fecundity and slow growth to large body size (King and McFarlane 2003; Moyle and Cech 1996); (Walker and Hislop 1998). The characteristics are associated with a *K*-type reproductive strategy, as opposed to *r*-type strategy, wherein reproductive success is achieved by high productivity and early maturity (Hoenig and Gruber 1990).

The longnose skate is oviparous (egg-laying) and invests considerable energy in developing a few large, well-protected embryos. There are three major stages in the life cycle of the longnose skate: the egg, the juvenile and the adult stages. After fertilization, the female forms a large tough, leathery yet permeable egg case (about 10×6 cm) that surrounds one or more eggs. After several months the female deposits the egg case onto the sea floor. The eggs incubate for several months in a benthic habitat where there is some exposure to predation and damage. Inside the egg case, the embryos develop with nourishment provided by a yolk. When the yolk is depleted and the juvenile fully formed, it exits the egg case. Once hatched, the young skate is similar in appearance to an adult, but smaller in size. The juvenile stage lasts from the time of hatching to the onset of maturity (Frisk, *et al.* 2002); (Pratt and Casey 1990). On average, longnose skate mature at ages ranging from six to nine years. Upon reaching maturity, skates enter the reproductive adult stage, which characterizes the remainder of their lives. The life span of this species is not well known, although individuals up to 23 years of age have been found. Longnose skates attain a maximum length of about 145 cm (Zeiner and Wolf 1993). The average size is about 60-90 cm (Thompson 2006); (Zeiner and Wolf 1993).

The reproductive cycle of oviparous skates has been observed for a few species but not for longnose skate. These studies indicate that egg production generally occurs throughout the year although there have been some instances where seasonality in egg laying was observed (Hamlett and Koob 1999). Information on fecundity of longnose skate is extremely limited. Holden (Holden 1974) found that species of genus *Rajidae* are the most fecund of all elasmobranches and can lay 100 egg cases per year, although eggs may not be produced every year. Frisk et al. (Frisk, *et al.* 2002) estimated that annual fecundity for medium-sized skates like longnose may be less than 50 eggs per year; however, those eggs exhibit high survival rates due to the large parental investment. Typically, an egg case houses 4-5 embryos although the numbers can go as low as one to as high as seven (Thompson 2006). Overall, little is known about breeding frequency, egg survival, hatching success and other early life history characteristics of the longnose skate.

Stock Status and Management History

Historically, skates in general, and longnose skate in particular, have not been high-priced fishery products. They are taken mostly as bycatch in other commercially important fisheries (Bonfil 1994). Although skates are caught in almost all demersal fisheries and areas off the U.S. west coast, the vast majority (almost 97 percent) are caught with trawl gear.

Landing records indicate that skates have been retained on the U.S. Pacific Coast at least since 1916 (Martin and Zorzi 1993). Little is known about the species composition of west coast skate fisheries, particularly prior to 1990. With few exceptions, longnose skate landings have been reported, along with other skate species, under the market category "unspecified skates." In recent years, the species composition of this market category has been sampled by state port samplers in Oregon and Washington.

Skate retention is probably influenced by the success of the target fisheries in which they occur as bycatch. A high catch of the target species could result in limited storage space for skate and subsequent drop in skate landings (Martin and Zorzi 1993). It has been found that skate landings do partially reflect changes in landings in other trawl fisheries, particularly rockfish and flatfish, but findings of direct correlations are inconsistent and there is often a time lag of several years (Martin and Zorzi 1993). Others have found that fluctuations in skate landings roughly followed general economic trends such that peaks in production occur at about the same period as economic peaks (Frey 1971).

Historically, only the skinned pectoral fins, or "wings" were sold, although a small portion of catch would be marketed round. The wings were cut onboard the boat and the remainder discarded. Currently, west coast skates are marketed both whole and as wings. Skates wings are sold fresh or fresh-frozen, as well as dried or salted and dehydrated, for sale predominantly in Asian markets (Bonfil 1994), (Martin and Zorzi 1993). There is no information to suggest change in skate markets prior to the mid 1990s. However, it appears that the demand for whole skates did increase greatly during the mid-1990s, as evidenced by the increase in the number of trips where skates were landed. While skates were encountered predominantly as bycatch previously, landings data from this period reveal greater targeting of skates by some vessels. After a few years, the whole-skate market cooled due to downturns in Asian financial markets (Leipzig 2006).

In Alaska, skates were primarily taken as bycatch in both longline and trawl fisheries until 2003 when a directed skate fishery developed in the Gulf of Alaska. Longnose skates, as well as big skates, comprise the majority of the skate biomass in the Gulf of Alaska. In 2003 skate species in the Gulf of Alaska, and the Bering Sea and Aleutian Islands were assessed as a group rather than as separate species. In 2005 the skate assessments were updated, with the recommendation that no directed fisheries for skates be conducted in the Gulf of Alaska due to high incidental catch in groundfish and halibut fisheries. Also, the area-specific Allowable Biological Catches for big and longnose skates were recommended (Matta, *et al.* 2003).

In Canada historic information regarding skate catches goes back to the 1950's. Prior to 1990's skates were taken mostly as bycatch and landings were reported as part of a skate complex (not by species). As with the west coast, the trawl fishery is responsible for the largest amount of bycatch. Skate catches off British Columbia accelerated in the early 1990's, partly due to emerging Asian markets. Since 1996, longnose skate has been targeted by the B.C. trawl fishery and, as a result, catches have been more accurately reported. A longnose skate assessment has not been done for B.C., but in 2001 a review of elasmobranch biology, fisheries, assessment, and management was conducted to assess the current state of knowledge and to examine possible methods for assessing elasmobranch species, including longnose skates (Benson, *et al.* 2001).

Given the low economic value of skates, information about their fisheries and basic biology is scarce. On the west coast, longnose skate has been grouped with other species in an “Other Fish” category, for purposes of setting ABCs and OY. Since landings are routinely well below OYs for this category, trip limits have not been used for inseason management. In most areas of the world, management of skates has been a low priority, and where management and assessments are implemented, the available data are generally inadequate (Shoton 1999).

The longnose skate, like other elasmobranches, present an array of potential problems for fisheries management. Skates’ life history characteristics make them more susceptible to overfishing than teleost fishes. The most extreme case of overexploitation has been reported in the North Atlantic, where the common skate (*Dipturus batis*) has disappeared from the Irish Sea (Brander 1981) and much of the North Sea (Walker and Hislop 1998). However, given the low economic value of skates, information about their fisheries and even their basic biology is scarce, patchy and scattered (Bonfil 1994). The vulnerability of these species, combined with past collapses of elasmobranches fisheries elsewhere, underscores the importance of ascertaining the status of longnose skate on the west coast. However, the absence of a strong directed fishery for skates in this region, combined with reductions in trawl effort shoreward of 150 fm to promote rockfish stock rebuilding, reflect a different fishing environment than has characterized other fisheries with collapses in skate stocks.

The 2007 assessment is the first for this species and covers the population occupying the waters off California, Oregon and Washington (Gertseva and Schirripa 2008). Within this study area, the longnose skate population is treated as one fishery stock, due to the lack of biological and genetic data supporting the presence of multiple stocks. Landings data are primarily for a combined-skate category, and there are few periods of species composition sampling that inform on longnose skate. Historical landed catch was reconstructed from a variety of sources, and landings peaked in the mid-1990s due to Asian market demand.

The SS2 (version 2.00e) modeling program used for the 2007 assessment utilized a single-sex model. The unexploited level of spawning stock biomass for longnose skate is estimated to be 7,034 mt. At the beginning of 2007, the spawning stock biomass is estimated to be 4,634 mt, which represents 66 percent of the unfished stock level. The assessment shows that the stock of the longnose skate in the U.S. west coast is not overfished. Historically, the exploitation rate for the longnose skate has been low. It reached its maximum level of 4.02 percent in 1981. Currently, it is at the level of 1.25 percent.

The 2007 longnose skate assessment reflects a data-moderate to data-poor circumstance with respect to several influential model elements, including catch history, survey catchability, and some life history characteristics. Consequently, some critical assumptions were based on very limited supporting data and research. There are several research and data needs which, if satisfied, could improve the assessment. These research and data needs include studies on genetics, age, life history especially related to maturity and reproduction, behavior and distribution, discard mortality rates with trawl gear, and catchability by gear types. It is also very important to continue to conduct species-specific identification and monitor discard of the longnose skate to improve the accuracy of fishery catch data.

The GMT recommended that longnose skate continue to be managed under the Other Fish management complex. The Council will consider this recommendation during the 2009-2010 Groundfish Specifications decision-making process.

1.4.5 Other Flatfish

The Other Flatfish complex contains all the unassessed flatfish species in the Groundfish FMP. These species include butter sole (*Isopsetta isolepis*), curlfin sole (*Pleuronichthys decurrens*), flathead sole (*Hippoglossoides elassodon*), Pacific sanddab (*Citharichthys sordidus*), rex sole (*Glyptocephalus zachirus*), rock sole (*Lepidopsetta bilineata*), and sand sole (*Psettichthys melanostictus*).

Starry flounder (*Platichthys stellatus*) has been managed as part of the Other Flatfish complex (through 2006). However, with the first assessment of starry flounder in 2005 (Ralston 2006), the Council intends to manage this species with its own stock-specific ABC and OY.

1.5 Non-Groundfish Species

Non-groundfish species and the fisheries that target them often need to be considered in groundfish management for two reasons. First, these species may be caught incidentally in directed groundfish fisheries. Thus, management measures that change total fishing effort in groundfish fisheries could increase or decrease fishing mortality on the incidentally-caught species. Second, those fisheries targeting non-groundfish species may also incidentally catch groundfish. This source of groundfish mortality cannot be directly regulated through the Groundfish FMP, as such vessels do not hold federal groundfish permits; however, its impact still must be subtracted from the overall OY for that groundfish species. Such catch accounting is particularly critical for depleted species. This section briefly describes these non-groundfish species and associated fisheries, and for certain fisheries, notes mitigation measures that have been introduced to decrease their incidental take of groundfish.

Since vessels operating within the incidental groundfish Open Access fleet do not hold licenses under the grounfish FMP, it has been difficult to assure their compliance with closed areas established to protect depleted rockfish species (i.e. the Rockfish Conservation Areas). However a new technology adopted by the Council has made this accounting easier. Beginning in 2007, all commercial vessels that take and retain, possess, or land federally-managed groundfish species taken in federal waters or in state waters prior to transiting federal waters must employ VMS.

Observer programs within the groundfish fishery are important contributions toward the accurate monitoring and recording of incidental take, including that of non-groundfish species. However one program, the Shoreside Whiting Observer Program (SWOP), is of particular relevance here. SWOP was established in 1992 to examine bycatch in the directed Pacific whiting fishery. Participating vessels must carry an exempted fishing permit (EFP) issued by NMFS, and are required to retain all catch and to land unsorted catch at designated shoreside processing plants. In return, permitted vessels are not penalized for landing prohibited species (e.g., Pacific salmon, Pacific halibut, Dungeness crab), nor are they held liable for exceeding groundfish trip limits.

1.5.1 Salmon

Salmon are anadromous fish, spending a part of their life in ocean waters, but returning to freshwater rivers and streams to spawn and then die. Council-managed ocean salmon fisheries mainly catch Chinook and coho salmon (*Oncorhynchus tshawytscha* and *O. kisutch*); pink salmon (*O. gorbuscha*) are also caught in odd-numbered years, principally off of Washington. For further information on the species, as well as management actions and harvest levels, see the *Review of 2007 Ocean Salmon Fisheries* (PFMC 2008).

The salmon troll fishery has an incidental catch of Pacific halibut and groundfish; this is of particular significance with respect to canary rockfish catch. In addition, to account for yellowtail rockfish landed incidentally while not promoting targeting on the species, a federal regulation was adopted in 2001 that allowed salmon trollers to land up to one pound of yellowtail per two pounds of salmon, not to exceed 300 pounds per month (north of Cape Mendocino).

Groundfish fisheries catch salmon incidentally. The Protected Species Chapter discusses the impacts on ESA-listed salmon in further detail. For both ESA-listed and non ESA-listed salmon species, incidental catch is highest in the limited entry groundfish trawl (whiting and non-whiting) sector. Bycatch of salmon by the groundfish trawl fleet is generally restricted to encounters with Chinook. Data from the west coast Groundfish Observer Program indicated an order of magnitude drop in coastwide Chinook bycatch for non-whiting limited entry trawl between 2003 to 2004; the reduction can be attributed to a large degree to a decrease in nearshore trawl effort, where salmon bycatch is usually highest (Hastie 2005). On the other hand, there was an order of magnitude increase in bycatch by the whiting fishery between 2004 and 2005.

1.5.2 Pacific Halibut

Pacific halibut (*Hippoglossus stenolepis*) belong to a family of flounders called *Pleuronectidae*. Pacific halibut are managed by the bilateral (U.S./Canada) International IPHC with implementing regulations set by Canada and the U.S. in their own waters. The Pacific Halibut Catch Sharing Plan for waters off Washington, Oregon, and California (Area 2A) specifies IPHC management measures for Pacific halibut on the west coast. Implementation of IPHC catch levels and regulations is the responsibility of the Council, the states of Washington, Oregon, and California, and the Pacific halibut treaty tribes.

Of groundfish fisheries, the fixed gear sablefish fishery is responsible for the most catch of Pacific halibut. To allow landing of these halibut, the Catch Sharing Plan stipulates that when the Area 2A total allowable catch (TAC) is above 900,000 pounds, halibut may be retained in the limited entry primary sablefish fishery north of Point Chehalis, Washington (46°53' 18" N latitude). Rockfish have been commonly caught historically in the halibut fishery. However, encounters have been significantly reduced over recent years by restricting the fishery to set depth greater than 100 fm.

1.5.3 Coastal Pelagic Species

Coastal pelagic species (CPS) are schooling fish, not associated with the ocean bottom, that migrate in coastal waters. These species include: northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and market squid (Decapoda spp.). For further information on the species, as well as management actions and harvest levels, see the 2005 CPS Stock Assessment and Fishery Evaluation (SAFE) document (PFMC 2005).

The catch of groundfish in CPS fisheries is negligible, and retention is prohibited. The whiting fishery accounts for a minor proportion of the catch of Pacific mackerel and jack mackerel; the federal harvest guideline for these mackerel species has not been met in recent years.

1.5.4 Highly Migratory Species

Highly migratory species (HMS) include tunas, billfish, dorado, and sharks—species that range great distances during their lifetime, extending beyond national boundaries into international waters and among the EEZs of many nations in the Pacific. In 2003, the Council adopted a HMS FMP to federally regulate the take of HMS within and outside the U.S. west coast EEZ. The FMP (PFMC 2003b) describes management unit species in detail; these are five tuna species, five shark species, striped marlin, swordfish, and dorado (dolphinfish).

The catch of HMS in groundfish fisheries are considered to be negligible.

Using federal observer data, it was concluded that bycatch of Pacific whiting and yellowtail rockfish in the drift gillnet fishery is considered "major" (greater than ten individuals per 100 sets observed) for the period of 2001–04 (PFMC, *et al.* 2006). Also, a notable source of groundfish species mortality within the HMS fishery has been due to "mixed trips," in which a vessel operating under a VMS license also targets groundfish during a single trip. The expansion of VMS coverage into the open access sector may contribute to a reduction of mixed trip impact on depleted species. Without the vessel monitoring system (VMS) requirement (which went into effect in February 2008), the activity of vessels under HMS permits within RCAs has been unknown, and it is possible that the vessels were targeting groundfish within these restricted areas.

1.5.5 Dungeness Crab

The Dungeness crab (*Cancer magister*) is distributed from the Aleutian Islands, Alaska, to Monterey Bay, California. It lives in bays, inlets, around estuaries, and on the continental shelf. Dungeness crab is found to a depth of about 180 m. Although it is found at times on mud and gravel, this crab is most abundant on sand bottoms; frequently it occurs among eelgrass. It is typically harvested using traps (crab pots), ring nets, by hand (scuba divers), or dip nets. Dungeness crab are managed by the states of Oregon and California, and by the State of Washington in cooperation with Washington Coast treaty tribes, and with inter-state coordination through the Pacific States Marine Fisheries Commission.

Dungeness crab is taken incidentally, or harmed unintentionally, by groundfish gears. In some areas, encounter with Dungeness crab by nearshore flatfish trawls is common. These encounter rates were one of criteria the Council considered when deciding to set the nearshore RCA boundary as seaward as possible. The incidental catch of depleted groundfish species is considered to be negligible.

1.5.6 Greenlings (other than kelp greenling), Ocean Whitefish, and California Sheephead

California sheephead (*Semicossyphus pulcher*) are a large member of the wrasse family *Labridae*. They range from Monterey Bay south to Guadalupe Island in central Baja California and the Gulf of California, in Mexico, but are uncommon north of Point Conception. They are associated with rocky bottom habitats, particularly in kelp beds to 55 m, but more commonly at depths of three m to 30 m. They can live to 50 years of age and a maximum length of 91 cm (16 kg). Like some other wrasse species, California sheephead change sex starting first as a female, but changing to a male at about 30 cm in length.

Ocean whitefish (*Caulolatilus princeps)* occur as far north as Vancouver Island in British Columbia, but are rare north of Central California. A solitary species, they inhabit rocky bottoms and are also found on soft sand and mud bottoms. Whitefish dig into the substrate for food.

In California, California sheephead and ocean whitefish are each managed by CDFG. Both are predominantly caught by the recreational fishery. Catch of California sheephead and ocean whitefish in the recreational fishery are restricted within the CCA to minimize interaction with cowcod.

While kelp greenling, managed under the Groundfish FMP, represents the majority of the greenling that are caught; the other species, rock, painted, and white spotted greenling, are managed by the states. Minimal take of rock greenling occurs in the commercial and recreational fisheries in California. It is often taken in conjunction with fishing for federally managed groundfish, primarily nearshore rockfish and cabezon.

1.5.7 Pink Shrimp

Pacific pink shrimp (*Pandalus jordani*) are found from Unalaska in the Aleutian Islands to San Diego, California, at depths of 25 fm to 200 fm (46 m to 366 m). Off the U.S. west coast these shrimp are harvested with trawl gear from Northern Washington to Central California, with the majority of the catch taken off the coast of Oregon. Pacific shrimp fisheries are managed by the states of Washington, Oregon, and California; the Council has no direct management authority.

Concentrations of pink shrimp are associated with well-defined areas of green mud and muddy-sand bottoms. Shrimp trawl nets are usually constructed with net mesh sizes smaller than the net mesh sizes for legal groundfish trawl gear. Thus, it is shrimp trawlers that commonly take groundfish in association with shrimp, rather than the reverse. In the past, the pink shrimp fishery had been responsible in some years for a significant proportion of canary rockfish incidental catch. However, such impact has been reduced to a negligible amount because of bycatch reduction devices (BRDs) that are now required on all vessels in this fishery. BRDs are added to the trawl net and divert finfish out of the codend of the net, where the shrimp catch is accumulated.

1.5.8 California Halibut

California halibut (*Paralichthys californicus*) are a left-eyed flatfish of the family *Bothidae*. They range from Northern Washington to southern Baja California, Mexico, (Eschmeyer, *et al.* 1983), but are most common south of Oregon. The species can be targeted by trawl vessels south of Point Arena, CA (38°57.50' N latitude). It is a state-managed species, and participation in the open-access fishery for California halibut does not require specific permits. California halibut is, at most, an ancillary fishery for limited-entry trawlers in California (Hastie 2005). The California halibut fishery is known to take only minimal amounts of depleted groundfish species; for example, the Council’s Groundfish Management Team estimated that, in 2005, the fishery was responsible for 0.1 mt mortality of bocaccio rockfish and 0.0 mt of all other depleted groundfish species.

1.5.9 Ridgeback and Spot Prawns

Ridgeback prawns (*Sicyonia ingentis*) are found from Monterey, California south to Baja California, Mexico, in depths of 145 metric feet to 525 metric feet (Sunada, *et al.* 2001). They are more abundant south of Point Conception and are the most common invertebrate appearing in trawls. Their preferred habitat is sand, shell and green mud substrate, and relatively sessile. They are prey for sea robins, rockfish, and lingcod. The Ridgeback prawn fishery occurs exclusively in California, centered in the Santa Barbara Channel and off Santa Monica Bay. The ridgeback prawn fishery is managed by the State of California and, similar to spot prawn and pink shrimp, is considered an “exempted” trawl gear in the federal open access groundfish fishery, entitling the fishery to groundfish trip limits. However, the catch of depleted groundfish in the ridgeback prawn fishery is considered to be negligible.

Spot prawn (*Pandalus platyceros*) are the largest of the pandalid shrimp and range from Baja California, Mexico, north to the Aleutian Islands and west to the Korean Strait (Larson 2001). They inhabit rocky or hard bottoms including coral reefs, glass sponge reefs, and the edges of marine canyons. They have a patchy distribution, which may result from active habitat selection and larval transport. Spot prawn are Hermaphroditic. Spot prawn fisheries are state-managed. The use of trawl gear to target spot prawn has been banned in all three states; the spot prawn pot fishery that remains is considered to have no incidental bycatch of depleted groundfish species.

1.5.10 Sea Cucumbers

Two sea cucumber species are targeted commercially: the California sea cucumber (*Parastichopus californicus*), also known as the giant red sea cucumber, and the warty sea cucumber (*P. parvimensis*) (Rogers-Bennett and Ono 2001). These species are tube-shaped Echinoderms, a phylum that also includes sea stars and sea urchins. The California sea cucumber occurs as far north as Alaska, while the warty sea cucumber is uncommon north of Point Conception and does not occur north of Monterey. Both species are found in the intertidal zone to as deep as 300 feet and are bottom-dwelling organisms.

Along the west coast, sea cucumbers are harvested by diving or trawling, and the fisheries are managed by the states. The warty sea cucumber is fished almost exclusively by divers. The California sea cucumber is caught principally by trawling in Southern California, but is targeted by divers in Northern California. The sea cucumber trawl fishery occurs over sandy flat habitat off of Santa Barbara (south of Point Conception), an area with no rocky outcroppings. Given that habitat, the fishery is considered to have negligible bycatch of depleted species.

CHAPTER 2 WEST COAST MARINE ECOSYSTEMS AND ESSENTIAL FISH HABITAT

2.1 Affected Environment

2.1.1 West Coast Marine Ecosystems

The term ecosystem is generally defined as a "functional unit of the environment" within which the basic processes of energy flow and cycling are identifiable and can be (relatively) localized. In this sense, marine ecosystems are extremely difficult to identify, as most are relatively open systems, with poorly defined boundaries and strong interactions across broad spatial scales. The California Current ecosystem, like other Eastern boundary current ecosystems, are especially difficult to define, as they are characterized by tremendous fluctuations in physical conditions and productivity over multiple time scales (Mann and Lazier 1996; Parrish, *et al.* 1981). Food webs tend to be structured around coastal pelagic species (CPS) that exhibit boom-bust cycles over decadal time scales (Bakun 1996; Schwartzlose, *et al.* 1999). Similarly, the top trophic levels of such ecosystems are often dominated by highly migratory species such as salmon, albacore tuna, sooty shearwaters, fur seals and baleen whales, whose dynamics may be partially or wholly driven by processes in entirely different ecosystems, even different hemispheres. For this analysis, the ecosystem is considered in terms of physical and biological oceanography, climate, biogeography, essential fish habitat (EFH), marine protected areas, and the role of depleted species' rebuilding in the marine ecosystem.

2.1.2 Physical and Biological Oceanography

The California Current is essentially the eastern limb of the Central Pacific Gyre, and begins where the west wind drift (or the North Pacific Current) reaches the North American Continent. This occurs near the northern end of Vancouver Island, roughly between 45° and 50° N latitude and 130° to 150° W longitude (Ware and McFarlane 1989). A divergence in the prevailing wind patterns causes the west wind drift to split into two broad coastal currents, the California Current to the south and the Alaska Current to the north. As there are really several dominant currents in the region, all of which vary in geographical location, intensity, and direction with the seasons, this region is often referred to as the California Current System (Hickey 1979).

The California Current itself is a year-round feature consisting of a massive southward flow of the cool waters of the west wind drift. The current is best characterized as a shallow, wide, and slow-moving body of water, ranging from the shelf break to 1,000 km offshore, with the strongest flows at the sea surface, and in the summertime (Dodimead, *et al.* 1963; Hickey 1979; Lynn and Simpson 1987). This surface current is matched in the summer by the California Undercurrent, which moves water northward from the south in a deep yet narrow band of subtropical water typically found just off of the shelf break at depths of 100 to 300 m. The undercurrent flows from Baja California to Vancouver Island, transporting warmer, saltier southern water north along the coast (Hickey 1979). On average, the California Current flow volume reaches a maximum in spring and summer, when the flow moves inshore, closer to the shelf break. The California Undercurrent develops in late spring through early summer and persists into the fall. During late summer and fall, there is considerably more mesoscale variability in flow patterns, with fields of cyclonic and anticyclonic eddies and considerable mixing of water masses between shelf and offshore waters (Brink and Cowles 1991). Beginning in the fall, and through the winter, the northward flowing Davidson Current is the dominant feature over the shelf and beyond the shelf break (Hickey 1998).

Current dynamics over the continental shelf are generally forced by regional wind fields, which tend to be southerly in the spring and summer, and northerly in the winter. Spring and summer winds drive offshore Ekman transport of surface waters, which is balanced by the upwelling of deeper waters that tend to be cooler and nutrient rich. Between the Strait of Juan de Fuca and Cape Blanco, summer upwelling leads to the development of a southward flowing upwelling jet over the continental shelf (Barth, *et al.* 2000; Hickey 1998). The shelf narrows as it approaches Cape Blanco, intensifying the energy of the jet (Barth, *et al.* 2000; Batteen 1997). As this jet reaches Cape Blanco it turns sharply offshore, mixing the cool, nutrient rich waters of the jet with the warmer, less productive waters of the slow-moving California Current. These interactions lead to the development of eddy fields and mesoscale variability in primary and secondary productivity that distinguish the region south of Cape Blanco from that to the north (Strub, *et al.* 1991). All these currents, countercurrents, undercurrents, jets, and meanders transport water masses of different origins and characteristics, as well as the nutrients and organisms entrained within them, to the California Current System.

Wickett (1967) demonstrated that secondary productivity off southern California was influenced by the advection of northern water from the west wind drift, such that interannual differences in southern Ekman transport explained 50 to 60 percent of the variance in zooplankton biomass. Chelton, et al. (1982) followed up these observations by observing that when the bulk of the divergent flow is to the south, the California Current experiences greater southward transport, more productive source waters and higher secondary production in the region off of southern California. Fulton and LeBrasseur (1985) further demonstrated that the zooplankton biomass, and even the mean size of copepods, was greater in the northern portion of the California Current when transport was high. Ongoing research has continued to demonstrate that climate-driven changes in transport and ocean conditions dramatically affect both the species composition and productivity of zooplankton in the northern California Current (Mackas, *et al.* 2005; Peterson, *et al.* 2002; Peterson and Schwing 2003). Thus, while local wind fields and coastal upwelling ultimately drive much of the primary production at the base of the food web, growing evidence suggests that large-scale physical processes and associated changes in the community composition of zooplankton is a significant factor in determining the overall productivity of the ecosystem (Feinberg and Peterson 2003; Peterson and Keister 2003; Swartman and Hickey 2003).

2.1.3 Interannual and Interdecadal Climate Forcing

The effects of climate on the biota of the California Current ecosystem have been recognized for some time. Hubbs (1948) believed so strongly in the correlation between water temperature and fish distributions that he felt "justified in drawing inferences, from the known data on fish distribution, regarding ocean temperatures of the past." It is worth noting that Hubbs had already drawn distinctions between eras that seemed to be associated with the establishment of warm-water populations over long time periods, and the occasional warm years (generally associated with stronger El Niño events) that brought irregular tropical or subtropical fish much further north along the coast.

Currently, the El Niño/Southern Oscillation (ENSO) is widely recognized to be the dominant mode of interannual variability in the equatorial Pacific, with impacts throughout the rest of the Pacific basin and the globe (Mann and Lazier 1996). During the negative (El Niño) phase of the ENSO cycle, jet stream winds are typically diverted northward, often resulting in increased exposure of the west coast of the U.S. to subtropical weather systems. Concurrently, coastally trapped waves propagate the equatorial ENSO signal northward along the west coast of Central and North America as far as the subarctic, resulting in increased northern advection, warmer sea surface (and subsurface) temperatures, elevated coastal sea levels, and deepened thermoclines (Bakun 1996). The impacts of these events to the coastal ocean generally include reduced upwelling winds, deepening of the thermocline, intrusion of offshore (subtropical) waters, dramatic declines in primary and secondary production, poor recruitment, reduced growth and survival of many resident species (such as salmon and groundfish), and northward extensions in the range of many tropical species (McGowan, *et al.* 1998; Pearcy 2002; Pearcy and Schoener 1987; Wooster, *et al.* 1985). There is reduced availability of many forage species, particularly market squid, and juvenile survival of most rockfish is extremely low. Concurrently, top predators such as seabirds and pinnipeds often exhibit reproductive failure.

In addition to interannual variability in ocean conditions, the North Pacific seems to exhibit substantial interdecadal variability. Mantua et al. (1997) first defined what is now commonly referred to as the Pacific (inter) Decadal Oscillation (PDO), which is defined as the leading principal component of North Pacific (above 20° N latitude) sea surface temperatures between 1900 and 1993, and superficially resembles ENSO over a decadal time scale. During positive regimes, coastal sea surface temperatures in both the Gulf of Alaska and the California Current tend to be higher, while those in the North Pacific Gyre tend to be lower; the converse is true in negative regimes. Evidence suggests that there have been two full PDO cycles in the 20th century. Cool (negative PDO) regimes occurred between 1890 and 1924, and from 1947 to 1976, while warm (positive PDO) regimes from 1925 to 1946 and again from 1977 to 1999. Variation in the productivity of salmon stocks throughout the Northeast Pacific seems to track these changes in ocean temperature, such that positive PDO regimes are associated with increased productivity of salmon stocks from western Alaska to northern British Columbia, and negative regimes favor stocks from California to southern British Columbia (Hare, *et al.* 1999; Mantua, *et al.* 1997).

Although the precise mechanism for the PDO remains elusive, the pattern is clearly linked to variability in atmospheric conditions. The average wintertime Aleutian low both deepened and moved eastward in the post-1977 regime (Mantua, *et al.* 1997), resulting in considerably stronger eastward wind stress (Parrish, *et al.* 2001). This increase in wind stress has been tied to the observed cooling (and increased productivity) of the waters in the central North Pacific and Alaska Gyre (Brodeur and Ware 1992; Polovina, *et al.* 1995), and the consequent warming of coastal waters in the Gulf of Alaska and California Current (Mantua, *et al.* 1997). In a more recent effort to quantify the broad scale impacts of the PDO on Northeast Pacific ecosystems, Hare and Mantua (2000) compiled 100 physical and biological time series throughout the Northeast Pacific, including time series of recruitment and abundance for commercially important coastal pelagics, groundfish and invertebrates. They found that the dominant principal component of these 100 time series has the same trajectory as the PDO, consistent with anecdotal accounts of covariance between the PDO and many other physical and biological indices.

Growing evidence also suggests that the PDO may have shifted from a positive to negative regime since 1999, as the period between 1999 and 2002 was associated with a negative PDO signal, cool coastal ocean temperatures, high southward transport, and tremendous salmon productivity (Peterson and Schwing 2003). However, since that period there has been considerable confusion with respect to whether a shift in the PDO did actually occur, or even whether the PDO remains a dominant mode of variability in North Pacific Climate (Bond, *et al.* 2003; Goericke, *et al.* 2005b; Goericke, *et al.* 2005a). The degree to which long-term warming is affecting the world's oceans and its ecosystems relative to other forms of variability is currently a major concern, and the consequent interactions between monotonic (global change), interdecadal (PDO) and interannual (ENSO) climate variability are difficult to disentangle. Although a great many processes drive changes in sea surface temperature trends over multiple time scales, there is growing consensus that the integrated heat content of the global oceans has been increasing, and can only be adequately accounted for by atmospheric forcing attributed to the accumulation of greenhouse gasses in the atmosphere (Barnett, *et al.* 2005; Barnett, *et al.* 2001; Levitus, *et al.* 2000).

Within the California Current itself, (Mendelssohn, *et al.* 2003) described long-term warming trends in the upper 50 to 75 m of the water column using subsurface temperature records in the California Current over the past 50 years. McGowan, et al. (1998) attributed significant long-term declines in zooplankton populations in the California Current over the same period to increased water temperatures that resulted in an intensification of stratification and a reduction of nutrient regeneration into surface waters. Recent paleoecological studies from marine sediments also indicate that 20th century warming trend in the California Current have exceeded natural variability in ocean temperatures over the last 1,400 years (Field, *et al.* 2006a). All of this evidence suggests that although the development of statistical indices of climate variability across multiple time scales have improved our understanding of how climate has affected North Pacific ecosystems and productivity in the past, the future remains subject to extremely poor predictability.

2.1.4 Biogeography

Biogeography describes spatial patterns of biological distribution. Along the U.S. west coast within the California Current system, such patterns have been observed to be influenced by various factors including depth, ocean conditions, and latitude. Each are discussed in the remainder of this section.

At the scale of the ecosystem, the most widely recognized patterns are distinct zoogeographic provinces extending North and South of Point Conception, California, known as the Oregonian and San Diego Provinces. The Oregonian Province extends from the Straight of Juan de Fuca in the North to Point Conception in the South. The San Diego Province begins at Point Conception and runs south past the terminus of the EEZ (NMFS 2004).

Patterns of adult groundfish distribution based on depth have been observed to occur between nearshore, continental shelf, and the continental slope and have been used to form discrete management units. This information is detailed in 4.1. Botsford and Lawrence (2002) showed considerable spatial and temporal synchrony in coho salmon and Dungeness crab catches among ports and regions in the California Current between 1950 and 1990; interestingly, they also found that Chinook landings did not have spatial coherence. Similarly, Field and Ralston (Field and Ralston 2005) showed that 51-72 percent of the year-to-year variability in recruitment for three winter spawning rockfish (yellowtail, widow and chilipepper) seems to be shared coastwide, over a spatial scale of 500-1,000 km. The major differences in recruitment strength seemed to be associated with Cape Blanco and/or Cape Mendocino, and some evidence suggests differences in relative year class strength north and south of Point Conception as well. With respect to genetic evidence for biogeographic boundaries, Hedgecock (1994) found that fish and invertebrates with planktonic larvae generally maintain low spatial genetic variance over large (500-2000 km) regions in the California Current. Analysis of a range of *Sebastes* species also suggests little genetic differentiation within the California Current region (McGauley and Mulligan 1995; Rocha-Olivares and Vetter 1999; Wishard, *et al.* 1980), although some nearshore species may exhibit greater spatial patterns of population substructure, particularly north and south of Cape Mendocino (Cope 2004).

Williams and Ralston (2002) found that Cape Mendocino (and the Mendocino Escarpment) was one of the most noteworthy barriers to the latitudinal distribution of rockfish species diversity. Most stock assessments for groundfish tend to be either coastwide assessments, or are relative to the stocks north or south of Cape Mendocino (occasionally Cape Blanco). Both Cape Mendocino and Point Conception are key management boundaries for the Council. In general, evidence suggests wide to very wide dispersal of larvae and juveniles for most groundfish, with modest to limited movement of adults (general on the scale of thousands of kilometers for most species, with limited examples of small numbers of some populations moving in the hundreds of kilometers). There are strong seasonal inshore and offshore migrations for many species, particularly flatfish, and some evidence for ontogenetic movement in some species by both/either depth and latitude. Pacific hake are the only confirmed highly migratory groundfish species in the FMP, with a clear seasonal migration from southern spawning grounds off of northern Mexico and Southern California to northern foraging habitat off of Oregon, Washington, and British Columbia (Bailey, *et al.* 1982). There is an ontogenetic component to this migration, as juveniles tend to be found off of central and northern California, with larger, older fish tending to travel further north. Similarly, the distribution of hake tends to be more northerly in warm years (Dorn 1995; Swartman and Hickey 2003), reflecting interannual shifts in marine habitat conditions.

While the physical and bathymetric features associated with these general biogeographic boundaries are fixed in space, the physical characteristics of water masses and associated plankton communities are clearly highly dynamic in space and time (as discussed in Section 3.1.2). Fulton and LeBrasseur (1985) described a transport-driven shifting subarctic domain in the northern reaches of the California Current System, the margin of which was characterized by abrupt declines in zooplankton biomass south of the subarctic boundary. Although the physical dynamics are now thought to be more complex than their model, it is clear that climate driven changes in transport and ocean conditions dramatically alter both the species composition and productivity of zooplankton throughout the California Current to a considerably greater extent than static boundaries based on geography (Mackas, *et al.* 2005; McGowan, *et al.* 1998; Peterson, *et al.* 2002; Peterson and Schwing 2003).

For example, in the late 1960s and early 1970s, the dominant copepod species in the Northern California Current during the summer tended to be subarctic (or boreal) types such as *Pseudocalanus mimus*, *Calanus marshallae* and *Arcatioa longiremis*; species that are commonly found over shelf waters throughout the Gulf of Alaska (Peterson and Miller 1977). Data suggest that northern species became relatively less abundant, while southern (subtropical) species such as *Paracalanus parvus* and *Calanus pacificus* were more abundant through the 1980s and early 1990s. These southern species were almost completely dominant during the 1997–98 El Niño, at which time standing biomass was near all time lows (Peterson, *et al.* 2002). Since 1999, northern species have again dominated numerically during spring and summer, and the standing biomass of zooplankton off of Oregon has been roughly double that observed prior to 1999 (Peterson and Schwing 2003).

In the CalCOFI region, the 1999 regime shift was associated with a substantially greater shift in zooplankton abundance, with a roughly tenfold increase (one order of magnitude) in seasonally detrended zooplankton abundance between 1998 and 1999 (Goericke, *et al.* 2007). This rapid transition from the 1997-1998 El Nino event to the cool conditions of 1999-2002 were also associated with tremendous recruitment in virtually all west coast groundfish, as evidenced by the age and size composition data available in stock assessment models in both the 2005 and 2007 stock assessment cycles. For most stocks in which recruitment events are reasonably well specified by the data (recruit tends to be poorly specified over time stocks with slow growth rates and/or little age data) the 1999 recruitment was estimated to be as great or greater than any recruitment over the preceding 10 to 20 years; for example, the 1999 bocaccio year class was the largest since 1989, resulting in a near doubling of stock spawning biomass between 1999 and 2005; the 1999 Pacific hake year class was the largest since 1984, which effectively doubled the stock biomass between 2000 and 2003; and the 1999 and 2000 lingcod year classes were the second and third largest since the early 1970s, resulting in greater than a tripling in abundance between 1999 and 2005. While there are signs of reasonably strong year classes in 2003 for some stocks, recent indices of recruitment from midwater trawl surveys and other sources have tended to indicate poor recruitment for most stocks since 2003, with particularly low levels of juvenile rockfish abundance observed in 2005 through 2007, a year in which low secondary productivity, anomalous upwelling conditions, and widespread die offs of some seabirds reflected unusual and generally unfavorable ocean conditions for many elements of the ecosystem (Goericke, *et al.* 2007; Sydeman, *et al.* 2006). As the production of eggs and larvae for most west coast groundfish appears to be only modestly related to interannual changes in ocean conditions (Harvey 2005), the causes of these strong year classes are thought to be related to post-spawning (or post-parturition) survival of larval and juvenile life history stages, although the mechanism remains elusive.

2.1.5 Essential Fish Habitat

EFH has been described within the project area for highly migratory species, CPS, salmon, and groundfish. The MSA defines EFH to mean "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 U.S.C. 1802 sec. 3(10)). Regulatory guidelines elaborate that the words "essential" and "necessary" mean EFH should be sufficient to "support a population adequate to maintain a sustainable fishery and the managed species' contributions to a healthy ecosystem." The regulatory guidelines also establish authority for Councils to designate Habitat Areas of Particular Concern (HAPC) based on the vulnerability and ecological value of specific habitat types. Councils are required to minimize, to the extent practicable, the adverse of fishing or of EFH. NMFS works through a consultation process to minimize adverse effects of non-fishing activities (50 CFR 600 subpart J).

2.1.5.1 *Coastal Pelagic Species*

The CPS fishery includes four finfish (Pacific sardine, Pacific [chub] mackerel, northern anchovy, and jack mackerel) and market squid. CPS finfish generally live nearer to the surface than the sea floor. The definition of EFH for CPS is based on the temperature range where they are found, and on the geographic area where they occur at any life stage. This range varies widely according to ocean temperatures. The EFH for CPS also takes into account where these species have been found in the past, and where they may be found in the future.

The east-west boundary of EFH for CPS includes all marine and estuary waters from the coasts of California, Oregon, and Washington to the limits of the EEZ (the 200-mile limit) and above the thermocline where sea surface temperatures range between 10°C and 26°C. (A thermocline is an area where water temperatures change rapidly, usually from colder at the bottom to warmer on top). The southern boundary is the U.S.-Mexico maritime boundary. The northern boundary is more changeable, and is defined as the position of the 10°C isotherm, which varies seasonally and annually. (The 10°C isotherm is a rough estimate of the lowest temperature where finfish are found, and thus represents their northern boundary.) In years with cold winter sea surface temperatures, the 10°C isotherm during February is around 43° N latitude offshore, and slightly further south along the coast. In August, this northern boundary moves up to Canada or Alaska. A more complete description of CPS and associated EFH is contained in the CPS FMP, which is incorporated herein by reference.

2.1.5.2 *Salmon*

Salmon range from more than 1,000 miles inland to thousands of miles out at-sea. Although the waters off Canada are salmon habitat, they are also not included in the description of salmon EFH because they are outside of U.S. jurisdiction. However, waters off Alaska are included in the description.

In estuaries and marine areas, salmon habitat extends from the shoreline to the 200-mile limit of the EEZ and beyond. In freshwater, salmon EFH includes all the lakes, streams, ponds, rivers, wetlands, and other bodies of water that have been historically accessible to salmon. The description of EFH also includes areas above artificial barriers, except for certain barriers and dams that fish cannot pass. However, activities that occur above these barriers and that are likely to affect salmon below the barriers may be affected by court rulings from ongoing EFH-related litigation.

The Council is required to minimize the negative impacts of fishing activities on essential salmon habitat. The ocean activities that the Council is concerned with include the effects of fishing gear, removal of salmon prey by other fisheries, and the effect of salmon fishing on reducing nutrients in streams due to fewer salmon carcasses in the spawning grounds. The Council may use gear restrictions, time and area closures, and harvest limits to reduce negative impacts on salmon EFH.

The Council is also required to comment and make recommendations regarding other agencies' actions that may affect salmon EFH. This usually takes the form of endorsing an enhancement program or other type of program, requesting information and justification for actions that might affect salmon habitat, and promoting the needs of the salmon fisheries. The Council works with many other agencies to identify cumulative impacts on salmon habitat, to encourage conservation, and to take other actions to protect salmon habitat. A more complete description of salmon and associated EFH is contained in the salmon FMP, which is incorporated herein by reference.

2.1.5.3 *Highly Migratory Species*

These species (tuna, swordfish, and sharks) range widely in the ocean, both in terms of area and depth. Highly migratory species (HMS) are usually not associated with the features that are typically considered fish habitat (such as seagrass beds, rocky bottoms, or estuaries). Their habitat may be defined by temperature ranges, salinity, oxygen levels, currents, shelf edges, and sea mounts. Little is known about why highly migratory species frequent particular areas. Nevertheless, these species may be affected by actions close to shore or on land, such as fishing, dredging, wastewater discharge, oil and gas exploration and production, aquaculture, water withdrawals, release of hazardous materials, and coastal development. A more complete description of HMS and associated EFH is contained in the HMS FMP which is incorporated herein by reference.

2.1.5.4 *Groundfish*

The Council first identified groundfish EFH in 1998 via Amendment 11 to the FMP. Because information about each groundfish species' habitat was limited, EFH was defined as the whole west coast EEZ. However, in 2000, based on the *American Oceans Campaign* v. *Daley* court case, the Council was directed to revisit the question of groundfish EFH. In 2001, NMFS Northwest Region staff began work on an EIS for groundfish EFH off Washington, Oregon, and California, which after several years of work was finalized in 2005. The Council's preferred alternative in the final EIS became Amendment 19 to the Groundfish FMP in 2006.

EFH for groundfish is described as all waters from the high tide line (and parts of estuaries) to 3,500 meters (1,914 fathoms) in depth. HAPCs are a subset of EFH used to focus management and restoration efforts. The current HAPC types are: estuaries, canopy kelp, seagrass, rocky reefs, and “areas of interest” (a variety of submarine features, such as banks, seamounts, and canyons, along with Washington state waters).

In addition to identifying EFH and describing HAPCs, the Council also adopted mitigation measures directed at the adverse impacts of fishing on groundfish EFH. Principal among these are closed areas to protect sensitive habitats. There are three types of closed areas: bottom trawl closed areas, bottom contact closed areas, and a bottom trawl footprint closure. The bottom trawl closed areas are closed to all types of bottom trawl fishing gear. The bottom trawl footprint closure closes areas in the EEZ between 1,280 m (700 fm) and 3,500 m (1,094 fm), which is the outer extent of groundfish EFH. The bottom contact closed areas are closed to all types of bottom contact gear intended to make contact with the bottom during fishing operations, which includes fixed gear such as longline and pots. A more complete description of groundfish and associated EFH is contained in the Groundfish FMP, which is incorporated herein by reference.

The question of monitoring EFH areas, and approaches for explicitly accounting for EFH (and other) area-closures in surveys and stock assessments remains a somewhat unresolved issue (Field, *et al.* 2006c). Fishery-independent surveys are specifically designed to be a reliable source of information on trends in stock abundance (NRC 1998), and on the west coast, the results from bottom trawl (and other) surveys are used in most stock assessments of shelf and slope species. Most fishery-independent survey techniques involve lethal sampling (e.g. to obtain otoliths for age determination) and may impact the habitat. Although monitoring is typically considered to be an essential element of marine protected areas (MPA) based approaches for resource management (Gerber, *et al.* 2005; National Research Council 2001), the issue of how to monitor has the potential to be controversial if extractive methods have been used in traditional surveys. On the west coast, over five percent of historical shelf survey tows, and nearly ten percent of historical slope survey tows, have been conducted in the recently implemented EFH areas (Field, *et al.* 2006c). If surveys were excluded or constrained from MPAs, the ability to track abundance and demographics throughout the range of a species could be compromised, although establishing MPAs in areas with complex bottom topography, or other areas in which trawl survey methods have not been used, would have negligible impacts (not surprisingly, a higher rate of bad performance tows have been documented from EFH areas, consistent with the intent of protecting high relief habitat). Even with no constraints on surveys, the imposition of a (large) MPA may have substantial implications for survey stratification and design, as changes in the abundance and demographic composition of stocks inside MPAs could lead to the need to either stratify survey effort, or post-stratify survey results, with explicit consideration of MPA boundaries. For example, along the U.S. East coast, most of the biomass of yellowtail flounder (*Limanda ferruginea*) has been found within the closed areas implemented to rebuild that (and other) groundfish stocks (Legault and Stone 2004). The failure to allocate and stratify survey effort consistently within and outside of these areas could result in increasing the variance in the abundance time-series, as could the simple consequence of having greater spatial heterogeneity in the distribution of the resource itself.

2.1.6 Marine Protected Areas

In addition to the closed areas described above, there are marine protected areas distributed throughout the project area. The EIS for Pacific Coast Groundfish EFH contains a complete analysis of these sites and is incorporated here by reference. The following is a brief summary of these areas.

Federally Designated Marine Managed Areas

- Twenty-eight National Wildlife Refuges, covering approximately 89,000 ha. Regulations vary by refuge, but generally, commercial fishing is not allowed in most refuges.
- Seven National Parks, covering approximately 570,000 ha (although only a small fraction of this area is the marine portion of the parks). Regulations vary by park.
- Five National Marine Sanctuaries covering approximately 3,000,000 ha. Regulations vary by sanctuary, but in general, all types of fishing are allowed in Federal waters of the sanctuaries.
- Four National Estuarine Research Reserves (NERR), covering approximately 8,000 ha. All fishing and fishing gear are prohibited from the Tijuana River NERR and the Elkhorn Slough NERR (which doesn't include the Slough's main channel). All other NERR sites allow or do not address specific fishing regulations.

Other Federal Areas

These are some additional areas under Federal jurisdiction that may have restrictions to vessel access, rather than specific regulations having to do with fishing or fishing gear. These data were developed in 1998 by Al Didier for the Pacific States Marine Fisheries Commission (PSMFC), so the total number of areas may have changed since these data were compiled.

- Twenty-two Regulated Navigation Areas (33CFR165) cover approximately 17,000 ha, and are located generally in urban areas such as Puget Sound, Columbia River, San Francisco Bay, Los Angeles, and San Diego.
- Forty-nine Danger Zones and Restricted Areas (33CFR334) cover approximately 170,000 ha. These are located in Puget Sound, San Francisco Bay, Monterey Bay, between Morro Bay and Point Conception, off some of the Channel Islands, and a few additional southern California locations.
- Twenty-seven weather and scientific buoys. Two buoys are located off the Washington coast, one is located off the Oregon coast, and twenty buoys are located off the California coast, with six of these located off Monterey Bay. Four of these buoys are located outside the EEZ.

Fishing regulated areas established by the Council:

- Rockfish Conservation Areas (RCAs): These areas have changed over time, as well as having a seasonal component to their locations. In addition, there are specific areas for trawl gear and non-trawl gear. Not all of the historical RCA areas have been developed into GIS data, but most of the areas from 2003 are mapped as an example. A chronology of changing trawl and non-trawl RCAs for the year 2003 is included below.
- Cowcod Conservation Areas (CCAs): Sections of the CCA cover a total area of 1,372,447 ha.
- Darkblotched Conservation Area (DBCA): The Darkblotched Conservation Area covered 1,029,415 ha.
- Yelloweye Rockfish Conservation Area (YRCA): This area encompasses 59,285 ha.
- Two National Marine Fisheries sites (Pacific Whiting Salmon Conservation Zones), covering approximately 44,000 ha. These two sites, one off the Columbia River and one off the Klamath River, prohibit fishing for Pacific Whiting with commercial mid-water trawl gear.

Currently, these area-based spatial management measures, as well as depth-based gear restrictions, are key to achieving a range of management objectives, particularly those to reduce the bycatch of rebuilding species while maintaining fishing opportunities on healthy stocks. Latitudinal area management is outlined in the ABC and OY tables within the biennial specifications (e.g., North 40°10 N. latitude and South 40°10 N. latitude) and in the trip limit tables where, in some instances, limits differ from the ABC/OY delineations because of bycatch considerations.

Complex spatial management measures have become increasingly necessary within the existing management framework, for example, the RCA configuration adopted in March 2007 to minimize canary rockfish bycatch created a spatial management regime considerably more complex than past management measures. Yet the underlying causes and consequences for the spatially varying abundance and bycatch rates were unclear; the management regime was implemented without explicit knowledge of whether the differences in high versus low bycatch rates by area reflected habitat association and stock distribution, or historical patterns of depletion that leave depleted (low bycatch) regions more vulnerable to localized depletion. As trawl rationalization management alternatives are considered by the Council, there may be a further increased need for spatial management measures, possibly in a manner different than status quo. For example, some intersector allocation alternatives, as well as trawl rationalization alternatives, could result in effort and catch being concentrated in smaller areas than status quo, as some current alternatives allocate the IQ of groundfish stocks according to the Council's ABC/OY table rather than existing cumulative limits that separates the fishery into as many as three latitudinal areas (i.e., north and south of 40° 10' N latitude and between 38° and 40° 10' N latitude). There is also some potential for greater spatial resolution of nearshore resource management relative to that offshore. For example, there is some evidence that nearshore ecosystems exhibit marked regional differences in their species composition, dynamics and productivity, and the specialization of associated fishery, offshore ecosystems (particularly the slope ecosystem and species) tend to have more population connectivity and more homogenous distribution and life history characteristics (Pacific Marine Conservation Council 2006).

There is growing recognition of spatially complex stock structure for many west coast groundfish (e.g. (Gunderson and Vetter 2008; Miller, *et al.* 2005), as well as increasing recognition for the need to characterize and maintain fish stocks at appropriate spatial scales (Berkeley, *et al.* 2004; Francis, *et al.* 2007). New approaches for evaluating relative exploitation rates or size structure of exploited populations have also provided insights into the relative impacts of fisheries over finer spatial scales than traditional assessments (Harvey, *et al.* 2006; O'Farrell and Botsford 2006). To accommodate and respond to such complexity appropriately, there is general agreement that additional research and analyses of current data sources will be needed, as spatial analysis in fisheries research and management have tended to lag behind more academic research in marine and terrestrial ecology (Pelletier and Mahevas 2005; Wilen 2006). A recent National Research Council report found that spatial analyses may be one of the greatest obstacles faced by fishery managers, and that advances in both assessment methods and simulation techniques should provide the means to better cope with the challenges of incorporating such complexity in the face of increasingly complex and spatially explicit management regimes (National Research Council 2006). Spatially-explicit management will continue to be critical to meeting conflicting management goals and objectives, such as maintaining fishing opportunities on healthy stocks while reducing incidental catches of rebuilding species, and meeting habitat protection requirements.

State Marine Protected Areas

California: MPA boundaries for sites in California were downloaded from the California Department of Fish and Game website. In these data, there are 79 sites covering approximately 59,000 ha. The California sites have been categorized into 13 designations. California is currently renaming and recategorizing these sites into three designations (marine reserve, marine park, and marine conservation area); however, the existing designations are used here for descriptive purposes.

- Ten State Marine Reserves: These areas are located adjacent to the Channel Islands. No commercial or recreational fishing is allowed in these areas.
- Two State Marine Conservation Areas: These areas are also located adjacent to the Channel Islands. Most commercial fishing, except for spiny lobster fishing, is prohibited in these areas.
- Seven State Parks: Five of these coastal state parks are located north of San Francisco, one is south of Monterey, and one is near Irvine. Fishing regulations vary by park.
- Four State Beaches: One is located north of San Francisco and the other three are south of Point Conception. Fishing regulations vary by site.
- One State Historic Park: This site is located north of San Francisco. There are no prohibitions on fishing gear of any type.
- Nine Reserves: Several areas in, near or north of San Francisco Bay. A few areas in southern California. Regulations are highly variable by site—some prohibit all fishing, and some allow all fishing.
- Twenty-two Ecological Reserves: These sites are located all along the coast. Regulations are highly variable by site—some are designated as no-take reserves, meaning all fishing is prohibited, and some are designated to prohibit certain type of fishing. Some allow all fishing, but prohibit take of other types of resources.
- Four MRPA Ecological Reserves: three sites are located along the central California coast, and one is north of San Francisco. Recreational and commercial fishing is prohibited at all sites.
- One Invertebrate Reserve: This site is located on the central coast. Recreational fishing is allowed for finfish. Commercial fishing is allowed for finfish, lobster, abalone, and crab.
- One Natural Preserve: This site is located in northern California. No access allowed to the site.
- Three Clam Preserves: These sites are located on the central coast, just north of Point Conception. No clams may be taken, but all commercial and recreational fishing and fishing gear are allowed.
- One Marine Gardens Fish Refuge: This site is located in Monterey Bay. Most commercial fishing gear is prohibited, except nets. Recreational pot gear is prohibited, other recreational gear is allowed.
- Fourteen Marine Life Refuges: These sites are located primarily along the central and southern coast. Most commercial gear, except pot and “other” gear, is prohibited from these sites. All recreational gear types are allowed.

Oregon: MPA boundaries for three types of sites in Oregon were provided by ODFW. These are all small intertidal sites encompassing approximately 460 ha.

- Seven Marine Gardens: Generally, commercial and recreational pot gear is prohibited, other gear types not restricted.
- Six Research Reserves: Generally, commercial pot gear is prohibited.
- One Habitat Refuge: All commercial and recreational fishing activities are prohibited.

Washington: The Washington State GIS data for MPAs contain 68 individual sites covering approximately 28,000 ha. The areas are managed by one of the following organizations: Washington Department of Fish and Wildlife (WDFW), Washington Department of Natural Resources (WDNR), San Juan County Marine Resource Committee (MRC), Washington State Parks and Recreation

Commission (WSPRC), or The Nature Conservancy (TNC). The total area figure is a bit of an overestimate because some of the areas, such as state parks and TNC areas include the upland portions of the sites as well as the marine portions.

- Nine WDFW Marine Preserves: generally prohibit most types of commercial fishing gear.
- Two WDFW Wildlife Refuges: generally closed to all access.
- Nine WDFW Conservation Areas: most restrictive of fishing—all fishing and gear are prohibited from nearly all of these sites.
- Two WDFW Sea Cucumber Closures: closed to commercial harvest of sea cucumbers and urchins.
- Six WDNR Aquatic Reserves: no restrictions on commercial or recreational fishing.
- Seven WDNR Natural Areas Preserves: highest level of restriction—only allowable activities are scientific or education functions. Therefore, no commercial or recreational fishing allowed.
- Two WDNR Natural Resource Conservation Areas: no specific prohibition of fishing activities.
- Eight San Juan County MRC Bottomfish Recovery Zones: these are voluntary bottomfish no-take zones—no specific prohibition of fishing activities.
- Seven State Parks: prohibited to take non-game invertebrates and seaweed. No specific prohibition of fishing activities.
- Two TNC Conservation Easements.
- Fourteen TNC Nature Preserves: limitation on public access and all fishing activities.

2.1.7 The Role of Rebuilding Species in the Marine Ecosystem

Under Section 304 of the MSA (104-297), fishery management plans, plan amendments, or proposed regulations for overfished species must take into account status and biology of any overfished stocks of fish as well as the interaction of overfished stocks within the marine ecosystem. This section was developed to consider the relevant aspects of these stocks with respect to their interaction with other biotic elements of the ecosystem.[2] The intent is not to replicate the evaluation of status, life history, and productivity of the stocks themselves, which is discussed in more detail in Chapter 1, but rather to focus on the role of these species in the environment.

The rebuilding rockfish stocks, and indeed all rockfish more generally, occupy a broad range of ecological niches and trophic roles, and some analysis of their principal predators, prey, and competitors is an important consideration with respect to the impacts that rebuilding decisions may have on the larger ecosystem. Larval rockfish (and larval fish more generally), have been shown to play a minor role in the macrozooplankton community, which is dominated by a wide range of predators and competitors (McGowan and Miller 1980). However, both juvenile and adult rockfish are important prey items to a wide range of other rockfish, other piscivorous fishes, seabirds, and marine mammals. Most food habits studies do not reliably or consistently report rockfish to the species level. Therefore, a summary of key predators here is focused more generally the role of rockfish as prey, rather than the role of individual rebuilding species as prey. Although it is not possible to assess potential impacts to predators that may or may not result from the depletion of rockfish populations, particularly with respect to the level of depletion beyond target levels or the natural population variability exhibited by unfished species (Miller and Sydeman 2004; Moser, *et al.* 2000), it is clear that rockfish in general (particularly juveniles) represent a significant trophic linkage throughout the ecosystem.

[2] Many marine organisms (such as many types of plankton, structure-forming invertebrates, and burrowing or bioturbating organisms) can and do interact with abiotic (physical and chemical) characteristics of an ecosystem that could have broader-scale impacts to marine communities and ecosystems. However, such interactions are neither known nor suspected for the rebuilding species evaluated in this section, and consequently are not explicitly considered here.

For example, Merkel (1957) reported that juvenile rockfish were particularly important prey of Chinook salmon along the central California coast, representing on the order of 22 percent of prey by volume throughout the year, with most predation occurring between May and July, when pelagic juveniles move inshore to settle. Brodeur and Pearcy (1990) also found heavy predation on larval and juvenile rockfish by coho and Chinook salmon along the Oregon and southwest Washington coasts. The importance of rockfish as prey to piscivorous rockfish such as bocaccio, cowcod, and yelloweye is summarized below; many nearshore rockfish species also predate heavily on other rockfish, particularly juveniles (Hobson, *et al.* 2001; Lee 1997; Love, *et al.* 2002). Lingcod are among the most voracious predators of both juvenile and adult rockfish; Phillips (1959) reported that a 54-lb lingcod in Monterey, California had been found with a 12-inch starry rockfish and an 18½-inch canary rockfish in its stomach. Additional studies have confirmed that rockfish are important prey items for California (Shaw and Hassler 1989), Oregon (Steiner 1978), and Washington lingcod, with considerable ontogenetic shifts towards increasing rockfish predation with lingcod size (Beaudreau and Essington 2007). Sablefish are also significant predators of both juvenile and adult rockfish, with rockfish representing between 20 and 60 percent of sablefish prey by volume (Buckley, *et al.* 1999; Cailliet, *et al.* 1988; Laidig, *et al.* 1997). However, for most depth ranges sablefish prey primarily on longspine thornyheads. Although Pacific hake are known predators of juvenile rockfish, juvenile rockfish represent significantly less than one percent of their diet by both volume and frequency of occurrence. Pacific halibut, soupfin sharks, dogfish sharks, and albacore tuna are other known rockfish predators (Bonham 1949; Rankin 1915; Ripley 1946), and many other fish are likely to feed on rockfish (particularly juveniles) as well.

A wide range of seabirds also prey heavily on juvenile rockfish (Chu 1984; Wiens and Scott 1975). For many species, as much as 90 percent of their diet comprises juvenile rockfish during the late spring and early summer, which coincides with the breeding season for many resident species (Ainley, *et al.* 1993; Miller and Sydeman 2004). However, there is considerable interannual, and interdecadal variability in the frequency of rockfish in seabird diets, related primarily to the availability of juveniles to seabirds. While many studies have not attempted to identify juvenile *Sebastes* to species, for those that have (largely off of the central and southern California coasts) unexploited species such as shortbelly rockfish generally account for more than two-thirds of the juvenile rockfish identified (Ainley, *et al.* 1996; Merkel 1957; Miller and Sydeman 2004). Throughout the 1990s, declines in juvenile rockfish predation by central California seabirds occurred in both exploited and unexploited rockfish species (Miller and Sydeman 2004; Mills, *et al.* 2006; Sydeman, *et al.* 2001). It is reasonable to expect that fisheries removals have contributed to overall declines in juvenile production, with proportionately greater declines in production for stocks that have been historically overfished and are now rebuilding.

As seabirds have a success-failure breeding response, rather than a response that is proportional to food supply, there is a potential for seabird populations to be highly sensitive to changes in food abundance (Furness and M.L.Tasker 2000; MacCall 1984; Sydeman, *et al.* 2001). This may be particularly true for seabirds in which juvenile rockfish have been shown to be a preferred prey item. Research has shown that common murres prefer to forage locally for juvenile rockfish during their breeding season (May-June, when juvenile rockfish are most abundant), since the close proximity to the breeding grounds reduces foraging trip duration. In years when juvenile rockfish are less abundant, murres forage in coastal waters for northern anchovy and other forage fishes (Ainley and Boekelheide 1990; Miller and Sydeman 2004). Consequently, it is difficult to determine whether declines in overfished species could have had a notable impact on seabird reproductive success or other predators above and beyond that which has occurred as a result of fishing stocks to target levels and natural variability. These declines are coincident with the poor recruitment observed in many exploited species (described in Section 1.1), as well as poor reproductive performance for many seabird species that depend heavily on juvenile rockfish in the breeding season (Sydeman, *et al.* 2001). However, the observation that declines were observed in the consumption by seabirds of juveniles of both unexploited and exploited species suggests that ocean conditions were a major factor in the low abundance of juvenile rockfish.

Both juvenile and adult rockfish are typically a modest, but significant, component in the diets of most California Current pinnipeds and many cetaceans; however, rockfish prey are rarely identified to the species level (Morejohn, *et al.* 1978; Perez and Bigg 1986; Stroud, *et al.* 1981). Morejohn et al. (1978) did identify bocaccio rockfish to species in diets of harbor seals and elephant seals, but other rockfish were listed solely as *Sebastes sp*. Lowry and Carretta (Lowry and Carretta 1999) reported that shortbelly rockfish were among the most frequently encountered prey items for California sea lions at San Nicolas, San Clemente, and Santa Barbara Islands. Lowry et al. (1991) also suggested that California sea lion food habits tend to be temporally dynamic and related to the relative availability of prey. Off of central California, some rockfish taken in food habits studies have been identified using otoliths, with those identified to species including shortbelly, bocaccio, splitnose, vermillion, and canary rockfish.[3]

Given that most marine mammal populations in the California Current exhibit either stable or increasing abundance trends over the last several decades, it seems unlikely that the depletion of overfished rockfish or any alteration to their expected recovery trajectories that might result from management decisions would have a negative impact on marine mammals. However, the converse situation, in which increasing marine mammal populations might slow or prevent the recovery of rebuilding species (a depensatory impact), may be plausible. For example, Bundy (2001) used a multispecies model of the Newfoundland-Labrador ecosystem to evaluate such potential interactions between harp seals and cod. Her results suggest that although the decline of cod was the result of overfishing, the recovery may be hindered by the increasing natural mortality rate associated with a nearly constant per capita consumption of cod by harp seals and concurrent increases in seal abundance. Such factors, which are know as depensatory processes that could complicate recovery efforts for some species, are difficult to quantify, and consequently are not explicitly considered in the analysis of rebuilding trajectories. However, since most rockfish are characterized by low growth, low metabolic rates, and low natural mortality rates, they are likely to be less tightly coupled with the dynamics of either their predators or their prey over most temporal and spatial scales.

With respect to the food habits of the depleted species themselves, accurate quantification of food habits is poor. Most rockfish are notoriously difficult to sample for food habits studies due to the eversion of their air bladder upon capture in sampling gear, usually resulting in regurgitation of any stomach contents. Thus, while several quantitative studies exist for widow, canary, yelloweye, and darkblotched rockfish, anecdotal accounts of food habits are the primary source of information for cowcod and bocaccio rockfish. For all of these species, general patterns of prey preferences are evident from the literature; however, prey preferences may also vary substantially over time (seasons, years), space (depth, latitude, habitat) and life history stage (most species tend to exhibit some ontogenetic shift in prey preferences with size).

Available food habits studies tend to confirm that POP, darkblotched, canary, and widow rockfish are primarily planktivorous, with the vast majority of the diets of the first three of these being euphausiids. For example, Brodeur and Pearcy (1984) found that euphausiids comprised 85 percent of prey by volume for POP, 92 percent by volume for Canary rockfish, and roughly 75 percent by volume (of identifiable remains) for a small number of darkblotched rockfish (for which most prey remains were unidentifiable). All three of these species also fed to some extent on smaller amounts of pelagic shrimp, cephalopods, mesopelagic fishes, and other prey. Lee (2002) also found that canary rockfish relied

[3] M. Weise, University of California Santa Cruz, unpublished data, but see Weise and Harvey (Weise and Harvey 2005) for an overview of the study and methods.

heavily on euphausiids, which accounted for over 98 percent of prey by volume. By contrast, widow rockfish have a more varied range of prey items, including a heavy reliance on gelatinous zooplankton. Phillips (1964) reported that widow rockfish, which tend to occupy semi-pelagic habitat, feed on macrozooplankton, particularly amphipods. Adams (1987b) found that widow rockfish diets in northern California were dominated by four key groups of prey items; salps and other gelatinous zooplankton, euphausiids, pelagic shrimp, and small fish (primarily mesopelagic fish, juvenile hake, and forage fish such as anchovy and smelt). Lee (2002) found that nearly 75 percent of the diet by volume of widow rockfish off of Oregon and Washington was composed of salps and other gelatinous predators, with smaller fractions of euphausiids, pelagic shrimps, and small fish.

Although quantitative food habits studies do not exist for either cowcod or bocaccio rockfish, both Phillips (1964) and Love, et al. (2002) described bocaccio rockfish as almost exclusively piscivorous. Love, et al. (2002) include other rockfish, hake, sablefish, anchovy, mesopelagic fishes, and squid as the key prey for large juvenile and adult bocaccio, while cowcod are described by Love et al. (2002) as feeding on "anything that is not bolted down," but primarily fish and cephalopods. Limited data is reported in the literature for yelloweye rockfish. Steiner (1978) reported on the stomach contents of 28 yelloweye caught on rocky reefs off of the central Oregon coast, which preyed primarily on benthic epifauna, flatfish, other rockfish, and shrimp. Rosenthal, et al. (Rosenthal, *et al.* 1988) found that yelloweye rockfish in southeast Alaska were primarily piscivorous, preying primarily on herring, other rockfish, and sand lance. Thus, the general patterns that emerge for these seven species are that three are higher trophic level piscivores that tend to be found on rocky or highly structured habitat (cowcod, bocaccio, and yelloweye rockfish), three are primarily planktivores associated with shelf and slope benthic habitat (POP, canary, and darkblotched rockfish) and one is an omnivorous species that occurs and feeds primarily in midwater, and primarily on gelatinous zooplankton (widow rockfish).

As higher trophic level predators, cowcod, bocaccio, and yelloweye rockfish have a greater potential to play a structuring role in the ecosystem, particularly over smaller spatial scales. Despite their overall rarity throughout the marine environment relative to more abundant omnivorous or planktivorous rockfish,[4] submersible surveys have found that these piscivorous species can be found at relatively high levels of abundance in many rocky reef habitats isolated and presumably lightly fished reefs (Jagielo, *et al.* 2003; Yoklavich, *et al.* 2002; Yoklavich, *et al.* 2000). In surveys of reefs that had high piscivores density, the concentration of smaller, fast-growing and early maturing *Sebastes* species was considerably lower (such as greenstripe, rosethorn, splitnose, and pygmy rockfish). By contrast, in rocky reef habitats known or suspected to be subject to heavier fishing pressure, the abundance of such small, fast-growing, and early-maturing species was considerably greater. For example, Stein et al. (1992) found that reefs with small numbers of piscivorous rockfish (such as yelloweye) had very high numbers (as much as three orders of magnitude greater) of smaller species. Yet the scarcity of data on spatial patterns of abundance and fishing pressure, and a lack of all but qualitative food habits data for most these species, makes demonstrating and quantifying such interactions extremely challenging.

Additional empirical support for either intraguild competition or top-down impacts of fishing that may have resulted in either localized or large-scale community changes is presented in Levin, et al. (Levin, *et al.* 2006), who found some evidence for broad-scale changes in the taxonomic composition of benthic

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[4] Estimates of unfished biomass (B_0) for cowcod and yelloweye are on the order of 3,000 and 7,500 mt respectively. By contrast, estimates of unfished biomass for bocaccio and widow and canary rockfish are on the order of 70,000, 90,000, and 230,000 mt respectively. Similarly, cowcod have always been among the rarest of *Sebastes* spp. larvae identifiable to species in the standard CalCOFI survey area (nearshore to offshore waters south of Point Piedras Blancas off California) between 1951 and 1998, with estimates of abundance as much as two orders of magnitude less than more abundant species (Moser, *et al.* 2000).

marine fishes in the California Current. Their analysis focused on 16 species of rockfish, eight species of flatfish, and seven species of cartilaginous fish that were sampled by bottom trawl surveys on the continental shelf between 1977 and 2001 (including all of the rebuilding species except for cowcod). For the species they included in their analysis, rockfish declined from over 60 percent of the catch in 1977 to less than 17 percent of the catch in 2001, with flatfish catches increasing by a similar magnitude. Additionally, populations of larger rockfish (including primarily the rebuilding species) had fallen at high rates (as reflected by stock assessments), while those of smaller species, particularly those associated with soft substrate, had generally increased in abundance. These authors also note that the potential for smaller species of rockfish to consume or outcompete recruiting juveniles of larger species highlights the potential that fishing could shift the community composition of the rockfish assemblage, or the benthic groundfish assemblage more generally, into an alternate state. Such species shifts and replacements have been documented for other temperate shelf ecosystems as a result of fishing, in which traditionally non-targeted species have maintained or increased their abundance during periods of high fishing pressure (Link 2007).

The potential for intraguild competition or top-down forcing, in both small-scale rocky reef systems and throughout the larger ecosystem, is also supported by theoretical considerations and simulation models. Walters and Kitchell (2001) as well as MacCall (2002a) have demonstrated the potential for strong interactions among the adults of higher trophic level piscivores and their prey, such that adults crop down forage species that may be potential predators or competitors of their own juveniles, with consequent negative impacts on higher trophic level predators when their populations are reduced by fishing (see also Swain and Sinclair 2000). Baskett, et al. (2006) have explored the potential for such interactions as well, with a community interactions model based on rocky reef habitat and juvenile and adult life history stages of rockfish parameterized to represent yelloweye and pygmy rockfish. Their model sought to evaluate interspecific dynamics among rocky reef rockfish within a marine reserve, and considered the interactions among fishing, population recovery following cessation of fishing mortality, juvenile predation and competition.

Without interspecific interactions, the model developed by Baskett, et al. (2006) predicted that larger piscivores would recover given minimal levels of dispersal and reserve size. However, when community interactions were taken into account, initial conditions such as the relative abundance of the piscivores and the size of the reserve became more important with respect to the ultimate stable state, and the models predicted that under some circumstances recovery could be unlikely. Due to lack of adequate information on abundance and plausible parameter values for many of the interactions, the model was simplistic in the sense of modeling a single predator (with two life history stages) and a single prey/competitor, with little evaluation of the complicating impacts of climate variation, variability in recruitment, multiple alternative prey items, and other factors. Despite this, their results were consistent with similar simulations of the potential consequences of community interactions in marine systems (MacCall 2002a; Mangel and Levin 2005; Walters and Kitchell 2001), and speak to the importance of considering such interactions in the design, implementation and monitoring of recovery efforts for rebuilding species.

2.2 The Effects of Fishing on Habitat and the Marine Ecosystem

With regard to EFH, NMFS recently completed an EIS to comprehensively evaluate groundfish habitat and the effects of groundfish fishing on that habitat, in response to litigation (*American Oceans Campaign v. Daley et al.*, Civil Action No 99-982[GK]). The current action, authorizing harvest of groundfish within EFH, are within the scope of fishery management actions analyzed in the EIS for groundfish EFH. Those analyses are incorporated by reference. A Record of Decision for Pacific Coast Groundfish EFH was issued on March 8, 2006, and concluded that partial approval of Amendment 19 to the FMP would minimize to the extent practicable adverse impacts to EFH from fishing. Amendment

19, approved on March 8, 2006, provides for a comprehensive strategy to conserve EFH, including its identification, designation of HAPC, and the implementation of measures to minimize to the extent practicable adverse impacts to EFH from fishing. The final rule implementing Amendment 19 provides measures necessary to conserve EFH and no additional EFH recommendations are necessary for this proposed action. Based on the analyses in the EFH EIS (NMFS 2005) and the mitigation measures implemented as part of that action, NMFS concluded that the effects of 2007–08 harvest specifications will not be significant and are therefore not analyzed further.

The 2004–05 groundfish harvest specifications EIS pointed out there is currently insufficient information to predict the effects of fishing on the marine ecosystem in any precise way nor distinguish among the alternatives in terms of these types of effects. As noted in that EIS, NEPA regulations address this issue. When an agency is evaluating reasonably foreseeable significant adverse effects, there is incomplete or unavailable information, and the costs of obtaining it are exorbitant or the means unknown, the agency must, (1) so state, (2) describe the importance of the unavailable information to the assessment, (3) summarize any existing scientific information, and (4) evaluate impacts based on generally accepted scientific principals (40 CFR Part 1502.22), which may accord with the best professional judgment of agency staff. NMFS acknowledges that the information necessary to fully evaluate impacts to EFH and marine ecosystems, as described in the preceding paragraph, cannot be reasonably obtained, and impacts are generally unknown.

Furthermore, it is not possible to separate out the direct/indirect effects of the action on the ecosystem (fishery removals), which may be modest, and the cumulative effects of past and future groundfish fishing mortality (occurring as past or reasonably foreseeable future actions under the management framework). Therefore, the following sections summarize existing scientific information on two potential long-term effects of the depletion of stocks from unfished biomass: (1) potential effects to constituents of the food web as a result of depletion of groundfish species at different trophic levels and (2) broad-scale genetic and demographic changes in fish populations resulting from fishing.

2.2.1 Effects of Fishing on the Food Web

The sections above provide a conceptual framework, based on trophic considerations and the basic structure and function of marine food webs, for considering the plausible impacts of the removal of both overfished (rebuilding) stocks as well as healthy stocks from the marine ecosystem. Biogeography and EFH are presented for consideration of other elements of the ecosystem along with current measures to protect EFH.

Although far from conclusive, the empirical evidence and theoretical considerations suggest some potential for top-down impacts or intraguild competition, as a result of declines in higher trophic level species such as cowcod, bocaccio, and yelloweye rockfish over small spatial scales. It is reasonable to expect that similar impacts could potentially be associated with fishery-induced declines in stocks of healthy species (those reduced from their equilibrium abundance, but not to levels below overfishing limits), such as sablefish, Pacific halibut, petrale sole, shortspine thornyhead, Pacific hake, and other piscivorous or higher trophic level species. Such impacts are often referred to as trophic cascades, in which declines of high trophic level species (keystone predators) have cascading impacts through food webs to the abundance, productivity, and species diversity of lower trophic levels. Empirical examples of trophic cascades tend to be more common for semi-enclosed ecosystems such as lakes, or highly structured (two dimensional) environments, such as intertidal or sub-tidal ecosystems (Paine 1966; Simenstad, *et al.* 1978; Tegner and Dayton 2000). As one ventures further from these environments, the evidence for top-down control, or trophic cascades, becomes considerably spottier, although (Van der

Elst 1979) reported a classic example of top-down control of a coastal ecosystem off of the Natal coast in South Africa.[5]

However, in coastal upwelling ecosystems such as the California Current, most evidence suggest that the primary forcing factor for ecosystem productivity and structure over the scale of the entire system tends to be either "bottom-up" (based on the amount and variability of primary or secondary production) or "middle-out." For example, (Ware and Thomson 2005) proposed that the carrying capacity of north Pacific coastal ecosystems was primarily determined by bottom-up control, based on correlations between latitudinal variability in primary production and commercial fisheries yields. Alternatively, bottom-up control in these ecosystems could be a function of secondary production, through variability in the productivity and species composition of the zooplankton community. As discussed in Section 3.1.2, the California Current seems to experience higher secondary production during periods of stronger southward transport and cooler sea surface temperatures. Zooplankton, particularly euphausiids, are the principal prey item for most of the mid-trophic level organisms in the California Current, including Pacific hake and most rockfish.

An alternative to bottom-up control is "middle-out" control, also referred to as "wasp-waist" control, in which a small number of key mid-trophic level species represent a bottleneck of energy flow between lower and higher trophic levels. It has long been noted that food webs in coastal upwelling ecosystems tend to be structured around CPS, such as krill, sardine, anchovy, and hake, that exhibit boom-bust cycles of abundance over decadal time scales (Bakun 1996; Parrish, *et al.* 1981; Schwartzlose, *et al.* 1999). Such dynamics have long been thought to be a consequence of the energetic and highly variable oceanographic processes that shape the physical environment and drive production throughout pelagic and benthic food webs in coastal upwelling ecosystems (such as the California Current system) over a range of time scales (Mann and Lazier 1996; Parrish, *et al.* 1981). The idea of wasp-waist control was first suggested by Rice (1995) and developed in greater detail in Cury et al. (2000). The premise is that the low species diversity often observed in the middle of many upwelling ecosystems results in a vast majority of the energy in the food web flowing through CPS such as sardine, anchovy, and mackerel. Many of these seem to feature "weak links" in their life cycles related to sensitivity to climate forcing, such that climate conditions determine the productivity of these stocks, and indirectly drive the dynamics of both higher and lower trophic levels.

Empirical evidence for any of these types of control is typically limited for large marine ecosystems (Hunt and McKinnell 2006). However, where trophic interactions among exploited species are documented or suspected, ecosystem modeling can provide a template to evaluate both the magnitude and consequences of removals of either predators or prey in the system of interest (Christensen and Walters 2004; Hollowed, *et al.* 2000). Although such models are unavoidably constrained by conceptual shortcomings and data limitations, most critical reviews of multispecies modeling approaches agree that ecosystem models can augment contemporary single species models by confronting an array of interactions and dynamics that are more difficult to address with single-species models, such as competition, predation and environmental variability (Fulton, *et al.* 2003; Hollowed, *et al.* 2000; Plagányi and Butterworth 2004). For example, Walters, *et al.* (2005) used the results from a number of existing ecosystem models to demonstrate that widespread application of contemporary (MSY proxy) single-species management approaches could lead to dramatic impacts on ecosystem structure, particularly where such approaches are applied to forage species. Their results add

[5] In this case, increased mortality of large sharks resulted from the use of shark nets to protect bathers, which subsequently caused an apparent increase in the abundance of smaller dusky and milk sharks on which they preferentially fed. This increase of smaller sharks resulted in a substantial decline in catch per unit effort of several populations of teleost fishes that were both commercially and recreationally important to coastal communities in the region.

considerable weight to the perceived need to consider forage species as resources whose value is derived from their role as prey to commercially and recreationally important stocks, a consideration consistent with recent the Council determination to place a precautionary ban on krill (euphausiid) harvests throughout the west coast EEZ.

Dynamic simulations of an ecosystem model of the Northern California Current were developed by Field, et al. (2006b), who modeled the continental shelf and slope ecosystem between Cape Mendocino and Cape Flattery between 1960 and 2004. The model was based on, and tuned to, biomass estimates from stock assessments and surveys, consumption and production rates estimated from empirical studies or the literature, historical estimates of landings and discard rates, and the limited food habits data that were available in this region. The model was run forward first under the assumption of a constant environment, then forced dynamically with several climate indices. They found that most of the variability observed in single species models and dynamics can be replicated with a multi-species modeling approach, despite significant changes in food web structure and the abundance of both predators and prey in this ecosystem over time. In general, these results imply that over the macro-scale, there do not appear to be obvious changes in ecological structure that have resulted in strong interspecific interactions (predation, competition) between most of these species. One large exception to this generalization was Pacific hake, which by virtue of their large biomass and high consumption of forage species in the model were shown to have potential competitive interactions. Agostini (2005) found that most model components (particularly pandalid shrimp, rockfish, salmon, seabirds and marine mammals) benefited from a reduction in hake biomass, primarily as a result of increases in the availability of euphausiids, forage fish and other prey.

The results of the ecosystem model are consistent with what is known of the life histories for many of the rockfish, roundfish and longer-lived flatfish in the California Current, where low mortality rates are indicative of low predation rates and presumably weakly coupled trophic interactions. In other words, species with a low natural mortality rate are unlikely to be a “key prey species” for higher trophic level predators, and are consequently less likely to effect significant bottom-up control in the energy flow or structure of the ecosystem. Consequently, the effects of severe declines in the overfished species that were explicitly included in this model (canary rockfish, widow rockfish, and POP) to other elements of the ecosystem appear to be minimal. The model found considerably stronger interspecific interactions in species such as shrimp, salmon, and small flatfish where there is high turnover and high predation coupled with substantial changes in many of their key predators (such as hake, sablefish, marine mammals) over the last forty years. There were, of course, other exceptions to this generalization; in fact one of the strongest interactions appeared to be among several of the slowest growing species; sablefish, shortspine thornyhead, and longspine thornyhead. Essentially, the model suggested that natural mortality rates for longspine thornyheads may have fallen by nearly fourfold over recent decades as a result of substantial declines in sablefish and shortspine thornyheads, their key predators. As a result, the expectation would be that longspine thornyhead abundance would increase over time, a prediction consistent with recent trawl survey results.

However, this work focused on integrating a broad array of species and habitats, and due to their relative rarity and the paucity of food habits data, the piscivorous species of rockfish described in the previous section were not modeled as independent populations. As the fauna and environmental conditions along the continental slope differ tremendously from those on the shelf and near the shelf break, evaluating these interactions more carefully is likely to require development of spatially explicit modeling efforts, coupled with more appropriate consideration of age and/or size based bioenergetic requirements and predation interactions. A comparable, but considerably more complex model, with greater population (demographic) structure, spatial complexity and explicit physical forcing (Fulton, *et al.* 2004), is the Atlantis model for the California Current (Brand, *et al.* 2007; Kaplan and Levin 2007). Like the Field et al (2006c) model, the Atlantis model suggests that the fisheries’ removal of slow growing, low turnover species such as rockfish has not led to obvious changes in ecological structure or to strong changes in interspecific interactions; hake predation on shrimp appears to be one exception to this general lack of top-down control. However, recent modeling results do indicate a key role for forage species and the possibility of bottom-up effects. Future research will be required to identify how these effects play out across space.

As baseline knowledge and modeling abilities increase, such models will hold greater promise for successfully identifying the processes and mechanism of ecosystem change, and guiding decisions that might hasten the recovery of both individual species and sustain the community and ecosystem in which they reside (Kaplan and Levin 2007; Sainsbury, *et al.* 2000).

Other theoretical considerations point to the potential for an important role for rebuilding species in the California Current over broad spatial and temporal scales, particularly the stocks that were historically more abundant. By virtue of their slow growth and low mortality rate, these stocks may fill a role in stabilizing highly dynamic ecosystems, by dampening what might otherwise be even greater ecological responses by high turnover species to rapid changes or short-term bursts in production (Apollonio 1994). However, the same could be said of any ecosystem for which all stocks were at their "target" levels. The premise of nearly all contemporary fisheries management is that reducing stocks to target levels results is sustainable from a single species perspective, but there is little or no theoretical or empirical basis on which to conclude that this approach is optimal from the perspective of other, codependent elements of the ecosystem (Goodman, *et al.* 2002; Mangel, *et al.* 2000). As Goodman et al. (2002) discuss, fishing to achieve any MSY-related objectives inevitably shifts the equilibrium biomass, age and size structure of a population from that which occurred in the unfished condition, and any such changes have the potential to propagate through the food web and effect consequent changes on other species.

2.2.2 Genetic and Demographic Effects of Fishing

While contemporary approaches to fisheries science focus on estimating surplus production, stock-recruit relationships and MSYs, it is worth noting that from a purely "holistic" perspective, the fishing down of any species removes or alters energy pathways and ecological structure from either other species (such as seabirds and marine mammals) or other ecosystem processes (Aydin 2004), although this observation does not invalidate the logic of surplus production from a single-species perspective. It has long been assumed that fish stocks and populations, and subsequently the ecosystems in which they exist, are healthy if they are maintained close to the levels that provide MSY. However, there is a growing body of ecological, genetic and theoretical evidence that suggests that this may not necessarily be a fair assumption, neither for the exploited species themselves nor the ecosystems in which they exist. A growing body of literature suggests that fisheries have the potential to effect substantial changes in both genetic and demographic characteristics of fish populations; as Stokes and Law (2000) suggest "to an evolutionary biologist, fishing is a massive uncontrolled experiment in evolutionary selection." Selection by fisheries has clearly been demonstrated to result in changes in size at age,[6] changes in size and age at maturity, changes in natural mortality and increased total fecundity (Conover and Munch 2002; Mangel, *et al.* 1993; Mangel and Stamps 2001; Stergiou 2002; Stokes and Law 2000);

[6] As early as 1912, it was noticed that fish caught in the early or developing years of a fishery tended to be larger at age than those caught in more recent years, and it is now known that when mortality increases as a result of size-selected fishing; faster-growing individuals are removed at higher rates than slower-growing individuals. The result is that slower-growing animals make up a greater percentage of their age group; and the population in question is selected to be smaller at a given age over time. The same logic applies to the selection of earlier ages at maturity and to other selective factors.

and some examples even suggest changes in body shape, alterations in heritable patterns of distribution and migration, and even changes in avoidance behavior (Heino and Godø 2006; Ricker 1981).

Their results speak not only to the necessity to consider evolutionary consequences, but also to the observation that the consequences could be detrimental to humans as well as fish. Quite simply, these evolutionary consequences can reduce the sustainable yield of a population by decreasing the age at maturity and consequently reducing the relative amount of somatic growth in a population relative to reproductive effort. As Conover (2000) suggests, "Yield… is not a currency that is crucial to fitness. From the fishes' point of view, the goal is maximizing the relative contribution of genes (not biomass) to succeeding generations." The current National Standard Guidelines recognize the significance of such factors on both populations and ecosystems, as they state that the benefits of protecting marine ecosystems include "maintaining viable populations (including those of unexploited species), maintaining evolutionary and ecological processes (e.g., disturbance regimes, hydrological processes, nutrient cycles), maintaining the evolutionary potential of species and ecosystems, and accommodating human use" (50 C.F.R. 600.310). Such observations demonstrate that maintaining the role of species in an ecosystem, and minimizing the selective role of fishing on marine fish diversity on multiple levels, are both key challenges and crucial element to any future ecosystem-based approach to the management of marine resources.

2.3 Possible Impacts of Harvest Policies

While considerable research has been undertaken to better understand trophic interactions and other ecosystem considerations throughout the U.S. and the world, and to consider the cumulative, large-scale effects of fishing on marine ecosystems from a more holistic perspective, there is no clear consensus on what would actually constitute precautionary harvest policies or rates from a multispecies or ecosystem perspective. As a result, there is no fundamental foundation upon which to consider the consequences of historical overfishing, or alternative strategies in rebuilding depleted species, with respect to the potential impacts or trade-offs to ecological integrity and future sustainability.

From a basic ecological perspective, all species have a role to fill in the system, and the loss or severe reduction of any stock or species could have reverberations throughout the food web. Even the reduction of fished populations to their target levels affect the flow of energy through the marine ecosystem, and has the potential to either modestly or massively alter the structure and integrity of the communities that either prey on, are preyed upon, or otherwise interact with those species. Some seabirds that depend on juvenile rockfish have undergone declines in breeding success, and declines in the availability of prey have been implicated as potential causes. However, ocean conditions and the effects of fishing are likely to be compounded, and the trends themselves are difficult to discern. Based on the observation that most resident or migratory marine mammal populations in the California Current have been increasing at modest to substantial rate over the past several decades (including California sea lions, harbor seals, elephant seals, gray whales, and humpback whales), it is similarly difficult to expect that the cumulative impacts of fishing have been detrimental for these guilds.

Based on what is known or suspected about the large-scale nature of energy flow in upwelling environments, it is reasonable to expect that the cumulative impacts that have resulted from overfishing, and may continue to result from any delay in rebuilding, are modest to negligible when integrated across the entire California Current ecosystem. This is particularly true when considering the potential cumulative impact of depleting these populations below target levels (e.g., 10 percent to 25 percent of historical abundance) relative to depleting such populations to precisely their target levels (e.g., ~40 percent of historical abundance). However, for several rebuilding species, particularly those at higher trophic levels, these impacts may be more significant at smaller spatial scales for some habitat types and regions, since severe depletion may well have resulted in substantial shifts in the community composition of some benthic habitat. Furthermore, clearly identifying and evaluating the potential consequences to the ecosystem of modest changes in population trends and abundance that may result from deviations in rebuilding trajectories, above and beyond those that would have resulted from fishing stocks down precisely to target levels, is an analysis beyond the scope of existing data and capacity. The empirical data, either from visual or trawl surveys, are limited in their resolution, and although theoretical (simulated) studies suggest that thresholds between alternative stable states may exist, identifying such thresholds is beyond the realm of existing capacity.

Despite these general observations about the effects of the groundfish management framework on ecosystem processes, the ability to say anything meaningful about the broad-scale ecosystem impacts associated with adopting a given harvest policy above another is by all measures an intractable question. Clearly, the relationship between OY alternatives for depleted species and targets in related rebuilding plans has the most relevance to ecosystem impacts because of the long-term, cumulative effect. They differ in the trajectories they set for rebuilding populations, and clearly those alternatives that rebuild stocks the fastest have the greatest potential to minimize the long-term impacts to the ecosystem that may have resulted from their removal. Despite these general observations, there exists no meaningful way of quantitatively assessing the potential difference with respect to the risk of undesirable consequences of choosing a given OY over another. To the extent that various harvest policies would require corresponding management measures that vary the size of area closures, thus protecting stocks, those policies may mitigate the potential consequences of fishing to ecological structure and function, although this generalization is unquantifiable.

In general, there is no empirical or theoretical evidence that show declines in stocks of west coast rockfish have had impacts on predators or higher trophic level species, particularly impacts above and beyond those which might be expected by reduction of biomass to their target levels. However, there is potential evidence, largely theoretical, that among those rebuilding species that are higher trophic level predators there could be cascading ecological consequences to some benthic communities resulting from severe depletion and potential replacement by more opportunistic species. Again, such impacts (if real) are impossible to quantify.

2.3.1 Benefits of an Ecosystem Approach to Fishery Management

An ecosystem-based approach to managing fisheries could more effectively account for and potentially mitigate some of the adverse effects of fishing on the marine ecosystem. A truly integrated ecosystem approach might make management decisions based on accurate indices of ecosystem productivity, the needs of other predators (such as seabirds and marine mammals), and the consequences of fishing on habitat and ecological structure. Another strategic issue could be that of ecosystem shifts and long-term rebuilding targets. The current management regime is based on rebuilding targets that assume equilibrium resilience, in other words, that stocks can rebuild to levels near the B_{MSY} proxy within some extended period of time. Yet in the face of a highly dynamic ecosystem and potential cumulative effects of past fishing (including depletion and subsequent recovery of marine mammals, or cultivation/ depensation processes), such rebuilding targets could conceivably be unachievable. A review of such considerations (including the results of spatially explicit multispecies models) could inform the Council of appropriate management goals in the face of such challenges. More explicit consideration of predator-prey relationships among harvested species and across fishery management plans could also inform the management process.

Unfortunately, the data necessary to develop and adequately parameterize multispecies models are lacking for most ecosystems, including the California Current. Even with adequate data, the ability of multispecies models to make meaningful predictions regarding the consequences of decisions is limited. Although multispecies models are capable of providing insight regarding potential or likely interspecific interactions, and can provide long-term (strategic) guidance regarding likely ecosystem impacts of fishing, there are still far too many unanswered basic ecological questions to expect that the ecological consequences of fishing at alternative harvest rates can be described or quantified. For example, May (1999) reminds us that even basic mechanisms responsible for density-dependent or density independent regulatory mechanisms continue to be unresolved for many populations, an issue of particular importance for rockfish, for which stock assessment models estimate a wide spectrum between strong density dependence and strong density independence. It may be that the only certainty that managers can expect is that decisions will have to continue to be made with imperfect information.

The Council has expressed an interest and intent in establishing an exploratory plan development team, comprised of members of existing FMP management teams, to consider the concept of an ecosystem fisheries management plan (E-FMP), or other alternatives that would serve to incorporate ecosystem considerations into fisheries management along the U.S. west coast (PFMC 2007). In initial discussions of this concept, the Council envisioned such a plan to be of an "umbrella" type structure, so as to allow the current four Council FMPs to continue. In moving towards an ecosystem-based approach, the development of an ecosystem information program was also recommended, in order to draw on expertise both within and outside of NMFS. The primary objective would be to provide a product that would be developed to inform decision makers of ecosystem information (such as trends in ocean conditions and productivity) that could be used in Council decision-making. For example, NMFS has recommended the development of Integrated Ecosystem Assessments (IEAs) to holistically assess the status of an ecosystem, forecast the future state to the extent possible or practicable, and identify opportunities for improvement in management measures that could result from such knowledge. Either, or both, of these approaches would be consistent with balancing current workload priorities and existing management objectives while still moving towards an ecosystem approach to fisheries management. As Francis et al. (2007) note, the intention when moving towards an ecosystem-based approach to fisheries management should be neither quasi-religious nor surreal, but rather should propose and implement tangible action items.

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CHAPTER 3 PROTECTED SPECIES

3.1 Introduction

This chapter describes protected species that may be affected by groundfish fisheries. Protected species are those species or stocks whose take is regulated by one or more of the following laws:

- **Endangered Species Act (ESA)**. The ESA protects species in danger of extinction throughout all or a significant part of their range and mandates the conservation of the ecosystems on which they depend. "Species" is defined by the Act to mean a species, a subspecies, or—for vertebrates only—a distinct population. Under the ESA, a species is listed as "endangered" if it is in danger of extinction throughout a significant portion of its range and "threatened" if it is likely to become an endangered species within the foreseeable future throughout all, or a significant part, of its range.
- **Marine Mammal Protection Act (MMPA)**. The MMPA guides marine mammal species protection and conservation policy off the U.S. west coast. NMFS is responsible for MMPA-based management of cetaceans and pinnipeds, while the United States Fish and Wildlife Service (USFWS) is responsible for sea otter management. Stock assessment reports review new information every year for strategic stocks and every three years for non-strategic stocks. "Strategic stocks" are those with a human-caused mortality and injury level that exceeds the potential biological removal level. (At 50 CFR 229.2, "potential biological removal level" is defined as, "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population…") Marine mammal populations with an abundance that falls below its optimum sustainable level are listed as "depleted" under the MMPA. All marine mammal species are protected under the MMPA, regardless of whether a particular species or stock is listed as threatened or endangered under the ESA.
- **Migratory Bird Treaty Act (MBTA) and EO 13186**. The MBTA implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, it is unlawful to take, kill, or possess migratory birds. In addition to the MBTA, an Executive Order, *Responsibilities of Federal Agencies to Protect Migratory Birds*, (EO 13186), directs federal agencies to negotiate Memoranda of Understanding with the USFWS that would obligate agencies to evaluate the impact on migratory birds as part of any NEPA process. All migratory seabird species are protected under the MBTA and EO 13186, regardless of whether a particular species or stock is listed as threatened or endangered under the ESA.

The following documents may be consulted for information on protected species affected by groundfish fisheries:

- Pacific Coast Groundfish Fishery Management Plan Bycatch Mitigation Program FEIS (PFMC 2004c), sections 3.3.3 and 4.3.3
- Proposed Acceptable Biological Catch and Optimum Yield Specifications and Management Measures for the 2007-08 Pacific Coast Groundfish Fishery and Amendment 16-4: Rebuilding Plans for Seven Depleted Pacific Coast Groundfish Species" (PFMC 2006b); chapter 5

Three types of protected species are known to be affected by groundfish fisheries: ESA-listed salmon, marine mammals, and seabirds. Of these groups, takes of ESA-listed salmon are the most well-documented and groundfish fisheries likely have a greater affect on these stocks than on marine mammals and seabirds. Therefore, this chapter describes these species and historical takes in groundfish fisheries in the most detail. Sea turtle species are ESA-listed and four of the six species found in U.S. waters have been sighted off the west coast. These are loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and olive ridley (*Lepidochelys olivacea*) sea turtles. No takes of these species have been documented; therefore, they are not described further here.

3.2 ESA-listed Salmon

Salmon caught in west coast fisheries have life cycle ranges that include coastal streams and river systems from Central California to Alaska and marine waters along the U.S. and Canada seaward into the north central Pacific Ocean, including Canadian territorial waters and the high seas. Some of the more critical portions of these ranges are the freshwater spawning grounds and migration routes. Chinook, or king salmon (*Oncorhynchus tshawytscha*), and coho, or silver salmon (*O. kisutch*), are the main species caught in Council-managed ocean salmon fisheries. In odd-numbered years, catches of pink salmon (*O. gorbuscha*) can also be significant, primarily off Washington and Oregon. Of these species, NMFS has concluded that the following "evolutionarily significant units" (ESUs) of ESA-listed Chinook are most likely to be affected by the groundfish fisheries: Snake River fall Chinook (threatened), Upper Willamette River Chinook (threatened), Lower Columbia River Chinook (threatened), Puget Sound Chinook (threatened), Sacramento River winter-run Chinook (endangered), California coastal Chinook (threatened), and Central Valley spring-run Chinook (threatened). Table 3–1 shows ESA-listed salmon ESUs on the west coast

Section 7 of the ESA requires Federal agencies, in consultation with and with the assistance of the U.S. Secretary of Commerce, to insure that their actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat that has been designated for those species. In the case of marine species NMFS' Protected Resources Division is the consulting agency. As part of this process NMFS may issue a Biological Opinion. The Biological Opinion may include an Incidental Take Statement for subject species, which establishes a level of take determined not to cause jeopardy, and other measures to mitigate adverse affects. The most recent Biological Opinion covering the incidental take of ESA-listed salmon in groundfish fisheries was published in 2006 (NMFS 2006). That document includes a detailed history of Section 7 consultations on the groundfish fishery.

Table 3-1. ESA-listed salmon ESUs on the west coast.

Species	ESU
Listed as endangered	
Coho salmon (*Oncorhynchus kisutch*)	Central California
Chinook salmon *(Oncorhynchus tshawytscha)*	Sacramento River Winter; Upper Columbia Spring
Sockeye salmon *(Oncorhynchus nerka)*	Snake River
Steelhead *(Oncorhynchus mykiss)*	Southern California; Upper Columbia
Listed as threatened	
Coho salmon *(Oncorhynchus kisutch*)	Southern Oregon/Northern California; Lower Columbia
Chinook salmon *(Oncorhynchus tshawytscha)*	Snake River Fall, Spring, and Summer; Puget Sound; Lower Columbia; Upper Willamette; Central Valley Spring; California Coastal
Chum salmon *(Oncorhynchus keta)*	Columbia River; Hood Canal Summer
Sockeye salmon *(Oncorhynchus nerka*)	Ozette Lake
Steelhead (*Oncorhynchus mykiss*)	South-Central California, Central California Coast, Snake River Basin, Lower Columbia, California Central Valley, Upper Willamette, Middle Columbia, Northern California; Puget Sound

Salmon ESA status as of June 15, 2007. Source: NMFS NW Regional Office website: www.nwr.noaa.gov\ESA-Salmon-Listings\

3.2.1 ESA-listed Salmon Take in the Pacific Whiting Fishery

Salmon are caught incidentally in both the at-sea and shore-based segments of the whiting fishery. (Figure 3–1 depicts salmon catches in the various sectors of the whiting fishery.) This bycatch is closely monitored through an at-sea observer program and dockside sorting of shore deliveries. A salmon bycatch reduction plan has also been implemented in this fishery. Groundfish fishery interception of salmon species other than Chinook is negligible and infrequent (NMFS 2006).

Past section 7 consultations have established a standard of 11,000 Chinook salmon caught in Pacific whiting fisheries which, if exceeded in a given year would be a basis for re-initiating consultation to determine whether this new information indicates the action would jeopardize the continued existence of listed ESUs and considering further mitigation measures to reduce bycatch. Although the 11,000 fish threshold is used a trigger to re-initiate consultations, the biological opinions produced in the course of these consultations have concluded that occasionally exceeding this threshold (as occurred in 1995, 2000, and 2005) is not by itself a basis for making a jeopardy determination. Chinook bycatch has averaged about 7,300 over the last 15 years and exceeded the reinitiation trigger of 11,000 in 1995, 2000, and 2005 (see Table 3-2). Since preparation of the 2006 Biological Opinion the following numbers of Chinook were caught in the whiting fishery: 3,957 in 2006 and 5,846 in 2007. (The 2007 number is from Preliminary Report #10 and may be adjusted when any final summary is produced.)

Table 3-2. Annual bycatch of salmonids in the whiting fishery

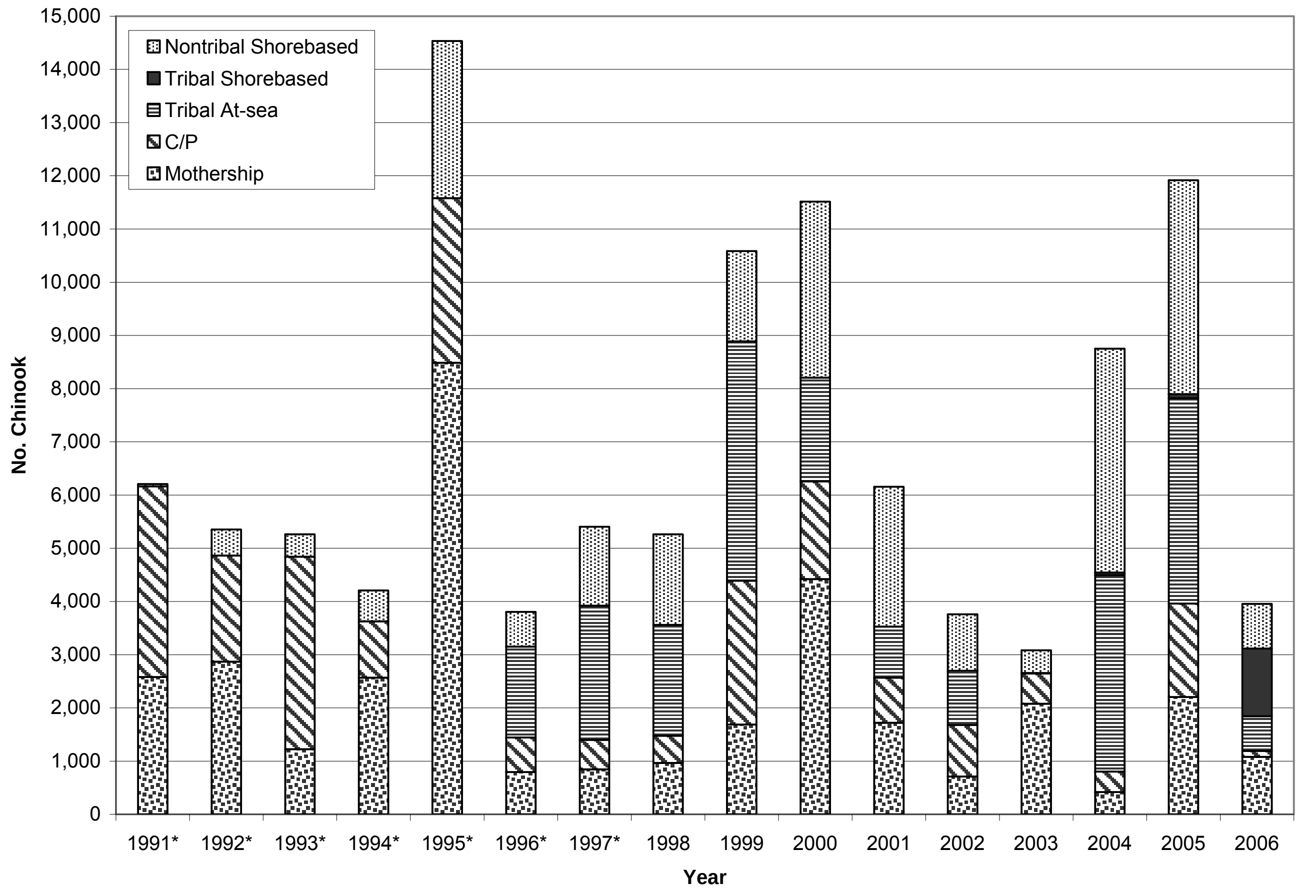
Year	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Unidentified	Total
1991	6,206	138	24	8	0	0	NA	6,376
1992	5,353	193	0	48	0	0	NA	5,594
1993	5,262	17	3,397	58	116	0	NA	8,850
1994	4,207	69	32	214	0	0	NA	4,522
1995	**14,533**	1,381	1,590	182	6	0	NA	17,692
1996	3,803	64	0	178	0	0	NA	4,045
1997	5,404	350	497	114	0	0	NA	6,365
1998	5,261	122	4	35	1	0	NA	5,423
1999	10,584	122	507	465	0	0	NA	11,678
2000	**11,513**	101	18	19	2	0	18	11,671
2001	6,154	138	303	87	3	0	312	6,997
2002	3,759	183	0	148	0	0	4	4,094
2003	6,512	186	3,774	20	0	0	192	10,684
2004	8,751	216	0	109	0	0	9	9,085
2005	**11,916**	467	480	28	0	0	8	12,899
Average	7,281	250	708	114	9	0	91	8,398

Source: NMFS 2006

Both the absolute and relative effects of the different whiting subsectors may considered in describing past impacts. Table 3-3 shows, for the whole 1991-2005 period, both the bycatch rate (number of Chinook/mt whiting) and the percent of all Chinook caught for each subsector (number of Chinook caught by subsector/number caught in all sectors). The rate can be considered a measure of relative impact, or the intensity of the impact of a given subsector, while the percent of total indicates the absolute magnitude of impact for each subsector. It can be seen that the tribal mothership sector has the highest relative impact (0.1171 Chinook/mt) but ranks second to last in terms of absolute impact. The nontribal mothership sector has had the highest absolute impact (31.73 percent) and the second-highest relative impact (0.0506 Chinook/mt). The catcher/processor sector has the lowest overall bycatch rate for the period followed (0.0219 Chinook/mt) and accounted for the third lowest proportion of overall bycatch (22.81 percent). The tribal shorebased sector has only operated since 2003 and thus accounts for a very small share of total bycatch for the period.

Table 3-3. Relative impact (average Chinook salmon/mt whiting) and absolute impact (percent of all Chinook caught 1991-2005) by whiting sector

	Relative Impact (rate)	Absolute Impact (% all Chinook)
Mothership	0.0506	31.73%
Catcher/Processor	0.0219	22.81%
Nontribal Shorebased	0.0246	24.25%
Tribal Mothership	0.1171	21.07%
Tribal Shorebased	0.0066	0.13%



* NOTE: 1991-1997 is based final inseason data files and may vary from estimates derived from NORPAC data. Shoreside data updated from Nottage and Parker 2005.
2002 shore-based landings does not include 432 mt of whiting or salmon taken in trip limit fishery
2003 shore-based landings does not include 195 mt of whiting or salmon taken in trip limit fishery
2004 shore-based landings does not include 1,644 mt of whiting or salmon taken in trip limit fishery - first year of video monitoring at-sea 2005 shore-based landings does not include 310 mt of whiting or salmon taken in trip limit fishery

Figure 3-1. Summary of Chinook salmon bycatch in the Pacific whiting fishery by sector in number of fish, 1991-2005
(Data from Table 4 in NMFS 2006 supplemented with 2006 data from http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Whiting-Management/upload/2006HAK.pdf)

The supplemental Biological Opinion (NMFS 2006) summarizes previous work to identify causative factors that would account for variations in salmon bycatch. On an annual basis there is some temporal and spatial variation in bycatch that can be accounted for by the behavior and biology of Chinook salmon and Pacific whiting. Bycatch rates tend to be higher closer to shore and earlier in the season. This may explain, for example, the high bycatch rate for the tribal mothership sector, since these vessels fish within the tribal usual and accustomed areas (U/As), and thus have less flexibility to make spatial adjustments in response to salmon bycatch. Similarly, the shorebased sector, for cost and operational reasons, tends to fish closer to shore. However, no such factors adequately account for inter-annual variation in bycatch. Previous work found no "obvious or consistent correlation" between annual Chinook abundance and bycatch (NMFS 2006, p. 19). Ocean conditions may play a role but specific causative factors, at least any that can be used predicatively, cannot be identified.

In 2005 fishery, when it became apparent to NMFS that the whiting fishery could exceed the 11,000 Chinook level, the agency took emergency action to close the fishery shoreward of a boundary line approximating the 100 fm depth contour (70 FR 51682, August 31, 2005). As part of the 2007-08 groundfish harvest specifications process, this new zone, referred to as the Ocean Salmon Conservation Zone, was established in permanent regulations. The regulations allow the area to be closed as an automatic action when NMFS projects the Pacific whiting fishery may take in excess of 11,000 Chinook within a calendar year (71 FR 78638; revised at 72 FR 53165)

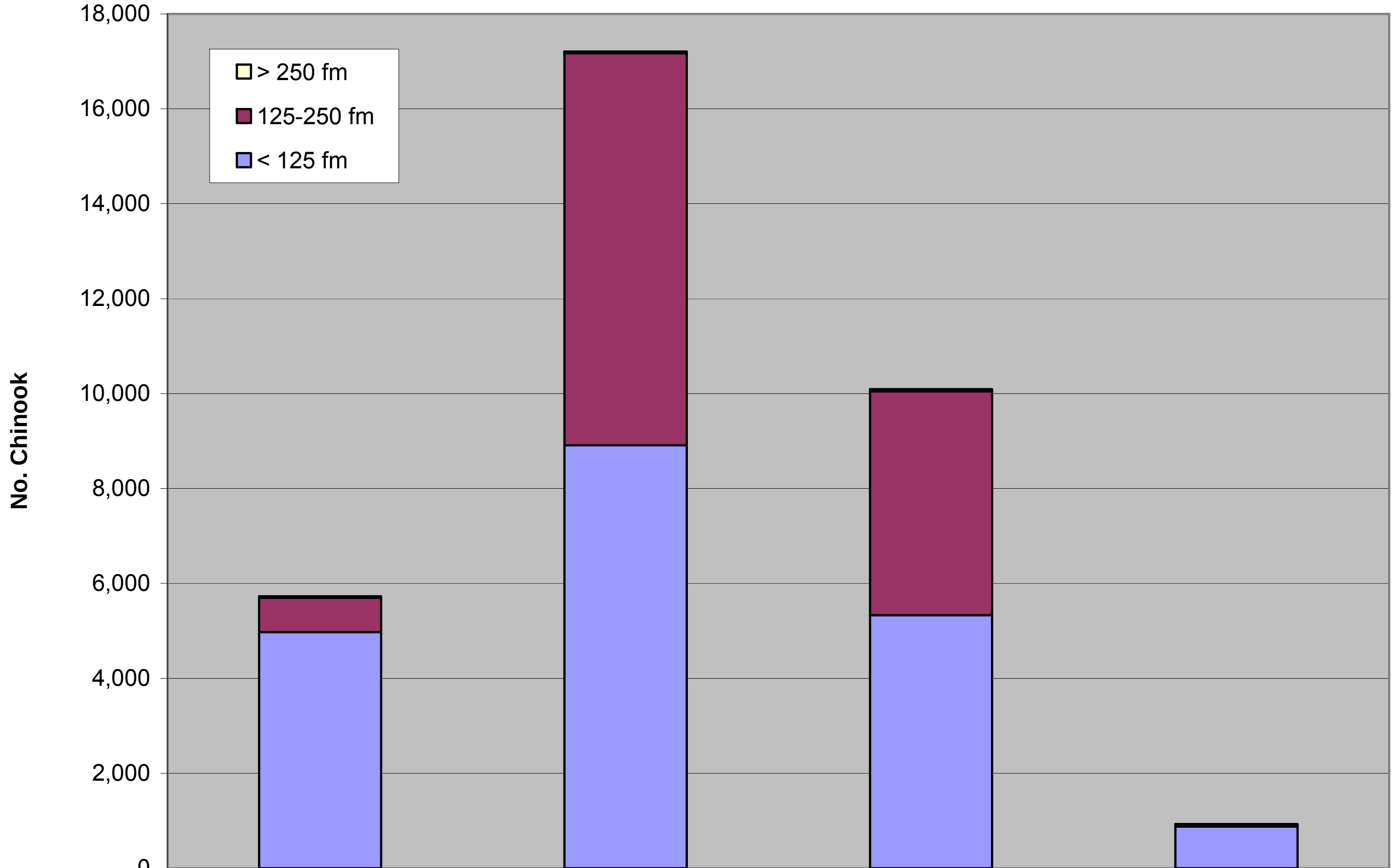
3.2.2 ESA-listed Salmon Take in the Limited Entry Bottom Trawl Fishery

The 1992 Biological Opinion (NMFS 1992) estimated the take of salmon in other, non-whiting groundfish trawl fisheries at 6,000-9,000 fish annually, with most of these taken in waters north of 43° N latitude. As with the whiting fishery, almost all of these were estimated to be Chinook salmon. Historically, the non-whiting groundfish trawl sector has not been comprehensively monitored for protected species bycatch and no similar re-initiation standard was established for this sector. With the implementation of the West Coast Groundfish Observer Program (WCGOP), however, it has become possible to estimate salmon bycatch in the non-whiting groundfish trawl sector more precisely. Data from the WCGOP were used to estimate that 18,120 salmon were caught in 2002, 13,862 fish in 2003, and 1,978 fish in 2004. Virtually all of the salmon caught were Chinook salmon (see Table 11 in NMFS 2006). Since these bycatch levels exceed the previous estimate of 6,000-9,000 Chinook specified in previous incidental take statements, NMFS also reinitiated its consultation on the Groundfish FMP and included an evaluation in the 2006 supplemental biological opinion. The previous estimates of salmon bycatch in the bottom trawl fishery were extrapolated from two coastwide research studies, one related to discards conducted from 1985 to 1987, and a second related to mesh size conducted from 1988 to 1990 (NMFS 1992). These were the only relevant data sources until NMFS began placing observers on bottom trawl vessels in August 2001.

The magnitude and distribution of bycatch in the trawl fishery from 2002 to 2004 was affected by significant changes in regulation and management of the fishery to protect overfished groundfish stocks. The past decade has seen significant changes in the management of the groundfish fishery to limit catch of overfished species. Because of changing regulations, shifts in fishing areas, reductions in trawl fishery effort from the December 2003 trawl vessel and permit buyback program, and gear innovations (including the new selective flatfish trawl gear) coastwide, it is difficult to pinpoint which of these various factors may be affecting Chinook bycatch negatively or positively.

The supplemental Biological Opinion (NMFS 2006) evaluates Chinook salmon bycatch by latitudinal and depth strata based on estimates from WCGOP data. Figure 3-2 aggregates this information (NMFS 2006, from Table 12) across the three years of available data. The highest bycatch occurs in depths shallower than 125 fm across all latitudinal strata with the highest overall bycatch occurring off the

Oregon coast from Cape Falcon to Cape Blanco, followed by the region to the south to Cape Mendocino in northern California. Looking at latitudinal differences alone over the three years, 56 percent of estimated Chinook bycatch occurred in the Cape Falcon-Cape Blanco region; in 2003 two-thirds of estimated bycatch was from that region. The 2006 supplemental Biological Opinion notes that "more bycatch, in the bottom trawl fishery in particular, was shifted south into northern California than was previously thought" (page 30). As a result, Sacramento winter-run Chinook, California coastal Chinook, and Central Valley spring-run Chinook may be disproportionately affected. However, component ESUs for these stocks have increased or remained stable over the past ten years.



	US/Canada Border to Cape Falcon	Cape Falcon to Cape Blanco	C. Blanco to C. Mendocino	C. Mendocino to US/Mex Border
> 250 fm	30	37	47	0
125-250 fm	724	8,264	4,713	57
< 125 fm	4,975	8,907	5,332	875

Area

Figure 3-2. Aggregated estimate of Chinook bycatch 2002–04 in the groundfish bottom trawl sector

Take of Chinook salmon in the trawl fishery is a relatively rare event with a few tows accounting for a disproportionate share of the estimates of catch. Thus, in terms of salmon bycatch, the distribution of effects is highly skewed. As a result, comparing tows within a given spatio-temporal sampling stratum, approximately 45 percent of all observed Chinook bycatch occurs in the single largest tow for any given stratum. For example, in the 2002 Cape Falcon-Cape Blanco and less-than-125-fathom-depth stratum there were 341 observed tows. One or more salmon was observed in only 24 of these tows while a single tow accounted for 179 salmon, which was 56 percent of all the observed salmon used to derive the estimate of 2,207 Chinook for that stratum.

This skewed distribution in the occurrence of salmon also affects the reliability of estimates derived from subsamples. In the groundfish bottom trawl sector only a portion of tows are observed. Even in the whiting fishery, where there is 100 percent observer coverage, observers may subsample some hauls rather than counting all fish brought aboard.

Although the estimated bycatch in 2002 and 2003 was substantially above the 6,000-9,000 expected salmon bycatch range articulated in the incidental take statement from the 1999 consultation, in the 2006 supplemental biological opinion NMFS reaffirmed 9,000 Chinook as a benchmark for making a jeopardy determination. As in the whiting fishery, exceeding this value in any one year is not by itself a reason for concluding jeopardy. NMFS, therefore, reaffirmed its prior determination that implementation of the Groundfish FMP is not likely to jeopardize the continued existence of any of the affected ESUs. However, in response to the larger than expected bycatch in two of three sample years NMFS will continue to monitor and collect data to analyze take levels.

3.3 Marine Mammals

The waters off Washington, Oregon, and California support a wide variety of marine mammals (Table 3-4). Approximately 30 species, including seals and sea lions, sea otters, whales, dolphins, and porpoise, occur within the EEZ. Many marine mammal species seasonally migrate through west coast waters, while others are year-round residents.

In addition to the ESA, the Federal MMPA guides marine mammal species protection and conservation policy. Under the MMPA, on the west coast NMFS is responsible for the management of cetaceans and pinnipeds, while the FWS manages sea otters. Stock assessment reports review new information every year for strategic stocks and every three years for non-strategic stocks. (Strategic stocks are those whose human-caused mortality and injury exceeds the potential biological removal [PBR].) Marine mammals, whose abundance falls below the optimum sustainable population (OSP), are listed as “depleted” according to the MMPA.

Fisheries that interact with species listed as depleted, threatened, or endangered may be subject to management restrictions under the MMPA and ESA. NMFS publishes an annual list of fisheries in the Federal Register separating commercial fisheries into one of three categories based on the level of serious injury and mortality of marine mammals occurring incidentally in that fishery. The categorization of a fishery in the list of fisheries determines whether participants are subject to certain provisions of the MMPA, such as registration, observer coverage, and take reduction plan requirements. According to the 2007 List of Fisheries, the west coast groundfish fisheries are in Category III, denoting a remote likelihood of, or no known, serious injuries or mortalities to marine mammals.

Table 3-4. Marine Mammals of the West Coast

Common Name	ESA Status	MMPA Status
<u>Pinnipeds</u>		
California sea lion (*Zalophus californianus*)		
Pacific harbor seal (*Phoca vitulina Richards*)*i*		
Northern elephant seal (*Mirounga angustirostris*)		
Guadalupe fur seal (*Arctocephalus townsendi*)	T	D
Northern fur seal (*Callorhinus ursinus*)		
Steller sea lion (*Eumetopias jubatus*)		D
Steller sea lion – Eastern stock	T	D
Steller sea lion – Western stock	E	D
<u>Sea otters</u>		
Southern (*Enhydra lutris nereis*)	T	D
Northern (*Enhydra lutris kenyoni*)	T (SW Alaska only)	
<u>Cetaceans</u>		
Minke whale (*Balaenoptera acutorostrata*)		
Short-finned pilot whale (*Globicephala macrorhyncus*)		
Gray Whale (*Eschrichtius robustus*)		
Harbor porpoise (*Phocoena phocoena*)		
Dall's porpoise (*Phocoenoides dalli*)		
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)		
Short-beaked common dolphin (*Delphinus delphis*)		
Long-beaked common dolphin (*Delphinus capensis*)		
The following cetaceans are present within the area managed by the Groundfish FMP but not likely to interact with groundfish fisheries or have not been documented having had interactions in observed groundfish fisheries:		
Bottlenose dolphin (*Tursiops truncates*)		
Striped Dolphin (*Stenella coeruleoalba*)		
Sei whale (*Balaenoptera borealis*)	E	D
Blue whale (*Balaenoptera musculus*)	E	D
Fin whale (*Balaenoptera physalus*)	E	D

Common Name	ESA Status	MMPA Status
Sperm whale (*Physeter macrocephalus*)	E	D
Humpback whale (*Megaptera novaeangliae*)	E	D
Bryde's whale (*Balaenoptera edeni*)		
Killer whale (*Orcinus orca*)		
Killer whale – Puget Sound southern resident stock	E	D
Baird's beaked whale (*Berardius bairdii*)		
Cuvier's beaked whale (*Ziphius cavirostris*)		
Pygmy sperm whale (*Kogia breviceps*)		
Risso's dolphin (*Grampus griseus*)		
Striped dolphin (*Stenella coeruleoalba*)		
Northern right-whale dolphin (*Lissodelphis borealis*)		

Source as of January 2008: NMFS Office of Protected Resources website: www.nmfs.noaa.gov/pr/species/mammals/

3.4 Seabirds

The highly productive California Current System, an eastern boundary current that stretches from Baja California, Mexico, to southern British Columbia, supports more than two million breeding seabirds and at least twice that number of migrant visitors. Tyler, et al. (1993) reviewed seabird distribution and abundance in relation to oceanographic processes in the California Current System and found that over 100 species have been recorded within the EEZ, including albatross, shearwaters, petrels, storm-petrels, cormorants, pelicans, gulls, terns, and alcids (murres, murrelets, guillemots, auklets, and puffins). In addition to these "classic" seabirds, millions of other birds are seasonally abundant in this oceanic habitat including: waterfowl, waterbirds (loons and grebes), and shorebirds (phalaropes). Not surprisingly, there is considerable overlap of fishing areas and areas of high bird density in this highly productive upwelling system. The species composition and abundance of birds varies spatially and temporally. The highest seabird biomass is found over the continental shelf, and bird density is highest during the spring and fall when local breeding species and migrants predominate.

The FWS is the primary federal agency responsible for seabird conservation and management. Three species occurring in the California Current Ecosystem are listed under the ESA and one species is a candidate for ESA listing, as shown in Table 3-5. In 2002, the FWS classified several seabird species that occur off the west coast as Bird of Conservation Concern (BCC), and these are also noted in Table 3-5. Short-tailed albatross (*Phoebastria albatrus*), Hawaiian petrel (*Pterodroma sandwichensis*) and Newell's shearwater (*Puffinus auricularis* Newell) are ESA listed seabird species that primarily occur around Hawai'i and U.S. Pacific Islands. Short-tailed albatross range from Japan to California and are ESA listed endangered.

The MBTA implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and Russia for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful. In addition to the MBTA, an Executive Order, Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186), directs federal agencies to negotiate Memoranda of Understanding with the FWS that would obligate agencies to evaluate the impact on migratory birds as part of any NEPA process. The FWS and NMFS are working on a Memorandum of Understanding concerning seabirds.

In February 2001, NMFS adopted a National Plan of Action (NPOA) to Reduce the Incidental Take of Seabirds in Longline Fisheries. This NPOA contains guidelines that are applicable to relevant groundfish fisheries and would require seabird incidental catch mitigation if a significant problem is found to exist. During the first two years of NPOA implementation, NMFS regions were tasked with assessing the incidental take of seabirds in longline fisheries. In the limited entry groundfish longline fleet off the coast of Washington, Oregon, and California during September 2001–October 2002, there were no incidental seabird takes documented by west coast Groundfish Observers. (During the assessment period, approximately 30 percent of landings by the limited entry fixed gear fleet had observer coverage.)

Table 3-5. Protected Seabirds of the West Coast

ESA-listed Endangered
California brown pelican (*Pelecanus occidentales*)
California least tern (*Sterna antillarum browni*)
ESA-listed Threatened
Marbled murrelet (*Brachyramphs marmoratus*)
ESA Listing Candidate
Xantus's murrelet (*Synthliboramphus hypoleucus)*
USFWS Bird of Conservation Concern (BCC)
Ashy Storm-petrel (*Oceanodroma homochroa)*
Arctic tern (*Sterna paradisaea)*
Elegant tern (*Sterna elegans)*
Western gull-billed tern (*Sterna nilotica)*
Black skimmer (*Rynchops niger)*
Xantus's murrelet (*Synthliboramphus hypoleucus)*
Cassin's auklet (*Ptychoramphus aleuticus)*
Caspian tern (*Sterna caspia)*

Source: (USFWS 2005)

CHAPTER 4 DESCRIPTION OF THE FISHERIES MANAGEMENT REGIME

4.1 Management Systems

This chapter addresses policy, science, and management entities directly affected by the current management regime, but does not include participants in the fishery or the fishing communities of the west coast (see Chapter 5 for a description of the socioeconomic environment). The management regime is an important issue, because it generates direct and indirect impacts. The regime is also affected by changes in law and policy, which can cumulatively affect the environment. This section is not intended to be a comprehensive description of the entire west coast groundfish management regime. Rather the chapter provides a general overview of the management regime and focuses on management regime components such as stock assessments, catch accounting, observer programs, enforcement, and research fisheries. These components are all crucial to the process of determining sustainable fishery yields and many have been substantially modified by NMFS and the Council in recent years. Additionally, the chapter briefly discusses enforcement issues affecting the efficacy of prescribed management measures with an emphasis on vessel monitoring systems.

In November 2002, the Council approved Amendment 17 to the Groundfish FMP which implemented a biennial management cycle. The complexity of the previous annual cycle left little time for fishery managers to work on other initiatives to improve the management regime. Starting in 2005 and 2006, harvest specifications (ABCs and OYs) and management measures are established for two years. This new cycle extends Council decision-making over three meetings. At its November meeting, 14 months before the start of the biennium, the Council identifies preliminary ABCs and OYs. At the following April and/or March meeting, the Council finalizes these harvest specifications and identifies a preliminary range of management measures. The Council makes its final decisions on these management measures at the June meeting preceding the next biennium. This schedule allows enough time for NMFS to publish a proposed rule in the Federal Register and take public comment before its final decision on whether to approve the Council recommendations. More time is also available to meet the procedural and documentary requirements of NEPA. Finally, this cycle accommodates an “off-year” during which the Council and NMFS would be less occupied with ongoing management of the groundfish fishery and could spend more time on long-term initiatives such as developing better assessment models and surveys. More information on the management cycle and Council decision-making may be found in Appendix A, Section 1.1.2 of the 2005–06 groundfish harvest specifications FEIS (PFMC 2004b). More information on Council priorities for preventing overfishing and achieving OY, for specification and apportionment of harvest levels, and for setting both short-term management measures and long-term management programs may be found in Chapters 4–6 of the Groundfish FMP (PFMC 2006a).

Uncertainty in fishery management and constraining OYs combine to create a potentially intensive inseason management burden on the management regime. This section focuses on data systems and mechanisms for inseason management. Ongoing research, existing observer programs, and revised fishery sampling programs could provide improved information during the 2006–07 management cycle. Entities and documents including the Pacific Coast Groundfish FMP, the Council, and NEPA all provide rules and guidance on inseason use of new information.

4.1.1 Catch Monitoring and Accounting

Various state, Federal, and tribal catch monitoring systems are used in west coast groundfish management. These are coordinated through the Pacific States Marine Fisheries Commission (PSMFC). PacFIN is the commercial catch monitoring database, and RecFIN is the database for recreational fishery catch monitoring. There are two components to total catch: (1) catch landed in port, and (2) catch discarded at-sea. Discards occur for regulatory reasons (i.e., catch in excess of trip and/or landing limits) and market reasons (i.e., catch of unmarketable species or size). A description of the relevant data systems used to monitor total catch and discards in commercial, recreational, and research fisheries follows.

4.1.1.1 *Monitoring Commercial Landings*

Sorting requirements are now in place for all species with trip limits, harvest guidelines, or OYs, including all depleted species. This provides accounting for the weight of landed depleted species when catches are hailed at-sea or landed. Limited entry groundfish trawl fishermen are also required to maintain state logbooks to record the start and haul locations, time, and duration of trawl tows, as well as the total catch by species market category (i.e., those species and complexes with sorting requirements). Landings are recorded on state fish receiving tickets. Fishtickets are designed by the individual states, PSMFC coordinates record-keeping requirements between state and Federal managers. Poundage by sorted species category, area of catch, vessel identification number, and other data elements are required on fishtickets. Landings are also sampled in port by state personnel to collect species composition data, otoliths for ageing, lengths, and other biological data. Federal observer sample rates vary between fishery and state, but the WCGOP attempts to sample about 20 percent of the landed catch. A suspension of at-sea sorting requirements coupled with full retention of catch is allowed in the whiting fishery (by FMP Amendment 10 and an annual EFP in the Shoreside Whiting sector). The at-sea whiting fishery has 100 percent on-board observer coverage, while the shoreside whiting sector brings most of their catch to port for sampling. Landings, logbook data, and state port sampling data are reported inseason to the PacFIN database managed by PSMFC (www.psmfc.org/pacfin/index.html). The GMT and PSMFC manage the Quota Species Monitoring (QSM) dataset reported in PacFIN. All landings of groundfish stocks of concern (depleted stocks and stocks below B_{MSY}) and target stocks and stock complexes in west coast fisheries are tracked in QSM reports of landed catch. The GMT recommends prescribed landing limits and other inseason management measures to the Council to attain, but not exceed, total catch OYs of QSM species. Stock and complex landing limits are modified inseason to control total fishing-related mortality; QSM reports and landed catch forecasts are used to control the landed catch component.

4.1.1.2 *Monitoring Recreational Catch*

Recreational catch is monitored by the states as it is landed in port. These data are compiled by the PSMFC in the RecFIN database. The types of data compiled in RecFIN include sampled biological data, estimates of landed catch plus discards, and economic data. Descriptions of the RecFIN program, state recreational fishery sampling programs in Oregon and Washington, and the most recent data available to managers, assessment scientists, and the general public, can be found on the PSMFC web site at www.psmfc.org/recfin.

The MRFSS has been an integral part of the RecFIN program. Traditionally, there have been two primary components of the survey; field intercept surveys (administered under supervision of PSMFC) and a random phone survey of coastal populations (administered by a third party contracted by NMFS). The field intercept surveys have been used to estimate catch, and the phone survey has been used to estimate effort. The results of these two efforts are combined in the RecFIN data system maintained by PSMFC, and estimates of total effort and fishing mortality are produced along with other data potentially useful for management and stock assessments. However, MRFSS was not designed to estimate catch and effort at the level of precision needed for management or assessment; it was designed to provide a broad picture look of national fisheries. Comparison with independent and more precise estimation procedures has shown wide variance in catch estimates. Inseason management of recreational fisheries using MRFSS has been compromised by inseason variance of catch estimates.

In recent years, efforts have been made to improve MRFSS for use in inseason management. Observing a growing concern with the use of MRFSS program data on the west coast, California and policy representatives from the west coast recommended the development of a new program to replace MRFSS. In response, staff from the CDFG and the PSMFC designed the CRFS, a new program for sampling California's recreational fisheries which incorporated both the comprehensive coverage of the MRFSS program and the high frequency on-site sampling of CDFG's Ocean Salmon Project. Additionally, in 2001 PSMFC, with support from NMFS, began a new survey to estimate CPFV fishing effort in California.

Washington and Oregon use the MRFSS system as a supplement to the extensive port sampling programs they use to derive most of their recreational catch estimates are derived. The Washington Ocean Sampling Program and the Oregon Boat Survey both operate annually from approximately April through October and focus on recreational finfish (including salmon, groundfish, halibut, and tuna) from private and charter fishing vessels.

A primary goal of west coast recreational survey programs is to produce timely marine recreational, fishery-based data needed for sustainable management of marine recreational fishery resources. Continuing improvements to west coast recreational fishery surveys should reduce uncertainty in recreational harvest estimates and improve preseason and inseason management processes, two important components of coastwide groundfish fishery management under constraining OYs.

4.1.1.3 *Management Response to Catch Monitoring*

Management measures are normally imposed, adjusted, or removed at the beginning of the biennial fishing period, but may, if the Council determines it necessary, be imposed, adjusted, or removed at any time during the period. As described in Section 6.2 of the Groundfish FMP, four different categories of management actions are authorized, ranging from automatic actions initiated by NMFS to full rulemaking actions requiring a minimum of two Council meetings. Inseason adjustments typically fall under the category of notice actions that are routine (as defined by the FMP) in nature and usually require one Council meeting and one Federal Register notice. Federal and/or state responses to management goals varies according to the specification of the harvest targets and are largely governed by the definitions in the FMP and Federal Regulations as follows:

> *Acceptable Biological Catch is a biologically based estimate of the amount of fish that may be harvested from the fishery each year without jeopardizing the resource. It is a seasonally determined catch that may differ from MSY for biological reasons. It may be lower or higher than MSY in some years for species with fluctuating recruitment. The ABC may be modified to incorporate biological safety factors and risk assessment due to uncertainty. Lacking other biological justification, the ABC is defined as the MSY exploitation rate multiplied by the exploitable biomass for the relevant time period.*

<u>Optimum yield</u> means the amount of fish which will provide the greatest overall benefit to the U.S., particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems, is prescribed as such on the basis of the maximum sustainable yield from the fishery as reduced by any relevant economic, social, or ecological factor; and in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery (Federal regulations adds final sentence: OY may be expressed numerically (as a HG, quota, or other specification) or non-numerically).

<u>Quota</u> means a specified numerical harvest objective, the attainment (or expected attainment) of which causes closure of the fishery for that species or species group. Groundfish species or species groups under this FMP for which quotas have been achieved shall be treated in the same manner as prohibited species (the second sentence is not included in Federal Regulations).

<u>Harvest guideline</u> is a specified numerical harvest objective which is not a quota. Attainment of a harvest guideline does not require closure of a fishery. (Identical language in Federal Regulations 50 CFR Part 660, Subpart G).

<u>California</u>

California has three possible courses of regulatory action for recreational fisheries when a harvest limit is reached.

1. Closure of recreational fisheries for any Federal groundfish, greenlings (of the genus *Hexagrammos*), California sheephead, and ocean whitefish when a Federal annual harvest limit for lingcod, rockfish, cabezon, or a subgroup of rockfish, and/or California scorpionfish has been exceeded or is projected to be exceeded (Section 27.82 of Title 14, California Code of Regulations).

   The CFGC has given CDFG the authority to close the following recreational fisheries when an annual harvest limit (OY or HG) established in regulation by NMFS for lingcod, rockfish, cabezon, or a subgroup of rockfish, and/or California scorpionfish has been exceeded or is projected to be exceeded: lingcod, rockfish, a subgroup of rockfish, California scorpionfish, cabezon, greenlings (of the genus *Hexagrammos*), California sheephead, ocean whitefish, and any Federal groundfish. Closures may encompass all state waters or specific areas, and may be for all or part of the calendar year. The CDFG must provide the public with a notice of the closure (via press release) at least ten days before the closure is to take effect.

2. Closure of recreational fisheries for California sheephead, cabezon, or greenlings (of the genus *Hexagrammos*) when a state-established TAC or allocation is reached or is projected to be reached (Section 52.10 of Title 14, California Code of Regulations).

   Statewide TACs are established in regulation for California sheephead, cabezon, or greenlings (of the genus *Hexagrammos*). The regulation sets allocations for recreational and commercial fisheries. CFGC has given the CDFG the authority to close the recreational and commercial fisheries for these species when an allocation or TAC is reached or is projected to be reached prior to the end of the calendar year. For the closure of a recreational fishery, CDFG is required to provide the public with at least ten days notice (via press release) prior to the closure.

3. Emergency action by CFGC (Section 240 of the Fish and Game Code).

The California State Legislature has authorized CFGC to adopt or repeal regulations on an emergency basis, provided the action is necessary for (1) the immediate conservation, preservation, or protection of birds, mammals, reptiles, or fish, including, but not limited to, any nests or eggs thereof, or (2) the immediate preservation of the public peace, health and safety, or general welfare. CFGC may adopt emergency regulations for recreational fisheries and for those commercial fisheries the Legislature has given CFGC the authority to regulate.

The law requires CFGC hold at least one hearing before taking emergency action, and the action is subject to the review of the Office of Administrative Law (OAL). Once CFGC takes action and submits the rulemaking file to OAL, OAL has ten days to review the file and approve or disapprove the regulation. If OAL approves the regulation, then it is filed with the Secretary of State and is in effect for 120 days (unless the regulation specifies a shorter time period).

Emergency regulation lapses by operation of law unless CFGC files a completed rulemaking for a permanent regulation with OAL or OAL approves a re-adoption of the emergency regulation. The rulemaking for the permanent regulation must follow the normal rulemaking provisions of the Administrative Procedures Act. This includes a 45-day public notice.

Oregon

The Oregon State Legislature granted the Oregon Fish and Wildlife Commission (OFWC) the authority to adopt regulations under the Oregon Administrative Rules (OAR). The OFWC delegates the authority to adopt temporary rules to the Director of ODFW (Director). Temporary rules may be considered for various reasons, including the achievement of quotas, OYs, harvest limits or HGs, and to conform to Federal regulations. Temporary regulations can be adopted, filed and in effect within a single business day, but in practice, 72 hours public notice is usually provided. A temporary rule approved by the Director is ratified by the OFWC at its next meeting, usually within 30 days.

Once filed, copies of the temporary rule are distributed to all marine related ODFW and Oregon State Police offices. The ODFW information and education program creates and distributes a general public news release. Additionally, specific industry notices are developed and distributed throughout local fishing communities.

Once adopted, temporary regulations are in effect for 180 days. If the regulations need to remain in place for a longer duration, ODFW can adopt a permanent rule through the full OFWC process. This two-meeting process includes public notice of the intent for rulemaking, an economic analysis, and adequate public review.

Washington

The Washington State Legislature has granted the Washington Fish and Wildlife Commission (WFWC) the authority to adopt emergency regulations under the Revised Code of Washington (RCW) 77.04.090. WFWC has delegated the authority to adopt emergency regulations to the Director of WDFW. Emergency regulations may be considered for various reasons, including the achievement of quotas, OYs, harvest limits or HGs, and to conform with Federal regulations. The parameters for approving emergency regulations are not specified in the authority language. Emergency regulations can be adopted, filed, and in effect within 24 hours of being drafted.

Once adopted, emergency regulations are in effect for 120 days. During this time, if the regulation needs to remain in place for a longer duration, WDFW may consider adopting a permanent rule. Depending on the nature of the rule, it may have to go through the WFWC approval process. Once the permanent rule process has been initiated, a second emergency regulation may be filed to extend the time period. For example, an emergency regulation filed on March 1 that must remain in effect for the calendar year would expire on June 28. Provided a permanent rule process has been initiated, a subsequent emergency regulation can be filed on June 29, that would remain in effect through October 26, in order to accommodate the time needed for the permanent rule process to be finalized.

Washington Administrative Code (WAC) 220-28-010 strengthens state's the ability to enforce emergency regulations, by stating, "It shall be unlawful to take, fish for or possess food fish or shellfish taken contrary to the provisions of any special season or emergency closed period prescribed in this chapter." A note at the end of the rule language also clarifies, "The department of fish and wildlife frequently adopts emergency rules of limited duration that relate to seasons, closures, gear, and other special matters concerning the industry...."

Once filed, copies of the emergency regulation are faxed to all WDFW regional offices and enforcement staff. WDFW also uses its Outreach and Education Program to inform the public of emergency regulations. Typically, a Fishing Rule Change Notice is distributed to local media and WDFWs sportfishing hotlines are updated within 24 hours of the rule adoption.

4.1.2 Standardized Bycatch Reporting Methodologies

Establishing a standardized bycatch reporting methodology and limiting bycatch to the extent practicable are MSA mandates. Effective bycatch accounting and control mechanisms are also critical for staying within target total catch OYs. The first element in limiting bycatch is accurately measuring bycatch rates by time, area, depth, gear type, and fishing strategy. This section describes west coast programs designed to achieve these goals.

At its November 2005 meeting, the Council approved Amendment 18 to the Groundfish FMP. The Council recommendation addresses National Standard 9 and Section 303(a)(11) of the MSA, which require practicable means to minimize bycatch and bycatch mortality a standardized bycatch reporting methodology. The purpose of FMP Amendment 18 is to clearly and comprehensively describe measures that address these requirements, which have been established through long-term regulations and the biennial management process. The amendment also describes new measures that could be implemented by future regulatory or amendment actions. For additional information on Amendment 18 see the Council web page (www.pcouncil.org/groundfish/gffmp/gfa18.html).

4.1.2.1 *West Coast Groundfish Observer Program*

The WCGOP includes the Observer Team and collaborators from the PSMFC that direct the program, train new observers, and manage and analyze the bycatch data. On May 24, 2001, NMFS established the WCGOP to implement the *Pacific Coast Groundfish Fishery Management Plan* (50 CFR Part 660). This regulation requires all vessels that participate in commercial groundfish fisheries to carry an observer when notified to do so by NMFS or its designated agent. These observers monitor and record catch data, including species composition of retained and discarded catch. Observers also collect critical biological data such as fish length, sex, and weight. The program currently deploys observers coastwide on the permitted trawl and fixed-gear groundfish fleet, as well as on some vessels that are part of the open-access groundfish fleet.

The WCGOP is designed to provide estimates of fleet-wide discards in commercial fisheries; fishtickets are the mandated landings accounting mechanism. Logbook data need to be available to fully use observer data because observers initially record hail weights and logbook data for retained catch, and these values need to be adjusted by fish ticket information to achieve total catch estimates. One difficulty is the need for a statistically significant number of observations of discard across all strata to determine representative bycatch rates for these strata.

NMFS first implemented the WCGOP in August 2001 to make direct observations of commercial groundfish discards. Given the skewed distribution of bycatch in west coast groundfish fisheries, many observations in each sampling strata (i.e., target effort by gear type by area) are needed to estimate representative bycatch rates of depleted groundfish species. The seasonality of bycatch is an important management consideration. Target opportunities for healthy flatfish and DTS species vary seasonally and geographically. It is reasonable to expect bycatch rates of depleted groundfish species to vary in accordance with the co-occurrence of target species and depleted species.

The WCGOP has annually released annual reports since 2003 which describe the analysis of observer data for various fishery sectors and species collected under the program. These reports and background materials on the WCGOP are available on the Northwest Fisheries Science Center website at: www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm.

NMFS continually reviews the program and has gradually expanded the programs coverage since its inception. Additionally, the NWFSC has worked closely with the Council and NMFS NWR to coordinate the availability of WCGOP results into the management regime. New WCGOP results are now incorporated into the fishery models and management regime in the fall, prior to the November through June management cycle. A description of how data from the WCGOP is being used in the modeling of commercial fishery impacts can be found in Section 4.5.

4.1.2.2 *At-Sea Pacific Whiting Observer Program*

To increase the utilization of bycatch otherwise discarded as a result of trip limits, Amendment 13 to the Groundfish FMP implemented an increased utilization program on June 1, 2001, which allows catcher/processors and motherships in the whiting fishery to exceed groundfish trip limits without penalty, providing specific conditions are met. These conditions include provisions for 100 percent observer coverage, non-retention of prohibited species, and either donation of retained catch in excess of cumulative trip limits to a bona fide hunger relief agency or processing of retained catch into mince, meal, or oil products.

Vessels participating in the at-sea Pacific whiting fisheries have been carrying observers voluntarily since 1991. NMFS made observer coverage mandatory for at-sea processors in July 2004 (65 FR 31751). These provisions have not only given fishery managers the tools necessary to allow the At-Sea Pacific Whiting Program to operate efficiently while meeting management goals, but have also provided scientists, through the observer coverage, an extensive amount of information on bycatch species. This dataset has both provided valuable information in the management of Pacific whiting, but has been used as a stock assessment data source.

4.1.2.3 *Shore-based Pacific Whiting Observation Program*

The Shoreside Hake Observation Program (SHOP) was established in 1992 to provide information for evaluating bycatch in the directed Pacific whiting fishery and for evaluating conservation measures adopted to limit the catch of salmon, other groundfish, and prohibited species. Though instituted as an experimental monitoring program, it has been continued annually to account for all catch in targeted whiting trip landings, enumerate potential discards, and accommodate the landing and disposal of non-sorted catch from these trips. Initially, the SHOP included at-sea samplers aboard shore-based whiting vessels. However, when an ODFW analysis of bycatch determined no apparent difference between vessels with and without samplers, sampler coverage was reduced to shoreside processing plants. In 1995, the SHOP's emphasis changed from a high observation rate (50 percent of landings), to a lower rate (10 percent of landings), and increased emphasis on collection of biological information (e.g., otoliths, length, weight, sex, and maturity) from Pacific whiting and selected bycatch species (yellowtail rockfish, widow rockfish, sablefish, chub (Pacific) mackerel (*Scomber japonicus*), and jack mackerel (*Trachurus symmetricus*). The required observation rate was decreased as studies indicated that fishtickets were a good representation of what was actually landed. Focus shifted again due to 1997 changes in the allocation of yellowtail rockfish and increases in yellowtail bycatch rates. Since then, yellowtail and widow bycatch in the shoreside whiting fishery has been dramatically reduced because of increased awareness by fishermen of the bycatch and allocation issues involved in the SHOP program.

The SHOP is a cooperative effort between the fishing industry and state and Federal management agencies to sample and collect information on directed Pacific whiting landings at shoreside processing plants. Participating vessels apply for and carry an EFP issued by NMFS. Permit terms require vessels to retain all catch and land unsorted catch at designated shoreside processing plants. Permitted vessels are not penalized for landing prohibited species (e.g., Pacific salmon, Pacific halibut, Dungeness crab), nor are they held liable for overages of groundfish trip limits. For additional information and complete reports go to: www.dfw.state.or.us/MRP/hake/.

Since inception, an EFP has been adopted annually to allow suspension of at-sea sorting requirements in the shore-based whiting fishery enabling full retention and subsequent port sampling of the entire catch. However, EFPs are intended to provide for limited testing of a fishing strategy, gear type, or monitoring program that may eventually be implemented on a larger fleet-wide scale and are not a permanent solution to the monitoring needs of the shore-based Pacific whiting fishery. In 2007 the Council and NMFS adopted a monitoring program which will be implemented in 2008 to provide a maximized retention opportunity without the use of the EFP process. Electronic monitoring of catches through the use of deck cameras and human at-sea observers will be used to ensure maximized retention of catch at-sea. Data quality managers will be stationed at shoreside processing plants to ensure catch is sorted and weighed to federally defined standards and to help obtain biological samples of delivered catch.

4.1.2.4 *Central California Marine Sport Fish Project*

The CDFG has been collecting angler catch data from the CPFV industry intermittently for several decades in order to assess the status of the nearshore California recreational fishery. The project has focused primarily on rockfish and lingcod angling and has not sampled salmon trips. Reports and analyses from these projects document trends by port area in species composition, angler effort, catch, and, for selected species, CPUE, mean length, and length frequency. In addition, total catch and effort estimates are made based on adjustments of logbook data by sampling information.

Before 1987, catch information was primarily obtained on a general port basis from dockside sampling of CPFVs, also called party boats. This did not allow documentation of specific areas of importance to recreational anglers and was not sufficient to assess the status of rockfish populations at specific locations.

CPFV operators are required by law to record total catch and location for all fishing trips in logbooks provided by the CDFG. However, the required information is too general for use in assessing the status of the multispecies rockfish complex on a reef by reef basis. Rockfish catch data are not reported by species and information on location is only requested by block number (a block is an area of 100 square miles). Many rockfishes tend to be residential, underscoring the need for site specific data. Thus, there is a strong need to collect catch information on board CPFVs at-sea. However, locations of specific fishing sites are often not revealed for reasons of confidentiality.

In May 1987, the Central California Marine Sport Fish Project began on board sampling of the CPFV fleet. Data collection continued until June 1990, when state budgetary constraints temporarily precluded further sampling, resumed in August 1991, and continued through 1994. The program depends on the voluntary cooperation of CPFV owners and operators. Angler catches on board central and northern California CPFVs were sampled from fourteen ports, ranging from Crescent City in the north to Port San Luis (Avila Beach) in the south. For additional information on this program, see the PSMFC website at: (www.psmfc.org/recfin/ccmsp.htm).

4.1.2.5 *Oregon Marine Recreational Observation Program*

In response to depleted species declarations and increasing concerns about fishery interactions with these species, ODFW started this program to improve understanding of recreational impacts. There were three objectives to this program: (1) document the magnitude of canary rockfish discard in the Oregon recreational fishery; (2) improve the biological database for several rockfish and groundfish species; and (3) gather reef location information for future habitat mapping. A seasonal sampler was stationed in each of the ports of Garibaldi, Newport, and Charleston to ride recreational groundfish charter vessels coastwide in Oregon from July through September, 2001. The Garibaldi sampler covered boats out of Garibaldi, the Newport sampler covered both Newport and Depoe Bay, and the Charleston sampler covered Charleston, Bandon, and Brookings charter vessels. During a typical day the sampler would ride a five to eight hour recreational groundfish charter trip and spend the remainder of the day gathering biological and genetic data dockside from several rockfish and groundfish species for which little is known mostly due to their infrequency in the catch. When allowed by the captain, the sampler also obtained Global Positioning System (GPS) locations of fishing sites for future use by the Habitat Mapping Project of the ODFW Marine Resources Program. Results from this program have been incorporated into recreational fishery modeling by ODFW. This program has continued and expanded to document the magnitude of discard of all groundfish species, not just canary rockfish. For more information on this program as well as other fishery research and survey programs see the ODFW Marine Program website at: www.dfw.state.or.us/MRP/.

4.1.2.6 *WDFW Groundfish At-Sea Data Collection Program*

The WDFW At-Sea Data Collection Program was initiated in 2001 to allow fishery participants access to healthier groundfish stocks while meeting the rebuilding targets of depleted stocks and to collect bycatch data through an at-sea sampler program. The data collected in these programs could assist with future fishery management by producing valuable and accurate data on the amount, location, and species composition of the bycatch of rockfish associated with these fisheries, rather than using calculated bycatch assumptions. These data could also allow the Council to establish trip limits in the future that maximize fishing opportunities on healthy stocks while meeting conservation goals for depleted stocks.

In recent years, WDFW has implemented its At-Sea Data Collection Program through the use of Federal EFPs. In 2001, 2002, 2003, and 2004, WDFW sponsored and administered a trawl EFP for arrowtooth flounder and petrale sole, and in 2002, WDFW also sponsored a midwater trawl EFP for yellowtail rockfish. The primary objective for these experimental fisheries was to measure bycatch rates for depleted rockfish species associated with these trawl fisheries. Fishery participants were provided access to healthier groundfish stocks and were constrained by individual vessel bycatch caps. State-sponsored samplers were used to collect data on the amount of rockfish bycatch caught on a per tow basis and to ensure the vessel complied with the bycatch cap; therefore, vessels participating in the EFP were required to have 100 percent sampler coverage. In 2003 and 2004, WDFW sponsored a longline EFP for spiny dogfish that also required 100 percent sampler coverage to measure the bycatch rate of depleted rockfish species associated with directed dogfish fishing.

4.1.2.7 *WDFW Ocean Sampling Program*

In addition to the At-Sea Data Collection Program, WDFW collects at-sea data through the Ocean Sampling Program. The at-sea portion is not intended to be an observer program for the purposes of enumerating the bycatch alone, but is coupled with shore-based sampling of anglers to calculate an estimated discard weight. At-sea samplers record biological information from discarded species. Shore-based creel surveys of anglers provide the estimate of total number of discards. Combining these two data sources yields estimates of the weight of total fishery discard by species.

4.1.2.8 *Tribal Observer Program*

Tribal directed groundfish fisheries are subject to full rockfish retention. For some rockfish species where the tribes do not have formal allocations, trip limits proposed by the tribes are adopted by the Council to accommodate incidental catch in directed fisheries (i.e., Pacific halibut, sablefish, and yellowtail rockfish). These trip limits are intended to constrain direct catches while allowing for small incidental catches. Incidental catch and discard of depleted species is minimized through the use of full rockfish retention, shore based sampling, observer coverage, and shared information throughout the fleets regarding areas of known interactions with species of concern. Makah trawl vessels often participate in paired tows in close proximity where one vessel has observer coverage. If landings on the observed vessel indicate higher than anticipated catches of depleted species, the vessels relocate and inform the rest of the fleet of the results (Joner 2004). Fleet communication in order to avoid depleted species is practiced by all tribal fleets.

4.1.3 Exempted Fishing Permits

An EFP is a NMFS-issued Federal permit that authorizes a vessel to engage in an activity that is otherwise prohibited by the MSA or other fishery regulations for the purpose of collecting limited experimental data. EFPs can be issued to Federal or state agencies, marine fish commissions, or other entities, including individuals.

The specific objectives of a proposed exempted fishery may vary. The Groundfish FMP provides for EFPs to promote increased utilization of underutilized species, realize the expansion potential of the domestic groundfish fishery, and increase the harvest efficiency of the fishery consistent with the MSA and the management goals of the FMP. However, EFPs are commonly used to explore ways to reduce effort on depressed stocks, encourage innovation and efficiency in the fisheries, provide access to constrained stocks while directly measuring the bycatch associated with those fishing strategies, and to evaluate current and proposed management measures.

Proposed EFPs are considered by the Council at the June meeting of the management year to allow the Council the opportunity to set-aside OY for EFPs it has tentatively approved. Final approval of EFPs for any given year occurs at the November Council meeting. For additional information on EFP protocols, visit the Council web site and review Council Operating Procedure 19 (www.pcouncil.org/operations/cops.html).

4.1.4 Research Fisheries

The reduction in directed fisheries and overall landings has resulted in less information available to fishery managers compromising efforts to assess stock abundance and recovery. There is an increasing reliance on fishery-independent sources of information such as research fisheries and surveys. This is particularly true for depleted species such as widow rockfish, yelloweye rockfish, cowcod, bocaccio, and canary rockfish since fisheries are designed to avoid areas inhabited by these species. There is a relatively sparse amount of data available for widow rockfish because widow rockfish directed fisheries have been eliminated and the Pacific whiting sectors have modified their behavior to avoid encounters with widow rockfish. Assessment scientists will continue to rely on research fisheries as landings, age composition, and logbook catch rate data from many fishery sources decreases. A summary of long-term research fisheries and resource surveys can be found in Appendix A, Section 1.1.1.3. of the 2005–06 groundfish harvest specifications FEIS (PFMC 2004b).

4.1.5 The Stock Assessment Process

The Council process for setting groundfish harvest levels and other specifications depends on periodic assessments of the status of groundfish stocks, rebuilding analyses of those stocks that are depleted and managed under rebuilding constraints, and a report from an established assessment review body or a STAR Panel. As appropriate, the SSC recommends the best available science for groundfish management decision-making in the Council process. The SSC reviews new assessments, rebuilding analyses, and STAR Panel reports and recommends the data and analyses that should be used to set groundfish harvest levels and other specifications for the following biennial management period.

NMFS conducted a round of stock assessments in 2007 for use in developing management measures and harvest specifications for the 2009–10 biennial management cycle. Rebuilding plans and stock assessments for depleted species are subject to review every two years. More information on the stock assessment process can be found in Appendix A, Section 1.1.1.1 of the 2005–06 groundfish harvest specifications FEIS (PFMC 2004b).

In 2004 and 2005 the Council reviewed its policy in regard to inseason management response to stock assessment results that become available during a biennial management cycle. The Council considered mechanisms for both liberalizing and constraining fisheries during a management cycle (mid-term) and took no action regarding adoption of a policy for mid-term adjustments in OY as a result of new stock assessment information. The Council remains in favor of existing language in Section 5.5.1 of the Groundfish FMP which provides for adjustments only in the downward direction and only for depleted species.

4.1.6 Rebuilding Analyses

In the case of depleted species, stock assessment results form the basis of a rebuilding analysis, which in turn is used to develop rebuilding policies and choose the rebuilding target identified in each rebuilding plan. The elements of rebuilding analyses are described in the SSC Terms of Reference for Rebuilding Analyses (SSC 2005). This guidance has been incorporated into a computer program for conducting rebuilding analyses developed by Dr. André Punt and the Marine Population Assessment and Management Group (MPAM) at the School of Aquatic and Fishery Sciences, University of Washington. Copies of the computer software and documentation can be found at the MPAM web page at: fish.washington.edu/research/MPAM/Rebuild.htm.

In a rebuilding analysis the probability the depleted stock will reach the target biomass defining a rebuilt stock (B_{MSY} or $B_{40\%}$) is determined in the absence of fishing (T_{MIN}) and the maximum permissible rebuilding time under National Standard Guidelines (T_{MAX}). The target rebuilding year (T_{TARGET}) is determined based on these limits and the probability of achieving the target biomass by T_{MAX} (denoted P_{MAX}). Probability statements are an estimate that something may happen (in this case, that stocks will reach a given size in a specified time period) and thus also the level of risk associated with a given action. Additional information on rebuilding analysis and interpretation of results can be found in Section 3.2.2.2 of Amendment 16-1 to the Pacific Coast Groundfish FMP (PFMC 2003a).

The MSA mandates these rebuilding periods need to be the shortest time possible while taking into account the status and biology of the depleted stock, the needs of fishing communities, and the interaction of the depleted stock within the marine ecosystem. This mandate was underscored in an August 2005 ruling by the Ninth Circuit District Court on a challenge to the Council's darkblotched rockfish rebuilding plan. In accordance with that ruling, the Council reconsidered all adopted rebuilding plans under Amendment 16-4 to the FMP to ensure they comply with the MSA as interpreted by the courts. In addition to the court ruling, the MSA was reauthorized in 2006 and NMFS is currently considering revisions to the National Standard Guidelines regarding the prevention of overfishing while achieving sustainable yield. Once National Standard Guidelines for rebuilding overfished stocks are revised, the SSC intends to amend the Terms of Reference for Rebuilding Analyses accordingly.

4.2 Enforcement

Enforcement of fishery regulations has become increasingly complex with the addition of large closed areas, smaller cumulative trip limits and bag limits, and depth-based closures for commercial and recreational fisheries. At the same time, decreased OYs and the need to rebuild depleted stocks has placed additional importance on controlling and monitoring fishery-related mortality. Enforcement agencies continue to use traditional methods to ensure compliance with groundfish fishery regulations including dockside sampling, at-sea patrols, and air surveillance. VMS dramatically enhances, rather than replaces, traditional enforcement techniques. Recent declines in enforcement agency budgets, combined with increased regulatory complexity, have stressed the ability to adequately monitor fisheries for regulatory compliance. In response, NMFS implemented a VMS monitoring program, which includes satellite tracking of vessel positions and a declaration system for those vessels legally fishing within an RCA. VMS was initially implemented on January 1, 2004, and is currently required on all vessels participating in the groundfish fishery with a limited entry permit. In November 2005, the Council recommended expansion of VMS requirements to all commercial vessels that take and retain, possess or land federally-managed groundfish species taken in Federal waters or in state waters prior to transiting Federal waters. Additionally, to enhance enforcement of closed areas for the protection of groundfish essential fish habitat, the Council recommends requiring VMS on all non-groundfish trawl vessels including those targeting pink shrimp, California halibut, sea cucumber, and ridgeback prawn. Implementation of expanded VMS requirements is recommended to coincide with implementation of regulations for the protection of groundfish habitat but, no sooner than January 1, 2007.

Detailed descriptions of VMS and the analyses of VMS monitoring alternatives are contained in an EA prepared by NMFS and presented to the Council in support of decisions to first implement and later expand the VMS monitoring program (NMFS 2003). Additional information on VMS, including links to the supporting NEPA documentation, can be found on the Council web site at: www.pcouncil.org/groundfish/gfvms.html#info.

4.3 Education and Outreach

California, Oregon, and Washington have actively engaged in education and outreach programs to help recreational fisherman learn ways to minimize bycatch and fishery impacts on depleted species. Efforts include publication of fish identification guides and posters and identification of areas to be avoided due to relatively high abundance of depleted species. Additionally, research programs have been implemented to develop release techniques which reduce mortality and, once developed, educate fisherman in the application of these techniques. Education can be an effective way to reduce bycatch thereby reducing the need for intensive inseason management and frequent fishery closures due to the constraints of depleted species.

4.4 Managing with Risk and Uncertainty

Uncertainty in fishery management exists for many reasons including imperfect sources of data from the past, inaccurate or inadequate monitoring of current fisheries, and unknown future environmental conditions. All of these factors contribute to the risks associated with the assessment of stock status, the estimation of impacts to fish stocks due to fishery management measures, and the projections of future stock health under varying long-term management alternatives. Appendix A of the 2005–06 groundfish harvest specification FEIS includes discussions of risk in fishery management (PFMC 2004b).

CHAPTER 5 FISHING SECTORS AND COMMUNITIES

5.1 Introduction

This first part of this chapter describes the fishery sectors comprising the west coast groundfish sector, buyers and processors of groundfish, and the markets within which such products compete. These sections include information on catch, landings, the geographic distribution of landings, and ex-vessel revenue earned from these landings. The last section of the chapter identifies sources of information on west coast fishing communities and includes recent demographic data for coastal counties that can be used in conjunction with data from the 2000 decennial census presented in previous Council documents. Most of the data and descriptions herein are adapted from previous Council document, updated where possible. Table 5–1 lists Council-produced documents containing groundfish-related socio-economic information.

Table 5-1. Sources of social science information in recent Council and NWFSC documents

Document/Topic	Page or Table No.
Trends in Fishing and Seafood Processing Related Establishments and Employment in West Coast Fishing Communities (1997-2005). In 2007-2008 Groundfish annual specifications EIS, Appendix A. URL http://www.pcouncil.org/groundfish/gfspex/07-08/Appendix_A.pdf	
Fishing and seafood processing-related establishments	Page A-5
Employment estimation	Page A-6
Seafood product preparation and packaging	Page A-10
Local employment dynamics	Page A-11
Age distribution of employees in fishing and processing (includes several tables)	Page A-15
Gender distribution (includes several tables)	Page A-18
Economic Revenue and Distributional Impacts Associated with Overfished Species Management in West Coast Commercial Groundfish Fisheries In 2007-2008 Groundfish annual specifications EIS, Appendix A. URL http://www.pcouncil.org/groundfish/gfspex/07-08/Appendix_A.pdf	
Overfished species catch tradeoffs in the Pacific Whiting fishery	Page A-24
Overfished species catch tradeoffs in the fixed gear sablefish fishery	Page A-26
Overfished species catch tradeoffs in the nearshore open access groundfish fishery	Page A-27
Overfished species catch tradeoffs in the limited entry bottom trawl fishery	Page A-29
Distributional impacts of changes in overfished species catch in commercial groundfish fisheries	Page A-35
Relative likelihood of ports being affected by management to reduce catch of overfished species (series of tables)	A.2-7-A.2-10
Commercial fisheries information generated from PacFIN data In 2007-2008 Groundfish Specifications EIS, Appendix A. URL http://www.pcouncil.org/groundfish/gfspex/07-08/Appendix_A.pdf	
Revenue description by port, 2005 (table)	A.3-1
Exvessel revenue by port and sector, 2003-2005 and five-year average (table)	A.3-2
Total vessels by port, 2003-2005 and five-year average (table)	A.3-3
Vessels by port and sector, 2003-2005 and five-year average (table)	A.3-4
Number of dealers by port, 2003-2005 and five-year average (table)	A.3-5
Dealers by port and sector, 2003-2005 and five-year average (table)	A.3-6
Number of trips by port and groundfish fishery, 2000-04 average and 2005	A.3-7
Landings (round weight in pounds) by port and fishing sector for 2000–04 average and 2005.	A.3-8
Fishing community engagement, dependence, resilience, and identification of potentially vulnerable communities In 2007-2008 Groundfish Specifications EIS, Appendix A. URL http://www.pcouncil.org/groundfish/gfspex/07-08/Appendix_A.pdf	
Literature review of socioeconomic and cultural indicators; indicators of dependence; methodologies used to identify dependence; indicators of resilience; etc.	Page A-68
Discussion of methodology for determining engagement, dependence, resilience, and “vulnerable areas”	Page A-71
Commercial indicators and rankings by city (table)	A.4-7
Commercial indicators and rankings by county (table)	A.4-8
Commercial fishing engagement scores by city (table)	A.4-9
Commercial fishing engagement scores by county (table)	A.4-10
Groundfish dependency scores by city (table)	A.4-11
Groundfish dependency scores by county (table)	A.4-12
California charter vessels ranked by region (table)	A.4-13
California recreational indicator values and rankings by region	A.4-14
Oregon and Washington recreational indicator values and rankings by city	A.4-15
California recreational engagement scores by region	A.4-16
Oregon and Washington recreational engagement scores by city	A.4-17

Document/Topic	Page or Table No.
Resiliency indicator values and rankings by city	A.4-18
Resiliency indicator values and rankings by county	A.4-19
Resiliency scores by city	A.4-20
Resiliency scores by county	A.4-21
Commercial and recreational scores and identification of vulnerable cities	A.4-22
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"Social Science in the Pacific Fishery Management Council process" (white paper) Describes mandates for collecting social science information. URL: http://www.pcouncil.org/research/resdocs/sswp_final.pdf	

5.2 Fishery Sectors

5.2.1 Overview

The Council allocates harvest specifications (OYs) between the limited entry and open access categories. Most of the Pacific coast commercial groundfish harvest is taken by the limited entry fleet. Commercial harvest rates of groundfish are constrained by annual harvest guidelines, two-month or one-month cumulative period landing limits, individual trip limits, size limits, species-to-species ratio restrictions, area closures, and other measures. This program is designed to control effort so that the allowable catch is taken at a slow enough rate to stretch the season over the full year. Cumulative period catch limits are set by comparing current and previous landings rates with the year's total available catch and predicted participation.

The groundfish limited entry program applies to bottom and midwater trawl, longline, and trap (or pot) gears. Each limited entry permit is endorsed for a particular gear type and that gear endorsement cannot be changed, so the distribution of permits among gear types has been fairly stable. Each permit also has a vessel length endorsement. The total number of permits has typically changed only when multiple permits have been combined to create a new permit with a longer length endorsement. However, in December 2003, a buyback program permanently retired 91 trawl permits, roughly 35 percent of the total. Limited entry permits can be sold and leased by their owners, so the distribution of permits among the three states often shifts. Information from the Table 5–2 shows states of residence for permit owners and holders.

Table 5-2. Count of groundfish limited entry trawl permits by state, for owners (rows) and holders (columns) and percent

Count of PERMIT_ID	H_STATE					
O_STATE	CA	HI	NV	OR	WA	Grand Total
CA	48		1	1		50
HI		1				1
OR	1			82	1	84
WA	2				41	43
Grand Total	51	1	1	83	42	178

Count of PERMIT_ID	H_STATE					
O_STATE	CA	HI	NV	OR	WA	Grand Total
CA	26.97%	0.00%	0.56%	0.56%	0.00%	28.09%
HI	0.00%	0.56%	0.00%	0.00%	0.00%	0.56%
OR	0.56%	0.00%	0.00%	46.07%	0.56%	47.19%
WA	1.12%	0.00%	0.00%	0.00%	23.03%	24.16%
Grand Total	28.65%	0.56%	0.56%	46.63%	23.60%	100.00%

Source: NMFS permit database.

Other non-tribal commercial fisheries, which either target groundfish or catch them incidentally, but do not hold federal groundfish limited entry permits, are considered "open access." Gears used by participants in open access commercial fisheries include longline, vertical hook and line, troll, pot, setnet, trammel net, shrimp and prawn trawl, California halibut trawl, and sea cucumber trawl gears. Open access trawl gear may not target groundfish, but may land incidental groundfish caught while targeting other species. Open access trap/pot and longline vessels may target groundfish under certain restrictions. Open access vessels may possess limited entry licenses for other, state-managed nongroundfish fisheries such as pink shrimp or Dungeness crab.

Members of the Makah, Quileute, Hoh, and Quinault tribes participate in tribal commercial, ceremonial and subsistence fisheries for groundfish off the Washington coast according to their treaty rights. Participants in the tribal commercial fishery use similar gear to non-tribal commercial fishers who operate off Washington, and groundfish caught in the tribal commercial fishery is typically sold through the same markets as non-tribal commercial groundfish catch. There are set tribal allocations for sablefish and Pacific whiting, while the other groundfish species' allocations are determined through the Council process in coordination with the tribes, states, and NMFS. Management of tribal fisheries is conducted by the individual tribes in accordance with their tribal regulations.

In addition to commercial and tribal fisheries, there are recreational fisheries associated with the groundfish fishery. Marine recreational fisheries consist of charter vessels, private vessels, and shore anglers. Charter vessels are larger vessels for hire, which typically can fish farther offshore than most vessels in the private recreational fleet. Shore-based anglers often fish in intertidal areas, within the surf, or off jetties. Recreational fisheries are managed by a series of seasons, area closures, and bag limits.

Since 2000, the management of west coast groundfish fisheries has been heavily centered on the need to rebuild overfished groundfish species. A species is considered overfished when its biomass is below 25 percent of its estimated unfished biomass level. West coast groundfish stocks are highly inter-mixed, meaning that overfished species co-occur and are caught in common with more abundant groundfish stocks. This inter-mixed nature of groundfish stocks means that eliminating the directed targeting of overfished species usually does not achieve the catch reductions needed to meet rebuilding goals. To adequately constrain total catch of overfished species, management must also constrain targeted fishing on healthy stocks that co-occur with overfished species in order to reduce incidental overfished species catch. This need to constrain harvest of healthy stocks has economic implications to sectors and communities engaged in fish harvesting and processing, because of the loss in landings and revenue that could have been derived from both overfished species and many target species that co-occur with those overfished species.

Table 5–3a and 5–3b shows the communities and sectors that are constrained in some way by overfished species. (Although this table applies to the commercial sectors, recreational fisheries in the communities listed would likely encounter similar bycatch species.)

Table 5-3a. Port engagement in groundfish sectors in areas north of 40°10' N latitude

Port	LE bottom trawl deep	LE bottom trawl shelf	LE fixed gear dogfish	LE fixed gear nearshore	LE fixed gear sablefish	LE midwater trawl- whiting	Open access fixed gear dogfish	Open access fixed gear nearshore	Open access fixed gear sablefish
	North of 40°10' N latitude								
Blaine	√	√	√		√				
Bellingham Bay	√	√	√		√		√		√
Everett					√				
Mill Creek								√	
Seattle						√			√
Port Townsend									√
Port Angeles					√				√
Neah Bay	√	√			√				√
La Push					√				√
Westport	√	√			√	√			√
Tokeland									√
Aberdeen									√
Ilwaco					√	√			√
Chinook					√				√
Cathlamet					√				
Astoria	√	√		√	√	√			√
Garibaldi (Tillamook)					√			√	√
Pacific City								√	
Depoe Bay								√	
Newport	√	√			√	√		√	√
Florence									√
Winchester Bay					√				√
Charleston (Coos Bay)	√	√			√	√		√	√
Bandon									√
Port Orford				√	√			√	√
Gold Beach								√	
Brookings	√	√			√			√	√
Crescent City	√	√		√	√	√		√	√
Trinidad								√	
Eureka	√	√			√	√		√	√
Fields Landing									√

Table 5-3b. Port engagement in groundfish sectors in areas south of 40°10' N latitude

Port	LE bottom trawl deep	LE bottom trawl shelf	LE fixed gear dogfish	LE fixed gear nearshore	LE fixed gear sablefish	LE midwater trawl- whiting	Open access fixed gear dogfish	Open access fixed gear nearshore	Open access fixed gear sablefish
	South of 40°10' N to 38° N latitude								
Shelter Cove								√	
Fort bragg	√	√			√			√	√
Albion								√	
Elk									√
Point Arena								√	
Bodega Bay					√			√	
	38° to 36° N latitude								
Point Reyes									√
Bodega Bay									√
San Francisco	√	√		√	√			√	√
Princeton / Half Moon Bay	√	√			√			√	√
Santa Cruz								√	√
Moss landing	√	√			√			√	√
Monterey	√	√			√			√	√
Big Creek								√	
	South of 36° N latitude								
Berkeley								√	
Morro Bay	√	√			√			√	√
Avila					√			√	
San Simeon								√	
Santa Barbara				√				√	
Ventura								√	√
Oxnard				√	√			√	√
Playa del Rey					√				
San Pedro								√	
Wilmington				√					
Long Beach					√				
Terminal Island					√				√
Newport Beach					√				
Dana Point					√				
Oceanside					√				√
Mission Bay					√				√
Point Loma									√
San Diego								√	√

5.2.2 Landings and Catch in Groundfish Fishery Sectors

Table 5–4a through Table 5–4h show landings by the groundfish sectors described above (and the recreational sector) from 1995 to 2002; Table–5a through Table 5–5d shows total catch estimates (landings plus bycatch) for these sectors, 2003–05. The non-tribal Pacific whiting fishery is composed of three sectors—at-sea catcher-processors, at-sea motherships, and shoreside whiting limited entry trawl. The total whiting fishery is made up of the non-tribal whiting sector and the tribal shore-based and at-sea whiting fisheries. Shore-based groundfish landings can be estimated by summing shoreside whiting limited entry trawl, shore-based non-whiting limited entry trawl, shoreside limited entry line gear, shoreside limited entry pot gear, shoreside directed open access, and shoreside incidental open access landings.

Figures 5–1 and 5–2 show total landings (all species), 1995–2005, in the limited entry trawl sector, limited entry fixed gear, open access and recreational sectors, based on Tables 5–4 and 5–5. Figures 5–3 and 5–4 show landings plus discards (total catch) by sectors, 2003–05. Some trends should be noted. For this period, landings in the whiting sector (at-sea catcher-processors and motherships and shoreside whiting limited entry trawl) reached a peak in 2005 of 244,548 mt, up from a low in 2003 of 139,646 mt. Tribal shoreside landing also reached a peak in 2005 of 13,698 mt. Tribal whiting fisheries were first instituted in 1996 with advent of the at-sea tribal fishery. Harvests by the shoreside non-whiting limited entry trawl fleet reached their lowest levels in 2005 at 18,882 mt in landings. The limited entry fixed gear had its lowest landings in 2002 at 2,188 mt. The directed open access sector had its lowest landings in 2004 at 1,215 mt. Recreational fisheries also saw the lowest landings in 2004 at 1,987 mt. The decline in such landings mirrors the status of the groundfish stocks and Council efforts to rebuild overfished species.

Table 5-4a. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 1995 Note: The Other Fish stock complex contains all the unassessed Groundfish FMP species that are neither rockfish nor flatfish. However, in Tables 5–4a through 5–4g, spiny dogfish (*Squalus acanthias*) and kelp greenling (*Hexagrammos decagrammus*) are shown separately at the Council's request.

	1995								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.0	-	0.1	1,069.7	42.4	278.1	69.1	391.7	-
N. of 42° (OR & WA)	0.0	-	0.1	775.0	9.2	79.4	59.0	139.6	-
S. of 42° (CA)	-	-	-	294.7	33.2	198.7	10.1	252.1	-
Pacific Cod	-	0.0	0.1	490.7	1.0	1.0	8.7	-	1.3
Pacific Whiting (Coastwide)	61,138.3	33,010.4	74,846.3	70.7	0.9	0.2	0.0	0.4	-
Sablefish (Coastwide)	4.4	2.8	42.8	3,705.4	2,687.9	587.7	59.2	2.8	769.3
N. of 36° (Monterey north)	4.4	2.8	42.8	3,499.0	2,643.9	513.0	58.5	2.8	769.3
S. of 36° (Conception area)	-	-	-	206.3	44.0	74.7	0.7	-	-
PACIFIC OCEAN PERCH	13.4	28.1	29.9	824.7	4.1	1.8	4.9	0.0	-
Shortbelly Rockfish	4.8	4.2	0.0	29.9	0.0	0.2	-	-	-
WIDOW ROCKFISH	87.0	95.3	236.1	6,165.3	8.2	83.5	20.6	6.1	-
CANARY ROCKFISH	0.2	0.2	0.5	675.4	59.5	124.3	12.6	108.7	0.0
Chilipepper Rockfish	-	-	-	1,474.8	15.7	382.1	9.0	7.2	-
BOCACCIO (S. of 40°10')	-	-	-	326.2	4.3	345.7	3.3	31.4	-
Splitnose Rockfish	-	-	-	274.5	1.5	22.3	0.3	-	-
Yellowtail Rockfish	81.4	505.3	294.2	4,006.9	14.6	59.3	221.6	29.8	0.2
Shortspine Thornyhead - coastwide	5.6	0.2	0.5	1,855.0	32.4	15.7	2.9	-	7.1
N. of 34°27'	5.6	0.2	0.5	1,212.6	19.1	5.3	2.7	-	7.1
S. of 34°27'	-	-	-	642.4	13.3	10.4	0.2	-	-
Longspine Thornyhead - coastwide	0.0	0.0	2.8	5,311.4	25.9	27.0	2.4	-	0.6
N. of 34°27'	0.0	0.0	2.8	5,311.4	25.9	27.0	2.4	-	0.6
S. of 34°27'	-	-	-	-	0.0	-	-	-	-
Other thornyheads	-	-	-	4.7	20.2	76.9	0.2	-	-
COWCOD	-	-	-	-	3.1	13.3	0.5	1.7	-
DARKBLOTCHED	48.9	3.3	0.5	709.9	2.0	2.2	2.6	-	-
YELLOWEYE	-	0.0	0.0	135.1	26.5	40.9	0.3	32.4	-
Black Rockfish - coastwide	-	-	0.1	9.2	34.0	224.3	1.2	723.4	-
Black Rockfish (WA)	-	-	0.1	3.2	0.0	-	-	212.9	-
Black Rockfish (OR-CA)	-	-	0.0	6.0	34.0	224.3	1.2	510.6	-
Minor Rockfish North	59.2	7.9	2.8	1,673.0	548.6	229.8	139.1	40.7	52.0
Nearshore Species	-	0.1	-	0.8	12.6	42.7	0.2	34.5	-
Shelf Species	30.4	4.0	2.5	963.4	399.1	181.1	130.8	6.1	52.0
Slope Species	28.8	3.8	0.4	708.8	136.9	6.1	8.2	0.0	0.0
Minor Rockfish South	0.0	0.0	0.0	701.0	164.4	1,053.1	27.6	646.7	0.0
Nearshore Species	-	-	-	9.0	18.2	286.0	4.1	327.7	-
Shelf Species	0.0	0.0	0.0	186.3	83.4	537.5	21.6	316.0	0.0
Slope Species	0.0	0.0	0.0	505.8	62.8	229.6	1.8	3.0	0.0
California scorpionfish	-	-	-	-	3.2	13.7	14.9	86.0	-
Cabezon (off CA only)	-	-	-	-	1.6	87.2	1.8	67.3	-
Dover Sole	0.0	0.0	0.4	10,376.9	3.4	2.2	84.9	-	0.8
English Sole	0.0	0.0	0.0	1,106.8	0.0	1.9	13.2	0.0	-
Petrale Sole (coastwide)	0.0	0.0	0.0	1,588.5	0.9	6.9	15.3	0.7	-
Arrowtooth Flounder	0.2	1.5	0.2	2,304.8	1.5	0.7	20.0	-	0.1
Starry Flounder	-	-	-	49.8	0.0	0.2	8.4	3.8	-
Other Flatfish	0.4	0.1	0.0	2,363.9	0.5	6.1	49.8	15.6	-
Kelp Greenling	-	-	-	1.5	0.6	3.3	0.0	35.9	-
Spiny Dogfish	145.4	40.7	0.1	355.3	7.3	0.8	0.2	17.7	-
Other Fish	-	0.0	0.1	848.5	63.1	76.6	16.1	157.2	-

Table 5-4b. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 1996

	1996							
	Non-Treaty Sectors							Treaty Sector
	LE Trawl Sectors			Non-LE Trawl Sectors				
Stock or Complex	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.0	0.7	1,204.1	54.1	238.8	64.4	473.7	1.2
N. of 42° (OR & WA)	0.0	0.7	911.0	10.3	110.9	48.2	145.8	1.2
S. of 42° (CA)	-	0.0	293.1	43.8	127.9	16.2	327.9	-
Pacific Cod	0.0	0.4	433.0	1.4	0.5	8.6	0.6	0.8
Pacific Whiting (Coastwide)	44,658.1	82,472.9	65.1	0.3	45.1	1.2	1.2	15,013.3
Sablefish (Coastwide)	0.1	37.0	4,132.7	2,609.3	640.8	81.9	2.8	853.5
N. of 36° (Monterey north)	0.1	37.0	3,918.6	2,523.5	599.2	81.6	2.8	853.5
S. of 36° (Conception area)	-	-	214.1	85.8	41.6	0.3	-	-
PACIFIC OCEAN PERCH	2.1	32.8	819.7	9.9	0.9	6.0	0.2	0.0
Shortbelly Rockfish	-	0.0	35.9	0.0	0.0	0.4	0.1	-
WIDOW ROCKFISH	117.3	571.5	5,403.2	7.9	47.1	13.8	24.3	11.5
CANARY ROCKFISH	1.4	1.2	966.6	67.8	156.3	25.7	85.6	0.1
Chilipepper Rockfish	-	-	1,395.6	12.4	277.7	9.5	30.3	-
BOCACCIO (S. of 40°10')	-	-	275.7	6.7	149.0	1.8	88.8	-
Splitnose Rockfish	-	-	401.7	0.9	4.5	0.1	-	-
Yellowtail Rockfish	350.4	482.6	4,157.9	32.7	71.0	310.9	31.7	93.2
Shortspine Thornyhead - coastwide	-	0.1	1,512.0	78.2	14.4	1.3	0.0	7.3
N. of 34°27'	-	0.1	1,081.6	19.0	2.4	1.1	0.0	7.3
S. of 34°27'	-	-	430.4	59.3	12.0	0.1	-	-
Longspine Thornyhead - coastwide	-	0.0	4,751.1	96.1	9.5	0.9	-	0.2
N. of 34°27'	-	0.0	4,751.1	79.1	9.2	0.9	-	0.2
S. of 34°27'	-	-	-	17.0	0.3	-	-	-
Other thornyheads	-	-	44.0	49.5	17.0	0.1	-	-
COWCOD	-	-	0.0	1.9	13.9	0.0	5.6	-
DARKBLOTCHED	0.7	5.9	721.6	1.6	0.6	2.5	0.0	-
YELLOWEYE	-	0.1	100.6	35.6	35.6	0.7	30.2	-
Black Rockfish - coastwide	-	0.0	17.5	22.8	218.7	1.1	767.9	-
Black Rockfish (WA)	-	-	-	0.0	-	-	234.1	-
Black Rockfish (OR-CA)	-	0.0	17.5	22.8	218.7	1.1	533.7	-
Minor Rockfish North	16.7	21.5	1,710.9	430.5	202.0	221.6	52.4	36.1
Nearshore Species	-	0.0	0.0	12.7	42.3	0.1	47.6	-
Shelf Species	1.6	18.3	1,072.6	342.4	149.4	211.6	4.4	36.1
Slope Species	15.1	3.2	638.3	75.4	10.3	9.9	0.4	0.0
Minor Rockfish South	0.0	0.0	951.4	237.5	834.2	27.1	965.5	0.0
Nearshore Species	-	-	18.6	36.1	285.5	4.6	467.4	-
Shelf Species	0.0	0.0	208.6	85.9	406.3	19.7	476.3	0.0
Slope Species	0.0	0.0	724.3	115.6	142.5	2.8	21.8	0.0
California scorpionfish	-	-	-	3.7	12.1	9.5	159.3	-
Cabezon (off CA only)	-	-	0.0	0.6	109.2	3.5	79.4	-
Dover Sole	-	1.4	12,160.6	4.5	4.1	96.8	-	1.1
English Sole	0.0	0.5	1,129.1	0.0	0.9	31.0	0.0	0.0
Petrale Sole (coastwide)	-	0.6	1,803.6	0.3	2.1	24.7	0.6	0.0
Arrowtooth Flounder	0.4	1.1	2,172.9	0.2	0.2	5.7	-	0.1
Starry Flounder	-	-	27.9	0.0	0.2	14.7	3.1	0.0
Other Flatfish	0.0	1.5	1,868.4	0.5	5.7	84.4	49.0	0.0
Kelp Greenling	-	-	0.0	0.4	3.8	0.1	53.9	-
Spiny Dogfish	104.1	3.8	195.2	22.2	29.2	0.3	19.8	198.0
Other Fish	0.0	0.0	746.7	577.1	297.7	22.5	78.7	0.0

Table 5-4c. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 1997

	1997								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.1	0.1	0.5	1,170.2	65.6	278.8	59.9	427.9	0.7
N. of 42° (OR & WA)	0.1	0.1	0.5	856.0	28.3	131.8	47.4	164.0	0.7
S. of 42° (CA)	-	-	0.0	314.3	37.3	147.0	12.4	263.9	-
Pacific Cod	-	0.0	0.0	589.4	0.6	1.3	3.7	0.3	1.0
Pacific Whiting (Coastwide)	70,809.6	48,911.7	87,287.5	115.1	0.8	0.0	6.3	0.7	24,827.6
Sablefish (Coastwide)	0.6	0.2	42.0	3,703.4	2,856.3	503.6	46.3	3.5	805.5
N. of 36° (Monterey north)	0.6	0.2	42.0	3,549.9	2,753.4	498.4	45.8	3.5	805.5
S. of 36° (Conception area)	-	-	-	153.5	103.0	5.2	0.5	-	-
PACIFIC OCEAN PERCH	2.0	1.6	6.4	663.0	2.0	1.7	4.0	0.5	6.5
Shortbelly Rockfish	0.5	0.3	0.0	78.2	0.0	-	0.1	0.0	-
WIDOW ROCKFISH	72.6	122.0	163.3	6,213.3	8.8	61.1	10.5	42.3	9.6
CANARY ROCKFISH	1.0	0.4	1.0	793.5	79.3	214.6	22.7	145.7	1.7
Chilipepper Rockfish	-	-	-	1,535.2	13.6	394.2	4.7	73.5	-
BOCACCIO (S. of 40°10')	-	-	-	220.5	11.8	69.1	1.0	146.3	-
Splitnose Rockfish	-	-	-	429.4	0.8	6.7	0.4	-	-
Yellowtail Rockfish	120.1	146.5	226.5	1,338.7	36.4	99.8	157.6	41.1	122.4
Shortspine Thornyhead - coastwide	0.4	0.0	0.2	1,398.4	52.4	2.8	2.8	-	7.7
N. of 34°27'	0.4	0.0	0.2	996.3	21.7	1.2	2.7	-	7.7
S. of 34°27'	-	-	-	402.1	30.7	1.6	0.1	-	-
Longspine Thornyhead - coastwide	-	-	0.4	3,851.3	69.6	12.6	3.3	-	0.1
N. of 34°27'	-	-	0.4	3,851.3	56.3	12.6	3.3	-	0.1
S. of 34°27'	-	-	-	-	13.3	-	0.0	-	-
Other thornyheads	-	-	-	33.6	75.2	3.9	1.0	-	-
COWCOD	-	-	-	-	1.3	4.0	0.2	2.5	-
DARKBLOTCHED	1.8	0.9	0.5	810.4	0.5	0.2	5.6	-	-
YELLOWEYE	0.0	-	0.1	83.4	47.5	52.4	0.6	35.8	-
Black Rockfish - coastwide	-	-	0.2	23.8	42.8	237.0	6.6	629.0	-
Black Rockfish (WA)	-	-	-	1.0	0.0	-	-	180.4	-
Black Rockfish (OR-CA)	-	-	0.2	22.8	42.8	237.0	6.6	448.6	-
Minor Rockfish North	26.9	3.9	23.1	1,529.5	286.7	209.4	47.4	91.0	30.2
Nearshore Species	-	-	-	0.3	12.3	60.6	0.0	84.4	-
Shelf Species	0.2	1.2	22.3	863.3	258.3	146.8	40.3	6.6	30.2
Slope Species	26.7	2.7	0.8	665.9	16.1	2.0	7.1	0.0	0.0
Minor Rockfish South	0.0	0.0	0.0	916.6	250.8	708.5	30.7	1,144.6	0.0
Nearshore Species	-	-	-	13.2	54.0	257.5	4.8	530.4	-
Shelf Species	0.0	0.0	0.0	261.9	125.0	344.8	24.2	602.5	0.0
Slope Species	0.0	0.0	0.0	641.4	71.8	106.3	1.7	11.7	0.0
California scorpionfish	-	-	-	5.8	0.7	15.9	10.8	100.1	-
Cabezon (off CA only)	-	-	-	-	9.2	120.9	2.0	57.1	-
Dover Sole	-	-	1.6	10,114.5	2.6	0.5	72.4	-	0.6
English Sole	-	0.0	0.6	1,428.7	0.0	0.2	65.6	-	0.1
Petrale Sole (coastwide)	-	-	0.6	1,862.9	1.6	0.6	62.3	0.3	0.0
Arrowtooth Flounder	0.1	0.1	0.9	2,325.1	0.5	0.0	4.3	-	0.2
Starry Flounder	-	-	-	58.9	0.0	0.3	28.9	3.3	0.0
Other Flatfish	0.0	0.0	3.3	1,815.7	0.9	7.1	152.9	35.0	0.0
Kelp Greenling	-	-	-	-	2.4	19.2	0.1	36.1	-
Spiny Dogfish	139.2	65.3	3.3	335.6	2.5	82.4	0.7	5.1	111.5
Other Fish	0.1	0.1	0.1	566.0	296.5	147.0	18.6	65.2	-

Table 5-4d. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 1998

	1998								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	-	0.1	0.4	217.3	25.4	88.8	20.3	335.7	2.4
N. of 42° (OR & WA)	-	0.1	0.1	143.2	13.9	32.2	13.0	100.7	2.4
S. of 42° (CA)	-	-	0.3	74.1	11.4	56.6	7.3	235.0	-
Pacific Cod	-	-	0.8	405.7	0.9	0.4	2.4	1.5	2.2
Pacific Whiting (Coastwide)	70,372.3	49,666.4	87,707.8	111.2	0.6	27.6	15.9	0.1	24,507.7
Sablefish (Coastwide)	27.2	0.5	27.9	2,144.4	1,581.0	180.0	31.8	2.9	444.9
N. of 36° (Monterey north)	27.2	0.5	27.9	2,029.9	1,485.7	176.7	31.2	2.9	444.9
S. of 36° (Conception area)	-	-	-	114.5	95.3	3.3	0.6	-	-
PACIFIC OCEAN PERCH	14.8	8.3	22.3	610.0	0.1	0.2	1.2	-	0.4
Shortbelly Rockfish	0.0	-	1.3	18.8	0.0	0.0	0.2	0.0	-
WIDOW ROCKFISH	120.9	173.7	349.6	3,346.7	12.2	155.4	10.3	51.9	14.8
CANARY ROCKFISH	0.3	2.5	0.9	902.6	105.5	165.8	19.1	80.4	3.1
Chilipepper Rockfish	-	-	-	1,036.2	15.6	266.5	11.7	5.4	-
BOCACCIO (S. of 40°10')	-	-	-	55.9	7.5	70.0	2.1	51.4	-
Splitnose Rockfish	-	-	-	1,304.8	0.1	45.3	8.9	-	-
Yellowtail Rockfish	63.7	334.8	499.7	1,691.0	43.7	123.7	156.1	64.0	165.3
Shortspine Thornyhead - coastwide	2.5	0.0	0.8	1,184.1	57.7	0.9	1.5	-	3.7
N. of 34°27'	2.5	0.0	0.8	855.7	16.9	0.5	1.3	-	3.7
S. of 34°27'	-	-	-	328.4	40.7	0.4	0.3	-	-
Longspine Thornyhead - coastwide	0.0	-	0.1	2,223.6	15.4	0.1	2.7	-	0.0
N. of 34°27'	0.0	-	0.1	2,223.6	4.5	0.0	2.6	-	0.0
S. of 34°27'	-	-	-	-	10.9	0.1	0.1	-	-
Other thornyheads	-	-	-	16.6	29.7	1.7	0.6	-	-
COWCOD	-	-	-	-	0.6	1.1	0.2	2.8	-
DARKBLOTCHED	6.9	12.9	5.1	901.8	6.2	11.0	10.6	-	0.0
YELLOWEYE	0.0	-	0.2	29.4	15.8	22.4	0.1	39.0	-
Black Rockfish - coastwide	-	-	0.7	81.1	33.5	175.6	1.1	692.8	-
Black Rockfish (WA)	-	-	0.7	17.6	0.0	-	-	224.4	-
Black Rockfish (OR-CA)	-	-	0.0	63.5	33.5	175.6	1.1	468.4	-
Minor Rockfish North	22.8	8.3	41.2	1,471.1	348.6	158.0	53.9	92.7	31.8
Nearshore Species	-	-	-	4.6	19.1	50.9	0.2	83.4	-
Shelf Species	2.4	1.0	23.0	1,012.8	252.8	104.9	46.6	9.1	31.8
Slope Species	20.4	7.2	18.2	453.6	76.7	2.2	7.1	0.1	0.0
Minor Rockfish South	0.0	0.0	0.0	814.5	226.6	771.7	25.4	770.9	0.0
Nearshore Species	-	-	-	0.8	37.2	228.4	2.7	465.3	-
Shelf Species	0.0	0.0	0.0	244.1	87.3	376.3	21.7	302.6	0.0
Slope Species	0.0	0.0	0.0	569.6	102.1	167.0	1.0	3.0	0.0
California scorpionfish	-	-	-	-	0.9	32.2	7.6	81.6	-
Cabezon (off CA only)	-	-	-	-	5.3	168.7	2.8	71.5	-
Dover Sole	0.0	0.0	3.5	8,058.8	2.0	0.3	52.9	-	2.0
English Sole	-	0.0	1.2	1,122.7	0.0	0.4	26.0	-	0.8
Petrale Sole (coastwide)	-	-	1.4	1,458.9	0.6	0.4	25.3	0.0	1.5
Arrowtooth Flounder	0.1	0.7	0.3	3,191.9	0.7	0.0	5.4	-	0.7
Starry Flounder	-	-	-	53.0	0.0	0.1	25.4	8.0	-
Other Flatfish	0.3	0.0	4.1	1,534.5	1.1	4.0	65.2	13.5	1.1
Kelp Greenling	-	-	-	0.0	1.7	15.8	0.0	18.6	-
Spiny Dogfish	57.8	162.3	56.2	402.3	0.7	2.0	0.2	2.5	98.8
Other Fish	0.7	0.3	0.3	622.4	158.7	73.0	26.7	63.0	0.2

Table 5-4e. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 1999

	1999								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.0	0.0	0.6	216.6	32.5	73.8	45.7	444.9	3.2
N. of 42° (OR & WA)	0.0	0.0	0.6	134.1	22.3	32.2	37.2	119.0	3.2
S. of 42° (CA)	-	-	0.0	82.5	10.2	41.6	8.6	325.9	-
Pacific Cod	0.0	0.0	0.2	276.8	1.3	0.3	1.7	0.4	1.3
Pacific Whiting (Coastwide)	67,671.8	47,565.5	83,392.5	25.8	0.0	0.4	0.2	1.8	25,836.6
Sablefish (Coastwide)	0.7	1.3	3.5	3,158.3	2,446.6	310.8	58.6	0.3	710.5
N. of 36° (Monterey north)	0.7	1.3	3.5	3,075.2	2,360.2	298.7	58.5	0.3	710.5
S. of 36° (Conception area)	-	-	-	83.1	86.3	12.1	0.1	-	-
PACIFIC OCEAN PERCH	9.4	4.1	1.9	520.2	1.2	0.3	9.0	-	1.2
Shortbelly Rockfish	-	0.0	5.5	2.2	0.0	-	0.4	-	0.0
WIDOW ROCKFISH	104.1	58.1	194.4	3,691.1	15.4	39.7	12.7	32.7	36.7
CANARY ROCKFISH	1.0	0.6	1.9	513.8	62.4	69.5	38.7	97.8	4.9
Chilipepper Rockfish	-	-	-	783.1	12.9	97.7	7.0	24.3	-
BOCACCIO (S. of 40°10')	-	-	-	31.3	4.4	22.5	1.3	120.2	-
Splitnose Rockfish	-	-	-	205.7	0.6	0.2	0.2	-	-
Yellowtail Rockfish	426.3	325.4	477.3	1,641.4	34.2	39.2	68.2	25.8	485.8
Shortspine Thornyhead - coastwide	0.0	-	0.4	713.0	99.3	7.4	1.4	0.6	6.1
N. of 34°27'	0.0	-	0.4	526.6	16.4	0.0	1.0	0.5	6.1
S. of 34°27'	-	-	-	186.4	82.9	7.4	0.4	0.1	-
Longspine Thornyhead - coastwide	-	-	0.2	1,770.1	26.0	1.9	2.6	-	-
N. of 34°27'	-	-	0.2	1,770.1	11.8	1.1	2.6	-	-
S. of 34°27'	-	-	-	-	14.2	0.8	0.0	-	-
Other thornyheads	-	-	-	36.1	4.1	0.9	0.2	-	-
COWCOD	-	-	-	-	0.3	1.8	0.0	5.6	-
DARKBLOTCHED	6.9	4.2	0.6	345.7	0.8	0.2	7.8	-	0.0
YELLOWEYE	0.0	-	0.1	25.5	50.7	16.3	0.8	48.3	0.0
Black Rockfish - coastwide	0.0	-	0.0	4.6	17.9	152.9	2.6	601.2	-
Black Rockfish (WA)	-	-	-	-	0.0	-	-	154.2	-
Black Rockfish (OR-CA)	0.0	-	0.0	4.6	17.9	152.9	2.6	446.9	-
Minor Rockfish North	12.2	11.4	14.8	734.0	269.0	81.9	52.3	75.4	33.2
Nearshore Species	-	-	-	0.1	15.6	45.0	0.0	64.9	-
Shelf Species	1.0	4.2	10.7	418.3	246.7	35.4	44.5	10.5	33.1
Slope Species	11.2	7.2	4.1	315.5	6.7	1.5	7.9	0.0	0.1
Minor Rockfish South	0.0	0.0	0.0	123.5	67.9	279.6	13.0	1,150.6	0.0
Nearshore Species	-	-	-	13.0	19.1	183.8	2.3	491.8	-
Shelf Species	0.0	0.0	0.0	35.8	32.2	77.3	10.1	653.2	0.0
Slope Species	0.0	0.0	0.0	74.8	16.6	18.5	0.7	5.6	0.0
California scorpionfish	-	-	-	-	0.1	30.3	7.8	131.2	-
Cabezon (off CA only)	-	-	-	0.1	3.7	119.3	2.0	41.6	-
Dover Sole	0.0	-	0.0	9,129.1	2.5	0.4	119.0	-	5.3
English Sole	0.0	0.0	0.1	888.0	0.0	0.1	33.9	-	0.3
Petrale Sole (coastwide)	-	-	0.2	1,473.2	0.3	0.1	36.1	0.1	0.2
Arrowtooth Flounder	2.6	0.6	3.4	5,336.8	1.7	0.0	14.6	-	9.2
Starry Flounder	-	-	-	22.2	0.0	0.2	25.1	4.9	-
Other Flatfish	0.0	0.0	1.5	1,882.8	0.4	4.7	68.2	20.9	0.4
Kelp Greenling	-	-	-	-	4.4	34.7	0.0	23.3	-
Spiny Dogfish	121.5	155.4	39.8	429.6	38.6	8.9	0.0	10.5	192.2
Other Fish	0.2	0.1	0.2	318.8	101.4	102.6	34.3	71.8	0.0

Table 5-4f. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 2000

	2000								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	-	0.3	0.8	66.1	15.8	37.3	27.6	264.8	3.1
N. of 42° (OR & WA)	-	0.3	0.8	38.1	10.7	17.2	25.6	84.5	3.1
S. of 42° (CA)	-	-	0.0	28.0	5.0	20.2	2.0	180.2	-
Pacific Cod	0.2	-	0.1	274.0	1.1	0.0	1.8	-	2.1
Pacific Whiting (Coastwide)	67,803.1	42,622.9	85,807.4	35.8	0.1	0.0	0.1	-	6,252.4
Sablefish (Coastwide)	45.7	0.9	1.7	2,690.8	2,407.6	444.4	70.6	0.2	705.7
N. of 36° (Monterey north)	45.7	0.9	1.7	2,654.6	2,338.3	428.3	70.1	0.2	705.7
S. of 36° (Conception area)	-	-	-	36.2	69.3	16.1	0.4	-	-
PACIFIC OCEAN PERCH	6.5	2.1	0.3	135.4	0.4	0.0	0.4	0.0	0.0
Shortbelly Rockfish	0.9	0.0	2.3	17.1	0.0	-	-	-	-
WIDOW ROCKFISH	69.8	141.2	83.3	3,718.5	5.4	15.0	3.2	14.9	10.5
CANARY ROCKFISH	0.9	0.3	1.1	36.1	7.6	5.5	13.8	94.0	1.3
Chilipepper Rockfish	-	-	-	359.5	8.4	47.5	2.4	38.9	-
BOCACCIO (S. of 40°10')	-	-	-	17.2	2.3	4.9	0.8	103.4	-
Splitnose Rockfish	-	-	-	83.5	5.2	0.3	0.0	-	-
Yellowtail Rockfish	269.5	227.9	190.2	2,621.9	3.8	2.4	100.4	23.9	134.5
Shortspine Thornyhead - coastwide	19.5	0.2	1.9	762.5	51.6	7.6	0.4	-	4.1
N. of 34°27'	19.5	0.2	1.9	481.9	12.1	0.4	0.2	-	4.1
S. of 34°27'	-	-	-	280.7	39.6	7.2	0.2	-	-
Longspine Thornyhead - coastwide	0.0	-	0.6	1,426.4	51.4	7.3	0.8	-	-
N. of 34°27'	0.0	-	0.6	1,426.4	31.4	0.4	0.8	-	-
S. of 34°27'	-	-	-	-	20.0	6.8	-	-	-
Other thornyheads	-	-	-	58.5	9.8	3.7	0.0	-	-
COWCOD	-	-	-	-	0.0	0.3	0.1	5.9	-
DARKBLOTCHED	3.8	4.7	3.7	239.0	9.5	0.5	1.6	-	0.0
YELLOWEYE	4.1	-	0.0	1.2	4.3	2.1	0.2	27.8	0.0
Black Rockfish - coastwide	1.2	-	0.0	1.8	20.1	127.9	3.7	595.9	-
Black Rockfish (WA)	-	-	-	-	0.0	-	-	143.3	-
Black Rockfish (OR-CA)	1.2	-	0.0	1.8	20.1	127.9	3.7	452.6	-
Minor Rockfish North	79.3	34.1	45.1	347.3	86.0	36.9	15.3	63.5	32.1
Nearshore Species	-	-	-	0.3	12.1	27.5	0.8	57.0	0.0
Shelf Species	1.1	30.3	30.5	52.7	24.7	6.9	5.5	6.3	22.8
Slope Species	78.3	3.8	14.5	294.2	49.1	2.5	9.0	0.1	9.3
Minor Rockfish South	0.0	0.0	0.0	175.7	73.9	168.1	9.6	859.4	0.0
Nearshore Species	-	-	-	0.4	19.7	133.6	2.7	419.9	-
Shelf Species	0.0	0.0	0.0	29.6	12.1	26.6	6.4	436.8	0.0
Slope Species	0.0	0.0	0.0	145.7	42.1	7.8	0.5	2.7	0.0
California scorpionfish	-	-	-	-	0.0	11.5	6.0	87.7	-
Cabezon (off CA only)	-	-	-	0.0	3.2	109.1	4.2	40.2	-
Dover Sole	0.3	0.0	0.3	8,813.5	2.6	0.5	63.9	-	0.9
English Sole	0.1	0.2	0.5	743.6	0.0	0.0	26.2	-	0.5
Petrale Sole (coastwide)	-	-	0.2	1,849.4	0.4	0.1	50.4	0.2	0.0
Arrowtooth Flounder	3.8	3.1	1.9	3,277.6	1.9	0.1	18.4	-	2.0
Starry Flounder	-	-	-	25.1	0.0	0.3	12.2	6.0	-
Other Flatfish	5.1	1.6	0.6	1,521.8	0.2	7.5	45.4	61.4	0.1
Kelp Greenling	-	-	-	-	4.5	38.0	0.3	34.9	-
Spiny Dogfish	25.6	47.9	34.6	274.5	313.9	4.7	2.0	10.0	40.0
Other Fish	1.1	0.1	0.3	236.5	34.7	119.1	21.4	53.4	0.0

Table 5-4g. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 2001

	2001								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.2	0.5	0.8	58.0	17.5	57.9	17.0	243.2	4.3
N. of 42° (OR & WA)	0.2	0.5	0.8	31.4	13.7	28.2	14.5	96.2	4.3
S. of 42° (CA)	-	-	-	26.6	3.7	29.7	2.5	147.1	-
Pacific Cod	0.0	0.0	0.1	315.2	1.3	0.4	1.5	0.0	4.2
Pacific Whiting (Coastwide)	58,627.6	35,586.5	73,386.2	25.1	0.2	-	64.8	0.0	6,080.0
Sablefish (Coastwide)	21.0	0.2	47.1	2,513.9	1,895.3	467.1	45.4	2.9	658.7
N. of 36° (Monterey north)	21.0	0.2	47.1	2,485.5	1,796.6	454.0	44.1	2.8	658.7
S. of 36° (Conception area)	-	-	-	28.4	98.7	13.1	1.3	0.1	-
PACIFIC OCEAN PERCH	19.7	0.1	0.1	187.3	0.0	0.0	0.1	-	0.7
Shortbelly Rockfish	0.0	27.2	0.6	4.4	0.0	0.3	-	0.0	-
WIDOW ROCKFISH	139.7	27.7	44.3	1,729.6	1.3	12.9	1.4	13.8	10.7
CANARY ROCKFISH	0.7	1.1	1.4	23.6	7.0	4.9	3.7	45.4	4.9
Chilipepper Rockfish	-	-	-	297.3	2.9	27.0	0.8	51.7	-
BOCACCIO (S. of 40°10')	-	-	-	13.3	2.4	6.0	0.5	103.1	-
Splitnose Rockfish	-	-	-	90.3	0.9	1.1	0.1	-	-
Yellowtail Rockfish	33.2	88.8	102.9	1,484.1	3.5	1.3	68.0	19.2	185.7
Shortspine Thornyhead - coastwide	15.2	0.0	0.1	471.4	51.0	1.6	0.5	-	5.0
N. of 34°27'	15.2	0.0	0.1	349.6	8.6	0.1	0.2	-	5.0
S. of 34°27'	-	-	-	121.7	42.3	1.5	0.3	-	-
Longspine Thornyhead - coastwide	-	-	0.0	1,131.7	36.9	6.5	0.7	-	-
N. of 34°27'	-	-	0.0	1,131.7	12.7	0.2	0.6	-	-
S. of 34°27'	-	-	-	-	24.2	6.4	0.1	-	-
Other thornyheads	-	-	-	21.5	22.8	3.4	0.2	-	-
COWCOD	-	-	-	-	0.0	-	-	-	-
DARKBLOTCHED	11.5	0.6	4.7	152.5	2.2	0.3	0.4	-	0.1
YELLOWEYE	-	-	0.0	2.0	6.5	2.9	0.0	24.1	0.0
Black Rockfish - coastwide	-	0.0	-	0.9	45.3	198.0	2.6	738.9	-
Black Rockfish (WA)	-	-	-	-	0.0	-	-	175.7	-
Black Rockfish (OR-CA)	-	0.0	-	0.9	45.3	198.0	2.6	563.2	-
Minor Rockfish North	46.6	16.9	5.0	327.6	64.2	45.9	5.9	58.6	37.9
Nearshore Species	-	-	-	0.5	19.6	37.3	0.4	52.5	0.0
Shelf Species	0.8	14.8	2.5	188.7	20.3	4.8	3.3	6.1	11.4
Slope Species	45.8	2.1	2.6	138.4	24.4	3.8	2.3	0.0	26.5
Minor Rockfish South	0.0	0.0	0.0	214.9	65.9	171.8	8.7	740.7	0.0
Nearshore Species	-	-	-	0.3	16.3	131.1	2.5	476.0	-
Shelf Species	0.0	0.0	0.0	22.9	9.3	16.5	4.9	264.2	0.0
Slope Species	0.0	0.0	0.0	191.7	40.3	24.1	1.3	0.6	0.0
California scorpionfish	-	-	-	0.0	0.0	14.3	4.9	99.0	-
Cabezon (off CA only)	-	-	-	0.0	1.1	66.2	5.4	53.9	-
Dover Sole	1.5	0.0	0.3	6,830.4	1.6	1.1	32.4	-	2.1
English Sole	0.1	0.0	1.3	958.6	0.0	0.3	24.1	-	3.2
Petrale Sole (coastwide)	-	-	1.8	1,775.8	0.5	1.0	35.7	0.1	0.9
Arrowtooth Flounder	2.7	0.9	1.3	2,450.2	1.0	0.6	1.6	0.0	1.1
Starry Flounder	-	-	-	7.3	0.0	0.1	15.5	380.8	0.0
Other Flatfish	18.0	0.5	0.8	1,596.4	0.2	8.2	76.5	44.0	1.7
Kelp Greenling	-	-	-	0.0	5.2	34.1	0.3	42.7	-
Spiny Dogfish	67.6	6.2	12.7	332.9	216.3	0.7	3.7	9.3	153.3
Other Fish	0.5	0.2	0.1	234.1	70.2	86.8	20.3	57.7	-

Table 5-4h. Landings or deliveries of PFMC-managed groundfish by west coast fishery sectors (mt), 2002

	2002								
	Non-Treaty Sectors								Treaty Sector
	LE Trawl Sectors				Non-LE Trawl Sectors				
Stock or Complex	At-Sea Catcher-Processors	At Sea Motherships	Shoreside Whiting LE Trawl	Shoreside Non-whiting LE Trawl	LE Fixed Gear	Directed OA	Incidental OA	Recreational	Treaty Totals
Lingcod - coastwide	0.2	0.1	0.4	102.3	12.2	68.4	13.6	606.9	11.3
N. of 42° (OR & WA)	0.2	0.1	0.4	65.8	7.6	30.4	11.0	129.7	11.3
S. of 42° (CA)	-	-	0.0	36.5	4.6	38.0	2.5	477.2	-
Pacific Cod	-	-	0.4	690.3	0.5	0.3	2.0	4.6	58.3
Pacific Whiting (Coastwide)	36,341.5	26,593.4	45,503.6	39.4	0.3	-	183.0	0.6	21,815.3
Sablefish (Coastwide)	20.6	0.4	131.9	1,444.7	1,399.7	380.8	29.7	6.6	437.1
N. of 36° (Monterey north)	20.6	0.4	131.9	1,395.6	1,289.3	356.4	23.8	6.6	437.1
S. of 36° (Conception area)	-	-	-	49.0	110.4	24.4	5.8	-	-
PACIFIC OCEAN PERCH	1.4	2.2	0.2	147.3	0.4	0.0	0.0	0.5	0.5
Shortbelly Rockfish	0.5	0.1	0.1	0.1	0.0	-	-	-	-
WIDOW ROCKFISH	114.8	20.4	5.1	254.9	0.0	0.5	0.4	2.9	32.2
CANARY ROCKFISH	1.6	0.8	0.5	42.3	1.6	0.2	1.4	16.6	6.1
Chilipepper Rockfish	-	-	-	153.8	0.5	3.2	0.2	12.0	-
BOCACCIO (S. of 40°10')	-	-	-	17.7	0.5	2.7	0.4	81.5	-
Splitnose Rockfish	-	-	-	55.7	1.3	1.3	0.1	-	-
Yellowtail Rockfish	12.9	1.4	42.5	694.3	0.6	2.1	28.6	20.8	439.2
Shortspine Thornyhead - coastwide	11.9	0.0	0.2	665.6	103.0	2.6	1.3	1.1	4.8
N. of 34°27'	11.9	0.0	0.2	427.0	8.0	0.1	0.1	1.1	4.8
S. of 34°27'	-	-	-	238.6	95.0	2.5	1.2	-	-
Longspine Thornyhead - coastwide	-	-	-	1,896.7	12.0	2.3	0.2	-	-
N. of 34°27'	-	-	-	1,896.3	1.9	0.2	0.1	-	-
S. of 34°27'	-	-	-	0.5	10.0	2.1	0.1	-	-
Other thornyheads	-	-	-	52.2	5.3	0.8	0.1	-	-
COWCOD	-	-	-	0.0	0.0	-	-	0.6	-
DARKBLOTCHED	2.2	0.9	0.0	107.0	0.2	0.4	0.6	0.0	1.6
YELLOWEYE	0.0	-	0.0	0.9	0.0	0.0	0.3	5.4	2.2
Black Rockfish - coastwide	-	-	-	3.2	22.2	194.2	1.7	599.4	-
Black Rockfish (WA)	-	-	-	0.3	0.0	-	-	169.6	-
Black Rockfish (OR-CA)	-	-	-	2.9	22.2	194.2	1.7	429.8	-
Minor Rockfish North	22.4	3.2	1.0	124.2	60.0	43.5	1.6	41.2	27.8
Nearshore Species	-	-	0.0	0.7	11.5	37.8	0.0	34.8	0.1
Shelf Species	10.3	2.3	0.8	44.0	3.6	4.0	0.9	6.3	10.3
Slope Species	12.1	0.9	0.2	79.5	44.9	1.7	0.7	0.1	17.4
Minor Rockfish South	0.0	0.0	0.0	391.8	57.1	172.5	4.3	711.4	0.0
Nearshore Species	-	-	-	0.8	7.8	101.5	1.8	511.6	-
Shelf Species	0.0	0.0	0.0	14.6	4.6	12.1	1.9	196.6	0.0
Slope Species	0.0	0.0	0.0	376.4	44.8	58.9	0.7	3.1	0.0
California scorpionfish	-	-	-	0.0	0.6	9.5	3.3	91.1	-
Cabezon (off CA only)	-	-	-	0.0	1.7	46.2	2.5	38.8	-
Dover Sole	0.6	0.0	1.6	6,317.7	1.7	0.3	17.1	-	16.1
English Sole	0.1	0.0	1.7	1,124.8	0.0	0.1	9.4	0.0	40.2
Petrale Sole (coastwide)	-	-	0.6	1,783.1	0.7	0.2	14.2	0.3	20.6
Arrowtooth Flounder	2.2	0.0	0.7	2,075.3	5.4	0.2	1.3	0.1	6.7
Starry Flounder	-	-	0.0	18.4	0.2	0.1	11.2	14.8	0.1
Other Flatfish	11.6	0.2	0.3	1,621.7	0.1	7.1	40.9	74.6	19.9
Kelp Greenling	-	-	-	0.0	6.4	54.9	0.3	55.7	-
Spiny Dogfish	35.9	1.2	11.4	447.0	403.7	4.4	18.3	8.1	263.4
Other Fish	-	-	-	182.9	67.3	100.5	18.1	57.9	-

Table 5-5a. Total catch of PFMC-managed groundfish by west coast fishery sectors (mt), 2003

Stock or Complex	2003 Total Catch																						
	Non-Treaty Sectors																			Treaty Sectors			
	LE Trawl						LE Fixed Gear			Directed OA			Incidental OA			Recreational							
	At-sea Catcher-Processors	At-sea Motherships	Shoreside Whiting	Shoreside Non-whiting																			
				Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Total Catch All Non-treaty Sectors	Shoreside	At-Sea	Treaty Sector Total Catch	Total Catch All Sectors
Lingcod - coastwide	0.4	0.1	0.4	60.4	70.3	130.7	8.4	1.0	9.4	64.9	3.1	68.0	10.8	N/A	10.8	1,014.2	194.1	1,208.3	1,428.0	22.3	-	22.3	1,450.4
N. of 42° (OR & WA)	0.4	0.1	0.4	48.2	61.8	110.0	6.1	1.0	7.1	31.1	2.2	33.3	6.5	N/A	6.5	173.6	35.4	209.1	366.7	22.3	-	22.3	389.1
S. of 42° (CA)	-	-	0.0	12.2	8.6	20.7	2.3	0.0	2.3	33.8	0.9	34.7	4.3	N/A	4.3	840.6	158.6	999.2	1,061.3	-	-	-	1,061.3
Pacific Cod	0.2	-	0.0	1,040.7	30.9	1,071.6	2.3	1.1	3.4	0.5	0.3	0.7	7.0	N/A	7.0	11.0	0.8	11.8	1,094.8	213.8	0.5	214.4	1,309.2
Pacific Whiting (Coastwide)	41,214.4	26,021.5	51,182.3	30.2	3,143.7	3,173.9	0.7	1.2	2.0	-	0.9	0.9	43.1	N/A	43.1	0.1	-	0.1	121,638.1	4,078.9	19,376.1	23,454.9	145,093.0
Sablefish (Coastwide)	16.6	0.3	40.3	2,324.0	551.9	2,875.8	1,906.4	46.6	1,953.0	585.5	14.3	599.8	36.1	N/A	36.1	7.1	0.9	8.0	5,530.0	602.4	0.1	602.6	6,132.6
N. of 36° (Monterey north)	16.6	0.3	40.3	2,246.2	533.4	2,779.6	1,799.9	44.0	1,843.8	557.9	13.6	571.5	29.0	N/A	29.0	7.1	0.9	8.0	5,289.2	602.4	0.1	602.6	5,891.8
S. of 36° (Conception area)	-	-	-	77.7	8.3	86.1	106.6	1.6	108.2	27.7	0.4	28.1	7.0	N/A	7.0	-	-	0.0	229.4	-	-	-	229.4
PACIFIC OCEAN PERCH	5.0	0.1	0.3	131.6	12.2	143.8	0.3	0.0	0.4	0.0	0.0	0.0	0.0	N/A	0.0	1.0	-	1.0	150.6	0.1	1.1	1.2	151.8
Shortbelly Rockfish	0.5	0.0	0.0	0.2	0.5	0.7	0.0	0.0	0.0	0.3	0.0	0.3	-	N/A	0.0	-	-	0.0	1.6	-	-	-	1.6
WIDOW ROCKFISH	11.6	0.7	12.5	4.0	0.1	4.1	0.0	0.3	0.3	1.1	0.1	1.3	0.2	N/A	0.2	1.3	-	1.3	32.0	9.3	2.1	11.5	43.5
CANARY ROCKFISH	0.2	0.1	0.1	7.6	20.1	27.7	0.1	0.2	0.3	-	1.7	1.7	0.2	N/A	0.2	23.3	6.3	29.6	59.9	1.5	0.7	2.1	62.1
Chilipepper Rockfish	-	-	-	7.4	7.1	14.5	0.1	0.0	0.1	0.1	0.0	0.1	0.1	N/A	0.1	0.0	-	0.0	14.8	-	-	-	14.8
BOCACCIO (S of 40°10')	-	-	-	0.1	2.4	2.5	0.2	0.0	0.2	0.2	0.9	1.1	0.0	N/A	0.0	8.9	1.9	10.8	14.6	-	-	-	14.6
Splitnose Rockfish	-	-	-	150.6	51.1	201.7	0.4	0.1	0.6	0.1	0.1	0.2	0.0	N/A	0.0	-	-	0.0	202.5	-	-	-	202.5
Yellowtail Rockfish	1.7	0.6	43.9	100.4	1.0	101.4	0.5	0.1	0.6	1.3	0.0	1.4	4.7	N/A	4.7	22.8	0.2	23.0	177.3	273.2	34.0	307.1	484.4
Shortspine Thornyhead - coastwide	15.5	0.2	0.1	665.0	472.8	1,137.8	155.6	15.8	171.3	2.1	12.1	14.2	0.6	N/A	0.6	0.1	-	0.1	1,339.8	5.8	-	5.8	1,345.6
N. of 34°27'	15.5	0.2	0.1	462.2		462.2	7.0		7.0	0.0		0.0	0.2	N/A	0.2	0.1	-	0.1	485.2	5.8	-	5.8	490.9
S. of 34°27'	-	-	-	202.8		202.8	148.6		148.6	2.1		2.1	0.5	N/A	0.5	-	-	0.0	353.9	-	-	-	353.9
Longspine Thornyhead - coastwide	-	-	0.0	1,552.1	289.8	1,841.9	19.3	7.1	26.4	0.3	5.5	5.8	0.0	N/A	0.0	-	-	0.0	1,874.2	0.1	-	0.1	1,874.4
N. of 34°27'	-	-	0.0	1,552.1		1,552.1	8.8		8.8	0.1		0.1	0.0	N/A	0.0	-	-	0.0	1,561.1	0.1	-	0.1	1,561.3
S. of 34°27'	-	-	-	-		0.0	10.5		10.5	0.2		0.2	0.0	N/A	0.0	-	-	0.0	10.7	-	-	-	10.7
Other thornyheads	-	-	-	37.2		37.2	3.4		3.4	0.3		0.3	0.2	N/A	0.2	-	-	0.0	41.1	-	-	-	41.1
COWCOD	-	-	-	-	0.1	0.1	0.0	0.0	0.0	-	0.0	0.0	-	N/A	0.0	-	-	0.0	0.1	-	-	-	0.1
DARKBLOTCHED	4.2	0.1	0.3	79.2	88.0	167.3	0.2	0.2	0.4	0.3	0.1	0.4	0.0	N/A	0.0	-	-	0.0	172.7	0.0	0.0	0.0	172.7
YELLOWEYE	0.0	-	-	1.0	0.2	1.2	0.1	1.6	1.7	0.0	2.3	2.3	0.2	N/A	0.2	7.1	3.1	10.2	15.5	0.3	-	0.3	15.8
Black Rockfish - coastwide	-	-	-	0.9		0.9	16.8		16.8	156.2		156.2	0.9	N/A	0.9	1,013.0	163.9	1,176.8	1,351.5	-	-	-	1,351.5
Black Rockfish (WA)	-	-	-	-		0.0	0.0		0.0	-		0.0	-	N/A	0.0	170.2	5.7	175.9	175.9	-	-	-	175.9
Black Rockfish (OR-CA)	-	-	-	0.9		0.9	16.8		16.8	156.2		156.2	0.9	N/A	0.9	842.8	158.2	1,000.9	1,175.7	-	-	-	1,175.7
Minor Rockfish North	24.3	1.7	10.4	148.9		148.9	34.9		34.9	29.3		29.3	0.9	N/A	0.9	46.9	0.8	47.8	298.1	22.1	0.5	22.5	320.7
Nearshore Species	-	-	-	0.2		0.2	2.7		2.7	23.5		23.5	0.2	N/A	0.2	40.4	0.6	41.0	67.7	0.0	-	0.0	67.7
Shelf Species	8.2	1.1	9.9	18.9	108.9	127.8	4.6	3.7	8.3	3.5	0.9	4.4	0.4	N/A	0.4	6.5	0.2	6.7	166.9	2.2	0.5	2.6	169.5
Slope Species	16.1	0.6	0.5	129.7	120.7	250.4	27.6	3.4	31.0	2.4	0.9	3.2	0.2	N/A	0.2	0.0	-	0.0	302.1	19.9	0.0	19.9	322.0
Minor Rockfish South	0.0	0.0	0.0	189.6		189.6	81.5		81.5	153.8		153.8	5.3	N/A	5.3	954.7	50.9	1,005.7	1,435.9	0.0	0.0	0.0	1,435.9
Nearshore Species	-	-	-	0.4		0.4	1.5		1.5	64.0		64.0	1.6	N/A	1.6	602.1	37.1	639.2	706.7	-	-	-	706.7
Shelf Species	0.0	0.0	0.0	2.7	2.3	5.0	1.8	0.2	2.0	7.0	0.2	7.2	2.6	N/A	2.6	351.6	13.8	365.4	382.2	0.0	0.0	0.0	382.2
Slope Species	0.0	0.0	0.0	186.5	5.0	191.4	78.2	0.2	78.4	82.8	0.2	83.0	1.1	N/A	1.1	1.1	-	1.1	354.9	0.0	0.0	0.0	354.9
California scorpionfish	-	-	-	-		0.0	0.0		0.0	2.2		2.2	2.2	N/A	2.2	76.9	12.5	89.4	93.8	-	-	-	93.8
Cabezon (off CA only)	-	-	-	-		0.0	0.1		0.1	37.8		37.8	1.9	N/A	1.9	84.7	11.4	96.1	135.9	-	-	-	135.9
Dover Sole	0.9	0.0	0.0	7,458.0	756.3	8,214.3	2.0	4.2	6.2	0.5	2.2	2.7	13.0	N/A	13.0	0.0	-	0.0	8,237.0	32.9	-	32.9	8,269.9
English Sole	0.0	0.0	0.4	853.9	533.1	1,387.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	N/A	18.9	0.0	-	0.0	1,406.3	67.7	-	67.7	1,474.0
Petrale Sole (coastwide)	0.0	-	0.0	1,940.2	106.2	2,046.4	0.5	0.0	0.6	0.1	0.0	0.1	52.3	N/A	52.3	0.2	-	0.2	2,099.6	84.2	-	84.2	2,183.8
Arrowtooth Flounder	2.8	0.0	0.2	2,304.8	7,122.2	9,427.0	3.7	24.4	28.1	0.1	6.2	6.3	14.5	N/A	14.5	0.1	-	0.1	9,479.1	22.6	1.4	24.0	9,503.1
Starry Flounder	-	-	0.0	28.9	1.3	30.2	0.0	0.0	0.0	0.1	0.0	0.1	14.1	N/A	14.1	15.8	-	15.8	60.2	0.0	-	0.0	60.2
Other Flatfish	6.7	0.2	0.0	1,470.7	850.0	2,320.6	0.3	0.0	0.3	2.2	0.0	2.2	38.8	N/A	38.8	43.1	8.7	51.8	2,420.6	11.0	0.0	11.0	2,431.6
Kelp Greenling	-	-	-	0.0		0.0	3.2		3.2	21.9		21.9	0.1	N/A	0.1	53.9	2.2	56.1	81.3	-	-	-	81.3
Spiny Dogfish	10.1	1.0	4.2	197.0	668.1	865.1	192.9	73.6	266.5	52.8	22.2	75.0	0.1	N/A	0.1	18.0	-	18.0	1,240.1	3.8	257.5	261.3	1,501.3
Other Fish a/	0.0	0.1	-	223.7	4,434.6	4,658.3	48.7	31.7	80.4	104.7	40.7	145.5	14.9	N/A	14.9	74.6	1.1	75.7	4,974.9	-	0.4	0.4	4,975.3

a/ Catches of kelp greenling and spiny dogfish, which are member species of the Other Fish complex, are not included.

Table 5–5b Total catch of PFMC-managed groundfish by west coast fishery sectors (mt), 2004

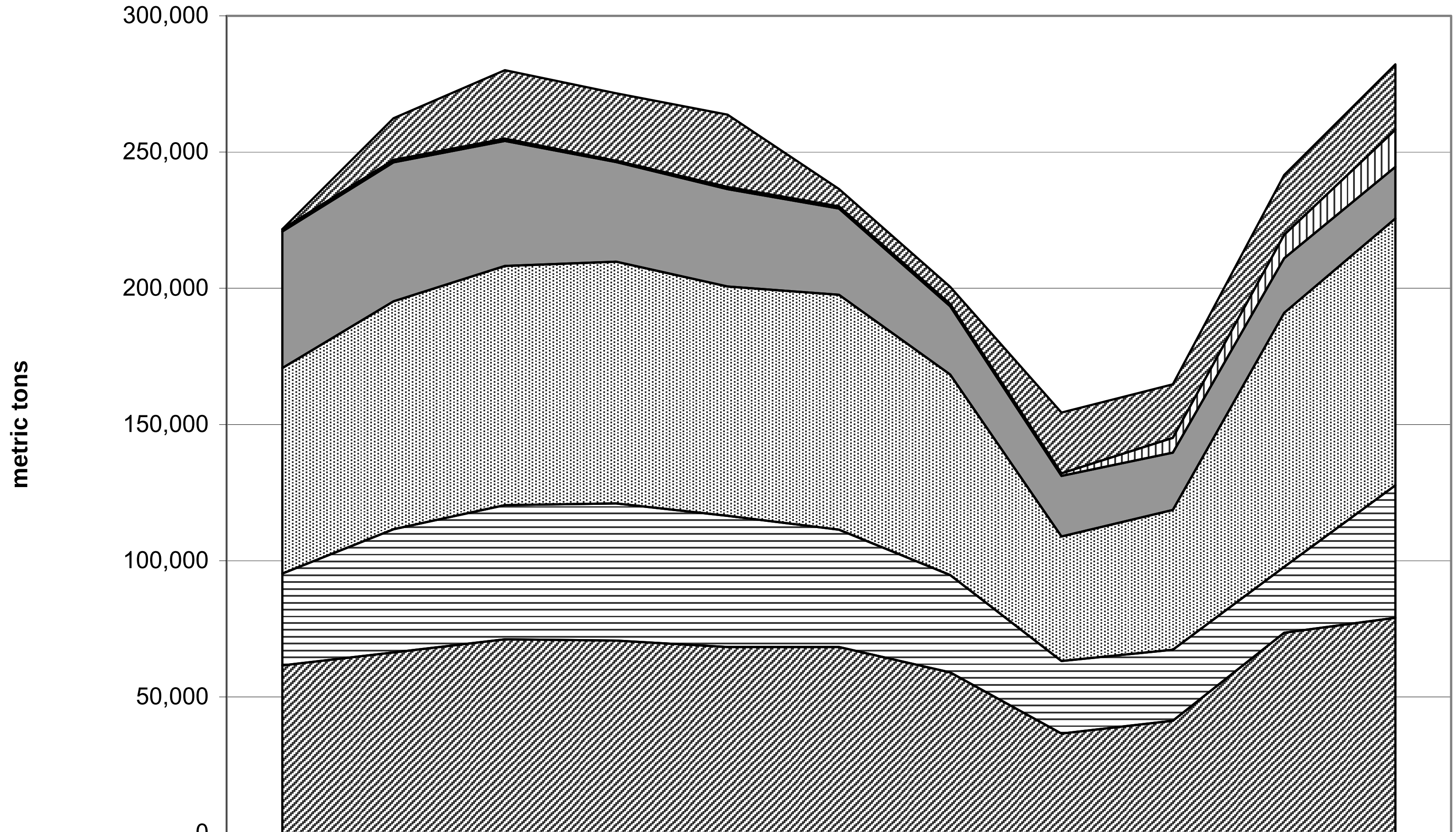
Stock or Complex	2004 Total Catch																						
	Non-treaty Sectors																			Treaty Sectors		Treaty Sector Total Catch	Total Catch All Sectors
	LE Trawl						LE Fixed Gear			Directed OA			Incidental OA			Recreational			Total Catch All Non-treaty Sectors				
	At-sea Catcher-Processors	At-sea Motherships	Shoreside Whiting	Shoreside Non-whiting																			
				Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total		Shoreside	At-Sea		
Lingcod - coastwide	0.4	0.8	4.1	58.0	91.7	149.7	11.7	0.9	12.6	73.2	3.5	76.7	8.9	N/A	8.9	297.3	8.5	305.9	559.2	23.8	-	23.8	583.0
N. of 42° (OR & WA)	0.4	0.8	4.1	42.3	78.5	120.8	8.3	0.8	9.1	33.3	2.3	35.6	5.3	N/A	5.3	173.0	3.2	176.2	352.4	23.8	-	23.8	376.2
S. of 42° (CA)	-	-	0.1	15.7	13.2	28.9	3.4	0.1	3.5	39.9	1.2	41.1	3.6	N/A	3.6	124.3	5.3	129.7	206.8	-	-	-	206.8
Pacific Cod	0.0	-	1.1	1,102.1	6.6	1,108.7	4.7	6.8	11.5	0.4	1.1	1.5	0.2	N/A	0.2	11.8	0.5	12.3	1,135.4	307.7	0.0	307.7	1,443.1
Pacific Whiting (Coastwide)	73,174.7	24,102.0	92,879.2	14.6	2,829.3	2,843.9	0.3	0.7	1.0	-	0.2	0.2	0.1	N/A	0.1	0.8	0.2	1.0	193,002.1	6,848.3	21,590.3	28,438.6	221,440.7
Sablefish (Coastwide)	19.4	9.4	130.9	2,444.6	329.6	2,774.1	2,105.7	72.7	2,178.5	515.1	17.7	532.8	33.0	N/A	33.0	2.8	-	2.8	5,680.8	712.5	0.1	712.6	6,393.4
N. of 36° (Monterey north)	19.4	9.4	130.9	2,364.4	321.0	2,685.4	2,028.9	71.6	2,100.5	493.5	17.4	510.9	28.1	N/A	28.1	2.8	-	2.8	5,487.4	712.5	0.1	712.6	6,199.9
Sablefish S. of 36° (Conception area)	-	-	-	80.2	8.6	88.8	76.8	1.2	77.9	21.6	0.3	21.9	4.8	N/A	4.8	0.0	-	0.0	193.5	-	-	-	193.5
PACIFIC OCEAN PERCH	1.0	0.1	1.0	130.2	24.2	154.4	0.0	0.0	0.1	0.0	0.0	0.1	-	N/A	0.0	-	-	0.0	156.5	3.9	0.0	3.9	160.4
Shortbelly Rockfish	0.0	0.0	0.0	0.1	4.6	4.7	0.0	0.0	0.0	0.0	0.0	0.0	-	N/A	0.0	-	-	0.0	4.8	-	-	-	4.8
WIDOW ROCKFISH	8.2	11.4	34.3	8.8	5.1	13.9	0.1	1.1	1.2	0.1	0.2	0.3	0.1	N/A	0.1	15.2	0.0	15.3	84.7	21.5	1.5	22.9	107.7
CANARY ROCKFISH	0.5	4.1	1.2	6.5	9.2	15.7	0.0	0.1	0.2	0.0	1.9	2.0	0.1	N/A	0.1	10.3	6.0	16.3	39.9	3.1	0.6	3.7	43.6
Chilipepper Rockfish	-	-	-	39.2	126.9	166.1	2.3	0.0	2.3	1.3	0.0	1.3	0.6	N/A	0.6	5.8	0.1	6.0	176.2	-	-	-	176.2
BOCACCIO (S of 40°10')	-	-	-	6.1	7.0	13.0	2.1	0.0	2.1	3.8	1.1	4.9	0.1	N/A	0.1	54.5	8.0	62.5	82.6	-	-	-	82.6
Splitnose Rockfish	-	-	-	163.7	149.7	313.4	0.0	0.0	0.0	0.1	0.0	0.1	0.0	N/A	0.0	-	-	0.0	313.5	-	-	-	313.5
Yellowtail Rockfish	6.3	12.2	127.5	92.9	86.4	179.4	1.2	1.0	2.2	2.2	0.2	2.4	8.0	N/A	8.0	34.7	1.2	35.9	373.7	351.8	28.0	379.8	753.5
Shortspine Thornyhead - coastwide	5.3	0.0	0.5	663.3	207.5	870.8	133.7	7.9	141.6	0.5	3.3	3.8	0.3	N/A	0.3	0.0	-	0.0	1,022.3	6.4	-	6.4	1,028.7
N. of 34°27'	5.3	0.0	0.5	438.0		438.0	5.8		5.8	0.3		0.3	0.0	N/A	0.0	-	-	0.0	449.9	6.4	-	6.4	456.4
S. of 34°27'	-	-	-	225.3		225.3	127.9		127.9	0.2		0.2	0.3	N/A	0.3	0.0	-	0.0	353.6	-	-	-	353.6
Longspine Thornyhead - coastwide	0.0	-	0.0	722.2	128.0	850.2	8.5	0.2	8.6	0.1	0.1	0.1	0.3	N/A	0.3	-	-	0.0	859.3	0.0	-	0.0	859.3
N. of 34°27'	0.0	-	0.0	722.2		722.2	0.9		0.9	0.0		0.0	0.3	N/A	0.3	-	-	0.0	723.4	0.0	-	0.0	723.4
S. of 34°27'	-	-	-	-		0.0	7.6		7.6	0.0		0.0	0.0	N/A	0.0	-	-	0.0	7.6	-	-	-	7.6
Other thornyheads	-	-	-	0.8		0.8	24.2		24.2	0.9		0.9	0.0	N/A	0.0	-	-	0.0	25.9	-	-	-	25.9
COWCOD	-	-	-	-	0.6	0.6	0.0	0.0	0.0	-	0.0	0.0	-	N/A	0.0	0.2	0.2	0.5	1.1	-	-	-	1.1
DARKBLOTCHED	4.4	3.0	1.9	186.6	38.0	224.6	0.2	0.4	0.7	0.5	0.1	0.6	0.0	N/A	0.0	-	-	0.0	235.2	0.1	-	0.1	235.3
YELLOWEYE	-	0.0	0.0	0.3	0.4	0.8	0.0	1.4	1.4	-	2.3	2.3	0.5	N/A	0.5	0.8	6.3	7.2	12.1	0.8	-	0.8	12.9
Black Rockfish - coastwide	-	-	-	2.4		2.4	12.3		12.3	165.7		165.7	1.5	N/A	1.5	655.8	17.2	673.0	854.9	-	-	-	854.9
Black Rockfish (WA)	-	-	-	-		0.0	0.0		0.0	-		0.0	-	N/A	0.0	203.5	12.4	215.9	215.9	-	-	-	215.9
Black Rockfish (OR-CA)	-	-	-	2.4		2.4	12.3		12.3	165.7		165.7	1.5	N/A	1.5	452.3	4.8	457.1	639.0	-	-	-	639.0
Minor Rockfish North	26.3	1.7	26.2	215.9		215.9	41.3		41.3	27.7		27.7	0.7	N/A	0.7	50.8	2.2	52.9	392.7	27.2	0.2	27.4	420.1
Nearshore Species	-	-	-	1.2		1.2	1.7		1.7	21.9		21.9	0.1	N/A	0.1	46.1	1.9	48.0	72.9	0.0	-	0.0	72.9
Shelf Species	3.2	1.4	22.3	11.7	41.3	53.1	3.6	8.7	12.3	2.5	1.4	3.9	0.5	N/A	0.5	4.6	0.2	4.9	101.6	3.9	0.2	4.0	105.6
Slope Species	23.1	0.2	3.9	202.9	39.0	242.0	36.0	9.7	45.7	3.3	1.6	4.9	0.2	N/A	0.2	0.0	-	0.0	320.0	23.4	0.0	23.4	343.3
Minor Rockfish South	0.0	0.0	0.0	239.9		239.9	57.6		57.6	154.3		154.3	3.0	N/A	3.0	620.5	10.0	630.5	1,085.4	0.0	0.0	0.0	1,085.4
Nearshore Species	-	-	-	0.1		0.1	1.8		1.8	82.3		82.3	1.1	N/A	1.1	336.3	4.9	341.2	426.5	-	-	-	426.5
Shelf Species	0.0	0.0	0.0	1.8	11.8	13.6	6.4	0.0	6.4	20.9	0.0	20.9	1.4	N/A	1.4	283.8	5.1	288.9	331.3	0.0	0.0	0.0	331.3
Slope Species	0.0	0.0	0.0	238.0	5.9	243.8	49.4	0.0	49.4	51.1	0.0	51.1	0.5	N/A	0.5	0.5	0.0	0.5	345.3	0.0	0.0	0.0	345.3
California scorpionfish	-	-	-	-		0.0	0.0		0.0	1.6		1.6	1.9	N/A	1.9	40.2	3.7	43.9	47.4	-	-	-	47.4
Cabezon (off CA only)	-	-	-	-		0.0	0.4		0.4	47.3		47.3	1.8	N/A	1.8	39.0	0.7	39.8	89.2	-	-	-	89.2
Dover Sole	0.1	0.0	0.0	7,127.9	371.9	7,499.9	2.2	1.6	3.8	0.3	0.5	0.9	3.7	N/A	3.7	0.0	-	0.0	7,508.4	83.6	-	83.6	7,591.9
English Sole	0.0	0.0	0.7	886.6	199.2	1,085.8	0.0	0.0	0.0	0.2	0.0	0.2	5.9	N/A	5.9	-	-	0.0	1,092.6	81.1	-	81.1	1,173.7
Petrale Sole (coastwide)	-	-	0.3	1,904.0	80.4	1,984.4	1.1	0.0	1.1	0.1	0.0	0.1	5.2	N/A	5.2	0.5	-	0.5	1,991.5	84.1	-	84.1	2,075.6
Arrowtooth Flounder	1.1	0.0	0.6	2,386.3	3,211.4	5,597.7	1.3	28.5	29.9	0.1	4.6	4.7	0.8	N/A	0.8	0.0	-	0.0	5,634.8	81.9	1.8	83.7	5,718.5
Starry Flounder	-	-	0.0	118.3	23.5	141.8	0.0	0.0	0.0	0.1	0.0	0.1	21.3	N/A	21.3	3.4	-	3.4	166.6	2.3	-	2.3	168.8
Other Flatfish	1.7	0.2	0.4	1,269.3	498.3	1,767.6	0.4	0.0	0.5	3.8	0.0	3.8	41.0	N/A	41.0	44.9	2.4	47.3	1,862.5	17.3	0.0	17.3	1,879.8
Kelp Greenling	-	-	-	-		0.0	2.6		2.6	22.7		22.7	0.0	N/A	0.0	31.3	0.9	32.2	57.5	-	-	-	57.5
Spiny Dogfish	331.6	9.8	30.3	119.2	588.0	707.2	131.4	168.0	299.3	91.4	27.5	118.9	0.1	N/A	0.1	2.4	0.0	2.4	1,499.7	40.1	273.9	314.0	1,813.6
Other Fish a/	0.7	0.3	0.2	109.6	2,707.1	2,816.7	23.9	77.7	101.6	101.4	18.5	119.9	11.2	N/A	11.2	63.8	16.3	80.1	3,130.6	-	0.4	0.4	3,131.0

a/ Catches of kelp greenling and spiny dogfish, which are member species of the Other Fish complex, are not included.

Table 5–5c Total catch of PFMC-managed groundfish by west coast fishery sectors (mt), 2005

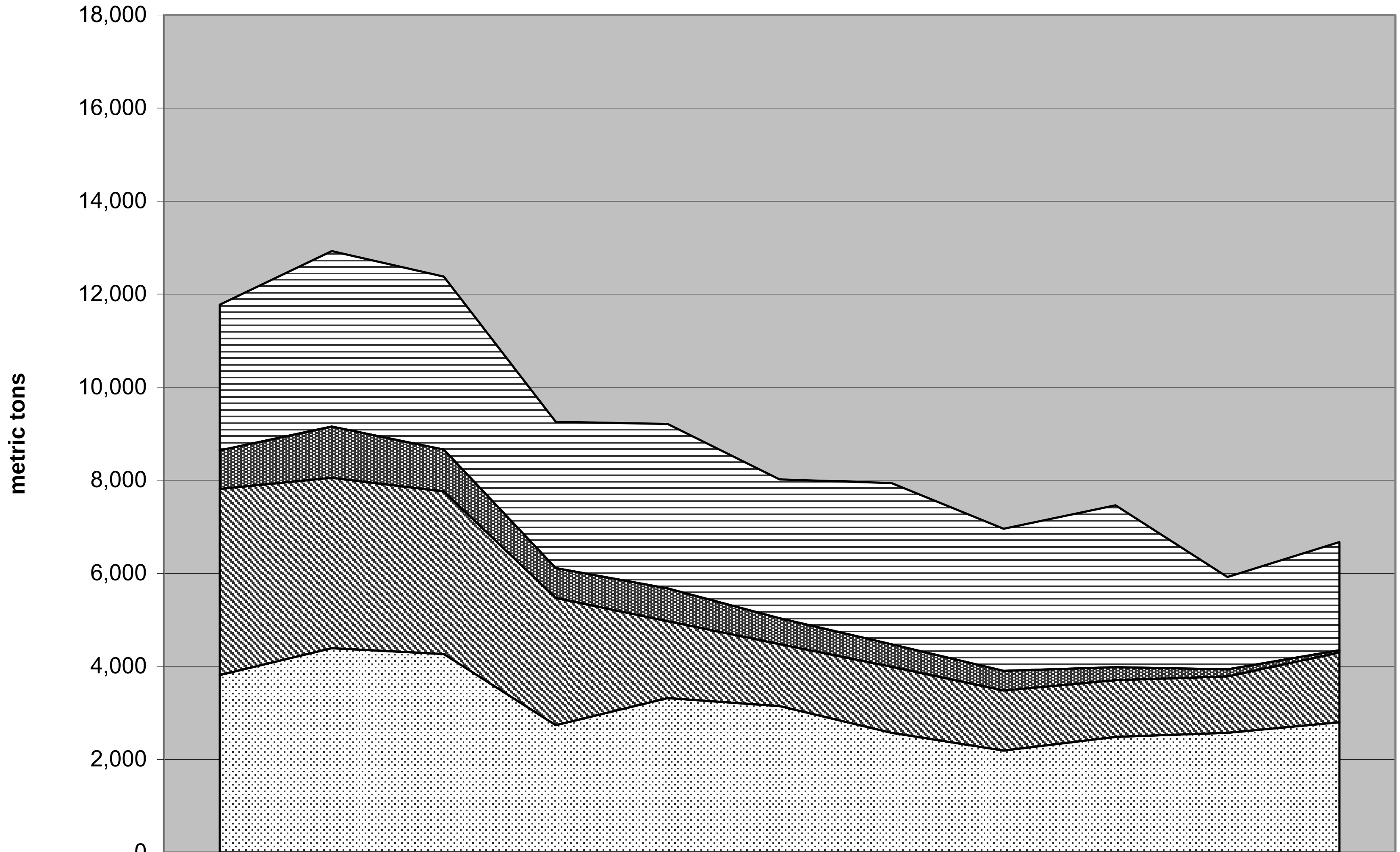
Stock or Complex	2005 Total Catch																						
	Non-treaty Sectors																			Treaty Sectors		Treaty Sector Total Catch	Total Catch All Sectors
	LE Trawl						LE Fixed Gear			Directed OA			Incidental OA			Recreational			Total Catch All Non-treaty Sectors				
	At-sea Catcher-Processors	At-sea Motherships	Shoreside Whiting	Shoreside Non-whiting																			
				Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total	Landings	Discard mort.	Total		Shoreside	At-Sea		
Lingcod - coastwide	0.4	2.0	5.9	77.6	191.7	269.3	14.7	1.8	16.5	70.7	4.1	74.8	3.7	N/A	3.7	489.8	19.1	509.0	881.5	29.9	1.0	30.9	912.4
N. of 42° (OR & WA)	0.4	2.0	5.9	57.3	181.9	239.2	11.2	1.8	13.0	33.5	2.7	36.3	3.1	N/A	3.1	206.2	3.0	209.2	509.1	29.9	1.0	30.9	539.9
S. of 42° (CA)	-	-	0.1	20.3	9.9	30.1	3.4	0.0	3.5	37.1	1.4	38.5	0.5	N/A	0.5	283.7	16.1	299.8	372.5	-	-	-	372.5
Pacific Cod	-	0.0	1.2	730.8	4.5	735.4	2.0	1.7	3.7	0.6	0.5	1.1	0.1	N/A	0.1	7.2	0.5	7.7	749.2	123.7	0.0	123.8	873.0
Pacific Whiting (Coastwide)	78,889.5	48,475.6	97,557.9	11.1	865.4	876.5	0.5	0.4	1.0	-	0.2	0.2	7.6	N/A	7.6	0.1	0.1	0.2	225,808.5	11,766.7	23,581.9	35,348.6	261,157.1
Sablefish (Coastwide)	13.0	2.1	22.4	2,363.3	267.9	2,631.2	2,234.2	60.3	2,294.5	922.8	25.1	947.9	2.2	N/A	2.2	1.4	-	1.4	5,914.8	699.8	0.0	699.8	6,614.6
N. of 36° (Monterey north)	13.0	2.1	22.4	2,308.4	262.0	2,570.4	2,161.5	59.2	2,220.7	905.9	24.8	930.7	2.0	N/A	2.0	1.3	-	1.3	5,762.7	699.8	0.0	699.8	6,462.5
Sablefish S. of 36° (Conception area)	-	-	-	54.9	5.9	60.8	72.7	1.1	73.8	16.9	0.3	17.1	0.2	N/A	0.2	0.1	-	0.1	152.0	-	-	-	152.0
PACIFIC OCEAN PERCH	0.8	0.9	0.5	59.1	10.8	69.9	0.2	0.2	0.4	0.2	0.1	0.2	0.0	N/A	0.0	-	-	0.0	72.7	3.4	0.1	3.5	76.2
Shortbelly Rockfish	0.0	2.7	-	-	1.1	1.1	0.0	0.0	0.0	-	0.0	0.0	-	N/A	0.0	-	-	0.0	3.8	-	-	-	3.8
WIDOW ROCKFISH	43.1	35.5	76.8	3.0	3.3	6.4	0.1	0.6	0.7	0.3	0.3	0.6	0.9	N/A	0.9	3.1	0.1	3.2	167.2	28.6	1.4	30.0	197.1
CANARY ROCKFISH	0.3	0.7	2.2	5.6	21.6	27.1	0.0	0.1	0.1	0.1	1.7	1.7	0.0	N/A	0.0	2.3	6.8	9.1	41.4	4.3	0.4	4.7	46.1
Chilipepper Rockfish	-	-	0.1	30.2	51.7	82.0	2.9	0.0	2.9	0.5	0.0	0.5	0.1	N/A	0.1	3.1	0.5	3.6	89.1	-	-	-	89.1
BOCACCIO (S of 40°10')	-	-	0.0	3.7	27.7	31.4	1.6	0.0	1.6	1.4	0.0	1.5	0.3	N/A	0.3	33.9	4.2	38.1	73.0	-	-	-	73.0
Splitnose Rockfish	-	-	0.0	86.3	143.9	230.2	0.7	0.0	0.7	0.1	0.0	0.1	-	N/A	0.0	-	-	0.0	230.9	-	-	-	230.9
Yellowtail Rockfish	47.4	25.4	173.1	30.3	28.6	58.9	0.5	0.3	0.8	2.3	0.1	2.4	7.0	N/A	7.0	29.9	3.0	32.9	348.0	539.1	39.3	578.4	926.3
Shortspine Thornyhead - coastwide	6.3	0.7	0.3	503.9	138.0	641.9	142.0	0.8	142.8	0.5	0.3	0.8	0.2	N/A	0.2	-	-	0.0	793.2	10.8	-	10.8	803.9
N. of 34°27'	6.3	0.7	0.3	359.6		359.6	7.1		7.1	0.2		0.2	0.0	N/A	0.0	-	-	0.0	374.3	10.8	-	10.8	385.1
S. of 34°27'	-	-	-	144.3		144.3	134.9		134.9	0.3		0.3	0.2	N/A	0.2	-	-	0.0	279.8	-	-	-	279.8
Longspine Thornyhead - coastwide	-	-	0.0	631.3	95.1	726.4	15.0	0.0	15.0	0.0	0.0	0.0	-	N/A	0.0	-	-	0.0	741.4	0.2	-	0.2	741.6
N. of 34°27'	-	-	0.0	631.3		631.3	7.1		7.1	0.0		0.0	-	N/A	0.0	-	-	0.0	638.4	0.2	-	0.2	638.6
S. of 34°27'	-	-	-	-		0.0	7.9		7.9	-		0.0	-	N/A	0.0	-	-	0.0	7.9	-	-	-	7.9
Other thornyheads	-	-	-	7.9		7.9	4.7		4.7	0.6		0.6	-	N/A	0.0	-	-	0.0	13.2	-	-	-	13.2
COWCOD	-	-	-	-	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	-	N/A	0.0	0.0	0.1	0.1	1.6	-	-	-	1.6
DARKBLOTCHED	5.9	5.1	5.5	77.1	23.7	100.8	2.0	0.4	2.4	2.2	0.2	2.4	0.0	N/A	0.0	-	-	0.0	122.1	0.1	0.0	0.1	122.2
YELLOWEYE	-	-	0.0	0.3	0.6	0.9	0.0	0.7	0.7	0.0	1.6	1.7	-	N/A	0.0	1.6	9.4	11.0	14.3	0.8	-	0.8	15.1
Black Rockfish - coastwide	-	0.0	-	0.5		0.5	14.0		14.0	155.5		155.5	1.9	N/A	1.9	754.2	32.7	786.9	958.8	-	-	-	958.8
Black Rockfish (WA)	-	-	-	-		0.0	0.0		0.0	-		0.0	-	N/A	0.0	253.8	17.6	271.3	271.3	-	-	-	271.3
Black Rockfish (OR-CA)	-	0.0	-	0.5		0.5	14.0		14.0	155.5		155.5	1.9	N/A	1.9	500.4	15.2	515.6	687.5	-	-	-	687.5
Minor Rockfish North	40.4	17.1	31.0	108.3		108.3	60.2		60.2	45.9		45.9	0.4	N/A	0.4	78.5	3.8	82.3	385.7	38.3	0.4	38.6	424.3
Nearshore Species	-	-	0.0	0.2		0.2	2.5		2.5	31.4		31.4	0.1	N/A	0.1	71.1	3.5	74.6	108.8	0.2	-	0.2	108.9
Shelf Species	0.6	5.5	27.1	9.3	74.8	84.0	4.0	10.8	14.8	3.7	3.3	7.0	0.3	N/A	0.3	7.4	0.3	7.7	147.0	8.8	0.4	9.1	156.2
Slope Species	39.9	11.6	3.9	98.8	22.3	121.2	53.7	13.4	67.2	10.8	4.2	15.0	0.0	N/A	0.0	0.0	-	0.0	258.7	29.3	0.0	29.3	288.0
Minor Rockfish South	0.0	0.0	0.0	116.7		116.7	35.1		35.1	127.6		127.6	1.1	N/A	1.1	683.5	15.0	698.5	979.0	0.0	0.0	0.0	979.0
Nearshore Species	-	-	-	0.0		0.0	1.5		1.5	79.9		79.9	0.2	N/A	0.2	400.9	6.6	407.5	489.1	-	-	-	489.1
Shelf Species	0.0	0.0	0.0	5.8	6.3	12.1	7.5	0.0	7.5	18.0	0.0	18.1	0.7	N/A	0.7	282.2	8.4	290.6	329.0	0.0	0.0	0.0	329.0
Slope Species	0.0	0.0	0.0	110.9	4.7	115.5	26.2	0.0	26.2	29.7	0.1	29.7	0.1	N/A	0.1	0.4	0.0	0.4	172.0	0.0	0.0	0.0	172.0
California scorpionfish	-	-	-	-		0.0	0.0		0.0	2.1		2.1	0.1	N/A	0.1	18.4	4.6	23.0	25.2	-	-	-	25.2
Cabezon (off CA only)	-	-	-	-		0.0	0.2		0.2	30.7		30.7	0.1	N/A	0.1	46.9	0.9	47.7	78.8	-	-	-	78.8
Dover Sole	0.3	0.0	0.0	6,952.2	672.6	7,624.7	2.4	2.6	5.0	0.3	1.1	1.4	3.7	N/A	3.7	0.0	-	0.0	7,635.2	145.0	-	145.0	7,780.2
English Sole	0.0	0.1	0.0	867.8	338.7	1,206.5	0.0	0.0	0.0	-	0.0	0.0	5.2	N/A	5.2	0.0	-	0.0	1,211.8	65.9	-	65.9	1,277.7
Petrale Sole (coastwide)	-	-	0.0	2,753.8	59.3	2,813.1	0.3	0.0	0.3	0.0	0.0	0.1	11.4	N/A	11.4	0.3	-	0.3	2,825.3	29.7	-	29.7	2,855.0
Arrowtooth Flounder	0.8	0.5	0.9	2,120.0	1,423.2	3,543.2	3.7	62.7	66.4	0.9	20.0	20.9	1.7	N/A	1.7	0.0	-	0.0	3,634.3	158.2	2.3	160.5	3,794.7
Starry Flounder	-	-	0.0	25.0	1.0	26.0	0.0	0.0	0.0	-	0.0	0.0	0.3	N/A	0.3	8.9	0.1	9.0	35.4	1.3	-	1.3	36.6
Other Flatfish	2.0	1.2	0.2	1,091.0	845.4	1,936.5	0.5	0.0	0.5	1.9	0.0	1.9	0.9	N/A	0.9	30.5	1.3	31.8	1,974.9	46.9	-	46.9	2,021.8
Kelp Greenling	0.0	-	-	-		0.0	1.5		1.5	21.0		21.0	-	N/A	0.0	29.3	0.8	30.1	52.6	-	-	-	52.6
Spiny Dogfish	42.2	27.9	95.5	126.0	1,104.9	1,230.9	229.8	111.3	341.1	10.3	38.3	48.6	0.7	N/A	0.7	2.7	0.1	2.8	1,789.9	5.9	284.9	290.8	2,080.7
Other Fish a/	0.6	1.1	0.0	99.0	2,410.0	2,509.0	29.1	95.4	124.5	97.5	32.2	129.6	0.3	N/A	0.3	100.8	0.5	101.3	2,866.5	-	0.5	0.5	2,867.0

a/ Catches of kelp greenling and spiny dogfish, which are member species of the Other Fish complex, are not included.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Treaty At-Sea	0	15,313	25,079	24,786	26,549	6,402	6,330	22,286	19,674	21,897	23,912
Trreaty Shoreside	832	903	846	496	778	788	826	938	5,452	8,698	13,698
Shoreside Non-whiting LE Trawl	50,107	51,026	45,897	36,551	35,777	31,661	25,027	22,242	21,008	20,019	18,882
Shoreside Whiting LE Trawl	75,458	83,636	87,763	88,728	84,139	86,177	73,613	45,703	51,296	93,240	97,974
At Sea Motherships	33,700	45,251	49,253	50,371	48,127	43,087	35,757	26,624	26,027	24,155	48,599
At-Sea Catcher-Processors	61,589	66,322	71,175	70,690	68,357	68,342	59,006	36,580	41,315	73,582	79,093

Figure 5–1. Total landings in the limited entry trawl sector, 1995–2005



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recreational	3,132	3,773	3,716	3,143	3,535	2,982	3,468	3,053	3,479	1,987	2,327
Incidental Open Access	827	1,099	903	640	704	558	481	422	281	150	50
Directed Open Acess	4,000	3,664	3,493	2,739	1,652	1,331	1,422	1,294	1,219	1,215	1,496
LE Fixed Gear	3,815	4,390	4,264	2,733	3,319	3,146	2,569	2,188	2,483	2,569	2,798

Figure 5–2. Total landings in the non-trawl sectors, 1995–2005

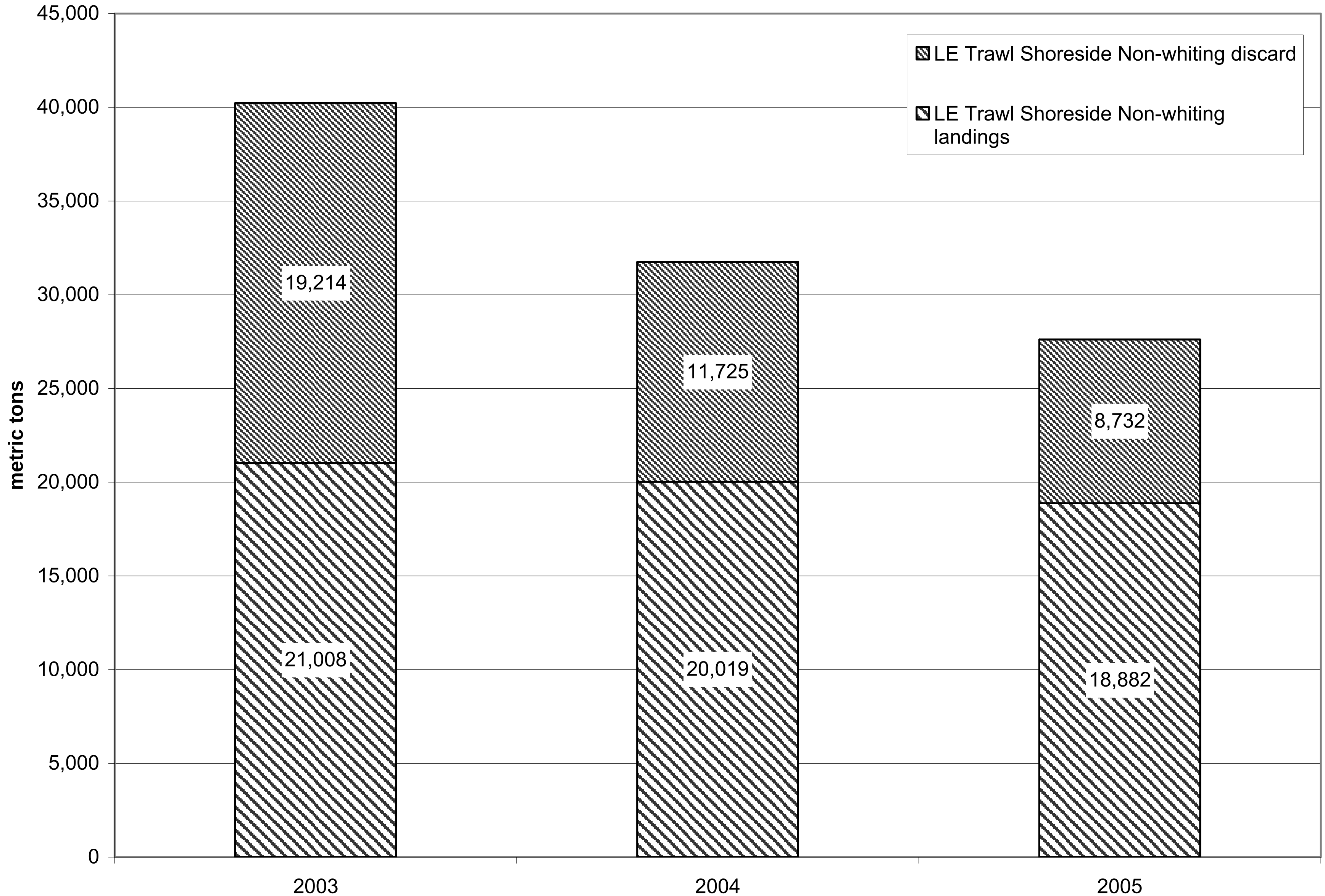


Figure 5-3. Landings plus discards in the limited entry trawl sector, 2003–05

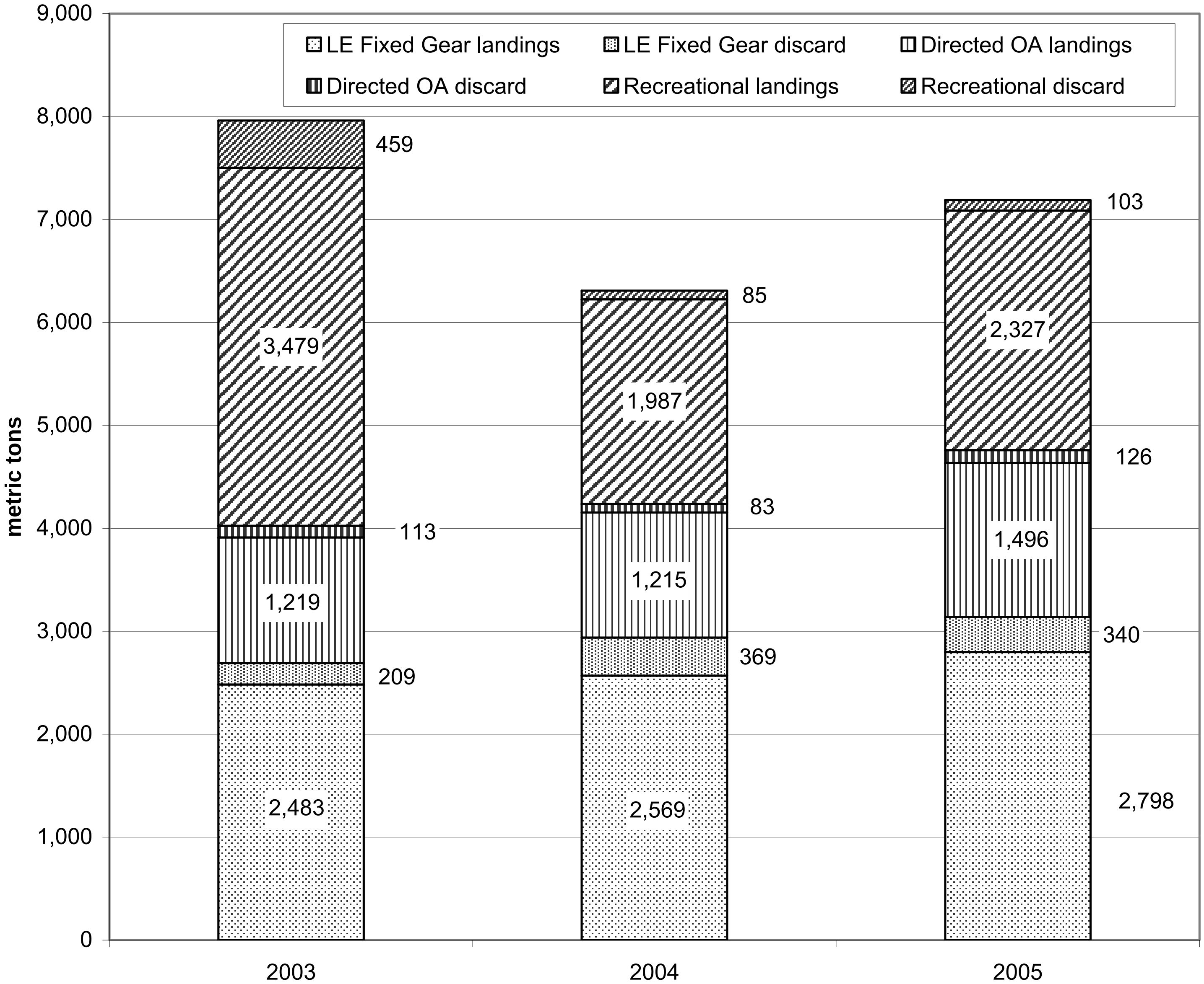


Figure 5–4. Landings plus discard in the non-trawl sectors, 2003–05

5.2.3 Limited Entry Groundfish Trawl Catcher Vessels

West coast limited entry trawl vessels catch a wide range of species. By weight, the following species account for the bulk of non-whiting landings: Dover sole, arrowtooth flounder, petrale sole, sablefish, longspine thornyhead and shortspine thornyhead, and yellowtail rockfish. Management measures intended to reduce the directed and incidental catch of overfished rockfish and other depleted species have significantly reduced rockfish catches in recent years substantially below historical levels. These vessels use midwater trawl gear, and small and large footrope bottom trawl gear (defined at 50 CFR 660.302 and 660.322(b)). Midwater trawl gear is not designed to touch the ocean bottom and is therefore used to target groundfish species, such as Pacific whiting and yellowtail rockfish that ascend above the ocean floor. Small and large footrope trawl gear are designed to remain in contact with the ocean floor and are used to target species that reside along the ocean bottom such as flatfish on the continental shelf and slope, or DTS species (Dover sole, thornyhead and sablefish complex) in deep water. Fishers generally use small footrope trawl gear in areas that have a regular substrate (few rocks or outcroppings) and more widely on the continental shelf than on the continental slope; this is due in large part to regulatory requirements. Fishers use large footrope trawl gear most commonly in areas that may have an irregular substrate, and along the continental slope and in deeper water.

The limited entry shore-based trawl vessels primarily deliver their catch to processors and buyers located along the coasts of Washington, Oregon, and California, and tend to have their homeports located in towns within the same general area where they make deliveries. Larger vessels in the shore-based limited entry trawl sector focus more heavily on the DTS complex in deep water, while smaller trawl vessels focus more heavily on the shelf. Large trawl vessels also tend to participate in the trawl fishery for more months of the year than small trawl vessels. The shore-based vessels range in size from less than 40 feet to over 90 feet in length (Table 5-6).

In 2003, a fishing capacity reduction program (buyback) was implemented off the west coast which retired 91 vessels from the limited entry trawl sector. These 91 vessels represented less than 40 percent of the number of boats actively engaged in the limited entry trawl sector, but approximately 50 percent of historic catch. The purpose of the program was to reduce the number of vessels and permits endorsed for the operation of groundfish trawl gear in order to increase and stabilize economic revenues for vessels remaining in the groundfish fishery and conserve and manage depleted groundfish species. Vessels that participated in the buyback program were sold, scrapped, or converted to nonfishing purposes, and those vessels cannot be used for fishing again.

The impact of the trawl vessel buyback appears to have been positive in terms of exvessel revenue per vessel although it varied by region. Average trawl exvessel revenues generated by non-Pacific whiting groundfish increased from approximately $108,000 to $151,000 between the years 2003 and 2004 even though total exvessel revenues for the fleet decreased from approximately $25,000,000 to $22,000,000 during the same period (Figure 5–5). Declining total bottom trawl revenues in 2005 resulted in a slight decline in average revenue per vessel compared to 2004. Some ports lost a disproportionate share of their trawl fleet, while others lost relatively few trawl vessels (Table 5-7). Figure 5–5 is based on Table 5–7 and shows the number of vessels in each state, 2001–06.The number of trawl vessels landing in the major trawl ports of Eureka, Crescent City, and Avila declined by 50 percent or more.

Trawl vessels make most of their landings in Oregon. Newport, Astoria, and Charleston/Coos Bay are three of the largest four ports for landed weight and exvessel revenue during the 2004–2006 period. Eureka, Fort Bragg and Crescent City, California; Brookings, Oregon; and Bellingham Bay, Blaine and Neah Bay, Washington comprise the remaining top 10 largest ports for trawl vessel landings.

Non-whiting landings and revenues by non-tribal trawlers in Oregon are significantly larger than the other two states (Table 5–8).

By weight, the vast majority of trawl vessel groundfish is caught with midwater trawl gear targeting Pacific whiting. In contrast, the majority of trawl exvessel revenues are attributed to the bottom trawl sector. Based on Table 5–9, on average for the period 2000–05 whiting accounted for about 75 percent of landings by weight but only 21 percent by value.

Limited entry trawlers take the vast majority of the groundfish harvest measured by weight but somewhat less if measured by value. The difference between the weight and revenue shares is mostly due to the catch of Pacific whiting. Since whiting fetch a relatively low price and are caught almost exclusively by limited entry trawl vessels, they skew the overall value per unit weight for this sector.

Table 5–6. Count of vessels making non-whiting landings with trawl gear; count of vessels by length category and average annual landings, 2004–06

Length Interval	No. Vessels	Avg. Annual Landings
California		
<40	19	70.3
40-49	21	520.9
50-59	25	1980.3
60-69	16	1129.3
70-79	11	759.7
>79	2	*
Oregon		
<40	2	*
40-49	9	835.4
50-59	16	2127.0
60-69	26	3807.7
70-79	22	3385.4
>79	7	244.9
Washington		
<40	4	35.8
40-49	4	240.5
50-59	9	857.5
60-69	8	1067.9
70-79	4	1057.0
>79		*

*Data not reported due to confidentiality requirements.
Records are not unique and should not be summed.

Table 5-7. Count of trawl vessels landing non-whiting groundfish by port and year

	2001	2002	2003	2004	2005	2006	2007
Washington							
Blaine	14	10	9	7	4	3	1
Bellingham Bay	31	16	19	17	12	8	9
Port Angeles	2		1	18			1
Neah Bay	15	18	19	23	25	19	22
Westport	6	4	4	5	5	2	6
Sub-total	**68**	**48**	**52**	**70**	**46**	**32**	**39**
Oregon							
Astoria	39	34	38	28	29	32	32
Garibaldi (Tillamook)	4	4	2	3	1	1	1
Newport	32	26	24	22	22	23	22
Charleston (Coos Bay)	29	24	27	19	19	19	23
Brookings	11	11	13	8	7	9	8
Sub-total	**115**	**99**	**104**	**80**	**78**	**84**	**86**
California							
Crescent City	19	24	19	3	5	7	7
Eureka	29	29	28	14	15	17	18
Fields Landing	14						
Fort Bragg	19	29	14	10	10	9	8
Bodega Bay	4	8	5	2		2	2
San Francisco	18	17	12	10	16	14	11
Princeton / Half Moon Bay	13	11	11	12	11	15	10
Santa Cruz	6	6	6	4	3	2	1
Moss Landing	15	14	16	16	16	11	2
Monterey	4	5	5	3	3	4	2
Morro Bay	11	12	10	10	9	5	5
Avila	15	16	14	7	2	4	2
Santa Barbara	14	15	8	4	4	2	9
Ventura	7	10	8	3			4
Terminal Island	1	5	2				
Sub-total	**189**	**201**	**158**	**98**	**94**	**92**	**81**
Total	**372**	**348**	**314**	**248**	**218**	**208**	**206**

Note: ports with fewer than three trawl vessels in all years were excluded for confidentiality purposes.
Source: PacFIN ft and ftl tables.

Table 5–8. Average landings (mt) and revenue, 2004–06 for the 20 largest ports for limited entry non-whiting trawl groundfish

Port	Average Landings (mt)	Average Revenue
Washington		
Bellingham Bay	1,369	$1,379,776
Blaine	835	$735,211
Neah Bay	488	$475,675
Westport	266	$345,689
Port Townsend	175	$140,710
Port Angeles	67	$72,643
Anacortes	33	$33,400
Ilwaco	22	$22,810
Oregon		
Astoria	5,607	$6,496,960
Charleston (Coos Bay)	2,494	$2,966,903
Newport	1,772	$2,310,664
Brookings	632	$808,659
California		
Eureka	1,775	$2,209,686
Fort Bragg	1,096	$1,262,801
Crescent City	492	$563,128
San Francisco	359	$633,213
Moss landing	229	$313,227
Princeton / Half Moon Bay	208	$478,751
Morro Bay	166	$203,022
Monterey	78	$131,293

Table 5–9. Non-tribal trawl shoreside landings and exvessel revenue by state and year

	Species Aggregation	2000		2001		2002		2003		2004		2005	
		Landed weight (mt)	Exvessel Revenue ($1,000s)	Landed weight (mt)	Exvessel Revenue ($1,000s)	Landed weight (mt)	Exvessel Revenue ($1,000s)	Landed weight (mt)	Exvessel Revenue ($1,000s)	Landed weight (mt)	Exvessel Revenue ($1,000s)	Landed weight (mt)	Exvessel Revenue ($1,000s)
CA	Non-whiting	9,764	$11,859	7,929	$9,546	8,026	$10,068	7,330	$8,618	6,101	$7,090	5,760	$7,021
	Pacific Whiting	4,986	$765	2,306	$171	2,773	$274	1,695	$166	4,742	$641	3,062	$338
OR	Non-whiting	15,952	$17,974	12,152	$14,687	8,410	$10,150	10,499	$12,897	10,245	$11,833	10,786	$12,441
	Pacific Whiting	68,702	$6,081	53,376	$4,132	32,305	$3,219	36,581	$3,642	59,075	$4,641	61,463	$7,107
WA	Non-whiting	5,593	$4,601	4,896	$4,319	8,370	$4,189	4,258	$3,598	3,481	$3,148	3,315	$3,191
	Pacific Whiting	12,156	$1,122	17,730	$1,439	10,630	$1,061	12,934	$1,283	25,838	$1,993	32,291	$3,848

Source: PacFIN ftl data. May 2006.
Note: Data shown is for PFMC management areas and does not include areas such as Puget Sound and Columbia River.

Table 5–10. Revenues 2004 (in dollars)

Stock or Complex	WA State Ports	Astoria, OR	Brookings, OR	Charleston/ Coos Bay, OR	Newport, OR	Bodega Bay, CA	Crescent City, CA	Eureka, CA	Fort Bragg, CA	Monterey, CA	Morro Bay, CA	Moss Landing, CA	Princeton/ Half Moon Bay, CA	San Francisco, CA	Grand Total
Lingcod	14,842	28,623	614	7,741	7,401										59,221
Pacific Cod	656,019	544,478		5,881	13,084			51							1,219,513
Pacific Whiting	1,993,585	1,277,090		338,493	3,024,820		136,872	503,805		1		125			7,274,791
Sablefish	476,027	1,246,019	201,713	732,962	1,191,468	5,845	95,006	486,543	395,083	10,645	56,197	105,520	1,633	217,999	5,222,660
PACIFIC OCEAN PERCH	17,619	68,894	10	3,321	26,343			5							116,192
WIDOW	6,669	9,702		196	3,907		3,760	4,003		58		3		725	29,023
CANARY	2,858	2,969	115	720	373		96	645		218		58	3		8,055
Chilipepper						127	3,432	12,882	17,151	7,257	1,623	1,605	2,393	7,805	54,275
BOCACCIO							12	106	237	2,558	1	75	19	183	3,191
Splitnose Rockfish							405	317	7,501	402	10			288	8,923
Yellowtail Rockfish	94,571	97,689		833	1,084		8	8,307		8			6	100	202,606
Shortspine Thornyhead	26,005	134,797	18,987	117,520	171,794	1,312	5,955	108,649	87,705	3,566	23,533	111,705	18	47,859	859,405
Longspine Thornyhead	6,584	39,712	32,132	158,423	50,024	1,336	8,647	86,326	140,709	8,329	44,948	92,211		102,832	772,213
Other Thornyheads							15	91	57	36	959	96		84	1,338
DARKBLOTCHED	6,143	50,426	895	45,971	43,123	29	2,343	19,869	18,281	568	24	191			187,863
YELLOWEYE	146	140		20	5					46					357
Black Rockfish		1,144	22	174				120					8	14	1,482
Minor Nearshore Rockfish	76	865		163				8		868		24	179		2,183
Minor Shelf Rockfish	1,749	1,023		554	643	318	9	3,422	46,969	16,962	2,798	25,201	346	20,415	120,409
Minor Slope Rockfish	24,541	78,704	2,319	6,640	30,805	596	5,138	20,256	104,019	6,815	22,725	9,631	18	66,425	378,632
Cabezon				11	7										18
Dover Sole	363,810	1,500,952	246,034	837,873	573,509	14,916	144,346	550,332	528,500	20,523	63,189	158,887	227	265,092	5,268,190
English Sole	330,446	201,051	3,359	65,163	19,314	525	33,867	127,822	5,904	14,679	25,861	4,782	18,009	6,234	857,016
Petrale Sole	958,540	1,335,670	21,100	478,818	271,795	259	45,526	389,788	12,999	84,396	275,969	33,319	88,278	41,299	4,037,756
Arrowtooth Flounder	285,276	186,023	1,561	34,133	28,869	27	6,415	3,085	427						545,816
Starry Flounder	8,672	55,346	77	240	1,057		724	2,981		4,713		24,200	16,116	2,904	117,030
Other Flatfish	62,817	319,269	29,179	146,546	43,653	2,333	102,974	72,317	37,188	49,108	6,736	42,573	146,244	26,376	1,087,313
Spiny Dogfish	58,442	3		0	435		12			15,583	2,257	395			77,127
Other Fish	29,994	43,196	1,572	57,891	50,382		6,761	23,336	1,543	1,524	114	1,672	5,770	1,045	224,800
Total	5,425,431	7,223,785	559,689	3,040,287	5,553,898	27,623	602,325	2,425,066	1,404,273	248,953	526,944	612,273	279,267	807,679	28,737,493

Table 5–11. Revenues 2005 (in dollars)

Stock or Complex	Washington State Ports	Astoria, OR	Brookings, OR	Charleston/ Coos Bay, OR	Newport, OR	Bodega Bay, CA	Crescent City, CA	Eureka, CA	Fort Bragg, CA	Monterey, CA	Morro Bay, CA	Moss Landing, CA	Princeton/ Half Moon Bay, CA	San Francisco, CA	Grand Total
Lingcod	21,918	34,123	1,336	8,944	15,241										81,562
Pacific Cod	499,964	286,163		67	2,294										788,488
Pacific Whiting	3,818,212	2,025,453		405,692	4,675,292		84,949	337,769				4,422			11,351,789
Sablefish	558,486	1,574,720	318,208	772,354	943,848		177,483	498,725	499,436	10,045	89,383	89,529	3,250	127,312	5,662,779
PACIFIC OCEAN PERCH	6,953	39,036		2,582	10,291			1							58,863
WIDOW	10,354	4,310		12,654	38,704		68	5,164				1		146	71,401
CANARY	1,560	1,781		879	1,718		29	272	1,824	2		3	2		8,070
Chilipepper							844	20,403	17,133	14,183	251	819	982	8,302	62,917
BOCACCIO								32	214	274	120	5		2,939	3,584
Splitnose Rockfish							397	193	124						714
Yellowtail Rockfish	91,778	72,208		4,763	23,562			362	3,864						196,537
Shortspine Thornyhead	22,068	138,951	35,001	122,994	118,401		26,770	114,852	139,987	115	45,139	69,915		33,019	867,212
Longspine Thornyhead	143	14,148	35,693	111,731	20,374		32,848	91,400	174,791	57	64,429	59,912		34,451	639,977
Other Thornyheads							403	6,101	2,224		369			1,449	10,546
DARKBLOTCHED	845	21,271	1,167	22,440	16,408		1,390	4,845	9,404						77,770
YELLOWEYE	119	97		31	13				23						283
Black Rockfish		367		158				5							530
Minor Nearshore Rockfish	29	102		54			75						436		696
Minor Shelf Rockfish	2,647	3,209		1,256	691			1,358	25,737	13,177	6,396	16,362	826	15,586	87,245
Minor Slope Rockfish	10,572	56,415	1,594	6,008	19,011		1,516	3,947	40,062	3,486	33,536	9,090		6,887	192,124
Cabezon		46		18									11		75
Dover Sole	465,939	1,725,394	317,662	819,479	433,096		204,877	671,199	607,770	2,740	83,167	116,157	308	107,420	5,555,208
English Sole	294,370	150,825	9,970	74,895	39,003		25,054	98,455	12,310	6,993	7,048	4,850	13,254	1,698	738,725
Petrale Sole	989,186	1,828,852	64,536	527,950	459,771		174,830	602,156	139,580	105,643	140,373	119,745	186,038	16,798	5,355,458
Arrowtooth Flounder	178,474	214,030	3,389	35,231	45,689		2,524	6,753	535						486,625
Starry Flounder	60,180	11,775	7	201	2,309		653	1,013		897		14,973	21,074	9,201	122,283
Other Flatfish	66,265	321,946	41,823	104,054	34,658		106,018	89,621	44,269	51,989	25,623	43,750	69,661	12,845	1,012,522
Spiny Dogfish	102,580	703		18	207		8				38	4			103,558
Other Fish	43,931	44,626	2,016	71,827	114,124		1,902	20,909	988	1,743	6	3,966	4,929	1,039	312,006
Total	7,246,573	8,570,551	832,402	3,106,280	7,014,705		842,638	2,575,535	1,720,275	211,344	495,878	553,503	300,771	379,092	33,849,547

Table 5–12. Revenues 2006 (in dollars)

Stock or Complex	Washington State Ports	Astoria, OR	Brookings, OR	Charleston/ Coos Bay, OR	Newport, OR	Bodega Bay, CA	Crescent City, CA	Eureka, CA	Fort Bragg, CA	Monterey, CA	Morro Bay, CA	Moss Landing, CA	Princeton/ Half Moon Bay, CA	San Francisco, CA	Grand Total
Lingcod	29,838	66,241	5,490	20,214	11,468										133,251
Pacific Cod	227,918	193,610		2	16										421,546
Pacific Whiting	4,306,208	3,681,880		774,273	4,324,091		193,818	438,193				167			13,718,630
Sablefish	601,630	1,904,810	414,352	1,142,651	1,187,722	960	181,232	823,607	495,943	11,662	24,508	142,767	14,408	187,352	7,133,604
PACIFIC OCEAN PERCH	13,001	38,442	-	2,066	14,358			281							68,148
WIDOW	29,909	5,068	13	1,547	6,953		867	2,779	367			3		11	47,517
CANARY	900	6,639	14	436	2,225		1	1,040	530	51	199			1,272	13,307
Chilipepper						215	4,461	10,478	4,818	8,695	379	3,157	2,295	7,300	41,798
BOCACCIO								6	395	344		189		16	950
Splitnose Rockfish							7	1,716	52					3,863	5,638
Yellowtail Rockfish	87,850	60,748		4,412	15,857			308	19					1,390	170,584
Shortspine Thornyhead	27,015	164,509	41,972	153,304	156,363	1	13,800	190,519	144,652	12	10,849	58,506	121	22,714	984,337
Longspine Thornyhead	1,292	34,339	91,698	161,585	41,785	2	18,406	264,993	242,222	801	4,789	68,665	119	25,621	956,317
DARKBLOTCHED	1,754	23,325	2,799	24,774	12,854	52	241	10,260	11,093			273	372		87,797
YELLOWEYE	423	202		45	64			4							738
Black Rockfish	91	2,400		11	-										2,502
Minor Nearshore Rockfish	323	590		61	4								37	318	1,333
Minor Shelf Rockfish	2,897	5,152	4	946	1,508	302	212	605	21,535	15,020	569	34,643	1,572	10,463	95,428
Minor Slope Rockfish	15,009	41,326	2,768	4,401	15,233	7	1,641	4,482	17,148	11,961	7,650	37,440	145	16,188	175,399
Cabezon		30		4											34
Dover Sole	397,967	1,485,384	278,745	793,572	405,148	252	162,144	622,846	410,356	5,612	7,037	123,508	3,879	77,371	4,773,821
English Sole	173,821	246,138	14,404	49,574	20,601	1,401	40,583	136,007	7,985	4,354	37	1,829	20,181	9,239	726,154
Petrale Sole	599,089	1,969,571	146,840	896,601	403,206	18,790	195,852	655,214	171,217	100,083	2,185	98,848	208,843	210,141	5,676,480
Arrowtooth	92,037	246,846	1,606	34,350	37,268		2,465	4,189	259					448	419,468
Starry Flounder	27,388	41,923		18	3			1,212		1,913	49	42	21,911	8,674	103,133
Other Flatfish	38,024	506,303	27,860	87,000	18,161	242	53,132	65,496	22,359	4,206	49	8,463	58,684	31,858	921,837
Spiny Dogfish	56,360	884		12	957		280	313		3,960		-			62,766
Other Fish	52,471	98,198	1,325	102,622	58,744		4,616	28,148	158	1,608		1,592	4,551	1,785	355,818
Total	6,783,215	10,824,558	1,029,890	4,254,481	6,734,589	22,224	873,758	3,263,118	1,551,108	170,282	58,300	580,092	337,118	616,024	37,098,757

Table 5–13. Revenues 2007 (in dollars)

Stock or Complex	Washington State Ports	Astoria, OR	Brookings, OR	Charleston/ Coos Bay, OR	Newport, OR	Bodega Bay, CA	Crescent City, CA	Eureka, CA	Fort Bragg, CA	Monterey, CA	Morro Bay, CA	Moss Landing, CA	Princeton/ Half Moon Bay, CA	San Francisco, CA	Grand Total
Lingcod	17,794	56,753	5,520	20,439	7,346										107,852
Pacific Cod	42,441	23,864		7											66,312
Pacific Whiting	4,661,350	3,392,616	274	502,434	3,629,796		124,942	302,385			34				12,613,831
Sablefish	474,951	1,776,529	475,608	1,174,688	1,474,270	1,540	274,213	919,469	425,983	17,366	11,337	22,018	7,895	229,692	7,285,559
PACIFIC OCEAN PERCH	19,216	63,715	-	2,651	18,750			19							104,351
WIDOW	25,629	46,163	-	178	5,463	6	232	826	97					4	78,598
CANARY	1,280	661		118	671			2	461	122			33	756	4,104
Chilipepper						873	1,695	5,051	16,571	11,523	588	372	5,818	19,920	62,411
BOCACCIO								11	263		14		311	58	657
Splitnose Rockfish							4	10,716	28,447	285				14,356	53,808
Yellowtail Rockfish	94,641	48,931		395	4,987	3	100	608					97	2,132	151,894
Shortspine Thornyhead	36,423	329,906	46,915	132,145	252,274	303	29,587	176,537	79,717	488	1,043	11,991	1	48,573	1,145,903
Longspine Thornyhead	9,925	99,933	79,615	147,824	45,653	288	36,053	255,830	110,393	382	788	14,145		54,441	855,270
Other thornyheads						6,458					1,753	420		8,631	
DARKBLOTCHED	2,698	25,722	5,953	30,535	18,512	919	4,662	11,772	31,461			122		265	132,621
YELLOWEYE	22	67		25	4									-	118
Black Rockfish	794	332		9									3		1,138
Minor Nearshore Rockfish	20	15		4		12			72				28	287	438
Minor Shelf Rockfish	759	1,620	13	634	42	685	18	89	723	3,969	489	57	23,838	5,181	38,117
Minor Slope Rockfish	16,006	57,330	4,395	5,238	25,931	403	3,742	8,713	47,650	4,613	241	5,773	14,553	11,303	205,891
Cabezon		23													23
Dover Sole	452,272	1,998,519	462,987	1,110,520	851,921	1,026	326,960	1,183,718	425,210		331	10,859	2,779	247,437	7,074,539
English Sole	58,322	197,678	7,784	40,991	7,193	2,988	13,254	62,575	16,992	2,053	67		15,263	11,955	437,115
Petrale Sole	298,281	1,202,247	194,173	609,958	206,508	61,235	113,021	450,328	423,091	115,311	602	1,172	187,545	290,217	4,153,689
Arrowtooth Flounder	73,040	277,442	1,852	41,444	29,422	10	922	11,696	650						436,478
Starry Flounder	17,379	5,871		10		9	8	445		269	12		10,558	5,299	39,860
Other Flatfish	20,926	237,127	40,790	102,745	25,539	425	42,221	79,052	18,188	11,608	14		89,472	31,419	699,526
Spiny Dogfish	29,779	2,345		3	137			9		3,429		1,860	82		37,644
Other Fish	41,181	135,643	12,913	169,794	67,515	18	1,484	35,647	2,578	747			4,514	849	472,883
Total	6,395,129	9,981,052	1,338,792	4,092,789	6,671,934	70,743	979,576	3,515,498	1,628,547	172,165	15,560	70,122	363,210	974,144	36,269,261

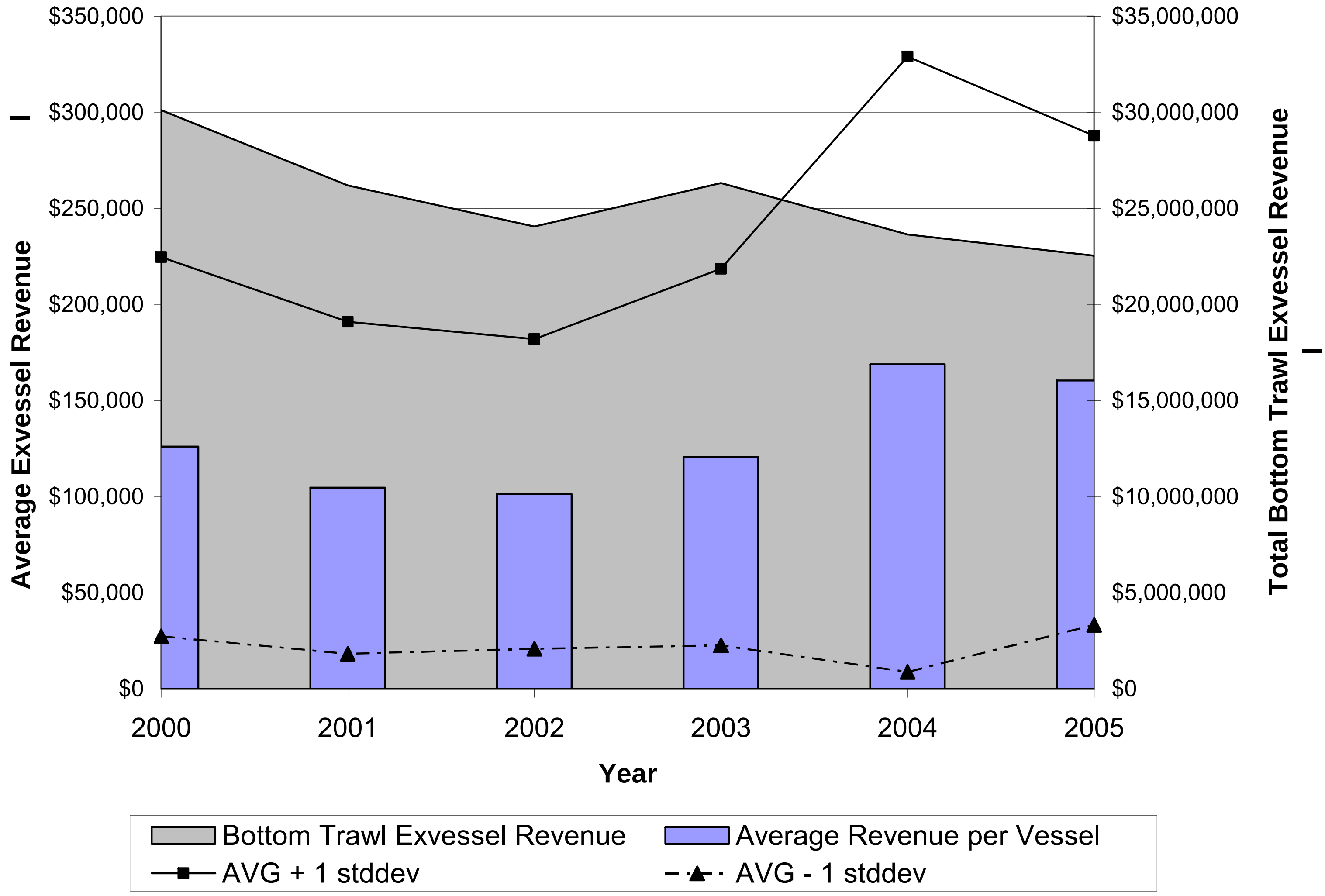


Figure 5-5. Annual limited entry trawl vessel revenues per year (excluding catch of Pacific whiting)

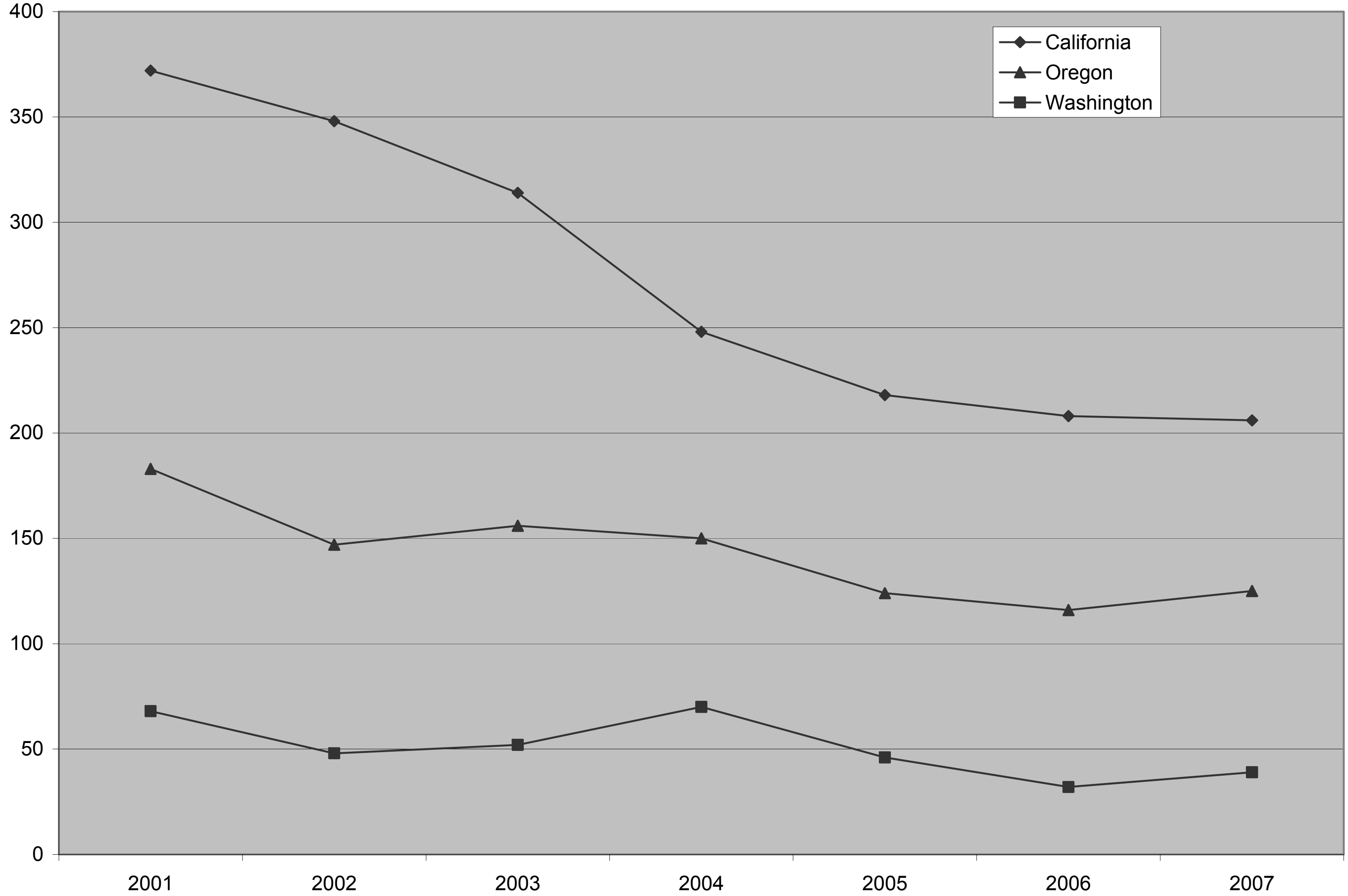


Figure 5–6. Count of vessels making non-whiting landings with trawl gear by state, 2004–06

5.2.4 At-Sea Sector (Catcher-Processors and Motherships)

In addition to the shore-based limited entry trawl fishery, an at-sea limited entry trawl fishery occurs off the coast of Washington, Oregon, and California. The high volume at-sea fishery targets Pacific whiting with the use of midwater trawls. Pacific whiting commands a relatively low price per pound in the market place. The limited entry at-sea sector is made up of a catcher-processor fleet and a mothership/catcher vessel fleet. A catcher-processor participates in both catching and processing; a mothership engages only in the processing of a particular catch, and relies on catch made by catcher vessels. Many of the catcher vessels that deliver to the west coast mothership sector may also fish as west coast shore-based trawl vessels outside the Pacific whiting season; other catcher vessels fish in west coast waters only during Pacific whiting fishery and return to North Pacific fisheries when the Pacific whiting season closes.

The catcher/processor sector is composed of vessels that harvest and process whiting (the fleet has typically been six to seven vessels since the formation of the Pacific Whiting Conservation Cooperative in 1997). The mothership sector is composed of a number of catcher vessels that harvest whiting for delivery to motherships. Typically three to five motherships operate in the fishery, with one mothership also servicing the tribal fleet; ach vessel is typically serviced by three to four catcher vessels. Motherships are vessels that process, but do not harvest, whiting.

According to PacFIN data, the at-sea sector annually catches over 100 million pounds of Pacific whiting, as well as several hundred thousand pounds of other types of west coast groundfish. Harvests of non-whiting groundfish are largely composed of harvests of yellowtail rockfish, widow rockfish and species within the Minor Rockfish North complex.

Depending on the OY, at-sea harvests by non-tribal motherships and catcher-processors have ranged since 1998 from 63,000 mt to the 128,000 mt; the latter harvest level was attained in 2005, worth $14 million. The amount of non-whiting groundfish harvested by this fleet is quite small, often in the range of less than half of one percent of total catch.

The catcher-processor fleet and mothership fleet in recent years have typically harvested a major portion of their allocations during May and June. After June, most of the vessels leave to fish off Alaska. The vessels then often return in late August or September to fish the remainder of their allocations. During the summer months, a few catcher-processors may remain to fish for whiting.

The majority of whiting harvested by the non-tribal at-sea fleet is processed into finished product and then transported at sea to foreign markets. As such, there are no key “at-sea” ports, other than Seattle and Anacortes where the corporate headquarters for these companies are located and where the hiring of crew and purchasing inputs most likely occurs.

5.2.5 Limited Entry Groundfish Fixed Gear Sector

Vessels deploying longlines and traps (pots) comprise the limited entry fixed gear sector. These gear types also may be used by vessels in the open access sector, but preferential harvest limits favor license holders. West coast limited entry fixed gear vessels typically use longline and fish pots (traps) for catching groundfish, particularly sablefish. Limited entry fixed gear fishers typically use shore-based vessels that range in size from 30 feet to 65 feet in length, with some vessels exceeding 100 feet, and some as small as 23 feet. Limited entry fixed gear vessels may also participate in open access fisheries or in the limited entry trawl fishery. Like the limited entry trawl fleet, limited entry fixed gear vessels deliver their catch to ports along the Washington, Oregon, and California coast.

The limited entry fixed gear sector has been plagued by overcapacity, although a series of management initiatives have largely addressed the problem. In the early to mid 1990s the fishery was a "derby" managed by very short seasons of two weeks or less. Two Groundfish FMP amendments have helped to alleviate the symptoms of overcapacity in the fixed gear sablefish fishery, effectively eliminating the short, derby season. Amendment 9 required a permit endorsement to participate in the primary sablefish fishery, and Amendment 14 introduced permit stacking. Permit stacking allows up to three sablefish-endorsed permits to be used per vessel. Through a tier system, landing limits vary with the number and type of permits held.

Fixed gear vessels primarily target high-value sablefish; this species accounts for a large share of landings, especially when measured by exvessel value. According to PacFIN data, the majority of limited entry fixed gear landings occur in Oregon and Washington. Oregon and Washington also have a higher price per pound for sablefish, while California has a higher price per pound for other types of groundfish. This is most likely representative of the higher amount of high valued live fish landings that occur in California.

Limited entry fixed gear vessels principally target sablefish, a species that tends to reside in relatively deep water. The limited entry fixed gear sector cannot fish within the boundaries of RCAs; however, the boundaries are somewhat different than those of the limited entry trawl sector. Fixed gear vessels are more prone than trawl vessels to catching some overfished rockfish species, such as yelloweye rockfish, and are therefore restricted from fishing on the continental shelf. Limited entry fixed gear vessels exert most of their effort during the late spring, summer, and early fall. The monthly distribution of effort has become more spread out over the year, and the number of vessels participating has declined after the tier system and permit stacking provisions were put in place in 1998 and 2001 respectively.

Table 5-14 shows the top 26 ports (of the 62 receiving landings) for limited entry fixed gear average landings and average exvessel revenue from 2004–06.

Table 5-14. Landings (mt), and ex-vessel revenue, 2004–06, in the largest ports for limited entry fixed gear

Port	Average Landings (mt)	Average Revenue
Washington		
Bellingham bay	1,008	$3,282,040
Everett	31	$204,377
Seattle	36	$243,740
Port Angeles	148	$679,654
Neah Bay	71	$414,655
La Push	80	$403,680
Westport	254	$1,277,418
Ilwaco	104	$580,561
Oregon		
Astoria	368	$1,949,421
Newport	818	$3,503,294
Florence	57	$253,140
Winchester	20	$126,987
Coos Bay	275	$1,599,317
Port Orford	241	$1,129,500
Brookings	28	$130,380
California		
Crescent City	183	$625,170
Eureka	213	$747,936
Fort Bragg	139	$576,200
San Francisco	131	$505,062
Princeton / Half Moon Bay	38	$125,891
Moss Landing	396	$1,170,974
Oxnard	117	$493,883
Newport Beach	88	$391,473
Dana Point	41	$235,636
Oceanside	113	$610,023
Other LA and Orange Cnty Ports	89	$520,145

5.2.6 Open Access Groundfish

The open access sector consists of vessels that do not hold a federal groundfish limited entry permit and target groundfish (called open access directed fisheries) or catch them incidentally (called open access incidental fisheries) using a variety of gears. Calling this the open access sector can be confusing because vessels in this sector may hold limited entry permits for other, nongroundfish fisheries issued by the Federal or state governments. However, groundfish catches by these vessels are regulated under the Groundfish FMP. For example, open access vessels must comply with cumulative trip limits established for the open access sector and are subject to the other operational restrictions imposed in the regulations, including general compliance with the RCA restrictions.

Participation in the directed open access fishery segment varies between years. Participants may move into other, more profitable fisheries, or they may take time off from fishing or quit fishing altogether. Fishers use various non-trawl gears to target particular groundfish species or species groups. Longline and hook and line gear are the most common open access gear types used by vessels directly targeting groundfish and are generally used to target sablefish, rockfish, and lingcod. Pot gear is used for targeting sablefish, thornyheads and rockfish. Though largely proscribed from use under current regulations, in the past off southern and central California, setnet gear was used to target rockfish, including chilipepper rockfish, widow rockfish, bocaccio, yellowtail rockfish, and olive rockfish, and to a lesser extent vermilion rockfish.

The directed open access fishery is further grouped into the "dead" and/or "live" fish fisheries. The terms dead and live fish fisheries refer to the state of the fish when it is landed. The dead fish fishery has historically been the most common way to land fish. However, more recently, the higher market value for live fish has resulted in increased landings in the live fish fishery. In 2001, 20 percent of fish landed (by weight, coastwide) by directed open access fishers was landed live as compared to only 6 percent in 1996 (PFMC 2004b).

In the live-fish fishery, groundfish are primarily caught with hook-and-line gear (rod-and-reel), limited entry longline gear, and a variety of other hook gears (e.g. stick gear). The fish are kept alive in a seawater tank on board the vessel. California halibut and rockfish taken in gill and trammel nets have increasingly appeared in the live fish fishery (CDFG 2001). Live fish are sold at a premium price to food fish markets and restaurants, primarily in Asian communities in California. Coastwide average price for live product was nearly 4 dollars per pound, compared to less than 1 dollar for other deliveries of the same species. Groundfish delivered live were primarily nearshore rockfish and perch, but also included thornyheads, sablefish and lingcod. About 86 percent of live fish landings were in California with the remainder in Oregon (PFMC 2004a). There were no recorded live fish landings in Washington. Although there is little information about the distribution of effort by open access vessels, nearshore species comprise most of the live fish landings, so it is likely that effort located near shore accounts for most live fish landings.

In California, hook and line gear for the live fish fishery has been limited since 1995 to a maximum of 150 hooks per vessel and 15 hooks per line within one mile of the mainland shore (CDFG 2001). Traps are limited to 50 per fisherman. In Washington, it is illegal to possess live bottom fish taken under a commercial fishing license. In Oregon, nearshore rockfish and species such as cabezon and greenling are the primary target of the live fish fishery. Sablefish and rockfish are also landed live in Oregon and are managed under limits that count against the federally established limited entry allocations. The Oregon live fish fishery occurs in waters of 10 fm (18 meters) or less. Only legal gears are allowed to be used to catch nearshore live fish. In early 2002, an Oregon Development Fisheries Permit was required for fishermen landing live fish species such as. cabezon, greenling (except kelp greenling), brown, gopher, copper, black and yellow, kelp, vermilion, and grass rockfish (among others), buffalo sculpin, Irish lords, and many surfperch species. Commercial fishing for food fish is also prohibited in Oregon bays and estuaries and within 600 feet (183 meters) seaward of any jetty.

Many fishers catch groundfish incidentally when targeting other species due to the kind of gear they use and the co-occurrence of target and groundfish species in a given area. Managers classify vessels as within the open access incidental fishery if groundfish comprises 50 percent or less of their landings, measured by dollar value. These incidental open access fisheries may also at times account for a significant amount of bycatch, especially for overfished groundfish species. Fisheries targeting pink shrimp, spot prawn, ridgeback prawn, California and Pacific halibut, Dungeness crab, salmon, sea cucumber, coastal pelagic species, California sheephead (California nearshore fishery), highly migratory species, and the mix of species caught in net fisheries comprise this incidental segment of the open access sector.

Given that vessels within the open access incidental fishery do not necessarily depend on revenue from the groundfish fishery as a major source of income, understanding the level of dependency that such participants have on the groundfish fishery must be considered in light of their overall fisheries revenues. Between November 2000 and October 2001, 1,287 vessels landed groundfish in the open access sector of the groundfish fishery. Of these vessels, 771 vessels (60 percent) had a greater than 5 percent dependency on the groundfish fishery with 345 of these vessels having a 95-100 percent level of dependency of groundfish. The open access fishery is dominated by vessels under 40 feet in length. About 78 percent of the vessels that landed open access groundfish between November 2000 and October 2001 were less than 40 feet on length. About one-third (36 percent) of the open access vessels had a greater than 65 percent dependency on groundfish, with just over half (56 percent) of the most dependent vessels having less than $5,000 in total exvessel revenue. A greater proportion of vessels with lower levels of dependency on groundfish had greater than $5,000 total exvessel revenue.

Though fishery managers divide the open access sector into directed and incidental categories, as discussed above, it should be noted that such segregation is difficult to do because the choice depends on the intention of the fisher. Over the course of a year or during a single trip, a fisher may engage in different strategies and they may switch between directed and incidental fishing categories. Such changes in strategy are likely the result of a variety of factors, including the potential economic return from landing a particular mix of species.

Rockfish, thornyheads, and sablefish account for most of the open access landings and revenue and hook and line is the major gear type used for open access landings. Fixed gear are used to catch most open access groundfish, although non-shrimp trawl gear and net gear also make substantial landings. Open access landings in the state of California have a large live fish component, which is made evident by the relatively high unit value of rockfish in that state compared to the unit value of rockfish landed in Oregon and Washington.

There is limited information on the distribution of effort by open access vessels. The open access sector is made up of many different gear types involved in directed and incidental catch, which makes it difficult to discern the location of effort. However based on the diversity of this sector, it is reasonable to assume that effort is widespread across the west coast.

Open access landings and revenue tend to occur primarily during the spring, summer, and fall months. Assuming that landed catch represents directed open access, and that landed catch is a function of effort, then more open access related fishing activity occurs during the spring, summer, and fall months than during winter months.

Table 5-15 shows that the top open access ports for average landings from 2004 to 2006 were Fort Bragg, Moss Landing and Port Orford, and the top ports for average revenue were Fort Bragg, Morro Bay, and Port Orford.

Table 5-15. Top ports for open access groundfish average landings (mt) and revenue, 2004-2006

Port	Average Landings (mt)	Avgerage Revenue
Washington		
Port Angeles	7.05	$35,769
La push	9.30	$47,964
Westport	12.27	$64,379
Ilwaco/Chinook	20.31	$116,062
Oregon		
Astoria	14.47	$78,956
Tillamook/Garibaldi	17.07	$49,225
Newport	9.64	$36,001
Coos Bay	30.52	$108,475
Port Orford	93.34	$389,834
Gold Beach	39.67	$220,205
Brookings	19.54	$74,165
California		
Crescent City	57.89	$240,730
Eureka	34.06	$105,817
Fort bragg	127.80	$455,726
Point Arena	5.25	$52,705
Bodega Bay	10.48	$59,459
Princeton / Half Moon Bay	7.42	$40,578
Moss Landing	100.94	$239,822
Monterey	13.60	$93,728
Morro Bay	54.36	$452,891
Avila	28.21	$299,500
Oxnard	11.00	$49,478
Other San Diego County Ports	10.15	$66,650
Unknown California	32.36	$260,740

5.2.7 Tribal Fisheries

West coast treaty tribes in Washington have formal groundfish allocations for sablefish, black rockfish, and Pacific whiting. Members of four coastal treaty tribes participate in commercial, ceremonial, and subsistence fisheries off the Washington coast. Participants in the tribal commercial fisheries use similar gear to non-tribal fishers. Fish caught in the tribal commercial fishery are distributed through the same markets as non-tribal commercial catch.

Tribal treaty fisheries are place-oriented—limited to the adjudicated usual and accustomed (U&A) areas. This results in fisheries that cannot move to a new location if the resources or habitat are depleted. In addition, the Tribes and their fishermen have a view of ownership of their fishing grounds rooted in centuries of use and control of these grounds. This sense of ownership influences fishing practices and these practices are used by the tribes to develop tribal rules and regulations to stay within the harvest limits established by the Council for overfished and abundant stocks. Tribal fisheries take several species for which they have no formal allocations, and some species for which no specific allocation has been determined. Rather than try to reserve specific allocations of these species, the tribes biennially recommend trip limits for some species to the Council, which in turn tries to accommodate these fisheries.

Groundfish fishing by the tribes occurs primarily with hook and line and trawl gear. All tribes participating in groundfish fisheries have longline vessels in their fleets, but only the Makah tribe has trawlers, and only the Makah tribe has participated in the Pacific whiting fishery. The Makah tribe also has the majority of longline vessels, followed by Quinault, Quileute, and Hoh tribes. Since 1996, a portion of the U.S. Pacific whiting OY has been allocated to the west coast treaty tribes. The tribal allocation is subtracted from the whiting OY before allocation to the non-tribal sectors. Since 1999, the tribal allocation has been based on a sliding scale related to the U.S. whiting OY. To date, only the Makah tribe has fished on the tribal whiting allocation. Makah vessels fish with mid-water trawl gear have also been targeting yellowtail rockfish in recent years.

In the Makah bottom trawl fishery, the Tribe adopted small footrope restrictions as a means to reduce rockfish bycatch and avoid areas where higher incidences of rockfish occur. In addition, the bottom trawl fishery is limited by overall footrope length as a means to conduct a more controlled fishery. Harvest is restricted by time and area to focus on harvestable species while avoiding bycatch of other species. If bycatch of rockfish is above a set amount, the fishery is modified to stay within the bycatch limit. The midwater trawl fishery has similar control measures. A trawl area must first be tested to determine the incidence of overfished rockfish species prior to opening the area to harvest. Vessels are provided guidelines for fishing techniques and operation of their net. Fishing effort is closely monitored by the on-board observer and harvest manager and changes or restrictions are implemented as needed to stay within the bycatch limits. In developing these trawl fisheries, the Makah management practices include testing of gear, area, vessels, and catch composition before the fishery can proceed from one level to the next. In addition, a new or developing fishery must show that it can be conducted in a manner that protects existing fisheries.

The majority of tribal groundfish landings occur during the March and April Pacific halibut and sablefish fisheries. Most continental shelf species taken in the tribal groundfish fisheries are taken during the halibut fisheries, and most slope species are similarly taken during the tribal sablefish fisheries. Approximately one-third of the tribal sablefish allocation is taken during an open competition fishery, in which vessels from the four tribes on the Washington coast have access to this portion of the overall tribal sablefish allocation. The open competition portion of the allocation tends to be taken during the same period as the major tribal commercial halibut fisheries in March and April. The remaining two-thirds of the tribal sablefish allocation are split between the tribes according to a mutually agreed-upon allocation scheme. Specific sablefish allocations are managed by the individual tribes. The fishery begins in March and continues into the autumn, depending on the number of vessels participating in the fishery. Participants in the halibut and sablefish fisheries tend to use hook and line gear, as required by the IPHC. For equity reasons, the tribes have agreed to also use snap-line gear in the fully competitive sablefish fishery.

Major ports for vessels engaged in tribal groundfish fisheries are Westport, Neah Bay, and La Push.

5.2.8 Recreational Fisheries

Demand for recreational trips and estimates of the economic impacts resulting from recreational fishing are related to numbers of anglers. In the U.S., over nine million anglers took part in 76 million marine recreational fishing trips in 2000. The west coast accounted for about 22 percent of these participants and 12 percent of trips. Seventy percent of west coast trips were made off California, 19 percent off Washington, and 11 percent from Oregon (Gentner 2001).

The distribution of resident and non-resident ocean anglers among the west coast states in 2000, 2001, and 2002 demonstrates the importance of recreational fishing, especially in Southern California.

Southern California has more than twice the number of resident recreational marine anglers than the next most numerous region, Washington state. While most of the recreational anglers were residents of those states where they fished, a significant number were also non-residents. Oregon had the largest share of non-resident ocean anglers in those three years.

5.3 Buyers, Processors, and Seafood Markets

5.3.1 Processors and Buyers

Excluding Pacific whiting delivered to at-sea processors, vessels participating in groundfish fisheries deliver to shore-based processors within Washington, Oregon, and California. Buyers are located along the entire coast; however, processing capacity has been consolidating in recent years. Several companies have left the west coast or have chosen to quit the business entirely. Remaining companies have purchased some former plants (Radtke and Davis 2004), but other plants have remained inactive. This has led to trucking groundfish from certain ports to other communities for processing. Therefore, landings do not necessarily indicate processing activity in those communities. However, examination of the species composition of landed catch by state can lead to inferences of some processor characteristics.

According to PacFIN data, in 2002 Oregon had the largest amount of groundfish landings (56 percent), followed by Washington (28 percent), and California (16 percent). Oregon also had the largest amount of exvessel revenue (40 percent), followed by California (32 percent) and Washington (22 percent), respectively. Oregon accounts for the majority of Pacific whiting landings, which creates a large difference between the share of landed catch and exvessel revenue because Pacific whiting has a relatively low price per pound. The relatively large amount of Pacific whiting being landed in Oregon may indicate a case in which processors must maintain capacity to handle large quantities at a time. Some groundfish processors in Washington may receive landings from Alaska fisheries. Depending on the amount of catch drawn from Alaska fisheries, some Washington groundfish processors may also require the capacity to process large amounts of product. California processors concentrating on non-whiting west coast fisheries may focus on relatively smaller throughput of groundfish.

The seafood distribution chain begins with deliveries by the harvesters (exvessel landings) to the shoreside networks of buyers and processors, and includes the linkage between buyers and processors and seafood markets. In addition to shoreside activities, processing of certain species (such as Pacific whiting) also occurs offshore on factory ships.

According to data from the Bureau of Labor Statistics, the number of seafood processing establishments along the west coast has declined in recent years. Examination of PacFIN data shows that the number of agents (buyers) buying groundfish along the west coast has also generally declined in recent years. When buyers are classified on a groundfish gear basis—e.g., how many buyers purchased sablefish from fixed gear-sablefish fishermen—evidence of decline is strong (Table 5-16, Figures 5–7a and 5–7b). Because of the multi-species involvement of most buyers, it is hard to develop unique counts of buyers by either of these two methods on a state basis. However, the total number of buyers from all fisheries can be uniquely determined. In California, the number of unique buyers in 2005 is estimated to be 465, a decrease of 21 percent from 2004. The number of Oregon buyers fell by 10 percent and the number of Washington buyers fell by 8 percent over the same time period.

In terms of quantity, the processing of west coast groundfish is dominated by a small number of companies. For this section, an estimate of unique groundfish companies was derived by grouping PacFIN information on groundfish buyers. Buyers with like names were assumed to be individual companies. For example, a hypothetical buyer with the name ZZZ seafood – Astoria was assumed to belong to the same company as a buyer with the name ZZZ seafood – Ilwaco. Using this approach, the results show that the three largest companies bought approximately 78 percent of commercially caught groundfish landed on the west coast in the years 2004 and 2005 (Table 5–17 and Figure–8). When a similar analysis is done based on exvessel revenues, the top three companies purchase about 56 percent of the groundfish sold. (For more accurate estimates, analysts would need to compile lists of affiliated companies and then map them to the PacFIN buyer codes. In addition, estimates of fish purchased by non-affiliated buyers and sold to a company for processing would also need to be developed.)

Of the top 10 seafood suppliers in the United States, according to Seafood Business (Hedlund 2006), three participate in Pacific groundfish fisheries. Their corporate strategies affect the Pacific groundfish fishery. Employment and location of facilities vary as companies pursue profits, market share, and efficiencies. For example, the build-up of Arctic Alaska Company has indirectly reshaped the Pacific groundfish fishery. It is an Alaska-based company that built a surimi plant and fish meal plant in Newport, Oregon, and brought down catcher-processors from Alaska to fish whiting. The company was eventually sold to Tyson's, a major poultry company that wanted to add seafood to its product line. Tyson's then sold its fishing business assets—including the shoreside surimi and fish meal plants, and several catcher-processors—to companies like Trident, which before the purchase had little involvement in Pacific groundfish.

Seafood Business describes Pacific Seafood Group (a shore-based company), Trident Seafoods Corporation (shore-based and at-sea), and American Seafoods Group (at-sea) as follows:

> Pacific Seafood Group #1 Sales-$874 million—Key Species: Dungeness crab, halibut, king crab, Pollock, salmon, shrimp. "With 2005 sales of $874 million, Pacific Seafood Group slid into the No. 1 spot on the Seafood Business Top 25 list for the first time this year. After an active 2003 and 2004, Pacific wasn't involved in any acquisitions or mergers last year or early this year. Instead the company grew organically, picking up new customers and increasing sales by approximately $174 million from 2004 to 2005. In 2004, Pacific acquired Seacliff Seafoods, a distributor with facilities in Houston, San Antonio and Wilmington, California. In 2003, the company purchased Starfish, a Bellevue Washington seafood processor and distributor and Craig & Hamiliton, a Stockton, California value-added meat processor. Now Pacific operates 15 processing facilities along the west coast and 10 distribution facilities in Washington, Oregon, California, Idaho, Montana, Nevada and Utah."
>
> Trident Seafood Corporations #3-Sales-$800 million—Key Species: cod, halibut, whiting, Pollock, king crab, salmon, snow crab. "Trident Seafoods Corp. has been busy growing over the past two months. In March, the company acquired Louis Kemp Seafood, which markets the No. 1 retail surimi-seafood brand, from Con-Agra Foods one of the nation's largest public conglomerates….Then, in April, Trident purchased Ocean Beauty Seafoods' seven Alaska processing facilities and merged its distribution and smoked-fish business with its Seattle rival. The acquisition of Louis Kemp and the deal with Ocean Beauty will surely push Trident's 2006 sales over the $1 billion mark. Trident's prior major acquisition occurred in 2004 when it bought Norquest Seafoods of Seattle and its Portlock and Silver Lining brands. Trident operates 25 fishing vessels and at-sea processors and 18 processing plants throughout Alaska, British Columbia, Washington and Oregon." (Note—In early May 2006 the proposed purchase of Ocean Beauty Seafoods was called off.)
>
> American Seafoods Group #10-Sales $514 million. Key species: catfish, cod, hake, Pollock, scallops, yellowfin sole. "In February, Centre Partners Management sold its

remaining 23 percent equity interest in American Seafoods Group to Coastal Villages Region Fund and a management group led by Chairman Berndt Bodal, increasing their ownership to 45 percent and 51 percent respectively of the company's voting equity. The buyers dished out nearly $82 million for the balance of Centre Partners' stake. Centre Partners is the New York investment Group that formed American Seafoods Group with Bodal in 2000, acquiring American Seafoods Co. and Frionor USA's New Bedford, Mass., processing facility from Norway Seafoods. The purchase came two years after the adoption of the American Fisheries Act, which forced many foreign owned fishing fleets out of U.S. waters. American Seafoods expanded in 2002 when it bought Southern Pride Catfish of Greensboro, Ala. Two years later, the company ditched a year and-a-half-long bid for an initial public offering.

Table 5-16. Number of dealers by fishing sector and state, 1986-2005

Fishery	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
California																				
Non-Whiting Groundfish Trawl	96	67	63	76	75	86	86	78	85	75	67	62	78	87	51	63	65	55	43	37
Fixed Gear – Hook & Line and Pot	229	300	306	328	347	340	382	323	335	284	291	320	303	294	286	259	216	200	200	156
Fixed Gear - Sablefish	34	28	33	48	40	44	66	48	40	52	51	62	43	60	60	53	56	60	48	34
Whiting Trawl	2	4	3	5	5	3	3	3	4	3	3	4	4	3	4	4	1	2	2	2
TOTAL (all fisheries)	**507**	**758**	**703**	**725**	**720**	**709**	**687**	**661**	**688**	**588**	**596**	**646**	**693**	**673**	**660**	**616**	**627**	**608**	**592**	**465**
Oregon																				
Non-Whiting Groundfish Trawl	21	31	25	22	24	26	29	28	29	27	25	22	21	22	18	18	16	13	12	13
Fixed Gear – Hook & Line and Pot	50	51	50	62	65	63	65	54	58	50	57	56	54	47	54	47	43	36	42	45
Fixed Gear - Sablefish	26	23	17	23	20	24	28	24	31	34	36	27	22	28	31	29	29	39	36	30
Whiting Trawl	6	3	5	1	4	8	6	7	8	9	7	10	7	8	8	7	7	8	5	5
TOTAL (all fisheries)	**154**	**159**	**152**	**208**	**192**	**170**	**153**	**166**	**161**	**147**	**156**	**159**	**204**	**180**	**179**	**222**	**233**	**246**	**195**	**177**
Washington																				
Non-Whiting Groundfish Trawl	41	29	35	28	28	27	29	25	20	14	16	15	12	8	12	15	9	8	6	7
Fixed Gear – Hook & Line and Pot	60	67	61	58	55	46	47	48	45	32	26	27	22	17	19	13	7	7	8	10
Fixed Gear - Sablefish	34	23	35	28	27	20	37	29	33	23	32	24	22	24	22	20	18	24	21	19
Whiting Trawl	5	6	5	5	3	6	5	6	4	4	6	5	4	4	2	3	2	2	3	2
TOTAL (all fisheries)	**354**	**358**	**363**	**356**	**347**	**367**	**340**	**367**	**273**	**261**	**237**	**236**	**245**	**210**	**229**	**233**	**258**	**277**	**242**	**223**

Table 5-17. Rank of processing companies by volume of groundfish purchased on the West Coast in 2004 and 2005

Company Rank	Percent of Groundfish Landings	Weight of Groundfish Landings (mt)
Top 3 Companies	77.8%	178,222
4-6th Largest Companies	11.7%	26,922
7-9th Largest Companies	5.6%	12,919
10-12th Largest Companies	2.2%	5,119
13-15th Largest Companies	1.3%	2,960
16-18th Largest Companies	0.4%	854

Source: PacFIN ftl and ft tables. December 2005.

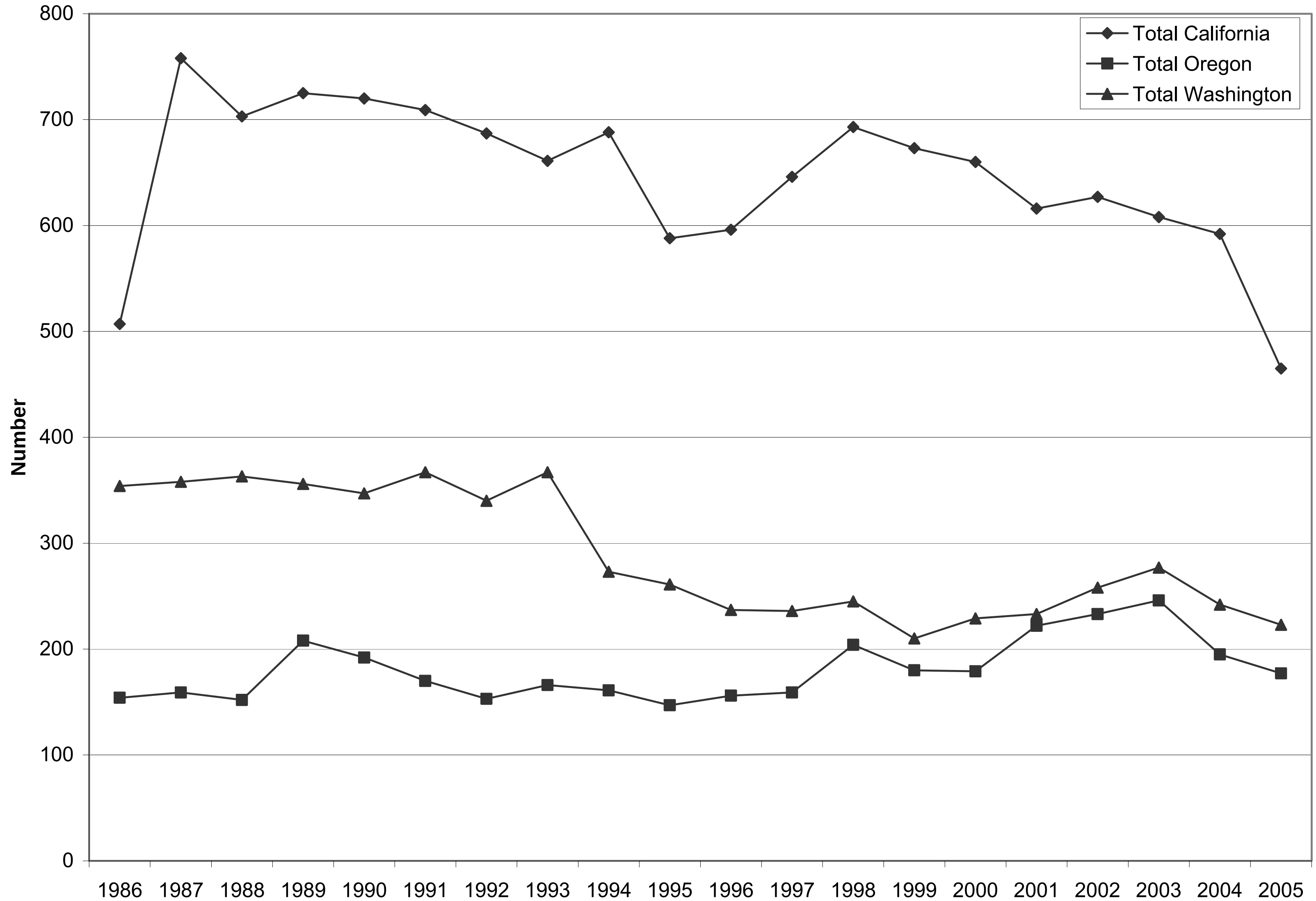


Figure 5-7a. Total number of dealers by state, 1986–2005

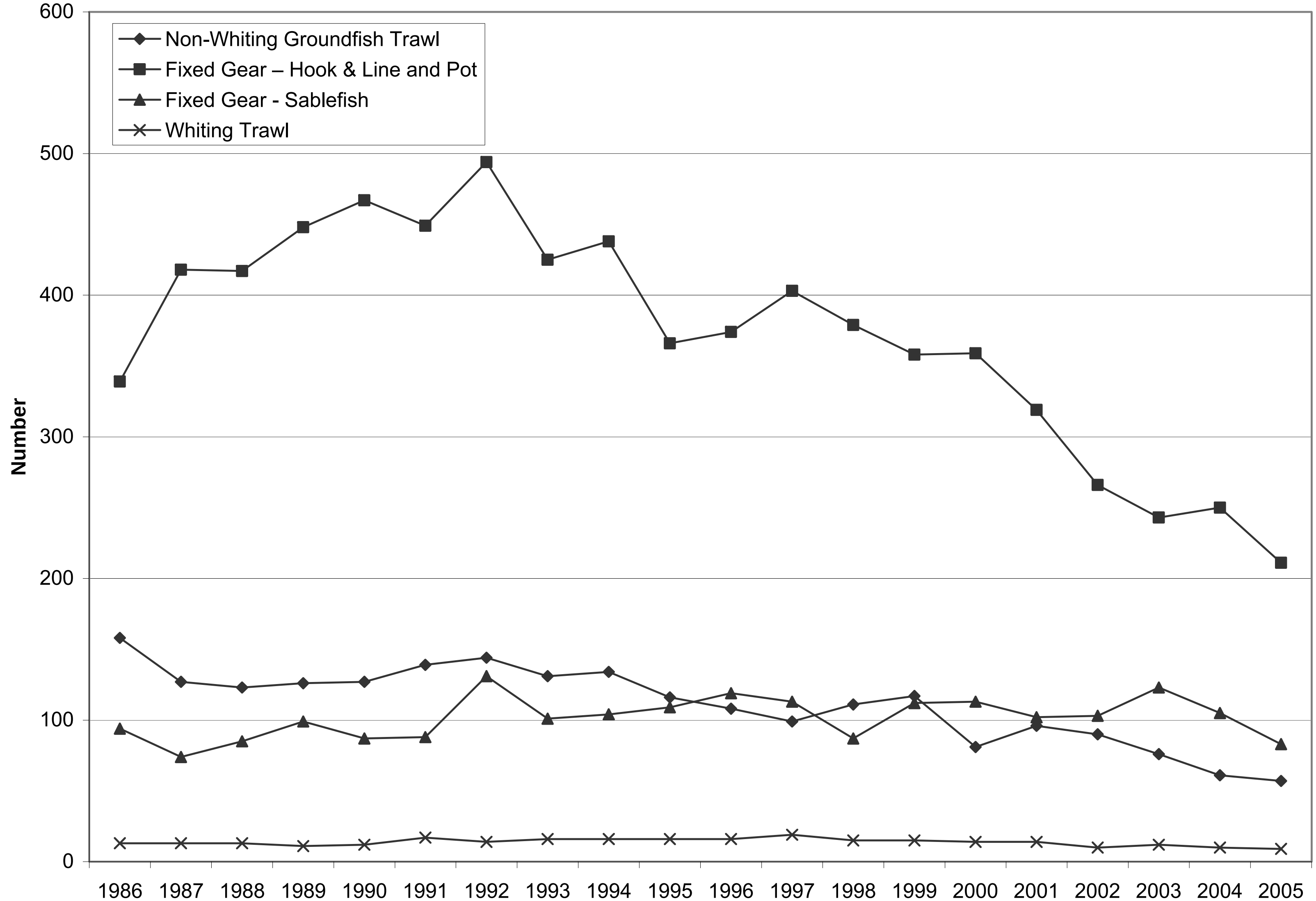


Figure 5–7b. Total number of dealers by sector, 1986–2005

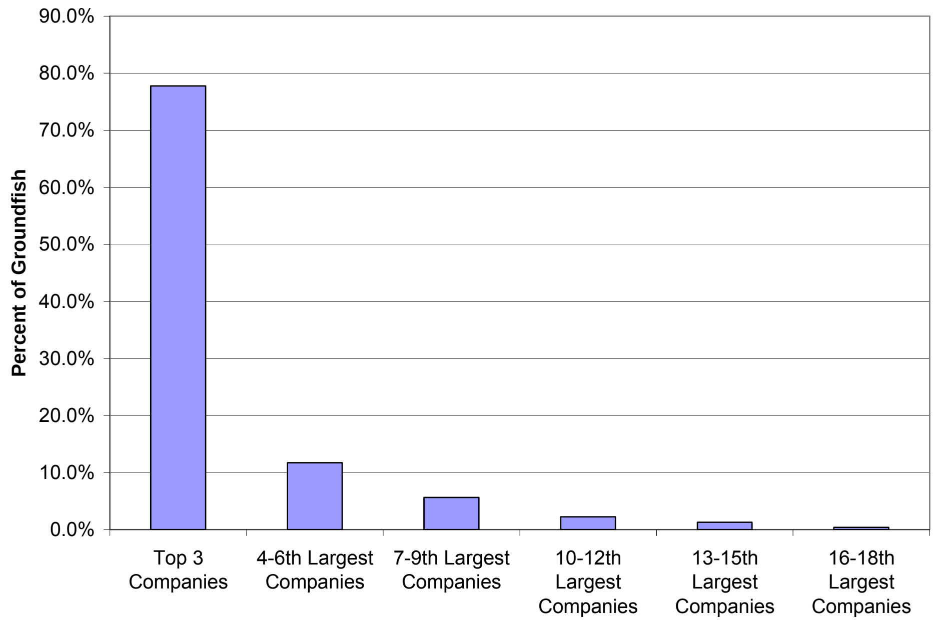


Figure 5-8. Rank of processing companies by volume of groundfish purchased on the west coast in 2004 and 2005
Source: PacFIN ftl and ft tables. December 2005.

5.3.2 Processing Labor, Processing Capital, and the Groundfish Fishery

Employment and wage information from the Bureau of Labor Statistics shows that seafood processing along the west coast generates approximately 380 to 420 million dollars in the form of wages annually to seafood product preparation and packaging employees, and in most years this sector employs over 10,000 workers (Table 5–18). Washington state represents the largest proportion of processing wages and employees, followed by California and Oregon. Washington benefits from the large degree of participation in Alaska-based fisheries, which make up a substantial portion of nationwide catch, while processing in Oregon and California is dominated by catch occurring in west coast fisheries.

The 35 to 44 age group is the predominant workforce in the seafood processing industry in all three states, representing 30 to 35 percent of workers employed (PFMC 2006b, Appendix A). The next largest group is the 45 to 54 age group. The gender distribution of employees in the seafood processing industry differs across states. California is the most evenly distributed with some counties where female employees outnumber males. In Oregon and Washington, male workers are the majority with approximately 60 percent and 70 percent respectively.

Processing labor can be generally divided into two types: specialized labor and unspecialized labor. Unspecialized labor is characterized as workers that can easily transition their skills to other industries and employers. For example, a forklift driver could be characterized as an employee within the unspecialized labor category. That worker can easily transition between a seafood processing employer and another employer that may be involved in warehousing office supplies for example. Specialized workers are those workers that have a particular skill set which is not easily converted to other industries. Workers in this category include those that fillet fish. Filleting is a skill that is specific to the seafood industry.

Workers within the unspecialized category are typically in higher supply and are relatively easy to hire if there happens to be a shortage of workers in that category. These workers require less training than specialized workers and new laborers in the unspecialized category are unlikely to negatively impact productivity for any given amount of time. Specialized workers, on the other hand, are relatively short in supply, and if there is a shortage of workers in this category, newly hired specialized labor is likely to require training and will have relatively low productivity in the early stages of their career. In the seafood processing industry, many laborers are transient and their employment is often temporary in nature due to the cyclical nature of fisheries. However, processors are more likely to try to retain specialized laborers on a year round basis as re-hiring and re-training new workers in the specialized category will reduce productivity. This makes the groundfish fishery one of the most important fisheries for many seafood processors.

According to the objectives of the Groundfish FMP, the Council attempts to manage the groundfish fishery on a year-round basis, which is important to those processors that try to keep specialized labor employed year round. A year round fishery keeps product volume flowing through the plants, gives the fish filleters product to process, and ultimately keeps specialized laborers employed. Without a year-round fishery, these laborers often find work elsewhere and this negatively affects processing revenue and product quality. Other fisheries are typically not managed on a year round basis because of several reasons including availability (salmon and albacore for example) and seasonal quality of the harvested species (Dungeness crab for example). Groundfish, however, can be available to fishers and marketable by processors all year.

Table 5-18. Seafood processing employment and wage information by state and year (information from private entities)

	Year	Washington	Oregon	California	Sum
Number of employees in seafood product preparation and packaging	2001	7,043	1,093	3,030	11,166
	2002	6,359	1,002	2,530	9,891
	2003	6,391	1,020	2,738	10,149
	2004	6,432	995	2,605	10,032
Number of seafood product preparation and packaging establishments	2001	147	30	69	246
	2002	128	25	62	215
	2003	117	24	65	206
	2004	109	24	65	198
Total wages from seafood product preparation and packaging	2001	$293,322,000	$21,478,000	$66,624,000	$381,424,000
	2002	$293,013,000	$21,178,000	$65,529,000	$379,720,000
	2003	$300,751,000	$21,115,000	$78,654,000	$400,520,000
	2004	$308,261,000	$21,507,000	$87,722,000	$417,490,000
Average weekly wage from seafood product preparation and packaging	2001	$801	$378	$423	
	2002	$886	$406	$498	
	2003	$905	$398	$552	
	2004	$922	$416	$648	
Average annual wage from seafood product preparation and packaging	2001	$41,648	$19,653	$21,989	
	2002	$46,080	$21,127	$25,898	
	2003	$47,058	$20,709	$28,728	
	2004	$47,924	$21,617	$33,673	

Source: Bureau of Labor Statistics. December 2005. Quarterly Census of Employment and Wages. Personal Communication. http://www.bls.gov/data/

5.3.3 Processing Capital

Unlike many forms of processing labor, the capital involved in fish processing is not easily substitutable for use in other industries. Capital tends to be fixed in its location and designed to handle fish products as opposed to some other type of food product. A processing facility is constructed to handle seafood and produce fillets, surimi, headed and gutted fish, or some combination of products. The size of these facilities is typically constructed around some expectation of what quantities of commercial fisheries landings are expected in the future.

Many fisheries are characterized by swings in available product due to seasonality and year to year fluctuations in species abundance. This means that during the off-season, or years when there are declines in species abundance, processor capital is idle. Groundfish (excluding Pacific whiting) was historically one of the more stable fisheries on the west coast and is a fishery that is prosecuted on a year round basis. This sense of stability, combined with an expectation of year round landings, historically gave managers of processing plants some increased degree of certainty when planning for the future and investing in capital in an otherwise highly variable and uncertain industry. The recent decline in landings of traditional groundfish species has eliminated much of that certainty and meant that increasing amounts of processing capital have been left idle. Idle capital increases the cost of producing a unit of output, so some plants reliant on groundfish have closed down and consolidation has occurred within portions of the processing industry (Radtke and Davis 2004). This is verified by the decrease in number of processing establishments over the past several years as reported by the Bureau of Labor Statistics.

5.3.4 Markets and Prices

West coast groundfish compete in a global market, not only with similar species produced in other regions of the world, but also with other fish species such as salmon and tuna. In addition, fish compete with other sources of protein in consumers' budgets. More than 4.3 million mt of fish and other seafood were landed in the U.S. in 2006, close to the amount landed in 2005, which was 4.4 million mt (DOC 2007). In comparison, total west coast groundfish landings in 2005 (see Table 5–5c) were slightly less than 243,000 mt. Pacific whiting typically comprises about two-thirds of west coast groundfish landings by weight, but only around 10 percent of groundfish exvessel revenue.

Production of farm-raised fish has increased rapidly in recent years. In 2001, almost 358,000 mt of cultured fishery products were produced in the U.S. Worldwide, more than 48 million mt were raised in 2005. Salmon aquaculture demonstrates the emerging importance of farmed species. While commercial salmon harvest is still near the 1980 to 1997 annual average, world salmon supply has tripled since 1980 due to a nine-fold increase in farmed salmon to almost 2 million mt in 2005 (DOC 2007).

An objective of groundfish management has been to spread harvest of the annual OY over as much of the year as possible. Consequently, groundfish harvesting occurs in every month, although beginning in the late 1990s, it took on increased importance during the summer months when sablefish harvest peaked during the primary limited entry fixed gear fishery. The bulk of whiting fishery also occurs during the summer.

Groundfish fishing has historically provided west coast commercial fisheries participants with a relatively steady source of income over the year, supplementing the other more seasonal fisheries. Though groundfish contributed only about 17 percent of total annual exvessel revenue in 2000, seasonal groundfish played a more significant role, providing one-fifth to one-third of monthly exvessel revenue coastwide during April and the three summer months. The peak value contribution by the groundfish fishery in 2000 was sablefish during August (20 percent of exvessel revenue). Flatfish harvest supplied between 3 percent and 9 percent of monthly exvessel revenue throughout the year, and rockfish contributed an additional 2.5 percent to 6.8 percent to monthly exvessel revenue. For northern parts of the coast, groundfish is particularly important just before the start of the December crab fishery.

While producer prices for groundfish products have not fared quite as badly as that for other frozen fish (including salmon), they still are significantly below recent highs. The trend may be flat or still lower in the future (Appendix A Table7-9 in PFMC 2004b). Increasing production of farmed salmon is partly responsible for a continuing slump in salmon commodity prices. Producer prices for meat products in general have been relatively weak, thereby helping to hold down prices for competitive fish protein. Preliminary 2003 estimates of producer price indices for fish and meat products were higher than seen in recent years, possibly due to the continuing improvement in the world economic outlook.

Most west coast groundfish compete in the fresh and frozen fish product markets. In 2006 the U.S. imported about 2.4 million mt of edible fishery products, including 2.1 million mt of edible fresh and frozen fish products (DOC 2007) and exported about 1.3 million mt of edible fishery products, including 1.2 million mt of edible, fresh or frozen products. The largest destination for exported fish products in 2006 was Japan at 19 percent. While surimi was the single largest component of total fresh and frozen exports by weight in 2006, scallops groundfish, and salmon were the most valuable exports, at 371 million dollars, 369 million dollars, and 367 million dollars respectively (DOC 2007) Asia was the largest export region, absorbing 52 percent of U.S. fishery exports by volume. Next to Japan, China and Canada were the largest export destinations at 15 percent and 10 percent respectively. Table 5–19 shows export and import quantities and values for 2000–06 derived from the FAO FishStat database.

Table 5–19. U.S. trade in fishery products, amount (mt) and value, 2000–05

	2000	2001	2002	2003	2004	2005
Export Quantity	967,816	1,158,311	1,083,348	1,079,595	1,256,174	1,321,791
Export Value	$2,955,877	$3,206,706	$3,134,511	$3,283,009	$3,512,829	$4,089,337
Import Quantity	1,697,364	1,756,299	1,893,751	2,085,178	2,120,886	2,196,814
Import Value	$10,410,598	$10,242,669	$10,005,167	$11,588,121	$11,882,828	$11,896,774

Source: FAO FishStat database.

From 1910 through the early 1970s, annual per capita fish consumption in the U.S. generally ran between 10 pounds and 12 pounds edible weight. Beginning in the early 1970s, per capita consumption increased, and in the mid 1980s began shifting upward again to the 15-pound to 16-pound range where it has generally remained since 1985. In 2006, annual per capita U.S. fish consumption was estimated to be 16.5 pounds. U.S. seafood consumption reached a record 16.6 pounds per capita in 2004.

5.4 Fishing Communities

5.4.1 Information Sources

Table 5-1 at the beginning of this chapter lists Council documents that are sources of community, social and economic information. For information on the relationship of bycatch species to fisheries sector, port and community, the reader is directed to the study, "Economic Revenue and Distributional Impacts Associated with Overfished Species Management in west coast Commercial Groundfish Fisheries" (PFMC 2006b Appendix A). For additional information about fishing communities see section 8.1.6 of the 2005-2006 EIS and Chapter 8 in Appendix A of that document. For a much more expansive discussion of fishing communities, the reader is referred to the NMFS Northwest Fisheries Science Center website, which contains detailed descriptions of west coast fishing communities: http://www.nwfsc.noaa.gov/research/divisions/sd
/communityprofiles/index.cfm.

In addition to these data, PacFIN data tables developed by NMFS SWFSC describe, by port and groundfish sector, the number of dealers, vessels, revenues, landings, and vessel trips (PFMC 2006b Appendix A Section A.3). Additionally, that EIS provides the most current information, evaluation and discussion regarding the vulnerability and resilience of west coast fishing communities.

Table 5–20a and 5–20b list port groups, counties, and ports; by state these entities are typically used when presenting groundfish fishery related socioeconomic data. Figures 5–9a and 5–9b and 5-10 are maps of coastal counties and port groups, respectively.

5.4.2 Updated Demographic Data for West Coast Counties

The tables in this section compare selected demographic characteristics in 2000 and 2006 for counties on the west coast. (Figures 5–9a and 5–9b show the selected counties.) The purpose of this comparison is to aid in interpreting past analyses of coastal community characteristics found in previous EISs evaluating groundfish actions. The 2005–06 groundfish harvest specification and management measures EIS (PFMC 2004b, Appendix A) used 2000 census data to identify low income and minority communities in order to comply with the environmental justice mandate of EO 12898. This analysis also provided supporting data for an evaluation of community engagement, dependence, resilience and the identification of potentially vulnerable communities, which was prepared to support the 2007-08 groundfish harvest specifications EIS and related amendments to overfished species rebuilding plans (PFMC 2006b, Appendix A).

The 2000 data are from the U.S. Census Bureau's decennial census Summary File 1 100 percent count data. The 2006 data are from the U.S. Census Bureau's Population Estimates Program, which estimates many of the population characteristics enumerated in the decennial census, allowing comparison and publishes population numbers between censuses. The 2006 population estimates start with a base population for April 1, 2000, and calculate population estimates for July 1 for years 2000 to 2006. These data were obtained from the Census Bureau's American FactFinder web site (http://factfinder.census.gov/home/saff/main.html?_lang=en). The source census tables are listed below tables in this section.

Tables 5–21, 5–22, and 5–23 present comparisons of the non-white,[7] Hispanic, and Native American population. Each table presents a computation of the percent change in the subject population characteristic, expressing the number of people in the category in 2006 divided by the number in 2000 multiplied by 100. In general, the number of people in the population identified as non-white, Hispanic, or Native American has increased along with an increase in the overall population (this is what the percent change value reflects). In many counties the proportion of the population in these categories has also increased (compare the percent in 2000 with the percent in 2006).

Table 5–24 compares the dependency ratio between the two years. The dependency ratio is computed as the sum of the population less than 15 years of age and older than 65 divided by the population between the ages of 15 and 64 years old. It is a measure of the economically dependent portion of the population. In addition to percent change in the dependency ratio, Table 5–24 also presents the percent change in the number of people in the under-15 and over-65 categories. In general, the U.S. population is aging and this is reflected in the change in the proportion of the population in these two categories as shown in Table 5–24. The number under 15 years old is generally declining while the number over 65 is increasing. Overall, the dependency ratio is declining.

In each table the percent change value for those counties in the top quartile in terms of percent change of the subject characteristic has been bolded. This indicates those counties that have experienced the greatest amount of change in the characteristic relative to all the coastal counties listed in the table. This can help in any new evaluation of the analyses based on 2000 census data referenced above. However, interpretation of this information should be made with caution for several reasons. First, in most cases non-white, Hispanics, and Native Americans are present in relatively small numbers in the population so a small increase in the actual number of people in these categories can result in a large percentage change, even if the proportion in the population only changes slightly (or even declines). Second, the 2006 population estimates are subject to error and no analysis has been made to determine if the change in any one county exceeds the error of the estimate (i.e., is statistically significant). Third, in many counties the population may be concentrated away from the coast, or coastal communities may be significantly

[7] The non-white category comprises the following fields from table P3: Population of one race; Black or African American alone, American Indian and Alaska Native alone, Asian alone, and Native Hawaiian and Other Pacific Islander alone,

different in composition in comparison to other parts of the county. Thus a change in the characteristics of the county as a whole may not accurately portray the actual changes in coastal communities.[8] Figure 5–10 shows the ports and port groups that are used in characterizing west coast fishery landings data. These are the coastal communities used in impact analyses of Council groundfish fishery management actions.

8 Decennial census data are available at a much finer scale, the census block group. Census data presented previously (PFMC 2004b, Appendix A) used block groups to characterize areas equivalent to the ports used in PacFIN to record fishery landings. The block groups were selected based on either census geography (census designated places, zip code tabulation areas) if available or empirically for places where census geography does not accurately match the extent of the port community.

Table 5–20a. Port group, county, and port relationships in Washington and Oregon

State-Port Group-County-Port		
Washington		
Puget Sound		
	Whatcom	Blaine
		Bellingham Bay
	San Juan	Friday Harbor
	Skagit	Anacortes
		La Conner
	Snohomish	Other North Puget Sound Ports
		Everett
	King	Seattle
	Pierce	Tacoma
	Thurston	Olympia
	Mason	Shelton
	Unknown	Other South Puget Sound Ports
North Washington Coast		
	Jefferson	Port Townsend
	Clallam	Sequim
		Port Angeles
		Neah Bay
		La Push
South & Central WA Coast		
	Grays Harbor	Copalis Beach
		Grays Harbor
		Westport
	Pacific	Willapa Bay
		Ilwaco/Chinook
	Klickitat	Other Columbia River Ports
Unidentified WA		
	Pacific	Other Washington Coastal Ports
	Unknown	Unknown WA Ports

State-Port Group-County-Port		
Oregon		
Astoria		
	Multnomah	Pseudo Port Code for Columbia R.
	Clatsop	Astoria
		Gearhart - Seaside
		Cannon Beach
	Unknown	Landed in WA; Transp. to OR
Tillamook		
	Tillamook	Nehalem Bay
		Tillamook / Garibaldi
		Netarts Bay
		Pacific City
Newport		
	Lincoln	Salmon River
		Siletz Bay
		Depoe Bay
		Newport
		Waldport
		Yachats
Coos Bay		
	Lane	Florence
	Douglas	Winchester Bay
	Coos	Coos Bay
		Bandon
Brookings		
	Curry	Port Orford
		Gold Beach
		Brookings

Table 5–20b. Port group, county, and community relationships in California

State-Port Group	County	Port
California		
Crescent City		
	Del Norte	Crescent City
		Other Del Norte County Ports
Eureka		
	Humboldt	Eureka (Includes Fields Landing)
		Fields Landing
		Trinidad
		Other Humboldt County Ports
Fort Bragg		
	Mendocino	Fort Bragg
		Albion
		Arena
		Other Mendocino County Ports
Bodega Bay		
	Sonoma	Bodega Bay
	Marin	Tomales Bay
		Point Reyes
		Other Son. & Mar. Co. Outer Coast Ports
		Sausalito
San Francisco		
	Alameda	Oakland
		Alameda
		Berkely
	Contra Costa	Richmond
	San Francisco	San Francisco
	San Mateo	Princeton
	San Francisco	San Francisco Area
		Other S.F. Bay & S.M. Co. Ports
Monterey		
	Santa Cruz	Santa Cruz
	Monterey	Moss Landing
		Monterey
		Other S.C. and Mon. Co. Ports
	San Luis Obispo	Morro Bay
		Avila
		Other S.L..O. Co. Ports
Santa Barbara		
	Santa Barbara	Santa Barbara
		Santa Barbara Area
	Ventura	Port Hueneme
		Oxnard
		Ventura
		Other S.B. and Ven. Co. Ports
Los Angeles		
	Los Angeles	Terminal Island
		San Pedro Area
		San Pedro
		Willmington
		Longbeach
	Orange	Newport Beach
		Dana Point
		Other LA and Orange Co. Ports
San Diego		
	San Diego	San Diego
		Oceanside
		San Diego Area
		Other S.D. Co. Ports
Unidentified CA		
	Unknown	Unknown CA Ports

Table 5–21. Non-white population (selected categories), change 2000 to 2006 by coastal county

State	County	2000 Total	2000 Non-white*	2000 Percent	2006 Total	2006 Non-white*	2006 Percent	Change
Washington		5,894,121	629,856	10.69%	6,395,798	784,073	12.26%	24.48%
	Whatcom	166,814	10,731	6.43%	185,953	13,773	7.41%	**28.35%**
	San Juan	14,077	290	2.06%	15,298	384	2.51%	**32.41%**
	Skagit	102,979	4,060	3.94%	115,700	5,460	4.72%	**34.48%**
	Snohomish	606,024	55,098	9.09%	669,887	79,820	11.92%	**44.87%**
	King	1,737,034	306,555	17.65%	1,826,732	382,152	20.92%	24.66%
	Pierce	700,820	100,198	14.30%	766,878	116,665	15.21%	16.43%
	Thurston	207,355	18,247	8.80%	234,670	23,246	9.91%	**27.40%**
	Mason	49,405	3,167	6.41%	55,951	3,559	6.36%	12.38%
	Jefferson	25,953	1,052	4.05%	29,279	1,290	4.41%	22.62%
	Clallam	64,525	4,683	7.26%	70,400	5,172	7.35%	10.44%
	Grays Harbor	67,194	4,249	6.32%	71,587	5,080	7.10%	19.56%
	Pacific	20,984	1,010	4.81%	21,735	1,124	5.17%	11.29%
Oregon		3,421,399	210,199	6.14%	3,700,758	263,836	7.13%	25.52%
	Clatsop	35,630	1,042	2.92%	37,315	1,384	3.71%	**32.82%**
	Tillamook	24,262	550	2.27%	25,380	737	2.90%	**34.00%**
	Lincoln	44,479	2,012	4.52%	46,199	2,295	4.97%	14.07%
	Lane	322,959	13,217	4.09%	337,870	17,647	5.22%	**33.52%**
	Douglas	100,399	2,428	2.42%	105,117	2,934	2.79%	20.84%
	Coos	62,779	2,384	3.80%	64,820	2,712	4.18%	13.76%
	Curry	21,137	655	3.10%	22,358	743	3.32%	13.44%
California		33,871,648	6,411,702	18.93%	36,457,549	7,530,301	20.65%	17.45%
	Del Norte	27,507	3,614	13.14%	28,893	4,048	14.01%	12.01%
	Humboldt	126,518	10,684	8.44%	128,330	12,039	9.38%	12.68%
	Mendocino	86,265	5,803	6.73%	88,109	6,744	7.65%	16.22%
	Sonoma	458,614	26,943	5.87%	466,891	34,232	7.33%	27.05%
	Marin	247,289	19,794	8.00%	248,742	22,676	9.12%	14.56%
	San Francisco	776,733	307,382	39.57%	744,041	299,689	40.28%	-2.50%
	Contra Costa	948,816	202,102	21.30%	1,024,319	247,427	24.16%	22.43%
	Alameda	1,443,741	529,104	36.65%	1,457,426	577,915	39.65%	9.23%
	San Mateo	707,161	179,067	25.32%	705,499	203,025	28.78%	13.38%
	Santa Cruz	255,602	14,109	5.52%	249,705	16,986	6.80%	20.39%
	Monterey	401,762	45,286	11.27%	410,206	49,782	12.14%	9.93%
	San Luis Obispo	246,681	14,191	5.75%	257,005	16,696	6.50%	17.65%
	Santa Barbara	399,347	31,023	7.77%	400,335	34,871	8.71%	12.40%
	Ventura	753,197	63,725	8.46%	799,720	82,006	10.25%	**28.69%**
	Los Angeles	9,519,338	2,172,498	22.82%	9,948,081	2,388,371	24.01%	9.94%
	Orange	2,846,289	463,278	16.28%	3,002,048	576,025	19.19%	24.34%
	San Diego	2,813,833	449,180	15.96%	2,941,454	509,659	17.33%	13.46%
Total		43,187,168	7,251,757	16.79%	46,554,105	8,578,210	18.43%	18.29%

*Non-white comprises selected categories as noted below.

Sources: 2000, Decennial Census, Table P3, fields used for "non-white": P003004, P003005, P003006, P003007
2006, Population Estimates Program, Table T-3, fields used for "non-white": T0032006003, T0032006004, T0032006005, T0032006006

Table 5–22. Hispanic population, change 2000 to 2006 by coastal county

State	County	2000 Total pop.	2000 Hisp. Pop.	2000 Percent	2006 Total pop.	2006 Hisp. Pop.	2006 Percent	Change
Washington		5,894,121	441,509	7.49%	6,395,798	581,357	9.09%	31.68%
	Whatcom	166,814	8,687	5.21%	185,953	11,510	6.19%	32.50%
	San Juan	14,077	338	2.40%	15,298	460	3.01%	36.09%
	Skagit	102,979	11,536	11.20%	115,700	15,683	13.55%	35.95%
	Snohomish	606,024	28,590	4.72%	669,887	43,714	6.53%	**52.90%**
	King	1,737,034	95,242	5.48%	1,826,732	131,277	7.19%	**37.84%**
	Pierce	700,820	38,621	5.51%	766,878	53,556	6.98%	**38.67%**
	Thurston	207,355	9,392	4.53%	234,670	12,808	5.46%	36.37%
	Mason	49,405	2,361	4.78%	55,951	3,258	5.82%	**37.99%**
	Jefferson	25,953	535	2.06%	29,279	716	2.45%	33.83%
	Clallam	64,525	2,203	3.41%	70,400	2,885	4.10%	30.96%
	Grays Harbor	67,194	3,258	4.85%	71,587	4,639	6.48%	**42.39%**
	Pacific	20,984	1,052	5.01%	21,735	1,321	6.08%	25.57%
Oregon		3,421,399	275,314	8.05%	3,700,758	379,038	10.24%	37.67%
	Clatsop	35,630	1,597	4.48%	37,315	2,287	6.13%	43.21%
	Tillamook	24,262	1,244	5.13%	25,380	1,895	7.47%	**52.33%**
	Lincoln	44,479	2,119	4.76%	46,199	3,104	6.72%	**46.48%**
	Lane	322,959	14,874	4.61%	337,870	19,818	5.87%	33.24%
	Douglas	100,399	3,283	3.27%	105,117	4,174	3.97%	27.14%
	Coos	62,779	2,133	3.40%	64,820	2,777	4.28%	30.19%
	Curry	21,137	761	3.60%	22,358	1,065	4.76%	**39.95%**
California		33,871,648	10,966,556	32.38%	36,457,549	13,074,156	35.86%	19.22%
	Del Norte	27,507	3,829	13.92%	28,893	4,419	15.29%	15.41%
	Humboldt	126,518	8,210	6.49%	128,330	9,858	7.68%	20.07%
	Mendocino	86265	14,213	16.48%	88,109	17324	19.66%	21.89%
	Sonoma	458,614	79,511	17.34%	466,891	102,749	22.01%	29.23%
	Marin	247,289	27,351	11.06%	248,742	32,615	13.11%	19.25%
	San Francisco	776,733	109,504	14.10%	744,041	104,575	14.06%	-4.50%
	Contra Costa	948,816	167,776	17.68%	1,024,319	224,134	21.88%	33.59%
	Alameda	1,443,741	273,910	18.97%	1,457,426	312,426	21.44%	14.06%
	San Mateo	707,161	154,708	21.88%	705,499	162,149	22.98%	4.81%
	Santa Cruz	255,602	68,486	26.79%	249,705	70,729	28.33%	3.28%
	Monterey	401,762	187,969	46.79%	410,206	211,382	51.53%	12.46%
	San Luis Obispo	246,681	40,196	16.29%	257,005	46,924	18.26%	16.74%
	Santa Barbara	399,347	136,668	34.22%	400,335	152,743	38.15%	11.76%
	Ventura	753,197	251,734	33.42%	799,720	292,063	36.52%	16.02%
	Los Angeles	9,519,338	4,242,213	44.56%	9,948,081	4,706,994	47.32%	10.96%
	Orange	2,846,289	875,579	30.76%	3,002,048	987,428	32.89%	12.77%
	San Diego	2,813,833	750,965	26.69%	2,941,454	885,504	30.10%	17.92%
Total		43,187,168	11,683,379	27.05%	46,554,105	14,034,551	30.15%	20.12%

Source:
2000: Decennial Census; Table P4 (SF1); fields total population (P004001); Hispanic or Latino (P004002)
2006: US Census Population Estimates Program; Table T4-2006, fields total population (T0042006001); Hispanic or Latino (T0042006009)

Table 5–23. Native American population, change 2000 to 2006 by coastal county

State	County	2000 Total Pop.	2000 Native Am.	2000 Percent	2006 Total Pop.	2006 Native Am.	2006 Percent	Change
Washington		5,894,121	93,301	1.58%	6,395,798	104,405	1.63%	11.90%
	Whatcom	166,814	4,709	2.82%	185,953	5,223	2.81%	10.92%
	San Juan	14,077	117	0.83%	15,298	144	0.94%	23.08%
	Skagit	102,979	1,909	1.85%	115,700	2,214	1.91%	15.98%
	Snohomish	606,024	8,250	1.36%	669,887	9,610	1.43%	16.48%
	King	1,737,034	15,922	0.92%	1,826,732	16,962	0.93%	6.53%
	Pierce	700,820	9,963	1.42%	766,878	11,053	1.44%	10.94%
	Thurston	207,355	3,143	1.52%	234,670	3,802	1.62%	20.97%
	Mason	49,405	1,840	3.72%	55,951	2,058	3.68%	11.85%
	Jefferson	25,953	599	2.31%	29,279	622	2.12%	3.84%
	Clallam	64,525	3,303	5.12%	70,400	3,505	4.98%	6.12%
	Grays Harbor	67,194	3,132	4.66%	71,587	3,552	4.96%	13.41%
	Pacific	20,984	513	2.44%	21,735	557	2.56%	8.58%
Oregon		3,421,399	45,211	1.32%	3,700,758	51,209	1.38%	13.27%
	Clatsop	35,630	367	1.03%	37315	460	0.86%	**25.34%**
	Tillamook	24,262	289	1.19%	25380	347	0.50%	20.07%
	Lincoln	44,479	1,397	3.14%	46199	1504	2.73%	7.66%
	Lane	322,959	3,642	1.13%	337870	3961	1.09%	8.76%
	Douglas	100,399	1,530	1.52%	105117	1672	1.58%	9.28%
	Coos	62,779	1,515	2.41%	64820	1596	2.55%	5.35%
	Curry	21,137	452	2.14%	22358	472	2.41%	4.42%
California		33,871,648	333,346	0.98%	36,457,549	421,346	1.16%	26.40%
	Del Norte	27,507	1,770	6.43%	28,893	1,928	6.67%	8.93%
	Humboldt	126,518	7,241	5.72%	128,330	7,760	6.05%	7.17%
	Mendocino	86,265	4,103	4.76%	88109	4584	100.56%	11.72%
	Sonoma	458,614	5,389	1.18%	466,891	6,769	1.45%	**25.61%**
	Marin	247,289	1,061	0.43%	248,742	1,404	0.56%	**32.33%**
	San Francisco	776,733	3,458	0.45%	744,041	3,842	0.52%	11.10%
	Contra Costa	948,816	5,830	0.61%	1,024,319	7,694	0.75%	**31.97%**
	Alameda	1,443,741	9,146	0.63%	1,457,426	10,527	0.72%	15.10%
	San Mateo	707,161	3,140	0.44%	705,499	3,455	0.49%	10.03%
	Santa Cruz	255,602	2,461	0.96%	249,705	2,978	1.19%	21.01%
	Monterey	401,762	4,202	1.05%	410,206	5,335	1.30%	**26.96%**
	San Luis Obispo	246,681	2,335	0.95%	257,005	2,850	1.11%	22.06%
	Santa Barbara	399,347	4,784	1.20%	400,335	6,265	1.56%	**30.96%**
	Ventura	753,197	7,106	0.94%	799,720	9,174	1.15%	**29.10%**
	Los Angeles	9,519,338	76,988	0.81%	9,948,081	97,257	0.98%	**26.33%**
	Orange	2,846,289	19,906	0.70%	3,002,048	24,697	0.82%	**24.07%**
	San Diego	2,813,833	24,337	0.86%	2,941,454	28,484	0.97%	17.04%
Total		43,187,168	471,858	1.09%	42,853,347	525,751	0.97%	11.42%

Sources
2000: Decennial Census, Table P3, Fields Total (P003001); one race; American Indian and Alaska Native alone (P003005)
2006: U.S. Census Population Estimates Program, Table T-3 2006, Total (T0032006001), Total: American Indian and Alaska Native alone (T0032006004)

Table 5–24. Dependency ratio in 2000 and 2006 and change

State	County	Dependency Ratio 2000	Dependency Ratio 2006	Change: Dependency Ratio	Change: pop. <15	Change: pop. >64
Washington		0.482	0.451	-0.031	-0.59%	**19.04%**
	Whatcom	0.461	0.432	-0.029	-0.86%	**19.15%**
	San Juan	0.528	0.500	-0.028	-0.35%	10.83%
	Skagit	0.566	0.507	-0.059	-13.25%	**19.59%**
	Snohomish	0.472	0.428	-0.044	**-0.19%**	11.63%
	King	0.414	0.404	**-0.010**	-7.84%	**19.41%**
	Pierce	0.490	0.449	-0.041	-9.72%	3.32%
	Thurston	0.469	0.428	-0.041	-0.53%	**13.00%**
	Mason	0.550	0.502	-0.049	**1.59%**	6.72%
	Jefferson	0.586	0.545	-0.041	-7.80%	3.21%
	Clallam	0.636	0.588	-0.048	-4.94%	0.75%
	Grays Harbor	0.566	0.489	-0.076	-7.12%	**13.14%**
	Pacific	0.654	0.595	-0.059	-0.83%	**15.14%**
Oregon		0.498	0.468	-0.030	-6.82%	1.28%
	Clatsop	0.524	0.491	-0.033	-6.46%	2.35%
	Tillamook	0.599	0.541	-0.058	-6.66%	9.75%
	Lincoln	0.578	0.524	-0.054	-9.84%	**13.18%**
	Lane	0.470	0.441	-0.029	-11.67%	5.29%
	Douglas	0.592	0.561	-0.031	-9.41%	6.83%
	Coos	0.578	0.542	-0.036	-2.84%	**13.04%**
	Curry	0.728	0.651	-0.076	-6.62%	8.76%
California		0.506	0.480	-0.026	-8.72%	1.24%
	Del Norte	0.483	0.419	-0.064	**-0.33%**	11.51%
	Humboldt	0.456	0.419	-0.037	-0.86%	4.92%
	Mendocino	0.521	0.481	-0.040	-9.07%	2.65%
	Sonoma	0.488	0.454	-0.034	**0.68%**	4.18%
	Marin	0.440	0.452	**0.013**	-13.57%	9.25%
	San Francisco	0.347	0.381	**0.034**	**0.15%**	1.37%
	Contra Costa	0.505	0.469	-0.036	**0.37%**	9.13%
	Alameda	0.449	0.450	**0.001**	**1.35%**	9.34%
	San Mateo	0.465	0.481	**0.016**	**1.74%**	4.34%
	Santa Cruz	0.421	0.403	-0.018	-8.91%	3.72%
	Monterey	0.513	0.501	**-0.012**	-1.71%	9.37%
	San Luis Obispo	0.472	0.425	-0.048	**1.39%**	**15.20%**
	Santa Barbara	0.506	0.492	**-0.014**	**0.81%**	3.98%
	Ventura	0.516	0.486	-0.031	-3.55%	1.51%
	Los Angeles	0.504	0.483	-0.021	-1.13%	10.11%
	Orange	0.488	0.488	**0.001**	-3.77%	10.58%
	San Diego	0.490	0.476	**-0.013**	-9.41%	6.30%

Source:
2000, Decennial census, Table P12,
2006, Population Estimates Program, Table T-6

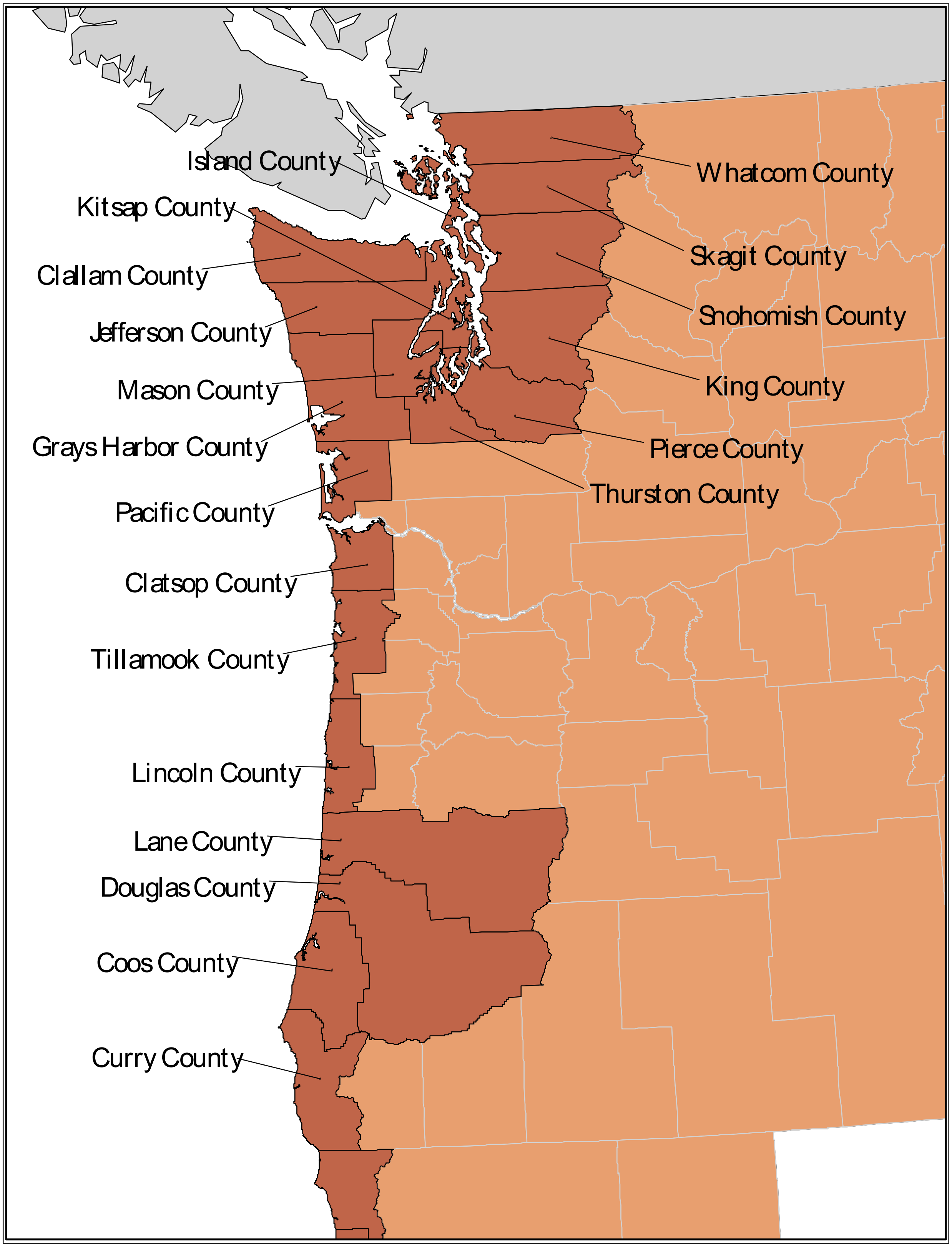


Figure 5–9a. Coastal counties in Washington and Oregon

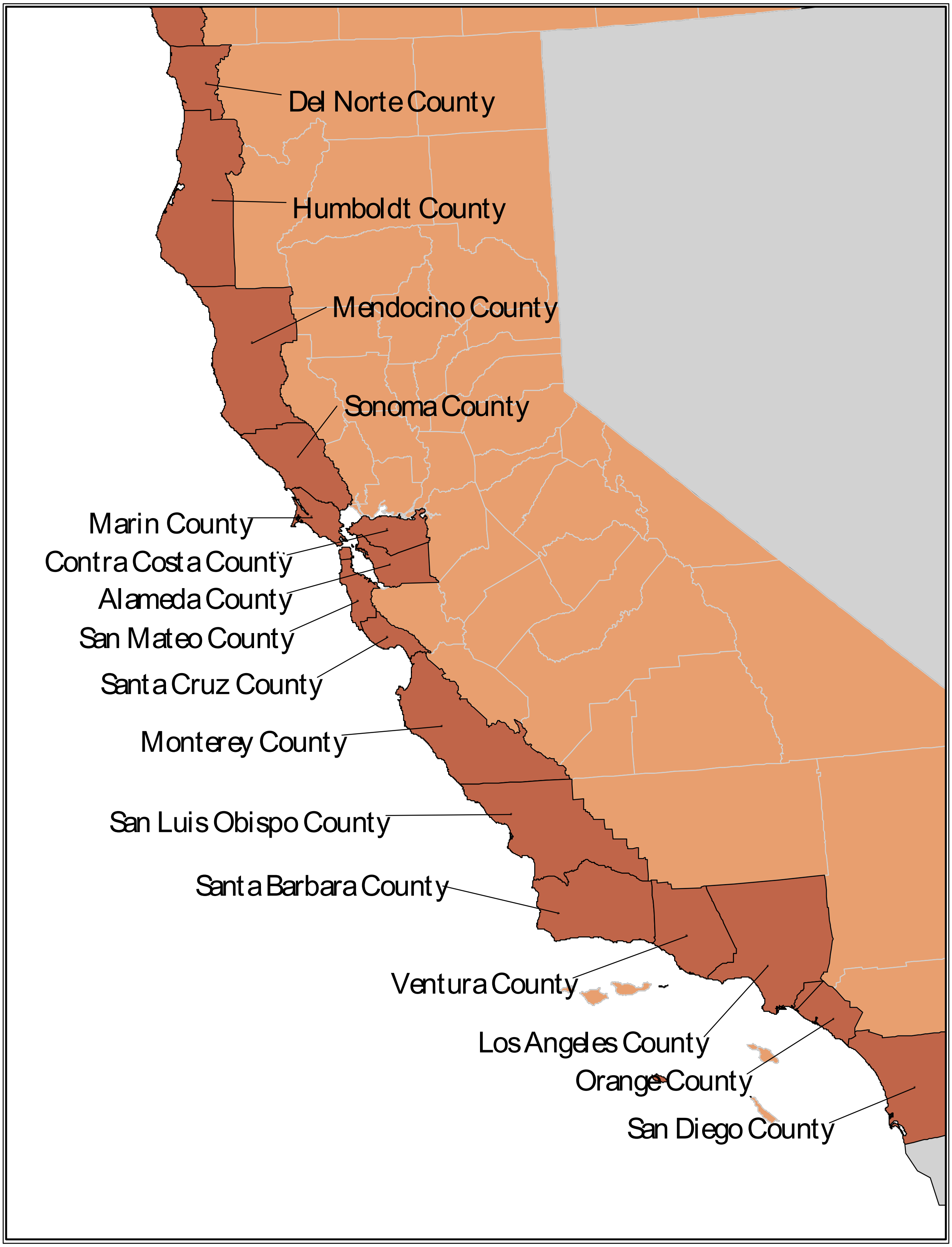


Figure 5–9b. Coastal counties in California

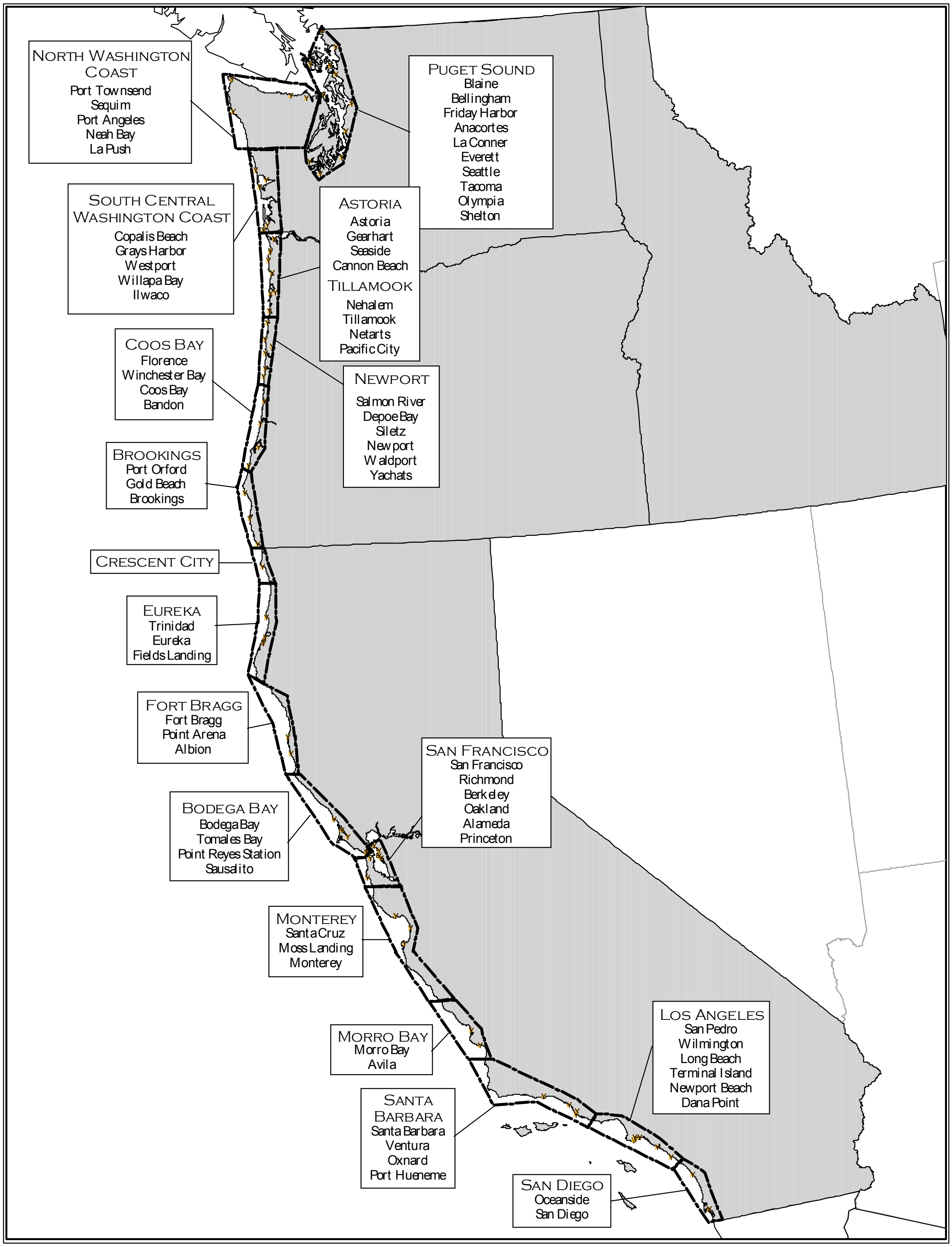


Figure 5–10. Ports and port groups used to evaluate coastal community impacts

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