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Estimated Discard and Catch of Groundfish Species in the 2021 U.S. West Coast Fisheries

April 2023

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Estimated Discard and Catch of Groundfish Species in the 2021 U.S. West Coast Fisheries

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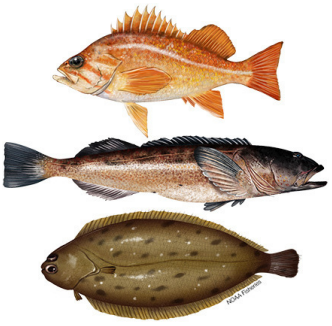
Plain Language Summary

Background



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 fishery management plan that first went into effect in 1982. NOAA Fisheries has since declared the majority of groundfish species 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 2021 data.

Key Takeaways

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

- In 2021, most fishery sectors landed catch within the range of the previous five years (2016–20).
- No management groupings exceeded 2021 fishery management guidelines.
- Compared to the previous five years, groundfish fisheries landed less of one consistently targeted species: Dover sole. Groundfish fisheries landed two other consistently targeted species, Pacific hake and northern sablefish, within the five-year range.
- Groundfish fisheries attained the highest percentage of harvest guidelines for Oregon black/blue/deacon rockfish, widow rockfish, Pacific hake, northern sablefish, petrale sole, 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
- Fishery management plan: https://www.fisheries.noaa.gov/management-plan/pacific-coast-groundfish-fishery-management-plan
- 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 2020, 2) provide mortality estimates for 2021, and 3) compare the 2021 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). PFMC's Groundfish Management Team (GMT) provides discard mortality rates for a subset of species as available based on scientific literature and after review by the SSC. Absent of specific guidance for other species, we report the full weight of discards without any mortality rates applied. This is not meant to imply that all discarded catch results in mortality for these species, but rather to emphasize the survivorship rates for a subset of studied species where sufficient data on survival are available. Electronic monitoring (EM) video reviewer estimates of at-sea discards for 2021 were not available at the time of this analysis, so final mortality estimation methods for the shoreside-processed EM fleet in 2021 differ from other years and are described in detail below. Across all sectors, our primary findings include that:

- Targeted landings by the plurality of fishery sectors reported for 2021 were within the range of the previous five years (2015–20). However, higher landings occurred in the midwater rockfish, pink shrimp, and OA California halibut trawl sectors, while lower landings occurred in the daily trip limit (DTL) fixed gear sector, at-sea catcher–processor (CP) and mothership catcher vessel (MS) hake fleets, and ridgeback prawn trawl sectors (Figure 2).
- No management groupings exceeded 2021 ACLs.
- Species consistently targeted by groundfish fisheries include: Pacific hake (a.k.a. Pacific whiting, hereafter: "hake"), Dover sole, and sablefish north of lat 36°N. 2021 ACL attainment of Dover sole (8%) was below the five-year range, while that of sablefish north of lat 36°N (71%) was within the five-year range (Table 1, Figure 3). Hake is managed using total allowable catch (TAC) and, at 73% attainment, was also within the five-year range (Table 1, Figure 3).
- The highest ACL attainments in 2021 occurred for black/blue/deacon rockfish in Oregon (77%), widow rockfish (74%), Pacific hake (73%), sablefish north of lat 36°N (71%), petrale sole (71%), 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 15% of the ACL was attained in 2021 (Table 1, Figure 3).
- ACL attainment of yelloweye rockfish, a 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 2021 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 Pacific ocean perch, widow rockfish, and yellowtail 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 CPs.
        - Hake MSes.
    c. Open access (OA) fixed gear nearshore (Oregon/California).*
    d. Fixed gear LE sablefish primary season (tier endorsed).*
    e. Fixed gear LE nonprimary sablefish (non-endorsed and 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 2021 catch from the following commercial nongroundfish 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 and Lorna Wargo (WDFW), Christian Heath (ODFW), and Melanie Parker (CDFW) provided recreational data. Lynn Massey, Dana Preedeedilok, and Monica Falcon (NOAA Fisheries West Coast Region [WCR]) ensured that catch associated with research permits was uploaded in a timely manner to an application built by Sara Ogaz and Melina Shak (NWFSC).

A note about tables:

Tables 1 and 2 have been typeset in this report. They are also available in the accompanying Excel file, together with Table 3, the Groundfish Expanded Multiyear Mortality data product, and appendix tables A-1–A-7.

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 catch 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 2021 were retrieved from the PacFIN database on 5 July 2022. 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 and is estimated using scientific at-sea observations conducted by the Fisheries Observation Science Program (FOS),[2] which consists of the West Coast Groundfish Observer Program (WCGOP) and the At-Sea Hake Observer Program (A-SHOP). However, a small amount of shoreside discard from fisheries operating under optimized or maximized retention is also included. In all other sectors, the small amount of discard at the dock is assumed to be accounted for in PacFIN fish ticket landings data.

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 take or land groundfish caught in the U.S. exclusive economic zone, from 3–200 miles offshore, are required to carry an observer when notified to do so by NOAA Fisheries or its designated agent. Thus, 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. 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. These additional fisheries include the pink shrimp, California halibut, and California ridgeback prawn trawl fisheries.

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[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).

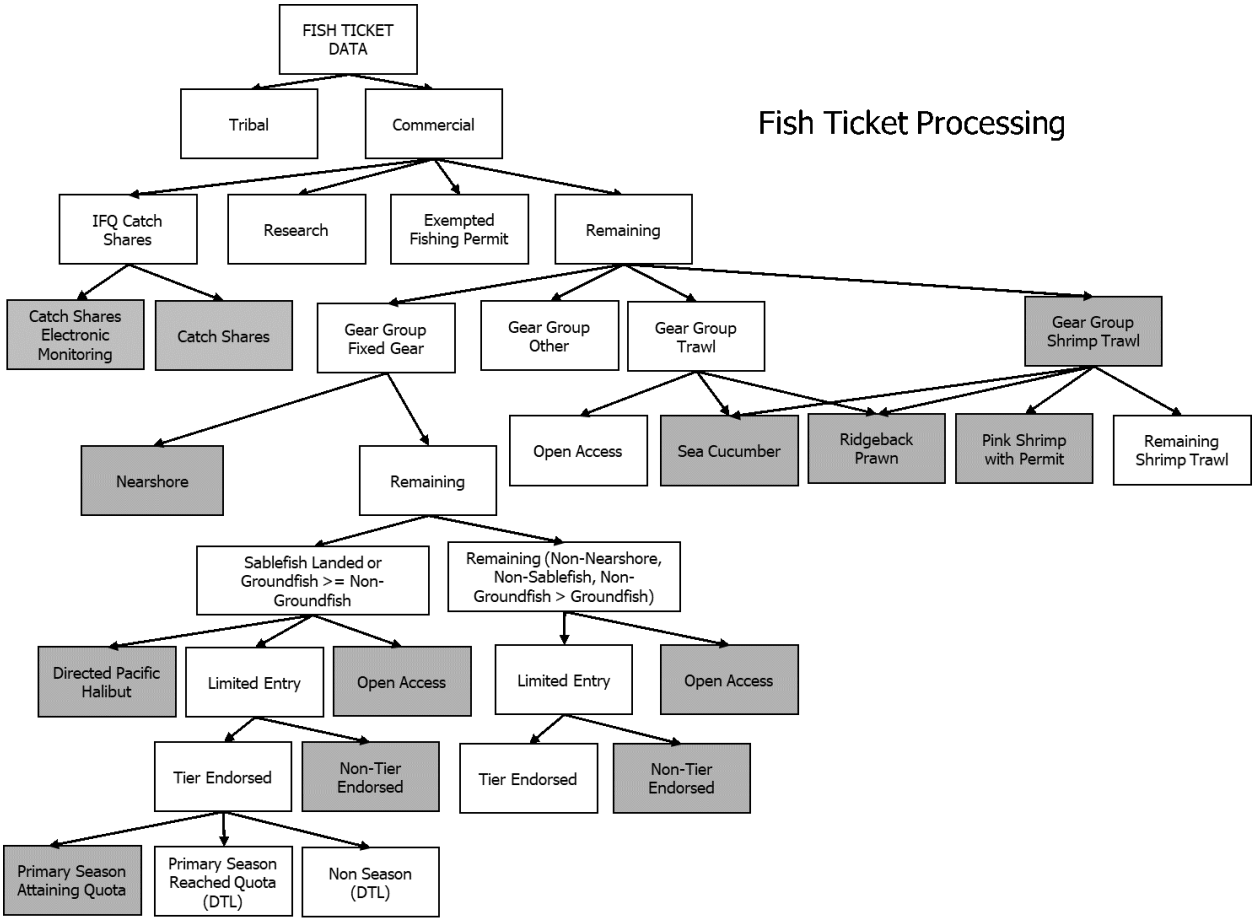

Figure 1. PacFIN fish ticket data processing for division into groundfish fishery sectors. Gray highlights indicate sectors for which federal observer data are available.

The sampling protocol employed by WCGOP includes quantifying all catch in fixed gear sectors and discarded catch in trawl sectors, as well as biological sampling and recording interactions with protected species. Deatiled information on data collection methods employed in each observed fishery can be found in the WCGOP manual (NWFSC 2021). Observers record haul-level retained amounts, either by estimating based on catch and effort, or by transcribing the captain's 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. 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 2021. Current A-SHOP program information and documentation on data collection methods can be found in the observer manual (NWFSC 2022). 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 hake fleets were recorded by EM systems. For data in years other than 2021, 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 and were recently updated to be consistent with stock assessment estimations. 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.

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, SSC reviewed and approved discard mortality rates, provided by GMT, 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). In the absence of specified discard mortality rates, we estimate that discard and mortality are equivalent for all other species. This is not meant to imply that all discarded catch results in mortality for these species, but rather emphasizes the survivorship rates for a subset of studied species. 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. 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 hake or midwater non-hake species such as widow and yellowtail rockfish. 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 2016 to 2021, 30% of targeted landings by pot gear and 23% of targeted landings by bottom trawl gear were observed (Somers et al. 2022).[3] 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 (for data in years other than 2021), and PacFIN fish ticket landings data. Fish tickets associated with the IFQ fishery were defined by FOS 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 (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.

[3] Somers, K. A., K. E. Richerson, V. J. Tuttle, and J. T. McVeigh. 2022. Fisheries Observation Science Program Coverage Rates, 2002–21. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR-2022-02. DOI: 10.25923/ky3a-g655

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:

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

where, for each stratum,

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

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

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

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:

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

where, for each stratum,

W = estimated unsampled discard weight of a given species within a stratum,
y = unsampled catch category (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.

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 or EM system 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, and mortality estimation methods varied by year and reflected available data.

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.

From 2016 to 2020, these refined protocols provided more accurate discard estimation. 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, while maintaining confidentiality where possible. 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 in 2015 to 2020, 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 at-sea discard occurs due to spillage or lost gear and so is not sorted. Video reviewers estimate the amount of catch lost, and we assume the catch composition matches that of the rest of the haul or trip, as appropriate.

The midwater hake and rockfish sectors operate under maximized retention when monitored using EM, 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 from 2015 to 2020. 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.

Video reviewer estimates of at-sea discards for 2021 were not available at the time of this analysis, so final mortality estimation methods for 2021 differ from other years. For EM vessels using bottom trawl and pot, we used the same methods as described above for 2016 to 2020 for non-IFQ species and applied them to all species, including IFQ species. Midwater rockfish and hake EM vessels operate under maximized retention and thus do not require additional scientific observer coverage. For the midwater rockfish EM fleet, the methods were the same as those for bottom trawl and pot trawl, but used observed discard rates from the 100%

observed midwater rockfish fleet. For the midwater hake EM fleet, we observed less than three vessels in the 100%-observed portion of the fleet, so could not use those confidential discard rates for estimation. Instead, we estimated the fleetwide discard amount using the median five-year discard percentage from all midwater hake trips (0.3%) and assumed that the species composition of discards was equivalent to that of the landed catch as recorded on fish tickets.

Mortality summary for shorebased IFQ sectors

We estimated coastwide landings, discard weight (from 100% observer coverage and, in 2016–20, 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,b). 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,b).

California Sea Cucumber Trawl Fishery

WCGOP observed this sector from 2017 to 2020. However, three or more vessels were observed only in 2017; in all other years, discard data are confidential. To be consistent across years, fleetwide landings are summarized for all years, and only 2017 estimates include discard. 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 spot 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) non-groundfish 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 non-groundfish 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 2002–20 in Washington and Oregon. In 2021, 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. The PFMC further distributes all sablefish mortality associated with the directed Pacific halibut fishery into the LE, zero-tier, and OA sectors to reflect management of the stock and inform management decisions. This report, however, consistently summarizes mortality of all stocks associated with each fishery sector and does not make an exception for sablefish.

Fish tickets were partitioned into three commercial fixed gear subsectors: LE sablefish endorsed primary season, LE non-sablefish endorsed, and OA fixed gear groundfish. Vessels landing catch without a federal groundfish permit were classified as the OA fixed gear groundfish subsector. Those vessels landing catch with a federal groundfish permit were further separated based on whether the vessel's federal groundfish permit(s) had a sablefish endorsement with tier quota for the primary season or whether 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 prior to 2020, or in January–March in 2020 and 2021) or made trips within the season after they had reached their cumulative tier quota, the fish tickets were placed in the LE non-sablefish endorsed subsector. Fish tickets from non-sablefish endorsed LE vessels were also placed in this subsector.

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

Observer data were stratified by subsector, gear type, and area, 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 non-sablefish 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 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 non-groundfish 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.

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

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 (Richerson et al. in prep), salmon species (Richerson et al. 2022a),[6] green sturgeon (Richerson et al. 2022b), and eulachon (Gustafson et al. 2021). Mortality estimations from 2002–21 for all non-protected fish species are available in Table 3 and in the Groundfish Expanded Mortality Multiyear (GEMM) product on the FRAM Data Warehouse.[7]

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.

[6] Richerson, K. E., K. A. Somers, J. E. Jannot, V. J. Tuttle, N. B. Riley, and J. T. McVeigh. 2022a. Observed and Estimated Bycatch of Salmon in U.S. West Coast Fisheries, 2002–20. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR-2022-01. https://doi.org/10.25923/pm3a-ad32

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

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 (mt)**	**% of ACL**	**ABC (mt)**	**% of ABC**	**OFL (mt)**	**% of OFL**
Arrowtooth flounder	807	9,933	8	9,933	8	13,551	6
Big skate	209	1,477	14	1,477	14	1,690	12
Black rockfish (CA)	236	348	68	348	68	379	62
Black rockfish (WA)	182	293	62	293	62	319	57
Black/blue/deacon rockfish (OR)	462	603	77	603	77	676	68
Bocaccio rockfish (CA)	369	1,748	21	1,748	21	1,887	20
Cabezon (CA)	50	210	24	210	24	225	22
Cabezon/kelp greenling (OR)	53	198	27	198	27	215	25
Cabezon/kelp greenling (WA)	7	20	33	20	34	25	26
CA scorpionfish (S of 34°27′N)	127	291	44	291	44	319	40
Canary rockfish	562	1,338	42	1,338	42	1,459	38
Chilipepper ockfish (S of 40°10′N)	748	2,358	32	2,358	32	2,571	29
Cowcod rockfish (S of 40°10′N)	13	84	15	84	16	114	11
Darkblotched rockfish	336	882	38	882	38	953	35
Dover sole	4,103	50,000	8	84,192	5	93,547	4
English sole	242	9,175	3	9,175	3	11,107	2
Lingcod (N of 40°10′N)	860	5,369	16	5,386	16	5,816	15
Lingcod (S of 40°10′N)	311	1,102	28	1,162	27	1,255	25
Longnose skate	635	1,823	35	1,823	35	2,086	30
Minor rockfish (N of 40°10′N)							
Nearshore	55	79	70	79	70	94	58
Shelf	487	1,511	32	1,511	32	1,888	26
Slope	533	1,595	33	1,595	33	1,862	29
Minor rockfish (S of 40°10′N)							
Nearshore	540	1,016	53	1,016	53	1,232	44
Shelf	569	1,438	40	1,439	40	1,842	31
Slope	82	709	12	709	12	873	9
Other flatfish	557	4,802	12	4,802	12	7,714	7
Other groundfish	53	223	24	223	24	286	19
Pacific cod	27	1,600	2	1,926	1	3,200	1
Pacific hake	270,183	2021 U.S. TAC = 369,400 mt; 73% of U.S. TAC					
Pacific ocean perch (N of 40°10′N)	500	3,854	13	3,854	13	4,497	11
Petrale sole	2,919	4,115	71	4,115	71	4,402	66
Sablefish (N of 36°N)	4,904	6,892	71	8,791	59	9,402	55
Sablefish (S of 36°N)	277	1,899	15				
Spiny dogfish	337	1,621	21	1,621	21	2,479	14
Splitnose rockfish (S of 40°10′N)	25	1,666	2	1,666	2	1,868	1
Starry flounder	7	392	2	392	2	652	1
Thornyheads							
Longspine thornyhead (N of 34°27′N)	91	2,634	3	3,466	3	5,097	2
Longspine thornyhead (S of 34°27′N)	9	832	1				
Shortspine thornyhead (N of 34°27′N)	463	1,428	32	2,183	23	3,211	16
Shortspine thornyhead (S of 34°27′N)	42	756	6				
Widow rockfish	10,880	14,725	74	14,725	74	15,749	69
YELLOWEYE ROCKFISH	18	50	37	83	22	97	19
Yellowtail rockfish (N of 40°10′N)	2,931	6,050	48	6,050	48	6,534	45

Table 2. Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021. *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	720.4	0.7	0.2	5.5	17.3	2.0	—	—	20.6	—	29.4	6.4	—	—	0.6	—	0.0	—	4.2	807.3
Big skate	186.4	—	0.4	1.3	0.6	0.3	8.4	—	—	0.0	4.1	5.1	0.3	0.0	0.7	—	0.1	—	1.4	209.3
Black rf. (CA)	—	—	—	—	—	—	—	—	—	—	0.1	—	38.0	1.0	—	—	—	197.1	—	236.1
Black rf. (WA)	0.0	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	181.8	—	—	—	181.8
Black/blue/deacon rf. (OR)																				
Black rf.	0.0	—	0.0	0.0	—	—	—	—	—	—	2.0	—	98.9	0.4	—	—	334.9	—	0.0	436.2
Blue/deacon rf.	0.0	—	—	0.0	—	—	—	—	—	—	0.0	—	7.0	0.1	—	—	19.1	—	0.0	26.2
Bocaccio rf. (S of 40°10′N)	254.1	—	—	—	—	—	—	—	—	—	32.1	—	2.9	1.4	—	—	—	76.5	2.3	369.3
Cabezon (CA)	—	—	—	—	—	—	—	—	—	—	0.3	—	25.8	0.0	—	—	—	23.9	0.0	50.0
Cabezon/kelp greenling (OR)																				
Cabezon	—	—	—	—	—	—	—	—	—	—	0.3	0.0	27.4	0.0	—	—	12.4	—	0.0	40.0
Kelp greenling	0.0	—	—	—	—	—	—	—	—	—	0.0	0.0	10.1	—	—	—	3.1	—	0.0	13.3
Cabezon/kelp greenling (WA)																				
Cabezon	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.8	—	—	—	5.8
Kelp greenling	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.8	—	—	0.0	0.9
California scorpionfish (S of 34°27′N)	—	—	—	—	—	—	0.1	—	—	0.1	—	—	0.9	0.1	—	—	—	125.8	0.1	127.0
Canary rf.	164.2	—	91.9	111.5	3.1	2.8	—	—	—	—	17.6	0.3	12.9	0.8	4.7	39.4	38.5	69.6	4.4	561.7
Chilipepper rf. (S of 40°10′N)	709.9	—	—	—	—	—	0.0	—	0.2	—	27.8	—	0.4	0.2	—	—	—	3.8	5.4	747.9
Cowcod rf. (S of 40°10′N)	1.9	—	—	—	—	—	—	—	—	—	1.5	—	0.1	—	—	—	—	8.9	0.5	13.0
Darkblotched rf.	207.9	0.0	0.9	50.2	33.5	6.9	—	—	30.8	—	4.0	0.1	0.1	—	0.2	—	0.0	—	0.9	335.5
Dover sole	4,024.9	0.8	0.2	0.0	1.3	0.1	0.0	—	2.9	—	2.2	0.4	0.0	0.4	7.7	—	—	—	61.9	4,102.7
ECS																				
Aleutian skate	0.4	—	—	—	—	—	—	—	—	—	0.0	0.2	—	—	—	—	—	—	0.0	0.6
Black skate	2.1	—	—	—	—	—	—	—	—	—	11.8	—	—	—	—	—	—	—	0.6	14.5
California grenadier	0.3	—	—	—	—	—	—	—	—	—	6.9	—	—	—	—	—	—	—	0.1	7.3
California skate	1.0	—	—	—	—	—	11.1	—	—	0.1	0.1	—	0.0	1.7	—	—	—	—	0.3	14.4
Deepsea skate	0.0	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	0.0	0.1
Giant grenadier	15.3	0.3	—	—	—	—	—	—	—	—	2.3	—	—	—	—	—	—	—	1.7	19.7
Grenadier, unid.	0.2	0.0	—	—	0.9	0.0	—	—	—	—	18.0	—	0.1	—	—	—	—	—	0.0	19.2
Pacific flatnose	0.0	0.0	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	0.1	0.2
Pacific grenadier	2.3	0.0	—	—	—	—	—	—	—	—	0.7	—	—	—	—	—	—	—	2.5	5.5
Popeye grenadier	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Sandpaper skate	36.3	—	0.0	0.0	0.0	—	—	—	0.0	—	0.6	0.1	—	—	—	—	—	—	1.1	38.1

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021.

	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
Shark and skate, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	0.1
Shortbelly rf.	11.1	—	19.1	177.5	69.1	52.3	—	—	0.2	—	0.1	—	0.0	0.0	0.0	—	—	—	4.3	333.6
Shoulderspot grenadier	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Smooth grenadier	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	0.0	0.2
Soupfin shark	5.3	—	0.1	0.7	1.0	1.0	1.6	—	—	—	0.2	—	1.5	13.0	—	—	—	—	0.0	24.4
Spotted ratfish	91.5	0.0	1.2	0.0	0.0	—	0.0	—	0.2	—	3.4	0.5	0.1	—	—	—	0.0	—	2.6	99.5
English sole	230.9	—	0.3	0.3	0.1	0.0	4.7	0.0	0.0	1.0	0.0	—	0.0	0.5	—	—	0.1	—	4.0	241.9
Groundfish, unid.	—	—	—	0.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.6
Lingcod (N of 40°10′N)	332.9	0.9	4.6	6.8	0.2	0.8	—	—	0.1	—	60.8	6.3	65.2	2.6	23.1	173.1	146.2	29.5	6.5	859.7
Lingcod (S of 40°10′N)	43.6	0.0	—	—	—	—	0.0	—	0.1	0.0	14.0	—	24.0	1.4	—	—	—	227.5	0.9	311.5
Longnose skate	571.9	0.0	0.2	0.7	0.5	0.1	1.3	0.2	0.1	—	38.0	4.9	0.4	0.1	1.8	—	0.1	—	14.2	634.6
LST (N of 34°27′N)	69.7	0.0	0.0	0.0	—	—	—	—	0.0	—	2.1	—	0.0	—	0.5	—	—	—	18.4	90.8
LST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	8.1	—	0.0	0.1	—	—	—	—	0.8	9.0
Minor ns. rf. (N of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	0.0	0.0	—	0.1
Blue/deacon rf.	—	—	—	—	—	—	—	—	—	—	0.2	—	3.2	—	—	1.1	—	6.0	0.0	10.4
Brown rf.	0.0	—	—	—	—	—	—	—	—	—	—	0.0	0.2	0.0	—	—	0.1	1.3	—	1.6
China rf.	—	—	—	—	—	—	—	—	—	—	0.1	0.0	5.4	—	—	1.6	1.8	0.4	—	9.4
Copper rf.	—	—	—	—	—	—	—	—	—	—	0.2	—	4.3	—	—	2.4	4.3	3.6	—	14.8
Gopher rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	0.0	0.1	—	0.2
Grass rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.5	—	—	—	0.0	0.3	—	0.9
Kelp rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	0.0
Nearshore rf., unid.	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Olive rf.	—	—	—	—	—	—	—	—	—	—	2.8	—	0.2	—	—	—	0.0	0.6	—	3.6
Quillback rf.	0.1	—	—	0.0	—	—	—	—	—	—	0.1	0.0	4.3	—	—	1.9	4.5	3.0	0.0	14.1
Treefish rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	0.0
Minor ns. rf. (S of 40°10′N)																				
Black and yellow rf.	—	—	—	—	—	—	—	—	—	—	0.2	—	16.2	0.0	—	—	—	3.5	—	19.9
Blue/deacon rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	12.8	0.1	—	—	—	127.6	0.0	140.5
Brown rf.	—	—	—	—	—	—	0.0	—	—	0.0	0.1	—	19.5	0.4	—	—	—	88.9	0.0	108.9
Calico rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.1	—	—	—	—	0.2	0.0	0.3
China rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	3.6	0.0	—	—	—	15.0	—	18.6
Copper rf.	—	—	—	—	—	—	0.0	0.0	—	—	0.6	—	12.7	0.0	—	—	—	79.8	0.2	93.3
Gopher rf.	—	—	—	—	—	—	—	—	—	—	0.7	—	25.5	0.0	—	—	—	55.6	—	81.9
Grass rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	8.9	—	—	—	—	2.9	—	11.8
Kelp rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	1.0	0.0	—	—	—	3.3	—	4.3
Nearshore rf., unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Olive rf.	—	—	—	—	—	—	—	—	—	—	0.1	—	0.7	0.2	—	—	—	40.5	0.0	41.6

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021.

	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
Quillback rf.	—	—	—	—	—	—	—	—	—	—	—	—	2.7	0.0	—	—	—	7.5	—	10.3
Treefish rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	2.6	0.0	—	—	—	6.2	0.0	8.8
Minor sh. rf. (N of 40°10′N)																				
Bocaccio rf.	38.1	—	27.7	8.7	1.0	1.5	—	—	0.0	—	1.7	0.3	0.1	—	1.3	7.1	0.5	0.0	0.9	88.9
Chilipepper rf.	126.8	—	5.2	0.4	0.7	0.1	—	—	0.0	—	0.0	0.1	—	—	—	—	0.1	—	0.4	133.8
Cowcod rf.	0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	0.2
Flag rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Freckled rf.	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	0.0
Greenblotched rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Greenspotted rf.	3.4	—	0.0	—	—	—	—	—	—	—	0.1	0.1	0.0	—	0.0	—	0.2	—	0.1	3.9
Greenstriped rf.	44.5	—	0.6	1.4	0.0	0.0	—	—	0.2	—	3.9	0.3	0.0	—	0.5	—	0.1	—	2.0	53.5
Halfbanded rf.	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	0.0	0.0
Harlequin rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Pygmy rf.	—	—	—	—	—	—	—	—	2.9	—	—	—	—	—	—	—	—	—	0.0	2.9
Redstripe rf.	1.2	—	31.4	8.0	0.1	2.2	—	—	—	—	—	—	—	—	0.1	—	0.0	—	0.5	43.5
Rockfish, unid.	—	—	—	—	2.8	0.0	—	—	—	—	—	—	—	—	—	—	—	—	1.3	4.1
Rosethorn rf.	3.3	0.0	0.2	0.1	—	—	—	—	—	—	0.6	0.0	—	—	0.0	—	0.1	—	0.2	4.6
Rosy rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	—	—	—	0.1	0.0	—	0.1
Shelf rf., unid.	1.4	0.0	0.0	—	—	—	—	—	4.3	—	1.3	0.0	0.0	0.1	0.1	—	—	—	0.0	7.3
Silvergray rf.	52.7	—	4.5	2.1	0.3	0.2	—	—	—	—	0.3	0.2	0.0	—	0.2	—	0.5	—	0.0	61.1
Starry rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	—	—	—	0.0	—	—	0.0
Stripetail rf.	48.4	—	0.0	0.0	2.0	0.0	—	—	11.9	—	0.0	0.0	0.0	—	—	—	—	—	3.5	65.8
Swordspine rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Tiger rf.	0.0	—	—	0.0	—	—	—	—	—	—	0.2	—	0.2	—	0.1	0.4	1.0	0.2	—	2.0
Vermilion rf.	0.0	—	—	—	—	—	—	—	—	—	0.7	0.1	4.1	—	—	1.4	5.5	3.5	—	15.3
Minor sh. rf. (S of 40°10′N)																				
Bronzespotted rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Chameleon rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	0.0
Flag rf.	—	—	—	—	—	—	—	0.1	—	—	0.2	—	0.1	0.0	—	—	—	4.9	0.0	5.2
Freckled rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Greenblotched rf.	—	—	—	—	—	—	—	—	—	—	2.6	—	0.0	0.0	—	—	—	0.6	0.1	3.3
Greenspotted rf.	1.8	—	—	—	—	—	—	—	—	—	5.7	—	1.1	0.1	—	—	—	17.1	0.6	26.4
Greenstriped rf.	2.9	—	—	—	—	—	0.0	—	0.0	—	0.4	—	0.0	0.0	—	—	—	1.6	0.4	5.3
Halfbanded rf.	0.0	—	—	—	—	—	—	—	0.0	—	0.0	—	0.0	—	—	—	—	1.2	1.5	2.8
Honeycomb rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	0.0	—	—	—	2.0	0.0	2.1
Mexican rf.	0.6	0.0	—	—	—	—	—	—	—	—	1.7	—	0.0	0.0	—	—	—	0.6	0.0	2.8
Pink rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	—	—	—	—	—	0.0	0.1
Pinkrose rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	—	0.0	—	—	—	—	0.0	0.0

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021.

	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
Pygmy rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Redstripe rf.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Rockfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Rosethorn rf.	0.0	—	—	—	—	—	—	—	—	—	0.0	—	0.1	—	—	—	—	—	0.0	0.1
Rosy rf.	—	—	—	—	—	—	—	—	—	—	0.3	—	0.7	0.0	—	—	—	6.1	0.0	7.2
Shelf rf., unid.	1.0	—	—	—	—	—	—	—	—	—	0.9	—	1.5	0.0	—	—	—	—	0.0	3.4
Speckled rf.	0.0	—	—	—	—	—	0.0	—	—	—	0.6	—	0.6	1.2	—	—	—	2.3	0.2	4.9
Squarespot rf.	—	—	—	—	—	—	—	—	0.0	—	0.1	—	0.1	0.0	—	—	—	12.1	0.2	12.4
Starry rf.	—	—	—	—	—	—	—	—	—	—	0.9	—	0.8	0.1	—	—	—	40.0	0.2	42.1
Stripetail rf.	23.7	—	—	—	—	—	—	—	0.7	—	—	—	—	—	—	—	—	—	3.3	27.7
Swordspine rf.	—	—	—	—	—	—	—	—	—	—	0.0	—	0.0	—	—	—	—	0.0	0.0	0.1
Tiger rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.6	—	0.6
Vermilion rf.	0.0	—	—	—	—	—	0.0	—	—	0.0	40.5	—	27.4	1.2	—	—	—	230.6	4.1	303.9
Yellowtail rf.	0.0	—	—	—	—	—	—	—	—	—	16.4	—	5.7	6.6	—	—	—	88.9	0.4	118.0
Minor sl. rf. (N of 40°10′N)																				
Aurora rf.	23.4	0.0	0.1	0.9	0.0	0.0	—	—	0.3	—	0.1	—	0.0	—	0.0	—	—	—	0.2	25.0
Bank rf.	0.8	—	1.5	0.3	0.3	0.0	—	—	—	—	0.1	0.0	—	—	0.0	—	—	—	—	3.1
Blackgill rf.	4.7	0.0	0.0	0.0	—	—	—	—	—	—	0.7	0.0	0.0	—	0.0	—	—	—	0.1	5.6
Redbanded rf.	13.1	0.3	0.0	0.4	0.0	0.0	—	—	0.1	—	16.3	2.0	0.7	—	3.3	—	0.0	—	0.2	36.3
Rockfish, unid.	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5	0.5
Rougheye/blackspotted rf.	10.4	1.0	0.0	21.4	22.4	15.2	—	—	0.0	—	17.0	1.7	0.2	—	4.1	—	—	—	0.2	93.5
Sharpchin rf.	47.6	—	17.2	23.5	0.8	0.0	—	—	0.0	—	0.0	—	—	—	0.0	—	—	—	2.0	91.2
Shortraker rf.	4.5	—	0.0	0.1	0.1	0.0	—	—	—	—	1.8	0.1	—	—	0.7	—	—	—	—	7.3
Shortraker/rougheye rf.	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1
Shortraker/rougheye/blackspotted rf.	0.0	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	0.1
Slope rf., unid.	5.7	0.0	0.1	0.0	—	—	—	—	—	—	9.1	1.0	—	0.0	0.0	—	—	—	0.0	16.0
Splitnose rf.	49.8	0.0	8.7	12.8	121.5	13.7	—	—	6.7	—	0.1	—	—	—	0.0	—	—	—	1.3	214.5
Yellowmouth rf.	27.1	—	8.4	3.8	0.0	0.0	—	—	—	—	1.0	0.1	—	—	0.0	—	0.0	—	0.0	40.4
Minor sl. rf. (S of 40°10′N)																				
Aurora rf.	1.7	0.0	—	—	—	—	—	—	—	—	1.0	—	—	0.0	—	—	—	—	0.4	3.2
Bank rf.	38.8	—	—	—	—	—	—	—	—	—	1.9	—	0.2	—	—	—	—	0.1	0.4	41.4
Blackgill rf.	5.7	0.8	—	—	—	—	—	—	—	—	22.2	—	5.3	0.1	—	—	—	—	0.5	34.6
Pacific ocean perch	—	—	—	—	—	—	—	—	0.0	—	0.0	—	0.0	—	—	—	—	—	—	0.0
Redbanded rf.	0.7	0.0	—	—	—	—	0.0	—	—	—	0.4	—	0.1	—	—	—	—	—	0.0	1.2
Rockfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Rougheye/blackspotted rf.	0.0	—	—	—	—	—	—	—	—	—	0.0	—	0.0	0.0	—	—	—	—	—	0.1
Sharpchin rf.	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.1
Shortraker rf.	0.1	0.0	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	0.1
Slope rf., unid.	0.2	—	—	—	—	—	—	—	—	—	1.3	—	0.0	—	—	—	—	—	0.0	1.5

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021.

	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
Mixed thornyheads																				
SST/LST	0.5	0.0	—	—	1.2	0.0	—	—	—	—	0.0	—	—	—	—	—	—	—	—	1.7
Other flatfish																				
Butter sole	0.0	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	0.0	—	0.0	0.0
Curlfin sole	0.9	—	—	—	—	—	2.4	—	—	—	—	—	—	—	—	—	—	—	0.1	3.4
Flatfish, unid.	6.8	—	0.0	0.1	0.0	0.0	0.1	—	2.5	—	0.0	—	0.0	0.0	0.0	1.8	—	—	0.0	11.3
Flathead sole	13.6	—	—	0.0	0.8	0.0	—	—	0.2	—	—	—	—	—	—	—	—	—	0.2	14.9
Pacific sanddab	86.2	—	0.0	0.0	—	0.0	1.2	—	5.7	0.2	1.8	0.0	1.2	0.1	—	—	0.1	12.1	7.0	115.6
Rex sole	329.2	0.0	0.1	0.5	10.2	0.7	0.0	—	35.1	—	0.0	—	—	—	3.7	—	—	—	13.4	393.0
Rock sole	0.6	—	—	0.0	—	—	0.4	—	—	0.0	0.0	—	0.0	0.3	—	—	0.0	1.6	0.1	3.1
Sand sole	0.1	—	—	—	—	—	7.8	—	—	—	0.1	—	0.0	0.3	—	—	0.1	0.2	0.0	8.6
Sanddab, unid.	6.0	—	0.0	0.0	—	—	0.0	—	0.0	0.2	0.6	—	0.0	0.1	—	—	—	—	0.0	7.0
Other groundfish																				
Kelp greenling (CA)	—	—	—	—	—	—	—	—	—	—	0.0	—	2.4	0.0	—	—	—	4.6	0.0	7.0
Leopard shark	—	—	—	—	—	—	0.5	—	—	—	0.1	—	0.2	4.1	—	—	—	41.6	—	46.5
Other rockfish																				
Rockfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.2	—	—	0.0	0.2
Pacific cod	1.3	—	0.0	0.1	—	—	—	—	—	—	0.9	0.0	—	0.0	23.0	1.5	0.0	—	0.0	27.0
Pacific hake	222.2	0.1	58.7	1,261.1*	1,033.6*	359.1*	—	—	54.8	0.0	0.7	0.8	—	0.0	3,638.1	—	0.1	—	828.4	2,701.8*
Pacific ocean perch (N of 40°10′N)	354.3	0.0	27.1	59.9	49.8	3.0	—	—	2.9	—	0.1	0.1	—	0.0	0.6	—	0.0	—	1.8	499.7
Petrale sole	2,816.3	0.1	0.2	0.0	—	—	1.4	—	0.1	0.0	2.0	0.5	0.0	0.4	71.2	—	2.5	3.6	20.1	2,918.5
Roundfish, unid.	—	—	—	—	0.9	0.0	—	—	—	—	—	—	—	—	—	—	—	—	0.6	1.6
Sablefish (N of 36°N)	1,496.7	658.5	0.1	191.8	48.1	7.3	—	—	0.2	—	1,815.5	122.1	8.3	3.9	491.9	—	1.9	—	57.5	4,903.6
Sablefish (S of 36°N)	0.7	80.0	—	—	—	—	0.0	—	—	—	172.9	—	4.2	18.3	—	—	—	—	1.3	277.4
SST (N of 34°27′N)	326.4	0.2	0.0	3.6	69.2	6.4	—	—	0.1	—	33.4	1.6	1.2	0.0	5.2	—	—	—	15.8	463.0
SST (S of 34°27′N)	—	—	—	—	—	—	—	—	—	—	40.5	—	0.0	1.1	—	—	—	—	0.3	42.0
Spiny dogfish	81.2	0.4	5.8	30.3	133.4	27.0	2.3	—	0.6	—	42.7	0.7	0.1	0.1	8.1	—	0.0	1.8	1.9	336.6
Splitnose rf. (S of 40°10′N)	19.5	—	—	—	—	—	—	—	0.0	—	0.0	—	0.0	—	—	—	—	—	5.6	25.1
Starry flounder	0.1	—	—	—	—	—	6.8	—	—	—	0.0	0.0	0.0	0.2	—	—	0.0	0.2	0.0	7.4
Widow rf.	104.0	—	101.4*	505.4	96.1	19.4	—	—	—	—	4.4	—	0.6	0.1	2.9	—	3.6	3.6	0.3	108.8*
Yelloweye rf.	0.4	—	0.0	0.1	—	—	—	—	0.0	—	2.6	1.1	3.2	0.0	1.0	2.6	3.3	4.0	0.2	18.3
Yellowtail rf. (N of 40°10′N)	412.0	—	1,346.6	942.0	3.5	78.9	—	—	0.0	—	5.2	0.1	1.2	1.7	47.1	61.5	28.0	1.1	1.8	2,930.8
Nongroundfish																				
California halibut	1.7	—	—	—	—	—	200.9	—	—	0.6	1.3	—	0.9	191.9	—	—	0.1	212.1	0.1	609.4
Dungeness crab	45.4	3.3	0.0	0.1	—	—	87.3	—	0.1	—	2.2	0.1	8.7	223.9*	1,889.2	—	—	—	7.1	244.4*

*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, 2021.

	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
Non-FMP flatfish																				
Deepsea sole	0.5	—	—	—	—	—	—	—	0.0	—	0.0	—	—	—	—	—	—	—	0.8	1.4
Diamond turbot	0.0	—	—	—	—	—	0.1	—	—	—	—	—	—	0.0	—	—	—	—	—	0.1
Hornyhead turbot	0.0	—	—	—	—	—	2.3	—	—	0.0	—	—	—	0.0	—	—	—	—	0.0	2.4
Longfin sanddab	—	—	—	—	—	—	0.0	—	—	—	0.1	—	0.0	—	—	—	—	0.0	0.1	0.2
Slender sole	38.1	—	0.0	—	0.0	0.1	—	—	148.8	—	—	—	—	—	—	—	—	—	2.0	188.9
Speckled sanddab	—	—	—	—	—	—	0.0	—	—	—	—	—	0.0	0.0	—	—	—	—	0.0	0.0
Other nongroundfish																				
Brown Irish lord sculpin	0.0	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	0.0
Buffalo sculpin	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	0.1	—	0.0	0.1
California sheephead	—	—	—	—	—	—	—	—	—	—	1.3	—	85.0	0.2	—	—	—	77.7	0.0	164.2
Greenling, unid.	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Red Irish lord sculpin	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	0.0	0.0
Sculpin, unid.	1.7	—	—	0.0	—	—	0.0	—	0.3	0.0	0.0	—	0.4	0.0	—	—	—	—	0.0	2.4
Skate, unid.	2.7	—	0.0	0.0	0.0	—	0.0	—	—	0.1	1.8	1.5	0.4	1.0	8.6	—	—	—	0.0	16.2
Squid, unid.	0.1	—	0.2	26.5	151.2	17.6	0.0	—	0.2	—	0.0	—	—	0.1	0.0	—	—	—	—	195.8
Starry skate	0.0	—	—	—	—	—	0.0	—	—	—	—	—	0.5	—	—	—	—	—	—	0.5
Shared ECS																				
Barracudina, unid.	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Blacksmelt, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Bristlemouth, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Deepsea smelt, unid.	0.0	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.1
Duckbill barracudina	—	—	—	—	0.4	0.0	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.4
Giant squid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Jacksmelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	72.6	0.0	72.7
Lanternfish, unid.	0.0	—	—	—	0.2	0.0	—	—	0.2	—	0.0	—	—	—	—	—	—	—	0.0	0.4
Lightfish, unid.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Longfin smelt	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Night smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Non-eulachon smelt, unid.	0.1	—	—	—	—	—	—	—	13.8	—	—	—	—	—	—	—	—	—	—	13.9
Non-Humboldt squid, unid.	3.8	—	0.1	—	—	—	0.0	—	3.4	—	0.0	—	—	—	—	—	—	—	0.2	7.6
Pacific sandlance	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Pacific saury	0.0	0.0	—	—	0.0	0.0	—	—	0.0	—	0.0	—	—	—	—	—	—	—	—	0.0
Rainbow smelt	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Round herring	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	—	—	—	—	0.0	0.0
Slender barracudina	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Smelt, unid.	0.0	—	0.0	0.0	0.0	—	—	—	0.2	—	0.0	—	—	119.3	—	—	—	—	0.0	119.5

Table 2 (continued). Estimated fishing mortality (mt) of groundfish and a subset of nongroundfish species, by sector, 2021.

	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
Smelt/herring, unid.	—	—	—	—	0.0	2.2	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2
Surf smelt	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
Top smelt	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	0.0
White barracudina	—	—	—	—	0.0	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0
Whitebait smelt	—	—	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—	—	—	0.0	0.0

Results

Targeted landings are defined using the same species or set of species defined in Methods as the retained weight used to calculate both discard rates and expansion factors. Targeted landings in 2021 by the DTL fixed gear sector, at-sea CP and MS hake fleets, and the sea cucumber and ridgeback prawn trawl sectors were less than the lowest annual landings of the previous five years (2016–20; Figure 2). However, 2021 targeted landings in the midwater rockfish, pink shrimp, and OA California halibut trawl sectors were greater than the last five years (Figure 2). Targeted landings by all other sectors were within the five-year range, but catch share fixed gear and bottom trawl landings were close to the minimum.

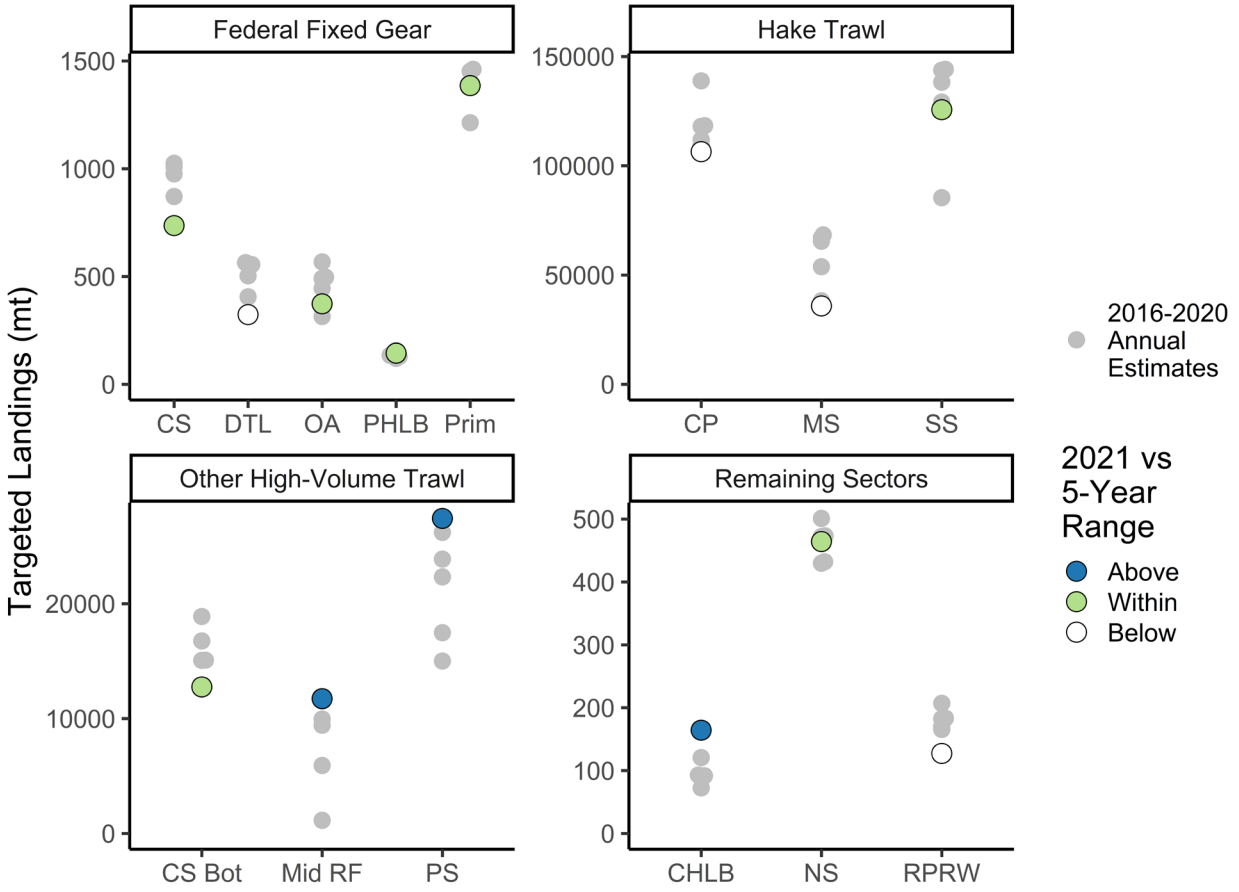

Figure 2. Sector-level targeted landings in 2021 compared to 2016–20. Gray points display annual estimates from 2016 to 2020; 2021 points are colored as indicated in the legend. Species and groupings included in targeted landings are defined in Methods. Abbreviations: *CS* = catch share, *DTL* = daily trip limit, *OA* = open access, *PHLB* = Pacific halibut, *Prim* = sablefish primary, *CP* = catcher–processor, *MS* = mothership catcher vessel, *SS* = shoreside, *CS Bot* = catch share bottom trawl, *Mid RF* = midwater rockfish, *PS* = pink shrimp, *NS* = nearshore, *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 contextualize the most recent year's estimate by comparing it to those of the previous five years.

Pacific hake, Dover sole, and sablefish north of lat 36°N are consistently targeted by groundfish fisheries. In 2021, ACL attainment of Dover sole was 8% and, for the second consecutive year, below the five-year range (Table 1, Figure 3). Landings by the catch share bottom trawl fleet are the primary contributor to Dover sole mortality (Table 2, Figure 4). Pacific hake is managed using a TAC and, at 73% attainment, was within the five-year range; this mortality was almost evenly split between landings by the at-sea and shoreside processing hake fleets (Table 1 and Table 2, Figure 3 and Figure 4). 71% of the sablefish north of lat 36°N ACL was attained, which is within the five-year range (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 fleets (Table 2, Figure 4).

A number of other groupings and species had high ACL attainments in 2021. Black/blue/deacon rockfish (in Oregon) was attained at 77%, which was the highest attainment of any stock. Approximately 75% of this mortality was landed by the Oregon recreational fishery and about 25% by the non-catch share fixed gear fleet (Table 2, Figure 4). 74% of widow rockfish ACL was attained in 2021, and nearly all the mortality was attributed to landings by the midwater rockfish fleet (Table 2, Figure 4). Petrale sole ACL attainment was 71% in 2021, which was the lowest value of the last five years for the second consecutive year; nearly all of this mortality was attributed to catch share bottom trawl landings (Table 1 and Table 2, Figure 3 and Figure 4). The 2021 ACL attainment of minor nearshore rockfish north of lat 40°10′N

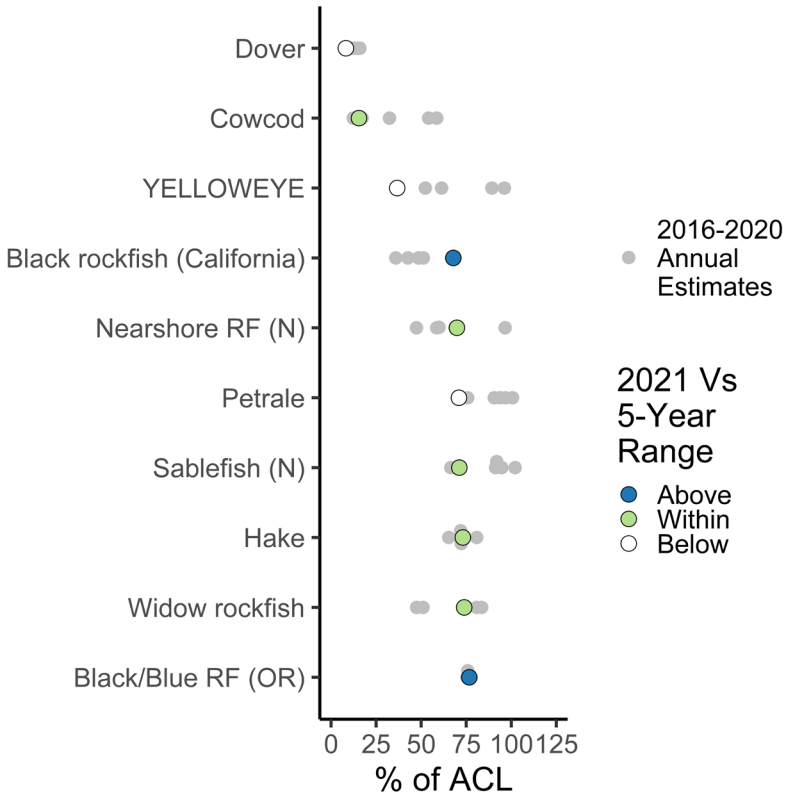

Figure 3. Proportion of ACL attained in 2021 compared to 2016–20 for select species that are highly targeted, highly attained, or rebuilding. Gray points display annual estimates from 2016–20; 2021 points are colored as indicated in the legend. Hake attainment is shown as proportion of TAC. Sablefish 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 three reference points are available. Rebuilding species are capitalized.

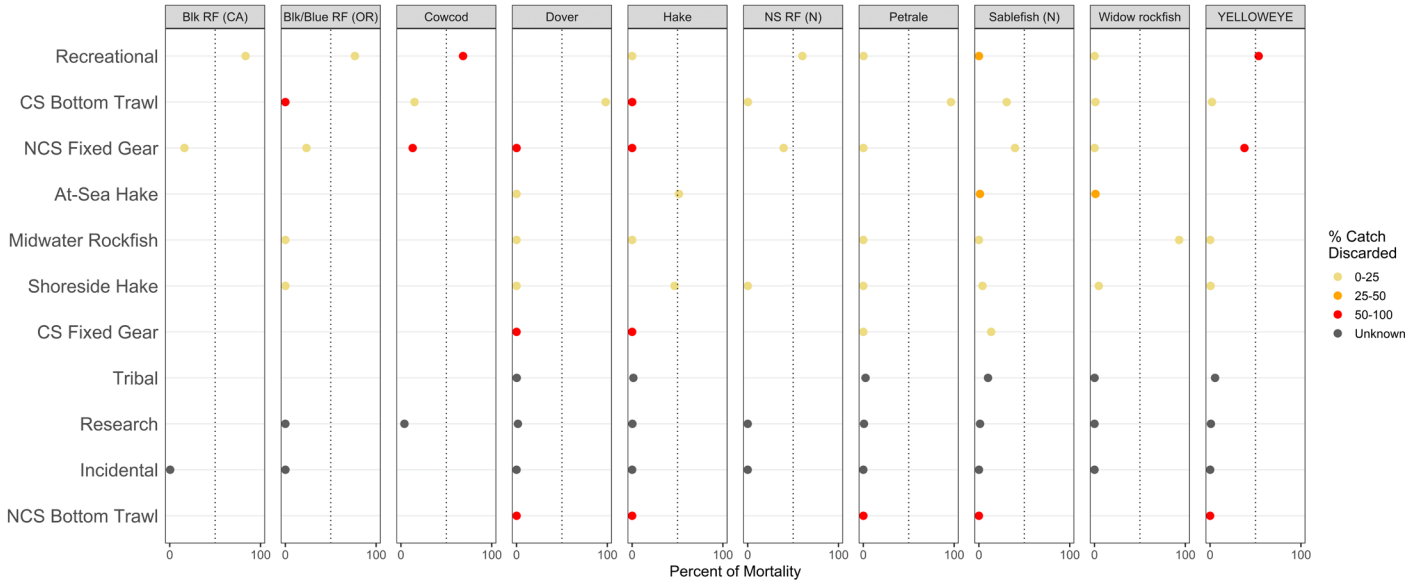

Figure 4. Sector-level contributions to 2021 mortality. Sablefish is managed north and south of lat 36°N; the minor nearshore rockfish complex (NS RF) is managed north and south of lat 40°10′N. Rebuilding species are capitalized.

was 70%, which is within the five-year range (Table 1, Figure 3). This mortality was primarily associated with the recreational fleet, followed closely by the non-catch share fixed gear fleet (Table 2, Figure 4). 68% of the ACL for black rockfish in California was attained, which was above the five-year range and associated primarily with landings by the California recreational fleet and a small amount with the NCS (Table 1 and Table 2, Figure 3 and Figure 4).

Cowcod rockfish was declared rebuilt in September 2019, and ACL attainment in 2021 was 15%, which is within, but near the minimum of, the five-year range (Table 1, Figure 3).[8] More than half of that mortality came from recreational discards, with the remaining mortality associated with catch share bottom trawl landings and non-catch share fixed gear discards (Table 2, Figure 4). The ACL attainment of yelloweye rockfish, a rebuilding groundfish species on the U.S. West Coast, was 37% and equivalent to that of 2020, which was the lowest attainment in the last five years (Table 1, Figure 3). Recreational fisheries contributed slightly more than half, and the non-catch share fixed gear fleet slightly less than half, of this mortality (Table 2, Figure 4).

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

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Appendix A:
Discard Mortality Analysis Details/Protocol

See supporting spreadsheet.

Table A-1. GMT-provided and SSC-approved mortality rates applied in bottom trawl and fixed gear fisheries.

Table A-2. GMT-provided and SSC-approved depth-dependent mortality rates applied in the nearshore fixed gear fishery.

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

Table A-4. In-season adjustments to 2021 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.[9]

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 2021.

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 2021 IFQ species, and the *NIFQ* category includes all non-IFQ fish species.

[9] 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 (summarized 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 2002–21 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-ticket data.
4. Incorporating state permit data.

FOS Sector definitions for PacFIN fish ticket data

This procedure identifies sectors, as shown in Figure 1.

"Tribal" landings are defined as tickets with PARGRP = *I.*

"Research" landings are defined as REMOVAL_TYPE = *R* and IFQ_LANDING = *FALSE.* These data are omitted, as commercial research data are provided by WCR for GM reports. Further, IFQ trips in early years of the program were often incorrectly identified as research, so we ignore overlap between those two fields.

"EFP" landings are defined as non-IFQ EFP landings from Non-Research, Vessel ID known as REMOVAL_TYPE = *E* and IFQ_LANDING = *FALSE*. 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 and beyond, the gear modification EFP trip was included in the IFQ catch share program as EM or observed, as appropriate.

IFQ landings are defined as tickets where IFQ_LANDING = *TRUE*. They are further subdivided as:

All IFQ landings where ADJ_GRID ≠ *MDT* are defined as "Catch Shares."

For IFQ landings 2011–14 where ADJ_GRID = *MDT*:
- "Shoreside Hake" where the captain's logbook identified Pacific hake as the intended target.
- "Catch Shares" where the captain's logbook identified a species other than Pacific hake as the intended target.

For IFQ landings 2015–present where ADJ_GRID = *MDT*:
- "Midwater Hake" when landing ≥50% hake on unique vessel landing date (VIDYMD).
- "Midwater Rockfish" when landing ≥50% midwater rockfish on VIDYMD.
- Any remaining tickets are defined based on the captain's logbook.

For IFQ landings where IS_EM_LANDING = *TRUE*, the same definitions as above are used, but EM is added to the sector definition.

Shrimp trawl landings (GRGROUP = *TWS*) are categorized as:
- "Pink Shrimp" landings where landed more pink shrimp (PS) than other species, had state permit, and occurred between April and November.
- "Ridgeback Prawn Trawl" landings where landed more ridgeback prawn than sea cucumber and had state permit.
- "Sea Cucumber Trawl" landings where landed more sea cucumber than ridgeback prawn and had state permit.

Non-IFQ landings where GRGROUP = *TWL* are categorized as follows:

"Limited Entry" landings if PERM1 ≠ [blank], further defined as:

"Non-Tribal Shoreside Hake" landings where ADJ_GRID = *MDT* for 2002–10.

"LE CA Halibut" if ADJ_GRID ≠ *MDT* and landed >150 lb of CA Halibut and, if after 2007, had state permit.

All remaining tickets defined as "LE Trawl."

"Open Access" landings if PERM1 = [blank], further defined as:

"OA CA Halibut" if ADJ_GRID ≠ *MDT* and landed >150 lb of CA Halibut and, if after 2007, had state permit.

"Ridgeback Prawn" if landed more ridgeback prawn than sea cucumber and had state permit.

"Sea Cucumber Trawl" if landed more sea cucumber than ridgeback prawn and had state permit.

"Nearshore" landings where GRGROUP = *HKL* or *POT* and landed nearshore species (see Table A-5) on VIDYMD in OR or CA. Additionally, from 2004–present, the ticket must be associated with a state permit.

"Non-Nearshore Fixed Gear" landings where GRGROUP = *HKL* or *POT*, did not land nearshore species, and landed sablefish or more groundfish than non-groundfish on VIDYMD. These are further categorized as:

"LE Sablefish Primary" landings where has federal permit, is tier endorsed, fished during primary season, and did not reach tier limit.

"LE Non-Primary"/"LE 0 Tier" landings where has federal permit, is not tier endorsed, and GRGROUP = *HKL* and landings where has federal permit, is tier endorsed, and has reached tier limit.

"OA Fixed Gear" landings where has no federal permit and landings where has federal permit, is not tier endorsed, and GRGROUP = *POT*.

"Directed PHLB" landings where identified by the IPHC and, for recent years of data where IPHC has not finalized identification and landings in CA, tickets recorded PHLB catch landed on one of the specific calendar-year 10-hour openings, plus two days post (to allow for any subsequent deliveries).

"Incidental" landings include tickets where:

DRVID = *MISSING*, *UNKNOWN*, or blank.

GRGROUP ≠ *HKL*, *POT*, *TWL*, or *TWS*.

GRGROUP = *TWL* but not included in federal or state trawl fisheries.

GRGROUP = *TWS* but not included in pink shrimp, sea cucumber, or ridgeback prawn fisheries.

GRGROUP = *HKL* or *POT* but not included in nearshore or non-nearshore fixed gear fisheries.

All additional data processing steps that were applied during the discard estimation process are described in Methods.

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 non-midwater logbook data are further delineated into the state CA halibut trawl fishery for each individual tow/haul as follows:*
a) If tow target is CA 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*
Chameleon rockfish	*Sebastes phillipsi*
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*
Giant squid	*Architeuthis dux*
Gopher rockfish	*Sebastes carnatus*

Common name	Species
Grass rockfish	*Sebastes rastrelliger*
Green sturgeon	*Acipenser medirostris*
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*
Longfin smelt	*Spirinchus thaleichthys*
Longnose skate	*Raja rhina*
Longspine thornyhead (LST)	*Sebastolobus altivelis*
Mexican rockfish	*Sebastes macdonaldi*
Nearshore rockfish, unid.	Scorpaenidae
Night smelt	Spirinchus starksi
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*
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*

Common name	Species
Sculpin, unid.	Cottidae
Sea cucumber	Holothuroidea
Shark and skate, unid.	—
Sharpchin rockfish	*Sebastes zacentrus*
Shelf rockfish, unid.	Scorpaenidae
Shortbelly rockfish	*Sebastes jordani*
Shortraker rockfish	*Sebastes borealis*
Shortraker/rougheye rockfish	*Sebastes borealis* and *S. aleutianus*
Shortraker/rougheye/blackspotted rockfish	*Sebastes borealis*, *S. aleutianus, and S. melanostictus*
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
Smelt/herring, unid.	*Osmeridae and Clupeidae*
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*
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*
Top smelt	*Atherinops affinis*
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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