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Fishing Effort in the 2002–19 U.S. Pacific Coast Groundfish Fisheries

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NOAA FISHERIES

Fishing Effort in the 2002–19 U.S. Pacific Coast Groundfish Fisheries

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The tables in this report, described below, can be accessed by following the "Supporting Files" link on the report's NOAA Institutional Repository[1] record and downloading the attached Excel file.

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

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 plan for fishery management that first went into effect in 1982. NOAA Fisheries has since declared all overfished groundfish, except yelloweye rockfish, rebuilt.

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

In this report, we focus on trends in fishing effort, in part to help evaluate how the catch share program (implemented in 2011) may impact endangered species in Pacific Coast fisheries. This report is updated every two years. Here we add the years 2018 and 2019 to the time series.

Key Takeaways

We present data by sector. First we look at the trawl sectors (grouped by gear, target species, and shoreside or at-sea processing), then the fixed gear sectors (grouped by gear type and catch shares or non-catch shares). We also provide data on lost and recovered fishing gear.

- In the bottom trawl sector, effort has been decreasing since 2013. The average length of hauls has also decreased since 2011. Most effort takes place near Astoria, Oregon, with hotspots near Newport, Oregon, and Fort Bragg, California.
- Annual catch limits in the midwater trawl sector (targeting rockfish) increased for yellowtail and widow rockfish. This appears to have revived this fishing sector, as effort has generally increased since 2011. Most effort occurs from central Washington to central Oregon, with more than half of all landings taking place near the Washington–Oregon border.
- The midwater trawl fleets targeting Pacific hake have all decreased in recent years. Towing hours have been variable, though in one sector (shoreside processing) they reached an almost historical high in 2019.

- Pot landings in the catch share sector have been slightly increasing, while non-catch share pot landings have been stable. Catch share pot landings occurred primarily near Astoria and Newport; non-catch share pot landings occurred primarily between Astoria and Fort Bragg.
- Groundfish landings in the hook-and-line sector have been decreasing since 2017 in the non-catch share fleet. They were fairly consistent between 2013 and 2019 in the catch share fleet. Landings by the non-catch share fleet remain more distributed along the coast than in the catch share fleet.
- We observed only a small percentage of gear lost at sea.

Links used in this section:

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

Executive Summary

This report analyzes trends in fishing effort of U.S. West Coast groundfish fisheries during the period 2002–19, 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 developments in 2017–18 and 2019. This analysis contextualizes the other reports required by this BiOp, and this executive summary highlights significant changes in the most recent three years of data.

Groundfish landings in the bottom trawl sector, in both 2018 and 2019, were the lowest since 2002. Total fleetwide towing hours and median duration of tows in the bottom trawl sector also declined. Spatial and depth distribution patterns of landings and effort were similar from 2011 to 2019 and showed a continued concentration to the north and into deeper waters. Seasonal patterns were also similar from 2011 to 2019, although the proportion of landings made in November–December 2018 were the highest on record for that bimonthly period.

Groundfish landings in the midwater rockfish trawl sector increased from 2011 to 2019, although landings decreased slightly in 2019, for the first time since 2016. The median tow duration remained between 1.2 and 1.8 hours. The spatial distributions of landings were similar across all years, although landings near Bellingham, Washington, at lat 48°N, were lower in 2017–19 than in 2011–16. Effort in this fishery has expanded to reach from the U.S.–Canada border to Northern California. A greater proportion of landings were made earlier in the year in 2017–19, reflecting an exempted fishing permit that allowed some vessels to fish prior to mid-May. The depth distributions of effort were similar across all time periods.

Pacific hake (a.k.a. Pacific whiting, hereafter: "hake") landings in the shoreside and at-sea hake sectors increased from 2011 to 2017, but decreased in 2018 and 2019. Total towing hours by the shoreside fleet reached an almost historic high of 6,600 hours in 2019, while the total number of hours of towing by the at-sea processing fleet was lower in 2017–19 when compared to the historic highs of 2016. Compared to 2011–16, the shoreside fleet in 2017–19 landed a lower proportion of hake near Newport, Oregon, and a greater proportion in Astoria, Oregon. The shoreside fleet landed a larger proportion of annual catch in May–June in 2017–19 than in the same period in 2011–16, reflecting a regulatory change in season start date. The majority of annual landings by the shoreside fleet occurred in 50–150 fathoms (fth) in 2017–19, shallower than in 2011–16. Fishing effort in the at-sea hake midwater trawl fishery was mainly concentrated off Oregon across all time periods. In 2017–19, catcher–processor (CP) effort continued to decrease around lat 45°N and was highly variable around lat 44°N. Mothership catcher vessel (MS) effort in 2017–19 was more concentrated around lats 47°N and 43°N than in previous years. The proportion of CP landings processed in the May–June and November–December periods increased from 2017 to 2019, and the MS landings processed in May–June increased from 43–97% over the same time period. From 2006 to the present, more than 80% of CP and MS landings came from hauls in 100–250 fth; from 2017 to 2019, this increased to almost 90%.

Annual groundfish landings in the non-catch share (NCS) pot/trap fleet remained around 600 metric tons (mt) from 2015 to 2019, while the catch share (CS) pot fleet showed a slight but generally increasing trend from 2013 to 2019 and peaked at more than 850 mt in 2019. Both sectors increased the amount of pot gear deployed from 2013 to 2017, before a decrease in 2018 and slight rebound in 2019. From 2011 to 2019, the majority of landings by the NCS pot fleet occurred between Astoria and Fort Bragg, California. From 2017 to 2019, landings in Astoria and Newport together accounted for more than half of annual CS pot catch. CS pot effort south of lat 40°10′N continued to decrease in 2017–18 and 2019, although two areas of concentrated effort persisted off of San Francisco and Fort Bragg. The proportion of NCS pot landings in September–October increased from 2017 to 2019, reaching a historic high of 46%. The proportion of CS pot landings in September–October in 2017–19 was around 25%, half of the median for 2011–16. From 2017 to 2019, CS pot effort became increasingly more concentrated in shallower depths (150–400 fth).

Groundfish landings by the NCS hook-and-line fleet ranged from 2,000–2,400 mt in 2012 to 2019, and decreased between 2017 and 2019. The median number of hooks per set in the NCS fleet remained around ~2,500 hooks per set from 2014 to 2019. CS hook-and-line landings have been lower and less variable than NCS, ranging from 115–200 mt of groundfish from 2013 to 2019. CS hook-and-line effort has generally decreased from 2011 to 2019, and hooks per set in the CS hook-and-line fleet generally increased from 2013 to 2019 and have remained around 3,200 since 2015. From 2017 to 2019, the proportion of NCS hook-and-line landings occurring in the lat 48°N, 39°N, and 34°N bins increased slightly. Landings in the CS hook-and-line fleet were much more concentrated, with more than half occurring in the lat 48°N bin in both 2017 and 2019. No landings in the CS hook-and-line fleet occurred south of lat 43°N after 2016. Seasonal and depth distributions were similar for both NCS and CS hook-and-line fleets across all time periods.

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The authors are grateful to the many A-SHOP and WCGOP observers who work hard under sometimes extreme conditions to collect these valuable data. The authors would also like to thank members of the Groundfish Endangered Species Work Group for helpful feedback and suggestions. Additionally, the authors are very appreciative of an extensive review from Lewis Barnett (Alaska Fisheries Science Center), whose comments greatly improved this report.

Introduction

The Pacific Fishery Management Council (PFMC) designs and adapts the groundfish fishery management plan (FMP; PFMC 2020), 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 (2002–19), but focus the main analyses on trends 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 this 18-year period. 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 2020), 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 quota, each vessel is required to be monitored on all trips, either via a federal observer or, starting in 2015, via electronic monitoring (EM).

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. Second, with the new explicit accounting of all discard, 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

Unlike the shore-based fleet, which delivers catch to processors on land, the at-sea hake midwater trawl fleet processes catch onboard while at sea. The at-sea midwater trawl fishery 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 catch 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 MSes 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 so 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 18 years.

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 2019. 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 (2002–17) and analyzes two additional years of data, 2018 and 2019. 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 (2011–19).
    - CS Midwater Rockfish Trawl: IFQ shoreside midwater trawl targeting rockfish (2011–19).
2. Midwater trawl targeting hake:
    - CS SS Midwater Hake Trawl: IFQ shoreside midwater trawl targeting hake (2011–19).
    - CS AS CP: At-sea midwater trawl targeting hake, utilizing CPs (2002–19).
    - CS AS MS: At-sea midwater trawl targeting hake, utilizing MSes (2002–19).
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 (2002–19).
    - CS Pot: IFQ pot (2011–19).
    - 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).

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 18 years.

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) state 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 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 catch 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. (2020).[2] WCGOP, A-SHOP, and fish ticket data quality assurance, quality control, and processing methods are described in detail in Somers et al. (2021).

Logbook Data

Vessel logbook recordkeeping is a state-mandated requirement for the LE and CS groundfish bottom trawl sectors in Washington, Oregon, and California. A common format logbook is used by all three states, and vessel-reported logbook information is entered into state agency databases. The electronic logbook data are then uploaded by state agencies to the PacFIN regional database, which is maintained by PSMFC.

Bottom trawl logbook data for 2002–19 were retrieved from the PacFIN database in November 2020. These data were assigned into groundfish fishery sectors following procedures described in Somers et al. (2021). Logbook and observer data sometimes have slight discrepancies, so summaries of fleetwide vessels, trips, and hauls may be inconsistent with other reports.

[1] https://www.fisheries.noaa.gov/west-coast/science-data/fisheries-observation-science-west-coast
[2] Somers, K. A., J. E. Jannot, K. E. Richerson, V. J. Tuttle, and J. T. McVeigh. 2020. Fisheries Observation Science Program Coverage Rates, 2002–19. U.S. Department of Commerce, NOAA Data Report NMFS-NWFSC-DR-2020-03.

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 (WA, OR, or CA) 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 April 2020. 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 for fishing effort comparisons. 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. 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 2015–19, 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, and depth than it did 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. These groupings are as consistent as possible across analyses of different metrics, while maintaining the data confidentiality. These time periods are summarized in Table 1 and further described here. 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; the 2006 data were included in all other summaries. The shoreside IFQ fishery was grouped, by gear, into 2011–16 and annually for the most recent three years of data, except in maps, where data were grouped into 2017–18 and 2019 to balance the necessary masking of confidential data with relevant time periods. To address changes around the implementation of IFQ management, we grouped the non-IFQ fixed gear sector into the pre-IFQ period (2002–10), the initial IFQ period (2011–16), and the most recent data (2017, 2018, and 2019 separately, except in maps and as needed to mask confidential data). The at-sea hake fishery was not impacted by the EFH closures, so we grouped years to create approximately equivalent time periods: 2002–05, 2006–10, 2011–16, and the most recent three years' data separately, except in maps as described above.

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 multi-species-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, total fixed-gear units deployed, towing duration per haul, and number of hooks or pots. 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:

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

where:

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

We also calculated the number of sets or hauls where lost gear 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 from 2010 to 2019 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 version 10.7.1 (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 (see How Line Density works).[3] 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

[3] https://desktop.arcgis.com/en/arcmap/10.7/tools/spatial-analyst-toolbox/how-line-density-works.htm

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, and is thus superior to depicting confidential tow lines. 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 larger search radius (5,000 m) was used to develop shoreside processing midwater trawl and fixed gear density outputs than for trawl densities (3,000 m), because effort in those sectors was generally patchier compared to the bottom and at-sea processing midwater trawl sectors. Because the density outputs cannot fully capture the entire footprint of fishing, we summarized length of all lines intersecting 10 × 10-minute cells. Cumulative lengths were divided by the total length of all lines for each gear sector and time period, and reported as relative coastwide effort (%).

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. To maintain confidentiality, we combine data for 2017 and 2018 for the catch share pot fleet. We do not report data for 2017, 2018, or 2019 for the catch share hook-and-line fleet because fewer than three vessels fished in each bimonthly period.

Depth of Effort

Patterns in fishing effort by depth were explored by calculating the proportion of hauls 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 ~15,000 mt of FMP groundfish species in both 2018 and 2019, the lowest annual catch by the bottom trawl fleet since 2002 (Table 2, Figure 1). Fleetwide bottom trawl effort continued to decrease from the high of the catch share period in 2013 and was almost half that level in 2019 (Table 2, Figure 2). Median haul duration has generally decreased since 2011 to around three hours in 2018 and 2019 (Table 2, Figure 3).

The spatial distributions of landings in 2017, 2018, and 2019 were similar (Table A-1, Figure 4). The greatest proportions of landings were made near Astoria, Oregon (lat 46°N), but were lower in all three years than in 2011–16 (Table A-1, Figure 4). Landings near the ports of Newport, Oregon (lat 44°N), and Fort Bragg, California (lat 40°N), each comprised approximately 20% of coastwide landings. The proportions of landings north of lat 46°N and south of lat 39°N for the most recent three years remained low and similar to past landings in those areas.

Maps of average annual fishing intensity illustrated these patterns in more detail and revealed the similarity of spatial distribution and intensity patterns from 2011 to 2019 (Figure 5). The more recent time periods illustrate the continued concentration of effort in the northern part of the coast and in deeper, farther-offshore waters. Effort in the southern parts of the coast is relatively low and patchy in the few places that bottom trawl fishing occurs, and almost no effort occurred south of lat 36°N in 2019.

Seasonal patterns of landings in 2017, 2018, and 2019 largely fell within the patterns observed in previous time periods, although the proportion of catch landed in November–December 2018 was the highest on record for that bimonthly period. The proportion of landings in all three years was lowest in January–February, and highest in March–April and November–December (Table A-2, Figure 6).

The proportion of hauls in the 0–50-fth depth bin continued to decrease, while activity in 50–100-fth waters increased slightly (Table A-3, Figure 7). 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 increased targeting opportunities, the CS midwater trawl rockfish fleet has re-emerged. Groundfish landings and effort in this sector generally increased from 2011 to

2019, although groundfish retained decreased slightly in 2019 for the first time since 2016 (Table 2, Figure 1 and Figure 2). Variation in tow duration per haul in the midwater rockfish trawl fleet has been similar from 2011 to 2019, and the median has remained between 1.2 and 1.8 hours (Table 2, Figure 3).

From 2011 to 2016, landings of midwater rockfish occurred from central Washington to central Oregon; in 2017 to 2019, a small amount of landings also occurred in southern Oregon and, as part of an exempted fishing permit (EFP), in northern California (Table A-1, Figure 8). More than half of the landings across all years occurred along the Oregon–Washington border at lat 46°N. Around 25% of landings in 2017, 2018, and 2019 occurred near Newport in the 44°N latitudinal bin, similar to the median value for 2011 to 2016. Landings near Bellingham, Washington (lat 48°N) were much lower in 2017, 2018, and 2019 than in 2011–16. Mapping the fishing effort shows that, even as effort continues to concentrate off of Astoria, the range of this fishery has expanded to reach from the U.S.–Canada border to northern California (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. Subsequently, approximately 10% of landings in 2018 and 2019 were made in January–February, and the percent of landings in March–April increased from 7% in 2017 to more than 25% in 2019 (Table A-2, Figure 10). The high variability in percent of landings made in July–August for 2011 to 2016 reflects the re-emergence of the targeting strategy during this period.

The depth distribution of midwater rockfish trawl effort in 2017–19 was similar to that of 2011–16, with more than 75% of effort occurring in the 50–100-fth depth bin in most years (Table A-3, Figure 11). The proportion of effort in the 100–150-fth depth bin increased from 2017 to 2019, but remained below the 2011–16 maximum of 27%.

Midwater trawl targeting hake

Landings by all three sectors of the hake-targeting midwater fleet increased from 2015 to 2016 (Table 2, Figure 12), and annual hake landings in the shoreside and CP fleets continued to increase in 2017. The two fleets decreased in 2018 and 2019, despite nearly constant allocations from 2017 to 2019. The MS fleet remained constant from 2016 to 2018 and then decreased substantially in 2019.

Effort, measured by total number of hours towing, increased in the shoreside fleet from 2016 to an almost historical high of 6,600 hours in 2019 (Table 2, Figure 13). Both at-sea processing fleets were more variable in recent years, but were lower in 2017–19 than their historic highs in 2016. Towing hours per haul were highly variable, ranging from 1–4 hr between 2017 and 2019. However, on average, the duration of shoreside and MS hauls was around 2–2.5 hr, while hauls by the CP fleet were slightly higher, at 2.5–3.3 hr (Table 2, Figure 14).

Shoreside hake fleet

Compared to 2011–16, the shoreside fleet in 2017 to 2019 landed a lower proportion of hake near Newport (44°N latitudinal bin) and a greater proportion near Astoria (46°N latitudinal bin; Table A-4, Figure 15). Fishing effort occurred from the U.S.–Canada border to the Oregon–California border across all three time periods, with a small amount occurring off of northern California between 2011 and 2016 (Figure 16). Across all three time periods, fishing effort was concentrated off of Newport, with additional hotspots farther north in 2017–18 and 2019.

In 2015, the shoreside fleet's opening date shifted from 15 June to 15 May to coincide with the at-sea sector. Reflecting this change, the fleet landed a greater proportion of annual catch in May–June in 2017 to 2019 than it did in 2011–16. The proportion of landings in all other bimonthly periods in 2017 to 2019 were on the low end of the range observed in 2011–16 (Table A-5, Figure 17). The majority of landings continued to occur in July and August in most years.

The majority of annual landings by the shoreside fleet occurred in 50–150 fth in 2017–19, shallower waters than in 2011–16 (Table A-6, Figure 18). The shoreside midwater fleet landed a greater proportion of its catch in 50–100 fth in 2017–19 and in 100–150 fth in 2017 and 2018, compared to earlier years. The proportion of catch made in 150–250-fth depths was lower in 2017–19 than in 2011–16.

At-sea hake fleet

Fishing effort in the at-sea midwater hake trawl fishery concentrated off Oregon across all time periods (Table A-4, Figure 19). The distribution of CP effort was fairly evenly distributed from lat 48–42°N across all time periods. In 2017–19, effort continued to decrease around lat 45°N and was highly variable around lat 44°N. Maps of CP fishing effort for 2017–18 show a hotspot off of Newport, while effort in 2019 was more concentrated between lat 48–47°N and around lat 43°N (Figure 20).

The spatial distribution of MS effort in 2017–19 was also similar to that of earlier time periods, with greater proportions of landings generally occurring around lat 47°N and lat 43°N (Table A-4, Figure 19). Mapping this effort further emphasizes the similarity of spatial distribution from 2011 to 2019, including an area of concentrated fishing around lat 44–43°N present in all three time periods (Figure 21).

The midwater at-sea fleet's season begins on 15 May. The proportion of CP landings processed in the May–June and November–December periods increased from 2017 to 2019, while the proportion remained near zero in July–August and decreased in September–October (Table A-5, Figure 22). The majority of MS landings were processed in May–June in most years, and increased from 43–97% from 2017 to 2019. Landings processed in September–October decreased from 53–5% over the same time period, and less than 8% of landings were processed in July–August or November–December from 2017 to 2019.

Since 2006, more than 80% of CP and MS landings have come from hauls in 100–250 fth; from 2017–19, this pattern increased to almost 90% or more in each year (Table A-6, Figure 23).

Fixed Gear Sectors

Pot

Annual groundfish landings using pot gear were fairly stable from 2015–19 in the NCS fleet, at about 600 mt, while the CS fleet showed a slight but generally increasing trend from 2013–19, with a high of more than 850 mt (Table 3, Figure 24). Based on landings and observer data in the NCS fleet and census monitoring in the CS fleet, both sectors increased the total number of pots deployed from 2013 to 2017, before a decrease in 2018 and slight rebound in 2019 (Tables 3 and 4, Figure 25). Since 2011, the median number of pots per set in both the CS and NCS pot fleets has ranged between ~15 and ~40 (Table 3, Figure 26). The median number of pots per set has been greater in the NCS than the CS fleet in all years except 2013 and 2018.

From 2002–19, the majority of landings by the NCS pot fleet occurred between Astoria (lat 48°N) and Fort Bragg (lat 39°N; Table A-6, Figure 27). From 2017–19, landings in the 44°N latitudinal bin increased from 19–36% of annual catch, while landings in the 39°N latitudinal bin decreased from 29–23%. Landings in Astoria and Newport (lat 44°N) together accounted for more than half of annual CS pot landings from 2017 to 2019, and were at the high end of or above the 2011–16 range (Table A-6, Figure 27). Landings in other parts of the coast largely showed the opposite pattern, including that 2017–19 landings in the 35°N latitudinal bin were below the 2011–16 minimum.

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 similarly distributed effort along the entire U.S. West Coast from 2011 to 2019 (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). Fishing in the southern part of the coast continued to decrease in 2017–18 and 2019, although two concentrated effort areas persist off of San Francisco and Fort Bragg. This new area of fixed gear fishing may represent initiatives introduced with catch share implementation that supported a shift from trawl to fixed gear fishing near Morro Bay, California.

From 2002–16, the majority of landings by the NCS pot fleet occurred between May and October (Table A-8, Figure 30). Landings typically peaked in May–June and July–August prior to IFQ implementation in 2011, when this peak shifted to September–October. The proportion of landings occurring in both July–August and September–October increased from 2017 to 2019 and reached a historic high of 46% of landings in September–October 2019. Landings in May–June decreased from 2017 to 2019, with a historic low of 8% in 2019. To mask confidential data, seasonal catch data for the CS pot fleet from January to April across all years and from 2017 and 2018 across all periods are summarized together. Landings from January to June in 2017–19 were within the range of 2011–16, but were near or above the maximum in July–August and November–December. In 2017–19, around 25% of catch was landed in September–October, as compared to a median of 50% in 2011–16.

From 2002–19, fishing effort in the NCS pot fleet occurred primarily in depths from 100–300 fth (Table A-9, Figure 31). The depth distribution of landings from 2017 to 2019 were generally within those of 2002–10 and 2011–16. The majority of CS pot fleet effort in 2011–16 occurred in depths from 150–600 fth. From 2017 to 2019, this effort became increasingly more concentrated in shallower depths, from 150–400 fth.

Hook-and-line

Groundfish landings by the NCS hook-and-line fleet ranged from 2,000–2,400 mt from 2012 to 2019, and recently decreased between 2017 and 2019 (Table 3, Figure 24). Estimated fleetwide hooks, calculated from total landings and observed hooks per set (see Table 4), showed a similar pattern, and on average remained around 11 million hooks per year (Table 3, Figure 32). The median number of hooks per set in the NCS fleet was 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 2019 (Table 3, Figure 33).

CS landings have been lower and less variable than NCS landings, ranging between 115–200 mt of groundfish from 2013 to 2019. CS effort has generally decreased from 2011 to 2019, and remained around a half-million hooks in all years from 2013 to 2019 except 2016 (Table 3, Figure 32). Hooks per set in the CS fleet generally increased from 2013 to 2019, and have remained around 3,200 since 2015.

Hook-and-line groundfish landings occurred from lat 48–32°N (Table A-7, Figure 34). Generally, landings by the NCS hook-and-line fleet were fairly evenly distributed along the coast. From 2017 to 2019, the proportion of landings occurring in the 48°N, 39°N, and 34°N latitudinal bins increased slightly. Landings in the CS fleet were much more concentrated, with more than half occurring in the 48°N latitudinal bin in both 2017 and 2019. Landings also increased in the 46°N latitudinal bin from 2017 to 2019, but remained at the lower range of 2011–16. No landings in the CS fleet occurred south of lat 43°N after 2016.

Observed effort in the NCS hook-and-line fleet occurred along the entire U.S. West Coast and was similar across the three analyzed time periods, although a hotspot near the U.S.–Canada border was present in both 2017–18 and 2019 (Figure 35). Due to the small number of vessels participating in the CS hook-and-line fleet, all years were summarized together and show areas of concentrated effort—in the north, off of Washington and Oregon, and in the south, off of southern California (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-8, Figure 37). To protect confidential data, the seasonal distributions of CS hook-and-line landings in 2017, 2018, and 2019 could not be shown. In 2011–16, around half of landings occurred in September–October, and landings in July–August and November–December were highly variable.

Both the NCS and CS hook-and-line fleets fish in depths ranging from 0–750 fth (Table A-9, Figure 38). The depth distribution of observed NCS hook-and-line hauls was similar across time periods and years, with the majority of landings coming from hauls in the 150–200-fth depth bin. The majority of CS hook-and-line effort occurred in the 200–250-fth depth bin across time periods and years, 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 bottom trawl fleets, gear loss occurred on ~0.1% of observed hauls annually, and was never observed in shoreside midwater trawl fleets (Table 5). On average, in at-sea midwater fleets, 0.02% of hauls lost gear annually, with a maximum of less than 0.2% (Table 6). Gear loss was observed more often in fixed gear fisheries than in the trawl fleet. Lost gear was observed in the non-catch share hook-and-line fisheries on about 2% of hauls, representing 0.3% of observed hooks. In the catch share hook-and-line fleet, approximately 1% of hauls lost approximately 0.4% of hooks. In the catch share pot fleet, around 4% of hauls lost approximately 0.4% of pots; in the non-catch share pot fleet, around 3% of hauls lost approximately 0.1% of pots.

The percentage of hauls recovering 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 ~3.7% of hauls recovered gear. Midwater gears rarely contact the ocean floor, so gear recovery is exceedingly rare. Less than 0.6% 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 less than 0.3% of observed hauls, with no incidents in most years. Approximately 0.1% of observed pot hauls recovered gear.

Figures

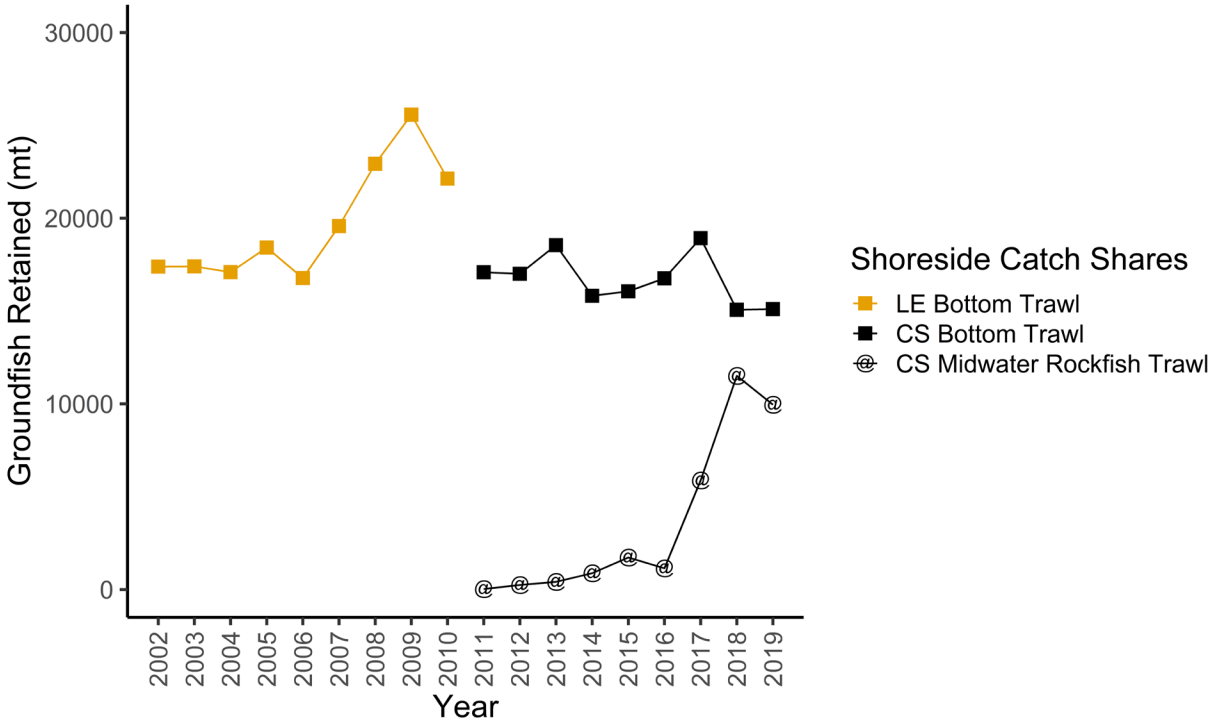

Figure 1. Annual total fleetwide FMP groundfish (not including hake) landings (in mt) in the bottom trawl and midwater rockfish trawl sectors.

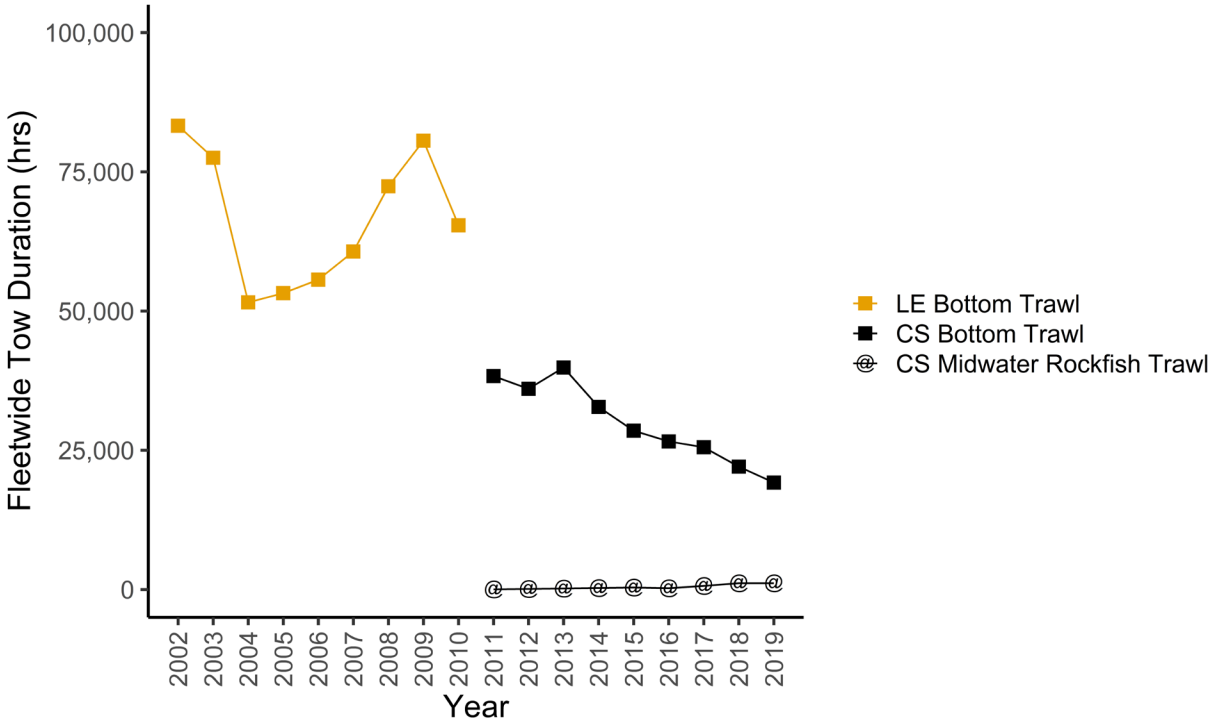

Figure 2. Annual fleetwide total towing hours in the bottom trawl and midwater rockfish trawl sectors.

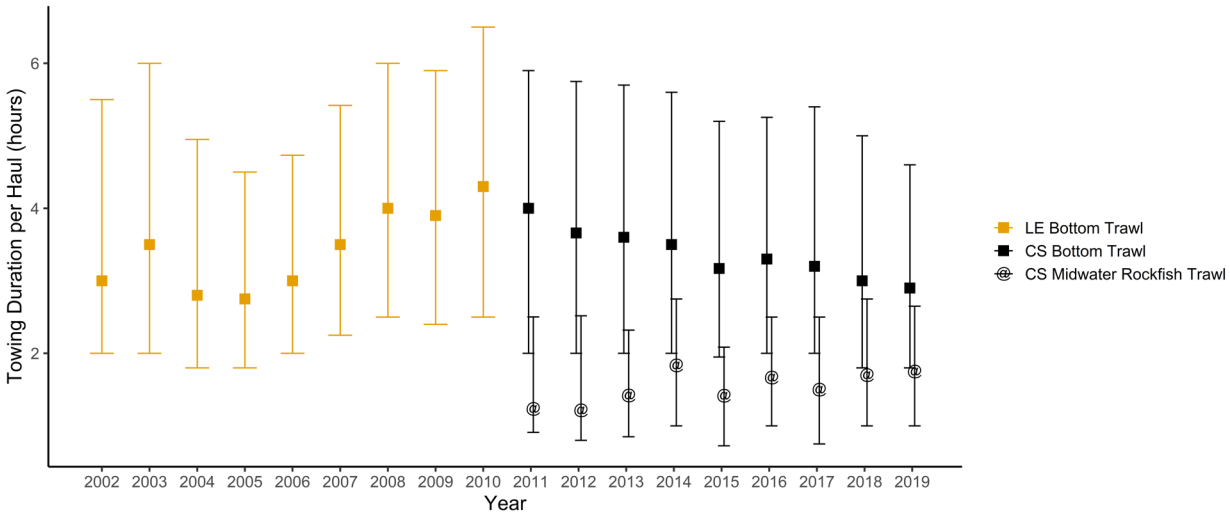

Figure 3. Tow duration per haul (in hours) in the bottom trawl and midwater rockfish trawl sectors. Medians and first and third quartiles for each year are shown.

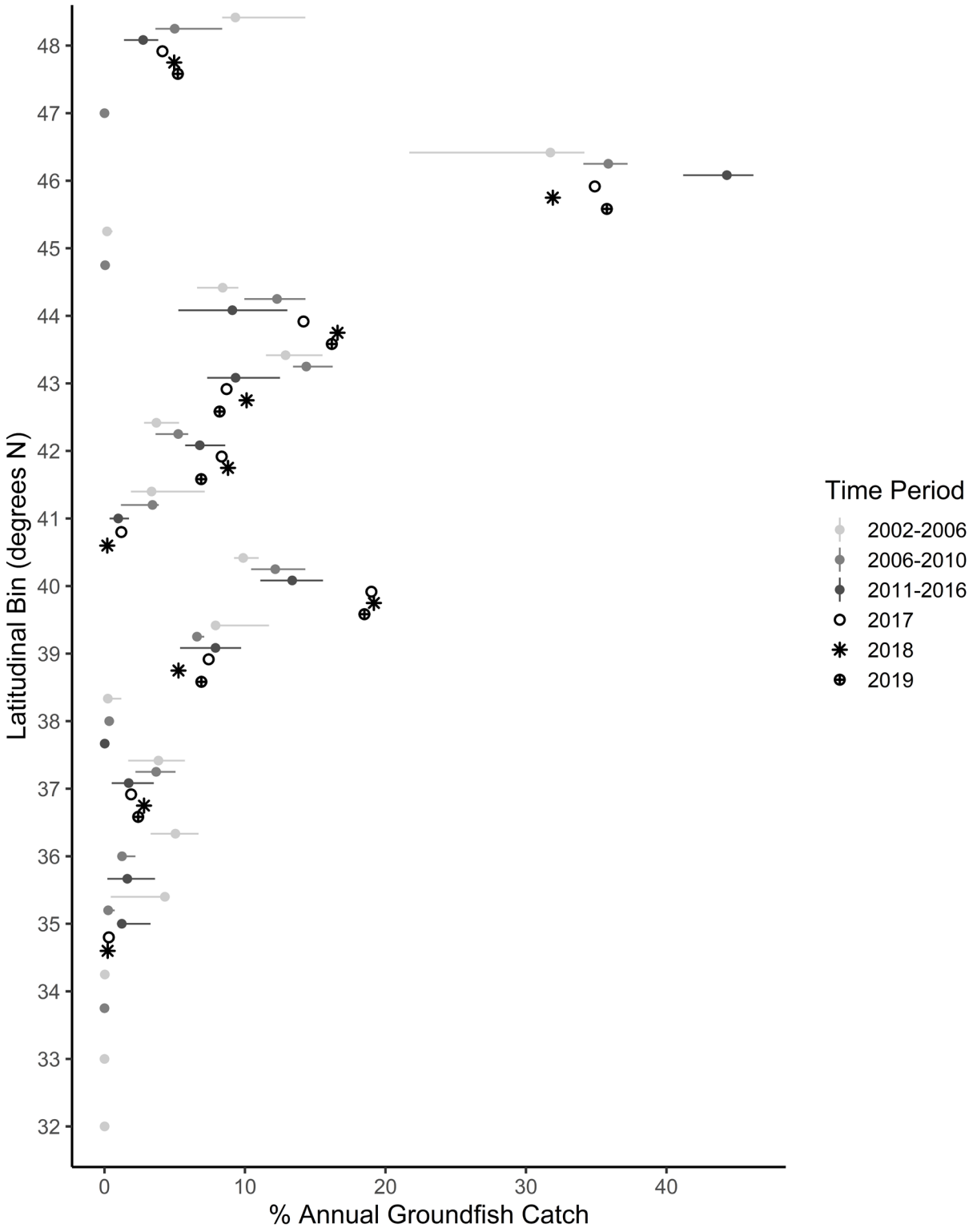

Figure 4. Percentage of retained FMP groundfish landed by the bottom trawl sector, in latitudinal bins; patterns in actual fishing activity are shown in Figure 5. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

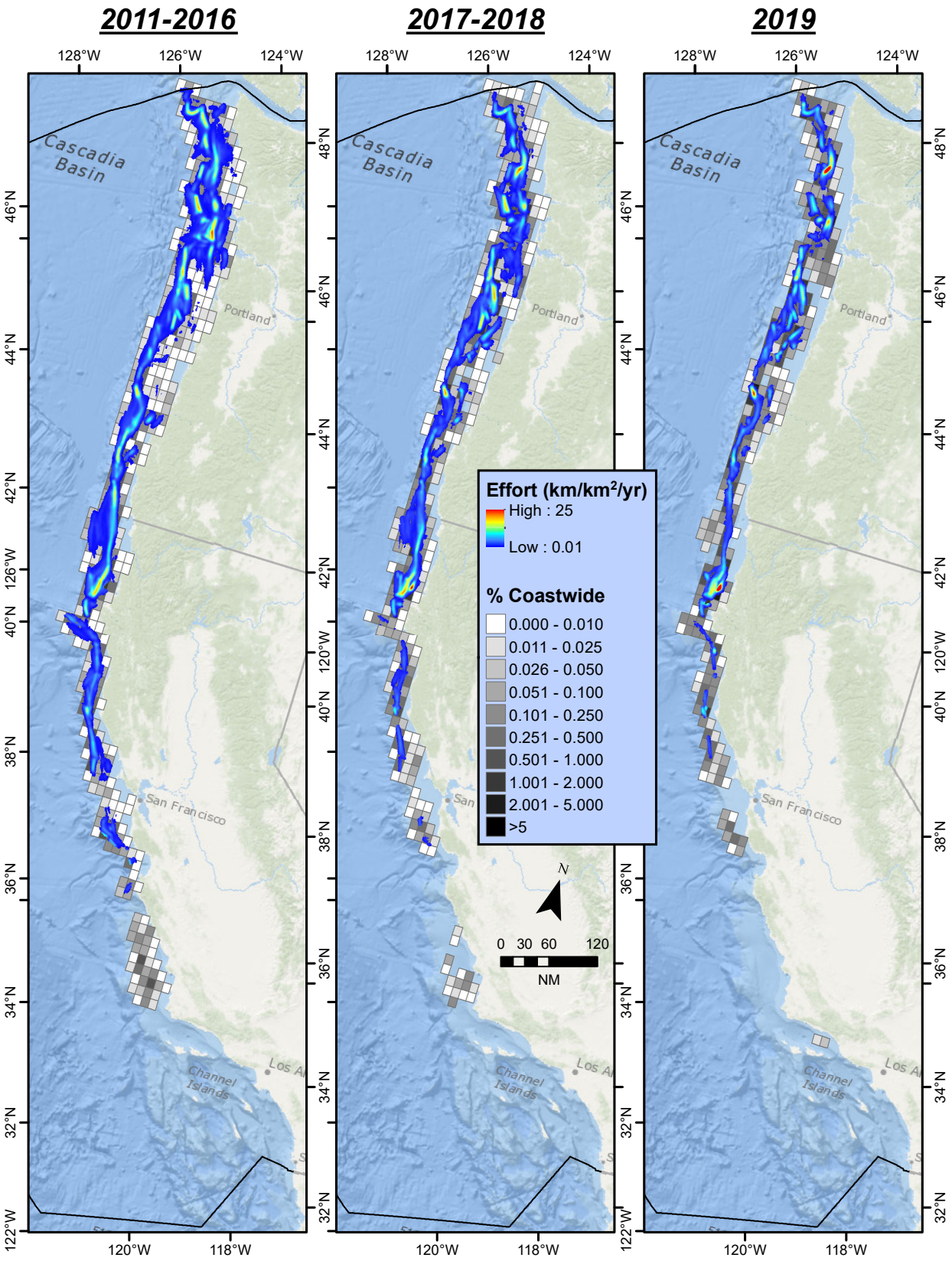

Figure 5. Spatial distribution and intensity (in km/km^2/yr) of bottom trawl fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The LE bottom trawl sector time periods account for EFH closures that began on 12 June 2006. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

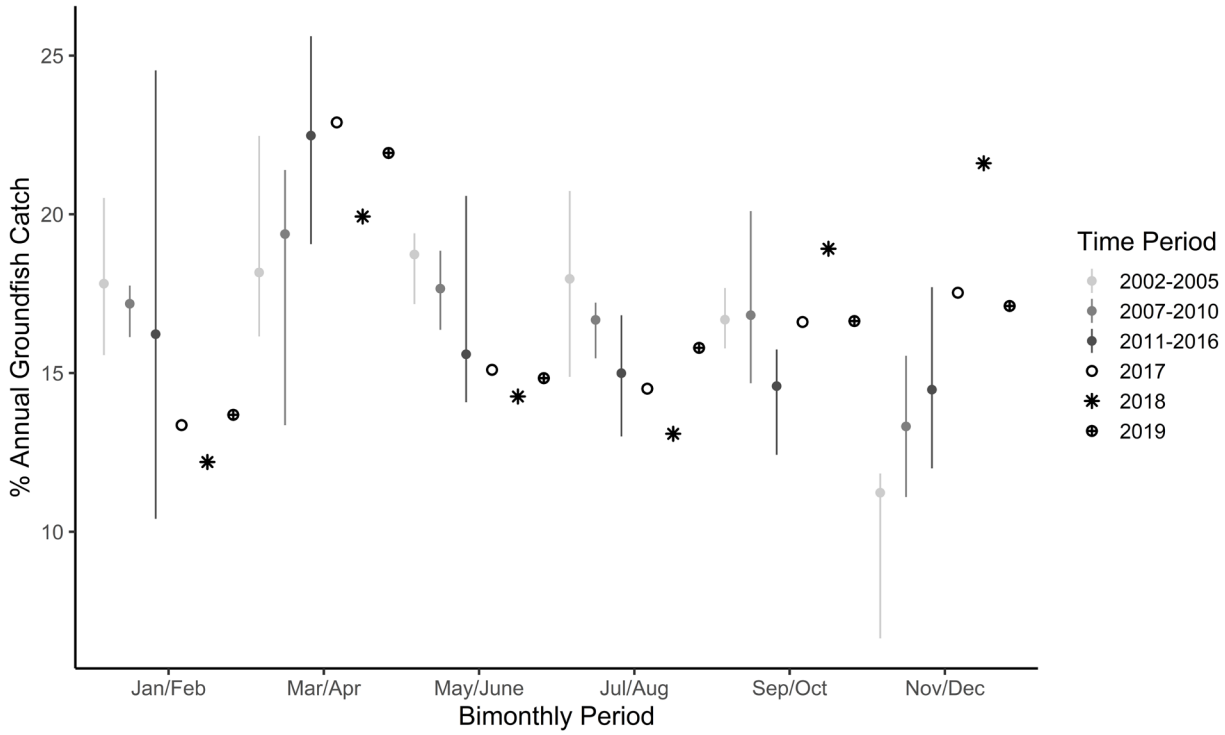

Figure 6. Percentage of retained FMP groundfish landed by the bottom trawl sector, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

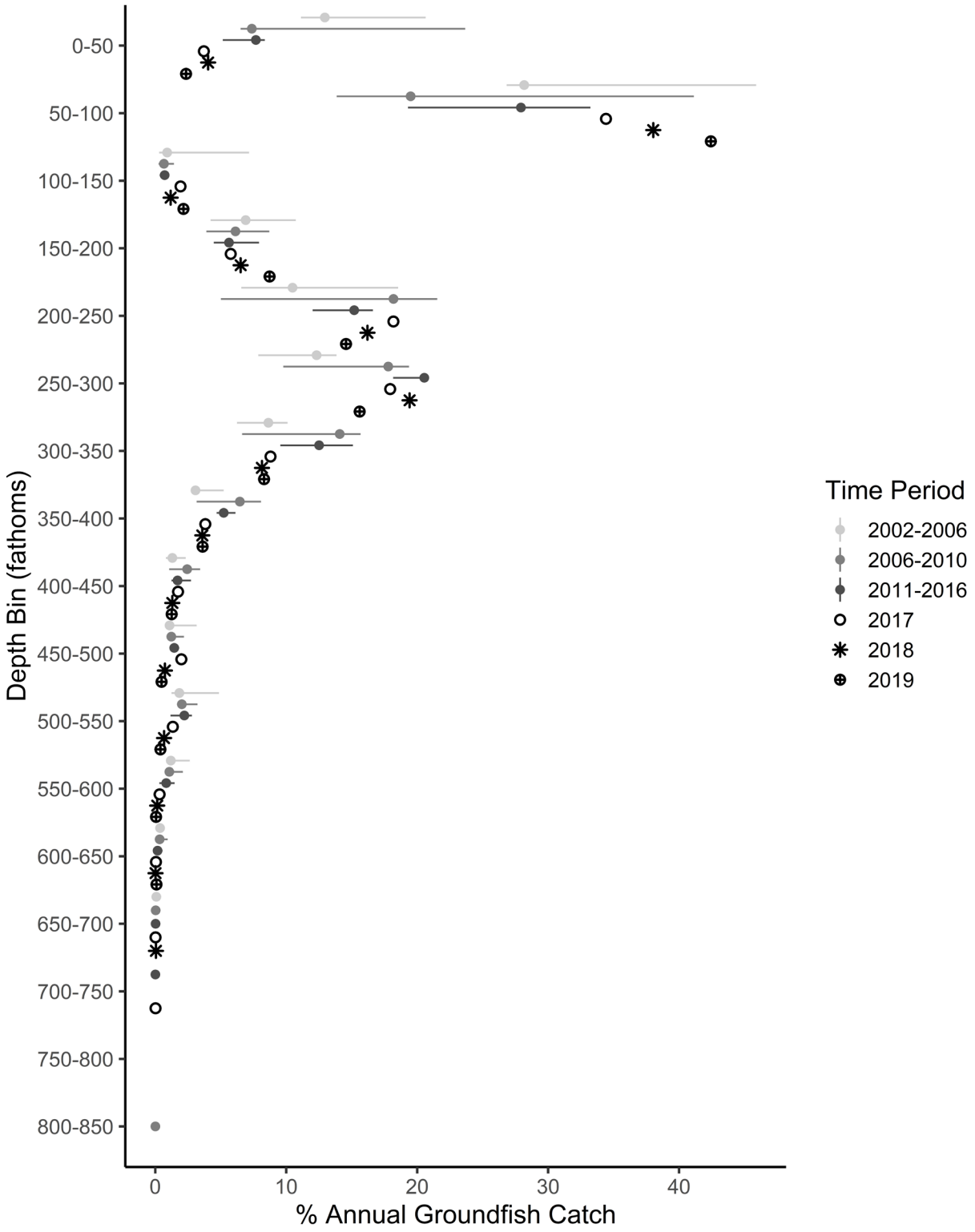

Figure 7. Percentage of bottom trawl hauls, in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

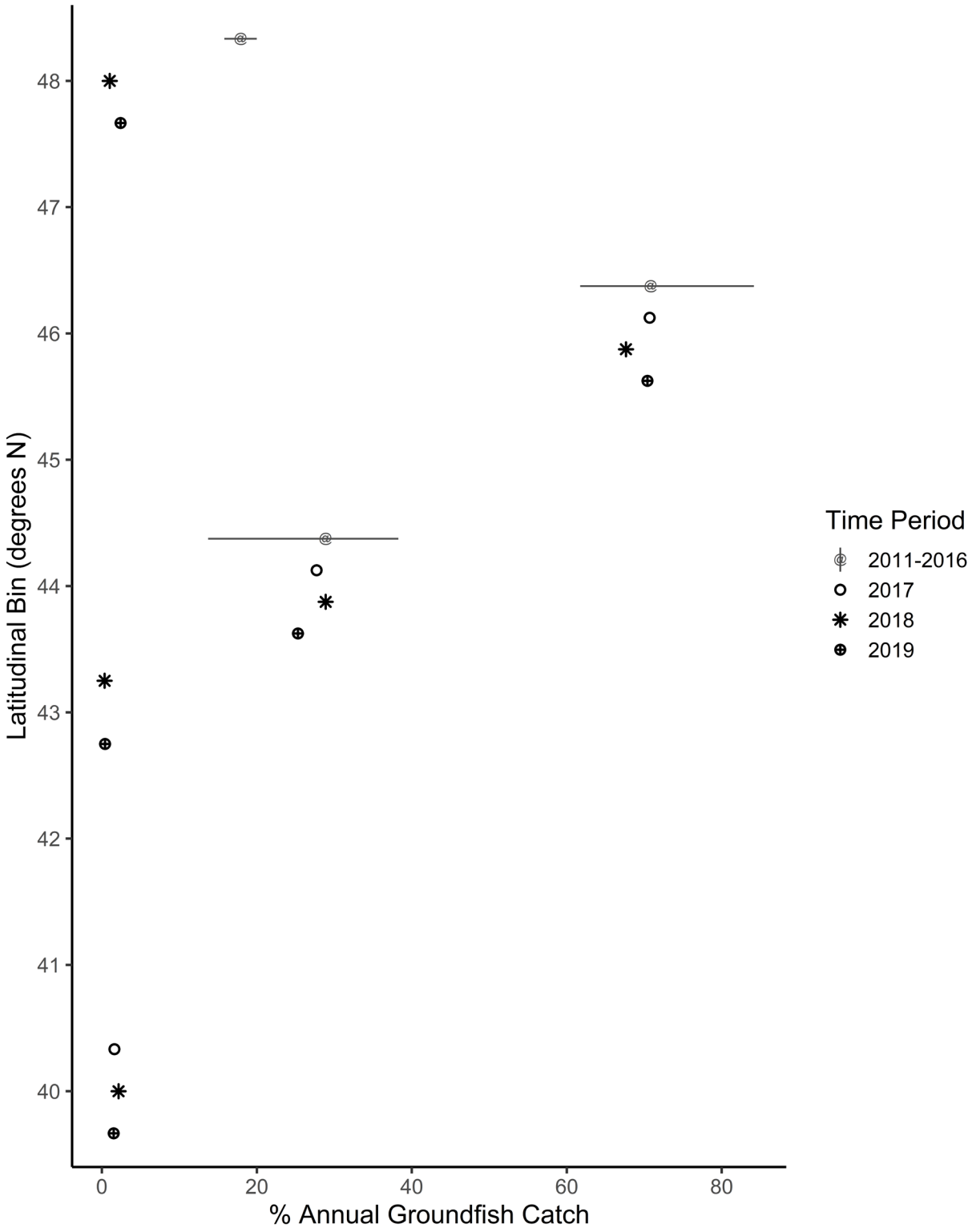

Figure 8. Percentage of retained FMP groundfish landed by the midwater rockfish trawl sector, in latitudinal bins; patterns in actual fishing activity are shown in Figure 9. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

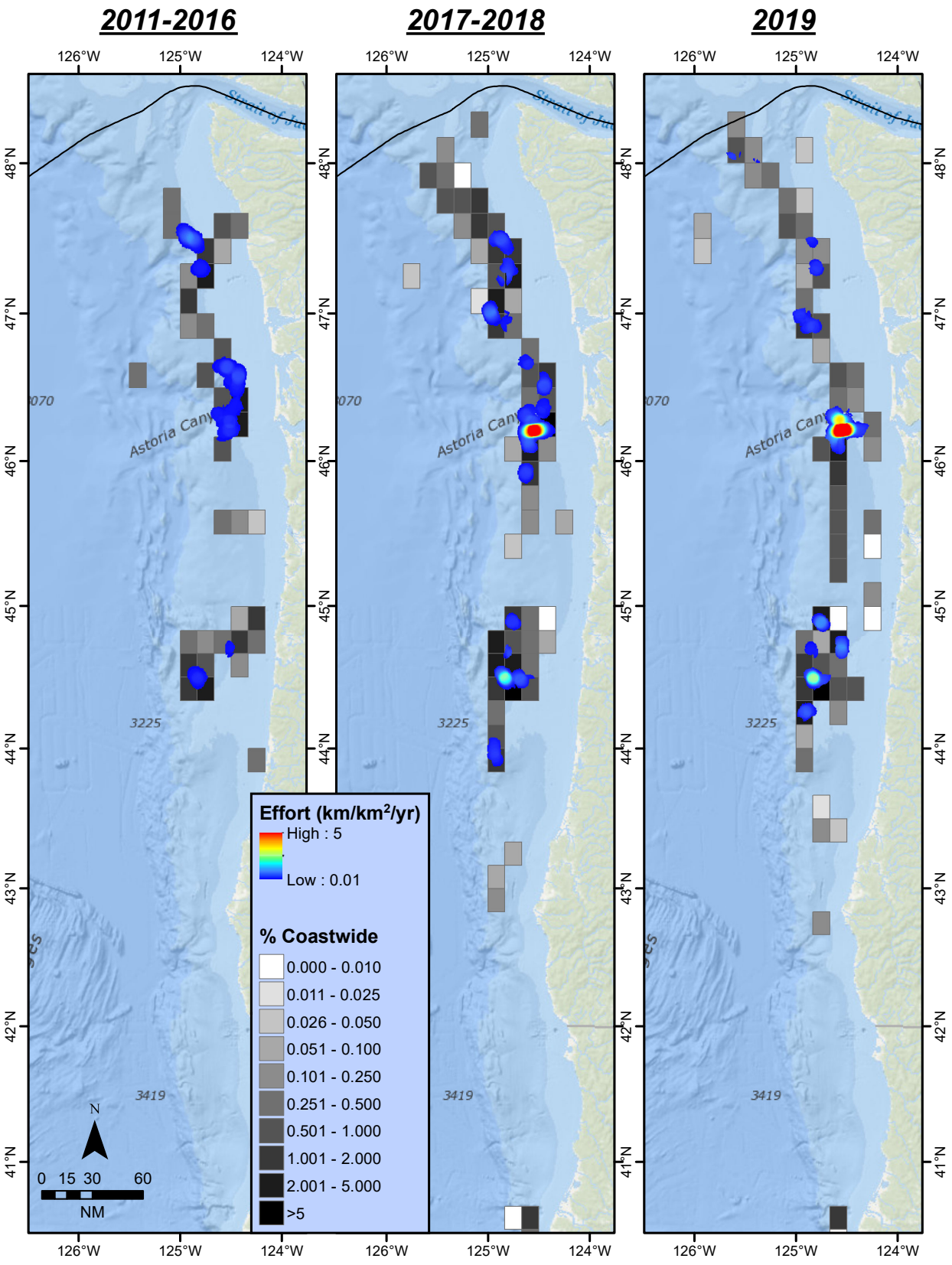

Figure 9. Spatial distribution and intensity (in km/km^2/yr) of midwater rockfish trawl fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

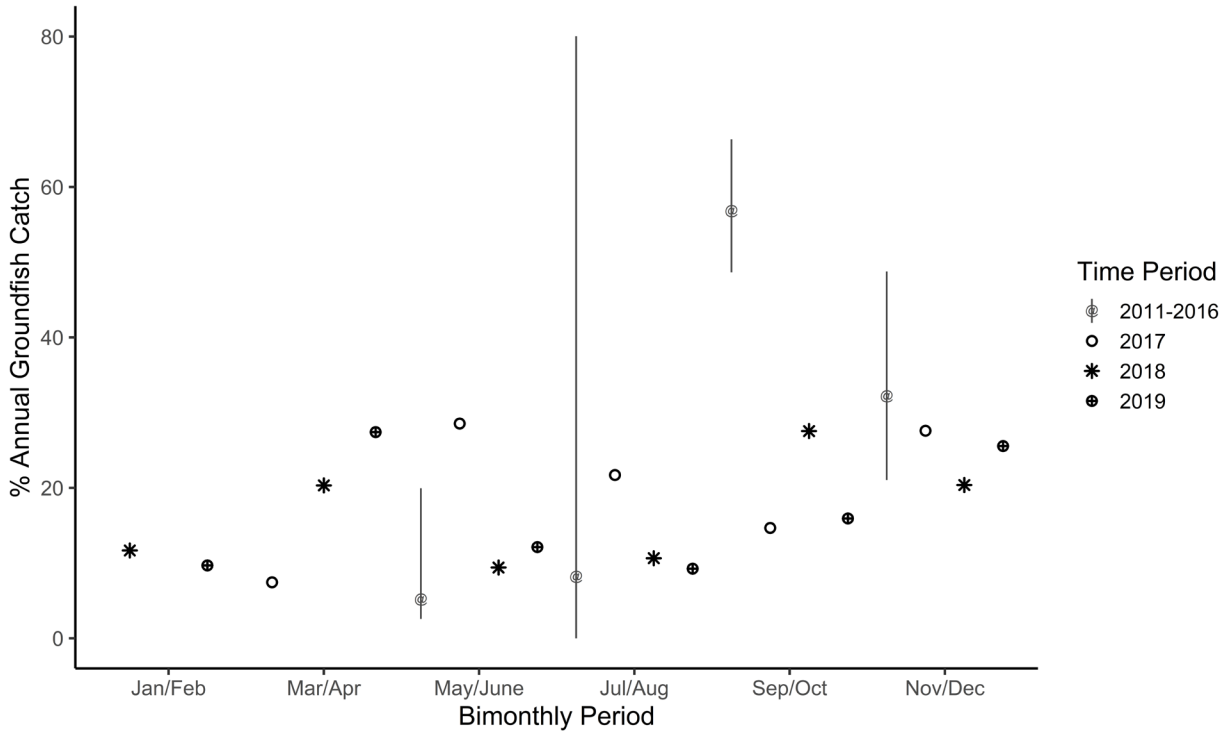

Figure 10. Percentage of retained FMP groundfish landed by the midwater rockfish trawl sector, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

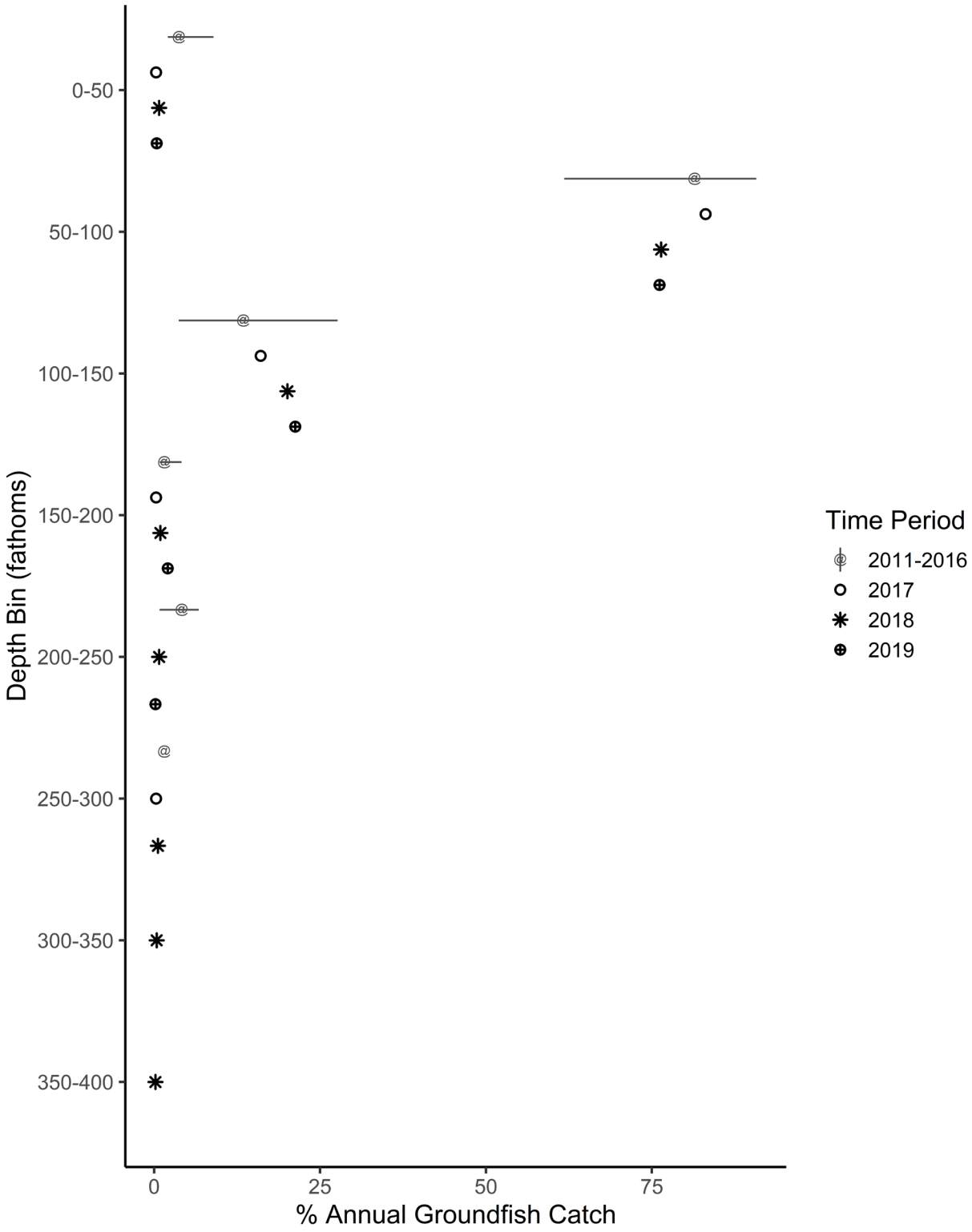

Figure 11. Percentage of midwater rockfish trawl hauls, in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

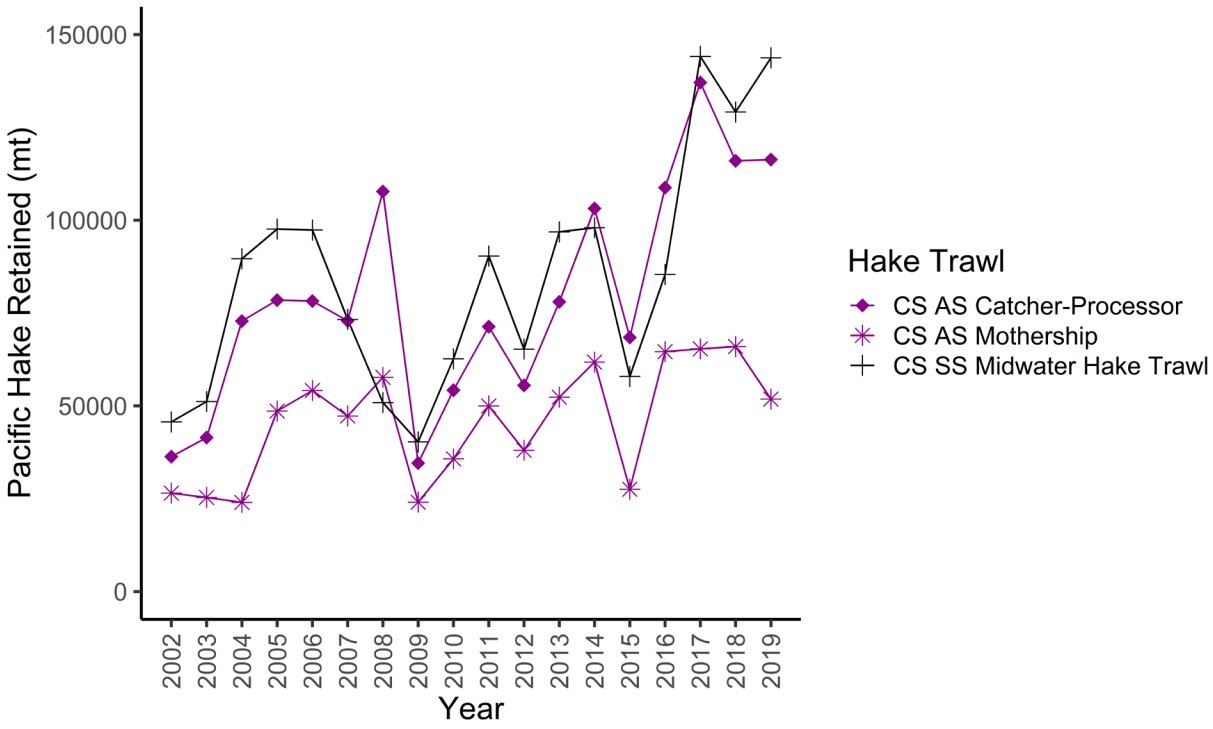

Figure 12. Annual total fleetwide Pacific hake landings (mt) in midwater hake trawl sectors.

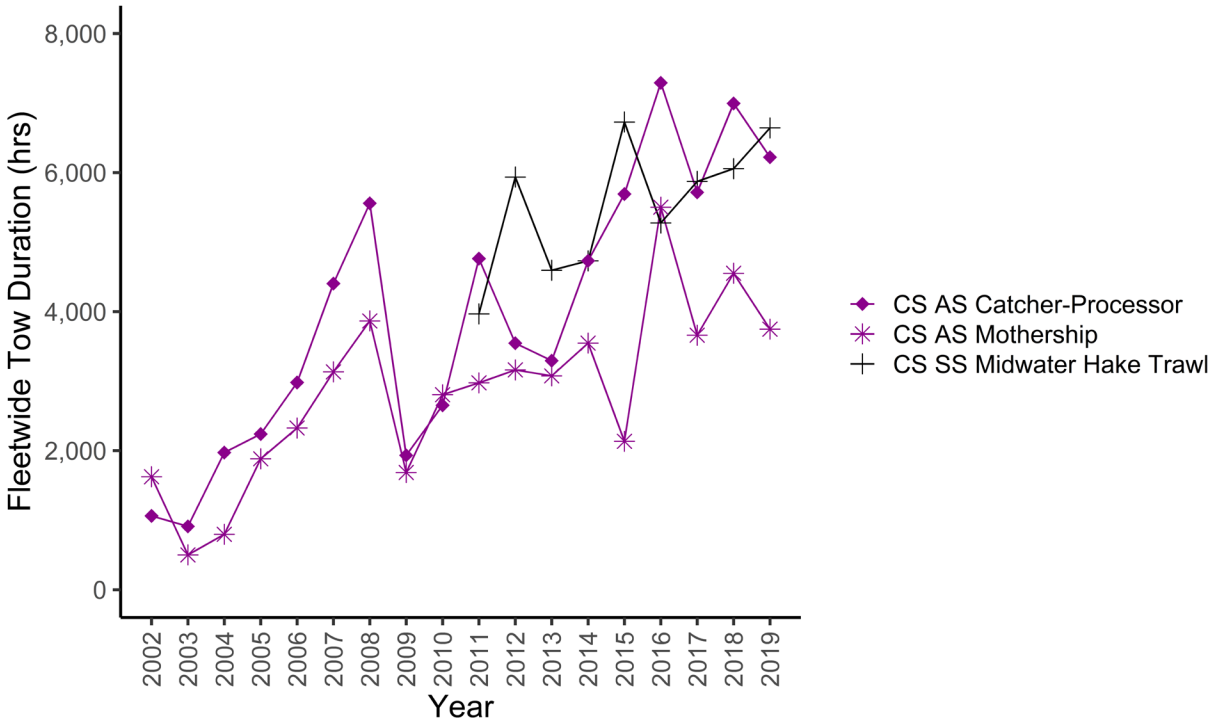

Figure 13. Annual fleetwide total towing hours in midwater hake trawl sectors.

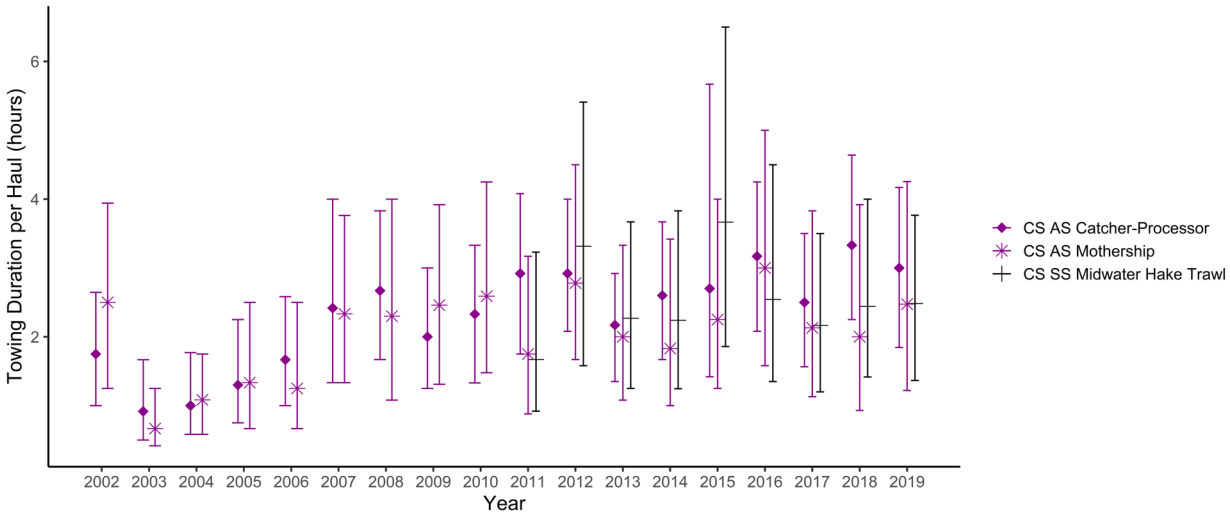

Figure 14. Tow duration per haul (hours) in midwater hake trawl sectors. Medians and first and third quartiles for each year are shown.

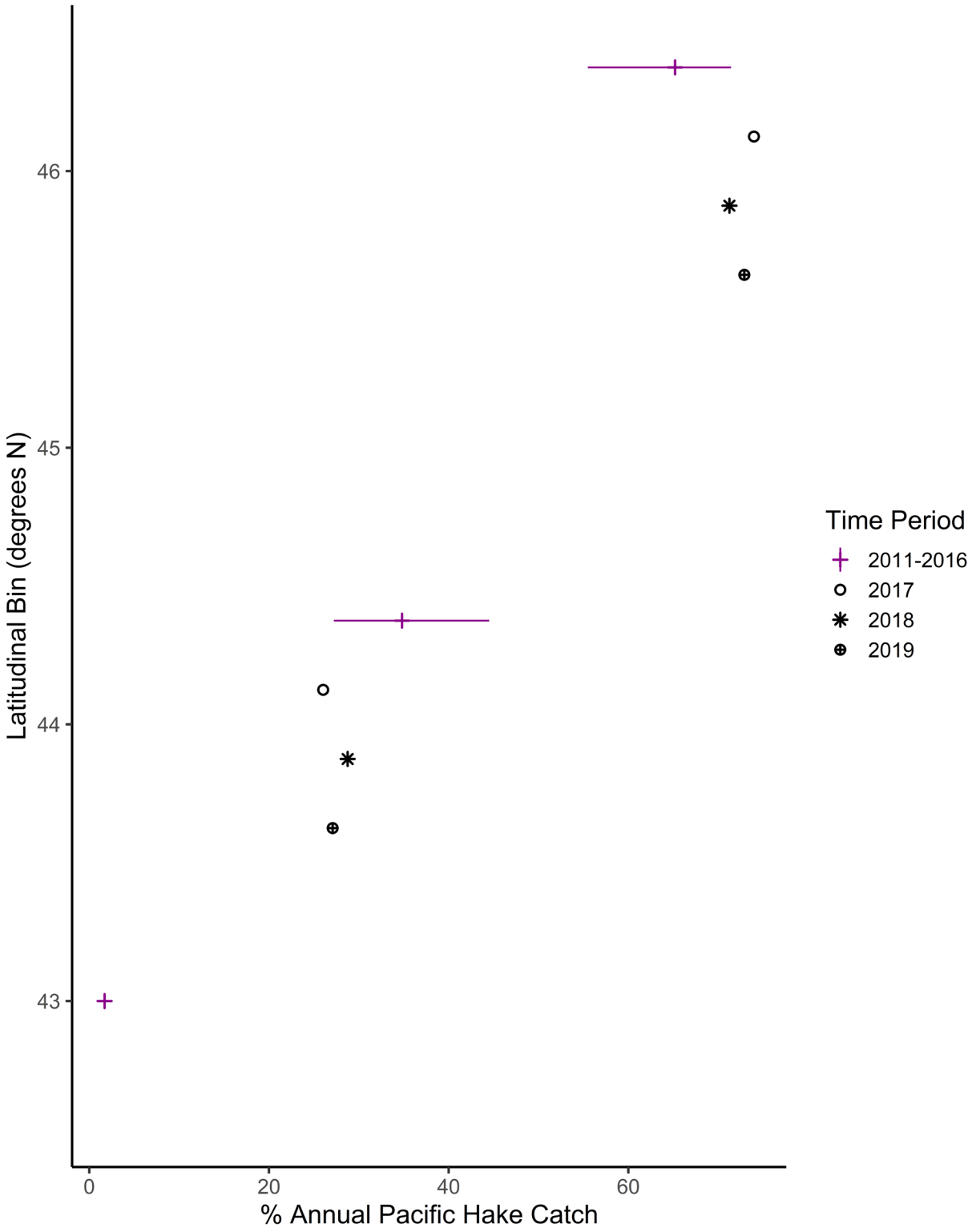

Figure 15. Percentage of retained hake landed by the shoreside midwater hake trawl, in latitudinal bins; patterns in actual fishing activity are shown in Figure 16. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

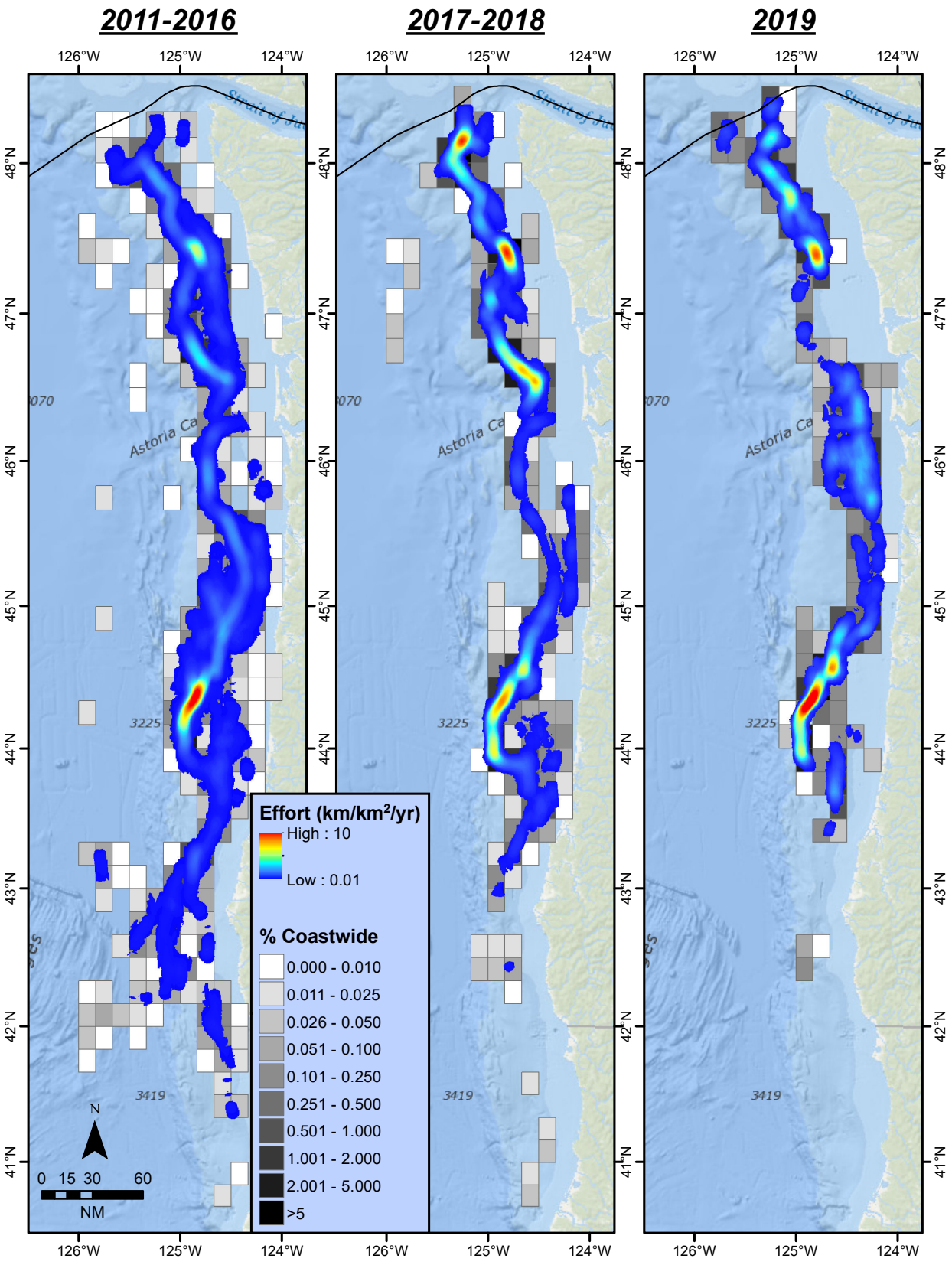

Figure 16. Spatial distribution and intensity (in km/km^2/yr) of shoreside midwater hake trawl fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

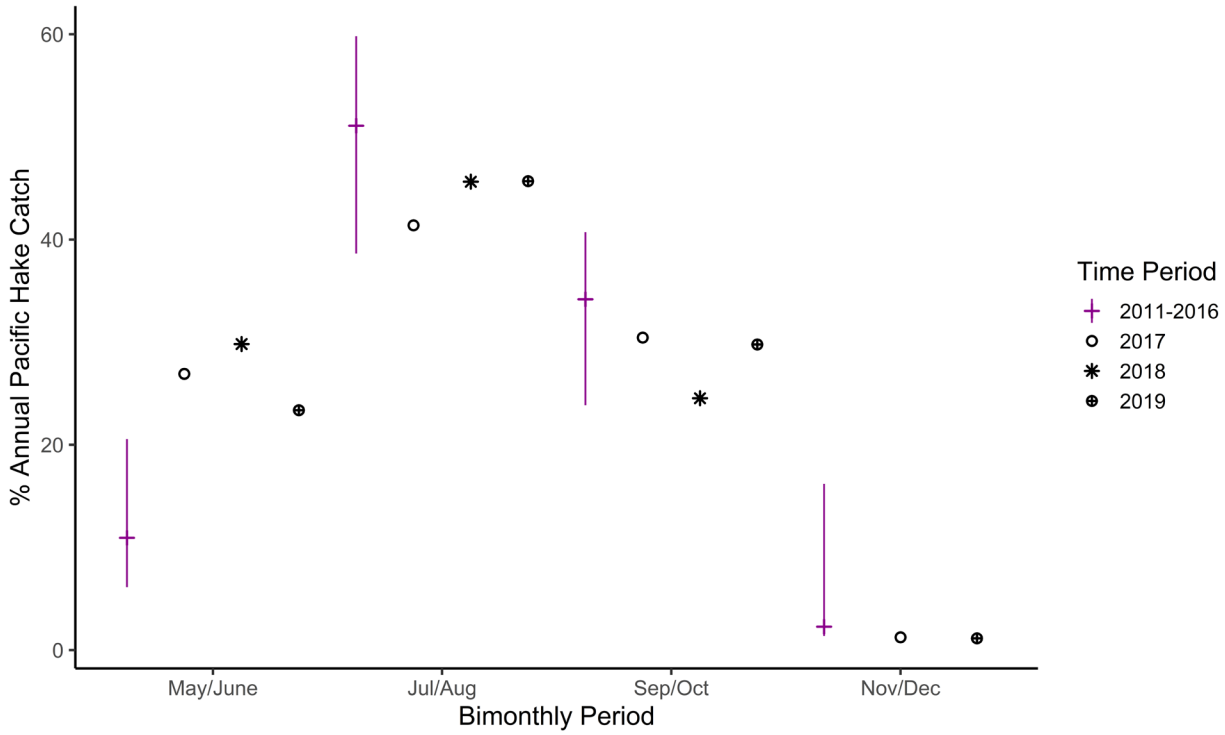

Figure 17. Percentage of retained hake landed by shoreside midwater trawl targeting hake, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

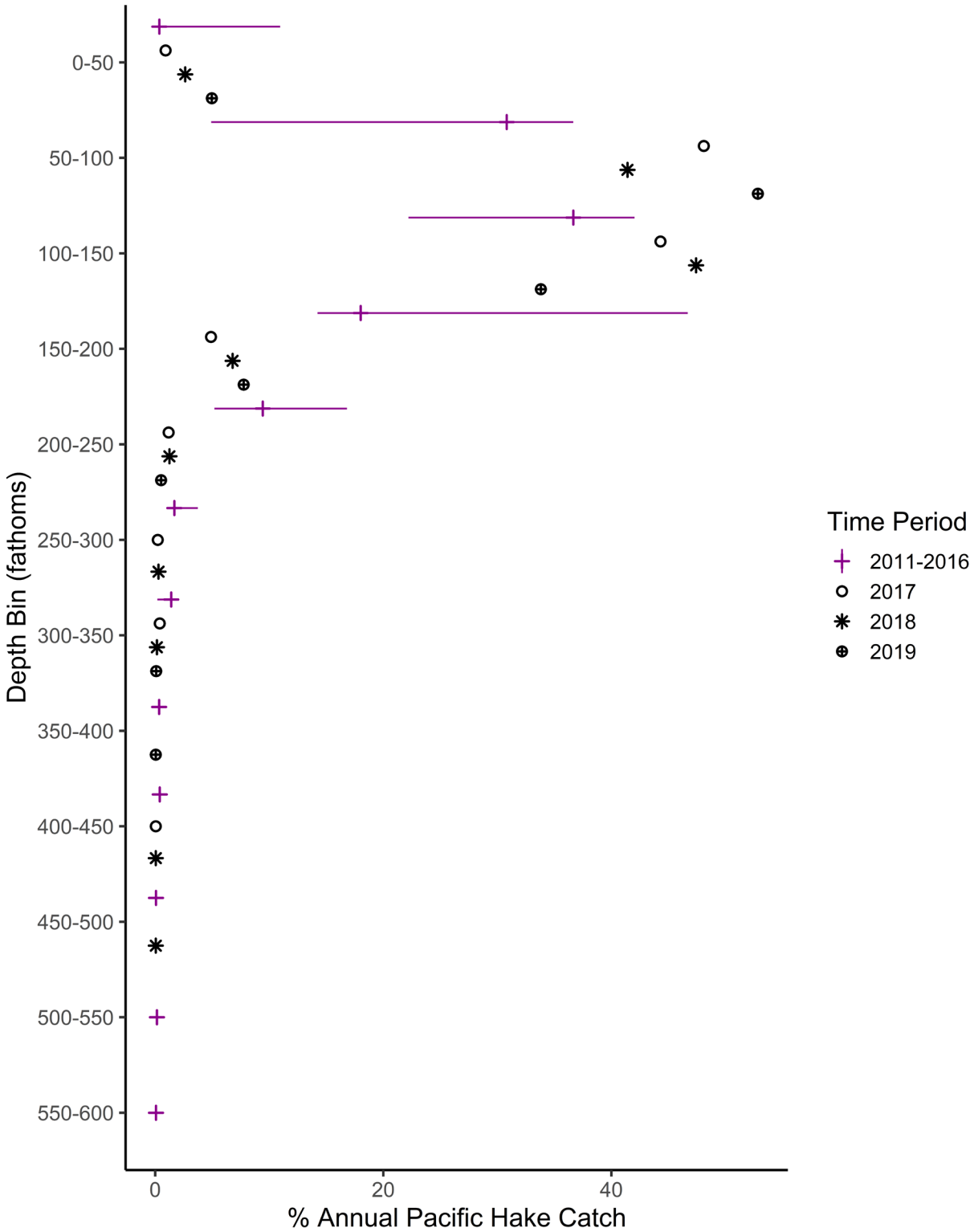

Figure 18. Percentage of shoreside midwater hake trawl hauls in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

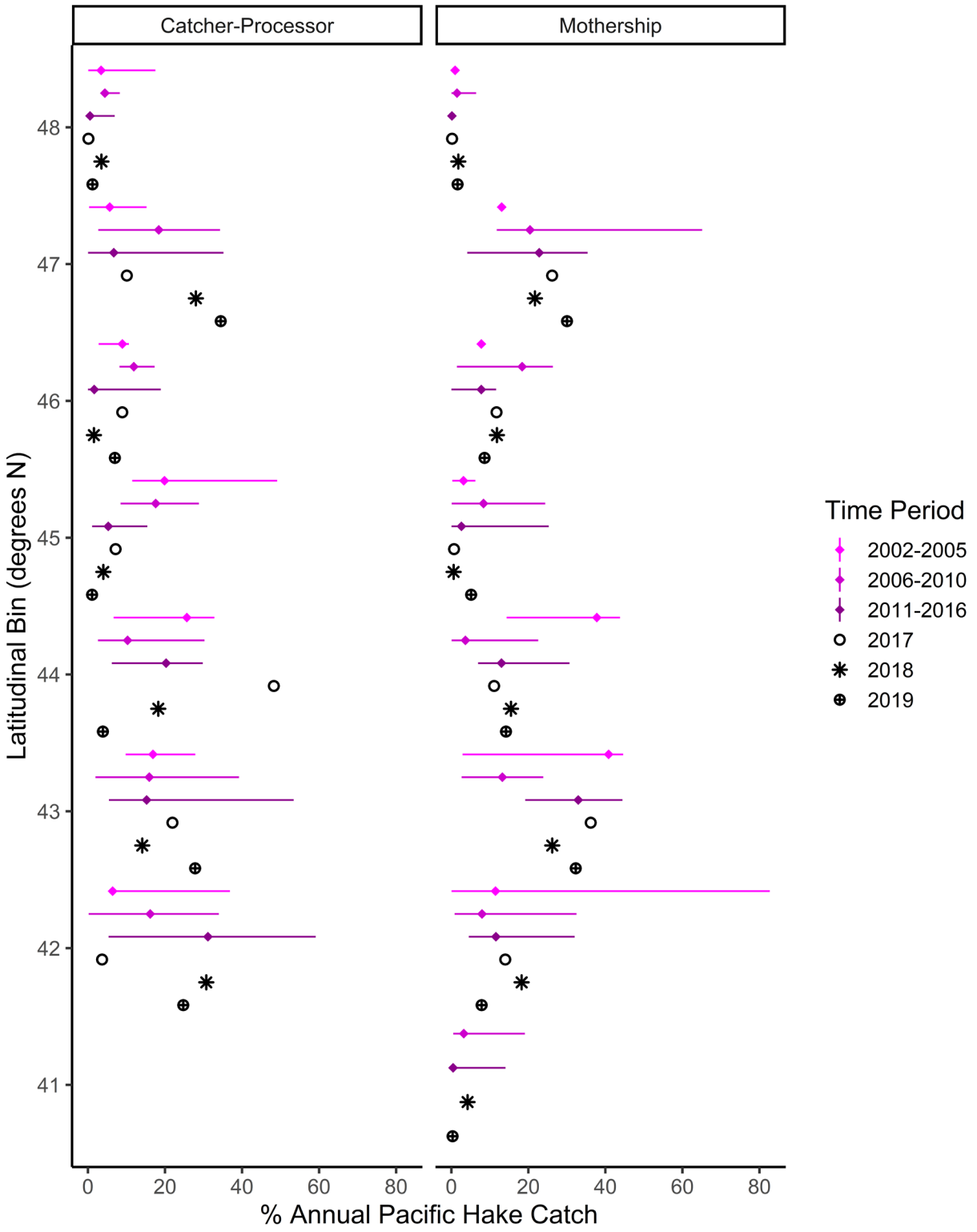

Figure 19. Percentage of retained hake caught by at-sea midwater trawl sectors, in latitudinal bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

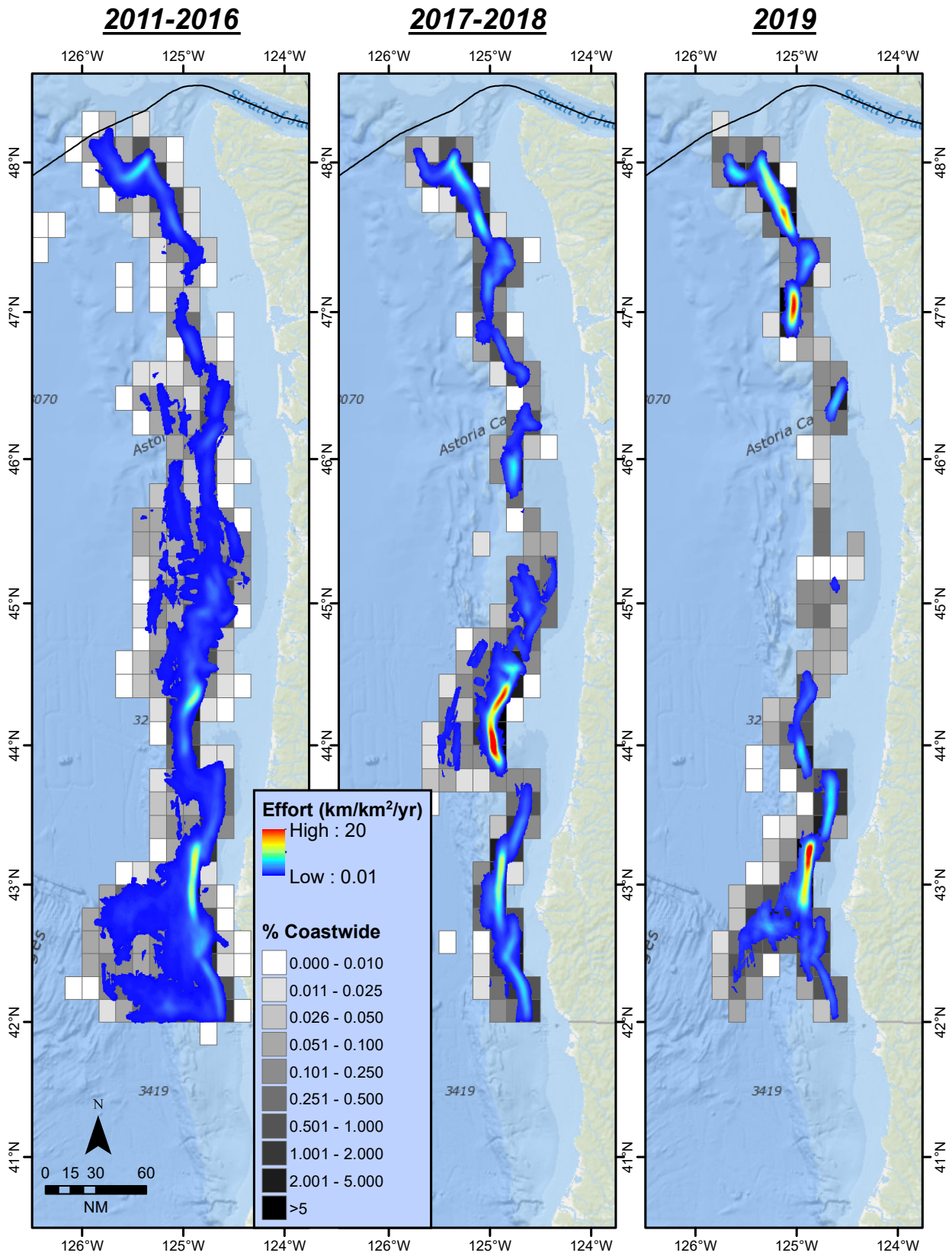

Figure 20. Spatial distribution and intensity (in km/km^2/yr) of at-sea midwater trawl catcher–processor fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

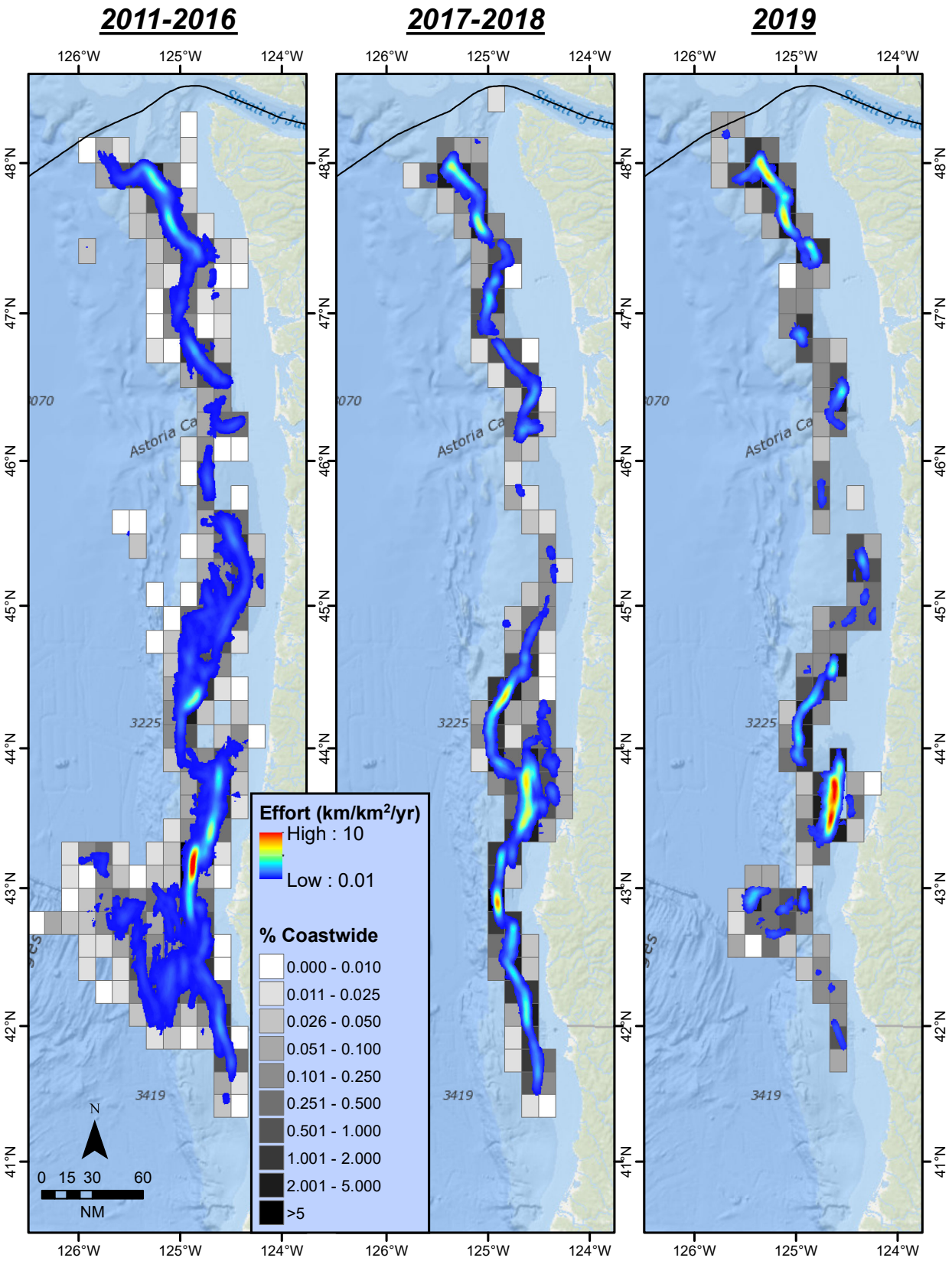

Figure 21. Spatial distribution and intensity (in km/km^2/yr) of at-sea midwater trawl mothership fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

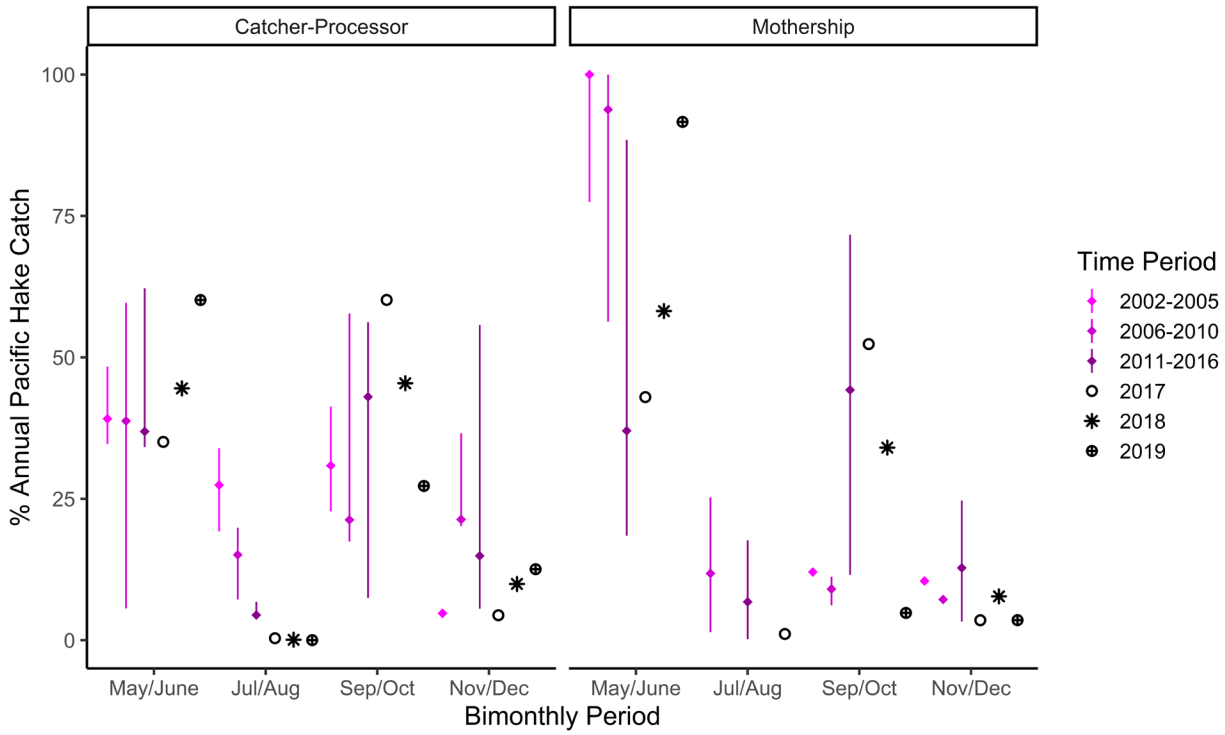

Figure 22. Percentage of retained hake caught by at-sea midwater trawl sectors, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

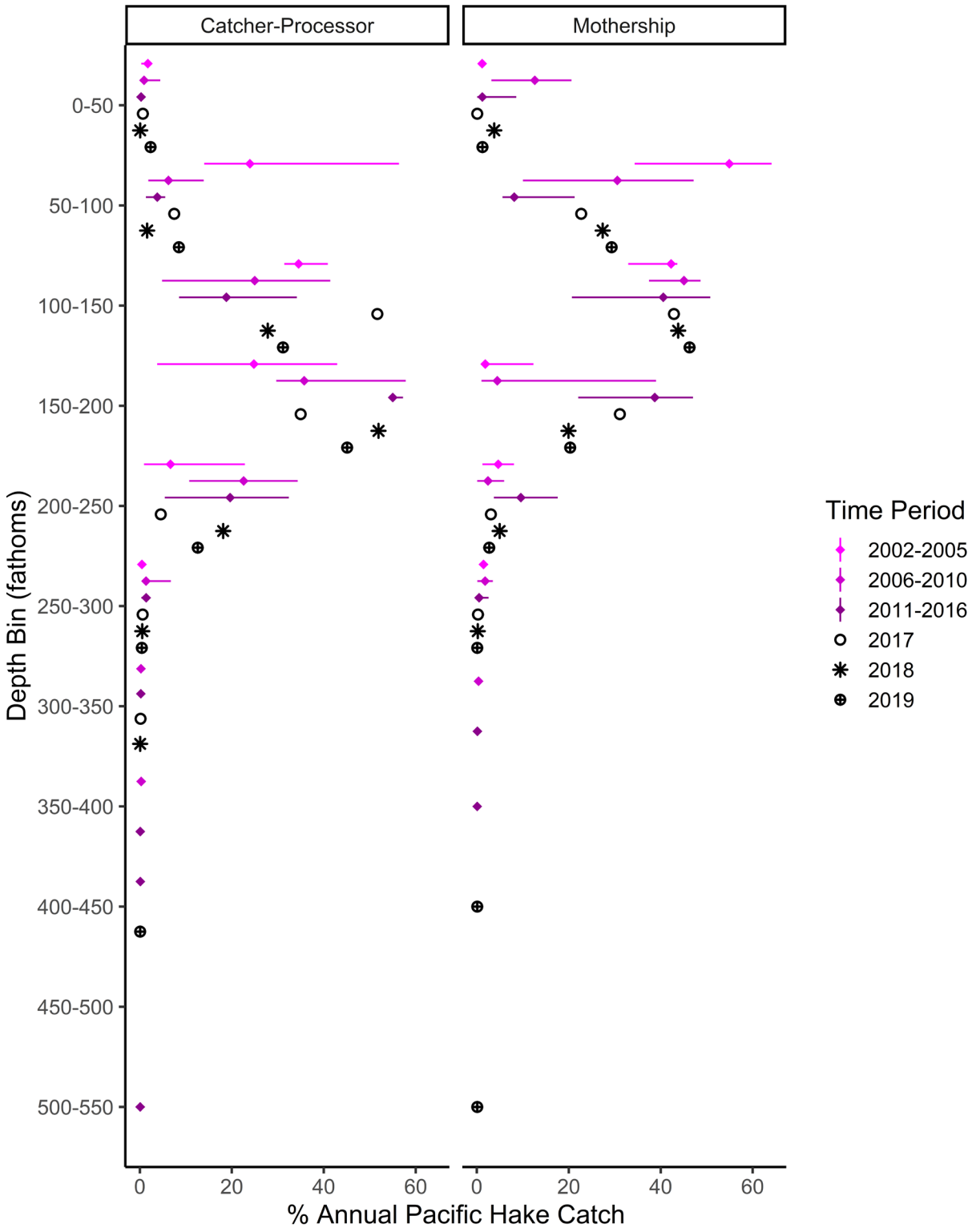

Figure 23. Percentage of at-sea midwater trawl hauls in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

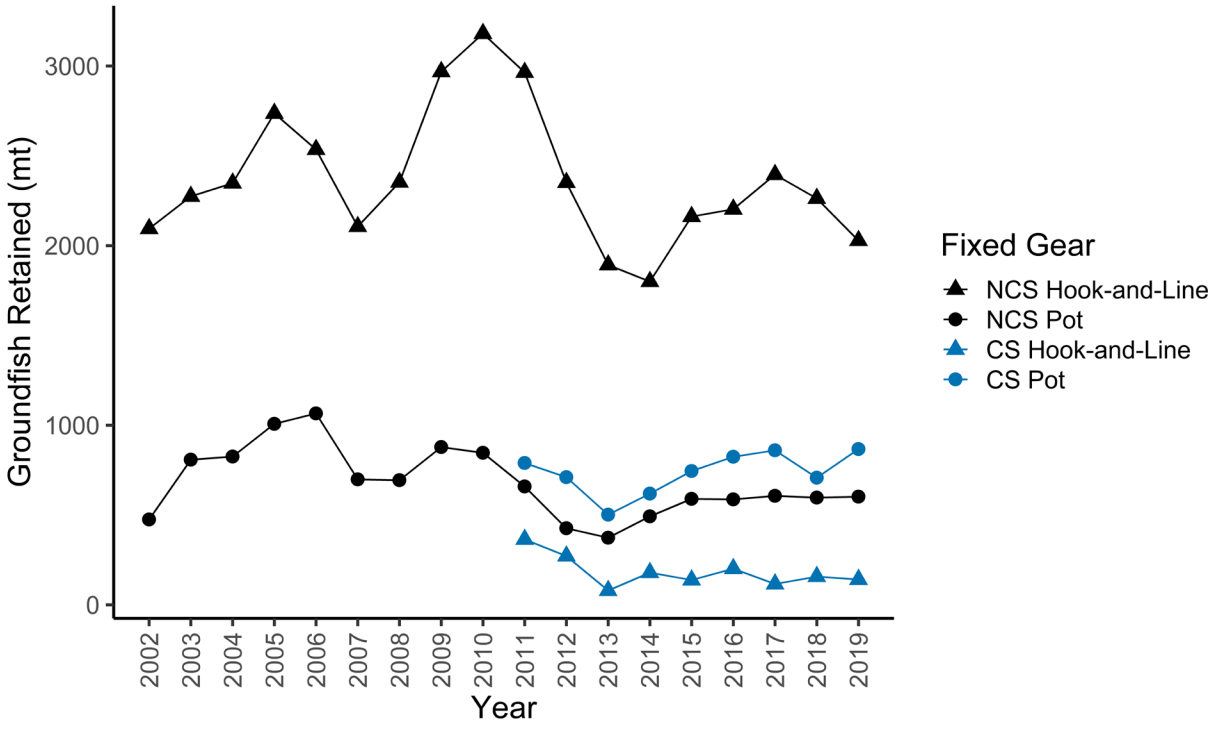

Figure 24. Annual total fleetwide groundfish landings (mt) in fixed gear sectors.

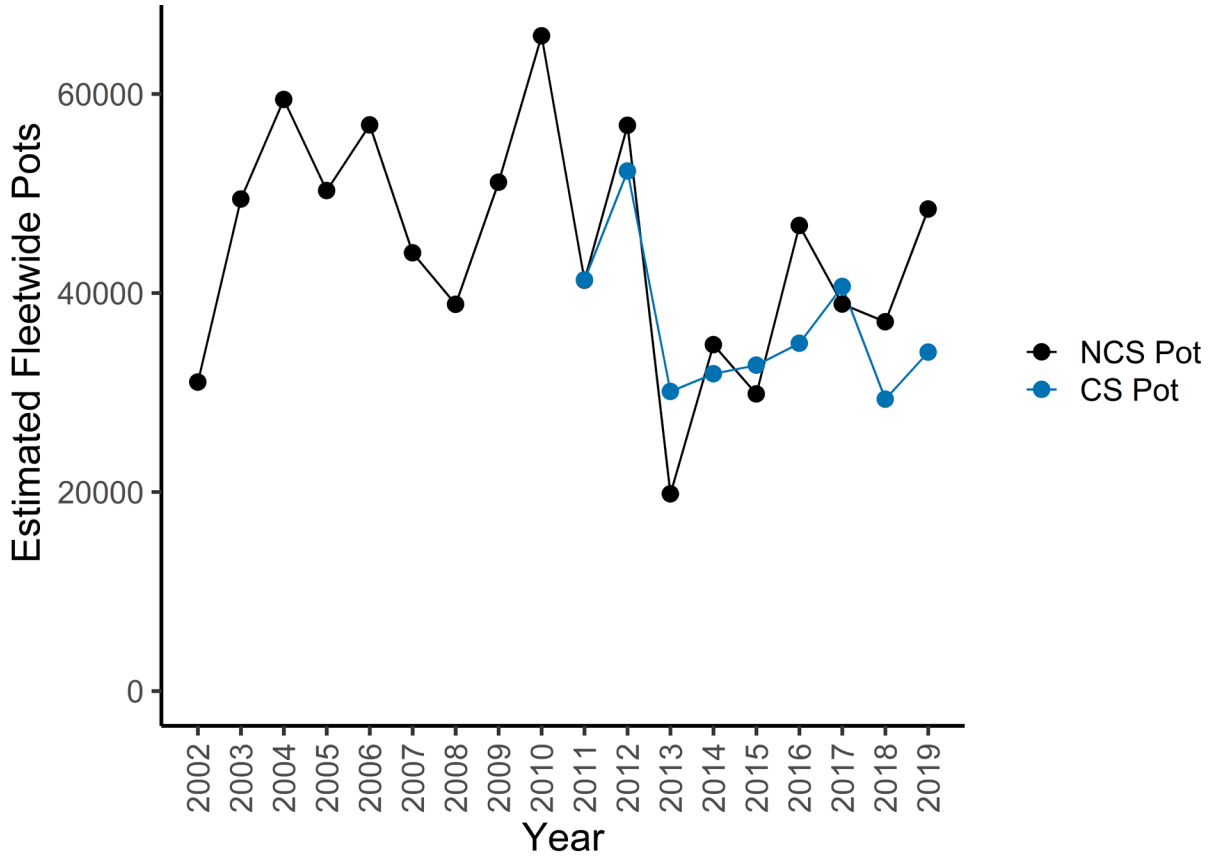

Figure 25. Annual total fleetwide number of pots in the pot sectors.

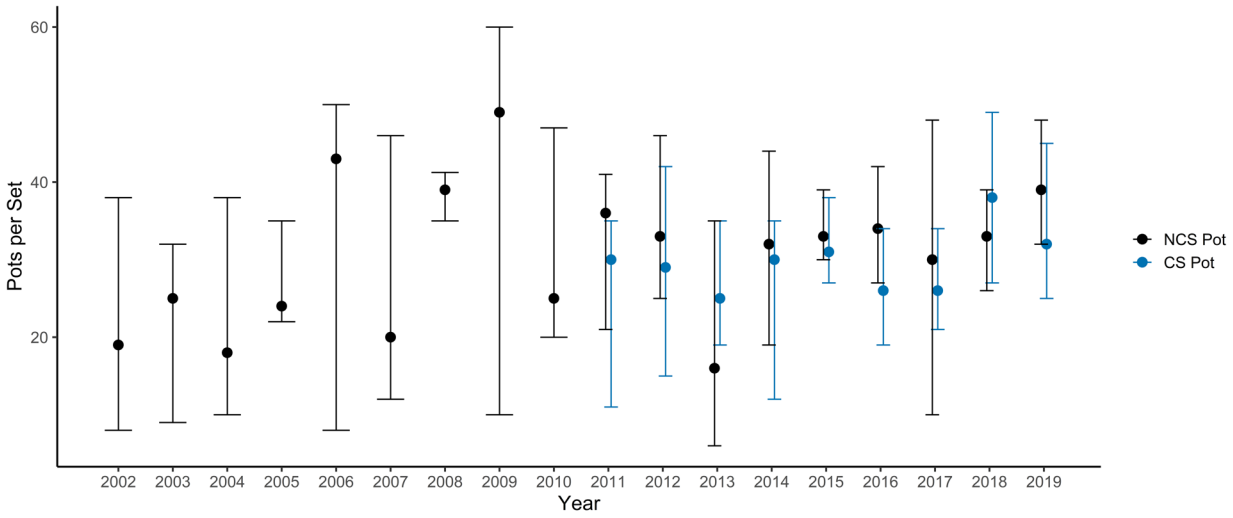

Figure 26. Number of pots per set in pot sectors, summarized as median, first, and third quartiles, in each year.

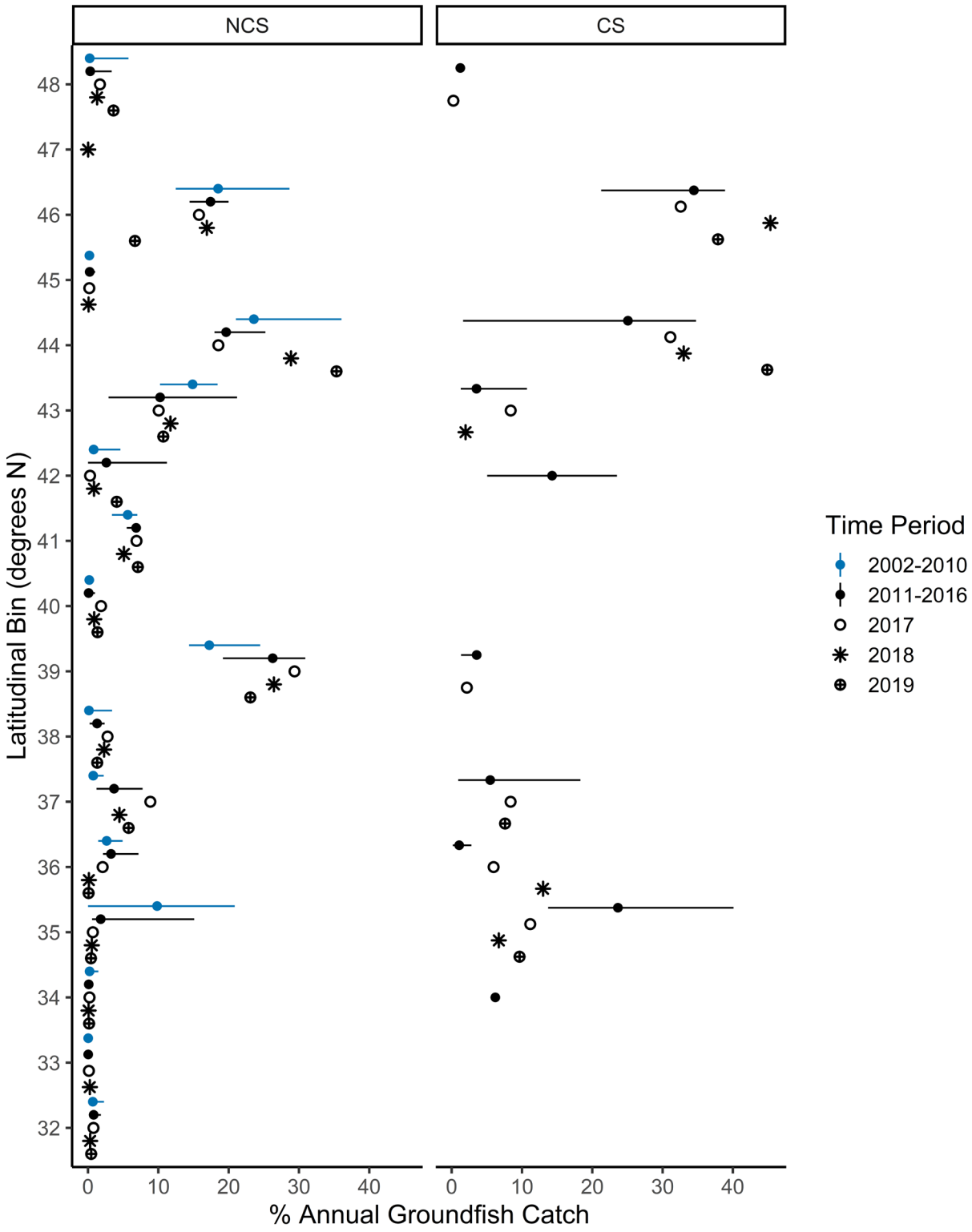

Figure 27. Percentage of retained groundfish landed by pot sectors, in latitudinal bins; patterns in actual fishing activity are shown in Figure 28 and Figure 29. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

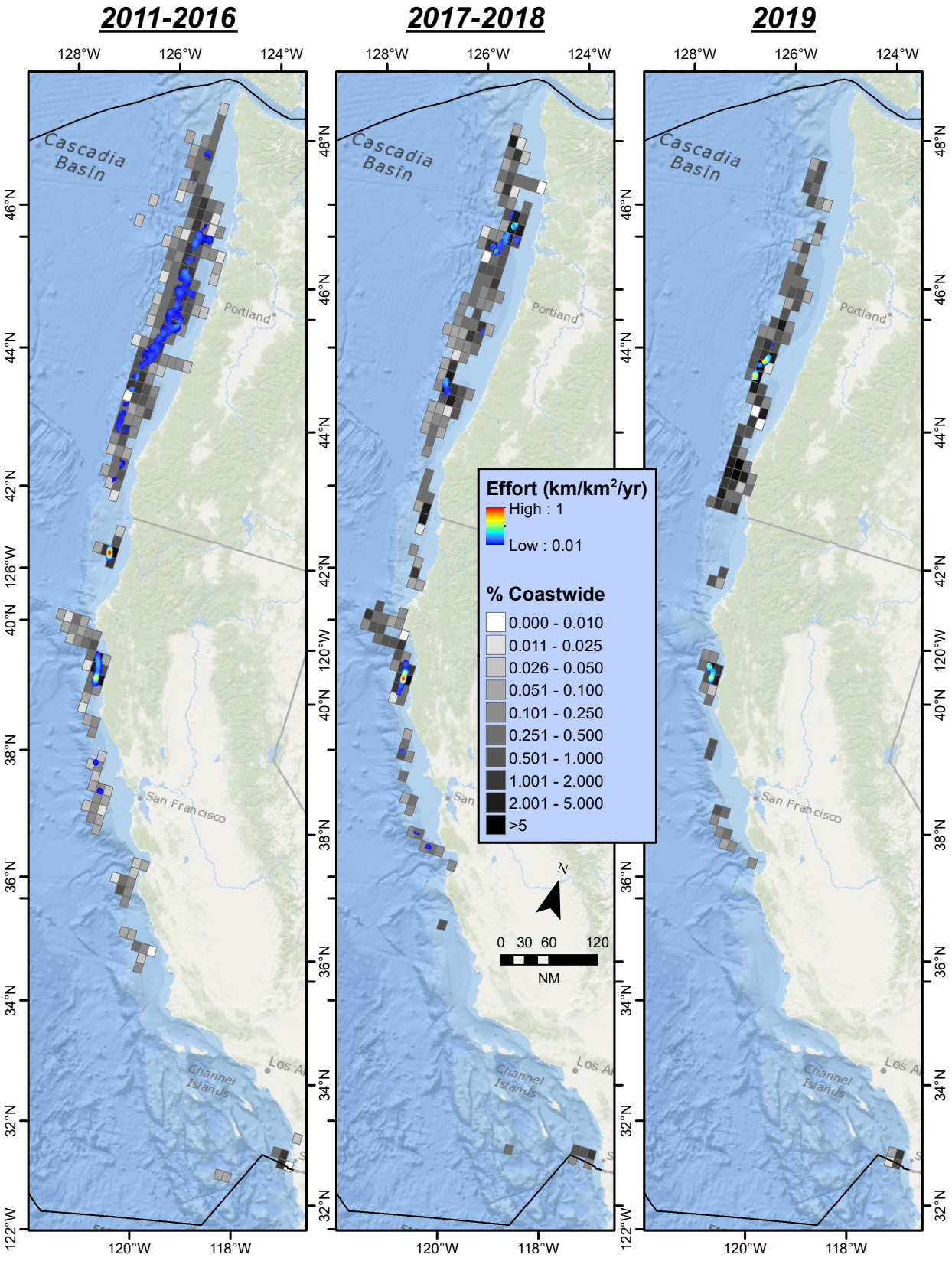

Figure 28. Spatial distribution and intensity (in km/km^2/yr) of non-catch share pot sector fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

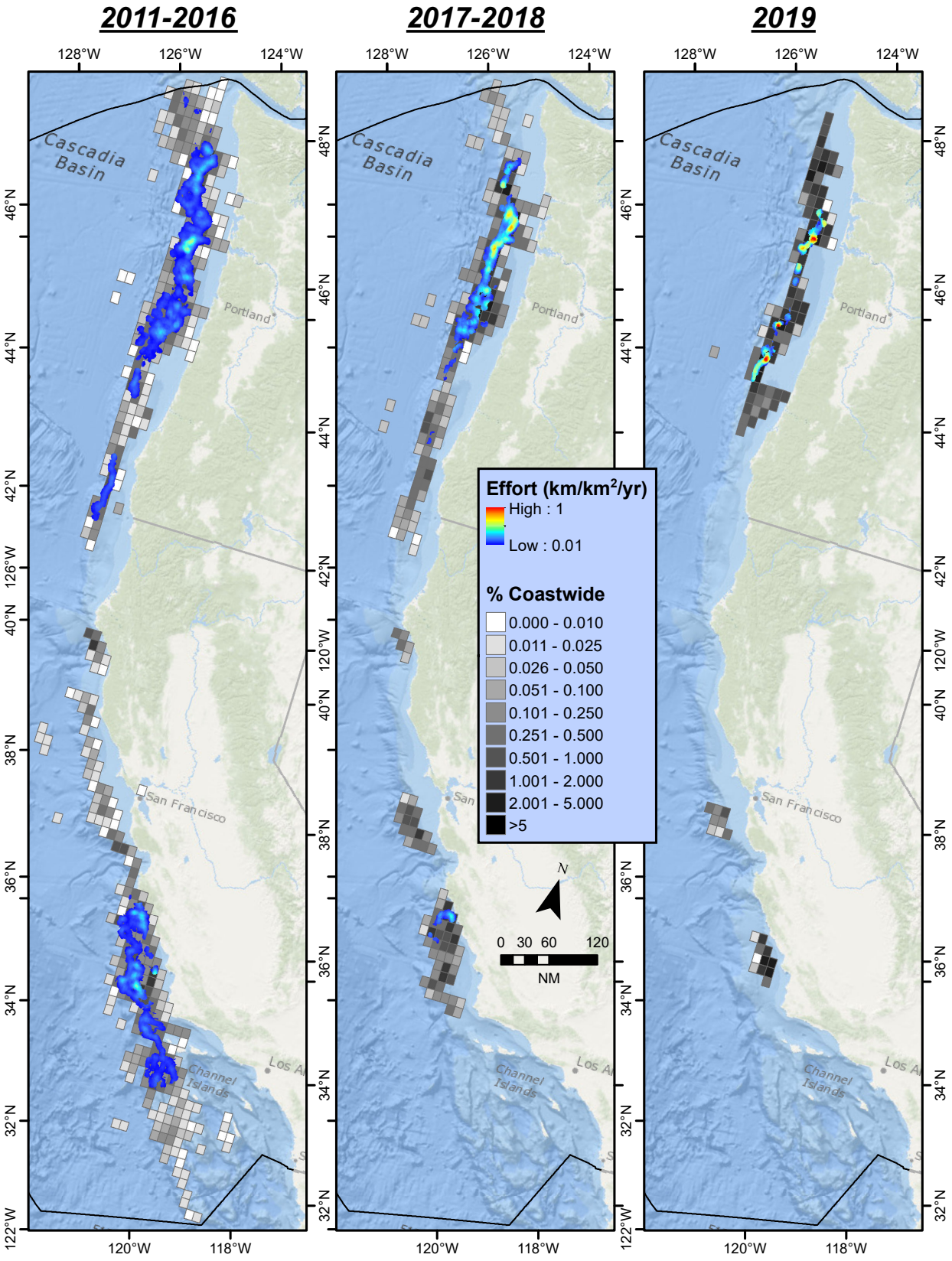

Figure 29. Spatial distribution and intensity (in km/km^2/yr) of catch share pot sector fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

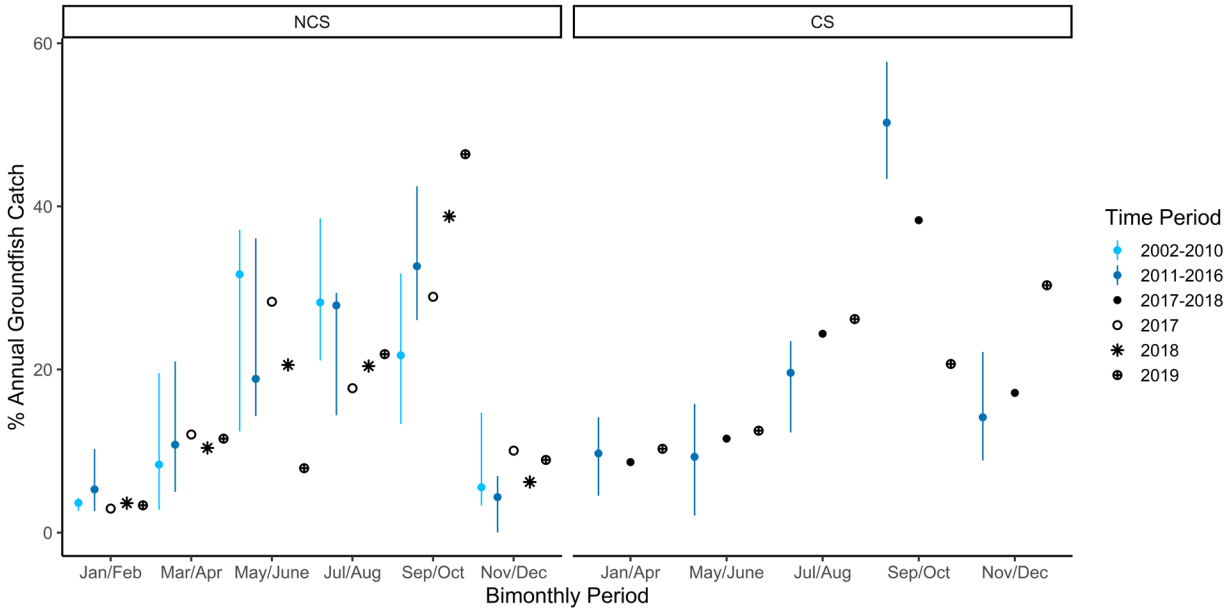

Figure 30. Percentage of retained groundfish landed by pot sectors, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data. To maintain confidentiality, the catch share fleet data are summarized for Jan–Apr and for 2017 and 2018.

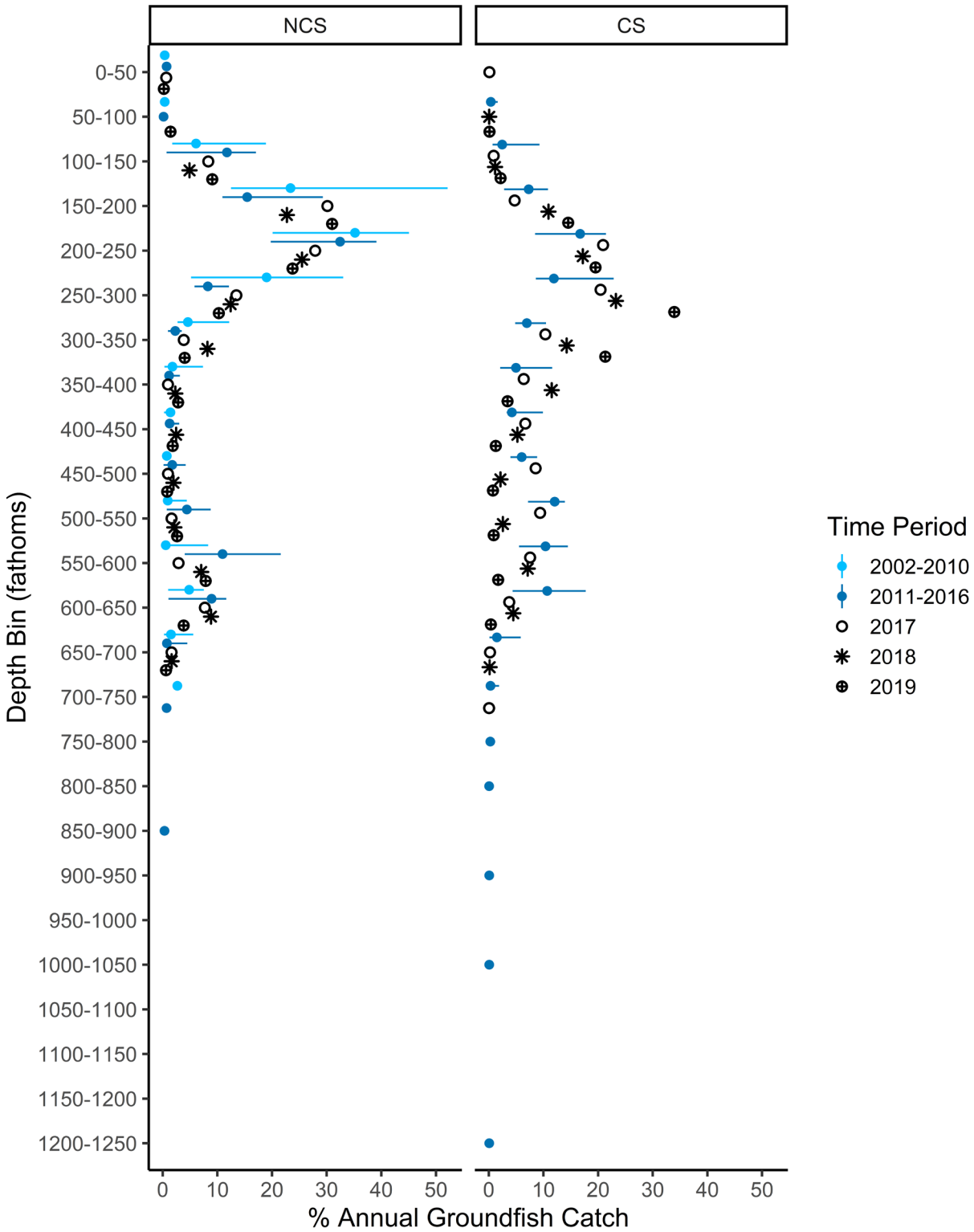

Figure 31. Percentage of observed pot hauls in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

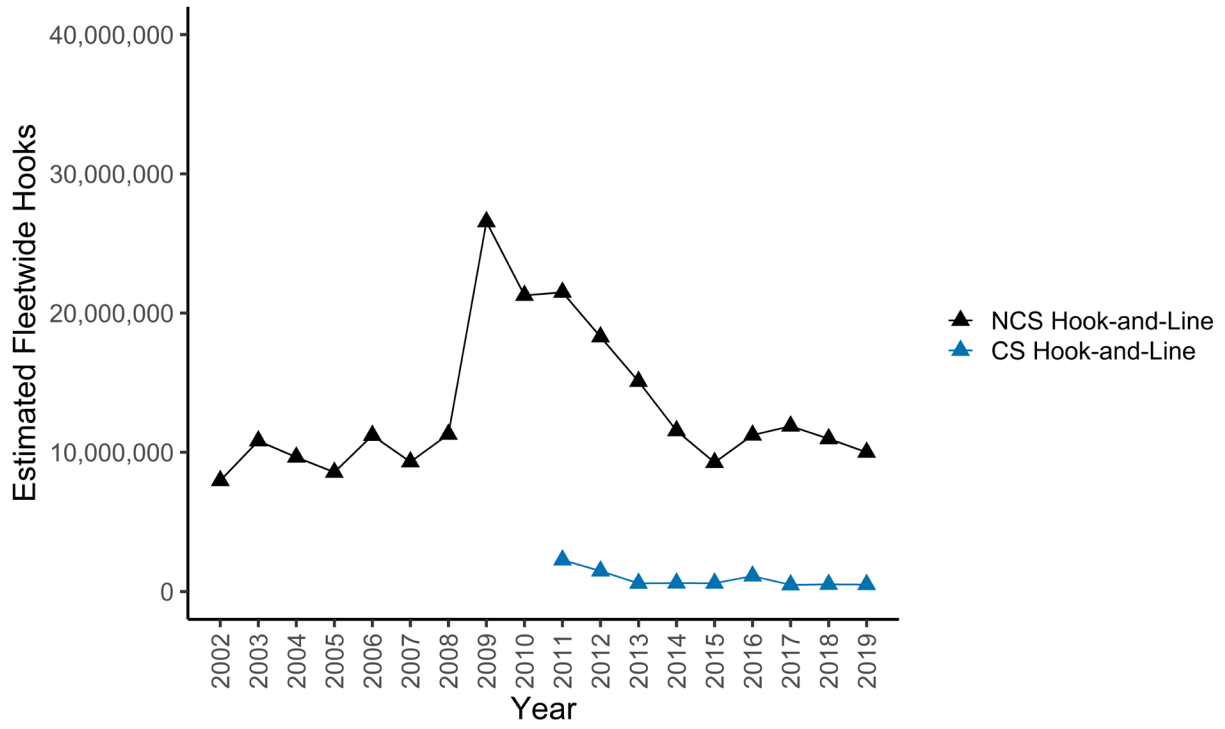

Figure 32. Annual total fleetwide number of hooks deployed in hook-and-line sectors.

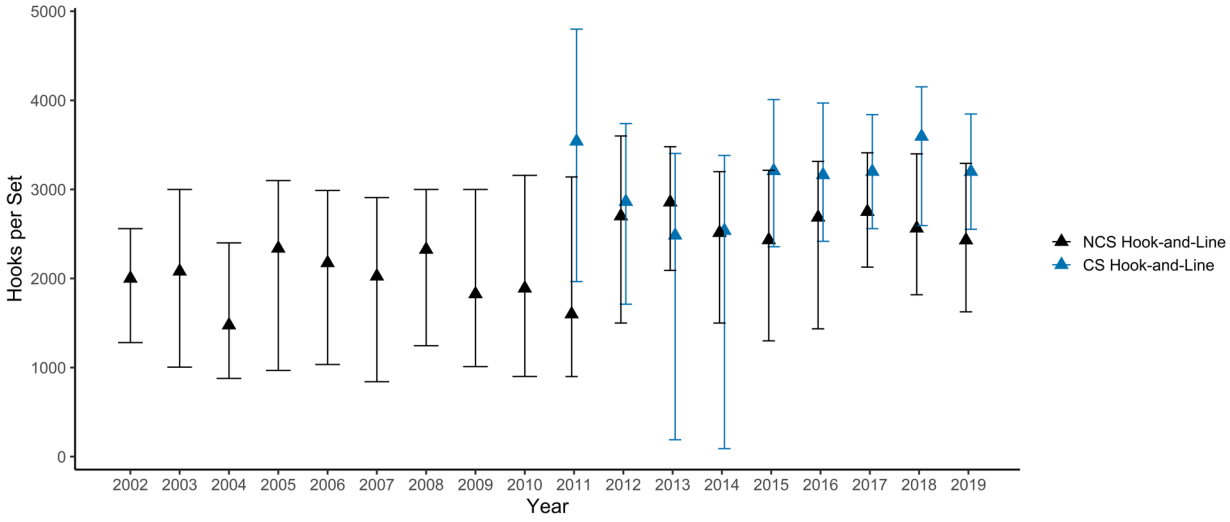

Figure 33. Number of hooks per set in hook-and-line sectors, summarized as median, first, and third quartiles in each year.

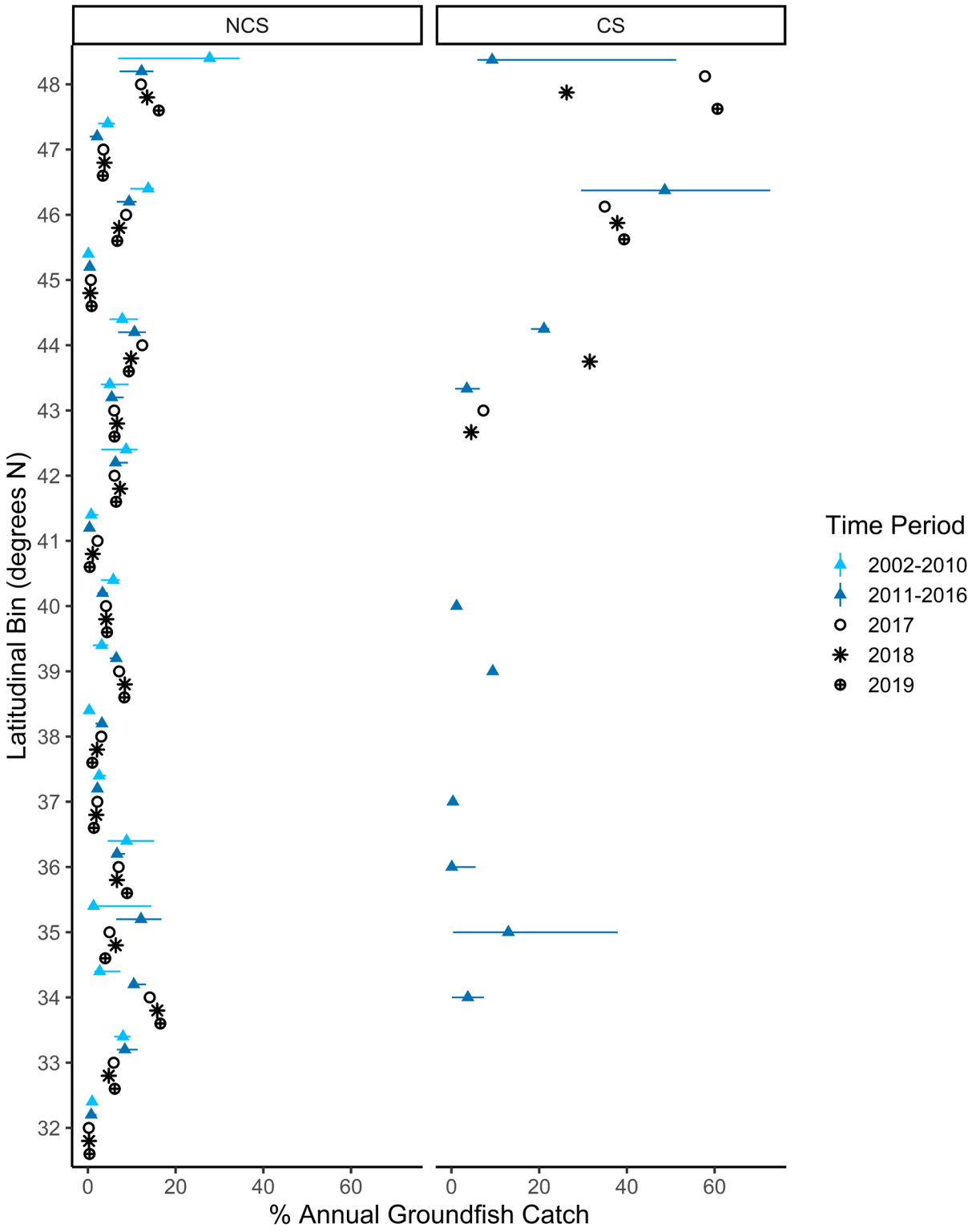

Figure 34. Percentage of retained groundfish landed by hook-and-line sectors, in latitudinal bins; patterns in actual fishing activity are shown in Figure 35 and Figure 36. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

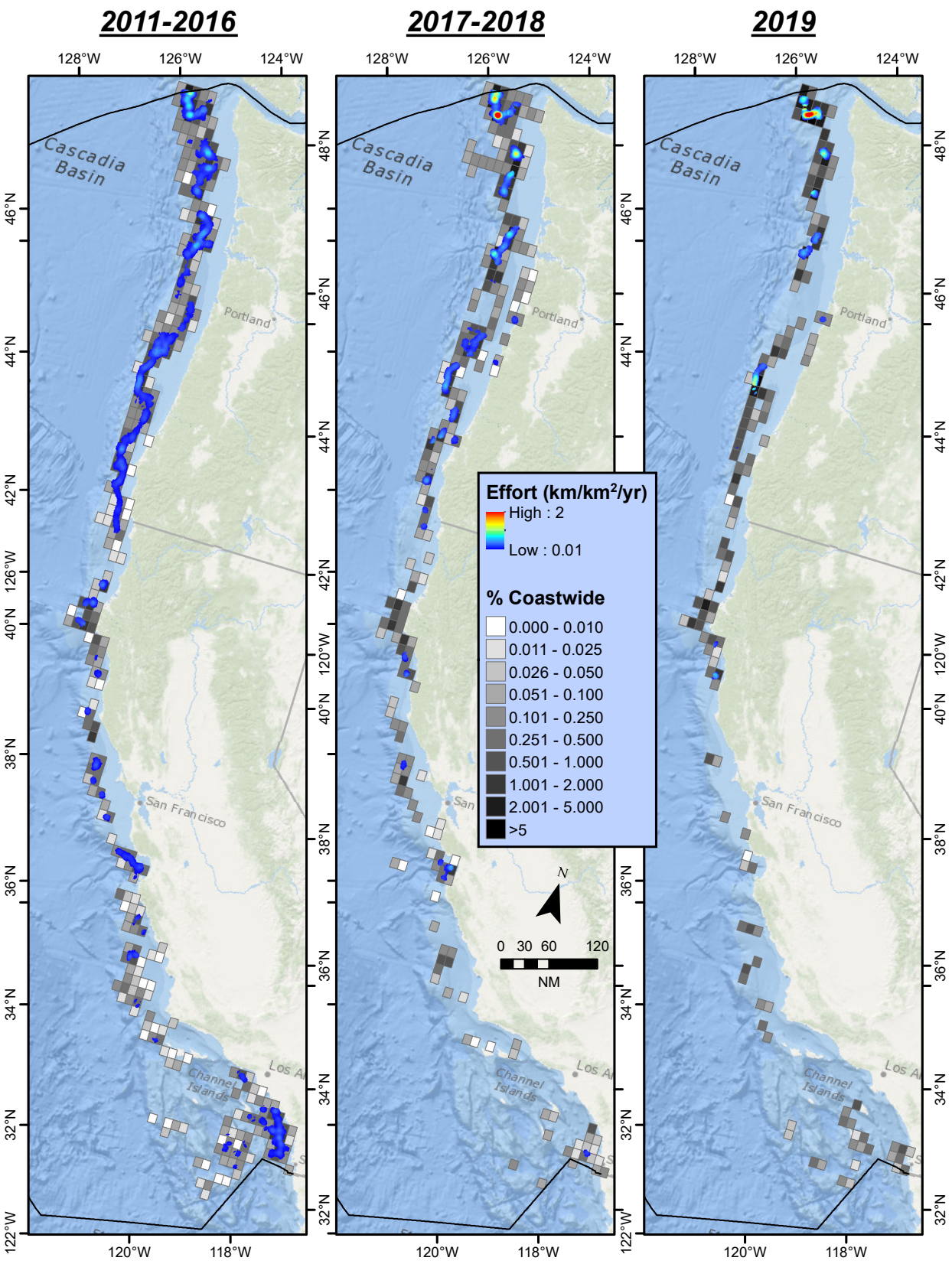

Figure 35. Spatial distribution and intensity (in km/km^2/yr) of non-catch share hook-and-line sector fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

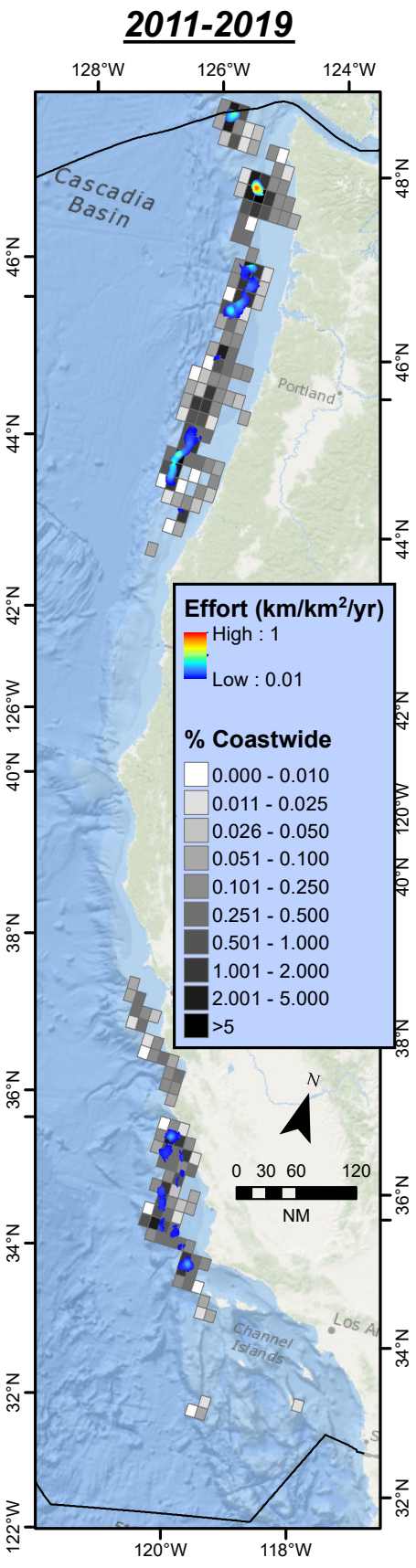

Figure 36. Spatial distribution and intensity (in km/km^2/yr) of catch share hook-and-line sector fishing effort. Intensity is depicted by a color ramp of blue (low) to red (high) colors. The overall footprint of fishing for each time period is depicted in grayscale, with darker tones depicting a higher relative contribution to coastwide effort within 10 × 10-minute cells.

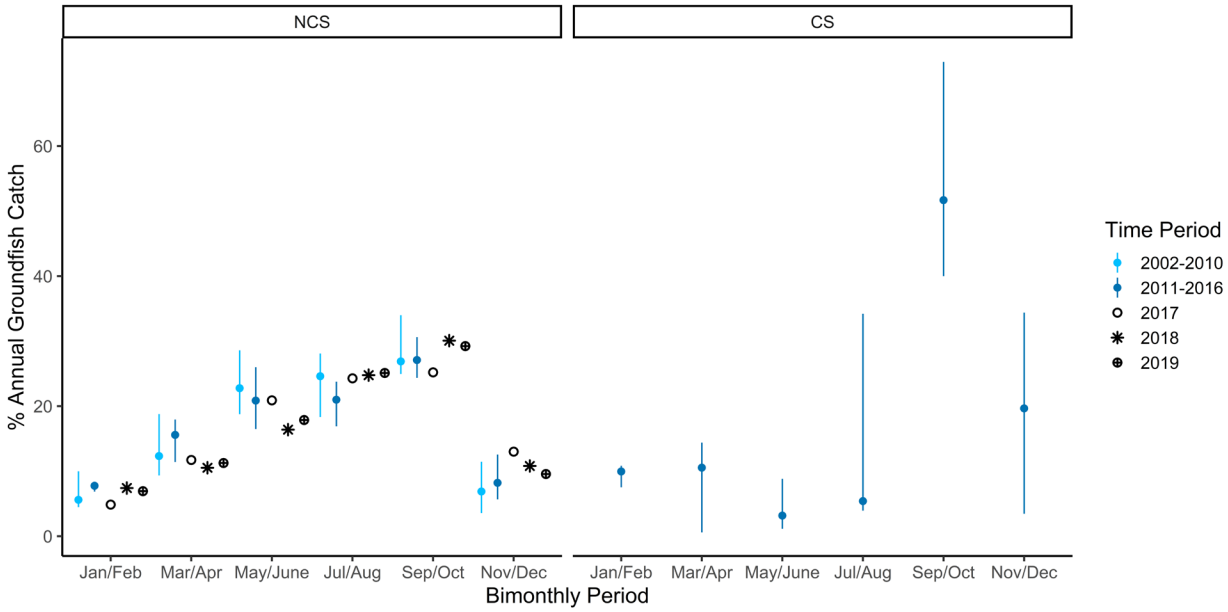

Figure 37. Percentage of retained groundfish landed by hook-and-line sectors, in bimonthly bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data. Catch share data for 2017, 2018, and 2019 are not shown to maintain confidentiality, as less than 3 vessels were active in some of the seasonal strata.

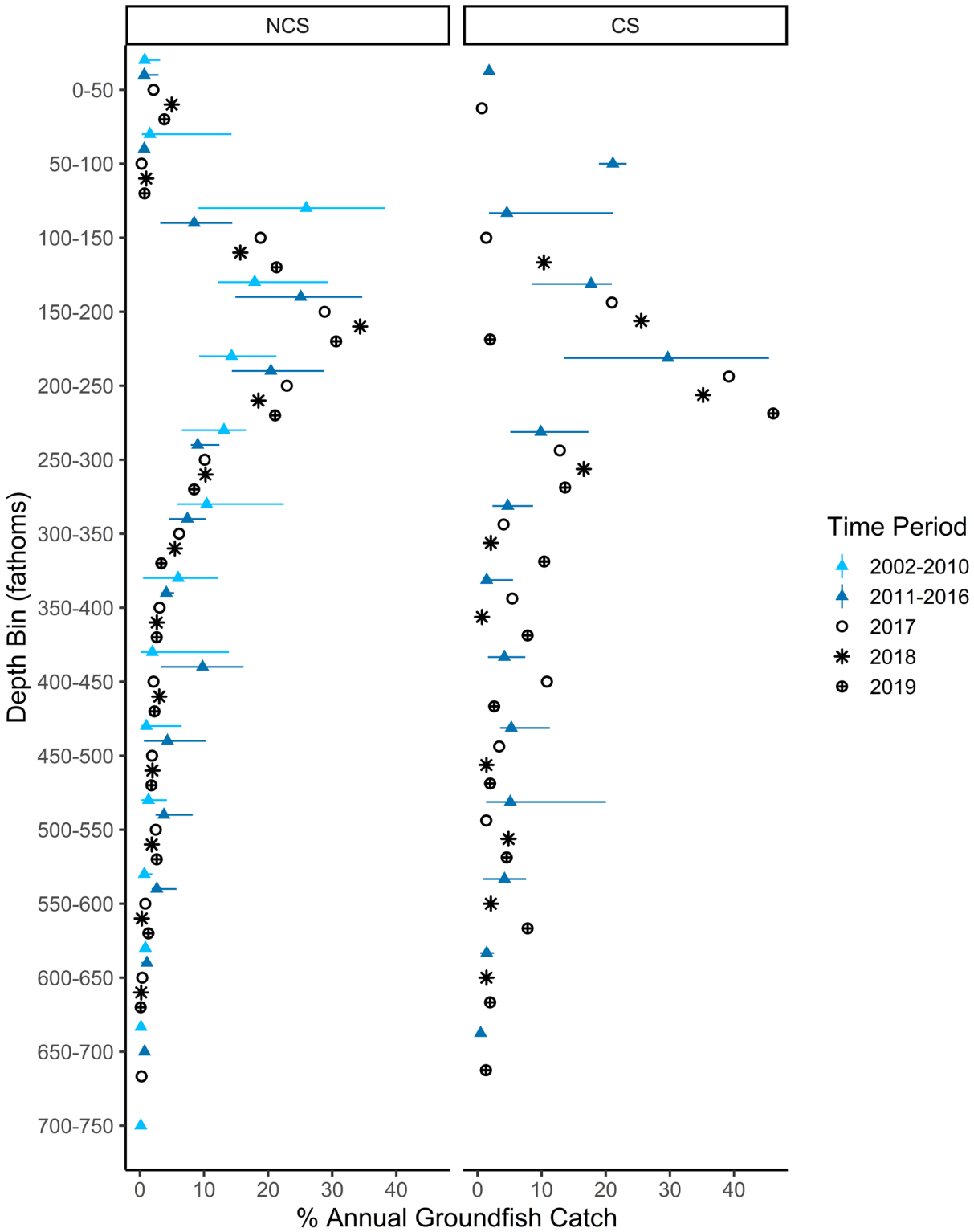

Figure 38. Percentage of observed hook-and-line hauls in 50-fth depth bins. Minimum, median, and maximum are shown for each time period; annual estimates are shown for the 3 most recent years of data.

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