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Estimated Discard and Catch of Groundfish Species in the 2020 U.S. West Coast Fisheries

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Estimated Discard and Catch of Groundfish Species in the 2020 U.S. West Coast Fisheries

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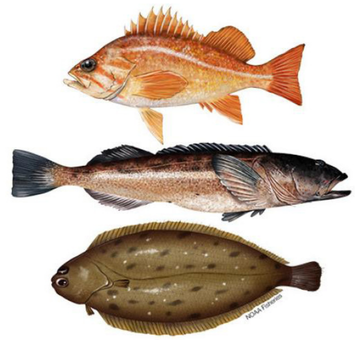

Groundfish is a term that includes dozens of ocean-dwelling fish, including species of sharks, skates, flatfish, and rockfish. Groundfish live off the entire U.S. West Coast, from Canada to Mexico, in environments from the nearshore to over 1,000 fathoms deep. Unfortunately, many groundfish species were overfished in the 1980s and '90s, leading to a plan for fishery management that first went into effect in 1982. NOAA Fisheries has since declared all overfished groundfish, except yelloweye rockfish, rebuilt.

The Northwest Fisheries Science Center helps the Pacific Fishery Management Council make management decisions for groundfish on the Pacific Coast. One way we do that is by providing data on how many are caught each year. Our data come from direct observation, electronic monitoring, and fish sales information.

In this report, we focus on the most recent year of data by comparing it to the previous five-year time period and to fishery management catch guidelines. This report is updated annually, and here we add and analyze 2020 data.

Key Takeaways

We present data by fishery sector, as well as by fishery management groupings and species.

- In 2020, most fishery sectors landed catch within the range of the previous five years (2015–19).
- No management groupings exceeded 2020 fishery management guidelines.
- Compared to the previous five years, groundfish fisheries landed less of two consistently targeted species: Dover sole and northern sablefish. Groundfish fisheries landed another consistently-targeted species, Pacfic hake, within the five-year range.
- Groundfish fisheries attained the highest percentage of harvest guidelines for Oregon black/blue/deacon rockfish, petrale sole, widow rockfish, and northern minor nearshore rockfish.
- Groundfish fisheries attained less than 70% of harvest guidelines for all other groundfish groupings and species.

Links used in this section:

- Groundfish: https://www.fisheries.noaa.gov/species/west-coast-groundfish
- Plan for fishery management: https://www.fisheries.noaa.gov/management-plan/pacific-coast-groundfish-fishery-management-plan
- Yelloweye rockfish: https://www.fisheries.noaa.gov/species/yelloweye-rockfish
- Pacific Fishery Management Council: https://www.pcouncil.org/
- Direct observation: https://www.fisheries.noaa.gov/west-coast/fisheries-observers/west-coast-groundfish-and-sea-hake-observer-data-collection-quality
- Electronic monitoring: https://www.fisheries.noaa.gov/west-coast/resources-fishing/electronic-monitoring-west-coast
- Fishery management catch guidelines: https://www.fisheries.noaa.gov/species/west-coast-groundfish#commercial

Executive Summary

The primary objectives of this report are to: 1) update estimated fishing mortality of groundfish species in U.S. West Coast fisheries in 2002 to 2019, 2) provide mortality estimates for 2020, and 3) compare the 2020 estimates to annual catch limits (ACLs). 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). Our primary findings include that:

- Targeted landings by the majority of fishery sectors in 2020 were within the range of the previous five years (2015–19). However, higher landings occurred in the directed Pacific halibut fleet, and lower landings occurred in the federal fixed gear and catch share bottom trawl sectors (Figure 2).
- No management groupings exceeded 2020 ACLs.
- Groupings consistently targeted by groundfish fisheries include Pacific hake (a.k.a. Pacific whiting, hereafter: "hake"), Dover sole, and sablefish north of lat 36°N. ACL attainments of both Dover sole (10%) and sablefish north of lat 36°N (66%) were below their five-year ranges (Table 1, Figure 3). Hake is managed using total allowable catch (TAC) and, at 65% attainment, was within the five-year range (Table 1, Figure 3).
- The highest ACL attainments in 2020 occurred for black/blue/deacon rockfish in Oregon (76%), petrale sole (76%), widow rockfish (75%), and minor nearshore rockfish north of lat 40°10′N (70%; Table 1, Figure 3).
- Cowcod rockfish south of lat 40°10′N was declared rebuilt in September 2019, and 58% of the ACL was attained in 2020 (Table 1, Figure 3).
- ACL attainment of yelloweye rockfish, the only remaining rebuilding groundfish species, was 37% and below the five-year range (Table 1, Figure 3). Discard by recreational and non-catch share fixed gear fisheries accounted for the majority of this mortality (Table 2, Figure 4).
- ACL attainment for all other groundfish species and complexes was <70% (Table 1).

Summaries of 2020 catch from the following groundfish fishery sectors are included:

1. Commercial:
    a. Limited entry (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 using electronic monitoring (EM).
        - Fixed gear using EM.
        - 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:*
        - Hake catcher–processors (CPs).
        - Hake mothership catcher vesels (MSes).
    c. Open access (OA) fixed gear nearshore (Oregon/California).*
    d. Fixed gear LE sablefish primary season (tier endorsed).*
    e. Fixed gear LE non-primary sablefish (non-endorsed and daily trip limit [DTL] sectors).*
    f. Directed 2A 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.

Summaries of 2020 catch from the following commercial non-groundfish fisheries are also included:

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 for catch estimation.

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), as well as the assistance of Jim Fellows (NWFSC) in data acquisition. Erica Crust (WDFW), Christian Heath (ODFW), and Melanie Parker and Mike Brown (CDFW) provided recreational data. Lynn Massey (NOAA Fisheries West Coast Region [WCR]) provided research catch. Aileen Smith at the Pacific States Marine Fisheries Commission (PSMFC) was extremely helpful in making EM data accessible and understandable.

A note about tables:

Tables 1 and 2 have been typeset in this report. They are also available, together with all the other mentioned tables, by following the "Supporting Files" link on the report's NOAA Institutional Repository[1] record and downloading the attached Excel file.

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

Data Sources

Data sources used to estimate groundfish fishing mortality include landing receipts, onboard observer records, 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, and distributed weights to individual species whenever possible. Landings 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.[1] Fish ticket landings data for the calendar year 2020 were retrieved from the PacFIN database on 27 April 2021. 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.

"Discard" is defined in this report primarily as catch which is discarded at sea; however, a small amount of shoreside discard in optimized or maximized retention is included. In all other sectors, WCGOP assumed that the small amount of discard at the dock is accounted for in PacFIN fish ticket landings data. Discard estimation focused on commercial groundfish fishery sectors, with scientific at-sea observations of discards conducted by the Fisheries Observation Science Program (FOS).[2] The West Coast Groundfish Observer Program (WCGOP) and the At-Sea Hake Observer Program (A-SHOP) observe distinct sectors of the groundfish fishery. WCGOP observes a number of different sectors of the groundfish fishery, including individual fishing quota (IFQ) shorebased, limited entry (LE), and open access (OA) fixed gear, Area 2A 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, and California ridgeback prawn trawl fisheries. A-SHOP observes the catcher–processor (CP) and mothership catcher vessel (MS) sectors of the at-sea Pacific hake fishery; WCGOP or electronic monitoring (EM) provide additional observations of catcher vessel effort prior to delivering to motherships. No tribal fishing in the at-sea hake fishery occurred in 2020.

WCGOP was established in 2001 by the National Marine Fisheries Service (NMFS, or NOAA Fisheries; USOFR 2001) to improve total catch estimates by collecting information on groundfish species discarded at-sea on the U.S. West Coast. All commercial vessels that land groundfish caught in the U.S. exclusive economic zone, from 3–200 miles offshore, are

[1] Scientific names of species and/or groups of species mentioned in this report appear in the List of Species.
[2] Fishery Resource Analysis and Monitoring Division (FRAM), Northwest Fisheries Science Center (NWFSC).

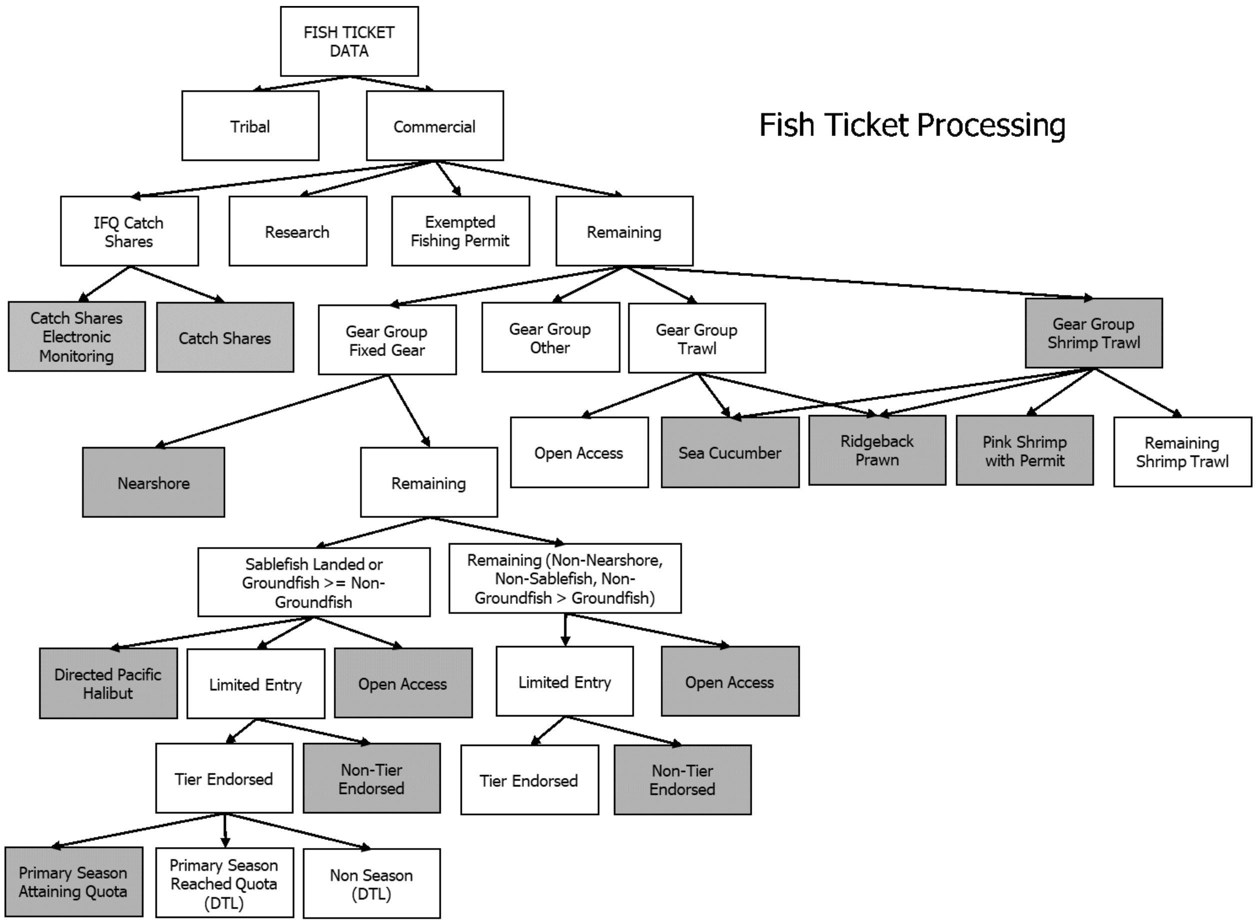

Figure 1. PacFIN fish ticket data processing for division into groundfish fishery sectors. Gray highlights indicate sectors for which federal observer data are available.

required to carry an observer when notified to do so by NOAA Fisheries or its designated agent. Subsequent state rule-makings and policies also require vessels that fish for groundfish within three miles of shore, or that participate in other state-managed fisheries, to carry federal observers when notified. The sampling protocol employed by WCGOP primarily focuses on the discarded portion of catch; detailed information on data collection methods employed in each observed fishery can be found in the WCGOP manual (NWFSC 2020). Observers record haul-level retained amounts, either by estimating based on catch and effort, or by transcribing the captain's visual estimates as recorded in the logbook. These haul-level data are reconciled with the physical measurements reported in trip-level fish ticket landings data, so that the WCGOP estimate of total retained catch is equal to that on landings receipts.

A-SHOP has conducted observations of the U.S. West Coast at-sea Pacific hake (a.k.a. Pacific whiting, henceforth: "hake") fishery since 2001. Prior to 2001, observer coverage of this 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 2021). The at-sea hake fishery has mandatory observer coverage, with each vessel over 38 m carrying two observers. Beginning in 2011 and in accordance with IFQ/co-op program management, all catcher vessels that deliver to motherships are required to carry WCGOP observers or EM systems in addition to the A-SHOP observers aboard the motherships.

At-sea discards of IFQ species by 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.

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), the Oregon Department of Fish and Wildlife (ODFW), and the California Department of Fish and Wildlife (CDFW) via the Recreational Fisheries Information Network (RecFIN). ODFW provided additional estimates of estuary impacts that are not currently included in RecFIN. Estimates from all three state agencies include catch weight (discarded and retained) estimates with 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.

In 2020, state agency sampling and estimation procedures differed from previous years due to the COVID-19 pandemic. Of note, California state and county COVID-19 health safety mandates and guidelines prevented sampling of marine recreational fisheries starting in late March 2020. As a result, the California Recreational Fisheries Survey (CRFS) could not produce catch and effort estimates for April, May, and June 2020. In July 2020, CRFS implemented modified sampling protocols to conform to California state and county COVID-19 prevention best practices. Those protocols limited the observation of catch and the collection of biological data, resulting in a reliance on angler-reported catch and established pooling rules for average weight, in order to convert numbers of fish to weight.

Each year, a certain portion of the ACL for groundfish species is harvested through research activities. 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 supports the evaluation of 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 a limited number of species and species groups in sectors using bottom trawl and fixed gears (see Tables A-1 and A-2 or PFMC 2019b). Species-specific mortality rates have not been identified for midwater, shrimp, prawn, or sea cucumber trawl gears, so we assume all discard results in mortality. Changes to estimation, discard mortality rates, and management are documented in Tables A-3 and A-4.

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 structures. 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. However, strata employed in this report provide mortality estimates that are relevant to the spatial and temporal structure of groundfish management while ensuring adequate sample size and meeting confidentiality mandates.

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 prevents potential double-counting due to differences in the species codes used by observers and those used by 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), any retained weights in observer and fish ticket data that share the same species code will be matched and adjusted. Species were defined and grouped for this report according to WCGOP data processing codes (Table A-5). Occasionally, WCGOP observers identify catch beyond the required taxonomic level, potentially resulting in mortality estimates that do not include catch sampled at the higher taxonomic level; we list the estimates that should be analyzed with caution in Table A-6. The Groundfish FMP provides a complete listing of groundfish species (PFMC 2019a).

As with all point estimates, mortality values presented in Table 1 and Table 2 should be considered with caution. We have provided the coefficient of variation (CV) of the discard ratio for each species (or species group) as a measurement of statistical uncertainty. We calculated the standard error (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. This informative statistic is unitless, allowing for comparisons across estimates of species regardless of differences in the magnitude of discarded amounts. In 2020, observer requirements were paused for all vessels from 16–30 April to minimize potential COVID-19 transmission. In all sectors other than those carrying EM systems, requirements resumed with additional safety protocols after the waiver period, including a mandatory two-week self-isolation period before an observer deployed to a different vessel. These mitigation protocols reduced the efficiency of observer deployment, but only the directed Pacific halibut fishery was observed at a rate below the historical minimum (Somers et al. 2021[3]). Additional 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. Fleets that deliver catch to shorebased processors use both trawl and fixed gears. Bottom trawl nets are used to target a variety of groundfish species. Midwater trawl nets are used to target midwater non-hake species, such as widow and yellowtail rockfish, or hake. Fixed gears are used primarily to target sablefish, and include pot or trap gear as well as longlines. Fleets that process catch at sea used midwater trawl nets to target hake. Catcher vessels deliver unsorted catch to a mothership for sorting and processing, while CPs process their own catch 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 in the impacted sectors. In 2015, EM systems provided another option for 100% monitoring of quota species catch. In the non-hake IFQ sectors, these regulation changes required that vessels must carry either NOAA Fisheries observers or, if operating with an EM EFP, EM systems as well as NOAA Fisheries observers when notified to do so. On average from 2015 to 2020, 30% of targeted landings by pot gear and 23% of targeted landings by bottom trawl gear were observed (Somers et al. 2021). Regulations also established that the use of multiple gear types (trawl or fixed gear) was 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 south of lat 40°10′N in less than 30 fathoms

[3] Somers, K. A., J. E. Jannot, K. Richerson, V. Tuttle, and J. McVeigh. 2021. NWFSC Observer Coverage Rates 2002–2020. National Marine Fisheries Service, Seattle.

(fth, ~55 m). 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, the minimal number of identified LE California halibut tows have been associated with less than three vessels and so are summarized with the IFQ bottom trawl fleet.

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. When sample size was adequate (10 hauls or more per stratum) and data confidentiality rules were 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[4]). 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-7). 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.

[4] 10 fth ≅ 18 m, so the depth distributions are approximately 0–228 m, 229–457 m, and >457 m.

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-7). IFQM included all IFQ managed species (see Tables A-5 and A-7, 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 are ignored, and discards are 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, is 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:

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

where, for each stratum,

W = estimated unsampled discard weight of a given species within a stratum,
y = unsampled catch category (NIFQ, IFQFF, IFQRF, IFQRD, IFQM, ZMIS, UNST, or FAIL),
x = weight of unsampled catch within a stratum,
f = sampled catch within a stratum, 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. Landings made in this fleet during the observer coverage waiver period in 2020 were summarized from fish tickets, and discards were estimated using the discard rates observed in the appropriate strata during the rest of the year.

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 was 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. 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 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 and by area, where possible while maintaining confidentiality. 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. 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 they provide 100% coverage of at-sea discard for this subset of species. 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. The small amount of at-sea discard of IFQ species was estimated by PSMFC based on video review. 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.

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 shorebased non-hake IFQ sectors. 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). A discard mortality rate of 100% is applied for all other species in bottom trawl and fixed gear sectors and for all species in midwater trawl sectors.

At-sea hake sectors

The midwater trawl fishery for hake comprises three at-sea processing fleets: CPs, MSes, 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.

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. Fleetwide landings of California halibut 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. They were used as a multiplier to expand observed discard ratios to the total discard estimate.

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).

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 2020, WCGOP observed fewer than three vessels in the sea cucumber trawl fishery. To maintain the confidentiality of those data, this report does not include discard estimates, but does summarize fleetwide landed catch in Table 1 and Table 2. 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 individual state pink shrimp trawl fisheries.

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 improve analysis stratifications.

California Ridgeback Prawn Trawl Fishery

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. WCGOP explored observation of the California coonstripe, ridgeback, and spotted prawn fisheries, but data were collected only from 2002–05 and are not used in discard estimations.

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 record sablefish or nearshore species were included in the non-nearshore fixed gear sector only if groundfish landings were greater than non-groundfish 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. 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 International Pacific Halibut Commission (IPHC) for 2002–19 in Washington and Oregon. In 2020, and in California across all years, 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 nonsablefish 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 they were 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 (i.e., in November–March) or made trips within the season after they had reached their cumulative tier quota, the fish tickets were placed in the LE nonsablefish endorsed subsector. Fish tickets from nonsablefish 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 (nonsablefish 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, as possible while maintaining confidentiality and appropriate sample size. 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 due to a lack of fleetwide records. 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 nonsablefish endorsed subsector, which is unobserved. 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. 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. 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-2).

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-2). 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 a) reflect the differing depth distributions of observed fishing effort, and b) 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 to the most current year of data.[5] Using data from all

[5] 10 fth ≅ 18 m, so the depth distributions are approximately 0–18 m, 19–36 m, 37–54 m, and ≥55 m.

previously observed years ensures that data are comparable across years and that proportions are available for all species landed in a given year. Annual fleet landings of each nearshore species and complex 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. Discard ratios were calculated within each stratum by dividing the 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.

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 as incidental. 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 1. 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%. PFMC accounts for discard mortality of fixed gear sablefish by reducing the tribal allocation appropriately. 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 from each state's recreational fisheries, combined across all gear types, is also summarized in Table 1.

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. 2022), salmon species (Richerson et al. 2020),[6] green sturgeon (Richerson et al. 2021),[7] and eulachon (Gustafson et al. 2021). Mortality estimations from 2002–20 for all nonprotected fish species, including Pacific halibut from Jannot et al. (2022), are available in Table 3 and in the Groundfish Expanded Mortality Multiyear (GEMM) product on the FRAM Data Warehouse.[8]

[6] Richerson, K. E., K. A. Somers, J. E. Jannot, V. J. Tuttle, N. B. Riley, and J. T. McVeigh. 2020. Observed and Estimated Bycatch of Salmon in U.S. West Coast Fisheries, 2002–19. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR-2020-04. https://doi.org/10.25923/rf3e-sd83
[7] Richerson, K., J. E. Jannot, Y.-W. Lee, J. McVeigh, K. Somers, V. Tuttle, and S. Wang. 2021. Observed and Estimated Bycatch of Green Sturgeon in 2002–2019 US West Coast Groundfish Fisheries. National Marine Fisheries Service, Seattle. Available: www.pcouncil.org/documents/2021/06/g-4-a-nmfs-report-3-observed-and-estimated-bycatch-of-green-sturgeon-in-2002-2019-u-s-west-coast-groundfish-fisheries.pdf/ (July 2021).
[8] https://www.nwfsc.noaa.gov/data

Cumulative Mortality Estimation Methods

We calculated the cumulative mortality for each species in a sector as the sum of the total discard mortality 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 sectors.

Table 1. Estimated fishing mortality of major U.S. West Coast groundfish species and corresponding management reference points (harvest specifications). Rebuilding species are capitalized. *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 (mt)**	**ACL**	**% of ACL**	**ABC**	**% of ABC**	**OFL**	**% of OFL**
Arrowtooth flounder	663	12,750	5	12,750	5	15,306	4
Big skate	138	494	28	494	28	541	25
Black rockfish (CA)	117	326	36	326	36	341	34
Black rockfish (WA)	138	297	46	297	46	311	44
Black/blue/deacon rockfish (OR)	465	611	76	611	76	670	69
Bocaccio rockfish (CA)	328	2,011	16	2,011	16	2,104	16
Cabezon (CA)	34	146	24	146	24	153	23
Cabezon/kelp greenling (OR)	65	204	32	204	32	216	30
Cabezon/kelp greenling (WA)	5	10	46	10	46	12	39
CA scorpionfish (S of 34°27′N)	73	307	24	307	24	331	22
Canary rockfish	486	1,368	36	1,368	36	1,431	34
Chilipepper ockfish (S of 40°10′N)	666	2,410	28	2,410	28	2,521	26
Cowcod rockfish (S of 40°10′N)	6	10	58	68	9	76	8
Darkblotched rockfish	342	815	42	815	42	853	40
Dover sole	4,834	50,000	10	87,998	5	92,048	5
English sole	168	10,135	2	10,135	2	11,101	2
Lingcod (N of 40°10′N)	816	4,541	18	4,558	18	4,768	17
Lingcod (S of 40°10′N)	290	869	33	934	31	977	30
Longnose skate	556	2,000	28	2,365	24	2,474	22
Minor rockfish (N of 40°10′N)							
Nearshore	57	82	70	82	70	92	62
Shelf	606	2,048	30	2,048	30	2,302	26
Slope	352	1,732	20	1,732	20	1,873	19
Minor rockfish (S of 40°10′N)							
Nearshore	369	1,163	32	1,165	32	1,322	28
Shelf	409	1,625	25	1,626	25	1,919	21
Slope	67	743	9	743	9	855	8
Other flatfish	530	6,041	9	6,041	9	8,202	6
Other groundfish	19	239	8	239	8	286	7
Pacific cod	18	1,600	1	2,221	1	3,200	1
Pacific hake	288,515	2020 U.S. TAC = 441,433 mt; 65% of U.S. TAC					
Pacific ocean perch (N of 40°10′N)	542	4,229	13	4,229	13	4,632	12
Petrale sole	2,156	2,845	76	2,845	76	2,976	72
Sablefish (N of 36°N)	3,805	5,723	66	7,896	52	8,648	48
Sablefish (S of 36°N)	327	2,032	16				
Shortbelly rockfish	583	3,000	19	5,789	10	6,950	8
Spiny dogfish	489	2,059	24	2,059	24	2,472	20
Splitnose rockfish (S of 40°10′N)	17	1,731	1	1,731	1	1,810	1
Starry flounder	8	452	2	452	2	652	1
Thornyheads							
Longspine thornyhead (N of 34°27′N)	123	2,470	5	3,250	4	3,901	3
Longspine thornyhead (S of 34°27′N)	9	780	1				
Shortspine thornyhead (N of 34°27′N)	411	1,669	25	2,551	18	3,063	15
Shortspine thornyhead (S of 34°27′N)	52	883	6				
Widow rockfish	8,429	11,199	75	11,199	75	11,714	72
YELLOWEYE ROCKFISH	18	49	37	77	24	84	22
Yellowtail rockfish (N of 40°10′N)	3,674	5,986	61	5,986	61	6,261	59

Table 2. Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020. *IFQ* = individual fishing quota, *BT* = bottom trawl, *FG* = fixed gear, *MW* = midwater, *Shs* = 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													
	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 tribal Shs	WA	OR	CA	Res.	EFM
Groundfish species																				
Arrowtooth flounder	623.02	0.54	0.26	6.24	4.60	0.26	0.01	—	1.37	—	24.91	1.74	0.04	0.06	0.11	—	0.08	—	—	663.22
Big skate	100.01	—	0.33	1.35	0.58	0.26	16.71	—	0.00	0.62	1.81	15.17	0.48	0.00	0.19	—	0.05	—	—	137.56
Black rf. (CA)	0.22	—	—	—	—	—	—	—	—	—	1.40	—	40.35	0.08	—	—	—	75.44	0.00	117.49
Black rf. (WA)	0.00	—	0.02	0.01	—	—	—	—	—	—	—	—	—	—	—	137.75	—	—	—	137.78
Black/blue/deacon rf. (OR)																				
Black rf.	0.00	—	0.00	0.02	—	—	—	—	—	—	1.66	0.01	99.64	0.33	—	—	336.59	—	—	438.25
Blue/deacon rf.	—	—	0.00	—	—	—	—	—	—	—	0.09	—	6.49	—	—	—	20.65	—	—	27.23
Bocaccio rf. (S of 40°10′N)	247.58	0.00	—	—	—	—	0.03	—	—	0.05	29.88	0.07	2.77	1.04	—	—	—	46.95	0.03	328.39
Cabezon (CA)	—	—	—	—	—	—	0.03	—	—	—	0.43	—	19.52	0.12	—	—	—	14.37	—	34.47
Cabezon/kelp greenling (OR)																				
Cabezon	—	—	—	—	—	—	—	—	—	—	0.73	0.49	19.71	—	—	—	14.25	—	—	35.18
Kelp greenling	0.01	—	—	—	—	—	—	—	—	—	0.09	0.25	11.67	—	—	—	17.35	—	—	29.37
Cabezon/kelp greenling (WA)																				
Cabezon	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.66	—	—	—	3.66
Kelp greenling	0.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.90	—	—	—	0.96
California scorpionfish (N of 34°27′N)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	—	0.00
California scorpionfish (S of 34°27′N)	—	—	—	—	—	—	1.20	—	—	0.88	3.39	—	1.79	0.02	—	—	—	65.40	0.01	72.68
Canary rf.	171.50	—	80.67	86.36	0.43	0.50	0.02	—	—	0.01	12.17	2.28	12.82	0.67	2.31	8.48	61.86	46.29	0.02	486.38
Chilipepper rf. (S of 40°10′N)	644.84	—	—	—	—	—	0.06	—	—	0.01	19.19	0.05	0.64	0.29	—	—	—	0.57	0.04	665.70
Cowcod rf. (S of 40°10′N)	0.79	—	—	—	—	—	—	—	—	0.05	4.08	—	—	—	—	—	—	0.91	—	5.83
Darkblotched rf.	212.96	0.05	0.08	69.83	34.28	5.04	—	—	17.04	—	2.69	0.42	—	—	0.02	—	—	—	—	342.41
Dover sole	4,815.85	0.35	0.45	0.62	0.20	0.01	0.02	—	3.89	4.35	4.93	0.20	—	0.14	3.07	—	0.00	—	0.01	4,834.07
ECS																				
Aleutian skate	0.63	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.63
Black skate	3.99	—	—	—	—	—	—	—	—	—	4.93	—	—	—	—	—	—	—	—	8.92
California grenadier	0.28	—	—	—	—	—	—	—	—	—	1.11	—	—	—	—	—	—	—	—	1.39
California skate	0.62	—	—	—	—	—	27.84	—	0.05	1.67	0.19	1.99	0.00	0.47	—	—	—	—	0.00	32.82
Deepsea skate	—	—	—	—	—	—	—	—	—	—	1.13	—	—	—	—	—	—	—	—	1.13
Giant grenadier	21.17	0.03	—	—	—	—	—	—	—	—	6.49	—	—	—	—	—	—	—	—	27.69
Grenadier, unid.	0.97	0.02	—	—	2.18	—	—	—	—	—	17.42	—	0.02	—	—	—	—	—	—	20.62
Pacific flatnose	0.01	0.00	—	—	—	—	—	—	—	—	0.26	—	—	—	—	—	—	—	—	0.27
Pacific grenadier	2.04	0.03	—	—	—	—	—	—	—	—	22.00	—	—	—	—	—	—	—	—	24.07
Popeye grenadier	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020.

	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 tribal Shs	WA	OR	CA	Res.	EFM
Sandpaper skate	29.21	—	0.02	0.02	0.00	—	—	—	0.03	—	0.59	0.25	0.01	—	—	—	—	—	—	30.13
Smooth grenadier	—	—	—	—	—	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	0.01
Soupfin shark	6.04	—	0.14	0.85	0.18	0.52	1.73	—	—	—	0.20	—	4.11	9.16	—	—	0.01	—	—	22.93
Spotted ratfish	95.28	—	1.00	0.02	0.00	—	0.06	0.04	0.17	2.69	2.44	1.89	0.00	—	—	—	0.01	—	0.00	103.62
English sole	127.50	0.00	0.48	0.11	0.03	0.00	5.01	0.08	0.04	33.69	0.00	—	—	1.51	—	—	—	—	0.01	168.47
Groundfish, unid.	—	—	—	0.71	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.71
Lingcod (N of 40°10′N)	322.19	1.72	3.99	13.28	0.07	0.68	—	—	0.23	—	61.99	8.32	59.73	3.37	16.11	117.73	165.75	40.83	0.00	816.01
Lingcod (S of 40°10′N)	56.57	0.31	—	—	—	—	0.32	—	—	0.05	16.38	0.11	14.70	2.07	—	—	—	199.66	0.01	290.17
Longnose skate	509.62	0.01	0.22	1.05	0.16	0.05	0.52	0.32	0.29	0.38	37.01	4.90	0.09	0.13	1.52	—	0.12	—	0.00	556.39
LST (N of 34°27′N)	120.86	0.01	0.01	—	0.01	—	—	—	0.01	—	1.89	0.00	0.00	—	0.02	—	—	—	—	122.80
LST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	9.21	—	—	—	—	—	—	—	—	9.21
Minor ns. rf. (N of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.05	—	—	—	0.02	0.01	—	0.09
Blue/deacon rf.	—	—	0.00	—	—	—	—	—	—	—	0.00	—	2.69	—	—	1.12	—	5.39	—	9.20
Brown rf.	0.00	—	—	—	—	—	—	—	—	—	0.02	—	0.13	—	—	—	0.21	0.79	—	1.15
China rf.	—	—	—	—	—	—	—	—	—	—	0.08	0.02	6.85	—	—	0.48	2.16	0.83	—	10.43
Copper rf.	0.00	—	—	—	—	—	—	—	—	—	0.22	—	4.37	—	—	0.71	4.79	5.95	—	16.05
Gopher rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.06	0.00	—	—	0.03	0.18	—	0.27
Grass rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	0.30	—	—	—	0.03	0.07	—	0.41
Kelp rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.02	—	—	0.02
Nearshore rf., unid.	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.04	—	—	—	—	0.05
Olive rf.	—	—	—	—	—	—	—	—	—	—	0.08	—	0.11	—	—	—	0.02	0.81	—	1.02
Quillback rf.	0.15	—	—	0.01	—	—	—	—	—	—	0.14	0.97	5.65	—	—	1.30	6.06	4.31	—	18.58
Minor ns. rf. (S of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	0.43	—	12.14	0.00	—	—	—	1.41	—	13.98
Blue/deacon rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	17.89	0.13	—	—	—	64.24	0.04	82.30
Brown rf.	0.01	—	—	—	—	—	0.74	0.00	—	0.00	0.09	—	20.52	0.03	—	—	—	45.98	0.03	67.40
Calico rf.	—	—	—	—	—	—	0.01	—	—	0.56	—	—	0.03	—	—	—	—	0.04	—	0.64
China rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	2.01	0.00	—	—	—	7.75	—	9.78
Copper rf.	0.00	—	—	—	—	—	0.00	0.03	—	—	1.55	—	14.26	0.04	—	—	—	60.33	0.00	76.21
Gopher rf.	—	—	—	—	—	—	—	—	—	—	0.40	—	26.70	0.09	—	—	—	29.80	0.00	57.00
Grass rf.	—	—	—	—	—	—	—	—	—	—	0.02	—	8.30	0.19	—	—	—	1.46	—	9.96
Kelp rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	0.80	0.00	—	—	—	0.94	—	1.75
Nearshore rf., unid.	—	—	—	—	—	—	—	—	—	—	—	—	0.02	—	—	—	—	—	—	0.02
Olive rf.	—	—	—	—	—	—	—	—	—	—	0.22	—	1.50	0.02	—	—	—	36.77	0.00	38.51
Quillback rf.	—	—	—	—	—	—	—	—	—	—	—	—	2.11	—	—	—	—	3.49	—	5.60
Treefish rf.	—	—	—	—	—	—	—	—	—	—	—	—	1.92	0.00	—	—	—	3.64	—	5.56

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020.

	Commercial fisheries																			
	IFQ/co-op management						Non-IFQ									Recreational fishing mortality				
	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 tribal Shs	WA	OR	CA	Res.	EFM
Minor sh. rf. (N of 40°10′N)																				
Bocaccio rf.	127.29	—	7.65	6.13	1.46	2.74	—	—	—	—	0.67	1.39	0.05	0.00	0.44	1.52	0.41	0.00	—	149.78
Chilipepper rf.	108.46	—	0.52	0.11	0.02	0.24	—	—	0.29	—	0.03	0.08	0.00	—	0.00	—	0.03	0.00	—	109.79
Cowcod rf.	0.04	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	0.02	—	0.06
Flag rf.	0.00	—	—	—	—	—	—	—	—	—	0.03	—	—	—	—	—	0.03	—	—	0.05
Greenspotted rf.	0.80	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	0.13	—	—	0.93
Greenstriped rf.	48.08	—	0.13	0.04	—	0.00	—	—	0.76	—	0.20	0.48	0.00	—	0.10	—	0.22	—	—	50.00
Halfbanded rf.	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Pygmy rf.	0.02	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.03
Redstripe rf.	1.72	—	36.41	10.78	0.01	0.01	—	—	0.00	—	—	—	—	—	—	—	0.01	—	—	48.94
Rockfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Rosethorn rf.	8.29	0.00	5.80	1.23	—	—	—	—	0.00	—	0.13	0.09	0.01	—	0.01	—	0.10	—	—	15.67
Rosy rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.01	—	—	—	0.13	0.01	—	0.16
Shelf rf., unid.	31.35	0.00	0.66	0.15	—	—	—	—	2.68	—	0.64	0.16	0.03	0.01	0.22	—	—	—	—	35.92
Silvergray rf.	119.04	—	0.66	0.16	0.13	0.20	—	—	—	—	0.62	0.44	0.00	—	0.07	—	0.35	—	—	121.68
Starry rf.	0.05	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	0.05
Stripetail rf.	49.12	—	0.00	0.01	—	—	—	—	1.49	—	—	—	—	—	—	—	—	—	—	50.63
Swordspine rf.	0.01	—	—	—	—	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	0.02
Tiger rf.	0.00	—	—	—	—	—	—	—	—	—	0.14	—	0.30	—	—	0.23	1.34	0.36	—	2.36
Vermilion rf.	—	—	—	—	—	—	—	—	—	—	0.59	0.00	5.00	0.01	—	0.44	8.89	5.31	—	20.24
Minor sh. rf. (S of 40°10′N)																				
Flag rf.	—	—	—	—	—	—	—	—	—	—	0.27	—	0.06	0.04	—	—	—	1.37	—	1.74
Freckled rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	—	0.00
Greenblotched rf.	0.00	—	—	—	—	—	—	—	—	0.21	2.29	—	0.03	0.01	—	—	—	0.11	0.00	2.65
Greenspotted rf.	0.67	—	—	—	—	—	—	—	—	0.01	3.43	0.11	0.73	0.05	—	—	—	3.82	0.00	8.82
Greenstriped rf.	2.16	—	—	—	—	—	—	—	—	0.16	0.35	—	0.02	0.00	—	—	—	0.18	0.00	2.87
Halfbanded rf.	—	—	—	—	—	—	0.00	—	—	12.43	0.93	—	—	—	—	—	—	0.25	0.01	13.62
Honeycomb rf.	—	—	—	—	—	—	—	—	—	—	0.06	—	0.09	0.03	—	—	—	0.27	—	0.44
Mexican rf.	0.00	—	—	—	—	—	0.00	—	—	0.02	1.09	—	—	0.00	—	—	—	0.05	0.00	1.17
Pink rf.	—	—	—	—	—	—	—	—	—	—	0.04	—	—	—	—	—	—	—	—	0.04
Pinkrose rf.	—	—	—	—	—	—	—	—	—	—	0.01	—	0.00	—	—	—	—	—	—	0.01
Redstripe rf.	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Rockfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Rosethorn rf.	0.01	—	—	—	—	—	—	—	—	—	0.26	—	0.05	—	—	—	—	—	—	0.32
Rosy rf.	—	—	—	—	—	—	—	—	—	—	0.29	—	0.42	0.01	—	—	—	2.64	0.00	3.36
Shelf rf., unid.	—	—	—	—	—	—	—	0.09	—	—	5.74	0.00	1.12	0.08	—	—	—	—	—	7.04
Silvergray rf.	1.83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.83
Speckled rf.	—	—	—	—	—	—	—	—	—	—	0.42	—	0.35	0.02	—	—	—	1.50	—	2.30

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020.

	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 tribal Shs	WA	OR	CA	Res.	EFM
Squarespot rf.	—	—	—	—	—	—	0.00	—	—	0.00	0.10	—	0.04	0.01	—	—	—	1.15	0.00	1.30
Starry rf.	—	—	—	—	—	—	—	0.00	—	—	1.13	—	0.93	0.04	—	—	—	16.86	—	18.97
Stripetail rf.	16.89	—	—	—	—	—	0.01	—	—	9.45	—	—	—	—	—	—	—	—	0.01	26.35
Swordspine rf.	—	—	—	—	—	—	—	—	—	—	0.02	—	—	—	—	—	—	0.01	—	0.03
Tiger rf.	—	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	0.16	—	0.17
Vermilion rf.	0.00	—	—	—	—	—	0.04	0.02	—	0.25	44.67	—	21.16	1.61	—	—	—	192.16	0.01	259.91
Yellowtail rf.	0.20	—	—	—	—	—	—	—	—	—	20.10	0.01	6.35	1.31	—	—	—	28.19	0.10	56.26
Minor sl. rf. (N of 40°10′N)																				
Aurora rf.	44.02	—	0.06	—	0.01	—	—	—	0.06	—	0.03	0.00	—	—	0.00	—	—	—	—	44.19
Bank rf.	2.54	—	0.01	0.02	0.04	0.01	—	—	0.83	—	0.02	0.00	—	—	—	—	—	—	—	3.47
Blackgill rf.	1.90	0.01	0.00	—	0.01	—	—	—	0.03	—	0.39	0.01	—	—	—	—	—	—	—	2.34
Redbanded rf.	19.04	0.13	0.02	0.17	0.01	—	—	—	0.06	—	8.25	3.68	0.28	0.01	2.09	—	—	—	—	33.74
Rockfish, unid.	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Rougheye/blackspotted rf.	10.88	1.17	0.16	29.18	35.19	6.70	—	—	0.00	—	15.40	5.66	0.13	—	3.52	—	—	—	—	107.98
Sharpchin rf.	24.35	—	0.51	2.23	—	0.00	—	—	0.02	—	0.00	—	—	—	0.00	—	—	—	—	27.11
Shortraker rf.	3.84	0.01	0.00	0.13	0.06	—	—	—	—	—	0.60	0.15	—	—	0.34	—	—	—	—	5.14
Shortraker/rougheye/blackspotted rf.	0.00	—	—	—	—	—	—	—	—	—	—	0.09	—	—	—	—	—	—	—	0.09
Slope rf., unid.	5.77	0.01	1.15	1.25	—	—	—	—	—	—	8.21	1.46	0.00	0.11	0.04	—	—	—	—	17.99
Splitnose rf.	64.95	0.00	0.98	11.76	14.08	0.39	—	—	0.73	—	0.00	—	—	—	0.00	—	—	—	—	92.90
Yellowmouth rf.	14.21	—	0.58	0.20	0.01	—	—	—	—	—	1.41	0.95	—	—	—	—	0.11	—	—	17.46
Minor sl. rf. (S of 40°10′N)																				
Aurora rf.	2.08	0.06	—	—	—	—	—	—	—	—	0.50	—	0.00	—	—	—	—	—	—	2.64
Bank rf.	30.31	—	—	—	—	—	—	—	—	0.00	2.30	—	0.03	—	—	—	—	0.05	—	32.69
Blackgill rf.	7.25	1.39	—	—	—	—	—	—	—	—	16.09	—	1.81	0.06	—	—	—	—	—	26.60
Pacific ocean perch	0.00	—	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	0.00
Redbanded rf.	1.76	0.01	—	—	—	—	—	—	—	—	0.44	0.30	—	—	—	—	—	—	—	2.50
Rougheye/blackspotted rf.	0.02	—	—	—	—	—	—	—	—	—	0.05	—	—	—	—	—	—	—	—	0.07
Sharpchin rf.	1.04	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.04
Shortraker rf.	0.03	—	—	—	—	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	0.05
Slope rf., unid.	0.07	0.00	—	—	—	—	—	—	—	—	1.82	—	—	—	—	—	—	—	—	1.90
Yellowmouth rf.	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Mixed thornyheads																				
SST/LST	2.78	0.02	—	—	0.07	—	—	—	—	—	0.23	—	—	—	—	—	—	—	—	3.10
Other flatfish																				
Butter sole	0.00	—	—	0.00	—	—	—	—	0.03	—	—	—	0.00	—	—	—	0.01	—	—	0.04
Curlfin sole	0.06	—	—	0.00	—	—	1.89	0.00	—	0.10	—	—	—	—	—	—	—	—	0.00	2.06
Flatfish, unid.	6.06	0.00	0.02	0.11	0.00	—	0.26	0.02	0.01	—	0.06	—	0.02	0.11	—	2.02	—	—	0.00	8.69
Flathead sole	23.01	—	—	0.06	0.00	0.00	—	—	0.17	—	—	—	—	0.00	—	—	—	—	—	23.26
Pacific sanddab	32.87	—	0.00	1.93	0.00	0.00	0.90	0.00	1.76	9.98	2.15	—	2.77	0.53	—	—	0.43	10.01	0.06	63.38

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020.

	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 tribal Shs	WA	OR	CA	Res.	EFM
Rex sole	399.11	0.00	0.29	2.73	2.95	0.06	0.04	—	19.38	0.15	0.00	—	—	0.01	0.42	—	—	—	0.00	425.13
Rock sole	0.49	—	0.00	0.01	—	—	0.54	—	—	0.07	0.02	—	0.04	0.22	—	—	0.02	0.63	—	2.03
Sand sole	0.08	—	0.00	0.03	—	—	3.71	—	—	—	0.01	—	0.02	1.32	—	—	0.20	0.08	—	5.45
Sanddab, unid.	0.00	—	—	0.00	—	—	—	—	0.01	0.03	0.13	—	0.00	0.01	—	—	—	—	—	0.18
Other groundfish																				
Kelp greenling (CA)	—	—	—	—	—	—	—	—	—	—	0.07	—	1.70	—	—	—	—	1.74	—	3.52
Leopard shark	0.01	—	—	—	—	—	3.29	—	—	—	0.08	—	0.34	2.52	—	—	—	9.57	—	15.81
Other rockfish																				
Rockfish, unid.	0.33	0.00	1.52	0.05	—	—	—	—	—	—	—	—	—	—	—	0.38	—	—	—	2.28
Pacific cod	3.15	—	0.00	0.03	0.05	0.00	—	—	0.00	—	0.95	0.10	0.02	0.03	13.00	0.77	0.18	—	—	18.29
Pacific hake	222.24	0.08	331.11	1,385.98*	1,110.14*	381.10*	0.03	—	96.52	9.29	0.60	—	—	0.05	133.16	—	0.14	—	0.00	2,885.15*
Pacific ocean perch (N of 40°10′N)	325.99	0.00	105.64	104.85	4.45	0.39	—	—	0.47	—	0.15	0.09	0.00	0.00	0.01	—	—	—	—	542.03
Petrale sole	2,113.22	0.42	0.03	1.94	0.00	—	0.82	—	0.36	0.09	2.38	0.35	0.07	0.31	30.25	—	4.13	1.98	—	2,156.37
Roundfish, unid.	—	—	—	0.01	0.00	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	0.02
Sablefish (N of 36°N)	1,094.16	669.96	0.93	89.41	6.45	8.73	—	—	0.20	—	1,465.63	201.21	2.91	0.09	260.98	—	3.98	—	—	3,804.63
Sablefish (S of 36°N)	0.03	61.89	—	—	—	—	—	—	—	0.16	262.87	—	1.77	0.40	—	—	—	—	—	327.13
Shortbelly rf.	7.33	—	187.17	355.15	2.97	29.86	—	—	0.30	—	—	—	—	0.00	—	—	—	—	—	582.79
SST (N of 34°27′N)	350.05	0.35	0.27	14.17	9.48	0.08	—	—	0.01	—	30.58	3.25	0.63	0.07	2.42	—	0.01	—	—	411.35
SST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	51.67	—	0.04	—	—	—	—	—	—	51.71
Spiny dogfish	126.13	0.93	1.61	197.51	90.19	3.64	0.60	—	0.03	0.15	61.16	1.44	0.14	0.45	3.37	—	0.01	2.05	—	489.41
Splitnose rf. (S of 40°10′N)	16.67	—	—	—	—	—	—	—	—	—	0.06	—	—	—	—	—	—	—	—	16.73
Starry flounder	0.15	—	—	0.03	—	—	4.81	—	—	—	0.02	—	0.03	2.52	—	—	0.02	0.29	0.00	7.87
Widow rf.	83.57	—	7,581.18	668.16	66.61	19.51	—	—	—	—	2.31	0.03	0.33	0.15	0.06	—	5.81	1.37	0.03	8,429.12
Yelloweye rf.	0.38	0.00	0.01	0.01	—	—	—	—	—	—	1.10	2.62	3.45	—	1.17	1.85	5.61	1.95	0.00	18.16
Yellowtail rf. (N of 40°10′N)	347.14	—	1,462.36	1,579.35	76.14	90.71	—	—	0.48	—	2.21	0.12	1.53	0.67	14.52	59.93	38.39	0.47	—	3,674.04
Nongroundfish																				
California halibut	1.21	—	—	—	—	—	139.61	—	—	0.62	1.16	—	2.54	220.90	—	—	0.29	174.59	0.00	540.93
Dungeness crab	45.95	—	0.02	0.11	—	—	75.19	—	0.23	—	3.60	—	5.42	175.90*	530.73	—	—	—	—	182.51*
Non—FMP flatfish																				
Deepsea sole	0.60	0.01	—	—	—	—	—	—	0.01	—	0.01	—	—	0.00	—	—	—	—	—	0.64
Diamond turbot	—	—	—	—	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.00
Hornyhead turbot	0.00	—	—	—	—	—	4.10	0.01	—	2.61	—	—	—	—	—	—	—	—	0.01	6.73
Longfin sanddab	—	—	—	—	—	—	0.60	0.00	—	4.95	—	—	0.00	0.00	—	—	—	0.02	0.03	5.59
Slender sole	45.35	—	0.00	—	0.00	0.00	—	—	79.34	0.89	—	—	—	—	—	—	—	—	0.00	125.58
Speckled sanddab	—	—	—	—	—	—	—	—	—	—	0.03	—	—	0.05	—	—	—	—	0.00	0.08

*Numbers in these cells should be multiplied by 100.

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2020.

	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 tribal Shs	WA	OR	CA	Res.	EFM
Other nongroundfish																				
Buffalo sculpin	—	—	—	—	—	—	0.00	—	—	—	—	—	0.03	—	—	—	0.04	—	—	0.08
California sheephead	—	—	—	—	—	—	—	—	—	—	1.83	—	26.02	0.07	—	—	—	68.81	—	96.73
Greenling, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
Red Irish lord sculpin	—	—	—	—	—	—	—	—	—	—	—	—	0.02	—	—	—	—	—	—	0.02
Sculpin, unid.	1.03	—	0.00	—	—	—	0.02	—	0.33	0.03	0.01	—	0.19	0.01	0.01	—	—	—	0.01	1.62
Skate, unid.	3.99	0.00	0.01	0.05	—	—	0.25	0.01	—	0.16	0.69	0.63	0.18	0.36	5.43	—	—	—	—	11.75
Squid, unid.	0.08	—	0.30	33.73	114.98	9.18	—	—	0.00	—	—	—	—	52.44	0.00	—	—	—	—	210.71
Starry skate	0.05	—	—	—	—	—	0.21	—	—	—	0.28	—	—	—	—	—	—	—	—	0.54
Shared ECS																				
Barracudina, unid.	—	—	—	—	0.01	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	0.01
Deepsea smelt, unid.	—	—	—	—	0.15	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—	0.18
Duckbill barracudina	—	—	—	—	1.26	0.04	—	—	—	—	—	—	—	—	—	—	—	—	—	1.29
Jacksmelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18.00	—	18.00
Lanternfish, unid.	0.00	—	—	—	0.54	0.02	—	—	0.06	—	—	—	—	—	—	—	—	—	—	0.63
Non-eulachon smelt, unid.	0.44	—	—	—	—	—	—	—	53.05	0.05	—	—	—	—	—	—	—	—	—	53.53
Non-Humboldt squid, unid.	1.96	—	0.00	—	—	—	0.02	—	40.49	0.48	0.00	—	0.05	—	—	—	—	—	—	43.00
Pacific saury	0.00	—	—	—	0.00	0.00	—	—	0.03	—	—	—	—	—	—	—	—	—	—	0.04
Rainbow smelt	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Round herring	—	—	—	—	—	—	—	—	—	—	—	—	—	9.25	—	—	—	—	—	9.25
Slender barracudina	—	—	—	—	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00
Smelt, unid.	—	—	—	0.01	—	—	—	—	—	—	0.00	—	0.03	193.05	—	—	—	—	0.00	193.09
Surf smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00
White barracudina	—	—	—	—	0.02	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	0.02
Whitebait smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.00

Results

Targeted landings are defined using the same species or set of species defined in Methods as the retained weight for both discard rates and expansion factors. Landings in 2020 by the catch share, primary, DTL, and OA fixed gear sectors, as well as the catch share bottom trawl sector, were less than the lowest annual landings of the previous five years (2015–19), while landings in the directed Pacific halibut fishery were greater than the highest value in the last five years (Figure 2). Targeted landings by all other sectors were within the five-year range. However, shoreside midwater hake and rockfish trawl landed near the maximum of the range, and sea cucumber trawl and nearshore fixed gear landings were close to the minimum.

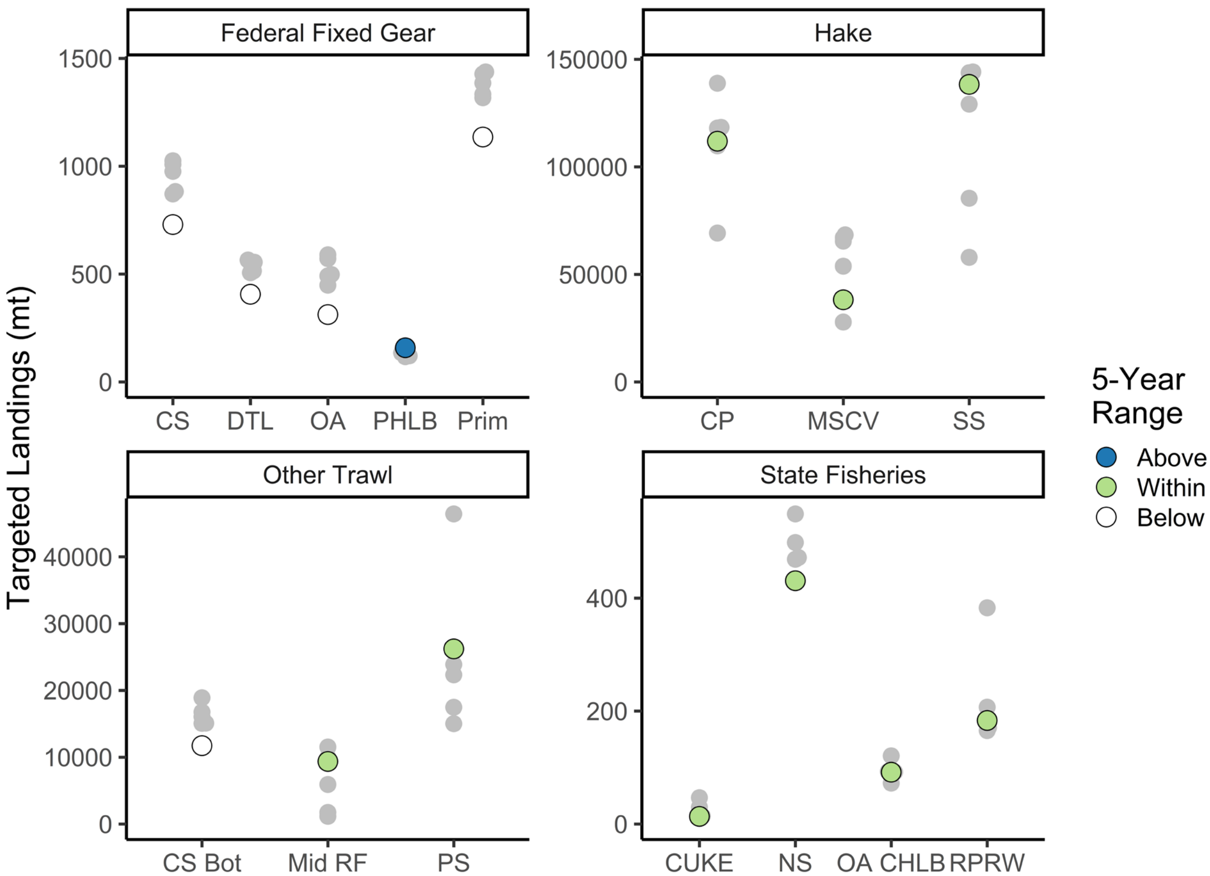

Figure 2. Sector-level targeted landings in 2020 compared to 2015–19. Gray points display annual estimates from 2015 to 2019; 2020 points are colored as indicated in the legend. Species and groupings included in targeted landings are defined in Methods. Abbreviations: *CS* = catch share, *DTL* = daily trip limit, *OA* = open access, *PHLB* = Pacific halibut, *Prim* = sablefish primary, *CP* = catcher-processor, *MSCV* = mothership-catcher vessel, *SS* = shoreside, *CS Bot* = catch shares bottom trawl, *Mid RF* = midwater rockfish, *PS* = pink shrimp, *CUKE* = sea cucumber, NS = nearshore, *OA CHLB* = open access California halibut, *RPRW* = ridgeback prawn.

The attainment for each species or grouping is compared to the ACLs, acceptable biological catch (ABC), and overfishing limit (OFL) harvest specifications in Table 1. For brevity, we only compare mortality to ACLs here. Additionally, we chose to compare the most recent year's estimate to those of the previous five years to contextualize the current year's estimate.

Pacific hake, Dover sole, and sablefish north of lat 36°N are consistently targeted by groundfish fisheries. In 2020, ACL attainment of Dover sole was 10%, less than the lowest value in the last five years (Table 1, Figure 3). Nearly all Dover sole mortality came from landings by the catch share bottom trawl fleet (Table 2, Figure 4). Pacific hake is managed using a TAC and, at 65% attainment, was within the five-year range; this mortality was almost evenly split between landings by the at-sea and shoreside hake fleets (Table 1 and Table 2, Figure 3 and Figure 4). Attainment of the sablefish north of lat 36°N ACL was 66%, less than the lowest value in the last five years (Table 1, Figure 3). The majority of sablefish mortality was attributed to landings by the non-catch share fixed gear and the catch share bottom trawl and fixed gear fleets (Table 2, Figure 4).

At 76% of their ACLs, black/blue/deacon rockfish (in Oregon) and petrale sole had the highest ACL attainment of any groupings or species during 2020 (Table 1, Figure 3). Approximately 75% of black/blue/deacon rockfish mortality was landed by the Oregon recreational fishery and about 25% by the non-catch share fixed gear fleet (Table 2, Figure 4). The ACL attainment of petrale sole was less than the lowest value of the last five years and almost entirely attributed to catch share bottom trawl landings (Table 1 and Table 2, Figure 3 and Figure 4). Widow rockfish was also highly attained, at 75% of its ACL, and was within the five-year range (Table 1, Figure 3). Nearly all mortality of widow rockfish was attributed to landings by the midwater rockfish fleet (Table 2, Figure 4). ACL attainment of minor nearshore rockfish north of lat 40°10′N was 70%, within

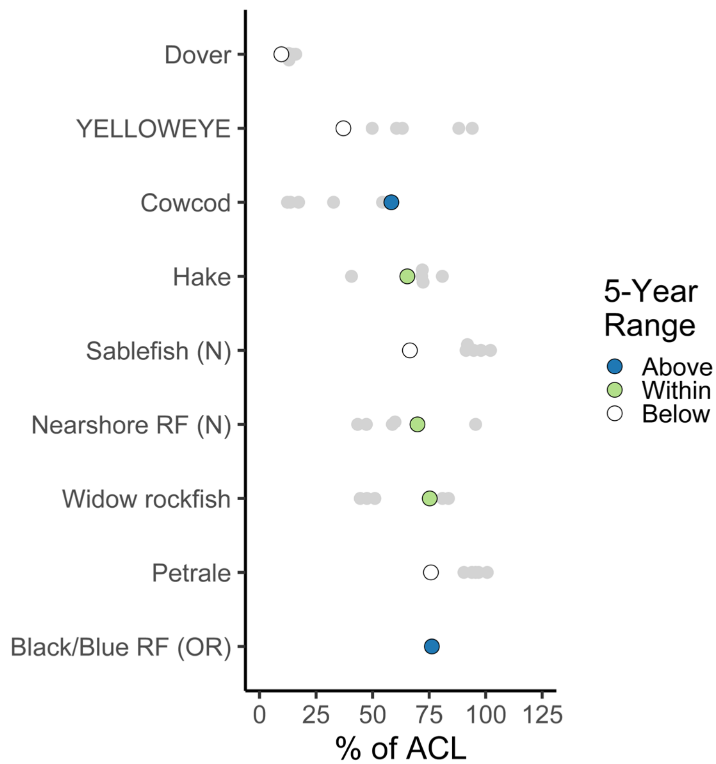

Figure 3. Proportion of ACL attained in 2020 compared to 2015–19 for select species that are highly targeted, highly attained, or rebuilding. Gray points display annual estimates from 2015 to 2019; 2020 points are colored as indicated in the legend. Hake attainment is shown as proportion of TAC. Sablefish is managed north and south of lat 36°N; the minor nearshore rockfish complex is managed north and south of lat 40°10′N. Black/blue rockfish (OR) was defined as a management grouping in 2019, so only one reference point is available. Rebuilding species are capitalized.

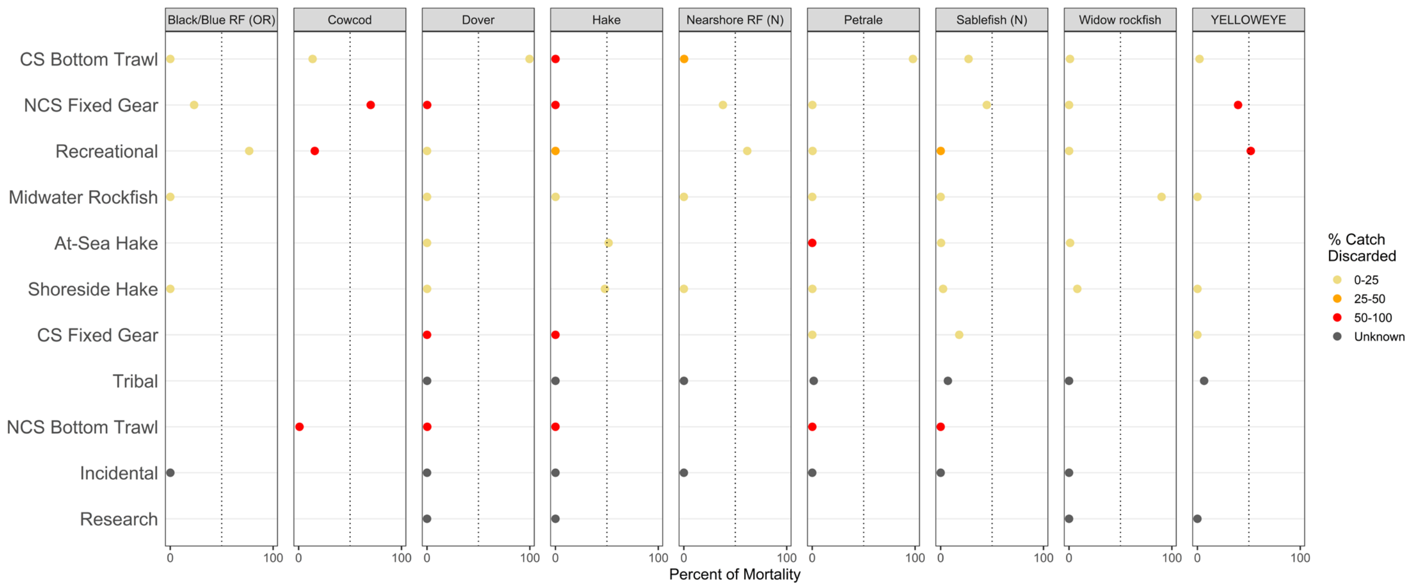

Figure 4. Sector-level contributions to 2020 mortality. Sablefish is managed north and south of lat 36°N; the minor nearshore rockfish complex is managed north and south of lat 40°10′N. Rebuilding species are capitalized.

the five-year range (Table 1, Figure 3). Mortality of minor nearshore rockfish north of lat 40°10′N was primarily associated with the recreational fleet, followed closely by the non-catch share fixed gear fleet (Table 2, Figure 4).

Cowcod rockfish was declared rebuilt in September 2019, and ACL attainment in 2020 was greater than the five-year range at 58% (Table 1, Figure 3).[9] More than half of that mortality came from non-catch share fixed gear discards, with the remaining mortality associated with catch share bottom trawl landings and recreational discards (Table 2, Figure 4). The ACL attainment of yelloweye rockfish, the only rebuilding groundfish species on the U.S. West Coast, was 37% and less than the lowest estimate in the last five years (Table 1, Figure 3). Recreational fisheries contributed more than half, and the non-catch share fixed gear fleet slightly less than half, of this mortality (Table 2, Figure 4).

[9] https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates

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Appendix A:
Discard Mortality Analysis Details/Protocol

Download these tables from this report's NOAA Institutional Repository[1] record by following the "Supporting Files" link.

Table A-1. 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-2. 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-3. Updates to analysis used in this report.

Table A-4. In-season adjustments to 2020 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]

Table A-5. 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 2020.

Table A-6. Identifications beyond taxonomic level required by WCGOP.

Table A-7. Species belonging to each WCGOP unsampled IFQ catch category. The *IFQM* catch category includes all 2020 IFQ species, and the *NIFQ* category includes all non-IFQ fish species.

[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 2002–20 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:

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

Explicit WCGOP postprocessing of PacFIN fish ticket data

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-day 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.”

2020:
((MONTH = 6) & (DAY %in% 22:26)) |
((MONTH = 7) & (DAY %in% 6:10)) |
((MONTH = 7) & (DAY %in% 20:24)) |
((MONTH = 8) & (DAY %in% 3:7)) |
((MONTH = 8) & (DAY %in% 17:21))

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):

2019:
```
((MONTH = 6) & (DAY %in% 26:28)) |
((MONTH = 7) & (DAY %in% 10:12)) |
((MONTH = 7) & (DAY %in% 24:26))
```

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

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

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.

Species

Species in this list have all been reported by one of the data sources used in this report. Not all of them will be found in any given year. See Table 1 and Table 2 for the most recent year's reported species.

Common name	Species
Aleutian skate	*Bathyraja aleutica*
Arrowtooth flounder	*Atheresthes stomias*
Aurora rockfish	*Sebastes aurora*
Bank rockfish	*Sebastes rufus*
Barracudina, unid.	Paralepididae
Big skate	*Raja binoculata*
Black and yellow rockfish	*Sebastes chrysomelas*
Black rockfish	*Sebastes melanops*
Black skate	*Bathyraja trachura*
Blackgill rockfish	*Sebastes melanostomus*
Blacksmelt, unid.	*Bathylagus* spp.
Blue/deacon rockfish	*Sebastes mystinus*
Bocaccio rockfish	*Sebastes paucispinis*
Bristlemouth, unid.	Gonostomatidae
Bronzespotted rockfish	*Sebastes gilli*
Brown Irish lord sculpin	*Hemilepidotus spinosus*
Brown rockfish	*Sebastes auriculatus*
Buffalo sculpin	*Enophrys bison*
Butter sole	*Isopsetta isolepis*
Cabezon	*Scorpaenichthys marmoratus*
Calico rockfish	*Sebastes dalli*
California grenadier	*Nezumia stelgidolepis*
California halibut	*Paralichthys californicus*
California scorpionfish	*Scorpaena guttata*
California sheephead	*Semicossyphus pulcher*
California skate	*Raja inornata*
Canary rockfish	*Sebastes pinniger*

Common name	Species
Chilipepper rockfish	*Sebastes goodei*
China rockfish	*Sebastes nebulosus*
Chinook (king) salmon	*Oncorhynchus tshawytscha*
Chum (dog) salmon	*Oncorhynchus keta*
Coho (silver) salmon	*Oncorhynchus kisutch*
Coonstripe prawn	*Pandalus hypsinotus*
Copper rockfish	*Sebastes caurinus*
Cowcod rockfish	*Sebastes levis*
Curlfin sole	*Pleuronichthys decurrens*
Darkblotched rockfish	*Sebastes crameri*
Deepsea skate	*Bathyraja abyssicola*
Deepsea smelt, unid.	Bathylagidae
Deepsea sole	*Embassichthys bathybius*
Diamond turbot	*Hypsopsetta guttulata*
Dover sole	*Microstomus pacificus*
Duckbill barracudina	*Magnisudis atlantica*
Dungeness crab	*Cancer magister*
English sole	*Parophrys vetulus*
Eulachon	*Thaleichthys pacificus*
Flag rockfish	*Sebastes rubrivinctus*
Flatfish, unid.	Pleuronectiformes
Flathead sole	*Hippoglossoides elassodon*
Freckled rockfish	*Sebastes lentiginosus*
Giant grenadier	*Albatrossia pectoralis*
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Green sturgeon	*Acipenser medirostris*

Common name	Species
Greenblotched rockfish	*Sebastes rosenblatti*
Greenling, unid.	Hexagrammidae
Greenspotted rockfish	*Sebastes chlorostictus*
Greenstriped rockfish	*Sebastes elongatus*
Grenadier, unid.	Macrouridae
Groundfish, unid.	—
Halfbanded rockfish	*Sebastes semicinctus*
Harlequin rockfish	*Sebastes variegatus*
Honeycomb rockfish	*Sebastes umbrosus*
Hornyhead turbot	*Pleuronichthys verticalis*
Jacksmelt	*Atherinopsis californiensis*
Kelp greenling	*Hexagrammos decagrammus*
Kelp rockfish	*Sebastes atrovirens*
Lanternfish, unid.	Myctophidae
Leopard shark	*Triakis semifasciata*
Lightfish, unid.	Phosichthyidae
Lingcod	*Ophiodon elongatus*
Longfin sanddab	*Citharichthys xanthostigma*
Longnose skate	*Raja rhina*
Longspine thornyhead (LST)	*Sebastolobus altivelis*
Mexican rockfish	*Sebastes macdonaldi*
Nearshore rockfish, unid.	Scorpaenidae
Noneulachon smelt, unid.	Osmeriformes
Non-Humboldt squid, unid.	Teuthida
Olive rockfish	*Sebastes serranoides*
Pacific cod	*Gadus macrocephalus*
Pacific flatnose	*Antimora microlepis*
Pacific grenadier	*Coryphaenoides acrolepis*
Pacific hake	*Merluccius productus*
Pacific halibut	*Hippoglossus stenolepis*
Pacific ocean perch	*Sebastes alutus*
Pacific sanddab	*Citharichthys sordidus*
Pacific sandlance	*Ammodytes hexapterus*

Common name	Species
Pacific saury	*Cololabis saira*
Petrale sole	*Eopsetta jordani*
Pink (humpback) salmon	*Oncorhynchus gorbuscha*
Pink rockfish	*Sebastes eos*
Pink shrimp	*Pandalus jordani*
Pinkrose rockfish	*Sebastes simulator*
Popeye grenadier	*Coryphaenoides cinereus*
Puget Sound rockfish	*Sebastes emphaeus*
Pygmy rockfish	*Sebastes wilsoni*
Quillback rockfish	*Sebastes maliger*
Rainbow smelt	*Osmerus mordax*
Red Irish lord sculpin	*Hemilepidotus hemilepidotus*
Redbanded rockfish	*Sebastes babcocki*
Redstripe rockfish	*Sebastes proriger*
Rex sole	*Glyptocephalus zachirus*
Ridgeback prawn	*Sicyonia ingentis*
Rockfish, unid.	*Sebastes* spp.
Rock sole	*Pleuronectes bilineatus*
Rosethorn rockfish	*Sebastes helvomaculatus*
Rosy rockfish	*Sebastes rosaceus*
Rougheye/blackspotted rockfish	*Sebastes melanostictus* and *S. aleutianus*
Round herring	*Etrumeus teres*
Roundfish, unid.	—
Sablefish	*Anoplopoma fimbria*
Salmon, unid.	*Oncorhynchus* spp.
Sand sole	*Psettichthys melanostictus*
Sanddab, unid.	*Citharichthys*
Sandpaper skate	*Bathyraja kincaidii*
Sculpin, unid.	Cottidae
Sea cucumber	Holothuroidea
Shark and skate, unid.	—
Sharpchin rockfish	*Sebastes zacentrus*

Common name	Species
Shelf rockfish, unid.	Scorpaenidae
Shortbelly rockfish	*Sebastes jordani*
Shortraker rockfish	*Sebastes borealis*
Shortraker/rougheye/blackspotted rockfish	*Sebastes borealis* and *S. aleutianus*
Shortspine thornyhead (SST)	*Sebastolobus alascanus*
Shoulderspot grenadier	*Caelorinchus scaphopsis*
Silvergray rockfish	*Sebastes brevispinis*
Skate, unid.	Rajidae
Slender barracudina	*Lestidiops ringens*
Slender sole	*Lyopsetta exilis*
Slope rockfish, unid.	Scorpaenidae
Smelt, unid.	Osmeridae
Smooth grenadier	*Nezumia liolepis*
Sockeye (red) salmon	*Oncorhynchus nerka*
Soupfin shark	*Galeorhinus galeus*
Speckled rockfish	*Sebastes ovalis*
Speckled sanddab	*Citharichthys stigmaeus*
Spiny dogfish	*Squalus suckleyi*
Splitnose rockfish	*Sebastes diploproa*
Spotted prawn	*Pandalus platyceros*

Common name	Species
Spotted ratfish	*Hydrolagus colliei*
Spotted rockfish, unid.	*Sebastomus* spp.
Squarespot rockfish	*Sebastes hopkinsi*
Squid, unid.	Teuthida
SST/LST	*Sebastolobus* spp.
Starry flounder	*Platichthys stellatus*
Starry rockfish	*Sebastes constellatus*
Starry skate	*Raja stellulata*
Stripetail rockfish	*Sebastes saxicola*
Surf smelt	*Hypomesus pretiosus*
Swordspine rockfish	*Sebastes ensifer*
Tiger rockfish	*Sebastes nigrocinctus*
Treefish rockfish	*Sebastes serriceps*
Vermilion rockfish	*Sebastes miniatus*
White barracudina	*Arctozenus risso*
Whitebait smelt	*Allosmerus elongatus*
Widow rockfish	*Sebastes entomelas*
Yelloweye rockfish	*Sebastes ruberrimus*
Yellowmouth rockfish	*Sebastes reedi*
Yellowtail rockfish	*Sebastes flavidus*

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NOAA Technical Memorandum NMFS-NWFSC-

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