NOAA Technical Memorandum NMFS-NWFSC-154

https://doi.org/10.25923/z38p-sy40

Estimated Discard and Catch of Groundfish Species in the 2018 U.S. West Coast Fisheries

April 2020

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Science Center

NOAA Technical Memorandum Series NMFS-NWFSC

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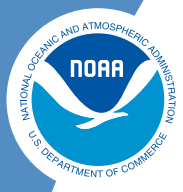
Reference this document as follows:

Somers, K. A., J. Jannot, K. Richerson, V. Tuttle, N. B. Riley, and J. T. McVeigh. 2020. Estimated Discard and Catch of Groundfish Species in the 2018 U.S. West Coast Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-154.

https://doi.org/10.25923/z38p-sy40



NOAA FISHERIES

Estimated Discard and Catch of Groundfish Species in the 2018 U.S. West Coast Fisheries

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https://doi.org/10.25923/z38p-sy40

April 2020

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Executive Summary

The primary objectives of this report are to estimate fishing mortality of groundfish species in U.S. West Coast fisheries during 2018 and evaluate mortality estimates relative to annual catch limit (ACL), acceptable biological catch (ABC), and overfishing limit (OFL) harvest specifications. These management specifications are published in the federal groundfish regulations for selected groundfish species (USOFR 2001, 2015). Based on a recommendation from the Pacific Fishery Management Council's (PFMC) Scientific and Statistical Committee (SSC), we present groundfish mortality estimates by species, whenever possible (PFMC 2014).[1] Our primary findings include that:

- One groundfish grouping exceeded 2018 harvest goals: shortbelly rockfish mortality reached 102% of its ACL. However, this is only 9% of the ABC and 7% of the OFL.
- Estimated fishing mortalities of four groundfish species were between 90% and 100% of their ACLs: petrale sole (97%), spiny dogfish (93%), cabezon in Oregon (92%), and sablefish north of lat 36°N (91%).
- All other groundfish species and complexes achieved less than 90% of their ACLs.
- Only two species remain in a rebuilding status: cowcod rockfish south of lat 40°10′N and yelloweye rockfish. The ACL attainment for cowcod increased from 17% in 2017 to 32% in 2018, while yelloweye rockfish decreased from 92% to 86%.
- Of the 46 management groupings compared between 2017 and 2018, 17 had greater mortality in 2018, 12 showed similar levels (less than 10% lower than 2017 estimates), and 17 had lower mortality.
- Twenty-seven of the groundfish species and complexes (63%) had fishing mortality estimates which were less than 50% of their 2018 ACLs (Table 16).
- Mortality estimates for all groundfish catch combined were higher in 2018 than in 2017 in the at-sea hake mothership catcher vessel (MSCV), midwater rockfish, catch share hook-and-line, limited entry (LE) fixed gear primary and nonprimary, directed west coast Pacific halibut, ridgeback prawn trawl, and nearshore sectors (Table 15; Somers et al. 2019a). Estimated fishing mortality of all groundfish species and complexes combined were lower than 2017 levels in the at-sea hake catcher–processor (CP), shoreside midwater hake, catch share bottom trawl and pot, open access (OA) California halibut, OA fixed gear, and coastwide pink shrimp sectors.

Summaries of 2018 catch from the following groundfish fishery sectors are included:

1. Commercial:
    a. LE shorebased individual fishing quota (IFQ) program:*
        - Bottom trawl gear.
        - Fixed gear.
        - Midwater trawl gear, landing 50% or more rockfish.
        - Midwater trawl gear, landing 50% or more hake.
        - Bottom trawl gear and using electronic monitoring (EM).
        - Fixed gear and using EM.

[1] Scientific names of species and/or groups of species mentioned in this report appear in the List of Species.
* Indicates sectors that use federal observer data.

        - Midwater trawl gear, landing 50% or more rockfish and using EM.
        - Midwater trawl gear, landing 50% or more hake and using EM.
    b. At-sea hake co-ops:*
        - Pacific hake CP.
        - Pacific hake MSCV.
    c. OA fixed gear nearshore (Oregon/California).*
    d. Fixed gear LE sablefish primary season (tier endorsed).*
    e. Fixed gear LE nonprimary sablefish (nonendorsed and daily trip limit [DTL] sectors).*
    f. Directed Pacific halibut fishery.*
    g. Fixed gear OA DTL.*
    h. Exempted fishing permit (EFP), not including EM sectors listed above.*
2. Tribal:
    a. Shoreside hake.
    b. At-sea hake.*
3. Recreational (Washington/Oregon/California).
4. Research.

Other commercial nongroundfish fisheries included with incidental catch of groundfish species:

1. OA pink shrimp trawl (Washington/Oregon/California).*
2. OA ridgeback prawn trawl (California).*
3. OA bottom trawl targeting California halibut.*
4. OA bottom trawl targeting sea cucumber (California).*
5. OA bottom trawl not included above.
6. Other gear groups not included above.
7. Fixed gear targeting nongroundfish.

* Indicates sectors that use federal observer data.

Acknowledgments

The authors gratefully acknowledge the hard work and dedication of the observers and staff from the West Coast Groundfish Observer Program (WCGOP) and the At-Sea Hake Observer Program (A-SHOP). Heather Reed (WDFW), Christian Heath (ODFW), and Melanie Parker (CDFW) provided recreational catch on behalf of the Washington, Oregon, and California Departments of Fish and Wildlife, respectively. Aja Szumylo and Lynn Massey (NOAA Fisheries West Coast Region [WCR]) provided research catch data and guidance on how to summarize the data. Aileen Smith at the Pacific States Marine Fisheries Commission (PSMFC) was extremely helpful in making electronic monitoring data accessible and understandable. Finally, reviews from members of the Pacific Fishery Management Council's (PFMC) Groundfish Management Team (GMT) were gratefully received, and a particularly helpful review from Dr. Marie Guldin (NWFSC) also greatly improved this report.

A note about tables:

Tables 15 and 16 have been typeset in this report. They are also available, together with all the other mentioned tables (1–14, A-1–A-6), in the accompanying Excel file. Download the file from the report's NOAA Institutional Repository[2] record by clicking on the "Supporting Files" tab.

[2] https://repository.library.noaa.gov

Data Sources

Data sources used to estimate groundfish fishing mortality include landing receipts, onboard observer records, electronic monitoring (EM) logbooks, and recreational and research catch information.

Fleetwide landing receipts (a.k.a. fish tickets) are the cornerstone of retained catch information for all shoreside sectors of the commercial groundfish fishery on the U.S. West Coast. Fish tickets are trip-aggregated sales receipts issued to vessels by fish buyers in each port for each delivery of fish and, in most fisheries, are now reported electronically to state agencies. Each state conducts species-composition sampling for numerous market categories reported on fish tickets. Market categories represent either a single species or a mixture of species. Fish ticket and species-composition data are submitted by state agencies to the Pacific Fisheries Information Network (PacFIN) regional database, which is maintained by the Pacific States Marine Fisheries Commission (PSMFC). For analytical purposes, we used fish ticket data with PacFIN-applied percentages of each species weight within market categories obtained from species-composition sampling. Landed weights from sampled market categories were distributed to individual species whenever possible.[1]

Fish ticket landings data for the calendar year 2018 were retrieved from the PacFIN database on 6 May 2019. We allocated these landings to reflect sectors as defined for observer coverage (Figure 1; Appendix B). All additional data processing steps are described in Methods.

The Northwest Fisheries Science Center's West Coast Groundfish Observer Program (WCGOP) was established in 2001 by the National Marine Fisheries Service (NMFS or NOAA Fisheries; USOFR 2001). All commercial vessels that land groundfish caught in the U.S. Exclusive Economic Zone from 3–200 miles offshore are required to carry an observer when notified to do so by NOAA Fisheries or its designated agent. Subsequent state rule-making also requires vessels that fish for groundfish within three miles of shore, or that participate in other state-managed fisheries, to carry federal observers when notified.

WCGOP's goal is to improve total catch estimates by collecting information on west coast groundfish species discarded at-sea. Detailed information on data collection methods employed in each observed fishery can be found in the WCGOP manual (NWFSC 2019b). The sampling protocol employed by WCGOP primarily focuses on the discarded portion of catch. To ensure that recorded weights for the retained portion of the observed catch are accurate, haul-level retained catch recorded by WCGOP observers is reconciled with trip-level fish ticket records. The WCGOP data are linked to fish tickets by fish ticket identification numbers obtained by the observer and are adjusted so that the total trip pounds of retained catch in the WCGOP data equal the total trip pounds on the fish ticket(s). This adjustment is necessary because observer retained catch weight estimates in the trawl sectors often consist of the visual estimate used in the vessel's logbook, while the fish ticket weight is a physical measurement and is legally binding (NWFSC 2020).

[1] Scientific names of species and/or groups of species mentioned in this report appear in the List of Species.

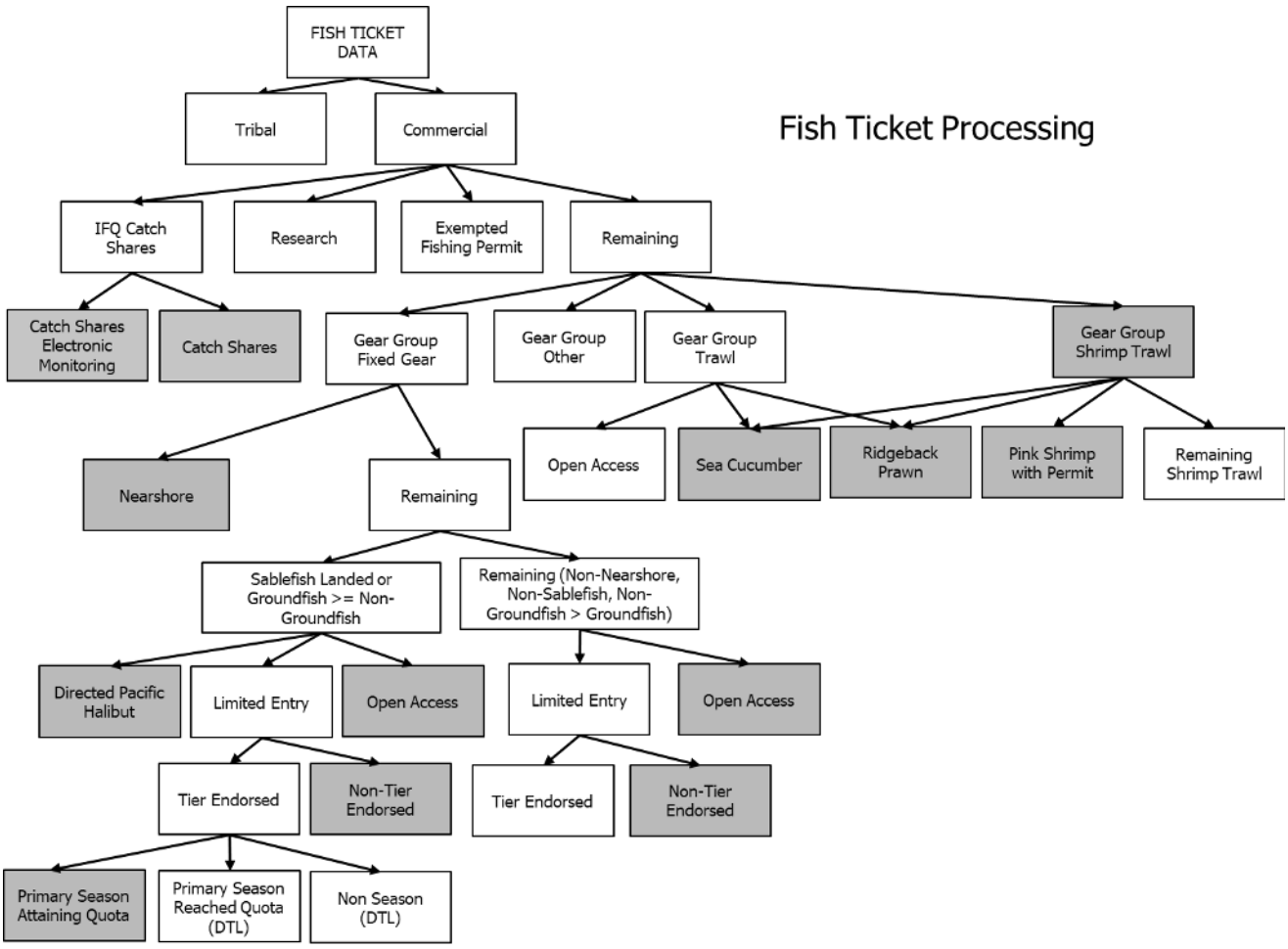

Figure 1. PacFIN fish ticket data processing for division into groundfish fishery sectors after retrieval of a full calendar year data set from the PacFIN database, queried 6 May 2019. Gray highlight indicates sectors for which federal observer data are available.

The At-Sea Hake Observer Program (A-SHOP) has conducted observations of the U.S. West Coast at-sea hake (a.k.a., Pacific whiting, henceforth referred to as hake) fishery since 2001. Prior to 2001, observer coverage of the west coast at-sea hake fishery was conducted by the North Pacific Observer Program. Current A-SHOP program information and documentation on data collection methods can be found in the observer manual (NWFSC 2019a). The at-sea hake fishery has mandatory observer coverage, with each vessel over 38 m carrying two observers. Beginning in 2011, under individual fishing quota (IFQ)/co-op program management, in addition to A-SHOP observers aboard the motherships, all catcher vessels that deliver to them are required to carry WCGOP observers or EM systems.

At-sea discards of IFQ species by IFQ vessels participating in the EM exempted fishing permit (EFP) sector in both the shoreside and at-sea processing fleets were recorded by EM systems. Estimates of discard weight by IFQ species or grouping at the haul level for vessels that process catch shoreside were provided by PSMFC and are used in this report.

"Discard" is defined in this report primarily as catch which is discarded at sea; however, some estimates of additional discard occurring shoreside in optimized or maximized retention are included and explicitly labeled. In all other sectors, WCGOP assumed that the small amount of discard at the dock is accounted for in PacFIN fish ticket landings data. Landing weights are presented in round weight (complete weight as caught, prior to any dressing), as any conversion factors (e.g., for at-sea processing) have already been applied by state agencies or in the PacFIN database.

Discard estimation focused on commercial groundfish fishery sectors with scientific at-sea observations of discards conducted by the Fisheries Observation Science Program (FOS), Fishery Resource Analysis and Monitoring Division (FRAM), NWFSC. WCGOP and A-SHOP observe distinct sectors of the groundfish fishery. WCGOP observes a number of different sectors of the groundfish fishery, including IFQ shorebased, limited entry (LE) and open access (OA) fixed gear, directed Pacific halibut, and state-permitted nearshore fixed gear sectors. WCGOP also observes several fisheries that incidentally catch groundfish, including the pink shrimp, California halibut, California ridgeback prawn, and California sea cucumber trawl fisheries. WCGOP data from each of these fisheries were used for the purposes of discard estimation. Mortality estimates were summarized from the A-SHOP data for the catcher–processor (CP) and mothership catcher vessel (MSCV) sectors of the at-sea Pacific hake fishery. No tribal fishing in the at-sea hake fishery occurred in 2018.

For all PacFIN, WCGOP, A-SHOP, and PSMFC data, we maintain confidentiality of persons and businesses as required by the Magnuson–Stevens Fishery Conservation and Management Act (MSA), which was most recently reauthorized in 2007. NOAA Fisheries guidance recommends, and FOS follows, the "rule of three," which states that "Information from at least three participants in the fishery must be aggregated/summarized at a temporal and spatial level to protect not only the identity of a person or a business, but also any business information" (N. Cyr, 2009 memorandum to NOAA Fisheries on data aggregation and summarization guidelines).

Groundfish species catch data from the recreational fisheries were provided by the Washington Department of Fish and Wildlife (WDFW) and the California Department of Fish and Wildlife (CDFW) via the Recreational Fisheries Information Network (RecFIN). Additionally, the Oregon Department of Fish and Wildlife (ODFW) provided data directly. Estimates from all three state agencies include catch weight (discarded and retained) estimates with Pacific Fishery Management Council (PFMC)-approved mortality rates applied to account for discard mortality (PFMC 2014). WDFW includes only surface-release mortality rates for released rockfish; ODFW and CDFW apply depth-dependent mortality rates.

Each year, a certain portion of the annual catch limit (ACL) for groundfish species is harvested through research activities. Research programs that caught groundfish included NWFSC's groundfish bottom trawl survey and sablefish tagging and collection research, and the International Pacific Halibut Commission's (IPHC) survey. Total groundfish research catch (discarded and retained) information was provided by NOAA's West Coast Region

(WCR) and compiled by FOS analysts. Catch varies by research permit, including but not limited to a) catch from permits with only retained catch, b) tagging study catch where all fish were released alive, and c) combined discarded and retained catch. In this report, depth-dependent mortality rates (PFMC 2019b) were applied to canary, cowcod, and yelloweye rockfish discards caught using fixed gear and released at depth, where data were available.

In addition to these data sources, discard mortality rates were provided by PFMC's Groundfish Management Team (GMT; PFMC 2014, 2017, 2019b). GMT is an advisory body to PFMC that comprises representatives from federal, state, and tribal agencies and is involved in evaluating management performance and alternatives for groundfish fisheries on the U.S. West Coast, between the U.S.–Canada and U.S.–Mexico borders. For the purposes of this analysis, GMT provided discard mortality rates, which estimate the survival of discarded catch: for big skate, in trawl sectors only; for sablefish, longnose skate, and lingcod, in trawl and fixed gear sectors; for spiny dogfish, in hook-and-line fixed gear sectors only; and for some individual species and major species groups in the state-permitted fixed gear nearshore sector. (For all discard mortality rates, see Tables A-3 and A-4 or PFMC 2019b). Trawl mortality rates only apply to bottom trawl gear. We assume 100% mortality for all species caught with midwater, shrimp, prawn, and sea cucumber trawl gear, because species-specific mortality rates have not been identified for these gear types. Changes to estimation, discard rates, and management are documented in Table A-5.

Methods

Discard Estimation Methods Overview

We used a deterministic approach to estimate discard mortality for all observed sectors of the groundfish fishery. Observed discard rates for each species were expanded to the fleetwide level to estimate total discard amount. Expansion methods varied slightly between fishery sectors to reflect varying data availability and management structure among sectors of the groundfish fishery.

The stratification scheme used in this analysis is inconsistent with the sampling design employed by WCGOP. The overall WCGOP sampling design is based on a stratified multistage random sampling. This design-based framework distributes observational effort more evenly coastwide than simple random sampling and uses prior landings information to improve the efficiency of sampling allocation. Strata employed in this report provide mortality estimates that are relevant to the spatial and temporal structure of groundfish management. The validity of stratification in terms of isolating variance in discard has not been rigorously tested. Until more work can be completed to evaluate which strata (area, depth, season, etc.) are most appropriate for discard analyses, broader stratification is often warranted to ensure adequate sample size and/or to meet confidentiality mandates.

In addition to standard error (SE), we have provided the coefficient of variation (CV) of the discard ratio for each species (or species group) as another measurement of statistical uncertainty. Although the confidence intervals (CIs) for the estimated discards can be derived from SEs based on normality assumption, we do not provide these statistics in the current report, because preliminary analyses indicated that this method may underestimate the upper CI bounds for rare species. We calculated the SE of the observed discard ratio for each fish species, as described in Pikitch et al. (1998). The SE of the discard ratio was then divided by the discard ratio itself to calculate the CV. Within a given stratum, the CV of the discard ratio of a fish species is identical to the CV of the expanded discard estimate of the given species (Lee 2015). This informative statistic is unitless, which allows for comparisons across estimates of species regardless of differences in the magnitude of discarded amounts.

In all cases where a Fishery Management Plan (FMP) groundfish species grouping, nearshore species grouping, or unsampled catch category was used to compute discard ratios, any retained weights that were recorded by the observer but 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 aggregated, weighed, and recorded together on the fish ticket under a grouped species code (e.g., NUSP = Northern Unspecified Slope Rockfish). When using a single species in the denominator (e.g., sablefish in the fixed gear fisheries), any retained weights in observer and fish ticket data that share the same species code will match and adjust properly. Species were defined and grouped for this report according to WCGOP data processing codes (Table A-1). The Groundfish FMP provides a complete listing of groundfish species (PFMC 2019a).

As with all point estimates, mortality values presented in Tables 15 and 16 should be considered with caution. Multiple sources of uncertainty that were not accounted for in this analysis might influence mortality estimates, including species composition sampling of landed catch, observed retained weights, and discard mortality rates.

IFQ Fishery Discard Estimation

The IFQ/co-op managed groundfish catch share fishery operates with a variety of gear types and target strategies, which depend on where catch is delivered and processed.

1. Catch delivered to shorebased processors:
    - Bottom trawl: Bottom trawl nets used to target a variety of groundfish species.
    - Midwater rockfish trawl: Midwater trawl nets used to target midwater non-hake species, such as widow and yellowtail rockfish.
    - Midwater hake trawl: Midwater trawl nets used to target hake.
    - Pot: Pot or trap gear used to target groundfish species, primarily sablefish.
    - Hook-and-line: Longlines primarily used to target groundfish species, mainly sablefish.
2. Catch processed at sea:
    - MSCV: Midwater trawl nets used to target hake. Catcher vessels deliver unsorted catch to a mothership, where it is sorted and processed at sea.
    - CP: Midwater trawl nets used to target hake, which is processed at sea.

In 2011, the implementation of the IFQ management program resulted in changes to fishing regulations which, in turn, resulted in the development of new methods for estimating fishing mortality under the IFQ fishery. In 2015, the addition of EM systems provided another option for 100% monitoring of catch of quota species. In the nonhake IFQ sectors, these regulation changes required that vessels must carry NOAA Fisheries observers or, if operating with an EM EFP, EM systems as well as NOAA Fisheries observers when notified to do so. Regulations also established that the use of multiple gear types (trawl or fixed gear) were allowed for fishing under a federal groundfish trawl-endorsed permit—although only one gear type is allowed per trip—and that only a single IFQ reporting area could be fished per trip. Additionally, observer sampling priorities were shifted to focus more on IFQ and rebuilding groundfish species.

Shorebased IFQ Sectors

Fleetwide discard estimates for the shorebased IFQ sectors were derived from WCGOP observer data, PSMFC EM data, and PacFIN fish ticket landings data. Fish tickets associated with the IFQ fishery were defined by analysts through an extensive quality control and review process of all available data sources.

IFQ bottom trawl vessels can hold a California halibut bottom trawl permit and participate in the state-permitted California halibut fishery. These LE California halibut tows can occur on the same trip as tows targeting IFQ groundfish, and were identified at the tow level based on the use of bottom trawl gear and the following criteria: 1) the target was California halibut and more than 150 lb of California halibut were landed, or 2) the target was

nearshore mix, sand sole, or other flatfish, and the tow took place in less than 30 fathoms (fth, ~55 m) and south of lat 40°10′N. All IFQ bottom trawl tows that met at least one of the above requirements were analyzed using methods for IFQ discard estimation to reflect the sampling protocol performed by observers on the boat. Tow targets are typically determined by the vessel captain. Since 2013, however, no LE California halibut tows have been identified.

100% Observed Shorebased IFQ Sectors

Observer data from the IFQ fishery not participating in the EM EFP were stratified by sector, gear type, and management area to the finest possible level while maintaining confidentiality (Table 1). When sample size was adequate (10 hauls or more per stratum) and data confidentiality rules could be met, we further stratified by season and depth. Records were separated into two groundfish management areas: north and south of lat 40°10′N. Each management area was divided into three depth strata (0–125, 126–250, and >250 fth[2]). The fishery was further stratified into two seasonal strata: winter (November–April) and summer (May–October), reflecting seasonal changes in Rockfish Conservation Area (RCA) boundaries, fishing effort, and target species (e.g., winter petrale sole).

On rare occasions (e.g., observer illness), tows or sets are unsampled, although an observer is present on 100% of trips. In some cases, tows or sets may have some portion of unsampled discarded catch recorded in very broad or mixed categories (Table A-2). At the stratum level, we used ratio estimators to apportion any unsampled discard weight to specific species based on the composition of observed catch.

To obtain the estimated discard weight of a species (W) when the entire haul or set was unsampled, the unsampled discard weight, summed within the stratum, was multiplied by the ratio of the discard weight of the species (summed across sampled hauls within a stratum) divided by the total discard weight of all species in all sampled hauls within a stratum:

$$W = \sum_{p} x_p \times \frac{\sum_f w_f}{\sum_f x_f}$$

where, for each stratum,

- W = estimated unsampled discard weight of a given species in a stratum,
- p = unsampled haul,
- x = total weight of discarded catch of all species,
- f = sampled haul, and
- w = sampled discard weight of a given species.

In hauls with unsampled catch categories, unsampled discard weight was recorded as non-IFQ species (NIFQ) or IFQ species. Unsampled IFQ species weight could be further categorized into IFQ flatfish (IFQFF), IFQ rockfish (IFQRF), IFQ roundfish (IFQRD), and IFQ mixed species (IFQM; Table A-2). IFQM included all IFQ managed species (see Tables

[2] 0–228, 229–457, >457 m.

A-1 and A-2, or USOFR 2013), while NIFQ included all other fish species. Observers are instructed to avoid double-counting in IFQ hauls or sets by ensuring that unsampled categories do not also contain sampled species. Rarely, observers are unable to sort discard by IFQ category, resulting in unsampled discard that contains both IFQ and non-IFQ species (referred to as ZMIS). Even less often, entire hauls, including species that would have normally been retained, are discarded at sea, due either to errors (e.g., net rips before landed) or operational considerations (e.g., deliberate release of catch from net before landing because of safety or other concerns). In these instances, the observer records a visual estimate as unsorted catch (UNST), including both discarded and retained species. Very infrequently, haul and trip data fail quality control measures. In these cases, observer data for the failed haul or trip were ignored, and discards were estimated based on stratum-level observed discard rates and haul-level estimates of retained values from fish tickets.

To obtain the estimated discard weight of a species (W) in strata that include unsampled categories, the unsampled discard weight, summed within the stratum, was multiplied by the ratio of the sampled discard weight of the species to the sampled weight of all species included in an unsampled category (NIFQ, IFQFF, IFQRF, IFQRD, IFQM, or ZMIS) within a stratum. When entire hauls, including species that are typically retained, were unsampled (UNST), the same formula was applied, but included both discarded and retained weight for all species. Data were failed (FAIL) when errors occurred consistently throughout an observer's sampling of a haul or trip. In these cases, discard is estimated using the ratio of sampled discarded to retained weight for each species in the stratum, multiplied by the known retained weight from the fish tickets associated with the failed trip. Estimated discard weight of the species was calculated and summed across unsampled categories as:

$$W = \sum_{y} \left(\sum x_y \times \frac{\sum_f w_{f,y}}{\sum_f x_{f,y}} \right)$$

where, for each stratum,

- W = estimated unsampled discard weight of a given species within a stratum,
- y = unsampled catch category (either NIFQ, IFQFF, IFQRF, IFQRD, IFQM, ZMIS, UNST, or FAIL),
- x = weight of unsampled catch,
- f = sampled catch, and
- w = sampled discard weight of a given species.

Expanded discard weights of a particular species obtained using the equations above for unsampled hauls or partially unsampled hauls (those containing both sampled and unsampled catch categories) were then added to the sampled discard weight of that species within each stratum to obtain the total species-specific discard weight per stratum (Tables 2a and 2b).

Prior to 2011, the shorebased midwater hake fishery was conducted under an EFP. It continues to operate as a maximum retention fishery, where minor amounts of operational discard at sea are permissible provided the observer accounts for the discarded weight. Prior to 2015, this fishery was defined based on the species targeted by the captain and recorded

in the logbook and observer notes and divided into the IFQ non-hake midwater trawl and the shoreside hake sectors. With new regulations (USOFR 2001, 2015), this fishery is now defined and managed based on percentage of hake landings for each vessel per landing day, so that the fishery now consists of the shoreside midwater hake (landing ≥50% hake) and the shoreside midwater rockfish sectors (landing ≥50% widow and yellowtail rockfish).

Electronically Monitored Shorebased IFQ Sectors

For those IFQ vessels participating in the IFQ EM EFP fishery, discard rules and observer requirements varied by gear. EM systems use video recordings to estimate weights of certain IFQ species that are allowed to be discarded at sea (see Table 2d). In 2015, the first year of this EFP, both WCGOP and fishing crews worked to implement and improve procedures for sorting catch into 1) discarded at sea, 2) retained and expected to be landed for revenue, and 3) retained but expected to be discarded shoreside. In 2016 and beyond, these refined protocols provided more accurate discard estimation, as described below.

Vessels fishing using pot or bottom trawl gear could only discard certain species; on those vessels, observer coverage was targeted at a random sample of 30% of trips to result in 25–30% of landings being observed. For non-IFQ species, total at-sea discard estimates were calculated in the same manner described below for non-catch share fisheries. A ratio estimator of observed discard rates from the EM fleet was applied to the total amount of groundfish retained by this fleet, with rates and total landings stratified by gear (pot or bottom trawl) and by area, where possible, while maintaining confidentiality (Table 2c). In addition, observers and fishers worked together to sort non-IFQ species that were not discarded at sea, but were expected to be discarded shoreside (Table 2c). The only species consistently recorded by both observers (as likely shoreside discard) and shoreside processors (on fish tickets) were longnose skate, Pacific grenadier, and spiny dogfish. For all other species, we calculated a "shoreside discard" rate, following the procedures described above for at-sea discard, and multiplied this rate by total groundfish landings. We are confident that very little double-counting between observed estimated shoreside discard and landings on fish ticket receipts occurred, as we specifically excluded species likely to be recorded twice. For at-sea discard of IFQ species, we chose to use EM video reviewer data as the most accurate record, as it provides 100% coverage of at-sea discard for this subset of species (Table 2d). However, a small amount of unmonitored at-sea discard occurs, due to spillage or lost gear; in these cases, we expanded the estimated amount of lost catch based on the known catch composition.

The midwater hake sector operates under maximized retention, so no observer coverage was required on any trips where EM systems were in place (Table 2e). Instead, the small amount of at-sea discard of IFQ species recorded by EM logbooks was provided by PSMFC and is included in the report. Similar to the EM pot and bottom trawl sectors, a small amount of unmonitored at-sea discard was expanded at the haul level, based on the composition of shoreside landings.

As with all other sectors, fleetwide landings data for the EM sector were acquired from PacFIN fish tickets. Data from observer records and from EM logbooks via PSMFC enabled the identification of all fish tickets associated with EM trips.

Mortality Summary for Shorebased IFQ Sectors

We estimated coastwide landings, discard weight (from 100% observer coverage and EM data), and fishing mortality (including discard mortality rates) in the 2018 shorebased nonhake IFQ sectors (Table 3a). We applied a 50% mortality rate to discarded sablefish and lingcod weight caught by IFQ bottom trawl and LE California halibut trawl sectors, reflecting guidance from the GMT to use rates used in the pre-IFQ LE groundfish bottom trawl sector. We also applied a 20% mortality rate to discarded sablefish caught by IFQ longline and pot gear, the rate suggested by GMT based on studies used to inform mortality rates in non-nearshore groundfish fixed gear sectors. We applied a 7% mortality rate to discarded lingcod caught by IFQ hook-and-line gear, based on mortality rates applied in other groundfish fixed gear sectors. We also applied discard mortality rate assumptions (previously made for stock assessment purposes) recommended by PFMC's Scientific and Statistical Committee (SSC) for longnose skate (50% for both bottom trawl and fixed gear) and spiny dogfish (50% for hook-and-line; PFMC 2012), as well as for big skate (50% for bottom trawl; PFMC 2015a, 2015b).

The total estimated weight, comprising the sampled and expanded discard weight and the landed weight, is reported by species for the shoreside midwater hake sector (Table 3a) and for the shoreside midwater rockfish sector (Table 3b). No discard mortality rates are applied in midwater trawl sectors.

At-Sea Hake Sectors

The midwater trawl fishery for hake comprises three at-sea processing fleets: CPs, MSCVs, and a tribal catcher vessel fleet delivering to motherships. A-SHOP produces estimates of total catch (discarded and retained) in the at-sea hake fishery. Observers sample unsorted catch and provide a visual estimate of the proportion retained, at the species level. Discarded catch weight is calculated on a haul basis for the total weight of all species. The discard weight estimate, along with the proportion retained, forms the basis for the two at-sea hake sectors summarized in Table 3b. In 2018, the tribal fleet did not make any at-sea landings; shorebased tribal landings are presented in Table 15. We estimated coastwide landings, sampled discard weight, estimated discard weight, and estimated fishing mortality in all 2018 hake IFQ/co-op program sectors (Table 3b).

California Halibut Bottom Trawl Fishery

Fleetwide discard estimates in the California halibut bottom trawl fishery were derived from WCGOP and fish ticket data. All California halibut vessels are permitted by the state of California, but are considered OA in this report unless they also have a federal LE groundfish permit. Since 2013, no fishing effort has occurred in the LE California halibut fishery. WCGOP randomly samples the OA California halibut fishery following non-catch share sampling priorities, protocols, and selection design.

Discard ratios for the OA California halibut fishery were calculated by dividing the observed discard weight of each species or complex by the observed retained weight of California halibut. The fleetwide landed weight of California halibut was then used as a multiplier to expand observed discard ratios to the fleetwide level (Table 4). Fleetwide landings were compiled from OA trawl fish tickets for those vessels that had a state-issued California halibut bottom trawl permit but no federal bottom trawl permit.

The discard estimate for each species was computed based on the following equation:

$$D = \frac{\sum_t d_t}{\sum_t r_t} \times F$$

where

- D = discard estimate for a given species,
- t = observed tows,
- d = observed discard weight for a given species,
- r = observed retained weight of California halibut, and
- F = weight of retained California halibut recorded on fish tickets for the fleet (expansion factor).

We estimated fishing mortalities of groundfish species caught in the OA California halibut trawl fishery (Table 4). A 50% mortality rate was applied for discarded lingcod and sablefish, based on assumptions made by GMT and carried over from management under the pre-IFQ groundfish bottom trawl sector. We also applied an SSC-recommended discard mortality rate assumption (previously made for stock assessment purposes) of 50% for longnose skate (PFMC 2012) and big skate (PFMC 2015a, 2015b).

California Sea Cucumber Trawl Fishery

In 2018, WCGOP observed less than three vessels in the sea cucumber trawl fishery. In order to maintain the confidentiality of those data, this report does not include discard estimates for the sea cucumber trawl fishery in 2018. However, we do include estimates of landed catch in Tables 15 and 16. Effort in this fishery was defined as occurring only in California, using shrimp or bottom trawl, and landing more sea cucumber than other species.

Pink Shrimp Trawl Fishery

Fleetwide discard estimates for the pink shrimp trawl fishery were derived from WCGOP and fish ticket data. The discard estimate for each species in each state was computed based on the same equation as described above for the OA California halibut fishery, but utilizing pink shrimp as the retained weight for both discard rates and expansion factors. We estimated landings, discard, and total mortality in the 2018 individual state pink shrimp trawl fisheries (Table 5a).

Prior to 2011, pink shrimp fish tickets in the area north of lat 40°10′N were compiled for a single discard expansion factor, but pink shrimp fish tickets south of lat 40°10′N were summarized as part of the remaining incidental fisheries. Observer data from all state pink shrimp fleets in the north were combined to calculate discard rates. In 2010, WCGOP coverage of the Washington pink shrimp fleet began, and coverage of all state fisheries from 2011 to the present was sufficient to further stratify the analysis by state.

California Ridgeback Prawn Trawl Fishery

WCGOP observed the California ridgeback prawn fishery from 2002–05, covering vessels targeting coonstripe, ridgeback, and spotted prawn, but these data have not been used in discard estimations. Effort in this fishery was defined as occurring only in California, using shrimp or bottom trawl gear, and landing more ridgeback prawn than other species. Discard estimates for each species were computed based on the same equation as described above for the OA California halibut fishery, but utilizing ridgeback prawn as the retained weight for both discard rates and expansion factors. No mortality rates were applied. We estimated landings, discard, and total mortality in the 2018 ridgeback prawn trawl fishery (Table 5b).

Non-Nearshore Fixed Gear Fishery

Fleetwide discard estimates for the LE and OA non-nearshore fixed gear sector of the groundfish fishery were derived from WCGOP and fish ticket data. Fish tickets for fixed gear that did not have recorded sablefish or nearshore species were included in the non-nearshore fixed gear sector only if groundfish landings were greater than nongroundfish landings based on a unique vessel and landing date. Fixed gear fish tickets where a) nongroundfish landings were greater than groundfish landings, and b) sablefish or nearshore species were not recorded, were summarized as incidental landings (Table 14). Fixed gear fish tickets with nongroundfish landings greater than groundfish landings but also containing sablefish were classified as non-nearshore fixed gear; those with nearshore species landings on a nearshore permit were classified as nearshore fixed gear. Fish tickets associated with the Pacific halibut directed commercial fishery were identified by the IPHC for 2002–17 in Washington and Oregon. In 2018 and in California, Pacific halibut directed fishery tickets were identified as using line gear and landing Pacific halibut on the day of the opening or within two subsequent days.

Fish tickets were partitioned into three commercial fixed gear subsectors: LE sablefish-endorsed primary season, LE non-sablefish-endorsed, and OA fixed gear groundfish. Vessels landing catch without a federal groundfish permit were classified as the OA fixed gear groundfish subsector. Those vessels landing catch with a federal groundfish permit were further separated based on whether the vessel's federal groundfish permit(s) had a sablefish endorsement with tier quota for the primary season or whether it was not endorsed (also referred to as zero-tier permits). Fish tickets for all LE vessels with tier sablefish endorsements operating during the sablefish primary season (April–October) and within their allotted tier quota were placed in the LE sablefish-endorsed primary subsector. If LE sablefish-endorsed vessels fished outside of the primary season (November–March) or made trips within the season after they had reached their cumulative tier quota, the fish tickets were placed in the LE non-sablefish-endorsed subsector. Fish tickets from non-sablefish-endorsed LE vessels were also placed in this subsector.

Data used in these analyses were collected by WCGOP from the following fixed gear subsectors in order of priority: LE sablefish-endorsed primary season fixed gear, LE zero-tier (non-sablefish-endorsed), and OA non-nearshore fixed gear. LE sablefish-endorsed vessels that were fishing outside of the primary season or that had reached their cumulative tier quotas in the primary season were not observed. However, observed LE zero-tier discard rates were assumed to be the most comparable discard rates and were used to estimate discard based on these landings.

Observer data were stratified by subsector, gear type, and area (where applicable; Tables 6–8). Area strata (north and south of lat 36°N) are based on PFMC area management for sablefish trip limits. Gear type was defined as longline or pot/trap gear. Explicit depth stratification of fixed gear fishing effort is not possible, because there are no fleetwide estimates of fishing depths in this fishery. If landings were made by a fixed gear subsector for which there were no or very few WCGOP observations, the most appropriate observed discard ratios were selected and applied to these landings based on similarities in the fishery management structure, fishing and discard behavior, and the gear fished. For example, observed discard rates from the OA fixed gear pot sector were used to estimate the total discard associated with the small amount of groundfish landed by the pot gear portion of the LE non-sablefish-endorsed subsector, which is unobserved.

We summarized the number of observed vessels, trips, and sets, along with fleetwide sablefish and FMP groundfish landings (Tables 6–8). Retained groundfish was used as the denominator, rather than sablefish weight alone, to reflect the wider range of target species in some subsectors, primarily fixed gear fisheries south of lat 36°N.

We calculated total coastwide landings, discard, and fishing mortality for the LE and OA non-nearshore fixed gear sectors (Table 9a). A 20% mortality rate is applied for discarded sablefish and a 7% rate for line-caught discarded lingcod, based on guidance from GMT. We also applied SSC-recommended discard mortality rates (previously made for stock assessment purposes) for longnose skate (50%) and spiny dogfish (50%; PFMC 2012).

Directed Pacific Halibut Fishery

As described above in the non-nearshore fixed gear sector, this fishery was defined based on IPHC-identified tickets using line gear and landing Pacific halibut within two days of the halibut fishery openings. Effort in this fishery occurs primarily in Washington and Oregon. Discard estimates for each species were computed based on the equation for the OA California halibut fishery, but utilizing Pacific halibut as the retained weight for both discard rates and expansion factors. We estimated landings, discard, and total mortality in the 2018 directed Pacific halibut fishery (Table 9b). Because the gear and effort in this fishery are similar to the non-nearshore and catch share hook-and-line fisheries, the same mortality rates were applied to discarded lingcod (7%), longnose skate (50%), sablefish (20%), and spiny dogfish (50%).

Nearshore Fixed Gear Fishery

Fleetwide discard estimates for the commercial nearshore fixed gear sector of the groundfish fishery were derived from WCGOP observer data, fish ticket landings, and mortality rates provided by GMT (Table A-4).

WCGOP selects commercial nearshore vessels in California and Oregon for observer coverage based on state-issued nearshore permits or licenses; no nearshore fishery exists in Washington. Although California and Oregon nearshore fisheries are sampled separately for observer coverage, fleetwide discard estimates are provided for the areas north and south of the groundfish management line at lat 40°10′N, in accordance with federal groundfish management specifications.

We applied a discard mortality rate of 7% for all FMP species without swim bladders (Albin and Karpov 1996). In June 2017, GMT provided revised depth-specific discard survival assumptions for some nearshore species (Table A-4). This update separated the >20 fth depth bin into 20–30 fth and >30 fth, allowing for more accurate accounting of discard mortality by depth, and provided distinct rates north and south of lat 40°10′N that reflect the differing depth distributions of observed fishing effort and align with recreational mortality rates using similar gear (PFMC 2017). We first generated estimates of the depth distribution of landings (0–10 fth, 11–20 fth, 21–30 fth, and >30 fth) based on the observed percentage of catch for each species or complex from 2003–18 (Table 10).[3] Using data from all previously observed years ensures that data are comparable across years and that proportions are available for all species landed in a given year. Fleet landings of each nearshore species and complex in 2018 were then distributed among depth intervals using the observed percentages. Finally, the total distributed landed weights of all nearshore groundfish species within each depth stratum were used to expand observed discard to the fleetwide level.

Prior to the calculation of discard ratios in this sector, WCGOP observer data were stratified by area and depth (Table 11). Discard ratios were calculated by dividing the stratum discard weight of each species or complex by the retained weight of nearshore species. Observed discard ratios were multiplied by the allocated landed weight of all nearshore groundfish species within each depth stratum, and then by the depth-specific discard mortality rates. Nearshore fishers focus much of their effort in shallow waters, so the estimated amount of catch in deeper depth bins is most often confidential. Because we are unable to display the observed discard ratios used to estimate mortality, we provide the CVs at the finest aggregated, nonconfidential strata possible north and south of lat 40°10′N (Table 11). We also report the total estimated gross discard and discard mortality, calculated at the confidential-level depth strata (Tables 12a and 12b).

We summarize the estimated total fishing mortality in observed non-IFQ groundfish fisheries by sector (Table 13).

[3] 10 fth ≅ 18 m, so the depth distributions are approximately 0–18 m, 19–36 m, 37–54 m, and ≥55 m.

Other Commercial Data Summaries

Landings of groundfish species from other nongroundfish fisheries operating under federal OA landing limits, which are mostly state-managed, and a small number of EFPs outside of the EM program, are summarized by gear group (Table 14). Other than observed non-EM EFP trips, catch summaries of incidental fisheries are based exclusively on fish ticket data and therefore do not include any estimates of discards at sea.

Landings of groundfish species from the Washington tribal shorebased fisheries are included in Table 15. The Washington tribal data are based exclusively on fish ticket data, because tribal directed groundfish fisheries employ full retention requirements. In addition, both the Makah bottom trawl and midwater (targeting yellowtail rockfish) trawl sectors are monitored at a target tribal observation rate of 15%. In tribal management, discard mortality of fixed gear sablefish is accounted for by PFMC reducing the tribal allocation. For more information on discard and retention in tribal sablefish fisheries and Makah trawl observations, see PFMC and NMFS (2012), Appendix B.

Groundfish species catch from research activities and each state's recreational fisheries, combined across all gear types, is also summarized in Table 15.

Bycatch estimation and summaries for managed and protected fish species observed by WCGOP and A-SHOP are available in separate reports: Pacific halibut (Jannot et al. 2020), salmon species (Somers et al. 2015, 2018), green sturgeon (Richerson et al. 2019), and eulachon (Gustafson et al. 2019). Mortality estimations for all fish species that are not protected from 2002–18 are available in the Groundfish Expanded Mortality Multiyear (GEMM) product on the FRAM Data Warehouse[4] and in Somers et al. 2020.[5]

Cumulative Mortality Estimation Methods

We calculated the cumulative mortality for each species in a sector as the sum of the total discard mortality (with mortality rate applied) and retained weight. To calculate the cumulative mortality across all sectors, we summed the estimated discard mortality and retained weight from all observed sectors, the retained weight from unobserved incidental fisheries, and the mortality estimates from research and recreational catch (Table 15).

[4] https://www.nwfsc.noaa.gov/data

[5] Somers, K. A., J. E. Jannot, V. Tuttle, K. Richerson, N. Riley, and J. T. McVeigh. 2020. Groundfish Expanded Mortality Multiyear (GEMM), 2002–18. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR-2020-01. DOI: 10.25923/zfxe-9m37

Results

Fishing mortality estimates of total groundfish species and complexes were higher in 2018 than in 2017 in the at-sea hake MSCV, midwater rockfish, catch share hook-and-line, LE fixed gear primary and nonprimary, Pacific halibut directed, ridgeback prawn trawl, and nearshore sectors (Table 15; Somers et al. 2019b). Estimated fishing mortality of all groundfish species and complexes was lower than 2017 levels in the at-sea hake CP, midwater hake, catch share bottom trawl and pot, OA California halibut, OA fixed gear, and pink shrimp sectors.

Landings by the catch share bottom trawl sector in 2018 were ~2,400 mt less than in 2017 (Somers et al. 2019b). Midwater rockfish landings almost doubled from 2017, to ~12,000 mt of groundfish in 2018, reflecting the continued redevelopment of the midwater rockfish fleet as the primary targets, widow and yellowtail rockfish, have rebuilt and quotas have subsequently increased (Somers et al. 2019b). In 2018, landings by the shoreside midwater hake fleet decreased by about 10% and ~15,000 mt compared to the previous year's historic high, with final catch in 2018 totaling ~130,000 mt (Somers et al. 2019b). Landings by the pot gear portion of the fleet in 2018 were ~150 mt lower than those in 2017, while hook-and-line landings increased by ~45 mt (Somers et al. 2019b).

The percentage of all shoreside catch share sectors using EM systems compared to 100% observer coverage increased from 2017 to 2018 (Somers et al. 2019b). Approximately 15% of the bottom trawl sector landings used EM, an increase from 12% in 2017, while the portion of the midwater rockfish fleet using EM increased from 27% to 44% (Somers et al. 2019b). The proportion of shoreside-processed midwater hake landings covered by EM remained around 92%, as in 2017 (Somers et al. 2019b). The percentage of pot landings monitored using EM increased slightly from 57% in 2017 to 59% in 2018, and the hook-and-line sector does not currently use EM technology (Somers et al. 2019b).

Landings by the CP portion of the at-sea hake fishery decreased by ~20,000 mt between 2017 and 2018, but hake catch in this sub-sector was the second highest observed from 2002 to 2018 (Somers et al. 2019b). The MSCV sector's landings increased slightly by ~640 mt in 2018, resulting in another historically high year for that portion of the fleet. In both parts of the fleet, less than 0.1% of catch was unsampled (Somers et al. 2019b).

Trends in both fleetwide landings and observed discard ratios inform fleetwide discard estimates. In state fisheries which are observed for incidental groundfish interactions, total 2018 landings in the OA California halibut trawl fishery were ~20 mt lower than in 2017, with a total of ~72 mt of California halibut caught (Table 4; Somers et al. 2019b). Landings in the sea cucumber trawl fishery continued to decrease in 2018, to a new historic low of ~13 mt (Somers et al. 2019b). Landings in the pink shrimp fishery increased in all states in 2018, in Washington and California by ~800 mt each and in Oregon by ~6,000 mt compared to 2017 (Table 5a; Somers et al. 2019b). Ridgeback prawn landings in 2018 were ~165 mt, similar to 2017 (Table 5b; Somers et al. 2019b).

Table 15. Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector. *Key*: IFQ = individual fishing quota, BT = bottom trawl, FG = fixed gear, MW = midwater, SS = shoreside, A-S = at-sea, CP = catcher–processor, MSCV = mothership catcher vessel, OA = open access, SC = sea cucumber, PS = pink shrimp, RP = ridgeback prawn, Dir. PHLB = directed Pacific halibut fishery, IF = incidental fisheries, Res. = research, EFM = estimated fishing mortality, rf. = rockfish, ECS = ecosystem component species, LST = longspine thornyhead, SST = shortspine thornyhead, sh. = shelf, sl. = slope, unid. = unidentified.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ								WA tribal SS					
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF		WA	OR	CA	Res.	EFM
Groundfish species																				
Arrowtooth flounder	999.09	2.94	0.75	6.81	45.36	10.02	0.00	—	0.97	—	46.65	8.78	—	0.05	0.90	—	0.04	—	10.31	1,132.68
Big skate	142.58	0.86	0.41	1.94	0.60	2.08	13.78	—	0.27	—	8.69	4.52	0.19	0.17	3.91	—	0.11	—	3.24	183.35
Black rf. (CA)	0.01	—	—	—	—	—	—	—	—	—	13.10	—	32.51	0.25	—	—	—	95.68	0.07	141.62
Black rf. (OR)	0.00	—	0.00	0.00	—	—	—	—	—	—	0.78	—	122.52	0.23	—	—	295.26	—	0.00	418.80
Black rf. (WA)	0.02	—	0.00	—	—	—	—	—	—	—	—	—	—	—	0.00	251.39	—	—	0.03	251.45
Bocaccio rf. (S of 40°10′N)	177.64	—	—	—	—	—	0.00	—	—	0.75	8.07	—	1.90	1.14	—	—	—	118.50	4.72	312.73
Cabezon (CA)	—	—	—	—	—	—	0.01	—	—	—	0.79	—	21.64	0.13	—	—	—	29.35	0.00	51.93
Cabezon (OR)	—	—	—	—	—	—	—	—	0.02	—	0.07	—	29.84	0.01	—	—	13.16	—	0.00	43.11
CA scorpionfish (N of 34°27′N)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00	0.00
CA scorpionfish (S of 34°27′N)	—	—	—	—	—	—	0.77	—	—	0.82	—	—	1.43	0.01	—	—	—	98.88	0.17	102.09
Canary rf.	184.93	0.00	64.26	194.25	0.86	4.69	—	—	0.24	0.05	4.13	0.31	8.36	0.41	21.07	4.52	39.04	61.84	6.22	595.17
Chilipepper rf. (S of 40°10′N)	278.36	—	—	—	—	—	—	—	0.14	2.13	2.73	—	0.04	0.07	—	—	—	2.02	14.05	299.54
COWCOD RF. (S of 40°10′N)	0.42	—	—	—	—	—	—	—	0.08	0.10	0.99	—	—	—	—	—	—	1.03	0.63	3.25
Darkblotched rf.	185.54	0.15	0.86	80.98	41.84	23.24	—	—	3.12	0.00	4.12	0.20	0.00	0.31	0.22	—	—	—	2.51	343.11
Dover sole	6,355.55	0.79	16.97	0.01	2.10	0.55	0.01	—	4.40	18.82	5.21	0.18	—	6.95	42.46	—	0.01	—	50.84	6,504.85
ECS																				
Alaska skate	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Aleutian skate	1.59	0.02	—	—	—	—	—	—	0.00	—	0.18	0.06	—	—	—	—	—	—	0.01	1.85
Black skate	8.75	0.03	—	—	—	—	—	—	—	—	4.80	—	—	—	—	—	—	—	0.62	14.21
CA grenadier	0.89	—	—	—	—	—	—	—	—	—	0.34	—	—	—	—	—	—	—	0.08	1.32
CA skate	1.80	—	—	—	—	—	14.67	—	0.16	1.13	0.07	—	0.01	0.49	—	—	—	—	0.35	18.68
Deepsea skate	0.39	—	—	—	0.00	—	—	—	—	—	0.13	—	—	—	—	—	—	—	0.07	0.60
Ghostly grenadier	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Giant grenadier	41.62	1.04	0.28	—	—	—	—	—	—	—	3.76	—	—	—	—	—	—	—	2.06	48.76
Grenadier, unid.	3.16	0.12	—	—	5.86	0.00	—	—	—	—	8.85	—	—	0.03	—	—	—	—	—	18.02
Pacific flatnose	0.35	—	—	—	0.00	—	—	—	—	—	0.07	—	—	—	—	—	—	—	0.16	0.58
Pacific grenadier	11.74	1.13	—	—	—	—	0.00	—	—	—	13.11	—	0.00	—	—	—	—	—	5.13	31.11
Popeye grenadier	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.01
Sandpaper skate	48.76	0.32	0.03	—	0.04	0.00	—	—	0.13	—	2.53	0.12	0.00	—	—	—	—	—	0.77	52.69
Shark and skate, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Shoulderspot grenadier	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Smooth grenadier	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.05	0.06
Softhead grenadier	—	—	—	—	—	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	0.01
Soupfin shark	2.71	—	0.05	0.77	0.63	1.06	1.46	—	—	—	1.12	—	0.75	5.75	—	—	0.01	—	0.64	14.95
Spotted ratfish	74.24	0.04	0.07	0.01	0.01	0.00	0.01	0.00	0.59	1.55	4.24	0.10	—	0.00	0.00	—	—	—	3.33	84.19
White skate	—	—	—	—	—	—	—	—	—	—	0.30	—	—	—	—	—	—	—	—	0.30

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ								WA tribal SS					
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF		WA	OR	CA	Res.	EFM
Groundfish species																				
English sole	208.30	—	0.75	0.02	0.13	0.05	2.27	0.04	0.36	37.44	0.08	—	—	2.41	40.45	—	0.01	—	4.84	297.15
Groundfish, unid.	—	—	0.00	0.16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.16
Lingcod (N of 40°10′N)	408.02	3.26	4.30	13.22	0.15	3.22	—	—	0.12	—	52.90	3.13	70.46	8.43	23.63	141.80	213.57	57.24	8.84	1,012.29
Lingcod (S of 40°10′N)	48.84	0.02	—	—	—	—	0.52	—	0.00	1.71	28.62	—	24.95	3.86	—	—	—	346.21	2.00	456.74
Longnose skate	669.76	3.04	1.82	0.45	0.93	1.01	0.33	—	1.90	0.28	79.80	6.25	0.09	0.80	13.04	—	0.23	—	12.45	792.18
LST (N of 34°27′N)	344.13	0.02	3.41	—	0.01	—	—	—	0.00	—	4.20	0.02	0.04	0.08	0.77	—	—	—	17.49	370.18
LST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	13.15	—	—	0.83	—	—	—	—	1.33	15.31
Minor ns. rf. (N of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.03	—	—	—	0.00	0.02	0.00	0.06
Blue/deacon rf.	0.00	—	—	—	—	—	—	—	—	—	0.22	—	8.08	0.02	—	0.72	13.85	3.02	0.02	25.93
Brown rf.	—	—	—	—	—	—	—	—	0.00	—	—	—	0.07	—	—	—	0.05	0.60	0.00	0.72
China rf.	—	—	—	—	—	—	—	—	—	—	0.02	—	5.90	0.00	—	1.41	2.57	1.21	0.01	11.11
Copper rf.	—	—	—	—	—	—	—	—	—	—	0.18	—	4.10	0.01	—	1.80	9.10	6.12	0.04	21.34
Gopher rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.10	—	—	—	0.02	0.10	—	0.22
Grass rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.23	—	—	—	0.02	0.14	—	0.40
Nearshore rf., unid.	0.00	—	—	—	—	—	—	—	—	—	—	—	0.03	—	0.00	—	—	—	—	0.03
Olive rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.02	—	—	—	0.03	0.59	—	0.65
Quillback rf.	0.04	—	—	—	—	—	—	—	—	—	0.19	—	3.44	—	—	1.95	9.35	4.15	0.04	19.16
Treefish rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	0.00
Minor ns. rf. (S of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	0.33	—	15.71	0.16	—	—	—	3.45	—	19.65
Blue/deacon rf.	—	—	—	—	—	—	—	—	—	—	0.07	—	12.84	0.32	—	—	—	198.23	0.09	211.55
Brown rf.	—	—	—	—	—	—	0.11	0.00	—	0.07	0.12	—	20.35	0.02	—	—	—	92.11	0.02	112.80
Calico rf.	—	—	—	—	—	—	0.00	—	—	0.44	—	—	0.08	—	—	—	—	0.40	0.00	0.93
China rf.	—	—	—	—	—	—	—	—	—	—	0.03	—	2.76	0.01	—	—	—	13.00	—	15.80
Copper rf.	0.00	—	—	—	—	—	0.01	0.02	—	0.31	0.65	—	11.67	0.07	—	—	—	183.32	0.28	196.34
Gopher rf.	—	—	—	—	—	—	0.00	—	—	—	0.14	—	32.48	0.01	—	—	—	40.32	0.00	72.95
Grass rf.	—	—	—	—	—	—	—	—	—	—	0.10	—	8.75	0.04	—	—	—	2.35	—	11.24
Kelp rf.	—	—	—	—	—	—	0.00	—	—	—	0.01	—	0.84	—	—	—	—	5.64	—	6.48
Nearshore rf., unid.	—	—	—	—	—	—	—	0.00	—	0.02	0.02	—	0.26	0.03	—	—	—	—	—	0.33
Olive rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	0.80	0.09	—	—	—	46.32	0.09	47.31
Quillback rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	1.18	0.00	—	—	—	5.96	—	7.15
Treefish rf.	—	—	—	—	—	—	—	—	—	—	0.00	—	2.37	—	—	—	—	10.28	0.00	12.65

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ													
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF	WA total SS	WA	OR	CA	Res.	EFM
Groundfish species																				
Minor sh. rf. (N of 40°10′N)																				
Bocaccio rf.	6.38	—	11.01	6.84	0.50	2.42	—	—	—	—	0.26	0.12	0.02	0.00	1.82	0.81	0.65	0.05	0.28	31.15
Chilipepper rf.	99.80	0.00	7.64	9.88	0.19	3.09	—	—	2.65	—	0.12	0.00	0.00	5.84	—	—	0.01	0.00	1.21	130.42
Cowcod rf.	0.05	—	—	—	—	—	—	—	0.01	—	0.03	—	—	0.00	—	—	0.00	0.00	0.00	0.10
Flag rf.	0.00	—	—	—	—	—	—	—	0.00	—	0.01	—	—	—	—	—	—	—	—	0.01
Greenspotted rf.	0.17	—	0.02	—	—	—	—	—	0.00	—	0.02	—	—	0.00	0.03	—	—	—	0.04	0.27
Greenstriped rf.	23.93	0.03	0.21	0.03	—	0.00	—	—	1.48	—	1.12	0.10	0.00	0.00	0.12	—	0.02	—	2.42	29.47
Halfbanded rf.	0.00	—	—	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	—	0.00	0.01
Harlequin rf.	0.00	—	0.00	0.01	0.00	0.00	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.02
Puget Sound rf.	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	0.00	0.00
Pygmy rf.	0.00	—	0.00	0.00	0.00	—	—	—	0.02	—	—	—	—	—	—	—	—	—	0.01	0.03
Redstripe rf.	0.25	0.00	14.67	12.39	0.12	2.40	—	—	0.01	—	0.01	0.00	—	—	0.46	—	0.02	—	0.28	30.61
Rockfish, unid.	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Rosethorn rf.	7.61	0.04	0.02	—	—	—	—	—	0.01	—	0.61	0.01	0.03	0.00	0.11	—	0.04	—	0.35	8.83
Rosy rf.	—	—	—	—	—	—	—	—	—	—	0.01	0.00	0.04	—	—	—	0.01	0.02	0.00	0.08
Shelf rf., unid.	36.49	0.00	0.06	0.57	—	—	—	—	0.46	—	0.39	0.01	0.09	0.12	0.01	—	—	—	—	38.21
Silvergray rf.	1.04	0.01	1.86	2.79	0.25	0.65	—	—	—	—	0.34	0.01	—	0.00	2.46	—	0.19	—	0.08	9.69
Squarespot rf.	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.00
Starry rf.	0.04	—	—	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	0.01	—	0.04
Stripetail rf.	37.42	—	0.04	0.02	0.02	1.14	—	—	8.63	—	0.00	0.00	—	0.01	—	—	—	—	2.60	49.88
Tiger rf.	0.00	—	—	—	—	—	—	—	0.00	—	0.01	0.00	0.31	—	0.04	0.23	1.29	0.32	0.00	2.21
Vermilion rf.	—	—	—	—	—	—	—	—	—	—	0.70	—	4.14	0.03	—	1.16	9.09	7.63	0.00	22.76
Minor sh. rf. (S of 40°10′N)																				
Flag rf.	0.02	—	—	—	—	—	—	—	—	0.00	0.10	—	0.05	0.00	—	—	—	10.35	0.02	10.55
Freckled rf.	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	0.00	0.01
Greenblotched rf.	0.09	—	—	—	—	—	—	—	—	0.44	0.19	—	0.13	0.00	—	—	—	0.15	0.16	1.16
Greenspotted rf.	0.66	—	—	—	—	—	—	—	—	0.13	1.18	—	0.58	0.01	—	—	—	14.45	1.05	18.06
Greenstriped rf.	1.33	—	—	—	—	—	—	—	0.04	0.16	0.32	—	0.03	—	—	—	—	0.91	0.51	3.30
Halfbanded rf.	—	—	—	—	—	—	0.00	—	0.00	29.27	—	—	—	—	—	—	—	2.94	2.02	34.23
Honeycomb rf.	—	—	—	—	—	—	—	—	—	—	0.00	—	0.06	0.01	—	—	—	3.34	0.00	3.42
Mexican rf.	0.01	—	—	—	—	—	0.00	—	—	0.01	0.51	—	0.00	—	—	—	—	—	0.04	0.57
Pink rf.	—	—	—	—	—	—	—	—	—	—	0.69	—	—	—	—	—	—	—	0.03	0.71

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ													
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF	WA total SS	WA	OR	CA	Res.	EFM
Groundfish species																				
Minor sh. rf. (S of 40°10′N)																				
Pinkrose rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Rosethorn rf.	0.00	—	—	—	—	—	—	—	—	—	0.04	—	0.13	0.00	—	—	—	—	0.03	0.20
Rosy rf.	0.00	—	—	—	—	—	—	—	—	—	0.11	—	0.35	0.00	—	—	—	16.94	0.07	17.47
Shelf rf., unid.	0.64	—	—	—	—	—	0.02	—	0.46	—	1.11	—	0.43	0.15	—	—	—	—	—	2.80
Silvergray rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Speckled rf.	—	—	—	—	—	—	—	—	—	—	0.79	—	0.42	0.10	—	—	—	7.48	0.44	9.23
Squarespot rf.	—	—	—	—	—	—	—	—	0.00	0.01	0.02	—	0.05	0.00	—	—	—	23.28	0.15	23.52
Starry rf.	—	—	—	—	—	—	—	—	—	—	0.77	—	0.63	0.01	—	—	—	37.19	0.17	38.78
Stripetail rf.	1.96	—	—	—	—	—	0.00	—	0.90	27.11	—	—	—	—	—	—	—	—	2.94	32.92
Swordspine rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	—	—	—	0.10	0.12	0.23
Tiger rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.45	—	0.45
Vermilion rf.	0.63	—	—	—	—	—	0.07	0.00	—	0.20	33.96	—	21.14	4.12	—	—	—	278.16	6.65	344.93
Yellowtail rf.	0.12	—	—	—	—	—	—	—	0.00	—	2.84	—	1.86	4.43	—	—	—	58.28	0.70	68.24
Minor sl. rf. (N of 40°10′N)																				
Aurora rf.	24.25	0.03	0.03	3.11	0.18	0.12	—	—	0.02	—	0.22	0.00	—	0.05	0.03	—	—	—	0.21	28.24
Bank rf.	0.29	—	0.27	1.70	0.05	0.04	—	—	0.00	—	0.01	—	—	—	—	—	—	—	0.01	2.38
Blackgill rf.	2.23	0.03	—	—	—	—	—	—	—	—	0.44	0.00	—	—	0.01	—	—	—	0.03	2.74
Redbanded rf.	7.28	0.64	0.04	0.25	0.22	0.04	—	—	0.22	—	24.02	0.94	0.05	0.94	8.38	—	0.00	—	0.22	43.25
Rockfish, unid.	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Rougheye/blackspotted rf.	16.90	3.28	0.14	2.55	156.59	4.65	—	—	0.05	—	37.17	1.10	0.02	0.05	16.84	—	—	—	0.27	239.61
Sharpchin rf.	1.39	0.00	0.68	6.66	0.01	0.02	—	—	0.03	—	0.01	—	—	—	0.00	—	—	—	1.50	10.31
Shortraker rf.	6.55	0.30	0.57	0.06	0.11	0.03	—	—	0.00	—	6.22	0.09	—	0.01	1.39	—	—	—	0.06	15.39
Shortraker/rougheye/blackspotted rf.	0.00	0.00	—	—	—	—	—	—	—	—	0.02	—	—	—	—	—	—	—	—	0.02
Slope rf., unid.	1.24	0.03	0.10	0.02	—	—	—	—	—	—	5.95	0.02	0.01	0.06	—	—	—	—	—	7.45
Splitnose rf.	22.03	0.00	3.68	73.86	62.12	68.84	—	—	3.87	—	0.04	0.00	—	—	0.03	—	—	—	1.87	236.35
Yellowmouth rf.	0.09	0.00	22.92	2.30	0.01	1.93	—	—	0.01	—	0.45	0.00	—	—	0.01	—	0.00	—	0.54	28.28
Minor sl. rf. (S of 40°10′N)																				
Aurora rf.	2.57	0.06	—	—	—	—	—	—	—	—	1.12	—	0.00	0.03	—	—	—	—	0.51	4.29
Bank rf.	27.77	—	—	—	—	—	—	—	—	—	0.68	—	0.01	0.70	—	—	—	0.23	0.92	30.30
Blackgill rf.	29.62	3.75	—	—	—	—	—	—	—	—	18.29	—	0.16	0.55	—	—	—	—	0.73	53.10
Pacific ocean perch	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	0.01

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ													
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF	WA total SS	WA	OR	CA	Res.	EFM
Groundfish species																				
Minor sl. rf. (S of 40°10′N)																				
Redbanded rf.	0.28	—	—	—	—	—	—	—	—	—	0.47	—	0.00	—	—	—	—	—	0.03	0.78
Rougheye/blackspotted rf.	0.01	—	—	—	—	—	—	—	—	—	0.02	—	—	—	—	—	—	—	—	0.03
Sharpchin rf.	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.26	0.27
Shortraker rf.	0.02	—	—	—	—	—	—	—	—	—	0.05	—	—	—	—	—	—	—	—	0.07
Slope rf., unid.	9.33	—	—	—	—	—	—	—	—	—	3.35	—	0.06	0.04	—	—	—	—	—	12.78
Mixed thornyheads																				
SST/LST	0.14	0.01	0.07	—	1.34	0.12	—	—	—	—	1.24	—	0.07	0.02	—	—	—	—	0.02	3.02
Other flatfish																				
Butter sole	0.00	—	—	0.00	—	0.00	0.00	—	—	—	—	—	—	—	—	—	0.01	—	0.02	0.04
Curlfin sole	0.50	—	—	0.00	—	0.00	1.34	—	—	0.12	—	—	—	0.75	—	—	—	—	0.11	2.83
Flatfish, unid.	2.88	—	0.04	0.01	0.00	0.01	0.14	0.01	1.34	1.91	0.04	—	0.01	1.23	10.77	1.58	—	—	0.00	19.97
Flathead sole	27.70	—	0.02	0.00	0.01	0.02	—	—	0.42	—	0.06	—	—	0.00	—	—	—	—	0.45	28.69
Pacific sanddab	131.28	—	0.01	0.07	0.00	0.87	0.78	—	3.22	20.51	0.12	—	0.78	0.00	—	—	0.21	35.07	8.13	201.05
Rex sole	441.92	0.00	0.35	0.33	26.84	3.88	0.04	—	28.26	2.45	0.00	—	—	0.86	32.91	—	—	—	13.04	550.86
Rock sole	1.67	—	0.00	—	—	—	0.10	—	0.02	0.14	0.08	—	0.07	0.27	0.17	—	0.02	2.45	0.18	5.17
Sand sole	0.61	—	—	—	—	0.00	13.42	—	0.14	—	—	—	0.03	0.10	—	—	0.14	0.14	0.01	14.60
Sanddab, unid.	2.79	—	—	0.00	—	—	—	0.00	0.01	0.76	4.39	—	2.98	0.47	0.13	—	—	—	0.00	11.51
Other groundfish																				
Cabezon (WA)	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	6.76	—	—	0.01	6.77
Kelp greenling (CA)	—	—	—	—	—	—	—	—	—	—	0.18	—	3.68	0.01	—	—	—	5.27	—	9.13
Kelp greenling (OR)	0.01	—	—	—	—	—	—	—	—	—	0.00	—	17.93	0.03	—	—	14.97	—	0.02	32.96
Kelp greenling (WA)	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.16	—	—	0.02	1.18
Leopard shark	—	—	—	—	—	—	1.49	—	—	1.75	1.41	—	0.50	3.51	—	—	—	13.01	—	21.67
Other rockfish																				
Rockfish, unid.	0.46	—	0.01	—	—	—	—	—	—	—	0.59	—	0.03	0.00	—	0.45	0.10	—	0.00	1.66
Pacific cod	6.31	—	0.01	0.10	—	—	—	—	—	—	0.34	0.02	—	0.15	69.76	1.07	0.10	—	0.12	77.99
Pacific hake	350.30	0.00	258.21	1,294.43[a]	1,160.49[a]	671.62[a]	0.71	—	118.51	5.15	1.59	0.04	0.02	0.00	5,706.38	—	0.06	—	13.97	3,191.11[a]
Pacific ocean perch (N of 40°10′N)	38.59	0.02	3.76	46.93	30.79	24.84	—	—	0.06	—	0.35	0.01	0.00	0.00	1.24	—	—	—	5.39	151.97

[a] Numbers in these cells should be multiplied by 100.

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ													
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF	WA total SS	WA	OR	CA	Res.	EFM
Groundfish species																				
Petrale sole	2,644.02	0.71	4.16	0.00	—	—	0.97	—	0.76	0.34	3.88	0.13	0.02	3.28	227.24	—	2.57	2.72	21.23	2,912.04
Roundfish, unid.	—	—	—	0.01	0.00	0.00	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.01
Sablefish (N of 36°N)	1,390.41	811.00	7.73	72.75	92.18	24.60	—	—	0.16	—	2,032.54	62.71	1.88	6.36	434.78	—	1.95	—	41.06	4,980.12
Sablefish (S of 36°N)	0.28	43.90	—	—	—	—	—	—	—	—	399.08	—	10.05	11.83	—	—	—	—	1.09	466.23
Shortbelly rf.	0.69	—	31.75	243.65	85.89	142.16	—	—	3.02	0.67	0.03	—	—	—	0.00	—	—	—	0.48	508.35
SST (N of 34°27′N)	634.70	4.19	4.96	1.57	59.57	9.82	—	—	0.13	—	64.99	1.11	0.89	1.11	21.93	—	0.00	—	7.75	812.73
SST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	105.34	—	0.00	6.00	—	—	—	—	0.45	111.79
Spiny dogfish	228.47	19.93	7.16	391.40	701.10	256.25	3.44	—	1.14	1.01	226.76	0.44	0.41	0.71	63.66	—	0.01	3.49	27.18	1,932.57
Splitnose rf. (S of 40°10′N)	35.38	—	—	—	—	—	—	—	0.51	1.20	0.02	—	0.00	—	—	—	—	—	5.44	42.56
Starry flounder	1.64	—	—	—	—	—	4.39	—	—	—	0.00	—	0.05	0.29	—	—	0.01	0.71	0.03	7.13
Widow rf.	21.87	0.00	9,423.92	868.38	62.65	144.25	—	—	0.23	—	1.26	—	0.87	0.35	3.77	—	7.53	23.44	12.56	105.71[a]
YELLOWEYE RF.	0.11	0.00	—	0.01	—	—	—	—	0.00	—	1.34	0.01	2.27	0.01	0.85	3.15	3.62	4.99	0.80	17.18
Yellowtail rf. (N of 40°10′N)	101.10	0.04	1,937.40	1,049.08	51.12	178.75	—	—	1.08	—	1.42	0.04	1.32	1.78	118.91	38.16	34.84	0.99	4.22	3,520.24
Nongroundfish species																				
CA halibut	0.01	—	—	0.02	—	—	101.17	0.01	—	2.23	1.53	—	1.97	177.04	—	—	0.33	154.96	—	439.28
Dungeness crab	85.06	2.32	0.05	0.00	—	0.01	61.07	—	0.02	—	3.70	—	2.22	246.42[a]	593.25	—	—	—	—	253.90[a]
Non-FMP flatfish																				
Deepsea sole	3.43	0.00	0.00	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	3.44
Diamond turbot	—	—	—	—	—	—	0.19	—	—	—	—	—	—	—	—	—	—	—	—	0.19
Hornyhead turbot	0.00	—	—	—	—	—	1.65	—	—	2.03	—	—	—	0.05	—	—	—	—	—	3.74
Longfin sanddab	0.01	—	—	—	—	—	0.13	—	—	3.82	—	—	0.02	—	—	—	—	0.01	0.01	3.99
Slender sole	43.39	0.00	0.01	0.00	0.01	0.02	—	—	145.13	7.58	—	—	—	—	—	—	—	—	0.25	196.39
Speckled sanddab	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	0.02	0.02
Other nongroundfish																				
Brown Irish lord sculpin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00
Buffalo sculpin	—	—	—	—	—	—	0.00	—	—	—	—	—	0.10	—	—	—	0.02	—	—	0.12
CA sheephead	—	—	—	—	—	—	0.04	—	—	—	0.01	—	95.26	0.26	—	—	—	48.34	0.00	143.92
Red Irish lord sculpin	—	—	—	—	—	—	—	—	—	—	0.00	—	0.14	—	—	—	0.04	—	0.00	0.18
Sculpin, unid.	0.83	—	—	—	0.00	0.00	0.06	—	0.12	0.07	0.01	—	0.24	0.31	—	—	0.00	—	0.01	1.65
Skate, unid.	7.44	0.25	0.02	0.08	0.00	—	0.02	0.18	0.00	1.75	0.90	0.01	0.25	3.19	67.20	—	0.07	—	0.02	81.39
Squid, unid.	0.20	—	0.09	9.02	130.63	18.76	—	—	0.00	—	—	—	—	—	0.01	—	0.00	—	—	158.72
Starry skate	0.06	—	—	—	—	—	0.04	—	0.00	—	—	—	0.08	—	—	—	—	—	0.03	0.21

[a] Numbers in these cells should be multiplied by 100.

Table 15 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector.

	Commercial Fisheries															Recreational fishing mortality				
	IFQ/co-op Management						Non-IFQ													
	BT	FG	MW rf.	SS MW hake	A-S MW CP	A-S MW MSCV	OA CA halibut	SC	PS	RP	Non-ns. FG	Dir. PHLB	Ns. FG	IF	WA total SS	WA	OR	CA	Res.	EFM
Nongroundfish species																				
Shared ECS																				
Barracudina, unid.	0.00	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.00
Blacksmelt, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	0.01
Capelin	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Deepsea smelt, unid.	0.00	—	—	—	0.21	0.00	—	—	—	—	—	—	—	—	—	—	—	—	0.02	0.24
Duckbill barracudina	—	—	—	—	2.04	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	2.08
Jacksmelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	30.33	—	30.34
Lanternfish, unid.	0.00	—	—	0.00	0.81	0.01	—	—	0.17	—	—	—	—	—	—	—	—	—	0.03	1.02
Lightfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.03
Night smelt	—	—	—	—	—	—	—	—	0.08	—	—	—	—	—	—	—	—	—	—	0.08
Noneulachon smelt, unid.	0.00	—	—	—	—	—	—	—	3.98	0.06	—	—	—	—	—	—	—	—	0.03	4.07
Non-Humboldt squid, unid.	4.03	—	0.03	0.02	—	—	0.04	—	87.61	0.28	0.00	—	0.00	—	—	—	—	—	0.05	92.06
Pacific sandlance	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Pacific saury	0.00	—	—	—	0.00	0.00	—	—	0.03	—	—	—	—	—	—	—	—	—	0.00	0.03
Round herring	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Slender barracudina	—	—	—	—	0.00	0.00	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Smelt, unid.	—	—	—	0.00	0.00	—	—	—	0.10	—	0.04	—	0.02	133.40	0.00	—	—	—	0.00	133.56
Smelt/herring, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Surf smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
White barracudina	—	—	—	—	0.01	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01
Whitebait smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.03

Groundfish landings by the longline portion of the LE sablefish-endorsed primary fishery were ~70 mt lower in 2018 than in 2017, while the pot gear portion was ~30 mt lower (Somers et al. 2019a). Landings by both pot and line gears in the LE non-sablefish-endorsed fixed gear fleet were similar from 2016 to 2018 (Somers et al. 2019b), while landings by both the OA longline and pot gear fleets decreased by ~30 mt each (Somers et al. 2019b). Pacific halibut fishery landings were ~20 mt lower in 2018 than in 2017 (Somers et al. 2019b). Nearshore fixed gear landings increased by ~20 mt from 2017 to 2018 coastwide, reflecting increases of ~14 mt in Oregon and ~ 6 mt in California (Somers et al. 2019b).

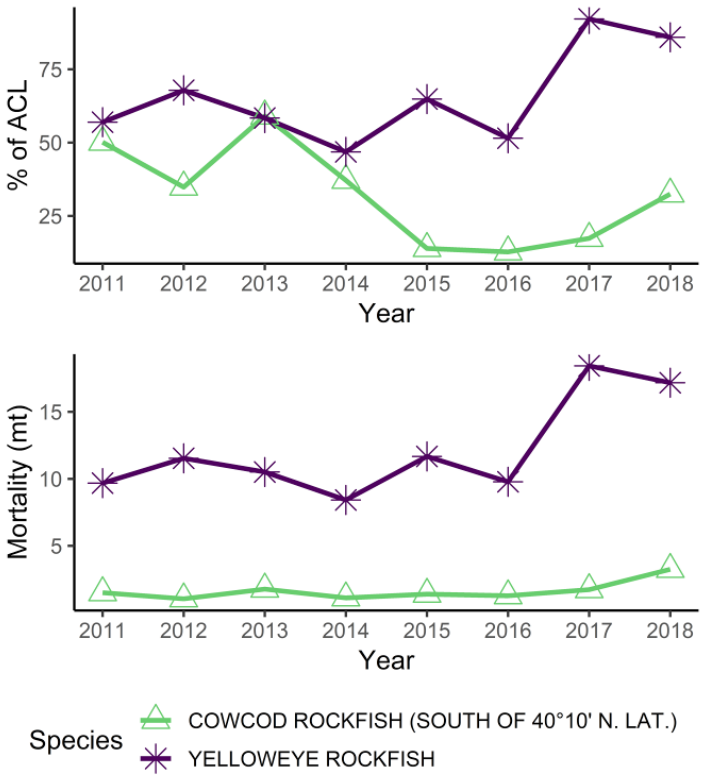

Figure 2. Estimated mortality and percentage of ACL for the two groundfish species defined by PFMC as rebuilding in 2018. Management reference points prior to 2011 were based on optimum yield rather than ACL so are not shown here.

Fishing mortality estimates are evaluated in terms of 2018 ACL, acceptable biological catch (ABC), and overfishing limit (OFL) harvest specifications from federal groundfish regulations (USOFR 2001, 2018). Only two rebuilding species remain: cowcod rockfish south of lat 40°10′N and yelloweye rockfish. The ACL percentage for cowcod increased from 17% in 2017 to 32% in 2018 (Figure 2; Somers et al. 2019a). The greatest contributions, of ~1 mt each, to cowcod mortality came from recreational fishing in California and from the non-nearshore fixed gear sector (Figure 4; Somers et al. 2019a). The next-largest contributors to cowcod mortality were research effort (0.63 mt) and the catch share bottom trawl fleet (0.42 mt). ACL attainment of yelloweye rockfish decreased from 92% in 2018 to 86% in 2017. The recreational fisheries were the primary contributors to yelloweye attainment in 2018, with mortality of ~3 mt in Washington, ~3.6 mt in Oregon, and ~5 mt in California. The nearshore and non-nearshore fixed gear sectors also included ~2.3 mt and ~1.3 mt of yelloweye rockfish mortality, respectively (Figure 4).

Five management groupings exceeded 90% of their ACLs, including shortbelly rockfish, the only grouping to exceed its ACL and attain 102%. The at-sea and shoreside hake sectors each contributed about half of the total shortbelly rockfish mortality in 2018 (Figure 4). Attainment of petrale sole remained high, achieving 94% of its ACL harvest goal in 2017 and 97% in 2018; nearly all mortality occurred in the catch share bottom trawl sector (Figures 3 and 4; Somers et al. 2019a). Spiny dogfish mortality nearly quadrupled, from ~500 mt in 2017 to ~1,900 mt in 2018, resulting in an increase in ACL attainment from 24% to 93% (Figure 3; Somers et al. 2019a). Most of this increase came from the hake fleets, primarily

Table 16. Estimated fishing mortality (mt) of major U.S. West Coast groundfish species and corresponding management reference points (harvest specifications). Values greater than 90–100% relative to a management reference point are highlighted in yellow. Values greater than 100% relative to a mangement reference point are highlighted in red. *Key*: EFM = estimated fishing mortality, ACL = annual catch limit, ABC = acceptable biological catch, OFL = overfishing limit, TAC = total allowable catch.

		Management reference points (harvest specifications)					
Species	**EFM**	**ACL**	**% of ACL**	**ABC**	**% of ABC**	**OFL**	**% of OFL**
Arrowtooth flounder	**1,133**	13,743	8	13,743	8	16,498	7
Big skate	**183**	494	37	494	37	541	34
Black rf. (CA)	**142**	332	43	332	43	347	41
Black rf. (OR)	**419**	520	81	520	81	570	73
Black rf. (WA)	**251**	301	84	301	84	315	80
Bocaccio rf. (S of 40°10′N)	**313**	741	42	1,924	16	2,013	16
Cabezon (CA)	**52**	149	35	149	35	156	33
Cabezon (OR)	**43**	47	92	47	92	49	88
CA scorpionfish (S of 34°27′N)	**102**	150	68	254	40	278	37
Canary rf.	**595**	1,526	39	1,526	39	1,596	37
Chilipepper rf. (S of 40°10′N)	**300**	2,507	12	2,507	12	2,623	11
COWCOD RF. (S of 40°10′N)	**3**	10	32	64	5	71	5
Darkblotched rf.	**343**	653	53	653	53	683	50
Dover sole	**6,505**	50,000	13	86,310	8	90,282	7
English sole	**297**	7,537	4	7,537	4	8,255	4
Lingcod (N of 40°10′N)	**1,012**	3,110	33	3,110	33	3,310	31
Lingcod (S of 40°10′N)	**457**	1,144	40	1,144	40	1,373	33
Longnose skate	**792**	2,000	40	2,415	33	2,526	31
Minor rockfish (N of 40°10′N)							
Nearshore	**80**	105	76	105	76	119	67
Shelf	**354**	2,047	17	2,048	17	2,302	15
Slope	**614**	1,754	35	1,754	35	1,896	32
Minor rockfish (S of 40°10′N)							
Nearshore	**715**	1,179	61	1,180	61	1,344	53
Shelf	**611**	1,624	38	1,625	38	1,918	32
Slope	**102**	709	14	719	14	829	12
Other flatfish	**835**	7,281	11	7,281	11	9,690	9
Other groundfish	**72**	441	16	441	16	501	14
Pacific cod	**78**	1,600	5	2,221	4	3,200	2
Pacific hake	**319,111**	2018 U.S. TAC = 441,433 mt; 72% of U.S. TAC					
Pacific ocean perch (N of 40°10′N)	**152**	281	54	941	16	984	15
Petrale sole	**2,912**	3,013	97	3,013	97	3,152	92
Sablefish (N of 36°N)	**4,980**	5,475	91	7,604	72	8,329	65
Sablefish (S of 36°N)	**466**	1,944	24				
Shortbelly rf.	**508**	500	102	5,789	9	6,950	7
Spiny dogfish	**1,933**	2,083	93	2,083	93	2,500	77
Splitnose rf. (S of 40°10′N)	**43**	1,761	2	1,761	2	1,842	2
Starry flounder	**7**	1,282	1	1,282	1	1,847	0
Thornyheads							
LST (N of 34°27′N)	**370**	2,747	13	3,614	11	4,339	9
LST (S of 34°27′N)	**15**	867	2				
SST (N of 34°27′N)	**813**	1,698	48	2,596	36	3,116	30
SST (S of 34°27′N)	**112**	898	12				
Widow rf.	**10,571**	12,655	84	12,655	84	13,237	80
YELLOWEYE RF.	**17**	20	86	48	36	58	30
Yellowtail rf. (N of 40°10′N)	**3,520**	6,002	59	6,002	59	6,574	54

the at-sea catcher–processor sector. The achievement of ACL for cabezon in Oregon decreased from 108% in 2017 to 92% in 2018 (Figure 3; Somers et al. 2019a). This decrease is attributable to lower mortality in the recreational sector; mortality by the nearshore fleet was close to 30 mt in both 2017 and 2018 (Somers et al. 2019a). Attainment of the ACL for sablefish north of lat 36°N decreased from 102% in 2017 to 91% in 2018, with the greatest contribution from non-catch share fixed gear, followed by catch share bottom trawl and then catch share fixed gear (Figures 3 and 4; Somers et al. 2019a). Twenty-seven of the groundfish species and complexes (63%) had fishing mortality estimates which were less than 50% of 2018 ACL harvest goals (Table 16).

Of the 46 management groupings compared across 2017 and 2018, 17 showed greater mortality in 2018 (Somers et al. 2019a). Spiny dogfish mortality showed the greatest relative increase and the second greatest total weight increase, as described above. The 2018 mortality of chilipepper rockfish in the south also showed a high increase relative to 2017 (~2×, ~170 mt), mostly attributable to larger landings by the catch share bottom trawl sector. As discussed above, the mortality of cowcod rockfish in the south also showed high relative increases between 2017 and 2018 (~2×, ~2 mt). Widow rockfish mortality increased the most of any grouping from 2017 to 2018, by more than 4,000 mt, almost

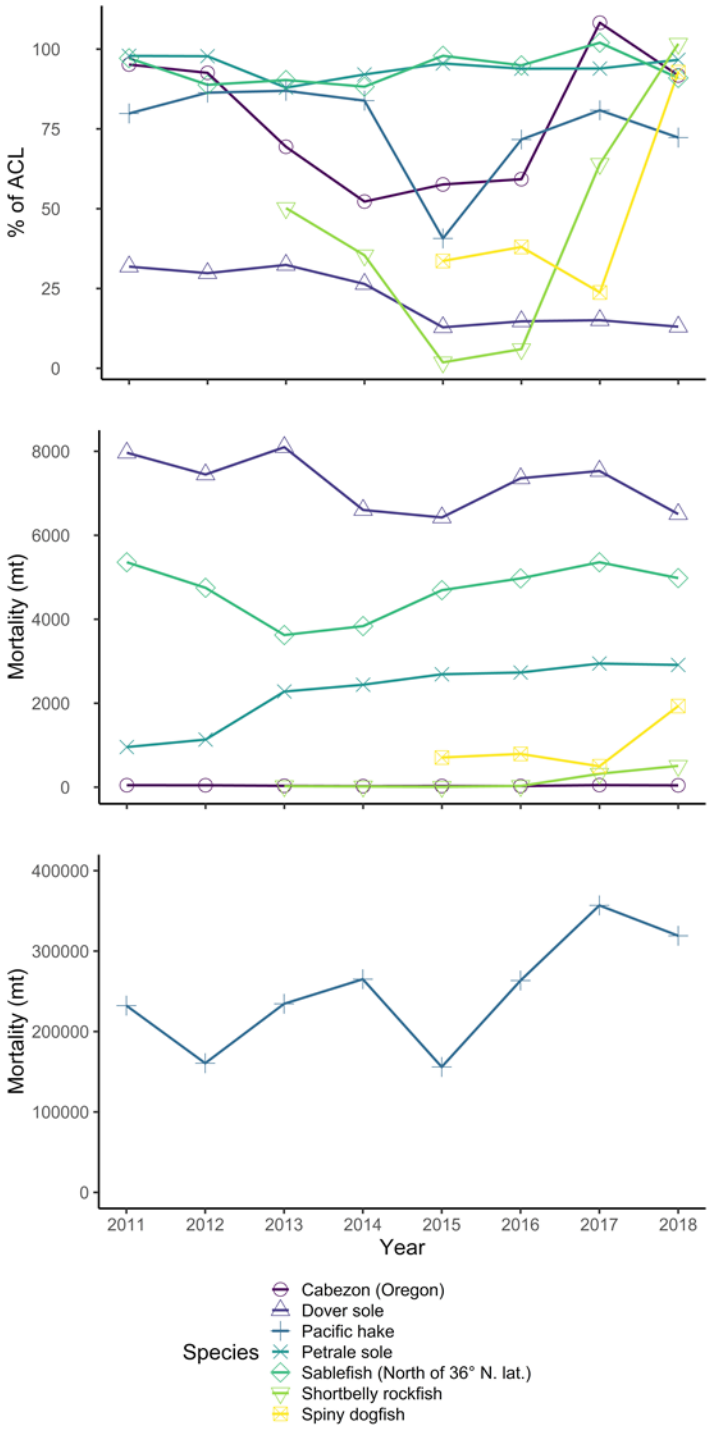

Figure 3. Estimated mortality and percentage of ACL for three of the most targeted groundfish species (Pacific hake, Dover sole, and sablefish in the north) and four other highly attained species (cabezon in Oregon, petrale sole, shortbelly rockfish, and spiny dogfish). Pacific hake mortality is shown in a separate panel to reflect the greater magnitude. Management reference points prior to 2011 were based on optimum yield rather than ACL, so are not shown here.

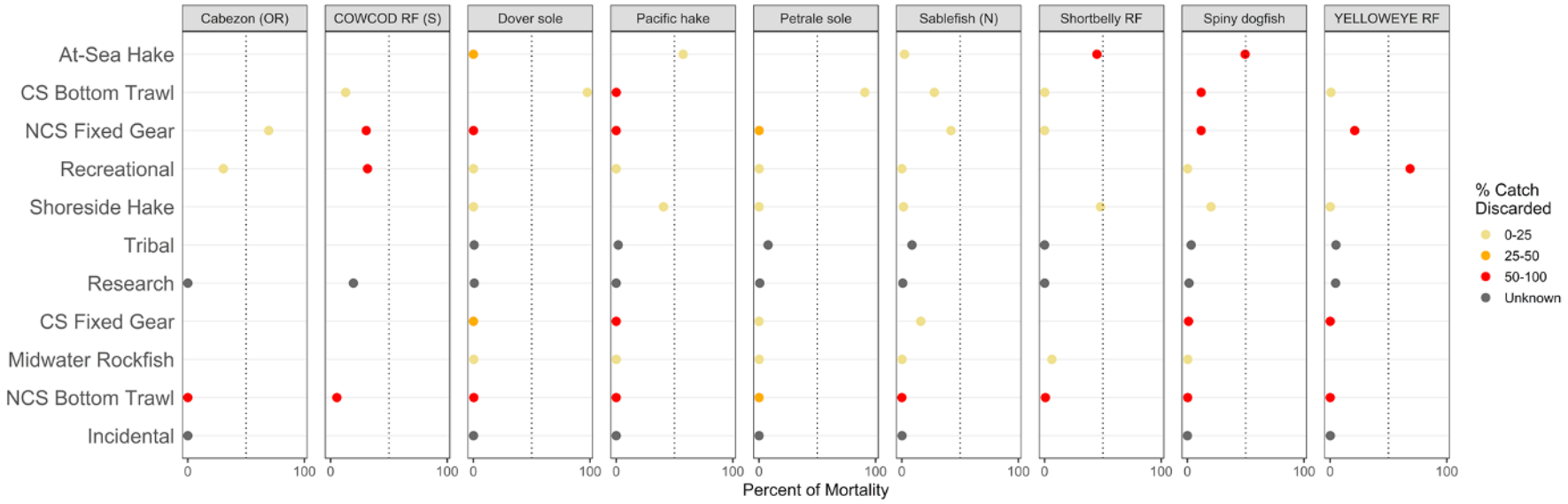

Figure 4. Percentage of mortality contributed by each sector to 2018 mortality for: the two rebuilding species (cowcod and yelloweye rockfish, capitalized), three of the most-targeted groundfish species (Pacific hake, Dover sole, and sablefish in the north), and four other highly attained species (cabezon in Oregon, petrale sole, shortbelly rockfish, and spiny dogfish). Sectors are ordered by mean percent contribution to mortality across all species displayed, with greatest contributors at the tops of the panels. NCS Fixed Gear includes all non-nearshore and nearshore fixed gear; NCS Bottom Trawl includes California halibut, pink shrimp, ridgeback prawn, and sea cucumber trawl. Dotted line specifies 50% of mortality. Dots are colored to reflect percentage of catch of the given species in the given sector that was discarded; sectors with no dots represent zero contribution.

entirely attributable to the growing midwater rockfish fleet (Somers et al. 2019a). The mortality of 17 management groupings in 2018 was lower than, but within 10% of, 2017 mortality (Somers et al. 2019a). Starry flounder decreased the most on a relative scale, with landings decreasing by two-thirds from 20 mt to 7 mt. Mortality of longspine thornyheads (in the north) and Pacific cod also decreased to half of that estimated for 2017. In total weight, Pacific hake mortality decreased by ~10% or ~38,000 mt between 2017 and 2018, and Dover sole decreased by ~14% or ~1,000 mt.

References

Albin, D., and K. A. Karpov. 1996. Mortality of lingcod, *Ophiodon elongatus*, related to capture by hook and line. Marine Fisheries Review 60(3):29–34.

Gustafson, R., K. Richerson, K. Somers, V. Tuttle, J. Jannot, and J. McVeigh. 2019. Observed and Estimated Bycatch of Eulachon in 2002–2017 U.S. West Coast Groundfish Fisheries. National Marine Fisheries Service, Seattle. Available: www.pcouncil.org/documents/2019/06/agenda-item-i-4-a-nmfs-report-2-observed-and-estimated-bycatch-of-eulachon-in-2002-2017-us-west-coast-groundfish-fisheries-electronic-only.pdf (March 2020).

Jannot, J. E., K. Richerson, K. A. Somers, V. Tuttle, and J. T. McVeigh. 2020. Pacific Halibut Bycatch in U.S. West Coast Groundfish Fisheries, 2002–18. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-152. DOI: 10.25923/tkr3-b927

Lee, Y.-W. 2015. Variance and CV Estimators for the Discard Ratios and Fleet-total Discards in the WCGOP Bycatch Reports. National Marine Fisheries Service, Seattle. Available: www.nwfsc.noaa.gov/research/divisions/fram/observation/pdf/Variance_CV_estimators_for_Discard_Estimates_in_WCGOP.pdf (July 2019).

NWFSC (Northwest Fisheries Science Center). 2019a. At-Sea Hake Observer Program, 2019 Sampling Manual. Fishery Resource Analysis and Monitoring, At-Sea Hake Observer Program. National Marine Fisheries Service, Seattle. Available: www.nwfsc.noaa.gov/research/divisions/fram/observation/data_collection/training.cfm (July 2019).

NWFSC (Northwest Fisheries Science Center). 2019b. 2019 Training Manual West Coast Groundfish Observer Program. National Marine Fisheries Service, Seattle. Available: www.nwfsc.noaa.gov/research/divisions/fram/observation/data_collection/training.cfm (July 2019).

NWFSC (Northwest Fisheries Science Center). 2020. Fisheries Observation Science: Data Processing. National Marine Fisheries Service, Seattle. Available: www.nwfsc.noaa.gov/research/divisions/fram/observation/data_processing.cfm (March 2020).

PFMC (Pacific Fishery Management Council). 2012. Scientific and Statistical Committee Report on Briefing on and Limited Actions for Emerging Issues in the 2013-2014 Biennial Specifications Process. Agenda Item F.2.b. Revised supplemental SSC report, March 2012. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2012/03/f-groundfish-management-march-2012.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2014. Groundfish Management Team Report on Proposed Discard Mortality for Cowcod, Canary Rockfish, and Yelloweye Rockfish Released Using Descending Devices in the Recreational Fishery. Agenda Item D.3.b. Supplemental GMT Report 2, March 2014. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2014/03/d-groundfish-management-march-2014.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2015a. Groundfish Management Team Report to the Scientific and Statistical Committee on a Literature Review of Skate Discard Mortality. Agenda Item D.7.a, GMT Report, June 2015. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2015/06/agenda-item-d-7-a-gmt-report.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2015b. Scientific and Statistical Committee Report on Inseason Adjustments. Agenda Item D.7.a, Supplemental SSC Report, June 2015. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2015/06/agenda-item-d-7-a-supplemental-ssc-report.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2017. Groundfish Management Team Informational Report on Updated Nearshore Discard Mortality Rates for Rockfish. Agenda Item F.10.a. Supplemental GMT report, June 2017. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2017/06/f10a_sup_gmt_rpt_inseasonrpt1-final_dmrs_for_bb_and_wcgop_jun2017bb.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2019a. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2016/08/pacific-coast-groundfish-fishery-management-plan.pdf (March 2020).

PFMC (Pacific Fishery Management Council). 2019b. Status of the Pacific Coast Groundfish Fishery: Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2019/01/status-of-the-pacific-coast-groundfish-fishery-stock-assessment-and-fishery-evaluation-description-of-the-fishery-revised-january-2019.pdf (March 2020).

PFMC and NMFS (Pacific Fishery Management Council and National Marine Fisheries Service). 2012. Proposed Harvest Specifications and Management Measures for the 2013–2014 Pacific Coast Groundfish Fishery and Amendment 21-2 to the Pacific Coast Fishery Management Plan; Final Environmental Impact Statement. Pacific Fishery Management Council, Portland, Oregon. Available: www.pcouncil.org/documents/2012/09/groundfish-harvest-specifications-and-management-measures-for-2013-2014-and-amendment-21-2.pdf/ (March 2020).

Pikitch, E. K., J. R. Wallace, E. A. Babcock, D. L. Erickson, M. Saelens, and G. Oddsson. 1998. Pacific halibut bycatch in the Washington, Oregon, and California groundfish and shrimp trawl fisheries. North American Journal of Fisheries Management 18:569–586.

Richerson, K., J. E. Jannot, Y.-W. Lee, J. McVeigh, K. Somers, V. Tuttle, and S. Wang. 2019. Observed and Estimated Bycatch of Green Sturgeon in 2002–2017 US West Coast Groundfish Fisheries. National Marine Fisheries Service, Seattle. Available: www.pcouncil.org/documents/2019/06/agenda-item-i-4-a-nmfs-report-3-observed-and-estimated-bycatch-of-green-sturgeon-in-2002-2017-us-west-coast-groundfish-fisheries-electronic-only.pdf (March 2020).

Somers, K. A., M. A. Bellman, J. E. Jannot, Y.-W. Lee, J. McVeigh, and V. Tuttle. 2015. Observed and Estimated Total Bycatch of Salmon in the 2002–2013 US West Coast Fisheries. National Marine Fisheries Service, Seattle. Available: www.nwfsc.noaa.gov/research/divisions/fram/observation/pdf/Salmon_Bycatch_Report_2002-2013.pdf (March 2020).

Somers, K. A., J. E. Jannot, V. Tuttle, N. B. Riley, and J. McVeigh. 2018. Observed and Estimated Total Bycatch of Salmon in U.S. West Coast Fisheries, 2002–16. U.S. Department of Commerce, NWFSC Processed Report 2018-01. Available: repository.library.noaa.gov/view/noaa/18732 (March 2020).

Somers, K. A., J. E. Jannot, K. Richerson, V. Tuttle, N. B. Riley, and J. T. McVeigh. 2019a. Estimated Discard and Catch of Groundfish Species in the 2017 U.S. West Coast Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-150. DOI: 10.25923/kr5q-je83

Somers, K. A., J. E. Jannot, K. Richerson, V. Tuttle, and J. McVeigh. 2019b. NWFSC Observer Coverage Rates 2002–2018. National Marine Fisheries Service, Seattle. Available to download from: www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/sector_products.cfm (March 2020).

USOFR (U.S. Office of the Federal Register). 2001. 50 CFR Part 660: Fisheries off West Coast States and in the Western Pacific; Pacific Coast Groundfish Fishery; Groundfish Observer Program, final rule (RIN 0648-AN27). Federal Register 66:79(24 April 2001):20609–20614.

USOFR (U.S. Office of the Federal Register). 2013. 50 CFR Part 660: Magnuson-Stevens Act Provisions; Fisheries Off West Coast States; Pacific Coast Groundfish Fishery; 2013–2014 Biennial Specifications and Management Measures, final rule (RIN 0648-BC35). Federal Register 78:2(3 January 2013):580–644.

USOFR (U.S. Office of the Federal Register). 2015. 50 CFR Part 660: Fisheries off West Coast States; Pacific Coast Groundfish Fishery Management Plan; Trawl Rationalization Program; Midwater Trawl Requirements, final rule (RIN 0648-BE29). Federal Register 80:239(14 December 2015):77267–77275.

USOFR (U.S. Office of the Federal Register). 2018. 50 CFR Part 660: Magnuson-Stevens Act Provisions; Fisheries Off West Coast States; Pacific Coast Groundfish Fishery; 2019–2020 Biennial Specifications and Management Measures, final rule (RIN 0648-BH93). Federal Register 83:238(12 December 2018):63970–64017.

Appendix A:
Discard Mortality Analysis Details/Protocol

The tables in this appendix can be downloaded from the report's NOAA Institutional Repository[1] record by clicking on the "Supporting Files" tab.

Table A-1. Species identification codes used in the Pacific Coast Fisheries Information Network (PacFIN) database and assigned to WCGOP data. Columns on the far right specify which species were defined as groundfish (as identified in the Pacific Coast Groundfish FMP), as nearshore species, as IFQ managed species or categories, or as rebuilding species in 2018.

Table A-2. Species belonging to each WCGOP unsampled IFQ catch category. The IFQM catch category includes all 2016 IFQ species, and the NIFQ category includes all non-IFQ fish species.

Table A-3. Mortality rates applied in bottom trawl and fixed gear fisheries. Unlisted species were assumed to have 100% mortality rate. Rates are provided by GMT.

Table A-4. Depth-dependent mortality rates applied in the nearshore fixed gear fishery. Unlisted species were assumed to have 100% mortality rate or were not observed in the given strata across all years of WCGOP data. Rates are provided by GMT and were updated in June 2017.

Table A-5. Updates to analysis used in this report.

Table A-6. In-season adjustments to 2018 U.S. West Coast groundfish fisheries. A complete list of NMFS Public Notices and a complete list of Federal Register Notices can be found on the NOAA Fisheries West Coast Region website.[2]

[1] https://repository.library.noaa.gov/

[2] https://www.fisheries.noaa.gov/rules-and-announcements/notices-and-rules?title=groundfish&management_area%5BWest+Coast%5D=West+Coast&fishing_type%5Bcommercial%5D=commercial&field_species_vocab_target_id=&sort_by=field_relevant_date_value

Appendix B:
PacFIN Data Processing Protocol

Fish Ticket Data Retrieval and Processing

The basic protocol we employ using Oracle SQL developer and R software is as follows:

1. Run an SQL query to retrieve PacFIN data from 2002 through previous year and output an initial data file (.csv file).
2. Postprocess the PacFIN data internally.
3. Utilize postprocessed PacFIN data files in analyses and groundfish mortality (GM) reporting.

Prior to PacFIN fish ticket data retrieval (from PacFIN website):

Landings can be recorded within the PacFIN system in very general categories consisting of many species, and others not as general but consisting of two or more species. Within the fish ticket tables, these are known as a fish ticket market category, or "category" for short. Examples in the PacFIN system are names such as "unspecified slope rockfish," "nominal yellowtail rockfish," and "unspecified small reds rockfish."

These market categories are sampled regularly, resulting in proportions that describe the composition of these various categories in terms of the actual species observed. This market category sampling occurs in various ports and for distinct gear types, producing proportions for individual species by port (or port group), gear (or gear group), and month (or quarter). For some PacFIN data sources, area is also a sampling dimension.

The PacFIN system combines monthly summations of market categories with corresponding species composition proportions to produce the best estimate of catch for individual species, where possible. If all possible combinations of market category, gear type, port, month, and area (where applicable) were actually sampled, then the resulting PacFIN reports/data would contain catch for only individual scientifically defined species. As it is, there are situations that result in unsampled strata and thus, PacFIN reports/data potentially include both individual species as well as market categories.

We selected from all data from 2002–18 from one view created by PacFIN, `WCGOP_COMPFT_FEDPERMITS_V2`, which joins permits tables to the comprehensive fish ticket table.

Prior to running the code below, edits are made to the downloaded PacFIN data, including:

- Correcting gear, vessel ID, IFQ landing, ticket date, and removal type fields based on intense QAQC of observer data.
- Removing duplicated tickets.
- Adding salmon counts based on electronic fish tickets data.
- Incorporating state permit data.

Explicit WCGOP postprocessing of PacFIN fish ticket data output from query above

This procedure will identify sectors, as shown in Figure 1.

Add field YMD and calculate:
([YEAR] × 10,000) + ([MONTH] × 100) + [DAY])

Add field VIDYMD and calculate:
[DRVID] & [YMD]

Select Tribal landings as PARGRP = *I.*
Assign sector "Tribal Commercial" and summarized with "Tribal landings."

Select Research landings as REMOVAL_TYPE = *R* and IFQ_LANDING = *FALSE.*
Assign sector "Commercial Research."

Note: Commercial research data are provided by WCR for GM reports, and thus the data from this step are omitted. Further, IFQ trips in early years of the program were often incorrectly identified as research, so we ignore overlap between those two fields.

Select Non-Research landings as !(REMOVAL_TYPE = *R* and IFQ_LANDING = *FALSE*).

Select fish tickets not identified to an entity/vessel in Non-Research as DRVID = *MISSING*, *UNKNOWN*, or blank.
Assign sector "Non-Identified Vessel/Entity."

Select fish tickets identified to an entity/vessel in Non-Research as DRVID ≠ *MISSING*, *UNKNOWN*, or blank.

Select non-IFQ EFP landings from Non-Research, Vessel ID known as REMOVAL_TYPE = *E* and IFQ_LANDING = *FALSE*.
Assign sector "Commercial EFP."

Note: We ignore the EFP flag where IFQ_LANDING = TRUE*, because this field is not always correct. Instead, we use a separate list from PSMFC to identify EM and other EFP tickets under the IFQ program. In 2017, the gear modification EFP trip was included in the IFQ catch share program as EM or observed, as appropriate.*

2002–2010:
If ADJ_GRID = MDT, summarized with "Non-tribal shoreside hake."
If ADJ_GRID ≠ MDT, summarized with "Incidental fisheries" or as "EFP."

Select non-EFP and IFQ EFP from Non-Research, Vessel ID known as REMOVAL_TYPE ≠ *E* or REMOVAL_TYPE = *E* and IFQ_LANDING = *TRUE*.

Select Individual Fishing Quota (IFQ) landings from Non-Research, Vessel ID known as IFQ_LANDING = *TRUE*.

Identify hake sector for all IFQ midwater tickets:
Landed ≥ 50% hake on VIDYMD, hake sector = "Midwater Hake."
Landed < 50% hake on VIDYMD, hake sector = "Midwater Rockfish."

Identify non-EM EFP fleet:
If not in EM list from PSMFC:
If fishing non-midwater, assign sector "Catch Shares."
If fishing midwater 2011–14 and observer identified as non-hake trip, assign sector "Catch Shares."
If fishing midwater 2011–14 and observer identified as hake trip, assign sector "Shoreside Hake."
If fishing midwater 2015–forward, assign sector "Midwater Hake" or "Midwater Rockfish" based on hake sector above.

If in EM list from PSMFC:
If fishing non-midwater, assign sector "Catch Shares EM."
If fishing midwater, assign "Midwater Hake EM" or "Midwater Rockfish EM" based on hake sector field above.

Select non-IFQ landings from Non-Research, Non-EFP, Vessel ID known: IFQ_LANDING = *FALSE.*

Select Gear Group Shrimp trawl landings from non-IFQ that landed more Pink Shrimp (PS) than not, fished with a state PS permit between April and November:
GRGROUP = *TWS* and PS permit and MONTH in 4–11.
Assign sector "Commercial Shrimp Trawl."
Summarized as "Pink Shrimp."

Select Gear Group Shrimp trawl landings from non-IFQ that did not land more Pink Shrimp (PS) than not, did not fish with a state PS permit, and/or fished outside of April to November:
GRGROUP = *TWS* and no PS permit or MONTH in 1–3, 12.

Select landed ridgeback prawn and no sea cucumber, had state permit, and fished in MONTH 1–5:
Assign sector "Commercial Prawn Trawl."

Select landed sea cucumber and no ridgeback prawn and had state permit:
Assign sector "Commercial Sea Cucumber Trawl."

Select landed sea cucumber and ridgeback prawn and had both state permits:

Select landed more ridgeback prawn:
Assign sector "Commercial Prawn Trawl."

Select landed more sea cucumber:
Assign sector "Commercial Sea Cucumber Trawl."

Select landed more of anything other than ridgeback prawn or sea cucumber:
Assign sector "Commercial Group Others."
Summarized with "Incidental fisheries."

Select did not land ridgeback or sea cucumber:
Assign sector "Commercial Group Others."
Summarized with "Incidental fisheries."

Select Gear Group Other landings from Non-Research/EFP Commercial:
(GRGROUP ≠ *HKL*) & (GRGROUP ≠ *POT*) & (GRGROUP ≠ *TWL*) & (GRGROUP ≠ *TWS*)
Assign sector "Commercial Group Others."
Summarized with "Incidental fisheries."

Select Gear Group Trawl landings from Non-IFQ:
GRGROUP = *TWL*.

Select Limited Entry permitted:
PERM1 ≠ [blank]

Select Midwater:
ADJ_GRID = *MDT.*
Assign sector "Commercial LE Trawl Midwater."
2002–2010:
Summarized with "Non-tribal shoreside hake."
2011–present:
If sector present, indicates an error that needs to be corrected. Often unlabeled research trip.

Select Non-Midwater:
ADJ_GRID ≠ *MDT.*
Assign sector "Commercial LE Trawl Non-midwater."

Select CA halibut:
2002–2006 based on CA halibut weight > 150 lb:
(SPID %in% c(*CHLB*, *CHL1*)) & (LWT_LBS > 150)
2007–present based on CA halibut on ticket and vessel carrying a year-specific CA halibut permit and CA halibut weight > 150 lb:
(SPID %in% c(*CHLB*, *CHL1*)) & (LWT_LBS > 150) & (DRVID %in% unique(FT.perm$DRVID))
Assign to "LE CA Halibut."

Select non-CA halibut:
Likely permit was not used for given landing. Assign to "Commercial OA Trawl Non-Midwater" and summarized with "Incidental fisheries."

Select Non-LE permitted (Open Access):
PERM1 = [blank]

Select Midwater:
ADJ_GRID = *MDT*.
Assign sector "Commercial OA Trawl Midwater."
Summarized with "Incidental fisheries."

Select Non-Midwater:
ADJ_GRID ≠ *MDT*.
Assign sector "Commercial OA Trawl Non-midwater."

Select CA halibut:
2002–2006 based on CA halibut weight > 150 lb:
(SPID %in% c(*CHLB*, *CHL1*)) & (LWT_LBS > 150)
2007–present based on CA halibut on ticket and vessel carrying a year-specific CA halibut permit:
(SPID %in% c(*CHLB*, *CHL1*)) & (DRVID %in% unique(FT.perm$DRVID))
Assign to "OA CA Halibut."

Select non-OA CA Halibut:

Select landed ridgeback prawn and no sea cucumber, had state permit, and fished in MONTH 1–5:
Assign sector "Commercial Prawn Trawl."

Select landed sea cucumber and no ridgeback prawn and had state permit:
Assign sector "Commercial Sea Cucumber Trawl."

Select landed sea cucumber and ridgeback prawn and had both state permits:

Select landed more ridgeback prawn:
Assign sector "Commercial Prawn Trawl."

Select landed more sea cucumber:
Assign sector "Commercial Sea Cucumber Trawl."

Select landed more of anything other than ridgeback prawn or sea cucumber:
Assign sector "Commercial OA Trawl Non-midwater."
Summarized with "Incidental fisheries."

Select any remaining:
Assign sector "Commercial OA Trawl Non-midwater."
Summarized with "Incidental fisheries."

Select Gear Group Fixed Gear landings from Non-IFQ/Research/EFP Commercial:
(GRGROUP = *HKL*) | (GRGROUP = *POT*)

Select Nearshore Species on FT:

SPID %in% c(*BLCK*, *BLK1*, *RCK9*, *RCK7*, *RCK2*, *BYEL*, *BYL1*, *BLU1*, *BLUR*, *BRW1*, *BRWN*, *CLC1*, *CLCO*, *SCOR*, *SCR1*, *CHN1*, *CHNA*, *COP1*, *COPP*, *GPH1*, *GPHR*, *GRAS*, *GRS1*, *KLP1*, *KLPR*, *OLV1*, *OLVE*, *QLB1*, *QLBK*, *TRE1*, *TREE*, *NSHR*, *NUSR*, *SSHR*, *SUSR*, *USHR*, *CBZ1*, *CBZN*, *KGL1*, *KLPG*, *SHPD*, *SHP1*, *UDNR*, *SSRS*, *SSRD*, *BISC*, *BSCL*, *RSCL*, *UGLG*)

Compile unique vessel landing date (VIDYMD) values for those FTs with Nearshore Species.

Retrieve all FTs (and all FT line items) for those VIDYMD values (so obtaining *all* fish tickets for a vessel's landing date if one or more of the vessel's fish tickets on that date had a nearshore species recorded on it).

2002–2003:

If not landed in WA, assign to "Nearshore."

2004–present:

If not landed in WA and had active Nearshore permit for given year, assign to "Nearshore."

Of the remaining Non-Nearshore Fixed Gear landings:

1. Create a catch variable for Groundfish (based on a GF_ID in a separate file maintained by WCGOP), and summarize RWT_LBS of groundfish and nongroundfish for each unique VIDYMD.

   If weight of nonsablefish groundfish weight is greater than nongroundfish weight in a unique fishing day for a vessel (VIDYMD), include in "Fixed Gear Sablefish Landings."

   GFLB.Sum ≥ NonGFLB.Sum
2. Select all VIDYMD if sablefish is a line item of catch on a FT:

   SPID = *SABL*
3. Compile unique VIDYMDs that fit either criteria of 1) sablefish landings, or 2) groundfish greater than nongroundfish.

   Retrieve all FT line items for those VIDYMD values. (See next section for more processing of these Fixed Gear Sablefish Landings).

Remaining not identified in Step 3 are Non-Nearshore, Non-Sablefish Fixed Gear landings:

Select Limited Entry permitted:

PERM1 ≠ [blank]

Select if Tier Endorsed:

SABL1 ≠ *0* | SABL2 ≠ *0* | SABL3 ≠ *0* | SABL4 ≠ *0*

Assign sector "Commercial Fixed-Gear Non-Nearshore Non-Sablefish LE Tier."

Select if Not Tier Endorsed:

SABL1 = *0* & SABL2 = *0* & SABL3 = *0* & SABL4 = *0*

Assign sector "Commercial Fixed-Gear Non-Nearshore Non-Sablefish LE 0 Tier."

Select Non-LE permitted (Open Access):
PERM1 = [blank]
Assign sector "Commercial Fixed-Gear Non-Nearshore Non-Sablefish OA."
Summarize with "Incidental fisheries."

Fixed Gear Sablefish landing FTs (see above for initial Steps 1–3 to identify):

Select Limited Entry permitted:
PERM1 ≠ [blank]
Assign sector "Commercial Fixed-Gear LE Sablefish."

Select if Tier Endorsed:
SABL1 ≠ *0* | SABL2 ≠ *0* | SABL3 ≠ *0* | SABL4 ≠ *0*
(See below for additional steps.)

Select if Not Tier Endorsed:
SABL1 = *0* & SABL2 = *0* & SABL3 = *0* & SABL4 = *0*

Select if Pot gear (LE 0 Tier cannot fish pot gear, so thus OA):
GRGROUP = *POT*
Assign sub-sector "Sable OA."
Summarize with "Non-nearshore fixed gear" (and "OA Fixed Gear" prior).
GRGROUP ≠ *POT*
Assign sub-sector "LE 0 Tier."
Summarize with "Non-nearshore fixed gear" (and "LE Non-primary" prior).

Select Non-LE permitted (Open Access):
PERM1 = [blank]
Assign sector "Commercial Fixed-Gear OA Sablefish."
Assign sub-sector "Sable OA."
Summarize with "Non-nearshore fixed gear" (and "OA Fixed Gear" prior).

For LE Tier Endorsed FTs, to determine if:
a) landings are assigned to the primary fishery (Primary Season Attaining Quota),
b) landings were made in the non-season fishery (Non-season DTL), or
c) if the vessel fished in the primary season but had already reached their tier limit and landings should be assigned to the DTL fishery (Primary Season Reached Quota DTL):

Select if definitely non-primary season (with 5 days buffer at end of the season to evaluate those FTs at the "borderline" which could fall into either primary or non-season):
(MONTH < 4) | (MD > 1105)
Note: MD is a concatenated field with Month and Day.

Assign sub-sector "LE SAB NonPSeason."
Summarize with "Non-nearshore fixed gear" (and "LE Non-primary" prior)

Select if primary season (with 5-day buffer at end of season to evaluate those FTs at the "borderline" which could fall into either primary or non-season):
(MONTH ≥ 4) & (MD ≤ 1105)

Order multiple landings on a day from greatest sablefish landing to smallest sablefish landing to ensure consistent results across different years of analysis.

Add fields SABL1_Lim, SABL2_Lim, SABL3_Lim, etc., and calculate using year-specific tier limits:
2002–present except 2011 (repeated for each sabletier undelimited data field; SABL1, etc.):
SABL1_Lim [which(SABL = 1)] = Tier1Quota
SABL2_Lim [which(SABL = 2)] = Tier2Quota
SABL3_Lim [which(SABL = 3)] = Tier3Quota
For 2011, tier limits were increased midseason, taking effect 11 June:
SABL1_Lim [which((SABL = 1) & (MD < 0611))] = Tier1Quota for 2011a
SABL2_Lim [which((SABL = 2) & (MD < 0611))] = Tier2Quota for 2011a
SABL3_Lim [which((SABL = 3) & (MD < 0611))] = Tier3Quota for 2011a
SABL1_Lim [which((SABL = 1) & (MD ≥ 0611))] = Tier1Quota for 2011b
SABL2_Lim [which((SABL = 2) & (MD ≥ 0611))] = Tier2Quota for 2011b
SABL3_Lim [which((SABL = 3) & (MD ≥ 0611))] = Tier3Quota for 2011b

Add field QUOTA and calculate:
[SABL1_Lim] + [SABL2_Lim] + [SABL3_Lim]

Add field SABL_LND and for weight of sablefish landings for each line:
SABL_LND = *0*
SABL_LND [which(SPID = *SABL*)] = RWT_LBS[which(SPID = *SABL*)]

Select out just those FT line items with Sablefish:
SPID = *SABL*

Add field CUMSABL and calculate the cumulative sablefish weight landed by a vessel (each fish ticket line item of sablefish weight gets added up over time to see how the vessel's sablefish landings move toward attaining their total quota limit).

Add field PROPORTION and calculate the proportion of sablefish weight caught relative to their total tier quota weight:
[CUMSABL] / [QUOTA]

Select if the vessel is over their tier quota:
PROPORTION > 1

Select by criteria to identify the DTL sector, based on a "cushion" of sablefish quota overage weight (PROPORTION > 1.15) to allow for vessels that have reached their quota and are landing below the annual maximum DTL weekly limit:
(PROPORTION > 1.15 and SABL_LND < 1880 "DTL Max from above") or
YMD > 20131105

Compile unique FTID values for the FTs selected in the "Select by criteria" step above.

Retrieve all FT line items for those FTID values (for the DTL sectors).
Assign sub-sector "LE SAB DTL."
Summarize with "Non-nearshore fixed gear" (and "LE Non-primary" prior).

Remaining are Sablefish Primary Season Attaining Quota landings.

One more step is used to place these into season vs. non-season landings.

Select if in Primary Season:
YMD < 20131101
Assign sub-sector "LE SAB Primary."
Summarize with "Non-nearshore fixed gear" (and "LE Sablefish Primary" prior).

Select if outside Primary Season (non-season):
YMD ≥ 20131101
Assign sub-sector "LE SAB NonPSeason."
Summarize with "Non-nearshore fixed gear" (and "LE Non-primary" prior).

All data segments are combined together to reproduce the original dataset. If a SubSector value was not designated in the processing above, it is given the value from the SECTOR field.

All additional data processing steps that were applied during the discard estimation process are described in Methods. Of these, specific identification and removal of commercial directed Pacific halibut fixed gear landings is as follows:

If SubSector equals "Sable OA," "LE 0 Tier," "LE SAB NonPSeason," "LE SAB DTL," or "LE SAB Primary":

For 2002–17: If listed by the International Pacific Halibut Commission (IPHC) as a directed PHLB ticket, summarize with "Directed PHLB."

For most recent year of data, IPHC's list is not yet available, and IPHC does not currently track directed PHLB landings in California. In the most recent year, for all states, FTID had recorded PHLB catch landed on one of the specific calendar year 10-hour openings, plus two days post (to allow for any subsequent deliveries):
Summarize with "Directed PHLB."

Table B-1. Annual tier quota and daily trip limit (DTL) maximums, in pounds (lb), for the limited entry sablefish primary fishery.

Year	Tier 1 quota	Tier 2 quota	Tier 3 quota	DTL maximum landing	Federal Register reference
2002	36,000	16,500	9,500	1,050	67 FR 10490
2003	53,000	24,000	14,000	1,050	68 FR 11182
2004	64,300	29,200	16,700	1,050	69 FR 11064
2005	64,000	29,100	16,600	1,050	69 FR 77012
2006	62,700	28,500	16,300	1,050	69 FR 77012
2007	48,500	22,000	12,500	1,050	71 FR 78638
2008	48,500	22,000	12,500	1,050	71 FR 78638
2009	61,296	27,862	15,921	1,000	73 FR 80516
2010	56,081	25,492	14,567	3,000	73 FR 80516
2011a	41,379	18,809	10,748	2,000	76 FR 11381
2011b	47,697	21,680	12,389	2,000	76 FR 34910
2012	46,238	21,017	12,010	1,800	76 FR 77415
2013	34,513	15,688	8,964	1,880	78 FR 49190
2014	37,441	17,019	9,725	2,000	78 FR 580
2015	41,175	18,716	10,695	2,000	80 FR 12567
2016	45,053	20,479	11,702	1,275	80 FR 12567
2017	45,120	20,509	11,720	1,275	82 FR 9634
2018	47,050	21,386	12,221	1,125	82 FR 9634

2018:
((MONTH = 6) & (DAY %in% 26:28)) |
((MONTH = 7) & (DAY %in% 10:12)) |
((MONTH = 7) & (DAY %in% 24:26))

In addition, California FTID had recorded PHLB catch landed on one of the specific calendar year 10-hour openings, plus two days post (to allow for any subsequent deliveries):

2017:
((MONTH = 6) & (DAY %in% 28:30)) |
((MONTH = 7) & (DAY %in% 12:14)) |
((MONTH = 7) & (DAY %in% 26:28))

2016:
((MONTH = 6) & (DAY %in% 21:23)) |
((MONTH = 7) & (DAY %in% 5:7)) |
((MONTH = 7) & (DAY %in% 19:21))

2015:
((MONTH = 6) & (DAY %in% 23:25)) |
((MONTH = 7) & (DAY %in% 7:9))

```
2014:
    ((MONTH = 6) & (DAY %in% 25:27)) |
    ((MONTH = 7) & (DAY %in% 9:11))

2013:
    ((MONTH = 6) & (DAY %in% 26:28)) |
    ((MONTH = 7) & (DAY %in% 10:12))

2012:
    ((MONTH = 6) & (DAY %in% 27:29)) |
    ((MONTH = 7) & (DAY %in% 11:13))

2011:
    ((MONTH = 6) & (DAY %in% 29:30)) |
    ((MONTH = 7) & (DAY = 1)) |
    ((MONTH = 7) & (DAY %in% 13:15)) |
    ((MONTH = 7) & (DAY %in% 27:29)) |
    ((MONTH = 8) & (DAY %in% 10:12)) |
    ((MONTH = 8) & (DAY %in% 24:26)) |
    ((MONTH = 9) & (DAY %in% 7:9)) |
    ((MONTH = 9) & (DAY %in% 21:23))

2010:
    ((MONTH = 6) & (DAY %in% 30:31)) |
    ((MONTH = 7) & (DAY %in% 1:2))

2009:
    ((MONTH = 6) & (DAY %in% 24:26)) |
    ((MONTH = 7) & (DAY %in% 8:10))

2008:
    ((MONTH = 6) & (DAY %in% 11:13)) |
    ((MONTH = 6) & (DAY %in% 25:27)) |
    ((MONTH = 7) & (DAY %in% 9:11)) |
    ((MONTH = 7) & (DAY %in% 23:25))

2007:
    ((MONTH = 6) & (DAY %in% 27:29)) |
    ((MONTH = 7) & (DAY %in% 11:13)) |
    ((MONTH = 7) & (DAY %in% 25:27)) |
    ((MONTH = 8) & (DAY %in% 8:10))

2006:
    ((MONTH = 6) & (DAY %in% 28:30)) |
    ((MONTH = 7) & (DAY %in% 12:14)) |
    ((MONTH = 7) & (DAY %in% 26:28))
```

2005:
((MONTH = 6) & (DAY %in% 29:30)) |
((MONTH = 7) & (DAY = 1)) |
((MONTH = 7) & (DAY %in% 13:15)) |
((MONTH = 7) & (DAY %in% 27:29)) |
((MONTH = 8) & (DAY %in% 10:12))

2004:
((MONTH = 6) & (DAY %in% 23:25)) |
((MONTH = 7) & (DAY %in% 14:16)) |
((MONTH = 7) & (DAY %in% 28:30)) |
((MONTH = 8) & (DAY %in% 11:13))

2003:
((MONTH = 6) & (DAY %in% 25:27)) |
((MONTH = 7) & (DAY %in% 9:11)) |
((MONTH = 7) & (DAY %in% 23:25)) |
((MONTH = 8) & (DAY %in% 6:8))

2002:
((MONTH = 6) & (DAY %in% 26:28)) |
((MONTH = 7) & (DAY %in% 10:12)) |
((MONTH = 7) & (DAY %in% 24:26))

Trawl Logbook Data Retrieval and Processing

Logbook data are downloaded from a view in PacFIN that incorporates logbook data and permit information: `pacfin.lbk_codemb0310multiftiddelim`.

Data from 2002–10 are used in estimations of discard for the LE trawl fleet. Data from 2011–present are sometimes used for effort estimations when observer data are unavailable because a trip was monitored using an electronic system.

Explicit WCGOP postprocessing of PacFIN logbook data output from query above

Select Puget Sound landings:
PSGRNDCODE ≠ 0

Select Non-Puget Sound (Ocean) landings:
PSGRNDCODE = 0

Select Midwater:
GRID = *MDT*

Select Non-Midwater:
GRID ≠ *MDT*

Select Limited Entry permitted:
PERMID_1 ≠ [blank]

Select Non-LE permitted (Open Access):
PERMID_1 = [blank]

Note: LE Nonmidwater logbook data is further delineated into the state California halibut trawl fishery for each individual tow/haul as follows:

a) If tow target is California halibut (PACFIN_TARGET = CHLB *or* CHL1*), or*
*b) Tow target PACFIN_TARGET = (*NSM *or* OFLT *or* SSOL *or* SSO1*) and DEPTH1 < 30 (fth) and SET_LAT < 40.16667.*

The remaining LE non-midwater logbook data tows are considered part of the LE groundfish trawl fishery.

Additional data processing steps are described in each report and product.

List of Species

Aurora rockfish	*Sebastes aurora*
Arrowtooth flounder	*Atheresthes stomias*
Aleutian skate	*Bathyraja aleutica*
Bank rockfish	*Sebastes rufus*
Blackgill rockfish	*Sebastes melanostomus*
Black rockfish	*Sebastes melanops*
Black skate	*Bathyraja trachura*
Blue/deacon rockfish	*Sebastes mystinus*
Bronzespotted rockfish	*Sebastes gilli*
Brown rockfish	*Sebastes auriculatus*
Buffalo sculpin	*Enophrys bison*
Big skate	*Raja binoculata*
Black and yellow rockfish	*Sebastes chrysomelas*
Cabezon	*Scorpaenichthys marmoratus*
California halibut	*Paralichthys californicus*
China rockfish	*Sebastes nebulosus*
Chinook (king) salmon	*Oncorhynchus tshawytscha*
Chum (dog) salmon	*Oncorhynchus keta*
Chilipepper rockfish	*Sebastes goodei*
Canary rockfish	*Sebastes pinniger*
Coho (silver) salmon	*Oncorhynchus kisutch*
Copper rockfish	*Sebastes caurinus*
California skate	*Raja inornata*
Curlfin sole	*Pleuronichthys decurrens*
Cowcod rockfish	*Sebastes levis*
Darkblotched rockfish	*Sebastes crameri*
Dungeness crab	*Cancer magister*
Dover sole	*Microstomus pacificus*
Deepsea sole	*Embassichthys bathybius*
Spiny dogfish	*Squalus suckleyi*
Diamond turbot	*Hypsopsetta guttulata*
Eulachon	*Thaleichthys pacificus*
Flag rockfish	*Sebastes rubrivinctus*
Freckled rockfish	*Sebastes lentiginosus*
Flathead sole	*Hippoglossoides elassodon*
Greenblotched rockfish	*Sebastes rosenblatti*
Grenadier, unid.	*Macrouridae*
California grenadier	*Nezumia stelgidolepis*
Popeye grenadier	*Coryphaenoides cinereus*
Shoulderspot grenadier	*Caelorinchus scaphopsis*
Smooth grenadier	*Nezumia liolepis*
Pacific grenadier	*Coryphaenoides acrolepis*
Greenspotted rockfish	*Sebastes chlorostictus*
Green sturgeon	*Acipenser medirostris*
Halfbanded rockfish	*Sebastes semicinctus*
Harlequin rockfish	*Sebastes variegatus*
Hornyhead turbot	*Pleuronichthys verticalis*
Kelp greenling	*Hexagrammos decagrammus*
Lingcod	*Ophiodon elongatus*
Longfin sanddab	*Citharichthys xanthostigma*
Longnose skate	*Raja rhina*
Longspine thornyhead (LST)	*Sebastolobus altivelis*
Leopard shark	*Triakis semifasciata*
Lanternfish, unid.	*Myctophidae*
Lightfish, unid.	*Phosichthyidae*
Bristlemouth, unid.	*Gonostomatidae*
Barracudina, unid.	*Paralepididae*
Mexican rockfish	*Sebastes macdonaldi*
Groundfish, unid.	—
Olive rockfish	*Sebastes serranoides*
Roundfish, unid.	—
Deepsea skate	*Bathyraja abyssicola*
Skate, unid.	*Rajidae*
Pacific cod	*Gadus macrocephalus*

Pacific sanddab	*Citharichthys sordidus*
Pacific flatnose	*Antimora microlepis*
Pygmy rockfish	*Sebastes wilsoni*
Pacific halibut	*Hippoglossus stenolepis*
Pink (humpback) salmon	*Oncorhynchus gorbuscha*
Pink rockfish	*Sebastes eos*
Pacific ocean perch	*Sebastes alutus*
Pinkrose rockfish	*Sebastes simulator*
Pink shrimp	*Pandalus jordani*
Petrale sole	*Eopsetta jordani*
Pacific hake	*Merluccius productus*
Quillback rockfish	*Sebastes maliger*
Spotted ratfish	*Hydrolagus colliei*
Rockfish, unid.	*Sebastes* spp.
Redbanded rockfish	*Sebastes babcocki*
Redstripe rockfish	*Sebastes proriger*
Rosy rockfish	*Sebastes rosaceus*
Red Irish lord sculpin	*Hemilepidotus hemilepidotus*
Rosethorn rockfish	*Sebastes helvomaculatus*
Sablefish	*Anoplopoma fimbria*
Pacific saury	*Cololabis saira*
Shortbelly rockfish	*Sebastes jordani*
Sculpin, unid.	*Cottidae*
Starry flounder	*Platichthys stellatus*
Sharpchin rockfish	*Sebastes zacentrus*
Slender sole	*Lyopsetta exilis*
Noneulachon smelt, unid.	*Osmeriformes*
Smelt, unid.	*Osmeridae*
Whitebait smelt	*Allosmerus elongatus*
Surf smelt	*Hypomesus pretiosus*
Deepsea smelt, unid.	*Bathylagidae*
Splitnose rockfish	*Sebastes diploproa*
Sockeye (red) salmon	*Oncorhynchus nerka*
Speckled rockfish	*Sebastes ovalis*
Sandpaper skate	*Bathyraja kincaidii*
Squarespot rockfish	*Sebastes hopkinsi*
Shortraker rockfish	*Sebastes borealis*
Speckled sanddab	*Citharichthys stigmaeus*
Starry skate	*Raja stellulata*
Sand sole	*Psettichthys melanostictus*
Shortspine thornyhead (SST)	*Sebastolobus alascanus*
Soupfin shark	*Galeorhinus galeus*
Starry rockfish	*Sebastes constellatus*
Stripetail rockfish	*Sebastes saxicola*
Tiger rockfish	*Sebastes nigrocinctus*
SST/LST	*Sebastolobus* spp.
Sanddab, unid.	*Citharichthys*
Shortraker/rougheye/ blackspotted rockfish	*Sebastes borealis/aleutianus*
Greenling, unid.	*Hexagrammidae*
Spotted rockfish, unid.	*Sebastomus* spp.
Salmon, unid.	*Oncorhynchus*
Vermilion rockfish	*Sebastes miniatus*
Widow rockfish	*Sebastes entomelas*
Yelloweye rockfish	*Sebastes ruberrimus*
Yellowmouth rockfish	*Sebastes reedi*
Yellowtail rockfish	*Sebastes flavidus*
Brown Irish lord sculpin	*Hemilepidotus spinosus*
Calico rockfish	*Sebastes dalli*
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Honeycomb rockfish	*Sebastes umbrosus*
Kelp rockfish	*Sebastes atrovirens*
Puget Sound rockfish	*Sebastes emphaeus*
California scorpionfish	*Scorpaena guttata*
California sheephead	*Semicossyphus pulcher*
Swordspine rockfish	*Sebastes ensifer*
Treefish rockfish	*Sebastes serriceps*

Pacific sandlance	*Ammodytes hexapterus*
Round herring	*Etrumeus teres*
Ridgeback prawn	*Sicyonia ingentis*
Shark and skate, unid.	—
Blacksmelt, unid.	*Bathylagus* spp.
Duckbill barracudina	*Magnisudis atlantica*
Slender barracudina	*Lestidiops ringens*
White barracudina	*Arctozenus risso*
Sea cucumber	*Holothuroidea*
Coonstripe prawn	*Pandalus hypsinotus*
Spotted prawn	*Pandalus platyceros*
Bocaccio rockfish	*Sebastes paucispinis*
Butter sole	*Isopsetta isolepis*
English sole	*Parophrys vetulus*
Giant grenadier	*Albatrossia pectoralis*
Greenstriped rockfish	*Sebastes elongatus*
Shelf rockfish, unid.	*Scorpaenidae*
Slope rockfish, unid.	*Scorpaenidae*
Nearshore rockfish, unid.	*Scorpaenidae*
Flatfish, unid.	*Pleuronectiformes*
Rougheye/blackspotted rockfish	*Sebastes melanostictus and S. aleutianus*
Rex sole	*Glyptocephalus zachirus*
Rock sole	*Pleuronectes bilineatus*
Silvergray rockfish	*Sebastes brevispinis*
Non-Humboldt squid, unid.	*Teuthida*
Squid, unid.	*Teuthida*

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153 **Somers, K. A., C. E. Whitmire, K. Richerson, J. E. Jannot, V. J. Tuttle, and J. T. McVeigh. 2020.** Fishing Effort in the 2002–17 Pacific Coast Groundfish Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-153. https://doi.org/10.25923/8y7r-0g25

152 **Jannot, J. E., K. Richerson, K. A. Somers, V. Tuttle, and J. T. McVeigh. 2020.** Pacific Halibut Bycatch in U.S. West Coast Groundfish Fisheries, 2002–18. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-152. https://doi.org/10.25923/tkr3-b927

151 **Pess, G., and C. E. Jordan, editors. 2019.** Characterizing Watershed-Scale Effects of Habitat Restoration Actions to Inform Life Cycle Models: Case Studies Using Data-Rich vs. Data-Poor Approaches. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-151. http://doi.org/10.25923/vka7-w128

150 **Somers, K. A., J. E. Jannot, K. Richerson, V. Tuttle, N. B. Riley, and J. T. McVeigh. 2019.** Estimated Discard and Catch of Groundfish Species in the 2017 U.S. West Coast Fisheries. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-150. https://doi.org/10.25923/kr5q-je83

149 **Harvey, C., N. Garfield, G. Williams, N. Tolimieri, I. Schroeder, K. Andrews, K. Barnas, E. Bjorkstedt, S. Bograd, R. Brodeur, B. Burke, J. Cope, A. Coyne, L. deWitt, J. Dowell, J. Field, J. Fisher, P. Frey, T. Good, C. Greene, E. Hazen, D. Holland, M. Hunter, K. Jacobson, M. Jacox, C. Juhasz, I. Kaplan, S. Kasperski, D. Lawson, A. Leising, A. Manderson, S. Melin, S. Moore, C. Morgan, B. Muhling, S. Munsch, K. Norman, R. Robertson, L. Rogers-Bennett, K. Sakuma, J. Samhouri, R. Selden, S. Siedlecki, K. Somers, W. Sydeman, A. Thompson, J. Thorson, D. Tommasi, V. Trainer, A. Varney, B. Wells, C. Whitmire, M. Williams, T. Williams, J. Zamon, and S. Zeman. 2019.** Ecosystem Status Report of the California Current for 2019: A Summary of Ecosystem Indicators Compiled by the California Current Integrated Ecosystem Assessment Team (CCEIA). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-149. https://doi.org/10.25923/p0ed-ke21

148 **Sharma, R., C. E. Porch, E. A. Babcock, M. Maunder, and A. E. Punt, editors. 2019.** Recruitment: Theory, Estimation, and Application in Fishery Stock Assessment Models. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-148. https://doi.org/10.25923/1r2p-hs38

147 **Sloan, C. A., B. Anulacion, K. A. Baugh, J. L. Bolton, D. Boyd, P. M. Chittaro, D. A. M. da Silva, J. B. Gates, B. L. Sanderson, K. Veggerby, and G. M. Ylitalo. 2019.** Quality Assurance Plan for Analyses of Environmental Samples for Polycyclic Aromatic Hydrocarbons, Persistent Organic Pollutants, Dioctyl Sulfosuccinate, Estrogenic Compounds, Steroids, Hydroxylated Polycyclic Aromatic Hydrocarbons, Stable Isotope Ratios, and Lipid Classes. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-147. https://doi.org/10.25923/kf28-n618

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