



## NOAA FISHERIES SERVICE

# Observed and Estimated Total Bycatch of Salmon in the 2002-2010 US West Coast Fisheries



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## **Executive Summary**

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Salmon bycatch estimates are provided for 2002 through 2010 for all groundfish fishery sectors observed by the West Coast Groundfish Observer Program and the At-Sea Hake Observer Program (Table 5).

For all observed salmon species except Coho, bycatch estimates have decreased dramatically since 2002 or 2003. Coho bycatch estimates have fluctuated over time, but remain less than 60 fish each year (except 2004 estimate = 96 fish).

Bycatch estimates were relatively low in 2010 compared to the annual estimates in each of the prior 8 years (2002 – 2009). In the non-hake groundfish sectors, bycatch estimates were greatest in the limited entry trawl sector, followed by the nearshore fixed gear sector. Chinook had the highest 2010 bycatch estimates in both non-hake and hake sectors followed by coho and unspecified salmon. In 2010, no pink salmon were observed in either non-hake or hake sectors and no chum salmon were observed in non-hake sectors.

Two changes to methods and reporting were implemented in this report. First, this report presents statistical uncertainties in bycatch estimation in the form of standard error values for bycatch ratios. Second, we used non-parametric bootstrapping to estimate bycatch in strata with fewer than three vessels observed by resampling with replacement all observed hauls in a three year period within a stratum. This technique satisfies confidentiality requirements while still providing a bycatch estimate for all fished strata.

## Introduction

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The primary objective of this report is to provide estimates of salmon bycatch in U.S. West Coast groundfish fisheries for the years 2002-2010. We present observed bycatch ratios and estimated bycatch (number of individual fish) for five species observed in the groundfish fisheries: Chinook salmon (*Oncorhynchus tshawytscha*), pink salmon (*Oncorhynchus gorbuscha*), coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), and sockeye salmon (*Oncorhynchus nerka*). This report includes bycatch estimates for all fisheries observed by the West Coast Groundfish Observer Program (WCGOP) that were recorded to have caught salmon. These include the following commercial fisheries:

- Limited entry (LE) bottom trawl
- State-permitted nearshore fixed gear
- LE bottom trawl - targeting California halibut
- LE fixed gear sablefish primary (tier endorsed)

Commercial fisheries observed by the WCGOP which did not have any observed bycatch of salmon during the 2002-2010 period included:

- Open access (OA) bottom trawl - targeting California halibut
- LE fixed gear non-primary sablefish (non-endorsed)
- OA fixed gear
- Shrimp trawl (Washington, Oregon and California)

Salmon bycatch in the Pacific whiting mid-water trawl fishery are also presented in this report for reference, including non-tribal mothership, tribal mothership, and catcher-processor data collected by the At-Sea Hake Observer Program (A-SHOP), and shoreside tribal and shoreside exempted fishing permit (EFP) data compiled by the NOAA Fisheries Northwest Regional Office (NWR).

Endangered Species Act (ESA) listing determinations for 16 Evolutionarily Significant Units (ESUs) of Pacific salmon (*Oncorhynchus sp.*) were issued in 2005 (70 FR 37160). These listings consisted of two sockeye ESUs (one listed as endangered), nine Chinook ESUs (two listed as endangered), three coho ESUs (one listed as endangered), and two chum ESUs. Recent status review updates for all of the listed ESUs maintained the listing level issued in 2005 (Ford 2011, Williams *in press*).

## Data Sources

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Data sources for this report include data from observers aboard commercial fishing vessels (WCGOP and A-SHOP), logbooks, as well as landing receipt data (referred to as fish tickets).

Bycatch estimation analyses focused on commercial fishery sectors in which the Northwest Fisheries Science Center (NWFSC) Fishery Resource Analysis and Monitoring Division (FRAM) has conducted scientific at-sea observation of bycatch. The WCGOP and the A-SHOP observe distinct sectors of the groundfish fishery. The WCGOP observes a number of different sectors of the groundfish fishery, including the limited entry

(LE) groundfish bottom trawl, limited entry and open access (OA) fixed gear, and state-permitted nearshore fixed gear sectors. The WCGOP also observes several fisheries that incidentally catch groundfish, including the California halibut trawl and pink shrimp trawl fisheries. Observations by the A-SHOP are from the federally-permitted and tribal sectors that target Pacific hake using mid-water trawl gear and process catch at-sea. More information on each of these programs is available in annual data products by the A-SHOP and WCGOP (<http://www.nwfsc.noaa.gov/research/divisions/fram/observer/>). For a list of groundfish sectors not covered by either program see the description of observer coverage provided in the annual report on estimated mortality of groundfish species ([http://www.nwfsc.noaa.gov/research/divisions/fram/observer/pdf/total\\_mortality\\_2010.pdf](http://www.nwfsc.noaa.gov/research/divisions/fram/observer/pdf/total_mortality_2010.pdf)).

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. For more details about WCGOP goals, vessel selections, and data collection, see the WCGOP website at <http://www.nwfsc.noaa.gov/research/divisions/fram/observer/>. The website also provides estimates of observer coverage, observed catch, and a summary of observed fishing depths for each sector. A list of fisheries, in order of coverage priority and detailed information on data collection methods employed in each observed sector can be found in the WCGOP manual (NWFSC 2010a).

Observer and fish ticket data processing steps are described in detail on the WCGOP website under Data Processing, and in prior reports produced annually by the WCGOP at <http://www.nwfsc.noaa.gov/research/divisions/fram/observer/>. All subsequent data processing steps specific to this report are described in the methods section below.

When salmon are encountered by an observer, the observer documents total weight and number of fish for each species. In addition, observers record length, weight, and sex, note presence or absence of an adipose fin, collect scales or fin clips for genetics, and collect snouts for coded wire tag recovery for all or a subsample of individuals. Biological data for salmon have previously been summarized in WCGOP data reports for each sector available at: <http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm>

Vessel 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 vessel completed logbook information is entered into state agency databases. The electronic logbook data are then uploaded 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 2002-2010 were retrieved from the PacFIN database and divided into groundfish fishery sectors as indicated in Figure 1. All subsequent data processing steps are described in the methods section below. Logbook data from the open access groundfish trawl sector were not included in our analyses.

## Methods

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### Bycatch Estimation Methods

All vessels fishing in the at-sea hake fishery carry two A-SHOP observers for every fishing day. Thus, expansion of bycatch estimates to the fleet level using ratio estimation is not necessary. However, A-SHOP

observers sample 50% of each haul and thus recorded salmon bycatch numbers were extrapolated to the remainder of a single haul. Also, in some cases, not all hauls are sampled so the extrapolated haul level bycatch numbers were expanded further to account for the very small proportion of hauls that were not sampled each year (0.04% to 1.6% in 2002-2010). Documentation of A-SHOP data collection methods can be found in the observer manual (NWFSC 2010b). Extrapolated haul level data were provided by the A-SHOP. The bycatch numbers were then expanded using the provided expansion factors. The final bycatch numbers were incorporated into Table 5. The number of individual salmon caught was reported by each observed at-sea hake sector: tribal and non-tribal motherships, and catcher-processors.

A deterministic approach was used to estimate salmon bycatch for all WCGOP observed sectors of the groundfish fishery. Through this approach, observed bycatch rates for salmon were directly expanded to the fleet-wide level. First, bycatch ratios were computed from observer data as the catch (number of fish) of salmon divided by the retained weight of either groundfish species included in the groundfish fishery management plan (FMP) (excluding Pacific hake), California halibut, nearshore species, or sablefish, depending on the fishery. Denominators differed for each fishery based on the targeting behavior of that fishery. Fleet-wide estimates of salmon bycatch (number of fish) were obtained by multiplying bycatch ratios by the fleet-wide landed weight of FMP groundfish, California halibut, nearshore species, or sablefish, depending on the fishery. Because of differences in data availability and management structure among sectors, this approach was applied with slight modifications for each sector (details below).

When the 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 under a grouped species code such as NUSP - northern unspecified slope rockfish. By using only the retained groundfish weight from fish tickets in bycatch ratio denominators, we prevent double-counting of retained weights. This is not an issue when using a single species in the denominator (e.g., California halibut, sablefish) as any retained weights in observer and fish ticket data that share the same species code will match and adjust properly.

Species were defined and/or grouped for this report according to the WCGOP Data Processing Appendix, found at: [http://www.nwfsc.noaa.gov/research/divisions/fram/observer/data\\_processing.cfm](http://www.nwfsc.noaa.gov/research/divisions/fram/observer/data_processing.cfm). A complete listing of groundfish species is defined in the Groundfish Fishery Management Plan (see Chapter 3 Part 1, page 15 of [http://www.pcouncil.org/wp-content/uploads/GF\\_FMP\\_FINAL\\_Dec2011.pdf](http://www.pcouncil.org/wp-content/uploads/GF_FMP_FINAL_Dec2011.pdf)).

For all sectors, observer data were stratified into four latitudinal areas: 1) north of Cape Falcon, Oregon (45.77° N lat.), 2) Cape Falcon to Cape Blanco, Oregon (42.75° N lat.), 3) Cape Blanco to the groundfish management line near Cape Mendocino, California (40.16° N lat.), and 4) south of Cape Mendocino, California (Figure 2). These areas correspond to the coastline attributed to ESUs of Chinook and coho salmon.

Bycatch in each sector was often seasonally variable, presumably because of seasonal salmon migration patterns. Therefore, season stratification for salmon bycatch estimation, defined as winter (January-April and



November-December) and summer (May-October), was preferred. However, stratifying the data by season was not possible in all sectors due to limited sample sizes.

Depth stratification was used in the LE trawl fishery because salmon were caught almost exclusively in the 0-250 fathom depth range (Table 1). For the LE trawl sector, we used the legally-mandated logbooks to apportion fleet-wide catch to depth strata and thus expand bycatch estimates accordingly. Depth stratification was not possible in other sectors due to a lack of fleet-wide, haul level fishing depth information.

Fishery data are aggregated with a minimum of three vessels per stratum to ensure confidentiality mandates are met. Bycatch ratios were calculated directly using observer data only when data from three or more vessels could be aggregated per stratum. When the three vessel aggregation could not be met, bycatch ratios were produced by applying non-parametric bootstrap resampling, which enabled us to simultaneously meet confidentiality guidelines and estimate bycatch ratios. The non-parametric bootstrap model was developed in R ([www.r-project.org](http://www.r-project.org)). The model re-sampled observed hauls within a single stratum across three years (year of interest, plus one year before and one year after the year of interest) with replacement (10,000 iterations), producing a bycatch ratio from each iteration. A mean bycatch ratio was then calculated from the 10,000 resampled bycatch ratios to produce an average bycatch ratio estimate for that year in that stratum. A 95% confidence interval was calculated to estimate error in the mean bycatch ratio.

Standard errors (SE) of bycatch ratios were calculated based on the method presented by Pikitch et al. (1998) and are provided in Tables 1-4.

## **Limited Entry Bottom Trawl Sector**

Fleet-wide salmon bycatch estimates for the LE bottom (non-midwater) trawl sector were derived from WCGOP observer data, logbook data and fish ticket landings data (Figure 1).

Several additional filtering steps were then applied to the data to ensure that data for the LE bottom trawl sector was defined appropriately. We investigated tows and landings with more than 2 mt of Pacific hake, to exclude effort that was targeted exclusively towards this species. On the basis of this criterion, nine observed tows between 2002 and 2010 met the criterion and were removed.

LE bottom trawl vessels can hold a California halibut bottom trawl permit and participate in the state-permitted California halibut fishery. California halibut tows can occur on the same trip as tows targeting groundfish and were identified 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 data that met at least one of the above requirements were removed from the LE bottom trawl data and included as data for the California halibut fishery (see below). Tow targets are typically determined by the vessel captain.

Observer data and trawl logbook data were then stratified by area, season, and depth (Table 1). Records were separated into four areas (Figure 2) and each area was divided into three depth strata (0-125, 126-250, > 250 fathoms). Two-month cumulative trip limit periods were combined to form two seasonal strata: winter (January-April and November-December) and summer (May-October).

Once the data had been stratified, bycatch ratios were computed from the observer data and multiplied by fleet-wide fish ticket landing weight in each stratum. This expansion was done according to the following equation:

$$\hat{D}_{sx} = \frac{\sum_t b_{sxt}}{\sum_t r_{sxt}} \times adj(R_{sx})$$

where:

- $s$ : salmon species
- $x$ : index strata (year, area, season, depth)
- $t$ : tows in observer data
- $b$ : observed number of bycatch individuals of species  $s$
- $r$ : observed retained weight of all FMP groundfish except Pacific hake
- $adj(R_{sx})$ : fish ticket adjusted weight of retained FMP groundfish (except Pacific hake) recorded on logbooks (see below)
- $D$ : bycatch estimate for species  $s$  in each index stratum

Note that the denominator of observed bycatch ratios and the adjusted logbook expansion factor included weight from all retained FMP groundfish except Pacific hake. Pacific hake was excluded from the denominator because vessels that target or land large amounts are considered to be part of Pacific hake mid-water trawl sectors, which are distinct from the LE groundfish bottom trawl sector.

Although logbooks are a source to describe the depth distribution of fishing effort, logbooks are not submitted for 100% of trawl trips and therefore do not capture all groundfish bottom trawl fishing effort. In addition, logbook retained weights are vessel-supplied estimates whereas fish ticket landings are actually weighed and legally binding. As a result, it was necessary to adjust the initial retained logbook weights of FMP groundfish (excluding Pacific hake) by strata to reflect the level of effort indicated by fish ticket landings. To do this, both the fish ticket and logbook data were aggregated by year, latitudinal area and bimonthly period, to be consistent with cumulative trip limit periods. An adjusted logbook weight was then computed for each year, area 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 depth distributed logbook catches and then summed across bimonthly periods:

$$adj(R_{sx}) = \sum_n \sum_b \left( R_{sxbn} \times \frac{F_{yabn}}{R_{yabn}} \right)$$

where:

- $x$ : index strata (year, area, season, depth)
- $y$ : year
- $b$ : bimonthly period
- $a$ : latitudinal area
- $n$ : state
- $F$ : weight of retained FMP groundfish (except Pacific hake) recorded on fish tickets
- $R$ : weight of retained FMP groundfish (except Pacific hake) recorded on logbooks
- $adj(R_{sx})$ : fish ticket adjusted weight of retained FMP groundfish (except Pacific hake) recorded on logbooks

Adjustment ratios were computed separately for each state and bimonthly period to account for differences between individual states' logbook submission rates and fish ticket recording methods. An adjustment ratio value less than 1 indicated that more FMP groundfish weight was recorded in logbooks than on fish tickets. Conversely, adjustment ratios greater than 1 occurred when fish ticket FMP groundfish weights were larger than logbook weights. In 2010, the value of the adjustment ratios computed for the LE bottom trawl sector ranged between 0.648 and 1.292, with a mean of 1.014.

Observed number of salmon, bycatch ratios, and estimated fleet-wide bycatch of salmon by year, area, season, and depth are presented in Table 1 for the LE bottom trawl sector.

## **California Halibut Bottom Trawl Fishery**

Fleet-wide salmon 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 consider this fishery to consist of both a limited entry (LE) and an open access (OA) component (i.e. vessels that do not have federal limited entry groundfish permits). The WCGOP provides observer coverage for both of these components. The WCGOP provides observer coverage under the LE groundfish bottom trawl sector and isolates data for the LE component of the California halibut fishery 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 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 dataset. The WCGOP randomly samples the OA California halibut component separately. The LE and OA components of the California halibut trawl fishery remain separate in this report, with bootstrapped bycatch ratios used when fewer than 3 vessels were observed by WCGOP within a stratum.

Bycatch ratios were computed for this fishery using the retained weight of California halibut in the denominator. The fleet-wide landed weight of California halibut was then used as a multiplier to expand observed salmon bycatch ratios to the fleet level. 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 during the period 2002-2006.

Starting in 2007, the state of California required vessels participating in the LE and OA trawl fisheries landing more than 150 lbs of California halibut to possess a California halibut bottom trawl permit. While all OA vessels that landed more than 150 lbs of CA halibut in 2007 possessed a permit, not all LE vessels did. To account for all California halibut fishing in 2007, the permit list was used to identify California halibut vessels in the OA component, while the 'more than 150 lbs' guide was used to isolate California halibut trips in the LE component of the fishery.

By 2008, California halibut bottom trawl permits for both the LE and OA trawl components represented all vessels targeting California halibut. Thus, landed California halibut weights from 2008-2010 for both the LE and OA components were compiled from "non-mid-water" trawl fish tickets (see Figure 1) for those vessels that had a state-issued California halibut bottom trawl permit.

Salmon bycatch estimates were only computed for the limited entry component because no salmon have been observed in the open access component. All LE California halibut fishing activity occurred south of Cape Mendocino, California. Estimates were generated for each salmon species by year and season based on the following equation:

$$\hat{D}_{sx} = \frac{\sum_t b_{sxt}}{\sum_t r_{sxt}} \times F_x$$

where:

*s*: salmon species

*x*: index strata (year, season)

*t*: tows in observer data

*b*: observed number of bycatch individuals of species *s*

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

*F*: weight (mt) of retained California halibut recorded on all fish tickets

*D*: bycatch estimate for species *s* in each index stratum

Observed number of salmon, bycatch ratios, and estimated fleet-wide bycatch of salmon by year and season are presented in Table 2 for the LE component of the California halibut fishery.

LE groundfish trawl tows can be differentiated from California halibut tows during observed trips by the observer. However, fish tickets are reported at the trip level, and landings cannot be differentiated between tows. This inability to distinguish between catch from LE trawl tows and California halibut tows is not expected to be a major source of bias in our analysis, as the primary species retained on observed California halibut tows were non-groundfish (NWFSC 2011). However, because some flatfish species were retained on these tows, it is possible that bycatch estimates in California for the LE groundfish bottom trawl sector could have been positively biased due to slightly larger expansion factors (caused by the inclusion of landed flatfish that were in fact caught on California halibut tows). Examination of the species composition on fish tickets in the areas where California halibut is typically landed suggests that the impact of other landed species on bycatch estimates is minor.

## Nearshore Fixed Gear Sector

Fleet-wide bycatch estimates for the commercial nearshore fixed gear groundfish sector were derived from WCGOP observer data and fish ticket landings data. Fish ticket data were assigned to this sector using the classification system outlined in Figure 1 and included only those fish tickets with recorded nearshore species weight. A list of nearshore species and associated species groups used in this analysis are listed in the WCGOP Data Processing Appendix available at: [http://www.nwfsc.noaa.gov/research/divisions/fram/observer/data\\_processing.cfm](http://www.nwfsc.noaa.gov/research/divisions/fram/observer/data_processing.cfm).

The WCGOP provides coverage for the commercial nearshore fisheries in California and Oregon based on a selection process of state-issued nearshore permits/licenses. The state of Washington does not allow commercial fishing within coastal state waters. State regulations in California and Oregon have extended the authority of the WCGOP to require that observers be carried by vessels participating in these state nearshore fisheries.

Bycatch ratios for this fishery were calculated by dividing the observed bycatch of each salmon species (number of fish) by the observed retained weight (mt) of nearshore species (Table 3). The fleet landed weight of nearshore species was then used as a multiplier to expand observed salmon bycatch ratios to the fleet. The equation for the expansion of bycatch ratios in the nearshore sector is identical to that presented for the California halibut fishery, where  $r$  represents the retained weight of nearshore species,  $x$  represents index strata of year, area and season and  $F$  represents the weight of retained nearshore species recorded on fish tickets.

Observed number of salmon, bycatch ratios, and estimated fleet-wide bycatch of salmon by year, area, and season are presented in Table 3 for the nearshore fixed gear groundfish sector.

## **Non-Nearshore Fixed Gear Sector**

### *Limited Entry Sablefish Primary*

Salmon were only observed in the hook-and-line portion of the LE sablefish primary sector of the non-nearshore fixed gear groundfish fleet. Fleet-wide bycatch estimates for the commercial LE fixed gear sablefish primary sector were derived from WCGOP observer data and fish ticket landings data. For further information about how this sector is defined refer to the 2010 Groundfish Mortality report (Bellman et al. 2011; [http://www.nwfsc.noaa.gov/research/divisions/fram/observer/pdf/total\\_mortality\\_2010.pdf](http://www.nwfsc.noaa.gov/research/divisions/fram/observer/pdf/total_mortality_2010.pdf)).

Bycatch ratios for this sector were calculated by dividing the observed bycatch of each salmon species (number of fish) by the observed retained weight (mt) of sablefish (Table 4). The fleet landed weight of sablefish was then used as a multiplier to expand observed salmon bycatch ratios to the fleet. The equation for the expansion of bycatch ratios in the LE sablefish primary sector is identical to that presented for the California halibut fishery, where  $r$  represents the retained weight of sablefish,  $x$  represents index strata of year and area, and  $F$  represents the weight of retained sablefish recorded on fish tickets.

Observed number of salmon, bycatch ratios, and estimated fleet-wide bycatch of salmon by year and area are presented in Table 4 for the LE sablefish primary fixed gear groundfish sector.

## **Biological Data Collection**

For protected resources, including any species regulated under the Endangered Species Act (ESA), additional biological data are collected whenever possible. For salmon species, observers record length, sex, presence/absence of adipose fin, and collect scales, snouts and pectoral fin clips. Snouts are collected to detect the presence of coded-wire tags (CWT). CWT data is delivered to a regional database, the Regional Mark Information System (RMIS) (<http://www.rmpc.org>). CWT data have been used to study the marine distribution of Chinook salmon (Weitkamp 2010), and coho salmon (Weitkamp and Neely 2002) in the Pacific Ocean.

Pectoral fin clip samples are used for genetic mixed stock analysis (also known as “genetic stock identification”) to estimate Chinook salmon stock composition and to better understand the stock-specific, spatial, and temporal distribution of bycatch. Results from genetic mixed stock analysis of 2008 WCGOP and A-SHOP salmon bycatch were provided in a report to the Northwest Regional Office (Moran et al. 2009). Most of the Chinook salmon collected by WCGOP in 2008 came from the Klamath River with a smaller

fraction coming from the Oregon and California coastal populations. Those three stocks accounted for more than 70% of the WCGOP samples in 2008. WCGOP provided 37 fin clips from 2008 sampling, 51 fin clips from 2009 sampling, and 8 from 2010 sampling to the Genetic and Evolution Laboratory at the NWFSC. Analysis of 2009 and 2010 WCGOP samples is currently on hold.

Table 6 summarizes salmon biological data collected by WCGOP observers from September 2003 through April 2010 by fishery sector. Across all years, observers sampled a total of 741 Chinook salmon, 20 coho salmon, 2 chum salmon, 1 pink salmon, and 3 unidentified salmon. Biological data for salmon have previously been summarized in WCGOP data reports for each sector, which are available at: <http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm>.

## Results

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Salmon bycatch was estimated for all fisheries observed by the WCGOP in which salmon were reported for the 2002-2010 period. These included the LE bottom trawl sector (Table 1), the LE component of the California halibut fishery (Table 2), the nearshore fixed gear sector (Table 3), and the LE sablefish primary sector of the non-nearshore fixed gear groundfish fleet (Table 4).

A summary of annual estimated salmon bycatch (number of fish) for each sector from 2002 to 2010 is provided in Table 5, along with salmon bycatch values for various sectors of the Pacific hake mid-water trawl fishery. Bycatch values from the at-sea Pacific hake sectors were from the A-SHOP, whereas the bycatch values from the shoreside tribal and EFP Pacific hake sectors were compiled from season summaries of the Pacific hake fishery by the Northwest Regional Office found at <http://www.nwr.noaa.gov/Groundfish-Halibut/Groundfish-Fishery-Management/Whiting-Management/>. Estimates of salmon species bycatch were not available for the shoreside Pacific hake sectors prior to 2007, except for Chinook salmon.

Point estimates of bycatch fluctuate due to a number of non-biological factors, including annual variation in observer coverage rates, fishing behavior, and various physical characteristics. Currently, it is not possible to fully quantify uncertainty for bycatch estimates presented in this report, as measures of the variability associated with all data sources are not available. Estimates of observer data uncertainty are presented in this report in the form of bycatch ratio standard errors.

While we provide estimates for the total number of salmon caught in observed groundfish fisheries on the U.S. West coast, discard survivorship rates have not been applied to these estimates.

### **Chinook salmon (*Oncorhynchus tshawytscha*)**

Overall, bycatch of Chinook salmon decreased substantially since 2003 in all of the WCGOP observed sectors (Table 5). The largest estimate of salmon bycatch in the non-hake groundfish sectors occurred in 2003 when 16,617 fish were estimated to have been caught by all of the sectors combined. Most of the 2003 individuals (~99%) were caught by the LE trawl sector. Chinook bycatch levels in the non-hake sectors dropped by an order of magnitude in 2004 and was down to 1328 fish in 2005. Chinook bycatch levels have hovered around 400 fish until 2010, which had the lowest Chinook bycatch level since observations began in 2002 and was estimated at 72 fish. Bycatch in the at-sea Pacific hake sectors decreased as well but less dramatically.

The largest bycatch of Chinook salmon in the 2010 non-hake groundfish sectors was estimated in the limited entry bottom trawl sector at 55 individual fish (Table 5). These were attributed to the two areas between Cape Falcon, Oregon and Cape Mendocino, California. The majority of Chinook bycatch in the LE trawl sector is attributed to areas north of Cape Mendocino, California in all years (Table 1).

### **Chum salmon (*Oncorhynchus keta*)**

Overall, bycatch of chum salmon decreased from a high of 30 fish in 2003 to zero in 2005 and has since stayed at zero in the non-hake groundfish sectors (Table 5). All bycatch of chum in non-hake sectors occurred in the LE trawl sector.

In Pacific hake sectors, chum bycatch has remained below 115 fish in all years except 2007 when 291 fish were recorded. Estimates prior to 2007 should be considered underestimates because estimates for all salmon species except Chinook were not available for the shoreside tribal and EFP Pacific hake sectors. The lowest Pacific hake sector bycatch of chum salmon occurred in 2010 at 19 fish.

### **Coho salmon (*Oncorhynchus kisutch*)**

Overall, bycatch of coho salmon fluctuated between 2002-2010 in the non-hake groundfish sectors but stayed below 100 fish each year (Table 5). Bycatch of coho in non-hake sectors was predominantly from the LE trawl sector in 2002- 2005, was exclusively from the LE California halibut component in 2006, was exclusively from the nearshore fixed gear sector in 2008-2009, and the LE trawl and nearshore fixed gear sectors made up the bycatch in 2010. Coho bycatch was highest in 2004 with an estimated 95 fish. The second highest coho bycatch estimate was in 2010 at 57 fish.

In Pacific hake sectors, coho bycatch peaked in 2007 at 475 fish, then dropped abruptly in 2008 to 52 fish (low 2006 bycatch at 31 fish). Estimates prior to 2007 should be considered underestimates because estimates for all salmon species except Chinook were not available for the shoreside tribal and EFP Pacific hake sectors. The lowest Pacific hake sector bycatch of coho occurred in 2010 at 21 fish.

### **Pink salmon (*Oncorhynchus gorbuscha*)**

Pink salmon bycatch was only observed in the limited entry bottom trawl sector during 2009 (Table 1). One individual pink salmon was observed during the summer season in depths shallower than 125 fathoms south of Cape Mendocino, California.

In Pacific hake sectors, pink salmon bycatch is mainly attributed to tribal mothership and shoreside sectors. Estimates prior to 2007 should be considered underestimates because estimates for all salmon species except Chinook were not available for the shoreside tribal and EFP Pacific hake sectors. Pink salmon were not observed in 2010.

## **Unspecified salmon**

Unspecified salmon species bycatch was highest in 2002 (111 fish), mostly from the LE California halibut fishery. Between 2005 and 2009, no unspecified salmon were recorded suggesting improved sampling and identification of salmon species. There are still cases when identifying salmon to species is not possible, such as when a salmon is observed on fishing gear but drops off the gear before reaching the deck. Two observed salmon fell into this category in 2010 in the nearshore fixed gear groundfish sector, explaining the increase from zero to 24 unspecified salmon estimated in 2010.

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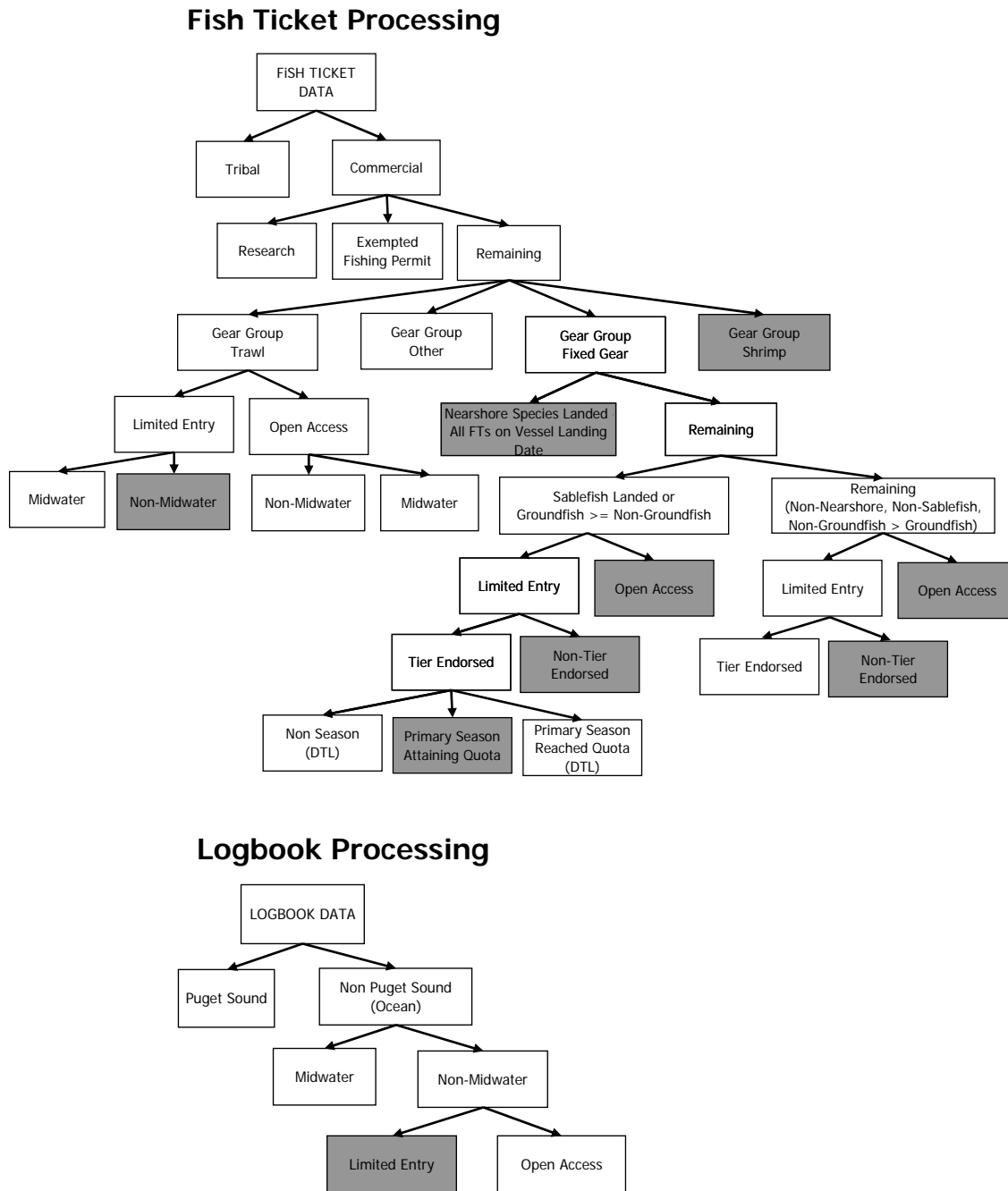
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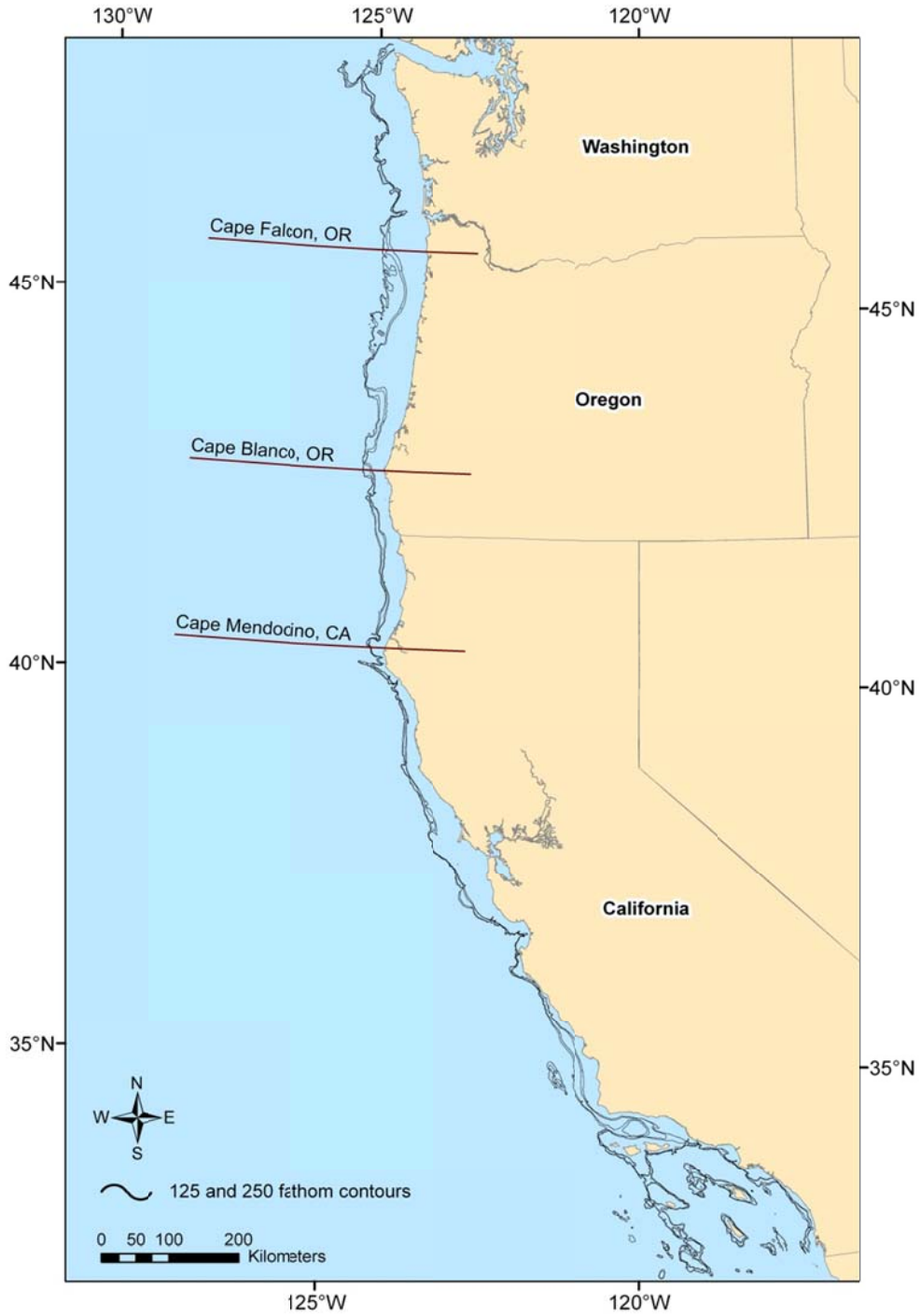
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# Figures

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



**Figure 2.** Geographic latitudinal regions and depths utilized in salmon bycatch estimation in the limited entry groundfish bottom trawl sector. Latitudinal regions are also used to summarize salmon bycatch estimates in the U.S. west coast groundfish fisheries.



# Tables

**Table 1.** WCGOP numbers of salmon observed, and bycatch ratios from limited entry groundfish bottom trawl vessels in four latitudinal areas, two seasons and three depth strata from 2002-2010. Bycatch ratios were calculated for each stratum as the observed catch of each salmon species (no. of fish) divided by the observed weight (mt) of retained groundfish (except Pacific hake) in each year. A fleet-wide bycatch estimate is obtained by multiplying the observed bycatch ratio by the fleet groundfish landings (mt). Discard survivorship rates have not been applied to these estimates. Winter season is January-April and November-December; summer is May-October. Italicized bycatch ratios and bycatch estimates result from bootstrapping in stratum (\*) with fewer than three observed vessels. Dashes (--) signify that the stratum was not observed. NA = Not Applicable.

Year	Area	Season	Depth (fm)	Observed Groundfish Catch (mt)	Fleet Groundfish Landings (mt)	Chinook				Chum				Coho				Pink				Unspecified			
						Observed		SE of Ratio	Bycatch Estimate (no. of fish)	Observed		SE of Ratio	Bycatch Estimate (no. of fish)	Observed		SE of Ratio	Bycatch Estimate (no. of fish)	Observed		SE of Ratio	Bycatch Estimate (no. of fish)	Observed		SE of Ratio	Bycatch Estimate (no. of fish)
						Bycatch (no. of fish)	Bycatch Ratio			Bycatch (no. of fish)	Bycatch Ratio			Bycatch (no. of fish)	Bycatch Ratio			Bycatch (no. of fish)	Bycatch Ratio			Bycatch (no. of fish)	Bycatch Ratio		
2002	North of Cape Falcon	winter	0-125	163.66	955.72	137	0.835	0.16	806.17	0	0.000	NA	0.00	1	0.006	0.01	5.90	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	236.04	1005.67	74	0.314	0.11	315.28	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	1	0.004	0.00	4.26
			>250	170.44	926.83	5	0.029	0.02	27.19	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	441.22	4116.89	116	0.263	0.05	1082.37	1	0.002	0.00	9.33	2	0.005	0.00	18.66	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	9.46	731.09	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	19.99	209.52	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	winter	0-125	52.85	458.18	132	2.497	1.20	1144.27	0	0.000	NA	0.00	1	0.019	0.02	8.67	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	69.64	773.53	544	7.812	4.92	6042.52	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	144.96	1067.83	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	121.00	978.89	7	0.058	0.03	56.63	1	0.008	0.01	8.09	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	17.51	219.40	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	52.06	345.49	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	winter	0-125	24.93	263.89	181	7.259	3.69	1915.65	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	1	0.040	0.04	10.58
			125-250	31.98	438.29	194	6.066	3.60	2658.66	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	197.98	1301.86	6	0.030	0.03	39.45	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	65.68	754.61	106	1.614	0.71	1217.94	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	17.47	176.90	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	103.27	634.16	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0-125	69.68	523.74	21	0.301	0.14	157.85	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	61.51	612.71	2	0.033	0.02	19.92	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	140.66	1154.23	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	7.61	270.08	3	0.394	0.29	106.42	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	109.93	650.34	6	0.055	0.04	35.49	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	254.06	1650.62	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00

Table 1 (continued).

Year	Area	Season	Depth (fm)	Observed Groundfish Catch (mt)	Fleet Landings (mt)	Chinook				Chum				Coho				Pink				Unspecified							
						Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate				
						Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio					
2003	North of Cape Falcon	winter	0-125	193.86	1257.31	98	0.506	0.12	635.58	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	90.14	993.71	29	0.322	0.14	319.71	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	162.30	1074.23	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	75.08	1393.69	121	1.612	0.71	2246.11	1	0.013	0.01	18.56	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	132.52	809.08	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	113.43	592.25	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	winter	0-125	105.13	647.20	1234	11.742	4.40	7599.79	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	162.46	831.85	569	3.502	1.69	2913.38	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	198.55	857.56	8	0.040	0.04	34.55	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	*	644.89	*	0.300	0.05 - 0.69	193.24	*	0.006	0 - 0.01	3.76	*	0.019	0 - 0.04	12.14	*	0.000	NA	0.00	*	0.012	0 - 0.03	7.54	*	0.012	0 - 0.03	7.54
			125-250	76.89	628.20	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	99.41	712.04	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	winter	0-125	35.98	187.28	146	4.059	1.53	760.17	0	0.000	NA	0.00	1	0.028	0.03	5.20	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	43.07	302.81	184	4.272	2.73	1293.62	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	188.43	966.30	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	23.00	229.82	23	1.000	0.61	229.79	0	0.000	NA	0.00	2	0.087	0.09	19.98	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	126.72	642.38	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	242.52	1394.22	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0-125	*	226.49	*	0.269	0.08 - 0.53	60.86	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
			125-250	34.39	477.64	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
>250			141.63	1265.18	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
summer		0-125	50.05	369.72	20	0.400	0.17	147.74	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		125-250	49.77	363.62	0	0.000	NA	0.00	1	0.020	0.02	7.31	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		>250	217.34	1737.03	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
2004	North of Cape Falcon	winter	0-125	152.83	319.25	146	0.958	0.28	305.84	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	2	0.013	0.01	4.18	2	0.013	0.01	4.18
			125-250	360.86	1502.99	36	0.100	0.03	149.94	1	0.003	0.00	4.17	1	0.003	0.00	4.17	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	402.75	1408.99	2	0.005	0.00	7.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	432.08	2751.04	33	0.077	0.02	210.81	0	0.000	NA	0.00	1	0.002	0.00	6.37	0	0.000	NA	0.00	1	0.002	0.00	6.37	1	0.002	0.00	6.37
			125-250	154.03	929.82	1	0.006	0.01	6.04	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	83.15	255.58	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	winter	0-125	12.52	14.51	7	0.559	0.31	8.11	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	243.51	808.72	94	0.386	0.14	312.18	0	0.000	NA	0.00	4	0.016	0.01	13.28	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	289.37	1170.13	1	0.003	0.00	4.04	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	41.69	537.95	36	0.864	0.68	464.53	0	0.000	NA	0.00	3	0.078	0.06	42.19	0	0.000	NA	0.00	2	0.048	0.05	25.81	2	0.048	0.05	25.81
			125-250	221.27	1020.37	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	225.86	653.67	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	winter	0-125	*	6.10	*	3.695	1.39 - 6.88	22.55	*	0.000	NA	0.00	*	0.026	0 - 0.08	0.16	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
			125-250	101.24	278.46	78	0.770	0.31	214.54	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	232.71	638.56	1	0.004	0.00	2.74	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	81.19	472.66	3	0.037	0.02	17.46	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	99.85	437.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	165.62	761.05	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0-125	8.84	77.88	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	89.03	383.24	2	0.022	0.02	8.61	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
>250			407.30	1093.67	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
summer		0-125	70.57																										







Table 1 (continued).

Year	Area	Season	Depth (fm)	Observed Groundfish Catch (mt)	Fleet Landings (mt)	Chinook				Chum				Coho				Pink				Unspecified											
						Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate								
						Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio					
2009	North of Cape Falcon	winter	0-125	41.14	152.21	39	0.948	0.54	144.29	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	576.42	2835.69	2	0.003	0.00	9.84	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	615.63	2899.40	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	517.04	1917.20	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	316.78	2027.56	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	282.01	1262.71	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	winter	0-125	*	17.42	*	0.115	0 - 0.38	2.01	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
			125-250	379.66	1391.10	14	0.037	0.02	51.30	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	783.86	2626.94	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	193.22	834.23	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	333.45	1175.43	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	405.21	1373.52	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	winter	0-125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
			125-250	94.48	623.09	5	0.053	0.03	32.97	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	392.00	1502.95	2	0.005	0.01	7.67	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	*	139.18	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
125-250			119.81	865.15	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
>250			353.58	1714.38	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
South of Cape Mendocino	winter	0-125	6.05	75.93	1	0.165	0.17	12.54	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		125-250	63.82	516.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		>250	155.37	665.57	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
	summer	0-125	78.81	195.73	18	0.228	0.11	44.71	0	0.000	NA	0.00	0	0.000	NA	0.00	1	0.013	0.01	2.48	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		125-250	142.01	490.87	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
		>250	171.57	842.24	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
2010	North of Cape Falcon	winter	0-125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--		
			125-250	269.54	1985.57	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	398.03	2636.45	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	236.75	1303.50	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	421.22	2168.70	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	344.13	1247.89	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	winter	0-125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
			125-250	139.62	1263.48	4	0.029	0.02	36.20	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	364.78	2166.18	0	0.000	NA	0.00	0	0.000	NA	0.00	4	0.011	0.01	23.75	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	87.82	351.66	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			125-250	257.76	1064.51	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
			>250	390.93	1494.27	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	winter	0-125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
			125-250	*	377.33	*	0.049	0.00 - 0.10	18.47	*	0.000	NA	0.00	*	0.008	0 - 0.02	3.06	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
			>250	138.37	1373.48	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
		summer	0-125	*	13.23	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
125-250			200.40	827.65	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	
>250			464.08	1426.65	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00													

**Table 2.** WCGOP numbers of salmon observed, and bycatch ratios from limited entry California halibut trawl vessels south of Cape Mendocino, CA in two seasons from 2002-2010. Bycatch ratios were calculated for each season as the observed catch of each salmon species (no. of fish) divided by the observed weight (mt) of retained California halibut in each year. A fleet-wide bycatch estimate is obtained by multiplying the observed bycatch ratio by the fleet California halibut landings (mt). Discard survivorship rates have not been applied to these estimates. Winter season is January-April and November-December; summer is May-October. Italicized bycatch ratios and bycatch estimates result from bootstrapping in stratum (\*) with fewer than three observed vessels. Dashes (--) signify that the stratum was not observed. NA= Not Applicable.

Year		Observed California Halibut Catch (mt)	Fleet California Halibut Landings (mt)	Chinook				Coho				Unspecified			
				Observed			Estimate (no. of fish)	Observed			Estimate (no. of fish)	Observed			Estimate (no. of fish)
				Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio	
2002	winter	3.59	68.80	13	3.625	1.46	249.36	0	0.000	NA	0.00	5	1.394	1.39	95.91
	summer	*	36.38	*	<i>1.764</i>	<i>0.77 - 2.85</i>	64.17	*	<i>0.000</i>	<i>NA</i>	<i>0.00</i>	*	<i>0.000</i>	<i>NA</i>	<i>0.00</i>
2003	winter	12.88	61.92	9	0.699	0.25	43.26	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	6.22	43.62	11	1.767	0.63	77.09	0	0.000	NA	0.00	0	0.000	NA	0.00
2004	winter	14.69	79.88	88	5.991	2.01	478.53	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	16.80	56.45	4	0.238	0.12	13.44	0	0.000	NA	0.00	0	0.000	NA	0.00
2005	winter	10.73	131.43	31	2.888	0.79	379.63	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	19.78	57.44	15	0.758	0.29	43.56	0	0.000	NA	0.00	0	0.000	NA	0.00
2006	winter	11.07	80.61	13	1.174	0.63	94.63	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	3.21	38.94	1	0.311	0.31	12.12	4	1.245	1.24	48.48	0	0.000	NA	0.00
2007	winter	3.00	27.42	11	3.663	2.26	100.45	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	2.42	11.77	5	2.069	1.70	24.36	0	0.000	NA	0.00	0	0.000	NA	0.00
2008	winter	9.51	35.79	21	2.209	0.76	79.07	0	0.000	NA	0.00	0	0.000	NA	0.00
	summer	0.13	3.24	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2009	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	summer	2.90	7.59	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2010	winter	*	33.13	*	*	*	*	*	*	*	*	*	*	*	*
	summer	*	21.59	*	<i>0.000</i>	<i>NA</i>	<i>0.00</i>	*	<i>0.000</i>	<i>NA</i>	<i>0.00</i>	*	<i>0.000</i>	<i>NA</i>	<i>0.00</i>

**Table 3.** WCGOP numbers of salmon observed, and bycatch ratios from nearshore fixed gear vessels in four latitudinal areas and two seasons from 2002-2010. Bycatch ratios were calculated for each stratum as the observed catch of each salmon species (no. of fish) divided by the observed weight (mt) of retained nearshore groundfish species in each year. A fleet-wide bycatch estimate is obtained by multiplying the observed bycatch ratio by the fleet nearshore species landings (mt). Discard survivorship rates have not been applied to these estimates. Winter season is January-April and November-December; summer is May-October. Italicized bycatch ratios and bycatch estimates result from bootstrapping in stratum (\*) with fewer than three observed vessels. Dashes (--) signify that the stratum was not observed. NA= Not Applicable.

Year	Area	Season	Observed Nearshore spp Catch (mt)	Fleet Nearshore spp Landings (mt)	Chinook				Coho				Unspecified				
					Observed			Bycatch Estimate	Observed			Bycatch Estimate	Observed			Bycatch Estimate	
					Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		
2002	North of Cape	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Blanco	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Blanco -	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Mendocino	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	South of Cape	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mendocino	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2003	North of Cape	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Blanco	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Blanco -	winter	0.42	52.14	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Cape Mendocino	summer	2.88	177.89	1	0.347	0.35	61.69	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	South of Cape	winter	0.36	34.23	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Mendocino	summer	4.43	143.84	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
2004	North of Cape	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Blanco	summer	8.11	43.00	2	0.247	0.25	10.60	2	0.247	0.17	10.60	0	0.000	NA	0.00	0.00
	Cape Blanco -	winter	5.26	53.47	1	0.190	0.19	10.17	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Cape Mendocino	summer	10.07	187.86	0	0.000	NA	0.00	1	0.099	0.10	18.66	0	0.000	NA	0.00	0.00
	South of Cape	winter	2.66	35.64	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Mendocino	summer	7.24	166.11	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
2005	North of Cape	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	2.34	9.38	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Cape Blanco	summer	5.38	31.73	1	0.186	0.19	5.90	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Cape Blanco -	winter	2.43	72.75	1	0.411	0.41	29.89	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Cape Mendocino	summer	10.25	170.46	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	South of Cape	winter	1.43	44.61	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00
	Mendocino	summer	2.88	130.89	1	0.347	0.35	45.47	0	0.000	NA	0.00	0	0.000	NA	0.00	0.00

Table 3 (continued).

Year	Area	Season	Observed Nearshore spp Catch (mt)	Fleet Nearshore spp Landings (mt)	Chinook				Coho				Unspecified			
					Observed			Bycatch Estimate (no. of fish)	Observed			Bycatch Estimate (no. of fish)	Observed			Bycatch Estimate (no. of fish)
					Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio		Bycatch (no. of fish)	Bycatch Ratio	SE of Ratio	
2006	North of Cape Falcon	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	North of Cape Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	0.97	3.81	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco	summer	10.79	37.63	1	0.093	0.09	3.49	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco -	winter	2.04	29.23	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Mendocino	summer	11.51	185.90	1	0.087	0.09	16.15	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	1.00	41.67	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	summer	1.45	126.96	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2007	North of Cape Falcon	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	North of Cape Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	1.24	3.51	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco	summer	9.51	35.05	0	0.000	NA	0.00	1	0.105	0.11	3.68	0	0.000	NA	0.00
	Cape Blanco -	winter	4.06	52.45	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Mendocino	summer	10.60	200.81	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0.74	38.36	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	summer	2.09	120.96	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2008	North of Cape Falcon	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	North of Cape Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	2.81	4.92	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco	summer	7.34	32.67	0	0.000	NA	0.00	3	0.409	0.30	13.35	0	0.000	NA	0.00
	Cape Blanco -	winter	3.82	81.42	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Mendocino	summer	5.59	198.71	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0.29	44.49	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	summer	0.97	119.89	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2009	North of Cape Falcon	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	North of Cape Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	1.59	8.48	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco	summer	9.85	37.10	1	0.102	0.10	3.77	6	0.609	0.29	22.59	0	0.000	NA	0.00
	Cape Blanco -	winter	3.86	78.74	1	0.259	0.26	20.42	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Mendocino	summer	3.58	205.14	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	winter	0.26	49.79	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	South of Cape Mendocino	summer	1.43	104.78	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
2010	North of Cape Falcon	winter	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	North of Cape Falcon	summer	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cape Falcon -	winter	2.49	4.86	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Blanco	summer	5.90	36.33	1	0.170	0.17	6.16	2	0.339	0.34	12.33	1	0.170	0.17	6.16
	Cape Blanco -	winter	0.94	47.05	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00
	Cape Mendocino	summer	8.27	146.14	0	0.000	NA	0.00	1	0.121	0.12	17.67	1	0.121	0.12	17.67
	South of Cape Mendocino	winter	*	42.60	*	0.000	NA	0.00	*	0.000	NA	0.00	*	0.000	NA	0.00
	South of Cape Mendocino	summer	2.36	114.70	0	0.000	NA	0.00	0	0.000	NA	0.00	0	0.000	NA	0.00

**Table 4.** WCGOP numbers of salmon observed, and bycatch ratios from limited entry sablefish primary fixed gear vessels in four latitudinal areas from 2002-2010. Bycatch ratios were calculated for each area as the observed catch of each salmon species (no. of fish) divided by the observed weight (mt) of retained sablefish in each year. A fleet-wide bycatch estimate is obtained by multiplying the observed bycatch ratio by the fleet sablefish landings (mt). Discard survivorship rates have not been applied to these estimates. Italicized bycatch ratios and bycatch estimates result from bootstrapping in stratum (\*) with fewer than three observed vessels. Dashes (--) signify that the stratum was not observed. NA=Not Applicable.

Year	Area	Observed Sablefish Catch (mt)	Fleet Sablefish Landings (mt)	Coho			Bycatch Estimate (no. of fish)
				Observed		SE of Ratio	
				Bycatch (no. of fish)	Bycatch Ratio		
2002	North of Cape Falcon	103.25	454.15	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	70.64	132.60	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	10.27	109.67	0	0.000	NA	0.00
	South of Cape Mendocino	6.62	73.55	0	0.000	NA	0.00
2003	North of Cape Falcon	158.30	482.16	1	0.006	0.01	3.05
	Cape Falcon - Cape Blanco	40.59	203.38	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	13.12	177.93	0	0.000	NA	0.00
	South of Cape Mendocino	*	112.23	*	0.000	NA	0.00
2004	North of Cape Falcon	94.68	773.40	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	64.31	215.52	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	*	135.44	*	0.000	NA	0.00
	South of Cape Mendocino	9.61	132.58	0	0.000	NA	0.00
2005	North of Cape Falcon	253.56	666.30	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	123.27	251.50	1	0.008	0.01	2.04
	Cape Blanco - Cape Mendocino	77.99	187.68	0	0.000	NA	0.00
	South of Cape Mendocino	26.63	105.92	0	0.000	NA	0.00
2006	North of Cape Falcon	177.79	823.85	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	95.10	206.16	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	*	225.05	*	0.000	NA	0.00
	South of Cape Mendocino	*	73.35	*	0.000	NA	0.00
2007	North of Cape Falcon	162.70	589.56	1	0.006	0.01	3.62
	Cape Falcon - Cape Blanco	106.32	185.39	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	11.41	156.39	0	0.000	NA	0.00
	South of Cape Mendocino	18.16	85.71	0	0.000	NA	0.00
2008	North of Cape Falcon	116.71	537.84	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	167.81	228.82	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	43.34	138.94	0	0.000	NA	0.00
	South of Cape Mendocino	*	91.99	*	0.000	NA	0.00
2009	North of Cape Falcon	43.88	672.91	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	36.22	346.56	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	*	225.53	*	0.000	NA	0.00
	South of Cape Mendocino	*	135.11	*	0.000	NA	0.00
2010	North of Cape Falcon	151.72	557.52	0	0.000	NA	0.00
	Cape Falcon - Cape Blanco	155.41	414.25	0	0.000	NA	0.00
	Cape Blanco - Cape Mendocino	16.79	135.15	0	0.000	NA	0.00
	South of Cape Mendocino	18.55	182.10	0	0.000	NA	0.00

**Table 5.** Estimated bycatch of salmon (no. of fish) in all U.S. west coast fisheries observed by the West Coast Groundfish Observer Program (WCGOP) and the At-Sea Hake Observer Program (\* = A-SHOP) from 2002-2010, as well as salmon bycatch in shoreside Pacific hake sectors (\*\* = numbers from annual NWR reports). Dashes (--) signify years when the fishery/sector was not observed, or data were not available.

Species	Sector	Year									
		2002	2003	2004	2005	2006	2007	2008	2009	2010	
Chinook	Non-hake sectors	Limited Entry Trawl	15626	16435	1746	824	61	193	338	305	55
		Limited Entry California Halibut	314	120	492	423	107	125	79	0	11
		Limited Entry Sablefish Primary	0	0	0	0	0	0	0	0	0
		Nearshore	--	62	21	81	20	0	0	24	6
	Hake sectors	Non-Tribal Mothership *	713	2060	388	2207	1095	585	226	297	457
		Tribal Mothership *	1010	3436	3701	3909	669	714	158	826	650
		Catcher Processor *	959	576	369	1756	114	736	496	22	257
	Shoreside - Tribal **	--	9	50	76	1271	1690	539	1321	28	
	Shoreside - EFP **	1062	425	4206	4018	839	2462	1962	279	2997	
Chum	Non-hake sectors	Limited Entry Trawl	17	30	4	0	0	0	0	0	0
		Limited Entry California Halibut	0	0	0	0	0	0	0	0	0
		Limited Entry Sablefish Primary	0	0	0	0	0	0	0	0	0
		Nearshore	--	0	0	0	0	0	0	0	0
	Hake sectors	Non-Tribal Mothership *	10	3	28	12	80	97	17	41	6
		Tribal Mothership *	51	9	11	2	24	0	0	11	1
		Catcher Processor *	14	8	24	8	8	73	43	0	4
	Shoreside - Tribal **	--	--	--	--	--	8	11	0	0	
	Shoreside - EFP **	--	--	--	--	--	113	8	2	8	
Coho	Non-hake sectors	Limited Entry Trawl	33	37	66	5	0	13	0	0	27
		Limited Entry California Halibut	0	0	0	0	48	0	0	0	0
		Limited Entry Sablefish Primary	0	3	0	2	0	4	0	0	0
		Nearshore	--	0	29	0	0	4	13	23	30
	Hake sectors	Non-Tribal Mothership *	77	3	0	82	26	139	18	12	0
		Tribal Mothership *	23	193	207	344	3	9	0	8	5
		Catcher Processor *	69	0	1	4	2	88	3	0	0
	Shoreside - Tribal **	--	--	--	--	--	98	21	49	0	
	Shoreside - EFP **	--	--	--	--	--	141	10	37	16	
Pink	Non-hake sectors	Limited Entry Trawl	0	0	0	0	0	0	0	2	0
		Limited Entry California Halibut	0	0	0	0	0	0	0	0	0
		Limited Entry Sablefish Primary	0	0	0	0	0	0	0	0	0
		Nearshore	--	0	0	0	0	0	0	0	0
	Hake sectors	Non-Tribal Mothership *	0	4	0	0	0	15	0	2	0
		Tribal Mothership *	0	3766	0	384	0	0	0	0	0
		Catcher Processor *	0	13	0	48	0	19	0	0	0
	Shoreside - Tribal **	--	--	--	--	--	513	9	129	0	
	Shoreside - EFP **	--	--	--	--	--	47	7	26	0	
Sockeye	Non-hake sectors	Limited Entry Trawl	0	0	0	0	0	0	0	0	0
		Limited Entry California Halibut	0	0	0	0	0	0	0	0	0
		Limited Entry Sablefish Primary	0	0	0	0	0	0	0	0	0
		Nearshore	--	0	0	0	0	0	0	0	0
	Hake sectors	Non-Tribal Mothership *	0	0	0	0	0	0	0	0	0
		Tribal Mothership *	0	0	0	0	0	0	0	0	0
		Catcher Processor *	0	0	0	0	0	0	2	0	2
	Shoreside - Tribal **	--	--	--	--	--	0	0	0	0	
	Shoreside - EFP **	--	--	--	--	--	0	0	0	0	
Unspecified	Non-hake sectors	Limited Entry Trawl	15	8	36	0	0	0	0	0	0
		Limited Entry California Halibut	96	0	0	0	0	0	0	0	0
		Limited Entry Sablefish Primary	0	0	0	0	0	0	0	0	0
		Nearshore	--	0	0	0	0	0	0	0	24
	Hake sectors	Non-Tribal Mothership *	3	188	0	0	0	0	0	0	2
		Tribal Mothership *	1	0	9	8	0	0	0	0	0
		Catcher Processor *	0	0	0	0	0	0	18	0	0
	Shoreside - Tribal **	--	--	--	--	--	--	0	0	0	
	Shoreside - EFP **	--	--	--	--	--	--	13	107	2	

**Table 6.** Summary of biological data for salmon species collected by WCGOP observers from September 2003 through April 2010 by sector. The number of length measurements and the number of individuals sexed is reported for each year where data are available.

<b>Sector</b>	<b>Species</b>	<b>Months</b>	<b>Year</b>	<b># lengths</b>	<b># sexes</b>
<b>Limited Entry Bottom Trawl</b>	Chinook	Sep - Dec	2003	8	8
		Jan - Dec	2004	276	265
		Jan - Dec	2005	118	105
		Jan - Dec	2006	9	9
		Jan - Dec	2007	28	28
		Jan - Dec	2008	54	53
		Jan - Dec	2009	74	72
		Jan - Apr	2010	4	2
	Chum	Sep - Dec	2003	1	0
		Jan - Dec	2004	1	1
	Coho	Jan - Dec	2004	5	5
		Jan - Dec	2005	1	1
		Jan - Dec	2007	2	1
		Jan - Apr	2010	2	1
	Pink	Jan - Dec	2009	1	0
Unspecified	Jan - Dec	2004	3	3	
<b>California Halibut Trawl - Limited Entry</b>	Chinook	Jan - Dec	2004	77	77
		Jan - Dec	2005	41	41
		Jan - Dec	2006	14	8
		Jan - Dec	2007	12	11
		Jan - Dec	2008	21	21
		Jan - Apr	2010	2	2
	Coho	Jan - Dec	2006	4	4
<b>Nearshore Fixed Gear</b>	Chinook	Jan - Dec	2004	2	0
		Jan - Dec	2006	1	0
	Coho	Jan - Dec	2004	2	0
		Jan - Dec	2007	1	0
		Jan - Dec	2009	1	0
<b>Non-Nearshore Fixed Gear</b>	Coho	Jan - Dec	2005	1	1
		Jan - Dec	2007	1	1