

Observed and Estimated Total Bycatch of Green Sturgeon in the 2002-2007  
U.S. West Coast Groundfish Fisheries

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## INTRODUCTION

The primary objective of this report is to provide estimates of green sturgeon (*Acipenser medirostris*) bycatch in U.S. West Coast groundfish fisheries from 2002-2007. We present bycatch estimates for all fisheries observed by the West Coast Groundfish Observer Program (WCGOP) that were recorded to have caught green sturgeon during this time. These include:

- Commercial limited entry (LE) bottom trawl
- Commercial LE bottom trawl – targeting California halibut
- Commercial open access (OA) bottom trawl – targeting California halibut

### *Data sources*

Data sources for this analysis include onboard observer data (from the WCGOP), trawl logbook data, and landing receipt data (referred to as fish tickets). Discard estimation analyses focused on commercial groundfish fishery sectors in which the WCGOP has conducted scientific at-sea observation of discards.

The WCGOP was established in 2001 by NOAA Fisheries (National Marine Fisheries Service, NMFS) (66 FR 20609). All commercial vessels that land groundfish caught in the United States Exclusive Economic Zone (EEZ) from 3-200 miles offshore are required to carry an observer when notified to do so by NMFS or its designated agent. Subsequent Oregon and California state rule-making also requires vessels that fish for groundfish within 3 miles of shore or participate in other state-managed fisheries to carry WCGOP observers when notified. The WCGOP's goal is to improve total catch estimates by collecting information on the discarded catch (fish returned overboard at-sea) of west coast groundfish species. The WCGOP coverage plan details program goals, vessel selection, observer coverage, and basic data collection (NWFSC 2006). A list of fisheries in order of coverage priority and detailed information on data collection methods employed in each observed fishery can be found in the WCGOP manual (NWFSC 2007).

The sampling protocol employed by the WCGOP is primarily focused on the discarded portion of catch. In order to ensure that the recorded weights for the retained portion of the observed catch are accurate, haul-level retained catch amounts recorded by WCGOP observers are reconciled with trip-level fish ticket records. The WCGOP data are linked to fish tickets by fish ticket number(s) obtained by the observer and are adjusted so that the total trip pounds of retained fish equals the total trip pounds on the fish ticket. This is done because the fish ticket weight is more accurate and fish tickets are legally binding documents. These steps are described in further detail in annual reports produced by the WCGOP ([www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm](http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm)) and were conducted prior to the analyses presented in this report.

When green sturgeon are encountered on an observed vessel, WCGOP observers document length, take photographs, scan for scute markings and tags, and take a tissue sample. If the specimen is dead, the observer will also take a fin ray sample and determine sex. Biological data for green sturgeon have previously been summarized in WCGOP data reports for each fishery, which are available at: <http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm>. WCGOP data employed in this report are limited to observed green sturgeon numbers, as well as total weights of groundfish species.

Logbook record-keeping is a state-mandated requirement for the LE groundfish trawl sector in Washington, Oregon, and California. A common-format logbook is used by all three states and completed logbook information is entered into state agency databases. The electronic logbook data are then submitted by state agencies to the Pacific Coast Fisheries Information Network (PacFIN) regional database, which is maintained by the Pacific States Marine Fisheries Commission (PSMFC).

Trawl logbook data for 2002-2007 were retrieved from the PacFIN database and divided into various sectors of the groundfish fishery as indicated in Figure 1. All additional data processing steps that were applied during the discard estimation process are described in the methods section below. Logbook data from the open access groundfish trawl sector were not included in our analyses.

Landing receipts, known as fish tickets, are completed by fish-buyers in each port for each delivery of fish by a vessel. Fish tickets are trip-aggregated sales receipts for market categories that may represent single or multiple species. They are issued to fish-buyers by a state agency and must be returned to the agency for processing. Fish tickets are designed by the individual states, and Washington, Oregon, and California each have a slightly different format of receipt. In addition, each state conducts species-composition sampling for numerous market categories that are reported on fish tickets. Fish ticket and species-composition data are submitted by state agencies to the PacFIN regional database. Percentages for the species composition within market categories were applied to the fish ticket data used in our analyses. As such, landed weights from sampled market categories were distributed to individual species to the greatest extent possible.

Annual fish ticket landings data were retrieved from the PacFIN database and subsequently divided into various sectors of the groundfish fishery as indicated in Figure 1. All additional data processing steps that were applied during the discard estimation process are described in the methods section below.

## **METHODS**

A deterministic approach was used to estimate green sturgeon bycatch for all sectors of the groundfish fishery for which WCGOP observer data were available. Through this approach, observed bycatch rates for green sturgeon were directly expanded to the fleet-wide level. First, bycatch ratios were computed from observer data as the catch (in

numbers) of green sturgeon divided by the retained weight of either all groundfish (except Pacific hake) or California halibut, depending on the sector. Denominators differed for each sector of the fishery based on targeting behavior of that sector. Bycatch ratios were then multiplied by the total fleet-wide landed weight of either groundfish or California halibut (depending on the denominator used to compute observed bycatch ratios). This provided an expanded estimate of fleet-wide green sturgeon bycatch (in numbers). Because of differences in data availability and management structure among the various sectors of the groundfish fishery, this approach was applied with slight modifications for each sector. A more detailed discussion of the methodology used to estimate bycatch within each sector is presented below.

### ***Limited Entry Bottom Trawl Fishery***

Fleet-wide green sturgeon bycatch estimates for the LE bottom trawl fishery were derived from WCGOP observer data, fish ticket landings data, and trawl logbook data. Fish ticket and logbook data were isolated for this sector based on processing steps outlined in Figure 1. A summary of observer data for the 2007 LE bottom trawl sector is presented in the WCGOP data report and summary analyses of the West Coast limited entry groundfish bottom trawl fishery published in October 2008 (NWFSC 2008a).

LE bottom trawl vessels that hold a California halibut bottom trawl permit may participate in the state-permitted California halibut fishery. California halibut tows can occur on the same trip as tows targeting groundfish and were identified in logbook and observer data based on the following criteria: 1) the reported tow target was California halibut or 2) the tow target was nearshore mix, sand sole, or other flatfish, and the tow took place in less than 30 fathoms and south of 40°10' N. latitude. All tows in the observer and logbook data that met at least one of the above requirements were removed from the LE bottom trawl data sets and included as data for the California halibut fishery (see below). Whether in observer or logbook data, tow target was typically determined by the vessel captain.

Several additional filtering steps were then applied to the data in order to ensure that we had distinguished the data set for the LE bottom trawl sector appropriately. First, we searched within the landings data for fish tickets with more than 2 mt of Pacific hake on a given day in order to remove them and exclude effort that was targeted exclusively towards this species. A similar check was then performed on the observer and logbook data, such that tows with more than 2 mt of retained Pacific hake were flagged for removal. Since no data in 2007 met these criteria, these steps did not remove any fish tickets, logbook entries or observer tows from data for the LE bottom trawl sector.

Next, trawl logbook and observer data were filtered to ensure that all spatial and temporal information was complete. To do this, any tows lacking a recorded depth or latitude were removed. None of the tows in the observer data met these criteria. However, 66 tows were removed from the logbook data set because they lacked depth information.

Observer data and trawl logbook data were then stratified by state of vessel landing and season. Catch of green sturgeon typically occurs in a shallow and limited depth range, and additional stratification by fishing depth was therefore unnecessary. Once both data sets had been stratified, bycatch ratios were computed from the observer data and multiplied by logbook catch weights in each stratum. This was done according to the following equation:

$$D_{asb} = \frac{\sum_t d_{ast}}{\sum_t r_{ast}} \times \sum_t R_{asbt}$$

where:

*a*: state of landing (Washington, Oregon or California)

*s*: season (winter: Nov - Apr / summer: May - Oct)

*b*: bimonthly period (Jan-Feb, Mar-Apr, ... , Nov-Dec)

*t*: tows in observer or logbook data

*d*: observed number of green sturgeon caught

*r*: observed retained weight of all FMP groundfish except Pacific hake

*R*: weight of retained FMP groundfish (except Pacific hake) recorded in logbooks

*D*: initial bycatch estimate for state *a*, season *s*, and bimonthly period *b*

Note that the denominator of observed bycatch ratios and the logbook expansion factor included weight from all FMP groundfish retained weight except Pacific hake. Pacific hake was excluded when using the retained FMP groundfish denominator because vessels that target or land large amounts of this species are considered to be part of Pacific hake sectors, which are distinct from the groundfish bottom trawl sector. A complete listing of groundfish species included in the Groundfish Fishery Management Plan and used to compute and expand bycatch ratios is provided in Appendix A. Observed numbers and bycatch ratios for green sturgeon in the LE bottom trawl fishery are presented in Table 1 by state of landing and season.

In all cases where a FMP groundfish species grouping was used to compute bycatch ratios, any retained weights that were recorded by the observer but that did not appear on fish tickets were excluded from the denominator. This was necessary to prevent double-counting associated with differences in the species codes used by observers and processors. For instance, while observers may record rockfish catch at the species level, various species of rockfish are often grouped, weighed, and recorded together on the fish ticket by the processor under a grouped species code such as NUSP - northern unspecified slope rockfish. In some cases, this difference in species coding prevents observer and fish ticket weights from being matched and adjusted properly. Species coding on fish tickets varies considerably between processors and over time, and it is not possible to make assumptions regarding which individual observer-recorded species likely coincide with species grouping codes on fish tickets. Instead, by using only the retained groundfish weight from fish tickets in bycatch ratio denominators, we prevent double-counting of retained weights. This is not a factor when using a single species in the denominator, such as California halibut in the California halibut bottom trawl fishery

(see below), as any retained weights in observer and fish ticket data that share the same species code will match and adjust properly.

Retained logbook weights of FMP groundfish (except Pacific hake) were used to conduct the initial expansion of observed bycatch ratios to the fleet-wide level in this sector. However, logbooks are not submitted for 100% of trawl trips and therefore do not capture all groundfish bottom trawl fishing effort. As a result, it was necessary to adjust initial fleet-level bycatch estimates to reflect the level of effort indicated by fish ticket landings. To do this, both the fish ticket and logbook data were aggregated by state and bimonthly period, since this duration is the same as most cumulative trip limit periods. An adjustment ratio was then computed for each state and bimonthly period as the weight of FMP groundfish (except Pacific hake) recorded on fish tickets divided by that recorded in logbooks. Each adjustment ratio was multiplied by coinciding bycatch estimates and then summed across bimonthly periods to produce adjusted bycatch estimates for each state of landing and season:

$$adj(\hat{D}_{sa}) = \sum_b \hat{D}_{sab} \times \frac{F_{ab}}{R_{ab}}$$

where:

$F$ : weight of retained FMP groundfish (except Pacific hake) recorded on fish tickets

$adj(D_{sa})$ : adjusted bycatch estimate in season  $s$  and state  $a$

Adjustment ratios were computed separately for each state and bimonthly period in order to account for differences between individual states' logbook submission rates and fish ticket recording methods. Estimated bycatch amounts for green sturgeon in the limited entry bottom trawl fishery during 2002-2007 are reported in Table 2.

### ***California Halibut Bottom Trawl Fishery***

Fleet-wide green sturgeon bycatch estimates in the California halibut bottom trawl fishery were derived from WCGOP observer data and fish ticket landings data. Although all California halibut vessels are permitted by the state of California, we considered this fishery to consist of both a limited entry and an "open access" component (vessels that do not have federal limited entry *groundfish* permits). The WCGOP provides observer coverage for both of these components. Observer data for the LE component of the California halibut fishery were collected as part of the LE groundfish bottom trawl sector. Observer data for the California halibut fishery were then subsequently isolated based on the following criteria: 1) the tow target was California halibut or 2) the tow target was nearshore mix, sand sole or other flatfish, and the tow took place in less than 30 fathoms, south of 40°10' N. latitude. All tows in the observer data set that met at least one of the above requirements were included in the LE California halibut bottom trawl data set. The WCGOP randomly samples the OA California halibut sector separately. This is described further in the WCGOP data report and summary analyses of limited entry and open access trawl vessels targeting California halibut, published in December 2008

(NWFSC 2008b). These two components of the California halibut trawl fishery remained separate in this analysis.

This is the first time that observer bycatch ratios from the California halibut fishery have been used to estimate fleet-wide amounts of green sturgeon bycatch. Bycatch ratios were computed for this fishery using the retained weight of California halibut in the denominator. The total landed weight of California halibut was then used as a multiplier to expand observed green sturgeon bycatch ratios to the fleet-wide level. In order to isolate fish tickets from trips on which California halibut was targeted, landings were only compiled from fish tickets that had greater than 150 lbs of California halibut. Starting in 2007, the state of California required that vessels participating in the LE and OA trawl fisheries have a California halibut bottom trawl permit in order to land more than 150 lbs of this target species. Therefore, for 2007, landed California halibut weight in the OA sector was compiled from “non-midwater” OA trawl fish tickets (see Figure 1) for those vessels that had a state-issued California halibut bottom trawl permit only. For the LE sector in 2007, landed California halibut weight was still compiled from non-midwater LE trawl fish tickets (see Figure 1) with more than 150 lbs of California halibut recorded. This was done because a small number of LE vessels that were not included on the California halibut permit list provided to the WCGOP were recorded to have landed large amounts of California halibut in 2007.

Table 3 presents the total LE and OA landed weights of California halibut that were used as multipliers to expand observer discard ratios to the fleet-wide level. Also summarized in this table are observer coverage rates, calculated as the proportion of California halibut landings that were observed, as well as bycatch ratios for green sturgeon. Bycatch ratios were computed by dividing the observed bycatch (in numbers) of green sturgeon by the observed retained weight (mt) of California halibut. Bycatch estimates were computed for each sector based on the following equation:

$$\hat{D}_s = \frac{\sum_t d_{st}}{\sum_t r_t} \times F_s$$

where:

*s*: season

*t*: observed tows

*d*: observed bycatch (number) of green sturgeon

*r*: observed retained weight (mt) of California halibut

*F*: weight (mt) of retained California halibut recorded on fish tickets in season *s*

*D<sub>s</sub>*: bycatch estimate for season *s*

The product of bycatch ratios and the total fish ticket landed weight of California halibut produced expanded fleet-level bycatch estimates of green sturgeon for each fishery component (LE and OA). These estimates are presented in Table 4.

## RESULTS

A summary of green sturgeon bycatch estimates in the limited entry trawl fishery and the California halibut trawl fishery from 2002-2007 is provided in Table 5. Green sturgeon bycatch was estimated for all fisheries observed by the WCGOP in which green sturgeon were reported. Estimates were not provided for the OA sector of the California halibut fishery in 2002 or 2006 because this sector was not observed during these years.

The largest amounts of green sturgeon bycatch were estimated in the limited entry sector of the California halibut fishery. Fishing in this sector primarily takes place in depths of less than 30 fathoms at fishing grounds adjacent to San Francisco Bay. LE vessels participating in this fishery hold a federal limited entry groundfish permit, and may target groundfish or California halibut on different tows within the same trip. The largest estimate of green sturgeon bycatch in the LE sector of the California halibut fishery occurred in 2006, when 767 individuals were estimated to have been caught. In that year, 108 individuals were observed on LE vessels during California halibut tows between January and April (Table 3).

Overall, estimated green sturgeon bycatch was highest in 2005, when 8 individuals were estimated as bycatch in the LE bottom trawl fishery, 504 in the LE California halibut sector, and 270 in the OA California halibut sector. This contrasted dramatically with bycatch estimates for 2007, during which 5 individuals were estimated in the LE bottom trawl fishery, 102 in the LE California halibut sector, and 0 in the OA California halibut sector. During 2007, a dramatic reduction in fishing effort occurred in both the LE and OA sectors of the California halibut fishery. Presumably, this was associated with the introduction of a state permitting process that reduced the number of active California halibut vessels.

While we provide estimates for the total number of green sturgeon caught in groundfish fisheries on the U.S. West Coast, we have not applied rates of discard survivorship to these estimates. Research indicates that green sturgeon may be susceptible to some level of discard mortality, particularly when encounters with fishing gear occur in higher temperature environments and last for longer periods of time (D. Erickson, University of Miami, personal communication). Handling mortality of sturgeon has been evaluated with various harvest methods in the Columbia and Rogue rivers (ODFW 2005, NMFS 2005). These studies indicate that discard mortality may be between 1 and 6%. However, it would be inappropriate to apply these mortality rates in the present analysis due to differences in gear type and the marine habitat of green sturgeon in coastal groundfish fisheries (O. P. Langness, Washington Department of Fish and Wildlife, personal communication). Information on the mortality of green sturgeon caught as bycatch in trawl fisheries on the West Coast is not currently available, and it is unclear what proportion of captured individuals survive.

Point estimates fluctuate due to a number of non-biological factors, including random annual variation in observer coverage rates, fishing behavior, and various physical characteristics. In addition, several sources of uncertainty that were not accounted for in

this analysis may influence green sturgeon estimates. These include uncertainty in sampling of landings for species composition, logbook spatial information, observed retained catch weight, discard mortality rates, as well as others. Currently, it is not possible to quantify uncertainty for bycatch estimates presented in this report, as measures of the variability associated with various data sources are not available. As with all point estimates, green sturgeon bycatch values presented in Table 5 should be considered with caution.

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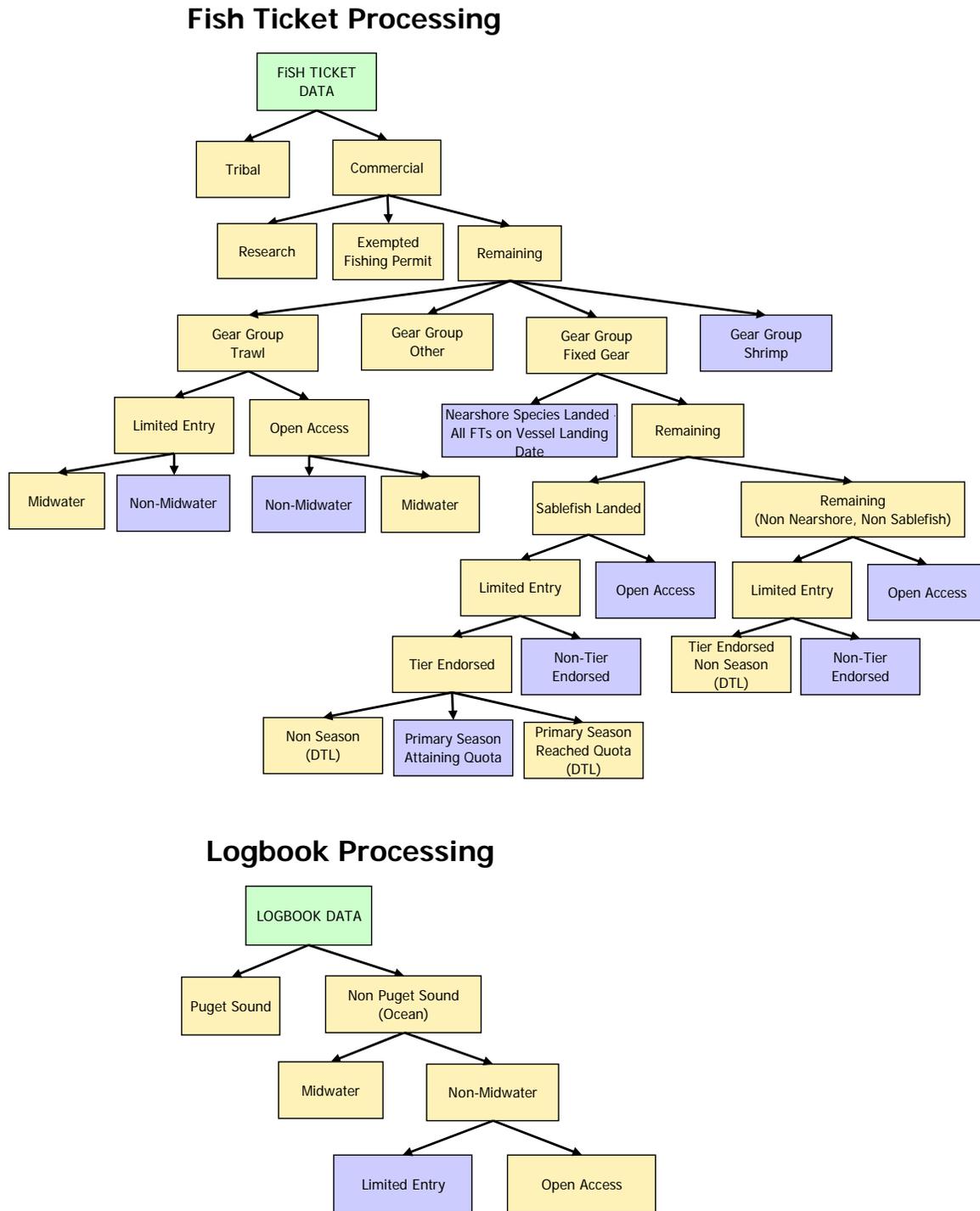
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**Figure 1.** Fish ticket and logbook data processing for division into groundfish fishery sectors after retrieval of a full calendar year data set from the Pacific Coast Fisheries Information Network (PacFIN) database. Blue sectors indicate sectors for which federal observer data is available.



**Table 1.** Coverage rates, numbers of green sturgeon observed, and green sturgeon bycatch ratios from limited entry bottom trawl vessels landing in Washington, Oregon, and California from 2002-2007. Coverage rates were computed as the proportion of FMP groundfish landings that were observed (see NWFSC 2008a for more details). Bycatch ratios were calculated for each state of landing and season as the observed catch of green sturgeon (in numbers) divided by the observed weight (mt) of retained groundfish (except Pacific hake).

Year	Season	Washington			Oregon			California		
		Coverage rate	Number observed	Bycatch ratio	Coverage rate	Number observed	Bycatch ratio	Coverage rate	Number observed	Bycatch ratio
2002	winter	26%	0	0.0000	17%	1	0.0016	14%	0	0.0000
	summer	5%	1	0.0064	16%	1	0.0019	15%	0	0.0000
2003	winter	12%	0	0.0000	21%	0	0.0000	13%	0	0.0000
	summer	11%	0	0.0000	13%	0	0.0000	15%	0	0.0000
2004	winter	46%	0	0.0000	29%	0	0.0000	37%	0	0.0000
	summer	20%	0	0.0000	21%	2	0.0019	23%	1	0.0013
2005	winter	18%	0	0.0000	28%	0	0.0000	22%	0	0.0000
	summer	22%	1	0.0023	23%	1	0.0008	21%	0	0.0000
2006	winter	18%	0	0.0000	23%	1	0.0011	21%	0	0.0000
	summer	26%	0	0.0000	22%	0	0.0000	21%	0	0.0000
2007	winter	25%	0	0.0000	15%	0	0.0000	20%	0	0.0000
	summer	7%	0	0.0000	20%	1	0.0008	20%	0	0.0000

**Table 2.** Total estimated bycatch of green sturgeon in the limited entry bottom trawl fishery from 2002-2007.

Year	Season	Estimated bycatch (numbers)			
		WA	OR	CA	Coastwide
2002	winter	0	7	0	7
	summer	19	6	0	25
2003	winter	0	0	0	0
	summer	0	0	0	0
2004	winter	0	0	0	0
	summer	0	10	4	14
2005	winter	0	0	0	0
	summer	4	4	0	8
2006	winter	0	4	0	4
	summer	0	0	0	0
2007	winter	0	0	0	0
	summer	0	5	0	5

**Table 3.** Observer coverage rates, number of green sturgeon observed, green sturgeon bycatch ratios, and total California halibut landings in the limited entry and open access sectors of the California halibut fishery from 2002 - 2007. Coverage rates were computed as the proportion of California halibut landings that were observed. Bycatch rates were calculated as the observed number of green sturgeon divided by the retained weight (mt) of California halibut.

SECTOR	Number of green sturgeon observed		Observed California halibut landings (mt)		Bycatch ratio		Total California halibut landings (mt)	
	winter	summer	winter	summer	winter	summer	winter	summer
<b>Limited Entry</b>								
2002	1	0	3.6	0.0	0.2788	0.0000	68.8	36.4
2003	2	48	12.9	6.2	0.1553	7.7123	61.9	43.6
2004	0	58	14.7	16.8	0.0000	3.4526	79.9	56.5
2005	18	98	10.7	19.8	1.6771	4.9540	131.4	57.4
2006	108	0	11.3	3.2	9.5272	0.0000	80.6	38.9
2007	6	10	3.0	2.4	1.9981	4.1384	27.4	11.8
<b>Open Access'</b>								
2002 *	--	--	--	--	--	--	21.6	14.2
2003	0	4	0.1	1.8	0.0000	2.1648	18.5	7.3
2004	2	0	0.9	4.2	2.2035	0.0000	29.6	41.3
2005	6	27	2.0	5.4	2.9403	4.9552	24.1	40.4
2006 *	--	--	--	--	--	--	18.4	35.4
2007	0	0	0.8	1.9	0.0000	0.0000	8.2	30.9

\* The open access California halibut bottom trawl sector was not observed in 2002 or 2006.

**Table 4.** Total estimated bycatch of green sturgeon in the limited entry and open access sectors of the California halibut fishery from 2002-2007.

	Estimated bycatch (numbers)		
	Limited Entry	Open Access	Total
2002* winter	19	--	19
2002* summer	0	--	0
2003 winter	9	0	9
2003 summer	336	15	351
2004 winter	0	65	65
2004 summer	194	0	194
2005 winter	220	70	290
2005 summer	284	200	484
2006* winter	767	--	767
2006* summer	0	--	0
2007 winter	54	0	54
2007 summer	48	0	48
<b>Total*</b>	<b>1,931</b>	<b>350</b>	<b>2,281</b>

\* The open access California halibut bottom trawl sectors was not observed in 2002 or 2006.

**Table 5.** Estimated bycatch of green sturgeon in all U.S. West Coast groundfish fisheries observed by the West Coast Groundfish Observer Program (WCGOP) from 2002-2007.

Year	Limited Entry Trawl			CA Halibut		Total
	WA	OR	CA	Limited Entry	Open Access	
2002	19	13	0	19	--	51
2003	0	0	0	345	15	360
2004	0	10	4	194	65	273
2005	4	4	0	504	270	782
2006	0	4	0	767	--	771
2007	0	5	0	102	0	107

Note: Discard survivorship rates have not been applied to these estimates for reasons cited in the text (see Results section).

## APPENDIX A

Common and scientific names of species included in the Pacific Coast Groundfish Fishery Management Plan, as amended through Amendment 19 (PFMC 2008).

### SHARKS

Big skate, *Raja binoculata*  
California skate, *R. inornata*  
Leopard shark, *Triakis semifasciata*  
Longnose skate, *R. rhina*  
Soupfin shark, *Galeorhinus zyopterus*  
Spiny dogfish, *Squalus acanthias*

### RATFISH

Ratfish, *Hydrolagus colliei*

### MORIDS

Finescale codling, *Antimora microlepis*

### GRENADIERS

Pacific rattail, *Coryphaenoides acrolepis*

### ROUNDFISH

Cabezon, *Scorpaenichthys marmoratus*  
Kelp greenling, *Hexagrammos decagrammus*  
Lingcod, *Ophiodon elongatus*  
Pacific cod, *Gadus macrocephalus*  
Pacific whiting, (hake) *Merluccius productus*  
Sablefish, *Anoplopoma fimbria*

### FLATFISH

Arrowtooth flounder, (turbot) *Atheresthes stomias*  
Butter sole, *Isopsetta isolepis*  
Curlfin sole, *Pleuronichthys decurrens*  
Dover sole, *Microstomus pacificus*  
English sole, *Parophrys vetulus*  
Flathead sole, *Hippoglossoides elassodon*  
Pacific sanddab, *Citharichthys sordidus*  
Petrale sole, *Eopsetta jordani*  
Rex sole, *Glyptocephalus zachirus*  
Rock sole, *Lepidopsetta bilineata*  
Sand sole, *Psettichthys melanostictus*  
Starry flounder, *Platichthys stellatus*

### ROCKFISH

Includes all genera and species of the family Scopaenidae, even if not listed, that occur in the Washington, Oregon, and California area. The Scopaenidae genera are *Sebastes*, *Scorpaena*, *Sebastolobus*, and *Scorpaenodes*.

Aurora, *Sebastes. aurora*

Bank, *S. rufus*  
Black, *S. melanops*  
Black-and-yellow, *S. chrysolmelas*.  
Blackgill, *S. melanostomus*  
Blue, *S. mystinus*  
Bocaccio, *S. paucispinis*  
Bronzespotted, *S. gilli*  
Brown, *S. auriculatus*  
Calico, *S. dalli*  
California scorpionfish, *Scorpaena guttata*  
Canary, *Sebastes pinniger*  
Chameleon, *S. phillipsi*  
Chilipepper, *S. goodei*  
China, *S. nebulosus*  
Copper, *S. caurinus*  
Cowcod, *S. levis*  
Darkblotched, *S. crameri*  
Dusky, *S. ciliatus*  
Dwarf-red, *S. rufianus*  
Flag, *S. rubrivinctus*  
Freckled, *S. lentiginosus*  
Gopher, *S. carnatus*  
Grass, *S. rastrelliger*  
Greenblotched, *S. rosenblatti*  
Greenspotted, *S. chlorostictus*  
Greenstriped, *S. elongatus*  
Halfbanded, *S. semicinctus*  
Harlequin, *S. variegatus*  
Honeycomb, *S. umbrosus*  
Kelp, *S. atrovirens*  
Longspine thornyhead, *Sebastolobus altivelis*  
Mexican, *Sebastes. macdonaldi*  
Olive, *S. serranoides*  
Pink, *S. eos*  
Pinkrose, *S. simulator*  
Pygmy, *S. wilsoni*  
Pacific ocean perch, *S. alutus*  
Quillback, *S. maliger*  
Redbanded, *S. babcocki*  
Redstripe, *S. proriger*  
Rosethorn, *S. helvomaculatus*  
Rosy, *S. rosaceus*  
Rougheye, *S. aleutianus*  
Sharpchin, *S. zacentrus*  
Shortbelly, *S. jordani*  
Shortraker, *S. borealis*  
Shortspine thornyhead, *Sebastolobus alascanus*  
Silvergray, *Sebastes. brevispinus*  
Speckled, *S. ovalis*  
Splitnose rockfish, *S. diploproa*  
Squarespot, *S. hopkinsi*

Starry, *S. constellatus*  
Stripetail, *S. saxicola*  
Swordspine, *S. ensifer*  
Tiger, *S. nigorcinctus*  
Treefish, *S. serriceps*  
Vermilion, *S. miniatus*  
Widow, *S. entomelas*  
Yelloweye, *S. ruberrimus*  
Yellowmouth, *S. reedi*  
Yellowtail, *S. flavidus*

## APPENDIX B

Species identification codes used in the Pacific Coast Fisheries Information Network (PacFIN) database and assigned to WCGOP observer data. Columns on the far right specify which species were included in discard ratio denominators and expansion factors as FMP groundfish species.

PacFIN Species ID	PacFIN Common Name	FMP groundfish
ALBC	ALBACORE	
AMCK	ATKA MACKEREL	
APLC	ALASKA PLAICE	
ARR1	NOM. AURORA ROCKFISH	yes
ARRA	AURORA ROCKFISH	yes
ART1	NOM. ARROWTOOTH FLOUNDER	yes
ARTH	ARROWTOOTH FLOUNDER	yes
ASRK	PACIFIC ANGEL SHARK	
BABL	BLACK ABALONE	
BANK	BANK ROCKFISH	yes
BCAC	BOCACCIO	yes
BCC1	NOM. BOCACCIO	yes
BCLM	BUTTER CLAM	
BGL1	NOM. BLACKGILL ROCKFISH	yes
BKGR	BLUE KING CRAB	
BLCK	BLACK ROCKFISH	yes
BLGL	BLACKGILL ROCKFISH	yes
BLK1	NOM. BLACK ROCKFISH	yes
BLU1	NOM. BLUE ROCKFISH	yes
BLUR	BLUE ROCKFISH	yes
BMCK	BULLET MACKEREL	
BMRL	BLUE MARLIN	
BMSL	BLUE OR BAY MUSSEL	
BNK1	NOM. BANK ROCKFISH	yes
BRNZ	BRONZESPOTTED ROCKFISH	yes
BRW1	NOM. BROWN ROCKFISH	yes
BRWN	BROWN ROCKFISH	yes
BRZ1	NOM. BRONZESPOTTED ROCKFISH	yes
BSJK	BLACK SKIPJACK	
BSKT	BIG SKATE	yes
BSOL	BUTTER SOLE	yes
BSRK	BLUE SHARK	
BSRM	UNSP. BAIT SHRIMP	
BTCR	BAIRDI TANNER CRAB	
BTNA	BLUEFIN TUNA	
BTRY	BAT RAY	
BYEL	BLACK-AND-YELLOW ROCKFISH	yes
BYL1	NOM. BLACK-AND-YELLOW ROCKFISH	yes
CBZ1	NOM. CABEZON	yes
CBZN	CABEZON	yes
CEEL	SPOTTED CUSK-EEL	
CHL1	NOM. CALIFORNIA HALIBUT	
CHLB	CALIFORNIA HALIBUT	
CHN1	NOM. CHINA ROCKFISH	yes
CHNA	CHINA ROCKFISH	yes
CHNK	CHINOOK SALMON	
CHUM	CHUM SALMON	
CKLE	BASKET COCKLE	

PacFIN Species ID	PacFIN Common Name	FMP groundfish
CLC1	NOM. CALICO ROCKFISH	yes
CLCO	CALICO ROCKFISH	yes
CLP1	NOM. CHILIPEPPER	yes
CLPR	CHILIPEPPER	yes
CMCK	CHUB MACKEREL	
CMEL	CHAMELEON ROCKFISH	yes
CML1	NOM. CHAMELEON ROCKFISH	yes
CMSL	CALIFORNIA MUSSEL	
CNR1	NOM. CANARY ROCKFISH	yes
CNRY	CANARY ROCKFISH	yes
COHO	COHO SALMON	
COP1	NOM. COPPER ROCKFISH	yes
COPP	COPPER ROCKFISH	yes
CPLN	CAPELIN	
CSKT	CALIFORNIA SKATE	yes
CSOL	CURLFIN SOLE	yes
CTRB	C-O SOLE	
CUDA	PACIFIC BARRACUDA	
CWC1	NOM. COWCOD ROCKFISH	yes
CWCD	COWCOD ROCKFISH	yes
DBR1	NOM. DARKBLOTCHED ROCKFISH	yes
DBRK	DARKBLOTCHED ROCKFISH	yes
DCRB	DUNGENESS CRAB	
DFLT	UNSP. DEEP FLOUNDERS	yes
DOVR	DOVER SOLE	yes
DRDO	DORADO	
DSOL	DEEPSEA SOLE	
DSRK	SPINY DOGFISH	yes
DTRB	DIAMOND TURBOT	
DUSK	DUSKY ROCKFISH	yes
DVR1	NOM. DOVER SOLE	yes
DWRF	DWARF-RED ROCKFISH	yes
EELS	UNSPECIFIED EELS	
EGL1	NOM. ENGLISH SOLE	yes
EGLS	ENGLISH SOLE	yes
ESTR	EASTERN OYSTER	
ETNA	BIGEYE TUNA	
EULC	EULACHON	
EURO	EUROPEAN OYSTER	
FLAG	FLAG ROCKFISH	yes
FLG1	NOM. FLAG ROCKFISH	yes
FNTS	FANTAIL SOLE	
FRCK	FRECKLED ROCKFISH	yes
FSOL	FLATHEAD SOLE	yes
GABL	GREEN ABALONE	
GBAS	GIANT SEA BASS	
GBL1	NOM. GREENBLOTCHED ROCKFISH	yes
GBLC	GREENBLOTCHED ROCKFISH	yes
GCLM	GAPER CLAM	
GDUK	GEODUCK	
GKCR	GOLDEN KING CRAB	
GPH1	NOM. GOPHER ROCKFISH	yes
GPHR	GOPHER ROCKFISH	yes
GPRW	GOLDEN PRAWN	
GRAS	GRASS ROCKFISH	yes
GRDR	UNSP. GRENADIERS	yes
GRS1	NOM. GRASS ROCKFISH	yes
GSP1	NOM. GREENSPOTTED ROCKFISH	yes
GSPT	GREENSPOTTED ROCKFISH	yes
GSQD	GIANT SQUID	
GSR1	NOM. GREENSTRIPED ROCKFISH	yes
GSRK	GREENSTRIPED ROCKFISH	yes

PacFIN Species ID	PacFIN Common Name	FMP groundfish
GSRM	GHOST SHRIMP	
GSTG	GREEN STURGEON	
GTRB	GREENLAND TURBOT	
HBRK	HALFBANDED ROCKFISH	yes
HCLM	HORSE CLAMS	
HLQN	HARLEQUIN ROCKFISH	yes
HNY1	NOM. HONEYCOMB ROCKFISH	yes
HNYC	HONEYCOMB ROCKFISH	yes
HTRB	HORNYHEAD TURBOT	
ISRK	BIGEYE THRESHER SHARK	
JCLM	CALIFORNIA JACKKNIFE CLAM	
JMCK	JACK MACKEREL	
KFSH	GIANT KELPFISH	
KGL1	NOM. KELP GREENLING	yes
KLP1	NOM. KELP ROCKFISH	yes
KLPG	KELP GREENLING	yes
KLPR	KELP ROCKFISH	yes
KMKA	KAMCHATKA FLOUNDER	
KSTR	KUMAMOTO OYSTER	
LCD1	NOM. LINGCOD	yes
LCLM	NATIVE LITTLENECK	
LCOD	LINGCOD	yes
LDAB	LONGFIN SANDDAB	
LDB1	NOM. LONGFIN SANDDAB	
LOBS	CALIF. SPINY LOBSTER	
LSKT	LONGNOSE SKATE	yes
LSP1	NOM. LONGSPINE THORNYHEAD	yes
LSPN	LONGSPINE THORNYHEAD	yes
LSRK	LEOPARD SHARK	yes
LSTR	OLYMPIA OYSTER	
LUVR	LOUVAR	
MACL	MUD CLAMS	
MAKO	SHORTFIN MAKO SHARK	
MCLM	MANILA CLAM	
MEEL	MONKEYFACE EEL	
MISC	MISC. FISH/ANIMALS	
MOLA	COMMON MOLA	
MRLN	STRIPED MARLIN	
MSC2	MISCELLANEOUS FISH	
MSHP	PLAINFIN MIDSHIPMAN	
MSQD	MARKET SQUID	
MSRM	MUD SHRIMP	
MXR1	NOM. MEXICAN ROCKFISH	yes
MXRF	MEXICAN ROCKFISH	yes
NANC	NORTHERN ANCHOVY	
NRCK	NORTHERN ROCKFISH	yes
NSHR	NORTHERN NEAR-SHORE ROCKFISH	yes
NSLF	NORTHERN SHELF ROCKFISH	yes
NSLP	NORTHERN SLOPE ROCKFISH	yes
NUSF	NOR. UNSP. SHELF ROCKFISH	yes
NUSP	NOR. UNSP. SLOPE ROCKFISH	yes
NUSR	NOR. UNSP. NEAR-SHORE ROCKFISH	yes
OABL	OTHER ABALONE	
OANC	OTHER ANCHOVY	
OBAS	OTHER BASS	
OCLM	OTHER CLAM	
OCRB	OTHER CRAB	
OCRK	OTHER CROAKER	
OCTP	UNSP. OCTOPUS	
ODSR	OTHER DEMERSAL RKFSH	yes
OECH	OTHER ECHINODERM	
OFLT	OTHER FLATFISH	yes

PacFIN Species ID	PacFIN Common Name	FMP groundfish
OGRN	OTHER GROUND FISH	yes
OLV1	NOM. OLIVE ROCKFISH	yes
OLVE	OLIVE ROCKFISH	yes
OMSK	OTHER MOLLUSKS	
OPLG	OTHER PELAGIC RKFISH	yes
ORCK	OTHER ROCKFISH	yes
ORCK	OTHER ROCKFISH	yes
ORND	OTHER ROUND FISH	yes
OSCL	OTHER SCALLOP	
OSKT	OTHER SKATES	yes
OSLR	OTHER SLOPE RKFISH	yes
OSRK	OTHER SHARK	
OSRM	OTHER SHRIMP	
OSTR	OTHER OYSTER	
OTCR	OPILIO TANNER CRAB	
OTNA	OTHER TUNA	
OURC	OTHER SEA URCHINS	
OWFS	OCEAN WHITEFISH	
PABL	PINK ABALONE	
PBNT	PACIFIC BONITO	
PBTR	PACIFIC BUTTERFISH	
PCLM	PISMO CLAM	
PCOD	PACIFIC COD	yes
PDAB	PACIFIC SANDDAB	yes
PDB1	NOM. PACIFIC SANDDAB	yes
PGMY	PYGMY ROCKFISH	yes
PHLB	PACIFIC HALIBUT	
PHRG	PACIFIC HERRING	
PINK	PINK SALMON	
PLCK	WALLEYE POLLOCK	yes
PNK1	NOM. PINK ROCKFISH	yes
PNKR	PINK ROCKFISH	yes
POMF	PACIFIC POMFRET	
POP	PACIFIC OCEAN PERCH	yes
POP1	GEN. SHELF/SLOPE RF	yes
POP2	NOMINAL POP	yes
PRCL	PURPLE CLAM	
PROW	PROWFISH	
PRR1	NOM. PINKROSE ROCKFISH	yes
PRRK	PINKROSE ROCKFISH	yes
PSDN	PACIFIC SARDINE	
PSHP	PINK SHRIMP	
PSRK	PELAGIC THRESHER SHARK	
PSTR	PACIFIC OYSTER	
PTR1	NOM. PETRALE SOLE	yes
PTRL	PETRALE SOLE	yes
PUGT	PUGET SOUND ROCKFISH	yes
PWHT	PACIFIC WHITING	yes
QCLM	NORTHERN QUAHOG CLAM	
QFSH	QUEENFISH	
QLB1	NOM. QUILLBACK ROCKFISH	yes
QLBK	QUILLBACK ROCKFISH	yes
RABL	RED ABALONE	
RATF	SPOTTED RATFISH	yes
RCK1	BOCACCIO+CHILIPEPPER RCKFSH	yes
RCK2	UNSP. BOLINA RCKFSH	yes
RCK3	UNSP. DPWTR REDS RCKFSH	yes
RCK4	UNSP. REDS RCKFSH	yes
RCK5	UNSP. SMALL REDS RCKFSH	yes

PacFIN Species ID	PacFIN Common Name	FMP groundfish
RCK6	UNSP. ROSEFISH RCKFSH	yes
RCK7	UNSP. GOPHER RCKFSH	yes
RCK8	CANARY+VERMILION RCKFSH	yes
RCK9	BLACK+BLUE ROCKFISH	yes
RCKG	ROCK GREENLING	
RCLM	RAZOR CLAM	
RCRB	ROCK CRAB	
RDB1	NOM. REDBANDED ROCKFISH	yes
RDBD	REDBANDED ROCKFISH	yes
REDS	REDSTRIPE ROCKFISH	yes
REX	REX SOLE	yes
REX1	NOM. REX SOLE	yes
REYE	ROUGHEYE ROCKFISH	yes
RFLT	REMAINING FLATFISH	yes
RGL1	NOM. ROCK GREENLING	
RGRN	REMAINING GROUND FISH	yes
RHRG	ROUND HERRING	
RKCR	RED KING CRAB	
ROS1	NOM. ROSY ROCKFISH	yes
ROSY	ROSY ROCKFISH	yes
RPRW	RIDGEBACK PRAWN	
RRCK	REMAINING ROCKFISH	yes
RRND	REMAINING ROUND FISH	yes
RSOL	ROCK SOLE	yes
RST1	NOM. ROSETHORN ROCKFISH	yes
RSTN	ROSETHORN ROCKFISH	yes
RURC	RED SEA URCHIN	
RZCL	ROSY RAZOR CLAM	
SABL	SABLEFISH	yes
SAIL	SAILFISH	
SARY	PACIFIC SAURY	
SBL1	NOM. SHORTBELLY ROCKFISH	yes
SBLY	SHORTBELLY ROCKFISH	yes
SCLM	SOFT-SHELLED CLAM	
SCLP	UNSP. SCULPIN	
SCOR	CALIFORNIA SCORPIONFISH	yes
SCR1	NOM. CALIF. SCORPIONFISH	yes
SDB1	NOM. SPECKLED SANDDAB	
SFL1	NOM. STARRY FLOUNDER	yes
SFLT	UNSP. SHALLOW FLOUNDERS	yes
SHAD	UNSPECIFIED SHAD	
SHP1	NOM. CALIFORNIA SHEEPHEAD	
SHPD	CALIFORNIA SHEEPHEAD	
SHRP	SHARPCHIN ROCKFISH	yes
SKCR	SCARLET KING CRAB	
SLGR	SILVERGREY ROCKFISH	yes
SLNS	SLENDER SOLE	
SMLT	UNSP. SMELT	
SNOS	SPLITNOSE ROCKFISH	yes
SNS1	NOM. SPLITNOSE ROCKFISH	yes
SOCK	SOCKEYE SALMON	
SPK1	NOM. SPECKLED ROCKFISH	yes
SPKL	SPECKLED ROCKFISH	yes
SPRW	SPOTTED PRAWN	
SQID	UNSP. SQUID	
SQR1	NOM. SQUARESPOT	yes
SQRS	SQUARESPOT ROCKFISH	yes
SRFP	SURFPERCH SPP.	
SRKR	SHORTTRAKER ROCKFISH	yes
SSCL	SHARPNOSE SCULPIN	
SSDB	SPECKLED SANDDAB	
SSHR	SOUTHERN NEAR-SHORE ROCKFISH	yes

PacFIN Species ID	PacFIN Common Name	FMP groundfish
SSHR	SOUTHERN NEAR-SHORE ROCKFISH	yes
SSLF	SOUTHERN SHELF ROCKFISH	yes
SSLP	SOUTHERN SLOPE ROCKFISH	yes
SSO1	NOM. SAND SOLE	yes
SSOL	SAND SOLE	yes
SSP1	NOM. SHORTSPINE THORNYHEAD	yes
SSPN	SHORTSPINE THORNYHEAD	yes
SSRD	Deep So. Near-shore RF	yes
SSRK	SOUPFIN SHARK	yes
SSRS	Shallow So. Near-shore RF	yes
STAR	STARRY ROCKFISH	yes
STL1	NOM. STRIPETAILED ROCKFISH	yes
STLH	STEELHEAD	
STNA	SKIPJACK TUNA	
STR1	NOM. STARRY ROCKFISH	yes
STRK	STRIPETAILED ROCKFISH	yes
STRY	STARRY FLOUNDER	yes
SUSF	SOU. UNSP. SHELF ROCKFISH	yes
SUSP	SOU. UNSP. SLOPE ROCKFISH	yes
SUSR	SOU. UNSP. NEAR-SHORE ROCKFISH	yes
SUSR	SOU. UNSP. NEAR-SHORE ROCKFISH	yes
SWRD	SWORDFISH	
SWS1	NOM. SWORDSPINE ROCKFISH	yes
SWSP	SWORDFISH	yes
TCOD	PACIFIC TOMCOD	
TGR1	NOM. TIGER ROCKFISH	yes
THD1	NOM. THORNYHEADS	yes
THDS	THORNYHEADS (MIXED)	yes
TIGR	TIGER ROCKFISH	yes
TRE1	NOM. TREEFISH	yes
TREE	TREEFISH	yes
TSRK	COMMON THRESHER SHARK	
UABL	UNSPECIFIED ABALONE	
UCLM	UNSPECIFIED CLAM	
UCRB	UNSPECIFIED CRAB	
UDAB	UNSP. SANDDABS	yes
UDF1	UNSP. DEEP-91 FLOUNDERS	yes
UDF2	UNSP. DEEP-95 FLOUNDERS	yes
UDM1	UNSP. DEMERSAL-91	yes
UDNR	UNSP. DEEP NEAR-SHORE RF	yes
UDSR	UNSP. DEMERSAL RKFSH	yes
UDW1	SHORTRAKER+ROUGHEYE	yes
UECH	UNSPECIFIED ECHINODERM	
UFL1	FLOUNDERS (NO FSOL)	yes
UFLT	UNSP. FLATFISH	yes
UGRN	UNSP. GROUND FISH	yes
UHAG	UNSPECIFIED HAGFISH	
UHLB	UNSPECIFIED HALIBUT	
UJEL	UNSP. JELLYFISH	
UKCR	UNSP. KING CRAB	
UMCK	UNSP. MACKEREL	
UMSK	UNSPECIFIED MOLLUSKS	
UPLG	UNSP. PELAGIC RKFSH	yes
UPOP	UNSP. POP GROUP	yes
URCK	UNSP. ROCKFISH	yes
URCK	UNSP. ROCKFISH	yes
URK1	SRKR+REYE+NRCK+SHRP	yes
URND	UNSP. ROUND FISH	yes
USCL	UNSPECIFIED SCALLOP	
USCU	UNSP. SEA CUCUMBERS	
USF1	UNSP. SHALLOW-91 FLOUNDERS	yes
USHR	UNSP. NEAR-SHORE ROCKFISH	yes

<b>PacFIN Species ID</b>	<b>PacFIN Common Name</b>	<b>FMP groundfish</b>
USHR	UNSP. NEAR-SHORE ROCKFISH	yes
USKT	UNSP. SKATE	yes
USLF	UNSP. SHELF ROCKFISH	yes
USLP	UNSP. SLOPE ROCKFISH	yes
USLR	UNSP. SLOPE RKFSH	yes
USMN	UNSP. SALMON	
USR1	UNSP. SLOPE-91	yes
USR2	UNSP. SLOPE-93	yes
USRK	UNSP. SHARK	
USRM	UNSP. OCEAN SHRIMP	
USTG	UNSP. STURGEON	
USTR	UNSPECIFIED OYSTER	
UTCR	UNSP. TANNER CRAB	
UTNA	UNSPECIFIED TUNA	
UTRB	UNSP. TURBOTS	yes
UURC	UNSP. SEA URCHINS	
VRM1	NOM. VERMILLION ROCKFISH	yes
VRML	VERMILION ROCKFISH	yes
WABL	WHITE ABALONE	
WBAS	WHITE SEABASS	
WCLM	WASHINGTON CLAM	
WCRK	WHITE CROAKER	
WDOW	WIDOW ROCKFISH	yes
WDW1	NOM. WIDOW ROCKFISH	yes
WEEL	WOLF EEL	
WHOO	WAHOO	
WSTG	WHITE STURGEON	
YEY1	NOM. YELLOWEYE ROCKFISH	yes
YEYE	YELLOWEYE ROCKFISH	yes
YLTL	YELLOWTAIL	
YMTH	YELLOWMOUTH ROCKFISH	yes
YSOL	YELLOWFIN SOLE	
YTNA	YELLOWFIN TUNA	
YTR1	NOM. YELLOWTAIL ROCKFISH	yes
YTRK	YELLOWTAIL ROCKFISH	yes