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Fishing Effort in the 2002-2023 U.S. Pacific Coast Groundfish Fisheries. 2025.

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EXECUTIVE SUMMARY

This report analyzes trends in fishing activity of U.S. West Coast groundfish fisheries during the period 2002–23, including the amount, timing, location, and depth of fishing effort and retained catch. The National Marine Fisheries Science (NMFS) Biological Opinion (BiOp) on Continuing Operation of the Pacific Coast Groundfish Fishery (NMFS 2012) requires that reports are issued every two years and align with harvest specification periods as feasible. We focus on changes that have occurred since the 2011 implementation of an individual fishing quota (IFQ) program, and specifically on trends from 2016 to 2020 compared to 2021 to 2022 and 2023. This analysis contextualizes the bycatch estimates required by this BiOp, and this executive summary highlights significant changes in the most recent three years of data.

Landings (mt) and effort (tow hours) in the catch shares (CS) bottom trawl fleet were variable but remained lower from 2020 to 2023 than in previous years. The spatial distribution of landings and effort continued to concentrate off of Astoria and Newport, OR. However, new processing opportunities in Eureka, Fort Bragg, and Moss Landing, CA resulted in increasing proportions of landings in and effort off of California. The seasonal distribution of landings was similar to previous years. The proportion of effort in shallower waters, especially 100-150-fth, increased between 2021 and 2023, likely reflecting the changes in areas open to bottom trawl effort implemented under Amendment 28 (84 FR 63966; PFMC 2024).

Landings in the midwater rockfish trawl fleet reached an historic high in 2022 and, for the first time, exceeded those of the bottom trawl fleet in 2023. The spatial distribution of landings from 2021 to 2023 were similar to previous years, although the proportion of landings near the Oregon-Washington Border decreased and the proportion near Newport, OR increased over that time. The proportion of landings near Eureka, CA also slowly increased from 2021 to 2023. The seasonal and depth distribution of landings from 2021 to 2023 were within the range of previous time periods.

Landings in the shoreside hake, at-sea hake motherships (MSs), and at-sea hake catcher processors (CPs) decreased from 2018 to 2023, except for an increase in landings in 2022 for the shoreside and MS fleets. All three fleets increased the number of tow hours from 2021 to 2022, but the shoreside and MS fleets decreased in 2023 while the CP fleet remained constant. The median tow durations in 2022 and 2023 in all three sectors were high compared to previous time periods. The proportion of landings by the shoreside hake fleet decreased near Newport, OR and increased near Astoria, WA compared to previous time periods. Fishing effort by both at-sea hake processing fleets were similar from 2016 to 2023, with both the CP and MS fleets concentrating effort off of central and southern Oregon. The seasonal and depth distributions of landings by all three hake fleets were similar to previous years, although the CP fleet processed a greater proportion of catch in the September-October period from 2021 to 2023 than in previous time periods. More than 80% of CP and MS landings came from hauls in depths of 100–250 fth from 2016 to 2023 and are increasingly concentrated in 100-200 fth waters.

Non-catch shares (NCS) pot landings remained around 600 mt from 2015 to 2020 and have increased to almost 1,000 mt in 2023, while the CS pot fleet has shown less consistent trends but reached an historic high in 2023 of almost 1,000 mt. Effort in number of pots decreased in both sectors from 2019 to 2021 but has since increased again in 2022 and 2023. The median number of pots per set in the CS fleet reached an all-time high of ~50 pots in 2020 and 2021, but have since returned to within the historic range. The spatial distribution of landings by the NCS pot fleet in 2021 to 2023 was within the historic range and continued to be concentrated near Newport, OR. CS pot effort primarily occurred off of Astoria, WA and Newport, OR with additional, smaller areas of concentration off of central California. The seasonal distribution of landings by both the NCS and CS pot fleets remained within the historic range. The depth distribution of landings by the NCS fleet was similar to that of previous time periods, but effort by the CS fleet increasingly concentrated in shallower depths of 150-350-fth in 2021 to 2023.

Groundfish landings by the NCS hook-and-line fleet decreased from 2017 to 2021 but have since rebounded in 2023, while the estimated annual fleetwide hooks has not significantly increased from the historic low of 2021. The median number of hooks per set in the NCS fleet has continued to increase from ~2,000 hooks per set in 2010 to ~2,500 hooks per set through 2023. Generally, landings by the NCS hook-and-line fleet were fairly evenly distributed along the coast, with increases in the proportion of landings near Newport, OR and Moss Landing, CA in recent years and concentrated effort off of those areas as well as off of northern Washington. Seasonal and depth distributions of landings by the NCS fleet were similar in 2021 to 2023 compared to previous time periods. No effort has occurred in the CS hook-and-line fleet since 2020.

Lost and recovered gear patterns in 2021 to 2023 were similar to those of previous years.

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Introduction

The Pacific Fishery Management Council (PFMC) designs and adapts the groundfish fishery management plan (FMP; PFMC 2024), with the goals of achieving maximum sustainable yield (MSY) and promoting year-round fishing opportunities to support domestic consumer markets and the economies of coastal communities. In 2011, PFMC implemented a major management shift by introducing a catch shares program to the federal trawl fleets. This report assesses changes in fishing effort in the U.S. Pacific Coast groundfish fisheries, with an emphasis on differences before and after catch shares implementation, and is mandated by the NMFS Biological Opinion (BiOp) on Continuing Operation of the Pacific Coast Groundfish Fishery (NMFS 2012). We provide data for the available time series (2002–23), but focus the main analyses on changes in fishing effort that have occurred since the previous report. We are cautious in definitively attributing differences to IFQ implementation, because many factors outside the scope of this report—including variations in weather, market price, stock size, quota leasing, and catch limits—have impacted fishing effort over these two decades. Management shifts and changes that occurred prior to IFQ implementation are described briefly to provide important background and context in understanding and analyzing fleet dynamics.

Shore-Based Trawl Fleet

1990s to 2000: Limiting participants

In the shoreside bottom trawl fleet, the number of commercial vessels participating was first limited in 1994, with the implementation of a federal licensing program. At that point, the fishery was considered overcapitalized and, rather than shortening trawl fishing seasons, the effort expended by individual vessels was constrained through a system of periodic (usually 1- or 2-month) cumulative landing limits. Beginning in the late 1990s, it became apparent that several species were depleted and in need of rebuilding. The severity and scope of management actions required to promote rebuilding led the Department of Commerce to declare the fishery a disaster in 2000. Catch allocations for rebuilding species were reduced by more than 90% from levels of the 1990s, resulting in new management approaches to ensure fishing opportunities for healthy stocks throughout the year.

At the dawn of this fishery transformation in 2000, the economic subcommittee of PFMC's Scientific and Statistical Committee released a report on overcapitalization of stocks by the groundfish fleet, which concluded that shore-based trawl capacity was two-to-four times the amount needed to harvest the available resource. With the help of NMFS, the trawl industry developed a proposal to reduce fleet capacity, which was subsequently enacted by the United States Congress. This plan resulted in a buyback program, initiated in late 2003, which permanently removed 91 vessels and 239 groundfish, crab, and shrimp permits from the fishery. The buyback was funded through both a grant from the federal government and a government-guaranteed loan repaid by the fleet through landings fees.

2000 to 2010: Developing data collection and management tools

Comprehensive catch and bycatch data were required to model and inform management alternatives. To collect the needed data, the West Coast Groundfish Observer Program (WCGOP) was established and, in 2002, began to place trained scientists aboard fishing vessels operating in fisheries that target and incidentally catch groundfish off the U.S. West Coast. WCGOP observed 20–30% of bottom trawl landings using a random stratified sampling design from 2002 through 2010, providing critical information that supported reliable fishery modeling and estimation of fishing mortality, especially for rebuilding species.

Using this new dataset and refined modeling tools, scientists and managers found that coastwide bycatch rates for rebuilding species were too high to support year-round fishing of target species. One response to this situation was the designation of closed areas. Preventing fishing from occurring in areas where bycatch of rebuilding species was highest lowered average fleet bycatch rates. Some closures, such as the Cowcod and Yelloweye Rockfish Conservation Areas, had fixed boundaries, while the rockfish conservation area (RCA) combined fixed, minimum boundaries (for example, lines approximating the 100- and 150-fathom [fth] contours) with the ability to extend the closed area shoreward or seaward. Cumulative limits for target species were frequently set differently for areas shoreward and seaward of the RCA, with limitations on fishing in both areas during the same cumulative period. To ensure that fishing did not occur in closed areas, all trawl vessels were required to install an approved vessel monitoring system (VMS). This requirement was later extended to cover other sectors of the groundfish fleet. On 12 June 2006, Amendment 19 to the FMP closed additional areas to bottom trawl fishing, and other areas to all bottom contact gears, to protect groundfish essential fish habitat (EFH).

In addition to area closures, gear restrictions were also implemented. Throughout the 1980s and 1990s, bottom-trawl fishing on the continental shelf was characterized by two very different strategies (Rogers and Pikitch 1992):

1. Flatfish were targeted over flat gravel or mud substrate, using nets with footropes whose bobbins were typically less than 12.7 cm in diameter, to minimize fish escaping under the footrope (Rogers and Pikitch 1992, PFMC 2000).
2. Rockfish, or a mix of rockfish and flatfish, were targeted using much larger footropes, including some that employed commercial truck tires, to allow fishing in very rocky substrate.

Concurrent with the implementation of the RCA, all bottom trawl fishing shoreward of the RCA was required to use footropes no larger than 20.32 cm in diameter and to restrict chafing gear, which protects the underside of the net but can damage habitat. Combined with low landing limits for all shelf rockfish, these restrictions removed economic incentive for vessels to trawl in rocky shelf habitats which could cause expensive damage to trawl gear. Subsequently, based on fishery testing of innovative gear designs, a new, more selective flatfish trawl net was required in waters shoreward of the RCA and north of lat 40°10′N. This design featured a headrope that was longer than the footrope, which increased selectivity by exploiting the behavior of many rockfish to swim upwards and escape the net in response to encountering the footrope. Continued development of novel gear that reduces bycatch and habitat impacts creates the potential for lessening gear and area restrictions in the future.

2011 to Present: Catch Shares

In 2011, the prior management regime of landing limits for trawl vessels was replaced by a catch share program, which allocates fishing privileges as individual fishing quotas (IFQ) for catch by species or species complex to individual fishers. The goal of the catch share program, as defined in Amendment 20 of the FMP (PFMC 2024), is to:

Create and implement a capacity rationalization plan that increases net economic benefits, creates individual economic stability, provides for full utilization of the trawl sector allocation, considers environmental impacts, and achieves individual accountability of catch and bycatch.

The program's objectives include promoting a viable, profitable, and efficient groundfish fishery that provides participants with increased operational flexibility and safety, while promoting practices that reduce bycatch and discard mortality and minimize ecological impacts. To accomplish these goals, shares of overall trawl sector allocations of numerous species are distributed to trawl permit owners based on catch history. Each year, share percentages are converted to poundage amounts that limit catch of those species. Transfers of quota pounds and quota shares themselves are allowed, but are subject to accumulation restrictions to discourage consolidation. To provide full accounting of catch, including at-sea discards, against these quotas, each vessel is required to be monitored on all trips, either via a federal observer or, starting in 2015, via electronic monitoring (EM). In 2020, Amendment 28 of the FMP (84 FR 63966; PFMC 2024) altered some area restrictions for certain gear types by eliminating the trawl RCA off of Oregon and California, re-configuring the EFH closed areas, and prohibiting all bottom-contact fishing in waters deeper than 3500 m.

IFQ management altered three major aspects of the shoreside trawl fishery. First, accountability for discards shifted from the fleet as a whole to individual operations, resulting in a rapid and substantial reduction in discards of most species (Somers et al. 2018). Second, with the new explicit accounting of all discards, landings limits no longer needed to be set artificially low in an attempt to implicitly account for this mortality. These new opportunities allowed individual operations to better target healthy stocks. The IFQ program creates incentives for individuals to avoid catching species that are overfished or rebuilding, and ensures that the fleet remains under species or species complex catch limits. Third, the regulations that implemented the IFQ program allowed for gear switching, which occurs when permit holders with quota pounds and a trawl endorsement can use multiple gear types (although not within the same trip), including trawl (bottom and midwater) and fixed gear (pot and hook-and-line). These management changes impacted fishing effort in bottom trawl and shoreside midwater sectors, and altered fixed gear fishing effort by providing a new opportunity for fixed gear fishing activity and potential competition between IFQ and other fixed gear sectors. Throughout this report, we aggregate the limited entry (LE) sablefish primary, open access (OA), and daily trip limit sectors into a single non-catch share (NCS) fixed gear fleet. Fishing areas, tactics, and methods in the NCS fleets are similar to the areas and methods used in the catch share fixed gear fishery, and thus could be impacted by catch share implementation. We include them here as a comparison to the IFQ fixed gear fleet, and for a broader understanding of catch share impacts to the entire groundfish fleet.

At-Sea Hake Midwater Trawl Fishery

The at-sea hake midwater trawl fleet processes catch onboard while at sea, and was observed by the North Pacific Groundfish Observer Program from 1975 until 2001, when the At-Sea Hake Observer Program (A-SHOP) began to manage observer coverage. Under both organizations, observer coverage on board mothership catcher vessels (MS) and catcher–processors (CP) was at or near 100% of fishing days prior to IFQ implementation. Coverage to detect discards by catcher vessels before the point of delivery to an MS began with catch share management. Before catch share implementation, the CP fleet had formed a fishing cooperative in response to other PFMC management goals. In response to the implementation of catch share management, the MS fleet formed a separate fishing cooperative. The shift to catch shares had ramifications on quota management and bycatch accountability, but only minor changes in overall fishery management, and therefore very little effect on fishing. The cooperative system somewhat relieved the race to fish, but the primary driver for change in amount of fishing effort for the at-sea hake fishery has been highly variable total allowable catch of hake over the last two decades.

Fishing Effort Trends

With this background in mind, we present trends in fishing effort in selected U.S. Pacific coast groundfish fishery sectors from 2002 to 2023, with particular emphasis on changes in the most recent three years of data. The primary objective of this report is to evaluate changes in fishing effort over time by gear type since implementation of the IFQ management program in the U.S. West Coast groundfish fishery. This report updates the previous release (2002–21) and analyzes two additional years of data, 2022 and 2023. We analyze fishing effort in the following sectors of U.S. West Coast groundfish fisheries:

1. Bottom and midwater trawl targeting groundfish, excluding hake:
   - LE Bottom Trawl: Limited entry bottom trawl (2002–10).
   - CS Bottom Trawl: IFQ non-hake bottom trawl (2011–23).
   - CS Midwater Rockfish Trawl: IFQ shoreside midwater trawl targeting rockfish (2011–23).
2. Midwater trawl targeting hake:
   - CS SS Midwater Hake Trawl: IFQ shoreside processed midwater trawl targeting hake (2011–23).
   - CS AS CP: At-sea processed midwater trawl targeting hake, utilizing CPs (2002–23).
   - CS AS MS: At-sea processed midwater trawl targeting hake, utilizing MSs (2002–23).
3. Fixed gear:
   - NCS Pot: Pot gear fished in NCS, aggregating sablefish LE fixed gear primary (tier endorsed), OA fixed gear, and LE fixed gear daily trip or quota limits (2002–23).
   - CS Pot: IFQ pot (2011–23).
   - NCS Hook-and-Line: Hook-and-line gear fished in NCS, aggregating the same sectors as NCS Pot.
   - CS Hook-and-Line: IFQ hook-and-line (2011–19; no, or in some years a small amount of effort by less than 3 vessels, occurred in 2020 and later).

This report describes changes in the magnitude of fishing catch and effort coastwide, as well as subtler changes in timing, spatial location, and depth. We analyze total groundfish and hake landings, and total and median tow duration or number of hooks or pots coastwide, as appropriate for the gear. We also present maps showing fishing effort across different sectors, gears, and time periods to compare and contrast fisheries and management regimes. To further explore changes in fishing effort, we present the proportion of shoreside landings (or catch, in the case of the at-sea midwater fleets) in bimonthly periods and latitudinal and depth bins. Together, this information helps to identify changes in the intensity and distribution of effort and catch over the past two decades.

Data Sources

Data sources for this report include: 1) observers aboard commercial fishing vessels landing catch shoreside (recorded and maintained by WCGOP), 2) observers aboard commercial fishing vessels processing catch at sea (recorded and maintained by A-SHOP), 3) federal trawl logbooks from the Pacific Fisheries Information Network (PacFIN), 4) fish tickets from PacFIN, and 5) electronic monitoring (EM) data from the Pacific States Marine Fisheries Commission (PSMFC).

Observer Data

Fishing effort estimates were derived from independent scientific observation of catch conducted on commercial groundfish vessels at sea by WCGOP and A-SHOP, which are managed under the Northwest Fishery Science Center's (NWFSC) Fishery Resource Analysis and Monitoring Division's (FRAM) Fishery Observation Science (FOS) program. WCGOP observes several federally managed sectors of the groundfish fishery, including the LE bottom trawl, LE and OA fixed gear, and shoreside midwater trawl. A-SHOP observes both the CP and MS portions of the at-sea hake midwater trawl fishery, although the majority of MS catcher vessels now use electronic monitoring.

WCGOP's primary goal is to improve total catch estimates by collecting information on at-sea discards of groundfish on the U.S. West Coast. A-SHOP accounts for total catch and documents bycatch by sampling all hauls on at-sea processors. For more details about observer program goals, vessel selection, and data collection, see the FOS web page.[1] Observer coverage for each fishery sector can be found in Somers et al. (2024).[2] WCGOP, A-SHOP, and fish ticket data quality assurance, quality control, and processing methods are described in detail in Somers et al. (2024).

Logbook Data

Vessel logbook recordkeeping is mandated for the LE and CS groundfish bottom trawl sectors in Washington, Oregon, and California. Prior to 2019, state agencies in Washington,

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[1] https://www.fisheries.noaa.gov/west-coast/science-data/fisheries-observation-science-west-coast

[2] Somers, K. A., K. Richerson, V. Tuttle, and J. T. McVeigh. 2024. Fisheries Observation Science Program Coverage Rates, 2002-23. U.S. Department of Commerce, NOAA Data Report DR-2024-03.

Oregon, and California used a common format logbook, which was entered into state databases and then uploaded to the PacFIN regional database, which is maintained by PSMFC. In 2019, California ceased this process, and the federal government developed new protocols to collect these data directly from fishers rather than via state agencies (84 FR 32096). Starting in 2025, fishers in waters off of Washington, Oregon, and California are required to document their fishing activity in an electronic logbook mandated and controlled by the federal government.

Bottom trawl logbook data for 2002–23 were retrieved from the PacFIN database in October 2024. These data were assigned into groundfish fishery sectors following procedures described in Somers et al. (2024). Logbook and observer data sometimes have slight discrepancies, so summaries of fleetwide vessels, trips, and hauls may be inconsistent with other reports.

Landings Data

Fleetwide landing receipts are the cornerstone of landed catch information for shoreside sectors. These fish tickets are trip-aggregated sales receipts issued to vessels by fish buyers in each port for each delivery of fish. Fish tickets are designed and issued by agencies in each state and must be returned to the agencies for processing. Fish buyers are required to record catch by market category (single species or a mix of species). Each state conducts species-composition sampling by market category, and submits fish ticket and species-composition data to the PacFIN database. PacFIN applies the percentage of weight of each species within market categories obtained from species composition sampling to the fish ticket data. In doing so, landed weights from sampled market categories are distributed to individual species whenever possible. PacFIN data for fish ticket landings with state species-composition sampling applied were queried in May 2024. As with logbook data, estimates of total vessels and trips in a fleet may differ between fish tickets and observer data, so discrepancies may exist between this and other reports.

Data Usage

We selected the data source for each analysis that ensures both high data quality and consistency for comparisons across sectors and time periods. These sources are summarized in Table 1 and are further described below.

In shoreside sectors, we report total landings as recorded on fish tickets of targeted species for each sector: FMP-managed groundfish (excluding hake) for non-hake-targeting sectors, and hake landings only for hake-targeting sectors. The LE bottom trawl fishery did not, and the NCS fixed gear sectors do not, have 100% observer coverage, so fish tickets are the primary data source available as a proxy of fishing activity. We approximated spatial location of catch using the latitude of the port of landing, although effort occurs at varying distances from landing locations. We also used fish ticket data to describe the proportional landings in bimonthly periods and in latitudinal bins in the shoreside sectors.

To describe haul duration and proportion of hauls in depth bins for bottom trawl sectors, we use logbook data to account for all fishing effort. In fixed gear and shoreside midwater sectors, we use WCGOP data to explore trends in gear usage and depth on observed hauls or sets. Although not all trips of the non-catch share portion of the fixed gear sector are observed, this is the only data source available. For 2015–23, logbook data for the EM portions of the CS pot and midwater fleets were incorporated. In NCS fixed gear sectors, we extrapolated the fleetwide numbers of hooks and pots based on observer data; see Methods for details. The use of observer data in sectors with less than 100% observer coverage produced more uncertainty in reported trends of total gear usage, gear use per haul or set, and depth than in sectors with logbook or observer data for all trips.

All data used to assess fishing effort in the at-sea hake fishery come from A-SHOP. Haul-level information on location and retained catch are captured directly in the observer data.

METHODS

Many of the data summaries described below aggregate data to explore variation between different time periods (Table 1). These groupings are as consistent as possible across analyses of different metrics, while maintaining data confidentiality. The LE bottom trawl sector was grouped into pre- and post-Amendment 19 periods, to account for changes caused by EFH closures that began on 12 June 2006. Bottom trawl data from 2006 were not included in summaries of annual proportion of bimonthly catch, as the year would be split into two periods; data from 2006 were included in all other summaries. The shoreside IFQ fishery other than hook-and-line was grouped, by gear, into 2011–15, 2016-20, 2021-22, and 2023. The hook-and-line portion of the IFQ fleet had low and decreasing participation from 2011 to 2019, and no effort has occurred from 2020 to 2023. To analyze the effort that did occur in the hook-and-line fishery while maintaining confidentiality, effort is grouped into a single period of 2011-2019. To address changes around the implementation of IFQ management, we grouped the non-IFQ fixed gear sector into the pre-IFQ period (2002–10), two five-year periods (2011-15, 2016–20), and the most recent data (2021-22 and 2023). CS and NCS pot gear were grouped into 2021-23 when exploring seasonal patterns in order to maintain confidentiality. The at-sea hake fishery was not impacted by the EFH closures, so we grouped years to create approximately equivalent time periods prior to the most recent years of data: 2002–05, 2006–10, 2011–15, 2016-20, 2021-22, and 2023.

LANDINGS

Total targeted landings were estimated coastwide for each sector by year. We calculated total FMP groundfish landings (excluding hake) to provide a unit of effort for the multispecies-targeting bottom and midwater trawl and fixed gear sectors, and total hake landings to estimate effort by hake-targeting midwater trawl fisheries.

Gear Usage

We calculated total hours of fleetwide towing, tow duration per haul, total fixed-gear units, and fixed gear units per set. These metrics provide estimates of effort that, unlike total catch, are not impacted by fishing efficiency, stock density, and other factors. Expansions were performed in NCS fixed gear sectors to estimate the total number of hooks or pots. NCS fixed gear estimates were generated for each effort index by year, sector, and gear based on the following equation and then summed across all strata:

$$\hat{E} = \frac{\sum_h b}{\sum_h r} \times C$$

where:

$\hat{E}$ = estimated effort,
b = observed number of gear units,
r = observed retained weight (in mt) of groundfish species,
h = number of hauls or sets in observer data, and
C = weight (mt) of retained groundfish species recorded on all fish tickets.

We also calculated the number of hauls or sets where gear loss was observed and where gear was recovered, by sector, gear, and year. Recovered gear could consist of crab pots, other fixed gear, or trawl nets retrieved in the codend, but does not include hauls where trawl gear was lost and immediately recovered in the same haul. We report only observed occurrences of lost or recovered gear and do not expand observed events to create fleetwide estimates. We report lost or recovered gear summaries at finer sector-level scales than other analyses in this report to better describe these patterns. As part of our quality control procedures, we developed rules to identify cases of lost or recovered gear which ensured consistent reporting and comparisons among years. Recovered gear is reported for all years in all fisheries, except for 2002 in the fixed gear fisheries. In the catch share fixed gear fisheries, lost gear is reported for all years, while those data were only available since 2010 in the non-catch share fixed gear fisheries. This report summarizes the most recent data and should be considered the best source of data for this information.

Location of Effort

To assess trends in the location of fishing effort, we explored landings patterns in the shoreside fishery and catch in the at-sea fishery by one-degree latitudinal bins. Similar to the methods used for timing described above, we calculated the proportion made in each latitudinal degree and then calculated the median and first and third quartiles across years in each time period.

Geospatial Analysis

In addition to describing broad trends in the location of landings and catch and the depth of fishing effort, we also assessed spatial patterns by plotting individual fishing locations. We used a straight line connecting the start and end points of trawl hauls or fixed gear sets to represent each fishing event. We excluded hauls or sets that intersected land or occurred outside the U.S. exclusive economic zone (EEZ) for all sectors and, for bottom trawl, also removed hauls deeper than 2,000 m or towing greater than five knots (straight line distance divided by tow duration). From these line features, we created an effort density layer that depicts the relative intensity of fishing effort within relevant gear types and time periods. The following description of methods closely matches those used for development of fishing intensity layers created for PFMC's review of groundfish EFH (GEFHRC 2012).

Fishing intensity was calculated as the total length of all lines intersecting a standardized area. To calculate this metric, we used a line density algorithm in ArcGIS Pro 3.3.2 (Environmental Systems Research Institute, Inc., Redlands, California). The line density algorithm calculates density within a circular search area centered at a grid cell of specified size. Effort values were standardized for each time period by dividing per-cell density values by the total number of years in each period. The value (units: km/km^2/yr) for each grid cell is the quotient of total line portions intersecting the circular area per grid cell area per year. Because density outputs are highly sensitive to the specified radius and cell size, relative values are more informative than absolute values. Relative density identifies areas where fishing effort is concentrated, while still ensuring confidentiality of individual fishing locations. The initial density output was more spatially extensive than what is shown in the map figures, because it included confidential cells where density values were calculated from tows or sets made by less than three vessels. Confidential cells, representing less than three vessels, were removed from the maps presented in this report. Density parameters were chosen to minimize data exclusion but maintain confidentiality while still providing a high spatial resolution (500-m cell size). A search radius of 3,000 m was used to develop density outputs. Because the density outputs cannot fully capture the entire footprint of fishing, we also summarized the percentage of relative coastwide effort in 10 × 10-minute cells by dividing the cumulative length of lines intersecting each cell by the total length of all lines for each gear sector and time period.

Seasonal Timing of Effort

To assess trends in the timing of fishing effort, we calculated the proportion of annual targeted landings in the shoreside fishery and catch in the at-sea fishery by each fleet and gear occurring in bimonthly periods over each year. We then calculated the median and first and third quartiles of that proportion across years in each time period.

Depth of Effort

Patterns in fishing effort by depth were explored by calculating the proportion of hauls or sets in 50-fth depth bins. Similar to timing and location, we calculated the median and first and third quartiles across years in each time period.

Results

Trawl Sectors

Bottom Trawl

The bottom trawl sector retained ~13,800 mt of FMP groundfish species in 2022 and ~12,000 mt in 2023 (Table A-1, Figure 1). These 2022 landings were the highest by the bottom trawl fleet since 2019, while the 2023 were the lowest since at least 2002. Fleetwide bottom trawl effort continued to decrease from the high of the catch share period in 2013, with a particularly drastic drop of almost 2,000 tow hours between 2022 and 2023 and was reflected in lower landings (Table A-1, Figure 2). Median haul duration has generally decreased since 2011 to around 2.3 hours in 2022 and 2023 (Table A-1, Figure 3).

The spatial distribution of landings was similar from 2021 to 2023 (Table A-2, Figure 4). The greatest proportions of landings were made near Astoria, OR (lat 46°N), with the highest proportion occurring in 2023 (Table A-2, Figure 4). Landings near Newport, OR (lat 44°N) comprised approximately 20% of coastwide landings from 2021 to 2023. New and enhanced processing opportunities have developed in three areas in California in recent years, and their presence was clear in the recent patterns of both landings and fishing effort. Specifically, landings near the port of Eureka, CA (lat 40°N) increased between 2002 and 2020, peaking around 20% before declining to ~12% in 2023. Approximately 15% of annual landings were made near Fort Bragg, CA (lat 39°N), in 2023 which was higher than in any previous time period. An additional 5% of landings in 2023 occurred near Moss Landing, CA (lat 36°N), the highest proportion since 2002-2006. The proportions of landings north of lat 46°N and south of lat 36°N for the most recent three years remained low and similar to previous time periods.

Maps of average annual fishing intensity illustrated these patterns in more detail and revealed the similarities from 2016 to 2023 (Figure 5). The more recent time periods illustrate the continued concentration of effort in the northern part of the coast, as well as distinct areas of effort in the waters off of Eureka, Fort Bragg, and Moss Landing, CA reflecting new processing opportunities in those locales. Continuing a decreasing trend from previous time periods, almost no effort occurred south of lat 36°N from 2021 to 2023.

Seasonal patterns of landings in 2021 to 2023 largely fell within the patterns observed in previous time periods (Table A-3, Figure 6). In 2021-22, more than a fifth of landings occurred in March/April; landings in other bimonthly periods were evenly distributed. The proportion of landings in January/February of 2023 were lower than typical and then fairly evenly distributed across March to December.

The proportions of hauls in the 0–50-fth and greater than 400-fth depth bins remained extremely low, with effort also decreasing in waters deeper than 200-fth (Table A-4, Figure 7). However, the proportion of hauls in shallower waters grew, continuing a gradual trend in 50–100-fth and 150-200-fth waters but rapidly increasing in 100-150-fth waters. These shifts may reflect the recent opening of the trawl rockfish conservation area to effort by this fleet via Amendment 28 (84 FR 63966; PFMC 2024). Across other depth bins, the distribution of effort was similar across all time periods.

Midwater trawl targeting rockfish

In 2015, the annual catch limit (ACL) for yellowtail rockfish increased 1.5 times over the 2014 ACL, from approximately 4,400 to 6,600 mt. More dramatically, from 2016 to 2017, the widow rockfish ACL increased more than sixfold, from 2,000 mt to more than 13,000 mt. With these increased targeting opportunities, the CS midwater trawl rockfish fleet has re-emerged. Groundfish landings in this sector generally increased from 2011 to 2018, although groundfish retained decreased slightly in 2019 and 2020 before returning to 2018 levels in 2021 and then increasing to a historic high of ~12,600 and ~12,200 mt in 2022 and 2023, respectively (Table A-1, Figure 1 and Figure 2). After doubling compared to the previous year in 2018, fleetwide tow hours remained around 1,100 between 2018 and 2023, except for a relative low of ~800 tow hours in 2020 and a historic high of ~1,300 tow hours in 2022. The median tow duration per haul in the midwater rockfish trawl fleet has mostly increased from 1.5 hours in 2017 to 1.85 hours in 2023 (Table A-1, Figure 3).

From 2011 to 2023, the majority of landings of midwater rockfish occurred from southern Washington to central Oregon (Table A-2, Figure 8), with the proportion of landings occurring near the Oregon–Washington border at lat 46°N decreasing and the proportion near Newport, OR (lat 44°N) increasing over time. Between 2020 and 2023, a small but growing proportion of landings has also occurred near Eureka, CA (lat 40°N). Mapping the fishing effort shows that activity continues to concentrates off of Astoria and Newport (Figure 9).

The shoreside midwater season starts in mid-May, except for participants in an EFP that began in 2017 and removed seasonal restrictions for this gear. The seasonal distribution of landings in 2021 to 2023 was within the range seen in 2011-2015 and 2016-2020, with the majority of occurring in March to June and September to December (Table A-3, Figure 10).

The depth distribution of midwater rockfish trawl effort in 2021 to 2023 was within the range of previous years (Table A-4, Figure 11). Around 75% of effort occurred in waters 50-100-fth deep, and the majority of hauls outside of these depths occurred in 100-150-fth.

MIDWATER TRAWL TARGETING HAKE

Landings by the shoreside midwater hake fleet have decreased from an historic high of ~144,000 mt in 2019 to ~100,000 mt in 2023, which still remains above the annual catch for 2002 to 2016 (Table A-1, Figure 12). Retained catch by the at-sea processing CP fleet from 2017 to 2023 similarly remains above 100,000 mt, which is greater than any annual catch from 2002 to 2016. However, the annual catch has mostly decreased since 2017 other than an increase to ~120,000 mt in 2022. Retained catch by the at-sea processing MS fleet from 2002 to 2023 has ranged between ~25,000 to ~60,000 mt, but mostly decreased from 2017 to 2023 other than an increase in 2022 similar to that in the CP fleet.

Effort, measured by total number of tow hours, increased in the shoreside fleet from 2016 to an historical high of 8,600 hours in 2020 and then decreased to 6,000 hours in 2021 (Table A-1, Figure 13). In 2022 and 2023, shoreside fleet effort comprised ~7,200 tow hours. Trends in both at-sea processing fleets were more variable in recent years, but have mostly decreased from historic highs in 2016 to 2020, and have since mostly increased other than a decrease in 2023 following particularly high effort in 2022. The median tow duration in 2022 in both at-sea processing fleets was 3.8 hours, the highest value observed from 2002 to 2023 (Table A-1, Figure 14). The shoreside fleet's median tow duration in 2022 and 2023 was also on the high end of the historic range, between 3.2 and 3.5 hours.

SHORESIDE HAKE FLEET

The majority of landings by the shoreside hake fleet occurred between southern Washington and central Oregon (Table A-2, Figure 15). The proportion of landings in the Oregon–Washington border at lat 46°N increased, while proportions near Newport, OR (lat 44°N) decreased. Across all three time periods, fishing effort occurred from the U.S.–Canada border to the Oregon–California border, with a small amount occurring off of northern California, and was most concentrated off of Newport, OR (Figure 16).

In 2023, the start of the hake season was changed from May 15 to May 1 to increase hake quota utilization (87 FR 77000). The seasonal distribution of landings by the shoreside hake fleet in 2021 to 2023 was within the range of previous time periods, with about half of landings occurring in July-August and a little less than a third each in May-June and September-October (Table A-3, Figure 17).

The depth distribution of landings in 2021 to 2023 was within the range of previous time periods while also reflecting the high variability of fishing depth in this fishery (Table A-4, Figure 18). The majority of annual landings by the shoreside fleet came from depths of 50–200-fth. Landings from deeper than 250 fth continued to be low, with no landings from waters deeper than 450 fth in 2023.

At-sea hake fleet

Fishing effort in the at-sea midwater hake trawl fishery was concentrated off Oregon across all time periods (Table A-2, Figure 19). In 2021 to 2022, effort by the CP fleet primarily occurred in the 44°N, 43°N, and 42°N latitudinal bins, while effort in 2023 was primarily concentrated around lat 43°N and 42°N. Maps of CP fishing effort show hotspots off of Newport, OR as well as increasing effort south of Newport, OR to lat 42°N (Figure 20).

The spatial distribution of MS effort in 2021 to 2023 was concentrated in the 43°N and 42°N latitudinal bins, with less effort in the 47°N latitudinal bin and more in the lat 41°N bin than in previous time periods (Table A-2, Figure 19). Mapping this effort further emphasizes the similarity of spatial distributions from 2016 to 2023, including continued concentrated fishing around lat 44°N and 43°N in all three time periods (Figure 21).

The midwater at-sea hake season previously began on May 15 but, as of 2023, now begins on May 1. The proportion of CP landings processed in the May–June period was on the lower range of previous years in 2021 to 2023 (Table A-3, Figure 22). The majority of catch processed in 2021 to 2023 occurred in September-October, resulting in some of the highest proportion of catch processed in that bimonthly period. The seasonal distribution of MS landings was within that of previous time periods. The majority of MS landings in 2021 to 2023 were processed in May–June and September-October, with the proportion processed in November-December continuing to decrease between 2016 and 2023.

Since 2006, more than 80% of CP and MS landings have come from hauls in depths of 100–250-fth; from 2021 to 2023, this effort further concentrated in 100-200-fth depths (Table A-4, Figure 23).

Fixed Gear Sectors

Pot

Annual NCS groundfish landings using pot gear were fairly stable at about 600 mt from 2015 to 2020 and have since increased to almost 1,000 mt in 2023 (Table A-5, Figure 24). The CS fleet showed a slight but generally increasing trend from 2013 to 2019, with a high of more than 850 mt, and has since decreased to 680 mt in 2021 and then rebounded to almost 1,000 mt in 2023. Based on landings and observer data in the NCS fleet, the number of fleetwide pots has not shown a clear trend, ranging from a low around 20,000 to a high of

65,000 pots (Tables A-5 and A-6, Figure 25). Between 2021 and 2023, this number almost doubled from almost 30,000 to 60,000 pots. The CS fleet has been less variable, ranging from about 25,000 to 50,000 pots, and increased from 2021 to 2023. Since 2011, the median number of pots per set in both the CS and NCS pot fleets has ranged between 15 and 50 (Table A-5, Figure 26). The median number of pots per set in the CS fleet in 2020 and 2021 reached an all-time high of 50 pots in 2020 and 2021, but has since decreased to within the historic range.

From 2002 to 2023, the majority of landings by the NCS pot fleet occurred between Astoria, WA (lat 46°N) and Fort Bragg, CA (lat 39°N; Table A-2, Figure 27). The spatial distribution of landings from 2021 to 2023 were within the historical range, with the greatest proportions of landings occurring near Newport, OR (lat 44°N). Catch shares pot landings also continued to primarily occur near Astoria, WA and Newport, OR, as well as further south than NCS pot landings, specifically between lat 37°N and 35°N.

The high dispersion of fishing effort by different vessels made it difficult to accurately display fishing intensity while maintaining confidentiality (Figure 28). However, comparing the primary fishing areas (excluding confidential data) across time periods revealed variable effort off of northern and central California and more consistently high effort off of Washington and Oregon (Figure 28). Due to lower observer coverage in the NCS fishery, direct comparisons of magnitude of effort between the NCS and CS maps are inappropriate. CS pot effort was greatest and increasingly concentrated off of Washington and Oregon (Figure 29). However, some areas of fishing effort persist off of San Francisco and Morro Bay, CA, which may partially reflect initiatives introduced with catch share implementation that supported a shift from trawl to fixed gear fishing near Morro Bay, CA.

The seasonal distribution of landings by the NCS pot fleet in 2021 to 2023 was within the range observed across previous time periods, with the majority of landings occurring between July and October (Table A-3, Figure 30). Landings from January to June for 2021 to 2023 were on the low end of the historic range. Landings made in November-December have continued to vary greatly across years since 2016, reflecting emergency extensions of the season from October 31 to December 31 in 2020 and 2021 which became permanent in 2023 (87 FR 77007). In the CS pot fleet, landings from 2021 to 2023 remained within the historical range as well, with the majority of landings occurring between September and December. The proportion of landings made in March-April were on the higher end of the historic range, while those in May-June were on the lower end, and those in July-August were more variable than in previous time periods.

From 2002 to 2023, fishing effort in the NCS pot fleet occurred primarily in depths from 100–300-fth (Table A-4, Figure 31). The depth distribution of landings from 2021 to 2023 were generally within the range of previous years. The majority of CS pot fleet effort in

2011-2015 occurred in depths from 150–600 fth. In 2016-2020, and even more so in 2021 to 2023, this effort concentrated in shallower depths, from 150–350-fth.

Hook-and-line

Groundfish landings by the NCS hook-and-line fleet decreased from 2,400 mt in 2017 to 1,500 mt in 2020, but have since rebounded to 2,100 mt in 2023 (Table A-5, Figure 24). Estimated fleetwide hooks, calculated from total landings and observed hooks per set (see Table A-6), showed a similar pattern and reached an historic low of 6 million hooks in 2021 and has remained at that level through 2023 (Table A-5, Figure 32). The median number of hooks per set in the NCS fleet was fairly stable from 2002 to 2010 at ~2,000 hooks; this rate increased in 2012 and has been closer to ~2,500 hooks per set through 2023 (Table A-5, Figure 33).

CS landings were lower and less variable than NCS landings, ranging between 115 and 200 mt of groundfish from 2013 to 2019, with no effort of 3 or more vessels in 2020 and beyond (Table A-5, Figure 32). Similarly, the number of hooks in the CS fleet generally decreased from 2011 to 2019 (Table A-5, Figure 32). Hooks per set in the CS fleet generally increased from 2013 to 2019 and remained around 3,200 from 2015 to 2019 (Table A-5, Figure 33).

Hook-and-line groundfish landings occurred from lat 48°N to 32°N (Table A-2, Figure 34). Generally, landings by the NCS hook-and-line fleet were fairly evenly distributed along the coast. The proportion of landings near both Newport, OR (lat 44°N) and Moss Landing, CA (lat 36°N) have generally increased over time. Landings in the CS fleet were patchier, with concentrations near lats 48°N, 46°N, and 45°N.

Observed effort in the NCS hook-and-line fleet occurred along the entire contiguous U.S. West Coast and was similar across all time periods (Figure 35). Effort was most concentrated in the northern part of the coast, especially around Neah Bay, WA; La Push, WA; and Newport, OR. Effort off of southern California has grown increasingly patchy in recent years. Due to the small number of vessels participating in the CS hook-and-line fleet, all years with effort (2011 to 2019) were summarized together and show areas of concentrated effort in the north off of Astoria, WA and Newport, OR and in the south off of Morro Bay, CA (Figure 36).

Landings by the NCS hook-and-line fleet increased throughout the calendar year before peaking in September–October across all time periods and years (Table A-3, Figure 37). In the CS fleet, the seasonal distribution of landings was fairly stable from January to June in most years and peaked in September-October, with typically half or more landings occurring in that bimonthly period.

Both the NCS and CS hook-and-line fleets fish in depths ranging from 0–750 fth (Table A-4, Figure 38). The depth distribution of observed NCS hook-and-line sets was similar across time periods and years, with the majority of landings coming from sets in waters 100–200-fth deep. The majority of CS hook-and-line effort occurred in the 150–250-fth depth bins in 2011-2015 and 2016-2020, while effort in other depth bins was highly variable.

Lost Gear and Recovered Gear

Observed gear loss was least common in trawl fisheries. In shoreside catch shares bottom trawl fleets, gear loss occurred on ~0.1% of observed hauls annually, and was never observed in shoreside midwater trawl fleets (Table A-7). On average, in at-sea midwater fleets, 0.02% of hauls lost gear annually, with a maximum of 0.13% (Table A-8). Gear loss was observed more often in fixed gear fisheries than in the trawl fleet. Lost gear was observed in the NCS hook-and-line fisheries on average on about 2% of sets, representing on average about 0.5% of observed hooks. In the CS hook-and-line fleet, on average approximately 1% of sets lost approximately 0.4% of hooks. In the NCS pot fleet, on average around 3% of sets lost approximately 0.4% of pots; in the CS pot fleet, around 4% of sets on average lost approximately 0.4% of pots.

The percentage of hauls recovering lost gear was typically greater than those losing gear, likely reflecting gear loss in unobserved fisheries. Gear recovery was observed most frequently in fisheries using bottom trawl gear, when on average ~4% of hauls recovered gear. Midwater gears rarely contact the ocean floor, so gear recovery is uncommon. On average 0.9% of observed shoreside midwater hauls recovered gear, and no recovered gear has been observed in the at-sea midwater fleet. Fixed gears are less likely than bottom trawl to recover gear due to differences in deployment and the gear itself. Hook-and-line fleets recovered gear on average on less than 0.4% of observed sets, with no incidents in most years. Approximately 0.09% of observed pot sets recovered gear on average.

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FIGURES

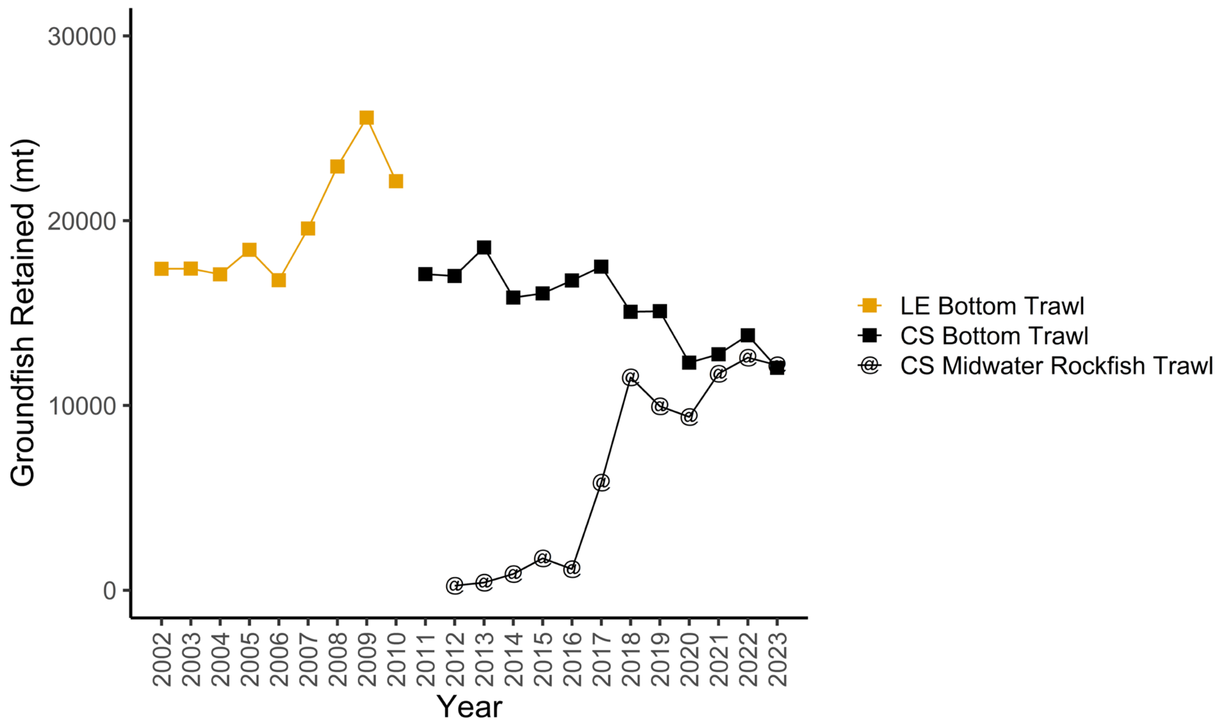

FIGURE 1. Annual total fleet-wide FMP groundfish (not including hake) landings (mt) in bottom trawl and midwater rockfish trawl sectors.

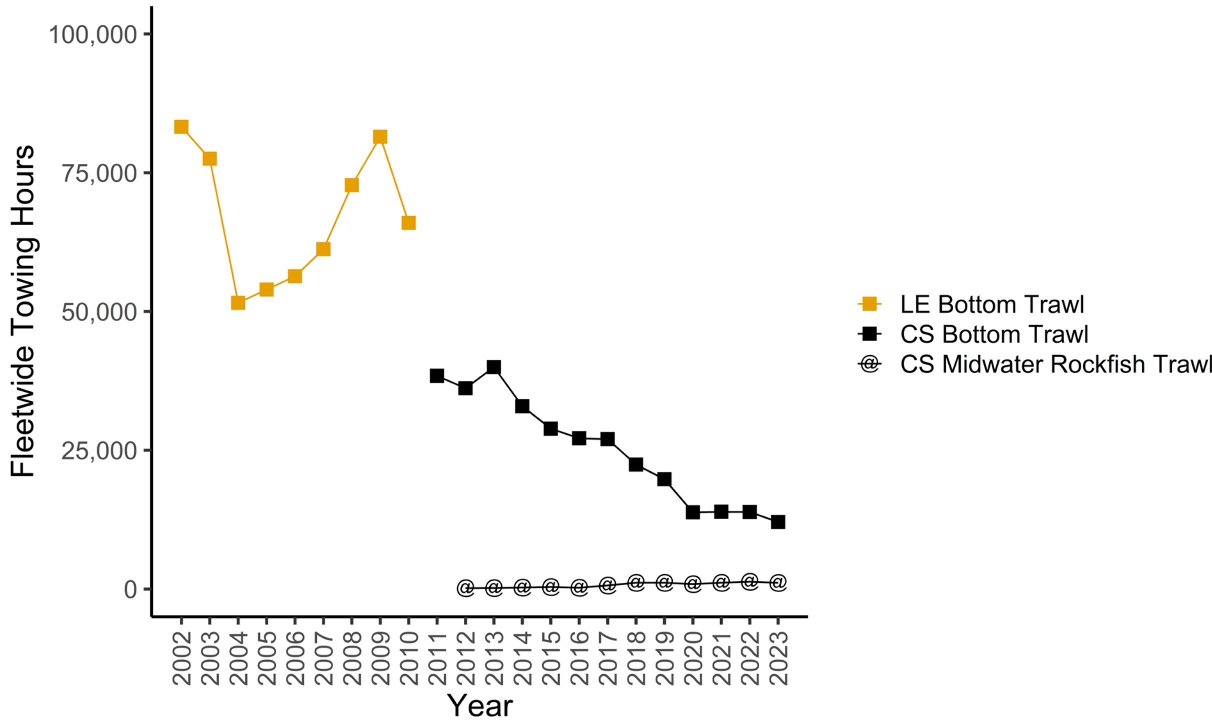

FIGURE 2. Annual fleet-wide total towing hours in the bottom trawl and midwater rockfish trawl sectors.

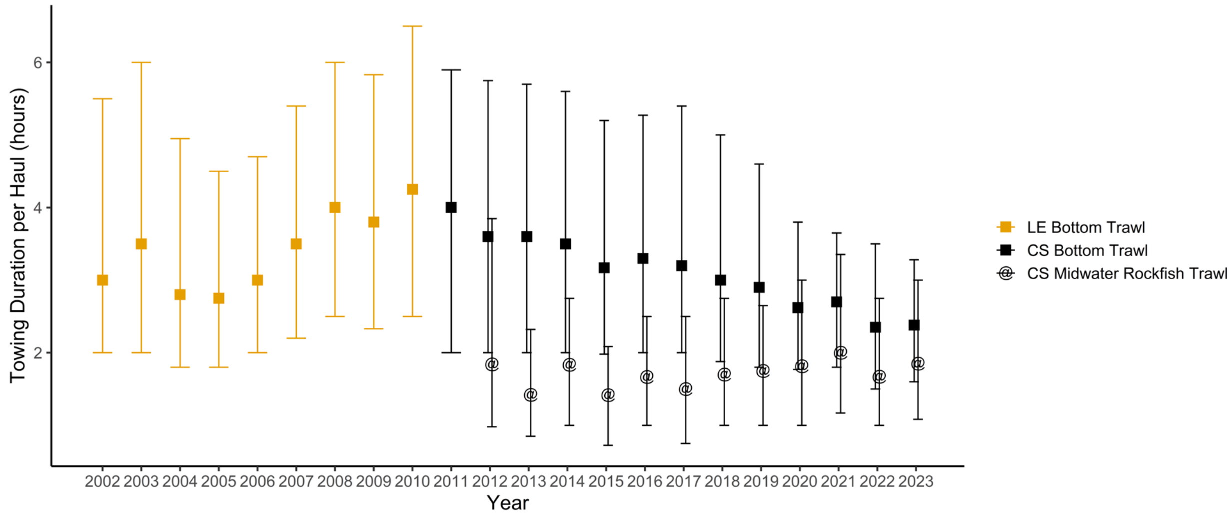

FIGURE 3. Tow duration per haul (hours) in the bottom trawl and midwater rockfish trawl sectors. Medians and first and third quartiles for each year are shown.

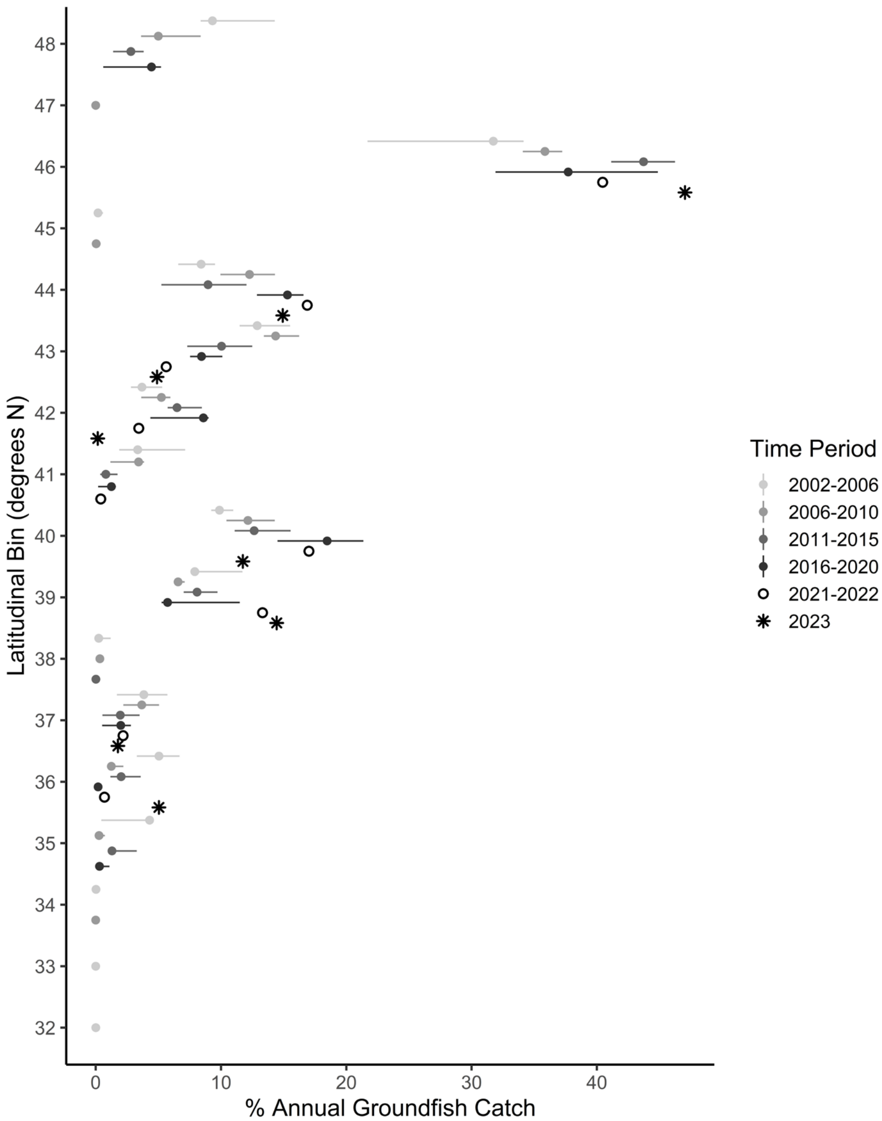

FIGURE 4. Percentage of retained FMP groundfish landed in latitudinal bins by the bottom trawl sector; patterns in actual fishing activity are shown in Figure 5. Minimum, median, and maximum are shown for each time period.

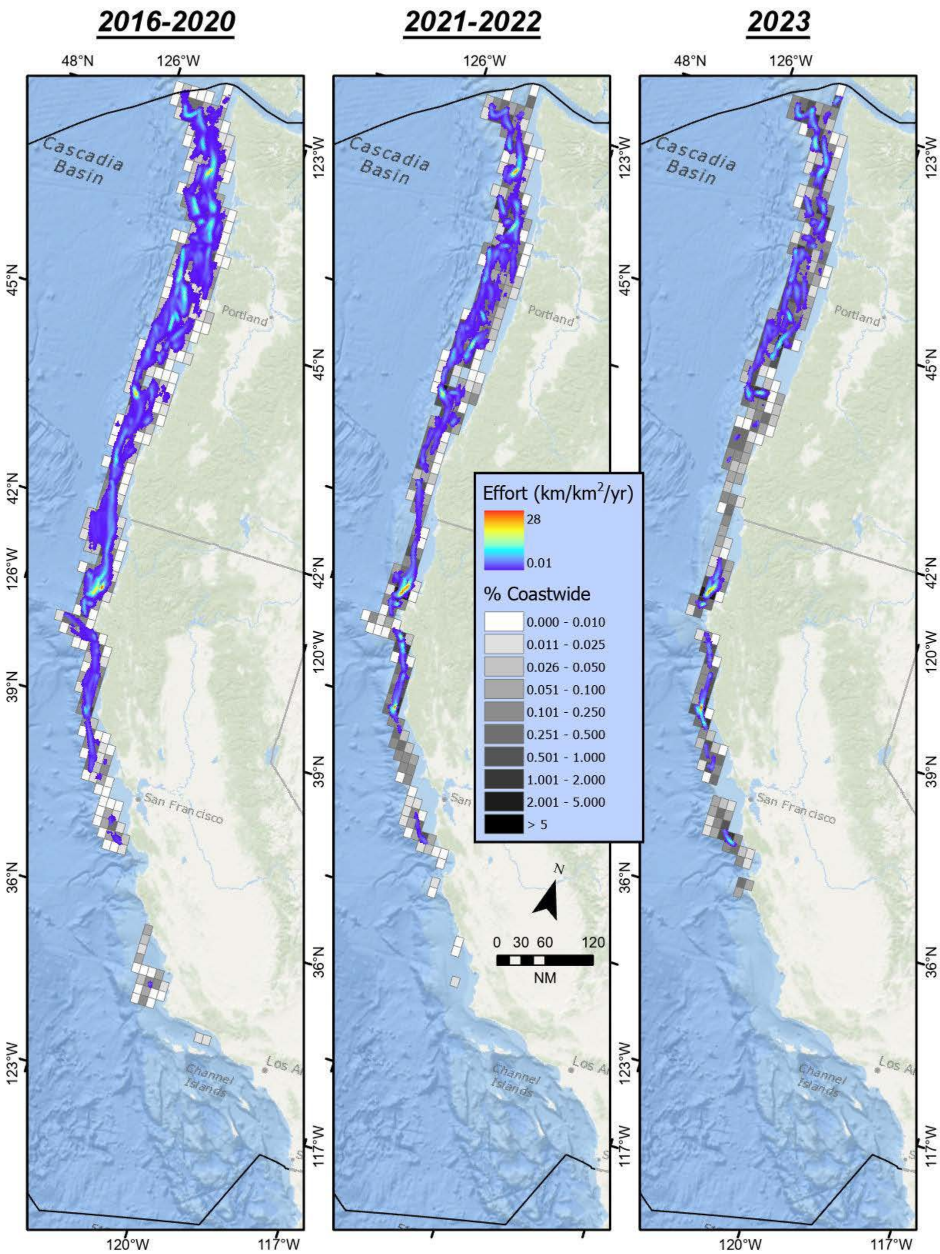

FIGURE 5. Spatial distribution and intensity of bottom trawl fishing effort. Intensity (units: km towed/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

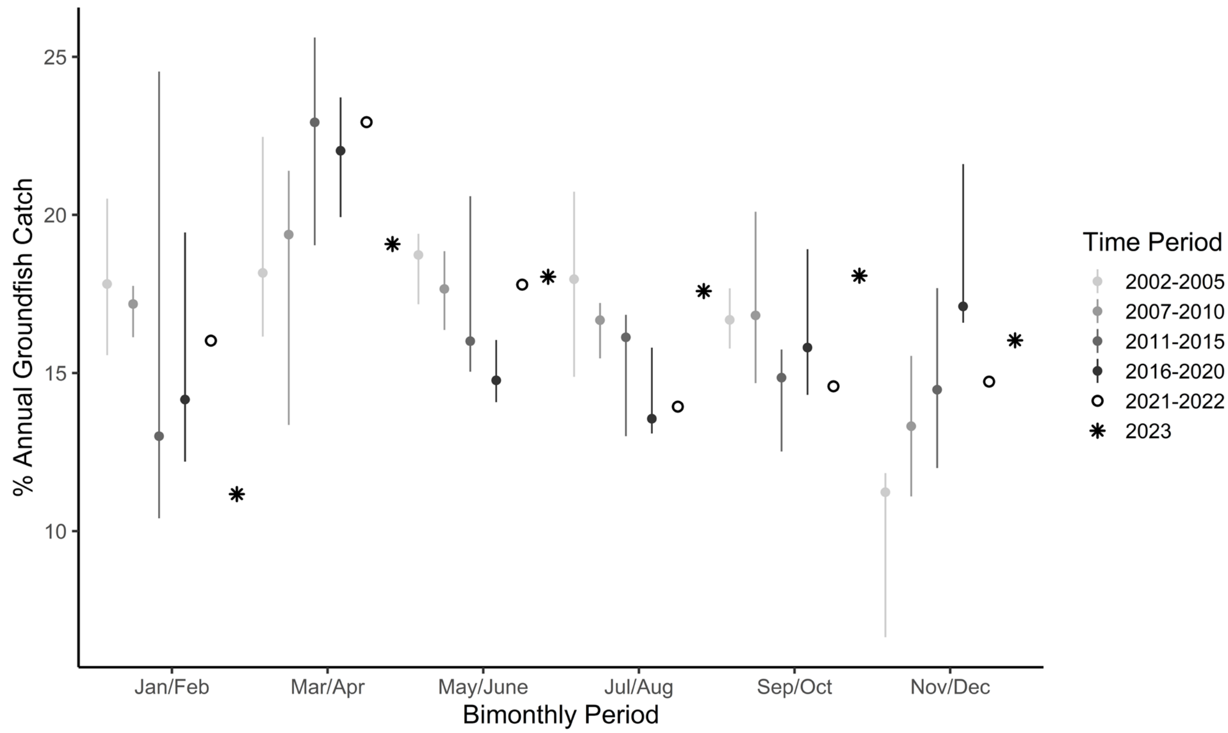

FIGURE 6. Percentage of retained FMP groundfish landed in bimonthly bins by the bottom trawl sector. Minimum, median, and maximum are shown for each time period.

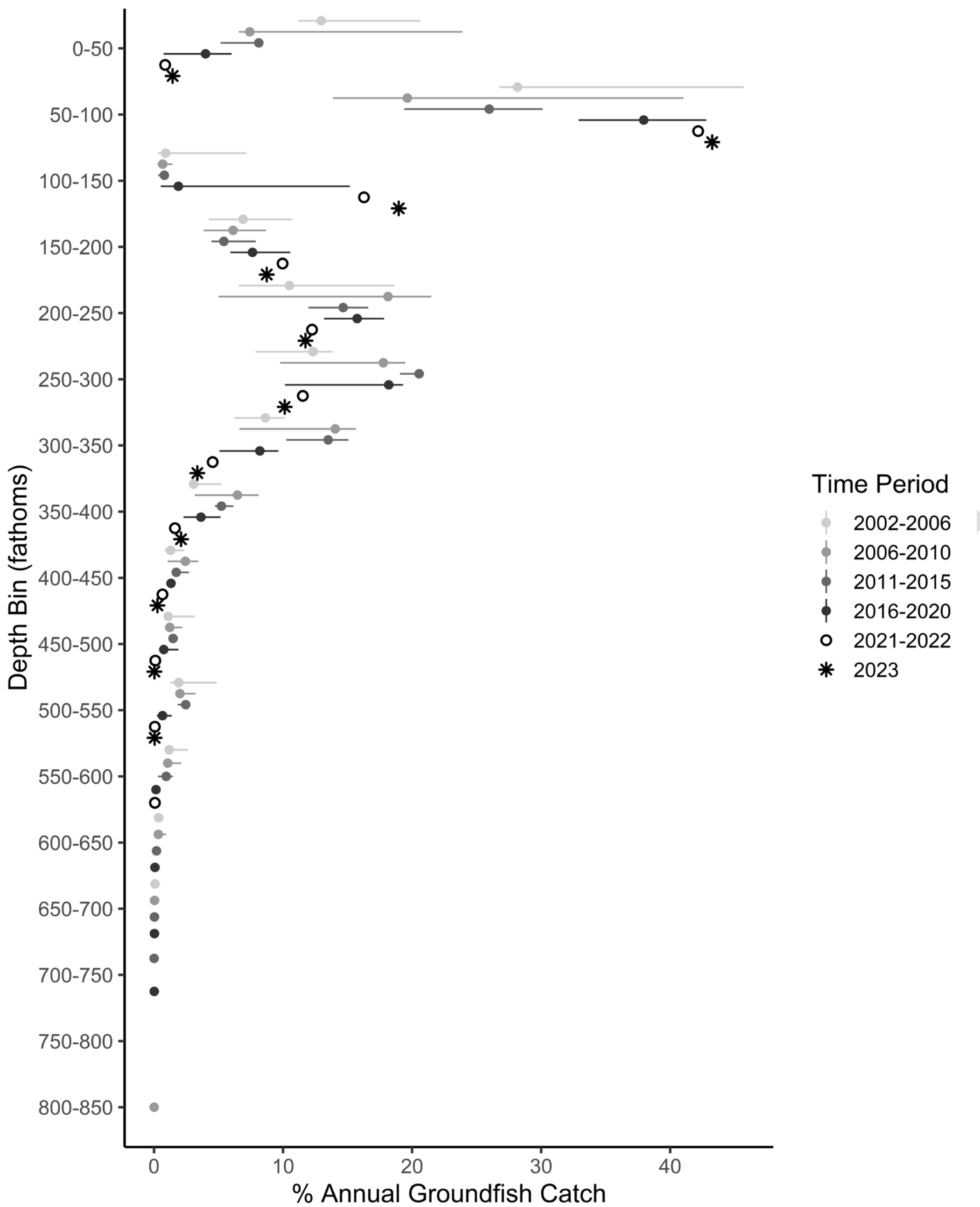

FIGURE 7. Percentage of bottom trawl hauls in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

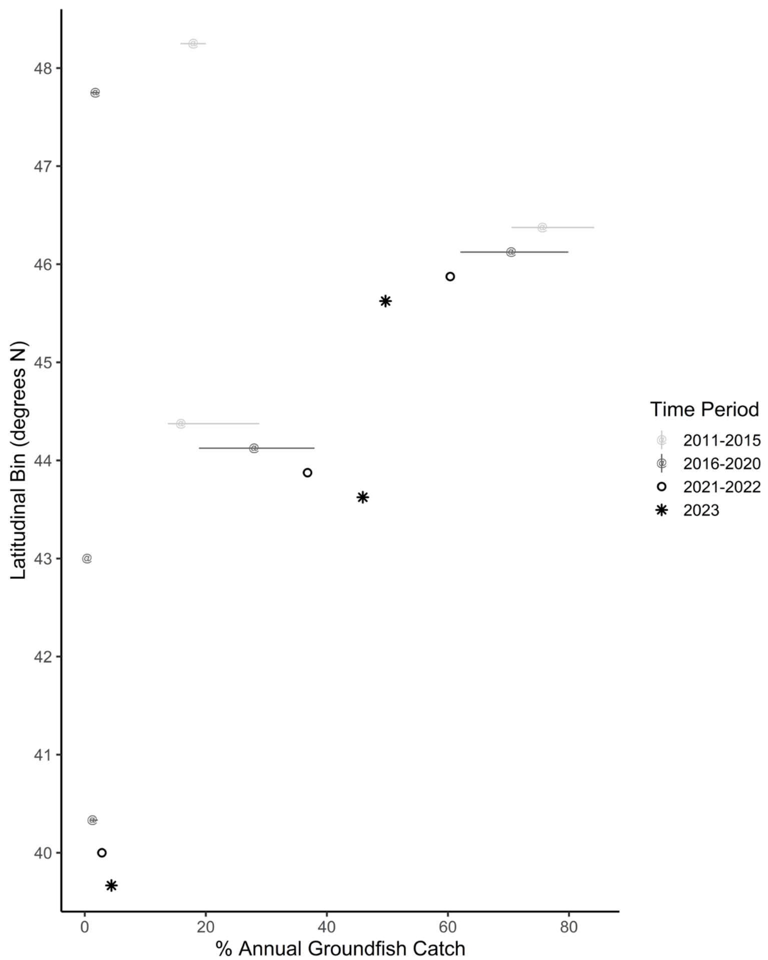

FIGURE 8. Percentage of retained FMP groundfish landed in latitudinal bins by the midwater rockfish trawl sector; patterns in actual fishing activity are shown in Figure 9. Minimum, median, and maximum are shown for each time period.

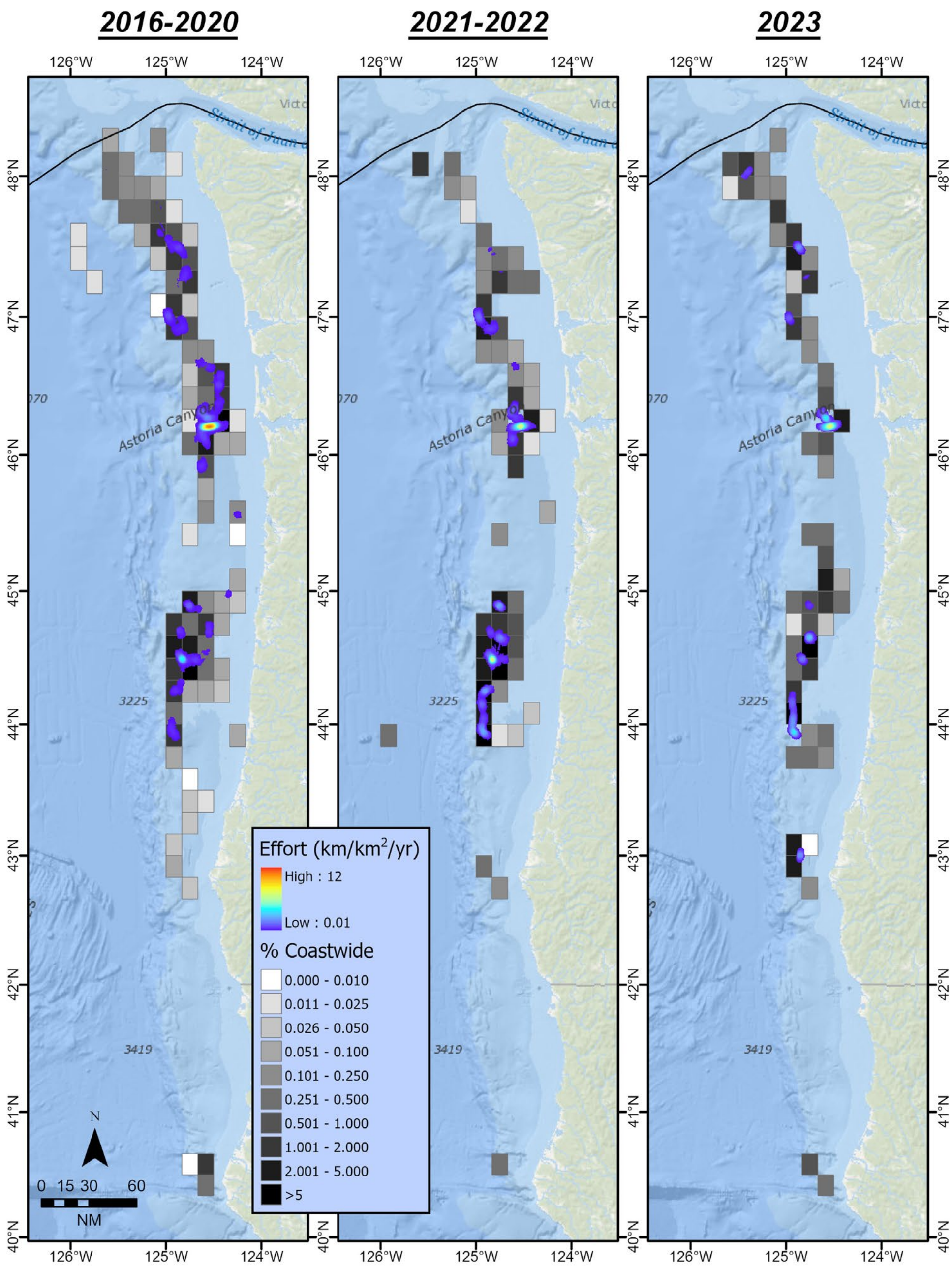

FIGURE 9. Spatial distribution and intensity of midwater rockfish trawl fishing effort. Intensity (units: km towed/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

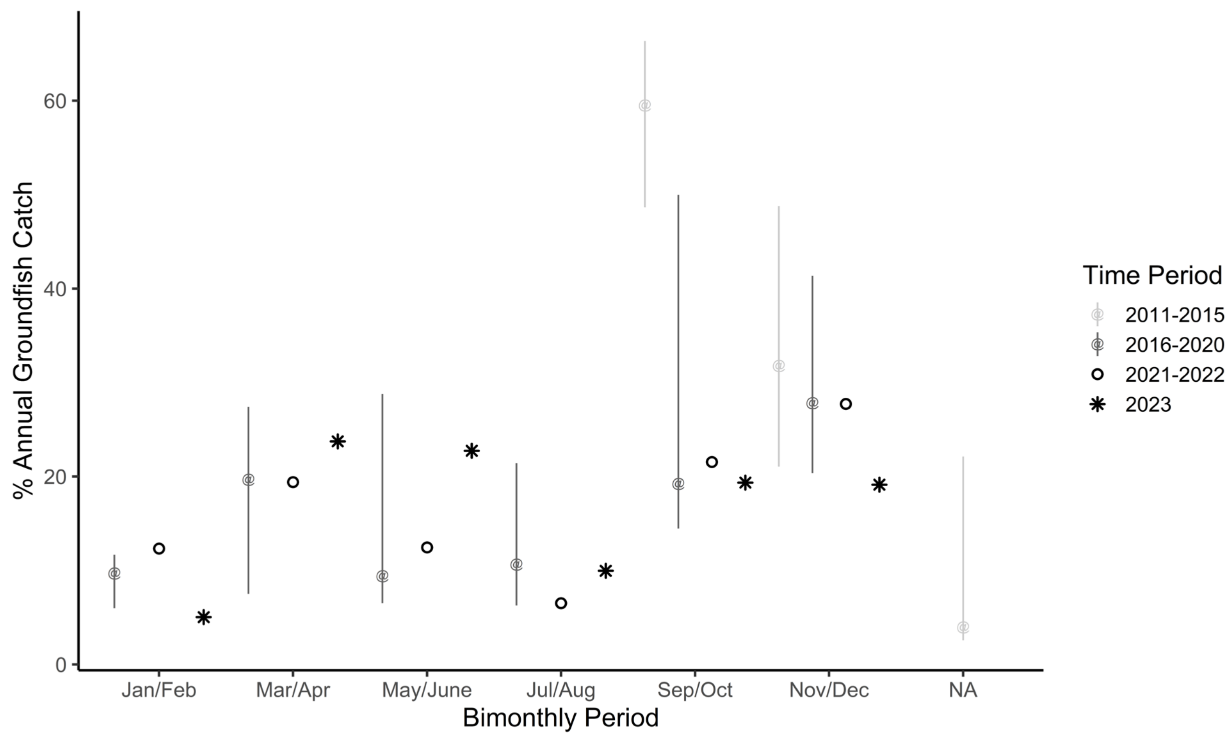

FIGURE 10. Percentage of retained FMP groundfish landed in bimonthly bins by the midwater rockfish trawl sector. Minimum, median, and maximum are shown for each time period.

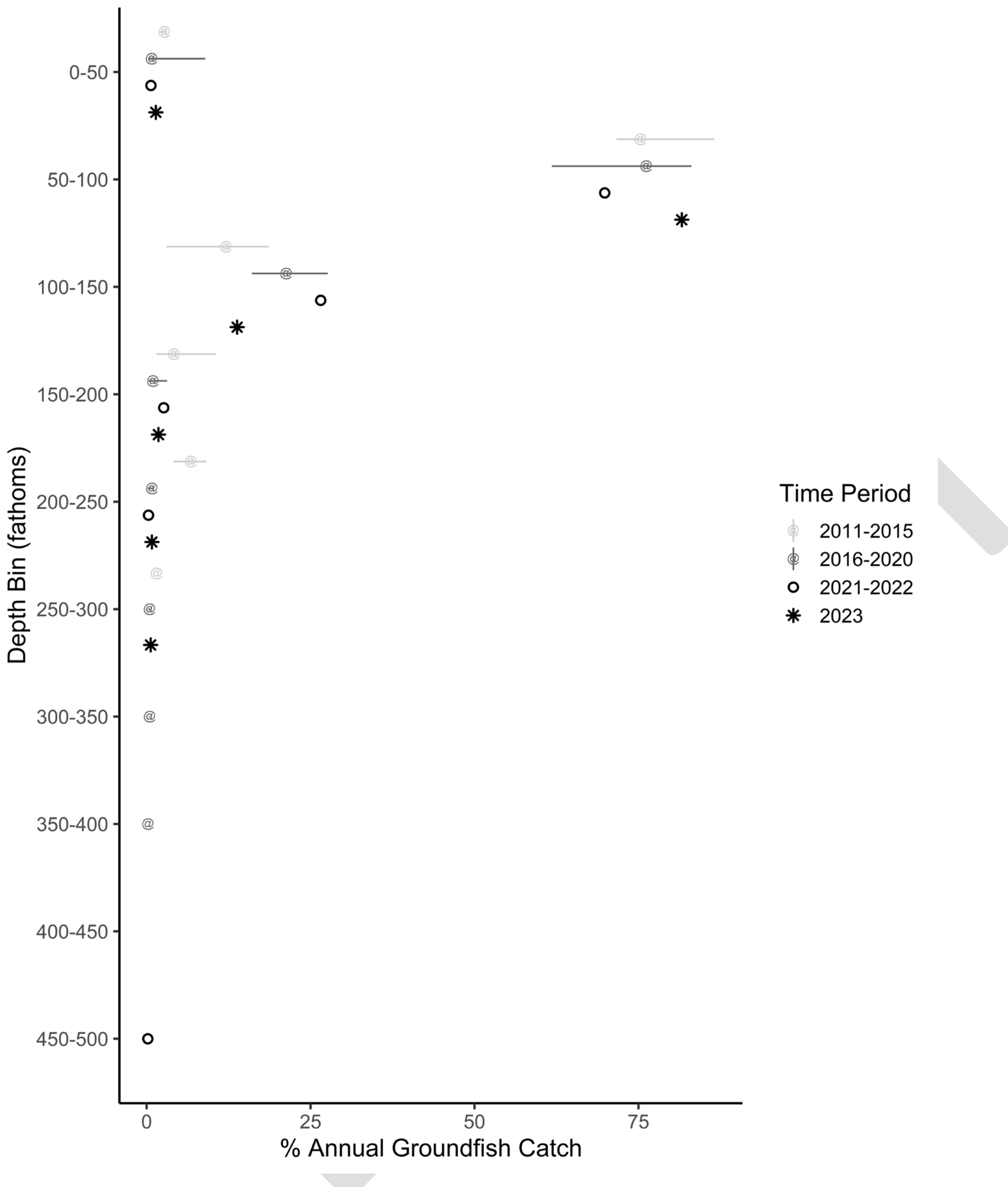

FIGURE 11. Percentage of midwater rockfish trawl hauls in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

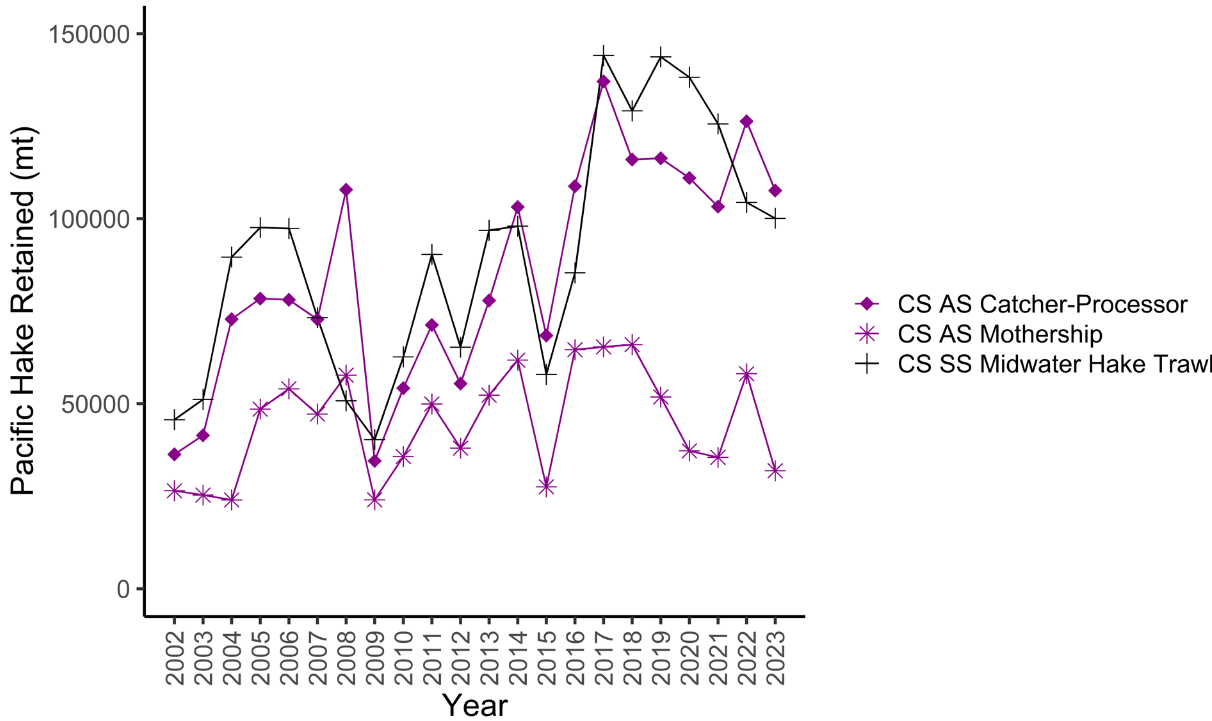

FIGURE 12. Annual total fleet-wide Pacific hake landings (mt) in midwater hake trawl sectors.

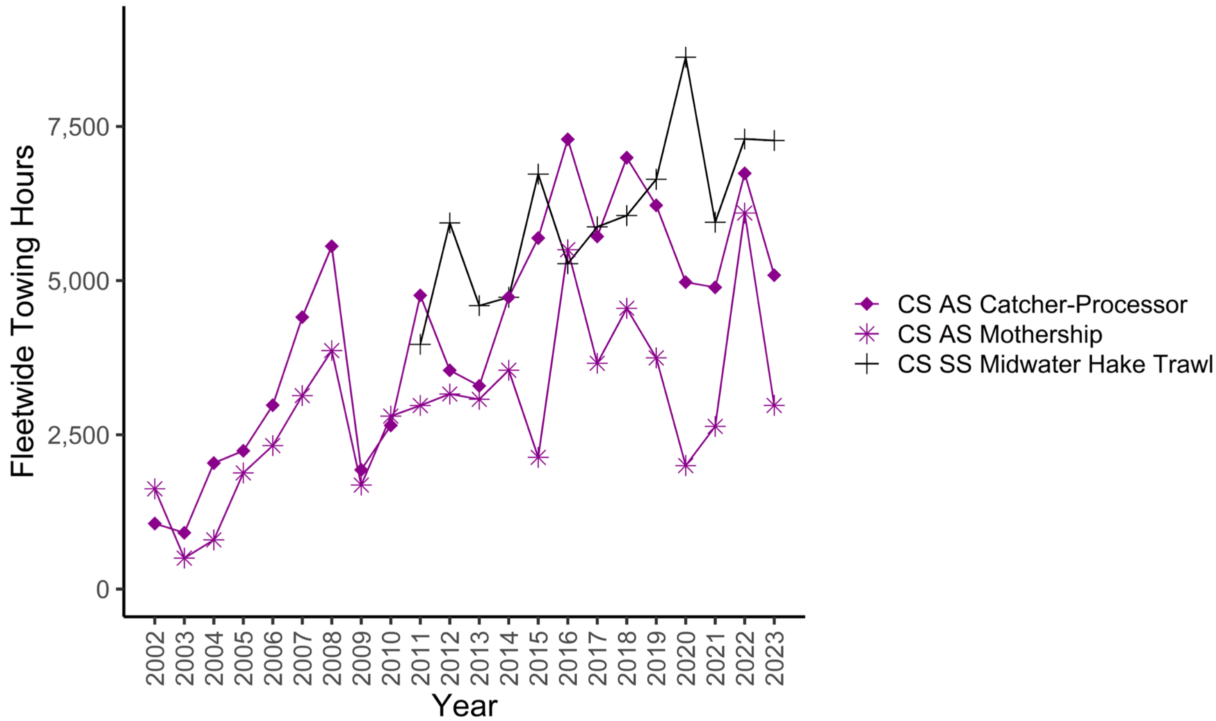

FIGURE 13. Annual fleet-wide total towing hours in midwater hake trawl sectors.

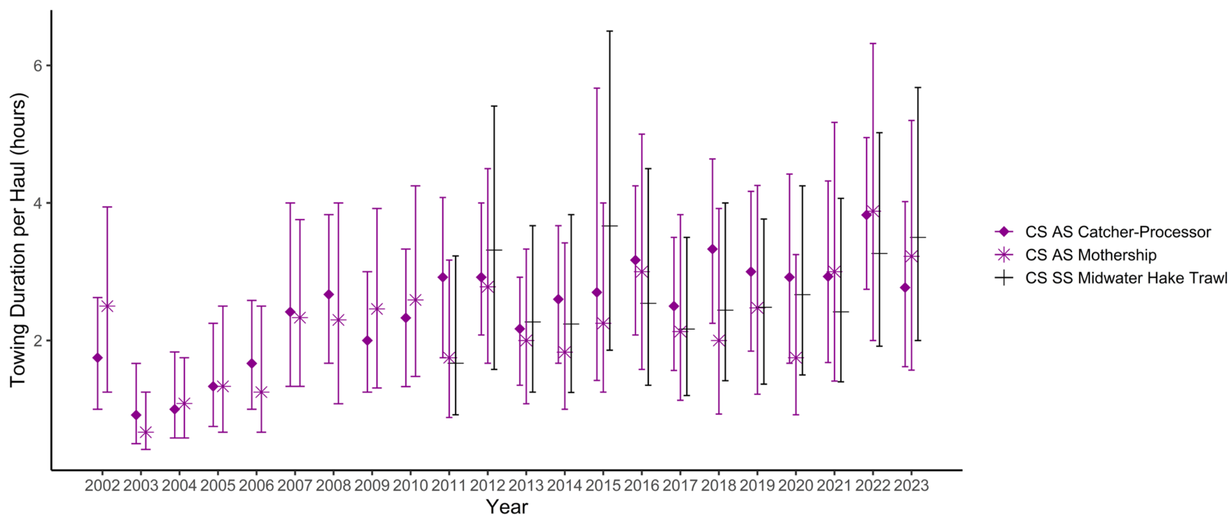

FIGURE 14. Tow duration per haul (hours) in midwater hake trawl sectors. Medians and first and third quartiles for each year are shown.

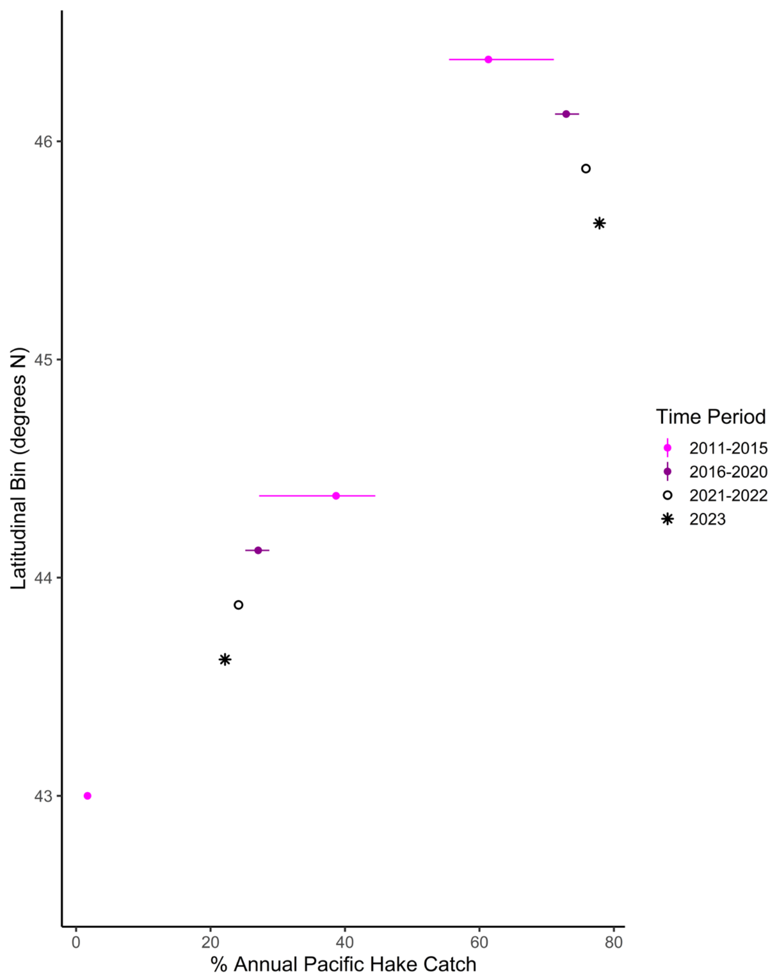

FIGURE 15. Percentage of retained Pacific hake landed in latitudinal bins by shoreside midwater hake trawl; patterns in actual fishing activity are shown in Figure 16. Minimum, median, and maximum are shown for each time period.

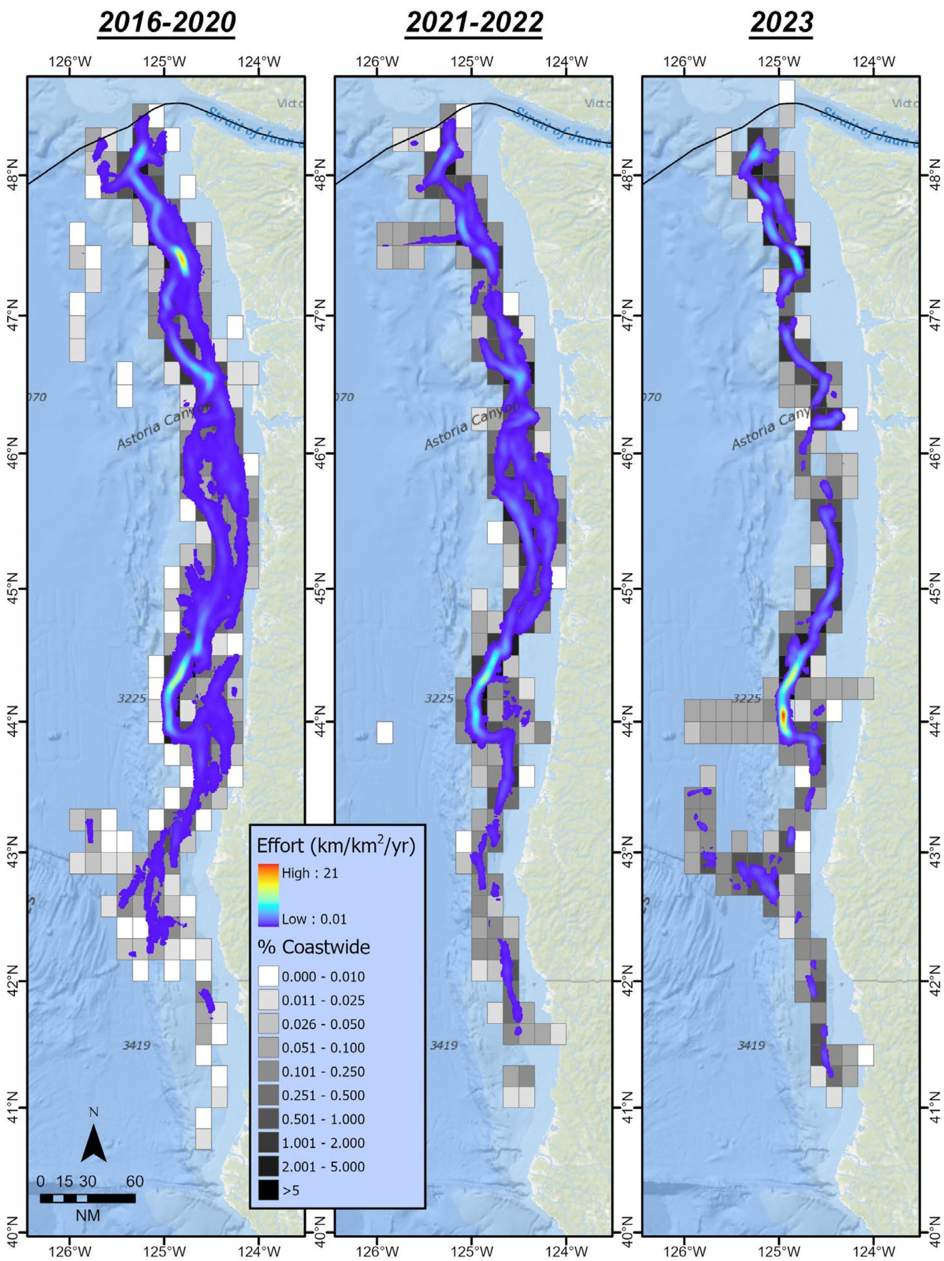

FIGURE 16. Spatial distribution and intensity of fishing effort by shoreside midwater hake trawl. Intensity (units: km towed /km²/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

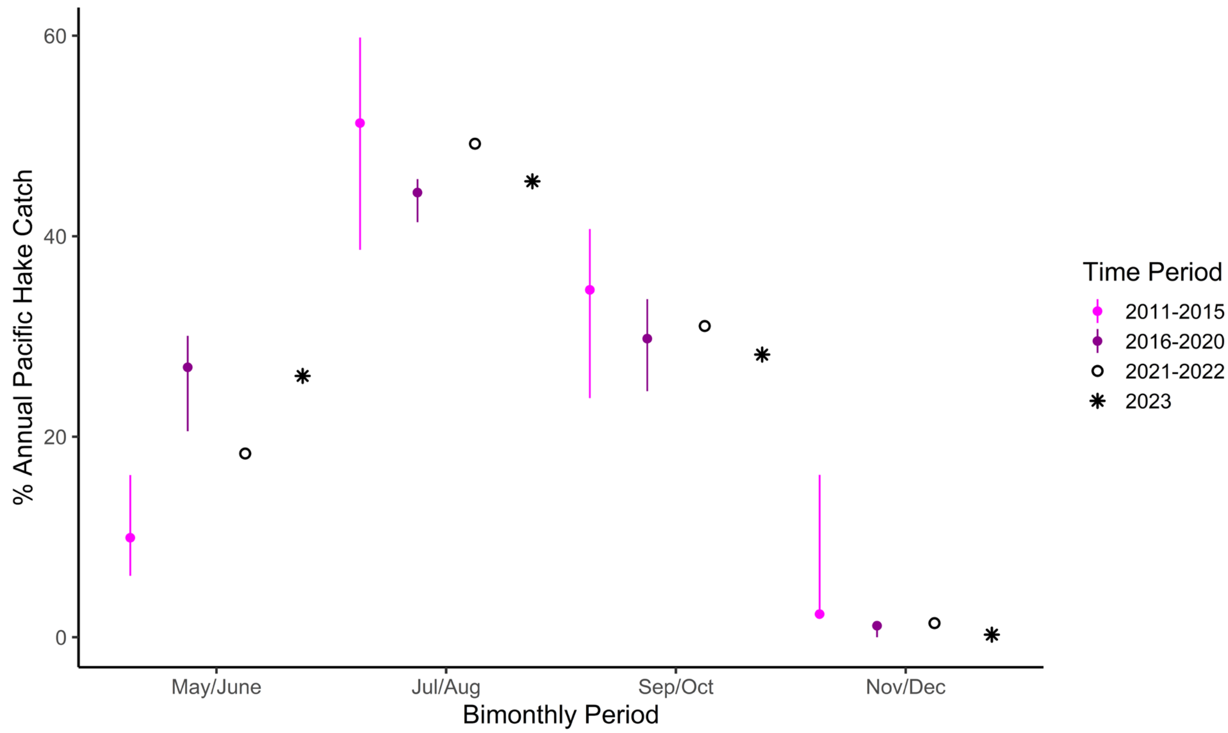

FIGURE 17. Percentage of retained hake landed in bimonthly bins by shoreside midwater trawl targeting hake. Minimum, median, and maximum are shown for each time period.

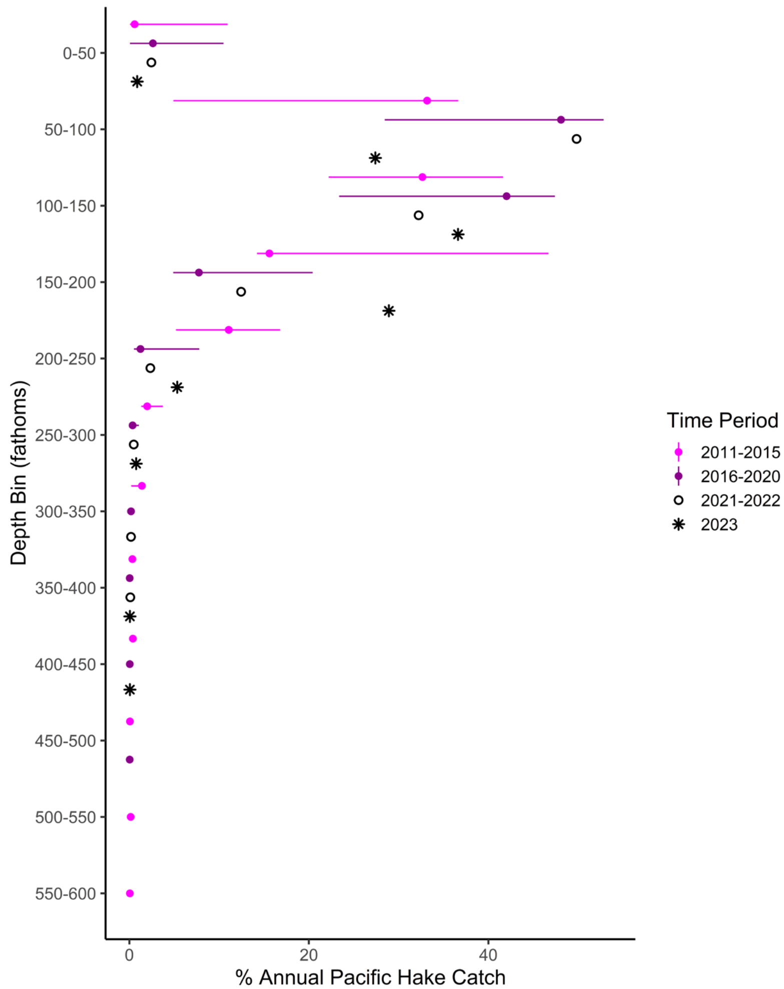

FIGURE 18. Percentage of shoreside midwater hake trawl hauls in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

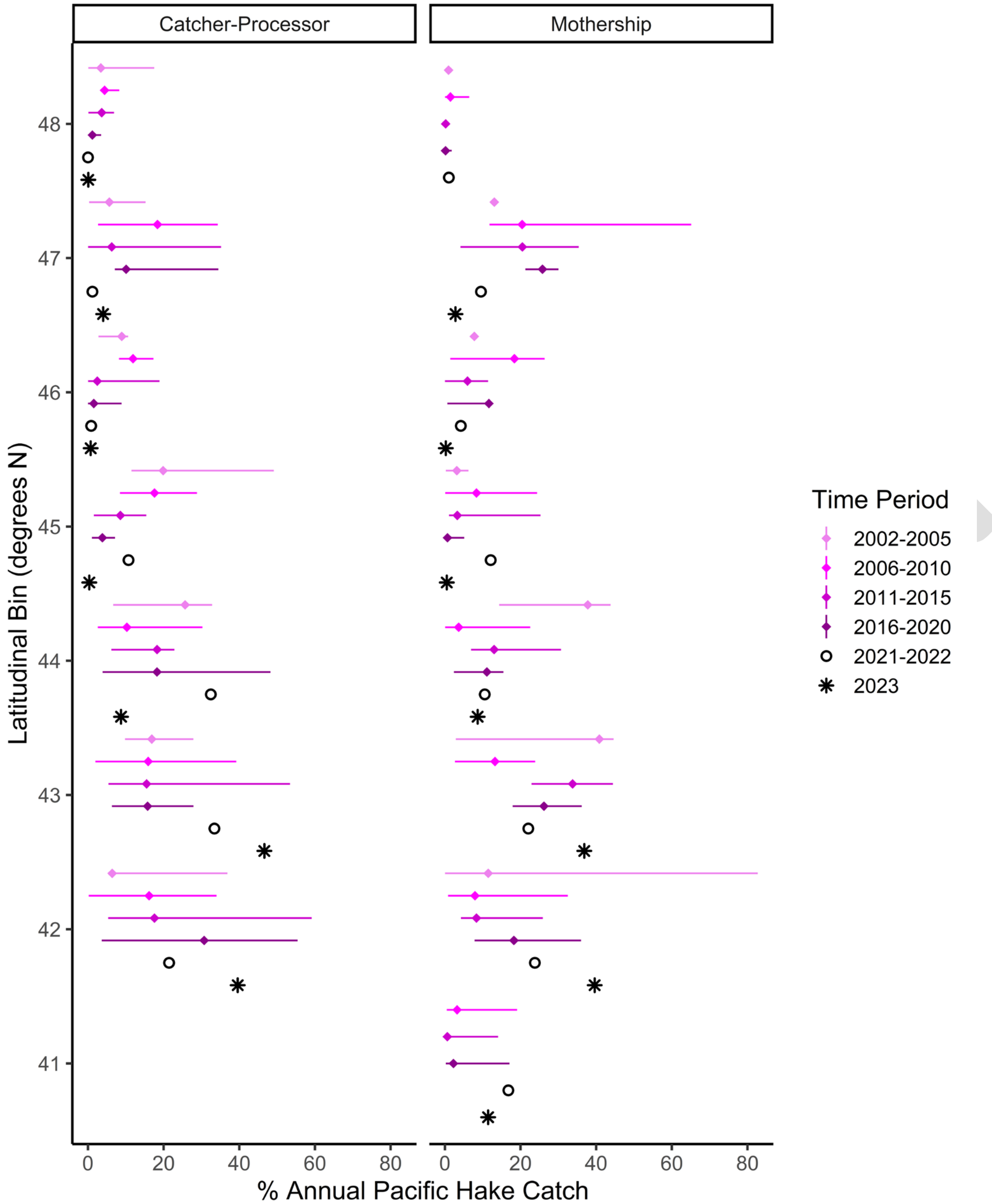

FIGURE 19. Percentage of retained hake caught in latitudinal bins by at-sea midwater trawl sectors. Minimum, median, and maximum are shown for each time period.

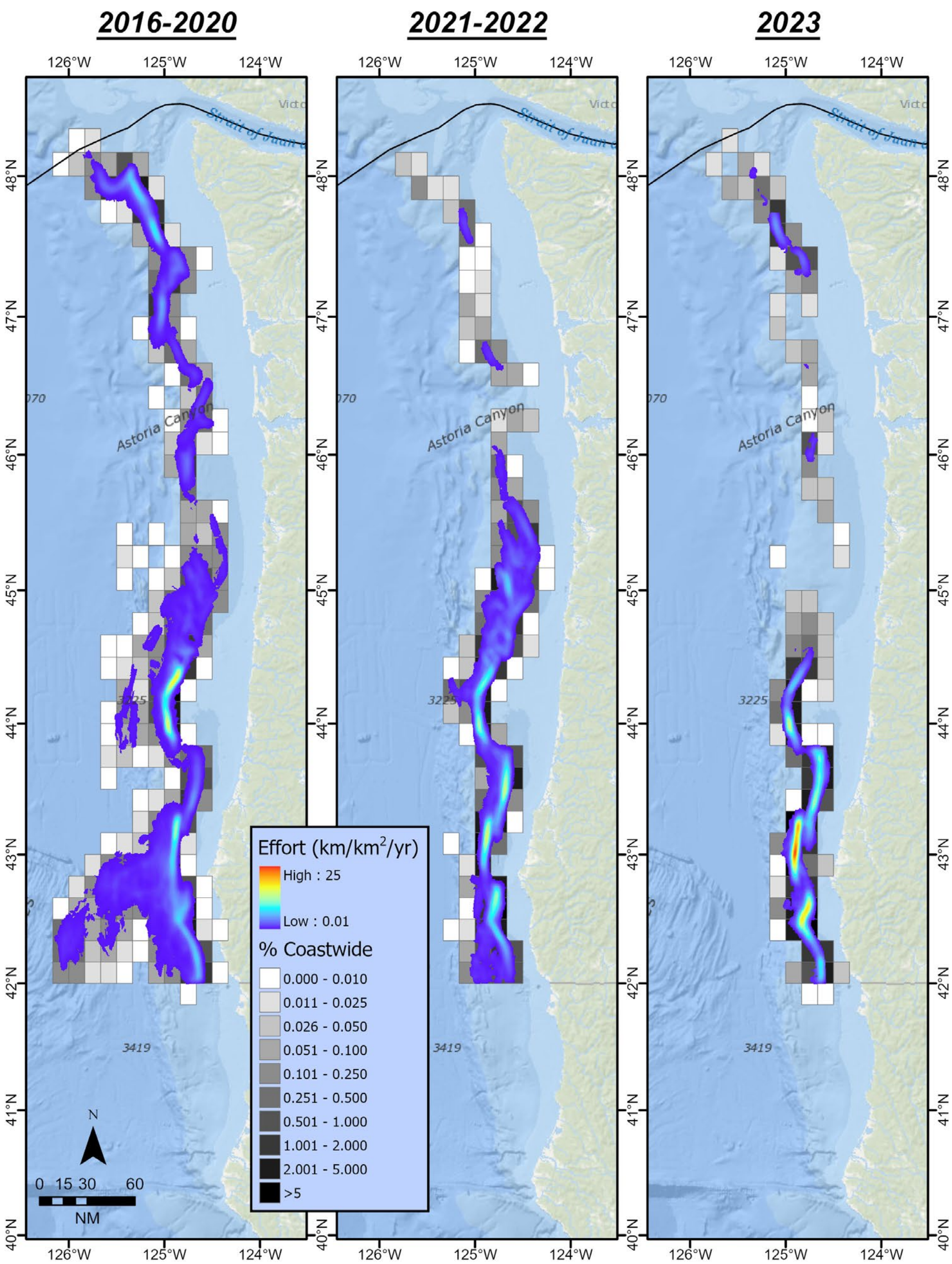

FIGURE 20. Spatial distribution and intensity of fishing effort by at-sea midwater trawl catcher-processors. Intensity (units: km towed/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

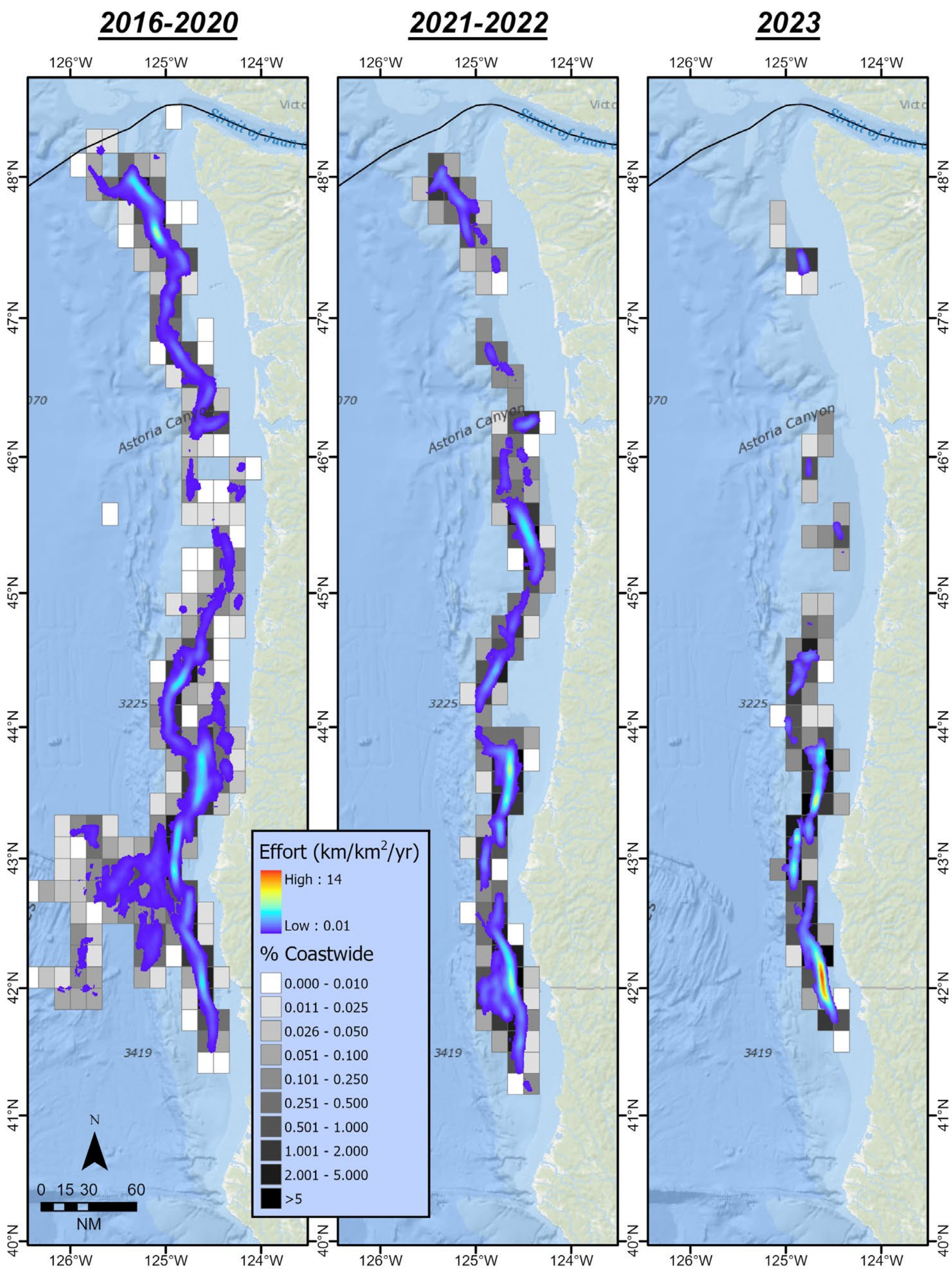

FIGURE 21. Spatial distribution and intensity of fishing effort by at-sea midwater trawl mothership catcher-vessels. Intensity (units: km towed/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

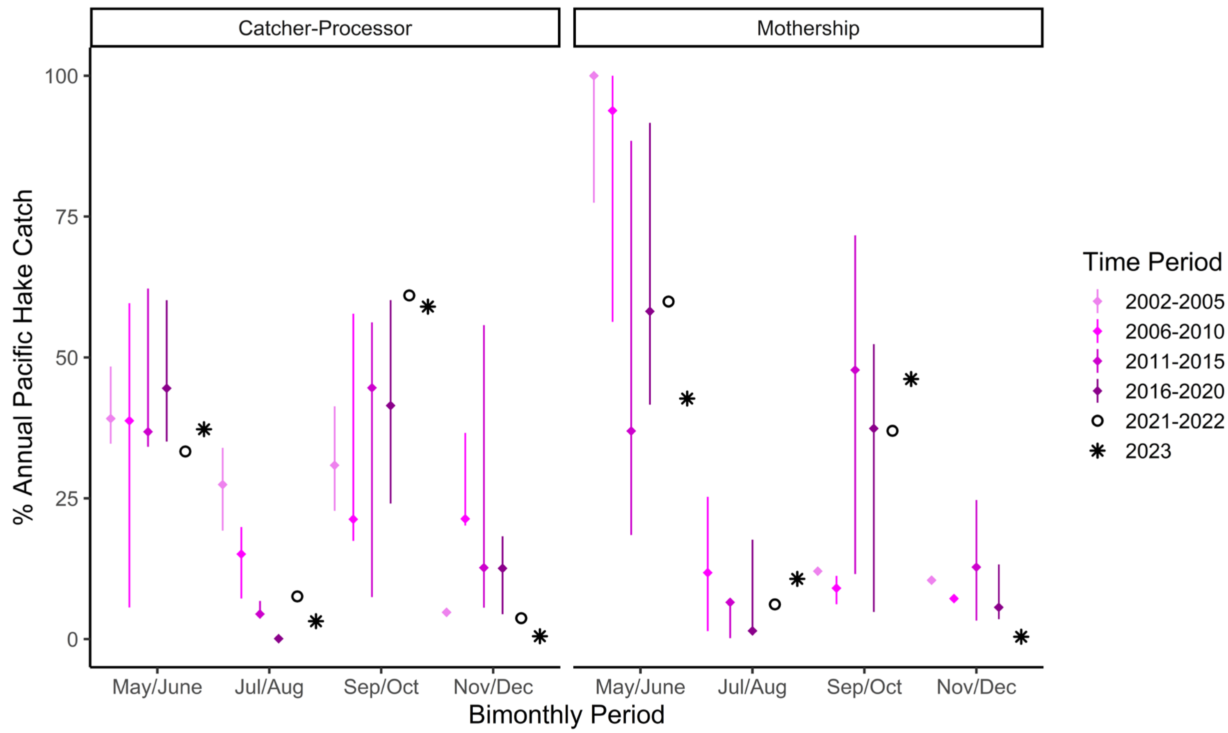

FIGURE 22. Percentage of retained hake caught in bimonthly bins by at-sea midwater trawl sectors. Minimum, median, and maximum are shown for each time period.

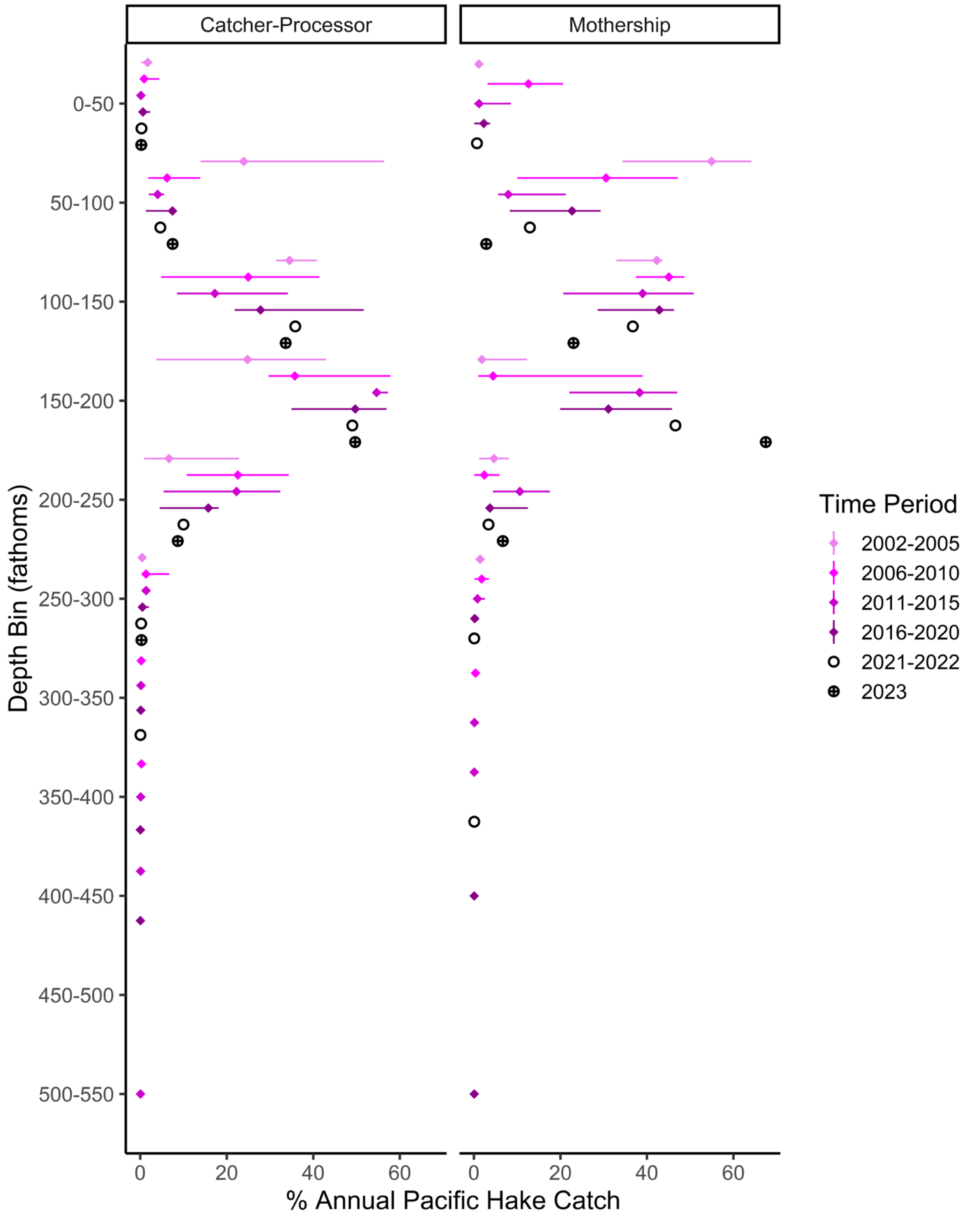

FIGURE 23. Percentage of at-sea midwater trawl hauls in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

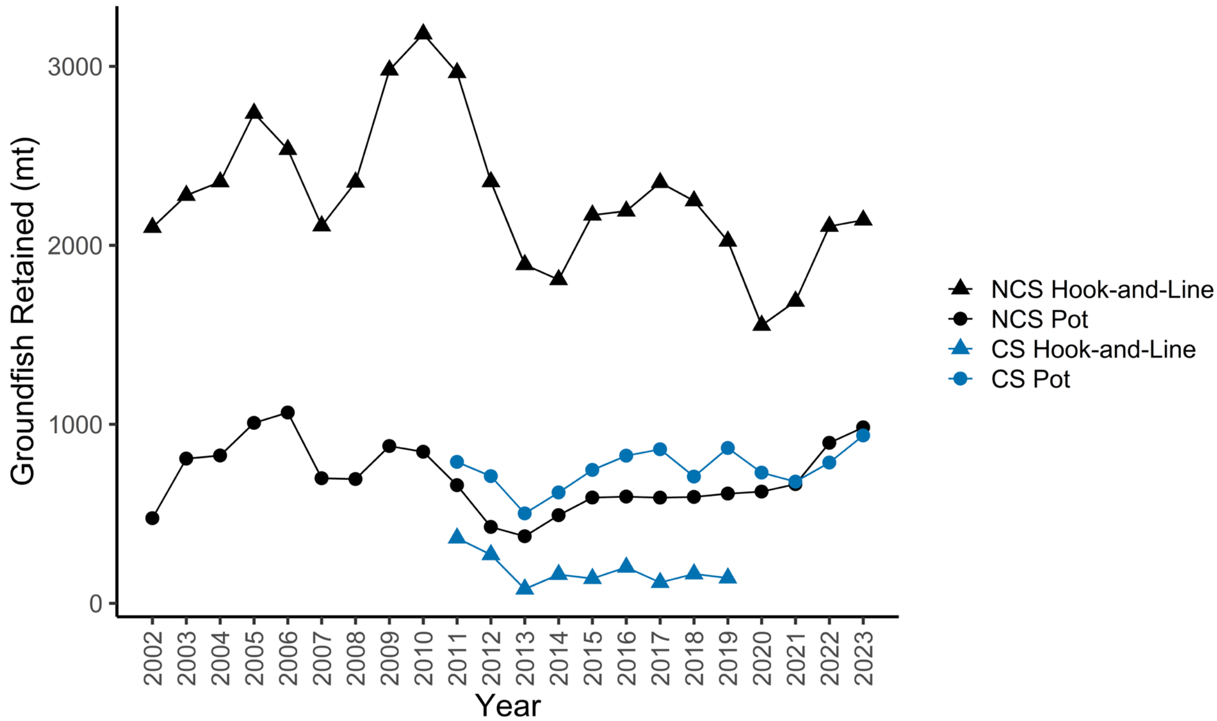

FIGURE 24. Annual total fleet-wide groundfish landings (mt) in fixed gear sectors.

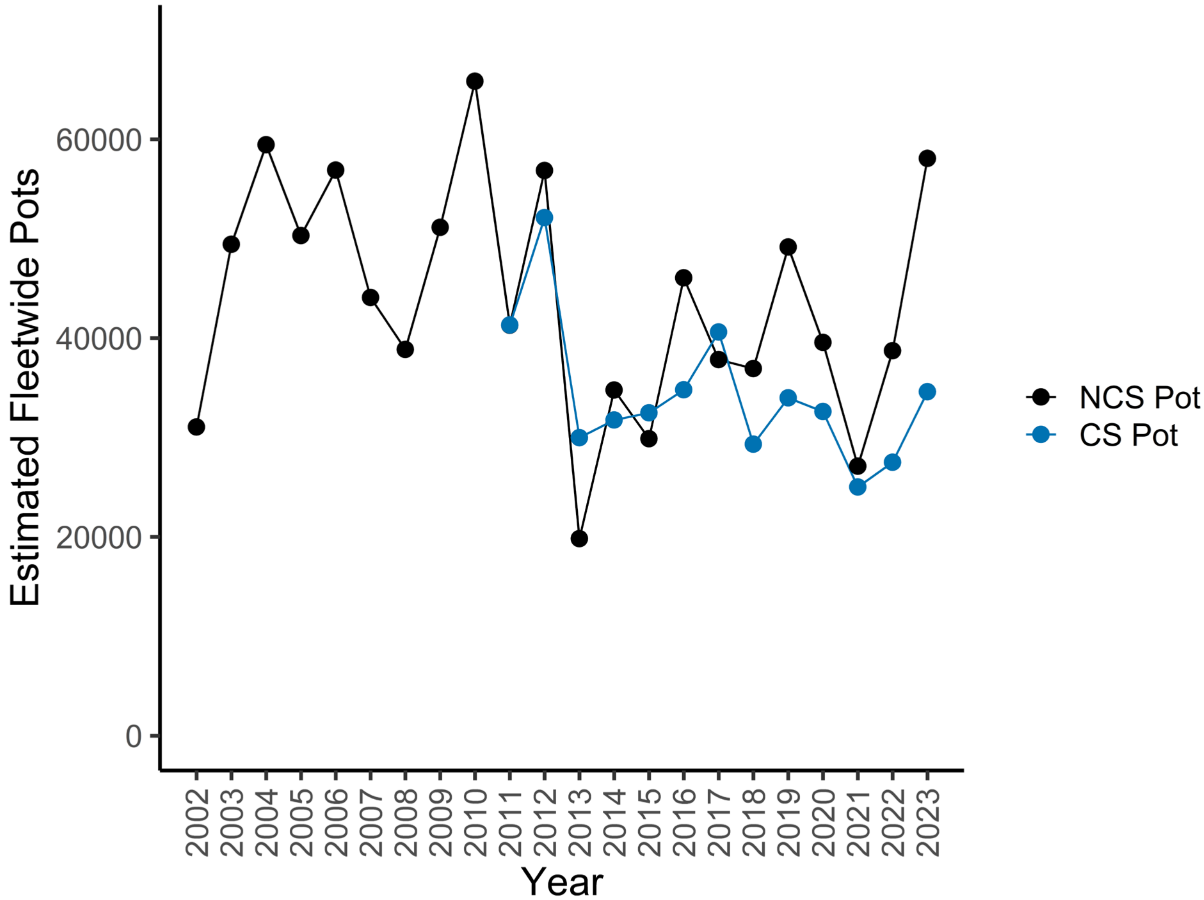

FIGURE 25. Annual total fleet-wide number of pots in the pot sectors.

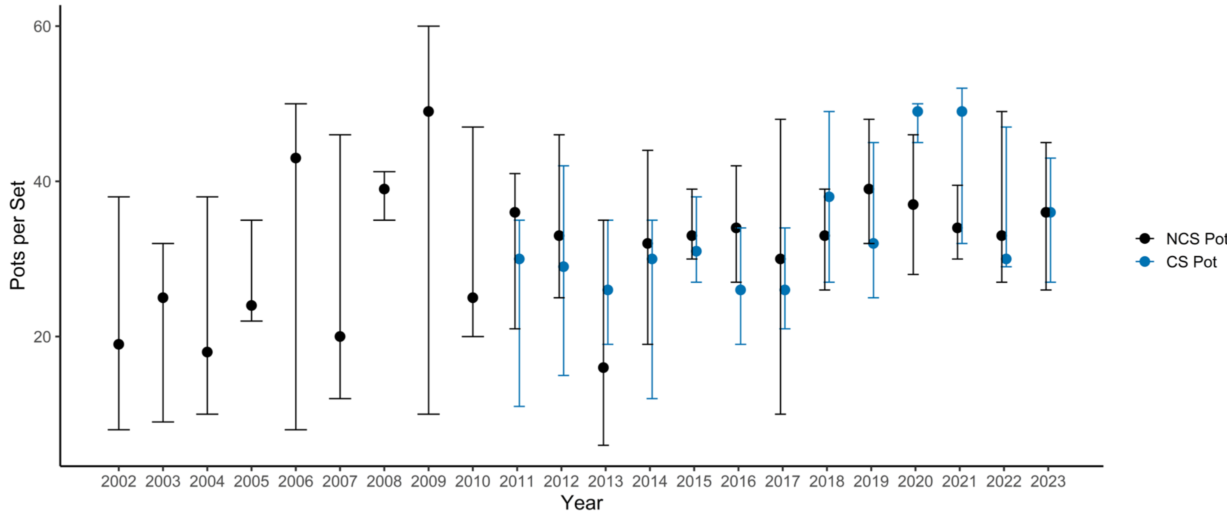

FIGURE 26. Number of pots per set in pot sectors, summarized as median, first, and third quartiles in each year.

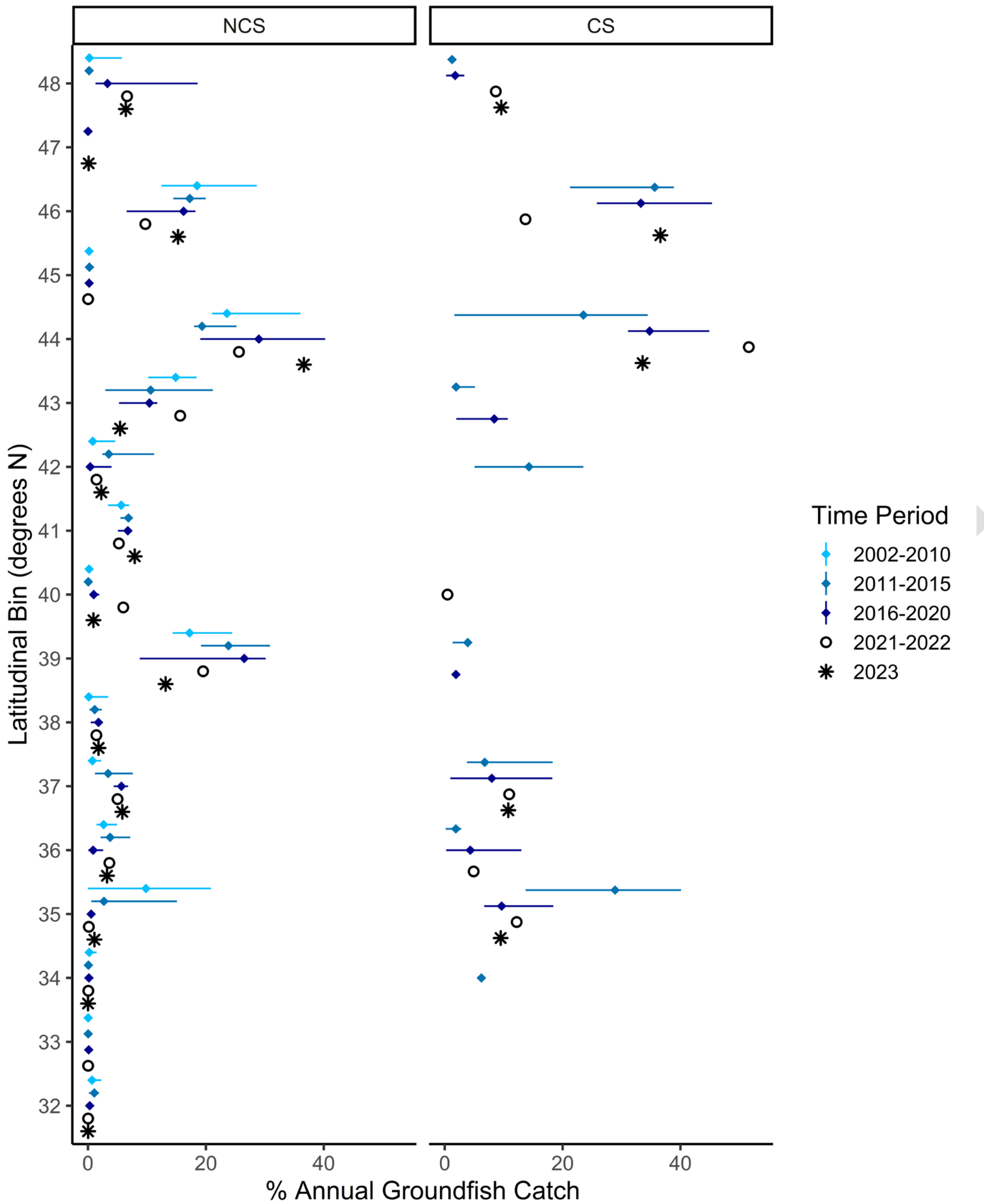

FIGURE 27. Percentage of retained groundfish landed in latitudinal bins by pot sectors patterns in actual fishing activity are shown in Figures 28 and 29. Minimum, median, and maximum are shown for each time period.

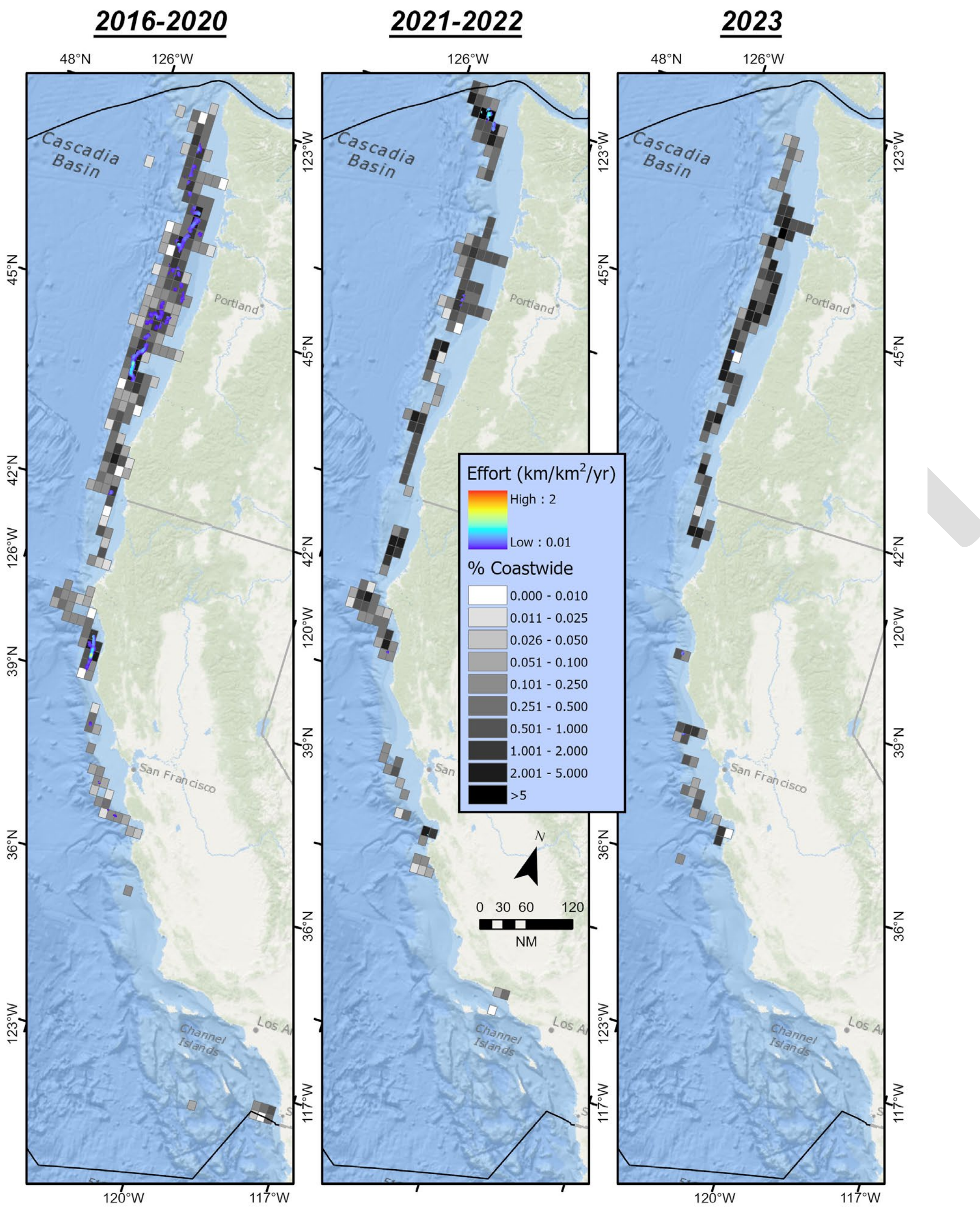

FIGURE 28. Spatial distribution and intensity of fishing effort by the non-catch shares pot sector. Intensity (units: km line/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

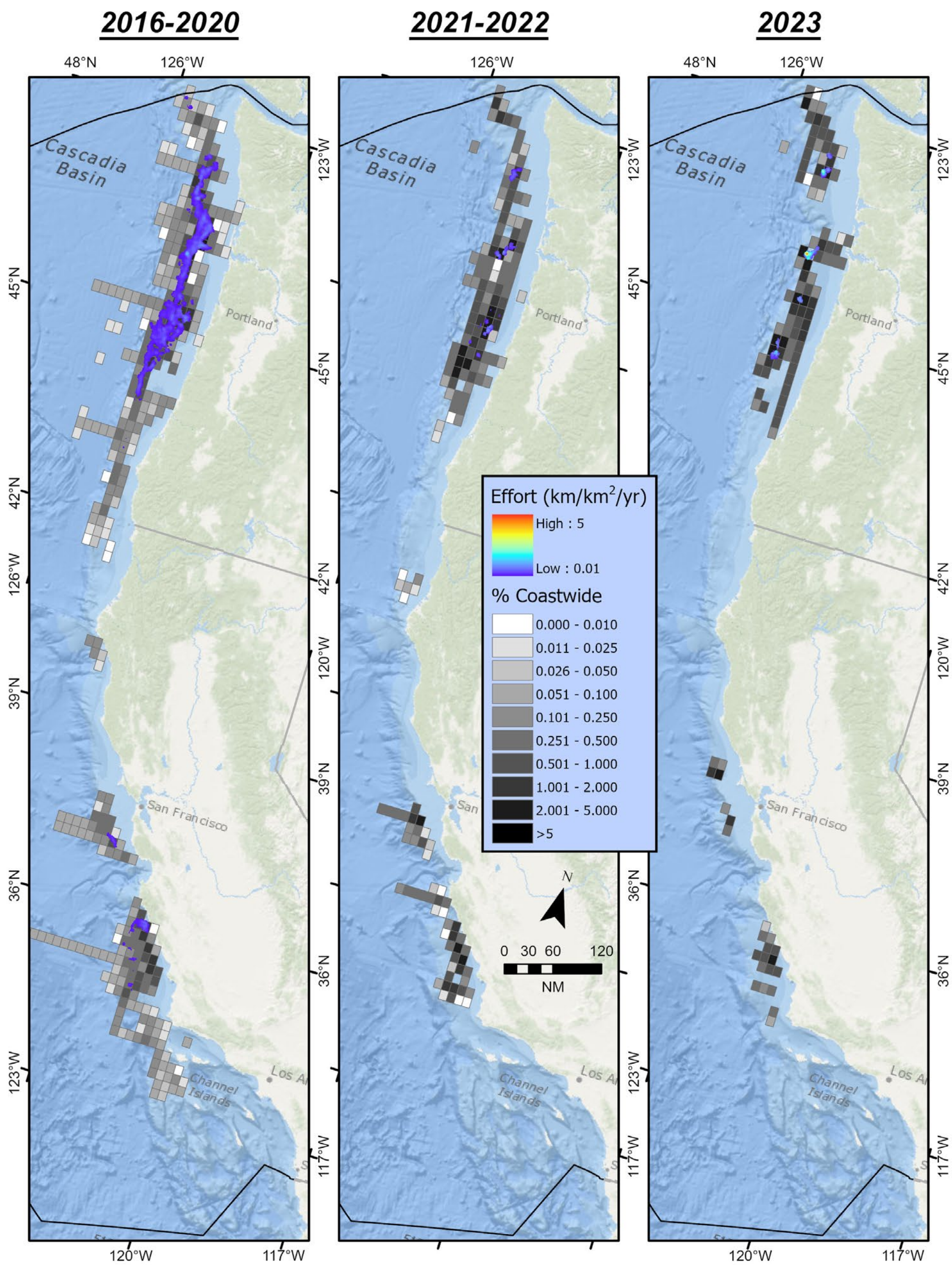

FIGURE 29. Spatial distribution and intensity of fishing effort by the catch shares pot sector. Intensity (units: km line /km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

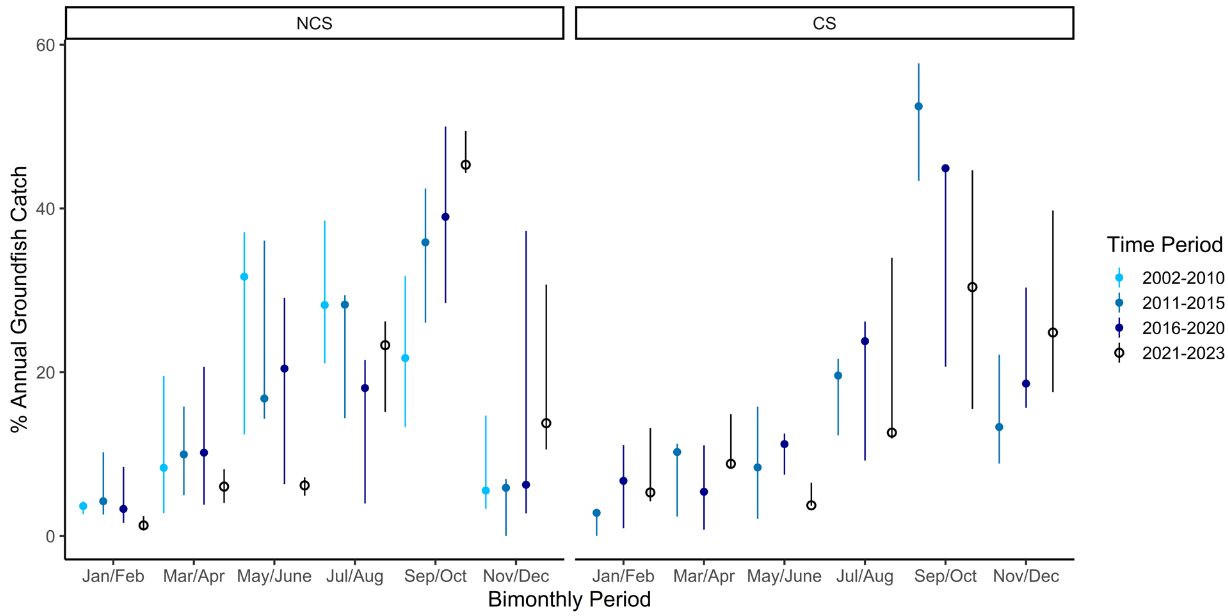

FIGURE 30. Percentage of retained groundfish landed in bimonthly bins by pot sectors. Minimum, median, and maximum are shown for each time period. To maintain confidentiality, the catch shares fleet data are summarized for March through June for 2021.

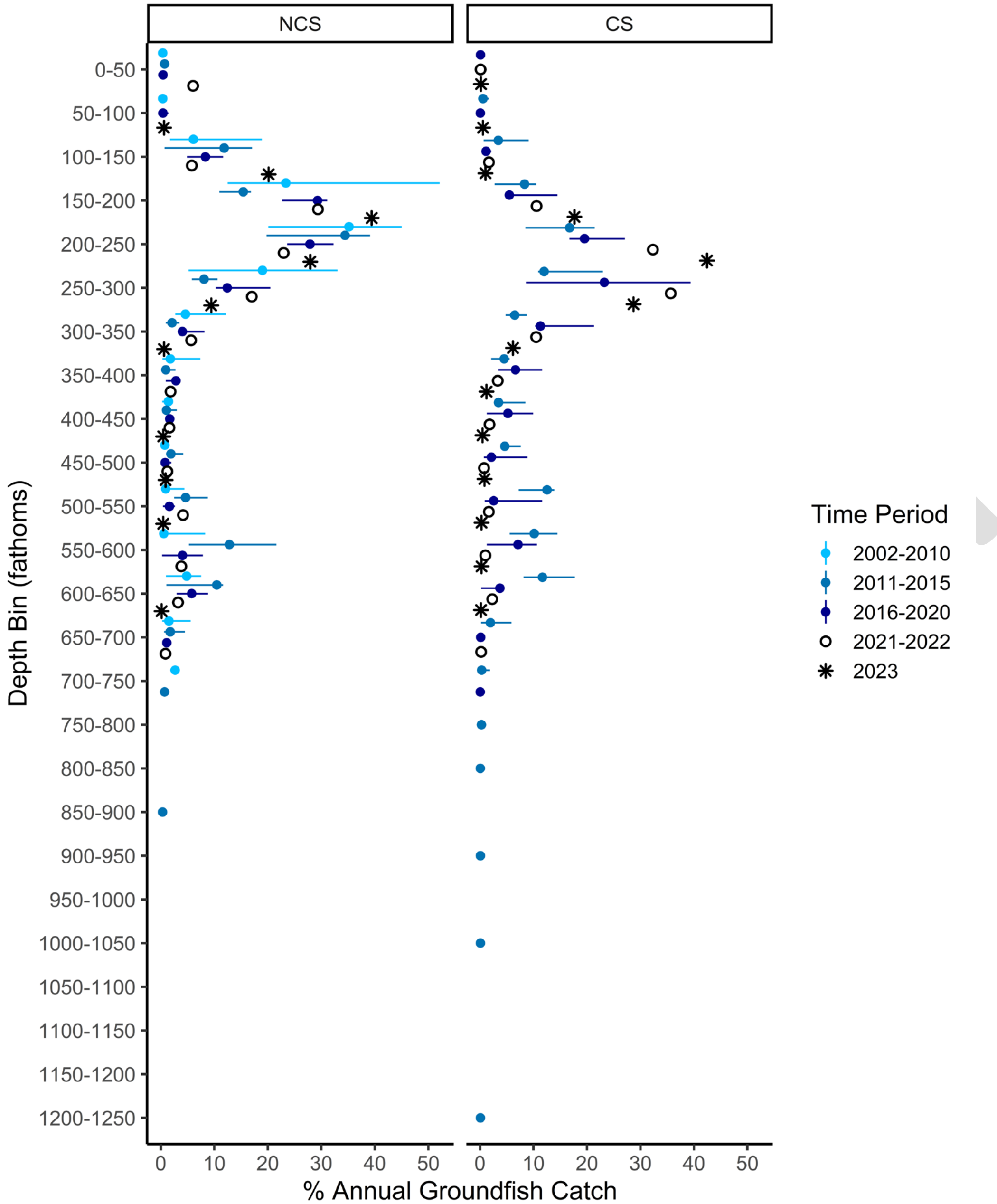

FIGURE 31. Percentage of observed pot sets in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

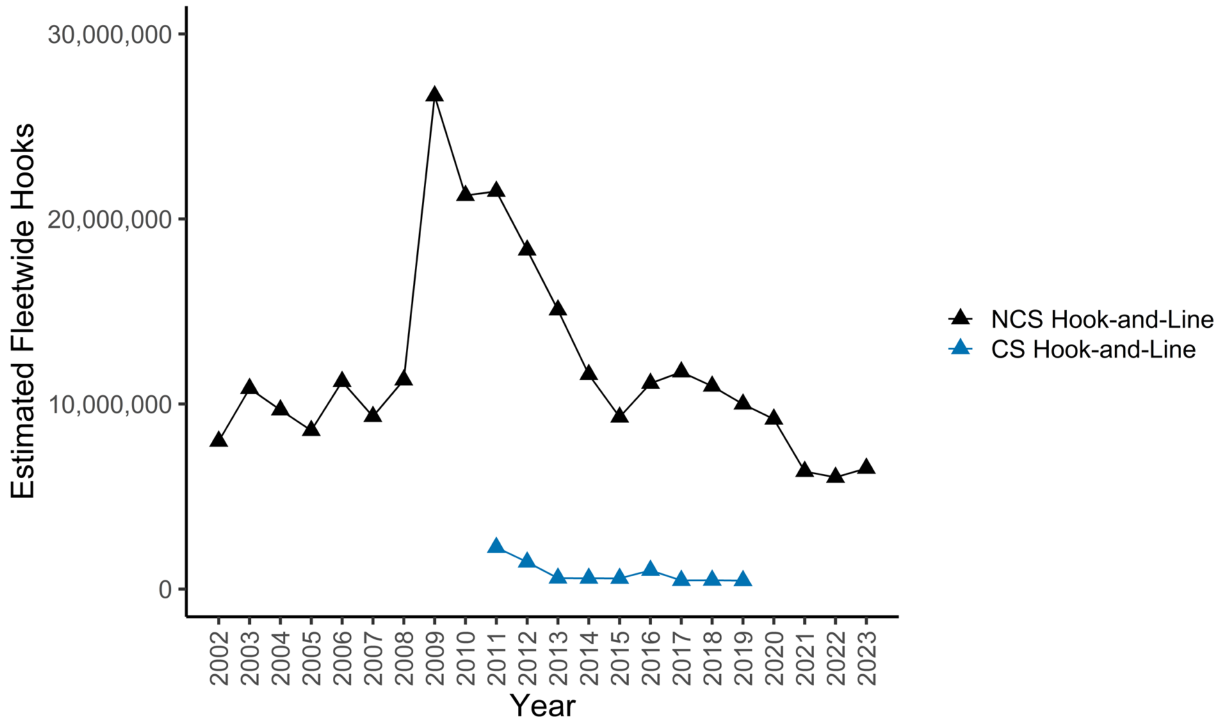

FIGURE 32. Annual total fleetwide number of hooks deployed in hook-and-line sectors.

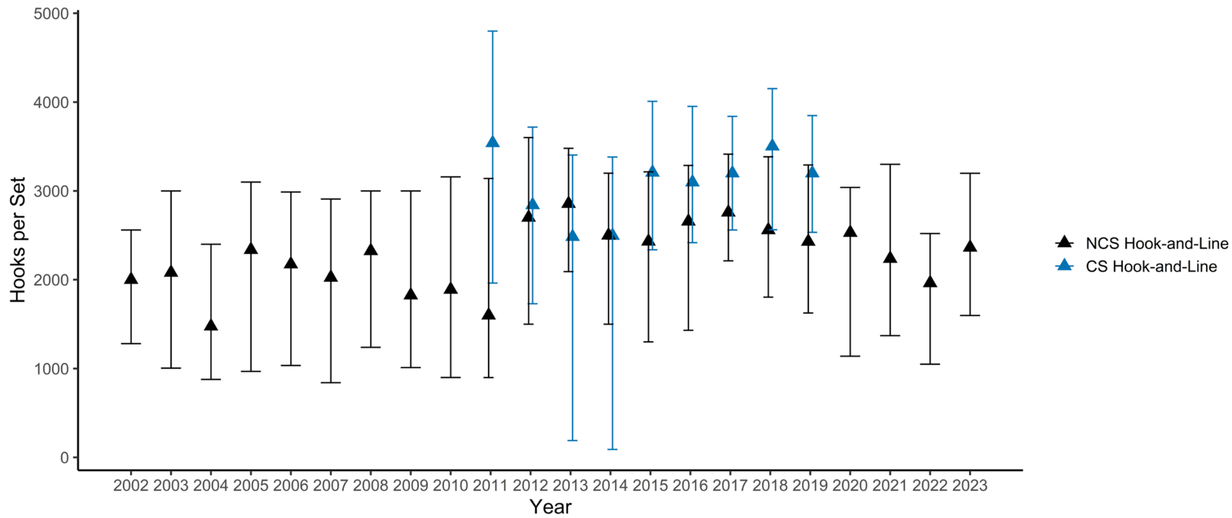

FIGURE 33. Number of hooks per set in hook-and-line sectors, summarized as median, first, and third quartiles in each year.

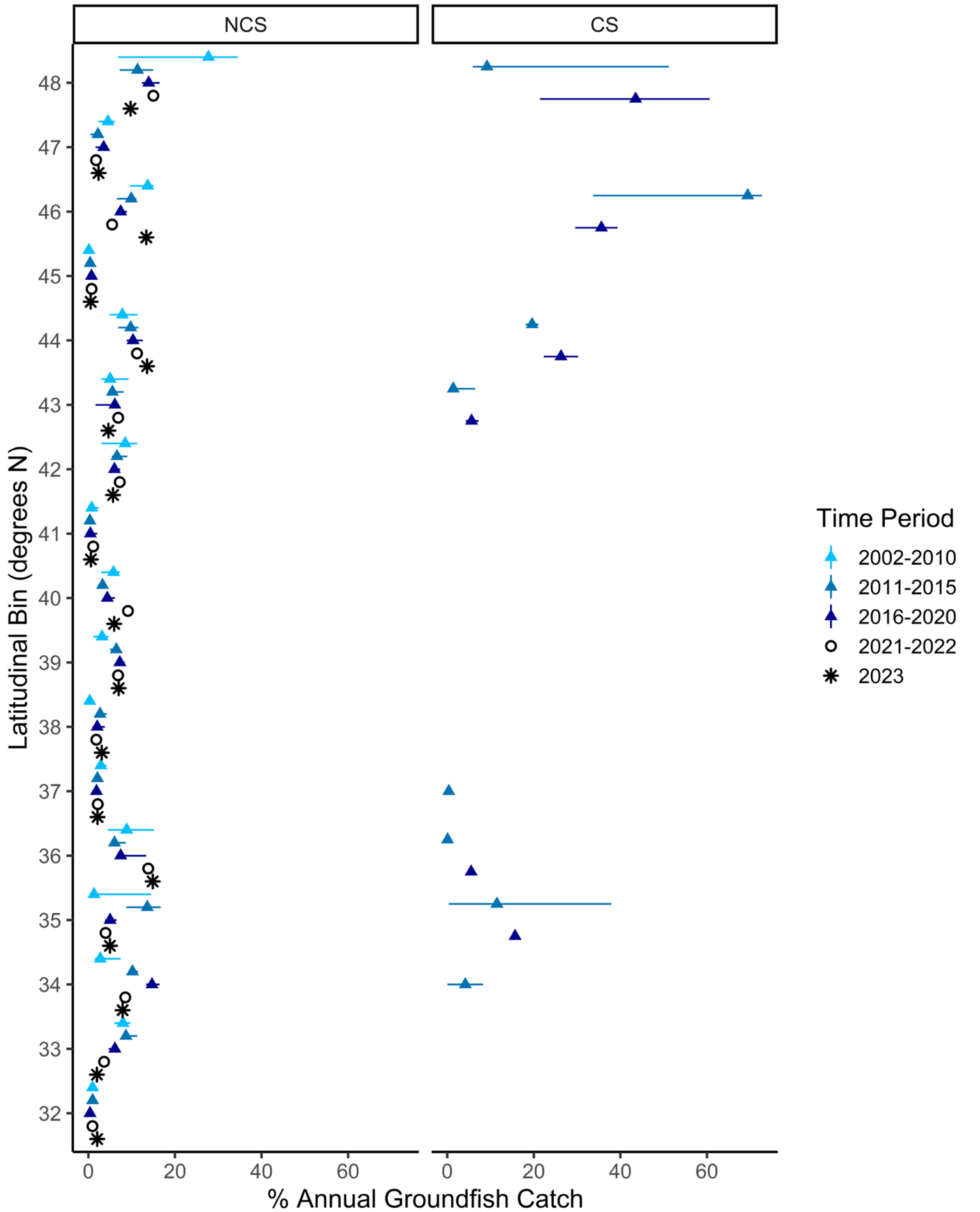

FIGURE 34. Percentage of retained groundfish landed in latitudinal bins by hook-and-line sectors patterns in actual fishing activity are shown in Figures 36 and 37. Minimum, median, and maximum are shown for each time period.

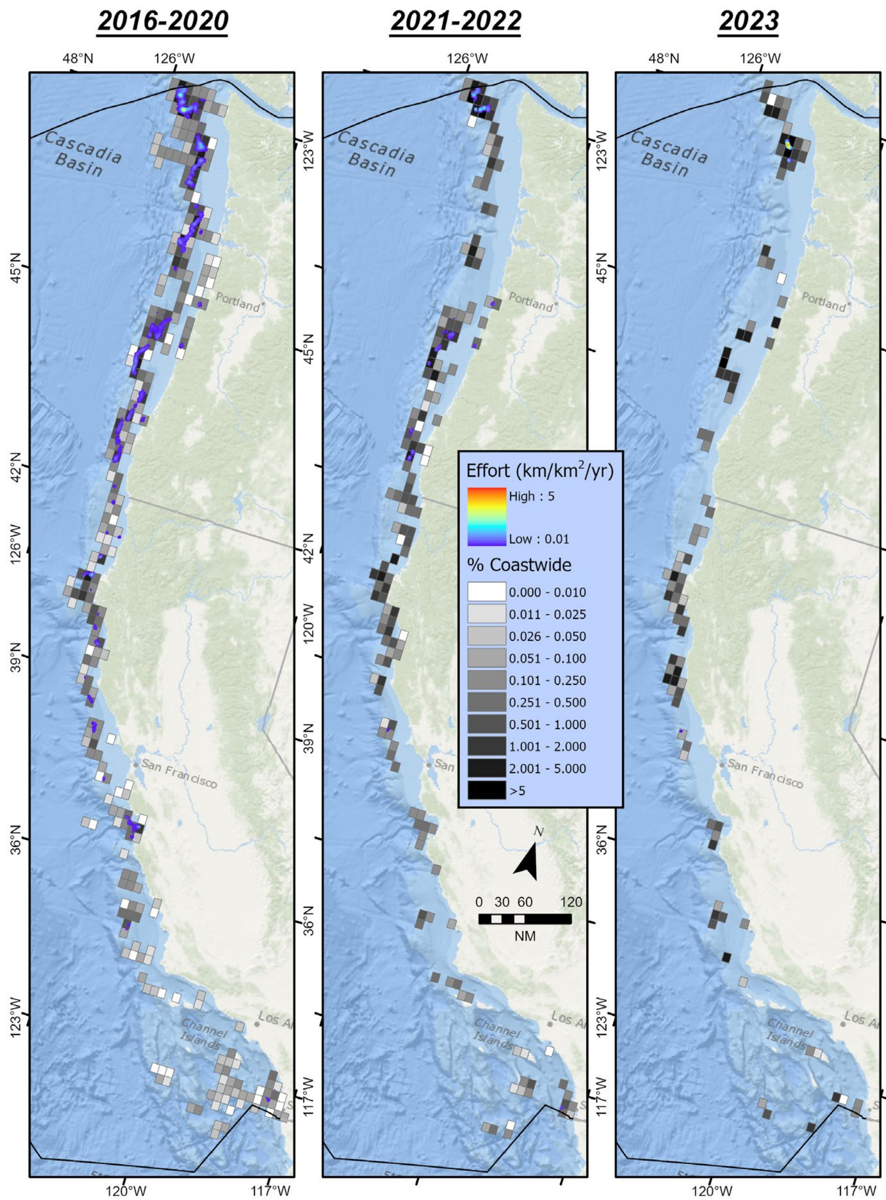

FIGURE 35. Spatial distribution and intensity of fishing effort by the non-catch shares hook-and-line sector. Intensity (units: km line/km^2/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

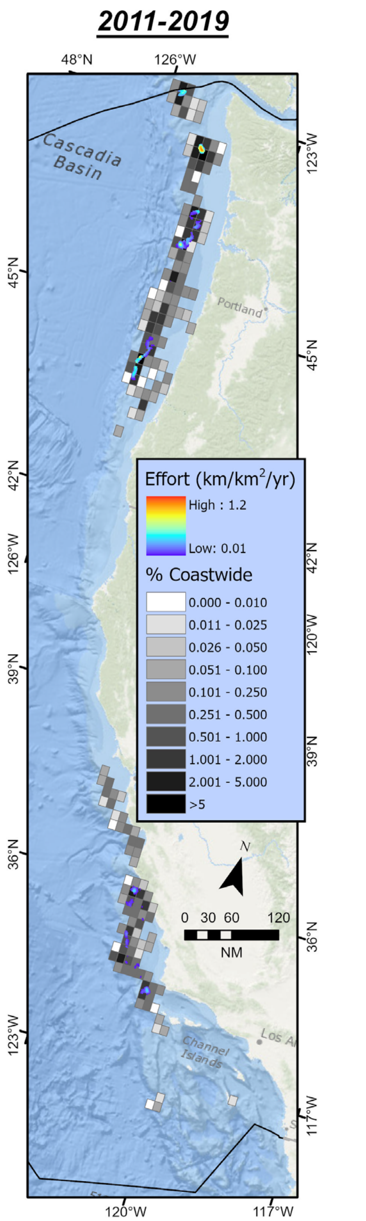

FIGURE 36. Spatial distribution and intensity of fishing effort by the catch shares hook-and-line sector. Intensity (units: km line/km²/yr) is depicted by a color ramp of cool (low) to warm (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker (black) tones depicting a higher relative contribution to coastwide effort within 10x10 min cells.

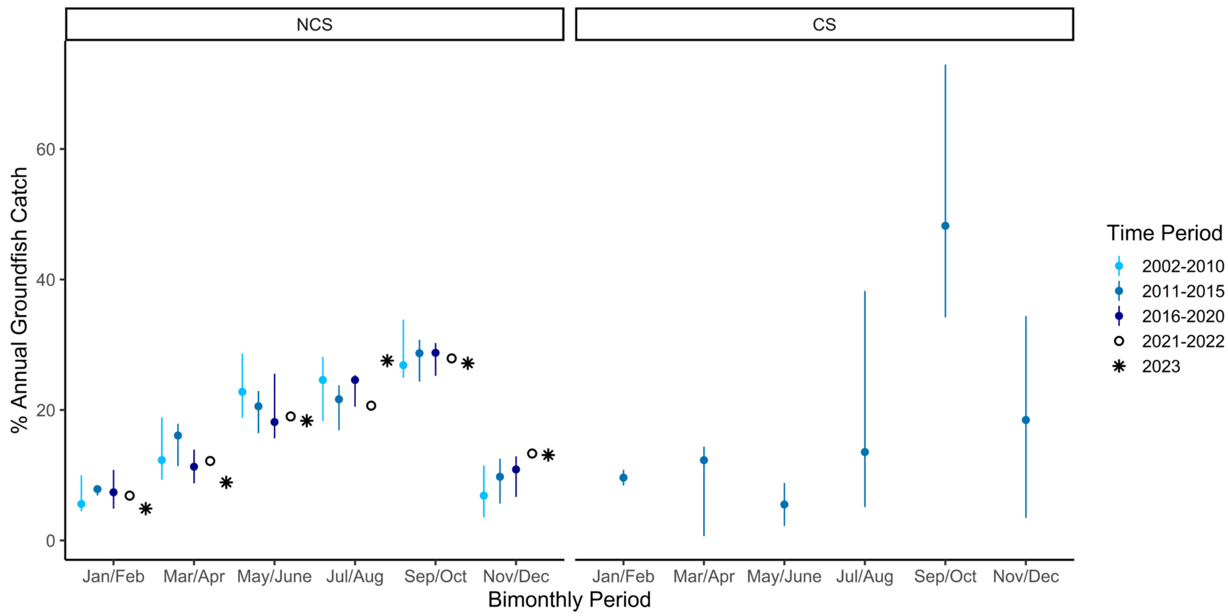

FIGURE 37. Percentage of retained groundfish landed in bimonthly bins by hook-and-line sectors. Minimum, median, and maximum are shown for each time period. Catch shares data beyond 2018 are not shown to maintain confidentiality, because less than 3 vessels were active in some of the seasonal strata.

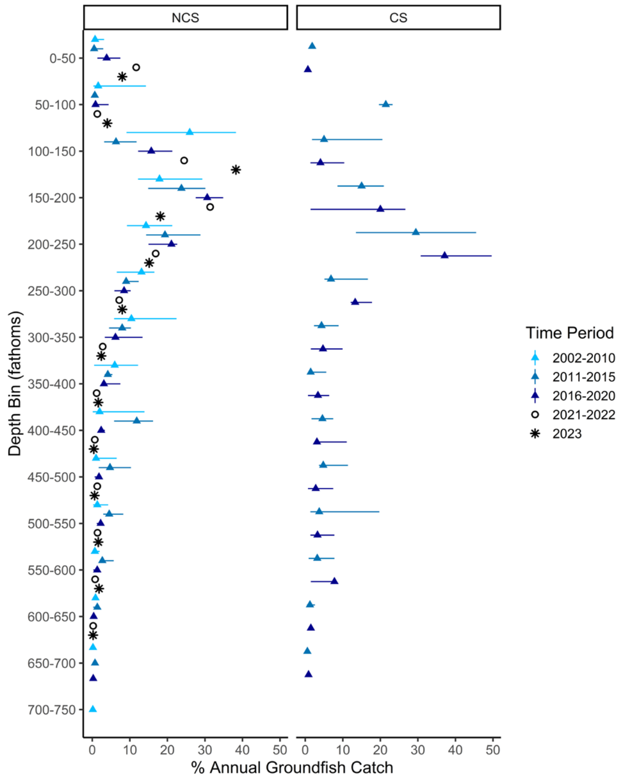

FIGURE 38. Percentage of observed hook-and-line sets in 50-fathom depth bins. Minimum, median, and maximum are shown for each time period.

TABLES

TABLE 1. Data sources for reported metrics for each sector and gear and time periods analyzed by sector and gear.

Sector and Gear	Landings	Gear Usage	Location of Effort	Geospatial Analysis	Seasonal Timing of Effort	Depth of Effort	Time Periods Analyzed
LE Bottom Trawl	Fish tickets	Logbook	Fish tickets	Logbook	Fish tickets	Logbook	2002 to mid-2006; mid-2006 to 2010. Seasonal: 2002 to 2005; 2007 to 2010.
CS Bottom Trawl	Fish tickets	Logbook	Fish tickets	Logbook	Fish tickets	Logbook	2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
CS Midwater Rockfish Trawl	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
CS SS Midwater Hake Trawl	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
CS At-Sea CP	A-SHOP	A-SHOP	A-SHOP	A-SHOP	A-SHOP	A-SHOP	2002 to 2005; 2006 to 2010; 2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
CS At-Sea MSCV	A-SHOP	A-SHOP	A-SHOP	A-SHOP	A-SHOP	A-SHOP	2002 to 2005; 2006 to 2010; 2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
NCS Pot	Fish tickets	WCGOP, Fish Tickets	Fish tickets	WCGOP	Fish tickets	WCGOP	2002 to 2010; 2011 to 2015; 2016 to 2020; 2021 to 2022; 2023. Seasonal: 2002 to 2010; 2011 to 2015; 2016 to 2020; 2021 to 2023.
CS Pot	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	2011 to 2015; 2016 to 2020; 2021 to 2022; 2023. Seasonal: 2011 to 2015; 2016 to 2020; 2021 to 2023.
NCS Hook-and-Line	Fish tickets	WCGOP, Fish Tickets	Fish tickets	WCGOP	Fish tickets	WCGOP	2002 to 2010; 2011 to 2015; 2016 to 2020; 2021 to 2022; 2023.
CS Hook-and-Line	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	Fish tickets	WCGOP, Logbook	2011 to 2015; 2016 to 2020. Seasonal: 2011 to 2015. Maps: 2011 to 2019.